CHAPTER - 11

PLASTERING AND POINTING

CONTENTS

CHAPTER - 11 PLASTERING AND POINTING

11.1 REFERENCES

1S:383 -1970	Coarse and fine aggregate from natural sources of concrete (Second revision) (Reaffirmed 1980).
1S: 1661 - 1972	Code of practice for application of cement and lime plaster finishes (first revision)(Reaffirmed 1987).
1S:2394-1984	Code of practice for application of lime plaster finish (first revision):
1S:2402- 1963	Code of practice for external rendered finishes.
1S:2645- 1975	Integral cement water proofing compound (first revision) (with amendment NO.1)(Reaffirmed 1987).
1S:2750-1964	Steel scaffoldings (with amendments number 1 to 3).
IS:3696(PU)-1987	Safety code for scaffolds and ladders: Part I Scaffolds.
1S:8605- 1977	Construction of masonry in dams.

Specification-77 of "Central Public Works Department".

Standard Specification - 77 of "National Building Organisation".

11.2 TERMINOLOGY

Blistering - The development of one or more local swellings on the finished plaster surface.

Cracking - The development of one or more f1ssures not assignable to structural cause.

Crazing -The development of a series of hair cracks on the finished plaster surface. Known as 'map crazing', when it forms an haphazard pattern over the wan surface affected.

Dubbing Out- The operation of attaching pieces of slate, tile, etc, to a wall with plaster, and then likewise covering them in order to fill out hollows or to form projections.

Hacking - The roughing of solid backgrounds, by hand or mechanical methods, to provide a suitable key.

Raking - Removing mortar from masonry joints to provide suitable key for the plastering and pointing.

Rendering - A mix which is applied white plastic to building surfaces and which hardens after application.

Spatter-dash - A mix of cement and fairly coarse sand, prepared as thick slurry. It is thrown on as initial C08ting to provide a key on dense backgrounds having poor suction, or to reduce or even-out suction of other types of background. .

Suction -The property of background which determines its rate of absorption of water.

11.3 MATERIALS

11.3.1 Cement

This shall conform to specification as given in Para 6.3.1 under Chapter 6 "Mortars".

11.3.2 Lime Class B and C

1 1.3.2.1 Lime shall conform to specification as given in Para 6.3.2 under Chapter 6 "Mortars".

11.3.2.2 Lime Putty - This shall be obtained by slaking LIme with water. This shall conform to specification as given in Chapter 6 "Mortars".

11.3.3 Neeru

This shall be obtained by mixing Lime putty end sand in equal proportion and chopped jute @ 4 kg per cum of mortar. The mixture shall be properly ground to a fine paste between two stones.

1 1.3.1 Sand

This shall conform to specification as given. in Para 6.3.4 under. Chapter 6 "Mortar". for white or coloured renderings, only quartz or silica sand shall be used.

1 1.3.5 Aggregates

All Aggregates other than sand shall conform to 15:383- 1970. For roughcast, crushed stone or fine gravel upto 12 mm maximum may be used in the finishing met. The grading and maximum size will vary according to the texture required and the type of stone; an aggregate of the desired grading may be obtained either by using a mixture of stone or gravel with send or ,by using crushed stone grilled from the maximum down to dust. The proportion of coarse material (over 4.75 mm 15 sieve) to fines sh8ll be between 1:1 and 1:2 by volume.

11.3.6 Pebbles

These shall be either small pebbles or crushed stones of si2e 6 to12 mm end well washed.

1 1.3.1 Water

This shall conform to specification as given in pare 6.3.6 under Chapter 6 "Mortars".

11.3.8 Integral Water Proofing Compound

IS:2645-1975 shall be followed. Water proofing liquid shall be "AZROK" or other equal of approved make.

11.3.9 Soil

This shall conform to specification as given in Para 6.3.5 under Chapter 6 "Mortars".

11.3.10 Chopped Straw (Bhoosa)

Chopped straw for mixing with mud mortar for plastering shall be clean, thin fibres not longer than 20 mm.

11.4 CARE OF TOOLS AND ACCESSORI ES

11.4.1 Tools

All tools shall be cleaned by scraping end washing at the end of each day's work, or after use with different materials. Metal tools shall be cleaned and greased after each operation. The tools shall be examined end thoroughly cleaned before plastering is begun. Cleanliness Is particularly important with cement plasters, where contamination with set material may seriously affect the performance as well as reduce the effective life of the tools.

11.4.2 Scaffolding (staging)

Wooden BALLIES, bamboos, planks, trestles end other scaffolding materials shall be sound and in accordance with local building regulations. These shall be properly examined before erection and use. Steel scaffolding, if used shall conform to 18:2160-1964 and used as in IS:3696(Part 1)-1981.

11.5 CEMENT AND CEMENT LIME PLASTER

1 1.5.1 Suitability of Cement lime Mixes

The weaker mixes of cement Lime plaster containing smaller proportions of cement, shall not be used in conjunction with a strong finishing coat.
Weaker mixes offer certain advantages Over the stronger (richer) mixes when applied to non-rigid backgrounds, such as lathing. For trowel finishes (very smooth surfaces, mixes of lime and

cement shall not, in general, be used for finishing coats, as their shrinkage on drying creates a tendency for surface crazing.

11.5.2 Number- of Plaster Coats

The number of plaster coats to be Adopted shall be as under:

(i) Reasonably plain backgrounds of brick, concrete, building blocks and timber materials .

(a) Thickness of plaster - upto 15mm	Single coat
(b) Thickness of plaster - greater than 15mm	Two coats
(jj) Very rough surfaces, such as rough stone masonry	Three coats
(jji) Metal lathing	Three coats
(iv) Renovation works on Wood lathes	Three coats

11.5.3 Thickness of Plastering

1 1.5.3.1 Finishing coats (and single-coat work, where employed) shall be of such minimum thickness as just to provide a sufficient body of materials to harden Satisfactorily under the site conditions in any particular case.

1 1.5.3.2 The total thickness of two - coat work exclusive of keys or dubbing out shall be generally about, but shall not normally exceed 20 mm and it shall not exceed 15 mm in the case of in situ concrete soffits. The thickness of three-coat work shall be about, but shall not normally exceed 25 mm.

11.5.3.3 The thickness of an individual coat shall generally be as recommended in Appendix-I.

11. 5. 4 Recommended Plaster Specifications

11.5.4.1 A list of specifications for mixes suitable for various situations is given in Appendix-I which covers single-coat work which is used generally and also two and three-coat works suitable for special situations. The Lime in the mixes specified in Appendix-I and in 11.5.4.2 is assumed to be measured as lime putty, but if it is measured as dry hydrated lime, the proportion of Lime in any mix shall be slightly higher than is indicated and 6 suitable adjustment shall be made as indicated in 11.5.4.1. 1.

11.5.4.1.1 The actual weight of hydrated Lime which a putty contains may be determined by using the following formula:

$$Wh = [G/G-1] [Wp- 1000]$$

Where,
Wh = Weight of dry hydrate in kg/m3,
G = Specific gravity of hydrate usually 2.25, and
Wp = weight of putty in kg/m3.

11.5.4.2 The mix for the finishing coat shall depend on the texture and colour of the surface desired. If the surface is to have a lime-putty finish, then it is advisable to have rich mix of 1 part of cement ,1 part of Lime and 3 parts of sand. For any rough finish a mix of I part of cement to 3 to 4 parts of sand is recommended.

11.5.5 General Precautions in Plastering

11.5.5.1. Cleanliness and Protection of Existing Work- Cleanliness is essential in carrying out plaster work. Adequate protection shall be given to an existing work and fittings which are liable to be damaged, not only in the area of plastering operations, but also In the approaches thereto by covering up with boards, dust sheets, etc, as necessary. On completion, all work affected by plastering operations shall be left clean. Special care is necessary when removing set plaster from glass to avoid damaging its surface.

11.5.5.2 Suction adjustment - The careful adjustment of suction is very necessary for good plastering, and may be done either by wetting the backing suitably if it is dry, or by sprinkling with a cement-mix as in the case of a concrete surface with low suction. Without the aid of suction, plaster would creep and slide down due to its own weight. On the other hand, high rate of suction withdraws all moisture from the plaster and makes it weak porous and friable. Too much water makes it impossible to keep the mortar in position till sets. A failure In bond due to excessive water leads to further failures as the pocket formed may hold water and break up the plaster when the water freezes; or if the water is salt-laden, the same results will be produced on evaporation by crystal formation. The wall shall not be soaked but only damped evenly before applying the plaster. If the surface becomes dry In spots. such areas shall be moistened again to restore uniform suction. A fog spray is recommended for this work. .

11.5.5.3 Adjustment of Working to the Setting Properties or Plaster - Cement plasters and cement-lime plasters contain materials which set when brought into contact with water, and the fullest use of their strength producing properties is not made unless the mix is applied before the setting process has started. If re-tempering of such mixes is carried out after the set has commenced, an inevitable loss in strength and efficiency will result. In the case of cement plasters, the commencement of the set is accompanied by a noticeable stiffening of the mix. In the case of cement plaster heavily gauged with lime, however, it is not always obvious to the operator when the set has started and it Is with this type of mix that the retention of the full measure of strength afforded by the cementitious material is particularly important. Such plasters may be overworked both before and after application with resultant impairment of the set of the gauging plaster. This not only reduces the strength of the material, but also gives it the shrinkage characteristics of a pure-lime plaster with its liable accompaniment of the surface crazing. It is essential, therefore, .that mixes shall be used as soon as possible after water has been added and that following working periods recommended shall not be exceeded:

(a) Cement mortar	30 minutes
(b) Cement lime mortar	2 hours

11.5.5.4 Control Cracking

11.5.5.4.1 In the case of discontinuity backgrounds, the best treatment would be to separate the two portions by a neat cut through the plaster at the junction. In the case of discontinuity from wall to ceiling, a cornice that would permit slight movement without cracking may advantageously be introduced. If it is not proposed to provide a cornice, B straight cut through the plaster or a groove joint at the junction may be provided.

1 1.5.5.4.2 In Load bearing construction, cracks are 8150 caused in the top floor partitions due to roof movement by variation in temperature. Development of such cracks shall be prevented by isolating the top of portion from the roof slab. To achieve this, plastering shall not be carried over the junctions of partition walls with roof slab.

11.5.5.4.3 When plaster is applied to provide an unbroken surface over board or slab background, the plaster coat bridging the joints is subject to higher stresses and any movement in the background will show by cracks along the joints. To avoid this, the plaster is reinforced at the joints by fixing jute scrim or suitable wire gauge. This treatment meIY still be ineffective if large changes in humidity take place and if thin board background with high moisture movement are used.

I 1.5.5.5 Avoidance of Surface Crazing - Surface crazing is due to excessive shrinkage caused by drying. The shrinkage causes tensile stress in the' plaster which is maximum at the skin. If the shrinkage is great these failures develop into cracks which exist through the whole depth of the plaster. Attention to the following points will reduce surface crazing to a minimum:

(a) Use of well-graded sand and suitable proportion of various ingredients for mortar,
(b) Thorough grinding of mortar and thorough mixing of different constituents ,
(c) Proper addition of solutions and other materials to improve the bending properties of mortar ,
(d) Observance of adequate Lime intervals between successive coats so that each successive coat undergoes a portion of its shrinkage before the next coat is applied and thus reduces the skin tension in the proceeding coat,
(e) Proper workmanship as regards application of different coats, and
(f) Avoidance of quick drying in the initial stages.

11.5.6 Preliminary Programming of Work

11.5.6.1 An materials necessary for plastering shall be kept readHyav8iiable at the site. In cases where Lime putty is to be used, it shall be run sufficiently in advance so as to mature before use. An adequate supply of water suitable for mixing . the plaster and for curing purposes shall be available.

11.5.6.2 In building operations, such as construction of brick and block walls, the encasement of steel columns and be6ms with concrete, etc. requiring plastering shall be so programmed that they are sufficiently matured to receive the plaster without subsequent damage to plaster or decoration. Careful programming 8rtd avoidance of last minute alterations in the design or in the sequence of work can avoid serious damage to the plaster finish. Where such alterations are unavoidable the permanent decoration shall be postponed.

11.5.6.3 Plastering operations shall not be started until all necessary fixing, such as door and window frames, mant1epjeces are completed and an pipes and conduits to be embedded in the wall or plaster are instal1ed.

11.5.6.1 A preliminary inspection shall be made to ensure that the surfaces are in a suitable condition for plastering particularly as regards their plainness and dryness. If dubbing out is necessary, it should be done in advance, so that an adequate time interval may be permitted before the application of the first undercoat.
Plastering operations shall be so scheduled as to allow sufficient interval between undercoats and f1nishing coats.

11.5.7 Preparation of Background for Application of Plaster

11.5.7.1 For the durability of the plaster or rendering, it is vital to obtain a satisfactory bond between the background and the first plaster coat and also to ensure that the bond is maintained subsequently. The requirements of good background in this respect are explained in 11.5.7.1.1 to 11.5.7.1.7. Necessary preparation of the background shall be 0008 to fulfl1 these requirements. The preparation for different types of backgrounds is individually dean with in 11.5.1.2 to 11.5.7.4.

11.5. 7.1.1 Cleanliness - The loose layer of dust on masonry shall be removed either by watering or by brushing as required. A freshly cast concrete surface is often covered by laitance and this shall be removed. A concrete surface may also often be contaminated by the S08p which is formed with calcium hydroxide end the oils in the moulds. The contaminated layer shall be removed by brush. Special care shall be taken in repairing for rendering an old plaster mat. Old layers of the plaster coot shall be completely removed and made ~ Crumbled and frost-damaged parts shall be cut out and patched. Any trace of algae or mass formation shall be removed. If the background contains soluble salts, particularly sulphates, the application of the plaster shall be done only after the efflorescence of the salts is complete, and the efflorescence is thorough Iy removed from the surface.

1 1.5.7.1.2 Roughness - The roughness of the background may generally improve the bond of the plaster. A smooth surface may be roughened by wire brushing, If It is not hard; or by hacking or bush-hammering if it is hard. A1ternative1y; to obtain a rough surface, a mortar 1 cement: 1.5 to :3 coarse send by volume prepared to a wet consistency may be forcibly dashed on to the surface (spatter dash treatment) by suitable means on to a hard surface like concrete. After roughening the surface, care shall be taken to moisten the surface sufficiently before plastering, as otherwise the surface may tend to absorb considerable amount of water. from the plaster. In addition to general roughness in the masonry, the joints shall also be raked to a depth of about one centimetre for providing key to the plaster. On a soft smooth surface after hacking a thin coat of cement slurry (1: 1 : : cement : fine sand) may be applied.
In special cases wire netting, etc. may be fixed to improve further the key to the plaster.

11.5.7.1.3 Suitable Suction - The adjustment of suction of the background during the appllcation of plaster is already dea1t within 11.5.5.2. The amount of water introduced in the background during its construction has an important bearing and adequate drying intervals shall be a110wed between erection end plastering to bring the surface suitable for suction adjustment.

11.5.7.1.4 Evenness - The background shall be even in order to avoid variations in the thickness of the plaster. Arty un eveness must be leveled before the piaster is applied. local projections in brickwork are serious from the point of view of plastering. for three coat plaster work, the local projection shall not exceed 1.2 cm of the general surface as determined by the periphery of the surface concerned end local depression sha11 not exceed 2.0 cm. For two-coat plaster. a local projection sOO11 not exceed 0.6 em and local depression 1.2 cm.

11.5.7.1.5 Strength and Elasticity - The strength and elasticity of the plaster shall be compatible with that of the background.

11.5.7.1.6 Immobility - The background must be immobile at the time of application of the plaster or subsequently the movements of the background shall be in s~ with and in the same direction as those of the plaster. Differential movements between the background and the plaster due to moisture change, temper8ture change, structural settlement, deflection, etc, wi11 cause cracking of the plaster. The major part of such movements shall be allowed to set in before the plaster is applied, as for example, by giving in the case of moisture movement sufficient drying interval to the background.

11.5.7.1.7 Precaution Against Discontinuity in Backgrounds -Cracking of walls or of plaster is often cased by discontinuity, for instance changing from concrete to brickwork, from clay brickwork to lightweight concrete block work or even changing from type of br1ck to another. Differential drying shrinkage is probable the main cause but difference in thermal movements may also contribute. Reinforcement of the plaster by metal lathing or scrim (fabric) over the junction is not 8lw8Ys successful. The treatment shall be as specified under Para 11.5.5.4.1 and 11.5.5.4.3.

11.5.7.2 Surface Preparation for Brickwork or Hollow Block Masonry - The masonry shall be allowed to dry out for sufficient period so that initial drying shrinkage is fairly complete, and suction adjustment is possible during plasterjng (see 11.5.1.1.3 and 11.5.7.1.6).

11.5.1.2.1 Joints of new brickwork or block masonry, if particularly the bricks or blocks are smooth, shall be raked out as the work proceeds (see 11.5.1.1.2).
Projecting bricks shall be trimmed off where necessary (see 1 t .5.1.1.1).

11.5.1.2.2 Old brickwork shall be considered on its merits with the object of securing adequate key. The surface shall be thoroughly brushed down to remove dust and loose particles or efflorescence where It has occurred. Low spots may, where necessary, be dubbed out at this stage by means of a mix similar to that intended for the -first coat of plaster but stronger (richer) and coarser.

11.5.7.3 Surface Preparation For in-situ Concrete

1 1.5.7.3.1 The surface shall be cleaned and roughened as in 11.5.7.1. 1 and 11.5.7.1.2.

11.5.7.3.2 Concrete surfaces shall have sufficient roughness to provide proper adhesion (see 11.5.7.1.2). The surface shall be evenly wetted (not saturated) to provide correct suction (see 11.5.7.1.3). If a chemical retarder has been applied to the formwork, a roughened surface may be formed by wire-brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarders is left on the concrete or on other surfaces, as it may interfere with the set of the plaster or with other building operations. Where mechanical key-forming devices have been used in the concrete, these shall be stripped off if still adhering and the resulting surface cleaned down. Ridges or fins left on soffits or on the sides of concrete beams by shuttering imperfections shall be removed before cleaning down, to be compatible with the plaster finish particularly when it is not thicker than one centimetre.

11.5.7.4 Boards and Slabs - When the boards or sl8bs are fixed in accordance wUh relevant Indian Standard for fixing wall coverings and fixing ceiling coverings, 'scrimming' (see 11.5.7.1.7) is all the preparation that is necessary.

1 1.5.8 Sequence of Operations

1 1.5.8.1 Scaffolding - For all exposed masonry work, double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed. For al1 other masonry work in buildings. single scaffolding shal1 be permitted. In such cases, the inner end of the horizontal scaffolding pole shall rest in 8 hole provided only in t~ header course for the purpose. Only one header for each pole shall be left out. Such holes for scaffolding shall, however, not be allowed in pi11ars/columns less than one metre in width, or immediately near the skew backs of arches.

NOTE - In case of special type of masonry work, scaffolding shall be got approved from Engineer- in-Charge in advance.

11.5.8.2 For external plaster, the plastering operations may be started from the top floor and carried downwards. For internal plaster, the plastering operations may be started wherever the building frame and cladding work are ready and the temporary supports of the ceiling resting on the wan or the floor have been removed.

11.5.8.3 The surfaces to be plastered shall first be prepared as described in Para 11.5.7.

I 1.5.8.4 When the preparation has been done, arrangements may be made for a constant supply of plastering material prepared as described in 11.5.9.

11.5.8.5 The first undercoat is then applied to ceilings and walls. It is an advent. to plaster the ceilings first to permit removal of scaffolding before plastering the wall. In the case of high rooms, the same scaffolding may be needed for plastering the top portions of the walls.

11.5.8.6 The second coat shall be applied after the undercoat has sufficiently set but not dried and in any case within 5 days (not before 2 days and not later than 5 days of the appl1eation of undercoat). Surface of the first undercoat shall be adjusted and screeds laid to serV8as guides in bringing the work to an even surface.
After a further suitable time interval, the finishing coat may be applied first to the ceilings and then to the walls.

11.5.8.7 Plastering of cornices, decorative features, etc, shall normally be completed before the finishing coat is applied.

11.5.8.8 Some times, ends of scaffolding BALLIES have to be housed in the wall which is being treated with plaster. In such cases after the BALLIES are tale en out, the hole or holes left in the wall shall be filled up with brick and mortar, and the patch plastered up true, even and smooth in conformity with the rest of the wall, so that no sign of any patch work shows out

11.5.8. 9 Rendering or chamfering corners, arrises, angles and junctions sbal1 be carried out with proper templates to the sizes as required and shall be completed with the nn1shing coat to prevent any Joint maries showing out later.

11.5.9 Mortar for Plaster

This shall conform to specification as described in Para 6.6.2 and 6.6.5 of Chapter 6 "Motars".

11.5.10 Application of Plaster

11.5.10.1 One Coat Plaster Work

11.5.10.1.1 Surface on which plaster is to be applied directly, shall be made clean as per Para 11.5.7.1.1 and dried the background as per the type. of surface shall be suitably roughened by raking, wire brushing bush hammering or " by hacking" and bv "spatter-dash" treatment incase of relatively smooth background, as described in Para 11.5.7.1.2. After toughening the surface, care shall be taken to moisten the surface sufficiently and evenly to control suction. For all other types of " surfaces where plaster is not to be applied directly the procedure and specifications as laid down under Para 11.5.5, 11.5.6, 11.5.7, 11.5.8 shall be followed.

11.5.10.1.2 The plaster shall be of specified thickness and carried out to the full length of wall on the natural breaking points like doors and windows. The mortar used shall be stiff enough to cling and hold when laid. For ceilings the mix is required to be stiffer than that used for walls. On soffits, the mortar shall be laid in long even spreads outwards from the operator over lapping each trowel full and using sufficient pressure to force it, into intimate contact with the background. On walls the mortar shall be laid on tong even spreads upwards and across over lapping each trowel full, using sufficient pressure to force it into intimate contact with the background.

11.5.10.1.3 The plaster shall be laid in a little more than the required thickness and leveled with a wooden float. The plaster shall be traveled hard and tight forcing it into joints to obtain a good bond and surface rubbed smooth with a plaster's trowel. For wooden and metal latching, the mortar shall be applied by laying and spreading diagonally across the lath work overlapping each travel full and using sufficient pressure to force it through the lath work to enable it to the other side. The material shall be laid as uniformly as possible. The average thickness shall not exceed 10 mm. This coat shall be allowed to stand to get firm before denting.

11.5.10.1.4 The plaster shall be cured as per Para 11.5.10.5

11.5.10.2 Two Coat Plaster work

11.5.10.2.1 First Coat - The first coat of the specified thickness shall be applied in a manner similar to one coat plaster mentioned in 11.5.10.1. Before the first coat hardens its surface shall be beaten up by edges of wooden tapers and close dents shall be made on the surface. This helps the plaster in several ways; the cracks are closed, the mortar is compacted and driven home into the joints and the dents serve as a key to the subsequent coat. The subsequent coat shall be applied after this coat has been allowed to set for 2 to 5 days depending upon weather conditions. The surface shall not be allowed to dry during this period.

11.5.10.2.2 Second Coat - The second coat shall be completed to the specified thickness in exactly the same manner as for the first coat. The finishing coat shall be laid down with a mason's trowel to an average thickness of 5mm.

1 1.5.10.2.3 Curing shall be done as described in 11.5.10.5.

11.5.10.3 Three Coat Plaster work - The first two coats shall be applied in a manner as explained in 11.5.10.1 and 11.5.10.2. Before starting to apply the third coat, the second coat shall be damped evenly as described in 11.5.5.2. The third coat shall be completed to the specified thickness in the same manner as for second coat and shall be cured as described in11.5.10.5.

11.5.10.4 Trueness of plastering system - The finished plaster surface shall not show any deviation more than 4 mm when checked with a straight edge of 2 m length placed against the surface.

11.5.10.5 Curing

11.5. 10.5.1 To develop maximum ' strength and density in the plaster, it is necessary to cure cement and cement lime plaster properly. Each coat shall be kept damp continuously till the next coat is applied for a maximum period of 7 days. Moistening shall commence as soon as the plaster has hardened sufficiently and is not susceptible to injury. The Water shall be applied by using a fine fog spray. Soaking of wall shall be avoided and only as much water as can be readily absorbed shall be used. Excessive evaporation on the sunny or windword sides of buildings in hot dry weather, may be prevented by hanging mattings or gunny bags on the outside of the plaster and keeping them wet.

11.5.10.5.2 After the completion of the finishing coat, the plaster shall be kept wet for at least seven days, and shall be protected during that period from extremes of temperature and weather.

11.5.10.6 Cement Water Proofing Compound

11.5.10.6.1 It may used for cement mortar for plastering to render it water proof. It shall be measured by weight.

11.5.10.6.2 The materials shall be brought to the site in their original packing. The containers will be opened and the material mixed with dry cement in the proportion by weight, recommended in the description of the item. Care shall be taken in mixing to see that the waterproofing material gets well and integrally mixed with the cement and does not run out separately when water is added.

11.5.11 Coloured Cement Work

11.5. 11.1 This work may be classified under two categories as follows:

(a) In which the coloured cement used in the work is made by intimately grinding mineral) pigments with the cement clinker, and

(b) Where mineral pigments are added to white or ordinary (grey) cement to get the required shade.

The former method has the advantage that the work can be carried out in the absence of skilled workmen. The mineral pigment added shall not in any way Interfere with the physical and chemical properties of cement.

11.5.11.2 In the case of coloured cement plastering, it is necessary to add integral waterproofer in the undercoats to minimise the risk of efflorescence.

Where a coloured cement plastering is to be done on an already existing mortar base, it is recommended to apply a surface waterproofer on the base and also mix an integral water proffer with the coloured cement plaster for the finishing cost.

11.6 LIME PLASTER

11.6.1 Suitability of Lime Plaster

11.6.1.1 Lime plasters are characterized by high workability and are generally suited for internal surfaces. Lime mixes have a long working time, a slow rate of strength development and reasonable strength.

11.6.1.2 Lime plastered finishes are not suitable for external surfaces in areas of heavy rainfall, very damp places and in places where extreme watertightness is required.

11.6.1.3 Plastering mixes, based on hydraulic, semi-hydraulic or fat limes may be successfully used both for undercoats and finishing coats, provided proper attention is paid to proportioning of various ingredients and workmanship. The plaster hardens by drying and by recarbonation. This is a slow process and during the early stages after application the plaster is rather sensitive to shock and vibration.

11.6.2 Number of Plaster Coats

Specification given in Para 11.5.2 shall be followed

11.6.3 Thickness of Plastering

The thickness for plaster work exclusive of key or dubbing out shall genera1ly be as given in Table below :

THICKNESS FOR LIME PLASTER WORK				
S.No.	Type of work	First coat	Second coat	Third coat

1	Brick masonry :				
	A	Single Coat work	15		
	B	Double coat work	10	10	
2	Stone masonry		15	10	
3	Stone masonry (very rough surface)		15	10	10

11.6.4 Recommended Plaster Specifications

11.6.4.1 The recommended mix proportions for lime mortars for plaster work shall be as given in Appendix - II. The lime in mortar mixes is assumed to be measured as lime putty. If it is measured as hydrated dry slaked lime, the proportion of lime in any mix shall be slightly higher than that is indicated and a suitable adjustment shall be made as indicated in Para 11.5.4.1.1.

11.6.5 Genera1 Precautions in P1asterlng

11.6.5.1 Cleanliness and Protection of Existing work – The specification as given in Para 11.5.5.1 shall be followed.

1 1.6.5.2 Suction Adjustment - The specification as given in para, 11.5.5.2 shall be followed.

11.6.5.3 Adjustment of Working to The Setting Properties of Plaster- Plastering work shall be completed before the setting process for the mortar has started. All mortars shall be used as soon as possible after grinding, preferably on the same day. If eminently hydraulic lime (Class A) is present as an ingredient the mortar shall be used within 4 hours after grinding. Lime pozzolana mortar shall be used within 24 hours of grinding.

11.6.5.4 Control of Cracking - The specification as given in Para 11.5.5.4 shallbe followed.

11.6.6 11.6.5.5 Avoidance of Surface Crazing - The specification as given in Para 11.5.5.5 shall be followed.

11.6.7 Preliminary Programming of Work

The specification as given in Para 11.5.6 shall be followed.

11.6.7 Preparation of Background for Application

The specification as given in Para 11.5.7 shall be followed.

11.6.8 Sequence of Operations

The specification as given in Para 11.5.8 shall be followed:

11.6.9 Mortar for Plaster

This shall conform to specification as described Chapter 6 Mortars".

11.6.10 Application of Lime Plaster

11.6.10.1 To ensure even thickness and a true surface, plaster about 150 mm 50 mm shall be first applied, horizontally and vertical1y, at not more than 2.0 m intervals over the entire surface to serve as gauges. The surface of these gauged areas shall be applied in a uniform surface slightly more than the specified thickness. This shall be beaten with thapies to ensure thorough filling of the joints and then brought to a true surface by working a wooden straight edge reaching across the gauges with small upward and sideways movements at a time. Finally the surface shall be finished off true with a trowel or wooden float to a smooth or a sandy granular texture. Excessive trowe1l1ng or over working the float Shall be avoided. During this process a Solution of lime putty shall be applied on the surface to make the letter workable.

11.6.10.1.1 In suspending work at the end of the day, the plaster shall be left cut clean to line both horizontally and vertical1y. When recommencing the plastering the edge of the old work shall be scrapped clean and wetted with lime putty before plaster is applied to the adjacent areas to enable the two to properly joint together. Plastering work shal1 be closed at the end of the day on the body of wall and not nearer than 150 mm to any corners or arrises. It shall not be closed on the body of feature such as plaster bands and cornices not at the corners or arrises. There shall be no horizontal joints in plaster work on parapet tops and copings, as these invariably lead to leakages. No portion of the surface shall be left out initia11y to be patched up later on.

11.6.10.2 One Cast Plaster Work

11.6.10.2.1 The specification as given in Para 11.5.10.1.1 to 11.5.10.1.3 shall be followed.

11.6.10.2.2 Trueness of Plastering system - Specification as given at Para 11.5. 10.4 shall be followed.

11.6.10.2.3 Curing shall be started 24 hours after finishing the plaster. The plaster shall be kept wet for a period of 7 days. During this period it shall be suitably protected from external damages. The dates of plaster shall be legibly marked on the various sections of the walls, so that curing for the specified period thereafter can be watched.

11.6.10.3 Two Coat Plaster Work

11.6.10.3.1 The specification as described in Para 11.5.10.2.and 11.5.10.2.2 shall be followed.

1 1.6.10.3.2 Trueness of Plastering System - Specification given at Para 11.5.10.4 shall be followed.

11.6.10.3.3 Curing - It shall be done as per Para 11.6.10.2.3.

11.6.10.4 Three Cast Plaster Work

11.6.10.4.1 The specification given at Para 11.5.10.3, except for the curing shall be followed.

11.6.10.4.2 Trueness of Plastering System - Specification given at Para 11.5.10.4 shall be followed.

11.6.10.4.3 Curing - It shall be done as per Para 11.6.10.2.3.

11.7 15 MM MUD PLAST£R

11.7.1 Scaffolding

Single scaffolding shall be done as spec1f1ed under Para 11.5.8.1.

11.7.2 Preparation of Surface

Stone and burnt brick surfaces to be plastered shall be prepared as described in 11.5.7. For sun dried brick surface, the joints shall be raked up and the whole surface gently wetted before applying the plaster.

11.7.3. Mortar

11.7.3.1 It shall conform to specification under Para 6.6.6 of "Chapter 6 Mortars.

11.7.3.2 Leeping Plaster - Leeping plaster shall be prepared by mixing soi1 which is free from coarse sand, with approximately equal volume of cow dung and required quantity of water. The mixture shall be worked to a homogeneous mass.

11.7.4 Application

11.7.4.1 Application Plastering shall be started from the top and worked towards the ground.

11.1.4.2 The plaster shall be applied in two coats of 9 mm and 6 mm thickness. for the first coat, the prepared mixture shall be applied to the surface in a uniform coat of average thickness of 9 mm and then smoothened and made even with a straight edge and with floats. This shall be allowed to set but not to become dry before the second coat is applied. The second coat shall be 6 mm thick applied uniformly throughout. It shallbe finally polished with a trowel after it has been smoothened with wooden floats.

11.7.4.3 If leeping plaster is decided to be applied by the Engineer-in-Charge, 8 thin coat of leeping plaster not less than 3 mm thick shall be app1ied over the surface of mud plaster when dry. It shall be finished with trowel or float and the surface shall be allowed to dry. Hair cracks, if any, shall be filled with a mixture of clay and cow dung.

11.7.4.4 For rounding or chamfering corners etc., specification of Para 11.5.8.9 shall be followed.

11.7.5 Trueness of Plastering System

Specification of Para 11.5.10.4 shall be followed.

11.7.6 Precautions

No curing shall be done. The surface shall be protected from damage till it dries out. Any cracks that open out during drying it shall be opened out and thoroughly repaired with a mixture of clay and cow dung. Any portions which sound ho11ow when tapped, shall also be redone after cutting out the hollow portions.

11.7.7 Thickness

The average thickness of the finished plaster excluding the key of the joints shall not be less than 15 mm. The minimum thickness of the plaster over any portion of the wall of brick work shall not be less than 12 mm at any point while in the case of stone walls, this shall not be less than 9 mm over the bushings.

11.8 SPECIAL FINISHES

11.8.1 Various Types of Special Finishes and Their Suitability

The suitabi1ity of various methods of finishing renderings for various conditions is explained in Appendix - III and also generally in Para 11.8.1.1 to 11.8.1.4 below.

11.8.1.1 Trowelled or Floated Plain Finishes - Steel trowelled finishes are not recommended for external renderings. Plain floated finishes require a high standard of workmanship to minimize the risk of cracking, crazing and irregular discoloration.

11.8.1.2 Scraped or Textured Finishes, Hand Applied - Scraped or textured finishes are genera11y less liable to crack and craze than plain finishes and are easier to bring to a uniform appearance; this is especia11y important when coloured renderings are used. Although offering more lodgement for dirt, a rough texture tends to an evenness of discoloration, which is less apparent than with a smoother finish. Also the distribution of the flow of rain water over the surface reduces the risk of penetration through the rendering.

11.8.1.3 Hand- Thrown Finishes, Roughcast and Dry-dash, etc. Hand-thrown finishes, roughcast and dry-dash have a11 the advantages of scraped or textured finishes. Under severe conditions of exposure these are more, satisfactory from the points of view of water proofness, durability and resistance to cracking and crazing than the types mentioned in 11.8.1.1 and 11.8.1.2.

11.8.1.4 Machine Applied Finishes - These are of various types, mainly proprietary materials and processes operated by specia1ists. The types are as follows :

(a) Finishes in which the material is Thrown at random - These have an open porous structure, behave similarly to hand-app1ied scraped finishes and are equal to the latter and to hand-thrown finishes in water proofness, durability and resistance to cracking and crazing.

(b) Finishes which are Applied by gun or Spray - These give low density porous finishes.

11.8.2 Neeru Finish

11.8.2.1 Scaffolding -Scaffolding shall be as specified in pare 11.5.8.1.

11.8.2.2 Mortar - The mortar for Neeru finish shall consist of 1 part lime putty and 1 part fine sand and chopped jute @ 4 kg/cum of mortar. The mixture shall be properly ground to a fine paste between two stones.

11.8.2.3 Application

11.8.2.3.1 The surface of the under coat on which the Neeru finish is to be done shall be left rough. The Neeru finish shall be applied in a uniform layer slightly more than 3 mm thick between gauged pads, with which to ensure an even and uniformly thick surface by frequent checking with a wooden straight edge. It shall be finished to an even and smooth surface w1th trowels.

11.8.2.3.2 All corners, arrises, angles and junctions shall be truly vertical and horizontal as the case may be and shall be carefully and neatly finished. Rounding or chamfering corners, arrises, junctions etc. where required, shall be Neeru finished. Such rounding or chamfering shall be carried out with proper templates to the sizes required. No portion of the surface shall be left out initially to be patched up later on.

11.8.2.4 Thickness - The thickness of the Neeru finish shall not be less than 3 mm thick

11.8.2.5 Curing - specification of Para 11.6.10.2.3 shall be followed.

11.8.2.6 Specification for general precautions shall be as specified under Para 11.5.5.

11.8.3 Rough Cast Plaster

11.8.3.1 Rough cast finish comprises of a mixture of sand and gravel in spec1f1ed proportions dashed over a freshly plastered surface.

11.8.3.2 Scaffolding - Scaffolding shall be done as specified in 11.5.8.1.

11.8.3.3 Requirement of Base

11.8.3.3.1 The plaster base over which rough cast finish is to be applied shall consist of two coats with under coat and finishing coat of 10 mm each. In case of stone masonry the under coat of 15 mm only shall be the base.

11.8.3.3.2 Finishing Coat - The mortar used for applying finishing coat shall be Sufficiently plast1c and of rich mix 1:3 (1 cement: 3 fine sand) or as otherwise specified so that the mix of sand and gravel gets well pitched with the plaster surface.

11.8.3.4 Application - The rough cast mixture shall consist of sand or gravel or crushed stone of uniform colour from 6 mm to 12 mm or as specified end in the proportions as specified accurately to the effect required. The mixture shall be wetted and shall be clashed on the plaster base in plastic state by hand scoop so that the mix get well pitched into the plaster base. The mix shall again be dashed over the vacant space if any so that the surface represents a homogeneous surfaces of sand mixed with gravel.

11.8.4 Pebble Dash Finish

11.8.4.1 The specification shall be the same as for rough cast plaster, except that the washed pebble or crushed stone graded from 12.5 mm to 6 mm or as specified shall be dashed over the plaster base and the vacant spaces if any shall be filled by pressing pebbles or crushed stone as specified, by hand, so that the finished surface represents a homogeneous surface.

11.8.4.2 Specification for scaffolding, requirement of base, application shall be as described under Para 11.8.3.

11.8.5 Plain Bands

11.8.5.1 'Plain band' is a plaster strip of uniform width not exceeding 30 cm and of uniform thickness, provided for decorative or other purposes flush with, sunk below or projecting beyond the wall plaster. A flush band is one where due to the difference in mix or shade of the mortar, the band is executed as a separate and distinct operation from the wall plaster.

11.8.5.2 Thickness

11.8.5.2.1 The specified thickness of a raised band is the thickness of the projection beyond the plane of wall plaster.

11.8.5.2.2 In the case of flush or sunk band, the thickness will be the thickness of the plaster measured from the untreated wall surface.

11.8.5.3 Preparation or Surfaces and Application

11.8.5.3.1 In the case of flush or sunk bands the joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scraping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

11.8.5.3.2 In case of concrete surface if a chemical retarder has been applied to the form work, the surface shall be roughened by wire brushing and al1 the resulting dust and loose particles cleaned off and care shall be taken that none of the retarders is left on the surface.

11.8.5.3.3 In case of raised band the surface of the wall plaster behind the band shall be left rough and furrowed 2 mm deep with a scratching tool, diagonally both ways to form key for the band

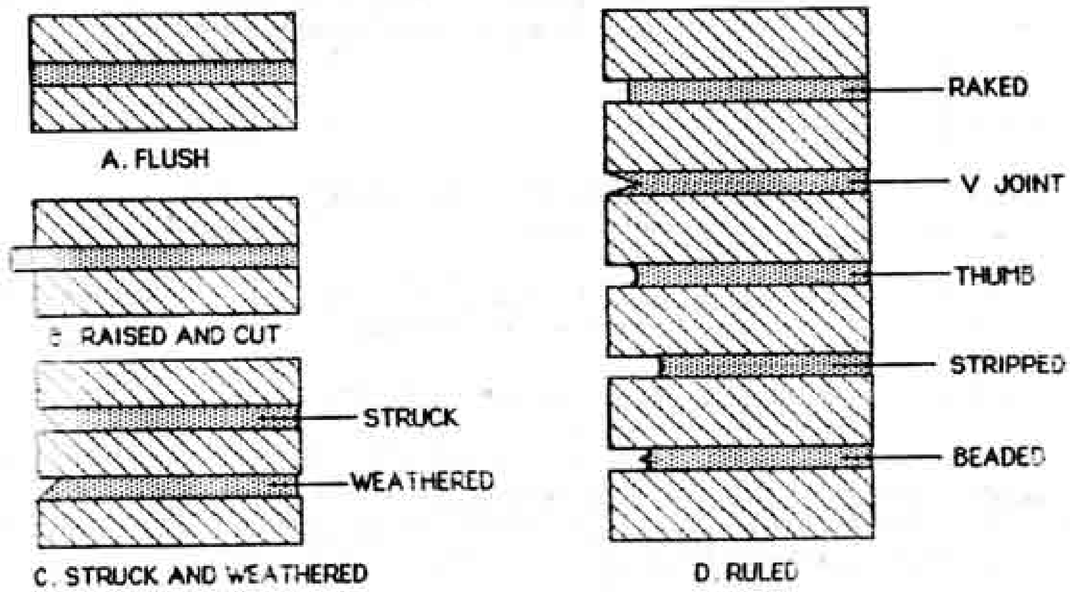
11.8.5.4 Mortar -Mortar of the mix and type of sand specified in the description of the item shall be used.

11.8.5.5 Finish - The bands shall be finished exactly to the size as shown in the drawings. The horizontal or vertical lines of bands shall be truly parallel and straight and the surfaces shall be finished truly plane and smooth. The lines and surfaces shall be checked with fine three for straightness, level and accuracy.

11.8.5.6 Scaffolding, precautions and curing described under Para 11.5.8.1, 11.5.5 and 11.5.12 shall be followed.

11.9 POINTING ON BRICK WORK AND STONE WORK (OTHER THAN DAM)

11.9.1 Pointing shall be of the type shown in figure below :



POINTINGS

The face shall ordinarily be flush pointed.

11.9.2 Scaffolding

It shall be provided as per Para 11.5.8.1.

11.9.3 Preparation of Surface

11.9.3.1 The joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scraping. The surface shall then be thoroughly washed with water, cleaned and kept wet before pointing is commenced.

11.9.3.2 The joints shall be raked to such a depth that the minimum depth of the new mortar measured from either the sunk surface of the finished pointing or from the edge of brick shall not be less than 12 mm.

11.9.4 Mortar

Mortar of specified mix shall be used. It shall be, as specified under "Chapter 6 Mortars".

11. 9.5 Application and finishing

11.9.5.1 The mortar shall be pressed into the raked out joints, with a pointing trowel, either flush, sunk or raised, according to the type of pointing required. The mortar shall not spread over the corner, edges or surface of the masonry. The pointing shall be finished with the-proper tool, in the manner described below :

11.9.5.2 Flush Pointing - The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks, or stones so as to give a smooth appearance. The edges shall be neatly trimmed with a trowel and straight edge.

11.9.5.3 Ruled Pointing - The joints shall be initially formed as for flush pointing and then while the mortar is still green, a groove of shape and size as shown in drawings or as instructed, shall be formed by running a forming tool, straight along the centre line of the joints. This operation shall be continued till a smooth and hard surface is obtained. The vertical joints shall also be finished in a similar way. The vertical lines shall make true right angles at their junctions with the horizontal lines and shall not project beyond the same.

11.9.5.4 Cut or Weather Struck Pointing - The mortar shall first be pressed into the joints. The top of the horizontal joints shall then be neatly pressed back 3 mm or as directed, with the pointing tool so that the joints are sloping from top to bottom. The vertical joints shall be ruled pointed. The junctions of vertical joints with the horizontal joints shall be at true right angles.

11.9.5.5 Raised and Cut Pointing - Raised and cut pointing shall project from the wall facing with Its edges cut paral1ed so as to have a uniformly raised band about 6 mm raised and width 10 mm more as directed.

11.9.5.6 The superfluous mortar then be cut off from the edges of the lines and the surface of the masonry shall also-be cleaned off all mortar. The finish shall be such that the pointing is to the exact size and shape stipulated and the edges are straight neat and clean.

11.9.6 Curing

11.9.6.1 The pointing shall be kept wet for seven days. During this period it shall be suitably protected from all damages.

11.9.6.2 The pointing lines shall be truly horizontal and vertical except where the joints are slanting as in random rubble masonry. Lines of joints from different directions should meet neatly at the junctions instead of crossing beyond

11.10 POINTING FOR DAM

11.10. 1 Mix of Mortar

All pointing shall be done with cement sand mortar 1:3 or richer mix. The sand to be used shall be fine, passing through 600-micron IS Sieve and conforming in all other respects to Para 6.3.4 of "Chapter 6 Mortars".

11. 10.2 Raking Joints

The joints in masonry to be pointed shall be raked square for a minimum depth of two times the thickness of the joint within 24 hours of laying of masonry. In special circumstances, this period may be relaxed to 48 hours. The refi11ing and pointing shall be done within three days of raking of the joints so as to ensure good adhesion between the two mortars.

11.10.3 Cleaning Joints

Before pointing, the joints shall be thoroughly cleaned of MY dirt or Joose1y adhering mortar, washed out properly and thorough1y wetted.

11.10.4 Filling Joints

The joints shall then be filled with cement mortar which shall be rammed and caulked into the joints. The pointing mix shall neither be too dry nor too wet. The mortar shall have just enough water so that it can be moulded into a ball by a slight pressure of hand but wm not give out free water when so pressed and wm leave the hands damp. Pointing shall be carried out as rapidly as possible and not touched again after the mortar has once set.

11.10.5 Final finish to Joints

The joints shall be neat, defined, regular and of a uniform width. The joints may be filled either flush or raised as required. The surfaces pointed should be kept wet for 21 days after pointing is completed.

APPENDIX-I

RECOMMENDED PLASTER SPECIFICATIONS (para 11.5.4.1. t)

Sl. No.		No. of Coat of Plaster	Situation	Mix proportion (Cement:Lime:Sand) by volume	Thickness
(i)		Single coat Plaster	Both internal and external	1:0:3 1 :0:4 1:0:6 1: 1:6 1:2:9	10 to 15mm
(ii)		Two coat plaster:	Both internal and external		
	(a)	Backing coat		1:0:3	10 to 12 mm
				1:0:4	
				1:0:6	
				1: 1:6	
	(b)	Finishing coat		1 :0:3 to 6	3 to 8 mm
				1: 1:6	
				1:2:9	
(iii)		Three coat plaster:	Very rough surface Both internal and external		
	(a)	Base coat		1:0:3	10 to 15 mm
				1:0:4	
				1:0:6	
				1: 1:6	
	(b)	Second coat		1:0:3 to 6	3 to 8 mm
				1: 1:6	
				1:2:9	
	(c)	Finishing coat		Fat Lime and fine sand or marble dust in equal proportions	3 to 5 mm

Note 1- Where two or three coat plasters are adopted, as far as possible the mix for the under coats should contain coarse sand conforming to grooil1g zone II of 15:383- 1970 and having fineness modulus not less than 2.0.

Note 2- For single coot plaster the f1neness modulus of sand should as far as possible 1.5 and conforming to grading zone IV of 15:303- t 970. Where only fine sand is available the fineness modulus of send may be improved by mixing the required percentage of coarse sand. The strength of plaster mix gets reduced with the reduction in the fineness modulus of sand.

Note 3 - Other mixes of cement/lime and sand may also be adopted depending on the Quality of sand available and local conditions provided the strength conforms to any of the above m mixes given above.

Note 4 - Lime is presumed to be measured as lime putty.

APPENDIX - II

RECOMMENDED MIX PROPORTIONS (par8 11.6.4.1)

S.No.	Type of coat	Mix proportions by volume	Class of Lime Conforming to 15:712-1984
(i)	Dubbing and first coat (both for external and or internal surfaces)	1 lime : 2 to 3 sand Or	A and B
		1 Lime: 1 pozzolana: 1 to 2 sand Or	C
		1 lime: 2 to 3 pozzolana(for first coat in the case of two coat work)	C
(ii)	Second coot	1 Lime: 1 pozzolana: 2 to 3 sand	C
(iii)	Neeru finishing Coat	Lime and fine sand ground in equal proportions	C

APPENDIX - III

SUITABILITY OF THE VARIOUS METHODS OF FINISHING RENDERINGS FOR VARIOUS CONDITIONS (Para 11.8.1)

Treatment	**Suitability on various Backing Materials**	**Suitability for Various Environments**	**Suitability for-various Exposure conditions**	**Remarks**
(1)	(2)	(3)	(4)	(5)
Pebble-dash or dry-dash Rough cast	Not suitable on weak types brick or light-weight concrete	All areas. but particularly suitable for situations subjected to heavy rainfall and strong winds	Particularly suitable for severe conditions	Requires maintenance except for fungus growth
Scraped finishes Textured	All backing materials	All areas, but coarser finishes less suitable in the dirtier urban atmosphere	All conditions	Greater freedom from crazing and patchiness of appearance than smooth finishes
Smooth (Floated) finishes	All backing materials	All areas (see 'remarks')	All conditions	This type is most likely to develop defects, including crazing, cracking and patchiness of appearance
Machine applied Finishes	All backing materials	Often less suitable for industrial areas and localities exposed to dust storms as they show dirt rather badly	All conditions	Do not craze but become patchy or streaky under certain conditions
White or light colours in any of above finishes	All backing materials	Less suitable for industrial	All conditions	Will probably require some maintenance to keep good appearance in urban areas

CHAPTER-12 WOOD WORK AND JOINERY CONTENTS

CONTENTS

CHAPTER-12 WOOD WORK AND JOINERY

12.1	REFERENCES
IS: 110- 1983	Ready mixed paint, brushing, gray filter, for enamels -for use over primers (first revision)
IS:204	Tower Bolts
IS:204(Pt.I) –1978	Ferrous metals (fourth revision) (Reaffirmed 1987)
IS: 204(Pt. II) –1978	Non-ferrous metals (fourth revision) (with amendment No.1 and 2)
IS: 206 - 1964	Gate and shutter hooks and eyes (revised) (with amendment No.1) (Reaffirmed 1985)
IS:207-1964	Gate and shutter hooks and eyes (revised) (with amendment No. 1) (Reaffirmed 1985)
IS:208- 1987	Door handles (fourth revision)
IS:210-1978	Grey iron castings (third revision)
IS:281-1973	Mild steel sliding door bolt for use with padlocks (second revision)
IS:287-1973	Recommendations for maximum permissible moisture content for timber used for different purposes (second revision) (with amendment No.1)
IS:303-1975	Plywood for general purposes {second revision) (with amendment Nos. 1 and 2)
IS:318-1981	Leaded tin bronze ingots and castings (second revision)
IS:362-1982	Parliament hinges (fourth revision)
IS:363-1976	Hasps and staples (third revision)
IS:364- 1970	Fanlight catch (second revision) (Reaffirmed 1978)
IS:401-1982	Core of practice for preservation of timber (third revision) (with amendment No.1)
IS:419-1981	Putty, for use of window frames (first revision) (with amendment No.1)
IS:451-1972	Technical supply conditions for wood screw (second revision) (with amendment No.1)
IS:452-1973	Door springs, rat-tail type (second revision)
IS:453-1973	Double acting spring hinges (second revision)
IS:707-1976	Glossary of terms applicable to timber technology and utilization (second revision)

IS:723-1972	Steel counter sunk head wire nails (second revision) (with amendment Nos. 1 to 3) (Reaffirmed- 1985)
IS:729-1979	Drawer locks, cupboard locks and box locks (third revision)
IS:737-1986	Wrought aluminium and aluminium alloy sheet and strip for general engineering purposes (third revision)
IS:848-1974	Synthetic resin adhesives for plywood (phenolic and aminoplastic) (first revision)
IS:851- 1978	Synthetic resin adhesives for construction work (non-structural) in wood (first revision)
IS:852-1969	Animal glue for general wood working purposes (first revision) (with amendment No.1)
IS:1003	Timber panel1ed and glazed shutters
IS:1003(Pt.I) – 1977	Door shutters (second revision) (with amendment Nos. 1 to 3)
IS:1003(Pt.II) –1983	Windows and ventilator shutters (second revision)
IS:1019-1974	Rim latches (second revision)
IS:1068- 1985	Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium on iron and steel (second revision)
IS:1141-1973	Code of practice for seasoning for timber (first revision) (with amendment Nos. 1 and 2)
IS:1328-1982	Veneered decorative plywood (second revision) (with amendment No.1 and 2) (Reaffirmed- 1989)
IS:1341- 1981	Steel butt hinges (fourth revision)
IS:1378-1987	Oxidised copper finishes (third revision)
IS:1658-1977	Fibre hard boards (second revision)
IS:1659-1979	Block boards (second revision) (with amendment No.1)
IS:1708-1986	Method of testing of small clear specimen of timber (second revision) (with amendment No.1)
IS:1734 (Pt.I) –1983	Methods of test for plywood; Part I: Determination of density and moisture content (second revision) (Reaffirmed-1989)
IS:1812-1982	Carbon steel wire for the manufacture of wood screws (second revision) (Reaffirmed -1987)
IS:1823-1980	Specification for floor door stoppers (third revision)(Reaffirmed -1989)
IS:1826-1961	Venetian blinds for windows (with amendment No.1)
IS:1868-1982	Anodic coatings on aluminium and its alloys (second revision)

IS:2062-1984	Weldable structural steel (third revision) (Reaffirmed -1987)
IS:2191 (pt. I)-	Wooden flush door shutters (cellular and hollow core type):Part I - 1983 Plywood face panels (fourth revision)
IS:2191(pt. II)- Part II -1983	Wooden flush door shutters (cellular and hollow core type): Particle board and hard board face panels (third revision)
IS:2202 (pt. I) -1983 -	Wooden flush door shutters(solid core type) : Part I Plywood face panels (fourth revision)
IS: 2202 (pt. II)- - 1983	Wooden flush door shutters (solid core type): Part II Particle board and hard board face panels
IS:2209-1976	Mortice locks (Vertical type)(third revision)(Reaffirmed1987)
IS:2380 (pt. I to XXIII)- 1977	Methods of test for wood particle boards and boards from other Iignocellulosic materials (Reaffirmed -1989)
IS:2525-1982	Dimensions for wrough aluminium and aluminium alloy wire (first revision)
IS:2681-1979	Non-ferrous metal sliding door bolts (aldrops) for use with padlocks (second revision)
IS:2835-1987	Flat transparent sheet glass (third revision)
IS:2931-1964	Ready mixed paints, brushing, alumin1um-zinc oxide composite primer
IS:2932-1974	Enamel, synthetic, exterior (a) undercoating, (b) finishing (first revision)(amendment No.2 April 1982) (Reaffirmed 1986)
IS:2933-1975	Enamel, exterior (a) undercoating, (b)finishing (first revision) (amendment No.2 April 1982) (Reaffirmed 1986)
IS:3087-1985	Wood particle boards (medium density) for general purposes (first revision) (with amendment No. I)
IS:3097-1980	Veneered particle boards (first revision)
IS:3337-1978	Ballies for general purposes (first revision) (Reaffirmed 1987)
IS:3548-1988	Code of practices for glazing in buildings (first revision)
IS:3564-1986	Door closers (hydraulically regulated) (second revision)
IS:3618-1986	Phosphate treatment of iron and steel for protection against corrosion
IS:3813-1987	'C' hooks for use w1th swivels (Reaffirmed 1988)
IS:3818-1986	Continuous (Piano) hinges (second revision)

IS:3847-1966	Martice night latches (with amendments No.1 and 2) (Reaffirmed 1978)
IS:3965- 1981	Dimensions for wrought aluminium and aluminium alloy bar, rod and section (first revision) (Reaffirmed 1986)
IS:4021- 1983	Timber door, window and ventilator frames (second revision) (with amendment No.1)
IS:4082- 1977	Recommendation on stacking and storage of construction materials site (first revision)
IS:4170- 1967	Brass rods for general engineering purposes (with amendment No.1)
IS:4413- 1981	Brass wires for general engineering purposes (first revision) (Reaffirmed 1986)
IS:4827-1983	Electroplated coating of nickel and chromium on copper and copper alloys (first revision),
IS:4835-1979	Polyvinyl acetate dispersion-based adhesives for wood (first revision)
IS:4962-1968	Wooden side sliding doors
IS:4992-1975	Door handles for motice locks (vertical type)(first revision)
IS:5187-1972	Flush bolts (first revision)
IS:5930- 1970	Mortice latch (vertical type)(with amendment No.1) (Reaffirmed 1978)
IS:6198- 1983	Ledged, braced and battened timber door shutters (first revision) (with amendment No.1)
IS:6318-1971	Plastic window stays end fasteners
IS:6607-1972	Rebated mortice locks (vertical type)
IS:6760-1972	Slotted countersunk head wood screws (w1th amendment No.1 and 2)
IS:7196-1974	Hold fast (with amendment No.1) (Reaffirmed 1987)
IS:7197-1974	Double action floor springs (without oil check) for heavy doors
IS:8760-1978	Mortice sliding door locks, w1th lever mechan1sm (Reaff1rmed 1987)
IS: 10019-1981	Steel window stays and f83teners (Reaffirmed 1987)

Standard Specifications - 1977 of "National Building Organisation."

Specifications - 1977 of "Central Public Works Department," Volume I.

12.2 TERMINOLOGY

12.2.1 For Wood

Air-Dried - The condition of timber, which has been subjected to air seasoning.

Air-Dry - A term applied to timber, the moisture content of which is in approximate equilibrium with the local atmospheric conditions, irrespective of the method of seasoning.

Air-Seasoned Timber - Seasoned Timber in open air protected from sun and rain.

Air- Seasoning - Seasoning done in open air, usually protected from sun and rain.

Ballies - Thin round poles usually without bark

Bark - The covering or rind of a tree outside the wood (Plate 12-P II Figure 1).

