TAMILNADU BUILDING PRACTICE

FOR USE IN THE PUBLIC WORKS DEPARTMENT OF THE TAMIL NADU STATE

VOLUME II

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FOREWORD

The Madras Detailed Standard Specifications was written during 1930-32, for use in the Public Works Department of the then Madras Presidency for execution of Government works. It contained (1) Preliminary specifications governing the general conditions of piece work and lump-sum contracts, (2) Standard specification on materials and items of work commonly used and undertaken in Government works serially numbered to facilitate reference in contract schedules and Appendices giving tender forms, articles of agreements etc., and technical data and tables for adoption in design.

2. The growth of construction techniques and development of economic designs during the long span of fifty-five years and the advent of modern synthetic materials and fittings have made it necessary to update the Madras Detailed Standard Specifications. In addition, numerous new specifications have been followed during this period of half a century embracing a large coverage of construction as well as design fields. All these innovations have to be incorporated, while updating the Madras Detailed Standard Specifications.

3. After the Independence of the country, the Indian Standard Institution has played a major role in the field of "Standardisation". In the buildings construction field, the Indian Standard Institution has published standards covering almost each and every aspect of building materials and construction practice. Apart from the above, the National Building Organisation of the Government of India, has published the National Building Code, covering the construction practices and procedure in general terms from national point of view. The updating of the Madras Detailed Standard Specification has necessarily to take into consideration and accord with the work done bythe above two institutions.

4. The Government of Tamil Nadu in their G.O. Ms. No. 1645, Public Works, dated 25th September 1972 sanctioned the creation of a separate review cell for revising the Madras Detailed Standard Specification. The title of Madras Detailed Standard specification was renamed as "The Tamil Nadu Building Practice" and the special cell headed by an Executive Engineer has prepared the draft specifications and drawings. A guiding committee consisting of Superintending Engineers and Executive Engineers specially constituted for this purpose has held a number of meetings under the Chairmanship of Chief Engineer (Buildings) and has helped the cell to bring out the finalised draft "Tamil Nadu Building Practice" for obtaining the comments of the Superintending Engineers, before taking further action for printing the book.

5. One important distinction has to be made while comparing the "Tamil Nadu Building Practice" with the National Building Code. The National Building Code is meant to be advisory while the "Tamil Nadu Building Practice" will be mandatory. The former is for regulating and controlling functions from the National Stand point whereas the latter is for specifications for legally binding the construction agencies doing Government work on different types of contracts. The "Tamil Nadu Building Practice" has of necessity to be more precise and specification orient. However, the need for updating the traditional safety factor and the outdated design criteria in the light of newer materials and newer design and construction techniques available has been kept in view, to make the "Tamil Nadu Building Practice" more comprehensive and more performance oriented.

6. It has also to be realised that the "Tamil Nadu Building Practice" is for Government use for its construction activities and its scope is limited to this purpose. It cannot in any sense be claimed to be a general manual on the wider fields of Building Science taught in academic institutions. Nor it can be a manual on specialised architecture practised in the commercial world.

7. The "Tamil Nadu Building Practice" contains 20 sections. The revision and updating of eighteen sections on various items of Civil Engineering Works as itemised in the Old Madras Detailed Standard Specification were completed in the first instance. The last two sections deal with specifications for electrical installations, etc., and are additional to the 18 sections of the old Madras Detailed Standard Specification.

8. The "Tamil Nadu Building Practice" contains numerous excerpts of Indian Standard Institution under the relevant passages. This will help the Engineers to make decisions on choice of materials and specifications.

9. The "Tamil Nadu Building Practice" should be followed in all contracts for works for State Government purposes. However, specific stipulations have to be made, where the National Building Code and Indian Standard Institution specifications are to be followed as a supplementary to "Tamil Nadu Building Practice".

10. The I.S.I. (Bureau of Indian Standards) has extended Financial help for this endeavour. This is gratefully acknowledged. The officers of the Public Works Department who have participated in this stupendous task deserve congratulations.

Madras-600 005.
Date : 3rd June 1988.

A. V. SATHYAKAMAN,
Chief Engineer, Public Works Department (Buildings).

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SPECIFICATION No. 72.

WOOD WORK WROUGHT AND PUT UP.

1.1. *Class, variety and strength.*—The variety of timber to be used in the wood work will usually be specified in the relevant schedule item. In the absence of such specification, best Indian teakwood shall be utilised for the schedule item. The working stresses to be adopted will be as per I.S. 883/1970 paragraph 5. The source from which the timber is procured is to be approved by the Executive Engineer before supply.

2. *Characteristics of timber to be supplied.*—The timber shall be of the best quality from the heart of a sound tree, the sap being entirely removed (sapwood will be rejected)—the wood uniform in substance, straight in fibre, free from large and dead knots, flaws, sun cracks, shakes, or blemishes of any kind. The colour should be uniform throughout (among coloured timbers, darkness of colour is, in general a sign of strength and durability).

3. *Structural timber—Beams, joists, struts, etc.*

3.1. *Limit of use of timber with "sound knots"—Angle of grain, etc.*

3.2. A sound knot is one which is solid across its face and which is as hard as the wood surrounding it. Structural timbers shall be free from rotten or unsound knots, or knots in clusters. Knots limited in size and location, as stated below, may be permitted if so fixed by growth or position that they will retain their place in the piece, as at the time of manufacture. The size of a knot in a stout shall be taken as its mean diameter ; the size of a knot on the narrow or horizontal face of a beam shall be its projection on a line perpendicular to the edge of the timber; on the wide or vertical face of a beam, it shall be its smallest diameter. For the limitation of knots, etc., I.S. 3629/1966 shall apply.

3.3. *Angle of grain.*

3.3.1. In hard woods or timbers of the deciduous varieties, rapid growth is not commonly an indication of weakness, but extremely slow growth is likely to produce, inferior material. These varieties shall be considered "dense" unless they show more than 8 annual rings per cm^2 or are obviously lighter in weight than the average for that species optimum moisture contents being equal. Structural timber shall be of "dense wood".

4. *Knots in other Carpentry or Joinery Wood Work.*

4.1. For doors, windows and other carpentry or joinery work, the Executive Engineer will reject all timber wrought or unwrought in which he considers "sound knots" are in excess to impair its strength. Timber with loose, rotten or dead knots shall ordinarily be rejected. Paragraph 6.8.1. of Standard specification 74 shall apply.

5. *Permissible moisture content of the timber at various zones.*

5.1. The moisture content in timber plays a significant role as far as the strength of nail joints is concerned. Presence of excessive moisture content decreases the strength and also the timber components are liable to be attacked by fungus, etc. It has been observed by laboratory tests that the nail joints fabricated out of dry timber are considerably stronger than those in green timber.

The permissible moisture content varies for different zones of India as follows :—

(*a*) Zone I (Dry zone) .... 12 per cent (average annual relative humidity less than 40 per cent).

(*b*) Zone II (Moderately dry zone). 14 per cent (average annual relative humidity between 40—50 per cent).

(*c*) Zone III (Moist zone) .. 17 per cent (average annual relative humidity between 50–67 per cent).

(*d*) Zone IV (Moist zone) 20 per cent (average annual relative humidity more than 67 per cent).

6. *Precautions against decay.*

6.1. The contractor must in all cases obtain orders of the Executive Engineer, regarding the time at which he shall do painting or oiling to wood-work and obtain permission of the Executive Engineer after the latter's inspection, before he paints, tars, oils, or otherwise treats wood-work.

NOTE.—Protection against moisture is afforded by oil paint, provided that the timber is perfectly dry when first painted; otherwise the filling up of the outer pores only confines the moisture and causes rot. For Indian timbers not less than one year should be allowed after erection, before painting, whenever it is practicable to do so. If possible, painting should be done at the end of the hot season and just before commencement of the rains. For teakwood roof timbers, wood oiling will usually suffice, except for parts exposed to sun and rain, in which case, painting is necessary.

6.2. All parts of wood work resting on or set in masonry shall be well painted with two coats of hot boiled tar of standard specification. The tar shall be so applied as not to appear on the exposed timber. This tarring is to be included by the contractor in his wood work rate for the relevant schedule item and no separate payment will be made for such tarring. Timber buried in the ground shall be tarred.

NOTE.—Damp masonry accelerates decay of wood. It is therefore important that the masonry in walls should be perfectly dry when the wood work is placed in them. To ensure a good and close joint between the frame and the masonry, the Executive Engineer will however, usually instruct the contractor to build in door and window frames as the work proceeds.

6.3. Recesses of 40 mm. are to be left for the circulation of air around the ends of all beams and the recesses protected, with perforated zinc-sheeting *vide* standard specifications for "Stone Masonry General" Clause 7 and "Brick Masonry—General" Clause 19.

7. *Miscellaneous.*

7.1. The Executive Engineer may inspect all logs and scantlings prior to use and reject any, which he considers defective in the requirements of this specification. The Executive Engineer shall have the power of rejecting at any stage, any work which may be found defective in quality or workmanship and he shall not be debarred from rejecting wrought timber by reason of his having previously passed the same in the log or other unworked stage. Rejected timber shall be removed from the site of the work within 24 hours of rejection, at the contractor's expense.

7.2. No wood work shall be placed in position, covered in the ground or walls until it has been approved by the Executive Engineer; otherwise it is to be removed or only uncovered portion paid for at the discretion of the Executive Engineer. The contractor should accordingly give notice to the the Executive Engineer for inspection. The preliminary passing of wood by a Sub-Divisional Officer should be done in a systematic manner by initialling with blue chalk or light stamp—so that the marks can be easily found and verified by the Executive Engineer or other inspecting officer.

7.3. *Workmanship* :

7.3.1. All workmanship shall be of the best description and all joints shall fit accurately without wedging or filling. The contractor is to observe the following principles in forming joints :—

(i) To cut the joints and arrange the fastenings so as to weaken the pieces of timber they connect, as little as possible.

(ii) To place each abutting surface in a joint, as nearly as possible perpendicular to the pressure it has to transmit.

(iii) To form and fit accurately every pair of surfaces that come in contact.

(iv) Framing and trussing are to be done in the best possible manner and all necessary wrought iron ties, straps, bolts, screws etc., fitted as shown on the drawings. If after the woodwork has been erected, undue shrinkage or bad workmanship is discovered, the contractor shall forthwith replace or refix the same to the satisfaction of the Executive Engineer. The Executive Engineer may order any truss or other framed work to be put together on the ground and submitted to suitable tests before being placed in position. All exposed faces of timber and all joint faces must be planed smooth before placing in position unless the work is of such an obviously rough construction as to render planing unnecessary in which case the contractor should obtain exemption from same from the Executive Engineer and mention, when submitting his tender, the basis of his rate. Glue shall not be used in joints of frames which are exposed to the weather, unless ordered, as it will absorb moisture in damp weather and so set up decay. The unauthorised usuage of glue for the joints will lead to the rejection of the portion of the work so treated. Adhesive to be used for joints shall conform to I. S. 851—1957.

7.4. Planking is to be supplied with straight and square edges or rebated, or tongued and grooved or with other type of edge for jointing as may be specified.

7.5. Bearing of joists on walls shall not be less in length than their depth, with a minimum of 100 mm.

8. *Payment and items included in the rate.*

8.1. The contract rate for "wrought and put up" timber includes carriage to and delivery at the site of works, the fair rendering of all surfaces, sawing, planning, moulding, jointing, framing and chamfering of angles in exact accordance wih drawings or other directions given by the Executive Engineer, supply and fixing of all nails, screws brads, etc., putting together of all truss and other framed work and supply and fitting of all iron straps, bolts, nails, trenails, spikes, screws, etc., necessary for framing and fixing of trusses, in accordance with drawings or instructions of the Executive Engineer. The contract rate also includes provision of labour and all apparatus for fitting up the wood work in the buildings, such as special scaffolding tackle, and other fitting apparatus—*vide* General conditions of contract.

8.1.1. The rate for the "wood work wrought and put up" shall include the cost of the wood and all other materials and fittings required in the fabrication of the wood work not expressly excluded by addendum specifications, carpenter, fitter and other labour to the best standard of workmanship and materials, in accordance with this specification, exclusive of painting, but including tarring —*vide* Cluase 6-2 above.

8.1.2. If any drawings are not in sufficient detail, in the opinion of the contractor, to enable him to arrive at his tender rate. it shall be his responsibility to obtain such further details. or submit to the Executive Engineer for prior approval; proposals for such details as he requires, before tendering his rate.

8.1.3. All wood work, when put up on the work, shall be of the dimensions specified, subject, however, to the allowance for planing as defined in the General conditions of contract under the clause "finished sizes" or remarks regarding "net" sizes on the drawings or in the standard or addendum specifications. Planning tolerance shall be 1.5 mm. for each planned face for frames and 1.5mm. for each planed face of shutter. The length of each piece (for cubic metre measurement) will be measured overall, so as to include projections for tenons or scaffs. For curved pieces cut out of the solid, the minimum overall dimensions of the required original rectangular section of scantling will be allowed in measurement.

8.2. When the schedule calls for supply of unwrought timber, the rate shall, as in all other cases, include carriage to and delivery at the place where it is required for use.

8.3. *Supply of timber to the contractor from Government Stores or from a dismantled building* will be made in accordance with the specifications or orders of the Executive Engineer, either in the log or wholly or partially wrought. In such cases, the value of the timber so supplied at the rate payable to the contractor for similar material, will be deducted from the price of the finished work. Where the contract schedule contains no rate for similar material, the value to be deducted will be dealt with as provided in the General conditions of contract. A separate rate will be required, when material thus supplied has to be reframed or refitted. In the case of supply under this clause, the contractor will be charged for the full dimensions of the wood, no allowance being made for wastage in working or altering it and all of such material not used and charged for as finished work will be the contractor's property. Cases under this sub-clause will be defined in sufficient detail in the tender notice.

NOTE.—National Building Code Part VI—Section 3—Wood shall also apply.

SPECIFICATION No. 73.

GLAZIER'S WORK.

1. Para 9 of I. S. 1003 Part I of 1966 shall apply for glazing of metal (steel and aluminium) doors and windows and ventilators —I.S. 1081/1960 shall apply.

2. *Putty*.—Specification for putty for use on window frames, door frames and ventilators—I.S. 419/1967 and I.S. 2468/1963 shall apply

3. "Dry" glazing shall be done for plate glass unless otherwise specified. The glass shall be held in place by moulded wooden fillets fixed with brass screws ; round the end of the glass and between it and the wood fillets, a piece of chamois leather, wash leather shall be inserted to act as a cushion. No separate payment will be made for this method of fixture.

4. No glazing shall be considered complete, until all stains have been removed from the surface of the glass.

5. No glass shall be inserted in wood frames until they have been primed and prepared for painting so that the wood may not draw oil out of the putty.

6. If frosted glasses are used, they are to be fixed with the frasted face away from the putty.

7. All glass panes that may have been set by the contractor, shall if they become loose be refixed properly by the contractor without extra charge.

8. The contractor shall make good any glass broken by his work people whilst cleaning.

9. Specification for transparent sheet glass for glazing and framing—I. S. 1761/1960 shall apply.

10. All the windows shall be cleaned, all damaged putty or glazing shall be repaired, and the whole left perfect at the completion of the work.

11. In measuring the glazier's work, all fractional parts 12 mm. in linear measuremts will be omitted, and all above that taken as 25 mm. Curved or irregularly shaped pieces will be measured as the least rectangle from which they can be cut. Measurement shall be taken net from rebate to rebate.

NOTE.—To soften putty for removal from old glazing work slake 1.5 kg., quick lime in water, and 0.5 kg. pearl ash and work upto the consistency of paint. Apply this mixture to the putty faces to be removed and let it remain twelve hours, after which the putty will be sufficiently softened for removal.

SPECIFICATION No. 74.

DOORS AND WINDOWS—GENERAL.

NOTE.—The remarks in this specification applicable to windows, apply also to ventilators.

1. *Conformance*.—The class of wood of which the doors and windows (frames and shutters) are to be constructed will be defined in the schedule for the relevant item. In the absence of such definition, best Indian teakwood shall be used throughout. Doors and windows shall be prepared in conformance with the relevant type-design defined in the Tamil Nadu Building Practice, or other designs which will be referred to in the schedule. For details I.S. 4021/67 and I.S. 1003 (Part I)/1966 shall apply.

1.1. The doors and windows shall be erected in place as shown in the general or other drawings of the buildings concerned. Panels of fully or partly panelled doors shall always be of the same class of wood as the shutter frames, unless plywood or other wood is expressly specified.

2. *Sizes of scantlings* :

2.1. The sizes of scantlings for, the doors and windows as given in the Tamil Nadu Building Practice or other drawings supplied, shall be subject to the allowance for planing as defined in section 1 materials unless the size of any member is marked "nett" on any drawing supplied and subject further to the condition that no planing allowance will be allowed for panel thickness in doors and windows. Styles, top freeze, lock and bottom of shutters and posts head and sill of threshold plates of frames shall be continuous throughout their length, the munting being divided into as many parts as required by the position of the rails vertical sash bars of windows shall be continuous throughout their length and horizantal sash bars mitred and tenoned thereto

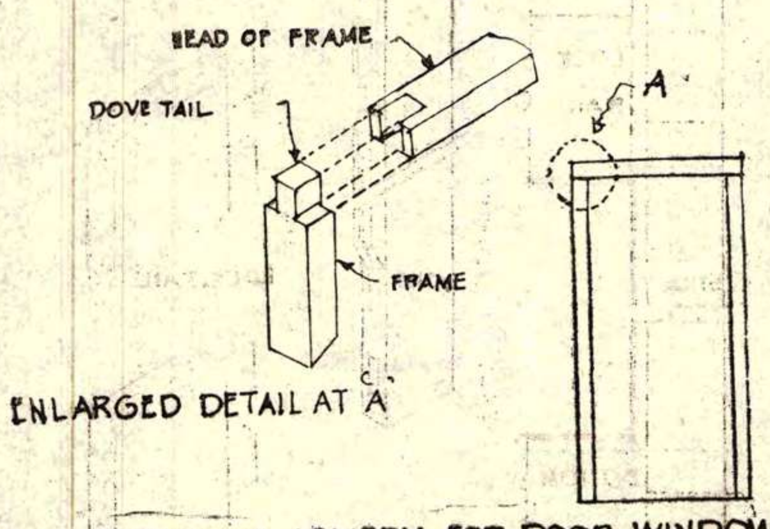
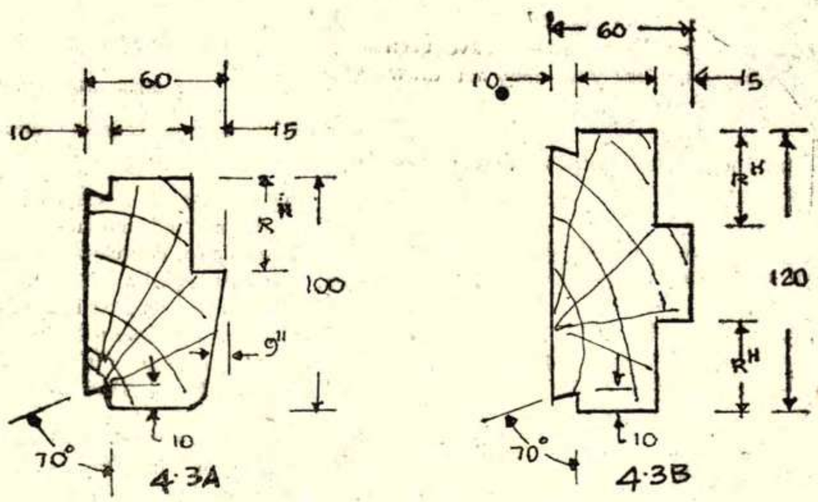


FIG. 4.2. TYPICAL JOINERY FOR DOOR WINDOW AND VENTILATOR FRAME



R = 30, 35 OR 40
ALL DIMENSIONS IN MILLIMETRES

FIG. 4·3 TYPICAL SECTIONS OF DOOR, WINDOW AND VENTILATOR FRAME

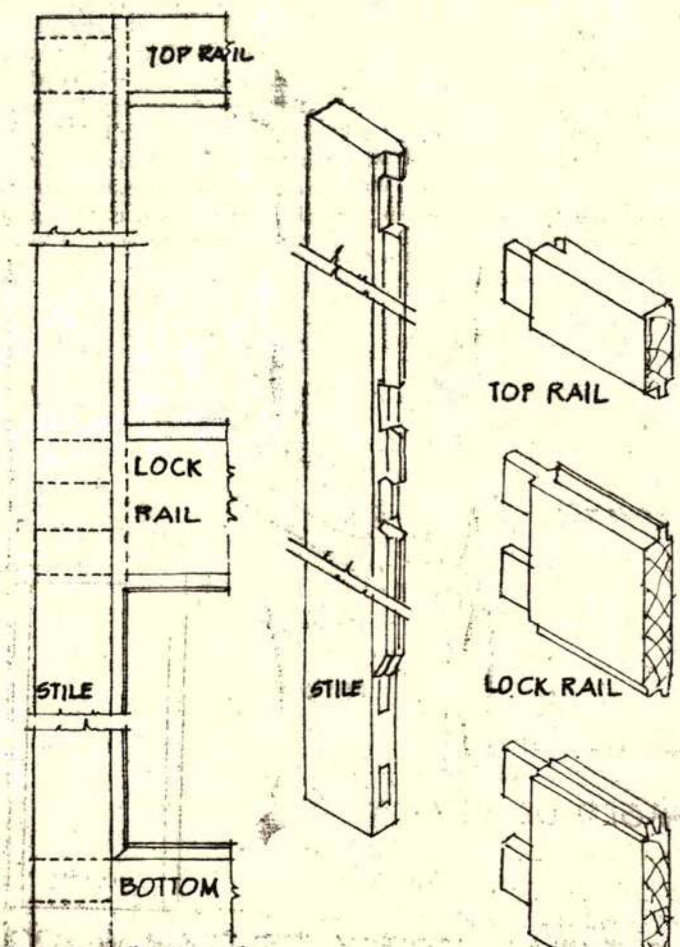


FIG. 4·4. DETAILS OF TYPICAL JOINERY BETWEEN RAILS AND STILES

2.2. Panels shall always be made in one piece, unless otherwise specitied.

3. *Time for framing* :

3.1. *Cracks, warps, etc*.—All doors and windows are to be cut out and framed together, soon after the commencement of the building but final jointing is not to be done until the building is ready for their fixture. Any portions that warp, get in winding, or develop shakes, cracks or other defects, or require adjustment by easing or otherwise to fit properly within six months after the date of completion of the building, shall be remade or rectified as the case may require to the satisfaction of the Executive Engineer, at the Contractor's expense.

3.2. In cases where door and window frames are built in during progress of construction of the building vide standard specification "Woodwork wrought and put up (S.S. No. 72)" they shall be protected against all damage by tarred sacking cover or by other means.

4. *Dimensions of openings, frames and shutters* :

.1. *Openings* :

4.1.1. The width (Mw) and height (Mh) of door opening is indicated by number of modules where each module is of 100 mm. Height of opening is considered from below the floor finish to the ceiling of lintel.

4.2. *Frame* :

4.2.1. The size of door frame is derived after allowing a margin of 5 mm. alround for convenience of fixing. Finished dimensions of the timber sections in frames for doors, windows and Ventilators shall be as given below subject to a general tolerance of ±3 mm.

Dimensions.	*Requirements.*	
	Door.	*Window & Ventilator.*
(1)	(2)	(3)
(*a*) Width for frames carrying one set of shutters.	100 mm.	75 mm.
(*b*) width for frames carrying two sets of shutters.	130 mm.	—
(*c*) Thickness	65 mm.	60 mm.

4.2.2. The typical sections of door, window and ventilator frame is illustrated in Fig. 4.3.

NOTE.—See also latest circular of Chief Enginer (B) vide Annexure enclosed.

OFFICE OF THE CHIEF ENGINEER, P.W.D. (BUILDINGS), MADRAS-5.

Circular Memo. No. AEE. T. 10/B 87221/81-272. dated 27th January 1986.

Subject: B ildings—Doors, windows, ventilators—sizes of scantlings and planks for frames, paneles, etc.—adopting of —Regarding.

It is seen during inspection of building works that scantlings adopted for doors and windows in certain cases were not to standards, with the result that these had to be rejected and replaced. It not only results in alround incanvenience also delay in completing the buildings in time for handing ever to occupying departments. The Superintending Engineers of Special Buildings Circles and Territorial circles and Exeeutive Engineers are requested to ensure by timely inspection and check that correct sizes of wood scantlings are adopted for frames, styles and rails of doors and windows. It is also specifically brought to the notice of all Superintending Engineers that following changes now made in the sizes of scantlings to be adopted in certain category of styles and rails and planks.

1. The thickness of planks to be used for single leaf door of size 1.05m. × 2.1m. (3'—6" × 7'—0") without introduction of Muntings in between shall be 15mm.

2. The section of frames to be adopted for windows of widths more than 1.2m. shall be 100mm, × 60mm.

3. The section of styles and rails for shutters of windows and ventilators both for single as well as two leaved shutters shall be 75mm. × 35mm.

4. The carrect sizes to be adopted as per standards furnished in the annexure to this circular which should be followed maticulously without lapse. The receipt of the circular should be acknowledged.

N. BALASUBRAMANIAN,
Chief Engineer (Buildings).

Enclose: annexure.

To

The Superintending, Engineers of all Buildings circles.

Copy to the Superintending Engineer/Planing and Designs Circle, Madras-5.

ANNEXURE.

Doors of 12.1m. Height.	*Size of scamtiings as per TNEB for adoption in P.W.D,*
Frames:	
For single shutter of one set of two shutters.	100mm. × 65mm.
For two sets of two shutters each, one inner and the other outer.	130mm. × 65mm.
Shutter:	
Styles	75mm. × 40mm.
Rails;	
Top and intermediate rails	75mm. × 40mm.
Lock rails	125mm. × 40mm.
Bottom rails	150mm. × 40mm.
Panels;	
Planks for panels:	
(For single leaf door of size 1.05mm. × 2.1m. without introducing muntings in between).	15mm. thick
For other small panels	12mm. thick
Windows and Ventilators:	
Frames (for windows of with more than 1.2m.)	100mm. × 60mm.
For Windows of widths upto 1.2m.	75mm. × 60mm.
Styles and rails for windows for single. Shutter.	75mm. × 35mm.
For two leaved shutters.	75mm. × 35mm.
Styles and rails for ventilators	75mm. × 35mm.
Panels: Planks for panels	12mm. thick
For single leaf without muntings in the middle.	15mm. thick

NOTE:— (1) All dimensions are finished dimensions.

(2) The sizes and types of doors, windows and ventilators adopted in each case will be furnished by the Chief Architect in the main drawings of the respcetive drawings.

(3) In case of flush doors, external lipping and internal solid care should be provided, the details of which will be furnished by the Chief Architect in the respective drawings.

Sd....

For C.E, (Buildings).

4.3. *Shutters* :

4.3.1. The standard width and height for door shutters are calculated by giving an allowance of (50+5) mm. for width on both sides and for height an allowance of (50+5) mm. is given at the top of the shutter and (40+5) mm. is given at the bottom of the shutter in which 40 mm. is the allowance for floor finish.

4.3.2. The size and type of door shutters shall be as given in Table 1 and C.A. drawing 1073 Nos. 48 to 53 shall also apply.

TABLE 1—DIMENSIONS OF OPENING DOOR FRAME AND DOOR SHUTIER.

(*Clause* 4.3.2.)

Serial number.	*Designation.*	*Size of opening in mm.*	*Size of door frame in mm.*	*Size of door shutter in mm.*
(1)	(2)	(3)	(4)	(5)
1	8 DS 20 ..	800×2000	790×1990	690×1900
2	8 DS 21 ..	800×2100	790×2090	690×2000
3	9 DS 20 ..	900×2000	890×1990	790×1900
4	9 DS 21 ..	900×2100	890×2090	790×2000
5	10 DS 20 ..	1000×2000	990×1990	890×1900
6	10 DS 21 ..	1000×2100	990×2090	890×2000
7	12 DT 20 ..	1200×2000	1190×1990	*1090×1900
8	12 DT 21 ..	1200×2100	1190×2090	*1090×2000

* 555 mm. each shutter and 20 mm. overlap when closed.

NOTE.—(1) In the designation first number for example 8, 9, etc., denote the width of door opening in modules where each module is of 100 mm.

(2) "D" denotes door and 'S' and 'T' denote single and double shutters respectively.

(3) The last number for example 20, 21, etc., denotes height of opening in modules of 100 mm.

4.3.3. The size and type of window and ventilator shutters shall be given in Table 2 and 3 respectively. C A. Drawing 107 Nos. 59 to 60 and 41 to 47 shall also apply.

TABLE 2—DIMENSIONS OF WINDOW SHUTTERS.

(*Clause* 4.3.3.)

Serial number.	*Designation.*	*Size of opening in mm.*	*Sise of window frame in mm.*	*Size of window shutters in mm.*
(1)	(2)	(3)	(4)	(5)
1	6 WS 12 ..	600×1200	5 ×11	×1
2	10 WT 12 ..	1000×1200	990×1190	460×1100
3	12 WT 12 .	1200×1200	1190×1190	560×1100
4	6 WS 13 ..	600×1300	590×1290	500×1200
5	10 WT 13 ..	1000×1300	990×1290	460×1200
6	12 WT 13 ..	1200×1300	1190×1290	560×1200

NOTE.—In the designation first number den[illegible]s the width of opening in modules of 100 mm. 'W' denote window 'S' and 'T' denote single and double shutters, the la[illegible] [illegible]ote the height of opening in modules of 100

TABLE 3 DIMENSIONS OF VENTILATORS SHUTTERS.

(*Clause* 4.3.3.)

Serial number.	*Designation.*	*Size of opening in mm.*	*Size of ventilator frame in mm.*	*Size of ventilator shutter in mm.*
(1)	(2)	(3)	(4)	(5)
1.	6 V 6	600×600	590×590	500×500
2.	10 V 6	1000×600	990×590	900×500
3.	12 V 6	1200×600	1190×590	1100×500

NOTE.—V Denote ventilator.

4.3.3.1 The thickeness of shutters shall be 20, 25 or 30 mm. depending on size.

5. *Dimension of components of door, window and ventilator.*

5.1 *Panelled and Glazed Shutter.*

5.1.1. The finished dimensions and tolerances of the different components of door shutters shall be as given in Table 4 below:—

TABLE 4—DIMENSIONS AND TOLERANCE OF COMPONENTS OF DOOR SHUTTERS.

Description.		*Width mm.*	*Thickness mm*
Vertical style, top and freeze rail	..	75±3	40±1
Lock rail	..	125±3	40±1
Bottom rail	..	150±3	40±1
Munting	..	100±3	40±1
Panel (Sec 8.1.3.5. to 8.1.3.9)	..	..	..
Glazing bar	..	40±1	40±1

5.2. *Flush Door Shutter.*

5.2.1 Nominal thickness shall be 25, 30 or 35 mm. It is recommened that, as far as possible, the thickness adopted for flush doors should be as given below:

Flush Door Designation.		*Thickness of shutters. in mm.*
8 DS 21	..	25
9 DS 21	..	30 or 35
10 DT 21	..	35
12 DT 21	..	35

5.2.2. The thickness of the door shutter shall be uniform throughout with a permissible variation of not more than 0·8 mm. when measured at any two points. CA drawing 1073 No. 48 & 51 shall also apply.

5.3. *Window and ventilator shutters.*—

5.3.1. The finished dimensions of the different components of windows and ventilators shutters shall be as given in Table 5.

TABLE 5—DIMENSIONS AND TOLERANCES OF COMPONENTS OF WINDOW AND VENTILATOR SHUTTERS.

(*Clause* 5.3.1.)

Description.		*Width of window shutter mm.*	*Width of Ventilator shutter mm.*
Vertical styles, top rails and freeze rail	..	75±3	60±3
Bottom rail	..	75±3	60±3
Munting	..	80±3	..
Panels (See 8.1.3. to 8.1.3.9)	..	..	..
Glazing bar	..	40+1	40±1

NOTE.—The thickness of various components will be the same as the thickness of the shutter (See 4.3.3.1.)

6. *Construction and workmanship for frames*—

6.1 All members of doors, window and ventilator shall be exactly at right angles. The right angle shall be checked from the inside surface of the respective members

6.2 All members of frames shall be straight without anywarp or bow and shall be smooth, well planed on the three sides exposed at right angles to each other. The surface touching the walls may be planed unless it is required in order to straight up the member or to obtain the over all sizes within the tolerance specified.

6.3 rames of timber doors, windows and ventilators shall have dovetailed joints. (See Fig. 4.2 to 4.7)

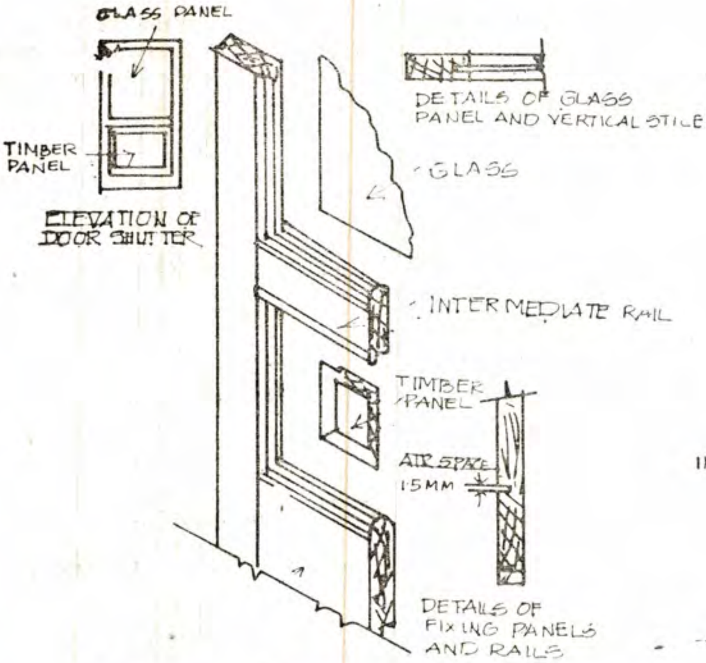
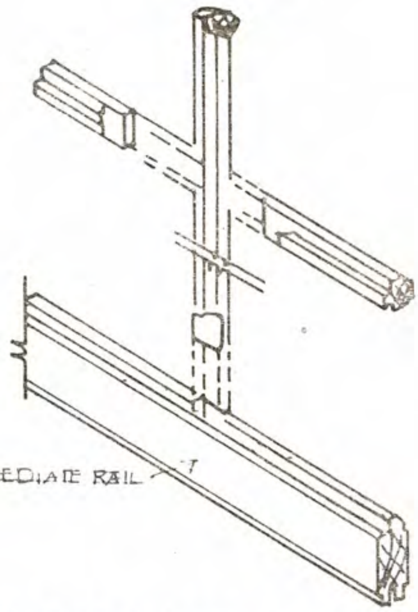
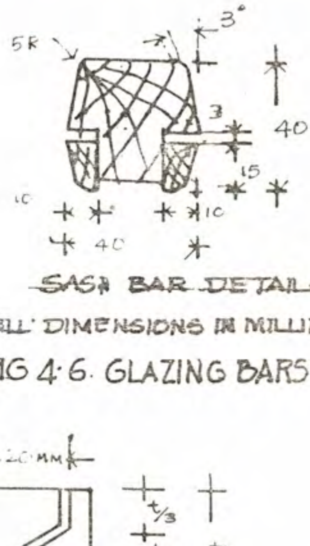


FIG 4·5 DETAILS OF DOOR SHUTTER

SECTION



JOINERY DETAILS OF GLAZING BARS



SASH BAR DETAILS

ALL DIMENSIONS IN MILLIMETRES

FIG 4·6. GLAZING BARS AND SASH BAR

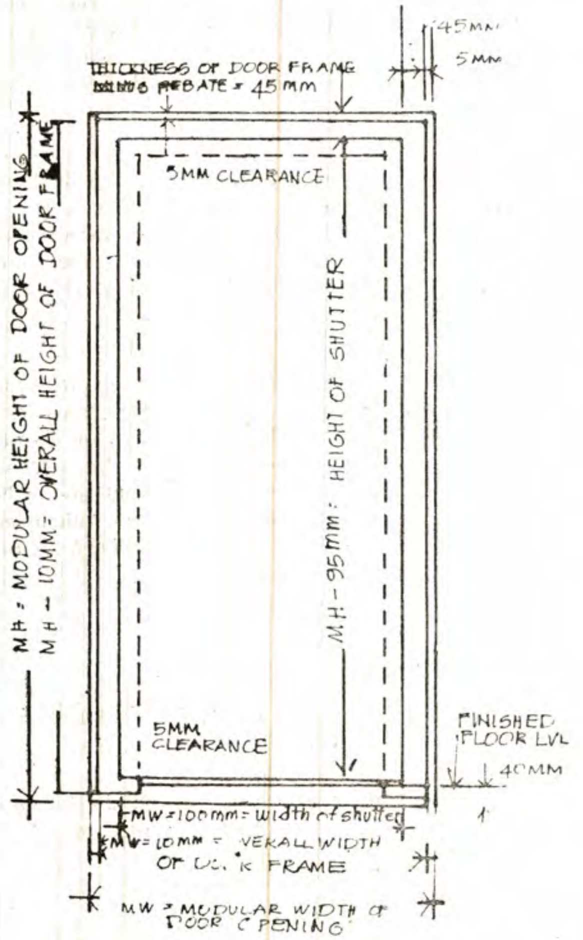
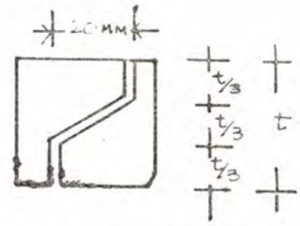
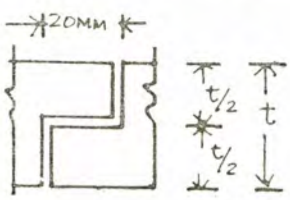


FIG. 4·6 SKETCH ILLUSTRATING DIMENSIONS OF SHUTTER



t - THICKNESS OF SHUTTER
SPLAYED TYPE



t = THICKNESS OF SHUTTER SQUARE TYPE

FIG 4·7 MEETING OF STILES FOR DOUBLE LEAVED SHUTTER

6.4. The post shall be through-tenoned into the mortices of the transom to the full width of the transom and the thickness of the tenon shall be not less than 15 mm. The tenons shall be closely fitting into the mortices and pinned with corrosion resisting star shaped metal pins not less than 8 mm. in diameter with wood dowels not less than 10 mm. diameter. The depth of rebate frames for housing the shutters shall be 15 mm.

6.5. Members of frames of doors, windows and ventilators shall be of the same species of timber except in the case of soft wood frames where the bottom sill of the window and ventilator frames shall be of hard wood.

6.6. ***Gluing of joints.***—The contact surface of tenons and mortices shall be treated before putting together with an adhesive conforming to WRB or MR Grade covered in I.S. 851—1957. or animal glue conforming to I.S. 852 —1969 or polyvinyl *acetate* dispersion based adhesives conforming to I.S. 4835—1968.

6.7. *Location of holdfast.*—A minimum number of threes, holdfast shall be fixed on each side of door and window frames one at the centre point and the other two at 300 mm. from top and the bottom of the frames. In case of window and ventilator frames whose height is less than 1m. two holdfasts on each side shall be fixed at quarter points of the frames. Unless otherwise specified the hold fasts shall be made from mild steel flat iron of size 50 mm. 6 mm. and 230 mm. long. 5 cm. length at one end of the hold fast shall be bent at right angles and one hole of 11 mm. diameter shall be made in it for fixing to the frame with 10mm. diameter bolt [See Fig. 4.1 (*a*)]. The other end of the holdfast shall be split and bent at right angles in the opposite direction.

6.8. *M.S. Bars and M.S. Grills in wooden frames.*—M.S. bars and M.S. grills shall be fixed as per detailed drawings or as directed by the Executive Engineer.

Fixing.—For M.S. bars to be fixed in wooden frames of window, etc. through holes shall be drilled in one frame and in the other frames holes shall be drilled 5 cm. deep. The bars shall be passed into the frame from one side and these shall be of the correct length to fit in at one end flush with outside of the frame at the other end. Where there are M.S. flats provided along with the bars, these shall be fixed at the ends to the wooden frame with wood screws. Holes for passing M.S. bars shall be punched in the flats at proper position.

The grills shall be fabricated as per design and fixed to the frame by round headed bolts and nuts in new work and by wood screws in old work.

Measurement.—The length of M.S. bars and flats shall be measured separately correct to a cm. and their weight calculated in kg. from standard tables.

Rate.—The rate-includes the cost of labour and materials required for all the operations described above.

6.9. *Finish* :

6.9.1. Defective knots where permitted in surfaces exposed to view shall be completely bored or cut out and tightly plugged with a cross graubed plug (either rounded or dovetailed) of similar species of timber and properly glued in. The grain of the plug shall run in the direction of the grain of the piece.

6.9.2 All door, window and ventilator frames shall be clamped together so as to be square and flat at the time of delivery. Each assembled door frame shall be fitted with temporary stretcher.

6.9.3. Holdfasts and other parts, which go into or but against masonry and hence are in accessible for maintenance, shall be protected against moisture and decay with a coating of coaltar or other suitable protective material.

7. *Shutters.*

7.1. *Types of shutters.*

7.1.1. The shutters can be of following types:—

(*a*) Panelled and glazed shutters for doors.

(*b*) Flush door shutters,

(*c*) Window and ventilator shutters,

(*d*) Miscellaneous shutters.

8. *Construction and workmanship of shutters.*

8.1 *Panelled and glazed shutters for doors.*—C.A drawing/1073 No. 50 shall also apply.

8.1.1. Timber panelled shutters shall be constructed in the form of timber frame work of styles and rails with panel inserts of timber, plywood, block board, wood particle board, veneered particle board, hard board or asbestos cement sheet, generally as illustrated in Fig. 4.1. The panels shall be fixed by either providing grooves in the styles and rails or beading or both. The styles and rails shall be joined to each other by mortice and tenon joints at right angles (See Fig. 4.4).

8.1.1.2. All members of the door shutters shall be straight without any warp or bow and shall have smooth, well planed faces at right angles to each other. The right angle for the shutters shall be checked by measuring the two diagonals from one extreme corner to the opposite one and the difference between the two diagonals shall be not more than 3 mm.

8.1.2. *Beading.*—Timber panels shall be fixed only with grooves but additional beading may be provided either on one side or on both sides; if so desired. Plywood, hardboard and particle boards shall have either grooves or beading or both. In so far as glass and asbestos panels are concerned, beading shall always be provided without grooves. Where beading is provided without grooves, the beading shall be only on one side, the other side being supported by rebate from the styles.

8.1.3. *Joinery.*

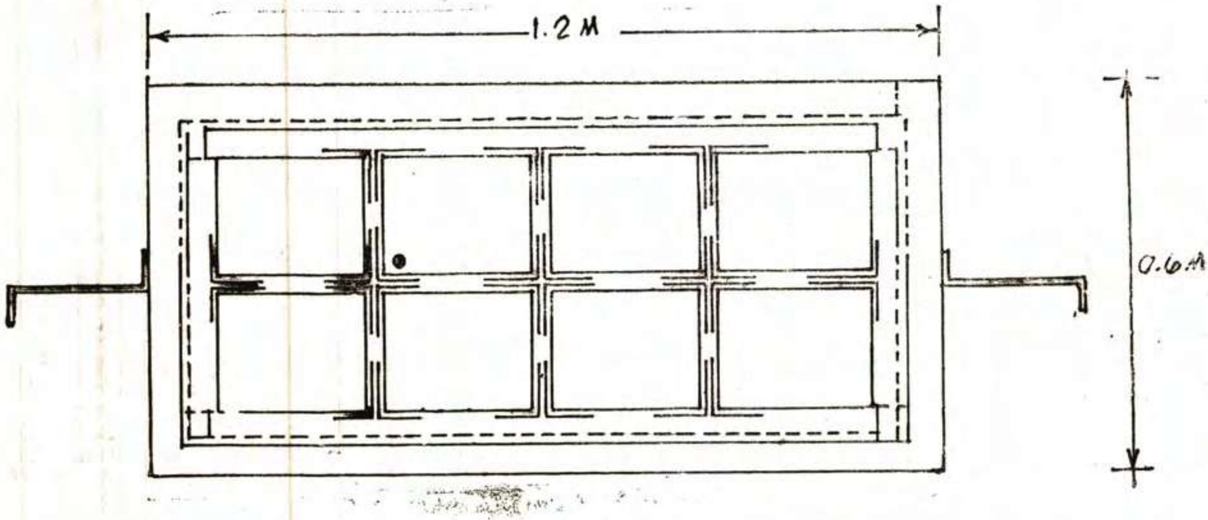
8.1.3.1. Depth of rebate in timber shutters for closing in double shutter doors shall be not less than 20 mm.

8.1.3.2. Styles rails and panels in door-shutters shall be of the same species of timber, unless otherwise permitted by the Executive Engineer.

8.1.3.3. Styles and end rails of shutters shall be made out of one piece only. Lock and intermediate rails exceeding 20 mm in width may be made out of one or more piees of timber, but the width of each piece shall be not less than 75 mm. Where more than one piece of timber are used, they shall be jointed with a continuous torgued and grooved joint glued together and reinforced with metal dowels at regular intervals not exceeding 20 mm. or pinned with not less thnn three 40 mm rust proof pins of the lost head type. Jointed pieces of timber shall belong to the same species. Alternatively the styles and rails may be of laminated construction glued with BWR type adhesive

8.1.3.4. Muntings and glazing bars shall be sub-tenoned to the maximum depth which the size of the member would permit or to a depth of 25 mm, whichever is less. The thickness of each tenon shall be approximately one third the finished thickness of the member and the width of each tenon shall not exceed five times its thickness (See Fig. 4.6 and 4.7).

8.1.3.5. *Timber panelling*.—Timber panels shall be preferably made of timber of larger width, the minimum width and thickness of a panel shall be 150 mm and 15 mm respectively. When made from more than one piece, the pieces shall be jointed with a continuous tongue and grooved joint glued together and reinforced with metal dowels.



VENTILATOR

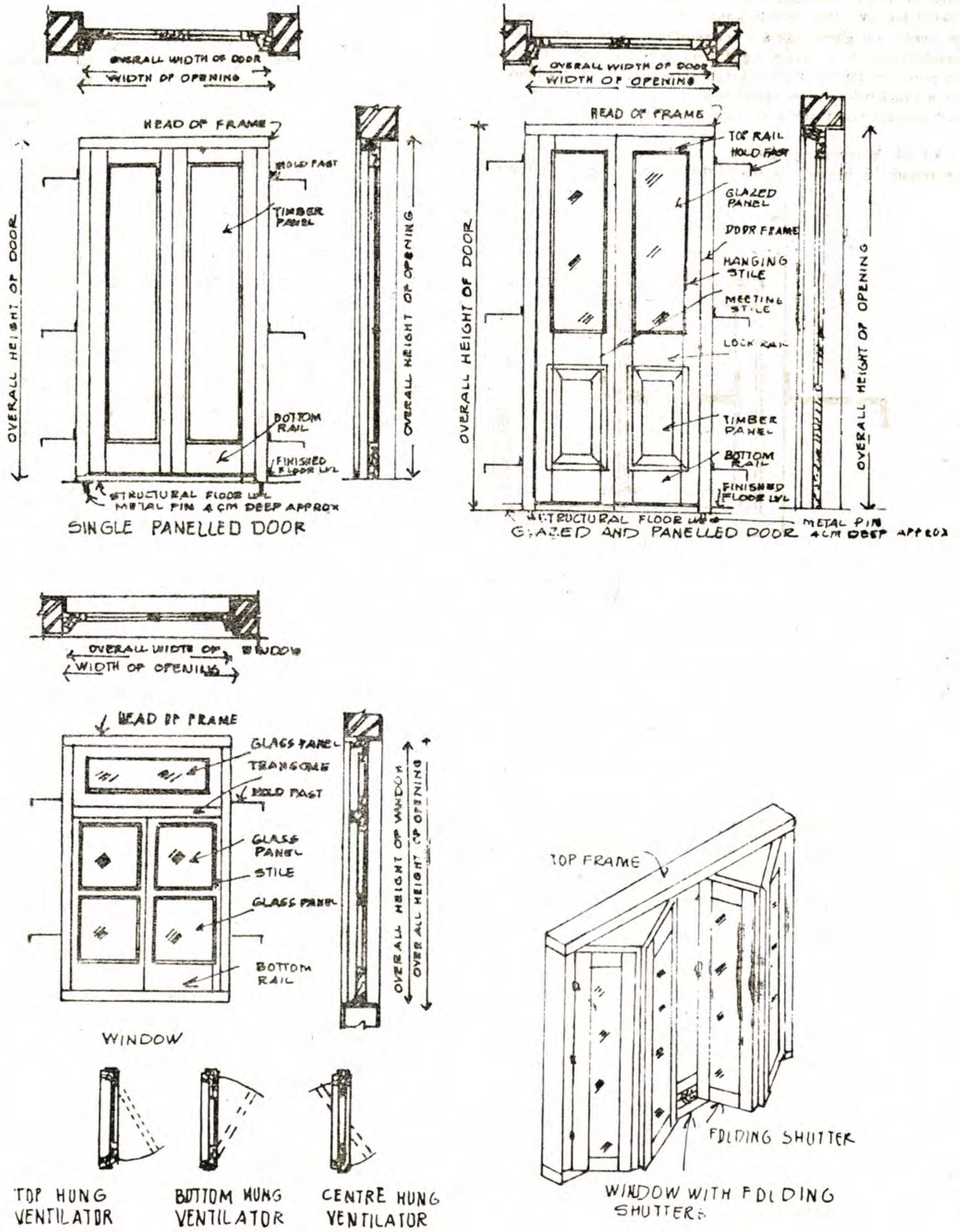
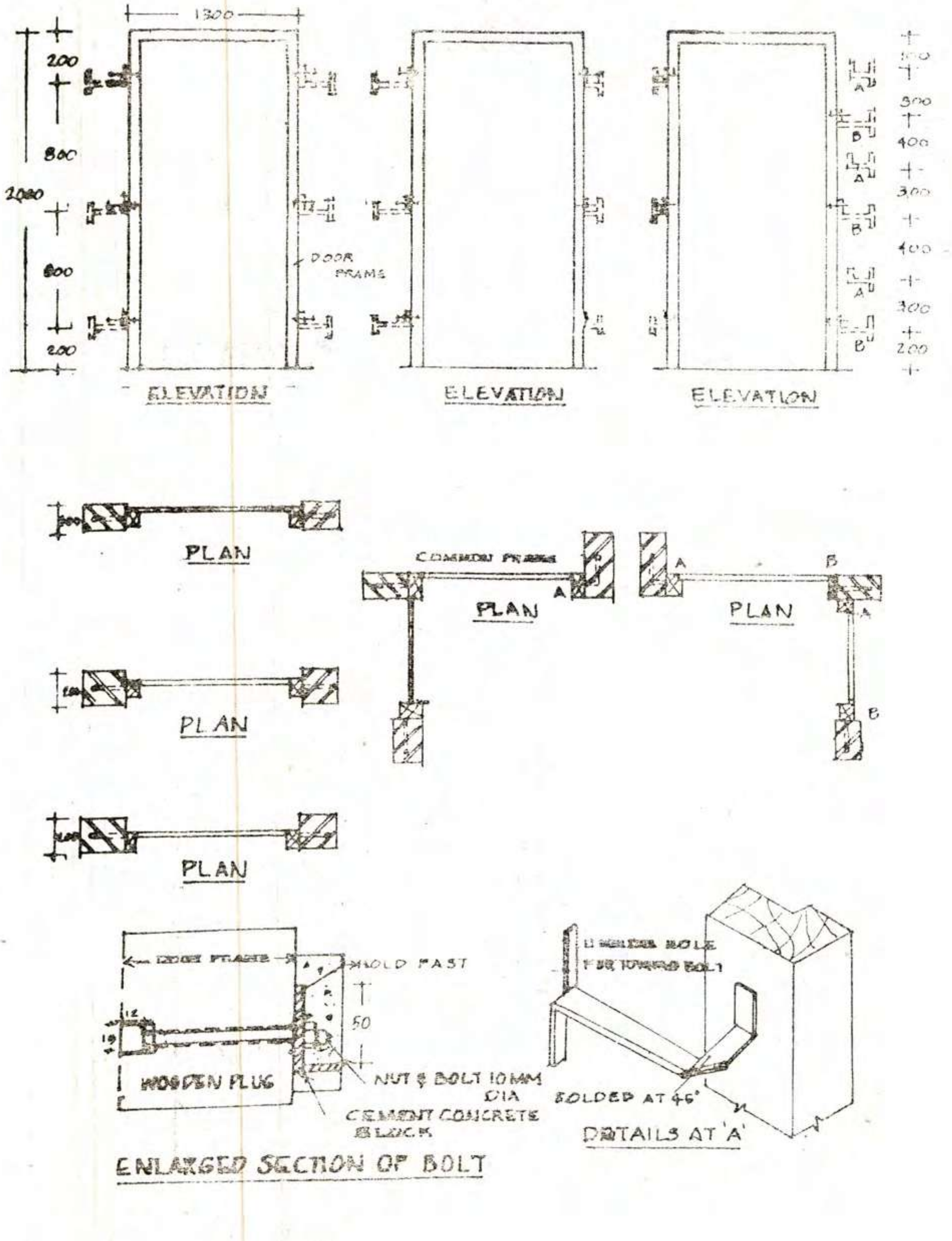
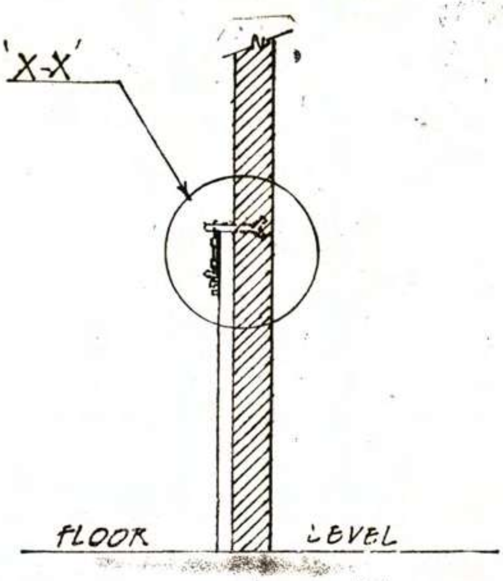


FIG 1 TERMINOLOGY FOR TIMBER DOOR AND WINDOW COMPONENTS

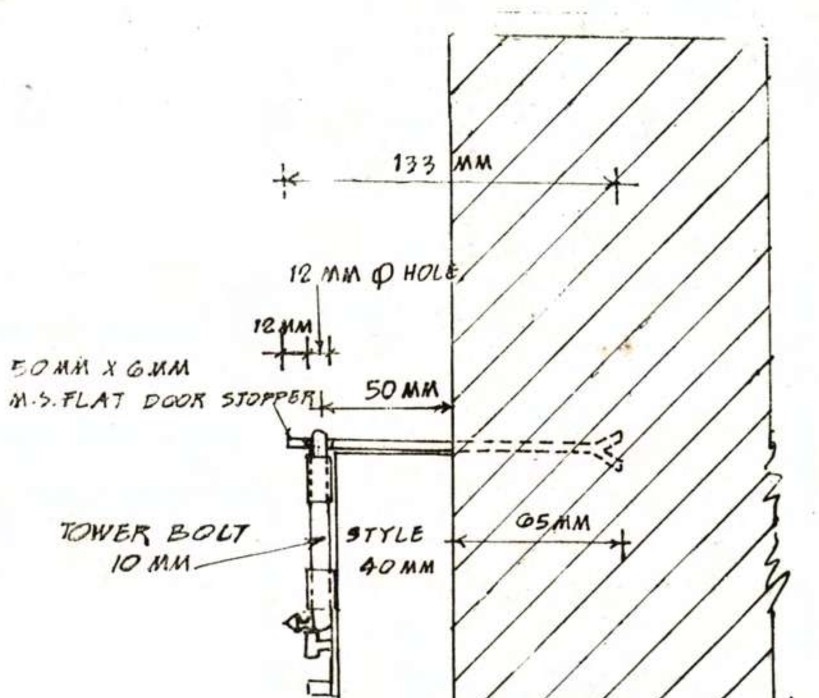
ARRANGEMENT OF HOLDFASTS



NOT TO SCALE
ALL DIMENSION ARE IN MM



FIXING OF M.S. FLAT DOOR STOPPER



DETAIL AT 'X.X'

The grains of timber panels shall run along the longer dimension of the panels. The panel shall be framed into grooves to the full depth of the groove leaving an air space of 1.5 mm. and the faces shall be closely fitted to the sides of the groove. Moulding at the edges of the panels shall be scribed at the joints. The panels shall be designed such that no single panel exceeds. 0·5 m² in area.

8.1.3.6. *Plywood paneling.*—Plywood panels shall be not less than 10 mm. in thickness for two or more panels construction and 12 mm. in thickness for single panel construction. There shall be no restriction in the size of the panel.

8.1.3.7. *Particle board panelling.*—Panel shall be made from one piece of veneered particle board or unveneered particle board. The thickness of particle boards used shall not generally be less than 12 mm. in case of single panel shutter and 10 mm. in case of two or more panel shutters. The panels shall be framed into the grooves to the full depth leaving an air space of 1·5 mm. and the faces shall be closely fitted to the sides of grooves before the panels are inserted into the grooves of styles and cross members.

8.1.3.8. *Hard Board Panelling.*—The thickness of hard board used shall not generally be less than 12 mm. in case of single panel shutter and 10 mm. in case of two or more panel shutters.

8.1.3.9. *Asbestos cement board panelling.*—The thickness of asbestos cement board used for panelling shall not generally be less than 12 mm. in case of single panel shutter and 10 mm. in case of two or more panel shutter.

8.1.4. *Gluing of Joints* :

8.1.4.1. The contact surfaces of tenon and mortice shall be treated before putting together, with bulk type synthetic resin adhesive. Tongue and grooved joints shall also be properly glued together with a suitable adhesive (See also 6.6.).

8.1.5. *Rebating.*–In the case of double leaved shutters, the meetings of the styles shall be rebated 20 mm. The rebating shall be either splayed or square type as shown in Fig. 4.7.

8.1.6. *Location of fittings and Accessories.*

8.1.6.1. The lock rail of door shutter, where provided shall be so placed that its centre line is at height of 800 mm. from the bottom of the shutter.

8.1.6.2. Each door shutter shall be fixed to the frame with three hinges of the type specified, one at the centre and the other two at 200 mm. from the top and the bottom of the shutter.

8.1.6.3. Timber panelled shutters may be provided with louvers or vision panels as specified. Where such a provision is made, the position, size and shape of louver and vision panel openings shall be as specified.

8.1.7. *Finish.*—For finishing of door shutter reference may be made to Section 10 Painting.

8.1.8. *Glazing.*—For glazing, reference may be made to standard specification No. 73.

8.2. *Flush door shutters.*—C.A. Drawing 1073 Nos. 48 & 51 shall also apply.

8.2.1. *Solid Core type.*—Solid core type flush door shutters may be of the decorative type and non-decorative (Paintable) type. The nature of construction of these shutters shall, therefore, be based on the type and construction of core.

8.2.1.1. *Block board type core* (See Fig. 4·9 and 4·10)—A frame constructed of styles and rails shall be provided for holding the core. The width of the frame including lipping where provided, shall not be less than 50 mm. and not more than 100 mm.

The wooden strips for core shall be cut out from the timbers and seasoned to a moisture content not exceeding 12 per cent. The width of each strip shall not exceed 25 mm. These strips may consist of pieces of small lengths placed end to end and the end joints shall be staggered. In any one block board the core strips laid separately. glued or otherwise jointed to form a slab which is glued between two or more outer veneers with the direction of the grain of core blocks running at right angles to that of the adjacent veneers.

Particle board core with or without block board :

8.2.1.2. (See Fig. 4.11 and 4.12). The core shall be either particle board or a combination of block board and particle board. In a combined construction the width of block board construction shall extend at least 150 mm. from inner edge of the styles on either side and the rest shall be particle board. The frame for holding the core including lipping where it occurs, shall be not less than 50 mm. and not more than 100 mm. in width.

8.2.1.3. *Construction of face panel.*—The face shall be formed by gluing by hot-press process of both faces of the core by either plywood or cross bands and face veneers. The thickness of the cross bands as such or in the plywood shall be between 1 mm. and 3 mm. The thickness of the face veneer as such be or in the plywood shall be between 0·5 mm. and 1·5 mm. for commercial veneers and between 0·5 mm. and 1 mm. for decorative veneers. The plywood conforming to these requirements shall be glued under pressure on both faces of the core. When the panel consists of cross bands and face veneers glued separately, the cross bands shall be laid with their grains at right angles to those of the core and glued to its both faces. Face veneer shall then be laid with their grains ar right angles to those of the cross bands. Where it is desired to have wooden strips in the block board core horizontal rather than vertical, this shall be permitted only if 3 ply panel is pressed on either side of core and total is 7 ply construction.

(a) Application of a decorative face veneer on a finished face having veneer in the same direction as the proposed veneer shall be avoided. Where, however, this is unavoidable due to special

SECTION II

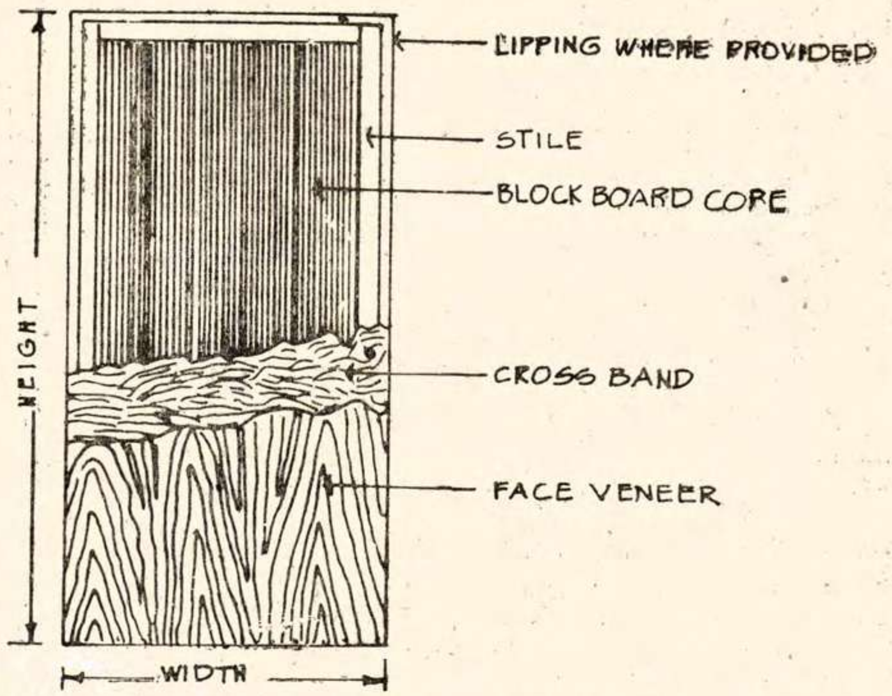


FIG. 4·9. TYPICAL BLOCK BOARD CORE FLUSH DOOR SHUTTER

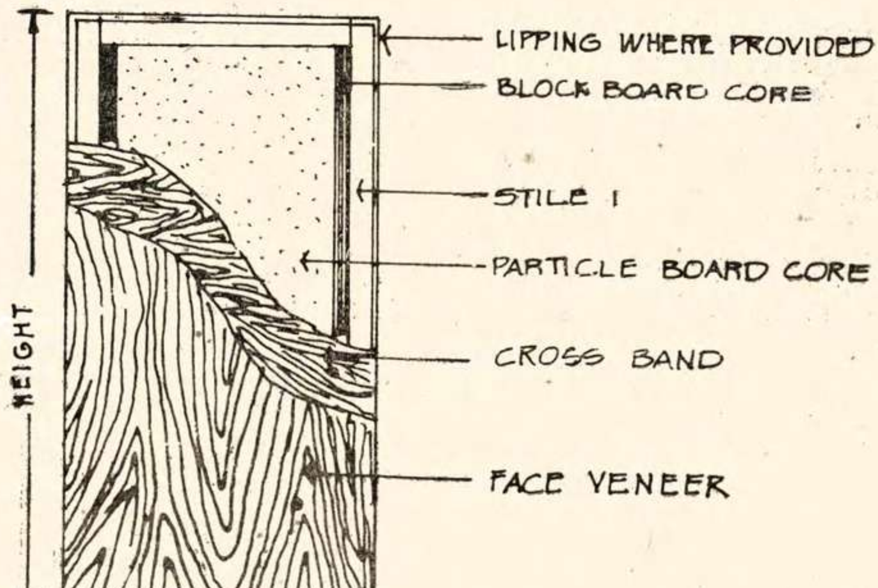


FIG. 4·10 TYPICAL PARTICLE BOARD AND BLOCK BOARD CORE FLUSH DOOR SHUTTER

SECTION II

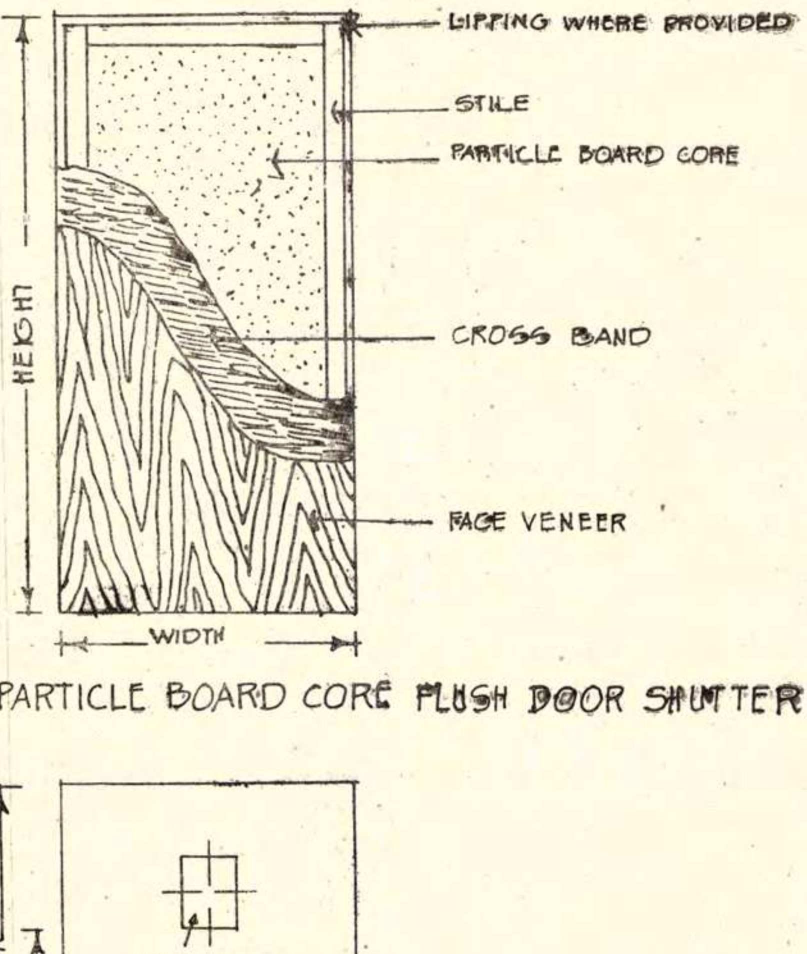


FIG. 4·11. TYPICAL PARTICLE BOARD CORE FLUSH DOOR SHUTTER

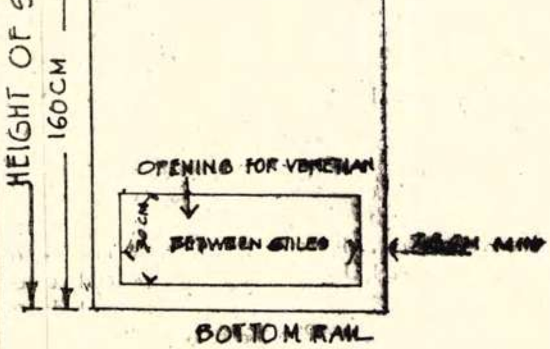


FIG. 4·12 TYPICAL LOCATION OF OPENING FOR GLAZING AND VENETIAN circumstances the already existing veneer, whether commercial or decorative shall be so sanded that the total thickness of both the existing and the approved face veneers together shall not exceed the maximum thickness specified. The thickness of the decorative veneer after finishing is in no case less than 0·5 mm.

(*b*) Face panels of particle boards or hardboard shall be framed by gluing by the hot-press process on both faces of the core particle boards or veneerned particle boards or hard board. The thickness of each of the face panels of particle board shall not be less than 4 mm. and of hard board not less than 3 mm.

8.2.1.4. All the four edges of the door shutter shall be square. The shutter should be free from twist.

8.2.1.5. Both faces of the door shutter shall be rounded to a smooth even texture.

8.2.1.6. *Fittings*.—Shutters shall be shop prepared for taking mortice locks, latches or bolts, if required. The size of the mortice lock shall be denoted by the length of thebody towards face and shall be 65 mm, 75 mm. and 100 mm. as specified. The measured length shall not vary more than 3 mm. from the length specified for the size.

Non-interchangeable keys.—The mortice locks shall be manufactured to have non-interchangeable keys. For the purpose of testing two lever locks three locks from each batch of 50 locks shall be so selected that the words of the keys differ from each other slightly. If the key of any of the locks opens any other lock amongst the selected locks, the whole lo~ shall be rejected. When the locks have more than two levers, five locks may be selected from a batch of 60 locks and tested for interchangeability.

Lock.—The clear depth of the body shall not be more than 15 mm. The fore end shall be firmly fitted to the body by suitable countersunk head machine screw. The locking bolt shall be of specified material and of section not less than 8 × 25 mm. for all sizes of locks. If made as two piece construction both parts shall be rivetted. Ordinary lever mechanism shall be provided with not less than two levers but false levers shall not be used. Pair of lever shall weigh not less than 0·50 kg. and each shall be fitted with one spring of phosphor bronze or steel wire and shall with stand the following tests without showing any sign of permanent set.

(*a*) The lever spring shall be pressed down so as to touch the top edge of the lever and released. This shall be repeated six times.

(*b*) The lever shall also stand a transverse load of 15 kg. before the failure of the joint between the lever and the spring takes place.

NOTE.—The lever shall be rigidly held flat and a point load of 15 kg. applied to the spring gradually, the spring shall withstand the total load before the final failure of the joint between lever and the lever spring occurs.

Keys.—Each lock shall be provided with two keys. The keys shall function smoothly.

Latch.—Mortice latch with one head bolt and a pair of leverhandles shall have steel casing and brass bolt shall be right or left handed as shown in the drawings or as directed by Executive Engineer. It shall be of the best make of approved quality, the latch for single leaf door shall have plain face and that of double leaf door a rebated face. Latch bolt shall be of material specified. End bolts shall be reversible. The bolt shall not project from the face to face of the fore end of the lock. The section of the bolt shall not be less than 12 × 16mm. for all sizes of lock. Each latch bolt shall be fitted with one spring which shall be phosphor bronze or steel wire. The latch spring shall withstand the test as for lever spring without any sign of permanent set. When required suitable block of wood may be provided for fixing the hardware.

8.2.2. *Cellular and Hollow core type*.—Cellular or hallow core flush door shutters may be of the decorative type or non-decorative (Paintable) type. The nature of construction of these shutters shall therefore depend on the type and construction of core.

8.2.2.1. *Cellular Core* (See Fig. 4.11).—Timber frame for holding the core shall be constructed from styles, top and bottom rails each not less than 75 mm. wide including internal lipping where provided. The cellular core shall be of any of the following types of construction as required.

Type A.—Particle board conforming to I.S. 3087—1965 *hard board conforming to I.S. 1658—1966 ** wooden or plywood battens, stubulars strips of blocks or batten strips of not less than 25 mm. width so fixed that each of the voids formed does not exceed 25 cm² in area and the volumetric contents of the voids do not exceed 50 per cent of the total core volume, that is, when measured from edge to edge.

Type B.—Rolls, strips, coils or corrugations of veneers not less than 1 mm. thick and not less than 100 mm. in length (when fully flat), so fixed that the distance between any two faces of the strips, coils or corrugations, at any place is such that the least one strip is intercepted by a square of side 200 mm. in any direction. The voids shall be uniformly distributed throughout the core.

8.2.2.2. *Hollow core*.—Timber frame for holding the core shall be constructed from styles and top, bottom and minimum two intermediate rails, each not less than 75 mm. wide including internal lipping where provided. In each segment, battens not less than 25 mm. wide shall be fixed in much a way that the voids are equally distributed and the void area in any segment is less than 500 cm². Battens may also be replaced by suitable rolls or strips or strips of veneers.

8.2.2.3. *Construction of face panels*.—The face panel can be of following type:—

(*a*) *Plywood face panel*.—The plywood forming the face panel shall not be less than 3 mm. in thickness in the case of cellular core shutters and not less than 6 mm. in thickness in the case of hollow core shutters except for 25 mm. thick door in which case 4 mm. thickness may also be permitted. Two ply face skin construction in a combination of cross band and face veneers may also be adopted in which case the combined thickness shall be not less than 4 mm. Thickness of the face veneers in the plywood shall be between 0·5 mm and 1.5 mm. for commercial veeners and between 0.5mm and 1mm for decorative veneers.

The plywood face skin assembly conforming to these requirements shall be glued under pressure on both faces of the core.

For application of a decorative face veneer on a finished face panel see 8.2.1.3.

(*b*) *Particle board and hard board face panel*.—The particle board or veneered particle board for the face panel shall be not less than 6 mm. thick in the case of cellular core flush doors and not less than 9 mm. in the case of hollow core flush doors. Hard Board, if useful for the face shall be not less than 4 mm. in thickness in the case of cellular core flush doors and not less than 6 mm. in thickness in the case of hollow core flush doors. The panel shall be glued under pressure on both faces of the core by the hot-press process.

8.2.2.4. *Fittings*.—For fittings *See* 8.2.1.6.

* Wood particle boards (medium density) for general purposes.

** Fibre Hardboards (revised).

8.3. *Window and Ventilator Shutters.*

8.3.1. *Hanging and suspension.*—Window shutter shall be hung on hinges fixed to its sides, ventilator shutters may be hung on hinges fixed to its top or bottom rail or suspensed on peg stay fixed in the centre of its both sides. Such a shutter shall be known as top hung, bottom hung or centre hung (*See* Fig. 4.1.).

8.3.2. *Construction and workmanship.*—The construction of timber window and ventilators shall be in accordance with the requirements laid down for doors.

8.3.3. *Fittings.*—Each window shutter shall be fixed to its frame with two hinges of suitable type at quarter points. Each ventilator shutter shall be either fixed to its frame with two hinges at quater points of top rail or bottom rail or suspended on a suitable peg stay in the centre of the frame.

8.3.4. *Finishing.*—All window and ventilator shutters shall be finished in accordance with the requirements laid down in Section 10 painting.

8.3.5. *Glazing.*—Glazing should be done in accordance with the requirements laid down in Standard Specification No. 73.

8.4. *Miscellaneous Shutters.*

8.4.1. *Ledged and Battened shutters.*—Battens shall be with rebated side joints and each batten shall be fixed with screws to the ledger. Two screws of adequate size shall be provided at each crossing of battens with ledgers.

8.4.2. *Ledged, Braced and Battened Shutters.*—The battens shall be tongued and grooved and headed or V chamfered on each side, and fixed with screws to ledgers as mentioned in 8.4.1. above. The braces shall run upwards from the hinged side. The edges of the ledges and braces shall be stop chamfered and the ends of the braces birds mouthed into the ledges. The thickness of ledged door is the thickness of the boarding (battens) only and not the combined thickness of boarding and ledges. Ledges and braces shall be 5 mm thicker than the battens, unless otherwise indicated.

8.4.3. *Ledged, Braced Battened and framed shutters.*—The shutters consist of two vertical styles, top rail, bottom rail and middle rail, The styles and top rail shall be equal to the thickness of door The bottom and middle rails shall be of less thickness so that the battens may run continuously in one length from the underside of the top rail to the bottom of the door. Battens shall be beaded or V chamfered both sides. The heads of battens shall be tongued cross grain into the top rail. The filling in battens shall be of even width. Doors exceeding 2 m in hegiht shall have an extra intermediate rail. Braces shall be provided as given in 8.4.2. The bottom and middle rails shall be weathered on the upper side, if so desired.

8.4.4. *Louvered Shutters.*—The framing shall be as for panelled shuters (*see* 8.1.1) louvers shall be fixed at an angle with edges splayed as desired

8.4.5. *Fully panelled doors.*—The sizes and types of frames of doors shall be as shown in C.A's drawing 1073 Nos. 48 & 49.

8.4.6. *Panelled and venetioned doors.*—The size and type of doors shall be as shown in C.A's drawing 1073 No. 53.

8.4.7. *Framed and planked doors.*—The size and type of doors shall be as shown in C.A's drawing 1073 No 49.

8.4.8. *Ledged Braced and battened doors.*—The size and type of doors shall be as shown in C.A's drawing 1073 No. 49.

8.4.9. *Fly Proof doors.*—The size and type of door shall be as shown C.A's. drawing 1073 No. 51.

8.4.10 *Expanded metal doors.*—The size and type of door shall be as shown C.A drawing 1073 No. 54.

8.4.11. *Panelled windows.*—The size and type of windows shall be as shown in C.A's drawing 1073 No. 53.

8.4.12 *Venetiacl loweredwindows.*—The size and type of windows shall beas shown in C.A's drawing 1073 No. 59.

8.4.13. *Ledged, Braced and battened windows.*—The size and type of windows shall be as shown in C.A's drawing 1073 No. 58.

8.5.1. *Finishing.*—All wood work shall be painted or finished as specified.

9. *Installation of doors, window and ventilator.*

9.1. *Installation of Door and window frames*—

9.1.1. Timber door and window frames shall be installed either by "built-in mehtod" or "prepared opening method" as described in 9.1.2 and 9.1.3. Installation into prepared openings shall be preferable, the advantage being that the frame is less liable to distortion and moisture changes.

9.1.2. *Built in method.*

9.1.2.1. *Door frames.*—Frames shall be installed at the required place and each door frame shall be provided with three hold fasts as shown in(Fig. 1a) The hold fast shall be tightly fixed to the frame by means of bolts. The bolt head shall be sunk into the frame and covered with wooden plugs 10cm long. In case of frames without sills, the vertical members shall be buried in floor for the full thickness of the floor. Where doors are not provided with sills, the door frame shall be temporarily braced at the sill level so as to prevent warping or distortion of frame during construction. Masonry or concrete in the wall shall be built after installation of the door frames so that the hold fasts and pins at the bottom are well anchored into them. Before construction of masonry the outside of the frames coming in contact with masonry shall be given a thick coat of coal tar or other water-proofing paint. Suitable arrangements shall be made to hold the frames in rectangular shape during construction. Usually one cross batten at the middle and one cross batten at the bottom (where no sill is provided for door) and two cross battens diagonally will be necessary to hold the frame rectangular.

9.1.2.2. *Window frames.*—Window frames shall be installed in the same manner as door frames except that hold fasts shall be fixed as described under 6.7.

9.1.3. *Prepared opening method.*—In this method the fixing of door and window frames in the opening may be flush or rebated as given in the working drawing. The clearance between the frame and opening shall be kept depending on whether the opening is externally rendered or fair faced. The frame shall be checked before fixing in position that the same is in square and in the proper position. The hold-fast opening and the bottom pin shall than be grouted. Plastering of the sides shall be done and allowed to dry before the door, window or ventilator shutters are fixed.

9.1.3.1. *Cleaning the surroundings.*—After the plaster and grouting have dried, all splatter and marks of cement shall be removed and the frames cleaned.

9.2. *Installation of door and window shutters.*

9.2.1. Before installation, it shall be ascertained that all materials that is the shutters, hardwares, etc., are at site and of the correct size and quality. The size of openings and the door frames shall be checked and also the verticality of the side frames and the level position of the floor and the wall. Any adjustment necessary shal be made before installation of the shutters. The shutters shall be installed only after the walls on either side have dried. Good ventilation at the time of installation is necessary.

9.2.2. The size of the shutters shall be checked before installation Usually adjustments will be possible by planing the sides, top and bottom to the extent of 6 mm. It is not necessary to cut any door shutter by more than 9 mm unless agreed to by the supplier and the consumer of shutters. The door shutters shall be adjusted and fixed with two screws on each hinge (blank fittings) before the polishing of the terrazo and similar types of floorings is taken up. Such shutters shall then be removed, the terrazo flooring polished and the shutters refixed in position with all screws.

9.2.3. During installation, the shutters shall be carefully lifted carried and fixed. Dragging of shutters particularly decorative shutters one over the other or on ground is likely to scratch and damage the surfaces.

9.2.4. Any special instruction by the door and window manufacturers regarding the position of hinges, aldrops and locks shall be noted and complied with during installation.

9.2.5. Any transit defects or storage defects should be rectified. Any crack should be filled up with a good putty. Any damaged surface veneer particularly in decorative shutter may be rectified by inserting a matching veneer and use of suitable glue and pressing by use of 'C' clamps or other suitable device. Any corner opening may be rectified by the use of glue and pressing by 'C' clamps. Any damage to moulding or glazing bars or other fixtures shall be done at site by use of similar material.

9.2.6 Unless otherwise specified, door shutters shall be fixed to the frames with 100 mm long hinges and width to suit the thickness of the door and using suitable wood screws. The hinges shall be fixed one at the centre and the other two at 250 mm each from top and bottom of shutter. In case of window shutters each shutter shall be fixed to its frame with 80 mm hinges at suitable places preferably at quarter height from up and down. When driving the screws it is advisable that in case of hard timbers pilot holes are drilled before fixing the screw. The screw shall be driven tight fit and straight. The ventilator shutters shall be fixed with two hinges.

10. (a) *Measurement for payment* :—The size of doors given in schedules and named on the drawings will be the size overall to the outside of frames above floor level. The sizes of windows will be to outside of frames. The unit of measurement for doors and windows shall be in cubic metres for frame work and in square metre for shutter works, or the size as thus defined in this clause, whichever is laid down in the schedule as the unit for the relevant item. Where the drawing shows a wooden threshold plate for a door, opening on to a verandah, the floor level of the room and not of the verandah will be the point of measurement for height of the door.

(*b*) Doors and windows with semi-circular or segmental heads will be measured for payment, when the unit is on a square decimetre basis, by multiplying the width by the greatest height both measurements being to outside of frames.

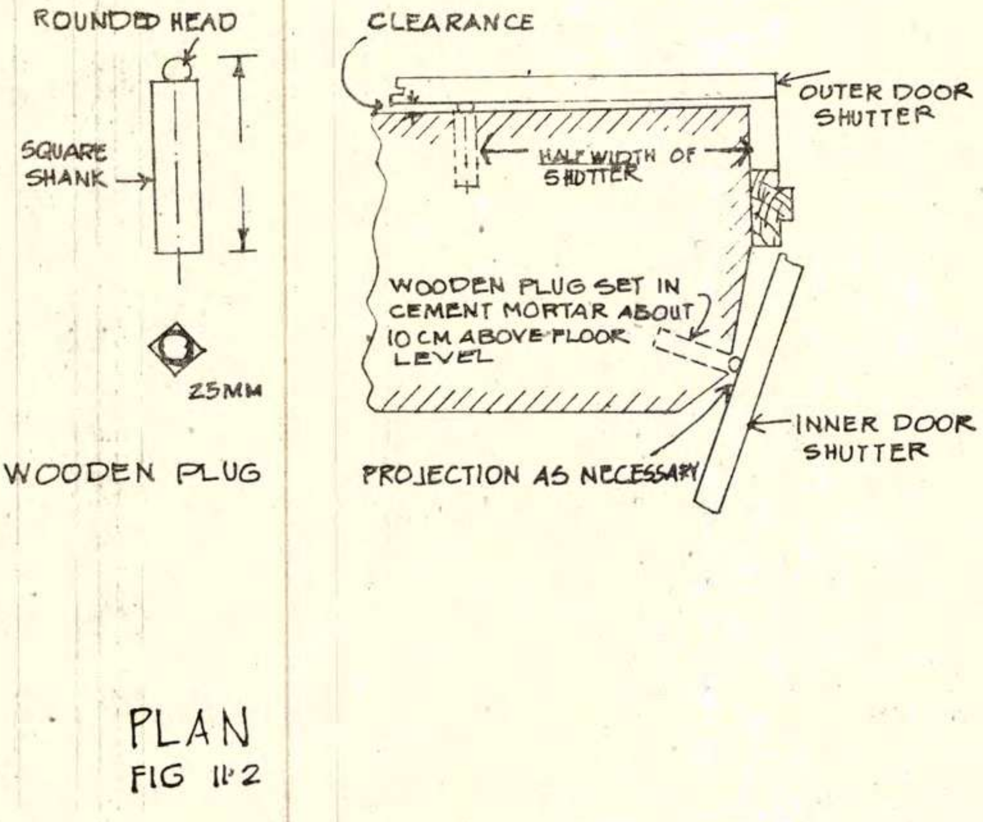
11. *Rate items included*.—(*a*) The contract unit rate, shall include the cost complete of the doors and windows, fixed in place, conforming in all respects with the drawing and relevant specifications, with the following exception:—

It is to be noted by tenderers and contractors:—that unless otherwise specified such furnishings for doors and windows as are defined in the relevant standard sub-specifications following, to be supplied at departmental cast, will be issued to the contractor at a place, which will usually be defined in the tender notice. The cost of conveying and fixing in place such furnishings to the best standard or workmanship shall be included in the unit rate. The Contractor should apply timely to the Executive Engineer for the supply of these furnishings. All fittings and appliances specified in these standard sub-specifications or in addendum specifications for doors and windows such as to keep the shutters open against the wind and holdfasts shall be provided and fixed by the contractor at his cost and therefore, included in his unit rate. Such metal articles shall be of best wrought iron or steel workmanship and shall not be of brass unless such is expressly specified. If samples of such appliances are available in the Division Office concerned, the contractor shall supply articles of the same quality and pattern.

(*b*) All iron and wood appliances and furnishings are to be painted two coats of the same colour as the bed to which they are fixed, i.e. when fixed to doors, of the same colour as the door and when to walls, the colour of the walls. Such painting shall be so done as not to impede, in any way, the free designed travel of the article. Woodwork of the frames of doors and windows abutting against masonry shall be painted with tar two coats *vide* standard specification for "wood work wrought and put up" (S.S. No. 72). Holdfasts will also be tarred two coats before fixing in masonry. The cost of painting in accordance with this clause shall be included in the unit rate.

(*c*) Rounded head wooden plugs 25 mm diameter and not less than 150 mm long shall be fixed into the walls in cement mortar about 100 mm from the floor level, in a manner uniform for all doors, wherever such door shutters open against the masonry. The plugs shall be fixed lower down, if necessary, to ensure that they meet the bottom rail. (*See* Fig. 11-2). The projection of the plugs shall be only sufficient to protect the masonry from contact with the shutter. The cost of the plugs and fixing shall be included in the unit rate for the doors.

SKETCH OF WOODEN PLUGS TO PREVENT DAMAGE TO JAMBS AND WALLS



PLAN
FIG 11·2

NOTE.—(i) Instructions regarding painting as given under the standard specification " Painting " (S.S. No. 66) and "Woodwork wrought and put up" (S.S.No. 72) shall be complied with. Painting shall not be included in the unit rate for doors and windows unless otherwise specified except as provided in clause (10) (*b*) above.

(ii) In cases where a 25 mm raised sloping sill (in cutstone or floor surfacing) is used for exterior doors instead of a threshold plate, with a 30 mm difference between the room and verandah floor levels, instructions on the relevant standard detail drawing shall be complied with.

(iii) Usually door and window openings in a building work will be designed with all the arches in a wall springing from the same level. Similarly, where fan lights are provided over a line of doors and windows, all the transoms should be at the same height. Window sills will normally be about 800 mm above floor level for hospital, office and other public buildings and 600 mm for residential buildings except in lavatories, bath rooms and kitchens, etc., where the height should be atleast 1,200 mm to 1,400 mm or as directed by the Executive Engineer. Swing ventilators will be preferable to windows for bath rooms, in cases where they open on a verandah.

DETAILS OF FURNITURE FITTINGS

A—Doors

Serial number and description.	Number of leaves.	Hold fasts.	Butt hinges. Size.	Butt hinges. Nos.	Top tower bolts. Size.	Top tower bolts. Nos.	Bottom tower bolts. Size.	Bottom tower bolts. Nos.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1 *Doors upto* 2.10 *m. Height*	*Two leaves.*							
(i) External ..	..	6 Nos. *See* foot note below.	125 mm. deep.	6	200 mm long.	2	200 mm long.	1
(ii) *Internal*		6 Nos.	125 mm. deep.	6	200 mm. long.	2	200 mm long.	1
2 *Doors above* 2.10 m. *height.*	*Two leaves.*							
(i) External. ..	..	6 Nos.	125 mm deep.	6	250 mm long.	2	150 mm long.	1
(ii) *Internal.* ..	..	6 Nos.	125 mm. deep.	6	250 mm. long.	1	150 mm. long.	1
3 *Doors upto* 210 *m. height with frames.*	*Single leaf* (flush shutters)							
(i) External ..	..	6 Nos.	125 mm. deep.	3	200 mm. long.	1	150 mm. long.	1
(ii) Internal ..	..	6 Nos.	125 mm. deep.	3	200 mm. long.	1	150 mm. long.	1
(i) ***Windows upto* 1.20 *m.* *Height.***	*Two leaves*	4 Nos.	75 mm. deep.	4	100 mm. long.	2	100 mm. long.	2
(ii) Windows upto 1.20 *m.* Height.	Four leaves (Bottom—2 Nos. Top—2 Nos.)	4 Nos.	75 mm. deep.	8	10 mm. long.	2	100 mm. deep.	2

NOTE.—(1) Fixing of Hold fasts shall be as per drawing 4-1 (*a*) of T.N.B.P.

(2) The tower bolts shall be of 10 mm. dia. for doors.

(3) .. iron furniture fittings are used they shall be Iron Oxidised.

(4) If Aluminium furniture fittings are used, they shall be of Aluminium anodised.

(5) For flush shutters, ball and socket arrangements fixed one in each side may be used as door stoppers or Hinged door stoppes may be used.

(6) For buildings in Coastal areas, aluminium anodised fittings should be used.

FOR DOORS AND WINDOWS.—*cont.*

A. Doors - cont.

Tower bolts at lock rail.		*Aldrops.*				
Size.	*Nos.*	*Size.*	*Nos.*	*Mortice locks.*	*Door/Window stoppers.*	*Remarks.*
(10)	(11)	(12)	(13)	(14)	(15)	(16)
..	..	*Inside* – (a) Aldrops of size 16 mm ×250 mm. (b) Tower bolts of 150 long. *Outside*— Aldrops of size 16 mm. ×250 mm. Aldrops of size 16 mm. ×250 mm.	1 for residential buildings. 1 for non-residential buildings. 1 for residential buildings. 1 for non-residential buildings.	1 No. Mortice lock, if flush shutters are adopted.	*Non-residential Buildings*— M.S. Flats, fixed on either side by the door as indicated in the sketch. *Residential buildings.*— 75 mm. to 125 mm. hooks and eves on either side of the door, well fixed with wood enplugs.	
150 mm.	1	15 mm. × 20 mm.	1 for residential. building.	..	..	
		Inside— (a) Aldrops of size 16 mm. ×250 mm. (b) Tower bolts of 150 mm. long. *Outside*— Aldrops of size 16 mm × 250 mm. Aldrops of size 16 mm. ×250 mm.	1 for residential buildings. 1 for non-residential buildings. 1 for Residential buildings. 1 for non-residential buildings.	1 No. Mortice Lock if flush shutters are adopted.	*Non-residential buildings*— M.S. Flats fixed on either side of the door as indicated in the sketch. *Residential buildings*— 75 mm. to 125 mm. Hooks and eyes on either side of the door well fixed with wooden plugs.	
150 mm. long.	1	16mm. × 250 mm.	1 for residential buildings.		..	
..	..	..	..	1 No. Mortice lock — outside.	As per External doors above.	
..	..	..	..	1 No. Mortice lock — outisde.	..	
..		..	..	..	125 mm. Hooks and eyes—two Nos.	
..	..	..	..		100 mm. Hooks and eyes—Four Nos.	

ANNEXURE—I

CLASSIFICATION FOR SPECIES OF TIMBER SUITABLE FOR MANUFACTUR OF DOOR SHUTTERS AND FRAMES.

Class number. (1)	*Botanical name.* (2)	*Trade name.* (3)
1. (Teak wood) ..	Tectona grandis Linn. f. ..	Teak.
2. (Deodar wood)	Cedrus deodara D. Don. ..	Deodar.
3. (Hard wood, other than teak).	Albizia lebbeck Benth ..	Kokko.
	Albizia procera Benth ..	Safed-Siris.
	Albizia Ordoratissima Benth	Kala-Siris.
	Artocarpus chaplash Roxb ..	Chaplash.
	Cedrela toona Roxb ..	Toon.
	Chukarsia Tabularis Adr. Juss	Chickrassy.
	Dalbergia Sission Roxb ..	Sissoo.
	Dalbergia Latifolia Roxb ..	Rosewood
	Dysoxylum malabaricum Bedd.	White Cedar.
	Syzygium Cumini skeels ..	Jaman.
	Gmelina arborea Roxb ..	Gamari
	Grevillea robusta A. Cunn ..	Silver Oak.
	Holoptelea intgrifolia Planch	Kanju.
	Legerstro mia hypoleuca kurz	Pyinma.
	Lagerstroemia Lanceolata wall.	Benteak.
	Mangifera indica Linn ..	Mango.
	Michelia spp	Champ.
	Palaquium ellipticum (Dalx) Engler.	Pali.
	Parishia insignis Hook. f. ..	Red Dhup.
	Pterocarpus marsumpium Roxb.	Bijasal.
	Shorea robusta Gaertn. f. ..	Sal.
	Terminalia bialata Steudel ..	White Ghuglam
	Terminalia myriocarpa Heurck at Muell. Arg.	Hollock.
	Terminalia Paniculata Roth	Kirdal.
	Terminalia Procera Roxb. ..	White Bombwe.
	Terminalia Tomentosa wight et Arn.	Laurel.
4. (Soft wood other than deodar).	Abies Pindrow Royle ..	Fir.
	Picea Smithinna Boiss ..	Spruce
	Pinus ranbuzghu Sargent ..	Chir.
	Pinus Wallichiana A.B. Jacks	Kail.

ANNEXURE—II

SPECIES OF TIMBER SUITABLE FOR THE MANUFACTURE OF PLUSH DOOR SHUTTERS GROUP I—SPECIES SUITABLE FOR CORE AND CROSS BAND ONLY

Serial number and Botanical name. (1)	*Trade name.* (2)	*Abbreviation.* (3)
1 Abies spp.	Fire	FIR
2 Ailanthus grandis prain ..	Gokul ..	GOK
3 Albizia Chenensis (Osbeck)	MeerSiris	SIR
4 Alnuss spp.	Alder	ALD
5 Canarium spp.*	White Dhup ..	WDH
6 Cedrela Spp.	Toon	TOO
7 Cedrus Deodarn D. Don. ..	Deodar ..	DEO

ANNEXURE II—*cont.*

Serial number and Botanical name. (1)	*Trade name.* (2)	*Abbreviation.* (3)
8 Cupressus Tonulosa D. Don. ..	Cypress ..	CYP
9 Duabanga grandiflora Walp (Syn. Duabanga sonner. ticides Buch-Ham).	Lampat ..	LAP
10 Dyoxylum hamiltoni Hiern ..	Keoti	..
11 Grevillea robusta A. Cunn ..	Silver Oak ..	SOA
12 Holigerna Armottiana Hook, f.	Kattu Chern ..	..
13 Parishia insignis Hook, f. ..	Red Dhup ..	RDH
14 Picea smithiana Boiss	Spruce ..	SPR
15 Pinus r. xburghii Sargent ..	Chir	CHR
16 Pinus Wallichiana A.B. Jacks ..	Kail	KAL
17 Pterygota alata R. Br.	Narikel ..	NAR
18 Shorea assamica Dyer	Mak. i ..	MAK
19 Swietenia spp.	Mahogany ..	MAO
20 Terminalia procera Roxb ..	White Bombwe	WBO
21 Tetrameles nudiflora R. BR. ..	Maina ..	MAI
22 Vatica spp.	Vatica ..	VAT

GROUP II—SPECIAL SUITABLE FOR FRAME, CORE AND CROSS BAND

Serial number and Botanical name. (1)	*Trade name.* (2)	*Abbreviation.* (3)
1 Acer spp.	Maple ..	MAP
2 Acrocarpus frazinifolius wight	Mundani ..	MUN
3 Adire Cordifolia (R. xb) RK. F	Haldu ..	HAL
4 Albizia odoratissima Benth ..	Kokko ..	KOK
5 Albiziz Trocera Benth	Kala-sirio ..	KSI
6 Artocarpus Chaplasha Roxb ..	Chaplash ..	CHP
7 Albizia Procera Benth	S. fed Siris ..	SSI
8 Artocarpus hirsuths Lamk ..	Aini	AIN
9 Aitocarpus lakoocha Roxb ..	Lakooch ..	LAK
10 Betula spp.	Birdh	BIR
11 Calophyllum spp.	Poon	POO
12 Canarium spp.*	White dhup ..	WDH
13 Carallia Brachiata (Lour) Merr (Syn. Carallia integerrima Dc).	Carallia (Maniawga)	CAR
14 Carepa moluccensis (Lam) ..	Pussur ..	PUS
15 Cadrela spp.	Toon	TOO
16 Chukrassia tabukaris A. Juss ..	Chikrassy ..	CHI
17 Cinnamomum spp.	Chinnamon ..	CIN
18* Cullenia rosayroana Kostermans (Syn. Oullenia excelsa wight inpart).	Karani ..	KAR
9 Balbergia latifolio Roxh ..	Rosewood ..	ROS
20 Delbergia sissoo Roxb	Sissoo	SIS
21 Dillonia spp.	Dillenia ..	DIL
22 Dicspyros spp. (Other than D. marmorata parker).	Ebony ..	EBO
23 Dipterocarpus macrsarpus vesque	Hollong ..	HON
24 Diptere carpus spp.	Gurjan ..	GUR
25 Dysoxylum binecta riferum HK. f.ex.	De Adam ..	DEV
26 Dysoxylum malabaricum Redd.	White Cedar ..	WCE
27 Hagara budrunga Roxb. Syn. Zanthoxylum rhetsa (Roxb) Dc.	Mullilam ..	MUI

*These species of timber are to be treated.

EXTRACT FORM I.S. 4021—1967.

Specification for Timber Door, Window and Ventilator Frames

3. *Materials.*

3.1 *Timber* :

3.1.1. Timber used for manufacture of door, window and ventilator frames shall be of four classes, namely—

(*a*) teak wood,
(*b*) de dar wood,
(*c*) hard woods other than teak, and
(*d*) Soft woods other than deodar.

Teak wood shall be of three grades, namely superior, first and second. The other three classes of wood shall be sub-divided into two grades namely, first and second.

The species of timber for the above four classes are given in Table 1 Teak, deodar and hard woods other than teak are suitable for door frames in permanent or temporary structures, while soft woods other than deodar are suitable for temporary structures only.

Note. —Until such time when detailed data for screw holding properties are available, it may be assumed that the timbers having a specific gravity of not less than 0.5 have adequate screw holding property.

TABLE I—CLASSIFICATION FOR SPECIES OF TIMBER SUITABLE FOR MANUFACTURE OF DOOR SHUTTERS. (CLAUSE 3.1.1.)

Class number. (1)	*Botanical name.* (2)	*Trade name.* (3)
1	Tectona grandis Linn. f.	Teak
2	Cedrus deodara D. Don	Deodar
3	Albizia lebbeck Benth	Kokko
	Albizia procera Benth	Safed-Siris
	Albizia odoratissima Benth	Kala-Siris
	Artocarpus chaplasha Roxb	Chaplash
	Cedrela toona Roxb	Toon
	Chukarsia tabularis Adr Juss.	Chickrassy
	Dalbergia Sissoo Roxb	Sissoo
	Dalbergia latifolia Roxb	Rosewood
	Dysoxylum malabaricum Bedd	White Cedar
	Syzygium Cumini Skeels	Jaman
	Gmelina arborea Roxb	Gamari
	Grevillea robusta A. Cunn.	Silver Oak.
	Holopteiea i ntegrifloia Planch	Kanju
	Lagerstroemia hypoleuca Kurz	Pyinma
	Lagerstroemia Lanceolata wall	Benteak
	Mangifera indica Linn	Mango
	Michelia spp.	Champ
	Palaquium ellipticum (Dalz.) Engler	Pali
	Parishia insignis Hook, f.	Red dhup
	Pterocarpus marsupium Rox	Bijasal
	Shorea robusta Gaertn, f.	Sal
	Terminalia bialata Steudel	White chuglam.
	Terminalia myriocarpa Heurek at Muell. Arg.	Hollock
	Terminalia paniculata Roth	Kindal
	Terminalia Procera Roxb	White Bombwe.
	Terminalia tomentosa Wight et Arn.	Laurel
4	Abies pindrow Royle	Fir
	Picea smithiona Boiss	Spruce
	Pinus ranbuzghu Sargent	Chir
	Pinus Wallichiana A. B. Jacks	Kail

3.1.2. *Moisture Content.*—The maximum permissible moisture content shall be from 10 to 16 per cent for timber 50 mm. and above in thickness and 8 to 14 percent of the timber less than 50 mm. for different regions as specified in I.S.287-1960.

3.1.3. *Seasoning and Treatment.*—All timber shall be well seasoned by a suitable process conforming to I.S. 1141-1950 before being planed to the required sizes, Sapwood of durable species, and heart wood and sapwood of non-durable species shall be treated with suitable preservatives as specified in I.S. 401-1961. The finished components shall be given suitable treatment.

3.1.5. *Permssible Defects.*—Permissible defects for various classes of timber shall be as covered in Table 2.

4. *Construction and Workmanship.*

4.1. All members of frame of doors, windows and ventilators shall be exactly at right angles. The right angle shall be checked from the inside surface of the respective members.

TABLE 2—PERMISSIBLE DEFECTS FOR VARIOUS CLASSES OF TIMBER FOR DOOR FRAMES (*Clause* 3.1.5)

Serial number.	*Defects.*	*Superior Grade. Teak*	*First Grade.*	*Second Grade.*
i)	Cross-grain	Not steeper than 1 in 20	Not steeper than 1 in 15.	Not steeper them 1 in 12; (twisted grain permissible provided these are not more than one per member)
(ii)	Sound knots and live knots.	Not more than 0.5 per cent of the area of the piece; 10 mm Max.	Not more than 1 per cent of the area of the piece; 25 mm Max.	Not more than 1.5 per cent of the price ; 40 mm Max.
(iii)	Pitch pockets or streaks.	None.	None.	Permissible except on exposed edges, provided that they are clean and filied up with suitable putty or filler. Where pitch pockets or streaks are located on the exposed edges of the core, they shall be cut out and filled with pieces of wood of similar species with grain running direction. The piece shall be well glued.
(iv)	Sapwood	None.	None.	Generally free from sapwood, but traces of sapwood. properly treated with preservative shall be allowed.
(v)	Pin holes.	None.	None.	Permitted provided they are filled.
(vi)	Worm holes.	None.	None.	Permitted provided they are not more than 9 mm in diameter and not more than one per member and provided such worm holes are plugged with similar timber in such a manner the plugging merges with the surrounoding area both as to colour and grain.

4.1.1. All members of frames shall be straight without any warp or bow and shall have smooth, well-planed surface on the three sides exposed at right angles to each other. The surface touching the walls may be planed unless it is required in order to straighten up the member or to obtain the over-all sizes within the tolerances specified under 5.1.

4.2. *Joinery* :

4.2.1. Frames of timber doors, windows and ventilators shall have dovetail joints (see Fig. 4.2).

4.2.2. The transom shall be through-tenoned into the mortises of the jamb post to the full width of the jamb post and the thickness of the tenon shall be not less than 1.5 cm. The tenons shall be closely fitting into the mortises and pinned with corrosion resisting starshaped metal pins not less than 8 mm. diameter, or with wood dowels not less than 10 mm. diameter (see Fig. 4.2). The depth of rebate in frames for housing the shutters shall in all cases be 1.5 cm.

4.2.3. Members of the frames of doors, windows and ventilators shall be of the same species of timber except in the case of soft wood frames when the bottom sill of the window and the ventilator frames shall be of hard wood.

4.3. *Gluing of Joints*.—The contact surface of tenons and mortises shall be treated before putting together with an adhesive conforming to BWR Grade covered in I.S. 851-1957.

5. *Dimensions, Sizes and Tolerances* :

5.1. *Dimensions of Frames and Tolerances*.—The finished dimensions of the timber sections in frames for doors, windows and ventilators shall be as given below subject to a general tolerance of ± 3 mm:

Dimension. (1)	*Requirement.* (2)
Width for frames carrying one set of shutter ..	100 mm.
Width for frames carrying two sets of shutters ..	120 or 140 mm
Thickness	60 mm.

5.2. *Sizes and Types*.—The sizes and types of frames of doors, windows and ventilators shall be as shown in Fig. 4.

Note.—The overall size shown in Fig. 4 is overall height and width on the outside of frames of timber doors, windows and ventilators. This size is derived after allowing a margin of 5 mm. all round for fitting and fixing to fit up to modular openings based on 10 cm. module. The sizes marked with asterisk mark (*) in Fig. 4 will be the preferred sizes.

5.3. *Designation*.—Frames of doors, windows and ventilators shall be designated by symbols denoting their width, type and height in succession in the following manner :

Width.—It shall be indicated by the number of module in the width of opening.

ype—It shall be indicated by the following letters of alphabet :

D for door
W for window
V for ventilator
S for single shutter
T for double shutter

Height.—It shall be indicated by the number of modules in height of opening.

Example.—'11 DT 20' would mean a frame of double shutter door with a width of 11 modules (109 cm.) and height of 20 modules (199 cm.).

5.3.1. *Combination of Frames of Doors, Windows and Ventilators*.— When frames of doors and windows are combined with those of windows and ventilators, they shall be designated as illustrated in the following manner :

Example 1.—'6WS 10/11 DT 20/6 WS 10' means 11 modules wide and 20 modules high double shutter door frame combined in its two sides with two windows, 6 modules wide and 10 modules high.

Example 2.—'$\frac{6\text{ V }5}{6\text{WS }10}\ \frac{6}{6\text{WS }10}$' means frames of two single-shutter windows of 6 modules wide and 10 modules high combined side by side and with two ventilators at top 6 modules wide and 5 modules high.

6. *Location of Holdfasts* :

6.1. A minimum number of three holdfasts shall be fixed on each side of door and window frames, one at the centre point and the other two at 30 cm. from the top and the bottom of the frames. In cases of window and ventilator frames whose height is less than 1 m. two holdfasts on each side shall be fixed at quarter points of the frames.

7. *Finish* :

7.1. All door, window and ventilator frames shall be well-planed on the three sides exposed at right angles to each other and finished smooth.

7.2. Defective knots, where permitted in surfaces exposed to view shall be completely bored or cut out and tightly plugged with a cross-grained plug (either rounded or dovetailed) of similar species of timber and properly glued in. The grain of the plug shall run in the direction of the grain of the piece.

7.3. All door, window and ventilator frames shall be clamped together so as to be square and flat at the time of delivery.

7.4. Each assembled door frame shall be fitted with temporary stretchers and shall have a temporary diagonal brace fitted inside the rebates.

7.5. Holdfasts and other parts, which go into or butt against masonry and hence are inaccessible for maintenance, shall be protected against moisture and decay with a coating of coal tar or other suitable protective materials.

7.6. All surfaces of door, window and ventilator frames which are required to be painted ultimately shall be covered evenly by brush painting with a priming coat of a white-lead based primer as specified in I.S. 103-1962. In the case of frames to be polished or varnished a priming coat of suitable polish or varnish shall be given before delivery.

NOTE 1 :—Priming alone does not provide full protection against weather, and therefore, all work should receive further coats of paint, polish or varnish as the case may be, within a reasonable period. Any cut surface, particularly that exposing end-grain should be primed before the joinery is set in position.

NOTE 2:—When aluminium primer is used, the user should assure himself that it is of a type especially prepared for this purpose. Unless suitable aluminium primers are used, it is not possible to obtain satisfactory finish.

8. *Sampling and Testing* :

8.1. *Lot.*—In any consignment, all the frames of the same type and manufactured under similar conditions of production shall be grouped together to constitute a lot.

8.2. The number of frames to be selected at random from a lot shall depend upon its size and shall be in accordance with Col. (1) and (2) of Table 3.

TABLE 3.

Sample size and criterion for conformity.

Lot size. (1)	*Sample size.* (2)	*Permissible number of defectives.* (3)	*Sub-sample size.* (4)
26 to 65	10	1	2
66 to 110	15	1	2
111 to 180	25	2	3
181 to 300	35	3	5
301 to 500	50	4	7
501 and above	75	6	10

NOTE :—For lot size 25 or less, no sample shall be taken for test.

8·3. *Number of Tests.*—The frames selected as in 8·2 shall be inspected for dimensions and sizes (see 5), and workmanship and finish (see 4 and 7).

8·4. *Criterion for Conformity* :

8·4·1. The lot shall be considered as conforming to the requirements of this standard if conditions laid down in 8·4·2 are satisfied.

8·4·2. The number of frames failing to satisfy the requirement of any characteristics mentioned in 8·3 shall not exceed the permissible number mentioned in col. (3) of Table 3. If the number of frames found unsatisfactory for the test exceeds this number, the lot shall be considered as unsatisfactory.

8·5. The manufacturer shall, at the request of the purchaser or his representative, give free of charge a certificate to the effect that the articles supplied conform to the requirements of this standard.

9. *Marking* :

9·1. All door, window and ventilator frames shall be hammer marked on the exposed surface with a mark identifying the manufacturer and the type.

9·1·1. The frames may also be marked with the ISI Certification Mark.

10. *Delivery* :

10·1. All external and internal door and window frames shall be supplied completely assembled, unless otherwise specified by the purchaser.

10·2. Accessories shall not form a part of the supply, unless specifically stated.

10.3. The manufacturer on receipt of information as required under A-1 (*a*) shall determine the position of plaster rebate to both sides of window and door frames and shall provide the rebate 1·25 in depth to receive the plaster.

APPENDIX A.

(Clause 10·3)

INFORMATION TO BE SUPPLIED BY THE PURCHASER AT THE TIME OF PLACING THE ORDER.

A-1. In order to enable the manufacturer to supply the correct type and size of frames of timber doors, windows and ventilators the purchaser shall supply the following information at the time of placing the order :

(*a*) The size and the type of frames of doors, windows and ventilators with particulars regarding the way the door is required to open (inward or outward).

(*b*) In frames without sills whether pins are required to be provided.

(*c*) Whether any door and window frame is not to be supplied in assembled unit.

(*d*) The class and grade of timber to be used.

(*e*) Whether the door is to be polished or painted.

EXTRACT FROM I.S. 1003 (PART 1)-1966.

Specification for Timber Panelled and Glazed Shutters.

4. *Material* :

4·1. *Timber*:

4·1·1. The timber for the manufacture of door shutters shall be of four classes as given in table 1.

NOTE.—Until such time detailed data for screw holding properties are available, it may be assumed that the timbers having a specific gravity of not less than 0·5 have adequate screw holding property.

4·1·2. *Moisture Content.*—The maximum permissible moisture content in timber shall be from 10 to 16 per cent for timber 50 mm. and above in thickness and 8 to 14 per cent for timber thinner than 50 mm. for different regions as specified in I.S. 287—1960.

4·1·3. *Seasoning and Treatment.*—All timbers shall be kiln-seasoned by a suitable process conforming to I.S. 1141—1958 before being planed to the required sizes. Sapwood of durable species and heart wood and sapwood of non-durable species shall be treated with suitable non-leachable type preservative as specified in IS: 401-1961. The finished components shall also be given suitable preservative treatment.

4·1·4. *Defects Prohibited.*—Timbers for door shutters shall be free from decay, fungal growth, boxed heart, pitch pockets or streaks on the exposed edges, borer holes splits, and cracks.

4·1·5. *Grades of Timber and Permissible Defects.*— Timbers shall be graded as superior grade 1 and grade 2 on the basis of permissible defects in timber.

4·1·5·1. The permissible defects for various grades shall be as covered in I.S. 4021.

4·2. *Plywood.*—Plywood used for panelling of door shutters shall be BWR grade conforming to I.S. 303—1960

4·3. *Particle Board.*—Particle board used for the panelling of door shutters shall be FPTH or FPSI type ; it shall have been bonded with BWR type synthetic resin adhesive and shall conform to I.S. 3087—1965. The shrinkage in thickness and length of the particle board shall not exceed five per cent. Veneered particle board used for panels shall also be that bonded with BWR type synthetic resin adhesive and shall conform to IS : 3097—1965.

4·4. *Hardboard.*—Hardboard used for the panelling of door shutters shall be of oil-tempered quality conforming to I.S. 1658—1960.

TABLE I.

CLASSIFICATION OF SPECIES OF TIMBER SUITABLE FOR MANUFACTURE OF DOOR SHUTTERS.

(*Clause* 4·1·1)

Class No.	*Species.* Botanical name.	Trade name.
(1)	(2)	(3)
1	Tectona grandis Linn.f.	Teak.
2	Cedrus deodara D. Don	Deodar.
3	Non-Coniferous Timbers other than Teak.	
	Albizia lebbeck Benth	Kokko.
	Albizia procere Benth	Safed siris.
	Albizia odoratissima Benth	Kala siris.
	Artocarpus chaplasha Roxb.	Chaplash.
	Cedrela toona Roxb	Toon.
	Chukrasia tabulanis Adr.Juss.	Chickrassy.
	Dalbergia sissoo Roxb.	Sissoo.
	Dalbergia latifolia Roxb.	Rosewood.
	Dysoxylum malabaricum Bedd.	White Cedar.
	Syzygium cumini Skeels	Jaman.
	Gmelina arborea Roxb	Gamari.
	Grevillea ronusta A. Cunn.	Silver Oak.
	Holoptelea integrifolia Planch	Kanju.
	Lagerstreemia hypoleuca Kurz.	Pyinma.
	Lagerstroemia Lanceolata Wall.	Benteak.
	Mangifera indica Linn.	Mango.
	Michelia sp.	Champ.
	Palaquium ellipticum (Dalz) Engler	Pali.
	Parishia insignis Hook.f.	Red dhump.
	Pterocarpus marsupium Roxb	Bijasal.
	Shoreta robusya Gaertn. f.	Sal.

TABLE I—*cont*.

CLASSIFICATION OF SPECIES OF TIMBER SUITABLE FOR MANUFACTURE OF DOOR SHUTTERS—cont.

(*Clause* 4.1.1) —*cont*.

Class No.	*Species.* Botanical name.	Trade name.
(1)	(2)	(3)
	Terminalia bialata Steudel	White chuglam.
	Terminalia myriocarpa Heurck et Muell Arg.	Hollock.
	Terminalia paniculata Roth	Kindal.
	Terminalia Procera Roxb	White bombwe.
	Terminalia tomentosa Wight et Arn.	Laurel.
4	Coniferous Timbers other than Deodar—	
	Abies Pindrow Royb	Fir.
	Picea smithiana Boiss	Spruce.
	Pinus roxbuzghii Sargent	Chir.
	Pinus walliohiana A.B. Jacks	Kail.

4.5. Asbestos sheet used for panels shall conform to I.S. 2098—1964.

4.6. Sheet glass for glazing shall conform to I.S. 1761—1960. The customer may also specify the type of glass to be used, such as frosted glass, wire-glass and coloured glass and the requirements for them.

5. *Construction and workmanship.*—

5.1. Timber panelled shutters shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, wood particle board, veneered particle board, hardboard or asbestos cement sheet, generally as illustrated in Fig. 4-1. The panels shall be fixed by either providing grooves in the stiles and rails or beading or both (*see* 5.2.). The stiles and rails shall be joined to each other by mortice and tenon joint at right angles (*see* **Fig. 4.4.**).

5.1.1. All members of the door shutters shall be straight without any warp or bow and shall have smooth, well-planed faces at right angles to each other. The right angle for the shutters shall be checked by measuring the two diagonals from one extreme corner to the opposite one and the difference between the two diagonals shall be not more than ± 3 mm.

5.2. *Beading.*—Timber panels shall be fixed only with grooves but additional beading may be provided either on one side or on both sides, if so desired. Plywood, hardboard and particle boards shall have either grooves or beading or both. In so far as glass and asbestos panels are concerned, beading shall always be provided without grooves. Where beading is provided without the grooves the beading shall be only on one side, the other side being supported by rebate from the stiles.

5.3. *Joinery.*

5.3.1. Depth of rebate in timber shutters for closing in double shutter doors shall be not less than 20 mm.

5.3.2. Stiles, rails and panels in door shutters shall be of the same species of timber.

*5.3.3. Stiles and end rails of shutters shall be made out of one piece only. Lock and intermediate rails exceeding **20** cm. in width may be made out of one or more pieces of timber, but the width of each piece shall be not less than 7.5 cm. Where more than one piece of timber is used they shall be jointed with a continuous tongued and grooved joint glued together and reinforced with metal dowels at regular intervals not exceeding **20** cm. or pinned with not less than three 4 cm. rust proof pins of the lost head type. Jointed pieces of timber shall belong to the same species. Alternatively, the stiles and rails may be of laminated construction glued with BWR type adhesives.

5.3.4. Muntings and glazing bars shall be stub-tennoned to the maximum depth which the size of the member would permit or to a depth of 25 mm, whichever is less. The thickness of each tenon shall be approximately one-third the finished thickness of the members and the width of each tenon shall not exceed five times its thickness (*see* Fig. 4.5 and Fig. 4.6).

5.3.5. *Timber Panelling.*—Timber panels shall be preferably made of timber of larger width; the minimum width and thickness of a panel shall be 150 mm and 15 mm respectively. When made from more than one piece, the pieces shall be jointed with a continuous tongued and grooved joint, glued together and reinforced with metal dowels. The grains of timber panels shall run along the longer dimensions of the panels. The panels shall be framed into grooves to the full depth of the groove leaving an air space of 1.5 mm and the faces shall be closely fitted to the sides of the groove. Mouldings to the edges of panel openings shall be scribed at the joints. The panels shall be designed such that no single panel exceeds 0.5 m^2 in area. Beading may be done as in 5.2.

5.3.6. *Plywood Panelling.*—Plywood panels shall be made of exterior grade quality of plywood of not less than 10mm thickness for two or more panel construction and 12 mm thickness for single panel construction. There shall be no restriction on the size of the panel. It shall be constructed in accordance with the requirements laid down in 5.3.5.

5.3.7. *Particle Board Panelling.*—When veneered particle board are used for decorative type shutters board of type ESD (see IS : 3097–1963) and for non-decorative, paintable type shutters board of type ESC shall be used.

5.3.7.1. Panels shall be made of one piece of veneered particle board or unveneered particle board. The thickness of particle boards used shall not generally be less than 12 mm in case of single panel shutter and 10 mm in case of two or more panel shutter. The panel shall be framed into grooves to the full depth leaving an air space of 1.5 mm and the faces shall be closely fitted to the sides of grooves before the panels are inserted into the grooves of stiles and cross members.

5.3.8. *Hardboard Panelling.*—Hardboard panels shall be made of only oil-tempered quality hardboards. The thickness of hard board used shall not generaly be less than 12 mm in case of single panel shutter and 10 mm in case of two or more panel shutters.

5.3.9. *Asbestos Cement Panelling.*—The thickness of the asbestos cement board used shall not generally be less than 12 mm in case of single panel shutter and 13 mm is case of two or more panel shutter. It shall be constructed in accordance with the requirements laid down in 5.3.5.

5.4. *Gluing of Joints.*—

5.4.1. The contact surfaces of tenon and mortice shall be treated, before putting together, with bulk type synthetic resin adhesive conforming to I.S. 851–1957 suitable for construction work in wood; or synthetic resin adhesive (phenolic and aminoplastic) conforming to I.S. 848–1957 suitable for plywood Tongued and grooved joints shall also be properly glued together with a suitable adhesive.

5·5. *Rebating.*—In the case of double-leaved shutters, the meeting of the stiles shall be rebated 20 mm. Where lipping is provided, the depth of lipping at the meeting of stiles shall be not less than 35 mm. The rebating shall be either splayed or square type as shown in Fig. 4·7.

6. *Dimensions, sizes and tolerances.*—

6.1. *Dimensions of components and tolerances.*—The finished dimensions and tolerances of the different components of door shutters shall be as given in Table 2.

TABLE 2.

Dimensions and tolerances of components of door shutters.
(Clause 6.1.)

Description. (1)	*Width.* (2) MM.	*Thickness.* (3) MM.
Vertical stile, top and freeze rail	100±3	40±1
Lock rail	160±3	40±1
Bottom rail..	250±3	40±1
Munting	100±3	40±1
Panel (*See* 5·3)	..	..
Glazing bar	40±1	40±1

6·2. *Sizes and types.*—The sizes and types of door shutters shall conform to Table 3. These sizes are derived after allowing for the thickness of door frame and a margin of 5 mm. all round for fitting and fixing into a modular opening based on 10 cm. module.

NOTE.—For two shutter doors, only the size of a single shutter has been given.

TABLE 3.

Dimensions of door shutters.

Type.	*Door Shutter.*	
	Width.	*Height.*
(1)	(2) MM.	(3) MM.
8 DS 20	700	1905
8 DS 21	700	2005
9 DS 21	800	2005
10 DS 21	900	2005
12 DT 21	560	2005

6·3. *Designation.*—Door shutters shall be designated by symbols denoting the width, type and height of the door in succession in the following manner :—

(*a*) *Width.*—It shall be indicated by the number of modules in the width of door opening.

(b) *Type*.—It shall be indicated by the following letters of Alphabet :—

D=Door.
W=Window.
S=Single Shutter.
T=Double shutter.

(c) *Height*.—It shall be indicated by the number of modules in the height of door opening.

Example. -12 DT 21 would mean a shutter suitable for a double shutter door of 12 module width and 21 module height.

6·3·1. In addition to this designation, the class and grade shall also be specified for the timber (see 4.1.1. and 4·1·5).

6·4. *Tolerence*.—Tolerance on the sizes of door shutters shall not exceed 3 mm.

7. *Location of fittings and accessories* :

7·1. The lock rail of door shutters, where provided, shall be so placed that its centre line is at a height of 80 cm. from the bottom of the shutter.

7·2. Each door shutter shall be fixed to the frame with three hinges of the type specified by the purchaser, one at the centre and the other two at 20 cm. from the top and the bottom of the shutter.

7·3. Timber panelled shutter may be provided with louvers or vision panels as specified by the purchaser. Where such a provision is made, the position, size and shape of louver and vision panel openings shall be as specified by the purchaser.

8. *Finish* :

8·1. All door shutters shall be finished smooth with well-planed faces.

8·2. Panels of shutters shall be flat and well-sanded to a smooth and level surface.

8·3. Defective knots, where permitted in surfaces exposed to view, shall be completely bored or cut out and tightly plugged with a cross-grained plug (round or dovetailed) or similar species of timber and properly glued in. The grain of the plug shall run in the direction of the grain of the piece.

8.4. All the surfaces of door shutters which are required to be painted ultimately shall be covered evenly by brush painting with a priming coat of a suitable primer as specified in I.S. 2338. In the case of doors to be polished or varnished, a priming coat of suitable polish or varnish shall be given before delivery.

NOTE 1 : Priming alone does not provide full protection against weather and, therefore all work should receive further coats of paint, polish or varnish, as the case may be, within a reasonable period. Any cut surface, particularly that exposing and grain should be primed before the joinery is set in position.

NOTE 2 : When aluminium primer is used the user should assure himself that it is of a type-especially prepared for this purpose. Unless suitable aluminium primer is used, it is not possible to obtain a satisfactory basis for subsequent painting.

9. *Glazing* :

9.1. The glass used for panels shall be of good and durable quality, weighing not less than 7.5 kg./m^2. The particular type, quality and shade shall be as agreed to between the purchaser and the supplier.

9.2. In specifying sizes of openings or panes of glass, the first dimension shall be the width.

9.3. The glass shall be embedded in putty and secured to the rebate by wooden beads of suitable size and shape.

9.4. For external glazed doors and windows, the beading shall be fixed on the outside.

9.5. Wash leather, ribbon velvet, rubber flannel, felt, asbestos or other similar material may be used in place of putty for internal glazing. The material shall be fitted either as a beading on one side or in such a manner that it covers all parts of the glass which will be covered by the beading.

10. *Sampling and testing* :

10.1. *Lot* : In any consignment, all the shutters of the same type and manufactured under similar conditions of production shall be grouped together to constitute a lot.

10.2. The number of shutters to be selected at random from a lot shall depend upon its size and shall be in accordance with Columns 1 and 2 of Table 4.

10.3. *Number of Tests* :

10.3.1. The shutters selected as in 10.2 shall be inspected for dimensions (*See* 6.1), size (*See* 6.2) workmanship (*See* 5) and finish (*See* 6).

TABLE 4.

SAMPLE SIZE AND CRITERION FOR CONFORMITY.

Lot size.	*Sample size.*	*Permissible No. of defectives.*
(1)	(2)	(3)
26 to 65	10	1
66 to 110	15	1
111 to 180	25	2
181 to 300	35	3
301 to 500	50	4
501 and above	75	6

NOTE : For lot of 25 or less, no sample shall be taken for test.

10.4. *Criterion for conformity* :

10.4.1. The lot shall be considered as conforming to the requirements of this standard if conditions laid down in 10.4.2. are satisfied.

10.4.2. The number of shutters failing to satisfy the requirements of any characteristic mentioned in 10.3.1 shall not exceed the permissible number mentioned in Col. 3 of Table 4. If the number of shutters found unsatisfactory for the test is one, twice the number of shutters initially tested shall be selected and tested for that test. All the shutters so tested shall satisfy the requirements of the test. If the number of shutters found unsatisfactory for the test is two or more, the lot shall be considered as unsatisfactory.

11. *Marking* :

11.1. All door shutters shall be hammer-marked on the exposed edge of a rail with a mark identifying the manufacturer and the type.

11.1.1. The shutters may also be marked with the I.S.I. Certification Mark.

12. *Delivery* :

12.1. All external and internal door shutters shall be supplied completely assembled, unless otherwise specified by the purchaser.

12.2. Glazed doors when ordered, shall be supplied along with glazing beads, ready mitred and loosely fixed in positions in which they are to be fixed with the door or window.

12.3. Accessories shall not form a part of the supply unless specifically stated.

12.4. The purchaser shall supply the following information at the time of placing the order :

(*a*) The size and type of door shutters, the class and grade of timber to be used with particulars regarding nature of panels, the handling of door (right or left) and the way the door is required to open (inward or outward) ;

(*b*) Whether single or double leaved and the type of rebate in double leaved shutter ;

(*c*) Whether provision has to be made for letter plates postal knockers, etc. ; and

(*d*) Whether the door shutters are to be polished or painted

EXTRACT FORM I.S. 3629—1966.

Specification for structural timber in buildings.

3. *Material* :

3.1. *Species of Timber* :—The species of timber recommended for constructional purpose are given in Table I of I.S. 883—1966. For availability and general characteristics like durability, treatability, etc., of these species reference may be made to I.S. 399—1963. Species of timber other than those recommended may be used provided the basic strength characteristics are determined and the general principles outlined for design in I.S. 883-1966 are followed.

NOTE.—For obtaining basic strength figures of the unlisted species a reference may be made to the Forest Research Institute and Colleges, Dehra Dun.

3.1.1. Different species of structural timber may be classified according to their—

(*a*) durability (*see* 3.3.1.),

(*b*) treatability (*see* 3.3.3.), and

(*c*) structural characteristics (*see* 3.1.2.).

3.1.2. In respect of the defects, structural timber is classified in three grades, namely, Select Grade, Grade 1 and Grade 2 (*see* I.S. 1629—1960.)

3.2. *Moisture content in timber*.—Unless otherwise specified the moisture content of timber shall conform to the requirements of I.S. 287-1960.

3.3. *Treatment and Protection of Timber* :

3.3.1. *Durability*.—The timbers shall be classified for durability into the following three classes according to their average life :

Class 1. Natural durable heartwood timbers having average life of 120 months and over,

Class 2. Natural durable heartwood timbers having average life of 60 months and over but less than 120 months, and

Class 3. Timbers having average life less than 60 months.

NOTE.—Durability of various species is indicated in Column 16 of Table 1 of I.S. 883-1966. Durability of various species in their heartwood is based on the ' Grave Yard ' tests carried out in the open in which test specimens of size 60 x 5 x 5 cm. of untreated heartwood were buried in the ground to half their length.

3.3.1.1. In a timber structure using untreated heartwood of secondary species if one end of the timber column or post is buried in the ground it will last only for a limited period. But to prolong the life of the structure well over 30 years, and to guard against termite attack and other adverse factors, the timber column or post shall not be buried, under ground and shall be kept well above floor level.

3.3.2. *Preservation*.—For use in permanent structures, species of the following types of timber shall be treated for protection against decay and termites before use in accordance with I. S. 401-1961.

(*a*) Heartwood of all species of timber of Class 2 and Class 3 durability,

(*b*) Heartwood of all species of timber of Class 1 durability containing more than 15 per cent sapwood, and

(*c*) Sapwood of all species of timber of any class or durability.

3.3.2.1. Heartwood of all species of timber of Class 1 durability do not require preservative treatment except in cases coming under (*b*) above.

3.3.3. *Treatability*.—Treatable timbers may be classified as follows to indicate appropriately the degree of resistance offered by the heartwood of a species to the penetration of the preservative fluids under a working pressure of 10.5 Kg./cm.;

Class "A" Heartwood easily treatable ;

Class "B" Heartwood treatable but complete penetration of preservative not always obtained.

Class "C" Heartwood only partially treatable;

Class "D" Heartwood refractory to treatment ; and

Class "E" Heartwood very refractory to treatment, penetration of preservative being practical only from side or end.

4. *Suitability and grouping* :

4·1. The suitability of structural timber for a given purpose depends upon the following :—

(*a*) Durability and treatability of the species,

(*b*) Strength characteristics of the species, and

(*c*) Grading in respect of freedom from defects.

4.1.1. *Suitability in respect of durability and treatability for perma nent structures.*—There are two choices and they are given below.

4.1.1.1 *First Choice.*—The species shall be of any of the following :

(*a*) Untreated heartwood of Class 1 durability as listed in Column 1 of Table 1;

(*b*) Treated heartwood of classes 2 and 3 durability and Class A and Class B treatability as listed in Column 2 of Table 1.

(*c*) Heartwood of Class 2 durability and Class C treatability after pressure impregnation as listed in Column 2 of Table 1; and

(*d*) Sapwood of all classes of durability after thorough treatment with preservative.

4.1.1.2. *Second Choice.*—The species shall be of heartwood of Class 2 durability and Class D treatability. The thicknesses up to 6 cm after further pressure impregnation shall be significantly used for uses under cover and with ground, such as for trusses, column, beams lamella, arches, solid web and top girder, out of contact small dimen sioned timber fabricated by modern timber engineering technique fo residential buildings, factories, shed, etc. Such timbers are listed in Column 3 of Table 1.

4.1.2. *Suitability in respect of durability and treatability for temporary structures*—Heartwood of Class 3 durability and Class E treatability may be used where the life of the structure is not pri mary consideration. Such timbers are listed in Column 4 of Table. I.

4.2. *Grouping.* —Various species of structural timber are classified in three groups on the basis of their strength characteristics, namely, modulus of elasticity (E) and flexure stress in bending or tension along the grain (*ft*) as follows (*see* also Table I).

Group.	*Modulus of Elasticity (E) kg./cm².*	*limit ft. kg./cm².*
Super	.. Above 126,000	180
Standard	.. Above 98,000 and up to 126,000 ..	120
Ordinary	.. Above 56,000 and up to 98,000	85

5. *Permissible stresses* :

5.1. Basic strength value of different species of timber are determined on small clear specimen by standard methods of test [*see* I.S. 1708 (Part I) 1960 and I.S. 1703 (Part II) 1963]. These value are then divided by the appropriated factors of safety as given in Table 2 to obtain permissible stresses. The value of these permissible stresses for species for different locations are given in Table I of I.S. 883-1966.

5.2. The value of permissible stresses shown in Table I of I.S 883-1966 are applicable without any further increases or decreases when all the following conditions are satisfied :—

(*a*) The timbers should be of class 1 and class 2 durability and given the suitable treatment where necessary. It may be used on any location. If the location is inside, Class 3 durability timber may be used after proper seasoning and preservative treatment ;

(*b*) The timbers should be of Grade 1; and

(*c*) The loads should be continuous and permanent.

TABLE 2—FACTORS OF SAFETY TO BE APPLIED TO BASIC STRESS OBTAIN SAFE PERMISSIBLE STRESS.

Serial number and Types of Stress.	*Factors of safety for different situations of use.*		
	Inside location.	*Outside location.*	*Wet location.*
(1)	(2)	(3)	(4)
(i) Fibre stress in beams for broad leaved species, Min.	5	6	7.5
(ii) Fibre stress for beams in conifers Min.	6	7	8.5
(iii) Shear along grain ..	7	7	7
(iv) Horizontal shear in beams	10	10	10
(v) Compressive stress parallel to grain, Min.	4	4.5	5.5
(vi) Compressive stress perpendicular to grain.	1.75	2.25	2.75

5.3. In cases where all the above conditions are not satisfied the permissible stresses given Table I of I.S 883—1966 require to be multiplied by the following factors to obtain working stresses :

(*a*) Class 3 durability timber used on outside location	0.80
(*b*) select grade timber in bending, shear and compression.	1.16
(*c*) Grade 2 timber in bending, shear and compression	0.84

5.3.1. When the timber has not been graded and has major defects like sloping range, knots and checks or shakes (but not beyond permissible value) the working stresses shall be obtained by applying suitable percentage reduction factors as given in Table 3.

5.4. *Shocks Under Impact.*—Under impact, wood shall be considered as capable of resisting a force twice that of the static load to which it has been designed.

6. *Tolerances on dimensions* :

6.1. Dimensions of structural timber shall be normally within maximum tolerances specified as follows, except where net dimensions are specificially mentioned :

Size (Width and Thickness.)	*Maximum Tolerance.*
Up to 100 mm	+3mm (no negative tolerance)
Above 100 mm	±3 mm

TABLE 3—PERCENTAGE REDUCTION IN STRENGTH TO ALLOW FOR SLOPE IN GRAIN.

(*Clauses* 5.3.1. *and* 8.2.1.3.)

Slope.	*Strength of Beams, Joists and Ties, Max. Per cent.*	*Strength Posts or Column. Max. Per cent.*
(1)	(2)	(3)
1 in 10	64	74
1 in 12	69	82
1 in 14	74	87
1 in 15	76	100
1 in 16	85	100
1 in 18	85	100
1 in 20	100	100

TABLE 1—GROUPING OF TIMBER FOR STRUCTURAL USE.

(*Clauses* 4.1.1., 4.1.2. *and* 4.2.)

Species for Permanent Structures.						*Species for Temporary Structures*	
First Choice.				*Second Choice.*			
(1)		(2)		(3)		(4)	
GROUP — SUPER.							
Botanical Name	Trade Name	Botanical Name	Trade Name	Botanical Name	Trade Name	Botanical Name	Trade Nene
Acacia catechu	Willd Khair	Cynometra polyandra	Ding	Grewia tiliaefolia Vahl.	dhaman	Stereospermum	Chelonoides Padri DC.
Albizzia odoratissima Benth	Kala siris	Dipterocarpus macrocarpus Vesque.	Hollong	Poeciloneuron	indicum		
				Bedd.	Ballagi		
Balanocarpus-utilis	Karung kongo	Schleicherr trijuga	Kusum	..	..	..	..
Hopea glabra & Hopea parviflora Bedd.	Hopea	..	..	..	..	..	..
Mesua ferrea Linn	Mesua	..	..	..	..	..	..
Mimusops elengi	Bullet-wood	..	..	..	..	..	..
Pterocarpus santalinus Linn. f.	red sanders	..	..	..			
Shorea robusta Gaertn. f.	Sal (U.P.)	..	..	..	..	..	
Vites altissima Linn. t.	milla	..	..	..	..	..	..
GROUP—STANDARD.							
Albizzia lebbeck Benth.	Kokko	Acacia arabica Willd.	Babul	Allingia excelia	Jutili	Anogeissus latifolia Wall.	Axlewood
Bassia butyracea	Hill mahua	Acrocarpus	Mundani	Amoora Sp.	Amari	Artocarpus hirsuta Damk.	Aini.
				Anegeissus acuminata			
Carapa moluccensis	pussur	fraxinifolius wight		wall.	Yon		
Dysoxylum malabaricum Bedd.	White Cedar	Casuarina equisetifolia Linn.	Casuarina	Carallia lucida	Maniagwa	Canarium strictum Roxb.	White duhp
Eucalyptus eugenioides.	Eucalyptus	Cullenia excelsa	Karani	Dichopsis elliptica and Dichopsis. palvantha.	Pali and tali.	Chloroxylon swietenia.	Satinwood
						Cinnamomum sp	Cinnamon
Cluta travancorica Bedd	Gluta	Dipterocarpus sp	Gurjan	Eugenia sp	Jaman	Dioxpyros melanoxylon Roxb.	Ebony
Hardwickia pinnata Roxb.	Piney	Terminalia belerica Roxb.	Behera	Grewia vestita Vahl.	Dhaman (UP. M.P)	Heritera sp	Sundri
Lagerstroemia Lanceolata Wall.	Benteak	Terminalia chebula	Myrabolm	Mimusops elengi	Bulletwood	Kayea floribunda	Karal
Pterocarpus datbergioides.	Padauk	Termanalia manii King.	Black Chuglam	Terminalia paniculata Roxb.	Kindal (Bombay)	Lagerstroemia parviflora Roxb.	Londi
Pterocarpus marsupium Roxb.	Bilasal	Terminalia terentosa	Laurel	Terminalia paniculata Roxb.	Kindal (Madras)	Machilus macrantha Ness.	Machilus
		Wight at Arn. Quercus sp.	Indian Oak	..			
Shorea rebusta Gaertn. f.	Sal. (M.P.)	..				Planchonia andamanica.	Red bombwe
Soymida febrifuga	Rohini	..	..	..	..	Saccopetalum tomentosum Hook f. ct. Th.	Hoom
Tectona grandis Linn	Teak	..	..	..	..		
Xylia dolabriformix	Irul	..	..	..	..	Terminalia bialate Steudel.	White Chuglam

TABLE , — GROUPING OF TIMBER FOR STRUCTURAL USE.—*cont.*

(Clauses 4.1.1., 4.1.2. and 4.2.)

Species for Permanent Structures.						*Species for Temporary Structures.*	
First Choice.				*Second Choice.*			
(1)		(2)		(3)		(4)	
			GROUP—ORDINARY.				
Artocarpus integrifolius Auct.	Kathal	Adina cordiolia Hook. f.	Haldu	Artocarpus chaplasha Roxb.	Chaplash	Abies pindrow spach	Fir
						Aegle marmelos	Bel.
Artocarpus lakoocha Roxb.	Lakooch	Albzizia procera	Safed sirsis	Bridelia retusa Spreng.	Kasi	Ailanthus grandis	Gokul
Azadirachta indica	Neem	Anthocephalus cadamba Miq.	Kadam	Calophyllum sp	Poon	Anisoptera glabra	Kaunghmu
Bassia latifolia Roxb.	Mahun	Castanopsis hystrix	Chestnut	Dalbergia sissoo Roxb.	Sissoo	Bischofia javanica Blume.	Uriam
Careya arborea Roxb.	Kumbi	Cedrala sp.	Toon			Boswellis serrata Roxb.	Salai
Cedrus deodara Laudon.	Deodar	Chukrasia tabularis Adv. Juss.	Chickrassay	Elaeocarpus tuberculatus Roxb.	Rudrak	Diospyros melanoxylon Roxb.	Ebony
Cupressus torulosa Don.	Cypress	Dillenia sp.	Dillenia	Lagerstroemia floserginae Retz and Lagerstroemia hypoleuca Kurz.	Pyinma and jarul.	Duabanga sonneratioides Ham.	Lampat
		Holoptelea integrifolia Planch.	Kanju			Garuga pinnata Roxb	Garuga
Dlabergia latifolia Roxb.	Rosewood (MP.)	Mangifera indica Linn.	Mango	Podocarpus sp.	Thitmin	Heterophraguma roxburhii	Palang
Dalberga latifolia Roxb.	Rosewood (Malabar)	Mitragyna parvifolia Korth.	Kalm			Juglans sp	Walnut
						Lophopetalum wightiamum Arm	Banati
Balbergia sissoo Roxb.	Sissco (UP)	Pinus excelsa Wall	Kail			Machilus macrantha Ness.	Machilus
		Pinus longifolia Roxb.	Chir			Michelia sp.	Champ
Gmelina arborea Linn.	Gamari	Phoebe sp.	Bonsum			Miliusa velutina	Domsal
Hardwickia binata Roxb.	Anjam	Pterospermum acerifolium Willd.	Hathipalia			Morus sp	Mulberry
						Myristica attenuata Wall.	Jathikai
Ougeimiadal bergioides Benth.	Sandan	Stereospermum cheleonoides DC	Padri			Picea morindabink	Spruce
Tectna dix Lin.f.	Teak (MP)	Swintonia floribunda	Civit			Polyalthia fragrans	Debdaru
		Terminalia arjuna Bedd.	Arjun			Pongamia glabra	Sakvarni
		Terminalia myriocarpa. Heurck et Muell. Arg.	Hollock			Schima wallichii Choisy	Chilaun
						Shorea assamica - Dyer.	Makai
						Sonneratia apetala	Keora
						Terminalia procera Roxb.	White Bombwe
						Vateria indica Linn	Vellapin

EXTRACT FROM I.S. 1761—1960.

Specification for Transparent sheet Glass for Glazing and Framing Purposes.

3. *Sampling* :

3.1. Representative samples of sheet glass shall be drawn as prescribed in Appendix A.

4. *Requirements* :

4.1. *Quality of Glass* :—Shall be reasonably free from blisters, stones, scratches and bubbles so as not to disturb the visibility through the glass. Blisters exceeding 4 mm. shall not be present. Blisters less than 4 mm, if present, shall be less than 30 per square metre and shall be fairly uniformly distributed. Bubbles below 2 mm. need not be considered.

4.2. *Waviness* :—The sheet glass shall not show any distortion of light from its parallel nature when tested according to the method prescribed in Appendix B.

4.3. *Tolerance on Cut Sizes* :—The cut sizes of sheet glass shall be within the following telorances, on both length and width of the prescribed cut sizes :—

Thickness. mm.	*Tolerance on cut size.* mm.
2.5 and below	±1.5
3.0 and above	±2·0

4.4 *Thickness*:—The thickness of sheet glass when tested according to the method prescribed in Appendix C, shall be as follows, within the tolerance indicated against each :—

Thickness. mm.	*Tolerance on thickness.* mm.
2.0	±0.2
2.5	±0.2
3.0	±0.2
4.0	±0.2
5.0	±0.2
5.5	±0.2
6.5	±0.3

5. *Packing and Marking*.

5.1. *packing*.—The sheet glass shall be packed as agreed between the purchaser and the supplier.

5.2 *Marking*.—The packages shall be marked with the name and size of the material, and the name of the manufacture or his trade mark, if any.

5.2.1 The packages may also be marked with an identification mark in code or otherwise to enable the lot of manufactures to be traced back from records.

5.2.2 The packages may also be marked with the ISI Certification Mark.

APPENDIX-A.

(*Clause* 3.1)

Sampling of Transparent Sheet Glass.

A-1 *Scale of Sampling*:

A-1.0. Samples to ascertain conformity of a consignment of sheet glass to this specification shall be selected so as to be representative o the consignment. Samples drawn in compliance with an agreemen between the purchaser and the supplier to evaluate the various characteristics of the sheets shall be held to be representative of the lot. In case of dispute, the following sampling scheme is recommended to serve as a guide.

A-1.1. *Lot*.—All the sheets of glass in a consignment belonging to the same grade, same size in width and length, same thickness and the same batch of manufacture shall constitute a lot. If the consignment is declared or known to consist of sheets of different grades, sizes, thickness or different batches of manufacture, the sheets pertaining to the same grade, size, thickenss and batch shall be grouped together and each such group shall constitute a separats lot.

A-1.2. Samples shall be tested from each lot for ascertaining conformity of the sheets in the lot to the requirements of this specification.

A-1.3. The number of samples to be tested from a lot shall be in accordance with Col. 1 and 3 of Table 1. These samples shall be drawn at random from the units in the lot.

A-1.4. In order to ensure the randomness of selection of the samples from the lot some random number table as agreed between the purchser and the vendor shall be used. In case such a table is not available, the following procedure shall be adopted.

A-1.4.1. Arrange all the sheets in the lot in a systematic manner and starting from any sheet count them as 1, 2, 3, etc., upto r and so on. Every rth sheet thus counted shall be drawn from the lot to give a sample for test, where

$$r = N/n$$

N being the total number of sheets in the lot and n the number of sheets to be chosen (sec A-1.3).

In case *r* comes out to be fractional number, its value shall be taken to be equal to the integral part of it.

A-2. *Criterion for Conformity*:

A-2.1 Tests on these samples for ascertaining the conformity of the lot to the various requirements laid down in 4 shall be done in two stages as shown in Col. 2 of Table I. Any sheet of glass not satisfying the requirements prescribed in this standard shall be considered as defective.

A-2.2. At the first stage of testing if the number of defectives found is lessthan or equal to the corresponding acceptance number shown in Col. 5 of Table I against the first stage, the lot shall be accepted as conforming to the specification without further tesing.

A-2.3. If the number of defectives is greater than or equal to the corresponding rejection number shown in Col. 6 of Table I against the first stage, the lot shall be rejected without any further testing.

A-2.4. If the number of defectives lies between the acceptance and the rejection number, a second sample consisting of as many sheets as shown in Col. 3 of Tabel I against the second stage shall be tested, The total number of defectives in the combined sample (that is, the tests results of the first and second samples taken together) shal then be compared against the acceptance and rejection numbers o the second stage of sampling.

A-2.4.1 The lot shall be accepted as conforming to the requirements of this specification if the number of defectives found in the combined samples is not more than the corresponding acceptance number. The lot shall be rejected if the number of defective sheets is equal to or greater than the corresponding rejection numbers.

TABLE I—CRITERION FOR CONFORMITY AT DIFFERENT STAGES OF SAMPLING.

(*Clauses* A-1.3, A-2.1, A-2.2., A.2.3, *and* A-2.4.)

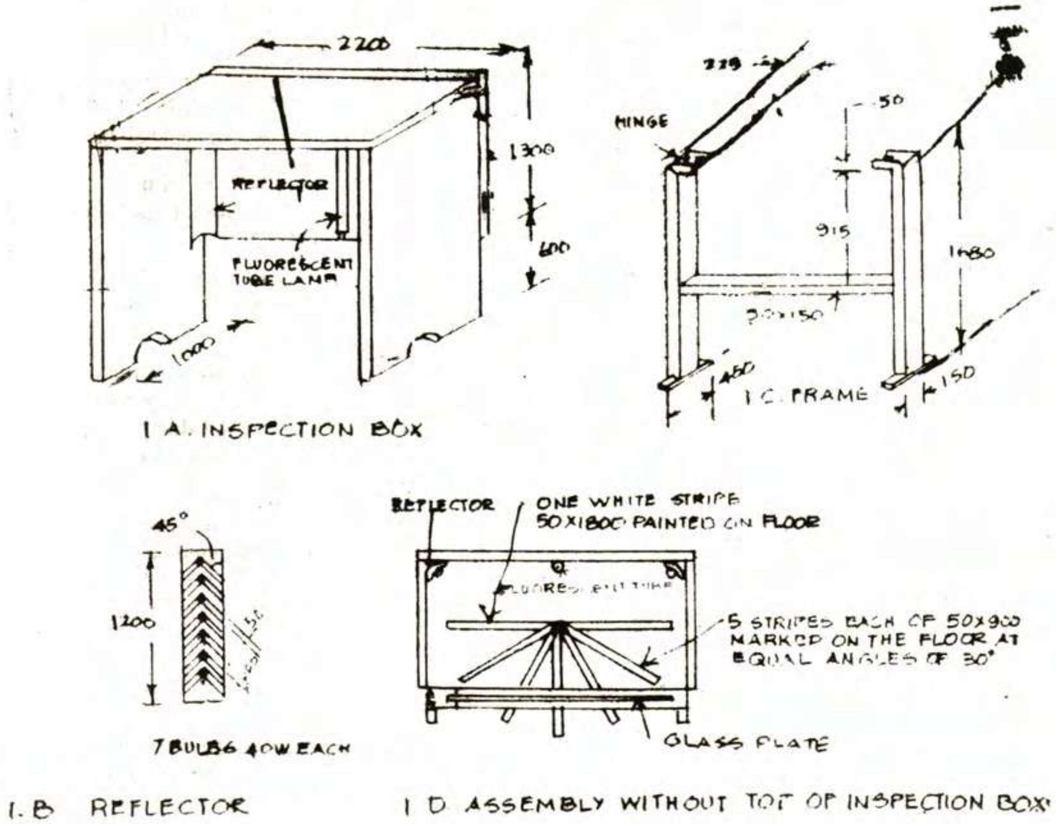
Lot size.	*Stage.*	*Sample size.*	*Combined.*	*Acceptance number.*	*Rejection number.*
(1)	(2)	(3)	(4)	(5)	(6)
Below 200 ..	First ..	7	7	1	5
	Second ..	14	21	4	5
200 to 500 ..	First ..	15	15	3	7
	Second ..	30	45	6	7
Over 500 ..	First ..	25	25	5	11
	Second ..	50	75	10	11

APPENDIX-B.

(*Clause* 4.2)

TEST FOR WAVINESS.

B-1 *Apparatus*.



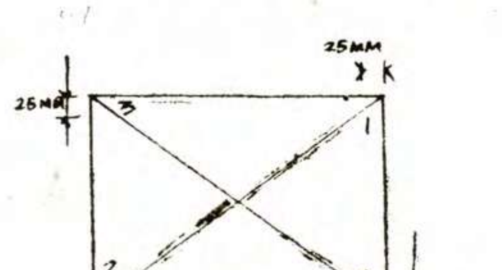


FIG 2. DETERMINATION OF THICKNESS

ALL DIMENSIONS IN MILLIMETRES

FIG. 1. APPARATUS FOR WAVINESS TEST

B-1 Apparates

B-1.1 *Quality Inspection Box.*—The quality inspection box as shown in Fig. 1 consists of the following parts :—

B-1.1.1 *Inspection Box.*—The inspection box is made of wooden planks or of mild steel sheets to the dimensions shown in Fig. I-A. The inside of the box is painted black. One fluorescent tube lamp 120cm long is fixed vertically at the back in the centre of the box. Two concave tinplates or plastic reflectors (See Fig. I-B), 120 cm long painted with black stripes in a white background are mounted, one each at the back corner of the box. Each reflector is provided with seven equally spaced bulbs of 40 watts.

B-1.1.2 *Frame.* The wooden frame to hold the sheet glass for inspection shall be made to the dimensions indicated in Fig. I-C. The slits on the top of the frame may be of a size suited to the thickness of the sheet glass to be tested.

B-1.2 *Assembly.*

B-1.2.1. On a plane truly horizontal floor is painted a white stripe 50 mm wide and about 180 cm. long. From the centre of this line, are marked radially 5 stripes each 50 mm, wide and 90 cm long at angles of (30° 60° 90° 120° and 150°) (see Fig. I-D).

B-1.2.2. The box is placed on the floor in such a way that its centre line is along the first long stripe and that its centre coincides with the centre from which the other painted stripes radiate.

B-1. 2.3. The frame is placed just in front of the box so that it is parallel to the box.

B-2. *Procedure.*

B-2.1· Mount the sheet glass on the frame so that it stands exactly vertical. Switch on the fluorsecent tube lamp and the other lamps in the inspection box. View the black stripes at the corner of the box through the glass from the 30° and the 150° lines.

B-2.1.1 Carry out the test along the direction of draw as well in the direction perpendicular to it.

B-2.2. The sheet glass shall be regarded as not showing any distortion or waiveess, if the black stripes appear truly parallel.

APPENDIX-C.

(*Clause* 4.4)

DETERMINATION OF THICKNESS.

C-1 *Apparatus.*

C-1.1 Screw callipers with an accuracy of 0.01 mm.

C-2. *Sheet Glass Sizes.*

C-2·1 For the purpose of determining thickness, sheet glass shall be divided into the following three categories:—

(*a*) Upto 60 united cm;
(*b*) From 60 to 120 united cm ; and
(*c*) Over 120 united cm.

Note —United cm means half the perimeter of the sheet.

C-3. *Procedure.*

C-3.1. *Marking of points* —Draw two diagonals across the rectangular sheet and mark points, 1, 2, 3 and 4 by screw callipers as shown in Fig. 2.

C-3.2 *Determination of thickness.*—Measure the thickness of the sheet at the points indicated below:

(*a*) Sheets upto 60 united cm Any one of the four points
(*b*) Sheets from 60 to 120 united cm Points 1 and 2, or 3 and 4.
(*c*) Sheets over 120 united cm All the four points.

C-3.2.1 In case more than one measurement is made under C-3·2 report the average of the measured values as the thickness of the sheet.

ETRACT FROM I.S. 3087—1965.

Specification for wood particle Boards (medium density) for general purposes.

2. *Terminology* :

2.0. For the purpose of this standard, the following definitions shall apply and for definitions other than those given below, reference may be made to I.S. 707 1958.

2.1. *Additive.* Any material introduced prior to the final consolidation of a board to improve some property of the final board. Fillers and preservative are included under this term.

2.2. *Binder.*- Organic bonding agent used to bond together the particles in a particle board, usually a synthetic resin based on phenol formaldehyde or urea formaldehyde.

2.3. *Extrusion-pressed particle board.*— Resin-bonded particle board manufactured by mixing wood particles of predetermined sizes and shapes with synthetic resins of the phenol formaldehyde or urea formaldehyde types and curing and pressing while the mix is being forced through an extrusion hot planten press, pressure being applied in the direction of the length of extrusion which tends to orientate the wood particles considerably in a direction at right angles to the direction of extrusion.

2.4. *Flat-pressed Particle Board.*—Resin-bonded particle board manufactured by mixing wood particles of pre-determined sizes and shapes with synthetic resins of the phenol formaldehyde or urea formaldehyde types and curing and pressing in a parallel platen hot press of the usual multiplaten type but may be pressed in a continuous band type of press. The applied pressure perpendicular to the plane of the Board which orientates the particles mainly with the larger dimension parallel with the plane of the board.

2.5. *Formation (Forming)* —The laying of the blended mass of particles to form a mat for particle board.

2.6. *Multi-Layer Particle Board.*— A board made of several layers of like material in which particles of different shapes and sizes may be used in different layers.

2.7. *Particles.* —Distinct partlce or fraction of wood or other lignocellulose material produced mechaniclly for use as the aggregate for a particle board. This may be in the form of flake, granule shaving splinter and sliver as stated bleow :—

Flakes.—Specially made thin flat particles, with the grain of the wood essentially parallel to the surface of the flake, prepared with the cutting action of the knife in a plane parallel to the grain but at an angle to the axis of the fibre.

Granule.—A particle in which the length, width and thickness are approximately equal, such as particle of saw-dust.

Shaving.—A thin slice or strip of wood pared off with a knife plane or other cutting instrument, the knife action being approximately along the axis of the fibre, such as the shavings produced in planing the surface of wood.

Splinter and sliver.—Particle of nearly square or rectangular cross-section with length parallel to the grain of the wood of atleast four times the thickness.

2.8 *Particle Board.*—A board manufactured from particles of wood or other ligno-cellulose material, for example, flakes; granules; shavings; slivers, splinters agglomerated, formed and pressed together by use of an organic binder together with one or more of the agents, such as heat, pressure, moisture, a catalyst etc.

2.9 *Single-layer particle Board.*—A Board made of one uniform layer of particles and resin mix and predominantly of uniform texture and stregnth in the whole depth of the board.

2.10 *Sizing material.*—Alum, wax, resin or other additive introduced to the agglomerate for a particle board prior to forming, primarily to increase water resistance.

2.11 *Three-Layer Particle Board.*—A particle board made of three layers of particles and resin mix, usually with finer and thinner particles for the top and bottom layers and coarser and bigger particles for the core layer. A three-layer board may consist of core of one species and the outer layers of another species. Resin content in a three-layer board is usually higher in the face layers than in the core layer leading to a sandwich construction with stronger and denser skin.

3. *Types.*

3.1 The particle boards for general purposes shall be of four-types, that is, flat pressed, single-layer type; flat pressed, three-layer type extrusion pressed, solid type; and extrusion, pressed, tubular-core type. The designation of particle boards for general purposes shall be based on the types as given in Table I.

TABLE 1: DESIGNATION OF PARTICLE BOARDS FOR GENERAL PURPOSES.

Serial number and type.	*Designation.*
(i) Flat pressed, single-layer board	FP SI
i) Flat pressed, three-layer board	FP TH
iii) Extrusion pressed, solid board	XP SO
(iv) Extrusion pressed, tubular-core board ..	XP TU

4. *Materials*:

4.1 Any species of timber, which is found satisfactory, may be used for production of particle boards.

4.2 *Adhesive.*—The adhesive, used for bonding purpose, shall be either of:

(*a*) BWR type,
(*b*) WWR type, or
(*c*) Unextended CWR type conforming to ISI 848-1957

4.3 *Sizing material.*—Paraffin wax dissolvd in mineral spirit or alternatively emulsified with water or melted shall be used as sizing material.

5. *Manufacture.*

5.1 Wood particles for the manufacture of particle boards shall be produced by cutting the specified timbers into shavings, flakes splinters or slivers on a suitable chipping machine. The wood particles shall be dried in a mechanical drier. The dried particles shall be graded to required uniform sizes and thoroughly blended with the requisite quantity of specified binders in mechanical mixers or applicators. The required sizing material may be added at this stage, either mixed with the binder or separately introduced into the mixer. Care shall be taken that the moisture content of the binder does not increase the moisture content of the chips. The well-blended chips are then formed and pressed into panels by passing into the pressing machine under controlled heat, pressure and time conditions.

5.2. In case of three-layer particle boards, the construction shall be well-balanced about the central plane. In case of a single-layer particle board, the particles shall be uniformly laid. care shall be taken that no asymmetric grading of chips takes place.

6. *Finish.*

6.1. The particle boards shall be of uniform thickness and uniform density throughout the length and width of the boards. All particle boards shall be flat. Both faces of the particle board shall be sanded to a smooth finish. The sanding, when given, shall be uniform on both the surfaces.

7. *Dimensions and tolerances.*

7.1. The sizes of wood particle boards shall generally be as follows:

Length.—485 (480), 365, (360), 300, 270, 240, 210, 180, 150, 120, 100, and 90 cm.

Width.—180, 150, 120, 100, 90, 60 and 45 cm.

Note.—Values which are underlined are multiples of the 30 cm module for building boards.

7.2. *Thickness.*—The thickness of particle boards shall be as given below: 6, 9, 12, 16, 19, 20, 21, 22, 25, 27, 30, 35, 40, 45 and 50 mm.

7.3. Other thicknesses or sizes may be manufactured on special demand as specified by the purchaser.

7.4. *Tolerances.*—The following tolerances on the dimensions of finished boards shall be permissible.—

Dimension. (1)	*Tolerance.* (2)
(*a*) Length: Above 150 cm.	± 9 mm
Upto 150 cm	± 6 mm
(*b*) Width. Above 150 cm	± 9 mm
Upto 150 cm	± 6 mm
(*c*) Thickness: Above 25 mm	± 2.5 per cent.
	± 5 per cent.

7.4.1. The lengths of the two diagonals of a wood particle board rectangular panel, shall not differ by more than 2.5 mm maximum

7.4.2. The edges of the board shall be straight with a tolerance of 3 mm.

8. *Physical Characteristics.*

8.1. *Density.*—The mean density of the boards, when tested in accordance with 10.3 shall be between 500 and 900 kg/m^3 The density shall not vary from one sample to another by more than ten per cent of the mean density.

8.2. *Moisture Content.*—The mean moisture content of the boards when determined in accordance with 10.4. shall not be less than 7 per cent and not more than 16 per cent. The moisture content of individual test specimen shall not vary from the mean percentage by more than ± 3 per cent.

8.3. *Water Absorption.*—The mean water absorption of the boards when tested as described in 10.5 shall not exceed the prescribed limit given in Table 2 for various types of boards after both 2-hour and 24 hour immersion.

8.4. *Swelling in water.*—The mean swelling in thickness, length and width. when tested as described in 10.6, shall not exceed the limits given in Table 2 for various types of boards.

8.5. *Swelling due to surface absorpotion.*—The mean swelling in thickness due to surface absorption, when tested in accordance with 10·7 shall not exceed the limits given in Table 2 for various types of boards.

8.6. *Workability.*—The particle boards shall not crack or split when drilled, sawed and nailed perpendicular to the surface.

NOTE.—Recommended precautions for storing, cutting and working with particle boards are given in Appendix A.

TABLE 2—STRENGTH AND OTHER CHARACTERISTICS OF VARIOUS TYPES OF WOOD PARTICLE BOARDS.

[*Clauses* 8.3, 8.5, 9.2.1 (*j*), 10.8, 10.9, 10.10 *and* 10.11.]

Types of Board.	*Bulk Density kg/m³.*	*Variation in Density percent.*	*Water Absorption.* *2-hour soaking.*	*4-hour soaking.*	*Swelling, Per cent.* *Thickness.*	*Length.*	*Width.*	*Swelling due to surface absorption in thickness per cent.*	*Minimum Modulus of Rupture kg/cm².* *Lengthwise.*	*Widthwise.*	*Minimum tensile strength perpendicular to surface kg/cm².*	*Thermal Conductivity k cal/hr/m²/°C/m thickness.*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Flat Pressed, Single-Layer Board (FPS).	500 to 900	±10	30	70	12	5	5	9	90	90	8	0.12
Flat Presssd, Three-Layer Particle Board (FPT).	500 to 900	±10	40	80	12	5	5	9	110	110	3	0.12
Extrusion Pressed, Solid Particle Board (EPS).	500 to 900	±10	40	80	5	12	5	4	3	20	12	0.12
Extrusion Pressed, Tubular Particle Board (EPT).	500 to 900	±10	45	80	5	12	5	4	–	10	4	0.06

NOTE.—The values for minimum modulus of rupture should be multiplied by 0.8, when the thickness of the board exceeds 20 mm.

EXTRACT FROM I.S. 852—1969.

Specification for Animal Glue for General Wood-working purposes.

2. *Material* :

2.1. The glue shall be prepared from skin or bone material. It shall be supplied in the form of shects, cakes, granules, pearls, flakes or powder, or in a kibbled form, as specified by the purchaser.

3. *Requirements* :

3.1. Final samples for testing shall be prepared in accordance with Appendix A from the samples selected as specified in 4.2. to 4.4. These final samples shall be subjected to the tests specified in 3.3 to 3.8 for the requirements specified in the respective clauses.

3.2. *Odour.*—The odour of a freshly prepared hot solution of ohe glue shall not be objectionable.

3.3. *Keeping quality.*—When tested by the method described in Appendix B, the glue shall keep not less than six days without evidence if liquefaction, putrefaction or mould growth.

3.4. *Storage Properties*—The glue shall retain all the properties specified under 3.2, 3.5 to 3.8 for atleast 12 months from the date of manufacture, when stored in a cool dry place.

3.5. *Moisture Content* :

3.5.1. The average moisture content of the glue, when determined by the method described in Appendix C, shall be not greater than 14 per cent and no individual value shall be greater than 18 per cent

3.5.2. Should the average moisture content be more than 14 per cent (not to exceed 18 per cent under any circumstances), the supplies shall make good the deficiency in the weight delivered in the manner stated below :

The weight of the material delivered (as weighed on delivery shall be equal to $N\frac{86}{100-M}$

Where N = nominal weight of the consignment ordered, and M = average percentage moisture content.

3.6. *Chloride.*—The chloride content shall not exceed 2 per cent calculated as sodium chloride, when determined by the method described in Appendix D.

3.7. *Reaction.*—The pH value of the glue, when determined by the method described in Appendix E, shall be not lower than 4.0 nor higher than 8.2.

3.8. *Overlap joint strength in Longitudinal Shear.*—The average failing load of five test specimens, prepared and tested by the method described in Appendix F, shall be not less than 275 kg.

4. *Sampling* :

4.1. Representative samples of the animal glues shall be selected in the manner specified in 4.2 to 4.4.

4.2. *Sheet and Cake Glue.*—A number of container shall be selected for sampling from various parts of the consignment in such a manner that complete representation is assured. The number of containers to be sampled shall be in accordance with Table 1.

TABLE 1 : SAMPLING OF SHEET AND CAKE GLUE.

Number of containers in the consignment.	*Number of containers to be sampled.*
1 to 5	1
6 to 50	5
51 to 100	10
101 to 500	15
501 to 1,000	20

4.2.1. In the case of containers of not less than 50 kg. of glue he weight of sample drawn shall be not less than 1 Kg. where there s only one container, and not less than 0.5 kg. from each container n other instances ; in the case of containers of less than 50 kg. of glue, the amount taken shall be proportional.

4.2.1.1. Each sample increment shall consist of the whole or equal proportions of not less than four sheets of cakes, which shall be representative of the contents of the container.

4.3. *Powdered, Pearl, Cube or Granulated Glue.*—Glue in these forms shall be sampled in the same proportions as prescribed for sheet and cake glues. Each increment shall be taken by means of a sampling tube scoop, or similar tool, to ensure glue being taken from the top, middle and bottom of the container.

4.4. *Flake and Kibbled Glues.*—Glues in these forms shall be sampled in the same proportions as prescribed for sheet and cake glues, the 0.5 kg. proportions taken from each container being as representative as possible.

5. *Instruction for use* :

5.1. The manufacturer shall state in his instructions the method of preparing the glue for use.

6. *Packing and marking* :

6.1. *Packing.*—Unless otherwise specified, the glue shall be packed in suitable quantities as agreed to between the purchaser and the supplier in gunny bags with alkathene liner.

6.2. *Marking.*—Each bag of animal glue shall be legibly and indelibly marked with the following information :—

(*a*) Manufacture's name or trade-mark, if any ;

(*b*) Description of the material ;

(*c*) Year of manufacture ; and

(*d*) Batch number.

6.2.1. Each bag may also be marked with the ISI Certification Mark.

EXTRACT FROM I.S. 4835—1968.

Specification for polyvinyl acetate dispersion-based adhesives for wood.

3. *Material* :

3.1. The polyvinyl adhesives covered in this standard shall be based on polyvinyl acetate dispersions.

4. *Keeping qualities* :

4.1. The adhesives shall comply with the requirements specified in 8 after the same has been stored in the original closed containers according to the manufacturer's instructions and up to the date recommended by the manufacturer.

5. *Instructions for use* :

5.1. The manufacturer shall furnish dated and written instructions detailing the manner in which the adhesive or recommended combination of adhesive with any modifier or extender that be necessary is to be used. These instructions shall cover in particular the following :—

(*a*) Storage of adhesive in original sealed containers ;

(*b*) Preparation for use of the adhesive, method of mixing or dilution where necessary, type of mixtures and apparatus for use of adhesive and other necessary precautions for handling of the adhesive;

(*c*) Recommended control necessary during thinning, if wanted

(*d*) Complete recommended application procedure including surface cleaning procedure, the recommended film thickness, range spread desired, number of coats, method of cleaning the equipment and recommended method of application in particular the following:

(1) Range of moisture content of wood ;

(2) Preparation of wood surfaces ;

(3) Methods of application, such as single or double spread ;

(4) Normal amounts of spread for single glue line ;

(5) Maximum and minimum open and closed assembly times ;

(6) Recommended range of pressures in kg/cm^2 ;

(7) Post-treatment of finished product;

(8) Cleaning of containers and test ;

(9) Type of other materials that can be glued to wood or to each other and special precautions that may be necessary of temperature to which the adhesive in any glue line may be subjected and the minimum and maximum time for which pressure shall be maintained on unstressed joints at temperatures within the range ;

(10) Setting time and setting conditions including recommended range ;

(11) Method of correcting viscosity or scum formation ; and

(12) Safety precautions for the workmen, if any.

6. *Sampling.*

6.1. The sampling of polyvinyl acetate dispersion-based adhesives is very important. Most of the polyvinyl acetate dispersions tend to settle and this separation increases with particle size. Before sampling bulk material shall be stirred thoroughly to make it homogeneous.

6.1.1. Sampling shall be done as given in Appendix A.

6.1.2. Each sample shall comply with the requirements laid down in 8.

7. *Testing* :

7.1. All the methods of tests for polyvinyl acetate dispersion-based adhesives shall be done as given in Appendix A except the method of test for glue joint which shall be done as given in Appendices A to E of I.S. 851—1957.

8. *Requirements for test* :

8.0. The tests shall be carried out on each of the samples and the sample shall conform to the test requirements as given in 8.1 to 8.7.

8.1. *Solid Content* :—The solid resin content of the adhesive shall not be less than 50 percent when tested in accordance with Appendix A.

8.2. *Viscosity* .—The adhesive shall have a viscosity not less than 600 and not more than 1200 centipoises as determined by tests laid down in Appendix A.

8.3. *pH Value* .—The pH value of the adhesive when tested in accordance with Appendix A shall be not less than 4 and shall not be more than 7.

8.4. *Bulk Density* .—The weight per litre of the adhesive when tested in accordance with Appendix A shall not be less than 0.90kg.

85.. *Glue Joint Strength* :

8·5.1. *Dry Strength* .—The average failing load of a se of six test pieces prepared by the method specified in Appendix B of I.S. 851-1957, conditioned approximately as specified in Appendix C of I.S. 851-1957 and when tested by method described in Appendix D of I.S. 851-1957, shall be not less than 100 kg.

8.5.2. *Resistance to Micro-Organism, Micrological Tests.*— The purchaser may specify any resistance to micro-organism of the adhesive. A general guide for testing the resistance to micro-organism is given in Appendix C of I.S. 851–1957.

8.6. *Early Strength Development.*— The average failing load of a set of six test pieces prepared by the method specified in Appendix B of I.S. 851–1957 using wood test slips and glue at 27°±2°C, kept under pressure for two hours at 27°±2°C as specified in Appendix C of I.S. 851–1957 and tested immediately after release from clamps by the method described in Appendix D of I.S. 851–1957 shall be not less than 60 kg.

8.7. *Stability.*— The adhesive shall meet the requirements for solid content, viscosity, pH, weight per litre, and adhesive strength at all the time within the storage period of adhesive as recommended by the manufacturer and at the specified upper limit of temperature. The manufacturer shall certify that the product has been tested and meets this requirements of stability.

8.8. *Working Consistency.*— The adhesive shall be of consistency for brushing or roller application. If a different working consistency is desired the adhesive shall be capable of being adjusted for its viscosity by the addition of a small amount of water according to the instruction sheet of the manufacturer.

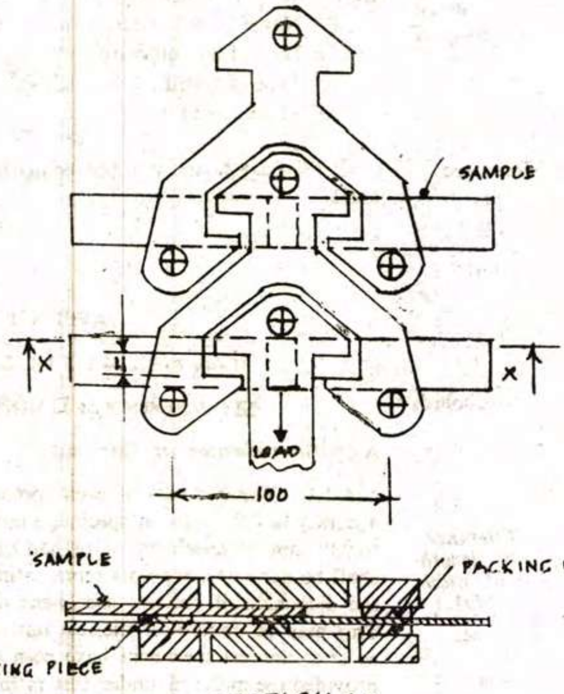
8.9. *Temperature of Set.*— The average failing load of a set of six test pieces prepared by the method specified in Appendix B of I. S. 851–1957 using wood test slips and glue at 10°±2°C, kept under pressure or 24 hours at 10°±2°C, released from clamps and freely exposed to the air at 27°±2°C for four days shall be not less than 60 kg.

8.10. *Resistance to Sustained Load.*— Support the test piece (prepared and conditioned in accordance with Appendix B of I.S. 851–1957 laterally by means of small packing pieces, between the frames of the jigs. as shown in Fig. 1. If necessary, use a small gauge to locate the joint correctly. Place the jig and test pieces in the conditioning atmosphere.

8.10.1. Suspend the top frame from a suitable support, apply a load of 25 or 45 kgf to the bottom frame, and note the time taken before each joint fails. The load used and the mean failing time of a group of ten test pieces shall be reported.

NOTE.—The mean failing time will be specified when test data is available.

IS: 4835 / 1968



ALL DIMENSIONS IN MILLIMETRES

FIG. 1. JIG FOR ASSESSING THE RESISTANCE TO A SUSTAINED LOAD.

EXTRACT FROM I.S. 1658—1966.

Specification for fibre hardboards.

2. *Types* :

2.0. Hardboards are generally classified into the following three types according to their method of manufacture, density and other elated mechanical and physical properties:—

(*a*) Medium hardboard,

(*b*) Normal hardboard, and

(*c*) Tempered hardboard.

2.1. *Medium hardboard* : A homogeneous fibre building board having a density exceeding 480 kg/m³, but not exceeding 800 kg/m³.

2.2. *Normal hardboard.*—A homogeneous fibre building board having a density exceeding 800 kg/m³, but not exceeding 1200 kg/m³.

2.3. *Tempered hardboard*.—Hardboard which has been further treated in the course of manufacture to increase its density, strength and water resistance.

3. *Dimensions and tolerances* :

3.1. The boards shall be rectangular and, unless otherwise specified shall have square edges. The lengths of the two diagonals of the board shall not differ by more than ± 3.0 mm per metre length of the diagonal.

3.2. *Thickness.*—The thickness of hardboards shall be as given in Table 1. The mean thickness shall be determined by the method described in Appendix A.

TABLE 1—THICKNESS OF HARDBOARDS.

Type.	*Nominal thickness. mm.*	*Tolerance. mm.*
(1)	(2)	(3)
Medium hardboard	6, 8, 10 and 12	$\pm 0{\cdot}6$
Normal hardboard Tempered hardboard	3, 4, 5, 6 and 9	± 0.3

3.3. *Width and length.*—The width and length of hardboards shall generally be as given in Table 2.

TABLE 2—WIDTH AND LENGTH OF HARDBOARDS.

Type.	*Width.*	*Length.*	*Tolerance on length and width Max.*
(1)	(2)	(3)	(4)
	m	*m.*	*mm.*
Medium hardboard	1.2	1.2, 1.8, 2.4, 3.0, 3.6, 4.8 and 5.5.	± 3.
Normal hardboard	1.2		
Tempered hardboard	1.2		

4. *Requirements*:

4.1.—The requirements of density, bending strength (modulus of rupture) and water absorption of hardboards as determined by mehodescribed in Appendices A, B and C respectively, shall be as given in Table 3.

TABLE 3—REQUIREMENTS OF HARDBOARDS.

Serial number.	*Type of Board.*	*Mean Density. kg/m3.*	*Bending strength.* *ModulusofRuptur Min Individual kg/cm².*	*Bending strength.* *Averag kg/cm².*	*Water. absorption pe cent (By weig rr after 24 h immehtsion Max.*
(1)	(2)	(3)	(4)	(5)	(6)
(i)	Medium hardboard	480 to 800	45	60	40
(ii)	Normal hardboard	800 to 1200 Grade A.	225	300	30
		800 to 1200 Grade B.	150	200	
(iii)	Tempered hardboard	1200 Min Grade A.	450	600	20
		1200 Min Grade B.	300	400	

4.2. Information on accelerated ageing test, cupping and twisting test and moisture content test is given in Appendix D.

5. *Marking* :

5.1.—Each hardboard shall be legibly and indelibly marked with the following information :—

(*a*) Name of manufacturer or trade-mark, if any ;

(*b*) Date of manufacture ;

(*c*) Type of board ; and

(*d*) Thickness of board.

5.1.1.—Each board may also be marked with the ISI certification Mark.

APPENDIX-A

(*Clauses* 3.2, 4.1, 7.1.1, *E*-2·2 *and E*-3.3)

MEASUREMENTS OF DIMENSIONS AND DENSITY.

A-1—*Determination of Thickness*:

A-1.1.—The thickness of each specimen shall be measured to an accuracy of 0.01 mm. for specimens less or equal to 7 mm. thick and to 0.05 mm. for specimens more than 7 mm. thick. The measurement shall be done at six points representing the points of inspection of the diagonals of six test specimens obtained from the test units. This may be done after the test unit has been marked for cutting or after the test specimens have been cut, whichever is convenient, provided the material under test is in a properly conditioned state (see 7.1) when the measurements are made.

A-1.2—The contacting surfaces of the measuring instrument shalls be flat and shall have a contact area of 2 cm.² $\pm$ 0.04 cm². While taking measurement of thickness, care shall be taken that the surfaces of the board are not deformed and for this purpose the lowering rate/shall preferably be 1 mm/s and the operating pressure 200 g/cm². The graduation of the measuring instrument shall be accurate to 0.01 mm²

A-2.—*Determination of Length and Width;*

A-2.1—The length and width of each test unit shall be measured to an acuracy of $\pm$ 1 mm.

A-3.—*Determination of Density* :

A-3.1—The weight of each unit shall be measured to an accuracy of $\pm$ 0.2 per cent. The density of each unit shall be calculated as follows :

$$\text{Density} = \frac{W \times 10^6}{L \times b \times t} \text{ kg/m}^3$$

where

W=weight of test unit in g,

L=length in mm.

b=width in mm, and

t=mean thickness in mm.

A-3.2. The density of each test unit shall be reported together with the average density of all the test units.

APPENDIX-B.

(*Clauses* 4.1, 7.2, *D*-1.2 *and E*-3.5)

METHOD OF TEST FOR BENDING STRENGTH

B-1 *General*.

B-1.1—This test shall be performed on the test specimens after conditioning (see 7.1) and also after subjecting to accelerated ageing test (Appendix-D). The test specimens shall preferably be tested with the same face upper-most.

B-1.2 *Specimens*.—The test specimen shall have the following dimensions :

Length 25 times the thickness+50 mm.

Width 75 mm.

B-2. *Procedure*:

B-2.1—Each test specimen shall be simply supported on horizonta parallel rollers, their length being 80 mm. and the diameter 15 mm$\pm$ 0.5mm.for specimens of thickness 7 mm. or less, and 30 mm. $\pm$0.5mm for specimens of thickness 7 mm. or less, and 30 mm. + 0.5 mm. for specimens of thickness more than 15 mm. The span of the specimen between rollers shall be equal to 25 times the nominal thickness of the test piece. The rollers should be so arranged as to be free to rotate on ball or roller bearings. The load then shall be applied at the centre of the span along a line parallel to the roller by means of a bar rounded to a radius of 15 mm. $\pm$ 0.5 mm. The load shall be applied at the rate of 30 mm. $\pm$ 3 mm/min.

B-2.2. The following information shall be reported :—

(*a*) The failing load and modulus of rupture (see Note) of each test specimen ;

(*b*) The mean failing load and mean modulus of repture for the test specimens, maked ' L ' as tested before and after ageing ; and

(*c*) The mean failing load and mean modulus of repture for the test specimens, markred, 'X' as tested before and after ageing.

Note.—The modulus of repture shall be calculated by the following formula :

Modulus of repture = 50 W/T

Where

W=failing load in kg., and

T = thickness of specimen in mm.

APPENDIX—C.

(Clauses 4.1, 7.3 and D-1.2)

MERHOD OF TEST FOR WATER ABSORPTION

C-1 *Procedure*.

C-1.1. Each of test specimens marked W, L as well as X shall b. weighed to an accuracy of $\pm$ 0.1 g. They shall then be just fully submerged in fresh clean water having PH value of 6$\pm$1. The temperature of water shall be 27° $\pm$ 2°C. The period of immersion shall be 2 hours as the case may be corresponding to the period for which absorption value is needed. At the conclusion of the appropriate period, the test specimen shall be withdrawn from the water and any excess water shall be wiped off with a damp cloth. Each specimen shall be reweighed to any accuracy of $\pm$ 0.1 g.

C-1.2. The following information shall be reported :—

(*a*) The water absorbed by each test specimen expressed as percentage of its weight before immersion as tested before ageing and after ageing, and

(*b*) The mean percentage water absorption of the six test speci mens before ageing and after ageing.

EXTRACT FROM I.S. 419—1953.

Specification for Putty, for use on Wooden Frames.

1. *Scope*;

1.1. This standard prescribes the requirements and the methods of test for the material commercially known as Putty, for use on woodenframes. The material is used for fixing glass panes on wooden frames and for filling cracks, holes and splits in wood.

2. *Terminology*:

2.1. For the purpose of this standard, the definitions given under 2 of I.S. 85-1950 shall apply.

3. *Sample*:

3.1. The vendor shall submit a tender sample packed in thee. different containers, each containing not less than 500 g. of ırh material.

3.2. The purchaser may select as approved sample the sample submitted by the vendor, or any other agreed samplee He shall return to the vendor one suitably sealed container of the approved sample.

3.3. Representative samples of the material shall be drawn as prescribed under 3 of I.S. 85-1950.

4. *Requirements*;

4.1. *Form and condition*.—The material shall be a homogenous paste and shall be free from dust, grit and other visible impurities.

4.2. *Composition*.—The material shall consist only of whiting (conforming to I.S. 63-1950) and linseed oil, raw (conforming to I.S. 75-1950) mixed in such proportions as to form a paste which shall comply with the requirements of this standard.

4.3. *Consistency*.—When tested as prescribed in Appendix A, the consistency of the materials shall not be inferior to that of the approved sample.

4.4. The material shall also comply with the requirements in Table 1.

5. *Tests.*

5.1. Unless specified otherwise, test shall be conducted as prescribed in I.S. 85-1950. References to the relevant clauses of the standard are given in column (4) of Table 1.

TABLE 1:—REQUIREMENTS FOR PUTTY, FOR USE ON WOODEN FRAMES

(*Clause* 4.4.)

Serial number and Characteristic.	*Requirement.*	*Reference to clause No. in I.S* 85-1950.
(1)	(2)	(3)
(i) Oil content ..	.. Within 3 per cent of the approved sample.	7
(ii) Residue on sieve, percent by weight, Max.	5.0	9
(iii) Water, present by weight, Max.	1.0	10
(iv) Keeping properties	Not less than 6 months from the date of manufacture.	13
(v) Marking and delivery	As agreed with the purchaser.	14

APPENDIX-A.

(*Clause* 4.3)

TEST FOR CONSISTANCY

A-1. *Procedure*

A-1.1 The material after thorough working in the hands shall have good plastic quality without sliminess or stickiness that would render it difficult to handle and apply. It shall work readily and smoothly under a pelette knife without crumbling or cracking. After being moulded in places, it shall hold its shape until set. In respect of these properties, it shall not be inferior to the approved sample when both are tested by the same person, in the same manner and at the same time.

EXTRACT FROM I.S. 1081 – 1960

Code of Practice for fixing and glazing of Metal (Steel and Aluminium) Doors, Windows and Ventilators.

3. *Materials:—*

3.1. *Putty.*—Putty used for glazing metal door, window or ventilator shall conform to I.S. 420–1953.

3.2. *Mastic.*—The requirements of mastic used in fixing metal door, window and ventilator shall be as agreed to between the purchaser and the supplier.

4. *Type and size of openings:—*

4.1. *Types of openings.*—Metal doors, windows or ventilators may be required to be fixed to either masonry openings (including brick, concrete, stone and marble) or timber openings or steel work openings.

4.1.1. *Masonry openings.*—Masonry openings may be either rebated or flush, and in either case they may either have external rendering applied or be 'fair-faced' (that is, without external render) it is usual for stone and marble masonry to be fair-faced.

4.1.2. *Timber openings.*—Timber openings are invariably rebated.

4.1.3. *Steel work openings.*—Steel work openings vary in detailed design, but shall be so designed that the outer flange of the door window or ventilator frame sections overlaps a steel surface either externally or internally.

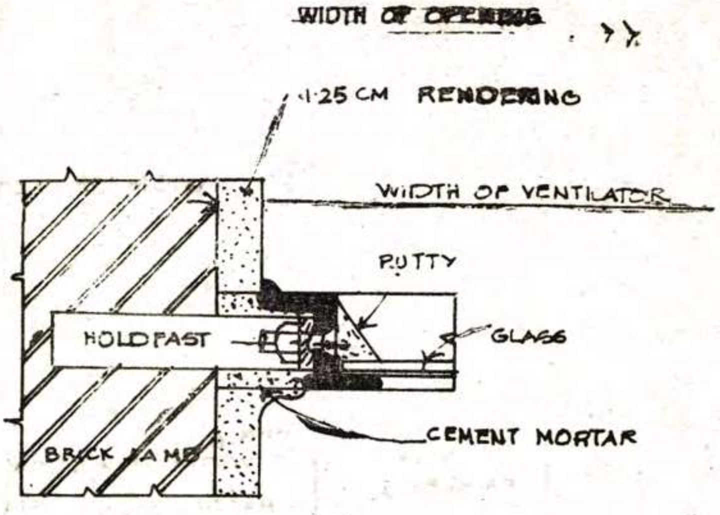
4.2. *Size of openings.*—The overall size of both flush or rebated openings to which the units are to be fixed shall allow a clearance between frame and opening, and the amount of clearance depends on whether the opening is externally rendered or fair-faced.

4.2.1. *Flush openings.*—Rendered flush openings shall allow a clearance between frame and opening equal to the thickness of the rendering (*see* Fig. 1-A and 1-B). Fair faced flush openings shall allow a clearance of 3 mm. (or 1/8 in.) between frame and opening (*see* Fig. 2).

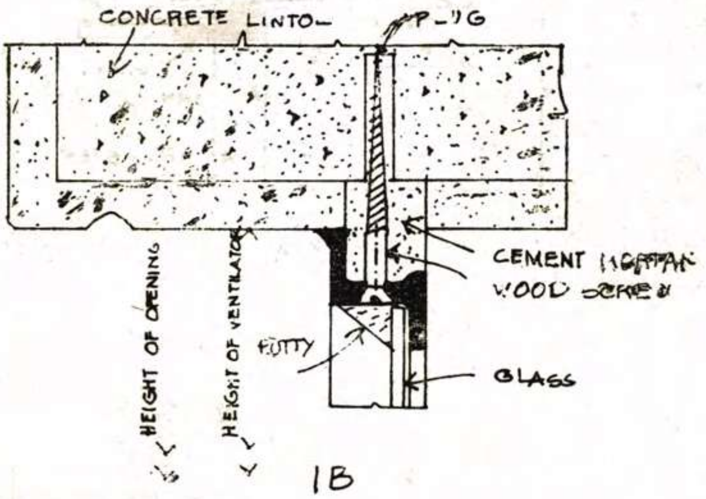
4.2.2. *Rebated openings:*

(*a*) Fair-faced masonry openings and timber openings shall allow a clearance of 3 mm. (or 1/8 in.) between the opening and the inner flange of the frame as well as between the opening and the outer flange of the frames. The depth of rebate shall therefore be equal to the distance between the inner and outer flanges of the door, window or ventilator frame. The rebate shall be 12.5 mm. (or 1/2 in.) in the case of general building and industrial windows (*see* Fig. 3-A 3-B and 4).

(*b*) Rendered masonry openings shall allow a clearance of 3 mm. (or 1/8 in.) between the opening and the inner flange of the frame and a clearance equal to the thickness of the rendering between the opening and the outer flange of the frame. The depth of rebate shall therefore be adjusted accordingly (*see* Fig. 5).



1 A



1B

MASONRY OPENINGS FLUSH WITH RENDERING

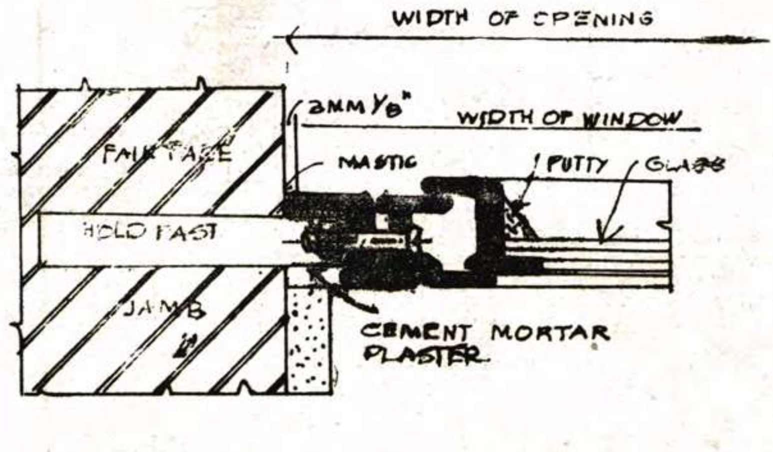


FIG. 2. MASONRY OPENINGS FLUSH WITHOUT RENDERING

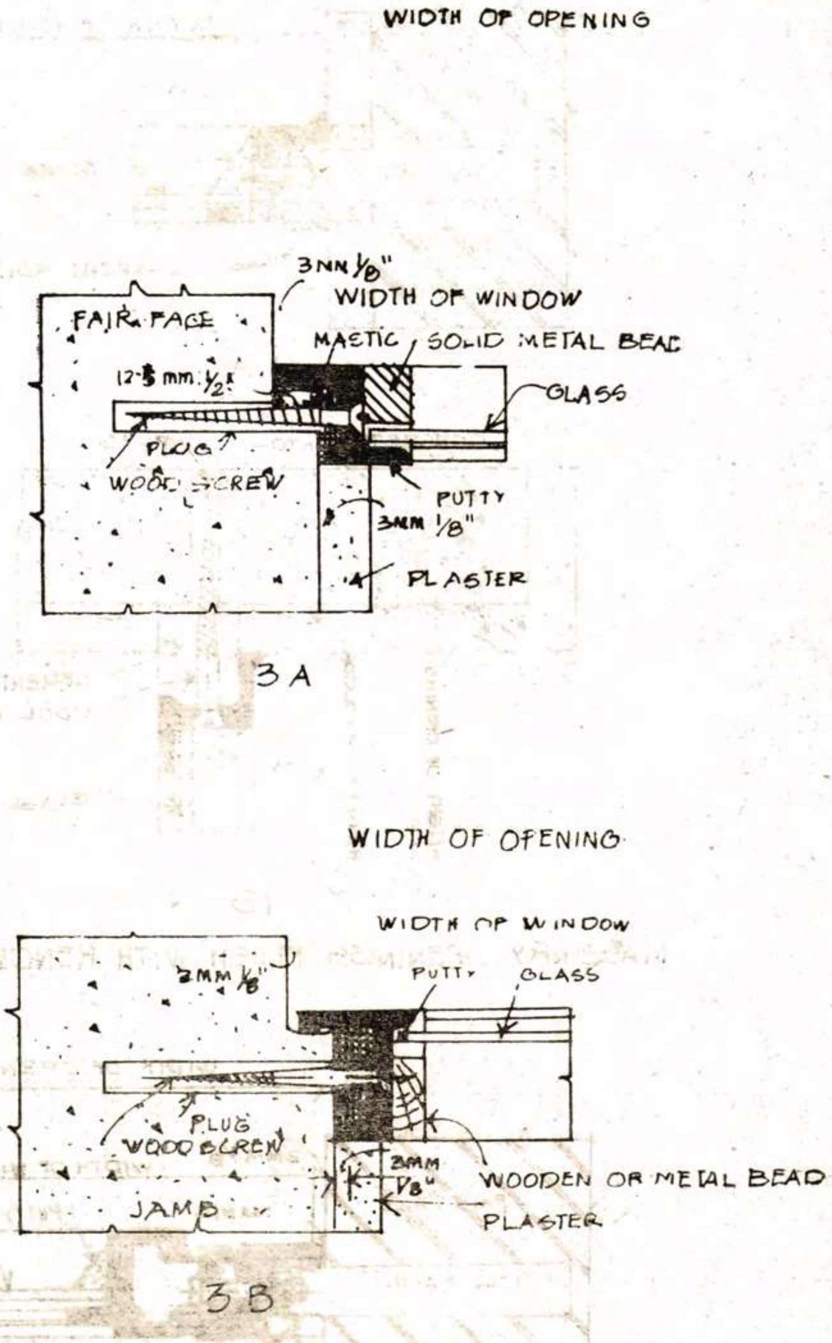


FIG 3 MASONRY OPENINGS REBATED WITHOUT RENDERING

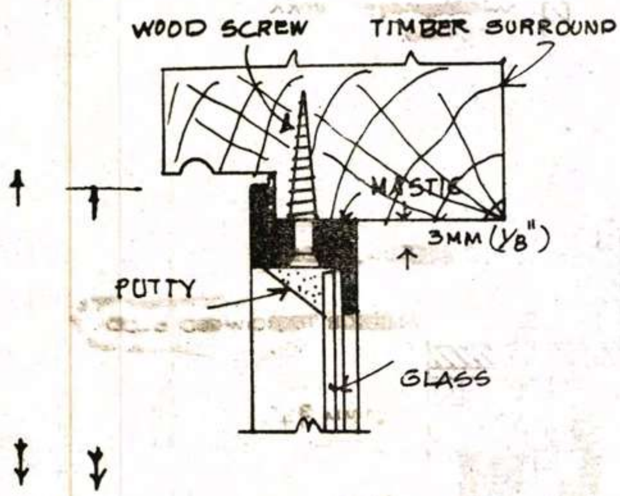


FIG. 4. FIXING TO WOOD SURROUND

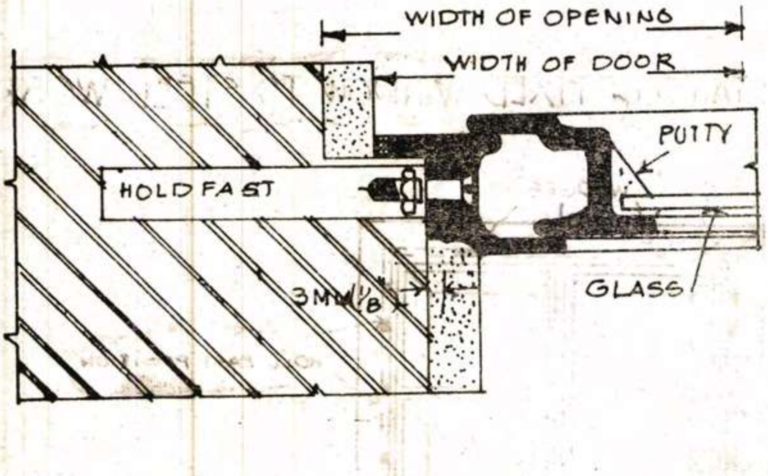


FIG 5. MASONRY OPENINGS REBATED WITH RENDERING

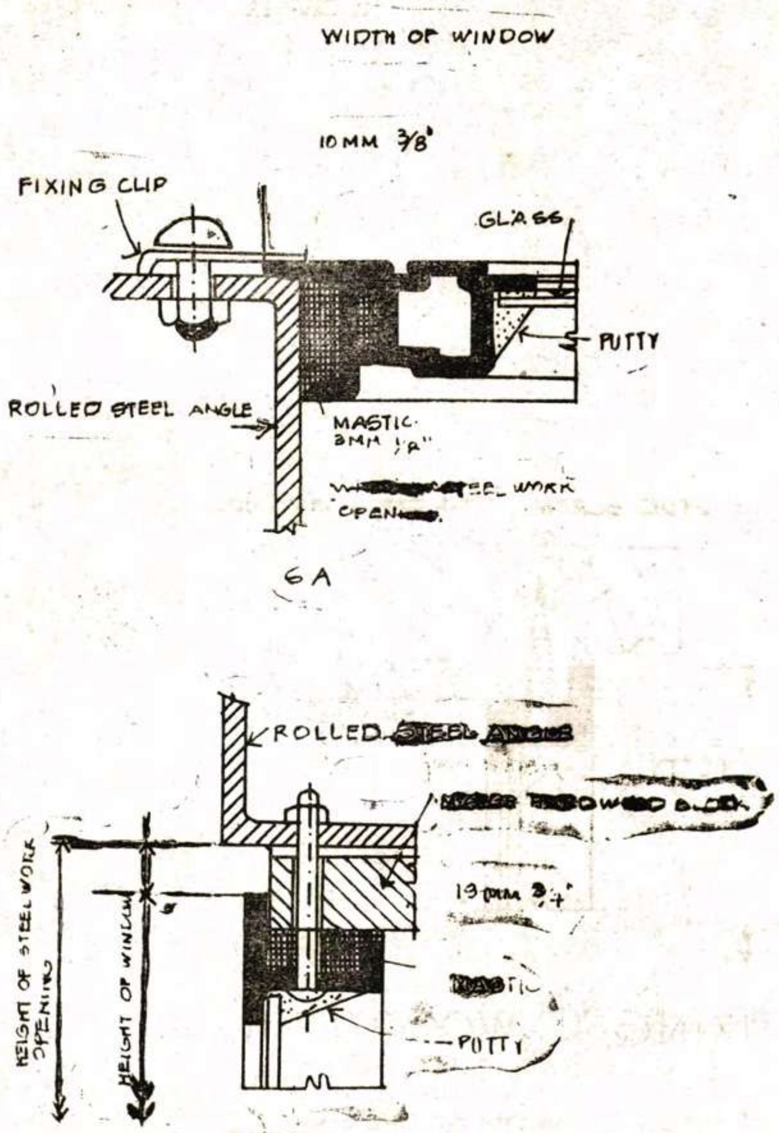


FIG 6 DETAILS OF FIXED WINDOW TO STEEL WORK

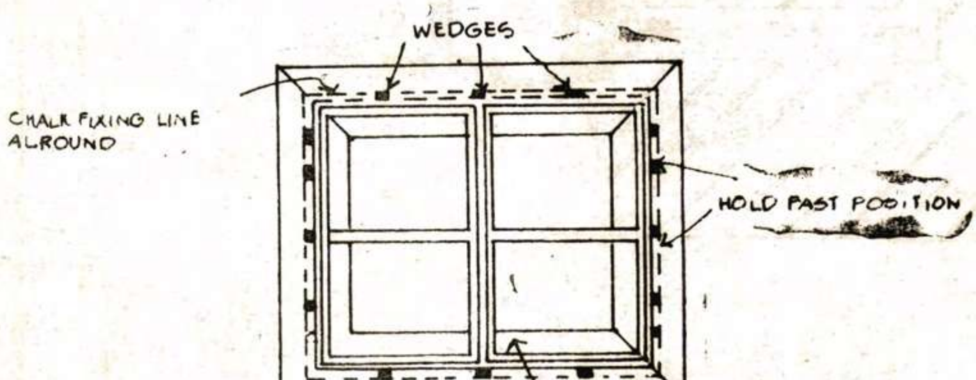


FIG 7 FIXING WINDOW IN POSITION.

4.2.3. Steel work openings shall be designed to allow the outer flange of the window frame section to overlap the steel surface by 10 mm. (or 3/8 in.) (*see* Fig. 6-A).

NOTE.—The sizes of Indian Standard doors, window and ventilators, both for general building and industrial purposes, are designed for modular openings 12.5 mm. (or 1/2 in.) which are larger all round than the doors, windows etc. The gap of12.5 mm. (or ½ in. is for the purpose of fixing of the units in the openings. In the case of masonry openings the gapis filled up with mastic cement and plaster after the unit is in position. In the case of steel or timber modular openings, extra steel or timber fillets will be necessary to cover this gap of 12.5 mm. (or 1/2 in.) (see Fig. 6-B).

5. *Handling of doors, windows and ventilators.—*

5.1. Care shall be taken in unloading and stacking windows and ventilators at site. They shall be examined for any damage that may have occurred in transit and shall then be stacked upright (on their sills) on level ground, preferably on wooden battens and shall not come into contact with dirt or ashes. Doors shall be stacked upside down, with the kick plates at the top. Doors shall not be allowed to stand for long the right way up before being fixed so as to avoid the doors getting out of true and the hinges being strained and the shutters dropping

5.2. Care shall be taken in ensuring that aluminium frames are not allowed to get into direct contact with wet cement and mortar. During the period of storage, aluminium should be protected from loose cement mortar by means of suitable covering such as tarpaulin.

The tarpaulin should be hung loosely on temporary framing to permit circulation of air to prevent condensation.

6. *Procedure for fixing single units.—*

6.1. Doors, windows or ventilators shall be fixed into prepared openings. They shall not be 'built-in' as the walls go up as this practice often results in brickwork being brought right up, to the frame with no clearance allowed and usually distorts the units and increases the likelihood of damage being done to the unit during subsequent building works. Placing of scaffolding on the frame or glazing bars shall on no account be done.

6.2. The size of the opening shall first be checked and cleaned of all obstructions. The position of the unit in the reveal shall be taken off the drawings and a vertical chalk line shall be marked on the reveal at the jams, using a plumb-line, at the correct distance from the face of the wall (*see* Fig. 7). This chalk line shall also be run along head and sill of the opening.

6.3. The fixing hole positions shall be taken fromthe unit and marked on this chalk line at the corresponding points. In case of masonry, holes for fixing the lugs or holdfasts shall be cut 5 cm. (or 2 in.) square and 5 cm. to 10 cm. (or 2 in. to 4 in.) deep, unless it is possible to put slotted lugs into joints in brick work. In the case of concrete or stone, fixing plugs are recommended to be embedded in the masonry during construction at the appropriate places.

6.4. To ensure that all units are set at the appropriate height in their openings, the datum line for the sill of the door, window or ventilator shall be taken from a fixed point on the wall or from finished floor or ceiling with the help of a level. The datum level for the sill of the door, window or ventilator unit shall be given by the builder to the fixer.

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6.5. Door, window and ventilator units shallbe checked to ensure that they are square and working satisfactorily. The unit shall then be set in its opening by using wooden wedges at jambs. head and sill, and shall be plumbed to the line chalked round the reveal-A spirit level shall be used to ensure that the frame is square and true and free from any warp and twist. When adjusting to the correct line, the wedges shall be struck with the hammer, care being taken so as not to strike the frame. The wedges shall not be inserted so firmly as to distort the frames, and wherever possible, they shall be placed near the points where a glazing bar meets the frame.

6.6. The unit shall be put in position and the lugs screwed on tight. Every hole in the frame need not be fixed with a lug ; some holes are incidental to manufacture (being guide holes for the welding jig.) and are not necessarily fixing holes. Lugs shall be placed in the specified positions.

6.7. The lugs shall than be grouted into their holes with cement mortar, and the wedges round the frame shall be let in position until this cement has hardened and the lugs firmly set (*see* Fig. 1)' The gap between unit and surround shall then be filled with cement mortar while fixing to flush openings.

6.8. When fixing to flush surrounds without rendering, the 3 mm. (or 1/8 in.) clearance round the frame shall be pointed with mastic on the outside. This mastic shall be applied after the unit has been fixed into position and before the internal plaster is applied. The mastic shall be applied from inside, squeezed into the channel of the frame until it oozes out through the narrower outside joint. The internal gap shall be filled about one-third with mastic and rest of the space be filled with cement mortar. The mastic shall then be cut off square outside and smoothed down (*see* Fig. 2).

6.9. When fixing to flush surrounds with internal plaster and rendering, the plaster and rendering shall be applied to surrounds after the lugs have firmly set taking care to keep it clear of hinges and not to bring it too close to the opening frame of casement. Hinges shall be wrapped in gunny to prevent plaster from adhering to them or being splashed on them. Before applying the rendering, the joint of unit and the mortar shall be pointed with mastic from the outside.

6.10. When fixing to rebated surrounds without rendering, the frame shall be bedded in mastic. This shall be applied freely to the channel of the outside frame before offering it up to the rebated opening. In the case of the sill the mastic shall be applied to the sill of the opening and the unit placed on it with the other three sides "buttered" with mastic. After the unit is firmly fixed in position, surplus mastic shall be cut away and smoothed down (*see* Figs. 3-A and 3-B).

6·11. When fixing to rebated surrounds with rendering, after fixing as in 6·10 plaster shall be applied on the outside. The hinges shall be wrapped with gunny before plastering to prevent plaster from adhering to them or being splashed on to them.

6.12. When fixing to concrete, lug may be used, but the reinforcing rods in the concrete usually prevent the holes for the lugs being cut to the required depth. It is recommended to fix by wood screws into plugs positioned in the concrete. These plugs may be wooden blocks set in the concrete when pouring or casting ; but these have to be set very accurately for the fixing holes in the unit.

6·12.1. In case the plugs could not be set in accurately, the fixer shall drill and plug the surrounds. White metal plugs are recommended for this purpose from the point of view of efficiency in fixing (see Fig. 3b).

6·13. Dressed stone and marble surrounds shall be drilled and plugged for wood screws in the same manner as recommended in 6.12.

6·14. Wood surrounds shall normally be rebated and when fixing to these mastic shall be applied to the sill of the opening and unit placed on it with the jambs and head buttered with mastic. This shall be applied freely to the channel of the outside frame before offering it up to the rebated opening. The unit shall be fixed with wood screws (see Fig. 4).

6·15. When fixing to steel work, mastic shall be applied as described in 6·14 and the unit shall be fixed with special fixing clip supplied with the unit (See Fig. 6-A) or with ruts and bolts (See Fig. 6-B).

6·16· Th external doors normally have a threshold (see Fig. 8) When doors are required for internal use, the threshold shall be substituted with a flat tie bar. In this case the door shutters shall be of usual size, but as 4 cm (or 1.5 in) finish has to be allowed for over the structural floor level, a special base tie bar shall be fixed to the jamb member of the frame which projects below the finished floor (see Fig. 9).

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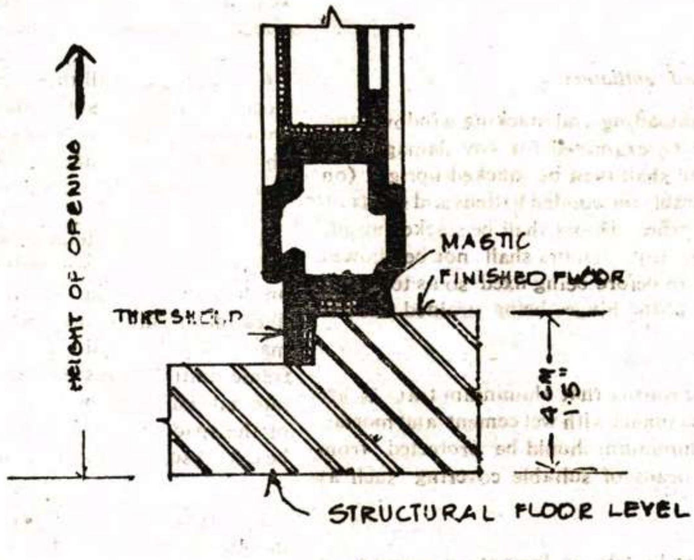


FIG 8 THRESHOLD FOR EXTERNAL DOOR

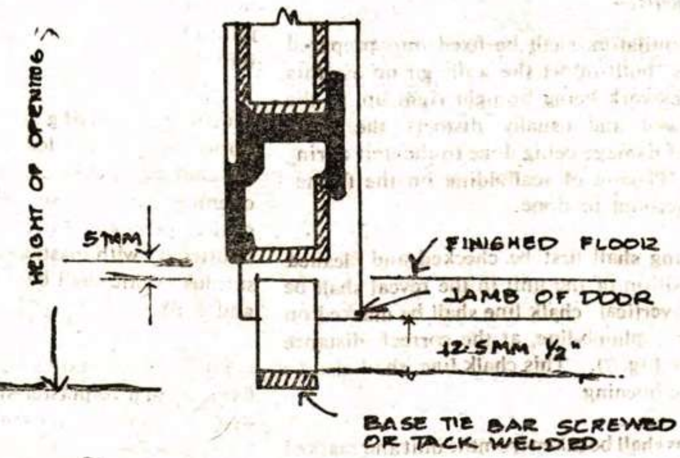
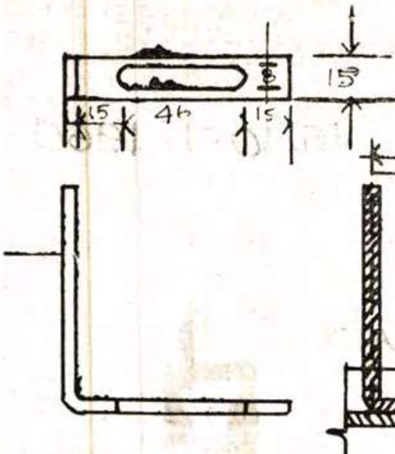
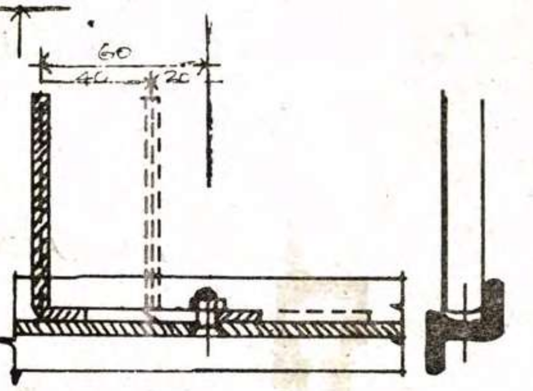


FIG 9. THRESHOLD DETAIL FOR INTERNAL DOOR





ALL DIMENSIONS IN MILLIMETRES

FIG 10 A SLOTTED REVERSIBLE FIXING LUG

FIG 10 B. FIXING LUG IN POSITION

NOTE :—Doors which are required for internal use are not required to have a threshold. This shall be specified at the time of placing the order as substitution of a flat tie bar for threshold is not possible after the door has been fixed.

6.17 In case of aluminium frames the surfaces that will be anchored in direct contact with masonry, metal or wood shall be protected with 2 coats of alkali-resistant bituminous paint to avoid direct chemical attack from alkaline or acid solutions formed by moisture and the surrounding materials.

6·18. All splatter and drips from wet cement and plaster during fixing of aluminium frames should be removed immediately.

7. *Fixing materials* :

7.1. The materials for fixing of doors, windows or ventilators to the surrounding shall be as given in Table 1.

TABLE 1—MATERIALS FOR FIXING OF DOORS, WINDOWS AND VENTILATORS.

Serial number	*surround and method of Fixing.*	*Fixing Material.*
	(1)	(2)
(i)	When fixed to wooden frame rebated on the outside.	38 mm (or 1½ in.) x No. 10 galvanized wood-screws.
(ii)	When fixed to plugs in concrete, stone or brick work rebated on the outside.	Do.
(iii)	When fixed to plugs in concrete, stone or brick work not rebated on the outside (that is, plain or square jambs).	63 mm (or 2½ in.) x No. 10 galvanized wood-screws

TABLE 1—MATERIALS FOR FIPING OF DOORS, WINDOWS AND VENTILATORS—*cont*.

(iv)	When fixed direct to brick work or masonry (that is, plain or square jambs).	Slotted steel adjustable lugs of sizes shown in Fig. 10.
(v)	When fixed to steelwork	Standard clips and 8 mm (or 5/16 in.) galvanized bolts with hexagonal nuts.

8. *Procedure for fixing Composite units* :

8·0. *General.*—The fixing procedure for composite doors, windows and ventilators shall generally be the same as described in 6 and in addition shall conform to provisions laid down in 8·1 to 8·6

8·1. Where larger units are formed by coupling individual units altogether, the mullions and transomes shall be bedded in mastic to ensure weather tightness. Mastic shall be applied liberally to the channels of the outside frame sections before assembly, and the two units being coupled shall be drawn together tight with clamps, the mastic being squeezed out and cut off neatly when the units shall be screwed together tight (see Fig. 11-A to 11-H).

8.2. Coupling screws vary in length for different types of coupling but manufacturers shall supply correct sizes and quantities, if coupling requirements are detailed when ordering. A common fault is to use coupling screws too long for the particular coupling and to leave a length of screw projecting through the frame of the unit to interfere with the closing of the casement or with the glass of fixed light. The offending length of screw shall be cut off, if this occurs.

8·3. If a composite unit is coupled in such a way that there is a cross joint of mullion with transome, the shorter coupling unit shall run through unbroken. Mullions normally project 2·5 cm (or 1 in) at head and sill into the brick, stone or concrete surround. Fabricated steel mullions shall be cut short when fixing to wood or steel surrounds or when meeting a continuous transome, so as to form a butt joint and aluminium mullions shall be supplied with ends cut to profile of window frame.

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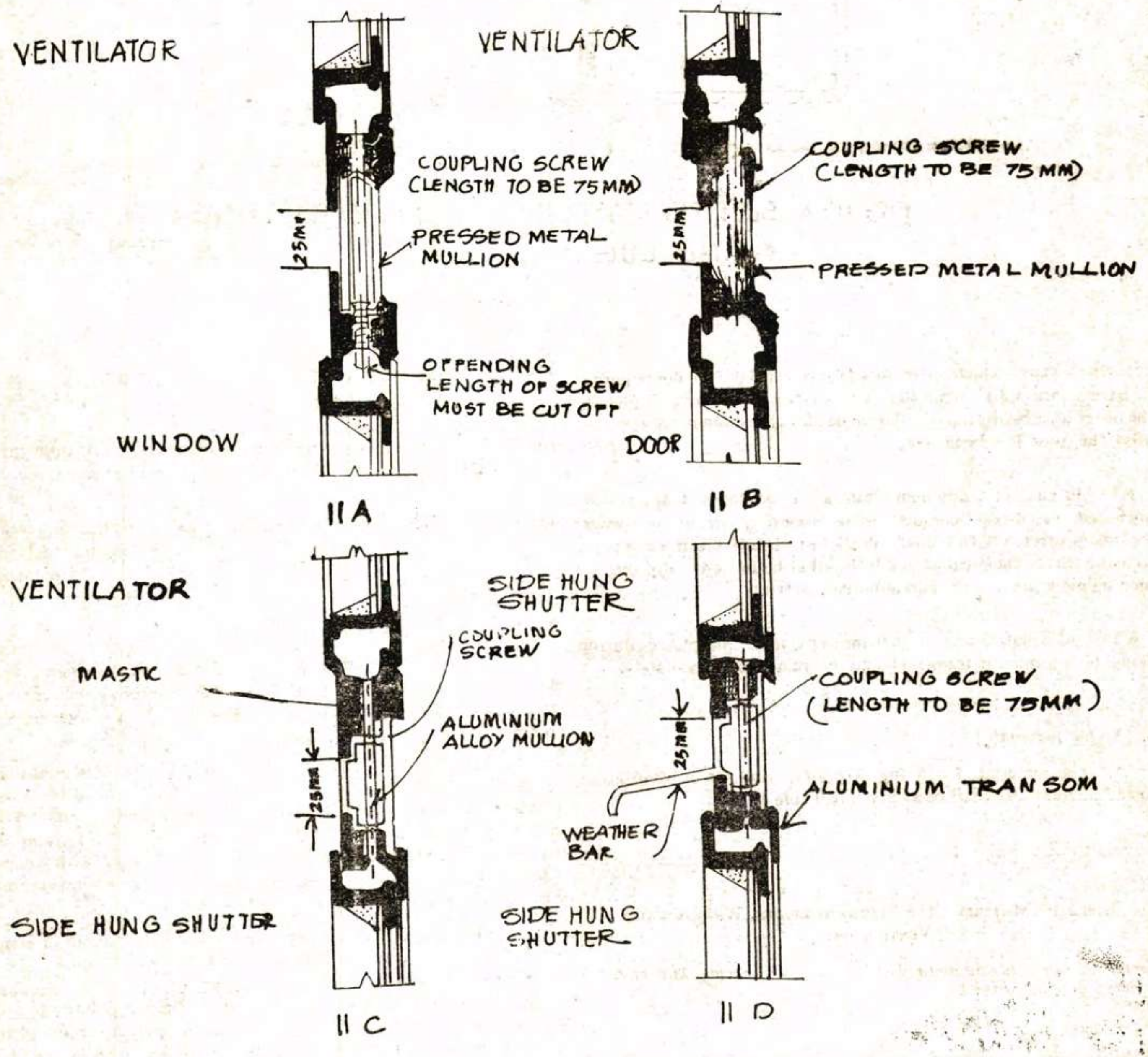
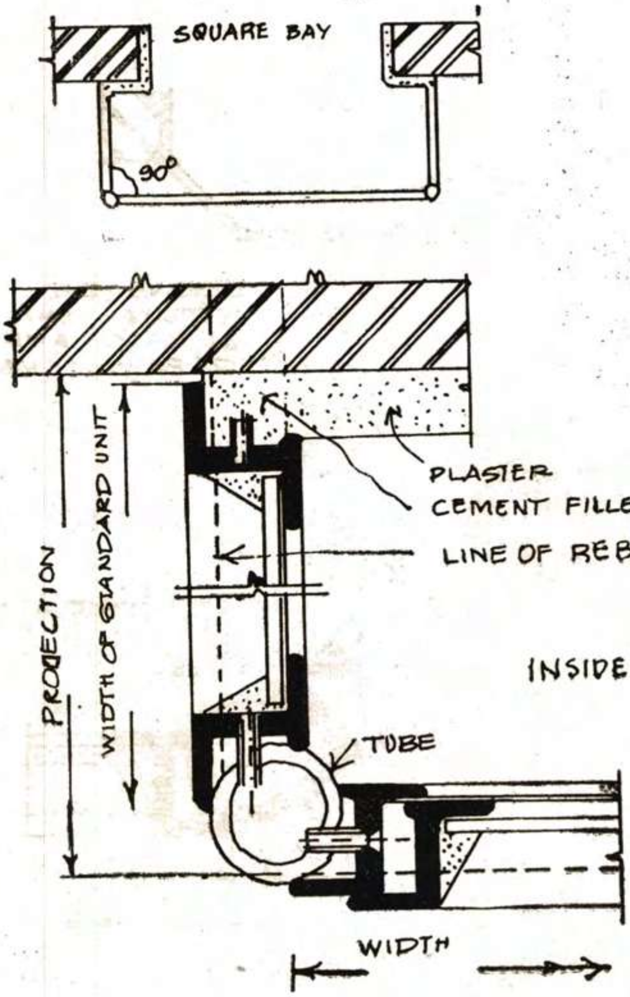
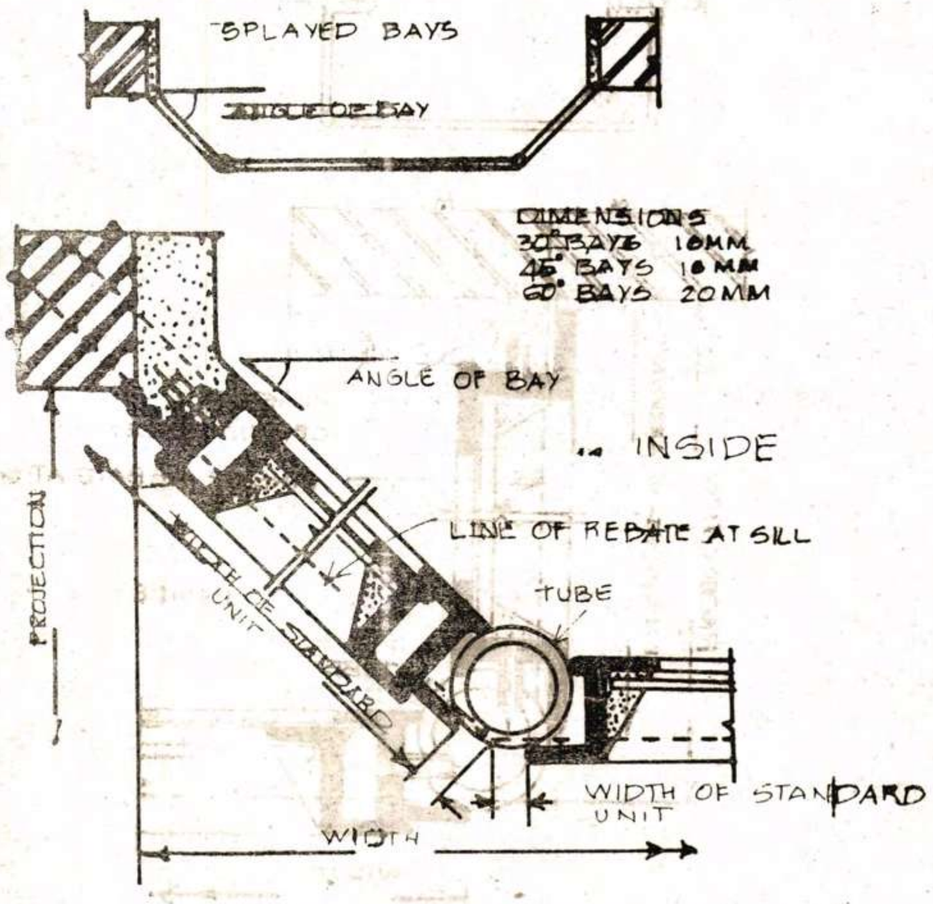


FIG 11. FORMING OF COMPOSITE DOORS, WINDOWS AND VENTILATORS



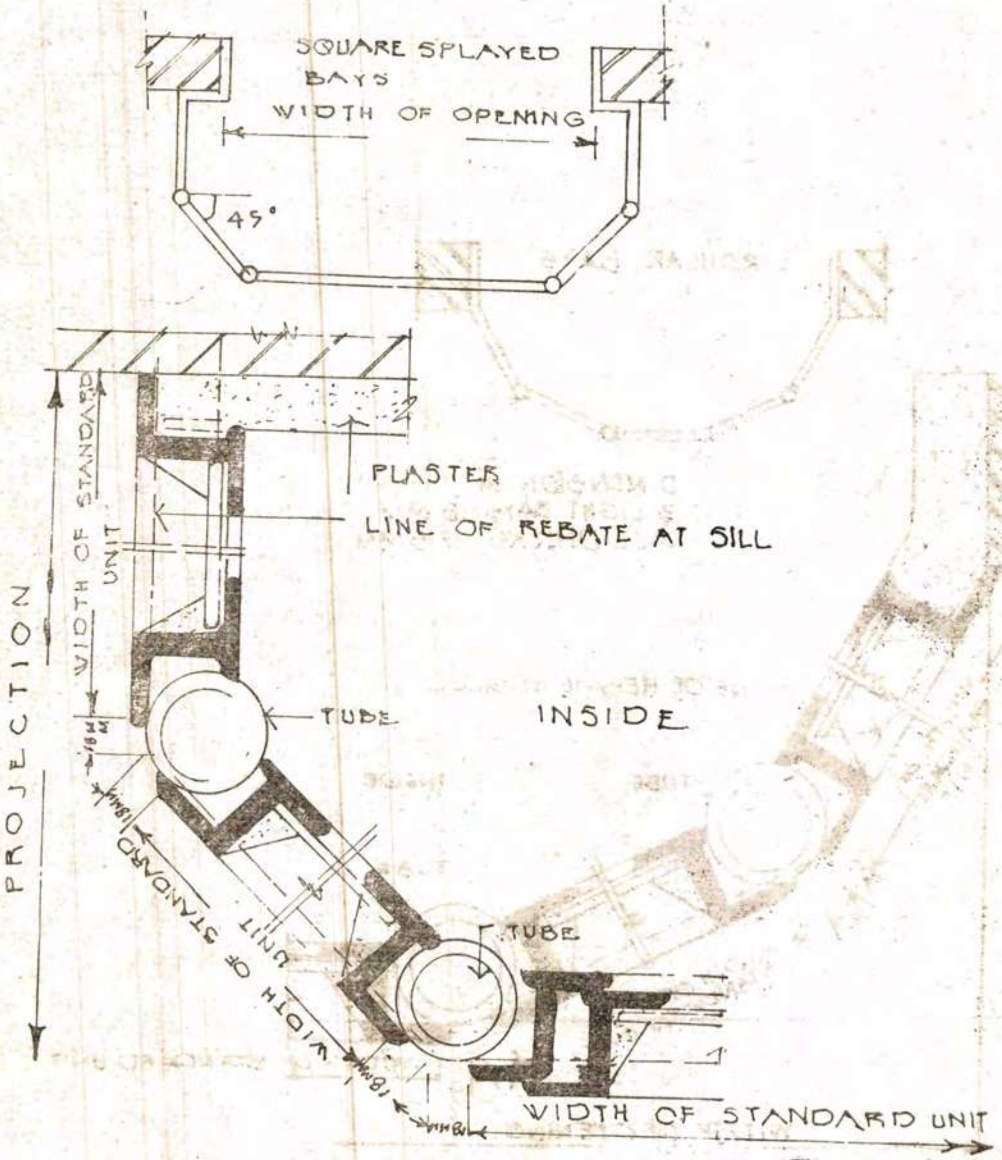
12 A SQUARE BAY

FIG. 12. METHOD OF FIXING STEEL WINDOWS IN DIFFERENT TYPES OF BAYS



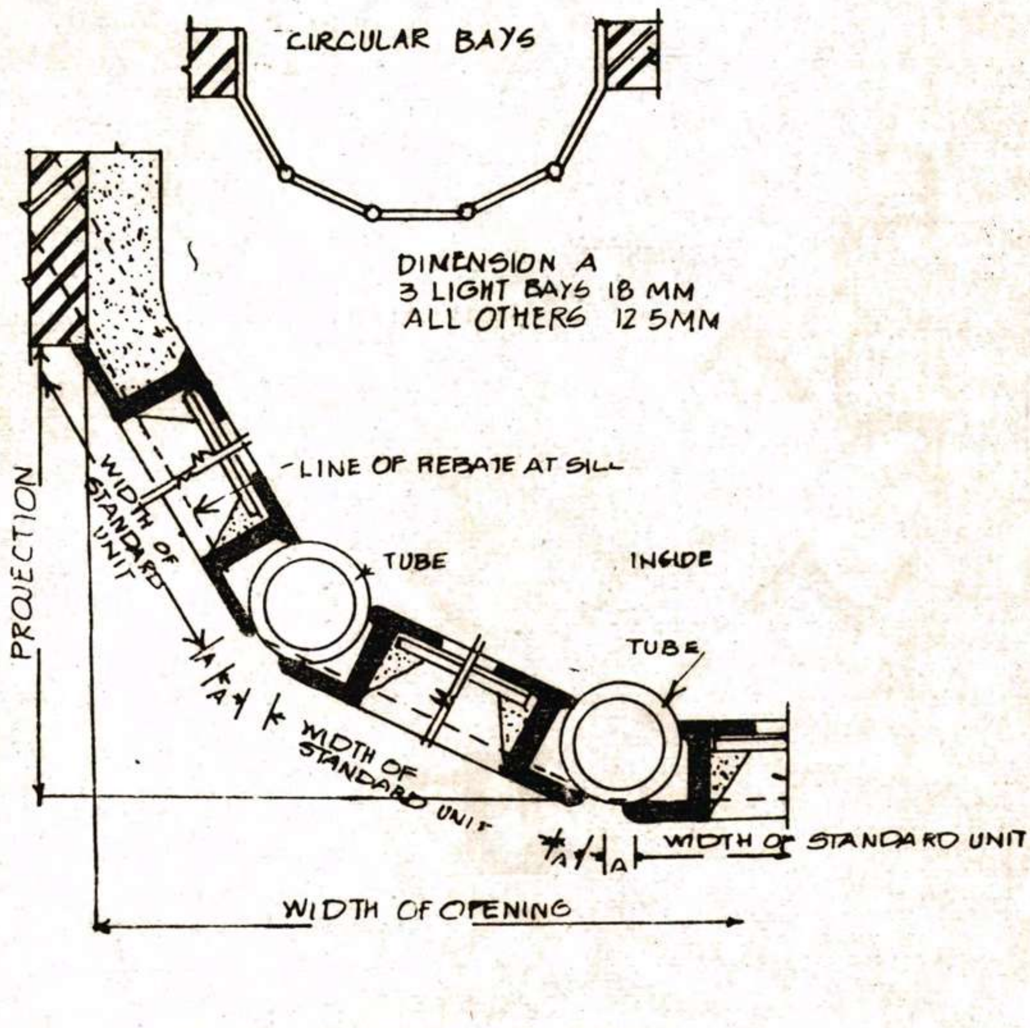
12 B. SPLAYED BAYS

FIG 12. METHOD OF FIXING STEEL WINDOWS IN DIFFERENT TYPES OF BAYS



12 . C . SQUARE SPLAYED BAYS 45° ONLY

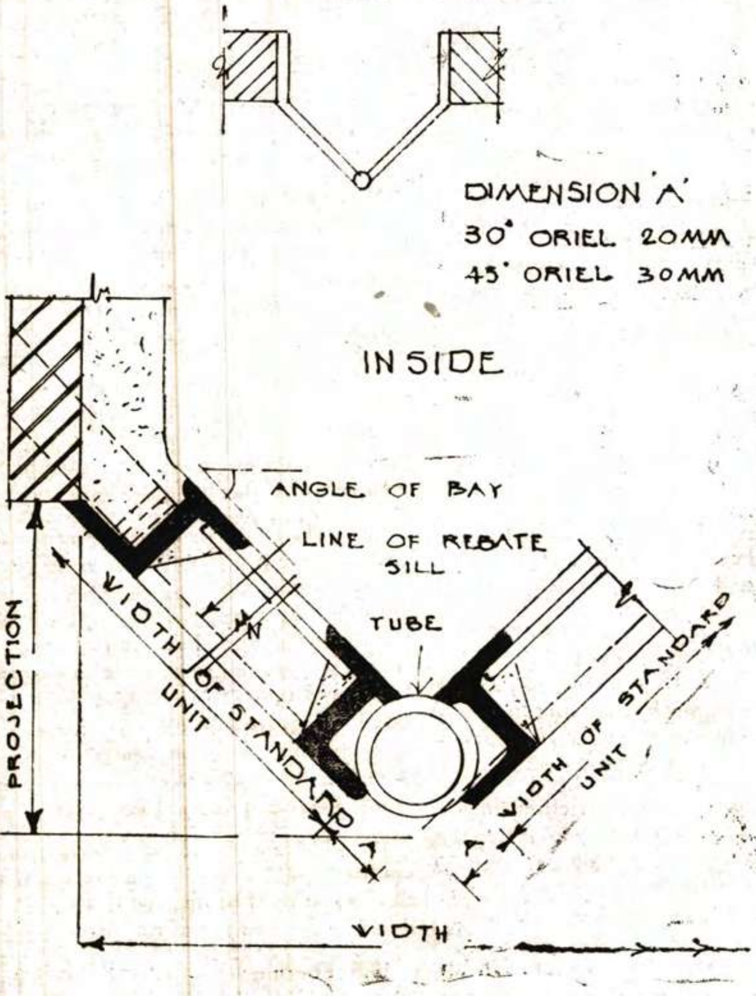
FIG 12. METHOD OF FIXING STEEL WINDOWS IN DIFFERENT TYPES OF BAYS



12 D CIRCULAR BAYS

FIG 12 METHOD OF FIXING STEEL WINDOWS IN DIFFERENT TYPE OF BAYS

ORIEL BAYS



12-E. ORIEL BAYS

METHOD OF FIXING STEEL WINDOWS IN DIFFERENT TYPES OF BAYS.

8·4. Transomes shall be made to project 2·5 cm (or 1 in.) into ~~brick, stone~~ or concrete jambs, where the transome is the member which runs through unbroken in a cross coupling. Transomes may be cut to match the outer or inner flange of the frame sections, as appropriate, or cut to profile of the frame section in the case of aluminium.

8·5. Pockets shall be cut in the surround to appropriate depth to take the projection of the coupling member, when cutting holes for lugs.

8·6. Doors, Windows and Ventilators may have tubes as vertical coupling members to allow coupling at any desired angle so as to form a bay composite unit. Standard galvanized iron pipe of nominal 25 or 32 mm (or 1 in. or 1¼ in.) inside diameter are suitable for this purpose. After carefully setting out the unit to determine the exact angle required, the tube mullions shall be drilled and tapped with holes to match the fixing holes in the door, window or ventilator frame. Tube mullions are normally supplied by the manufacturer ready drilled and tapped and therefore full details of the setting out of the bay shall be provided when ordering.

Caps and bases of steel plate of suitable thickness and area shall be welded to the top and bottom of tube mullions where these are required to bear a load. Otherwise tube mullions are non-load bearing and shall project 2·5 cm (or 1 in.) at head and sill as in 8·3 (*see* Fig. 12-A to 12-E).

Mastic shall be applied to tube mullions as described in 8·1 and the outside joints subsequently pointed.

9. *Fitting and Hardware* :

9·1. Any hardware, if fixed in position, shall be removed before fixing the unit in the surround and the moving part shall be secured with wire or string during erection and while the building work is being completed to prevent damage to the part.

9.2. Hardware shall be fixed as late as possible preferably just before the final coat of paint is applied. It shall be fitted in a workman like manner, so that it may not work loose, and in such a way that screws and pins are not marked and mutilated by hammers and screw drivers. It shall be tested for correct operation.

9·3. When side hung casement are fitted with friction hinges, the hinges shall be adjusted to the required tension by adjusting the nuts on top and bottom hinges equally. If one hinge is tighter than the other the casement may get twisted when opening or closing and there is a consequent danger of breakage of the glass panes.

9·3·1. The friction required depends on the location. In an exposed site where high winds are expected, more friction is needed than in a sheltered location. For average conditions the normal setting of a friction hinge requires a pressure of 10 kg/cm² (or 14 lb/cm²) to overcome it. Friction shall be measured with gauges or judged. From time to time the nuts may require slight adjustment, but ovl shall not be used on friction hinges.

9.4. Whereas the friction hinges are of the protecting type side hung casements may have ordinary projecting type or non-projecting type hinges. The projecting type hinges project approximately 6·5 cm (or 2⅝ in.) and enable the outside surface of the glass panes to be cleaned from the inside. In case of double shutter casements the out side surface of the glass can be cleaned even though the hinges are not of the projecting type. But in the case of all other side hung casements projecting hinges are necessary from the point of view of cleaning. The proejcting hinges also enable the opening shutter of door or window to fold back against the wall which is not possible with the non-projecting type. In order to enable the door or window shutters to fold back, the doors or windows shall be set in the reveal as shown in Fig. 13-A and 13-B.

10. *Glazing*:

10.1. Before glazing, all opening parts shall be checked to see that they are closing correctly and are well bedded and not twisted in any way.

10.2. The weight of glass in a side hung casement causes it to drop slightly on its hinges. Before glazing, therefore, the casement shall be set in a slightly high position in its frame. The glass shall also be set slightly out of square in the frame, that is, high and towards the outside (handle) jamb. This can be effected by using little springs of wood to wedge the glass at certain points (*see* Fig. 14).

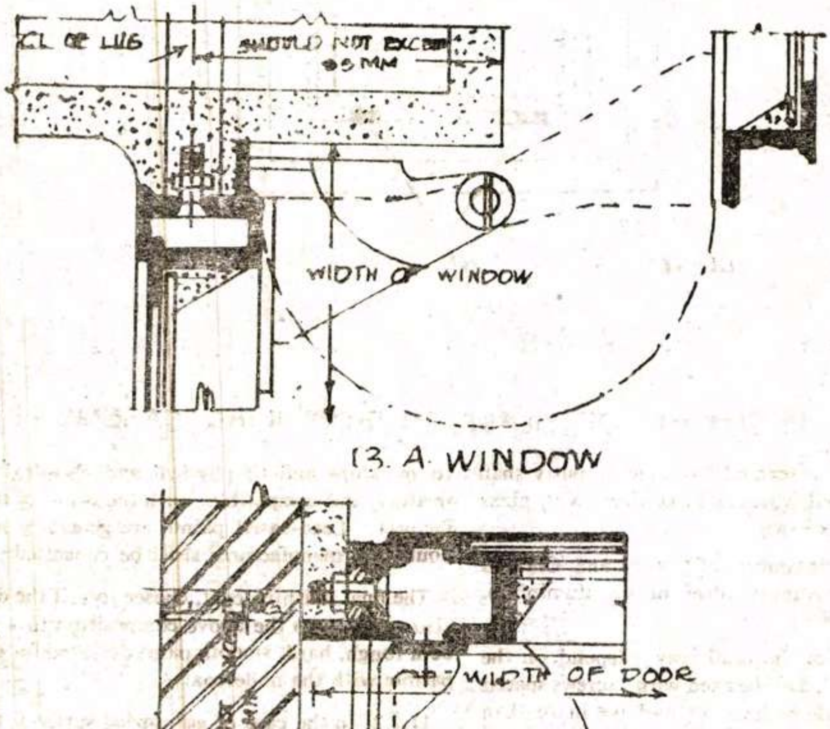
10.3. In case newly galvanized doors, windows or ventilators not exposed to the weather for at least three months, difficulty may be experienced when glazing as the putty may fail to stick to the frames. To overcome this, a thin film of raw linseed oil shall be applied to the glazing rebate with cloth soaked in linseed oil.

10.4. The frame shall be completely cleaned and bedding putty shall be placed in the rebate before glazing. Glass shall then be cushioned into this bedding putty properly and shall be fronted with front putty which shall stop 2 to 3 mm (or 1/16 to 1/8 in.) from the sight line of the back rebate to enable the painting to be done up to the sight line, to seal the edge of the putty to the glass. The back putty which has oozed out over the glazed rebate shall then be cut off square and smoothed down. This back putty is necessary as apart from preventing contact of this glass with the steel at any point; it will also prevent glass rattle and the ingress of moisture which may corrode the steel frame.

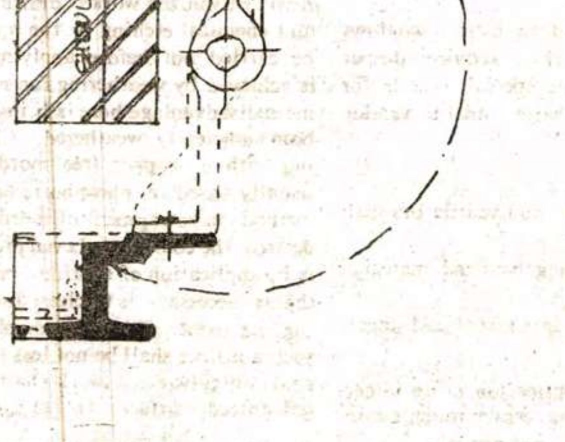
10.5. For doors and windows where pane size exceeds 60×30 cm (or 24 x 12 in.) glass shall be secured by special spring glazing clips which shall be inserted in holes already provided in the steel doors or windows, before applying the front putty.

10.6. For outside glazed windows where pane sizes do not exceed 60 x 30 cm (or 24 x 12 in.) spring glazing clips are not considered necessary.

10.7. When glazing very large panes of glass, or when heavy wind pressure may be experienced or in any case where specially desired by the user dazing bead may be used instead of front putty.



13. A WINDOW



13 B DOOR

FIG. 13 REVEAL FOR EXTENDED HINGE

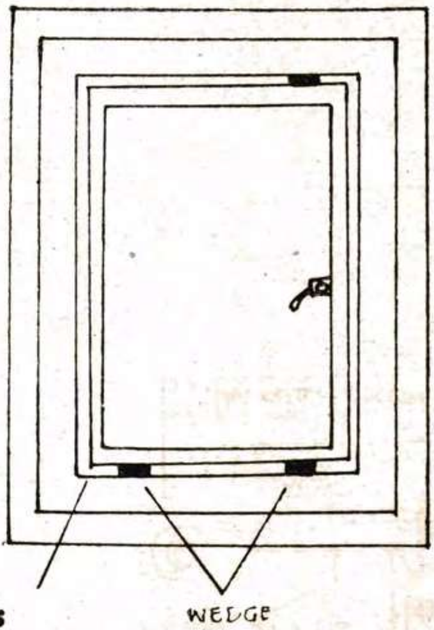


FIG 14 POSITION OF GLASS IN SIDE HUNG CASEMENT

10.8. When glazing with bed instead of front putty, putty shall be applied to the face of the bead which is in contact with glass and back putty would also be necessary.

10.8.1. Beads shall be of durable timbers of Class I and Class II specified in I.S. 401-1954 or of rustproof steel or of aluminium. The bead shall have mitred corners.

10.8.2. The position and size of the bead may depend on the thickness of glass used. The bead shall be fixed with screws spaced not more than 10 cm (or 4 in.) from each corner and not more than 20 cm (or 8 in.) apart and the doors or windows shall be drilled during manufacture with holes accordingly.

10.9. The standard sections for domestic and industrial windows are not suitable for double-glazing units, which require deeper rebates and glazing nibs. Special frames, or special inserts for standard frames as agreed between the purchaser and the vendor shall be used in such cases.

11. *Finishing* :

11.1. The site finishing of doors, windows and ventilators shall assure two purposes :

(a) protection of the metal (in the case of ungalvanized material) and

(b) decoration of the assembly (for both galvanized and ungalvanized material).

11·2. Site finishing shall consist of the application of an undercoat and a finishing coat of paint, after any necessary touching up. In the case of aluminium frames site painting is not necessary.

11.2.1. In the case of ungalvanized surfaces, the undercoat need not necessarily contain rust inhibitive ingredients as it is not in direct contact with the steel. It shall however be highly resistant to moisture and to physical and chemical disintegration by the weather, and compatible with the priming coat used by the manufacturer. Lead-based paints are generally suitable, but in case or doubt the manufacturer shall be consulted.

The final finishing coat, chosen to suit the decorative scheme shall also conform to the above composition to a lesser degree. It shall be a tough, hard, smooth paint designed for external use, and compatible with the undercoat.

11.2.2. In the case of galvanzied surfaces, the primary consideration for the undercoat is to obtain good adhesion. Adhesion to newly galvanized work is difficult to obtain and consequently natural and chemical etching or the application of a suitable primer shall be carried out before applying finishing coats. Natural etching is achieved by weathering for several months before painting. The main disadvantage here is being able to judge when the frames have been sufficiently weathered. Chemical etching is achieved by treating with a copper free mordant solution ; these mordants are usually based on phosphoric acid. The main disadvantage of this method is entrapment of mordant solution in crevices where it can destroy the coating and even promote corrosion. The safest method is by application of a primer based on calcium plumbate, where all that is necessary is to clean down (normal practice) before applying the paint. The calcium plumbate content of the pigment in such a primer shall be not less than 70 per cent. The final finishing coat on galvanized work shall be similar to that specified for ungalvanized surfaces in 11.2.1.

11.2.3. Care shall be taken to see that the putty receives adequate coats of paint and shall be dry and hard before painting. It is advisable to carry the paint slightly beyond the edge of the putty-glass junction line to be certain of sealing the junction line (see 10.4

11.2.4. On no account shall non-ferrous parts, that is handles, stayes eatches, etc. be painted.

11.2.5. Paint shall not be applied to working parts, such as handle pins, hinge pins, etc., where it can impede free action.

EXTRACT FROM I.S. 851—1957.

Specification for Synthetic resin Adhesives for Construction Work in Wood.

2.1. *Assembly Time* :

2.1.1. *Closed Assembly Times.* The time elapsing between the application of the adhesive and assembly of the joint components and the application of pressure.

2.1.2. *Open Assembty Time.*—The time elapsing between the application of the adhesive and assembly of the joint components.

2.2. *Close Contact Adhesive* .—A non-gap-filling adhesive suitable for use only in those joints where the surfaces to be joined are brought into close contact by means of adequate pressure, and where glue lines exceeding 0·12 mm (or 0.005 in.) can be avoided with certainty.

2.3. *Gap-Filling Adhesive* .—An adhesive suitable for use in those joints where the surfaces to be joined may or may not be in close or continuous contact owing either to the impossibility of applying adequate pressure or to slight inaccuracies in machining. Unless otherwise stated by the manufacturer, they shall not be used where the glue line exceeds 1.2 mm (or 0·05 in·) in thickness.

2.4. *Glue line.*—The resultant layer of adhesive effecting union between any two adjacent parts in an assembly.

2.5. *Hardener.*—A material used to promote the setting of the resin. It is supplied separately in liquid or powder form. It is an essential part of the adhesive, the properties of which depend upon using the resin and the hardener as directed.

2.6. *Pot Life.*—The time between the mixing of the constituent parts of an adhesive and its reaching the stage when it is no longer usable.

2.7. *Spread of Adhesives.*—The area of surface covered by 0.5 kg. (or 1.0 lb.) of glue mix prepared in accordance with the manufacturer's instructions.

2.8. *Storage Life.*—The period for which the adhesive or the adhesive components can be stored without affecting their suitability for use in accordance with this standard.

2.9. *Synthetic Resin.*—A phenolic synthetic resin is derived from the reaction of a phenol with an aldehyde. An aminoplastic synthetic resin is derived from the reaction of urea, thio-urea, melamine or allied compounds, or mixtures of these compounds, with formaldehyde.

2.10. *Synthetic Resin Adhesive.*—A composition substantially consisting of a synthetic resin of either the phenolic or aminoplastic type, including any hardening agent or filler and extender which may have been added by the manufacturer or which may be required to be added before use, according to the manufacturer's instructions.

3. *Types* :

3.1. Synthetic resin adhesives shall be of the following three types, depending on their degree of resistance to water and micro-organisms :

(*a*) Weather and Boil Proof (WBP),

(*b*) Moisture Resistance (MR), and

(*c*) Interior (INT).

3.1.1. Gap-filling and close-contact adhesives of the three types shall be distinguished by the following symbols :—

Type.	*Symbol.*	
	Gap-Filling adhesive.	*Close-contact adhesive.*
(1)	(2)	(3)
(*a*) Weather and Boil Proof ..	WBP/GF	WBP/CC
(*b*) Moisture Resistance	MR/GF	MR/CC
(*c*) Interior	INT/GF	INT/CC

4. *Keeping Qualities* :

4.1. The adhesives shall comply with the requirements specified under 6 after the resin and hardener have been stored in the original closed containers according to the manufacturer's instructions and up to the date recommended by the manufacturer.

5. *Instructions for use* :

5.1. The manufacturer shall furnish written instructions detailing the manner in which each resin or recommended combination of resin(s), hardener(s), filler, fortifier and extender shall be used. The instructions shall give information in the manner indicated under 5.2. to 5.6. where applicable.

5.2. *Storage Life of Adhesive Components.*—The manufacturer shall specify the storage life of the adhesive components.

5.3. *Preparation for use.*—The preparation of resin, hardener, fortifier, filler and extender, m thod of mixing, recommended types of mixing, apparatus, and necessary precautions of any kind shall be stated.

5.4. *Usable Life of Mixed adhesive or Pot Life.*—The maximum time shall be stated during which the adhesive maintained at temperatures of 15, 20, 25, 30, 40, and 45° C would remain fit for use so as to comply with the requirements of the specification.

5.5. *Methods of Use* .—Guidance on the following points shall be given:—

(*a*) Range of moisture content of wood ;

(*b*) Preparation of wood surfaces ;

(*c*) Methods of application, such as single or double spread;

(*d*) Normal amounts of spread for single glue line ;

(*e*) Maximum and minimum open and closed assembly times,

(*f*) Recommended range of pressures in Kg. per sq. cm. (or lb. per sq. in.);

(*g*) Post-treatment of finished products ; and

(*h*) Cleaning of containers and test.

5.6. *Setting times and conditions.*—The recommended range of temperature to which the adhesive in any glue line may be subjected and also the minimum and maximum times for which pressure shall be maintained on unstressed joints at temperatures within the range shall be stated.

EXTRACT FORM I.S. 883—1970.

Code of practice for design of structural timber in building.

4. *Material* :

4.1. *Species of Timber*.—The species of timber recommended for constructional purposes (classified into three groups, namely, Group A, B and C) are given in Table 1.

4.1.1. The characteristics of these groups are given below :

Group A. Modulus of elasticity in bending above 126 tonnes/cm²

Group B. Modulus of elasticity in bending above 98 and upto 126 tonnes/cm².

Group C. Modulus of elasticity in bending above 56 and upto 98 tonnes/cm²

4.1.2. Actual values of safe permissible stresses for the species of timber (classified into three groups in 4.1) are given in Table 2 for reference purposes.

4.1.3. Timber species may be identified in accordance with I.S. 4970 1968.

4.2. The availability and general characteristics like durability, treatability, etc., of the species are given in Table 1. The species of timber other than those given in Table1 may be used provided the basic strength characteristics are determined.

NOTE.—For obtaining basic strength figures of the unlisted species, a reference may be made to the Forest Research Institute and Colleges, Dehra Dun.

4.3 *Moisture content in Timber*.—Unless otherwise specified the moisture content of the timber shall conform to the requirements given in I.S. 287—1960.

4.4. *Requirements of Structural Timber*.—The various requirements of structural timber for use in building shall conform to I.S. 3629—1966.

4·5. *Sawn Timber*.--The cut sizes of timber of structural purposes and also tolerances shall be those as given in I.S. 4891—1968.

4·6. *Grading of structural timber* :

4.6.1. The cut sizes of structural timber shall be graded, after seasoning, into the following three grades :

(*a*) Select Grade ;

(*b*) Grade I ; and

(*c*) Grade II.

4.6.2. The prohibited defects given in 4.6.2.1 and permissible defects given in 4.6.2.2 and 4.6.2.3 shall apply to structural timber.

4.6.2.1. *Prohibited defects*.—All grades of timber with the following defects shall be probibited for structural use :

(*a*) Timber with loose grain, splits, compression wood in coniferous structural timber, heartwood rot, saprot and warp ; and

(*b*) Worm holes made by powder post beetles and pitch pockets.

4.6.2.2. *Permissible defects*.—The following defects are permissible for all grades of timber : (*a*) Wanes are permitted provided they are not combined with knots and the reduction in strength on account of the wanes is not more than the reduction with the maximum allowable knots. Wanes may also be permitted provided there is no objection to its use as bearing area, nailing edge and affects general appearance ; (*b*) Worm holes other than those due to powder post beetles located and grouped to reduce the strength of timber shall be evaluated in the same way as knots; (*c*) All other defects which do not affect any of the mechanical properties of timber shall be permitted.

4.6.2.3. In addition to the permissible defects under 4.6.2.2. the defects listed in Table 3 shall be permitted for Select Grade, Grade I and Grade II timber for structural purposes.

5. *Permissible stresses* :

5.1. Basic stress values of different groups of timber are determined on small clear specimen according to I.S. 1708—1969. These values are then divided by the appropriate factors of safety to obtain the permissible stresses.

5.2. The permissible stresses for Groups A, B and C for different locations applicable to Grade I structural timber shall be as given in Table 4 provided that the following conditions are satisfied :

(*a*) The timbers should be of high or moderate durability and be given the suitable treatment where necessary. They may be used on any location. If the location is inside and not in contact with the ground, low durability timber may be used after proper seasoning and preservative treatment are given in accordance with I.S. 401—1967 ; and

(*b*) The loads should be continuous and permanent.

5.3. For other grades the permissible stresses given in Table 4 shall be multiplied by the following factors to obtain the permissible stresses, assuming that the conditions laid down in 5.2 are satisfied :

(*a*) For Select Grade timber 1.16 ;

(*b*) For Grade II timber 0.84

TABLE 4—PERMISSIBLE STRESSES FOR GRADE I TIMBER.

(*Clauses* 5.2, 5.3, 5.4.1., 5.4.2., 6.4.7.2. *and* 6.4.7.3.)

Serial number and Permissible Stresses. Kg/cm²		Group. *A*	Group. *B*	Group. *C*
(1)		(2)	(3)	(4)
(i) Bending and tension along grain.	Inside locations.	182	123	84
	Outside locations.	152	102	70
	Wet locations ..	120	81	60
(ii) Shear ..	Horizontal all locations *	12	9	6
	Along grain all locations. †	17	13	9
(iii) Compression parallel to grain.	Inside locations.	120	70	64
	Outside locations.	106	63	56
	Wet locations ..	88	58	46
(iv) Compression perpendicular to grain.	Inside locations.	60	22	22
	Outside locations.	46	18	17
	Wet locations ..	38	15	14

* The values of horizontal shears to be used only for beams.

† Inall other cases shear along grain to be used.

5.3.1. When low durability timbers are to be used on outside locations, the permissibe stresses for all grades of timber, arrived at by 5·2 and 5·3 shall be multiplied by 0·80.

5·4. *Modification Factors for Permissible Stresses* :

5·4·1. *For Change in slope of grain* : —When the timber has not been graded and has major defects like slope of grain, knots and checks or shakes (but not beyond permissible value) the permissible stress given in Table 4 shall be multiplied by the modification factor K1 for different slopes of grain as given in Table 5.

5.4·2. *For change in duration of load* :—For durations of design load other than continuous, the permissible stresses given in Table 4 shall be multiplied by the modification factor K2 given in Table 6.

6. *Design* :

6.1. All structural members, assemblies or framework in a building in combination with the floors, walls and other structural parts of the building shall be capable of sustaining, with due stability and stiffness and without exceeding the limits of stress specified, the whole dead and superimposed loading including other types of loading referred to in this standard.

6·2. The loads (other than impact and live loads) as in the design shall conform to I.S. 875—1964.

6.3. *Net Section* :

6·3·1. The net section is obtained by deducting from the gross section the projected area of all material removed by boring, grooving or other means.

NOTE.—In case of nailing, the area of the prebored hole shall not be taken into account for this purpose.

TABLE 5—MODIFICATION FACTOR K1 TO ALLOW FOR CHANGE IN SLOPE TO GRAIN.

(*Clause* 5·4·1.)

Slope.	K1	
	Strength of Beams, joists and ties.	*Strength of Posts or column.*
(1)	(2)	(3)
1 in 10	0·80	0·74
1 in 12	0·90	0·82
1 in 14	0·98	0·87
1 in 15 and flatter ..	1·00	1·00

TABLE 6—MODIFICATION FACTOR K2 FOR CHANGE IN DURATION OF LODING.

(*Clause* 5·4·2.)

Serial number.	*Duration of loading.*	*Modification Factor* K_2
(1)	(2)	(3)
(i)	Continuous	1·0
(ii)	Two months	1·15
(iii)	Seven days	1·25
(iv)	Wind and earthquake	1·33
(v)	Instantaneous or impact	2·00

466-3A—9

6·3·2. The net section used in calculating load-carrying capacity of a member shall be the least net section determined as above by passing a plane or a series of connected planes transversely through the members.

6·3·3. Notches shall, in no case, remove more than one quarter of the section.

6·3·4. In the design of an intermediate or a long column, gross section shall he used in calculating load-carrying capacity of the column.

EXTRACT FROM I.S. 2468—1963.

Specification for whiting for putty.

1. *Scope* :

1·1. This standard prescribes the requirements and methods of test for the material commercially known as whiting used for making putty for use on wooden and metal frames (See I.S. 419—1953 Specification for Putty, for Use on Wooden Frames and I.S. 420—1953 Specification for Putty, for Use on Metal Frames.)

3. *Requirements* :

3·1. *Composition.*—The material shall consist of natural chalk and shall contain not less than 85 per cent by weight of calcium carbonate ($CaCO_3$). It shall not contain any free lime (CaO).

3·1·1. The composition of the material shall be determined as prescribed in Appendix A.

3·2. *Form and Condition.*—The material shall be an amorphous, fine powder, free from grits, and shall closely resemble the approved sample in particle shape and size when examined microscopically.

3.3. *Putty making Property.*—The material when kneaded with linseed oil, raw (conforming to I.S. 75—1950 specification for Linseed Oil, Raw, for Paints) in suitable proportion shall form a coherent paste which after thorough working in the hands shall have good plastic quality without sliminess or stickiness that would render it difficult to handle and apply.

3·3·1. In addition, it shall work readily and smoothly without crumbling or cracking, and after being moulded in place it shall hold its shape until set.

3·4. The material shall also comply with the requirements given in Table I.

TABLE I—REQUIREMENTS FOR WHITING FOR PUTTY.

Serial number and Characteristic.	*Require-ment.*	*Method of Test. (Ref. to various Indian Standards.)*
(1)	(2)	(3)
(i) Volatile matter, per cent by weight, Max.	0·2	6 of I.S. 33—1963.
(ii) Residue on sieve, per cent by Weight, Max.	0·5	7 of I.S. 33—1963.
(iii) Oil absorption, per cent by weight.	10 to 22	8 of I.S. 33—1963.
(iv) Matter insoluble in 1:1 hydrochloric acid, per cent by Weight, Max.	8·0	C-6 of I.S. 1683—1960.
(v) Alumina and iron oxide, per cent by Weight, Max.	1·5	B-3 of I.S. 1685—1960.

4. *Packing and Marking* :

4·1. *Packing.*—The material shall be suitably packed as agreed to between the purchaser and the supplier.

4·2. *Marking.*—The containers shall be marked with the name of the material ; manufacturer's name and trade-mark, if any ; weight of the material ; and month and year of manufacture.

4·2·1. The containers may also be marked with the I.S.I. Certification Mark.

5. *Sampling* :

5·1. *Preparation of Test Samples.*—Representative samples of the material shall be prepared as prescribed under 3 of I.S. 33—1963 Methods of Test for Dry Pigments and Extenders for Paints (Revised).

5·2. *Number of Tests.*—Tests for the determination of all the characteristics specified shall be conducted on the composite sample.

5·3. *Criteria for Conformity.*—The material shall be taken as conforming to this specification if the composite sample satisfies all the requirements prescribed.

6. *Test Methods* :

6·1. Tests shall be conducted as prescribed in Appendix A of this standard and according to the methods prescribed in I.S. 33—1963 Methods of Test for Dry Pigments and Extenders for Paints (Revised). I.S. 1683—1960 Specification for Barytes for Rubber Industry ; and I.S. 1685—1960 Specification for Whiting for Rubber Industry, Reference to Appendix A appears in 3·1·1· and to relevant clauses of various standards in Col. 4 of Table 1.

6·2. *Quality of Reagents.*—Unless otherwise specified, pure chemicals and disitilled water (see I.S. 1070—1960 Specification for water, Distilled Quality (Revised) shall be employed in tests.

NOTE.—' Pure chemcials ' shall mean chemicals that do not contain impurities which affect the results of analyses.

APPENDIX A.

(*Clause* 3·1·1.)

ANALYSIS OF WHITING FOR PUTTY.

A-1. *Determination of Calcium Carbonate Content.*

A-1·0. *General.*—The calcium carbonate content is determined volumetrically using standard potassium permanganate solution.

A-1·1. *Reagents*:

A-1·1·1. *Standard Potassium Permanganate Solution* (0.1. N)—Dissolve 3·2g. of potassium permanganate in 1,000 ml. of distilled water and allow it to stand for 8 to 14 days. Siphon off the clear supernatant solution into a dark-coloured glass-stoppered bottle. Weigh accurately about 3·3g. of sodium oxalate, previously dried for a few hours at 100°±2°C and cooled over fused calcium chloride in a desiccator. Dissolve it in distilled water and make up the solution to exactly 500 ml. Transfer 25 ml. of sodium oxalate solution to a conical flask, add 50 ml. of water and 10 ml. of dilute sulphuric acid (1 : 1 by volume). Heat the solution to about 60°C and titrate with potassium permanganate solution.

$$\text{Strength of permanganate solution} = 0{\cdot}373 \times \frac{W}{V}$$

where

W—weight in g. of sodium oxalate in 1000 ml. of solution ; and

V—volume in ml. of potassium permanganate required for titration against 25 ml. of sodium oxalate solution.

A-1·1·2. *Bromine Water* :

A-1·1·3. *Ammonium Oxalate Solution*—Saturated.

A-1·1·4. *Dilute Hydrochloric Acid.*—Add one volume of concentrated hydrochloric acid (conforming to I.S. 265—1962 specification for Hydrochloric Acid (Revised) to one volume of water.

A-1·1·5. *Dilute Sulphuric Acid.*—Carefully add one volume of concentrated sulphuric acid conforming to I.S. 266—1961 specification for Sulphuric Acid (Revised) to 4 volumes of water.

A-1·2. *Procedure.*—Transfer about 0·2 g. of accurately weighed whiting, dried as described under 6 of I.S. 33—1963 Methods of Test for Dry Pigments and Extenders for Paints (Revised), to a beaker. Dissolve the whiting in about 20 ml. of dilute hydrochloric acid. Digest for 10 minutes on a steam bath, dilute to 150 ml. filter and wash the residue with water, Add a few millilitree, of bromine water heat to boiling and make the boiling solution ammoniacal. Filter off the residue, wash it thorughly and reduce the filtrate by evaporation to 200 ml. To the slightly ammoniacal solution, heated to boiling, add an excess of a hot ammonium oxalate solution, Continue boiling, till the precipitate becomes granular. Allow to stand for one hour, filter and wash with hot water. Pierce the apex of the filter paper with a strirring rod and wash the precipitate into beaker with hot water. Pour warm dilute sulphuric acid through the paper and wash it a few times with warm acid. Add about 30 ml. of dilute sulphuric acid, dilute to about 250 ml. heat to 60°C and titrate with standard pottassium permanganate solution.

A-1.3. *Calculation* :

$$\text{Calcium carbonate, per cent by weight} = \frac{0.5004\,V}{W}$$

Where

V — volume in ml of 0.1 N potassium permanganate solution used for titration, and

W — weight in g. of the material taken for test

A-1.4. The carbon dioxide content shall be estimated by a suitable method. This shall not be less than the equivalent value for calcium carbonate ($CaCO_3$) content.

A-2. *Test for free lime* :

A-2. *Reagents* :

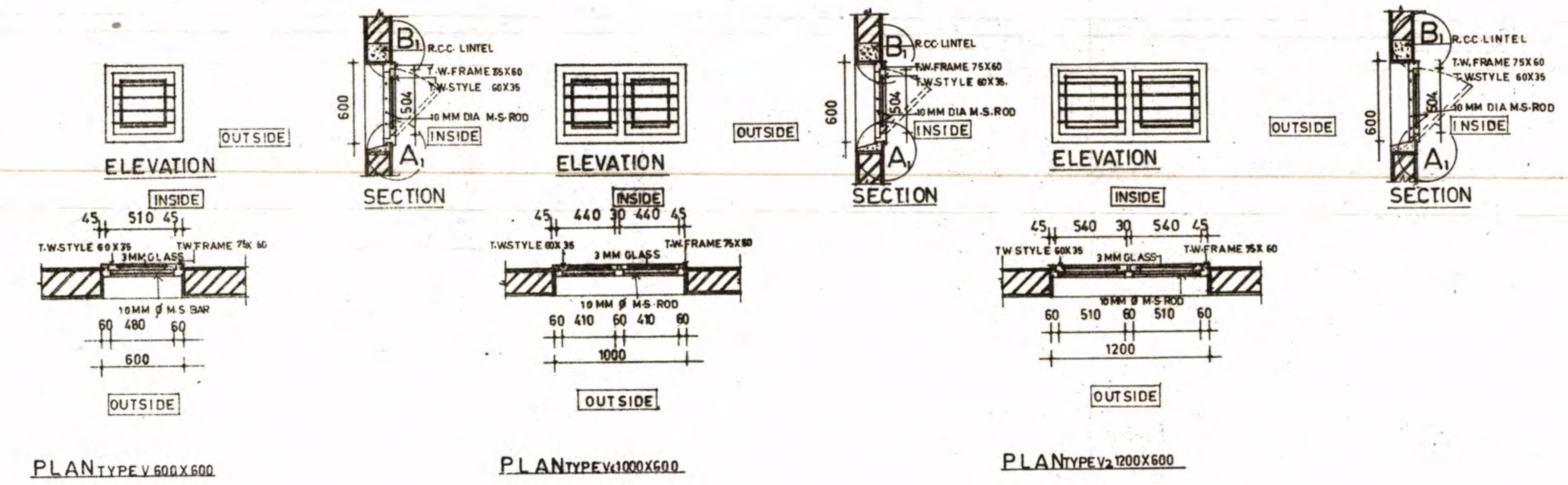
A-2.1.2. *Phenolphthalein Indicator Solution* : Dissolve 0·1 g. in 100 ml. of rectified spirit (conforming to I.S. 323-1959 Specification for rectified spirit (Revised).

A-2.1.3. *Standard Hydrochloric Acid* : exactly 0.1 *N*.

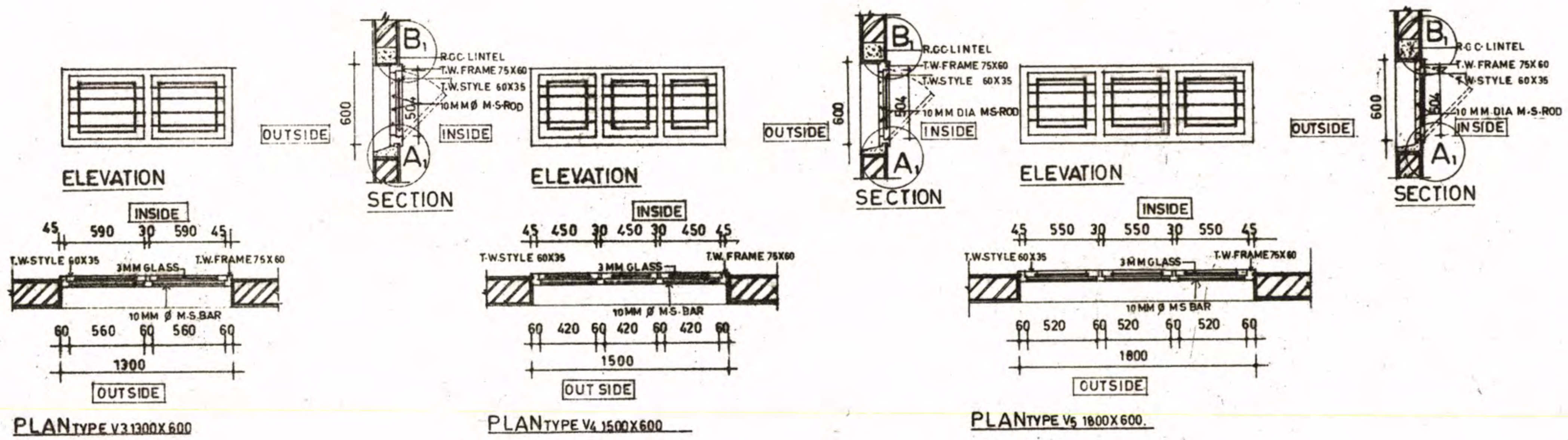
A-2.2. *Procedure* : Grind the material to a fine powder, take about 0.1g of it in a conical flask, shake vigorously with about 30 ml., of cane sugar solution, filter and test the filtrate with phenolphthalein indicator. If a pink colour is developed, add to the solution 3 drops of standard hydrochloric acid.

A-2.2.1. The material shall be deemed to contain no free lime if on the addition of the indicator no colour is developed; or if any pink colour is developed it is discharged by the addition of 3 drops of standard hydrochloric acid.

BOTTOM HUNG VENTILATORS



BOTTOM HUNG VENTILATORS



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SNO	NOTES-
1.	THIS DRAWING SUPERSEDES JOB NO 1073 DRG NO 22R
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CHIEF ARCHITECT 16-7-86
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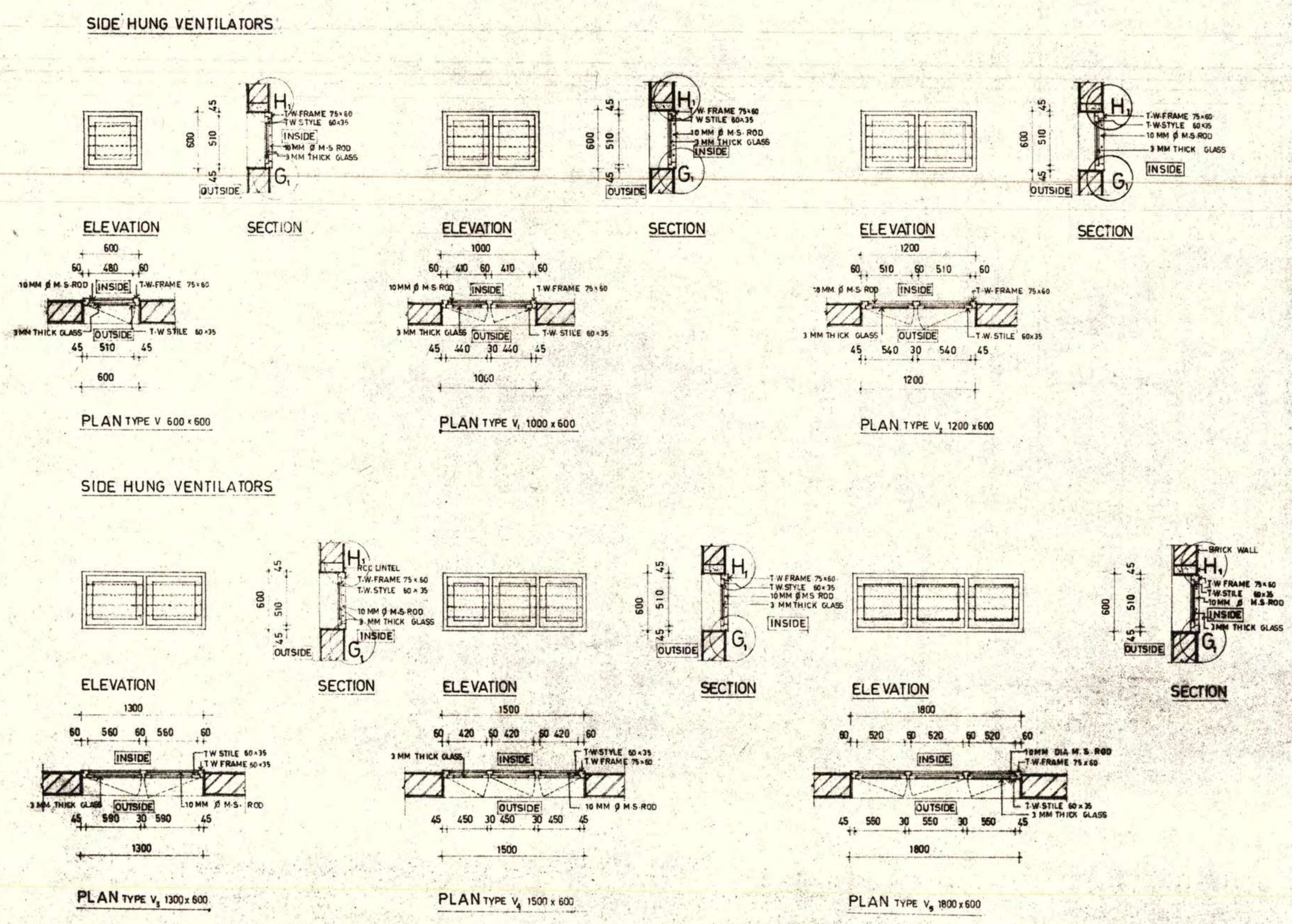
ARCHITECT
ASST ARCHITECT

OFFICE OF THE CHIEF ARCHITECT MADRAS-5

SCALE: 1:20		DATE: 19-6-86
DEALT manimekalai	JOB NO	DRG NO
CHECKED A.V.	1073	41

TYPE DESIGN FOR VENTILATORS(BOTTOM HUNG) TYPE V_1 V_2 V_3 V_4 & V_5

PLAN, ELEVATION & SECTION.



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2.	READ WITH JOB NO 1073 DRG NO 45
3.	ALL DIMENSIONS ARE IN MILLIMETRES

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SCALE 1 : 20

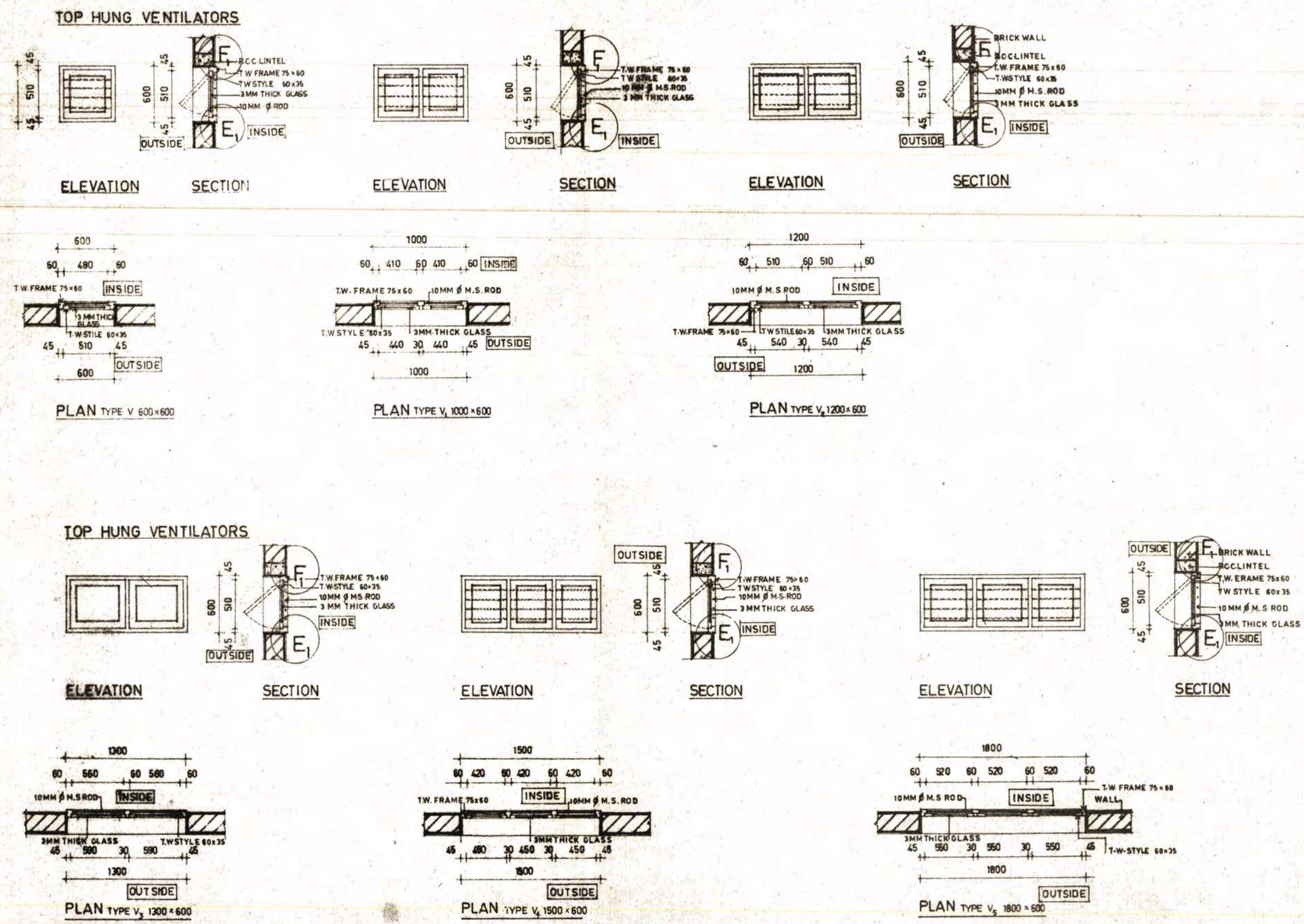
DEALT BY :

CHECKED BY : A.V.

JOB NO 1073 — DRG NO 42

TYPE DESIGN FOR VENTILATORS TYPE V V_1 V_2 V_3 V_4 V_5 (SIDE HUNG)

PLAN ELEVATION AND SECTION



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NO	NOTES
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2.	READ WITH JOB NO 1073 DRG NO 46
3.	ALL DIMENSIONS ARE IN MM

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CHIEF ARCHITECT — SENIOR ARCHITECT

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OFFICE OF THE CHIEF ARCHITECT MADRAS-5.

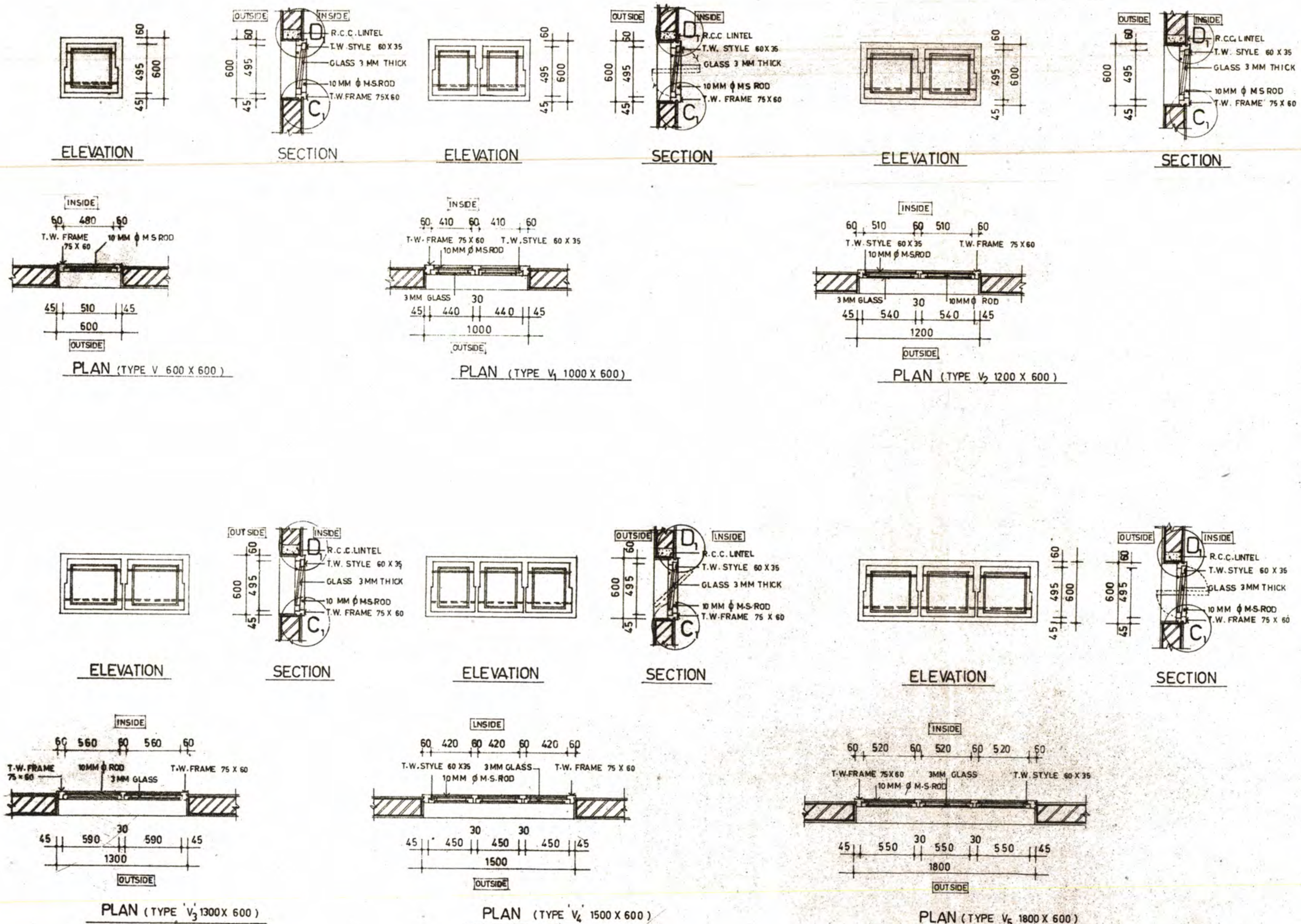
SCALE: 1:10 — DATE: 19-6-85

DEALT BY: V. malathi — CHECKED BY: A.N. — JOB NO 1073 — DRG NO 43

TYPE DESIGN FOR VENTILATORS TYPE V V1 V2 V3 V4 V5 (TOP HUNG)

PLAN ELEVATION AND SECTION

HORIZONTAL PIVOTED VENTILATORS



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S.NO	NOTES
1	ALL DIAMENSIONS ARE IN MM
2	THIS DRG SUPERCEDES JOB NO 1073 DRG NO. 23 R
3	READ WITH JOB. NO. 1073 DRG. NO. 45
4	ALL DIMENSIONS ARE IN MM.

S.NO.	REVISION	SIGN	DATE

CHIEF ARCHITECT 16.7.85 — SENIOR ARCHITECT

ARCHITECT — ASST. ARCHITECT

OFFICE OF THE CHIEF ARCHITECT, MADRAS.

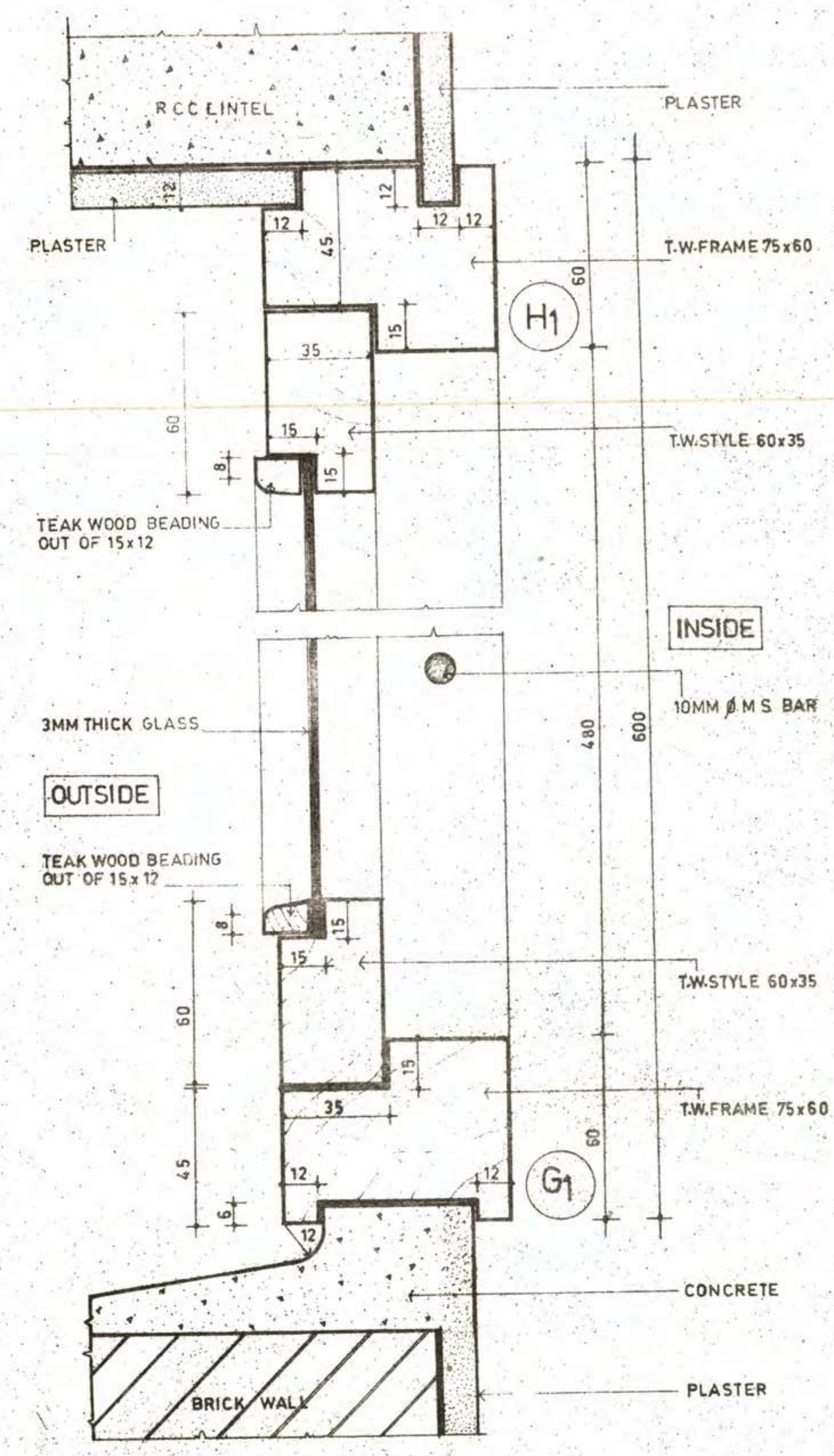
SCALE : 1 : 20 — DATE 19-6-85.

DEALT S. indira — JOB. NO 1073 — DRG. NO 44

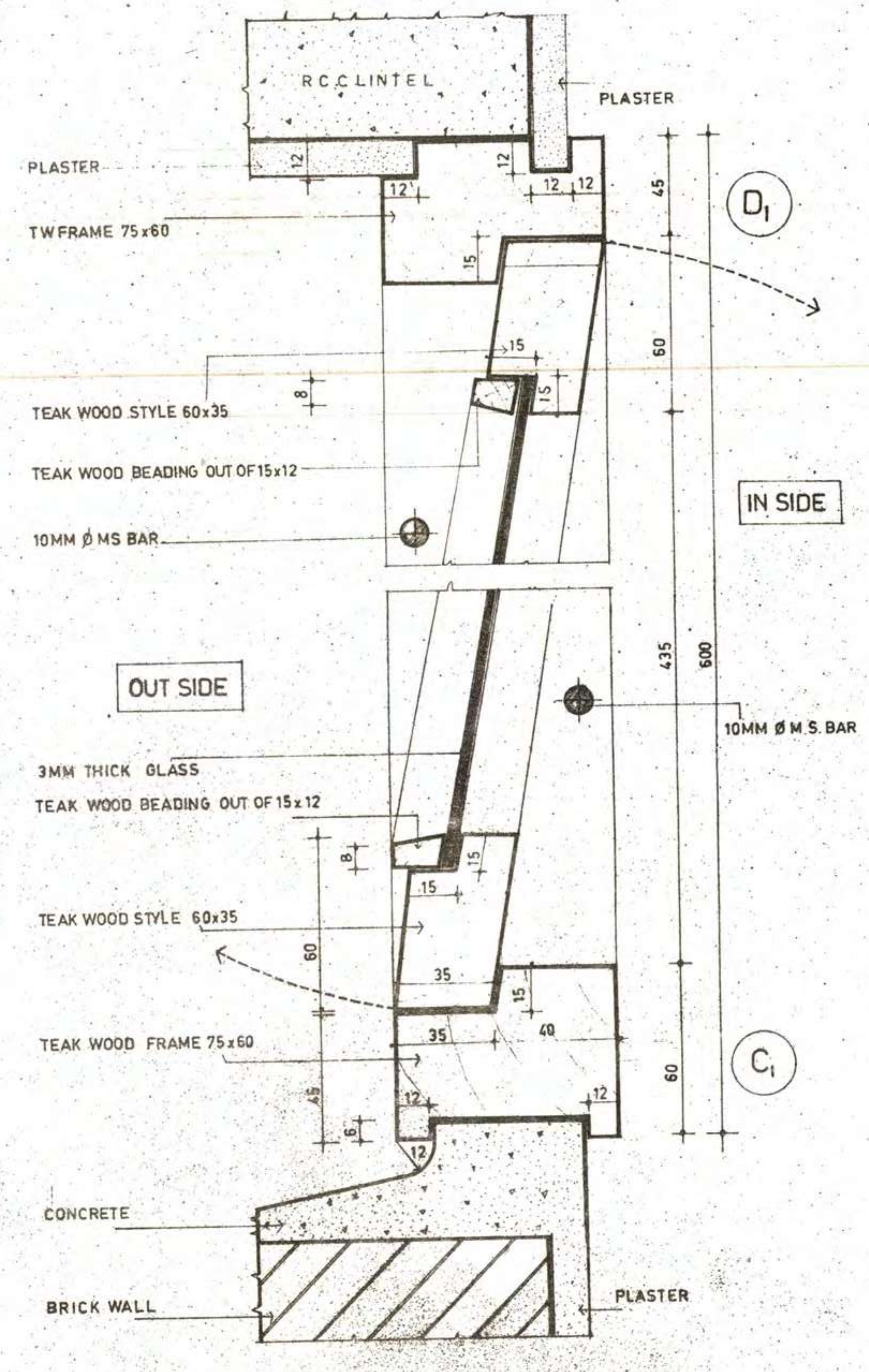
CHECKED A.V.

TYPE DESIGN FOR VENTILATOR HORIZONTAL PIVOTED (TYPE V, V_1, V_2, V_3, V_4 & V_5)

PLAN, ELEVATION & SECTION.



SIDE HUNG VENTILATOR
FULL SIZE DETAILS AT G1 H1



HORIZONTAL PIVOTED VENTILATOR
FULL SIZE DETAILS AT C1 D1

PUBLIC WORKS DEPT.
TAMILNADU.

NO	NOTES
1	THIS DRG SUPERSEDES JOB NO 1072 DRG NO 27R
2	READ WITH JOB NO 1073 DRG NO 42
3	ALL DIMENSIONS ARE IN MM

SNO	REVISION	SIGN	DATE

CHIEF ARCHITECT — SENIOR ARCHITECT

ARCHITECT — ASST. ARCHITECT

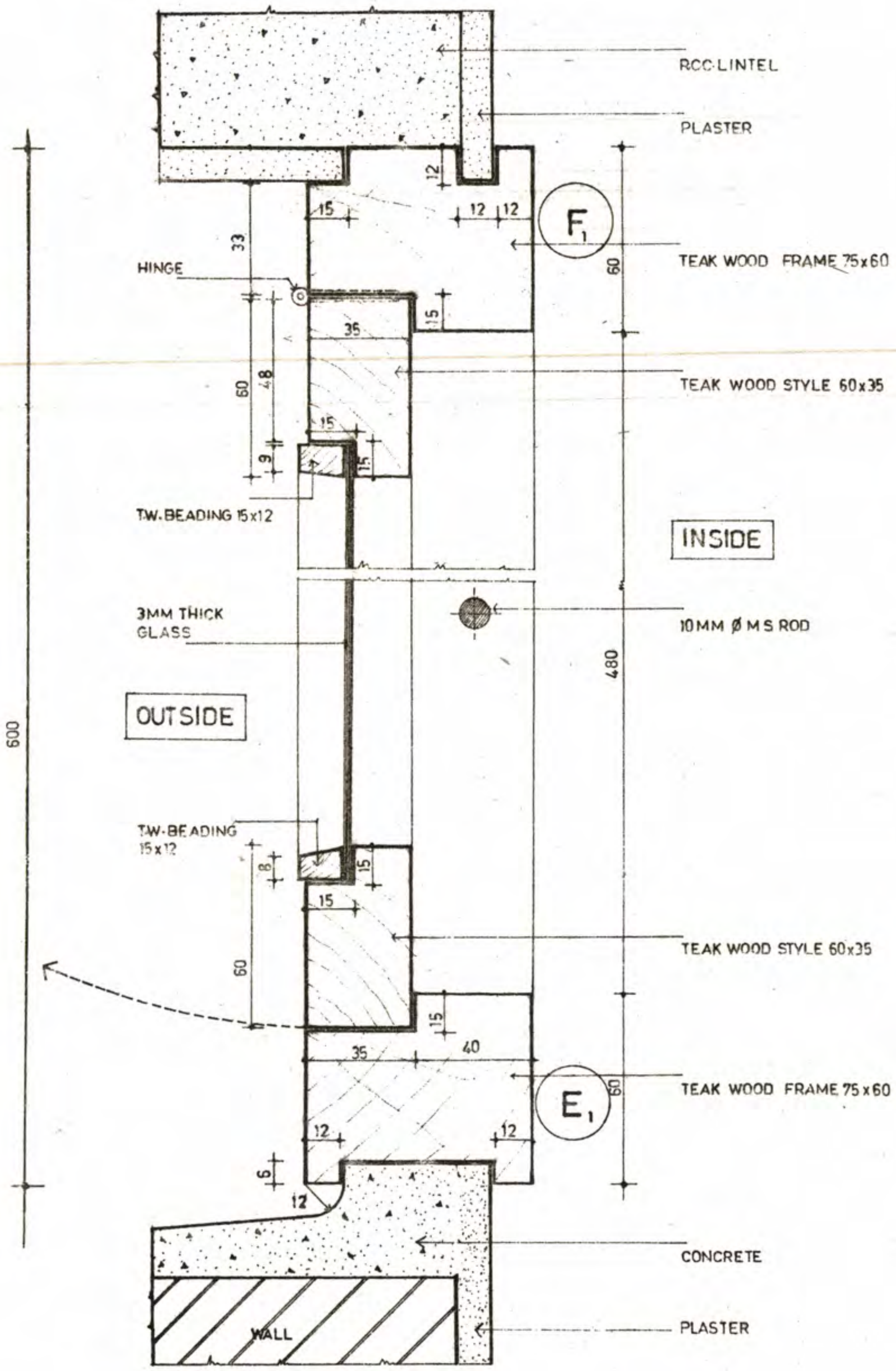
OFFICE OF THE CHIEF ARCHITECT MADRAS - 5

SCALE: FULL SIZE — DATE 19-6-86

DEALT BY: s.indra — CHECKED BY: A.V. — JOB NO 1073 — DRG NO 45

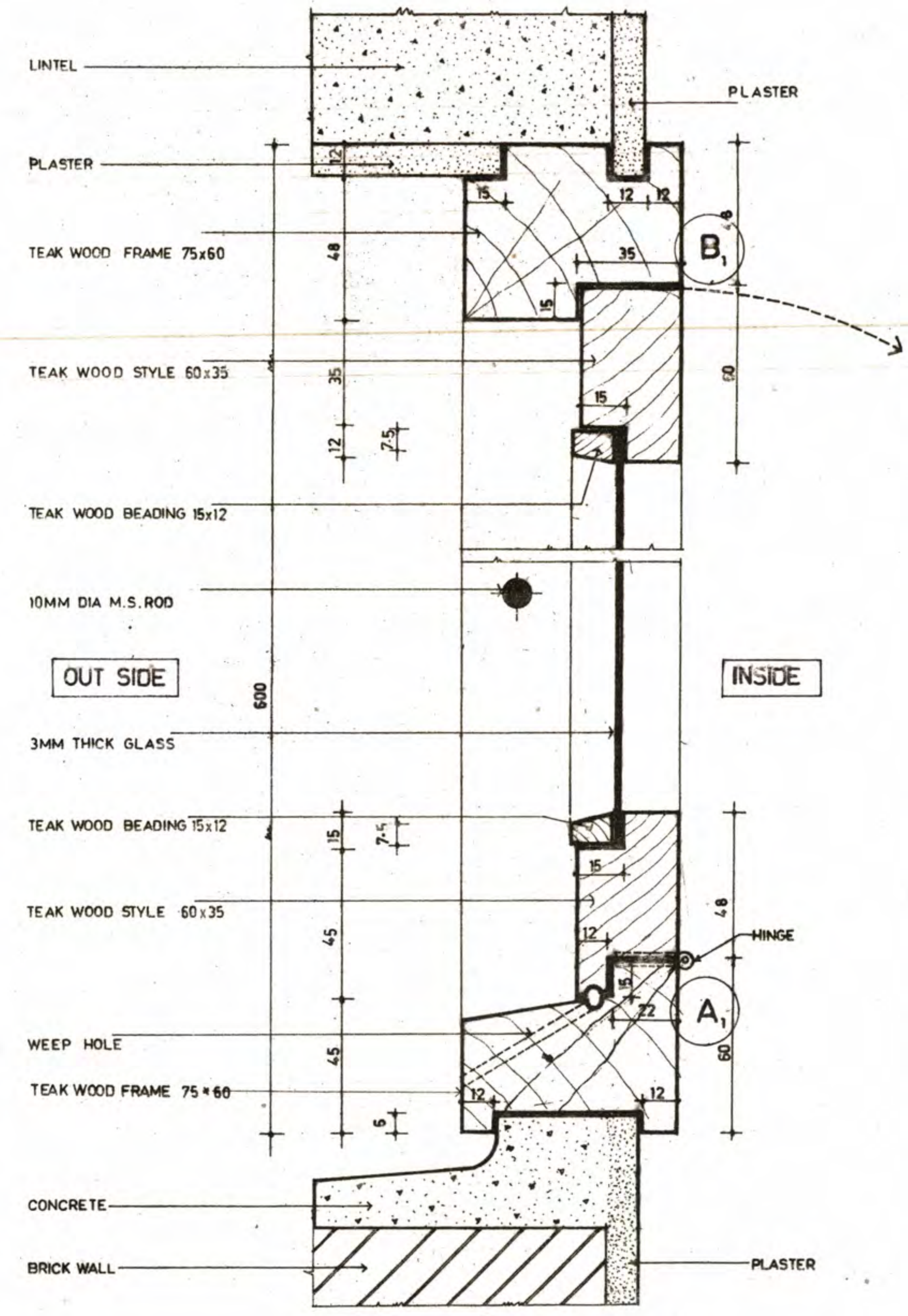
TYPE DESIGN FOR VENTILATORS-DETAILS

DETAILS.



TOP HUNG VENTILATORS

FULL SIZE DETAIL AT E1 F1



BOTTOM HUNG VENTILATORS

FULL SIZE DETAIL AT A1 B1

PUBLIC WORKS DEPT. TAMILNADU.

NO	NOTES
1	THIS DRG. SUPERSEDES JOB NO 1073 DRG NO. 26.
2.	REFER JOB NO 1073 DRG NO. 41 AND 43
3	ALL DIMENSIONS ARE IN MM

NO	REVISION	SIGN	DATE

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OFFICE OF THE CHIEF ARCHITECT MADRAS

SCALE - FULL SIZE | DATE: 19.6.85

DRAWN BY: s.indira | JOB NO 1073 | DRG NO 46

CHECKED BY: A.V.

TYPE DESIGN FOR VENTILATORS - DETAILS.

FULL SIZE DETAILS OF TOP HUNG AND BOTTOM HUNG VENTILATORS

PUBLIC WORKS DEPT
TAMILNADU.

NO	NOTES
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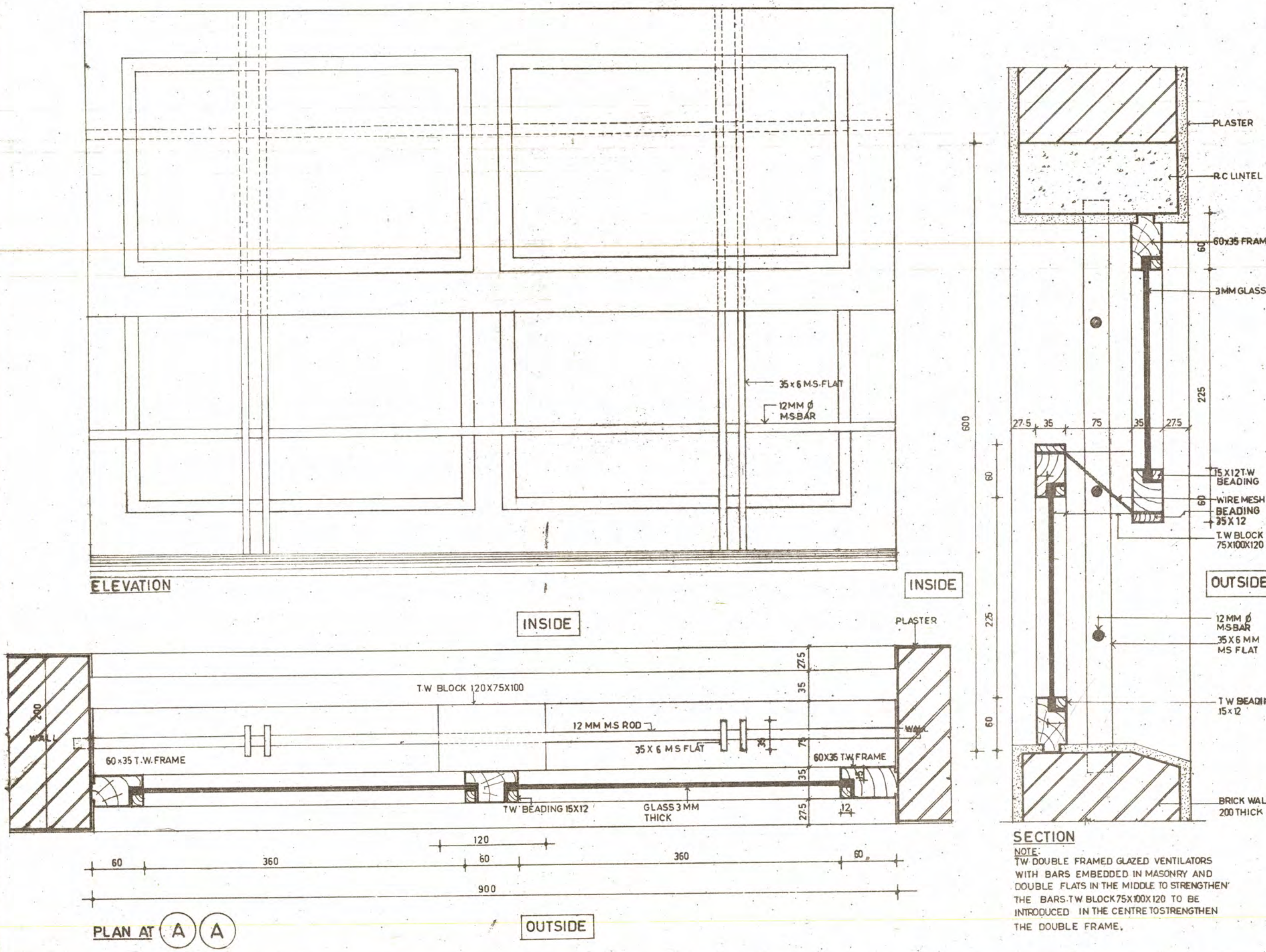
2	ALL DIMENSIONS ARE IN MM.



NOTE:
TW DOUBLE FRAMED GLAZED VENTILATORS WITH BARS EMBEDDED IN MASONRY AND DOUBLE FLATS IN THE MIDDLE TO STRENGTHEN THE BARS. TW BLOCK 75X100X120 TO BE INTRODUCED IN THE CENTRE TO STRENGTHEN THE DOUBLE FRAME.

NO	REVISION	SIGN	DATE

CHIEF ARCHITECT 16-7-85 | SENIOR ARCHITECT

ARCHITECT | ASST ARCHITECT

OFFICE OF THE CHIEF ARCHITECT MADRAS-5

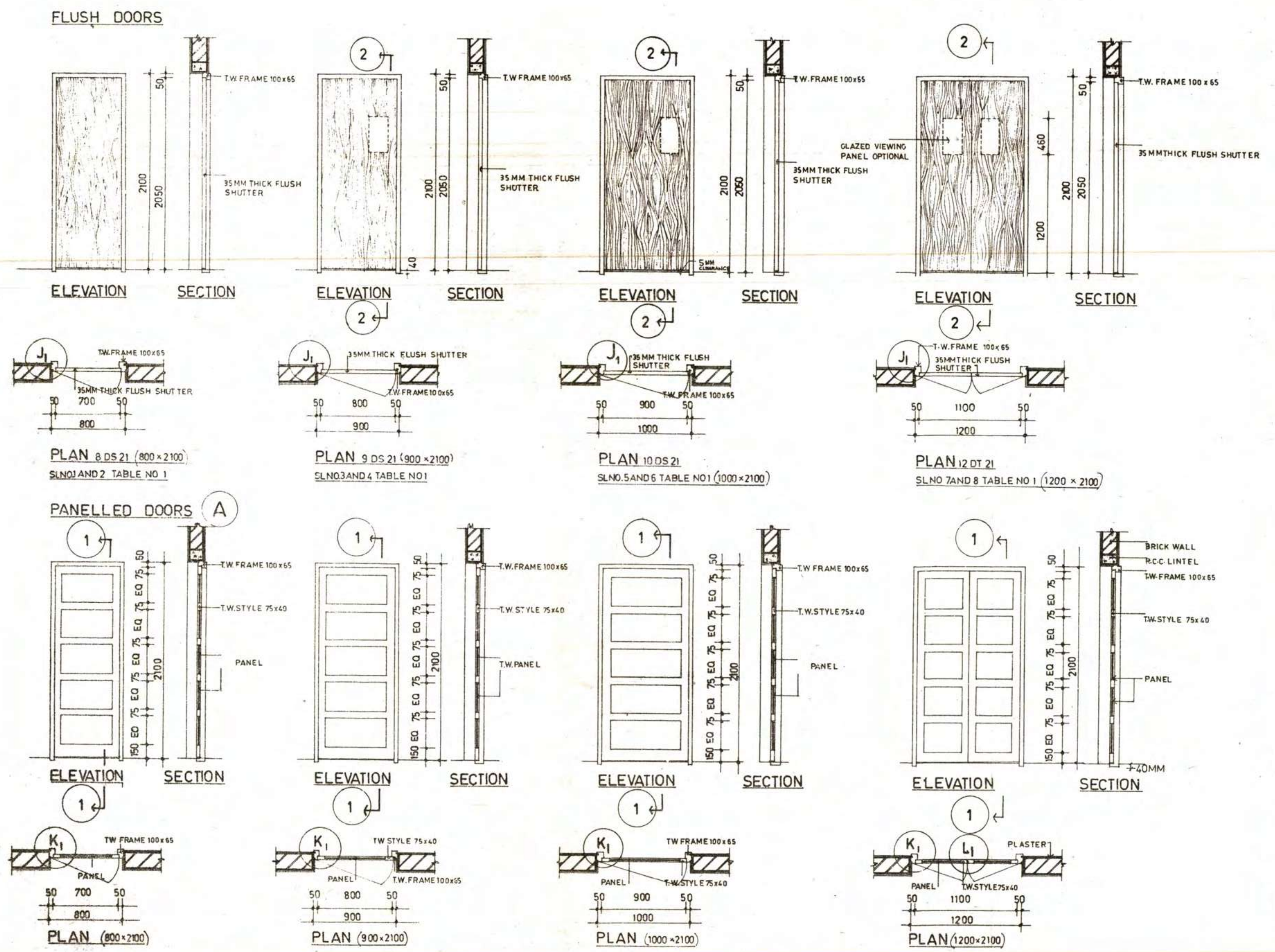
SCALE: 1:2 | DATE 19-6-85

DEALT BY: s. indira | JOB NO 1073 | DRG NO 47

CHECKED BY: A.V.

TYPE DESIGN FOR FIXED VENTILATOR WITH WIRE NETTING - DETAILS

PLAN, ELEVATION & SECTION.



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NO	NOTES
1	THIS DRAWING SUPERSEDES JOB NO.1073 DRG NO.28.
2.	READ WITH JOB NO.1073 DRG NO.60.
3.	ALL DIMENSIONS ARE IN MM.
4	ALTERNATIVE SPECIFICATION FOR FLUSH DOOR PRELAMINATED VENEERED PARTICLE BOARD OF 25mm THICKNESS AND ABOVE CONFORMING TO IS 3097 _ 1980
5	ALTERNATIVE SPECIFICATIONS FOR PANELS IN PANELLED DOORS 1.12mm TEAKWOOD PANELS 2.18mm TREATED COUNTRY WOOD PANELS 3. PLY WOOD CONFORMING TO IS_303_1975 4. " " " IS_4990_1969 5 PARTICLE BOARD " IS_3087_1985 6 PRE LAMINATED VENEERED PARTICLE BOARD CONFORMING TO IS_3097_1980 7.MEDIUM DENSITY FIBRE BOARD CONFORMING TO IS 3097_1980

NO	REVISION	SIGN	DATE
1.	ALTERNATIVE SPECIFICATIONS WITH RELEVANT IS INCLUDED		19.5.88

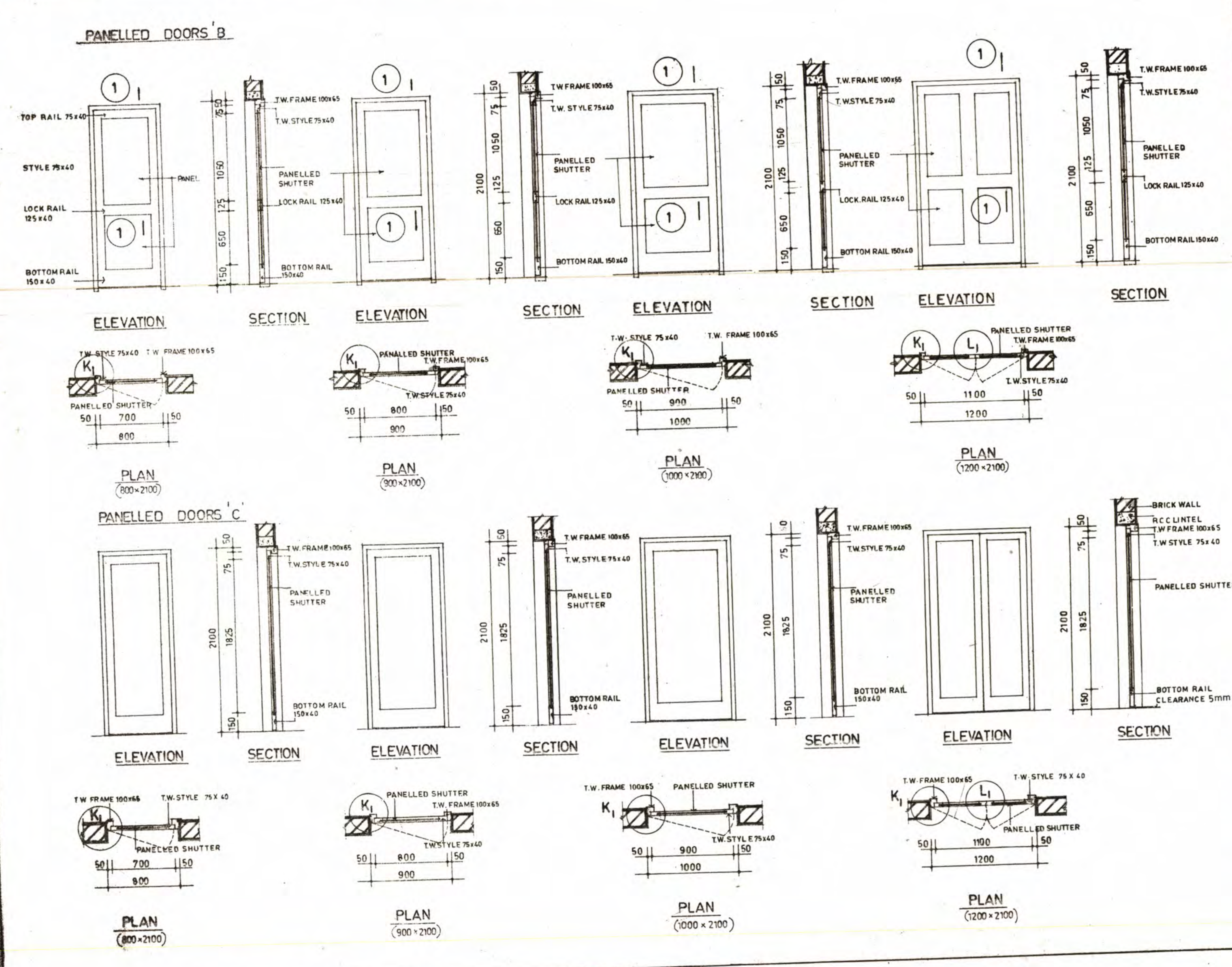
CHIEF ARCHITECT — SENIOR ARCHITECT
ARCHITECT — ASST. ARCHITECT

OFFICE OF THE CHIEF ARCHITECT MADRAS-5

SCALE : 1 : 20		DATE : 19.6.86
DEALT BY : s. indira	JOB NO	DRG NO
CHECKED BY : A.V.	1073	48 R

TYPE DESIGN FOR DOORS

PLAN ELEVATION AND SECTION



PUBLIC WORKS DEPT. TAMILNADU.

NO	NOTES
1	THIS DRAWING SUPERCEDES JOB NO. 1073 DRG. NO. 29
2	READ WITH JOB. NO. 1073. DRG. NO. 60
3.	ALL DIMENSION'S ARE IN MM.
4	ALTERNATIVE SPECIFICATIONS FOR PANELS IN PANELLED DOORS 1. 12 MM TEAK WOOD PANELS. 2. 18 MM TREATED COUNTRY WOOD PANELS. 3. PLY WOOD CONFORMING TO IS. 303-1975 4. " " - IS 4990-1968 5. PARTICLE BOARD " - IS 3087-1985 6. PRE-LAMINATED VENEERED PARTICLE BOARD CONFORMING TO IS 3097-1980 7. MEDIUM DENSITY FIBRE BOARD CONFORMING TO IS 3097-1980

NO	REVISION	SIGN	DATE
1.	ALTERNATIVE SPECIFICATIONS WITH RELEVANT IS INCLUDED		

CHIEF ARCHITECT — SENIOR ARCHITECT

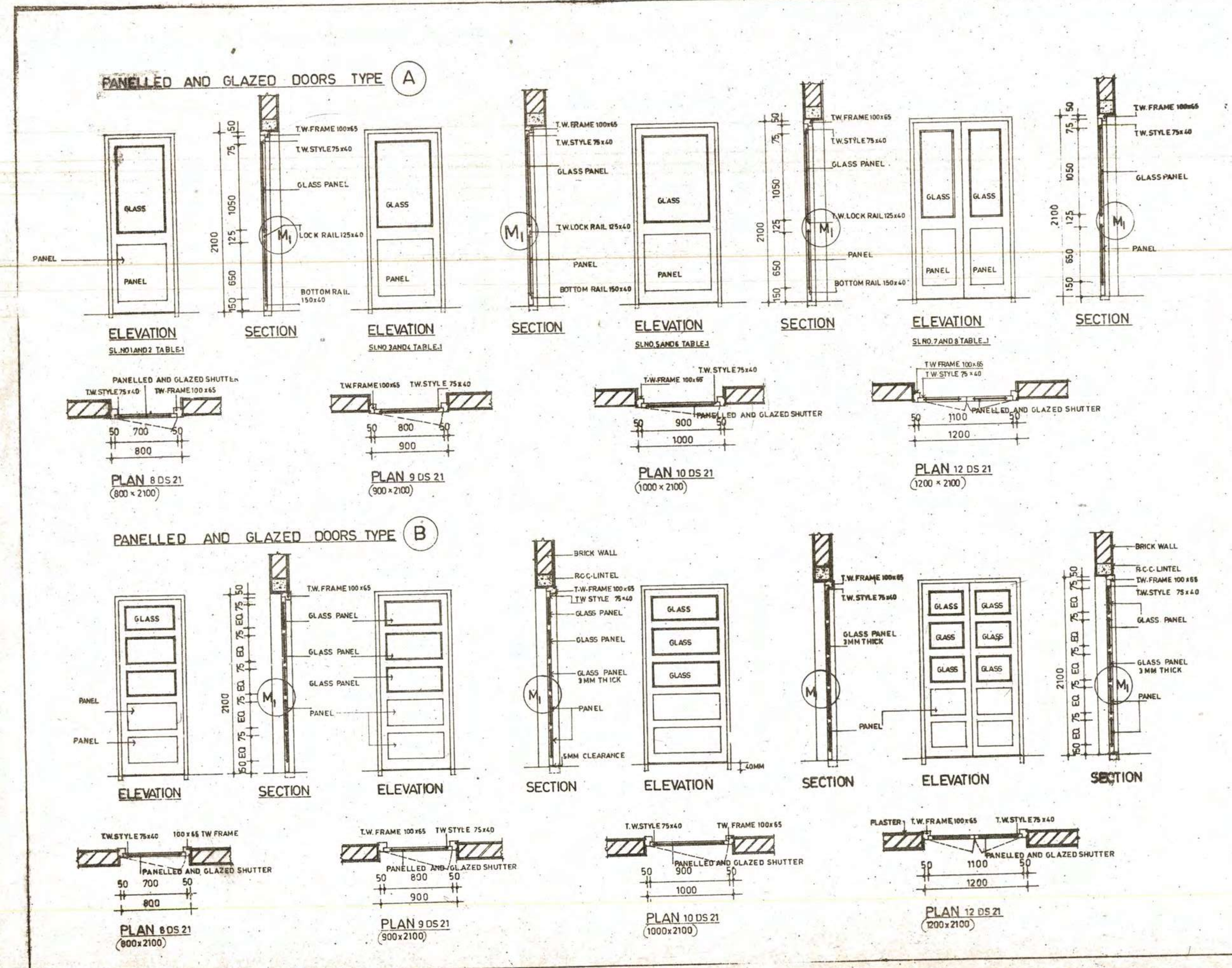
ARCHITECT — ASST. ARCHITECT

OFFICE OF THE CHIEF ARCHITECT MADRAS-5

SCALE : 1 : 20		DATE 19-6-86.
DEALT BY k.k.shanthi	JOB.NO. 1073	DRG.NO. 49R
CHECKED BY : A.V.		

TYPE DESIGN FOR DOORS

PLAN ELEVATION AND SECTION



PUBLIC WORKS DEPT
TAMILNADU.

NO	NOTES
1.	THIS DRG SUPERSEDES JOB NO 1073 DRG NO. 29 R.
2.	READ WITH JOB NO.1073 DRG NO.38.
3.	ALL DIMENSIONS ARE IN MM
4.	ALTERNATIVE SPECIFICATIONS FOR PANELS IN PANELLED DOORS. 1. 12mm TEAKWOOD PANELS 2. 18mm TREATED COUNTRY WOOD PANELS 3. PLY WOOD CONFORMING TO IS 303_1975, IS 4990_1969 4. 5. PARTICLE BOARD IS 3087_1985 6. PRE LAMINATED VENEERED PARTICLE BOARD CONFORMING TO IS. 3097-1980 7. MEDIUM DENSITY FIBRE BOARD CONFORMING TO IS. 3097. 1980

ALTERNATIVE SPECIFICATION WITH RELEVANT IS INCLUDED

NO	REVISION		

CHIEF ARCHITECT — SENIOR ARCHITECT
ARCHITECT — ASST. ARCHITECT

OFFICE OF THE CHIEF ARCHITECT MADRAS-5.

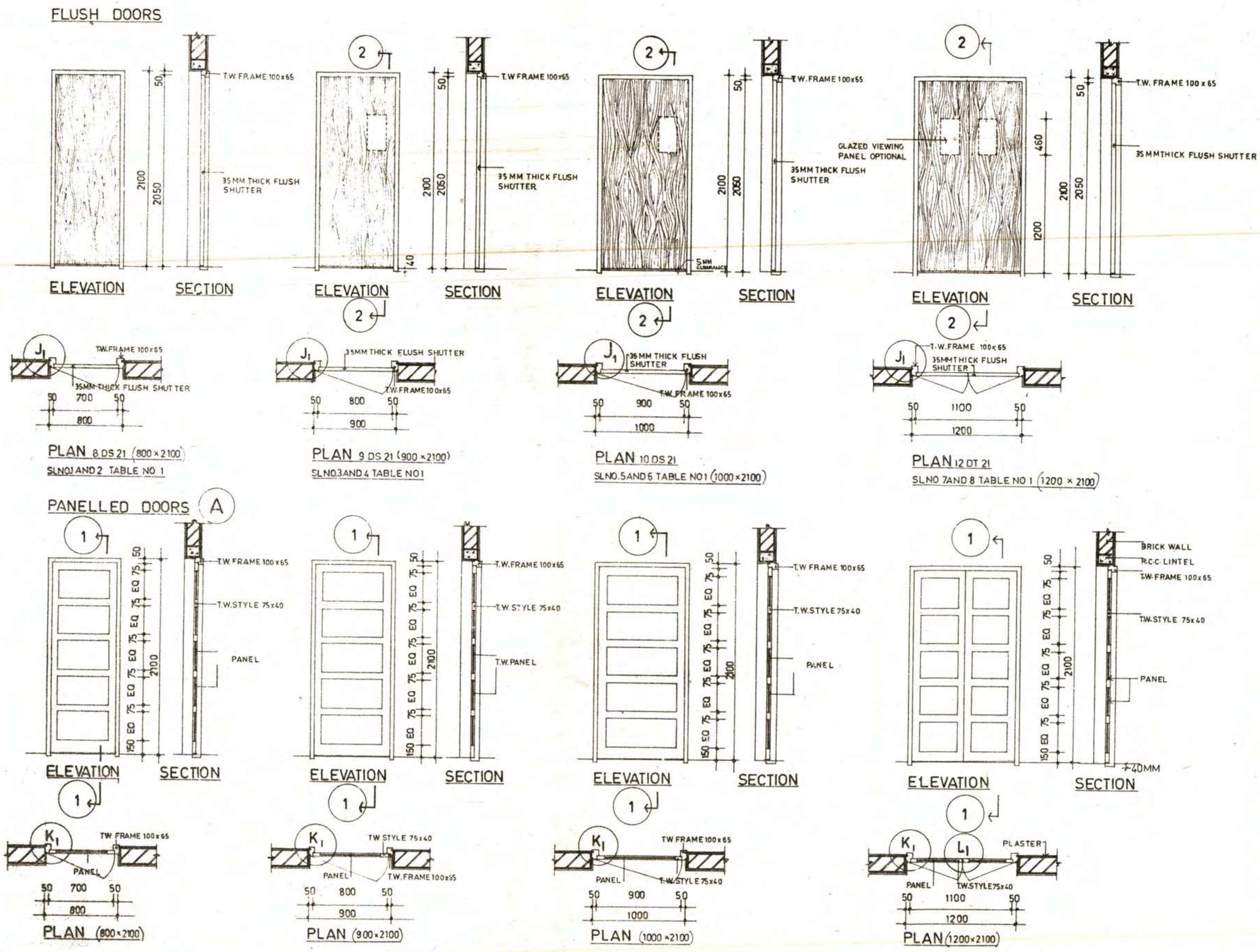
SCALE : 1:20

DEALT BY : s.indira
CHECKED BY : A.V.

1073 | 50 R

TYPE DESIGN FOR DOORS

PLAN ELEVATION AND SECTION



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NO	NOTES
1	THIS DRAWING SUPERSEDES JOB NO.1073 DRG NO.28.
2.	READ WITH JOB NO. 1073 DRG NO. 80.
3.	ALL DIMENSIONS ARE IN MM.
4	ALTERNATIVE SPECIFICATION FOR FLUSH DOOR PRELAMINATED VENEERED PARTICLE BOARD OF 25mm THICKNESS AND ABOVE CONFORMING TO IS 3097 – 1980
5	ALTERNATIVE SPECIFICATIONS FOR PANELS IN PANELLED DOORS 1. 12mm TEAKWOOD PANELS 2. 18mm TREATED COUNTRY WOOD PANELS 3. PLY WOOD CONFORMING TO IS-303-1975 4. " " " IS-4990-1969 5 PARTICLE BOARD = IS-3087-1985 6 PRE LAMINATED VENEERED PARTICLE BOARD CONFORMING TO IS-3097-1980 7. MEDIUM DENSITY FIBRE BOARD CONFORMING TO IS 3097-1980

NO	REVISION	SIGN	DATE
1.	ALTERNATIVE SPECIFICATIONS WITH RELEVANT IS INCLUDED	Sd.	19.5.88

CHIEF ARCHITECT 16.7.85 — SENIOR ARCHITECT

ARCHITECT — ASST. ARCHITECT

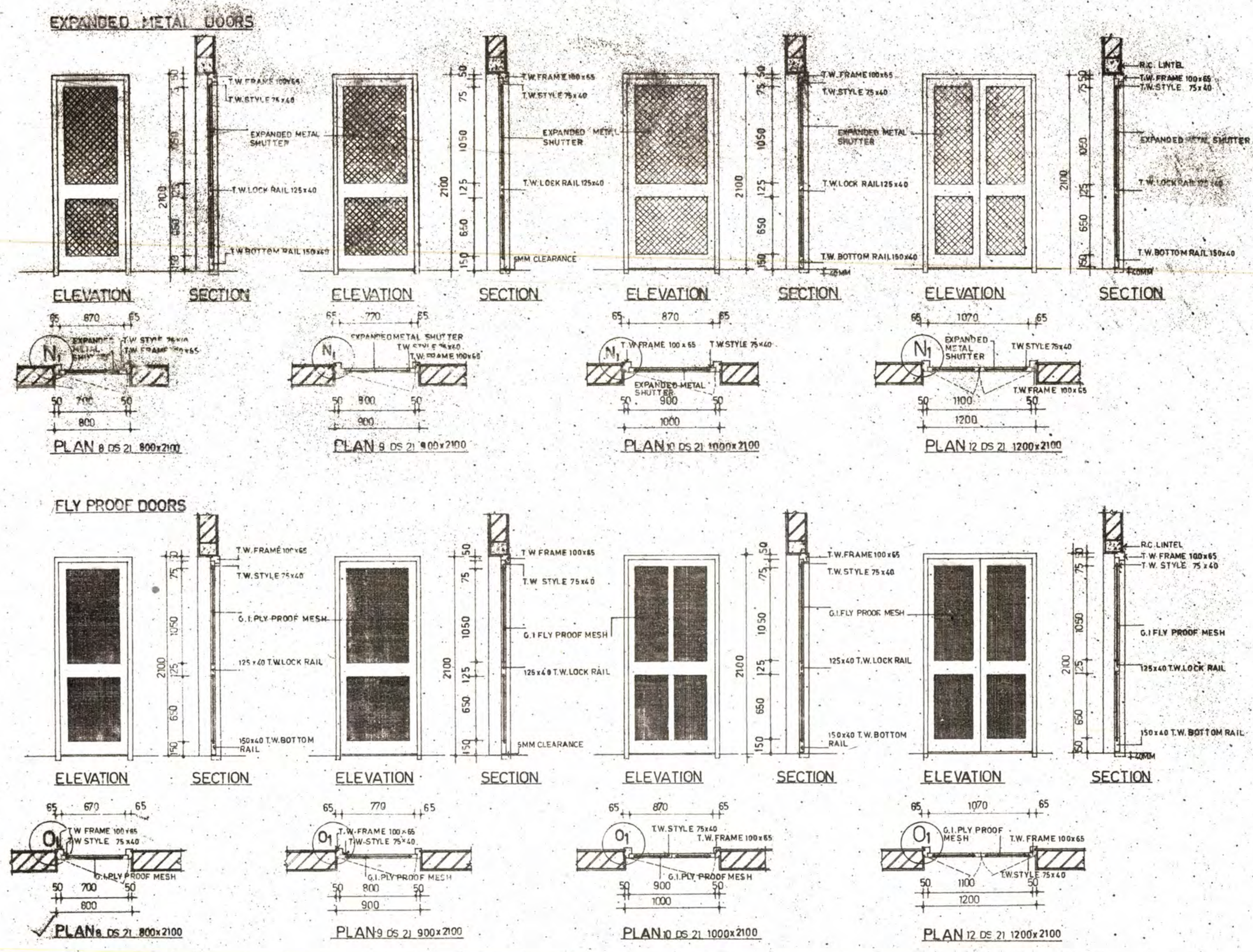
OFFICE OF THE CHIEF ARCHITECT MADRAS-5

SCALE : 1 : 20 — DATE : 19.6.85

DEALT BY : s. indira — CHECKED BY : A.V. — JOB NO 1073 — DRG NO 48R

TYPE DESIGN FOR DOORS

PLAN ELEVATION AND SECTION



PUBLIC WORKS DEPT
TAMIL NADU

SL.NO	NOTES.
1	THIS DRAWING SUPERSEDES JOB NO 1073 & DRG NO 28
2.	READ WITH JOB NO 1073 DRG NO 58
3.	ALL DIMENSIONS ARE IN MM.

SL.NO	REVISIONS	SIGN	DATE

CHIEF ARCHITECT — SENIOR ARCHITECT

ARCHITECT — ASST. ARCHITECT

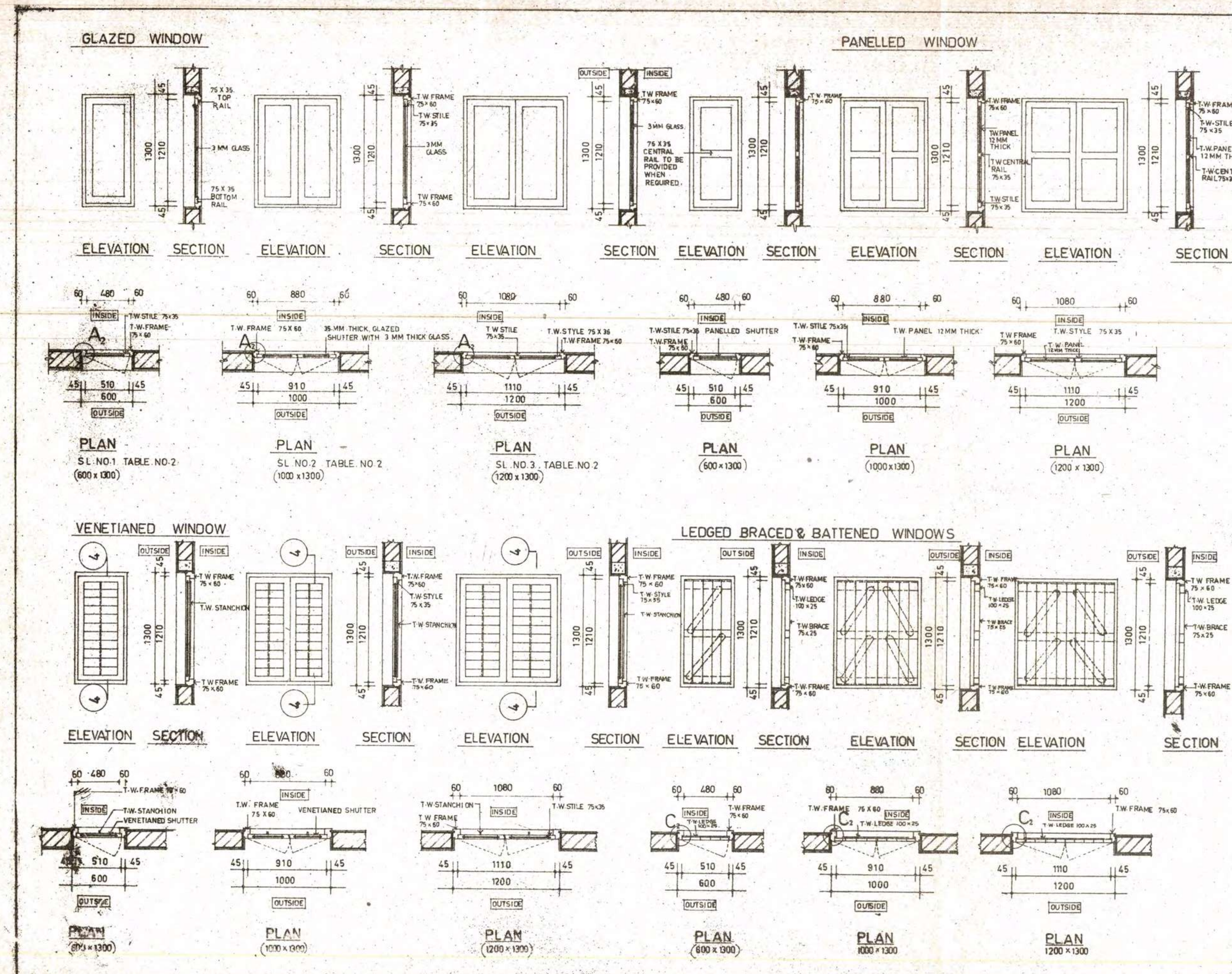
OFFICE OF THE CHIEF ARCHITECT, MADRAS.5

SCALE 1:20 — DATE 19-6-85.

DEALT BY: S. ... — CHECKED BY: A. V. — JOB NO. 1073 — DRG. NO. 51

TYPE DESIGN FOR DOORS

PLAN, ELEVATION & SECTION



PUBLIC WORKS DEPT, TAMILNADU.

NO	NOTES
1	THIS DRAWING SUPERSEDES JOB. NO-1073 DRG NO 81
2	READ WITH JOB NO-1073 DRG NO 86
3	ALL DIMENSIONS ARE IN MM.

NO	REVISION	SIGN	DATE

CHIEF ARCHITECT — SENIOR ARCHITECT

ARCHITECT — ASST ARCHITECT

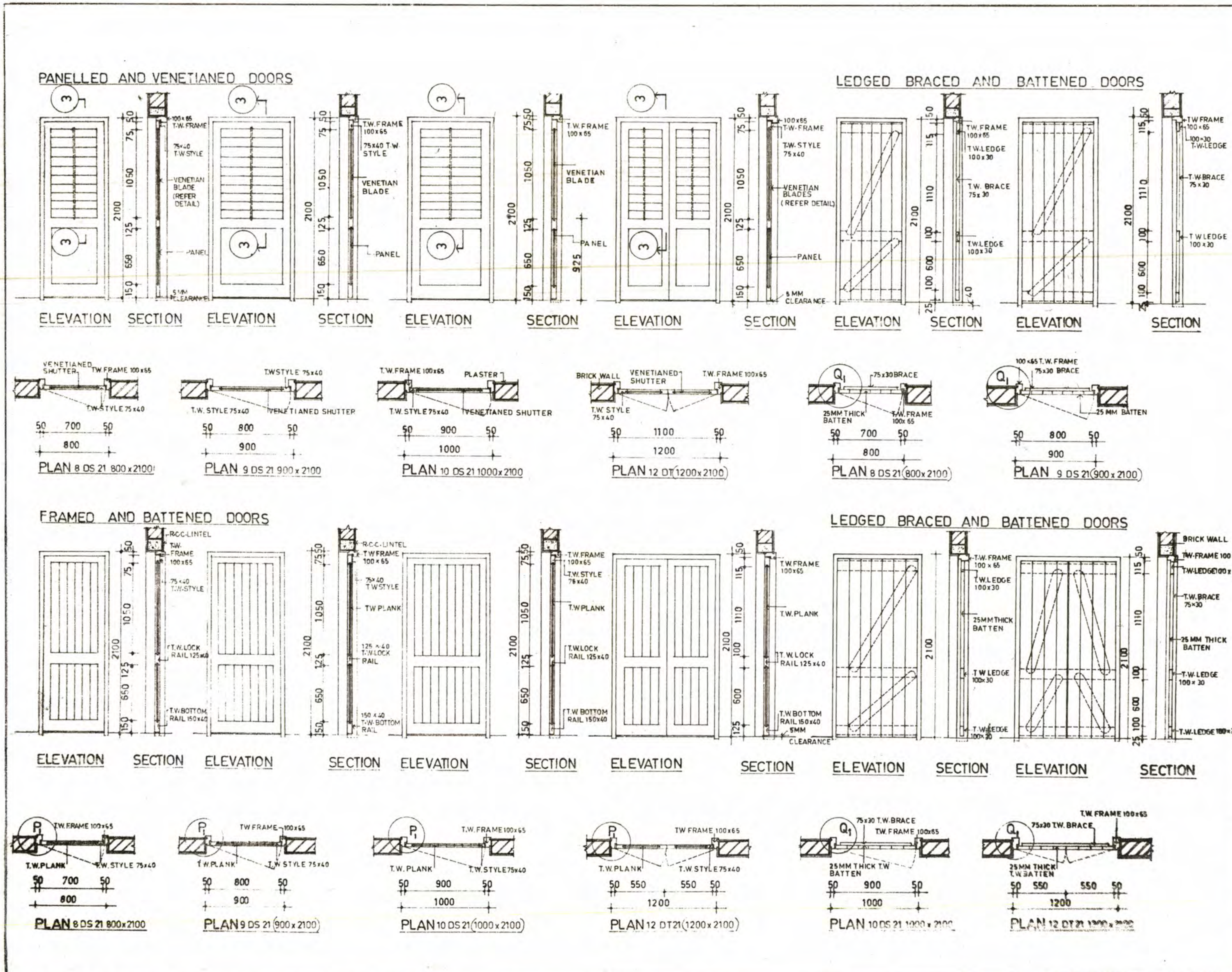
OFFICE OF THE CHIEF ARCHITECT MADRAS-5

SCALE : 1:20 — DATE : 18-6-86.

DEALT BY S. Indira — CHECKED BY A.V — JOB NO 1073 — DRG NO 52

TYPE DESIGN FOR WINDOWS.

PLAN ELEVATION AND SECTION



PUBLIC WORKS DEPT
TAMILNADU

NO	NOTES
1	THIS DRAWING SUPERSEDES JOB NO 1073 DRG NO 30
2.	READ WITH JOB NO 1079 DRG NO 58.
3	ALL DIMENSIONS ARE IN MM
4	ALTERNATIVE SPECIFICATIONS FOR PANELS IN PANELLED DOORS 1. 12mm TEAKWOOD PANELS 2. 18mm TREATED COUNTRYWOOD PANELS 3. PLY WOOD CONFORMING TO IS_303_1975 4. " " IS_4990_1969 5. PARTICLE BOARD " IS_3087_1985 6. PRE LAMINATED VENEERED PARTICLE BOARD CONFORMING TO IS_3097_1980 7. MEDIUM DENSITY FIBRE BOARD CONFORMING TO IS_3097_1980

NO	REVISION	SIGN	DATE
	ALTERNATIVE SPECIFICATIONS WITH RELEVANT IS INCLUDED	Sd.	

CHIEF ARCHITECT — SENIOR ARCHITECT

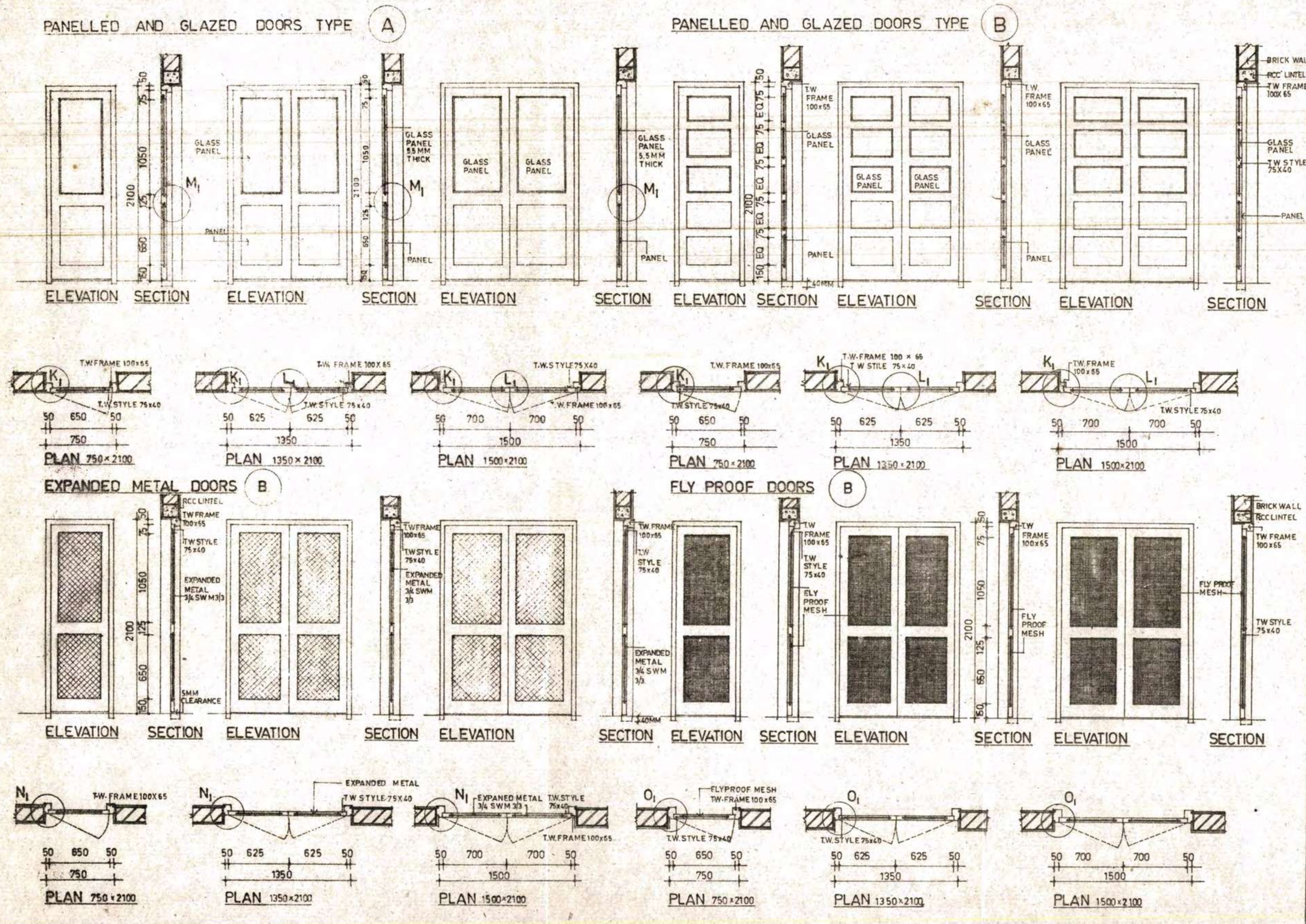
ARCHITECT — ASST. ARCHITECT

OFFICE OF THE CHIEF ARCHITECT MADRAS.5

SCALE : 1:20		DATE: 19-4-85.
DEALT BY :	JOB NO. 1073	DRG. NO. 53R
CHECKED BY : A.V.		

TYPE DESIGN FOR DOORS

PLANS, ELEVATIONS AND SECTIONS



PUBLIC WORKS DEPT.,
TAMILNADU.

NO	NOTES
1	THIS DRG. SUPERSEDES JOB NO.1073 DRG NO.36.
2	READ WITH JOB NO.1073 DRG NO.58 AND 60
3	ALL DIMENSIONS ARE IN MM.
4.	ALTERNATIVE SPECIFICATIONS FOR PANELS IN PANELLED DOORS 1. 12mm T.W PANELS 2. 18mm TREATED COUNTRY WOOD PANELS 3. PLYWOOD CONFORMING TO IS 303 _ 1975 4. IS 4990_1969 5. PARTICLE BOARD IS 3087_1985 6. PRE LAMINATED VENEERED PARTICLE BOARD CONFORMING TO IS 3097_1980 7. MEDIUM DENSITY FIBRE BOARD CONFORMING TO IS 3097_1980

NO	REVISION	SIGN	DATE
1.	ALTERNATIVE SPECIFICATION WITH RELEVANT IS INCLUDED		

CHIEF ARCHITECT — SENIOR ARCHITECT

ARCHITECT — ASST. ARCHITECT

OFFICE OF THE CHIEF ARCHITECT - MADRAS-5.

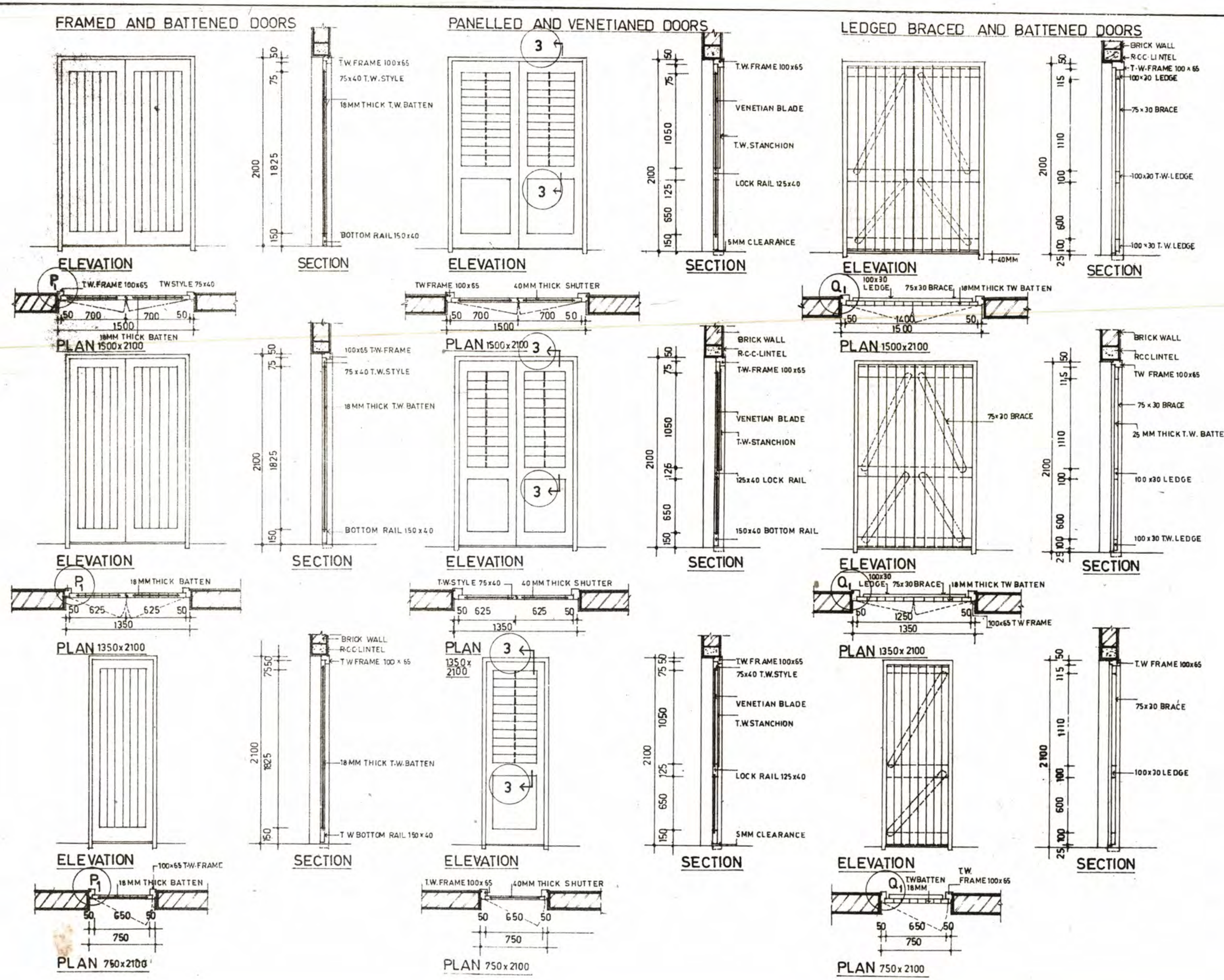
SCALE : 1:20 — DATE: 19-6-85

DEALT BY: m.s. Parthasarathi — JOB NO 1073 — DRG NO 54R

CHECKED BY:

TYPE DESIGN FOR DOORS

PLAN ELEVATION AND SECTION



PUBLIC WORKS DEPT
TAMIL NADU

NO	NOTES
1.	THIS DRAWING SUPERSEDES DRG NO 36 OF JOB NO 1073
2.	REFER DETAILED DRAWING NO 58 OF JOB NO 1073.
3.	ALL DIMENSIONS ARE IN MM.

NO	REVISION	SIGN	DATE

CHIEF ARCHITECT 16-7-85 — SENIOR ARCHITECT

ARCHITECT — ASST ARCHITECT

OFFICE OF THE CHIEF ARCHITECT MADRAS.5

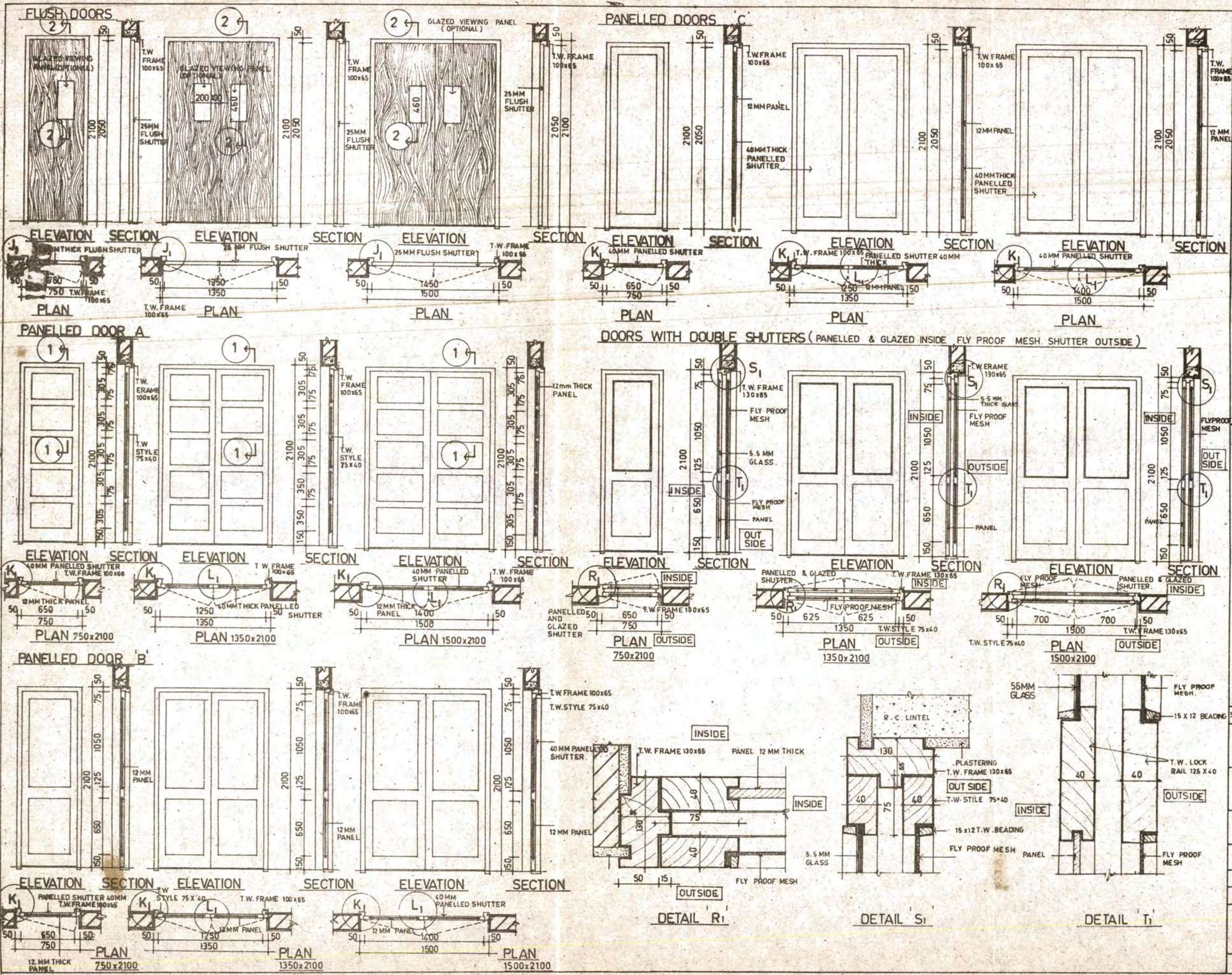
SCALE : 1 : 20 — DATE : 19-6-85

DEALT : s. indira — JOB NO 1073 — DRG NO 55

CHECKED : A.V.

TYPE DESIGN FOR DOORS

PLANS, ELEVATIONS & SECTIONS



PUBLIC WORKS DEPT.
TAMILNADU

S.NO	NOTES
1	ALL DIMENSIONS ARE IN MM
2	THIS DRAWING SUPERSEDES JOB NO.1073 DRG. NO. 56
3.	ALTERNATIVE SPECIFICATION FOR FLUSH DOOR. PRELAMINATED VENEERED PARTICLE BOARD OF 25mm THICKNESS AND ABOVE CONFORMING TO IS 3097_1980
4.	ALTERNATIVE SPECIFICATIONS FOR PANELS IN PANELLED DOORS 1. 12 MM TEAKWOOD PANELS. 2. 18mm TREATED COUNTRY WOOD PANELS 3. PLYWOOD CONFORMING TO IS 303_1975 4. " " " IS 4990_1969 5. PARTICLE BOARD " IS 3087_1985 6. PRELAMINATED VENEERED PARTICLE BOARD CONFORMING TO IS 3097_1980 7. MEDIUM DENSITY FIBRE BOARD CONFORMING TO IS 3097_1980

S.NO	REVISION	SIGN	DATE
1	ALTERNATIVE SPECIFICATIONS WITH RELEVANT IS INCLUDED		

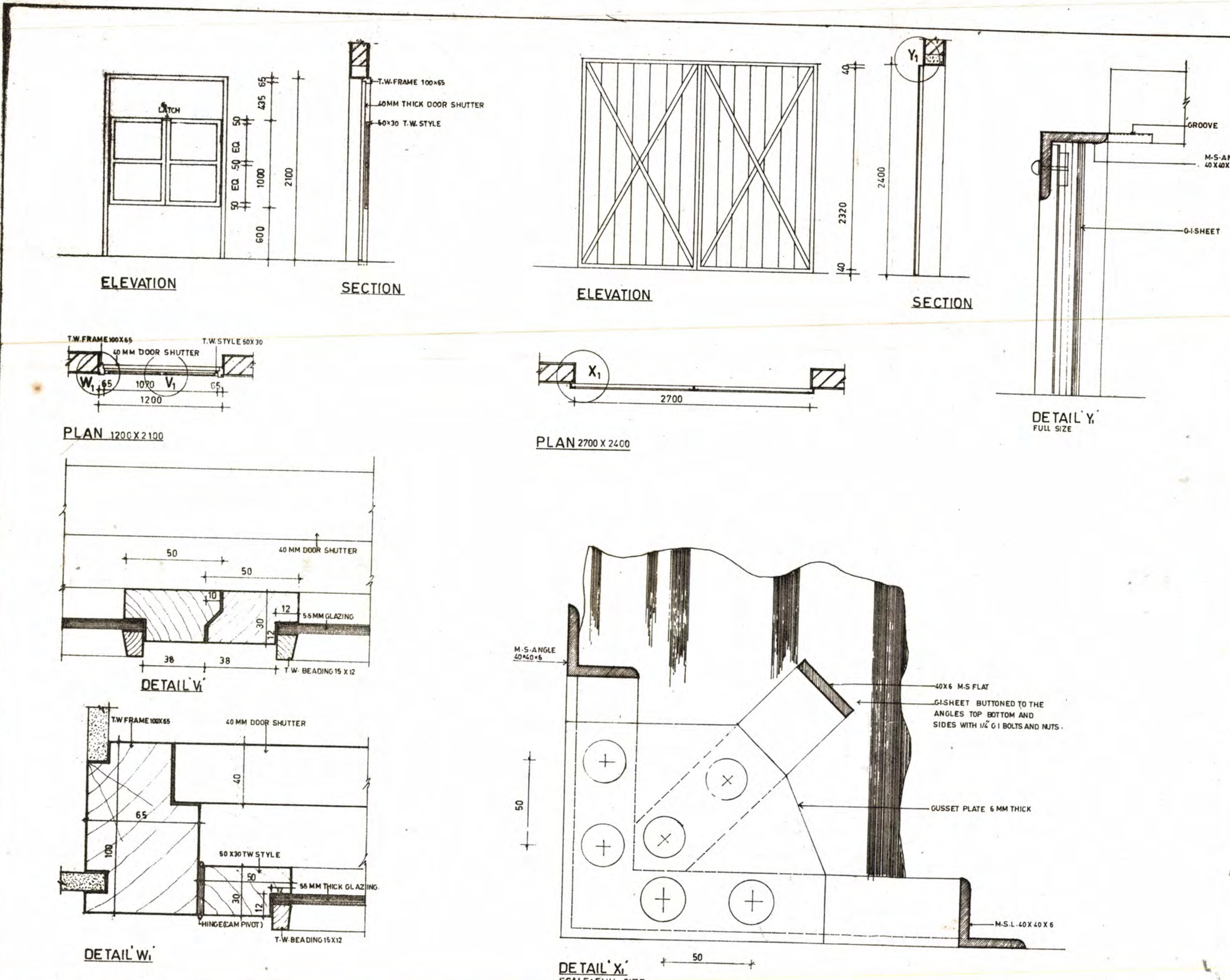
CHIEF ARCHITECT — SENIOR ARCHITECT
ARCHITECT — ASST. ARCHITECT

OFFICE OF THE CHIEF ARCHITECT - MADRAS.

SCALE : 1 : 20		DATE
DEALT K.K SHANTHI	JOB. NO 1073	DRG. NO 56
CHECKED : A.V.		

TYPE DESIGN FOR DOORS.

PLAN ELEVATION & SECTION WITH DETAILS



PUBLIC WORKS DEPT
TAMILNADU.

NO	NOTES
1	THIS DRAWING SUPERSEDES JOB NO 1073 DRG NO 38
2	ALL DIMENSIONS ARE IN MILLIMETRES.

NO	REVISION	SIGN	DATE

CHIEF ARCHITECT 16.7.86 — SENIOR ARCHITECT

ARCHITECT — ASST ARCHITECT

OFFICE OF THE CHIEF ARCHITECT MADRAS 5

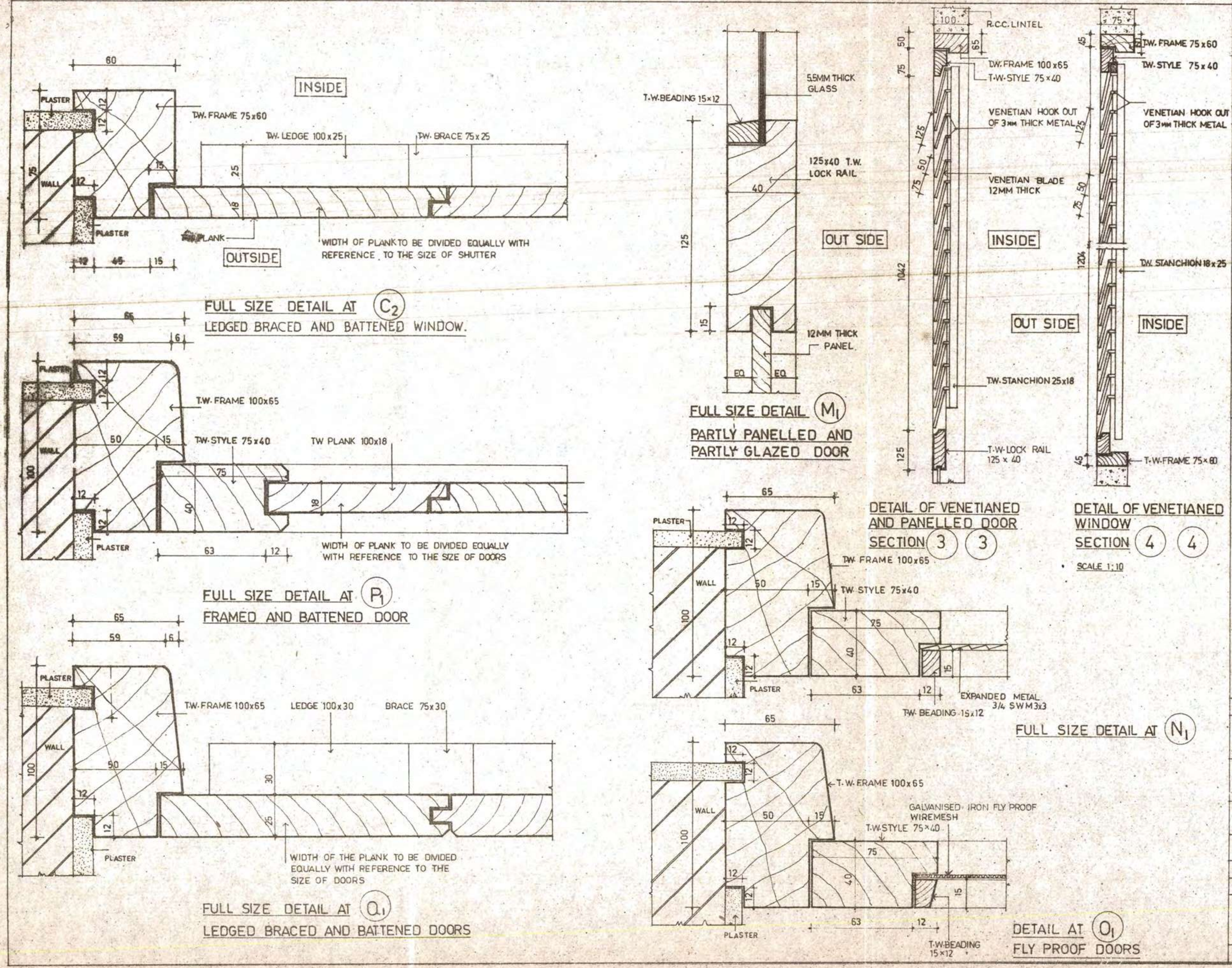
SCALE : 1:20 & FULL SIZE — DATE : 19.6.86

DEALT BY : p.banu. — JOB NO 1073 — DRG NO 57

CHECKED BY:

TYPE DESIGN FOR HALF-DOOR AND GARAGE DOOR

PLAN ELEVATION & SECTION WITH DETAILS



PUBLIC WORKS DEPT
TAMILNADU

NO	NOTES
1.	THIS DRAWING SUPERSEDES JOB NO 1073 DRAWING NO 23
2.	REFER JOB NO 1073 DRG NO 50 51 52 55 & 56
3.	ALL DIMENSIONS ARE IN MM
4.	ALTERNATIVE SPECIFICATIONS FOR PANELS IN PANELLED DOORS 1. 12mm TEAKWOOD PANELS 2. 18mm TREATED COUNTRY WOOD PANELS 3. PLY WOOD CONFORMING TO IS-303-1975 4. " IS-4990-1969 5. PARTICLE BOARD " IS-3087-1985 6. PRE LAMINATED VENEERED PARTICLE BOARD CONFORMING TO IS-3097-1980 7. MEDIUM DENSITY FIBRE BOARD CONFORMING TO IS-3097-1980

NO	REVISION	SIGN	DATE
1.	ALTERNATIVE SPECIFICATIONS WITH RELEVANT IS INCLUDED	[illegible]	[illegible]

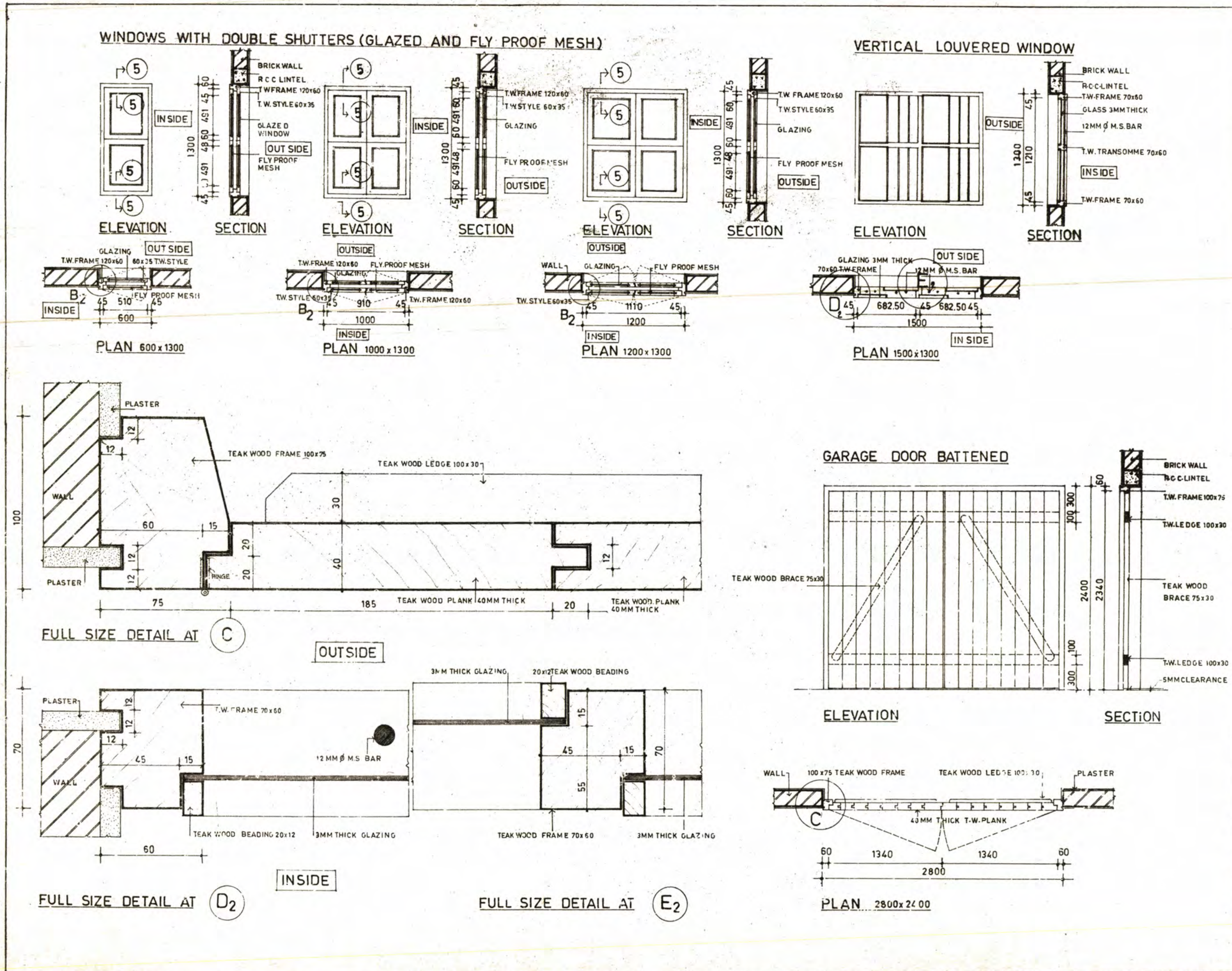
CHIEF ARCHITECT — SENIOR ARCHITECT
ARCHITECT — ASST ARCHITECT

OFFICE OF THE CHIEF ARCHITECT MADRAS 5

SCALE	FULL SIZE & 1:10		DATE 19-6-85
DEALT BY: s.indira		JOB NO	DRG NO
CHECKED BY: A.V.		1073	58R

TYPE DESIGN FOR DOORS AND WINDOWS-DETAILS

DETAILS



PUBLIC WORKS DEPT., TAMILNADU.

NO	NOTES
1.	THIS DRG SUPERSEDES DRG NO 37 OF JOB NO 1073
2.	ALL DIMENSIONS IN MILLIMETRES.
3	REFER JOB NO 1073 DRG NO 60
4.	ALL DIMENSIONS ARE IN MM.

NO	REVISION	SIGN	DATE

CHIEF ARCHITECT — SENIOR ARCHITECT

ARCHITECT — ASST ARCHITECT

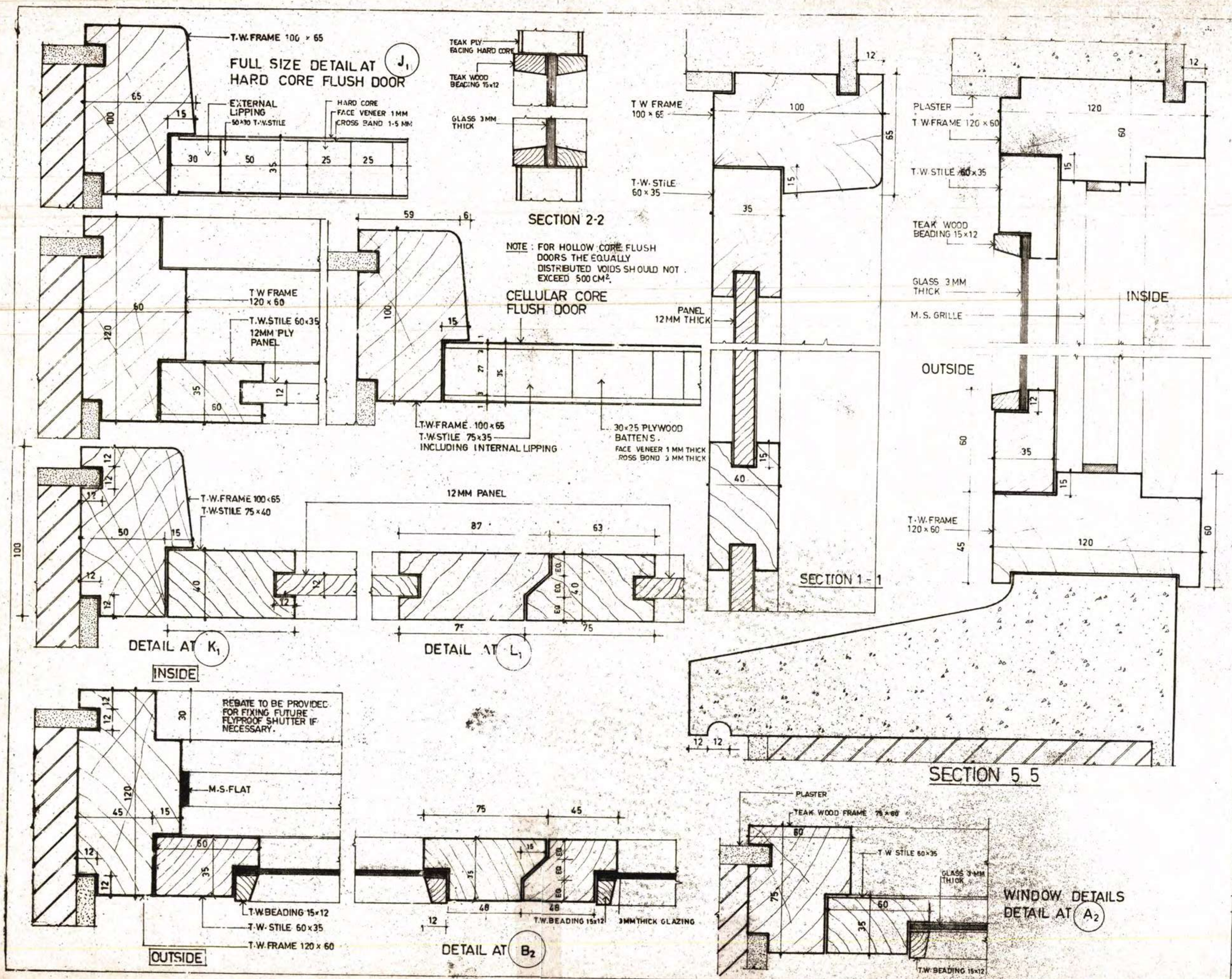
OFFICE OF THE CHIEF ARCHITECT MADRAS-5

SCALE : 1 : 20 & FULL SIZE — DATE : 19-6-85

DEALT BY : S. Indira	JOB NO	DRG NO
CHECKED BY : A.V.	1073	59

TYPE DESIGN FOR DOORS AND WINDOWS

PLAN ELEVATION AND SECTION WITH DETAILS



PUBLIC WORKS DEPT., TAMILNADU.

NO	NOTES
1	THIS DRAWING SUPERSEDES JOB NO 1073 DRG NO 32
2	REFER JOB NO 1073 DRG NOS 48, 49, 52 & 54
3	ALL DIMENSIONS ARE IN MM.
4	ALTERNATIVE SPECIFICATION FOR FLUSH DOOR. PRE-LAMINATED VENEERED PARTICLE BOARD OF 25 MM THICKNESS AND ABOVE CONFORMING TO IS 3097.1980
5	ALTERNATIVE SPECIFICATIONS FOR PANELS IN PANELLED DOOR. 1 12 MM TEAK WOOD PANELS 2 18 MM TREATED COUNTRY WOOD PANELS 3 PLY WOOD CONFORMING TO IS 303-1975 4 " " " IS 4990-1969 5 PARTICLE BOARD " IS 3087 1985 6 PRE LAMINATED VENEERED PARTICLE BOARD CONFORMING TO IS 3097-1980 7 MEDIUM DENSITY FIBRE BOARD CONFORMING TO IS 3097-1980.

NO	REVISION	SIGN	DATE
1	ALTERNATIVE SPECIFICATIONS WITH RELEVANT IS INCLUDED		11.8.88

CHIEF ARCHITECT	SENIOR ARCHITECT
ARCHITECT	ASST ARCHITECT

OFFICE OF THE CHIEF ARCHITECT MADRAS-5.

SCALE : FULL SIZE		DATE 19-6-85.
DEALT BY: s.indira	JOB NO 1073	DRG NO 30R
CHECKED BY: A V		

TYPE DESIGN FOR DOORS AND WINDOWS. DETAILS.

FULL SIZE DETAILS

SECTION XII

MISCELLANEOUS

SECTION XII

MISCELLANEOUS.

CONTENTS.

SECTION XII.

MISCELLANEOUS.

EXTRACT OF I.S. CODES FOR SECTION XII.

SECTION XII.

MISCELLANEOUS.

SPECIFICATION No. 75.

BAMBOO CHICKS WITH BLUE DUNGRY CLOTH, PULLEYS, RINGS ROPES, HOOKS, STAPLES, ETC., COMPLETE INCLUDING PAINTING TWO COATS.

1. Bamboos.—Good bamboos shall be spliced into single laths of uniform size for the entire width of the chick. These shall be 6 mm. to 10 mm. in width and not less than 4 mm thickness and shall be free from all projecting knots, etc., planed smooth with a knife. There shall be no fibres coming out. They shall then be laid on the ground and closely bound together by country twine, in straight Lines not more than 20 cms. apart. The binding shall be so done that the splice cannot be removed, while at the same time freedom for rolling the chick is present. Two straight solid bamboos, 50 mm, in diameter, shall be tied to top and bottom of the chick. The chick so made shall then be painted with standard specification two coats best approved green paint on both sides. After the paint is completely dry, best blue dungry cloth shall be spread over the chick so as to cover the whole of the chick and fold round to a width of about 40 mm on the sides and 75 mm on the top and bottom. Best country made white tape, 75 mm wide, shall now be placed at the ends in such a way that it covers on either side and shall be stitched on to the chick with strong white twine. Similarly tape 40 mm wide, shall be put on both sides of the chick at intermediate distances of not more than 1.2 metres and then stitched on. The cloth shall cover the bamboos and be stitched round them.

2. Two good wooden pulleys small be tied near the ends of the top bamboo by stout copper wire and 12 mm diameter cotten rope shall be so passed round as to enable the chicks to be lifted and lowered—rolling and unrolling the chicks. Provision shall also be made for fixing the chicks to the floor or side walls as instructed so as not to allow them to beat about the wind. This may be made by letting in iron hooks or rings into wooden plug fixed into the walls or floor vertically below the hooks at top, to which the chicks may be tied by endless ropes, passing round the chicks and through the hocks at top and hooks or rings at bottom. A slip ring with a wooden peg tied to it with a string may, also, be provided to keep the chick in any desired position as per sketch appended.

NOTE : The above arrangement will apply to chick of more than 3 metres height only. Chicks of 3 metres height and less should have no lifting or lowering ropes, but only endless ropes with slip rings. The lowering and lifting should be done by hand"

2.1. Two or three firm iron hooks 10 mm diameter, shall be fixed to the joists, bressummer, or ceiling as instructed, so that the chicks may be hung from them by the top bamboo. In cases where suspension is to be from chick hooks fixed in masonry, the hooks shall be 10 mm diameter with a 50 mm bend in opposite direction at each end set with one end 15 cms in the masonry and the other end and projecting 50 mm from the wall face with the bent end upwards to receive the top bamboo. The upper end of the hook should be rounded off with a file. It must be seen that the hooks are in a horizontal lime.

SPECIFICATION No. 76.

TEAKWOOD TRELLIS WORK FOR VERANDAS

1. *Description*.—Teak battens 25 mm by 12 mm shall be crossed verticially horizontally or diagonally in opposite direction at an angle of 45 degree with the floor leaving 50 mm square openings between the battens. Each joint shall be secured by 25 mm wire nails. A teakwood floor rail 10 cms by 5 cms. shall be fixed on teakwood blocks 10 cms. square by 5 cms. deep at about 1.5 metre intervals and secured by rag bolts—the heads being countersunk into the top of the railing set with cement mortar 15 cms in to the masonry of the floor. The teak battens shall be of sufficient lengths to go from top to battom (or side as the case may be) in one length. They shall be spiked with 65 mm, wire nails through both battens to the verandah posts or bressummer and floor rail and finished all round with a frame of teakwood 50 mm by 19 mm fixed with 75 mm iron screws at 75 cms. intervals. The outside of frame and ends of the battens shall be flush with outer face of verandah posts top of bressummer and bottom of floor rail. The timber used shall comply with the specification for wood in the standard specification "Wood work, wrought and put up"

2. *Painting* : The trellis shall be given two coats best standard specification green paint or such other paint over one coat of primer as may be specified.

3. *Rate* : The rate will be per 10 square metres and will include the cost and fixing of the battens, frame floor rails blocks, rag bolts nails, screws, painting.

NOTE 1 : In the case of masonry verandah-pillars-opening in masonry with an appreciable drop below-heavier sections of either battens or frame-work or both and different methods of fixture will be necessary and a separare plan and speciciation will therefore be required.

2 Treated country wood battens may also be used if so specified in the tender schedule. The size of battens should be 50 mm x 20 mm. opening between each batten should be 100 mm x 100 mm.

3. Specification for the material to be used for wood screws and mild steel wire nails shall be as per I.S. : 723—1961 and I.S. : 451—1961.

SPECIFICATION No. 77.

WOVEN WIRE FENCING—1.2 METRES HIGH.

1. *Fencing Wire :—I.S. 2721/64 shall apply*

2. *Posts*: Intermediate, and corner and intermediate straining bolts shall be of the proper size for the wire fencing tendered for and of the type supplied by the manufacturer of the fencing for the purpose. The spacing and method of fixture of the posts shall be that recommened by the manufacturer in his catalogue, if such is described therein. If the manufacturers' catalogue does not so specify, then intermediate posts will be placed not more than 4.5 metres apart, intermediate straining posts not more than 60 metres apart, end posts at the end of a line of fencing, corner straining post at corners, and 30 cms. by 20 mm diameter galvanized straining bolts at intermediate straining posts end posts and corner straining posts. End posts, intermediate straining posts, and corner straining posts shall be set in a block of standard specification broken stone in lime mortar concrete the blocks being rectangular of a suitable size to cover by 15 cms. ends of struts and bottom of posts, and brought to ground level.

3. *Erection* shall be done in the manner specified by the manufacturer and the finished fencing must be tight with no sagging up right wires of the fencing truly vertical and the rows of wires horizontal or parallel to ground slope. On slightly uneven ground the posts should be placed, on the highest and lowest points and the fencing stretched tight between the two highest placed posts

The fencing can then be pulled down and secured to the posts in the low points care being taken that these are so tightly planted as not to pull out.

4. Gate—If gates are required they will be specified by size, and the woven wire manufactures, gate and gate posts shall also be supplied of the same pattern and correct height for the fencing.

5. *Painting.*—If this is required to be done, it will be done with such anti-corrosive paint as may be specified and the rate for the fencing will then include the painting.

6. The tender schedule should include a site location sketch of the fencing marking thereon the position of all posts to be supplied and also a catalogue description of the fencing. A full statement of all parts of the fencing to be supplied and method of fixture shall be detailed as defined in this specification. The rate will be per square metre and will include all items in the foregoing specification the whole completely erected in place to the satisfaction of the Executive Engineer.

SPECIFICATION No. 78.

STAND WIRE FENCING—1·2 METRES HIGH.

Barbed wire fencing as per I.S. 278/69 and N.B.C. Part V of appendix shall apply.

SPECIFICATION No. 79.

FIXED TYPE BLACK BOARDS.

1·1. Forming black boards on walls : If there are bushings on stone walls to receive the plaster, they shall be removed to within 12 mm. projection before plastering is done. All joints in masonry shall be raked out atleast 20 mm. deep. The wall is to be washed with fresh water and thoroughly wetted before plastering is commenced. But before applying plaster, it must be seen that the wall shall not be soaked but only damped evenly. The surface shall then be plastered with cement mortar 1 :3, 20 mm. thick in two coats, backing coat 10 mm. thick and finishing coat 10 mm. thick and finished even and smooth. The black board shall be formed at 0·9 to 1·2 m. high from floor or dais level and may be 0·9 to 1·2 m. high. Cement mortar beadings 25 mm. wide and 15 mm. thick shall be formed all round the board. After curing the plastered surface, properly painting 3 coats with approved black board paint shall be carried out over the plastered surface and the board finished smooth.

1·1·2. Rate : The rate shall include the cost of beading also.

1·2. Glass Boards : The glass plate boards may be fixed 0·9 to 1·2 m. from floor or dais level and may be 0·9 to 1 2 m. high. The glass plate shall be 6 mm. thick ground on one face and, painted on the other polished face with two coats of approved black board paint.

The glass plate shall be framed with teak wood reepers of size 50 mm. × 25 mm. having 12 mm. out grooves to receive the glass plate, and the frames screwed by means of 40 mm. screws to the wooden plugs of size 50 × 50 × 50 mm. fixed in the wall at suitable intervals. The glass plate may also be framed with aluminium frame if so specified in the tender schedule. The teak wood frame shall be painted with two coats of approved quality and colour over a priming coat. The gap between the plate and the wall shall be filled with felt or other suitable cushioning material.

1·2·1. Rate : The rate shall include cost of frame also.

2. *Mobile Type;*

2·1. These units normally are of size 0·9 m. × 0·9 m. and 1·2 m. × 0·9 m.

2·2. The weight of each board of size 1·2 m × 0·9 m. shall be about 7 kg. If plywood is used the face veneer shall be of teak wood· Plywood of 7-ply board, 16 mm. thick shall be used.

2·3. The surface of any type of board shall be such that it will remain firm and rigid while in use and shall be of matt finish. The texture over the whole writing surface shall be even, and made smooth by applying necessary filler. The texture shall be smooth with just sufficient roughness to enable the chalk to make a legible mark without undue pressure, but not so rough that the chalk is so severely cut the smudging and marking of the surface takes place when the board is wiped with a dry cloth. The surface shall not be too shining.

2·4. Each board shall be constructed well and sharply in such a way that it is not subjected to warping. The corners of the board shall be rounded off to a radius of not more than 25 mm. A suitable framing shall be given to the board for making the board rigid and firm.

2·5. The method of construction and mounting shall enable each type of board to remain firm and rigid when in use and adjustable revolving and movable type to be easily adjusted and moved.

2·6. The rate shall include cost of the frame also.

3. *Dust Rail and holder for chalks etc.,*—On all wall mounted boards and in type where possible provision shall be made for a dust rail to collect dust falling from the writing surface during use. A suitable container shall be provided for chalks and wipers.

SPECIFICATION No. 80.

BRICK ENCASING GRIDERS.

1. The rolled steel girder shall be finally fixed in place in accordance with the drawings, cleaned, and wire brushed. A coating of neat cement shall be given to the girder flanges and web, using a proportion of one kg. of cement mixed with 0·65 kg. of water to cover 14·35 square metres one coat.

2. The space on either side of the web of the girder and between flanges shall be filled with standard specification brick in cement mortar with mortar proportion 1 : 3, with the bricks flush with edge of flange, or overlapping edge of the flange not more than 6 mm. The size of bricks used should be chosen from those locally available to satisfy the above—alternatively, brick work of terrace bricks in standard specification cement mortar 1 : 3 may be used instead of wall bricks in mortar.

3. Expanded metal 20 mm. mesh—3 mm. × 3 mm. shall be bent to a rectangular shape 6 mm. larger than the girder all round. The ends of the expanded metal cut to size shall lap over each other one mesh on the top flange, and be secured together by wire bindings, fixed at 30 cm. of length of the girder. The expanded metal should be blocked away from the lower flange 6 mm. by means of pieces of iron bar wired at intervals to the inner side of the expanded metal in order to give a key to the plaster.

4. Standard specification on "plastering with cement mortar 1 : 3, 12 mm. thick" shall finally be done over the expanded metal to the, bottom flange and the two sides of the girder, ensuring that the plaster bonds well with the brick work and lower flange of the girder, through

the expanded metal. The plaster shall be rounded to 12 mm. radius at the lower corners of the girder, and shall be rounded to the same radius to join the ceiling plaster, plastering being done after the floor above the girder is laid. Watering shall be done as specified in the standard specification for plastering.

5. Unless otherwise specified, the rate shall be per metre run of girder for encasing complete in accordance with this specification (exclusive of cost of girder, fixed in place), or the cost may be included in the unit-tonne rate, based on the weight of the rolled steel girders, as may be fixed in the relevant schedule item.

N.B.—(a) Where concrete filling is proposed to be used instead of brick filling, details such as whether the filling is to be given before or after erecting the girder, applying plaster after erection, etc., will be given in a separate specification. Similarly, a separate specification will be given where patent types of lathing are proposed to be used and plaster applied without any filling between lathing and central part of girder.

(b) In all types of encasing, the extra weight of the encasing material should be added to the dead weight—designing the girder.

(c) Plastering without filling has the objection that corrosion of the beam may be going on unnoticed, as no treatment can be given after encasing.

SPECIFICATION No. 81.

Steel Doors and Windows.

1. I.S. 1038–1968. Appendix A and N.B. Code, Part V of Appendix shall apply.

2. In the absence of other instructions, the erection of doors and windows shall ordinarily be left until all the rougher building operations have been finished. The position of fixing lugs may be marked and necessary holes left as the building progresses. A brick with sand mortar may be placed where the lugs will come, to facilitate subsequent fixing of the lugs in mortar. The fixing-lugs are to be tarred before insertion in masonry and securely fixed with Standard Specification cement mortar 1 : 2 I.S. 1038—1968, Paragraph 7 shall also apply.

3. The openings for these doors and windows shall be made with a clearance all-round of 12 mm. for doors and windows up to 1·8 metres height and 20 mm. for heights above 1·8 metres, they shall never be forced into position. The space between the masonry and the frame shall then be carefully filled with standard specification cement mortar 1 :2 or such other type of cement as is recommended or supplied by the maker. It should be a stiff mix and be pressed firmly full bedding for the full opening and neatly finished with smooth surface and pointed as instructed

4. The fixing of frames shall be so done that no lime either in plaster or in the masonry, comes in contact with the steel door or window frame.

5. Where the doors and windows have to be fixed before rougher building operations are finished, care shall be taken that the articles or fittings are not damaged by placing boards, poles, etc., on the sills, transoms, or glazing bars, and that they are not used as convenient support for scaffolding. Any damage shall be made good by the contractor.

6. Frames shall be fixed plumb and accurate, as otherwise opening portions will not function satisfactorily. For actual fixing the procedure is usually given by the makers of each type of doore or window, and shall be followed with such modifications as the Executive Engineer may order.

7. The glazing shall conform to the standard specification for "Glaziers work" regarding thickness and type of glass and putty to be used Glazing shall be on the inside of the door or window, unless otherwise specified or shown on drawings. The glass shall be cut at least 3 mm smaller in height and width than the tight rebate size of the opening into which it is to fit, and shall be bedded in putty in the usual way keeping the front putty as narrow as possible, to obtain a neat and workmanlike finish. The glass shall be held in position for puttying by small wedges of hard wood or lead, and the glazing completed by bedding the glazing beads in putty and screwing into position or by fixing the glass with glazing pins and clips, according to the type of door or window tendered for. The contractor shall clearly show the method of fixture of the glass proposed to be adopted, following the instructions in the steel door or window maker's catalogue.

Rate– I.S. 1200–1967 Part VIII– Para 86 shall apply.

SPECIFICATION No. 81-A.

Specification for Aluminium doors, windows and ventilators.

1. I. S. 1948–1961 shall apply.

2. For fixing and glazing of Aluminium doors, windows and ventilators I. S. 1081– 1960 shall apply.

3. In the absence of other instructions, the erection of doors and windows shall ordinarily be left until all rougher building operations have been finished. The position of fixing lugs may be marked and necessary holes left as the building progresses. A brick with sand mortar may be placed where the lugs will come to facilitate subsequent fixing of the lugs in mortar. The fixing lugs are to be treated with lacquer based on methacrylates or cellulose butyrate before insertion in masonry and securely fixed with cemen mortar 1 : 2 of standard specifications and as specified in para 7t of I.S. 1948–1961.

The space between the masonry and the frame shall then be carefully filled with standard specification cement mortar 1 :2 or such other type of cement specified by the maker. It should be a stiff mix and be pressed firmly full bedding for the full opening and neatly finished with smooth surface and pointed as instructed.

4. Para 5 and 6 of specification No. 81 shall apply.

5. The glazing shall conform to the para 10 of I.S. 1081– 1960.

6. Specification for Aluminum windows for Industrial buildings is not covered in the specifications.

7 For sizes of frames, I.S. 1948-61 shall apply.

SPECIFICATION No. 82.

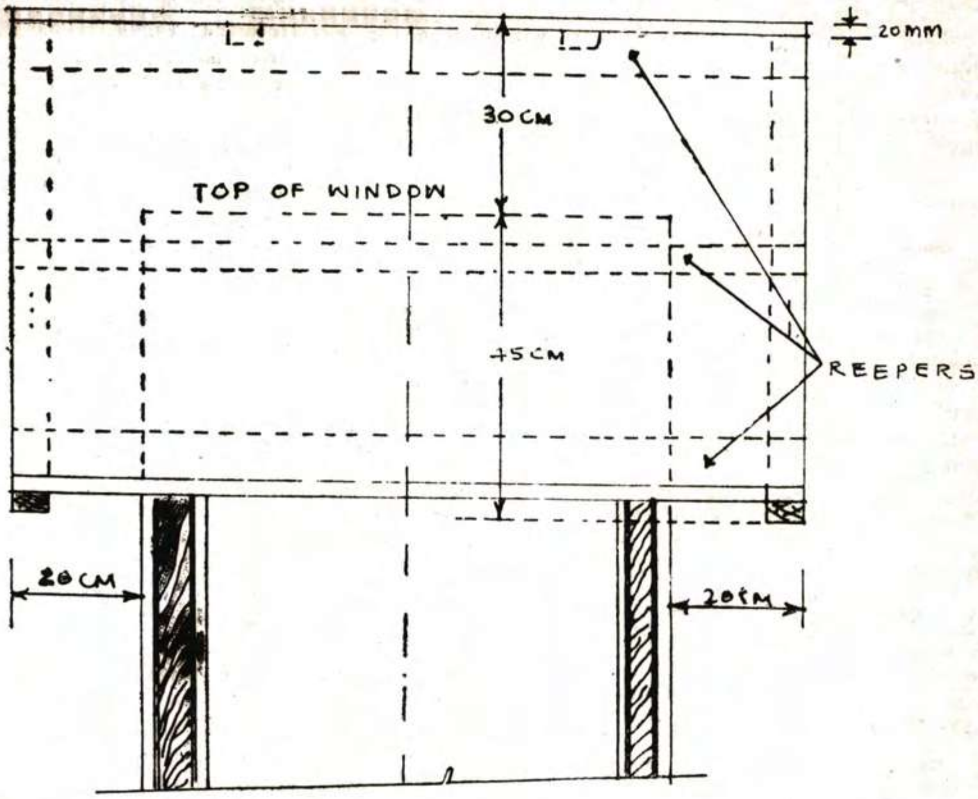
Window sunshade—Sheeting type.

The frame work shall be of teak, unless other wood is specified, sizes of members, and shape of sunshade, being as shown in the type design. The width will be at least 20 cm in each side wider than the clear opening of the masonry outside the windows, frames, with depth and projection as shown on the type design. The outer horizontal frame members shall be taken 23 cm. into the wall and anchored by 10 mm diamter, mild-steel rods 23 cm, long. The wall purlin shall be supported at about 0.90 m centres by mild-steel dogs set in cement mortar as shown in the type design. If the lintel is of arch work, these dogs shall be built in with the arch, and the arch is not to be dug out to fit in the dogs afterwards. For fiting to existing windows, the outer dogs will be located clear of he arch, with a central support to the purlin fixed in a brick joint with cement. This central support will be 10 mm diameter mild-steel rod taken 10 cm into the joint and bent up to support the purlin similar to the other dogs. The main frame joints shall be halved and screwed and the reepers shall be housed in the frame.

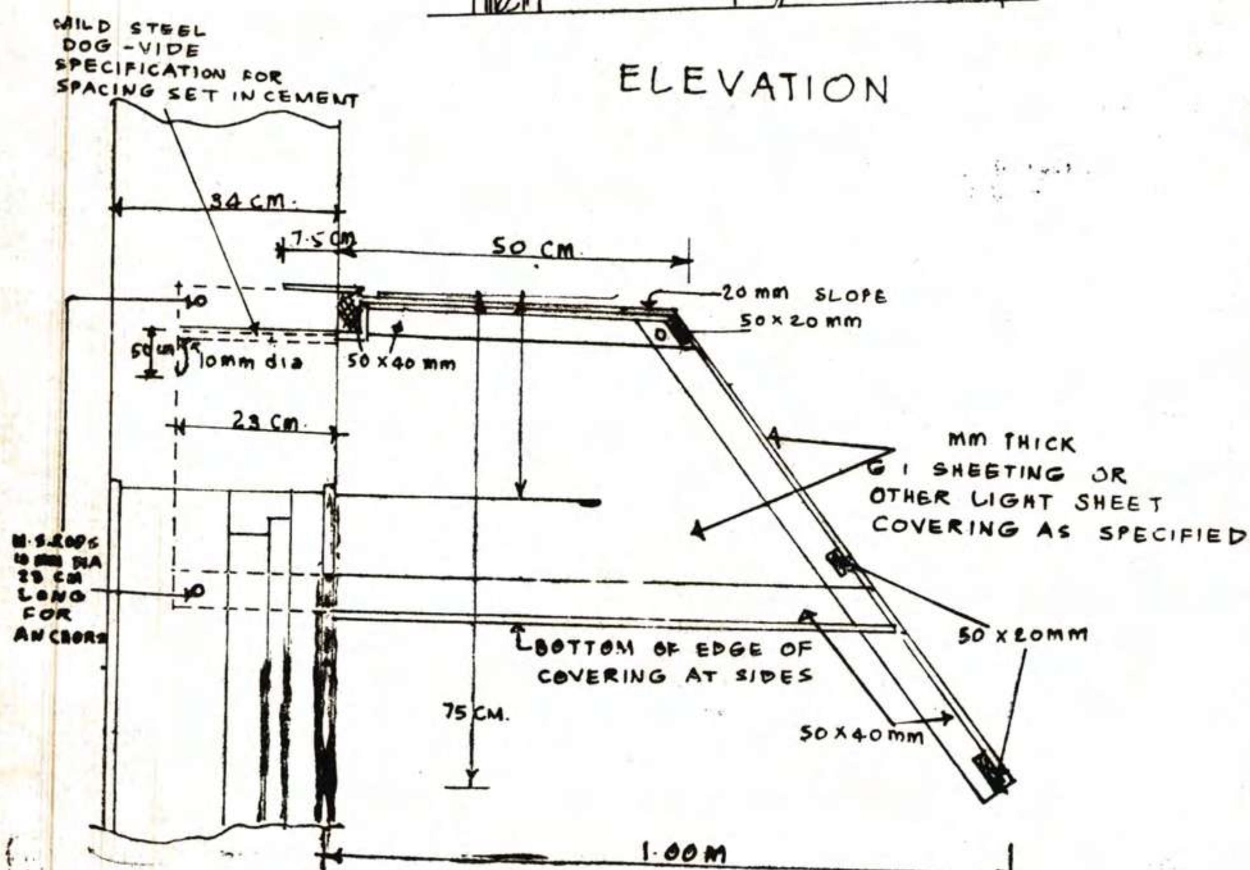
2. The covering shall be of 1.25 mm thick galvanized iron sheeting or other light sheet, as may be defined in the schedule item. The top and front sloping free of the sunshade, for pliable sheeting shall be in one piece without joints and the two side sheets of the frame in single sheets, unless otherwise permitted by the Executive Engineer. The covering shall be fixed to the wood work at the corners and at about 15 cm intervals along the edges of the frame with 2 cm galvanized iron screws and washers. In all cases, the top covering shall be taken 7.5 cm. into the wall, and set and finished properly with mastic or cement mortar. Neat joints shall be made and so finished that there will be no leakage during rains.

3. The rate shall be complete for one sunshade to suit the size of window defined in the schedule item, and shall include all wood work—sheet covering, mild-steel anchors and dogs, fixing, etc. complete in position and painting two coats of best approved paint of colour which will be defined in the schedule item or in an addendum specification (*See* fig. 1).

WINDOW SUNSHADE
SHEETING TYPE SCALE 1 CM - 10 CM



ELEVATION



SECTION

FIG. 1

NOTE.—with this type of sunshades, parliamentary hinges should not be used on the windows, as they cannot fold back against the outside wall, but cabin-hooks or keeping windows open will be used.

SPECIFICATION No. 83.

WOOD STAIRS.

1. *Wood*—The class of wood to be used will be defined in the relevant schedule item.

2. *Design.*—As the design of the stairs will be governed by the purpose for which the stairs are required and the space available' such addendum plans to the standard detail drawings as are necessary in each case, will be furnished to the contractor.

3. *Strings.*—I.S. 1634/1973 para 5.3 and N.B. Code Part VII (C) of appendix shall apply.

3.1. The strings will be either close strings (i.e. with risers and tread housed or housed and wedged into the string) or cut and mitred (i.e., with the string out to receive the tread and the riser mitred to the string) whichever is specified. Strings shall be connected together with 20 mm tie rods at intervals of approximately 1.8 m. (position not shown in accompanying plates). The bolt head of the tie rod shall be housed in the outer string and covered, with a wooden plug dressed flush. The tie rod shall be cut off to the required length and the nut need not be housed if it is not exposed to view.

3.2. Strings will be tenoned into newels and notched and bolted in trimmers and floor joists or fixed in other manner as may be specified. Details for fixing the wall string to the wall by dog bolts or plugs will be furnished when such fixing is required-separate details also be given when curved strings are specified or shown on the relevent sections of the stairs. Grooves 20 mm deep, shall be accurately out in strings to receive the risers and treads and wedges where such as specified to be used.

3.3. The size of the strings will depend on width of the steps, spacing of carriage pieces, length of flight, etc. and shall be of size specified for each work.

3.4. Wedges will be fixed with a 25 mm nail or if it is a cool district they will be dipped in glue before wedging up.

4. *Carriage Pieces.*—Carriage pieces shall be used for support of steps in the case of use of cut strings, or where the stairs, are 100 cm. or more in width. The size of carriage pieces and spacing of same will be shown on the relevant drawings. If the soffit of the stairs is to be boarded or plastered, rough bracktes 25 mm thick may be spiked to the carriage piece to support the steps. Otherwise, fitted bracket pieces or larger size fitted cut carriago pieces shall be used, finished in a neat manner. The carriage pieces shall be securely housed, framed or tenoned to the trimmer wall or floor joists as the case may require.

5. *Treads and Risers.*—The treads shall have round moulded nosings along the front and returns with mouldings planted on of the type shown in the standard detail or other drawings supplied. The projection of the nosing shall be equal to the thickness of the tread. The treads and risers shall be fixed to the strings as described in clause 3 supra and as shown in the relevent standard or other details furnished. The risers shal be rebated top and bottom 12 mm and with width of rebate, 1/2 thickness of the riser. They shall be fitted into grooves in the tread cut be receive them vide standard detail drawing. The thickness of tread and risers shall be as shown in the relevent drawings.

5.1. In better class work, where the soffit will be boarded or plastered the risers and treads will be blocked and screwed together as shown in the standard detail drawing while in stairs with the steps exposed below, the bottom of risers may be screwed at the rear to the treads and the treads to the riser from the top, countersinking the head of the screw into the top of the tread.

6. HANDRAIL AND BALUSTERS.—These shall be of the type shown in the standard or other detail drawing—specified. In the case of the use of cut strings they will be dovetailed into the tread and the return nosing of tread will be mitred and planted on to cover the dovetail. The baluster will be tenoned into the lower face of the handrail and splayed to the slope of the rail (and similarly splayed for the string, when fixed to close strings)—unless it is specified that they will be screwed to an iron core housed in the lower face of handrail. Balusters shall be evenly spaced. Unless otherwise specified or shown in relevent plans, two balusters will be provided for each step, one over the riser and the other at mid width of the step. For winders, one baluster at the narrow and will be used.

6.1. The handrail shall be housed and tenoned into the newel post, or may be given a ramp at the lower newel, swan neck at the upper newel, curved in plan or elevation all as may be shown in the relevant details specified. Joints for handrails will be butt joints dowelled together and fixed with handrail scrwes or as may be otherwise specified.

NOTES ON STAIRS

(*a*) There are several rules in common use, which lay down the proportion of tread to rise. The limits of variation for width of tread and height of rise may be taken as from 23 cm. × 18 cm. to 28 cm and or 30 cm × 15 cm for ordinary purposes, the rise being reduced to 13 cm. or 14 cm. for public buildings where possible. The wider the tread, the less should be the rise and the greater the rise, the less the tread.

(*b*) An ordinary staircase should not be less than 90 cm in breadth, 100 cm. to 1·5 m. is preferable.

(*c*) Winders should not be housed if they can be avoided, but if they are necessary, then they should be atleast 23 cm. in width at about 40 cm. away from the handrail and located near the bottom—not the top—of the stairs. It is good practice to provide separate bearers for each winder together with carriages.

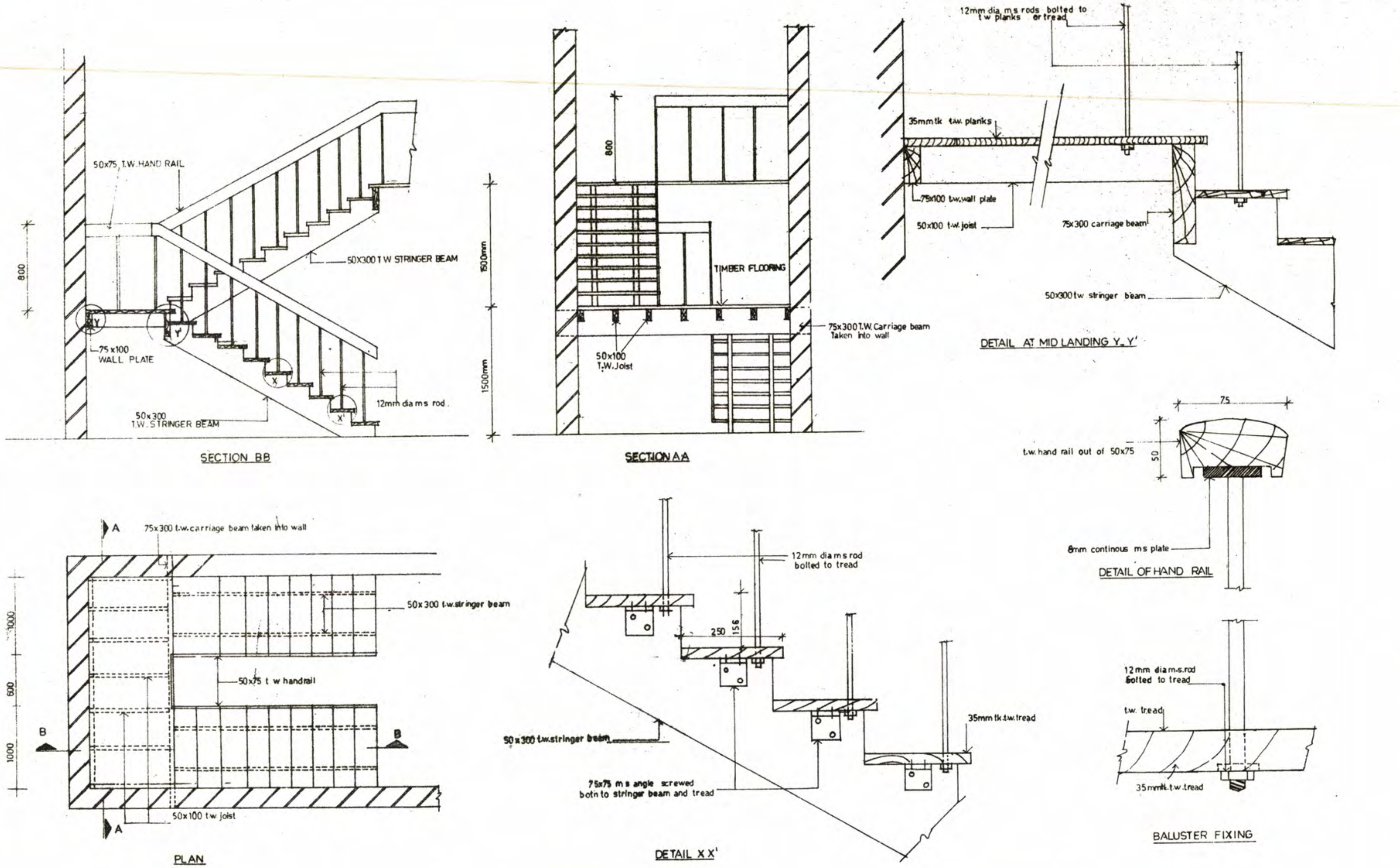
(*d*) A landing space should be provided at not more than about every fourteen steps. Two consecutive flights in the same direction should be avoided, if possible. A suitable height for the top of the handrail immediately above the risers is 75 cm or 80 cms. On landings, the handrail may be 90 cm. high. In dog-legged stairs the outer string of the upper and lower flight will be in the same vertical plane.

(*e*) *Carriage Pieces*—For carriage pieces with brackets fixed thereto the following sizes may be used ; 105 cm width stairs —10 or 11 step flight—one carriage piece— 5 cm. × 10 cm increasing for 1·35 cm. width stairs—14 or 15 step flight to 5 cm. × 18 cm.

(*f*) *Strings.*—The following sizes are suitable for teakwood 5 cm × 33 cm. for close strings—105 cm width stairs—10 or 11 step flight—increasing to 5 cm × 38 cm for close strings (wall string) and 7·5 cm × 38 cm for cut strings —1 ·35 m width stairs —14 or 15 step flight.

(*g*) *Treads and Risers.*—Treads 30 mm. thick, with risers 25 mm. thick for 1·05 m and 1·2m width stairs each increasing by 3mm upto 45 mm and 38 mm respectively, maximums, for every 150 mm extra width of stairs over 1·2 m—may be used for ordinary stairs.

NOTE.—C.A. Drawings No. 1849, drgs. 1 and 2 shall also apply.



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PUBLIC WORKS DEPARTMENT
T A M I L N A D U

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CHIEF ARCHITECT

ARCHITECT | ASST. ARCHITECT

OFFICE OF THE CHIEF ARCHITECT MADRAS

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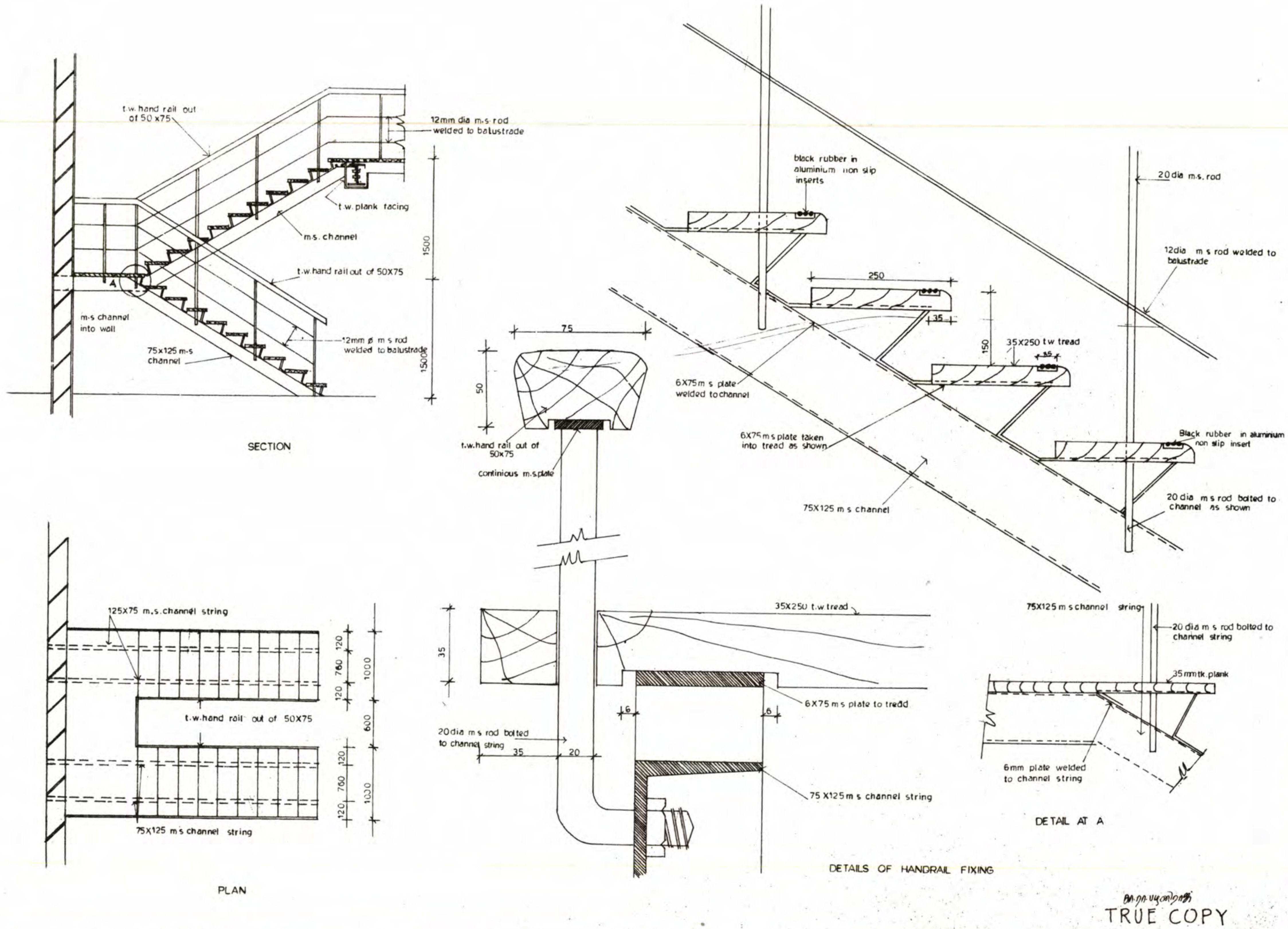
TYPE DESIGN FOR WOODEN STAIRCASE

PLAN, SECTION & DETAILS



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STEEL CUM WOODEN STAIRCASE DETAILS

PLAN SECTION AND DETAILS

SPECIFICATION No. 84

LIGHTNING CONDUCTORS.

1. *Diagram.* -The system of conductors shall be installed in accordance with the diagram which will be prepared by the Executive Engineer for each building to be protected.

2. *Material and Size.*—The size of the conductors will be defined in the tender notice. If the tenderer is unable to obtain the materials of size specified, he shall state the size and give such other explanatory particulars as are necessary, relating to the conductor to which his tender rate applies-*vide* notes accompanying this specification.

2.1. All air terminations shall be of galvanized iron and all down conductors shall be of galvanized iron or aluminium except where the atmospheric conditions necessitates the use of copper or copper clad steel for air terminations and conductors.

3. *Points and Terminals.*—These shall be installed in conformance with the diagram and of design shown in the standard or other drawings specified. Where not otherwise defined, elevation rods or terminals shall be of galvanized iron 20 mm diameter, fixed at least 60 cm above that portion of the building to which it is attached and provided with three additional points, each 15 cm long, made from 12 mm round rods, as shown in the standard detail drawing.

4. *Aigrettes.*—These shall be of the pattern shown in the standard detail drawing and shall be located at distances between 6 mm and 9 mm along horizontal conductors as may be shown on the diagram—*vide* clause 1 supra.

5. *Single Points*—These shall be provided for all the finials flag poles and such roof projections and at places shown on the diagram They shall be of the type shown in the standard drawing accompanying this specification.

6. *Joints and Fixing Accessories.*—Every joint whether between successive lengths of rod or at junction of terminals, points, aigrettes and earths shall be well cleaned, screwed or riveted and thoroughly soldered. The contractor should employ an experienced linesman to enable proper lineman's joints to be made for cables to ensure sound joints.

6·1. The rod shall be connected to the masonry by holdfasts of wrought iron of the standard type design accompanying or such other type as may be specified. Such holdfasts shall be fixed near the top and bottom of the vertical face of the building and at intermediate distances of not more than 1·8 metres. The masonry joint will be chiselled out for a depth of 15 cm and the holdfasts then grouted in with cement mortor 1: 3.

7. *Method of Running Conductors.*—These shall be run in as direct a line to earth as convenient and sharp bends and joints avoided. They shall accordingly be kept a certain distance away from walls, but must not be insulated from the walls.

7.1· Conductors shall so far as possible be run in single lengths and joints in same will not ordinarily be permitted except where vertical and horizontal conductors are connected.

7.2. The diagram will show the position of rods, which will be taken down the sides of the building most exposed to rain.

7·3. Where a string course or other projecting stone work will admit of it, the rod may be carried straight through instead of around the projection, but in such a case, the hole should be large enough to give 75 mm clearance all round the conductor.

8. *Painting*—All conductors and terminals shall be painted with two coats of such anti-corrosive paint as may be specified in the tender notice.

9. *Earths and earth connection*—The earth connection shall be of one or more of the following types as may be described in the tender notice or shown in the diagram it being essential that the lower extremity of the conductor be buried in permanently damp soil. (in most cases two separate earths will be required and when the "Birdcage" system is used, vide paragraph (*b*) of notes accompanying this specification, a separate earth on each side of the building is required) Special attention shall be given to joint connections vide clause 6 supra.

(*a*) Connect the cable to a galvanized iron plate 75 mm X 75mm X 6 mm thick, the iron plate being immersed in charcoal at a depth where it will be continuously wet. (A 75 mm X 75 mmX 4 mm copper plate should be used when the conductor is of copper). It is better to set the plate vertically.

(*b*) Where permanent moisture is at a considerable depth or where it is not conventent to open up an excavation to the required depth to lay an earth plate, drive a galvanized iron pipe down to permanent subsoil water-level. The pipe should be provided with a suitable driving cap or dolly and shoe and successive lengths jointed by a screwed and coupled joint or screwed and socketed joint. The lower 1.8 metres of the pipe shall be perforated with 3 mm drilled holes, three lines circumferectially and at 15 cm. staggered spacing along the length of the pipe. The cable shall be passed down to the bottom of the pipe and finely powdered charcoal then packed arround the cable for the full length of the cable. The pipe shall be brought to about 45 cm. from ground level, the cable being rivetted or boltted to the pipe and soldered and a surface box provided as shown in the standard drawing. It is also advantageous to connect the driven perforated pipe with a pipe connection from the nearest water tap or clean waste, water so that there will be an additiona assurance of maintaining the earth connection always in an efficient wet condition.

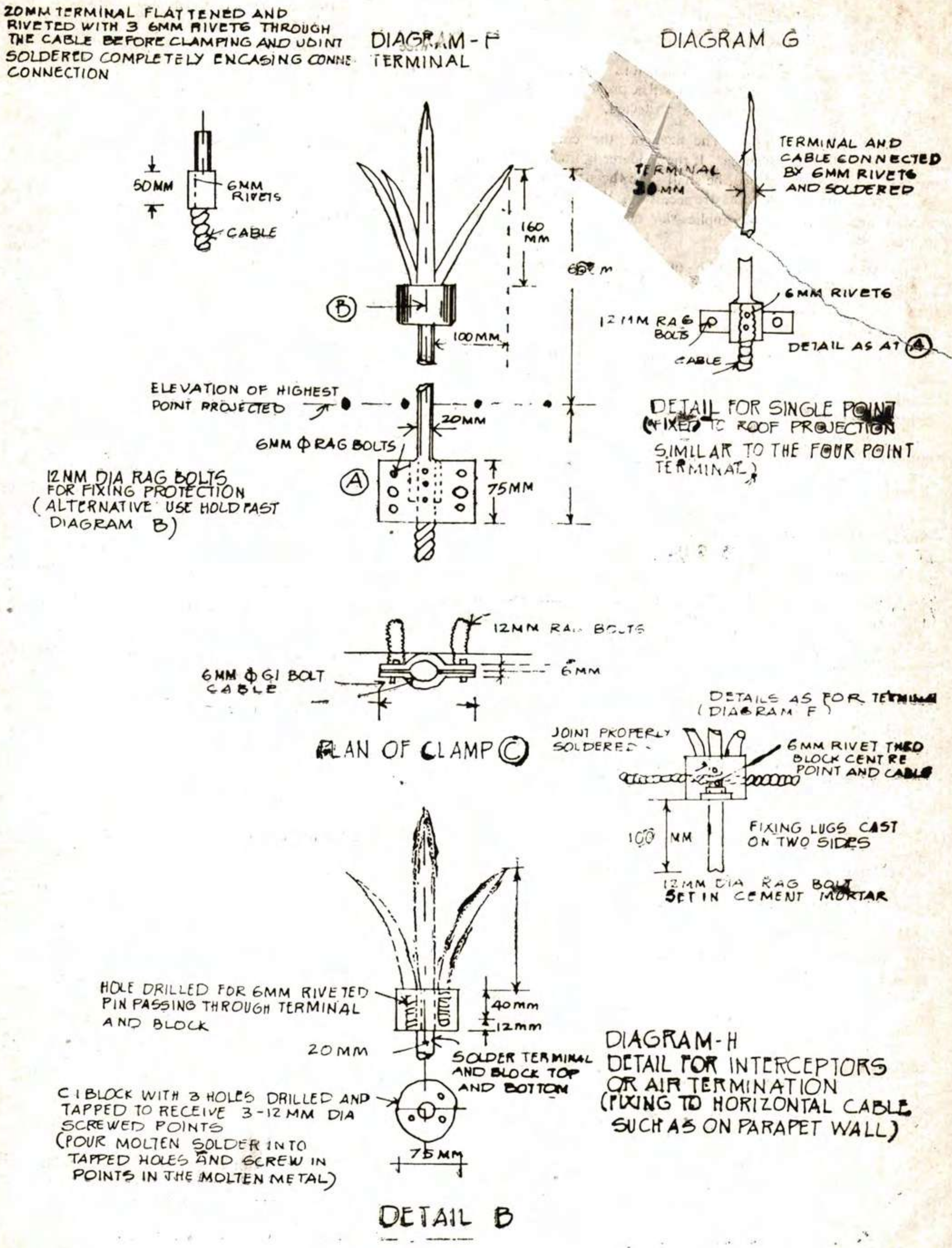
(i) When this method of earthing is provided the tender notice will specify the lengths of 50 mm driven tube required, the length of 12 mm pipe connection to be supplied and laid and the overall rate for the conductor will be for complete execution in accordance with this sub-clause (inclusive of surface box, masonry etc.)

NOTE.—If the ground is hard, a 50 mm pipe cannot be driven deep and it may be necessary in such a case to use a boring outfit of the smallest size to get the pipe to the required depth. The contractor should inspect the site and decide his method of execution before tendering, as his rate shall cover the execution of the work by whatever method he finds most suitable.

(*c*) Carry the cable from the bottom of the rod of the nearest water main (not to a lead pipe) ; clean the main thoroughly, where the contact is to be made, to a bright surface and connect the cable to the main with a clamp as shown in the standard drawing—soldering also at intervals around the pipe.

(*d*) As a modification of (*a*) above, where there is a suitable well convenient, connect the cable securely to a galvanized iron plate 75 mm X 75 mm X 6 mm and lower the same to the bottom of the well, clipping the cable securely to the masonry of the well at 90 cm. intervals by dogs set with cement mortar 1 : 3, 15 cm. into masonry joints. The cable should be admitted through the steining at 45 cm. below ground level.

(i) The location for the "earth" shall be as shown in the diagram—vide clause 1 supra (the distance may be 10 to 30 metres from the building). Unless otherwise specified, the cable shall be laid from the building to the pit, well or sunk pipe "earth" at a level 45 cm. below ground level. The cable shall be tarred thoroughly with two coats of standard tar painting for the full length of the cable from the earth plate (or "earth" sunk pipe) 60 cm. above ground level at the building. Hessian cloth shall then be soaked



20MM TERMINAL FLATTENED AND RIVETED WITH 3 6MM RIVETS THROUGH THE CABLE BEFORE CLAMPING AND JOINT SOLDERED COMPLETELY ENCASING CONNECTION
DIAGRAM - F
TERMINAL
DIAGRAM G
50MM
6MM RIVETS
CABLE
160 MM
100MM
B
TERMINAL AND CABLE CONNECTED BY 6MM RIVETS AND SOLDERED
TERMINAL 20MM
6MM RIVETS
12MM RAG BOLTS
CABLE
DETAIL AS AT A
ELEVATION OF HIGHEST POINT PROJECTED
20MM
6MM ϕ RAG BOLTS
12MM DIA RAG BOLTS FOR FIXING PROTECTION (ALTERNATIVE USE HOLDFAST DIAGRAM B)
A
75MM
DETAIL FOR SINGLE POINT (FIXED TO ROOF PROJECTION SIMILAR TO THE FOUR POINT TERMINAL)
12MM RAG BOLTS
6MM ϕ GI BOLT
CABLE
6MM
PLAN OF CLAMP C
DETAILS AS FOR TERMINAL (DIAGRAM F)
JOINT PROPERLY SOLDERED
6MM RIVET THRO BLOCK CENTRE POINT AND CABLE
100 MM
FIXING LUGS CAST ON TWO SIDES
12MM DIA RAG BOLT SET IN CEMENT MORTAR
HOLE DRILLED FOR 6MM RIVETED PIN PASSING THROUGH TERMINAL AND BLOCK
40mm
12mm
20MM
SOLDER TERMINAL AND BLOCK TOP AND BOTTOM
DIAGRAM-H
DETAIL FOR INTERCEPTORS OR AIR TERMINATION (FIXING TO HORIZONTAL CABLE SUCH AS ON PARAPET WALL)
C I BLOCK WITH 3 HOLES DRILLED AND TAPPED TO RECEIVE 3-12 MM DIA SCREWED POINTS (POUR MOLTEN SOLDER INTO TAPPED HOLES AND SCREW IN POINTS IN THE MOLTEN METAL)
75MM
DETAIL B

DIAGRAM-A
METHOD OF RUNNING A LIGHTNING CONDUCTOR

NOTE (THE CONDUCTOR TO BE KEPT AT LEAST 75 MM AWAY FROM THE STRUCTURE AND ALL SHARP BENDS AVOIDED

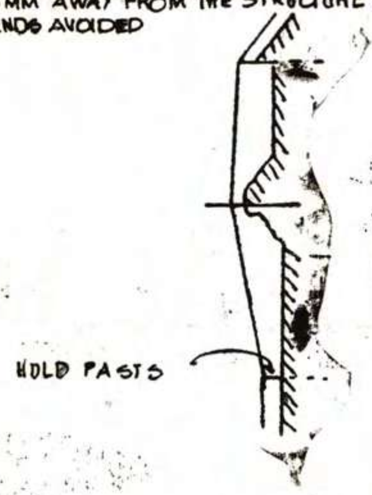


DIAGRAM B
HOLD FASTS

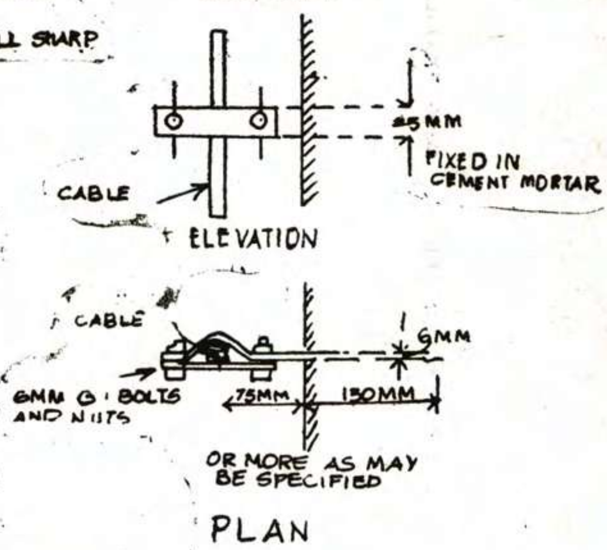


DIAGRAM C
DETAILS FOR CROSSING OF TWO CONDUCTORS

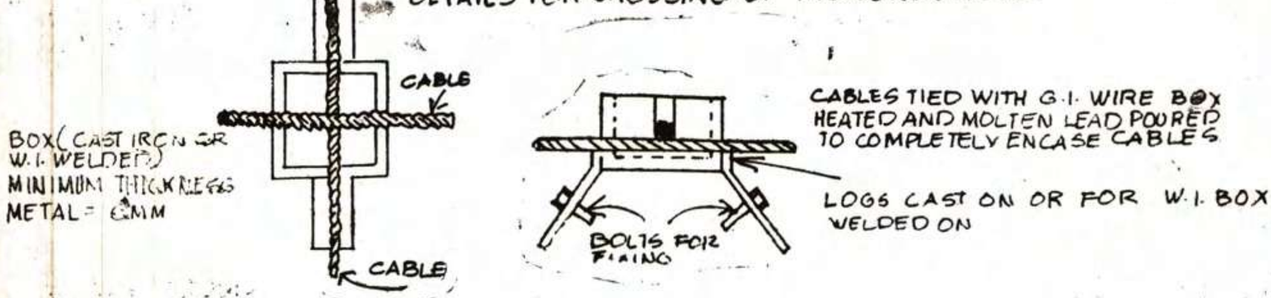


DIAGRAM D
DETAIL SHOWING METHOD OF CONNECTING CONDUCTORS AND WATER PIPES FOR 'EARTHS'

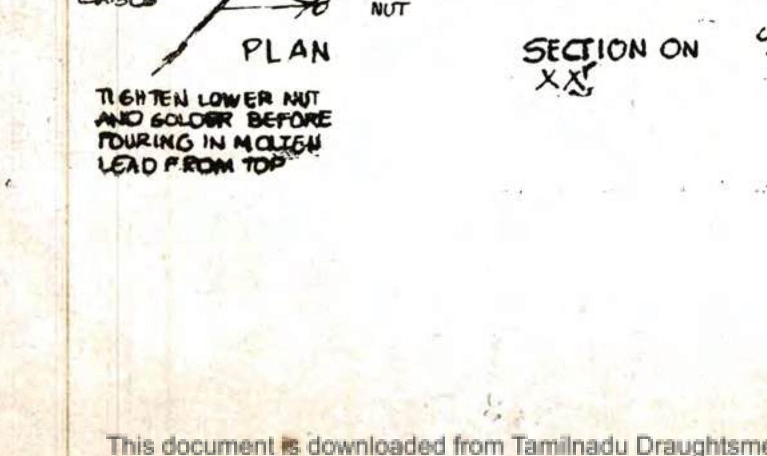
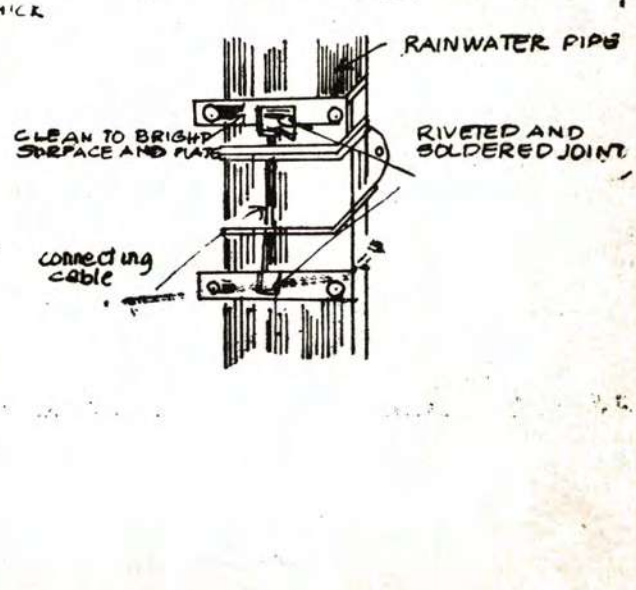
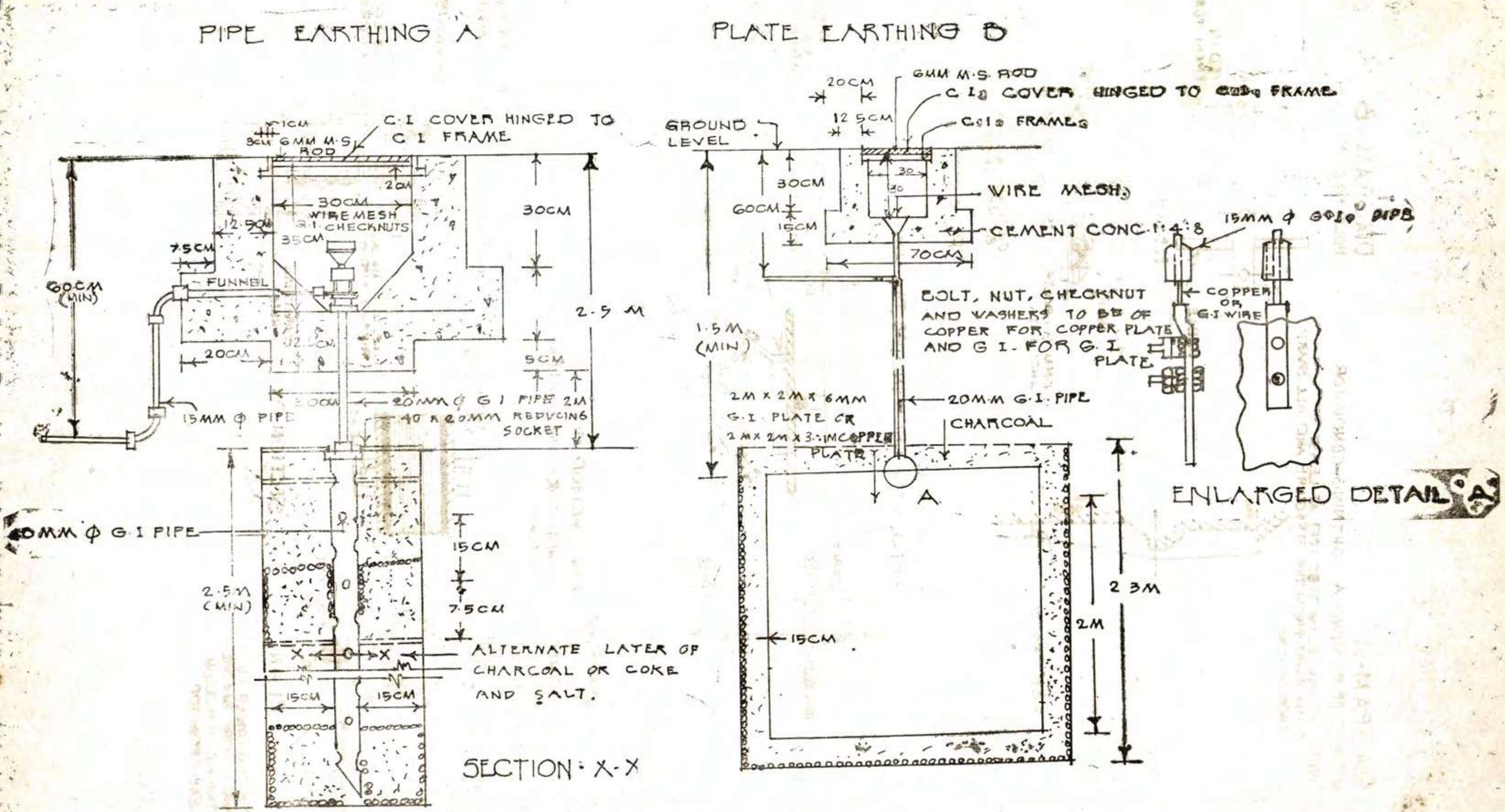


DIAGRAM E.
DETAILS FOR MAKING RAIN WATER PIPES ELECTRICALLY CONTINOUS





Note.—Three or four buckets of water to be poured into sump every few days to keep the soil surrounding the earth plate on pipe permanently moist.

in hot tar and wrapped tightly while hot in a bandage form to thoroughly encase the length of cable which has been tarred as above, i.e., for the underground portion and for 60 cm. above ground level.

NOTE.—If the cable is likely to receive close attention where burried, so that it can be renewed as soon as it corrodes badly, then it need not be made watertight but simply laid about 36 cm. to 60cm.. below ground level, where the rain will percolate and thus give more efficient earthing. Unless however expressly otherwise specified the cable shall be tarred and wrapped as described above.

10. *Testing.*—The system be inspected and tested by an authorized Government officer and shall pass such inspection and test, before the contractor shall be come entitled to any payment, for the lightning conductor system. This test will usually be conducted in the driest season of the year. The maximum resistance from the top conductor to the "ground" of the testing apparatus shall in no case exceed 10 ohms.

11. *Rate*—The rate will be for the lightning conductor system complete installed in place, inclusive of all points, terminals, aigretts rods earth connections and painting—complete to the requirements of the diagram referred to in clause 1 supra, this standard specification and such further addendum specification and drawings or tender notice description as may be furnished.

Notes of lightning conductors.

(*Vide* clause 1 of Standard specification).

(*a*) Number of conductors—No "area of protection" can be defined and no definite rule can be laid down as to the number of rods necessary to protect a building. The extent of protection should therefore bear some relation to the value and importance of the building concerned. It should, however, be the practice to provide at least two rods on any building.

(*b*) Birdcage system—This is the best known method of protection whereby the structure is enclosed in a metal frame work. In a building which is sufficiently important to warrant an approach to this system, there will usually be metal gutters and rain-water pipes. These should be made electrically continous by proper bonding together and utilized as part of the system. Ordinary conductors must be fixed in addition and the whole connected. It is said to be advantageous to have a horizontal conductor taken round the building either 50 mm. or 75 mm. above ground level or burried in the ground. The former will not usually be possible on account of unsightliness. The whole system should then be efficiently connected to earth at several places.

(i) Such approach to this system should therefore be made in design as warranted by consideration referred to in paragraph (*c*) supra.

(*Vide* Clause 2 of Standard Specification.)

(*c*) Material for rod—The lightning Research Committee of 190 recommend for main conductors copper weighing not less than 500 grammes per metre run either in the form of tape (20 mm by 3 mm) or stout wires-no individual wire being less than No. 12 BWg—or iron weighing not less than 3.3 kg. They state subsidiary conductors for connecting metal ridging, etc., to earth may with advantage be of iron of a smaller gauge such as No. 4 S.W.G. galvanized iron. The phoenix fire office lay down among other alternatives, soft iron wires cable 7 strands, each strand of 3 mm. diameter.

(i) This latter size cable out of galvanized iron should be adopted in all cass in Madras, unless considerations necessitate other size If this size is not available then three 7 strand fencing wire cables (each strand of No. 14 S.W.G. and each separate cable No. 4 S.W.G. which fencing wire cables are usually available, shall be securely clipped together at intervals of not more than 60 cm. and used as main conductors (three 7 standard No. 4 fencing cables each strand No. 14 S.W.G. give a cross-sectional area of 6.77 sq.cm. whilst 7-Strands 3 mm wires have an area of 6.4 sq.cm.). The Executive. Engineer should give such further details for joints, etc., that are necessary, if he finds it necessary to adopt the less desirable conductor formed from the three fencing cables.

(ii) Copper is more expensive than iron conductors, is moret liable to be stolen and on account of its high conductivity is more liable to side flashes and to this extent is objectionable.

(*d*) *Alignment.*—For small gabled buildings without towers 5 may be sufficient in some cases to provide two terminals one at each end of the ridge connected by a conductor along the ridge and carried down a hip to eaves, thence to ground. For a long ridge provide two earths at each end of the ridge.

(i) For a flat terrace roof a cable along the top of parapet with airgrettes at 6 metres to 9 meters interval and carried to ground at two diagonal corners, for a moderate size roof, will suffice.

(*e*) *Masses of metal*—Connect all masses of metal in a building and ornametal iron work, iron trusses, hotwater pipes, etc., either to the system or to separate earths. Keep the system away from soft metal pipes.

(*f*) *Inspection*—The joints of all conductors should be carefully inspected annually and earth plates tested once a year before the rains.