Batten - A piece of sawn timber whose cross-sectional dimensions do not exceed 5 cm in either direction.

Beam - A structural timber generally long in proportion to its width and thickness and used for supporting load primarily by its internal resistance to bending. In commercial practices it is sometimes used to mean 'flitches',

Bearer -A beam supported at two or more points and provided for the purpose of carrying other members.

Blister - A bulge on the surface due to a separation of the constituent plies or veneers, usually at a glue line.

Board - Thin planks.

Batten Board - A board having a core made up of strips of wood usually 8 cm wide, each laid separately or glued or otherwise joined to form a slab which is glued between two or more outer veneers with the direction of the grain of the core battens running at right angles to that of the adjacent outer veneers (Plate 12-P /1 Figure 2.).

Block Board - A board having a core made up of strips of wood, each not exceeding 25 mm in width, laid separately or glued or otherwise Joined to form a slab which is glued between two or more outer veneers with the direction of the grain of the core blocks running at right angles to that of the adjacent outer veneers (Plate 12-P /1 figure 3).

Fibre Hard Board - Sheet material Qeneral1y exceeding 1.5 mm in thickness, manufactured from lignocellulosic fibres with the primary bond deriving from the felting of the fibres and their inherent adhesive properties. Bonding materials and/or additives may be added.

Particle Board - A board manufactured from particles of wood or other lignocellulose material, for example, flakes, granules, shavings and slivers or splinters, agglomerated, formed and pressed together with one or more of the agents, such as heat, pressure, moisture and a catalyst.

Plywood - A board formed of three or more layers of veneer cemented or glued together, usual1y with the grain of adjacent veneers running at right angles to each other.

Borer Hole. -A hole caused by the attack of wood boring insects and other organisms.

Boxed Heart -A piece of timber, so sawn or hewn that the pith or the centre heart falls entirely within the four surfaces throughout its length (Plate 12-P/I , Figure 5).

Bond - An adhesive on the wood at the line of applicat1on.

Bonding - The process of uniting two or more pieces of wood or veneers by means of an adhesive. This process is characterized by continuity of the union over the whole of the areas of contact.

Braces - Diagonal members in frame work.

Breast Height - Height above ground level at which the girth of tree is generally measured. It is taken as 1.37 m.

Check -A Separation of fibres along the grain which is confined to one face of a piece of wood.

Column -A structural member which supports load primarl1y by inducing compressive stress along the grain.

Common Rafter - A roof member which supports roof battens and roof covering such as boarding and sheeting.

Compression Failure - Deformation caused by the wood being overstressed in compression due to normal forces during the growth of the tree or felling trees on irregular ground or rough handling of Jogs. The deformation range from well-defined buckling of the fibres, visible to the eye as wrinkles across the face of the piece, to slight crinkling of fibres.

Cross Band - A general term indicating a transverse layer of veneer or veneers in composite wood products.

Cross Break - Break or fracture across the grain of the wood.

Curvature - Deviation of a ballie from straightness.

Decay - Disintegration of wood tissues caused by fungi (wood destroying) or other microorganisms.

Diameter at Breast Height - The diameter of stem measured over bark at a height of 1.37 m from the ground level. Where the tree stands on a sloping ground the height shall be measured from that side of the tree which faces the top of the slope.

Discoloration - A change from the normal color of the wood which does not impair the strength of the wood

Date - An early stage of decay characterized by local discoloration of the wood most frequently in the form of streaks along the grain but some-times as spots.

Durability - Resistance offered by wood to agents of natural destruction like insects and fungi.

Elastic Limit - The greatest stress which a material is capable of developing without a permanent deformation remaining upon the complete release of the stress.

Elongation - This term is used to describe the permanent change in length affected by the load. Elongation is sometimes referred to as permanent set.

End Coating - Coating applied to the ends of timber to retard end drying and subsequent splitting.

End Cracks - Cracks appearing on the end surface of the timber.

Equilibrium Moisture Content - The moisture content at which timber neither gains nor loses moisture when subjected to a given constant condition of temperature and humidity.

Fence Posts - Pieces of timber of specified length, circular or rectangular in cross section and which may be su1tably connected to each other in vertical position to form a protective barricade to a place or bui1ding so as to prevent intruders.

Hollow Heart -A cavity in the heart of a bole resulting from decay.

Insect hole - Open hole caused by wood boring insects.

Joint - A prepared connection for joining adjacent pieces of wood, veneer, etc.

Butt Joint - Joint in which two pieces of Timber are joined end to end usually across the grain. Sometimes dowels are used in such a manner that half of the dowel is thrust in each piece (Plate 12-P/1 figure 8).

Combed joint - A joint formed by series of tenons engaged in corresponding slots (Plate 12-P /1 Figure 6).

Dovetail Joint -A joint at the corner of two pieces in such a way that the notches made on one are fitted exactly into projections of corresponding size and shape made in the other. There are various kinds of dovetail joints, for instance, lapped dovetail joint and wedge shaped dovetail joint, joined in a way which will resist withdrawal except in the direction in which it was assembled (Plate 12-P/1, figure 7).

Dowel Joint - A joint in which dowels or pegs are placed in corresponding holes made on the two joining faces (Plate 12-P/1, Figure 9).

Edge Joint - A joint made between two pieces of timber' or veneers in the general direction of the grain (Plate 12-P/2, figure 1)

End Joint -A joint made between two veneers across the grain.

Lap Joint - A joint in which two pieces of timber' are jointed in such a way that one overlaps the other and the entire surface may or may not remain continuous (Plate 12-P/2, Figure 2).

Halved Joint - A lap joint in which the timber is reduced to half section up to a certain length at one end in both the pieces, which are lapped one on another and joined (Plate 12-P/2, Figure 3).

Scarf Joint - A lap joint in which the ends or edges are beveled and the entire surface remains continuous. (Plate 12-P/2 Figure 4).

Mitred Joint - A joint between two members at an angle in which the jointing surfaces are cut to corresponding edges at the intersect ion.

Mortise and Tenon Joint - A joint in which the reduced end (tenon) of one member fits into the corresponding slot (mortise) in another member (Plate 12-P/2, figure 5).

Tongue and Groove Joint - A joint in which a tongue is provided on edge of one member to fit into a corresponding groove on edge of the other (Plate 12-P/2 Figure 6).

Joist - A beam directly supporting floor, ceiling or roof of a structure.

Kadi - A trade term to denote scantlings of odd sizes generally used as roof timbers.

Kiln - A chamber in which temperature, humidity and circulation of air may be controlled for seasoning timber.

Knot - A branch base or limb embedded in the tree or timber by natural growth (Plate 12-P /2, Figure 7),

(a) Knots Classified According to Size:

Large Knot -A knot more than 40 mm in diameter.

Medium Knot - A knot more than 20 mm but not more than 40 mm in diameter.

Pin Knot -A knot not more than 6.50 mm in diameter.

Small Knot - A knot more than 6.50 mm but not more than 20 mm in diameter.

(b) Knots Classified According to Quality:

Blind Knot - A large occluded knot that leaves a pronounced local swelling on the bole.

Branch Knot - Two or more knots branching from common axis.

Dead Knot - A knot in which the layer-s of annual growth are not completely inter grown with those of the adjacent wood. It is surrounded by pith or bark. The encasement may be partial or complete.

Enclosed Knot - A knot that does not appear- on the surface of the timber.

Hollow Knot - See 'pith knot' below.

Live Knot - A knot free from decay and other defects, in which the fibres are firmly inter-grown with those of the surrounding wood.

Loose Knot - A knot that is not held firmly in place by growth or position and that cannot be relied upon to remain in place.

Pith Knot - An otherwise sound knot with a pith hole. American usage reserves this for torn holes less than 6.0 cm in diameter.

Punk Knot - An unsound knot containing much fungus infected tissue.

Sound Knot - A tight knot free from decay which is solid across its face, and at least as hard as the surrounding wood.

Tight Knot - A knot so held by growth or position as to remain firm in position in the piece.

Unsound knot -A knot which is not solid across its face or which, as a result of decay, is not as hard as the surrounding wood. If the decay is advanced, there may be a hole in the centre with decay on the sides of the hole.

(c) Knots Classified According to Form or Shape:

Oval Knot - A knot with one axis longer than the other due to cutting obliquely to the lengthwise direction of the branch.

Round Knot - A knot revealed in a section cut approximately at right angles to its axis and so appearing round.

Splay Knot - A knot revealed in section cut approximately parallel to its axis and so having an elongated shape.

Diameter of Knot - A maximum distance between two points farthest apart on the periphery of a round knot, on the face on which it becomes visible. In the case of a spike or splay knot, the maximum width of the knot visible on the face on which it appears shall be taken as its diameter.

Metal Clips and Staples - Fasteners used in the assembly of plywood to prevent movement of the veneers during processing. These are removed from the finished product.

Moisture Content - The mass of water present in wood or other material expressed as a percentage of its oven-dry mess.

Mortise - A hole or slot to receive a tenon or dowel of corresponding size.

Mould -A soft vegetative growth forms on wood in damp, stagnant atmosphere. It 1s the least harmful type of fungus, usually confined to the surface of the wood.

Moulding -Shaping Umber to a required out1ine or contour.

Oven Dry - The condition of timber dried artificially in an oven at slightly above 100°C until its mass becomes constant.

Overlap - A ride-like elevation noticeable on the surface due to overlapping of two adjacent core veneers.

Particle - Distinct particle or fraction of wood or other lignocellulose material produced mechanically for use as the aggregate for a particle board. This may be in the form of flake, granule, shaving, or splinter or sliver.

Patch - A piece of sound veneer placed in and glued to a veneer from which the defective portion has been removed.

Pitch Pocket - Accumulation of resin between growth rings of coniferous wood as seen on the cross sect ion.

Pitch Seam - An opening along the grain following the growth rings and containing resin.

Pith - The soft tissues found near about the centre of the log, also called central core of the tree (Plate 12 - P 11, Figure 1).

Plies -Individual veneers in plywood.

Preservation - Treatment of timber with chemicals so as to enhance its durability.

Primer -An undercoat given on the surface for subsequent painting where required.

Principal Rafter -A roof member which supports purlins.

Rails - Horizontal members of shutters of doors, windows, panels or fencing.

Fence Rails - Horizontal members in a fence to ensure a pre-designed protection which the fence is expected to serve.

Rebate - A recess along the edge of a piece of timber to receive another piece or a door, sash or frame.

Sapwood - The outer layers of the log, which in the growing tree contain living cells and food material. The sapwood is usually lighter in colour and is readily attacked by insects and fungi (See Plate 12P/1, Figure 1).

Seasoned Timber - Timber whose moisture content has been reduced to the specified minimum under more or less controlled processes of drying.

Seasoning - A process involving the reduction of moisture content in timber under more or less control1ed conditions toward or an amount suitable for the purpose for which it is to be used.

Short Crook - A localised deviation from straightness which, within any section of 1.50 m or less in length, is more than one half mean diameter of the crooked section.

Shrinkage - The reduction in dimensions of timber which take place during drying.

Sizing Material - Alum, wax, resin or other additive introduced to the agglomerate for a particle board prior to forming, primarily to increase water resistance.

Sleeper - A piece of timber used as transverse support under rails in railway lines, usually square sawn.

Slot - A slot made around one end of a log to prevent the drag chain or rope from slipping when the log is dragged.

Spiral or Twisted Grain - Grain in which the vertical elements are aligned spirally in the bole of a standing tree or a log.

Split - A separation of fibres which extends from one face of a piece of wood to another and runs along the grain of the piece.

Closed Split - A split in which two adjacent edges of the broken veneers are in close contact with each other.

End Split - A split at the end of B Jog or B piece of timber or plywood.

Open Split - A split in which the adjacent edges are not in close contact with each other.

Swirl - figure produced by irregu1ar grain in the region of a crotch or knot.

Tenon - A tongue like projection on the end of a piece of timber to fit into a corresponding mortise.

Texture - Term to indicate relative size and distribution of wood elements.

Coarse Texture - Indicates large size or wide distribution or both of wood elements.

Even Texture - Indicates large variation in size and distribution of wood elements.

Fine Texture - Indicates small size or close distribution or both of wood elements.

Uneven Texture - Indicates variability of sizes and distribution of wood elements.

Veneer - A thin sheet of wood of uniform thickness obtained by slicing rotary cutting or sawing.

Venetian Blind or louvers - A blind capable of being raised or lowered, having thin parallel slots placed horizontally one above the other with two or more heavier cross members carrying operating devices, one at the top and one at the bottom. It is equipped with B mechanical tilting device and a cord lock which will permit simultaneous adjustment of slots and bottom rails at any desired angle and height, thereby giving maximum control of light and privacy while allowing ventilation.

Wound - An injury inflicted upon the growing tree which has subsequently healed or occluded.

Yield Stress - The lowest stress at which an extension of the test piece increases without increase of load.

12.2.2 For Glass

Glass - An inorganic product of fusion which has cooled to a rigid condition without crystallizing. It is typically hard and brittle, and has a conchoidal fracture. Masses or bodies of glass may be tinted, translucent or opaque by the presence of dissolved, amorphous or crystalline material. Glass that does not contain such added materials is termed as 'clear' glass, even though the finished product may not be transparent in the ordinary sense as a result of the pattern furnished (wired, corrugated, figured).

Sheet Glass - Transparent, flat glass having glossy, fire-finished, apparently plane and smooth surfaces, but having a characteristic waviness of surface.

Crush - A lightly pitted area resulting in a dull gray appearance over the region.

Digs - Deep short scratches.

Dirt - A small particle of foreign matter embedded in the glass surface.

Gaseous Inclusions -Elongated bubbles in sheet glass.

Knot -A transparent area of incompletely assimilated glass having an irregular knotty or tangled finish.

Lines - Fine cords or strings, usually on the surface of sheet glass.

Open Gaseous Inclusions - Elongated bubbles at the surface of sheet glass which are open leaving a cavity in the finished surface.

Ream - Inclusions within the glass or layers or strings of glass which are not homogeneous with the main body of the glass.

Rubs - Abrasion of the glass surfaces producing a frosted appearance. A 'rub' differs from a 'scratch' in having appreciable width.

Scratches - Any marking or tearing of the surface produced in manufacturing or handling, appearing as though it were done by a sharp or rough instrument.

Smoke - Streaked areas appearing as slight discoloration.

Stones - Any crystalline inclusion embedded in the glass.

Strings - Transparent lines appearing as though a thread of glass had been incorporated into the sheet.

Sulphur Stain - A surface defect in sheet glass, in the form of streaky lines or multi-coloured blemishes caused by sulphur dioxide, if present in kiln atmosphere.

Wave - Defect resulting from irregularities of the surfaces of glass making objects viewed at varying angles appear wavy or bent.

12.3 MATERIALS

12.3.1 Timber

12.3.1 General - Our country has been broadly divided into the following four zones (see also map enclosed at Appendix-I) on the basis of the information collected by the Forest

Research Institute on the seasonal changes in the moisture content of timber at 12 localities in India, supplemented by published meteorological data on the humidity variation in the country:

TABLE - 1

Particulars	Zone I	Zone II	Zone III	Zone IV
Average annual relative humidity, percentage	less then 40	40-50	above 50 end upto 67	more than 67

12.3.1.2 Timber suitable for the manufacture of door, window and ventilator shutters and frames have been grouped under four classes, namely Class A, B, C and D as given in Tab1e-2 below:

TABLE - 2 CLASSIFICATION OF SPECIES OF TIMBER SUITABLE FOR MANUFACTURE OF SHUTTERS AND FRAMES		
CLASS	SPECI ES	
	Standard Trade Name	Abbreviated Symbol
(1)	(2)	(3)
A	Teak	TEA
B	Deodar	DEO
C	Non-Coniferous Timbers other than Teak : Aini	AIN
	Amari	AMA
	Benteak	BEN
	Bijasal	BIJ
	Bonsum	BON
	Champ	CHM
	Chaplash	CHP
	Chickrassy	CHI
	Cinnamon	CIN
	Gamari	GAM

	Gurjan	GUR
	Haldu	HAL
	Hollock	HOL
	Jaman	JAM
	Kala siris	KSI
	Kanju	KAN
	Kindal	KIN
	Koko	KOK
	lakooch	LAK
	lampati	LAP
	laurel	LAU
	Machilus	MAC
	Mango	MAN
	Padauk	PAA
	Pali	PAL
	Poon	POD
	Pyinma	PYI
	Rosewood	ROS
	Red-Dhup	RDH
	Safed-siris	SSI
	Sal	SAL
	Silver-oak	SOA
	Sissoo	SIS
	Toon	TOO
	White-bombwe	WBO
	White- cedar	WCE
	White-chuglam	WCH
D	ConiFerous Timbers other than deodar	
	Chir	CHR
	Fir	FIR
	Kail	KAL
	Spruce	SPR

Teak wood shall be of three grades namely, superior, first and second. The other three classes of woods shall be sub divided into two grades, namely, first and second. Teak, deodar and non-coniferous timbers other than teak- are suitable for door frames in permanent or temporary structures, while coniferous timbers other than deodar are suitable for temporary structures only.

12.3.1.3 Moisture Content - The maximum permissible limits of moisture content when tested in accordance with IS: 287- 1973 based on optimum moisture contents indicated by experimental data, for seasoned Timber required for various wooden stores and uses in each of the four zones are given in Table-3 below :

TABlE-3 MAXIMUM PERMISSIBLE MOISTURE CONTENT OF TIMBER FOR DIFFERENT USES

S. No.	USE	MOISTURE CONTENT PERCENT, MAX.			
		Zone I	Zone II	Zone III	Zone IV
1	Beams and rafters	12	14	17	20
2	Doors and windows:				
a	50 mm and above in thickness	10	12	14	16
b	thinner than 50 mm	8	10	12	14
3	Flooring strips for general purposes	8	10	10	12
4	Furniture and cabinet making	10	12	14	15
5	Handles	12	12	14	15
6	Timber meant for further conversion, posts and poles	20 percent in all zones, moisture content being determined within depth of 12 mm from the surface and excluding 30 cm from each end			

NOTE -The above limits have been derived from the principle that timber for uses for any particular store shall be seasoned to a moisture content which is midway between the maximum and minimum equilibrium moisture contents of the particular place.

12.3.1.4 Seasoning and Treatment - All timbers shall be well seasoned by a suitable process conforming to IS: 1141-1973 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 IS:401-1982.

The finished components shall be given suitable treatment

12.3.1.5 Defects Prohibited - Timber for frames end shutters of doors, windows end ventilators shall be free from decay fungal growth, boxed heart, pitch pockets or streaks on the exposed edges, borer holes, splits and creeks.

12.3.2 Paneling Materials

12.3.2.1 Commercial Plywood

12.3.2.1.1 Grades - Plywood for general purposes shall be of the following four grades depending upon the type of adhesive used for bonding the veneers, and their manufacture shall be according to provisions in IS: 303- 1975 (as amended from time to time).

(A) Boiling Water Proof or BWP Grade,

(B) Boiling Water Resistant or BWR Grade,

(C) Warm Water Resistant or WWR Grade,

(D) and Cold Water Resistant or CWR Grade.

12.3.2.1.2 Moisture Content - The plywood when tested in accordance with IS: 1734(Part 1) 1983 shall have a moisture content of not less than 5 per cent and not more than 15 percent.

12.3.2.1.3 Permissible Defects - Gaps in cores and cross bands may be permitted except for 3-ply wood of BWP and BWR Grades provided the width of gap does not exceed 1 mm in case of 3-ply and 5-ply and 2 mm in case of multiply and provided such-gaps, if more than one, shall be spaced not less than 8 cm away from each other and are staggered not less than 5 cm away as between ply, the next ply having the same grain direction. Splits in cores and cross-bands may be permitted to an extent of 2 per core or cross-band. Overlap and warp shall not be permitted in any of the grades.

12.3.2.1.4 Stacking Storage : It shall be unloaded and stacked with utmost care avoiding damage to the corners and surface. It shall be stacked on a flat dunnage, on the top of which a wooden frame shall be constructed with 50 x 25 mm battens in such a way that it will give support to all four edges and corners with intermediate battens placed at suitable intervals to avoid warping. It shall be stacked in a solid block in a clear vertical alignment. The top sheet of each stack shall be suitably weighed down to prevent warp1ng wherever necessary. It shall not be stored in the open and exposed to direct sun and rain.

12.3.2.1.5 Types Based on Classification of Appearance

(a) Plywood for general purposes shall be classified into ten types, namely AA, AB, AC, AD, BB, BC, BD, CC, CD, and DD based on the quality of the two surfaces in terms of general permissible defects, each surface being of four kinds; namely, A, B, C and D. The type of plywood shall, therefore, be designated by the kind of two surfaces of the panels. The better quality surface shall be called 'face' and the opposite side shall be called 'back'. If the face and back are of the same quality, they are not distinguished. The type of plywood shall denote first the quality of face followed by the quality of back. For example, Type AA shall have both surface of Quality A. Type AB shall have one face of quality A and the back of the quality B and so on.

(b) The quality requirements of each of the surface mentioned under above para shall conform to the requirements given in Table-4 below.

TABLE- 4 QUALITY REQUIREMENTS OF PLYWOOD FOR GENERAL PURPOSES

S.No.	DEFECTS	TYPE OF SURFACES			
		A	B	C	D
(i)	Blister	Nil	Nil	Nil	Occasional
(ii)	Checks	Individual check not more than25 mm in length and the total length not more than 300 mm per sq m	Individual check not more than 50 mm in length, and the total length not more than 600 mm per sq m	Individual check not more than 100 mm in length and the total length not more than 1000 mm per sq m	Individual check not more than125 mm in length, and the total length not more than 1200 mm per sq m
(iii)	Discolouration (sound not injurious)	3% of the area	25% of the area	50 % of the area	75% of the area

(iv)	Discolouration (unsound not injurious)	Nil	Nil	Nil	20 percent
(v)	Dote	Nil	5 cm/sqm	15 cm/sqm	15 cm/sqm
(vi)	Insect hole	Nil	Scattered up to 12 holes/sqm	Scattered up to 24 holes/sqm	Scattered up to 50 holes/sqm may be permitted
(vii)	Joints	None in 250 mm wide face and in wider faces one joint for every multiple of 200 mm in width provided no individual piece is less than 125 mm in width	Not more than one in 250 mm wide face and in wider faces one joint for every multiple of 200 mm provided no individual piece is less than100 mm in width	No restriction	No restriction
(ix)	Pin knots (Dead)	Nil	2 per sqm	6 per sqm	10 per sqm
(x)	Pin knots (Live)	Permitted, provided they do not mar the appearance	No restriction	No restriction	No restriction
(xi)	Knots(tight.)	3 upto 25 mm diameter per sqm	6 upto 25 mm diameter per sqm	No restriction	No restriction
(xii)	Patches	Nil	4 patches per sqm provided they are all tight patches provided they do not mar the appearance	Any number, provided they are all tight patches and are matched for colour	Any number, provided they are all tight patches and properly made
(xiii)	Splits	One split not more than 1 mm wide and not longer than50 mm provided it is filled with a suitable filler	Two splits. not more than 6 mm wide and total length not more than 200 mm provided they are filled with suitable veneer inserts	Three splits. not more than 10 mm wide and total length not more than 300 mm provided they are filled with suitable veneer inserts Splits upto 25 mm long and 0.8 mm wide may be ignored	Six splits. not more than 25 mm wide and total length not more than 400 mm provided they are suitably filled

(xiv)	Swirl	Upto 4 per sqm provided they do not mar the appearance	Unlimited. provided they do not mar the appearance	No restriction	No restriction

However, the maximum number of categories of defects, permitted on anyone surface of the panel shall be restricted in accordance with the requirements laid down in Table-5 below: .

TABLE-5 PERMISSIBLE CATEGORIES OF DEFECTS	
Type of surface	Maximum number of categories of permissible defects per sqm
A	3
B	6
C	9
D	No Limit

(c) If the number of categories of defects visible on any one surface of the panel exceeds the maximum indicated in Table 5 above, such a surface shall be classified as the next lower quality. However, if on any one surface the extent of any single category of defects exceeds the specified limit such that it falls under the next lower category of surface but the total number of categories of permissible defects on the surface under consideration, is less than the number specified for it in Table- 5 above, it shall 8tm be referred to as the surface of the higher category.

12.3.2.1.6 Dimensions And Tolerances - The dimensions of plywood boards shall be quoted in the following order:
The first dimension shall represent the length, that is, the dimension parallel to the grain of the faces; the second the width; and the third, the thickness.

(a) Size - Unless otherwise specified, plywood boards shall be of the sizes given below :

cm x cm	cm x cm
240 x 120	180 x 90
240 x 90	150 x 120
210 x 120	150 x 90
210 x 90	120 x 120

180 x 120	90 x 90

(b) Thickness - Unless otherwise specified, thickness of plywood boards shall be as specified below. The thickness shall be measured upto one place of decimal.

Board	Thickness (mm)
3-ply	3, 4, 5, 6
5-ply	5, 6, 8, 9
7-ply	9,12,15,16
9-ply	12,15,16,19
11-ply	19, 22, 25
Above 11-ply	As ordered

(c) Tolerance - The following tolerances on the nominal size of finished boards shall be permissible :

Dimension	Nominal size	Tolerance
Length	Upto and including 120 cm	+ 3mm
		- 0mm
	Above 120 cm	+ 6mm
		-0 mm
Width	Upto and including 90 cm	+ 3mm
		- 0mm
	Above 90 cm	+ 6mm
		- 0mm
Thickness	Upto and including 5 mm	± 10%
	6 to 9 mm	± 7%
	Above 9 mm	± 5%

12.3.2.1.7 Workmanship and Finish - The plywood boards shall be of uniform thickness with in the tolerance limits. The faces of plywood boards shall be reasonably smooth and face veneers shall be of reasonably uniform thickness, slight sanding may be given to rough boards in order to make them reasonably smooth. The edge of the boards shall be trimmed square within 3 mm.

12.3.2.2 Decorative Plywood

12.3.2.2.1 Types - It is a plywood with ornamental veneers on one or both faces used for decorative purposes. It shall be manufactured according to provisions in IS:1328-1982 as amended from time to time and shall be of the following two types:

(a) Type 1 - It shall comply with the requirements specified below:

(i) Open splits, checks, or open joints not more than 150 mm in length and 0.5 mm in width shall be permissible, provided the same are rectified with a veneer insert bonded with synthetic resin adhesive, as the case may be, and further provided that the insert matches with the surrounding veneer in colour as well as in figure.

(ii) The decorative veneered surface shall be free from torn grain, dead knots, dote, discolouration and sapwood. Also the surface shall be selected for figure, texture, colour and grain characteristics. It shall be free from all manufacturing and wood defects except to the extent mentioned under (a) (1), above.

(b) Type 2 - It shall comply with the requirements specified below:

Open splits, checks or open joints not more than 200 mm in length and 1 mm in width shall be permissible, provided these are rectified in the manner specified under pare (a) above. Tight knots and patches not more than 25 mm in diameter, and pin knots not more than 4 mm in diameter, shall be permissible. The decorative veneer shall be free from the torn grain, dead knots, dote and discolouration. Sapwood, if it does not affect the appearance, shall be permissible.

The surface requirement shall be as mentioned in Type 1.

12.3.2.2.2 Moisture Content - The limits shall be same as given in para 12.3.2.1.2.

12.3.2.2.3 Stacking and Storage - The procedure as described under para 12.3.2.1.4 shall be followed.

12.3.2.2.4 Dimensions and Tolerances

(a) The dimensions of plywood boards shall be quoted in the following order, the first dimension shall represent the length, that is, the dimensions parallel to the grain of the faces, the second the width and the third the thickness.

(b) Tolerances

(i) The following tolerances shall be permitted on length and width:

Length	Upto 120 cm	±3mm
	Above 120 cm	±6mm
Width	Upto 90 cm	±3mm
	Above 90 cm	±6mm

(ii) The following tolerances shall be permitted on the thickness:

Positive = 10% of nominal thickness
Negative = 5 % of nominal thickness

12.3.2.2.5 Finish - The decorative plywood shall be uniform in thickness within the tolerance limits specified in para 12.3.2.2.4. The edges of the decorative plywood shall be trimmed square within 3 mm and sanded to a smooth finish.

12.3.2.3 Particle Board

12.3.2.3.1 Types - The particle boards for general purposes shall be of four types, that is, flat pressed single layer type; not pressed three layer type; extrusion pressed so1td type; and extrusion pressed tubular-core type. The designation of these four types shall be FPSI, FPTH, XPSO, and XPTU respectively.

All these types shall be manufactured according to provisions given in IS: 3087-1985 as amended from time to time.

12.3.2.3.2 Moisture Content - The mean moisture content of the boards, when tested in accordance with IS:2380 (Pt.I to XXII I) - 1977 shall not be less then 7 percent and not more than 16 percent. The moisture content of individual test specimen shall not vary from the mean percentage by more than ±3 percent.

12.3.2.3.3 Stacking and Storage - Wood particle boards shall be stored in packs on 8 level flat surface in a clean, dry and covered place with free circulation of air.

The boards shall be protected from rain, dampness and insect and fungal attack. The edges of boards in a pack shall be in a straight vertical plane. If required, the edge may be sprayed or painted with a suitable protective coat or sealing material. The packs shall be kept clear of the floor. The top of the stack shall be kept covered with a cover board and weighted down suitably.

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

12.3.2.3.5 Dimensions and Tolerances

(a) 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 cm modules for building boards.

Thickness - The thickness of particle boards shall be 6, 9, 12, 16, 19,20,21,22,25,27,30,35,40,45 and 50 mm.

(b) Tolerances - The following tolerances on the dimension~ of finished boards shall be permissible:

Dimension	Tolerance
(a) Length	
Above 150 cm	± 9 mm
Upto 150 cm	± 6mm
(b) Width	
Above 150 cm	± 9mm
Upto 150 cm	± 6mm
(c) Thickness	
Above 25 mm	± 2.5%
Up to 25 mm	± 5%

The length of the two diagonals of a wood particle board, rectangular panel, shall not differ by more than 2.5 mm maximum. The edges of the board shall be straight with a tolerance of 3 mm

12.3.2.4 Block board

12.3.2.4.1 Grades and Types

(a) B lock boards shall be of the following two grades:

(i) Grade 1 - Exterior grade of b lock board which is meant for bus bodies, railway coaches, prefabricated houses, where it is likely to be exposed to high humidity, rain etc.

(11) Grade 2 - Interior grade of block board which is meant for furniture, partition, paneling, ceiling etc.

(b) Each of the grades specified at (a) above shall be of the following two types:

(1) Type 1

With ornamental veneers on one side or on both sides for use in high crass furniture, paneling, interior decorations, partitions etc.

(ii)Type 2 - Block Boards, Commercial Type - These are block boards with faces of commercial timber and are used for ordinary furniture, table tops, partitions and paneling to be painted over flooring and seats of bus bodies, railway carriages, etc.

(c) The grades and types of block boards shall be represented by symbols given below :

S.No.	Grade and Type	Symbol
1	Exterior grade, commercial type	XCOM
2	Exterior grade, decorative type	XDEC
3	Interior grade, commercial type	ICOM
4	Interior grade, decorative type	IDEC

12.3.2.4.2 Dimensions and Tolerances

(a) Thickness - The thickness of block boards shall be 12,16,20, 25,30,32,35,38,40,45 or 50 mm.

(b) Sizes - Block boards shall be of the following sizes:

Length(cm)	Width (cm)
300,270,240,210, 180, 150 and 120	150, 120 and 90

(c) Tolerances - Tolerances on dimensions shall be as follows:

Dimensions	**Tolerances**
Length	± 6 mm
Width	± 6 mm
Thickness	± 5% up to 25 mm thickness
	± 2.5% above 25 mm thickness

Variation in thickness in the same board	0.5 mm of the mean thickness of the board

(d) The length of the two diagonals of e block board shall not differ by more than 2.5 mm per metre length of the diagonal.

12.3.2.5 Fibre Hard Board

12.3.2.5. 1 Types - Hardboards are generally classified into the following three types according to their method of manufacture, density, and other related mechanical and physical properties:

(1) Medium hardb08rd, (in Standard hardboard, and (111) Tempered hardboard.

(a) Medium Hardboard - A homogeneous fibre building board having a density exceeding 0.35 g/cm:5 but not exceeding 0.8 g/cm:5.

(b) Standard Hardboard - A homogeneous fibre building board having a density exceeding 0.80 g/cm3.

(c) Tempered Hardboard - Hardboard which has been further treated in the course of manufacture in order to modify one or more of their properties (this m6Y have the effect of altering the density).

12.3.2.5.2 Dimensions and Tolerances

(a) 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.

(b) The thickness of hardboards and tolerances thereon shall be as given in Table-6 below:

TABLE -6 THICKNESS OF HARDBOARDS

S.No.	Type	Nominal thickness(mm)	Tolerence(mm)
i	Medium Hardboard	6	± 0.5
		8	± 0.7
		10	± 0.7
		12	± 0.9
ii	Standard Hardboard	3	± 0.4
iii	Tempered Hardboard	4	
		5	
		6	± 0.5
		9	± 0.7

(c) Width and Length - The width and length and tolerances thereon shall be as given in Table-7 below :

TABLE-7 WIDTH AND LENGTH OF HARDBOARDS

Type	Width (m)	Tolerance on width, Max. (mm)	Length (m)	Tolerence on length, Max. (mm)
Medium Hardboard	1.2	± 3	1.2, 1.8,2.4, 3.0,3.6, 4.8 and 5.5	± 5
Standard Hardboard	1.2			
Tempered Hardboard	1.2			

12.3.2.5.3 Workability and Finish - The hard boards shall not crack, split or chip when drilled, sawed or nailed perpendicularly to the surface. The boards shall be of uniform thickness within the tolerance Limits. The boards shall be free from warp. The surfaces shall be flat, free from cracks and lumps and of natural colour.
At least one face shall be smooth.

12.3.2.6 Sheet Glass

12.3.2.6.1 Sheet glass shall be flat, transparent and clear as judged by the unaided eye. It may, however, possess a light tint when viewed edge-wise, it shall be free from any cracks. The sheet glass shall be classified into the following 4 qualities:

(a) AA Quality or Special Selected Quality (SSQ) - Intended for use for superior quality of safety glass, high quality mirrors, photographic plates, projection slides, etc.

(b) A Quality or selected quality (SO) - Intended for selected glazing, manufacture of mirrors, safety glass, etc.

(c) B Quality or Ordinary Quality (00) - Intended for glazing and

flooring etc.

(d) C Quality or Green house Quality - Intended for' green house glazing, production of frosted glass, strips for flooring, etc.

1.2.3.2.6.2 Dimensions - Thickness and tolerances on cut sizes (length and width) of sheet glass shall be as specified in Table-8 below :

TABLE -8 THICKNESS OF SHEET GLASS AND TOLERANCES ON CUT SIZES

S.No.	Nominal thickness (mm)	Range of thickness (mm)	Tolerances on cut sizes(mm)
1	1.1	1.0 to 1.3	± 1.5
2	1.4	> 1. 3 to 1.6	± 1.5
3	1.6	>1.6 to <1.8	± 1.5
4	2.0	1.8 to 2.2	± 1.5
5	2.5	2.3 to 2.7	± 2.0
6	3.0	2.8 to 3.2	± 2.0
7	4.0	3.8 to 4.2	± 2.0
8	4.8	4.5 to 5.1	± 2.0
9	5.5	5.2 to 5.8	± 2.0
10	6.3	6.0 to 6.6	± 3.0
11	8.0	7.5 to < 8.5	± 3.0

12	9.0	8.5 to < 9.5	± 3.0
13	10.0	9.5 to 10.5	± 3.0
14	12.0	11.0 to13	± 3.0

12.3.2.6.3 Permissible Defects - Sheet glass shall not have defects and cluster of defects more than those specified in Table numbers 9 and 10 below:

TABLE -9 DISTRIBUTION OF ALLOWABLE DEFECTS IN SHEET GLASS

S.No.	**DEFECTS**	**'AA' QUALITY**		**'A' QUALITY**		**'B' QUALITY**		**REMARKS**
		Central	**Outer**	**Central**	**Outer**	**Central**	**Outer**	
1	2	3	4	5	6	7	8	9
i	Gaseous incluslon, max. size, mm	1.0	2.0	3.0	6.0	12.0	18.0	Separated by at least 30 cm
ii	Opaque Gaseous inclusion, max. size, mm	Nil	0.5	3.0	6.0	6.0	12.5	Separated by atleast 60 cm
iii	Knots, dirt, and stones* max. size, mm	Nil	1.0	1.0	1.0	1.5	2.0	Separated by at least 60 cm
iv	Scratches, rubs and crush	Faint	Faint	Faint	Light	Light	Medium	Separated by at least 60 cm
v	Bow, percent, max.	0.25	0.25	0.5	0.5	1.0	1.0	
vi	Reams, strings and Lines	Light	Light	Light	Light	Medium	Heavy	
vii	Waviness, mm	10.0	10.0	15.0	15.0	20.0	20.0	
viii	Sulphur stains	Nil	Nil	Nil	Nil	Inconspicuous one allowed		
ix	Corner breakage and chips	Not more than nominal thick-ness of sheet glass		Not more than nominal thick-ness of sheet glass		Not more than nominal thickness of sheet glass		
NOTE - 'C' quality sheet glass may have defect of any size or intensity but shall have no stones or knots which may cause breakage								
* There shall be none which hinders serviceability for automobile industry.								

TABLE-10 ALLOWABLE CLUSTER OF DEFECTS MENTIONED UNDER Sl.No. i, ii AND iii of TABLE-9

S. No.	Quality of sheet glass	Central Area	Outer Area

1	2	3	4
i	AA	Nil	One cluster of maximum 3 defects comprising only 1 from (iii) and 2 from either (i) or (ii). or 1 each from (i)and (ii) in an optional circle of 30 cm dia.
ii	A	One cluster of maximum 3 defects comprising l from (iii) and only 2 from either (i) ore (ii), or 1 each from (i) and (ii) in an optional circle of 30 cm dia.	One cluster of maximum 5 defects of any type mentioned in (i), (ii) and (iii) but the presence of stone should not be more than 1 in an optional circle of 30 cm dia.
iii	B	-do-	One cluster' of maximum 6 defects of any type mentioned in (i), (ii) and (iii) but the presence of stone should not be more than one in optional circle of 30 cm dia.

12.3.2.6.1 Stacking and Storage -It is important that all glass sheets whether' stored inn crates or not shall be kept dry. Suitable covered storage space shall be provided for the safe storage of the glass sheets. In removing glass sheets from crates, great care shall be taken to avoid damages. The glass sheets shall be lifted and stored on its long edges and shell be put into stacks of not more than 25 panes, supported at two points by fillets of wood at 300 mm from each end. The first pane laid in each stack shall be so placed that its bottom edge is about 25 mm from the base of the wall or other' support against which the stack rests. The whole stack shall be as close and as upright as possible.

1.2.3.3 Fittings and Accessories

12.3.3.1 These shall be of iron, brass, and aluminium or as specified. These shall be well made, reasonably smooth, and free from sharp edges and corners, flaws and other defects, Screw holes shall be counter sunk to suit the head of specified wood screws.

12.3.3.2 Handles

12.3.3.2.! Types - These shall be of the following four types according to the material used:

TYPE	**MANUFACTURING PROCESS**	**MATERIAL**
Type 1	Cast	Cast iron, malleable cast iron, cast brass cast aluminium of

		zinc alloy die casting
Type 2	Pressed oval	Mild steel
Type 3	Pressed half oval	
Type 4	Fabricated	Brass or aluminium alloy

12.3.3.2.2 Dimensions and Tolerances - The sizes and dimensions of the handles shall conform to those given on Plate 12-P/21 and 12-P/22. The shape of the handles indicated on the plate is only illustrative but the dimensions and minimum requirements are binding. The tolerances on dimensions of door handles shall be as under:

. Dimensions (mm)	Tolerance (mm)
Upto 1 00	± 1
101 to 200	± 1.5
201 and above	± 2

12.3.3.2.3 Finish - Handles shall be finished correct to shape and dimensions. All sharp edges and corners shall be removed and finished smooth so as to facilitate easy handling. Unless otherwise specified, the finish shall be as follows:

Type 1 - Bright satin finish, nickel chromium, copper oxidised, bronze finish for cast brass and zinc die cast handles. Stove enameled black or copper oxidised for cast iron and malleable cast iron handles. Aluminium anodised to a bright, natural, mat or satin finish or dyed.

Type 2 - Stove enameled black

Type 3 - Stove enameled black

Type 4 - Bright satin finish, nickel plated, copper oxidised, bronze finish for brass handles. Aluminium anodized to a bright, natural, mat or satin finish or dyed.

12.3.3.3 Sliding Door Bolts (A/drops)

12.3.3.3.1 Types

(a) Mild Steel Bolts - These are of two types, namely, p I ate type, and clip or bolt types.

(b) Non-ferrous Metal Bolts - Bolts made of non-ferrous materials are of the following three types :

Type 1 - Brass sliding door bolts with sand-cast brass hasp, staple and fixing bolts or clips and rolled or drawn brass bolts.

Type 2 - Brass sliding door' bolts with die-cast brass hasp, staple end fixing bolts or clips and rolled or drawn brass bolts.

Type 3 -Aluminium alloy sliding door' bolts with hasp, staple and fixing clips of sheets, or extruded sections and fixing bolts and sliding bolts of extruded sections of aluminium alloy.

12.3.3.3.2 Dimensions and Tolerances

(a) Mild Steel Bolts - The leading dimensions of the plate type and clip or bolt type sliding door bolts and tolerances thereon shall conform to those given on Plate 12-P/23.

(b) Non-ferrous Metal Bolts - The essential dimensions of the different types of sliding door bolts and tolerances thereon shall conform to those given on Plate 12-P/24.

12.3.3.3.3 Finish

(a) Mild Steel Bolts

(i) Plate Type - Back plate, straps and staple plate shall be stove enameled black before assembling. Hasp and bolt shall be finished bright or copper' oxidised in accordance with IS: 1378-1987 or shall be plated with nickel or chromium in accordance with IS: 1 068- 1985.

(ii) Clip or Bolt Type - Hasp, bolt, staple and clips or fixing bolts shall be copper oxidised in accordance with IS: 1378-1987 or' shall be plated with nickel or chromium in accordance with IS: 1 068- 1985.

NOTE - When the sliding bolt is to be finished bright, a thin coating of rust preventive shall be given.

(b) Non-ferrous Metal Bolts - Brass sliding door bolts shall have satin finish or shall be polished or plated. Aluminium alloy sliding door bolts shall be anodized and the anodic coating shall be not less than Grade AC 10 of IS: 1868- 1982,

12.3.3.4 Flush Holts

12.3.3.4.1 Types - Typical details of two types of flush bolts are shown at Plate 12-P/25

12.3.3.4.2 Dimensions and Tolerance - These shall be a5 given on Plate 12-P/25

12.3.3.4.3 Finish - Flush bolts when assembled shall have smooth, and easy working Brass flush bolts shall be satin or bright-polished. Alternatively they may nickel or chromium plated as specified in IS:4827- 1983 or copper oxidised in accordance with IS: 1378-1979. Aluminium flush bolts shall be anodized and the quality of anodized finish shall be not less than Grade AC 10 of IS: 1868-1982.

12.3.3.5 Tower Bolts

12.3.3..5.1 Barrel and Skelton tower bolts, wherever' possible shall have knob integral with the bolt. In case it is not possible, provide a single piece construction 0i bolt, the knob may preferably be fitted to the bolt with a pin or' alternatively. Screwed and riveted to the bolt and its shape may be round, half round, spherical or conical of robust construction.

12.3.3.5.2 Types, Dimensions and Tolerances - Tower- Bolts are made of ferrous metals and non-ferrous metals. The types and the leading dimensions along with the Tolerances normally used are illustrated on Plate 12-P/26 end Plate 12-P/27 for ferrous and non-ferrous metal tower- bolts respectively.

12.3.3.5.3 Finish - Unless otherwise specified bolts shall have finish as given below:

(a) Tower Bolts of Ferrous Metals

(i) Barrel Tower Bolts - Bolts bright finished or plated and barrel and socket stove enameled black.

(ii) Semi-barrel Tower Bolts' - Bolt bright finished and other parts stove enameled black.

(iii) Riveted or. Spot Welded Tower Bolts - Bolts bright finished or plated and plate, straps and socket stove enameled black.

(iv) Skelton Tower Bolts - Bolt bright finished or plated and plate dr.: -.tar-lies stove enameled black.

(b) Tower Bolts of Non-ferrous Metals

(i) Barrel Tower Bolts

Types 1 to 3 - Bolt and barrel polished or plated.

Type 4 - Bolt and barrel anodized. The anodic film may be either transparent or dyed. The quality of anodized-finish shall not be less than Grade AC 10 of IS: 1868-1982.

Type 5 - Bolt and barrel oxidized, bronzed or plated.

Types 6 and 7 - Bolt, plate 8IIQ staples bright finished.

Type 8 - Bolt, plate and staples anodized. The anodic film may be either, transparent or dyed. The quality of anodized finish shall not be less than Grade AC 10 of IS: 1866- 1982.

Type 9 - Bolt, plate and staples oxidized, bronzed or plated.

12.3.3.6 Hinges - Hinges shall be free from all defects. All sharp ~ shall be rounded.

12.3.3.6.1 Continuous (Piano)Hinges - Dimensions of Type I, II and III continuous (Piano) hinges and permissible tolerance;; on the dimensions shall conform to those specified in Plate No. 12-P/28. Mild steel hinges shall be protected with anti-corrosive treatment such as bright polished, chromium plated or oxidized finish. Aluminium hinges shall be anodized and the Quality of anodized finish shall not be less than Grade AC 10 of IS: 1868- 1982.

12.3.3.6.2 Steel Butt Hinges - Mild steel butt hinges shall be of the types:
Light weight hinges, medium weight hinges, broad type hinges, square type hinges and heavy weight hinges (see Plate 12-P/29). The leading dimensions of various types of hinges and tolerances thereon shall be -as given at Plate 12-P /29. Unless otherwise specified, hinges shall be finished bright with smooth surfaces.

12.3.3.6.3 Non-ferrous Metal Butt Hinges - These hinges shall be of the four types according to the material used:

(a) Extruded aluminium alloy butt hinges, (b) Extruded brass butt hinges, (c) Cast brass butt hinges, and (d) Sheet brass butt hinges.

Brass hinges shall have bright or satin finish and shall be suitably protected against discoloration. Specification for aluminium alloy hinges shall be the same as specified under Para 12.3.3.5.1 the dimensions of different types of hinges shall be normally as given on Plate 12-P/30. The tolerances on dimensions of hinges specified for different types shall be as given in Table-11 below:

TABLE-11 TOLERANCES OF DIMENSIONS OF HINGES
(All dimensions in Millimeters)

S. No.	Type	Length	Breadth	Butt Dia	Pin Dia	Thickness of Flap
		A	**B**	**D**	**d**	**c**
(i)	Extruded 6~uminium all0y hinges	±1	In accordance with IS:2525- 1982 and IS:3965-1981			
(ii)	Extruded brass butt hinges					

(iii)	Cast brass butt hinges	±1	±1	± 0.3	± 0.10	± 0.3
(iv)	Sheet brass butt hinges					

12.3.3.6.4 Parliament Hinges - Parliament hinges shall be of three types:

Type I - Cast made of cast brass,
Type 2 - Pressed made of mild steel or aluminium alloy and,
Type 3 - Fabricated made of extruded aluminium alloy.

Brass hinges shall have either bright or satin finish and shall be suitably protected against discoloration. Aluminium alloy hinges shall be anodized to a bright natural, mat or satin finish or dyed. The anodic coating shall not be less than Grade AC 10 of IS: 1868-1982. The dimensions of different types and sizes of parliament hinges and tolerances thereon shall be as given on Plate 12-P /31.

12.3..3.6.5 Tee and Strap Hinges - Tee hinges shall be light weight type, medium weight type and heavy weight type. Strap hinges shall also be of the similar three types. Hinges shall be well made, free from burrs, flews end defects of any kind. The movement shall be square and the working shall be free and easy, without any play or shake. Tee and strap hinges shall be either bright finished or stove enameled black. The leading dimensions of the various types of Tee and Strap hinges and tolerances thereon shall conform to those given on Plates 12-P/32 and 12-P/33.

1 2.3.3.6.6 Spring Hinges

(a) Rat-tail Type Spring - These springs shall be of the two types according to the materials used -

(i) Mild Steel Springs, and
(ii) Brass Springs.

In the case of mild steel springs, casing, tall rod, spindle cap and base plate shall be stove enameled black or. Copper' oxidised. Spindle, roller' plate and roller shall be bright finished and the spring if made of steel wire shall be copper oxidised or electro-galvanized. In the case of brass springs, casing, tail rod, spindle cap and base plate shall be bright finished or copper oxidised. Spindle, roller plate and roller shall be bright finished and the spring if made of mild steel wire shall be copper oxidised or electro-galvanized. The leading dimensions of the springs shall conform to those specified on Plate 12-P/34.

(b) Double Acting Spring hinges - These shall be of the two types according to the material used - Mild steel spring hinges and brass spring hinges.
Unless otherwise specified, the finish of the hinges shall be as follows:

(i) Mild Steel Hinges - Stove enameled black or copper oxidized.

(ii) Brass Hinges - Satin, bright, nickel-plated, or copper-oxidized.

The leading dimensions of double-acting spring hinges shall conform to those specified on Plate 12-P /35.

(c) Double Action Floor Springs (without oil check) - It is essential that these devices shall be compact in shape and size, and easy to mount.
Typical details of a floor spring are given on Plate l2-P 136, Figure 1.

The cover sheet, shoue and top centre pivot shall be polished, electroplated or anodized. All dents, burrs and sharp edges shall be removed from the components and they shall be pickled, scrubbed and rinsed to remove grease, rust scale or any other foreign elements. After pickling, the components shall be given phosphate treatment in accordance with IS:3618- 1986, followed by a coat of suitable primer, such as red oxide. Putty shall be applied to all surfaces requiring filling end shall conform to IS: 11 0- 1983. Aluminium primer shall conform to IS:2931-1964. A finish coat with synthetic stoving enamel conforming to IS:29321974 or IS:2933-1975 shall then be applied. The dimensions and tolerances of floor springs shall be as specified by the Engineer- in-Charge.

12.3.3.7 Other Fittings and Accessories

There are certain other fittings and accessories used for wood work. Some of them commonly used are given below:

12.3.3.7.1 Mortise Latch - This shall conform to specification IS:5930-1970 as amended from time to time. The shape, design, mechanism and the leading dimensions shall be normally as illustrated on Plate 12-P /37.

12.3.3.7.2 Mortise Night Latch - This shall conform to IS:3847-1966. A typical illustration of a mortise night latch is shown on plate 12-P /36, Figure 2.

12.3.3.7.3 Hold fast - This shall conform to IS: 7196-1974. The size and dimensions for the hold fast shall be as given on Plate 12-P /38.

12.3.3.7.4 'C' hooks for use with Swivels - These shall conform to IS:3813-1987. The form and dimensions of the hook shall be in accordance with the Plate 12-P /39.

12.3.3.7.5 Window Stays and Fasteners - These may be either made of mild steel conforming to IS: 10019-1981 or made of cast brass, aluminium or' made of plastic conforming to IS:6318- 1971. These shall normally conform to the size and shape illustrated on Plate 12-P /40.

12.3.3.7.6 Wood Screws - Wood screws made of mild steel shall conform to IS: 1812-1961. In case of wood screws made of brass, the brass chosen shall be Cu Zn 37 according to IS:4413-1981 or Cu Zn 40 according to IS:4170-1967.

12.3.3.7.7 Hooks and Eyes - These are commonly used on door's and windows for Leading them in position. The types, sizes along with the leading dimensions and tolerances shall conform to specifications illustrated on Plate 12-P /41.

12.3.3.7.8 Rebated Mortise Locks - These shall conform to specifications of IS:6607- 972 as amended from time to time. The shape, design, mechanism and the leading dimensions shall be, normally, as illustrated on Plate 12-P/42.

12.3.3.7.9 Vertical Type Mortice Locks - These shall conform to specification of IS:2209-1976 as amended from time to time. The shape, design, mechanism and the leading dimensions of the locks, normally used are illustrated on Plate 12-P/43.

12.3.3.7.10 Door Handles for Mortice Locks - These shall conform to specification of IS:4992-1975 as amended from time to time. The type, size and the dimensions along with tolerances shall normally be as specified on Plate 12-P/44.

12.3.3.7. 11 Drawer, Cup-board and Box Locks - These shall conform to specifications of IS: 729-1979 as amended from time to time. The design, shape, mechanism Bid the leading dimensions along with tolerances thereon, normally used, are i1J':5rated on Plate 12-P /45.

12.3.3.7. 12 Rim Latches - These shall conform to specification of IS: 1019-1974 as emended from time to time. The shape, design Mechanism and leading dimensions along with tolerances shall normally be as specified on Plate 12-P /46.

12.3.3.7.13 Door Closers (Hydraulically Regulated) - These shall conform to specification IS:3564-1986 as amended from time to time. The types, mechanism and the normal sizes are illustrated on Plate 12-P /47.

12.3.3.7.14 Floor Door Stoppers - These shall conform to specifications of IS:1823-1920 as amended from time to time. Typical illustration along with .dimensions and tolerances is given on Plate 12-P/48.

12.3.3.7.15 Hasps and Staples - These shall conform to specifications of IS:363-1976 as amended from time to time. The types and the leading dimensions along with tolerances thereon shall conform to those specified on Plate 12-P /49.

12.3.3.7. 16 Fan-light Catch - This shall conform to specifications of 18:364- 1970 as amended from time to time. The types and the leading dimensions along with tolerances shall normally conform to those specified on Plate 12-P / 50.

12.3.3. 7. 17 Mortice Sliding Door locks - These shall conform to specifications of 18:8760-1978 as amended from time to time. The shape, design and the leading dimensions shall normally be as specified on Plate 12-P /51.

12.3.3.7. 18 Steel Countersunk Hem Wire Nails - These shall conform to specifications of IS: 723-1972 as amended from time to time. The dimensions and tolerances shall be according to Plate 12-P/52.

12.3.4 Ballies

12.3.4.1 Bellies ere thin round poles usually without bark. Ballies shall be dried in open air, usually protected from the direct action of sun and rain. Ballies of various sizes are extensively used for the construction of scaffolding and for the erection of temporary and semi-permanent structures. Ballies are also used in large quantities for fencing work, open foundation, supports for shuttering and for flood protection work in the form of permeable spurs and bank piling for preventing erosion. Unless otherwise specified, the bark shall be completely removed and all the branches and excrescences shall be dressed down flush with the surface. The top and bottom ends shall be cut square.

12.3.4.2 Dimensions- Unless otherwise specified, the ballies shall conform to the dimensions given below:

Class of Ballies	**Diameter at the Top (cm)**	**Diameter at the Butt End (cm)**	**Length (m)**
1	Over 8.5 upto 12.5	Over 15 upto 20	3 to 9
2	Over 6-5 upto 8.5	Over 11.5 upto 15	3 to 9
3	Over- 5 upto 6.5	Over 7.5 upto 11.5	3 to 9

12.3.4.3 Requirements

12.3.4.3.2 Ballies shall be air dried to a moisture content not exceeding 20% with in a depth of 12 mm from the surface when measured at one third Length of the Dollies from its butt end.

12.3.4.3.2 Ballies shall be reasonably straight, and shall be free from cuts across the grain, Jive insect attack, any kind of decay (rot), pronounced spiral or twisted grain, hollow heart and dead knots exceeding 5 cm in diameter.

12.3.4.4 Permissible Defects

12.3.4.4.I Surface Cracks - These shall not exceed 20 mm in depth and 3 mm in width for class 1 ballies, and shall not exceed 12 mm in depth and 3 mm in width for Class 2 and 3 ballies provided they are not so numerous or so located as to impair the usefulness of the ballies.

12.3.4.4.2 End Cracks - The longest end crack at each end shall be measured end the lengths 00ded together. The total length of the longest cracks shall not exceed 30 cm irrespective of the length of the balli.

12.3.4.4.3 Spiral or Twisted Grain - These shall not be more than one complete twist of grain of spiral in any 6 m of length.

12.3.4.4.4 Curvature - Ballies shall be so straight that when laid horizontally in any position the centre line joining the apex and base shall not deviate from the actual axis of the bellies by more than 7.5 cm

12.3.4.4.5 Short Cracks - These shall not exceed two in number per ballie.

12.3.4.4.6 Pin Hole (Dead Infestation) - These shall be scattered and not concentrated, provided they are not due to power post beetles.

12.4 DOOR, WINDOW AND VENTILATOR FRAMES

12.4.1 Timber

12.4. I. I Suitable timber species of specifications given under Para 12.3.1 shall be used.

12.4.1.2 Permissible Defects - Permissible defects for various classes of timber shall be as covered in Table-12 below:

TABLE-12 PERMISSIBLE DEFECTS FOR VARIOUS CLASSES OF TIMBER FOR DOOR FRAMES

S. No.	**Defects**	**Superior grade (teak)**	**First Grade**	**Second grade**
1	**2**	**3**	**4**	**5**
(i)	Cross-grain	Not steeper than 1 in 20	Not steeper than 1 in 15	Not steeper than 1 in 12
(ii)	Sound knots and live knots	Not more than 0.5 percent of the area of the piece; 10mm, Max	Not more than 1% of the area of the piece; 25mm, Max	Not more than 1.5% of the piece; 40mm, Max
(iii)	Pitch pockets or streaks	None	None	Permissible except on exposed edges, provided that they are cleaned and filled 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 of wood of similar species with grain running in the same direction. The piece shall be well glued.
1	**2**	**3**	**4**	**5**
(iv)	Sapwood	None	None	Generally free from sap wood, 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 10 mm in diameter and not more than one per member and provided such worm holes are plugged with similar timber in such a manner that the plugging merges with the surrounding area both as to colour and grain

12.4.2 All members of frame of Worst windows and ventilators shall be exactly at right angles. The right angles shall be checked from the inside surfaces of the respective members.. All members of the frames shall be straight without any warp or bow and shall have smooth, well-planed on the three sides exposed at right angles to each other. The surface touching the walls may not be planed unless it is required in order to straighten up the member or to obtain the overall sizes with in the tolerances, specified under 12.4.4.1.