SPECIFICATION No. 84-A.

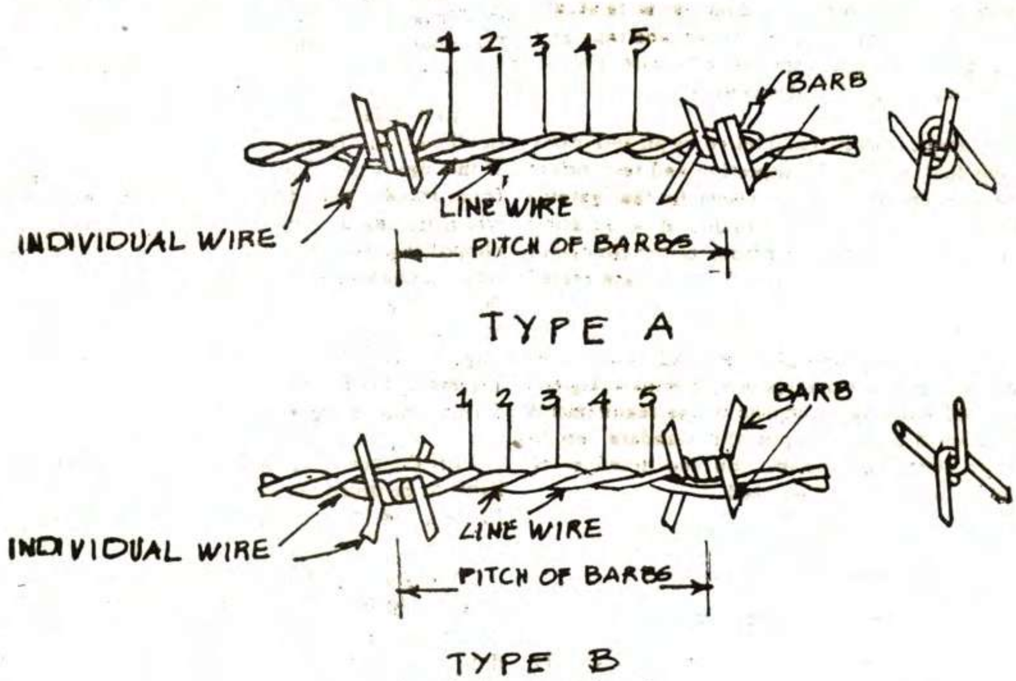
COLLAPSIBLE GATE, ROLLING SHUTTERS AND ROLLING GRILLS.

1. I.S. 6248—1971—Specification for metal rolling shutters and Rolling grills shall apply.

EXTRACT FROM I.S. 278—1969.

4. *Manufacture and sizes* :

4.1. *Types* : - The galvanized steel borbed wires shall be of two types. Type A (Iowa Type) and Type B (Glidden Type).



DETAILS OF BARBED WIRE

4.1.1. *Type A (Iowa Type)* .—The barbs shall have four pontsi and shall be formed by twisting two point wires, each two turns, tightly around both line wires making altogether four complete turns.

4.1.2. *Type B (Glidden Type)*.—The barbs shall have four points and shall be formed by twisting two point wires, each two turns, tightly around one line wire making altogether four complete turns.

4.2. The galvanizsd steel barbed wire shall be of the size designations given below : -

Size designation.	Nominal diameter of wire — Line wire.	Nominal diameter of wire — point wire.	Weight of completed barbed wire. — Max.	Weight of completed barbed wire. — Min.	Distance between two barbs.
(1)	(2)	(3)	(4)	(5)	(6)
	mm.	mm.	g/m.	g/m.	mm.
1	2.50	2.00	125	108	75±12
2	2.50	2.00	103	89	150±12
3	2.24	2.00	106	97	75±12
4	2.24	2.00	85	78	150±12

4.3. The barbed wire shall be formed by twisting together two line wires, one or both containing the barbs. The sizes of the line and point wires and barb specings shall be as specified in 4.2.

4.4. *Tolerances* : The permissible deviation from the nominal diameter of the line wire and the point wire shall not exceed 0.08 mm.

4.5. The barbs shall be so finished that the four points are set and locked at right angles to each other (*see* Fig. 1). The barbed shall have a length of not less than 13 mm. and not more than 18 mm. The points shall be sharp and cut at an angle not greater than 35° to the axis of the wire forming the barb.

5. *Freedom from defects* :

5.1. The line and point wires shall be circular in section, free from scales and other defects and shall be uniformly galvanized.

5.2. The line wire shall be in continuous lengths, and shall not contain any welds other than those in the rod before it is drawn. The distance between successi ve, splices shall not be less than 15 metres.

EXTRACT FROM I.S. 1038 - 1968.

4. *Standard sizes, tolerances and designations* :

4.1. *Sizes* : The types and the overall sizes of steel doors, window and ventilators shall be as given in Figure 2.

4.1.1. The dimensions shown in fig. 2 are overall heights and widths to the outside of frames of steel doors, windows and ventilator. These sizes are derived after allowing 3 mm. clearance on all the four sides for the purposes of fitting the doors, windows or ventilators into modular openings (*see* Fig. 3).

4.2. *Tolerance* : The sizes indicated in Fig. 2, for door, window or ventilator frames shall not very by more than ± 1.5 mm.

4.3. *Designation* : Doors, windows and ventilators shall be designated by symbols denoting their width, type and height in succession in the following manner.:—

(*a*) *Width* : It shall be indicated by the number of modules in the width of opening.

(*b*) *Type* : It shall be indicated by the following letters of alphabet :

C Centre hung shutter,

F Fixed glass panes,

H With horizontal glazing bars.

N Without horizontal glazing bars.

S Side hung shutters, and

T Top hung shutters.

(*c*) *Height* : It shall be indicated by the number of module in the height of opening.

Example : A window of a width of 10 modules (99.4 cm.) and height 12 modules (119.4 cm) having horizontal glazing bars and side hung shutters is designated by 10HS 12.

4.3.1. Composite doors, windows or ventilators shall be designated in the following manner: —

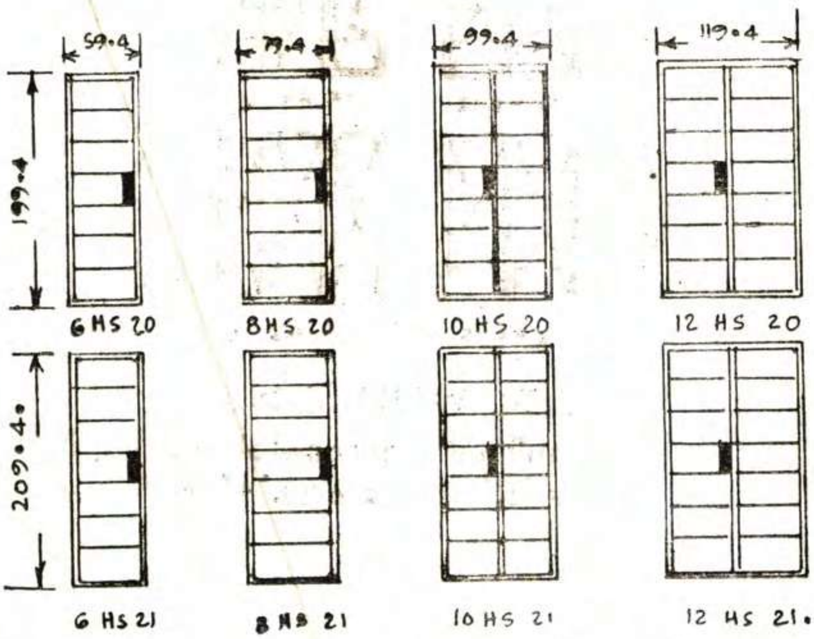
(*a*) A 12 module wide and 21 module high horizontally glazed side hung door coupled on its two sides with two side hung horizontally glazed windows, 6 modules wide and 12 module high is designated by 6 HS 12/12HS 21/6 HS 12.

(*b*) Two 10 module wide and 12 module high horizontally glazed side hung windows coupled side by side with two fixed glass pane ventilators at top, each 10 module wide and 6 module high, is designated by

10 HP 6/10HF 6

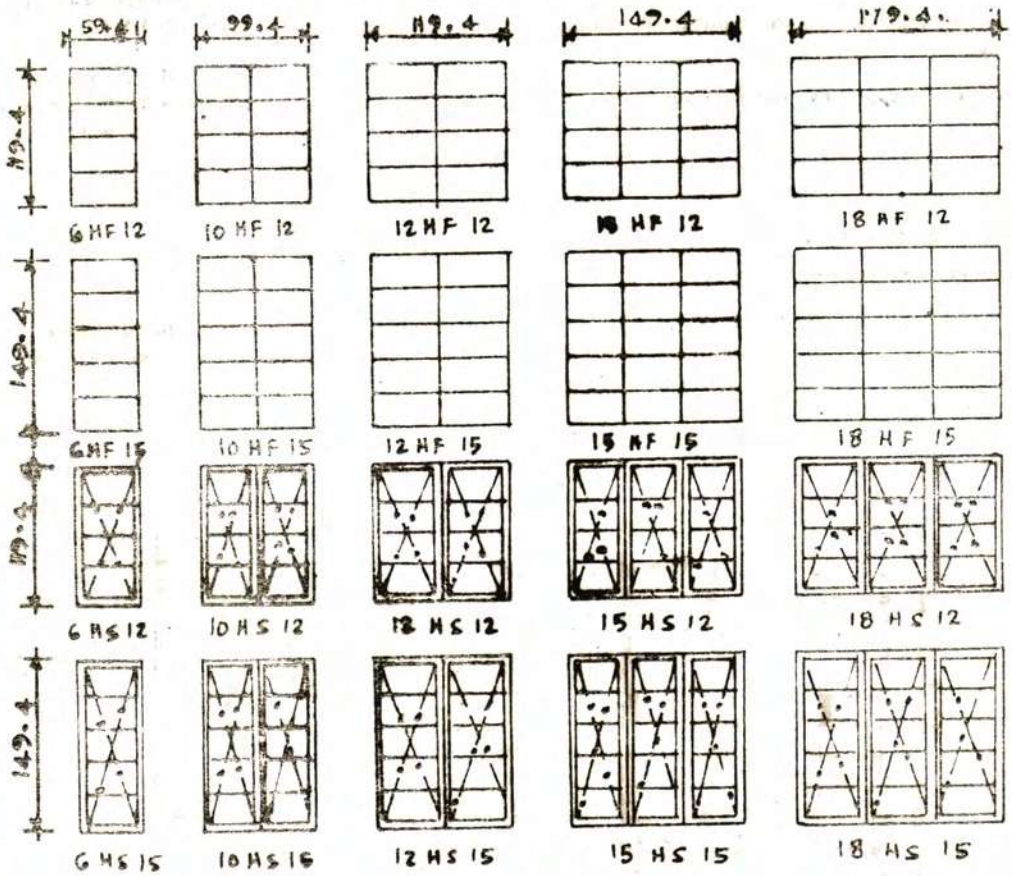
10HS 12/10 HS 12

4.4. The purchaser shall supply the information as given in Appendix A while placing order for steel doors, windows and ventilators.



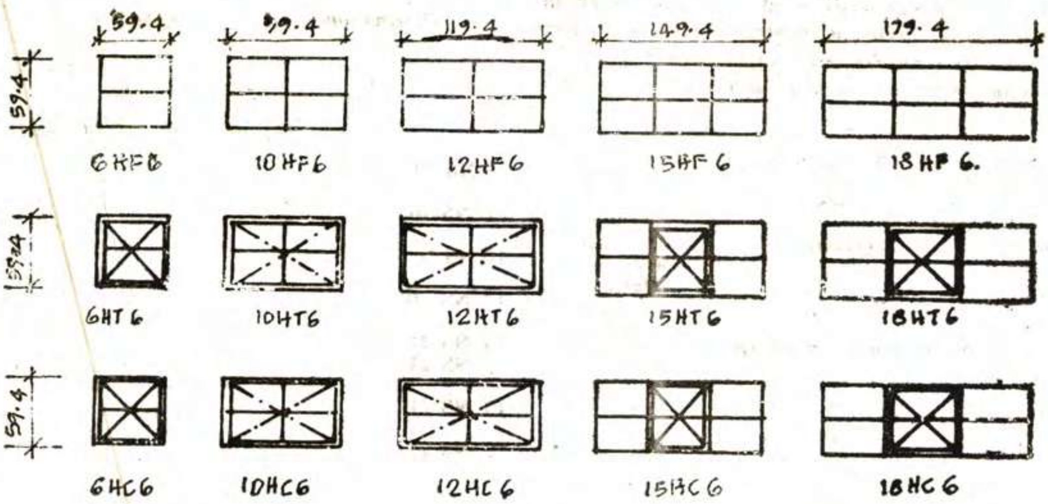
2 A DOORS.

466-3A—11A



2B WINDOWS

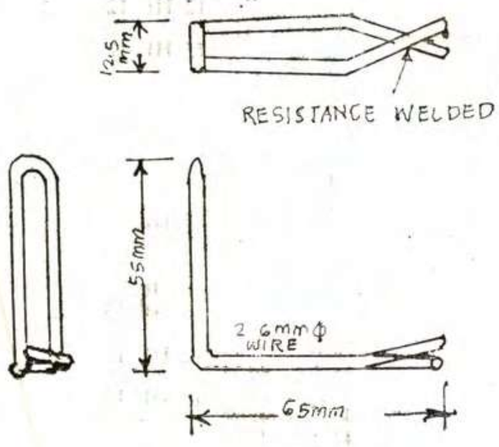
note : windows without horizontal glazing bars shall be designated 'N' in place of 'H' in its range shown



2.C. VENTILATORS

(ALL DIMENSIONS IN CENTIMETRES)

TYPE AND SIZE OF STEEL DOORS, WINDOWS AND VENTILATORS



WIRE LUG

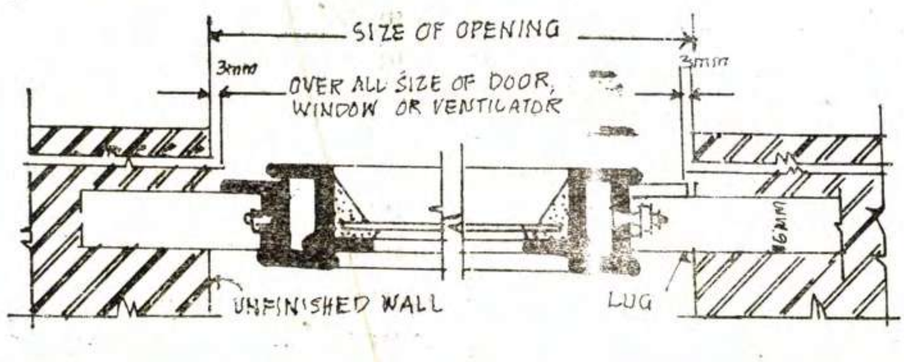


FIG.3 SIZE OF STEEL DOORS, WINDOWS OR VENTILATORS IN RELATION TO SIZE OF OPENING

5.3. *Glass panes.*—Glass panes shall weigh at least 7.5 **kg./m** and shall be free from flaws, specks or bubbles. All glass panes shall have properly squared corners and straight edges. The sizes of glass panes for doors, windows and ventilators shall be as given in Table 1.

TABLE 1—GLASS SIZES (Clearance Allowed)

(*Clauses* 5.3 *and* 9.1.1)

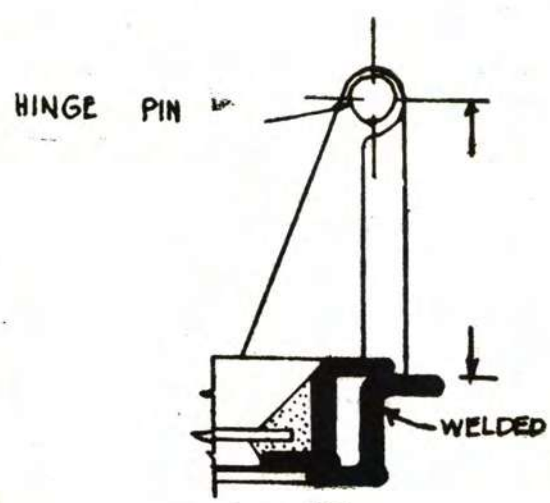
Designation.	*Quantity.*	*Glass size (width × Height).*
(1)	(2)	(3)
	No. glazing bar fixed type.	
6 NF 6	1 ..	55 × 55
10 NF 6	2 ..	46 × 55
12 NF 6	2 ..	56 × 55
15 NF 6	2 ..	46 × 55
	1 ..	48 × 55
18 NF 6	2	56 × 55
	1 ..	58 × 55
6 NF 12 ..	1 ..	55 × 115
10 NF 12	2 ..	46 × 115
12 NF 12	2 ..	56 × 115
15 NF 12	2 ..	46 × 115
	1 ..	48 × 115
18 NF 12	2 ..	56 × 115
	1 ..	58 × 115
6 NF 15	1 ..	55 × 145
10 NF 15	2 ..	46 × 145
12 NF 15	2 ..	56 × 145
15 NF 15	2 ..	46 × 145
	1 ..	48 × 145
18 NF 15	2 ..	56 × 145
	1 ..	58 × 145
	No glazing bar top hung type	
6 NT 6	1 ..	52 × 52
10 NT 6	2 ..	45 × 52
12 NT 6	2 ..	55 × 52
15 NT 6	2 ..	45 × 52
	1 ..	46 × 52
18 NT 6	2 ..	55 × 52
	1 ..	56 × 52
6 NC 6	1 ..	48.0 × 48
10 NC 6	2 ..	43.5 × 48
12 NC 6	2 ..	53.5 × 48
15 NC 6	2 ..	43.5 × 48
	1 ..	42.0 × 48
18 NC 6	2 ..	53.5 × 48
		52.0 × 48
	No. Glazing bar side hung type—cont.	
6 NS 12	1 ..	52·0 × 112
10 NS 12	2 ..	44.5 × 112
12 NS 12	2 ..	54.5 × 112
15 NS 12	2 ..	44.5 × 112
	1 ..	48.5 × 112
18 NS 12	2 ..	54.5 × 112
	1 ..	58.5 × 112
6 NS 15	1 ..	52.0 × 142
10 NS 15	2 ..	44.5 × 142
12 NS 15	2 ..	54.5 × 142
15 NS 15	2 ..	44.5 × 142
	1 ..	48.5 × 142
18 NS 15	2 ..	54.5 × 142
	1 ..	58.5 × 142

Designation.	*Quantity.*	*Glass size (width × Height).*
(1)	(2)	(3)
	No Glazing bar side hung type—cont.	
6 NS 20	1 ..	52.0 × 192
8 NS 20	1 ..	72.0 × 192
10 NS 20	2 ..	44.5 × 192
12 NS 20	2 ..	54.5 × 192
6 NS 21	1 ..	52.0 × 202
8 NS 21	1 ..	72.0 × 202
10 NS 21	2 ..	44.5 × 202
12 NS 21	2	54.5 × 202
	Horizontal glazing bar fixed type	
6 HF 6	2 ..	56 × 27
10 HF 6	4 ..	46 × 27
12 HF 6	4 ..	56 × 27
15 HF 6	6 ..	46 × 27
18 HF 6	6 ..	56 × 27
6 HF 12	4 ..	55 × 27
10 HF 12	8 ..	45 × 27
12 HF 12	8 ..	55 × 27
15 HF 12	8 ..	45 × 27
	4 ..	47 × 27
	Horizontal glazing bar fixed type.	
18 HF 12	8 ..	55 × 27
	4 ..	57 × 27
6 HF 15	5 ..	55 × 27
10 HF 15	10 ..	45 × 27
12 HF 15	10 ..	55 × 27
15 HF 15	10 ..	45 × 27
	5 ..	47 × 27
18 HF 15	10 ..	55 × 27
	5 ..	57 × 27
6 HF 20	6 ..	53 × 30
6 HF 21	6 ..	53 × 32
	Horizontal glazing bar top hung type.	
6 HT 6	2 ..	50 × 25
10 HT 6	4 ..	44 × 25
12 HT 6	4 ..	54 × 25
15 HT 6	4 ..	46 × 26
	2 ..	44 × 25
18 HT 6	4 ..	56 × 26
	2 ..	54 ×

Designation. (1)	Quantity. (2)	Glass size (width × Height). (3)
Horizontal glazing bar side hung type.		
6 HS 12	2 ..	50 × 25
	2 ..	50 × 27
10 HS 12	4 ..	44 × 25
	4 ..	44 × 27
12 HS 12	4 ..	54 × 25
	4 ..	54 × 27
15 HS 12	4 ..	44 × 25
	4 ..	44 × 27
	4 ..	47 × 27
18 HS 12	4 ..	54 × 25
	4 ..	54 × 27
	4 ..	58 × 27
6 HS 15	5 ..	50 × 27
10 HS 15	8 ..	44 × 27
	2 ..	44 × 29
12 HS 15	8 ..	54 × 27
	2 ..	54 × 29
15 HS 15	8 ..	44 × 27
	2 ..	44 × 29
	5 ..	47 × 27
18 HS 15	8 ..	54 × 27
	..	54 × 29
	5 ..	57 × 27
6 HS 20	1 ..	48 × 24
	4 ..	48 × 26
	1 ..	38 × 26

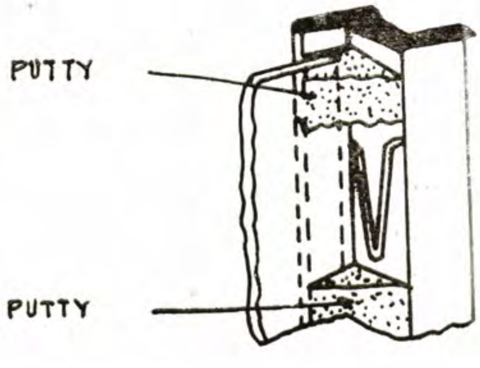
Designation. (1)	Quantity. (2)	Glass size (width × Height). (3)
Horizontal glazing bar side hung type—cont.		
8 HS 20 ..	1 ..	58 × 24
	4 ..	58 × 26
	1 ..	58 × 26
10 HS 20	2 ..	45 × 24
	9 ..	45 × 26
	1 ..	35 × 26
12 HS 20	2 ..	55 × 24
	9 ..	55 × 26
	1 ..	45 × 26
6 HS 21	1 ..	48 × 26
	4 ..	48 × 28
	1 ..	38 × 28
8 HS 21	1	68 × 26
	4 ..	68 × 28
	1 ..	58 × 28
10 HS 21	2 ..	45 × 26
	9 ..	45 × 28
	1 ..	35 × 28
12 HS 21 ..	2 ..	55 × 26
	9 ..	55 × 26
	1 ..	45 × 28 t

6.2 *Side hung shutter.*—For fixing steel hinges, slots shall be cu in the fixed frame and the hinges inserted inside and welded to the frame. The hinges shall be normally of the projecting type and not less than 65 mm. and not more than 75 mm. wide (*see* Fig. 31). The hinge pin shall be of electro-galvanized steel or aluminium alloy 51 S-WP of suitable thickness.



TYPICAL PROJECTING TYPE HINGE FOR SIDE HUNG SHUTTER

* Windows and ventilators without horizantol glazing bars



GLAZING CLIPS

8. *Finish* :

8.1. Doors, windows or composite units shall be either hot-dip galvanized or painted. All the steel surfaces shall be thoroughly cleaned free of rust, mill-scale dirt, oil, etc., either by mechanical means, for example, sand or shot blasting or by chemical means for example, pickling and then painted or hot-dip galvanized as may be agreed to between the purchaser and the manufacturer.

9. *Glazing* :

9.1. Glazing shall be provided on the outside of the frames.

9·1·1. If required, glazing clips (*See* **Fig. 32)** may be provided as **extra fittings by mutual arrangement between the purchaser and the supplier.**

Note 1.—**Glazing clips are usually not provided for normal size glass panes; where large size glass panes are required to be used or where the casement of the window is located in heavily exposed situation, holes for glazing clips will have to be drilled during fabrication.**

Note 2.—Where the pane size does not **exceed** 60×30 cm. glazing clips are not considered necessary. (For inside glazed windows for special use only two spring **glazing** clips per pane should be provided). In case of doors the glazing clips may be spaced according to the slots in the vertical members, provided the spacing does not exceed 30 cm. The quantity of glazing clips required per window for standard size windows will be as given in Table 1.

9.1.2. When agreed to between the purchaser and the supplier metal or wood glazing bead with screws or nails shall be supplied separately for holding the glass in postion. Use of metal or wood bead in place of putty glazing shall be specified when placing the **order.**

APPENDIX-A.

(*Clause* 4.4)

Information to be supplied by the purchaser while placing the order.

A-1. The purchaser shall furnish information to the manufacturer or the supplier in regard to the following points :—

(*a*) Type and size of door, window or composite unit quoting the designation as given in 4.3.

(*b*) Whether the units are to be fixed in brick masonry, stone masonry, concrete or steel;

(*c*) Type of hinges required, for example, whether projecting, non-projecting or friction type;

(*d*) Details of fittings required including couplings, weather bars, etc.;

(*e*) Whether the mullions and transomes are to be cut to suit masonry or steel work ;

(*f*) Whether removable fly-proof sereens are required ;

(*g*) Whether the shutters are required to be opened from inside or outside ;

(*h*) Type of finish to be provided conforming to the require. ments laid down in 8 ;

(*i*) Whether wood or metal bead is to be provided in place of putty glazing ; and

(*j*) Any other information.

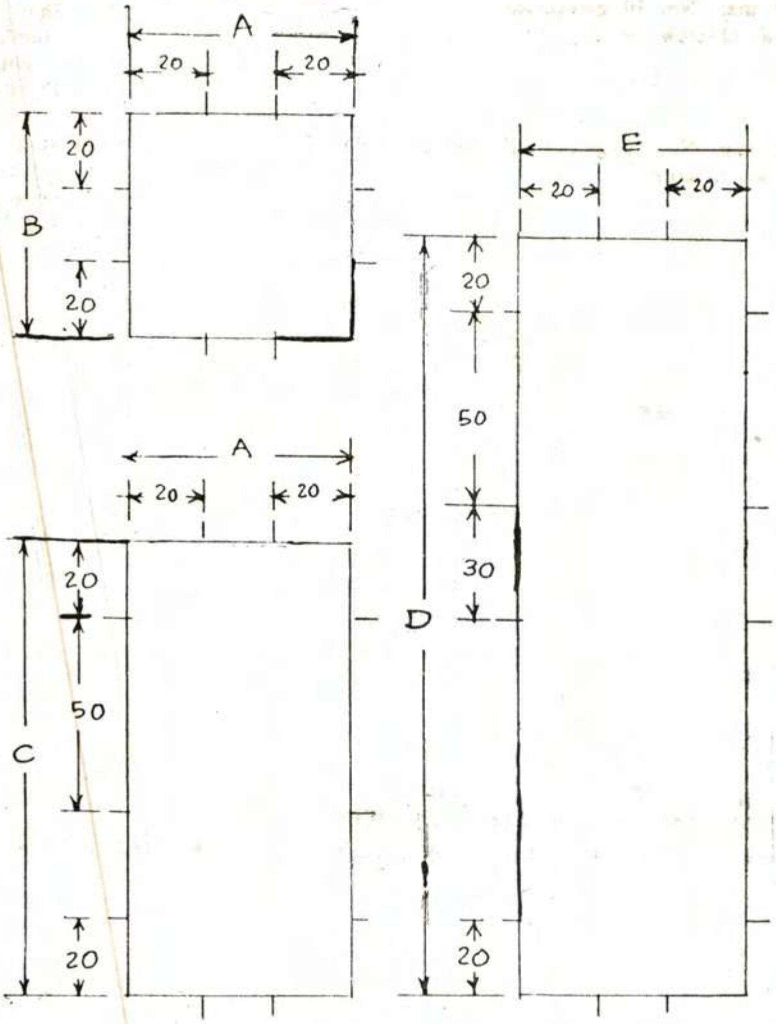
EXTRACT FROM I.S. 1038—1968

Standard specification for steel doors, windows and ventilators.

(First Revision).

7. *Position of holes, fixing screws and lugs.*—

7.1. Outer frames shall be provided with fixing holes centrally in the web of the section in positions indicated in Fig. 28. Additional holes are provided in certain types of doors and windows for manufacturing purposes but only the holes indicated in Fig. 28 are for us for fixing. Fixing lugs and fixing screws are to supplied for the quantities and for the **positions** shown in Fig. 28.



A 59.4, 99.4, 149.4 or 179.4.
B = 59.4
C = 119.4 or 149.4.
D = 199.4 or 209.4.
E = 59.4, 79.4, 99.4 or 119.4.
all measurements in centimetres

FIG. 28. CHART SHOWING APPROXIMATE POSITION OF FIXING HOLES AND NUMBER OF FIXING LUGS.

7.2. The fixing screws and lugs shall be as given in Table 2.

TABLE 2—FIXING SCREWS AND LUGS.

Serial number and place of fixing. (1)	*Size of the screw or lug.* (2)
(i) To wooden frames rebated on the outside.	38 mm. No. 10 galvanised wood screws (*see* Fig. 20).
(ii) To plugs in concrete work or brick work rebated on the outside.	Do.
(iii) To plugs in concrete work or brick work rebated on the outside (that is, plain or square jambs).	65 mm. No. 10 galvanized wood screws.
(iv) Direct to brick work or masonry (that is, plain or square jambs).	Slotted steel adjustable lugs (natural finish) not less than $70 \times 16 \times 3$ mm. countersunk galvanized machine screws and nuts 12×6 mm. (*see* Fig. 30).
(v) To steel work	Fixing clips and 8 mm. galvanized bolts and hexagonal nuts (*see* Fig. 31).

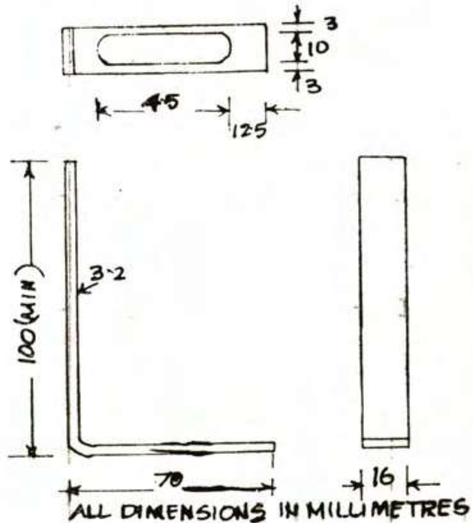


FIG 30. SLOTTED FIXING LUG FOR BRICK WORK AND MASONRY

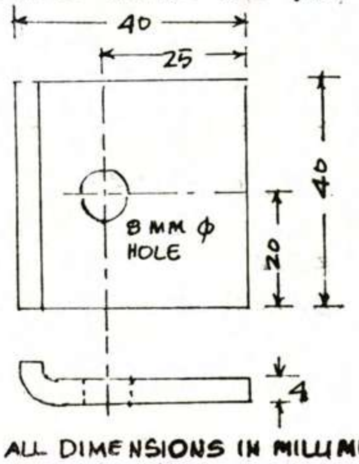


FIG 31. FIXING CLIP FOR STEELWORK

IS 1038-1968

EXTRACT FROM I.S. 1200 (Part VIII) 1967.

Miscellaneous.

8.6. Steel doors and windows shall be given in square metres, stating the sizes of various members and shall be fully described.

8.6.1. The method of fixing and hanging and fastenings shall be included with the item.

8.6.2. Any protective treatment required to be applied at manufacturer's works, such as painting and hot dip galvanizing shall be described.

(I.S. : 1948—1961).

SPECIFICATION FOR ALUMINIUM DOORS, WINDOWS AND VENTILATORS.

4. *Standard sizes, Tolerances and Designations* :

4·1. *Sizes.*—The types and the overall sizes of aluminium doors, windows and ventilators shall be as given in Fig. 3.

4·1·1. The dimensions shown are overall heights and widths to the outside of frames of aluminium doors, windows and ventilators. These sizes are derived after allowing 1·25 cm. clearance on all the four sides for the purpose of fitting the doors, windows or ventilators into modular openings (*See* Fig. 4).

4·2. *Tolerances.*—The sizes for door, window or ventilator frames shall not vary by more than ±1·5 mm

4.3. *Designation.*—Doors, windows and ventilators shall be designated by symbols denoting their width, type and height in succession in the following manner :

(*a*) *Width*—It shall be indicated by the number of modules in the width of opening.

(*b*) *Type.*—It shall be indicated by the following letters of alphabet :

C—Centre hung shutters;

F—Fixed glass panes;

H—With horizontal glazing bars;

N—Without horizontal glazing bars;

S—Side-hung shutters ; and

T—Top-hung shutters.

(*c*) *Height.*—It shall be indicated by the number of modules in the height of opening.

Examples.—A window of a width of 10 modules (97·5 cm.) and height 9 modules (87·5 cm.) having horizontal glazing bars and side-hung shutters is designated by 10 HS 9.

4·3·1. Composite doors, windows or ventilators shall be designated in the following manner :

(*a*) A 12 module wide and 21 module high horizontally glazed side-hung door coupled on its two sides with two-side-hung horizontally glazed windows 6 module wide and 12 module high is designated by 6 HS 12/12HS21/6HS12.

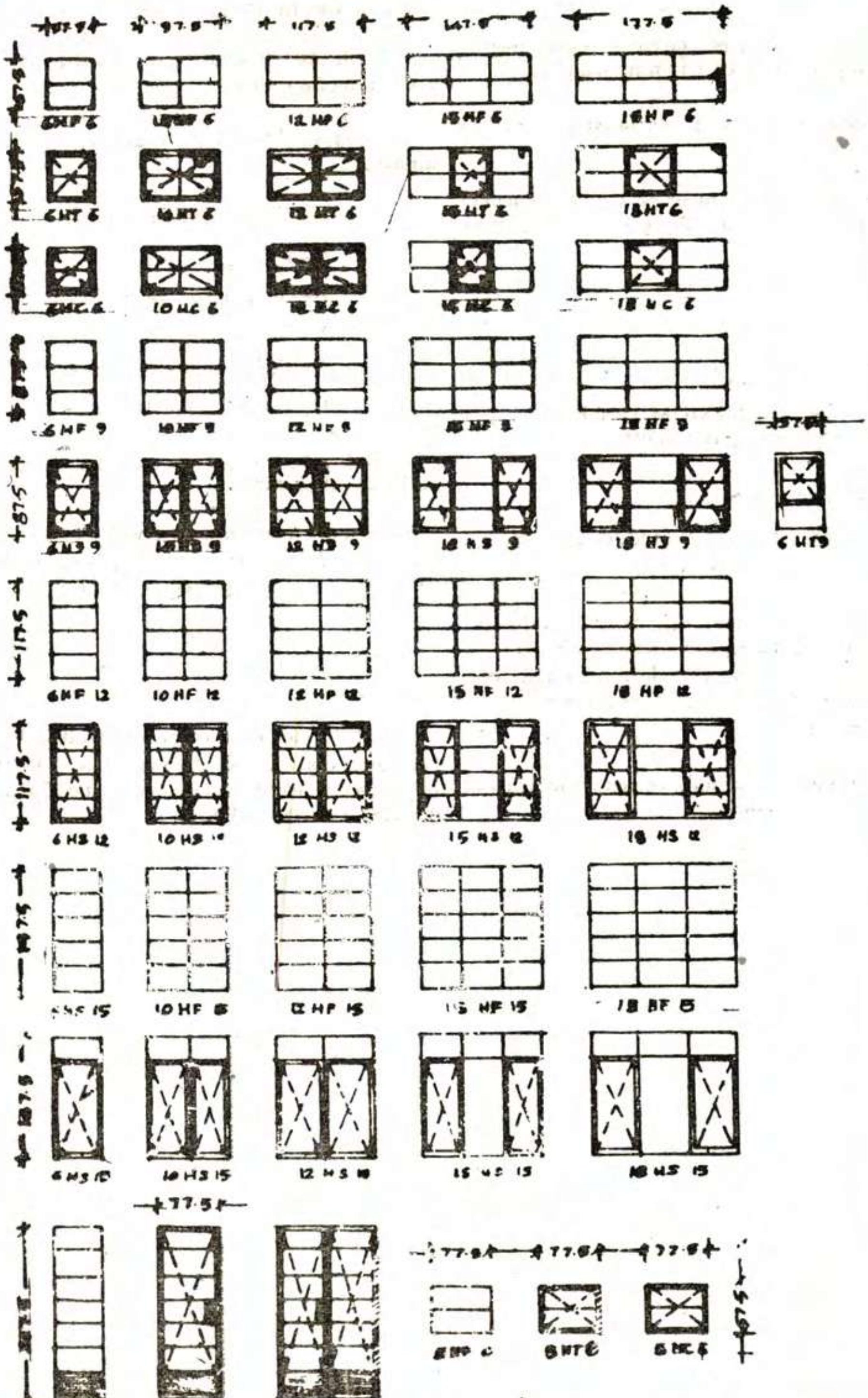


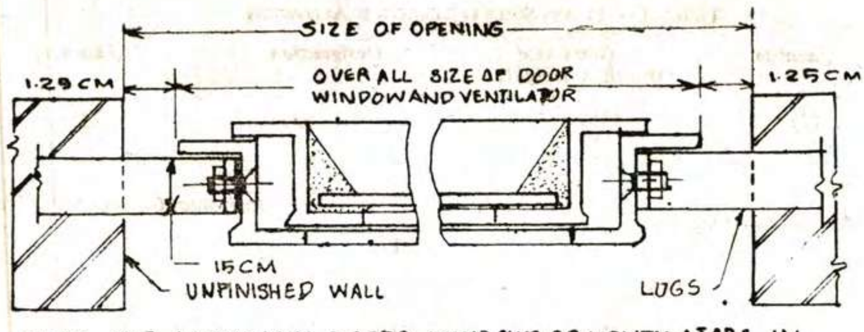
FIG 3

TYPES AND SIZE OF ALUMINIUM DOORS, WINDOWS AND VENTILATORS

NOTE 1 windows without horizontal glazing bars shall be designated by 'N' in place of 'H' in the range shown

NOTE 2 doors and side lights shall be only coupled with 12 module (117.5 cm) high window

ALL DIMENSIONS ARE IN CM.



SIZE OF ALUMINIUM DOORS, WINDOWS OR VENTILATORS IN RELATION TO SIZE OF OPENING

(*b*) Two 10 module wide and 12 module high horizontally glazed side-hung windows coupled side by side with two fixed glass pane ventilators at top each 10 module wide and 6 module high is designated by

$$\frac{10\ HF\ 6/10HF\ 6}{10\ HS\ 12/10HS\ 12}$$

5. *Materials.*

5·1. *Aluminium Alloy Extruded Sections* :

5·1·1. Aluminium alloy used in the manufacture of extruded window sections shall correspond to I.S. Designation HE9—WP of I.S. : 733—1956. Specification for Wrought Aluminium and Aluminium alloys, Bars, Rods and Sections (For General Engineering Purposes).

5.3. *Glass panes.*—Glass panes shall weigh at least 7.5 kg/M² and shall be free from flaws, specks, or bubbles : All panes shal have properly squared corners and straight edges. The sizes of the glass panes for use in doors, windows and ventilators shall be as given in Table I.

TABLE I—.GLASS SIZES (CLEARENCE ALLOWED).

(*Clause* 5·3.)

Designation. (1)	*Quantity.* (2)	*Glass size Width × Height.* (3) CM.
	No Glazing Bar—Fixed Type.	
6NF6	1	53·0×53·0
10NF6	2	45·0×53·0
12NF6	2	55·0×53·0
15NF6	2 1	45·0×53·0 47·5×53·0
18NF6	2 1	55·0×53·0 57·5×53·0
6NF9	1	53·0×83·0
10NF9	2	45·0×83·0
12NF9	2	55·0×83·0
15NF9	2 1	45·0×83·0 47·5×83·0
18NF9	2 1	55·0×83·0 57·5×83·0
	No Glazing Bar Fixed Type	
6NF12	1	53·0×113·0
10NF12	2	45·0×113·0
12NF12	2	55·0×113·0
15NF12	2 1	45·0×113·0 47·5×113·0
18NF12	2 1	55·0×113·0 57·5×113·0
6NF15	1 1	53·0×27·0 53·0×113·0
10NF15	2 2	45·0×27·0 45·0×113·0
12NF15 .. .	2 2	55·0×27·0 55·0×113·0
15NF15	2 1 2 1	45·0×27·0 47·5×27·0 45·0×113·0 47·5×113·0
18NF15	2 1 2 1	55·0×27·0 57·5×27·0 55·0×113·0 57·5×113·0
8NF6	1	73·0×53·0
6NF21	1 1 1	53·0×84·5 53·0×27·5 53·0×56·0
	No Glazing Bar Top-Hung Type.	
6NT6	1	50·0×50·0
10NT6	2	44·5×50·0
12NT6	2	54·5×50·0
15NT6	2 1	45·0×53·0 45·5×50·0
18NT6	2 1	55·0×53·0 54·5×50·0
8NT6	1	70·0×50·0
6NT9	1 1	50·0×51·5 53·0×27·5

TABLE I— GLASS SIZES (CLEARENCE ALLOWED)

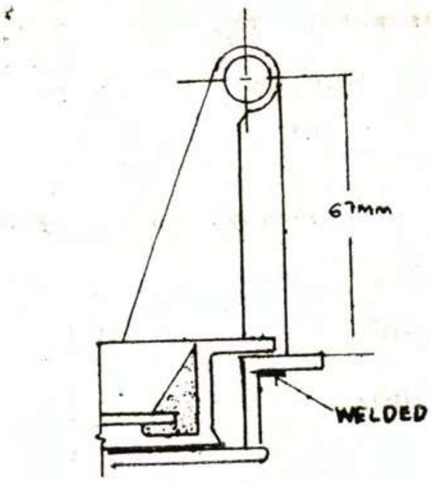
Designation	Quantity	Glass Size Width × Height.
(1)	(2)	(3)
		CM.
No Glazing Bar Centre-Hung Type.		
6NC6	1	46·0×46·0
10NC6	2	42·5×46·0
12NC6	2	52·5×46·0
15NC6	2	45·0×53·0
	1	43·5×46·0
18NC6	2	55·0×53·0
	1	53·5×46·0
8NC6	1	66·0×46·0
No Glazing Bar Side-Hung Type.		
6NS9	1	50·0 ×80·0
10NS9	2	43·5×80·0
12NS9	2	52·5×80·0
15NS9	2	43·5×80·0
	1	47·5×83·0
18NS9	2	52·5×80·0
	1	57·5×83·0
6NS12	1	50·0×110·0
10NS12	2	53·5×110·0
12NS12	2	52·5×110·0
15NS12	2	43·5×110·0
15NS12	1	47.5×113.0
18NS12	2	52·5×110·0
	1	57·5×113·0
6NS15	1	53·0×27·0
	1	50·0×110·0
10NS15	2	45·0×27·0
	2	43·5×110·0
12NS15	2	55·0×27·0
	2	52·5×110·0
15NS15	2	45·0×27·0
	1	47·5×27·0
	2	43·5×110·0
	1	47·5×113·0
18NS15	2	55·0×27·0
	1	57·5×27·0
	2	52·5×110·0
	1	57·5×113·0
8NS21	1	66·0×81·0
	1	56·0×27·5
	1	66·0×56·0
12S21	2	50·5×81·0
	2	50·5×56·0
	1	50·5×27·5
	1	40·5×27·5

Designation.	Quantity.	Class Size Width × Height.
(1)	(2)	(3)
		CM.
Horizontal Glazing Bar–Fixed Type.		
6HF6	2	53·0×26·0
10HF6	4	45·0×26·0
12HF6	4	55·0×26·0
15HF6	4	45·0×26·0
	2	47·5×26·0
18HF6	4	55·0×26·0
	2	57·5×26·0
6HF9	2	53·0×27·5
	1	53·0×26·0
10HF9	4	45·0×27·5
	2	45·0×26·0
12HF9	4	55·0×27·5
	2	55·0×26·0
15HF9	4	45·0×27·5
	2	45·0×26·0
	2	47·5×27·5
	1	47·5×26·0
18HF9	4	55·0×27·5
	2	55·0×26·0
	2	57·5×27·5
	1	57·5×26·0
6HF12	4	53·0×27·5
10HF12..	8	45·0×27·5
12HF12..	8	55·0×27·5
15HF12..	8	45·0×27·5
	4	47·5×27·5
18HF12..	8	55·0×27·5
	4	57·5×27·5
6HF15	1	53·0×27·0
	4	53·0×27·5
		45·0×27·0
10HF15..	2	
	8	45·0×27·5
12HF15..	2	55·0×27·0
	8	55·0×27·5
15HF15..	2	45·0×27·0
	1	47·5×27·0
	8	45·0×27·5
	4	47·5×27·0
18HF15..	2	55·0×27·0
	1	57·5×27·0
	8	55·0×27·5
	4	57·5×27·5
8HF6	2	73·0×26·0
6HF21	6	53·0×27·5
Horizontal Glazing Bar top-hung Type.		
6HT6	2	50·0×24·5
10HT6	4	44·5×24·5
12HT6		54·5×2·5

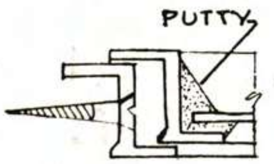
TABLE 1— GLASS SIZES (CLEARENCE ALLOWED.)

Designation. (1)	*Quantity.* (2)	*Glass Size Width × Height.* (3) CM.
Horisantal Glasing Bar top-hung Ty8e—cont.		
15HT6	4	45·0×26·0
	2	44·5×24·5
18HT6	4	55·0×26·0
	2	54·5×24·5
6HT9	1	50.0×26·0
	1	50·0×24·5
	1	53·0×27·5
8HT6	2	70·0×24·5
Horizontal Glazing Bar Centre hung type.		
6HC6	2	46·0×22·5
10HC6	4	42·5×22·5
12HC6	4	52·5×22·5
15HC6	4	45·0×26·0
	2	43·5×22·5
18HC6	4	55·0×26·0
	2	53·5×22·5
8HC6	2	66·0×22·5
Horizontal Glazing Bar side-hung type.		
6HS9	3	50·0×26·0
10HS9	6	43·5×26·0
12HS9	6	52·5×26·0
15HS9	6	43·5×26·00
	2	47·5×27·5
	1	47·5×26·0
18HS9	6	52·5×26·0
	2	57·5×27·5
	1	57·5×26·0

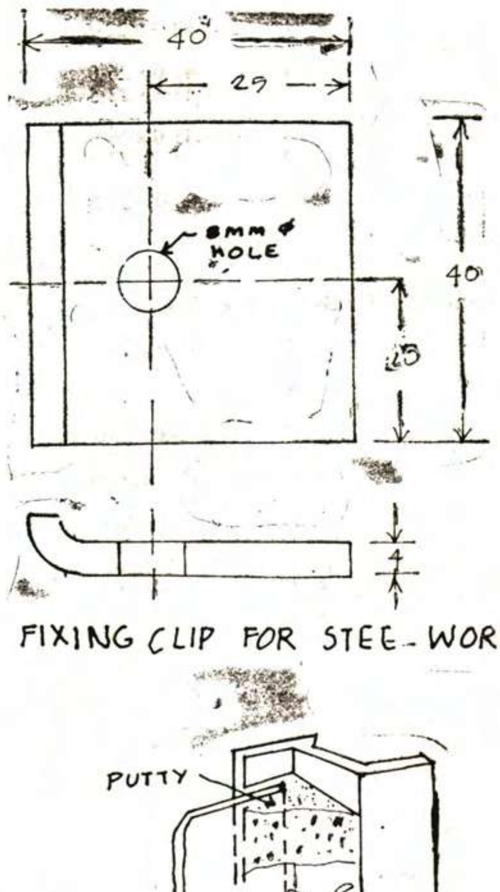
Designation. (1)	*Quantity.* (2)	*Glass Size Width × Height.* (3) CM.
Horisontal Glosing Bar top-hung Nype—cont.		
6HS12	2	50·0×26·0
	2	50·0×27·5
10HS12	4	43·5×26·0
	4	43·5×27·5
12HS12	4	52·5×26·0
	4	52·5×27·5
15HS12	4	43·5×26·0
	4	43·5×27·5
	4	47·5×27·5
18HS12	4	52·5×26·0
	4	52·5×27·5
	4	57·5×27·5
6HS15	1	53·0×27·0
	2	50·0×26·0
	2	50·0×27·5
10HS15	2	45·0×27·0
	4	43·5×26·0
	4	43·5×27·5
12HS15	2	55·0×27·0
	4	52·5×26·0
	4	52·5×27·5
15HS15	2	45·0×27·0
	1	47·5×27·0
	4	43·5×26·0
	4	43·5×27·5
	4	.7·5×27·5
18HS15	2	55·0×27·0
	1	57·5×27·0
	4	52·5×26·0
	4	52·5×27·5
	4	57·5×27·5
8HS21	1	66·0×24·0
	4	66·0×27·5
	1	56·0×27·5
12HS21	2	50·5×24·0
	9	50·5×27·5
	1	40·5×27·5



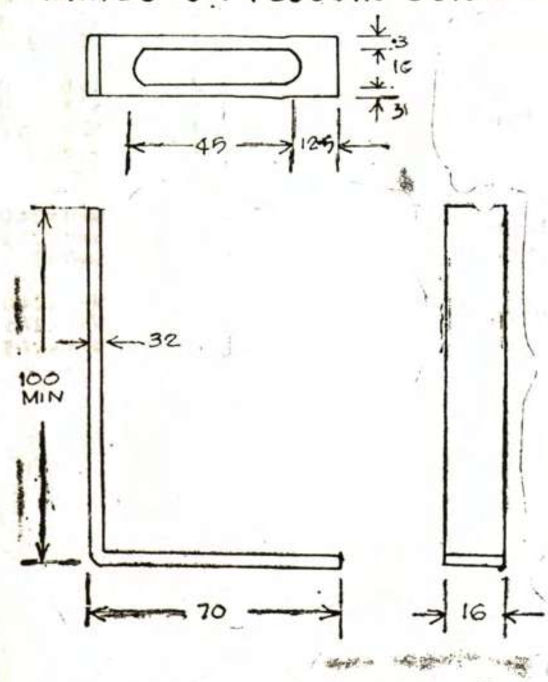
TYPICAL PROJECTING TYPE HINGE FOR SIDE HUNG SHUTTER



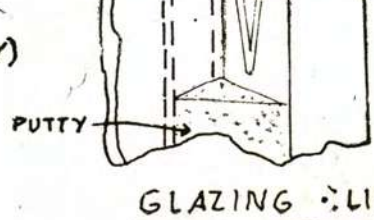
FIXING SCREW FOR WOODEN FRAMES OR PLUGSIN CONCRETE



FIXING CLIP FOR STEE-WORK



SLOTTED FIXING LUG
(FOR BRICKWORK AND MASONRY)



ALL DIMENSION IN MM

GLAZING CLIPS

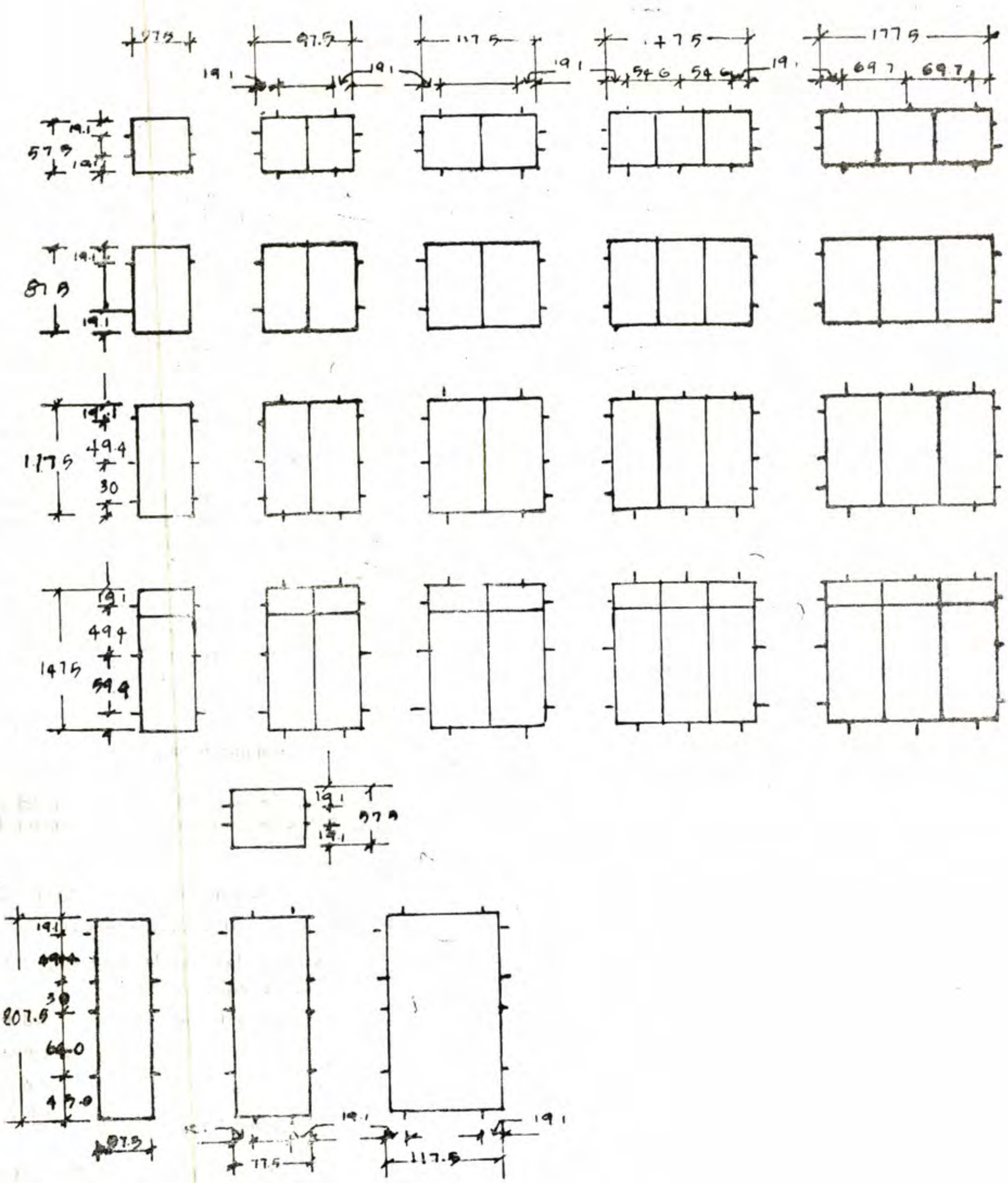


CHART SHOWING APPROXIMATE POSITIONS OF FIXING HOLES AND NUMBERS OF FIXING LUGS

ALL DIMENSIONS ARE IN CM

6·2. *Side Hung Shutters.*—For fixing aluminium alloy hinges slots shall be cut in the fixed frame and the hinges inserted inside and may be rivetted to the frame. The hinges shall normally be of the projecting type 67 mm. wide (*See* Fig. 14). The pins for hinges in case of non-oxidized work shall be of stainless-steel of non-magnese type of suitable aluminium alloy However, in the case of anodized work only suitable type of aluminium alloy for pins shall be used. Non-projecting types of hinges (*See* Fig. 15) may also be used, where agreed to between the purchaser and the vendor.

7. *Position of Bolts, Fixing Screws and lugs.*

7.1. Outer frames shall be provided with fixing holes centrally in the web of the sections in the position indicated in Fig. 31 (*See* 17) Moreover, any steel lugs coming in contract with aluminium should be either galvanized or given one coat of bituminous paint.

7·2. The fixing screws and lugs shall be as given in Table II.

TABLE II.—FIXING SCREWS AND LUGS.

Serial number.	*Place of fixing.*	*Size of screw or lug.*
(1)	(2)	(3)
(i)	To wooden frames rebated on the outside.	30 mm × No. 10 galvanized wood-screws (*See* Fig. 32).
(ii)	To plugs in concrete, stone or brick work rebated on the outside.	Do.
(iii)	To plugs in concrete, stone or brick work not rebated on the outside (that is plain or square jambs).	45 mm × No. 10 galvanized wood-screws.
(iv)	Direct to brick work or masonry (that is plain or square jambs).	Slotted steel adjustable lugs (natural finish) not less than 100 × 16 × 3 mm. counter-sunk galvanized machine screws and nuts 19·0 × 6·3 mm. (See Fig. 33.)
(v)	To steel work	Standard clips and 8 mm-galvanized bolts with hexagonal nuts (*see* Fig. 34).

8. *Finish.*

8·1. Aluminium doors, windows and ventilators may be supplied in either matt, scratch-brush or polished finish. They may, additionally, also be anodized, if so required by the purchaser. If colour-anodizing is to be done then only approved light-fast shades should be used.

8·2. A thick layer of clear transparent lacquer based on methacrilates or cellulose butyrate, shall be supplied on aluminium doors, windows and ventilators by the suppliers to protect the surface from wet cement during installation. This lacquer coating shall be removed after installation is completed.

9. *Glazing.*

9·1. Glazing shall be provided on the outside of the frames.

9·1·1. If required, glazing clips (*See* Fig. 35 on P. 18) may be provided as extra fittings by mutual arrangement between the purchaser and the supplier. Four glazing clips may be provided per glass pane, except for door type 8HS21 where the glazing clips shall be six per glass pane. In case of doors, windows and ventilators without horizontal glazing bars the glazing clips shall be spaced according to the slots in the vertical members otherwise, the spacing shall be 30 cm.

NOTE.—Glazing clips are not usually provided for normal size glass panes. Where large size glass panes are required to be used or where the door or the window is located in heavily exposed situation, holes for glazing clips have to be drilled prior to fabrication and can not be done at any later stage. Use of glazing clips, where necessary, shall be specified while placing the order.

EXTRACT FORM I.S. 1,200 (Part XIV) 1970.

3. *Measurement.*

3.1 Each pane of glass shall be measured to the nearest 0.5 cm. both in width and height.

3.2. Irregular shaped or circular panes shall be measured as the smallest rectangular area from which the irregular or circular pane can be cut, Irregular panes shall be measured separately and described as irregular shapes (measured square).

3.2.1. All cutting on glass and glazing sheets (Other than straight cutting on sheet glass) shall be described and measured separately in running metres. Straight cutting on sheet glass shall not be measured separately but included in the description of item.

3.2.2. Circular cutting on all types of glass and glazing sheets, shall be measured in running metres.

3.3. All glazing shall be measured in square metres and grouped according to the following categories, stating the nominal thickness :

(*a*) Sheet glass—

(i) Squares not exceeding 0.5 sq.m. in each pane, and

(ii) Squares exceeding 0.5 sq.m. in each pane.

(*b*) Glasses other than glass and glazing sheets:—

(i) Squares not exceeding 0.5 sq.m.

(ii) Squares exceeding 0.5 sq.m. but not exceeding 0.75 sq.m.

(iii) Squares exceeding 0.75 sq.m. but not exceeding 1.00 sq.m.,

(iv) Squares exceeding 1.00 sq.m. but not exceeding 1.5 sq.m and

(v) Squares exceeding 1.5 sq.m.

3.4. Glass and sheet louvres shall be described and enumerated.

3.5. Hacking out old broken glass and preparing for new glass shall be measured in square metres.

3.6. Holes drilled in glass and sheet shall be enumerated stating the diameter of the hole, type and thickness of the glass/sheet and size of the pane.

3.7. In the case of wired glass, the type designed or pattern of reinforcement shall be described.

3.8. Frosted glass be measured separately and described whether frosted on one or both sides.

3.9. Grinding, polishing and rounding off edges of glass or glazing sheet, if required, shall be described and measured in running metres

EXTRACT FORM I.S. 1634—1973.

Code of Practice for design and construction of Wood Stairs in Houses.

5.2. *Thickness of members.*—When the width of stairs is not more than 1.2 m. the finished thickness of the members shall be not less than the following :—

Members.	*Finished thickness.* mm.
(*a*) Tread	32
(*b*) Riser for —	
Wood	16
Plywood	9
(*c*) String	28

NOTE.—Where the width of staircase exceeds 1.2m. the thickness of treads and risers may be increased appropriately as required by design; or carriage and rough brackets may be used for additional support of the steps.

5.2.1. The other details shall be in accordance with 5.3.

5.3. *Treads, risers and strings.*—Treads and strings shall be of solid timber, and when of more than one piece in width they shall be joined with tongued and grooved joint. In joints like 'tongued and grooved' or 'mortice and tenon' where crevices are likely to occur, the surface of wood in both pieces that will remain hidden after 'joining' shall be treated with a suitable preservative; or the crevices shall be sealed with an approved meterial such as 'white lead compound' to prevent access to moisture. Each piece of timber shall be not less than 80 mm. wide on the finished face of the work. In a tread, the front piece on which the nosing is formed shall be no less than 90 mm. wide.

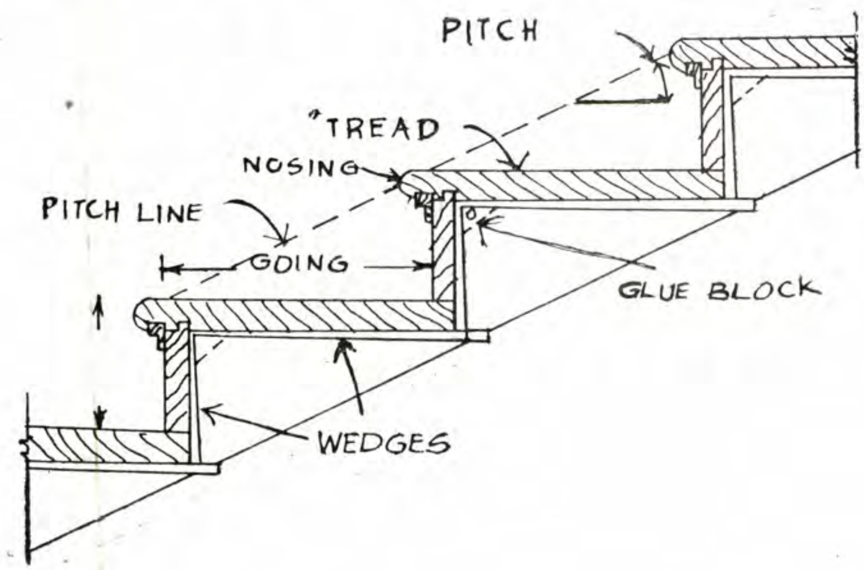
5.3.1. Risers shall be of solid timber or of plywood. The top of the risers shall be tongued and fitted, or their full thickness housed to a minimum depth of 6 mm. into the underside of the treads.

5.3.2. Risers and treads shall be glue-blocked with angle blocks not less than 80 mm. long and 40 mm. wide glued in position. The spacing between glue blocks shall not be less than 250 mm.

5.3.3. The lower edges of risers shall be fixed to treads with No. 10 wood screws conforming to I.S. 451-1961 at intervals not exceeding 250 mm. The length of screws shall be atleast equal to twice the thickness of the materials through which they are fixed, and in any case not less than 32 mm.

5.3.4. In the case of close strings, the treads and risers shall be housed to a depth of not less than 15 mm. into tapered housings in the strings and securely wedged and glued (see Fig. 2).

5.3.5. Strings shall be of not less than 250 mm. in nominal depth. They shall be tenoned and prepared for pinning to newels where these occur. The tenons shall be not less than 15 mm. thick and 50 mm long.



DETAILS OF TREAD AND RISER SHOWING ALSO THEIR FITTING INTO A CLOSE STRING

5.3.5.1. Tie rods connecting the strings at suitable intervals may be provided if considered necessary.

5.3.6. The curved portion of riser in the lower steps may be bull-nosed or semi-circular and shall be built from solid blocks dowelled, cross-tongued and glued as given in 5.4.

5.3.7. *Carriage Bearers.*—Where carriage bearers are used, they shall not be cut but the treads and risers shall be fixed on to them by means of small angle blocks or rough brackets. The size of the carriage bearers may be 50×180 mm. for a width of 1.4 m. and the size may be appropriately increased for larger widths in accordance with requirement of design. Where the width of staircase exceeds 2.4 m. two carriage bearers shall be provided.

5.4. *Shaped ends to Steps.*

5.4.1. Where a bull-nosed or similar shaped end to a riser is constructed with a block against which the ends of one or two straight parts of the riser about, the following details shall be satisfied. :—

(*a*) The grain of the block shall be horizontal. The faces of block and straight riser where they meet shall be flush with one another unless the design otherwise requires ;

(*b*) The meeting edges of block and straight riser on the face of the work shall form a closely fitted vertical joint; and

(*c*) The ends of block and straight riser shall be so fitted and fixed together by tonguing and grooving, rebating, blocking, gluing, nailing, screwing and/or other means, as to secure adequate strength and rigidity.

5.4.2. Where a bull-nosed, half round or similar shaped end is formed by cutting away material from the back of a solid riser to leave a veneer which can be bent to the required shape, the following details shall be satisfied ;

(*a*) The veneer shall be fitted with a solied backing block. The back of veneer and the face of the block shall be so prepared and fitted and glued together as to secure adequate adhesion over the whole area of the veneer; and

(*b*) The block shall be so fixed to the straight (unreduced) parts of the riser as to secure adequate strength and rigidity.

5.4.3. Where a riser with a bull-nosed, half round or similar shaped end is formed with thin plywood bent to shape during manufacture of the stairs the following details shall be satisfied :—

(*a*) The face of the complete riser shall consist of one piece of plywood or, alternatively, of a solid straight portion with plywood for the curved portion, and with plywood close jointed to the edge of the straight portion and properly secured to the solid backing; and

(*b*) The straight parts of the riser shall have solid backings not less than 20 mm. thick. The curved part of the riser shall be backed either with a solid block or with three shaped horizontal backing pieces each not less than 20 mm. thick. The various parts shall be so prepared, fitted and fixed together by gluing and screwing as to secure adequate strength and rigidity.

5.4.4. The top edge of every riser shall be housed or tongued into the underside of the tread as specified in 5.3 and shown in Fig. 2 laong the whole of the straight part of its face.

5.4.5. The shape of the front edge of the tread of any step, shall properly agree with that of the riser or otherwise satisfy the requirements of the design and the nosing shall be of proper section throughout.

5.4.6. Where so desired, wooden boarding may be fixed to the underside of the soffit tc give a flat appearance.

EXTRACT FORM I.S. 2721—1964.

3. *Dimensions.*

3.1. The dimensions of the chain link fences for different purposes shall be as given in Table I.

TABLE 1—CHAIN LINK FENCES—GENERAL CAARACTERISTICS.

Purpose.	Mesh.			Line Wire.		Height of pole.
	Width of roll.	Length of side.	Nominal Dia. of wire.	Number of wires.	Nominal Dia. of wire.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	m.	mm.	mm.		mm.	m.
Pigs ..	0.8	80	4.75	2	4.75	1.0
House garden fronts Division.	1.0	50	3.00	2	3.00	1.0
Rabits	1.5	30	1.80	2	3.00	1.0
Children's playgrounds.	1.2	20	3.00	2	3.00	1.0
General Agriculture.	1.2	50	3.00	2	3.00	1.0
Railways and General.	1.5	50	3.00	3	3.00	1.0
House garden flanks, playing fields, recreation grounds.	1.5	50	3.00	3	3.00	1.5
Highways	1.5	50	3.00	4	3.00	1.5
Railways	1.5	50	3.00	4	3.00	1.5
Commercial property.	2.0	50	3.00	4	3.00	2

NOTE.—Top line wire may be plain wire or barbed wire as required.

3.2. The steel posts (intermediate, straining and struts) for chain link fences shall be of appropriate dimensions; the angles usually being of the following dimensions :

a. 45 mm x 45 mm x 6 mm and

b. 45 mm x 45 mm x 4 mm.

3.3. *Tolerances.*—The mesh-wire shall not vary from the specified diameter by more than ±0.05 mm.

4. *Workmanship and Finish.*

4.1. Each roll shall be warranted to contain no weld joint or splice whatever. The wire shall be circular and shall be free from scale; irregularities, imperfections, flaws sand splits and other defects. The zinc coating shall be smooth, even and bright.

EXTRACT FROM I.S. 2300—1969.

Code of practice for the Protection of Buildings and Allied Structures against lightning (First Revision).

1. *Scope.*

1.1. This code covers design, installation, testing and maintenance of lightning protective systems for buildings including those designed for the storage of explosives and highly flammable materials, and allied structures, such as towers, chimneys, fences and hangars.

1.2. This code also deals with the precautions to be taken for personal safety during lightning.

1.3. Lightning protection of ships, aircrafts, underground mining installations, radio transmitting and receiving stations and electric traction is excluded from the scope of this code.

7. *Zone of protection.*

7.1. The zone of protection of a lightning conductor denotes the space within which a lightning conductor provides protection against a direct lightning stroke by diverting the stroke to itself. For a single vertical conductor this zone is described as a cone with its apex at the highest point of the conductor and with an angle, the so-called protective angle, between the side of the cone and the conductor to which different authorities have given different values depending on the degree of protection required. Experience has, however, shown that a conductor cannot be relied upon to provide complete protection within any particular zone. All that can be stated is that the protection afforded by a lightning conductor increases as the protective angle decreases.

7.2. In general, for the purpose of providing an acceptable degree of protection the protective angle of any single component part of an air termination net work, namely, either one vertical or one horizantal conductor is considered to be 45° (*See* Fig. 1 and 2. Between two or more vertical conductors of equal height spaced at a distance not exceeding twice their height, the equivalent protective angle within the space bounded by the conductors may be taken as 60° to the vertical, while the protective angle away from the conductor is still taken as 45° to the vertical (see Fig. 3 and 4).

7.3. Example of the protection of different types and shapes of building along with zone of protection provided by their lightning protective systems are given in A-1.

7.4. For structures requiring a higher degree of protection, such as explosive factories, stores and dumps and fuel tanks, other protective angles are chosen (*See* 14.2).

8. *Meterials and Dimensions.*

8.1. *Materials.*—The meterials of lightning conductors, down conductors, earth termination network, etc., of the protective system shall be reliably resistant to corrosion or be adequately protected against corrosion. The following materials are recommended:

8-1. (a) *Copper*: When solid or stranded copper wire or flat copper strips are used, they shall be of grade ordinarily required for commercial electrical work, generally designated as being of 98 per cent conductivity when annealed. They shall conformed to relevant Indian Standard Specifications.

(b) *Copper-Clad steel*: Where copper clad steel is used, the copper covering shall be permenantly and effectively welded to the steel core. The proportion of copper and steel shall be such that the conductence of the material is not less than 30 per cent of the conductance of solid copper of the same total cross-sectional area.

(c) *Galvanized steel*: Where steel is used it shall be thoroughly protected against corrosion by a zinc coating which will satisfactorily withstand the test specified in Appendix D. Copper is preferred to galvanized iron where corresive gases, industrial pollution or salt laden atmospheric conditions are encountered.

(d) *Aluminium*: Aluminium wire and strips are inereasingly finding favour for use as lightning conductors in view of the fact that aluminium has a conductivity almost double that of copper weight for weight. When used, it must be atleast 99 per. cent pure of sufficient mechanical strength and effectively protected against corrosion.

NOTE: Aluminium should not be used underground or in direct contact with walls.

(c) *Alloys*: Where alloys of metals are used they shall be substantially as resistant to corrosion as copper under similar conditions.

8.2. *Shapes and sizes*: The recommended shape and minimum sizes of conductors for use above ground and below ground are given in Table 1 and Table 2 respectively (*See* also A-2).

TABLE 2 :—SHAPES AND MINIMUM SIZE OF CONDUCTORS FOR USE ABOVE GROUND (Clause 8.2).

Serial number.	*Material and Shape.*	*Minimum Size.*
(1)	(2)	(3)
1	Round copper wire or copper clad steel wire.	6 mm diameter.
2	Stranded copper wire ..	50 mm 2 (or 7/3.00 mm diameter)
3	Copper strip	20 x 3 mm
4	Round galvanized iron wire	8 mm diameter.
5	Galvanized iron strip ..	20 x 3 mm
6	Round aluminium wire ..	9 mm diameter.
7	Aluminium strip ..	25 x 3.15 mm

TABLE 2 : SHAPES AND MINIMUM SIZES OF CONDUCTOR FOR USE BELOW GROUND (Clause 8.2).

Serial number.	*Meterial and shape.*	*Minimum Size.*
(1)	(2)	(3)
1	Round copper wire or copper clad steel wire.	8 mm diameter.
2	Copper strip	32 x 6 mm
3	Round galvanized iron wire	10 mm diameter.
4	Galvanized iron trip ..	32 x 6 mm.

8.3. *Corrosion*: Where corrosion due to atmospheric chemical electrolytic or other cause is likely to impair its any part of the lightning protective system suitable precautions be taken to prevent its occurrence. The contact of dissimilar metals is likely to initiate and accelerate corrosion unless the contact surfaces are kept completely dry and protected against the ingress of moisture.

8.3.1. Dissimilar metal contacts can exist where a conductor is held by fixing devices or against external metal surfaces. Corrosion can arise also where water passing over one metal comes into contact with another. Run-off water from copper, coppe alloys and lead can attack aluminium alloys and zinc. Thr metal of the lightning protective system should be compatible with the metal or metals used externally on the structure over which the system passed or with which it may make contact.

10. *Component parts and their installtion* :

10.0. The principal components of a lightning protective system are :

(a) Air terminations,
(b) Down conductors,
(c) Joints and bonds,
(d) Testing points,
(e) Earth terminations,
(f) Earth electrodes, and
(g) Fasteners.

10.1. For the purpose of lightning protection, the vertical and horizontal conductors are considered equivalent and the use of pointed air terminations or vertical finials is, therefore, not regarded as essential except when dictated by practical considerations. An air termination may consist of a vertical conductor as for a spire, a single horizantal conductor as on the ridge of a small dwelling or a system of horizontal and vertical conductors for the protection of bigger buildings.

10.1.1. A vertical air termination need not have more than on point and shall project at least 30 cm above the object, salient point or net work on which it is fixed.

10.1.2. Horizantal air terminations should be so interconnectets t at no part of the roof is more than 9 m away from the nearest horizantal conductor except that an additional 30 cm may be allowed for each 30 cm by which the part to be protected is below the nearest protective conductor. For a flat roof horizantal air termination along the outer perimeter of the roof are used. For a roof of building with larger horizontal dimensions a net work of parallel horizontal conductor should be installed as shown in Fig. 4.

NOTE : Salient points even it less than 9 m apart should each be provid with an air termination.

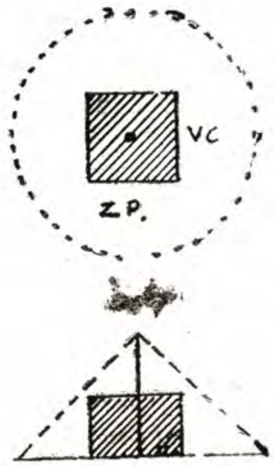


FIG 1. AIR TERMINATION CONSISTING OF A SINGLE VERTICAL CONDUCTOR

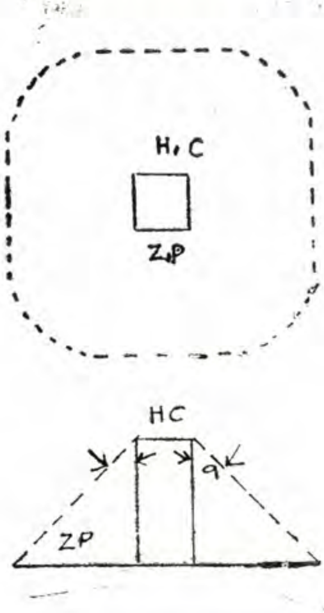


FIG 2. HORIZONTAL AIR TERMINATION

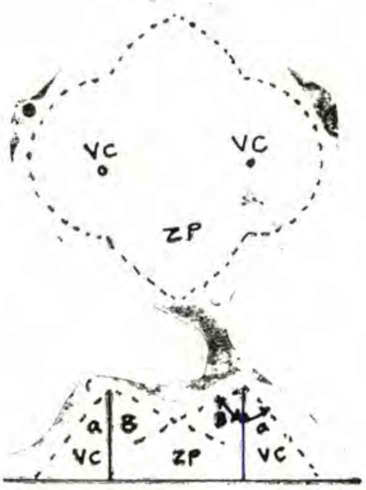


FIG. 3. ADJACENT VERTICAL CONDUCTORS SHOWING INCREASED ZONE OF PROTECTION BETWEEN CONDUCTORS

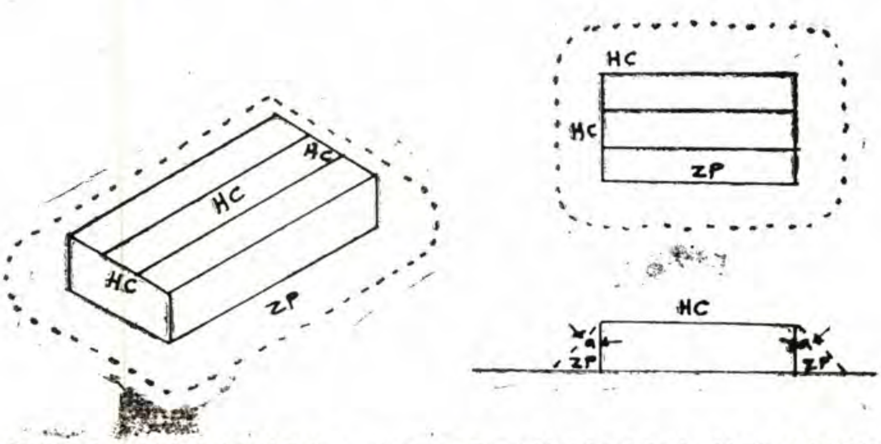


FIG. 4. HORIZONTAL AIR TERMINATION NET WORK ON A STRUCTURE WITH LARGE AREA ROOF

10.1.3. Horizontal air terminations should be coursed along contours, such as ridges, parapets and edges of flat roofs, and where necessary over flat surfacesin such way as to join each air termination to the rest and should themselves form a closed net work.

10.1.4. The layout of the network may be designed to suit the shape of the roof and architectural features of the building.

10.1.5. The air termination net work should cover all salient points of the structure.

10.1.6. All metallic finials, chimneys, dacts, vent pipes, railings, gutters and the like on or above the main surface of the roof of the structure shall be bonded to end form part of the air termination network. If portions of a structure very considerably in height, any necessary air termination or air termination network of the lower portion should in addition to their own conduct, be bonded to the down conductors of the taller portion.

10.1.7. All air terminals shall be effectively secured against overturning either by attachement to the object to be protected or by means of substantial braces and fixings which shall be permanently and rigidly attached to the building. The method and nature of the fixings should be simple, solid and permanent due attention being given to climatic conditions and possible corrosion.

10.2. *Down Conductors* : (*See* also A-3) The number and spacing of down conductors shall largely depend upon the size and shape of the building and upon aesthetic considerations. The minimum number of down conductors may however, be decided on the following considerations :—

(*a*) A structure having base area not exceeding 100 m^2 may have one down conductor only, if the height of the air termination provides sufficient protection. However, it is advisable to have at least two down conductions except for very small buildings.

(*b*) For structures having a base area exceeding 100 m^2, the number of down conductors required should be worked out as follows :—

(i) One for the first 100 m^2 plus one more for every additiona 300 m^2 or part thereof; or

(ii) One for every 30 m of perimeter.

The smaller of the two shall apply.

(*c*) For a structure exceeding 20 m in height additional consieration as given in 13.1 shall apply.

10.2.1. Down conductors should be distributed round the outside walls of the structure. They shall preferably be run along the corners and other projections, due consideration being given to the location of air terminations and earth terminations (*See* Fig. 5). Lift shafts shall not be used for fixing down conductors.

10.2.2. It is very important that the down conductors shall follow the most direct path possible between the air termination and the earth termination, avoiding sharp bends, upturns and kinks. Joints shall as far as possible be avoided in down conductors. Adequate protection may be provided to the conductors against mechanical damage. Metal pipes should not be used as protection for the conductors.

10.2.3. Metal pipes leading rainwater from the roof to the ground may be connected to the down conductors but cannot replace them. Such connections shall have disconnecting joints for testing purposes (*See* Fig. 5 F).

10.2.4. Where the provision of suitable external, routes for down conductors is impracticable or inadvisable, as in buildings of cantilever construction, from the first floor upwards down conductors may be used in an air space provided by a non-metallic non -conbustible internal duct (*See* A-3-3). Any covered recess not smaller than 75 mm x 15 mm or any vertical service duct running the full height of the building may be used for this purpose, provided it does not contain an unarmoured or non-metal sheathed cable.

10.2.5. Any extended metal running vertically through the structure should be bonded to the lightning conductor at the top of the bottom unless the clearance are in accordance with 12 for tall structures.

10.2.6. A structure on bare rock,should be provided with atleast two down conductors equally spaced.

10.2.7. In deciding on the routing of the down conductor, its accessibility for inspection, testing and maintenance should be taken into account.

10.3. *Joints and bonds*.

10.3.1. *Joints* : The lightning protective system shall have few joints in it as possible. In the down conductors below ground level there shall be no joints. Where joints are necessary they shall be mechanically and electrically effective and shall be so made as to exclude moisture completely. The joints may be clamped, screwed, bolted, crimped, riveted or welded. With overlapping joints the length of the overlap should not be less than 20 mm for all types of conductors. Contact surfaces should first be cleaned and then inhibited from oxidation with a suitable non-corrosive compound. Joints of dissimilar metals should be suitably protected against bi-metallic action and corrosion.

10.3.1.1 In general joints for strips shall be tinned, soldered, welded or brazed and at least double-riveted. Clamped or bolted joints shall only be used on the test points or on bonds to existing metals but joints forged may be of the clamped over screwed type.

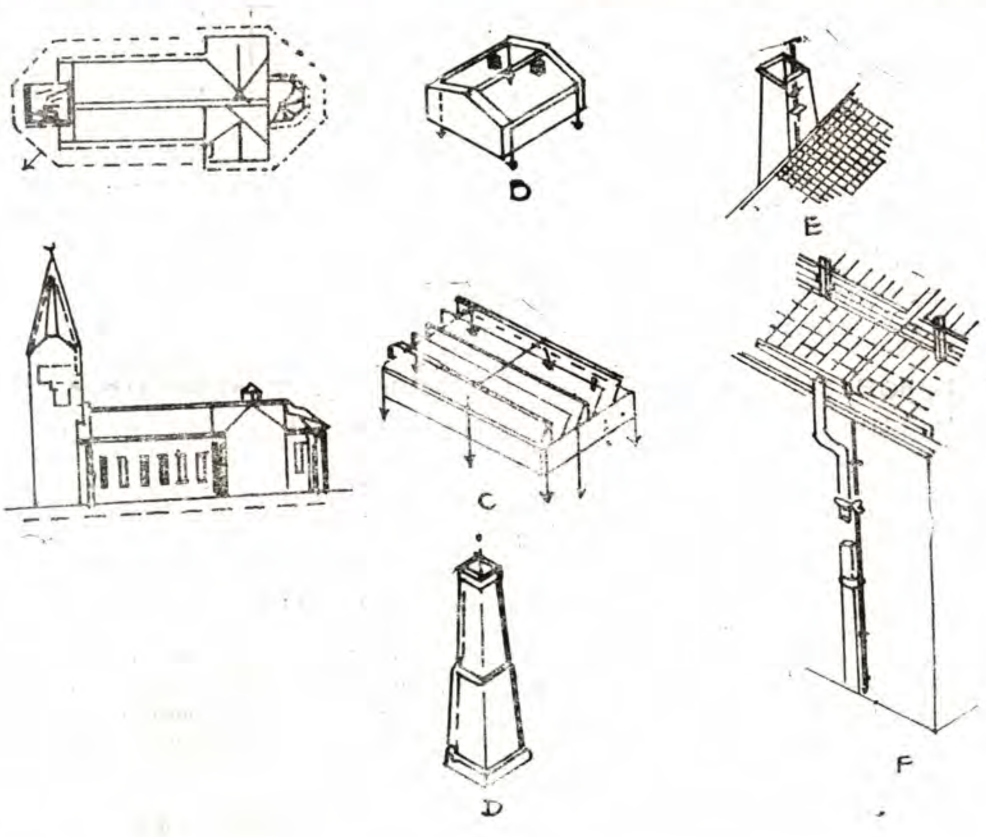
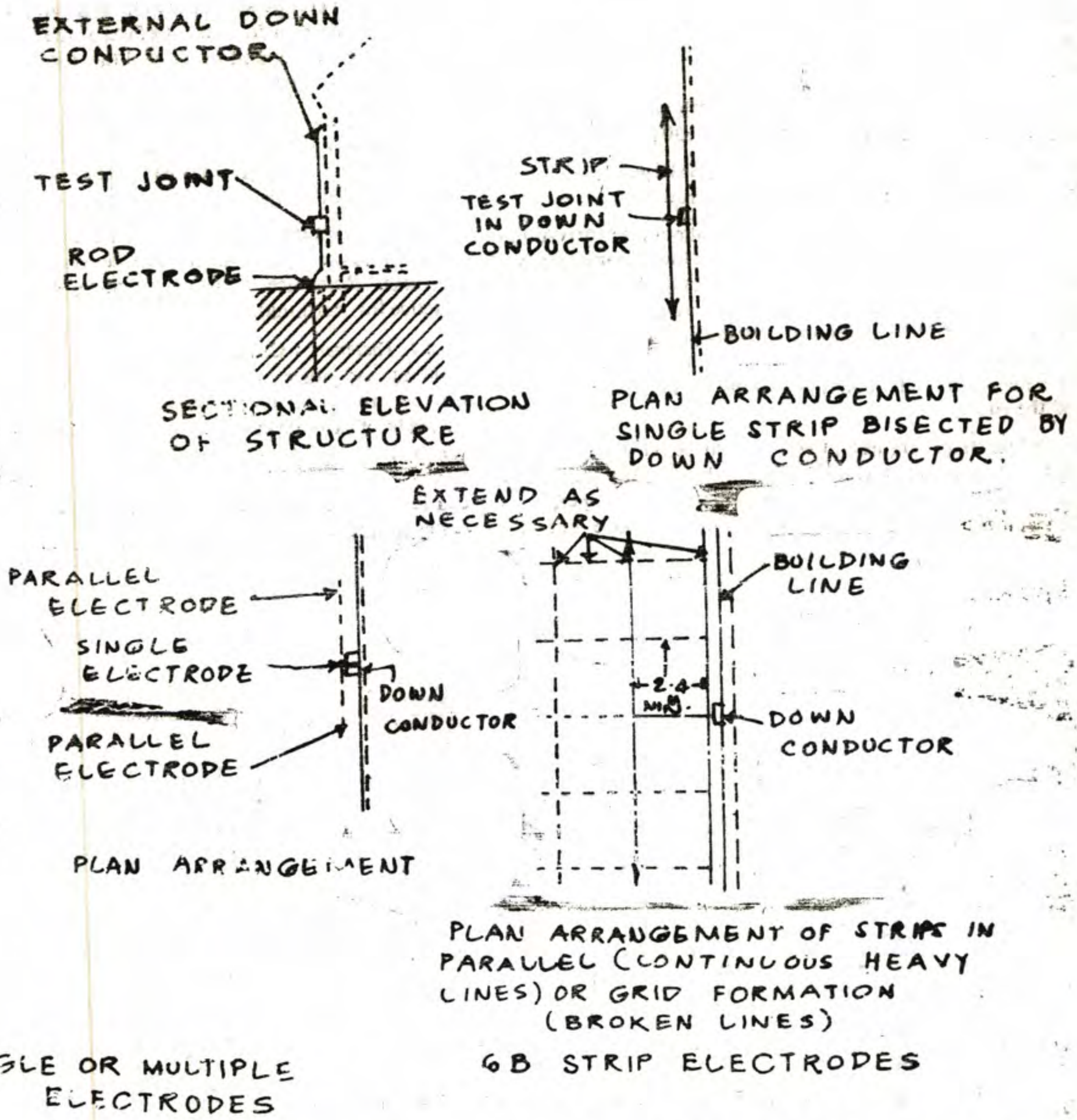


FIG. 5 SOME BUILDINGS OR PARTS OF BUILDINGS ILLUSTRATING HOW LIGHTNING PROTECTIVE SYSTEM IS ADOPTED



6A SINGLE OR MULTIPLE ELECTRODES

6B STRIP ELECTRODES

FIG 6 ARRANGEMENT FOR EARTH ELECTRODES

10.3.2. *Bonds*.—External metal or on forming part of a structure may have to discharge the full lightning current. Therefore, the bond to the lightning protective system shall have a cross sectional area not less than that employed for the main conductors. On the other hand, internal metal is not so vulnerable and its associated bonds are at most, only likely to carry a portion of the total lightning current, apart from their function of equilizing potential These latter bonds may, therefore, be smaller in cross setional area than those used for the main conductors. All the bonds should be suitably protected against corrosion. Bonds shall be as short as possible.

10.4. *Testing Points*.—Each down conductor shall be provided with a testing point in a position convenient for testing but inaccessible for interference No connection other than one direct to an earth electrode. shall be made below a testing point. Testing points shall be phosphor-bronze, gun-metal copper or any other suitable material.

10.5. *Earth Terminations* (*See also A*-4),—Each down conductor shall have an independent earth termination. It should be capable of isolation for testing purposes. Suitable location for the earth termination shall be selected after testing and assessing the spesific resistivity of the soil and with due regard to reliability of the sub-soil water to ensure minimum soil moistness.

10.5.1. Water pipe system should not be bonded to the earth termination system. However, if adequate clearance between the two cannot be obtained, they may be effctively bonded and the bonds should be capable of isolation and testing. The gaspipes, however, should in no case be borded to the earth termination system.

10.5.2. It is recommended that all earth termination should be interconnected Common earthing, besides equilizing the voltage at various earth terminations also minimizes the possibility of a side flashover from one earthing system to another (*Se* also A-4.3).

10.5.3. A structure standing on bare rock should be equipped with a conductor encircling and fixed to the structure at ground level and following reasonably closely the contour of the ground. This conductor should be installed so as to minimize any risk to it of mechanical damage. The condition for limiting earthing resistance given in 11 does not apply and in such a case no provision need be made for isolation in earth termination for testing. Where there is a risk to persons or to valuable equipment expert advice should be sought.

10.6. *Earth Electrodes* (See *also A*-4).—Earth electrodes shall be constructed and installed in accordance with I.S. 3043-1966.

10.6.1. Earth electrodes shall consist of rods strips or plates metal sheaths of cables shall not be used as earth electrodes.

10.6.2. When rods or pipes are used they should be driven into the ground as close as practicable but outside the circumference of the structure (*see* Fig. 6.) Long length in sections coupled by screwed connectors or socket joints can be built up where necessary to penetrate the substrate of low resistivity. Where ground conditions are more favourable for the use of shorter lengths or rods in parallel, the distance between the rods should preferably be not less than twice length of the rods.

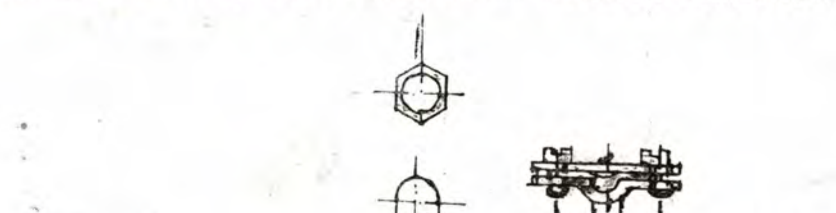
10.6.3. When strips are used, these should be buried in trenches or beneath the structure at a suitable depth, but not less than 0.5 m. deep to avoid damage by building or agricultural operations. The strips should preferably be laid radily in two or more directions from the point of connection to a down conductor. But if this is not possible they may extend in one direction only. However, if the space restriction requires the strips to be laid in paralled or in grid formation the distance between two strips should not be less than 2m.

10.6.4. When plate electrodes are used they shall be buried vertically into the ground so that the top edge of the plate is at a depth not less than 1.5 m from the surface of the ground. If two plate electrodes are to be used in parallel the distance between the two shall not be less than 8 m.

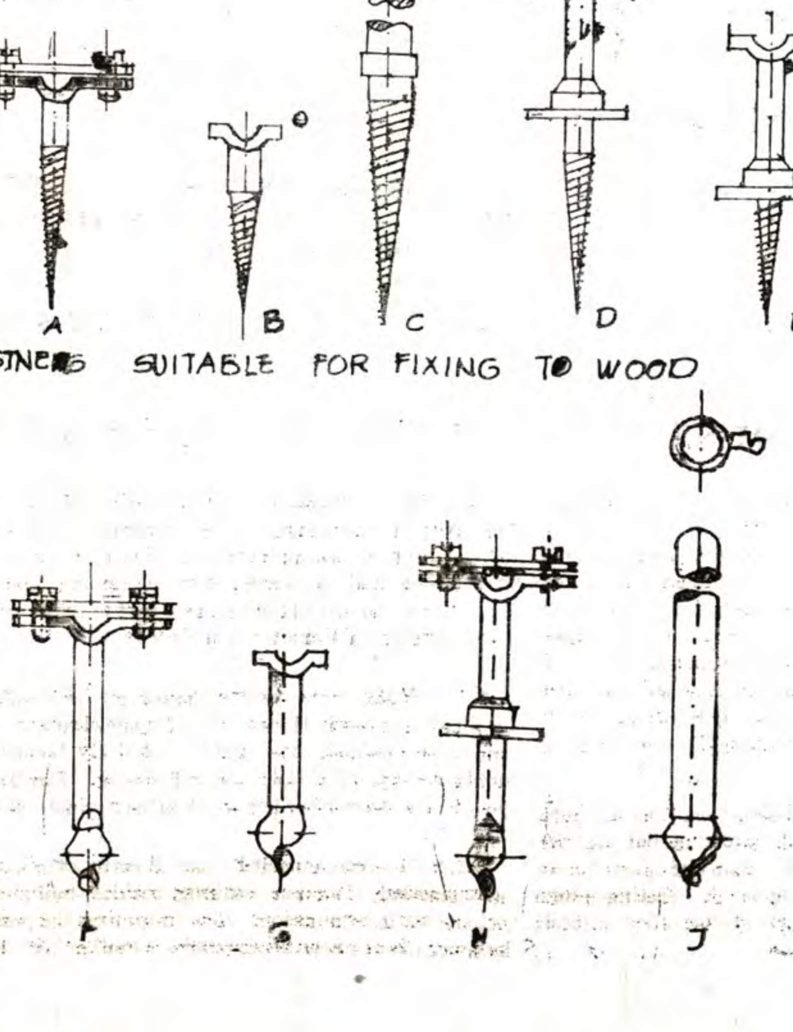
10.6.5. In the neighbourhood of structure where high temperatures are likely to be encountered in the sub-soil, for example, brick kilns, the earth electrodes may have to be installed at such a distance from the structure where the ground is not likely to be dried out.

10.6.6. Appendix E gives general guidance on the conditions for determining the type of earth electrode system to be used and their locations. Reference is also invited to I.S. 3043-1966 (Code of Practice for earthing).

10.7. *Fasteners* : Conductors shall be securely attached to the building or other object to be protected by fasteners which shall be substantial in construction not subject to breakage and shall be made of galvanized steel or other suitable material. If fasteners are made of steel they should be galvanized to protect them against corrosions. If they are made of any other material, suitabe precantion should be taken to avoid corrosion. Some samples of fasteners are shown in Fig. 7.



FASTNERS SUITABLE FOR FIXING TO WOOD



11. *Earth Resistance*.

11.1. Properly made earth connections are essential to the effective functioning of a lightning protective system and every effort should be made to provide ample contact with the earth so that the earth resistance can be kept as low as possible. Distribution of metal in the ground or upon its surface should be such as to permit the dissipation of a stroke of Lightning.

11.2. Each earth termination should have a resistance in Ohms to earth not exceeding numerically the product of 10 and the number of earth terminations to be provided. The whole of the lightning protective system should have a combined resistance to earth not exceeding 10 Ohms before any bonding has been effected to metal in or on a structure or to a surface below ground (*see* also A-43.)

11.3. If the value obtained for the whole of lightning protective system exceeds 10 Ohms a reduction may be achieved by extending or installing additional earth electrodes or by inter-connecting the individual earth terminations of down conductors by a conductor installed below the ground level. As a last resort a temporary reduction in soil resistivity may be achieved by chemical treatment of soil (*See* also 5.3.7 and 17.2.11 of I. S. 3043-1966) Code of Practice for earthing.

(*See* also A-4-3).

12. *Metal Parts in and on a structure.*—

12·1. When a lightning protective system is struck with a lightning discharge, its electrical potential with respect to earth is raised, and unless suitable precautions are taken, the discharge may seek alternative paths to earth by side flashing to other metal in the structure. Side flashing may be avoided by the following two methods:—

(*a*) Isolation, and

(*b*) Bonding.

12·1·1. For additional information on this subject (*see* A-5).

12·2. *Isolation.*—Isolation requires large clearance between the lightning protective system and other metal parts in the structure To find out the approximate clearance, the following two factors should be taken into account:—

(*a*) The resistive voltage drop in the earth termination, and

(*b*) The inductive voltage drop in the down conductors.

12·2·1. The resistive voltage drop requires a clearance of 0·3 m/Ohm of earthing resistance while the inductive voltage drop requires a clearance of 1 m. for each 15 m. of structure height. For two or more down conductors with a common air termination this distance should be divided by the number of down conductors. The total clearance require is the sum of the two distances and may be expressed by the following simple equation :—

$$D = 0{\cdot}3\,R + \frac{H}{15\,n.}$$

Where—

D = required clearance in metres.

R = the combined earthing resistance of the earth termination in Ohms.

H = structure height in metres, and

n = number of down conductors connected to a common air termination.

12·2·2. The above clearance may be halved if a slight risk of a side occurring can be accepted.

12.2.3. The drawbacks of isolation lie in obtaining and maintaining the necessary safe clearance and in ensuring that isolated metal has connection via the water pipes or other services with the earth. In general. isolation can be practised only in small buildings.

12·3. *Bonding.*—In structures which contain electrically continuous metal, for example, a roof, wall, floor or covering, this metal suitably bonded, may be used as part of the lightning protective system provided the amount and arrangement of the metal render it suitable for use in accordance with 10.

12·3·1. If a structure is simply a continuous metal frame without external coverings it may not require any air termination or down conductors provided it can be ensured that the conducting path is electrically continuous and the base of the structure is adequately earthed.

12·3·2. A reinforced concrete structure or a reinforced concrete frame structure may have sufficiently low inherent resistance to earth to provide protection against lightning and if connections are brought out from the reinforcement at the highest points during construction, a test may be made to verify this at the completion of the structure (*see* 11).

12·3·3. If the resistance to earth of the steel frame of a structure or the reinforcement of a reinforced concrete structure is found to be satisfactory, a suitable air termination should be installed at the top of the structure and bonded to the steel frame or to the reinforcement. Where regular inspection is not possible, it is recommended that a corrosion resistant material be used for bonding to the steel or to the reinforcement and this should be brought out for connection to the air termination. Down conductors and earth terminations will, of course, be required if the inherent resistance of the structure is found to be unsatisfactory when tested.

12·3·4. Where metal exists in a structure as reinforcement which cannot be bonded into a continuous conducting network, and which is not or cannot be equipped with external earthing connections, its presence, should be disregarding. The danger inseparable from the presence of such metal can be minimized by keeping it entirely isolated from the lightning protective system.

12·3·5. Where the roof structure is wholly or partly covered by metal, care should be taken that such metal is provided with a continuous conducting path to earth.

12·3·6. In any structure, metal which is attached to the outer surface or projects through a wall or a roof and has insufficient clearance from the lightning protective system, and is unsuitable for use as part of it, should preferably be bonded as directly as possible to the lightning protective system. If the metal has considerable length (for example, cables pipes, gutters, rainwater pipes, stairways, etc.) and runs approximately parallel to a down conductor or bond, it should be bonded at each end but not below the test point. If the metal is in discontinuous lengths, each portion should be bonded to the lightning protective system ; alternatively, where the clearance permits, the presence of the metal may be disregarded.

12·3·7. Bonding of metal entering or leaving a structure in the form of sheathing or armouring of cable, electric conduit, telephone, steam, compressed air or other services with earth termination system, should be avoided. However, if they are required to be bonded, the bonding should be done as directly as possible to the earth termination at the point of entry or exist outside the instructure on the supply side of the service. The gas pipes should in no case be bonded with other metal parts. However, water pipes may be bonded to other metal parts, if isolation and adequate clearance cannot be obtained In this operation all the statutory rules or regulations, which may be in force should be followed and the competent authority should be consulted for providing lightning protection in such cases.

12·3·8. Masses of metal in a building, such as bell frame in a tower, should be bonded to the nearest down conductor by the most direct route available.

12·3·9. Metal cladding or certain walling having a continuous conducting path in all directions may be used as part of a lightning protective system.

12·3·10. In bonding adjacent metal work to the lightning protective system careful consideration should be given to the possible effects such bonding would have upon metal work which may be cathodically protected.

13. *Protection of Special Structures.*

13·1. Structures exceeding 30 metres in height, such as spires, steeples and flag poles (*see* also A-5).

13·1·1. *Non-conducting structures.*—On a non-conducting structure other than chimney which is very high compared with its length and breath if of rectangular cross-sectional area or diameter if of circular excess sectional area a single down conductor may be used provided the air termination gives the desired zone of protection.

13·1·1·1. A non-conducting chimney of which the overal l width or the diametre at the top exceeds 1·5 m. should have at east two down conductors equally spaced and bonded by a metal cap or by a metal conductor round the top of the chimney.

13·1·2. *Conducting Structures.*—The requirements of 12·3·1 to 12·3·4 shall apply for tall conducting structures. Where down conductors are need not less than two should be installed and this should be spaced at more than 15 m. apart around the perimeter.

13·1·3. *All types of tall structures.*—Both conducting and non-conducting structures which are supported by stay wires, should be protected in accordance with 13·1·1· and 13·1·2· but, in addition, the upper ends of the stay wires should be bonded to the lightning protection system and the lower ends should be adequately earthed.

13·1·4. *Earthing of metallic spires and flag poles.*—Spires and flag poles composed entirely of, or covered entirely with metal and resting on foundations of non-conducting materials, with the top so constructed as to receive a stroke of lightning without appreciable damage, need not be provided with air terminations or down conductors. However, these shall be earthed or connected to the nearest lightning conductor or both, according as the structure is isolated set within the parameter of a building or near it, respectively.

Protection of Structures with Explosive or Highly Flammable Contents.—

14·0. The presence of explosive or highly flammable materials in a structure may increase the risk to persons or to the structure and the vicinity in the event of, a lightning stroke. For this reason higher degree of protection is essential for these structures. Protection of a greater or less degree may be secured in the case of both self-protecting and other structure by installation of various types of protection equipment, such as vertical and horizontal air terminations and other means. The recommendations given in 14·1 to 14·10 should be followed for structures in which explosive or highly-flammable solids, liquids, gases vapours or dusts are manufactured, stored or used or in which highly flammable or explosive gases, vapours or dusts may accumulate.

14·0·1. For additional information on protection of each structure reference is invited to A-10.

14·1. Following precautions should be taken for the protection of structures and their contents from lightning :

(*a*) Storage of flammable liquids and gases in all metal structures, essentially gas tight ;

(*b*) Closure or protection of vapour or gas openings against entrance of flames ;

(*c*) Maintenance of containers in good condition, so far as potential hazards are concerned ;

(*d*) Avoidance, so far as possible, of the accumulation of flammable air-vapour mixtures about such structures ;

(*e*) Avoidance of spark gaps between metallic conductors at points where there may be an escape or accumulation of flammable vapours or gases ;

(*f*) Location of structures not inherently self-protecting in positions of lesser exposure with regard to lightning. Elevated positions should be avoided ; and

(*g*) In connection with structures not inherently self-protecting, the establishment of zones of protection through use of earthed rods, masts, or the equivalent.

14·2. *General Principles of Protection.*—For the protection of structures with explosives or highly flammable contents following general principles should be followed. In case of doubt, expert advice should be sought.

14·2·1. An air termination net work should be suspended at an adequate height above the area to be protected. If one horizontal conductor only is used, the protective angle adopted should not exceed 30°. If two or more parallel horizontal conductors are installed, the protective angle to be applied may be as much as 45° within the space bonded by the conductors, but it should not exceed 30° outside that space. The height of the horizontal conductor should be sufficient to avoid all risk of flashover from the protective system to the structure to be protected. The supports of the net work should be adequately earthed.

14·2·2. Where the expense of the method given in 14·2·1. is unjustified and where no risk is involved in discharging the lightning current over the surfaces of the structure to be protected, a net work of horizontal conductors with a spacing of 3 m to 7·5 m, according to the risk, should be fixed to the roof of the structure.

14·2·3. A structure or a group of structures of small horizontal dimensions may be protected by one or more vertical lightning conductors. If one lightning conductor is used, the protective angle adopted should not exceed 30°. If two or more lightning conductors are installed, the protective angle to be used may be 45° within the space bonded by the conductors, but it must not exceed 30° outside the space.

14·2·4. If the vertical conductor is separate from the structure to be protected, the minimum clearance between it and the protected structure shall be not less than 2 m ; this clearance should be increased by 1 m. for every 10 m. of structure height about 15 m. to prevent side flashes. Also the minimum clearance between the suspended horizontal air termination and the highest projection on the protected structures shall be 2 m.

14·2·5. A structure which is wholly below ground and which is not connected to any services above ground may be protected by an air termination net work in accordance with14·2·1.by virtue of the fact that soil has an impulse breakdown strength which can be taken into account when determining the risk of flashover from the protective system to the structure to be protected, including its services. Where the depth of burying is adequate, the air termination net work may be replaced by a net work of earthing strips arranged on the surface in accordance with expert advice. Where this method is adopted, the bonding recommendations between metal in the structure, or metal conductors entering the structure given in 14·6 should be ignored.

14·3. *Types of lightning protection system.*—These should generally be of the integral mounted system with the horizontal air terminals running along the perimeter of the roof in all cases excepting for highly sensitive explosives and very small buildings. The following type of protection are recommended.

Type of Building.	*Recommended type of protection.*
(1)	(2)
Building with explosives dust or flammable vapour risk.	Integrallly mounted system with vertical air terminals 1·5 m. and horizontal air terminals spaced 3 m. to 7·5 m. from each other designing on the types of storage and processes involved.
Explosives storage building and explosive workshops.	Integrally mounted system with vertical, air terminals 0·3 m. and horizontal air terminals 7·5 m.
Small explosives storage buildings.	Vertical pole type.
Buildings storing more dangerous types of explosives, for example nitroglycerine (NG) and for initiatory explosives manufacturing.	Suspended horizontal air terminations at least 2 m. higher than structure and with a spacing 3 m.

14·4. Each separate structure protected in accordance with 14·2·2 should be equipped with twice the number of down conductors recommended in 10·2.

14·5. The earth terminations of each protective system should be inter-connected by a ring conductor. This ring conductor should preferably be buried to a depth of at least 0·5 m. unless other considerations, such as the need for bonding other subjects to it, testing, or risk of corrosion make it desirable to leave it exposed in which case it should be protected against mechanical damage. This resistence value of the earth termination net work should be maintained permanently at 10 Ohms or less. If this value proves to be unobtainable, the methods recommended in 11 should be adopted, or the ring conductor should be connected to the ring conductors of one or more neighbouring structure until the above value is obtained.

14·6. *Bonding.*

14·6·1. All major members of the metallic structure, including continuous metal reinforcement and services, should be bonded together and connected to the lightning protective system. Such connections should be made at least in two places and should, so far as is possible, be equally spaced round the perimeter of the structure at intervals not exceeding 15 m.

14·6·2. Major metal work inside the structure should be bonded to the lightning protective system.

14·6·3. Electrical conductors entering a structure of this category should be metal-cased. This metal casing should be electrically continuous within the structure. It should be earthed at the point of entry outside the structure on the supply side of the service and bounded directly to the lightning protective system.

14·6·4. Where the electrical conductors are connected to an overhead electrical supply line, a length of buried cable with metal sheath or armouring should be inserted between the overhead line and the point of entry to the structure and a surge protective device, for example, of the type containing voltage dependent resistors, should be provided at the termination of the overhead line (*see* also 13·5·3). The earth termination of this protective device should be bonded direct to the cable sheats or armouring. The sparkover voltage of the lightning protective device should not exceed one-half the breakdown with stand voltage of the electrical equipment in the structure. On account of the low impulse strength of mineral insulated metal sheathed cable, such cables are not recommended for the above purpose.

14·6·5. Metallic pipes, electrical cable sheaths, steel ropes, rails or guides not in continuous electrical contact with the earth, which enter a structure of this kind, should be bonded to the lightning protective system. They should be earthed at the point of entry outside the structure and at two points, one about 75 m. away and the other further 75 m. away.

14·7. For a buried structure or underground excavation to which access is obtained by an adit or shaft, the recommendation in 14·6·5· as regard extra earthing should be followed for the adit or shaft at intervals not exceeding 75 m.

14.8. The metal aprights components and wires of all fences, and of retaining walls in close proximity to the structure should be connected in such a way as to provide continuous metalic connection between themselves and the lightning protective system. Discontinuous metal wire fencing on non-conducting supports or wire coated with insulating material should not be employed.

14.9. The vents of any tanks containing flammable gas or liquid and exhaust stacks from process plants emitting flammable vapours or dusts should either be constructed of non-conducting material or be filled with flame traps.

14.10. Structures of this category should not be equipped with a tall component, such as spire or flag staff or radio aerials on the structure or within 15m. of the structure. This clearance applies also to the planting of new trees, but structures near existing trees should be treated in accordance with 13.2.6.

16. *Inspection and Testing.*

16.1. *Inspection.*—All lightning protective systems shall be examined by a competent engineer after completion, alteration or extension in order to verify that they are in accordance with the recommendations of this code. A routine inspection shall be made at least once a year.

16.3. *Deterioration.*—If the resistance to earth of a lightning protective system or any section of it exceeds the lowest value obtained at the first installation by more than 100 per cent, appropriate steps shall be taken to ascertain the causes and to remedy defects, if any.

APPENDIX A.

Explanatory Notes on some of the recommendations in the code.

A-1. *Zone of Protection.*

A-1.1. According to the best theoretical considerations at present available, a single vertical lightning conductor of any practical height attracts to itself all, lightning dischagres of average or greater intensity which in its absence would have struck a circular piece of ground round its base, the radius of which equals twice the height of the conductor. Weaker lightning discharges are attracted over shorter distances and the presence within this space of other conducting objects providing independent paths to earth further reduces the protected area. On the other hand, the protected area increases rapidly with increasing severity of the discharge. For these reasons, and in order to provide adequate protection against majority of lightning discharges, the zone of portection of a single vertical lightning conductor has been defined in 7.1. as a cone with apex at the highest point of the conductor and with base of radius equal to its height and not twice its height. Similar considerations apply to a horizontal lightning conductor in which case the zone of protection will be extended by the length of the conductor. The possibility of any point within such a zone of protection being struck by lightning is remote. For parallel horizontal conductors the area bonded between them is better protected than would follow from the above considerations provided no point of the area to be protected is more than 9 m. away from the nearest horizontal conductor.

A-1.2. For structures of exceptional vulnerability, like the presence of explosives or highly flammable contents, every possible protection may need to be provided even against the rare occurrence of a lightning discharge stricking within the protected zone. For this reason a reduced zone of protection and various other special measures as given in 14 should be taken.

A-1.3. Zone of protection provided by a single vertical conductor, horizontal air terminations and by two vertical conductors installed side by side is shown in Fig. 1,2 and 3 respectively. Figures 1 shows the zone of protection afforded by a single vertical conductor, Figure 2 shows a simple horizontal air termination consisting of roof conductor around the periphery of rectangular building and Figure 3 shows two adjacent vertical conductors and the increased zone of protection available between them.

A-1.4. Typical examples of protection of various types of buildings, along with their zones of protection are shown in Fig. 4 and Figures 9 to 12.

A-1.4.1. Figure 4 shows the typical arrangements of a structure with a large area of flat roof where it is necessary to employ a system of horizontal roof conductors. The maximum spacing of 18 m. is shown, which applied to structures without special inherent risk.

A-1.4.2. Figure 9 shows a system of horizontal air termination net work of structures with large areas of roof of varying porfiles.

A-1.4.3. Figure 10 shows the protection for a thatched rondavel along with the zone of protection.

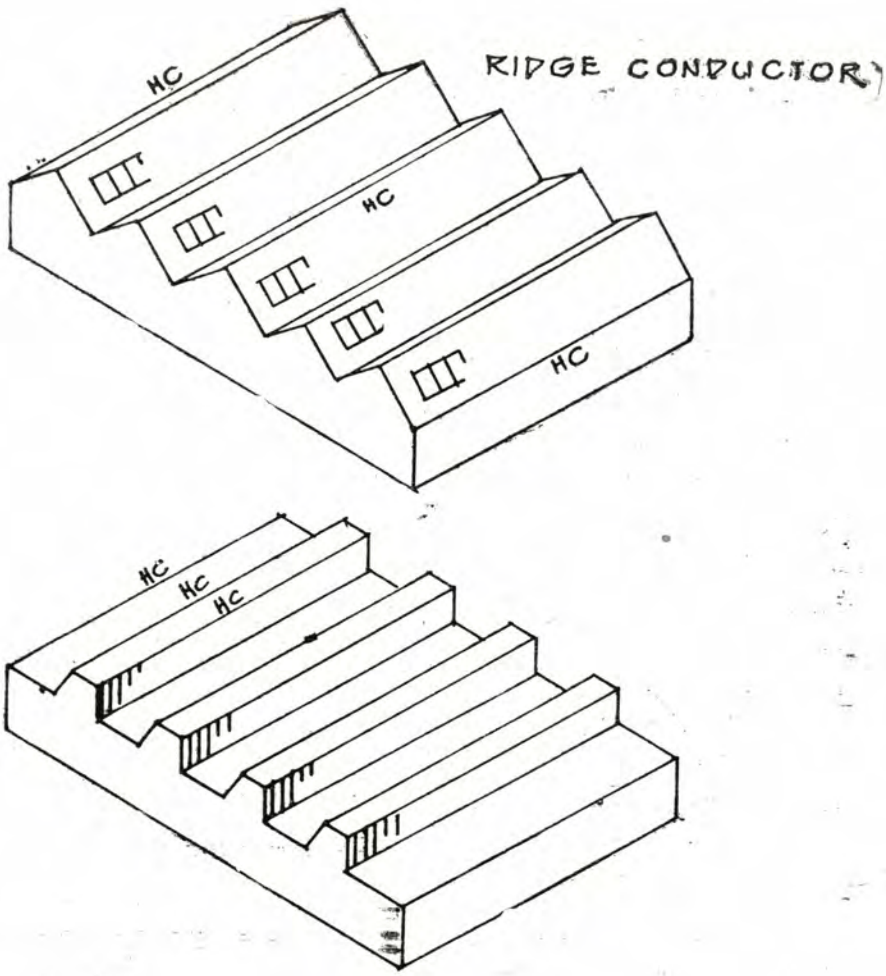


FIG. 9. HORIZONTAL AIR TERMINATION NET WORK ON STRUCTURES WITH LARGE AREAS OF ROOF OF VARYING PROFILES.

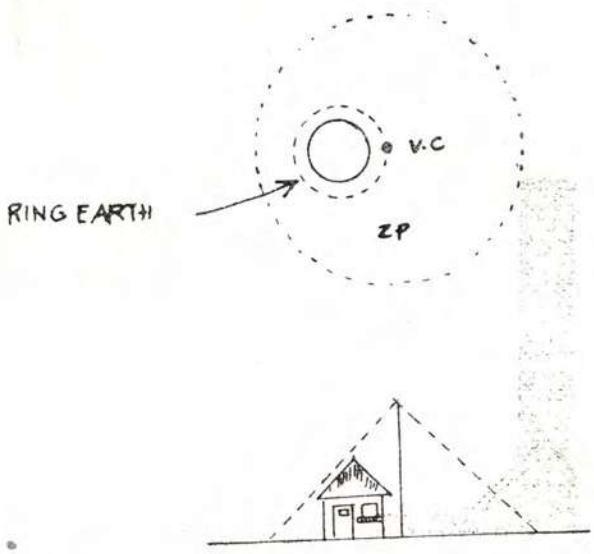
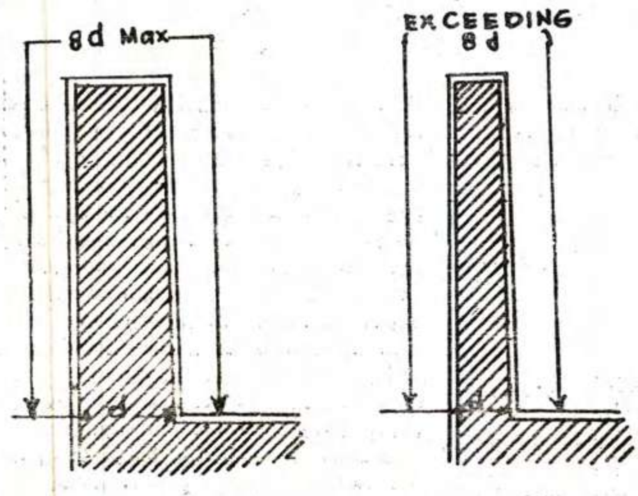


FIG 10. PROTECTION OF A THATCHED RONDAVEL



13 A PERMISSIBLE   13 B NON-PERMISSIBLE.

FIG 13. GENERAL PRINCIPLES OF A RE-ENTRANT LOOP IN A CONDUCTOR TAKEN OVER A PARAPET WALL.

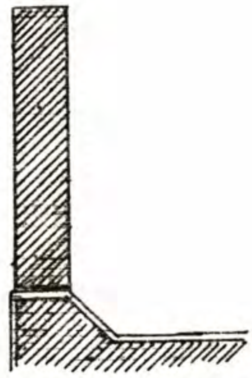


FIG 14 PERMISSIBLE METHOD OF TAKING CONDUCTOR THROUGH A PARAPET WALL

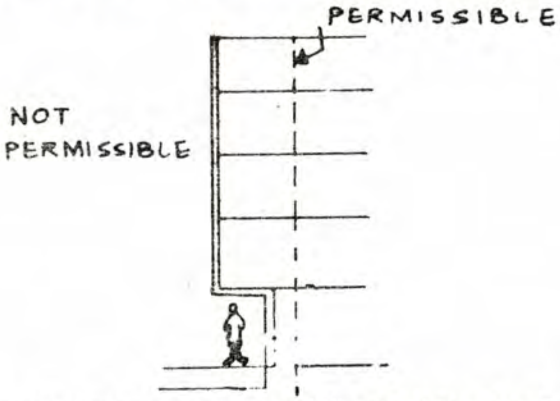


FIG 15 ROUTES FOR DOWN CONDUCTORS IN A BUILDING WITH CANTILEVERED UPPER FLOORS

A-1.4.4. Figure 11 shows the zone of protection for simple structure with explosive hazards. It consists of two vertical conductors connected by a horizontal catenary wire. The zone of protection is shown in plan and elevation and reflects the effects of the sag in the catenary wire.

A-1.4.5. Figure 12 shows the air termination net work with zone of protection for a structure with varying heights.

A-2. *Materials and Dimensions.*

A-2.1. In India, strips have been commonly used for providing horizontal air terminations down conductors, bonds, etc., for the purpose of lightning protection. However, rods may sometimes provide a more convenient alternative, particularly, since in contrast to the former it enables bends to be made in any plane with equal facility. Internal bonds are permitted with approximately half the cross sectional areas of external once (*see* 10.3.2.). Flexible bonds may be in braided formor have an outer covering to constrain the small wires.

A-3. *Down Conductors.*

A-3.1. Th positioning and spacing of down conductors on large structures has often to be decided in practice by architectural consideration. However, their number should be governed by the recommendation of 10.2.

A-3.2. It is now recognized that sharp bends in a down conductor, such as arise at the edge of a roof, do not significantly impede the discharge of a lightning current, nor are the mechanical forces produced by the lightning current likely to endanger the conductor or its fixing. In contrast re-entrant loops in a conductor can produce high inductive voltage drops so that the lightning discharge may jump across the open side of the loop. As a rough guide it can be stated that this risk may arise when the length of the conductor forming the loop exceeds 8 times the width of the open side of the loop (*see* Fig. 13). It follows from the above that there is no need to round the path of the down conductors at the edge of a roof and that an upturn with the limits stated is permissible. Where large re-entrant loops as defined cannot be avoided, for example, in the case of some cornices of parapets, the conductor should be arranged in such a way that the distance across the open sides of the loop complies with the rule quoted. Alternatively, such cornices or parapets should be provided with hoels through which the conductor can passes freely (*see* Fig. 14).

A-3.3. An exception to the above practice is required to be made inthe case of a building cantilevered out from the first sotrey upwards. The down conductors in this case must be taken straight down to ground since, by following the contour of the building, a hazard could be created to persons standing under the overhang formed by the cantilever. In such a case the use of internal ducts for down conductors is recommended (*see* Fig. 15).

A-5. *Metal in and on a structure and structures exceeding* 30 *metres in Height:*

A-5.1. **When** a lightning current is discharged into lightning protective system, the entire system is raised to a potential with respect to the true earth. This can be calculated as the sum of two factors the first of which takes into account the resistive voltage drop across the earth termination, and the second the inductive voltage drop in the down conductors. The determination of these two factors is given in A-5.2. to A-5.11.

A-5.2. Any extended metal in or on the structure and not connected to the lightning protective system, for example, water pipes, gas pipes, metal-sheathed electrical installations, etc., which is in conducting connection with earth remains essentially at earth potential during a lightning discharge. Even if an extended vertical metal part is not in contact with earth, a potential difference between it and the lightning protective system is liable to arise although the magnitute of this potential difference will be smaller than if the metal were, earthed. If the resulting short time potential difference between any part of the lightning protective system and any adjacent metal exceeds the electric breakdown strength of the intervening space, be this air, a wall, or any other structural material, a side flash can occur and this can cause physical damage, ignite flammable material or cause electric shocks to persons or animals.

A-5·3. The clearance necessary to avoid the risk of side flashing are given in 12. The clearance required to withstand the resistive voltage difference between the lightning protective system and adjacent metal is based on a severe lightning stroke of 150 KA. amplitude (as compared with an average value of 20 KA) and on an electric breakdown of air of 500 KV/m., a value which is exceeded if the breakdown occurs through solid structural material.

A-5·4. The clearance given on account of the inductive voltage drop along the down conductors is based on a steeply rising lightning current of 4×10^{10} A/s (as compared with an average value of 10KA/µs) and in inductance of 160 µH/100 m of conductor ; the breakdown strength of air under the wave shape produced by an inductive voltage drop is taken as 890 KV/m.

A-5·5. A structure having reinforcement, steel work or cladding forming a continuous close metal mesh in the form of internal reinforcement or screen, approaches the condition of a " Parady Cage " in which any internal metal assumes the same potential as the cage itself. On such a structure the risk of side flashing is greatly reduced and the rules for bonding can be substantially relaxed.

A-5·6. While it may not be difficult in the design stage to locate the lightning protective system in such a manner as to assure the required clearance, subsequent alteration should not be made to the structure, or to internal installations, without due regard to these requirements. It is for this reason that the principle of isolation of the lightning protective system with respect to internal or external metal in or on a structure can usually be recommended for small dwellings only.

A-5·7. In general, bonding between the lightning protective system and internal or external metal, as recommended, is preferable. Such bonding has to be affected at both extremities of any extended vertical metal. The metal may then form part of the discharge path but any risk of physical damage or injury is avoided.

A-5·8. Difficulties are liable to arise in deciding which metal parts require bonding and which can be disregarded. No such difficulties should arise with long continuous installations, such as metallic service pipes, ducts, lifts, staircases, or long ladders. These can usually be bonded to the lightning protective system without excessive inconvenience or cost. On the other hand, the presence of short isolated pieces of metal, such as window frames, which are merely in fortuitous connection with the earth through the rain covered surface of the structure can be disregarded.

A-5·9. If any part of the outer surface of the structure is covered with a thin metal skin, this metal may, by accident or design, form part of the path of the lightning current as it goes to earth ; the current may be caused to leave the metal, either through the metallic path not being continuous or through its cross-sectional area being inadequate to carry the current without melting. In either case an are will be formed, and this arc entails some risk of fire if easily ignitable materials are present.

A-5·10. The metal bars of a reinforced concrete structure cast-in-situ are occasionally welded, thus providing definite electrical continuity. More frequently, however, they are tied together by metal binding wire at crossing points but, despite the fortuitous nature of the metallic connection, the very large number or bars and crossing points of such a construction assures a substantial sub-division of the total lightning current into a multiplicity of parallel discharge paths. Experience shows that such a construction can be readily utilized as part of the lightning protective system.

A-5·11. In the ground, bonding between the earth termination net work of any structure and buried metal service pipes is essential. If this is not done an electric breakdown can occur through the soil is between these systems and the electric arc can cause structural damage or may puncture a service pipe.

A-10. *Structures with Explosive or Highly Flammable Contents* :

A-10·0. The problems arising in the provision of lightning protective systems for these structures are preferably dealt with by specialists who will be conversant with any relevant statutory regulations.

A-10·1. The protective angle and mesh of the air termination net work be chosen from the range of 30° to 45° and 3 m. to 7·5 m. respectively according to the risk as assessed by a lightning specialist.

A-10·2. An acceptable risk may be present when the quantity of dangerous material is strictly limited as in a laboratory or small store or where the structure is specifically designed to restrict the effects or of a catastrophe, or sited in an isolated position. Circumstances may also arise in which the dangerous materials are not exposed but are completely encased in metal of an adequate thickness, and under these conditions lightning protection may not be required at all. In other situations the risk to life and property may be so patently obvious that the provision of every means possible for protection from the consequence of a lightning discharge is essential.

A-10·3. A protective system based upon suspended air terminations or an adequate grouping of vertical conductors of correct height is to be preferred for structures in higher risk categories (*see* 14·2·2· and 14·2·3.)

Structures in the lower risk category permit the conductors being fixe to the structure itself (*see* 14·2·3) but in some cases it may be found that suspended air terminations prove to be a cheaper installation.

A-10·4. The need to bond to the lightning protective system all metal work associated with such structures other than minor items, for example, door hinges, metal gutter brackets, reinforcement of isolated small concrete beams, will necessitate a ring conductor being run externally about 0·5 m. above ground level in order to provide a convenient point for the connection of such bonds. The ring conductor should preferably visible throughout its length and rise over, doorways rather than be buried beneath their thresholds with the additional advantage of avoiding corrosion at these positions. The extent and arrangement of bonding should be such as to avoid possibles sparking, particularly inside the structure, in the event of a lightning discharge to the structure.

A-10 5. Where a group of these structures is involved, each utilizing common buried supply services efficiently bonded to the protective systems, the combined earthing resistance is likely to be low and to remain so. If the structure is isolated or without any form of connection to another protective system, correspondingly greater care must be taken to ensure an adequately low earthing resistance.

A-10.6. A length of buried cable bringing the electricity supply to the structure form an overhead supply line is inadequate to provide any effective surge protection to the internal installation. Installation of a surge protective device at the junction of the overhead electricity supply line and the buried cable provides for the discharge to earth of a large fraction of the lightning current at a safe distance from the structure.

EXTRACT FROM I.S. 6248-1971.

Specification for Metal Rolling Shutters and Rolling Grills.

3. *Sizes.*

3.1. The size of a rolling shutter shall by denoted by specifying the clear width (W) and the clear height (H) of the opening for which the rolling shutter is required, in the following manner, care shall be taken to mention the width first always :

2500 (W) × 3500 (H) mm.

3.1.1. The clear size of rolling shutters shall be defined and identified as given in 3.1.1.1. and 3.1.1.2.

3.1.1.1. *Clear Size.*—The clear size of a rolling shutter, to suit any opening, shall be arrived at by measuring the opening as follows :

(*a*) Clear Width—The clear distance between the two jambs of the opening.

(*b*) Clear Height—The clear distance between the sill and the soffit (bottom of lintel) of the opening.

3.1.1.2. It is recommended that all openings for taking rolling shutters be designed with width and length rounded off to 0·2 m.

3.2.2. *Stopper height.*—The maximum available stopper height shall be 10 cm. less than the clear height of the rolling shutter, although special arrangements may be made for the stopper height to be equal to the clear height in exceptional cases. The stopper height shall always be specified by the user, whenever there is a minimums height stipulation for the clearance of vehicles, goods, etc., through the rolling shutter in the open position.

4. *Positions of fixing.*

4·1. The different standard positions of fixing rolling shutters and the standard designations applicable to them shall be as given in Table I (see also Fig. 2).

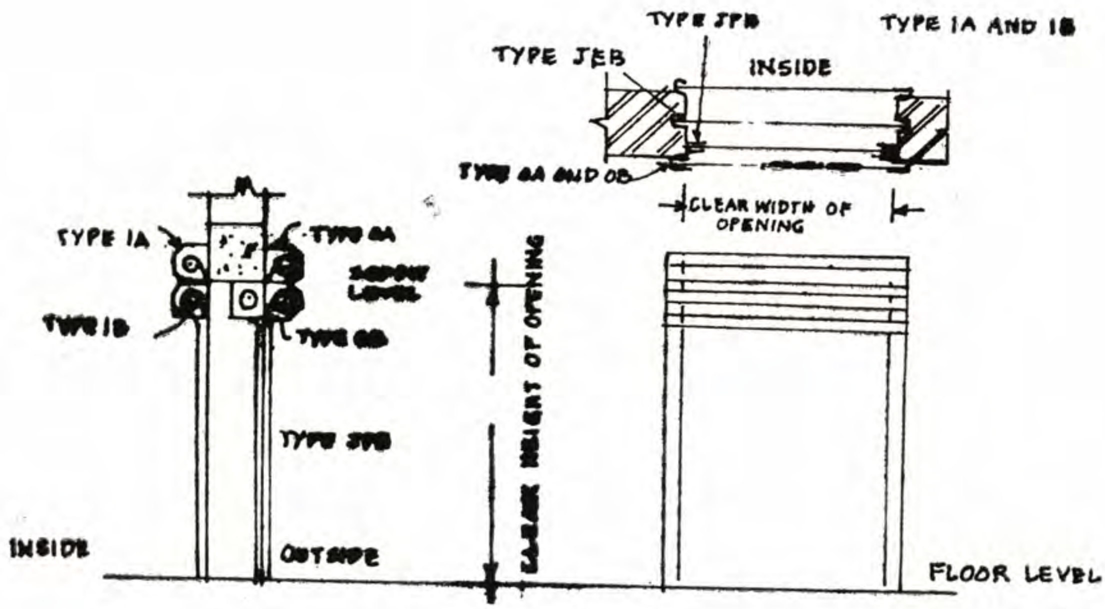


FIG. METHODS OF FIXING ROLLING SHUTTERS

5. Types of shutters and applicable sizes.

5·1. Rolling shutters shall be supplied in the following alternative types based on different methods of operation (see 8). The size range applicable to each type shall be as given below :—

(*a*) *Self-Coiling Type* (*Push -Pull type or Manual type*).—It shall be used up to a maximum of about 8 m² clear area without ball bearings and upto a clear area of about 12 m² with ball bearings.

(*b*) *Gear-operated type* (*Mechanical type*).—It shall be fitted with ball bearings. It shall be used up to a maximum of about 25 m² clear area, if the rolling shutter is operated by a level gear box and crank handle and up to a maximum of about 35 m² clear area, if the rolling shutter is operated by chain wheel and hand chain, mounted directly on the worm shaft.

(*c*) *Electrically operated type*.—It shall be used up to a maxium of about 50m² clear area.

TABLE 1—FIXING ROLLING SHUTTERS.

(*Clause* 4·1)

Designation. (1)	*Representing.* (2)	*Description.* (3)
Type I-A ..	Inside and above soffit.	With guide channels overlapping the jambs on the inside face of the wall on either side and with the roll on the face of the lintel inside.
Type I-B ..	Inside and below soffit.	With guide channels as in Type I-A, but with the roll below soffit level inside.
Type OA ..	Outside and above soffit.	With guide channels overlapping the jambs on the outside face of the wall on either side and with the roll on the face of the lintel outside.
Type OB ..	Outside and below soffit.	With guide channels as in Type OA, but with the roll below soffit level outside (where sunshades CHAJJAS, etc., project from the soffit level).
Type JPB ..	Jamb, projecting and below soffit.	With guide channels projecting into the opening in front of the jambs and with the roll mounted in between the jambs just below soffit level (for example, when a large opening is surrounded by concrete columns on either side and a concrete beams on top).
Type JEB ..	Jamb, embedded and below soffit.	With guide channels embedded inside the jambs in grooves and with the roll mounted in between the jambs (slightly recessed at the top) just below soffit level. The exact position where the guide channel is to be embedded in the thickness of the wall is left to the preference of the user, as it will not affect the fabrication.

6. Materials.

6·1. *Cold Rolled Steel Strips.*—Cold rolled steel strips used for rolling shutter lath sections shall conform to temper No. 5 dead sof quality of I.S. 4030-1967.

6.2. *Mild Steel Sections.*—Mild steel sections used for manufactu ring various components of rolling shutters shall be rolled from weldable quality steel conforming to St 32·0 of I.S. 1977–1969.

6.3. *Mild Steel Sheets and Plates.*—Mild Steel sheets and plates used for manufacturing the guide channels, bracket plates, hood covers, etc., shall be rolled from mild steel conforming to I.S. 513–1963 and shall be free from rolling and surface defects. The steel sheets and plates shall be clearly sheared.

6.4. *Steel Pipes.*—Mild Steel pipes used for the suspension shaft of the roller shall be heavy duty pipe suitable for mechanical purposes and shall conform to I.S. 1161–1968.

6.5. *Cast Iron Castings.*—Grey iron castings used for rolle pulley wheels and locking clips, U-clamps, geafe, etc., shall conform to Grade 15 of I.S. 210–1961.

6.6. *Springs.*—The springs used in the roller for counter balancing the rolling shutter shall be made either from high tensile spring steel wire or flat spring steel strip.

6.6.1. The spring steel wire used for helical spring shall conform to Grade 2 of I.S. 4454–1967.

6.6.2. Flat steel strip used for spiral spring shall by from 0.8 to 1.0 per cent carbon steel strip, specially hardened and tempered.

6.7. *Malleable Cast Iron.*—Malleable cast iron used for clips shall conform to I.S. 2108–1962.

6.8. *Aluminium Alloy Sheets.*—Aluminium alloy sheets to be used for certaln in case of rolling grills, shall conform to NS 4, NS 5 or NS 30 of I.S. 737–1965.

6.9. *Aluminium Alloy Extrusions.*—Aluminium alloy extrusion for the components of rolling shutters in aluminium shall conform to NE 5 or HE 30 of I.S. 733–1967 *

7. Fabrication :

7.1. *Curtain.*—The curtain shall be built up of interlocking lath sections formed from cold rolled steel strips (see 6.1.). The thickness of steel sheets from which the lath sections have been rolled shall be not less than 0.900 mm for shutters upto 3.5m width and not less than 1.25 mm for shutters 3.5 m width the above. The lath section shall be rolled so as to have interlocking curls at both edges and deep corrugation at the centre with a bridge depth of not less than 12 mm to provide sufficient curtain stiffness for resisting manual pressure and normal wind pressure (see Fig. 3). Each lath section shall be continuous single piece without any welded joint. When interlocked, the lath sections shall have a distance of 75 mm between rolling centres, the although lath sections with 50 mm and 25 mm rolling centres may be used for special purposes like small show windows, bus windows, etc. Each alternate lath section shall be fitted with malleable cast iron or mild steel clips securely riveted at either end thus locking the lath section a both ends and preventing lateral movement of the individual lath sections. The clips shatl be also designed as to fit the contour of the lath sections.

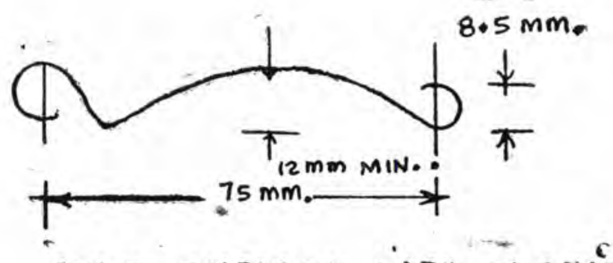


FIG 3. TYPICAL LATH SECTION.

7.2. *Lock Plate.*—A fabricated lock riveted construction made of mild steel sheet of less than 35 mm thickness, reinforced with mild steel angle section of not less than 35 x 35 x 5 mm size at the bottom, shall be interlocked with bottom most lath section of curtain so as to provide contact against the sill when closed. Alternatively, the lock plate may also be fabricated out of unequal mild steel angles or "Tee" section, of not less than 5 mm thickness. The lock plate shall be fitted with sliding bolts at either end to engage with suitable receiving pockets at the bottom of guide channels. The sliding bolts shall be capable of being locked by means of padlocks both from outside and inside. The lock plate shall also be provided with pulling handles, one handle for widths upto 2.5 m and two handles for widths of above 2.5 m. Pulling handles shall be fixed both the interior side and exterior side of the lock plate.

7.3. *Guide Channels*:

7.3.1 The guide channels shall be of mild steel deep channel section and of rolled, pressed or build up (fabricated) construction. The thickness of the sheet used shall not be less than 3.15mm. The depth of the guide channels shall be sufficient to enable the curtain to project adequately into the channels at either end, so as to keep the curtain in place during its movement and under normal wind pressure of about 200 kg/cm2. The minimum depths for guide channels shall be as follows:

Clear width of shutter	Depth of Guide Channels
Upto 3.5 m	60 mm
3.5 m and above	75 mm

7.3.1.1. The gap between the two legs of the guide channel shall be sufficient to allow the free movement of the curtain and at the same time close enough to prevent the rattling of the curtain due to wind.

7.3.2. Each guide channel shall be provided with a minimum of three fixing cleats or support for attachment to the walls or column by means of bolts or screws. The spacing of cleats shall not exceed 7.5 m. Alternatively the guide channels may also by provided with suitable dowels, hocks or pins for embedding in the walls.

7.3.3. The guide channels shall be attached to the jambs, plumb and true either in the overlapping fashion, projecting fashion or embedded in grooves, depending on the method of fixing.

7.3.4. For OA and OB type fixings, the guide channels shall have a box welded on at the bottom to conceal the end of the slide bolt.

7.4. *Bracket Plate.*—It shall be fabricated out of mild steel sheet of 3.15 mm minimum thickness. The thickness of the bracket plate shall he proportinately higher upto at least 7 mm for large size gear operated rolling shutters. The bracket plate may be of hexagonal square or circular contour. The bracket plate shall have fixed at the centre a U-shaped support of mild steel or preferably of cast iron, welded or riveted to it. Since the bracket plate carries the full weight of the moving parts of the rolling shutter mechanism, the bracket fixing shall be carried out by means of suitable foundation bolts (not less than two for each bracket) in order to obtain a sound fixing.

7.5. *Roller.*— The suspension shaft of the roller shall be made of steel pipe conforming to heavy duty of I.S. 1161-1968* and of sufficient diameter so as to resist deflection due to the weight of the rolling shutter. The deflection shall not exceed 5 mm per metre width. The suspension shaft shall be provided with steel or preferably cast iron pulleys and helical wire springs or flat spiral springs for counter balancing the weight of the shutter adequately. The rollers shall also be provided with self-aligning double row ball bearings for large size rolling shutters. For wide openings, the roller shall be of the fabricated cage type so as to resist deflection. The roller assembly shall be designed so as to be capable of producing sufficient torque to ensure easy operation of the rolling shutters in any position. The spring tension shall be adjustable by means of suitable adjustment holes drilling on the rims of the pulleys.

7.6. *Hood Covers.*—Hood covers shall be made of mild steel sheets not less than 0.900 mm thick. They shall he of hexagonal, square or circular contour depending on the contour of the bracket plate.

7.6.1 The hood cover shall be properly stiffened with angle/flat stiffeners at top and bottom edges. The hood cover shall be fixed in a neat manner and supported at the top at suitable intervals for preventing sagging.

7.7. *Gears, worms, etc.*— All gears, worms, etc., used in the assembly of the rolling shutters shall be machine cut. Worm gear wheels shall he or high grade cast iron or mild steel or phosphor bronze. The worms shall be of mild steel or gun metal or phospher bronze.

7·8. *Fixing bolts.*—All fixing bolts shall be of good quality and adequate strength and at sufficiently close pitch to ensure strength and rigidity of the rolling shutter after erection.

7.9. *Safety devices*—For width upto 2.5 m. properly fabricated and reinforced bottom lock plate shall be provided to give protection. For widths above 2.5 m one or both of the safety devices mentioned in 7.9.1 and 7.9.2 may be provided.

7.9.1. *Anchoring rods.*—A crank shaped rod, fitted with clamps, behind bottom lock plate shall be provided by means of removable wing screws (see Fig.4). There shall be a suitable pocket on the sill of the opening lined with two close fitting pipes of approximately 150 mm length for receiving bottom end of the anchoring rod to a length of at least 100 mm, Of the two pipes, the outer pipe shall be grouted to the floor and the inner pipe shall be removable and have a closed bottom to enable any dust accumulation to be cleared periodically. The pipes shall be embedded in the sill so as not to project above the sill surface. Anchoring rods shall be provided at the rate of one per extra 2.5 m width or part thereof above a clear width of 2.5 m. Anchoring rods prevent the bottom lock plate from being pulled forward by tampering instruments, such as pullers used by burglars. The anchoring rods may be removed from the bottom lock plate, when opening the shutter, so as not to cause any obstruction in the door way and may then be replaced when closing the shutter.

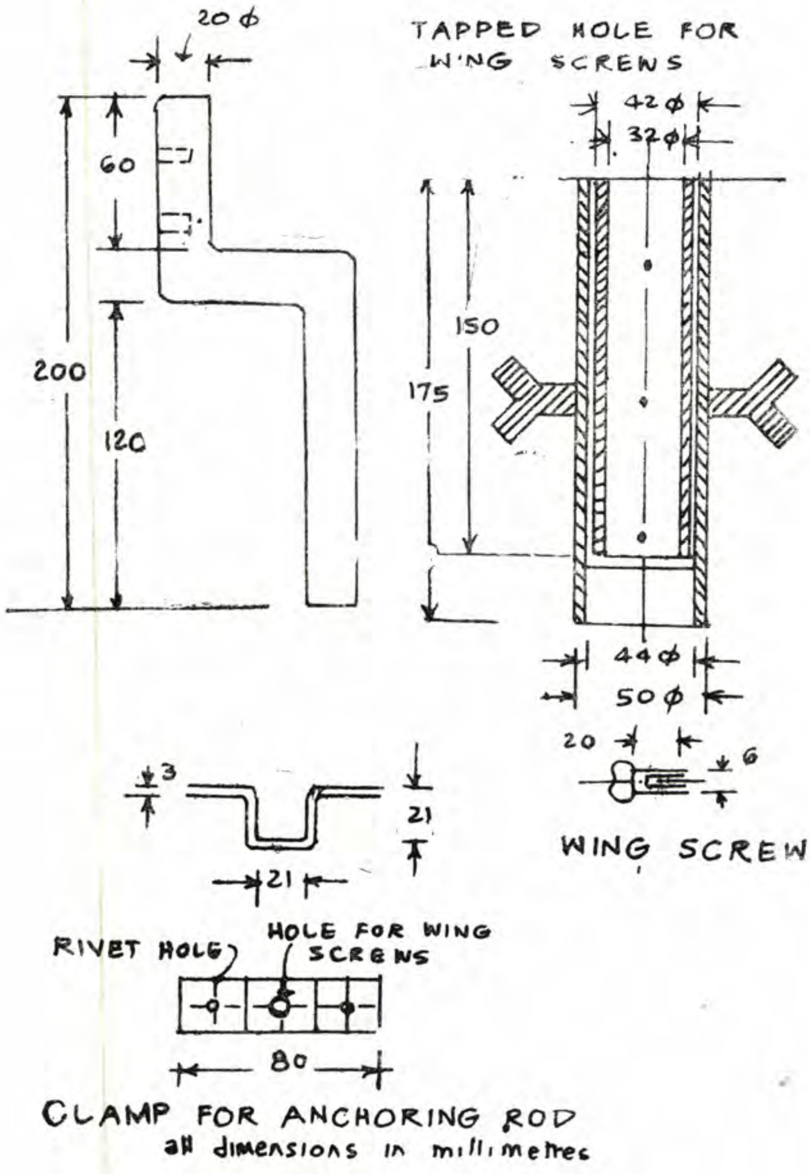


FIG.4. TYPICAL DETAIL OF ANCHORING ROD DEVICE.

7.9.2. *Central Hasp and Staple.*—In case of shutters of large width an additional safety device is necessary in order to cut down the unsupported length of the bottom lock plate to prevent tampering. This shall be achieved by providing a central hasp and staple outside at the centre of the bottom lock plate. The hasp shall be grouted on the ground so as to be level with the sill and thus not to cause any obstruction. The staple shall be fitted at the centre of the bottom lock plate outside at a correct position so that the hasp may properly engage with the staple when the shutter is in the closed position and bottom lock plate lines against the sill. Normally, one central hasp and staple outside will be sufficient for any width of door.

7.10. *Optional Features* :

7.10.1. *Intermediate posts or mullions.*—Intermediate posts or mullions may be of the fixed, removable or sliding type and are used for sectionalizing the rolling shutters for multiple door installations for unusually wide openings. These mullions form the guide channels between the various sections of the rolling shutters. The sliding mullions may also be of the winch operated type for large sizes. The intermediate posts or mullions shall be fitted so as to be plumb and true, when placed in position before closing the rolling shutters.

7.10.2. *Wicket doors.*—Where required by the purchasers for main entrances of mills, factories, etc., a subsidiary door known as the "Wicket door" may be provided. The wicket door is hinged service door provided in the rolling shutter for affording pedestrian acces without opening the rolling shutter when it is closed. The wicket door may be of 600 x 1200 mm size, for ordinary use, and 900 x 1800 mm size for large installations. Larger size wicket doors are not recommended as they cause difficulties in installation and operation. The wicket doors shall be of robust construction and shall be fitted with a good lever lock operated by key, lockable both from inside and outside. The wicket doors shall be erected in such a way as not to foul with the main rolling shutter when opening or closing. The wicket doors shall be swung clear of the opening before the rolling shutter is raised or lowered.

7.10.3. *Safety lever locks.*—In addition to the padlock arrangement, one pair of safety lever locks may be fitted on either end of the bottom lock plate so as to secure the slide bolts in the closed position for extra security.

7.10.4 *Galvanizing* .—In order to deal with the problem of corrosion in the vicinty of the sea or in chemical factories, etc., the lath sections, the guides, the lock plate, the bracket plates, the suspension shaft and the hood cover may be hop-dip galvanized with a zinc coating containing not less than 97.5 percent pure zinc. The weight of the zinc coating shall be not less than 230 g/m2 and the coating shall force from flaking or peeling (See I. S. 1477 –Part I. 1959).

8. *Operation* :

8.1. *Self-coiling type rolling shutters* : Self-coiling type rolling shutters shall be raised or lowered manually by means of a pulling hook applied to the pulling handles fixed on the bottom lock plate. The length of the pulling hook shall be adequate to push the bottom lock plate to the top most position with ease (*see* Fig. 1).

8.2. *Gear-operated type rolling shutters.*—Gear-operated type rolling shutters ordinarily employ a worm drive arrangements the worm driving the worm wheel attached to one end of the roller, Worm drive is preferred in view of its irreversible nature which provides a safeguard against any accidental downward descent of the curtain due to failure of the springs.

8.2.1. *Gear-operated type rolling shutters shall be operated.*—(a) By means of level gear box and crank handle or (b) by a chain wheel and endless hand chain mounted directly on the worm shaft (*see* Fig. 5-A and 5-B) respectively. The level gear box shall be mounted on the wall adjacent to the shutter at a height of approximately 0.85 m from the floor. The gear box shall operate the worm by a straight shaft connecting the top of the gear box and the worm. The crank handle of the gear box shall be detachable. If so desired by the customer, the crank handle operation shall be provided on both sides of the wall by extending the horizontal shaft of the gear box backwards and providing an extra crank handle at the back of the wall. Chain wheel and hand chain operation may also be provided from both sides, if needed. The endless hand chain shall hang to a distance of approximately 0.85 m from the floor level. The gear reduction shall be calculated to reduce the pressure exorted on the crank handle or the pull exorted on the hand chain to not over 16 Kg.

8.3. *Electrically operated Rolling Shutters*.—Electrically operated rolling shutters shall be operated by an electric motor operating on 400/440 V. 3 Phase, 50 cycle AC supply. The electric motor shall drive the worm shaft by chain or vee-belt drive or through a reduction gear box. The reduction gear box shall have a control lever within easy reach from the floor so that the motor may be disengaged and the auxiliary chain gear operating mechanism may be engaged instantly in the event of power failure. The motor unit shall be so mounted that the motor may be completely removed without interfering with the operation of the rolling shutter or the auxiliary drive. The electric drive shall be so designed as to limit the speed of movement of the curtain in either direction to not more than about 10 cm/s (*See* Fig. 5-C).

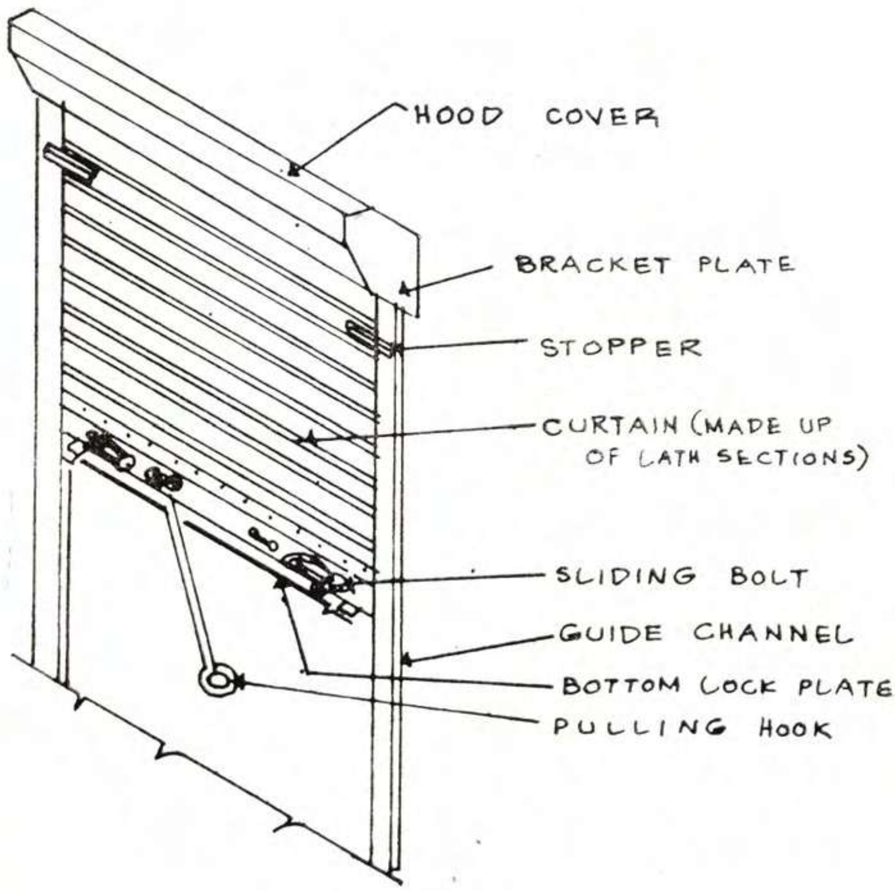
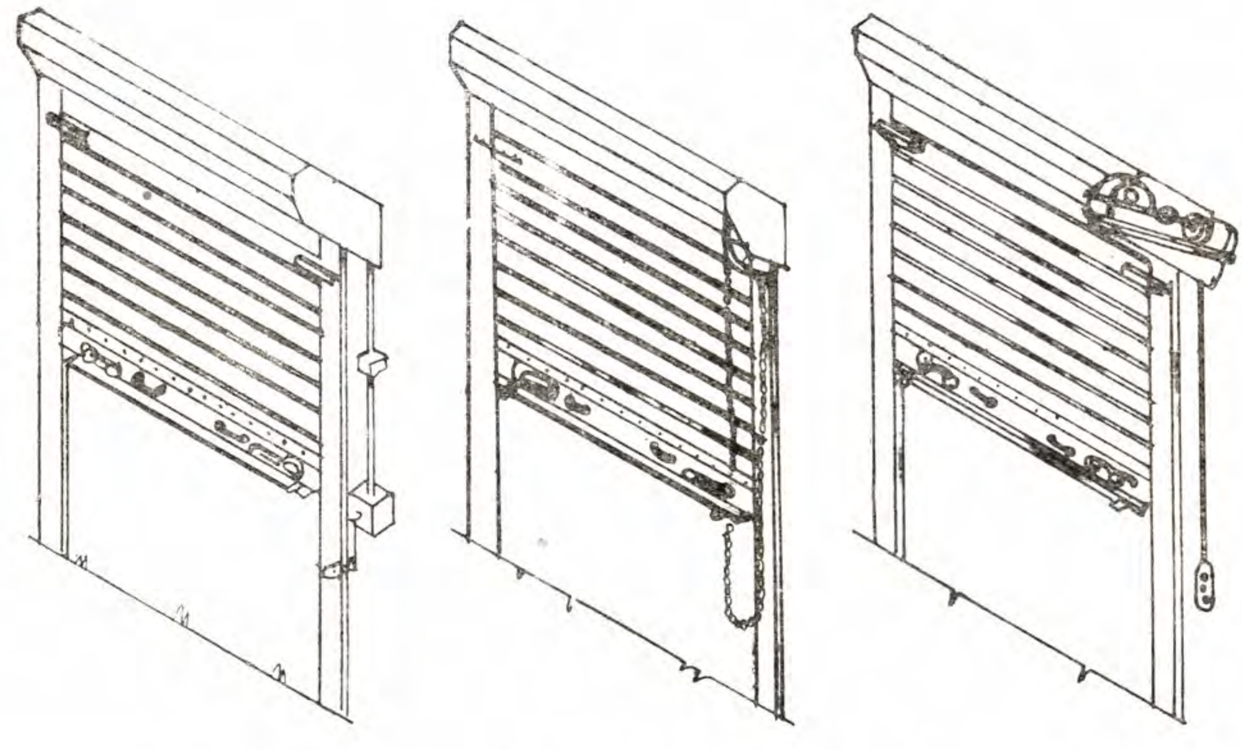


FIG. I. SELF-COILING SHUTTER SHOWING COMPONENT PARTS OF ROLLING SHUTTERS.



5A. GEAR OPERATED TYPE WITH CRANK HANDLE

5.B. GEAR OPERATED TYPE WITH CHAIN WHEEL & HAND CHAIN.

5.C. ELECTRICALLY OPERATED TYPE

FIG. 5. OPERATION OF SHUTTER

8.3.1. The controls provided for the electric motor shall include push button control through the medium of a 3 phase reversirg s tarter with interlocking contractors and overload protection. The reversing starter shall be wall mounted and fitted adjacent to the shutter in a convenient position. A minimum of 3 phase buttons marked "Forward", "Resverse" "Stop" or "Up". "Down", "Stop" shall be provided with a mechanical locking arrangement to prevent unauthorized or irregular operation of the push buttons. Limit switches shall be provided to cut off current to the motor when the rolling shutter reaches the limit of its travel in the "Up" and "Down" directions.

8.3.2. Arrangement shall also be provided for emergency mechanical operation of the rolling shutter in the event of failure of electricity or electrical equipment. The emergency mechanical operation shall be by an auxiliary chain wheel and hand chain drive on the worm shaft.

9. *Rolling Grills* :

9. 1. Roing grills are similar in design construction and operation to rolling shutters and consequently all the provisions applicable to rolling shutter apply edually to rolling grills exept in respect of the curtains. Rolling grill curtains may be built of aluminium alloy (*see* 6.8 and 6.9) or cold rolled steel sheet links of 0.90 mm thickness assembled on tubes or rods. Grills may also be manufactured out of 8 mm dia. mild steel or alluminium alloy round bars

9.1.1. Rolling grill links may be manufactured in a number of designs to suit manufacturers' convenience and customers' preference as also the purpose, the degree of safety required, etc. The details of fabrication and assembly of the rolling grill curtain depend on the actual type of links chosen. The function of a rolling grill is to provide visibility and/or ventilation where necessary. At the same time, it provides less protection and less saftey as compared to rolling shutter. This factor shall be borne in mind when specifying rolling grills.

92. *Rolling shutter-cum-Grill.*— In situations where a certain amount of ventilation combined with safety is called for, forexample, in transformer rooms, sub-stations, etc., the rolling shutter may have a small rolling grill portion either at the top, or at the bottom or at both places. The height of the grill portion shall be maximum of 0·5 m.

APPENDIX A.

(*Clause* 0.3)

Information to be supplied by the Purchaser while placing the order.

A-1. The purchaser shall furnish information to the manufacturer or the supplier in regard to the following points ;—

(*a*) Clear width and clear height of the opening together with a drawing of the opening, if possible (*see* 3.1 and 3.2).

(*b*) Special stopper height to be stipulated, if any ;

(*c*) Thickness of lath section required, that is, 0.900 mm or 1.25 mm.

(*d*) Position of fixing (*see* 4) ;

(*e*) Type of shutter required, that is self-colling type or gear operated type or electrically operated type (*see* 5.1).

(*f*) Detail of construction of masonry around the opening that is whether brick masonry, stone masonry, concrete or structural steel;

(*g*) Details of any beams, sunshades, etc. that may be present near the opening either parallel to it or perpendicular to it, together with the clearance, etc. ;

(*h*) Thickness of wall or column, where gear-operated shutters require crank handle or chain gear operation both from inside and outside ; and

(*i*) Special or optional features required , if any (*see* 7.10).

EXTRACT FROM I.S. 723—1961.

Specification for mild steelwire Nails.

1. *Scope.*

1.1. This standard covers requirements of mild steel round wire nails of the following types :

(*a*) Plain head nails (*See* Fig. 1).

(*b*) Lost head nails (lost head brads) (*See* Fig. 2).

(*c*) Clout, slate or felt nails (*See* Fig. 3).

(*d*) Exrta large head felt nails (*See* Fig. 4).

(*e*) Roofing nails (convex head, chisel point) (*See* Fig. 5).

(*f*) Panel pins (*See* Fig. 6).

(*g*) Lath nails (*See* Fig. 7).

(*h*) Wall nails (*See* Fig. 8).

(*i*) Cut-lath nails (cut tacks) (*See* Fig. 9), and

(*k*) Round wire dowells with double diamond points (dowell pins) (*See* Fig. 10).

2. *Material.*

2.1. Nails shall be manufactured from mild steel wire conforming to * I. S. 280-1951 Specification for Mild Steel Wire (Tentative) having a minimum ultimate tensile strength of 55 kg/m.2 and satisfying the following bend test. The condition of 55 kg/mm2 minimum tensile strength shall not apply to wire for extra large head nails due to annealing property needed for wire to form extra large head :

Suitable test pieces when cold shall not break or develop cracks when doubled over, either by pressure or by blows from a hammer, until the internal radius is equal to the diameter of the test piece and the sides are parallel.

4. *Dimensions and Tolerances.*

4.1. The dimensions of the different types of wire nails shall satisfy the respective requirements specified for there in Fig. 1 to 10 and Table I.

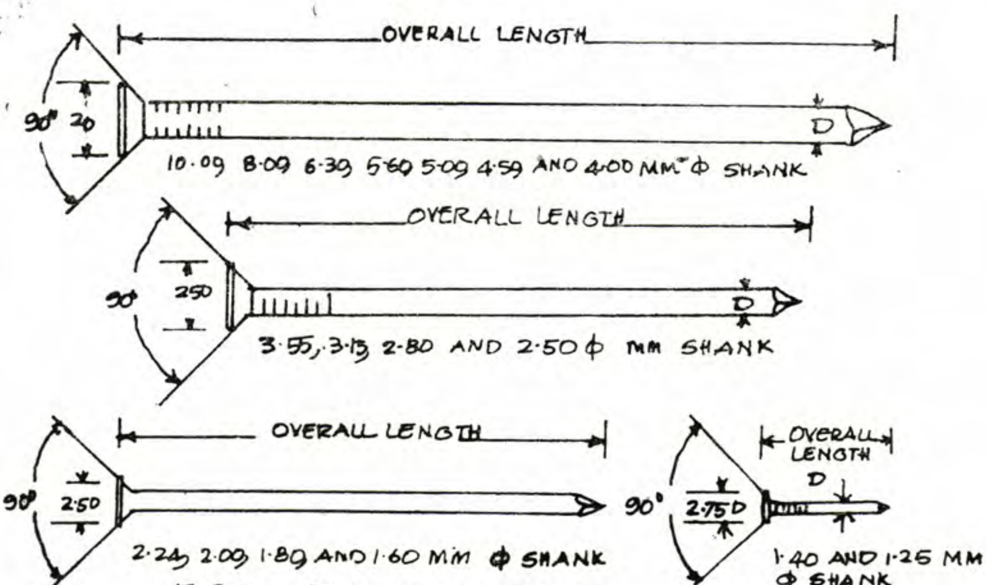


FIG 1. PLAIN HEAD NAILS

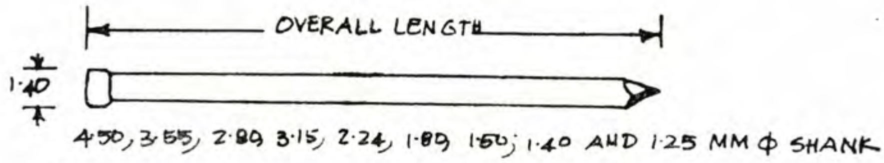


FIG 2. LOST HEAD NAIL (LOST HEAD BRAD)

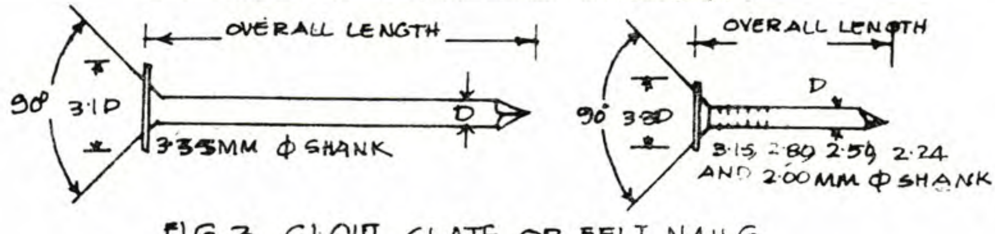
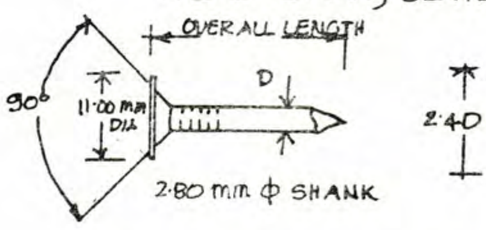


FIG 3 CLOUT, SLATE OR FELT NAILS



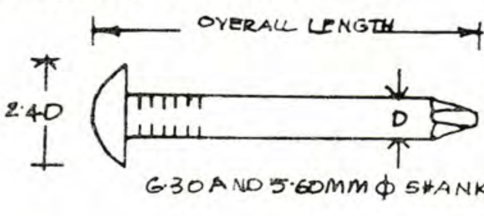
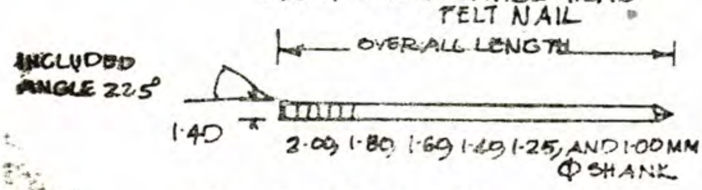


FIG 4 EXTRA LARGE HEAD FELT NAIL

FIG 5 ROOFING NAIL (CONVEX POINT, CHISEL POINT)



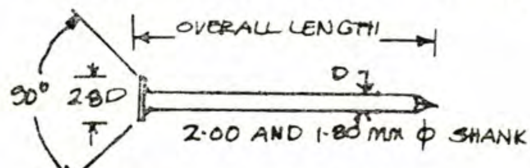


FIG 6. PANEL PIN

FIG 7. LATH NAIL

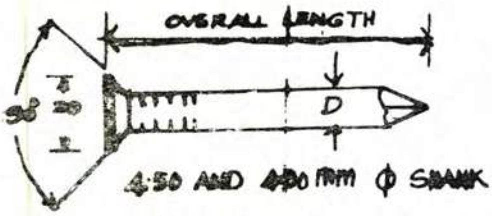


FIG. 8 WALL NAIL

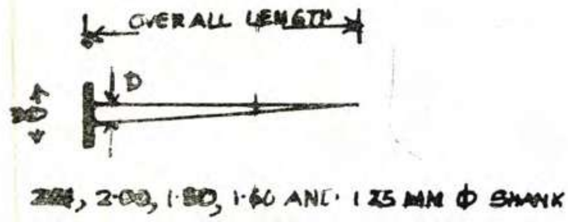


FIG. 9 CUT LATH NAIL (CUT TACK)

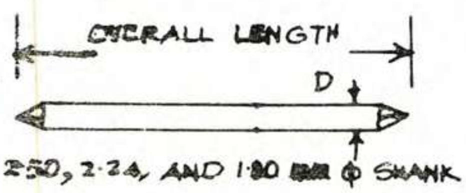


FIG. 10 ROUND WIRE DOWELS WITH DOUBLE DIAMOND POINTS (DOWEL PINS)

4.2. *Tolerances.*

4.2.1. The maximum permissible variations for wire nails, other than cut-lath nails (cut tacks), form the dimension given in Table 1 shall be as follows :

Diameter of Shank D mm	Tolerance on. Head Dia. percent.	Dia. of Shank D. mm	Overall length mm
(1)	(2)	(3)	(4)
10.00 to 2.50	± 5 for all nails except extra large head felt nails in which case it shall be. — 0 + 5	±0.06	−0.0 +1.5
2.50	±5	±0.05	− 0 + 1
Less than 2.50 ..	± 5	±0.04	−0 +1

4.2.2. In the case of cut-lath nails (cut tacks) the maximum permissible variations from the dimensions given in Table I shall be as follows :

Tolerance on Head Dia. percent.	Dia. of Shank D. mm.	Over all length mm.
± 5	± 0.10	± 1

TABLE I—DIMENSIONS AND APPROXIMATE COUNT OF ROUND MILD STEEL WIRE NAILS.

(*Clauses* 4.1, 4.2.1 *and* 4.2.2.)

Type of Nail.	Length. mm	Diameter of Shank D. mm	Head Diameter mm	Approximate No. of Bright nails per Kg.
(1)	(2)	(3)	(4)	(5)
Plain Head Nails ..	250	10·00	20.0	7
	225	8.00	16.0	10
	200	8.00	16.00	12
	175	6·30	12·6	22
	150	6·30	12·6	30
	150	5,60	11.2	35
	125	5·60	11·2	40
	125	5·00	10·0	60
	100	4·50	9·0	80
	100	4·00	8·0	90
	100	3·55	8·00	100
	90	4·50	9·0	90
	90	4·00	8·0	105
	90	3·55	8·0	110
Plain Head Nails—*cont.*	80	4·00	8·0	120
	80	3·55	8·0	140
	70	3·55	8·0	150
	70	3·15	7·1	190
	70	2·80	6·3	290
	70	2·50	5·6	390
	70	2·24	5·6	450
	60	3·55	8·0	180
	60	3·15	7·1	330
	60	2·80	6.3	350
	60	2·50	5·6	440
	60	2·24	5·6	540
	50	3·15	7·1	280
	50	2·80	6·3	440
	50	2·50	5·6	550
	50	2·24	5·6	600
	50	2·00	5·0	650
	45	2·50	5·6	600
	45	2·24	5·6	650
	45	2·00	5·0	800
	40	2·50	5·6	640
	40	2·24	5·6	700
	40	2·00	5·0	840
	35	2·24	5·6	1000
	35	2·00	5·0	1 050
	30	2·00	5·0	1,170
	30	1·80	4·5	1 41
	25	2·00	5,0	1,430
	25	1,80	4·5	1,720
	25	1·60	4,0	2,110
	20	1,60	4·0	2,710
	20	1·40	3·	3,740
	20	1,25	3·4	5,060
	15	1,60	4·0	3,94
Lost Head Nails (Lost Head Brads).	100	4,50	6.3	80
	80	3,55	5,0	150
	70	3,15	4.4	200
	60	3.15	4.4	240

TABLE 1—DIMENSIONS AND APPROXIMATE COUNT OF ROUND MILD STEEL WIRE NAILS—*cont.*

Type of Nail.	*Length.* mm	*Diameter of Shank D.* mm	*Head Diameter.* mm	*Approximate number of Bright Nails per kg.*
(1)	(2)	(3)	(4)	(5)
Lost Head Nails (Lost Head Brads)—*cont.*	50	2.80	3.9	400
	50	2.24	3.1	500
	40	2.24	3.1	700
	40	1.80	2.5	800
	25	1.60	2.2	1000
	20	1.40	2.0	1,400
	12	1.25	1.8	2,400
Clout, Slate or Felt Nails.	50	3.55	11.0	230
	50	3.15	10.4	285
	45	3.15	10.4	330
	40	3.15	10.4	385
	40	2.50	8.2	570
	40	2.24	7.4	700
	30	2.80	9.2	660
	30	2.50	8.2	825
	30	2.24	7.4	900
	25	2.80	9.2	810
	25	2.50	8.2	900
	20	2.80	9.2	1,030
	20	2.50	8.2	1,100
	15	2.24	7.4	1,500
	12	2.00	6.6	2,400
Extra large head Felt Nails.	25	2.80	11.0	480
	20	2.80	11.0	580
	15	2.80	11.0	650
	12	2.80	11.0	740
Roofiing nails (Convex head, Chisel point).	80	6.30	15.1	50
	70	6.30	15.1	60
	60	5.60	13.4	80
	50	5.60	13.4	95

TABLE 1—DIMENSIONS AND APPROXIMATE COUNT OF ROUND MILD STEEL WIRE NAILS—*cont.*

Type of Nail.	*Length.* mm	*Diameter of Shank D.* mm	*Head Diameter.* mm	*Approximate number of Bright Nails per kgs.*
(1)	(2)	(3)	(4)	(5)
Panel Tins	50	2.00	2.8	770
	40	1.80	2.5	1,350
	40	1.60	2.2	1,580
	30	1.60	2.2	1,890
	30	1.40	2.0	2,440
	25	1.60	2.2	2,330
	25	1.40	2.0	3,080
	20	1.40	2.0	1,960
	20	1.25	1.8	5,280
	15	1.25	1.8	6380
	15	1.00	1.4	8,800
	12	1.25	1.8	7,700
	12	1.00	1.4	10,780
Lath Nails	40	2.00	5.6	970
	30	2.00	5.6	1,170
	25	2.00	5.6	1,430
	25	1.80	5.0	1,740
	20	2.00	5.6	1,850
	20	1.80	5.0	2,240
Wall Nails	40	4.50	9.0	190
	30	4.00	8.0	260
Cut-Lath Nails (Cut Tacks).	40	2.24	6.7	8C0
	30	2.24	6.7	860
	25	2.00	6.0	1,060
	20	2.00	6.0	1,280
	20	1.80	5.4	1,370
	15	1.80	5.4	2,310
	10	1.80	5.4	3,280
	10	1.60	4.8	4,100
	5	1.25	3.8	9,770
Round wire .. .. Dowells with double Diamond Points (Dowell Pins).	50	2.50	..	440
	45	2.50	..	500
	45	2.24	..	640
	40	2.50	..	570
	35	1.80	..	1,400
	30	1.80	..	1,500

NOTE.—The number of nails per kilogram is likely to vary to a considerable extent. The figures given in Column 5 of this Table are intended only for guidance to the purchaser.

EXTRACT FROM I.S. 451—1961.

Specification for Wood Screws.

1. *Scope* :

1.1. This standard covers mild steel and brass wood screws used in buildings and furniture, and for other general purposes.

2. *Materials* :

2.1. *Mild Steel Wire* : Mild Steel wire to be used shall conform to I.S. 1812—1961 Specification for Mild Steel Wire for Manufacture of Wood Screws.

2.2. *Brass Wire.*

2.2.1. The brass wire for the manufacture of brass wood screws shall have the following chemical composition :—

Constituent.	*Per cent.*
Copper	60 ro 72
Zinc	28 to 40
Tin, Max	0.05
Iron, Max	0.1
Lead, Max	0.1
Total Impurities including tin, iron, lead, etc., Max. ..	0.8

2.2.2. Brass wire shall have a minimum ultimate tensile strength of 42.5 kg/mm^2 and a minimum elongation of 15 per cent, when tested in accordance with is : 497—1953 Specification for tensile testing of Metals non-ferrous.

TABLE I—SLOTTED COUNTERSUNK HEAD WOOD SCREWS.

(*Clause* 3.1 *and* 4.1)

Size of screw and diameter of unthreaded shank.				*Pitch.*	*Diameter of Head.*			*depth of Head C.*	*Slot.*		
Screw Designation.	*D*				Y	*B*			*Width, S.*		*Depth N+—*
	Nom.	*Max.*	*Min.*			*Max.*	*Min.*	*Max.*	*Max.*	*Min.*	*Max.*
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
0	1.52	1.55	1.47	0.85	3.20	3.04	2.89	0.89	0.58	0.48	0.48
1	1.78	1.85	1.70	0.91	3.73	3.56	3.43	1.02	0.71	0.61	0.53
2 .. .	2.08	2.16	1.98	0.98	4.42	4.16	3.91	1.17	0.84	0.74	0.61
3	2.39	2.46	2.29	1.06	5.05	4.78	4.52	1.32	1.97	0.86	0.69
4	2.74	2.87	2.64	1.15	5.84	5.48	5.23	1.50	1.02	0.86	0.76
5	3.10	3.23	2.97	1.27	6.63	6.20	5.94	1.75	1.14	0.99	0.91
6	3.45	3.58	3.33	1.41	7.39	6.90	6.55	1.98	1.27	1.11	1.04
7	3.81	3.94	3.68	1.59	8.20	7.62	7.34	2.16	1.27	1.11	1.14
8 ..	4.17	4.29	4.04	1.81	8.97	8.34	8.03	2.34	1.40	1.24	1.22
9	4.52	4.65	4.39	2.12	9.75	9.04	8.71	2.51	1.40	1.24	1.30
10	4.88	5.00	4.72	2.12	10.52	9.76	9.40	2.69	1.52	1.37	1.37
11	5.23	5.36	5.05	2.31	11.30	10.46	10.08	2.87	1.52	1.37	1.47
12	5.59	5.72	5.38	2.54	12.09	11.18	10.77	3.05	1.65	1.50	1.55
14	6.30	6.43	6.05	2.82	13.67	12.60	12.12	3.40	1.90	1.75	1.70
16	7.01	7.14	6.76	3.18	15.21	14.02	13.49	3.89	1.90	1.75	2.01
18	7.72	7.85	74.7	3.39	16.76	15.44	14.86	4.24	2.16	2.01	2.16
20	8.43	8.56	8.18	3.63	18.31	16.86	16.23	4.60	2.16	2.01	2.34
24	9.86	9.98	9.60	4.23	21.46	19.72	18.97	5.31	2.41	2.26	2.67
28	11.28	11.40	11.02	4.62	24.56	22.56	21.72	6.02	2.67	2.51	3.00
32 .	12.70	12.83	12.45	5.08	27.64	25.40	24.46	6.73	2.67	2.52	3.33

*The Dimensions for 'F' are the theoretical diameters of head to sharp corners and are given for design purposes.

** The maximum depth of head 'C' on a nominal size shank is given for the convenience of users only.

***Dimension' N' is measured from the top of the head to the point at which the slot breaks through.

TABLE II—SLOTTED ROUND HEAD WOOD SCREWS (clauses 3.1 and 4.1).

Size of screw and Diameter of unthreaded shank.				Pitch.	*Diameter of Depth of Head.*				*Radius of Head.*	*Slot*		
Screw Designation.	*D*				*B*		*H*		*R**	*Width S*		*Depth. N+*
	Nom.	*Max.*	*Min.*		*Max.*	*Min.*	*Max.*	*Min.*		*Max.*	*Min.*	*Max.*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
0 ..	1.52	1.55	1.47	0.85	3.04	2.89	1.14	1.02	2.67	0.58	0.48	0.66
1 ..	1.78	1.85	1.70	0.91	3.56	3.43	1.35	1.22	3.10	0.71	0.61	0.81
2 ..	2.08	2.16	1.98	0.98	4.16	3.91	1.57	1.45	3.66	0.84	0.74	0.94
3 ..	2.39	2.46	2.29	1.06	4.78	4.52	1.80	1.68	4.19	0.97	0.86	1.09
4 ..	2.74	2.87	2.64	1.15	5.48	5.23	2.06	1.80	4.80	1.02	0.86	1.24
5 ..	3.10	3.23	2.97	1.27	6.20	5.94	2.34	2.08	5.44	1.14	0.99	1.40
6 ..	3.45	3.58	3.33	1.41	6.90	6.65	2.59	2.34	6.05	1.27	1.11	1.55
7 ..	3.81	3.94	3.68	1.59	7.62	7.34	2.87	2.62	6.68	1.27	1.11	1.73
8 ..	4.17	4.29	4.04	1.81	8.34	8.03	3.12	2.87	7.29	1.40	1.24	1.88
9 ..	4·52	4.65	4.39	2.12	9.04	8.71	3.40	3.15	7.92	1.40	1.24	2.03
10 ..	4.88	5.00	4.72	2.12	9.76	9.40	3.66	3.40	8.53	1.52	1.37	2.18
11 ..	5.23	5.36	5.05	2.31	10.46	10.08	3.94	3.66	9.17	1.52	1.37	2.36
12 ..	5.59	5.72	5.38	2.54	11.18	10.77	4.19	3.91	9.78	1.65	1.50	2.51
14 ..	6.30	6.43	6.05	2.82	12.60	12.12	4.72	4·42	11.02	1.90	1.75	2.84
16 ..	7.01	7.14	6.76	3.18	14.02	13.49	5.26	4.90	12.27	1.90	1.76	3.15
18 ..	7.72	7.85	7.47	3.39	15.44	14.86	5.79	5.41	13.51	2.16	2.01	3.48
20 ..	8.43	8.56	8.18	3.63	16.86	16.23	6.32	5.92	14.76	2.16	2.01	3.78
24 ..	9.86	9.98	9.60	4.23	19.72	18.97	7.39	0.91	17.25	2.41	2.26	4.45

* The shape of the head should closely approximate to a half ellipse but it should be noted that except for the radius 'R' is impossible to control this shape accurately as it is dependant upon the flow of metal which occurs during forging.

+ Dimension 'N' is measured from the top of the head to the point at which the slot breaks through.

4. *Dimensions.—*

4.1. The Wood screws shall conform to the dimensions given in Tables I, II and III and the minimum depth of threads as specified in 4.2.

4.2. *Depth of threads*.—The depth of threads, measured at a distance of 1.5 to 2 times nominal diameter from the point, shall be not less than that specified in Table IV.

4.3. *Length of wood screws.*—Wood screws shall be of the following standard lengths :—

4, 6, 8, 10, 12, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 110, 125, 150, 175 and 200 mm.

The permissible tolerances in the nominal length of wood screws shall be as given below :

Length. (mm.)		*Tolerance.* (mm.)
Upto and including 10	..	+0 −0.5
Above 10, up to and including 25	..	+0 −0·8
Above 25	..	+0 −1.0

TABLE III—SLOTTED RAISED—COUNTERSINK HEAD WOOD SCREWS.
(*Clauses* 3.1 *and* 4.1.)

Size of screw and Diameter of Unthreaded Shank.					*Diameter of Head.*			*Depth of Head*		*Radius of Head. R*	*Slot.*		
Screw Designation.	*D*			*Pitch.*		*B*					*Width S*		*Depth N++*
	Nom.	*Max.*	*Min.*		*	*Max.*	*Min.*	*C* +	*E*		*Max.*	*Min.*	*Max.*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
0	1.52	1.55	1.47	0.85	3.20	3.01	2.89	0.89	0·51	2.54	0.58	0.48	0.82
1	1.78	1.85	1.70	0.91	3.73	3.56	3.43	1.02	0.58	2.97	0.71	10.6	0.91
2	2.08	2.16	1.98	0.98	4.42	4·16	3.91	1·17	0.69	3.48	0.84	0.74	1.04
3	2.39	2·46	2.29	1·06	5.05	5.48	4.52	1·32	0.79	3.99	0.97	0·86	1.19
4	2.74	2.87	2.64	1.15	5.84	4.38	5.23	1.50	6.91	0.57	1.02	0.86	1.35
5	3.10	3.23	2.97	1.27	6.63	6.20	5.94	1.75	1.04	5.16	1.14	0.99	1.60
6	3.45	3.58	3.33	1.41	7.39	6.90	6.65	1.98	1.14	5.77	1.27	1.11	1.80
7	3.81	3.94	3.68	1.59	8·20	7.62	7.34	2.16	1.27	6.35	1.27	1.11	1-96
8	4.17	4.29	4.04	1.81	8.97	8.34	8.03	8.34	1.40	6.93	1.40	1.24	2.13
9	4.52	4.65	4.39	2.12	9.75	9.04	8.71	2.51	1.50	7.54	1.40	1.24	2.26
10	4.88	5.00	4.72	2.12	10.52	9.76	9.40	2·69	1.63	8.13	1.52	1.37	2.44
12	5.59	5.72	5.38	2.54	12.09	11.18	10.77	3'05	1.85	9.32	1.65	1.50	2.74
14	6.30	6.43	6.05	2.82	13.67	12.60	12.12	3.40	2.11	10.49	1.90	1.76	3.07
16	7.01	7.14	6.76	3.18	15.21	14.02	13.49	3.89	2.34	11.68	1.90	1.75	3.53
18	7.72	7.85	7.47	3.39	16.76	15.44	14.86	4.24	2.57	12.88	2.16	2.01	3·84
20	8.43	8.56	8.18	3.63	18.31	16.86	16.23	4.60	2.82	14.05	2.16	2.01	4.47
24	9.86	9.98	9.60	4.23	21.46	19.72	18.97	5.31	3.28	16.43	2.41	2.26	4.08

* The dimensions for 'V' are the theoretical diameters of head to sharp corners and are given for design purposes only.

\+ The depth of head 'C' on a nominal size shank is given for the convenience of users only.

++ Dimension 'N' is measured from the top of the head to the point at which the slot breaks through.

TABLE IV—DEPTH OF THREADS.
(*Clause* 4.2)

Size of Screw.	*Depth of Screw. Min. (mm·)*	*Size of Screw.*	*Depth of Screw. Min. (mm·)*
Screw designation.			
0	0.20	10	0.66
1	0.23	11	0.71
2	0.25	12	0.76
3	0.30	14	0.86
4	0.46	16	0.96
5	0.41	18	1.04
6	0.46	20	1.14
7	0.51	24	1.35
8	0.56	28	1.55
9	0.61	32	[illegible]

SECTION XIII

ROAD WORK

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SECTION XIII.

ROAD WORK.

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SECTION XIII.

ROAD WORK.

INDIAN STANDARD EXTRACTS

SECTION XIII.

ROAD WORKS.

SPECIFICATION No. 85.

1. *Road Construction and Repairs* :

1·1. Road formation for new roads - (a) Preparation of bed :

1.1.1. *Clearing* :Clearing shall consist of the cutting and disposing of trees bush, shrubs, windfalls, logs and objectionable vegetation occurring within the clearing limts, as hereinafter defined, or which interfere with excavation, embankment, or designated clear vision areas.

1.1·2. All of the areas of the right of way so designated on the plans or in the special provisions, and all areas between lines 1·5 metres outside of the grading limits for cuts, fills, channels, ditches, and borrow pits shall be cleared of all trees, bush, shrubs, and objectionable vegetation occurring within clearing limits as above defined with the exception of those that are designated to be saved and the products thereof shall be disposed of as hereinafter provided

1.1.3. All desirable and structurally sound trees and shrubs suitable for shade or road beautification purposes and occurring within the clearing limits but located 5 m. or more from the outside edges of the proposed pavement and located at a point where the existing ground surface or base of the tree or shrub, will be at the surface of the proposed grading section or where a fill of not more than 1·2 m. or a cut of not more than 600 m. will occur at the location of the tree or shrub, shall be preserved unless otherwise specified on the plans, in the special provisions, or directed by the Engineer.

1·1·4. Trees and shrubs located beyond the clearing limits shall not be removed unless their removal is specifically authorised. Within areas to be cleared, and where gurbbing is not required, all shrubs shall be cut within 75 mm. of the ground surface and all trees shall be clean cut as nearly flush with the ground surface as is reasonably possible with tools ordinarily used for such operations.

1·1·5. Trees and shrubs located beyond the clearing limits of way shall not be damaged or injured by the Contractor, his agents, his employees, or through his operations.

1·1·6. When limbs or branches of trees to be left in place overhand the road bed and do not leave a clearance of at least 5 m above the finished grade, such trees shall be carefully and symmetrically trimmed of their lower limbs or branches so as to provide a clearance of not less than 5·3 m. above the finished grade. Such trimming shall be performed in a manner as directed in accordance with generally accepted horticultural practices (*vide* Vol. II-Chapter 7 on Road side development of Tamil Nadu Highways Manual).

1·1·7. Where feasible trees shall be felled towards the centre of the area to be cleared. Where trees cannot be felled without danger to traffic or injury to other trees, structures, or property, they shall be cut in sections from the top down.

1·1·8. The ground shall be formed to the proper gradient, camber, super elevation, etc., corresponding to the required finished surface by trimming the surface. If necessary, all soft spots shall be excavated and filled in with approved soil and well rammed. Surplus spoil (if any) shall be placed clear of the road formation. The formation shall be watered and rolled, if required. Relevant S.S.R.B. shall apply for standards regarding proper gradient, camber, superelevation width of roadways vertical and horizontal covers, etc., depending upon the nature of road finish.

1·2. *Setting out* : The line and levels of formation, side slopes drainage carriage ways, foot-paths and shoulders, etc., shall be carefully set out and frequently checked, care being taken to ensure that correct gradients and cross sections are obtained at all places. The finished surface of the carriage ways and foot-paths shall be formed so as to provide adequate fall and satisfactory run off at all surface water outlets, gullies, etc.

1·3. *Borrow pits* : Borrow pits shall be rectangular in shape with the side paralled to the centre line of the road· The depth shall however, be so regulated that the borrow pits do not cut an imaginary line having a slope of 1 in 4 projected from the edge of the final section of the bank. Borrow pits shall not be dug continuously. Ridges of not less than 8 metres width shall be left, at intervals not exceeding 300 metres. Small drains shall be cut through the ridges, if necessary, to facilitate proper drainage. The borrow pits shall be well drained. To ensure efficient drainage the bed level of the borrow pits shall be as far as possible, slope down progressively towards the nearest cross drain, if any, and shall not be lower than the bed of the cross drains.

1·4. *Drains* : Side drains, catch water drains, cross drainages, culverts etc., shall be provided as indicated and shall be paid for under the respective sections of the schedule.

1·5· *Preparing formation* : The ground shall be formed to the proper gradient, camber, super elevation, etc., corresponding to the required finished surface by trimming the surface. If necessary all soft spots shall be excavated and filled in with approved soil and well rammed. Surplus spoil (if any) shall be placed clear of the road formation. The formation shall be watered and rolled, if required.

1·6. For further details, Section 3-Earth work in Tamil Nadu Building Practice shall apply.

2. *Collection of materials and stacking*.

Stone and coarse aggregates :

2.1. *Source* : Stone for soling, block kankar, road metal, coares aggregate, chipping, etc., shall be obtained from the quarries/sources as specified in the contract, when the quarry/sources is not so specified these shall be obtained from the sources, approved by the Executive Engineer, from which the best materials normally used for the purpose in the locality are obtained. A sample of the material shall be kept in the custody of the Executive Engineer and all subsequent supplies shall conform strictly to the samples.

2.2. *Stone for soling*.

2·2·1. *General* : Stone for soling shall be broken granite, trap basalt lime stone, sand stone laterite, Kankar or any other rock as indicated. Stone shall be clean, hard reasonably free from laminations, unsound fragments and free from decay and weathered staff. Smaller stones for filling voids shall be of the quality rot inferior to that of the larger stones.

2·2·2. *Shape and size* : The stone shall be as regular as can be obtained by quarrying without attempt at shaping or dressing. Stone for soling shall be in the smallest dimensions equal to thickness of telfored base which will be ordinarily 15 to 22 cm.

2·2·2·1. When boulders are used for soling, these shall not be less than 13 cm. when measured across the broadest part in any direction.

3. *Course aggregate for water bound macadam.*

3·1. *General* : (1) Course aggregate shall be of crushed or broken stone, laterite or Kankar, etc., as indicated. Unless otherwise specified, screening shall be of the same material as course aggregate.

3·1·1. Crushed or broken stone aggregate shall be hard and durable and shall be free from excess of flat, elongated, soft and disintegrated particles dirt and other objectionable matter.

(*b*) Crushed or naturally occurring aggregate shall meet the following requirements :—

(*i*) Flat or elongated pieces —not more than 15 per cent.

(*ii*) Wear at 500 revolitons —not more than 40 per cent of Loss Angeles Ruttler Test.

3·2. *Size and grading of coarse aggregate* : Coarse Aggregate shall be graded as under :

Coarse Aggregate.	*Grade-ing Number.*	*Size Range.*	*I.S. Sieve designation.*	*% Passing (by weight).*	*Remarks.*
(1)	(2)	(3)	(4)	(5)	(6)
Soft stones like .. laterite, etc.	1	90 mm to 40 mm	100 mm	100	Suitable for surface treated WBM course.
			80 mm	65–85	
			63 mm	25–60	
			40 mm	0–15	
			20 mm	0–5	
Harder stones, lime stone, sand stone, flint, quartzite, etc.	2	**63 mm to 40 mm**	80 mm	100	Suitable for surface treated WBM course.
			63 mm	90–100	
			50 mm	35–70	
			40 mm	0–15	
			20 mm	0–5	
Hard tough stone granite, trap or basalt.	3	**50 mm** to 20 mm	63 mm	100	
			50 mm	95–100	
			40 mm	35–70	
			20 mm	0–10	
			10 mm	0–5	

3·2·1. The maximum size to be used in any case would depend upon the type of aggregate available and the total consolidated thickness of the layer the harder the material the smaller the size.

3·2·2. For aggregate such as Kankar, laterite, etc., which get crushed excessively under roller, the above suggested grading is not very important.

3·3. *Tests on Aggregates* : Following tests shall be performed on the samples of coarse aggregate and it shall meet the requirements noted against each test:—

(i) *Field Test* : Sieve analysis as in paragraph 3·2.

(ii) *Impact test* : Maximum fines 40 per cent for base course maximum fines 30 per cent for wearing course.

(iii) *Water absorption test*: Maximum 1 per cent, if considered necessary by the Executive Engineer, the following laboratory tests shall be performed.

(iv) *Wetting and drying tests* : The sample shall be subjected to alternate drying and wetting for 3 days and shall not show signs of disintegration.

(v) *Loss Angles Wear Test* (As per I.S. 2386),– Maximum percentage fines 50 for base course maximum percentage fines 40 for wearing course.

4. *Size and grading of screenings*

4·1. The screenings and other filler material used to fill voids in the coarse aggregate shall as for as possible, meet the following gradings,

Coarse Aggregate.	*Grading classification.*	*Size of screenings.*	*I.S. Sieve designation.*	*% Passing (by weight)*
(1)	(2)	(3)	(4)	(5)
Lime stone, flint, quartzite, Kankar and laterite.	A	12·5 mm	12·5 mm	100
			10 mm	09–1
			4·70 mm	10-800
			150 micron.	0–30
Granite Trap and basalt.	B	10 mm	10 mm	100
			4·75 mm	85–100
			150 micion.	10–30

4·2. Screenings of type A shall be used with coarse aggregates of grading. 1. Screenings of type A or B as specified, shall be used with coarse aggregate of grading 2. Type B screenings shall be used with coarse aggregate of grading 3.

4·3. The use of screening may be omitted in the case of soft aggregate such as kankar and laterite.

5. *Binding Material.*

5·1. *Material* : The plasticity index of binding material in the screenings shall not exceed 9 in the case of unsurfaced water bound macadam course or where traffic is to be permitted on compacted water bound macadam before surfacing is laid and not more than 6 in the case of surface treated water bound macadam. Where lime stone formation exist nearby, lime stone dust or kankar nodules may preferably be used.

5·2. *Field Tests* : When sample of the binding material is wetted and squeezed in hand, the following characteristics shall be noted :

(i) The material is extremely gritty.

(ii) It can be formed into definite shapes that retain their form even when dried.

(iii) When the wetted sample is potted in the palm of the hand, it will compact into dense cake that cannot be penetrated readily with a blunt stick.

5·3. *Coarse aggregate for bituminous work.*

5·3·1. *General* : Coarse aggregate for bituminous work shall consist of broken/crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable of fairly cubical shape and free from disintegrated pieces salt, alkali, organic or other deleterious matter. The aggregates shall preferably be hydrophobic in nature and of low porasity.

5·3·2. *Size and grading of coarse aggregate* :

(*a*) *Surface dressing* : The size of the stone chippings shall be as under : —

Single coat.	*Two coat.*	*Specification.*
(1)	(2)	(3)
(i) For first coat, 12mm nominal size.	For 1st coat, 10 mm nominal size.	100 Per cent passing through 20 mm sq. mesh sieve and retained on 10 mm sq. mesh sieve.
(ii) For subsequent or renewal coat ; 100 mm nominal size.	For 2nd coat, 10 mm nominal size.	100 Per cent passing through 12.5 mm sq. mesh sieve and retained on 6·3 mm sq. mesh sieve.

(*b*) *Bitumen and Tar Carpets.*— Rounded gravel shall be used only, if specifically permitted by the Executive Engineer and shall be of the also as specified above.

(*c*) *Pre-mixed tar/Bitumen macadam.*—The grading of coarse aggregate for premixed Tar/bitumen macadam of different thickness shall be as under:

I.S. Sieve Designation.	*Percentage passing by weight.*	
	70 mm compacted thickness.	50 mm compacted thickness.
(1)	(2)	(3)
63 mm ..	100	....
50 mm ..	90–100	100
40 mm ..	35–65	90-100
25 mm ..	20–40	50-80
20 mm ..	0–15	....
12·5 mm ..	5–20	10–30

(*d*) *Premixed bitumen concrete.*—The size of coarse aggregate for premixed bitumen concrete of different thickness shall be as under : –

(i) 4 cm. compacted thickness 12 mm nominal size.

(ii) 5 cm. compacted thickness 20 mm nominal size.

(iii) 6 cm. compacted thickness 60 per cent 40 mm nominal size.
40 per cent 25 mm nominal size.

(iv) 7·5 cm. compacted thickness 60 per cent 50 mm nominal size.
40 per cent 40 mm nominal size

Here the nominal size of coarse aggregate shall mean as defined below :—

Nominal size of coarse aggregate.	*Designation of I.S. Sieve through which the aggregate shall wholly pass.*	*Designation of I.S. Sieve on which the aggregate shall wholly be retained.*
(1)	(2)	(3)
(i) 40 mm.	50 mm.	25 m.
(ii) 25 mm.	40 mm.	20 mm.
(iii) 20 mm.	25 mm.	12·5 mm.
(iv) 12 mm.	20 mm.	10 mm.
(v) 10 mm.	12·5 mm.	6·3 mm.
(vi) 6 mm.	10 mm.	2·36 mm.

(*e*) *Bitumen and Tar carpets.*—The size of chippings for bitumen and tar carpets shall be as under :—

(i) *Stone chippings 12 mm. nominal size.*—Passing through 20 mm. sq. mesh sieve and retained on 10 mm. sq. mesh sieve.

(ii) *Stone chippings 10 mm. nominal size.*—Passing through 12 mm. sq. mesh sieve and retained on 6 mm. sq. mesh sieve.

5.3.3. *Physical requirements.*—The aggregates shall satisfy the physical requirements set forth in the table given below :—

Serial number and Test.	*Test method.*	*Requirements.*
(1)	(2)	(3)
1 *Loss Angeles abrasion value.	I.S. 2386/1963 (Part IV).	35 per cent Maximum.
2 *Aggregate impact value.	Do.	30 per cent Maximum.
3 Flakiness Index ..	I.S. 2386/1963 (Part I).	25 per cent Maximum.
4 Stripping value ..	*Vide* Method given in Appendix III I.R.C. specification for Road and Bridge works.	25 per cent Maximum.
5 Water absorption ..	I.S. 2386/1963 (Part III).	1 per cent Maximum.

5.4. *Shingle.*—Shingle shall be clean and free from foreign matter and obtained from approved river or nallah beds. Shingle of all in size shall contain a sufficient proportion of fine material to fill all interstices and to ensure binding when consolidated.

5.5. *Gravel.—Gravel shall be composed of large, coarse, silicious grains, sharp and gritty to the touch and free from dirt and impurities.* Laterite gravel may be used if the excess of clay is separated by screening. All in size shall contain a sufficient proportion of fine material to fill all interstices and *to ensure binding when consolidated.*

5.6. *Laterite.*— When ordered for use as soling or breaking into metal shall be *hard, compact, heavy and of a dark colour. Light coloured sandy laterite and that containing much orchroons clay shall not be used on the work.*

5.7. *Kankar for base and wearing course.*

5.7.1. *General.*—Kankar shall be clean, *tough*, free from dirt, flat or elongated, disintegrated particles, moorum, sand and *shall not contain clay* in the cavities between modules and shall not disintegrate on exposure to sun and rain. A *bluish surface* on *fracture* shall generally be indicated of *good quality.*

5.7.2. *Size and grading requirements* :

(*a*) Kankar for base course shall not be of size less than 10 cm.

(*b*) Kankar coarse aggregate for wearing course shall conform to the following grading :—

Size range.	*I.S. Sieve designation.*	*Percentage passing.*
(1)	(2)	(3)
63 mm.	80 mm.	100
to 40 mm.	63 mm.	90—100
	50 mm.	35—70
	40 mm.	0—15
	20 mm.	0—5

*Aggregates may satisfy requirement of either of the two tests.

The physical requirement for coarse aggregate (for light and heavy traffic) shall also apply as per S.S.R.B. No. 203-03 (b) wherever necessary.

5.7.3. *Tests.*—The following field tests shall be performed on samples of Kankar and it shall meet the requirements noted against each test :—

(i) Sieve analysis (as per I.S. 2386).—Refer paragraph 5.7.2.

(ii) *Dry impact test.*—Maximum percentage fines 50 for base course 32 for wearing course.

(iii) *Wet impact test.*—Maximum percentage fines 60 for base course 39 for wearing course.

(iv) *Wetting and dry test.*—A sample of Kankar when subjected to alternate wetting and drying for 3 days shall not show signs of disintegration.

5.7.4. *Source.*—The Kankar shall be obtained from the source specified in the contract or approved in writing by the Executive Engineer. Quarrying shall be done only from sound portions of the approved quarry, the disintegrated or weathered portions being rejected. A sample of the material approved shall be kept in custody of the Executive Engineer and all subsequent supplied shall conform strictly to the samples.

5.8. *Sand.*—For blinding tarred or bitumanised surfaces or for mixing withtar or bitumen shall be clean, hard, sharp, grity, coarse dr particles, free from earth, silt and other deleterious matter.

5.9. *Moorum.*—Shall be clean, of good binding quality and obtained from approved pits and quarried of disintegrated rocks which contain silicious material and natural mixture of clay of calcarious origin.

The size of the moorum shall not be more than 20 mm.

6.0. *Pre-moulded fillers for expansion joints.*

6.0.1. Pre-moulded fillers for expansion joints shall comply with h requirements of I.S. 1834–1961 specification for pre-moulded fillers for expansion joints in concrete, not extrading and resicilent type (Bitumen impregnated fibre). Fibre use may be of soft board, fibre board, or other suitable fibres (natural or artificial) of cellular nature and shall be securely bonded together and uniformly impregnated with bitumen.

6.0.2. Pre-moulded strips of expansion joint filler shall not be deformed by twisting, bending or other handling when exposed to atmospheric conditions. Pieces of the joint filler that have been damaged shall be rejected.

6.1. *Sealing compounds for joints in concrete.*—Sealing compounds for filling in the joints in concrete payment shall conform to I.S. 1834–1961, specifications for hot applied sealing compound for joints in concrete. Sealing compounds shall be either Grade A (Normal) or Grade B (Jet fuel resistant) as indicated.

6.2. *Bonders.*—(Tar and Bitumen).

6.3. *Road Tar.*—Road tar shall conform to I.S. 215/1961, specification for road tar (revised).

6.4. *Bitumen.*—(*a*) Paving Bitumen—shall conform to I.S. 73–1961 specification for paving bitumen.

(*b*) Cut back bitumen—shall conform to I.S. 217/1961.

(*c*) Bitumen Emulsion –shall conform to I.S. 3117/1965.

When binders are to be supplied by the contractor, he shall obtain these from approved manufacturers or their authorised agents and deliver to the site in makers, sealed containers bearing I.S.I. marking etc., Binders brought in damaged containers shall not be accepted. The Executive Engineer may call upon the contractor to produce vouchers, etc., so as to satisfy himself that the materials supplied by the contractor conform to relevant I.S. The binders shall be stacked in fenced enclosures as directed by the Executive Engineer on one side of the road way.

7.0. *Stacking of materials*:

7.1. The materials shall be stacked on the side of the road and clear of the road way. Stacks shall be uniformly distributed along the road in proportion of estimated quantities required for construction so that no rehandling is involved. The collection of the materials shall be completed for the entire work or for a complete stretch as directed by the Executive Engineer. Aggregates shall not be stacked, unless they have been screened to gauge and freed from all earth rubbish, etc., or any rejected materials. The rejected materials shall be removed from the site immediately. Measurements shall not be taken until sufficient materials have been collected and all rejected stuff has been removed. The contractor shall ensure that his transport vehicles do not drop any aggregate etc., on the road, and shall keep screens or sieves of proper size at the site of stacks at his own cost to enable the Executive Engineer to exercise checks reagrding sizes etc., if desired. The contractor shall also provide suitable template or bottomless boxes of suitable sizes so as to ensure sizes of stacks.

7.2. Materials shall be brought to the site sufficiently in advance of their use. Collection and utilisation of materials shall not be carried out simultameously in one and the same stretch of the road formation (usually one Km.) Before starting the operations involved with the utilisation, it shall be ensured that full estimated quantity of materials have been stacked along the road/formation in the specified stretch (usually one km.) in which it is proposed to start the operation.

8.0. *Sub-Grade.*

8.1. *Preparation of sub-grade.*—The surface of the formation for a width actual to that of soling course shall first be cut to a depth below the proposed finished level, equal to the combined depth of soling and wearing courses (due allowance being made of consolidation).

8.1.2. It shall then be cleared of all foreign substances. Any ruts, or soft yielding places that appear due to improper drainage conditions traffic hauling or any other cause shall be corrected and the sub-grade dressed off parallel to the finished profile.

8.2. *Consolidation of sub-grade.*—The sub-grade shall then be sprinkled wih water and rolled with minimum of 5 numbers of passes of 8-10 tonne smooth wheeled roller till the soil is evenly and densely consolidated.

8.2.1. All undulations in the surface that might develop due to rolling shall be made good with earth or quarry spoils as the case may be and the sub-grade re-rolled.

8.3. *Super elevation.*—All curves should be suitably cross banked, templates with straight profiles being used in place of cambered profiles adopted for straight reaches.

The super elevation depends on the design speed, of the road, which in turn depends on the class of road and nature of terrain. Paragraph 502.08 of S.S.R.B. shall apply.

The full super elevation shall be carried around the entire length of curve from P.C. to P.T. (i.e., from the beginning to end of curve). The transition from the cambered or two way slope on the tangents to the one way slope of the curve shall be spread gradually by raising the outside edge, the centre line elevation and inner edge remaining normal.

The road width shall gradually be increased by say 900 mm to 2.5 m at the centre of the curve on the inside. The amount of widening required shall be devided by the Executive Engineer after personal observation, to suit the condition of approaches, visibility, radius of curve, etc. The contractors shall be provided with cross section sheets showing the super elevation and widening at the transit strips and curves. For typical section showing variations,vide plan attached.

9.0. *Stone soling :*

9.1. General soling shall be constucted on the prepared sub-grade in conformity with lines, grades, thickness and cross section shown on drawings or as indicated by the Executive Engineer.

9.2. *Marking out*: The edges of soling shall be marked out by strings and stakes. The lines shall be carefully ranged.

9.3. *Laying and packing* : The soling stones shall be hand packed carefuly to the required cambers of the top surface by laying correct to the templates placed 15 metres apart. These shall be laid resting on their broad bases with their height equal to the thickness of the soling and the largest dimension at right angles to the centre line of the road. Stones shall be laid breaking joint in close contact with each other but not leaning against each other. Large size stones shall be arranged at the edges and the centre of the road. The joints shall be stagged. All interstices between soling stone shall be wedged in by smaller stones of suitable size well driven in by crow bars and hammers to ensure tight packing and complete filling of interstices. The wedging shall be carried out simultaneously with the placing in position of soling stone and shall not lag behind. After the hand packing has been completed, inequalities in the surface shall be checked with by templates and carefully set right.

9.4. *Consolidation* : The soling shall be consolidated by a road-roller of 8 to 12 tonne weight as directed by the Executive Engineer, depending upon the type of soling stones and the nature of sub-grade. Rolling shall progress from edges towads the centre, parallel to the centre line. Rolling shall be continued till a closly knit compacted surface is obtained. The surfaces shall again be checked by templates hollows corrected with spalls and consolidated.

10.0. *Water Bound Macadam*;

10.1. *Surfaced water bound Macadam* : Where the road side streps do not confine the spread metal, well tempered clay bunds or fillets about 15 cm wide and to the height required shall be formed on each side of the metal to prevent its spreading out during consolidation. These shall be laid true and parallel having a clear distance between them equal to the width to be metalled.

10.2. *Preparation of sub-grade, sub-base or base* : Sub-grade, sub base or base shall be well drained and cleared of all foreign substances, any ruts or soft yielding places that appear due to improper drainge conditions, traffic or hauling or from any other cause shall be corrected to the required grade, camber, shape and finish and thoroughly compacted before course aggregate is placed thereon.

In case of existing road surfaces, where new material is to be laid it shall be carified and reshaped to the required grade, camber and shape, if necessary. Weak places shall be strengthened, corrugations removed and depressions and potholes made good with suitable material before laying the water bound macadam course on it.

10.3. *Spreading coarse aggregate* : The coarse aggregate shall be spread uniformly and evenly upon the prepared in required quantities from stock piles along the side of the road way. But in no case shall the aggregate be dumped in heaps directly on the base within the area over which it is to be spread nor shall hauling over the partly completed base be permitted. The aggregate shall be spread uniformly to proper profile by using templates placed across the road about 6 metres apart.

10.3.1. The surface of the aggregate spread shall be carefully trued up and all high and low spots corrected by removing or adding aggregates as may be required. The surface shall be checked from time to time during the spreading and rolling of the coarse aggregate to ensure a finished surface without variation grater than 12.5 mm. when a 3 metre long straight edge is laid parallel to the centre line of the road. The coarse aggregate shall not normally be spread more than 3 days in advance of the subsequent construction operations.

10.4. *Dry Rolling* : Immediately following the spreading of the coarse aggregates rolling shall be started with 3 wheeled power rollers of 6 to 10 tonne capacity or tandem roller or equivalent vibratory roller. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Executive Engineer.

10.4.1. Except on super elevated portions where the rolling shall proceed from inner edge to outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with the roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road, in sucessive passes uniformly lapping preceding tracks by at least one half width.

10.4.2. Rolling shall continue until the aggregate is thoroughly keyed and the creeping of the aggregate ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done if necessary. Rolling shall not be done when the sub grade is soft or yielding or when it causes a wave like motion in the sub-grade or sub-base course.

10.4.3. The rolled surface shall be checked transversely and longitudinally with templates and any irregularities corrected by loosening the surface, adding or removing necessary amounts of aggregate and rerolling untill the entire surface conforms to desired camber and grade. In no case shall the use of screenings be permitted to take up depressions.

10.5. *Application of screenings*: After the coarse aggregate has been thoroughly keyed and set by rolling, screenings to completely till the interstices shall be applied gradually over the surface. Dry rolling shall be continued while the screenings are being spread so that the vibration of the roller will cause them to settle into the voids of the course aggregate. The screenings shall be spread uniformly in successive thin layers in three or more operations to fill all voides. Screenings shall not be applied so fast and thick as to cake or bridge on the surface. Rolling and brooming shall continue with spreading of the screenings until no more screenings can be forced into the voids. Damp and wet screenings shall not be used. The spreading, rolling and brooming of screenings shall be performed on sections which can be completed within one day's operation.

10.6. *Sprinkling and grouting* : After the screening have been applied the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the screeings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be confined, with additional screenings applied as necessary, until the coarse aggregate has been thoroughly keyed, well bonded and firmly set in its full depth and a grout has been formed of the screenings. Care shall be taken to see that the base or sub-grade does not get damaged due to addition of excessive quantities of water during construction.

10.7. *Application of binding material* : After the application of screenings, the binding material (comprising of a suitable material approved by Executive Engineer having plastic index value of less than 6) where it is required to be used shall be applied sucessively in two or more thin layers at as low and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms or mechnical brooms to fill the voids properly, and rolled during which ware shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms a wave head of the wheels of the moving roller.

10.8. *Setting and Drying* : After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning, hungry spots shall be filled with screenings of binding material as directed, lightly sprinkled with water, if necessary, and rolled. No traffic shall be allowed on the road until the macadam has set. The Executive Engineer shall have this discretion to stop hauling traffic from using the completed water dound macadam source if in his opinion it would cause excesive damage to the surface.

11.0 *Unsurfaced Water Bound Macadam*

11·1 *Application of screenings* : The quantity of screening used shall be such as to fill only approximately 50 per cent of the voids. The rest of the voids shall be filled with filter material.

11.2. *Wet Rolling* : After the application of screening and dry rolling. filler material shall be applied at a uniform and slow rate in two or more successive thin layers. After each application of the filler material, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms or mechnical brooms or both, to fill the voids properly and the surface rolled by a 6 to 10 tonne roller, water being applied to the wheels in order to wash down the binding material that may stick to the wheels of the roller. The spreading of filler material, sprinkling of water sweeping with brooms and rolling shall continue until the slurry that is formed will, after filling the voids, form a wave ahead of wheels of moving roller.

11.2.1. After the final, compaction of the course, the road shall be allowed to dry overnight and when the surface is still damp, a layer of sand of quarry dust, grit etc., about 6 mm thick shall be spread on the surface, lightly sprinkled with water, if necessary and rolled. No traffic shall be allowed till the macadam sets.

12.0. *Priming With Bituminous Primers.*

12.1. *Preparation of Surface* : The surface to be primed shall be swept clean, free from, dust, dirt or other deleterious matter by hand brushing with wire brushes, bass brooms and finally by fanning the cleared surface with gunny bags to remove all loose dirt. Large irregularities, pot holes, depression, etc., shall be repaired before priming, as indicated.

12.2. *Application of bituminous primer* : Primer shall be sprayed uniformly at the rate specified herein below, over the prepared surface using machanical sprayers and it shall be sprayed at normal air temperature. No bituminous primer shall normally be applied on wet surface or during dust storm or when the weather is foggy or an rainy. Any further treatment such as surfacedressing primer carpet, etc., shall be applied after the lapse of 24 hours. At the end of this period, if there are any random spots containing traces of excess primer they shall be blotted with sand and wherever necessary additional primer shall be applied.

12.3. *Quantity of bituminous primer*: Quantity of Bituminous primer for different types of surface shall be as under :—

Type of surface.	*Quantity of primer per 10 sq. metre.*
Surface of low porosity	7,5 to 10 Kg
Surface of medium porosity	10 to 12 Kg
Surface of high porosity	12 to 15 Kg

13.0. *Surface dressing with tar / bituminous.*

13.1. *Single coat surface dressing.*

13 1.1. *Prepration of road surfaces.*—The surface shall be prepared by sweeping clean and free from dust, dirt or other deliterious matter by hand brushing with wire brushes, bass brooms, and finally by fanning the cleaned surface with gunny bags to remove all loose dirt if the surface to be treated is an old bituminous surfacing, it shall be swept clean and free from sand, dust and other loose foreign matter by means of mechanical sweepers and blowers and if available, supplemented by hand brooms or by means of wire brushes, small packs, bas brooms etc. The edges of the surface to be treated shall be defined by rope lines stretched in position.

13.12. Any depression or pot holes, if any, shall be repaired as indicated. The surface shall be thoroughly dried before application of binder.

13.1.3. *Application of binder.*—After the surface to be treated has been prepared as indicated above in a perfectly dry condition the binder heated to a temperature as recommended by the manufacturer shall be sprayed over the surface preferably using mechanical sprayers, The sprayer shall be operated in such a way as will ensure an even and uniform distribution of the binder on the road surface. An even and uniform distribution of the binder shall be ensured from the calibration chart showing the relation between pumping pressure height of the nozzle above the road and the amount of binder that will be deposited per minute at a specific temperature. Excessive deposits of the binder on the road surface caused by stopping and starting the sprays of distributor or by leakage shall he avoided. Spraying shall be carried out parallel to the centre line of the road.

13.1.4. *Application of covering material Chippings).*— immediately following the application of the binder, stone chippings in a perfectly dry condition, shall be uniformly and evenly spread at rate indicated below over the entire surface, which has been sprayed. The surface shall be checked by means of a camber board laid across the road and a three metre straight edge laid parallel to the centre line of the road and the irregularities, if any, shall be corrected by removal or addition of bindage.

The rate of application of binder and aggregate per ten sq. metres of surfacing shall be as under :—

Aggregate.		*Binder in kg.*			
Nominal size.	*Quantity in Cu. m.*	*Straight run.*	*Cut back.*	*Road Tar.*	*Emulsion.*
(1)	(2)	(3)	(4)	(o)	(6)
1. *Surface water bound macadam surface:*					
12 mm.	0·14 to 0·15	17 to 20	20 to 22	17 to 22	..
2. *Subsequent or renewal coats.*					
10 mm.	0·09 to 0·11	10 to12	10 to 12	12 to 16	...
10 to 30 mm. ..	0·08				10 to 12

13.1.5 *Rolling* The blinded or gritted surface shall be rolled with a 8 to 10 tonne road-roller. The rolling shall begin at the edge and proceed lengthwise, over the area to be rolled lapping not less than one third of the roller tread and proceed towards the centre. When the centre is reached, the rolling shall then start at the opposite side and again proceed towards the centre. In the super elevated portions, the rolling shall proceed from the inner to the outer edge. While the rolling is in progress, additional aggregate, if required, to fill the irregularities, shall be spread. Rolling shall be continued until the chippings are firmly embedded in the bituminous material and present a uniform closed surface. Excessive rolling which results in the crushing of the aggregate shall be avoided.

13.1.6. *Finishing.* The finished surface shall be uniform and conform to the lines, grades and cross section indicated, and when tested with a template and straigt edge shall show no variation greater than 6 mm. over a three metre length.

13.1.7. *Opening to Traffic*—Where straight run bitumen or road tar is used as binder, the finsihed surface shall be thrown open to traffic on the following day.

13.1.8. Where cut back bitumen and emulsion is used, the finished surface shall be kept closed to traffic until it has sufficiently cured to hold the cover aggregates in place.

13.2. *Simultaneous Two coats—Surface dressing.*

13.2.1. The second coat shall be applied immediately after the first coat before opening the road to traffic so that binder in the second, grouts the chipping of the first coat.

13.2.2. Both the coats shall be applied as described before except that no cleaning etc., of the surface shall be necessary for the second coat. The rate of application of binder and aggreage for first and second coat shall be as under :

Surfacing.	Aggregate. Normal size.	Aggregate. Quantity in cu. m.	Binder in Kg. St. run bitumen.	Binder in Kg. Cut back bitumen.	Binder in Kg. Road Tar.
(1)	(2)	(3)	(4)	(5)	(6)
First coat	12 mm.	0·14 to 0·15	17 to 20	20 to 22	20 to 22
Second coat	10 mm.	0·09 to 0·11	10 to 12	12 to 15	12 to 15

13.2.3. Chippings in the first coat shall not be excessively rolled to avoid their being crushed. Excess of chippings at any one place shall be removed by hand. Depressions shall be removed by hand. Depressions shall be made good by addition of more chippings. Any signs of road bleeding appearing within a period of four weeks shall be arrested by sprinkling coarse sand.

13.3. *Surface dressing (Subsequent or renewal coat)* :

13.3.1. *Using Tar/Bituman* Subsequent or renewal coat shall be applied in the same manner as for priming with bituminous primers described before, except that the road surface shall require thorough cleaning involving removal of caked mud, cowdung, etc., and repairs to pot holes, etc., shall proceed sufficiently in advance of surface dressing.

13.3.2. *Using emulsion (cold application)* The road surface shall be prepared as for single coat surface dressing described before.

13.3.2.1. The binder shall be spread evenly at the rate indicated by means of special pouring cans fitted with baffle mouth pieces.

13.3.2.2. Before the emulsion has "broken" *i.e.*, changed from brown to black colour due to evaporation of water and coagulation of butumen, the surface shall be blinded with chippings and rolled. Rolling shall be stopped as soon as chippings start to crush under the roller.

14.0. *Pre-mixed bitumen/Tar Macadam.*

14.1. *General.* The term "Premixed Macadum" refers to carpet of graded aggregate without an admixture of sand, pre-coated with the binder, spread to camber on prepared foundation, consolidated and given a seal coat.