1 2.1.3 Joinery

12.4.3.1 Frames of timber doors, windows and ventilators shall have dovetail joints (see Plate 12-P/5. Figure 2).

12.4.3.2 The jamb post shall be through-tenoned into the mortise of the transom to the full width of the transom and the thickness of the tenon shall not be less than 1.5 cm. The tenons shall be closely fitted into the mortises and pinned with corrosion resisting star-shaped meta} pins not less than 8 mm diameter, or with wood dowels not less than 10 mm diameter (see Plate

12-P/5, Figure 2). The contact surfaces of tenons and mortise shall be treated before putting together with an adhesive conforming to WBP or MR grade covered in 18:851-1978 or animal glue conforming to IS:852-1969 or polyvinyl acetate dispersion-based adhesive conforming to IS:4835-1979. The depth of rebate in frames for housing the shutters shall in all cases be 1.5 cm

12.4.3.3 Members of the frames of doors, windows and ventilators shall be of same species of timber except in the case of softwood frames when the bottom sill of the window and the ventilator frames shall be of hardwood.

12.4.4 Dimensions, Sizes and Tolerances

12.4.4.1 Dimensions or Frames and Tolerances - The finished dimensions of Umber section in frames for doors, windows and ventilators subject to a gener6l tolerances of ± 3 mm shall be as under (see Plate 12-P /3, Figure 2) :

S.No.	Requirement	Dimension (mm)
1	Width for frames carrying one set of shutters	100
2	Width for frames carrying two sets of shutters	120 or 140
3	Thickness	60

12.4.4.2 Sizes and Types - Sizes and types of door, window end ventilator frames shall generally conform to the modular sizes as shown in figure 1 of Plate 12-P/3. S1zes other than modular sizes may also be permitted as per the requirement decided by the Engineer-In-Charge.

NOTE - The overall size shown in figure 1 Plate 12-P /3 i30ver8lJ height and width on the out side of frames of timber doors, windows and ventilators. The sizes of frames is derived after allowing a margin of 5 mm 8ll round for fitting and fixing to fit up to modular openings b8S'ed on 10 cm module.

12.4.4.3 Designation - The frames 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 module in the width of opening.
(b) Type - 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.

NOTE - Where a frame is intended to carry two sets of shutters, the frame shall be designated as DD, WW and VV.

(c) Height -It shall be indicted by the number of modules in height of opening.

Example - '12 DT 20' would mean a frame of a double shutter door with width of 12 modules (119 cm) and height of 20 modules (199 cm).

(d) Combination of frames of doors, window and ventilators -When frames of doors and windows are combined with those of windows and ventilators, they shall be designated as illustrated m the following manner:

Example 1 - '6 WS 12/12 DT 20/6WS 12’ means 12 modules wide and 20 modules high double shutter door frame combined in its two sides with two windows, 6 modules wide and 12 modules high.

Example - 2 - '6V6/6WS12' '6V6 /6WS12' Means frames of two single shutter windows of 6 modules wide and 12 modules high combined side by side and with two ventilators at top 6 modules wide and 6 modules high.

12.4.5 Location of Hold fasts

A minimum number of 3 hold fasts as shown in Plate 12-P /4 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 case of window and ventilator frames whose height is less than 1 m two hold fasts on each side shall be fixed at quarter points of the frames.

12.4.6 Finish

Defective knots, when permitted on surface exposed to view, shall be completely bored or cut out and tightly plugged with same timber species and properly glued in. The grain of the plug shall run in the direction of the grain of the piece. The face of the frame abutting the wall and lintel shall be given a coating of coal tar. All the surfaces of door, window and ventilator frames which required to be painted ultimately shall be covered evenly by brush painting with a priming coat of a wood primer. In the case of frames to be polished or varnished, a priming coat of suitable polish or varnish shall be given.

NOTE - 1 Priming alone does not provide full protection against weather and, therefore, all work should receive further coats of paints, 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 the purpose. Unless suitable aluminium primers are used, it is not possible to obtain satisfactory finish.

12.4.7 Stacking and Storage

12.4.7.1 General - White unloading, shifting, handling and stocking timber frames care shall be taken that the material is not dr8gJBd one over the other as it may cause damage to the surface of the materials particularly in the case of decorative shutters. The material should be lifted and carried preferably flat avoiding damage of corner~ or sides.

12.4.7.2 All wooden frames shall be stored in a dry and clean covered space 8WfJy from any infestation and dampness. The storage shall preferably be in well-ventilated dry rooms. The frames shall be stacked one over, the other in Vertical stacks with cross battens and regular distances to keep the stack vertical and straight. These cross battens should be of uniform thickness and placed vertically one above the other, the top of the stack shall be covered by a protecting cover and weighed down by means of scantlings or other suitable weights.

I 2.4.7.3 Separate stacks shall be built up for each size, each grade and each type of material. When materials of different sizes, grades and types are to be stacked in one stack due to shortage of space, the bigger size shall be stacked in the lower portion of the stacks. Suitable pallets or separating battens shall be kept in between the two types of material.

12.4.1.4 If any wooden frame becomes wet during transit, it shall be kept separate from the undamaged material. The wet material may be dried by stacking in shade with battens in between adjacent boards with free access of dry air generally following the guidance laid down in IS:1141 -1973.

12.5 DOOR. WINDOW AND VENTILATOR PANELLED I PANELLED AND GLAZED SHUTTERS -

12.5.1 Materials

12.5.1.1 For Paneled Shutters -Suitable timber species of specifications given under para 12.3.1 and suitable paneling materials of specifications given under para 12.3.2.1 to 12.3.2.5 shall be used.

12.5.1.2 For Blazed or Paneled anti Blazed Shutters - Panel inserts of any type of glass sheet such as frosted glass, wired glass of 6.4 :to 0.4 mm thickness made with wire mesh or steel wire 0.46 to 0.56 mm in diameter, and coloured gl00s as per the specifications given under pare 12.3.2.6 shall be used in case of fully glazed shutters. In case of partly glazed shutters such panel inserts shall be used in addition to the materials described under para 12.5.1.1 above.

12.5.2` Construction and Workmanship

12.5.2.1 Paneled shutters shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood. veneered particle board, blackboard, fibre hard board and sheet glass generally as illustrated at Plate 12-P /8 The panels shall be fixed by either providing grooves in the stiles and rails or beading (see para 12.5.2.2) or both. The stiles and rails shall be joined to each other by mortice and tenon joint at right angles (see figure 1 of Plate 12-P /6). All members of the shutters shall be straight without any warp or bow and shall have smooth, well planned faces at right angles to each other. The right angle for the shutters shall be checked by measuring the two diagonals from the one extreme corner to the opposite one and the difference between the two diagonals shall be not more than ± 3 mm.

12.5.2.2 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, block board and particle board panels shall have either grooves or. beading or both. In case of glass panels 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.

12.5.2.3 Joinery

12.5.2.3.1 Stiles, rails and panels in door shutter shall be of the same species of timber. Stiles and end rails of shutters shall be made out of one piece of timber 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 shape 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 wooden/bamboo pins. Jointed pieces of timber shall belong to the same species.

12.5.2.3.2 Muntings and glazing bars shall be, stub-tennoned to the maximum depth which the size of 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 Plate 12-P /7, Figure 2 and 3).

12.5.2.3.3 Timber Panelling - Timber panels shall be preferably made of specified variety 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 panel. The panels shall be framed into grooves to the fun 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 of the edges of panel openings shall be scribed at the joints. The panels shall be designed such that no single panel exceeds 0.5 sqm in area. Beadings may be done as described in para 12.5.2.2.

12.5.2.3.4 Plywood Paneling - Plywood panels shall be made of the specified BWP grade as per para 12.3.2.1 and shall be not less than 9 mm 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 para 12.5.2.3.3.

12.5.2.3.5 Block Board Paneling -Block board panels shall be made to grade 2, interior grade as specified in para 12.3.2.4 and of thickness not more than 12 mm. There shall be no restriction on the size of the panel.

12.5.2.3.6 Particle Board Paneling - Panels shall be made of one pita of veneered particle board. The thickness of particle boards used shall not be less than 12 mm. The panels 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.

12.5.2.3.7 Hard Board Paneling - Hard board panels shall be made of only tempered quality hard boards described under 12.3.2.5. The thickness of hard boards used shall not be less than 12 mm.

12.5.2.3.8 Glass Paneling - The glass panels shall be properly cut to fit into the rebate of the frames with a clearance of about 2.5 mm on all sides. The glass used for panels shall be of good and durable quality, weighing not less than 7.5 kg/m2. The rebate shall not be less than 10 mm in the stiles and rails. Before glazing, the rebates in the stiles and rails shall be firmed and prepared for painting so that wood may riot draw oil out of the putty and putty may adhere properly. The putty to be used for fixing the glass wood frames shall conform to 18:419-1987. The putty may be coloured to suit the colour of doors or windows etc. The rebate shall be puttied first and glass pan is then pressed into position and secured with glazier’s springs and firmly back putted. The rebate shall be neatly chamfered. The putty may be given a coat of oil paint to match the side surface and also seal the edge of the putty to the glass. The putty shall be left for a week or so before painting to ensure its setting.

For external glazed doors and windows, the beading shall be fixed on outside. Wash leather, ribbon velvet, rubber flannel, felt, asbestos or other simi1ar m6ter-ial may be used in p1ace 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.

12.5.2.4 Bluing or Joints - The contact surfaces of tenon and mortice shall be treated, before putting together, with resin suitable for construction work in wood or ply wood as the case may be. Tongued and grooved joints shall also be properly glued together with suitable adhesives.

12.5.2.5 Rebating - In the case double leaved shutters the meeting of the stiles shall be rebated by one-third the thickness of the shutter. The rebattng shall be either splayed or square type as shown in Figure 2 of P1ate 12-P /6.

12.5.3 Dimensions. Sizes and Tolerances

12.5.3.1 The finished dimensions and tolerances of the different components of door, window and ventilator shutters shall be as given in Table-13 be1ow:

TABLE -13 DIMENSIONS AND TOLERANCES OF COMPONENTS OF DOOR, WINDOW AND VENTILATOR SHUTTERS

S.No.	Description	Width of Door shutter (mm)	Width of window shutter (mm)	Width of ventilator shutter (mm)
1	Vertical Stile, top and freeze rail	100 ± 3	80 ± 3	80 ± 3
2	Lock rail	160 ± 3	-	-
3	Bottom rail	250 ± 3	80 ± 3	80 ± 3
4	Munting	100 ± 3	60 ± 3	-
5	Blazing bar	40 ± 1	40 ± 1	40 ± 1

NOTE - The thickness of door shutters shall be 40 ± 1 mm and that of window and ventilator shall be 20, 25 or 30 mm depending on the size.

12.5.3.2 Designation – Door, window end ventilator shutters shall be designated in the same manner as described under pare 12.4.4.3.
Example - 12 DT 21 would mean a shutter suitable for a double shutter door of 12 module width and 21 module height

12.5.3.3 Sizes and Types - The sizes and types of door, window and ventilator shutters shall generally conform to modular sizes as specified in Table- 14, Table -15 and Table- 16 respectively with tolerance of ±:3 mm. However, sizes other than modular sizes may also be permitted as decided by the Engineer-in-charge.

TABlE-14 DIMENSIONS OF DOOR SHUTTERS

S.No	Designation of Doors	Width (mm)	Height (mm)
1	8 DS 20	700	1905 (1945)
2	8 DS 21	700	2005 (2045)

3	9 DS 20	800	1905 (1945)
4	9 DS 21	800	2005 (2045)
5	10 DS 20	800	1905 (1945)
6	10 DS 21	900	2005 (2045)
7	12 DT 20	1100 *	1905 (1945)
8	12 DT 21	1100 *	2005 (2045)

* combined width of two shutters in closed position.

NOTE - In arriving at the standard width and height of face pannel doors, an allowance of 6 cm has been made for door frames, 4 cm for floor finish and 0.5 cm for clearance all round door opening and door frames and 1.5 cm for rebate al1round I for the shutter into the frame. In case the modular height is taken from the finished floor level, the height of the door shall be the one given in bracket. In the case of double shutters, the rebate and clearance between the shutters shall be as given in Plate 12-P/6, Figure 2.

TABLE-15 DIMENSIONS OF WINDOW SHUTTERS

S.No	Designation of Doors	Width (mm)	Height (mm)
1	6 WS 12	500	1100
2	10 WS 12	460	1100
3	12 WS 12	560	1100
4	6 WS 12	500	1200
5	10 WS 13	460	1200
6	12 WS 13	560	1200

TABLE-16 DIMENSIONS OF VENTILATOR SHUTTERS

S.No	Designation	Width (mm)	Height (mm)
1	6 V 6	500	500
2	10 V 6	900	500
3	12 V 6	1100	500

NOTE - The sizes for window and ventilator shutters mentioned in Table-15 and 16 are derived after allowing the thickness of the frame and a margin of 5 mm all round for fitting and fixing into a modular opening based on 100 mm module.

12.5.4 Location of f1ttings and Accessories

12.5.4.1 The lock rail of door shutters, where provided, shall be so placed that its centre I1na is at a height of 80 cm from the bottom of the shutter. 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 20 cm from the top and the bottom of the shutter. However, if the height of the door leaf exceeds 2.15 m above floor level, one extra hinge shall be provided for every additional height of 0.5m or part thereof.

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

12.5.4.3 Finish - A door window and venti1ator shutters shall be finished smooth with well planed faces. Panels of shutters shall be flat and well-sanded to a smooth and level surface. An other specifications described under para 12.4.6 excluding specifications for the face of the frame abutting the wall and the lintel shall also be followed.

12.6 LEDGED, BRACED AND BATTENED DOOR SHUTTERS

12.6.1 Ledged, braced and battened timber door is the simplest form of door and is frequently used in places where appearance is not the main criterion, for example, for temporary sheds, warehouses, stores and cheaper type of construction etc. It is relatively cheap and has a tendency to twist especially, if the timber is not of good quality and if ledges of thinner sections are used

12.6.2 Materials

Suitable timber species of specification of para 12:3.1 shall be used.

12.6.3 Dimensions, Sizes and Tolerances

12.6.3.1 Dimensions of Components - The finished dimensions of different components of door shutters shall be as given in Table-17 below:

TABLE-17 DIMENSIONS OF COMPONENTS OF DOOR SHUTTERS

S.No	Description	Width (mm)	Height (mm)
1	Top and bottom ledges	150	30
2	Middle ledge	200	30
3	Braces	110 to 125	30
4	Batten	140 to 160 (Depending upon the width of shutter)	25

NOTE -All the battens in a door shutter shall be of uniform width.

12.6.3.2 Designation - Door shutter shall be designated in the same manner as described under para 12.4.4.3.

12.6.3.3 Sizes - Sizes of ledged, braced and battened timber door shutter shall conform to those specified in para, 12.5.3.3 Table-14 (see Plate 12-P/5). Sizes other than modular sizes may also be permitted as per the requirement and as decided by the Engineer- in-charge.

12.6.3.4 Tolerance - Tolerance on size of door shall not exceed ± 3 mm.

12.6.4 Construction and Workmanship

12.6.4.1 All wood work shall be neatly and truly finished to the exact dimensions required and all mortice and tenon and other joints shall be fitted truly without wedging or filling. The following principles shall be observed in forming joints. ~.

(a) Cut the joints and arrange the fastening in such a way so as to weaken the pieces of Umber they connect as little as possible.

(b) Place each abutting surface in a joint, as nearly as possible, perpendicular to the pressure it has to transmit; and,

(c) Form and fit accurately every pair of surfaces that come in contact.

12.6.4.2 Joiner's Work - A joiner's work shall be cut and framed together immediately after the commencement of building operations but shall not be wedged up until required for fixing in position and approved by the Engineer-in-charge. Any portion that may warp and develop shakes and other defects shall be replaced with new component before wedging up. An exposed faces of joinery shall be wrought. A framed joinery for external work shall be put together with white teed and joints pinned with hard wood or bamboo pins. For internal work, the joints shall be glued and suitably pinned Where specified, butt joints shall be crossed tongued, the tongues to be cut at right angles or diagonally to the grains of wood. All mouldings shall be cleaned and accurately finished and all mitres shall be neatly and truly made. The edges and ends of ledges and the edges of braces shall be chamfered before fixing. All battens shall be fixed to ledges, two screws for each ledge. Battens and braces shall also be screwed to each other. The braces shall incline upwards from the hanging edge. Length or screw shall be the same as combined thickness of batten and ledge or batten brace. The point of screw shall not penetrate the wood completely and project even slightly on heather side.

12.6.4.3 Rebating - In case of double leaved shutters, the meeting of stiles shall be rebated 20 mm. The rebating shall be either splayed or square type.

12.6.5 Fitting and Accessories

Each door shutter shall be fixed to its frame with three tee hinges, screwed to ledges, one at the centre and the other two at 20 cm from top and bottom of the shutter. Each door shutter shall also be provided with two barrel bolts and one sliding bolt for locking purpose. The fittings and other accessories shall be as shown in Figure 1 of P1ate 12-P/5.

12.6.6 Finish

Similar specifications as given under para 12.5.4.3 shall be followed.

12.7 SOLID CORE TYPE FLUSH DOOR SHUTTERS WITH PLYWOOD FACE PANELS

I 2.7.1 Materials

12.7.1.1 Timber

12.7.1.1 The species of Umber suitable for use in the core of flush door shutters shall re from among the species specified in Appendix -II.

12.1.1.1.2 For stiles, rails and lipping only non-coniferous timber (hard wood).
Specified in Group 2 of Appendix-II shall be used.

12.7.1.1.3 The moisture content in Umbers used in the manufacture of flush door shutters shall be not more than 12 percent when tested according to IS:1708-1986.

12.7.1.1.4 Timber shall be free from decay and insect attack. Knots and Knot holes less than half the width of cross section of the members in which they occur may be permitted. Pitch pockets. Pitch streaks and harmless pin holes shall be permissible except in the exposed edges of the core members where they shall be cut out and filled in with carefully fitted glued pieces of wood of similar species and character with their grain running in the same direction.

12.7.1.1.5 Species of timber marked with an asterisk in Appendix-II and sapwood of all other timbers shall be preservative treated before assembly. Trimmed and cut ends shall be given a protective treatment by brush or spray appl1C8t1on.

12.7.1.2 Plywood

12.7.1.2.1 Commercial plywood used in flush door shutters shall conform to BWP grade atleast type BC as specified under P8r8 12.3.2.1 above.

12.7.1.2.2 Decorative plywood used in flush mar shutters shall conform to Type 1 as specified under para 12.3.2.2.

12.7.1.3 Cross-Bands - Cross-band used in flush door shutters shall conform to the requirements laid down for 8 W P grade plywood under para 12.3.2.1.

12.7.1.4 Face Veneers

12.7.1.4.1 Commercial face Veneers used in flush door shutters shall conform to the requirements laid down for Veneers for 8 W P grade plywood under para 12.3.2.1.

12.7.1.4.2 Decorative face veneers used in flush door shutters shall conform to the requirements of decorative veneers specified for Type 1 decorative plywood under para 12.3.2.2.

12.7.1.5 All plywood cross-bands and veneers used shall be preservatively treated.

12.7.1.6 Adhesives

12.7.1.6.1 Adhesive used shall be phenol formaldehyde synthetic resin conforming to BWP type specified in IS:848-1974.

12.7.1.6.2 Only synthetic resin adhesive shall be used for bonding core members to one another, including, core-frame, and for lipping, glazing frame, Venetian frame and other exposed parts where such bonding is done.

12.7.1.6.3 Adhesive used for bonding cross-band and plywood to core and face veneers to cross-band shall be phenol formaldehyde specified in IS:848-1914.

12.7.1.7 Particle Board - Particle board used for the core of the flush doors shall be either flat-platen pressed or extrusion pressed type specified under para 12.3.2.3 end shall be made using phenol formaldehyde adhesive. The swelling of the particle board in thickness and length, when tested in accordance with IS:2380 (Part 17)-1977 shall not exceed 5 percent

12.7.2 Types

Solid core flush door shutters may be of the decorative type or non-decorative (paintable) type. The nature of construction of these shutters shall, therefore, be specified based on the type and construction of core as given in Table- 18 below:

TABLE-18 NATURE OF CONSTRUCTION OF WOODEN FLUSH DOOR SHUTTERS (SOLID CORE TYPE)

CORE	TYPE	ABBREVIAT ION
Blackboard	Decorative Non-decorative	BD BN
Particle board with or without blackboard	Decorative Non-decorative	PD PN

12.7.3 Sizes and Tolerances

12.7.3.1 Sizes of the door shutters shall generally conform to the modular sizes specified at para 12.5.3.3 (See also Plate 12-P /10 Figure 1). Sizes other than modular sizes may also be permitted; however, the thickness of shutters in such cases shall not be less than that spec1fied against the nearest higher modular size given in 12.7.3.2.

12.7.3.2 Nominal thickness of shutters shall be 25, 30 or 35 mm.

NOTE - It is recommended that, as far as possible, the thickness adopted for flush doors shall be as given below:

Flush Door Designation	**Thickness of Shutter (mm)**
8 DS 20 and 8 DS 2 1	25
9 DS 20 and 9 DS 21	30 or 35
10 DS 20 and 10 DS 2 1	35
12 DT 20 and 12 DT 21	35

12.7.3.3 Tolerances-Tolerance on nominal width and height shall be ±3 mm and tolerance on nominal thickness shall be ±1.2 mm. 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.

12.7.4 Construction

12.7.4.1 Blackboard Core (PIate 12-P/10, Figure 2) - The blackboard core shall conform to the requirements specified at para 12.7.4.1.2. A frame constructed of stiles 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.

12.7.4.1.1 The wooden strips for core shall be cut out from the timbers and seasoned to a moisture content not exceeding 12 percent. The width of each strip of wood 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 anyone blackboard, the core strips shall be of one species of Umber only. The strips of wood may be laid separately or spot 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 veneer.

12.7.4.2 Particle Board Core With or Without Blockboard (Plate 12-P/11) - The core shall be either particle b08rd or a combination of block board and particle board. In a combined construction, the width of blockboard construct1on shall extend at least 150 mm from inner edge of the stile on either side, and the rest shall be particle board. Block board shall conform to the requirements specified in 12.7.4.1.1 and the particle board shall be as spec1fied in 12.7.1.7. 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.

12.7.4.3 Stiles and Rails -Stiles and rails may be made of one piece or alternatively, two or more pieces glued together; joints being permitted both horizontally or vertically.

12.7.4.4 Leveling. - Leveling not necessarily by planing of surface shall be carried out during each stage of construction, that is, fabrication of core and bonding of cross-bands and face veneers. The thickness of core shall be checked for uniformly before bonding the plywood or cross-bands and face veneers as the case may be.

NOTE - In a blockboard construction the impressions of the core strips on the outside face may be minimized to 8 large extent by following the above provisions of 12.7.4.4 but can not be eliminated altogether because of the nature of construction.

12.7.4.5 Face Panel - The face panel shall be formed by gluing (para 12.7.1.6) by the hot press process on both faces of the core 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 or in the plywood shall be between 0.5 mm and 1.5 mm for commercial veneers and between 0.5 mm and 1.0 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 at right angles to those of the cross-bands. Where it is desired to have wooden strips in the blockboard core horizontal rather than vertical this shall be permitted only if 3-ply panel is pressed on either side of the core and the total is a 7-ply construction. Application of a decorative face veneer on a finished face panel having veneer in the same direction as the proposed veneer shall be avoided. Where, however, this is unavoidable le due to special 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 decorative veneer after finishing is, in no case less than 0.5 mm.

12.1.4.6 Lipping - Lipping shall be provided, if so desired. Lipping, where provided, may be internal and designated as edge-band, or external as specified.
Joints shall not be permitted in the lipping. .

12.1.4.6.1 Edge-band, that is, internal lipping shall have a total depth of not less than 25 mm (para 12.7.4.7). Edge-band may be provided separately, when it is of species different from that of backing or as one piece with the stile, designated as frame-cum-lipping, when edge-band and backing are of the same species. The overall width shall be as given in para

12.7.4.6.2 External lipping, where provided, shall be solid and shall measure at least 6 mm on the face of the door.

12.7.4.7 Rebating - In the case of double - leaved shutters, the meeting of the stiles shall be rebated by one-third the thickness of shutter. The rebating shall be either splayed or square type as shown in Figure 2 of Plate 12-P/6. Where lipping is provided the depth of lipping at the meeting of stiles shall not be Jess than 35mm.

12.7.4.8 Opening For Glazing - When required by the Engineer-in-Charge, opening for glazing shall be provided and, unless otherwise specified. The opening provided shall be 25 cm in height and 20 cm in width. Unless otherwise specified, the bottom of the opening shall be at a height of 140 cm from that of the shutter (see Plate 12-P /7 figure 1). The opening for glazing shall lipped internally with solid timber.

12.7.4. 9 Venetian - When required by the Engineer-in-Charge. A Venetian opening shall be provided and, unless otherwise specified, the height of the opening shall be 30 cm from the top of the bottom rail. The width of the opening shall be as spec1f1ed by the Engineer-in-Charge, but shall provide for a clear space of at least 75 mm between the edge of the door and the Venetian opening.

12.7.5 Fittings

Shutters shall be prepared for taking mortice locks or latches as the case may be. Preparing the door with mortised holes for lock fixing shall be done only when desired. If required, suitable blocks of wood may be provided for fixing the hardware; 1n the absence of specific requirements, the sizes of blocks shall I preferably correspond to the maximum size of lock indicated on Plate 12-P/43).

12.7.6 Workmanship and Finish

12.7.6.1 All the four edges of the door shutter shall be Square. The shutter I shall be free from twist or warp in its plane. Both faces of the door shutter shall be sanded to a smooth even texture. If required by the Engineer-in-charge, 811 the surfaces of shutters which are required to be painted ultimately shall be covered evenly by brush painting with suitable priming coat.

12.1.6.2 Workmanship and the finish of the face panels shall be in conformity I with those specified under para 12.3.2. 1.6 for non-decorative type and para 12.3.2.2.4 for decorative type.

12.8 SOLID CORE TYPE FLUSH DOOR SHUTTERS WITH PARTICLE BOARD AND HARD BOARD FACE PANELS

12.8.1 Materials

12.8.1.1 Timber - Specifications as specified under para 12.7. 1. 1. shall be followed

12.8. 1.2 Particle boards used for core as well as face panels for flush doors shall be made with phenol formaldehyde adhesive and the swelling in thickness and length when tested 1n accordance with' IS:2380 (Part 17)- 1977 shall not exceed 5 percent.

12.8.1.2. I Unveneered particle board used for face panel of flush Door shutters of B N P and P N P types shall conform to Type FP81 or FPTH of 18:3087-1985, and shall be manufactured using Type BWR synthetic resin adhesives conforming to .
IS:851-1978 and out of natural1y durable timbers 1fsted in Appendix-A of 18: 1659-1979.

12.8.1.2.2 For B D P V and P D P V types of flush door shutters, face panel of only veneered particle board of Types E50 of IS:3097-1980 shall be used.

12.8.1.2.3 For flush door shutters of BNPV and PNPV (veneered) the particle board with commercial veneers conforming to type ESC of 18:3097-1980 shall be used.

12.8.1.3 For shutters with fibre hardboard face, only tempered hardboard conforming to IS: 1658-1977 shall be used.

12.6.1.1 Adhesive - Adhesive used for bonding particle board or hardboard face panels to the core shall be phenol formaldehyde synthetic resin conforming to BWP type specified in IS:848-1974.

12.6.2 Types and Designation

Solid core flush door shutters with particle boards face panels may be of the decorative type or non-decorative (paintable) type. The designation of various types of shutters shall be based on the type of core and the type of face panel 6S given in Table -19 below:

TABLE-19 DESIGNATION OF WOODEN FLUSH DOOR SHUTTERS, SOLID TYPE WITH Particle BOARD FACE PANELS

CORE	**TYPE (FACE PANEL)**	**DESIGANTION**
(1)	**(2)**	**(3)**
BlocK board	Decorative with skins of decorative veneered particle boards Non-decorative (Paintab1e) with skins of partic1e boards unveneered Non-decorative(Paintable) with skins of particle boards veneered with commercial veneers	B D PV B N P B NPY
Particle board with or without b lock board	Decorative with skins of decorative veneered particle boards Non-decorative with skins of particle boards unveneered Non-decorat1ve with skins of particle boards with commercial veneers	PD PV * P N P* P N PV*

* Where particle board beated core is used, the designation will be PEPDY, PENP and PENPV respectively-

12.8.3 Sizes and Tolerances

Specification of para 12.7.3 shall be followed.

12.8.4 Construction

12.8.4.1 The construction of flush Doors shall be in accordance with the relevant requirements laid down under para 12.7.4 with modification as given in 12.8.4.1.1 and

12.8.4.1.1 Face Pannel - The face panel shall be formed by gluing by the hot press process on both faces of the core particle boards or veneered particle board or hardboard. The thickness of each of the face panels of particle board shall be not less than 4 mm and of hard board not less than 3 mm.

12.8.1.2 Flush door shutters with particle board beaded type core sha1l be manufactured with core of particle boards of Types FPSI or FPTH conforming to IS:3087-1985 or veneered particle board of Types EXSOD or EXSOOP conform1ng to IS:3097-1980. The beading shall be of solid timber of any of the species mentioned in Appendix-II. The beading shall be to the fun thickness of the fixed. The depth of beading all round shall be not less than 25 mm excluding the tongue for the joint. The beading shall be provided all round and shall be fixed by tongue and brew joint using BWP- type adhesive conforming to IS:848-1974. and the beading shall be further secured by additional screws of adequate length. The tongue shall not be less than 12 mm deep, and its width shall not be less than one-third of the finished thickness of the shutter. The Umber used for beading for flush doors with decorative face shall preferably be of the same species as the face veneers unless otherwise specified by the Engineer-in-Charge.

12.8.5 Fittings

12.8.5.1 Locks - Shutters shBI1 be prepared for taking mortice locks or latches as per the requirement. In case of Doors with particle board core suitable blocks of wood of size 150 x 50 mm shall be provided in the thickness of core at a height of about 1 mm above the bottom edge. For other hardware, suitable blocks of wood may be provided as decided by the Engineer-in-charge.

12.8.5.2 Where special blocks are provided for fixing hardware, these portions shall be so marked in indelible ink.

12.8.6 Work.8Oship and Finish

12.8.6.1 Specifications of para 12.7.6. 1 shall be followed.

12.8.6.2 Workmanship and finish of face panels shall conform to the requirements specified under para 12.3.2.3.4.

12.9 CELLULAR AND HOLLOW CORE TYPE FLUSH DOOR SHUTTERS WITH PLYWOOD FACE PANELS

12.9.1 Materials

12.9.1.1 Timber - Specifications of para 12.7. 1. 1{ 12.7. I. I. 1 to 12.7. 1. 1.5) shall be followed

12.9.1.2 Plywood, Cross-Bands, Face Veneers, Adhesives and Particle Board - Specifications of the corresponding para 12.1. 1.2, 12.7.1.3, 12.7.1.4,12.1.1.5, 12.7.1.6 and 12.1.1.1 shall be followed.

12.9.2 Types

Cellular or hollow core flush door shutters may be of the decorative type or non-decorative (paintable) type. The nature of construction of these shutters shall, therefore, be specified based on the type and construction of core 8S given in Table-20 below:

12.9.3 Sizes end Tolerances

Specifications of para 1.2.1.3 (12.7.3.1 to 12.7.3.3) shall be followed.

TABLE-20 NATURE OF CONSTRUCTION OF WOODEN FLUSH DOOR SHUTTER (CELLULAR AND HOLLOW CORE TYPE)

.

CORE	**TYPE (FACE PANEL)**	**Designation**
(1)	**(2)**	**(3)**
Cellular	Decorative Non-decorative	CD CN
Hollow	Decorative Non-decorative	HD HN

12.9.4 Construction

12.9.4.1 Cellular Core {Plate 12-P/12, Figure 1} - Timber frame for hold1ng the core shall be constructed from stiles, and top and bottom rails, each not Jess than 75 mm wide including internal lipping where provided. The cellular core shall be of any of the following types of construction as specified by the Engineer- in-charge.

Type A - Particle board conforming to specifications of para 12.3.2.3, hard board conforming to specifications of para 12.3.2.5, wooden or plywood battens, tubular, 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 Sq.cm in area and the volumetric contents of toe voids do not exceed 50 percent of the total core volume, that is, when measured from edge to edge.

Type B - Rolls, strips, coils or corrugation 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 rolls, strips, coils or corrugations, at any place is such that at least one strip is intercepted by a square of side 200 mm in any position.

12.9.4.1.1 The void shall be uniformly distributed throughout the core.

12.9.4.2 Hollow Core{Plate 12-P/12, Figure 2} -Timber frame for holding the core shall be constructed from stiles 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 such a way that the voids are equally distributed and the void area 1n any segment is less than 500 sq.cm. Battens may also be replaced by suitable rolls or strips of veneers.

12.9.4.3 Stiles and Rails - Stiles and rails of shutters shall be of one piece construction or laminated one piece construction using BWP type of adhesive. Butt (end) joints shall not be perm1tted for making-up the length of the frame.

12.9.4.4 Leveling - Leveling not necessarily by planing of surface shall be carried out during each stage of construction, that is, fabrication of core and bonding of the plywood.

Thickness of the core shall be checked for uniformity before bonding the cross- bands and face veneers as the case may be.

12.9.4.5 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 6mm 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 for cellular core shutters only but in that case the combined thickness of one cross-band and one face veneer shall be not less than 4 mm. The thickness of the face veneers in the plywood shall be between 0.5 mrn and 1.5 mm for commercial veneers and between 0.5 mm and 1.0 mm for decorative veneers. The plywood face skin assembly conforming to these requirements shall be glued under pressure on both faces of the core.

12.9.4.5.1 Application of a decorative face veneer on a finished face panel having veneer in the same direction as the proposed veneer shall be avoided. However. where this is unavoidable due to special circumstances the already existing veneer. whether commercial or decorative, shall be so sanded that the total thickness of both the existing and applied face veneers together shall not exceed the maximum thickness specified. and provided that the thickness of decorative veneer is in no case less than 0.5mm.

12.9.4.5 Lipping - Specifications of para 12.7.4.6 shall be followed.

12.9.4.7 Rebating - Specifications of para 12.7.4.7 shall be followed.

12.9 4.8 Opening for Blazing - Specifications of para 12.7.4.8 shall be followed.

12.9 4.9 Venetian -Specifications of pare 12.7.4.9 shall be followed.

12.9.5 Fittings

Specifications of para 12.7.5.1 shall be followed.

12.9.6 Workmanship and Finish

Specifications of para 12. 7.612. 7.6.1 and 12.7.6.2) shall be followed.

12.10 CELLULAR AND HOLLOW CORE TYPE FLUSH DOOR SHUTTERS WITH PARTICLE BOARD AND HARDBOARD FACE PANELS

12.10.1 Materials

Specifications for all the materials of para 12.8.1 (12.8. 1. 1 to 12.8.1.4) shall be followed.

12.10.2 Types and Des1gnaUon

Cellular and hollow solid core flush door shutters with particle board face panels may be of the decorative type or non-decorative (paintable) type. The designation of various types of shutters shall be based on the type of core and the type of face panel as given in Table - 21 below:

TABLE-21 DESIGNATION OF WOODEN FLUSH DOOR SHUTTERS CELLULAR AND HOLLOW CORE TYPES WITH PARTICLE BQI\RD FACE PANELS

CORE	**TYPE**	**DESIGNATION**
Cellular	Decorative with skins of decorative particle boards	CDPV
	Non decorative with skins of particle boards unveneered	CNP
	Non-decorative with skins of particle boards veneered with commercial veneers	CNPV
Hollow	Decorative with skins of decorative veneered particle boards	HDPV
	Non decorative with skins of	HNP

	particle boards unveneered	
	Non-decorative with skins of particle boards veneered with commercial veneers.	HNPV

12.10.3 Sizes and Tolerances

Specifications of para 12.7.3 shall be followed.

12.10.4 Construction

12.10.4.1 The construction of flush doors shall be in accordance with the relevant requirements laid down under para 12.9.4 with modifications as in 12.10.4.2 below.

12.10.4.2 The particle board or veneered particle board for the face panel shall be not less than 6 mm thick in the case of ce1lular core flush doors and not less than 9 mm thick in the case of hollow core flush doors. Hardboard, .if used, for the face panel 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.

12.10.5 Fittings

Specifications of para 12.7.5.1 shall be followed.

12.10.6 Workmanship and Finish

Specification of para 12.8.6(12.8.6.1 and 12.8.6.2) shall be followed.

12. I 1 WOODEN SIDE SLIDING DOORS

12.11.1 Materials

12. 11.1.1 Rolled steel sections used in the manufacture of sliding doors shall be of weld able Quality and shall conform to 1S:2062-1984.

12.11.1..2 Track -The track shall be made of 2 mm thick structural steel sheet conforming to IS:2062-1984. The sheets may be galvanized to prevent corros10n.
A typical shape of the track is shown at Plate 12-P / 13.

12.11.1.3 Roller and Roller Guide - The material for the roller shall conform to Grade 15 of IS:210-1978. A typical four-roller trolley is shown in Plate 12-P /15, Figure 2. Bottom guide shall be made of gun metal conforming to 1S:318-1981 of rolled steel section. A typical bottom guide is shown at Plate 12-P/15, Figure 3.

12.11.1.4 Trolley Guide - Trolley guide shall be me of gun metal conforming to is:318-1981 and its shape shall conform to Figure 4 of Plate 12-P/15.

i 2. 11. 1.5 Bracket - Brackets used for holding the track shall be made of cast iron conforming to IS:210-1978. Sketches of typical shape of bracket are given at Figure 5 of Plate 12-P /15.

12.11.1.6 Door Shutters - Door shutters shell be made of wood end its construction shall be in accordance with para 12.5 and 12.7.

12.11.1.7 Wood screws used in the fixing of sliding doors shall conform to IS:451- 1972.

12.11.1.8 Hardware and ail screws, nuts, washers, bolts and rivets and other fastening devices used in the sliding doors shall be chromium plated or other rust proof mild steel, anodized aluminium or of stainless steel that has a chromium content of not less than 12 percent or other non-corrosive material as decided by the Engineer- in-charge.

12.11.2 Type and Size

12. 1 1.2. 1 The various components of door shall be defined as illustrated on Plate 12-P/13.

12. 1 1.2.2 Wooden side sliding doors shun be classified in accordance with the mode of sliding of panels into the frame unit as shown on Plate 12-P/14. The Plate (Types 1 to 5) shows typical economical arrangements of panels which give a clear opening, while if the full width is not required to be opened at anyone time, simple double track arrangements (Types 6 and 7) needing no space at the sides may be used. The overall size of the door shall be such as to cover completely modular openings as decided by the Engineer-in-charge.

12. 11.3 Construction and Workmanship

12.11.3.1 Frames - Frames shall be square and flat. Frames shall be constructed of rolled steel section. All joints shall be continuously welded or secured with spot or projection welded space plates to present a neat appearance and smooth functioning.

12.11.3. 1.1 Frame shall be provided with anchors as required for the adjoining wall structure, which shall consist of three 'T' - shaped adjustable anchors per jamb for masonry and three welded anchors per jamb for stud construction.

.

12.11.3.1.2 The track shall be fitted with the he1p of four brackets (See Figure 5 of Plate 12-P /15).

12.11.3.2 Door Assembly - The doors shall be so assembled as to have rigid well fitted joints. Joints or metal parts shall be by welding or by mechanical connectors. Sliding panels shall not be removable from the outside when in the closed and locked position. They shall be adjustable to fit well and to operate freely and smoothly, without binding or sticking against the frame members, so that when a panel is in motion it can be operated in either direction with a force not exceeding 3 kg per metre of panel width.

12.11.3.2.1 All channels in sill members shall be designed so that water will not be entrapped and that drainage is not directed into the space in the sill. Sill shall slope or step down at least 12 mm towards the exterior.

12.1 1.3.3 Sliding Bolts - Sliding bolts shall conform to IS:2661- 1979 as specified under para 12.3.3.3.1 (b), 12.3.3.3.2 (b) and 12.3.3.3.3 (b). These shall be securely attached to the 000r and shall be easily accessible from the ins1de.

12.11.3.4 Locks -Locks shall be strong and durable, and shall provide positive locking action. They shall be readily accessible for service. The lock design shall provide for vertical and horizontal adjustment. The bolt and strike shall be adjustable on the job and so designed that no damage will result if the door is closed with the unit in the locked position. Locks shall not lock automatically. When specified, locks shall be of the key operated cylinder type.

12.11.3.5 Rollers - Rollers shall be pre-lubricated or of self-lubricating type, designed to provide easy movement and adequate support to the panel without deformation or development of flat spots. Rollers shall operate on ball or roller bearings. The roller shall be readily replaceable and shall be adjustable for height.

12.11.4 Finish

All component parts of the door and gear assembly shall be machined and finished smooth to the correct dimensions. All component parts of the door frame shall be given one coat of red oxide priming paint. Roller guides, fittings for. locking arrangement, and bracket, etc, may be hot dip galvanized.

12.12 WIRE GAUGE FLY PROOF SHUTTERS

12.12.1 Materials

Suitable timber species of specifications given under para 12.3.1 shall be used. Wire gauge shall, unless otherwise specified, be of galvanized mild steel wire and IS gauge designation 85G with wire of diameter 0.56 mm.

12.12.2 Construction and Workmanship

The stiles and rails of specification described under para 12.5.2.3 shall be given a rebate to receive wire gauge which shall form the panel. The wire gauge shall be bent at right angles and shall be securely housed in the rebate of stiles and rails, turned back, and fixed right with staples at interval of about 75 mm centre to centre fixed 81ternatively in the two faces of the rebates. Over this wooden beading shall be fixed with nails or small screws at about 75 mm centres to cover the rebate fully. The space between the beading and rebate, where the wire gauge is bent, shall be neatly finished with putty so that the end of wire gauge may not be visible.

12. 12.3 Fittings

Iron fittings, wooden cleats, door stapel or eyes and hooks including spring hinges, tower bolts and handles shall be provided as specified. The number of hinges and their location shall be as given in para 12.5.4. 1.

12.13 VENETIAN BLINDS OR LOUVERS FOR WINDOWS

12.13.1 Materials

12.13.1.1 Timber - Suitable timber species of specification given under para 12.3. I shall be used.

12.13.1.2 Metal

12. 13. 1.2. 1 Aluminium alloy used for rolling of slats shall conform to NS 4 of IS:737-1986. Sheet and strip shall have the following properties:

Hardness	Zero
Ultimate tensile strength	17.3 to 22 kg/cm2
Elongation	18 percent, Min

12.13.1.2.2 All hardware including pulleys, guide channels and other fittings, unless otherwise specified, shall be of corrosion-resistant materials, if made of steel the hardware shall be hot galvanized. All screws used for mounting hardware and installation of blinds and guide channels shall be of brass suitably electroplated.

12.13.3 Sizes

12.13.3.1 The size of a Venetian blind shall be defined by the width (length) and the height (drop) of the blind as ordered for the position of fixing (see para 12.1~.3.2 and Plate 12-P/17).

12.13.3.2 The size of a Venetian blind shall depend upon the method of fixing.
Venetian blinds may be fixed in anyone of the three positions indicated on Plate 12-P /17. Depending upon the method of fixing, the size shall be as defined for each position and each individual Venetian blind shall be made to the required size of the corresponding window or opening.

12.13.3.3 Maximum Sizes of Venetian Blinds.

12.13.3.3.1 Venetian blinds of Grade 1 shall not exceed 500 cm In width and 10 m^2 in area.

,

12.13.3.3.2 Venetian blinds of Grade 2 shall not exceed 275 cm in width and 7.5 m^2 in area.

12.13.4 Construction

12.13.4.1 Components - Components of Venetian blinds shall be as specified in 12.13.4.2 to 12.13.4.14.

12.13.4.2 Installation Brackets

12.13.4.2.1 The installation brackets (see figure A & B of Plate 12.-P /18) shall be of such design as to provide a minimum back clearance of 16 mm to the blind.
They shall have a provision to hold the facia board in position and in a manner that would facilitate the easy removal and refixing of the facia boards.

12.13.4.2.2 The installation brackets shall be of sufficient strength to support the weight of the entire Venetian blind and shall be so designed as to install the blind in any of the positions as specified in 12.13.3.2.

12. 13.4.3 Tilt Rail, Bottom Rail and Top Rail

12.13.4.3. Material - Tilt, bottom and top rails for both the grades of blinds shall be made from any of the timbers specified in 12.3. 1.

12.13.1.3.2 Sizes

(a) Tilt rails shall be 50±1 mm wide and 20±1 mm thick (see figure C of Plate 12-P/18).

(b) Bottom rails for blinds of Grade 1 and for blinds of Grade 2 up to a width of 250 cm shall be 50±1 mm wide and 20±1 mm thick for blinds of Grade 2 exceeding 250 cm in width, the thickness of the rail shall be increased to 25 mm (see figure D of Plate 12-P /18).

(c) Top rails, wherever required, shall be 62±1 mm wide and 22±1 mm thick (see Figure E of Plate' 2-P /18).

12.13.4.3.3 The rails shall be free of twist and shall be reasonably straight.

12.13.4.4 Slats

12.13.4.4.1 Wooden slots shall be made from the timbers specified in 12.3.1.
Wooden slats shall be reasonably flat and be free from twist and cup or bow in width.
The slat shall be held at ends on a base board at an angle of 85° to the horizontal and the slat shall not be clear of the base board by more than 1/500th of the width of the slat.

12.13.4.4.2 Aluminium slats shall be of convex. M or S shape and shall be made from aluminium alloy of Quality specified in 12. 13. 1.2. 1.
12.13.4.4.3 sizes

(a) Wooden slats shall be 48±0.5 mm while and 2.5±0.3 mm thick (see Figure F of Plate 12-P /18).

(b) Aluminium slats shall be 48±0.5 m wide when formed. The thickness of coated aluminium slats shall be 0.254 to 0.315 mm with a tolerance of 0.004 mm (see Figure A of Plate 12-P /19).

12.13.4.4.4 The number of slats per blind of different heights (drops) shall be as shown in Table-22 below:

TABLE-22 NUMBER OF SLATS FOR BLIND OF DIFFERENT HEIGHTS (DROPS)

Height (Drop) (1)	Total No. of Slats (2)	Height (Drop) (1)	Total No. of Slats (2)	Height (Drop) (1)	Total No. of Slats (2)	Height (Drop) (1)	Total No. of Slats (2)
30	4	32.5	5	35	6	37.5	6
40	7	42.5	8	45	8	47.5	9
50	10	52.5	10	55	11	57.5	12
60	12	62.5	13	65	13	67.5	14
70	14	72.5	15	75	16	77.5	16
80	17	82.5	17	85	18	87.5	19
90	20	92.5	20	95	21	97.5	21
100	22	102.5	22	105	23	107.5 2	4
110	24	112.5	25	115	26	117.5	26
120	27	122.5	27	125	28	127.5	29
130	30	132.5	30	135	31	137.5	31
140	32	142.5	32	145 33	147.5	33	
150	34	152.5	35	155	35	157.5	36
160	37	162.5	37	165	38	167.5	39
170	39	172.5	40	175	41	177.5	42
180	42	182.5	42	185	43	187.5	44
190	44	192.5	45	195	45	197.5	46
200	47	202.5	48	205	49	201.5	49
210	49	212.5	50	215	50	217.5	51
220	51	222.5	52	225	52	227.5	53
230	54	232.5	54	235	55	237.5	56
240	56	242.5	57	245 58	247.5	58	
250	59	252.5	59	255	60	257.5	61
260	61	262.5	62	265	63	267.5	63

270	64	272.5	64	275	65	277.5	66
280	66	282.5	67	285	67	287.5	68
290	69	292.5	69	295	70	297.5	71
300	71	302.5	72	305	72	307.5	73
310	74	312.5	74	315	75	317.5	75
320	76	322.5	77	325	78	327.5	78
330	79	332.5	79	335	80	337.5	80
340	81	342.5	82	345	82	347.5	83
350	84	352.5	85	355	85	357.5	86
360	86						

12.13.4.5 Route Holes

12.13.4.5.1 Route holes in the slats for the passage of l1fting cord shall conform to the size and shape shown in Figure B of Plate 12-P/19. The route holes shall be clean-cut with All edges free from burrs.

12.13.4.5.2 Route holes in top, tilt and bottom rails shall be of sufficiently large size to accommodate the pulley and provide for free passage of lifting cords.

12.13.4.6 Ladder Web

12.13.4.6.1 The face and cross tapes shall be made of high grade cotton or synthetic yarn. Yarn shall be clean and free from motes.

12.13.4.6.2 Construction - The ladder web shall consist of two vertical tapes with cross tapes placed w1thin them. The edges of the cross tapes shall be interwoven in the back of the face tapes to form ladders 50 mm long (see Figure C of Plate 12-P 119).

12.13.4.6.3 The successive ladders shall be placed on alternate sides at 40 mm 1:
0.5 mm centres to permit 10 mm overlap of the slats. The cross tapes shall be interwoven at a minimum distance of 3 mm from the edge of the tapes and Shall on each side be in a straight line one over the other (see Figure C of Plate 12-P 119).

12.13.4.6.4 The ladder webs shall be so spaced in a Venetian blind as not to exceed 75 cm between centres. The number of ladder webs per blind of different widths shall be as shown 1n F1gure A to F of Plate 12-P /20.

12.13.4.7 Tilting Device - The tilting device shall be of synchronized worm and gear design capable of lifting the blind including the slats from one extreme to the other. It shall allow slats to be changed from horizontal plane to vertical plane when tilted both frontward and backward. The tilting operation shall be smooth and positive.

12.13.4.7.1 Where tilting device is of a type in which the tilting cord is locked to the tilting pulley to provide a positive pull, the minimum gear ratio shall be 7:1.

12.13.4.7.2 In other cases, the tilting device shall have a self-adjusting clutch mechanism for maintaining the level of the tilting cord, the cord having limit beads attached at its two ends to avoid its slipping beyond a given height and the pul1ey carrying the tilt cord shall be so designed and finished that there is no undue wear on the tilt cord. The minimum gear ratio in such a type of tilter shall be 17: I.

12.13.4.8 Cord Lock - The blind shall be provided with automatic cord lock (see Figure D of Plate 1 2- P /1 9) so designed that it wi1l hold the blind at any desired height without the need for fastening the lifting cords on hooks. The cord lock shall lock both the ends of the lifting cord simultaneously without stoppage and with a single pull of the lifting cords. The cord lock shall be so mounted that the lifting cords can be operated without interference and without undue wear and tear.

12.13.4.9 Tilling and Lifting Cords

12.13.4.9.1 The cords shall be made of good quality cotton yard or a combination of cotton and rayon or of nylon yarn.

12.13.4.9.2 The cords shall be of sufficient length for convenient and efficient use.

12.13.4.9.3 Cords shall be attached in a neat and secure manner and shall be easily detachable and replaceable. Unless otherwise indicated, the tilting cords shall be near the end of the left side of the blind and the lifting cords shall be near the end of the right side of the blind.

12.13.4.9.4 Cords shall be No. 4 1/2, hollow or filled, uniformly braided and of smooth finish to minimize wear, stretch and abrasion. Cord No.4 1/2 shall be 3.5:1: 0:4 mm in diameter.

12.13.4.10 Cord Equalizer -The lifting cord of each blind shall be provided with a cord equalizer (see Figure E of Plate 12-P /19) for maintaining equal pull on both the ends of the cord.

12.13.4.11 Pulleys

12.13.4.11.1 The pulleys shall be made of a suitable material, that is, strong and hard and which needs no oiling.

12.13.4.11.2 Multi-lift blinds shall have ball-bearing pulleys on the bottom rail.

12.13.4. 12 Centre Supports

12.13.4. 12. 1 Tilt Rail Supports - Every blind over 90 cm in width shall have one tilt rail centre support for the tilt rail; and for each additional width of 75 cm, an additional centre support as shown in Figure A to F of Plate 12-P/20 shall be provided. '

12.13.4.12.2 Installation Supports - There shall also be provided installation centre support brackets of a design and shape as to allow for ample safety factor and to prevent sagging of the blind.

(a) Every blind without top ran shall be provided with equal number of installation centre supports of a suitable design as the tilt rail centre supports and shall be suitably attached to the same.

(b) Every blind with top ran but 135 cm and over in width shall be provided with installation centre supports for every additional width of 90 cm suitably attached to the top rail.

(c) The installation centre supports shall be screwed to the back wan or the ceiling as may be found convenient

(d) The installation centre supports shall be so designed as to hold the facia board in line.

12.13.4.13 Side Guide Channels - Wherever specially ordered, blinds shall be provided with side guide channels (see Figure F of Plate 12-P/19). The side guide channels shall consist of guide rails and slat-end clips (see figure e of P18te 12-PI19), and wherever required, wooden battens. The guide rails shall permit free up and down movement of the slats without allowing undue play of the slat-end clips. The slat-end clips shall be of nylon stainless steel or equivalent non-rusting material; and shall be of a design that will hold the slats firmly without damaging or deforming them. The slat-end clips shall be removable easily. One slat-end clip shall be provided for each alternate slat at opposite ends.

12.13.4.14 Fascia Boards (Pelmets) - Fascia board (see figure H of Plate I 2-P /, 9) shall be of wood, metal or plastic of sufficient width and thickness to fit the installation bracket, and shall be of the colour matching the blind, unless otherwise specified.

12.13.4.15 General

12.13.4.15.1 Venetian blinds shall be generally assembled as shown in Figure 1 of PIate 12-P/16. .

12.13.4.15.2 The route holes In the top ran and/or tilt rail, slats and bottom rail shall match each other so that they are centred correctly in relation to each other and the width of the blind

12.13.4.15.3 The ladder webs shall be centred equidistant from the ends of the blind and from each other.

12.13.4.15.4 The slats after assembly shall be parallel to each other in horizontal position.

12.13.5 Installation

12.13.5.1 All blinds shall be secured to their proper places with screws conforming to 15:451-1972 and all work shall be performed in a workmanlike manner. Installation brackets and installation centre supports shall be fixed in a workmanlike manner. If installed on wood, 2.5 cm No.8 screws or Larger size may be used. If installed on masonry, plaster, brick. Cement blocks or tile, drill a neat hole 2.5 cm deep by using a No.8 drill, insert a fibre or plastic plug or lead shield and use 2.5 cm No.8 screw or larger as in wood.

12. 13.5.2 Nails shall. not be used in the installation of brackets and centre supports.

12.13.6 Finish

12.13.6.1 Aluminium Slats - The aluminium slats shall be given a pretreatment to provide a permanent bond between the aluminium and the finishing paint and then given suitable coats of primer and upper coats of paint which shall be high gloss and of a baked enamel type. -

12. 13.6.2 Wooden Slats and Rails - The wooden slats and rails shall be sanded smooth before painting. For finishing wooden slats and rails, one coat of sealer, one coat of primer-surfacer, putty and two coats of paint shall be applied.
The paint used shall be semi-gloss good quality enamel or Cellulose paint

12. 13.6.3 The final paint finished surface shall be smooth and even.

12.14 PLAIN GLASS LOUVERS

12. 14. 1 Material

12.14.1.1 The sheet glass shall conform to specifications laid down under para 12.3.2.6. The glass shall be transparent end reasonably free from blisters, stones, scratches and bubbles so as to give a clear 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 sqm and shall be fairly uniformly distributed.
Bubbles(blisters) below 2 mm need not be considered. The sheet glass shall not show any distortion of Light from its parallel nature. The cut sizes of sheet glass shall be within the following tolerances 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

12.14.2 Workmanship

The panel space shall be fitted with the plain glass louvers which shall be 3 mm thick unless otherwise specified. The width of each louver blade shall be as specified. These louvers shall be fixed in grooves or rebates, which shall be rigid and true, of at least 10 mm depth made in the stiles unless otherwise specified by the Engineer-in-charge. The minimum 2.50 mm clearance shall be allowed between the edge of the glass and the wood surrounds. The clearance may be increased, provided the depth of rebate or groove is sufficient to provide not less than 1.50 mm cover to the glass. The detai1ed process of glazing shall be as specified In 15:3548- 1988. All stains from the surface of the glass shall be removed and cleaned with thinner or spirit. The glazed louvers shall slope down towards the outside at an angle of 458 and at 80 mm clear spacing as shown in the drawing. These shall be fixed in grooves cut into the frame. Wooden beads shall be screwed to the frame to prevent removal of louvers. The size of wood bead for glass panes not exceed1ng 0.50 Sqm in area and hav1ng thickness upto 4 mm shall be 1 cm x 2 cm., while for glass panes having thickness more than 4 mm, its size shall be 1.50 cm x 3 cm. Beads shall be secured to wooden frames with either panel pins or screws to prevent removal of louvers. In securing to wooden frames an adequate number of nx1ng for the beads shall be used. Sufficient putty shall be applied to the rebate so that when the glass has been pressed into the rebate a bed of putty not less than 1.50 mm thick will remain between the glass and the rebate. Beads shall also be bedded with the putty against the glass and wood, bead shall also be bedded against the rebate. Care shall be taken to see that no voids are left between the glass and bead.

12. 15 TRELLIS (JAFREE) WORK

12.15.1 Materials

12.15.1.1 Timber - Suitable timber species of specification of para 12.3.1 shall be used.

12.15.1.2 Plain Trellis (Jafree) - This shall consist of specified wooden strips or laths 25 x 12 mm /50 x 12 mm section unless otherwise specified, planed and nailed together at every alternate crossing. The strips shall cross each other at right angle and shall be spaced 50 mm apart, so as to form 50 mm x 50 mm sqU8re opening. The change in the spacing may also be permitted by the Engineer-in-charge so as to form other Square openings as desired.

12.15.1.3 Half Round Bamboo Strips -Half round bamboo strips shall be made out of best quality hard bamboos of 40 mm to 50 mm die. These strips shall be dressed to give a neat appearance and shall be of uniform width of 35 mm to 40 mm.

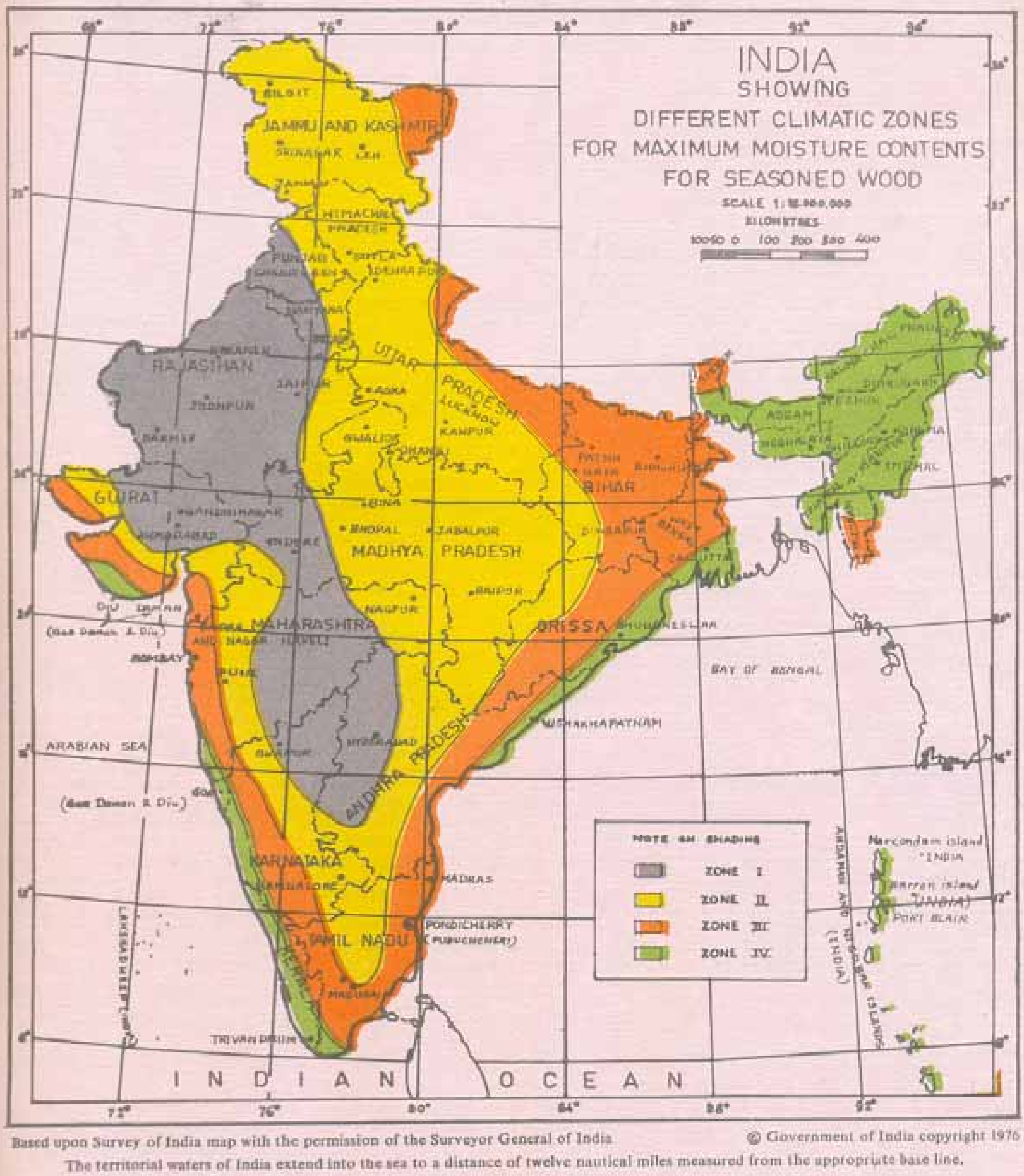
12. 15.2 Construction

12.15.2.1 With Plain Trellis -Shutter frame shall consist of two stiles and top, Jock and bottom rails each of specified section. The stiles and rails shall be properly mortised and tenoned. The tenons shall pass through the stiles for at least 3/4th of the width of the stile. Shutter frame shall be assembled and approved by the Engineer-in-charge before Joining. The joints shall be pressed and secured by bamboo pins of about 6 mm diameter. To this frame plain trellis (Jafree) work as described in 12. 15. 1.2 shall be fixed with nails. To cover the ends of strips, 50 x 12 mm beading shall be fixed to the frame with screws. The tolerance permitted for the finished work shall be ±1 mm. The fittings, wooden cleats, and blocks shall be provided as specified by the Engineer-in-charge.

12.15.2.2 With Half Round Bamboos - The bamboo strips made as per para 12. 15. 1.3 shall be f1xed to wooden frames at a clear distance of 50 mm so as to form uniform square opening of 50 mm x 50 mm. The strips shall be nailed to the frame at alternate crossings. The work shall be finished by 40 mm wide beading of bamboo str1p fixed around the ~ of the work to cover the ends of trellis work.

APPENDIX - I

DIFFERENT CLIMATIC ZONES FOR MAXIMUM MOISTURE CONTENTS FOR SEASONED WOOD



Based upon Survey of India map with the permission of the Surveyor General of India

The territorial waters of India extend into the sea to a distance of twelve nautical miles measured from the appropriate base line.

The boundary of Meghalaya shown on this map is as interpreted from the North-Eastern Area (Reorganisation) Act, 1971, but has yet to be verified.

NOTE — Lakshadweep (India) fall under zone IV.

APPENDIX - II

SPECIES OF TIMBER SUITABLE FOR THE MANUFACTURE OF FLUSH DOOR SHUTTERS

Group 1 Species Suitable for Core and Cross-Band Only

Sl. No.	Standard Trade Name	Abbreviated Symbol
1.	Alder	ALD
2.	Chatian	CHT
3.	Chir	CHR
4.	Cypress	CYP
5.	Debdaru(Nedunar)	DEB
6.	Deodar	DEO
7.	Fir	FIR
8.	Gendelipoma	GEN
9.	Gokul	GOK
10.	Jathikal	JAT
11.	Kadam	KAD
12.	Kail	KAL
13.	Kattucheru	KCH
14.	Lampati	LAP
15.	Maharukh	MAH
16.	Mahogany	MAG
17.	Maina *	MAI
18.	Makai	MAK
19.	Malabar Neem	MNE
20.	Narikel	NAR
21.	Red Dhup	RDH
22.	Rudrak.	RUD
23.	Salai	SAA
24.	Siris	SIR
25.	Spruce	SPR
26.	Tanaku	TAN
27.	Toon	TOO
28.	Vatica	VAT
29.	White Dhup	WDH

Group-2 Species Suitable for Frame, Core and Cross Band

Sl. No.	Standard Trade Name	Abbreviated Symbol
1.	Aini	AIN
2.	Arjun	ARJ
3.	Bahera *	BAH
4.	Birch	BIR
5	Bonsum	BON

6.	Carallia (Maniawga)	CAR
7.	Champ	CHM
8	Chap lash	CHP
9.	Chickrassy	CHI
10.	Chilauni	CIL
11.	Cinnamon	CIN
12.	Debdaru (Nedunal) *	DEB
13.	Devdam	DEV
14.	Dillenia	DIL
15.	Dipika{ Lapse)	DIP
16.	Ebony	EBO
17.	Gamari	GAM
18.	Garcinia	GAR
19.	Gujan	GUR
20.	Haldu	HAL
21.	Hathipaila	HAT
22.	Hollock	HOL
23.	Hollong	HON
24.	Jaman	JAM
25.	Jathikai	JAT
26.	Jhingan	JHI
27.	Kaim	KAI
28.	Kala-Siris	KSI
29.	Kanju	KAN
30.	Karani *	KAR
31.	Kathal	KAT
32.	Kindal	KJN
33.	Kokko	KOK
34.	Lakooch	LAK
35.	Lampati	LAP
36.	Laurel.	LAU
37.	Machilus	MAC
38.	Mango	MAN
39.	Maple	MAP
40.	Mulillam	MUI
41.	Mundani *	MUN
42.	Padauk	PAA
43.	Pail	PAL
44.	Piney *	PIN
45.	Poon	POO
46.	Pussur	PUS
47.	Pyinma	PYI
48.	Red Bombwe	RBO
49.	Rosewood	RS
50.	Safed-Siris	SSI
51.	Silver Oak	SOA
52.	Sissoo	SIS
53.	Teak	TEA
54.	Toon	TOO
55.	Vellapine *	VEL
56.	Walnut	WAL

57.	White Bombwe	WBO
58.	.White Cedar	WCE
59.	White Chuglam	ECH
60.	White Dhup	WDH
61.	Ywegi	YWE

NOTE - The suitability of timber for stiles,- rails and lippings is normally based on the screw holding properties of timber. However, in the absence of detailed data relating to screw holding properties of all the species. the Classification as given in Group 2 is based on both the density of the species and the data relating to screw holding properties as available for some of the species.

PLATE 12-P/1

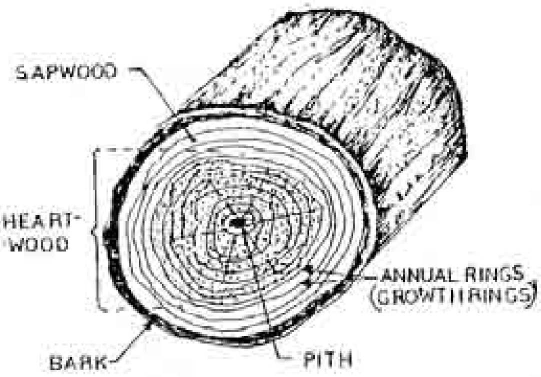


FIG. 1 CROSS SECTION OF LOG

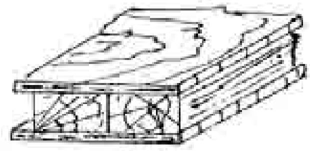


FIG. 2 BATTEN BOARD

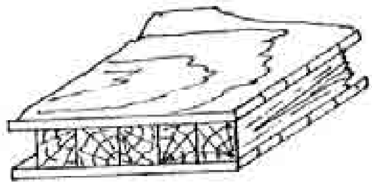


FIG. 3 BLOCK BOARD

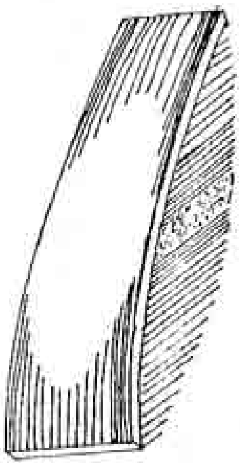


FIG. 4 BOW

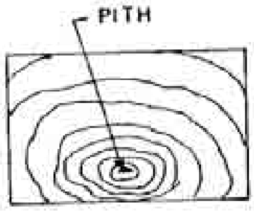


FIG. 5 BOXED HEART

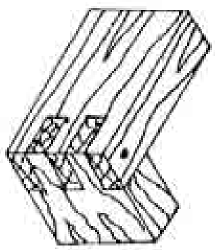


FIG. 6 COMBED JOINT

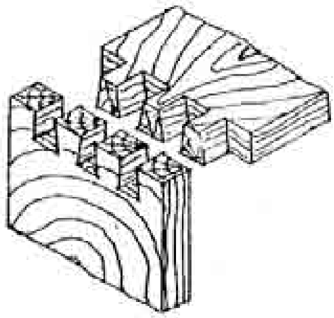


FIG. 7 DOVETAIL JOINT

FIG.8 BUTT JOINT

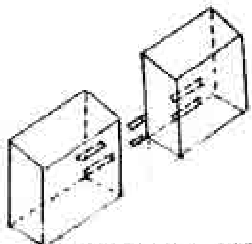


FIG.9 DOWEL JOINT

PLATE 12-P/2

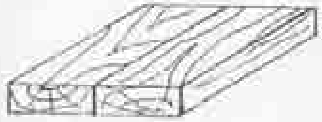


FIG. 1 EDGE JOINT

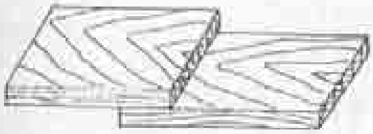


FIG. 2 LAP JOINT

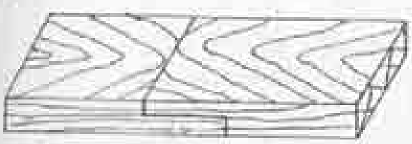


FIG. 3 HALVED JOINT

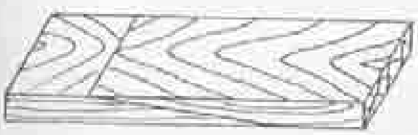


FIG. 4 SCARF JOINT

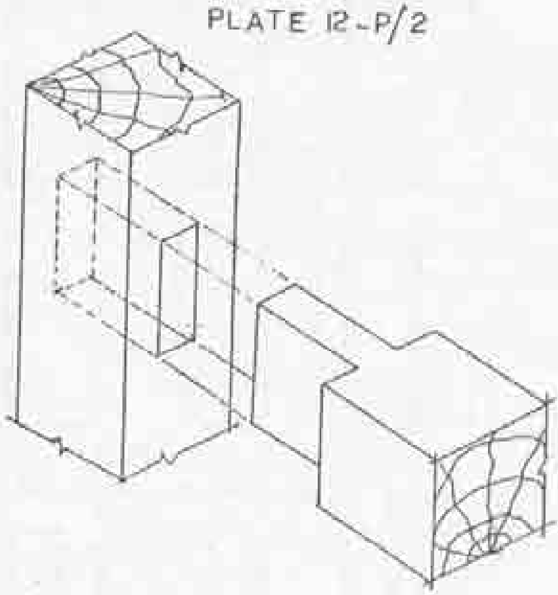


FIG. 5 MORTISE AND TENON JOINT

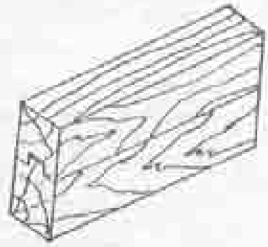


FIG. 6 TONGUE AND GROOVE JOINT

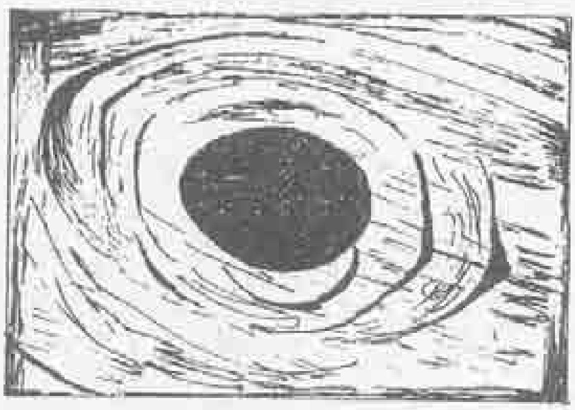
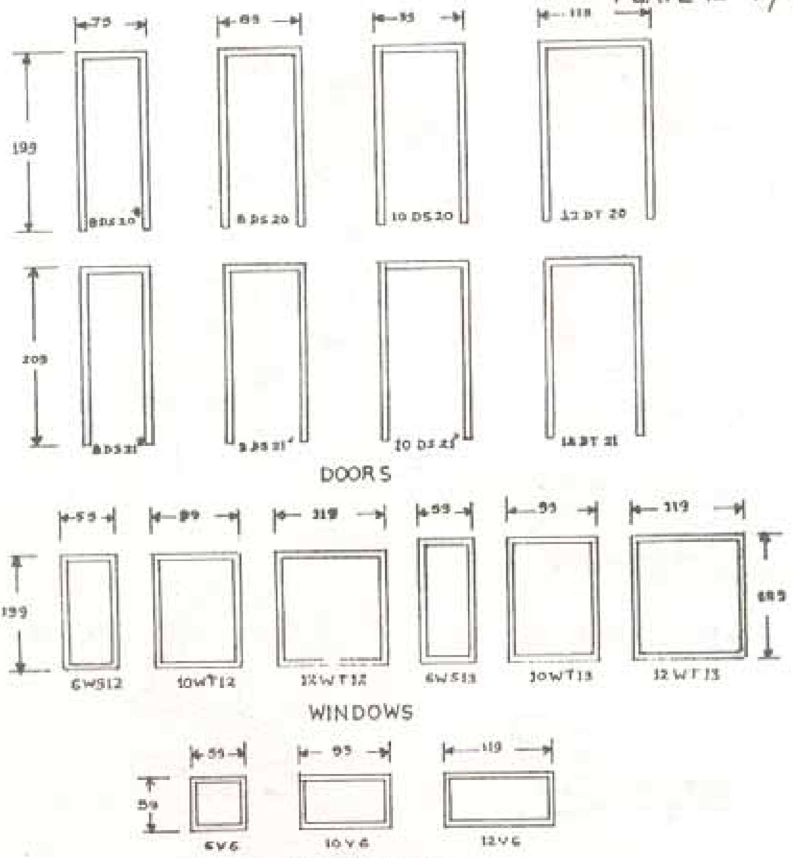


FIG. 7 KNOT

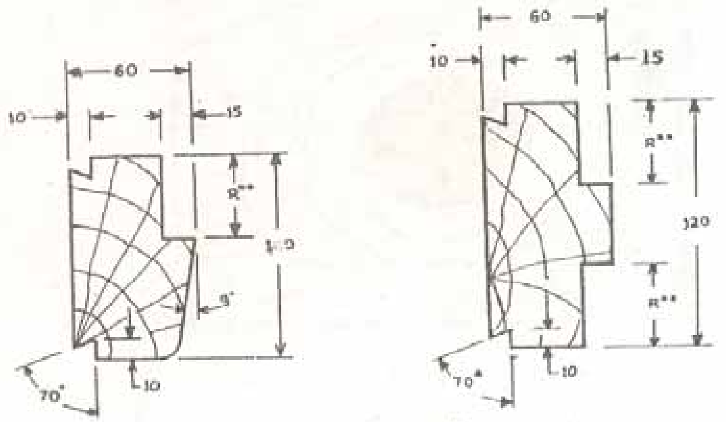
PLATE 12 - P/3



*PREFERRED SIZES

ALL DIMENSIONS IN CENTIMETRES.

FIG. 1 TYPE AND SIZE OF FRAME OF TIMBER DOORS, WINDOWS AND VENTILATORS



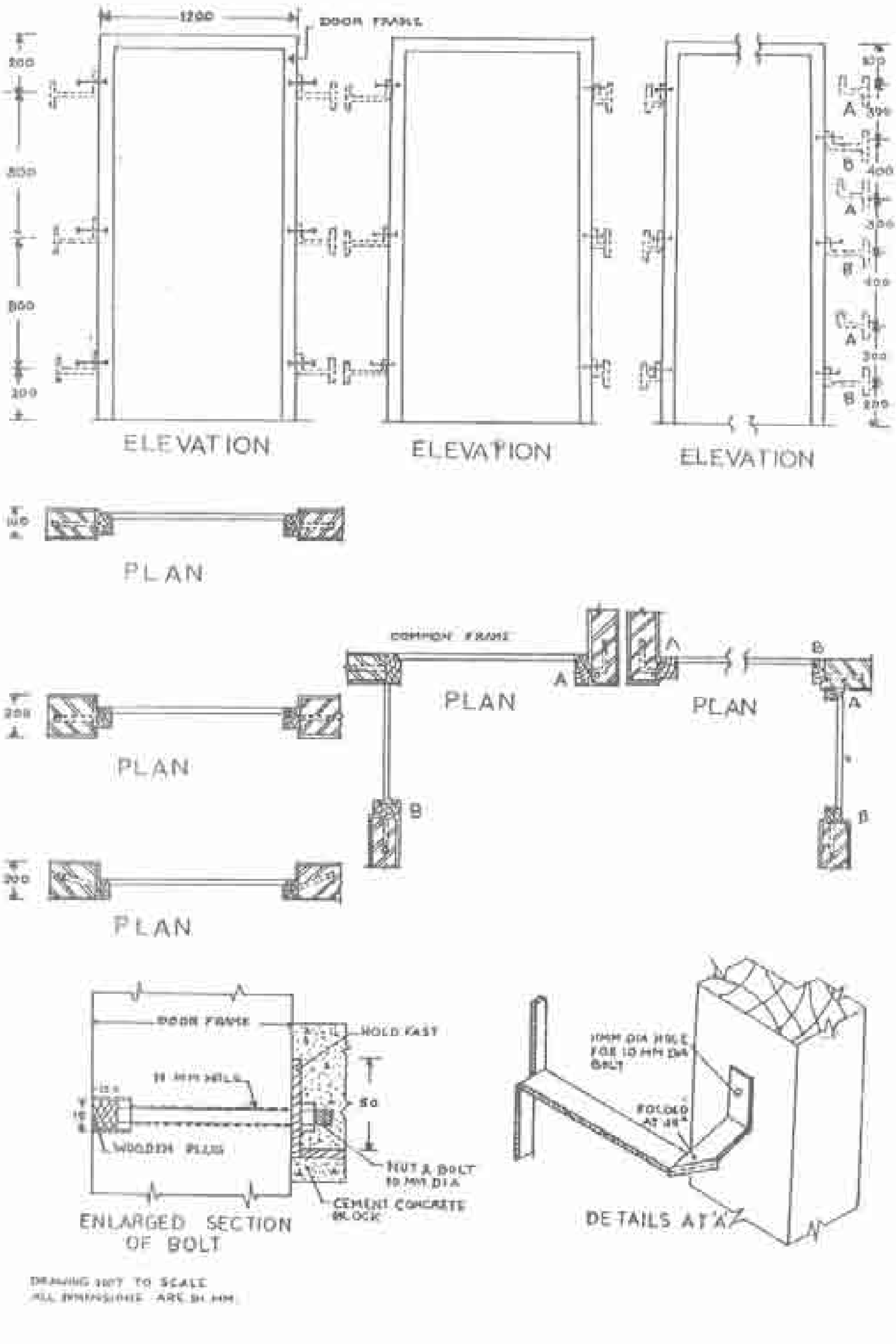
R** 25, 30, 35, or 40

ALL DIMENSIONS IN MILLIMETRES

FIG. 2 TYPICAL SECTIONS OF DOOR WINDOW AND VENTILATOR FRAME

PLATE 12-P/4

ARRANGEMENT OF HOLDFASTS



DRAWING NOT TO SCALE
ALL DIMENSIONS ARE IN MM

PLATE 12-P/5

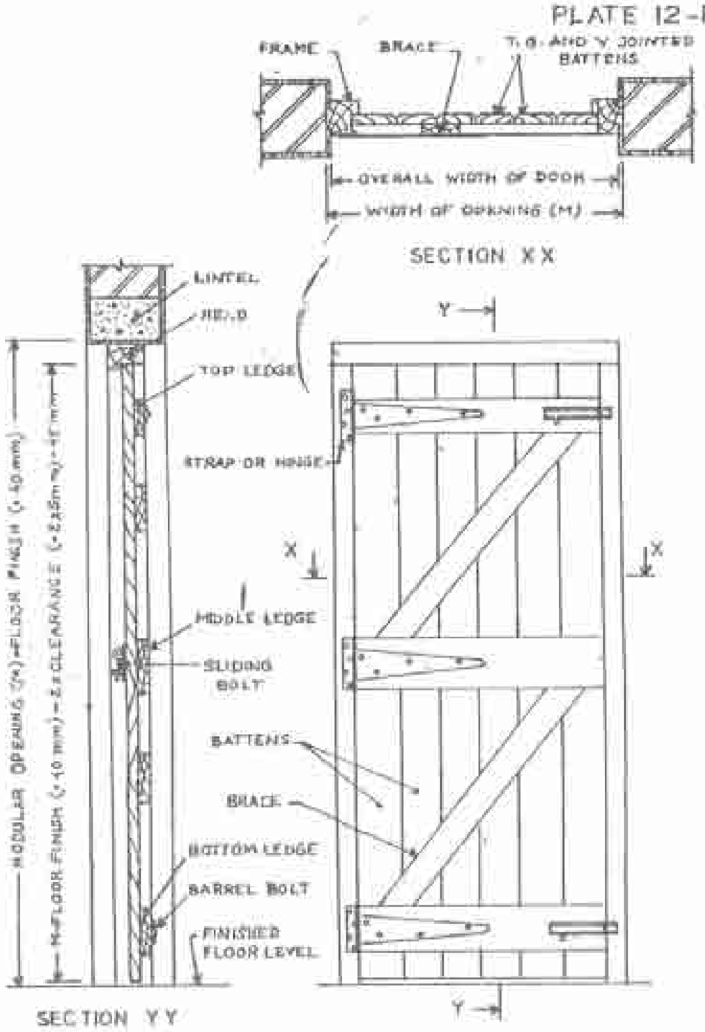
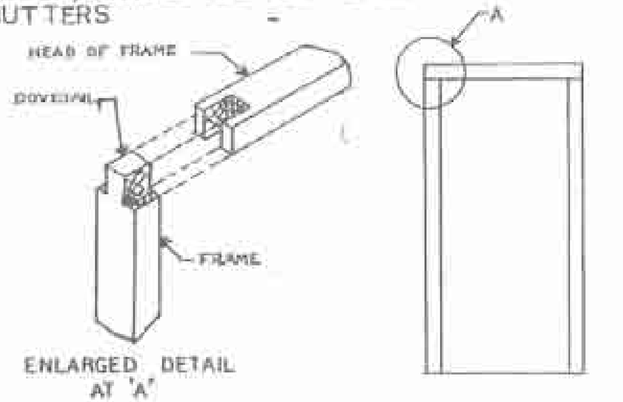


FIG. 1 LEDGED, BRACED AND BATTENED TIMBER DOOR SHUTTERS



G. 2 TYPICAL JOINERY FOR DOOR, WINDOW AND VENTILATOR FRAME

PLATE 12-P/6

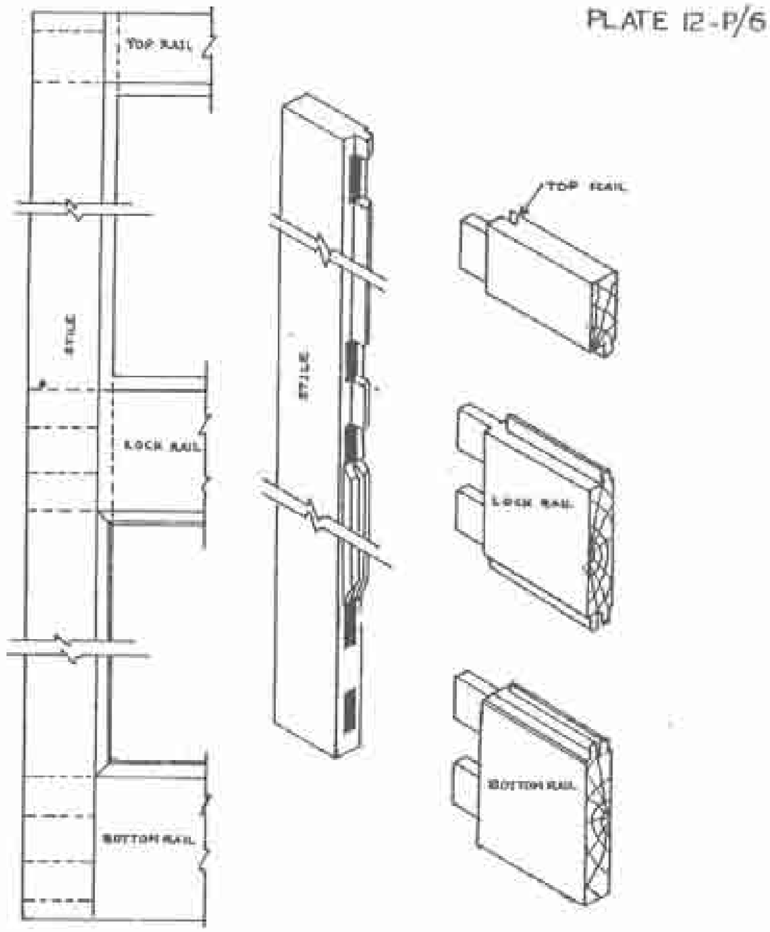


FIG. 1 DETAILS OF TYPICAL JOINERY BETWEEN RAILS AND STILES

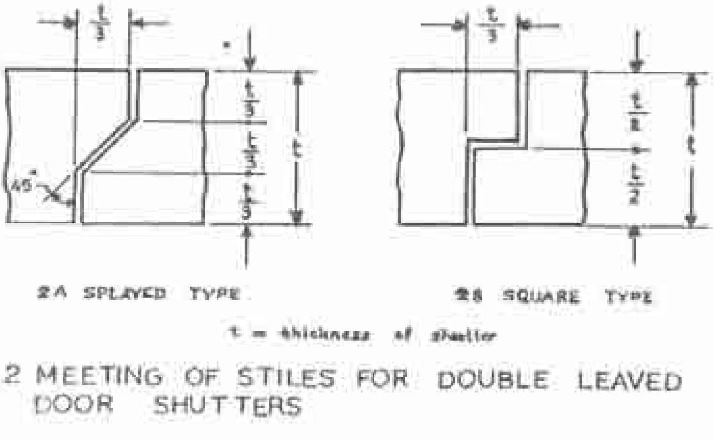


FIG. 2 MEETING OF STILES FOR DOUBLE LEAVED DOOR SHUTTERS

PLATE 12-P/7

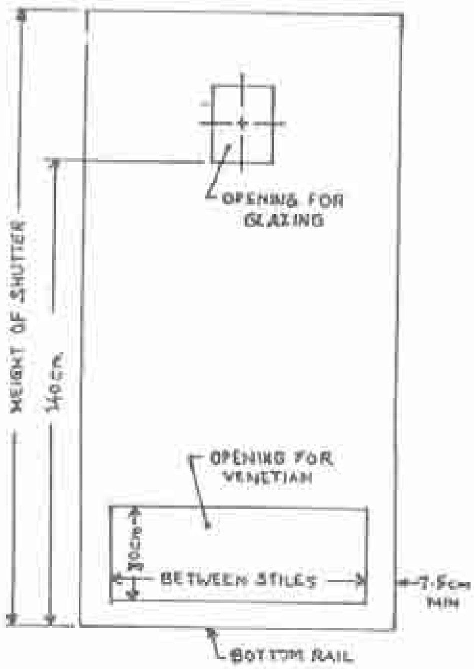
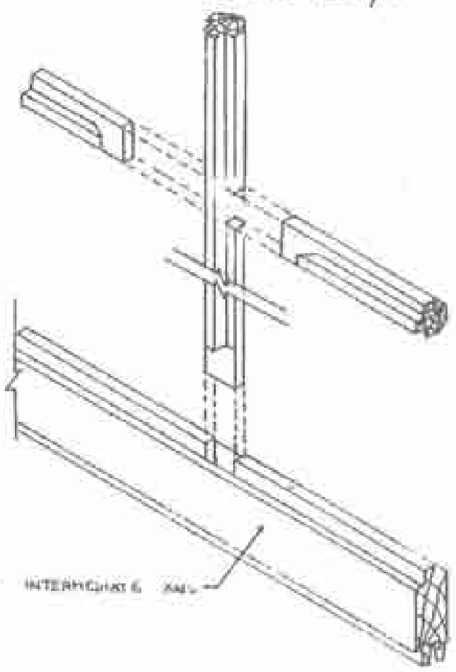


FIG. 1 TYPICAL LOCATION OF OPENING FOR GLAZING AND VENETIAN



3A JOINERY DETAILS FOR GLAZING BARS

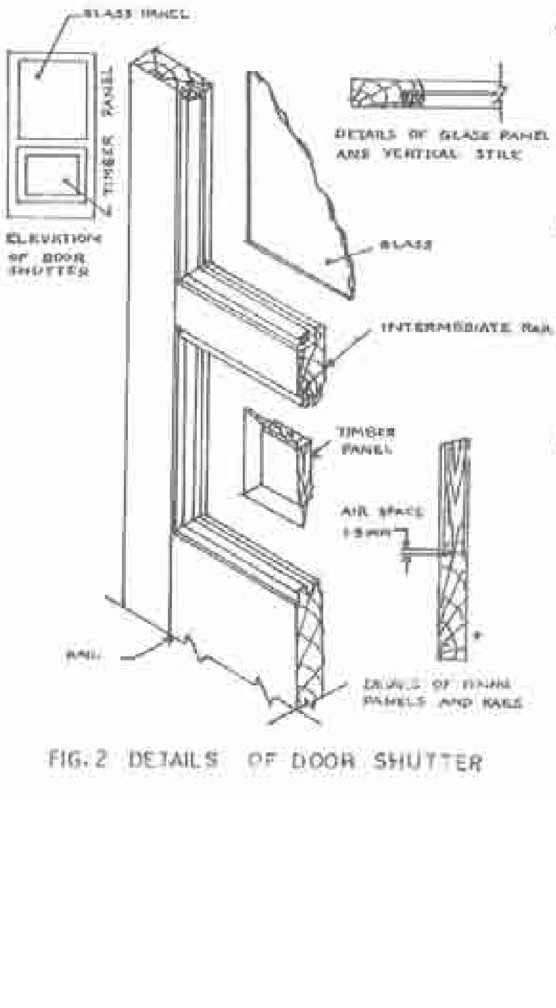
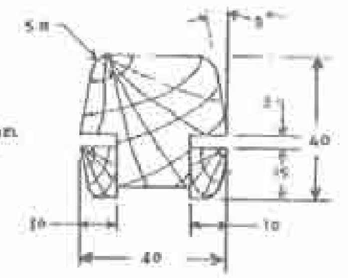


FIG. 2 DETAILS OF DOOR SHUTTER

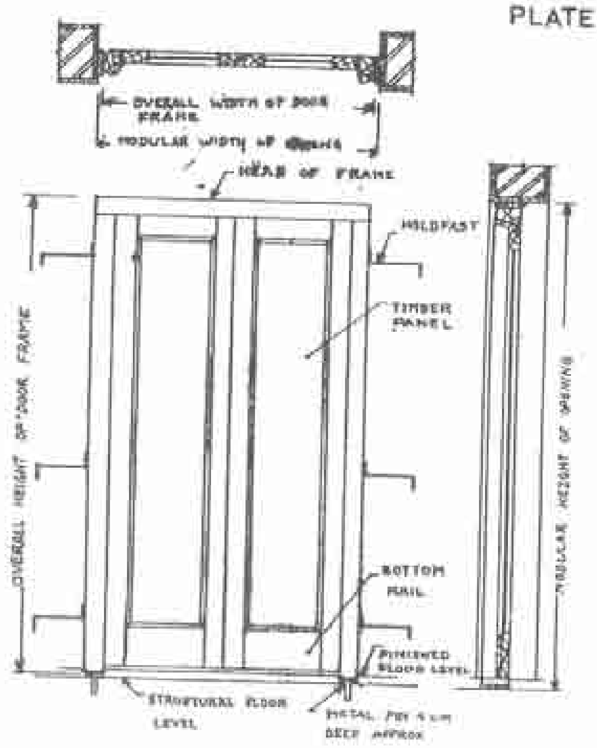


3B SASH BAR DETAILS

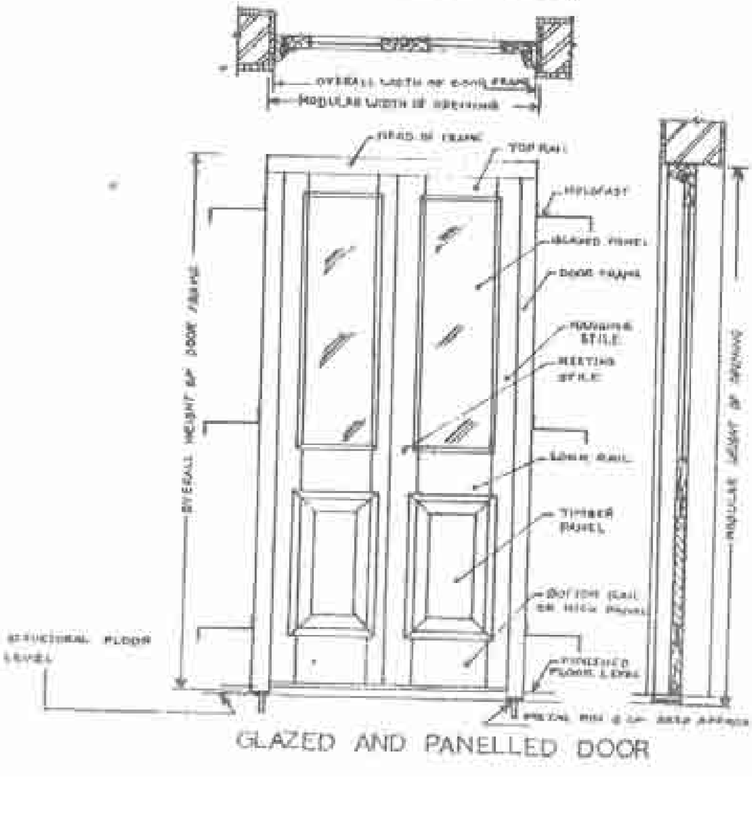
ALL DIMENSIONS IN MILLIMETRES

FIG. 3 GLAZING BARS AND SASH BAR

PLATE 12-P/B

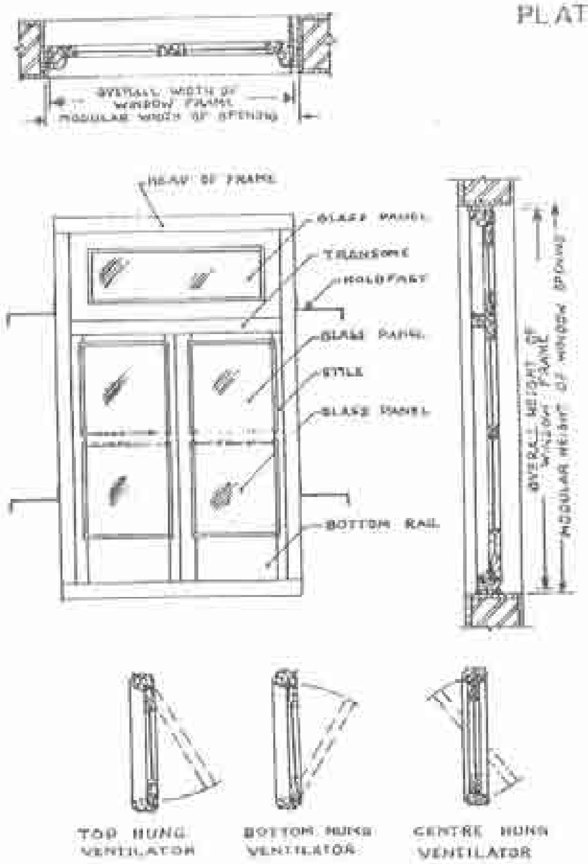


SINGLE PANELLED DOOR

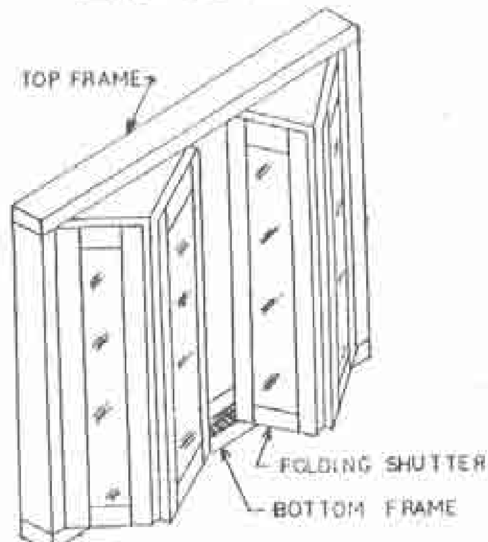


GLAZED AND PANELLED DOOR

PLATE 12-P/9



WINDOW AND VENTILATORS



WINDOW WITH FOLDING SHUTTER

TERMINOLOGY FOR TIMBER WINDOW AND VENTILATORS

PLATE 12-P/10

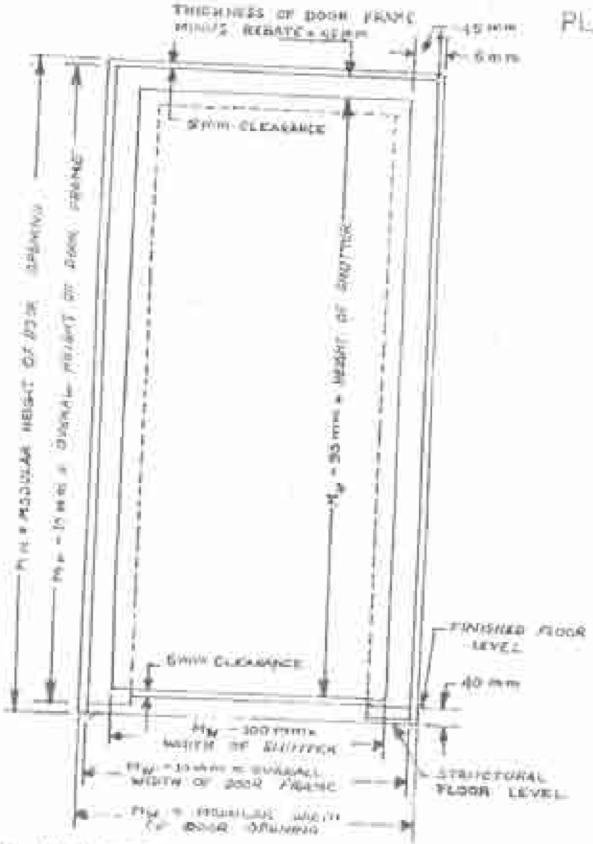


FIG.1 SKETCH ILLUSTRATING DIMENSIONS OF SHUTTER

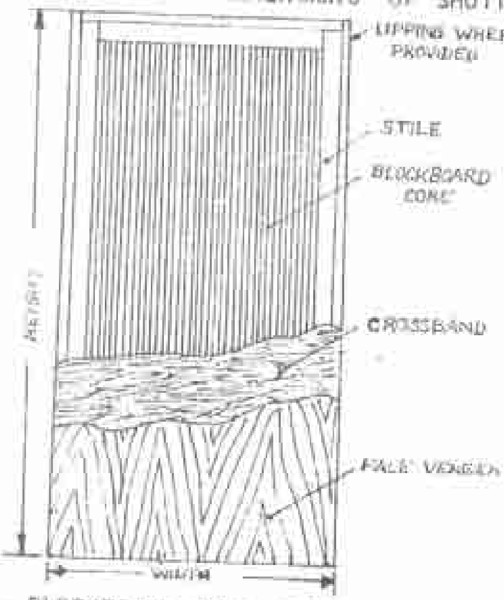


FIG. 2 TYPICAL BLOCKBOARD CORE FLUSH DOOR SHUTTER (WIDTH AND HEIGHT IN ACCORDANCE WITH PARA ~~12-9-4-1~~ 12·5·3·3)

PLATE 12-P/11

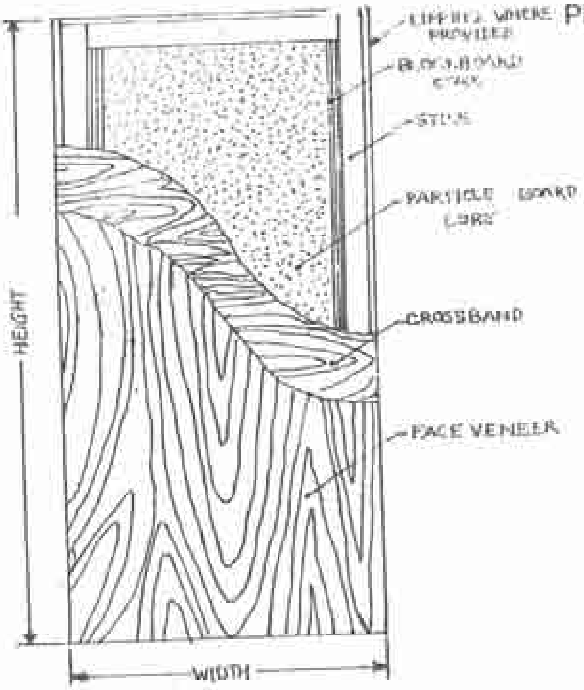


FIG. 1 TYPICAL PARTICLE BOARD AND BLOCKBOARD CORE FLUSH DOOR SHUTTER

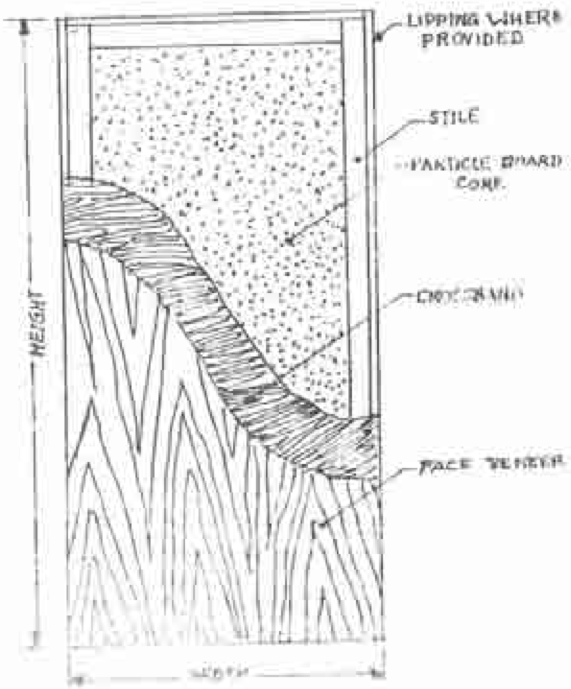


FIG. 2 TYPICAL PARTICLE BOARD CORE FLUSH DOOR SHUTTER (WIDTH AND HEIGHT IN ACCORDANCE WITH ITEM 12.5.5 A)

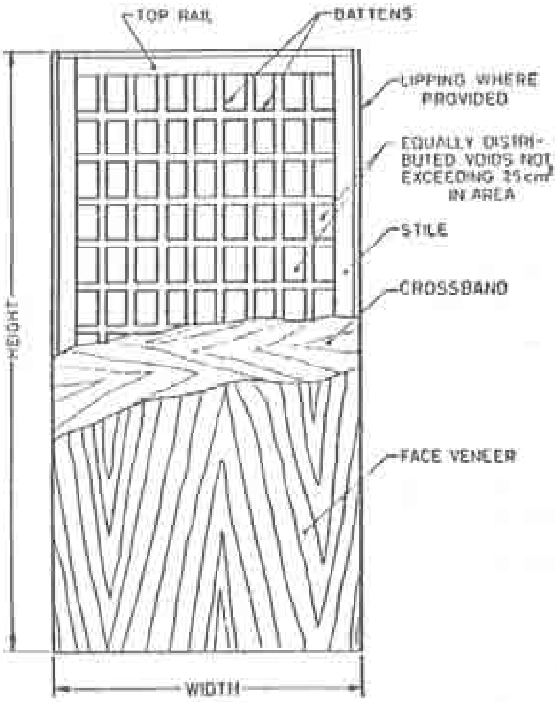


FIG. 1 CELLULAR CORE FLUSH DOOR SHUTTER
(WIDTH AND HEIGHT IN ACCORDANCE WITH PARA 12-5-3-3)

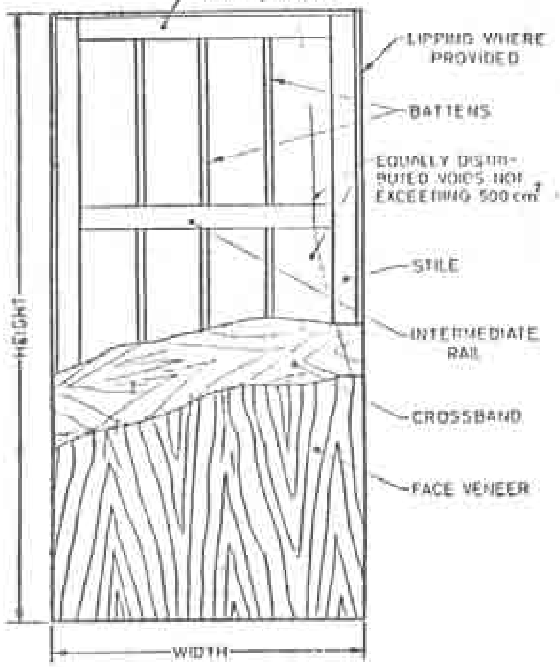
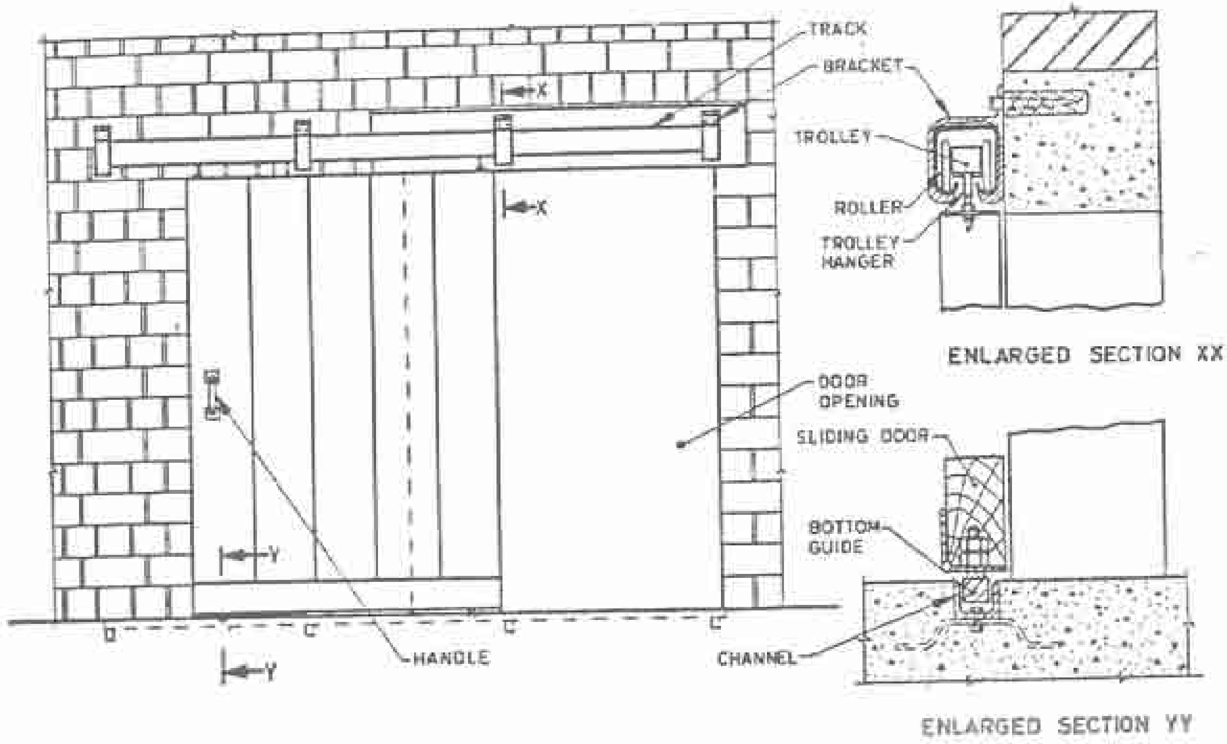


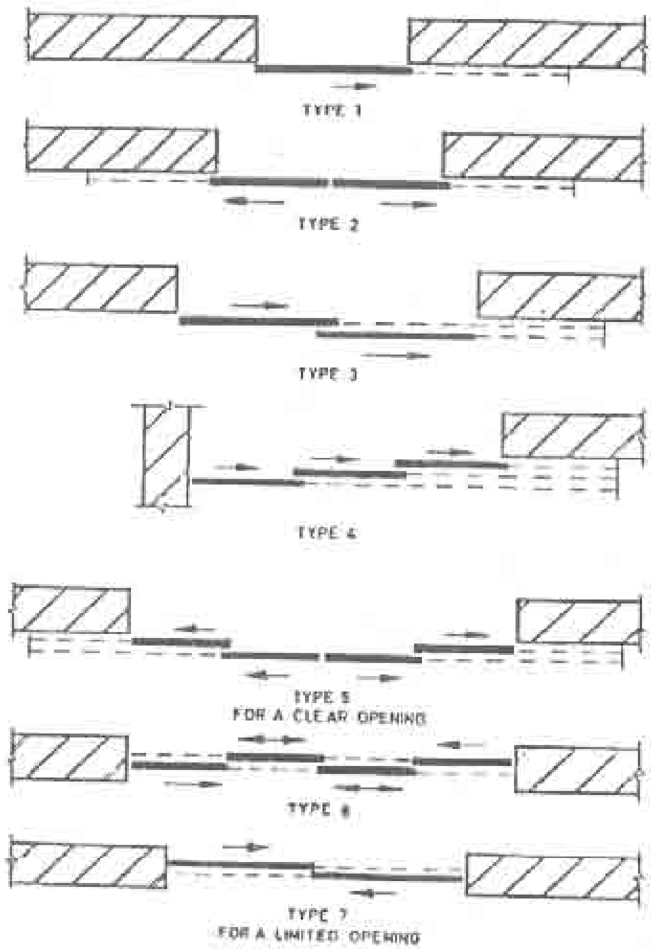
FIG. 2 HOLLOW CORE FLUSH DOOR SHUTTER
(WIDTH AND HEIGHT IN ACCORDANCE WITH PARA 12-5-3-3)

PLATE : 12-P/13



TERMINOLOGY FOR SIDE SLIDING DOOR

PLATE : 12-P/14



Typical Arrangement of Panels of Side Sliding Door

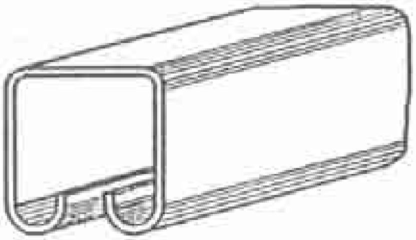


Fig. 1 Typical Shape of Track

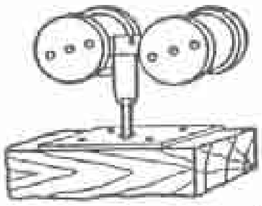


Fig. 2 Typical Four-Roller Trolley

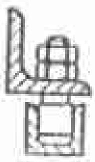


Fig. 3 Bottom Guide

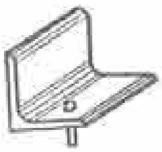
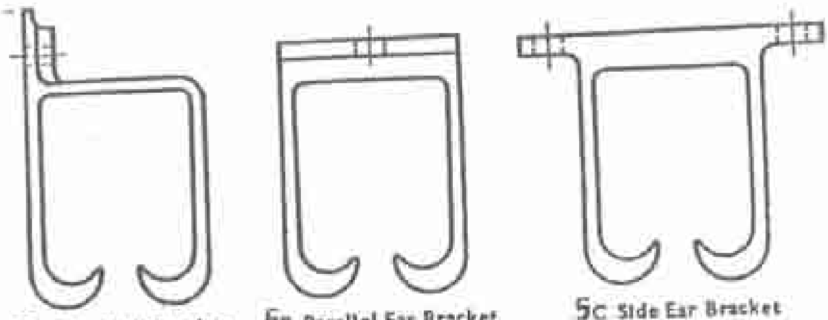
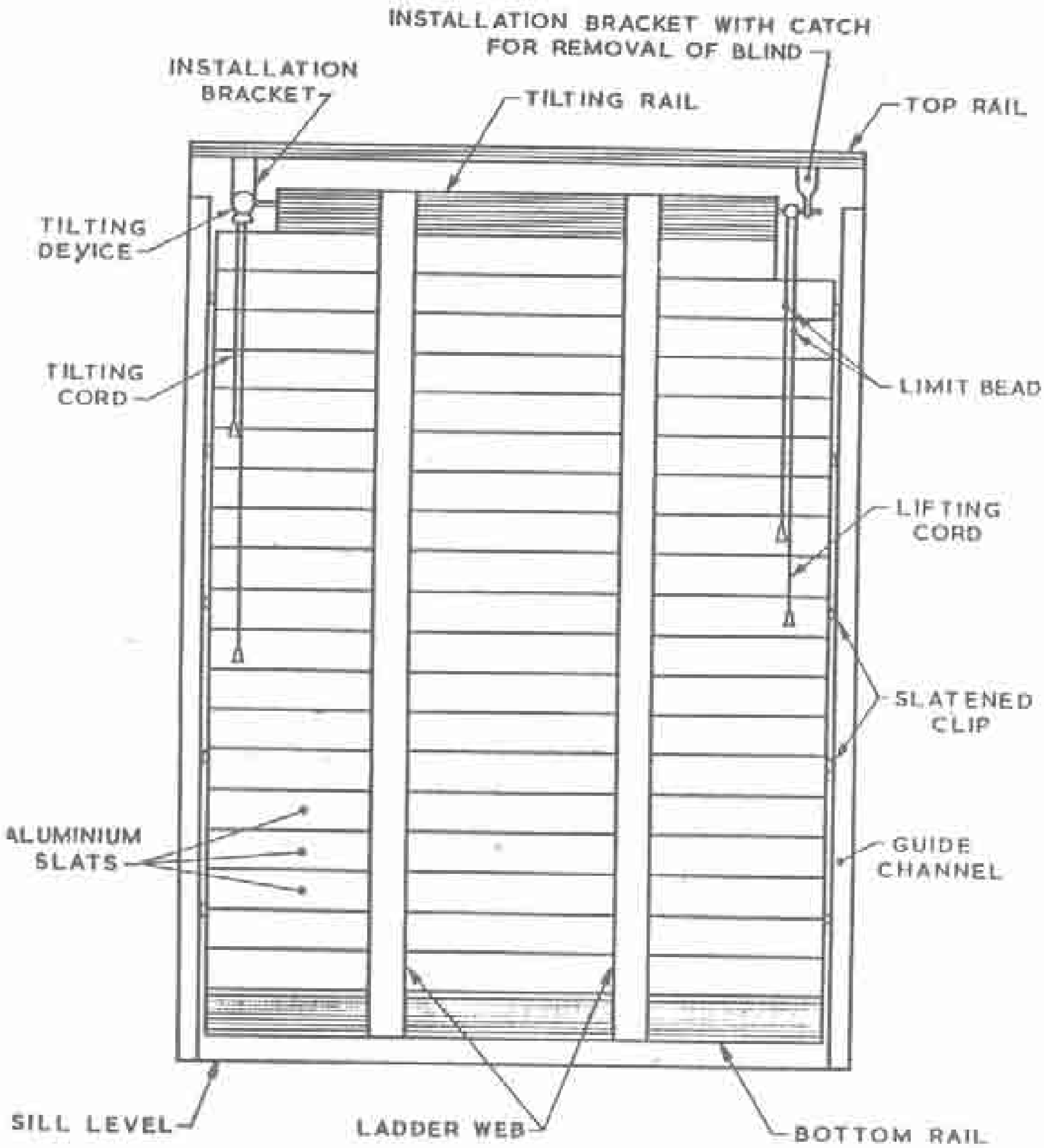


FIG. 4 TYPICAL GUN METAL TROLLEY GUIDE



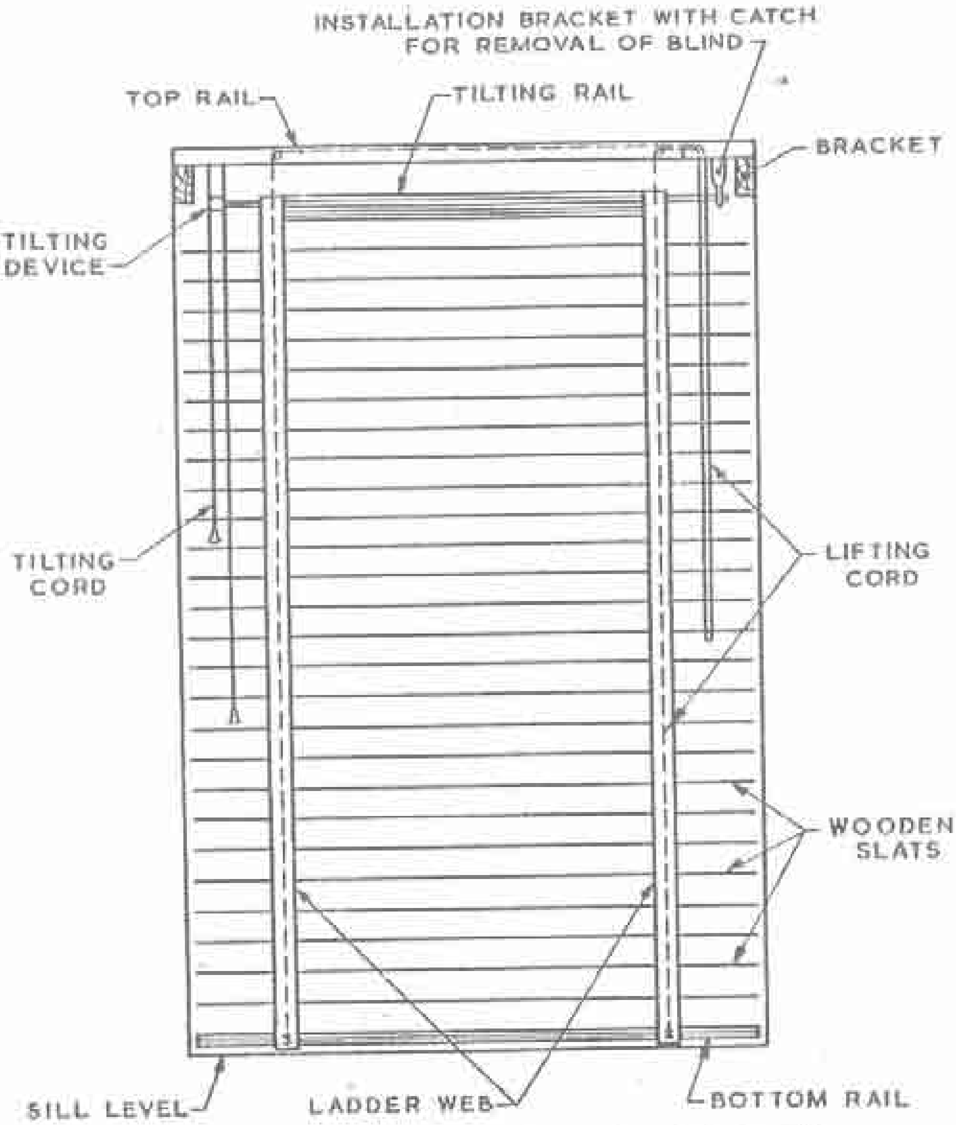
5A Side Wall Bracket 5B Parallel Ear Bracket 5C Side Ear Bracket

Fig. 5 Typical Shape of Brackets



(Full blind shown in closed position)

FIG. 1 VENETIAN BLIND ASSEMBLY
(Removable Type Aluminium Slats)

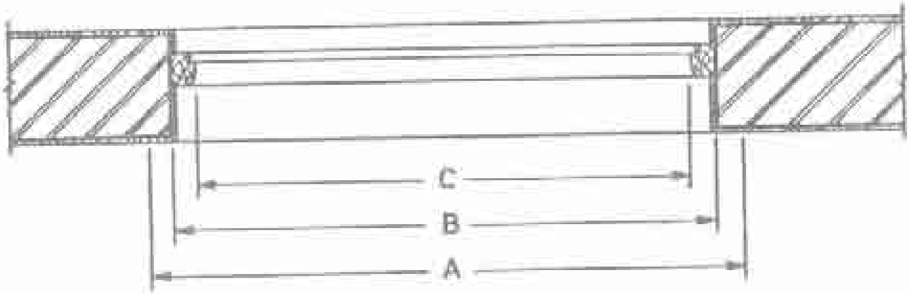


NOTE — In this blind the lifting cord passes through the top rail.