14.1.1. The carpet shall consist of a base coat and a seal coat. The seal coat may be a liquid seal (*i.e.*, surface dressing) or a precoated chippings seal (*i.e* a light chipping carpet). For 75 mm. and 50 mm compacted thickness of carpet, the thickness of the base coat shall be 65 mm. and 40 mm. respectvely with a seal coat of 10 mm. thick for each.

14.2. *Preparation of underlying course.* The underlying course on which premixed macadams to be laid, shall be prepared, shaped and conditioned to a uniform grade and section. Any depression or pot holes shall be properly made up and thoroughly swept clean and free from dirt or dust and foreign material and shall be quite dry.

14.3. *Application of bituminous primer* The primer shall be heated to the temperature as recommended by the manufacturer, except in the case of emulsions, and applied uniformly to the base at the rate of 5 to 7.5 kg./10 sq. metres for bitumen treated surfaces and 7.5 to 10 kg./10 sq. metres for untreated water bound macadam surfaces.

14.3.1. The bituminous primer shall be applied just ahead of spreading of premixed macadam.

14.4. *Quantities of aggregate and binder.* The quantities of aggregate required per 10 sq. metre of area of premixed macadam shall be 0·90 cu. metre and 0.60 cu. metre for compacted thickness of 75 mm and 50 mm. respectively 6 mm. chippings at the rate of 0·15 cu. metre per 10 sq. metre for liquid seal coat and 0.24 cu. metre per 10 sq. metre for premix seal coat shall be used.

14.4.1. The binder shall be used at the rate of 56 kg. per cu. metre aggregate. If tar is used, the binder shall be increased by 10 per cent.

14.5. *Mixing and spreading.* Mechanical mixers shall be used for mixing the aggregate and the binder. Improvised hand mixing drums may be used with the prior approval of the Executive Engineer. The binder shall be heated to the temperature as recommended by the manufacture and distributed over the aggreagte. The mixing shall be continued till homogeneous mixture is obtained, in which all particles of the aggregate are coated uniformly. The mixed material shall be conveyed by suitable means to the road surface and shall be even spread to the desired thickness and to the correct camber uneven areas shall be brought to camber.

14.6. *Rolling.*—The surface shall be rolled with a 8-10 tonne power roller as early as possible and rolling shall continue as long as it is necessary to obtain proper consolidation, The wheels of the roller shall be kept moistended to prevent the wheels from picking up the coated material. Rolling shall be carried out from haunches to the centre of road, the roller moving parallel to the sides and gradually edging in towards the middle (except on super elevated courses, when rolling shall commence at the lower edge and progress towards the upper edge). The final consolidated thickness shall be the thickness as indicated. The base coat and the seal coat shall be rolled separately.

14.6.1. The surface shall be teated by a camber board and stariaght edge for depressions which shall be filled in with more pre-mix wet rolled in. It shall then be sealed either with a liquid seal coat or precoated chippings seal coat as indicated.

14.7 *Liquid seal coat* —Liquid seal coat shall be applied by spraying the binder at the rate of 10 Kg./10 sq. metre and blinded with 6 mm. Chippings at the rate indicated. It shall then be thoroughly rolled and then opened to traffic.

15.0. *Pre-mixed bitumen concrete:*

15.1. *General* —This type of road carpet is similar to premix macadam, the difference being :—

(*a*) A mixture of sand and stone is used as aggregate instead of stone only, producing a dense mixture

(*b*) Seal coat is not necessary, as the sand used in the mix works upto the surface and forms a seal by itslef.

15·2. *Quantities of materials* —The quantities of materials viz., stone, sand binder required per 10 sq. metre of carpet will be as under :—

Consolidated thickness of bitumen concrete.	*Stone.*		*Sand.*	*Binder for.*	
	Size.	*Quantity in cu. m.*	*Quantity in cu. m.*	*Stone.*	*Sand.*
(1)	(2)	(3)	(4)	(5)	(6)
50 mm.	20 mm.	0·48	0·24	56 kg. per cu. m. of stone in case of bitumen and 66 kg. per cu. m. for tar.	128 kg. per cu. m. of sand in case of bitumen and 118 kg. per cu. m. for tar.
40 mm.	12 mm.	0·36	0·13	Do.	Do.

15.3. *Materials* —Quantity of materials required per 10 sq. metre in mechancial mixers and laid and consolidated. The sand shall be clean, dry and not fine grained, with a small percentage of particles retained on a 10mm. sq. mesh sieve

15.3.1. In order to ensure proper precoating, the binder shall be put into the mixer in two shots *i.e.*, stone and two thrid total quantity of binder put in when stone is well coated.

16.0. Pre-mixed Carpet.

16.1. *Preparation of case* —Before the carpet is applied to the existing base, the road shall be free from dust or caked mud. Where the existing base is pot holed pinrutted, these irregularities shall be corrected with pre-mixed chippings coated, laid after applying a tack coat of binder and well rammed thereafter. The surface shall be cleaned by removing caked earth and other foreign matter with wire brushes, followed by sweeping with brooms and finally dusting with sacks.

16.2. *Priming/tact coat.* —The binder shall be heated to the temperature as recommended by the manufacturers and then applied uniformly to the base by means of a prayer.

16·2.1. The tack coat shall be applied just ahead of the spreading of the premix.

16.3. *Materials* —Quantity of materials required per 10 sq. metre of road surface shall be as given in the Table below :—

(1)	*Stone Chippings in cu. m.* (2)	*Sand in cu. m.* (3)	*Binder in cu. m.* (4)
(A) Using straight run/cut back bitumen			
1. Priming/tack coat.			
(*a*) On a water bound macadam surface ..	....	....	7·30 to 9·75
(*b*) On an existing black top surface ..	....	....	5·85 to 7·30
2. Carpet	(*a*) 0·18 (12 mm. nominal size)	....	10·25
	(*b*) 0·09 (10 mm. nominal size) ..	....	5·85
3. Seal Coat			
(*a*) Dry areas (premixed sand seal coat) ..	....	0·06	6·85
(*b*) Wet areas (liquid seal coat)	0·09	....	9·75
(B) Using Road Tar.			
1. Priming/tack coat	....	....	....
(*a*) On a water bound macadam surface ..	....	....	12·20 to 14·65
(*b*) On an existing black top surface ..	....	....	7·30 to 9·75
2. Carpet	(*a*) 0·18 (12 mm. nominal size) } (*b*) 0·09 (10 mm. nominal size) } ..	....	17·60 to 21·95
. Seal coat	....	[illegible]	[illegible]

16.4. *Preparation of pre-mix* - The composition of mix shall be as per paragraph 714-02 of S.S.R.B., Mechanical mixers shall be employed. For small quantities of work, improvised hand mixing drums may be used as directed by the Executive Engineer. The binder shall be heated to the temperature as recommended by the manufacturer and mixed until the chippings are thoroughly coated with the binder.

16·4·1. The premix shall then be emptied on to the stretchers or wheel barrows and carried to the site.

16·5. *Spreading of premix.*—Immediately after applying the tack coat/priming coat, the premix shall be spread with rakes to the desired thickness and to the correct camber, or distributed evenly by means of a drag spreader. The surface shall then be checked for camber by means of a camber board and any inequalities found, shall be corrected.

16·6. *Rolling.*—As soon as sufficient length, say 15 metres of the premix has been laid, the surface shall be rolled with 6 to 8 tonne power roller. Rolling shall commence at the edge and progress towards the centre (except in case of Super elevated curves, where the rolling shall progress from the inside towards the outside of course longitudinally.

16·6·1. When the roller has passed once over the area, any high spot or depression which becomes apparent, shall he corrected by removing or adding premix. When this has been done, the surface shall be rolled to compaction. The roller wheels are moistened in the process to precent from weathering to wheel and beirg picked.

16·7. *Seal coat.*—In dry areas, a premix sand seal coat shall be applied immediately after laying the carpet. The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen. The aggregates shall be dry and suitably heated to a temperature directed by the Executive Engineer before the same and placed in the mixer of suitable design. Mixing of binder with aggregates to the specified proportions shall be continued till the latter are thoroughly coated with binder. The mix shall be immediately transported from the mixing plant to the joint of use and spread-uniformly on the bituminous surface to be sealed. As soon as sufficient length has been covered with premix material, the surface shall) be rolled with 6 to 8 tonne power roller. Rolling shall be continued till the premix material completely seals the void in the bituminous course and a smooth uniform surface is obtained.

16.7.1. In wet areas, a liquid coat chippings (not sand) shall be applied immediately after laying the carpet. The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen and spread on the surface preferably, using mechanical sprayers. Immediately following the application of the binder, stone chippings in a perfectly dry condition shall be uniformly spread on the surface, immediately after the application of the cover material, the entire surface shall be rolled with a 8 to 10 tonne road roller.

17·0. *Cement Concrete Pavement.*

17·1. *General.*—The cement concrete payement shall be of designed mix as per para 901·16 of S.S.R.B. depending upon the wheel or other loads coming on he pavement. Graded concrete shall be used if so specified concrete shall be laid on the prepared base including compaction and curing.

17·2. *Preparation of surface.*—The surface shall be examined for existence of soft patches and suitably treated to have uniform bearing capacity with rest of the area. The prepared surface shall conform to the line, grade and cross section shown on plans and for this purpose the sub base shall be prepared by the existing surface where necessary and adding extra materials and consolidating.

17·3. Where the existing sub base is to be widened, and cement concrete to be laid on the entire road including the widened portion, every percaution shall be taken to avoid unsightly cracks along the junction between the old surface and the newly laid strips. For this purpose a longitudinal construction joint shall be useful.

17·4. *Form work.*—All side forms shall be of mild steel unless use of wood forms are specially permitted. The steel forms shall be of mild steel channel section and their depth equal to the thickness of the pavement.

17·4·1. The sections shall have a length of atleast 3 metres except on curves of less than 45 metres radius, where shorter sections may be used. When set to grade and stacked in place, the maximum deviation of the top surface of any section from a straight line shall not exceed 3 mm. The method of connection between sections shall be such that the joint formed shall be free from movement in any direction. The use of bent twist or worn out forms shall not be permitted.

17·4·2. They shall be provided with an efficient looking device to ensure continuity of line and level through joints and with steel pins to hold them in position. Sufficient rigidity shall be obtained to support the forms in such position during the entire operation of compacting and finishing that they will not at any time deviate more than 3 mm. from a straight edge 3 metre in length. Forms which show a variation from the required rigidity or the alignment and levels shown on the plans shall be reset or removed as directed. The length and number of stakes shall be such as to maintain the forms at the correct line and grade. All forms shall be cleaned and oiled every time, before they are used. Forms shall be set, in advance to a length sufficient for at least one day's concreting and shall remain in position for at least 12 hours after laying of the concrete or longer if in the opinion of the Executive Engineer, it should be necessary.

17·5. *Setting Forms.*—The forms shall be set to exact grace and alignment at 30 cm. in advance of the point of depositing concrete and checked with levelling instruments. Generally the width of any bay shall not be more than 6 m. Before setting, the forms shall be thoroughly cleaned and shall be firmly fixed to prevent displacement due to, placing and tamping of concrete. After setting, the working fades shall be thoroughly oiled before concrete is placed against them.

17·6. *Mixing.*—The mixing shall be normally done by mechanical mixer unless hand mixing is permitted specifically by the Executive Engineer in writing.

17·7. *Machine mixing.*—The quantity of materials loaded in the drum shall not exceed the rated capacity of the mixer. The water shall be added slowly upto the required quantity and the wet mixing of bath shall be continued for atleast two minutes in the drum, till a uniform mix of required consistency is obtained such that the mortar does not tend to separate from the coarse aggregate. The entire concrete of the batch shall be discharged before the materials for new batch are changed into the drum mixer shall be cleaned by revolving the drum with plenty of water each time before suspending the work.

17·8. *Consistency.*—It shall be recorded in terms of mm or subsidence of the specimen during the test, which is known as "slump".

17·8·1. The following slumps shall be adopted for different kinds of work :—

Serial number.	*Type of work.*	*Slumps.* *When vibrators are used.*	*Slumps.* *When vibrators are not used.*
(1)	(2)	(3)	(4)
1	Pavements, roads, taxi tracks and runways.	Not to exceed 6 mm.	No to exceed 12·5 mm

17·9. *Placing.*—Concrete shall be laid in regular bays. The sub-base shall be throughly watered before laying the concrete. The entire concrete used in work shall be laid gently (not thorwn) in layers not exceeding 15 cm. and shall be thoroughly vibrated by means of mechanical vibrators both interlaid surface by means of mechanical vibrators till a dense concrete is obtained. The layers of concrete shall be so placed that the bottom layer does not finally get before the top layer is placed. Compaction shall be completed before the initial setting starts, i.e. within 30 minutes of addition of water to dry mixture.

17·9·1. During cold weather concreting shall not be done when the temperature falls below 1·25 °C. While concreting in monsoon period, necessary tarpaulines shall be kept ready for protecting concrete surface. The concrete placed shall be protected against frost by suitable covering, concrete damaged by frost shall be removed and work redone. During hot weather precautions shall be taken to see that the temperature of wet concrete does not exceed 40 °C. No concrete shall be laid within half an hour of the closing time of the day, unless permitted by the Executive Engineer.

17·9·2. When the placing of concrete is suspended, necessary removal of laitance and roughening the surface for jointing future work shall be done before the concrete sets. When the work is resumed the previous work must be throughly cleaned, roughened watered and a grout of neat cement slurry at the rate of 2·75 kg. of cement per sq. metre applied, which will be paid separately.

17·10. ***Compaction.*—The concrete after laying shall be compacted by (tempering) with 7·5 cm. wide tamper made of selected timber, shod with steel, to ensure a dense homogeneous mass free from voids, honey combing and surface undulations.** The temper shall be shaped to the cross section of the slab and shall weigh not less than 10 Kg./metre and shall be 60 cm. longer than the proposed width of pavement slab. The tamper shall rest on side forms. The tamper shall be drawn forward with a sewing motion in combination with a series of lifts and drips alternately with lateral shifts of about 2·5 cm. Compaction by tamping shall be continued till the mortar in the mix just works up to the surface.

17·10.1. Where so specified, compaction shall be done by vibration. Internal vibration shall also be used for compaction of portion of the slab along the edges, corners and joints and particularly when slabs more than 200 mm. thickness are laid.

17·10·2. After compaction of the concrete in bays, the surface level shall be checked by straight edge longitudinally and by tamper itself transversely. Any lone spots or depressions shall be made up to with cement concrete by compaction till a uniform surface is obtained. The surface may also be checked with a string.

17·11. *Finishing surface.*—The finish shall be produced by smoothening board following the tamper or by wooden flats, the workmen sitting on a platform spanning the slab width **so as not to disturb the finished surface of concrete.**

17·12. *Belt finish.*—This produces a surface similar to float finish. The belt usually consists of a piece of canvas 15cm wide and 100 cm longer than the width of the slab, having wooden handles at each end. The process consists of a preliminary stage when the belt shall be drawn slowly across by a series of long strokes and finally by short strokes with rapid advance, intermediate stages being used as decided by the Executive Engineer.

17·13. *Brooming.*—When desired by the Executive Engineer to have a roughened surface, this shall be accomplished by brooming. The finish shall be carried out by stiff fibre brush having a long handle attached to it, drawing it transversely across the slab or across half width from either side of the slab. The finish shall be carried out after the surface is slightly set.

17·14. *Curing.*—The curing shall be done for a minimum period of 21 days and ponding of water shallbe done during that period wherever it is possible to pond water.

18·0. *Joints in cement concrete pavement* :

18·1. *General.*—All joints shall be constructed true to line with their faces perpendicular to the surface of the pavement. Joints shall not vary more than 6 mm. from a true line, or from their designated position.

18·1·1. The surface of the pavement adjacent to all joints shall be edged to a radius of 6 mm. The surface across the joints shall be treated with a 3 m. straight edge as the joints are finished and any irregularities in excess of 3 mm. shall be corrected before initial set in the concrete takes place.

18·1·2. The joints shall be formed by inserting the web of a "T" iron section or any other suitable device with oiled surfaces into the concrete when the concrete is stiff enough to receive the "T" iron, etc.

18·1·3. The "T" iron or any other device adopted shall be taken out carefully in such a way that it will not slump and close the slot.

18·2. *Transverse expansion joint.*—Transverse expansion joints shall be of the preformed type and shall be constructed at right angles to the centre line of the pavement, and shall extend to the full width of the pavement. The spacing of the joints shall be 27 m. for pavement of 10 cm. to 15 cm. thick and 36 m. for pavement 20 cm. thick or more where so stipulated, transverse expansion joints shall also be provided with dowel bars.

18.3 *Transverse contraction joint.*—Transverse contraction joints shall be formed by a groove at the top of the slab. The groove shall be 13 mm. wide at the surface and 10 mm. wide at the bottom. It shall extend verticplly down wards from the top to a depth equal to the depth of pavement. The joint, shall be located at 6 m. or 5.4 m intervals, depending on whether the expansion joint spacing is 36 m. or 27 m. respectively.

18.4 *Transverse construction joints.*—Transverse construction joint shall be made at the end of each day's run or when unavoidable interruption of more than 30 minutes in the concrcting operations.

18.4.1 Transverse construction joints shall be plain butt joints and formed so as to make a salb at least 3 m in length. If this is not possible, the joints shall be formed at the preceeding transverse expansion or contraction joint location. The exposed face of the joint shall be painted with approved quality bitumen before concreting the adjacent bay. The spacing of subsequent transverse contraction joints shall be measured from the transverse construction joint last placed.

18.5 *Arrangement of Transverse joint.*—The transverse joints on each side of a longitudinal joint shall be of the same type and shall be in line with each other and not staggered.

18.6 *Longitudinal Joints.*—Longitudinal joints shall be plain butt joints as per details for transverse construction joints.

18.7. *Installation of Transverse Expansion joints.*—The joints shall be set to the required line and grade and shall be held in the required position, during the placing and finishing of the concrete, by securing stakes or other suitable device. The joints shall be vertical and no joint shall deviate more than 6 mm in the horizontal alignment either way from a straight line. The lower end the top edges shall be cut to conform to the prescribed cross section of the base and the crown of the slab respectively.

18.8. *Filling of Joints* :

18.8.1. *Pre-formed joint filler.*– It shall conform to I.S. 1838/1961, the thickness shall be 20 mm or 25 mm as specified and shall be of maximum available standard length.

18.8.1. During the casting of the slab the premoulded joint filler shall be placed accurately in position against the finished end of concrete slab. The filler shall remain 20 mm below the top surface of the pavement and shall extend upto the sub grade.

18.8.2. *Scaling compound.* – After the curing period is over the joint portion above filler board shall be cleaned thoroughly as directed by the Executive Engineer. The joints shall be filled with hot applied sealing compound Grade A(Normal) for concrete, construction other than those which are subjected to spillage of kerosene or other heavy petroleum oils and grade B (Jets fuel resistant) for concerte construction of runways for jet aircrafts conforming to I.S. 1934/1961.

19.0. *Miscellaneous* :

19.1. *Dry Stone Pitching* :

Preparation of surface.—The sides and bottom of earth work to be pitched, shall be brought to the required shape and gradient and shall be compacted to a form and even surface.

19.2. *Pitching.*—Pitching shall be of 22.5 cm depth unless specified otherwise. Profiles shall first, be put up by means of pegs and strings or by placing stones, at intervals of not more than 15 cm. Stones shall then be laid closely in position in between the profile and firmly embedded with joints staggered with exposed faces true to line, gradient and in uniform slope throughout.

19.2.1. Cross bands of approximately 22.5 cm width through bond stones equal to the full depth of pitching, shall be provided at an interval of approximately 3 m centre to centre both longitudinally and transversely.

19.2.2. The interstices between adjacent stones shall be filled in with stones of proper size, well driven in with drow bars to ensure right packing and complete filling of all interstices. Such filling shall be carried on simultaneously with the placing in position of the large stones and shall in no case be permitted to fall behind Final wedging shall be done with the largest sized chip practicable each chip being well driven home with a hammer so that no chip is possible of being picked up or removed by hand.

19.3. *Repairing to pot holes, etc.*

19.3.1. *In water bound macadam.*—The top holes (or ruts) shall be cut to a rectangular form with vertical sides and filled with new materials of thesame kind of which the carpet is made, well rammed, watered, blinded with fins and again well rammed. The finished surface shall conform to the contour of the road surface.

19.3.2. In macadam bound with tar or bitumen or in water bound macadam perior to surface dressing.

(*a*) The pot holes (or ruts), shall be cut as nearly square' or rectangular as possible, the sides being cut vertical. The holes shall then be painted with the binder indicated and filled with aggregates previously coated at the rate of 68 kg. of binder per cu.m. of stone the size of the aggregates depending upon the size of the pot holes.

(*b*) The pre-coated metal shall be rammed in layers of 25 mm at a time (the rammer being dipped in water from time to time so that the coated metal may not stick to it).

(*c*) The surface shall then be finished slightly raised, say at least about 6 mm to allow for subsequent settlement under traffic.

(*d*) After repairs, the patch shall be given a seal coat and blinded with 12 mm chippings and well rammed,

20.0. *Measurements and Rates* :

20.1 *General.* A reference shall be made to the following I.S. code of Practice.

I.S. 1200 (Pprt XVII)/1969—Method of measurement of Building and Civil Engineering work - Road work including Air fileld pavements.

(*a*) Dimensions shall be measured to the nearest 0.01 metre. Where the thickness is less 20 cm., thickness shall be measured nearest 0.005 metre.

(*b*) Areas shall be worked out to the nearest 0.01 sq.m. and

(*c*) Cubic contents shall be worked out to the nearest 0.01 cu.m.

20.2 *Collection of materials.* All the items except pre-moulded bituminous joint filler shall be measured in cubic metres. Pre-moulded bituminous joint filler shall he measured in sq. metres.

20.2.1. Measurements shall be taken in bottom-less boxes or measuring boxes or in/stacks prepared on level ground for items measured in metres closely packed.

20.2.2. While no compaction is necessary by ramming, shaking or hammering, no attempt at loose stacking shall be permitted.

20.3 *Road work generally* :

20.3.1 Measurements shall be taken of the net finished work except where rates are provided for spread thickess, in which case spread thickness shall be measured.

20.3.2 Measurements for finished work which "Material and Labour"rates are to be paid, shall be taken in two stages, measurements of road aggregates in stacks and measurements of the completed work. The farmer is necessary to ensure that the required quantities of road aggregates have actually been collected and are of the sizes etc., indicated. The first set of measurements shall not, however, absolve the contractor from the responsibility of conforming to the required specification and dimensions, etc., and provision of more materials if necessary to make up the thickness. etc. indicated without any extra charge to Government.

20.3.3 Spread thickness (i.e., thickness before consolidation shall be checked from the net quantity of Materials measured, divided by the superficial area over which the materials are spread.

20.4 *Consolidation by hand ramming.* - Rate for hand ramming road surfaces shall only be allowed when whole consolidation is carried out by hand ramming and this method of consolidation is specially ordered in writing by the Executive Engineer. Hand ramming carried out in angles, edges, etc., where a roller can not be worked is included in rate for rolling.

20.5 *Formation, Sub Grade, Berms, etc.* Rough excavation, disposal of spoil, surface dressing, filling, forming embankment to required profiles, digging side drains, excavating and filling soft places with approved soil etc., shall be paid for under section **"Earth work".**

20.5.1 Trimming bottom of rough excavation to required levels camber or super elevation, etc., including throwing trimmed spoil clear of road etc. shall be paid for under items of preparation of sub-grade provided in this section.

20.5.2 Preparation of sub-grade shall be measured in square metres.

20.5.3 Watering and rolling formation, etc., if ordered shall be paid for separately.

20.6 *Soling.*– Soling shall be measured in square metres of the area covered.

20.7 *Water bound macadam.*—This shall be measured in square metres. The thickness measured shall be spread (loose, i.e., thickness before consolidation). The rates includes forming clay puddle bunds (retaining fillets) on both edges of spread aggregate.

20.8 *Preparation of surfaces prior to application of primer, etc.*—This shall be measured in sq. metres of the area covered. Priming surfaces shall be measured in square metres of the area covered.

20.9 *Surface dressing.*—The measurements shall be taken for the finished work in square metres. Filling in pot holes and preparation for surface prior to surfacing shall be paid for separately. Priming/ tack coat, if indicated shall be paid for separately.

20.10 *Pre-mixed carpet.*—The measurement shall be taken for the finished work in square metres. Thickness of the carpet shall be the ruling criterion for payment. Preparation of surface and priming/tack coat shall be paid for separately.

20.11 *Pre-mixed bitumen/Tar macadam.*—The measurement shall be taken for the finished work in sq. metres. Preparation of surface and priming/tack coat shall be paid for separately.

20.12 *Pre-mixed bitumen concrete.*—The measurement shall be taken for the finished work in sq. metres. Thickness shall be the ruling criterion for payment. Preparation of surface and priming tack coat shall be paid for separately.

20.13 *Seal coat.*—Measurement shall be taken for the finished work in square metres.

20.14 *Concrete paving.*—For measurements and rates refer to section "Concrete" Joints in concrete roads, etc., shall be measured in running metres. The rates given in items include for any extra form work if required to form joints No deduction shall by made for concrete for the space taken up by contraction (Dummy) and construction joints. Deduction shall however be made for expansion joints. Surface finishes shall be paid for separately.

20.15 *Screening road metal, etc.*—These shall be measured in cubic metres.

20.16 *Breaking stone, etc.*—This shall be measured in cubic metres. The rates include removing the broken stone to a distance not exceeding 200 metres (from the crusher if a crusher is used) and stacking in regular stacks for measurements. Measurement shall be taken of the stacked materials after breaking. The smaller stuff produced in breaking or crushing is not to be screened out unless ordered. If ordered to be screened, screening will be paid. The rates are not applicable if stone for breaking is supplied by the contractor.

20.17 *Dry stone pitching.*—The measurement of the finished work shall be taken in sq. metres. The area of pitching for drains shall be calculated by multiplying the perimetre (bed width plus side slopes) by the length of the pitching. The rate shall include materials and labour involved in all the operations.

20.18 *Repairs to surfaces of Macadam roads.—(Any gradient).*—The rates for scarifying by power are applicable for areas amounting in the aggregate to 400 sq. metres or over within a radius of 1/2 km unless in the opinion of the Executive Engineer the exigencies of the site preclude the use of power scarifiers. In each an event the Executive Engineer will issue a written order to this effect and the rates for picking by hand will be allowed.

20.18.1 The items for scarifying or picking up include raking over and grading the broken up surfaces to the proper camber etc., as required. Any gravel, broken stone, etc., required in addition to the materials obtained from scarifying or picking will be supplied by the department or will be paid for under "collection of materials" (as measured before spreading) as ordered.

20.18.2. The measurements for spreading are based on the thickness of unconsolidated broken stone if 0.7 cu.m. of stacked gravel or broken stone is spread over 10 square metres payment for spreading is to be on the basis of 7 cm. thick.

20.18.3. The rates for pot holes not exceeding 1 sq. m. each apply to repairs carried out in connection with repainting. Any pot holes less than 0.1 sq.m. will be paid for as 0.1 sq.m. Repairs to pot holes and patches exceeding 1 sq.m. each and "Aggregating 40 sq.m. or more within a radius of 1/2 km. whether carried out in connection with repainting or not will be paid for at the rates for ordinary work. When the area of such pot holes patches aggregates to less than 40 sq.m. within a radius of 1/2 km. 20 per cent will be added to the rates for ordinary work.

20.18.4. Breaking through macadam surfaces for pipe trenches, etc., shall be paid for under Section "Earth work". Making good such surfaces shall be paid for at the rates for ordinary work or for pot hole and patch repairs according to the area made good.

21.0 *Workmanship and Traffic Diversion.*

21.1. *General.*—All roads, etc., shall be constructed to the widths alignments, cambers, proper elevations and gradients, etc., specified or shown on the drawings. Where road is required to be opened to traffic urgently, work shall be carried out in convenient complete sections as directed by the Executive Engineer.

21.2. *Watching.*—The contractor shall be responsible for the proper lighting, watching, provision of barriers and protection of all unfinished sections of the road and for the safety of the travelling public.

21.3 *Diversion.*—Where practicable, the contractor shall construct temporary diversion ways in advance of taking up of the road work and regularly maintain for so long as required in a satisfactory condition to the approval of Executive Engineer at his own expense.

21.4 Sign boards, barriers, etc., shall also be provided by the contractor at his own expense. Care shall be taken to interfere as little as possible with the traffic and the contractor shall facilitate the passage of traffic where no diversion is provided. Only such length shall be taken up at a time as can be consolidated the same day.

Acknowledgment,

(1) National Buildings Organisation—Section 31—Roads and Culverts—Draft Standard Specifications.

(2) Madras Highways Manual, Vol. I—Standard Specification or Road and Bridge Construction.

EXTRACT FROM I.S. 2386 (PART IV), 1963.

Methods of test for Aggregates for Concrete.

PART IV—MECHANICAL PROPERTIES.

4. *Determination of aggregate impact value.*

4.1. *Object.*—This method of test covers the procedure for determining the aggregate impact value of coarse aggregate.

NOTE.—The "aggregate impact value" gives a relative measure of the resistance of an aggregate to sudden shock or impact, which in some aggregate differs from its resistance to a slow compresive load.

4.2. *Apparatus.*—The apparatus shall consist of the following :—

(*a*) An impact testing machine of the general form shown in Fig. 2 and complying with the following :—

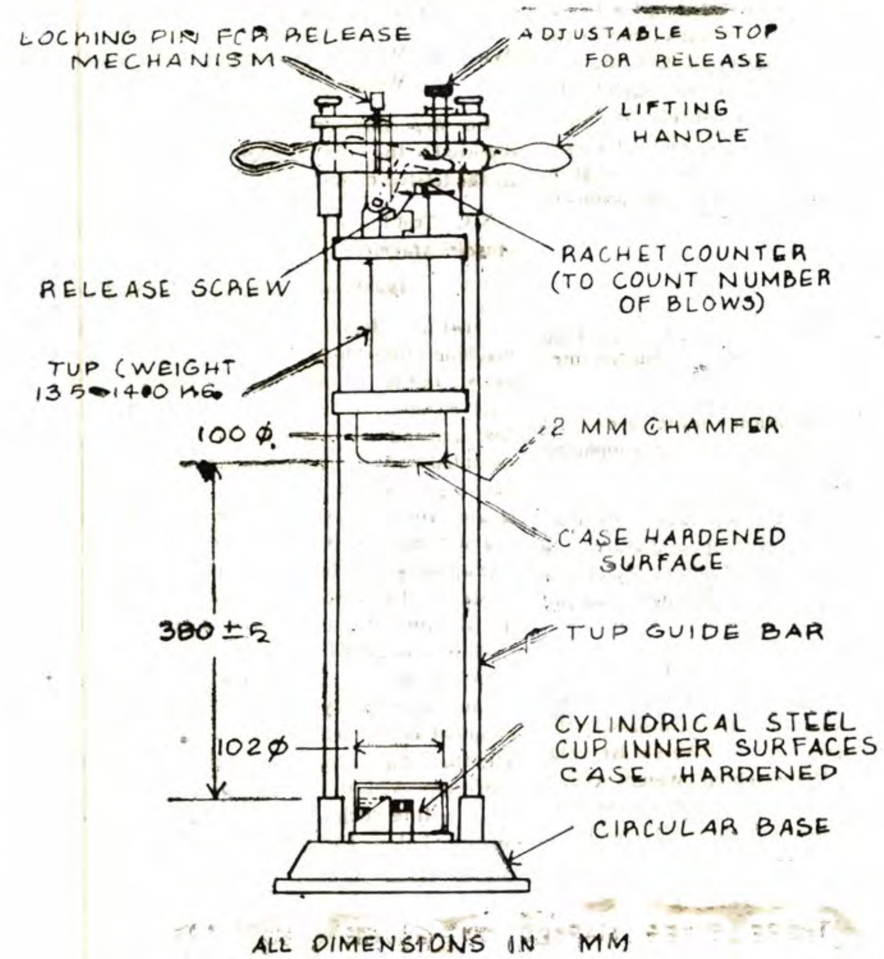


FIG. 2 AGGREGATE IMPACT TEST MACHINE

(1) Total weight not more than 60 kg. nor less than 45 kg.

(2) The machine shall have a metal base weighing between 22 and 30 kg. with a plane lower surface of not less than 30 cm. diameter, and shall be supported on a level and plane concrete or stone block or floor at least 45 cm. thick. The machine shall be prevented from rocking either by fixing it to the block of floor or by supporting it on a level and plane metal plate cast into the surface of the block or floor.

(3) A cylindrical steel cup of internal dimensions—
Diameter—102 mm.
Depth—50 mm.
and not less than 6.3 mm. thick with its inner surface case hardened that can be rigidly fastened at the centre of the base and easily removed for emptying.

(4) A metal cup or hammer weighing 13.5 to 14.0 Kg. the lower end of which shall be cylindrical in shape, 100.0 mm. in diameter and 5 cm. long, with a 2 mm. chamfer at the lower edge, and case hardened. The hammer shall slide freely between vertical guides so arranged that the lower (cylindrical) part of the hammer is above and concentitic with the cup.

(5) Means for raising the hammer and allowing it to fall freely between the vertical guides from a height of 380 or 5.00 mm. and the test sample in the cup, and means for adjusting the height of fall within a 5 mm.

(6) Means for supporting the hammer whilst fastening or removing the cup.

NOTE.—Some means for automatically recording the number of blows is desirable.

(*b*) *Sieves.*—The I.S. Sieves of sizes 12.5 mm., 10 mm. and 2.36 mm.

(*c*) *Measure.*—A cylindrical metal measure, tared to the nearest gram, of sufficient rigidity to retain its form under rough usage, and of the following internal dimenions :—

Diameter—75 mm.
Depth—50 mm.

(*d*) *Tamping Rod.*—A straight metal tamping rod of circular cross section 10 mm. in diameter and 230 mm. long, rounded at one end.

(*e*) *Balance.*—A balance of capacity not less than 500 g. readable and accurate to 0.1 g.

(*f*) *Oven.*—A well-ventilated oven, thermostatically controlled to maintain a temperature of 100° to 110 °C.

4.3. *Preparation of the Test Sample.*

4.3.1. The test sample shall consist of aggregate, the whole of which passes a 12.5 mm. I.S. Sieve and is retained on a 10 mm. I.S. Sieve.

The aggregate comprising the test smaple shall be dried in an oven for a period of four hours at a temperature of 100° to 110 °C. and cooled.

4.3.2. The measure shall be filled about one-thrid full with the aggregrate and tamped with 25 strokes of the rounded end of the tamping rod. A further similar quantity of aggregate shall be added and a further tamping of 25 strokes given. The measure shall finally be filled to over-flowing, tamped 25 times and the surplus aggregate struck off, using the tamping red as a stright-edge. The net weight of aggregate in the measure shall be determined to the nearest gram (weight) and this weight of aggregate shall be used for the duplicate test on the same material.

4.4. *Test procedure.*

4.4.1. The imapct machine shall rest without wedging or packing upon the level plate, block or floor, so that it is rigid and the hammer guide columns are vertical.

4.4.2. The cup shall be fixed firmly in position on the base of the machine and the whole of the test sample placed in it and compacted by a single tamping of 25 strokes of the tamping rod.

4.4.3. The hammer shall be raised until its lower face is 380 mm. above the upper surface of the aggregate in the cup, and allowed to fall freely on to the aggregate. The test sample shall be subjected to a total of 15 such blows each being delivered at an interval of not less than one second.

4.4.4. The crushed aggregate shall then be removed from the cup and the whole of it sieved on the 2.36 mm. I.S. Sieve until no further significient amount passes in one minute. The fraction passing the sieve shall be wieghted to an accuracy of 0.1. g. (Weight B). The fraction retained on the sieve shall also be weighted (Weight A) and if the total weight (B C) is less than the initial wieght (Weight A) by more than one gram, the result shall be discarded and a fresh test made. Two tests shall be made.

4.5. *Calculations.*—The ratio of the weight of fines formed to the total sample wieght in each test shall be expressed as a percentage the result being recorded to the first decimal place—

Aggregate impact value=B/Ax100.

Where B=Weight of fraction passing 2.36 mm. I.S. Sieve, and
A=Weight of oven dried sample.

4.6. *Reporting of results.*—The mean of the two results shall be reported to the nearest whole number as the aggregate impact value of the tetsted material.

5.3. Test for Abrasion of Coarse Aggregates by the use of *Los Angeles Machine*.

5.3.1. *Apparatus.*—The apparatus shall consist of the following;—

(*a*) *Los Angeles machine.*—The Los Angeles abrasion testinn machine conforming in all its essential characteristics to the desig. shown in Fig. 3 shall be used. The machine shall consist of a hollow steel cylinder, closed at both ends, having an inside diameter of 700 mm. and an inside length of 500 mm. The cylinder shall be mounted on stub shafts attached to the ends of the cylinders but not entering it, and shall be mounted in such a manner that it may be rotated about its axis in a horizontal position. An opening in the cylinder shall be provided for the introduction of the test sample The opening shall be closed dust tight with a removable cover belted in place. The cover shall be so designed as to maintain the cylin drical contour of the interior surface unless the shelf is so located that the charge will not fall on the cover, or come in contact with it during the test. A removable steel shelf projecting radially 88 mm into the cylinder and extending its full length, shall be mounted along one element of the interior surface of the cylinder. The shelf shall be of such thickness and so mounted, by bolts or other approved means as to be firm and rigid. The position of the shelf shall be such that the distance from the shelf to the opening, measured along the circumstances of the cylinder in the direction of relation, shall be not less than 1250 mm.

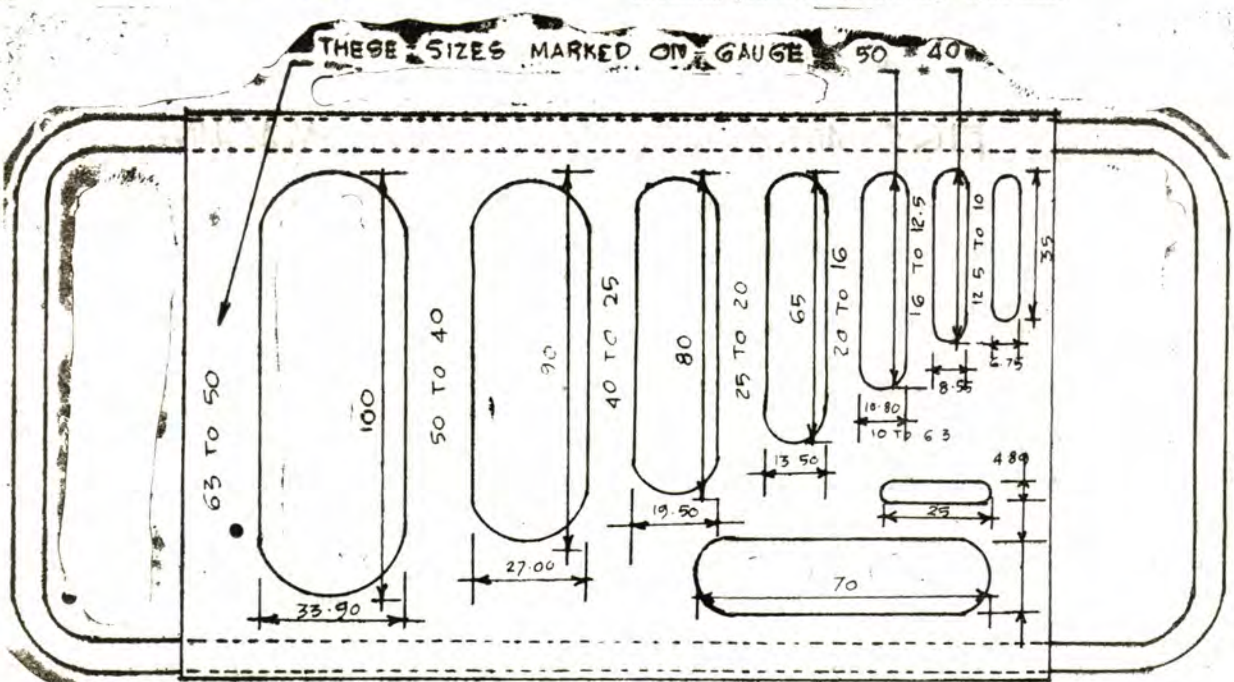


FIG THICKNESS GAUGE

EXTRACT FORM I.S. 2386 (PART I) 1963.

Methods of Test for aggregates for concrete.

PART I—PARTICLE SIZE AND SHAPE.

4. *Determination of Flakiness Index.*

4.1. *Object.*—This method of test lays down the procedure for determining the flakiness index of coarse aggregate.

NOTE.—The flakiness index of an aggregate is the percentage by weight of particles in it whose least dimension (thickness) is less than three fifths of their mean dimension. The test is not applicable to sizes smaller than 6.3 mm.

4.2. *Apparatas.*—The apparatus shall consist of the following:—

(a) *Balance.*—The balance shall be of sufficient capacity and sensitivity (see 4.4.3.) and shall have an accuracy of 0·1 per cent of the weight of the test sample.

Metal gauge.—The metal gauge shall be of the pattern shown in Fig.

Sieves.—IS Sieves of sizes shown in Table V.

TABLE V—DIMENSIONS OF THICKNESS AND LENGTH GAUGES.

(*Clauses* 4.2., 4.4.1., 4.4.2, 5.2. *and* 5.4.1.)

Size of aggregate. Passing through IS sieve. (1)	Retained on IS Sieve. (2)	*Thickness gauge.* * (3)	*Length Gauge.* + (4)
		mm	*mm*
63 mm	.. 50 mm	39·90	..
50 mm	.. 40 mm	27.00	81.00
40 mm	.. 25 mm	19.50	58.50
31.5 mm	.. 25 mm	16.95	..
25 mm	.. 20 mm	13.50	40.40
20 m	.. 16 mm	10.80	32.40
16 mm	.. 12.5 mm	8.55	26.5
12.5 mm	.. 10 mm	6.75	20.2
10 mm	.. 6.3 mm	4.89	14.7

*This dimension is equal to 0·6 times the mean sieve size.

+This dimension is equal to 1.8 times the mean sieve size.

4.3 *Sample.*—A quantity of aggregate shall be taken sufficient to provide the minimum number of 200 pieces of any fraction to be tested.

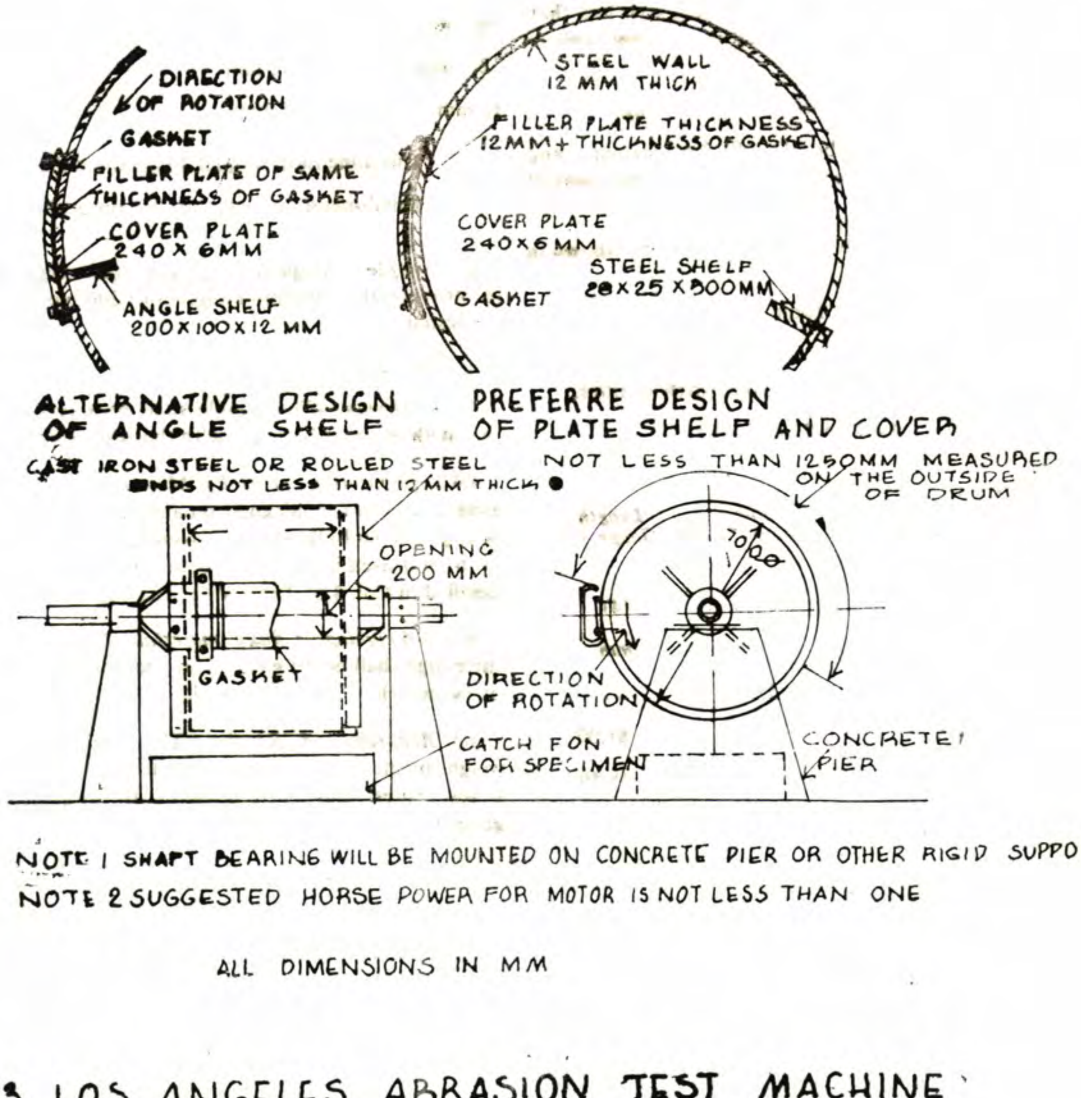
4.4. *Procedure*—

4.4.1. *Sieving.*—The sample shall be sieved in accordance with the method described in 3 with the sieves specified in Table V.

4.4.2. *Separation of flaky Material.*—Each fraction shall be gauged in turn for thickness on a metal gauge of the pattern shown in Fig. 2 or in bulk on sieves having elongated slots. The width of the slot used in the gauge or sieve shall be of the dimensione specified in Col. 3 of Table V for the appropriate size of materials.

4.4.3. *Weighing of flaky material.*—The Total amount passing the gauge shall be weighed to an accuracy of at least 0.1 per cent of the weight of the test sample.

4.5. *Reporting of Results.*—The flakiness index is the totag weight of the material passing the various thickness gauges or sieves, expressed as a percentage of the total weight of the sample gauged.



NOTE 1 SHAFT BEARING WILL BE MOUNTED ON CONCRETE PIER OR OTHER RIGID SUPPORT

NOTE 2 SUGGESTED HORSE POWER FOR MOTOR IS NOT LESS THAN ONE

ALL DIMENSIONS IN MM

FIG. 3 LOS ANGELES ABRASION TEST MACHINE

NOTE.—The use of the shelf of wear-resistant steel, rectangular in cross section and mounted independently of the cover, is preferred. However, a shelf consisting of a section of rolled angle properly mounted on the inside of the cover plate, may be used provided the direction of rotation is such that the charge will be caught on the outside face of the angle.

(a) Sieves.—The 1·70 mm. I.S. sieve.

5.3.2. *Abrasive charges.*—The abrasive charge shall consist of cast iron spheres or steel spheres approximately 48 mm. in diameter and each weighing between 390 and 445 g.

5.3.2.1. The abrasive charge, depending upon the grading of the sample as described in 5.3.3. shall be as follows:—

Grading.	*Number of spheres.*	*Weight of charge* g.
A	12	5,000 ± 25
B	11	4,584 ± 25
C	8	3,330 ± 20
D	6	2,500 ± 15
E	12	5,000 ± 25
F	12	5,000 ± 25
G	12	5,000 — 25

5.3·3. *Test Sample*—The test sample shall consist of clean aggregate which has been dried in an oven at 105° to 110° C to substantially constant weight and shall conform to one of the gradings shown in Table II. The grading or gradings used shall be those most nearly representing the agregate furnished for the work.

NOTE—It is recognised that different specification limits may be required for gradings E, and G than for A,B,C, and D. It is urged that investigations be conducted to determine the relationship, if any, which exists between results for these coarse grading using the 10000 g samples and the finer ones using the 5000 g samples.

TABLE II—GRADINGS OF TEST SAMPLE

(Clause 5·3.3)

Sieve size square hole. Passing mm	Retained on mm	*weighing of test sample for Grade* A	B	C	D	E	F	G
80	63	..	..	..	..	2500*	..	..
63	50	..	..	..	..	2500*	..	..
50	40	..	..	..	..	5000*	5000*	..
40	25	1200	..	..	..	..	5000*	5000*
25	20	1200	..	..	..	..	..	5000*
20	12.5	1200	2500	..	..	..	..	..
12.5	10	1200	2500	..	..	..	..	..
10	6.3	..	..	..	..	..	..	..
6.3	4.75	..	..	2500	..	..	..	..
4.75	2.36	..	..	..	5000	..	..	..

5.3.4. *Procedures.*—

5.3.4.1. The test sample and the abrasive charge shall be placed in the Los Angeles abrasion test machine and the machine rotating at a speed of 20 to 33 rev./min. For gradings A, B, C and D, the machine shall be rotated for 500 revolutions ; for gradings E, F and G it shall be rotated for 1,000 revolutions. The machine shall be so driven and so counter balanced as to maintain a substantially uniform peripheral speed. If an angle is used as the shelf, the Machine shall be rotated in such a direction that the caught is in the outside surface of the angle. At the completion of the test, the material shall be discharged from the machine and a preliminary separation of the sample made on a sieve coarser than the 1·70 mm. I.S. Sieve. The finer portion shall then be sieved on a 1·70 mm. I.S. Sieve in the manner described in 2·3 of part I of this standard.

5.3.4.2. The material coarser than the 1·70 mm. I.S. sieve shall be washed dried in an oven at 105 degree to 110 degrees to a substantialy constant weight, and accurately weighed to the nearest gram.

Note.—Attention is called to the fact that valuable information concerning the uniformity of the sample under test may be obtained by determining the loss after 100 revolutions. When this determination is made, care should be taken to avoid loss of any part of the sample ; the entire sample including the dust of abrasion, shall be returned to the testing machine for the completion of the test.

5.3.5. *Reporting a Results.*—The different between the original weight and the final wieght of the test sample be expressed as a percentage of the original weight of the test smaple. This value shall be reported as the percentage of wear.

EXTRACT FROM I.S. 2386 (PART III), 1963.

Methods of test for aggregates for concrete.

PART—III—SPECIFIC GRAVITY, DENSITY, VOIDS ABSORPTION AND BULKING.

2. *Determination of specific gravity and water absorption.*—

2.1. *Object*:—This test covers the procedures for determining the specific gravity, apparent specific gravity and water absorption of aggregates.

Note. 1—Three main methods are specified for use according to whether the size of the aggregate is larger than 10 mm. (Method I) between 40 mm. and 10 mm. (Method I or II may be used) ; or smaller than 10 mm. (Method III). An alternate method (Method V) is also permitted.

Note 2.—The water absorption test will not always be reproducible with aggregates of high porosity.

2.2.1 Apparatus—The apparatus shall consist of the following :-

(*a*) *Balance.*—A balance or scale of capacity not less than 3 Kg. and accurate to 0·5 gm. and of such a type and shape as to permit to the basket containing the sample to be suspended from the beam and weighed in water.

(*b*) *Oven.*—A well ventilated oven thermostatically controlled, to maintain a temperature of 100 degree to 110 degree C.

(*c*) A wire basket of not more than 6·3 mm. mesh or a perforated, container of convenient size, preferably chromium plated and polished with wire hangers not thicker than one millimetre for suspending it from the balance.

(*d*) A stout watertight container in which the basket may be freely suspended.

(*e*) Two dry soft absorbent cloths each not less than 75x45 cm.

(*f*) A shallow tray of area not less than 650 cm.^{2}

(*g*) An airtight container of capacity similar to that of the basket

2.2.2. *Sample.*—A sample of not less than 2,000 g. of the aggregate shall be tested. Aggregates which have been artificially heated shall not normally be used. If such material is used the fact shall be stated in the report. Two tests shall be made, and it is recommended that the two samples should not be tested concurrently.

2.2.3. *Test Procedure.*—The sample shall be thoroughly washed to remove finer particles and dust, drained and then placed in the wire basket and immersed in distilled water at a temperature between 22 degree and 32 degree C with a cover of atleast 5 cm. of water above the top of the basket.

EXTRACT OF I.S. 386 (PART III) 1963.

2.2.3.1. Immediately after immersion the entrapped air shall be removed from the sample by lifting the basket containing it 25 mm. above the base of the tank and allowing it to drop 25 times at the rate of about one drop per second. The basket and aggregate shall remain completley immersed during the operation and for a period of 24 $\pm$ 1/2 hours afterwards.

2.2.3.2. The basket and the sample shall then be jolted and weighed in water at temperature of 22degree to 32 degree C. If it is nesessary them to be transferred to a different tank for weighing, they shall be jolted 25 times as described above in the new tank before weighing (weight A1).

2.2.3.3. The basket and the aggregate shall then be removed from the waer and allowed to drain for a few minutes, after which the aggregate shall be gently emptied from the basket on to one of the dry clothes, and the empty basket shall be returned to the water jolted 25 times and weighed in water (weight A2).

* Tolerance of 12 per cent permitted.

2.2.3.4. The aggregate placed on the dry cloth shall be gently surface dried with the cloth, transferring it to the second drycloth when the first will remove no further moisture. It shall then be spread out not more than one stone deep on the second cloth, and lest exposed to the atmosphere away from direct sunlight or any other source of heat for not less than 10 minutes, or until it appears to be completely surface dry (which with some aggregates may take an hour or more). The aggregate shall be turned over atleast once during this period and a gentle current of unheated air may be used after the first ten minutes to accelerate the drying of difficult aggreates. The aggregate shall then be weighed (weight B).

Note.—If the apparent specific gravity only is required the operations described in 2.2.3.4. may be omitted.

2.2.3.5. The aggregate shall then be placed in the oven in the shallow tray, at temperature of 100 degree to 110 degree C and maintained at this temperature for 24—1/2 hours. It shall then be removed from the oven, cooled in the air-tight container and weighed weight C).

2.2.4. *Calculations.*—Specific gravity, apparent specific gravity and water absorbtion shall be calculated as follows :—

Specific gravity; $= \dfrac{C}{B-A}$

Apparent specific gravity : $\dfrac{C}{C-A}$

Water absorbtion (per cent of dry weight) $\dfrac{100\,(B-C)}{C}$

Where

A = the weighting of the saturated aggrega'e in water (A1-A2)

B = the weight in g of the saturated surface-dry aggregate in air, and

C = the weight in g of oven-dried aggregate in air.

2.2.5. *Reporting of Results.*—The individual and mean result shall be reported. The size of the aggregate tested shall be stated and whether it has been artificialy heated.

2.3. *Method* II—*Aggregate between* 40 mm. and 10 *mm.*—

2.3.1. *Apparatus.*—The apparatus shall consist of the following :—

(*a*) *Balance.*—A balance or scale of capacity not less than 3 kg. readable and accurate to 0·5 g. and of such a type as to permit the weighing of the vessel containing the aggregate and water.

(*b*) *Oven.*—A well ventilated oven thermostatically controlled to maintain a temperature of 100 degree to 110 degree C.

(*c*) *Glass Vesel, or Jar.*—A wide-mouthed glass vessel such as a jar of about 1·5 litre capacity, with a flat ground lip and a plane ground disc of plate glass to cover it, giving a virtually watertight fit.

(*d*) *Clothes.*—Two dry soft absorbent clothes each not less than 75 × 45 cm.

(*e*) *Tray.*—A shallow tray of area not less than 325 cm.^{2}

(*f*) *Container.*—An air tight container large enough to take the sample.

2.3.2. *Sample.*—A sample of about one Kilogram of the aggregate hall be used. Aggregates which have been artificially heated shall not normally be used ; if such material is used, the fact shall be stated in the report.

Two tests shall be made and it is recommended that the two sample

2.3.3. *Test procedure.*—The sample shall be screened on a 10 mm. I.S. Sieve, thoroughly washed to remove fine particles of dust, and immersed in distilled water in the glass vessel ; it shall remain immersed at a temperature of 22 degree to 32 degree C for 24—½ hours. Soon after immersion and again at the end of the seaking period, air entrapped in or bubbles on the surface of the aggregate shall be removed by gentle agitation. This may be achieved by rapid clockwise and anticlockwise rotation of the vessel between the operator hands.

2.3.3.1. The vessel shall be overfilled by adding distilled water and the plane ground-glass disc slide over the mouth so as to ensure that no air is trapped in the vessel. The vessel shall be dried on the outside and weighed (weight A).

2.3.3.2. The vessel shall be emptied and the aggregate allowed to drain. Refill the vessel with distilled water. Slide the glass disc in position as before. The vessel shall be dried on the outside and weighed (weight B).

2.3.3.3. The difference in the temperature of water in the vessel during the first and second weighings shall not exceed 2 degree C.

2.3.3.4. The aggregate shall be placed on a dry cloth and gently surface dried with the cloth, transferring it to a second dry cloth when the first will remove no further moisture. It shall then be spread out not more than one stone deep on the second cloth, and left exposed to the atmosphere away from direct sunlight or any other source of heat for (which with some aggregates may take an hour or more). The aggregate shall be turned over atleast once during this period and a gentle current of unheated air may be used after the first ten minutes to accelerate the drying of difficult aggregates. The aggregate shall then be weighed (weight C.)

NOTE.—If the apparent specific gravity only is required, the operations described in 2.3.3.4. may be omitted.

2.3.3.5. The aggregate shall be placed in the oven in the shallow tray, at a temperature of 100 degree to 110 degree C for 24—1/2 hours. It shall then be cooled in airtight container and weighed (weight D).

2.3.4. *Calculations.*—Specific gravity, apparent specific gravity and water absorption shall be calculated as follows:—

Specific gravity $= \dfrac{D}{C-(A-B)}$

Apparent specific gravity $= \dfrac{D}{D-(A-B)}$

Water absorption (per cent of dry weight) $= \dfrac{100\,(C-D)}{D}$

Where

A = Weight in g of vessel containing sample and filled with distilled water.

B = Weight in g of vessel filled with distilled water only ;

C = Weight in g of saturated surface dry sample, and

D = Weight in g of oven-dry sample.

2.3.5. *Reporting of Results.*—The individual and mean results shall be reported. The grading of aggregate tested shall be stated and whether, it has been artificially heated.

2.4. *Method III – Aggregate smaller than 10 mm.*

2.4.1. *Apparatus.*—The apparatus shall consist of the following :—

(*a*) *Balances.*—A balance or scale of capacity not less than 3 kg. readable and accurate to 0·5g., and of such a type as to permit the weighing of the vessel containing the aggregate and water.

(*b*) *Oven.*—A well ventilated oven, thermostatically controlled to maintain a temperature of 100 degree to 110 degree C.

(*c*) *Vessel.*—Any form of vessel capable of holding 0·5 to 1 kg. of material upto 10 mm. in size and capable of being filled with water to a constant volume with an accuracy of $\pm 0{\cdot}5$ ml. Ei ther of the two following vessels is suitable.

(1) A glass vessel, referred to later as a pycnometer, of about one litre capacity having a metal conical screw top with a 6 mm. diameter hole at its apex. The screw top shall be watertight when it is screwed on to the jar, and, if necessary a rubber or fire washer shall be inserted in the joint. If such a washer is used, a mark shall be made on the jar to correspond with a mark on the screw top so that the screw is tightened to the same position every time and the volume contained by the jar is constant throughout the test. A suitable vessel can be made from a 1 Kg. fruit preserving jar which the glass lid normally used is replaced by a sheet metal cone as shown in Fig. 1 ; or

(2) A wide-mouthed glass vessel, such as a gas jar, of about 1·25 litres capacity, with a flat ground lip and a plane ground disc of plate glass to cover it, giving a virtually watertight fit.

(*d*) A means of supplying a current of warm air, such as a hair drier.

(*e*) A tray area of not less than 325 cm^2.

(*f*) An air tight container large enough to take the sample.

(*g*) Filter papers and funnel.

2.4.2. *Test Procedure.*

2·4.2·1. *Using the pycnometer.*—A sample of about 1 kg. for 10 mm. to 4·75 mm. or 500 g. if finer than 4·75 mm. shall be placed in the tray and covered with distilled water at a temperature of 22° to 32°C. Soon after immersion, air entrapped in or bubbles on the surface of the aggregate shall be removed by gentle agitation. The sample shall remain immersed for $24 \pm 1/2$ hours.

The water shall than be carefully drained from the sample, by decantation through a filter paper, any material then retained being returned to the sample. The aggregate including any solid matter retained on the filter paper shall be exposed to a gentle current of warm air to evaporate surface moisture and shall be stired at frequent intervals to ensure uniform drying until no free surface moisture can be seen and the material just attains a "free running" condition. Care shall be taken to ensure that that stage is not passed. The saturated and surface-dry sample shall be weighed (weight A).

NOTE.—If the apparent specific gravity only is required, the operations described in this paragraph may be omitted, although for material finer. than 4.75 mm. some surface drying may be desirable to facilitate handling.

The aggregate shall then be placed in the pycnometer which shall be filled with distilled water. Any trapped air shall be eliminated by rotating the pycnometer on its side, the hole in the apex of the cone being covered with a finger. The pycnometer shall be topped up with distilled water to remove any froth from the surface and so that the surface of the water in the hole is flat. The pycnometer be dried on the outside and weighed (weight B).

The contents of the pycnometer shall be emptied into the tray. care being taken to ensure that all the aggregate is transferred. The pycnometer shall be refilled with distilled water to the same level as before, dried on the outside and weighted (weight C). The difference in the temperature of the water in the pycnometer during the first and second weighings shall not exceed 2° C.

The water shall then be carefully drained from the sample by decantation through a filter paper and any material retained returned to the sample. The sample shall be placed in the oven in the tray at a temperature of 100° to 110° C for $24 \pm 1/2$ hours during which period it shall be stirred occasionally to facilitate rying. It shall be cooled in the air tight container and weighed, (weight D).

Two tests shall be made.

2.4.2.2. Using the Second (gas jar) apparatus described in 2.4.1, (c) the procedure shall be the same except that in filling the jar with water it shall be filled just to overflowing and the glass plate slide over it to exclude any air bubbles.

2.4.3. *Calculations.*—Specific gravity, apparent specific gravity and water absorption shall be calculated as follows :—

$$\text{Specifie gravity} = \frac{D}{A-(B-C)}$$

$$\text{Apparant specific gravity} = \frac{D}{D-(B-C)}$$

$$\text{Water absorption (percent of dry weight)} \quad \frac{100\,(A-D)}{D}$$

Where

A = Weight in g of saturated surface dry sample.

B = Weighting of pycnometer or gas jar containing/sample and filled with distilled water.

C = Weight in g of pycnometer or gas filled with distilled water only ; and

D = Weight in g of oven dried sample.

2.4. *Reporting of results.*—The individual and mean results shal be reported and the grading of the aggregate shall be stated.

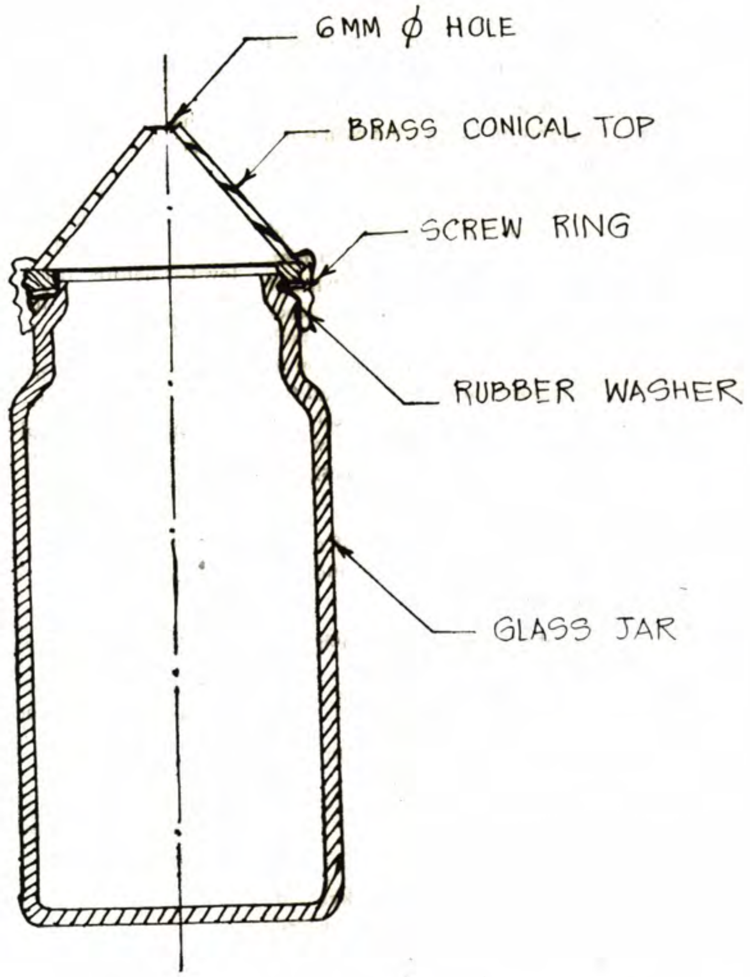


FIG-1 SECTION OF PYCNOMETER MADE FROM FRUIT JAR

2·5. *Method IV—Alternate Method.*

2.5.1. The specific gravity and water absorbtion of aggregate smaller than 40 mm. may be determined by using the apparatus described in I.S. 1199 –1959 Methods of Sampling and Analysis of Concrete, but distilled water shall be used in place of tap water.

2.5.2. When testing aggregate between 40 mm. and 10 mm. the procedure shall be as described in 2·2. Substituting the bucket for the wire basket and stirring with a rod instead of jolting to remove air from the sample.

2.5.3. When testing aggregate smaller than 10 mm. the apparatus shall be used in the same way as above, but the sequence of operaions shall be as given in 2·4. After transferring the sample to the bucket, water shall be added to cover the aggregate by atleast 25 m. and the sample stirred to remove air. The bucket shall then e filled with water and the level of water in the tank raised slowly o avoid as far as possible, the loss of fine particles from the ample in the bucket to the tank.

EXTRACT FROM I.S. 1834—1961.

Specification for Hot Applied Sealing Compounds for Joints in concrete.

1. *Scope.*

1.1. This standard specified hot applied sealing compounds intended for use in sealing joints in concrete roads, runways, bridges and other structures.

1.2. The material covered by this standard is suitable only for longitudinal joints and transverse joints not more than 10 m. apart.

2. *Materials.*

2.1. Joint sealing compounds composed of suitable mixtures of materials, shall from a resilient and adhesive barrier in concrete joints and shall be capable of resisting the inflitration of water and the ingress of solid particles. They shall not be unduly affected by temperature variation, and shall resist any tenency to flow out of the joint or be picked up by vehicle tyres under hot weather conditions, they shall not become brittle or suffer loss of resiliency during cold weather conditions.

2·2. On heating in suitably designed kettles they shall be capable of acquiring a pouring consistency enabling them to be run molten in a uniform manner into all types of horizontal joints without difficulty.

2·3. Sealing compounds shall be employed for filling contraction and construction joints as well as sealing medium above expansion joint fillers (*see* I.S. : 1838—1961) specification for preformed Fillers or Expansion Joint in Concrete non-extruding and Resilient type (Bitumen—impregnated Fibre) to a depth not exceeding 40 mm.

2·4. Suitable primers may be first applied to the vertical faces of the concrete joint before the pouring of sealing compounds in order to improve the adhesive qualities of the latter.

3. *Grades*:

3·1. This standard covers two grades of sealing compounds.

(*a*) Grade A (Normal) and (*b*) Grade B (Jet Fuel Resistant).

3·1·1. Grade A is suitable for concrete constructions other than those which are subjected to spillage of kerosene or other heavy petroleum oils.

3·1·2. The increasing use of jet aircraft has rendered the use of joint sealing compounds resistant to jet fuels essential in certainrunway constructions. Grade B is suitable for this purpose.

4. *Sampling*:

4.1. A representative sample of the joint sealing compound of approximately 3 kg. in weight shall be removed from the package (*see* I.S. :—1201 —1958 Methods for Testing Tar and Bitumen). Care shall be taken during removal that the sample is not contaminated in any way by oil, water, etc.,and it shall be placed in a clean closed metal container.

5. *Preparation of specimens for Test*:

5·1. During the melting of the sample for preparing the test specimen, the compound shall be continuously agitated and shall not be heated to a temperature 20° C above its pour point as defined by the procedure described in Appendix A.

5·2. The test specimens shall be poured in succession from the same sample, which shall not be re-heated. Heating and pouring shall be carried out as expeditiously as possible in order to avoid alteration due to prolonged heating.

EXTRACT FROM I.S. 215—1961.

Specifications for Road Tar (Revised.)

1. *Scope* :

1.1. This standard covers five grades of road tar with different viscosity ranges suitable for various types of road construction under the climatic conditions prevalent in various parts of India.

2. *Terminology* :

2.1. For the purpose of this standard, the definitions given in I.S. 334—1953 Glossary of Terms Relating to Bitumen and Tar shall apply.

3. *Grades* :

3.1. There shall be five grades of road tar as follows :—

RT 1 : For surface painting under exceptionally cold weather conditions and for use on hill roads at high elevations.

RT 2 : For standard surface painting under normal Indian climatic conditions.

RT 3 : (*a*) For surface painting and renewal coats, and

(*b*) For premixing chips (top course and light carpets).

RT 4 : For premixing tar macadam (base course), and

RT 5 : For grouting.

4. *Requirements* :

4·1. Road tar shall be prepared entirely from crude tar produced as a by-product of high temperature carbonization of coal in coke ovens or in retorts.

4·2. The material shall comply with the requirements according to grade given in Table 1.

TABLE I.—REQUIREMENTS FOR ROAD TAR.

(*Clause* 4·2.)

Serial number.	*Characteristic.*	*Limits for Grade.* *RT* 1	*RT* 2	*RT* 3	*RT* 4	*RT* 5	*Reference to Indian Standard Methods of Test.*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Specific gravity at 27° C. ..	1·16 to 2·26	1·16 to to 2·26.	1·18 to 1·28.	1·18 to 1·28.	1·18 to 1·28.	I.S. : 1202—1958
2	Viscosity by standard tar viscometer (10 mm.) :						
	(*a*) Temperature of test ..	35°C	40°C.	45°C.	55°C.	..	I. S. : 1206—1958 (Method A).
	(*b*) Viscosity in seconds ..	30 to 55.	30 to 55.	35 to 60	40 to 60.	..	
3	Equiviscous temperature (EVT.).	32° to 36° C.	37° to 41°C	43° to 46° C.	53° to 57° C.	63° to 67° C.	I.S. : 1207–1958

TABLE I—REQUIREMENTS FOR ROAD TAR—*cont.*
(*Clause* 4.2.)—cont.

Serial number.	*Characteristic.*	*Limits for Grade.* RT 1	RT 2	RT 3	RT 4	RT 5	*Reference to Indian Standard Methods of Test.*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
4	Softening point	..	..	..	..	45 to 50 C.	I.S. : 1205—1958.
5	Softening point of residue, Max.	48° C	50° C 52° C	54° C	56° C		I.S. : 1205—1958.
6	Water content, percent by weight, Max.	0·5	0·5	0·5	0·5	0·5	I.S. : 1211—1958.
7	Distillation fractions, percent by weight (g per 100 g) distilling :						I.S. : 1213—1958. (Method B.)
	(*a*) Upto 200° C. Max. ..	0·5	0·5	0·5	0·5	0·5	
	(*b*) from 200° C. to 270° C.	5 to 12.	2 to 9.	1 to 6.	0·5 to 4.	0 to 4.	
	(*c*) from 270° C. to 300° C.	4 to 10.	4 to 8.	3 to 6.	2 to 7.	1 to 5.	
	(Total distillation) (*b*+*C*) Max.	16	14	12	10	7	
8	Phenols, percent by volume, Max.	2·0	2·0	2·0	2·0	1·0	I.S. : 1218—1958.
9	*Naphthalene, per cent by weight, Max.	4·0	3·5	3·0	2·5	2·0	I.S. : 1219—1958.
10	Matter insoluble in toluene. percent by weight, Max.	22·0	22·0	24·0	24·0	24·0	I.S. : 1215—1958.

EXTRACT FROM I.S. 73—1961.

Specification for paving Bitumen.

1. *Scope* :

1.1. This standard covers physical and chemical requirements of paving bitumen for use in roadways, air fields and allied construction.

2. *Terminology* :

2·1. For the purpose of this standard, the definitions given in I.S. 334–1953 Glossary of Terms Relating to Bitumen and Tar shall apply.

3. *Types and Grades* :

3·1. Paving bitumen shall be of the following two categories :—

(*a*) Paving bitumen from Assam Petroleum, and

(*b*) Paving bitumen from other sources.

3·1·1. Paving bitumen from Assam Petroleum shall be classified into six grades according to their penetration and each grade shall be given a designation as shown in Table 1 with letter 'A' denoting the type and numeral representing the mean of the limit of the penetration specified for the grade.

3·1·2. Paving bitumen from other sources shall be classified into five grades according to their penetration and each grade shall be given a designation as given in Table II with letter 'S' denoting the type and a numeral representing the mean of the limits of the penetration specified for the grade.

NOTE.—For example A-25 means that paving bitumen corresponding to this grade is from Assam Petroleum and has approximately a penetration value of 25. S 35 means that paving bitumen corresponding to this grade is from sources other than Assam Petroleum and has approximately a penetration value of 35.

* The corrected wet crystallizing point of napthalene present shall be not below (70°) C.

TABLE I.—REQUIREMENT FOR PAVING BITUMEN FROM ASSAM PETROLEUM.

(*Clause* 3·1·1.)

Serial number.	*Characteristic.*	*Requirement for grade.* A-25.	A-35.	A-45.	A-65.	A-90.	A-200.	*Methods of Test reference to*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	Specific gravity at 27° C. Min.	0·99	0·99	0·99	0·99	0·98	0·97	I.S.: 1202—1958
2	Water, per cent by weight, Max.	0·2	0·2	0·2	0·2	0·2	0·2	I.S.: 1211—1958.
3	Flash point, Penaky Marterns closed type * C. Min.	175	175	175	175	175	175	I.S. 1209--1958. (Method A.)
4	Softening point * C	55 to 70.	55 to 70.	45 to 60.	45 to 60.	35 to 50.	30 to 45.	I.S. 1205--1958.
5	Penetration, at 25°C 100g, 5 Sec. in 1/100 cm.	20 to 30.	30 to 40.	40 to 50.	60 to 70.	80 to 100.	175 to 225.	I.S. 1203—1958
6	Ductility, at 27° C. in cm. Min.	5	10	12	15	15	15	I.S.: 1208—1958.
7	(*a*) Loss on heating, per cent by weight, Max.	1	1	1	1	1	2	I.S. : 1212—1958
	(d) Penetration of residue (expressed as percentage of item V) Min.	60	60	60	60	60	60	I.S.: 1203—1958.
8	Matter soluble in Carbon disulphide * per cent by weight, Min.	99	99	99	99	99	99	I.S.: 1216—1958.

* Carbon tetrachloride may also be used instead of carbon-disulphide, the method of test being the same.

TABLE II.—REQUIREMENTS FOR OTHER BITUMEN.

(*Clause* 3·1·2.)

Serial number.	*Characteristic.*	*Requirement for grades.* S-35.	S-45.	S-65.	S-90.	S-200.	*Method of Test reference to*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(i)	Specific Gravity at 27° C. Min.	0·99	0·99	0·99	0·98	0·97	I.S.: 12C2—1958.
(ii)	Water, per cent by weight, Max.	0·2	0·2	0·2	0·2	0·2	I.S. : 1211—1958.
(iii)	Flash point, Pensky Martens closed type, ° C, Min.	175	175	175	175	175	I.S.: 1209—1958 (Method A.)
(iv)	Softening point, °C.	50 to 65.	45 to 60.	40 to 55.	35 to 50.	30 to 45.	I.S. : 1205—1958.
(v)	Penetration at 25° C. 100g. 5 Sec. in 1/100 cm.	30 to 40.	40 to 50.	60 to 70.	80 to 100.	175 to 225.	I.S. : 12C3—1958
(vi)	Ductility, at 27° C. in cm. Min.	50	75	75	75	..	I.S. : 1208—1958
(vii)	(*a*) Loss on heating, per cent by weight Max.	1	1	1	1	2	I.S.: 1212—1958
	(*b*) Penetration of residue (expressed as percentage of item V) Min.	60	60	60	60	60	I.S.: 1203—1958
(viii)	Matter soluble in carbon disulphide per cent by weight, Min.	99	99	99	99	99	I.S. : 1216—1958

* In the event that bitumen is manufactured from all or part way indigenous crude oils, the specification for ductility is to be agreed between the purchaser and the supplier but shall not be less than the corresponding values given in Table M.

466-3A—20A

Extract From I.S. 217—1961.

1. *Scope* :

1·1. This standard covers the physical and chemical requirements of cutback bitumen produced by fluxing bitumen with distillates of petroleum or coal tar for use in road constructions.

2. *Terminology* :

2·1. For the purpose of this standard, be definitions given in I.S. 334—1953 Glossary of Terms Relating to Bitumen and Tar shall apply,

3. *Types and Grades* :

3·1. Cutback bitumen shall be of three types namely (*a*) Rapid curing (RC) ; (*b*) Medium curing (M.C.), and (*c*) Slow curing (SC).

3.2. Rapid curing (R.C.) cutback bitumen shall be classified on the basis of initial viscosity into six grades with the designations RC—0, RC—1, RC—2, RC—3, RC—4 and RC—5.

3.2.1. The uses of the six grades are as follows :—

(*a*) RC—0 is a rapid curing production of sufficiently low initial viscosity to be sprayed at normal air temperature without heating. It is used as a prime coat on untreated sand-clay gravel or crushed rock bases of dense texture, but without an excess of clay binder ; or as a seal coat for newly constructed road mix surface without the use of cover coat material ;

(*b*) RC—1 is a rapid curing product of low initial viscosity for use as a seal coat for surface treatment and retreatment or in the construction of thin asphaltic wearing courses with a light cover of suitable mineral aggregate free from dust.

(*c*) RC—2 is a rapid curing product of relatively low viscosity suitable for the preparation of cold patch mixtures which, preferably should be aged in stock piles for 24 hours before use.

(*d*) RC—3 is a rapid curing product of relatively high viscosity suitably for use in the construction of roller compacted road-mix wearing courses or for cold patch mixtures in which the mineral aggregate consists principally of crushed fragments from 6 to 38mm. in size, or for seal coat and non-skid treatment of existing paved surface when covered with suitable mineral aggregate.

(*e*) RC—4 and RC—5 are rapid curing products of high viscosity also suitable, for use in the construction of roller compacted, cold-laid, plant-mix wearing courses in which the mineral aggregates has a maximum size not over 38 mm and all of which is retained on a 6 mm. screen or for seal coat and non-skid treatment when covered with suitable mineral aggregate.

3.3. Medium curing (M.C.) cutback bitumen shall be classified on the basis of initial viscosity into six grades with the designations MC-0, MC-1, MC-2, MC-3, MC-4 and MC-5.

3.3.1. The uses of the six grades are as follows :—

(*a*) MC-0, and MC-1 are medium curing products of very low viscosity suitable for cold application and for use as a primer on earth, gravel or broken stone surfaces prior to the construction of thin asphaltic wearing course, It hardens in place and develops considerable binding quality, but not fast enough to hold a cover on stone chips or gravel.

(*b*) MC-2 is a medium curing product of low viscosity which could ordinarily be heated before application and which is suitable for use in construction of road-mix wearing courses in which the mineral aggregate is densely graded from a maximum diamater of 20 mm with 35 mm. to 60 per cent of the material passing I.S· Sieve 160 and 7 to 15 per cent passing I.S. Seve 8.

(*c*) MC-3 is a medium curing product of medium viscocity which should be heated before application and which is sutiable for use in the construction of cold-laid, plant-mix wearing courses in which the mineral aggregate is densely graded from a maximum amount of 25 mm. with 35 to 60 per cent of the material passing I.S. Sieve 160 and 7 to 14 per cent passing I.S. Sieve 8 and also for use in the construction of roller compacted road-mix wearing courses which the mineral aggreage is of the open graded type with a maximum diameter of 25 mm. containing little or no material passing I.S. Sieve 8 but having not less than 35 per cent I.S. Sieve 160. The asphalt and the aggregate require heating before mixing.

(*e*) MC-5 is a medium curing product of high viscosity suitable for use in the construction of roller compacted cold-laid, plant-mix courses in which the mineral aggregate is of the open graded type with a maximum diameter of 25 mm. containing practically no material passing I.S. Sieve 7 but having an appreciable percentage passing a 6 mm. screen. Both the asphaltic material and aggregate require heating before mixing.

3.4. Slow curing (SC) cutback bitumen shall be classified on the basis of the initial viscosity into six grades with the desginations SC-0, SC-1, SC-2, SC-3, SC-4 and SC-5.

3.4·1. The uses of the six grades are as follows :—

(*a*) SC-0 is a product of very low viscosity suitable for cold application as a dust layer on soil and earth roads requiring a light oil which would penetrate. It may also be used for initial treatment of soils or fine grained aggregates, where gradual improvement is to extend over a number of years by subsequent treatments applying more viscous asphaltic material. This product is not intended to serve as a hardening or cementing medium.

(*b*) SC-1 is a product of relatively low viscosity which should ordinarily be warmed slightly before application. It does not develop cementitiousness and is generally used for dust laying of traffic-bound gravel or macadam roads. It is also used as a priming treatment just prior to the application of more viscous asphaltic material in the construction of asphaltic wearing course.

(*c*) SC-2 is a very slow curing liquid product of low viscosity sutiable for use in dry climates during cool weather for the construction of traffic or roller compacted road-mix wearing course in which the mineral aggregate is densely graded from a maximum diameter of 25 mm. with 35 to 60 per cent of the material passing I.S. Sieve 8. It should ordinarily be heated before application. The material may also be used in the treatment of clay-bound roads maintained with a loose cover of gravel or rock roads and followed by covering of rock screenings or sand.

(*d*) SC-3 is a slow curing liquid product of medium viscosity suitable for use in dry climates during hot weather, in the construction of traffic or roller compacted road-mix wearing courses with densely graded mineral aggregate. It requires heating before application. It is sometimes used for plant-mix wearing courses with densely graded mineral aggregate but SC-4 is preferable for this purpose.

(*e*) SC-4 is a slow curing liquid product of relatively high viscosity suitable for use in dry climates in the construction of cold laid traffic roller compacted plant-mix wearing courses of densely graded mineral aggregate.

(*f*) SC-5 is similar to SC-4, but of higher viscosity and is used for the same purpose. It may also be used for seal coat treatment when followed by covering of rock screening of 12 mm,

EXTRACT FROM I.S. 3117-1965.

Specification for bitumen Emulsion for roads (Anionic Type).

2. *Terminology.*

2.0. For the purpose of this standard the definition given in I.S. 334-1965 shall apply.

3. *Materials.*

3.1. *Bitumen.* –The bitumen straight or fluxed, used for the manufacture of the emulsion, shall comply with the following requirements :–

(*a*) The penetration shall be between 150 and 350 ;

(*b*) Softening point (Ring and Ball) shall not be higher than 480 degree C ;

(*c*) Solubility in carbon disulphide shall not be less than 990 per cent ; and

(*d*) The loss of weight after heating for five hours at 163 degree C shall not exceed two per cent of the original weight. After carrying out this test the penetration of bitumen shall not be less than 60 per cent of its original value.

3.1.1. If it is desired to modify the performance of the emulsion during periods of low temperature, fluxing the bitumen with the addition of a quantity of fluxing agent not exceeding five per cent by weight of bitumen shall be permitted. Unless otherwise agreed to between the manufacturer and the purchaser, the fluxing agents shall comply with the following requirements :–

(*a*) Initial boiling point not less than 140 degree C ; and

(*b*) Distillate at 350 degree C not less than 90 percent by volume.

3.2. *Emulsifying Agent.* – The emulsifying agent, in the proportion in which it is present in the bitumen deposited by he emulsion, shall not have any deleterious effect upon the properties of that bitumen.

4. *Types.*

4·1. Emulsified bitumen shall be of the following three types : –

(*a*) Rapid setting–Type RS.

(*b*) Medium Setting–Type MS.

(*c*) Slow setting –Type SC.

4.1.1. Applications–The uses of three types of bitumen are given below : –

(*a*) *Type RS.*–A quick setting emulsified bitumen used the for penetration and surface treatment ;

(*b*) *Type MS.* –A medium setting emulsified bitumen used for plant mixes with course aggregate, substantially all of which is retained on 2.80 mm.I.S. Sieve with practically no material passing a 75 micron. IS· Sieve ;

(*c*) *Type SS.* –As low setting emulsified bitumen used for fine aggregate mixes in which a subtantial quantity of aggregate passes a 2.80 mm. I.S. Sieve and a portion may pass a 75 micron I.S. Sieve.

NOTE.–These types are to be used only down to a temperature of 5 degree C below 5 degree C the utility of the bitumen emulsion is likely to be impaired because off reezing.

5. REQUIREMENTS.

5.1. Bitumen emulsion shall be homogenous. Within 90 days after manufacture it shall show no undispersed bitumen throughly mixing.

Glossary of terms relating to bitumen and tar (revised).

EXTRACT FROM I. S. 1834-1961.

Specification for hot applied sealing compounds for joints in Concrete.

1. *Scope.*

1.1. This standard specified hot applied sealing compounds intended for use in sealing joints in concrete roads, runways, bridges and other structures.

1.2. The material covered by this standard is suitable only for longitudinal joints and transverse joints not more than 10 m. apart.

2. *Materials.*

2.1. Joint Sealing compounds, composed for suitable mixtures of materials, shall form a resilient and adhesive barrier in concrete joints and shall be capable of resisting the infiltration of water and the ingress of solid particles. They shall not be unduly affected by temperature variation, and shall resist any tendency to flow out of the joint or be picked up by vehicle tyres under hot weather conditions. They shall not become brittle or suffer loss of resilience during cold weather conditions.

2.2. On heating in suitably designed kettle they shall be capable of acquiring a pouring consistency enabling them to be run melten in a uniform manner into all types of horizontal joints without difficulty.

2.3. Sealing compounds shall be employed for filling contraction d construction joints as well as a sealing medium above expansion joint fillers (*see* I.S. 838-1961–Specification for Preformed Fillers for expansion joint in concrete non-extruding and resilient type Bitumen-impregnated fibre) to a depth not exceeding 40 mm.

2.4. Suitable primers may be first applied to the verticial faces of the concrete joint before the pouring of sealing compound in order to improve the adhesive qualities of the latter.

3. *Grades.*

3.1. This standard covers two grades of sealing compounds :–

(*a*) Grade A (Normal) and (*b*) Grade B (Jet Fuel Resistant.)

3.1.1. Grade A is suitable for concrete constructions other than those which are subjected to spillage of kerosene or other heavy petroleum oils.

3.2.3. The increasing use of jet aircraft has rendered the use of joint sealing compounds resistant to jet fuels essential in certain runway constructions. Grade B is suitable for this purposes.

4. *Sampling.*

4.1. A representative sample of the joint sealing compound approximately 3 Kg. in weight shall be removed from the package (*See* I.S. 1201-1958-Methods for Testing Tar and Bitumen). Care shall be taken during removal that the sample is not contaminated in any way of oil, water, etc., and it shall be placed in a clean closed metal container.

5. *Preparation of specimens for test.*

5.1. During the melting of the sample for preparing the test specimen, the compound shall be continuously agitated and shall not be heated to a temperature 20 degree C above its pour point as defined by the procedure described in Appendix A.

5.2. The test specimens shall be poured in succession from the same sample, which shall not be re-heated. Heating and pouring shall be carried out as expeditiously as possible in order to avoid alteration due to prolonged heating.

6. *Tests and Physical requirements.*

6.1. The physical requirements of sealing compounds shall conform to those given in Table 1.

6.2. Tests shall be carried out as described in the appropriate appendices specified in Table 1.

TABLE 1.—PHYSICAL REQUIREMENTS OF SEALING COMPOUNDS OF GRADES A AND B.

(*Clauses* 6.1. *and* 6.2)

Serial number and Characteristics.	*Requirement.*	*Method of Test.*
(1)	(2)	(3)
(i) Pour point, Max	180° C	Appendix A.
(ii) Softening point, Min... ..	75°C	I.S. 1205-1958.
(iii) Increase in softening point after heating to 20°C above pour point for 3 hours, Max.	5°C	Do.
(iv) Flow test, percentage, max. ..	5	Appendix B.
(v) Extensibility Min.	6 mm.	Appendix C.
(vi) Fuller settlement, different from mean per cent, Max.	10	Appendix D.
(vii) Resistence to grit penetration on impact test at 35° C, in tenths of a mm., Max. (For Grade A only).	20 or less	Appendix E.
(viii) Flash point, Min.	200°C	I.S.-1209-1958 Method C.
(ix) Penetration, at 25°C 100 g. 5s, 1/100.	15 Min. 20 Max.	I.S. 1203-1958
(x) Jet fuel resistence :—		
(a) increase in penetration as measured in (ix) after 7 days immersion in jet fuel, max (For grade B only).	15	Appendix F and I.S. 1203-1958.
(b) Change in weight, after 7 days immersion in jet fuel per cent, Max.	1	Appendix G.

SECTION XIV

STEEL AND IRON WORK

SECTION XIV.

STEEL AND IRON WORK.

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SECTION XIV.

STEEL AND IRON WORK.

INDIAN STANDARD EXTRACTS

SECTION XIV

STEEL AND IRON WORK.

SPECIFICATION No. 86.

1. *General.*—This specification will include governing clauses on the supply and delivery fabrication and erection at site,of all materials covered by east iron, wrought iron, and steel, employed for structural purposes, shown on the relevant drawings and described in the supplementary specifications and schedules.

2. All matetials must strictly conform to relevant specifications, and proof thereof is to be furnished, if so required to the Executive Engineer.

3. The work includes all bolts, nuts, washers and field rivets required for complete erection at site together with an allowance for waste, etc., upto 10 per cent (unless otherwise specified in the schedule) on net-number of bolts, nuts, washers and field rivets required.

In addition to the above, the contractor is to supply all service bolts and nuts, and ordinary plates, washers, necessary for erecting the work at site.

4. For design of steel sections, Part VI Section 6 of N.B. Code and I.S. 800.1962 shall apply.

SPECIFICATION No. 86-A.

STEEL AND STEEL WORK.

Clauses additions to " General" preceding.

1 *Quality* :—(i) Regarding quality relevant I.S. shall apply Especially I.S. 800/1962 and N.B. Code Part VI—Section 6.

NOTE :—Steel articles will in a large number of cases, be provided by the Executive Engineer and issued to the Contractor at a rate specified when calling for tenders. The preceding clause and relevant clauses under " General" are to govern cases of local purchase by a contractor, where the schedule item requires same.

(A) As regards " Tests " relavant I.S. shall apply.

(B) *Tensile stength of rivet bars* :—Regarding the Tensile strength of rivet bars paragraphs 9.1 to 9.2.1. in I.S. 1148-1964 shall apply.

Cold Bend Test :—For cold bend test-relevant paragraphs 8.3 to 8.3.2. in I.S. 226-1969 shall apply

(C) *Test for manufactured rivets* :—Regarding tests—paragrapah 7.2 in I.S. 1929-1961 shall apply

(D) *Margin over and under dimensions and weights* :

(*a*) *Specified lengths* :—When steel in bars or sections is specified to be cut to certain lengths it shall be cut within a margin of 25.5 mm. under or 25.5 mm. over the specified length, but when the minimum lengths are specified the margin shall be within 51 mm. over.

(*b*) *Exact lengths* :—When lengths are specified to be " exact ", the steel in bars or sections shall be cold sawn or machined within a margin of 3 mm. over and 3 mm. under the lengths specified.

(*c*) *Weight* : When a minimum weight is specified the rolling margin or plates, sections and bars shall be 5 per cent over and when a maximum weight as specified the rolling margin shall be 5 per cent under the specified weight.

When the specified weight is not stated to be either a minimum or maximum, the rolling margin shall be between 2½ per cent over and 2½ per cent under the specified weight.

The margin shall be ascertained separately for plates, each Section (e.g. angles, tees, beams, channels, etc.,) and bars

NOTE : In the case of heat treated wire the tolerance shall be determined on the diameter and not on the weight. When a minimum diameter of wire is specified the tolerance shall be 2 percent over and where the maximum diameter is specified the tolerance shall be 2 per cent under the specified diameter. When the specified diameter is not stated to be a minimum on a maximum the tolerance shall be 1 per cent over and 1 per cent under the specified dia meter. Heat treated wire may be sheared to length.

(*d*) *Cross sectional diamensions of beams and channels* :—The permissible upwards and downwards variation in the specified depth of beams and channels is shall not exceed the following :

	Depth.		Tolerance.	
	Over mm.	*Upto and including. mm.*	*Plus. mm.*	*Minus. mm.*
Beams—	..	200	3·0	2.0
	200	400	3.5	2.5
	400	600	4.0	3.0
Channels—	..	200	3.0	2.0
	200	400	3.5	2·5

In additon to the above, the I.S. 800;1962 Appendix II shall also apply.

2. *Shop and field finish and workmanship* :

(*a*) All sheared edges and ends where stress is transmitted shall be planed on machined. Rough edges shall be filed off, ground or machined as may be instructed. No article shall be supplied with any edge or end in a rough or improperly finished manner to require further treatment before it can be fitted closely into its intended position. Ends of all stiffeners, etc., must bear tightly top and bottom.

Joints in angles, plates, etc., are to be made only in such positions as may be shown on plans or ordered. Butt joints must meet truly over the whole of the butting surface. Plates and bars should be levelled and straightened when necessary by pressure and not by hammering. All steel work intended to be revived or bolted together must be absolutely in contact over the whole surface.

(*b*) *and* (*c*) Regarding drilling and other operations, instructions contained in Paragraphs 35 to 37 of I.S. 800/1962 shall apply.

(*d*) All bolts and nuts shall conform to I.S. 1367-1961 technical supply conditions for threaded fasteners. The heads and nuts shall be hexagonal unless otherwise specified. Headed bolts are to have heads forged in one piece with the shank, the shank being truly cylindrical and the head concentric. Nuts, when measured across the flats, are to be at least twice the diameter of the bolt and to be at least equal in depth to the diameter of the bolt.

(*e*) The screws of all bolts should show full thread above the nuts when the latter has been screwed up tight, any length beyond this amount for finished work, observable to view as in buildings and bridges shall where so instructed, be cut off and the end rounded with a file.

Care must be taken that all holding down belts are are provided with proper hexagonal heads and have not merely got the end of the shank burred over the washer.

Heads and nuts of bolts and rivet heads shall be tightened and drawn closely home and shall lie squarely and closely on the plates. Bolts and rivets shall pass through holes in plates accurately fitting and without distortion of bolts, rivet or plate.

(*f*) *Welding*.— Wherever welding is proposed relevant I.S. may be referred.

(*g*) *Bearings* :—The surface of every steel bed and bearing plate, or plate over saddle casting shall be made perfectly fair and level all over, and when attached to the member supported by it, shall be lead true in every direction to its proper angle of bearing.

All rivet heads of bearing surfaces shall be counter sunk and dressed flush.

(*h*) *Expansion gear, etc.* :—Generally in connection with the roller and bearing gear, all meeting surfaces, including the sides of the roller frames, are to be machined, all bolts turned and fitted, all washers faced and the whole to be got up in a style of first-class machine work, the rollers, knuckles, and pins being polished to a smooth surface.

(*i*) *Camber in fabrications*:—Main girders are to be erected on block accurately set to give them, while so erected, the camber, specified of the drawings, which must not be exceeded. No camber shall be given to cross girders.

(*j*) *Oiling and Painting* :—Painting should not be done to steel work till it has been inspected by the Executive Engineer, unless otherwise permitted.

(*k*) Regarding detailed instructions on the method of painting relevant I.S. 800/1962, paras 43.1 to 43.4 shall apply. The exemption made under clause 43.3 of I.S. 800/1962 shall not apply, in cases of hollow structures likely to be punctured later on; in such case the interior of sealed hollow sections shall also receive the full specified protective treatment before assembly.

(*l*) All field rivets, bolts, nuts, washers, etc., are to be dipped into boiling linseed oil.

(*m*) All machined surfaces are to be well coated with a mixture of a white lead and tallow.

(*n*) No extra payment will be made for the oiling and painting under this clause unless there is definite provision as a separate schedule item of the contract.

(*o*) Regarding details for erection operations, I.S. 800/1962 Para 45 shall apply.

3. In the case of spans upto and including 18.30m the erection of every span at the contractor's works will not be insisted upon, provided that methods are used to ensure strict inter changeability of parts and correctness of assembleage and bearing of the span as a whole. In such cases, one span in ten of each type will be erected from pieces selected at random by the Executive Engineer, all pieces of the ten spans being previously marked with a consecutive number representing the span to which they belong. Should there be any failure of parts to fit, or of the span, as a whole, to correctly assemble and to have all bearings true when assembled, all similar spans must be erected complete.

(*a*) The work is to be put together with a sufficient number of either parallel drifts or turned bolts to bring the pieces into place. When so erected, all holes left to be filled in the field, must be so fair that a cold rivet of the size specified, or a gauge turned to the same size can be passed through them without difficulty. No drift is to be used anywhere about the work, larger in any part than the hole into which it is to be driven.

(*b*) *Putting together*:—In putting iron work together, the greatest care is to be taken to fit the plates and bars accurately in contact, and to see that rivet and bolt holes correspond before riveting up. All joints are to be perfectly cleaned and freed from rust Should any parts be bent or injured, they are to be repaired according to the instructions of the Executive Engineer.

In case holes do not exactly correspond, they should not be slotted out to fit, but shall with the permission of the Executive Engineer be enlarged with a circular bit and larger rivets or bolts used to fill the holes.

All members must be so formed that they can be accurately assembled without being unduly packed strained or forced into position and when built, shall be true and free from twists, kinks, buckles, or open joints between component pieces. Failure in these respects will involve the rejection of the defective members.

(*c*) *Heating rivets*:—Rivets shall be heated uniformly throughout their whole substance, if possible in an air furnace, the rivets being kept clear of the fuel. Great care is necessary in heating rivets to prevent the iron from burning and becoming brittle.

(*d*) *Packing to camber during erection*.—In erecting girders, the different parts are to be first fitted together with service bolts and packed upto camber before riveting is done, care is to be taken to keep the girders laterally straight.

(*e*) *Bed Plates*.— In fixing bed plates, special care must be taken to put the holding down bolts exactly in position, so that the nuts may bearsquare, and firmly grip, the plate below. The upper surface of the bed plates or rollers must be exactly at the level given by the Executive Engineer. The bed plates are to be set in cement or on lead sheets as the plans or addendum spce fication may show or as the Executive Engineer may direct, the cost of which shall be included in the rate for fixing.

(*f*) *Marking*.— Every portion of the work is to have its erection letters or numbers distinctly stencilled on it with paint and marked with a punch for guidance in erection at site and every piece, bundle, or packing case shall be also clearly marked as the Executive Engineer may require.

In cases where the field erection of the work is not to be executed by the steel work supplying contractor, the latter shall supply a plan showing the marking of the different portions of the work.

(*g*) *Rivet and bolt lists*.– The contractor is also to supply without charge complete lists in duplicate of the rivets and bolts required for erecting the work at site showing the parts of the work to which the various rivets and bolts belong and having each item marked,so as to indicate the particular case in which it will be found

(*h*) *Despatch*.—The work is to be despatched in such portions as may be found convenient for carriage or as specially instructed by the Executive Engineer.

4. All projecting pieces, plates or bars are to be kept in shape by timber or angle bars bolted (or) spiked to them, to the extent necessary to protect them from injury in transit. Before despatch, screwe ends of the rods and machined surfaces shall be efficiently protected from injury during transit.

a) All straight bars and plates, except small pieces, are to be sent out in convenient bundles temporarily riveted (or) bolted together or bound with rod iron or suitable wire as may be necessary. Corrugated floor plates are to be sent out in nests, bolted together at ends, with washers between.

(b) All rivets, bolts, nuts, washers, plates under 30 cm. square and small articles generally, are to be packed in cases, of strength sufficient for purposes of safe transit and separately for each span each case weighing when full not more than 356 kg. All bolts and rivets of different sizes are to be packed in separate bags, each bag having a label indicating its contents.

(c) Regarding inspection and testing relevant I.S. 800/1962 paras 47·1 to 47·6 shall apply.

5. *Special items* :—(a) *Lintels*.—Where two or more parallel joists are used as a lintel, they must be so connected with bolts and separators (*vide* structural steel hand-books for sizes)or some other approved method as to form practically a single unit. Separators should be placed near each bearing and at intervals of three to four feet along the joists.

(b) *Iron grated doors and gratings*.—When making iron grated doors or gratings for jails, or other buildings the ends of the square bars must not be reduced to less than will just allow of their insertion into a circular hole of diameter equal to the side of the bar and when placed in position in its frame, the end of each bar must project to a length equal to the diameter of this hole, to admit of the bar being firmly secured with a snap head.

NOTES ON DESIGN OF ROLLED STEEL BEAMS, GIRDERS AND ROOF TRUSSES.

Beams and Plate Girders :

1. *Vide* Appendix for "Properties of Sections" and table of safe distributed loads in tons on beams of varying spans and for "safe loads on standard heavy beams as Stanchions", *vide* I.S.I. Hand Book, 1. Structural Steel Sections, Section D Beams channels and other compounded sections used as column (Tables XXXII to XXXVIII) (Page 158 to 185).

2. The depth of plate girders varies from 1/10 to 1/15 of span ; 1/12 is the most economical proportion. The width of the flange under compression should not be less than 1/30 to 1/40 of the span, or it will be liable to buckle sideways. Both flanges must be wide enough for the rivets and for the ends of stifleners where they are used. No plates of less than 6 mm in thickness should be used or they will soon be destroyed by corrosion. There should be as few joints as possible especially in the tension flange and web.

3. The ends of girders must not be rigidly fixed, unless they have been designed as girders to be fixed at the ends, otherwise, stresses, will come upon them, which they were not designed to bear.

4. The ends of girders resting upon walls should be supported by hard stone bed plates and may be bedded upon sheet lead, or upon two thicknesses of asphalted or tarred felt, and if they are required to afford a tie to the structure, they may be secured by bolts to the walls. The stone bed plate should be chamfered at its outer face.

5. Girders of over 15 m. span should have cast iron shoes upon the ends, so that they may slide when the girder alters in length under changes of temperature, and large girders should have one end supported on rollers. working in a roller box.

6. As a rule, girders should be connected by the webs, not the flanges. The latter arrangement would often be inconvenient, and would in many cases be equivalent to fixing the ends, or making the girders continuous.

7. Where possible, the holes for bolts, etc., should be made as near as possible to the neutral axis or centre line of the girder, so that they may be clear of the direct stresses upon it.

8. Care should be taken to use market sizes of plates and steel angles as far as possible. For example, the web in small girders should, where possible, be made an even multiple of 5 cm. in order that market widths of plates may be used to avoid the extra cost of shearing. Steel angles should not be specified of peculiar size and thickness exactly to suit the calculated dimensions, or the difficulty in fitting them will cause not only expense but delay. It may, however, be cheaper in some cases to use specific lengths in order to reduce the number of joints.

9. All parts should be so arranged as to be got at easily for riveting and for periodical painting.

10. Plate girders should be constructed with a camber of about 1/480 of the clear span, so that when loaded they may not sag or appear to do so.

11. For live and dead loads of the floors refer relevant I.S. 1911 1967 and N.B. Code Part VI—Section I.

12. For rolled steel joists over small spans, say upto 2·45 m. an overlap or minimum bearing of 15 cm. over the walls at either ends should be allowed, for spans from 2-75 m. to 3·66 m, a minimum bearing of 23 cm., and for rolled steel beams or girders, in span 2·75 to 3·66 m. a minimum bearing of 30 cm. should be provided. The length of bearing at each end should also be preferably not les than the depth of the girder where this can readily be provided.

In case of heavy loads and larger spans, the bearing is to be determined by the safe bearing capacity of the bed stone masonry used under the ends of the girders as per N.B. Code Part VI—Section 4.

13. *Steel trusses for roofs* :—(a) For roofs of small spans the ends of trusses should be laid on lead sheets and the holes for bolt which secure them should be slots, of an oblong form, so that the end can move slightly backward and forward on the lead.

The end of the truss from which direction the prevailing winds blow should invariably be fixed.

In roofs of large span the chair or saddle at the free end of the truss should be supported on steel rollers, so that it can move outwards and inwards with ease under changes of dimensions caused by the effect of temperature.

(b) In sheds, open at the sides, the trusses should be strongly braced together by wind ties to secure them against the effect of gales. The wind ties or rods should pass from the foot of principal rafter diagonally across three or four trusses, to which they should be secured until they reach the ridge. The wind ties should be arranged to converge in pairs and should be furnished with adjustable joints.

14. *Calculations for roof Trusses* :—Tables of Co-efficients for the determination of stresses, and lengths of members in roof trusses, for any span, the proportion of height to half the span being 1:2, is given below :

14·1. *To find the stress in any member* :—Let S=Span between the points of inter-section of the rafter and tie L=Total dead load carried by the truss including its own weight. W=Total wind pressure resisted by the truss, acting on one side of the roof and normal to its surface. F=Total stress required. Then F=(L, multiplied by the co-efficient for dead load)+(W1 multiplied by the co-efficient for wind pressure).

NOTE.— In trusses of large spans, to provide for expansion, the co-efficient for wind pressure corresponding to "one end free "should be used.

To find the length of any member between points of intersection multiply S by the length co-efficient for that member.

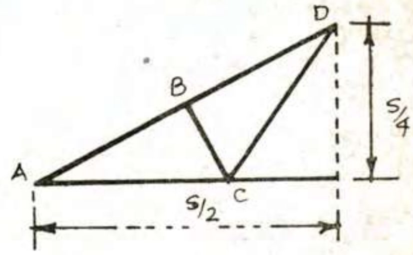
NOTE.—The following stress co-efficients have been calculated on the assumption that the roof purlins occur over the points of intersection of the various members with the principal rafter; when such is not the case, bending is produced in the rafter which necessitates further calculation, or allowance being made, when deciding its section.

For additional information I.S. 800/1962 shall apply.

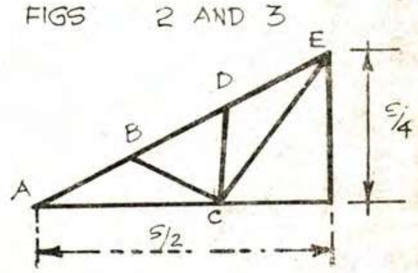
TABLE XIV.

Figure number.	*Member of truss.*	*Dead lead.*	*Stress co-efficients. Normal wind Pressure*		*length co-efficients.*
			Both ends fixed.	*One end free.*	
(1)	(2)	(3)	(4)	(5)	(6)
1	AB	0·838	0·875	..	0·27950
	BD	0·727	0·375	..	0·27950
	BC	0·223	0·500	..	0·13075
	AC	0·750	0·978	..	0·31250
	CE	0·500	0·419	..	0·18750
	CD	0·250	0·559	..	0·31250
2 and 3	AB	0·932	1·042	..	0·18634
	BD	0·758	0·820	..	0·18634
	DE	0·783	1·042	..	0·18634
	BC	0·179	0·401	..	0·16797
	DC	0·179	0·401	..	0·16797
	AC	0·833	1·165	..	0·31250
	CF	0·500	0·419	..	0·18750
	CE	0·333	0·746	..	0·31250
4 and 5	AB	0·978	1·125	1·125	0·13975
	BD	0·922	1·125	1·125	0·13975
	DF	0·866	1·125	1·125	0·13975
	FH	0.811	1·125	1·125	0·13975
	BC	0·112	0.250	0·250	0·06987
	FG	0·112	0·250	0·250	0·06287
	DE	0·224	0·500	0·500	0·13975
	AC	0·875	1·258	1·397	0.15625
	CE	0·750	0·978	1·118	0·15625
	EJ	0·500	0·419	0·559	0·18750
	CD	0·125	0·279	0·279	0·15625
	DG	0·125	0·279	0·279	0·15625
	GH	0·375	0·838	0·838	0·15625
	EG	0·250	0·559	0·559	0·15625
6	AB	1·025	1.208	1·208	0·09317
	BD	0.938	1·097	1·097	0·09317
	DE	0·950	1·208	1·208	0·09317
	EG	0·913	1·208	1·208	0·09317
	GJ	0·826	1·097	1·097	0·09317
	JK	7·838	1·208	1·208	0·09317
	BC	0·090	0·200	0.200	0·08398
	DC	0·090	0·200	0·200	0·08398
	GH	0·090	0·200	0·200	0·08398
	JH	0·090	0·200	0·200	0·08398
	EF	0·224	0·500	0·500	0·13975
	AC	0·917	1·351	1,491	0.15628
	CF	0·750	0·978	1,118	0 15625
	FL	0·500	0·419	0·559	0·18750
	CE	0·167	0·373	0 373	0·15625
	EH	0·167	0·373	0 373	0·15625
	HK	0·417	0·932	0 932	0·15625
	FH	0·250	0·559	0 559	0·15625

FIG 1.



FIGS 2 AND 3



FIGS 4 AND 5

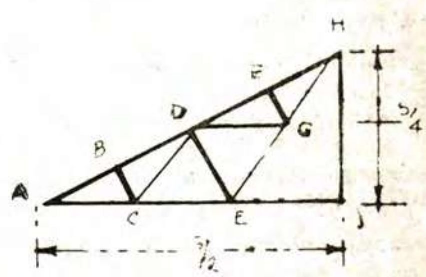
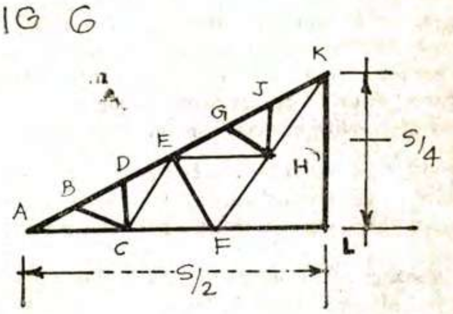


FIG 6



SPECIFICATION No. 86-B.

1. *Wrought Iron.*

NOTE —Steel has practically superseded wrought iron for structural purposes, but it is in use for some smithy and forge purposes. Some grades are more rust-resistant than steel, and hence are at times used on hydraulic and marine works. Certain grades of so called rustless iron sheets have, however, been found in practice to have alife but little greater than properly treated and maintainedmild steelsheets.

2. The wrought iron supplied shall be such as to meet the following tests :—

(a) Bars over 5 cm. in diameter and angle and other shaped iron shall have an ultimate tensile strength of not less than 34·65 kg./mm² of original section with an elongation of at least 12 per cent in a length of 20 cm. and be capable of bending double, when cold, without cracking, to a curve of which the inner radius is twice the thickness of the piece tested.

(b) Plate iron shall have an ultimate tensile stength of not less than 33 kg. per mm. ² of original section and an elongation in a length of 20 cm. of at least 8 per cent with the grain and 26·8 kg/mm² and 3 per cent elongation across the grain. The cold bend shall be 35 degrees with the grain and 15 degrees across for 1 cm. plate and proportionate amounts for other thicknesses, the radius of the curve being equal to the thickness of the plate.

(c) The wrought iron used for rivets, bolts and bars under 5 cm. in diameter shall have an ultimate tensile strength of not less than 36·2 Kg./mm² of original section, with an elongation of not less than 20 per cent in 20 cm. and shall stand bending double when cold without cracking.

3. Where finished articles are to be supplied under the contract schedule they should be forged clean from the anvil, neat, sound and properly worked. All edges shall be filed square when so directed. Coating, whether of boiled linseed oil- applied to the hot iron, or whether of a particular brand of paint, will be separately specified.

SPECIFICATION No. 86-C.

1. *Cast Iron.*

Clauses additional to "General" preceding:

1·1. All Cast iron used on the work shall be of the best tough, close grained, grey metal, clean sound, without admixture of deleterious matter, true in section with an even thickness of metal throughout conforming to the design, free from air holes, sand holes, flaws or defects of any kind, and with clean and sharp edges, where so shown on plan, and with an even surface. It shall be sufficiently soft to admit of being easily cut by either chisel or drill.

NOTE.—(a) The quality of material may be fairly well judged from the appearance of fracture. It is made either as a grey or as a white iron, Grey, being the strongest, is in demand the most and should invariably be used where strength is desired. Hard and brittle material is commonly light grey in colour, having little or no lustre. A tough iron is marked by a uniformly diffused dark grey colour having a good lustre, but if mottled in colour and without lustre, then the material is weak. A light grey colour with pronounced lustre indicates a hard and tenacious iron and when a fracture shown up as a much mottled dark colour with an entire absence of lustre the suitability of the iron should be suspected, with a view to rejection.

(b) For all practical purposes of importance, steel has entirely displaced cast iron in structural engineering, but owing to its relative cheapness and the ease with which it can be cast in moulds to almost any desired shape, there are still many uses to which it is put.

(c) Brazing and riveting are inadmissible operations where cast iron is concerned. Grey iron is much cheaper to machine than white iron which is not easily worked.

2. Moulds and patterns shall be supplied by the contractor unless otherwise specified. It will be specified if the castings are to be oversize in any dimension to permit of subsequent machining.

3. Stopping or plugging with lead, putty, or paint shall be prohibited. Castings shall not be painted until they have been passed by the Executive Engineer.

4. Castings must be of such a strength that a test bar cast from the same heat of metal 5 cm. deep X 2·5 cm. wide placed upon bearings 90 cm. apart will sustain without fracture a weight of 1360 kg, placed at the centre with a minimum deflection of 8 mm.

5. Castings having wearing surfaces shall be made from cold blast pig.

6. Holes for bolts, etc., shall be drilled out or cast in the casting as may be directed in each case.

7. Cast iron pipes and special castings for water, sewage or hydraulic power shall be supplied to the standard laid down in the relevant Indian Standard specification Surface treatment whether by Doctor Angus Smith's composition or other paint will be separetly specified.

8. When cast iron is required only for counter weights, the Executive Engineer will amend this specification to suit the particular requirements of the work.

9. Regarding measurement of steel work and iron work-relevant I.S. 1200 (Part VIII) 1967-shall apply.

EXTRACT FROM I.S. 226—1969.

Specification for Structural Steel.

7. *Tensile Test.*

7·1. Number of Tensile tests.

7·1·1. *Plates, Sections (Angles, Tees Beams, channels and flats, etc).*—

One tensile test shall be made from finished steel for every 40 tonnes or part thereof from each cast, a separate test being made for each class of steel product (namely plates, Sections and flats) rolled from a cast.

7·1·1·1. Where plates, sections or flats of more than one thickness are rolled from the same cast, one additional tensile test shall be made from the material in each class of product for each variation in thickness of 6 mm. above or below the thickness of the test piece first selected in such a class.

7·1·2. *Bars (round, square and hexagonal).*— One tensile test shall be made from finished steel for every 40 tonnes or part thereof from each cast and for every class of product. When more than one diameter or thickness of the bar is specified, one additional tensile test shall be made for each diameter or thickness of the bar ordered if so desired by the purchaser.

7.2. Tensile test pieces—The tensile strength, yield stress and percentage elongation of steel shall be determined from standard test pieces cut lengthwise or cross wise from plates and lengthwise from sections, flats and bars. The tests shall be carried out on Indian Standard test pieces prepared in accordance with I.S. 1608—1960.

7.3. *Tensile test.*—The tensile strength, yield stress and percent age elongation, when determined in accordance with I.S. 1608—1960 shall be as given in Table 1.

7.3.1. In case of sections, the thickness of which is not uniform throughout the profile, the limits shall be applied according to the actual maximum thickness of the piece selected for test.

7.3.2. Should a tensile test piece break outside the middle half of its gauge length (*see* I.S. 1608—1960) and the percentage elongation obtained is less than that specified, the test may be discarded at the manufacturer's option, and another test made from the same plate, section, flat or bar.

TABLE 1 : Mechanical Properties of Structural Steel.

(Standard Quality).

(Clause 7·3.)

Class of steel product.	*Nominal thickness Diameter. mm.*	*Tensile Strength. Kgf/mm²*	**Yield stres Min. Kgf/mm²*	*Percentage elongation min. guaeg length* $5{\cdot}65\sqrt{So.}$
Plates, Sections (for example, angles, tees, beams, channels etc.) and flats.	Below 6	*Bend test only shall be required		
	6 upto and including 20	42 to 54	26·0	23
	Over 20 upto and including 40	42 to 54	24·0	23
	Over 40	42 to 54.	23·0	23
Bars (round, square and hexagonal).	Below 10	*Bend test only shall be required		
	10 upto and including 20	42 to 54	26·0	23
	Over 20	42 to 54	24·0	23

NOTE.—Guage lengths more than $5{\cdot}65\sqrt{So}$ may also be used, in which case the elongation shall be read from I.S. 3803—1967 "Methods for elongation conversions for Steel".

*In case of plates, sections and flats below 6 mm. the yield stress shall be assumed to be at least the same as that for thickness between 6 and 20 mm.

+In case of bars below 10 mm diameter, the yield stress shall be assumed to be at least the same as for bars of diameter between 10 and 20 mm.

8·3. Bend Test—Bend test shall be conducted in accordance with I.S. 1599-1960.

8·3·1. For bend tests except in the case of round bars 25mm in diameter and under, the test piece when cold shall, without fracture be doubled over, either by pressure or by blows from the hammer, until the internal diameter is not grater than three times the thickness of the test piece, and the sides are parallel.

8·3·2. In the case of round bars 25 mm in diameter and under the internal diameter of the bend shall be not grater than twice the diameter of the bar.

EXTRACT FROM I.S. 1148-1964.

Specificatiou for rivet bars for structural purposes.

9. *Tensile Test.—*

9.1. One Tensile test shall be made from the finished steel for every 10,000 Kg. of cast iron or part thereof.

9·2. The Tensile strength, yield stress and percentage elongation of steel, when determined on test piece cut lengthwise from bars, in accordance with I.S. 1068-1968 shall be given in Table I.

TABLE 1.—TENSILE PROPERTIES OF RIVET BARS.

for Structural purposes.

Tensile Strength (kgs/mm²)	*Yeild stress min. (kgs/mm²).*	*Elongation per cent min. Gauge length* $5{\cdot}65\sqrt{So.}$	$4\sqrt{So.}$
39·0 to 51.0	19·5	31	35

9·2·1. Should a tensile test piece break outside the middle half of its gaugelength the test may be discarded at the supplier's option, and another test made from the same rivet bar If, however, the specified elongation has been obtained the additional test shall not be required.

EXTRACT FROM I.S. 1929-1961.

Specification for rivet for general purposes.

(12 to 48 mm. Diameter).

7·2. *Tests.*

7·2.1. *Bend Test.*—The rivet shank shall be bent cold, and hammered until the two parts of the shank touch in the manner shown in Fig. 10. There shall be no fracture on the outside of the bend.

7·2·2. Flattening Test.—The rivet head shall be flattened, while hot in the manner shown in Fig. 11. The head shall be flattend until its daimeter is $2\frac{1}{2}$ times the diameter of the shank .There hall be no cracking at the edges.

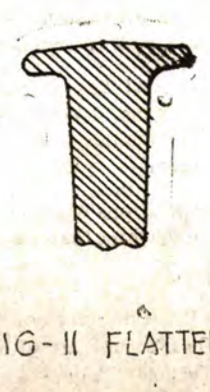


FIG 10 BEND TEST - FIG-11 FLATTENING TEST

EXTRACT FROM I.S. 800—1962.

Code of p actice for use of structural steel in general building construction.

APPENDIX—H.

(Clause 14·6)

Loading Tests.

H 1. *Acceptance tests:*

H.1.0. The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests conducted as follows :

H.1.1. *Stiffness Test.*—In this test, the structure or member shall be subjected in addition to its actual dead load, to a test load equal to 1.5 times the specified super-imposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during this test should not be excessive. If, after removal of the test load, the member on structure does not show a recovery of at least 80 per cent of the maximum strain on deflection shown during the 24 hours under load, the test shall be repeated. The structure shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain on deflection shown during the second test.

H.1.2. *Strength Test* :

H.1.2.1. The structure shall be subjected, in addition to its actual dead load to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be mai tained for 24 hours, except that for dwelling houses of not more than two storeys and for single storey schools, the structure may be subjected in addition to its actual dead load to a test load of twice the specified superimposed load only.

H.1.2.2. In the case of wind load, a load correspondingt to wice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load, according to which condition is the more severe in the member under consideration on the structure as a whole. Complete tests under both conditions may be necessory to verify the strength of the structure. The structure shall be deemed to have adequate strength if during the test no part completely fails, and if on removal of the test load the structure shows a recovery of at least 20 per cent of the maximum deflection on strain shown during the 24 hours under load.

H.2. *Structures of same Design:*—

H.2.1. Where several structures are to be built to the same design and it is considered unnecessary to test all of them one structure, as a prototype, shall be fully tested, as described in H.1.1. and H.1.2., by a qualified Engineer, but in addition during the first application of the test load particular note shall be taken of the strain or deflection when the test load, at 1·5 times the specified super imposed load, has been maintained for 24 hours. This information is required as a basis of comparison in any check tests carried out on samples of the structure.

H.2.2 When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to be super imposed test load, equal to 1.5 times the specified live load, in a manner and to an extent prescribed by the Engineer carrying out the test. This load shall be maintained for 24 hours during which time the maximum deflection should be noted. The check test shall be considered to be satisfactory, provided that the maximum strain or deflection noted in the check test does not execeed by more than 20 percent the maximum strain or deflection shown at similar load in the test on the prototype.

H.3. *Satisfactory Structure:*—

H.3.1. An actual structure which has passed the "Strength test" (see H.1.2) and is subsequently to be erected for use, shall be considered satisfactory for occupancy after it has been strengthened by e-placing any distorted members, and has subsequently satisfiedt he "stiffness Test" (See H.1.1)

NOTE: *method of testing*—The manner in which the loading is to beapplied and the position at which deflections or strains are to be measured can only be decided with reference to the particular structure to be tested, but as general guide the following are suggested:—

(a) *Beams and Girders.*—The deflection should be measured at mid span and if it is expected that considerable strain on settlement may occur at the supports, the deflection on settlement at the support should also be recorded.

(b) *Cantilevers.*—The deflections at the end of the cantilever should be measured, and under the conditions visualised above for the beams the deflections at the support should also be recorded.

(c) *Stanchion.*—The lateral deflections at the mid height of the stanchion and at the head of the stanchion should be measured relative to the joint next below and to the base.

NOTE 2 : *Loading*:—

(a) *Vertical loading.*—Uniformly distributed loading on beams may be represented by two loads, each half the total of the uniformly distributed load applied at the quarter points.

(b) *Horizontal loading.*—Where the effect of horizontal forces on the structure as a whole has to be tested, the action of the cladding in applying the load to the frame should be taken into account. The horizontal forces would in general be represented by a limited number of point loads.

(c) *Dead Load equivalent.*—It has been assumed that the actual dead load is in place, but when it is convenient to do the test before the dead load is applied, an equivalent can be used, placed as described in (a). The deflection due to the dead load on its equivalent should not be included in the measurements.

Para 35—*I.S.* 800—1962.

35. *Holing.*—

35·1· Holes through more than one thickness of material for members such as compound stanchion and girder flanges shall, where possible, be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly provided the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall be not greater than 16 mm.

35.2. When the holes are drilled in one operation through two or more separable parts, these parts when so specified by the Engineer, shall be separted after drilling and the burrs removed.

35.3. Holes in connecting angles and plates, other than splices, also in roof members and light framing, may be punched full size through material not over 13mm. thick, except where required for close tolerance on barrel bolts.

35.4. Matching holes for rivets and block belts shall register with each other so that a gauge of 1·5 mm or 2·0 mm (as the case may be depending on whether the diameter of the rivet or bolt is less than or more than 23 mm) less in diameter than the diameter of the hole will pass freely through the assembled members in the direction at right angles to such members. Finished holes shall be not more than 1.5 mm. or 2·0 mm. (as the case may be) in diameter larger than the diameter of the rivet or black bolt passing through them, unless otherwise specified by the Engineer.

35.5. Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to H8 tolerance specified in I.S. 919-1959 recommendations for limits and fits for Engineering. Preferably, parts to be connected with close tolerance barrel bolts shall be firmly held together by taking belts or clamps and the holes drilled through all the thicknesses at one operation and subsequently reamed to size. All holes not drilled through all thicknesses at one operation shall be drilled to a smaller size and reamed out after assembly. Where this is not practicable, the parts shall be drilled and reamed separately through hard bushed steel.

35.6. Holes for rivets or bolts shall not be formed by a gas outting process.

36. *Assembly*:—

36.1. The assembly shall be assembled in such a manner that they are neither twisted or otherwise damaged, and shall be so prepared that the specified cambers if any, are provided.

37. *Riveting* :

37.1. Rivets shall be heated uniformly through-out their length, without burning or excessive scaling, and shall be of sufficient length, to provide a head of standard dimensions. They shall, when driven completely fill the holes and, if countersunk, the countersinking shall be fully filled by the rivet, any proudness of the countersunk head being dressed off flush, if required.

37.2. Riveted members shall have all parts firmly drawn and held together before and during riveting, and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

37.3. Wherever practicable, machine riveting shall be carried out by using machines of the steady pressure type.

37.4. All loose, burned or otherwise defective rivets shall be cut out and replaced before the structure is loaded and special care shall be taken to inspect all single riveted connections.

37.5. Special care shall be taken in heating and drilling long rivets.

Welding.

39.1. Welding shall be in accordance with any of the following standards as appropriate.

I.S. 816-1956 –Code of Practice for use of metal Arc welding for general construction in mild steel.

I.S. 819-1957 –Code of Practice for resistance spot welding for light assemblies in mild steel.

I.S. 820 – Code of Practice for use of welding in tubular construction.

I.S. 821 – Code of Practice for use of welding in pipelines.

I.S. 822— Code of Practice for inspection of welds.

I.S. 823— Procedure code for metal arc welding of mild steel.

I.S. 1024 – Code of Practice for welding of structures subject to dynamic loading.

I.S. 1261-1959—Code of Practice for seam welding in mild steel.

I.S. 1323-1959—Code of Practice for Oxy-Acetylene welding for structural work in mild steel.

39.2. For welding of any particular type of joint, welders shall give evidence acceptable to the purchaser of having satisfactorily completed appropriate tests as described in any one of the following standards as relevant :

I.S. 817-1957—Code of Practice for training and testing of metal arc welders.

I.S. 1181-1957—Qualifying tests for metal arc welders (Engaged in welding structures other than pipes).

I.S. 1393-1961—Code of Practice for training and testing of oxy-accetylene welders.

43. *Painting* :

43.1. All surfaces which are to be painted, oiled or otherwise treated shall be dry and thoroughly cleaned to remove all loose scale and loose rust.

43.2. Shop contact surfaces need not be painted unless so specified. If so specified, they shall be brought together while the paint is still, wet.

43.3. Surfaces not in contact, but inaccessible after shop assembly shall receive the full specified protective treatment before assembly. This does not apply to the interior of sealed hollow sections.

43.4. In the case of surfaces to be welded, the steel shall not be painted on metal coated within a suitable distance of any edges to be welded if the paint specified on the metal coating would be harmful to welders or impair the quality of the welds.

45. *Shop erection* :

45.1. The steel work shall be temperarily shop erected complete or as arranged with the inspector so that accuracy of fit may be checked before despatch. The parts shall be shop assembled with a sufficient number of parallel drifts to bring and keep the parts in place.

45.2. In the case of parts drilled or punched, through steel jigs, with bushes resulting in all similar parts being inter-changeable the steel work may be shop erected in such position as arranged with the inspector.

47. *Inspection and testing* :

47.1. The inspector shall have free access at all reasonable times to those parts of the manufacturer's works which are connected with the fabrication of the steel work and shall be afforded all reasonable facilities for satisfying himself that the fabrication is being undertaken in accordance with the provisions of this standard.

47.2. Unless specified otherwise, inspection shall be made at the place of manufacture prior to despatch and shall be conducted so as not to interfere unnecessarily with the operation of the work.

47.3. The manufacturer shall guarantee compliance with the provisions of this standard, if required to do so by the purchaser.

47·4. Should any structure or part of a structure be found not to comply with any of the provisions of this standard, it shall be liable to rejection. No structure or part of the structure, once rejected shall be resubmitted for test, except in cases where the purchaser or his authorised representative considers the defect as rectifiable.

47·5. Defects which may appear during fabrication shall be made good with the consent of and according to the procedure laid down by the inspector.

47·6. All gauges and templates necessary to satisfy the inspector shall be supplied by the manufacturer. The inspector may at his discretion, check the test results obtained at the manufacturer's works by independent tests at the Government test house or elsewhere, and should the material so tested be found to be unsatisfactory, the costs of such tests shall be borne by the manufacturer, and if satisfactory, the costs shall be borne by the purchaser.

31·2. *Roof Trusses*:

31·2·1. For any member normally acting as a tie in a roof truss but subject to reversal of stress resulting from the action of wind, the ratio of the effective length to the least radius of gyration shall not exceed 350.

31·2·2. The windward roof trusses in multiple-bay buildings shall be designed to resist the appropriate wind forces estimated as set out in I.S. 875—1957—Code of Practice for structural safety of Buildings:—Loading standards, and the component members of the sheltered trusses, if the trusses are of the same height, span, rise and spacing as the windward truss shall be of the same sections as those of the windward trusses.

31·2·2·1. Where in multiple-bay buildings, a sheltered truss is either of different height, span, rise or spacing from the wind ward truss, the component members of the sheltered truss shall be however the wind loads produce greater force or reversal of forces in any of the members, such members shall be proportioned to resist those greater forces or reversed forces.

EXTRACT FROM I. S. 1911–1967.

Exatract from Indian Standard Schedule of Unit Weights of Building Materials (First Revision)

Schedule of unit weights of building materials.

Dead load:—The unit weight of building materials are given below for calculating the dead loads.

TABLE 1—UNIT WEIGHTS OF BUILDING MATERIALS.

Material.	*Nominal size or thickness.*	*Weight.*	
	mm.	*Kg.*	*Per.*
(1)	(2)	(3)	(4)
2. Aggregate, Coarse.			
Broken stone ballast :			
Dry, well-shaken	..	1600 to 1870	m^3
Perfectly wet	..	1920 to 2240	m^3
Shingles, 3 mm. to 38 mm.	..	1460	m^3
Broken bricks :			
Fine	..	1450	m^3
Coarse	..	1010	m^3
Foam slag, foundry pumice	..	700	m^3
3. Aggregate, fine			
Sand :			
Dry, clean	..	1540 to 1600	m^3
River	..	1840	m^3
Wet	..	1760 to 2000	m^3
Brick dust (Surkhi)	..	1010	m^3

TABLE 1 : UNIT WEIGHTS OF BUILDING MATERIALS—*cont*.

Material.	*Nominal size or thickness mm.*	*Weight.* *Kg.*	*Per.*
(1)	(2)	(3)	(4)
9. Asbestos Cement Sheeting (*See* IS : 459–1962) :			
Corrugated (146 mm.)	6	12.0 to 13.3	m^2
	7	14.1 to 15.6	m^2
Semi-corrugated (340 mm.)	6	12.0 to 13.3	m^2
	7	14.1 to 15.6	m^2
Plain	5	9.16	m^2
11. Blocks :			
Lime Cement cindor solid blocks .. .. (*See* IS : 3115–1965)	..	880 to 1280	m^3
13. Bricks :			
Common burnt clay bricks (*See* IS : 1077–1957)	..	1600 to 1920	m^3
Engineering bricks	..	2160	m^3
Pressed bricks	..	1760 to 1840	m^3
Refractory bricks	..	1760 to 2000	m^3
Sand cement bricks	..	1840	m^3
Sand lime bricks	..	2080	m^3
19. Cement :			
Ordinary and aluminous	..	1440	m^3
Rapid hardening	..	1280	m^3
20. Cement concrete plain :			
Aerated	..	760	m^3
No fines, with heavy aggregate	..	1600 to 1920	m^3
No fines, with light aggregate	..	800 to 1280	m^3
With standard gravel or crushed natural stone aggregate ..	..	2240 to 2400	m^3
21. Cement concrete reinforced with sand and gravel or crushed natural stone aggregate :			
With 1 per cent steel	..	2310 to 2470	m^3
With 2 per cent steel	..	2370 to 2530	
With 5 per cent steel	..	2530 to 2720	
23. Cement concrete prestressed :			
(conforming IS : 1343–1960)	..	2400	m^3
24. Cement mortar	..	2080	m^3
25. Cement plaster	..	2080	m^3
36. Mastic asphalt	10	22	m^2
37. Masonry brick :			
Common burnt clay bricks	..	1920	m^3
Engineering bricks	..	2400	m^3
Glazed bricks	..	2080	m^3
Pressed bricks	..	2240	m^3
38. Masonry stone :			
Cast	..	2300	m^3
Dry rubble	..	2080	m^3
Granite ashlar	..	2640	m^3
Granite rubble	..	2400	m^3
Lime stone ashlar	..	2560	m^3
Marble dressed	..	2700	m^3
Sand stone	..	2240	m^3

Live load; For live load refer NBO, Part VI Structural Design Section 1, Loads.

EXTRACT FROM I.S. 1200 (PART VIII)—1967.

Method of measurement—Steel work and iron work.

1. *Scope.*

1.1. This standard (Part VIII) covers the method of measurement of steel work and iron work in buildings and civil Engineering works.

NOTE.—The method of measurement of roof covering, pipe lines, etc., for water supply and pipe lines, etc. for gas and oil are respectively covered in I.S. 1200 (Part IX) 1973, I.S. 1200 (Part XVI) 1969 and I.S. 200 (Part XX) 1969.

2. *General Rules.*

2.1. Clubbing of items—Items may be clubbed together provided that break up of clubbed items is agreed to be on basis of detailed description of items, stated in this standard.

2·2. Booking of Dimensions-In booking dimensions, order shall be consistent and genera lly in sequence of length, width and height or depth or thickness.

2·3. Description of items—The description of each item which covers both fabrication and erection shall include conveyance and delivery, handling, unloading storing, hoisting and all labour for finishing to required shape and size' Alternatively, in each item of work fabrication or erection shall be described and measured separately.

2.4. Bill of quantities—Items of work shall fully describe the materials and truly represent the work to be executed.

2.5. Dimensions—unless otherwise stated all work shall be measured not in decimal system, as fixed in its place as given in 2.5.1. to 2.5.3.

2.5.1. Dimensions excepting cross-sections and thickness of plate shall be measured to nearest 0.001 m except for reinforcement which shall be measured to nearest 0.005 m.

2.5.2. Areas excluing cross-sectional measurements shall be worked out to nearest 0.001 m^2.

2.5.3. Weights shall be worked out to nearest 1 kg.

2.6. Mill tolerance shall be ignored when the weight is determined by calculation.

2.7. The priming cost shall be described and included in item of fabrication.

3. *Steel Work.*

3.1. Various items of steel work shall be classified and measured separately under following categories work in each classification shall be described. Bolted, riveted and welded structures shall be described as such and measured separately.

(*a*) Rolled sections (joist, channel, angle or tee) fixed independently without connecting plates.

(*b*) Rolled sections fixed with connecting plate or angle cleats as in main and cross-beams, hip and jack rafters, purlins connected to common rafters and the like;

(*c*) Rolled joists, with or without stiffeners in grillages (the weight of stiffeners shall be added to the weight of joists);

(*d*) Compound girders;

(*e*) Plate girders (stating type and overall height of girder);

(*f*) Lattice girders, aerial masts, tank staging and like (stating details of members and overall height of structure).

(*g*) Single stanchions composed of rolled joists or channels with caps, bases, splices, angle brackets, etc.;

(*h*) Compound stanchions with caps, bases, splices, angle brackets, etc.

(*i*) Trussed and Trussed purlin (stating spans and overall eights);

(*j*) Framing of cladding and glazing ;

(*k*) Crane gantry rails including fastenings;

(*l*) Staircases including stringers, treads, landings, handrails, etc.,;

(*m*) Plates (plain or chequered) square cut or notched, holed (ordinary or countersunk) without any attachments;

(*n*) Plates of classifiration (*m*) above with reveted, bolted or welded attachment;

(*o*) Running rails and girders for sliding doors;

(*p*) Plate work with or without stiffeners for—

(1) Bankers;
(2) Chutes;
(3) Chimneys including ladders;
(4) Tanks with or without covers including stays but excluding stagings;
(5) Gutters and downpipes ; and
(6) Furnace cell.

(*t*) Anchor bolts, holding down bolts including all fittings and sag rods;

(*u*) Wind ties to roofs, strakes for wooden bridges, cores for hand rails (straight portion) running bars for doors and fencing posts and struts

(*v*) Framed work, such as grills, gratings, framed guard bars, adders, walk ways, railings, brackets and similar work;

(*w*) Straps, hooks, clamps, holdfasts, wall ties, inserts, knee pieces and similar work;

(*y*) Ornamental work as in grills, balustrades and curved, ramped and scroll portion of cones or hand-rails and

(*z*) Steel-work for—

(1) Doors,
(2) Hydraulic gates and
(3) Cussions and well curbs.

NOTE.— (1) In composite construction shear connectors, if any, will form part of stuctural steel work.

(2) The above classification with suffix B1 R or W shall be indicated in bills of quantities to denote bolted, riveted or welded construction respectively.

3.2. The steel work shall be measured by weight except otherwisel mentioned.

3.3. Unless otherwise specified, weight of cleats, brackets, packing, pieces, bolts, nuts, washers, distance pieces, separators, diaphragm, gussets (taking overall square dimensions) fish plates, etc., shall be added to the weight of respective items. In riveted work, allowance is to be made for weight of rivet heads (see 3.6) No deduction shall be made for rivet or bolt holes (excluding holes for anchor or holding down bolts). Deduction in case of rivet or bolt hole shall however be made if its area exceeds 0.02 m^2.

3.4. The weight of steel sheet, plate and strip shall be taken from relevant Indian Standard based on7.8o Kg./m^2 for every millimetre sheet thickness. For rolled steel sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.

3.5. For forged steel and steel castings, weight shall be calculated on he basis of 7,850 Kg./m^3

3.6. Unless otherwise specified an addition of 2.5 per cent of the weight of structures shall be made for shop and site rivet heads in riveted steel structures.

3.7. Unless otherwise specified, in the case of welded steel structures no allowance shall be made for the weld metal.

3.8. Wedging-up under stanchion bases or steel grillages shall be described and enumerated.

4. *Tubular structures.*

4.1. The tubular structures shall be described and measured by weight.

5. *Cables/Guy wires.*

5.1. The cables and guy wires shall be described and measured in running metres stating the diameter or by weight.

6. *Bearings.*

6.1. These shall be classified as roller, recker, sliding, etc., and fully described and enumerated.

7. *Pipes for flues.*

7.1. Flue pipes of steel sheeting shall be measured overall in running metres and described as including all short lengths, cutting and waste The method of jointing and fixing shall be described. Supports shall be measured separately.

7.2. The diameter of pipes, thickness of sheeting and whether black or galvanized shall be stated. In case of glavanized steel pipes, class of glavanization [*See* I.S. 1239 (Part I) 1968] shall also be stated.

7.3. Bends, elbows, cowls, tapered pipes to fit outlets of ranges and roof plates with sleeve shall be enumerated and measured as, extra over.

8. *Duct work.*

8.1. The duct metal work shall be described and measured in square metres on basis of surface area. Support shall be measured separately.

9. *Expanded metal work and weld mesh work.*

9.1. Expanded metal work and weldmesh work shall be described including laps, meshes, weight, strands and method of fixing and measured in square metres. Openings exceeding 0.2 m^2 shall be deducted, Raking or circular cutting and waste shall be included, in the description.

10. *Steel Reinforcement.*

10.1 Bar reinforcement shall be measured by weight in Kilograms and shall include cutting to length hooked ends, cranking or bending (Straight or spiral). Authorized over laps, chairs/separators shall be measured.

10.1.1. When welding of joints is authorized same shall be described, joints, butt welded shall be measured in numbers and lap welded shall be measured in running metres of the length welded.

10.2 Fabric reinforcement shall be described (including meshes and strands) and measured, in square metres. Authorized laps shall be maesured.

10.2.1. Wire netting used as encasment shall be described (including meshes and wires) and shall be measured in square metres. Authorized laps shall be measured.

10.2.2. Raking or circular cutting and waste shall be included in description.

10.3. Binding wire for reinforcement shall not be measured, but shall be included in description of item.

NOTE.—Term, "binding wire", is reserved for wire binding together reinforcement in contact.

10.4. Hoop iron shall be fully described and measured in running metres.

11. *Miscellaneous work.*

11.1. Bolts including nuts and washers other than those covered in 3.1. (t) shall be described and measured by weight in kilograms.

11.2. Plain or barbed wire fencing shall be fully described, and each line or wire shall be measured in running metres.

11.3. Patent plain wire fencing shall be fully described and measured in square metres.

11.4. Wire mattresses, nets shall be fully described including method of tying and measured in square metres. Authorized laps shall be measured.

11.5. Collapsible gates shall be described and measured, in square metres as fixed stating size of gate opening, pickets, piveted flat bars and size of meshes formed by them when fully extended.

11.5.1. Top and bottom runners, pulleys, locking lugs and handles shall be described and included with item. Description shall also include erection in position and securing runners with holdfasts and brackets.

11.6. Steel rolling shutter/grills shall be described and measured in square metres. The width shall be measured as the width of the shutters including portion hidden in the guide channels and height shall be measured as the length of shutter, from the bottom of the locking plate to the top of the laths including the portion above the opening. The top cover shall be described and measured in running metres separately.

11·6.1. Gauge and type of the shutter/grills, distance, between centres of interlock and bridge depth shall be stated.

11.6.2. Description shall include spring winding mechanism operated mechanically or manually, jam guides, bottom rail, locking and door operating arrangements.

11.6.3. Where a wicket gate has to be provided it shall be described.

11.7. Unless otherwise stated, steel doors windows, ventilators and glazing frames shall be measured in sqaure metres as fixed stating type given in relevant Indian Standard.

11.7.1. Method of fixing and hanging and fastenings shall be included with item.

11.8. Gates for compound walls and railing—Gates shall be described and enumerated or measured in square metres; hangings, guide rails and fastenings shall be described and included with item.

11.9. Steel louvre—Louvres shall be described and measured in quare metres on basis of opening covered.s

12. *Cast iron work.*

12.1. Cast iron flue (or smoke) pipes shall be measured over all in running me res and described as including all short length, cutting and waste.

12.1.1. Method of jointing and fixing shall be described and diameter of pipes and weight per standard length stated.

12.1.2. Bends, insepction doors and cowls shall be enumerated and measured as extra over.

12.2. Spiral staircases—Spiral staircases shall be enumerated stating overall diameter and height, total number of treads, riser and sleves in one piece, central shaft or poles inlcuding base plate and other attachment hand rail and balusters.

12.2.1. Exit landings shall be described and enumerated.

12.2.2. Stays, if required, shall be stated.

12.3. Stanchions, columns and lamp posts—These shall be described and measured in numbers specifying weight.

12.4. Grid flooring and grills shall be described including size and weight of each pipes and measured in square metres on basis of overall area.

12.5. Except as herein before described, cast iron work shall be measured by weight and classified under following headings;—

(*a*) Unmachined—Such as brackets, frames, gully traps, man hole covers, grating, fire doors, soo door and frames and balls and stop cock boxes.

(*b*) Machine turned—such as pulleys and similar work.

EXTRACT FROM I. S. 1608–1960

Method for Tensile Testing of steel product other than sheet, strip, wire and tube.

1. *Scope.*

1.1. This standard prescribes the method of conducting tensile test on steel products other than sheet, strip, wire and tube.

1.2. This standard applies only to products of diameters equal to or greater than 4 mm (or 0.157 in.) or thicknesses equal to or greater than 3 mm (or 0.18 in). For the tensile testing of other products, such as sheet, strip wire and tube, other standards are under preparation.

5. *Test piece.*

5.1 The cross section of the test pieee may be circular, sqaure, rectangular or in special cases of other form. For test pieces of rectangular section, it is recommended that a ratio of 4:1 for sides should not be exceeded.

5.1.1. There should be a transition curve between the gripped heads and the parallel length; and the gripped heads may be of any shape to suit the holders of the testing machine. Sections, bars, etc., may be tested without being machined.

5.1.2. The tolerances on the preparation of the test pieces shall be in accordance with Table I.

5.2. As a general rule, the diameter of machined cylindrical test pieces should not be less than 4.0 mm or 0.157 in.)

5.3. As a rule, only proportional test pieces eomplying with the requiremen $Lo = 5.65 \sqrt{So}$ should be used for the tensile test.

Note.—The use of proportional test pieces with $Lo = K \sqrt{So}$ where $K = 4$, 8.16 and 11.8 should be avoided and these should only be used in connection with those existing standards where these values are specified. It is likely that the international use of these values would be discontinued.

5.4. Test pieces other than proportional test pieces as defined in 5.3 may, for technical reasons, be used for products of very small cross section and for economical reasons with other products.

5.5. The parallel length shall be between [Lo+d/2] and Lo+2d except that, provided there is sufficient material, Lo+2d shall always be used for arbitration purposes.

5.6. If prismatic test pieces with rectangular cross sections are to be cut from a parcel of rolled sections a uniform parallel length shall be adopted which may be obtained from the formula Lo+2d where Lo and "d" refer to the test piece with the largest cross section.

6. *Test requirements.*

6.1. Rate of Testing.

6.1.1. If the yield stress is to be determined, the speed of the machine should be so regulated that the rate of increase of a stress on the test piece is not more than 1 Kg per mm^2 (or 0·6 tons per in^2) per second from a stress of approximately 5 kg per mm^2 (or 3 tons/ $in.^2$) until the yield point is reached. Alternatively, within this range, the extension speed instead of the loading rate, may be determined. This speed should be not more than 0.3 per cent of the gauge length per minute.

6.1.2. In the plastic range, the rate should not at any moment be higher than 40 per cent of the gauge length per minute; no value is fixed for the lower limit of this rate. When testing steels having a nominal testing strength of less than 110 kg. per mm^2 (or 70 tons per in^2) and the yield point of which is not to be determined, the rate in the elastic range may be as high as that permitted for the plastic range.

6.1.2.1. In all cases, the rate of increase of load in each range shall be as uniform as possible and the change of rate from one range to the other shall be made gradually and without shock.

6.2. *Measurement of load.*

6.2.1. The load should be measured, without interpolation between the graduations of the testing machine, to an accuracy compatible with the relevant material specifications.

6.3. *Determination of Elongation*

6.3.1. The elongation should be determined on the gauge length which, before the test should be marked to within ± 1 per cent of that gauge length. The fractured parts of the test piece should be carefully fitted together so that they lie in a straight line. The variation of the length between the jaws is measured to the nearest 0.25 mm (or 0.01 in)

6.3.1.1. This type of determination should be valid only if the distance between the fracture and the nearest gauge mark is not less than;

(*i*) 1/3 of the gauge length after fracture for test pieces with $Lo = 4 \sqrt{So}$

(*b*) 1/3 of the gauge length after fracture for test pieces with $Lo = 5.65 \sqrt{So}$

(c) 1/4 of the gauge length after fracture for test pieces with $Lo=8.16\sqrt{So}$

(d) 1/5 of the gauge length after fracture for test peices with $Lo=11.3\sqrt{So}$

6.3.1.2. The measurement is valid in any case if the elongation reaches the specified value, whatever the position of t fracture

6.3.2. To avoid the possibility of rejection of test pieces due to the fracture being outside the limits specified 6.3.1, the following method may be employed.

6.3.2.1 Before testing, subdivide the gauge length int N equal parts.

6.3.2.2 After testing, designate by 'A' the end mark on the shorter piece. On the larger piece, designate by 'B' graduation mark the, distance of which from the fracture is most nearly to the distance from the fracture to the end mark 'A'

6.3.2.3 If 'n' be the number of intervals between 'A' and 'B' the breaking elongation is determined as follows ;

(a) If 'N'—'n' is an even number [*see* Fig. 5A], measure the distance between 'A' and 'B' and the distance from 'B' to the graduation mark "C" at $\frac{N-n}{2}$ intervals from B.

Then calculate the breaking elongation from the formula :

$$A= \frac{AB + 2BC- Lo}{Lo} \times 100 \text{ per cent.}$$

[b] if N — n is an odd number [*see* Fig. 5—B], measure the distance between A and B and the distance from B to the graduation marks C' and C" at $\frac{N-n-1}{2}$ and $\frac{N-n+1}{2}$ intervals from B

Then calculate the breaking elongation from the formula :

$$A= \frac{AB+BC'+BC''-Lo}{Lo} \times 100 \text{ per cent.}$$

6.4 Determination of Permanent Set Stress :

6.4.1 For the accurate determination of the permanent set stress [0.2 per cent or other specified value], the measurement of the permanent elongation for successively applied loads [unloading method] should be used [*sec* 6.4.2]. As the time required for this is relatively long, it should be permissible, if not otherwise specified, to make use of the graphical intersection from total extension method to determine a proof limit [*see* 6.5.1]. Special agreement may be made for the substitution of a proof test [*see* 6.6.1 and 6.6 .

6.4.2 The unloading method of determining permanent set limit is as follow :

Increasing loads are successively applied to the test piece and maintained in each case for about 10 to 12 seconds, After removal of each load, the permanent elangotion which the test piece has taken is measured. The test is stopped when the elangation exceeds 0·2 per cent, or whatever the prescribed percentage may be, By interpolation from the results obtained, the limit of permanent elongation at the prescribed value is determined.

6.5 *Determination of proof Stress.*

6.5.1 The proof limit should be determined as follows :

A curve is plotted with suitable accuracy, taking the loads as ordinates and the corresponding elongations as abscissae. A stright line is drawn on the graph parallel to the straight part of the curve. at a distance from the part, measured along the axis of the abscissae, equal to the prescribed percentage of the initial gauge length. The desired limit corresponds to the point of intersection of the straight line and the curve.

6.6 *Proving Test.*

6.6.1 The proving test should be carrled out as follows :

The test piece is to be placed for between 10 and 12 seconds under the load corresponding to the specified proof stress, and it is verified, after release from load that the permanent elongation remains equal to or less than the prescribed value of the nitial lengt .

6.6.2 Alternatively, the following three-point method may be used :

The increments of load equal to 5, 25 and 100 per cen respectively of the specified proof stress are applied, and the corresponding differences in the extensions observed by means of a suitable extensometor. The increase in extension between the first and third increments of load shall be not greater than the specified percentage of the gauge length plus 4.75 times the increase in extension between the first and second increments of load.

EXTRACT FROM I. S. 1599—1960

Method for bend Test for Steel Products other than Sheet, Strip, Wire and Tube.

1. *Scope* :

1·1. This standard prescribes the method of conducting bend test on steel products other than sheet, strip wire and tube.

1·1·1 Methods of bend test for sheet, strip, wire and tube are under preparation.

4. *Test Piece*.

4·1. The test piece should generally be of rectangular cross section The edges should be rounded to a radius not exceeding 1/10 of the thickness. However, a test on a test piece, the edges of which have not been rounded, shall be acceptable provided the resultant bend is satisfactory.

4·2. The width of the test piece should be fixed at a value normally between 25 and 50 mm. (or 1 and 2 in.) with a tolerance of $\pm$ 5 mm. (or $\pm$ 0·20 in.)

4·3. The thickness of the test piece should be chosen as follows:—

4·3.1 For semi-finished products and forged pieces, the thickness of the test piece should be 20 $\pm$ 5 mm (or 0·80 $\pm$ 0·20 in.), unless another thickness is specified.

4·3.2. For specimens cut from finished products, the thickness of the test piece should be the thickness of the materials to be tested. If the rolled tnickness is greater than 25 mm (or 1 in.), it may be reduced by machining on one side to a specified thickness not less than 25 mm. (or 1 in.) ; in bending, the machined sufrace shall be on the outside.

4·4 In the case of steel of round or polygonal section, the test piece may consist of a piece as cut from the bar if the diameter (for round cross section) or the diameter of the inscribed circle (for a polygonal cross section) does not exceed 50 mm (or 2 in·).

4·4·1. Material over 30 mm. (or 1·2 in.) may, and over 50 mm (or 2 in.) should be reduced to a convenient size between 20 and 50 mm· (or 0·8 and 2 in.) in diameter.

5. *Method of Test.*

5·1. The Test piece should be tested either hot or cold or specified in the material specification.

5·2. A common method of carrying out the test is to lay the test piece on two parallel supports and bend it in the middle by means of a mandrel to the specified angle. The widths of the supports and of the mandrel should be greater than that of the test piece.

5.2.1. The radii of the supports and the mandrel and distance between the supports shall be as specified in the material specification. if the distance between the supports is not specified in the material specification, this distance should be taken as approximately $D+3a$ (see Fig. IB).

5·2·2. If it is necessary to observe the point at which cracking begins, the outer surface of the test piece should remain clearly visible in the portion being bent while conducting the test.

5·3. Another method of test is to lay the specimen across a Vee block and bend it in the middle to the specified angle by means of a pressure piece (see Fig. 2). The tapered surfaces of the Vee block should form an angle of—

$60° + 10°$ or $60° - 10°$

and the opening should be at least 125 mm (or 5 in.). The supporting edges should be slightly rounded off. In this case, the length of the test piece is generally 250 mm (or 10 in.).

5·4. In both the methods, the bending force should be applied slowly with the object of permitting free plastic flow of the material.

5·5. If it is not possible to bend the test piece to the specified angle in the manner described in 5·2 and 5·3, the bend should completed by pressing directly on the ends of the two legs of the test piece.

5·5·1. In this method of test, it is very difficult to maintain the specified radius of bend indicated by the symbol (see Fig. 4-B and 4-C)

5·6. If the test is to be effected by bringing the two legs of the test piece parallel to each other, this may be done as described in 5·6·1 and 5·6·2.

5.6·1. In this method, the specimen is supported at the ends on rollers or laid across a block U-shaped or V-shaped according to the type of pressure piece used. The widths of the supports and of the presure piece should be greater than that of the test piece. The bending is started by the application of a steady pressure.

5·6·2. The specimen is then placed as shown in Fig. 4-A, and pressure applied until the radius of the intrados of the specimen reaches that specified for the bend and the legs become parallel to each other (see Fig. 4-B and 4-C).

6. *Test Requirements* :

6·1. After bending, the sides and the outside of the bent portion should be examined.

6·1·1. The interpretation of the appearance of the bent portion shall be done in accordance with the material specification.

EXTRACT FROM I.S. 3803–1967.

Method for elongation conversions for steel.

5.3. ***Conversion from a proportional gauge length to a non-proportional gauge length*** :—The conversion factors are variable according to the cross sectional area of the non-proportional test piece. Table 4 gives the multiplying factors for conversion from elongation on $5.65\sqrt{S_0}$ gauge length to the equivalent on fixed gauge lengths of 50 mm, 100 mm, and 200 mm for a range of cross-sectional area.

For conversions in the reverse direction, that is, elongation on fixed gauge length to the equivalent on $5.65\sqrt{S_0}$ guage length the reciprocal of the factor is used.

Examples :

(*a*) Elongation of 20 per cent on $5.65\sqrt{S_0}$ guage length is equivalent to 20 X1. 158=23.2 percent on a test piece of 167.7 mm² cross-section with a 50 mm length (*see* Table 4).

(*b*) Elongation of 24 per cent on a 200 mm gauge length for a test piece of 483.9 mm² cross-section is equivalent ot 24 X 1/0.822= 29.2 per cent on 5.65 $\sqrt{S_0}$ gauge length (*see* Table 4).

5.3.1. From the examples shown, it will be seen that conversion involving other proportional gauge lengths may be obtained by prior or subsequent use of the factors shown in Table 1. Tables 5, 6 and 7 may be used to obtain some of these conversions. Similarly, Tables 8, 9 and 10 may be used for conversion to $4.\sqrt{S_0}$ gauge length.

TABLES 4—CONVERSION FACTORS FROM $5.65\sqrt{S_0}$ TO NON-PROPORTIONAL GAUGE LENGTHS (Clause 5.3.)

Cross-Sectional area of test piece. mm²	*Factor for non proportional gauge length, mm.*		
	200	100	50
6.5.	..	..	0.604
12.9	..	..	0.693
19.4	..	0.570	0.552
25.8	..	0.603	0.796
32.3	..	0.631	0.832
38.7	..	0.655	0.863
45.2	..	0.675	0.890
51.6	..	0.693	0.914
58.1	..	0.710	0.936
64.5	..	0.725	0.956
71.0	0.560	0.739	0.975
77.4	0.570	0.752	0.992
83.9	0.579	0.764	1.008
90.3	0.587	0.775	1.022
96.8	0.595	0.786	1.036
103.2	0.603	0.796	1.050
109.7	0.611	0.806	1.064
116.1	0.618	0.816	1.076
122.6	0.625	0.824	1.088
129.0	0.631	0.833	1.099
135.5	0.637	0.841	1.109
141.9	0.643	0.849	1.119
148.4	0.649	0.857	1.130
154.8	0.654	0.864	1.139
161.3	0.660	0.871	1.149
167.7	0.665	0.878	1.158
174.2	0.670	0.884	1.166
180.6	0.675	0.890	1.175
187.1	0.679	0.896	1.182
193.5	0.684	0.903	1.191
200.0	0.689	0.909	1.200
206.5	0.693	0.915	1.207
212.9	0.697	0.920	1.213
219.4	0.702	0.926	1.222
225.8	0.706	0.932	1.229
232.3	0.710	0.937	1.236
238.7	0.713	0.941	1.241
245.2	0.717	0.946	1.248
251.6	0.721	0.952	1.255
258.1	0.725	0.957	1.262
264.5	0.728	0.961	1.267
271.0	0.731	0.965	1.27

TABLE 4—*contd.*

Cross-Sectional Area of Test Piece. mm²	*Factor for non-proportional gauge length, mm.*		
	200	100	50
277.4	0.734	0.969	1.278
283.9	0.737	0.973	1.283
290.3	0.740	0.977	1.288
296.8	0.744	0.982	1.295
303.2	0.748	0.987	1.302
309.7	0.752	0.992	1.309
316.1	0.755	0.997	1.314
322.6	0.758	1.001	1.320
354.8	0.772	1.019	1.344
387.1	0.786	1.038	1.368
419.4	0.799	1.055	1.391
451.6	0.811	1.071	1.412
483.9	0.822	1.085	1.431
516.1	0.833	1.098	1.450
548.4	0.842	1.111	1.466
580.6	0.852	1.125	1.483
612.9	0.862	1.138	1.501
645.2	0.872	1.151	1.518
709.7	0.887	1.171	1.544
774.2	0.903	1.192	1.572
838.7	0.918	1.218	1.598
903.2	0.931	1.229	1.621
967.7	0.944	1.246	1.644
1032.3	0.956	1.262	1.664
1096.8	0.968	1.278	1.685
1161.3	0.979	1.292	1.704
1225.8	0.990	1.307	1.724
1290.3	1.000	1.320	1.741
1354.8	1.009	1.332	1.757

Cross-Sectional Area of Test piece mm²	*Factor for non-proportion— m.*		
	200	100	50
1419.4	1.018	1.344	1.774
1483.9	1.028	1.357	1.790
1548.4	1.037	1.369	1.806
1612.9	1.046	1.381	1.821
1677.4	1.054	1.391	1.835
1741.9	1.062	1.402	1.849
1806.4	1.069	1.411	1.862
1871.0	1.076	1.420	1.875
1935.5	1.084	1.431	1.888
2000.0	1.091	1.440	1.900
2064.5	1.098	1.449	1.912
2129.0	1.105	1.459	1.924
2193.5	1.112	1.468	1.936
2258.1	1.119	1.477	1.948
2322.6	1.125	1.485	1.959
2387.1	1.131	1.493	1.969
2451.6	1.137	1.501	1.980
2516.1	1.143	1.509	1.990
2580.6	1.149	1.517	2.000

NOTE :—Factors shown under non-proportional gauge lengths give the values of $2\left[\dfrac{\sqrt{So}}{Lo}\right]^{0.4}$

To **convert** from **values** on a gauge length of $5.65\sqrt{So}$ to a non-proportional **gauge length, multiply** by the appropriate **factor**.

To convert from values **on a** non-proportional guage length **to** $5.65\sqrt{So}$ **divide** by **the** appropriate factor.

EXTRACT FROM I.S. 1367–1961.

Technical supply conditions for threaded fasteners.

1. *Scope.*

1.1. This standard deals with the technical supply conditions for threaded fasteners, such as bolts, screws and nuts, and covers general and specific requirements for different grades, mechanical properties and methods of test for the same. The requirements specified in this standard may also be applied, with due care, to items not expected to be available as standard products.

3. *Grades.*

3.1. The fasteners shall be of the following three grades :

(*a*) Precision (P)

(*b*) Turned (T)

(*c*) Black (B)

4. *General requirements.*

4.1. Finish :—The fasteners shall be cleanly finished, sound and free from defects which may affect their serviceability, consistent with the grade of the product. Unless otherwise specified, centre marks may be allowed to remain.

4.2. Preservation :—Unless the purchaser has specified specific treatment at the time of making enquiry or at the time of placing the order, the fasteners shall be supplied in a well-cleaned condition and suitably protected against rust in a manner which is left to the discretion of the manufacturer.

5. *Specific requirements.*

5.0. The specific requirements of the three grades shall be as given under 5.1 to 5.5.3.

5.1. *Accuracy* :—The tolerances on various types of fasteners shall be as indicated in the respective figures (*see* Fig. 1 to 73) Tolerances shall be on the basic size given in the relevant dimensional standards. For ready reference, the values of basic tolerances and tolerance zones are given in Table I (For further reference *see* I.S. 919-1959 Recommendations for Limits and Fits for Engineering).

5.1.1. Thread Tolerances :—Thread tolerances shall conform to the following classes in accordance with I.S. 1362-1959 Dimensions for Screw Threads for General purposes (Diameter Range 0.25 to 39 mm.).

Grade.	*Class of tolerance.*	
	Bolt thread.	*Nut thread.*
Precision	Medium	Medium
Turned	Medium	Medium
Black	Coarse	Medium

5.3. *Eccentricity* :—The eccentricity of various elements of a threaded fastener shall be within the limits specified in various figures read with Table II for Precision grade, Table III for Turned grade and Table IV for Black grade.

5.4. *Angularity Error* :—The angularity error for various fasteners shall not exceed the limits given in figures noted below :

Grade.	*Fig. No.*
Precision	1, 8, 9 and 31.
Turned	40, 43, 44 and 50.
Black	58, 62 and 70.

5.5. *Surface finish* :—The surface finish for the three grades of fasteners shall be as detailed in 5.5.1 to 5.5.3 (*see* I.S. 696-1960 Code of Practice for General Engineering Drawing (Revised).

5.5.1. *Precision Grade* (*P*) :

All surfaces including threads	▽ ▽
Screw ends	▽

5.5.2. *Turned trade* (*T*) :

Threads and seating face	▽ ▽
All other faces.	∼

5.5.3. *Black grade* (*B*) :

Threads	▽ ▽
All other faces	∼

466–3A–23A

HEADS - P

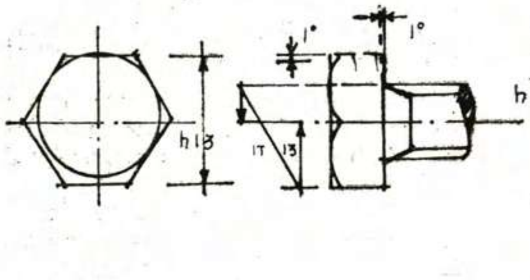


FIG - 1

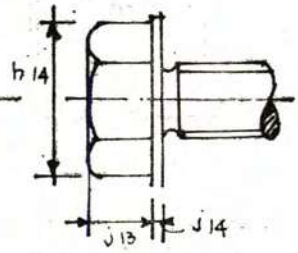


FIG · 2

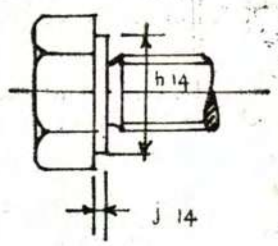


FIG · 3

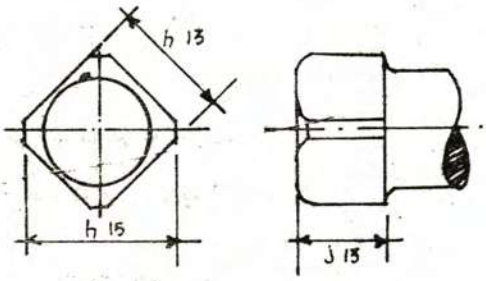


FIG · 4

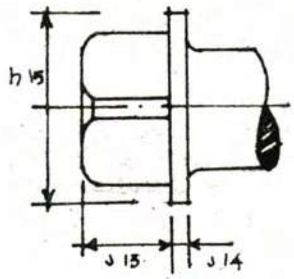


FIG · 5

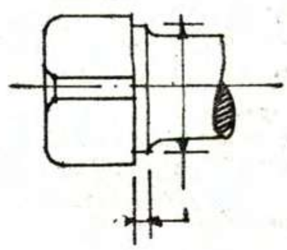


FIG · 6

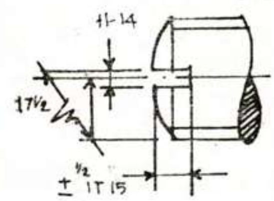


FIG 7

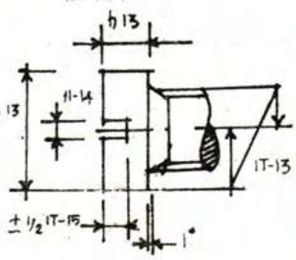


FIG · 8

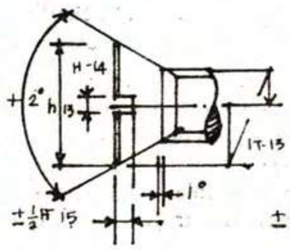


FIG 9

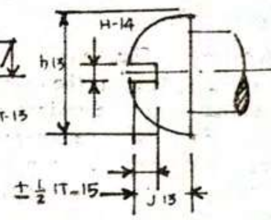


FIG 10

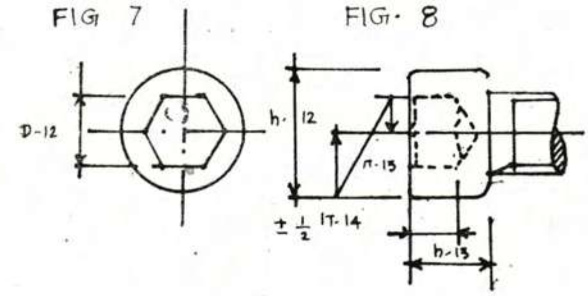


FIG · 11

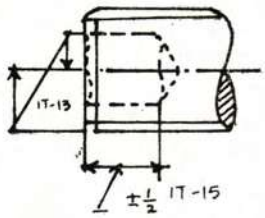


FIG · 12

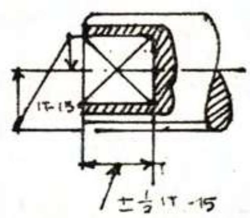


FIG · 13

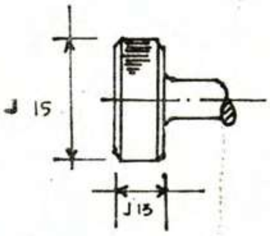


FIG · 14

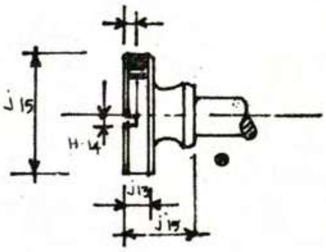


FIG · 15

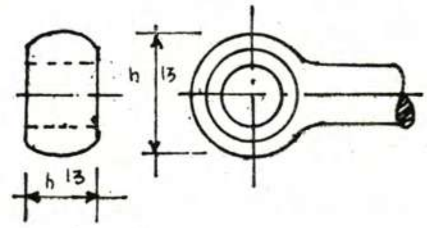


FIG · 16

SHANKS-P

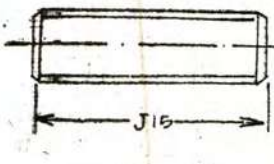


FIG.17

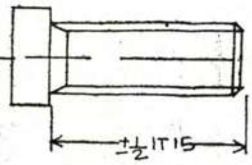


FIG-18

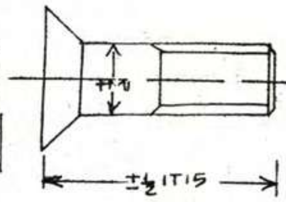


FIG-19

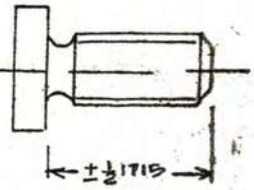


FIG-20

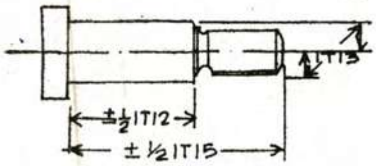


FIG-21

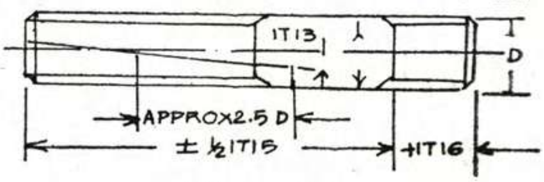


FIG-22

ENDS-P

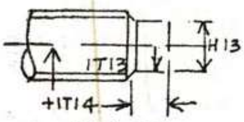


FIG.23

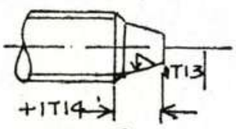


FIG-24

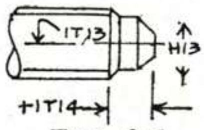


FIG.25

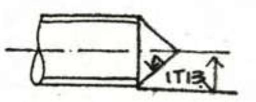


FIG-26

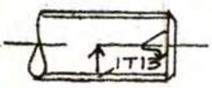


FIG.27

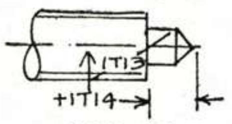


FIG-28

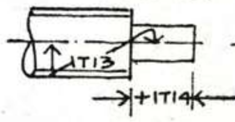


FIG-29

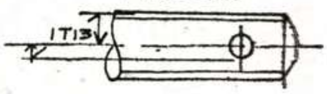


FIG-30

NUTS-P

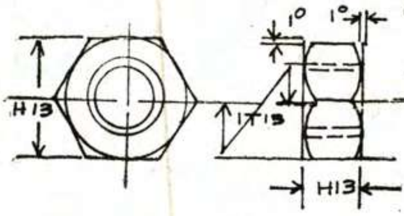


FIG-31

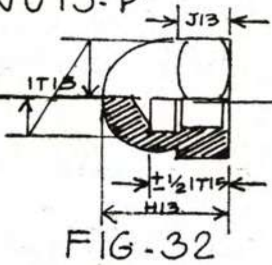


FIG-32

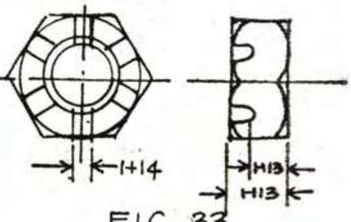


FIG-33

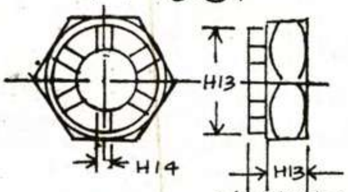


FIG-34

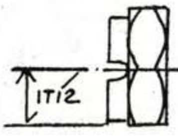


FIG-35

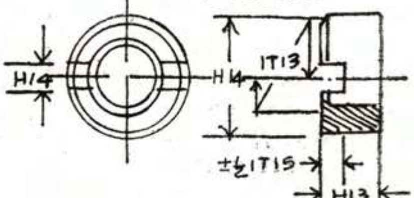


FIG-36

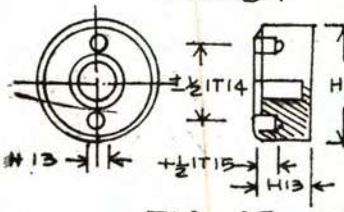


FIG-37

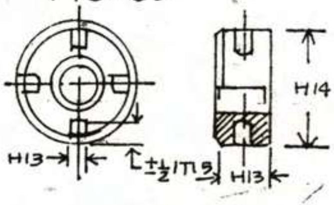


FIG-38

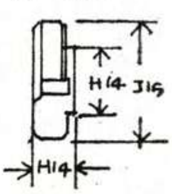


FIG-39

HEADS - T

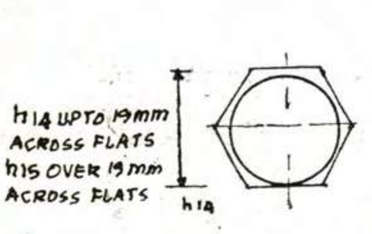


FIG 40

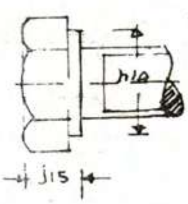


FIG 41

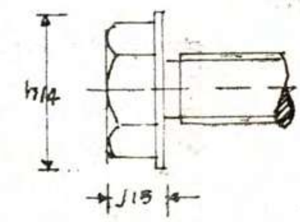


FIG 42

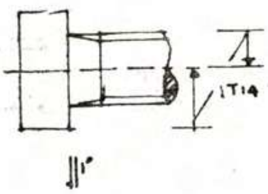


FIG 43

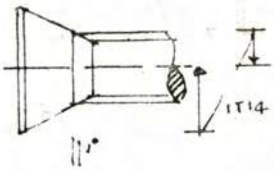


FIG 44

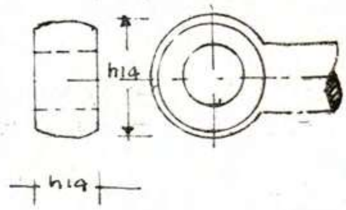


FIG 45

SHANKS - T

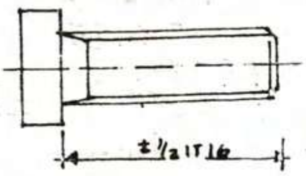


FIG 46

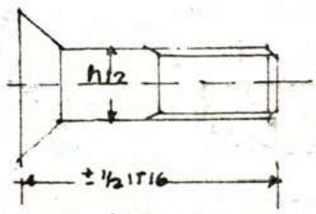


FIG 47

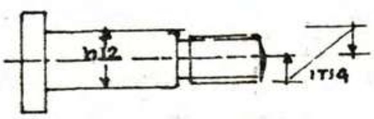


FIG 48

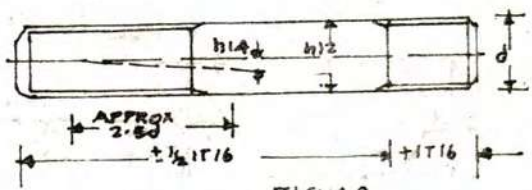


FIG 49

NUTS - T

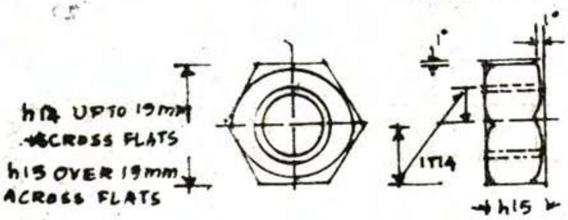


FIG 50

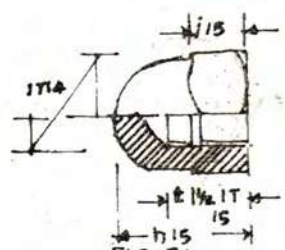


FIG 51

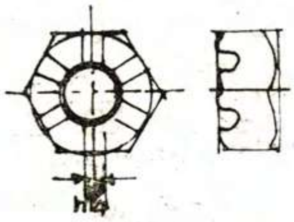


FIG 52

FIG 53

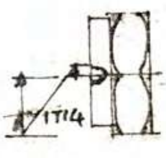


FIG 54

HEADS - B.

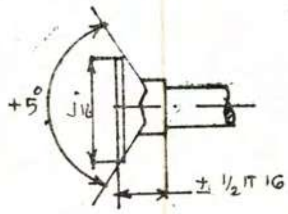


FIG - 55

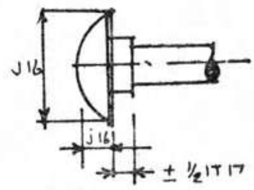


FIG 56

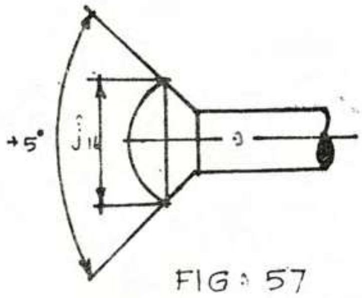


FIG 57

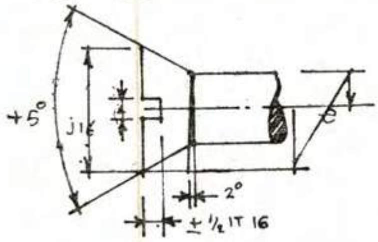


FIG 58

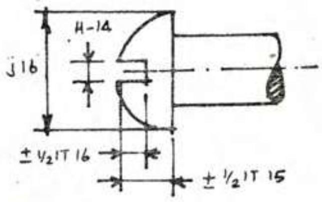


FIG 59

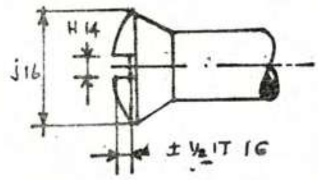


FIG 60

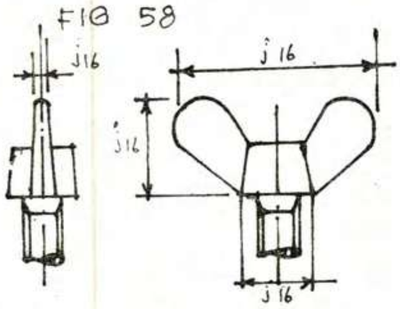


FIG 61

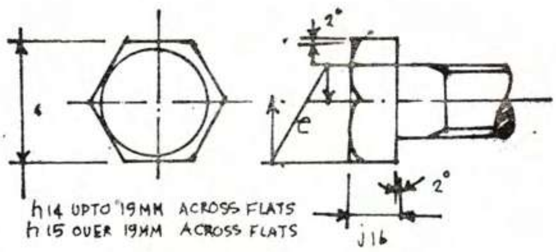


FIG 62

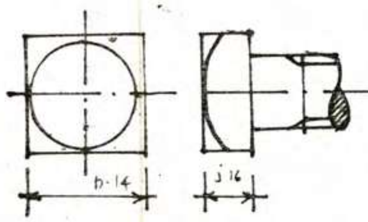


FIG 63

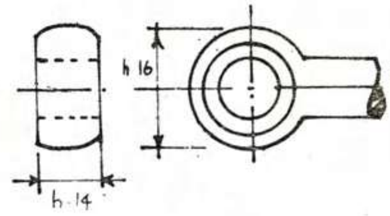


FIG 64

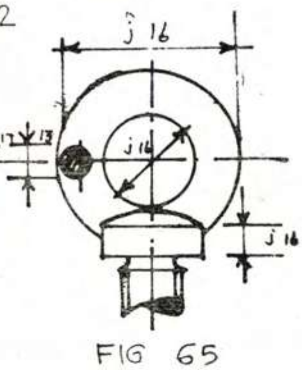


FIG 65

SHANKS B

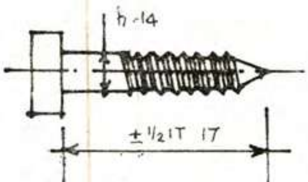


FIG 66

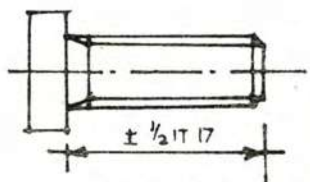


FIG 67

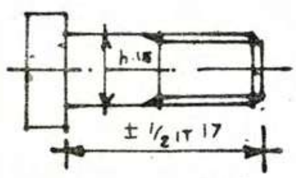


FIG 68

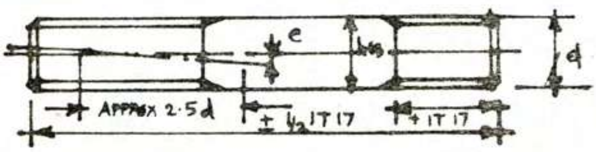


FIG 69

SECTION XV

RIVER CONSERVANCY (Sundry items)

SECTION XV.

RIVER CONSERVANCY (SUNDRY ITEMS).

CONTENTS.

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SECTION XV.

RIVER CONSERVENCY (SUNDRY ITEMS)

SPECIFICATION No. 87.

PLANTING NANAL WITH CUTTINGS 45 CM. APART.

1. Healthy sticks not less than three knots and measuring not less than 45 cm. in length shall be dibbled in, three for every hole at intervals of 45 cm. After the sticks are put in, the holes shall be refilled properly with earth, and pressed so that the portions below surface may not be exposed.

2. Where the silt is cracked due to exposure, these sticks shall not be put into the cracks thus leaving them exposed, but they shall be put in so that no part of the stick below surface is exposed.

3. Final measurement of the plantation shall be made three months after planting has been completed or soon thereafter as found practicable by the Executive Engineer or Sub-Divisional Officer, supervising the work. The contractor should therefore address the Sub-Divisional Officer two weeks before the expiry of the three months to arrange for measurement. Until this final measurement is made, the contractor shall be liable for all costs incurred in maintaining the growth and for all loss or damage of the plantation from whatever causes arising. Payment shall be made only for such portions of the plantations as have, at the time of final measurement, attained new growth to a height of not less than 60 cm.

4. No watering charges will be separately paid where a work is given on contract after tenders have been called for. If a tenderer considers that watering will be required to ensure healthy plantation and growth, his rate for plantation should be inclusive of such charges.

5. Ordinarily, where a work is given on contract without calling for tenders no watering charges should be paid for the plantation as the cuttings should be planted in the slush while the river receding after the floods. However, If the contract is awarded ate or if the situation, where plantation is done necessitates watering and if the officer competent to accept the contract considers watering is necessary and provides for watering in the estimate watering charges may be provided in the agreement as a separate tem, but payment for this item of work will be subject to the follow, ng condition :—

(i) Immediately after planting is completed and where watering is necessary, the contractor should apply to the Sub-Divisional Officer in writing for permission to water the plantation. The Sub-Divisional Officer should, in consultation with the Section Officer and with his local knowledge or after personal inspection of the locality in cases of doubt, issue an order specifying the blocks where watering is necessary and the period for which such watering is to be allowed.

(ii) Payment will be made for such block as are covered by the Sub-Divisional Officer's orders only for plantations which are alive and have reached a satisfactory height at the time of final payment Copies of these orders shall be attached to the contractor's final bill.

(iii) Watering charges should be paid only with the final bill.

(iv) Final bills will always be check-measured by the Sub-Divisional Officer, who should note in the measurement book against the original measurement, the condition of plantation that is alive and make a percentage deduction in area where the plantation is dead, or not in healthy growth.

5. The planting of cuttings shall be completed by the date set in the tender notice. The tender notice will state whether the nanal is to be obtained from Government land at sites approved by the Sub-Divisional Officer supervising the work in which case, the sites will be stated and the tendered rate shall include the cutting and conveyance of the nanal – or whether the contractor shall arrange for obtaining the nanal himself from non-Government lands and include the cost of the nanal in his tendered rate.

NOTE.—This type of plantation is chiefly suitable for silt accretions and marginal slopes, which can be planted as the water recedes at the end of the flood season.

SPECIFICATION No. 88.

PLANTING NANAL CUTTINGS WITH ROOTS,

1. Good green sticks with root having not less than three knots and measuring not less than 45 cm. in length shall be dibbled in, three for every hole at intervals of 60 cm. (Stout full grown or ripe sticks, which have lost their sap are not to be used, as they will not grow). Young sticks should be chosen, and planted within 24 hours of being cut-otherwise they do not sprout well. A hole must be made for the sticks with a crow-bar and they shall not be forced into the ground. Ramming the holes must be carefully done, so as to fill the whole hole and not the top only.

2. Clauses 3, 4 and 5 of the standard specification " Planting nanal with cuttings, 45 cm. apart" shall apply and no watering charges what ever will be paid to the contractor, except in the case defined therein vide clause 5 of the latter specification regarding cost of nanal.

NOTE.—This class of plantation is suitable for low sand shoals which have to be planted latter in the season than is the case with cuttings and in which case the growth has to be more rapid. Late planting should be guarded against, but where found necessary, the date for completion of planting should be set in the tender notice.

SPECIFICATION No. 88-A.

PLANTING THILLA OR ALCHI WITH ROOTS.

1. Holes 15 cm. to 23 cm. diameter and 45 cm. deep shall be dug at intervals of 1 metre. Thilla or Alchi shall be dug up with the roots and planted in the holes (1 to 3 sticks depending on the size of the roots), the roots being fixed not less than a 30 cm. below the surface. The holes shall then be carefully filled with earth.

2. Clauses 3 to 8 of the Standard specification " Planting Dubtus" shall apply to this plantation.

NOTE.—These sea plants grow well in salt swamps below H.T.L.

SPECIFICATION No. 89.

PLANTING DUBBUS.

1. Holes measuring 23 cm. diameter, 45 cm. deep shall be made at intervals of 80 cm.

2. Clumps of green stout well grown nanal shall be dug up with roots and planted in the prepared holes at eight sticks per hole, with roots atleast 30 cm. below the surface and filled up with good site earth having an admixture of fine sand.

When plantation is done in sandy or oily clay soil, the holes shall be filled up completely with good earth, brought from a site approved by the Sub-Divisional Officer supervising the work.

3. Into each hole one pot full of water shall be poured, so that the earth may settle well and good pathies or cup like basins shall be made round each plant to receive and hold one pot full of water.

4. These dubbus shall be planted zig-zag, so as not to form furrows in the course of the current.

5. Watering shall be done properly so that pits are not formed by the side of dubbus due to the water being poured in one place only. When the soil is hard and water poured in the pathies does not sink, a fine stick shall be used to rake the pathies while water is being poured so that the water may sink to the root.

To ensure proper growth, watering should be done daily for the first 20 days, every alternate day for the next 20 days, and once every three days for the next two months.

6. The plantation shall be handed over in a healthy condition, and shall attain a height of atleast 1 metre within three months of planting. If the height is not satisfactory, and if the plantation is not in healthy condition no payment, or only a proportionate payment for the accepted area, shall be made, at the discretion of the Executive Engineer.

7. No extra payment will be made for watering, unless provision is expressly made for same in the tender notice, in which case the terms on which payment will be made will be defined therein. Otherwise, the watering which is necessary to attain the minimum growth defined in clause 6 above, shall be done by the contractor and included by him in his unit tender rate for the plantation.

8. Clauses 3 and 5 of the standard specification for "Planting nanal with cuttings, 45 cm. apart" shall apply also to this specification, except that height of growth in three months shall be at least 1 m. The date for completion of planting will be set in the tender Notice.

NOTE.—This type of plantation is suitable for all sand shoals and hard oily clay or stony soils.

SPECIFICATION No. 89-A.

UPROOTING AND BURNING SPONTANEOUS GROWTHS.

1. The site shall be cleared of all scrub jungle and dirt. A pit 60 cm. x 60 cm. or deeper if the roots of the bush go down, shall be excavated round each plant or bush and the whole with the root shall be completely removed. All the plants and bushes shall in a similar manner be removed and burnt to ashes. The rate shall be for every 100 sq. m. of clearance measured and check -emasured before removal.

SPECIFICATION No. 89-B.

PLOUGHING SAND SHOALS AND HARD GEDDAS TWICE.

1. The surface of the sand shoal or gedda shall be ploughed just before floods with a double bullock plough once length wise and once breadthwise. The interval between two lines of ploughing shall be 60 cm. or such distance as specified by the Sub-Divisional Officer. The point of the plough shall run not less than 15 cm. below the surface of shoal and shall uproot all grass an scrub over it and thoroughly loosen the surface to enable the floods to wash away the shoal. The contractor shall intimate in writing not less than ten days before starting the work to enable officers to inspect and give instructions.

2. The rate shall be 100 sq. m. of area or per hectare ploughed as may be specified.

SPECIFICATION No. 90.

DURBA OR NANAL ROLLER REVETMENT, 23 CM. DIAMETER INCLUDING WATERING FOR THREE MONTHS.

1. On level ground, five strings of double twisted coir rope sufficiently long to securely tie the rollers, shall be stretched at intervals of 30 cm. in parallel lines over the ground, and over this three bundles of rellu grass 20 cm. diameter shall be spread in two layers, the stems being placed differently in the second layer. Over this, a layer of fine silt earth shall be spread evenly, to a thickness of not less than 10 mm. the whole thing rolled tightly and tied properly. This constitutes one roller.

1.1. Trenches 23 cm. wide shall be dug on slopes formed for the revetement and in these trenches, the rollers prepared, shall be laid very closely and staked down with kanat bamboos, third class, not less than 1 metre long, at intervals of not more than 1 metre apart.

2. Watering shall be done as necessary to produce a dense mass of plantation 2 metres high. The unit rate for the plantation shall include this watering, unless provision is expressly made in the tender notice for watering charges, in which case the terms on which payment will be made will be defined therein.

3. Clauses 3 and 5 of the standard specification for "Planting nanal with cuttings, 45 cm. apart" apply also to this specification, except that the plantation shall have attained a height of growth in 3 months of at least 2 metres otherwise proportionate less payment will be made as considered warranted by the Executive Engineer. The date for completion of the revetment will be stated in the tender notice.

4. The rate will be inclusive of all materials and work complete, unless otherwise specified.

NOTE.—This type of cheap revetment is useful to protect banks gently sloped from scouring.

SPECIFICATION No. 90-A.

KORUKKAI ROLLER REVETMENT 23 CM. DIAMETER INCLUDING WATERING FOR THREE MONTHS.

1. Double twisted coir rope, sufficiently long to securely tie the rollers. shall be stretched on level ground at intervals of 30 cm. in parallel lines. Two bundles of green Korukkai sticks 20 cm. diameter shall be spread over the ropes in two layers, the stems and tops being placed alternately in the two layers. Over this, a layer of fine silt earth mixed with roots of korukkai plants shall be spread evenly for a thickness of not less than 10 mm. the whole rolled tightly and tied properly. This constitutes one roller.

1.1. Trenches 23 cm. wide shall be dug on the slopes formed for the revetment and in these trenches, the rollers prepared shall be laid close and fixed with kanati bamboos, thrid class not less than 1 metre long, not more than 1 metre apart. Unless otherwise specified and the roller revetment shall be watered to produce a dense growth of plantation 1 metre high. The rate for plantation shall include watering for three motnhs.

2. Clauses 3 and 4 of the standard specification " Durba or Nanal roller revetment 23 cm. diameter including watering for three months " shall apply to this work except that the plantation will have to attain a growth of not less than 1 metre.

NOTE.—This revetment thrives well in reaches affected by salt water. It is not easily damaged by cattle trespass.

SPECIFICATION No. 91.

WEIGHTED BAMBOO BRUSHWOOD ROLLER OF OVER 1 METRE DIAMETER AND 3.5. METERS LONG.

1. Seven pegs shall be driven into the ground at 45 cm. apart, and about 8 metres away, seven other pegs shall be driven opposite to the first peg. Strong twisted ropes of six twists each of thin coir and. 9 metres long shall then be temporarily tied to these pegs at either end Ten strong standard specification Kanat bamboos, second class, shall then be tied transverse to the ropes 40 cm. apart. 3 cubic metres of brushwood shall be spread and pressed evenly over this and 0·35 cu. m. of rough stone shall be then laid over uniformly. Over this again 1.5 cu. m. of brushwood shall be spread, and the whole rolled up and tied very tightly. The two ends of the roller shall then be tied up securely with coir yarn and each roller shall be gently lowered into the river by means of two stout ropes, at the place pointed out by the Sub-Divisional Officer. These lowering ropes will then be removed.

2. The rate will be for labour and materials complete, unless the, tender notice defines the materials to be supplied departmentally, their place of supply, and other relevant partiuclars. 6 Kg. of twisted coir ropes and 0·75 kg. coir yarn shall be used in each roller.

NOTE.—If rough stone is not available, six sand bags of total 0·35 cu. m. stitched strongly will replace the stone. This will be efined in the tender notice.

SPECIFICATION No. 92.

BRUSHWOOD EDGING 30 M. × 1M. × 1M. WITH KANAT BAMBOOS.

NOTE.—This type of edging is suitable for main canals and cross edging in rivers.

1. Standard specification first class bamboo pegs shall be prepared, cut just above the knot at the top, and sharpened to a point, at bottom. They shall be driven properly so that the tops may not split. Those that split while driving shall be renewed with fresh ones. The bamboos shall be driven not less than 1.5 metre into the ground. The width between 2 numbers should be 1 metre and the average depth of the compressed brushwood shall be not less than 1 metre. Cross piece shall be cut from the bamboos at the thin end. The cross pieces and walings should be nailed to the piles by wire nails 10 cm. to 12.5 cm. long and the ends turned over. The edging shall be protected by the contractor till the final bill is paid for. The brushwood shall be of branches about 50 mm. to 75 mm. diameter placed in bundles and well pressed in by means of a plank with three or four men standing over it.

2. *The following materials shall be used in 30 metres of edging.*—33 full bamboo pegs for outer row ; 33, 2.5 metre long bamboo pegs for inner row, and the balance of length used for cross pieces ; 16 bamboos for waling pieces ; 3 kg. 10 cm. to 12.5 cm. wire nails 25.5. cu. m. compressed brushwood.

3. The rate shall be inclusive of all materials and labour complete unless otherwise defined in the tender notice. If departmental supply is to be made for any of the items, the place of supply and other terms will be defined in the tender notice.

3·1. In the case of departmental supply of bamboos, the contractor shall bring to the notice of the Sub-Divisional Officer previously such of the bamboos as may split while driving and with his approval, the contractor may use others in their place. The contractor shall make good, at his own expense, bamboos split by careless handling.

SPECIFICATION No. 92-A.

PILES AND PILE-DRIVING FOR RIVER CONSERVANCY WORKS.

(For first-class Work.)

1. *Description* — (*a*) *Piles.*—Piles for conservancy works shall be of country wood, bamboo or casuarina, as may be specified by the Executive Engineer. They shall be straight and free from projections.

(*a*-1) The size of a pile shall be specified by the girth measured at the middle of its length. Generally a mid girth of 30 cm. for piles upto 3 m; 40 cm. upto 4·5 m. and 45 cm. for lengths over 4·5 m. are suitable. No pile which is less than the specified girth exceeding by 5 cm. will be allowed.

(*b*) Waling pieces shall be of country wood, casuarina or bamboos. They shall be straight of not less than 25 cm. girth and 3·5 m. to 3.6m in length.

(*c*) Diagonals shall be of casuarina country-wood, or bamboo, 23 c.m. in girth and in straight length of 1·75 m. to 2 m.

2. *Execution.*—(*a*) *Preliminary.*—The contractor shall collect the required number of piles as per list given to him by the Section Officer. The piles shall be stripped of bark and tarred two coats. At the sides, 15 cm. below top, the piles shall bear the serial number, girth and length. The thinner end of the piles shall be sharpened nearly to a point for a length not exceeding 45 cm. The piles shall be, grouped and arranged serially in the order in which they are to be driven. All piles shall be measured and check-measured before driving.

(*b*) *Driving piles.*—The head of each pile shall be provided with a temporary wooden cap to prevent it getting split by blows. The piles shall be driven in one of the following ways and as specified by the Executive Engineer: —

(1) by wooden mallets ;

(2) by heavy wooden monkeys dropped from a tripod ; and

(3) by a pile driven or other approved drivers. They shall be driven truly vertical and to correct depths. The tops of piles shall be to correct levels and their positions shall be as shown in sanctioned plans. Any pile which is 10 cm. or more out of position shall be rejected and be immediately removed by the contractor.

(*c*) *Fixing waling pieces.*—The waling pieces shall be stripped of bark and tarred 2 coats before use. The number to be fixed depends on the nature of the work and shall be specifed in each case in the tender notice. Fixing shall be at intervals ranging from

50 cm. to 1 metre with iron nails which shall penetrate atleast 50 mm. into the main pile and shall be of sufficient length to be turned over in case of piles less than 40 cm. girth. The top row of waling pieces shall be fixed 23 cm. to 30 cm. below the tops of the piles.

(*d*) *Fixing diagonals.*—The diagonals shall be fixed to the piles diagonally in parallel rows with country nails 15 cm. to 23 cm. long with ends turned over. The fixing shall be done after well filling the interior space of piles with brush wood or weighted brushwood rollers (15 cm. to 23 cm. below the tops of piles) as the case may be.

(*e*) *Brushwood filling.*—The space between the rows of piles shall be filled with brushwood as specified in clause 1 of standard specification No. 93, and clause 3 of specification No. 94.

(*f*) *General.*—Edgings and groynes shall be constructed strictly according to sanctioned plans. Edgings shall be parallel to the axis of the river. In the case of groynes, the work shall be commenced at the upstream end. Each groyne and its connection to the bank shall be completed before the next length is taken up. Piles for edging and groynes shall be 1 metre centre to centre and two rows 1 metre apart unless otherwise specified by the Executive Engineer in the tender notice.

3. *Rates for work.*—(*a*) The rate for piles shall be for every 10 running metre and for supply at site of work exclusive of labour for sharpening, tarring and driving which shall be paid for separately. The piles shall be measured and checkmeasured before use and shall be in the custody of the contractor till they are driven, piles which have been measured but not driven shall not be taken away by the contractor without the written approval of the Executive Engineer. No payment shall be made until the piles have been correctly driven in position.

(*b*) The rate for driving piles shall be for every 10 running metre of driven length. This length shall be calculated for each pile by deducting the height of the piles above ground from the length of pile measured before driving. All such lengths shall be added up and the total length driven arrived at.

(*c*) The rate for waling pieces shall be for every 10 running metre, omitting over-lapped lengths and shall include labour for fixing and cost of materials.

(*d*) The rate for diagonals shall be for every 10 running metre of diagonal pieces inclusive of cost of materials and labour for fixing.

4. *General—Supply of the punts.*—When in any case the Executive Engineer considers that punts are required for any pile work, he shall notify this fact in the tender notice and Government punts will then be supplied to the contractor at the site of the work free of charge, if available. When so supplied the contractor shall not unduly retain the punts by slackness of execution due to want of labour or materials. The normal out turn to be shown by the contractor for punt per day shall be at least 60 running metre of piles driven into ground or 120 running metres of waling or diagonals fixed in position. Short outturn causing delay of punts shall make the contractor responsible for punt hire, proportionate to the short outturn.

4·1. If Government punts are not available, the contractor shall apply to the Sub-Divisional Officer for permission to engage private punts. The Sub-Divisional Officer may ask the contractor to wait until punts are available or if the work cannot wait, grant permission specifying the tonnage of the punt required and hire shall be paid to the contractor on the tonnage fixed by the Sub-Divisional Officer.

SPECIFICATION No. 92-B.

PILE AND PILE-DRIVING FOR RIVER CONSERVANCY WORKS.

(*For Second-Class work whereinferior sort of work is considered sufficient.*)

1. *Description.*—(*a*) Piles—Piles for conservancy works shall be of strong male bamboos. They shall be straight and free from projections.

(*a*-1) The size of a pile shall be specified by the girth measured at the middle of its length. Generally, a mid-girth of 12·5 cm. is suitable. Length of pile shall be as specified by the Executive Engineer.

(*b*) Waling pieces shall be of strong male bamboos. They shall be staright, not less than 12·5 cm. girth and 3·5 m. to 3.6 m. in length.

(*c*) Diagonals shall be of strong male bamboos 10 cm. to 12·5 cm in girth and in straight lengths of 1·8 m. to 2 m.

2. *Execution.*—same as Specification 92-A.

3. *Rate for work.*—Same as specification 92-A.

4. *General.*—Same as specification 92-A.

(At the discretion of the Executive Engineer, ordinary coir rope may be used for fixing waling pieces and diagonals in place of nails. If this variation is made, it shall be so specified in the tender notice. This will apply to both Specifications 92-A and 92-B.)

SPECIFICATION No. 92-C.

BAMBOO SCREENS 30 CM. MESH.

1. Bamboo screens consist of frames of solid bamboos stiffened with bamboo laths.

2. A rectangular frame of first-class solid bamboo is first made by tying them at corners with coir yarn. Into the frame, laths, i.e., bamboos split into two from first-class bamboos over 15 cm. girth and 3·5 m. to 4·25 m. long shall be tied diagonally with coir yarn so that each mesh formed may be 30 cm .rhombus, as shown in sketch below.

2·1. The size of the frame shall be as specified in each case and shall not be larger than what two men can easily carry.

3. Bamboo screens are used—

(1) Over pile boxes to prevent brushwood being washed out, and

(2) Over slopes of margins, covered with brushwood to stop erosion.

3·1. The screens shall in all cases be firmly secured to the piles.

4. The rate shall be for ten sq. metre of bamboo screens fixed in position.

SPECIFICATION No. 93.

BRUSHWOOD WOVEN WIRE FENCING FASCINE WORK.

1. Brushwood fascines of 30 cm. diameter 3.5 metres long shall be prepared with brushwood of 0.5 cubic metre compressed to 0.25 cubic metre for each fascine and tied securely with twisted coir rope (two twists of coir yarn) at 35 cm. intervals. These fasines shall be woven into a fascine mattress, by inter-twisting at one metre intervals with G.I. wire of dia 3.25 mm.

2. Brushwood rollers one metre diameter and 3.5 metres long shall now be formed at the end of the strips of fencing wire, which wire shall be woven into a cylindrical casing by tying with loops of wire of dia. 3.15 mm to contain the roller. The filling for the roller shall be 0.35 cubic metre of sand in bags or 0.35 cubic metre of rough stone as specified, encased in 4.2 cubic metre of brushwood. This wire fencing round the roller shall be securely tied so that the roller can be lowered with the fencing wire and the ties shall support the dead weight of the roller and mattress without any signs of rupture. If the ordinary bamboo rope rollers are used in place of the above, they shall be tied securely to the wire fencing mesh and they shall be paid for at the corresponding mate for this type of roller.

3. The brushwood fascine mattress referred to in clause 1 shall be securely tied to the wire fencing by wire ties at intervals of not more than one metre.

4. The woven wire fencing mesh with its weighted roller anchor and brushwood mattress covering shall be carefully lowered down the slope to rest tightly against the slope.

5. Posts shall now be driven to a depth not less than one metre, at 2 meter intervals, beyond any cracks on the high margin at places indicated by the departmental representative incharge of the work. Three strands of wire of thickness 3.15 mm. are to be twisted and tied securely to the fencing wire and carried width round the post and tied strongly.

6. The ends of separate units of each mattress shall be well tied to prevent any ends being exposed to the tearing action of the current.

7. The tender notice will define such items as will be supplied departmentally and method of payment for the work. Woven wire fencing and the G.I. wire will usually be supplied departmentally. Patent woven wire fencing—7 or 8 horizontal wires, 1.2 m etres of rolls—is suitable.

NOTE.—This type of work is suitable where protection to a slope is required below water level to reduce under cutting action and i.e. such cases as protection of freshly cut bank slopes, which slopes could not be reveted prior to advent of the floods.

SPECIFICATION No. 94.

BRUSHWOOD EDGING OR MODASAL WORK WITH HALF AND QUARTER SPLIT PALMYRA PILES AND QUARTER SPLIT WALING AND CROSS PIECES.

1. Sound, full grown palmyra trees shall be freshly cut for use on the work. The bottom portion of tree shall be cut to 5.0 metre lengths, half split for piles and given sharpened points. The top portion of the tree shall be quarter split and used for waling, cross and diagonal pieces. The waling, cross and diagonal pieces shall be freshly prepared as they are required for use on the work; otherwise they rot if they are prepared and kept long before they are fixed. The files shall be driven not less than 2.5 metres into the ground by means of a monkey (heavy iron weight or a heavy wooden block) suspended from a triped stand and operating up and down a guide rod by a rope pull. The best height for the drop will be determined by trial. A dolly or cap for the piles will usually be necessary.

2. The half-split piles shall be driven at 3 metres centres in two rows being one metre apart and quarter split ones at one metre centres between the half split piles. Cross pieces over the brushwood shall be fixed to the half-split piles connecting the opposite piles in the front and rear rows. Two rows of waling pieces shall be fixed, one on the river side, and one on the land side of the piles. Diagonal pieces shall be fixed to the top of the half palmary piles, after filling and compressing the interior wall with brushwood. The brushwood filling cross and diagonal pieces shall be 15 cm. to 25 cm. below the top of piles. Waling cross and diagonal pieces shall be nailed to each pile they cross or connect with country nails 15 cm. to 25 cm. long and ends turned over, where possible.

3. The brushwood shall be of branches of babul trees up to 50 mm. diameter and shall be filled in, in bundles and well pressed down by means of a plank with three or four men treading over it.

4. The rate shall be per ten running metres of edging completely erected in place inclusive of all materials and tools and plant, except that a departmental pile driven will be loaned to the contractor without hire charges, unless otherwise specified. If the palmyra trees or brushwood are to be taken from Government land, without cost to the contractor, such will be defined in the tender notice.

SECTION XVI

SANITARY WORKS AND ROOF PLUMBING

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SANITARY WORKS AND ROOF PLUMBING

SPECIFICATION No. 95.

TRENCH WORK-EXCAVATION AND REFILLING.

1. Conformance to plans and sections and agreement rate basis.

(*a*) The trenches shall be taken out truly to the alignment, levels and width shown on the relevant plans and sections subject, never the less, to any changes which the Executive Engineer may make therein.

For details of specification for excavation please refer to paragraphs 10.1 to 10.1.2. of the National Buildings Code Part IX, Section 2, Drainage and Sanitation.

(*b*) If the contractor excavates the trench to a greater depth than is required, the extra depth shall be filled up, at the contractor expense, with standard specificaion lime concrete, or cement concrete, according as the soil is dry or wet respectively and to the instructions of the Executive Engineer.

(*c*) The contractor shall be paid for the actual excavation subject to the following provisions : —

(i) He will not be paid for a greater depth nor width than the scheduled depth or width, unless he produces an order in writing from the Executive Engineer requiring the greater depth or width.

(ii) He will not be paid for the scheduled depth or width when the Executive Engineer orders in writing prior to excavation being done, a less depth or width.

(*d*) It is to be distinctly understood that the contractor in tendering his rate for excavating inspected the site of the excavation, examined the nature of the soil to be excavated, estimated the amount of pumping and baling to be done, examined the provisions, which he will have to make during excavation by timbering, shoring, etc., to prevent any caving in off the sides of the trench, to accommodate and safeguard traffic, the public and his workman and prevent damage to buildings and other property in proximity to the excavation, and after examination of all the above requirements - *vide* his responsibilities as laid down in the General conditions of contract has tendered a rate to include all the contingent expenses in connection with the trench excavation.

(*e*) Sides of trenches will usually be made vertical but in any case where the contractor shall desire to excavate the trench with side slopes other than those shown in the relevant sectional plans in order to save himself the extra cost of timbering, he shall only do so when the extra widths will not inconvenience or endanger traffic or property and after he has obtained in writing the permission of the Executive Engineer. He shall, in such a case be paid only for the scheduled quantity based on the relevant sectional plans, irrespective of the extra earthwork actually executed.

2. *Sight Rails.* —Before the trench excavation is commenced, sight rails (two uprights, one on each side of the trench to be excavated and a cross rail railed thereto) shall be erected every 30 m. or at distances as fixed by the Executive Engineer, and at all changes of direction or gradient, at a definite and as far as practicable, uniform height above the proposed invert level of the pipes, the centre line being clearly marked on each horizontal rail. The depth of excavation and the level of the pipe invert shall be checked by means of boning rods of appropriate length. These sight rails shall be provided, fixed, and maintained by the contractor at his own cost, similarly the boning rods.

3. *Spoils.*—Order of removal and replacement :

(*a*) The various materials excavated shall be separated and stacked so that in refilling they may be again relaid in the same order, and, thus the least possible damage be done to public roads, cultivated fields, etc.

(*b*) The contractor shall arrange to deposit spoil at sides of trench without inconvenience to traffic and without danger to workmen in the trench.

4. *Insecure Foundation soil.*—In soil, too soft or unreliable for purpose of carrying the pipe line is met with during excavation, and for which no provision has been made in the agreement schedule—then the Executive Engineer will give the necessary orders regarding removal and replacement by broken stone, gravel, concrete, or other material, and ramming—and fix a rate prior to execution of the work defining the extra payment to be made therefor.

5. *Rock Requiring Blasting.*—In cases where blasting is expected to be required during excavation, a separate schedule item will usually be provided to cover the rock excavation. In such cases, the contractor shall observe the precautions for blasting operations, which are laid down elsewhere in these detailed standard specifications. Where no rate has been provided in the schedule for rock excavation by blasting, and where the work done is not on a lump sum basis irrespective of type of soil met with, then before any such work is done, a rate shall first be fixed and necessary instructions given by the Executive Engineer. In the absence of addendum defining clauses regarding rock excavation work, the contractor shall always arrange for excavation of the rock to a depth to permit approved filling material to be blasted and rammed under the pipe to support it securely for its full length, 10 to 15 cm. will usually be the maximum filling required for this, and sand which is the best filling material all be used. This filling work over the rock and under the pipes shall be included in the unit rate for "Trench work excavation and refilling and unless otherwise specified, no extra payment to be made for the filling material specified.

6. *Change of classification of soil.*—Wherever during excavation a change of classification of soil is met with, and the basis of payment is for a defined class of soil, then the contractor shall immediately inform the Executive Engineer in writing, accordingly. In case where a rate has not been entered in the agreement schedule for the new classification of soil, the contractor will be paid for that class of the earth work on the basis of the schedule of rates of the PWD Division which is executing the work, or such other rate as may be fixed by the Executive Engineer, having regard to the contingent conditions of excavation.

7. *Socket Hollows.*—After excavating the trench to the correct level, hollows shall be cut at the required positions to receive the socket of the pipes and these hollows shall be of sufficient depth to ensure that the barrels of the pipes shall rest throughout their entire length on the solid ground and that sufficient space is left for jointing the underside of the pipe joint. These socket holes should be refilled with sand after jointing the pipe.

8. *Excavation for manholes and such Masonry structures on the Pipe lines.*—The Contractor shall only excavate the cross sectional area and depth essential to contain the masonry and timbering if any required, and shall only be paid for the quantity as thus defined—irrespective of actual excavation done above this quantity.

9. *Shoring, Planking and Timbering*:

(*a*) This work shall be done in all cases where it is necessary to safeguard life, property or efficient excavation of work – *vide* clause 1 above. It shall be included in the unit rate for excavation – *vide* clause 1 above – unless otherwise defined in the specification and schedule.

(*b*) The contractor shall comply with such orders as the Executive Engineer may issue regarding shoring precautions, when the latter deems the contractors arrangements insufficient but the failure of the Executive Engineer to give such orders shall not in any way free the contractor from his responsiblities as laid down inthis specification and the general conditions of contract, nor shall compliance with such orders entitle the contractor to any extra rate therefor.

(*c*) The usual sizes for trench timbering are: sheeting planks – 30 cm. *wide* and 5 cm. thick and of suitable lenghts; waling pieces – 15 cm.x10cm. upto 6 m. length ; struts–15 cm. diameter and of suitable lengths, spaced as required but not more than 1.2 m. apart, unless the Executive Engineer shall permit of longer spacing. The strength of the timber must be sufficient for the purpose it is to serve and subject to the approval of the Executive Engineer.

(*d*) The contractor may use steel sheet piling if he so desires – but if departmental steel sheet piles are to be furnished, the conditions assertaining thereto, will be defined in the tender notice and the tender rate governed thereby.

(*e*) Voids shall not be allowed to occur behind sheeting.

(*f*) If the Executive Engineer directs in writing (but not otherwise) that any timbering shall be left in the work it shall be measured up and allowed for at the rate agreed upon, but if the necessity for leaving it in, has in the opinion of the Executive Engineer, arisen from carelessness or neglect or lack of skill on the part of the contractor the timber, so ordered by the Engineer to be left in the trench, shall not be paid for.

10. *Roads Crossings – Intercepting Pipes, Cables, etc.* –

(*a*) At road crossing, not more than one half the breadth of road shall be opened at one time, nor shall two or more roads at their function be opened except in such manner as shall avoid interference with traffic. The protection of traffic at such places shall be carefully attended to by the Contractor.

(*b*) Pipes, water mains, cables, etc., met with in the course of excavation shall be carefully protected and supported, and any damage to such pipes or cables, or their joints shall be made good by the contractor. Mains are usually hung from timbers placed across the top of the trench.

11. *Accidents, Boarding, Lighting Observations, Watchmen.*—

The relevant cluase in the general conditions of contract and the relevant para 3.11 of I.S. 412-71967 for detailed instructions shal tapply.

12. *Open Trench Length* – The length of trench to be opened at one sime will depend on its depth, the nature of the pipe line, and of the soil and traffic convenience and shall usually be so regulated as to enable the excavation to be completed about two days in advance of the pipe laying, or such other length of open trench as may be fixed by the Executive Engineer.

13. *Material surplus to requirements for refilling.* –

13.1. The descriptive specification sheet mentioned in the tender notice shall specify, (i) the sites to which the spoil, surplus to refilling and settlement should be conveyed, and (ii) if extra payment is to be made for earthing such spoil, the basis of such payment. If these partiuclars are not specified in the descriptive specification sheet the parties intending to tender shall ascertain them from the Executive Engineer, before tendering. Otherwise or if no kind of rate is tendered for the carting of the surplus spoil, it shall be understood that the tender unit rate for the earthwork includes removal of surplus spoil at contractor's expense to the disposal sites specified in the descriptive specification sheets or ordered by the Executive Engineer at the time of removal.

14. *Tunnelling*. If extensive tunnelling is to be done, such work will be described in a separate specification. This does not apply to tunnelling and timbering at road crossings and other short lengths, where such is necessary the latter arrangements being considered as included in the agreement unit rate for "Trench work – Excavation and Refilling ".

15. *Ramming and refilling.* –

(*a*) Trenches shall not be filled in until the pipe joints have been tested and alignment passed by the Executive Engineer, but In the case of iron pipes, to reduce temperature effects, back filling shall be done, unless otherwise specified or ordered by the Executive Engineer, to the extent of 30 to 60 mm height over the pipes leaving 45 cm on either side of joint uncovered with earth till the testing is completed. This 90 cm length of pipe shall be covered with mats, gunny bags, palm leaves, or straw kept damp so as to avoid damage to the joint by expansion and contraction from variations of temperature.

(*b*) The utmost care shall be taken in refilling trenches so that no damage may be done to the pipe line. The first 30 cm of filling material immediately over and round every sewer, shall consist of the finest selected material,and unless of fine soft material, shall be lowered into the trench by pails or skips. No lumps shall be put round the pipe line, or thrown into the trenches until the pipe line has been protected in the manner described above. The reminder of the filling material shall be well rammed in layers not exceeding 20 cm at a time.

(*c*) Vide clause 3 above, regarding order of replacement of excavated materials. Paying and metalling shall be reinstated in a good order as before removal, and the contractor shall, by adequate ramming and watering of under layers, guard against subsequent settlement.

(*d*) The contractor will be held responsible for any subsidence in the line of the trenches, which may take place any time within six months after the total completion of the work covered by the contract, and should he fail to attend, when any such subsidence occurs, the necessary repairs may be done at his cost.

16. *Rate*. – The rate will usually be ten cubic metres for earth work and per one cubic metre for rock blasting work and will, in the absence of other modifying addendum specifications or schedule provision, be for excavation and refilling complying with all the clauses of this specification.

NOTES. – The width of trenches will usually be such that 20 cm is left on either side of stoneware pipes for laying operations, 30 cm in the case of iron pipes, and for brick sewers, no allowance on each side. If more room is required for jointing iron pipes. extra width of trench at joints may be provided for in the approximate schedule quantities accordingly.

Minimum cover for iron pipes will usually be 75 cm. which will ordinarily render expansion joints unnecssary for the length so covered.

SPECIFICATION No. 96.

STONEWARE PIPES.

For details regarding the stoneware pipes, relevant paras in I.S.651 —1963 shall apply.

SPECIFICATION No. 97.

CAST IRON PIPES AND SPECIAL CASTINGS FOR WATER AND SEWAGE.

I.S. 1536—1967 where in the specification for the pipes, etc., are contained shall apply.

SPECIFICATION No. 98.

1. *Conveyance, laying and jointing mild steel or cast iron pipes for water supply and fixing accessories.*

1.1. National Building Code Part IX—Section 1, water supply Paras 11.1. to 11.3 for jointing of pipes shall apply.

1.2. *Receipt—Transport and custody of materials :*

(*a*) The clauses 1 (*a*), (b), (*c*) and (*d*) of the Standard specification for "Cenveyance, laying and jointing stoneware pipe for sewers" shall apply to this specification.