(Full blind shown in open position)

FIG. 2 VENETIAN BLIND ASSEMBLY
(Fixed type — Wooden slats)

PLATE : 12-F/17

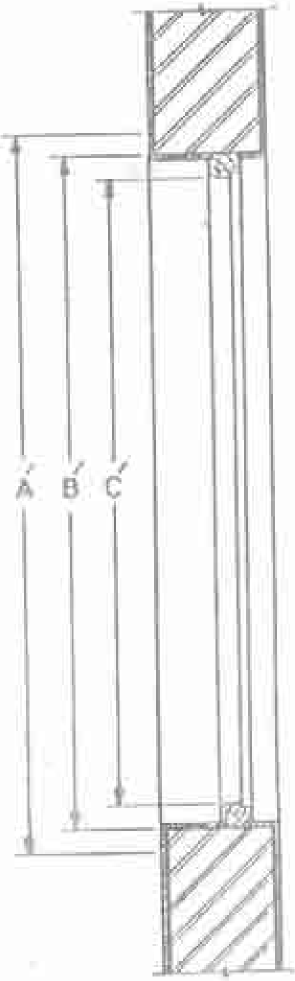


PLAN

POSITION	WIDTH (LENGTH)	HEIGHT (DROP)
* OVER THE WALL	A	A'
+ INSIDE JAMB OR REVEAL	B	B'
WITHIN WINDOW FRAME	C	C'

* TAKE AN OVERLAP OF 75 mm ON EACH SIDE

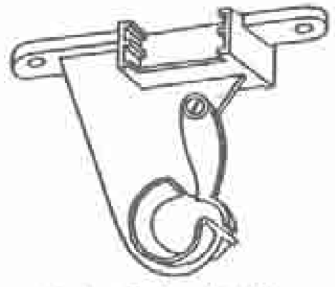
+ MEASURE AT THREE DIFFERENT POINTS AND ORDER THE SMALLEST MEASUREMENT



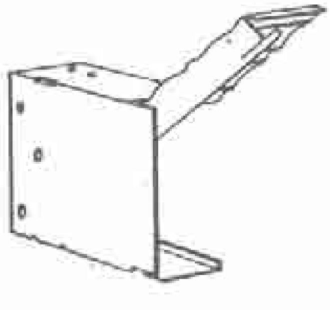
SECTION

METHODS OF FIXING VENETIAN BLINDS

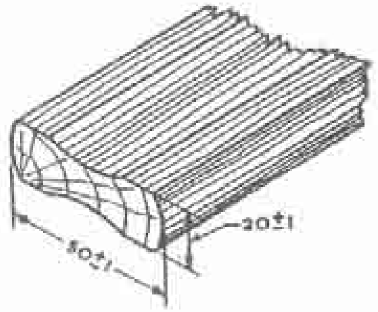
PLATE : 12-P/18



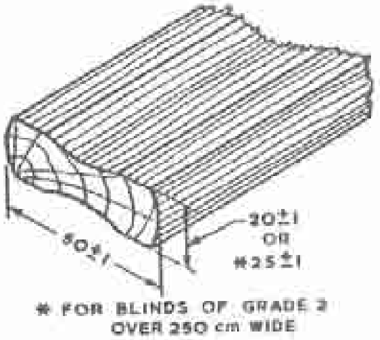
A Installation Bracket



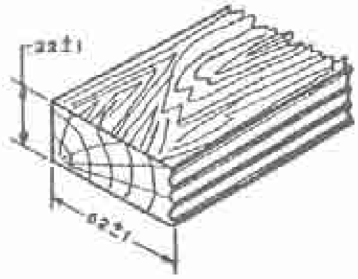
B Installation Bracket (With Provision for Pelmet)



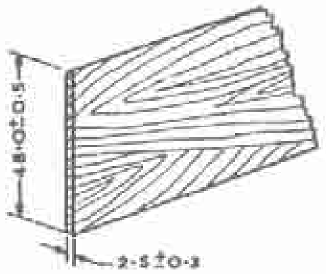
C Tilt Rail



D Bottom Rail



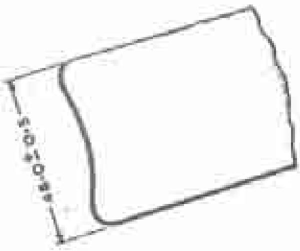
E Top Rail



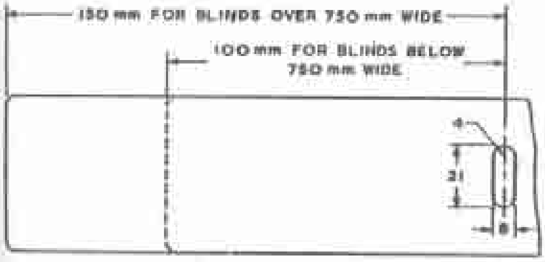
F Wooden Slat

TYPICAL ILLUSTRATION OF COMPONENTS OF VENETIAN BLINDS

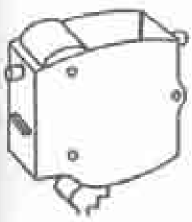
PLATE:12-P/19



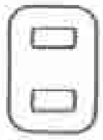
A Aluminium Slat



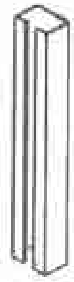
B Route Hole



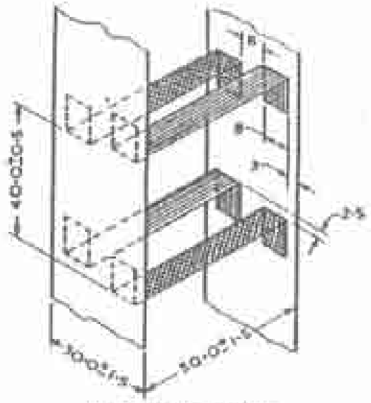
D Cord Lock



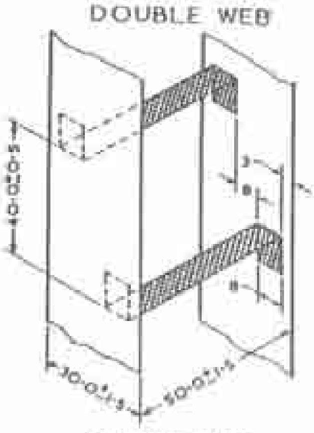
E Cord Equalizer



F Guide Channel



DOUBLE WEB



SINGLE WEB

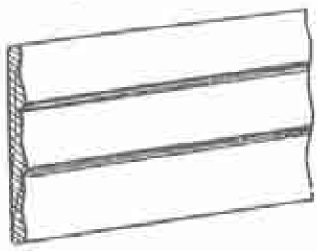
All dimensions in millimetres.

Fig. C Ladder Web

For Wooden Slat

For Aluminium Slat

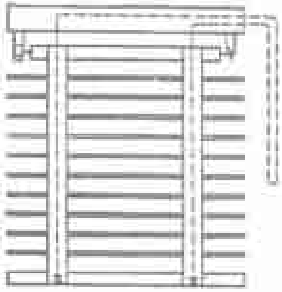
G Slat End Clips



H Facia Board or Pelmet

Typical Illustration of Components of Venetian Blinds

PLATE : 12-P/20

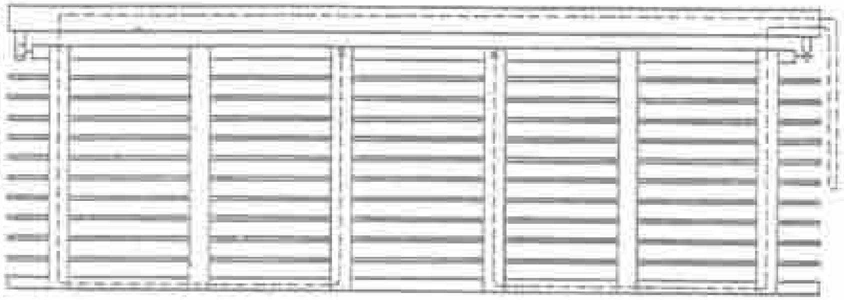


A. Up to 105 cm Wide
(2 Tapes Single Lift)

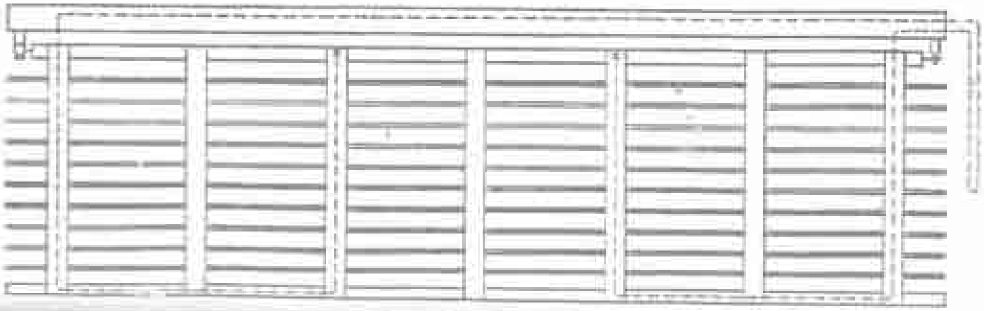
B. From 105 cm to 180 cm Wide
(3 Tapes Single Lift)

C. From 180 cm to 255 cm Wide
(4 Tapes Single Lift for Grade I)

D. From 255 cm to 330 cm Wide
(5 Tapes Multiple Lift)



E. From 330 cm to 410 cm Wide
(6 Tapes Multiple Lift)



12-103

PLATE: 12-P/21

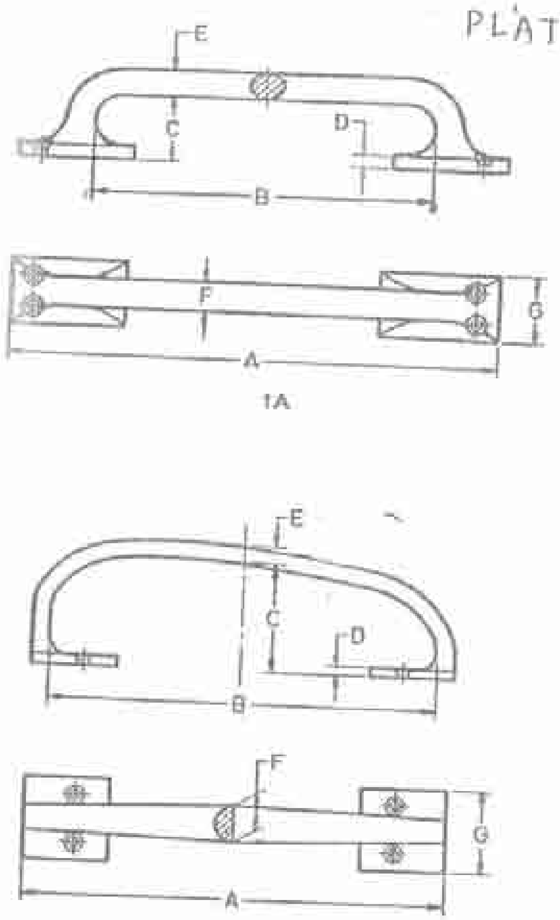


FIG. 1 TYPICAL DOOR HANDLE (TYPE 1)

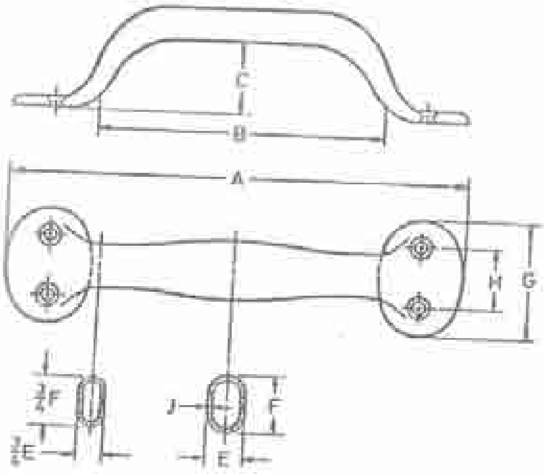


FIG. 2 TYPICAL DOOR HANDLE (TYPE 2)

PLATE : 12-F/21 (Contd.)

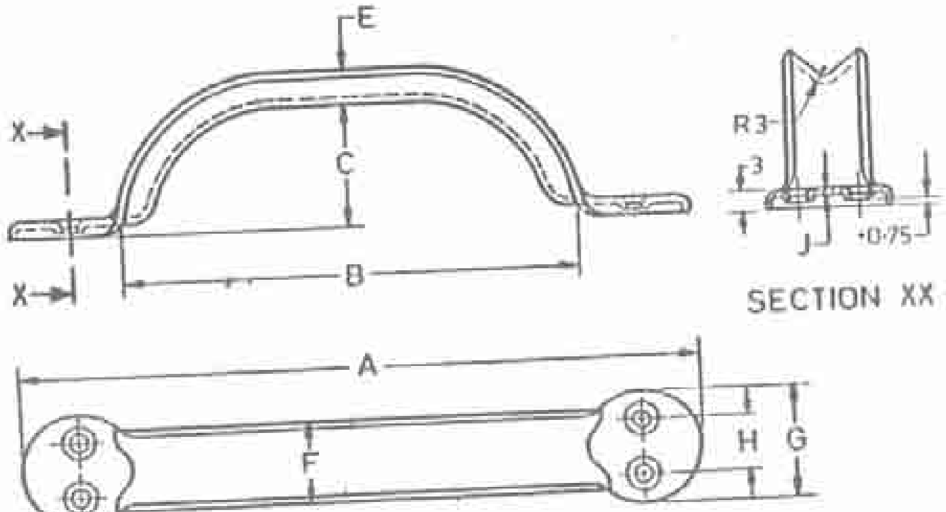


Fig. 3 Typical Door Handle (Type 3)

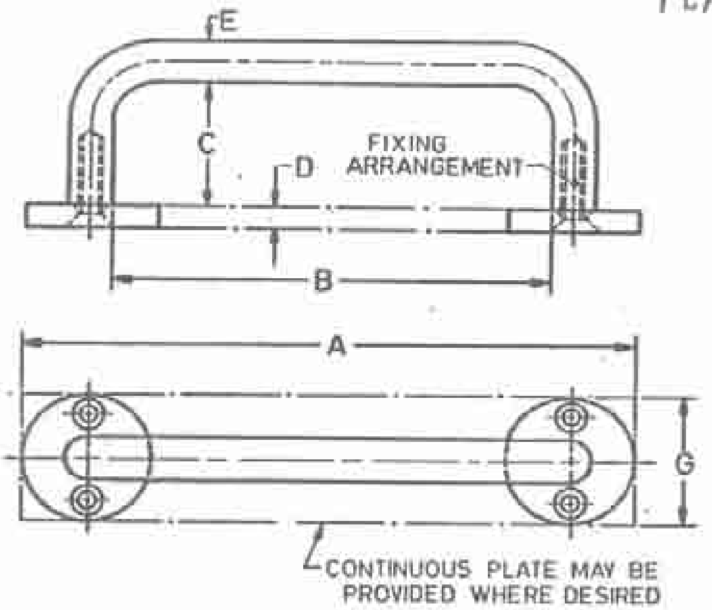
TABLE DIMENSIONS OF DOOR HANDLES

All dimensions in millimetres.

Type	Ref to Fig.	Size	A Min	B	C Min	D Min	E Min	F Min	G Min	H Min	J Min	Screw Holes*: No. in Each Leg	Screw Holes*: Size Designation of Countersunk Head Wood Screws (IS : [illegible] 1972)†
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1	1A	75	125	75	20	2·5	5	8	15	—	—	2	6
		100	150	100	25	3·0	8	10	20	—	—	2	6
		125	190	125	25	4·0	10	12	22	—	—	2	6
		150	215	150	30	4·5	12	15	25	—	—	2	8
	1B	75	85	75	20	2·5	5	8	15	—	—	2	6
		100	110	100	25	3·0	5	10	20	—	—	2	6
		125	140	125	25	3·0	7·5	12	22	—	—	2	6
		150	165	150	30	4·0	7·5	15	25	—	—	2	8
2	2	75	125	75	20	—	10	16	32	20	1·0	2	6
		100	150	100	25	—	11	19	38	20	1·0	2	6
		115	175	115	28	—	13	22	45	25	1·0	3	8
		135	200	135	30	—	14	25	50	32	1·25	3	8
3	3	75	100	75	20	—	5	14	16	8	1·25	1	6
		90	125	90	25	—	6	16	20	10	1·25	2	6
		100	150	100	28	—	7	18	25	12	1·60	2	6

*More evenly spaced screw holes may be provided, if so required by the purchaser.
†Specification for slotted countersunk head wood screws.

PLATE : 12-P/22.



NOTE — M5 × 20 mm G I countersunk machine screw or any other suitable fixing arrangement may be used.

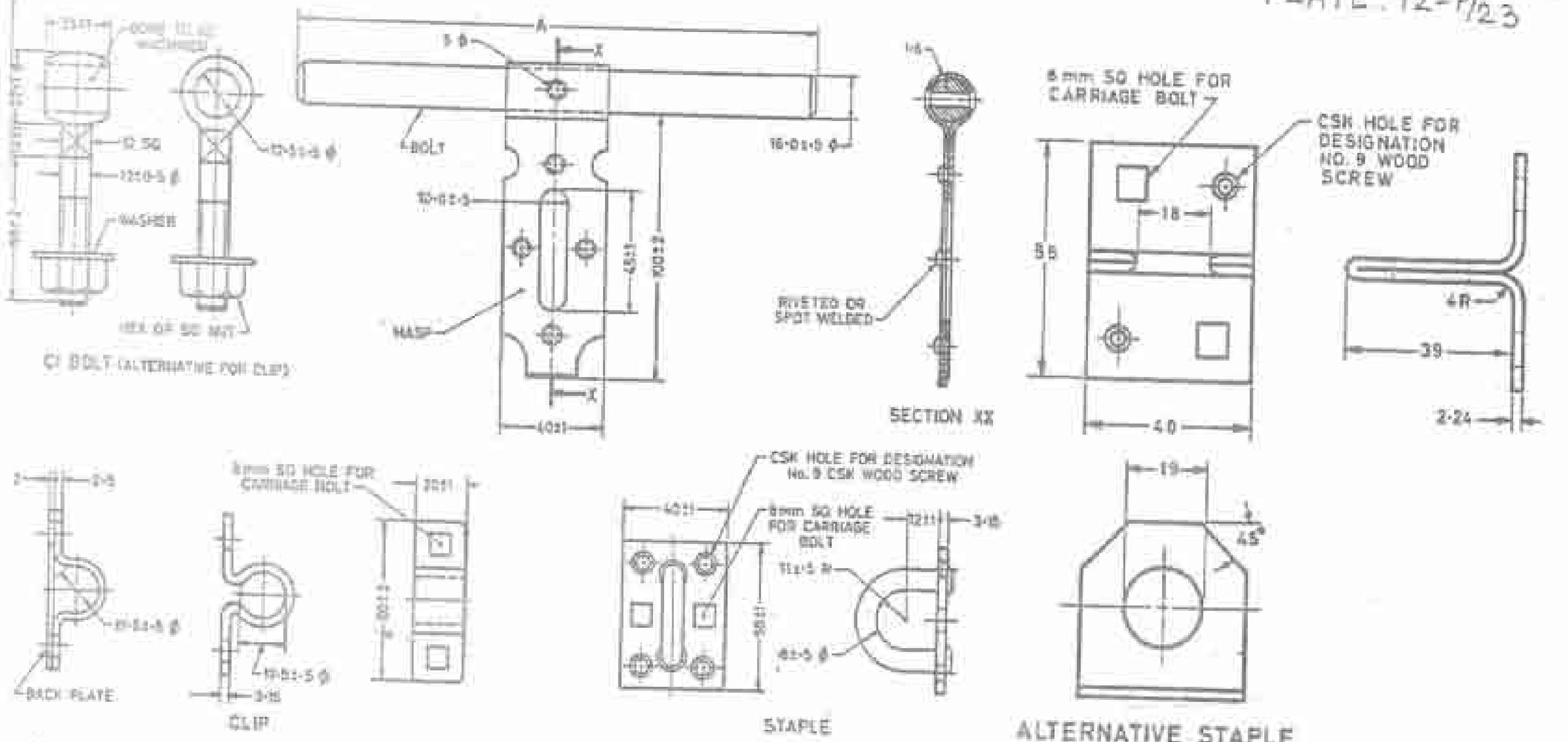
FIG. 4 TYPICAL DOOR HANDLE (TYPE 4)

TABLE DIMENSIONS OF DOOR HANDLES

All dimensions in millimetres.

TYPE	REF TO FIG.	SIZE	*A* *Min*	*B*	*C* *Min*	*D**	*E*†	*G* (DIA)	SCREW HOLES‡		
									No. in Each Lug	No. in a Plate When a Continuous Plate is Used	Size Designation of Counter-sunk Head Wood Screws (*see* IS : 6760-1972§)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
4	4	75	115	75	25	5 ± 0.5	10 ± 0.5	30^{+0}_{-1}	2	4	6
		100	140	100	30	5 ± 0.5	10 ± 0.5	30^{+0}_{-1}	2	4	6
		125	175	125	35	5 ± 0.5	12 ± 0.5	38^{+0}_{-1}	3	6	[illegible]
		150	200	150	35	5 ± 0.5	12 ± 0.5	38^{+0}_{-1}	3	6	6

*In case a continuous base plate is used, the thickness may be reduced to 3 mm.
†Hexagonal or round.
‡More evenly placed screw holes may be provided, if so required by the purchaser.
§Specification for slotted countersunk head wood screws.



NOTE — Shapes of parts are only illustrative but the dimensions and the minimum requirements, where specified, are binding.

All dimensions in millimetres.

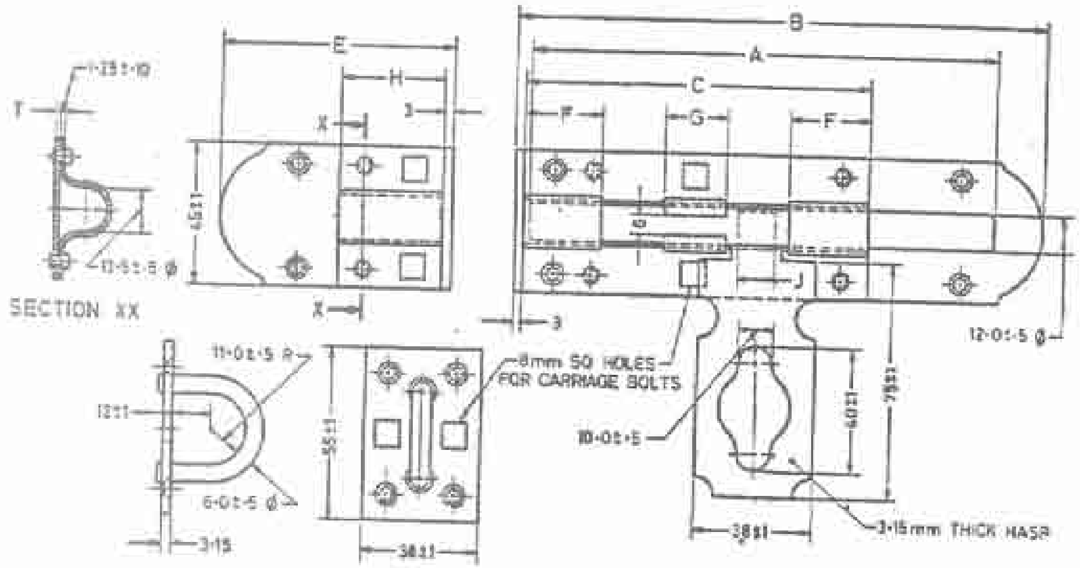
MILD STEEL SLIDING DOOR BOLT, CLIP, OR BOLT TYPE

TABLE 1 DIMENSIONS OF MILD STEEL SLIDING DOOR BOLTS, PLATE TYPE

Size	Dimensions A	B	C	E	F	G	H	J Min	T	Holes Drilled and Countersunk to Accommodate Wood Screw Designation No. (*see* IS : 451-1972)	No. of Rivets: Bolt Plate	Socket	No. of Screw Holes: Bolt	Socket	Staple	No. of 8 mm Square Holes for Carriage Bolts: Plate and Socket	Staple
(1) mm	(2) mm	(3) mm	(4) mm	(5) mm	(6) mm	(7) mm	(8) mm	(9) mm	(10) mm	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
150	150 ± 2	170 ± 3	110 ± 2	75 ± 2	25 ± 1	20 ± 1	34 ± 1	12	1·60 ± 0·10	9	4	2	4	2	4	4	2
200	200 ± 2	220 ± 3	135 ± 2	75 ± 2	32 ± 1	25 ± 1	34 ± 1	12	1·60 ± 0·10	9	4	2	6	2	4	4	2
250	250 ± 2	280 ± 3	180 ± 2	100 ± 2	32 ± 1	32 ± 1	54 ± 1	18	2·00 ± 0·10	9	4	4	6	4	4	4	2
300	300 ± 2	330 ± 3	200 ± 2	100 ± 2	38 ± 1	38 ± 1	64 ± 1	18	2·00 ± 0·10	9	6	4	6	4	4	4	2
375	375 ± 3	405 ± 3	200 ± 2	100 ± 2	38 ± 1	38 ± 1	64 ± 1	18	2·00 ± 0·10	9	8	4	8	4	4	4	2
450	450 ± 3	480 ± 3	200 ± 2	100 ± 2	38 ± 1	38 ± 1	64 ± 1	18	2·00 ± 0·10	9	8	4	8	4	4	4	2

NOTE — For 375 mm and 450 mm sizes of bolt, one extra supporting clip, 31 ± 1 mm in length and made of 1·25 ± 0·10 mm thick mild steel sheet shall be provided.

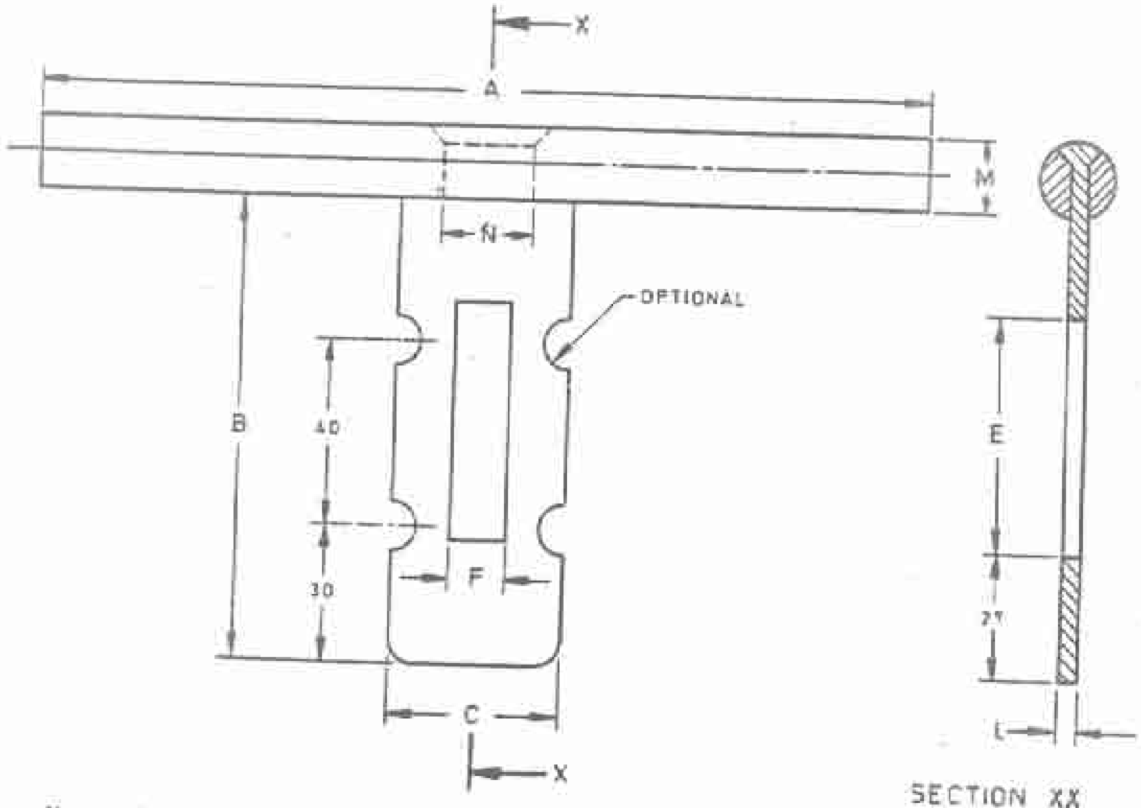
PLATE: 12-P/23 (Contd.)



NOTE — Shapes of parts are only illustrative but the dimensions and the minimum requirements, where specified, are binding.

All dimensions in millimetres.

FIG. 1 MILD STEEL SLIDING DOOR BOLT, PLATE TYPE



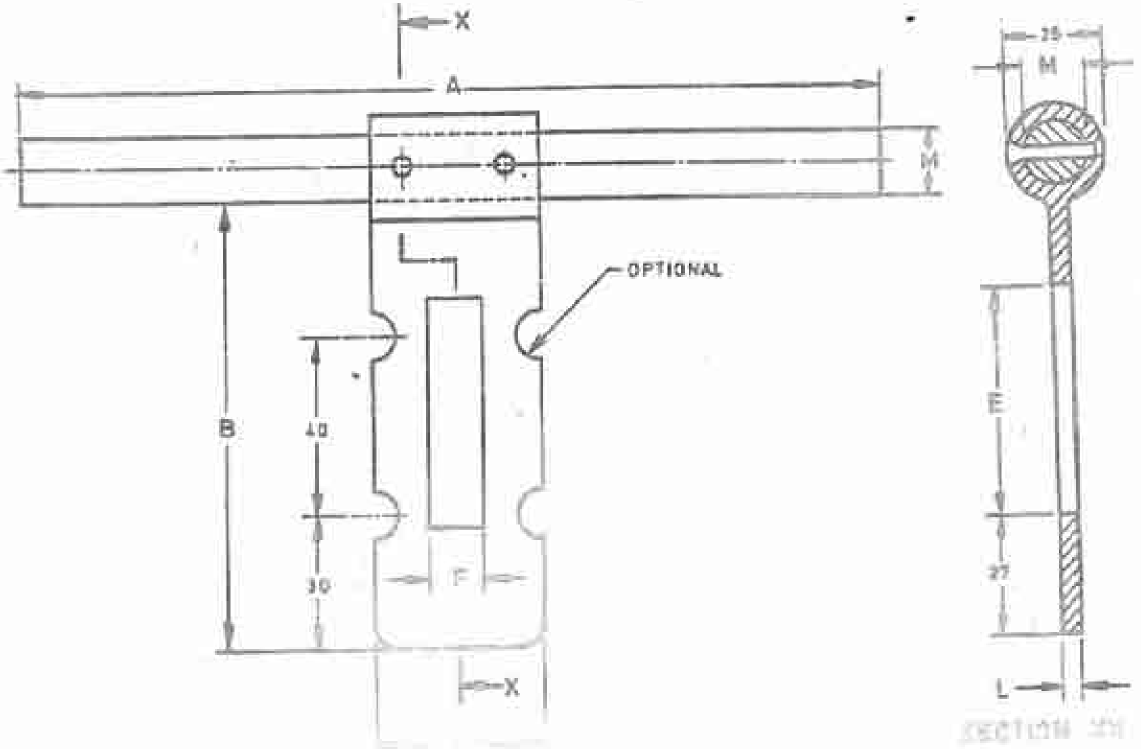
NOTE — The shape of the hasp is illustrative only but the dimensions and minimum requirements where specified are binding.

All dimensions in millimetres.

1A Hasp Riveted

FIG. 1 TYPICAL ILLUSTRATION OF NON-FERROUS METAL SLIDING DOOR BOLT — *Contd*

PLATE : 12- P/24 (Contd)

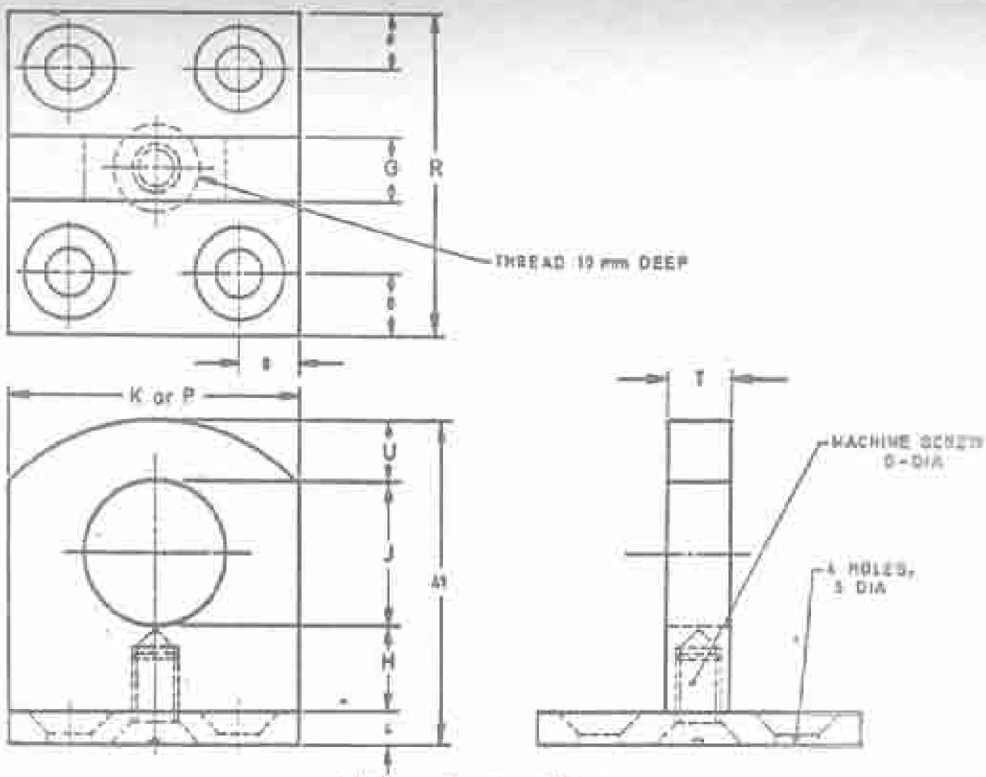


NOTE — The shape of the hasp is illustrative only but the dimensions and minimum requirements where specified are binding.

All dimensions in millimetres.

1B Pin Riveted

FIG. 1 TYPICAL ILLUSTRATION OF NON-FERROUS METAL SLIDING DOOR BOLT — *Contd*



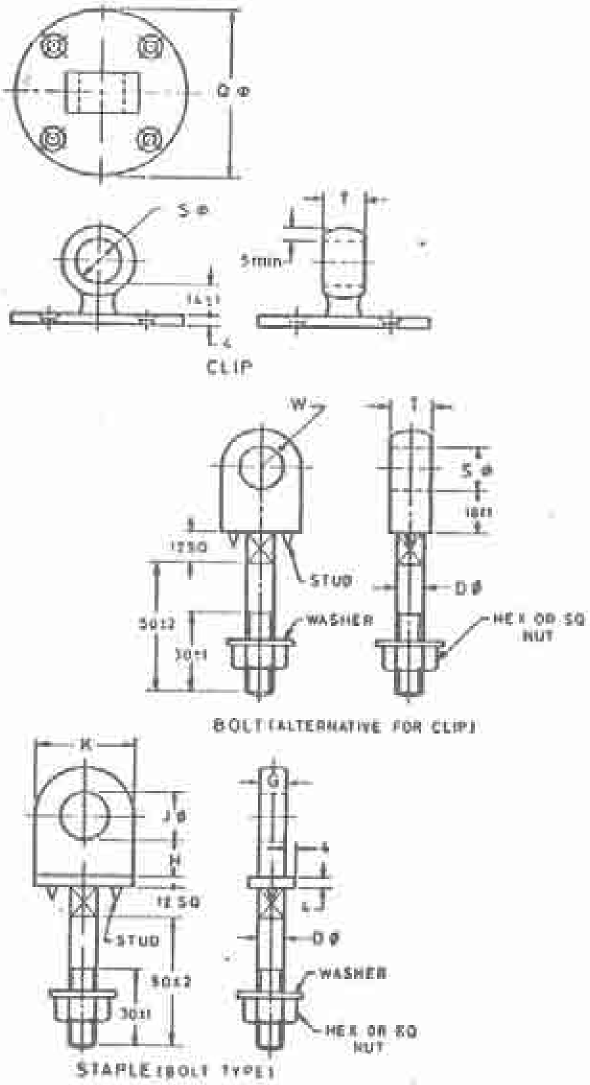
All dimensions in millimetres.

1C Aluminium Alloy Clip and Staple

NOTE — The shape of parts are illustrative only but the dimensions and minimum requirements where specified are binding.

FIG. 1 TYPICAL ILLUSTRATION OF NON-FERROUS METAL SLIDING DOOR BOLT — *Contd*

PLATE : 12-P/24 (contd.)



NOTE — The shape of parts are only illustrative but the dimensions and minimum requirements where specified are binding.

All dimensions in millimetres.

1D Brass Clip and Staple

FIG. 1 TYPICAL ILLUSTRATION OF NON-FERROUS METAL SLIDING DOOR BOLT

PLATE : 12-P/24 (Contd.)

TABLE 2 DIMENSIONS OF BRASS SLIDING DOOR BOLTS (TYPE 1 & 2)

All dimensions in millimetres.

Size	A	B	C	D Dia	E	F	G	H	J Dia	K	L	M Dia	N	Q Dia	S Dia	T	W Rad	No. of Screw Holes on Staple or Clip to Accommodate Wood Screw No. 4
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
150	150	90	38	10	45	13	10	14	18	37	4	16	20	65	18	16	15	4
200	200	90	38	10	45	13	10	14	18	37	4	16	20	65	18	16	15	4
250	250	100	45	12	55	15	12	20	22	47	6	16	20	65	18	16	15	4
300	300	100	45	12	55	15	12	20	22	47	6	16	20	65	18	16	15	4
375	375	110	50	14	60	17	14	25	25	55	8	18	22	70	20	18	15	4
450	450	110	50	14	60	17	14	25	25	55	8	18	22	70	20	18	15	4
Tolerances	±2	±2	±1	±0.5	±1	±1	±1	±1	±1	±1	±0.5	±0.5	±1	±1	±0.5	±1	±0.5	—

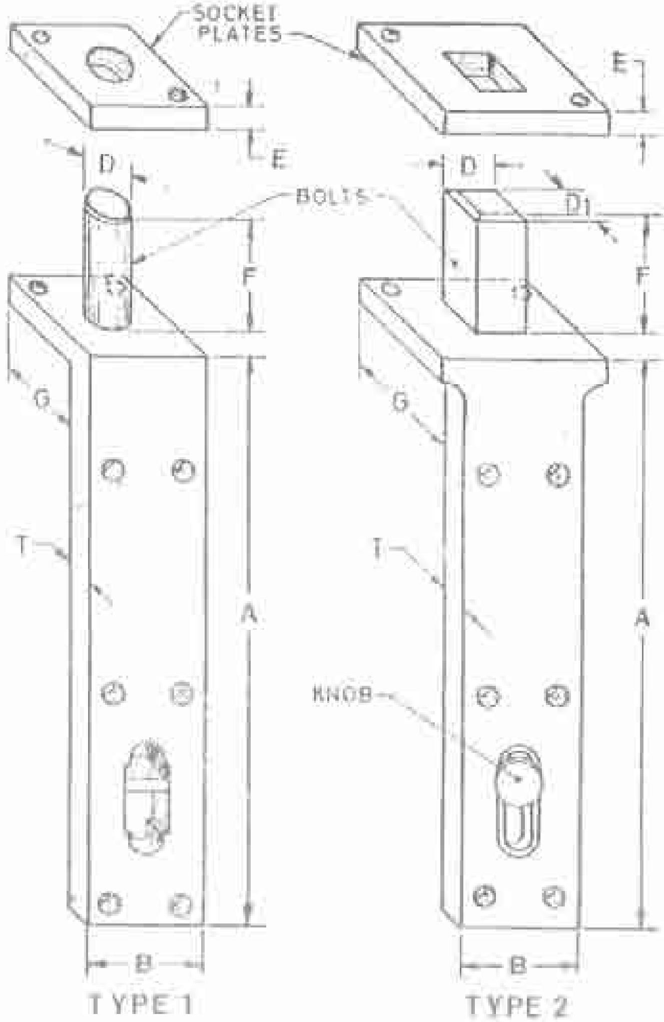
TABLE 3 DIMENSIONS OF ALUMINIUM ALLOY SLIDING DOOR BOLTS (TYPE 1)

All dimensions in millimetres.

Size	A	B	C	D Dia	E	F	G	H	J Dia	K	L	M	Pin* Dia	P	R	T	U Min	No. of Screw Holes on Staple or Clip to Accommodate Wood Screw No. 4
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
200 250 300 350 375 450	200 250 300 350 375 450	110	38	6	45	10	8	11	18	30	4	16	5	38	42	8	8	4
Tolerance	±2	±2	±1	—	±1	±1	±1	±1	±0.5	±1	±0.5	±0.5	±1	±1	±1	±1	—	—

*Minimum two numbers of pins shall be used.

PLATE: 12 - P/25



TYPE 1 TYPE 2

NOTE 1 — Number and position of screw bolts are illustrative and shall conform to requirements given in Table 1 and Table 2.

NOTE 2 — The shapes of the component parts are only illustrative and are not intended to limit the design. Movement of the bolt may be either by means of a knob or a lever.

FIG. 1 FLUSH BOLTS

PLATE : 12- P/25 (Contd.)

TABLE 1 DIMENSIONS OF FLUSH BOLTS (TYPE 1)

All dimensions in millimetres.

Size	Face Plate			Throw of Bolt	Bolt Dia	Lip Extension	No. of Screw Holes		Size of Screw Hole for Wood Screw No.	Socket Plate	
	Length	Breadth	Thickness				Bolt Plate	Socket Plate		Thickness	Length and Breadth
	A *Min*	*B* *Min*	*T* *Min*	*F* *Min*	*D*	*G* *Min*				*E* *Min*	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
100	100	20	4	20	8 ± 1	20	4	2	6	4	The minimum dimensions shall not be less than the lip extension of the face plate.
150	150	20	4	25	8 ± 1	30	4	2	6	4	
200	200	20	4	30	8 ± 1	50	4	2	6	4	

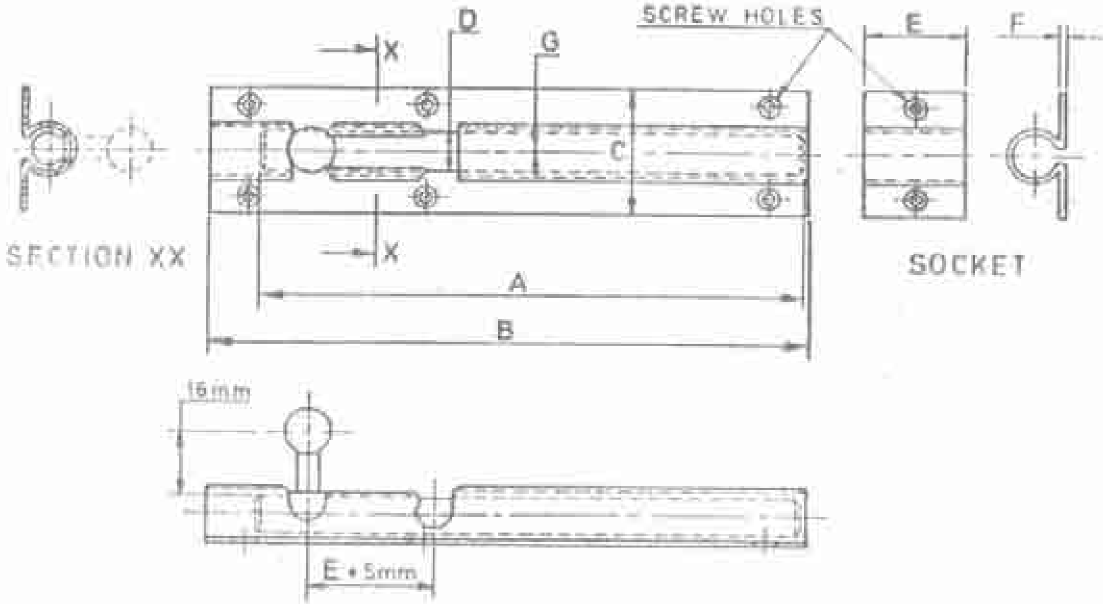
TABLE 2 DIMENSIONS OF FLUSH BOLTS (TYPE 2)

All dimensions in millimetres.

Size	Face Plate: Length	Face Plate: Breadth	Face Plate: Thickness	Throw of Bolt	Lip Extension	Dimension of Bolt: D	Dimension of Bolt: D_1	No. of Screw Holes: Bolt Plate	No. of Screw Holes: Socket Plate	Size of Screw Hole for Wood Screw No.	Socket Plate: Thickness	Socket Plate: Length and Breadth
	A Min	B Min	T Min	F Min	G Min						E Min	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
100	100	20	4	15	20	8 ± 1	8 ± 1	4	2	6	4	The minimum dimensions shall not be less than the lip extension of the face plate.
150	150	20	4	15	30	8 ± 1	8 ± 1	4	2	6	4	
200	200	20	4	15	30	8 ± 1	8 ± 1	4	2	6	4	
250	250	20	4	15	30	8 ± 1	10 ± 1	5 (Min)	2	6	4	
300	300	20	4	15	30	8 ± 1	10 ± 1	5 (Min)	2	6	4	

TABLE 1 BARREL TOWER BOLTS (Ferrous Metals)

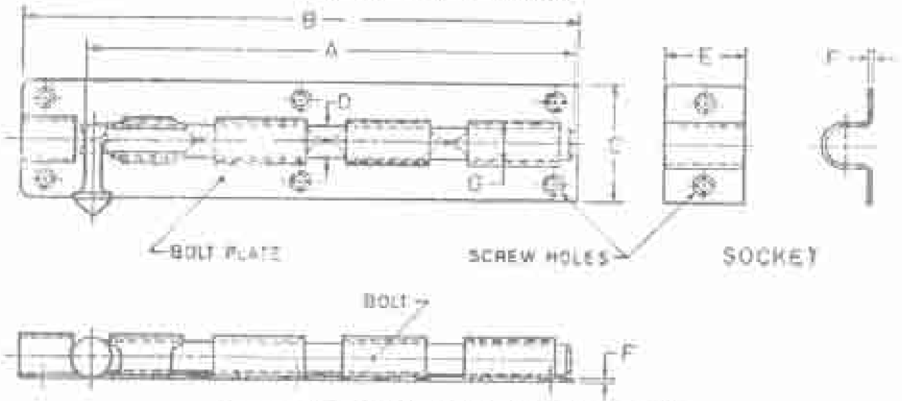
All dimensions in millimetres.



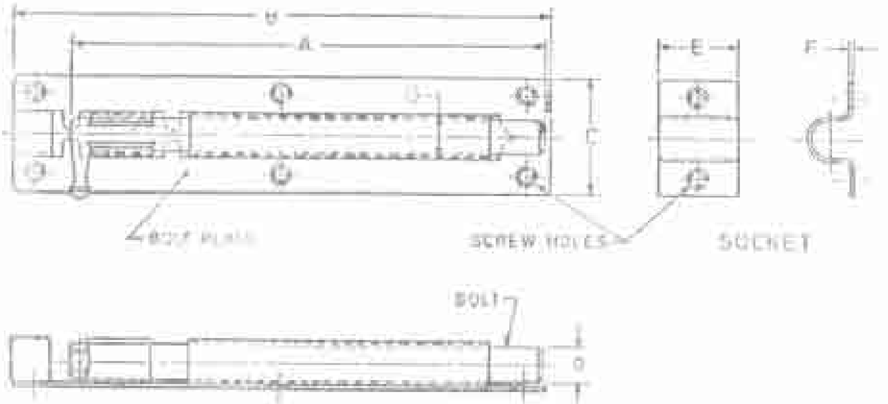
Size	Length of Bolt, A	Length of Barrel, B	Width of Barrel, C When D = 10·0	Width of Barrel, C When D = 12·0	Dia of Bolt D	Length of Socket E	Thickness of Mild Steel Sheet for Barrel, F	Dia of Bore of Barrel or Socket G	Minimum No. of Equally Spaced Screw Holes in Barrel and Socket for Wood Screw No. 6
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
75	75	95							6
100	100	120							6
125	125	145							6
150	150	170							8
175	175	195	22	32	10·0 or 12·0	33	1·25	0·2 to 1·5 more than dia of bolt	8
200	200	220							8
225	225	245							8
250	250	270							10
300	300	320							10
Tolerance	±1	+3 −1	+3 −1	+1 −1	±0·1	[illegible]	±0·05	—	—

TABLE 2 SEMI-BARREL TOWER BOLTS (Ferrous Metals)

All dimensions in millimetres.



SEMI BARREL TOWER BOLTS WITH OPEN COVER

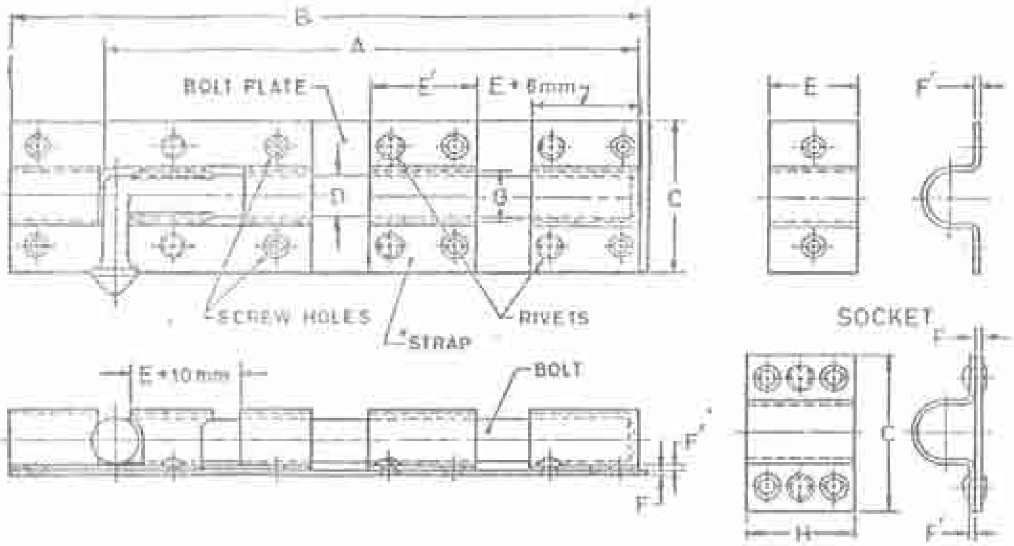


SEMI BARREL TOWER BOLT WITH FULL COVER

Size	Length of Bolt A	Length of Bolt Plate B	Width of Bolt Plate C	Dia of Bolt D	Length of Socket E	Thickness of Bolt Plate and Socket F	Dia of Boss of Bolt Plate or Socket G	Minimum No. of Counter Sunk Screw Holes in Bolt Plate and Socket for Wood Screw No. 8
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
75	75	95	38	10·0				6
100	100	120	38	10·0				6
125	125	145	38	10·0				6
150	150	175	42	12·0				8
175	175	200	42	12·0				8
200	200	225	42	12·0	25	1·25	1 to 1·5 times the dia of bolt	8
225	225	250	42	12·0				8
250	250	275	42	12·0				10
300	300	325	42	12·0				[illegible]
375	375	400	42	12·0				[illegible]
450	450	475	42	12·0				[illegible]
Tolerance	+3 −1	+3 −1	±1	±0·5	±1	±0·15	—	—

TABLE 3 RIVETED OR SPOT WELDED TOWER BOLTS (Ferous Metals)

All dimensions in millimetres.



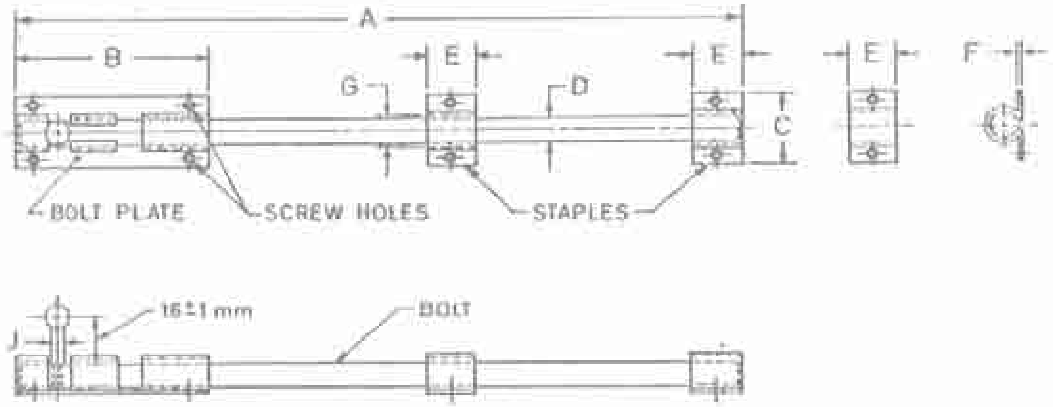
*For spot welded type, same dimensions shall be given; however, there shall not be riveted holes.

Size	Length of Bolt A	Length of Bolt Plate B	Width of Bolt Plate C	Dia of Bolt D	Length of Socket E	Length of Strap E'	Thickness of Back Plate F	Thickness of Socket or Upper Plate & Strap F'	Dia of Bore of Bolt Plate or Socket G	Length of Alternative Socket H	Minimum No. of Equally Spaced Screw Holes in Bolt Plate & Socket for Wood Screw No. 6
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
100	100	120	40	10·0						30	8
125	125	145	40	10·0						30	8
150	150	180	45	12·0						35	8
175	175	205	45	12·0						35	8
200	200	230	45	12·0						35	8
225	225	255	45	12·0						35	8
250	250	280	45	12·0	25	31	1·60	1·25	1 to 1·5 more than dia of bolt	35	10
300	300	330	45	12·0						35	10
375	375	405	45	12·0						35	10
450	450	480	45	12·0						35	12
600	600	630	45	12·0						35	14
750	750	780	45	12·0						35	16
900	900	930	45	12·0						35	16
Tolerance	+ 3 / − 1	+ 3 / − 1	± 1	± 0·5	± 1	—	± 0·15	± 0·15	—	—	—

PLATE: 12-P/26 (Contd.)

TABLE 4 SKELETON TOWER BOLTS (Ferrous Metals)

All dimensions in millimetres.

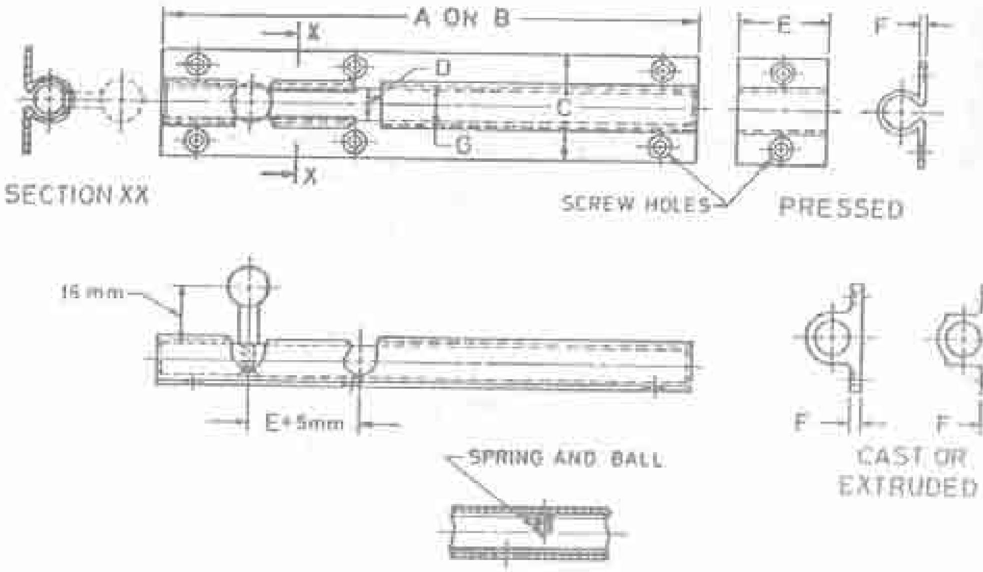


SIZE	LENGTH OF BOLT A	LENGTH OF BOLT PLATE B	WIDTH OF BOLT PLATE OR STAPLE C	DIA OF BOLT D	LENGTH OF STAPLE E	THICKNESS OF PLATE OR STAPLE F	DIA OF BORE OF PLATE OR STAPLE G	DIA OF SHANK OF KNOB J	NO. OF STAPLES	MINIMUM NO. OF SCREW HOLES FOR WOOD SCREW NO. 6
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
375	375								3	14
450	450								3	14
600	600	170	32	10·00	25	1·25	1 to 1·5 more than dia of bolt	5·0	4	16
750	750								5	18
900	900								6	20
TOLERANCE	± 3	± 2	± 2	± 0·5	± 1	± 0·15	—	+ 0·5 − 0	—	—

PLATE : 12-1/27

TABLE 1 BARREL TOWER BOLTS, TYPES 1 TO 5 (Non-Ferous Metals)

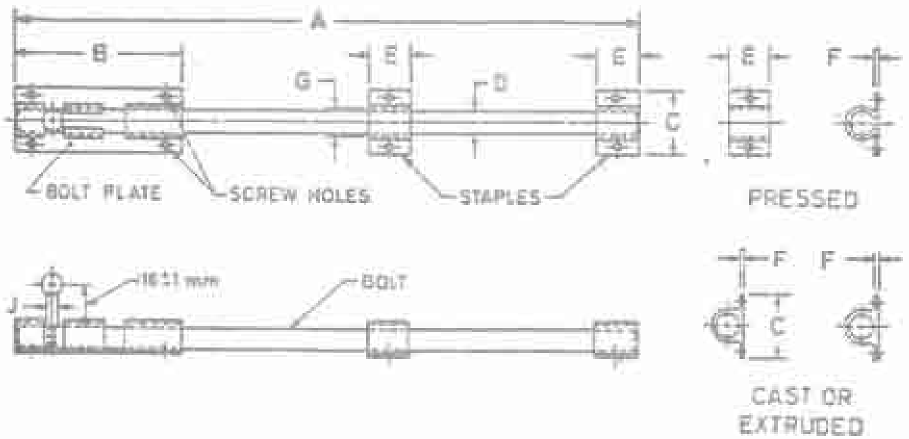
All dimensions in millimetres.



Size	Length of Bolt or Barrel (A or B)	Width of Barrel, C: When D = 10·0	Width of Barrel, C: When D = 12·0	Dia of Bolt D	Length of Socket E	Thickness of Metal of Barrel, F: Brass or Zinc Alloy	Thickness of Metal of Barrel, F: Aluminium Alloy When D = 10·0	Thickness of Metal of Barrel, F: Aluminium Alloy When D = 12·0	Thickness of Metal of Barrel, F: Sheet Brass	Dia of Bore of Barrel or Socket G	Minimum No. of Equally Spaced Holes in Barrel & Socket for Wood Screw No. 8
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
75	75					1·5					6
100	100					1·5					6
125	125					2·0					6
150	150					2·0					8
175	175	32	38 or 42	10·0 or 12·0	25	2·0	1·60	2·40 or 1·90	1 in 1·23	0·7 to 1·5 more than dia of bolt	8
200	200					2·0					8
225	225					2·0					8
250	250					2·0					10
300	300					2·0					10
Tolerance	+3 −1	+3 −1	+1 −1	±0·5	±1	+0·5 −0·2	±0·33	±0·36	±0·15	—	—

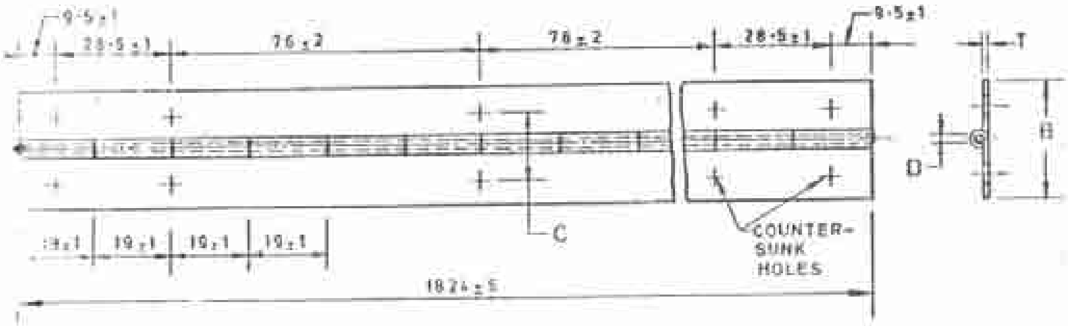
TABLE 2 SKELETON TOWER BOLTS, TYPES 6 TO 9 (Non-Ferrous Metals)

All dimensions in millimetres.



Size	Length of Bolt A	Length of Bolt Plate B	Width of Bolt Plate or Staple C, When D = 10·0	Width of Bolt Plate or Staple C, When D = 12·0	Dia of Bolt D	Length of Staple E, When D = 10·0	Length of Staple E, When D = 12·0	Thickness of Plate or Socket F, Brass, When D = 10·0	Thickness of Plate or Socket F, Brass, When D = 12·0	Thickness of Plate or Socket F, Aluminium Alloy or Zinc Alloy, When D = 10·0	Thickness of Plate or Socket F, Aluminium Alloy or Zinc Alloy, When D = 12·0	Dia of Bore of Plate or Staple G, When D = 10·0	Dia of Bore of Plate or Staple G, When D = 12·0	Dia of Shank of Knob, When D = 10·0	Dia of Shank of Knob, When D = 12·0	No. of Staples	Minimum No. of Screw Holes for Wood Screw No. 4
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
375	375															3	10
450	450															4	12
600	600	100	22·0	30·0 or 42·5	10·0 or 12·0	22·0	25·0	1·20	1·50	1·60	2·40 or 1·90	11·0	13·0	5·0	6·0	4	12
750	750															5	14
900	900															6	18
Tolerance	±1	±0·5	±0·5	±0·5	±0·5	±0·5	±0·5	+0·25 −0	+0·25 −0	+0·25 −0	+0·25 −0	±0·5	±0·5	+0·5 −0	+0·5 −0	—	—

PLATE : 12-P/28

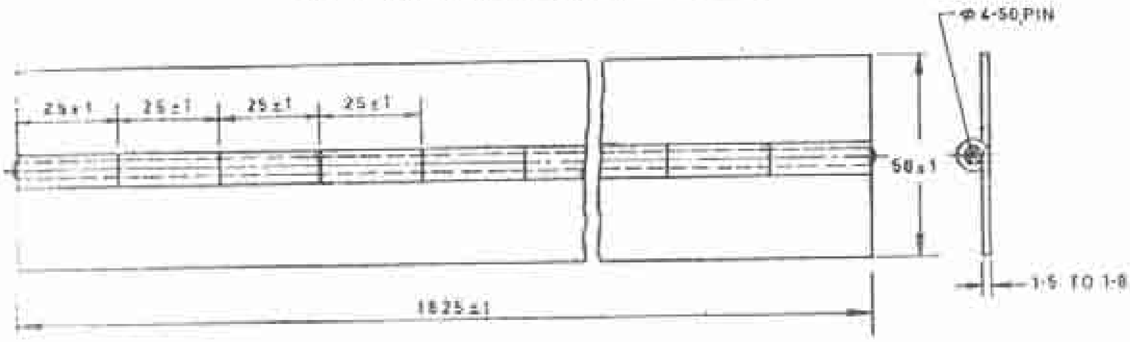


All dimensions in millimetres.

NOTE — Length other than this where required by the purchaser should be in multiples of 304.

Nominal Size	B	C	Pin Dia D	T	Csk Screw No.	Examples of Uses	Type
25	25 ± 1	15 ± 1·5	2·00	0·8 to 1·0	3	Light fixture like electrical panels in Railway coaches	I
30	30 ± 1	18 ± 1·5	2·00	0·8 to 1·0	3		
35	35 ± 1	20 ± 1·5	2·50	0·8 to 1·5	5	Cub board and light flush doors	II
40	40 ± 1	22 ± 1·5	2·50	0·8 to 1·5	5		
50	50 ± 1	27 ± 1·5	2·80	0·8 to 1·5	5		

FIG. 1 CONTINUOUS (PIANO) HINGES TYPES I AND II



All dimensions in millimetres.

NOTE 1 — Can be supplied with/without holes subject to special agreement with indication of hole diameter, counter sinking hole position and length.

NOTE 2 — For heavy duty purposes like engine bonnet covers in vehicles.

FIG. 2 CONTINUOUS (PIANO) HINGES TYPE III, 50 mm NOMINAL SIZE

PLATE: 12-P/29

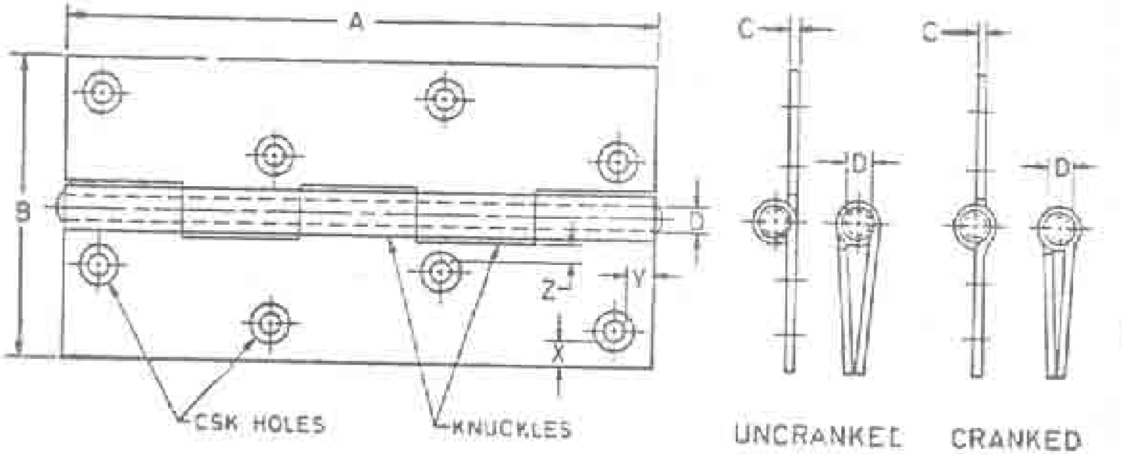


Fig. 1 A Typical Mild Steel Butt Hinge

PLATE : 12-P/29 (Contd.)

12-126

TABLE 2 DIMENSIONS OF LIGHT WEIGHT MILD STEEL BUTT HINGES

Size of Hinge (1) mm	Length A (2) mm	Breadth B (3) mm	Thickness of Flap C (4) mm	Diameter of Hinge Pin D (5) mm	No. of Knuckles (6)	No. of Screw Holes (7)	Holes for Screw No. (8)
15	15 ± 0·5	18 ± 1	0·63 ± 0·04	2·00 ± 0·08	3	4	2
25	25 ± 0·5	22 ± 1	0·71 ± 0·04	2·00 ± 0·08	3	4	2
40	40 ± 0·5	25 ± 1	0·80 ± 0·04	2·50 ± 0·08	3	4	3
50	50 ± 0·5	30 ± 1	0·90 ± 0·04	2·50 ± 0·08	3	4	3
65	65 ± 0·5	35 ± 1	1·00 ± 0·04	3·15 ± 0·08	3	6	4
75	75 ± 0·5	40 ± 1	1·12 ± 0·04	3·15 ± 0·08	5	6	5
100	100 ± 0·5	50 ± 1	1·25 ± 0·06	3·55 ± 0·08	5	8	6

NOTE — Dimension B is for uncranked hinge. For cranked hinge this dimension will increase accordingly.

PLATE : 12-P/29 (Contd.)

TABLE 3 DIMENSIONS OF MEDIUM WEIGHT MILD STEEL BUTT HINGES

Size of Hinge (1) mm	Length *A* (2) mm	Breadth *B* (3) mm	Thickness of Flap *C* (4) mm	Diameter of Hinge Pin *D* (5) mm	No. of Knuckles (6)	No. of Screw Holes (7)	Holes for Screw No. (8)
20	20± 0·5	20± 1	1·20± 0·06	2·00± 0·08	3	4	3
25	25± 0·5	25± 1	1·25± 0·05	2·24± 0·08	3	4	4
40	40± 0·5	30± 1	1·40± 0·05	2·50± 0·08	3	4	5
50	50± 0·5	37± 1	1·50± 0·06	3·15± 0·08	3	4	5
65	65± 0·5	42± 1	1·60± 0·06	3·55± 0·08	5	6	6
75	75± 0·5	47± 1	1·70± 0·06	4·00± 0·08	5	6	8
90	90± 0·5	52± 1	1·80± 0·06	5·00± 0·08	5	6	8
100	100± 0·5	58± 1	1·90± 0·06	5·60± 0·08	5	8	9
125	125± 0·5	65± 1	2·12± 0·06	5·60± 0·08	5	8	10
150	150± 0·5	75± 1	2·24± 0·08	6·30± 0·08	5	8	10

NOTE — Dimension *B* is for uncranked hinge. For cranked hinge, this dimension will increase accordingly.

PLATE : 12-P/2.9 (Contd.)

TABLE 4 DIMENSIONS OF BROAD TYPE MILD STEEL BUTT HINGES

Size of Hinge	Length A	Breadth B	Thickness of Flap C	Diameter of Hinge Pin D	No. of Knuckles	No. of Screw Holes	Holes for Screw No.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
mm	mm	mm	mm	mm			
50	50 ± 0·5	45 ± 1	1·50 ± 0·06	4·00 ± 0·08	3	4	6
75	75 ± 0·5	60 ± 1	1·70 ± 0·06	5·00 ± 0·08	5	6	8
100	100 ± 0·5	70 ± 1	1·90 ± 0·06	5·60 ± 0·08	5	8	9
125	125 ± 0·5	80 ± 1	2·12 ± 0·08	6·30 ± 0·08	5	8	10
150	150 ± 0·5	100 ± 1	2·24 ± 0·08	7·10 ± 0·08	5	8	10

NOTE — Dimension *B* is for uncranked hinge. For cranked hinge, this dimension will increase accordingly.

TABLE 5 DIMENSIONS OF SQUARE TYPE MILD STEEL BUTT HINGES

Size of Hinge	Length A	Breadth B	Thickness of Flap C	Diameter of Hinge Pin D	No. of Knuckles	No. of Screws per Hinge	Gauge for Screw No.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
mm	mm	mm	mm	mm			
50	50±0·5	50±1	1·70±0·06	3·00±0·08	3	4	8
65	65±0·5	65±1	1·80±0·06	3·60±0·08	3	6	8
75	75±0·5	75±1	2·00±0·06	[illegible]	3	6	8
90	90±0·5	90±1	[illegible]	[illegible]	[illegible]	6	[illegible]
100	100±0·5	100±1	2·50±0·06	[illegible]	[illegible]	[illegible]	[illegible]

NOTE — Dimension B is for uncranked hinge. For cranked hinge, this dimension will increase accordingly.

PLATE: 12-P/29 (contd.)

TABLE 6 DIMENSIONS OF HEAVY WEIGHT MILD STEEL BUTT HINGES

Size of Hinge	Length A	Breadth B	Thickness of Flap C	Diameter of Hinge Pin D	No. of Knuckles	No. of Screw Holes	Holes for Screw No.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
mm	mm	mm	mm	mm			
50	50± 0·5	40± 1	2·50± 0·06	4·00± 0·08	3	6	8
65	65± 0·5	50± 1	2·80± 0·06	5·00± 0·08	3	6	8
75	75± 0·5	60± 1	3·15± 0·06	5·00± 0·08	5	6	9
90	90± 0·5	65± 1	3·15± 0·06	5·00± 0·08	5	6	9
100	100± 0·5	75± 1	3·55± 0·08	6·30± 0·08	5	8	12
125	125± 0·5	90± 1	4·00± 0·08	7·10± 0·08	5	8	12
150	150± 0·5	100± 1·5	4·50± 0·10	8·00± 0·08	5	10	12
175	175± 0·5	115± 1·5	5·00± 0·10	9·00± 0·08	5	10	14
200	200± 0·5	130± 1·5	6·00± 0·10	10·00± 0·08	5	10	14

NOTE — Dimension B is for uncranked hinge. For cranked hinge, this dimension will increase accordingly.

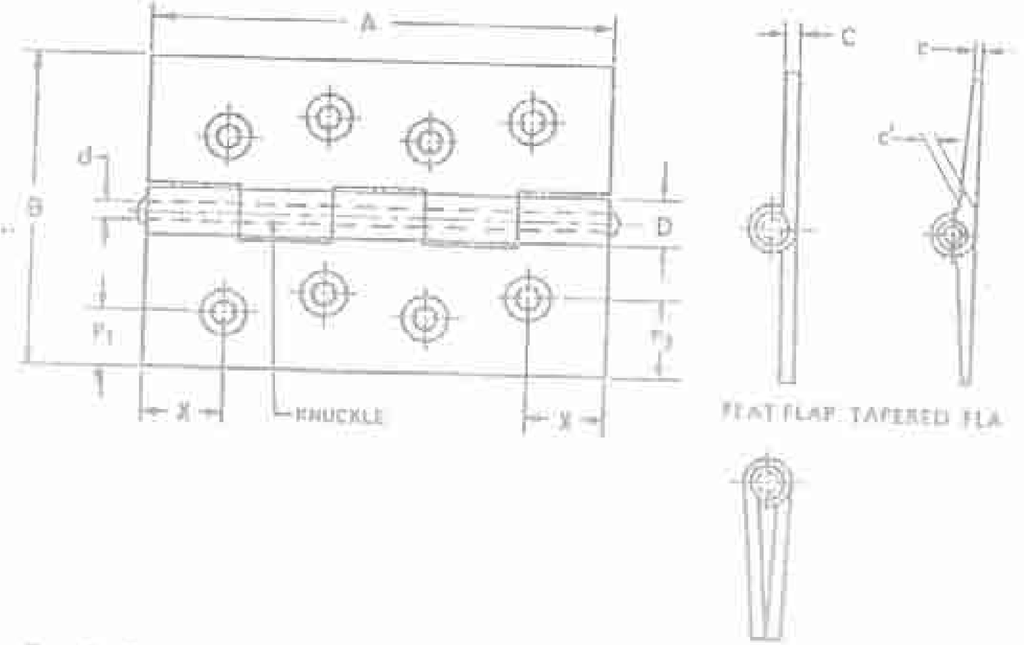


FIG. 1 BUTT HINGES (ALUMINIUM ALLOY, CAST BRASS OR EXTRUDED BRASS)

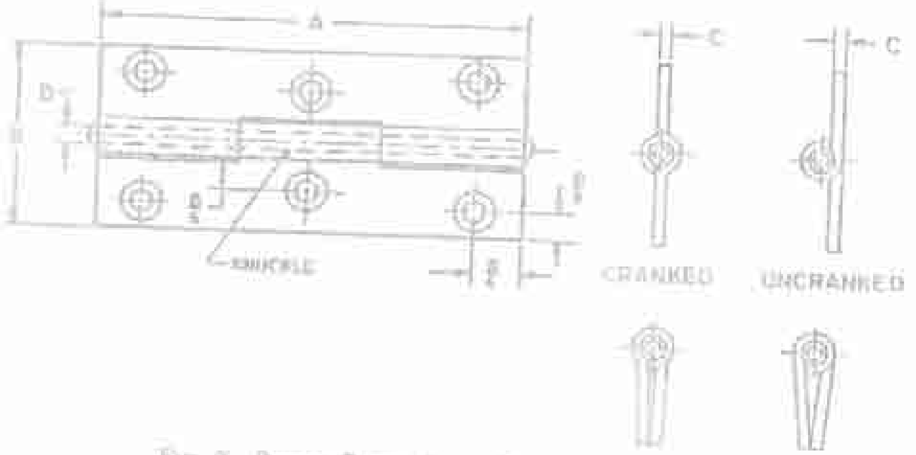


FIG. 2 SHEET BRASS BUTT HINGES (CRANKED)

PLATE: 12-P/306 (contd.)

TABLE 2 DIMENSIONS OF EXTRUDED ALUMINIUM ALLOY BUTT HINGES

Hinge Designation	Length A	Breadth B	Butt Dia D	Pin Dia d	Thickness of Flap C	Thickness of Flap C1	Holes for Screw Designation	No. of Screw Holes
(1)	(2) mm	(3) mm	(4) mm	(5) mm	(6) mm	(7) mm	(8)	(9)
150A22	150	75	14	5·00	4·0	4·8	12	12
125A22	125	75	14	5·60	4·0	4·8	12	10
125B21	125	63	13	5·30	4·0	4·8	10	10
125B22	125	63	11	4·00	4·0	4·8	10	10
125C22	125	63	10	3·55	3·2	4·0	10	10
100A22	100	75	14	5·60	4·0	4·8	12	8
100B21	100	63	13	5·30	4·0	4·8	10	8
100B22	100	63	11	4·00	4·0	4·8	10	8
100C22	100	63	10	3·55	3·2	4·0	10	8
90C22	90	63	10	3·55	3·2	4·0	10	8
75C21	75	63	13	5·30	4·0	4·8	10	6
75C22	75	63	11	4·00	4·0	4·8	10	6
75D22	75	63	10	3·55	3·2	—	9	6
75E22	75	45	7	2·50	3·2	—	8	6
75F22	75	40	7	2·50	2·5	—	6	6
65E22	65	45	7	2·50	3·2	—	[illegible]	[illegible]
65F22	65	40	7	2·50	2·5	—	8	6
50E22	50	45	7	2·50	3·2	—	6	4
50F22	50	40	[illegible]	2·50	2·5	—	6	4

TABLE 3 DIMENSIONS OF EXTRUDED BRASS BUTT HINGES

Hinges Designation	Length A	Breadth B	Butt Dia D	Pin Dia d	Thickness of Flap C	Holes for Screw Designation No.	No. of Screw Holes
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	mm	mm	mm	mm	mm		
150A11	150	75	11·5	5·0	5·0	12	12
150A12	150	75	9·5	4·0	4·0	11	12
125A11	125	75	11·5	5·0	5·0	12	10
125A12	125	75	9·5	4·0	4·0	11	10
125B11	125	65	9·5	4·0	4·0	10	10
125B12	125	65	7·5	3·0	3·0	10	10
125C11	125	65	9·5	4·0	4·0	10	10
125C12	125	65	7·5	3·0	3·0	10	10
125C21	125	60	9·5	4·0	4·0	10	10
125C22	125	60	7·5	3·0	3·0	10	10
100A11	100	75	11·5	5·0	5·0	12	8
100A12	100	75	9·5	4·0	4·0	11	8
100B11	100	65	9·5	4·0	4·0	10	8
100B12	100	65	7·5	3·0	3·0	10	8
100C11	100	65	9·5	4·0	4·0	10	8
100C12	100	65	7·5	3·0	3·0	10	8
100C22	100	60	7·5	3·0	3·0	10	8
100C32	100	55	7·5	3·0	3·0	10	8
100D11	100	50	7·5	3·0	3·0	9	8
90C11	90	55	7·5	3·0	3·0	10	8
90D11	90	50	7·5	3·0	3·0	9	8
75C11	75	55	7·5	3·0	3·0	10	6
75D11	75	50	7·5	3·0	3·0	9	6
75E11	75	40	7·5	3·0	3·0	8	6
75E12	75	40	4·5	1·5	1·5	6	6
75F11	75	30	4·5	1·5	1·5	6	6
65E11	65	40	7·5	3·0	3·0	8	6
65E12	65	40	4·5	2·0	1·5	6	6
65F11	65	30	4·5	2·0	1·5	6	6
50E11	50	40	7·5	3·0	3·0	8	4
50E12	50	40	4·5	2·0	1·5	6	4
50F11	50	40	4·5	2·0	1·5	8	4
40F11	40	40	4·5	2·0	1·5	6	4

PLATE : 12-P/30 (Contd.)

TABLE 4 DIMENSIONS OF CAST BRASS BUTT HINGES

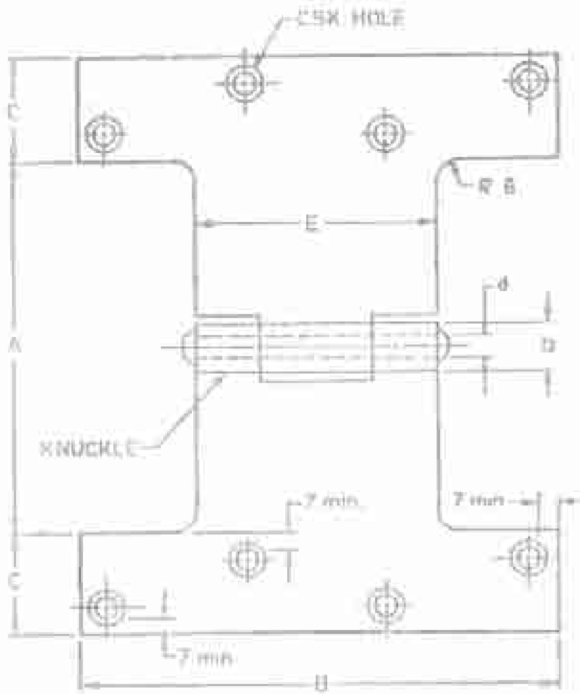
Hinge Designation (1)	Length A (2) mm	Breadth B (3) mm	Butt Dia D (4) mm	Pin Dia d (5) mm	Thickness of Flap C (6) mm	Holes for Screw Designation No. (7)	No. of Screw Holes (8)
150A11	150	85	12·5	5·5	5·5	12	12
150A12	150	85	11·5	5·0	5·0	12	12
125A11	125	85	12·5	5·5	5·5	12	10
125A12	125	85	11·5	5·0	5·0	12	10
125B11	125	75	11·5	5·0	5·0	12	10
125B12	125	75	9·5	4·0	4·0	10	10
125C11	125	70	11·5	5·0	5·0	12	10
125C12	125	70	9·5	4·0	4·0	10	10
125C21	125	65	11·5	5·0	5·0	12	10
125C22	125	65	9·5	4·0	4·0	10	10
100A11	100	85	12·5	5·5	5·5	12	8
100A12	100	85	11·5	5·0	5·0	12	8
100B11	100	75	11·5	5·0	5·0	12	8
100B12	100	75	9·5	4·0	4·0	10	8
100C11	100	70	11·5	5·0	5·0	12	8
100C12	100	70	9·5	4·0	4·0	10	8
100C21	100	65	11·5	5·0	5·0	12	8
100C22	100	65	9·5	4·0	4·0	10	8
100C23	100	65	7·5	3·0	3·0	10	8
100D11	100	55	9·5	4·0	4·0	10	8
90C11	90	65	9·5	4·0	4·0	10	8
90D11	90	55	9·5	4·0	4·0	10	8
75C11	75	65	9·5	4·0	4·0	10	6
75D11	75	55	9·5	4·0	4·0	10	6
75E11	75	40	8·0	3·5	3·5	8	6
75E12	75	40	6·5	2·5	2·5	6	6
75F11	75	35	6·5	2·5	2·5	6	6
65E11	65	60	8·0	3·5	3·5	8	6
65E22	65	40	6·5	2·5	2·5	6	6
65F11	65	35	6·5	2·5	2·5	6	6
50E11	50	40	8·0	3·5	3·5	8	4
50E12	50	40	6·5	2·5	2·5	6	4
50F11	50	35	6·5	2·5	2·5	6	4
40F11	40	30	6·5	2·5	2·5	6	4
30F11	30	25	6·5	2·5	2·5	6	4
25F11	25	25	6·5	2·5	2·5	6	4

TABLE 5 DIMENSIONS OF SHEET BRASS BUTT HINGES (FOR [illegible]T)

Hinge Designation (1)	Length A (2) mm	Breadth B (3) mm	Thickness of Flap C (4) mm	Dia of Hinge Pin D (5) mm	Holes for Screw Designation No. (6)	No. of Screw Holes (7)
25SB	25	15	1·00	1·80	[illegible]	4
30SB	30	15	1·00	1·80	[illegible]	4
40SB	40	20	1·15	2·00	[illegible]	[illegible]
50SB	50	25	~~1·25~~	2·00	4	4

12-135

PLATE : 12-P/31



All dimensions in millimetres.

FIG. 1 A TYPICAL PARLIAMENT HINGE

PLATE 12-P/32 (Contd.)

12-136

TABLE 1 DIMENSIONS FOR CAST BRASS PARLIAMENT HINGES

All dimensions in millimetres.

Size of Hinge	Width Between Flanges A	Length B	Width C	Diameter of Butt D	Diameter of Pin d	Length of Joint E	Thickness of Flap	Number of Screw Holes in Each Hinge	Holes for Screw Designation
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
50	50±1	100±1	20±1	8±0·9	4·5±0·10	48±1	3·5±0·3	6	8
65	63±1	100±1	20±1	8±0·3	4·5±0·10	48±1	2·5±0·3	6	8
75	75±1	100±1	20±1	8±0·3	4·5±0·10	48±1	3·5±0·3	6	8
100	100±1	125±1	27±1	12·5±0·3	6·5±0·10	63±1	5±0·3	8	10
125	125±1	125±1	27±1	12·5±0·3	6·5±0·10	63±1	5±0·3	8	10
150	150±1	125±1	27±1	12·5±0·3	6·5±0·10	63±1	5±0·3	8	10
175	175±1	125±1	27±1	12·5±0·3	6·5±0·10	63±1	5±0·3	8	10
200	200±1	125±1	27±1	12·5±0·3	6·5±0·10	63±1	5±0·3	8	10

TABLE 2 DIMENSIONS FOR ALUMINIUM ALLOY PARLIAMENT HINGES

All dimensions in millimetres.

Size of Hinge	Width Between Flanges A	Length B	Width C	Diameter of Butt D	Diameter of Pin d	Length of Joint E	Thickness of Flap	Number of Screw Holes	Holes for Screw Designation
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
50	50±1	100±1	20±1	10·5	4·5	48	3	6	8
65	65±1	100±1	20±1	10·5	4·5	48	3	6	8
75	75±1	100±1	20±1	10·5	4·5	48	3	6	8
100	100±1	125±1	27±1	16·5	6·3	63	5	8	10
125	125±1	125±1	27±1	16·5	6·3	63	5	8	10
150	150±1	125±1	27±1	16·5	6·3	63	5	8	10
175	175±1	125±1	27±1	16·5	6·3	[illegible]	5	8	10
200	200±1	125±1	27±1	[illegible]	[illegible]	63	5	8	10

NOTE — For dimensions given [illegible] shall be in accordance with IS : 3965-1981* and IS : 2378-1982†.

*Dimensions for [illegible]

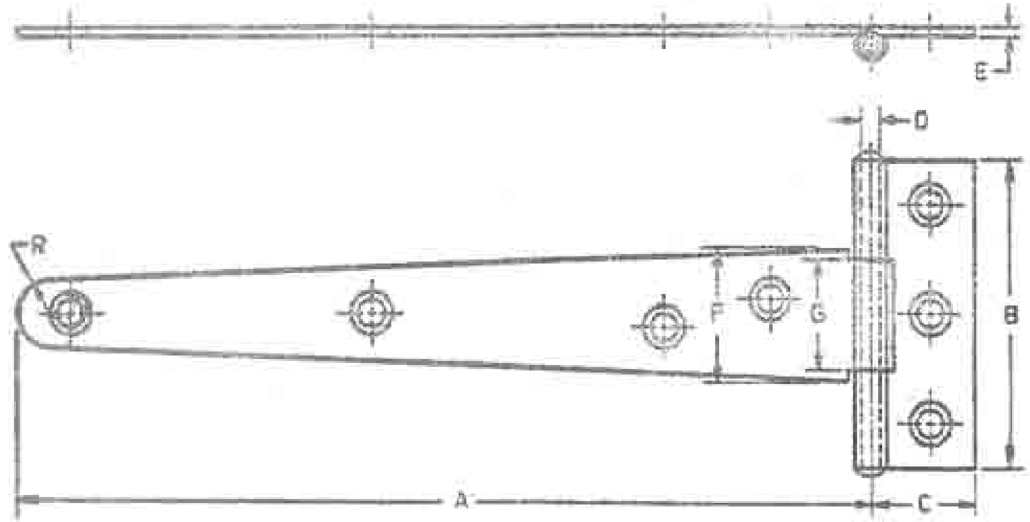
†[illegible]

TABLE 3 DIMENSIONS FOR MILD STEEL PARLIAMENT HINGES

All dimensions in millimetres.

Size of Hinge	Width Between Flanges A	Length B	Width C	Diameter of Butt D	Diameter of Pin d	Length of Joint E	Thickness of Flap	Number of Screw Holes	Holes for Screw Designation
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
50	50±2	100±1	20±1	—	6.3±0.06	48±1	2.24±0.08	6	8
65	65±2	100±1	20±1	—	6.3±0.06	48±1	2.24±0.08	6	8
75	75±2	100±1	20±1	—	6.3±0.06	48±1	2.24±0.08	6	8
100	100±3	125±1	27±1	—	8±0.06	63±1	2.5 ±0.06	8	10
125	125±3	125±1	27±1	—	8±0.06	63±1	2.5 ±0.06	8	10
150	150±3	125±1	27±1	—	8±0.06	63±1	2.5 ±0.06	8	10
175	175±3	125±1	27±1	—	8±0.06	63±1	2.5 ±0.06	8	10
200	200±3	125±1	27±1	—	8±0.06	63±1	2.5 ±0.06	8	10

PLATE: 12- P/32



TYPICAL MILD STEEL TEE HINGES

PLATE: 12-1/32 (Contd-)

TABLE 1 DIMENSIONS FOR MEDIUM WEIGHT TEE HINGES

All dimensions in millimetres.

Size	Dimensions								Size Designation of Countersunk Head Wood Screws	Number of Holes in Strap	Number of Holes in Tee
	A	*B*	*C*	*D*	*E*	*F*	*G*	*K*			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
75	75±2	65±1	20±1·5	3·15±0·05	1·60±0·10	25±2	20	5±1	6	3	3
100	100±2	70±1	20±1·5	3·15±0·05	1·60±0·10	30±2	25	5±1	6	3	3
125	125±2	75±1	25±1·5	4·00±0·05	1·60±0·10	35±2	30	6±1	8	4	3
150	150±2	75±1	25±1·5	4·00±0·05	1·60±0·10	40±2	35	6±1	8	4	3
200	200±2	90±1	25±1·5	5·00±0·05	2·00±0·10	45±2	40	8±1	8	4	3
250	250±3	100±1	30±1·5	5·60+0·06	2·24±0·10	45±2	40	8±1	9	5	3
300	300±3	115±1	30±1·5	6·30±0·06	2·24±0·10	50±2	45	8±1	9	5	3
350	350±3	120±1	35±1·5	6·30±0·06	2·50±0·10	55±2	50	8±1	10	7	4
400	400±3	135±1	35±1·5	6·30±0·06	2·50±0·10	60±2	55	8±1	10	7	4
450	450±3	140±1	45±1·5	8·00±0·06	2·50±0·10	60±2	55	9±1	12	7	4
500	500±3	150±1	50±1·5	10·00±0·06	3·15±0·10	65±2	60	9±1	12	8	4

NOTE — In straight cut medium weight Tee hinges dimension *F* shall be followed through.

140

PLATE : 12-P/32 (Contd.)

TABLE 2 DIMENSIONS FOR LIGHT WEIGHT TEE HINGES

All dimensions in millimetres.

SIZE	DIMENSIONS								SIZE DESIGNATION OF COUNTERSUNK HEAD WOOD SCREWS	NUMBER OF HOLES IN STRAP	NUMBER OF HOLES IN TEE
	A	*B*	*C*	*D*	*E*	*F*	*G*	*R*			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
75	75±2	60±1	20±1·5	2·80±0·05	1·60±0·10	25±2	20	5±1	6	3	3
100	100±2	65±1	20±1·5	3·15±0·05	1·60±0·10	30±2	25	6±1	6	3	3
125	125±2	65±1	20±1·5	3·15±0·05	1·60±0·10	30±2	25	6±1	6	4	3
150	150±2	65±1	20±1·5	3·15±0·05	1·60±0·10	30±2	25	6±1	6	[illegible]	3
200	200±2	70±1	25±1·5	4·00±0·05	1·60±0·10	30±2	25	8±1	8	4	[illegible]
250	250±2	80±1	30±1·5	4·00±0·05	2·00±0·10	35±2	30	8±1	8	5	3
300	300±2	100±1	30±1·5	5·00±0·05	2·00±0·10	40±2	35	8±1	8	5	3
350	350±2	105±1	35±1·5	5·00±0·05	2·00±0·10	50±2	45	8±1	[illegible]	7	4
400	400±2	120±1	35±1·5	5·60±0·06	2·24±0·10	50±2	45	8±1	[illegible]	7	4

NOTE — In straight cut light weight Tee hinges dimension *F* shall be followed through.

12-141

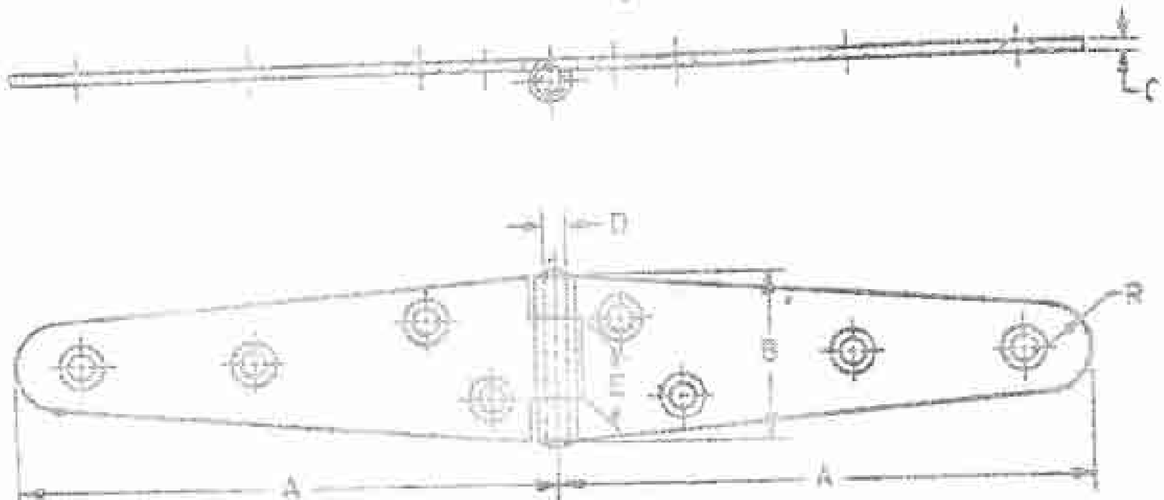
TABLE 3 DIMENSIONS FOR HEAVY WEIGHT TEE HINGES

All dimensions in millimetres.

SIZE	DIMENSIONS								SIZE DESIGNATION OF COUNTERSUNK HEAD WOOD SCREWS	NUMBER OF HOLES IN STRAP	NUMBER OF HOLES IN TEE
	A	*B*	*C*	*D*	*E*	*F*	*G*	*R*			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
150	150±2	100±1	30±2	8±0·06	3·15±0·10	50±2	40	8±1	10	4	3
200	200±2	115±1	40±2	10±0·06	3·15±0·10	55±2	45	8±1	10	4	3
250	250±2	120±1	40±2	10±0·06	3·15±0·10	60±2	50	8±1	10	5	4
300	300±2	125±1	45±2	10±0·06	3·15±0·10	60±2	50	9±1	10	6	4
350	350±4	125±1	45±2	10±0·06	3·15±0·10	60±2	50	9±1	10	6	4
400	400±4	135±1	50±2	12±0·06	4·00±0·10	65±2	55	9±1	12	7	4
450	450±4	135±1	50±2	12±0·06	4·00±0·10	65±2	55	10±1	12	7	4
500	500±4	150±1	65±2	12±0·06	5·00±0·10	70±2	60	10±1	14	8	4
600	600±4	165±1	70±2	12±0·06	5·00±0·10	75±2	65	10±1	14	8	4

NOTE — In straight cut heavy weight Tee hinges dimension *F* shall be followed through.

PLATE : 12-P/33



Typical Mild Steel Strap Hinges

PLATE : 12-F/33 (Contd.

12-144

TABLE 4 DIMENSIONS FOR LIGHT WEIGHT STRAP HINGES

All dimensions in millimetres

Size	Dimensions						Size Designation of Countersunk Head Wood Screws	Number of Holes in Strap
	A	B	C	D	E	R		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
75	75±2	25±1	1·60±0·10	2·80±0·05	10±1	5±1	6	3
100	100±2	30±1	1·60±0·10	3·15±0·05	15±1	6±1	6	3
125	125±2	30±1	1·60±0·10	3·15±0·05	15±1	6±1	6	4
150	150±2	30±1	1·60±0·10	3·15±0·05	15±1	6±1	6	4
200	200±2	30±1	1·60±0·10	4·00±0·05	15±1	8±1	8	4
250	250±2	35±1	2·00±0·10	4·00±0·05	15±1	8±1	8	5
300	300±2	40±1	2·00±0·10	5·00±0·05	20±1	8±1	8	5
350	350±2	50±1	2·00±0·10	5·00±0·05	25±1	8±1	9	7
400	400±2	50±1	2·24±0·10	5·00±0·06	25±1	8±1	9	7

PLATE : 12-P/83 (Contd.)

12-145

TABLE 2 DIMENSIONS FOR MEDIUM WEIGHT STRAP HINGES

All dimensions in millimetres.

* Size	Dimensions						Size Designation of Countersunk Head Wood Screws	Number of Holes in Strap
	A	*B*	*C*	*D*	*E*	*R*		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
75	75±2	25±1	1·60±0·10	3·15±0·05	10±1	5±1	6	3
100	100±2	30±1	1·60±0·10	3·15±0·05	15±1	6±1	6	3
125	125±2	35±1	1·60±0·10	4·00±0·05	15±1	6±1	8	4
150	150±2	40±1	1·60±0·10	4·00±0·05	20±1	6±1	8	4
200	200±2	45±1	2·00±0·10	5·00±0·05	20±1	8±1	8	4
250	250±2	45±1	2·24±0·10	5·60±0·06	20±1	8±1	9	5
300	300±2	50±1	2·24±0·10	6·30±0·06	25±1	8±1	9	5
350	350±2	55±1	2·50±0·10	6·30±0·06	25±1	8±1	10	7
400	400±2	60±1	2·50±0·10	6·30±0·06	30±1	8±1	10	7
450	450±2	60±1	2·50±0·10	8·00±0·06	30±1	9±1	12	7
500	500±2	65±1	3·15±0·10	10·00±0·06	30±1	9±1	12	8

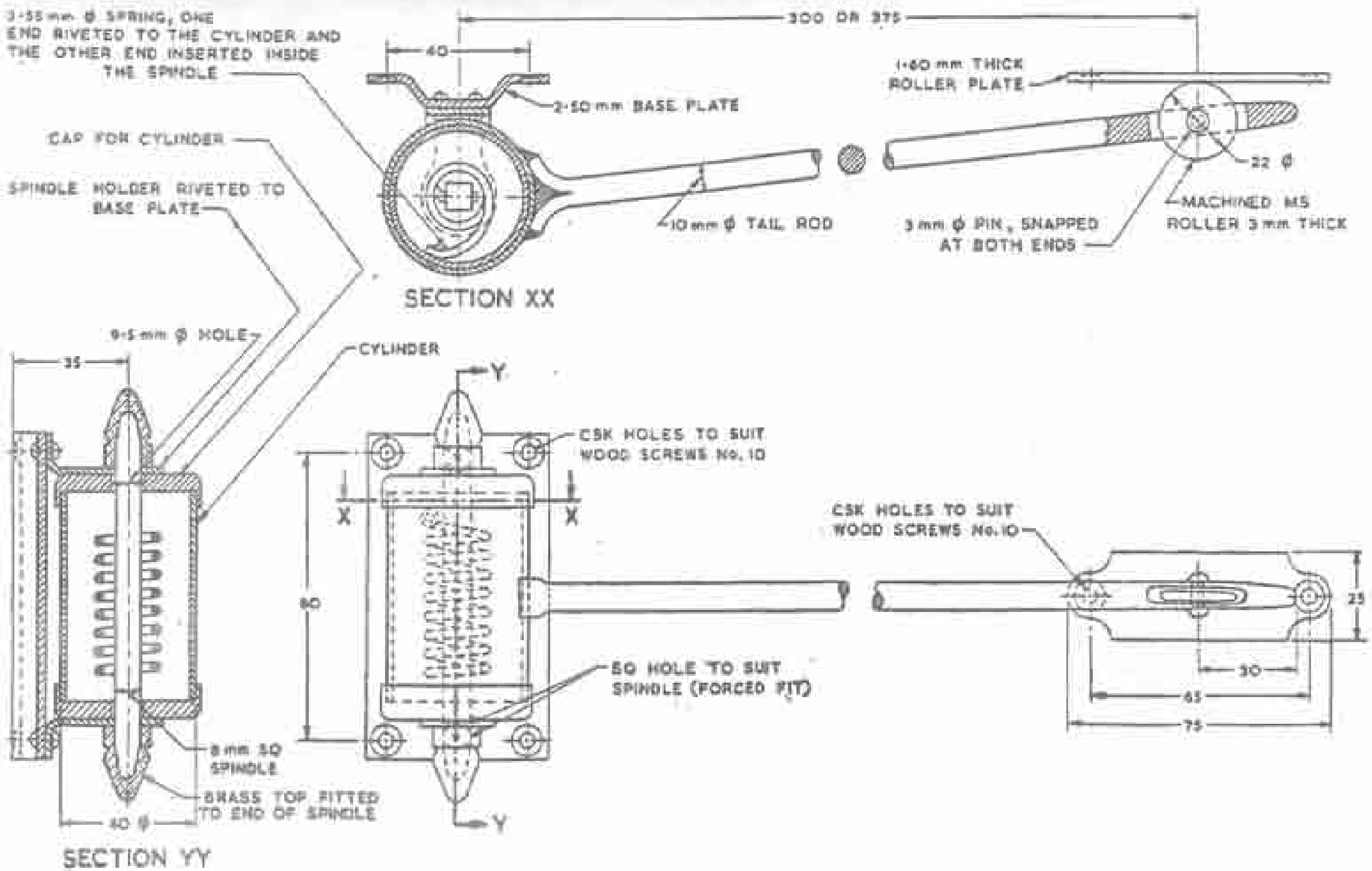
PLATE: 12-P/33 (Contd.)

TABLE 3 DIMENSIONS FOR HEAVY WEIGHT STRAP HINGES

All dimensions in millimetres.

Size	Dimensions						Size Designation of Countersunk Head Wood Screws	Number of Holes in Strap
	A	B	C	D	E	R		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
150	150±2	50±1	3·15±0·10	8±0·06	25±1	8±1	10	4
200	200±2	55±1	3·15±0·10	10±0·06	25±1	8±1	10	4
250	250±2	60±1	3·15±0·10	10±0·06	30±1	8±1	10	5
300	300±2	60±1	3·15±0·10	10±0·06	30±1	9±1	10	6
350	350±2	60±1	3·15±0·10	10±0·06	30+1	9±1	10	6
400	400±2	65±1	4·00±0·10	12±0·06	30±1	9±1	12	7
450	450±2	65±1	4·00±0·10	12±0·06	30+1	10±1	12	7
500	500±2	70±1	5·00±0·10	12±0·06	35±1	10±1	14	8
600	600±2	75±1	5·00±0·10	12±0·06	35±1	10±1	14	8

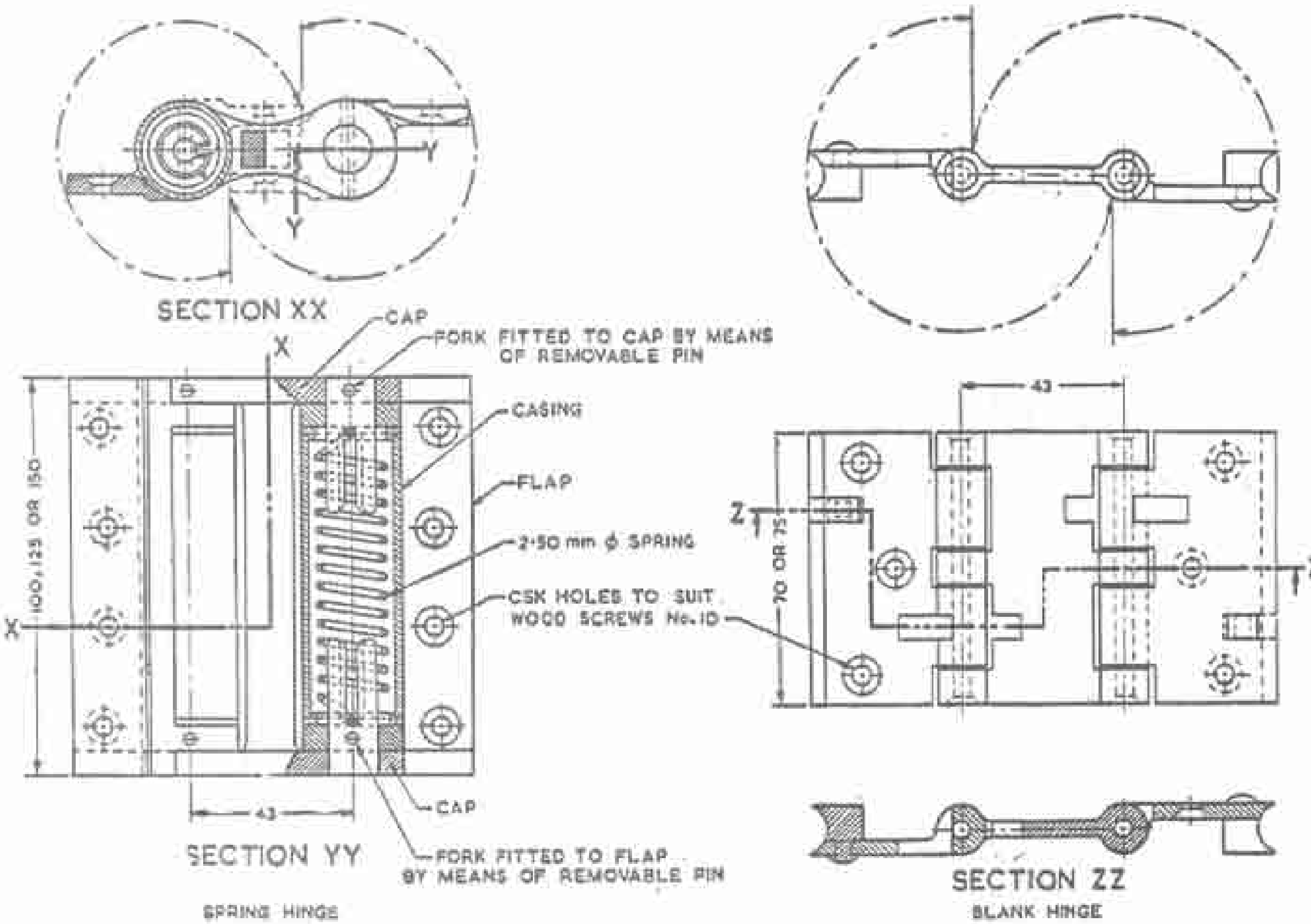
PLATE - 12 - P/34



All dimensions in millimetres.