(*b*) *Responsibility for damage to materials.*—Any pipes, specials valves, fountains, or other articles which shall have been handed over to the contractor, in good condition, and which thereafter shall be damaged before, when or after, being placed in the work shall be paid for by the contractor at the rate originally paid for such articles, plus 10 per cent in excess of such rate, or if the Executive Engineer decides that the damage can be rectified without prejudice to the efficiency of the pipe or other fitting then he will instruct the contractor regarding the repair which shall be done at the contractor's expense. Should the spigot ends of any cast iron pipes with ordinary spigot and socket (not turned and boxed or other such pipe joint) be cracked or broken after they are received by him, the contractor shall (if the cracked portion be less than half the length of the pipe) cut the damaged part off at his own expense, and pay for the actual length cut off, plus 10 per cent extra. Should the damage be at a socket end, or reach to half the length from the spigot end, then the contractor shall pay the cost of the whole pipe plus 10 per cent and the pipe shall then become his property.

2. *Cleaning, examining and lowering.*—Each pipe, before it is laid shall be examined and tested with a hammer to prove its soundness and then shall be brushed through and washed to remove all soil or dirt.

2.1. The pipes shall be placed in the trenches by means of proper shear legs, chains and other tackle and shall be properly driven home.

3. *Laying.*—Clause 3 of the standard specification for "Conveyance, laying and jointing stoneware pipe for sewers" shall apply only deleting the third sentence regarding "pipes between manholes".

4. *Jointing.*—(*a*) The tender notice will define the "Type of pipes to be jointed, i.e., in the case of cast-iron pipes whether turned and bored, plain spigot and socket or other type and in the case of the spigot and socket type, whether the contractor shall tender alternative rates for molten lead and lead wool joints.

(*b*) The trench must be kept quite dry during jointing, unless in any particular case the Executive Engineer permits laying of the pipe in wet conditions. In such case joints under water shall be made with lead wool inserted in strings not less than 6 mm thick and very thoroughly caulked.

(*c*) Instruction regarding jointing of various types of joints are given below :—

(i) *Turned and bored joints.*—The pipes before being laid shall be thoroughly cleaned and the turned and bored surfaces cleaned from rust or paint. Care should however, be taken that the turned and bored portions are not rubbed excessively so as to make them oval or uneven as, if this is done, the joints will leak. The joints shall be made with red lead, cement or salammoniac solution as may be specified. Unless otherwise spacified, cement joints will be used and jointing done as follows :

(*d*) The turned and bored surfaces after cleaning shall be thinly coated with cement wash. When the spigot end of a pipe has been inserted into the socket of another, so as to be truly concentric and in a straight line with the pipes already laid, the former pipe shall be driven home with a heavy wooden rammer or by means of a ram formed of a cast-iron pipe suitably a slung so as to ram the pipe which is being jointed, a wooden plank being used between the pipes, to prevent damage to the pipes from concussion.

(*e*) After a reasonable length of pipe has been rammed home, the space left remaining between the inside of the socket of one pipe and the spigot of another shall be filled with nearly dry standard specification portland cement mortar but of composition 1 to 1 which shall be thoroughly well caulked into the space and the face neatly finished off flush with the face of the socket.

(*f*) The object of filling up this space with cement mortar is not primarily to make a water-tight joint but with the desirable object of preventing, "the sucking" into the pipe line through this space of subsoil water and soil which would seriously contaminate the water in the pipe line in the event of the turned and bored joint being slightly drawn apart owing to subsidence or contraction of the pipes themselves.

(i) To allow for expansion and contraction of pipes with turned and bored joints, 10 per cent of the joints in the straight as well as all fittings and specials will be usually specified to be plain spigot and socket.

(ii) *molten lead joint.*—Plain spigot and socket pipes shall be jointed as follows :

(iii) Paras 5.1.3.1. to 5.1.3.5. of I.S, 3114/1965 for additional instructions shall apply.

(iv) The spigot of the pipe must be forced well home into its socket and must be centred so that the joint may be of even thickness all round at least one complete lap of clean white hempen spun yarn shall be driven into the bottom of the socket without being forced through the joint into the pipe. As many laps of tarred yarn as may be needed to leave the space required for the lead shall then be run with molten lead in sufficient quantity so that, after being caulked solid, the lead may project 0.5 mm beyond the face of the socket against the outside of the spigot, but must be flush with the outside edge of the socket.

(v) Filling may be best done by using rubber jointing rings, When these are not available, a ring of hemp rope covered with clay shall be wrapped around the pipe at the end of the socket, leaving an opening at the top of the socket into which the lead can be poured, The hemp rope shall be supported by clay packing so as to stand the operation of lead pouring.

(vi) The lead used shall be pig lead of best quality, soft and of a minimum purity of 99.94 per cent and shall be carefully skimmed of all scale, when melted in a cast-iron pot or patent melting machine. Sufficient lead shall then be taken from the pot by a ladle and ram hot into the joint, and the joint filled at one running. Tde joint shall then be "set up" when cool by a suitable caulking tool and a 2kg. hammer and the joint left neat and smooth.

(vii) Regarding quantity of lead and spun yarn required for different sizes of pipes, para 5,1.3.2 in I.S. 3114/1965 shall apply.

Nominal diameter of pipe (mm)	*Depth of lead (mm)*
upto 200	40 to 50
250 to 400	50 to 60
450 to 750	65 to 75
800 to 1500	75 to 90

NOTE.—(1) The minimum depth of lead given above shall be insisted on in every case. The quantity of lead to be used shall be that required for making a compact water-tight and efficient joint to ensure the minimum depth of lead specified above. Payment shall always be at a "Rate per joint" or "per running metre of pipe laid and joined" under these conditions irrespective of the quantity of lead that may be actually used or required for each joint.

(2) The quantity of lead required joint given in the table 1 as per I.S. 3114/1965 with variation of 20·/. [per issible] is the correct quantity if the pipes are exactly to standard dimension. It may be taken for guidance in preparing estimates and indents for lead and actual execution.

(3) *Lead wool joints.* –In the event of the Executive Engineer specifying or permitting the use of lead wool, the joints shall be made as follows :—

(i) A strand of lead wool shall first be introduced into the socket and thoroughly caulked, care being taken that no lead wool passes into the interior of the pipe.

(ii) A portion of the remainder of the socket shall then be filled in with best white hemp or spun yarn and this shall be thoroughly caulked with suitable caulking tools (Kutcha tools or cold chisels are not to be used). Lead wool shall then be introduced and this caulking shall be repeated with each of the lead wool compressed into a dense mass. The joint shall then be finally faced up with a finishing tool.

(iii) The following are the minimum quantities of lead wool and yarn which shall be used for each joint for the different sizes of pipes exclusive of the strand of lead wool first introduced:—

TABLE XVIII.

Diameter of size in mm.	Lead wool.		Yarn.		
	Depth. mm.	Weight. kg.	Number of skeins.	Depth. mm.	Weight. kg.
(1)	(2)	(3)	(4)	(5)	(6)
50	25	0·48	1	50	0·19
75	28	0·74	1½	47	0·11
100	30	0·96	2	35	0·12
125	30	1·19	2½	55	0·21
150	35	1·70	3½	55	0·24
175	35	2·20	4½	55	0·27

TABLE XVIII—*cont.*

Diameter of size in mm.	Lead wool.		Yarn.		
	Depth. mm.	Weight. kg.	Number of skeins.	Depth. mm.	Weith. kg.
(1)	(2)	(3)	(4)	(5)	(6)
200	35	2·40	5	65	0·40
225	35	2·90	6	65	..
250	35	4·00	7½	65	0·17
300	35	4·30	9	65	0·26
350	37	5·30	11	75	0·10
375	37	5·80	12	75	0·17
400	37	6·00	12½	75	0·22
450	40	7·25	15	75	0
600	40	9·50	19½	85	0

(iv) *Flanged Joints.*—Flanged joints should be made by painting the facing of the flange with red lead freely and bolting up evenly on all sides. A thin fibre of lead wool may be very useful in making the joints watertight, where facing of the pipes is not true.

In addition to the above paras 5·2 to 5·2·4 of I.S. 3114-1965 shall apply.

Where packing must be used, it should be of rubber insertion cloth, three-ply and of approved thickness. The packing should be of the full diameter of the flange with proper pipe hole and bolt holes cut, and even at both the inner and outer edges.

(v) Mild steel pipe joints and pipes with patent joints.—Jointing of patent type joints shall be done in accordance with the maker's instructions. Addendum specification will be given for mild steel pipes joints.

5. *Clearness.*—(*a*) The interior of the pipes must be carefully freed from all dust as the work proceeds, for which purpose of dise plate or brush sufficiently long to pass two or more joints from the end of the pipe last laid, shall be continuously drawn forward as the pipes are laid.

(*b*) The ends of the pipes must be securely protected during the progress of the work. The pipes laid shall not be made receptacles either for tools, clothes or of any other matter during the progress of the works.

6. *Testing.*—Testing joints by water pressure. The pipes after being laid and jointed shall be tested by the Officer in charge in such lengths as seems to him desirable, under the circumstances of availability, of water for testing purposes.

6.1. For testing pipes and joints for water pressure relevant para 6.1 (*a*) of I.S. 3114-1965 shall apply.

6.2. The testing will be done by the officer in charge who will supply all the apparatus required, unless otherwise specified, but the contractor shall provide all water and necessary labour for filling the length of pipes, to be tested fixing all apparatus and for carrying on the testing operations until the length of pipes, specials and connections are finally passed by the officer-in-charge.

6.3. The length to be tested shall be provided with two blank flanges fastened on in the usual manner by collar bands and bolts to the end pipes or, if the length to be tested shall have a sluice valve at each end, such blank flanges may be dispensed with.

6.4. The length of pipes to be tested shall first be filled in with water from a higher section of pipes already laid or with clean water obtained from a service connection well, tank or water course as the contractor may arrange, with the approval of the Executive Engineer.

6·5. Before the actual testing pressure is applied any air which has lodged in the length of pipes to be tested shall be got rid of, by screwing on at the highest part of the length of pipes a temporary air valve or by opening a temporary stop cock or by other means as the officer in charge may direct.

6.6. The test pressure shall then be applied to the length of pipes under test by means of a hand power hydraulic test pump. The connection of the test pump to the length of pipes shall either be at the union connection provided at a blank flange or shall be at a temporary stop cock or fountain connection as the officer in charge may in the circumstances direct.

6.7. For actual test procedures paragraphs 6.5.1. to 6.6.3 of I.S 3114-1965 shall apply.

6.8. When a turned and bored joint is found leaking or sweating, the cement filling of socket space shall be removed by the contractor and this space shall be filled with lead wool properly caulked or with red lead as the officer-in-charge may direct.

6.9. When a lead joint is found to be sweating or leaking, the. contractor shall again set up the lead joint by caulking it with a caulking tool and a 2 Kg. hammer.

6.9.1. When a flange joint is found to be leaking, care shall be taken that in tightening up the flanges the neighbouring joints are not affected.

6.9.2. When a screw joint is found leaking, it shall be put right by the contractor by putting a tighter coupling or by replacing the pipe of which the screwed portion is found defective or by caulking the joint to the satisfaction of the officer-in-charge. If the gland of a sluice valve is found to be leaking, the gland shall be tightened up or repacked as required.

6.9.3. If the length of pipe line under the test is found to be satisfactory and no leaks or sweatings are found at the pipe joints or at the joints of specials and connections then this length of pipe line and specials and connections will be passed by the officer-in-charge.

6.9.4. But should any pipe joint, special or connection be found to sweat or leak, the contractor shall make good at his cost such defective joint and the length of pipe line shall be again re-tested by the officer in charge until all pipes, joints, specials and connections are found to be satisfactory.

7.0. *Flat Curves.*—Plain spigot and socket cast iron pipes permit small bends to be made at joints without the use of specials. Any deviation, either in plan or elevation of less than 11¼°, shall usually be effected by laying the straight pipes round a flat curve, of such radius that the minimum thickness of lead at the face of the socket shall not be reduced below 6 mm. or the opening between the spigot and socket increased beyond 12 mm. at any joint. A deviation of about 2¼° at each joint can be effected in this way. If the joints used are spigot and socket joints, the spigot shall be carefully centred in the socket by one or more laps of white hempen spun yarn, sufficient yarn only being forced into the socket to leave a depth of lead as shown in the table given above in this specification. The proper depth of each joint shall be tested before running the lead, by passing completely round it a wooden gauge notched out to the correct depth of lead, the notch being held close up against the face of the socket. The pipes shall be carefully laid so that they shall bear properly on their bed throughout their whole length.

8. *Fixing accessories to the pipe line.*—Type plans and in some cases also detail plans, will be furnished to the contractor for fixing specials, branches, etc. Changes will at times be necessary, while the work is in progress from type or detail plans to suit the local conditions of the special fitting. The Contractor shall in all such cases, take timely instructions from the Executive Engineer (or Sub-Divisional Officer in charge of the work), and conform without delay, to the local requirements of the particular fitting' in accordance with the orders given.

8.1. The following instructions are for general compliance in connection with fitting accessories :—

(*a*) *Fixing Sluice Valves.*—The sluice valves to be fixed on the pipe lines shall be examined, cleaned and placed in the positions to be indicated by the officer in charge.

(i) The valves shall be placed on the pipe lines in valve boxes constructed according to drawings which will be furnished to the contractor. The depths at whcih the valve is to be laid shall be varied when necessary under the orders of the officer-in-charge. The dimensions of concrete and masonry shall also be varied when necessary and on receipt of written orders from the officer-in-charge.

(ii) As the pipes in some instances may be required to be fixed at a less depth than will permit the top of the valve spindle being below the level of the road (but this may only be in cases where the position of the valve is to one side of the metalled road) the walls of the valve box shall, in such cases, be carried upto such height as may be ordered and the box shall have such covering as the officer-in-charge may direct.

(iii) The valve shall be supported in the valve box so that no stress or strain occurs in the flange or other joints of the valve.

(iv) The valve shall be carefully protected from lime or other dust by a suitable mat or gunny covering and the pit itself shall be cleared of lime, mortar and other refuse.

(*b*) *Fixing Air Valves.*—Air valves shall be fixed at the summits of pipe lines. The air valve shall be either small orifice type or large orifice type or of combination of both (Double air valve) depending upon the pressure involved. The air valves shall be tested hydraulically to double the maximum working pressure.

(i) A galvanised iron pipe shall be taken from the top of the main pipe on which an air valve is to be fixed, to the side of the road where a suitable site for the air valve has been selected by the Officer in-charges.

(ii) This galvanized pipe shall be laid and the air valve shall be fixed to the pipe line in such a way that air tending to accumulate on the summit of the main will escape by a gradually ascending gradient from the main until it ultimately passes the air valve. The air valve shall be fixed in a suitable masonry pit for protection and care shall be taken that a suitable weep hole is provided for the escape of water which may pass the air valve with the escaping air.

(c) *Fixing Scour valve.*—At all depressions on a main there shall be fixed a scour valves of diameter at least equal to half the diameter of the main plus 25 mm, subject to a minimum of 75 mm in diameter, The scour value shall be fixed so that the outlet is from the underside of the main it is intended to scour and not from the side as is frequently the case.

(i) The outlet shall lead to the nearest ditch or low place and special care shall be taken that the outlet is above ordinary fleed level. The parts of a scour connection shall be a branch opening pointing downwards, a quarter bend, a straignt piece of pipe a sluice valve in a pit and the necessary length of straight pipes to carry the scour water to a suitable ditch. From the point of discharge at the main to the ditch there shall be without interruption a continuous downward gradient.

(ii) In some cases where a suitable ditch is not available within a reasonable distance of say 30 m, for part of the straight, pipes after the scour valve shall be substituted two quarter bends so that the top of the second quarter bend is above flood level.

(iii) The second quarter bend shall be protected by a masonry block.

(iv) The above remarks will be modified to the extent that sanctioned plans show other arrangements.

(*d*) *Fixing Reflux valve*.—These shall be fixed at the positions shown in the plans or pointed out by the officer in charge. As a rule they will be fixed on the rising main and near the pumping station.

(i) In cases where there are long lengths of ascending mains' reflux valves will be suitably fixed at positions on these mains so as to avoid loss of water from the mains in the vent of a burst on the long ascending mains, which would otherwise occur if reflux valve were not fixed.

(*e*) *Fixing Hydrants*.—The position of the hydrants will be shown on the plan of the distribution mains.

(i) A 60 mm branch pipe shall be taken from the distribution main and laid to the side of the road.

(ii) On this branch there shall be a sluice valve in a pit and the continuation of the branch shall be connected by a flange joint to a cast iron hydrant pillar provided with a standard hose connection on the side of the pillar facing the centre of the road.

(*f*) *Fixing Fountains*.—The fountains to be errected may be of the following descriptions.

(1) Wall tap or masonry pillar funtain-one type of which is described below.

(2) Cast-iron pillar fountain.

Wall tap fountains.—The fountains shall be as shown in the drawing which will be furnished to the contracter. From the main, a 50 mm galvanised iron pipe shall be taken to the side of the street, to the site selected by the officer in-charge according tothe sanctioned plan of the distribution system.

(3) At the end of this branch pipe there shall be 50mm × 30mm reducing coupling and then a 30 mm stop cock in a masonry pit provided with a cast-iron cover, the top of which shall be at ground level.

(4) From the stop cock a 30 mm galvanized pipe shall be taken as far as the first 20 mm tap connection as shown in the drawing.

(5) The masonry shall consist of a pillar of brick in surki mortar with a stone cap and a platform of surki concrete plastered with cement mortar.

(6) The platform shall be surrounded by a retaining wall of brick on edge and shall slope to a drain running along side the pillar.

(7) The outlet of this drain shall be provided with a 10 cm x 10 cm grating of wrought iron bars 6 mm diameter and 12 mm apart and the spill waters shall be conveyed by a 50 mm galvanized pipe to the nearest open drain. In the case a sewer being available, the connection shall be a 100 mm stoneware pipe through a 100 mm syphon trap adjoining the retaining wall of platform.

(8) When a suitable paddy field or a natural water course is available within 30 m of a fountain the 50 mm galvanized pipe outlet shall be extended to discharge into this field or water course.

(9) In case where neither an open drain, sewer nor a natural water course is available to receive the spill water from a fountain,the spill water shall be led into a filter well or trench according to type design.

(10) *Pillar fountains*.—These pillar fountains shall be made of cast iron and shall be erected in the middle of a masonry platform as shown in the drawing. The connections shall be made of cast iron and shall be erected in the middle of a masonry plaftorm as shown in the drawing. The connections shall be generally simila to the connections for a wall tap fountain.

(11) The cast iron pillar when erected shall be scrappad cleaned and painted with three coats of the best white lead or zine paint of a dark state colour.

(12) The spill water shall be disposed of in a similar manner that from the masonry wall tap fountains.

(*g*) *Jointing Galvanized Iron Tubes and Fittings*.—The excavation required for laying galvanized iron tubes shall be done in the same order and manner as described in the standard specification for "Trench Works" Excavation and refilling"

(i) The trenches for laying galvanized iron pipes shall not unless otherwise specified, exceed 30 cm in width and 45 cm in depth, but if a less width than 30 mm is excavated by the contractor, he shall not be paid for more width than that actually excavated. The depth however of the trench excavted shall not be less than 45 cm

(ii) The screw threads of tubes and fittings shall be carefully preserved from damage and before jointing, they shall be cleaned and smeared with red lead in best linseed oil. When straight galvanized iron tubes are jointed, the coupling shall be scrwed back on one tube so that when the adjoining tube is screwed into the couplig or the coupling is screwed back on the second tube, both tubes shall abut evenly on each other. In cases where the joints require it, owing to slackness of screw threads, cotton threads, smeared with red lead may be used to make a water tight joint. Such procedure shall only by allowed by the officer in-charge when he considers it necessary owing to slackness of joints.

(iii) The Contractor shall not tap the coupling or screw the ends of pipes in such a manner as will result in slackness of joints when screwed together.

(iv) Taps and dies shall only be used by the contractor for strightening screw threads which have become bent or damaged and shall not be used for turning off the threads so as to make them, slack which procedure would result in a non-water tight joint.

(v) The schedule accompanying the agreement will give the approximate quantities of galvanized iron tubes and fittings to be joined, but this quantity shall be varied by the officer incharge as circumstances or requirements of the work demand and the contractor shall be bound to lay and joint such less or greater quantity of such galvanized tubes and fittings at the rate for so doing tendered by him and on the instructions in writings of the officer-incharge.

9. *Repairs to Coating of Pipes*—If damage is done to the coating of cast iron or steel pipes due to the contractors carelessness, the damage shall be repaired at the contractors expense, under the orders of the Executive Engineer.

9.1. When pipes are received on the work spot with the coating of Angus Smith's composition damaged, is broken off in patches, the the officer-incharge of the works shall have the patches recoated with Angus Smith's composition before the pipes are laid in the trench.

9.2. A quantity of this composition will be obtained with the pipes. The compositions shall first be heated to 200° C to 260° C in a suitable iron cauldron and then applied while hot to the patches requiring recoating.

9.3. Care shall be taken when jointing pipes that the caulking tool or hammer shall not injure the coating on any pipe, but in the event of such coating being injured, fresh composition as specified above shall be applied to the injured pipe before the trench is refilled.

9.4. Special care is required in laying steel pipes to see that injured coatings are replaced with fresh composition as specified, before the pipes are laid in the trenches and also before filling of the trenches is ordered.

9.5. When a steel pipe line is to be laid, the officer-incharge will inspect the soil disclosed by the excavation of the trenches and if the same shall appear to be swampy or otherwise water-logged or to contain deleterious earth or salts he shall direct the contractor to protect the particular length of steel pipe to be laid in a suspicious site, by first painting the steel pipe, before laying, with composition as specified and then wrapping round the pipe a length of jute cloth in the form of a bandage, so that this cloth will stick to the composition which has been freshly applied.

9.6. The outside of the jute cloth shall then be coated with composition and the places where this operation is carried out shall be recorded on the plan of the pipe lines for future reference and for examination after the pipe has been one or two years in situ. The rate to be paid for this extra work and its specification will be decided by the Executive Engineer before the work is started.

9.7. In cases where a supply of Angus Smith's composition is not available and if other asphalt paint or tar varnish is not specified, the following composition shall be used:

One part coal tar.

Three parts Burgundy pitch or Asphalt.

Five per cent linseed oil.

9.8. The tar shall be placed in a cauldron and boiled until the naptha in it has been evaporated which will occur in a few minutes.

9.8.1. The pitch or asphalt shall be broken into pieces, of the size of an egg, and shall be gradually added to molten tar and stirred until the asphalt is dissolved in the tar.

9.9. The linseed oil shall then be added and well stirred into the mixture and heated until the temperature is sufficiently high.

10. *Payment,*—The basis of payment will be defined in the schedule item description of work to be done, and shall be for executing work in accordance with this specification, modified as may be necessary by an addendum specification.

(*a*) *Cutting pipes.*—The cost of cutting off the ends of pipes damaged and the cost of cutting sound pipes which it may be necessary to do in order to lay down branches, bends, valves or other specials in any particular position, shall be paid for at the tender rate according to the size of the pipe which it may be necessary to cut. Pipes damaged in transit shall not have their damaged portions cut off till they are actually required for use at bends valves or other specials. It is of course impossible to state the number of each description of pipe which may require to be cut tenderers will bear this in mind when entering rates for cutting viz., that the rates are to be irrespective of the number to be cut.

(*b*) *Laying of Bends.*—The net length, measured on the curve, shall be taken as the length to be paid for and the rate shall be the same as for plain pipes.

(*c*) *Laying of Branches.*—Supposing a cast iron branch to be say, a 300 mm X 80 mm branch the net length of 30 mm piece (1 m will be paid for at the rate for laying a similar length of 300 mm plain pipe and the branch part, at the net length for the 80 mm pipe measured from the outside of the 30 mm pipe.

(*d*) *Laying Tapers.*—The net length will be paid for at the rate for plain pipes of the larger diameter of taper. For example a taper of 1.2m in length, 350 mm × 300 mm. will be paid for as 1.2 m of 350 mm plain pipe.

(*e*) *Laying Collars.*—The paymnt for laying a collar will be calculated as three times the rate for laying a plain pipe of the same dimension.

NOTES.

Rate of Progress.—Excavation, laying, jointing, fixing of branches specials, etc., testing and refilling should be carried on in a systematic order, so as to avoid having a larger trench opened at one time that is necessary.

The "Rate of Progress" to be entered in the agreement could be fixed on the following basis which is a reasonable turnout of work, where work can be proceeded with, at say three or more parts of the pipe line system at one time, or on such other basis as the Executive Engineer may find the circumstances demand.

100 m per day for pipes 350 mm to 450 mm diameter.

150 m per day for pipes 300 mm to 350 mm diameter.

200 m per day for pipes 200 mm to 250 mm diameter.

275 m per day for pipes 65 mm to 150 mm diameter.

The Contractor may be allowed one day for each fountain to be fixed in addition to the time fixed in the preceeding statment.

This rate should include excavation of trenches, laying and jointing fixing of branches and specials, testing and refilling of trenches.

SPECIFICATION No. 99.

1. CONVEYANCE, LAYING AND JOINING STONEWARE PIPES FOR SEWERS AND FIXING ACCESSORIES.

1.1. *Receipts, Transport and custody of materials.*—

(*a*) *Contractor taking receipt.*—The Contractor shall unload the pipes from the railway wagons or take delivery of the pipes where they are stacked as may be defined in the tender notice. In either case, he shall be responsible thereafter for the safe custody of the pipes till the pipe line is laid and back-filled to the satisfaction of the Executive Engineer. He shall accordingly verify the condition of the Pipes on receipt, and note, in the railway receipt any breakages or cracks, to enable recovery being made from the suppliers of the railway company where such is provided for under the conditions of purchase and delivery otherwise the contractor will become liable for demage pipes subsequently discovered. If the articles are so packed as to render the examination difficult or impossible during taking delivery, the contractor shall at once inform the Executive Engineer of the Sub Divisional Officer and obtain written instruction thereon.

(*i*) If intermediate storage of the pipes is required to be done after receipt by rail and prior to laying, the site where they are to be stacked will be defined in the tender notice, and the contractor will fix his tender rate to include the double conveyance and stacking.

Note.—In the case of departmental execution of the work under this clause, the departmental subordinate will take similar precautions in verifying when he takes delivery of the pipes.

(*b*) Store sheds shall be provided as necessary by the contractor at his own expense, to enable safe custody of valves, small stores ets., until they are wanted on the work.

(c) Stacking shall be done in a neat and orderly manner to facilitate check and counting and to avoid damage to the pipes.

(d) Conveyance to work site and stacking and laying along trench shall be done in a manner to cause the minimum of inconvenience to traffic and the public and to a programme approved by the Executive Engineer. Pipes shall not be dumped from carts, but shall be unloaded by hand, singly with care.

(e) *Responsibility for damage to materials.*—Any pipes, specials or other articles which shall have been handed over to the contractor in good condition and which thereafter become damaged before when or after, being placed in the work, shall be paid for by the contractor at the rate originally paid for such articles plus 10 per cent in excess of such rate. In the case of damage to any other article than stoneware pipe or special, the Engineer shall be the sole judge whether the damaged article can be used usefully on the work and, if not, the contractor shall pay the actual cost of the damaged article at the site plus 10 per cent to cover departmental and other charges.

2. *Trial fitting-Cleaning-Lowering.*—Cracked pipes-whether at the socket or in the body shall be rejected. All stoneware pipes should be carefully fitted together on the surface of ground to ensure a proper fit before they are lowered-then barrels, spigots and sockets properly cleaned-scraped and brushed, if necessary and lowered by hand to the bottom of trench.

3. *Laying.*—The pipes shall be carefully laid to the alignment, levels and gradients shown on the plans and sections, and great care shall be taken to prevent any sand, earth or other matter from entering the pipes during laying. As it is not permitted to rectify errors of grade by packing up underneath with earth, care should be taken in excavating and slight scraping, if necessary, done to bring to grade. The pipes between manholes shall be laid truly, in straight lines, without vertical or horizontal undulations.

3.1. All inverts shall be laid from sight rails fixed at the true levels, with proper boning rods. The sight rails and boning rods shall be provided, fixed and maintained by the contractor at his own expense.

3.2. The pipes shall be laid sockets facing up the gradient, beginning at the lower end, and with the sockets resting in the socket holes cut in the trench bottom, vide standard specification for "Trench work-Excavation and refilling". Each pipe shall be laid singly and no pipe shall be laid until the trench has been excavated to its required depth for a distance of twenty metres in front of the pipe to be laid.

3.3. No pipes of any description shall be covered until they have been passed by the Executive Engineer.

4. *Jointing.*—In each jont a gasket of tarred yarn shall be passed round the Joint, and inserted in it by means of suitable jointing tools. More skeins of yarn shall be added and well "rammed home". The yarn will be moistened to avoid absorbing water from the mixed cement and mortar of neat standard specification. Portland cement shall be filled it as per table 6.1.2.4. of I.S. 4127/1967.

4.1. Jointing of pipe shall be done as per I.S. 4127/1967 paragraph 6

4.2. The object of the yarn is to centre the spigot of one pipe within the socket of the other, and to prevent the jointing the mortar penetrating inside the pipe, where it might set and interfere with the ow of liquid.

4.3. The cement for the joint shall be of a type not liable to contraction on setting. This property shall be tested by the Exeutive Engineer before the cement is used.

4.4. The cement shall be slightly moistened, and on no account must be soft, or sloppy, and shall be carefully inserted by hand into the joint, special care being required with the underneath portion of the joint. When the cement has been inserted, it shall be punched or caulked into the joint with wooden caulking tools, and more cement shall be added until the space of the joint has been filled completely with tightly caulked cement. No fillet of cement shall be added.

4.5. The inside of each pipe shall be carefully wiped on with a mop or scraper, sufficiently long to pass two joints, from the end of the pipe and any projecting cement shall be removed.

4.6. All pipes entering man holes should be set in cement mortar 1:3 and a completely water tight junction effected.

5. *Testing.*—Testing pipes shall be done wholly at the contractors expense inclusive of apparatus, provision of water, etc.

5.1. After the cement has had time to set, the pipe shall be tested in lengths between man holes in the following manner in the lowest manhole a plug shall be inserted in the pipe. The disc in the pipe at the upper manhole shall be fitted with a filling pipe with a right angle bend and air cock. The length of pipes shall then be filled with water by means of the pipe connection on the upper disc. The air cock on the upper disc shall be be kept open while thepipe line is being filled, to permit of the escape of air. When the pipes have been filled with water, and air excluded, the air cock shall be shut and water shall be poured into a conical "filler" attached to the testing and filling pipe of the disc in the upper manhole until water remains in the filler. The testing or filling pipe shall then be raised and fastened so that the height of the surface of water in the "filler" above the invert of the pipe is 8 m which will be usual test pressure for stoneware pipe joints.

5.2. The test will be for an hour or such longer period as may be set by the Executive Engineer. If the water level does not fall more than 12 mm in a length of 90 m, the test may be considered satisfactory.

5.3. It is found that certain pipe joints are leaking, the water shall be run off and joints recaulked with cement, and in troublesome cases if ordered by the Executive Engineer, the pipe and the joint shall be encased in fine cement concrete (1:2:4.) at least 10 cm thick, at the contractors' expense.

6. *Use of concrete bed cover.*—Where ordered by the Executive Engineer during progress of the work and in the cases cited under this clause payment will be made for concrete at the relevant agreement scheduled rate or in the absence of such rate, at a rate to be fixed in writing by the Executive Engineer, prior to execution of the work.

6.1. Where the depth of the trench is over 4.5 m or where the soil is treacherous, or where orders are given by the Executive Engineer to this effect, the pipes shall be laid on a bed of concrete 15 cm thick. A space formaking the joints shall be left in the concrete under each socket, and this shall be subsequently filled in with concrete.

6.2. After the joints and pipes have been proved to be water tight, they shall be beded in concrete to the extent of one half of the external diameter of the pipes, the concrete being made to slope away towards the sides of the foundation already laid, as shown on the detailed drawings which will be given.

6.3. Where sewers are less than 1.2 m of cover at places of heavy traffic, they shall be surrounded with 15 cm of concrete, if directed the Executive Engineer.

7. *Laying and fixing bends, traps, Y's and other specials.*

7.1. In fixing bends, care shall be taken to see that the axis of the bend is truly vertical or horizontal as the case may be and that the spigot of the bend is "well in" the socket of the pipe with which a joint has to be formed. In the case of ordinary traps and gully traps they shall be so fixed that the vertical axis is truly vertical and the axis of the discharge of part of the trap is truly in line which it makes a connection. The fixing of bends, traps and other specials out of line and level, shall not be passed, and the contractor shall be called on to replace such faulty work at his own expense.

7.2. The net length of the bend measured on the curve shall be taken as the length to be paid for, and the rate shall be the same rate, as for straight pipes.

7.3. Y Junctions for house drains will be fixed with the branch canted up above the horizontal at the angle corresponding to the gradient of the house connection, and so that the flow from the branch will enter in the direction of flow of the sewer.

7.4. No extra payment will be made for laying and jointing Y's over the agreement rate for straight pipes.

SPECIFICATION No. 100.

1. CONSTRUCTION OF MANHOLES FLUSH TANKS AND OTHER MASONRY WORKS ON SEWERS.

N.B.—When the work to be done is extensive, separate specifications should be prepared for each type of masonry work on the sewer and detail plans prepared for each structure.

1.1. The masonry work shall be built in the sewer trench at such place and to such level as is shown on the plans supplied to the contractor, or at such place and level as may be instructed by the Executive Engineer during progress of the work. The work shall be executed to the type design or other design specified/modified as may be necessary during progress of the work to suit local condition and which modifications shall be carried out into plans and furnished to the contractor with written instructions as authority for the deviation.

2. All materials and workmanship shall comply with the relevant standard specifications for the class of work shown on the plans. Where the designs or addendum specifications do not define the class of mortar in which the masonry is to be built, standard specification lime mortar 1:2 shall be understood to apply.

3. For detailed instructions regarding covers for manholes, flush tanks, etc., relevant paras in I.S. 1726/1967 shall apply.

4. All pipes and step irons, of type the specified shall be built in while the walls are being constructed and fixed in cement mortar 1:3.

5. Unless otherwise specified or ordered, in the case of manhole upon pipe sewers the channels shall be formed of half round glazed stoneware channels bedded in standard specification cement mortar 1:3, and they shall be shaped to fit the ends of the sewer accurately. Where possible, there shall be a fall of not less than 40 mm to the invert in each manhole. In the case of manholes upon brick sewers, the inverts shall be of brick work and proper grooves shall be formed, if directed by the Executive Engineer, to enable a dam for flushing or other purposes to be formed in the sewers at any time.

6. All pipes entering a manhole shall be relieved of pressure by having an arch turned over them in the brick work.

7. The manholes into which flushing tanks discharge shall be provided with vent shafts to allow an inflow of fresh air to follow the flush.

8. The designs furnished to the contractor will describe whether the flush tank is to be equipped with automatic syphon or other water-supply arrangement. If supply is obtained by a pipe connection to a municipal main, then such connection shall be provided with a stop cock in a suitable chamber with a surface box, and a disconnection gully shall be fixed to prevent ingress of sewer air to the water main.

9. Payment will either be for each masonry work complete to the plan furnished together with all necessary accessories which will in most cases be detailed, or for separate classes of work at unit rates.

SPECIFICATION No. 101.

1. CONSTRUCTION OF OPEN DRAINS.—

1.1 The open drains shall be of such size as shall be specified in the schedule and laid to such gradient and in such locations as may be shown in the relevent plans or ordered in writing by the Executive Engineer. They shall be constructed to type design as shown in the drawing enclosed for sizes 150 mm. 200 mm. 300 mm. 400 mm. 500 mm. 600 mm. 800 mm. and 1,000 mm.

1.1.1. The length of covered portion of an open drain should be reduced to a minimum, but where covering is necessary, it shall be made of the best material of the class shown on the plan or specified.

2. Earth work shall be done in accordance with the standard specification for "Trench work excavation and refilling".

3. The concrete shall be standard specification "Broken stone in lime mortar, unless otherwise specified".

4. The masonry shall be standard specification "Brick in lime mortar" unless stone masonry or other masonry is specified. If the work to be done is extensive such as municipal drains and when so specified in the tender notice, bricks specially moulded to suitable size and shape for the invert shall be burnt and supplied. For small lengths of drain such as for draining house and office compounds, the ordinary size bricks of quality conforming to standard specification may be used and cut to the shape of the invert. If stone masonry is specified to be used then this specification will be supplemented by an addendum specification describing the type of, hammer or chisel dressing, joint widths, class of stone to be used, etc.

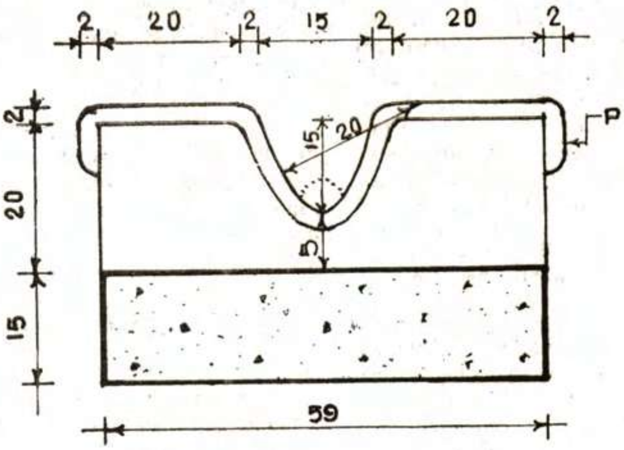
5. The plastering shall be standard specification "Plastering with cement mortar 1 : 3, 20 mm. thick.

6. The oval form of drain shall be obtained in the masonry and also in the plaster by the use of wooden templates of convenient lengths. These templates shall be shaped, white washed or oiled to prevent the mortar adhering to them.

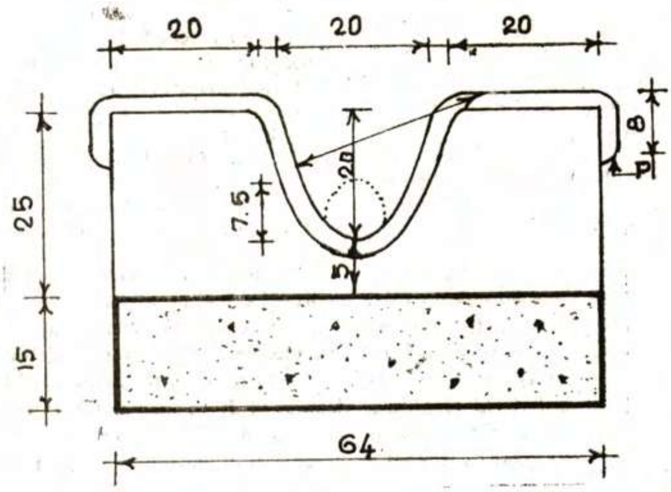
7. The cement plastering and masonry shall be kept wet and protected from the weather and from damage traffic for at least three weeks.

8. Unless otherwise specified, the unit rate shall be per 10 m of drain completely built in place inclusive of removal of surplus earth as may be specified, and with earthen slopes above drain dressed in conformation to plan or as may be ordered. In this case, the quantities of earth work shown on the sanitary department type plans referred to above which are for ground level at top of drain shall not apply.

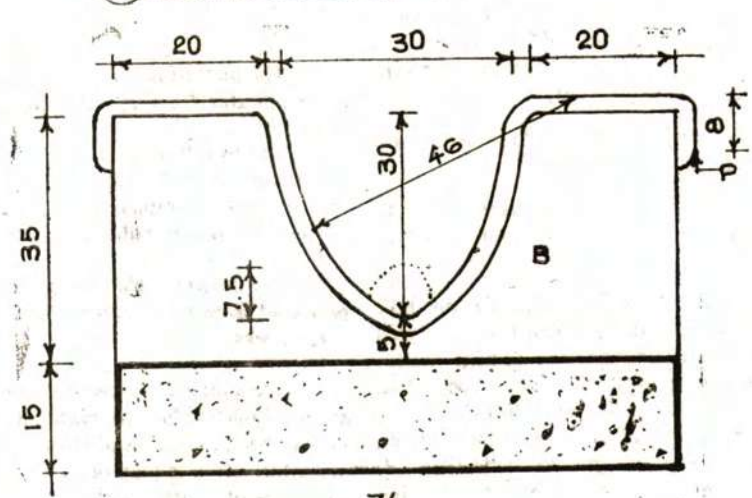
8.1. If, however, as in municipal open drains and elsewhere may be specified or ordered, it becomes necessary to raise the sides of these type design drains to road level, then the tender notice w il call for unit rates for concrete, masonry, plastering and earth wor



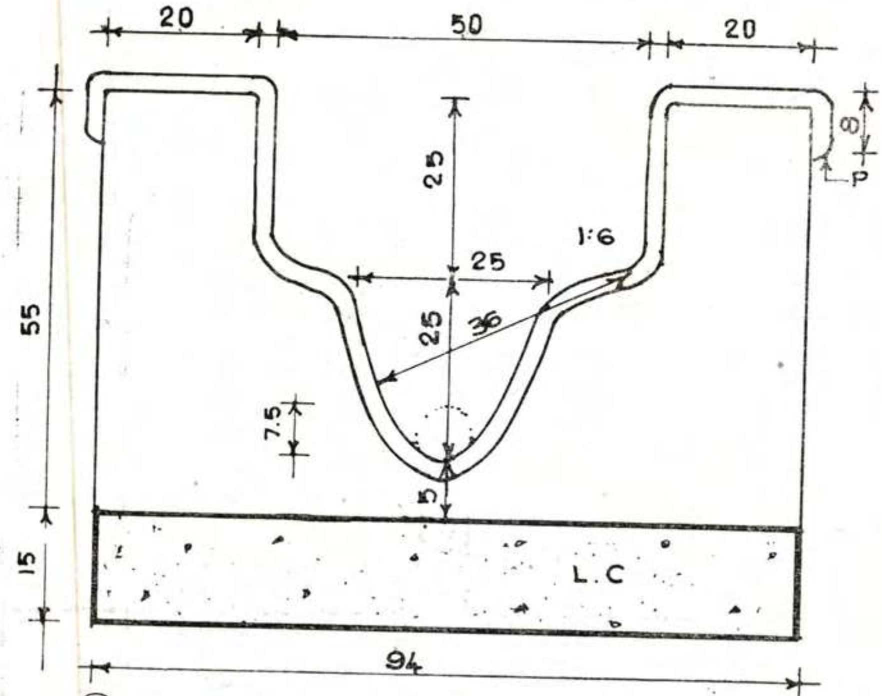
① 15 CM DRAIN



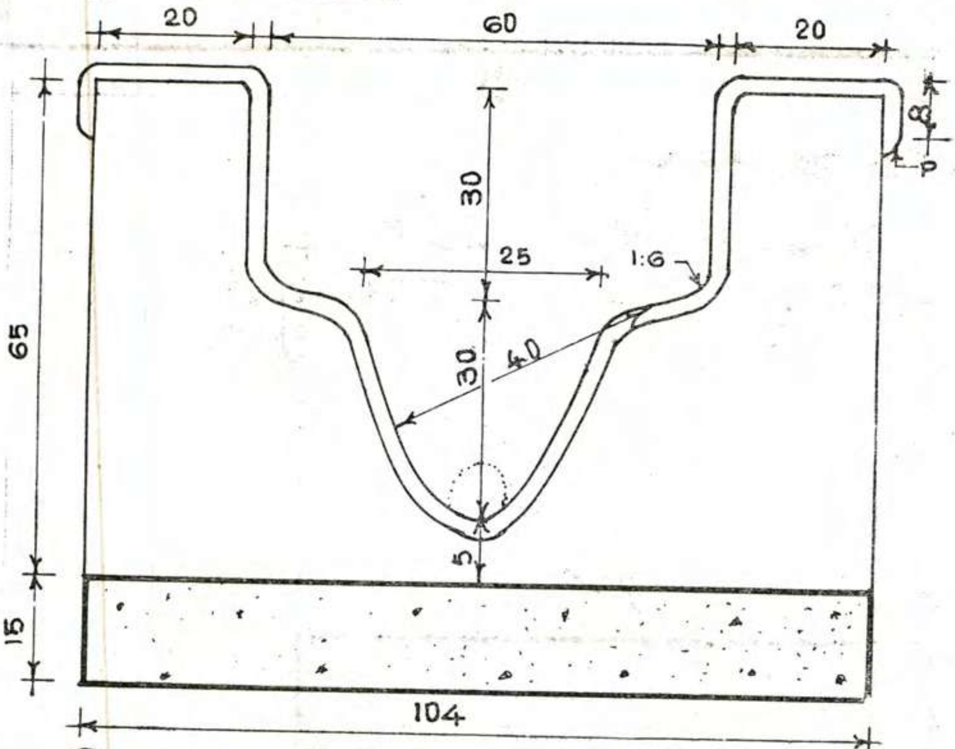
② 20 CM DRAIN



③ 30 CM DRAIN

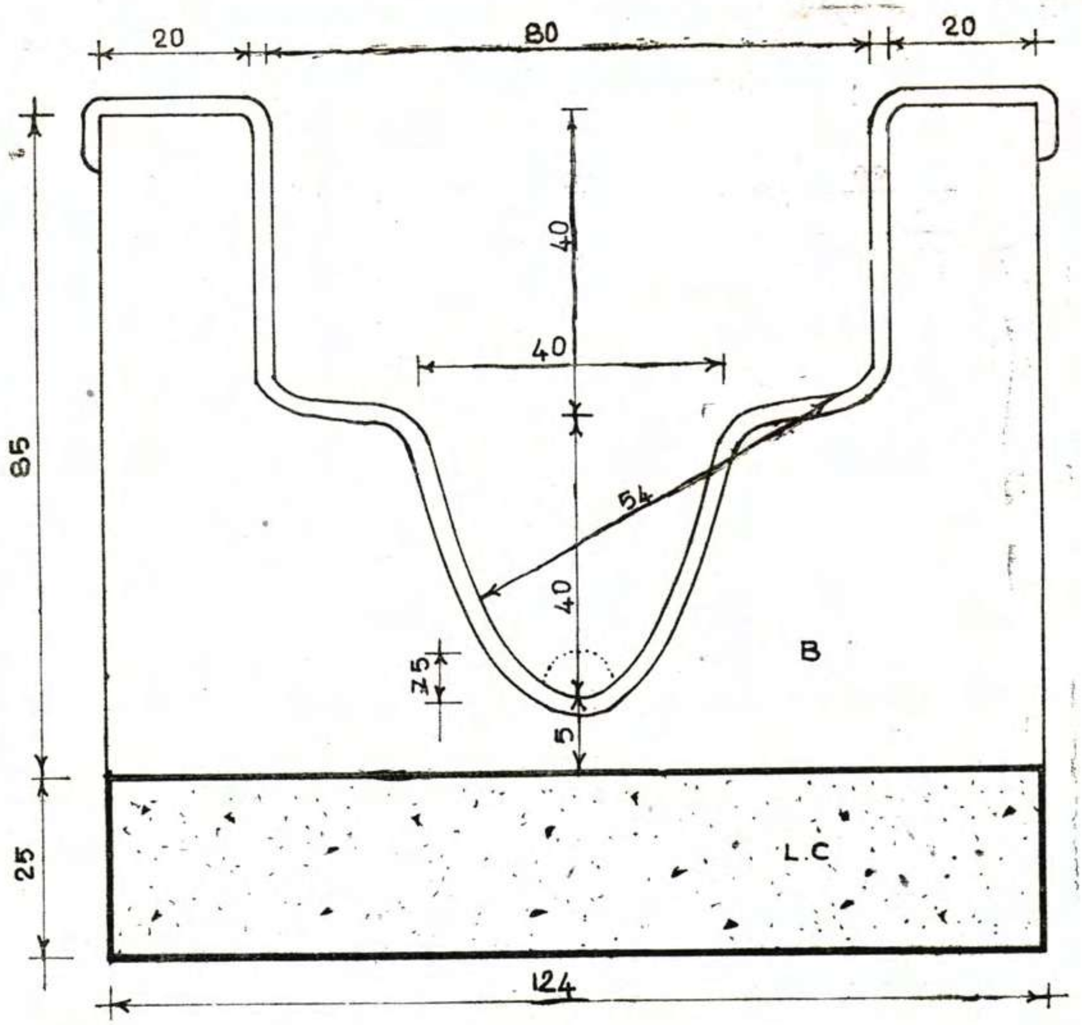


5 50 CM DRAIN

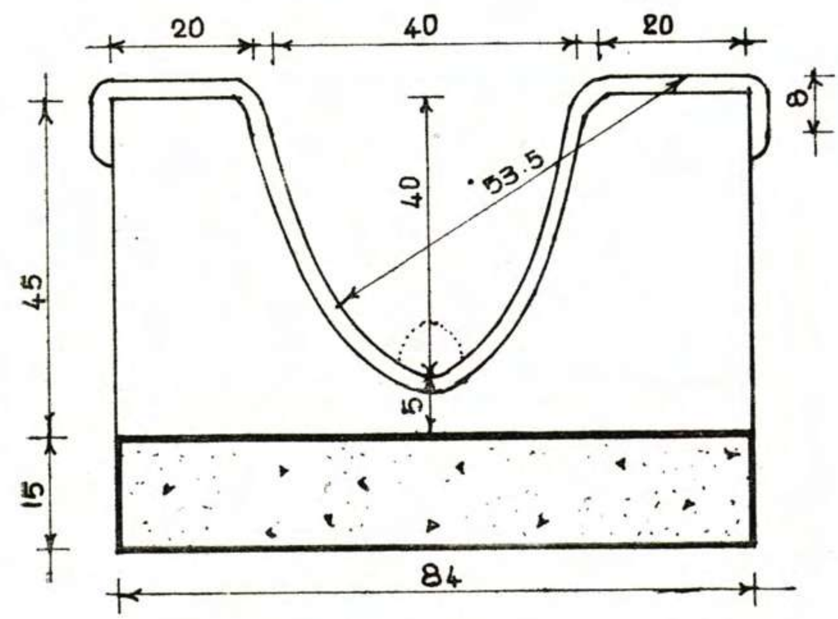


6 60 CM DRAIN

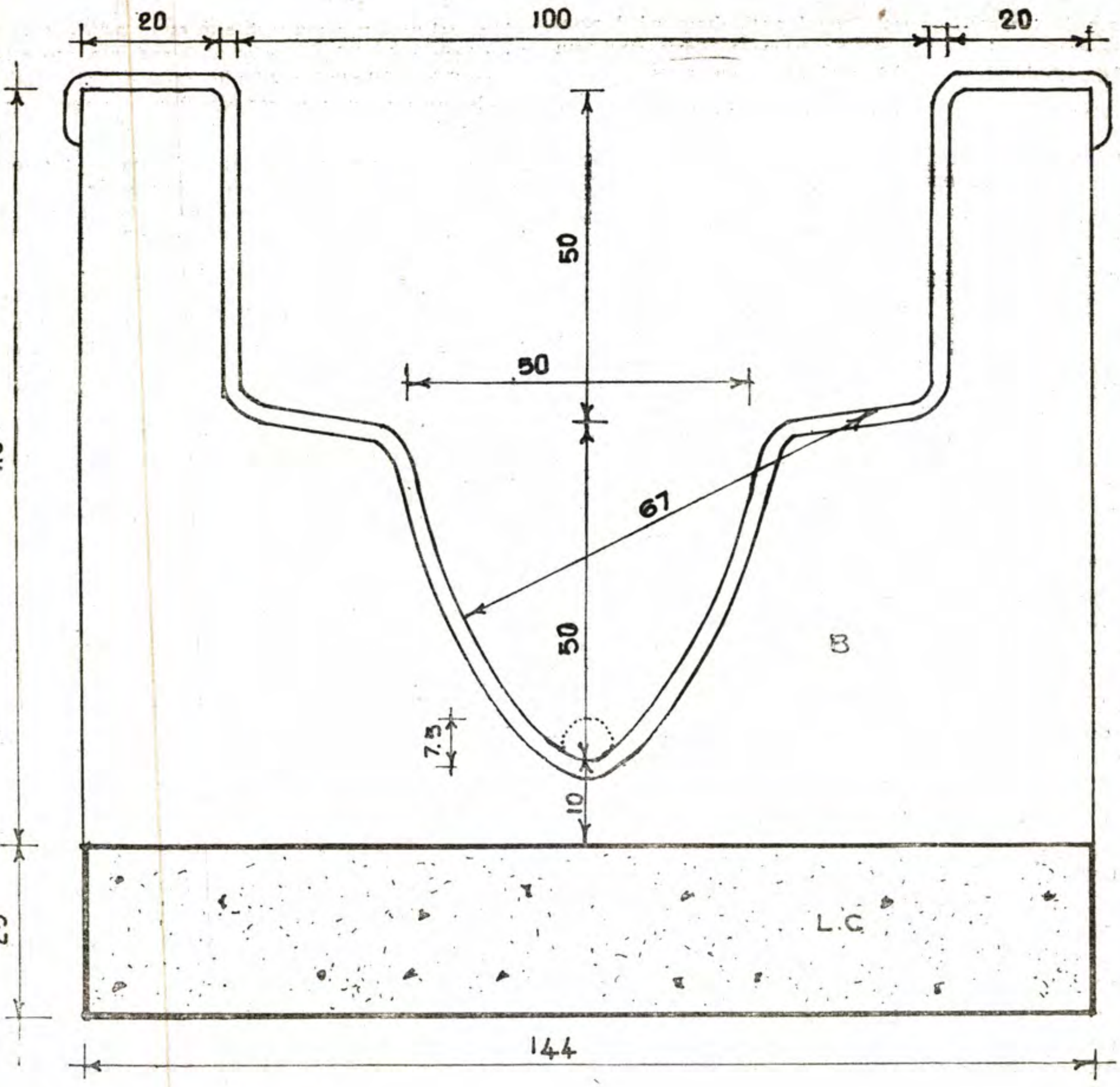
466-3A—27



(7) 80 CM DRAIN



(4) 40 CM DRAIN



(8) 100CM DRAIN

NOTES :

1. ALL DIMENSIONS IN TYPE PLANS ARE 14 CM.
2. PLASTERING IN CEMENT MORTAR 1:3, 20 MM THICK.
3. L.C. CONCRETE BROKEN STONE IN LIME MORTAR USING 40 MM BROKEN STONE OR BRICK JELLY.
4. 5 BRICK WORK IN STANDARD SPECIFICATION ON LIME MORTAR.
5. SIDE WALLS OF DRAIN TO BE RAISED ABOVE MINIMUM HEIGHT SHOWN IN TYPE PLANS TO SUIT GROUND LEVELS. IN SUCH CASES SIDE WALLS TO BE DESIGNED AS RETAINING WALLS TO RESIST EARTH PRESSURE WHERE NECESSARY.

COMPUTING DISCHARGE.

ADOPT MANNINGS FORMULA V 19NR 2/8 S 1/2.

WHERE V VELOCITY OF FLOW IN MTS PER SEC.

N COEFFIENT OF RUGOSITY (ADOPT VALUE OF 0.0135 FOR SMOOTH PLASTERED BRICK OR STONE MASONRY.

R HYDRAULIC MEAN RADIUS IN M.

S HYDRAULIC GRADIENT.

TYPE DESIGN FOR OPEN DRAINS

SCALE : 1/10 FULL SIZE - SECTION-16.

defining method of dressing slopes if any above the drain and disposal of surplus earth and payment will then be made on measured quantities of the scheduled classes of finished work at unit rates.

8.2. Cover slabs, where essential, will usually be a separte schedule item.

SPECIFICATION No.102.

FIXING AND PLUMPING OF SANITARY FITTING IN GOVERNMENT BUILDINGS.

General:

1. Any plan hereinafter referred to shall mean a plan supplied to or made accessible to tenderers or the selected contractor by the Executive Engineer or other Government officer incharge of the work depicting either a plan or elevation of the building in which the sanitary fittings are to be fixed, a plan of the site in which buildings are situated, a plan or description of any individual fitting or any other plan necessary to explain the work which is required to be executed. Wherever the contractor is hereinafter referred to in this specification, it shall mean the contractor who has been selected for the supply and erection or for the erection only of the sanitary fittings.

2. The appoximate position of all the sanitary fittings will be shown on the plans and the contractor shall be resposnible for ascertaining on the work spot from the Executive Engineer or other officer-in-charge, the exact position where each fitting is to be fixed before carrying out the work.

3. A soil pipe is the pipe which conveys the discharge of a water closet, bed-pan washer or slop sink, from the trap of the fitting to he sewer below ground level.

3·1. A waste pipe in the pipe which conveys the discharge of a sink, lavatory basin, bath or similar fitting from the latter to the gully trap at ground level.

3·2. An anti-syphonage pipe is a pipe provided to ventilate branch soil pipes, waste pipes and traps and to prevent loss of water seal in traps by the suction produced by the flow of water down a soil pipe or waste pipe.

3·3. The approximate position of soil pipes, waste pipes, anti-syphonage pipes, ventilating pipes, drain pipes, etc. will be indicated on the plans but the omission of any pipe on any plan shall not release the contractor from his obligation to supply and fix without additiona payment such pipes as are necessary to drain and ventilate the fitting concerned satisfactorily and in accordance with the general provision of this specification.

3·4. A trap is a bend or depression in a fitting, pipe or drain, which remains constantly full of liquid this slutting off air, connection, between the portions of the pipe of drain on opposite sides of the trap.

4. A sanitary fitting shall include a water closet, bed pan washer slop sink, laboratory sink, ordinary sink, wash basin, bath urinal floor trap, syphon trap, flush tank, water tank, shower bath, water tap hydrant or any similar fitting to which a supply of water is made or from which water, sullage or sewage has to be drained.

5. In those cases where a lump sum is called for in the tender notice f or supply and fixing in place complete of a sanitary fitting inclusive of all accessories, then whether or not the specification is accompanied by a schedule of quantities prepared by the Executive Engineer for estimating purposes showing the material of manufacture, length, sizes and numbers of soil pipes, wastepipes, ventilating pipes, branches junctions, traps, brass sockets, brass thimbles, wiped joints, galvanised iron pipes, sockets, running joints, bends, stop-cocks, cleaningeyes, wire domes, gullies, stoneware pipes, etc., the contractor shall satisfy himself that sufficient provision has been made for the proper xecution of the work and shall provide and fix without any additional payments any such articles or materials which ma have been omitted from the schedule and are necessary for the proper fixing of the fitting or for its drainage and ventilation in a satisfactory manner or in accordance with any general provision of this specification.

5·1. In cases where the unit rates, as defined the tender notice are on basis of payment for individual parts of a fitting, then extras and omissions on estimate quantities shall be dealt with as provided for in the "General Conditions of Contract".

6. The contractors tender prices shall include all jointing material, copper, galvanised iron, or other nails, tacks and secrews, wooden and lead wedges, wallhooks, lead collars and all other materials and labour necessary to make the construction perfect and complete, for both cases referred to in clause 5 above, unless otherwise defined in the schedule of specifications.

7. The whole of the work shall pass a test conducted at the contrac tors expense, at such time and in such manner as the Executive Engineer shall direct.

8. All dimensions for pipes shall be clear internal dimensions. Sanitary fitting unless otherwise specified shall comply with the following specifications (Clauses 9 to 14).

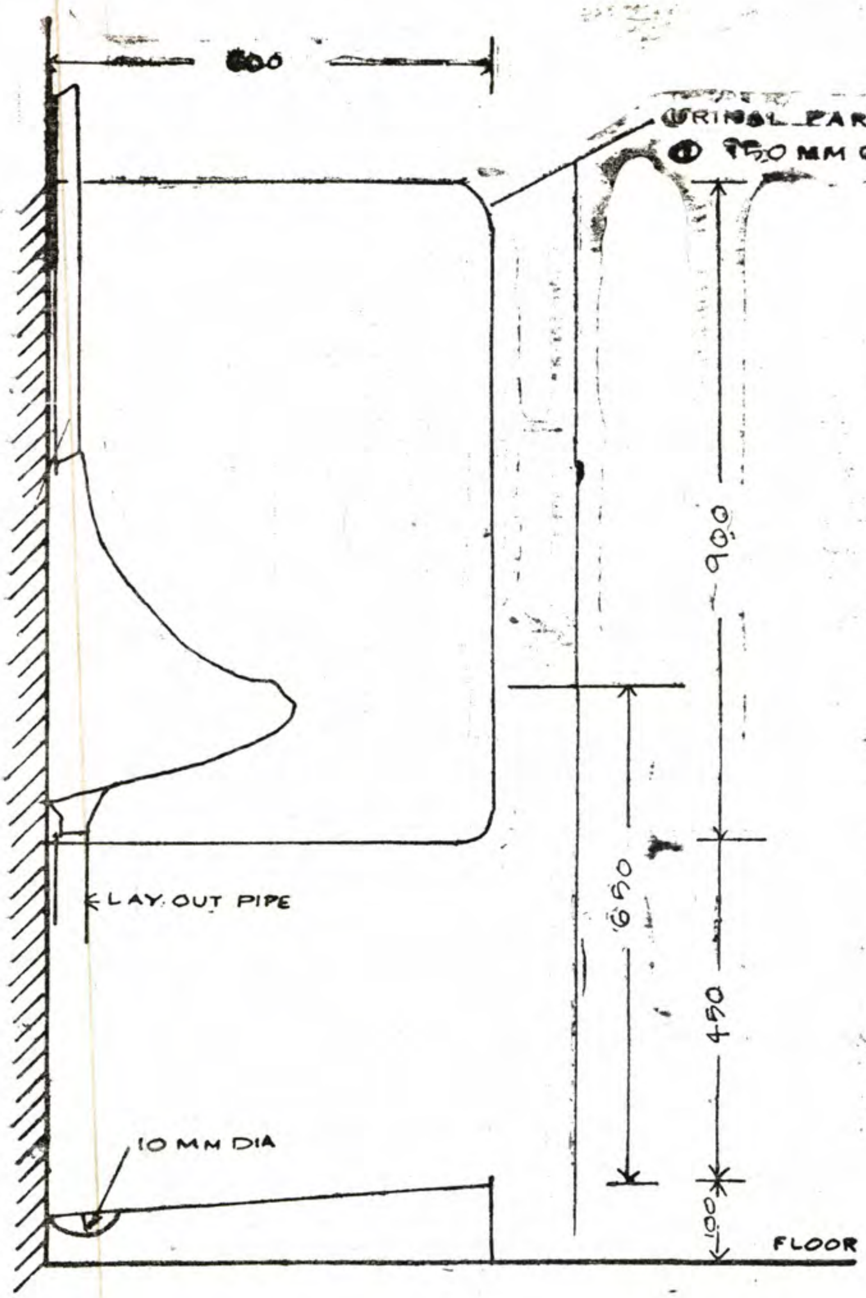
NOTE.—It is important that contractors should submit illustration of the fittings offered and give the manufacturer's names.

9. Baths shall be of cast iron, porcelain enamelled inside. The waste outlets shall not be less than 50 mm. in diameter with brass caps and lining for connection to lead pipe and shall be fitted with waste plugs of vulcanite. The tape shall be screw down pillar taps of not less than 30 mm. in size and shall be fitted in the roll of the bath. Baths should be properly trapped and waste pipes should be of the same diameter as the waste fittings, e.g., 5 cm. legs should be detachable and the bottom of the bath should slope to the outlet.

10. Wash basins should be of white glazed earthenware. The top of the wash basin shall be at a height of 80 cm. from the floor level. Overflows should be of the open type capable of being easily cleaned. The waste outlet should not be less than 40 mm. in diameter with vulcanite plugs securely attached to the basin by means of a chain, unless a standing waste or other type of waste is specified by the Executive Engineer. The supply of taps should not be less than 10 mm. diameter. The waste fittings should be provided with unions for connection to lead any other suitable pipe. Basins shall be fixed on approved cast iron frames or brackets.

11. Sinks shall be of heavy, white glazed earthenware fixed on cast iron frames or brackets. They shall be provided with heavy brass waste, fittings not less than 50 mm. in diameter fitted with vulcanite plugs securly attached by means of a brass chain. unless a standing waste or other type of waste is specified by the Executive Engineer. The waste fittings shall be fitted with union for connection to lead any other suitable pipes. The waste fitting shall be of glazed earthen ware as per I.S. 771-1963—Para 13.2.2.3. Overflows where provided, shall be accessible for cleaning purposes.

Urinals—(a) Bowl Urinals.—Shall be of eathern were glazed. Colour of urinals shall be specified in the tender schedule. These shall be of one piece construction. Each urinals shall be provided with not less than two fixing holes on each side having a minimum diameter of 6·5 mm. At the bottom of the urinal an outlet horn for connecting to the trap and an outlet pipe shall be provided. The exterior of the outlet horn shall not be glazed and the surface shall be provided with grooves at right angles to the axis of outlet to facilitate fixing the outlet pipe with cement or suitable binding material. The inside surface of the urinal shall be regular and smooththroughout to ensure efficient flushing. The bottom of pan shall have sufficient slope from the front towards the out let such that there is efficient draining of the urinal.



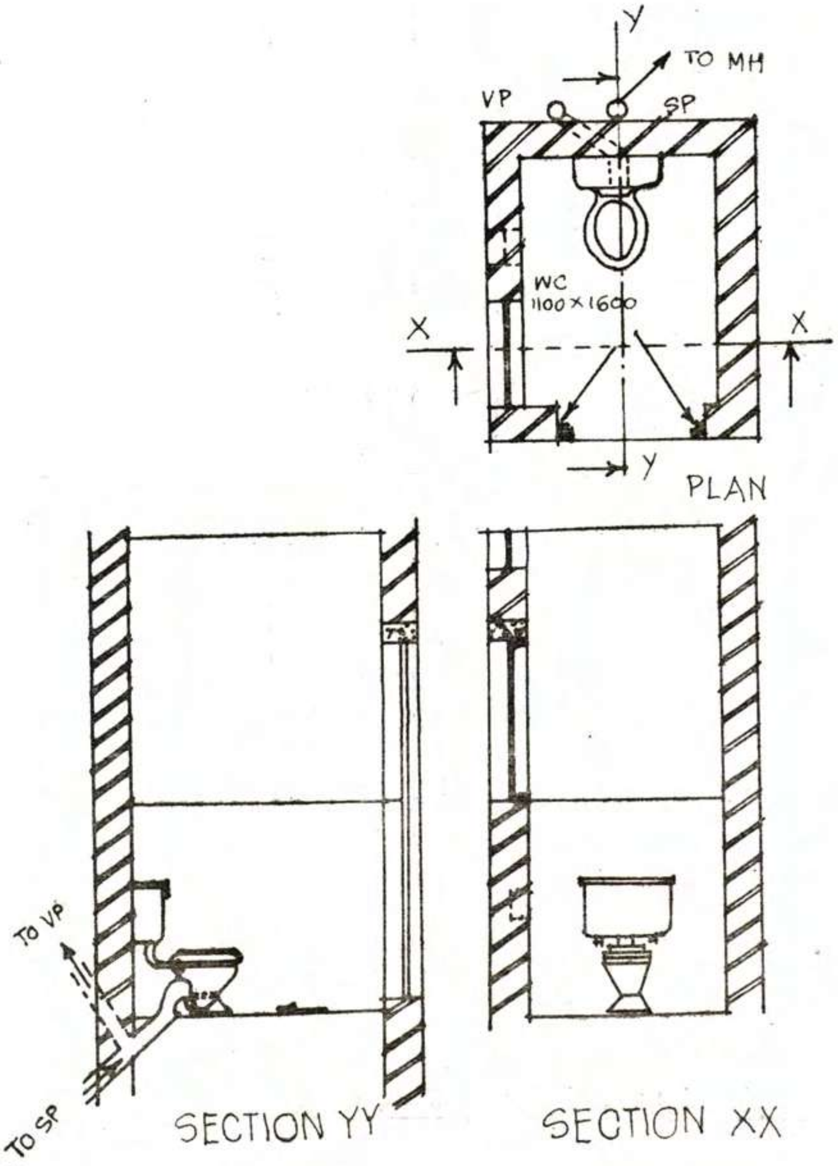
TYPICAL LAYOUT OF URINALS

Fixing.—Urinals shall be fixed in position as shown in figure by using wooden plugs of size 50 mm. x 50 mm. at base tapering to 40 mm. x 40 mm. at the top and of length 50 mm. These plugs shall be fixed in wall in C.M. 1 :3 (1 cement :3 sand) Each urinal shall be connected to 32 mm. dia galvanised mild steel waste pipe or P.V.C. pipe which shall discharge into the channel or a floor trap.

The urinal partition shall be of R.C.C. with suitable finish or marble slab and shall be fixed with (U) clamps made up of non-rusting material and shall be fixed as shown in figure.

11. ***(b) Squatting Plate.***—Squatting plate shall be of one piece onstruction. Each urinal shall have an integral longitudinal flushing pipe of suitable type which can be connected to the flush pipe. The integral flushing type shall be connected to the sump by three 13 mm. diameter holes.

Fixing.—The top edge of the squatting plate shall be flush with the finished floor level adjacent to it. It shall be embedded on a layer of 25 mm. thick cement mortar 1 : 8 laid over a bed of cement concrete 1 : 5 : 10 (1 cement : 5 fine sand : 10 graded stone/brick aggregate 20 mm. nominal size). There shall be 100 mm. dia glazed earthen ware or Uitreous China channels as specified with stop and out let pieces suitably fixed in the floor in Cement mortar 1 : 3 and joint finished with white cement.



SP : SOIL PIPE   MH : MAN-HOLE

VP : VENT PIPE   WC WATER CLOSET

ALL DIMENSIONS IN MILLIMETRES

FIG. 1. TYPICAL LAYOUT OF WATER CLOSET WITH WASH DOWN WATER CLOSET.

12. *Closets.*—Closet pans shall be of earthern ware, Glazed inside and out side except sqatting pans which shall be of unglazed outside. Colour of water closets will be specified in the tender schedule. The back of the pan shall be as near vertical as possible to prevent fouling. The area of water shall be large and the depth of seal shall not be less than 50 mm. The flushing rim in combination with the form of the basin shall be such as to ensure a perfect cleaning of the basin and trap at every flush. The pan shall be provided with a small after flush chamber to ensure proper sealing of the trap after each flush. In the case of water closets all basins shall be fitted with extended lugs for the attachment of a suitable seat. The WaterCloset pan shall be sunk into the floor and embeded in a cushion of average 15 cm of brick jelly concrete in lime mortar 1:2. The concrete shall be left below the top level of the pan so as to allow for flooring and its bed concrete. The floor should be suitably sloped so that the waste water is drained in to the pan, Vent holes shall be placed and so constructed as to avoid internal soiling and choking. The closet outlets shall be unglazed on the outside for a distance of 50mm, on 75mm, and shall be sufficiently long to ensure the making of a good cement joint. Flush pipes shall conform to I.S. 774-1071 para 3·2 and 4·3 and 4·3· The dimensions of water closets and squatting pans shall be as per I.S. 771-1963 and as detailed below:—

I.*S*. 771-1963 :

Wash Down Water Closets :

Patterns and Sizes—Wash down water closets shall be of one of the following patterns and sizes :—

(*a*) Pattern 1 Height 400 mm. front and rear.

(*b*) Pattern 2 Height 340 mm. front and 320 mm. rear.

(*c*) Pattern 3 Height 410 mm. Max front and rear.

Squatting Pans and Traps :

Patterns of squatting pans : Squatting pans shall be made in any one of the following patterns :—

(*a*) Long pan pattern.

(*b*) Orissa pattern.

(*c*) Rural pattern.

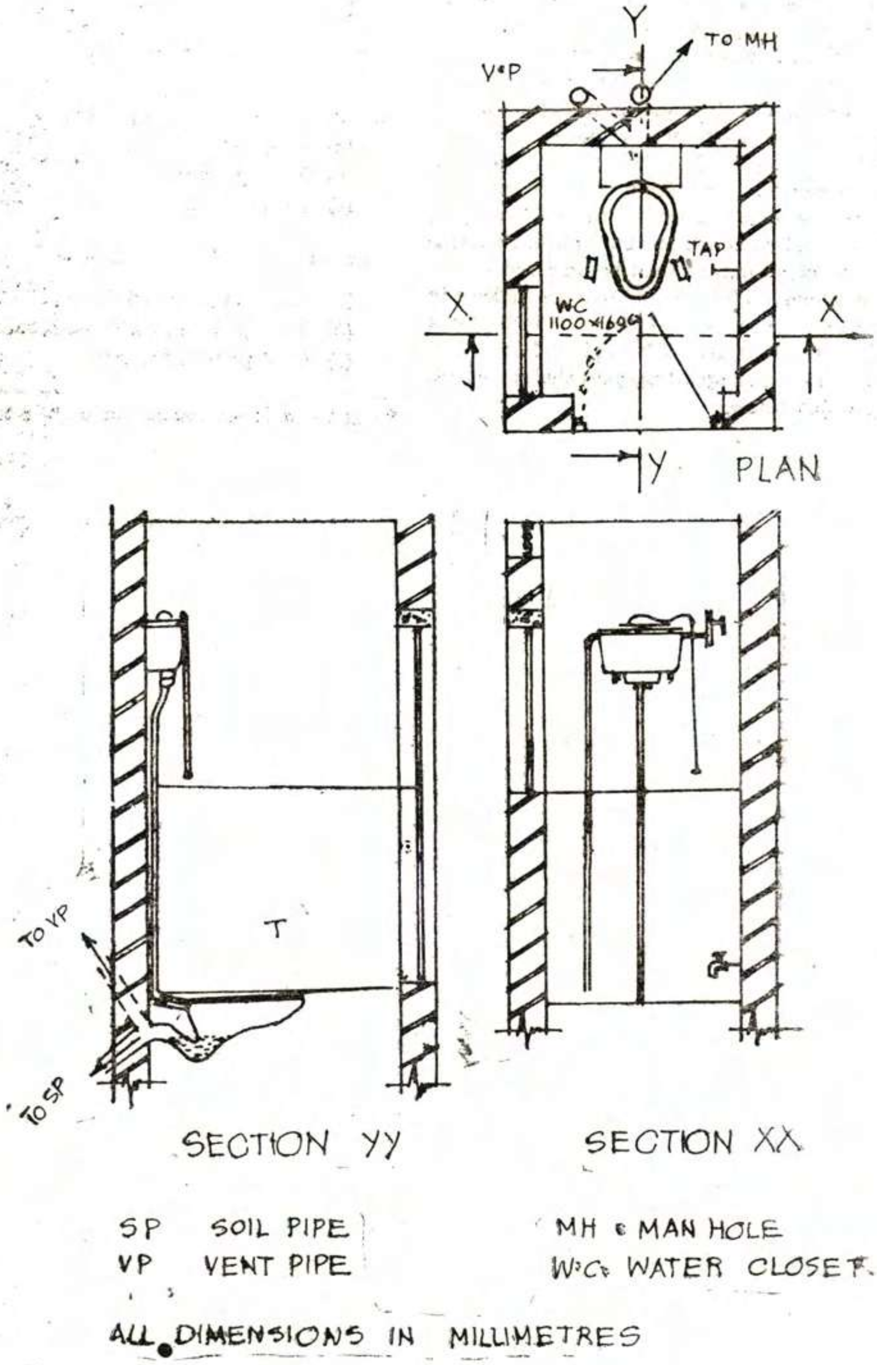
Sizes : Sizes of squatting pans shall conform to the following :

(*a*) Long pan pattern 450mm., 580.mm. 630 mm. and *680 mm.

(*b*) Orissa pattern 580x'40 mm., 630 x 450 mm. and 680 x 470mm.

(*c*) Rural pattern 425 mm.

* 680 mm. is not recommended as a standard size.



SP SOIL PIPE
VP VENT PIPE
MH MAN HOLE
W.C. WATER CLOSET

ALL DIMENSIONS IN MILLIMETRES

FIG TYPICAL LAYOUT OF WATER CLOSET WITH SQUATTING PAN

13. *Flushing Cistern*

Flushing cisterns for closets shall be of cast iron glaze earthware vitreous china, pressed, steel or plastic.

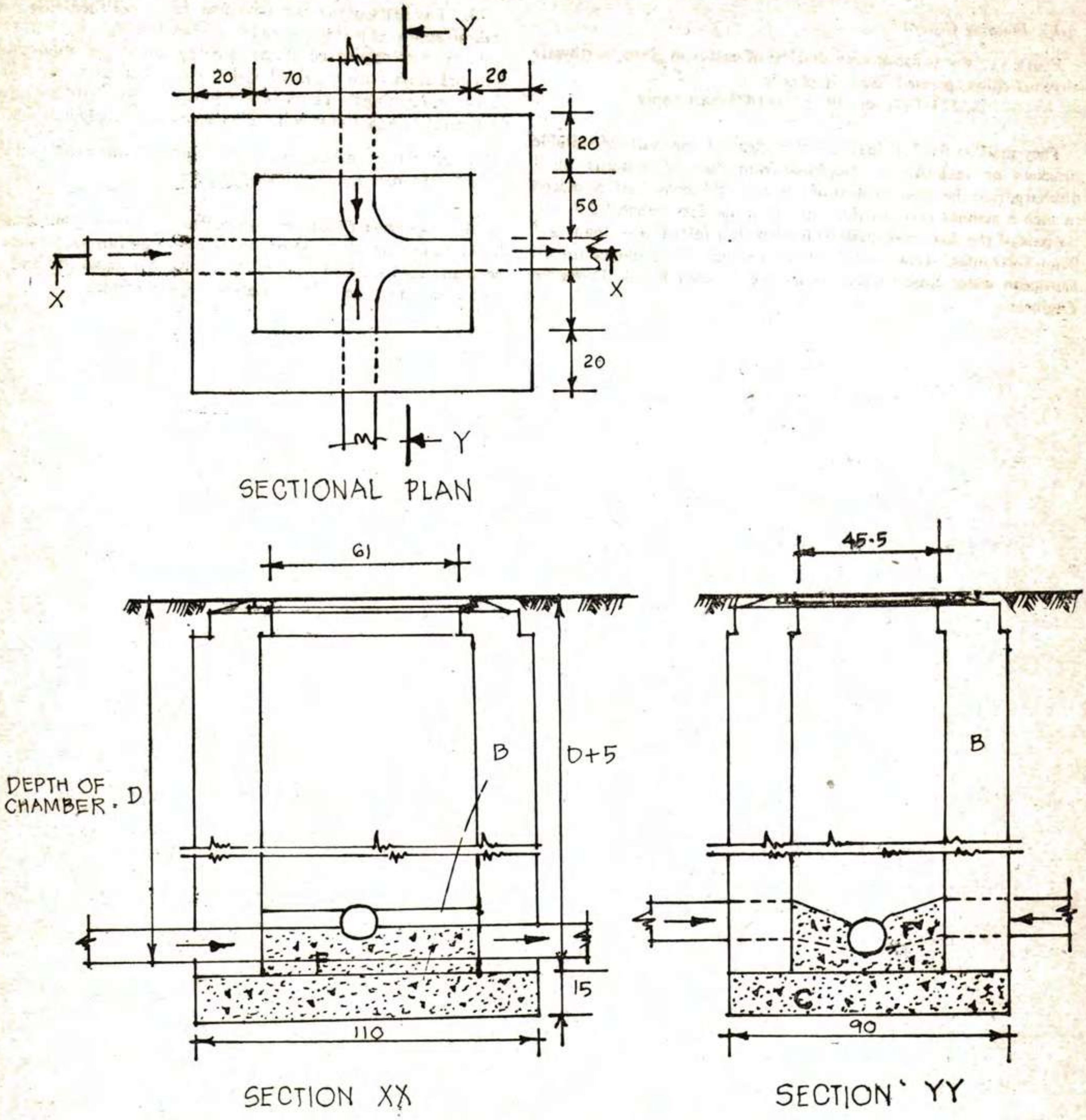
IS. 774–1971 and IS 7231–1974shall apply

They shall be fixed at least 25 mm. clear of the wall on suitable brackets on teak fillets. Overflows from flushing cisterns shall discharge into the open air clear of the wall. Cisterns shall be placed in such a manner as to provide a head of not less than 1.5m. and no part of the flush pipe shall be fixed with a fall of less than 45° from horizontal. Low level flush tanks should be provided for all European water closets unless otherwise directed by the Executive Engineer

14. The seats of water closets shall be of polished rose wood or teak of approved pattern or bakelite black for white or white closets and the seats should be of the same colour of the water closet if coloured closets are provided and shall be secured to the pan with heavy brass hinge and suitable rubber buffers shall be provided to prevent damage to the pan. Plaster seats also may be used.

15. All closets shall connect direct to the drain or soil pipe with suitable 100 mm. pipes as described hereafter.

16. *Inspection Chambers.*—Inspection chambers and manholes shall be constructed at the positions shown and in accordance with the plans furnished to the Contractor. All materials and work shall conform to the relevant standard specification.



NOTE : ALL DIMENSIONS ARE IN CM LENGTH OF INSPECTION CHAMBER TO BE INCREASED TO SUIT NUMBER OF DRAIN CONNECTIONS AT CHAMBER. MANHOLE COVER AND FRAME TO CONFORM TO GRADE LD RECTANGULAR, SINGLE OR DOUBLE SEAL TYPE AS SPECIFIED, OF I.S. 1726 - 1960.
C- CONCRETE BROKEN STONE IN CEMENT MORTAR 1:4 USING 40MM BROKEN STONE.
F- CONCRETE BROKEN STONE IN CEMENT MORTAR 1:2:4 USING 20MM BROKEN STONE, PLASTERED OVER WITH CEMENT MORTAR 1:1, 20 MM THICK. B - BRICK WORK IN. CEMENT MORTAR 1:5, PLASTERED INSIDE AND OUTSIDE WITH CEMENT MORTAR 1:3. 12 MM THICK, MANHOLE FRAME TO BE FIXED IN CONCRETE 1:2:4

FIG. 16-11 TYPE PLAN FOR AN INSPECTION. CHAMBER (DEPTH UPTO 1 METRE)

The type plan for an inspection chamber of depth upto 0.8 m. s shown in Fig. 16-11. The chamber shall have a minimum internal dimension of 70 cm. × 50 cm. (between brick faces). The length of the chamber may be increased depending on the number of branch connections at the chamber. The manhole cover and frame for the inspection chamber shall be of cast iron and as per I.S. 1726–1960, grade "L.D." Type rectangular, with clear opening 610 mm. × 455 mm. and with single seal or double seal as may be specified. In the absence of any specification, double seal type shall be adopted. Square manhole covers of size 455 mm. × 455 mm. may also be used if available in the market.

Above 1.0 m. depth, inspection chambers shall be of same design as manholes of different depths vide S.S. No. 100–Constructionl of manholes except that the manhole cover and frame shall be of grade "LD" as specified above unless grade "HD" or "MD" is specified taking traffic conditions into consideration.

17. All stoneware drain pipes used on the work shall be as per S.S. 96.

18. All cast iron pipes used below ground shall be as specified in S.S. No. 98.

19. All lead pipes shall be solid drawn, and fixed complete with all necessary wiped solder joints, brass thimbles, sockets or unions, hold-fasts, lead tacks, etc., and so as to empty themselves.

For specification of lead pipes I.S. 404-1962 shall apply.

20. Lead pipes, other than soil pipes, shall not weight less than—

Internal diameter	12 mm	18 mm.,	25 mm.,	32 mm.,	38 mm.,	50 mm.
Kg. per linear metre		3	5	5.5	6.5	7.5

21. All wrought iron pipes, bends, tees, elbows and specials shall be of best quality, highly galvanized and of approved manufacture and shall not be of less thickness and weight than is shown in the following table:—

TABLE—WEIGHT AND THICKNESS OF GALVANISED WROUGHT IRON PIPES OF DIFFERENT DIAMETERS.

Medium Class.

Nominal diameter.	*Thickness.*	*Weight.*
(1)	(2)	(3)
mm.	mm.	(Kg./metre.)
6	2.00	0.410
8	2.35	0.639
10	2.35	0.85

Medium Clase—*cont*

Nominal diameter	*Thickness.*	*Weight.*
(1)	(2)	(3)
mm.	mm.	Kc/metre.
15	2.65	1.21
20	2.65	1.57
25	3.25	2.42
32	3.25	3.11
40	3.25	3.59
50	3.65	5.07
65	3.65	6.49
80	4.05	8.43
90	4.05	9.70
100	4.50	12.10
125	4.85	16.60
150	4.85	19.70

All wrought iron waterr pipes laid under ground, when separately specified, should be taped and coated with tar or approved bitumatic solution.

22. The Contractor's tender for all work involving the use of wrought iron galvanized pipe shall be deemed to include all the bends, tees, unions, running joints, etc. necessary to make the construction perfect and complete, unless otherwise defined in the schedule of specification.

23. All cocks unless otherwise specified, shall be best fullway high pressure screw down in gun-metal to J.C.W.R. Standard, from an approved maker with screwed bosses.

24. All pipes and soil pipes other than lead pipes within or on the external walls of buildings, unless otherwise specified, shall be so fixed by special brackets or lugs and wooden blacks inset with cement mortar into the wall and in a manner to be approved by the Executive Engineer, as to provide a clear space 50 mm between the pipe and the finished surface of the wall.

The contractor should supply sketches with his tender showing the manner of the fixture which he proposes to adopt, e.g., vide sketch accompaying the standard specification "cast iron rain water pipes" for one type of fixture.

pipe Joints.

25. *Stoneware pipes.*– All joints between spigot and socket stoneware pipes shall be made with the two rings of hemp yarn soaked in thick cement slurry and caulked with hard wood caulking tools and the remaining space in the joint filled with Portland cement in mortar in the proportion of 2 cement to 1 sand.

26. *Stoneware trap of water closet, bed pan washer or slop sink to cast iron soil pipe.*—The stoneware pipe of the closet trap shall be ointed to a brass socket of suitable size with Portland cement. The plain end of the brass socket which should be of the same internal diameter as ths lead pipe and the stoneware outlet pipe of the trap shall be connected to the lead soil pipe by means of a wiped solder joint. The lead pipe shall then be lead by easy bends and at a continuous fall to the socket on the 45 degrees cast iron branch of the cast iron soil pipe and shall meet that branch at such an angle that at least the last 12 mm. of the lead pipe shall have its centre line, in line with the centre line of the branch. The end of the lead pipe shall be connected to a brass thimble by means of a wiped solder joint and the brass thimble shall be of correct diameter to slide over the lead pipe and shall be of sufficient length to be inserted to the full depth of the cast iron socket and the joint between it and the socket made by the hemp yarn and molten lead properly caulked. All branches and bends on soil pipes shall be provided with access caps, when specified by the Executive Engineer and tenderers shall always state whether such access caps are included in their tender.

27. Unless otherwise ordered by the Executive Engineer, the methods summarised in the following table of jointing pipes, or of pipes and the outlets of fittings such as traps, shall be adopted.

Materials of the pipes to be connected.	*Method of jointing.*	*Reference to figure at the end of this specification figure.*
(1)	(2)	(3)
Lead to lead, iron to iron.	Wiped solder joint, two rings of hemp yarn and caulked with molten lead.	Fig. 4. Fig. 5.
Stoneware to Stoneware.	Two rings of hemp yarn and Portland cement mortar (2 cement 1 sand).	Fig. 1.
Lead to Stoneware.	THIMBLE or socket of brass with wiped solder joint to lead pipe and joint with stoneware pipe made with Portland cement.	Fig. 6.
Lead to cast-iron..	Brass thimble or socket as above but final joint in socket of iron pipe with yarn and molten lead properly caulked.	Fig. 3.
Iron to stoneware (where stoneware socket is large enough).	Hemp yarn and Portland cement.	Do.
Stoneware to iron.	As described in Clause 26 ..	Figs. 2 and 3
Lead to galvanised wrought iron pipe.	Brass plumbers union with wiped soldered joint on lead pipe and connected to a nipple on wrought iron pipe secured to later by socket and lock nut.	

The following table gives the length of a wiped soldered joint which shall be used for each size of pipe.

TABLE XX..

Size of pipe. mm.	*Length of Joint.*	
	Minimum. mm.	*Maximum. mm.*
(1)	(2)	(3)
12	56	70
18	62	70
25	70	75
38	70	82
50	75	82
75	75	88
100	82	88
125	88	93
150	88	100

Solders unless otherwise specified shall consist of two parts o lead and one of tin and fine solder shall consist of equal parts of each.

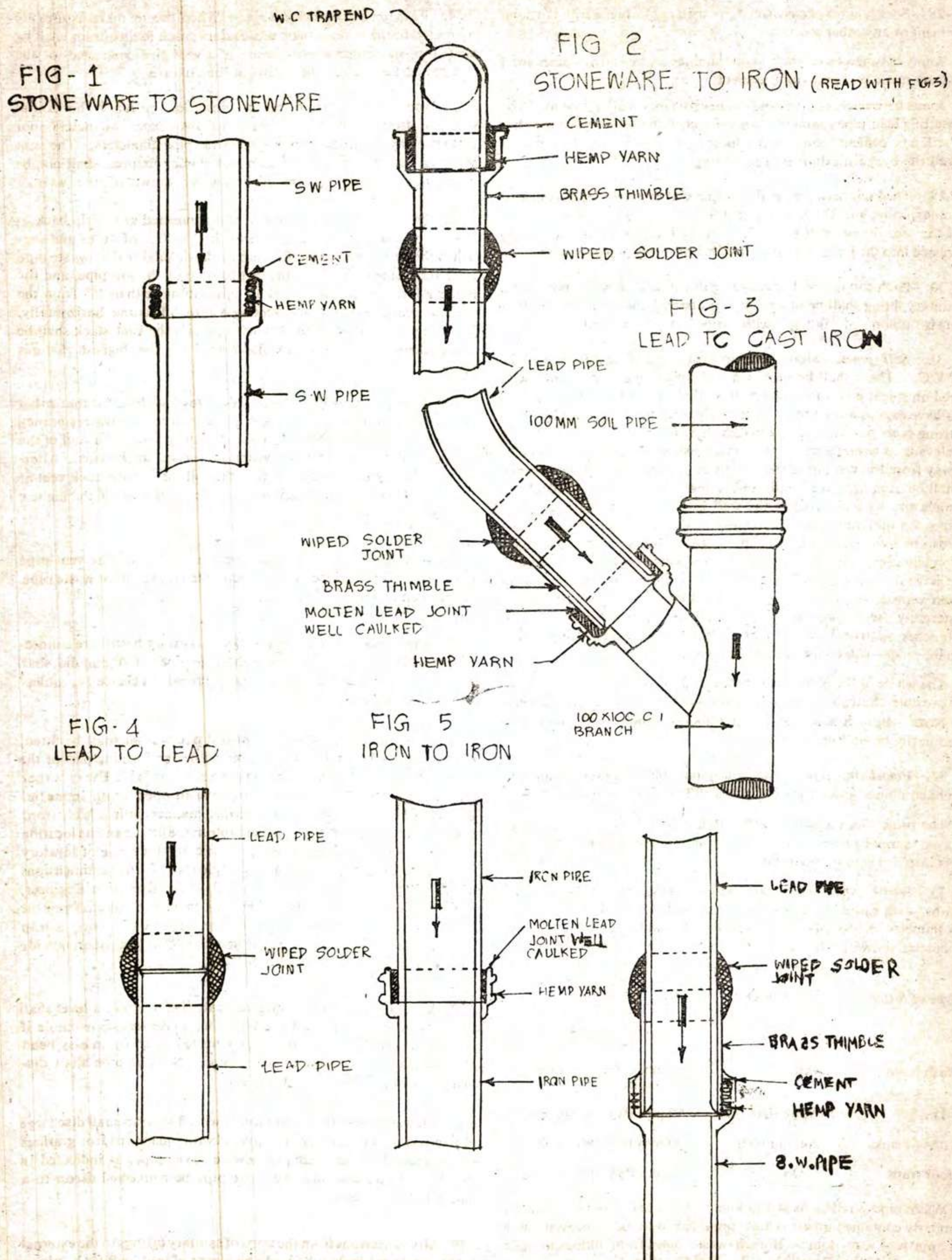


FIG-1
STONE WARE TO STONEWARE
S W PIPE
CEMENT
HEMP YARN
S W PIPE
W C TRAP END
FIG 2
STONEWARE TO IRON (READ WITH FIG3)
CEMENT
HEMP YARN
BRASS THIMBLE
WIPED SOLDER JOINT
LEAD PIPE
FIG-3
LEAD TO CAST IRON
100MM SOIL PIPE
WIPED SOLDER JOINT
BRASS THIMBLE
MOLTEN LEAD JOINT WELL CAULKED
HEMP YARN
100 X100 C I BRANCH
FIG-4
LEAD TO LEAD
LEAD PIPE
WIPED SOLDER JOINT
LEAD PIPE
FIG 5
IRON TO IRON
IRON PIPE
MOLTEN LEAD JOINT WELL CAULKED
HEMP YARN
IRON PIPE
LEAD PIPE
WIPED SOLDER JOINT
BRASS THIMBLE
CEMENT
HEMP YARN
S.W.PIPE

PIPE JOINTS

28. Socket joints of cast iron pipes shall not be made with Portland cement or any other mortar.

Joints between brass sockets or thimbles and cast iron pipes shall not be made with portland cement.

Joints between lead pipes and stoneware pipes shall not be made by inserting lead pipe into a stone-ware socket and jointing with either Portland cement, any other mortar, or lead, wool or molten lead or by the insertion of a rubber ring.

29. The joint between the flush pipe of a water closet, slop sink of similar fitting and the flushing inlet arm of the glazed pan or basin of the said fitting shall be made with red and white lead properly pressed into the joint and covered with a properly prepared lead cone.

30. Each connection between a galvanised iron water pipe and a sanitary fitting shall be of lead pipe properly jointed to the plumbers brass union of fitting, with wiped soldered joint.

31. *Soil pipes.*—Main soil pipes shall be of cast iron A.C. or P.V.C. These shall be provided with spigot and socket ends, with bed on spigot end, the socket sufficiently large to receive molten ead to have ears cast on and to be securely fixed to walls, etc., by long strong pipe nails threaded through short (25 mm) length of 12 mm galevanised wrought ironpipe forming distance piece to keep the pipe away from the wall, or if the Executive Engineer so requires screws shall be used instead of nails and screwed into teakwood blocks of ample size securely fixed in the wall with cement mortar, or if the pipes, on the orders or with the approval of the Executive Engineer are to be without ears they shall be secured it walls by strong wrought iron pipe clips or brackets in two sections bolted together, one section to have or other suitable type and for building into revised walls with cement mortar. The pipes are to be coated externally and internally with suitable anti-corrosive paint. All the bends, branches, swan neaks and other parts shall correspond in every respect to the pipes—*vide* clauses 18 and 24 above.

The whole of the pipes shall be carried down in as vertical a line as possible. Soil pipes shall not be less than 10 cm. internal diameter.

NOTE.—Branch soil pipes from fittings to main soil pipes shall ordinarily be of PVC or A.C.

32. *Ventilating pipe.*—The soil pipe above highest branch is to be continued upward to a height of 600 mm. above roof level.

The projecting portion of ventilating pipe may be required to be stayed to roof by iron stays if in the opinion of the Executive Engineer it is insecure without such stays.

33. *Waste pipe.*—The main outside waste stacks from sinks, baths, wash basins, floor sinks, floor traps, etc., when 50 mm. or more in diameter, shall be of cast iron spigot and socket pipes of the internal diameter shown in the following table (*vide* also clause 18 above)

WASTE PIPES.

Type of fitting.	*Number connected to external waste stack.*	*Size of waste stack.*
Wash basin	One	40 mm PVC or 50 mm. cast iron.
Do.	More than one	50 mm PVC or cast iron.
Baths or sinks	Any number	50 mm PVC or cast iron.
Floor traps	Do.	75 mm PVC or cast iron.

Waste pipes shall be fixed and jointed as for soil pipes and shall be similarly continued upwards and provided with an approved with in approved wire dome. Branch waste pipes from fittings to main waste stack shall ordinarily be C.I., P.V.C., or A.C.

34. *Vent (or antisyphonage) pipe*—.When two or more fixtures are connected to the same (soil or waste) stack, each fixture drain shall be vented to the atmosphere by means of a vent pipe connected to the fixtures drain after the trap of the fixture.

The vent opening shall not be installed within a horizontal distance from the trap weir equal to two pipes diameters nor farther away from the trap weir then 48 pipe diameters. The vent opening, except for water closers and similar fixtures, shall not be more than one pipe diameter below the crown of the weir.

All vent lines shall be so graded and connected as to drip back to the soil or waste pipe by gravity and shall be free of drops and sag. When the vent pipes takes off from the horizontal soil or waste pipe it shall be taken off above the centre line of the soil pipe, and the pipe shall rise vertically, or at an agle not more than 45° from the vertical above the fixture it is venting before off-setting horizontally. The connection between the branch vent and the vent stack shall be made atleast 15 cm. above the flood level of the highest fixtures served.

The vent stack shall connect full. size at its base to the soil or (waste) stack at or below the lowest horizontal soil (or waste) branch the vent stack shall terminate independently above the roof of the building similar to soil stack vents and waste stack vents. Alternatively, it may be connected with the soil or waste stack vent at an angle of 45° at east 15 cm above the flood level of the highest fixture.

The vent pipe sizes shall be as given in Table II. The vent pipe diameter shall not reduce in the direction from the soil or waste pipe to the opening into the free air.

35. Where two or more baths, sinks or lavatory basins are connected to the same waste pipe anti-syphonage pipes of 40 mm dia. shall be provided for waste pipes also, as described in clause 34, unless otherwise specified.

36. No water closet, slop sink or bed pan washer shall be fitted, without a glazed trap of suitable size and design forming part of the fitting, or connected immediately on the outlet thereof. Every other Sanitary fittings unless discharging into an open drain immediately below it, shall be fitted in a proper manner with a lead, iron, brass or stoneware or P.V.C. trap suitable to the fitting and its location and of correct design, except that, in the case of a range of lavatory basins fitted close to one another, a single trap of ample dimensions may be fitted, with the prior approval of the Executive Engineer, on the waste pipe immediately after the connection thereto from the basin nearest to the external waste pipe, instead of having a trap for each basin. Sinks and water closets should be against an outside wall, when it is possible to so locate them.

37. All soil pipes after passing vertically below ground level shall be led by an easy bend into the adjoining house service manhole if one is provided in the scheme or be connected direct by an easy bend into the glazed stoneware sewer pipe. No soil pipe shall discharge into a gully trap or open drain.

38. All waste pipes if not connected with floor trap shall discharge into open stoneware gully traps provided with square cast iron gratings and connected to the glazed stoneware sewer pipe, as indicated in the plan. In no case shall be waste pipe be connected direct to a man hole or to a sewer.

39. All connections from the traps of sanitary fittings to the external soil or waste pipes shall be made by means of lead or P.V.C. pipes.

40. All brackets, lewis bolts, wooden blocks or other material or fixture required for fixing or securing sanitary fittings shall be securely fixed into the wall floor or ceiling as the case may be with standard specification 1 : 3 Portland cement mortar only.

41. Any demolition of walls, roofs, floors or partitions or any holes to be made in same for the purpose of fixing sanitary fittings or leading pipes to or from sanitary fittings, shall be carried out by the contractor without additional payment, after obtaining the approval of the Executive Engineer in each case to such demolition or making of holes and the contractor shall, unless otherwise specified or ordered, finally make good the surface of the wall, roof floor or partition to its original condition, all holes being made good with masonry in standard specification 1 : 3 cement mortar only and the surface plastered or finished to agree with the adjoining wall, floor, etc. The contractor shall not be entitled to any additional payment for any work done under this clause.

Galvanized and black wrought iron pipes shall not be used for soil, waste, anti-syphonage, ventilating or drain pipes. Stoneware pipes shall not be used above ground level for soil pipes or waste pipes.

TABLE II—SIZE AND LENGTH OF MAIN VENT STACKS FOR SOIL AND STACKS.

Size of soil or waste stack· mm.	*Fixture units connected·*	*Diameter of vent required (mm.)* 32	40	50	65	80	100
		Maximum length of vent (metres).					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
32	2	22					
40	8	21	45				
50	12	9	22				
50	24	8	21	90			
65	42		10	42			
80	30			24	78		
80	60			22	72		
100	100			10	30	78	
100	250			9	28	72	
100	500			7	21	54	
125	650				8	21	
125	1,100					15	72

NOTE. —1. For fixture unit values *see* Table IV.

2. The length of the vent stack shall be its developed length from the lowest connection of the vent system with the soil stack, waste stack or building drain to the vent stack terminal.

3. Individual vents shall be not less than 32 mm. nor less than one half dia. of the pipe it is venting.

TABLE IV—SANITARY FIXTURES, SIZES OF TRAPS AND FIXTURES—UNIT VALUES.

Fixture type.	*Minimum Trap size required. (mm.)*	*Fixture unit values.*
(1)	(2)	(3)
1 Bathroom group of 1 W.C., 1 lavatory 1 bath tub or 1 shower.	..	8
2 Bath tub	45–50	2–4
3 Bed Pan washer	80	10
4 Drinking fountain	32	1-5
5 Floor drain	50	1-2
6 Kitchen sink (domestic)	40	2-4
7 Lavatory (wash basin)	32–40	1-2
8 Surgeon's lavatory	40	3
9 Showers (each head)	50	2-4
10 Slop sink	50	4
11 Urinal (wall lip)	40	5
12 Water closet	80	6–12

NOTE.—Where two values have been given for fixture unit values and trap sizes the higher values are to be adopted for public buildings and the lesser values for residential buildings.

43. In all plumbing work unless otherwise specified or ordered one screw down gun metal isolation stop cock shall be fitted for each sanitary fitting on the water-supply pipe leading to that fitting in addition to any cocks or taps forming part of the fitting. The purpose of such an isolation cock is to enable the water supply to be cut off from the fitting whilst the fitting is being repaired, dismantled or replaced.

In certain cases where only baths, sinks and lavatory basins are fitted, one such isolation tap for every room may be permitted instead of one for every fitting, with the approval of the Executive Engineer and in exceptional cases of this class, the isolation taps may, with his approval, be omitted altogether.

A screw down isolation cock shall, however, be fitted invariably on the water-supply pipe to the flushing tank of a water closet, bed-pan washer, slop sink, etc., and no exception to this rule will be permitted.

The tenderer shall declare in his tender whether his tender includes the provision of such isolation cocks for each fittings, or each room and in the absence of such a declaration, his tender shall be deemed to provide an isolation cock for each fitting.

44. Inspection eyes, access screw caps and access doors shall be provided where specified or shown on plans, commonly on waste traps and soil pipe junctions and bends *vide* clause 26 above. When tendering, the tenderer should detail such, that he intends to supply (in the absence of detailing in the tender notice) and state, wether he is tendering for brass caps or cast iron caps fixed with brass screws or bolts. Cast iron duck foot bends shall be fixed to the bottom of each vertical soil pipe, when so specified or shown on plans.

45. All soil and waste pipe shall be tested by means of the smoke test by the contractor at his own expense in the presence of the Executive Engineer, unless a hydraulic test is specified, in which case the head of test pressure will be stated.

N.B.—The smoke test is frequently utilised for testing old installations and the hydraulic test for new installations.

46. The following general principles should be carefully observed in the installation of plumbing:—

(*a*) Vitrified pipes should not be carried through foundation walls as they are liable to be broken by uneven settlement.

(b) No pipe carrying sewage should be buried under the basement floor, unless placed in masonry lined trenches with removable covers.

(*c*) Fixtures should be completely exposed to view and should not be enclosed in wood work. They should be durable, smooth and of non-absorbent materials and protected by a good trap.

(*d*) Sanitary fittings for hospitals should be quite plain and free from ornamentation, of a suitable type, and fixed in place in a way to be readily kept clean.

(*e*) To avoid a multiplicity of unnecessary traps and pipe work in ordinary buildings, white glazed floor channels may be provided where practicable and approved by the Executive Engineer to receive the waste from basins and baths. These channels will discharge through 100 mm. × 50 mm. bell-mouthed floor traps, the outlets being protected with gratings of approved design.

SPECIFICATION No. 102-A.

ASBESTOS CEMENT SOIL, WASTE AND VENTILATING PIPES AND FITTINGS.

1. All Asbestos cement pipes and fittings must conform to I.S. 1626/1960.

2. The pipes and fittings are to be fixed with straps or clips which are made with the approval of the Executive Engineer.

3. Joining shall be carried out as shown in the diagrams for cast iron pipes.

SPECIFICATION No. 103.

HOUSE DRAINS AND CONNECTIONS—MATERIALS, SUPPLY AND CONSTRUCTION.

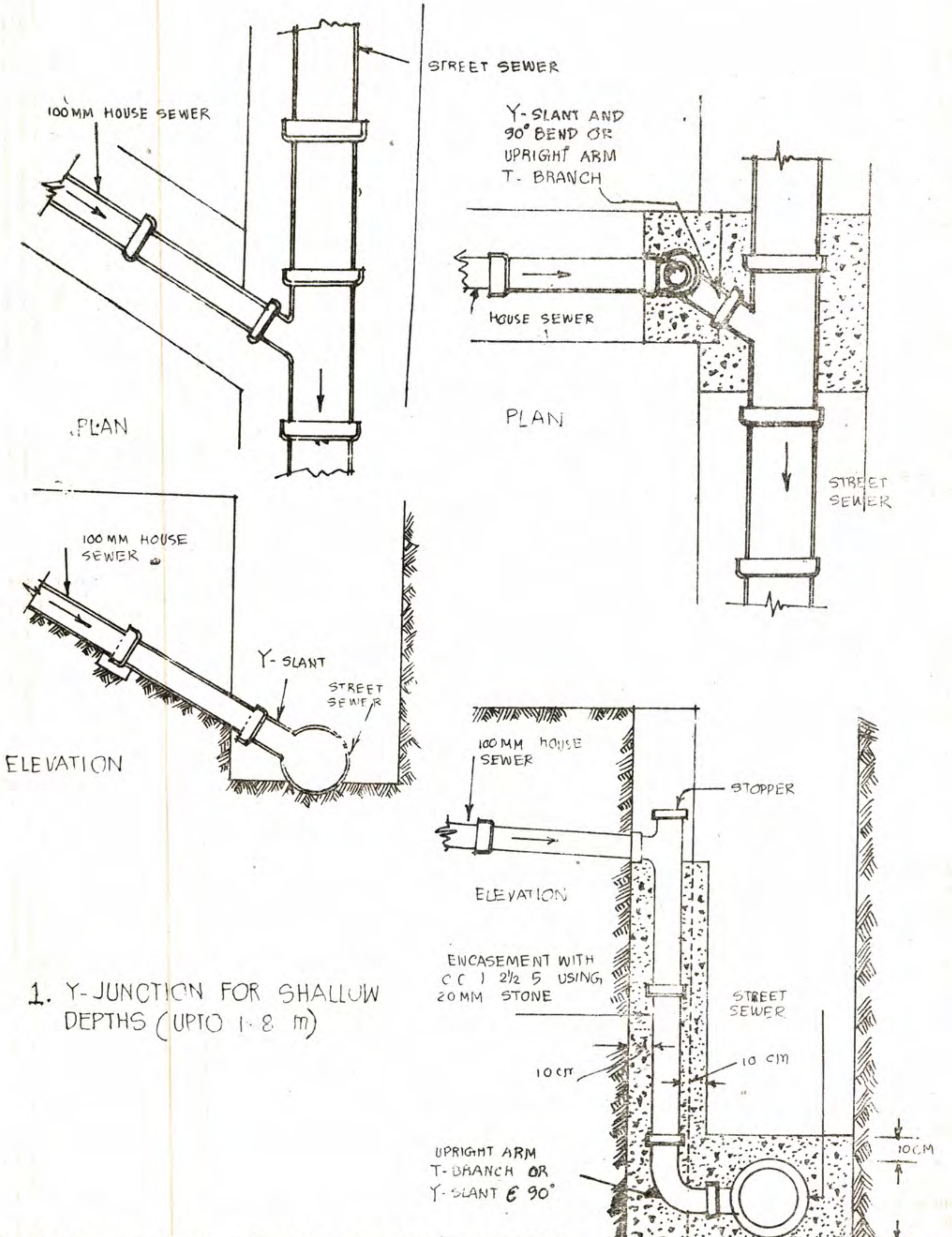
1. *Pipes.*—Stone ware pipes shall be of size specified (usually 100 mm.) and complying with the standard specification for stone ware pipes. They shall be laid and jointed in accordance with the standard specification fo "conveyance, laying and jointing stoneware pipes for sewers and fixing accessories". They will be laid on a concrete bed, if the soil is soft.

If cast iron pipes are specified they shall be in accordance with the I.S. 1536/1967.

2. *Gradient.*—The minimum gradients shall be 1 in 40 for 100 mm. diameter drains and 1 in 60 for 150 mm. diameter drains.

3. *Sewer connections.*—House drains shall connect to the main sewer either at a manhole or by means of a Y Junction pipe. The house drain shall be disconnected from the main sewer by means of a disconnecting trap. These fittings shall be arranged as shown in the detailed drawings or as the Executive Engineer may direct.

FIG 4



1. Y-JUNCTION FOR SHALLOW DEPTHS (UPTO 1·8 m)

2. UPRIGHT ARM JUNCTION FOR SEWER DEEPER THAN 1·8 M.

TYPE PLAN FOR HOUSE SEWER JUNCTION WITH STREET SEWER

4. *Disconnecting traps.*—Disconnecting traps shall comply with he following principles.

(*a*) The trap shall be free of all angles, corners and places where filth can accumulate.

(*b*) A free way shall be made for the discharge to pass through the trap without undue friction, and the traps shall be so made as to form a water seal of at least 75 mm. depth.

(*c*) The body section of the trap shall be smaller in area than its inlet section, so as to hold as small a quantity of water as possible.

(*d*) The minimum sized trap shall be used, consistent with circumstances.

(*e*) The inlet side of all traps shall be open to the atmosphere.

5. *Branch drains.*—All branches to the main house drain shall be connected at an inspection chamber and on the house side of the disconnecting trap.

6. *Air Vents.*—The inlets of disconnecting traps shall be connected to the atmosphere by means of a fresh air inlet, or by some alternative method shown in the detail drawings, or as ordered by the Executive Engineer. The head of the main drain shall be ventilated by means of a soil pipe extension or by means of a ventilating shaft.

7. *Testing.*—All drains shall be water tight and shall be passed by the Executive Engineer before being filled in vide clause 45 in the standard specification for " fixing and plumbing of sanitary fittings in Government Buildings " which shall apply.

8. *No bends in alignment.*—House drains should be laid without bends between the house or inspection chamber and the sewer conection.

9. *Rate.*—The rate shall be either a lump sum for the complete supply and construction of the house connection together with inspection chamber, if any, disconnecting trap, and air vent, complying with the plans furnished, this specification and its addendum specification, if any, or on a unit rate basis, for schedule quantities as may be defined in the schedule.

SPECIFICATION No. 104.

DOCTOR ANGUS SMITH'S SOLUTION.

1. *Cleaning.*—Pipes and castings shall be scrapped and cleaned of all deposit, rust and coats of former solution by means of iron scrapers specially designed for the purpose. The pipes and specials shall be washed clean and dried immediately before immersion.

2. *The coating.*—The solution shall consist of the following mixture of clean and pure materials, samples of which shall be provided at the contractor's expense for the approval of the Executive Engineer.

50. kg. of coal tar.

3 kg. of paraffin wax on tallow.

5. kg. of quick lime.

2. kg. of resin.

Black naptha, or pitch oil shall be added as required to bring the mixture to a proper consistency.

3. *Immersion.*—The pipes or castings shall be immersed in a tank sufficiently deep to admit of the largest sized piece being totally submerged under a depth of at least 30 cm of solution. The solution shall be maintained at a temperature of at least 25°C and a reliable type of pyrometer, which shall be subject to the approval of the Eexcutive Engineer shall be provided for this purpose.

The pipes or castings shall be kept continuously immersed in this solution for a period of at least twenty minutes and wire ropes or chan shall be used for suspending them.

4. *Ignition of coatings.*—Should the solution catch fire, the whole quantity at that time in the tank shall be discarded and not used again for coating purposes, either alone or mixed with fresh solution, but it shall be removed from the site of the work immediately. Pipes or castings which may happen to be immersed at the time of the fire shall be removed, scrapped, and washed again before immersion in new solution.

5. *Removal from coating solution.*—When the period of twenty minutes has elapsed, the pipes or castings shall be removed and kept suspended over the tank, until all superfluous solution has dripped back into the tank. The pipes or castings shall then be stacked and proper supports, well clear of the ground, and with free access of air and shall be protected from contract with dust and leaves and other deleterious matter until they are dry.

6. *Hrdening period.*—All pipes or castings on which the solution does not show signs of hardening into a glossy coat within twenty-four hours after removal from the tank shall be rejected, re-scrapped cleaned, and re-dipped in proper solution. No pipe shall be brought into use in a public water supply until four weeks have elapsed after coating operations.

7. *Rate.*—The rate for this work shall include the cost of scraping cleaning, washing water fuel and solution hauling, hoisting and stacking and all tools and plant required for the efficient prosecution of the work.

SPECIFICATION No. 105.

GALVANISED IRON GUTTERING.

(*Vide* Appenbed sketches.)

The following specification will be amplified or amended as necessary and further sketches given as may be required to suit the particular work under execution.

1. Gutters of galvanized iron 1.25 mm shall be used, unless otherwise specified. The guttering shall comply with the standard specification for " Sheets, mild steel, galvanized flat, etc., " The gutter shall be semi-circular in section and shall have a width at top as defined in the relevant schedule item. The gutters shall be fixed about 2.5 cm below the edge of the roof.

2. M. S. brackets 25 mm X 6 mm-wide type sketches appended shall be used to support, the gutter at about 1.2 m intervals. A convenient method will be to fix the brackets to every alternate rafter, with three 5 cm nettlefolds screws. The bracket may be fixed to the side of rafter as shown in the type of sketch, or it may be fixed to the top of rafter without the 90 degrees twist shown in the sketch as may be decided by the Executive Engineer.

3. All junctions and joints shall be sound and thoroughly water tight, riveted or bolted and soldered. All joints between sucessive length of gutters and elsewhere shall have an overlap of atleast 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of guttering shall be closed with an 1.25 mm galvanised sheet to fit the section, and made water tight as for other joints. Junctions with down fall rain water pipes shall be a soldered and either riveted or bolted joint, unless otherwise shown or specified.

4. As an alternative special guttering with slip joints 1.25 mm (vide type B sketch appended) may be used with brackets and fixed the same, as for type A.

5. Gutters should have a fall of at least 25 mm in 3.0 m, greater fall being given at bends and elsewhere as possible.

6. The rate unless otherwise defined, will be per metre run and will include all brackets, screws, junctions joints, ends, complete in every respect, fixed in place to specification and type design or other drawings defined in the schedule item.

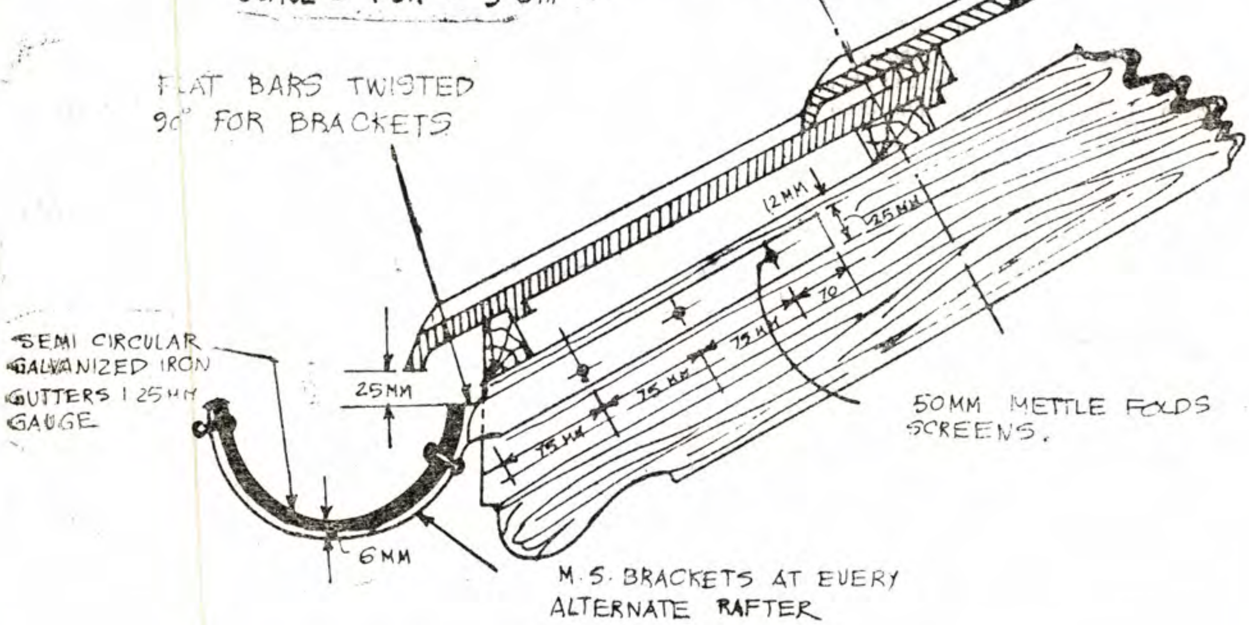
Note.—Gutters will ordinarily be provided of top width about twice the diameter of the down pipe vide note to standard specification for " cast-iron water pipes " regarding size of such pipes.

(*Wide* — —)

FIG - 6

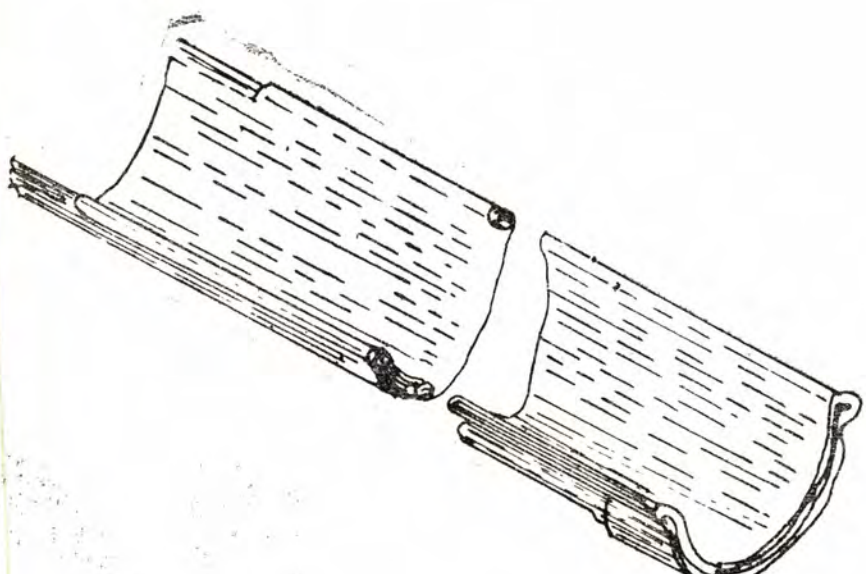
GALVANIZED IRON GUTTERING (1·25 mm gauge)

SCALE - 1 CM - 5 CM



GALVANIZED IRON GUTTERING 1·25 MM GAUGE
WITH M S BRACKETS.

TYPE - A



GALVANIZED IRON GUTTERING 1·25 MM GAUGE
WITH SLIP JOINTS

TYPE - B

SPECIFICATION No. 106.

FLASHING.

Flashing shall be provided as may be specified and shown in the plans. It will be of 25 kg. per sq. metre milled lead. 1.25 mm gauge zinc or galvanised iron as may be specified widths will be as shown in the relevant drawings.

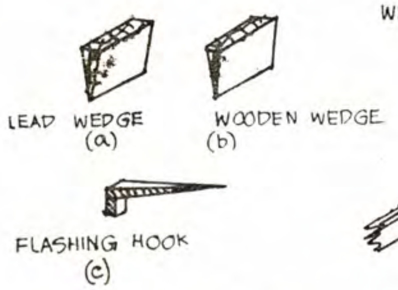
Against a wall, the flashing will, unless otherwise specified, be slightly tilted and turned up 150 mm, the upper edge being left free and covered by an apron over lapping it by about 100 mm, the upper edge of which should be tucked 50 mm. deep into a joint of the masonry and be secured by lead wedges, the joint being finally filled with mastic or Portland cement mortar.

In flashing a sloping surface, the turned up edge will be stopped as also the apron, so that it can be tucked into the horizontal joints of the brick works.

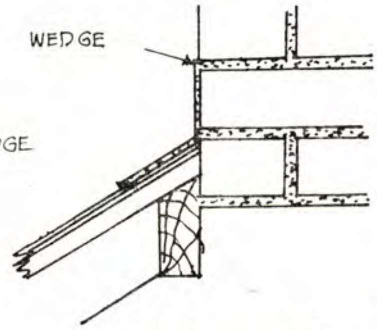
Sketches appended show methods of fixing flashing.

Rate will be per sq metre of flashing or other unit defined in Schedule item, and will include fixing in place complete.

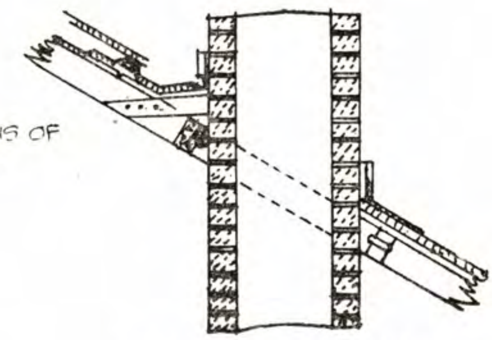
FLASHINGS.



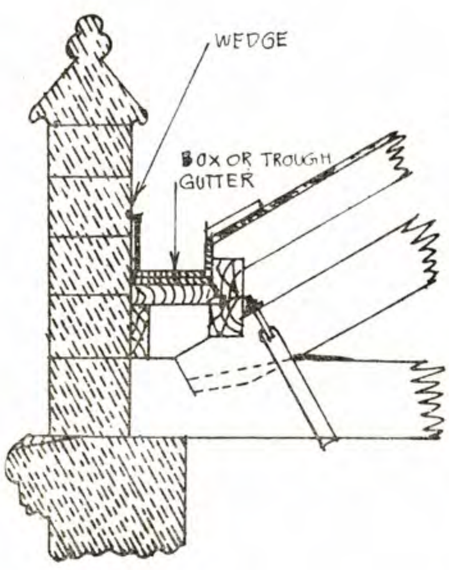
NOTE : (a) IS BEST TYPE OF WEDGE TO SECURE FLASHING



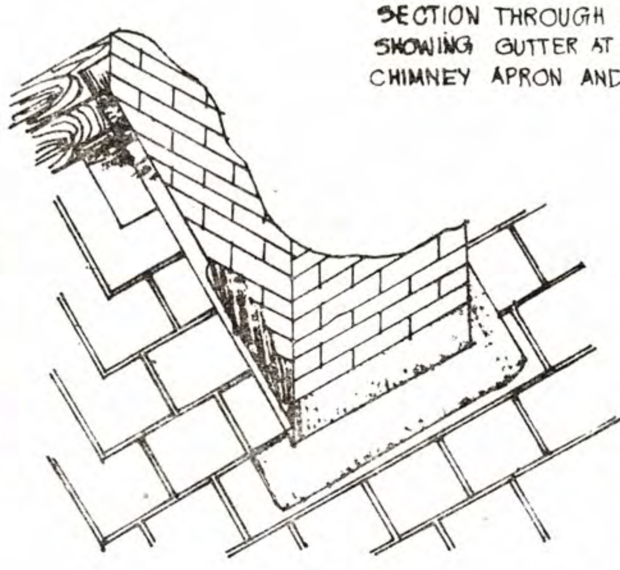
SECTION THROUGH BRICKWORK AND MEANS OF SECURING FLASHING



SECTION THROUGH A BRICK CHIMNEY SHOWING GUTTER AT BACK OF CHIMNEY CHIMNEY APRON AND FLASHING



SECTION OF A PARALLEL BOX OF TROUGH GUTTER



ELEVATION OF A BRICK CHIMNEY SHOWING GUTTER AT BACK OF CHIMNEY CHIMNEY APRON AND FLASHING

SPECIFICATION No. 107.

ASBESTOS CEMENT RAINWATER PIPES AND GUTTERS.

1. The asbestos cement rain water pipes and Gutters shall conform to I.S. 1626—1960.

2. The work shall be executed similar to that described in the st .r-dard specification for cast-iron rain water pipes only the pipes will be fixed with straps or clips.

3. Pipes are obtainable in different lengths. For further details please refer N.B. Code IX (32) 9.3.4/9.6.3.2.

EXTRACT FROM I. S. 4127-1967.

Code of Practice for laying of Glazed Stoneware Pipes.

3.11. *Barricades, Guards and saftey provisions.*—To protect person from injury and to avoid damage to property, adequate barricades, construction signs, torches, red lanterns and guards as required shall be placed and maintained during the progress of the construction work and until it is safe for traffic to use the roadway. All materials, piles, equipment and pipe which may serve as obstructions to traffic shall be enclosed by fences or barricades and shall be protected by proper lights when the visibility is poor. The rules and regulations of the local authorities regarding safety provisions shall be observed.

6. JOINTING OF PIPE.

6·1. *Types of joints.*—The stoneware pipes shall be cement jointed or provided with bituminous joints as approved by the administrative authority.

6·1·1. *Matetials for cement joints.*—The materials shall consit o the following :—

(*a*) Spun yarn of tarred gaskets.

(*b*) Cement (*See* I.S. 269–1958 or I.S. 455–1962.)

(*c*) Sand (*See* I.S. 1542–1960).

6·1·2. *Joining procedure for cement joints.*—The procedure as laid in 6·1.2·1 to 6·1·2·4· shall be followed.

In each joint, spun yarn soaked in neat cement slurry or tared gasket shall be passed round joint and inserted in it by means of a cualking tool. More skeins of yard or gasket shall be added if necessary and shall be well caulked. Yarn or gasket so rammed shall not occupy more than one, fourth of the depth of socket.

6·1·2·2. *Caulking of cement mortar.*—Cement mortar (1) : (One part of cement to one part of sand, shall be slightly moistened and carefully inserted by hand into the remaining space of the joint after caulking of yarn or gasket. The mortar shall then be caulked into the joint with a caulking tool. More cement mortar shall be added until the spece of joint has been compeltely filled with tightly caulked mortar. The joint shall then be finished off neatly outside the socket at an angle of 45 degrees as shown in Fig. 4.

6.1.2.3. *Curing.*—The cement mortar jointsshall be cured at least for seven days before testing.

6.1.2.4. The approximate quantity of cement and spun yarn required for each joint for certain common sizes of pipes are given below for guidance.

Nominal dia. of pipe.	*Cement.*	*Spun yarn.*
mm.	Kg.	Kg.
100	1	0.25
150	1.5	0.35
200	2	0.70
250	2.5	0.80
300	3.25	1.10
350	4.5	1.25
400	5.5	1.50

EXTRACT FROM I. S. 651—1965.

Specification for salt glazed stoneware pipes and fittings.
(Second revision.)

1. *Scope.*

1.1. This specification lays down the material and performance requirements for the following stone ware pipes and fittings :—

(*a*) Straight pipes,

(*b*) Fittings :—

(1) Taper pipes ;

(2) Bends ;

(3) Taper bends ;

(4) Junctions ;

(5) Half-section channels straight and taper ;

(6) Channel junctions ;

(7) Channel bends ;

(8) Channel interceptors ;

(9) Gully traps ; and

(10) Inspection pipes.

1.2. Dimensions of salt-glazed stoneware pipes and fittings are grouped into two sections. A and B. Section A covers dimensions straight pipes and all such fittings which normally form part of a pipe line and which are subject to same conditions, specifications and tests as straight pipes. Section B includes dimensions of fittings which are commonly used but do not form a part of the normal pipe line. The fittings in Section B being hand-moulded material, their conformity to dimensional specifications are not required to be so accurate as for those in Section A.

3. *Classification.*

3.1. The salt glazed stoneware pipes and fittings shall be of two classes, namely "Grade A" and "Grade AA."

3.1.1. Pipes which comply in every respect with the requirement of this standard, but of which only 5 per cent have been submitted to the hydraulic test conducted by the manufacturer as specified in7.2, shall be classified as "Grade AA". Such pipes and fittings shall bear the word "Grade AA" in addition to other markings.

3.1.2. Pipes and fittings (given in Section A) which comply in every respect with the requirement of this standard and all of which have satisfactorily passed the hydraulic test conducted by the manu. facturer as specified in 7.2 shall be classified as "Grade AA". Such pipes and fittings shall bear the word "Grade AA" in addition to other markings.

4. *Right and left hand fittings.*

4.1. A right hand fittings is such that when viewed from the spigot towards the socket, the arm of a junction or the socket of a bend projects to the right (*see* Fig. 1-A, 1B and 1-C). A left hand fitting is such that when viewed as above, the arm or socket projects to the left.

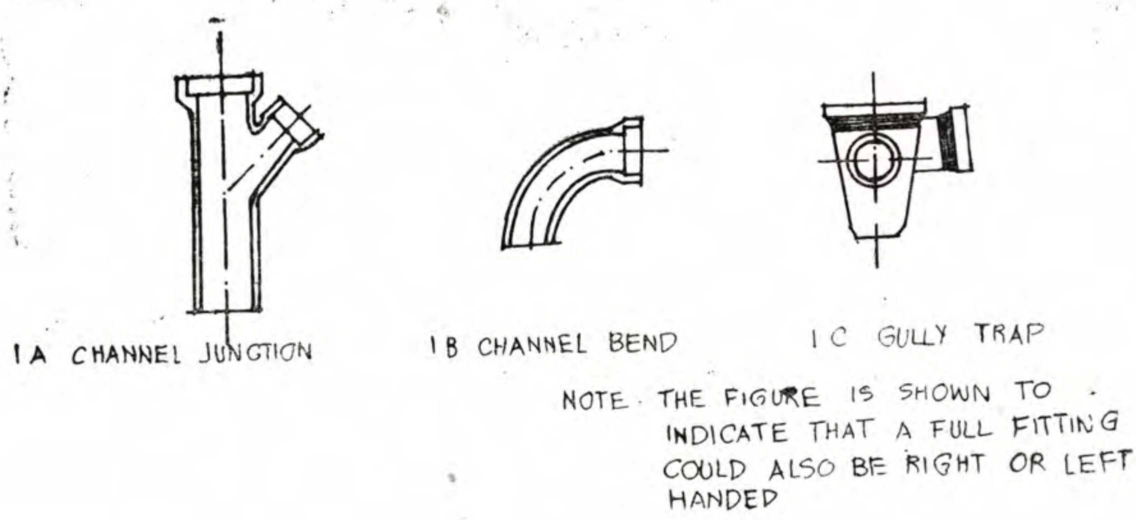


FIG- 1 RIGHT HAND FITTINGS.

5. *General quality.*

5.1. All pipes and fittings shall be sound, free from visible defects such as fire cracks or hair cracks, which impair the strength durability and serviceability. The glaze of pipes and fittings shall be free from cracking. The pipes and fittings shall give a sharp clear note when struck with a light hammer. There shall be no broken blisters.

5.2. For pipes and fittings, a maximum of 10 per cent shall be acceptable, with any one of the following blemsihes which do not impair the strength, durability and serviceability provided these pipes and fittings satisfatorily pass the hydraulic test specified in 7.2.

(*a*) A thin chipping not exceeding one quarter of thickness of the body and not exceeding 10 cm^2 on outside of spigot or on either side of the socket ;

(*b*) One blister, unbroken not more than 3 mm. high nor more than 4 cm. in largest dimension inside or outside of pipe ; and

(*c*) Hair line surface cracks.

6. *Glazing.*

6.1. The interior and the exterior surfaces of the pipes and fittings which remain exposed after jointing, shall be glazed. The portions which remain covered after jointing may or may not be glazed. The glazing shall be obtained by the action of the fumes of violatized common salt on the material of the pipes and fittings during the rocess of burning.

SECTION A.

DIMENSIONS OF STRAIGHT PIPES.

10.2. *Permissible variation.*—The internal diameter of the barrel of a pipe shall no where deviate from the internal diameter specified in Col. 1 of Table 1 by more than the following : -

Internal Dia. of pipe. mm.	*Permissible deviation from Dia.* mm
100	3
150	5
200 to 230	6
250 to 350	8
400 to 450	10
500 to 600	12

EXTRACT FROM I.S. 1536—1967.

Specification for Centrifugally cast (Spun) iron pressure pipes for water gas and sewage.

(First revision.)

1. *Scope.*

1.1. This standard covers the requirements for centrifugally (spun) iron pipes for pressure main lines for water, gas and sewage, manufactured in metal or sand moulds.

1.2. This standard is applicable to pipes suitable for lead joints or rubber joints or a combination of both. In case of rubber joint the inner profile of socket end of the pipe shall depend on the type of rubber joint ensuring that the overall dimensions are maintained. for reasons of safety and interchangeability.

2 *Classification*:

2.1. Pipes have been classified in this standard as LA, A and B according to their thickness. Class LA pipes have been taken as the basis for evolving the series of pipes. Class A allows a 10 per cent increase in thickness over class LA. Class B allows a 20 per cent increase in thickness over Class LA.

2.1.1. For special uses, Classes C, D, E, etc., may be derived after allowing corresponding increase of thickness of 30 per cent, 40 per cent, 50 per cent etc., over Class LA.

4.3. The pipes shall be such that they could be cut, drilled or machined. Pipes shall be accepted provided the hardness of the external unmachined surface does not exceed brinell hardness of 210 HB.

5.1. *Tests*.—Two test pieces obtained by cutting rings or bars from the spigot end of two pipes selected for testing, when tested in accordance with the methods specified in Appendix B, shall satisfy the following requirements :—

(*a*) *Ring test*.—(for pipes centrifugally cast in metal moulds)—

Nominal Diameter	*Modulus of Rupture, Min. Kgf/mm²*
Upto and including 300 mm	40

(*b*) *Tensile test*—

Type of moulding.	*Nominal diameter.*	*Tensile strength, Min Kgf/mm².*
(1) For Pipes centrifugally cast in metal moulds.	Over 300 mm and upto and including 600 mm.	20
	Over 600 mm ..	18
(2) For pipes centrifugally cast in sand moulds.	All diameters	18

NOTE.—Subject to agreement between the manufacturer and the purchaser, the tensile test on machined test bar may be replaced by a quicker test on ring.

5.1.1. All pipes from which rings or bars have been cut shall be accepted by the purchaser as complete lengths.

6. *Brinell hardness test* :

6.1. For checking the Brinell hardness specified in 4.3. the test shall be carried out on the test rings or bars cut from the pipes used for tests under 5.1, in accordance with I.S. 1789-1961.* The test shall be carried out by applying either a load of 3,000 Kgs. to a ball of 10 mm. diameter for 15 seconds, or a load of 750 Kgs. to a ball of 5 mm diameter for 10 seconds.

8.2. *Works Test Requirements*.—All pipes shall withstand hydrostatic test pressure specified under Col. 2 of Tables 1 and 2.

8.3. *Installation test requirements*.—All pipes shall withstand hydrostatic test pressures specified under Col. 3 of Tables 1 and 2.

TABLE 1—HYDROSTATIC TEST PRESSURES FOR CENTRIFUGALLY CAST SOCKET AND SPIGOT PIPES.

(*Clauseas* 8.2 *and* 8.3.)

Class. (1)	*Hydrostatic test Pressure at works.* (2) kgf/cm2	*Maximum Hydrostatic test Pressure after installation.* (3) kgf/cm2
LA	35	12
A	35	18
B	35	24

TABLE 2—HYDROSTATIC TEST PRESSURES FOR CENTRIFUGALLY CAST FLANGED PIPES (Upto 300 mm diameter).

(*Clauses* 8.2. *and* 8.3.).

Class. (1)	*Hydrostatic test Pressure at works.* (2) kgf/cm2	*Maximum Hydrostatic Test Pressure after installation.* (3) kgf/cm2
A	35	18
B	35	24

10.2. *Tolerance on thickness*.—The tolerance on the wall thickness and flange thickness of pipes shall be as follows :—

Dimension.	*Tolerance.* mm
(*a*) Wall thickness	—(1 +0.05 e)**
(*b*) Flange thickness ..	±(2+0.05 b)

Where 'e' is the thickness of the wall in millimetres and 'b' is the thickness of the flange in millimetres.

10.3. *Tolerance on length*.—The tolerance on length of pipes shall be as follows :—

Type of casting.	*Tolerance.* mm
(*a*) Socket and spigot, and plain ended pipes.	±25
(*b*) Flanged pipes	±10

EXTRACT FROM I. S. 3114—1965.

Code of practice for laying of cast iron pipes.

5.1.3. *Lead joints* –

5.1.3.1. Lead –Lead for caulking purposes should conform to I.S. 782—1962*.

5.1.3.2. Quantity of lead and spun yarn for joints—

The quantity of lead and spun yarn required for different size pipes are given in Table.

TABLE 1.—QUANTITY OF LEAD AND SPUN YARN FOR DIFFERENT SIZES OF PIPES.

(*Clause* 5.1.32.)

Nominal size of pipe. mm.	*Lead/Joint.* Kg.	*Spun yarn/joint.* Kg.
80	1.8	0.10
100	2.2	0.18
125	2.6	0.20
150	3.4	0.20
200	5.0	0.30
250	6.1	0.35
300	7.2	0.48
350	8.4	0.60
400	9.5	0.75
450	14	0.95
500	15	1.00
600	19	1.20
700	22	1.35
750	25	1.45

* Method for Brinell hardness test for g5ey cast iron.

** No limit for the plus tolerances is specified (See 11.1.1.2.)

Nominal size of dipe. mm.	*Lead/Joint. Kg.*	*Spun yarn/joint Kg.*
800	31.5	1.53
900	35	1.88
1000	41	2.05
1100	46	2.40
1200	50	2.60
1500	66.5	2.80

NOTE.—The quantities of lead and spun yarn given in the table are provisional and a variation of 20 per cent is permissible. Specification for caulking lead (revised).

5.1.3.3. *Heating and pouring of lead.*—Lead shall be heated in a melting pot keep in easy reach of the joint to be poured so that the molten metal will not be chilled in being carried from the melting pot to the joint and shall be brought to a proper temperature so that when stirred it will show a rapid change of colour. Before houring, all scum shall be removed. Each joint shall be made with one continuous pour fillings of the entire joint space with solid lead. Spongy or imperfectly filled joints shall be burnt out and repoured.

5.1.3.4. *Position of joint runner.*—The joint runner shall fit snugly against the fact of the socket and the outside of the pipe shall be dammed with clay to form a pouring lip to provide for filling the joint flush with the face and to the top of the socket.

5.1.3.5. *Procedure for caulking of socket and spigot joints.*—The common form of joint is made by running in molten lead, taking care that no cross enters the joint, and then thoroughly caulking the lead. The lead need not extend into the joint further than the back of the groove formed in the socket.

The spun yarn is used to centre the spigot in the socket, to prevent the flow of molten lead into the bore of the pipe, to reduce the amount of lead required to complete the joint and to the joint water tight. Spun yarn may become infected with bacteria which may contaminate the water and, therefore, shall be effectively disinfected before use.

Alternately, propriefary brands of sterilized spun yarn may be used. Shred lead or lead wire or strip may be used instead of spun yarn, thus producing a solid lead joint. Lead covered yarn may also be used which does not have the disadvantages of plain yarn. Cold lead may be caulked into the joint space first followed by spun yarn and the joint then completed with cold or molten lead.

Caulking may be done with pneumatic tools or with a hand hammer weighing not less than 2 kgs. when working with lead wool, it is very important to use caulking tools of appropriate thickness to fill the joint space, and to thoroughly consolidate the material from the back to the front of the socket. Lead run joints shall be preferably finished 3 mm behind the socket face.

5.2. *Flanged joints.*—Cost iron pipes may also be jointed by means of flanges cast on.

5.2.1. The jointing material used between flanges of pipes shall be compressed fibre board or rubber (*see* I.S. : 638—1955*) of thickness between 1.5 mm to 3 mm. The fibre board shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per m² shall be not less than 112 g/mm thickness.

5.2.2. Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively. The practice of fully tightening the bolts one after another is highly undesirable.

5.2.3. Several proporietary fllexible joints are available for jointing cast iron pipes and these may be used with the specific approval of the Authority ; however, they shall be used strictly in accordance with the manufacturer's instructions.

5.2.4. For joints in small diameter cast iron piping, copper-alloy screwed unions or ferrules shall be used, and for large diameters the joints shall be made by flanged connecting pieces.

6. *Hydrostatic tests* :

6.1. *Types of tests.*—After a new pipe has been laid, jointed and back filled, shall be subjected to the following two tests :—

(*a*) Pressure test at a pressure of at least double the maximum working pressure, pipe and joints shall be absolutely water-tight under the test.

(*b*) Leakage test (to be conducted after the satisfactory completion of the pressure test) at a pressure to be specified by the Authority for a duration of two hours.

6.5. *Procedure for pressure test.*—

6.5.1. Each valved section of the pipe shall be slowly filled with water and all air shall be expelled from tle pipe through hydrant and blow-offs. If these are not available at high places, necessary tapping may be made at points of highest elevation before test is made and plugs inserted after the tests have been completed.

6.5.2. If the trench has been partially back-filled the specified pressure based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Authority. The duration of the test shall not be less than 5 minutes.

6.5.3. *Examination under pressure.*—All exposed pipes, fittings, valves, hydrants and joints should be carefully examined during the open-trench test. When the joints are made with lead, all such joints showing visible leaks shall be recaulked until tight. When the joints are made with cement and show seepage or slight leakage, such joints shall be cut out and replaced as directed by the Authority. Any cracked or defective pipes, fittings, valves or hydrants discovered in consequence of this pressure test shall be removed and replaced by sound material and the test shall be repeated until satisfactory to the Authority.

6.5.4. If the trench has been back-filled to the top, the section shall be first subjected to water pressure normal to the area and the exposed parts shall be carefully examined. If any defects are found they shall be repaired and the pressure test repeated until no defects are found. The duration of the final pressure tests shall be at least one hour.

6.6. *Procedure for leakage test* :

6.6.1. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

6.6.2. No pipe installation shall be accepted until the leakage is less than the number of cm³/h as determined by the formula :

$$qL = \frac{ND\sqrt{P}}{3.3.}$$

where

qL = the allowable leakage in cm³/h,

N = number of joints in the length of the pipeline,

D = diameter in mm, and

P = the average test pressure during the leakage test in kg/cm².

6.6.3. *Variation from permissible leakage.*—Should any test of pipe laid disclose leakage greater than that specified in clause 6.6.2. the defective joints shall be repaired until the leakage is within the specified allowance.

* Specification for rubber and inseralionr jointing.

EXTRACTS FROM I. S. 1726—1967.

Specification for cast iron manhole covers and frames intended for use in drainage works.

(*First Revision.*)

4. *Manufacture and Workmanship* :—

4.1. Covers and Frames :—

4.1.1. Covers and frames shall be cleanly cast and they shall be free from air and sand holes, cold shuts and warping which are likely to impair the utility of the castings.

4.1.2. Covers shall have a raised chequered design to provide an adequate non-slip grip.

NOTE.—Where a chequered pattern is shown in the figure, it shall not be regarded as a particular design.

4.1.3. Dimensions of covers and frames shall be according to the table 1 read with fig. 1, 2, 3, 4 and 5 (*see* also. 2.2).The amount of draw in pattern may slightly affect the measurements given. They may be made for dimensions other than those shown in figures where so agreed to between manufacturer and purchaser.

4.2. Key holes and keys :—key holes and keys shall be as indicated in fig. 5.

4.3. Locking devices : —Locking devices, such as galvanized chain or lock or a combination of both, may be provided if required by the purchaser.

5. *Weights and tolerance* :—

5.1. The minimum weights of manhole frames and covers shal be as specified in Table 2 :—

TABLE 2.— MINIMUM WEIGHTS OF MANHOLE FRAMES AND COVERS

Grade.	*Type.*	*Clear opening.*	*Weight of cover.*	*Weight of cover.*
(1)	(2)	(3)	(4)	(5)
		MM.	KG.	KG.
HD	Double triangular	500	118	111
		560	140	115
HD	Circular	500	118	111
		560	140	115
MD	Circular	500	58	58
		560	64	64
MD	Rectangular	..	80	64
LD	Rectangular : Single seal : Pattern 1	..	23	15
	Pattern 2 ..	..	15	10
	Double seal	..	29	23

6. *Coating*—

6.1. Manhole covers and frames shall be coated with a material having tar base or with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to a temperature of 63°C and shall not be so brittle as to chip off at a temperature of 0°C.

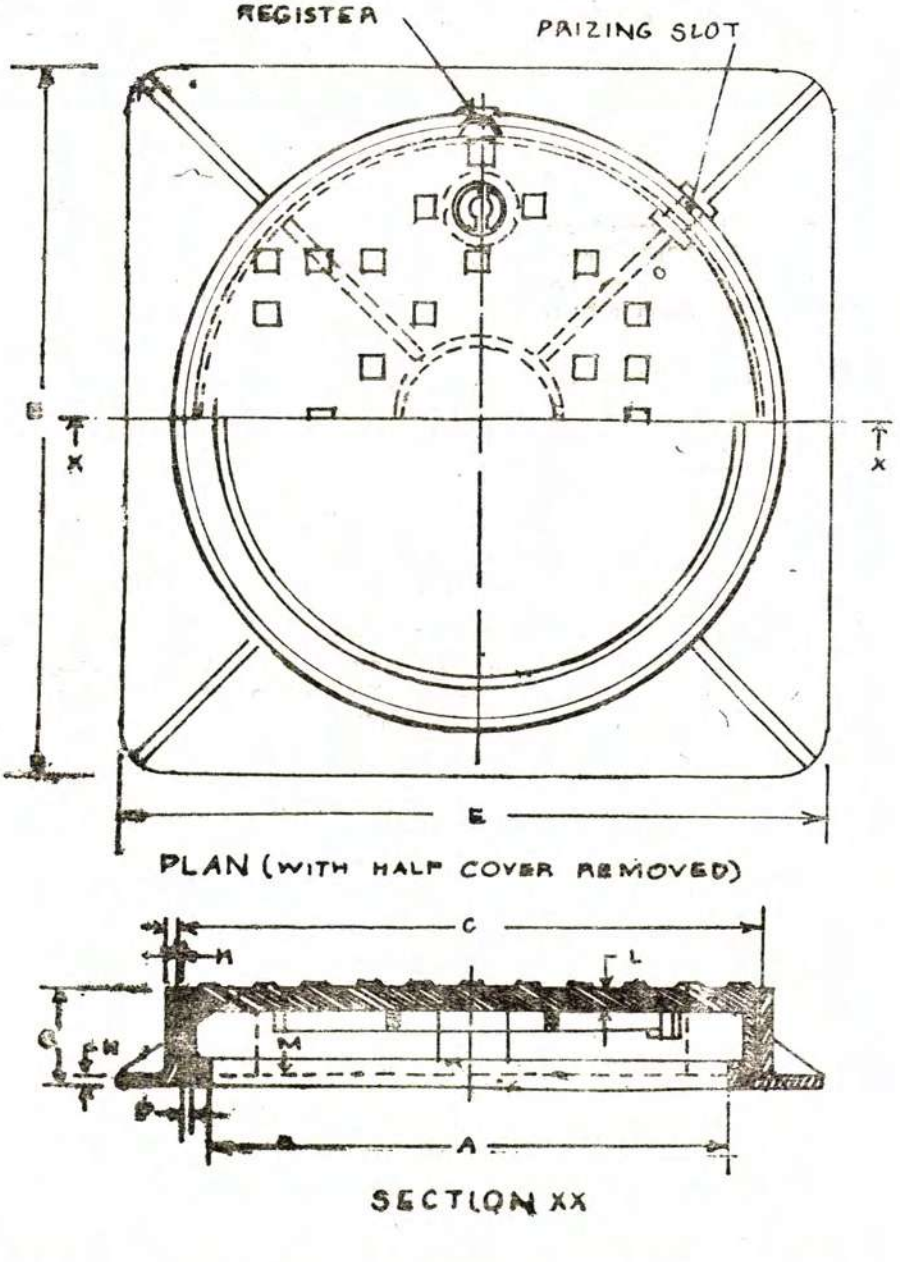
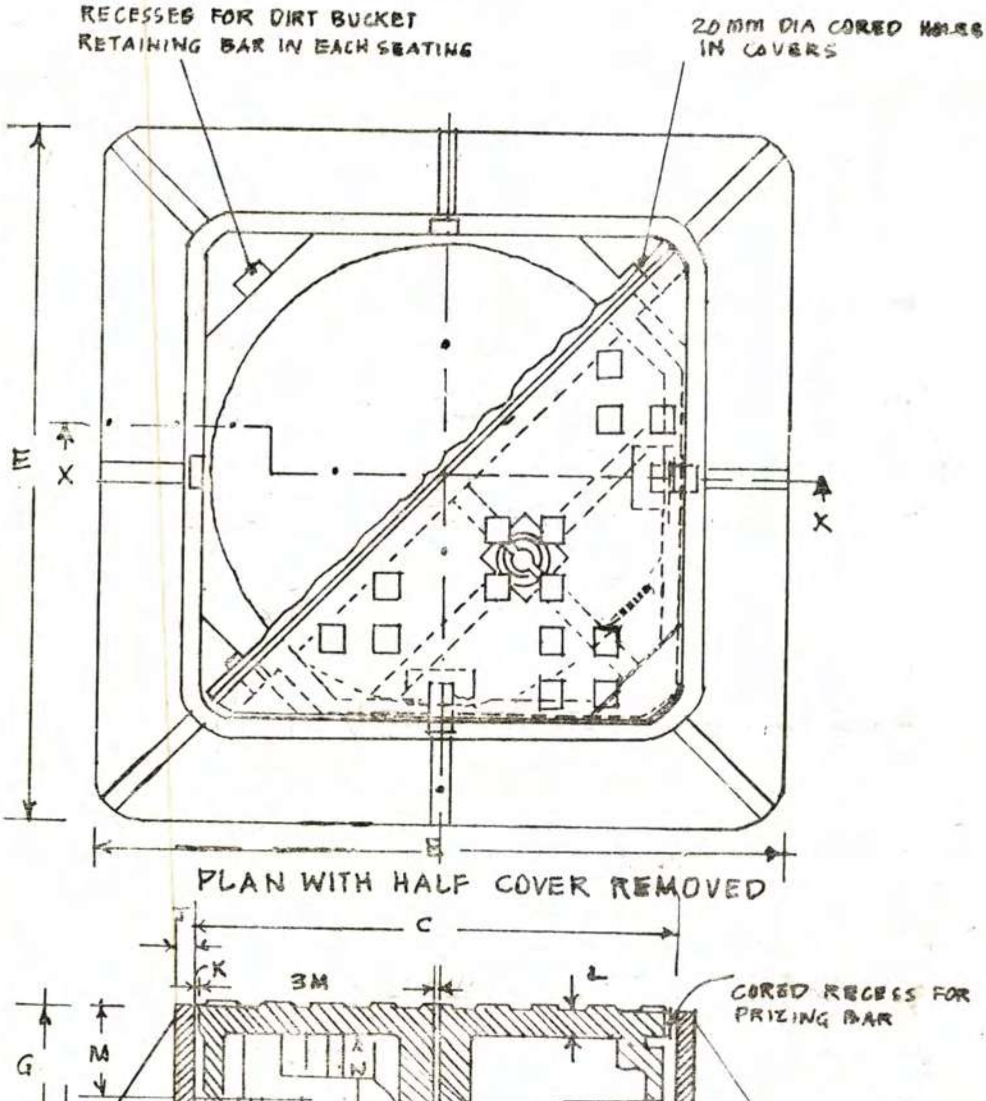


FIG 1 HEAVY DUTY AND MEDIUM DUTY CIRCULAR COVER AND FRAME



SECTION X-X

(COVERS LOOSELY COUPLED BY 30MM NOMINAL DIA HEXAGONAL BOLTS WITH LOCK NUTS)

FIG 2. HEAVY DUTY DOUBLE TRIANGULAR SOLID TYPE COVER AND FRAME

466-3A—30A

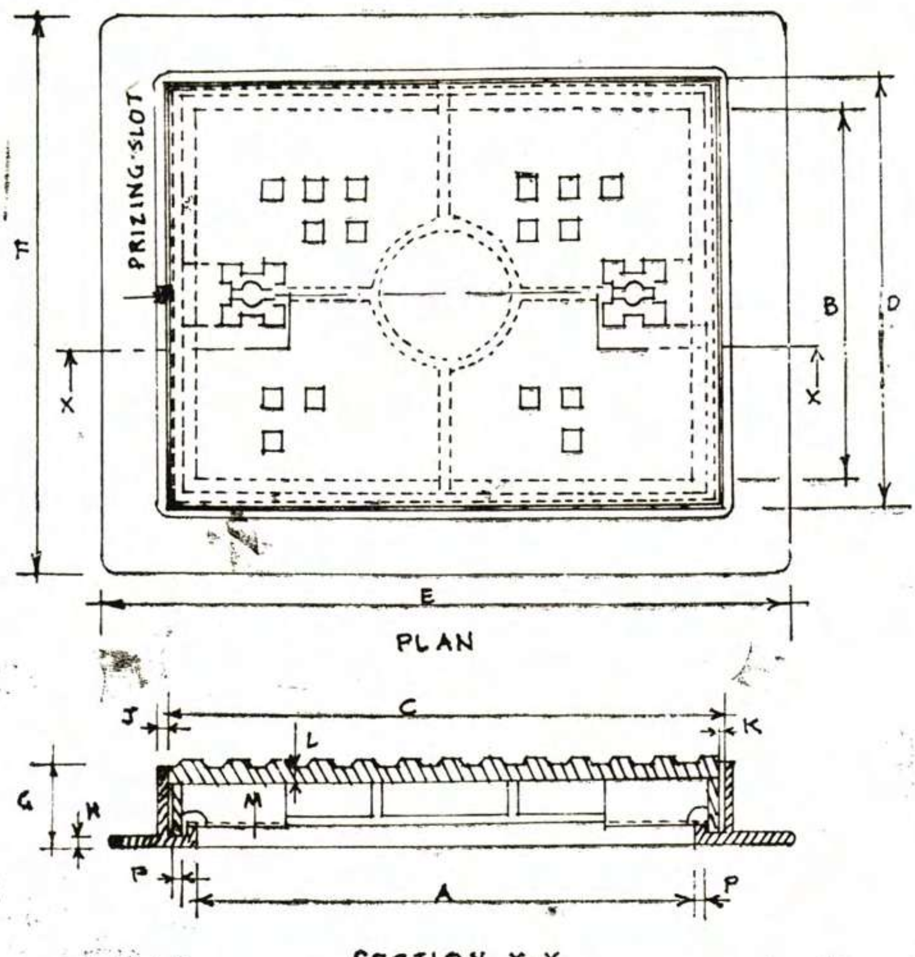
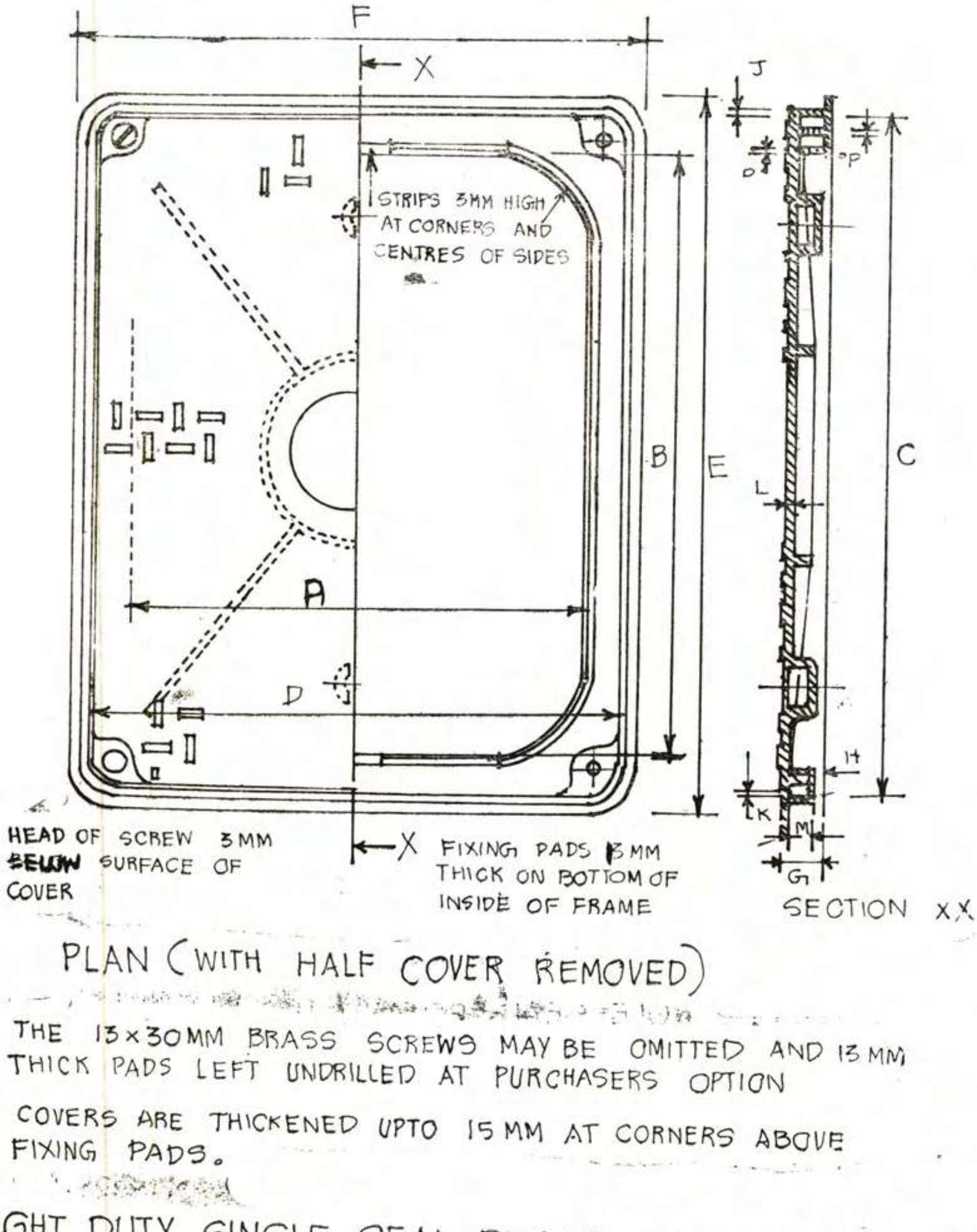


FIG 3 MEDIUM DUTY RECTANGULAR COVER AND FRAME.



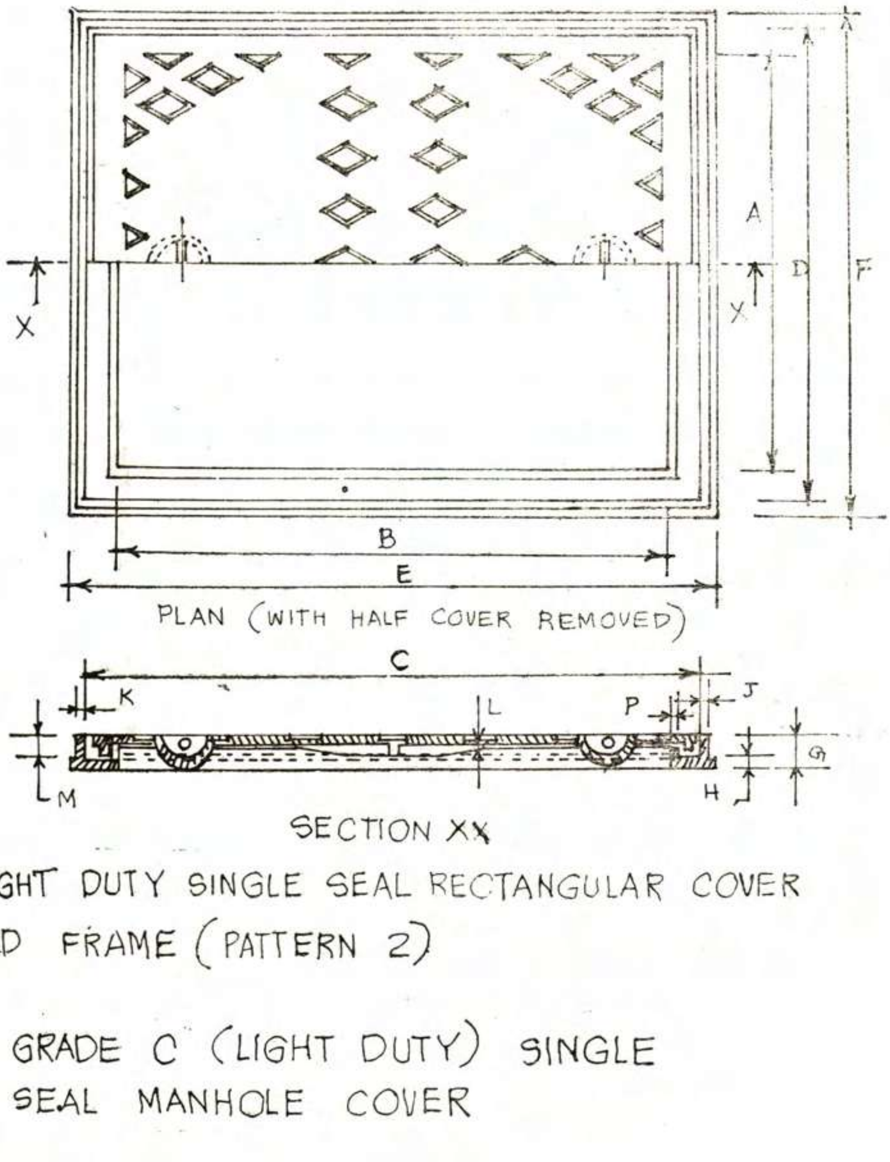
PLAN (WITH HALF COVER REMOVED)

NOTE 1 THE 13 × 30 MM BRASS SCREWS MAY BE OMITTED AND 13 MM THICK PADS LEFT UNDRILLED AT PURCHASERS OPTION

NOTE 2 COVERS ARE THICKENED UPTO 15 MM AT CORNERS ABOVE FIXING PADS.

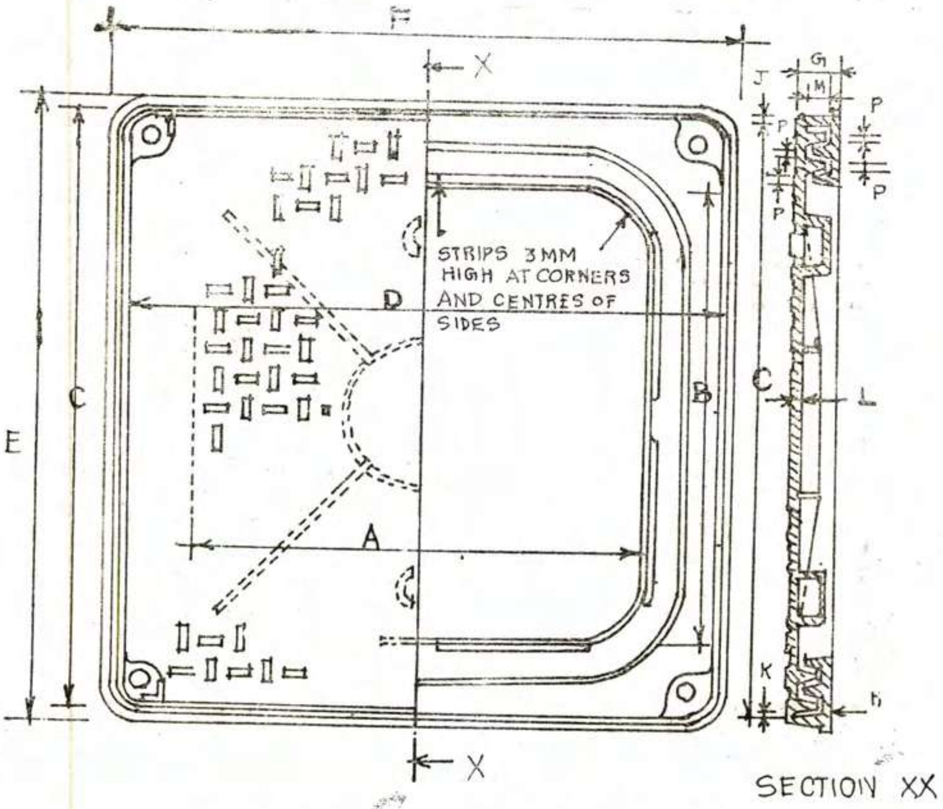
4-A LIGHT DUTY SINGLE SEAL RECTANGULAR COVER AND FRAME (PATTERN 1)

FIG-4 GRADE 'C' (LIGHT DUTY) SINGLE SEAL MANHOLE COVER - CONTD.



4 B LIGHT DUTY SINGLE SEAL RECTANGULAR COVER AND FRAME (PATTERN 2)

FIG. 4 GRADE C (LIGHT DUTY) SINGLE SEAL MANHOLE COVER

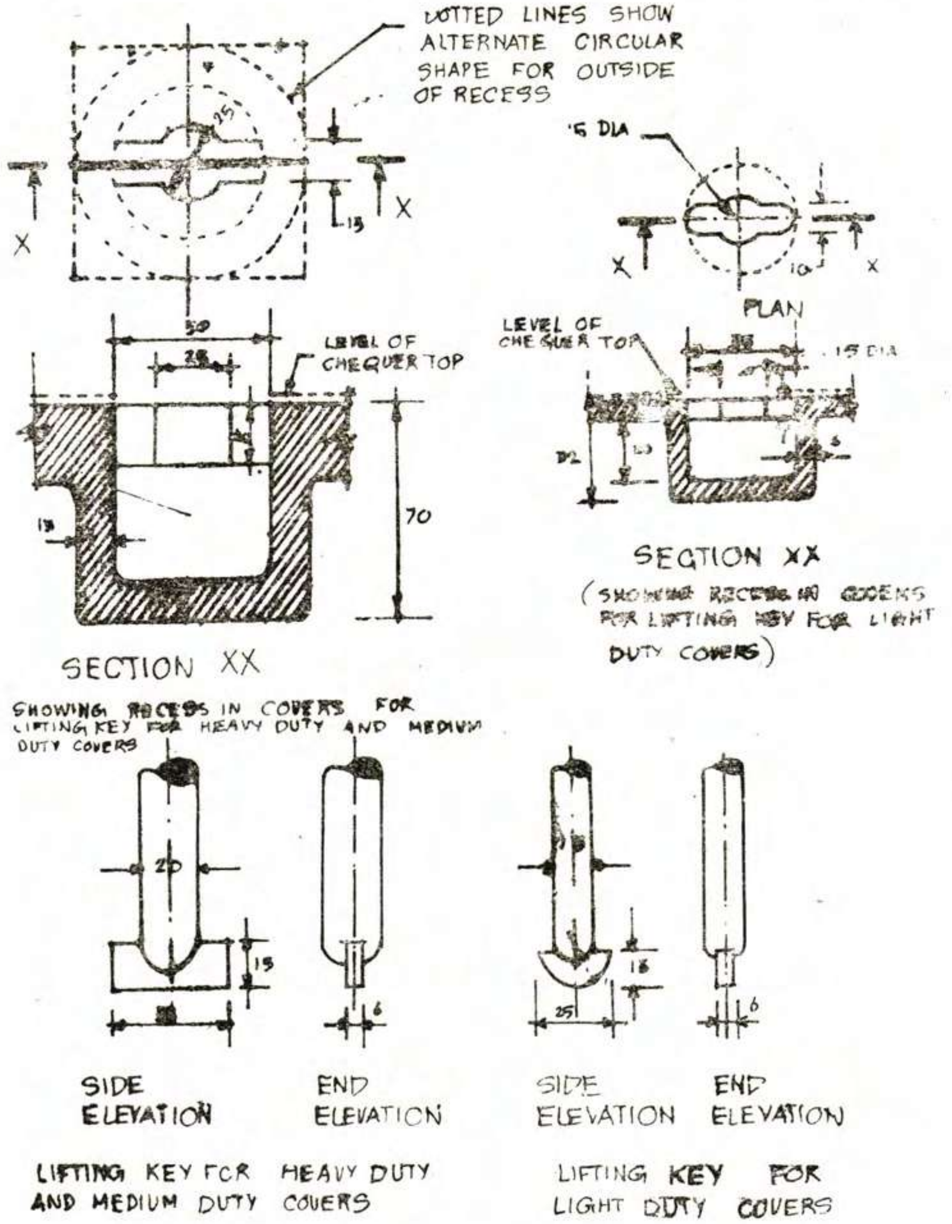


PLAN (WITH HALF COVER REMOVED)

NOTE : 1. THE 13 × 30 MM BRASS SCREWS MAY BE OMITTED AND THE 13 MM THICK PADS LEFT UNDRILLED AT PURCHASERS OPTION

NOTE 2. COVERS ARE THICKENED UPTO 15 MM AT CORNERS ABOVE FIXING PADS

FIG - 5. LIGHT DUTY DOUBLE SEAL RECTANGULAR COVER AND FRAME.



(ALL DIMENSIONS IN MILLIMETRES)

FIG. 6 DETAILS OF KEY HOLES AND KEYS

EXTRACT FROM I.S. 404—1962.

Specification for lead pipes (Revised).

1. *Scope* :

1.1. This standard covers the minimum requirements for lead pipes for plumbing and for use in chemical industry.

2. *Supply of material* :

2.1. General requirements relating to the supply of lead pipes shall be laid down in I.S. 1387—1959 general requirements for the supply of Metals and Metal Products.

3. *Freedom from defects* :

3.1. The pipes shall be sound and free from laminations, flaws, pronounced extrusion marks or other imperfections and shall, as far as possible, be circular in cross section, smooth and of uniform wall thickness throughout.

5. *Size* :

5.1. Lead pipes, other than those used in Chemical industry, shall be extruded to the sizes given in Tables I, II, III, IV, V, VI, VII and VIII.

5.2. Sizes of lead pipes for use in chemical industry shall be agreed to between the purchaser and the supplier.

6. *Tolerance* :

6.1. The minimum and maximum wall thickness at any point in the length of the pipe, measured at a number of points, shall not vary from the average wall thickness by more than 7.5 per cent except for local increase to receive the marking.

TABLE 1 —SERVICE AND DISTRIBUTION PIPES TO BE LAID UNDER GROUND.

Working pressure.	*Nominal internal diameter.*	*Wall thickness.*	*Weight per meter.*
Kg/cm².	mm.	mm.	kg.
(1)	(2)	(3)	(4)
4	10	3.8	1.87
	15	4.5	3.13
	20	4.8	4.24
	25	5.6	6.11
	32	5.6	7.50
	40	5.7	9.28
	50	7.1	14.45
7	10	4.4	2.26
	15	5.3	3.73
	20	5.6	5.11
	25	6.3	7.03
	32	8.8	12.80
	40	10.0	17.82
10	10	5.4	2.96
	15	6.4	4.88
	20*	7.1	6.86
	25*	..	10.75

TABLE II—SERVICES PIPES TO BE BE FIXED OR LAID ABOVE GROUND.

Working pressure.	*Nominal Internal Diameter.*	*Wall thickness.*	*Weight per metre.*
(1)	(2)	(3)	(4)
Kg./cm².	mm.	mm.	Kg.
4	10	3·0	1.39
	15	3.3	2.15
	20	3.3	2.74
	25	3.6	3.67
	32	4.6	6.00
	40	5.7	9.28
	50	7.1	14.45
7	10	3.7	1.81
	15	3.7	2.47
	20	5.6	3.11
	25	6.3	7.03
	32	8.8	12.80
	40	10.0	17.82
80	10	5.4	2.96
	15	6.4	4.88
	20*	7.1	6.86
	25*	8.9	10.75

* The maximum working pressure these size in 9 kg./cm²

TABLE III—COLD WATER DISTRIBUTION PIPES TO BE FIXED OR LAID ABOVE GROUND (CLAUSE 5.1)

Wworking pressure.	*Nominal Internal Diameter.*	*Wall thickness.*	*Weight per metre.*
Kg./cm².	mm.	mm.	kg.
(1)	(2)	(3)	(4)
2-5	10	3·1	1·45
	15	3·3	2·15
	20	3·3	2·74
	25	3·6	3·67
	32	3·8	4·85
	40	4·3	6·79
	50	4·4	8·53
4	10	3·1	1·45
	15	3·3	2·15
	20	3·3	2·75
	25	3·6	3·67
	32	4·6	6·00
	40	5·8	9·28
	50	7·1	10·65

TABLE IV—HOT WATER DISTRIBUTION PIPES TO BE FIXED OR LAID ABOVE GROUND (CLAUSE 5.1)

Working pressure.	*Nominal Internal Diameter.*	*Wall thickness.*	*Weight per metre.*
(1)	(2)	(3)	(4)
Kg./cm2.	mm.	mm.	kg.
2	10	3·2	1·50
	15	3·6	2·34
	20	3·7	3·13
	25	4·0	4·13
	32	4·8	6·30
	40	5·2	8·38
	50	7·1	14·45
3·5	10	3·2	1·50
	15	4·1	2·79
	20	5·1	4·56
	25	7·5	8·69
	32	9·2	13·51

TABLE V—SOIL, WASTE AND SOIL AND WASTE VENTILATING PIPES.

(CLAUSE 5·1).

Nominal internal diameter.	*Wall thickness.*	*Weight per metre.*
(1)	(2)	(3)
mm.	mm.	Kg.
50	2·7	5·07
75	2·7	7·48
100	2·7	9·88
150	3·0	16 36

TABLE VI—FLUSHING AND WARNING PIPES (CLAUSE 5·1).

Nominal Internal Diameter.	*Wall thickness.*	*Weight per metre.*
(1)	(2)	(3)
mm.	mm.	Kg.
20	2·6	2·09
25	2·6	2·56
32	2·6	3·28
40	2·6	3·95
50	2·7	5·07

TABLE VII—HEAVY WEIGHT GAS PIPES (CLAUSE 5·1.)

Nominal Internal Diameter.	*Wall thickness.*	*Weight per metre.*
(1)	(2)	(3)
mm.	mm.	Kg.
10	1·9	0·81
15	2·7	1·70
20	3·2	2·60
25	3·4	3·44
32	3·6	4·57
40	4·0	6·27
50	5·1	7·20

TABLE VIII—LIGHT WEIGHT GAS PIPES (CLAUSE 5·1)

Nominal Internal Diameter.	*Wall thickness.*	*Weight per metre.*
(1)	(2)	(3)
mm.	mm.	Kg.
10	1·9	0·81
15	2·0	1·21
20	2·6	2·09
25	3·0	2·99
32	3·0	3·74
40	3·1	4·76
50	3·1	5·87

EXTRACT FROM I.S. 1230—1968.

Specification for Cast Iron Rainwater Pipes and fittings.

(First Revision)

1. *Scope.*

1.1. This standard covers the requirements for (*a*) rainwater pipes, fittings and accessories and (*b*) half-round gutters, fittings and accessories.

2. *Supply of Materials.*

2.1. General requirements relating to the supply of cast iron rain--water pipes, gutters and fittings shall be laid down in IS 1387—1967

3. *Quality of material.*

3.1. The metal used for the manufacture of cast iron rainwater pipes, gutters and fittings shall be suitable for the method of manufacture and shall be of quality not lower than Grade 15 of IS 210—1962. The holderbats may, however, be of cast iron or mild steel.

3.2. Pipe nails for attaching pipes in walls may be plain or galvanized.

4. *Manufacture.*

4.1. Rainwater pipes shall be manufactured by sand cast or spun processes with Type A or Type B sockets (*see* Table 1) together with fittings manufactured by sand cast process.

5. *Dimensions, weights and Tolerances.*

5.1. Straight pipes shall comply with the dimensions given in Table 1. They shall have an overall length of 1,800 mm. subject to the following tolerances :—

Dimension. (1)	*Nominal Diameter.* (2) mm.	*Tolerance.* (3) mm.
External Diameter of barrel (B).	50, 75 ..	± 3·0
	100, 125 ..	± 3·5
	150	± 4·0
Internal diameter of socket (F).	All diameters	± 3·0
Depth of socket (J) ..	Do. ..	± 10.0
Thickness (C)	Do. ..	± 1.
Length	Do. ..	± 13

5.1.1. The tolerance on weight shall be—10 per cent.

5.2. Pipe fittings and their sockets and spigots shall conform to the thickness and other dimensions specified for the corresponding parts of the straight pipes subject to the following tolerances :—

Thickness ± 1 mm
Length ± 3 mm

5.2.1. Double socketed lengths of pipes shall comply with the requirements and tests laid down for the corresponding spigot and socket pipes.

6. *Ears.*

6.1. Unless otherwise specified, pipes and fittings shall be supplied without ears. When ears are required, the purchaser shall state in his enquiry and order.

6.2. Ears, if required, shall comply with the details given in Table 1 and have the following projections measured from outer surface of the pipe or fittings to face the ears.

Nominal bore with fittings.	*Projection from Back of Ear to Back of pipe.*
mm	mm
50 and 75	30
100, 125 and 150	40

7. *Freedom from Defects.*

7.1. Pipes and fittings shall be cylindrical, reasonably true with the inner and outer surfaces and as nearly concentric as practicable. The outer surface shall be smooth and shall, in all respects, be sound and free from pinholes, laps or other imperfections which may affect their utility and shall be neatly dressed. The ends shall be finished reasonably sqaure to their axes.

8. *Hammer Test.*

8.1. Each pipe when tested for soundness by stricking with a light hand hammer, shall emit a clear ringing sound.

9. *Coating.*

9.0. After inspection, if required, each pipe shall be coated.

9.1. Coating shall not be applied to any pipe unless its surface is clean, dry and free from rust.

9.2. Except when otherwise agreed to between the purchaser and the manufacturer, all pipes shall be coated externally and internally with the same material.

9.3. The coating material shall set rapidly with good adherence and shall not scale off.

9.4. In all instances where the coating material has a tar or similar base, it shall be smooth and tenacious and hard enough not to flow when exposed to a temperature of 77° C but not so brittle at a temperature of 0° C as to chip-off when scribed lightly with a pen-knife.

9.5. In case of pipes and fittings, wholly or partially-coated, which are imperfectly coated or where the coating does not set or conform to the quality specified above, the coating shall be removed and pipes recoated.

EXTRACT FROM I.S. 1026—1960

Specification for asbestos Cement Building Pipes, Gutters and Fittings (Spigot and Socket Type.)

1. *Scope.*

1.1. This standard covers asbestos cement building pipes of diameters 50 to 150 mm (or 2 to 6 in) for use as rain-water pipes, soil waste and ventilating pipes, also valley gutters, boundary wall (caves) gutters, half round gutters, ogee gutters and their respective fittings.

2. *Composition.*

2.1. The material used in the manufacture of pipes, gutters and fittings shall be composed of an inert aggregate, consisting of clean asbestos fibre cemented together by ordinary Portland cement conforming to I.S. 269-1958 or Portland blast-furnace slag cement conforming to I.S. 455-1953. No organic material shall be added to the composition.

3. *Dimensions.*

3.1. The diemensions of asbestos cement building pipes, gutters and fittings shall be a specified in Tables V to XXVIII (or Tables VI A to XXVII A for inch dimentsions) read with appropriate figure. The slope of sockets and fittings illustrated in this standard, are for guidance only and they may vary according to the manufacturers' design. The dimensions of angles for half round, ogee and boundary wall gutters are not covered in any of the tables. They shall be as indicated in Fig. 10-A and 10-B.

3.2. The length of pipe shall be its effective length exclusive of internal depth of socket. Unless otherwise specified, the length shall be in accordance with the corresponding tables. A tolerance of ±5mm shall be allowed on the length of individual pipe but the total length of pipe supplied shall not be less than the length ordered.

4. *Tolerances.*

4.1. The permissible tolerances on the thicknesses and external dimensions of pipes, gutters and fittings shall be as given in Tables I and II (or Tables I-A and II-A), The thickness of the socket at any point shall in no case be less than that specified.

TABLE 1 :—PERMISSIBLE TOLERANCES ON DIMENSIONS OF PIPES AND FITTINGS.

(*Clause* 4.1.)

Nominal Diameter of pipe or fitting.	*Thickness of pipe or fitting.*	*Permissible variation in thickness.*	*Permissible variation in external diameter.*
(1)	(2)	(3)	(4)
mm	mm	mm	mm
50	6·5	± 1·0	± 1·5
60	6·5	± 1·0	± 1·5
80	8·0	± 1·0	± 1·5
90	8·0	± 1·0	± 1·5
100	8·0	± 1·0	± 1·5
125	9·5	± 1·5	± 2·5
150	9·5	± 1·5	± 2·5

TABLE I-A.—PERMISSIBLE TOLERANCES ON DIMENSIONS OF PIPES AND FITTINGS (CLAUSE 4.1.)

Nominal Diameter of pipe or fittings.		*Thickness of pipe or fittings.*		*Permissible Variation in thickness.*		*Permissible variation in external diameter.*	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
mm	in.	mm	in.	mm	in.	mm	in.
50·8	2	6·4	1/4	± 0·8	± 1/32	± 1·6	± 1/16
63·5	2	6·4	1/4	± 0·8	± 1/32	± 1·6	± 1/16
76·2	3	7·9	5/16	+ 0·8	± 1/32	± 1·6	± 1/16
88·9	3	7·9	5/16	± 0·8	± 1/32	± 1·6	± 1/16
101·6	4	7·9	5/16	± 0·8	± 1/32	± 1·6	± 1/16
127·0	5	9·5	3/8	± 1·6	± 1/16	± 2·4	± 3/32
152·4	6	9·5	3/8	± 1·6	± 1/16	± 2·4	± 3/32

TABLE II—PERMISSIBLE TOLERANCES ON DIMENSIONS OF GUTTERS AND GUTTER FITTINGS (CLAUSE 4.1.).

Thickness of Gutter or fitting.	*Permissible variation in thickness.*	*Permissible variation in external dimension.*
(1)	(2)	(3)
MM	MM	MM
8	±1	±2
9·5	±1·5	±3
12·5	±1·5	±3

TABLE II-A.—PERMISSIBLE TOLERANCES ON DIMENSIONS OF GUTTERS AND GUTTER FITTINGS (CLAUSE 4.1.).

Thickness of Gutter or fitting.		*Permissible variation in thickness.*		*Permissible variation in External dimension.*	
(1)	(2)	(3)	(4)	(5)	(6)
mm	in.	mm	in.	mm	in.
7·9	5/16	±0·8	±1/32	±1·6	±1/16
9·5	3/8	±1·6	±1/16	±3·2	±1/8
12·7	1/2	±1·6	±1/16	±3·2	±1/8

5. *General quality and workmanship.*

5.1. The material used in the manufacture of the pipes, gutters and fittings shall be intimately mixed by mechanical means.

5.2. The pipes shall be straight and the ends of the pipes, gutters and fittingshall be finished square to their axes.

5.3. The finished pipes, gutters and fittings shall be true and smooth, their inner and outer surfaces being as nearly as practicable concentric. They shall be in all respects sound, homogeneous and free from impurities or other imperfections.

5.4. The pipes, gutters and fittings shall be allowed to mature or at least four weeks before the specified tests are carried out and before delivery is made. During the first five days of this period they shall be kept in a moist condition.

6. *Finish.*

6.1. The finished products when delivered shall be free from visiole defects.

7. *Sampling.*

7.1. Three test specimens, from each group of 200 similar items shall be selected for testing purposes.

7.2. When the number in the group is less than 200, two tests specimens shall be selected upto 100 (inclusive) and from 101 to 200 three test specimens shall be selected.

7.3. The samples and the group from which samples are taken shall be suitably marked so as to be capable of being identified with each other.

EXTRACT FROM I.S. 774—1971

Specification for flushing cisterns for water closets and urinals (valveless siphonic type) (Third Revision).

2. *Terminology* :

2.0 For the purpose of this standard, the following definitions shall apply :—

2.1. *High level cistern* :—A cistern intended to operate with a minimum height of 125 cm between the top of the pan and the underside of the cistern.

2.2. *Low- level cistern* : A cistern intended to operate at a height not exceeding 30 cm between the top of the pan and the underside of the cistern.

3. *Materials* :

3.1. *Cisterns* : Cisterns shall be of cast iron, glazed earthenware, vitreous china. or pressed steel, complying with the requirements specified under 3.1.1. to 3.1.4 respectively; or they may be made of any other impervous material agreed upon between the purchaser and the supplier. Wooden bodies, either with or without lead, copper or any other lining shall not be used.

3.1.1. *Cast Iron* : Cast iron used for the manufacture of cistern shall be of a quality not less than Grade 15 of I.S. 210-1962.

3.1.2. *Earthenware* :—Earthenware cistern shall conform to the material requirements specified in Par. I of I.S. 771-1963.

3.1.3. *Vitreous China* :—Vitreous China cistern shall conform to the requirements specified in Part I of I.S. 2556-1967.

3.1.4. *Pressed Steel* :—Pressed steel used for the manufacture of cisterns shall conform to any one of the types of steel sheets given in I.S. 513-1963.

3.2. *Flush Pipe.*—The following materials may be used for flush pipe:

(a) Steel tube, seamless or welded (See I.S.1239 (Part I) 1968

(b) Lead pipe (See I.S.404-1962)***

(c) Copper alloy pipes (See I.S. 407-1966 and I.S.1545-1969)

(d) Polyethylene pipes, low density (See I.S. 3076-1968) high density (See I.S. 4984-1968)*

(e) Unplasticized PVC pipes (See I.S. 4985-1968) and

(f) Smooth bore cast iron pipe (for low level flushing cistern).

3.3. *Bolts and Nuts.*—Bolts, and nuts used in the cisterns shall be made of galvanized steel or non-ferreous metal.

3.4. *Cover*—Cover shall be made of the same material as the body.

3.5. *Ball Valves.*—The materials used for manufacture of ball valves shall conform to those specified in I.S. 1703-1965. Where made of other materials, they shall be non-corridible and non absorbent and shall have equivalent strength and performance as given in I.S. 1703-1969.†

3.6. *Chain*—Chain shall be of galvanized steel wire or inter locked non-ferrous metal or other corrosion resisting material.

3.7. *Overflow pipe*.—Overflow pipe shall be manufactured from non-ferrous metal or other corrosion resisting material.

4. *Construction* .

4.1. *Cistern*–The body thickness shall be not less than 5, 10 and 13 mm for cast iron, vitreous china and earthenware cisterns respectively. The body of pressed steel cistern shall be of seamless or welded construction, of thickness not less than, 1.60 mm before coating, and shall be porcelain enamelled or otherwise protected against corrosion by an equally efficient coating. Cistern shall be free from manufacturing faults and other defects affecting its utility. All working parts shall be designed to operate smoothly and efficiently. Cistern shall be mosquito-proof; it shall be deemed to be mosquito-proof only when there is no clearance anywhere which would permit a 1.60 mm wire to pass through the cistern. The outlet of each siphon or stand pipe shall be securely connected to the cistern by means of lock nut made of any non-corrosive material, non-ferrous metal or galvanized steel.

4.1.1. Cisterns shall be of curved type, bell type or any other type working on siphonic principle and shall comply with the requirements of 6. Typical illustrations of curved type and bell type cisterns are given in Fig. 1 and Fig. 2.

4.2. *Cover*.—Cistern shall be provided with a removable cover which shall fit closely on the cistern and be secured against displacement. In designs where the operating mechanism is attached to the cover, this may be made in two sections, but the section supporting the mechanism shall be securely bolted or screwed to the body.

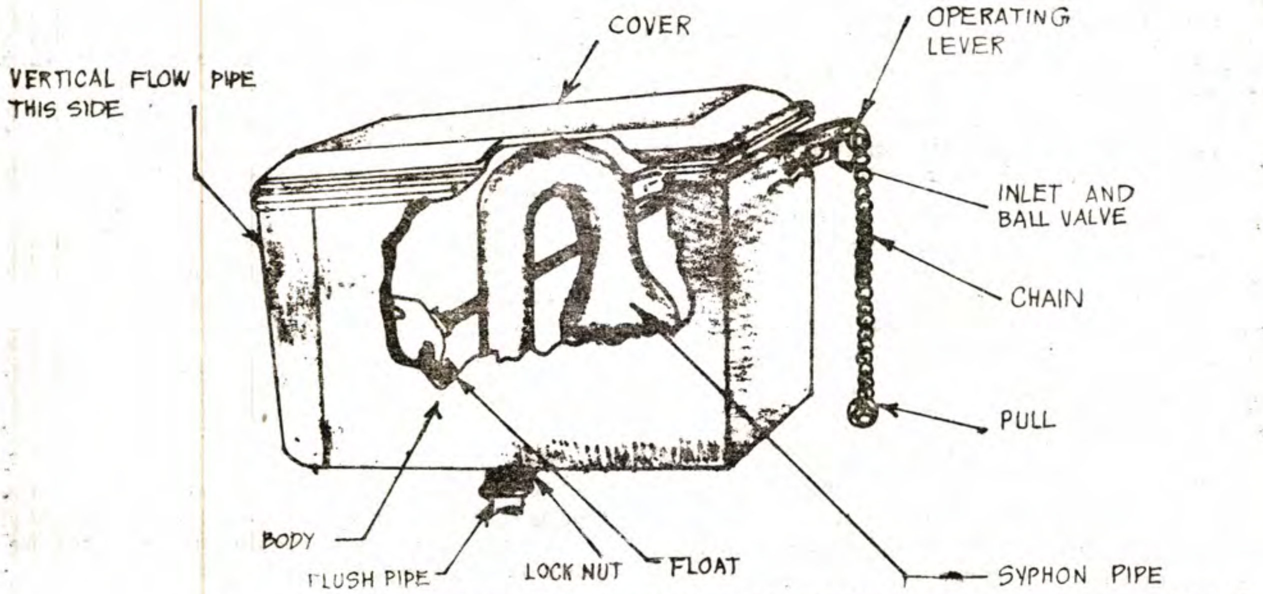


FIG- 1 TYPICAL SKETCH OF CURVED SIPHON TYPE CISTERN.

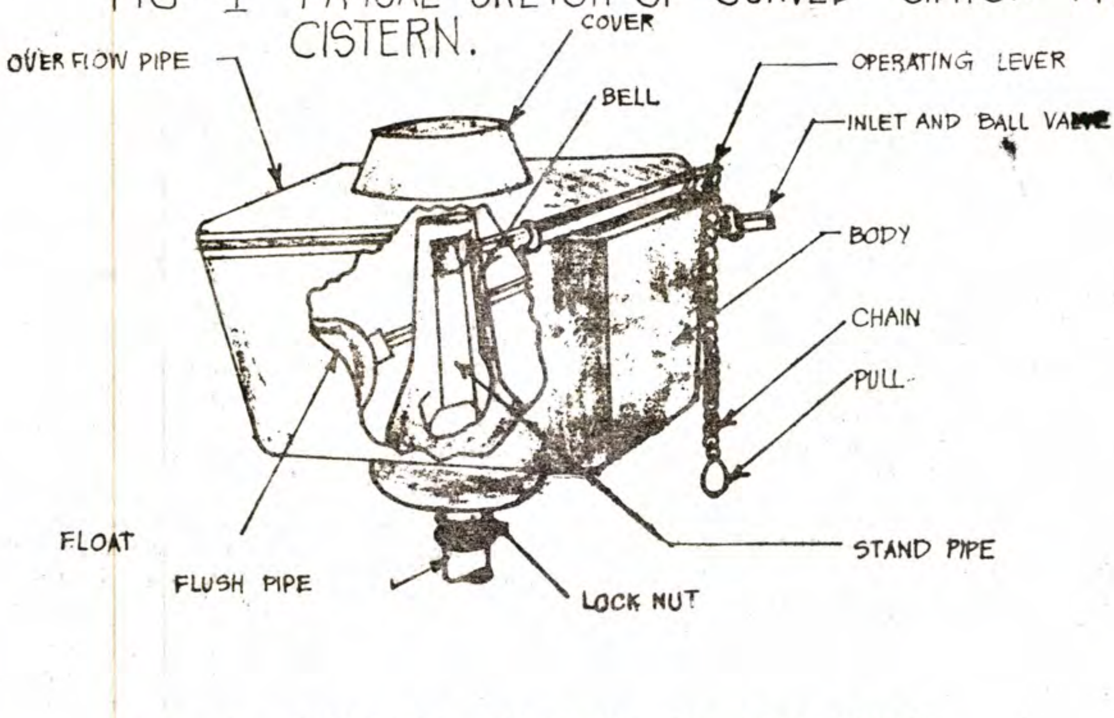


FIG. 2 TYPICAL SKETCH OF BELL-TYPE CISTERN.

4.3. *Flush Pipe*.—Flush pipe shall have a nominal internal diameter of 32mm for high level cisterns and nominal internal diameter of 40 mm for low-level cisterns however, for high-level flushing cisterns of 15 litres discharge capacity it shall not be less than 40 mm (*See* Note under 6.5). The steel flush pipe shall be not less than 1.00 mm thick and the flush pipe shall be completely protected inside and outside by hot galvanized or other equally efficient method of protection. Lead flush pipe shall have a minimum thickness of 3.5 mm. A pipe clip fitted with a rubber buffer shall be fixed to flush pipe to prevent damage either to the pipe or to the seat when the seat is raised.

NOTE.—The minimum thickness recommended are for normal conditions of service but where highly corrosive atmospheres are expected greater thickness are recommended.

4.3.1. *Flush Pipe Connection to Cistern.*—The flush pipe shall be securely connected to the cistern outlet by means of coupling nut made of any non-corrosive material, non-ferrous metal or galvanized steel. The nominal internal diameter of the outlet of the cistern shall be not less than 32 mm and 40 mm for high-level and low level cisterns respectively however, for high-level flushing cisterns of 15 litres discharge capacity it shall not be less than 40 mm (*see* Note under 6.5). The screw threads for connection to flush pipe shall conform to FP 1½ of I.S. 2643–1964. When ordered for use with a lead flush pipe the outlet connection may be supplied with coupling nut of brass or other non-corrodible material and a plain tailpiece having a minimum length of 6 mm. The centre of the outlet hole shall be generally central to the length of the cistern.

4.4. *Inlet and Overflow Holes.*—Cistern, in the case of curved siphon or bell type, shall be provided with inlet and overflow holes, situated one at each end, which shall be capable of accommodating an overflow pipe of not less than 20 mm nominal bore or a 15 mm ball valve (*see* 4.5). The holes for inlet and overflow shall be cleanly cast or drilled and the adjacent surfaces shall be smooth.

4.5. *Ball valves.*—Ball valves shall be of 15 mm nominal size and shall conform to I.S. 1703–1968. The design shall permit the cistern to fill in rapidly and close effectively when the level of the water reaches the working water level.

4.6. *Lever.*—The lever shall not project beyond the side of the cistern for a distance greater than 35 mm measured from the centre of the cistern to the end of lever arm. The lever arm in the case of curved siphon or bell type cistern shall be provided with a suitable hole near the end through which a split ring or a S-hook can be inserted. A chain shall be attached by the ring or hook. Where the S-hook is employed it shall be effectively closed after assembly to prevent accidental disconnection.

4.6.1. In case of low-level cisterns, where the mechanism is handle operated the handle, whether situated on the front or at the end of the cistern, shall be within the projection limit for levers given in 4.6. Particular attention shall be given to the case of operation of the handle.

4.7. *Chain.*—The chain shall be of such a strength as to sustain a dead load of 50 kg. without any apparent or permanent deformation of the shape of the link.

4.7.1. The chain shall terminate in a suitable handle or "pull" which shall be of galvanized iron, non-ferrous metal or a moulding in any heat resisting and non-obsorbent plastic. The finish shall be smooth and all burrs, which are liable to cause injury to the hand when gripped shall be removed.

4.8. *Overflow pipe.*—The overflow pipe shall be of not less than 20 mm nominal bore. The flow pipe shall incorporate a non-corrodible over mosquito-proof devise secured in a manner which will permit it to be readily cleaned or renewed when necessary. No provision shall be made whereby the overflows from the cistern shall discharge directly into the water closet or soil pipe without being detected.

4.8.1. The invert of the overflow pipe shall be 22 ± 3 mm above the working water level, but shall be so placed that under all circumstances the water shall overflow into the overflow pipe before overflowing into the siphon pipe, when the level of water rises above the working water level (that is, the level at which siphon can start functioning) (*see* also 6.3.)

5. *Finish* :

5.1. Cast iron cisterns shall be painted inside with suitable anti-corrosive paint and with a priming coat on the outside before delivery. Moulding sand shall be removed from all surfaces before application of the protective coating. Painting and finishing shall be done in accordance with the recommendations made in I.S. 1477-(Part I) 1971. Alternatively, cast iron cisterns shall be protected against corrosion by a coating of enamel.

EXTRACT OF I.S. 7231—1974.

I.S. Specification for Plastic Flushing Cisterns (Valveless Siphonic Type) for Water Closets and Urinals.

1. *Scope*:

1.1. This standard covers the requirements for manually operated high level and low-level valveless siphonic type plastic flushing cisterns for water closets and urinals.

2. *Terminology*:

2.0. For the purpose of this standard, the following definitions shall apply.

2.1. *High-Level Cistern.*—A cistern intended to operate with a minimum height of 125 cm. between the top of the pan and the under side of the cistern.

2.2. *Low-Level Cistern.*—A cistern intended to operate at a height not exceeding 30 cm. between the top of the pan and the under-side of the cistern.

3. *Materials*:

3.1. Cisterns shall be made from high density polyethylene conforming to the requirements given in I.S. : 7328—1974. Cistern made from other plastic materials will also be permissible if they satisfy the requirements as given in the standard.

3.2. *Flush Pipe.*—The following materials may be used for flush pipe :—

(*a*) Steel tube, seamless or welded (*see* I.S. : 1239 (Part I)—1968.)

(*b*) Lead pipe (*see* I.S. : 404—1962).

(*c*) Copper alloy pipes (*see* I.S. : 407—1967 and I.S. : 1545—1969).

(*d*) Polyethylene pipes, low density (*see* I.S. : 3076—1968) or high density (*see* I.S. : 4984—1972).

(*e*) Unplasticized PVC pipes (*see* I.S. : 4985—1968) and

(*f*) Smooth bore cast iron pipe (for low-level flushing cisterns).

3.3. *Cover.*—Cover shall be made of the same mateiral as the body.

3.4. *Ball valves.*—The material used for the manufacture of ball valves shall conform to those specified in I.S. : 1703—1968. Where made of other materials they should be non-corrodable and non-absorbent and shall have equivalent strength and performance as given in I.S.: 1703—1968.

3.5. *Overflow pipes.*—The overflow pipes shall be manufactured from high density polyethylene conforming to I.S. : 4984—1972 or unplasticized PVC pipes conforming to I.S. : 4985—1968.

4. *Construction*:

4.1. The wall thickness shall be not less than 4 mm. All working parts shall be designed to operate smoothly and efficiently. Cistern shall be mosquito proof ; it shall be deemed to be mosquito-proof when there is no clearance anywhere which would permit 1·60 mm. wire to pass through the cistern. The outlet of siphon or stand pipe shall be clearly connected to the cistern by means of lock nut made of high density polyethylene or any other non-corrosive material.

4.1.1. Cistern shall be of curved type or bell type or any other type working on siphonic principle and shall comply with the requirements given in 6.

4.2. *Cover.*—Cistern shall be provided with a removable cover which shall fit closely on the cistern and be secured against displacement. In designs where the operating mechanism is attached to the cover, this may be made in two sections, but the section supporting the mechanism shall be securely fixed or hooked to the body.

4.3. *Flush pipe.*—Flush pipe shall have a nominal internal diameter of 32 mm. for high-level cisterns and 40 mm for low-level cistern. The steel flush pipe shall be not less than 1·00 mm. thick and the flush pipe shall be completely protected inside and outside by hot galvanizing or other equally efficient method of protection.

NOTE.—The minimum thickness recommended are for normal conditions of service but where highly corrosive atmospheres are expected, greater thicknesses are recommended.

4.3.1. *Flush pipe connection to Cistern.*—The flush pipe shall be securely connected to the cistern outlet by means of coupling nut made of any non-corrosive material, non-ferrous metal or galvanized steel. The nominal internal diameter of the outlet of the cistern shall be not less than 32 mm and 40 mm. for high level and low level cisterns respectively. The screw threads for connection to flush pipe shall conform to FP 1½ of I.S. : 2643—1964. When ordered for use with a lead flush pipe the outlet connection may be supplied with coupling nut of brass or other non-corrosive material and a plain tail piece having a minimum length of 6 cm. The centre of the outlet hole shall be generally central to the length of the cistern. The length of the outlet of the cistern shall be 37±2 mm. in the case of interchangeable siphon ; however, where integral siphons are provided, the outlet length shall be 20±2 mm.

4.4. *Inlet and Overflow Holes.*—Cistern, in the case of curved siphon or bell type, shall be provided with inlet and overflow holes, situated one at each end, which shall be capable of accommodating an overflow pipe of not less than 20 mm. nominal bore or a 15 mm. ball valve (*see* 4·5). The holes for inlet and overflow shall be cleanly cast or drilled and the adjacent surfaces shall be smooth.

4.5. *Ball valves.*—Ball valves shall be of 15 mm. nominal size and shall conform to I.S. : 1703—1968. The deisgn shall permit the cistern to fill in rapidly and close effectively when the level of the water reaches the working water level.

4.6. *Overflow pipe.*—The overflow pipe shall be of not less than 20 mm. nominal bore. The overflow pipe shall incorporate a non-corrosive mosquito proof device secured in a manner which will permit it to be readily cleaned or renewed when necessary. No provision shall be made whereby the overflows from the cistern shall discharge directly into the water closet or soil pipe without being detected.

4.6.1. The invert of the overflow pipe shall be 22±3 mm. above the working water level, or shall be so placed that under all circumstances the water shall overflow into the overflow pipe before overflowing into the siphon pipe, when the level of water rises above the working water level, that is, the level at which siphon can start functioning (*see* also 6.3.).

4.7. *Flushing mechanism.*—A knob or any other suitable means of lifting or pressing type shall be provided for the operation of flushing cistern.

4.8. *Lever.*—The lever shall not project beyond the side of the cistern for a distance greater than 35 cm. measured from the centre of the cistern to the end of lever arm. The lever arm in the case of curved siphon or bell type cistern shall be provided with a suitable hole near the end through which a split ring or a S-hook can be inserted. A chain shall be attached to the ring of hook. Where the S-hook is employed it shall be effectively closed after assembly to prevent accidental disconnection.

4.8.1. In case of low-level cisterns, where the mechanicsm is handle operated the handle, whether situated on the front or at the end of the cistern shall be within the projection limit for levers given in 4.8. Particular attention shall be given to the case of the operation of the handle.

4.9. *String (Chain).*—The String or Chain shall be of such a strength as to sustain a dead load of 50 kg. without any appearent or permanent deformation.

4.9.1. The string shall terminate in a suitable handle or "pull" made of moulding in any heat-resisting and non-absorbent plastic or any other equally suitable material. The finish shall be smooth and all burns, which are liable to cause injury to the hand when gripped, shall be removed.

5. *Finish and Workmanship*:

5.1. The surface of the cistern shall be free from blisters and delamination and reasonably free from flow line streaking or colour variations.

6. *Operation and performance requirements*:

6.1. *Siphonic Arrangements*—Cistern shall operate on the valveless siphon principle, the siphonic action being started by the operating lever. The cistern under working conditions and with the ball valve in position shall operate on a single operation of the lever without calling for a sudden jerk in pulling.

6.2. *Working Water Level.*—The working water level shall be a minimum of 6·5 cm. below the effective top edge of the cistern and shall be legibly and permanently marked on the inside of the cistern.

6.3. *Freedom from Self-Siphonage.*—The siphonic system shall be capable of being rapidly brought into action when the water is at the working water level, but shall not self-siphon or leak into the flush pipe when the water is up to one centimetre above the invert of the overflow pipe.

6.4. *Reduced Water Level.*—The discharge shall operate satisfactorily when cistern is filled to a level up to one centimere below the working water level.

6.5. *Discharge capacity.*—Discharge capacities of cisterns and tolerances on the same, shall be as follows :—

$$\left.\begin{array}{r}5 \text{ litres}\\10 \text{ litres}\\12{\cdot}5 \text{ litres}\end{array}\right\} \pm 0{\cdot}5 \text{ litres.}$$

6.6. *Discharge rate.*—Cisterns shall discharge at an average rate of 5 litres in 3 seconds when connected to the appropirate flush pipe and there shall be no appreciable change in the force of the flush during the period discharge.

6.6.1. For the purpose of test, the "appropriate flush pipe" shall be deemed to be.

(*a*) Vertical pipe 125 cm. long having a nominal internal diameter of 32 mm. in the case of high-level cistern, and

(*b*) a vertical pipe 30 cm. long having a nominal internal diameter of 40 mm. of the pipe actually supplied or recommended by the cistern manufacturer in the case of low-level cisterns.

EXTRACT FROM I.S. 780-1969.

Specification for Sluice Valves for Water Works purposes.

(50 to 300 mm. Size) (Fourth Revision).

1. *Scope*—

1·1. This standard covers requirements for inside screw, non-rising spindle type sluice valves from 50 mm. to 300 mm. size used for water works purposes with double flange and cap or handwheel for operation.

2. *Classification.*

2·1. Sluicevalves shall be of two classes,namely, Class I and Class 2.

2·2. Test pressures and maximum working pressures for the two classes of sluice valves shall be as specified below :—

	Test pressure Kgf./Cm.^{2}		*Maximum working pressure Kgf./Cm.^{2}*
	Body.	*Seat.*	
Class 1 ..	20	10	10
Class 2 ..	30	15	15

3. *Nominal Sizes* : –

3·1. Sluice valves shall be of the following nominal sizes :

50, 65, 80, 100, 125, 150, 200, 250 and 300 mm.

3·1·1. The nominal size shall refer to the nominal bore of the waterway.

4. *Materials* :

4·1. *Cast Iron.*—Cast iron for bolles, domes, covers, stuffing box, thrust plates, handwheel, wedge, gland and cap shall be of a quality not less than Grade 20 of I.S. 210-1962.

4·2. *Material for Spindle.*—The spindle may be manufactured from any of the non-ferrous and ferrous metals given in 4·2·1 and 4·2·2, the type of metal shall be specified by the purchaser.

4·2·1. *Non-ferrous Metals*:

4·2·1·1. *High Tensile brass or aluminium bronze.*—Spindle shall be machined from rolled, extruded or forged high—tensile brass or aluminium bronze. The tensile strength of the rolled, extruded or forged metal shall not be less than 44 Kgf/cm^2 with a minimum elongation of 20 per cent on a gauge length of 5 cm ; other requirements are given below :—

(*a*) The tensile strength shall be determined in accordance with I.S. 2654-1964!.

(*b*) For rods or sections over 30 mm the longitudinal axis of the test piece shall be 15 mm. from the outside edge of the bar, rod or section.

(*c*) The sample from the forged test bar shall not show any sign of cracking when subjected to the mercurous nitrate test specified in I.S. 2305-1962.

(*d*) The minimum Brinell hardness number for the materials specified shall be 80, when tested with a 10 mm. diameter ball and a load of 1,000 kg. applied for 15 seconds.

4·2·2. *Ferrous Metals* :

4·2·2·1. *Chromium Steel.*—Chromium content shall not be less than 12 per cent (*see* I.S. 1570-1961).

4·3. *Mild Steel.*—Bolts and nuts shall be of mild steel unless otherwise specified by the purchaser ; and the mild steel shall conform to I.S. 226-1962.

4·4. *Material for Rings and Spindle Nut.*—The rings and spindle nut may be manufactured from any of the non-ferrous or ferrous materials given in 4·4·1 and 4·4·2.

4·4·1. Leaded Gunmetal : (non-ferrous Metal).—It shall have a minimum tensile strength of 22 kgf/mm^2 and an elongation of not less than 12 per cent on gauge length of 5 cm. when tested in accordance with I.S. 2654-1964. Wedges of 50 and 65 mm. size, however, may also be made of the same material.

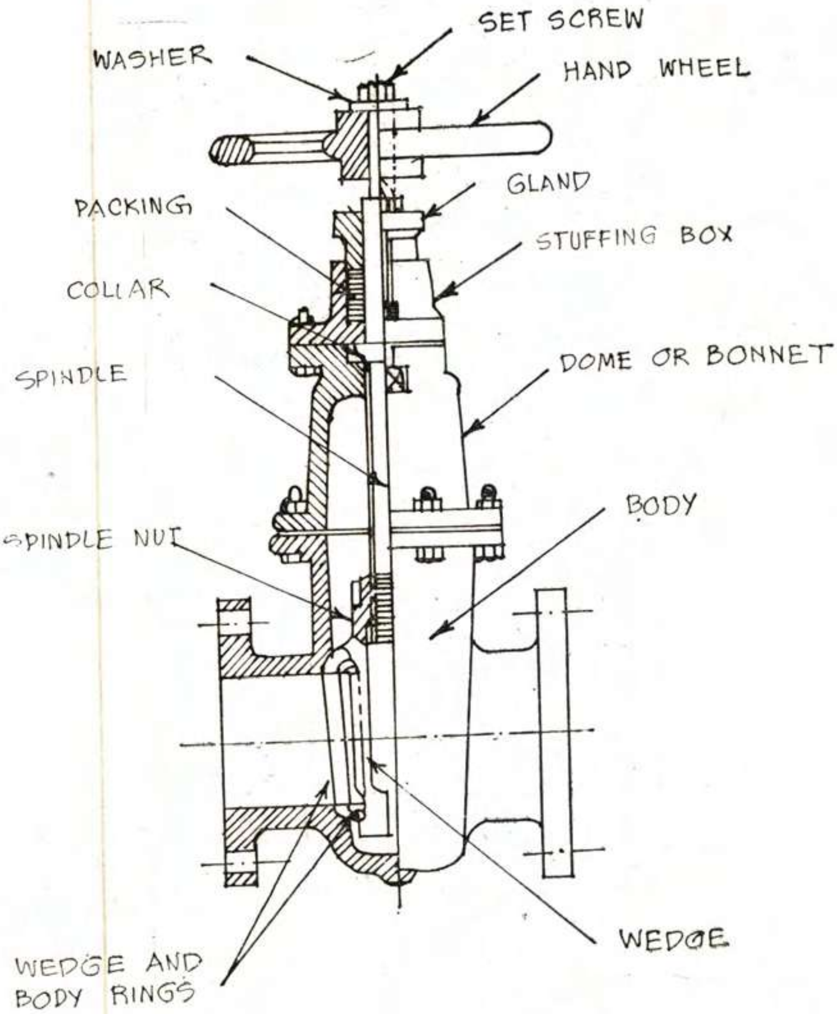
4·4·1·1. The manufacturer shall ensure that there is no segregation of lead and give a guarantee to this effect to the purchaser. However, where so desired by the purchaser, a typical sample may be effered by the manufacturer for checking for segregation by micro-examination at a recognized testing laboratory.

4·4·1·2. The minimum Brinell hardness number shall be 65 when tested with a 10 mm. diameter ball and a load of 1,000 kg. applied for 15 seconds (*see* I.S. 3054-1965).

4·4·2. *Ferrous Metal* :

(*a*) Spheroidal or modular cast iron (*see* I.S. 1865-1961).

(*b*) Chromium steel—Chromium content shall not be less than 12 per cent (*see* I.S. 1570-1961). The Brinel hardness members of the body ring and wedge ring, shall differ at least by 50.

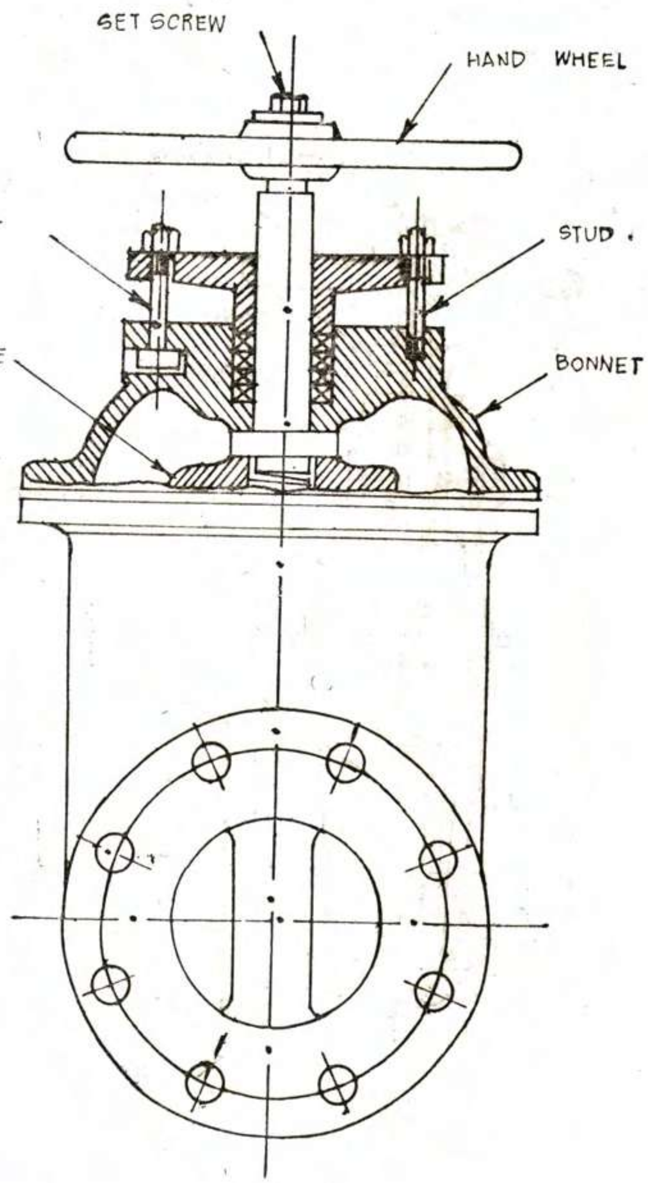


NOTE: THE SHAPES OF THE COMPONENT PARTS ARE ONLY ILLUSTRATIVE AND WHERE DIMENSIONS ARE SPECIFIED THEY ARE BINDING.

1A TYPICAL SKETCH OF SLUICE VALVE

FIG 1 - SLUICE VALVE - CONTD.

466-3A—32



NOTE : THE SHAPES OF THE COMPONENT PARTS ARE ONLY ILLUSTRATIVE AND WHERE DIMENSIONS ARE SPECIFIED THEY ARE BINDING .

1B TYPICAL SKETCH OF SLUICE VALVE WITH DOUBLE FLANGED ENDS

FIG- 1 SLUICE VALVE

4·5. *Flange Jointing Material.*—The jointing material used between he flange of component parts of the valves shall be compressed fibre board or rubber (*see* I.S. 638-1965**) of thickness between 1·5 mm to 8 mm. The fibre board shall be impragnated with chemically neutral mineral oil and shall have than 112 g per millimetre thickness.

4·5·1. Jointing material between connecting flanges and adopters shall conform to the materials specified in I.S. 638-1965.**

4·6. *Stuffing Box Packing.*—The packing used in the stuffing box shall be of plated construction made from Italian line hemp or other suitable material throughly impregnated with a high quality chemically neutral mineral grease containing no leading material and free from saponifiable matter; alternatively, graphite impregnated packing material may also be used. It shall be twisted from 1 or 2 lea* yarn or a combination of these according to size and shall have a density of not less than 0·9 g./cm.^{3} or more than 1·2 g/cm.^{3}

5. *Manufacture.*

5·1. Sluice valves of 200 mm. 250 mm and 300 mm. shall be provided with domes as shown in Fig. I-A. Other sizes shall be provided with bonete itably designed to take T-bolts or studs, as shown in Fig. I-B

EXTRACT FROM I.S. 2470 (PART I) 1968.

Code of Practice for Design and Construction of Septic Tanks

PART I—SMALL INSTALLATIONS.

(First revision)

1. *Scope.*

1·1. This code lays down recommendations for the design, lay out, construction and maintenance of septic tanks and includes method of treatment and disposal of tank effluent of domestic sewage. It is applicable to houses, flats and such other residential building where the number of users does not exceed 50 persons. Capacities and sizes required for 5, 10, 15, 20 and 50 persons are recommended to facilitate selection of sizes of septic tanks.

2. *Terminology.*

2·0. For the purpose of this standard, the following definition shall apply.

2·1. *Biological Filter.*—It consists of a bed of gravel, broken stone, clinkers or such other material through which sewage flows. The organic matter present in the sewage gets partly removed and stabilised by the biological slime on the surface of the media.

2·2. *Dispersion Trench.*—A trench in which open jointed pipes are laid and surrounded by coarse aggregate media and overlaid by fine aggregate. The effluent gets dispersed through the open joints and is absorbed in the neighbouring soil.

2·3. *Effluents.*

(*a*) *Tank Effluent.*—The supernatant liquid discharge from a septic tank.

(*b*) *Filter Effluent.*—The liquid discharged from a biological filter.

2·4. *Filter Media.*— Materials, such as clinker, broken stone,and gravel through which sewage flows and on the surface of which zoogleal films develop.

2·5. *Invert.*— The lowest point of the interior of a sewer or drain at any cross-section.

NOTE.— For example, in a manhole chamber, the bottom of channel which carries the flow of sewage through the manhole.

2·6. *Scum.*— The greasy and other substances floating on the surface of sewage.

2·7. *Seepage Pit.*—(Soakaway, Soak Pit).—A pit through which effluent is allowed to seep or leach into the surrounding soil.

2·8. *Septic Tank.*—A watertight single storeyed tank in which sewage is retained sufficiently long to permit sedimentation of suspended solids and partial digestion of settled sludge by anaerobic bacteria.

2·9. *Sewage.*— The liquid waste of a household or community including human excreta.

2·10. *Sludge.*— Sludge is the settled solid matter in semi-solid condition.

2.11. *Subsoil Water*·—Water occurring naturally below the surface of the ground.

2.12. *Surface Water*: The run-off from precipitation and other water that flows over surface of the ground.

2.13. *Waste water*: The discharge from wash basins, sinks and similar appliances, which does not contain human excreta.