– Typical Design of Rat-Tail Type Door Spring

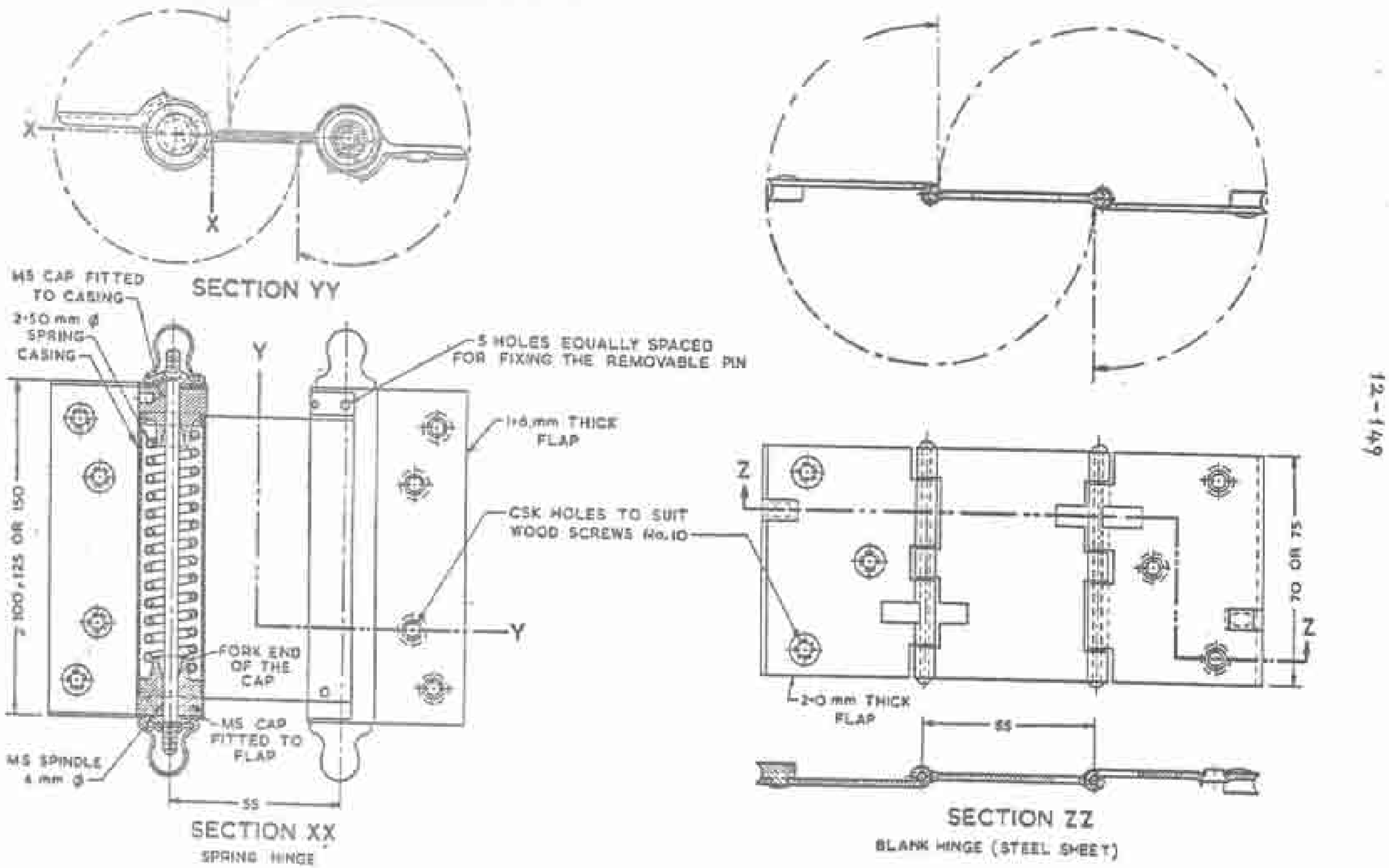
12-147



All dimensions in millimetres.

TYPICAL DESIGN OF BRASS DOUBLE-ACTING SPRING HINGE

PLATE: 12-9/35 (Contd.)



All dimensions in millimetres.

TYPICAL DESIGN OF MILD STEEL DOUBLE-ACTING SPRING HINGE

PLATE : 12-P/36

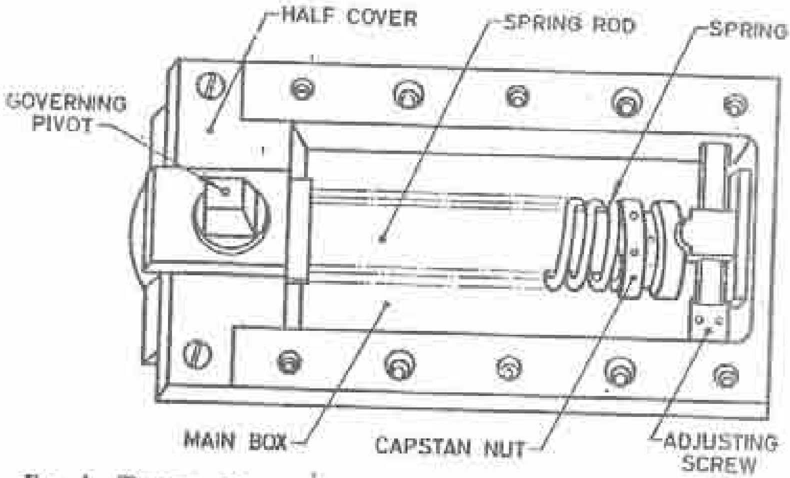


FIG. 1 TYPICAL DETAILS OF A DOUBLE ACTION FLOOR SPRING (WITHOUT OIL CHECK)

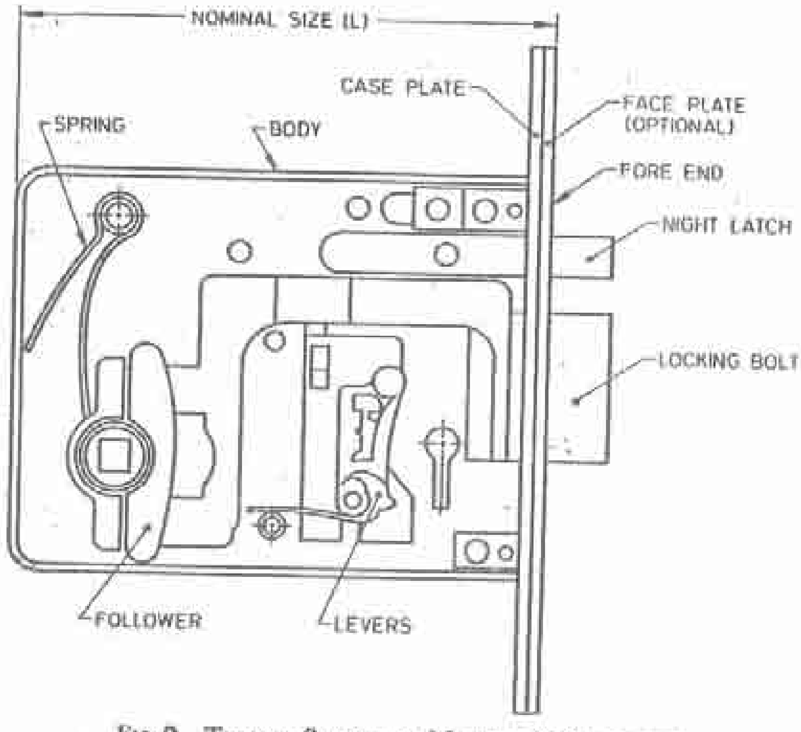
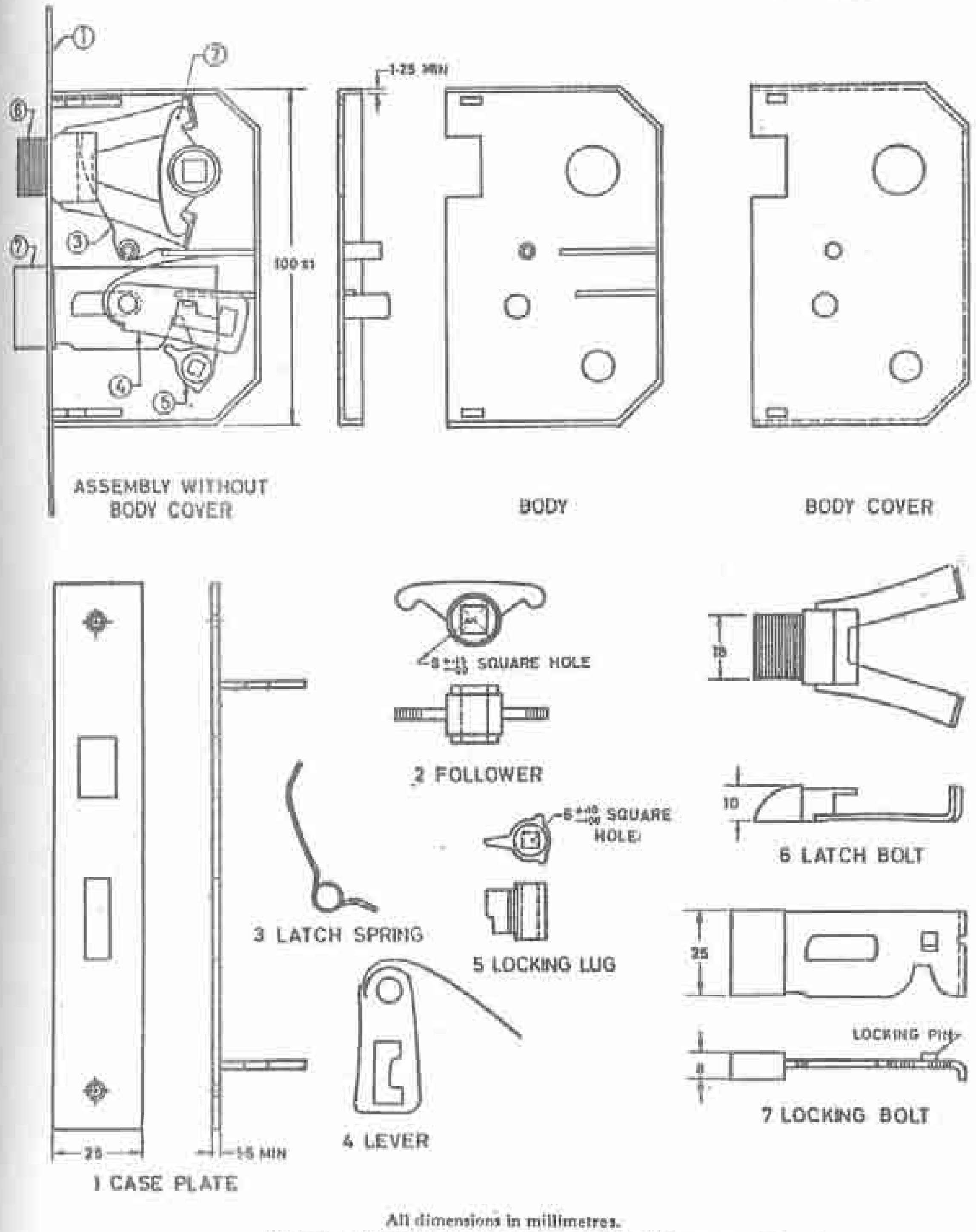


FIG. 2 TYPICAL SKETCH OF MORTICE NIGHT LATCH

PLATE : 12-P/37

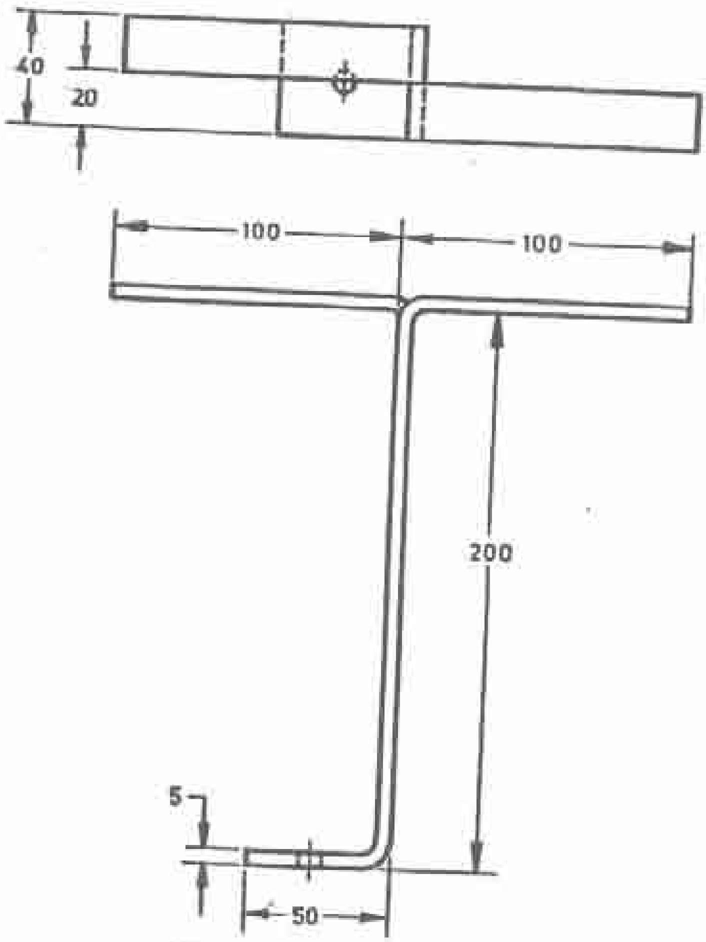


All dimensions in millimetres.

TYPICAL DESIGN OF MORTICE LATCH (VERTICAL TYPE)

12-152

PLATE : 12-P/3B

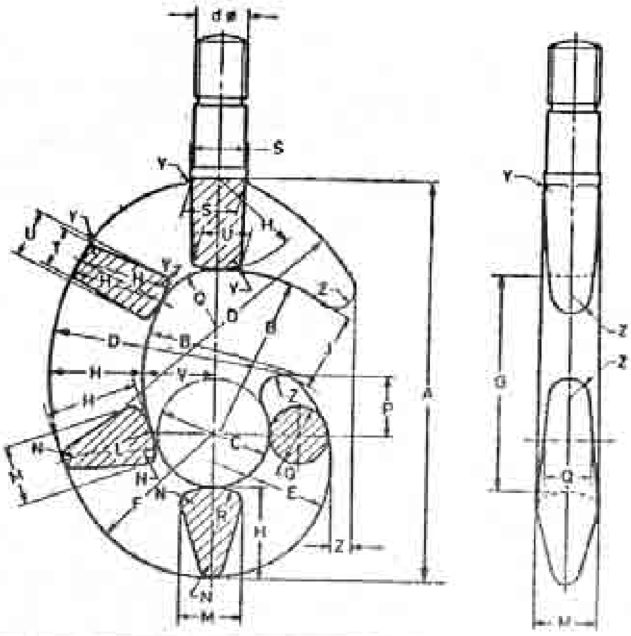


All dimensions in millimetres.

MILD STEEL HOLD FA

DIMENSIONS FOR 'C' HOOKS FOR USE WITH SWIVELS

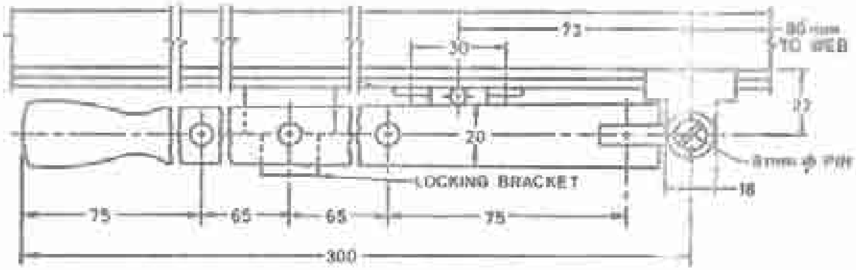
All dimensions in millimetres.



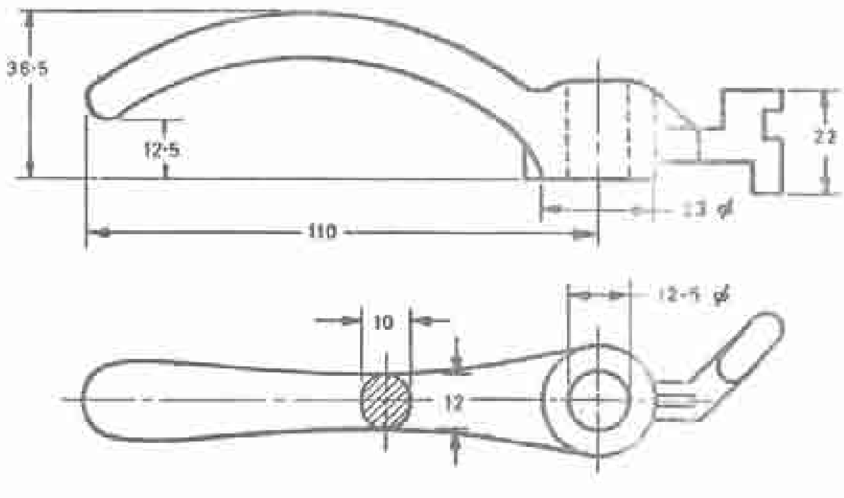
Safe Working Load, W Tonnes	$C = 34{\cdot}8\sqrt{W}$	Thread d	Size of Bearing when Used	A 3·68 C	B 1·50 C	D 2·34 C	E 1·05 C	F 1·34 C	G 2·00 C	H 0·84 C	J 0·71 C	L 0·63 C	M 0·55 C	N 0·10 C	P 0·54 C	Q 0·50 C	R 0·42 C	S 0·48 C	T 0·36 C	U 0·44 C	V 0·635 C	Y 0·05 C	Z 0·17 C
1·0	35	M16	17	129	52	82	37	47	70	29	25	22	19	4	19	18	15	17	13	15	22	2	6
2·0	49	M24	25	180	74	115	51	66	98	41	35	31	27	5	26	25	21	24	18	22	31	2	8
3·2	62	M30	30	228	93	145	65	83	124	52	44	39	34	6	33	31	26	30	22	27	39	3	11
5·0	78	M36	40	286	117	182	82	105	156	65	55	49	43	8	42	39	33	37	28	34	50	4	13
6·3	87	M42	45	320	131	205	92	117	175	73	62	55	48	9	46	44	37	42	31	38	55	4	15
8·0	98	M48	45	360	147	230	103	131	196	82	70	62	54	10	53	49	41	47	35	43	62	5	17
10·0	110	M52	53	405	165	258	115	147	220	92	78	69	60	11	59	55	46	53	40	48	70	5	19
12·5	123	M56	60	450	184	288	129	165	246	103	87	77	68	12	66	62	52	59	44	54	78	6	21

NOTE — Locking pin hole in nut shall be drilled with a lap from edge equal to diameter of locking pin in position.

PLATE: 12-P/4.0



A Typical Sketch of Window Stay



B Typical Sketch of Window Fastener

All dimensions in millimetres.

WINDOW STAY AND FASTENER

PLATE : 12-P/41

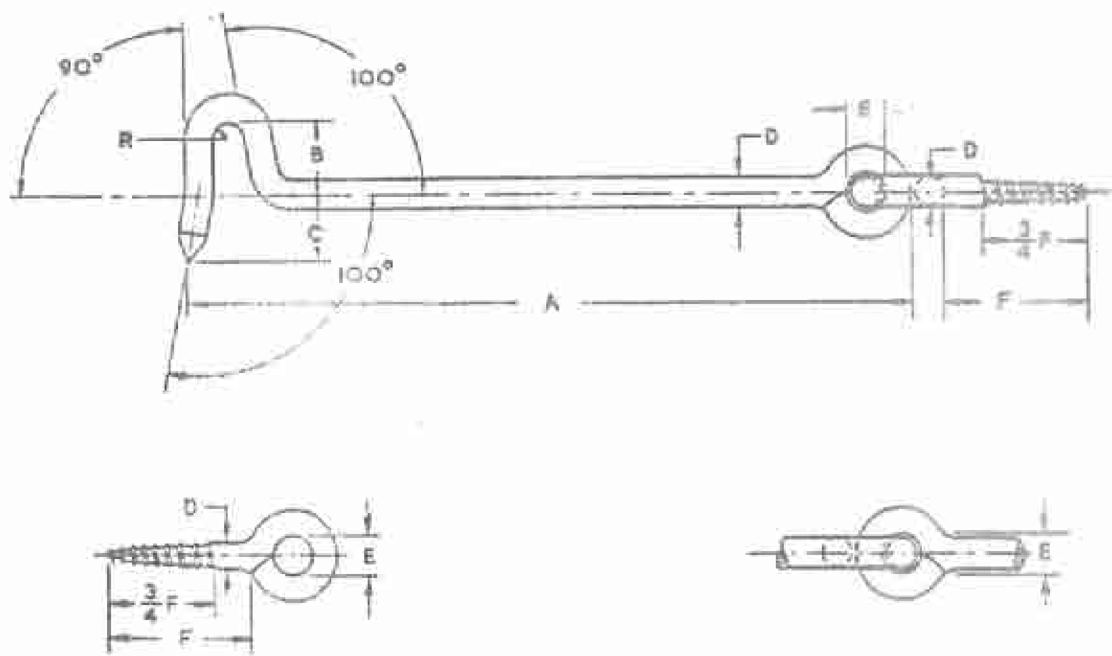


Fig. 1 Mild Steel and Brass Gate and Shutter Hooks and Eyes

12-155

PLATE: 12-P/41 (contd.)

TABLE 1 DIMENSIONS OF MILD STEEL AND BRASS GATE AND SHUTTER HOOKS AND EYES

SIZE	*A*	*B* Approx	*C* Approx	*D** Screw Designation No.	*D** Dia of Unthreaded Shank	*E* ($D^* + 1·5$)	*F* Approx	*R*
mm	mm	mm	mm		mm	mm	mm	mm
65	65 ± 2	10	9	8	4·17	5·7	14·0	2·2
75	75 ± 2	11	10	9	4·52	6·0	15·0	2·4
100	100 ± 2	13	12	11	5·23	6·7	17·5	2·8
125	125 ± 2	15	14	12	5·59	7·1	18·5	3·0
150	150 ± 2	15	14	12	5·59	7·1	18·5	3·0
200	200 ± 2	16	14	14	6·30	7·8	20·5	3·4
250	250 ± 2	17	15	14	6·30	7·8	20·5	3·4
300	300 ± 3	17	15	16	7·01	8·5	23·0	3·7

*Screw designation No. and dia of unthreaded shank conform to those given in IS : 451-1972 Specification for Wood Screws (*Revised*).

PLATE : 12-P/41 (Contd.)

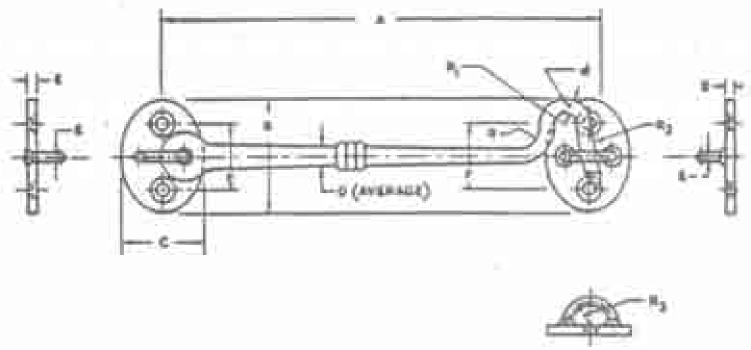
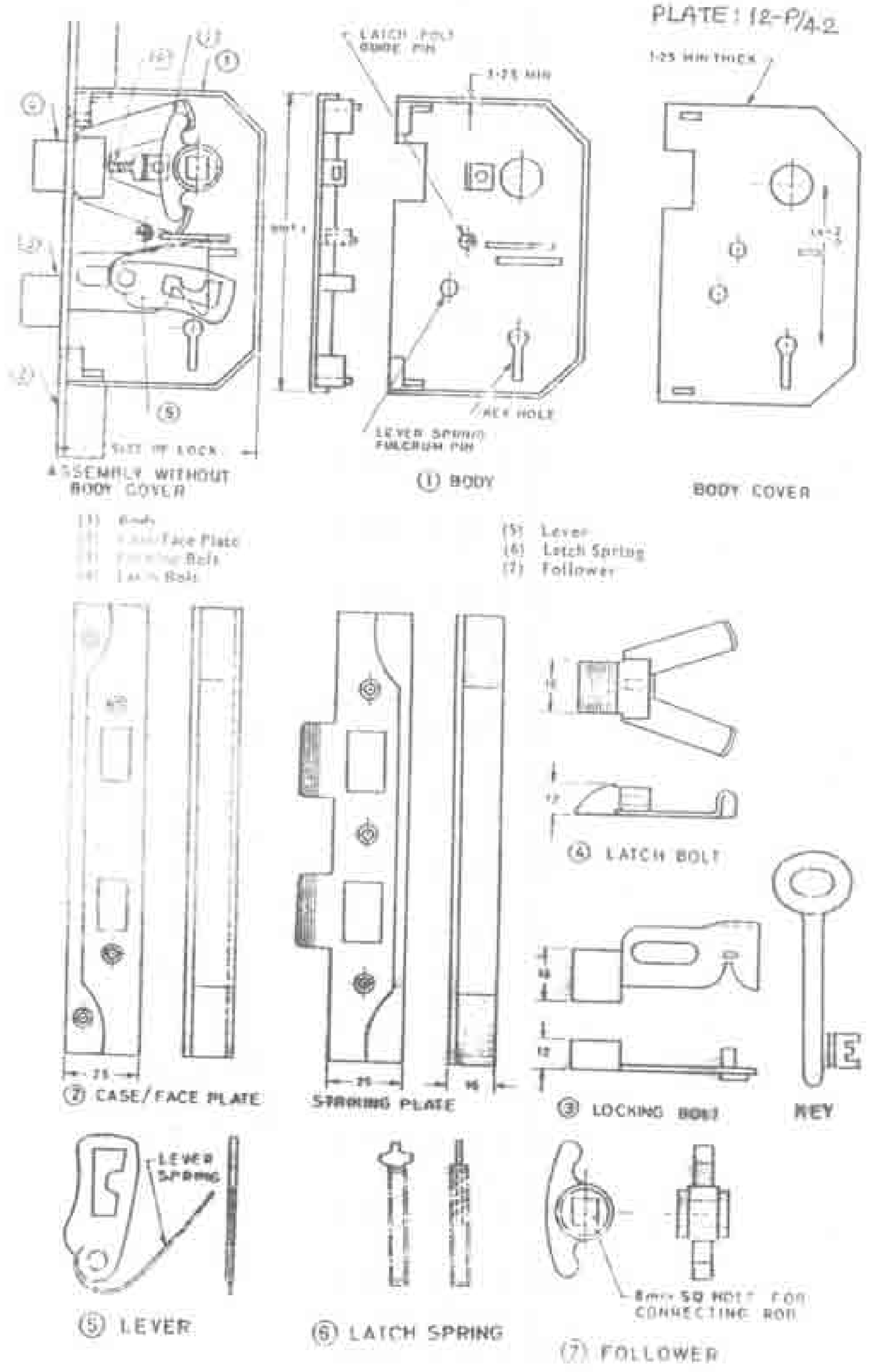


FIG. 2 CAST BRASS HOOKS AND PLATES

TABLE II DIMENSIONS OF CAST BRASS HOOKS AND PLATES

SIZE	A	B	C	D (AVERAGE)	d	E	F	R	R_1	R_2	R_3	SCREW HOLES FOR WOOD SCREW No.
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	
75	75±2	30±1	20±1	4·0±0·5	2·5±0·5	2·5±0·5	16±1	4±0·5	2·5±0·5	32±1	5·0±0·5	6
100	100±2	35±1	25±1	5·0±0·5	3·5±0·5	2·5±0·5	20±1	5±0·5	2·5±0·5	35±1	6·5±0·5	8
125	125±2	40±1	30±1	6·5±0·5	5·0±0·5	3·5±0·5	22±1	6±0·5	3·5±0·5	40±1	8·0±0·5	8
150	150±2	40±1	30±1	6·5±0·5	5·0±0·5	3·5±0·5	22±1	7±0·5	3·5±0·5	40±1	8·0±0·5	8
200	200±2	45±1	35±1	8·0±0·5	6·5±0·5	5·0±0·5	25±1	8±0·5	4·0±0·5	42±1	11·0±0·5	10

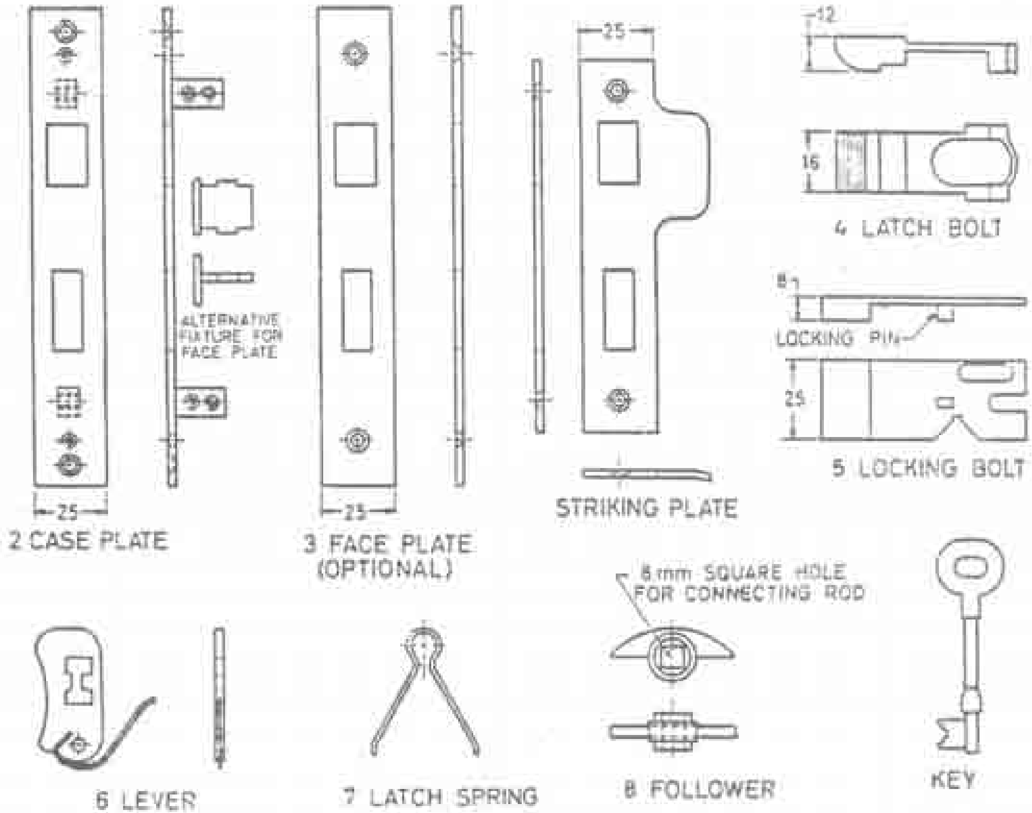
PLATE: 12-P/4.2



REBATED MORTICE LOCKS

All dimensions in millimetres.

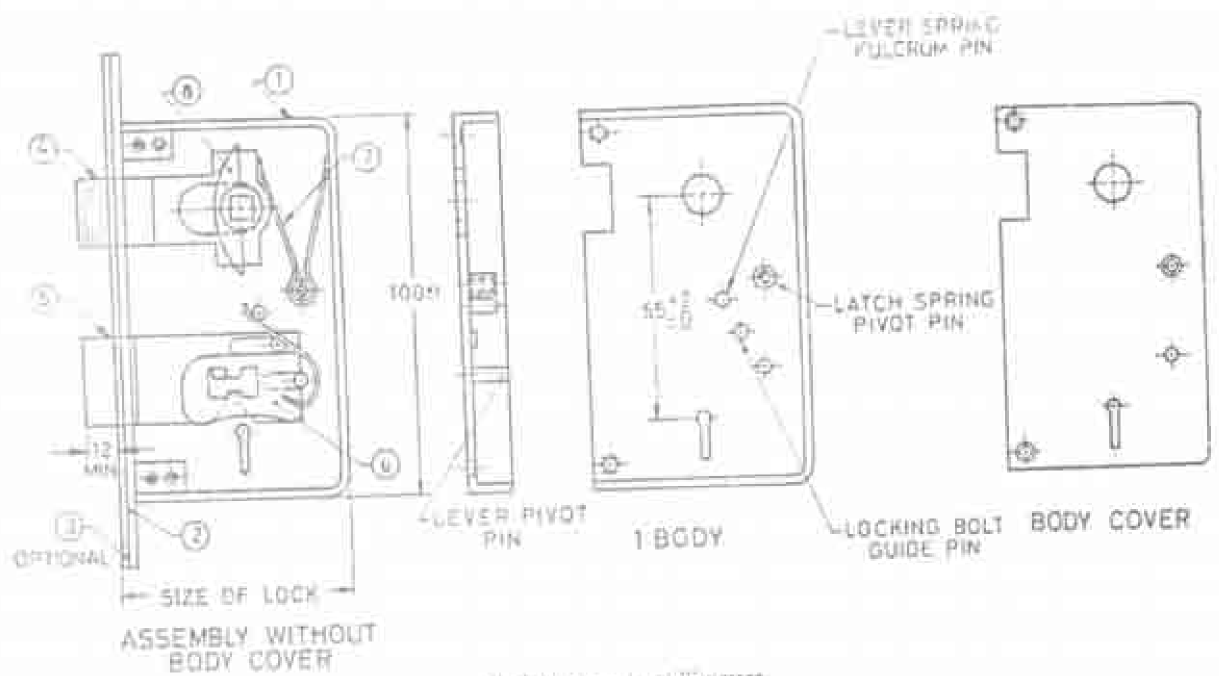
PLATE: 12-P/43



All dimensions in millimetres.

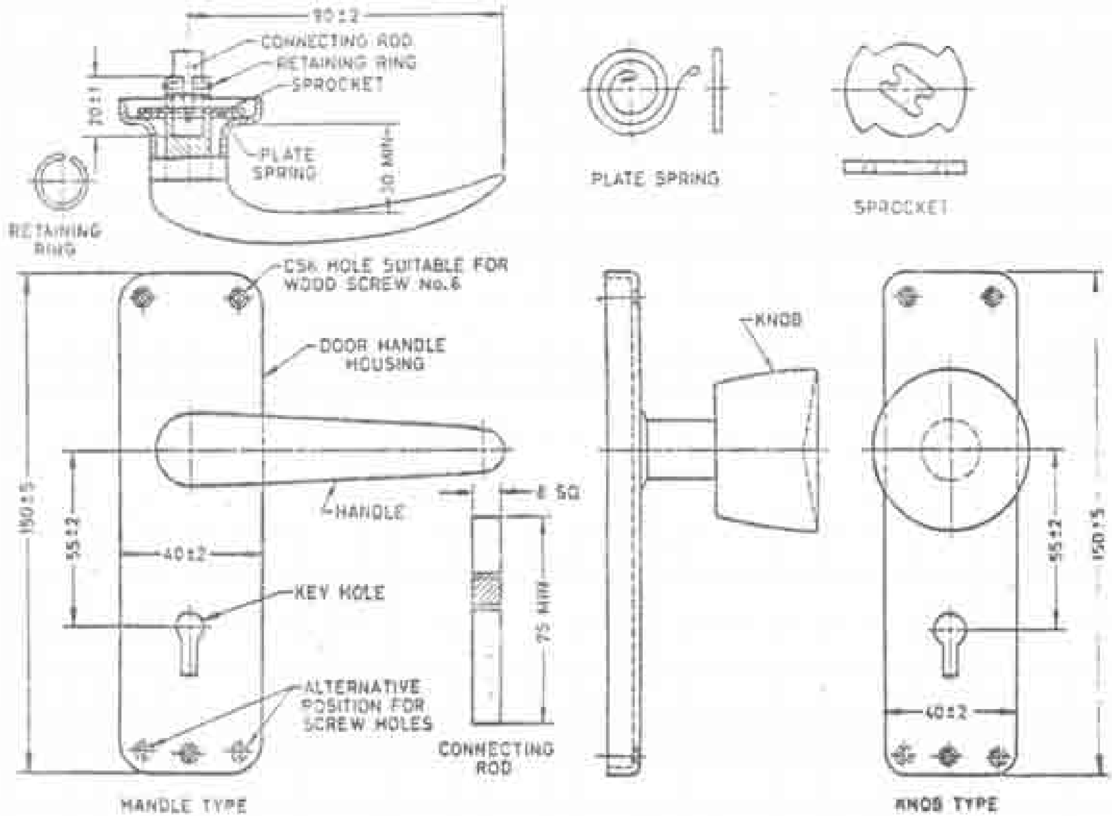
Fig. 1 Typical Design of Mortice Lock (Vertical Type)

12-159



All dimensions in millimetres.

FIG. 1 TYPICAL DESIGN OF MORTICE LOCK (VERTICAL TYPE) — *Contd*



NOTE — Shapes of the component parts are illustrative and not binding.

All dimensions in millimetres.

Door Handle for Mortice Lock (Vertical Type)

PLATE: 12-P/45

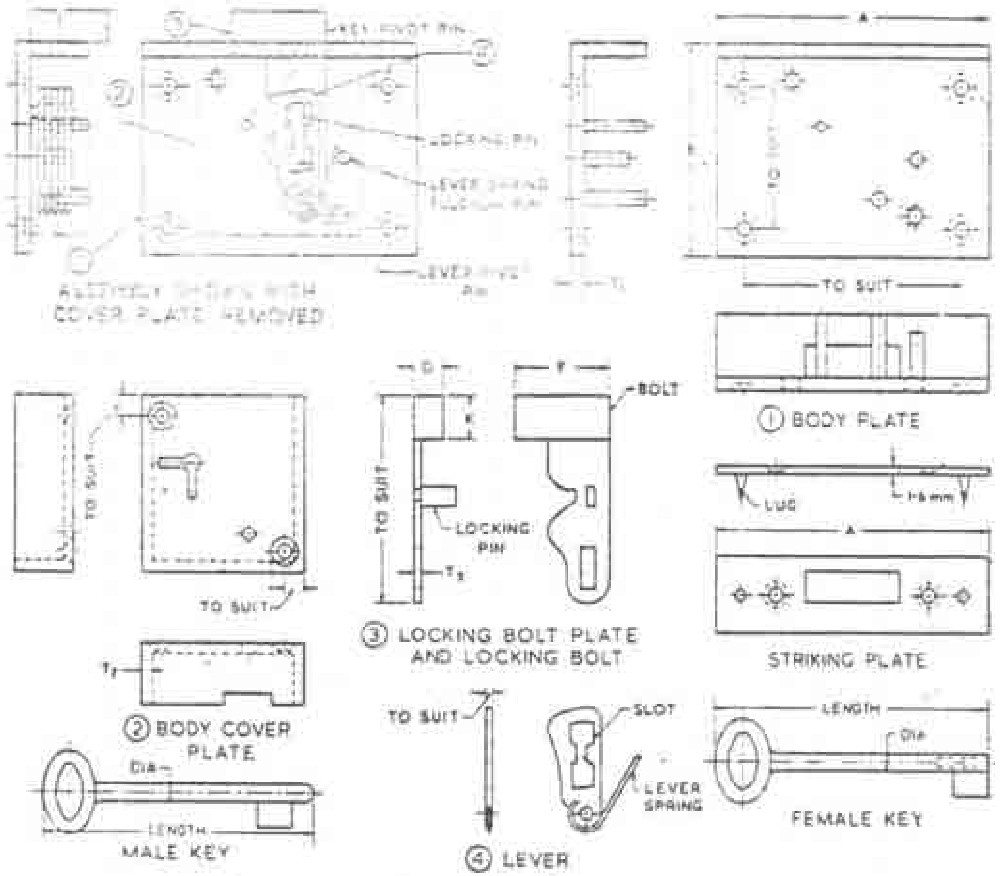


Fig. 1 Typical Design of Drawer Lock

PLATE: 12- P/45 (contd.)

12-163

TABLE 1 DIMENSIONS OF DRAWER LOCKS

All dimentions in millimetres.

Nominal Size	A	B	F	G	K	T_1 Casting	T_1 Sheet	T_2 Casting	T_2 Sheet	T_3 Casting	T_3 Sheet	Thickness of Spring Wire	Hole to Accommodate Screw of Designation No.	Keys: Thickness of Ward	Keys: Outside Dia	Keys: Length
			Min	*Min*	*Min*	*Min*	*Min*	*Min*	*Min*	*Min*	*Min*	*Min*				*Min*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
a) *Grade 1*																
40	40	29	14	5	5	2·0	1·25	2·0	1·25	1·6	1·25	0·90	4	1·6	3·2	40
50	50	38	17	6	6	2·0	1·25	2·0	1·25	2·0	1·25	1·25	4	1·8	3·6	50
65	65	48	22	7	7	2·0	1·25	2·0	1·25	2·0	1·25	1·25	6	2·0	4·5	65
75	75	50	24	8	8	2·5	1·25	2·5	1·25	2·5	1·25	1·60	6	2·2	5·0	75
b) *Grade 2*																
40	40	29	14	5	5	2·0	1·25	1·6	1·25	1·6	1·25	0·90	4	1·6	3·2	40
50	50	36	17	6	6	2·0	1·25	1·6	1·25	1·6	1·25	1·25	4	1·8	3·6	50
65	65	38	20	7	7	2·0	1·25	1·6	1·25	1·6	1·25	1·25	6	2·0	4·5	65
75	75	41	22	8	8	2·0	1·25	2·0	1·25	2·0	1·25	1·25	6	2·0	4·5	75
Tolerances	±2	±1	—	—	—	—	—	—	—	—	—	—	—	±0·2	±0·3	—

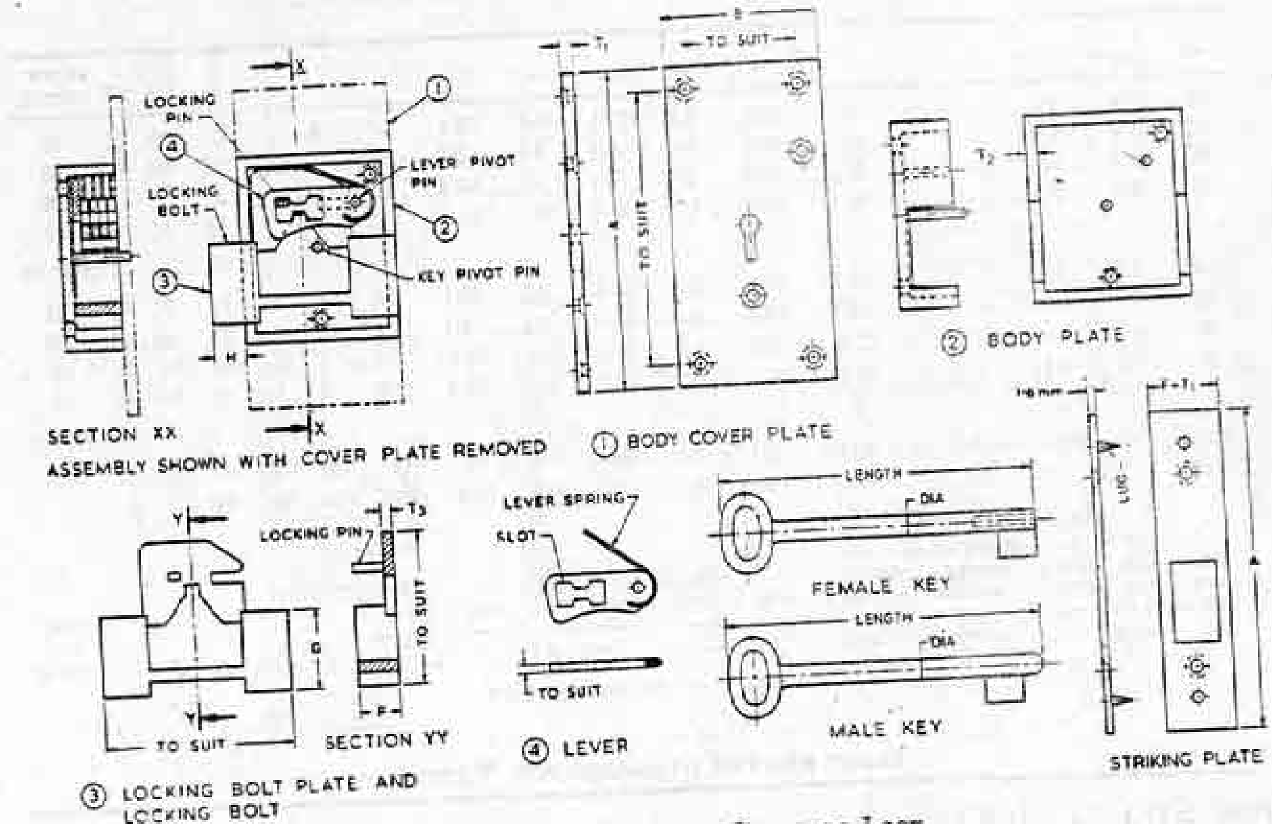


FIG. 2 TYPICAL DESIGN OF CUPBOARD LOCK

PLATE : 12-P/45 (Contd.)

TABLE 2 DIMENSIONS OF CUPBOARD LOCKS

All dimensions in millimetres.

Nominal Size	A	B	F	G	H	T_1 Casting	T_1 Sheet	T_2 Casting	T_2 Sheet	T_3 Casting	T_3 Sheet	Thickness of Spring Wire	Holes to Accommodate Screw of Designation No.	Keys: Thickness of Ward	Keys: Outside Dia	Keys: Length
			Min	*Min*	*Min*	*Min*	*Min*	*Min*	*Min*	*Min*	*Min*	*Min*				*Min*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
a) *Grade 1*																
40	40	29	8	11	6	2	1·25	2	1·25	1·6	1·25	0·9	4	1·6	3·2	40
50	50	32	8	13	6	2	1·25	2	1·25	2	1·25	1·25	4	1·8	3·6	50
65	65	35	10	16	8	2	1·25	2	1·25	2	1·25	1·25	6	2	4·5	65
75	75	38	10	19	8	2·5	1·25	2·5	1·25	2·5	1·25	1·6	6	2·2	5	75
b) *Grade 2*																
40	40	27	7	9·5	5	1·6	1·25	2	1·25	1·6	1·25	0·9	4	1·6	3·2	40
50	50	29	7	11	5	1·6	1·25	2	1·25	1·6	1·25	1·25	4	1·8	3·6	50
65	65	32	8·5	14	7	1·6	1·25	2	1·25	1·6	1·25	1·25	6	2	4·5	65
75	75	35	8·5	16	7	2	1·25	2	1·25	2	1·25	1·6	6	2	5	75
Tolerances	±2	±1	—	—	—	—	—	—	—	—	—	—	—	±0·2	±0·3	—

PLATE: 12-P/4-5 (Contd.)

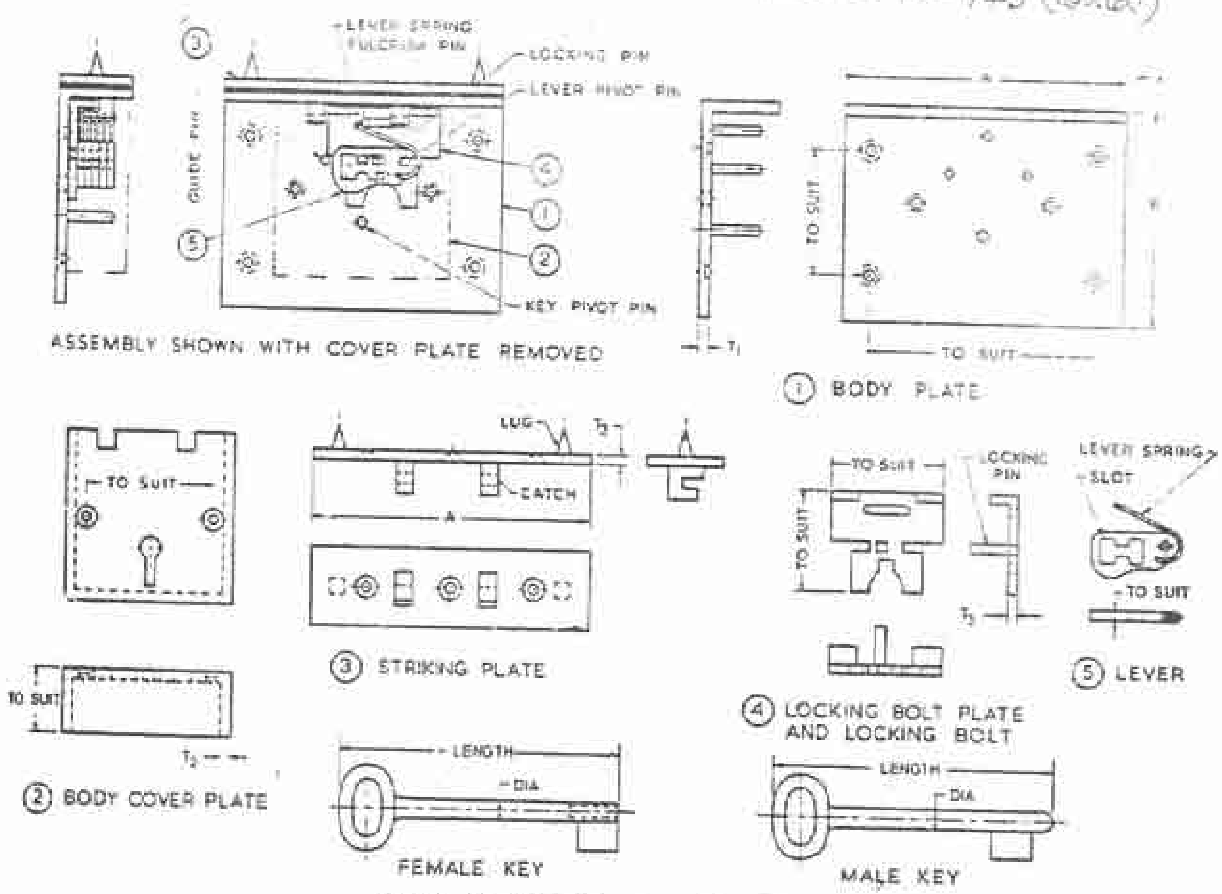


Fig. 3 Typical Design of Box Lock

PLATE : 12-P/45 (contd.)

TABLE 3 DIMENSIONS OF BOX LOCKS

All dimensions in millimetres.

Nominal Size	A	B	T_1 Casting	T_1 Sheet	T_2 Casting	T_2 Sheet	T_3 Casting	T_3 Sheet	Thickness of Spring Wire	Hole to Accommodate Screw of Designation No.	Keys: Thickness of Ward	Keys: Outside Dia	Keys: Length
			Min	*Min*	*Min*	*Min*	*Min*	*Min*	*Min*				*Min*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
a) *Grade 1*													
40	40	29	2	1·25	2	1·25	1·6	1·25	0·9	4	1·6	3·2	40
50	50	38	2	1·25	2	1·25	2	1·25	1·25	4	1·8	3·6	50
65	65	48	2	1·25	2	1·25	2	1·25	1·25	6	2	4·5	65
75	75	50	2·5	1·25	2·5	1·25	2·5	1·25	1·6	6	2·2	5	75
b) *Grade 2*													
40	40	29	2	1·25	1·6	1·25	1·6	1·25	0·9	4	1·6	3·2	40
50	50	36	2	1·25	1·6	1·25	1·6	1·25	1·33	4	1·8	3·6	50
65	65	38	2	1·25	1·6	1·25	1·6	1·25	1·25	6	2	4·5	65
75	75	41	2	1·25	2	1·25	2	1·25	1·6	6	2·2	5	75
Tolerances	±5	±1	—	—	—	—	—	—	—	—	±0·2	±0·3	—

PLATE: 12-P/46

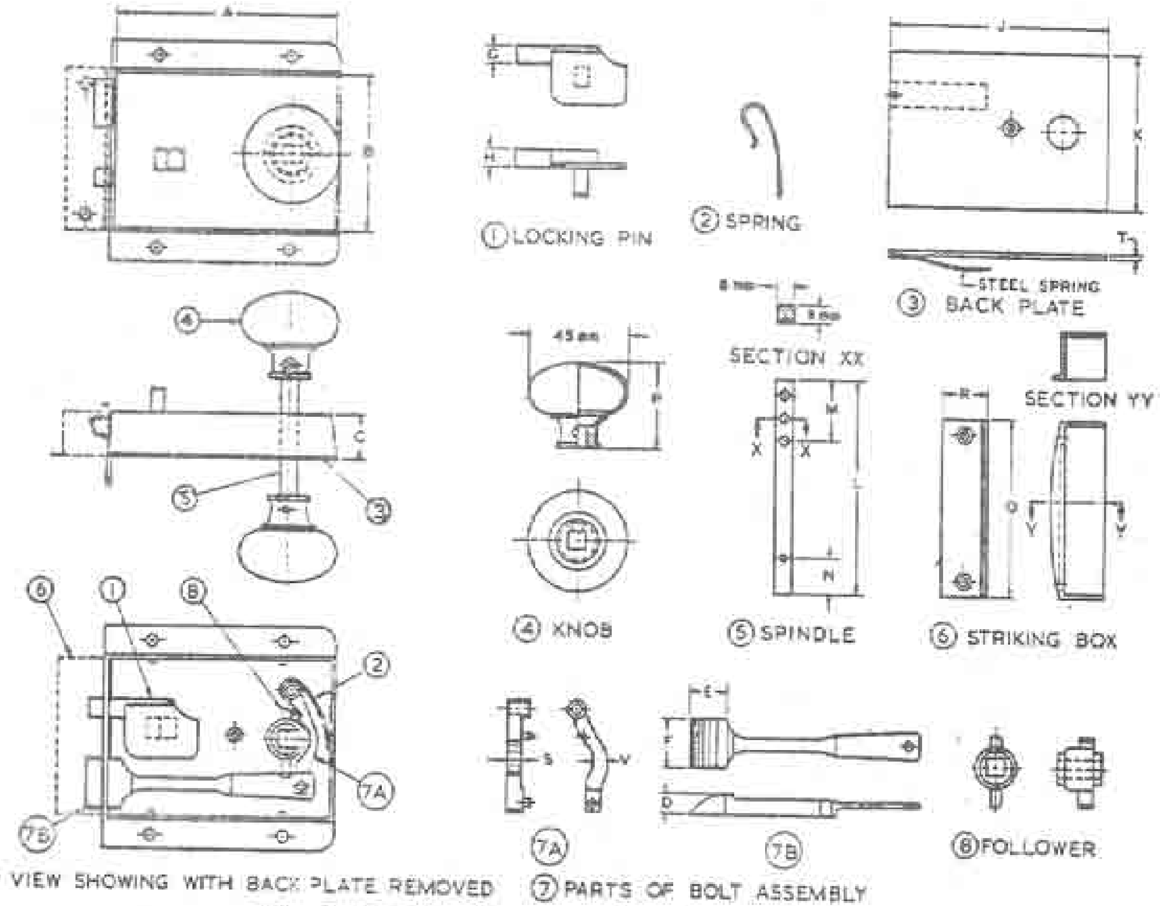


FIG. 1 TYPICAL DESIGN OF RIM LATCH — TYPE 1

12-168

TABLE 1 DIMENSIONS OF RIM LATCHES, TYPE 1

All dimensions in millimetres.

(a) *Mild Steel Latch*

SIZE OF RIM LATCH	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*J*	*K* (Approx)	*L*	*M*	*N*	*P*	*Q*	*R*	*S* Min	*T* Min	*V* Min
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
75	75	60	14	10·0	16	20	8·0	8·0	73	60	95	27	16	40	75	20	6	1·60	6
100	100	70	20	10·0	16	22	8·0	8·0	98	70	95	27	16	40	80	20	6	1·60	6
125	125	70	20	11·2	20	22	8·0	8·0	123	70	95	27	16	40	80	20	6	1·60	6
150	150	70	20	12·5	22	22	8·0	8·0	148	70	95	27	16	40	80	20	10	1·60	5
TOLERANCES	±1	±1	±1	±0·5	±1	±1	±0·5	±0·5	±0·5	—	±2	±1	±1	±1	±2	±1	—	—	—

(b) *Brass, Aluminium Alloy and Zinc Base Alloy Latches*

Same as for mild steel latch, except that the thickness of body plate and back plate shall be not less than 2·5 mm finished for 100 mm and 125 mm rim latches and not less than 3 mm for 150 mm rim latch.

PLATE: 12-P/46 (Contd.)