3. *Preliminary data for design.*

3.1. In order to design a septic tank installation and the associated secondary treatment works, information on the following items should be collected:—

3.1.1. *Particulars of site and sewerage system.*

(*a*) The Nature of the soil and subsoil conditions :

(1) The fullest possible information on the nature of the soil and subsoil conditions should be obtained, as well as the approximate water-table and any available records of flood levels or information as to the variation seasonal or otherwise, in the water-table.

(2) The soil should be explored to a sufficicient depth to ascertain the soil horizons and the soil types, grading, structure and permeability. The external drainage factors, such as slope of ground and position of surface water drains, if any should be ascertained Exploration of the soil to a significant depth should be made because, casual or visual inspection may fail to reveal unsuitable conditions such as an impervious granite, layer under sand, or on the other hand suitable conditions, such as permeable schist overlaid by clay.

(3) *Soil Types.*—An approximate field identification of the soil should be made in accordance with the methods given in I.S. 1498–1959†. Trial bores or boreholes should be sunk along the line of the proposed septic tank and biological filter, and data there from tabulated. In general, the information obtained from trial bores is more reliable than that from boreholes. The positions of trial bores or boreholes should be shown on the plans together with sections showing the strata found and the dates on which the water levels were recorded. Full information should be given as to the structure, type, colour, permeability, depth and horizons of the soils; as well as any impedances to drainage such as rock bars.

(4) *Percolation test.*—To, decide on the details of a soil absorption system a soil absorption test shall be conducted. The percolation rate that is time required in minutes for water to fall 25 mm in the test-hole shall be determined. A test in trial pits at more than one place in the area should be undertaken to permit deriving an average figure for percolation rate.

(*b*) Site plan showing the proposed or existing buildings to be drained as well as reduced ground levels over the site.

(*c*) Plans and sections of the proposed buildings, showing the positions and types of all sanitary fittings and other equipment requiring sewerage and the position of all rainwater pipes.

(*d*) The invert level of the drain at its point of discharge into the proposed septic tank.

(*e*) The number of users and number and types of fixtures in order that the total quantity and peak discharge may be computed

(*f*) The position and nature of outfall ditches or small streams.

(*g*) The position of any wells or tanks.

6. *Design considerations :*

6.1. *General*: In unsewered areas, every house should have arrangements for its sewage being treated in a septic tank, effluent from which should be given secondary treatment either in a biological filter on the land, or in a subsurface disposal system.

6.1.1. Surface and subsoil water should be excluded from finding way into the septic tank. Waste water may be passed into the septic tank provided the tank and the means for effluent disposal are designed to cope up with this extra liquid.

6.1.2. Depending on the location of the water-table and the nature of the strata, the type of disposal for the effluent from the septic tank may be decided (sec 6.8.1.)

6.1.3. Under no circumstances should effluent from a septic tank be allowed into an open channel drain or body of water without adequate treatment.

6.2. *Layout*: —

6.2.1. The lay out should be as simple and direct as practicable. A typical arrangement is illustrated in Fig. 1.

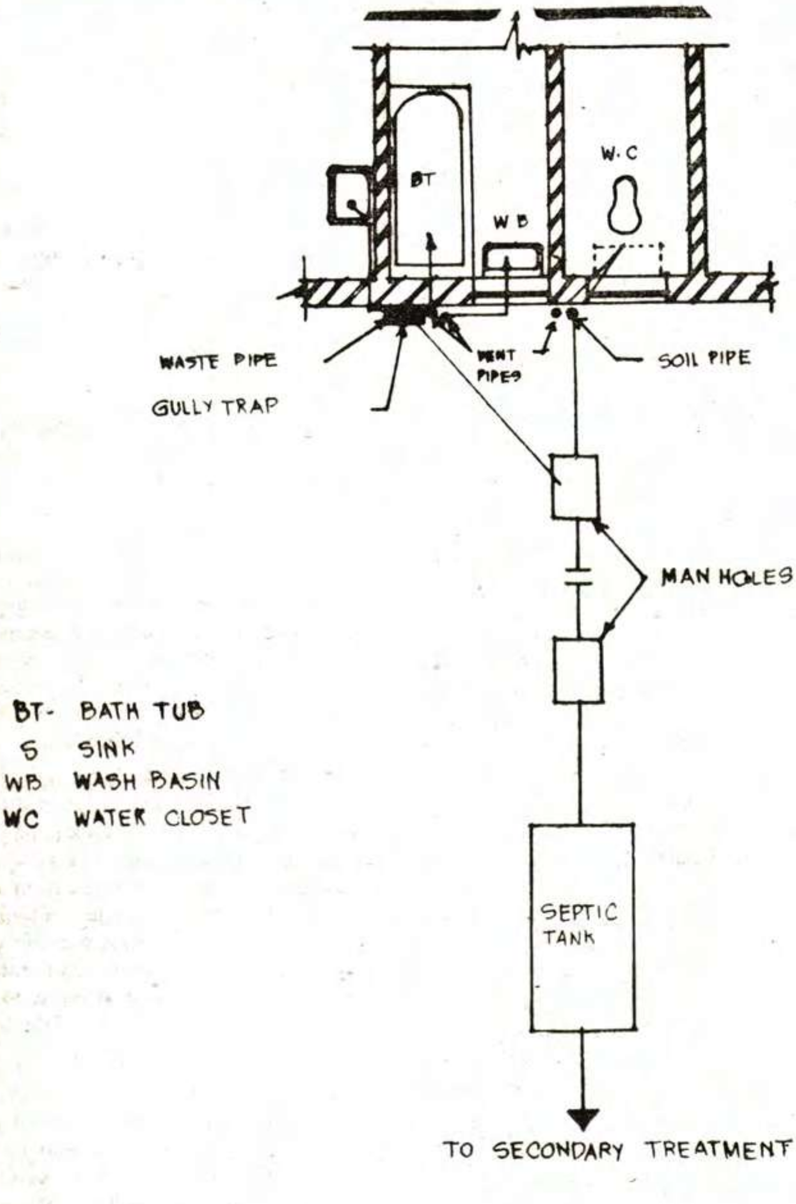


FIG-1 TYPICAL LAYOUT OF A SEPTIC TANK SEWERAGE SYSTEM.

6.2.2. The pipes should be laid as for as possible, in straight lines in both vertical and horizontal planes ; however where bends are unavoidable they should be long radius bends with cleaning eyes. Anything that is likely to cause irregularity of flow should be avoided.

6.2.3. At junctions of pipes in manholes direction of flow from a branch connection should not make an angle exceeding 45° with the direction of flow in the main pipe.

6.3. *Pipe Diameter*.—From practical considerations a minimum nominal diameter of 100 mm is recommended.

6.4. *Gradients*.—The gradients of land drains, under-drainage as well as the bottom of dispersion trenclhes and soakaways should be between 1:300 and 1 : 400.

6.5. *Location of Septic Tanks and Subsurface Absorption Systems*:

6.5.1. *Septic Tank*—Septic tank should be located at a place open to sky, as far away as possible from the exterior of the wall of building. It should also be accessible for cleaning.

6.5.2. *Subsurface Absorption Systems*.—A subsoil dispersion system shall not be closer than 18 m from any source of drinking water, such as well to mitigate the possibility of bacterial pollution of water-supply. It shall also be as far removed from the nearest habitable building as economically feasible but not closer than 6 m, to avoid damage to the structures. The actual distance however shall be based on the soil conditions in relation to both percolation and bearing capacity. Care should be taken that the ground below the adjacent building is not likelly to be affected by the effluent seeping into the soil. In limestones or crevice rock formations, the soil absorption system is not recommended as there may be channels in the formation which may carry contamination over a long distance; in such cases, and generally where suitable conditions do not exist for adoption of soil absorption systems, the effluent, where feasible should be treated in a trickling filter or chlorinated.

6.6. *Septic Tank* :

6.6.1. *Dimensions of septic tanks*.—Septic tanks shall have minimum width of 75cm, minimum depth of one metre below water level and a minimum liquid capacity of one cubic metre. Length of tanks shall be 2 to 4 times the width. Suitable sizes of septic tanks for use of 5, 10, 15, 20 and 50 persons based on certain assumptions (*see* Appendix B) are given in Table 1 for guidance.

6.6.1.1. A detention period of 24 to 48 hours is usually available based on the average daily flow of sewage. It may be noted however, that the average daily flow varies considerably from one installation to the other and the detention period should not be considered as a criterion for design of septic tank.

6.6.2. *Recommended designs*.—Figures 2 to 4 give typical designs of septic tanks.

6.6.3. *Construction*.—Septic tanks may be constructed of brickwork, stone masonry, concrete or other suitable materials.

6.6.3.1. *Brickwork and stone masonry*.—Walls built out of brick should not be less than 20 cm thick and should be plastered to a minimum thickness of 12 mm inside and outside with cement mortar not weaker than 1:3 where they are built out of stone masonry, they should have a minimum thickness of 37 cm.

6.6.3.2. The floor should be of cement concrete of grade M 150 (*see* I.S. 456-1964*) and should be sloped towards the sludge outlet, if any.

6.6.3.3. *Pipes and fittings*.—Inlet and outlet pipes and other fittings should be built in as the work proceeds. At the outlet ends, only tees are preferred but baffle walls may also be used where so desired.

6.6.3.4. *Concrete*.—Septic tanks may be built out of precast or cast in-situ concrete and shall have a mix of proportion not leaner than 1:2:4 or Grade M 150 (*see* I.S. 456-1964*).

6.6.3.5. *Other materials*.—Where septic tanks are constructed with materials other than brick stone or concrete, they should be of adequate thickness and quality to ensure water-tigtness and strength.

6.6.3.6. *Cover*.—Every septic tank shall be provided with a cover of adequate strength. Access openings shall be provided for purposes of desludging and inspection, if circular, the clear opening shall be 500 mm dia, minimum and if rectangular, the opening shall have minimum dimensions of 600 x 450 mm.

6.6.3.7. *Ventilating pipe*.—Every septic tank shall be provided with ventilating pipe of at least 50 mm diameter. The top of the pipe shall be provided with a suitable cage of mosquito proof wire mesh.

The ventilating pipes shall extend to a height which would cause no smell nuisance to any building in the area. Generally the ventilating pipe may extend to a height of about 2 m when the septic tank is at least 15 m away from the nearest building and to a height of 2 m above the top of the building when it is located closer than 15 metres. The ventilating pipe may also be connected to the norms soil ventilating system of the building where so desired.

6.7. *Disposal of sludge*.—The sludge from septic tanks may be delivered into covered pit or into a suitable vehicle for removal from the site. Spreading of sludge on the ground in the vicinity should not be allowed.

6.8. *Secondary treatment and disposal of the septic tank effluent* :

6.8.1. The effluent from septic tank should be disposed of by one of the methods given in Table 2 depending on the position of the subsoil water level soil and subsoil conditions and the size of the installation.

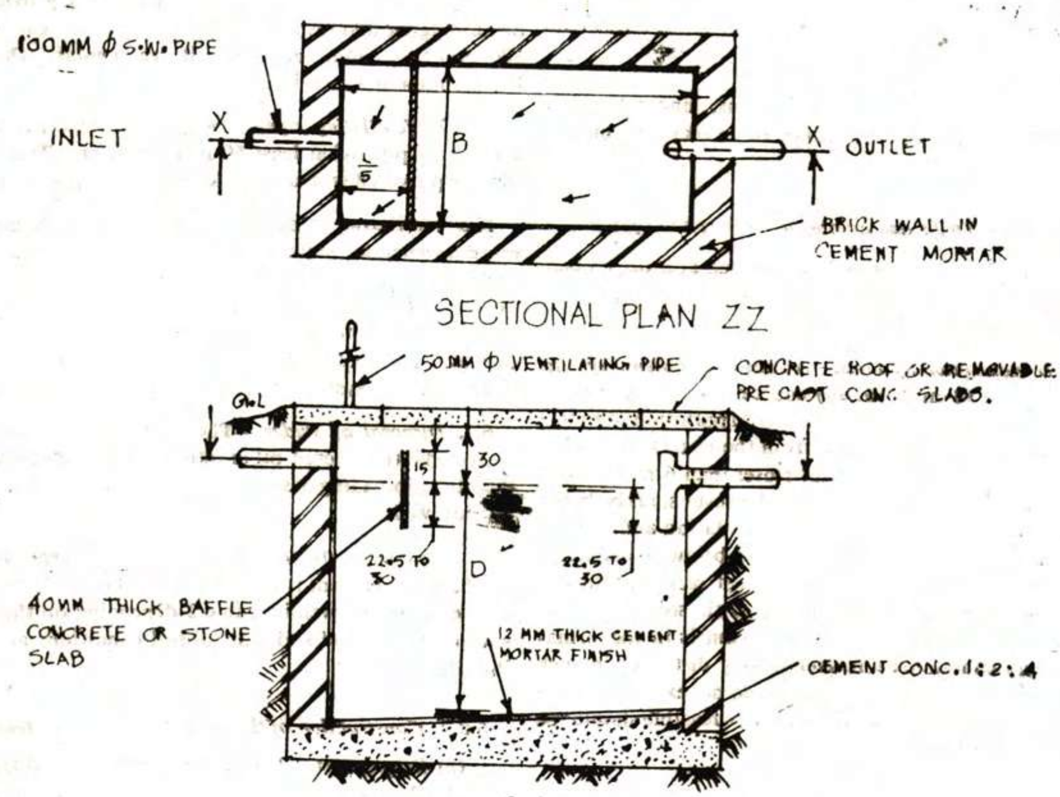
6.8.2. *Construction of the Soil Absorption systems* :

(*a*) *Seepage pit*.—The seepage pit may be of any suitable shape with the least cross—sectional dimension of 90 cm and not less than 100 cm in depth below the invert level of the inlet pipe. The pit may be lined with stone, brick or concrete blocks with dry open joints which should be backed with atleast 7.5 cm of clean coarse aggregate (*see* Fig. 5-A). The lining above the inlet level should be finished with mortar. In the case of pits of large dimensions, the top portion may be narrowed to reduce the size of the RCC cover slabs. Where no lining is used specially near trees, the entire pit should be filled with loose stones. A masonry ring may be constructed at the top of the pit to prevent damage by flooding of the pit by surface run off (*see* Fig. 5-B). The inlet pipe may be taken down a depth of 90 cm from the top as an antimosquito measure. Illustration of typical construction of seepage pits are given in Fig. 5.

(*b*) *Dispersion trench*.—Dispersion trenches shall be 50 to 100 cm deep and 30 to 100 cm wide excavated to a slight gradient and shall be provided with 15 to 25 cm of washed gravel or crushed stones. Open-jointed pipes placed inside the trench shall be made of unglazed earthen ware clay or concrete and shall have minimum internal diameter of 75 to 100 mm. Each dispersion trench should not be longer than 30 m. and trenches should not be placed closer than 1.8 m.

6.8.2.1. The covering for the pipes on the top should be with coarse aggregate of uniform size to a depth of approximately 15 cm. The aggregate above this level may be graded with aggregate 12 to15 mm to prevent ingress of top soil while the free flow of water is no way retarded. The trench may be covered with about 30 cm. of ordinary soil to form a mound and turfed over. Dispersion trenches are not recommended in areas where fibrous roots of trees or vegetation are likely to penetrate the system and cause blockages. The finished top surface may be kept at least 15 cm above ground level to prevent direct flooding of the trench during rains.

* Coee of practice for laid and reinforced conesete (second revision)



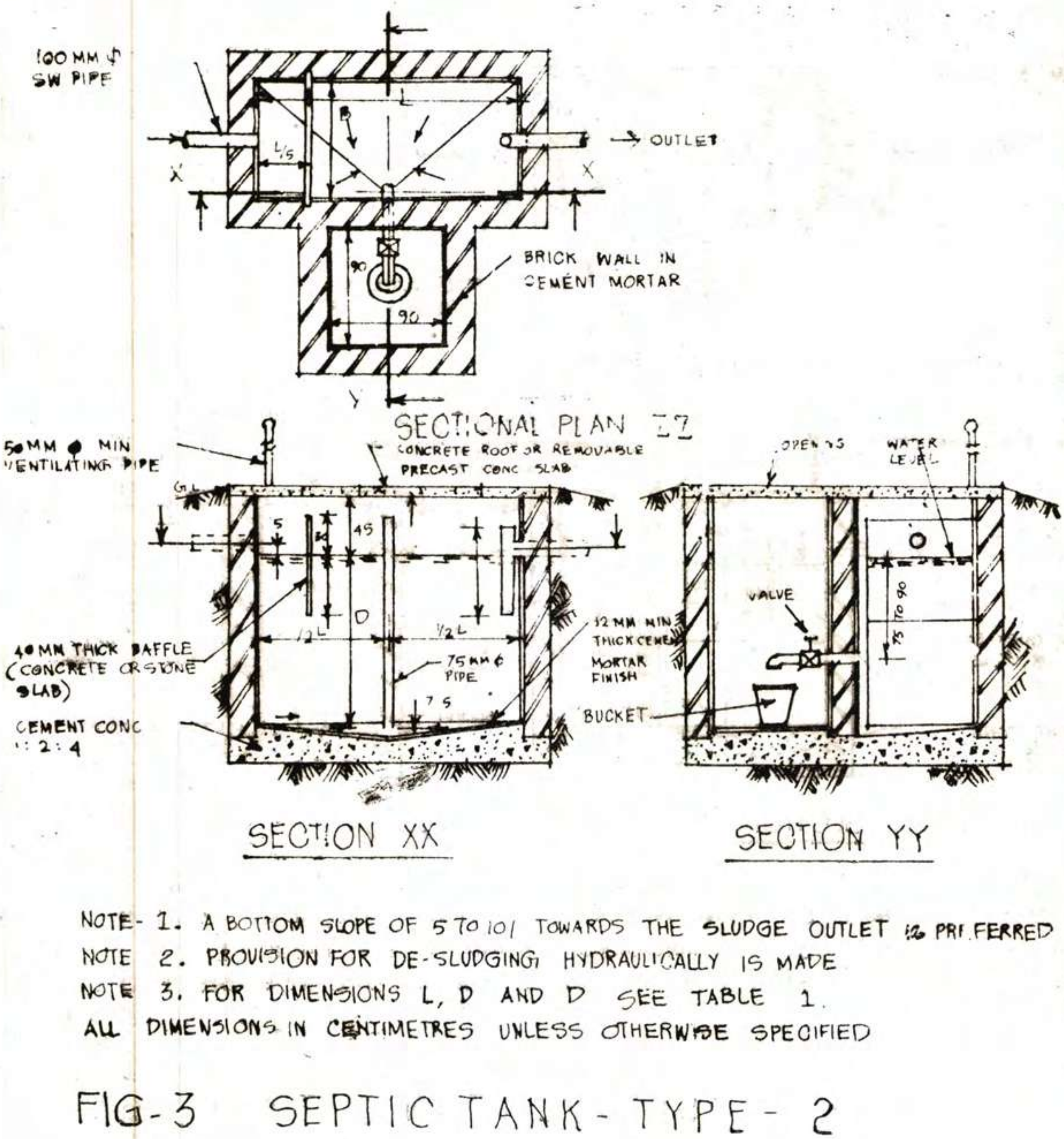
NOTE : 1. A BOTTOM SLOPE OF 5 TO 10 / TOWARDS INLET IS PREFERRED

NOTE : 2. TO BE DE-SLUDGED PREFERABLY BY PORTABLE PUMP

NOTE : 3. FOR DIMENSIONS L, B AND D SEE TABLE 1

ALL DIMENSIONS IN CENTIMETRES UNLESS OTHERWISE SPECIFIED

FIG 2 · SEPTIC TANK - TYPE - 1



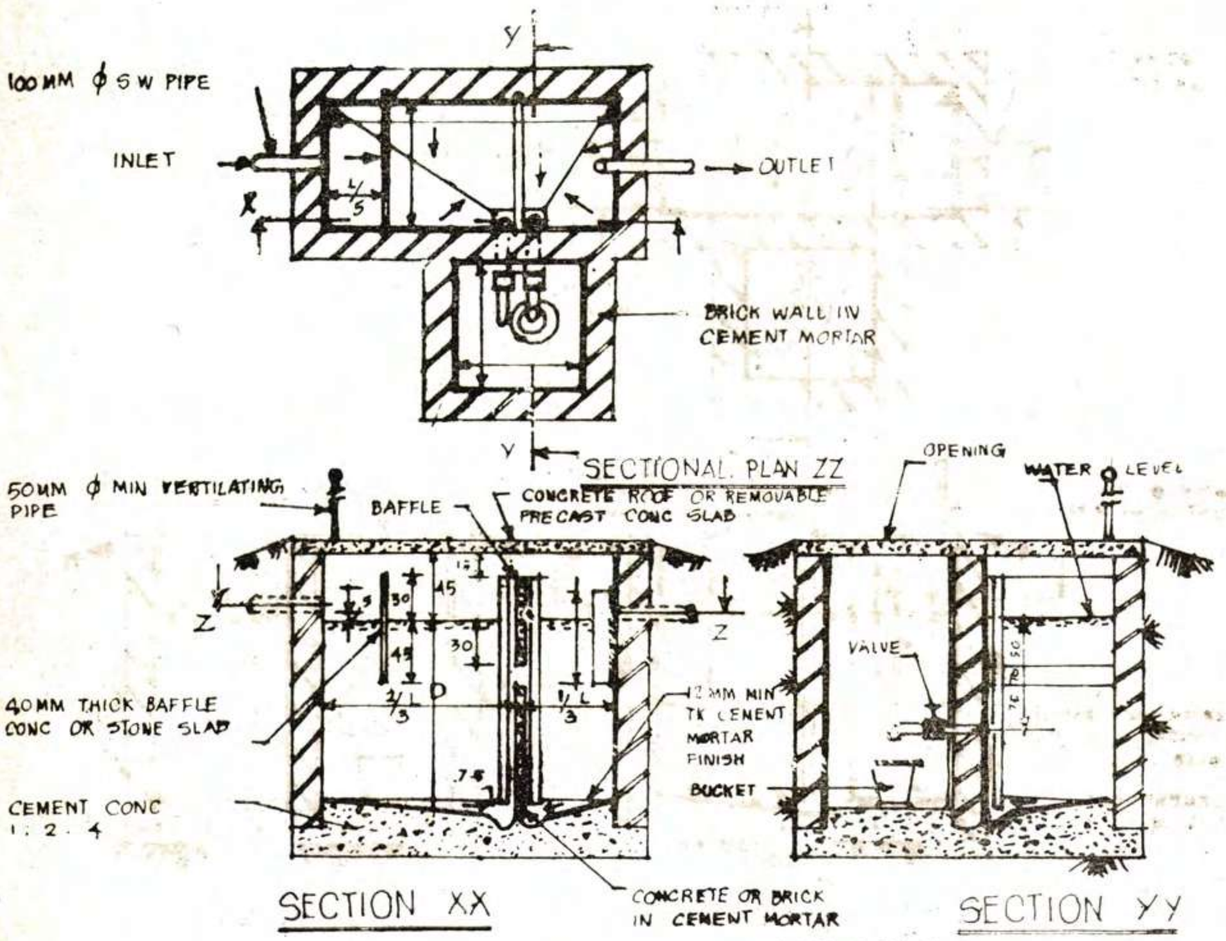
NOTE- 1. A BOTTOM SLOPE OF 5 TO 10/ TOWARDS THE SLUDGE OUTLET IS PREFERRED

NOTE 2. PROVISION FOR DE-SLUDGING HYDRAULICALLY IS MADE

NOTE 3. FOR DIMENSIONS L, D AND D SEE TABLE 1.

ALL DIMENSIONS IN CENTIMETRES UNLESS OTHERWISE SPECIFIED

FIG-3 SEPTIC TANK - TYPE - 2



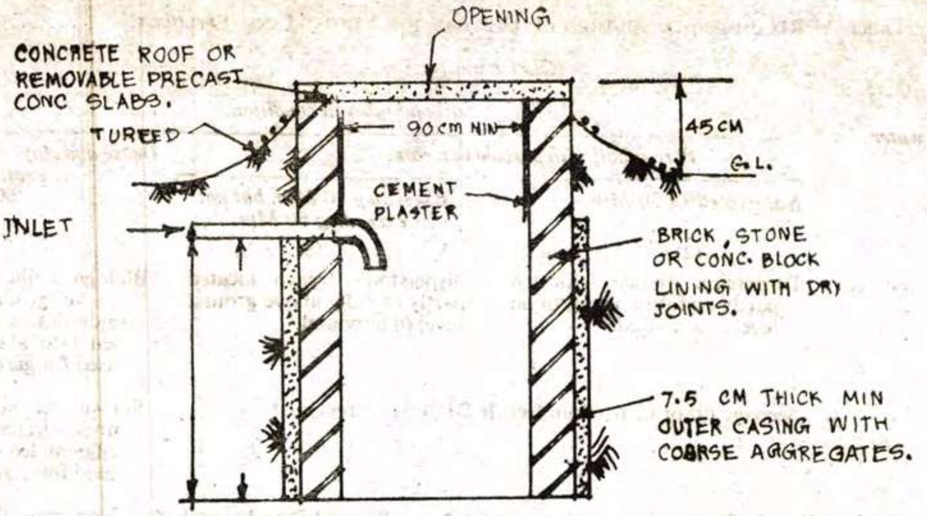
NOTE 1 A BOTTOM SLOPE OF 5 TO 10% TOWARDS THE SLUDGE OUTLET IS PREFERRED

NOTE 2 PROVISION FOR DE SLUDGING HYDRAULICALLY IS MADE

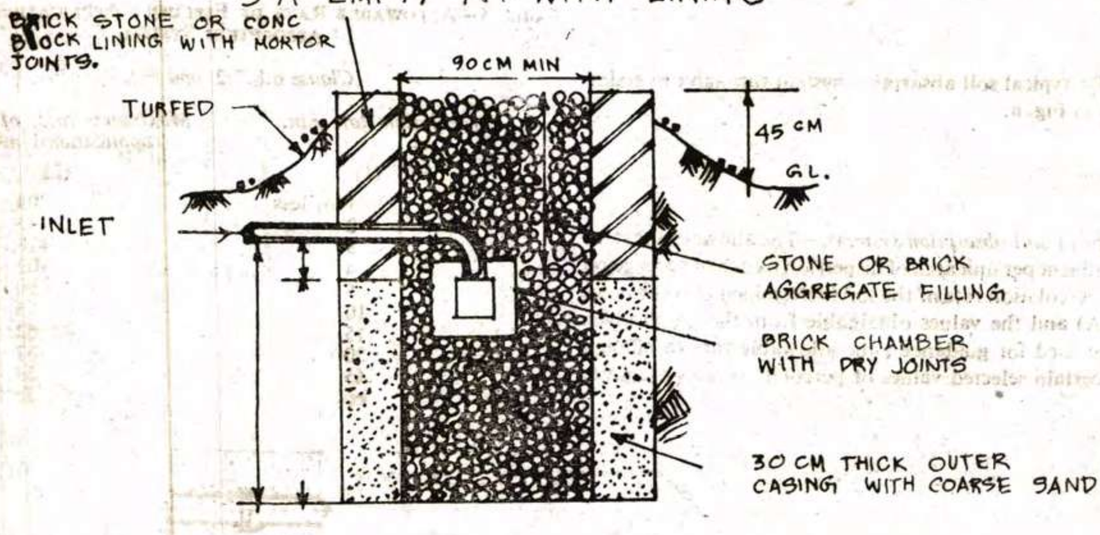
NOTE 3. FOR DIMENSIONS L, B AND D SEE TABLE 1

ALL DIMENSIONS IN CENTIMETRES UNLESS OTHERWISE SPECIFIED

FIG 4 SEPTIC TANK - TYPE 3



5 A EMPTY PIT WITH LINING



58 PIT WITH FILLING WITHOUT LINING

FIG - 5 TYPICAL ILLUSTRATIONS OF SEEPAGE PITS.

Table 1—Recommended Capacities and Sizes of Septic Tanks (Clause 6.6.1. and Figs. 2 to 4.)

Number of users.	*Length* L	*Breath* B	*Liquid depth (For cleaning interval of).*			*Liquid capacity (For cleaning interval of.)*			*Sludge to be removed (For cleaning interval of.)*			*Depth of Sludge to be withdrawn in.*		
			6 *Months.*	1 *Year.*	2 *Years.*	6 *Months.*	1 *Year.*	2 *Years.*	6 *Months.*	1 *Year.*	2 *Years.*	6 *Months.*	1 *Year.*	2 *Years.*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	m	m	m	m	m	m^3	m^3	m^3	m^3	m^3	m^3	m	m	m
5	1 50	0·75	..	1·00	1·05	..	1·12	1·18	..	0·36	0·72	..	0·32	0·64
10	2·00	0·90	..	1·00	1·40	..	1·80	2·52	..	0·72	1·44	..	0·40	0·80
15	2·00	0·90	..	1·30	2·00	..	2·34	3·60	..	1·08	2·16	..	0·50	1·20
20	2·30	1·10	1·00	1·30	1·80	2·53	3·30	4·55	0·72	1·44	2·88	2·23	0·57	1·14
50	4·00	1·40	1·00	1·30	2·00	5·60	7·28	11·20	1·80	3·60	7·2	0·32	0·64	1·28

***Note* 1 :** The capacities recommended provide for waste water also.

***Note* 2 :** A provision of 30 cm. should be made for free board.

466-3A—33

TABLE 2—RECOMMENDED METHOD OF DISPOSAL FOR SEPTIC TANK EFFLUENT.

(*Clause* 6.8.1.)

Position of the sub-soil water level from ground level.	*Soil and sub-soil condition.*		
	Porous soil with percolation rate.		*Dense and clays soil with percolation rate exceeding 60 Min.*
	Not exceeding 30 Min.	*Exceeding 30 Min. but not exceeding 60 Min.*	
(1)	(2)	(3)	(4)
Within 180 cm.	Dispersion trench located partly or fully above ground level in a mound.	Dispersion trench located partly or fully above ground level in a mound.	Biological filter partly or fully above ground level with underdrains and the effluent led into a surface drain or used for gardening.
Below 180 cm.	Seepage pit or dispersion. trench	Dispersion trench.	Sub-surface biological filter with under-drains and the effluent led into a drain or used for gardening.

Note.—Where the above mentioned methods are not feasible and where the effluent has to be discharged into open drain it should be disinfected.

Illustration of a typical soil absorption system through dispersion trenches is given in Fig. 6.

6.8.2.2. *Design of soil absorption systems.*—The allowable rate of application of effluent per unit area of dispersion trench or seepage pit is limited by the percolation rate of the soil (determined in accordance with Appendix A) and the values obtainable from the graph given in Fig. 7 may be used for guidance ; the allowable rate of effluent application for certain selected values of percolation rates are given in Table 3.

TABLE 3—ALLOWABLE RATE OF EFFLUENT APPLICATIONS TO SOIL ABSORPTION SYSTEM.

(*Clause* 6.8.2.2. *and Fig.* 7)

Procolation Rate min.	*Maximum rate of Effluent application* $1/m^2/day$.
(1)	(2)
1 or less	204
2	143
3	118
4	102
5	90
10	65
15	52
30	37
45	33
60	26

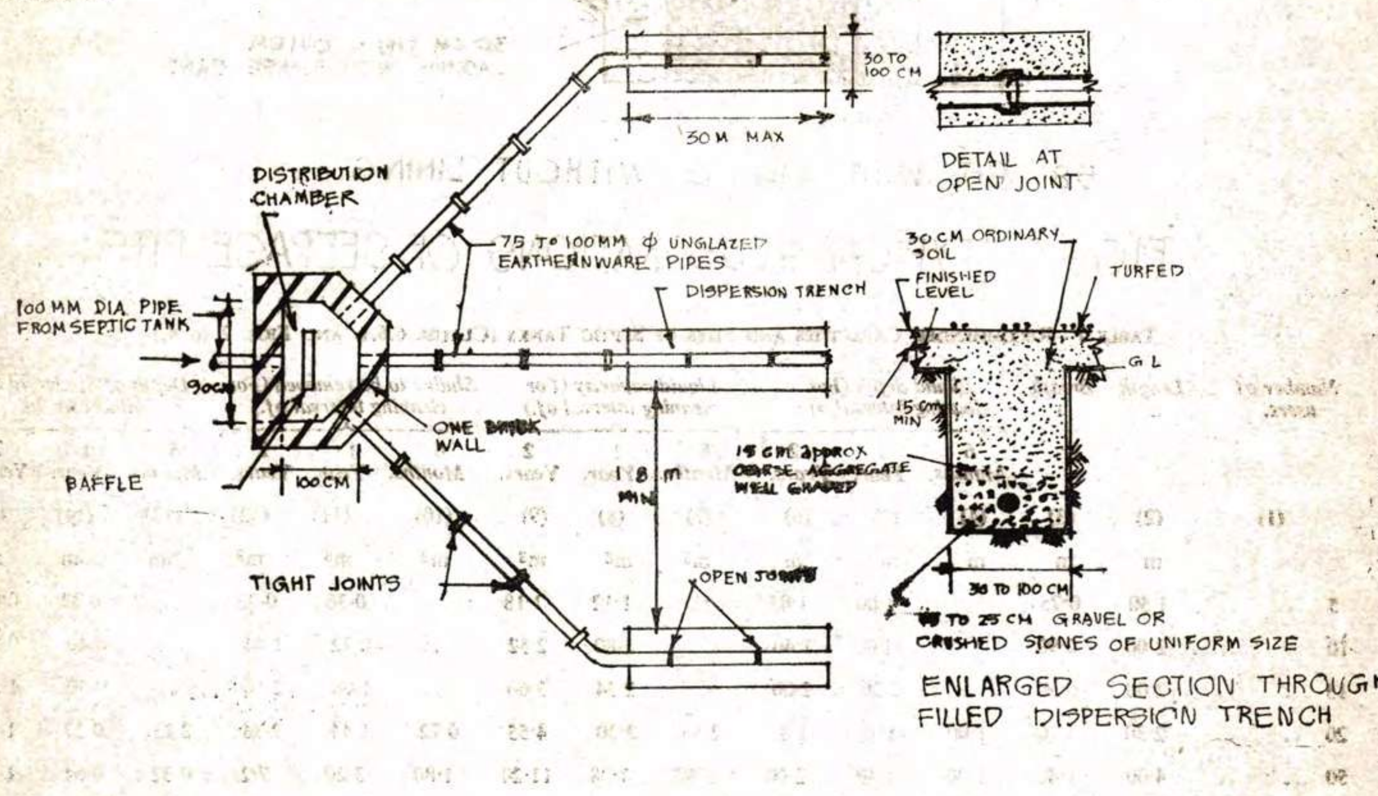


FIG · 6 TYPICAL SOIL ABSORPTION SYSTEM WITH DISPERSION TRENCHES.

NOTE 1.—The absorption area for a dispersion trench is the trench bottom area.

NOTE 2.—The absorption area for seepage pits is the effective side wall area, effective depth being measnred from 15 cm. below invert level of inlet pipe to the bottom of the pit (*See* Fig. 5).

NOTE 3.—If the percolation rate exceeds 30 minutes, the soil is unsuitable for soak aways. If the percolation rate exceeds 60 minutes the soi unsuitable for any soil absorption system.

6.8.3. *Biological Filters* :

6.8.3.1. The septic tank effluent should be discharged uniformly over the filter media so that adequate aeration is provided for the assimilation and oxidation of the remaining organic matter present in the septic tank effluent.

6.8.3.2. All the soil absorption systems given in 6.8.2. act as surface filters as well, where the soil bacteria, in addition to the bacteria thriving on the material of the system, act on the organic matters in the effluent converting them into stable compounds which go with the effluent, while the solid residue called " humus " is left in the soil pores.

6.8.3.3. Under no circumstances should it be assumed that the effluent from a biological filter is harmless. Where the effluent is likely to contaminate the water course, the effluent should be adequately disinfected (*eee* Note in Table 2).

7. *Work on site* :

7.1. *General.*—Work at site shall conform to I.S. : 1742–1960*

7.2. *Filter Media.*—Filter media should be inert, clean free from dirt and insoluble in sewage Screening at site is advisable. The material is graded 75mm. to 40 mm. with coarser ones at the bottom.

8. *Inspection and testing* :

8.1. *Inspection.*—The work should be carefully inspected at all stages to ensure that it is being carried out according to the recommendations of this code.

8.2. *Testing.*—Before the tank is commissioned for use, it should be tested for water-tightness by filling it with water and allowing it to stand for 24 hours. It should then be topped up, if necessary, and allowed to stand for a further 24 hours, during which time the fall in the level of the water should not be more than 1.5 cm.

9. *Commissioning of Septic Tanks* :

9.1. The sewerage system should be complete and ready for operation before connection is made to the building.

9.2. The tank should be filled with water to its outlet level before the sewage is let into the tank. It should preferebaly be seeded with well digested sludge obtained from septic tanks or sludge digestion tanks. In the absence of digested sludge a small quantity of decaying organic matter such as digested cow-dung may be introduced.

10. *Maintenance* :

10.1. *Desludging of septic tanks.*—Septic tanks should be desludge periodically in accordance with the procedure given in 10.1.1. in interval of the desludging depending upon the design of the septic tank and the capacity in relation to the users. Desludging may be done when the sludge level reaches a predetermined level.

10.1.1. A rod pole or any other suitable means may be inserted vertically into the septic tank up to the bottom to find the depth of the sludge (*See* Col. 13, 14 and 15 of Table 1). Sludge may then be removed until its depth is reduced to about 25 mm. from the bottom of the tank, where more accurate quantities of sludge to be removed are desired values given in Cols. 10, 11 and 12 of Table 1 may be used for guidance.

10.1.2. Desludging should be preferably carried out by hydrostatic head or by using a portable pump. Manual handling of sludge should be discouraged.

10.2. *Maintenance of Biological filter.*—When the filtergets clogged, the media should be removed, washed thorughly and replaced.

APPENDIX A.

(Clauses 3.1.1. and 6.8.2.2.)

Determination of the Soil Absorption Capacity.

A-1. *Percolation Test* :

A-1.1. Percolation test should be conducted as described in A-1.2 to A-1.6 to determine the permeablity of the soil at any depth at which it is intended to dispose of the effluent.

A-1.2. A square or a circular hole with side width or diameter respectively of 10cm. to 30cm. and vertical sides shall be dug or bored to the depth of the proposed absorption trench. The bottom and sides of the holes shall be carefully scratched in order to remove any smeared soil surface and to provide a natural soil interface into which water may percolate All the loose material shall be removed from the hole and coarse sand or fine gravel shall be added for a depth of about 5 cm. to protect the bottom from scouring and sediment.

A-1.3. Water shall then be poured up to a minimum depth of 30 cm over the gravel. In order to ensure that the soil is given ample opportunity to swell and to approach the condition it will be in, during the wettest season of the year, the percolation shall be determined 24 hours after the water is added. If the water remains in the test hole after the overnight swelling period the depth shall be adjusted to 15 cm over the gravel. Then from fixed reference point the drop in water level shall be noted over a 30 minute period. This drop shall be used to calculate the percolation rate.

A-1.4. If no water remains in the hole, water shall be added to bring the depth of the water in the hole till it is 15 cm over the gravel. From a fixed reference point the drop in water level shall be measured at 30 minutes intervals for 4 hours, re-filling 15 cm over the gravel, as necessary. The drop that occurs during the final 30 minutes period shall be used to calculate the percolation rate. The drops during prior periods provide information for possible modification of the procedure to suit local circumstances.

A-1.5. In sandy soils or other porous soils in which the first 15 cm of water seeps away in less than 30 minutes after the overnight swelling period, the time interval between measurement shall be taken as 10 minutes and the test run for one hour. The drop that occurs during the final 10 minutes shall be used to calculate the percolation rate.

A-1.6. *Percolation Rate.* Based on the final drop, the percolation rate, that is the time in minutes required for water to fall 25 mm, shall be calculated.

APPENDIX B.

(Clause 6.6.1).

Assumptions made for recommended capacities and sizes of septic Tanks.

B-1. *Main assumptions* :

B-1.1. The main assumption on which the capacities and size[8] given in Table I have been worked out are set out below :—

(*a*) *Sedimentation*

(1) Peak discharge considered for design :

Number of users.	Maximum Discharge. Litres/min.	Fixture Unit* Actual number.	Probable, number discharging simultaneously.
(1)	(2)	(3)	(4)
5	9	1	1
10	18	2	2
15	18	3	2
20	27	4	3
50	63	10	7

(2) The surface area of the tank is designed on the basis of 0.83 m^2 for a flow of 9 litres per minute.

(3) Depth of sedimentation assumed at 23 cm to 30 cm.**

(*b*) *Sludge Digestion* :

(1) For Indian conditions, per capital contribution of dry solids assumed at 70 g per day.

(2) The capacity required for sludge digestion at 0.033 m^3 per capita at 25° C.

(3) Volume of digested sludge assumed as 0.00021 m^3 per capita per day.

(*c*) *Detention Time* : It may work out to 24 h to 48 h based on an average daily flow of sewage.

It is a quantity in terms of which the load producing effect of different plumbing fixturers on the plumbing system are expressed in some arbitrarily chosen scale. —In this case 9 litres per minute.

EXTRACT FROM I.S. 2470 (PART II) 1971.

Code of practice for design and construction of septic tanks.

PART II—LARGE INSTALLATIONS.

(First Revision)

1. *Scope* :

1.1. This standard(Part II) lays down the recommendations for the design, layout construction and maintenance of septic tanks and includes methods of treatment and disposal of tank effluent of as domestic sewage. It is applicable to residential housing colonies, hostels and boarding schools where the number of users ranges from 50 to 300. Capacities and sizes required for 50, 100, 150, 200 and 300 persons are recommended to facilitate selection of sizes of septic tanks.

2. *Terminology* :

2.1. For purpose of this standard, the definitions given in 2 of I.S. 270 (Part I) 1968** shall apply.

3. *Preliminary data for design* :

3.1. In order to design a septic tank installation and the associated secondary treatment works, information on the items given in 3.1.1. to 3.1.3. of I.S. 2470 (Part I) 1968** should be collected.

6. *Design considerations* :

6.1. *General.*—In unsewered urban and semi-urban areas, all housing Colonies, hostels etc., should have arrangements for treating sewge, from these institutions in treatment units, such as a septic tank, the effluent from which is given secondary treatment either in a sub-surface disposal system or in a biological filter.

6.1.1. Surface and sub-soil water should be excluded from finding way into the septic tank. Waste water may be passed into the septic tank provided the tank and the means of effluent disposal are designed to take the additional load.

6.1.2. Depending on the location of the water-table and the nature of the strata, the type of disposal for the effluent from the septic tank may be decided.

6.1.3. The effluent from septic tanks may be allowed into an open channel or a body of water if local health authority permits.

6.2. *Layout.*—The layout should conform to the requirements given in 6.2.1. to 6.2.3. of I.S. 2470 (Part I) 1968*

6.3. *Pipe Diameter.*—A minimum nominal diameter of 150 mm is recommended.

6.4. *Gradients* : The gradients of land drains, under drains as well as the bottom of dispersion trenches and soakways should be between 1 : 300 and 1 : 400.

6.5. *Location of Septic tanks add Sub surface absorption systems.*

6.5.1. *Septic tank* : Septic tank should be located in an open space wherever possible and as far away as possible from the exterior of the wall of the building. Wherever it cannot be located in open space adequate ventilation arrangement for the escape of the gases from the septic tank should be made. It should also be accessible for cleaning

6.5.2. *Sub-surface absorpition system* : A sub-soil dispersion system shall not be closer than 18 m from source or storage of drinking water such as a well, to mitigate the possibility of bacterial pollution of water supply. It shall also be as far removed from the nearest habitable building as economically leasible but not closer than 6m, to avoid damage to the structures. The actual distance, however, shall be based on the soil condition. Care should be taken that the ground below the adjacent building is not likely to be affected by the effluenit seeping into the soil. In limestones or crevice rock formaton the soil absorption system is not recommended as there may be cannels in the formation which may carry contamination over a long distance. In such cases, and generally where suitable conditions do not exist for adoption of soil absorption systems, the effluent, where feasible, should be treated in a trickling filter or chlorinated.

6.6. *Septic Tank* :

6.6.1. *Dimensions of Septic Tanks* : Sixes and capacities of tanks are given Table 1 and 2 for guidance, Table 1 gives dimension of septic tanks suitable for housing colonies for use of 100, 150, 200 and 300 persons; Table 2 gives the dimension of tanks suitable for hostels and boarding schools for use of 50, 100, 150, 200 and 300 persons.

TABLE I—RECOMMENDED CAPACITIES AND SIZES OF SEPTIC TANKS FOR HOUSING COLONIES.

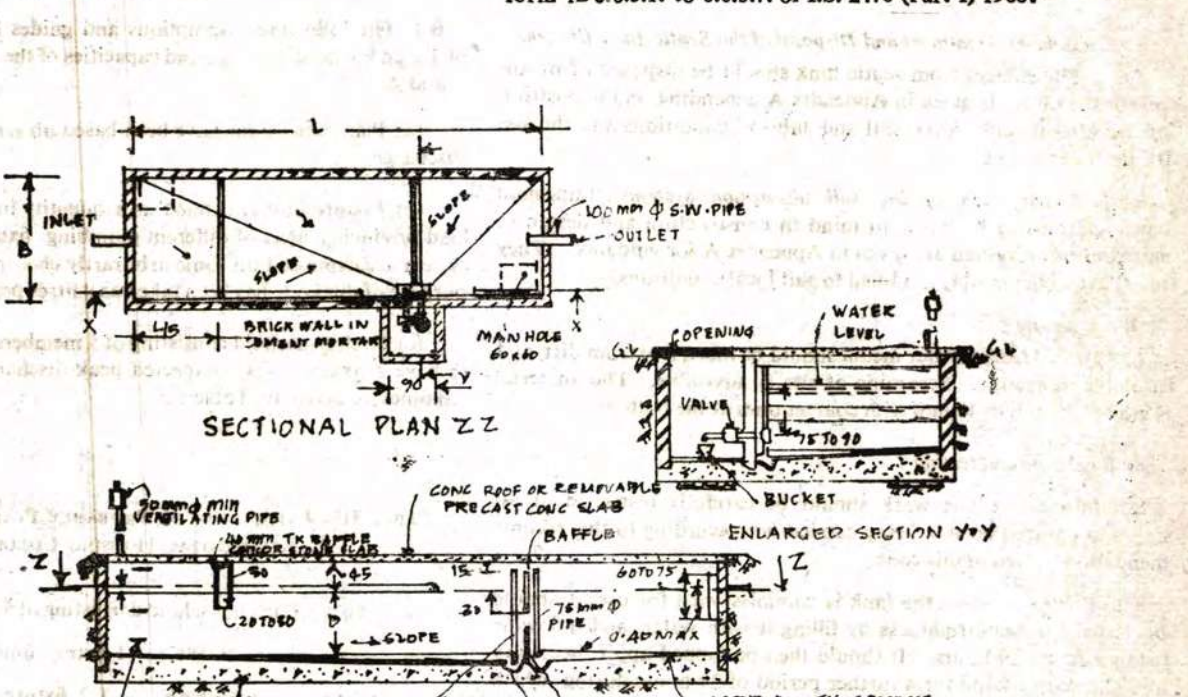
(Clause 6.6.1. and Appendix B.)

Number of users.	Length (L).	Breadth (B).	Liquid depth (D) for stated intervals of sludge withdrawal, Once in a year or less.	Once in two years.	Liquid capacities for stated interval of sludge withdrawal. Once in a year or less.	Once in two year.	Distance of the partition wall from the inlet end.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	m	m	m	m	m^3	m^3	m
100	8·0	2·8	1	1·04	22·4	23·3	5·3
150	10·6	2·7	1	1·15	28·6	32·9	7·1
200	12·4	3·1	1	1·15	38·4	44·2	8·3
300	14·6	3·9	1	1·15	56·9	65·5	9·7

6.6.1.1. A detention period of 24 to 48 hours is usually availalbe based on the average daily flow of sewage. It may be noted however hat the average daily flow varies considerably from one installations to another and the detention period should not be considered as a criterion for design of septic tanks.

6.6.2. *Recommeded Designs* : A typical design of a septic tank for large installtaions is given in Fig. 1.

6.6.3. *Construction* : Septic tanks may be construeted out of brick work, stone masonry concrete of other suitable materials. The requirements for each of these items shall firm to those given conform in 6.6.3.1. to 6.6.3.7. of I.S. 2470 (Part I) 1968.*



NOTE 1. A BOTTOM SLOPE OF 10% OR MORE TOWARDS THE OUTLET IS PREFERRED.

NOTE 2. PROVISION FOR DESLUDGINGS MADE HYDRAULICALLY

NOTE 3, FOR DIMENSIONS L, B AND D SEE TABLES 1 & 2

NOTE 4. WHERE INLET IS LOCATED MUCH BELOW G.L ONLY MANHOLE SHAFT MAY BE RAISED ABOVE THE GROUND LEVEL

ALL DIMENSIONS IN CENTIMETRES

FIG. 1. TYPICAL DESIGN OF A SEPTIC TANK FOR LARGE INSTALLATIONS

TABLE II—RECOMMENDED CAPACITIES AND SIZES OF SEPTIC TANKS FOR HOSTELS AND BOARDING SCHOOLS.

(Clause 6.6.1. and Appendix B)

Number of users.	*Length.* (*L*)	*Width* (*B*)	*Liquid Depth* (*D*) *for stated intervals of sludge withdrawal in months.*		*Liquid capacities for stated intervals of sludge withdrawal in months.*		*Distance of the partition wall from the inlet end*
			Once in a year.	*Once in two years.*	*Once in a year.*	*Once in two years.*	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	m	m	m	m	m^3	m^3	m
50	5	1·6	1·3	1·4	10·4	11·2	3·3
100	5·7	2·1	1·4	1·7	16·8	20·4	3·8
150	7·7	2·4	1·4	1·7	25·8	31·4	5·2
200	8·9	2·7	1·4	1·7	33·6	41·0	6·0
300	10·7	3·3	1·4	1·7	49·5	60.0	7·2

6.7. *Collection and Disposal of sludge* : The sludge from septic tank may be delivered into suitable vehicles for transport to the disposal site where it may be discharged into a sludge drying bed or trenched.

6.8. *Secondary Treatment and Disposal of the Septic Tank Effluent* :

6.8.1. The effluent from septic tank should be disposed of by any one of the methods given in Appendix A depending on the position of the subsoil water level, soil and sub-soil conditions and the size of the installation.

6.8.2. *Construction of the soil absorption systems* : Important considerations to be borne in mind in construction and design of soil absorption system are given in Appendix A for guidance. They may have to be suitably modified to suit local conditions.

7. *Work on site* :

7.2. *Filter Media*: Filter media should be inert, free from dirt and insoluble in sewage. Screening at site is advisable. The material is graded 75 mm to 40 mm with coarser ones at the bottom.

8. *Inspection and testing* :

8.1. *Inspection* : The work should be carefully inspected at all stages to ensure that it is being carried out according to the recommendations given in this code.

8.2. *Testing* : Before the tank is commissioned for use, it should be tested for watertightness by filling it with water and allowing it to stand for 24 hours. It should then be topped up, if necessary and allowed to stand for a further period of 24 hours during which time the fall in the level of the water should not be more than 1.5 cm.

9. *Commissioning of septic tanks* :

9.1. The tank should be filled with water to its outlet level before the sewage is let into the tank. It should preferably be seeded with small quantities of well digested sludge obtained from septic tanks or sludge digestion tanks. In the absence of digested sludge a small quantity of decaying organic matter, such as digested cow-dung, may be introduced.

10. *Maintenance* :

10.1. *Desludging of Sepitic Tanks* : Septic tanks should be desludged periodically, the intervals of desludging depending upon the design of the septic tanks and the capacity in relation to its users. Desludging may be done when the sludge level reaches a predetermined level. A portion of the sludge may be left in the tank to seed the fresh deposits.

10.1.1. Desludging should preferably, be carried out by hydrostatic head or by using a portable pump. Manual handling of sludge hould be discouraged.

APPENDIX—B

(Clause 6.6.1.)

Design guides and assumptions

B-1. The following assumptions and guides have been the basis of design for the dimension and capacities of the tanks given in Table 1 and 2.

(a) Plan dimensions have been based on surface loading at peak discharge.

(b) Fixture unit is defined as a quantity in terms of which the load producing effect of different plumbing fixtures on the plumbing system are expressed on some arbitrarily chosen scale which for the purpose of this code has been taken as 9 litres per minute.

(c) Each household consisting of 5 members has been considered to have 2 fixture units. Expected peak discharge from the housing colonies is given in Table 3.

TABLE III—ESTIMATION OF PROBABLE PEAK DISCHARGE FOR RESIDENTIAL HOUSING COLONIES.

Basis : Each household consisting of 5 persons may have

1 WC — 1 fixture unit

1 bath — 1/2 fixture unit

1 wash basin/kitchen sink —1/2 fixture unit.

Total load — 2 fixture units.

Number of Users.	*Number of Households.*	*Number of Fixture units.*	*Probable Peak Discharge Litres/Minute.*
(1)	(2)	(3)	(4)
100 ..	20	40	216
150 ..	30	60	324
200 ..	40	80	432
300 ..	60	120	648

(d) The number of plumbing fixture units in hostels and boarding schools has been assumed according to the recommendations contained in I·S. 1172–1971. The probable peak discharge from these unit is give in Table 4·

TABLE IV—ESTIMATION OF PROBABLE PEAK DISCHARGE FOR HOSTELS AND BOARDING SCHOOLS.

Basis : Same as for Table 3.

Number of Users.		*WC*	*Bath*	*Wash Basin/ Kitchen sink.*	*Number of Fixture Units.*	*Probable Peak Discharge Litres/ minute.*
(1)		(2)	(3)	(4)	(5)	(6)
50	..	6	6	6	12	76
100	..	12	12	12	24	130
150	..	19	19	19	38	205
200	..	25	25	25	50	270
300	..	37	37	37	74	400

(*e*) Estimation of peak discharge is based on 60 per cent of the fixture units discharging simul taneously except in the case of boarding schools with 50 members where it is based on 70 per cent of the fixture units discharging simultaneously.

(*f*) For the estimation of quantities of sludge, contribution of dry solides has been assumed as 70 g. per capita per day.

(*g*) Average temperature in septic tanks has been assumed as 25° C.

(*h*) Capacity required for sludge digestion on the basis of assumptions at (f) and (g) is 3.3 m^3 per 100 persons.

(j) Capacity required for storage of digested sludge on the basis of the assumption at (f) is 7.47 m^3 per 100 persons per year.

(*k*) Minimum depth of septic tank is considered to be one metre.

(*m*) Detension time may work out to 24-48 h based on an average daily flow of sewage.

EXTRACT FROM I.S. 909—1965.

Specification for underground fire Hydrant, sluice valve type.

1. *Scope* :

1.1. This standard lays down the requirements regarding material shape dimensions and test of underground hydrant, sluice-valve type.

1.2. Generally the sluice-value type hydrant shall be sluices utilities Where it is intended to introduce into this additional valve for closing off mains for repairs then ant to the sluicevalve on of a similar type may be introduced adin dotted the side of mains as shown rig. 1.

2. *Description* :

2.1. The hydrant shall consist of the following components :

(*a*) One or two slice valves with a road surface box.

(*b*) A duckfoot bend,

(*c*) A 63 mm male instantaneous pattern, and

(*d*) Castiron (CI) cap permanently secured to the duckfoot bend by means of a chain.

3. *Materiel* :

3.1. Sluice valves shall be of Class I Type conforming to I.S. 780–1963.*

3.2. Road surface box and the cap shall be of cast iron conforming to Grade 15 of I.S. 210—1962.

3.3. Duckfoot bend shall be of cast iron conforming to grade 20 of I.S. 210–1962.+

3.4. The outlet of the hydrant shall be made of one of the materials given in 3.4.1. and 3.4.2.

3.4.1. *Copper Alloys* : Copper alloys used for castings or forgings shall conform to the requirements given below against each.

(*a*) Sand castings ..	..	Grade 2 of I.S. 318–1962 + Grade 3 of I.S. 304–1961†
(*b*) Die castings ..	..	Grade 3 of I.S. 292–1961@
(*c*) Hot forgings ..	..	Grade 1 of I.S. 291–1961%

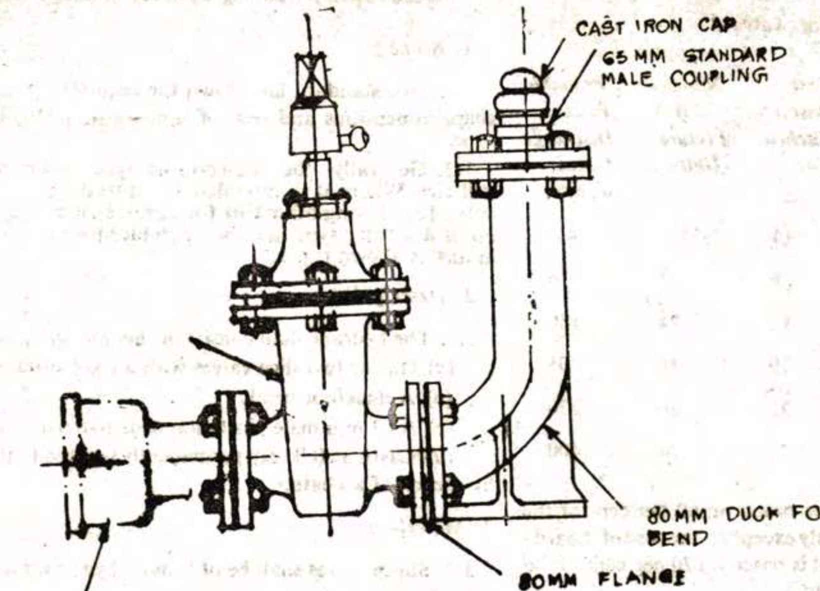


FIG 1 UNDER GROUND FIRE HYDRANT SLUICE VALVE TYPE.

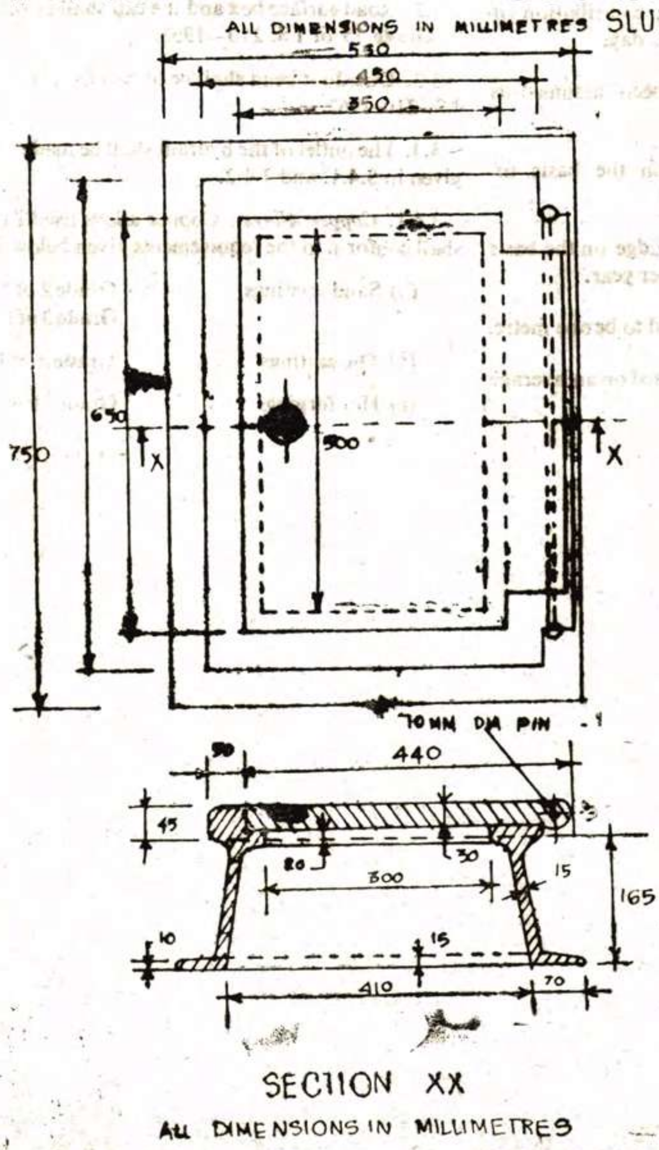


FIG 2 C I ROAD SURFACE BOX

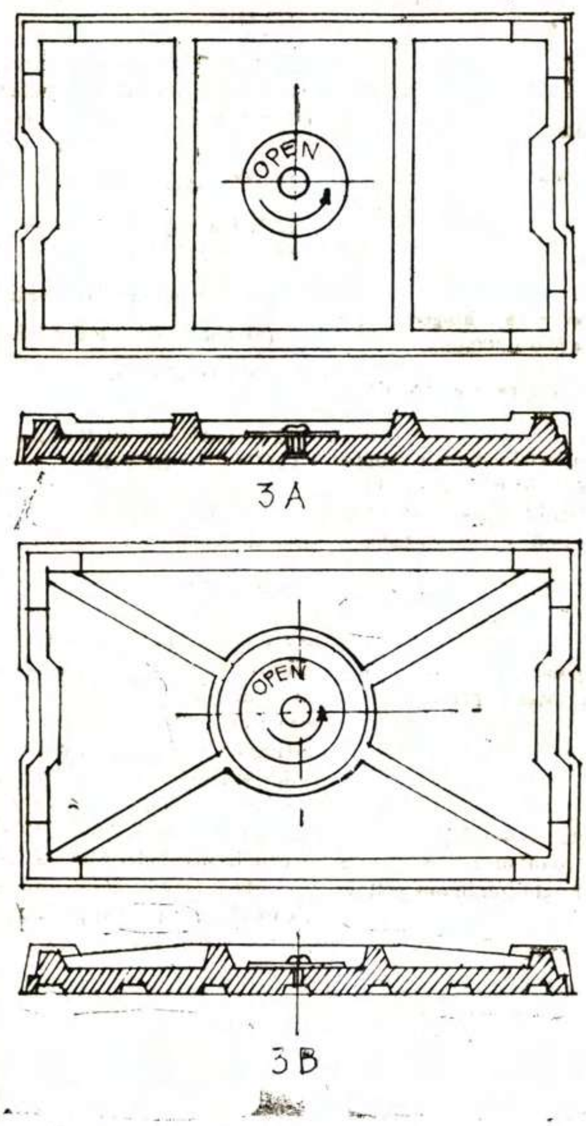


FIG-3 TYPICAL ROAD SURFACE BOX COVERS

3.4.2. *Aluminium Alloy.*—Aluminium alloy used for castings shall conform to I.S. Designation A-8-WP or A-16-WP of I.S. 617-1959

4. *Shape and Dimensions.*

4.1. The shape and dimensions of the various components of the hydrant shall be as given in Figs. 1, 2 and 3.

5. *Tolerance.*

5.1. The tolerance on the dimensions of road surface box shown in Fig. 2 shall be as under :

Dimensions. (1)	*Tolerance* (2) mm
Up to and including 50 mm.	±0·5
51 mm. and above up to and including 100 mm. ..	± 1
101 mm. and above up to and including 500 mm. ..	± 2
501 mm. and above	± 3

6. *Construction.*

6.1. The road surface box shall be provided with a hinged cover and the internal dimensions of the box shall be 500 x 300 mm.

6.2. The duckfoot bend shall be flanged at both ends with drilled holes as shown in Fig. 1.

6.3. The outlet of the hydrant shall conform to 63 mm male coupling, instantaneous pattern, as specified in I.S. 903-1965†. It shall be attached to the flanged end of the duckfoot bend by means of M.S bolts. The opening of outlet shall be covered by a C.I. cap attached to the duckfoot bend by means of a suitable chain.

7. *Workmanship.*

7.1. All parts of the hydrant shall be of good workmanship and finish. All burrs and sharp edges shall be removed. The waterway shall have a smooth finish.

8. *Painting.*

8.1. All parts of the hydrant shall be painted externally with two coats of fire-red paint. The cover of the road surface box shall be painted with two coats of rust-resisting bright luminious yellow Paint or clear visibility during night.

9. *Test.*

9.1. All castings shall be satisfactorily tested and proved perfectly watertight under a hydraulic pressure of 183 metres head.

10. *Testing Facilities .*

10.1. The manufacturer shall, at his own cost, furnish material supply labour and appliances for such testing as may be carried out on his premises in accordance with the provisions of this standard. Failing facilities at his own works for making the prescribed test, the manufacturer shall bear the cost of making the test elsewhere.

11. *Inspection.*

11.1. The purchaser or his representative shall have access at all reasonable times to the manufacturer's works in which the hydrants ordered are being made and tested.

12. *Marking,*

12.1. Each hydrant shall be clearly and permanently marked with the following information :—

(*a*) Manufacturer's name or trade-mark.

(*b*) The letters " Ref. I.S.S. 909 " , and

(*c*) Year of manufacture.

12.2. The cover of the road surface box shall have the letters " FH " embossed on it.

12.2.1. The hydrant may also be marked with the I.S.I. Certification Mark.

NOTE.—The use of the I.S.I. Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act, and the Rules and Regulations made thereunder. Presence of this mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection testing and quality control during production. This system, which is devised and supervised by I.S.I. and operated by the producer has the further safeguard that the products as actually marketed are continuously checked by I.S.I. for conformity to the standard. Details of conditions, under which a licence for the use of the I.S.I. Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

SECTION XVII

STANDARD DESIGNS

SECTION XVII.

STANDARD DESIGNS

CONTENTS.

SECTION XVII

STANDARD DESIGNS.

INDIAN STANDARD EXTRACT

SECTION XVII.

STANDARD DESIGNS.

SPECIFICATION No. 108.

1. *Reinforced Concrete Lintels* :

1·1. The lintels shall be constructed complying with standard specification No. 30 and the notes on reinforced concrete design appended thereto. Size of aggregate shall not be more than 12 mm. to 18 mm. guage, unless otherwise specified. The aggregate shall be the hardest available in the vicinity. If further description of same is required, it will be given either in the descriptive specification sheets of the agreement or in Schedule A; untested rods shall not be used (As there is frequently difficulty in obtaining tested rods in local markets, stock is usually maintained at the Public Works Engineering Corporation, Madras. The Contractor shall before tendering his rate for reinforced concrete lintels, assure himself as to the cost and source of purchase of the tested rods). The concrete mix shall be 1 : 2 : 4 of grade M 150.

2. The work shall be moulded in situ or cast in moulds and hoisted to position after 7 days as may be ordered by the Executive Engineer. Any lintels which develop cracks or become reduced in strength before being placed in situ shall be rejected and the contractor shall remove them from the site forthwith. Care shall be taken that corners of lintels are not broken off during hoisting or at any stage of the work.

3. *Design of Lintel* :

3·1. For normal loading conditions in buildings single or multi-storeyed, thin lintels can be used as detailed below.

3·1·1. 75 mm. thick R.C.C. precast lintels with M.S. rods placed centrally may be used for span upto 1·8 metres.

3·1·2. The concrete mix should be M. 150 (1 : 2 : 4) using stone jelly of not greater than 20 mm. size.

3·1·3. Three 10 mm. dia. M.S. bars as main reinforcement and 6 mm. dia. distribution bars at 30 cm. intervals in required numbers for varying spans upto 1·8 metres are adequate for a 23 cm. wide lintel. The same reinforcement is adequate even for 20 cm. wide lintels to be used in modular brick walls of 20 cm. wide. The reinforcement in lintel for widths more than 23 cms. shall be provided at the rate of 1·03 sq. cm. per 10 cm. width, the thickness of lintel being kept constant.

3·1·4. The number of courses of brickwork over the thin lintel should be at least 5 courses in C.M. 1 : 5 i.e. 46 cm. height of brick masonry.

3·1·5. The top surface of the precast lintel shall be finished rough to provide proper bonding with the brickwork on top.

3·1·6. Such thin lintels can be used for openings for windows and doors for all buildings and for openings in framed structures of any number of floors.

3·1·7. The lintels shall be propped to a length of about 30 cm. in the middle while brickwork is constructed. The props may be removed after 7 days of curing brickwork.

3·1·8. Where required, provision of R.C.C. sun shade can be made by projecting the steel bars during casting of lintels and the sunshade cast-in-situ separately.

4. The rate shall be per cubic metre.

NOTE.—(*a*) *Vide* paragraph 5 (*b*), Tamil Nadu Building Practice regarding tying frame work of reinforcements.

(*b*) In lieu of hooking the stirrups in the standard design beams, as required on page Tamil Nadu Building Practice the stirrups shall be continued as a binding on top of the frame and each end bent around a top longitudinal main rod and wired in position.

(*c*) *Vide* page Tamil Nadu Building Practice regarding design of hooks.

5. For random rubble or other classes of masonry where there is doubtful bonding it may be advisable to design the lintel for the whole load directly above the clear opening but this will be a matter for judgement for the designer. In cases where a diagram is necessary to explain the assumption made for the load, this should accompany the calculations for the information of the checking authority.

REPORT ON PRE-CAST R.C.C. THIN LINTELS

COMMUNICATED IN CE(B)'S CIRCULAR No
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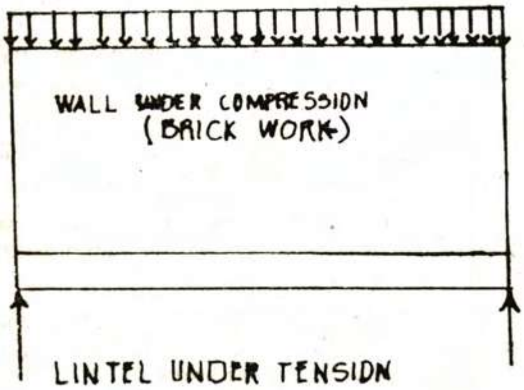
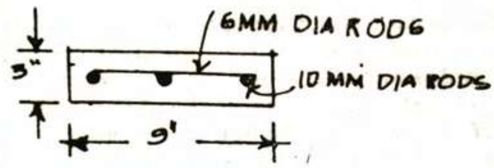
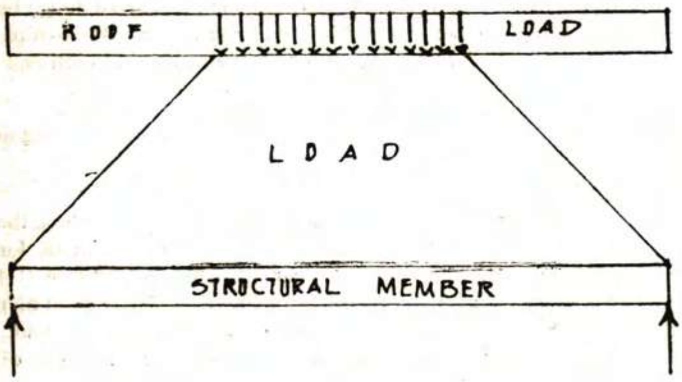
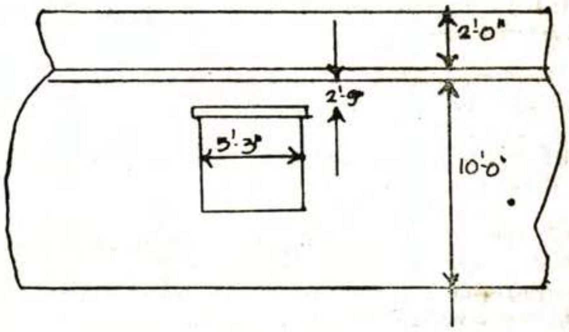
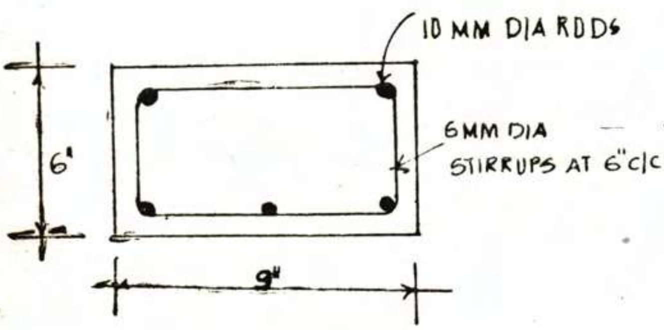
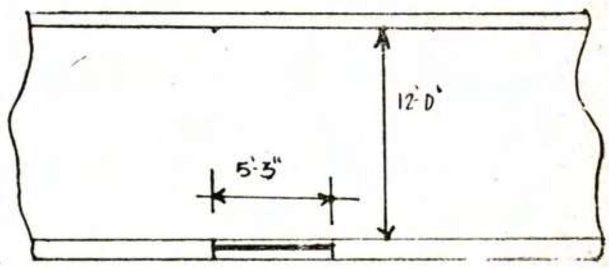










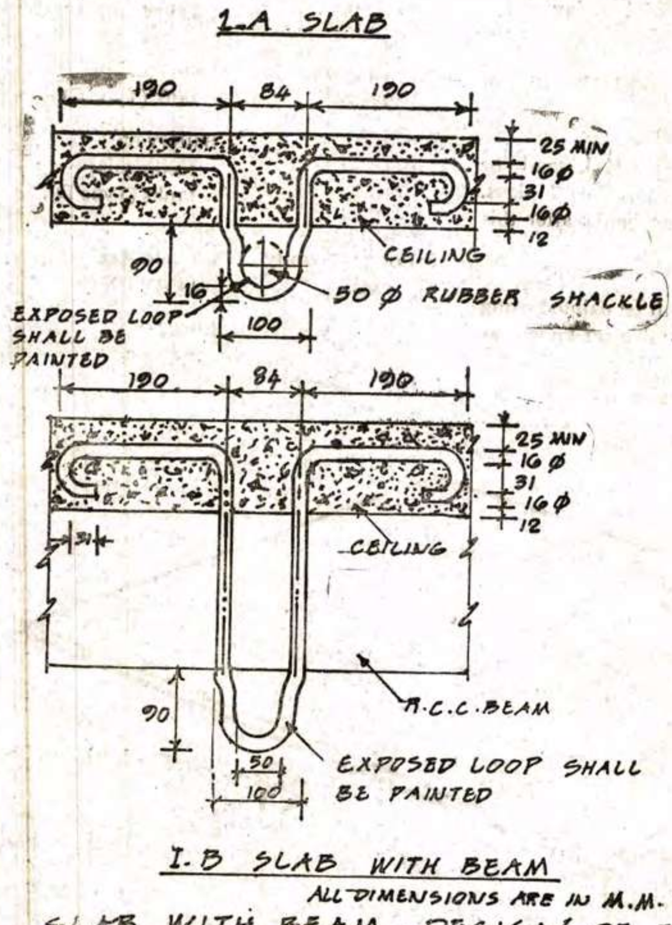


WINDOW

SPECIFICATION No. 108-A.

Fan clamps shall be of suitable design according to the nature of construction of ceiling on which these clamps are to be fitted. In all cases, fan clamps shall be fabricated from tested metal of suitable sizes and they shall be as close fittings as possible. Fan clamps shall have a sufficient clearance between ceiling and hook and the shape of the hook shall be proportioned for fixing a 50 mm. shackle insulator. Fan clamps for reinforced concrete roofs shall be buried with the casting and due care shall be taken that they shall serve the purpose. Fan clamps for wooden beams shall be of suitable flat iron fixed on two sides of the beam and according to the size and section of the beam, one or two mild steel bolts passing through the beam shall hold both flat irons together. Fan clamps for steel joist shall be fabricated from tested flat iron to fit in rigidly to the bottom flange of the beam. Care shall be taken during fabrication that the metal does not crack while hammering to shape. Other fan clamps for example, recessed one shall be made to suit the position but in all cases care shall be taken to see that they are rigid and safe.

A typical arrangement of a fan clamp is given in Figure I.



SLAB WITH BEAM - DESIGN OF FAN CLAMPS

NOTE.—All fan clamps shall be so fabricated that fans revolve steadily.

108-B. SPECIFICATION FOR FERRO CEMENT WATER TANKS.

1. *General.*—Ferro cement is a versatile structural material possessing unique properties of strength and serviceability. It is made with closely knit wire mesh and mild steel reinforcing bars filled with rich cement mortar, welded mesh may also be used in place of reinforcing bars.

2. *Materials.*—

2·1. For sand and cement used for mortar specification given in Section I shall apply.

2·2. Specification of M.S. bar is covered by I.S. 456/1964, 432/1966.

2·3. The chicken mesh and welded mesh shall be of approved quality.

3. *Fabrication details.*—The general fabrication details of ferro cement water tanks shall be as shown in the drawings while the cage is fabricated necessary provision shall be made for inlet pipe, lifting hook, over flow pipe, scour and outlet pipes.

The size of the tank shall depend on the water storage capacity required. The possible sizes shall be selected from Table I below. In circular tanks D/H rate of 1·04 shall be preferred for any capacity.

4. *Casting.*—No separate shuttering shall be necessary while casting the tank as the cage is made to required shape. But, for casting the base a plain or level platform shall be essential. The casting platform shall be lubricated using mould oil in advance before casting of the tank. The mesh cage shall be then placed on the lubricated level platform.

Cement and river sand sieved through a sieve with aperture size 2.36 shall be mixed dry in 1 : 2 proportion by weight. Water shall be added to the dry mixed mortar adopting a water cement ratio of 0.5. The bottom slab of the tank shall be cast to the required thickness with the mortar then prepared.

The vertical walls shall be then plastered with the cement mortar prepared as above. A small piece of plywood shall be used on the opposite side of the plaster as a back-up and the mortar shall be forced into the cage from on side and finished to the required thickness by following the same process on either side. Both the inside and outside surface shall be finished fine after the initial setting of the mortar.

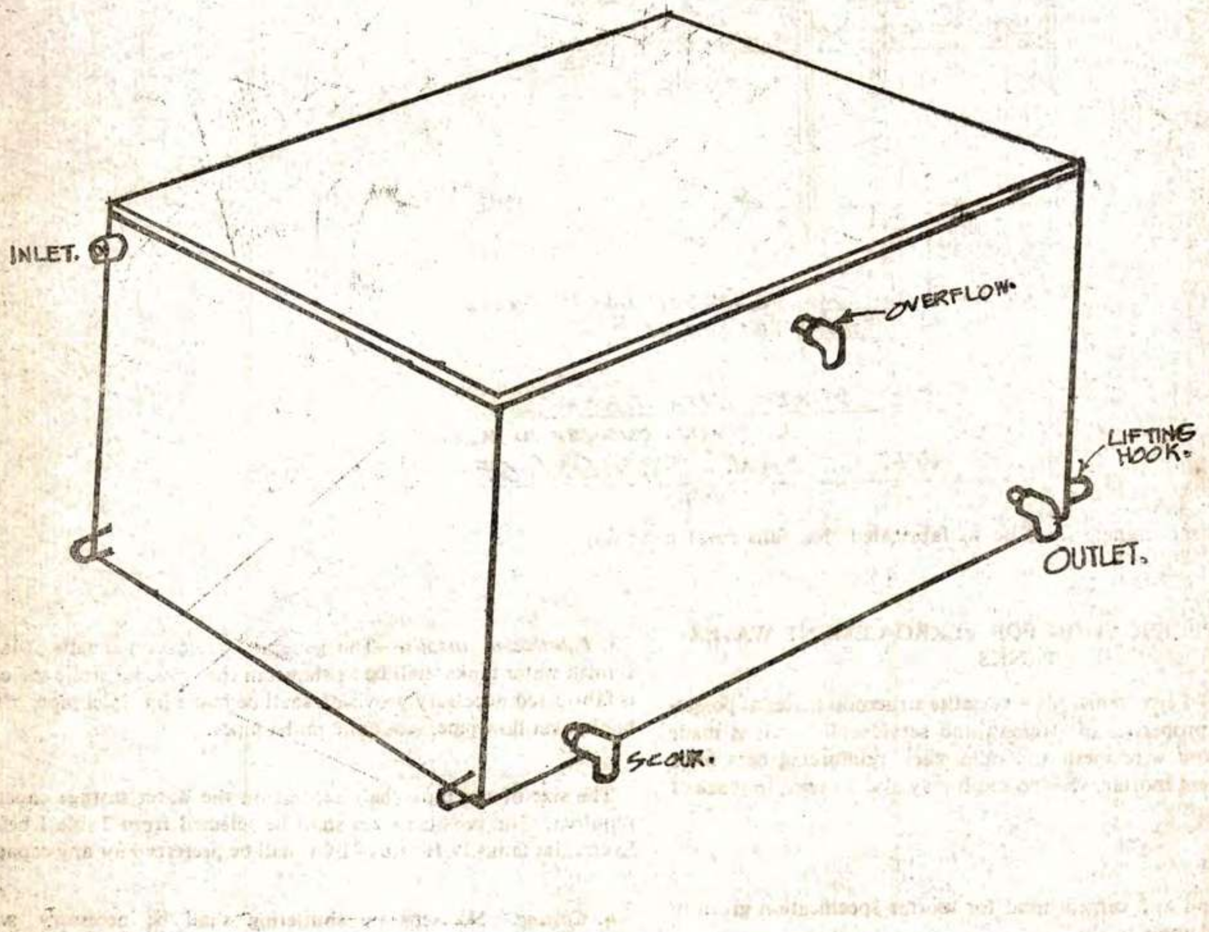
Cover platform shall be cast separately on a level platform and finished fine.

5. *Curing and Transportation.*—The curing of the tank shall be done after 24 hours by using continuous water spray for 7 days. The water tanks shall be transported using lifting hooks after this period.

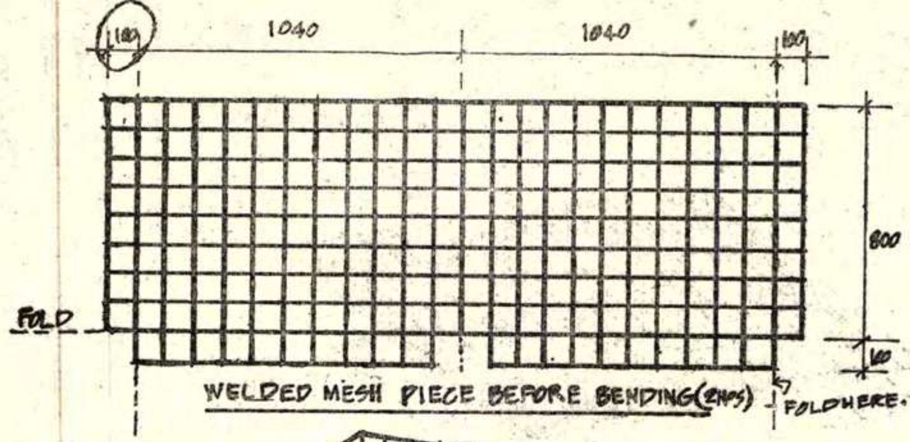
6. *Painting.*—The interior of the water tank shall be painted using a tank mastro paint of I.S. 158/8 grade or its equivalent known as drinking water paint.

7. Suggested capacities for various uses and their weights:

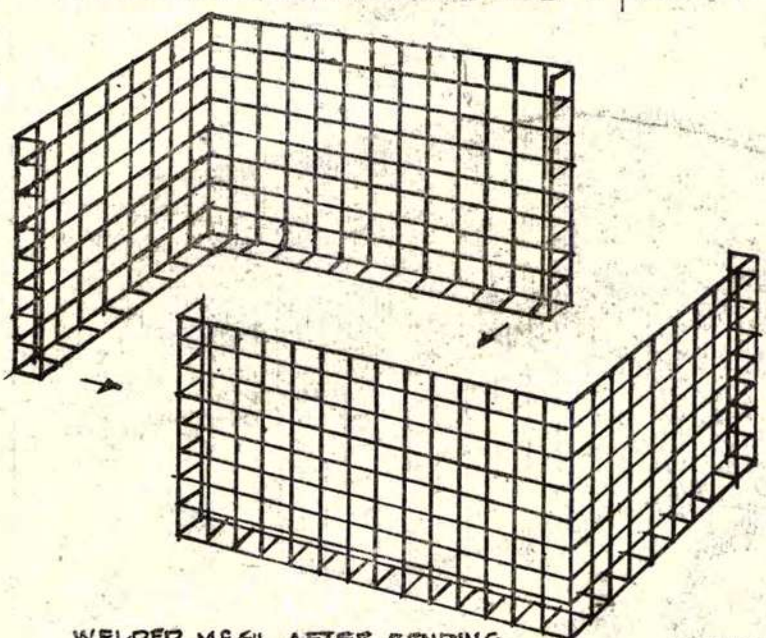
Serial number and type of building.	*Shape.*	*Capacity in litres.*	*Weight in kg.*
(1)	(2)	(3)	(4)
1 Individual Residential Houses.	Rectangular (Type A)	800	31
	Cylinderical (Type B).	800	300
2 For blocks of flats.	Twin rectangular tank (Type C).	1,600 (800 × 2)	580
	Battery of rectangular tanks (Type D).	7,500 (625×12).	3,300
3 For community uses.	Cylinderical (Type E).	5,000	1,500
	Single or multiple.	10,000	2,250



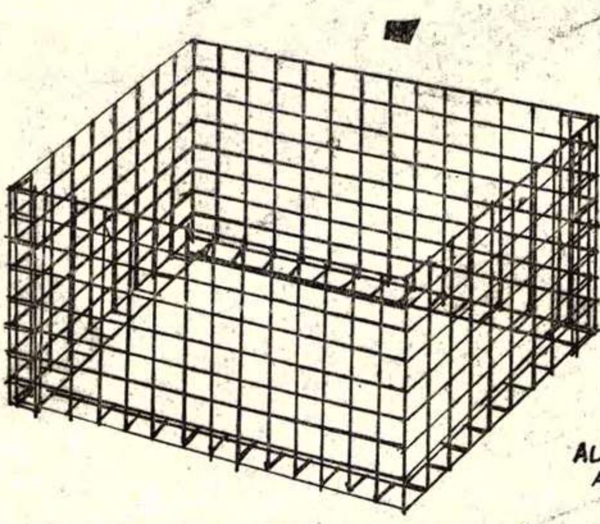
FERROCEMENT RECTANGULAR WATER TANK (TYPE A)_800LITRES CAPACITY.



WELDED MESH PIECE BEFORE BENDING (2 NOS)



WELDED MESH AFTER BENDING

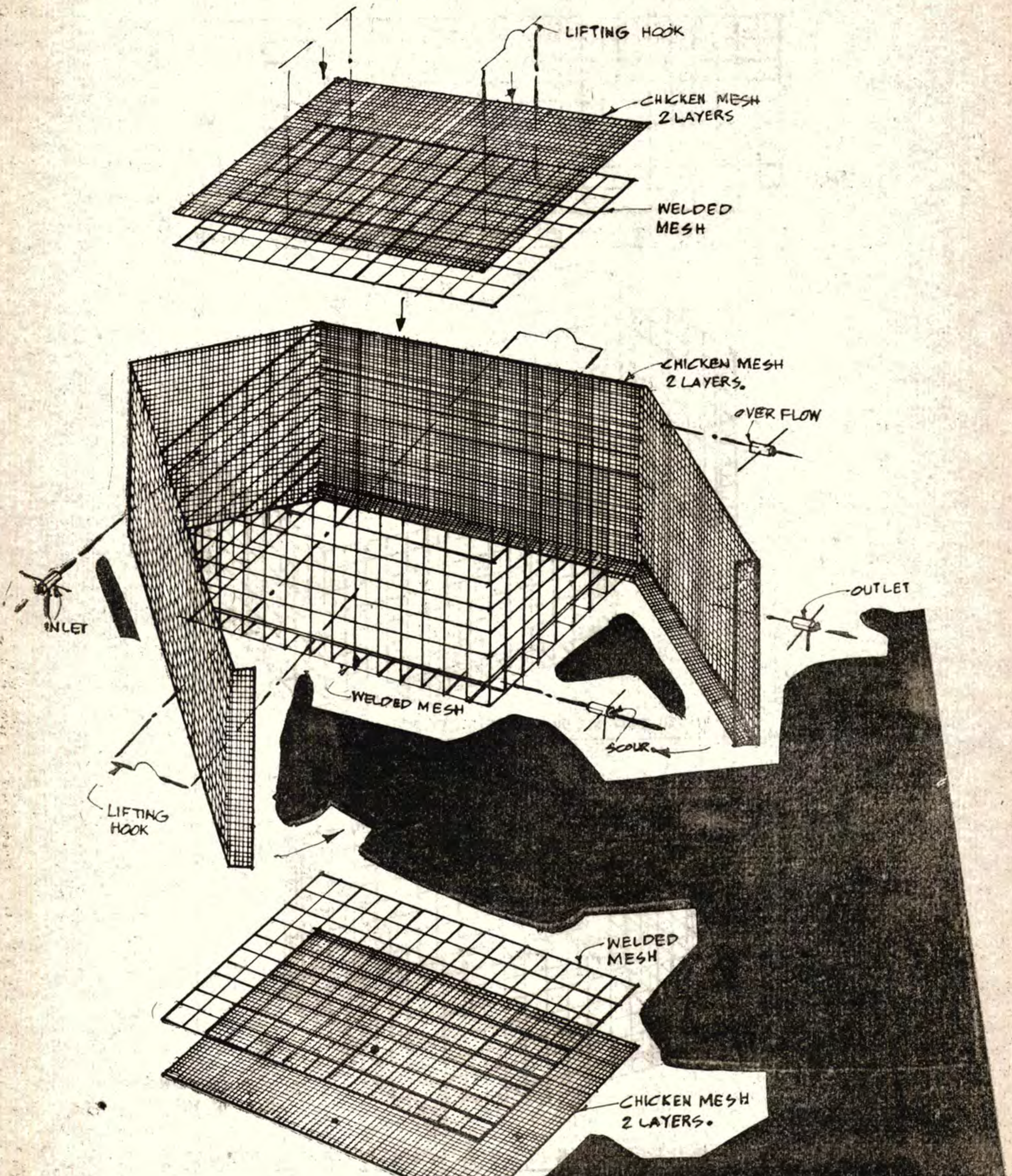


ALL DIMENSIONS ARE IN MM.

WELDED MESH AFTER ASSEMBLING (FOR SIDE WALLS).

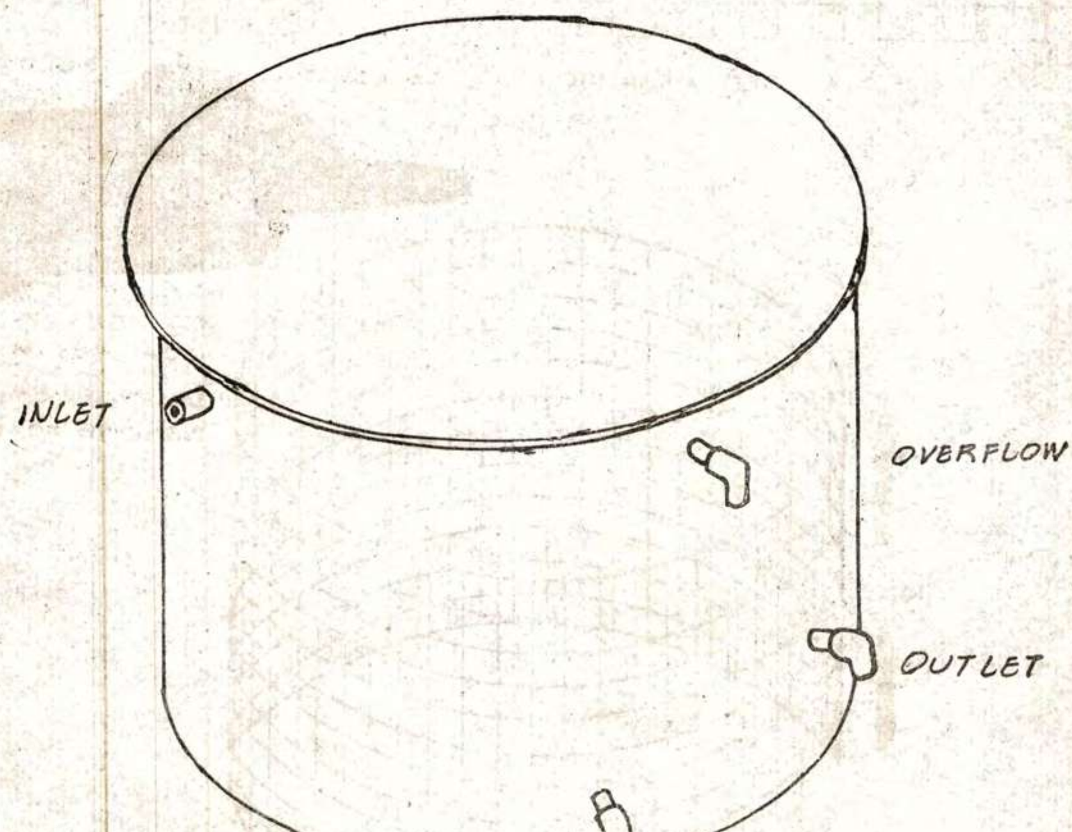
DETAILS OF WELDED MESH FOR SQUARE OR RECTANGULAR TANKS (TYPE A)

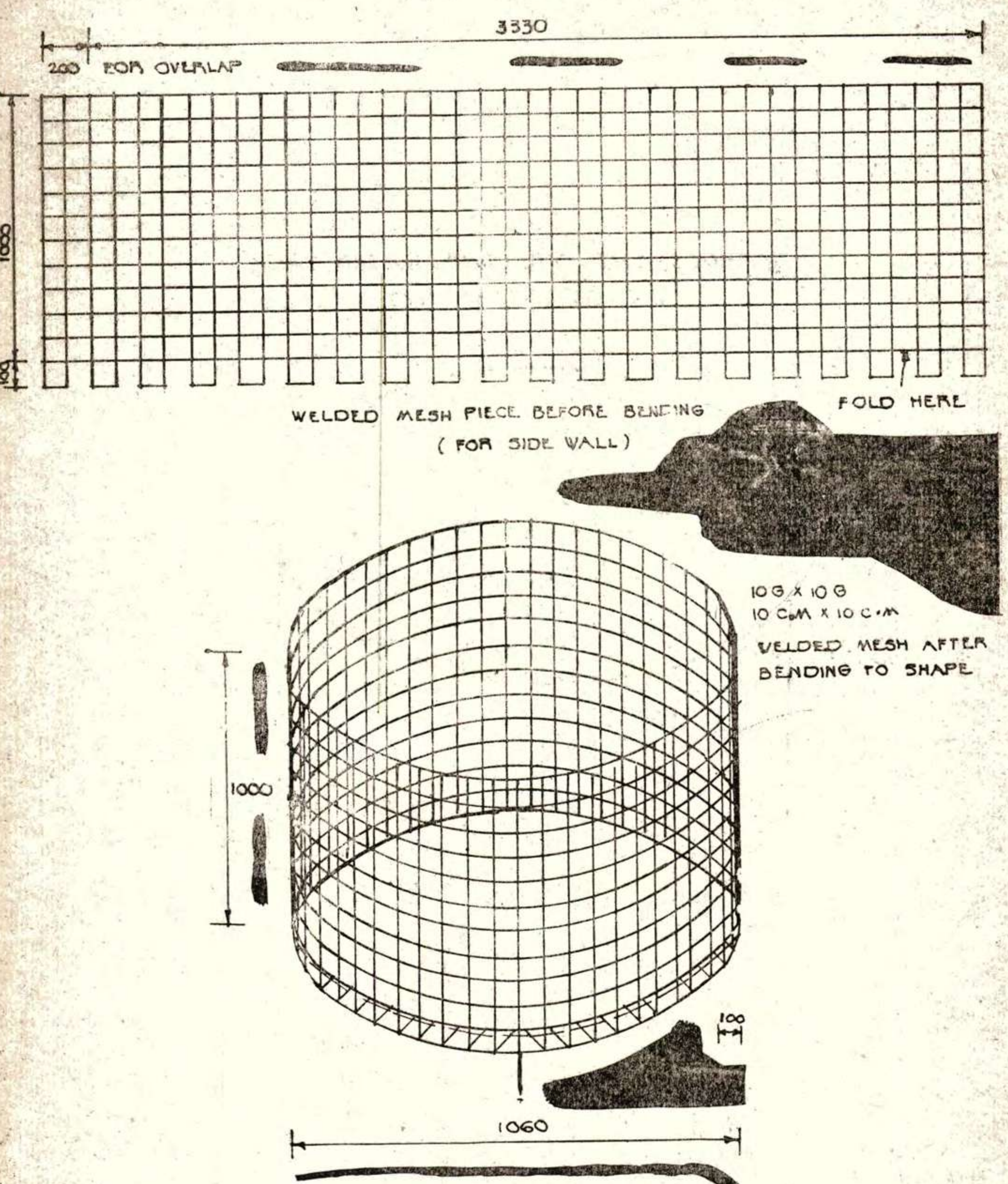
466-3A—35A



DETAILS OF MESH FOR SQUARE OR RECTANGULAR TANKS (TYPE A).

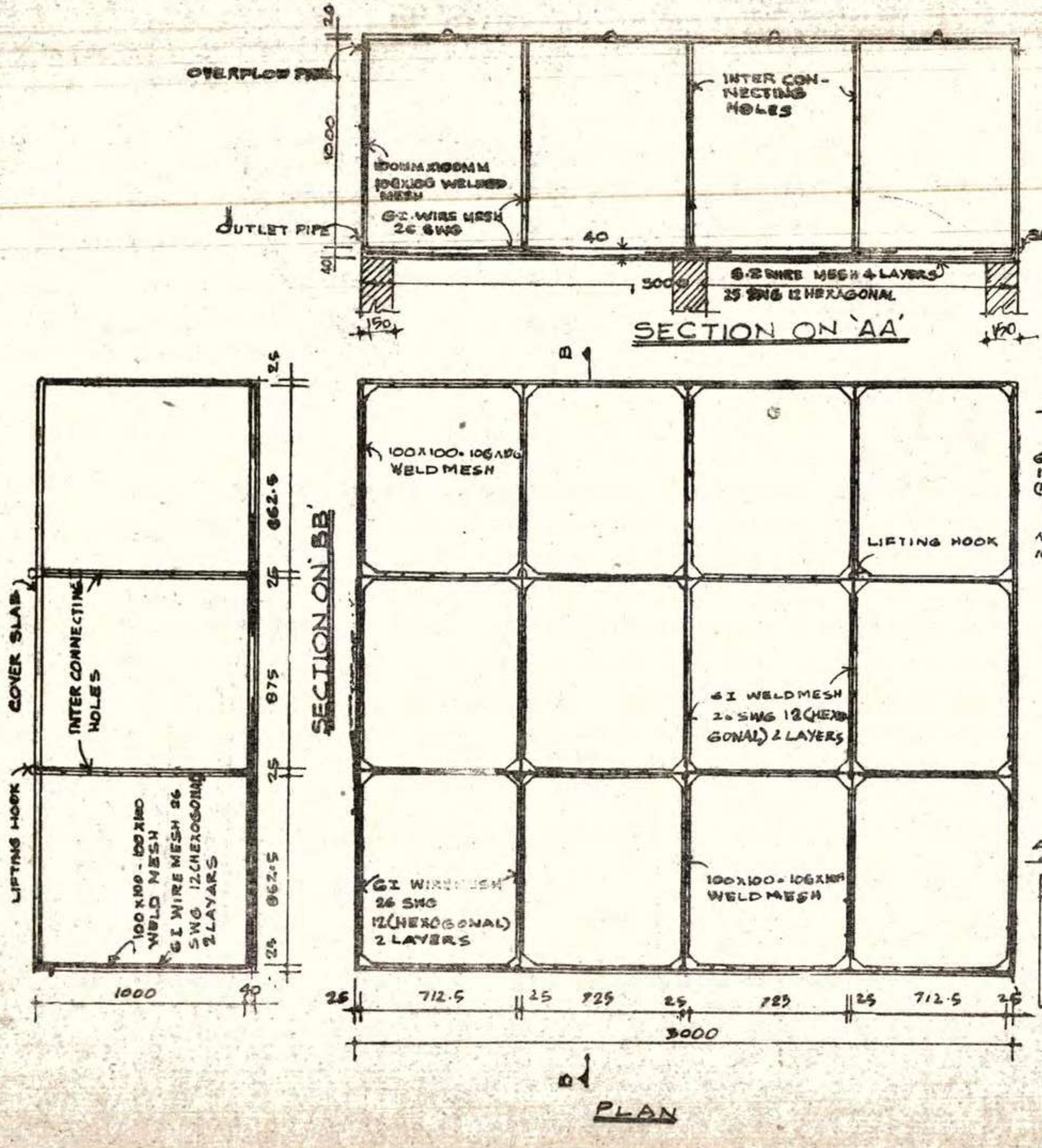
FERROCEMENT CIRCULAR WATER TANK
800 LITRES CAPACITY (TYPE B)

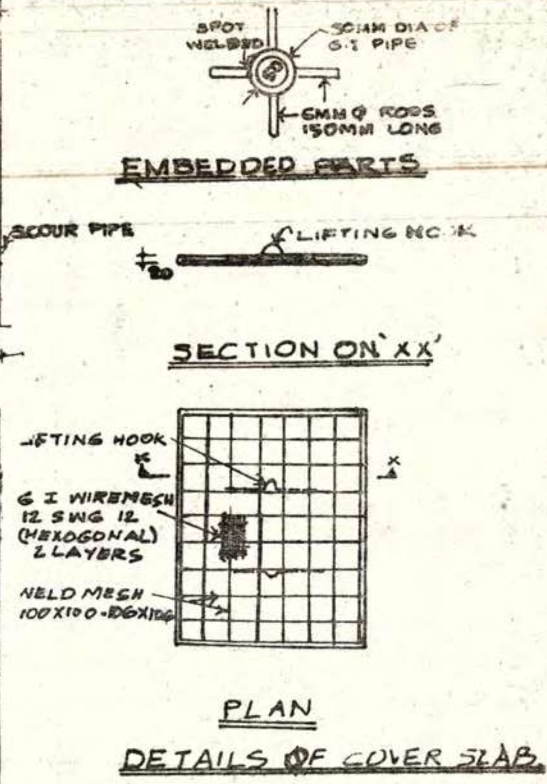




ALL DIMENSIONS ARE IN MILLIMETERS

FIG. DETAILS OF WELDED MESH FOR CIRCULAR TANK TYPE-B

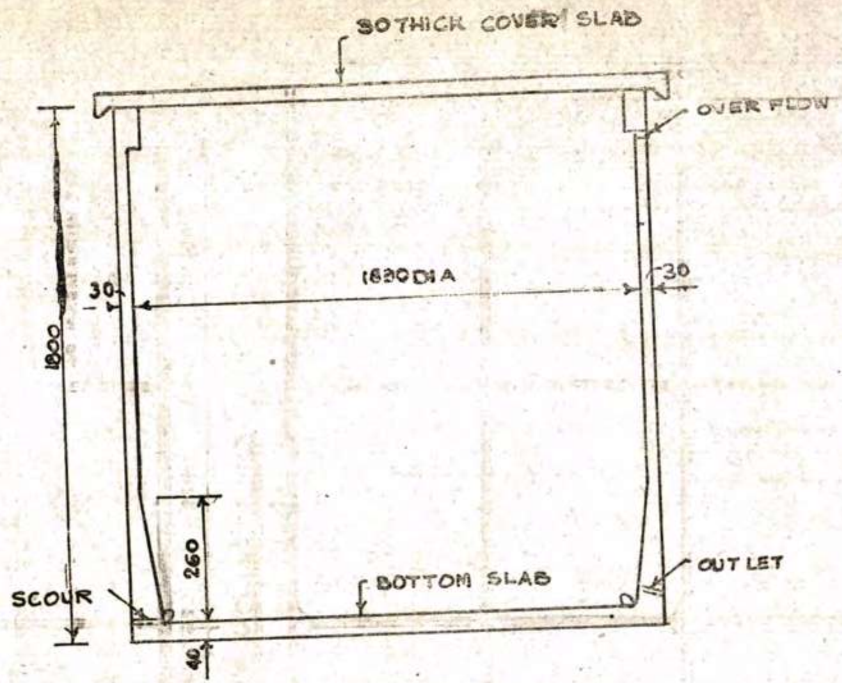




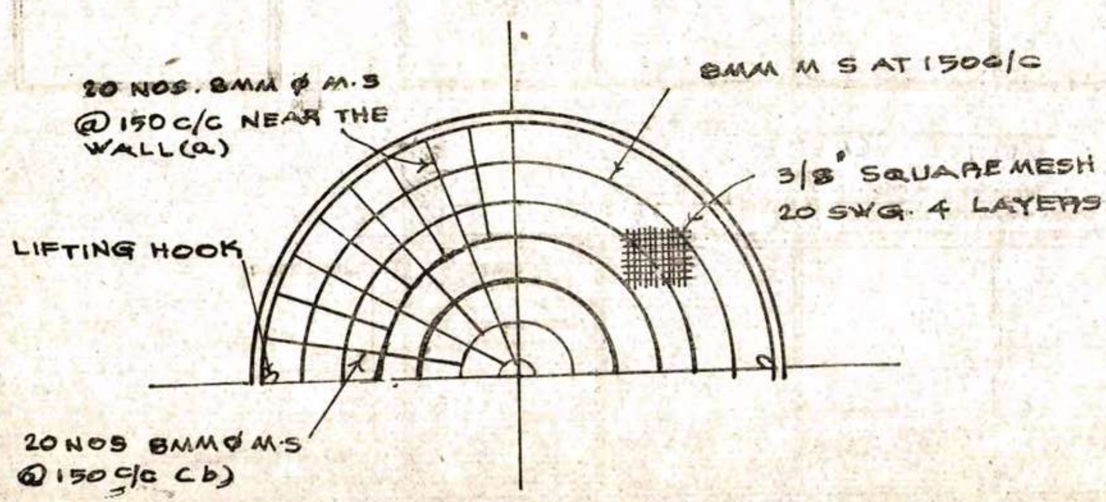
NOTES

ALL DIMENSIONS ARE IN MILLIMETERS
CAPACITY OF INDIVIDUAL TANK 600 LITERS
INDIVIDUAL OUTLET AND SCOUR PIPES ARE TO BE PR[illegible]

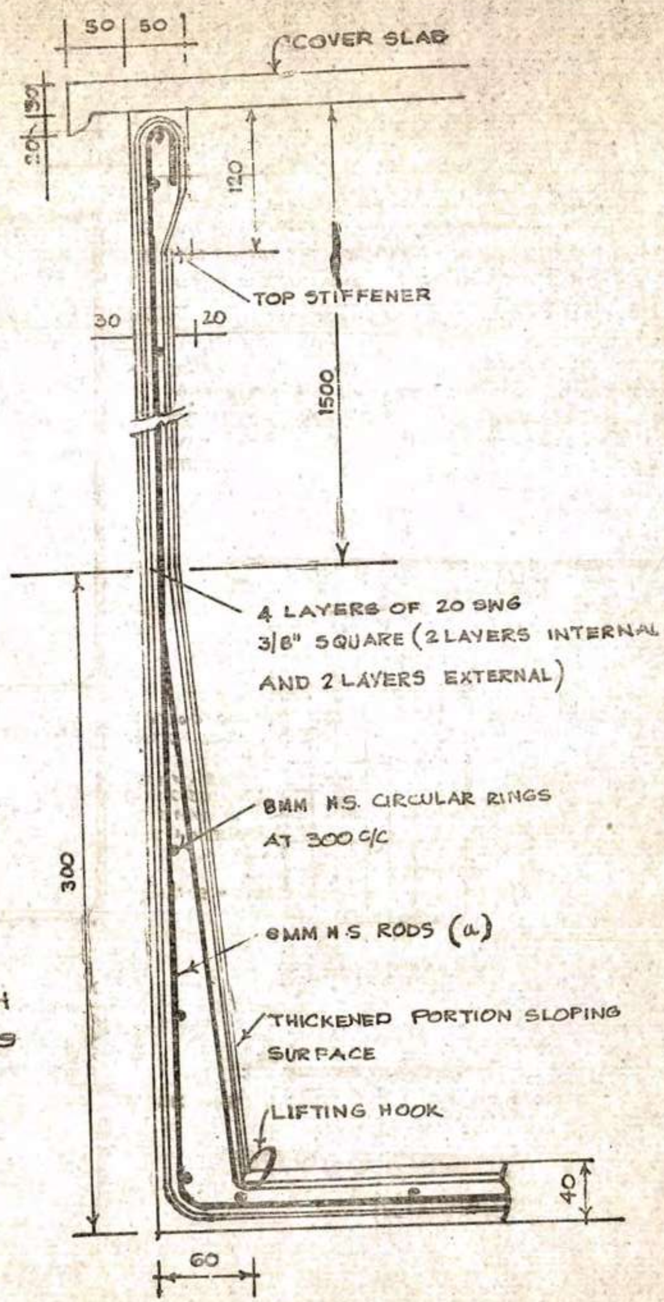
S NO	DESCRIPTIONS	QTY REQD
1.	CEMENT MORTAR 1:2 W/C RATIO 0.5	1.5 CU M
2.	WELD MESH 100 X 100 - 10G X 10G	40 OM²
3.	G I WIREMESH 26 SWG 12 (HEXOGONAL)	70 OM²
4.	50 DIA G.I PIPE (EMBEDD 30 PARTS)	5 METERS



SECTION ON A-A'



PLAN



SECTION (ENLARGED)

NOTE.—All dimensions in Millimeters.

Ferro Cement Water Tank 5,000 Litres Capacity(Type-E)

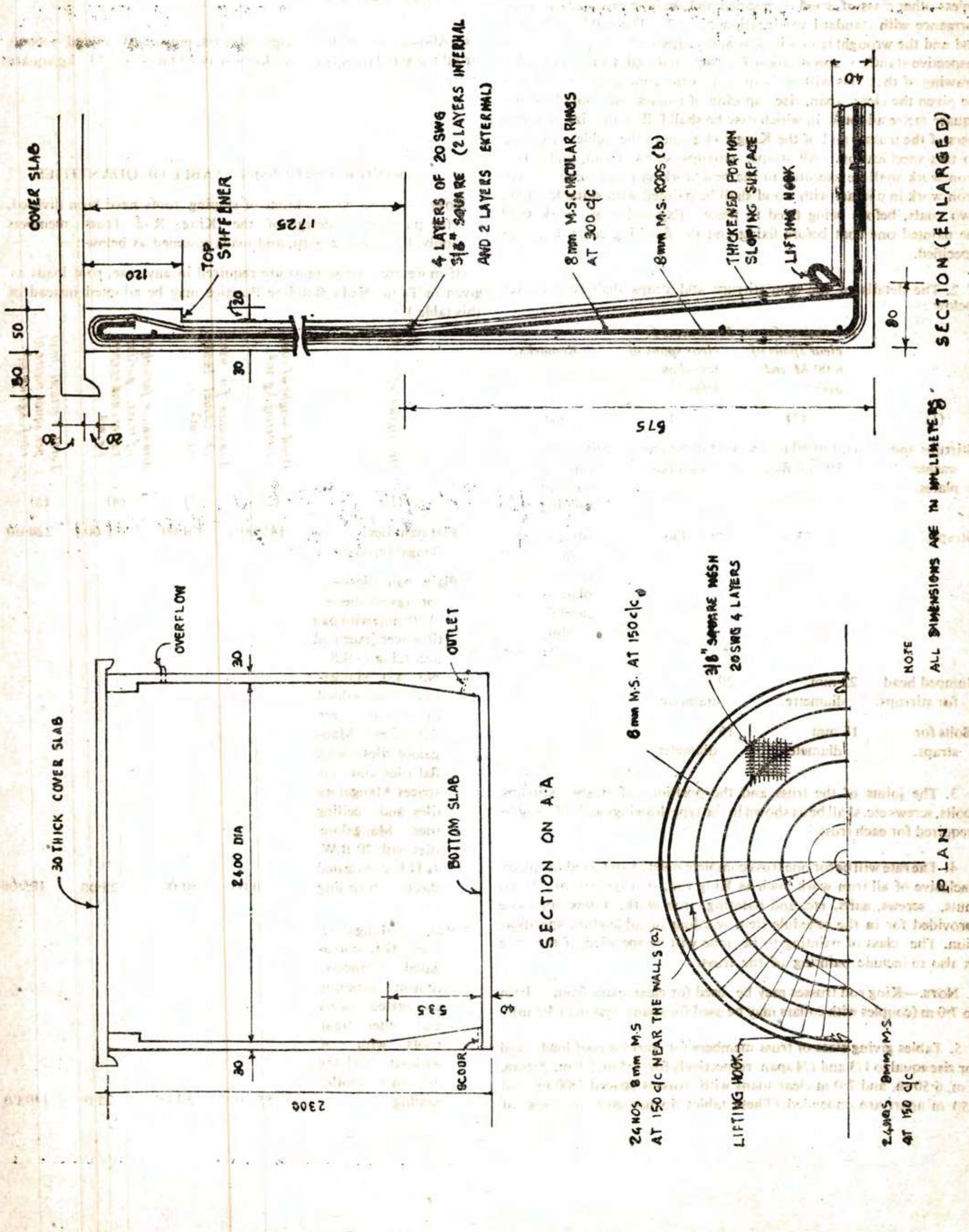


FIG. 10(b) FERROCEMENT WATER TANK 10000 Litres CAPACITY (TYPE E)

SPECIFICATION No. 109.

1. *King Rod Trusses.*

1.1 The wood work for the trusses shall be of best Indian Teakwood unless other class of wood is specified and shall be executed in conformance with standard specification No. 72. The mild steel king rod and the wrought iron stirrups and straps shall comply with the respective standard specification for each material. Either a detailed drawing of the truss will be furnished to the contractor or he will be given the clear span, rise, spacing of trusses and roof load per square metre adopted, in which case he shall follow the size of members of the trusses and of the King rod given in the tables attached to this specification. All straps, stirrups, screwed end, and other iron work shall be executed in the best workman like manner. All iron work in contact with wood shall be painted with suitable paint two coats, before being fixed in place. Exposed iron work shall be painted one coat before fixing and the finishing coats done as specified.

2. The details of the iron stirrups and straps shall be as given below :—

	For trusses for clear spans of 6·00 M and over.	*For trusses for clear spans of less than 6·00 M.*	*Remarks.*
(1)	(2)	(3)	(4)
Stirrups and washer plates.	Out of 50 mm x 10 mm flat.	Out of 50 mm x 6 mm flat.	Stirrups to formed without welding.
Straps.	Do.	Do.	T straps may either be cut from solid plate or careful welding may be done.
Jumped head for stirrups.	22 mm diametre.	20 mm diametre.	....
Bolts for straps.	16 mm diameter.	16 mm diameter.	....

3. The joints of the truss and the positions of straps, stirrups, bolts, screws etc. shall be as shown in the type drawings and of lengths required for each truss.

4. The rate will be for one truss complete hoisted and fixed in place, inclusive of all iron work such as King rod, stirrups, straps, bolts, nuts, screws, nails, etc. and painting iron work, unless otherwise provided for in the schedule item wording or addendum specification. The class of painting to be done will be specified, if the rate is also to include painting of the truss.

NOTE.—King rod trusses may be used for clear spans from 4·5m to 7·0 m (couples with collars may be used for spans less than 4·5 m).

5. Tables giving sizes of truss members for various roof loads and for rise equal to 1/3 and 1/4 span, respectively for 4·5 m, 5·0 m, 5·50m, 6 m, 6·50 m, and 7·0 m clear spans with trusses spaced 3·00 m and ·50 m apart are appended (These tables do not give the sizes of purlin, common rafter, etc., as the spacing and fixing of these may vary considerably and will therefore have to be designed, in each case, according to requirements. Also, the tables will not hold good for cases in which the purlins are not fixed in the positions indicated in the type drawings).

6. Allowances for dead weight of truss, purlin, rafters and reepers for all the standard spans and slopes may be taken as 24 kg/square metre.

KING ROD TRUSSES—TABLE OF QUANTITIES.

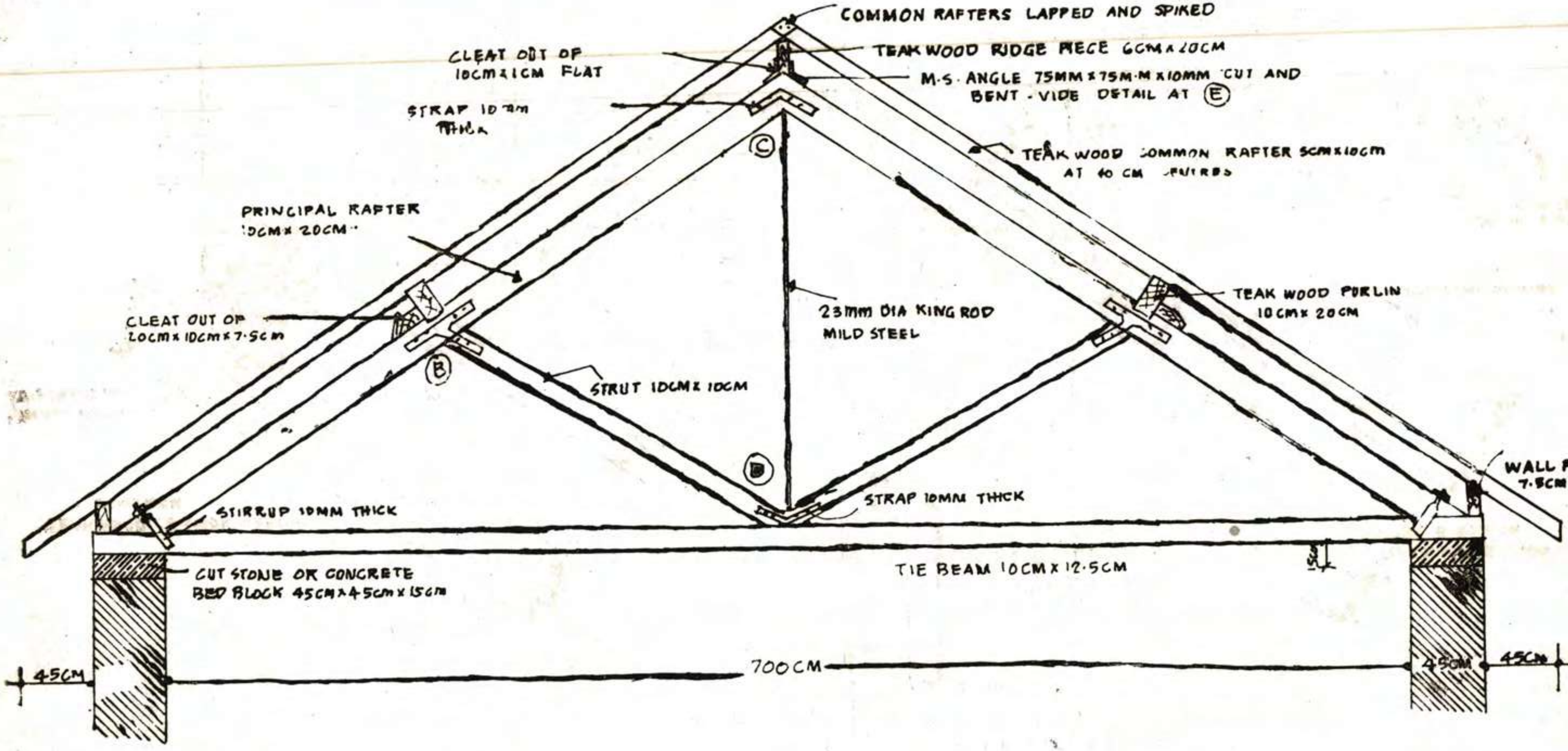
NOTE.—1. The various kinds of sloping roofs have been divided, for purposes of design of the King Rod Truss members only, into three groups, and loads assumed as below : —

(If more accurate weights are required in any case, roof loads as given in Tamil Nadu Building Practice may be adopted instead of this table.)

Description of roof.	*Dead weight of roof covering.kg/m².*	*Allowance for wind or casual loads. kg/m²*	*Allowance for weight of truss, purlins, rafters and reepers kg/m².*	*Total Vertical load per squar metre of roof. kg/ kg/m².*
(1)	(2)	(3)	(4)	(5)
1 Flat pan tiles; Bengal terrace.	145·00	50·00	25·00	220·00
2 Plain pan tiles—corrugated sheets (0·80 mm) with pan tiles over (executed according to S.S. No. 43) Mangalore tiles bedded in mortar over flat tiles. Mangalore tiles with flat tiles and air spaces Mangalore tiles and ceiling tiles. Mangalore tiles with 20 B.W. G.G.I. corrugated sheets or boarding	110·00	50·00	25·00	185·00
3 Plain Mangalore tiles G.I. corrugated sheets, cement asbestos corrugated sheets and other light roofs, with or without Celotex or other similar ceiling	55·00	50·00	25·0·	1?0.00

PLATE T 43

TYPE DESIGN OF KINGROD TRUSS
CLEAR SPAN = 7 M : RISE - 1/3 SPAN
SCALE 3CM = 1M



NOTE :-

1. FOR DETAILS OF A, B, C & D SEE PLATES T44 & T45
2. THE SIZES OF MEMBERS ARE FOR CARRYING A ROOF OF PAN TILES OVER FLAT TILES WITH TRUSSES SPACED 3.5 METRES APART
3. IN THE CASE OF G.I. SHEET OR ASBESTOS CEMENT SHEET ROOFING, THERE WILL BE TWO PURLINS FIXED WITH NECESSARY CLEATS AT 20CM DISTANT APART AT CROWN TO FACE SHEETS IN THESE CASES COMMON RAFTERS MAY BE OMITTED

DETAILS OF KING ROD TRUSS
CLEAR SPAN: 7M : RISE = 1/3 SPAN.

PLATE T.44
READ WITH PLATES T43 & T45

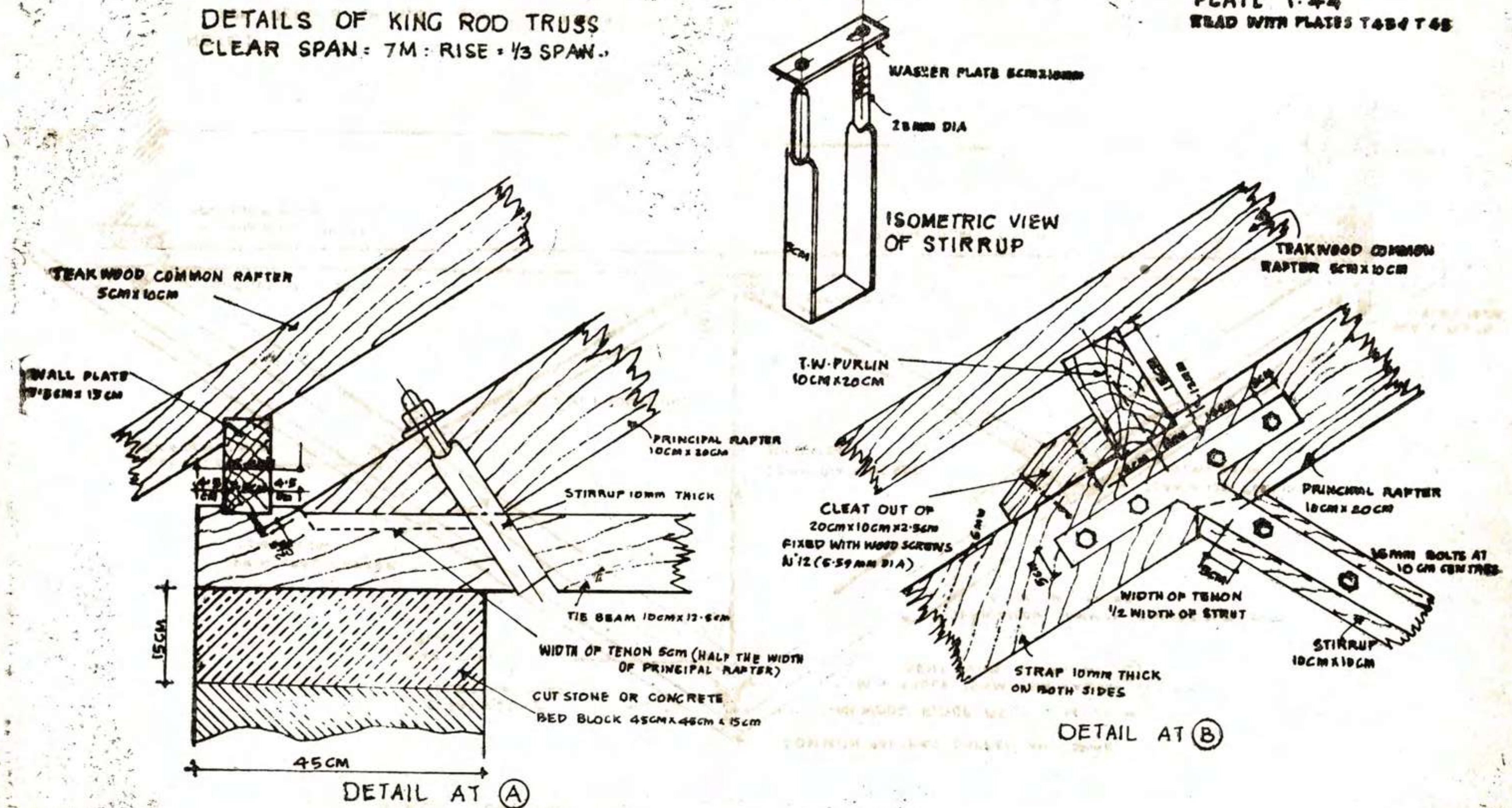
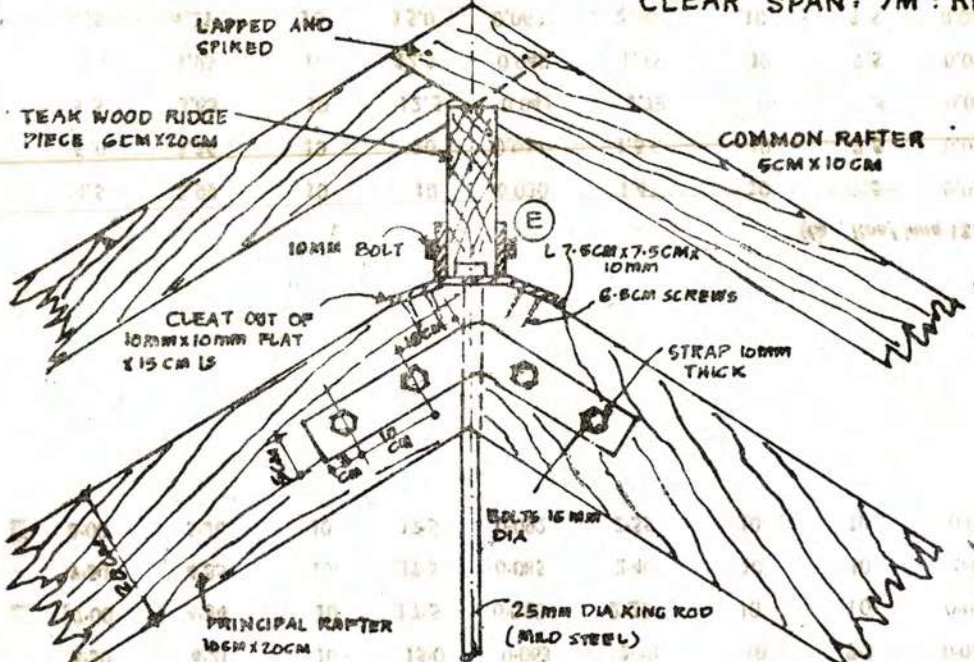
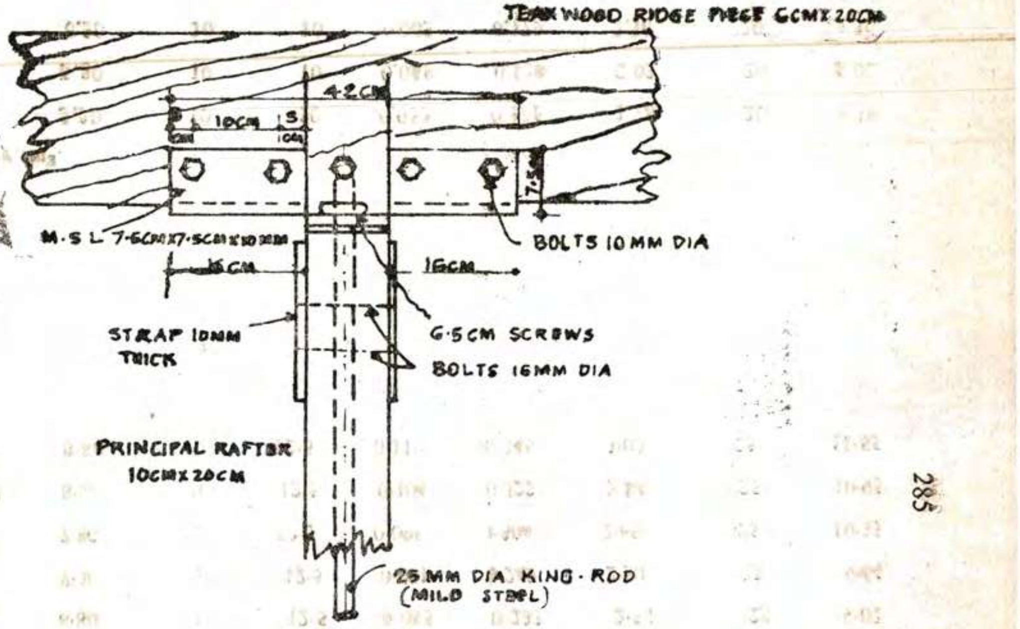


PLATE T.45
READ WITH PLATES T43 & T44

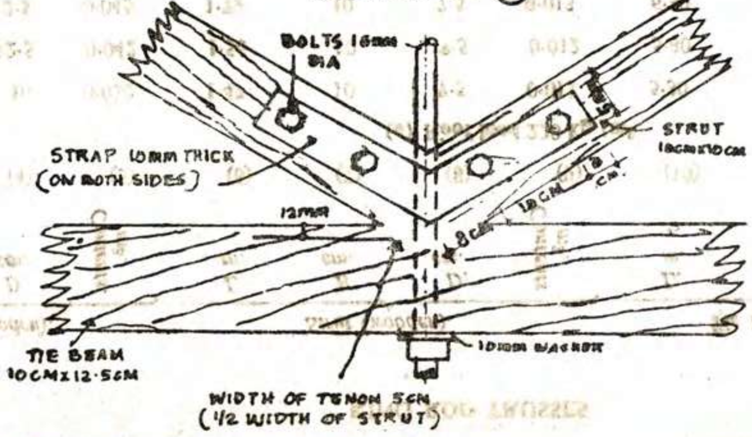
DETAILS OF KING ROD TRUSS
CLEAR SPAN : 7M : RISE = 1/3 SPAN



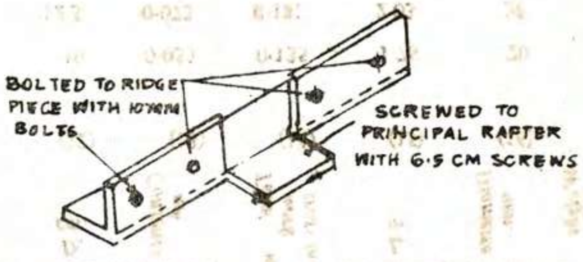
DETAIL AT (C)



SIDE ELEVATION



DETAIL AT (D)



ISOMETRIC VIEW OF ANGLE
7·5CM X 7·5CM X 10MM
DETAIL AT (E)

NOTE:-
THE KING ROD SHOULD BE SCREWED BEFORE THE BOLTS IN THE STRAP ARE TIGHTENED

The maximum length of water-tight pan tile roof for rise=1/3 span, may be taken as about 5.60 m, and for rise=1/4 span, about 4.25 m.—*vide* "Note" to Standard Specification No. 44-A. Pan tile roofs should not be used if the lengths of the roof slopes exceed the limits mentioned above.

3. In the following tables, L=length, B=breadth and D=Depth of member.

KING ROD TRUSSES.

se 1/3 span. (TRUSSES 3 m apart)

Clear span in metres.	Principal rafter (Wooden). L. m.	B. cm.	D. cm.	Contents. m³.	Strut (wooden). L. m.	B. cm.	D. cm.	Contents m³.	Tie Beam (wooden). L. m.	B. cm.	D. cm.	Contents m³.	Total wood work per truss in m³.	King Rod (Mild Steel). L. m.	Diametre mm.	Weight in kg. (7850 kg./m³.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(a) Roof load 220 kg./m².																
4·5	2·99	10	10	0·030	1·47	10	7·5	0·011	5·30	10	10	0·053	0·135	1·78	20	4·39
5·0	3·36	10	12·5	0·042	1·56	10	7·5	0·012	5·80	10	12·5	0·073	0·181	2·03	20	5·02
5·50	3·63	10	12·5	0·045	1·79	10	7·5	0·013	6·30	10	12·5	0·079	0·195	2·16	20	5·36
6·00	3·93	10	15·0	0·059	1·95	10	7·5	0·015	6·80	10	12·5	0·085	0·233	2·34	25	9·02
6·50	4·21	10	15·0	0·063	2·10	10	7·5	0·016	7·30	10	12·5	0·091	0·249	2·50	25	9·64
7·00	4·54	10	17·5	0·080	2·25	10	10	0·023	7·80	10	12·5	0·098	0·304	2·68	25	10·33
7·50	4·85	10	17·5	0·085	2·40	10	10	0·024	8·30	10	12·5	0·104	0·322	2·84	25	10·95
8·00	5·26	10	17·5	0·092	2·55	10	10	0·026	8·80	10	12·5	0·110	0·346	3·02	25	11·65
(b) Roof load 188 kg./m².																
4.5	2.99	10	10	0.030	1.47	10	7.5	0.011	5.30	10	10	0.053	0.135	1.78	20	4.39
5.0	3.36	10	10	0.034	1.56	10	7.5	0.012	5.80	10	10	0.058	0.150	2.03	20	5.02
5.5	3.63	10	12.5	0.045	1.79	10	7.5	0.013	6.30	10	10	0.063	0.179	2.16	20	5.36
6.0	3.93	10	12.5	0.049	1.95	10	7.5	0.015	6.80	10	12.5	0.085	0.213	2.34	20	5·77
6.5	4.21	10	15.0	0.063	2.10	10	7.5	0.016	7.30	10	12.5	0.091	0.249	2.50	20	6·17
7.0	4.54	10	15.0	0.068	2.25	10	7.5	0.017	7.80	10	12.5	0.098	0.268	2.68	26	10.38
7.5	4.85	10	15.0	0.073	2·40	10	7.5	0.018	8.30	10	12.5	0.104	0.286	2.84	25	10.95
8.0	5.26	10	15.0	0.079	2.55	10	7.5	0.019	8.80	10	12.5	0.110	0.306	3.02	25	11.65

Clear span metres.	Principal rafter (Wooden). L. m.	B. cm.	D. cm.	Contents m2.	Sirui (wooden). L. m.	B. cm.	D. cm.	Contents m3.	Tie Beam (wooden). L. m.	B. cm.	D. cm.	Contents m3.	Total wood work per truss in m3.	King Rod (Mild Steel). L. m.	Diametre mm.	Weight in kg. (7853 kg./m3.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
							(c) *Roof load* 130 kg/m^2.									
4.50	2.99	10	10	0.030	1.47	10	7.5	0.011	5.30	10	10	0.053	0.135	1.78	20	4.39
5.00	3.36	10	10	0.034	1.56	10	7.5	0.012	5.80	10	10	0.058	0.150	2.03	0	5.0
5.50	3.63	10	10	0.036	1.79	10	7.5	0.013	6.30	10	10	0.063	0.161	2.16	20	5.36
6.00	3.93	10	12.5	0.049	1.95	10	7.5	0.015	6.80	10	10	0.068	0.196	2.34	20	5.77
6.50	4.21	10	12.5	0.053	2.10	10	7.5	0.016	7.30	10	10	0.073	0.211	2.50	20	6.17
7.00	4.54	10	12.5	0.057	2.25	10	7.5	0.017	7.80	10	12.5	0.098	0.246	2.68	20	6.61
7.50	4.85	10	12.5	0.061	2.40	10	7.5	0.018	8.30	10	12.5	0.104	0.262	2.84	20	7.01
8.00	5.26	10	12.5	0.066	2.55	10	7.5	0.019	8.80	10	12.5	0.110	0.280	3.02	20	7.45

N.B. – Notes1 and 2 same as for "King Rod Trusses Rise 1/3 span Trusses 3 m apart".

RISE = $\frac{1}{4}$ span

(a) *Roof load* 220 kg/m^2

(Trusses 3.5 m apart)

Clear span metres.	L. m.	B. cm.	D. cm.	Contents m2.	L. m.	B. cm.	D. cm.	Contents m3.	L. m.	B. cm.	D. cm.	Contents m3.	Total wood work per truss in m3.	L. m.	Diametre mm.	Weight in kg.
4-50	2.84	10	12.5	0.036	1.39	10	7.5	0.010	5.30	10	12.5	0.066	0.158	1.44	20	3.56
5.00	3.14	10	15.0	0.047	1.54	10	7.5	0.012	5.80	10	12.5	0.073	0.191	1.58	25	6.09
5.50	3.43	10	17.5	0.060	1.69	10	7.5	0.013	6.30	10	15.0	0.095	0.241	1.73	25	6.67
6.00	3.71	10	17.5	0.065	1.83	10	10	0.018	6.80	10	15.0	0.102	0.268	1.86	25	7.17
6.50	4.01	10	20.0	0.080	1.98	10	10	0.020	7.30	10	15.0	0.110	0.310	2.00	25	7.71
7.00	4.30	10	22.5	0.097	2.14	10	10	0.021	7.80	10	15.0	0.117	0.353	2.14	25	8.25
7.50	4.60	10	22.5	0.104	2.30	10	10	0.023	8.30	10	15.0	0.125	0.379	2.28	25	8.79
8.00	4.90	10	25.0	0.123	2.45	10	10	0.025	8.80	10	15.0	0.132	0.428	2.43	25	37.9

(c) *Roof load* 130 *kg./m²*.

4.5	2.99	10	7.5	0.022	1.47	10	7.5	0.011	5.30	10	10	0.053	.119	1.78	20	4.39
5.0	3.36	10	7.5	0.025	1.56	10	7.5	0.012	5.80	10	10	0.058	0.132	2.03	20	5.02
5.5	3.63	10	10	0.036	1.79	10	7.5	0.013	6.30	10	10	0.063	0.161	2.16	20	5.36
6.0	3·93	10	10	0.039	1.95	10	7.5	0.015	6.80	10	10	0.068	0.176	2.34	20	5.77
6.5	4.21	10	10	0.042	2.10	10	7.5	0.016	7.30	10	10	0.073	0.189	2.50	20	6.17
7.0	4.54	10	12.5	0.057	2.25	10	7.5	0.017	7.80	10	10	0.078	0.226	2.68	20	6.61
7.5	4.85	10	12.5	0.061	2.40	10	7.5	0.018	8.30	10	10	0.083	0.241	2.84	20	7.01
8·0	5.26	10	12.5	0.066	2.55	10	7.5	0.019	8.80	10	10	0.088	0.258	3.02	20	7.45

NOTES—1. The longest length of principal rafter, struct and tie beam, respectively necessary for the same span truss but with the different sizes of members (due to the different loadings) has been entered in the above table, so that in individual cases the lengths may be found to be slightly (2.5 cm. or 5 cm.) too much.

2. (*a*) The weight of the mild steel kingrod includes allowance for a jumped head, but does not include the nut and washer at the bottom.

(*b*) *Add* for all other iron work, viz., stirrups, straps, bolts, nuts, washers, etc., approximate value of 40 kg. per truss for clear spans of 6 m. and over and 30 kg. per truss for clear spans of less than 6 m.

(TRUSSES 3.5 m. apart).

(*a*) *Roof load* 220 *kg./m²*.

4.5	2.99	10	12.5	0.037	1.47	10	7.5	0.011	5.30	10	12·5	0.066	0.162	1.78	20	4.39
5.00	3.36	10	15.0	0.050	1.56	10	7.5	0.012	5.80	10	12.5	0.073	0.197	2.03	25	7.82
5.50	3.63	10	15.0	0.054	1.79	10	7.5	0.013	6.30	10	12.5	0.079	0.213	2.16	25	8.32
6.00	3.93	10	17.5	0.069	1.95	10	7.5	0.015	6.80	10	12.5	0.085	0.263	2.34	25	9.02
6.50	4.21	10	20.0	0.084	2.10	10	10	0.021	7·30	10	15.0	0.110	0·320	2.50	25	9.64
7.00	4.54	10	20	0.091	2.25	10	10	0.023	7.80	10	15.0	0.117	0.345	2.68	25	10.38
7.50	4.85	10	20	0.097	2.40	10	10	0.024	8.30	10	15.0	0.125	0.367	2.84	25	10.95
6.00	5.26	10	20	0.105	2.55	10	10	0.026	8.80	10	15.0	0.132	0.394	3.02	25	11.65

(*b*) *Roof load* 185 *kg./m²*.

4.5	2.99	10	10	0.030	1.47	10	7.5	0.011	5.30	10	10	0.053	0.135	1.78	[illegible]	4.39
5.00	3.36	10	12.5	0.042	1.56	10	7.5	0.012	5.80	10	12.5	0.073	0.181	2.03	20	5.02
5.50	3.63	10	12.5	0.045	1.79	10	7.5	0.013	6.30	10	12.5	0.079	0.195	2.16	20	5·36
6.00	3.93	10	17.5	0.069	1.95	10	7.5	0.015	6.80	10	12.5	0.085	0.253	2.34	25	9.02
6.50	4.21	10	17.5	0.074	2.10	10	7.5	0.016	7.30	10	12.5	0.091	0.271	2.50	25	9.64
7.00	4.54	10	17.5	0.080	2.25	10	10	0.023	7.80	10	12.5	0.098	0.304	2.68	25	10.33
7.50	4.85	10	17.5	0.085	2.40	10	10	0.024	8.30	10	12.5	0.104	0.322	2.84	25	10.95
8.00	5.26	10	17.5	0.092	2.55	10	10	0.026	8.30	10	12.5	0.110	0.346	3.02	25	11.68

(b) *Roof load* 185 kg/m^2.

4·5	2.84	10	12.5	0.036	1.39	10	7.5	0.010	5.30	10	12.5	0.066	0.158	1·44	20	3.56
5.0	3.14	10	12.5	0.039	1.54	10	7.5	0.012	5.80	10	12.5	0.073	0.175	1.58	20	3.90
5.5	3.43	10	15.0	0.051	1.69	10	7.5	0.013	6.30	10	12.5	0.079	0.207	1.73	20	4.27
6·0	3.71	10	15.0	0.056	1.83	10	7.5	0.014	6.80	10	12.5	0.085	0.225	1.86	25	7.17
6.5	4.01	10	17.5	0.070	1.98	10	10	0.020	7.30	10	15.0	0.110	0.290	2.00	25	7.71
7.0	4.30	10	20.0	0.086	2.14	10	10	0.021	7.80	10	15.0	0.117	0.331	2.14	25	8.25
7.5	4.60	10	20.0	0.092	2.30	10	10	0.023	8.30	10	15.0	0.125	0.355	2.28	25	8.79
8.0	4.90	10	20.00	0.098	2.45	10	10	0.025	8.80	10	15.0	0.132	0.378	2.43	25	9.37

(c) *Roof load* 130 kg/m^2.

4.5	2.84	10	10	0.028	1.39	10	7.5	0.010	5.30	10	10	0.053	0.129	1.44	20	3.56
5.0	3.14	10	10	0.031	1.54	10	7.5	0.012	5.80	10	10	0.058	0.144	1.58	20	3.90
5.5	3.43	10	12.5	0.043	1.69	10	7.5	0.013	6.30	10	12.5	0.079	0.191	1.73	20	4.27
6.0	3.71	10	12.5	0.046	1.83	10	7.5	0.014	6.80	10	12.5	0.085	0.205	1.86	20	4.59
6.5	4.01	10	12.5	0.050	1.98	10	7.5	0.015	7.30	10	12.5	0.091	0.221	2.00	20	4.93
7.0	4·30	10	15.0	0.065	2·14	10	7.5	0.016	7.80	10	12.5	0.098	0.260	2.14	20	5.28
7.5	4.60	10	15.0	0·069	2.30	10	7.5	0.017	8.30	10	12.5	0.104	0.276	2.28	20	5.63
8.0	4.90	10	15.0	0.074	2.45	10	7.5	0.018	8.80	10	12.5	0.110	0.294	2.43	20	6.00

N.B.—Notes 1 and 2 same as for "King rod Trusses—rise 1/3 span—Trusses—3 m apart".

(a) *Roof load* 220 $kg/m2$ (Trusses 3 m apart.)

4.5	2.84	10	12.5	0.036	1.39	10	7.5	0.010	5.30	10	12.5	0.066	0.158	1.44	20	3.56
5.0	3.14	10	12.5	0.039	1.54	10	7.5	0.012	5.80	10	12.5	0.073	0.175	1.58	20	3.90
5.5	3.43	10	15.0	0.051	1.69	10	7.5	0.013	6.30	10	12.5	0.079	0.207	1.73	20	4.27
6.0	3.71	10	15.0	0.056	1.83	10	7.5	0.014	6.80	10	12.5	0.085	0.225	1.86	20	4.59
6.5	4.01	10	17.5	0.070	1.98	10	10	0.020	7.30	10	15.0	0.110	0.290	2.00	25	7.71
7.0	4.30	10	20.0	0.086	2.14	10	10	0.021	7.80	10	15.0	0.117	0.331	2.14	25	8.25
7.5	4.60	10	20.0	0.092	2.30	10	10	0.023	8.30	10	15.0	0.125	0.355	2.28	25	8.79
8.0	4.90	10	20.0	0.098	2.45	10	10	0.025	8.8	10	15.0	0.132	3.78	2.43	25	9.37

Clear span in metres.	Principal rafter (Wooden).				Strut (wooden).				Tie Beam (wooden).				Total wood work per truss in m3.	King Rod (Mild Steel).		
	L. m.	B. cm.	D. cm.	Contents m3.	L. m.	B. cm.	D. cm.	Contents m3.	L, m.	B. cm.	D. cm.	Contents m3		L. m.	Diametre mm.	Weight in kg. (7353 kg./ms.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
								(b) Roof load 185 kg/m^2.								
4.5	2.84	10	10	0.028	1.39	10	7.5	0.010	5.30	10	12.5	0.066	0.142	1.44	20	3.56
5.0	3.14	10	12.5	0.039	1.54	10	7.5	0.012	5.80	10	12.5	0.073	0.175	1.58	20	3.90
5.5	3.43	10	12.5	0.043	1.69	10	7.5	0.013	6.30	10	12.5	0.079	0.191	1.73	20	4.27
6.0	3.71	10	15.0	0.056	1.83	10	7.5	0.014	6.80	10	12.5	0.085	0.225	1.86	20	4.59
6.5	4.01	10	15.0	0.060	1.98	10	7.5	0.015	7.30	10	12.5	0.091	0.241	2.00	20	4.93
7.0	4.30	10	17.5	0.075	2.14	10	7.5	0.016	7.80	10	12.5	0.098	0.280	2.14	20	5.28
7.5	4.60	10	17.5	0.081	2.30	10	7.5	0.017	8.30	10	12.5	0.104	0.300	2.28	20	5.6
8.0	4.90	10	17.5	0.086	2.45	10	7.5	0.018	8.80	10	12.5	0.110	0.318	2.43	20	6.00
								(c) Roof load 130 kg/m^2.								
4.5	2.84	10	7.5	0.021	1.39	10	7.5	0.010	5.30	10	10	0.053	0.115	1.44	20	3.56
5.0	3.14	10	10	0.031	1.54	10	7.5	0.012	5.80	10	10	0.058	0.144	1.58	20	3.90
5.5	3.43	10	10	0.034	1.69	10	7.5	0.013	6.30	10	10	0.063	0.157	1.73	20	4.27
6.0	3.71	10	10	0.037	1.83	10	7.5	0.014	6.80	10	10	0.068	0.170	1.86	20	4.59
6.5	4.01	10	12.5	0.050	1.98	10	7.5	0.015	7.30	10	12.5	0.091	0.221	2.00	20	4.93
7.0	4.30	10	12.5	0.054	2.14	10	7.5	0.016	7.80	10	12.5	0.098	0.238	2.14	20	5.28
7.5	4.60	10	12.5	0.058	2.30	10	7.5	0.017	8.30	10	12.5	0.104	0.254	2.28	20	5.63
8.0	4.90	10	12.5	0.061	2.45	10	7.5	0.018	8.80	10	12.5	0.110	0.268	2.43	20	6.00

SPECIFICATION No. 110.

1. *Steel Roof Trusses.*

1.1. The steel work for trusses shall comply with standard specification 86-A for "Steel and Steel work". The members of the truss joints and the bearing arrangments shall be as shown in the standard drawings. The rate will be for the weight of this truss, in Kg. including all boring and anchor arrangments complete, fixed in place, unless otherwise provided for in the Schedule [*vide* paragraph 2(j) standard specification No. 86-A regarding oiling and painting.]

NOTE.—(Additional to "Notes on design of R.S. beams, girders and roof trusses", of the Tamil Nadu Building Practice.)

1.2. Steel roof trusses will usually be used for clear spans of 6 m and over. Detailed designs of trusses for clear spans of 6, 8, 10 and 15 m are appended. The designs are for 30 degree pitch of roof. These trusses are to be spaced 3 M Centre to Centre in the case of roofing of Mangalore tiles set in mortar over flat tiles. For other kinds of roof covering, the same trusses may be used but the distance apart of trusses should be adjusted to suit the load due to the roof-covering (*vide* table)

1.3. The following allowances for dead load may be assumed: Due to weight of truss: 14·50 kg. per sq. m. for clear spans of 7·5 m, 9·0 m. and 10·5 m and 19·50 kg. per sq. m. for clear spans of 12·0 m. and 15·00 m.

Due to weight of purlins, rafters, reepers, etc., 19·50 kg. per sq. m. for all standard trusses.

The maximum l/r for all roof truss compression members may be taken as 120.

1.4. The joints are to develop the full strength of the member and not mererly the computed stress in the member.

1.5. No camber need be allowed but sag ties may be provided for tusses with clear spans of 9·15 m. and over.

1.6. The tension members also should be of L Section to ensure stiffness and rigidity of frame work and to minimise bending and distortion during handling and transport.

TABLE I: Table showing maximum spacing of standard stee roof trusses for different kinds of roofs.

Description of roof covering. (1)	*Maximum spacing of trusses, centre to centre.* (2) Metre.
Mangalore tiles bedded in mortar over flat tiles; plain pan tiles and corrugated G.I. sheets with pan tiles over.	3·00
Flat and pan tiles	2·50
Mangalore tiles with flat tiles and airspaces; Mangalore tiles and ceiling tiles.	3·60
Mangalore tiles with corrugated G.I. sheets on Mangalore tiles with boarding.	3·90
Plain Mangalore tiles	4·20
G.I. Corrugated sheets, cement Asbestos sheets; and other light roofs with or without wooden, colotex or similar ceiling.	4·90

TABLE—APPROXIMATE WEIGHTS OF STANDARD STEEL ROOF TRUSSES

Clear span. (1) METRE.	*Approximate weight of one truss (including bearing plate, anchor bolts, anchor plate complete).* (2) KG.
15	875
12	595
10·75	480
9	460
7·50	340

NOTE.—The above weights are approximate and are intended for estimate purposes only.

In the case of Asbestos cement or similar light roof coverings a 1/6 rise may be adopted.

2. *Welding.*

2.1. Welded joints are recommended for connecting the members with the gussets. But however is trusses of long span fabricated in two or three parts for easy transportation, bolts of field rivets can be adopted at the connecting joints, and other joints can be welded.

2.2. Regarding welding Section 14 of Tamil Nadu Building Practice shall apply.

2.3. In addition to the above, paragraph 31 to 31.2.2.1. in I.S. 800/62 shall apply.

2.4. For design of trusses N.B. Code Part VI (Section 6) shall apply.

EXTRACT OF I.S. 800–1962–30 WELDS AND WELDING.

31. Constructional details.

31.1. Braced frames and trusses.

31.1.1. Members of braced frames and trusses shall, where practicable be disposed symmetrically about the resultant line of force, and the connections shall, where practicable be arranged so that their centroid lies on the resultant of the force they are intended to resist (see 26.3).

31.1.1.1. In the case of bolted, rivted on welded trusses and braced frames, the strut members act under complex conditions and the effective length 'l' shall be taken as between 0.7 and 1.0 times the distance between centres of intersections depending on the degree of end restraint (See also 19.10).

31.1.2. where braced frames on trusses are supported by walls or piers they shall be secured thereto where necessary for anchorage.

31.1.3. Tension members which are subject to reversal of stresses due to temperature changes or vibration shall be designed to have rigidity.

31-2 *Roof Trusses:*

31.2.1. For any member normally acting as a tie in a roof truss but suject to reversal of stress resulting from the actiou of wind, the ratio of the effective length to the least radius of gyration shall not exceed 350.

31.2.2. The wind ward roof trusses in multiple-bay buildings shall be designed to resist the appropriate wind forces estimated as set out I.S.815-1956 classification and coding of covered Electrodes for metal A.C. welding of mild steel and low alloy High Tensile steel and the component members of the sheltered trusses, if the trusses are of the same height, span rise and spacing as the wind ward truss shall be of the same sections as those of the windward trusses.

31.2.2.1. Where in multiple-bay buildings, a sheltered truss in eigther of different height span rise or spacing from the windward truss, the component members of the sheltered truss shall be proportioned as if the sheltered rruss shall be proportioned as if the sheltered truss were a windward truss. Where however the wind loads produce greater force or reversal of force in any of the members such members shall be proportioned to resist these greater forc s or reversed forces.

Corrugated Galvanised Iron Sheet Garage Door with 40 cm. Expanded Metal Head Door 270 × 240 cm.

Mild steel work. (1)	*Length.* (2)	*Weight per metre run.* (3)	*Total weight.* (4)	*Wrought Iron work.* (5)	*Corrugated galvanised iron sheet 0·8 mm. thick-depth of corrugation 18 mm. vide I.S. 277/62.* (6)	*Expanded metal 20 mm S.W.M. 3·25 × 3·15 mm. as per I.S. 412/62.* (7)	*10 mm. bolts** 6 mm. bolts. ** Galvanised Iron bolts and nuts with washers (as per I.S. 1363/1960).* (8)	*Galvanised steel hasp and staple.* (9)	*Steel grip handle.* (10)
	Metres.	Kg.	Kg.	Kg.					
Angles 35 × 35 × 6 mm.	20·00	3	60·00	Anchor forged from 50 mm. square bar 45 cm. × 19·6 Kg. vide I. S. 1732/61 = 35·3 Kg.	5·20 square metres at 7·03 Kg/M2 = 36·60 Kg.	1·04 square metres.	45 Nos. 75 Nos.	1 No.	2 Nos.— 18 cm. [illegible]
Flat bars 32 × 6 mm.	17·56	1·4	24.6						
Gusset plate 6 mm. thick	0·226 sq.m.	50/Kg./sq.m.	11·3						
Angle (for hinges) 150 × 115 × 12 mm.	0·14	23·8	3·4						
Rivet heads.	..	..	5·0						
Total			104·3 kg. or						
		say	105 kg.						

PLATE T. 46

GENERAL DRAWING FOR STEEL TRUSS FOR ROOFS
CLEAR SPAN = 20M : RISE 1/4 SPAN
SCALE 2.5CM = 1M

NOTE :-

(A) FOR DETAILS A, B, C, D, E, F, G, H, J, K, & L SEE PLATES T 48 & T 49

(B) NOTES 2, 3 & 4 PLATE T50 FOR 15M CLEAR SPAN SHALL BE SAME FOR THIS PLATE ALSO

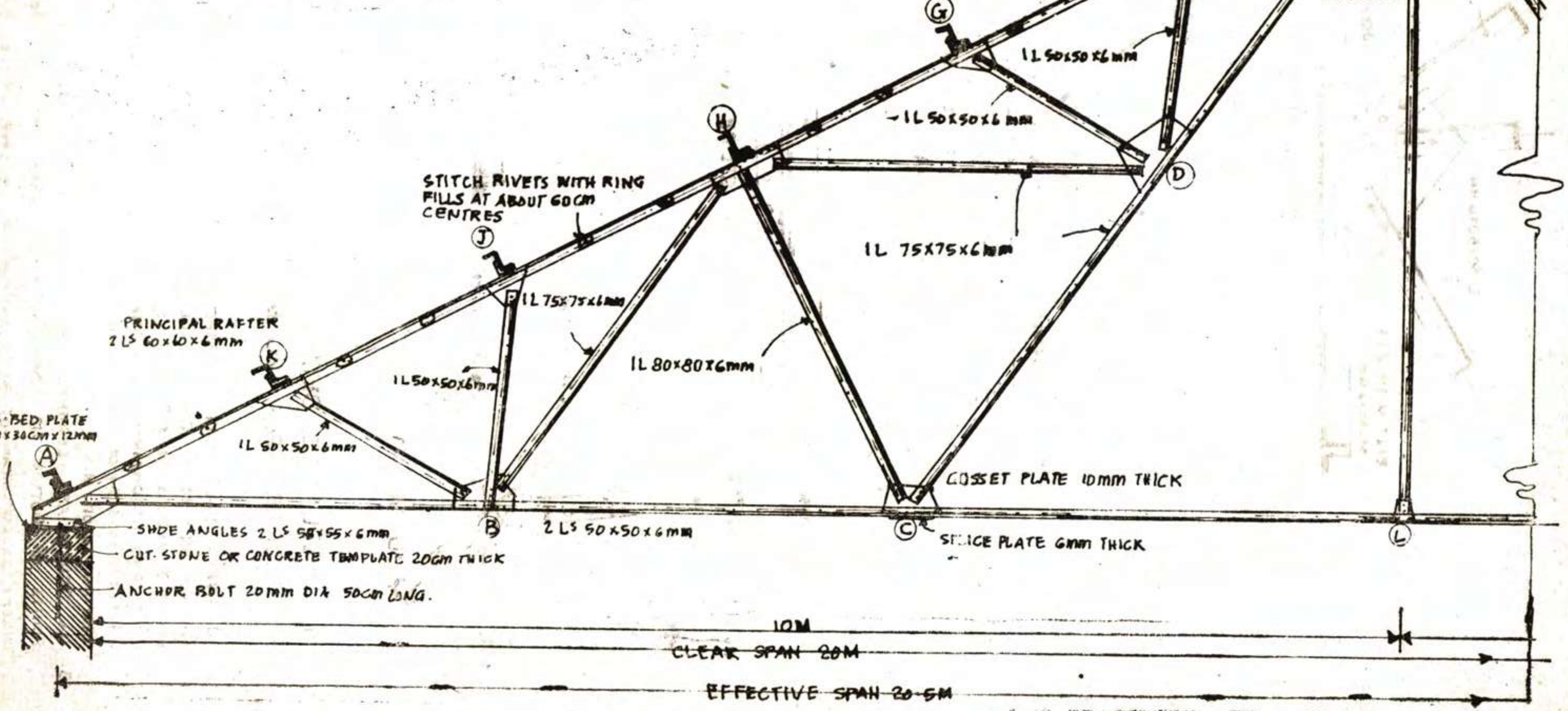
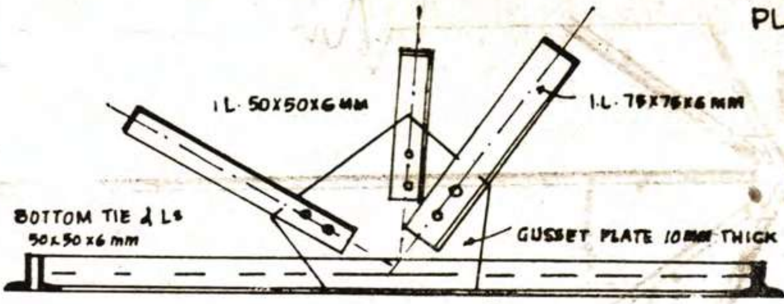
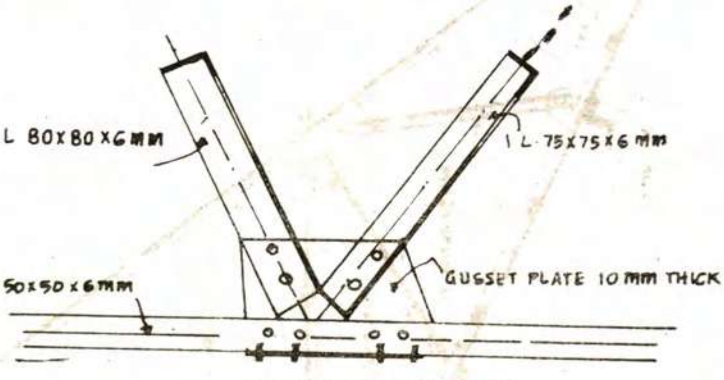


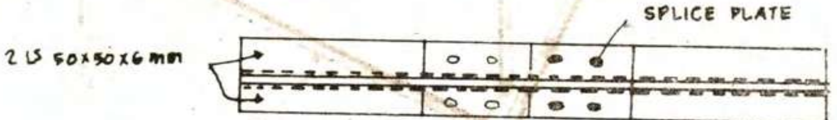
PLATE: T 48



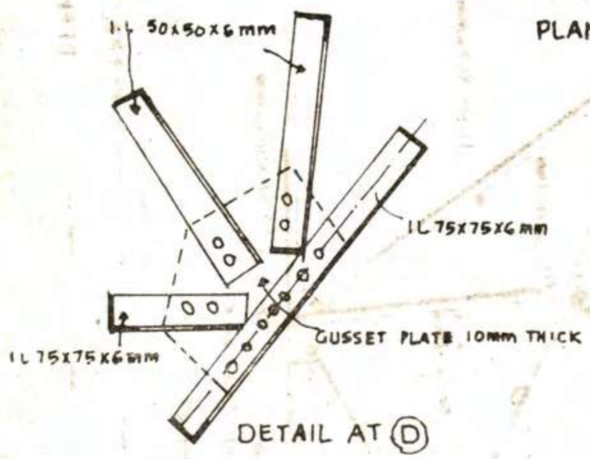
DETAIL AT (B)



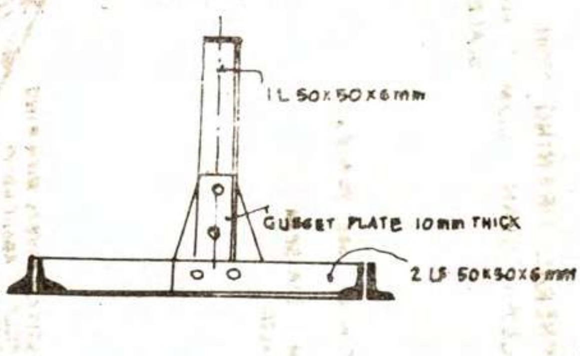
ELEVATION



PLAN OF SPLICE LOOKING UP



DETAIL AT (D)



DETAIL AT (L)

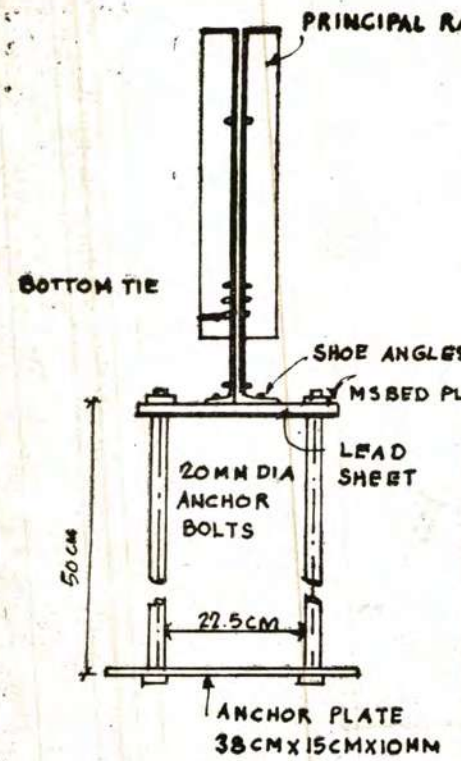
1/10 FULL SIZE DETAILS OF STEEL TRUSSES FOR ROOFS
CLEAR SPAN 20 METRES RISE 1/4 SPAN

READ WITH PLATES T 46 & T 49

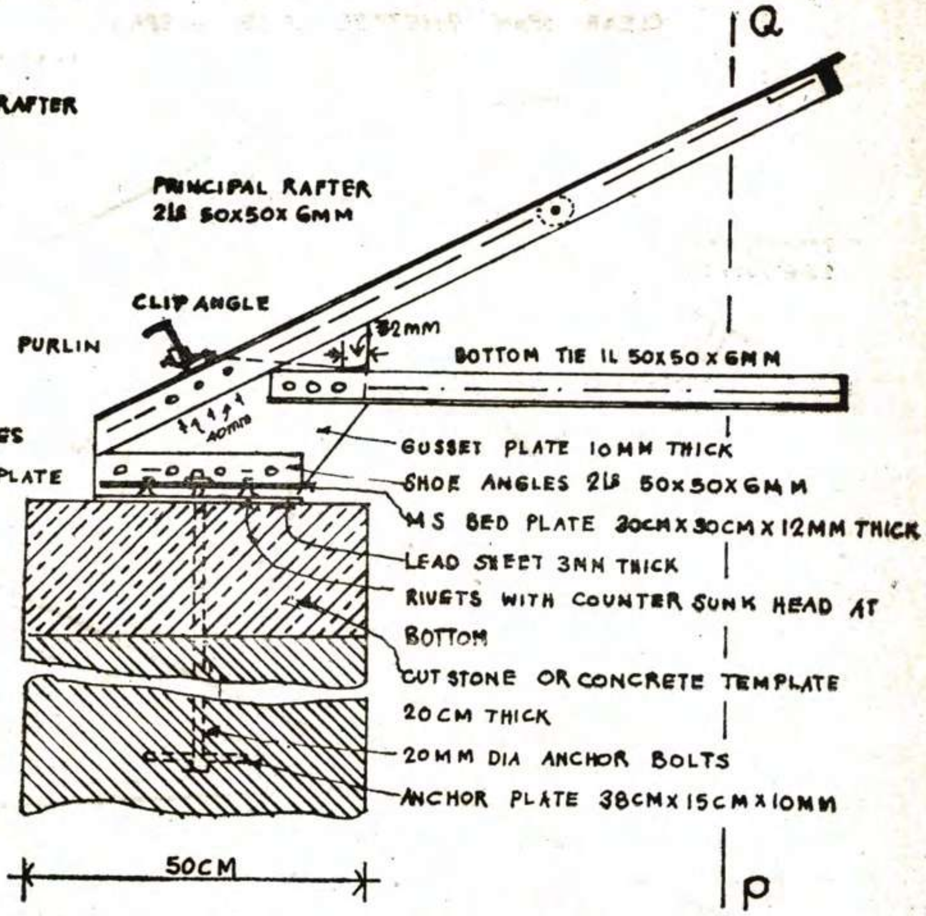
NOTE:-

1. THE RIVETS SHALL BE IN THE STANDARD GUAGE LINES OF ANGLES SHALL BE OF 15MM FOR 50X50X6 MM SECTION AND 20 MM DIA FOR ALL THE GREATER SECTIONS.
2. IN THE JOINTS ALL THE RIVETS ARE PLACED AT CENTRES NOT LESS THAN 2.5 TIMES THE DIA OF THE RIVET HOLE, AND ALL DISTANCES FROM THE CENTRE OF RIVET TO EDGE OF PLATES OR END OF ANGLES SHALL BE AS PER CLAUSE 7-1 OF NOTES ON DESIGN OF ROLLED STEEL BEAMS, GIRDERS AND ROOF TRUSSES UNDER SECTION 14 OF M.S.S.
3. ALL JOINTS ARE DESIGNED FOR SHOP RIVETS, EXCEPT JOINTS AT APEX OF TRUSS AND ONE THIRD POINTS OF BOTTOM TIE PORTIONS OF WHICH ARE LIKELY TO BE FIELD RIVETED IN CASES WHERE TRUSSES CANNOT BE TRANSPORTED IN ONE PIECE.

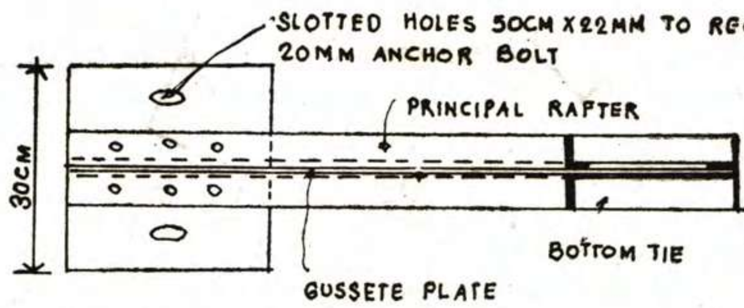
DETAIL AT A



SECTION ON P.Q



ELEVATION



PLAN

NOTE ON DETAIL AT A

THIS DETAIL IS FOR THE FREE END WHICH IS AWAY FROM THE DIRECTION OF THE PREVAILING WIND

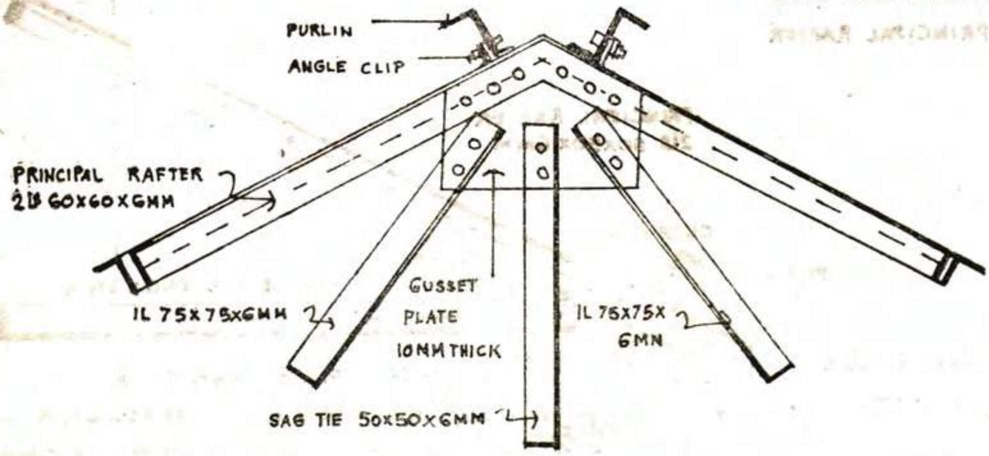
THE OTHER END IE THE END FROM WHICH DIRECTION THE PREVAILING WIND BLOWS SHALL BE FIXED THE JOINT DETAIL SHALL BE THE SAME AS SHOWN HERE EXCEPT THAT THE HOLES FOR ANCHOR BOLTS SHALL BE ROUND AND NOT SLOTTED AND THE LEAD SHEET SHALL BE OMITTED AND REPLACED BY CEMENT GROUT

PLATE T 49

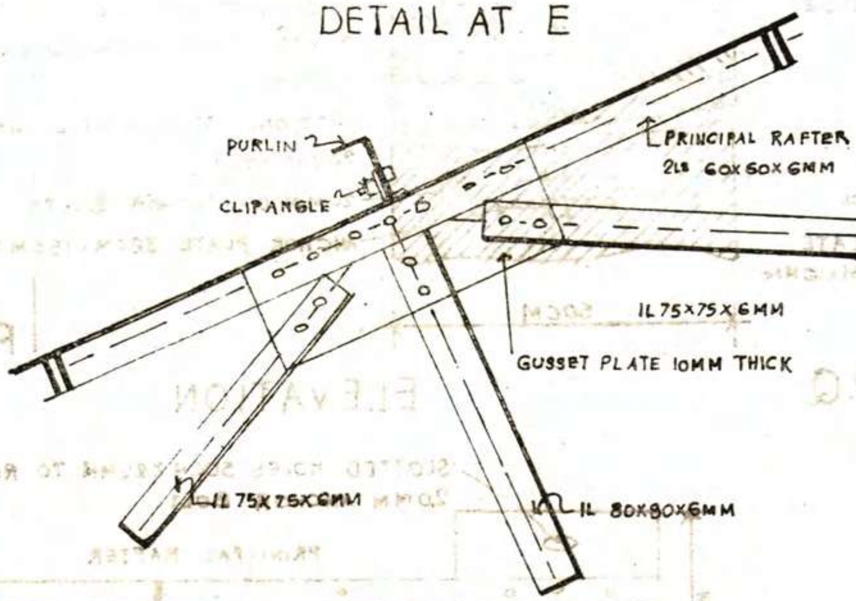
1/10 FULL SIZE DETAILS OF STEEL TRUSS FOR ROOFS

CLEAR SPAN : 2 METRES : RISE 1/4 SPAN

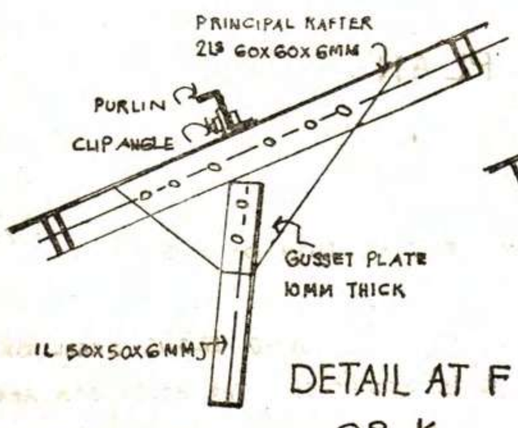
READ WITH PLATES T45 AND T48



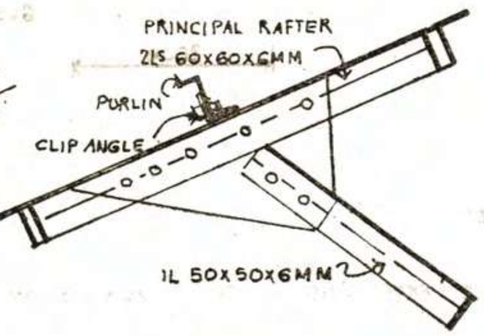
DETAIL AT E



DETAIL AT H



DETAIL AT F OR K



DETAIL AT G OR J

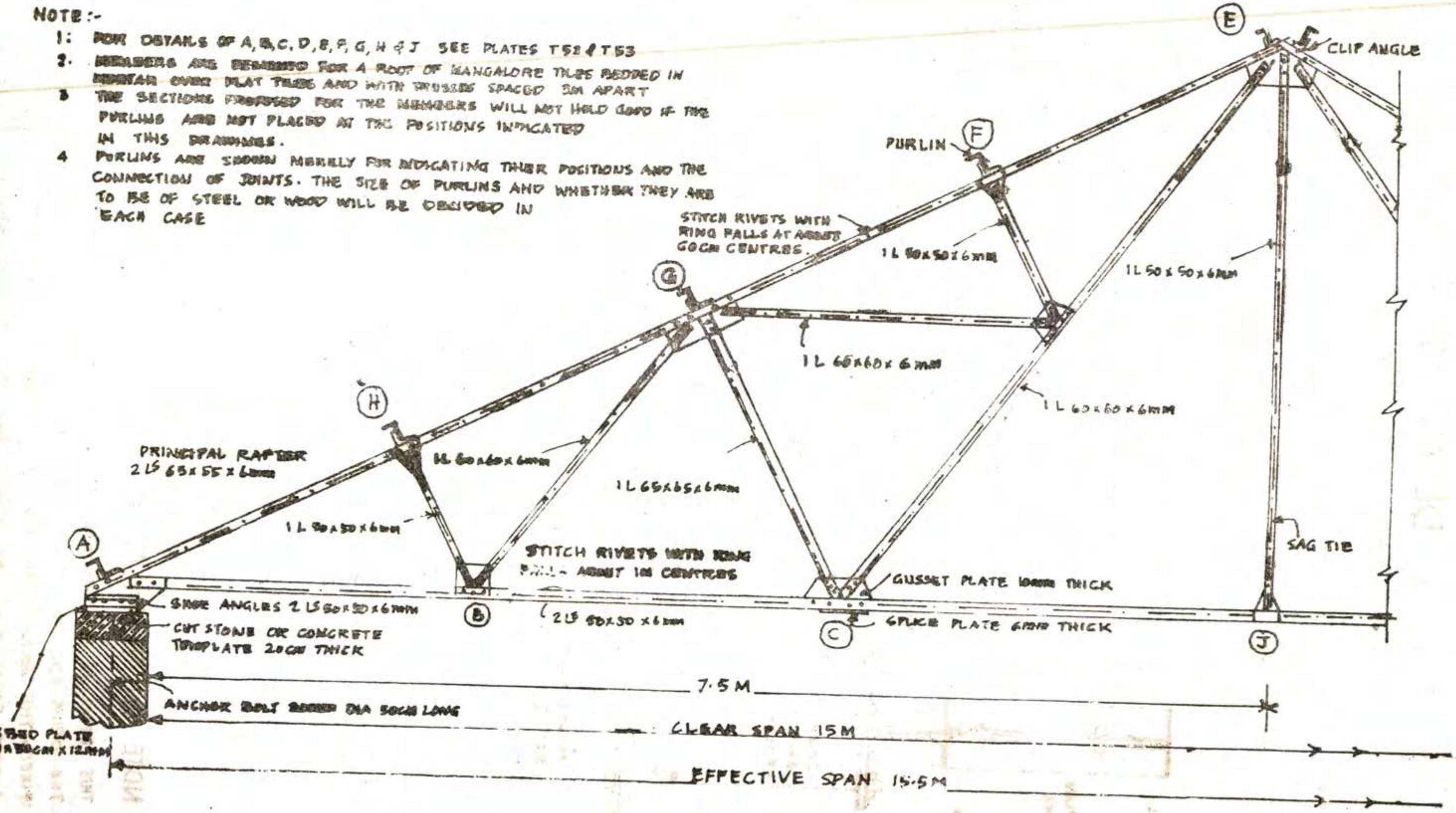
GENERAL DRAWING FOR STEEL TRUSS FOR ROOFS

CLEAR SPAN 15.M - RISE : 1/4 SPAN

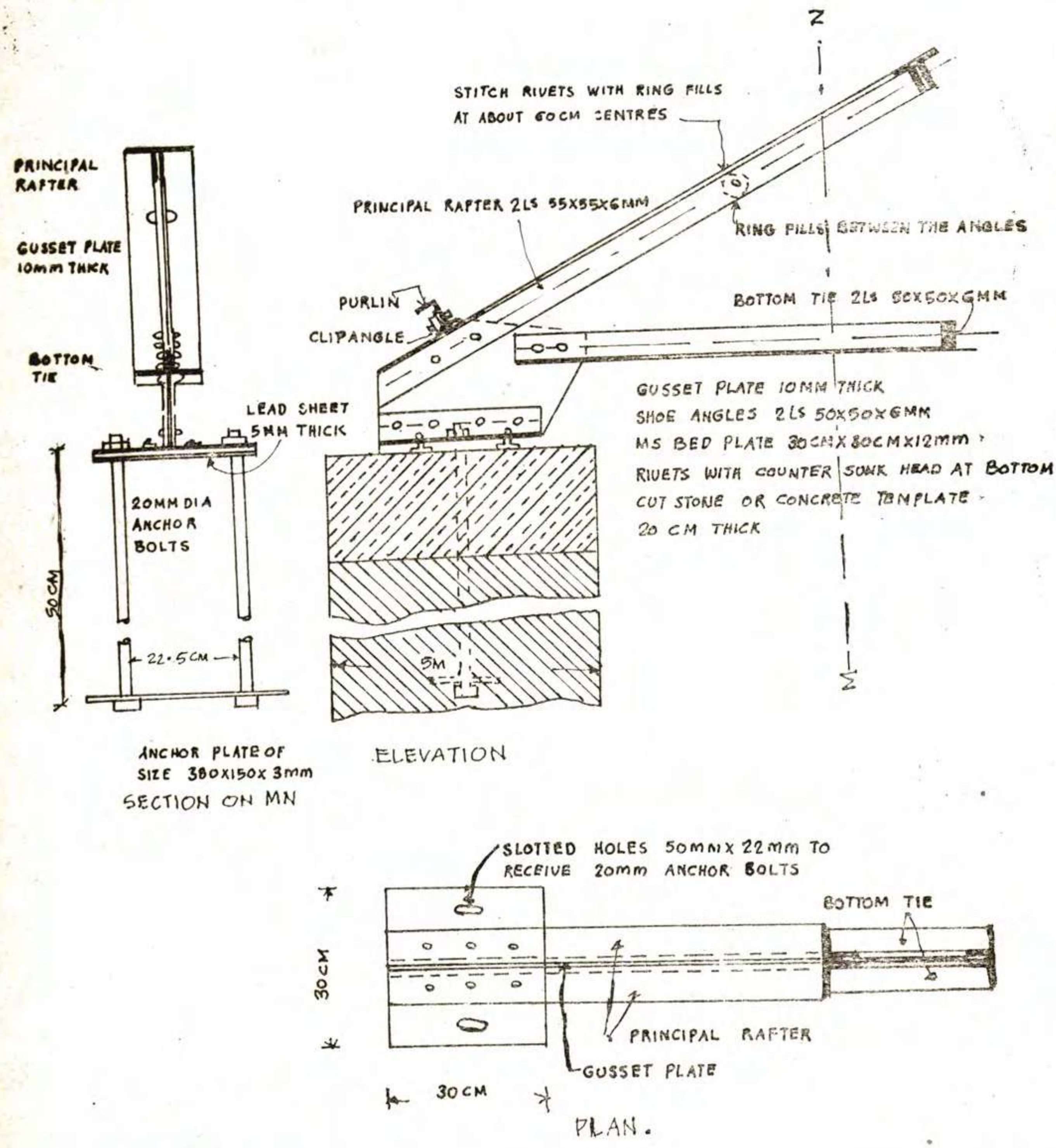
PLATE T 50

NOTE :-

1: FOR DETAILS OF A, B, C, D, E, F, G, H & J SEE PLATES T52 & T53
2. MEMBERS ARE DESIGNED FOR A ROOF OF MANGALORE TILES BEDDED IN MORTAR OVER FLAT TILES AND WITH TRUSSES SPACED 3M APART
3 THE SECTIONS PROPOSED FOR THE MEMBERS WILL NOT HOLD GOOD IF THE PURLINS ARE NOT PLACED AT THE POSITIONS INDICATED IN THIS DRAWINGS.
4 PURLINS ARE SHOWN MERELY FOR INDICATING THEIR POSITIONS AND THE CONNECTION OF JOINTS. THE SIZE OF PURLINS AND WHETHER THEY ARE TO BE OF STEEL OR WOOD WILL BE DECIDED IN EACH CASE



DETAIL AT A



NOTE ON DETAIL AT A

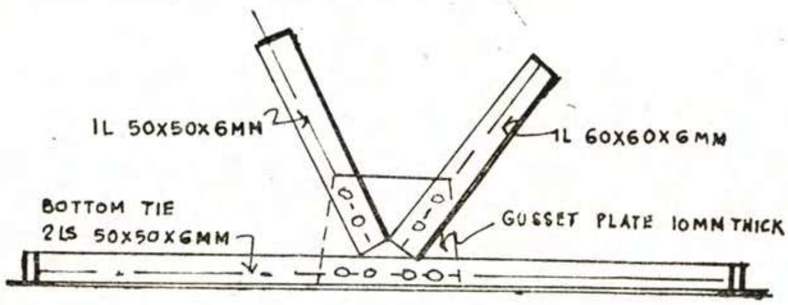
THIS DETAIL IS FOR THE FREE END WHICH IS AWAY FROM THE DIRECTION OF PREVAILING WIND THE OTHER END ie. THE END FROM WHICH DIRECTION THE PREVAILING WIND BLOWS SHALL BE FIXED. THE JOINT DETAIL SHALL BE THE SAME SHOWN HERE, EXCEPT THAT THE HOLES FOR ANCHOR BOLTS SHALL BE ROUND AND NOT SLOTTED AND THE LEAD SHEET SHALL BE OMITTED AND REPLACED BY CEMENT GROUT

1/10 FULL SIZE DETAILS OF STEEL TRUSS FOR ROOFS

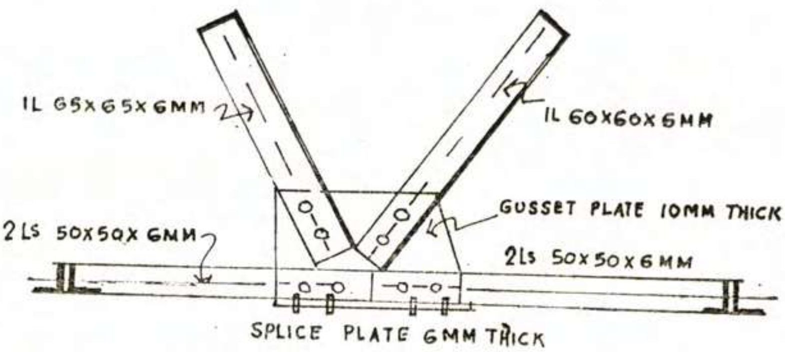
CLEAR SPAN 15 METRES RISE 1/4 SPAN

READ WITH PLATES T50 AND T53

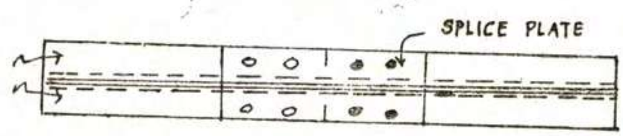
PLATE T52



DETAIL AT B

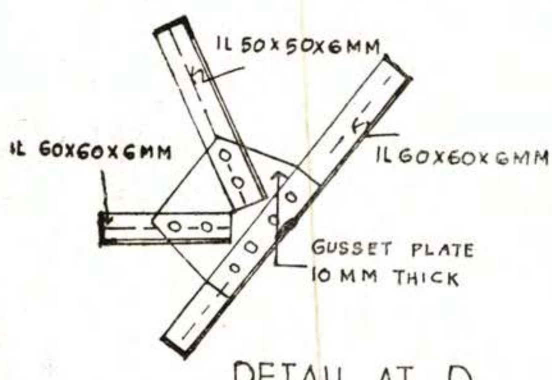


ELEVATION

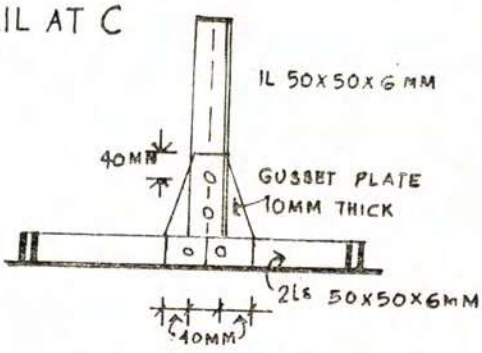


PLAN OF SPLICE LOOKING UP

DETAIL AT C



DETAIL AT D



DETAIL AT J

NOTE

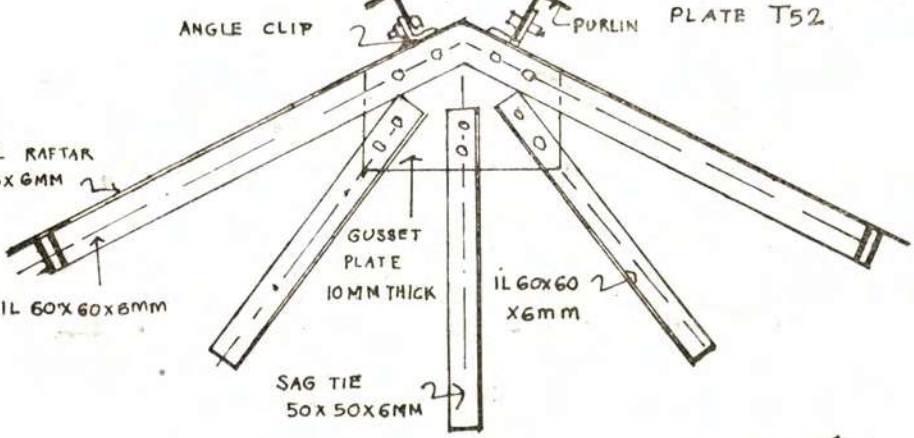
1. THE RIVETS SHALL BE IN THE STANDARD GAUGE LINES OF ANGLES AND SHALL BE OF 16MM DIA FOR 50X50X6 MM SECTION AND 20MM DIA FOR ALL THE GREATER SECTIONS
2. IN THE JOINTS ALL RIVETS ARE PLACED AT CENTRES NOT LESS THAN 2.5 TIMES THE DIA OF RIVET HOLE AND ALL DISTANCES FROM CENTRE OF RIVET TO EDGE OF PLATES OR END OF ANGLES SHALL BE AS PER CLAUSE 7 OF NOTES ON THE DESIGN OF ROLLED STEEL BEAMS, GIRDERS AND ROOF TRUSSES UNDER SECTION 14 OF T.N.B.P
3. ALL JOINTS ARE DESIGNED FOR SHOP RIVETS EXCEPT JOINTS AT APPEX OF TRUSS AND ONE THIRD POINTS OF BOTTOM TIE PORTIONS OF WHICH ARE LIKELY TO BE FIELD RIVETED IN CASES WHERE THE TRUSSES CANNOT BE TRANSPORTED IN ONE PIECE

PLATE T 5

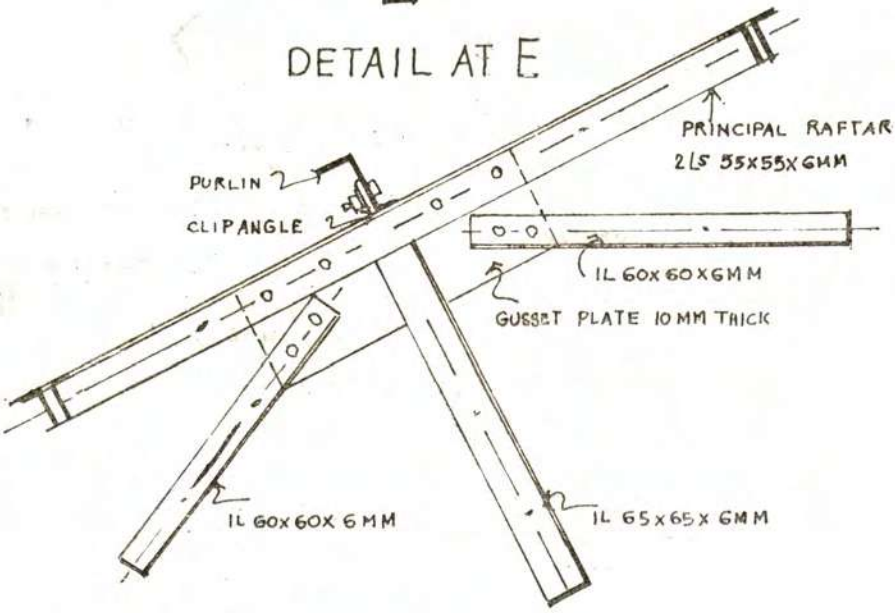
1/10 FULL SIZE DETAILS OF STEEL TRUSS ROOFS

CLEAR SPAN : 15 METRES : RISE 1/4 SPAN

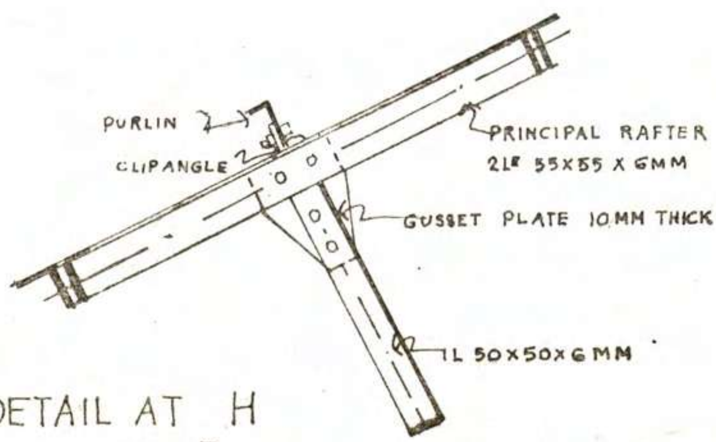
READ WITH PLATES T50 AND T52
NB: NOTES 1 2 AND 3 SAME AS IN PLATE T52.



DETAIL AT E



DETAIL AT G



DETAIL AT H
OR. F

GENERAL DRAWING FOR STEEL TRUSS FOR ROOFS

PLATE T 54

CLEAR SPAN. 10 METRES : RISE = 1/4 SPAN

SCALE 4 CM : 1 METRE

NOTE

(a) FOR DETAILS AT A, B, C, D, E & F SEE PLATE T 52

(b) NOTES 2, 3 & 4 PLATE T. 50. FOR 15 METRE CLEAR SPAN SHALL BE THE SAME FOR THIS PLATE ALSO

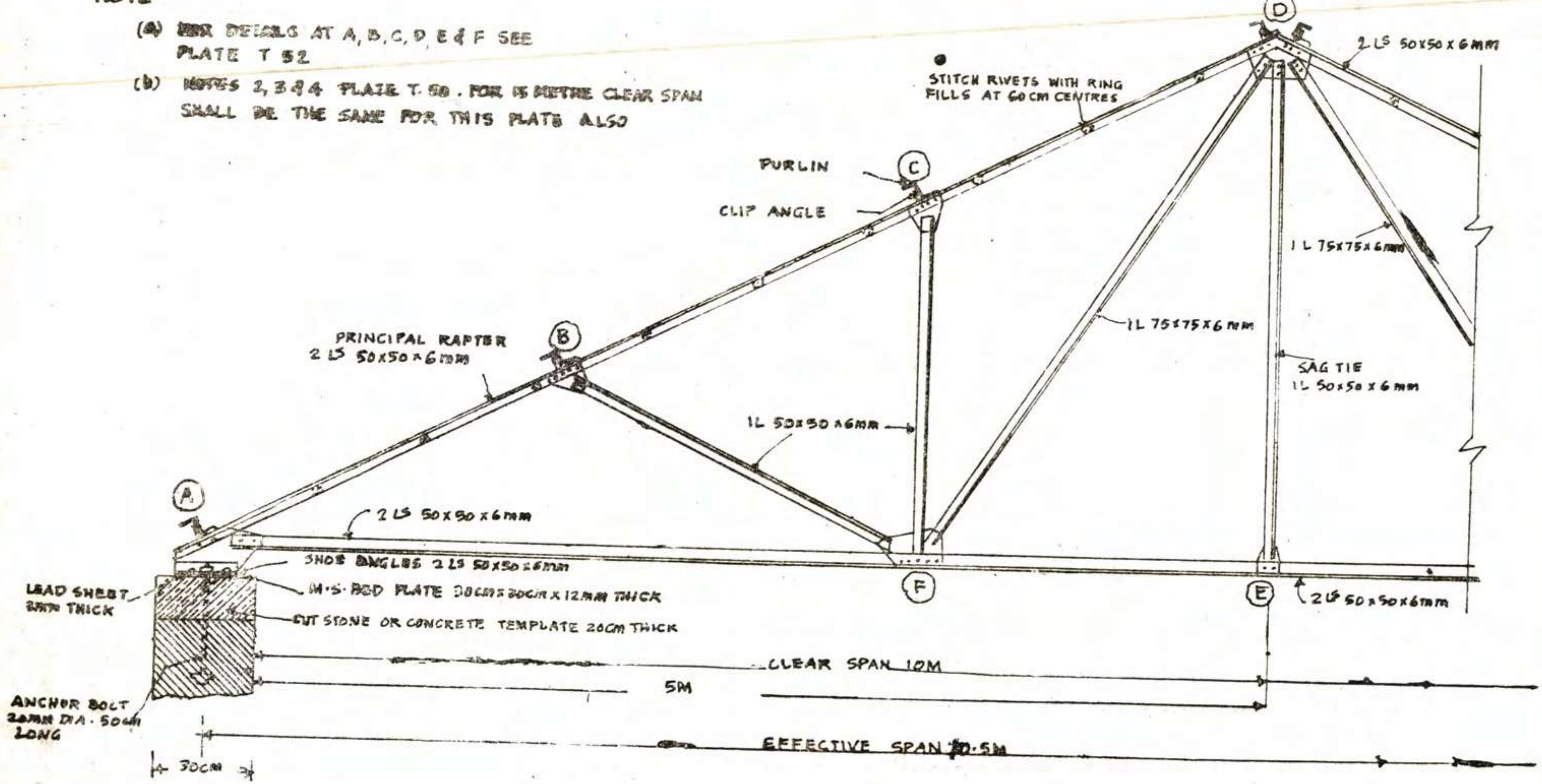
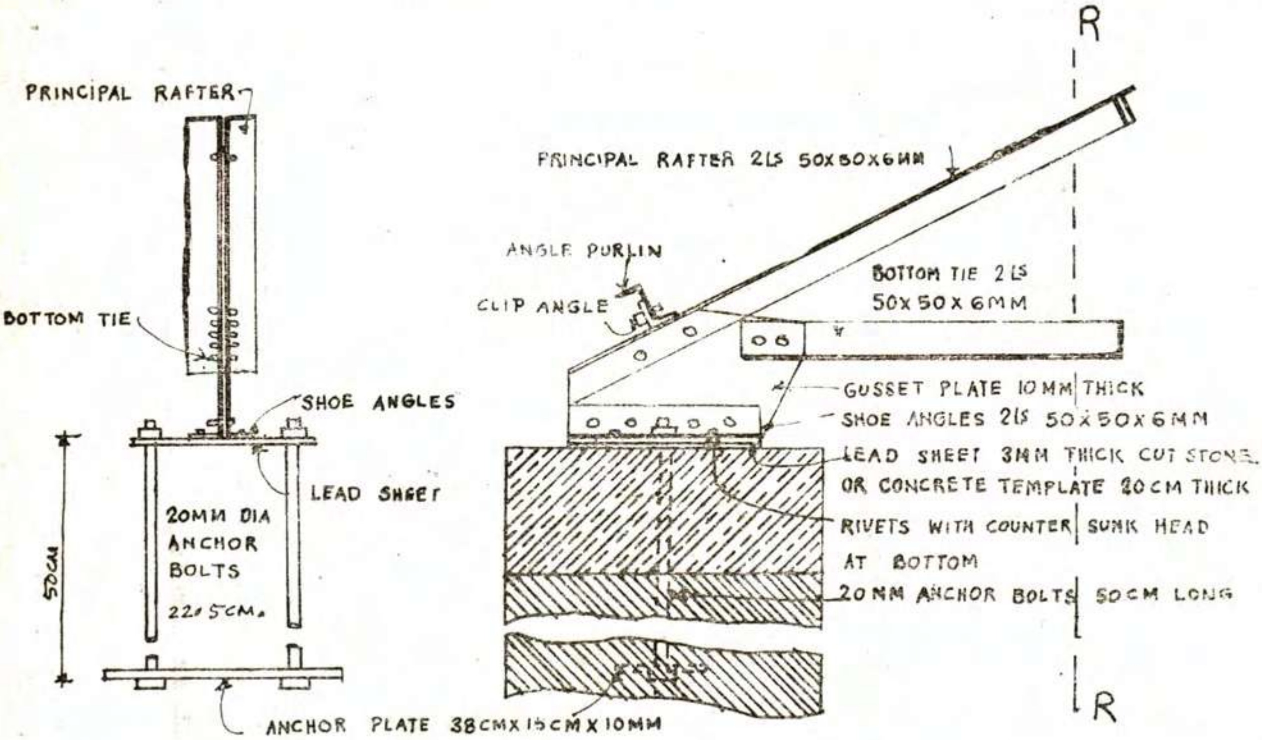


PLATE T55

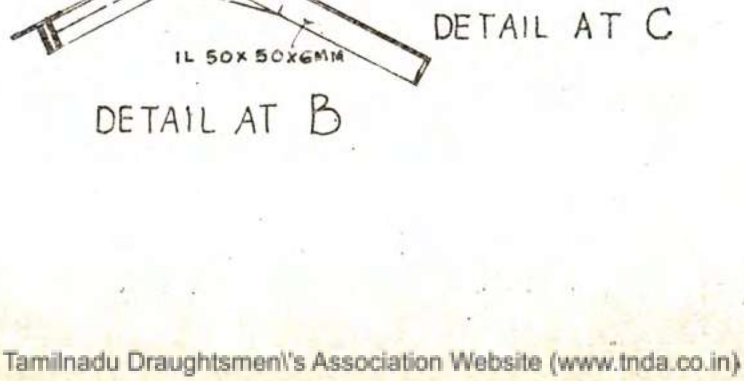
DETAIL AT A



SECTION ON RR

ELEVATION

PLAN



DETAIL AT C

DETAIL AT B

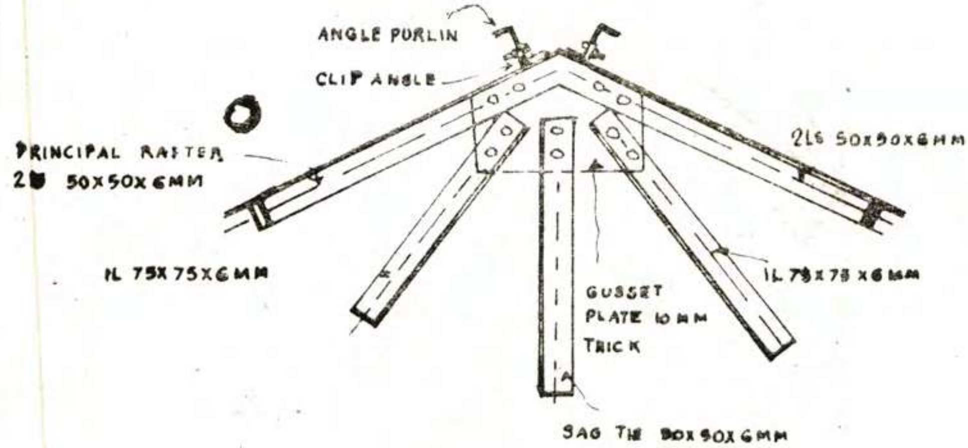
NOTE ON DETAIL AT A

SAME AS PER OTHER TRUSSES

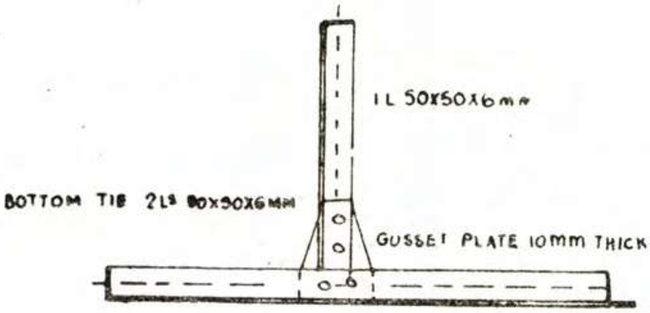
PLATE T56

1/10 FULL SIZE DETAILS OF STEEL TRUSS FOR ROOFS

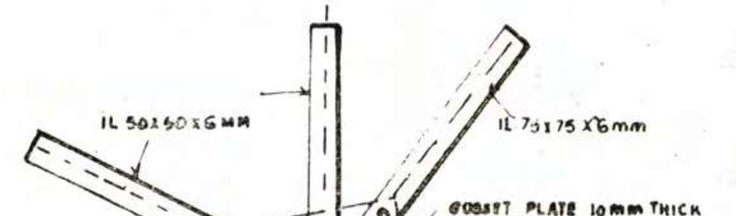
CLEAR SPAN 10 METERS RISE 1/4 SPAN



DETAIL AT D



DETAIL AT E



ELEVATION

DETAIL AT (F)

NOTE:

NOTES 1 TO 3 PLATE T49 FOR 18M CLEAR SPAN SHALL BE THE SAME FOR THIS PLATE ALSO EXCEPT THAT FIELD RIVETING IS NOT LIKELY TO BE NECESSARY

PLATE T. 57

GENERAL DRAWING FOR STEEL TRUSS FOR ROOFS

CLEAR SPAN: 8 METRES: RISE = 1/4 SPAN.

SCALE 5CM = 1METRE

NOTE :-

(a) DETAILS OF JOINTS SHALL BE SIMILAR TO THOSE SHOWN FOR TRUSSES OF 6M CLEAR SPAN 1/4 RISE

(b) NOTES 2,3 & 4 PLATE T 50 FOR 15M CLEAR SPAN SHALL BE SAME FOR THIS PLATE ALSO.

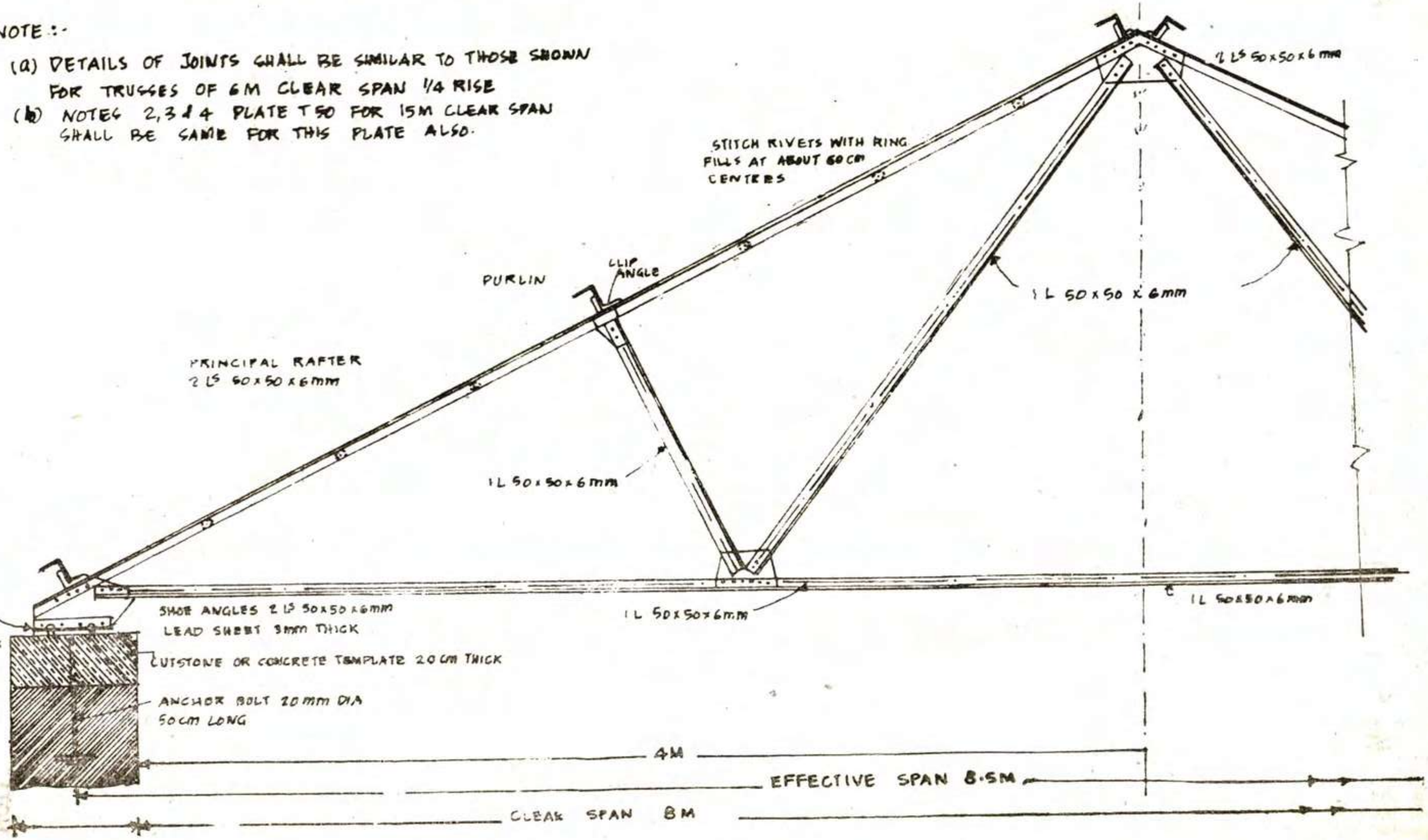


PLATE :T·58

GENERAL DRAWING FOR STEEL TRUSS FOR ROOFS

CLEAR SPAN = 6 METRES : RISE = 1/4 SPAN

SCALE 6 CM = 1 METRE

NOTE :-

(a) FOR DETAILS AT A, B, C & D SEE PLATE T 60
(b) NOTES 2, 3 & 4 PLATE = T 50 FOR 15 M CLEAR SPAN SAME FOR THIS PLATE ALSO

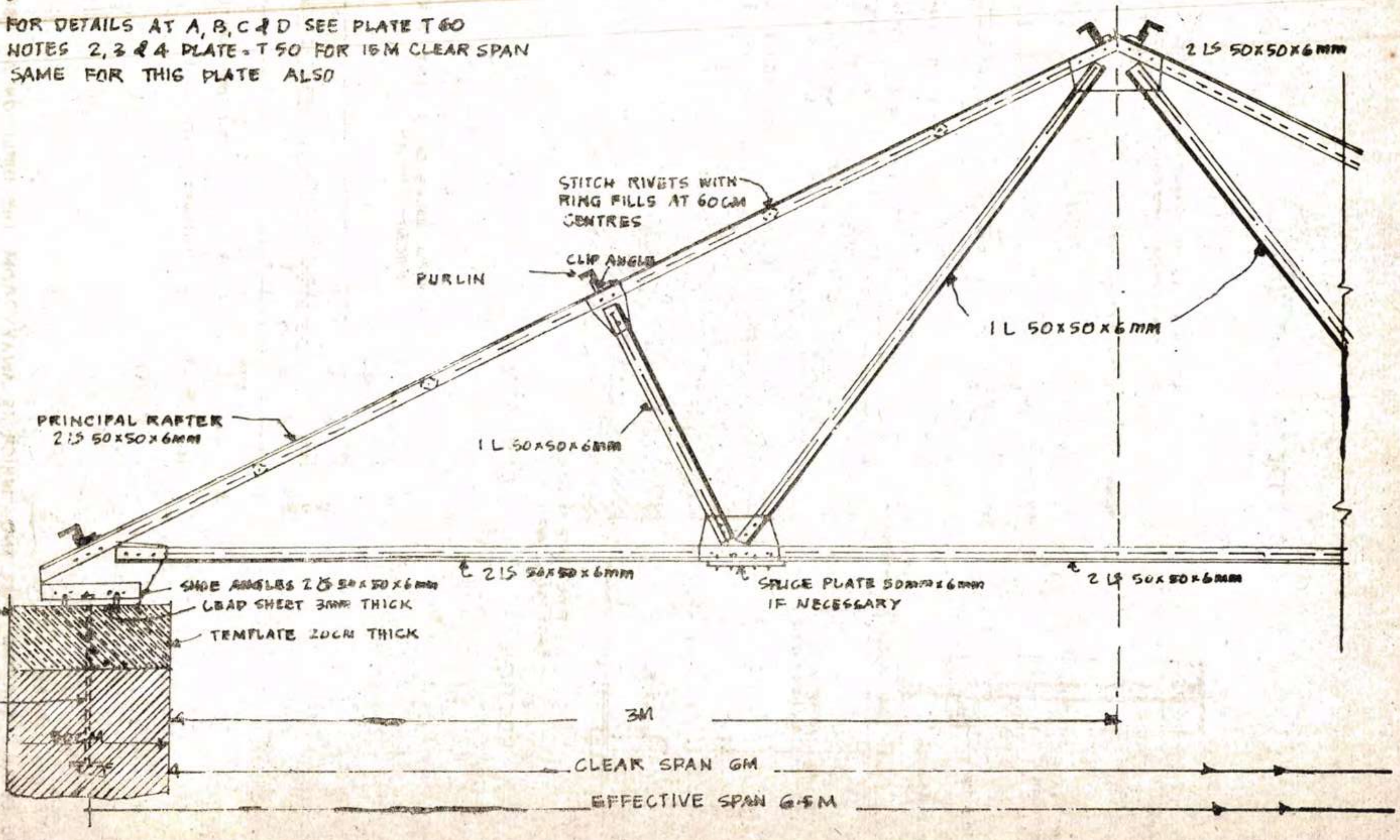
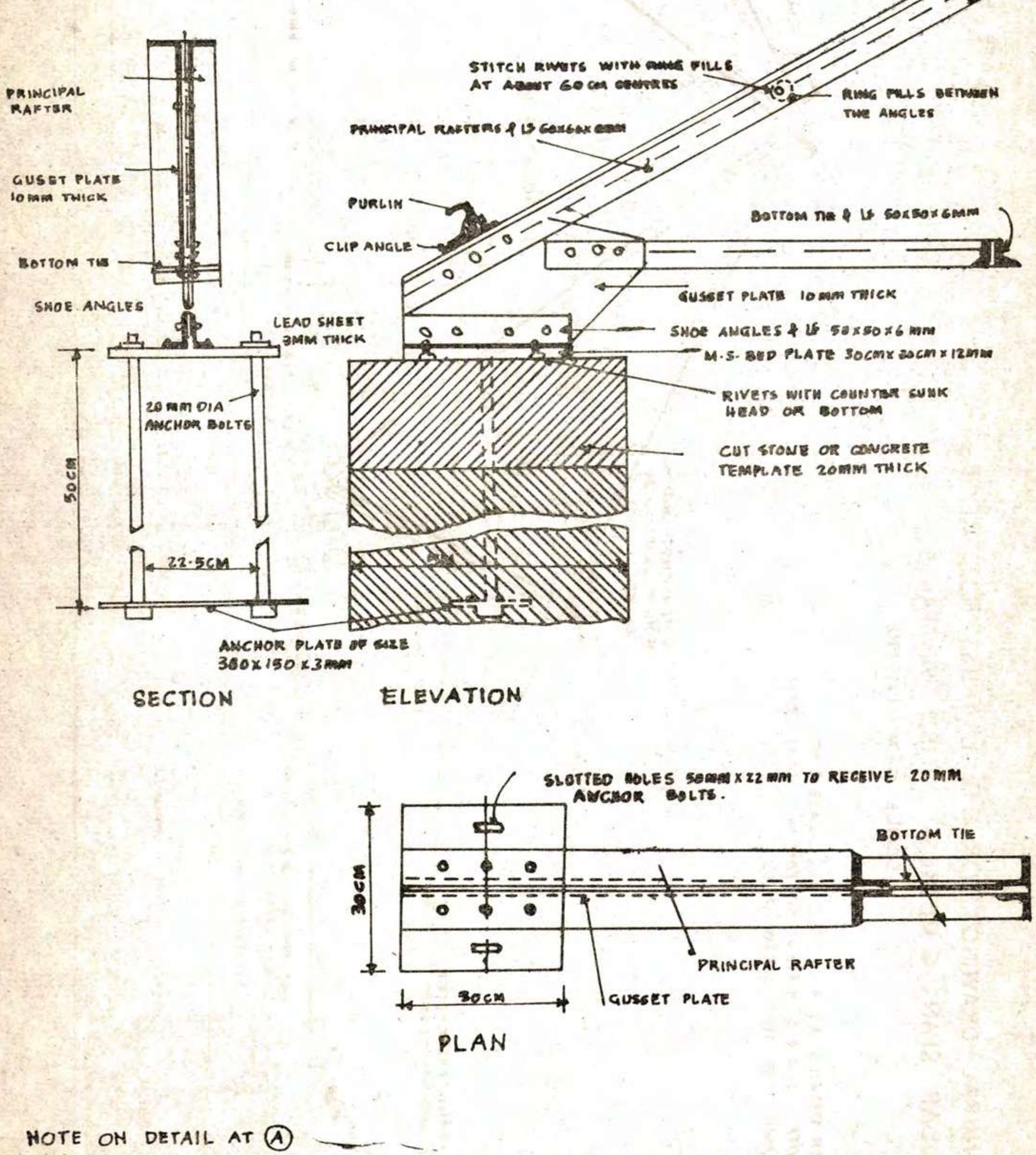


PLATE : T 47

DETAIL AT (A)



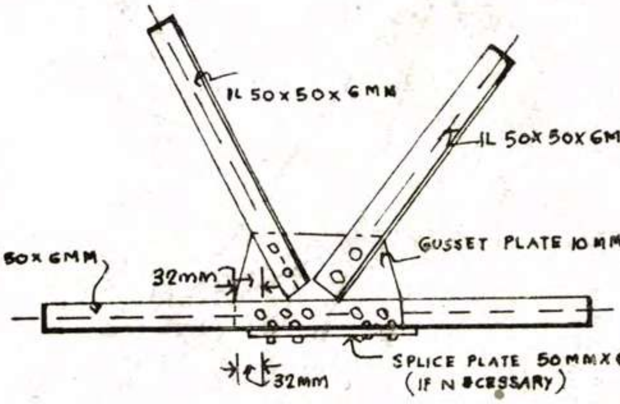
NOTE ON DETAIL AT (A)

THE DETAILS FOR THE FREE END WHICH IS AWAY FROM THE DIRECTION AT PREVAILING WIND. THE OTHER END I.E THE END FROM WHICH DIRECTION THE PREVAILING WIND BLOWS SHALL BE FIXED. THE JOINT DETAIL SHALL BE THE SAME SHOWN HERE EXCEPT THAT THE HOLES FOR ANCHOR BOLTS SHALL BE ROUND AND NOT SLOTTED AND THE LEAD SHEET SHALL BE OMITTED AND REPLACED BY CEMENT GROUT

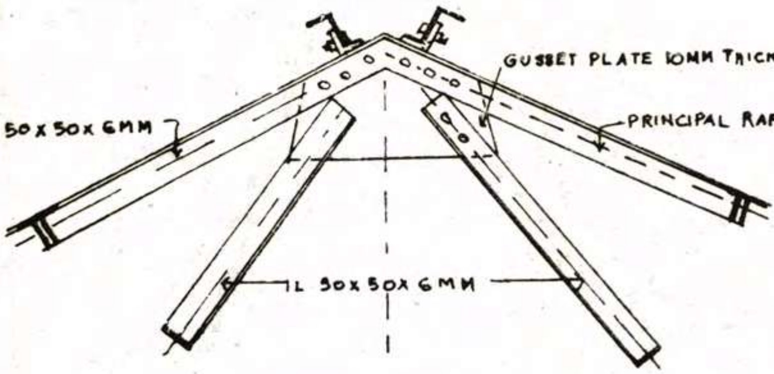
PLATE T60

1/10 FULL SIZE DETAILS OF STEEL TRUSS FOR ROOFS

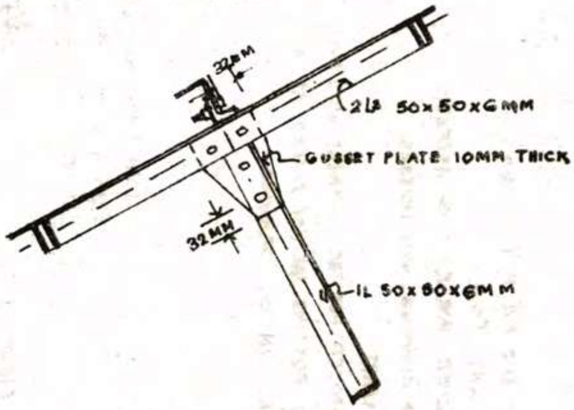
CLEAR SPAN: 6METRES RISE 1/4 SPAN



DETAIL AT "B"



DETAIL AT C



DETAIL AT D

NOTE

NOTES 1 AND 3 PLATE T50 FOR 15M SPAN SHALL APPLY TO THIS PLATE ALSO EXCEPT THAT FIELD RIVETING IS NOT LIKELY TO BE NECESSARY

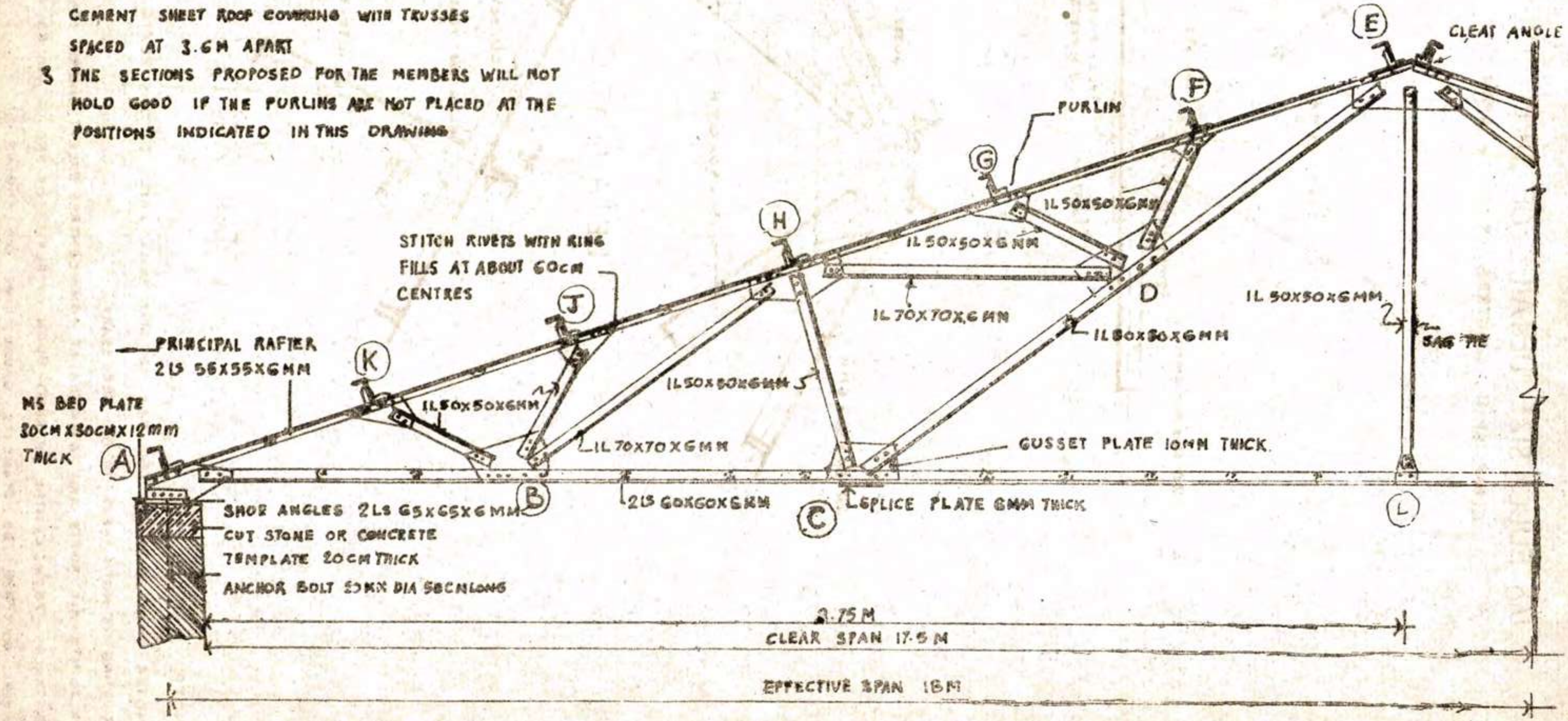
IN JOINTS ALL RIVETS ARE 16MM DIA AT 40MM CENTRES EXCEPT WHERE STATED OR OTHERWISE AND ALL DISTANCES FROM CENTRE OF RIVET EDGE OF PLATES OR END OF ANGLES NOT LESS THAN 32MM EXCEPT WHERE GOVERNED BY STANDARD GAUGE LINE OF ANGLES

GENERAL DRAWING FOR STEEL TRUSS FOR ROOFS

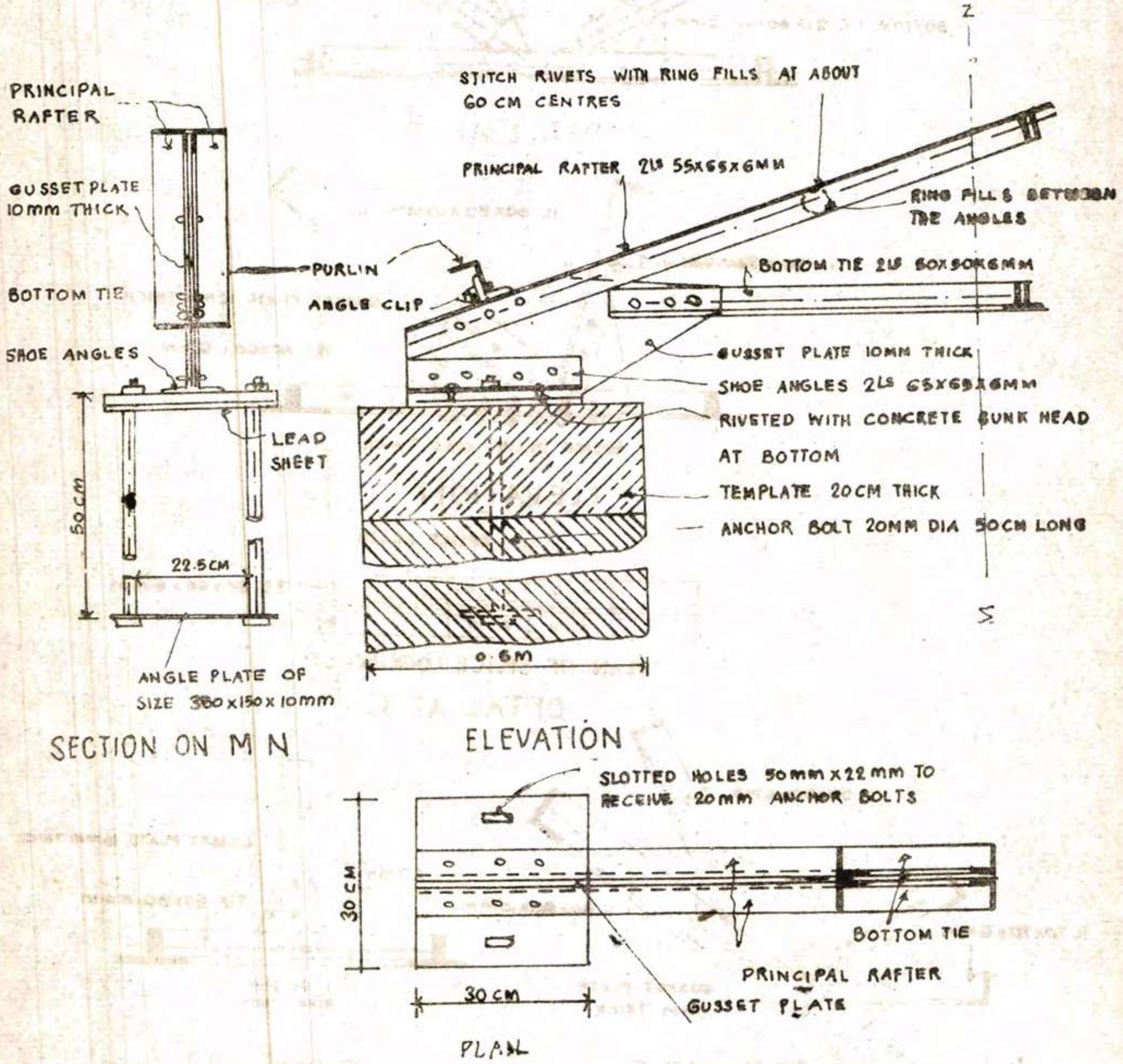
CLEAR SPAN 17.5M RISE 1/6 SPAN

SCALE 2.5CM . 1M

1 FOR DETAILS A.B.C. D.E, F.G. H, J, K. AND L SEE PLATE T63 AND T64
2 MEMBERS ARE DESIGNED FOR ROOF OF ASBESTOS CEMENT SHEET ROOF COVERING WITH TRUSSES SPACED AT 3.6M APART
3 THE SECTIONS PROPOSED FOR THE MEMBERS WILL NOT HOLD GOOD IF THE PURLINS ARE NOT PLACED AT THE POSITIONS INDICATED IN THIS DRAWING



DETAIL AT A



NOTE ON DETAIL AT A

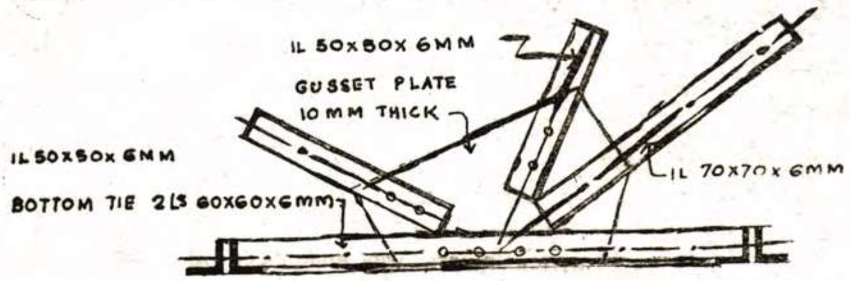
THE DETAIL IS FOR THE FREE END WHICH IS AWAY FROM PREVAILING WIND THE OTHER END ie. THE END FROM WHICH DIRECTION THE PREVAILING WIND BLOWS SHALL BE FIXED THE JOINT DETAIL SHALL BE THE SAME AS SHOWN HERE EXCEPT THAT THE HOLES FOR ANCHOR BOLTS SHALL BE ROUNDED AND NOT SLOTTED AND THE LEAD SHEET SHALL BE OMITTED AND REPLACED BY CEMENT GROUT

PLATE T 63

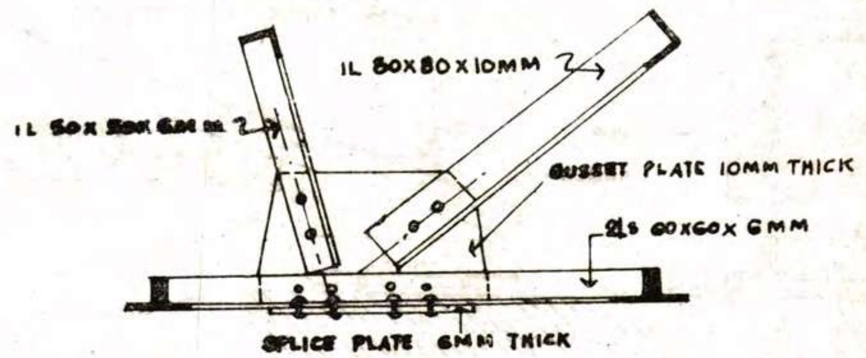
1/10 FULL SIZE DETAILS OF STEEL TRUSS FOR ROOFS

CLEAR SPAN : 17.5M RISE 1/6 SPAN

READ WITH PLATES T61 AND T64

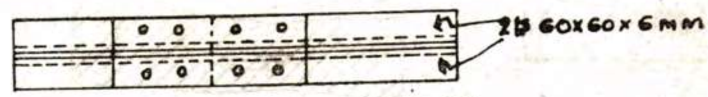


DETAIL AT B



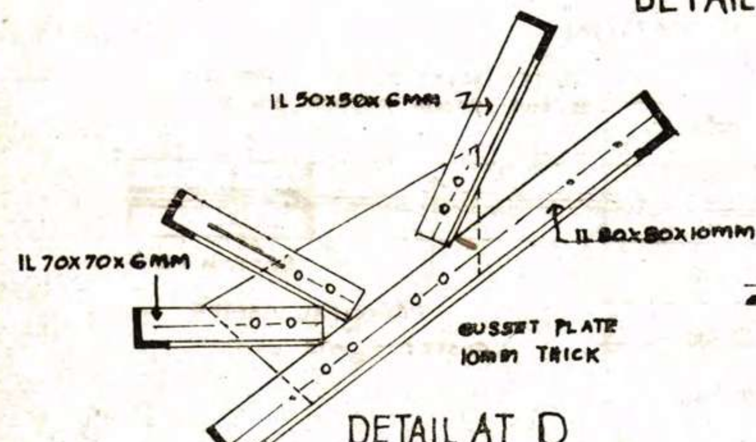
ELEVATION

SPLICE PLATE

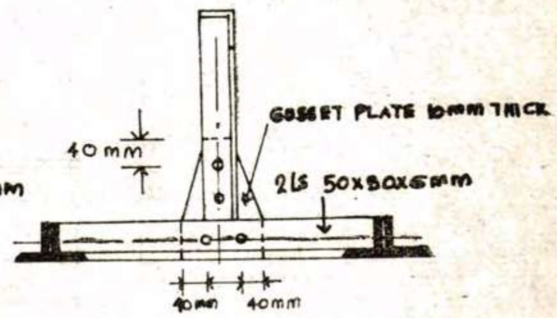


PLAN OF SPLICE LOOKING UP

DETAIL AT C



DETAIL AT D



DETAIL AT L

NOTE:

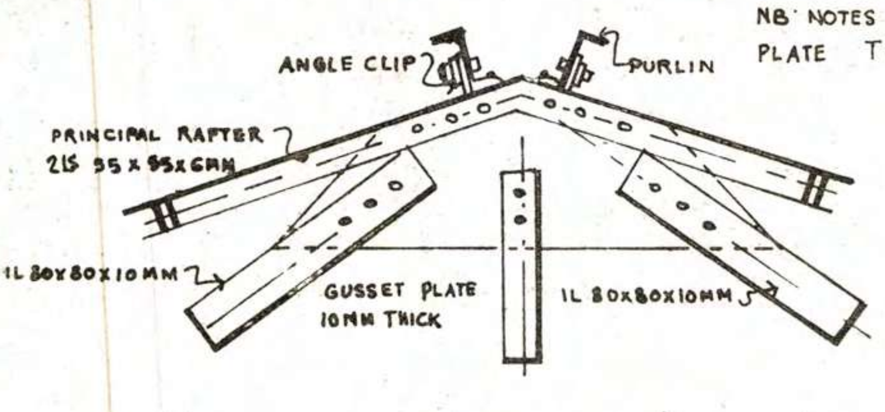
1. THE RIVETS SHALL BE IN THE STANDARD GAUGE LINES OF ANGLES AND SHALL BE OF 16MM DIA FOR 50x50x6MM SECTION AND 20MM DIA FOR THE GREATER SECTIONS.
2. IN THE JOINTS ALL RIVETS ARE PLACED AT CENTRES NOT LESS THAN 2.5 TIMES THE DIA OF RIVET HOLE AND ALL DISTANCES FROM CENTRE OF RIVET TO EDGE OF PLATES OR END OF ANGLES SHALL BE AS PER CLAUSE 7. OF NOTES ON DESIGN ON ROLLED STEEL BEAMS, GIRDERS AND ROOF TRUSSES UNDER SECTION 14 OF TNBP
3. ALL JOINTS ARE DESIGNED FOR SHOP RIVETS EXCEPT JOINTS AT APPEX OF TRUSS AND ONE THIRD POINTS OF BOTTOM TIE, PORTIONS OF WHICH ARE LIKELY TO FIELD RIVETED IN CASES WHERE THE TRUSSES CANNOT BE TRANSPORTED IN ONE PIECE

PLATE T64

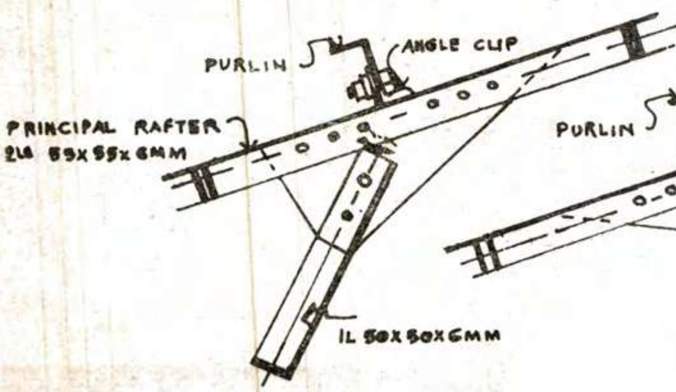
1/10 FULL SIZE DETAILS OF STEEL TRUSS FOR ROOFS

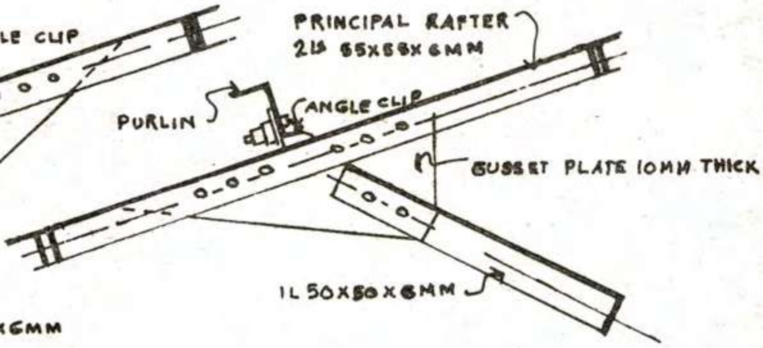
CLEAR SPAN : 17.5M : RISE : 1/6 SPAN

READ WITH PLATE T61 AND T63
NB: NOTES 1 & 3 SAME AS IN PLATE T63



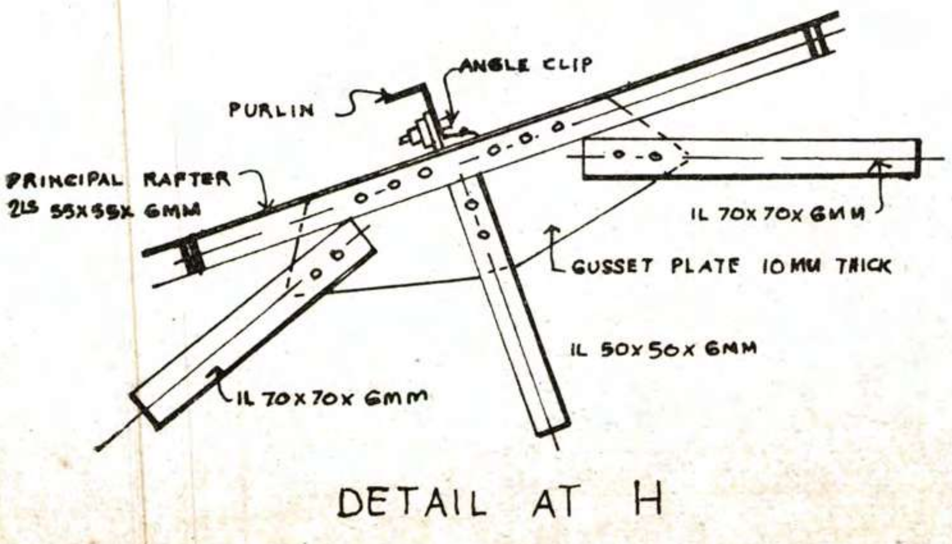
DETAIL AT E





DETAIL AT F OR J

DETAIL AT G OR K



DETAIL AT H

SECTION XVIII

B-CLASS HIGHWAY CULVERTS AND BRIDGES

SECTION XVIII.

B-CLASS HIGHWAY CULVERTS AND BRIDGES

CONTENTS.

SECTION XVIII.

B-CLASS HIGHWAY CULVERTS AND BRIDGES.

EXTRACT OF I.R.C. CODES.

SECTION XVIII.

B-CLASS HIGHWAY CULVERTS AND BRIDGES.

SPECIFICATION No. 111.

1. *Reinforced Concrete Slab Culverts*:

1·1. The reinforced concrete work for the slab shall comply with standard specification No. 30 and the notes on reinforced concrete design annexed thereto. The aggregate and reinforcing rods sh.ll comply with clause I of standard specification No. 108 for "R.C. lintels". The concrete mix shall be 1 : 2 : 4.

2. The slab shall be laid in situ, and shall be free to move on the masonry supports. If precast slabs are to be used, an addendum specification will define the size of slabs,method and period of curing, details of jointing, etc. Any precast blocks which develop cracks or become reduced in strength before being placed in situ shall be rejected and removed from the site. Care shall be taken that the corners of such blocks are not broken off during hoisting or at any stage of the work.

3. The rate shall be per cubic metre of slab, finally built in place, unless, otherwise specified.

NOTE.—For conditions of loading, general features of design loads and stresses—Section II—Loads and stresses in standard specifications and code of practice for Road Bridges—I.R.C. 6—1966 shall apply. For width of roadway and footpath I·R·C. 5 Section 1 shall apply.

SPECIFICATION No. 112.

1. *Steel Highway Bridges*:

1·1. *Intent of this specification*.—The clauses of this specification shall govern the supply and delivery, fabrication and erection at site, of steel highway bridges.

2. *Materials*.—National Building Code, Part VI—Section 6, Paragraph 3 shall apply.

3. *Workmanship etc.*—Instructions for steel structures—Specification 1011 of the Madras Highways Manual, pages 176 to 180 shall apply.

3·1. Meticulous attention shall be given to the quality of materials, thorough scraping and cleaning, and application of paint to all parts of the bridge. All surfaces so close together as to prevent the insertion of paint brushes, must be painted thoroughly by using a piece of cloth, instead of the paint brush.

3·2. No thinning of paint with turpentine or other thinner will be allowed without special written permission from the Executive Engineer.

3·3. If the source of purchase or brand of oil and paint is not specified in the tender notice, the tenderer shall describe in his tender the brand of oil and paint which he will supply.

4. *Loads and Stresses*.—The tender notice will define the standard design on which the tenderer shall submit his tender, or if the contractor is required to prepare and submit his own calculation and design, he shall comply with the relevant instructions in this specifi cations. These instructions shall also be followed in cases where tenderers propose deviations from the standard designs.

4·1. For loads, wind loads, trusses in truss members, working stresses, details of construction, riveted connections, finish of joints erection, specifications of I.R.C. standards of loading as given in Highways Manual shall apply.

5. *Contractor's responsibility*.—It shall be the contractor's responsibility (*a*) to verify that the details on the drawings are correctly shown before he commences cutting and fabrication and (*b*) for bringing timely to notice, errors or discrepancies on such drawings for orders of the contract awarding authority.

6. Included in the lumpsum tender amount.—Unless otherwise specified, the tender lumpsum shall include provision for supply and delivery fabrication and erection at site, of all steel and iron work required for the completion of the bridge, as described in the tender notice, specifications and contract drawings. Erection shall include all necessary haulage from the railway station, unloading of materials, and their proper care until the contract is completed.

6·1. Bridge railings, anchorages, and bearings, shown on the contract drawings shall be included in the tender lump sum. Driling and painting, *vide* clause 3 supra, shall also be included in the tender lumpsum.

6·2. The reinforced concrete roadway slab and road surfacing material shall not be required of the tenderer under this specification

7. *Deviations from standard designs*.—Standard designs shall be conformed to in all details and no deviations shall be permitted except with the prior approval of the contract accepting authority who shall refer such deviations to the technical authority concerned for orders.

7.1. Deviations will not ordinarily be desirable,but where a tenderer anticipates difficulty in compliance with the standard or other drawings described in the tender notice he shall submit, with his tender,complete drawings with calculations for the alternative details which shall in no case be of less strength than the standard details The full strength of the alternative details shall be developed in the riveted connections.

7·2. Inability of a contractor to obtain in the local market any materials required for the fabrication of the contract design shall not relieve him from any of the liabilities under the contract (i.e. if he has to import the articles, or if his application for submitting an alternative detail subsequent to the execution of the agreement is not accepted) tenderers should therefore assure themselves egarding availability of materials before submission of their timber.

7·3. For steel road bridges, Section V of I.R.C. 24—1967 shall also apply.

NOTE.—The following information will usually be furnished to tenderers in the tender notice :—

(*a*) Name of Bridge.

(*b*) Location—Nearest Railway Station—Approximate distance by road to site, inclusive of diversions, if any, and such other descriptive information as may be useful to tenderers.

(*c*) Nature of work (i.e.) Supply and delivery, fabrication and erection at site (usually all steel work operations for complete erection of steel truss bridges will be required of tenderers. Masonry work including reinforced concrete road slab and road surfacing materials may, in many cases, be done under a separate contract. Bridges will normally be contracted for on the basis of a lumpsum for completed operations).

(*d*) Design (i.e.) whether a standard design or a special design—*vide* clauses 4 and 7 supra, for cases where the tenderer has to supply the calculations and the designs.

(*e*) Dimensions.—Clear span, span centre to centre of bearings clear width of roadway, width and length of piers (clear of cut-waters) or plan of substructure masonry will be made available to tenderers.

(*f*) *Load Tesis if any, and nature of same*—For inspection and tes:—*vide* the General conditions of contract of the Tamil Nadu Building practice.

(*g*) Earnest money, security deposit, nature of agreement form (usually the standard agreement form modified as may be necessary in each case) and the rate of progress (defined by stages from date from which the superstructure is made ready for the steel work contractor, which date may be approximately given (but not guaranteed)

(*h*) Restrictions, if any, on source of purchase of paints or other materials.

TABLE XXXIII—STANDARD R.S. BEAM.

B—*Class Highway Bridges.*

(For Standard R.S. Beams.)

I.R.S. Loading specifications shall apply.

TABLE XXXIV.

(B—*Class Highway Bridges*.)

(With Standard Pratt Trusses.)

I.R.S. Loading specifications shall apply.

EXTRACT OF I.R.C. STANDARD SPECIFICATIONS AND CODE OF PRACTICE FOR ROAD BRIDGES—SECTION II LOADS AND STRESSES.

(*I.R.C.* 6 - 1966).

Loads and stresse .:

201. *Classification* :

201.1. Road bridges and culverts shall be divided into classes according to the loadings they are designed to carry.

I.R.C. Class AA Loadings.—This loading is to be adopted within certain Municipal limits, in certain existing or contemplated industrial areas, in other specified areas, and along certain specified highways. Bridges designed for class AA loading should be checked for class A loading also, as under certain conditions, heavier stresses may be obtained under Class A Loading.

NOTE.—"Where Class 70-R is specified, it shall be used in place of I.R.C. Class AA loading."

I.R.C. Class A Loading.—This loading is to be normally adopted on all roads on which permanent bridges and culverts are constructed.

I.R.C. Class B Loading.—This loading is to be normally adopted for temporary structures and for bridges in specified areas. Structures with timber spans are to be regarded as temporary structures for the purpose of this clause.

For particulars of the above three types of loading, *see* Clause 207.

201.2. Existing bridges which were not originally constructed or later strengthened to take one of the above specified. I.R.C. Loadings will be classified by giving each a number equal to that of the highest standard load class whose effect it can safely withstand.

Appendix I gives the essential data regarding the limiting loads in each bridge class and forms the basis for the classification of bridges.

201.3. Individual bridges and culverts designed to take electric tramways or other special loadings and not constructed to take any of the loadings described in clause 201.1 shall be classified in the appropriate load class indicated in class 201.2.

202. *Loads, Forces and Stresses.*

202.1. The loads, forces and stresses to be considered in designing road bridges and culverts are :—

1. Dead load.
2. Live load.
3. Impact on dynamic effect of the live load.
4. Wind load.
5. Horizontal forces due to water currents.
6. Longitudinal forces caused by the tractive effect of vehicles or by braking of vehicles and or those caused by restraint to movement of free bearings.
7. Centrifugal forces.
8. Buoyancy.
9. Earth pressure.
10. Temperature stresses.
11. Deformation stresses.
12. Secondary stresses.
13. Erection stresses.
14. Seismic forces.

202.2. All members shall be designed to sustain safely the various loads, forces, and stresses that can co-exist, and all calculations shall tabulate distinctly the various combinations of the above loads and stresses covered by the design.

205. *Dead load.*—The dead load carried by a girder or member shall consist of the portion of the weight of the superstructure (and the fixed loads carried thereon) which is supported wholly or in part by the girder or member including its own weight. The following unit weights of materials shall be used in determining loads, unless the unit weights have been determined by actual weighing of representative samples of the materials in question in which case the actual weights as thus determined shall be used :

Materials.	*Weight per m3 in Tonnes.*
1. Ashlar (Granite)	2.7
2. Ashlar (Sand stone)	2.4
3. Stone Setts : (a) Granite	2.6
(b) Basalt	2.7
4. Ballast (Stone screened, broken, 2.5cm to 7.5 cm gauge, loose).	
(a) Granite	1.4
(b) Basalt	1.6
5. Brickwork (pressed) in Cement Mortar	2.2
6. Brickwork (common) in Cement mortar	1.9
7. Brick work (Common) in lime mortar	1.8
8. Concrete (Asphalt)	2.2
9. Concrete (Breeze)	1.4
10. Concrete (Cement—plain)	2.2
11. Concrete (Cement plain with plums)	2.3
12. Concrete (Cement—reinforced)	2.4
13. Concrete (Cement—pre-stressed)	2.5
14. Concrete (lime—brick aggregate)	1.9
15. Concrete (lime—Stone aggregate)	2.1
16. Earth (Compacted)	1.8

Materials.	*Weight per m3 in Tonnes.*
17. Gravel	1.8
18. Macadam (Grinder premix)	2.2
19. Macadam (rolled)	2.6
20. Sand (loose)	1.4
21. Sand (wet compressed)	1.9
22. Coursed rubble stone masonry (Cement mortar)	2.6
23. Stone masonry (lime mortar)	2.4
24. Water	1.0
25. Wood	0.8
26. Cast iron	7.2
27. Wrought iron	7.7
28. Steel (rolled or cast)	7.8

206. *Traffic lanes* : The number of traffic lanes on a bridge shall be determined by the maximum integral number of trains of standard class A vehicles described in Clause 207, which can be accomodated on the clear carriage way width of the bridge, with the vehicles travelling parallel to the length of the bridge and leaving the minimum clearances specified in clause 207.

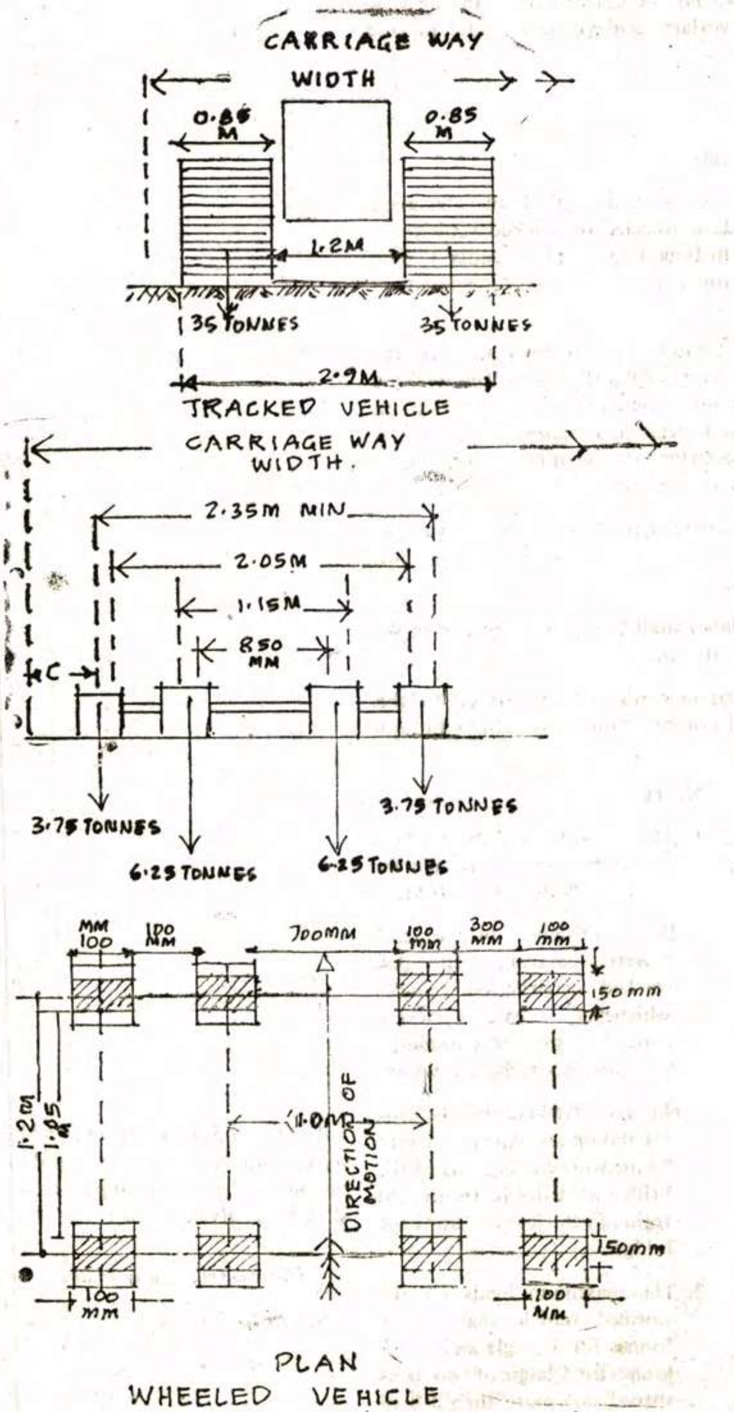
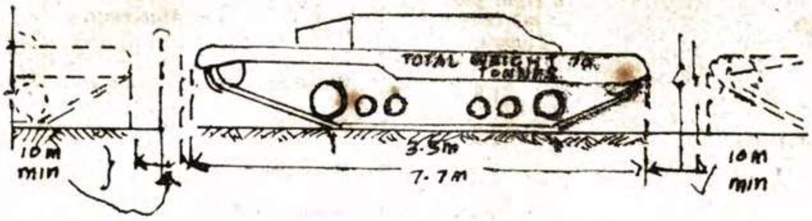


FIG 1. CLASS AA TRACKED AND WHEELED VEHICLES. (CLAUSE 207.1)



TRACKED VEHICLE

FIG 1. CLASS A A TRACKED AND WHEELED VEHICLES
(CLAUSE 207.1)

All new bridges shall be of either one-lane, two lane, or four-lane width. Three-lane bridges shall not be constructed. In the case of four-lane or multiples of two-lane bridges, at least 1.2 m vide central verge shall be provided.

207. ***Live loads*** **:**

207. 1. *Details of I.R.C. Loadings.*

207.1.1. For bridges classified under clause 201.1, the designed live load shall consist of standard wheeled or tracked vehicles or trains of vehicles as illustrated in Figs. 1 to 3 and appendix 1. The trailers attached to the driving unit are not to be considered as detachable.

207.1.2. Within the kerb to kerb width of the roadway, the standard vehicle or train shall be assumed to travel parallel to the length of the bridge, and to occupy any position which will produce maximum stresses provided that the minimum clearances between a vehicle and the roadway face of kerb and between two passing or crossing vehicles, shown in Figs. 1 to 3 are not encroached upon.

207. 1.3. For each standard vehicle or train all the axles of a unit of vehicles shall be considered as acting simultaneously in a position causing maximum stresses.

207.1.4. Vehicles in adjacent lanes shall be taken as headed in the direction producing maximum stresses.

207.1.5. The spaces on the carriage way left uncovered by the standard train of vehicles shall not be assumed as subject to any additional live load.

NOTES :

1. The nose to tail spacing between two successive vehicles shall not be less than 90 M.
2. For multi-lane bridges and culverts, one train of class AA tracked or wheeled vehicles whichever creates severe conditions shall be considered for every two traffic lane width.

   No other live load shall be considered on any part of the said 2 lane wide carriageway of the bridge when above mentioned train of vehicles is crossing the bridge.
3. The maximum loads for the wheeled vehicle shall be 20 tonnes for a single axle or 40 tonnes for a bogie of two axles spaced not more than 1.2 m centres.
4. The minimum clearance between the road face of the kerb and the outer edge of the wheel or track C, shall be as under :

Carriage way width.		*Minimum Value of C.*
Single lane bridges.		
3.8 m and above.	..	0.3 m
Multi-lane bridges.		
Less than 5.5. m		0.6 m
5.5 m or above		1.2 m

NOTES :

1. The nose to tail distanc between successive trains shall not be less than 18.4 m.
2. No other live load shall cover any part of the carriage way when a train of vehicles (or trains of vehicles in multi-lane bridge) is crossing the bridge.
3. The ground contact area of the wheels shall be as under :

Axle load tonnes.		*Ground contract area.* B. mm.	W mm.
11.4	..	250	500
6.8	..	200	380
2.7	..	150	200

4. The minimum clearance, 'f' between outer edge of the wheel and the roadway face of the kerb, and the minimum clearence, 'g' between the outer edges of passing or crossing vehicles on multi-lane bridges shall be as given below :

Clear carriage way width.		g.	f.
5.5 m to 7.5 m.	..	Uniformly increasing from 0.4m to 1.2 m.	150 mm. for a carriage way widths
Above 7.5 m.	..	1.2 m.	

NOTE :—

1. The nose to tail distance between successive trains shall not be ess than 18·4 m.

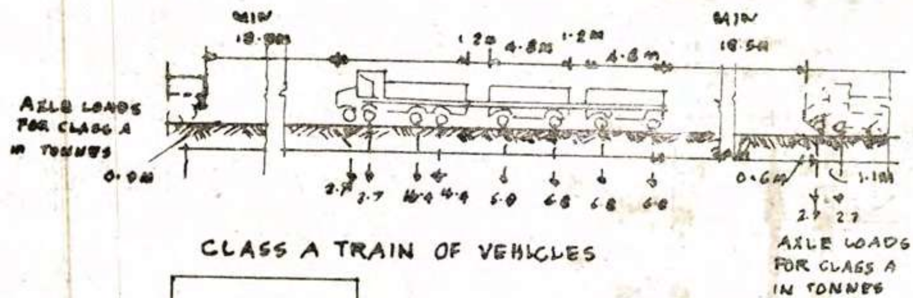
2. No other live load shall cover any part of the carriage way when where a train of vehicles (or trains of vehicles in multi-lane bridge) is crossing the bridge.

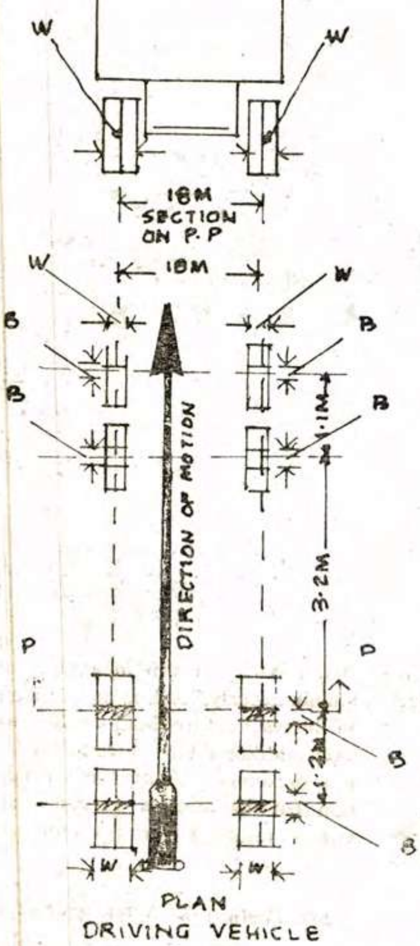
3. The ground contact area of the wheels shall be as under :—

Axle load tonnes.	*Ground contact area.*	
	B mm.	W mm.
(1)	(2)	(3)
6·8	200	380
4·1	150	300
1·6	125	175

4. The minimum clearance, 'f' between outer edge of the wheel and the roadway face of the kerb, and the minimum clerance, 'g' between the outer edges of passing or crossing vehicles on mutli-lane bridges shall be as given below :—

Clear carriage way width.	g	f
(1)	(2)	(3)
5·5 m .to 7·5 m.	Uniformly increasing from 0·4 to 1·2 m.	150 mm. for all carriage way widths.
Above 7·5 m.	1·2 m.	





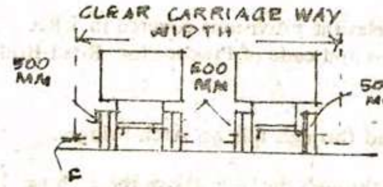
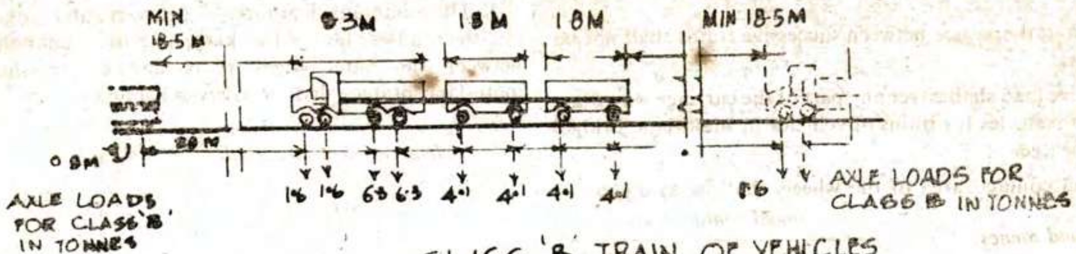
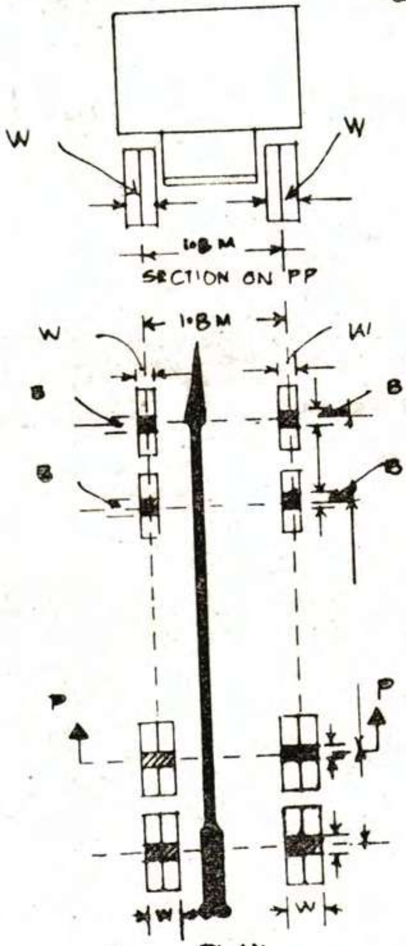
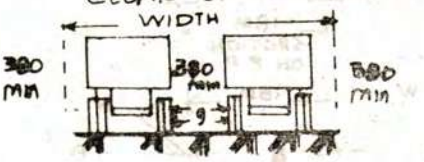


FIG 2
CLASS A TRAIN OF VEHICLES
(CLAUSE 207·1)



CLASS 'B' TRAIN OF VEHICLES





PLAN

DRIVING VEHICLE

FIG 3

CLASS B TRAIN OF VEHICLES

CLAUSE 207·1

207·2. (Please refer to relevant provisions covered in I.R.C. 21—1966 standard specifications and code of Practice for Road Bridges Section III).

207·3. Dispersion of load through fills on Arch bridges.

The dispersion of loads through the fills above the arch shall be assumed at 45 degrees both along and perpendicular to the span in the case of arch bridges.

208. *Reduction in the intensity of live load stresses on bridges accomodating more than two traffic lanes.*

208. 1. The position and number of loaded lanes used shall be such o produce maximum stresses in all cases.

208.2. Where maximum stresses are produced in any member by simultaneously, loading more than two traffic lanes, the intensities of the resultant live load stresses shall be reduced by 10 per cent for each additional loaded traffic lane in excess of the two lanes subject to a maximum reduction of 20 per cent and subject also to the condition that the stresses as thus reduced are not lower than the stresses resulting from a simultaneous loading on two traffic lane

209. *Footway, kerb, railings and parapet loading.*

(The provisions under this clause do not apply to Foot-Bridges.)

209·1. For all parts of bridge floors accessible only to pedestrians and animals and for all footways the loading shall be 40 kg. per m^2. Where crowd loads are likely to occur, such as on bridges located near towns, which are either centres of pilgrimage or where large congregational fairs are held seasonably, the intensity of foot-way loading shall be increased from 400 kg. per m^2 to 500 kg. per m^2.

209.2. Kerbs, 0·6 m. or more in width, shall be designed for the above loads and for a local lateral force of 750 kg. per metre, applied horizontally at the top of the kerb. If the kerb width is less than 0·6 m. no, live load shall be applied in addition to the lateral load specified above.

NOTE.—The horizontal force need not be considered in the design of the main structural members of the bridge.

209.3. In calculating stresses in members of structures with cantilevered footways, shall be considered as loaded on one side or on both sides or unloaded whichever condition gives the maximum stresses.

209.4. In bridges designed for any of the loadings described in Clasue 207.1. the main girders, strusses, arches, or other members supporting the footways shall be designed for the following live loads per sqaure metre of footway area, the loaded length of footway taken in each case being such as to produce the worst effects on the member under consideration :—

(*a*) For effective spans of 7.5 m. or less, 400 kg. per m^2 or 500 kg. per m^2 as the case may be, based on sub-clause 209.1.

(*b*) For effective spans of over 7·5 m but not exceeding 30, m the intensity of load shall be determined according to the equation :—

$$P = P^1 - \frac{(40\,L - 300)}{9}$$

(*c*) For effective spans of over 30 m, the intensity of load shall be determined according to the equation :—

$$P = (P^1 - 260 + \frac{4800}{L})\,\frac{(16{\cdot}5 - W)}{15}$$

Where P^1 = 480 kg. per m^2 or 500 kg. per m^2 as the case may be, based on sub-clause 209·1.

P = the live load in kg. per m^2.

L = the effective span of the main girder, truss or arch in m., and

W = Width of the footway in m.

209·5. Each part of the footway shall be capable of carrying a wheel load of 4 tonnes, which shall be deemed to include impact, distributed over a contact area 300 mm in diameter, the permissible working stresses shall be increased by 25 per cent to meet this provision. This provision need not be made where vehicles cannot mount the footway as in the case of a footway separated from the roadway by means of an insurmountable obstacle, such as truss or a main girder.

NOTE.— A footway kerb shall be considered mountable by vehicles.

209.6. The railings and parapets shall be designed to resist a lateral horizontal force and a vertical force each of 150 kg. per metre applied simultaneously at the top of the railing or parapet. These forces need not be considered in the design of the main structural members if foot paths are provided. In cases where foot paths are provided, the effect of these forces shall be considered in the design of the structural system supporting the railings and the footpath upto the face of the footpath kerb only.

211. *Impact.*—

211.1. Provision for impact or dynamic action shall be made by an increment of the live load by an impact allowance expressed as a fraction or a percentage of the applied live load.

211.2. *For Class A or Class B Loading.*— In the members of any bridge designed either for Class A or Class B loading (*vide* Clause 207'1), this impact percentage shall be determined from the following equations which are applicable for spans between 3 m. and 45 m.

(i) Impact factor fraction for reinforced concrete bridges : $= \dfrac{4.5}{6 + L}$

(ii) Impact factor fraction for steel bridges : $= \dfrac{9}{13{\cdot}5 + L}$

Where L is the length in metres of the span as specified in Clause 211.5.

211·3. *For Class AA Loading and Class* 70 *R Loading.*—

The value of the impact percentage shall be taken as follows :—

(*a*) For spans less than 9 m ;

(i) For tracked vehicles : 25 per cent for spans upto 5 m. linearly reducing to 10 per cent for spans of 9 m.

(ii) For wheeled vehicles : 25 per cent.

(*b*) For spans of 9 m. or more—

(i) Reinforced concrete bridges :—

Tracked vehicles : 10 per cent upto a span of 40 m and in accordance with the curve in Fig. 5 for spans in excess of 40 m.

Wheeled vehicles : 25 per cent for spans upto 12 m and in accordance with the curve in Fig. 5 for spans in excess of 12 m.

(ii) Steel Bridges :—

Tracked vehicles : 10 per cent for all spans.

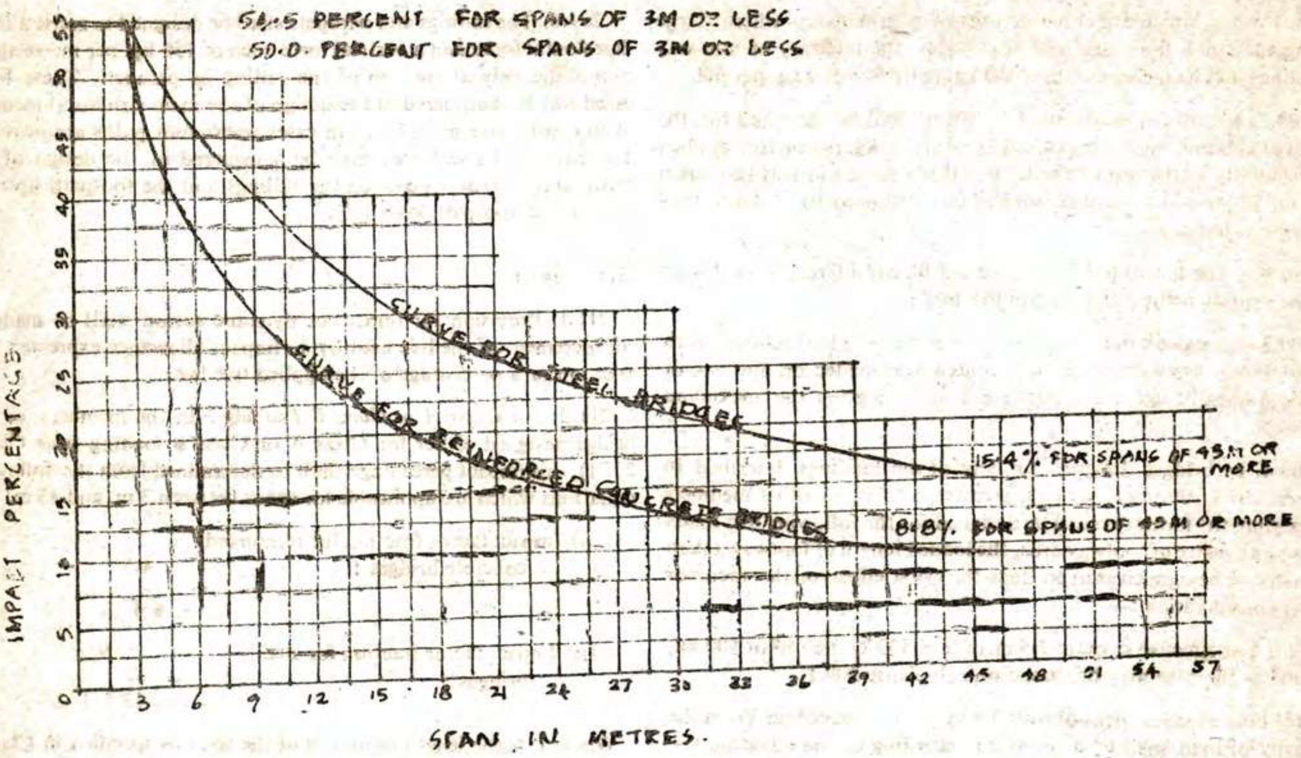


FIG. 5. IMPACT PERCENTAGE CURVES FOR HIGHWAY BRIDGES FOR CLASS A AND CLASS B LOADINGS (CLAUSE 211·3)

Wheeled vehicles :	25 per cent for spans upto 23 m. and in accordance with the curve indicated in Fig. 5 for spans in excess of 23 m.

211.4. No impact allowance shall be added to the footway loading specified in Clause 209.

211.5. The span length to be considered for determining the impact percentage shall be as follows :–

(*a*) For spans simply supported or continuous or for arches .. .. .. the effective span on which the load is placed.

(*b*) For bridges having cantilever arms without suspended spans .. .. the effective overhang of the cantilever arm reduced by 25 per cent for loads on the cantilever arm and the effective span between supports for loads on the main span.

(*c*) For bridges having cantilever arms with suspended spans .. .. the effective over change of the cantilever arm plus half the length of the suspended span for loads on the cantilever arm, the effective length of the suspended span for loads on the suspended span and the effective span between supports for loads on the main span.

211·6. In any bridge structure where there is a filling of not less than 0.6 m including the road crust, the impact percentage to be allowed in the design shall be assumed to be one-half of what is specified in Clauses 211·2 and 211·3.

211·7, For calculating pressure on the bearings and on the top surface of the bed blocks, full value of the appropriate impact percentage shall be allowed, but for the design of piers, abutments and structures, generally below the level of the top of the bed block-e appropriate impact percentage shall be multiplied by the factor given below :

(*a*) For calculating the pressure at the bottom surface of the bed block.	0·5
(*b*) For calculating the pressure on the top 3 m of the structure below the bed block.	0·5 decreasing uniformly to zero.
(*c*) For calculating the pressure on the portion of the structure more than 3 m. below the bed block.	Zero.

211·8 In the design of members subject among other stresses to direct tension, such as hangers in a bow string girder bridge, and in the design of members subject to direct compression, such as spandrel columns or walls in an open spandrel arch, the impact percentage shall be taken the same as that applicable to the design of the corresponding member or members of the floor system which transfer loads to the tensile or compressive members in question,

211·9. These clauses on impact do not apply to the design of suspension bridges.

212.—*Wind Load.*

212·1, All structures shall be designed for the following lateral wind forces. These forces shall be considered to act horizontally and in such a direction that the resultant stresses in the member under consideration are the maximum.

212·2. The wind force on a structure shall be assumed as a horizontal force of the intensity specified in clause 212·3 and acting on an area calculated as follows :

(*a*) For a deck structure : The area of the structure as seen in elevation includiug the floor system and railing, less area of perforations in the hand-railing or parapet walls.

(*b*) For a through or half-through structure :

The area of the elevation of the windward truss as specified at (*a*) above plus half the area of elevation above the deck level of all other trusses or girders.

212·3. The intensity of the wind force shall be based on the table of wind pressures and wind velocities given on page 21 and shall be allowed for in the design. The pressures given therein may, however, be doubled for bridges situated in areas such as the Kathiawar Peninsula and the Bengal and Orissa coasts shown hatched in Fig. 6.

IRC. 6.1966

INTENSITY WIND PRESSURE

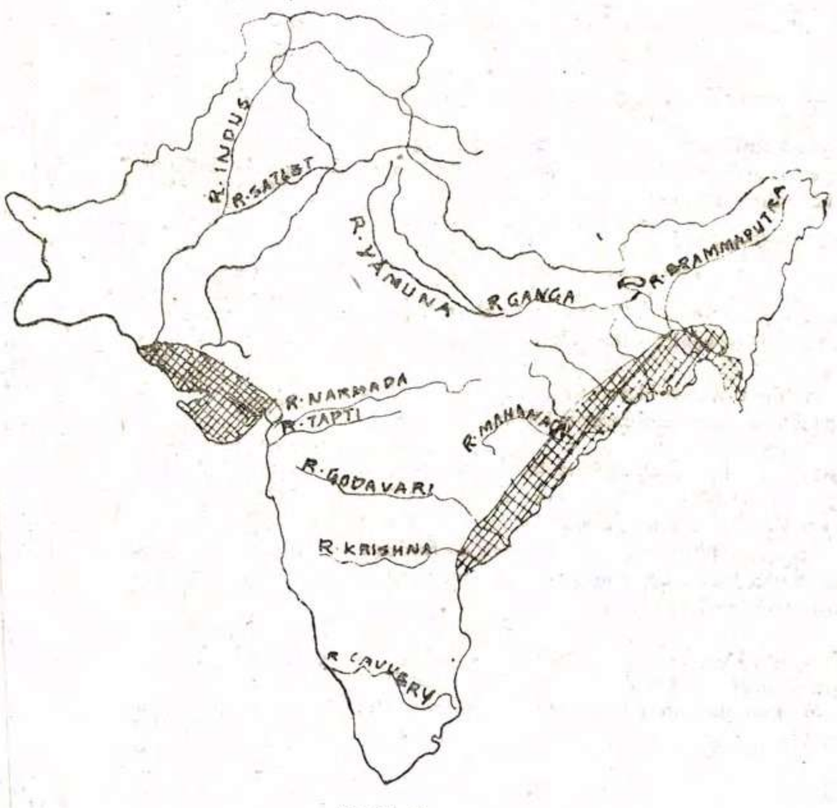
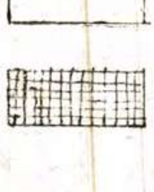


FIG. 6



AS GIVEN IN THE TABLE IN CLAUSE 212·3

DOUBLE THE VALUES IN THE TABLE IN CLAUSE 212 3

TABLE OF WIND PRESSURES AND WIND VELOCITIES.

H	V	P	H	V	P
(1)	(2)	(3)	(1)	(2)	(3)
0	80	40	10	118	91
2	91	12	15	158	107
4	100	63	20	136	119
6	107	73	25	142	130
8	113	82	30	147	141
40	155	157	80	177	202
50	162	171	90	180	210
60	168	183	100	183	217
70	1[illegible]3	193	110	186	224

Where, H=the average height in metres of the exposed surface above the mean retarding surface (ground or bed level or water level).

V=Horizontal velocity of wind in kilometres per hour at height H

P=Horizontal wind pressure in kilogram per sq. m. at height H

212·4 The lateral wind force against any exposed moving live load shall be considered as acting at 1·5 m above the roadway and shall be assumed to have the following values :

Highway Bridges. Ordinary—300 kg/linear M

Highway Bridges, carrying tramway—450 kg/linear M.

While calculating the wind force on live load, the clear distance between the trailers of a train of vehicles shall not be omitted.

212·5 The bridges shall not be considered to be carrying any live load when the wind velocity at deck level exceeds 130 km. per hour.

212·6 The total assumed wind force as calculated according to clasuses 212·2, 212·3, 212·4 and 212·5 shall, however, not be less than 450 kg., per linear metre in the plane of the loaded chord and 225 kg., per linear metre in the plane of unloaded chord on through or half-through truss, latticed or other similar spans, and not less than 450 kg. per linear metre on deck spans.

212·7 A wind pressure of 240 kg. per m^2 on the unloaded structure, applied as specified in clauses 212·2 and 212·3 shall be used if it produces greater stresses than those produced by the combined wind forces as per clauses 212·2. 212·3. 212·4 and 212·5 or by the wind force as per clause 212·6.

212·8 In calculating the uplift in the posts and anchorages of high latticed towers due to the above mentioned lateral forces, stresses shall also be investigated for the condition of decking being loaded on a traffic lane or anes. on the leeward side only.

213. *Horizontal forces due to water currents* :

213·1 Any part of a road bridge which may be submerged in running water shall be designed to sustain safely the horizontal pressure due to the force of the current.

213·2 On piers parallel to the direction of the water current the intensity of pressure shall be calculated from the following equation :

$$P=52\ KV^2$$

Where P=Intensity of pressure due to the water current, in kg. per sq. m.

V=The velocity of the current at the point where the pressure intensity is being calculated, in metres per second, and

K—A constant having the following values for different shape of piers illustrated in Fig. 7.

(i) Sqaure ended piers (and for the superstructure)— ·50

(ii) Circular piers or piers with semi-circular ends—0·66.

(iii) Piers with triangular cut and ease waters, the angle included between the faces being 30 degrees or less— 0·50.

(iv) Piers with triangular cut and ease waters, the angle included between the faces being more than 30 degrees but less than 60 degrees—0·50 to 0·70.

(v) Piers with triangular cut and ease waters, the angle ncluded between the faces being more than 30 degrees but less than 60 to 90 degrees — 0·70 to 0.90

1 Piers with scquar ends.

2 Circular piers or piers with semi-circular ends.

3 Piers with triangular cut and easee waters, the angle included between the faces s being 30 degree

4 Piers with triangular cut and ease waters, the angle included between the faces being more than 30 degrees but less than 60 degrees.

5 Piers with triangular cut and ease waters, the angle included between the faces being 60 to 90 degrees.

6 Piers with cut and ease water of equilateral arcs of circles.

7 Piers with arcs of the cut and ease waters intersecting at 90 degrees.

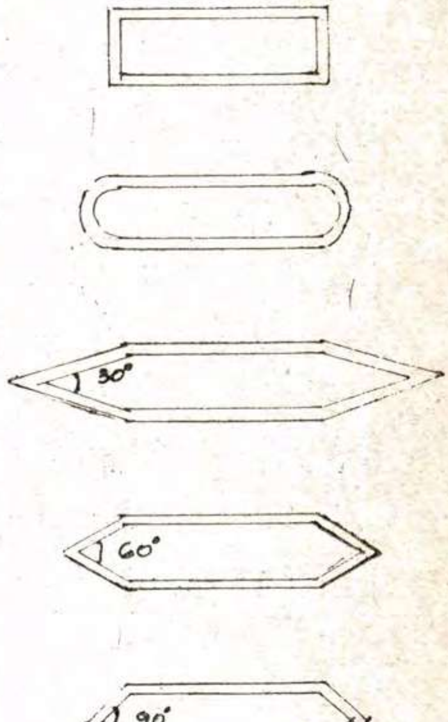


FIG 7

SHAPES OF BRIDGE PIERS

(CLAUSE 213.2)

(vi) Piers with cut and ease waters of equilateral ares of cirles —0·45.

(vii) Piers with arcs of the cut and ease waters intersecting at 90 degrees —0·50.

213·3 The value of V^2 in the equation given in Clause 213·2 shall be assumed to vary linearly from zero at the point of deepest scour to the square of the maximum velocity at the free surface of water. The maximum velocity for the purpose of this sub-clause shall be assumed to be $\sqrt{2}$ times the maximum mean velocity of the current.

square of volicity at a height X from the point of deepest scour

$$= u^2 = 2 \frac{V^2 X}{H}$$

Where V is the maximum mean velocity.

213·4 When the current strickes the pier at an angle, the velocity of the current shall be resolved into two components—one parallel and the other normal to the pier.

(*a*) The pressure parallel to the pier shall be determined as indicated in clause 213·2 taking the velocity as the component of the velocity of the current in a direction parallel to the pier.

(*b*) The pressure of the current, normal to the pier and actings on the area of the side elevation of the pier, shall be calculated similarly taking the velocity as the component of the velocity of the current in a direction normal to the pier, and the constant K as 1·5, except in the case of circular piers where the constant shall be taken as 0·66.

213·5 To provide against possible variation of the direction of the current from the direction assumed in the design, allowance shall be made in the design of piers for an extra variation in the current direction of 20 degrees, that is to say, piers intended to be parallel to the direction of current shall be designed for a variation of 20 degrees from the normal direction of the current and piers originally intended to be inclined at θ degrees to the direction of the current shall be designed for a current direction inclined at $(20+\theta)$ degrees to the length of the pier.

213·6 In case of a bridge having pucca floor or having an inerodible bed, the effect of cross currents shall in no case be taken as less than that of a static force due to a difference of head of 250 mm betweeu the opposite faces of a pier.

213·7. When supports are made with two or more piles or trestle columns, the group shall be treated as a solid rectangular pier of the same overall length and width and the value of K taken as 1.25 for calculating pressurees due to water currents both parallel and normal to the pier.

213·8. The effects of the force of water, currents shall be duly considered upto the level indicated in clause 214·7.

214.1 *Longiiudinal forces* :

214·1. In all road bridges, provision shall be made for longitudinal forces arising from any one or more of the following causes :—

(*a*) Tractive effort caused through acceleration of the driving wheels ;

(*b*) Braking effect resulting from the application of the brakes to braked wheels ; and

(*c*) Frictional resistance offered to the movement of free bearings due to change of temperature or any other cause.

NOTE : Braking effect is invariably greater than the tractive effort.

214·2. The braking effect on a simply supported span or a continuous unit of spans or any other type of bridge unit shall be assumed to have the following value :—

(*a*) In the case of a single lane or a two-lane bridge, twenty per cent of the first train load plus ten per cent of the load of the succeeding trains or part thereof, the train loads in one lane only being considered for the purposes of this sub-clause. Where the entire first train is not on the full span, the braking force shall be taken as equal to twenty per cent of the loads actually on the span.

(*b*) In the case of bridges having more than two lanes ; as in (a) above for the first two lances plus five per cent of the loads on the lanes in excess of two.

NOTE : The loads in this clause shall not be increased on account of impact.

214·3 The force due to braking effect shall be aussmed to act along a line parallel to the roadway and 1·2 m above it. While transferring the force to the bearings, the change in the vertical reaction at the bearings should be taken into account.

214·4 The longitudinal force at any free bearing shall be limited to the sum of dead and live load reactions at the bearing multiplied by the appropriate co-efficient of friction. The co-efficient of friction at the bearing shall be assumed to have the following values ;—

For roller bearings—0·03

For sliding bearings of hard copper alloy—0.15

For sliding bearings of steel on cast iron or steel on steel—0.25.

For sliding bearing of steel on ferro asbestos —0.20

For other types of bearings of proved utility if permitted at the discretion of the Engineer-in-charge.	As may be permitted by the Engineer-in-charge on examination of the available data.

For simply supported reinforced concrete and prestressed concrete superstructure the span upto which plate bearings can be used shal be limited to 1.5 metres.

214.5. The longitudinal force at the fixed bearing shall be taken as the algebraic sum of the longitudinal forces at the free bearings in the bridge unit under consideration and the force due to the braking effect on the wheels as mentioned in clause 214.2.

214.6. The effects of braking force on bridge structures without bearings, such as arches, rigid frames, etc., shall be calculated in accordance with approved methods of analysis of indeterminate structure.

214.7. The effects of the longitudinal forces and all other horizontal forces should be calculated upto a level where the resultant passive earth resistance of the soil below the deepest scour level (floor level in case of a bridge having pucca floor) balances these forces.

215. *Centrifugal forces* :

215.1. Where a road bridge is situated on a curve, all portions of the structure affected by the centrifugal action of moving vehicles are to be proportioned to carry safely the stress induced by this action in addition to all other stresses to which they may be subjected.

215.2. The centrifugal force shall be determined from the following equation :—

$$C = \frac{WV^2}{127\,VR}$$

Where C=Centrifugal force acting normally to the traffic (1) at the point of action of the wheel loads or (2) uniformly distributed over every metre length on which a uniformly distributed load acts, inio nnes ;

W=Live load (i) in case of wheel loads, each wheel load being considered as acting over the ground contact length specified in clause 207, in tonnes, and (2) in case of a uniformly distributed live load, in tonnes per linear metre.

V=the design speed of the vehicles using the bridge in km per hour ;and

R=the radius of curvature in metres.

215.3. The contrifugal force shall be considered to act at a height of 1.2 m above the level of the carriage way.

215.4. No increase for impact effect shall be made on the stress due to contrifugal action.

215.5. The overturning effect of the centrifugal force on the structure as a whole shall also be duly considered.

216. *Buoyancy* :

216.1. The effects of buoyancy indicated in clause 122.5.6 of I.R.C. 5—1970 shall be considered in the design if there is any possibility of a combination of forces whereby the stability of the bridge foundation considering buoyancy may be compromised.

216.2. In the design of abutments, especially those of submersible bridges, the effects of buoyancy shall also be considered assuming that the fill behind the abutments has been removed by scour.

216.3. To allow for full buoyancy a reduction is made in the gross weight of the member affected, in the following manner :—

(*a*) When the member under consideration displaces water only, e.g., a shallow pier or abutment pier founded at or near the bed level, the reduction in weight shall be equal to that of the volume of the displaced water.

(*b*) When the member under consideration displaces water and also silt or sand,e.g., a deep pier or abutment pier passing through strata of sand and silt and founded on similar materi l, the upward pressure causing the reduction in weight shall be considered as made up of two factors :

(i) Full hydrostatic pressure due to a depth of a to the difference in levels between the free surface of water and the foundation of the member under consideration, the free surface being taken for the worst consideration, and

(ii) Upward pressure due to the submerged weight of the silt or sand calculated in accordance with Rankine's theory, for the appropriate angle of internal friction.

216.4. In the design of submerged masonry or concrete structure the buoyancy effect through pore presure may be limited to 15 percent of full buoyancy.

216.5. In case of submersible bridges, the full buoyancy effect on the superstructure shall be taken into consideration.

217. *Earth Pressure* :

217.1. Structure designed to retain earth fills shall be proportioned to withstand pressure calculated in accordance with any rational theory. Conlomb's theory shall be acceptable, subject to the modification that the centre of pressure exerted by the backfill, when considered dry is located at an elevation of 0.42 of the height of the wall above the base instead of 0.33 of that height . No structure shalt however be designed to withstand a horizantal pressure lessthan thal exerted by a fluid weighing 480 kg. per cu.m.

217.2. (*a*) The distribution of normal pressure on a retaining wall due to a concentrated surface load on the backfill shall be obtained by any rational method of design, the one using Spangler's equation, which is given below, being acceptable.:

$$h = \frac{KP}{X^n} - \frac{X^2 Z}{R^5}$$

in which h=normal unit pressure on the wall at any point, in kg per sq.m.

p=applied wheel load in kg.

X=distance from load to back face of wall in M, subject to a minimum of 150 mm.

Y=lateral distance from any point on the wall to the normal vertical plane containing the load in M.

X=Vertical distance from any point on the wall in the horizontal plane containing the load, in M.

R=Radius vector measured from the wheel load to the point at which the pressure is to be calculated in M.

$= \sqrt{X^2 + Y^2 + Z^2}$ and

K and n are empirical constants equal to 1.0 and 0.25 respectively.

(*b*) In the particular case of bridge abutments, the concentrated surface loads due to the wheel or track loads of any of the I.R.C. standard vehicles or trains described in clause 207.1 placed on the backfill, shall be considered to have the same effect as the equivalent heights of surcharge of earth shown in the table given on page 30 and curves in plate I which are based on the Spangler's equation given in cluase 217.2 (*a*). These heights of surcharge shall be assumed to act over the entire length of the abutment.

217.3. Where an adequately designed reinforced concrete approach slab covering the entire width of the roadway, with one end resting on the structure, designed to retain earth and extending for a length of not less than 3.5 m into the approach is provided, no live load urcharge need be considered in the design of that structure.

TABLE OF EQUIVALENT HEIGHTS OF SURCHARGE OF EARTH.

Depth of abutment below the road level in metres.	H, in metre, for the concentrated surface loads due to wheel or track loads of the following I.R.C. standard loadings.					
	I.R.C. Class AA and Class 70 R loadings.		I.R.C. Class A loading.		I.R.C. Class B loading.	
	Single-lane bridges.	*Multi-lane bridges.*	*Single-lane bridges.*	*Multi-lane bridges.*	*Single-lane bridges.*	*Multi-lane bridges*
(1)	(2)	(3)	(4)	(5)	(6)	(7)
0.2 ..	26.0	15.4	14.3	17.2	8.3	10.0
1.0 ..	15.0	9.1	8.5	10.0	5.1	5.8
2.0 ..	8.0	5.5	5.1	6.1	3.0	3.7
3.0 ..	6.8	4.1	3.8	4.6	2.3	2.7
4.0 ..	5.5	3.3	3.0	3.5	1.8	2.1
6.0 ..	3.8	2.3	2.2	2.6	1.3	1.5
8.0 ..	3.0	1.8	1.7	2.0	1.0	1.2
10.0 and above.	2.6	1.5	1.4	1.7	0.9	1.0

NOTE.—The above figures are based on the following values for the constants for the abutment and the backfill:

(1) Length of abutment (L)=4.5 m-for signle-lane bridges and 7.6 m. for multi-lane bridges.

(2) Angle of internal friction of the backefill ($\varnothing$)=30°

(3) Weight of backfill (W). 160 kg. per cu.m.

(4) The resultant earth pressure acts in a horizontal direction.

For different values, say, L1, $\varnothing$, and W1 for the constants the figures given in the above table should be multiplied by the following factors :—

$$\frac{L\ (4.5 \text{ or } 7.6 \text{ as the case may be})}{L_1} \;:$$

$$\frac{(1+\sin\varnothing_1)}{3(1-\sin\varnothing_1)} \text{ and } \frac{2600}{W^1} \text{ respectively}$$

217.4. All designs shall provide for the thorough drainage of back filling material by means of weep holes and crushed rock or gravel drains, or pipe drains, or perforated drains.

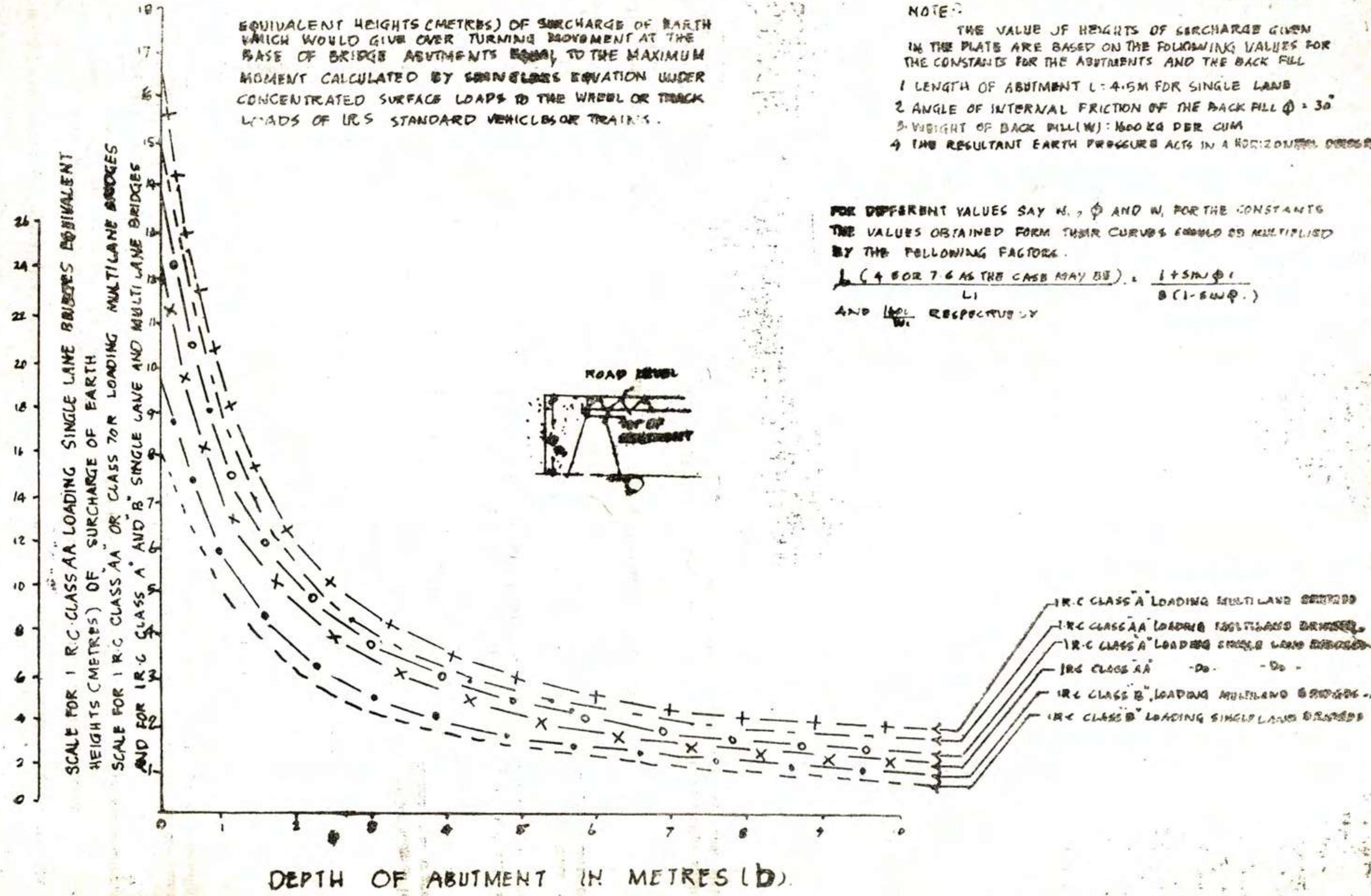
217.5. The pressure of submerged soils (not provided with drinage arrangements) shall be considered as made up of two components—

(*a*) Pressure due to the earth calculated in accordance with the method laid down in clause 217·1, the unit weight of earth being reduced for buoyancy and

(*b*) full Hydrostatic pressure of water.

217·6. In the design of return walls, live load surcharge shall be taken for loads pleased beyond the length of the approach slab.

PLATE I.



NOTE:-

THE VALUE OF HEIGHTS OF SURCHARGE GIVEN IN THE PLATE ARE BASED ON THE FOLLOWING VALUES FOR THE CONSTANTS FOR THE ABUTMENTS AND THE BACK FILL

1. LENGTH OF ABUTMENT L : 4.5M FOR SINGLE LANE
2. ANGLE OF INTERNAL FRICTION OF THE BACK FILL $\phi = 30^\circ$
3. WEIGHT OF BACK FILL (W) : 1600 KG PER CUM
4. THE RESULTANT EARTH PRESSURE ACTS IN A HORIZONTAL DIRECTION

FOR DIFFERENT VALUES SAY L_1, ϕ AND W_1 FOR THE CONSTANTS THE VALUES OBTAINED FORM THEIR CURVES SHOULD BE MULTIPLIED BY THE FOLLOWING FACTORS.

$\frac{L\ (4\ \text{OR}\ 7.6\ \text{AS THE CASE MAY BE})}{L_1}$, $\frac{1+\sin\phi_1}{3(1-\sin\phi_1)}$

AND $\frac{1600}{W_1}$ RESPECTIVELY

218· *Temperature Effects* :

218.1. Provision shall be made for stresses or movements resulting from variations in temperarure (see also Clause 214).

218.2. The raise and fall in temperature shall be fixed for the locality in which the structure is to be constructed and shall be figured from an assumed temperature at the time of erection·

218.3. Due consideration shall be given to the lag between air temparature and the interior temperature of massive concrete members of structures.

218.4. Except where stated otherwise, the following range of temperature shall generally be assumed in the design:

(*a*) *Metal Structures* :

Moderate Climate : from minus 18 degrees C to 50 degree C
Extreme Climate : from minus 35 pegree C 50 degree C.

(*b*) *Concrete Structure* :

	Temparature raise.	*Temparature fall.*
Moderate climate	17° C	17° C
Extreme climate	25° C	25° C

But in both cases i.e., in (a) and (b), intermediate values can be allowed at the discretion of the engineer responsible for the design.

218.5. The co-efficient of expansion per degree centigrade shall be taken as 0.0000117 for steel and reinforced concrete structures and 0.0000108 for plain concrete structures.

219. *Deformation Stresses* : (For steel bridges only)

219.1. Deformation stress is defined as the bending stress in any member of an open web girder caused by the vertical deflection of the girder combined with the rigidity of the joints. No other stresses are included in this definition.

219.2. All steel bridges shall be designed, manufactured and erected in a manner such that the deformation stresses are reduced to a minimum. In the absence of calculations deformation stresses shall be assumed to be not less than 16 per cent of the dead and live load stresses.

219.3. In prestressed girders of steel deformation stresses may be ignored.

220. *Secondary Stresses* :

220.1. (a) *Steel Structures* : Secondary stresses are additional stresses brought into play due to the eceentricity of connections, floor beam loads applied at intermediate points in a panel cross girders being connected away from panel points, lateral wind loads on the end-posts of through girders, etc., and stresses due to the movement of supports.

(b) *Reinforced Concrete Structures* : Secondary stresses are additional stresses brought into play due either to the movement of supports or to the deformations in the geometrical shape of the structure or its member, resulting from causes such as rigidity of end connection or loads applied at intermediate points of trusses or restrictive shrinkage of cencrete floor beams.

220.2. All bridges shall be designed and constructed in a manner such that the secondary stresses are reduced to a minimum and they shall be allowed for in the design.

220.3. For reinforced concrete members, the shrinkage, co-efficient for purposes of design may be taken as 2X 10-4.

221. *Erection Stresses* :

Allowance shall be made in the design for stresses set up in any member during erection. Such stresses may be different from those which the member will be subjected to during actual working.

222. *Seismic Force* :

222·1. If a bridge is situated in a region subject to earth quakes allowance shall be made in the design for seismic force and earthquaqe resistant features shall be embodied in the structural details of design.

222·2. The seismic force shall be taken as a horizontal force equal to the appropriate fraction specified in clause 222.3 of the weight of the dead and the live loads acting above the section under consideration. (Parts of the structure embedded in soil shall not be considered to produce any seismic forces.

222. 3. The country is divided into three regions as shown in Fig. 8 and the seismic forces in the regions shall be taken as nil, G/20 and G/10 for the regions shown there in as "Liable to minor damage or Nil", "Liable to moderate damage" and "Liable to severe damage" respectively. For bridges situated in epicentral tracts where large devastations have occurred in the past due to earthquakes the percentage shall be fixed by the engineer responsible for the design, with due regard to the local conditions regarding the intensity of earthquakes generally experienced in these regions.

222. 4. These horizontal forces due to the seismic effect shall be taken to act through the centre of gravity of all the loads under consideration. The direction of these forces should be such that the resultant stresses in the member under consideration are the maximum.

222. 5. Seismic and wind forces shall not be considered to act simultaneously.

222. 6, The magnitude of the seismic force shall not be reduced on account of reduction in the weight due to boeyancy obtained on a submerged mass.

EXTRACT OF STANDARD SPECIFICATION AND CODE OF PRACTICE FOR ROAD BRIDGE. [I. R. C.—5]

SECTION I.

GENERAL FEATURES OF DESIGN.

113. Width of roadway and footway.

113·1. For high level bridges constructed for the use of road traffic only, the width of roadway shall not be less than 4·25 m for a single lane bridge and 7·5 m for a two lane bridge and shall be increased by 3·5m for every additional lane of traffic for a multiple lane bridge. Road bridge shall provide for either one lane two lanes or multiples of two lane. Three lanes bridges shall not be constructed. If a central verge is constructed in a wide bridge, thus providing two separate carriage way on each side of the verge shall provide for atleast two lanes of traffic and width thereof shall individually comply with the minimum requirements stipulated above. The width of central averge when provided shall not be less than 1·2 m.

113.2. For bridges carrying combined road and train way or any other special type of traffic, the width indicated in clause 113·1 shall be modified to suit these special requirements.

113.3. Cause ways and submersible bridges shall provide for atleast two lanes of traffic as specified in Clause 113·1 above unless one lane of traffic is specially permitted for the design.

113.4. For a bridge on a horizontal curve, the road way width shall be increased by an amount not less than that required by the relevant I. R. C. Road Standard.

113.5. When a footway is provided its width shall not be less than 1·5 metres.

EXTRACT OF SPECIFICATION 101 OF THE MADRAS HIGHWAY MANUAL

(Pages 176 to 180)

Steel Structures.

1011-01. *General* : The provisions of this section shall apply to all types of bridge structures in which the main members spanning the various supports are composed of steel. Steel bridges and such parts of bridges as are of steel shall be built in conformity with the lines, grades and dimension and designs shown on the plans and in accordance with pertinent requirement of the T. N. B. P. Section No. 14, with the following additions or modifications for all the works necessary to complete the structure.

1011-02. *Materials* : All materials shall conform to standard specifications or sepcifications issued by other bodies as set forth below or any special provisions pertaining to a special work :—

Concrete for structure ..	SSRB : 1007
Reinforcement bars ..	SSRB : 1008
Structural steel	IS : 226–1950 and SSRB : 213
High Tensile steel	BS 548—1934
Cast steel	BSS for steel castings for Marine purposes, Grade B (BSS No. 30)
Steel for pins and rollers ..	As for structural steel or high tensile steel.
Wrought iron	BSS for wrought iron for use in Railway rolling stock (BSS No. 51), Grade C for plates and bars and Grade B for rivet and rod iron.
Timber	SSRB : 215
Paints and paint materials	SSRB 222
Joint Filler	SSRB : 220

Cast Iron : Cast iron shall not be made from first runnings, but shall be re-melted in the cupola. It shall be made from a mixture of strong grey cast iron, composition of which shall be left to the discretion of the manufacturer, but the metal must be sufficiently tough to allow of all casting being readily drilled, chipped or filed.

When cast iron is used for such purposes as bearing plates, screws cylinders, and other parts of the structure liable to straining action, the metal shall comply with the following requirements. Two test bars each 3 ft. 6 inches long by 2 inches deep and 1 inch wide, shall be cast from each melting of the metal as used and shall have a distinguishing mark, which shall also be cast on all the casitngs run from the same melting. Each bar shall be tested by being placed on edge on bearings 3 ft. apart and shall be required to sustain without fracture a load of 28 Cwt. applied at the centre with a deflection of not less than one-third of an inch. The bar shall be tested to destruction.

Where cast iron is used for balustrades or similar purposes, in which the material is not subjected to straining action, no special test s for strength will be called for.

1011-03. *Removal of existing structures* : Where the removal and satisfactory disposal of existing structures are required, the work shall be performed as specified in SSRB 1002.

1011·04. *Workmanship and finish* : The workmanship and finish shall be equal to the best practice in modern structural shops. Shearing and chipping shall be neatly and accurately done and all portions of the work exposed to view shall be neatly finished. If a cutting torch is used, all burnt metal burns shall be removed by chipping and ground smooth.

1011-05. *Changes and substitutions* : Sections having different dimensions than those shown on the plans shall not be used except with the written approval of the Engineer.

1011-06. *Fabrication* : All riveted and pin connected steel structures shall be fabricated in accordance with articles C-30 to C-58 of I. R. C standard specification and codes of practice for road bridges in India. 1937 or its latest revision.

1011-07. *Erection* : The contractor shall erect the steel work, remove the temporary construction, and do all work required to complete the bridge as covered by the contract, including the remova l of the old structure or structures if stipulated , all in accordance with the plans and specifications.

1011-08. *Plant* : The contractor shall provide the false work and all tools, machinery and appliances, including drift pins and fitting up bolts, necessary for the expeditious handling of the work.

1011-09. *Handling and storing materials* The material shall be placed on skids above the ground. It shall be kept clean and the under lying ground properly drained. Girders and beams shall be placed upright and stored. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent injury from deflection. The Contractor shall be responsible for the loss of any material which has been paid for by the department while it is in his care, or for any damage to such material resulting from his work.

1011-10. *False work* : The false work shall be properly designed and substantially constructed and maintained for the loads which will come upon it. The contractor, if required shall prepare and submit to the Engineer for approval, plans for false work and also changes in existing structures necessary for maintaining traffic. Approval of such plans shall not be considered as relieving the con ractor of any responsibility.

1011–11. *Methods and equipment.*—Before starting work the contractor shall inform the Engineer as to method of erection he proposes to follow, and the amount and character of equipments he proposes to use, which shall be subject to the approval of the Engineer,. The approval of the Engineer shall not be considered as relieving the contractor of the responsibility for the safety of his method or equipment or from carrying out the work in full in accordance with the plans and specifications. No work shall be done without the sanction of the Engineer.

1011–12. *Gearings and anchorage.*—Masonry bearing plates shall not be placed upon bridgeseat bearing areas which are improperly finished, deformed, or irregular. Bearing plates shall be set level in exact position and shall have a full and even bearing upon the masonry.

1011–13. *Adjustment of pin nuts.*—All nuts on pins shall be thoroughly tightened and the pins so located in the holes that the members shall take full and even bearing upon them.

1011-14. *Setting anchor bolts.*—When provided on the plans, the anchor bolts shall be set in the fresh concrete of the sub-structure in accordance with provisions of Article 1010-17(e). Except when otherwise required, holes for anchor bolts shall be drilled in the correct locations, in the concrete of the sub-structure perpendicular to the plane of the bridge seat, and the anchor bolts set in them in cement mortar. The mortar shall consist of one part Portland cement and one part coarse sand, mixed with sufficient water to be readily workable.

Anchor bolts shall first be dropped into the dry holes to assure their proper fit after setting. They shall then be set as follows :—

Fill the hole about two-thirds full of mortar and by a uniform even pressure or by light blows with a hammer (flogging and ramming will not be permitted) force the bolt down until the mortar rises to the top of the hole and the anchor bolt nuts rests firmly against the metal shoe or pedestal. Remove all excess mortar which may have flushed out of the hole, to permit proper field painting of the metal surfaces.

The location of the anchor bolts in relation to the slotted holes in expansion shoes shall be varied with the prevailing temperature The nuts on anchor bolts at the expansion ends of spans shall permit the temperature movement of the span.

Anchor bolts which are to be set in the masonry prior to the erection of the superstructure shall be carefully set to proper location and elevation, with templates or other suitable means, such anchor bolts shall be furnished by the contractor for the superstructure and set by the contractor for substructure.

1011-15. *Setting rocker bearings.*—Rocker bearings at expansion end of spans shall be adjusted to provide movement due to temperature elongations of bottom chord and probable substrucure movement

1011-16. *Swinging the span.*—Before concrete is placed in the floor of steel spans, the centering shall be struck and the spanswung free on its supports.

1011-17. *Straightening bent material.*—The straightening of plates, angles, and other shapes shall be done by methods not likely to produce fracture or other injury but the metal shall not be heated for this purpose. Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

1011-18. *Assembling steel.*—The parts shall be accurately assembled as shown on the plans and match marks shall be followed. The material shall be carefully handled so that no parts will be damaged. Hammering which will injure or distort the members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled. Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber. The blocking shall be left in place until the tension chord splices are fullyriveted and all other truss connections pinned and bolted. Rivets in splices of butt joints of compression members and rivets in railings shall not be driven until the span has been swung. Splices and field connections shall have one-half of the holes filled with bolts and cylindrical erection pins (half bolts and half pins) before riveting. Fitting up bolts shall be of the same nominal diameter as the rivets, and cylindrical erection pins shall be 0.8 mm larger. Drifting shall be only such as to draw the parts into position and not sufficient to enlarge the holes or distort the metal.

1011.-19. *Field riveting.*—Pneumatic hammers shall be used for field riveting. Cup faced dollies, fitting the head closely to ensure good bearing shall be used. Connections shall be securely and accurately fitted up before the rivets are driven. Unfair holes shall be reamed or drilled. Rivets shall be heated uniformly to a light cherry-red colour and shall be driven while hot. They shall not be overheated or burned, Rivet heads shall be full and symmetrical concentric with the shank, and shall have full bearing all round. They shall not be smaller than the heads of the shop rivets. Rivets shall be tight and shall grip the connected parts securely together. Caulking or recupping will not be permitted. In removing rivets the surrounding metal shall not be injured, if necessary, they shall be drilled out. Field riveting shall be done before false work is removed.

NOTE;.—The results obtained in the field assembling and riveting of the members of a structure shall fulfil the requirements of shop assembling and riveting. All field driven rivets shall be inspected and accepted before being painted.

1011-20.—*welding*—Welding may be substituted for riveting only with written approval of the Engineer. When welding is permitted, it shall be performed only by competent workmen using electric arc welding process under strict control.

All welding shall be done with the prior approval of the Engineer in accordance with S.S.R.B. : 1009.

1011-21. *Bolted connexions*—In bolted connexions, the bolts shall be drawn up tight, and the threads burred at the face of the nut with a pointed tool.

1011-22. *Pin connexions.*—Pilot and driving nuts shall be used in driving pins. Pins shall be so driven that the members will take full bearing on them. Pin nuts shall be screwed up tight, and the threads burred at the face of the nut with a pointed tool.

1011-23. *Misfits.*—Corrections of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets will be considered a legitimate part of the erection. Any error in shop work which prevents the proper assembling and fitting up of parts by the moderate use of drift pins or a moderate amount of reaming and slight chipping or cutting shall be reported immediately to the Engineer, and his approval of the method of correction obtained.

1011-24. *Setting hand rails.*—Hand rail connexions shall in all cases, be bolted and the hand rail shall be adjusted firmly to true alignment. All bolts for hand rails shall have hexagonal heads and nuts and shall be provided with lock washers and shall be secured by checking the nuts.

1011-25. *Removal of old structure and false work*—If stipulated in the contract, the contractor shall dismantle the old structure and shall dispose it off as specified in SSRB : 1002.

Upon completion and before final acceptance, the contractor shall remove all false work, excavated or useless materials, rubbish and temporary buildings, replace or renew any fences damaged and restore in an acceptable manner all property both public and private which may have been damaged during the prosecution of his work, and shall leave the bridge site and adjacent highway in a neat and presentable condition satisfactory to the Engineer. All excavated material or false work placed in the stream channel during construction shall be removed by the contractor before final acceptance.

1011-26. *Inspection.*—The work shall be subject, at all time to inspection by the Engineer.

1011-27. *Painting.*—Unless otherwise specified, all structural steel will be given one coat of paint in the shop and two coats after erection in the field. Field painting shall not be started until permitted by the Engineer in writing. The paint for the various coatings, the preparation of the surfaces and application of paint shall conform to the requirements as set forth in SSRB : 1021.

1011-28. *Method of measurement.*—The quantities of the various items of concrete, steel reinforcements, structural steel which constitute the completed and accepted structure will be measured for payment according to the plans and specifications for the several pay items, and in terms of the prescribed units provided for such items. Only accepted work will be included and the dimensions used will be those shown on the plans or ordered by the Engineer in writing.

The quantity of the various items ofconcrete masonry,steel reinforcement, structural steel, etc., involved in construction of steel structures will be computed by the Engineer in accordance with the provisions of the section applying to these respective items as follows :

(*a*) concrete masonry, article 1007–21

(*b*) steel reinforcement, article 1008–12

(*c*) *Structural steel.*—All structural steel will be classified in the proposal and contract as "plain structural steel" or "fabricated structural steel". The quantities of these items to be paid for will be determined as follows :—

(i) *Plain structural steel.*—The weight of plain structural steel shall include the net weights of all roped shapes, such as beams-diaphragms, bracing, castings for anchorage or bearing plates, expansion devices, bolts, rivets, metal railings etc., incorporated in I-beam spans or structures requiring lesser amounts of fabrication, except steel reinforcement in concrete.

(ii) *Fabricated structural steel*—The weight of fabricated structural steel shall include the net weights of all rolled shapes composing fabricated members, casting for anchorage or bearing plates, expansion devices, bolts, rivets, metal railings, etc., incorporated in trusses,arches girders,and viaducts,except steel reinforcement in concrete.

(iii) *Weight paid for.*—The weight of plain structural steel or fabricated structural steel which will be paid for will be the weight estimated by the Engineer as shown on the plans or shop drawings using nominal weights for the structural shapes and plates as given in the hand-books of the mills rolling the various sections.

(iv) *Computed weight*—The Engineer's estimate of weight of structural steel will be made on following basis.—

The weight of steel shall be assumed as 7,849 Kg/Cu.m. and wrought iron 7,769 kg/cu.m.

The weight of cast iron shall be assumed as 7,208 kg/cu.m

The weights of rolled shapes and of plates in width shall be computed on the basis of their nominal weights and dimensions, as shown on the plants, deducting for copes and cuts and all open holes except rivet holes.

For the weight of rivet heads for computing weight of structural steel reference to Appendix D, I.R.C.: 24—1967, D6, Table B, D7 shall be made.

The weight of unfinished service bolts, rivets and drifts shall be computed from the unit weights thereof as tabulated in the latest hand-books and paid for separately.

The weight of castings shall be computed from the dimensions shown on the plans with an addition of 5 per cent for fillets and overrun. To the total computed weight of metal may be added an allowance of 0.4 per cent for shop paint.

The weight of railings shall be included unless it is paid for on a linear foot basis.

1011-29.*Basis of Payment*–All steel structures will be paid for at the contract unit prices for concrete, steel reinforcements, plain structural steel, fabricated steel, etc., as specified in the contract.

These contract unit prices shall be for furnishing all materials for fabrication and erection of steel in the structure together with all labour, materials, transportation and shop and field painting necessary for the proper completion of the work in accordance with the contract.

The contract price for fabrication without erection shall include all labour and materials necessary for fabrication, shop painting, shipping and delivery at the place designated.

Payment will be made on weight basis or a lumpsum basis, as required by the terms of the contract, but unless stipulated otherwise, it shall be on a round price basis. For the purpose of payment, such items as bearing plates, pedestals, etc., shall unless otherwise provided, be considered as structural steel even though made of other materials.

Under contracts containing an item for structural steel, all minor metal parts other than metal reinforcement, such as expansion joints, drains, bolts etc., which are embedded in concrete shall be paid for as structural steel.

EXTRACT OF I.R.C. 24—1967.

APPENDIX D

B-6.—The weight of rivet heads shall be computed by taking the weight of 100 snap heads as given in Table 13.

When specially agreed upon, the allowance for snap heads may be taken as a flat percentage of the total weight. This percentage may be taken as 3 per cent or modified by mutual agreement.

TABLE 13—WEIGHT OF RIVET HEADS.

Dia. of rivet as manufactured.	*Weight of 100 snap heads.*
mm	*Kg.*
12	1.3
14	2·1
16	3·4
18	4·45
20	6·1
22	8·1
24	10·5
27	15·0
30	20·5
33	27·2

Detailed calculated weight sheets shall be supplied.

No addition shall be made for the weight of protective coatings or weld fillets.

D-7.Where computed weight is to be the basis of payment,the weight shall be calculated for the exact cut sizes of members used in the structure, deductions being made for all cuts. Additions shall be made for the rivet heads as in the clause above.

When payment is based on weigh bridge weight, no deducution shall be made for the weight of weld fillets or the weight of any protective coating.

SECTION XIX

GENERAL CONDITIONS OF CONTRACT AND APPENDICES

SECTION XIX

GENERAL CONDITIONS OF CONTRACT

CONTENTS

466-3A—43

TAMIL NADU BUILDING PRACTICE.

FOR USE IN THE PUBLIC WORKS DEPARTMENT AND HIGHWAYS AND RURAL WORKS DEPARTMENT OF TAMIL NADU.

GENERAL CONDITIONS OF CONTRACT.

A PREFACE.

Intent and reference to Tamil Nadu Building I ractice—

1. It is intended by these Tamil Nadu Building Practice to describe

(a) the character of the materials to be used ;

(b) the method of execution of work and

(c) the contractor's responsibilities and liabilities to the Public, Government and its workmen and general contract conditions which are to be accepted by every contractor who executes work entrusted to him by the Department.

1.2. Wherever the term 'Standard Specifications' or "Specifications" or the abbreviation "TNBP No." or "TNBP" is used in the specifica ions or in estimates or contract documents, it shall refer to the relevent specification in the Tamil Nadu Building Practice.

3. The abbreviation "I.S.". shall mean "Indian Standard".

2. Applicability of the Tamil Nadu Building Practice.

2.1. It shall be unnecessary to include in any contract documents a specification for any item of work which is defined in the tender notice in the contract schedule of work to be done by a Tamil Nadu Building Practice number (TNBP No.). The fact that the item is defined as specification, shall mean that the contractor is to execcute the work according to such specification modified as may be necessary by an addendum specification for that particular item of work. In the absence of specification for any work or material in the T.N.B.P such work should be carried out in accordance with the instruction given by the Executive Engineer.

2.2. THESE GENERAL CONDITIONS OF CONTRACT SHALL APPLY TO ALL AGREEMENTS ENTERED INTO BY CONTRACTORS WITH THE PUBLIC WORKS DEPARTMENT, OR HIGHWAYS AND RURAL WORKS DEPARTMENT AND shall form an inseparable condition of contract, and it shall not be necessary to append a copy of the same to the agreement.

3. Contractor to sign in the Divisional (or the sub-Divisional) copy of the T.N.B.P.

3.1. Every contractor who executes work for the Public Works Department of the Highways and Rural Works Department shall carefully study the specification for all items of work which are included in the schedule for work to be done and his obligation under the 'General Conditions of Contract' which apply to all agreements, and he shall sign in the Divisional Office copy of the T.N.B.P. (or the sub-Divisional copy if so arranged by the Executive Engineer) as evidence that he understands clearly the conditions of contract governing his agreement and accepts the same.

3.2. It shall not be necessary for the contractors to sign the Divisional Office copy of the T.N.B.P. for every contract awarded to him, but his signature therein will be evidence that the accepts the conditions of contract (which include the standard specifications) as detailed in the T.N.B.P. for every contract into which he enters. It shall also be the contractor's responsibility by frequent perusal of the Divisional Office (or the sub Divisional Office) copy to become conversant with sanctioned alterations or additions made to the T.N.B.P. as soon as they are made. A seperate volume of addenda to the T. N. B. P. will be maintained in each Division (or sub division office as the case may be in which will be entered all sanctioned corrections and additions. This must also be studied and signed by every contractor before executing an agreement. Interleaving correction slips will not be made for this purpose. The contractor should purchase book of the T.N.B.P. for his reference while executing work.

4. Sub-specifications :—

4.1. Works of similar nature having many common clauses in their specifications are grouped under one specification number with a 'General' preface thereto, and the sub-specifications are therefore given an alphabetical affix.

5. Additions and alterations to the T.N.B.P.

5.1. Additions and alterations to the T.N.B.P. will be incorporated in the addenda volume as authorised by the Chief Engineer.

6. Powers of Superintending Engineers and Executive Engineers to supplement or alter the T.N.B.P.

6·1. Superintending Engineer and Executive Engineer may alter the specification for any particular contract which is within their respective powers of sanction, when such alteration is found necessary by attachment of a correction sheet to the contract form, bearing the T.N.B.P. number, the corrections and the signature of the Superintending Engineer or the Executive Engineer as the case may be, together with the signature of the contractor. Similarly additional specifications for items for which there are no standard specifications will be made by attachment to the contract documents of addendum specifications sheets bearing the signature of the Superintending or the Executive Engineer as the case may be and the signature of the contractor.

A-1. DEFINITIONS AND INTERPRETATIONS.

7. *Definition of terms.—*

7.1. Wherever the works and expressions defined in this clause or pronouns used in their stated occur in contract documents (which includes the T.N.B.P.), they shall have the meanings hereby assigned to them except where the context otherwise requires.—

(a) 'Executive Engineer' means the Executive Engineer for the time being in charge of the concerned work under execution or such other departmental assistants or subordinates to whom the Executive Engineer may have delegated certain duties, acting severally within the scope of the particular duty entrusted to them.

(b) No delegation by Executive Engineer which affects agreements. It is however, to be distinctly understood that the Executive Engineer or the Superintending Engineer or the higher authority who is vested with the powers of acceptance of the particular agreement under refere e will make no delegation of powers to such assistants or subordi tes which in any way affects the agreement and its contract conditio when such agreement is to be or has been accepted by the Executive Engineer or by the other higher authority respectively. The duties of such assistants or subordinates will be solely duties o supervision to ensure compliance with contract conditions.

(c) 'Contractor' means the particular person, firm or corporation with whom an agreement has been made by the Executive Engineer or higher authority as the case may be, for executing work defined in the concerned agreement, and for purposes of instructions regarding compliance with contract conditions, it shall include the contractor's authorised agent, who is maintained on the work by the contractor.

(d) Works or work means the works by or by virtue of the contractor contracted to be executed whether temporary or permanent and whether original, altered substituted or additional or connected with the supply repairs or carriage of tools and plants and supply or manufacture of other stores.

7.2. Works importing the singular only also include the plural and vice-versa where the context requires.

NOTE.—The terms sub-divisional officer, Assistant Engineer, Executive Engineer, Superintending Engineer and Chief Engineer, used in the following clauses shall where the context so requires, be constructed as also including officers of the corresponding grade in the Highways and Rural Works Department.

8. *Evidence of experience.*—Tenderer shall, if required, present satisfactory evidence to the Executive Engineer that they have been regularly engaged in constructing such works, as the proposed to execute and that they are fully prepared with the necessary capital, machinery and materials to begin the work promptly and to conduct it as required by the T.N.B.P. and the other specifications for the particular work it tendered for, in the event of their tender being accepted.

9. *Legal address Notices*:

9.1. Tenderers should give in thier tender, their place of residence and postal address. The delivering at the above named place or posting in a post box regularly maintained by the Post Office Department or sending by letter registered for acknowledgement of any notice, letter or other communication to the contractor shall be deemed sufficient service thereof upon the contractor in writing as may be changed at any time by an instrument executed by the contractor, and delivered to the Executive Engineer.

9.2. Nothing contained in the agreement and its contract conditions shall be deemed to preclude or render inoperative the service of any notice, letter or other communications upon the contractor personally.

B. STATEMENT OF APPROXIMATE QUANTITIES IN SCHEDULE—A.

10.1. The quantities mentioned in tender notices and in agreement schedule A are worked out from the relevant drawings in office and may or may not be the actuals required for execution. The Executive Engineer does not expressly or by implication agree that the actual amount of work to be done will correspond therewith but reserves the right to increase or decrease the quantity of any class or portion of the work as he deems necessary.

10.2. Tenderers must satisfy themselves by a personal examination of the site of the proposed work, by examination of the plans and specifications and by other means as they prefer as to the accuracy and sufficiency of the statement of quantities and all conditions affecting the work and shall not any time after the submission of their tender, dispute or complain of such statement of quantities or assert, that there was any misunderstanding in regard to the nature or amount of the work to be done nor in consequence apply orextension of time for completion beyond the agreement date.

11. *Approximate not to mean deviation from drawings and specification.*—

11.1. This declaration of the approximate nature of the statement of quantities in Schedule-A does not, however, in any way imply that the quantities will be increased for departure by the contractor from strict compliance with sanctioned drawings and specifications to suit his own convenience or reduce his costs.

12. *To compare tenders*:

12.1. The quantities in Schedule-A are given for a uniform comparison of lump-sum tenders.

C. DRAWINGS AND SPECIFICATIONS.

13. *Purpose*:

13.1. The contract drawings if any, read together with the contract specifications are intended to show and explain the manner of executing the work and to indicate the type and class of materials to be used.

14. *Conformance*:

14.1. The works shall be carried out in accordance with the drawings and specifications which form part of the contract and in accordance with such further drawings, details and instructions, supplementing or explaining the same as may from time to time be given by the Executive Engineer.

14.2. If the work shown on any such further drawings or details, or other work necessary to comply with any such instructions, directions, or explanations, be in the opinion of the contractor, of a nature which the schedule rate in the contract does not legitimately cover he shall before proceeding with such work, give notice in writing to this effect to the Executive Engineer. In the event of the Executive Engineer and contractor failing to agree as to whether or not there is any excess rate to be fixed and the Executive Engineer deciding that the contractor is to carry out the said work, the contractor shall accordingly do so, and the question whether or not there is any excess and if so the amount thereof, shall failing agreement, be settled by an arbitrator as provided in the arbitration clause, unless the subject is one which is left to the sole discretion of the Executive Engineer under the clauses of these conditions of contract and the contractor shall be paid accordingly.

14.3. It shall be the responsibility of the contractor to give timely notice to the Executive Engineer regarding anything shown on the drawings and not mentioned in the specification. or mentioned in the specifications and not shown in the drawings or any error or discrepancy in drawings or specifications and obtain his orders thereon. Figure dimensions are to be taken and not those obtained from sealing the drawings. In any discrepancy between drawings and specifications, the latter shall prevail. In any such cases or in case any feature of the work is not fully described and set forth with the drawings and specifications, the contractor shall forthwith apply to the Executive Engineer for such further instructions, drawings or specifications as he requires it, being understood that the subject is to be dealt with under the building precedure of best modern practice. The Executive Engineer will furnish the further instructions, drawings or specifications if in his opinion, they are required by competent workmen, for the proper execution of the work.

15. *Variations by way of modifications, omissions or additions.*

15.1. For all modifications, omissions from or additions to the drawings and specifications, the Executive Engineer willissue revised plans, or written instructions or both, and no modifications, omissions or additions shall be made unless so authorised and directed by the Executive Engineer in writing.

15.2. The Executive Engineer shall have the previlege of ordering modifications, omissions or additions at any time before the completion of the work and such orders shall not operate to annul these portions of the specifications with which said changes do not conflict.

15.3· The contractor shall submit to the Executive Engineer a statement giving details of the claims for any additional work within 30 days of the order of the work and no claim for any such work will be considered which has not been included in the statement.

16. *Copies of drawings and specifications*:

16.1. One copy of the available drawings and specifications (apart from the T.N.B.P. a copy of reference) shall be furnished free of cost to the contractor for his own use. Such copies and copies of supplementary details furnished by the Executive Engineer shall be kept by the contractor on the work until the completion thereof, and the Executive Engineer shall at all times have access to them.

17. *Signed drawings*– No authority to the contractor.

17.1. No signed drawing shall be taken as in itself and order for variation, unless either it is entered in the agreement schedule of drawings under proper attestation of the contarctor and the Executive Engineer, or unless it has been sent to the contractor by the Executive Engineer with a covering letter confirming that the drawing is an authority for variation of the contract under reference.

D. MATERIALS AND WORKMANSHIP.

18. *To be the best quality*:

18.1. All materials, articles and workmanship shall be the best of their respective kind for the class of work described in the contract specifications and schedule, materials being obtained from sources approved by the Executive Engineer. The word · best' as used in these specifications shall mean, that in the opinion of the Executive Engineer there is no other superior quality of materials or finish of articles on the market and that there is no better class of workmanship available for the nature of the particular item described in the contract schedule. The contractor shall, upon the request of the Executive Engineer, furnish him with the vouchers to prove that the materials are such as are specified.

18.2. Samples of materials shall be furnished at the contractor's expense to the Executive Engineer when called for in the tender notice or ordered to be furnished by the Executive Engineer prior to execution of any work.

19. *Conventions for proportions* :

19.1 Wherever the proportions are written by figures without further description and where the meaning is otherwise clear as to which figure is intended to apply to each material, then the usual conventions will be understood to apply.

For example,

1:2. Means 1 lime (or cement in accordance with the context) and 2 sand ;

1:2:4. Means 1 lime (or cement in accordance with the context) 2 sand and 4 broken stone (or other aggregate in accordance with the context).

20. *Measurement and mixing*:

20.1. In the case of loose materials such as lime, sand, cement, broken stone, surki, mortar, etc. the proportions demanded by the specifications must be measured in properly constructed measuring boxes or weighed or in such other manner as shall be instructed by the Executive Engineer. Measurement is not to be done in loose heaps when intimate mixtures such as mortar, concrete, etc., are to be formed. The mixing must always be done on closely constructed platforms so that there will be no leakage of any of the materials through the floor of the platform and also that no foreign materials can be incorporated during the mixing. These platforms must be approved by the Executive Engineer. The cost of such measuring boxes and platforms and all the wotk referred to herein shall be borne by the contractor.

21. *Data* :

21.1. The materials and labour utilised in the execution of work by the contractor shall not be less than that given in the Tamil Nadu P.W.D. Standard Data for the relevant item.

NOTE.—In case the contractor considers that the materials and labour provided in the Madras P.W.D. Standard data for the execution of particular items of work are in excess, the contractor may furnish detailed data for such items along with tender with reasons for variations from P.W.D. Standard Data.

22. *Layout of materials stacks*:

22.1. The contractor shall deposit materials for the purpose of the work on such parts only on the ground as may be approved by the Executive Engineer. He shall submit for the approval of the Executive Engineer before starting work, a detailed site survey clearly indicating positions and areas where materials shall be stacked and sheds built.

23. *Source of purchase of materials and stores* :

23.1. The Executive Engineer shall, during the progress of the work, have power to cause the contractor to purchase and use such materials or supplies from Government brick fields, stores or other sources as may be specified in the contract for the purposes therein specified.

24. *Contractor liable for materials supplied by Government.*

24.1. The contractor shall be responsible for all materials and other articles and things which may be supplied by Government from the time he takes delivery thereof and shall use them only for the purposes of this contract and shall make good any loss, damage, wastage or undue wear and tear that may take place from whatever cause and pay to Goverment, for such loss, damage, wastage or undue wear and tear such sum as the Executive Engineer may determine.

24.2. If at any time subsequent to the execution of the agreement Government materials other than those specified in the Agreement are to be supplied to the contractor for use on the work they will be charged at the market value prevailing at the time of supply or stock issue rate whichever is greater. The contractor will be informed in writing of this change and he should intimate in writing the rate which he demands for finished work in view of the fact that he is to use Government materials.

24.3. For any excess issue of cement be yond the allowable limit of 5 per cent over the theortical requirement of cement the ecovery shall be made a double the ssue rate from the contractor.

25. *Test inspection and refection of defective materials and works* :—

25.1. The contractor shall provide proper facilities at all for the testing of materials and inspection of the work by the Executive Engineer, and the Executive Engineer shall according by also have access at all times to the places of storage. or manufacture where materials are being made for use under the contract to determine that manufacture is proceeding in accordance with the drawings and specifications.

25.2. The contractor shall, upon demand, also forward for the Executive Engineer's inspection, test certificate supplizd by the vendors, when he is purchasing consignments of cement, steel and other materials in respect of which such certificates are usually available.

25.3. The Executive Engineer shall have power to reject at any stage, any work which he considers to be defective in quality of material or workmanship and he shall not be debarred from rejecting wrough materials by reasons of his having previously passed them in an unworked condition. Any portio n of the work or materials rejected or pronounced to be inferior or not in accordance with the drawings and specications, shall be taken down and removed from the work site at the contractor's expense, within 24 hours after written instructions to that effect have been given by the Executive Engineer. Replacement shall at once be made in accordance with the specifications and drawings at the contractor's expense.

25.4. In case of default on the part of the contractor to carry out such orders, the Executive Engineer shall have power to employ and pay other persons to carry out the orders at the contractor's risk and all expenses consequent thereon and incidenta thereto shall be borne by the contractor.

25.5. In lieu of recting work not done in accordance with the contract, the Executive Engineer may allow such work to remain, and in that case shall make such allowance for the difference in value, as in his opinion may be reasonable.

25.6. *Works opened for inspection*.— The contractor shall, at the request of the Executive Engineer, within such time as the Executive Engineer shall name, open for inspectio n any work covered up; and should the contractor refuse or neglect to comply with such a request, the Executive Engineer may employ other workmen to open up the same. If the said work has been covered up on contravention of the Executive Engieer's instructions, or if on being opened up, it be found not in accordance with drawings and specifications or the written instructions of the Executive Engineer the expenses of opening it and covering it up again. whether done by the contractor or such other workmen, shall be borne by, or recovered from the contractors. If the work has not been covered up in contravention of such instructions or if on being opened up it be found to be in accordance with the drawings and specifications or the written snstructions of the Executive Engineer, the expenses aforesaid shall be borne by Government and shall be added to the contract sum, provided always that in the case offo unda tions, or any other urgent works so opened up and requiring immediate attention the Executive Engineer shall, within reasonable time after the receipt of a notice from the contractor that the work has been opened, make or cause the inspection there of to be made, and at the expiration of such time if such inspection shall not have been made, the contractor may cover up the same, and shall not be required to open it up again inspe ction except at the expense of Government.

26. *Defects, shrinkages, etc., after completion*:

26.1. Any defects, shrinkage or other faults which may appear within six months from the completion of the works arising, in the opinion of the Executive Engineer from faulty materials or workmanship not in accordance with the drawings and specifications or the instructions of the Executive Engineer shall, upon the directions in writing of the Executive Engineer and within such reasonable time as shall be specified therein, be amended and made good by the contractor at his own cost, unless the Executive Engineer shall decide that the contractor ought to be paid for the same at the rates agreed on such reduced or other rates as the Executive Engineer may fix and incase of default, the Executive Engineer may employ and pay other persons to amend and make good such defects, shrinkage or other faults or damage, and all expenses consequent thereon and incidental thereto shall be borne by the contractor.

26.2. Provided that in the event of Government taking over portions of the works as and when they are completed the liability of the contractor under this clause shall extend to a period of sixmonths from the date of final taking over of the work irrespective of the actual dates on which portions of the works were taken over.

27. *Executive Engineer's decision* :

27.1. To prevent disputes and litigation, it shall be accepted as an inseparable part of the contract that in matters regarding materials workmanship, removal of improper work, interpretation of the contact drawings and contract specifications, mode of procedure and the carrying out of the work, the decision of the Executive Engineer shall be final and binding on the contractor and in any technical question which may arise touching the contract, the Executive Engineer's decision shall be final and conclusive.

28. *Dismissal of workmen* :

28.1. The contractor shall employ in and about the execution of the works only such persons as are careful, skilled and experience in their several trades and callings and the Exec tive Engineer sha be at liberty to object to and request the contract or to remove from the works any person employed by the contractor in or about the exceeution of the works who in the opinion of the Executive Engineee misconducts himself or incompetent or negligen in the proper performance of his duties and such persons shall not be a again employed upon the works without the permission of the Executive Engineer.

D.I. GENERAL OBLIGATIONS.

29. *Contractors' maistri or agent and contractor's staff* :

29.1. The contractor shall in his own absence keep constantly onthe works a competent maistry or agent and any directions or explanations given by the Executive Engineer or his reprsentatives to such maistri or agent shall be held to have been given to the contractor.

29.2. The contractor shall further provide all staff which is necessary for the proper supervision, execution and measurement of the work to ensure full compliance with the terms of the contracit.

30. *Government Maiatries or agents*:

30.1. The Government may be represented on the work by an agent clerk of the works, or maistri who is not borne on the Official of officers and subordinates of the P.W.D. or Highways and RuralWorks Department.He (if appointed)shall, in the absence of the

Executive Engineer, furnish the contractor with the Executive Engineer's or his representative's instructions of the works and the contractor shall duly comply with such instructions and directions and shall on the written requisition of the maistri clerk of works or agent, stay the further progress of any portion of the works which in his judgement is being constructed with unsound or improper material or workmanship, until the opinion and determination of the Executive Engineer shall be obtained thereon,but such maistri ,clerk of works or agent is to have no power whether to order any extra works or deviation from the specifications and drawings.

E. INCLUDED IN CONTRACT RATES.

31. *Defining contract schedule rates*:

31.1. The rate entered in a contract schedule for any class of work shall be for finished work in site and shall include all contingent expenses whether direct construction expenses involved in the building in place in accordance with the drawings and specifications or whether they be expenses imposed by an outside authority such as a local body. Such contingent expenses shall not entitle the contractor to claim an extra in respect thereof.

32. *Carriage* :

32·1. Rates for finished work shall always include the cost of conveyance and all leads, lifts, loading, unloading and stacking in the manner and at the place ordered by the officer in immediate charge of the work, unless circumstances necessitate provisions for a separate schedule item, in which class such will be specified in the tender notice or schedule.

32·2. Wherever the term 'carriage' or 'conveyance' is used in a schedule item, it shall in the absence of other schedule provisions or modifying description in the specification, be taken to include all leads, lifts, loading, unloading and stacking in uniform stacks to the satisfaction of the Executive Engineer with careful attention close packing in the case of materials which are to be measured stacks as a basis of payment for finished work.

NOTE—1. In the case of important leads and lifts as may occur in river conservancy and other such works, where lifts over flood banks and long leads may be involved, it is usual to make separate schedule item provision with a specification defining the exact work to be done for each tendered rate.

NOTE—2. Paymentfor carriage will ordinarily be by bulk or weight at a rate between specified places and on the basis of the method adopted in the standard schedule of rates for carriage of materials. The distances will be measured bythe nearest practicable and cheapest routes, whether metalled or unmetalled road or cart track.

32·3. When carts or vehicles of any sort are engaged by the day, the quantity of materials to be conveyed, the distance to be travelled and the number of trips to be made shall, if he considers necessary be fixed by the Executive Engineer.

32·4. The contractor is responsible for making good all loss in transporting materials entrusted to him or his agents, whether caused by wastage, breakage, theft or any other cause.

32·5. No payment shall, in any case, be made for the return trips with carts empty. Where there are loads also for the retrun trip, the agreement rates should allow for the reduced cost thereby on each set of materials so conveyed.

33. *Construction plant*:

33·1. The contractor shall include in his tendered price and shall provide and install all necessary construction plant and shall use such methods and appliances for the performances the operations connected with the work embraced under the contract as will secure a satisfactory quality of work and rate of progress which, in the opinion of the Executive Engineer will ensure the completion of the work within the time specified. If at any time before the commencement, or during the progress of the work, or any part of it such methods or appliances appear to the Executive Engineer to be insufficient or inappropriate for securing the quality of the work required or the said rates of progress, he may order the constrators to increase their efficiency or to improve their character, and the contractor shall comply with such orders, but the failure of the Executive Engineer to demand such increase of efficiency of improvement shall not relieve the contractor from his obligation to secure the quality of work and the rate of progress required by the contract and the contractor alone shall be responsible for the efficiency and safety of his plant, appliances and methods.

33.2. It is however, open to the Executive Engineer to lend or supply to the contractor any tools, implements, materialsand machinery that the Executive Engineer may consider desirable but for any such tools, implements materials and machinery that may be lent or supplied to contractor by Government, the contractor shall pay such deposit and hire, or purchase price as may be determined by the Executive Engineer. . All atricles that may be so lent or hired to the contractor shall be returned in good serviceable condition by him to the Executive Engineer before the final bill for work is paid and any shortage or damage shall be recovered from the contractor in the final bill at such rate as may be determined by the Executive Engineer after making such allowance as he may consider suitable for fair wear and tear.

34. *Scaffolding instructions*:

34·1. All requisite scaffolding shall be provided at the contractor's expense and shall be double, i.e. it must have two sets of upright supports. Care must be taken to ensure the safety of the work people and the contractor must comply with such instructions as the Executive Engineer may issue to ensure such safety. The contractor will be entirely responsible for any damage or injuries to persons or property resulting from ill erected scaffolding, defective ladders, or otherwise arising out of his default in this respect. The contractor's attention is also invited to the 'safety code'.

35. *Temporary structure*:

35·1. The contractor shall erect and maintain at his own cost temporary weather proof sheds at such places and in a manner approved by the Executive Engineer for keeping materials under cover, The contractor shall also provide and maintain at his own expenses such temporary fences, guards, bridges and road as may be necessary for the execution of his contract work or for safeguarding or accommodating the public if the Executive Engineer shall order any departure, he shall comply with such orders as the Executive Engineer mry issue to safeguard or accommodate the public, sheds for housing workmen shall be provided at the contractor's expenses if, in the opinion of the Executive Engineer, such are ecessary or desirable.

36. ***Water and lighting*** :

36·1. The contractor shall pay all fees and provide water and ligtht as required from municipal mains or other sources and shal l pay all charges therefor (including storage tanks, meters, etc.) for the use of the work and workmen unless otherwise arranged and decided on, in writing with the Executive Engineer. The water for the works all be, so far as practicable, free from earthy vegetable, or organic matter and from salts or other substances likelytointerfere with the setting of mortar otherwise prove harmful to the work.

37. *Sun protection, keeping dry and pumping* :

37·1. The contractor shall at his own expense arrange all requisite protection of the work and materials against sun or rain effects and shall keep all portions of the work free fromwater to the satisfaction of the Executive Engineer and shalluse his own plant for the purpose unless otherwise specificaly provided in the contract specification.

38. *Tools and Seigniorage* :

38·1. The contractor shall, unless otherwise specifically stated in the tender . otice and subsequently on this basis in the contract be responsible for the payment wherever payable of all import duties, tools, octroi duties seigniorages, quarry fees, etc., on all materials and articles that he may use.

38.2. The contractor shall be solely responsible for the payment of sales tax under the proviston of the MadrasGeneral SalesTaxAct, 1939 (Madras Act IX of 1939) as in force for the time being and the rates for the various items of the work shallremain unaffected by any change that may be made from time to time in the rate at which such tax is payble.

38·3. Notwithstanding anything contained in section 10 of the Indian Traffic Act of 1894, the rates for items involving, the use or supply of articles obtained by the contractor from outside India shall remain unaffected by any changes that may be introduced in Customs duties.

NOTE.—For works carried out on behalf of the Government of India, Seigniorage fees, etc., referred to in this clause will have to be levied in every case.

38.4 No seigniorage shall be charged where due for materials quarried, from the P.W.D. or other Government Quarters.Assistance as necessary will be given to the contractor by the department to obtain access to quarries approved by the Executive Engineer. No plot rent shall be charged for materials stacked on the Government land during the course of construction provided all such materials are removed within one month after the work is completed.

38.5. Seigniorage charges due for use of private quarries and private land shall be paid by the contractor.

38.6. The contractor shall form his own approach road to the work site for which no extra will be due to him. On completion the contractor shall not be permitted to remove the materials laid for formation of road. If the contractor is allowed to use the existing roads he shall maintain them in good condition at his own cost through out the period of the contract.

39. *Setting Out Works* :

39.1. The contractor shall be responsible for the true and proper setting out of the worksand for the correctness of the position levels, dimension and alignment of all parts of the works and for the provision of all materials, staff and labour in connectiont herewith.

40. *Cleaning up during progress and for delivery*:

40.1. All rubbish shall be burnt or removed from the site, as it accumulates. All floors, stairs, landingwindows, surface and soil drains shall becleaned down and put in a thoroughly complete clean,sound and workman like state to the satisfaction of the Executive Engineer, before the work is finally handed over all rubbish and surplus materials not required by the Executive Engineer having first been removed by the contractor. The contractor shall give notice in writing to the Executive Engineer when the work is so ready to be handed over,and shall be responsible for its maintenance unti it is taken over by the Executive Engineer.

F. RESPONSIBILITIES AND LIABILITIES OF THE CONTRACTORS.

41. *Observance of laws, local regulations and notices Attachments.*

41.1.The contractorshall conform to the regulations and by-laws of any local authority and or of any water or lighting companies with those systems the structure is proposed to be connected and shall, before making any variations from the drawings or specificationthat may be necessitated by so conforming, given to the Executive Engineer written notice, specifying the variations proposed to be made and the reasons for making them, and apply for instructions thereon. In case the contractor shall not receive such instructions within seven days, he shall proceed with the work conforming to the proivisions regulating or by-law in question and any variation in the drawings or specifications so necessitated shall be dealt with under clause 59. The contractor shall give all notices required by the said Act, regulation or by-laws and pay all fees in connection therewith unless otherwise arranged and decided on in writing with the Executive Engineer. He shall also ensure that no attachments are made against matetials of work forming part of or for the use of the contract. In every case referred to in this clause the contractor shall protect and indemnify Government against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order, decree, or attachment whether by himself or by his employees

42. *Accidents—Hoarding—Lighting observations—Watchmen.*

42.1. When excavations have been made or obstacles have been put in public thorough fares or in palces where there is any likelihood of accidents, the contractor shall comply with any requirement of law or the subject, and shall provide suitable hoarding lighting and watchmen as necessary.

42.2. It shall be the contractor's sole responsibility to protect the public and his employees against accident from any cause and he shall indemnify Government against any claims for damages for injury to person or property, resulting from any such aclaim and shallwherethe provisions of theWorkmen's Compensation Act apply, take steps to properly insure against any claims there-under.

42.3. On the occurrence of accident which results in the death of any of the workmen employed by the contractor or which is so seriousness as to be likely to result in the death of any such workmen, the contractor shall, within 24 hours of the happening of such accident, intimate in writing to the concerned section officer of the Department the fact of such accident. The contractor shall indemnify Government against all loss or damage sustained by Government resulting directly or indirectly from his failure to give intimation in the manner aforesaid including the penalties of fines if any payable by Government as a consequence of Government's failure to give notice under the Workmen's Compensation Act or otherwise conform to the provisions of the said Act in regard to such accident.

42.4. In the event of an accident in respect of which compensation may become payable under the Workmen's Compnesation Act VIII of 1923 whether by the contractor or by the Government as principal it shall be lawful for the Executive Engineer to retain out of money due to and payable to the Contractor such sum or sums of money as may, in the opinion of the said Executive Engineer be sufficient to meet such liability. The opinion of the Executive Engineer shall be final in regard to all matters arising under this clause.

42.5. The contractor shall indemnify Government from and against all claims and proceedings for or on account of infringement of any patent rights, design, trade mark, or name of other protected rights in respect of any constructional plant, machine work or material used for or in connection with the works or temporary works, or any of them and from and against all claims, demands, proceedings, damages, costs, charges and expenses whatsoever in respect thereof in relation thereto.

42.6. In respect of all labour directly or indirectly employed in the works for the performance of the contractor's part of this agreement, the contractor shall comply with or cause to complied with all the rules framed by the Government from time to time for the provision of health and sanitary arrangements to workers employed by P.W.D. and Highways and Rural Works Department and their contractors (*Vide* Appendix). In case the contractor fails to make arrangements and provide necessary facilities as aforesaid the Executive Engineer shall be at liberty to make arrangements and provide facilities as aforesaid and recover the costs incurred in that behalf from the contractor.

42.7. In respect of all labour directly or indirectly employed in the works for the performance of the contractor's part of this agreement ,the contractor at his own expense shall arrange for the safety provisions as per 'Safety Code' framed from time to time and shall at his own expense provide for all facilities in connection therewith. In case the contractor fails to make arrangements and provide facilities as aforesaid and recover the costs included in that behalf from the contractor.

42.8. In respect of all labour directly or indirectly employed in the work for the performance of the contractor's part of this agreement the contractor shall arrange to furnish in triplicate particulars for each work in the proforma *vide* Appendix XXXVIII by the end of every month to the Executive Engineer in charge of the work.

43. *Blasting*:

43.1. Blasting executed by contractors in connection with Government works shall be carried out in the manner described under 'Blasting operations—Instructions to Contractor' of the TNBP.

44. The contractor is to protect the whole of the adjoining and where necessary, the existing premises and all works and all fittings to all buildings on and adjoining the site against the structural and decorative damages caused by the execution of these works and make good in all respects all such damage done or occuring to the same, and leave such reinstatement in prefect order. He is also to make good any damage done to private footways or roadways.

45. *Permit other workmen—Co-operation—Afford facilities*:

45.1. The Executive Engineer shall have full power to send workmen upon the premises to execute fittings and other works not included in the contract, for whose operations the contractor is to afford every reasonable facility during ordinary working hours, provided that such operations shall be carried on in such a manner as not to impede the progress of the work included in the contract, but the contrctor is not to be responsible for any damage which may happen to or be occasioned by any such fittings or other works, provided he complies with, the Executive Engineer's instructions in connection therewith, and provided that the damage is not caused by himself or his workmen.

45.2. The contractor shall, at all times, co-operate, assist, attend on, and afford facilities for such specialists as may be employed by the Executive Engineer on other works in connection with the building, allowing them free of charge the use of all plant, light and water installed in the works. The contractor shall cause such special work or protect it as instructed to avoid injury during progress of the works. For failure so to protect, the contractor must make good any damage caused.

45.3. When two or more contractors are engaged on installation or construction work in the same vicinity, the Executive Engineer shall have authority to direct the manner in which each shall conduct the work so far as it affects other contractors.

46. *Holes for water services, gas, electrical and sanitary fittings*

46.1. The contractor shall leave all holes in masonry and floors for the insertion of water services, gas and electrical connections and sanitary fittings in the exact positions indicated by the Executive Engineer during the progress of the work. These holes must be properly built up in a workmen like manner at the contractor's cost, as soon as the fittings have been installed in cases, where the installations are made during the construction of the building and where in the opinion of the Executive Engineer, delays in settlement of accounts will not thereby occur.

47. *Contractor's risk and insurance:*

47.1. The work executed by the contractor under the contract shall be maintained at the contractor's risk until the work is taken over by the Executive Engineer. The contractor shall accordingly arrange his own insurance, against fire and other usual risk during such period unless otherwise specified.

47.2. Provided however, that the contractor, shall not be liable for all or any loss or damages occasioned by or arising out of acts of God, and in particular unprecedented flood, volcanic eruption, earth quake or other convulsion of nature, invasion, the act of foreign enemies, hostilities or warlike operations (before or after declaration of war) rebellion, military or usurped power.

48. *Holidays*:

48.1. Subject to any provision to the contrary contained in the contract none of the permanent work shall save as hereinafter provided be carried on during the night or on Sundays and other holidays without the permission in writing of the Executive Engineer or of the officer in charge of the work: save when the work is unavoidable or absolutely necessary for the save of life or property or for the safety of the works in which case the contractor shall immediately advise the Executive Engineer.

G. MISCELLANEOUS.

49. *Sand and gravel*:

49.1. The contractor shall not make any excavations upon the site for the purpose of obtaining gravel, sand or soil other than that shown or implied by the drawings, except with the previous permission of the Executive Engineer.

50. *Old curiosities* :

50.1. All old curiosities, relics, coins, minerals, etc., found in excavating or pulling down, shall be the property of the Government and be handed over to the Executive Engineer. Should any ancient masonry, or other old work of interest be opened up, the Executive Engineer's attention shall be called to the same before demolition or removal.

51. *Assignment or sub-lettings* :

51.1. The contractor shall not without the written consent of the Executive Engineer, assign the contract nor sub-let any portion of the same. Ordinarily no sub-letting will be permitted, but in case such should be permitted by the Executive Engineer, it shall in no way free the contractor from any of his responsibilities under any clause of these " Conditions of Contract " or of the " Articles of agreement ".

52. *Specialists* :

52.1. The Executive Engineer shall, during the progress of the work have powers to select, nominate or recommend tradesmen or specialists to supply material or execute such portion of the work as he may consider desirable in the interests of the Government.

53. *Ratification of the orders of the Executive Engineer* :

53.1. Should the acceptance of the tender be beyond the authorised powers of the Executive Engineer as laid down in the P.W.D. code, the orders and decisions of such Executive Engineer with regard to extension of time for completing the contract or the termination of the contract or of the employment of specialists for certain portion of the work as described in the previous clause will be subject to the ratification of the higher authroity who accept the tender.

54. *Order book*:

54.1. An order book shall be kept at the P.W.D. office on the site of the work. As far as possible, all orders regarding the work are to be entered in this book. All entries shall be signed and dated by the P.W.D. officer in direct charge of the work and by the contractor or by his representative. In important cases, the Executive Engineer or the Superintending Engineer will countersign the entries, which have been made. The order book shall not be removed from the work except with the written permission of the Executive Engineer.

54.2. No photographs of the site or of the work of any part thereof shall be taken except with the permission in writing of the Executive Engineer and no such photographs shall be published or otherwise circulated without the permission of the Chief Engineer.

H. DATE OF COMMENCEMENT, COMPLETION, DELAYS, EXTENSION, SUSPENSION OF WORK AND FORFEITURE.

55. *Date of commencement and completion* :

55.1. On notification of possession of the site (or premises) being given to the contractor by letter registered for acknowledgement as provided in Clause 9.1. supra, he shall forthwith begin the work, shall regularly and continuously proceed with them, and shall complete the same (except for painting or other work which, in the opinion of the Executive Engineer, it may be desirable to delay) by the date of completion, as defined in the "Articles of Agreement" subject nevertheless, to the provisions of extension of time mentioned in the next clause. The contractor shall under no circumstances be entitled to claim any damages from Government if he incurs any expenses or liabilities to payment under the contract before the date of commencement defined above. The contractor shall have the right to withdraw from the contract and obtain refund of his security deposit if such intimation of handing over the site is delayed more than two months from the date of acceptance of the agreement by competent authority.

56. *Delays and extension of time* :

56.1. No claim for compensation on account of delays or hindrances to the work from any cause whatever shall tie except as hereinafter defined.

Reasonable extension of time will be allowed by the Executive Engineer or by the officer competent to sanction the extension for unavoidable delays, such as may result from causes which in the opinion of the Executive Engineer are undoubtedy beyond the control of the contractor. The Executive Engineer shall asses the perod of delay or hindrance caused by any written instruction issued by him at twenty-five percent in excess of the actual woking period so lost. If at anytime the Executive Engineer is of the opinion that there has been avoidable delays and the contractor fails to maintain the rate of progress specified in the articles of agreement, it shall be lawful for the Executive Engineer to impose penalty or order forfeiture from the Deposit sanction the extension of time for such delays, provided however, the penalty and forfeiture shall be governed as per Clause 57.2. and 57.3.

56.2. In the event of the Executive Engineer failing to issue necessary instructions and thereby causing delay and hindrance to the contractor the latter shall have the right to claim an assessment of such delay by the Superintending Engineer of the Circle The Contractor shall lodge in writing to the Executive Engineer a statement of claim for any delay or hindrance referred to above within fourteen days from its commencement, otherwise no extension of time will be allowed.

56.3. Whenever, authorised alterations or additions made during the progress of the work are of such nature in the opinion of the Executive Engineer as to justify an extension of time in consequenc thereof, such extension of time will be granted in writing by the Executive Engineer or other competent authority when ordering such alterations or additions.

57. Delays in commencement, or progress or neglect of work or suspension of works by the contractor and forfeiture of Earnest Money, Security Deposit and withheld amounts.

57.1. Time shall be considered as the essence of the contract. If at any time, the Executive Engineer, shall be of the opinion that the contractor is delaying commencement of the work, neglecting or delaying the progress of work as defined in the tabular statement, Rate of Progress in the Articles of Agreement or the contractor fails to maintain the Rate of Progress in the Articles of Agreement plus any extension of time, or the contractor shall suspend the works, or sublet the work or a portion thereof without the sanction of the Executive Engineer or violates any of the provisions of the contract the Executive Engineer shall so advise the contractor and at the same time demand compliance. If the contractor neglects to comply, with such demand within seven days after receipt of such notice, it shall then or at any time be lawful for the Executive Engineer to impose a penalty or forfeiture on this contractor from the deposit or to determine the contract.

57.2. The penalty or forefeiture referred to in Clause 57-1 shall not exceed 5% of the value of the work executed and is imposed in cases where the contractor is allowed to proceed with the whole or part and complete the whole or such part of the works. The penalty or forfeiture imposed by the Executive Engineer under this clause is however subject to modification or waiver at the absolute discretion of any authority higher in rank than the Executive Engineer.

57.3. It shall be a further right of the Executive Engineer to give any part of the work to any other contractor at his discretion or have it done departmentally in order to maintain the rate of progress and the contract shall then be determined for only that portion of the work given to the other contractor or done departmentally. The forfeiture under clause 57.2. will in these circumstances be applied and any excess expenditure incurred on this account shall be recovered from the original contractor.

57.4. Determination of the contract referred to in Clause 47.1 shall carry it the forfeiture of the Security Deposit. After determining the contract, the Executive Engineer shall have the right to give any part of the work to any other contractor in the unexecuted portion of the contract, in which case any expenses which may be incurred in excess of such amount which would have been aid to the original contractor if the whole work had been executed deducted from any money due to him by Government under this contract or any other account what so ever. Provided, also that if the expenses incurred by the Government are less than the amount payable to the contractor at his agreement rates , the difference will not be paid to the contractor.

57·5. In the event of anyone of the above clauses being adopted by the Executive Engineer, the contractor shall have no compensation for any loss sustained by him by reason of his having purchased or processed any materials or entered into any engagements or made any advances on account or with a view to the execution of the work or the performance of contract, and in case action is taken under any of the provisions aforesaid, the contractor shall not be entitled to be paid any sum for any work actually performed under the contract unless and until the Executive Engineer has certified in writing the performance of such work and the value payable in respect thereof and he shall only be entitled to be paid the value so certified.

57.6. In the event of the Executive Engineer putting in force all or any of the powers vested in him under the clause 57.4 he may if he so desires after giving a notice in writing to the contractor take possession of the works, and site and all such plants and materials thereon (or any ground contiguous thereof) and all such plant and materials as above mentioned shall thereupon be at the disposal of Government absolutely for the purpose of completing the work. After such notices shall have been given, the contractor shall not be at liberty to remove from the site of works or from the ground contiguous thereto any plant or materials belonging to him which shall have been placed thereon for the purpose of the above work. Government shall not be able to make any payment to the contractor on account of use of such plant for the completion of the works, under the provisions hereinbefore contained. On taking possession of the materials and stores belonging to the contractor or procured by the contractor and intended to be used for the execution of the work or any part thereof, the contractor shall be paid for the same in account, at the contract rates, to be certified thereof shall be final, otherwise, the Government may give notice in writing to the contractor to remove any of his plant or materials from the site and not required for any completion of the works, if such plant and or materials are not removed within fourteen days after notice, shall have been so given, Government may remove and sell the same, holding the proceeds less the cost of removal and sale, to the credit of the contractor. The certificate of the Executive Engineer as the expense of any such removal and sale, shall be final and binding on the contractor.

I. PARTICULARS OF PAYMENT.

58. Payment of lump sum basis or by final measurement at unit prices :

58.1. Final measurements need not be taken unless either the contractor or the Executive Engineer claims extras to or deductions from, the quantities of Schedule A.

58.2. In case final measurements are claimed,they shall be taken only for those items for which either the contractor or the Executive Engineer claims final mearurements and the quantities of the remaining items in Schedule A shall be accepted as correct. The lump sum amount mentioned in the agreement will then be varied by adding thereto or deducting therefrom as the case may be, the difference (if any) between the amounts mentioned in Scheule A for such items and the amounts arrived at by calculation at contract rates based on the revised quantities for the same, obtained by the final measurements aforesaid.

58.3. It shall be accepted as a condition of the contract that the payment of the final bill to the contractor less the withheld amounts and his acceptance thereof shall consititute a full and absolute release of Government from all further claims by the contractor under the contract.

59. *Payment for additions and deductions for omissions*:

59.1. No authorised variation shall vitiate the contract, but additions and omissions shall be measured up and dealt with in accordance with clause 58.2.

59.2. If there is no rate in Schedule A for additional work ordered to be carried out by the Executive Engineer, when prior to execution of the additional work, a rate for the additional work shall be worked out in accordance with the methods indicated in 59·3 and with the rate agreed upon a supplemental agreement shall be entered in the proper departmental form signed and dated by the contractor and the Executive Engineer and or any other officer for the time being authorised to accept such agreement and supplemental agreement shall on such acceptance form part of the orginal agreement. A copy of the supplemental slip shall be given to the contractor.

59.3.1. The rate for additional works shall be derived from the rate for similar items of work in the accepted agreement.

59.3.2. In the case of works for which supplemental agreement is to be entered into during the period when the schedule of rates has not changed from the date of execution of the original agreement, then the rates for supplemental agreements may be the prevailing schedule of rates plus or minus tender premium in case the rates cannot be derived from the items in the original agreement. In other case, where the schedule of rates has changed in the intervening period, the rates prevailing as per the schedule of rates at the time of execution of supplemental items will be adopted with no tender premium over this rate.

59.3.3. If the rate for a particular item of work is not in the schedule of rates, the prevailing market rate when the work was done shall be adopted.

59.3.4. If the rates cannot be determined as above, the rates shall be fixed on the cost of labour and materials plus 10 per cent thereon, provided the vouchers shall have been delivered to the Executive Engineer within 7 days after such work is completed. If the Executive Engineer considers that the vouchers are unduly high, the Executive Engineer can valuate the work as reasonable and fair and make payment if the value of payment is less than Rs. 1,000. If the value of additional payment exceeds Rs. 1,000 the contractor shall have the right to submit the matter to arbitration.

60. *No payment for unsanctioned extras*:

60.1. It shall be disctinctly understood that no payment whatever will be made to the contractor for variations by way of extras, in cases where such variations have been made within the written sanction of the Executive Engineer.

61. *Accounts Receipts and Vouchers*:

The contractor shall at any time upon the request of the Executive Engineer furnish him with all invoices ; accounts, receipts and other vouchers that he may require in connection with the contract.

62. *Fraud, wilful neglect or default*:

62.1. No final or other certificate of payment of or completion, acceptance or settlement of account shall, in any circumstances, relieve the contractor from his liability for any fraud, or wilful neglect or default in the execution of the contract or any wilful or unauthorised deviations from drawings, specifications, instructions and directions for the time being binding upon him.

63. *Unfixed materials*:

63.1. No payment or advance will be made for unfixed materals when the rates are for finished work in situ.

64. *Payments and certificates*:

64.1. Payments will be made to the contractor under the certificates to be issued at reasonably frequent the intervals by the Executive Engineer or the Sub-Divisional Officer, within 14 days of the date of each certificate an intermediate payment will be made by the Executive Engineer or the Sub-Divisional Officer of a sum equal to 95 per cent of the value of work, as so certified and the balance of 5 per cent will be withheld and retained as security for the due fulfilment of the contract.

Under the certificate to be issued by the Executive Engineer or Sub-Divisional Officer on the completion of the entire works, the contractor will receive the final payment of all the moneys due or payable to him under or by virtue of the contract except security deposit and the withheld amount equal to 2½ per cent of the total value of the work done provided there is no recovery from or forfeiture by the contractor to be made under clasue 57. The amount withheld from the final bill will be retained under. 'Deposits' and paid to the contractor together with the Security Deposit after six months reckoned from the date of completion of work or as soon after the expiration of such period of six months as all defects shall have been made good according to the true intent and meaning hereof whichever shall last happen. In the event the final bill remains unpaid even after the period of six months afore-said, the Executive Engineer shall refund the security deposit which includes the E.M.D. and also the withheld amount on a separate bill if requested for by the contractor in writing. No certificate of Executive Engineer or Sub-Divisional Officer shall be considered conclusive evidence as to the sufficiency of any work or materials or correctness of measurements to which it relates, nor shall it relieve the contractor from his liability to make good defects as provided by the contract. The contractor when applying for a certificate, shall prepare a sufficiently detailed bill baesd on the origional figures of quantities and rates in the contract scheuled Ato the satification of the Executive Engineer, to enable the Executive Engineer or the Sub-Divisional Officer to check the claims and issue the certificate. The certificate as to such of the claims mentioned in the application as are allowed by the Executive Engineer or the Sub-Divisional Officer shall be issued within fourteen days of the application. No appilication for a certificate shall be made within fourteen days of a previous application.

64.2. When there are complaint from the Labour Department about non-payment of wages to the Labourers employed by the Contractors for the execution of works under agreement, the Executive Engineer, shall have full powers to withhold the bills claimed by the contractor pending clearance certificate from the Labour Department and to act as per the direction given by the Labour Department.

65. *Interest on money due to the contractors*:

65.1. No omission by the Executive Engineer or the Sub-divisional Officer to pay the amount due upon certificates shall vitiate or make void the contract nor shall the contractor be entitled to interest upon any guarantee fund or payments in arrear, nor upon any balance which may, on the final settlement of his accounts, be fond to be due to him.

65.2. Whenever the withheld amount reaches Rs. 1,000 or a multiple thereof, the contractor may, at his option, deposit with the Executive Engineer an equal amount in sums of Rs. 1,000 or a multiple thereof, in any of the forms of interest bearing securities recognized for the purpose by the Madras Public Works Account Code and subject to the provisions thereof contained in which case the equivalent withheld amount shall be paid to him forthwith. The Contractor will be permitted to exercise the option in this clause, subject only to the condition that the rates of progress contained in the Articles of Agreement is properly maintained.

66. *Acceptance of final measurements* :

66.1. The contractor agrees that before payment of the final bill shall be made on the contract, he will sign and deliver to the *Executive Engineer either in the measurement book or otherwise as demanded a valid release and discharge from any and all claims and demands whatsoever for all matters arising out of or connected with the contract and also produce a certificate from the Incomes tax Authorities that all income tax payable by him upto-date has been duly paid ; provided that nothing in this clause shall discharge or release the contractor from his liabilities under the contract. It is further expressly agreed that Executive Engineer in supplying the final measurement certificate need not be bound by the preceeding measurements and payments. The final measurements, if any of the Executive Engineer shall be final conclusive and binding on the contractor.

67. *Recovery of money from contractor in certain cases.*

67.1. In every case in which provision is made for recovery of money from the contractor, Government shall be entitled to retain or deduct the amount thereof from any money, that may be due or may become due to the contractor under these presents and or under any other contract or contracts or any other account what so ever.

68. *Contractor dying becoming insolvent, insane or imprisoned.*

68.1. In the event of the death of insanity or insolvency or imprisonment of the contractor, or where the contractor being a partnership or firm becomes dissolved or being a corporation goes into liquidation, voluntary or otherwise, the contract may at the option of the Executive Engineer, be terminated by notice in writing posted at the site of the works and advertised in one issue of the local distric Gazette and all accepted and acceptable works shall forthwith be measured up and paid for at the rates provided in the contract schedule where such apply, or otherwise, by the most recent schedule of rate of the division approved by competent authority to the person or persons entitled to receive and give a discharge for the payment.

J. SETTLEMENT OF DISPUTES.

69. *Arbitrations* :

69.1. In case of any dispute or difference between the parties to the contract either during the progress or after-the completion of the works or after the determination. abandonment or breach of the contract, or as to any matter or thing arising thereunder except as to the matters left to the sole discretion of the Executive Engineer under clauses 18, 20,25-3,27, 34, 35 and 37 of 'General conditions of contract' or as to the with holding by the Executive Engineer of payment of any bill to which the contractor may claim to be entitled, the either party shall forthwith give to the other notice of such disput

* as demanded a valid release and discharge from any and all claime.

of difference, and such dispute or difference shall be and is hereby referred to the arbitration of the Superintending Engineer of the nominated circle mentioned in the 'Articles of Agreement' (hereinafter called the 'Arbitrator').

Subject as aforesaid to the provisions of the arbitration Act, 1940, or any statutory modification or re-enactment thereof and the rules made thereunder and for the time being in force shall apply to the Arbitration Proceeding under this clause.

Upon every and any such reference, the costs of and incidental to the reference and award respectively shall be discretion of the arbitrator subject to the condition that the amount of such costs to be awarded to either party shall not, in respect of a monetary claim exceed the percentage set out below of any such award irrespective of the actual fees, costs and expense incurred by either party provided that where a monetary claim is disallowed in full the said percentage shall be calculated on the amount of the claim. The arbitrator may determine the amount of the costs be awarded or direct the same to be taxed as between solicitor and client or as party and partly and shall direct by whom and to whom and in what manner the same shall be borne and paid.

The percentage above referred to in this clause are 5 per cent on any such monetary award which does not exceed Rs.10,000, 3 per cent on the next Rs. 40,000 or any part thereof, 2 per cent on the next Rs. 50,000 or any part thereof and 1 per cent on any excess over Rs. 1,00,000.

Provided that the Government shall not be liable to any claim in respect of any such dispute or difference until the liability and the amount thereof shall have been referred to and decided by the Arbitrator and decreed by the court.

APPENDIX No. I.

Public Works Department Safety Code.

General Rules as to Scaffolds.

1. Suitable scaffolds shall be provided for workmen for all works that cannot be safely done from a ladder or by other means. When a ladder is used an extra mazdoor shall be engaged for holding the ladder and the ladder shall be given an inclination not steeper than 0·25 to I (0·25 horizontal to I vertical). When the ladder is used for carrying materials as well, suitable foot holds and hand holds shall be provided on the ladder.

2. A scaffold shall not be constructed, taken down or substantially altered, except (*a*) under the supervision of a competent and responsible person; and (*b*) as far as possible by competent workers possessing adequate experience in such work.

. All scaffolds and appliances connected therewith and all ladders shall—

(*a*) be of sound material ;

(*b*) be of adequate strength having regard to the load strain to which they will be subjected ; and

(*c*) be maintained in proper condition.

4. Scaffolding or staging more than 3·5 metres above the ground or floor shall have a guard rail properly attached, bol-braced and otherwise secured at least O. metres above the floor or platform of such scffolding or staging and extending along the entire length of the outside and ends thereof with only such opening as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure.

5 Scaffolds shall be so constructed that no part thereof can be displaced in consequence of normal use.

6. Scaffolds shall not be overloaded and so for as practicable the load shall be evenly distributed.

7 Before installing lifting gear or scaffolds special precautions shall be taken to ensure the strength and stability of the scaffolds.

8. Working platform, gangways and stairways should be so constructed that no part there can save unduly or unequally. If the height of the platform or the gangway or the stairway is more than 3·5 metres above ground level or floor level they should be closely boarded, should have adequate width and should be suitably fenced as described in (4) above.

9. Every opening in the floor of a building or in a working platform shall be provided with suitable fencing or railing for a minimum height of 0·9 metre to prevent the fall of persons or material.

10. Safe means of access shall be provided to all working platforms and other working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9 metres in length while the width between side rails in rung ladder shall in no case be less than 30 cm. for ladder upto and including 3 metres in length. For longer ladders this width should be increased atleast 20 mm. for each additional metre of length. Uniform step spacing should not exceed 30 cm. Adequate precautions should be taken to prevent danger from electrical equipment. No materials on the site of work shall be so stacked or placed as to cause danger or inconvenience to any person or the public. The Contractor shall provide all necessary fencing and lights to protect the Public from accidents and shall be bound to bear the expenses of defence of every suit, action or other proceedings at law that may be brought by any persons for injury sustained owing to neglect of the above precautions and to pay any damages and cost which may be awarded in any such suit, action or proceedings to any such persons or which may with the consent of the contractor be paid to compromise any claim by any such person.

Excavation and trenching :

11. Trenches.—1·2. metres or more in depth, shall at all times be supplied with atleast one ladder for each 30 metres in length or fraction thereof. Ladder shall be extended from bottom of the trench to at least 0·8 metre above the surface of the ground. The sides of the trenches which are 1·5 metres or more in depth shall be stepped back to give suitable slope or hold securely by timber bracing, so as to avoid the danger of sides to collapse.

12. *Demolition*.—Before any demolition is commenced and also during the process of the work.—

(*a*) All roads and open areas adjacent to the work site shall either be closed or suitably protected ;

(b) No electric cable or apparatus which is liable to be a source of danger over a cable or apparatus used by the operator shall remain electrically charged.

(*c*) All practical steps shall be taken to prevent danger to persons employed from risk or fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render it unsafe.

13. All necessary personal safety equipment as considered adequate by the Executive Engineer shall be kept available for the use of the person employed on the site and maintained in a condition suitable for immediate use, and the contractor should take adequate steps to ensure proper use of equipment by those concerned.

(*a*) Works employed on mixing asphaltic materials,cement and lime mortars shall be provided with protective footwear and protective gogles.

(*b*) Those engaged in white-washing and mining or stacking of cement bags or any material which is injurious to the eyes shall be provided with protective gogles.

(*c*) Those engaged in welding works shall have protective gogles and protective clothing and seated at sufficiently safe intervals.

(d) Those engaged in welding works shall be provided with welder's protective sight ligs.

(*e*) When workers are employed in sewers and man holes, which are in use, the contractor shall ensure that the manholes covers are opened and are ventilated atleast for an hour before the workers are allowed to get into the manholes, and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident to the public.

(*f*) The contractor shall not employ men below the age of 18 years and women on the work of painting with products containing lead in any form. Wherever men above the age of 18 are employed on the work of lead painting, the following precautions shall be taken

(i) No paint containing lead and lead products shall be used except in the form of paste or ready-made paint.

(ii) Suitable face masks should be supplied for use by the workers when paint is applied in the form of spray or a surface having lead paint dry rubbed and scrapped.

(iii) Overalls shall be supplied by the contractors to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.

(iv) When workers are employed in dangerous occupations like work with hot bitumen, drilling operations, etc., which are likely to prove dangerous resulting in physical damage and casuality, adequate protection of the workers should be provided.

14. When the work is done near any place where there is risk of drawing all necessary equipments should be provided and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provision should be made for prompt first aid treatments of all injuries likely to be sustained during the course of the works.

15. (*a*) Hoisting machines and tackle including their attachments anchorages and supports shall be good mechanical construction, sound materials and adequates strength and free from patent defect and shall be kept in good repair and in good working order. Every rope used in hoisting or lowering materials or as a means of suspension shall be of suitable quality and adequate strength and free from patent defect.

(*b*) Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years should be in control of any hoisting machine, including the scaffold winch or give signals to the operator.

(*c*) In the case of every hoisting machine and of every chain' ring, hook shackle level and pulley block used in hoisting or lowering or as a means of suspension, the safe working load shall be ascertained by adequate means. Every hoisting machine and all ear referred to above shall be plainly marked with the safe working load,in the case of a hoisting machine havinga variable safe working load, each safe working load and the conditions under which it is applicable shall be clearly indicated. No part of any hoisting machine or of any gear referred to above in this paragraph shall be loaded beyond the safe working load except for the purpose of testing.

16. Motors, gearing, transmissions, electric wiring and other dangerous parts of hoisting appliance shall be provided with efficient safeguards. Hoisting appliances shall be provided with such means as will request to a minimum the risk of the accidental descent of the load. Adequate precautions shall be taken to reduce to a minimum the risk of any part of a suspended load becoming accidentally displaced.

When workers are employed on electrical installations which are already energised, insulating mats, wearing apparel such as gloves, sleevs and boots as may be necessary should be provided. The workers and carry keys or other materials which are good conductors of electricity.

17. These safety provisions should be brought to the notice of all concerned by display on a notice board at a prominent place at workshop. The person responsible for the compliance of the safety code shall be named by the contractor.

18. To ensure effective enforcement of the rules and regulations relating to safety precautions, the arrangements made by the contractor shall be open to inspection by the Labour Officer, Executive Engineer of the Department or other representative.

19. Notwithstanding the above clauses (1) to (18) there is nothing in these to exempt the contractor from the operations of any other Act of rules in force in the Republic of India.

Model Rules for the provision of Health and Sanitary arrangements for workers employed by the P.W.D. and Highways and Rural Works Department and their contractors.

The contractor's special attention is invited to relevant clauses of the "General conditions of contract" in the Tamil Nadu Building Pratice and he is requested to provide at his own expense the following amenities to the satisfaction of the Executive Engineer.

1. *Application.*—These rules shall apply to all building and construction works in charge of P.W.D.

2. *Definitions.* —() "Work place" means a place at which an average fifty or more workers are employed in connection with construction work.

(ii) "Large work place" means a place at which, at an average 500 or more workers are employed in connection with construction work.

3. *First-aid.*—(*a*) At the work site there shall be maintained in a readily accessible place, first aid appliances and medicines including an adequate supply of sterilised dressing and sterilised cotton wool. The appliances shall be kept in good order. They shall be placed under the charge of a responsible person who shall be readily available during working hours.

(*b*) At large work places, where hospital facilities are not available within easy distance of the works, first-aid posts shall be eatablished and be run by a trained compounder.

(*c*) Where large work places are remote from regular hospitals an in-door ward shall be provided with one bed for every 250 employees.

(*d*) Where large work places are situated in cities, towns or in their suburbs and no beds are considered necessary owing to the proximity of city or town hosipitals, suitable transport shall be provided to facilitate removal of urgent cases to these hospitals At other work places, some conveyance facilities, such as a car shall be kept readily available to take injured persons or persons suddenly taken seriously ill to the nearest hospital.

4. *Drinking Water.*—(*a*) Water of good quality fit for drinking purposes shall be provided for the work people on a scale of not less than 15 litres per head per day.

(*b*) Where drinking water is obtained from an intermittant public water supply each work place shall be provided with storage tank where such drinking water shall be stored.

c) Every water supply storage shall be at a distance of not less than 15 metres from any latrine, drain or other source of pollutions. Where water has to be drawn from an existing well, which is within such prominity of latrine, drain or any other source of pollution, the well shall be properly chlorinated before water is drawn from it for drinking. All such wells shall be entirely closed in and be provided with a trap docr which shall be dust and water proof.

(*d*) A reliable pump shall be fitted to each covered well, the trap door shall be kept locked and opened only for cleaning or inspection which shall be done atleast once a month.

5. *Washing and bathlng places.*——Adequate washing and bathing places should be provided, separately for men and women Such places shall be kept in clean and drained condition. Bathing or washing should not be allowed in or near any drinking water well.

6. *Latrines and Urinals.*—There shall be provided within the precincts of every work place, latrines and urinals in an accessible place and the accommodation, separately for each of them, shall be on the following scale or on the scale so directed by the Executive Engineer in any particular cases.

	Seats.
(i) Where the number of persons employed does not exceed 50.	2
(ii) Where the number of persons employed exceed 50 but does not exceed 100.	3
(iii) For every additional 100	3

If women are employed separate latrines and urinals, screened from those for men shall be provided on the same scale.

Except in work places provided with water flushed latrines connected with a water borne sewage system, all latrines shall be provided with receptacle on dry earth system which shall be cleaned at least four times daily and at least twice during the working hours and kept in strictly sanitary conditions. The receptacles shall be tarred inside and outside atleast once a year.

The excreta from the latrines shall be disposed off at the contractor's expense, in outway pits approved by the local Public Health Authority. The Contractor shall also employ adequate number of scavengers and conservancy staff to keep the latrines and urinals In a clean condition.

7. *Shelters during rest* : At very work site there shall be provided, free of cost, two shitable sheds one for meals and the other for rest separately for men and women for the use of labourers.

8. *Creches* : (a) At every work place at which 50 or more women workers are ordinarily employed there shall be provided two huts of suitable size for the use of children under the age of 6 years, belonging to such women, one hut shall be used for infants, games and play and the other as their bed room. The huts shall not be constructed on a lower standard than the following :—

(i) thatched roofs (ii) mud floors and walls.

(iii) Planks spread over the mud floor and covered with matting,

The huts shall be provided with suitable and sufficient opening for light and ventilation. There shall be adequate provision of sweepers to keep the places clean. There shall be two Dais in attendance. Sanitary utensils shall be provided to the satisfaction of the Health Officer of the area concerned ; The use of the huts shall be restricted to children, their attendants and mothers of the children.

(*b*) Where the number of Women workers is more than 25 but less than 50, the contractor shall provide atleast one hut and one Dai to look after the children of women workers.

(*c*) The size of creche or creches shall vary according to number of women workers.

(*d*) The creche or creches shall be properly maintained and necessary equipment like toys, etc shall be provided.

9. *Canteens* :—A cooked food canteen on a moderate scale shall be provided for the benefits of workers if it is considered expedient.

10. *S heds for Workmen* :—The contractor should provide at his own expense sheds for housing his workmen. The sheds shall be on a standard not less than the cheap shelter type, to live in which the work people in the locality are accustomed to.

A floor area of about 1.8 metres x 1.5 metres for two persons shall be provided. The sheds to be in rows with 1.3 metres clear space between sheds and 9 metres clear space between rows if conditions permit. The work people's camp shall be laid out in units of 400 persons, each, each unit to have a clear space of 12 metrse alround.

APPENDIX IX. XXXVIII.

MONTHLY REPORT OF CONSTRUCTION EMPLOYEES UNDER CONTRACTORS.

Return for the Month Ending.

1. Name, location and Type of work.

2. Name of contractor .. ..

3. Works engaged in—

(i) P.W.D. work .. ..

(ii) Government work other than P.W.D.

(iii) Other works .. ..

4. Name and address of Manager (s) of works.

5. Value of contract .. ..

6. Employment earnings—

Category.	Employees.			
	Men.	*Women.*	*Boys.*	*Girls.*
(1)	(2)	(3)	(4)	(5)
(i) Total number of employees during the month.				
(ii) Number of employees in the work on the last working day of the month.				
(iii) Total wages paid for the				
(iv) Total number of working days during the month.				
(v) Length of normal wage period.				

Date :

Place :

Signature of contractor or Manager.

To

1 The Employmemt Officer,
District Employment Office.

2. The Executive Engineer,
Division.

Instructions to complete the Proforma.

1. Contractor means the person who has contracted to execute the works.

2. Manager means any person who manages, superviser the work(s) or behalf of the contractor.

3. *Item* 6—(i) The cumulative total of daily employment on all days in a calender month, if the last day of the calender month is a holiday, the working day immediately previous to the holiday.

Item 6 (ii)—Wages means basic wage, dearness allowance, project allowances etc. including work benefits paid in cash or kind.

Item 6 (iii)—Columns 2 and 3 refer to adults who are 17 years of age or over.

Item 6—Columns 4 and 5 refer to others not covered by columns 2 and 3.

4. Returns should cover a calender month.

5. Completed returns to reach the employment exchanges concerned on or before the 5th of the month succeeding] the month to which he return relates.

APPENDICES.

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APPENDICES.

APPENDIX I.

TENDER NOTICE (LUMP SUM)

1. For and on behalf of the Governor of Tamil Nadu Tenders will be received by the Superintending/Executive Engineer,

Circle/Division at his office upto p.m. on for the work of*

The tender should be in the prescribed form obtainable from the Superintending/Executive Engineer's Office. The tenders will be opened by the Superintending/Executive Engineer, Circle/Division at the place and on the date forementioned. The tenderers or their agents are expected to be present at the time of opening of tenders. The tender receiving officer will on opening each tender prepare statement of the attested and unattested corrections therein and hand it over to the tenderer concerned and initial all such corrections in the presence of the tenderer. If any of the tenderers or their agents find it inconvenient to be present at the time, then, in such a case the tender receiving officer will on opening the tender of the absentee tenderer make out a statement of the unattested corrections and communicate it to him. The absentee tenderer shall then accept the statement of corrections without any question whatsoever.

Tenders must be submitted in sealed covers and should be addressed to the Superintending/Executive Engineer, Circle/Division, the name of the tenderer and the name of the work being noted on the cover.

2. If the tender is made by an individual, it shall be signed with his full name and his address shall be given. If it is made by a firm, it shall be signed with the co-partnership name by a member of the firm, who shall also sign his own name, and the name and address of each member of the firm shall be given. If the tender is made by a corporation, it shall be signed by a duly authorised officer who shall produce with his tender, satisfactory evidence of his authorisation. Such tendering corporation may be required before the contract is executed, to furnish evidence of its corporate existence.

3. Each tenderer must also send a certificate of income-tax verification from the appropriate income-tax authority in the form prescribed therefor. This certificate will be valid for one year from the date of issue for all tenders submitted during the period.

In the case of proprietory and partnership firm, it will be necessary to produce the certificate aforementioned for the proprietors and for each of the partner, as the case may be.

If the tenderer is a registered P.W.D. contractor and if a certificate for the current year has already been produced by him during the calender year in which the tender is made, it is sufficient if particulars regarding the previous occasion on which the said certificate was produced are given.

All tenders received without a certificate as afore-mentioned will be summarily rejected.

4. Each tenderer must pay, as earnest money, a sum of rupees into the branch of State Bank of India or into the Government treasury or sub-treasury within the jurisdiction of the Executive Engineer concerned to the credit of Revenue Deposits on behalf of the Executive Engineer of the Division and enclose with his tender the chalan endorsed accordingly. This earnest money will be refunded to the unsuccessful tenderer on application after intimation is sent of rejection of the tender or at the expiration of two months from date of tender, whichever is earlier. This refund will be authorised by the Executive Engineer by suitable endorsement on the chalan. The earnest money will not be received in cash or currency notes by the Public Works Department's Officers, save in exceptional cases, where there are no treasuries or banks within the jurisdiction of the officer calling for tenders. When currency notes are given, the tenderer should sign his name in full with date, on the back of all the currency notes given by him, whatever their denominations may be.

The earnest money will be retained in the case of the successful tenderer and will not carry any interest. It will be dealt with as provided in the tender.

5. When a tender is to be accepted the tenderer whose tender is under consideration shall attend the Superintending/Executive Engineer's office before the end of the period specified by written intimation to him. If the tenderer fails to attend the Division office before the end of the period specified, his tender will not be considered. He shall forthwith upon intimation being given to him by the Superintending/Executive Engineer of acceptance of his tender make as security deposit of Rupees....in one of the forms prescribed in the Tamil Nadu Public Works Account Code and sign an agreement in the proper departmental form for the due fulfilment of the contract. This security deposit together with the earnest money and the amount withheld according to clause 64 of the General condition of contract of the Tamil Nadu Buildings Practice shall be retained as security for the due fulfilment of his contract. If a cash security deposit is made by the contractor he shall follow the procedure laid down on the preceding paragraph for payment of earnest money and such deposit will not bear interest. Failure to enter into the required agreement or to make the security deposit as defined in this paragraph shall entail forfeiture of the earnest money. The written agreement to be entered into between the contractor and the Government shall be the foundation of the rights of both the parties and contract shall not be deemed to be complete until the agreement has first been signed by the contractor and then by the proper officer authorised to enter into contracts on behalf of Government.

6. The tenderer shall examine closely the Tamil Nadu Building Practice and also the General conditions of contract contained therein and sign the Divisional Office copy of the Tamil Nadu Buildings Practice and its addenda volume in token of such study before submiting his tender and rates which shall be for finished work in situ. He shall also carefully study the drawings and additional specifications and all the documents which form part of the agreement to be entered into by the accepted tenderer. The Tamil Nadu Buildings Practice and other documents connected with the contract such as specifications, plans, descriptive specifications, sheet regarding materials, etc. can be seen at any time between 11 a.m. and 5 p.m. on office days, in the office of the Superintending/Executive Engineer, Circle/Division. A copy of the set of contract documents can also be had on payment of Rs. for each set.

7. The tenderer's attention is directed to the requirements for materials under the clause 'Materials and workmanship' in the "conditions of contract". Materials conforming to the Indian Standard specifications shall be used on the work and the tenderer shall quote his rates accordingly.

*To be struck out if such copies are not to be issued for sale.

8. Every tenderer is expected before quoting his rates to inspect the site of the proposed work. He should also inspect the quarries and satisfy himself about the quality and availability of materials. The names of quarries, kilns, etc., where from certain materials, are to be obtained will be given in the Descriptive Specification Sheet. The best class of materials to be obtained from the quarriers or other source defined shall be used on the work. In every case the materials must comply with the relevent standard specifications. Samples of materials as called for in the standard specifications, or in this tender notice, or as required by the Executive Engineer in any case shall be submitted for the Executive Engineer's approval before the supply to site of work is begun. If the contractor after examination of the source of materials defined in the Descriptive Specification Sheet, is of opinion that materials complying with the standard or other specifications of the contract cannot be obtained in quality or sufficient quantity from the source defined in the Descriptive Specification sheet, he shall so state clearly in his tender and state where from he intends to obtain materials subject to the approval of the Superintending/Executive Engineer.

The Government will not, however, after acceptance of a contract rate pay any extra charges for lead or for any other reason in case the contractor is found later on to have misjudged the material available. Attention of the contractor is directed to the General conditions of contract regarding payment of seigniorage tolls, etc.

9. The tenderer's particular attention is drawn to the sections and clauses in the General conditions of contract dealing with :

1. Test, inspection and rejection of defective materials and work.
2. Carriage.
3. Construction plant.
4. Water and lighting.
5. Cleaning up during progress and for delivery.
6. Accidents.
7. Delays.
8. Particulars of payment.

The contractor should closely peruse all the specification classes which govern the rates which he is tendering.

10. A schedule of quantities accompanies this tender notice. It shall be definitely understood that the Government does not accept any responsibility on the correctness on completeness of this schedule and that this schedule is liable to alteration by omissions, deductions or additions at the discretion of the Executive Engineer Division, or as set forth in the conditions contract. The tenderer will, however base his lumpsum tender on this schedule of quantities. He should quote specific rates for each item in the schedule and the rates should be in rupees and paise. The rates should be written both in words and figures and the units in words. The tenderer should also show the total of each item and the grand total of the whole contract and quote in the tender a lump-sum for which he will undertake to do the whole work subject to the condition of contrac. such lumpsum-agreeing with the total amount of Schedule A. This schedule accompanying the lumpsum tender shall be written legibly and free from erasures, over writtings or conversions of figure. Corrections, where unavoidable should, be made by crossing out, initialing, dating and re-writing.

11. Tenders offering a percentage deduction from or increase on the estimate amount and those not submitted in proper form or in due time will be rejected. Rates or lump-sum amounts for items not called for shall not be included in the tender. No alteration which is made by the tenderer in the contract from the conditions of contract, the drawings, specifications, or quantities accompanying same will be recognized, and if any such alterations are made, the tender will be void.

12. The tenderer should work out his own rates without reference being made to the Public Works Department current schedule of rates or to the Public Works Department estimate rates which are not open for inspection by tenderers.

13. The price at which and the source from which certain particular materials shall be obtained by the contractor are given at the end of the schedule accompanying the tender form. Tenderers must accept the materials at these prices, and shall quote their prices for finished work accordingly. Not withstanding any subsequent change in the market value for these materials, the charge to the contractor will remain as originally entered in the written contract. No centage or incidental charges will be borne by Government in connection with this supply.

14. The attention of the tenderers is directed to the contract requirements as to the time of begining works, the rate of progress, and the dates for the completion of the whole work and its several parts. The following rate of progress and of proportionate value of work done from time to time as will be indicated by the Executive Engineer's certificate of the value of work done will be required. Date of commencement of this programme will be the date on which the site (or premises) is handed over to the contractor.

Period after date of commencement.	*Percentage of work completed (based on contract lump-sum amount).*
(1)	(2)

NOTE.—(1) The periods to be entered in column (1) for the purpose of defining the rate of progress may be fixed by the Superintending/Executive Engineer to suit each case.

15. No part of the contract shall be sublet without written permission of the Executive Engineer nor shall transfer be made by power-of-attorney authorizing others to receive payment on the contractor's behalf.

16. If further necessary information is required, the Executive Engineer of the Division will furnish such, but it must be clearly understood that tenders must be received in order, and according to instructions.

17. The Superintending/Executive Engineer or other sanctioning authority reserves the right to reject any tender or all the tender without assigning any reason therefor.

18. Preference in the selection from among the tenderers will be given, other things being equal, to those who are themselves professionally qualified men at their cost to look after the work. The tenderers should therefore state in clear terms whether they are professionally qualified or whether they undertake to employ technical staff and if so to give the professional qualifications of the staff to be employed. In case the selected tender is one who has undertaken to employ technical staff under him, he should see that one of the staff is always at the site of the work during working hours, personally checking all items of work and paying extra attention to such works as may demand special attention e.g., reinforced concrete works, etc.

Note:- This paragraph should be scored out if the cost of the work involved is less than Rs. 1,00,000 (Rupees ten thousand) only.

19. A tenderer submitting a quotation which the tender accepting authority considers excessive and or indicative of the insufficient knowledge of current prices or definite attempt at profiteering will render himself liable to be debarred permanently from tendering or for such period as the tender authority accepting may decide. The tender rates should be based on the controlled price for materials if any, fixed by Government or the reasonable price permissible

for the tenderer to charge a private purchase under the provision of clause 8 of the Hoarding and Profiteering Prevention Ordinance, 1943, as amended from time to time and on similar principles in regard to labour and supervision in the construction.

20. The contractor should offer employment to ex-toddy tappers as for as p›ssible. The number of ex-toddy tappers to whom he can offer employment should be mentioned in the tender and he should undertake in the agreement to offer such employment to such number.

APPENDIX II (*a*).

TENDER.

Date

The Superintending/Executive Engineer
Circle/Division

Sir,

I/We do hereby tender and, if this tender be accepted, undertake to execute the following works, viz., as shown in the drawings and described in the specifications deposited in the Office of the Superintending/Executive Engineer of Circle/Division with such variations by way of alterations of, additions to, and omission from the said works and method of payment as are provided for the conditions of contract for the sum of Rupees*

or such other sum as may be arrived at under the clause of the General conditions of contract relating to "Payment on lump-sum qasis or by final measurement unit prices".

I/We have also completed the price list of items in Schedule 'A' annexed (in words and figures) for which I/We agr e to execute the work when the lump-sum payment under the terms of the agreement is varied by payment cn measured quantities.

I/We hereby distinctly and expressly declare and acknowledge that, before the submission of my/our tender I/We have carfully followed the instructions in the tender notice and have read the Tamil Nadu Building Practice and the General conditions of contract therein, and that I/We have made such examination of the contract documents and of the plans, specifications and quantities, and of the location where the said work is to be done and such investigation of the work required to be done, and in regard to the material required to be furnished as to enable me/us to throughly understand the intention of same and the requirements, covenants, agreements, stipulations and restrictions contained in the contract, and in the said plans and specifications and distinctly agree that I/we Will not hereafter make any claim or demand upon the Government based upon or arising out of any alleged misunderstanding or misconception or mistake on my/our part of the said requirements, covenants, agreements, stipulations and restrictions and conditions. I/We
being a registered P.W.D. contractor *enclose an income-tax verification*/have already produced an income-tax verification certificate in respect of (here particulars of the previous occasion on which the certificate was produced should be given) I/We enclose herewith a chalan for the payment of the sum of the Rupees*

If my/our tender is not accepted, this shall be returned to me us on my/our application. when intimation is sent to me/us of rejection on or at the expiration of two months from the date of this tender whichever is earlier. If my/our tender is accepted, the earnest money shall be retained by the Government as security for the fulfilment of the contract. If upon written intimation to me/us by the Superintending/Executive Engineer's office I/we fail to attend the said office before the end of the period specified on such intimation, the tender will not be considered and if upon intimation being given to me/us by the Superintending/Executive Engineer of acceptance of my/our tender I/We fail to make the additional security deposit or to enter into the required agreements as defined in clause 4 of the tender notice, then I/We agree to the forfeiture of the earnest money. Any notice required to be served on me/us hereunder shall be sufficiently served on me/us if delivered to me/us personally or forwarded to me/us by post to me/us (registered or ordinary) or left at me/us address given herein. Such notices shall if sent by post be deemed to have been served on me/us at the time when in due courses of post it would be delivered at the address to which it is sent.

I/We fully understand that the written agreement to be entered into between me/us and the Government shall be the foundation of the rights of both the parties and contract shall not be deemed to be complete until the agreement has first been signed by me/us and then by the proper officer authorised to enter into contracts on behalf of Government.

I am/We are professionally qualified and my/our qualifications are given below :—

Name. *Qualifications.*

I/We will employ the follwing technical staff for supervising the work and will see that one of them is always at site during working hours personally checking all items of works and paying extra attention to such wotks as require special attention (e.g.) Reinforce concrete works.—

Names of members of Technical Staff Proposed to be employed. *Qualifications.*

NOTE.—(a) The last two clauses should be scored out if the cos of the work involved i.e. less than Rs. 1,00,000.

(b) The tenderes should be scored out the last clause or the penuitimate according as they are themselves professionally/ qualified or undertake to employ technical staff under them.

Contractor.

Rate of progress.

(Fill in from Tender Notice)

Extract from schedule of quantities.

(Fill in only the table from Tender Notice).

Contractor.

* To be entered in words and figures.

APPENDIX II (*b*).

NOTICE TO TENDERER WHOSE TENDER IS UNDER CONSIDERATION

To

....

....

....

Sir,

In order to enable me to consider your tender for the work, you are requested to attend at*

on† or within three days from

during office hours for the purpose of further enquiry in connection therewith.

2. An agreement in proper departmental form will have to be signed by you if your tender is found acceptable. Please note that if you fail to attend in manner aforesaid, your tender will not be considered.

Executive Engineer, P.W.D.,
Division.

*Name of Division Office.

†Date.

APPENDIX II (*c*)

To

Sir,

Your tender, dated....................is acepted for and on behalf of the Governor of Tamil Nadu *subject to the corrections made therein and attested by you and me for and on behalf of the Governor of Tamil Nadu under date..................and subject also* to the conditions that you forthwith deposit the security specified in condition 10 of the notice inviting tenders in addition to the earnest money which will be retained as part of the security deposit for the due fulfilment of the contract and that you also at the same time sign the contract documents.

2. The written agreement to be entered into between you and the Government shall be the foundation of the rights of both the parties and the contract shall not be deemed to be complete until the agreement is first signed by you and then by the proper officers authorised on behalf of Government.

Executive Engineer, P.W.D.,
Division.

Date:

N.N.—The portion underlined is to be inserted only in case whereas a result of the settlement made during the "further enquiry" mentioned in the "Notice to tenderer whose tender is under consideration" the selected tenderer has been permitted or required by the tender accepting authority to make any corrections in his tender before acceptance.

APPENDIX. III.

Articles of Agreement (Lump Sum).

ARTICLES OF AGREEMENT made this day 19 between the Governor of Tamil Nadu (hereinafter called the Governor which expression shall where the context so admits include his successors-in-office and assigns) of the one part and? of† (hereinafter called the Contractor which expression shall where the context so admits include his heirs, executors, administrators and legal representatives) of the other part.

WHEREAS the Government of Tamil Nadu (hereinafter called the Government) are desirous of † and have caused an estimate of probable quantities contained in Schedule A, drawings and specifications describing the work to be done to be prepared.

AND WHEREAS the said Schedule A, drawings number serially 1 to inclusive-(Schedule B)—and the specifications (Schedule-C) have been signed by or on behalf of the partes,

AND WHEREAS the Contractor has agreed to the retention by Government of the earnest money of Rupees paid by him when he submitted his tender as security for the due fulfilment of the contract to the satisfaction of the Executive Engineer, Division (hereinafter referred to as "the Executive Engineer") or the alternative as the Executive Engineer may direct, to deposit as security for the aforesaid purpose Government securities, muniscipal debentures, bearer debentures issued by the trustees of the Port of or Post Office cash certificate of the nominal value of Rs. duly endorsed to or registered in or transferred to the name of the Executive Engineer(with the previous sanction of theHead Post-Master in the case of the last-mentioned security) as the case may require to perfect such security.

** AND WHEREAS the Contractor has deposited with the Executive Engineer, the sum of Rupees in cash as additional security for the due fulfilment of the contract to the satisfaction of the Executive Engineer.

** AND WHEREAS the contractor, has delivered to and deposited with and endorsed over to the Executive Engineer, Government securities to the extent of Rupees of which the numbers, amounts and other particulars are set forth in the margin hereto as additional security for the due fulfilment of the contract to the satisfaction of the Executive Engineer.

** AND WHEREAS the Contractor has endorsed over and delivered to the Executive Engineer Municipal debentures to the value of Rupees the numbers and particulars of which are set forth in the margin hereto and such endorsement has been registered in the office of as additional security for the due fulfilment of the contract to the satisfaction of the Executive Engineer.

** AND WHEREAS the Contractor has delivered to the Executive Engineer bearer debentures issued by the Trustees of the Port of of the value of equivalent to Rupees. the numbers and particulars of which are set forth in the margin thereto as additional security for the due fulfilment of the contract to the satisfaction of the Executive Engineer

** AND WHEREAS the Contractor has deposited in the Bank at the sum of Rupees in the name of the Executive Engineer and has obtained a receipt bearing No. , dated made out in the name of the Executive Engineer and the same is now standing to the credit of the Executive Engineer and is withdrawable by him on demand as additional security for the due fulfilment of the contract to the satisfaction of the Executive Engineer.

** AND WHEREAS the Contractor is the holder of Post Office cash certificates and Defence Savings certificates of the value of Rupees which have been registered in the Post Office at particulars of which are set forth in the margin hereto and whereas the Contractor has deposited with and transferred to the Executive Engineer the said certificate with the previous sanction of the Head Postmaster of Post Office in which the certificates have been registered having been obtained as additional security for the due fulfilment of the contract to the satisfaction of the Executive Engineer.

AND WHEREAS the Contractor has also signed the copy of Tamil Nadu Building Practice and addenda volume thereto maintained in the Division office in acknowledgment of being bound by all the conditions of the clauses of the General Condition of contract and all the standard specifications for items of works described by a Standard Specification number in Schedule A.

AND WHEREAS the Contractor has agreed to execute upon and subject to the conditions set forth in condition of contract of the Tamil Nadu Buildings Practice and such other conditions as are contained in all the specifications forming part of this contract (hereinafter referred to as "the said conditions") the works shown up on the drawings and described in the said specifications and set forth in Schedule A as the "Probable quantities" and comply with the rate of progress noted at the end of this Articles of Agreement for a sum of Rupees * or such other sum as may be arrived at under the clause of the general condition of contract relating to "Payment on lump-sum basis or by final measurement at unit prices".

Now it is hereby agreed as follows :—

(1) In consideration of the payment of the said sum of Rupees* or such other sum as may be arrived at under the clause of the General condition of contract relating to Payment on lump-sum basis or by final measurement at unit prices, the Contractor will, upon and subject to the said conditions execute and complete the works shown upon the said drawings and described in the said specifications and to the extent of the probable quantities shown in Schedule A with such variations by way of alterations of, additions to, or deductions from, the said works and method of payment there for as are provided for in the said conditions.

(2) The term Executive Engineer in the said conditions shall mean the Public Works Officer in charge of the Division, who shall be competent to exercise all the powers and privileges reserved herein, in favour of the Government, † with the previous sanction of or subject to the ratification by the ‡ in cases where such sanction or ratification may be necessary.

(3) The arbitrator for fulfilling the duties set forth in the arbitration clause of the general condition of contract shall be Superintending Engineer of Circle.

(4) Time shall be considered as the essence of the agreement and the Contractor hereby agrees to commence the work as soon as this agreement is accepted by competent authority as defined by the Madras Public Works Department Code and the site (or premises) is handed over to him as provided for in the said conditions and agrees to complete the work within months from the date of such handing over of the site (or premises) and to show progress as defined in the tabular statement "Rate of Progress" below subject nevertheless to the provisions for extension of time contained in clause 56 of the General conditions of Contract.

(5) The said conditions shall be read and construed as forming part of this agreement and the parties hereto/ will respectively abide by and submit themselves to the conditions and stipulations and perform the agreements on their parts, respectively.

(6) Upon the terms and conditions of this agreement being fulfilled and performed to the satisfaction of the Executive Engineer, the security deposited by the Contractor as hereinbefore recited or such portion thereof as he may be entitled to under the said condition shall be returned to the Contractor.

In witness whereof the Contractors † has hereunto set his hand and ‡ on behalf of any by the order and direction of His Excellency the Governor of Tamil Nadu has hereunto set his hand the day and year first above written.

Signed by Contractor : —

Address : —

In the presence of witness :—

Signed by on behalf of Government :—

Designation :—

In the presence of witness :—

Rate of Progress.

The following rate of progress and proportionate value of work done from time to time, as will be indicated by the Executive Engineer's certificate of the value of work done will be required.

Date of commencement of this programme will be the date on which the site (or premises) is handed over to the Contractor.

Period after date of commencement.	*Percentage of work completed (based on contract lump-sum amount).*
(1)	(2)

NOTE.—The periods to be entered in column (1) for the purpose of defining the rate of progress may be fixed by the Executive Engineer to suit each case.

NOTE.—Of the six recital clauses relating to the additional security marked ** the one suitable to the kind of security actually deposite should be retained and the rest scored outwith the attestation at the time of execution of the agreement.

† Contractor's name.

‡ Name and designation.

* To be entered in words and figures.

† Rest of sentence to be struck of in the Executive Engineer can himself enter into the contract without reference to any higher authority.

‡ Designation of officer who is competent to approve of the contract, under the Madras P.W.D. Code.

SCHEDULE A.

Schedule of rates and approximate quantities.

(*a*) The quantities given here are those upon which the lump-sum tender cost of the work is based but they are subject to alterations, omissions, deductions or additions as provided for in the conditions of this contract and do not necessarily show the actual quantities of work to be done. The unit rates noted below are those governing payment for extras or deductions or omissions according to the conditions of the contract, as set forth in the general conditions of contract of the Tamil Nadu Building Practice and other conditions or specifications of this contract.

(*b*) It is to be expressly understood that the measured work is to be taken nett (not withstanding any custom or practice to the contrary) according to the actual quantities when in place and finished according to the drawings or as may be ordered from time to time by the Executive Engineer and the cost calculated by measurement or weight at the respective prices, without any additional charge for any necessary or contingent works connected therewith. The rates quoted are for works in situ and completed in every respect.

Item number.	*Probable quantity*.*		*Description of work.*	*T.N.B.P. number.*	*Rate.*		*Units wors.*	*Amount. (in Figures.)*
		Figures.			*Words.*	*Figures.*		
(1)	(2)		(3)	(4)	(5)	(6)	(7)	(8)
								RS. P.

(*Signature of the Contractor.*)

NOTE.—The Second subdivision of this column (i.e. column 3) is for description in words such as numbers, cubic feet, lb, etc.

SCHEDULE B.

List of Drawings

NOTE:— All drawings to be signed by the contractor as well as the officer entering into the contract.

Supplemental List

As referred to in the specifications (including the general conditions of contract of Tamil Nadu Building Practice).

Serial number	*Drawing number*	*Description*	*Serial number*	*Drawing number*	*Description*	*Date on which the drawing was supplied*
(1)	(2)	(3)	(4)	(5)	(6)	(7)

Date

(*Signature of Contractor*)

SCHEDULE C.

List of specifications for the various items of works supplementing those described in Schedule A by Standard Specification numbers.

* Contractor's name.

† Contractor's legal address for registered letters and notices.

‡ Name of work and locality.

Descriptive Specification Sheet.

Items	*Materials.* (i) *Size alternative to standard specification size or size prescribed.* *Mortars and concrete.* (ii) *Mixes prescribed if deviation from standard specification.* (iii) *Masonry joint thickness and deviations.*	*Source from which item is to be obtained.*	*Approximate lead.*	*Remarks.*
(1)	(2)	(3)	(4)	(5)
Lime				
Surki				
Portland Cement				
Sand for mortar works				
Sand for filling in				
Earth for refilling and disposal of surplus*				
Broken stone for concrete, reinforced concrete, etc.				
Broken stone for road works				
Broken brick				
Gravel				
Quarry rubbish				
Rough stone, jeddy stone, etc.				
Flooring stone				
Cut stones				
Cuddapah slabs				
M.S. Sheets				
Corrugated roofing-deviations in gauge.				
Bricks (wall)				
Bricks (terrace)				
Bricks (flooring)				
Pan tiles				
Flat tiles				
Mangalore tiles				
Pressed, ornamental tiles, etc.				
Teak wood				
Other classes of wood				
Furnishings for doors, windows, etc. ..				
Standardised items of furniture				
Paints				
Tar				
Wood oil				
Varnish				
Distemper (Brand and number of coats).				

* Insert in remarks Column where excess earth required for filling is to be obtained from and where excess spoil if any, is to be carted or conveyed.

Discriptive Specifications Sheet—cont.

Items.	*Materials.* (i) *Size alternative to standard specification size or size prescribed.* *Mortars and concrete.* (ii) *Mixes prescribed if deviation from standard specification.* (iii) *Masonry joint thickness and deviations.*	*Source from which item is to be obtained.*	*Approximate lead.*	*Remarks.*
(1)	(2)	(3)	(4)	
Steel R.S. Beams etc.				
Iron work for jail cells-ventilators, doors, lock boxes, cage latrines, etc.				
Cast iron				
Lime mortar				
Surki mortar				
Pointing				
Terrace work				
Deviations, if any, and proportions if surki mortar required for any stages.				
Plastering*				
Concrete broken stone in lime mortar ..				
Concrete broken stone in surki mortar ..				
Concrete broken stone in cement mortar				
Reinforced cement concrete				
Brick work or masonry joint thickness.				
Floor surfacing				

*Deviation in plastry thickness if any. State with Line Motor, or Surki Mortar as cement Mortar and proportions.

APPENDIX IV.

Descriptive Specification Sheet

Description.	*Materials* :— (i) Size alternative to stand and specification size or size prescribed mortar and concrete. (ii) Mixes prescribed if deviation from standard specification. (iii) Masonry joint thickness and deviations.	Source from which item is to be obtained.	Approximate lead	Remarks
(1)	(2)	(3)	(4)	(5)
Lime				
Surki				
Portland cement				
Sand for mortar works				
Sand for filling in				
*Earth for filling and disposal of surplus				
Broken stone for Masonry works ..				
Broken brick				
Quarry rubbish				
Rough stone, jeddy stone, etc.				
Flooring stone				
Cut stone				
Cuddapah slabs				
M.S. Sheets				
Corrugated roofing Deviations in gauge				
Bricks (wall)				
Bricks (Terrace)				
Bricks (Flooring)				
Pan itles				
Flat tiles				
Mangalore tiles				
Pressed, ornamental tiles, etc.				
Teak wood				
Other classes of wood				
* Furnishing for doors				
** Standardised items of furniture ..				
Paints				
Tar				
Wood oil				
Varnish				

***Iron work for Jail cells, ventilation doors, lock boxes, cage latrons, etc.

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APPENDIX IV—*cont.*

Descriptive Specification Sheet—cont.

Description.	Materials :— (i) *Size alternative to stand and specification size or size prescribed* mortar and concrete (ii) *Mixes prescribed if deviation from standard specification.* (iii) *Masonry joint thckness and deviations.*	*Source from which item is to be obtained.*	*Approximate lead.*	*Remarks*
(1)	(2)	(3)	(4)	
Distemper (Brand and No. of coats) ..				
Steel R. S. Beams, etc.				
Iron works for Jail cells ventilatiors doors, lock boxes cage latrines, etc.				
Cast Iron				
Lime Mortar				
*Pointing				
** Plastering				
Surki mortar				
Pointing				
Plastering				
Cement fiastering				
Terrace work				
Deviation if any and proper from [illegible] smaller mortar required for any stage.				
Broken stone lime concrete				
Broken Surki concrete				
Broken cement concrete				
Reinforced cement concrete				
Brick work or masonry joint thickness.				
Floor surfacing				

* Insert in remarks column where excess earth required for filling is to be obtained from and where excess spoil, if any, is to [illegible]

* Enter if deviation from standard specification procedure and if iron or brass.

* These will usually be purchased from jails—vide current price list for same.

** Enter if these are to be supplied from the Salem Jail and if so where contractor shall take delivery of same.

** Pointing-state if to be done asper "Remarks on pointing " in Tamil Nadu Building Practice.

** Deviation in plaster thickness, in any, state with lime mortar or surki mortar as cement and proportions

APPENDIX IV (a)

Tender Notice (Piece-work).

Tenders will be received by the Executive Engineer/Sub-Divisional Officer, P.W.D., ... Division / Sub-Division at his office at .... upto .... p.m., on ....for the work of................ ....

The tender will be opened by the Executive Engineer/Sub-Divisional Officer..Division/ Sub-Division on the date and at place aforementioned. The tenderers or the agents are expected to be present at the time of opening tender. The tender receiving officer will on opening such tender prepare a statement of the attested and unattested corrections therein and hand it over to the tenderer concerned and initial all such corrections n presence of the tenderer. If any of the tenderers or their agents finds it inconvenient to be present at the time then in such a case the tender receiving officer will on opening the tender of the absentee tenderer make out a statement of the unattested corrections and communicate it to him. The absentee tenderer shall then accep the statement of corrections without any question whats ever.

The tender should be in the K2 Form obtainable from the Executive Engineer's/Sub- Divisional Officer's office. The Tamil Nadu Building Practice specification and other documents relating to the contract such as additional specifications, drawings, descriptive specifications sheet regarding materials, etc. can be seen at any time between 11-00 a.m. to 5-00 p.m. on office days in the office of the Executive Engineer/ Sub-Divisional Officer.

2. Tenders must be submitted in sealed covers, superscribed and should be addressed to the Executive Engineer/Sub-Divisional Officer..............................Division/Sub-Division. The name of the tenderer and the name of the work being noted on the cover.

If the tender is made by an individual it shall be signed with his full name and his address shall be given if it is made by firm it shall be signed with the co-partnership name by a member of the firm, who shall also sign his own name and the name and address of each member of the firm shall be given if the tender is made by a corporation it shall be signed by a duly authorised officer who shall produce with his tender the satisfactory evidence of his authorisation. Such tendering corporation may be required before the agreement executed to furnish evidence of its corporate existence.

3. Each tenderer must pay as earnest money a sum of Rs.......... ....into the branch of the Imperial Bank of India or into Government Treasury or Sub-Treasury within the Jurisdiction of the Executive Engineer/Sub-Divisional Officer concerned to the credit of Revenue Deposits on behalf of the Executive Engineer / Sub-Divisional Officer of the .... and enclose with his tender the chalan endorsed accordingly. The earnest money will be refunded to the unsuccessful tenderer on application after intimation is sent on rejection of the tender or at the expiration of two months from date of tender whichever is earlier. This refund will be authorised by the Executive Engineer by suitable endorsement on the chalan. The earnest money will not be received in cash or currency notes by the public works department officers, have in exceptional cases where there are no treasuries or banks within the jurisdiction of the officer calling for renders. When currency notes are given the tenderer should sign his name in full with date on the back of all the currency notes given by him whatever their denominations may be.

The earnest money will be retained in the case of the successful tenderer and will not carry any interest. It will be dealt with as provided in the conditions attached to the tender.

When a tender is to be accepted the tenderer whose tender is under consideration shall attend the office of the Executive Engineer/Sub-Divisional Officer................................ before the end of the period specified by written intimation to him failing which the tender will not be considered. He shall forthwith upon intimation being given to him by the .... of acceptance of his tender complete the execution of the agreement by signing all documents connected therewith. Failure to do so shall entail forfeiture of the earnest money.

4. Tenderers shall peruse carefully the instructions and directions to parties tendering and the conditions of the standard K-2 Form and all other relevant documents before tendering rates for piece work. The approximate quantity of work to be executed under each class is given in the accompanying schedule. The quantities are given only with a view to enable the tenderer to quote his over all rate for each class of work in the tender form.

5 The Executive Engineer /Sub-Divisional Officer reserve the rights to reject any tender or all the tenders without assigning any reason therefor. Tenders offering a percentage deduction from or increase on the estimate amount and those not submitted in proper form or in due time will be rejected.

SCHEDULE

Number of item.	*Class and description of work to be executed.*	*Approximate quantity.*	*T.N.B.P. number and number of other specifications, if any.*	*Unit of calculations.*
(1)	(2)	(3)	(4)	(5)

Descriptive Specification sheet.

N.B.—(Here under relevent extract from P. 355 of T.N.B.P. or items as may otherwise applicable.)

APPENDIX IV (b)

P.W.D. K-2 FORM.

AUTHORITY—

G.O. No. 837, P.W. (General), dated 22nd April 1937.

Agreement between the Governor of Tamil Nadu and (Name of Contractor)..................................

Number of pages in the agreement... ....for piece-work.

Number of items in the schedule...........................

N.B.—Piece-work is that which involves a payment for work done at stipulated rate only, without reference to a total quantity or time.

TENDER AND CONDITIONS.

DIRECTIONS TO PARTIES TENDERING.

A list of materials proposed to be supplied by Government and the places where and the prices at which they are proposed to be supplied is given at the end of the schedule accompanying the tender notice. This should be entered by the tenderer also at the end of schedule accompanying the tender. Tenderers must accept these materials at the specified pricesand quote for finished work accordingly. Notwithstanding any subsequent change in the market value those materials the change to the party executing the work will remain as originally entered in the agreement. If any time subsequent to the execution of this agreement Government material other than those specified in the agreement are to be supplied to the piece worker for use on the work, they will be charged at market value prevailing the time of supply or stock issue rate whichever is greater. The piece worker will be informed in writing of this change and be should intimate in writing rate which he demands for finishing work in view of the fact that he is to use Government materials. No cartage or incidental charges will be borne by Government connection with the supply of materials referred to in this paragraph.

2. Subsidiary item such as water for work, clearing and marking out side, hire of tools and plant should be separately entered. If such items are not so entered, it will be assumed that the rates quoted in the schedule include provision for them also.

3. The tenderer shall examine closely the Tamil Nadu Building Practice, and also the relevant clause of the General Conditions of contract contained therein, and sign the $\frac{\text{Divisional}}{\text{Sub-divisional}}$ office copy of the Tamil Nadu Building Practice and its Addenda Volume in token of such study before submitting his tender unit rates which shall be for finished work in sites. He shall also carefully study the drawings and additional specifications and all the documents which form part of the agreement to be entered into by the accepted tenderer.

4. Each tenderer must also send a certificate of income-tax verification from the appropriate income-tax authority in the form prescribed therefor. This certificate will be valid for one *year* from the date of issue for all tenders submitted during the period.

In case of proprietary and partnership firm it will be necessary to produce the certificate aforementioned for the proprietors and for each partner as the case may be.

If the tenderer is a registered P.W.D. Contractor and if a certificate for the current year had already been produced by him during the calendar year in which the tender is made it will be sufficient if particulars regarding the previous occasion on which the said certificate was produced are given $\frac{\text{enclose an}}{\text{have already produced}}$ income tax verification certificate.

All tenders received without a certificate as aforementioned will be summarily rejected.

5. Every tenderer is expected before quoting his rates to inspect the site of the proposed work. He should also inspect the quarries and satisfy himself about the quality and availability of materials. The name of quarries, kilns, etc. wherefrom certain materials to be obtained will be given in the descriptive specification sheet. The best class of mate rials to be obtained from the quarries or other source defined shall be used in the work. In every case the materials just comply with the relevent standard specifications Samples of materials as called for in the standard specifications or in this tender notice, or as required by the $\frac{\text{Executive Engineer}}{\text{Sub-divisional Officer}}$ of the $\frac{\text{Division}}{\text{Sub-Division}}$ Public Works Department, having jurisdiction for the time being over the work hereinafter called the $\frac{\text{Executive Engineer}}{\text{sub-divisional Officer}}$ shall be submitted for the $\frac{\text{Executive Engineer's}}{\text{sub-divisional}}$ approval before the supply to site of work is begun. If the contractor after examination of the source of materials defined in the Descriptive Specification Sheet is of opinion that materials complying with the standard or other specification of the contract cannot be obtained in quality or sufficient quantity from at source defined in the Descriptive Specification sheet he shall so state clearly in his tender and state where from he intends to obtain materials subject to the approval of the $\frac{\text{Executive Engineer}}{\text{Sub-divisional Officer}}$. Attention of the piece-worker of directed to the Standard Preliminary "Specification" regarding payment of seigniorage, tolls, etc.

6. The tenderer should quote specific rates for each item in the schedule, and the rates should be in rupees and paise. The units and rates should be written both in words and figures. The schedule accompanying the tender shall be written legibly and free from erasures over writings or conversions of figures. Corrections where unavoidable should be made by crossing out initialling, dating and rewriting. No alteration which is made by the tenderer in the agreement form, the condition of agreements the drawings or specifications accompanying same will be recognized, and if any such alterations are made the tender will be void.

To

Name of Officer.......................

(acting for and on behalf of the Governor of Tamil Nadu)

TENDER FOR PIECE-WORK.

No.......of 19.

do hereby tender to execute works for the Governor of Tamil Nadu of the under mentioned description by piece-work, and in accordance with the conditions noted below and the rules set forth in Schedule 'B' below in consideration of payment being made, for the quantity of work executed at the respective rate specified in the Schedule 'A' below.

I/We hereby distinctly and expressly declare and acknowledge that before the submission of my/our tender I/We have carefully followed the instructions in the tender notice and have read the Tamil Nadu Building Practice and the relevent clauses of the preliminary Specification of the Tamil Nadu Building Practice, I/We have made such examinations of the contract documents and of the specifications, etc, and of the location where the said work is to be done and such investigation of the work required to be done and in regard to the materials required to be furnished as to enable me/us thoroughly to understand the intention of same and the requirements, covenents, agreements, stipulations, and restrictions contained in the contract and in the said specifications and distinctly agree that I/We will not hereafter make any claim or demand upon the Government based upon or arising out of any alleged misunderstanding or misconception or mistake on my/our part of the said requirements, covenents, agreements, stipulations, restrictions and conditions $\frac{\text{I}}{\text{We}}$ ....being a registered P. W. D. $\frac{\text{Contractor enclose an incometax verification}}{\text{have already enclosed an income tax verification}}$ certificate in respect of (here particulars of the previous occasion on which the certificat

SCHEDULE A.

Name of work.				
Number of item.	Class and description of work to be executed.	T.N.B.P.* number or other special specification, if any.	Unit of calculation (in figures and in words.)	Rate of payment (to be entered both in figures and words one below the other). RS. P.

*Enter S.S. before the number if it is a T.N.B.P. number.

NOTES.—(1) Enter below the schedule a list of drawings and a Descriptive Specification Sheet with relevant extract from T.N.B.P. Item as may otherwise be applicable—*vide* also paragraph 1 of Directions to parties tendering.

(2) The tenderer should affix his signature at the end of each page of his tender and other documents attached thereto. The accepting authority should similarly affix his signature to the accepted tender.

CONDITIONS.

The Executive Engineer/Sub-divisional Officer of the Division/ Sub-division, Public Works Department having jurisdiction for the time being over the work. Hereafter called the Executive Engineer/ Sub-divisional Officer or a Subordinate Officer deputed by him shall within a period of two months from the date of acceptance of the agreement by the competent authority give to the contractor full and complete particulars of the work to be done hereunder and within like period permit the contractor and his workmen free access to the site on which the work is to be executed. On receiving such particulars and permissions, the contractors shall forthwith start the work and shall carry on same with due deligence and all work executed to be done in a workmen-like manner. The decision of the Executive Engineer/Sub-Divisional Officer or any officer of the Public Works Department of the Government of Tamil Nadu duly authorized in this behalf by such Executive Engineer/Sub-divisional Officer as to the rate of progress and the quality of work or materials shall be final. The contractor shall have the right to cancel the contract and obtain refund of his earnest money if such particulars and/or the permission are not given within the said period of two months.

2. The following clauses of the Standard Preliminary Specification of the Tamil Nadu Building Practice only subject to the modification noted below shall apply to this agreement. (*N.B.*—In cases where the acceptance of this tender is within the powers of the Sub-divisonal Officer incharge of the work, and where he has accordingly accepted this tender, he shall exercise such functions as are delegated to the Executive Engineer in the relevant clauses of the Standard Preliminary Specifications applicable to this agreement).

General Conditions of contract.

Section A.—All clauses, except that, in clauses 2 and 3 where the General Conditions of Contract is mentioned, the reference shall be only to such clauses of the General Conditions of contract as are herein made applicable to this agreement.

Section C.—All clauses except 14.2.

Section D.—All clauses except that clause 26·1 in place of the words, "within six months from the completion of", *read* "before final payment for".

Section E.—All clauses except that in clause 33·1 the word "which occurring between the words "progress" and "in" in the first sentence shall be deleted as also the concluding portion of that sentence beginning from "will". The following be substituted for the present clause 39·1.

"The departmental officer in-charge of the work shall be responsible for the correct setting out of all works but the piece-worker shall provide at his own cost all labour, materials and staff required for so doing".

Section F.—All caluses.

Section G.—All clauses except clause 53.

Section I.—J.—Clauses 60 to 63 inclusive of second sub-paragraph of clause 64, clauses 66, 67 and 68.

3. The quantity of works executed shall be measured and payments made ordinarily monthly. On the completion of the work or the termination of this agreement, final measurements will be made and the account adjusted accordingly.

4. The Executive Engineer/Sub-divisional Officer or any officer of the Public Works Department of the Government of Tamil Nadu duly authorized in the behalf by such Executive Engineer/Sub-divisional Officer may put an end of this agreement at his option at any time and, in the case of bad work or material action shall be taken as provided in clause 25·3 General Conditions of Contract. (*Note*—If action is taken as provided in the last sub-paragraph of clause 25·5, General Conditions of Contract, the piece-worker's agreement to the reduced rates shall be taken in writing.)

5. Such Executive Engineer/Sub-divisional Officer or any such officer so authroized as aforesaid may fine the piece-workers not less that Rs. 10 and not more than 5 per cent of the value of completed work, for slow progress of work provided however that any authority higher than that of Executive Engineer/Sub-divisional Officer may in his absolute discretion waive or modify any fine imposed by the Executive Engineer/Sub-divisional Officer under the provisions by this clause.

6. Any unforeseen additional work that may become necessary and is accordingly carried out under this agreement under proper written orders shall be measured and valued by the Executive Engineer/ Sub-divisional Officer or his representatives at the rates containd in the piece-worker's original schedule and if these rates do not apply, than prior to execution of the additional work a rate for such work shall ordinarily be agreed upon and entered in a supplemental schedule and signed by both the piece-worker and the accepting authority. If it is not possible to arrive at such an agreement then the piece-worker shall be paid according to the cost of labour employed and materials used to which will be added 10 per cent to cover the piece-worker's profit on the said work on his delivery of the necessary vouchers to the Executive Engineer/Sub-divisional Officer.

7. The Earnest Money deposited by the selected piece-worker shall be retainedas securit deposit for the due uflfilment of the agreement. After work has been carried out by the piece-worker to the extent of twenty times the valu of this security deposit, a deduction of 5 per cent of the value of further work done by him shall be made for purpose of additional security from each intermediate bill to be paid to him unitl the completion of the work. Such deposits and or deduction or any portion thereo

may at the discretion of the Executive Engineer/Sub-divisional Officer be forfeited on failure or non- fulfilment by the piece-worker of any of the the above condition. Any authority higher than the one who ordered a forfeiture under the provisions of the clause, may in his absolute discretion waive or modify the forfeiture so levied.

Date :

Witness :

Signature of the party making the tender

Residence.

Accepted by me on behalf of the Governor of Tamil Nadu.

Note.—While accepting the agreement the accepting authority should specify on the first page of this document the number of pages in the agreement and the number of items in the schedule. A line should also be drawn under the last item in the schedule.,

APPENDIX V—A.

STANDARD ABBREVIATIONS FOR METRIC UNITS.

1. *Decimal multiples and sub-multiples.*

Prefix.	*Value in terms of units.*	*Abbreviation.*
(1)	(2)	(3)
Kilo	1,000	k
Centi.	0·01 (10^{-2})	c
Milli.	0·001 (10^{-3})	m
Micro	0·000001 (10^{-4})	P

2. *Weights*.—

Denomination.	*Value.*	*Abbreviation.*
(1)	(2)	(3)
Tonne.	1000 kg.	t
Quintal.	100 kg.	q
Kilogram	1 kg.	kg.
Gram.	1 g.	g.
Milligram	1 mg.	mg.
Carat.	200 mg.	c

3. *Capacity*.—

Kilolitre	1,000 l	kl.
Litre	1 l	l
Millilitre	1 ml.	ml,

4. *Volume*—

Cubic metre	m^3	m^3 or cu.m.*
Cubic Centimetre	cm^3	cm^3 or cu.cm*
Cubic Millimetre	mm^3	mm^3 or cu.mm*

Denomination.	*Value in terms of Units.*	*Abbreviation.*
(1)	(2)	(3)
5. *Length*—		
Kilometre	1,000 m.	km.
Metre	1 m.	m.
Centimetre.	1 cm.	cm
Millimetre	1 mm.	mm.
Micron	1/1,000, mm. or 10 (—)^3 mm.	um.
6. *Area*—		
Square kilometre	1,000,000 m^2	km^2, or sq. km.
Square metre	1 m^2	m^2 or sq. m.
Square centimetre	1 cms^2	cm^2 or sq. cm *
Square millimetre	1 mm^2	mm^2 or sq. mm. *

*Both these abbreviations are corect, but the first set should preferably be used. The former abbreviation is used more commonly internationally than the latter.

Rules for Abbrevations.

1. Do not make any change such as addition of "S" to indicate plurality (*e.g.*) write 1 kg. 10 kg., 20g., 10 t., 20 ml.. 27 l. 165 km., 100 cm^2, 66 km^2.

2. Do not capitalise the abbreviations. For example, do not write. 1 Kg. 2 Kg. 20 Mm., 50 Mm. The right way to write is 1 kg., 20 mm. 50 mm., etc.

3. Do not use any other abbreviations except those given above.

APPENDIX V-B

UNITS OF MEASUREMENT.

These are in most cases defined in the relevant standard specification. The following units will usually apply:—

Serial number and description of item of work.	*Unit.*
(1)	(2)
1. Earth work excavation	m^3
2. Rock excavation (Measured in the solid before removal).—	
(i) Unless by blasting	m^3
(ii) if by blasting	m^3
3. Excavation—	
(i) Extra lead over the initial lead (1) Part thereof.	m^3 or
(ii) Extra lift over the initial lift (11) part thereof.	m
4. Filling of foundation with sand	m^3
5. Plain concrete	m^3

Serial number and description of item work.	Unit.
(1)	(2)
6. Vertical joint..	m^2
7. Brick and stone masonry ..	m^3
8. Out stone (i)	m^3
(ii)	m^3
9. Damp Proof course ..	m^2
10. Filling in basement with —	
(i) Sand	m^3
(ii) Earth	m^3
11. Floors and Floor finishes ..	m^2
12. Cement concrete for R.C.C.	m^3
13. R.C.C. Jali ..	m^2
14. R.C.C. Sunshades, Chajjes, Boxing, etc.	m
15. Brick cornices, string course, etc.—	
(i) m^2 if measured square over projection	
(ii) m, if measured lin-early	
16. Cut stone band and other cornices	m
17. Carved cut stone ornaments	By the piece.
18. Plastering, Pointing, white and colour washing, distempering, etc.	m^2
19. Wood work ..	m^3
20. Doors and Windows—	
(i) For frames	m^3
(i) For shutters ..	m^2

Serial number and description of item work.	Unit.
(1)	(2)
21. Mild steel joints and other steel and iron work (i)	Tonne
(ii)	Quintal.
22. Trellis work ..	m^2
23. Painting and varnishing	m^2
24. Brick partition	m^2
25. A. C. Sheet partition and weldmesh screens	m^2
26. Built in cup-boards and shelves (i)	Each
(ii)	m^2
27. Roofs and Roof finishes	m^2
28. Expansion joints in floors and roofs	m
29. Gates and rolling shutters (i)	Each
(ii)	m^2
30. Iron bars and grill works for windows and ventilator heads.— (i)	Each
(ii)	m^2
31. Hand rails ..	m
32. Well sinking—	
(a) for open excavation ..	m
(b) 1 m depth for sinking in water	

Carriage of materials. - *Vide* relevant clause in General conditions of contract.—

33. Form work for R.C.C. items	m^2
34. Fabrication of steel reinforcement for R.C.C. works	Quintal

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APPENDIX VI

PRESUMPTIVE SAFE BEARING CAPACITY.

Serial number and types of Rocks and soils. (1)	Presumptive safe bearing capacity. in Kgs./cm². (2)	Remarks. (3)
(a) Rocks.—		
1 Rocks (hard) without lamination and defects, etc., granite, traps and dionite.	33	....
2 Laminated rocks, etc., sand stone and lime stone in sound condition ..	16·5	....
3 Residual deposits of shattered and broken bedrock and hardshole, cemented materials.	9·0	....
4 Soft rock	4·5	....
(b) Non-Cohesive soils—		
5 Gravel, sand and gravel, compact and offering high resistance to penetration when excavated by tools.	4·5	See Note 1.
6 Coarse sand, compact and dry	4·5	Dry means that the ground water level is at a depth not less than the width of foundation below the base of the foundation.
7 Medium sand, compact and dry	2·5	....
8 Fine sand, silt (dry lumps easily pulverized by the fingers)	1·5	....
9 Loose gravel or sand gravel mixture; loose coarse to medium sand. dry ..	2·5	See Note 1.
10 Fine sand, loose and dry	1·0	....
(c) Cohesive soils—		
11 Soft shale, hard or stiff clay in deep bed, dry	4·5	This ground is susceptible to long term consolidation settlement.
12 Medium clay, readily indented with a thumb nail	2·5	....
13 Moistclay and sand clay mixture which can be indeated wiih strong thumb pressure.	1·5	....
14 Soft clay indented with moderate thumb pressure	1·0	....
15 Very soft clay which can be penetrated several centimetres with the thumb.	6·5	....
16 Black cotton soil or other shrinkable or expansive clay in dry conditions (50 per cent saturation).	..	See Note (2) to be determined after investigation.
(d) Peat—		
17 Peat	..	See Notes (2) and (3) To be determined after investigation.
(e) Made upground—		
18 Fills or made up ground	..	See Notes (1) and (4) to be determined after investigation.

NOTE (1)—Compactness or looseness of non cohesive materials may be determined by driving a wooden picket of dimensions 5 cm. × 5 cm. × 70 cm. with a sharp point. The picket shall be pushed vertically into the soil by the full weight of a person and if the penetration of the picket exceeds 20 cm. the loose state shall be assumed to exist.

NOTE (2)—No generalized values for presumptive safe bearing capacity can be given for these types of soils. In such areas adequate site investigation shall be carried out and expert advice shall be sought.

NOTE (3)—Peat may occur in a very soft spongy condition or may be quite firm and compact. While ultimate bearing capacity may be high in the compact cases very large consolidation settlement occurs even under small pressures and the movements continue for decades.

NOTE (4)—The strength of made-up ground depends on the nature of the material, its depth and age and the methods used for consolidating it.

NOTE (5)—The presumptive safe bearing values may be increased by an amount equal to weight of the material (virgin soil) removed from above the bearing level that is the base of the foundation.

NOTE (6)—For non-cohesive soils, the presumptive safe bearing value shall be reduced by 50 per cent if the water table is above or near the bearing surface of the soil. If the water table is below the bearing surface of the soil at a distance at least equal to the width of the foundation, so such reduction shall apply. For intermediate depths of the water table, proportional reduction of the presumptive safe bearing value may be made.

(Extract of Table 2 in Par VI—Structural design—Section 2. Foundation in National Building Code.)

APPENDIX VII.

BASIC COMPRESSIVE STRESS FOR MASONRY MEMBERS AT AND AFTER THE STATED TIMES.

Serial number and description of mortar.	Mix (Parts by volume). *Cement.*	*Lime (see note 5).*	*Lime Pozzolana Mixture (See note 6).*	*Pozzolana.*	*Sand.*	*Hardening time after completion of work (see note 7).*
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Cement	1	0–¼C*	..	..	3	7
2. Cement	1	½ C*	..	..	4½	14
3. Cement-lime	1	1 C	..	..	6	14
4. Cement-lime	1	2 B	..	..	9	14
5. Cement	1	..	..	..	6	
6. Lime Pozzolana mixture ..	.	..	1	.	1·5	
7. Cement-lime	1	3 B or C	..	..	12	14
8. Hydraulic lime	..	1 A	..	..	2	14
9. Lime Pozzolana	..	1 C	..	1	2	
10. Lime	..	1 B	..	..	3	28

Serial number and description of mortar	Basic stress in kg/cm² corresponding to masonry units with crushing strength (kg./cm²). 35	70	105	140	175	210	280	350	440
(1)—*cont.*	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1. Cement	3·5	7·0	10·5	12·5	14·5	16·5	21·0	25·0	30·5
2. Cement	3·5	7·0	10·0	11·5	13·0	14·5	17·5	21·0	25
3. Cement-lime	3·5	7·0	10·0	11·0	12·0	13·0	16·0	19·0	22
4. Cement-lime	3·5	5·5	8·5	10·0	11·0	12·0	14·5	16·5	19
5. Cement									
6. Lime Pozzolana mixture ..									
7. Cement-lime	2·5	5·0	7·0	8·0	9·0	10·0	12·0	14·0	16
8. Hydraulic lime	2·5	5·0	7·0	8·0	9·0	10·0	12·0	14·0	16
9. Lime Pozzolana									
10. Lime	2·5	4·0	5·5	6·0	6·5	7·0	7·5	8·5	9·5

Note 1 : This table is valid for slenderness ratio 6 and the loading with zero eccentricity.

Note 2 : Lincer interpolation is permissible for units whose crushing strength are intermediate between those given in the table.

Note 3 : It is advisable to use plasticizers for cement mortars in order to improve properties of mortar, such as flow and water retentivity. Plasticizers should be used according to manufacturer's instructions.

Note 4 : Masonry cement mortars are also advisable and shall be used according to manufacturer's instructions. The mix proportion of masonry cement, sand shall be such as to give comparable mortar crusing strengths with the cement : lime : sand mortar of the particular grade.

Note 5 : Lime classification (Class A, B and C) and building lime shall conform to accepted standards [VI-4(2)].

Note 6 : For mortar under Sl. No. 6 lime pozzolana mixture shall be of grade LP 40 conforming to accepted standards. [VI-4(2)].

Note 7 : These periods should be increased by the full amount of any time during which the air temperature remains below 4·5°C plus half the amount of any time during which the temperature is between 4·5° C and 10° C.

* The inclusion of lime in cement mortar is optional.

[Extract from N.B. Code—Part VI Structural Design—Section (4)—Masonry—Table 4—Page VI-4-14)]

APPENDIX VIII.

WEIGHTS OF CONSTRUCTION MATERIALS.

	Weight. kg. per m^3
1. *Brick Masonry.—*	
(*a*) Common burnt clay bricks ..	1920
(*b*) Engineering bricks	2400
(*c*) Glazed bricks	2080
(*d*) Pressed bricks	2240
2. *Stone Masonry—*	
(*a*) Cast	2300
(*b*) Dry rubble	2080
(*c*) Granite ashler	2640
(*d*) Granite rubble	2400
(*e*) Lime stone ashler	2560
(*f*) Marble dressed	2700
(*g*) Sand stone	2240
3. *Cement Concrete, Plain—*	
(*a*) Aerated	760
(*b*) No-fines with heavy aggregate	1600 to 1920
(*c*) No-fines with light aggregate ..	880 to 1280
(*d*) With burnt clay aggregate ..	1760 to 2160
(*e*) With expanded clay aggregate ..	960 to 1680
(*f*) With clinker aggregate	1280 to 1760
(*g*) With pumice aggregate ..	560 to 1120
(*h*) With sand and gravel or crushed natural stone aggregate.	2240 to 2400
(*i*) With sand dust	640 to 1680
(j) With foamed slag aggregate ..	960 to 1840
4. *Cement Concrete, Reinforced—*	
With sand and gravel or crushed natural stone aggregate:—	
With 1% steel	2310 to 2470
With 2% steel	2370 to 2530
With 5% steel	2560 to 2720

Note.—For unit weights of other materials the above I.S. shall apply. (Extract from I.S. 1911-1967 Schedule of Unit weights of Building Materials.)

APPENDIX IX.

LIVE LOADS ON FLOORS.

Serial number.	*Loading class Number.*	*Types of floors.*	*Minimum live loads per kg/m^2 of floor, area.*	*Alternative minimum live load.*
(1)	(2)	(3)	(4)	(5)
1	200	Floors in dwelling houses, tenements, hospital wards, bedrooms and private sitting rooms in hostel and dormitories.	200	Subject to a minimum total load of 2·5 times the values in Col. 4 for any given slab panel and 6 times the values in Col, 4 for any given beam. This total load shall be assumed uniformly distributed on the entire area of the slab panel or the entire length of the beam.
2	250	Office floors other than entrance halls, floors of light workrooms.	250–400*	
3	300	Floors of banking halls, office entrance halls and reading rooms.	300	
4	400	Shop floors used for the display and sale of merchandise, floors of workrooms generally, floors of class rooms in schools, floors or places of assembly with fixed seating, restaurants, circulations space in machinery halls power stations, etc., where not occupied by plant or equivalent.	400	
5	500	Floors of warehouses, workshops, factories and other buildings or parts of buildings of similar category for light weight loads, office floors for storage and filing purposes and floors of places of assembly without fixed section, public rooms in hotels, dance halls, waiting halls, etc.	500	
6	700	Floors of warehouses, workshops, factories and other buildings or parts of buildings of similar category for medium weight loads.	750	....
7	1000	Floors of warehouses, workshops, factories and other buildings or parts of buildings of similar category for heavy weight loads, floors of book stores and libraries, roofs and pavement lifts over basement projecting under the public footpath.	1000	....

APPENDIX IX—*cont.*

LIVE LOADS ON FLOORS—*cont.*

Serial number.	*Loading class No.*	*Types of floors.*	*Minimum live loads per kg/m² of floors area.*	*Alternative minimum live load.*
(1)	(2)	(3)	(4)	(5)
8	Garage light.	Floors used for garage for vehicles not exceeding 2·5 tonnes gross weight		
		Slabs	400	The worst combination of actual wheel loads whichever is greater.
		Beams	250	
9	Garage heavy.	Floors used for garages for vehicles not exceeding 4 tonnes gross weight.	750	Subject to a maximum of one and a half times maximum wheel load but not less than 900 kg. considered to be distributed over 75 cm square.
10	Stairs.	Stairs, landings and corridors for lass 200 loading but not liable to over crowding.	300	Subject to a minimum of 130 kg. concentrated load at the unsupported end of each step for stairs constructed out of structurally independent cantilever steps.
		Stairs, landings and corridors for class 200 loading but liable to overloadings and for all other classes.	500	
11	Balcony.	Balconies not liable to over crowding—		
		For Class 200 loading	200	....
		For all other classes	500	....
		Balconies liable to overcrowing	500	....

*The lower value of 250 Kg./m² should be taken where separate storage facilities are provided and the higher value of 400 Kg./m² should be taken where such provisions are lacking.

NOTE 1: A reference to a "floor" includes a reference to any part of that floor and a reference to "slabs" includes boarding of beams or ribs spaced not further apart than one metre between centres and a reference to "beams" means all other beams and ribs.

NOTE 2: Under loading Class No. 250, the reference to light workrooms envisages room in which some light machines (for example, sewing machines used by milliners or tailors) are operated without any central power driven unit, that is, the machines are independently operated, either by hand or by small motors. Under loading class No.400,the reference to "dark rooms", generally envisages the installation of machines operated with a central power driven unit, with the individual machines being belt driven.

NOTE 3: "Fixed seating"implies that the removal of the seating and the use of the space for other purposes is improbable. The maximum likely load in this case is therefore, closely controlled.

NOTE 4: The loading in workshops, warehouses and factories varies considerably and so three loadings under terms "light" "medium" and "heavy" are introduced in order to allow for more economical designs but the terms have no special meaning in themselves other than the live load for which the relevant floor is designed. It is however, important particular in the case of heavy weight loads,to assess the atual loads to ensure that they are not in excess of 1,000 Kg./m² in cases where they are in excess the design shall be based on the actual loading.

NOTE 5: The load classification of stairs, corridors, balconies and landings provide for the fact that these often serve several occupancies and are used for transporting the furniture and goods.

(Extract from Table 1—Part VI Structural Design—Section 1—Loads of N.B.C.)

Dead load.

Assessment of dead load: The dead load in a building shall comprise the weight of all walls, partitions,floors and roofs and shall include the weight of all other permanent constructions in the buildings and shall conform to good practice. Where positioning of partitions are not decided, a uniformly distributed load of one third of wegiht of partition subject to a minimum of 100 kg./m² in case of office floors may be assumed.

(Extract of Clause 2·1—Part VI—Structural design—Section 1—Loads in N.B.C.—Table 1.)

APPENDIX X.

LIVE LOADS ON ROOF.

Serial number and type of roof. (1)	*Live load measured on plan.* (2)	*Minimum live load measured on plan.* (3)
1 Flat sloping or curved roof with slope upto and including 10 degrees—		
(a) Access provided	150 Kg./cm	375 Kg. uniformly distributed over any span of one metre width of the roof slab and 900 kg. uniformly distributed over the span in the case of all beams.
(b) Access not provided except for maintenace.	75 Kg./cm²	190 Kg. uniformly distributed over any span of one metre width of the roof slabs and 450 Kg. uniformly distributed over the span in the case of beams.
2 Sloping roof with slope greater than 10 degrees.	(a) For roof membrane, sheets or purlins— 75 kg./mm² less 2 kg./m² for every degree increase in slope over 10 degrees. (b) For membrane supporting the roof membrane and roof purlins, such as trusses, beams, girders, etc. 2/3 of load in (a). (c) Loads in (a) and (b) do not include loads due to snow, rain, dust collection, etc. and the effects of such load shall be appropriately considered.	Subject to a minimum of 40 Kg./m².
3 Curved roofs with slope are springing greater than 10 degrees.	$(75—345r^2)$ Kg./m² .. .. Where $r=h/l$ h=the height of the highest point of the structure. and l=Chord width of the roof if simply curved and shorter of the two sides and doubly curved.	Subject to a minimum of 40 Kg./m².

NOTE.—For special type of roofs with highly permeable and absorbent materials, the contingency of roof material increasing in weight due to absorption of moisture shall be provided for.

(Extract from Table 2—Part I—Structural Design—Section 1—Loads of N.B.C.)

APPENDIX—XI.

(a) Unit safe srtess for timber in compression.

Formula p .. .. 56·25—0·98 l/d.

Where p = permissible stress in kg. per sq. cm.
l = length in cm.
d = least dimension in cm.

l/d (1)		*p* (2)	*l/d* (1)	*p* (2)
8	..	48·41	17	39·59
9	..	47·43	18	38·61
10	..	46·45	19	37·63
11	..	45·47	20	36·65
12	.	44·49	21	35·67
13	..	43·51	22	34·69
14	..	42·53	23	33·71
15	..	41·55	24	32·73
16	..	40·57	25	31·75

l/d (1)		*p* (2)	*l/d* (1)	*p* (2)
26	.. .. ..	30·77	38	19.01
27	.. .. ..	29·79	39	18.03
28	.. .. ..	28·81	40	17.05
29	.. .. ..	27·83	41	16.07
30	.. .. ..	26·85	42	15.09
31	.. .. ..	25·87	43	14.11
32	.. .. ..	24·89	44	13.13
33	.. .. ..	23·91	45	12.15
34	.. .. ..	22·93	64	11.17
35	.. .. ..	21·95	47	10 19
36	.. .. ..	20·97	48	9 21
37	.. .. ..	19.29		

(b) Safe Permissible Loads on Posts of Standard Dimensions.

Serial number	*Section of posts.*	*Net area taken for calculations.*	*Safe loads in Kg.* — *Length of post (measured to top of bressummer).*					
			1·5 m.	2 m.	2·5 m.	3 m.	3·5 m.	4 m.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9
1	10x10 cm.	81·25 sq. cm. ..	3,375·94	2,977·81	2,579·69	2,181·56	1,783·44	1,385·31
2	12·5x12·5 cm.	135·94 sq. cm. ..	6,047·97	5,515·09	4,982·20	4,449·32	3,916·41	3,383·55
3	15x15 cm	198·44 sq. cm. ..	9,217·54	8,568·64	7,919·74	7,272·83	6,623·93	5,976·03

APPENDIX—XII (*a*).

TABLES FOR BEST INDIAN TEAKWOOD WHERE DESIGN IS BASED ON ALLOWABLE DEFLECTION.

DISTRIBUTED SAFE LOAD IN KG. FOR TIMBER CLASS II (STIFFNESS—DEFLECTION 1/480xSPAN).

(i) Stiffness formula (ends supported) : W (including weight of beam) $= \frac{0 \cdot 152\ bd^3}{L^2}$

Where W is in Kg., *b* and *d* in cm and L in metre.

Serial number.	*Standard Scantlings* *bxd*	*Clear span in metre.*								
		1	1·5	2	2·5	3	3·5	4	4·5	5
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	5x7·5	321	143	80	51	36	27	20	16	13
2	5x10·0	760	338	190	122	84	62	48	38	30
3	5x12·5	1,484	660	371	238	165	121	93	73	59
4	5x15·0	2,565	1,140	641	410	285	209	160	127	103
5	6·2x15	3,181	1,414	795	509	353	260	199	157	127
6	6·2x17·5	5,051	2,245	1,263	808	561	412	316	249	202
7	6·2x20	7,539	3,351	1,885	1,206	838	615	471	372	302
8	7·5x10	1,140	507	285	182	127	93	71	56	46
9	7·5x12·5	2,227	990	557	356	247	182	139	110	89
10	7.5x15 ..	3,848	1,710	962	616	428	314	240	190	154

Serial number.	Standard Scantlings b x d	Clear span in metre. 1	1·5	2	2·5	3	3.5	4	4.5	5
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(18)
11	7·5x17·5	6,110	2,715	1,528	978	679	499	382	302	244
12	7·5x20	9,120	4,053	2,280	1,459	1,013	744	570	450	365
13	7·5x22·5	12,985	5,771	3,246	2,078	1,443	1,060	812	641	519
14	10x12·5	2,969	1,319	742	475	330	242	186	147	119
15	10x15	5,130	2,280	1,283	821	570	419	321	253	205
16	10x17·5	8,146	3,621	2,037	1,303	905	665	509	402	326
17	10x20	12,160	5,404	3,040	1,946	1,351	993	760	600	485
18	10x22·5	17,314	7,695	4,328	2,770	1,924	1,413	1,082	855	693
19	10x25	23,750	10,556	5,938	3,800	2,639	1,939	1,484	1,173	950
20	12·5x17·5	10,183	4,526	2,546	1,629	1,131	831	636	503	407
21	12·5x20	15,200	6,756	3,800	2,432	1,689	1,241	950	751	608
22	12·5x22·5	21,642	9,619	5,411	3,463	2,405	1,767	1,353	1,069	865
23	12·5x25 . . .	29,688	13,194	7,422	4,750	3,299	2,423	1,855	1,466	1,188
24	15x20	18,240	8,107	4,560	2,918	2,027	1,489	1,140	901	730
25	15x22·5	25,971	11,543	6,493	4,155	2,886	2,120	1,623	1,283	1,039
26	15x50	2,85,000	1,26,667	71,250	45,600	21,667	23,265	17,813	14,074	11,400

(ii) Stiffness formula (ends partly fixed) : W (including weight of beam) $0{\cdot}38 \dfrac{pd^2}{L^2}$

Where W is in Kg., *b* and *d* in cm. and L in metres.

Serial number.	Standard scantlings cm. cm. b × d.	Clear span in metre. 1·0	1·5	2·0	2·5	3·0	3·5	4.0	4.5
(.)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	5 × 7·5	802	356	200	128	89	65	50	40
2	5 × 10	1,900	944	475	304	211	155	119	94
3	5 × 12·5	3,711	1,649	928	594	412	303	232	183
4	5 × 15	6,413	2,850	1,603	1,026	713	523	401	317
5	6·2 × 15	7,952	3,534	1,988	1,272	884	649	497	393
6	6·2 × 17·5	12,627	5,501	3,157	2,020	1,403	1,031	789	624
7	6·2 × 20 ..	18,848	8,377	4,712	3,016	2,094	1,539	1,128	931
8	7·5 × 10	2,850	1,267	713	456	317	233	178	141
9	7·5 × 12·5	5,566	2,474	1,392	891	618	454	348	275
10	7·5 × 15	9,619	4,275	2,405	1,539	1,069	785	601	475
11	7·5 × 17·5	15,274	6,789	3,819	2,444	1,697	1,247	955	754
12	7·5 × 20	22,800	10,133	5,700	3,648	2,533	1,861	1,425	1,126
13	7·5 × 22·5	32,463	14,428	8,116	5,194	3,607	2,650	2,029	1,603
14	10 × 12·5 . ..	7,422	3,299	1,855	1,188	825	606	464	367
15	10 × 15	12,825	5,700	3,206	2,052	1,425	1,047	802	633
16	10 × 17·5 ..	20,366	9,051	5,091	3,259	2,263	1,663	1,273	1,006
17	10 × 20	30,400	13,511	7,600	4,864	3,378	2,482	1,900	1,501

Serial Number.	Standard scantlings cm. × cm. b × d	Clear spans in metre. 1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
18	10 × 22·5	43,284	19,238	10,821	6,926	4,809	3,533	2,705	2,138
19	10 × 25	59,375	26,389	14,844	9,500	6,597	4,847	3,711	2,932
20	12.5 × 17·5 ..	25,457	11,314	6,364	4,073	2,829	2,078	1,591	1,381
21	12.5 × 20	38,000	16,889	9,500	6,080	4,222	3,102	2,375	1,877
22	12·5 × 22·5 ..	54,105	24,047	13,536	8,657	6,012	4,417	3,382	2,672
23	12·5 × 25	74,219	32,986	18,555	11,875	8,247	6,056	4,639	3,665
24	15 × 20	45,600	20,267	11,400	7,296	5,067	3,722	2,850	2,252
25	15 × 22.5	64,927	28,856	16,232	10,388	7,216	5,300	4,058	3,206
26	15 × 50	7,12,500	3,16,667	1,78,125	1,14,000	79,167	58,163	44,531	35,185

NOTE.—Common rafters are partly fixed if continuous and spiked to ridge piece, purlin and wall plate. Joists under terrace roots and floors may be given partly fixed enos by the use of fish-plates at joist joints (and will be more fixed, when built into a wall without air spaces) binding walls being used over the ends.

APPENDIX XII (*b*).

Table for best Indian Teakwood where design is based on allowable strength. Distributed Safe lead in kg. for timber class III (Strength).

(i) Strength formula (ends supported) :— W (including weight of beam)$=1\cdot52\times \frac{bd^2}{2}$ where w is in kg., b and d in cm. and L in metre.

Standard scantlings cm. × cm. b × d	Clear spans in metre. 1·0	1·5	2·0	2·5	3·0	3·5	4·0	4·5
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
5 × 7·5	428	285	214	171	143	122	107	95
5 × 10·0	760	507	380	304	253	217	190	169
5 × 12·5	1,188	792	594	475	396	339	297	264
5 × 15·0	1,710	1,140	855	684	570	489	428	380
6·2 × 15·0	2,120	1,414	1,060	848	707	606	530	471
6·2 × 17·5	2,886	1,924	1,443	1,154	962	825	722	641
6·2 × 20·0	3,770	2,513	1,885	1,508	1,257	1,077	942	838
7·5 × 10·0	1,140	760	570	456	380	326	285	253
7·5 × 12·5	1,781	1,188	891	723	594	509	445	396
7·5 × 15·0	2,565	1,710	1,283	1,026	855	733	641	570
7·5 × 17·5	3,491	2,328	1,746	1,397	1,164	998	873	776
7·5 × 20·0	4,560	3,040	2,280	1,824	1,520	1,303	1,140	1,013
7.5 × 22·5	5,771	3,848	2,886	2,309	1,924	1,649	1,443	1,283
10 × 12·5 .	2,375	1,583	1,188	950	792	679	594	528
10 × 15·0	3,420	2,280	1,710	1,368	1,140	977	855	760
10 × 17·5 . .	4,655	3,103	2,328	1,862	1,552	1,380	1,164	1,034
10 × 20·0 . .	6,080	4,053	3,040	2,432	2,027	1,737	1,520	1,351
10 × 22·5	7,695	5,130	3,848	3,078	2,565	2,199	1,924	1,710
10 ×25 .. .	9,500	,333	4,750	3,800	3,167	2,714	2,375	2,111

Standard scantlings cm. × cm. b × d	Clear spans in metre. 1·0	1·5	2·0	2·5	3·0	3·5	4·0	4·5
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
12·5 × 17·5	5,819	3,879	2,909	2,328	1,940	1,663	1,455	1,293
12·5 × 20	7,600	5,067	3,800	3,040	2,533	2,171	1,900	1,689
12·5 × 22·5	9,619	6,413	4,809	3,848	3,206	2,748	2,405	2,138
12·5 × 25	11,875	7,917	5,938	4,750	8,958	3,393	2,969	2,639
15·0 × 20	9,120	6,080	4,560	3,648	3,040	2,606	2,280	2,027
15·0 × 22·5	11,543	7,695	5,771	4,617	3,848	3,298	2,886	2,565
15·0 × 50	57,000	38,000	28,500	22,800	19,000	16,286	14,250	12,667

(ii) Strength formula (ends partly fixed) :—W (including weight of beam) = $\frac{1\cdot9\ bd^2}{L}$ Where W is in kg, b and d in cm. and L in metre.

5 × 7·5	534	356	267	214	178	153	134	119
5 × 10	950	633	475	80	317	271	238	211
5 × 12·5	1,484	990	742	594	495	424	371	330
5 × 15	2,138	1,425	1,069	855	713	611	534	475
6·2 × 15	2,651	1,767	1,325	1,060	884	757	663	582
6·2 × 17·5	3,608	2,405	1,804	1,443	1,203	1,031	902	801
6·2 × 20	4,712	3,141	2,356	1,885	1,571	1,346	1,178	1,045
7·5 × 10	1,425	950	713	570	475	407	356	317
7·5 × 12·5	2,227	1,484	1,113	891	742	636	557	495
7·5 × 15	3,206	2,138	1,603	1,283	1,069	916	802	713
7·5 × 17·5	4,364	2,909	2,182	1,746	1,455	1,247	1,091	970
7·5 × 20	5,700	3,800	2,850	2,280	1,900	1,629	1,425	1,267
7·5 × 22.5	7,214	4,809	3,607	2,896	2,493	2,061	1,804	1,609
10 × 12·5	2,969	1,979	1,484	1,188	900	848	742	660
10 × 15	4,275	2,850	2,138	1,710	1,423	1,221	1,069	950
10 × 17·5	5,819	3,879	2,909	2,328	1,940	1,663	1,455	1,293
10 × 20	7,600	5,067	3,800	3,040	2,533	2,171	1,900	1,689
10 × 22·5	9,619	6,413	4,809	3,848	3,206	2,748	2,405	2,138
10 × 25	11,875	7,917	5,938	4,750	3,958	3,393	2,969	2,639
12·5 × 17·5	7,273	4,849	3,637	2,009	2,424	2,078	1,818	1,616
12·5 × 20	9,500	6,333	4,750	3,800	3,167	2,714	2,375	2,111
12·5 × 22·5	12,023	8,016	6,012	4,809	4,008	3,435	3,006	2,671
12·5 × 25	14,844	9,896	7,422	5,938	4,948	4,241	3,711	3,299
15 × 20	11,400	7,600	5,700	4,560	3,800	3,257	2,850	2,538
15 × 22·5	14,428	9,619	7,214	5,771	4,800	4,122	3,607	3,203
15 × 50	71,250	47,500	35,625	28,504	11,130	20,357	17,813	5,833

NOTE—Same note as under Appendix XII (*a*).

APPENDIX XIII (A)

Permissible stresses Pt in Axial Tensioning in Structural Steel.

Form.	*Steel conforming to.*	*Thickness or Diameter.*	*Pt. Kg/cm²*
(1)	(2)	(3)	(4)
Rolled I beams and channels	I.S. 326/1969 I.S. 2062/1969 and St. 42-0 of I.S. 1977/1969.	All	1,500
Plates, bars, universal beams and columns and sections other than above.	I.S. 226/1969 I.S. 2062/1969 and St. 42-0 of I.S. 1977/1969.	Up to and including 20 mm. ..	1,500
		Over 20 mm.	1,420
Plates, Sections and bars	I.S. 961/1962, H.T. Grade	Upto and including 45 mm. ..	2,125
Plates, Sections and bars	I.S. 961/1962, H.T. Grade	Over 45 mm.	1,810
Plates, Sections and bars	I.S. 961/1962, H.T.W. Grade	Up to and including 32 mm. ..	2,125
	I.S. 961/1962, H.T.W. Grade	Over 32 mm.	1,810
Tubes	I.S. 1161/1968, Grade	Yst 22	1,250
		Yst 25	1,500
	..	Yst 32	1,900

(Extract from N.B.C. Part VI—Structural Design—Section 6—Steel—Table I—Page VI—6-5)

APPENDIX XIII (B).

Permissible Stress in Axial Compression in Structural Steel.

(Clause 7·2·2·1 (a) — (Pe in kg/cm²).

$\frac{l}{r}$	*Steel conforming to I·S.* 226·69 *and St.* 42·0 *of I.S.* 1977/69.	*Steel Conforming to I.S.* 961/62			*Steel Tubes conforming to I.S.* 1161/1968 *Grade.*		
		HTW grade thickness not exceeding 32 *mm.*	*TH grade thickness exceeding* 45 *mm. and HTW grade thickness exceeding* 32 *mm.*	*HT grade thickness not exceedng* 45 *mm.*	*Yst* 22	*Yst* 25	*Yst* 32
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
0	1,250	1,719	1,640	1,719	1,250	1,500	1,900
10	1,246	1,713	1,635	1,713	1,217	1,448	1,821
20	1,239	1,698	1,621	1,698	1,175	1,400	1,750
30	1,224	1,670	1,596	1,670	1,131	1,352	1,679
40	1,203	1,626	1,556	1,626	1,088	1,303	1,610
50	1,172	1,563	1,499	1,563	1,046	1,255	1,439
60	1,130	1,475	1,422	1,475	1,002	1,207	1,468
70	1,075	1,363	1,320	1,363	970	1,155	1,375
80	1,007	1,230	1,199	1,230	929	1,088	1,283
90	928	1,089	1,067	1,089	876	1,003	1,128
100	840	953	939	953	814	910	989
110	753	830	821	830	745	813	869
120	671	724	717	724	674	721	758
130	597	634	629	634	603	638	665
140	531	557	554	537	540	585	584
150	474	493	490	493	490	503	517
160	423	438	436	438	432	443	450
170	377	387	386	387	381	392	398
180	336	344	343	344	339	348	353
190	300	307	306	307	304	311	315
200	270	275	274	275	271	278	280
210	243	244	246	247	243	249	250
220	219	223	222	223	219	225	227
230	199	202	202	202	198	204	205
240	181	183	183	183	180	185	187
250	166	167	167	167	162	167	167
300	109	110	110	110	106	106	106
350	76	76	76	76	71	71	7

Note.— Intermediate values may be obtained by linear interpolation.

(Extract from N.B.C. Part VI— Structural Design—Section 6—Steel Table 2—Page VI—6-6.)

APPENDIX XIII (C).

Permlssible stressess Pbc or Pbt in bending in Structural Steel.

Serial number. (1)	*Form.* (2)	*Steel conforming to.* (3)	*Thickness or Diameter.* (4)	*Pbc or Pbt.* (5) *Kg./cm2.*
1.	Rolled I beams and channels	I.S. 226/1969, I.S. 2062/1969 and St. 42-0 of I.S. 1977/69.	All	1,650
2.	Compound girders composed of rolled I beams or channels, with cover plates of thickness.	I,S. 226/1969, I.S. 2062/1969 and St. 42-0 of I.S. 1977/1969.	Upto and including 20 mm. ..	1,650
			Over 20 mm.	1,575
3.	Plates, flats, universal beams* and columns, rounds, squars, angles, tees and any other sections.	I.S. 226/1969, I.S. 2062/1969 and St. 42-0 of I.S. 1977/1969.	Upto and including 20 mm. ..	1,650
			Over 20 mm.	1,575
4.	Plates, girders with angle or multiple webs ..	I.S. 226/1969, I.S. 206 /1969 and St. 42-0 of I.S. 1977/1969.	Upto and including 20 mm. ..	1,575
			Over 20 mm.	1,500
5.	Plates, flats, rounds, squares and other similar sections. rolled I-beams, double webs forming a symmetrical I Sections which act as an integral unit, compound beams compound of rolled II-beams or webs with cover plates, single channels, angles and tees.	I.S. 961/1962, H.T. Grade ..	Upto and ineluding 45 mm. ..	2,285
			Over 45 mm. upto and including 60 mm.	1,970
		I.S. 961/1962, H.T.W. Grade ..	Upto and including 32 mm. ..	2,258
			Over 32 mm.	1,970
6.	Plate girders with single or multiple webs ..	I.S. 961/1962, H.T. Grade ..	Upto and including 63 mm. ..	2,125
			Over 63 mm.	1,890
		I.S. 961/1962, H.T.W. Grade ..	Upto and including 32 mm. ..	2,125
			Over 32 mm.	1,890
7.	Tubes	I.S. 1161/1968 Grade ..		
		Yst 22		1,400
		Yst 25		1,655
		Yst 32		4,080

* Not being produced in India at present.

(Extract from N.B.C. Part VI— Structural Design— Section 6— Steel— Table 3— Page VI-6-7.)

APPENDIX-XIV.

Value of Rivets accordance with I. S. 800-1962 for mild steel power driven shop rivets.

Turned and fited bolts.

Dia. of Rivett in mm. As per I. S. 1929—1961.	Axil tension (785 kg/cm 2.)	Single shear (1025 kg/cm 2).	Double shear (Twice single shear).	Values in. Bearing (2360 kg/cm 2) Thickness of Plate in mm. as per I. S. 1730-1961. (5)	(6)	(8)	(10)	(12)	(14)	(16)	(18)	(20)	(22)	(25)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
12	888.2	1159.7	2319.4	1416.0	1699.2	2265.6	2832.0	..						
14	1208.9	1578.5	3157.0	1652.0	1982.4	2643.2	3304.0	3964.8						
16	1578.0	2061.7	4123.4	1888.0	2265.6	3020.8	3776.0	4531.2	s5286.4					
20	2467,1	3221.4	6442.8	2360.0	2832.0	[3776.0	4720.0	5664.0	6608.0	7552.0	8496.0			
18	s1998.4	2609.4	5218.8	2124.0	2548.8	3398.4	4218.0	5097.6	5947.2	6796.8				
22	2985.2	3897.9	7795.8	2596.0	3115.6	4153.6	5192.0	6231.2	7268.8	8307.2	9345.6	10384.0		
24	3552.7	4638.9	9277.8	2832.0	3398.4	34531.2	5664.0	6796.8	7929.6	9062.4	10195.2	11328.0	12460.8	
27	4496.4	5871.1	11742.2	3186.0	3823.2	5097.6	6372.0	7946.0	8920.8	10195.2	11469.6	12744.0	14018.4	15930.0

Power Driven Field Rivets.

Dia. of Rivert mm.	Axil tension 630 kg/cm 2.	Single shear 945 kg/cm2.	Double shear (Twice single).	Values in. Bearing 2125 kg/cm2 Thickness of plate in mm. (5)	(6)	(8)	(10)	(12)	(14)	(16)	(18)	(20)	(22)	(25)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
12	712.8	1069.2	2130.4	1275.0	1530.0	2040.0	2550.0							
14	970.2	1455.3	2910.6	1487.5	1785.0	380.0	2975.0	3570.0						
16	1267.2	1900.8	3801.6	1700.0	2040.0	2720.0	3400.0	4080.0	4760.0					
18	1603.8	2405.7	4811.4	1912.5	2295.0	3060.0	3825.0	4590.0	5355.0	6120.0				
20	1980.0	2970.0	5940.0	2125.0	2550.0	3400.0	4250.0	5100.0	5950.0	6800.0	7650.0			
22	2395.8	3593.7	7187.4	2337.5	2805.0	3740.0	4675.0	5610.0	6545.0	7480.0	8415.0	9350.0		
24	2851.2	4276.8	8553.6	2550.0	3060.0	4080.0	5100.00	[6120.0	7140.0	8160.0	9180.0	10200.0	11220.0	
27	3608,6	5412.9	10225.8	2868.8	3442.5	4590.0	5737.5	6885.0	8032.5	9180.0	10327.5	11475.0	12622.5	14343.75

Black Bolts.

Diameter in mm.	Axial tension 680 kg/cm2.	Single shear 865 kg/cm2.	Double shear (Twice single shear).	Values in. Bearing 2046 kg/cm2. thickness of plate in mm. (5)	(6)	(8)	(10)	(12)	(14)	(16)	(18)	(20)	(22)	(25)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
12	769.4	978.7	1957.4	1227.0	1472.4	1963.2	2454.0	..	..	..	..	..	..	..
14	1047.2	1332.1	2664.2	1431.5	1717.8	2290.4	2863.0	3435.6	..	..	..	..	..	..
16	1367.8	1739.9	3479.8	1636.0	1963.2	2617.6	3272.0	3926.4	4580.8	..	..	..	..	..
18	1731.1	2202.0	4404.0	1840.5	2208.6	2944.8	3681.0	4417.2	5153.4	5889.6	..	..	..	..
20	2137.1	2718.6	5437.2	2045.7	2454.0	3272.0	4090.0	4908.7	5726.0	6544.0	7362.0	..	..	..
22	2585.9	3289.5	6579.0	2249.6	2699.4	3517.4	4499.0	5398.8	6298.6	7304.8	8098.2	8998.0	..	..
24	3077.5	3914.7	7339.4	2454.0	2944.8	3926.4	4903.7	5889.6	6871.2	7853.0	8834.7	9816.0	10797.6	..
27	3894.9	4954.6	9909.2	2760.75	3312.9	4417.2	5521.5	6625.8	7730.1	8834.4	9938.7	11043.0	12147.3	12803.75

Hand Driven Rivets.

Diameter in mm	Axial tension 520 kg/cm2.	Lingle shear 785 kg/cm 2.	Double shear (Twice single).	Values in. Be2ring 1575 kg/cm2 Thickness o! Plate in mm. (5)	(6)	(8)	(10)	(12)	(14)	(16)	(18)	(20)	(22)	(25)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
12	588.3	888.2	1776.4	945.0	1134.0	1512.0	1890.0	..	..	..	..	..	..	..
14	800.8	1208.9	2417.8	1102.5	1323.0	1764.0	2205.0	2646.0	..	..	..	..	..	..
16	1045.9	1578.0	3156.0	1260.0	1512.0	2016.0	3530.0	3024.0	3528.0	..	..	..	..	..
18	1323.8	1998.4	3996.8	1417.5	1701.0	2268.0	2835.0	3402.0	3699.0	4536.0	..	..	..	..
20	1634.3	2467.1	4934.2	1575.0	1890.0	2520.0	3150.0	3780.0	4410.0	5040.0	5670.0	..	..	..
22	11977.5	2985.2	5970.4	1732.5	2079.0	2772.0	3465.0	4158.0	4851.0	5544.0	6237.0	6930.0	..	..
24	2353.4	2552.7	7105.4	1890.0	2268.0	3024.0	3780.0	4536.0	5292.0	6048.0	6804.0	7560.0	—	..
27	2978.5	4496.4	8992.0	2126.25	2551.5	3402.0	4252.5	5103.0	5953.5	6804.0	7654.5	8505.0	3316.0 9355.5	10631.25

APPENDIX—XV.

TABLE OF WEIR DISCHARGE AS GIVEN IN CIRCULAR.

Memorandum Dis. No. 77, dated 20th January 1911.

FORMULA $D = 2/3 Cd.L. \sqrt{2g}\ h^{3/2}$

(The discharges furnished in this Table are for 0.3 m length of weir.)

Serial number	Head of water in Metres.	$Cd = \frac{2}{3} = 0.667$ Discharge in cums. Sharp-crested wier.	$Cd = \frac{10}{16} = 0.625$ Discharge in cumecs. Narrow-crested Masonry Weir.	$Cd = \frac{9}{16} = 0.562$ Discharge in cumecs. Broad-crested weirs. Where $w > h$ (w being width of weir and h depth of crest)	$Cd = \frac{8}{16} = 0.500$ Discharge in cumecs. Rought-stone escapes.	$Cd = \frac{7}{16} = 0.437$ Discharge in cumecs. Paved-Bye-Washes.	$Cd = \frac{6}{16} = 0{\cdot}375$ Discharge in cumecs. Natural Bye-washes.	Head of water in metres.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	0.075	0.012	0.011	0.010	0.009	0.050	0.007	0.075
2	0.150	0.034	0.032	0.029	0.026	0.023	0.019	0.150
3	0·225	0.063	0.059	0.053	0.047	0·041	0.035	0.225
4	0.300	0.097	0.091	0.082	0.073	0·064	0.055	0.300
5 ..	0.375	0.136	0.127	0.114	0.102	0.089	0.076	0.375
6	0.450	0.178	0.167	0.150	0.134	0.117	0.100	0.450
7	0.525	0.225	0.211	0.190	0.169	0.147	0.126	0.525
8	0.600	0.275	0.258	0.232	0.206	0.181	0.155	0.600
9	0.675	0.328	0.307	0.276	0.246	0.215	0.184	0.675
10	0.750	0.384	0.360	0.324	0.288	0.252	0.216	0.750
11	0.825	0.443	0.415	0.373	0.332	0.290	0·249	0.825
12	0.900	0.504	0'473	0.425	0.378	0.331	0.284	0.900
13	0.975	0·569	0.533	0·480	0.426	0.373	0.320	0.975
14	1.050	0·635	0.596	0.536	0.477	0.417	0.357	1.050
15	1.125	0.705	0.661	0.594	0.528	0.462	0.396	1,125
16	1.200	0.776	0.728	0.655	0.582	0.509	0.437	1,200
17	1,350	0.926	0.868	0.781	0.695	0.608	0.521	1,350
18	1,500	1.08	1.02	0.915	0.814	0.715	0.610	1.500
19	1,650	1.25	1.17	1.06	0.939	0.822	0.704	1 650
20	1,800	1.43	1.34	1.20	1.07	0 936	0 808	1 800

The discharge for a drowned weir for one metre length $= \frac{D}{L}$

$$\frac{D}{L} = 1.712\ [\ (h+ha)^{3/2} - ha\ 3/2.]$$

$$+\ 4.417\ Cd\ d(h+ha)^{\frac{1}{2}}.$$

Where 'h' represents the known difference of water level between front and rear, 'ha' the positive head due to velocity of approach either gauged or otherwise known, do the depth of tail, water over crest and L = the length of weir in metres. Different values of Cd are given E.I.'s No. 2973/17 C, dated 4th October 1917 for various depth of tail water and a diagram is included therein.

Depth of tail water.	Cd.
0.30 to 1.5 m	0.60
1.8 m...	0.62
2.1 m	0.66
2.4 m	0.75
2.7 m	0.84
3.0 m	0.90
3.3 m	0.93
3.6 m and over	0.95

APPENDIX XVI (a)

Cement Concrete pipe sluices.

Table of Discharge of concrete pipes of Diametre ranging from 80 *mm to* 600 *mm and of lengths from* 1 *to* 18 *m. Under varying working heads from* 0.005 *m to* 1.5 *m.*

Formula $D = Cd\ A.\ \sqrt{2\ gh}$ (For values of Cd, *vide* Appendix XV-B)

Ref. Chief Engineer's (Irrigation) Circular Memo. 3354/37 dated 4th August 1938).

Discharge Table for 80 mm pipe in cu.mecs.

Serial number.	*Working Head 'H' Metre.*	*Length in metres.*					
		1	2	6	9	12	15
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	0.005	0.0012	0.0010	0.00084	0.00072	0.00063	0.00055
2	0.015	0.0021	0.0018	0.0015	0.0012	0.0011	0.00096
3	0.030	0.0029	0.0025	0.0021	0.0018	0.0015	0.0014
4	0.050	0.0038	0.0038	0.0027	0.0023	0·0020	0.0017
5	0.075	0·0046	0·004	0.0033	0.0028	0.0024	0.0021
6	0.105	0.0055	0.0047	0.0038	0.0033	0.0029	0.0025
7	0.140	0.0063	0.0054	0.0044	0.0038	0.0033	0.0029
8	0.180	0.0072	0.0061	0.0050	0.0043	0.0038	0.0033
9	0.225	0.0080	0.0068	0.0056	0.0048	0.0042	0.0038
10	0.275	0.0089	0.0076	0.0063	0.0053	0.0046	0.0041
11	0.330	0.0097	0.0083	0.0068	0.0058	0.0051	0.0045
12	0.390	0.0105	0.009	0.0074	0.0063	0.0055	0.0049
13	0.455	0.0114	0.0097	0.0080	0.0068	0.0060	0.0053
14	0.525	0.0122	0.0105	0.0086	0.0073	0.0064	0.0057
15	0.600	0.0131	0.0112	0.0092	0.0078	0.0069	0.0060
16	0.680	0.0139	0.0119	0.0098	0.0083	0.0073	0.0064
17	0.765	0.0148	0.0126	0.0104	0.0089	0.0077	0.0068
18	0.855	0.0156	0.0134	0.0110	0.0093	0.0082	0.0072
19	0.950	0.0164	0.0141	0.0116	0.0099	0.0086	0.0076
20	1.050	0.0173	0.0148	0.0122	0.0104	0.0091	0.0080
21	1.155	0.0182	0.0155	0.0127	0.0109	0.0095	0.0084
22	1.265	0.0190	0.0162	0.0133	0.0114	0.0099	0,0088
23	1.380	0.0198	0.0170	0.0139	0.1119	0.0104	0.0092
24	1.500	0.0207	0.0177	0.0145	0.0124	0.0108	0.0095

Note : $g = 9.807\ m/Sec^2$

DISCHARGE TABLES FOR 100 *mm* PIPE.

DISCHARGE IN CUMECS.

Serial number.	Working head 'H' Metres.	Length in metres. 1	3	6	9	12	15	18
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	0.005	0.00198	0.00167	0.0014	0.00124	0.00108	0.00098	0.00089
2	0.015	0.00328	0.0029	0.0024	0.0021	0.0019	0.0017	0.0015
3	0.030	0.0046	0.0041	0.0034	0.0030	0.0027	0.0024	0.0022
4	0.050	0.0060	0.0053	0.0044	0.0039	0.0034	0.0031	0.0028
5	0.075	0.0074	0.0065	0.0054	0.0048	0.0042	0.0038	0.0034
6	0.105	0.0087	0.0076	0.0064	0.0057	0.0050	0.0045	0.0041
7	0.140	0.010	0.0088	0.0074	0.0065	0.0057	0.0052	0.0047
8	0.180	0.0114	0.0100	0.0084	0.0074	0.0065	0.0059	0.0053
9	0.225	0.0127	0.0112	0.0094	0.0083	0.0073	0.0066	0.0060
10	0.275	0.0141	0.0124	0.0104	0.0092	0.0080	0.0073	0.0066
11	0.330	0.0154	0.0135	0.0114	0.0100	0.0088	0.0080	0.0072
12	0.390	0.0168	0.0147	0.0124	0.0109	0.0096	0.0087	0.0078
13	0.455	0.0181	0.0159	0.0134	0.0118	0.0103	0.0093	0.0085
14	0.525	0.0194	0.0171	0.0144	0.0127	0.0111	0.0100	0.0091
15	0.600	0.0208	0.0183	0.0154	0.0135	0.0119	0.0107	0.0097
16	0.680	0.0221	0.0195	0.0164	0.0144	0.0126	0.0114	0.0103
17	0.765	0.0235	0.0207	0.0174	0.0153	0.0134	0.0121	0.0110
18	0.855	0.0248	0.0218	0.0184	0.0162	0.0142	0.0128	0.0116
19	0.950	0.0262	0.0230	0.0194	0.0171	0.0149	0.0135	0.0122
20	1.050	0.0275	0.0242	0.0203	0.0179	0.0157	0.0142	0.0129
21	1.155	0.0288	0.0254	0.0214	0.0188	0.0165	0.0149	0.0135
22	1.265	0.0302	0.0266	0.0224	0.0197	0.0172	0.0156	0.0141
23	1.380	0.0315	0.0277	0.0233	0.0206	0.0180	0.0163	0.0147
24	1.500	0.0328	0.0289	0.0243	0.0214	0.0188	0.0170	0.0154

DISCHARGE TABLE FOR 150 MM. PIPE.

DISCHARGE IN CUMECS.

Working head 'H' Metres.	Length in metres.						
	1	3	6	9	12	15	18
0.005	0.0044	0.0040	0,0035	0,0032	0.0029	0,0027	0.0024
0.015	0.0076	0.0069	0.0061	0.0055	0.0050	0.0046	0.0042
0.030	0.0107	0.0098	0.0086	0.0077	0.0071	0.0065	0.0060
0.050	0.0138	0,0126	0.0111	0.0010	0.0091	0.0084	0.0077
0.075	0.0170	0.0155	0.0136	0,0122	0,0112	0.0103	0.0094
0.105	0.020	0,0183	0.0161	0.0144	0.0132	0.0122	0.0112
0.140	0.0232	0.0211	0.0186	0.0167	0.0152	0.0141	0.0123
0.180	0.0262	0.0239	0.0211	0,0189	0,0173	0,0159	0,0146
0.225	0.0294	0.0268	0.0236	0.0212	0.0193	0.0178	0,0163
0.275	0.0325	0,0296	0.0261	0,0234	0,0214	0,0197	0.0181
0.330	0.0356	0.0324	0,0286	0.0257	0.0234	0.0216	0.0198
0.390	0.0386	0.0352	0.0311	0.0279	0.0254	0.0235	0.0215
0.455	0.0418	0,0381	0.0336	0.0301	0.0275	0.0254	0.0232
0.525	0.0448	0.0408	0.0360	0,0324	0.0295	0.0272	0.0250
0.600	0.0480	0.0437	0.0385	0.0346	0.0316	0.0291	0.0267
0.680	0.0510	0.0465	0.0410	0.0368	0.0336	0.0310	0.0284
0.765	0.0542	0.0493	0.0435	0.0390	0.0356	0.0329	0.0302
0.855	0.0573	0.0522	0.0460	0.0413	0.0377	0.0348	0.0319
0.950	0.0603	0.0550	0.0484	0.0435	0.0397	0.0366	0.0336
1.050	0.0634	0.0578	0.0510	0.0457	0.0417	0.0385	0.0353
1.155	0.0665	0.0606	0.0535	0.0480	0.0438	0.0404	0.0371
1.265	0.0696	0.0634	0.0559	0.0502	0.0458	0.0423	0.0388
1.380	0.0726	0.0662	0.0584	0.0524	0.0478	0.0441	0.0404
1.500	0.0758	0.0690	0.0609	0.0546	0.0498	0.0460	0.0422

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DISCHARGE TABLES FOR 250 mm PIPE.

DISCHARGE IN CUMECS.

Working Head 'H' Meters.	Length in meters.						
	1	3	6	9	12	15	18
0.005	0.0125	0.0117	0.0108	0.0101	0.0904	0.0088	0.0083
0.015	0.0216	0.0202	0.0187	0.0175	0.0163	0.0152	0.0144
0.030	0.0305	0.0286	0.0264	0.0247	0.0230	0.0215	0.0204
0.050	0.0394	0.0370	0.0341	0.0320	0.0297	0.0278	0.0263
0.075	0.0483	0.0453	0.0417	0.0390	0.0364	0.0340	0.0322
0.105	0.0570	0.0535	0.0493	0.0462	0.0429	0.0402	0.0380
0.140	0.0658	0.0618	0.0568	0.0533	0.0496	0.0464	0.0439
0.180	0.0747	0.0704	0.0646	0.0605	0.0563	0.0526	0.0498
0.225	0.0835	0.0784	0.0722	0.0676	0.0630	0.0588	0.0557
0.275	0.0925	0.0867	0.0798	0.0747	0.0695	0.0650	0.0616
0.330	0.1012	0.095	0.0875	0.0818	0.0762	0,0712	0.0675
0.390	0.1100	0.1032	0.0950	0.0890	0.0828	0.0774	0.0733
0.455	0.1190	0.1115	0.1028	0.0960	0.0895	0.0836	0.0792
0.525	0.1275	0.1196	0.1102	0.1032	0.0960	0.0898	0.0850
0.600	0.1364	0.1280	0.1179	0.1102	0.1028	0.0960	0.091
0.680	0.1453	0.1364	0.1255	0.1175	0.1093	0.1022	0.0968
0.765	0.1542	0.1447	0.1334	0.1247	0.1160	0.1084	0.1028
0.855	0.1630	0.1530	0.1408	0.1318	0.1228	0.1147	0.1085
0.950	0.1718	0.1611	0.1483	0.1389	0.1294	0.1208	0.1145
1.050	0.1805	0.1692	0.1560	0.1460	0.1360	0.1270	0.1204
1.155	0.1893	0.1778	0.1636	0.1531	0.1428	0.1333	0.126[illegible]
1.265	0.1982	0.1860	0.1713	0.1603	0.1492	0.1395	0.1321
1.380	0.2070	0.1941	0.1789	0.1672	0.1558	0.1406	0.1380
1.500	0.2158	0.2025	0.1865	0.1745	0.1625	0.1518	0.1439

DISCHARGE TABLES FOR 300 mm PIPE.

DISCHARGE IN CUMECS.

Working head 'H' Metres.	Length in metres.						
	1	3	6	9	12	15	18
0.005	0.018	0.0171	0.0159	0.0150	0.0141	0.0134	0.0126
0.015	0.0311	0.0296	0.0277	0.0260	0.0244	0.0232	0.0219
0.030	0.044	0.418	0.0391	0.0368	0.0345	0.0329	0.0310
0.050	0.0568	0.0540	0.0505	0.0475	0.0445	0.0424	0.040
0.075	0.0695	0.0661	0.0618	0.0582	0.0545	0.0519	0.0489
0.105	0.0821	0.0780	0.0729	0.0687	0.0644	0.0613	0.0578
0.140	0.0948	0.0902	0.0843	0.0793	0.0744	0.0708	0.0667
0.180	0.1078	0.1023	0.0957	0.090	0.0844	0.0804	0.0758
0.225	0.1204	0.1144	0.1070	0.1005	0.0943	0.0899	0.0847
0.275	0.1329	0.1264	0.1180	0.1110	0.1041	0.0994	0.0935
0.330	0.1459	0.1387	0.1297	0.1220	0.1145	0.1090	0.1025
0.390	0.1586	0.1508	0.1410	0.1325	0.1242	0.1185	0.1115
0.455	0.1712	0.1628	0.1522	0.1432	0.1343	0.1278	0.1205
0.525	0.1838	0.1746	0.1633	0.1535	0.1440	0.1372	0.1293
0.600	0.1966	0.1870	0.1750	0.1645	0.1542	0.1463	0.1384
0.680	0.2090	0.1988	0.1860	0.1750	0.1640	0.1563	0.1473
0.765	0.2220	0.2110	0.1970	0.1855	0.1740	0.1656	0.1560
0.855	0.2345	0.2230	0.2085	0.1960	0.1838	0.1750	0.1650
0.950	0.2472	0.2350	0.2198	0.2068	0.1938	0.1845	0.1740
1.050	0.2600	0.2470	0.2312	0.2174	0.2038	0.1941	0.1830
1.155	0.2728	0.2595	0.2424	0.2280	0.2139	0.2038	0.1920
1.265	0.2854	0.2714	0.2536	0.2388	0.2238	0.2130	0.2008
1.380	0.2981	0.2835	0.2650	0.2493	0.2338	0.2225	0.2098
1.500	0.3110	0.2956	0.2765	0.2600	0.2438	0.2323	0.2188

DISCHARGE TABLES FOR 350 mm PIPE.

DISCHARGE IN CUMECS.

Working head 'H' Metres.	Length in metres.						
	1	3	6	9	12	15	18
0.005	0.0244	0.0234	0.0221	0.0209	0.0199	0.0188	0.0181
0.015	0.0423	0.0406	0.0383	0.0362	0.0345	0.0326	0.0313
0.030	0.0598	0.0574	0.0543	0.0513	0.0488	0.0462	0.0444
0.050	0.0773	0.0742	0.0700	0.0662	0.0630	0.0595	0.0573
0.075	0.0946	0.0908	0.0857	0.0811	0.0772	0.0728	0.0702
0.105	0.1118	0.1072	0.1012	0.0958	0.0912	0.0862	0.0829
0.140	0.1291	0.1239	0.1170	0.1107	0.1052	0.0994	0.0957
0.180	0.1467	0.1406	0.1328	0.1255	0.1195	0.1130	0.1088
0.225	0.1639	0.1572	0.1484	0.1405	0.1338	0.1262	0.1215
0.275	0.1814	0.1740	0.1648	0.1555	0.1480	0.1398	0.1344
0.330	0.1986	0.1904	0.1800	0.1700	0.1620	0.1530	0.1471
0.390	0.2159	0.2070	0.1955	0.1850	0.1760	0.1668	0.1600
0.456	0.233	0.2236	0.2110	0.1995	0.1900	0.1795	0.1726
0.525	0.2509	0.2406	0.2268	0.2142	0.2040	0.1926	0.1854
0.600	0.2678	0.2568	0.2425	0.2292	0.2183	0.2062	0.1985
0.680	0.2850	0.2736	0.2580	0.2440	0.2325	0.2195	0.2110
0.765	0.3020	0.2895	0.2736	0.2588	0.2465	0.2325	0.2239
0.855	0.3195	0.3065	0.2895	0.2735	0.2605	0.2460	0.2366
0.950	0.3370	0.3230	0.3050	0.2888	0.2750	0.2596	0.2499
1.050	0.3548	0.3400	0.3212	0.3038	0.2890	0.2730	0.2625
1.155	0.3716	0.3562	0.3365	0.3182	0.3025	0.2860	0'2750
1.265	0.3885	0.3726	0.3520	0.3330	0.3170	0.2995	0.2880
1.380	0.4060	0.3890	0.3675	0.3476	0.3310	0.3125	0.3008
1.500	0.4230	0.4060	0.3836	0.3625	0.3450	[illegible]	0.3138

DISCHARGE TABLES FOR 400 mm PIPE.

DISCHARGE IN CUMECS.

Working head 'H' Metres.	*Length in metres.*						
	1	3	6	9	12	15	18
0.005	0.0318	0.0308	0.0293	0.0278	0.0266	0.0255	0.0243
0.015	0.0552	0.0535	0.0508	0.0483	0.0462	0.0442	0.0422
0.030	0.0781	0.0756	0.0781	0.0682	0.0653	0.0624	0.0595
0.050	0.1008	0.0975	0.0927	0.0880	0.0844	0.0805	0.0768
0.075	0.1235	0.1195	0.1136	0.1078	0.1033	0.0987	0.0942
0.105	0.1460	0.1412	0.1343	0.1275	0.1220	0.1167	0.1113
0.140	0.1686	0.1631	0.1550	0.1472	0.1410	0.1348	0.1285
0.180	0.1913	0.1850	0.1760	0.1671	0.1600	0.1530	0.1453
0.225	0.2138	0.2068	0.1965	0.1865	0.1786	0.1708	0.1628
0.275	0.2366	0.2290	0,2175	0.2066	0.1978	0.1890	0.1804
0.330	0.2590	0.2510	0.2382	0.2262	0.2165	0.2070	0.1975
0.390	0.2818	0.2726	0.2590	0.2460	0.2355	0.2250	0.2143
0.455	0.3040	0.2942	0.2800	0.2656	0.2545	0.2430	0,2319
0.525	0.3260	0.3160	0.3000	0.2850	0.2730	0.2608	0.2483
0.600	0.3490	0.3378	0.3210	0.3050	0.2920	0.2790	0.2660
0.680	0.3712	0.3594	0.3415	0.3245	0.3110	0.2970	0.2833
0.765	0.3942	0.3818	0.3628	0.3442	0,3298	0.3150	0.3005
0.855	0.4170	0.4042	0.3836	0.3643	0.3490	0.3335	0.3130
0.950	0.4392	0.4255	0.4040	0.3840	0.3678	0.3515	0.3352
1,050	0.4620	0.4470	0.4240	0.4030	0.3860	0.3690	0.3521
1.155	0.4845	0.4685	0.4460	0.4230	0.4055	0.3875	0.3696
1,265	0.5070	0.4905	0.4660	0.4425	0.4240	0.4050	0.3860
1.380	0.5295	0.5120	0.4871	0.4625	0.4430	0.4280	0.4030
1.500	0.5523	0.5342	0.5080	0.4825	0.4620	0.4420	0.4214

DISCHARGE TABLES FOR 450 mm PIPE.

DISCHARGE IN CUMECS.

Working head 'H' Metres.	*Length in metres.*						
	1	3	6	9	12	15	18
0.005	0.0404	0.0394	0.0375	0.0359	0.0344	0.0331	0.0316
0.015	0.0698	0.0682	0.0650	0.0622	0.0596	0,0574	0.0548
0.030	0.0988	0.0964	0.0920	0.0878	0.0842	0.0812	0.0775
0.050	0.1278	0.1246	0.1187	0.1135	0.1088	0.1049	0.1009
0.075	0.1565	0.1526	0.1454	0.1392	0.1333	0.1285	0.1228
0.105	0.1849	0.1804	0.1718	0.1643	0.1575	0.1518	0.1448
0.140	0.2137	0.2085	0.1986	0.1900	0.1820	0.1755	0.1675
0.180	0.2425	0.2366	0.2255	0.2156	0.2065	0.1990	0.1900
0.225	0.2710	0.2642	0.2520	0.2410	0.2310	0.2225	0.2123
0.275	0.2999	0.2924	0.2790	0.2664	0.2554	0.2461	0.2350
0.330	0.3285	0.3205	0.3050	0.2920	0.2798	0.2698	0.2576
0.390	0.3571	0.3480	0.3320	0.3175	0.3041	0.2931	0.2800
0.455	0.3830	0.3756	0.3580	0.3422	0.3282	0,3162	0.3020
0.525	0.4140	0.4040	0.3850	0.3680	0.3528	0.3400	0,3245
0.600	0.4422	0.4320	0.4110	0.3930	0.3768	0.3630	0.3465
0.680	0.4710	0.4590	0.4375	0.4180	0.4010	0.3863	0.3692
0.765	0.5000	0.4875	0.4650	0.4445	0.4260	0.4108	0.3920
0.855	0.5280	0.5154	0.4920	0.4698	0.4500	0.4340	0.4145
0.950	0.5575	0.5444	0.5180	0.4955	0.4750	0.4575	0.4370
1.050	0.5850	0.5710	0.5440	0,5200	0.4980	0.4805	0.4580
1.155	0.6140	0.5920	0.5710	0.5460	0.5240	0.5045	0.4820
1.265	0.6435	0.6275	0.5975	0.5720	0.5475	0.5280	0.5045
1.380	0.6720	0.6550	0.6245	0.5960	0.5720	0.5515	0.5260
1.500	0.6995	0.6825	0.6500	0.6220	0.5955	0.5740	0.5480

DISCHARGE TABLE FOR 500 mm PIPE.

DISCHARGE IN CUMECS.

Working Head	Length in metres.						
	1	3	6	9	12	15	18
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
0.005	0.0498	0.0489	0.0467	0.0449	0.0430	0.0417	0.0403
0.015	0.0865	0.0847	0.0811	0.0778	0.0746	0.0722	0.0698
0.030	0.1221	0.1199	0.1147	0.1100	0.1055	0.1022	0.0988
0.050	0.1579	0.1549	0.1481	0.4122	0.1364	0.1320	0.1278
0.075	0.1931	0.1896	0.1812	0.1741	0.1669	0.1616	0.1561
0.105	0.2282	0.2240	0.2140	0.2057	0.1973	0.1909	0.1846
0.140	0.2638	0.2590	0.2478	0.2378	0.2280	0.2208	0.2135
0.180	0.2990	0.2938	0.2808	0.2698	0.2585	0.2500	0.2420
0(225	0.3340	0.3278	0.3135	0.3010	0.2885	0.2795	0.2700
0.275	0.3699	0.3630	0.3470	0.3330	0.3196	0.3092	0.2990
0.330	0.4050	0.3975	0.3800	0.3650	0.5500	0.3390	0.3265
0.390	0.4400	0.4320	0.4130	0.3966	0.3805	0.3680	0.3560
0.455	0.4755	0.4467	0.4460	0.4280	0.4110	0.3978	0.3845
0.525	0.5106	0.5010	0.4780	0.4600	0.4410	0.4275	0.4130
0.600	0.5460	0.5360	0.5120	0.4920	0.4720	0.4560	0.4420
0.680	0.5810	0.5700	0.5450	0.5240	0.5040	0.4860	0.4700
0.765	0.6160	0.6050	0.5780	0.5560	0.5330	0.5156	0.4980
0.855	0.6520	0.6380	0.6110	0.5870	0.5630	0.5450	0.5270
0.950	0.6875	0.6746	0.6450	0.6192	0.5940	0.5750	0.5555
1.050	0.7220	0.7080	0.6770	0.6504	0.6240	0.6040	0.5840
1.155	0.7570	0.7440	0.7102	0.6825	0.6545	0.6325	0.6122
1.265	0.7925	0.7780	0.7445	0.7145	0.6850	0.6630	0.6430
1.380	0.8266	0.8120	0.7755	0.7450	0.7145	0.6920	0.6680
1.500	0.8640	0.8475	0.8100	0.7780	0.7460	0.7225	0.6980

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DISCHARGE TABLES FOR 600 mm PIPE.

DISCHARGE IN CUMECS.

Working Head· H' Metres.	Length in Metres.						
	1	3	6	9	12	15	18
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
0.005	0.0720	0.0715	0.0682	0.0660	0.0637	0.0616	0.0599
0.015	0.1243	0.1232	0.1182	0.1143	0.1105	0.1068	0.1040
0.030	0.176	0.1742	0.1672	0.1617	0·1664	0.1512	0.1472
0·050	0.2270	0.2250	0.2158	0.2088	0.2108	0.1950	0.1899
0.075	0.2780	0.2755	0.2645	0·2558	0.2472	0.2390	0.2325
0.105	0.3285	0.3258	0.3125	0·3025	0.2921	0.2825	0.2750
0.140	0.3798	0.3760	0.3610	0.3490	0.3375	0.3260	0.3175
0.180	0.4308	0.4260	0.4090	0.3960	0·3825	0.3700	0.3600
0.225	0.4820	0.4775	0.4580	0.4440	0.4280	0.4145	0.4030
0.275	0.5330	0·5280	0.5060	0·4905	0.4740	0.4580	0.4455
0.330	0.5846	0·5795	0.5552	0.5370	0.5192	0 5018	0.4886
0.390	0.6346	0.6285	0.6040	0.5840	0·5640	0.5450	0.5310
0.455	0.6850	0.6790	0.6520	0.6300	0.6085	0.5885	0.5725
0.525	0.7350	0.7285	0.6990	0.6760	0.6540	0.6320	0.6150
0·600	0.7860	0.7785	0.7475	0.7230	0.6982	0.6755	0.6575
0.680	0.8375	0.8300	0.7955	0.7700	0.7445	0.7200	0.700
0.765	0·8875	0.8795	0.8440	0.8160	0.7885	0.7625	0.7420
0.855	0.9385	0.9300	0.8925	0.8640	0.8348	0.8060	0.7850
0.950	0.9900	0.9800	0.9400	0.910	0.8791	0.8500	0.8275
1.050	1.0400	1.0285	0.9875	0.9555	0.8400	0·8940	0.8691
1.155	1.0906	1.0810	1.0380	1.004	0.9700	0.9380	0.9140
1.265	1.1416	1.1316	1.0860	1.050	1.0150	0.9850	0.955
1.380	1.1920	1.1820	1.1350	1.097	1.0600	1.0250	0.9975
1·500	1·245	1.233	1.1890	1.1460	1.1060	1.0700	1.040

APPENDIX XVI (d).

CEMENT PIPE SLUICES

Valueof Cd in the formula $Q = / CcdA \sqrt{2gh}$ *for different values of* $\frac{length}{diameter}$.

Length. / Diameter	Co-efficient. (Cd)	Length / Diameter	Co-efficient. (Cd)
(1)	(2)	(3)	(4)
4	0.81	104	0.47
8	0.78	108	0.465
12	0.76	112	0.455
16	0.74	116	0.45
20	0.72	120	0.44
24	0.70	124	0.435
28	0.685	128	0.43
32	0.67	132	0.42
36	0.655	136	0.415
40	0.635	140	0.41
44	0.62	144	0.405
48	0.61	148	0.40
52	0.60	152	0.395
56	0.58	156	0.39
60	0.57	160	0.385
64	0.56	164	0.38
68	0.55	168	0.375
72	0.54	172	0.377
76	0.53	176	0.365
80	0.52	180	0.36
84	0.515	184	0.355
88	0.505	188	0.35
92	0.50	192	0.348
96	0.49	196	0.345
100	0.48	200	0.34

(*Reference* :—Chief Engineer's (Irrigation Circular Memo. N No. 3354/37-A-5, dated 4th August 1938).

APPENDIX XVII.

DETERMINATION OF BULKING OF SAND AND NET QUANTITY.

Based on Chief Engineer (General and Buildings)'s Circular Memo No. 595 G/53, dated 9th July 1953 and Chief Engineer (Irrigation),s Circular Memo. No. 1304/58-H2, dated 22nd August 1958.

Sand occupies minimum volume (1) when it is perfectly dry and (2) when it is completely saturated with water. With the addition of water the volume of sand increases causing bulking of sand ; 5 to 7 per cent water by weight in the sand increasing its volume by 20 to 30 percent. Since sand is generally measured by volume and used on work, it is necessary that the bulking of sand due to moisture cotent in it should be taken into consideration and allowance made for it in—proportioning mortar and concrete, in the case of all important works as may be decided by the Executive Engineer.

2. The percentage of bulking of sand can be determined easily by conducting the following simple test in the field.

"In a 250 cc measuring cylinder, pour the damp sand (Consolidated by shaking) until it reaches the 200 mark. Then fill the cylinder with water and stir the sand well. (The water shall be sufficient to submerge the sand completely). It will be seen that sand surface is now below its original level. Suppose the surface is at the mark y cc. The percentage of bulking of the sand due to moisture should be calculated from the formula :—

$$\text{Percentage buiking} = \frac{(200-1}{Y\,b} \times 100 \text{ ''}$$

3. When payment is to be made to the contractors for the net quantity of sand from the gross measurements in stacks as warranted by the specific conditions in tender schedule, the not quantity shall calculated from the following formula :—

$$Q \text{ (net)} = Q \text{ (gross)} \times \frac{100}{100+b}$$

Where 'b' is the bulking percentage of sand determined as per luos 2 above.

ADDENDUM TO

TAMIL NADU BUILDING PRACTICE

VOLUME II

PILE FOUNDATION

SCHEDULE FORMAT.

Serial number.	*Approx. Qty.*	*Description of work.*	*MDSS number.*	*NBC number.*	*Rate (in figures and in words).*	*Units.*	*Amount.*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(3)
		I. EXCAVATION :					
1		Earthwork excavation for foundation in all soils and sub-soils and to full depth as may be directed including dewatering, shuttering wherever found necessary, refilling the sides of foundation in layers not exceeding 15 cm. depth including thoroughly consolidating, necessary watering and depositing the excavated earth at site where directed with all leads and lifts and clearing, levelling the site, etc., complete.	24	..	..	1m3 (one cubic metre)	--
2		**Conveying the surplus excavated earth or soil from the site by lorries for distance of one kilometre or part thereof over the initial lead.**	..	--	--	1m3 (One cubic metre).	..
		II. CONCRETING :					
3		Cement concrete 1 :4 : 8 (One cement, four sand and eight broken stone) 7.5 cm. thick for mudmat below pile cap and for any other foundation using 40 mm. gauge hard broken stone jelly including thoroughly consolidating the same complete (Deduction will be made for pile).	28	..	..	1m3 (One cubic metre)	--
		Driven cast in situ piles :					
4		Installing vertical cast in situ driven RCC piles of suitable length using 20 mm. gauge hard broken stone jelly including cost of reinforcement to the full length of the pile.	...	ISS 2911 Pt.(I) Sec. I 1979.	...	..	--
	(i)	40 cm. dia pile : In cement concrete 1 :2 :4 (One cement, two sand and four stone jelly) of capacity ......tonnes.	...	..	...	1m (One metre).	..
		Or/And					
	(ii)	40 cm. dia pile : In cement concrete 1 :1½ :3 (One cement, one and a half sand and three stone jelly) of capacity........tonnes.	..	...	..	Do.	--
	(iii)	45 cm. dia pile : In cement concrete 1 :2 :4 (One cement, two sand and four stone jelly) of capacity ....tonnes.	..	..	..	Do.	--
		Or/And					
	(iv)	45 cm. dia pile : In cement concrete 1 :1½ :3 (One cement, one and a half sand and three stone jelly) of capacity........tonnes.	..	..	..	Do.	..
	(v)	50 cm. dia pile : In cement concrete 1 :2 :4 (One cement, two sand and four stone jelly) of capacity ....tonnes.	..	..	..	Do.	..
		Or/And					
	(vi)	50 cm. dia pile : In cement concrete 1 :1½ :3 (One cement, one and a half sand and three stone jelly) of capacity........tonnes.	..	..	..	Do.	..
	(vii)	52.50 cm. dia : In cement concrete 1 :2 :4 (One cement, two sand and four stone jelly) of capacity ....tonnes.	..	..	..	Do.	..
		Or/And					
	(viii)	52.50 cm. dia : In cement concrete 1 :1½ :3 (One cement, one and a half sand and three stone jelly) of capacity........tonnes.	..	..	..	Do.	..

SCHEDULE FORMAT—cont

Serial number.	Approx. Qty.	Description of work.	MDSS number.	NBC number.	Rate (in figures and to words)	Units.	Amount
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		BORED CAST IN SITU PILES :					
5		Installation of vertical cost in situ bored RCC piles of suitable length using 20 mm. gauge hard broken stone jelly including cost of reinforcement to the full length of the pile, including providing a temporary casting pipe of minimum length of one metre at the top and using drilling mud (bentonite slurry) of suitable consistency for stabilising the sides of bore holes for the remaining length the concreting for this pile shall be done through tremic pipes and the minimum cement content for concrete shall be not less than 370 Kg./m3.	..	ISS 2911 Pt. (I)/ Sec. 2 1979.	..	..	..
	(i)	40 cm. dia : pile in cement concrete 1 : 2 : 4 (One cement, two sand and four stone jelly) of capacity ....tonnes .	..	..	..	1M (One metre).	..
		Or/And					
	(ii)	40 cm. dia : pile in cement concrete 1 : 1½ : 3 (One cement, one and a half sand and three stone jelly) of capacity........tonnes.	..	..	..	Do.	..
	(iii)	45 cm. dia : Pile in cement concrete 1 : 2 : 4 (One cement, two sand and four stone jelly) of capacity ....tonnes.	..	..	..	Do	..
		Or/And					
	(iv)	45 cm. dia : Pile in cement concrete 1 : 1½ : 3 (One cement, one and a half sand and three stone jelly) of capacity........tonnes.	..	..	..	Do	.
	(v)	50 cm. dia : Pile in cement concrete 1 : 2 : 4 (One cement, two sand and four stone jelly) of capacity ....tonnes.	..	..	..	Do.	..
		Or/And					
	(vi)	50 cm. dia : Pile in cement concrete 1 : 1½ : 3 (One cement, one and a half sand and three stone jelly) of capacity........tonnes.	..	..	..	Do.	..
	(vii)	52.50 cm. dia : Pile in cement concrete 1 : 2 : 4 (One cement, two sand and four stone jelly) of capacity ....tonnes.	..	..	..	Do	..
		Or/And					
	(viii)	52.50 cm. dia : Pile in cement concrete 1 : 1½ : 3 (One cement, one and a half sand and three stone jelly) of capacity........tonnes.	..	..	..	Do	..
	(ix)	56 cm. dia : Pile in cement concrete 1 : 2 : 4 (One cement, two sand and four stone jelly) of capacity ....tonnes.	..	..	..	Do	..
		Or/And					
	(x)	56 cm. dia : Pile in cement concrete 1 : 1½ : 3 (One cement, one and a half sand and three stone jelly) of capacity........tonnes.	..	..	..	Do	..
	(xi)	60 cm. dia : Pile in cement concrete 1 : 2 : 4 (One cement two sand and four stone jelly) of capacity........tonnes.	..	..	..	Do	..
		Or/And					
	(xii)	60 cm. dia : Pile in cement concrete 1 : 1½ : 3 (One cement, one and a half sand and three stone jelly) of capacity........tonnes.	..	..	..	Do	..
6		Cement concrete 1 : 1½ : 3 (One cement, one and a half sand and three stone jelly) for reinforced cement concrete pile caps using 20 mm. guage hard broken stone jelly excluding cost of reinforcement grill in position but including necessary shuttering centering to concrete faces and curing, finishing, etc., complete.	30	..	..	1M3 (One cubic metre).	..

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
7		Cement concrete 1 : 2 : 4 (one cement, two sand and four stone jelly) for reinforced cement concrete grade beams using 20 mm. guage hard broken stone jelly excluding cost of reinforcement grill in position but including cost of shuttering, centering to concrete faces and curing, finishing etc., complete.	30	..	..	1m3 (one cubic metre).	..
8		Supplying, fabricating and placing, in position mild steel grills plain or RTS rods for dowel rods to the RCC columns, grade beams, pile caps, etc., inclusive of cost of steel which will be supplied departmentally at Section Stores and cost thereof recovered at issue rate (rate to include cost of binding wire to be supplied by the Contractor).	30,97 Genl.	..	..	..	..
	(i)	Using MS plain rods.	..	..	..	1 Qtl. (One quintal).	..
	(ii)	Using RTS Rounds.	..	..	..	Do.	..
9		LOAD TEST.					
		(ISS : 2911) (Part IV)-1979.					
		Cyclic Load Test/Routine Load Test.					
		Test of a single pile under routine cyclic load test (150 per cent of pile capacity plus 25 per cent additional load totalling to 175 per cent pile capacity as per ISS) as per the testing procedure specified in the tender conditions inclusive of all charges for extension of /cutting off piles that may be necessary, erecting loading platform in the manner acceptable and approved by the departmental officers together with labour and other incidental charges for loading and unloading the test loads and hire and transport charges and all other incidental charges for conducting the test including retaining the test load for 24 hours at 100 per cent capacity. Testing equipments cost and test certificate and calibration chart for pressure guage produced to the Executive Engineer incharge before commencing day of the test. Calibration of pressure gauge must be done before taking up the first load test in every site of work.	ISS 2911—Part IV 1979. C.E's Circular No. 176/81.				
(a)		Working loads (Test loads at 1½ times working load plus 25 per cent as per ISS) *First Load Test.*					
(i)		............tonnes capacity............					
(ii)		............tonnes capacity............				Each.	
(iii)		............tonnes capacity............				Each.	
(iv)		............tonnes capacity............				Each.	
(b)		Working loads (Test loads at 1½ times working load plus 25 per cent as per ISS). (*Subsequent Load Test.*)					
(i)		.... onnes capacity............				Each.	
(ii)		............tonnes capacity............				Each.	
(iii)		............tonnes capacity............				Each.	
(iv)		............tonnes capacity............				Each.	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
10		INITIAL LOAD TEST.					
		(ISS 2911) (Part IV)—1979.					
		Test of a single pile under initial load (200 per cent of pile capacity plus 25 per cent as per ISS) totalling to 225 per cent pile capacity as per the testing procedure specified in the tender conditions inclusive of all charges for extension of cutting of piles that may be necessary, erecting loading platform in the manner acceptable and a proved by the departmental officers together with labour and other incidential charges for loading and unloading the test loads and hire and transport charges and all other incidental charges for conducting the test including retaining the test load for 24 hours at 100 per cent capacity. Testing equipments shall be got tested at contractor's cost and test certificate and calibration chart for pressure gauge produced to the Executive Engineer incharge before commencing the day of the test. Calibration of pressure gauge must bedone before taking up the first load test in every site of work.	ISS 2911 Pt (IV) 1979. C.E. Circular No. 176/81.				
(a)		FIRST LOAD TEST.					
(i)		............tonnes capacity.................				Each.	
(ii)		............tonnes capacity.................				Each	
(iii)		............tonnes capacity.................				Each.	
(iv)		............tonnes capacity.................				Each	
11		Installation charges inclusive of transportation to and fro and labour for assembling and dismantling of piling equipments irrespective of number of rigs employed for the work. This includes trial runs of the equipment before commencing actual piling and necessary sundry items required for installation.				Lumpsum.	

SPECIAL CONDITIONS.

1. The tenderer shall fill in quantities, rates and amounts for all items except 9, 10, 11 and for alternative items where only rates are to be quoted.

2. The tenderer shall fill in, the designed capacity of RCC piles for which he is quoting his rate. He must give quantities against items 4 or 5 as per his design and quote his rates thereof. The design calculations for pile camps grade beams and piles must accuompany the tender.

3. Details of dowel bars will be given by the Executive Engineer/Superintending Engineer during execution of work but quantity of steel in piles caps and grade beams will be in accordance with the design of the tenderer and to be approved by the competent authority. The cost of reinforcement in piles should be included in the cost of piles against items 4 and 5 of the schedule.

4. The number of tests to be conducted in items 9 to 11 shall depend on the direction of the Executive Engineer/Superintending Engineer.

5. The tenderer shall fill in the schedule, the quantities of steel and cement required to be supplied by the department and recovered at issue rate for the execution of the job. He should also enclose detailed calculations in support of the figures.

6. The tenderer shall also enclose a layout of piles as per pile design proposed by him.

7. The piles shall be designed and executed generally conforming to the ISS 2911 (Part I/Part II/and Part IV) 1979 and National Building Code and other National Standards prevailing from time to time.

8. Payment shall be restricted only to the quantity furnished in the tender for items of work (Grade beams, pile caps, mat concrete, etc.) or as per the tenderer's design to be approved later on, if any alternative design is furnished by the tenderer. It may be noted that under no circumstances payment shall be made for any additional quantities over and above the quantity furnished in the tender. However, payment shall be made for quantities executed at the request of the department for which approval will be obtained by the contractor from competent authority.

9. The rates shall include work in shift system also and no extra payment will be entertained for such shift system of work.

10. The tenderer must state the number of piling equipment, the type of equipment and the staff that will be earmarked for this work.

11. The tenderer must furnish the capacity of Jack, the number of dial guages and their range, the range of pressure gauge, the last date of calibration of pressure guage and the manufacturing details for Jack, pressure guage and dial guages at the time of submitting his tender.

12. The tenderers must also furnish in his tender a diagrammatic sketch of the load test arrangement offered by them indicating all details of the load test therein if they do not agree to the standard norms for load test prescribed by the department.

13. The tenderer must offer only in the departmental schedule furnished in the tender documents.

14. Tenders which do not comply with the above conditions will be summarily rejected without assigning any reasons.

NOTICE TO TENDER AND GENERAL CONDITIONS.

1. Tenders may be sent in for any accepted standard system of reinforced cement concrete piling and capping slabs subject, however, to such piles satisfying the limit of settlement of 12 mm under a test load of one and a half time working load for pile kept on as specified in ISS 2911 (IV) 1979. The safe working load adopted in the tenderer's design must conform to the standard specifications (ISS) and schedule of conditions of contract and in so far as they may be applicable to the conditions hereinafter set forth (please *see* clause 60 also).

2. The Superintending Engineer, PWD Circle (hereinafter called Superintending Engineer) reserve to himself the right of rejecting al or any of the tenders without assigning any reason whatsoever for so doing or of accepting tender in parts.

3. Any tender not received in proper order and accordingly instructions given in the notice and in due time will be rejected.

4. Time shall be considered as the essence of this contract on the part of the contractor. If the contractor fails to complete the works within the times specified or within any extended time to which he may become entitled under these presents, then the contractor shall pay or allow the Superintending Engineer a sum calculated at the rate of Rs. 200 (two hundred) per day as liquidated damage and not by way of penalty, for the period beyond the said date or dates or extended time as the case may be during which the works shall remain unfinished and such damages shall be deducted from any money due or which may become due to the contractor.

5. The contractor will be permitted to do work at nights, at the discretion of departmental officers but no extra rate will be allowed on account of overtime wages, cost of lighting or any other account.

6. The successful tenderer should not assign or sublet any portion of the contract without the written permission of the Superintending Engineer.

7. The tenderers are requested to state at the time of tendering the facilities and the number of pile driving machines they have at their disposal for piling work.

8. The tenderer is required to state clearly the details of machinery and staff that can be earmarked for this work to commence the work immediately upon acceptance of his tender. The whole work consisting of pile foundation, pile caps and grade beams should be completed within .... months from the date of handing over of site and according to schedule A attached.

9. The tenderers must furnish the make and capacity of Jack, the number of dial gauges and their range of travel, the range of pressure gauge, the last date of calibration of pressure gauge and other relevant information on equipments and instruments proposed to be used on this work.

10. The load test must be done as per the details prescribed by the department and conforming to norms indicated in the relevant ISS.

11. The tenderers must give their offers only in the departmental schedule furnished to them with the tender documents.

13. Tenderers will be furnished with the details of soil profile in the form of borechart as obtained from sub-soil investigation at site to enable them to quote rates for piles. However, they are also permitted to put up their own bores at their cost at site with the written-authority of Superintending Engineer/Executive Engineer and verify the soil profile, before tendering, to satisfy themselves about the correctness of soil profils and characteristics of soil at site.

14. Plans at various floor levels, section, elevation of the proposed building and a key plan showing the RCC columns in Ground Floor/Basement floor together with loads carried by them independently are furnished to them in the tender documents. In addition, schedule of columns and loads carried by each column is also given in a statement. Tenderers will work out their pile sizes, capacity of piles, etc. for the above column loads.

15. Tenderers must thoroughly acquant themselves with the tender notice, drawings, specifications, articles of agreement and conditions of contract. Each tender should contain not only rates but also the value of each item of work entered in a separate column, all the items being totalled up in order to show the aggregate value of each tender. The rates quoted by the tenderer should be expressed both in words and figures. Every tenderer is expected before quoting his rates, to inspect the site of the proposed work. Samples of materials to be used on the work shall be submitted at the tenderer's cost to the Executive Engineer for approval before the supply to the site of work is begun. It must be clearly understood that neither the probable quantities forming schedule "A" to the tender nor the value of the individual items for the aggregate value of the entire tender will form part of the contract and the department does not in any way assure the tenderers or guarantee that the said probable quantities are correct or that the work will correspond thereto.

16. The successful tenderer (contractor) should have all necessary materials and equipment ready at the site to commence the work within a week after the date of signing the contract or within a fortnight from the date on which intimation is sent to him to the effect that he can enter upon the site for preceeding with the work covered by the contract, whichever is earlier.

17. The tenderer shall examine closely the Tamil Nadu Detailed Standard specification and also the standard preliminary specification contained therein before submitting his item rates. Tender which shall be for finished work insitu. He shall also carefully study the drawings and additional specifications and all the documents which form part of the agreement to be entered with the accepted tenderer.

18. The tender's attention is invited to the requirements of materials under the clause (materials and workmanship) in the prliminary specification of the Tamil Nadu Detailed Standard Specification or the Indian Standard Specification and where these specifications are not applicable to the best specification possible as directed by the Superintendnig Engineer and the tenderer shall quote the rates accordingly.

19. The successful tenderer (contractor) shall make no alteration in the drawings or in the specifications or schedules or calculations, once these have been approved by the Superintending Engineer and shown. An error or discrepancy appear in them or any doubt as to dimensions arise later, he shall refer it in writing to the Superintending Engineer and proper adjustment shall be made only with his appproval. The successful tenderer (contractor) will not be entitled to any remuneration for preparing or supplying the above and the rates quoted for the work will be held to be inclusive of the above charges.

20. The contractor would give to the Municipal, Police and other authorities all notices, etc., that may be required by law and obtain all requisite licence for temporary obstructions and enclosures and pay all fees. tax and charges which may be leviable on account of his operations in executing the contract.

21. He shall make good any damage to adjoining property whether public or private and shall supply and maintain any lights (either for illumination or for cautioning the public) required at nights.

22. Upon final completion of the work at the expiration of six months from the date of completion, upon a certificate to be issued by the Superintending Engineer, the retention amount of 2-1/2 per cent (in addition to Earnest Money Deposit and Security Depost) will be released for payment provided the work is free from defects, shrinkage, settlements or other faults for which the contractor is responsible under the terms of this contract. If any defects, shrinkage, settlements or other faults as aforesaid shall appear within six months from the date of competition of the said works, such balance shall be withheld and disposed of subject to and in the manner laid down in the General Conditions of contract.

DEFINITION OF TERMS :

23. *Driven cast-in-situ pile*.—The pile formed within the ground by driving a casing of uniform diameter, permanent or temporary and subsequently fiilling in the hole as formed with plain or reinforced cement concrete. For displacing the sub-soil, the casing tube is installed with a shoe or plug at the bottom end.

24. *Cut off level*.—It is the level where the installed pile is cut off to support the pile caps or beams or any other structural components at that level.

25. *Test file*.—A plie which is selected for subjects to load test and which is subsequently loaded, for that purpose. The test pile may form a working pile itself if subjected to routine load test up to 1-1|2 times the safe load.

26. *Trial piles*.—Initially one or more piles, which are not working piles, may be installed to assess load carrying capacity of the piles by load test. These are called trial piles. The pile are tested either to their ultimate bearing capacity or twice the working load.

27. *Proposed working load*.—This shall mean the safe load carried by the pile or group indicated by tenderer while submitting the tender.

28. *Final working load* —This shall mean the safe load that will finally becoming on each pile or pile goup due to RCC columns and grade beams. If the loading tests, as defined in clause show that the proposed working load cannot be obtained, the Superintendent Engineer shall work out the safe load of pile or group of piles which shall be binding on the contractor.

29. *Routine Test load*.—This is the load applied to a selected pile or group of piles to test its behaviours, under excess of loading at 150 per cent of the working load.

30. *Settlement*.—This is the downward movement of the pile recorded from time to time during the test loading of pile.

31. *Total settlement*.—This is the downward movement recorded during the test loading of the piles and may consist of closer deformation of the pile itself, deforming of the ground surrounding the pile and any movement of the piles through the ground.

32. *Residual settlement*.—This is the difference between the total settlement and the amount of recovery records if the test load has been totally removed from the pile.

33. *Elastic deformation*.—It is the shortening of pile within the elastic limit of the material forming.

34. *Follower tube*.—A tube which used following the main casing tube when adequate set is not obtained with the main casing tube and if it requires to be extended further. The inner diameter of the follower tube should be the same as the inner diameter of the casing. The follower tube shall preferably be an outside guide and should be watertight when driven in water bearing strata or soft clays.

35. *Bored-cast-in-situ Pile*.—The pile formed within the ground by excavating or boring a pile within it with or without the use of a temporary casing and subsequently filing it with plain or reinforced concrete. When the casing is left permanently it is termed as cased pile and when the casting is taken out, it is termed as uncased pile.

In installing a borded pile, the sides of the borehole (when it does not stand by itself) it is required to be stabilized with the aid of a temporary casing or with the aid of drilling mud (Bentonite) of suitable consistency. For marnie situations, such piles are formed with permanent casing (liner).

36. *Initial load test*.—It is carried out on test pile(s) which is generally made for the purpose, with a view to determining the safe load and|or ultimate load capacity.

37. *Routine (Check) load test*.—It is carried out on a working pile with a view to determine displacement (settlement) corresponding to the allowable (working) load.

SPACING OF PILES :

38. The centre to centre spacing of pile is considered from two aspects (viz).

39. Practical aspect involving installing the piles and

40. The nature of the load transfer, i.e., by friction alone or by end bearing alone or by both to the soil and possible reduction in the bearing capacity or group of piles thereby. The choice of spacing is normally made on semi-empirical approach.

41. In case of piles founded on a very hard stratum and deriving their capacity mainly from and bearing, the spacing will be governed by the compentency of the end bearing strata. The minimum spicing in such cases shall be 2.5 times the diameter of the shaft.

42. Piles deriving their bearing capacity mainly from friction shall be sufficiently apart to ensure that the zones of soil from which the piles derive their support do not overlap to such an extent that their bearing values are reduced. Generally, the spacing in such cases shall not be less than 3 times the diameter of the shaft.

43. In the case of loose sand or filing, closer spacing than in dense sand may be possible since displacement during the piling may be absorbed by vertical and horizontal compaction of the strata. Minimum spacing in such strata may be twice the diameter of the shaft.

Note.—In case of piles of non-circular cross section, diameter of the circumscribing circle shall be adopted.

FOR "DRIVEN" CASTS-IN-SITU PILES :

44. Piles shall be installed as accurately as possible according to design and drawings either vertically or to the specified batter. Greater care should be exercised in respect of installation of single piles or piles in two pile groups. As a guide for vertical piles, a deviation of 1.50 per cent and for raker piles, a deviation of 4 per cent should not normally be exceeded. Piles should not deviate more than 75 mm. from their designed positions at the working level of the piling rig. In the case of a single pile in a column, positional tolerance

should not be more than 50 mm. For piles to be cut off at a substantial depth, the design should provide for the worst combination of the above tolerance in Position and inclination. In case of piles deviating beyond these limits and to such an extent that the resulting eccentricity cannot be taken care of by a re-design of the pile cap or pile-ties, the piles should be replaced or supplemented by one or more additional piles.

45. In a pile group, the sequance of installation of piles shall normally be from centre to the Periphery of the group or from one side to the other.

46. Sufficient time shall be allowed, when installing piles in a group, for the freshly poured concrete in a pile to set before installing adjacent piles.

No pile should be less than 12 inches (30 cm.) in diameter of side of a square.

47. In forming cast in situ-piles the joints of the piling forms and follower and the bearing of the piling from on its shoe or any driving rim shall be effectively seded in an approved manner so as to prevent subsoil water from gaining access into forms at any stage of driving or withdrawing the forms or when the concrete is being shunted into forms. If water sand or slush or any other impurity get into the forms at the stage of casting or driving the piles and if the water sand or slush or any other impurity cannot be removed to the satisfaction of the Superintending Engineer, the forms shall be pulled out and driven if so required at the contractor's expense. If in withdrawing the form after casting the pile, it is found that cast in situ pile has been disturbed in any manner, either through the displacement of the reinforcement or pile as a whole or in part, the same shall be reported by the contractors to Superintending Engineer, who shall decide whether the piles shall be rejected and a fresh pile will have to be driven in the same place with a newshoe and if this is considered impossible or difficult, fresh piles not less than two in number shall be driven in every case of such rejection, at such places as will ensure the centre of gravity of the originally proposed group of system of piles to remain undisturbed and the contractor shall not be entitled to any payment on account of the rejected pile or of the extra piles required to preserve the centre of gravity of the system of piles undisturbed, nor can payments be made for any consequential increase in the capping or beams and payment shall be made only for one pile as if it were good pile.

48. *Pile withdrawals.*—Following the founding of the piles at the correct depth, concrete sufficient for a length of one third pile death shall be placed in the tube before the initial withdrawal. As soon as the skin friction between the earth and the tube has been broken withdrawal shall be stopped and the reminder of the concrete placed in the tube after which the withdrawal may proceed.

49. During the process of withdrawal the concrete shall be completed by raising and dropping the 3 tons hammer on top of the tube. The amount of drops and the rate of striking shall be applied when the pile tube, is at its maximum depth and during the pile tube withdrawal the drop may be reduced and the speed of the striking increased.

50. All concrete in the pile must be thoroughly completed in one operation throughout its length from pile shoe to top of pile, as son as pile driving is completed. Piles shall not be left unconcreted after driving and founding the casing in position at the end of day's work. Either the concreting should be carried out the same day or the pile casing stopped well above the founding depth say for 2 or 3 metres and driving continued next day.

51. *Records.*—Observations made during the driving of each pile shall be recorded in the pro forma enclosed. Number of piles driven and their respective length should be recorded and send to Executive Engineer's office every day. When the last blows for set are given on piles, the executive Engineer or his representative should be intimated to enable him to record the "set" observation made and recorded set each day shall be sent to the Executive Engineer's office the following day.

A record shall be kept by the contractor of the total penetration of every pile and the behaviour of such pile during driving. Any deviation from the designed location, alignment or load carrying capacity of any pile shall be promptly reported to the Executive Engineer/Superintending Engineer and adequate corrective measure reported to him. Such measures shall be taken after approval of Executive Engineer/Superintending Engineer plans showing such deviations and corrective measures shall be filed with the department. On completion of the pile installation all pile records together with other records such as additional boring or other subsoil information that were obtained during installation of the piles shall also be filed with the department.

52. The contractor is to guarantee that each pile will sustain after the period of maturing safety without any undue deformation and settlement the proposed working load specified for the pile plus 50 per cent over load. All piles shall be fit to carry the specified test load 28 days after placing of concreting in the pile.

53. In case the installation of piles shows a tendency to make the previously installed piles to have accurate level marks shall be put on all piles immediately after installation and all heaved piles shall be reinstated to the required resistance.

54. *Mixing.*—The concrete ingredients shall be mixed thoroughly in mixers designed so as to positively ensure uniform distribution of all the compound materials throughout the mass at the end of mixing period. The mixing of each 1-1/2 cu.m. and less shall continue for about 1-1/2 to 2 minutes for as found best in practice after all materials except the full amount of water are in the mixer.

55. The concrete in RCC items shall be proportioned by volume.

56. For all RCC items, the coarse aggregate will be of broken stone, passing through a screen with 20 mm. square meshes and retained on a screen with 6 mm. square mesh.

57. The reinforced concrete work shall comply in all respects with the Indian Standard specification and practice

58. Effective means shall be adopted to ensure the specified cover to the reinforcement rods, as per ISS 2911 (Pt/Sec. 1) 1979.

59. Where rods are lapped, the laps shall be of approved length in accordance with the ISS 456-1978.

60. *Consolidation.*—Each layer of concrete shall be on worked to obtain concrete of maximum density. All concrete works except concrete for "cast-in-situ" piles shall be compacted by the use of the vibrator.

61. *Unifority and strength.*—To obtain a uniformly good quality of concrete test specimen shall be taken by the contractor at his own cost on the days of concreting as and when required by the Executive Engineer. These test specimens

shall be standard cylinder 15 c.m. diameter and 30 cm. high. These tests cylinders shall be tested departmentally or at other approved laboratories and if these tests give strength less than these specified below, the Executive Engineer shall have a right to penalise the contractor by rejecting the work done.

Minimum cylindrical strength requirements of RCC works.

Mix	7 day	28 day
1:2:4	10 N/mm^2	15 N/sq. mm
1:1½:3	13.5 N/sq. mm	20 N/sq. mm

62. *Stresses*.—In no case shall the stress in the concrete under proposed working load exceed 50 kg.| cm; and 70 kg.|cm; in the case of 1:2:4 and 1:1½:3 mix respectively, steel stresses shall not exceed 2300 Kg|cm; in tension and 1900 kg|cm; in compression. When the stresses in concrete piles are reviewed. no consideration will be given for the effectiveness of reinforcement.

63. *For-Bored-cast-in-situ piles*.—No pile should be less than 12" (30 cm), in diameter or side of a square. The full depth of the boring in collapsible soil strata should be lined with temporary steel casings. Alternatively approved drilling mud suspension bentonite sturry), of adequate specific gravity shall be used for the full depth of the bore, as boring proceeds, to prevent the sides of the borehole from collapsing. Accordingly the piles shall be classified as (1) lined, bored cast-in-situ piles, (2) partily lined bored cast in situ piles using drilling mud. In any case, a minimum length of one metre of temporary casing shall be inserted in each bored pile.

6. The bottom of the bored hole shall be cleaned very carefully before commencing the conerating work. The cleaning of the hole must be ensured by careful operation of boring tool/and/or flushing of the drilling mud through the bottom of the hole. Flushing of the boreholes before concreting with fresh drilling fluid|mud is necessary. Sufficient pressure to flush the boredhole must be maintainedd, which shall normally continue for required periods. After the borehole has been drilled to its final depth, fresh bentonite slurry shall be pumped through the chisel resting at the base of the hole, to remove completely all cuttings and other loose materials from the base of the hole. During this flushing the speed of the pump shall be increased to maintain additional high pressure. This flushing will normally be executed upto the required time say 15 minutes approximately depending upon the cleaning. After the hole has been thoroughly flushed, the chisel shall be removed for concreting.

65. *Control of alignment*.—Piles shall be installed as accurately as possible as per the designs and drawings either vertically or specified batter. Greater care-should be exercised in respect of installation of single piles or piles in two pile group. As a guide, for vertical piles, a deviation of 1.50 per cent and for raker piles, a deviation of 4 per cent should not be exceeded, piles should not deviate more than 75 mm or D|10 whichever is more in the ase of Piles having diameter more than 600 mm. from their designed position at the working level of the piling rig. In the case of a single pile in a column. positional toletrance should not be more than 50 mm (100 mm. in case of piles having dia. moer than 600 mm). In case of piles deviating beyond these limits and to such, an extent that the resulting eccentricity cannot be taken care of by a re-design of the Pile caps or pile ties, the piles should be replaced or supplemented by one or more additional piles. In case of piles with non-circular cross sections "D" should be taken as the dimension of pile along which the deviation is computed. In such cases, the permissible deviation in each direction should be different depending upon the dimension of the pile along that direction.

66. The specification for bentonite and bentonite slurry shall be as under :

(a) Bentonite Powder used for the work shall be tested for its liquid limit which shall be more than 300 per cent and less than 450 per cent. Sand content in bentonite shall be apply 7 per cent (i.e. passing through 15 "5 Microm-Sleve in dry condition) Method of testing liquid limit shall be as per ISS 2720 (Pt. V), clauses 3.4 and 3.5.1.

(b) Bentonite solution shall be made by mixing it with fresh water using a pump for circulation. The density of the solution shall be about 1.12 depending upon the site conditions and the viscocity as tested by March Cons method shall be approximately 35 seconds.

(*c*) Consistency of the drilling mud suspension shall be controlled throughout the boring as well as concreting operations in order to keep the hole stabilized as well as to avoid concrete getting mixed up with thicker suspension of the mud.

(*d*) The swelling index as measured by the swelled volume after 12 hours in abundant quantity of water shall be at least 2 times its dry volume.

(*e*) The PH value of the bentonite solution shall be less than 11.5.

67. Concreting operations should not be taken up when the specific gravity of bottom slurry is more than 1.12. Concreting shall be done by Tremie method.

68. During installation of board cast-in situ piles, the convenience of installation may be taken into account while determining the sequence of Piling in a group.

69. *Tremie method*.—In addition to the normal precautions to be taken in the Tremie concreting the following requirements are particularly applicable in Tremie concerning.

(*a*) The concrete should be coherent, which in cement (not less than 370 Kg|m3), and of slump not less than 150 mm.

(*b*) When concreting is carried out under water, a temporary casing shall be installed to the full depth of the borehole or 2 metres into non-collapsible stratum, so that fragnants of ground cannot drop from the sides of the hole into the concrete as it is placed. The temporary casing may not be required except near the top when concreting is done under drilling mud.

(*c*) The hopper and Tremic should be a closed system embedded in the placed concrete, through which water cannot pass.

(*d*) The tremie should be large enough with due regard to the size of the aggregate. For 20 mm. aggregate, the tremis pipe should be of dismeter not less than 200 mm; aggregate more than 20 mm shall not be used.

(*e*) The first charge of concrete shall be filled up in the hopper after plugging the control hole of the hopper with a steel plug or plate. The plug is pulled up after the hopper is filled so that the entire concrete in the hopper will be charged in the bore hole the plus should not be lift within the concrete. ?

(*f*) The tremic pine should always penetrate well into the concrete with an adequate margin with safety against accidental withdrawal of pipe is surged to discharge the concrete.

(*g*) The pile should be concreted wholly by tremie and the method of deposition should not be changed part way up the pile to prevent the latiance from being entrapped within the pile.

(*h*) All tremie tubes should be scrupulously cleaned after use.

Normally concreting of the piles should be uninterrupted. In the exceptional case of interruption of concreting but which can be resumed within one or two hours, the tremie shall not be taken out of the concrete. Instead, it shall be raised and lowered slowly from time to time to prevent the concrete around the tremie from setting. Concreting should be resumed by introducing a little richer concrete with a slump of about 280 mm for easy displacement of the partly set concrete. If the concreting cannot be resumed before final set of concrete already placed, the pile so cast, may be rejected.

In case of withdrawal of tremie out of the concrete either accidentally or to remove a choke in the tremie, the tremie may be re-introduced in the following manner to prevent in Pregnation of laitance of scum lying on the top of concrete already deposited in the bore. The tremic shall be gently lowered on to the old concrete with little penetration initially. A warmiculite Plug should be introduced in the tremie. Fresh concrete of slump between 150 mm and 175 mm shall be filled in the tremie which will push the plug forward and emerge out of the tremie displacing the laitance or scum. The tremie will be pushed further making fresh concrete sweep away laitance/scum on its way. When tremie is burried by about 60 cm to 100 cm. concreting may be resumed.

70. *"Records"*.—Observations made during driving of each pile shall be recorded in the Proforma enclosed. Number of Piles bored and their respective lengths should be recorded and sent to the Executive Engineer every day. When the pile boring is finished for every pile, it should be intimated to the Executive Engineer or his representative so as to enable him to record the "set" observations.

71. *For both "driven" and "bored" cast-in-situ piles.*—Tenderers must satisfy themselves by careful inspection of the plans, examination of the actual sites and of the levels obtaining at the sites about the amount of levelling involved.

72. Tenderers shall furnish the following design features for the Pile foundation offered by them after careful examination of the borechells, Laboratory test results on soil samples plans schedule of column loads for the buildings and specifications and tender conditions furnished in the tender document.

(*a*) the type of pile foundatton proposed by them,

(*b*) a layout of piles showing the single piles, pile groups, category of piles, total number, working load of proposed piles, mix design in each category of pile, etc.

(*c*) Plan and cross section of pile proposed showing the reinforcement details plan and section of typical pile caps, section of typical grade beam, etc.

(*d*) a statement showing the number of piles adopted, pile capacity, working load actually allowed on each pile.

(*e*) breakup details for the quantities of various item adopted in the respective tender.

73. The tenderer may be required to substantiate his claim for the proposed working load of each category of pile by a test carried but on a trialpile at his cost at site of work before the award of contract. This includes the cost of pile driving also and this test may be an initial load test or a reoutine load test at the discretion of the departmental officer.

74. In case the working load proposed in the tender cannot be achieved, additional piles and increased size of pile caps as determined by the Superintending Engineer will have to be installed. The cost of the additional piles and any consequential increase in RCC cappings and grade beams will have to be borne by the contractor.

75. The mode of measurements for the piles shall be from the tip of the pile shoe to the bottom of the respective pile caps.

The contractors are requested to state the method of piling and concreting proposed by them i.e. by volume basis or by weigh batcher.

76. The roots of trees, etc. if met with during the pile drivings has to be removed by the contractors at their cost.

77. As the area available for depositing excavated earth at the site is limtted, the contractor should make his own arrangements to remove the surplus earth in such a manner that under the circumstances should progress of work in the particular building or in any part of either building within the site is held up due to accumulation of surplus earth.

78. The contractor should ensure before arranging for the conveyance of earth from site of work that sufficient quantity of the earth for filling in sides of foundations and basement is retained in the site and no extra payment will be made if due to the neglect of the contractor, earth has got to be broughf from outside at a later date.

The rate for excavation shall include all necessary shortng, baling and pumping water found necessary for the execution of the work.

79. The rate should also include for carting away surplus earth to anywhere within the site and within the purview of standard specification, i.e., lead of 10 metres and a lift of 2 metres as may be directed by the Superintending Engineer.

80. The Superintending Engineer will supply details of column dowel bars to be provided in pile caps and the rods will be delivered at the section stores at site of work. The position of dowel bars for each RCC column shall wholly agree with the position of respective RCC columns as indicated in drawings supplied by the Superintending Engineer.

81. The contractor shall water, ram and thoroughly consolidate the bottom of all excavations at his cost before the construction of the foundation or other work is commenced.

82. A 75 mm thick layer of plain cement concrete 1:4:8 (1 cement, four sand and eight hard broken granite stone jelly) 40 mm gauge, shall be provided under all pile caps and grade beams and may project 150 mm all round beyond the caps and beams.

83. All caps and beams shall be cast so as to have a few constructions joints as possible, provision shall therefore be made for casting caps and beams is not less than 8½ cu.m. per day of 8 hours continuous operation. Normal setting cement conforming to I.S.S. alone shall be used for RC caps and beams and for cast insitu piles.

84. The design calculations for safe load on pile offered by the tenderer shall be in accordance with the relevant formulae as per ISS 2911 (Part I/Section I/Section 2)—1979 and consistent with the soil characteristics and soil parameters furnished in the tender. Note:—Design calculations adopting dynamic pile formulae, when the sub-soil is clayey and when the hard stratum is soft rock is not relevant.

85. Reinforcement proposed for the pile shall be proportional to the size of pile offered so that the reinforcement are not flimsy and does not drift out of position during concreting of piles.

86. Tenderer shall also work out the structural capacity of the Pile offered to substantiate tht safe load proposed on pile. The stresses adopted for concrete and steel bars shall be in accordance with the ISS 456—1978 and ISS 2911 (Part I/Section I/Section 2) 1979.

87. Tenderer shall adopt Provisions in ISS 2911 (Part I/ Section I), 1979 in the design calculations for pile caps. The depth of pile cap adopted should be proportionate to the size of pile offered.

88. The design details for grade btams shall be in accordance wtth the Provisions in ISS 2911 (Pt. III) 1980.

89. When a pile is a group, designed for a certain safe load is found, during or after execution, to fall just short of the load required to be carried by it, an overload upto 10 per cent of the Pile capacity may be allowed on each pile. The total overloading on the group should not be more than 10 per cent of the capacity of the group nor more than 40 per cent of the allowable load on a single pile. This is subject to the increase of the load on any pile not exceeding 10 per cent of its capacity. This overloading of Pile will, however, not be acceptable in the initial stages at the time of submitting his tender.

90. The reinforcement and cover and all other details reating to this will be governed by provision is ISS 2911 (Part I/Section 1/Section 2)/1979 and as Per the directions of the Superintending Engineer/Executive Engineer during execution.

91. The contractor will conduct loading tests for any Particular Pile or Piles selected by the Superintending Engineer. The test load specified above should be put on a test cap over the pile unaided by another support.

92. The load test on a pile shall not be carried out earlier than 28 days from the time of casting the pile.

93. The contractor shall himself arrange for the neccessary equipments for the application of loads, etc., in the load test and shall remove the same after the test. All the equipments, sand bags, etc., should also be removed from the site after the test is completed to the satisfaction of the Executive Engineer. Rates for testing shall include this and the Department will not incur any expenditure for supplying or transporting the loads, etc.

94. Before any load test is made, the proposed testing equipments, instruments, loading structures to be used for making the load test shall be got approved by the Superintending Engineer.

95. The pressure gauge will be got calibrated from a recognized institution and the cilebration chart produced to the Superintending Engineer before commencement of test.

96. The arrangement of loading platform, etc., shall conform to the specifications and drawing enclosed to tender documents.

97. The floor of test pit shall be [illegible] cm. clear below the bottom of pilet cap and filling with soil bottom of pile cap should not be done.

98. The top of the pile cap shall be finished even and smooth and true to plane.

99. The dial gauges used shall be of metric units enabling direct reading of settlement in millimetres and shall be fitted to the datum bars with magnetic bases. The dial gauges should have a range upto 15 mm at least.

100. The datum bars shall be of suitable structural section, (preferably channel section) and should be built in Position into masonry or concrete at a distance 5 d (Five times the stem diameter of the pile) from face of the pile. The datum bars, if used as angles, or any other structural sectons, should be straight for the full length. They may be stiffened with cross plates if neccessary to keep the straightness.

101. The loading platform should be kept atleast 1.50 m above G.L. to have sufficient headroom to move about. The static load on the platform should be 175 per cent working load in the case of routine test and 225 per cent working load in the case of initial test.

102. The test load may be applied by means of an appropriate capacity hydraulic Jack with pressure gauge or load gauge with remote control pump, reacting against rolled Steel Joists or suitable load frame obtaining reaction from the following :—

(a) Kentlege heavier than the required test load placed on a platform supported clear of the test pile. An existing structures of adequate weight and suitable construction may serve as kentiedge. The centre of gravity of that Kentledge should generally be on that sale of the pile and the load applied by the Jack should also be coaxial in the pile.

103. The test loads shall be applied in increments of about 20 per cent of the working load of pile as per design.

104. Settlements shall be recorded with preferably four dial gauges (placed equi distance around the pile) of 0.02 m.m. sensitivity.

105. Each stage of loading shall be maintained till the rate of movement of the pile top is not more than 0.10 m.m. per hour in sandy soils and 0.02 m.m. per hour in case of clayey soils and hard strata or a maximum of 2 hours whichever is greater. For this purpose, the type of soil met with at pile tip shall be considered. The designed safe load should be maintained for 24 hours and settlements should be observed every hour during this period.

106. For each increment, application of load shall be as smooth as possible. Time and settlement observations should be made at the commencement and completion of each increment. Settlement observations shall be continued when each increment load is kept constant at about 15 minutes intervals.

107. Each load increment on the pile will be maintained by operating the Jack pumps as required and even if the pressure falls down in the course of testing it will be restored by jacking to the required level.

108. The loading shall be continued upto twice the safe load (working load) designed for the pile or the load at which the total displacement of pile top/cap. equals the appropriate value of settlement specified below in the case of initial load test.

109. The loading shall be continued upto $1\frac{1}{2}$ times the safe load (working load) designed for the pile or the load at which the total displacement of pile top/cap equals the appropriate value of settlement specified below in the case of Routine load test/routine cyclic load test.

110. The routine load test shall be cyclic load test.

111. The load on the pile should be removed stage by stage releasing the pressure steadily after completion of the test and rebound observations made for two hours.

112. The assessment of safe load on the pile will be computed as follows in the case of "driven" cast in-situ piles and bored cast-in-situ piles;

(*a*) Two thirds of the final load at which the total settlement attains a value of 12mm; unless it is specified that a total settlement different from 12 mm is permissible in a given case on the basis of nature and type of structure. In the latter case, the safe load shall be the corresponding load to actual total settlement permissible.

(*b*) Fifty per cent of the final load at which the total settlement equals to 10 per cent of the pile diameter in case of uniform diameter of piles and 7.50 per cent of bulk diameter in case of under-reamed piles.

113. The observation readings of load test and the load displacement curve for the test shall be sent in triplicate to the Executive Engineer, in the prescribed pro-forma appended.

114. The rates quoted shall include charges for such items of work as the following and shall be for the finished work in situ and shall include all contingent expenses including of taxes or import duties, etc.

(*a*) Marking nd setting t the work.—The contractors shall carryout the ame with odolite and dumpy level and get it checked by he Executive Engineer. The instruments required for accurate alignment should be procured by themselves.

(*b*) Provision of rods, stakes, ropes, concrete and masonry pillars for centre lines, level and labour required in setting out the work.

(*c*) Provision of all necessary scaffoldings, centering and labour and appliances for transporting the hoisting and pile driving machinery and appurtenances inclusive of preparation of road, and paths and for their transports.

(*d*) Provision of sheds to keep materials under cover.

(*e*) Payment for water and electricity charges, required for the construction, load test, etc.

(*f*) Arrangements for protecting work during inclement weather.

(*g*) Supply of clean pure water required for work and workmen from any source of water supply. Include for all charges of laying pipes, etc., and supply of water from the corporation mains for works and workman.

(*h*) Disposal as may be directed of all rubbish superfluous materials and debris as they accumulate

(*i*) Thorougly clearing the whole of the work and work site in a clear and orderly condition.

(*j*) Allow for all necessary haulage and transport of earth from cutting to banking.

(*k*) Allow for hire tools and plant and test loads required for tests of piles and materials thereof inclusive of all labour and incidental charges.

(*l*) Allow for carriage expenses including all leads, lifts, loading, unloading and stacking to the satisfaction of the Executive Engineer.

(*m*) Include for periodical test expense of materials and all inclusive charges that may be levied by the Superintending Engineer to whom samples of materials used on the work will be sent up at the Superintending Engineer's discretion, periodically for test purposes. The opinion of the Superintending Engineer on the results of the tests as above conducted shall be final and binding on the contractor.

(*n*) Allow for all cost of excavation and running the necessary timber steel form or combination of both and pumping water wherever necessary.

(*o*) Watering R.C. caps and slabs for a period of three weeks from laying of each and other necessary incidental charges.

(*p*) Allow for cutting off piles to an even level surfaces the top of the piles to project 50 mm into the beams and caps and also for all cutting wastes or wrackage, etc.

(*q*) Allow in rate for providing necessary arrangements to enable observations of pile driving, load tests, etc.

(*r*) Allow for the cost of binding wire for which no extra rate will be allowed.

(*s*) Providing in case of cast-in-situ, piles for sealing the bearing of the piling form its shoe, as also at the joints of the followers and form with gunnies or homp or pulley or in any suitable and approved manner to prevent the subsoil water or any impurity from gaining access into the forms at any strata or driving the form.

(*t*) The contractor should arrange for their own mixer and mixer driver

NAME OF WORK RECORD SHEET

DRIVEN PILE DETAILS :

1 Type of Pile : circular/............mm.

2 Location of Pile............Capacity of pile............To

3 Type of shoe............Flat/conical............mm, weight............Kg.

Depth............cm.

4 Weight of Tube............To : Length............M. Follower Length :

5 Driving started on............at............hrs. and finished on............at............hr .

6 Time for driving and concreting............hrs.

7 Pile details (Reduced levels to be indicated) :

Ground level.

Plinth level.

Top of pile cap.

Cut off. level (bottom of Pile cap).

Pile top (*i.e.* bottom of shoe).

Payment length............M.

Built-up length............M.

Empty casing............M.

8 Mix............

9 Cement............Bags/Kg.

10 Reinforcement details :

Main rods.

Stirrups/helical.

hook.

11 Set obtained............mm. for............blows.

Certified that the "set" obtained for the above pile has been............mm for............ blows which is in accordance with the agreement conditions and with the set obtained. The pile is properly keyed into and resting on hard strata (*i.e.*) soft rock/disintegrated rock/hard/rock/dense sand etc.

Countersigned A.E./A.E.E. *Contractor.*

FOR DRIVEN CAST-IN-SITU PILES

NAME OF WORK.

OBSERVATION SHEET

Sl. No. of Pile :

466—3A—52A

Dia of pile............mm.	Weight of Tube............Te	Climate ....
Capacity of pile............Te	Length of Tube............M.	Concrete mix ....
Location of pile............	Weight of follower............Te	Reinforcement details ....
Type of Pile............Circular.	Length of follower............M.	
Shape of Pile............	Weight of Hammer............Te	Labour strength..
Type of shoe Flat, Conical............m.m	Type of Hammer............	Set determined ....
Depth of Shoe ....Cm.	Drop of Hammer............cm.	
Weight of shoe............kg.		

Serial number.	*Date.*	*Shifting time from theel location.*			*Driving.*					*Stoppage of work if any with reason and time.*	*The interval between closing of driving and starting of concreting.*	*Time involved during which machine stopped.*	*Reasons for the break with details of time.*
		From	*To*	*Total.*	*Depth.*	*Number of Blows.*	*From*	*To*	*Total.*				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
					MTS.				HRS.MTS.	HRS.MTS.	HRS.MTS.	HTS.MTS.	HRS.MTS.

Concreting.			*Remarks.*
Time.	*Number of loads.*	*Stoppage of work if any with necessary reasons and time.*	
(15)	(16)	(17)	(18)
HRS.MTS.		HRS.MTS.	

Net Time :

1. Shifting time1. .. .. ..
2. Driving time .. ..
3. Concreting time .. .. ..

Total time

Labour strength.

Pile length :............M. Set bar............blows............mm.

Certified that the set obtained for the above pile has been............mm. for............blows which is in accordance with the agreement conditions and with 2 set" achieved, the Pile is properly keyed into and resting on hard state is soft rock/disintegrated rock/hard rock/dense sand.

Counter Signed A.E./A.E.E.

Contractor.

FOR BORED CAST-IN SITU PILES
NAME OF WORK

OBSERVATION SHEET

1 Dia of Pile............mm.
2 Location of Pile.
3 Capacity of Pile............Te.
4 Concrete mix............
5 Machine Boring Diesel Engine............
6 Dia of Rope............mm.
7 Winch capacity............Te
8 Shifting of Pig............From............To............hrs..hrs. (Date............
9 Checking of centre line............
10 Centering and erection of bailer............
11 Erection of casing and centering............
12 Flushing the bore............
13 Erection of Reinforcement cege............
14 Erection of Tremie pipes and funnel............
15 Removal of casing............

Date.	Time.			Reinforcement details.
	Starting.	Finishing.	Total.	
				Labour strength Climate Reduced Level.

				Boring Time.				Deciding of hard Strata.					Checking through hard strata or Foundation level.					Concreting Time.					
Serial number.	Date.	Bore log details.	Depth in metres. from basement level	Start.	Finish.	Time.	Stoppage of work if any with reasons and time.	Start	Finish	Time.	Settlement in Cm.	Number of blows.	Start	Finish	Time.	Settlement in Cm.	Number of blows.	Start.	Finish.	Time.	Number of cement bags used.	Number of Bentonite bags used.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)

Certified that the rockmet atbottom of bore is hard enougth to take the designed load and the pile has been keyed into the rock, as there was no penetration even after boring for .... minutes after reaching the depth measured above.

A E./A.E.E. Contractor.

NAME OF WORK

OBSERVATION SHEET

INITIAL/ROUTINE LOAD TEST :

Location of the piles.

1 Date of Driving/Sering.

2 Gorund level.

3 Depth of Pile from top.

4 Height of show.

5 Cut off Level.

6 Depth of Pile below out off level.

7 Dis of Pile.

8 Reinforcement of the Pile.

9 Concreted on............Date............

10 Cubs strength of concrete............7 days............28 days............

11 Date of costing of pile cap.

12 Size of Pile Cap, Mix.

13 Reinforcement details of pile cap.

14 Period of testing............From (Mrs.)............To (Mrs.)............

15 Working load.

16 Test Load.

17 (*A*) Details of 3 cok.—

Type and Name............
Make............
Year of manufacture.
Made in............
Serial Number............
Capacity............
Hydraulic lift............

(*B*) Details of Pump :

Type and Name............
Make............
Year of manufacture.
Made in............
Serial number............
Capacity............

(*C*) Details of Pressure gauge :

Type and name
Serial number
Calibrated on............at............
Made............
Made in............
Year of Manufacture.
Maximum pressure.

(*D*) Dial Gauge details :

Type and name.
Serial number.
Made
Made in............
Least count.
Range of travel.

18 Specefic reasons for the Selection of the Pile.

19 Result : Total settlement............
Net settlement............

Countersigned AE/AEE.

Contractor.

INITIAL/ROUTINE LOAD TEST

Name of the Work ....

Type of Pile .... Design load ......Te Miz. ....Test started on....................at................hrs.

Dis of Pile ....mm Test load..........Te Reinforcement........Test completed on........................at................hrs.

Depth of pile............................M

Serial number.	*Date and time.*	*Preasure gauge reading*		*Dial gauge set at*	*Def sto Meter reading*				*Average reading.*	*Settlement mm.*	*Remarks,*
		Number of Divisions.	*Tonnes.*		*A Gauge.*	*B Gauge.*	*C Gauge.*	*D Gauge.*			
											1. Initial Reading. 2. Setting Read 3. Istl› ading ; 2nd loading 4. Working load 5. Final load 6. Release,....1st, 2nd, 3rd.... 7. Glass Plate introduced/removed 8. Correction to gauge 9. Rebound noticed at....Hrs. etc.

Settlement at working load of........tonnes ....mm

Settlement at interim/test load of.......... tonnes........mm

Net settlement after release........mm.

Countersigned

AE/AEE *Contractor.*

DATA FOR FIRST ROUTINE LOAD TEST (150 PER CENT WORKING LOAD) ON WORKING PILE.

Standard Data.

Description of work.	*Capacity of Piles.*								*Remark*
	60 *Te*	70 *Te*	80 *Te*	90 *Te*	100 *Te*	110 *Te*	120 *Te*	130 *Te*	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
I. *Hire Charges*									
A. R. S. J. Girders—									
Hire charges for RSJ Girders	0.007t	0.007t	0.01t	0.01t	0.01t	0.01t	0.01t	0.01t	
Painting one coat for R.S.J.	7.00 m^2	7.00 m^2	10.80 m^2	11.00 m^2	11.00 m^2	12.60 m^2	12.60 m^2	12.60 m^2	
B. Centering Sheets— ..									
Cost of centering sheets using 10 gauge M. S. sheets with angles of size 25 x 25 x 3 mm.									
Cost of sheet with angle frames, etc ..	25 Kg	25 Kg	36 Kg	42 Kg	42 Kg	48 Kg	48 Kg	48 Kg	
Painting one coat on sheets and frames ..	2.25 m^2	2.25 m^2	3.24 m^2	3.78 m^2	3.78 m^2	4.32 m^2	4.32 m^2	4.32 m^2	
C. Equipments—									
Equipments like heavy duty Jack, Oil tank with connected hose, pressure gauge 4 Nos. dial gauges, etc.	As per sub data								
D. Wooden Cribes, plants, posts etc.—									
Cost of teak wood cribes with teak wood planks.	0.016 m^3	0.016 m^3	0.016 m^3	0.016 m^3	0.016 m^3	0.016 m^3	0.016 m^3	0.016 m^3	
Casurina Post	LS	LS	LS	LS	LS	LS	LS	LS	
E. Charges for calibration including transportation	Rates to be obtained from Government Departments or teaching Institutions.								

Conveyance Charges—

Conveyance charges for all the materials like R.S.J., Girders, centering/sheets, Jack, oil tank, hose, dial gauges, wooden cribes, wooden planks, casurina posts, etc.

For works situated within 20 Km. belt around Madras City.

For other works beyond the above limit.

DATA FOR FIRST ROUTINE LOAD TEST (150 PER CENT WORKING LOAD) ON WORKING PILE.

Standard Data.

Description of work.	Capacity of Piles.								Remarks.
	60 *Te*	70 *Te*	80 *Te*	90 *Te*	100 *Te*	110 *Te*	120 *Te*	130 *Te*	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
III. *Materials*—									
A. Cost of gunny bags	1440 Nos.	1680 Nos.	1920 Nos.	2160 Nos.	2400 Nos.	2400 Nos.	2880 Nos.	3120 Nos.	
B. Salvage value for gunny bags	75 per cent of cost of gunny bags.								
C. Cost of Sand at site	$60 m^3$	$70 m^3$	$80 m^3$	$90 m^3$	$100 m^3$	$110 m^3$	$120 m^3$	$130 m^3$	
D. Salvage value for sand	95%	95%	95%	95%	95%	95%	95%	95%	
IV. *Labour for Erection and Dismantling*—									
A. Arranging for R.S.J. girders, centering sheets, wooden cribs, planks, posts, jack with its installation fixing in position and dismantling the arrangements after completion of the test.									
Erection—									
Syrang	8.8 Nos.	8.8 Nos.	13.2 Nos.	13.2 Nos.	13.2 Nos.	15.40 Nos.	15.40 Nos.	15.40 Nos.	
Mazdoor Category I	17.6 Nos.	17.6 Nos.	26.4 Nos.	26.4 Nos.	26.4 Nos.	30.80 Nos.	30.80 Nos.	30.80 Nos.	
Dismantling—									
Syrang	4.4 Nos.	4.4. Nos.	6.6. Nos.	6.6 Nos.	6.6 Nos.	7.7 Nos.	7.7 Nos.	7.7 Nos.	
Mazdoor Category I	8.8 Nos.	8.8 Nos.	13.2 Nos.	13.2 Nos.	13.2 Nos.	15.4 Nos.	15.4 Nos.	15.4 Nos.	
B. Labour for filling up sand in gunny bags stitching up, stacking in position and removal of the bags from the platform after conducting the load test.—									
Syrang	15.84 Nos.	18.48 Nos.	21.12 Nos.	23.76 Nos.	26.40 Nos.	29.04 Nos.	31.68 Nos.	34.32 Nos.	
Mazdoor Category I	31,68 Nos.	36.96 Nos.	42.24 Nos.	47.52 Nos.	52.80 Nos.	58.08 Nos.	63.36 Nos.	68.64 Nos.	
Mazdoor Category II	31.68 Nos.	36.96 Nos.	42.24 Nos.	47.52 Nos.	52.80 Nos.	58.08 Nos.	63.36 Nos.	68.64 Nos.	

C. Filling up of sand in between the stacked bags on the platform—									
Mazdoor Category I	10.89 Nos.	12.71 Nos.	14.52 Nos.	16.34 Nos.	18.15 Nos.	19.97 Nos.	21.78 Nos.	23.60 Nos.	
Mazdoor Category II	7.26 Nos.	8.47 Nos.	9.68 Nos.	10.89 Nos.	12.10 Nos.	13.31 Nos.	14.52 Nos.	15.73 Nos.	
D. Removing the loads sand from the platform.									
Mazdoor Category I	10.89 Nos.	12.72 Nos.	14.52 Nos.	16.34 Nos.	18.15 Nos.	19.97 Nos.	21.78 Nos.	23.60 Nos.	..
Mazdoor category II	7.26 Nos.	s8.47 Nos.	9.68 Nos.	10.89 Nos.	12.10 Nos.	13.31 Nos.	14.52 Nos.	15.73 Nos.	..
Works :—									
A. Earth work excavation and depositing the same as directed.	11.25 m3	11.25 m3	11.25 m3	11.25 m3	11.25 m3	11.25 m3	11.25 m3	11.25 m3	..
Size 3.0 M x 2.50 M x 1.50 M (minimum).									
B. Brickwork in cement mortar 1: 3 using stock/metric/country bricks for fixing datum bar.	$0.18m^3$	$0.18m^3$	$0.18m^3$	$0.18m^3$	$0.18m^3$	$0.18m^3$	$1.80m^3$	$0.18m^3$	..
Size 1.00 x 0.30 x 0.30 minimum.									
C. R.C.C. Pile Cap.—									
Cement concrete 1 : 2 : 4	0.343 m3	0.422 m3	0.422 m3	0.512 m3	0.512 m3	0.512 m3	0.562 m3	0.562 m3	..
Shuttering arrangements	2.00 m2	2.25 m2	2.25 m2	2.56 m2	2.56 m2	2.56 m2	3.00 m2	3.00 m2	..
Reinforcement (fabrication)	17 Kg.	21 Kg.	21 Kg.	26 Kg.	26 Kg.	26 Kg.	30 Kg.	30 Kg.	..
Salvage value of rainforcement grill ..	17 Kg.	21 Kg.	21 Kg.	26 Kg.	26 Kg.	26 Kg.	30 Kg.	30 Kg.	..
Straightening of reinforcement Fitter Ist class.	0.50 No.	0.50 No.	0.50 No.	0.50 No.	0.50 No.	0.50 No.	0.50 No.	0.50 No.	..
Finishing the top surface of Pile cap—									
(*a*) Mason I Class	0.50 No.	0.50 No.	0.50 No.	0.50 No.	0.50 No.	0.50 No.	0.50 No.	0.50 No.	..
(d) Mazdoor Category II	0.50 No.	0.50 No.	0.50 No.	0.50 No.	0.50 No.	0.50 No.	0.50 No.	0.50 No.	..
D. Labour required for conducting the load test minimum 36 hours.—									
Pump Operator	4.0 Nos.	4.0 Nos.	4.0 Nos.	4.0 Nos.	4.0 Nos.	4.0 Nos.	4.0 Nos.	4.0 Nos.	..
Mazdoor category II helper	4.0 Nos.	4.0 Nos.	4.0 Nos.	4.0 Nos.	4.0 Nos.	4.0 Nos.	4.0 Nos..	4.0 Nos.	..
Carpenter II Class	2.0 Nos.	2.0 Nos.	2.0 Nos.	2.0 Nos.	2.0 Nos.	2.0 Nos.	2 0 Nos.	2.0 Nos.	..
Mazdoor category II helper	2.0 Nos.	2.0 Nos.	2.0 Nos.	2.0 Nos.	2.0 Nos.	2.0 Nos.	2.0 Nos.	2.0 Nos.	..

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DATA FOR ROUTELINE LOAD TEST (150 PER CENT WORKING LOAD ON WORKING PILE

Description of work.	Capacity of Piles.								Remarks.
	60 *Te*	70 *Te*	80 *Te*	90 *Te*	100 *Te*	110 *Te*	120 *Te*	130 *Te*	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
E. Dismantling of RCC and brick masonry—									
Pile cap	0.343m3	0.422m3	0.422m3	0.512m3	0.512m3	0.512m3	0.562m3	0.562m3	..
Brick masonry (at datum bar) ..	0.18m3	0.18m3	0.18m3	0.18m3	0.18m3	0.18m3	0.18m3	0.18m3	..
VI. Sundries for nails, thread, insulation, tape, plaster of paris, glass plates, wedges, magnetic datum bar, hydraulic oil, Tarpaulin, dismantling of pile cap, upto out off level, lighting arrangements, etc.	LS	LS	LS	LS	LS	LS	LS	LS	..
Total ..									

Serial number.	Capacity of pile or load fest.	Load on Platform.	Capacity of Jack.	Size of platform.	Load / m2	BM for secondary Joists.	Z for secondary Joist.	No. of Joists requirement.	Weight / M	B.M. for primary joists.	Z for Joists.	No. of Joists required.	Weight / M	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	Te	Te	Te	M	tm/2	t/m	cm3	15MB	Kg	tm3	cm3	15 MB	Kg.	
	60	105.00	200	5.0×5.0	4.20	1.92	116.36	100 mmxs 200 mm 11 Nos.	25.4	12.75	773	180 mm 500 mm 3 Nos.	86.9	
2	70	122.50	Do.	Do.	4.90	Do.	Do.	Do.	Do.	Do.	Do.	Do.	Do.	
	80	140.00	Do.	6.0×6.0	3.90	2.20	113.33	Do.	Do.	9.95	603	180 mm 500 mm 5 Nos.	Do.	
4	90	157.50	Do.	7.0×6.0	3.75	2.35	142.16	Do.	Do.	16.40	994	Do.	Do.	
5	100	175.00	Do.	Do.	4.17	Do.	Do.	Do.	Do.	Do.	Do.	Do.	Do.	
6	110	192.50	300	8.0×6.0	4.01	2.67	161.59	100 mmx 200 mm 13 Nos.	Do.	24.92	1510	Do.	Do.	
7	120	210.00	Do.	Do.	4.38	Do.	Do.	Do.	Do.	Do.	Do.	Do.	Do.	
8	130	227.5C	Do.	Do.	4.74	Do.	Do.	Do.	Do.	Do.	Do.	Do.	Do.	

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WORKING SHEET.

Hire Charges for Centering Sheets.

Manufacturing and supply of M.S. centering sheet for loading Platform of size 90 cm x 60 cm with 10 gauge M.S. sheet and alround M.S. angles stibbaner of size 25 mm x 25 mm x 3 mm

Angles .. .. .. 25 mm x 25 mm x 3 mm 1·1 kg/m. } $3 \times 0.6m \times 2 \times 0.9m^2 = 3.60\ m^2$ Weight 3.96 kg/m.

Sheet 2.5 mm=1800 mm x 600 mm=19.62 Kg/m^2.
Required sheet............................1.00 m x 0.70 m
Weight of the sheet..................1.00 m x 0.70 m 13.74 Kg.
Weight of single sheet of size......0.90 m x 0.60 m

Angles	3.96 Kg.
Sheet	13.74 Kg.
	17.70 Kg.

Weight of sheet for One m^2 at $\dfrac{17.70\ kg.}{0.52\ m} = 33$ Kg.

Number of uses assumed...............................25 times.
Salvage cost at the end expected 25 per cent.
Co-efficient of painting (centering sheets and angles) 2¼
Painting proposed once (25 uses) :

(1) G.I. sheet 16 uses—CPWD norms.
(2) Spreading and stacking of sand.

Requirement of Centering Sheet.

Working Load. Te	*Area of the Platform.* m^2	*Weight of 33 Kg. per* m^2 *Kg.*	*Salvage at 25 per cent.* *Kg.*	*Balance* *Kg.*	*Weight/Test (25 uses) Kg.*	*Remarks.*
(1)	(2)	(3)	(4)	(5)	(6)	(7)
60, 70	25	825	206.50	618.50	24.75 or 25	Rate Rs. 7000 / M.T.
80	36	1188	297.00	891.00	35.64 or 36	No. of uses 25.
90, 100	42	1386	346.50	1039.50	41.58 or 42	
110, 120, 130	48	1584	396.00	1188.00	47.52 or 48	

Painting area or Centering Sheet.

Working Load Te	Area of Platform M^2.	Painting area for each test M^2.	Remarks.
(1)	(2)	(3)	(4)
60, 70	25	$\frac{25}{25} \times \frac{9}{4} = 2.25$	
80	36	$\frac{36}{25} \times \frac{9}{4} = 3.24$	
90, 100	42	$\frac{42}{25} \times \frac{9}{4} = 3.78$	
110, 120, 130	48	$\frac{48}{25} \times \frac{9}{4} = 4.32$	

HIRE CHARGES FOR EQUIPMENT.

Test—Time requirement.

	HRS.
Time required for increments at 20 per cent up to safe capacity of pile.	5
Keep the load for 24 hours	24
Raise it to 1.5 times safe load	3
Release the load gradually	4
Total ..	36

Hire Charges.

Pressure Gauge and Dial Gauges :

36 hrs—1 No. Pressure gauge at Rs. 0.41/hour ..	14.76
36 hrs x 4 Nos. Dial gauges at Rs. 0.06/hour ..	8.64
	23.40

Jack.

36 hrs. Jack of 100 Te cap at Rs. 3.29/hour	119.52
36 hrs. Pressure gauge and 4 Nos. dial gauges	23.40
36 hrs. Hose pipe at Rs. 1.29/hour	46.44
Total ..	189.36

Rs. 190

	Rs.
36 hrs Jack 200 Te cap at Rs. 5.70/hour	205.2
36 hrs. pressure gauge and 4 Nos dial gauges.. ..	23.40
36 hrs. Hose pipe at Rs. 1.29/hour	46.44
Total ..	275.04

Rs. 275

	Rs.
36 hrs Jack 300 Te cap at Rs. 9.61/hour	345.96
36 hrs. Pressure gauge and 4 Nos. dial gauges.. ..	23.40
36 hrs. Hose pipe at Rs. 1.29/hour	46.44
Total ..	415.80

Rs. 416.00

Hire Charges for Wooden Sleepers, Planks, Casuring Post Etc.

Teekwood sleepers .. .. .. 40 pieces—1.80m. long (0.30 m × 0.23 m)
= 4.968 m^3
Planks (LS) = 0.032 m^3
5 000 m^3

Casurine post ....LS .... to be added separately
Teakwood weight 850 to 950 Kg/m^3 .. Say 900 Kg/m^3
900 × 5 = 4500 Kg. (or) 4.5 Te.
($5m^3$) Weight of Teakwood at 900 Kg/m^3 = 4.5 Te.
Total life .. .. =30 years.
Cost of Rs. 5250/m^3 6 Test in a year.
Cost of wood .. ..=5250 × 5=26250
Charges per test .. .. $=\dfrac{5250 \times 5}{6 \times 50}$ = Rs. 87.50

Rs. 88.00

Number of uses.................50 × 6 = 300 uses.

4.5 Te of T.W. sleepers is required for 300 uses.

$\frac{4500}{300}$ Kg. (Or) 0.016 m^3 is required for ONE TEST.

Hire charges for equipments—

(1) Hydraulic Jacks
(2) Pressuse gauge
(3) Dial gauge
(4) Hose Pipe.

Jack

Tangee Heavy Duty Hydraulic Jacks (Tested as per I.P.S.S—1—02-002) with detached remote control Hand pump with Plain ram with single acting pump (Rate as per the Ref. No. 11969/L/M/34/HT/s, dated 22nd March 1982 of Messrs. Mardtools, No. 1, Perianna Maistry Street, Madras-1.

Life of Jack is assumed as 2160 hrs.

(Based on the Highways and Research Station, Guindy).

Life span=6 years ; one year—360 working hrs;

Total 2160 hrs.

100 *Te Jack* :—

		RS.
Cost of Jack and accessories	.. ..	6,247
S.T. S.C. Packing charges and conveyance etc. at 15%		937
Maintenance cost at 10%	.. ..	718
	Total ..	7,902
Less —Depreciation of material at 10%	.. ..	(—) 790
	Net ..	7,112

$$\text{Rate/hours} = \frac{7112}{2160} = \text{Rs. } 3.29.$$

200 *Te Jack* :—

		RS.
Cost of Jack and accessories	.. ..	10,810.00
S.T., S.C., packing charges and conveyance at 15%	..	1,621.50
Maintenance cost at 10%	.. ..	1,243.15
	Total ..	13,674.65
Less—Depreciation of material at 10%	.. ..	(—) 1,367.47
		12,307.18

$$\text{Rate/hour} = \frac{12307.18}{2160} = \text{Rs. } 5.70$$

300 *Te Jack* :—

		RS.
Cost of Jack and accessories	.. ..	18,225.00
S.T./S.C. Conveyance, packing and delivery at 15%	..	2,735.00
Maintenance cost at 10%	.. ..	2,096.00
	Total ..	23,056.00
Less—Depreciation at 10%	.. .. ..	(—) 2,306.00
	Net ..	20,750.00

$$\text{Rate/hour} = \frac{20750}{2160} = \text{Rs. } 9.60$$

Pressure Gauge.—

Tangee pressure gauges duly calibrated in tonnes for direct reading dial size in 150 mm.

(Rate as per Ref N . 64/L/M/34/HT/S, dated 23rd March 1982 of Messr . ardtools, No. 1, Perianna Maistry Street, Madras-1).

Life assumed at 2160 hrs. (as stated above).

		Rs.
Cost of pressure gauge	.. ..	810.00
S.T., S.C., Conveyance Packing, delivery at 15%	..	122.00
Maintenance cost at 5% for Rs. 932	.. .. ..	47.00
	Total ..	979.00
Less—Depreciation at 10%	.. ..	(—) 98.00
	Net Cost Rs. ..	881.00

$$\text{Rate/hour} = \frac{881}{2160} = \text{Re. } 0.41$$

Dial Gauge —

Baken Mercer—Model 60 plunger type Dial gauges with accessories range 15 mm—graduation 0-50-0/0—100 (Rate as per Price list of Messrs. Baken Mencen India Private Limited, 33/1/2, Nagar Road Pune-411 014.

		RS.
Life assumed 2160 hours (as stated above) Cost of dialgauge with its accessories.		125 00
(Data purpose—Rate for 10 m is adopted).		
S.T. S.C. Conveyance packing and forwarding charges at 15%		18.75
Add—Maintenance charges at 5%	.. .. ..	7.19
	Total ..	150.94
Less—Depreciation at 10%	.. ..	(—) 15.0
	Nets ..	135.85

$$\text{Rate/hours} = \frac{135.85}{2160} = \text{Re. } 0.06.$$

Hose—

Tangee rubber hoises required for remote controlledJacks wi 3/8 B'S.P. female swivelling and connections.

Life span assumed 1/3 x 2160 hours 720 hours.

		RS.
Cost of hose pipe 3 M at a rate of Rs. 270.00/m.		810
S.T. S.C. Conveyance, Packing and forwarding charges at 15%		122
Maintenance	.. ..	Nil.
	Total ..	932.00
	Depreciation ..	Nil.
	Net Cost ..	932.00

$$\text{Rate/hour} = \frac{932.0}{720.00} = \text{Rs. } 1.2$$

INITIAL LOAD TEST—

WORKING SHEET:—

Hire Charges for R.S.J.

Total Life .. .. 100 Years.
Platform size .. .. 6.00 m × 6.00 m.
Measurement of R.S.J. Girders 95-MB.

		Painting.	Weight KG.
100 mm x 200 mm 25.40 KGm	0.8-m x 7.00-m x 13 Nos.	72.80 m^2	2311
180-mm x 500 mm 86.90 KG/m	1.72-m x 7.00-m x 3 Nos.	36.12	1825
L.S. ..	Allowance for Plates master Joists and extra Projection beyond Platform etc.	2.08	864
		1,11.00	5,000

Number o : Test in a year.. 6
600 Test canbe down. with R.S.J. weighting 5 Te

For one test the weight of RSJ required. $= \frac{5}{100 \times 6} = 0.008$ T

Painting of R.S.J. has to be done once in two years
Area of Painting of R.S.J. Girders etc. — 111 m^2.

Area of Painting to be done for one Test $\frac{111}{2 \times 6}$ 9.25 m^2

WORKING SHEET.—

Hire Charges for R.S.J. .. .. 70 & 80 Te

Total Life .. .. 100 Years.

Platform size 7.00 m x 6.00 m.

Measurement of Girders—95 MB

		Painting M^2	Weight. KG.
100 mm x 200 mm 25.40 KG/m	0.8 m x 7.00 m x 15 Nos.	84.00	2667
100 mm x 500 mm 86.9 KG/m.	1.72 m x 8.00 m x 5 Nos.	68.80	3476
L.S.	Allowance for weight of Plates, master. Joists, extra Projections beyond platform etc.	3.20	857
		156.00	7,000-KG.

Or 7 Te.

Number of Test n a year.. 6
600T ests in a year can be done.
with R.S.J. weighting................7 Te.

For ONE TEST the weight of R.S.J. required $= \frac{7}{100 \times 6} = 0.012$ T

Area of painting to be done for ONE TEST. $= \frac{156.00}{12} = 13\ m^2$

WORKING SHEET—

Hire charges for R. S. J. .. .. .. 90 and 100 Te
Total life .. .. 100 Years.
Platform size .. .. 6.00 m X 6.00 m
Measurement of R. S. J. Girders .. .. 95-MB.

		Painting. M2	Weight KG
100 mm × 200 mm 25.40 KG/m	0.8-m × 7.00m × 17 Nos.	95.2	3 023
180-mm × 800-mm 86.9 KG/m. ..	1.72 × 9.00-m × 5 Nos.	77.4	3.911
L. S.	Allowance for weight of plates, master joists, extra projection beyond platform, etc.	3.40	1,066
		176.00	8,000

Number of test in a year 6
600 Tests can be done with R.S.J. weighting .. 8 Te.

For ONE TEST the weight of R.S.J. required $= \frac{8}{6 \times 100} = 0.013$ T

Area of painting to be done for ONE TEST $= \frac{176.00}{12} = 14.66\ m^2$ (or) 14.65 m^2

WORKING SHEET.—

Hire charges for RSJ .. .. 110/120/130 Te.
Total life .. .. 100 Years.
Platform size .. .. 7-00 m × 9.00 m
Measurement of R. S. J. Girders .. .. 95 MB.

		Painting. M^2	Weight. KG.
100-mm × 200-mm 25.40 KG/m ..	0.80 m × 8 m × 19 Nos.	121.60	3,861
100 mm × 500 mm 85.90 KG/m ..	1.72 m × 10.00 m × 7 Nos.	120.40	6,083
L. S.	Allowance for weight of plates, master joists, extra projection beyond platform etc.	4.00	1,056
		246.00	11,000

Number of test in a year 6
600 Tests can be done with R.S.J. weighting .. 11 Te.

For ONE TEST the weight of R.S.J. required $= \frac{11}{100 \times 6} = 0.018$ T

Painting of R. S. J. has to be done ones in two years.
Area of painting to R.S.J. Girders etc. .. 246 m

Area of painting to be done for ONE TEST $= \frac{246}{2 \times 6} = 20.50\ m^2$

HIRE CHARGES FOR R. S. J.

Serial number.	Capacity of Pile.	Weight of R.S.J.	Cost of R.S.J. at Rs. 6,000/MT.	Charges for Test.	Painting. Area.	Rate;m².	Amount. ;	Charges Test.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Te.	Te.	RS.	RS.	m2.	RS.	RS.	RS.	
1	60	5	30,000	50	9.25	5.60	51.80	101.80	
2	70	7	42,000	70	13.00	5.60	72.80	142.80	
3	80	7	42,000	70	13.00	5.60	72.80	142.80	
4	90	8	48,000	80	14.65	5.60	82.00	162.00	
5	100	8	48,000	80	14.65	5.60	82.00	162.00	
6	110	11	66,000	110	20.50	5.60	114.80	224.80	
7	120	11	66,000	110	20.50	5.60	114.80	224.80	
8	130	11	66,000	110	20.50	5.60	114.80	224.80	

WORKING SHEET :

Hire Charges for Centering Sheets :

Manufacturing and supply of M. S. Centering sheet has LOADING PLATFORM OF Size 90 cm × 60 cm with 10 Gauge M. S. Sheet and alround M. S. angles stiffness of size 25 mm 25 mm × 3-mm.

Angles.

25 mm × 25-mmX3 mm } 3X0.06-m + 2 X 0.9-m = 3.60-m
1.1-KG;m .. .. } Weight—?.96 Kg.

Sheet 2.5-mm = 1800X600 = 21.2-KG.
= 19.62-KG/m²

Required Sheet .. 1.00-m X 0.70-m

Weight of the Sheet .. 1.00-m X 0.70-m = 13.74-KG.

Weight of single Sheet of size 0.90-m X 0.60-m } Angles .. .. 3.96-KG.
Sheet .. .. 13.74-KG.

17.70-KG.

Weight of Sheet for/m² at Rs. $= \frac{17.70\ KG.}{0.54\ m^2} = 33$ KG.

Weight .. .. = 33 KG/Sq.m.

Number of uses assumed .. .. .. 25 times.

Salvage cost at the end of expected .. .. 25 per cent.

Co-officient of painting (Centering Sheet and angles .. 2 1/2

Painting proposed once 25 uses.

(1) G. I. Sheet 16-uses-CPWs.

(2) Spreading and stocking of sand.

REQUIREMENT OF CENTERING SHEET.

Working Load Te. (1)	Area of the platform m². (2)	Weight at 33-KG. m². (3)	Salvage at 25 per cent. (4)	Balance. (5)	Weight/Test 25 uses. (6)	Remarks. (7)
		KG.	KG.	KG.	KG.	
60	36	1,188	297.00	891.00	35.64 or 36	Rate Rs. 7,000/MT.
70, 80	42	1,386	346.50	1,039.50	41.58 or 42	Number of uses 25.
90, 100	48	1,584	396.00	1,188.00	47.52 or 48	
110, 120, 130.	63	2,079	519.75	1,559.25	62.37 or 63	

PAINTING AREA OF CENTERING SHEETS.

Working Load To.	Area of Platform m²	Painting area for each test. m2		Remarks.
60	36	$36 \times \frac{1}{25} \times \frac{9}{4} =$	3.24	
70, 80	42	$42 X \frac{1}{25} X \frac{9}{4} =$	3.78	
90, 100	48	$48 X \frac{1}{25} X \frac{9}{4} =$	4.32	
110/120, 130.	63	$63 X \frac{1}{25} X \frac{9}{4} =$	5.67	

Centering Sheet .. .. 33 KG/m²

Centering sheet fabrication charges etc. complete Rs. 7,000.00 / M.T.

Cost per m² $= \frac{7000\ X\ 33}{1,000} =$ Rs. 231,00-m²

1-m² cost of centering sheet .. .. Rs. 231.00

(1 Sq. m. X 2½) Painting one cost on iron work at Rs. 5.60/m²). Rs. 12.60

Total .. Rs. 243.60

Deduct for salvage value at (25 per cent for Rs. 231.00). (—) 57.75

185·85

Hire charges per m² for ONE USE .. .. $\frac{185.85}{25}$

(— 7.43 (c.)

Rs. 7.50

Serial number.	Working Load.	Area.		Cost.		Total.
		Platform m^2	Painting m^2	Platform Rs.	Painting.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	60 ..	36	3.24	252.00	18.10	270.10
2	70, 80 ..	42	3.78	294.00	21 20	315.20
3	90, 100 ..	48	4.32	336.00	24.20	360.20
4	110, 120, 130	63	5.67	441.00	31.75	472.75

Hire charges for equipments.

(1) Hydraulic Jacks.
(2) Pressure Gauge.
(3) Dial Gauge.
(4) Hose Pipes.

***Jack*:**

Tangee Heavy Duty Hydraulic Jacks (Tested as per IPSS-1-02-002) with detached remote control Hand Pump with Plain ram with single acting Pump (Rate as per the Ref. No. 11969/L/m/34HT/s, dated 22nd March 1982, of M/s. Handteals, No. 1, Perianna Maistry Street, Madras-1. Life of Jack is assumed as 2160-hrs.

(Based on the Highways and Research Station Guindy). Life open 6-years ; one year 360-hrs. Total 2,160-hrs.

200 *Te Jack* :

	RS. P.
Cost of Jack and accessories	10,810.00
ST, SC, Painting charges and conveyance etc., at 15 per cent	1,621.50
Maintenance cost at 10 per cent	1,243.15
	13,674.65
Less—Depreciation of material at 10 per cent	1,367.47
Net cost ..	12,307.18

$$\text{Rate/Hour} = \frac{12307.18}{2160} = \text{Rs. } 5.70$$

300 *Te Jack* :

	RS. P.
Cost of Jack and accessories	18,225.00
ST, SC. conveyance, packing and delivery at 15 per cent	2,735.00
Maintenance cost at 10 per cent	2,096.00
Total ..	23,056.00
Less—Depreciation at 10 per cent	2,306.00
Net cost ..	20,750.00

$$\text{Rate/Hour} \quad \frac{20750}{2160} \quad \text{Rs. } 9.61$$

400 *Te Jack* :

At present material not available and hence rate is not known.

However the rate may be taken as Rs. 15.00 hour for data purpose.

Pressure Gauge :

Tangee pressure gauges duly calibrated in tonnes for direct reading dial size in 150 mm.

(Rate as per Ref. No. 11969/L/M/34/HT/S, dated 23rd March 1982 of M S. Mantoold, No. 1, Perianna Maistry Street, Madras-1)

Life assumed at 21.60 hrs. (as stated above).

	RS. P.
Cost of pressure gauge	810.00
ST, SC, Conveyance, packing delivery at 15 per cent	122.00
Maintenance cost at 5 per cent for Rs. 932 ..	47.00
Total ..	979.00
Less—Depreciation at 10 per cent	98 00
Net cost ..	881.00

$$\text{Rate/Hour} = \frac{881}{2160} = \text{Rs.} 0.41$$

Die Gauge :

Baken mercer—model to plunger type Dial Gauges with accessories —range 15 mm—(graduation 0-50-0) (0-100 (Rate as per list of M/s. Baker Merces (India Private Limited) 33/1/2 Nagar Road, Pune-411 014.

Life assumed at 2160 hrs. (as stated above).

	RS.
Cost of dial gauge with its accessories	125.00
ST, SC, Conveyance, packing and forwarding charges at 15 per cent.	18.75
Maintenance charges at 5 per cent	7.19
Total ..	150.94
Less depreciatuon at 10 per cent	15.09
Net cost ..	135.85

$$\textbf{Rate}/\text{hour} = \frac{135.85}{2160} = 0.06 \text{ p.}$$

***Hose*:**

Tangee rubban hoses required for remote controlled jacks with 3/8" BSP female swivelling and connections

	RS.
Life span assumed 1/3 x 2160 hrs. = 720 hrs.	
Cost of hose pipe 3m at a rate of Rs. 270/m	810.00
ST. SC., Conveyance, packing and forwarding charges at 15 per cent	122.00
Maintenance	Nil.
Total	Rs. 932.00
Depreciation	Nil.
Net ..	932.00

$$\text{Rate/hour} = \frac{932.00}{720} = \text{Rs. } 1.29.$$

Test time Requirement :

	Hours.
Time required for increments at 20 per cent upto safe capacity of pile	5
Keep the load for 24 hours	24
Raise it to 1.5 times safe load	3
Release the load gradually	4
Total ..	36

MINIMUM STANDARD REQUIREMENTS.

Serial number and Details.	Various Capacity.								Remarks.
	60 Te.	70 Te.	80Te.	90 Te.	100 Te.	110 Te.	120 Te.	130 Te.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1. Platform size	6.00 x 6.00 M	7.00 x 6.00 M	7.00 x 6.00 M	6.00 x 8.00 M	6.00 x 8.00 M	7.00 x 9.00 M	7.00 x 9.00 M	7.00 x 9.00M	..
2. Minimum weight of platform ..	5 Te.	7 Te.	7 Te.	8 Te.	8 Te.	11 Te.	11 Te.	11 Te.	..
3, Capacity of Jack	200 Te	200 Te	200 Te	300 Te	300 Te	300 Te	300 Te	400 Te	..
4. Range for pressure gauge (nearest to next 50).	$\frac{135 \times 10^3}{D^2/4}$	$\frac{157.50 \times 10^3}{D^2/4}$	$\frac{180 \times 10^3}{D^2/4}$	$\frac{205.50 \times 10^3}{D^2/4}$	$\frac{225 \times 10^3}{D^2/4}$	$\frac{247.50 \times 10^3}{D^2/24}$	$\frac{270 \times 10^3}{D^2/4}$	$\frac{292.50 \times 10^3}{D^2/4}$	D is dia meter Jack pisom in Cm·
5. Range for Dial gauge	15 MM in Metric dimensions.								
6. Minimim load of platform for the test.	135.00	157.50	180.00	202.50	225.00	247.50	270.0C	292.50	..

HIRE CHARGES FOR EQUIPMENT.

Pressure Gauge and Dial Gauge—

36 hrs. 1 No. Pressure gauge at 0.41 /hr. ..	14.76
(36 hrs x4)—4 Nos. Dial gauge at 0.60/hrs. ..	8.64
Total ..	23.40

Jack—

36 hrs. Jack of 200 Te cap at Rs. 5.70/hr. ..	205.20
36 hrs. pressure gauge and 4 numbers dial gauges	23.40
36 hrs. Hose pipe at Rs. 1.29/hr.	46.44
Total Rs. ..	275.04

Rs. 275.00

36 hrs. Jack of 300 Te cap. at 9.61/hr.	345.96
36 hrs. Pressure gauge and 4 numbers dial gauges	23.40
36 hrs. Hose pipe at Rs. 1.29/hr. ..	46.44
Total Rs. ..	415,80

Rs. 416.00

36 hrs. Jack of 400 Te cap. at 15.00/hr. ..	540.00
36 hrs. Pressure gauge and 4 numbers dial gauges	23.40
36 hrs. Hose pipe at Rs. 1.29/hr.	46.44
Total Rs. ..	609.84

Rs. 610.00

Hire Charges for Wooden Sleepers, Planks, Casurina Posts, etc.

Teak wood sleepers =40 pieces—1.80 m long (0.30m x 0.23m)

= 4.968 m^3

Planks (Ls) 0.032 m^3

5.000 m^3

Casurina post————LS......... to be added sepa rately

Teak wood weight 850 to 950 kg/m^3

900 x 5 = 4,500 Kg. (or) 4.5 Te.

(5 m^3) Weight of teakwood at 900 Kg/m^3 = 4.5 Te.

Total life .. .. .. 50 years.

Cost at Rs. 5,250/m^3 6 test/year.

Cost of wood = 5,250 x 5 = 26,250

Charges per test = $\frac{5,250 \times 5}{6 \times 50}$ = 87.50

Rs. 88.00

Number of uses = 50 x 6 = 300 uses.

4.5 Te of T. W. sleepers is required for 300 uses.

$\frac{4,500}{300}$ Kg. (or) 0.016 m^3 is required for One Test.

DATA SHEET TO ACCOMPANY THE ESTIMATE FOR MADRAS CITY (CENTRAL ZONS) 1982-83.

Serial number.	Description of work.	Rate.	Per.	Amount.	Total.
(1)	(2)	(3)	(4)	(5)	(6)
		RS. P.		RS. P.	
1	Sand for mortar —				
	Cost of river sand	2.25	m	2.25	
	Conveyance	31.64	m^3	31.64	
	Loading and unloading charges	7 77	m^3	7.77	
	Total ..			41.66	Rs. 41.66 / m^3

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(1)	(2)	(3)	(4)	(5)	(6)
2	Earth work excavation in all soils and depositing the same as directed by the departmental officers.				

Avg. of items $1e + 1e + 1f + 1g$

$$\frac{18.70 + 26.55 + 48.50 + 93.00}{4} \qquad \frac{46.69}{10m^3} \text{ (or) } \frac{4.67}{m^3}$$

3 Brick work in cement mortar 1 : 3 using Ist class bricks of size $8\frac{3}{4}'' \times 4\frac{3}{8} \times 2\frac{3}{4}$ for foundation and basement.

(2)	(3)	(4)	(5)	(6)
1,300 Nos.	Stock bricks	266.04	1,000	345.85
25 cft. (or) 0.71 m^3	Cement mortar 1 : 3	334.51	m^3	237.50
1 No.	Mason Ist class	20.00	1 No.	20.00
3 Nos.	Mason IInd class	17.00	1 No.	51.00
2 Nos.	Mazdoor Ist classs	10.00	1 No.	20.00
6 Nos.	Mazdoor IInd class	8.00	1 No.	48.00
	for 100 cft.			722.35

$$\frac{\text{Rs. } 255.10}{m^3}$$

4 Cement conerete 1 : 2 : 4 for RCC work for foundation,

(2)	(3)	(4)	(5)	(6)
9 00 m^3	Broken stone jelly (20mm)	127.24	m^3	1,145.15
4·50 m^3	Sand	41.66	m^3	187.47
3,231 Kg.	Cement (1981-82 rates)	600.00	1Mt.	1,938.60
3.5 Nos.	Mason IInd class	17.00	each	59.50
21.2 Nos.	Mazdoor Ist class	10.00	each	212.00
35.3 Nos.	Mazdoor IInd class	8.00	each	282.40
	Sundrise	..	..	0.87
				3,826.00

Rate for 1 m^3 = Rs. 382.60

5 Form work for plain surface (Sl. No. 18)

Rate/m! = Rs. 50.00 /m^2

6 Form work for plinth beam ...... (Sl. No. 17)

$$\text{Rs. } \frac{500.00 - 68}{10 \text{ M}^2} = \frac{432}{10} \qquad \text{Rs. } 43.20$$

7 Supplying and fabricating and placing in position steel

(*a*) Mild steel rods (as per item 48) Rs. 576.00/Qtl.

(*b*) R. T. S. bars .. .. .. Rs. 587.00/Qtl.

8 Painting over old iron work—10m^2

(2)	(3)	(4)	(5)	(6)
1.11 ltr.	Ready mixed paint	40.00	lt.	44.40
0 7 No.	Painter	16.00	each	11.20
LS	Sundries including brushes, scoap, putty etc.,		LS	0.40
	Total for 10m^2.. ..			56.00

Rs. 5.60/m^2.

(1)	(2)	(3)	(4)	(5)	(6)
9	Labour cost :—				
	Carpenter Ist class	19.00	..	..	..
	Carpenter IInd class	16.00	..	..	..
	Fitter Ist Class	16.00	..	..	..
	Fitter IInd elass	13.00	..	..	..
	Mason Ist class	20.00	..	..	..
	Mason IInd class..	17.00	..	..	..
	Painter Ist class	16.00	..	..	..
	Painter IInd class	14.00	..	..	..
	Mazdoor :—				
	Head Mazdoor	11.00	..	..	..
	Category I—Adult	10.00	..	..	..
	Category II—Adult	8.00	..	..	..
	Category III—Child	6.00	..	..	..
	Mechanic Ist class	15.00	..	..	..
	Pump Driver	15.00	..	..	..
	Syrang	17.00	..	..	..

Dismantling clearing away and carefully stacking material useful for reuse for any—thickness of walls.

(1) Brick on store masonry in cement mortar walls under 3.00 M high (S. I. No. 5 CI. Rs. $\frac{18.55}{m^3}$

(2) R. C. C. work S. I. No. 5 O1 .. .. Rs. $\frac{2.50}{0.01}$ m^3

Teak wood scantling upto 2.00 m in length Rs. 5,250/m^3

Cement bag $\frac{\text{Rs. 1. 20}}{\text{each}}$ (Local Rate).

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DATA FOR INITIAL LOAD TE;T (200 PER CENT WORKING LOAD) ILLUTIRATION.

Description of work.	Capacity of Piles. 60 *To*	70 *To*	80 *To*	90 *To*	100 *To*	110 *To*	120 *To*	130 *To*	*Remarks.*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
I. Hire Charges—									
A. R.S.J. Girders—									
Hire Charges for RSJ Girders ..	50.00	70.00	70.00	80.00	80.00	110.00	110.00	110.00	..
Painting One coat for RSJ	51.80	72.80	72.80	82.00	82.00	114.80	114.80	114.80	Rs. 5.60/m²
B. Centering sheets—									
Cost of centering sheets using 10 Gauge MS. sheets with angles of Size 25 x 25 x 3 mm Cost of sheet with angle frames.	252.00	294.00	294.00	336.00	336.00	441.00	441.00	441.00	Rs. 7.00/m²
Painting one coat on sheets and frames ..	18.10	21.20	21.20	24.20	24.20	31.75	31.75	31.75	Rs. 5.60/m²
C. Equipments—									
Equipments like heavy duty Jack, Oil Tank with connected hose, Pressure Gauge 4 Nos. dial gauges, etc.	275.00	275.00	275.00	416.00	416.00	416.00	416.00	610.00	Sub Data
D. Wooden Cribs, Planks, posts, etc.—									
Cost of teak wood cribs with teak wood planks.	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00	Rs. 5250;m²
Casurina posts	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	..
E. Charges for calibration including transportation.	500.00	500.00	500.00	500.00	500.00	500.00	500.00	500.00	Data purpose.
II. Conveyance Charges—									
Conveyance charges for all the materials like RSJ Girders, centering sheets, Jack, oil tank, hose, dial gauges, wooden cribs, wooden planks, Casurina posts, etc.	1,200.00	1,200.00	1,200.00	1,200.00	1,200.00	1,200.00	1,200.00	1,200.00	Data purpose.
For works situated within 20 Km belt around Madras City.									
For other works beyond the above limit.									
III. Materials—									
A. Cost of Gunny Bags	2,160.00	2,520.00	2,880.00	3,240.00	3,600.00	3,960.00	4,320.00	4,680.00	Rs. 1.20/bag.
B. Salvage for Gunny Bags value ..	(—)1,620.00	(—)1,890.00	(—)2,160.00	(—)2,430.00	(—)2,700.00	(—)2,970.00	(—)3,240.00	(—)3,510.00	Rs. 0.90/bag.
C. Cost of sand at site	3,207.80	3,749.40	4,291.00	4,832.60	5,374.10	5,915.70	6,457.30	6,998.90	Rs. 41.65/m³
D Salvage Value for sand	(—)3,047.40	(—)3,561.90	(—)4,076.40	(—)4,5,91.00	(—)5,105.40	(—)5,619.90	(—)6,134.40	(—)6,649.40	95 per cent.

IV. Labour for Erection and dismantling.—									
A. Arranging of RSJ Girders centering sheets, wooden cribs, planks, jack with its installations, fixing in position and dismantling the arrangements after completion of the test—									
Erection—									
Syrang	187.00	261.80	261.80	299.20	299.20	411.40	411.40	411.40	Each 17.00
Mazdoor Category I	220.00	308.00	308.03	352.00	352.00	484.00	484.00	484.00	10.00
Dismantling—									
Syrang	93.50	130.90	130.90	149.63	149.60	205.70	205.70	205.70	17.00
Mazdoor, category I	110.00	154.00	154.00	176.00	176.00	242.00	242.00	242.00	10.00
B. Labour for filling up sand in gunny bags stitching up stacking in position and removal of the bags from the platform after conducting the lead test.									
Syrang	336.60	392.70	448.80	504.90	561.00	617.10	673.20	728.30	Each 17.00
Mazdoor, category I	396.00	462.00	528.00	594.00	660.00	726.00	792.00	858.00	10.00
Mazdoor, category II	316.00	369.60	422.40	475.20	528.00	580.80	633.60	686.40	8.00
C. Filling up of sand in between the stacked bags on the platform.									
Mazdoor, category I	148.50	173.50	198.00	223.00	247.80	272.50	297.00	322.00	10.00
Mazdoor. Category II	79.20	92.40	105.60	118.80	135.20	145.20	158.40	171.60	8.00
	2,588.00	3,162.40	3,492.10	3,944.30	4,277.50	4,970.50	5,300.20	5,630.30	
D. Removing the iosse and from the Plat form.									
Mazdoor, category ı	148.50	173.50	198.00	223.00	247.50	272.50	297.00	322.00	Rs. 10.00
Mazdoor, category II	79.20	92.40	105.60	118.80	135.20	145.20	158.40	171.60	8.00
V. Works—									
A. Earth Work exvation and depositing the same as directed—									
Size 3.0 M x 2.50 M x 1.50 M (Minimum)	52.55	52.55	52.55	52.55	52.55	52.55	52.55	52.55	4.60/m^3
B Brick work in cement mortar 1:3 using stock/country/metric bricks for fixing datum bar—									
Size 1.00 x 0.30 M x 0.30 Minimum ..	45.90	45.90	45.90	45.90	45.90	45.90	45.90	45.90	225.10/m^3

DATA FOR INITIAL LROD TEST (200 PER CENT WORKING LOAD) ILLUSTRATION—*cont.*

Description of work.	*Capacity of Piles.* 60 *To*	70 *To*	80 *To*	90 *To*	100 *To*	101 *To*	120 *To*	130 *To*	*Remarks.*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
C. R.C.C. Pile cap.									
Cement concrets 1 : 2 : 4	131.20	161.50	161.50	195.90	195.90	195.90	215.00	215.00	332.60/m³
Shuttering arrangements	86.40	97.20	97.20	110.60	110.60	110.60	129.60	129.60	43.20/m³
Reinforcement R.T.S. (fabrication) ..	99.80	123.25	123.25	152.60	152.60	152.60	176.10	176.10	587/Qtl.
Salvage value of reinforcement grill ..	(—)88.90	(—)109.80	(—)109.80	(—)136.00	(—)136.00	(—)156.00	(—)156.90	(—)156.90	523/Qtl.
Straightening of reinforcement Fitter. Ist Class.	8.00	8.00	8.00	12.00	12.00	12.00	16.00	16.00	Rs. 16
Finishing the top surface of pile cap—									
(*a*) Mason Class I	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	Rs. 20
(*b*) Mazdoor Category II	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	Rs. 8.00
D. Labour required for conducting the load test minimum 36 hours—									
Pump operator	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	Rs. 15.00 each.
Mazdoor category II helper	32,00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	Rs, 8.00 each.
Carpenter, II Class	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	Rs. 16.00 each.
Mazdoor, Category II helper	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	Rs. 8.00 each.
E. Dismentling of RCC and brick masonry—									
Pile Cap	85.75	105.50	150.50	128.00	128.00	128.00	140.50	140.50	Rs. 250/m³
Brick masonry (at datum bar)	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	Rs. 18.55/m³
VI. Sundries for nails insuation tape, plaster of aris, glass, plates, wedges magnatic datum hydraulic oil Tarapaulin, dismantling of pile cap upto cuf off level lighting arrangements, etc.									
Total ..									

INITIAL LOAD TEST.

100 Te Capacity.

Test of a simple pile under INITIAL ROUTINE LOAD (200 per cent of pile capacity as per ISS) as per the testing Procceducre specified inclusiue of all charges for extension. cutting off piles that may be necessary for erecting R.S.J. platform together with all labour and other charges for and unloading the test loads using sand and hire and transport charges and all other incidential charges for conducting the test (calibration of pressure gauge has to be done and certificate to that effect has to be produced before commencement of the test,

working Load		100 Te
Test Load	.. ..	200 Te
Minimum load on the platform	.. ..	225 Te

Quantity.	*Description of work.*	*Rate.*	*Per*	*Amount.*	*Total.*
(1)	(2)	(3)	(4)	(5)	(6)
	Hire charges (R.S.J. Girders.				
0.0133 m²	Hire charges for R.S.J. girders as per design	6,000.00	1 MT	80.00	..
14.65 m²	Painting one coat over R.S.J.	5.60	m2	s82.00	..
	Centering sheets using 10 *gauge.*				
	M.S. sheets with angles of size 25mm x 25mm x 3mm.				
48 Kg.	Cost of sheets with angles and frames etc.	7.00	Kg.	336.00	..
4.32 m2	Painting one coat on sheets and angle frames etc. ..	5.60	m2	24.20	..
	Instruments				
	Instruments like heavy duty Jack, oil tank, with connected hose, Pressure gauge 4 Nos. dial gauges etc. (Data purpose).	416.00	Set.	,416.00	..
	Sleepers, Flanks, Posts etc.				
0.0166 m3	Cost of teakwood cribs with teakwood planks	5,250.00	m3	88.00	.
	Casurina posts	..	LS	10.00	
	Testing Charges				
	Testing charges for instruments including trnsportation charges (for calibration of pressure guage).	500.00	Test.	500.00	..
	Conveyance charges				
	Conveyance charges for all the materials like R.S.J., girders, centering sheets, Jack, oil tank, hose, dial gauges, wooden cribs, wooden planks, casurina posts etc (conveyance Ist trip fr m shed to worksite before commencement of test and second trip from site to shed).				
	For works situated within 20 KM belt around Madras City (Data purpose).	1,200.00	LS	1,200.00	..
	MATERIALS COST.				
3,000 Nos.	Cost of gunny bags	1.20	Bag.	3,600	..
3,000 Nos.	Salvage value of gunny bags at 25 per cent	0.90	bag	(—) 2,700.00	..
129 m3	Cost of sand at site	41.60	m3	5,374.10	..
129 M3	Salvage value of sand at 95 per cent of Rs. 5,347.10		..	(—)5,105.40	..
	Labour for erection and dismantling				

Arranging of R.S.J. gridrs, centering sheets, wooden cribs, planks, parts, jacks with its installations fiaxing in position and dismantling he arrangements after conpletion of the test.

(1)	(2)	(3)	(4)	(5)	(6)
	Erection.				
17.60 Nos.	Syrang	17.00	Each.	299.20	..
35.20 Nos.	Mazdoor category	10.00	Do.	352.00	..
8.80 Nso.	Syrang	17.00	Do.	149.60	
17.60 Nos.	Mazdoor category labour for filling up of sand in gunny bags stittching up, stacking in position and removal of the bags from the platform after conducting the load test	10.00	Do.	176.0)	..
33 Nos. ..	Syrang	17.00	Each	561.00	
66 Nos. ..	Mazdoor category I	10.00	Do.	660.00	..
66 Nos. ..	Mazdoor category II	8.00	Do.	528.00	..
	Filling up of sand in between the stocked bags on the platform—				
24.75 Nos.	Mazdoor category I	10.00	Do.	247.50	..
16.90 Nos.	Mazdoor category II	8.00	Do.	135.20	..
Works—					
	Removing the loose sand from the platfrom				
24.75 Nos.	Mazdoor category I	10.00	Do.	247.50	..
16.90 Nos.	Mazdoor category II	8.00	Do.	135.20	..
Work—					
	Earth work excavation and depositing the same as directed—				
11.25 m3 ..	Size 3.00m X 2.50m X 1.50m (minimum)	4.67	m3	53.55	..
	Brickk wor in cement mortar— 1.3 using stock bricks of size 9"X4⅜"X2¾" for fixing datum bar				
0.18m3	1.00m X 0.30m X 0.30m (Minimum)	255.10	Do.	45.90	..
	R.C.C. Pile Cap				
	Reinforced cement coneret 1:2:4. using 20 mm guage hard broken stone jelly for all R.C.C. works, excluding centering, shuttering, and cost of reinforcement grill but including curing etc., complete.—				
0.512 m3 ..	Cement concrete	382.60	m3	195.90	..
2.56 m2 ..	Shuttering arrangements	43.20	m2	110.60	..
26 Kg. ..	Reinforcement—R.T.S. (Fabrication)	587.00	Qtl.	152.60	..
26 Kg. ..	Salvage value of reinfor cement	523.00	Qtl.	(—)136.00	..
½ Nos. .. (26 kg. LS.)	Straightining of reinforcement Fitter Ist class	16.00	Each	12.00	..
	Finishing the top surface of pile cap—				
No. ..	Mason 1st class	20.00	Do.	10.00	..
½ No. ..	Mazdoor category II (helper)	8.00	Do.	4.00	..
	Labour required for conducting the load test-36 hrs-Minimum				
4 Nos. ..	Pump operator	15.00	Do.	60.00	..
4 Nos. ..	Mazdoor category II (helper)	8.00	Do.	32.00	..
2 Nos. ..	Carpenter IInd class	16.00	Do.	32.00	..
2 Nos. ..	Mazdoor category II (Helper)..	8.00	Do.	16.00	..
	Dismantling of R.C.C. and brick masonry after completion of the test—				
0.521 m3	R.C.C. pile cap	250.00	1m3	128.00	
0.18 m3 ..	Brick masory (datum bar)	18.55	Do.	3.00	..
	Sundries for nails, thread insulation taps, plaster of paris, glass plates, wedges, magnetic datum bar, hydrauilc oil, Tarpaulin, dismantling of pile cap, upto cut off level, lighting arrangements etc.	LS.			

ADDENDUM TO

TAMIL NADU BUILDING PRACTICE

VOLUME II

REVISED FORMS OF TENDER, TENDER NOTICE
(LS AND K2)

466-3A :5

APPENDICES.

APPENDIX-I —TENDER NOTICE.

(*as amended in G. O. Ms. No.* 618, *P. W., dated* 30*th April* 1985.)

1. On behalf of the Governor of Tamil Nadu, tenders will be received by the Superintending Engineer............................ Circle/Executive Engineer.. Division at his office at upto P.M. on .... for the work of**

The tenders should be in the prescribed form obtainable from the Superintending Engineers'/Executive Engineers' office.

The tenders will be opended by the Superintending Engineer.. Circle/Executive Engineer.. Division at the place and on the date aformentioned.

The tenderers or their agents are expected to be present at the time of opening of tenders. The tender-receiving officer will, on opening each tender, prepare a statement of the attested and unattested corrections therein and hand it over to the tenderer concerned and initial all corrections in the presence of the tenderers If any of the tenderers or their agents finds it inconvenient to be presect at the time, then in such a case, the tender receiving officer will, on opening the tender of the absentee tenderer, make out a statemnt of the unattested corrections and communicate it to him. The absentee tenderer, shall then accept the statement of the corrections without any question whatsover.

2. Tenders must be submitted in sealed covers and should be addressed to the Superintending Engineer............................ Circle/Executive Engineer....................................... Division, the mame of the tenderer and the name of the work being noted on the cover.

If the tender is made by an individual it shall be signed with his full name and his address shall be given. If it is made by a firm, it shall be signed with the copartnership name by a member of the firm, who shall also sign his own name, and the name and address of each member of the firm shall be given. If the tender is made by a Corporation, it shall be signed by an authorised officer who shall produce with his tender, satisfactory evidence of his authorisation. Such tendering Corporation may be required before the contract is executed, to furnish evidence of its Corporate existence.

3. Each tenderer must also send a certificate of income-tax verification from the appropriate income-tax authority, in the form prescribed therefor. The Certificate will be valid for one year from the date of issue for all tenders submitted during the period.

In the case of proprietary or partnership firm it will be necessary to produce the certificate aforementioned for the proprietor or proprietors and for each of the partners as the case may be.

If the tenderer is a registere Public Works Department Contractor and if a Certificate for the current year had already been produced by him during the calender year, in which the tender is made, it will be sufficient if particulars regarding the previous occasion on which the said certificate was produced are given.

All tenders received without a certificate as aforementioned will be summarily rejected.

4. Each tenderer must pay, as earnest money, a sum of rupees....................... into the branch of State Bank of India or in the Government Treasury or Sub-Treasury within the jurisdiction of the Superintending Engineer /Executive Engineer concerned to the credit of Revenue Deposits on behalf of the Superintending Engineer of the Circle /Executive Engineer of the .... Division and enclose with his tender the chalan endorsed accordingly. The earnest Money Deposit can also be paid in any other form as may be approved by the State Government from time to time as per para 155 of T.N.P.W.D. Code. This earnest money will be refunded to the unsuccessful tenderer on application, after intimation is sent of rejection of the tender or at the expiration of two months from the date of tender; whichever is earlier. The refund will be authorised by the Superintending Engineer : Executive Engineer by suitable endorsement on the chalan. The earnest money will not be received in cash or currency notes by the Public Works Department Officer, save in exceptional cases, where there are no Treasuries or Banks within the jurisdiction of the officer calling for tenders. When currency notes are given, the tenderer should sign his name in full with date, on the back of all the currency notes given by him, whatever their denominations may be.

The earnest money will be retained in the case of the successful tenderer and will not carry any interest. It will be dealt with as provided in the tender.

5. The tender will remain valid for a period of two clender months from the last date for receipt of tender. The validity period can be extended further if the contractor gives his consent in writing, specifying the period of extension.

ii. The tenderer whose tender is under consideration shall attend the Superintending Engineers /Executive Engineers' office, before the end of the period specified by written intimation to him. If the tenderer fails to attend the office before the end of the specified period, his tender will not be considered. He shall forthwith, upon and intimation being given to him of acceptance of his tender by the officer duly authorised in this behalf under article 299 (1) of the Constitution, hereinafter called the accepting authority "make security" deposit of 2 per cent of the value of contract in one of the forms prescribed in Tamil Nadu Public Works Account Code (i.e.) by taking into account of the amount of earnest money deposit, already deposited with the tender, it would be sufficient to pay the

** Name of work

balance amount to make up the 2 per cent of the value of contract for the purpose of security deposit). The security deposit together with earnest money deposit and the amount withheld according to clause 64-1 of General conditions to the contract, shall be retained as security for due fulfilment of contract; If a cash security deposit is made by the contractor, he shall follow the procedure laid down in the preceding paragraph for payment of earnest money deposit and such deposit shall not bear any interest.

(iii) On receipt of written communication of acceptance of tender if the tenderer fails to pay the requisite security deposit within the period specified in the written communication or backs out from the tender or withdraws his tender, the earnest money deposit shall be forfeited to the Government.

If the contractor fails to carryout the contract, after paying the requisite deposits, then he will be liable for the excess expendiutre, if any incurred to complete the work as contemplated in the General conditions to the contract.

(iv) It shall be expressly understood by the tenderer, that on receipt of written communication of acceptance of tender from the accepting authority, there emerges a valid contract between the Governor of Tamil Nadu and the tenderer, for execution of the work without any separate written agreement. Hence for this purpose, the tender documetns, i.e., tender notice, tender offered by the contractor, General conditions to the contract, special conditions to the contract, negotiation, correspondences, written communication of acceptance of tender, etc., shall constitute a valid contract and that will be the foundation of the rights of both the parties to the contract.

Provided that, it shall be open to the accepting authority to insist execution of any written agreement by the tenderer, if administratively considered necessary or expedient.

6. The tenderer shall examine clearly the Tamil Nadu Building Practice and also the general conditionh to contract contained therein, and sign the Divisional Office copy of the Tamil Nadu Building Practice and its addenda volume in token of such study before submitting his tender unit rates, which shall be for finished work in-situ. He shall also carefully study the drawings and additional specifications and all the documents connected with the contract. The Tamil Nadu Building Practice and other connected documents with the contract, such as specifications, plans, descriptive specification sheet regarding materials, etc., can be seen at any time between 11-00 a.m. and 5 p.m. on office days in the office of the Executive Engineer, ... Division. * A copy of the set off contract documents can also be had on payment of Rs. .... for each set.

7. The tenderers attention is directed to the requirements for materials under the clause " Materials and Workmanship " in the general conditions to contract. Materials conforming to the ISI standards shall be used on the work, and the tenderer shall quote his rates accordingly.

8. Every tenderer is expected before quoting his rates, to inspect the site of the proposed work. He should also inspect the quarries, and satisfy himself about the quality and availability of materials. The names of quarries and kilns etc., wherefrom certain materials are to be obtained will be given in the Descriptive Specification Sheet. The best class of materials to be obtained from the quarries or other source, defined shall be used on the work. In every case the materials must comply with the relevant Standard Specifications. Samples of materials as called for in the standard specification or in this tender notice or as required by the Executive Engineer in any case shall be submitted for the Executive Engineer's approval, before the supply to site of work is begun. If the contractor, after examination of the source of materials defined in the Descriptive Specification Sheet, is of the opinion that materials complying with the Standard or other Specifications of the contract cannot be obtained in quality or sufficient quantity, from the source defined in the Descriptive Specification Sheet, he shall so state in his tender and state wherefrom he intends to obtain materials, subject to the approval of the Executive Engineer.

The Government will not, however, after acceptance of contract rate, pay any extra charges for lead, or for any other reason, in case the contractor is found later on to have misjudged the materials available. Attention of the contractor is directed to the General conditions to contract regarding payment of seigniorage, tolls, etc.

9. The tenderer's particular attention is drawn to the sections and clauses in the General conditions to contract dealing with:—

(1) Test, inspection and rejection of defective materials and work.

(2) Carriage.

(3) Construction plant.

(4) Water and lighting.

(5) Cleaning up during progress and for delivery.

(6) Accidents.

(7) Delays.

(8) Particulars of payment.

The contractor should closely peruse all the specification clauses which govern the rates which he is tendering.

10. A schedule of quantities accompanies this tender notice. It shall be definitely understood, that the Government does not accept any responsibility for the correctness or completeness of this schedule and that this schedule is liable to alterations by omissions, deductions or additions at the discretion of the Executive Engineer, ... Division/or the Superintending Engineer, ... Circle or as set forth in the conditions of contract. The tenderer will, however, base his lumpsum tender on this schedule of quantities. He should quote specific rates for each item in the schedule, and the rates should be in Rupees and in sums of five paise. The rates should be written both in words and figures and the units in words. The tenderer should also show the totals of each item and the grand total of the whole contract, and quote in the tender a lumpsum for which he will undertake to do the whole work, subject to the conditions of contract such lumpsum agreeing with the total amount of Schedule A. This Schedule accompanying the lumpsum tender shall be written legibly and free from erasures, overwritings or conversion of figures. Corrections where unavoidable, should be made by crossing out, initialling, dating and rewriting.

11. Tenderers offering a percentage deduction from or increase on the estimate amount and those not submitted in proper form or in due time will be rejected. Rates or lumpsum amounts for items not called for, shall not be included in the tender. No alteration which is made by the tenderer in the contract form.

* To be struck out, if such copies are not to be issued for sale.

the conditions of contract, the drawings, specification, or quantities accompanying same will be recognised; and if any such alterations are made the tender will be void.

12. The tenderer should workout his own rates, without reference being made to the Public Works Department current Schedule rates or the Public Works Department estimate, which are not open for inspection by the tenderers.

13. The price at which and the source from which certain particular materials shall be obtained by the contractor are given at the end of the schedule accompanying the tender form. Tenderers must accept the materials at these prices, and shall quote their price for finished work accordingly. Notwithstanding any subsequent change in the market value for these materials, the charge to the contractor will remain as originally entered in the written contract. No centage or incidental charges will be borne by Government in connection with this supply.

14. The attention of the tenderers is directed to the contract requirements as to the time of beginning work, the rate of progress and the dates for the completion of the whole work and its several parts. The following rate of progress and proportionate value of work done from time to time, as will be indicated by the Executive Engineer's certificates of the value of work done, will be required. Date of commencement of this programme will be the date on which the site (or premises) is handed over to the contractor.

Period after date of commencement.	*Percentage of work completed based on contract lumpsum amount.*
(1)	(2)

Note.—The periods to be entered in column (1) for the purpose of defining the rate of progress may be fixed by the Superintending Engineer or Executive Engineer to suit each case.

15. No part of the contract shall be sub-let without written permission of the Executive Engineer, nor shall transfer be made by power of attorney, authorising others to receive payment on the contractor's behalf.

16. If further necessary information is required, the Executive Engineer of the Divisions will furnish such, but it must be clearly understood that tenders must be received in order, and according to instructions.

17. The Executive Engineer or other sanctioning authority reserves the right to reject any tender or all the tenders without assigning any reason therefor.

18. The tenderers who are themselves not professionally qualified, shall undertake to employ qualified technical men at their cost to look after the work. The tenderers should state in clear terms, whether they are professionally qualified or whether they undertake to employ technical men required by the department specified in the schedule below for the work. In case the selected tenderer is professionally qualified or has undertaken to employ technical men under him, he should see that one of the technically qualified men is always at the site of the work during working hours personally checking all items of works and paying extra attention to such works as may demand special attention (e.g.) reinforced concrete works, etc.

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(In the format below enter or incorporate the latest norms fixed by Government for the employment of Technical assistant from time to time and penalty for non-employment of such technical assistant etc.)

Value of contract.	*Qualification and No. of Technical Assistant to be employed.*

Note 1.—Items (1), (2), (3), (4), (5) or (6) should be scored out in case where not applicable to the particular work.

Note 2.—A penalty of Rs. 500 per month, for diploma holder and Rs. 1,000 per month for degree holder, be levied in case of default on the part of contractors in following the norms laid down above.

Note 3.—The employment of technical Assistants could be based only on the value of contract. Engineers with Mechanical Engineering qualification and retired from Civil Engineering Department are also suitable to supervise the Civil Engineering works because of their experience in Civil Engineering field.

Note 4.—In case the contractor who is professionally qualified is not in a position to remain always at the site of work and to pay extra attention to such work, as may demand special attention (e.g. R.C. work, etc.) he should employ technically qualified man as prescribed above.

19. Tenderers who have not already registered themselves as PWD contractors shall furnish evidence of good record and capacity to do works.

20. A tenderer submitting a quotation which the tender accepting authority considers excessive and/or indicative of the insufficient knowledge of current prices or definite attempt at profiteering will render himself liable to be debarred permanently from tendering or for such period as the tender accepting authority may decide. The tender rates should be based on the controlled price for materials—price permissible for the tenderer to charge a private purchaser under the provision of clause 8 of Hoarding and Profiteering Prevention Ordinance 1943 as amended from time to time and on similar principles in regard to labour and supervision in the construction.

21. The contractor should offer employment to ex-toddy tappers as far as possible. The number of ex-toddy tappers to whom he can .... and he should undertake in the agreement to offer such employment to such number.

Note.—This paragraph should be scored out, if the cost of the work involved is less than Rs. 10,000.

22. The contractor shall comply with the provisions of the Apprentices Act, 1961 and the rules and orders issued thereunder from time to time. If he fails to do so, his failure will be a breach of the contract and the competent authority, may at his discretion, cancel the contract or invoke any of the penalties for the breach of contract provided in the agreement. The contractor shall also be liabe to any pecundary liability arising on account of any violation by him of the provisions of the Act.

"Contractor shall, during the currency of the contract, ensure engagement of the apprentices in the categories mentioned below who may be assigned to him by the Director of Employment and Training|State Apprenticeship Adviser, Tamil Nadu. The contractor shall train them as required under the Apprentices Act, 1961 and rules made thereunder, and shall be responsible for all obligations of the employer under the said Act including the liability to make payments to the apprentices as required under the said Act.

Value of contract.	*Category.*	*No. to be appointed.*
Rs. 1 lakh and up to 3 lakhs.	1. Building Constructor	1
	2. Brick layer.	1
Above Rs. 3 lakhs and up to Rs. 10 lakhs.	1. Building Constructor	1
	2. Brick layer.	1
	3. Diploma Holder in Civil Engineering	1
Above Rs. 10 lakhs and up to Rs. 50 lakhs.	1. Building Constructor	1
	2. Brick layer.	1
	3. B.E. (Civil) or equivalent degree holder	1

"Unless the contractor has been exempted from engagement of apprentices by the Director of Employment and Training| State Apprenticeship Adviser, a Certificate to the effect that the contractor had discharged his obligation under the said Act, "satisfactorily" should be obtained from the Director of Employment and Training|State Apprenticeship Adviser and the same should be produced by the Contractor for final payment in the settlement of the contract".

23. The contractor should employ one I.T.I. trained mason for every ten masons or parts thereof. In case of non-availability of I.T.I. trained masons the contractor should obtain the prior approval of the Executive Engineer concerned before proceeding with the contract with the other kinds of masons.

Executive Engineer|Superintending Engineer

Division|Circle.

Station :

Date :

APPENDIX II (a)—TENDER.

Date: 19 .

To

His Excellency, the Governor of Tamil Nadu, represented by the Superintending Engineer/ Executive Engineer of .... Circle/Division.

Sir,

I/We do hereby tender and, if this tender be accepted, undertake to execute the following works, viz., ... as shown in the drawings and describing in the specifications deposited in the Office of the Superintending|Executive Engineer of .... Circle|Division with such variation by way of alterations of, additions to, and omission from the said works and method of payment as are provided for in the 'conditions of contract' for the sum of Rupees * .... or such other sum as may be arrived at under the clause of the General conditions to contract relating to payment on lumpsum basis or by final measurements at unit prices.

2. I/We have also completed the priced list of items in Schedule 'A' annexed (in words and figures) for which I/We agree to execute the work and receive payment on measured quantities as per the general conditions to the contract.

3. I/we do hereby distinctly and expressly declare and acknowledge that, before the submission of my or our .... tender, I/we have carefully followed the instructions in the tender notice, and have read the Tamil Nadu Building Practice and the general conditions to the contract therein and the Tamil Nadu Building Practice addenda volume; and that I/we have made such examination of the contract documents and of the plans, specifications, quantities and of the location, where the said work is to be done, and such investigation of the work required to be done, and in regard to the materials required to be furnished as to enable me/us........ .... to thoroughly understand the intention of the same and the requirement, covenants, stipulations and restrictions contained in the contract and in the said plans and specifications; and distinctly agree that I/we will not hereafter make any claim or demand upon the Government, based upon or arising out of any alleged misunderstanding or misconception or mistake on .... part of the said requirements, covenants, stipulations, restrictions and conditions.

4. .... Enclose an income-tax verification certificate ....

I/we being a registered Public Works Department contractor .... I/we have already produced an income-tax verification certificate during the current calender year in respect of .... (here particulars of the previous occasions on which the certificate was produced should be given). The legal address of the contractors for service of all letters and notices will be as follows....................

5 (i) (*a*) I|we enclose herewith a chalan for the payment of the sum of rupees .... as earnest money not to bear interest.

5 (i) (*b*) I|we have paid Rs........... (Rupees.......... .... only) against the EMD of Rs............ (Rupees............ only) since I am|we are.......... and eligible to pay the EMD at concessional rates.

5 (i) (*c*) In lieu of cash deposits, I|we.............. have enclosed a.................... bearing No.............Date................ issued by .... for a value of Rs............ (Rupees .... only) drawn|endorsed|pledged in favour of the Executive Engineer .... Division.

5 (i) (*d*) I am|we are .... and hence exempted from payment of EMD.

6. If my/our tender is not accepted, this sum shall be returned to me|us on my|our applications when intimation is sent to me/our of rejection or at the expiration of two months from the date of this tender, whichever is earlier. If my|our tender is accepted, the earnest money shall be retained by the Government as security for the due fulfilment of contract. If upon intimations being given to me|us by the authority authorised by the Governor under Article 299 (1) of the constitution (hereinafter called the accepting authority) of acceptance of tender (I|We) fail to

* To be entered in words and figures.

† me|our

make the dditional security depoit, then I|we agree to the forfeiture of Earnest Money Deposit. Any notice required to be served on me|us here under shall be sufficiently served on me|us if delivered to me|us personally or forwarded, to me|us by post to (registered or ordinary) or left at any|our address given herein. Such notice shall, if sent by post be deemed to have been served on me|us at the time when in due course of post it would be delivered at the address to which it is sent.

7. I|we fully understand that on receipt of communication of acceptance of tender, from the accepting authority, there emerges a valid contract between me/us and the Governor of Tamil Nadu and the tender documents, i.e., tender notice, tender with schedules, General conditions to the contract and special conditions of the tender, negotiations letters, communication of acceptance of tenders, shall constitute the contract for this purpose and be the foundation of rights of both the parties, as defined in clause (iv) of tender notice, provided that, it shall be open to the accepting authority to insist on executions of any written agreement by tenderer, if administratively considered necessary or expedient.

8. I/we have also signed the copy of the Tamil Nadu Building Practice and National Building code and addenda volume thereto, maintained in the...............Division office, in acknowledgement of being bound by all conditions of the clauses of the General conditions to the contract and all specifications for items of works described by a specification number in Schedule 'A'.

9. In consideration of the payment of rupees..................or such other sum as may be arrived at under the clause of the General conditions to the contract, relating to payment on lumpsum basis or by final measurement at unit prices I/we agree subject to said conditions to execute and complete the works shown upon the said drawing serially from number 1 to .... inclusive .... (Schedule B) and described in the specifications (Schedule C) and to the extent of probable quantities shown in (Schedule-A) with such veriations by way of alteration of, additions to or deductions from, the said work and method of payment therefor as are provided for in the said conditions.

10. The term "Executive Engineer" in the said conditions shall mean the public works officer incharge of the Divisions having jurisdiction for the time being over the work, who shall be competent to exercise all the powers and previleges reserved herein in favour of the Government with the previous sanction of or subject to ratification by the competent authorities in case where such sanction or ratification may be necessary and who has been duly authorised under Article 299 (1) of the Constitution.

11. I/we agree that the time shall be considered as the essence of this contract and to commence the work, as soon as this contract is accepted by the competent authority as defined by the Tamil Nadu Public Works Department code and the site (or premises) is handed over to me|us as provided for in the said conditions and agree to complete the work within ....months from the date of such handing over of the site (or premises) and to show progress as defined in the tabular statement "Rate of Progress" subject nevertheless to the provision for extention of time contained in clause 56 of the General conditions to the contract appended to the Tamil Nadu Building Practice.

12. I/we agree that upon the terms and condtions of this contract being fulfilled and performed to the satisfaction of the Executive Engineer, the security deposited by me/us as hereinbefore recited or such portion thereof as I/we may be entitled to, under the said conditions be paid back to me|us as provided in clause 64 of the General conditions to the contract.

13. I am/we are professionally qualified and my/our qualifications are as follows:

I|we in pursuance of clause 18 of tender notice undertake to employ the following technical staff for Supervising the work and will see that one of them is always at site during working hours personally checking all items of works and paying extra attention to such works as may require special attention (e.g.) reinforced cement concrete.

Name of Technical staff proposed to be employed.	*Qualification and experience.*
1.	
2.	
3.	

14. I|we, agree that the arbitrator for fulfilling the duties set forth in the arbitration clause of the General conditions to the contract shall be:

(i) The Superintending Engineer of the ....Circle in case the value of claim upto Rs. 50,000; and

(ii) I/we agree that in case, the value of claim is Rs. 50,001 and above, the remedy will be through the competent Civil Court only.

Signature of the Contractor with date.

15. In pursuance of negotiation with the Executive Engineer/ Superintending Engineer of...............Division/Circle on...........

I/we agree to reduce the rates for the items in the schedule as follows:

Serial number.	*Item number.*	*Schedule.*	*Reduced rate per unit.*

Date

Signature of Contractor.

16. On behalf of the Governor of Tamil Nadu and as duly authorised by the Governor under Article 299 (1) of the constitution the above tender for a value of Rs....................; (Rupees..................) only is accepted on this day.................; of .... 19 .

Signature and Designation.

Signature of the witness in full and

address with name in black letters.

ANNEXURE TO TENDER NOTICE.

SCHEDULE A.

Schedule of rates and Approximate quantities.

(*a*) The quantities here given are those upon which the lumpsum tender cost of the work is based, but they are subject to alterations, omissions, deductions or additions as provided for in the conditions of this contract and do not necessarily show the actual quantities of work to be done. The unit rates noted below are the governing payment of extras or deductions for omissions according to the conditions of the contract as set forth in the General conditions to the contract of the Tamil Nadu Building Practice and other conditions or specifications of this contract.

(*b*) It is to be expressly understood that the measured work is to be taken that (not withstanding any custom or practice to the contrary) according to the actual quantities when in place and finished according to the drawing or as may be ordered from time to time by the Executive Engineer, and the cost calculated by measurement or weight, at the respective prices, without any additional charge for any necessary and contingent works connected therewith. The rates quoted are for work in-site and complete in every respect.

Item number.	Probable quantity* *Figures.	Descriptiou of work.	TNBP number.
(1)	(2)	(3)	(4)

Rate, Words.	Rate, Figure. Rs. P.	Unit words.	Amount. Figures. Rs. P.
(5)	(6)	(7)	(8)

Date : Signature of Contractor.

The Second sub-division of this column (i.e.) column 3 is for entering description in words such as members, cubic metre, k.g., etc.

SCHEDULE B.

LIST OF DRAWINGS.

Note.—All drawings to be signed by the Contractor as well as the officer entering in to the contract.

Serial number.	Drawing number.	Description.
(1)	(2)	(3)

SUPPLEMENTAY LIST.

As referred to in the specification including the General conditions to the contract of Tamil Nadu Building Practice.

Serial number.	Drawing number.	Description.	Date on which the drawing was Supplied.
(4)	(5)	(6)	(7)

SCHEDULE C.

List of specifications for the various items of works supplementing those described in Schedule-A by standard specification Numbers.

1. The Contractor shall employ the following technical staff for supervising the work and shall see that one of them is always at site, during working hours, personally checking all items of work and paying extra attention to such works as may demand special attention, e.g., Reinfocred concrete work,

Name of the Members of the Technica staff to be employed	Qualifications.

Note.—In case the contractor is himself professionally qualified the above specification should be suitably altered and in cases in which the contractor selected has not given an undertaking to employ qualified men, it should be scored out.

***Note.*—Additional specifications, if any, which have to be** entered in Schedule C, should be entered below held (1) above and Numbered continuously.

APPENDIX IV.

Descriptive Specification Sheet.

Item.	Materials. (i) Size alternative to Standard specification size or size prescribed Mortars and Concrete. (ii) Mixes prescribeP, if deviation from Standard Specification. (iii) Masonry Joint Thickness and Deviations.	Source from which item is to be obtained.	Approximate lead.	Remarks.
(1)	(2)	(3)	(4)	(5)
Lime.				
Surki.				
Portland Cement.				
Sand for Mortar works.				
Sand for filling in.				
* Earth for refilling and disposal of surplus.				
Broken stone for masonry works.				
Broken stone for Road works.				
Broken Brick.				
Gravel.				
Quarry rubbish.				
Rough stone, jelly stone, etc.,				
flooring stone.				
cut stone				
cuddappa slabs.				
M. S. Sheets.				
Corrugated roofing Deviations in Gauge Brick (Wall)				
Bricks (terrace).				
Bricks (flooring).				
Pantiles				
Flat tiles.				

)1(	)?)	(3)	(4)	(5(
Mangalore tiles.				
Pressed, ornamental tiles, etc.				
Teak Wood.				
Other classes of wood.				
† Furnishings for doors, Windows, etc.				
‡ Standardised Items of furniture.				
Paints.				
Tar.				
Wood oil.				
Varnish.				
Distemper (Brand and No. of coats).				
Steel R.S. Beams, etc.				
$ Iron work for Jail cells, ventilators, Doors, lock boxes, cage latrines, etc. cast iron.				
Lime Mortar.				
Pointing. £				
Plastering.				
Surki Mortar.				
Pointing.				
Plastering.				
Cement plastering.				
Terrace work.				
Deviations, if any and proportions, if surki mortar required for any stage.				
Broken stone lime concrate.				
Broken Stone Surki concrete.				
Broken stone cement concrate.				
Brick or masonry joints.				
Thickness.				
Floor surfacing.				

(APPENDIX XXIV—TENDER NOTICE PIECE WORKS.)

1. On behalf of the Governor of Tamil Nadu, tenders will be received by the Superintending Engineer Circle/ Executive Engineer Division/Sub Divisional Officer (Asst. Executive Engineer) Sub Division at his office at up to P.M. on for the work of * (*Name of work).

The tenders will be opened by the Superintending Engineers Circle/Executive Engineer Division Sub Divisional Officer (Assistant Executive Engineer) Sub Division on the date and at the place aforementioned. The tenders or their agents are expected to be present at the time of opening of tenders. The Tender rceiving officer will on opening each tender, prepare a statement of the attested and unattested correction therein and hand it over to the tenderer concerned and initial all such correction in the presence of the tenderer. If any of the tenderers or their against finds it inconvenient to be present at the time, then in such a case, the tender receiving officer will on opening the tender of the absentee tenderer makeout a statement of the unattested corrections and communicate it to him. The absentee tenderer shall then accept the statement of the Corrections without any question whatsoever. The tender should be in the K2 form, obtainable from the Superintending Engineer/Executive Assistant Executive Engineer's Office. The Tamil Nadu Building Practice and other documents relating to the contract, such as Additional Specification, Drawings, descriptive specification sheet regarding materials, etc., can be seen at any time between 11.00 a.m. and 5.00 p.m. on office days in the Office of the Superintending Engineer/Executive Engineer/ Sub Divisional Officer (Assistant Executive Engineers).

2. Tenders should be addressed to the Governor of Tamil Nadu and submitted in sealed covers addressed to the Superintending Engineer/Executive Engineer/Sub-Divisional Officer of Circle/Division/Sub Division. The name of the work and name and address of the Tenderer should be noted on the cover.

If the tender is made by an individual, it shall be signed with the full name and his address shall be given. If it is made by a firm, it shall be signed with the Co-partnership name by a member of the firm, who shall also sign his own name and the name and address of each member of the firm shall be given. If the tender is made by a corporation, it shall be signed by a duly authorised officer, who shall produce with his tender satisfactory evidence of his Authorisation Such tendering corporation may be required, before the tender is accepted the furnish evidence of its corporate existence.

3. Each Tenderer must pay, as earnest money, a sum of Rupees in to the branch of the State Bank of India or into the Government Treasury of Sub Treasury within the jurisdiction of the Superintending Engineer/Executive Engineer/Sub Divisional Officer of Circle/Division/Sub-Division to the credit of Revenue Deposits on behalf of the Superintending Engineers/Executive Engineer/Sub Divisional Officer of Circle/Division/Sub Division, and enclose with his tender or in the form of accepted security or bond as the case may be.

This earnest money will be refunded to the unsuccessful tenderer on application, after intimation is sent of rejection of the tender at the expiration of two months from the date of tender whichever is earlier. This refund will be authorised

* Enter in remarks Column. Where excess earth required for filling is to be obtained from and where excess soil if any is to be carted or conveyed.

† Enter, if deviation from Std. Specfn. procedure and if iron or Brass.

‡ These will usually be purchased from Jails vide current Price list for same.

$ Enter if these are to be supplied from Salem and if so where contractor shall take delivery of same.

£ Pointing-State if to be done as per "Remarks on pointing".

// Deviations in plaster thickness if any.

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by the Executive Engineer in the form of accepted security or bond as the case may be. The earnest money will not be receivd in cash or currency notes by the Public Works Department Officers, save, in exceptional cases, where there are no treasuries or banks within the jurisdiction of the officer calling for tenders when currency notes are given, the tenderer should sign his name in full with date, on the back of all the currency notes given by him, whatever their denominations may be.

The earnest money will be retained in the case of successful tenderer and will not carry any interest. It will be dealt with as provided in the conditions attached to the tender.

When a tender is to be accepted, the tenderer, whose tender is under consideration, shall attend the office of the Superinding Engineer/Executive Engineer/Sub Divisional Officer of Circle/Division/Sub Division/on the date fixed by written intimation to him. If the tenderer fails to attend the office before the end of the specified period, his tender will not be considered. On receipt of written communications of acceptance of his tender, if the tenderer backout from the contract, his earnest money deposit will be forfeited to the Government. It shall expressly be understood, by the tenderer that on receipt of written communication of acceptance of tender, there emerges a valid contract between the Governor of Tamil Nadu and the tenderer, for the execution of the work, without any further or seperate written agreement. For this purpose, the tender documents, i.e., the tender notice, tender offered by the contractor, General conditions to the contract, special conditions to contract, negotiation, correspondence written communication of acceptance of tender, etc., shall constitute a valid contract and will be the fundation of the rights of both the parties to the contract.

4. * Tenderers shall peruse carefully the instructions in 'Directions to parties Tendering" and the conditions of the Standard K-2 Form and all other relevant documents, before tendering rates for piece work. The approximate Quantity of work to be executed under each class is given in the accompanying Schedule. The quantities are given only with a view to enable the tenderer to quote his over all rates for each class of work in the tender form.

(*NOTE—Any departure from the piece worker's liabilities Under claseuses 35, 37, etc., of the General conditions to the contract of the Tamil Nadu Building Practice must be clearly defined in the contract conditions as furnished for the Tenderers' information.

5. The Superintending Engineer|Executive Engineer Sub-Divisional Officer, reserves the right to reject any tender or all the tenders without assigning any reasons therefor. Tenderers offering a percentage deduction from or increase on the estimate amount, and those not submtited in proper form or in due time will be rejected.

SCHEDULE.

Number of Item.	Class and description of work to be executed.	Approximate cuarity.	T.N.B.P. number of other special Specification if any.	Unit of calculations in figures and in words.

Descriptive specification sheet.

N.B.—(Here enter relevant Extract from Page—TNBP—or items as may otherwise be applicable.

(* Enter SS before the number if it is a TNBP number)

TENDER AND CONDITIONS.

Directions to the parties tendering.

1. Piece work is that, which involves a payment for work done at a stipulated rate only, without reference to a total quantity or time.

2. A list of materials proposed to be supplied by Government and the places where and the prices at which they are proposed to be supplied is given at the end of the schedule accompanying the tender notice. This should be entered by tenderer also at the end of the schedule accompanying the tender. The tenderers must accept these materials at the specified prices and quote for finished work accordingly. Notwithstanding any subsequent change in the market value for those materials, charge to be party executing the work will remain as originally entered in the tender. If at anytime Subsequent to the acceptance of this tender, Government materials other than those specified in the tender documents are to be supplied to the piece worker for use on the work, they will be charged at the market value prevailing at time of supply or stock issue rate, whichever is greater. The piece worker will be informed in writing of this change and he should intimate in writing the rate which he demands for finished work in view of the fact that he is to use Government material. No cartage or incidental charges will be borne by Government in condition with the supply of materials referred to in this paragraph.

3. Subsidiary items such as water for work cleaning and marking out site, hire of tools and plant should be separately entered. If such items are not so entered; it will be assumed that the rates quoted in the schedule include provisions for them also.

4. The tenderer shall examine closely the Tamil Nadu Building Practice and also the relevant clauses of the General conditions to the contract contained therein and sign the Sub-divisional/Divisional office copy of the Tamil Nadu Building Practice and its addenda volume, in token of such study, before submitting his tender unit rates, which shall be for finished work *in situ*. He shall also careuully study the drawings and additional specifications and all the documents, which form part of the contract between him and the Governor of Tamil Nadu.

5. Each tenderer must also send a certificate of income-tax verification certificate from the appropriate income-tax authority in the form prescribed therefor.

In the case of proprietory or partnership firm, it will be necessary to produce the certificate aforementioned for the proprietor or proprietors and for each of the partners as the case may be.

If the tenderer is a registered Public Works Department contractor and if a certificate for the current year had already been produced by him during the calendar year in which the tender is made it will be sufficient, if particulars regarding the pervious occasion on which the said certificate was produced are given.

All tenders received without a certificate aforementioned will be summarily rejected.

6. Every tenderer is expected before quoting his rates, to inspect the site of the proposed work. He should also inspect the quarries and satisfy himself about the quality and availability of materials. The names of quarries, kilns, etc., where from

certain materials are to be obtained will be given in the descriptive specifications sheet. The best class of materials to be obtained from the quarries or other source defined shall be used on the work. In every case the materials, must comply with the relevant *standard specification*. Samples of materials as called for in the standard specifications or in this tender notice or as required by the Superintending Engineer/Executive Engineer/ Sub-Divisional Officer of Circle/Divisions/Sub-Division having jurisdiction for the time being over the work hereinafter called the Superintending Engineer/Executive Engineer/Sub-Divisional Officer shall be submitted for approval before the supply to the site work is begun. If the contractor after examination of the source of materials defined in the Descriptive Specification sheet, is of opinion, that materials complying with the standard or other specifications of the contract, cannot be obtained inquality or sufficient quantity from the source defined in the descriptive specification sheet, he shall so state clearly in his tender and state wherefrom he intends to obtain materials subject to the approval of the Superintending Engineer/Executive Engineer/Sub Divisional Officer. Attention of the piece worker is directed to the general conditions to the contract, regarding payment of signiorage, tolls, etc.

7. The tenderer should quote specific rates for each items in the schedule, and the rates should be in rupees. The units and rates should be written both in words and figures. The schedule accompanying the tender, shall be written legibly and free from erasures, overwritings, or conversions of figures. Corrections where unavoidable be made by crossing out, initialling, dating and rewriting. No alteration which is made by the tenderer in the tender conditions stipulated in the tender notice and tender form, the drawings or specifications accompanying same will be recognised, and if any such alterations are made, the tender will be void.

8. The Tenderers, who are themselves not professionally qualified, shall undertake to employ, qualified technical men at their cost to lookafter the work. The tenderers should state in clear terms, whether they are professionally qualified or whether they undertake to employ technical men required by the department, specified in the schedule below for the work. In case the selected tenderer is professionally qualified or has undertaken to employ technical men under him, he should see that one of the technically qualified men is always at the site of the work during working hours personally checking all items of works and paying extra attention to such works as may demand special attention (e.g.) Reinforced concrete work, etc.

N.B.—In the format below enter or incorporate the latest norms fixed by Government from time to time for the employment of Technical Assistant and penalty for non employment of such Technical Assistant.

Value of contract.	*Assistants to be employed.*

Note: (1) Item (1), (2), (3), (4), (5) or (6) should be scored-out in case where not applicable to a particular work.

Note : (2) A penalty of Rs. 500 per month, for diploma holder and Rs. 1,000 per month for degree holder be levied in case of default on the part of contractors in following the norms laid down above.

Note: (3) The employment of Technical Assistants could be based only on the value of contract. Engineers with Mechanical Engineering qualification and retired from Civil Engineering Department are also suitable to supervise the Civil Engineering works, because of their experience in Civil Engineering field.

Note: (4) In case the contractor who is professionally qualified is not in a position to remain always at the site of work and to pay extra attention to such work as may demand special attention (e.g.) R.C.C. work etc., he should employ technically qualified men as prescribed above.

NOTE: (5) The entire clause relating to employment of Technical Assistants will be applicable for works given on tender under piece work contract and not for the works given on nomination under piece work system.

Date. Designation

Station: Office

TENDER FORM (K 2)

Tender for piece work (K2 Form)

To

His Excellancy, the Governor of Tamil Nadu represented by the Superintending Engineer/Executive Engineer/Sub Divisional Officer of Circle/Division/Sub Division at

I/We do hereby tender to executive works of undermentioned description by piece work and in accordance with the conditions noted below and as per the stipulations in the tender notice in consideration of payment being made for the quantity of work executed at the respective rates specified in the following schedules:—

I|We .... hereby distinctly and expressly acknowledge that, before the submission of my|ourtender, I|We have carefully followed the instructions in the tender notice and have read the Tamil Nadu Building Practice and the relevant clauses of the General conditions to the contract of the Tamil Nadu Building Practice and that I|We have made such examination of the contract documents and of the specifications, etc., and of the location, where the said work is to be done and in regard to the materials required to be furnished as to-enable me|us thoroughly to understand the intention of same and requirements, covenants, stipulations and restrictions contained in the contract and in the said specifications; and distingtly agree that I|We will not hereafter make any claim or demand upon the Government based upon or arising out of any alleged misundertanding or misconception or mistake on my|our part of the said requirements|covenant, stipulations, restrictions and conditions.

I|We .... enclose an income Tax Certificate

I|We .... being a registered Public Works Department Contractor, have already produced on income-tax verification certificate during the current calendar year in respect of (here particulares of the previous occasion on which the certificate was produced should be given).

SCHEDULE.

NAME OF WORK.

Number of Items	Class and discription of work to be executed*	TNBP Number of other Specialspecification if any.	Un	Calculation in figures and in work.	Rate of payment to be entered both in figures and words one below the other.

*Enter S.S. before the numbe
if it is a TNBP number

NOTE.—Enter below the schedule, a list of drawing and a descriptive specification sheet with relevant extracts from the relevant page of Tamil Nadu Building Practice item as may other wise be applicable—Vide also paragraph I of Directions to parties tendering.

NOTE 2.—The tenderer should affix his signature at the end of each page of his tender and otherdocuments attached thereto. The accepting authority should similarly affix the signature in the accepted tender.

I am|we are professionally qualified and my|our qualifications are as follows:—

I|We, in pursuance of clause .... of tender notice undertake to employ the following technical staff for Supervising the work and will see that one of them is always at site during working hours personally checking all items of works and paying extra attention to such works as require special attention e.g. R.C.C.

Names of Technical Staff Proposed to be employed.	Qualifications and experience.
1.	
2.	
3.	

Signature of contractor with date

(NOTE: Scoreout the above clause if not necessary).

Conditions.

1. The Superintending Engineer|Executive Engineer| Sub-Divisional Officer .... of Circle|Division|Sub-Division, Public Works Department, having jurisdiction for the time being (hereinafter called the Superintending Engineer|Executive Engineer|Sub-Divisional Officer|or a subordinate officer deputed by him shall within a period of two months from the date of acceptance of the tender by the competent authority give to the contractor full and complete particulars of the work to be done hereunder and within like period permit the contractor and his workmen free access to the site on which the work is to be executed. On receiving such particulars and permission, the contractor shall forthwith start the work and shall carry on same with due deligence and all work executed is to be done in a workman like manner. The decision of the Superintendenting Engineer/Executive Engineer/Sub-Divisional Officer or any officer of the Public Works Department of the Government of Tamil Nadu duly authorised in this behalf by such Superintending Engineer/Executive Engineer/Sub Divisional officer as to the rate of progress and the quality of work or material shall be final. The contractor shall have the right to cancel the contract and obtain refund of his earnest money, if such particulars and or the permission are not given within the said period of two months.

2. The following clauses of the General conditions to the contract of the Tamil Nadu Building Practice only subject to the modifications noted below shall applly to this contract.

NOTE.—In cases where the acceptance of this tender is within the powers of the sub-divisional officer in charge of the work and where he has accordingly accepted this tender, he shall exercise such functions as are delegated to the Executive Engineer in the relevant clauses of the Gneral conditions to the contract applicable to this contract.

General conditions to the contract of the Tamil Nadu Building Practice :—

Section A.—All clauses, except that in clauses two and three where the General conditions to the contract is mentioned the reference shall be only to such clauses of the General conditions to the contract as are hereinmade applicable to this contract.

Section C.—All causes except 14-2.

Section D.—All clauses except that in clause 26-1 in place of the words "within six months from the completion of, " *read* " before final payment for ".

Section E.—All clauses except that in clause 33-1 the word " which occurring between the words " Progress " and " in " in the first sentence shall be deleted, as also the concluding portion of that sentence beginning from " will ". The following shall be substituted for the present clause 39-1.

" The departmental officer incharge of the work shall be responsible for the correct setting out of all works but the piece worker shall provide at his own cost all labour, materials and staff required for so " doing "

Section F.—All clauses.

Section G. All clauses except 53.

Section I. J.—Clauses 60 to 63 inclusive second sub-paragraph of clause 64, clauses 66, 67 and 68.

3. The quantity of work executed shall be measured and payments made ordinarily monthly. On the completion of work or termination of this contract, final measurements will be made and the account adjusted accordingly.

4. The Executive Engineer|Sub-divisional officer or any officer of the Public Works Department of the Government of Tamil Nadu, duly authorised in this behalf by such Executive Engineer|Sub-Divisional officer may put up an end to this contract at his option at any time and in the case of bad work or material, action shall be taken as provided in clauses 25-3, 25-4 and 25-5 of the General conditions to the contract.

NOTE.—If action is taken as provided in the last sub-paragraph of clause 25-3, 25-4 and 25-5 of the General conditions to the contract, the piece workers acceptance to the reduced rates shall be taken in writing).

5. Such Superintending Engineer|Executive Engineer| Sub-Divisional Officer or any such officer so authorised as aforesaid may fine the piece workers not less than Rs. 10 and not more than five per cent of the value of the completed work for slow progress of work, provided, however that any authority higher than that of Superintending Engineer/Executive Enginner/ Sub-Divisional Officer, may in his absolute discretion waive or modify any fine imposed by the Superintending Engineer /Executive Engineer/Sub-Divisional Officer under the provisions of this clause.

6. Any unforeseen additional work that may become necessary and is accordingly carried out under this contract under proper written orders shall be measured and valued by the Executive Engineer|Sub-Divisional Officer or his representative at the rates contained in the piece workers' original schedule and if these rates do not apply then prior to execution of the additional work, a rate for such work shall ordinarily be agreed upon and entered in a supplement schedule and signed by both the piece worker and the accepting authority. If it is not possible to arrive at such an agreement, then the piece worker shall be paid according to the cost of labour employed and the materials used to which will be added 10 per cent to cover the piece workers profit on the said work on his delivery of the necessary vouchers to the Executive Engineer|Sub-Divisional Officer.

7. The earnest money deposited by the selected piece worker shall be retained as security for the due fulfilment of the contract. After the work has been carried out by the piece workers to the extent of fifty times the value of this security deposit, a deduction of two per cent of the value of further work done by him shall be made for purposes of additional security, from each intermediate bill to be paid to him until the completion of the work. Such deposit and|or deduction or any portion thereof may at the discretion of Executive Engineer/Sub-Divisional Officer be forfeited on failure or non fulfilment by the piece workers of any of the above conditions. Any authority higher than one who ordered a forfeiture under the provisions of this clause, may in his absolute discretion wave or modify the forfeiture so levied.

Signature of the party making the tender

Full address:

Date:

I|We, after negotiation with the Superintending Engineer| Executive Engineer|Sub-Divisional Officer on .... agree to reduce the rates as follows:—

Item No.	Brief description	Rate Rs. P.

Signature of the Tenderer

On behalf of the Governor of Tamil Nadu, the above tender is accepted by me on ....

Signature:

Designation

Witness:

NOTE:—While accepting the tender, the accepting authority should specify on the first page of this document, the number of pages in the tender and the number of items in the schedule. A line should also be drawn under the last item in the schedule.