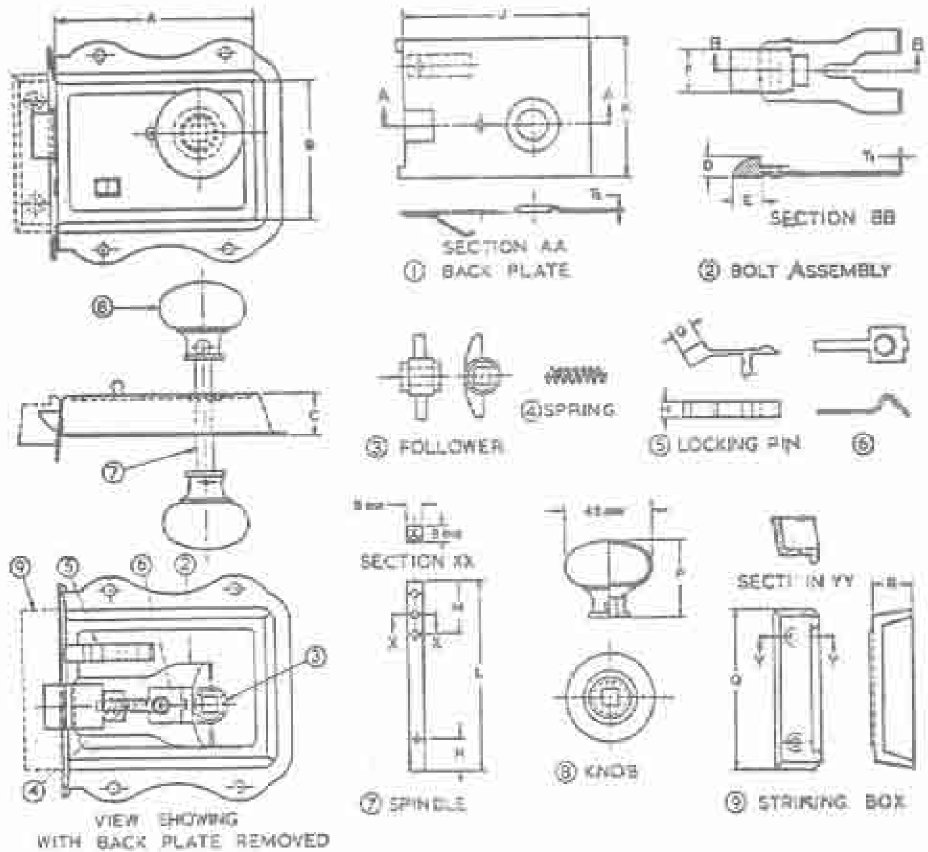


FIG. 2 TYPICAL DESIGN OF RIM LATCH — TYPE 2

PLATE: 12-P/47

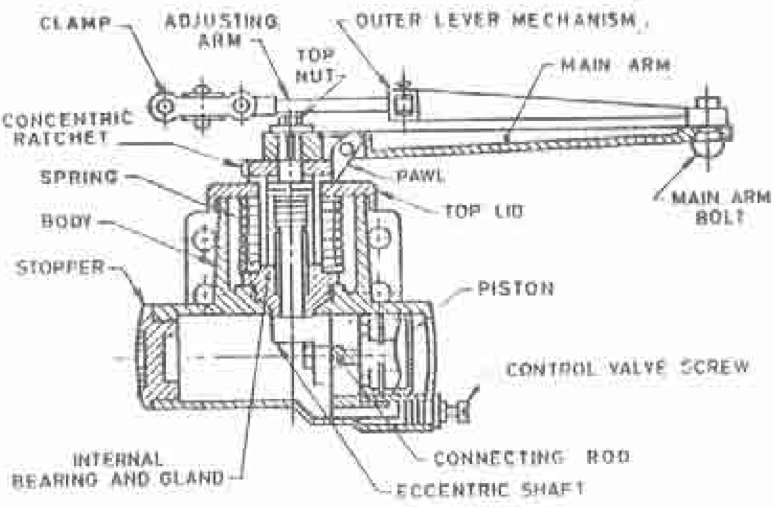


FIG. 1 TYPICAL SKETCH OF HYDRAULIC DOOR CLOSER SHOWING MAIN COMPONENTS

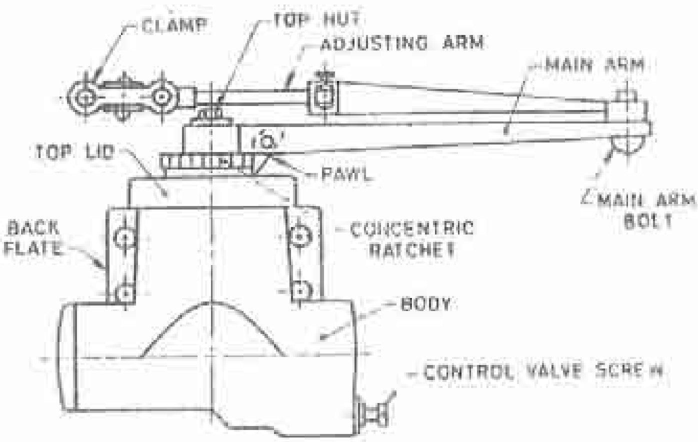
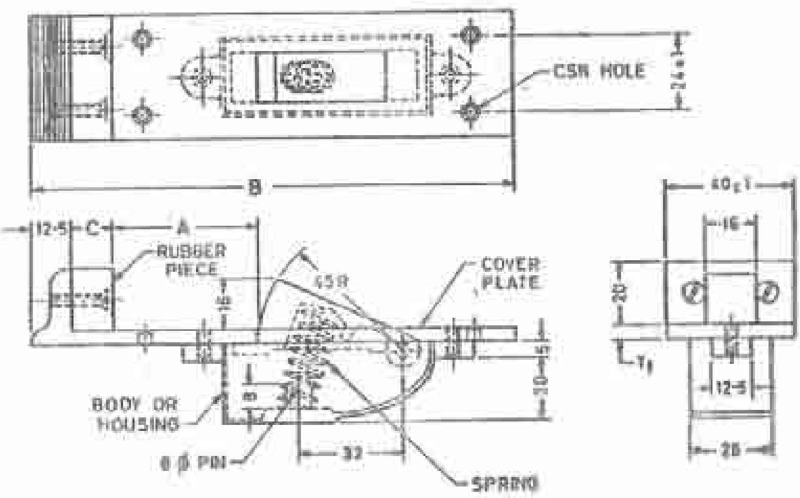


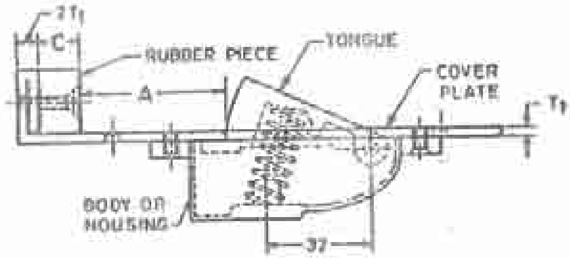
FIG. 2 TYPICAL ILLUSTRATION OF DOOR CLOSER (HYDRAULICALLY REGULATED)

12-173

PLATE: 12-P/48



A CAST TYPE



B CAST BODY OR HOUSING WITH SHEET METAL COVER

All dimensions in millimetres.

TYPICAL ILLUSTRATION OF FLOOR DOOR STOPPER

12-174

PLATE: 12-P/48
(contd.)

TABLE 1 DIMENSIONS AND TOLERANCES OF FLOOR DOOR STOPPERS

All dimensions in millimetres.

THICKNESS OF DOOR SHUTTER	*A*	*B*	*C* *Min*	*T1* Casting	*T1* Sheet	COUNTERSUNK WOOD SCREWS: Screw Designation for Casting	COUNTERSUNK WOOD SCREWS: Screw Designation for Sheet Metal	COUNTERSUNK WOOD SCREWS: No. of Holes
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
30	35	140	13	4·5	3	9	8	4
35	40	140	8	4·5	3	9	8	4
40	45	150	13	4·5	3	9	8	4
45	50	150	8	4·5	3	9	8	4
TOLERANCES	±0·5	±0·5	—	+0·3 −0	+0·3 −0	—	—	—

PLATE: 12-P/4.9

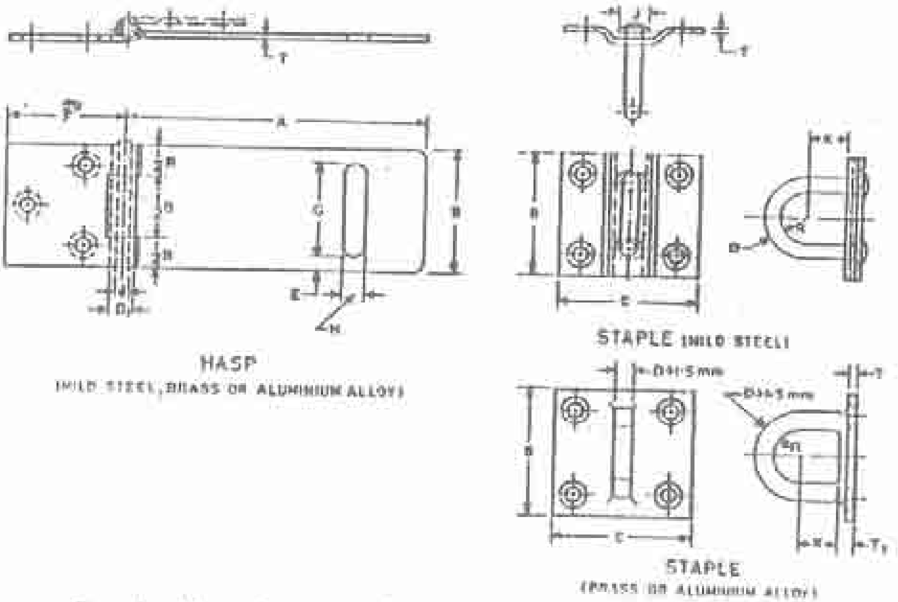


FIG. 1 MILD STEEL OR BRASS OR ALUMINIUM ALLOY HASPS AND STAPLES (SAFETY TYPE).

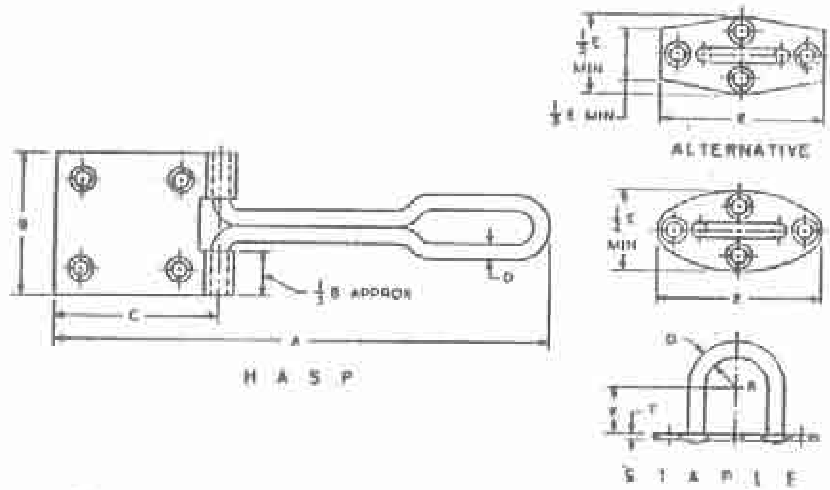


FIG. 2 MILD STEEL HASPS AND STAPLES (WIRE TYPE)

PLATE: 12-P/49 (Contd.) -

TABLE 1 DIMENSIONS OF MILD STEEL HASPS AND STAPLES — TYPE 1

Size	A	B	C	D	E	F	G	H	J	K	R	Thickness of Sheet, T	Dia of Hinge Pin, d	Screw Holes: No. on Hasp	Screw Holes: No. on Staple	Screw Holes: For Wood Screw No.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm			
90	90±2	38·0±1·5	46±2	5·00±0·10	5·0±0·5	35·0±1·5	28·0±0·5	8·0±0·5	12±1	8±1	8·0±0·5	2·00±0·10	4·00±0·10	3	4	8
115	115±2	38·0±1·5	46±2	5·00±0·10	5·0±0·5	55·0±1·5	28·0±0·5	8·0±0·5	12±1	8±1	8·0±0·5	2·00±0·10	4·00±0·10	3	4	8
150	150±2	45·0±1·5	60±2	6·30±0·10	6·0±0·5	65·0±1·5	33·0±0·5	10·0±0·5	15±1	14±1	9·0±0·5	2·24±0·10	5·00±0·10	4	6	10
175	175±2	45·0±1·5	60±2	6·30±0·10	6·0±0·5	65·0±1·5	33·0±0·5	10·0±0·5	15±1	14±1	9·0±0·5	2·24±0·10	5·00±0·10	4	4	10

TABLE 2 DIMENSIONS OF BRASS OR ALUMINIUM ALLOY HASPS AND STAPLES — TYPE 1

Size	A	B	C	D	E	F	G	H	K	R	Thickness: T	Thickness: T_1	Dia of Hinge Pin, d	Dia of Butt, D_1	Screw Holes: No. on Hasp	Screw Holes: No. on Staple	Screw Holes: For Wood Screw No.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm			
90	90±2	40·0±1·5	42·0±1·5	5·00±0·25	6·0±0·5	35±1	28·0±0·5	10·0±0·5	8±1	6·5±0·5	2·00±0·25	5·00±0·25	3·15±0·10	6·0±0·2	5	4	5
115	115±2	40·0±1·5	42·0±1·5	5·00±0·25	6·0±0·5	45±1	28·0±0·5	10·0±0·5	11±1	6·5±0·5	2·00±0·25	3·00±0·25	3·15±0·10	6·0±0·2	5	4	5
150	150±2	46·0±1·5	48·0±1·5	6·00±0·25	7·0±0·5	65±1	32·0±0·5	11·0±0·5	14±1	7·5±0·5	3·00±0·25	4·00±0·25	4·00±0·10	8·0±0·2	4	4	8
175	175±2	46·0±1·5	48·0±1·5	6·00±0·25	7·0±0·5	65±1	32·0±0·5	11·0±0·5	16±1	7·5±0·5	3·00±0·25	4·00±0·25	4·00±0·10	8·0±0·2	4	4	8

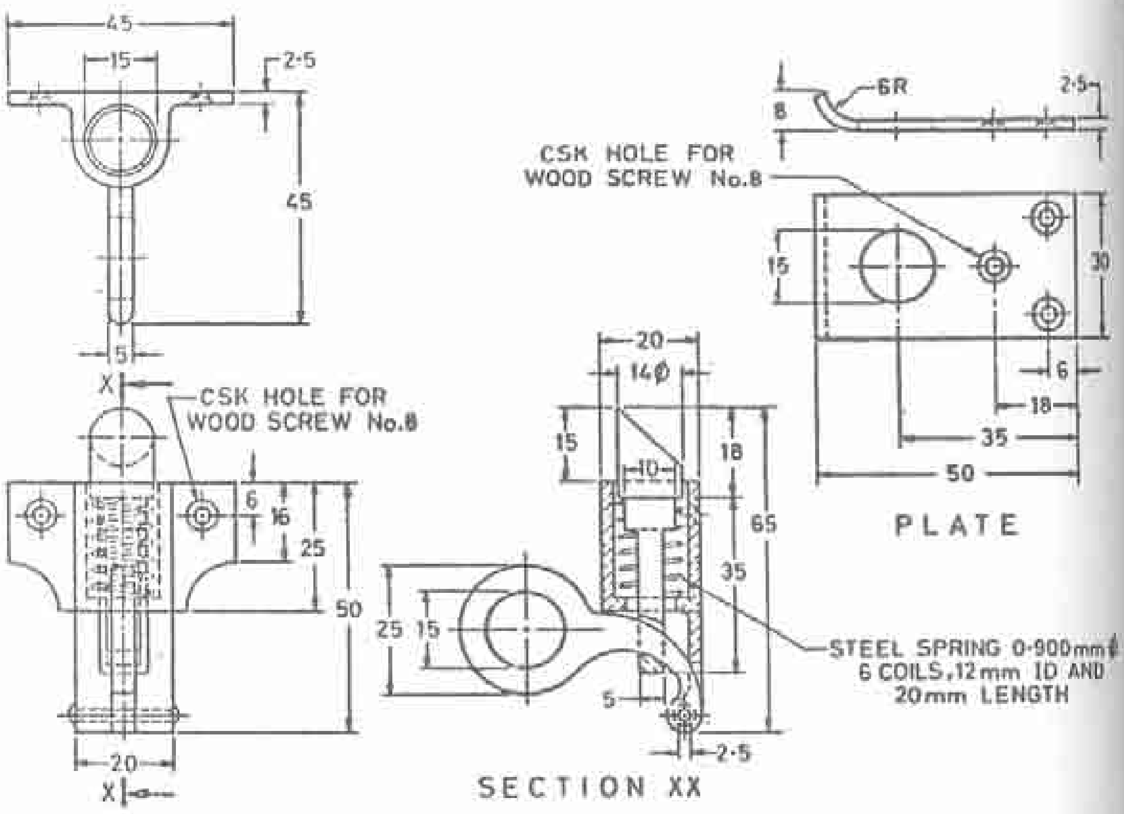
PLATE : 12-P/49 (Contd.)

TABLE 3 DIMENSIONS OF MILD STEEL HASPS AND STAPLES — TYPE 2

Size	A	B	C	D	E	F	R	Thickness of Sheet, T	Screw Holes		
									No. on Hasp	No. on Staple	For Wood Screw No.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
mm	mm	mm	mm	mm	mm	mm	mm	mm			
65	65±2	25·0±1·5	22·0±1·5	3·15±0·10	38·0±1·5	8·0±0·5	5·0±0·5	1·25±0·10	2	2	6
75	75±2	25·0±1·5	25·0±1·5	3·15±0·10	38·0±1·5	8·0±0·5	5·0±0·5	1·25±0·10	2	2	6
90	90±2	25·0±1·5	28·0±1·5	3·15±0·10	38·0±1·5	8·0±0·5	5·0±0·5	1·25±0·10	2	2	6
100	100±2	32·0±1·5	38·0±1·5	4·00±0·10*	42·0±1·5	11·0±0·5	6·0±0·5	1·60±0·10	3	2	6
125	125±2	38·0±1·5	48·0±1·5	5·00±0·10	55·0±1·5	14·0±0·5	7·0±0·5	1·60±0·10	4	4	6
150	150±2	45·0±1·5	55·0±1·5	6·30±0·10	55·0±1·5	14·0±0·5	7·0±0·5	2·00±0·10	4	4	10
175	175±2	50·0±1·5	55·0±1·5	6·30±0·10	55·0±1·5	14·0±0·5	8·0±0·5	2·00±0·10	4	4	10

*Where so required by the purchaser, diameter may be 5·00±0·10 instead of 4·00±0·10.

PLATE: 12-P/50



A Typical Design of 14-mm Fanlight Catch

PLATE : 12-P/51

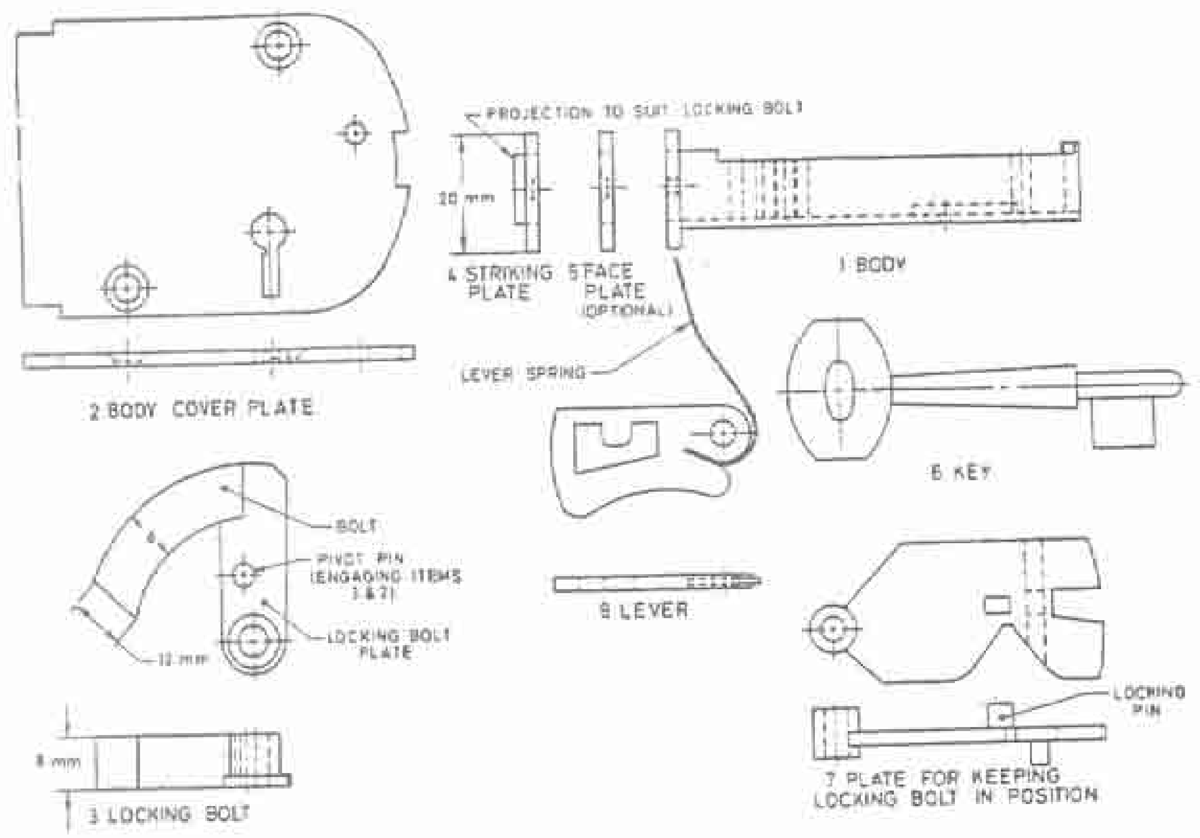


FIG. 1 A TYPICAL ILLUSTRATION OF MORTICE SLIDING DOOR LOCK

PLATE: 12-P/51 (Contd.)

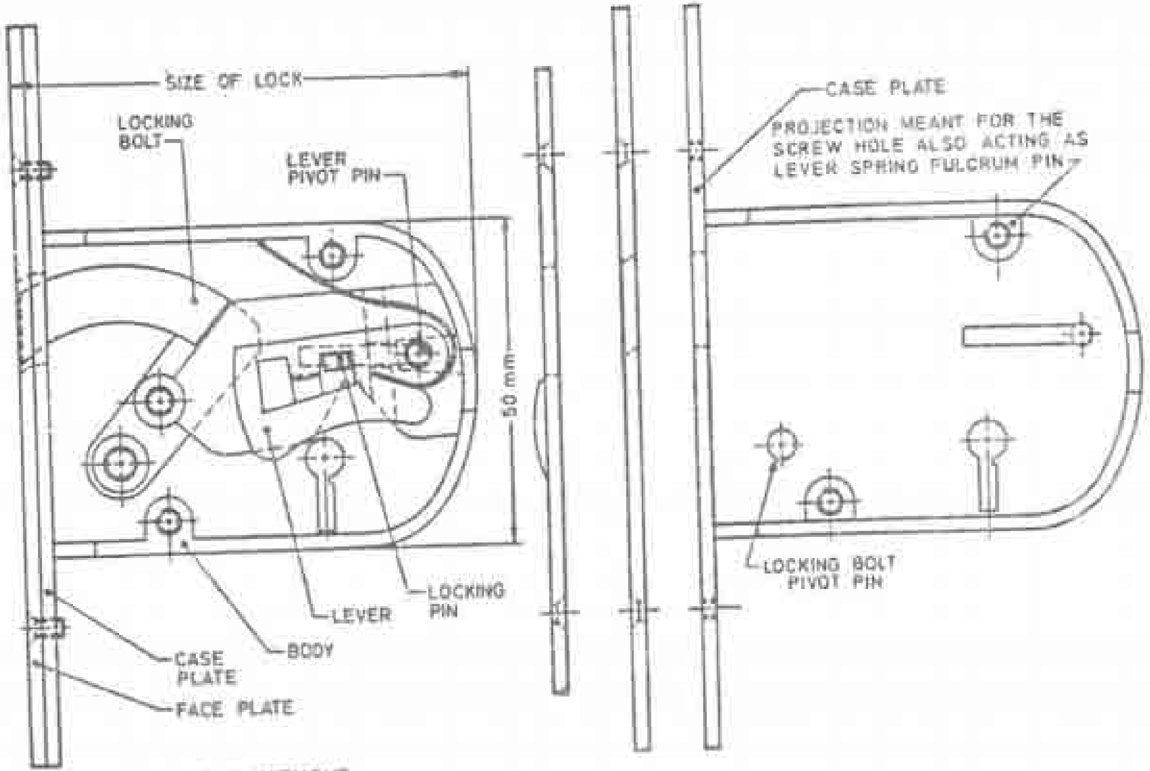


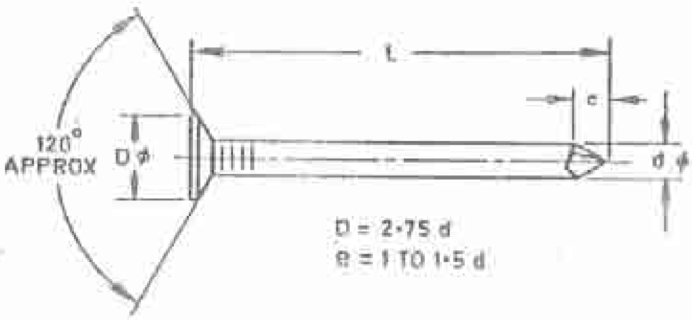
FIG. 1 A TYPICAL ILLUSTRATION OF MORTICE SLIDING DOOR LOCK — *Continued*

12-181

PLATE: 12- P/52

TABLE 1 DIMENSIONS AND TOLERANCES OF STEEL COUNTERSUNK HEAD WIRE NAILS (SIZE 1·25 TO 1·40 mm)

All dimensions in millimetres.



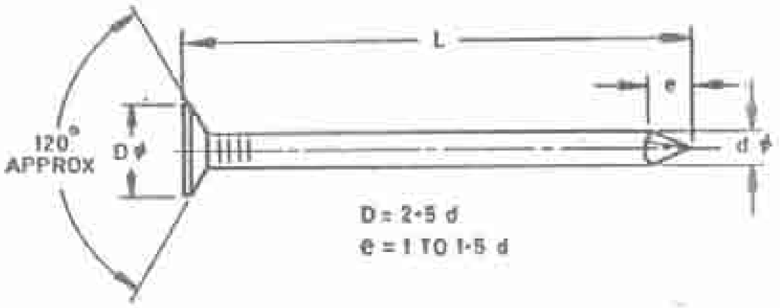
Size d (Shank Dia)		Head Diameter D		Length L		Approximate Number of Nails/kg
Basic	Tolerance	Basic	Tolerance	Basic	Tolerance	
1·25	±0·04	3·4	±0·17	20	±1·0	5 000
1·40	±0·04	3·8	±0·17	20	±1·0	3 040

Note — The number of nails per kilogram is likely to vary to a considerable extent. The figure given in the table is intended only for guidance to the purchaser.

PLATE : 12-P/52 (contd).

TABLE 2 DIMENSIONS AND TOLERANCES OF STEEL COUNTERSUNK HEAD WIRE NAILS (SIZE 1·60 TO 1·80 mm)

All dimensions in millimetres.

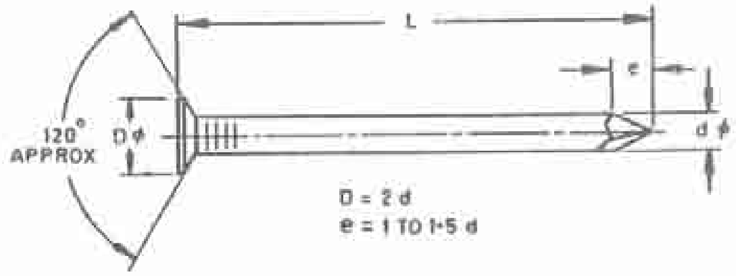


Side *d* (Shank Dia)		Head Diameter D		Length L		Approximate Number of Nails/kg
Basic	Tolerance	Basic	Tolerance	Basic	Tolerance	
1·60	±0·04	4·0	±0·2	15	±1·0	3 940
				20	±1·0	2 710
				25	±1·2	2 110
1·80	±0·04	4·5	±0·23	25	±1·2	1 720
				30	±1·2	1 410

Note — The number of nails per kilogram is likely to vary to a considerable extent. The figure given in the table is intended only for guidance to the purchaser.

TABLE 3 DIMENSIONS AND TOLERANCES FOR STEEL COUNTERSUNK HEAD WIRE NAILS
(SIZE 2·00 TO 2·80 mm)

All dimensions in millimetres.

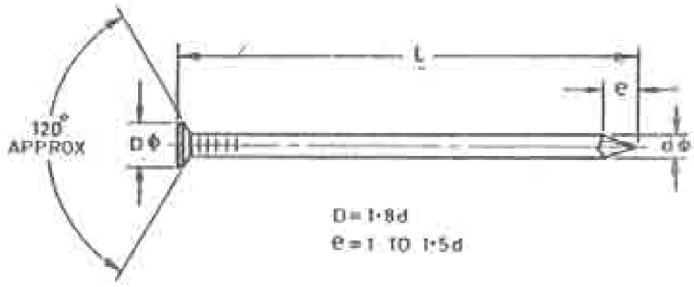


Size d (Shank Dia)		Head Diameter D		Length L		Approximate Number of Nails/kg
Basic	Tolerance	Basic	Tolerance	Basic	Tolerance	
2·00	±0·04	4·00	±0·2	25	±1·2	1 470
				30	±1·2	1 170
				40	±1·5	840
				50	±2·1	650
2·24	±0·04	4·5	±0·23	40	±1·5	700
2·50	±0·05	5·0	±0·25	50	±2·1	550
2·80	±0·06	5·6	±0·28	60	±2·1	350

Note — The number of nails per kilogram is likely to vary to a considerable extent. The figure given in the table is intended only for guidance to the purchaser.

TABLE 4 DIMENSIONS AND TOLERANCES FOR STEEL COUNTERSUNK HEAD WIRE NAILS
(SIZE 3·15 TO 10 mm)

All dimensions in millimetres.



Size *d* (Shank Dia)		Head Diameter D		Length L		Approximate Number of Nails/kg
Basic	Tolerance	Basic	Tolerance	Basic	Tolerance	
3·15	±0·06	5·7	±0·29	60	±2·1	230
3·55	±0·06	6·4	±0·32	80	±2·6	140
4·00	±0·06	7·2	±0·36	100	±3·4	80
4·50	±0·06	8·1	±0·41	90	±3·1	90
				100	±3·4	80
				125	±3·8	65
5·00	±0·06	9·0	±0·45	100	±3·4	60
				125	±3·8	50
				150	±3·8	40
6·30	±0·06	11·3	±0·57	150	±3·8	30
8·00	±0·06	14·4	±0·72	200	±4·4	12
				225	±4·4	10
10·00	±0·06	18·0	±0·90	250	±4·4	7

Note — The number of nails per kilogram is likely to vary to a considerable extent. The figure given in the table is intended only for guidance to the purchaser.

SECTION - III

CHAPTER –13   STEEL AND IRON WORKS

CHAPTER -13
STEEL AND IRON WORKS
CONTENT

CHAPTER -13

STEEL AND IRON WORKS

13.1 REFERENCES

IS : 226-1975	Structural steel (standard quality) fifth revision (with amendments No. 1 to 5.
IS : 278-1978	Galvanized steel barbed wire for fencing (third revision), (with amendment No. 1 & 2)
IS : 280 -1978	Mild steel wire for general engineering purposes (third revision), (with amendment No. 2)
IS : 432 (Pt. I) 1982	Mild Steel and medium tensile steel bars (third revision).
IS : 456-1978	Code of practice for plain and reinforced concrete (third revision) (with amendment No.1)
IS : 800 -1984	Code of practice for general construction in steel (second revision) (with amendment No.2)
IS : 813-1961	Scheme of symbols for weldings
IS : 814 (Pt. I & II) 1974	Covered electrodes for metal arc welding of structural steel.
IS : 816-1969	Code of practice for use of metal arc welding for general construction in mild steel, (first revision), (with amendment No. 1 & 2)
IS : 818-1968	Code of practice for safety and health requirements in electric and gas welding and cutting operations (first revision)
IS : 822-1970	Code of procedure for inspection of welds.
IS : 1038-1983	Steel doors, windows & ventilators (with amendment No.1)
IS : 1081-1960	Code of practice for fixing and glazing of metal (steel and aluminum) doors, windows and ventilators (with amendment No.1)
IS : 1148-1982	Hot rolled steel rivet bars (up to 40 mm diameter) for structural purpose (third revision)
IS : 1161-1979	Steel tubes for structural purposes (third revision)
IS : 1361-1978	Steel windows for industrial buildings (first revision) (with amendment No. 1&2)

IS : 1363 (Pt.I,II,III) 1984 Hexagonal hard bolts, screws & nuts of product grade C.

IS : 1566-1982	Specification for hard drawn steel wire fabric for concrete reinforcement (Second revision)
IS : 1732-1971	Dimension for round and square steel bars for structural and general engineering purposes (first revision) with amendment No.1)
IS : 1786-1985	High strength deformed steel bars and wires for concrete reinforcement (IIIrd revision)
IS : 1852-1979	Rolling and cutting tolerances for hot rolled steel products (third revision).
IS : 1977-1975	Structural steel (ordinary quality) second revision) (with amendment No.1 to 3).
IS : 2061-1984	Weldable structural steel (fusion welding quality) third revision), (with amendment No.1).
IS : 2140-1978	Standard galvanized steel wire for fencing (first revision) Reaffirmed 1986).
IS : 2502-1963	Code of practice for bending and fixing of bars for concrete reinforcement
IS : 2721-1979	Galvanized steel chain link fence fabric (first revision) (Reaffirmed 1986)
IS : 2751-1979	Code of practice for welding of mild steel plain and deformed bars for reinforced concrete construction (first revision)
IS : 3386-1979	Wooden fence posts (first revision)
IS : 4082-1977	Recommendations of stacking and storage of construction materials of site (first revision)
IS : 4351-1976	Steel door frames (first revision)
IS : 4454(I)-1981	Steel wires for cold formed springs-patented and cold drawn steel wires-unalloyed (second revision)
IS : 4948-1974	Welded steel wire fabric for general use (first revision) (with amendment No.1)

IS : 4996-1984	Reinforced concrete fence posts (first revision)
IS : 6248-1979	Specification for metal rolling shutters and rolling grills.
IS : 8629 (Pt.I to III)1977	Code of practice for protection of iron and steel structure from atmospheric corrosion.
IS : 9077-1979	Code of practice for corrosion protection of steel reinforcement in RB and RCC construction.
IS : 9417-1979	Recommendations for welding cold worked steel bars for reinforced concrete construction.
IS : 9595-1980	Recommendations for metal arc welding of carbon and carbon manganese steel (with amendment No.1) Reaffirmed 1987)
IS : 10521-1983	Collapsible gates.
IRC 21-1979	Standard specifications and code of practice for Road Bridges Section-III; cement concrete (plain & reinforced) (first revision).
SP : 24(S&T)-1983	Explanatory Hand Book on Indian standard code of practice for plain and reinforced concrete.
	Standard specifications - 77 of CPWD, Maharashtra PWD specifications
	Standard specifications of National Building Organisation.
	“Design of concrete Members with Ribbed Torsteel” by R. Chandra.

13.2 TERMINOLOGY

Bottom Lock Plate - The fabricated bar inserted at the bottom of rolling shutter curtain, so as to lie against the sill, including the slide bolts, pulling handles etc.

Bracket plates - The supporting plates at either end on the top, together with the U-shaped clamps supporting the entire moving mechanism of the rolling shutter.

Bundle - Two or more coils or a number of lengths properly bound together.

Coil - One Continuous bar as rolled in the form of a coil.

Composite Window - A window comprising of two or more sashes joined together with one or more coupling members.

Coupling - Joining door, window or ventilator units, side by side or one on the top of another or any combination of these units with mullions or transomes.

Crank Handle -The winding handle used for raising and lowering mechanical gear-operated rolling shutters through a bevel gear box.

Curtain- The main apron of the rolling shutter consisting of the assembly of lath sections end-locking clips and the connecting pieces at the top.

Elongation- The increase in length of a tensile test piece under stress. The elongation at fracture is conventionally expressed as a percentage of the original gauge length of a standard test piece.

Fixing- Securing metal door, window or ventilator to prepared structural or masonry surrounds and fixing of fittings and accessories.

Flange- The flange of the metal section on the inside is called “Inner flange” and the flange exposed to the outside is called the “Outer flange”.

Glazing- Securing of glass in the metal door, window or ventilator.

Glazing Bead - Strips of metal or timber used for glazing in addition to putty.

Guide Channels - The channels on either side in which the shutter moves up and down.

Holdfast - A metal lug used for fixing door, window or ventilator.

Hood Cover - A sheet metal cover bent into a suitable shape for covering the roller.

Jamb - The vertical sides of the door, window or ventilator opening.

Lath Sections - The individual rolled inter locking laths or slats with which the rolling shutter curtain is assembled.

Longitudinal Rib - A rib of uniform cross-section, parallel to the axis of the bar/wire (before cold-working, if any).

Mastic - A weather proofing compound usually with a putty base which remain pliable and plastic.

Mesh size- The pitch on center to center distance of main wires by the pitch on center to center distance of cross wires

Nominal Diameter or Size - The diameter of a plain round bar/wire having the sameness per meter length as the deformed bar/wire.

Nominal Perimeter of a Deformed Bar/Wire-3.14 times the nominal diameter.

Nominal Mass - The mass of the bar/wire of nominal diameter and of density 0.007 kg/mm^2 per meter run.

Overall Height -The distance between the sill and the top of the bracket plate of the rolling shutter plus an allowance of not more than 150 mm.

Overall Width -The Outer distance between the back of the two guide channels of the rolling shutter.

Proof Stress -The stress which is just sufficient to produce, under load, a permanent deformation equal to a specified percentage of the original gauge length.

0.2 Percentage Proof Stress - The stress at which a non-proportional elongation equal to 0.2 percent of the original gauge length takes place.

Pulling Hook - The steel rod shaped into a hook at one end and into a ring at the other, used for raising and lowering self-coiling type rolling shutters.

Putty Bedding - Putty which is placed in the glazing rebate of the door, window or ventilator into which glass is bedded.

Putty Back - Portion of the bedding putty remaining between the glass and rebate after the glass has been pressed into position in the glazing rebate of the section.

Putty Front - Putty forming a mitred filling between the surface of the glass and the front edge of the section.

Rendering - Plastering of the outside face of the wall and the outer reveal.

Revent -The depth of the wall revealed beyond the frame in the sides of the opening. The reveal on the inner sides is called the inner reveal and the reveal exposed to outside is called the 'outer reveal'.

Flush Reveal - A reveal which is not rebated.

Rebated Reveal -A reveal which forms an angle or sometimes a grown which the outer flange of the steel window section fits.

Roller - The entire rolling portion at the top of the shutter including the suspension shaft, the pulleys, the springs and ball bearing, if any.

Sash - A complete industrial window unit, whether of the fixed or opening type.

Sill -The lower boundary of a door, windows, ventilator opening.

Stopper Height -The stopper height of a rolling shutter shall be the height as measured from the sill to the bottom of the lock plate, when the rolling shutter is in the full open position.

Tensile Strength -The maximum load reached in a tensile test by the effective cross-sectional area of the gauge length portion of the test piece. Also termed as ultimate tensile stress.

Threshold - The portion of the doorframe which is fixed to floor.

Transverse Rib - Any rib on the surface of a bar/wire other than a longitudinal rib.

Ventilator - The opening part of a sash. It consists of an inner frame and an outer frame.

Centre-Hung ventilator - A ventilator horizontally pivoted at the centre of each side, with the top half opening inwards and the bottom half opening outwards.

Top-Hung ventilator - A ventilator hinged at the top and opening outwards.

Yield Stress - Stress (that is load per unit cross-section area) at which elongation first occurs in the test piece without increasing the load during tensile test. In the case of steels with no such definite yield point, the yield stress is the stress under the prescribed testing conditions at which the observed increase in the gauge length is 1/200 of the gauge length when the rate at which the load applied is not more than 5 N/mm^2 when approaching the yield stress.

13.3 REINFORCEMENT

13.3.1 General

The work shall consist of furnishing and placing steel reinforcement of the shape and dimensions indicated in the drawings and as specified in these specifications.

All steel used for reinforcement shall be clean, free from oil, grease, paints dust, mortar, scales, kinks, rust or any rolling defects or bands other than those required as per drawings or as directed by the Engineer-in-Charge.

13.3.2 Quality of reinforcement

13.3.2.1 The steel reinforcement shall be any of the followings as may be specified for the job in question.

(a) Mild steel and medium tensile steel bars conforming to IS:432-1982 as amended from time to time.

(b) Cold twisted bars conforming to IS: 1786-1985 as amended from time to time.

(c) Hard drawn steel wire fabric conforming to IS: 1566-1982 as amended from time to time.

13.3.2.2 The ultimate tensile stress, yield stress and percentage elongation of reinforcing steel shall be as given in Appendix I.

13.3.2.3 In case of material purchased from re-rollers or other than authorized suppliers of manufacturer, the supplier shall furnish manufacturers certificate containing the results of all the required tests on samples taken from the delivered material. For each bundle/coil of bars, a tag shall be attached indicating cast No, lot No., grade & size.

13.3.3 Stacking and storage

Steel reinforcement shall be stored in such a way as to prevent distortion, deterioration and corrosion. Reinforcing bars shall not be left in direct contact with the ground but they shall be stacked on top of an arrangement of timber sleepers or the like-suitable racks shall also be used for stacking reinforcement in tiers. Bars of different classifications, sizes and lengths shall be stored separately to facilitate issues in such sizes and lengths as to minimize wastage in cutting from standard lengths.

13.3.4. Cutting and Bending

13.3.4.1 Bars bent during transport or handling shall be straightened before being used on work; they shall not be heated to facilitate bending.

13.3.4.2 Reinforcement bars shall be of the size prescribed shall be accurately cut to length and bent to shape and fixed in position as shown on the drawings or as directed by the Engineer-in-charge and shall conform to IS:2502-1963 as revised from time to time. The tolerances for being and cutting shall be as given in Table-1.

TABLE 1- PERMISSIBLE BENDING AND CUTTING TOLERANCES

	Length		**Tolerance**	
	over cm.	upto and including cm.	plus cm.	minus cm.
For bent bars	-	75	3	5
	75	150	5	10
	150	250	6	15
	250	-	7	25
For Straight bars.	All lengths		25	25

13.3.4.3 Reinforcement bars shall be bent cold, but bars larger than 25 mm in size may be bent hot at cherry red heat (no exceeding 850°C) except those bars which depend for their strength on cold working. Hot bars shall not be cooled by quenching. Bars shall not be straightened or bent in a manner that will injure or weaken the material.

13.3.4.4 Bars of 12mm diameter and under may be bent by simple tools such as a claw. For bars upto 16 mm simple hand machine (without gears) is recommended. For larger diameter, a graded bar bending machine (hand operated) will be suitable. For bars 36 mm and above, where large quantities of bars are to be bent, power operated benders may be used advantageously.

13.3.4.5 Unless otherwise specified a U type hook shall invariably be provided at the end of each bar. The radius of the bend shall not be less than twice the diameter or the round bar and the length of the straight part of the round bar. Deformed bars may be used without hooks.

13.3.5 Joint and splicing

13.3.5.1 Lopper Splices

13.3.5.1.1 All reinforcement shall be furnished in full length indicated in the drawings as far as possible splicing bars, except as shown in the drawings shall not be permitted without written approval of the Engineer-in-charge.

13.3.5.1.2 Where splices are provided in the reinforced bars, they shall conform the requirements contained in Design Series Technical Circular No.24 appended at Appendix II.

13.3.5.2 Welded Splices

13.3.5.2.1 Reinforcement in structure shall not be welded except where shown in the drawing. All welding procedures shall be subject to the prior approval of the Engineer-in-charge in writing.

13.3.5.2.2 Welding of reinforcements shall be done in accordance with the recommendations of the following Indian Standards.

(a) IS: 2751-1979 gives the requirements of weldings of mild steel round and deformed bars conforming to grade-I of IS: 432(part-I) - 1982 and IS:1786-1985

(b) Is: 9417-1979 gives requirements of welding of cold worked steel bars confirming to IS:1786-1985.

(c) The M.S. electrodes used for welding shall conform to IS: 814-1974.

13.3.5.2.3 Joint welding procedures which are to be employed shall invariably be established by a procedure specification and shall be qualified prior to use by tests as prescribed in IS: 2751-1979 and IS: 9417-1979. All welders and welding operators to be employed shall have to be qualified by tests prescribed in IS: 2751-1979 and IS:9417-1979. Inspection of welds shall conform to IS: 822-1970 and destructive and non-destructive testing may be undertaken when deemed necessary. Joints with weld defects detected by visual inspection or dimensional inspection shall not be accepted.

13.3.5.2.4 Reinforcement bars upto and including 20mm in diameter should be lap welded and those larger than 20mm diameter should be butt welded.

As far as possible in concrete structures subjected to large numbers of repetition of substantial loads, welding should be avoided.

13.3.5.2.5 Welds shall be avoided at bends or in curved parts of the reinforcing bars and shall be located atleast at a distance of 50 times the diameter from bends.

13.3.5.2.6 The design strength of a welded splice or mechanical connection shall be taken as equal to 80 percent of the design strength of the bar for tension splices and 100 percent of the design strength for compression splices. However, 100 percent of the design strength may be assumed in tension when the spliced area forms not more than 20 of the total area of steel at the section and the splices are staggered at least 60 cm.

NOTE : Welded joints or mechanical connections in reinforcement may be used but in all cases of important connections, tests shall be made to prove that the joints are of the full strength of bars connected.

13.3.5.2.7 Deformed bars shall not be lap welded at splices except where lap welding is shown on the drawings or otherwise specifically approved. In the welds of lapped joints, the shear strength of the filler materials should be taken as 0.38 times its yield or proof stress as given in appropriate standards. The length of weld should be sufficient to transmit the design load in the bar, that is the cross sectional area of (parent) bar X0.87 fy should be equal to effective length of weld X throat thickness X the shear strength of the filler material. The length of a run of weld should not normally exceed five times the size of the bar. If a longer length of weld is required, it should be divided into sections and the space between runs made not less than five the size of the bar.

13.3.5.2.8 Butt welding of reinforcement bars shall be performed under cover from the weather and may be performed either by the gas pressure or flash pressure welding process or by electric arc methods. The following shall apply for all welding of reinforcement bars including butt welding and the preparation of welded reinforcement mats:

(i) The ends of the bars to be butt-welded by gas pressure or flash pressure welding shall be squared off by an abrasive disc cutter. Any accumulation of dirt or oxide film formed after the cutting operation shall be removed by sand blasting or buffing prior to welding. Ends of bars to be joined by flash pressure welding shall be cleaned off all rust and projections on the end faces and for a distance of about 15 cm from the ends, if necessary to event arching. Care shall be taken in aligning and separating the ends of the bars to be joined by arc welding and the ends of the bars shall be matched accurately and shall be retained firmly in position during the welding operations. For pressure welding, the bars shall be accurately held in position with the prescribed pressure applied prior to heating and during heating and welding.

(ii) Where bars are to be joined by electric arc welding the weld metal shall be deposited in successive layers and each layer shall be thoroughly cleaned before subsequent layer is deposited.

(iii) All structural welds shall have complete fusion and free iron imperfections. Defective pressure welded joints shall be separated by flame cutting and re welded.

(iv) Tack welding of reinforcement bars, for fixing bars in place or for preparation of mats shall be carried out by competent operators using short discontinuities or loss of cross section in the jointed bars at or adjacent to the weld.

13.3.6 Binding and placing

13.3.6.1 Before reinforcement is placed, the surfaces of the reinforcement and the surfaces of any metal supports shall be cleaned of heavy flaky rust, loose mill scale, dirt, grease coats of paints, oil or other foreign substances which may destroy or reduce bond. Heavy flaky rust can be removed by rubbing with gunny (burlap) or equivalent treatment. A note on rust over reinforcement is given at Appendix III for general guidance.

13.3.6.2 Reinforcement bars shall be placed accurately in the positions indicated in the drawing and maintained in these positions. When delay occurs between assembling the steel and depositing the concrete, the placing of the reinforcement shall be again carefully checked immediately prior to concreting.

13.3.6.3 Reinforcement after being placed in position shall be maintained in a clean condition until completely embedded in concrete. Special care shall be exercised to prevent any displacement or reinforcement in concrete already placed.

13.3.6.4 When reinforcement bars are bent aside, at construction joints and afterwards bent back into their original positions, care should be taken to ensure that at no time the radius of the bend is less than 4 bar diameters for plain mild steel or 6 bar diameters for deformed bars. Care shall also be taken when bending back bars, to ensure that the concrete around the bars is not damaged.

13.3.6.5 Bars crossing each other should be secured by annealed binding wire of size not less than 0.90 mm and confirming to IS:280-1978 in such a manner that they will not slip over each other at the time of fixing and concreting.

13.3.6.6 The bars shall be kept in position by the following materials:-

(a) In case of beam and slab construction, precast cover blocks in cement mortar 1:2 (1cement :2 sand) about 4cm×4cm section and of thickness equal to the specified cover shall be placed between the bars and shutterings, so as to secure and maintain the requisite cover of concrete over reinforcement.

(b) In case of cantilevered and doubly reinforced beams on slabs, the vertical distance between the horizontal bars shall be maintained by introducing chain spacers or support bars of steel at 1 m or at shorter spacing to avoid sagging.

(c) In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them; or with block of cement mortar (1:2) suitably tied to the reinforcement. If, templates are used, they shall be removed after the concreting has progressed to a level just below them.

(d) In case of R.C.C. structures, such as arches, domes, curved profiles of spillways, falls, training walls, etc. cover blocks, spacers and templates, shall be used as directed by the Engineer-in Charge.

13.3.6.7 Chairs, spacers, hungers supporting wires or other approved devices at sufficiently close intervals may also be used as approved by Engineer-in-Charge. All materials used for positioning the steel shall be non-corrodible material. Supports shall not extend to the surface of concrete except where shown on drawings.

13.3.6.8 All the bars protruding from concrete and to which other bars are to be spliced and which are likely to be exposed for an indefinite period shall be protected by a thick coat of neat cement grout.

13.3.6.9 Reinforcement will be inspected for compliance with requirements as to size, shape, length, spacing and position after it has been placed.

13.3.7 Substitution

13.3.7.1 Substitution of size of bars different from specified in the drawing shall be allowed only with the permission of Engineer-in-Charge. Substitution of the same type and grade such as plain bars and deformed bars of various grades say F415, F500 shall be used as main reinforcement in a structural member. However simultaneous use of two different type of steel for main and secondary reinforcement respectively is permissible. Guidelines for substitution are given in Appendix IV.

While permitting substitution of bars, the Engineer-in-Charge shall satisfy himself regarding the design requirements in respect of bond, spacing between bars, and minimum cover etc. as given in IS:456-1978 end IS:3370-(PT-II)-1965. The relevant clauses are given below for guidance:

(i) Bond - 25.2 of IS:456-1978
(ii) Spacing- 25.3 of IS:456-1978
(iii) Cover- 25.4 of IS:456-1978 and 7.2 of IS: 3370 -1963

13.3.8 Bundling of Bars

13.3.8.1 The bundles of bars may be provided in the original design/drawing or may be necessitated as a requirement of substitution. The bars shall be bundled in shapes of triangular, square or L -shaped to act as one unit of reinforcement The bar diameters in a bundle shall be tied to two nearest sizes., Bundled bars shall be tied together to ensure the bars remaining together. Bars larger than 36 mm dia shall not be bundled except in columns.

13.3.8.2 ***Curtailment*** - Bars in a bundle shall terminate at different points spaced apart by not less than 40 times the bar diameter except for bundles stopping at a support.

When all bars in a bundle are carried to the support, the increased development length (based on single bar) for bundles as given in para 2.2 of Appendix IV should be used for checking of the development of stress.

13.3.8.3 Diameter of bundled bars - Where spacing limitations and minimum concrete cover are based on bar diameter, a group of bars bundled in contact shall be treated as a single bar of diameter derived from the total equivalent area.

13.3.8.4 The minimum free distance between groups of bundled bars should be at least the maximum of the followings :

(i) C + 15 cm where , C = maximum size of aggregate (c.m.)
(ii) the diameter of the largest size of bar used
(iii) 3 cm

13.3.8.5 If more than one layer of bundled bars are used, then the groups should be Placed one over the other.

13.3.8.6 Bundles shall not be used in a member without stirrups.

13.3.8.7 For column where large amount of bundled bars are used (2 to *3%)* the spacing of tie should be reduced to half the normal tie spacing (1/2 the minimum lateral size of the member).

13.4 STRUCTURAL STEEL & IRON WORK

13.4.1 Material

13.4.1.1 ***Steel -*** All finished steel shall be well and clearly rolled to the dimensions and weight specified by ISI subject to permissible tolerances as per IS:1852-1979. The finished materials shall be reasonably free from cracks, surface flaws, laminations, rough and imperfect edges and all other harmful defects. Steel sections, shall be free from excessive rust, scaling and pitting and shall be will protected.

The mechanical properties and chemical composition of the structural steel shall be as per Appendix V & VI. The following varieties of steel should be used for structural purposes.

13.4.1.1.1 ***S.T. 42-S-*** The standard quality steel designated as ST-42-S, conforming to IS:226-1975 shall be used for all the types of structure (rivetted or bolted) including those subject to dynamic loading and where fatigue, wide fluctuation of stresses, reversal of stresses and great restraint are involved as for example crane gantry girders, road and rail bridges etc.

It is also suitable for welded structures provided that the thickness of materials does not exceed 20mm.

13.4.1.1.2 ***ST. 42-W-*** The fusion welding quality steel designated as S.T. 42-W, conforming to IS:2062-1984 shall be used for structures subject to dynamic loading (Wind load is not to be considered as dynamic for this purpose) where welding is employed for fabrication and where fatigue, wide fluctuation of stress, reversal of stress and great restraint are involved as for example, crane gantry girders and road and rail bridges.

13.4.1.1.3 ***ST. 42-O-*** The ordinary quality steel designated as S.T. 42-0, conforming to IS:1977-1975 shall be used for structures not subjected to dynamic loading other than wind loads where welding is not employed or/and structures not situated in earth quake zones or/and design has not been based on plastic theory.

13.4.1.1.4 ***ST. 32-O-*** The ordinary quality steel designated as S.T. 32-0 conforming to IS:1977-1975 shall be used for doors, window frames, window bars, grills, steel gates, hand railing, builders hardware, fencing post, tie bars etc.

13.4.1.2 ***Rivets-*** Rivets shall be made from rivet bars of mild steel as per IS:1148-1982. The tolerance on diameter of bars shall be as given in table 2.

TABLE – 2

Diameter of Bars (mm)	Maximum Tolerance (mm
Below 20	(-) 0.40
20	(-) 0.45
22 and 24	(-) 0.50
Over 24	(-) 2 percent on diameter

13.4.1.3 ***Black Bolts -*** These are also known as machine bolts and are made from rods as they come from the rolling mills and are not finished to exact size.

13.4.1.4 ***Turned And Fitted Bolts -*** These bolts are turned to exact diameter in automatic lathe.

13.4.1.5 ***Electrodes -*** The electrodes required for metal are welding shall be covered electrodes and shall conform to IS: 814-1974.

The size of the electrode shall be designated by the diameter of the core wire expressed in mm.

The contact end of the electrodes shall be bare and clean to a length of 20 to 30 mm. The arc striking end of the electrodes permit easy striking of arc. Where the end is bare, the distance from the arc end to the first point where the full cross-section of the covering prevails shall not exceed the 2/3 rd of the diameter of the core wire, subject to a maximum length of 2.5 mm.

The electrodes shall be of three types, namely:-

(a) Normal penetration electrodes,

(b) Deep penetration electrodes, and

(c) Electrodes suitable for deep penetration and normal penetration.

13.4.1.6 ***Covering -*** The covering shall be sufficiently robust to withstand without damage, normal conditions of handling and storage and shall be free from defects which would interfere with satisfactory performances of the electrodes. The covering shall fuse and/or burn evenly.

13.4.2 Steel Work In Single Section Fixed Independently/With connecting plate.

The steel work in single sections of R.S. joists, flats, Tees, Angles fixed independently, without connecting plate and the steel work in single section 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 shall be covered by the provisions in these paras.

13.4.2.1 **Fabrication -** The steel sections as specified or required, shall be straightened and cut square and to correct lengths and measured with a steel tape. The cut ends exposed to view shall be finished smooth. No two pieces shall be welded or otherwise jointed to make up the required length of a member.

All straightening and shaping to form, shall be done by pressure. Bending or cutting shall be carried out in such a manner as not to impair the strength of the metal.

13.4.2.2 ***Paintings***

13.4.2.2.1 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.

13.4.2.2.2 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.

13.4.2.2.3 Parts to be encased in concrete shall not be painted or oiled.

13.4.2.2.4 Shop contact surfaces need not be painted unless so specified. If so specified, they shall be brought together while the paint is still wet.

13.4.2.3 ***Erection -*** Steel work shall be hoisted and placed in position carefully without any damage to itself and other building work and injury to workmen. Where necessary, mechanical appliances such as lifting tackle, winch etc. shall be used. The suitability and capacity of all plant and equipment used for erection shall be to the satisfaction or Engineer-in charge.

13.4.3. **Steel Work in Built-up Sections (Rivetted and Bolted)**

The steel work in built up sections (Rivetted and bolted), such as in trusses, framed work etc. shall be covered by the provisions in these paras.

13.4.3.1 ***Laying out -*** Steel structure shall be laid out on a level platform to full scale. Engineer-in-Charge. A steel tape shall be used for measurements.

13.4.3.2 ***Fabrication*** - Fabrication shall be done as described in subsequent paras.

13.4.3.2.1 ***Strengthening, Shaping to Form and Cutting-*** The steel sections as specified or required, shall be straightened and cut, square and to correct lengths and measured with a steel tape. The cut ends exposed to view shall be finished smooth. No two pieces shall be welded or otherwise jointed make up the required length of a member.

All straightening and shaping to form, shall be done by pressure. Bending or cutting shall be carried out in such a manner as not to impair the strength of the metal.

In major works or where so specified, shop drawings giving complete information for the fabrication of the component parts of the structure including the location, type size length and details of rivets, bolts or welds, shall be prepared in advance of the actual fabrication and approved by the Engineer-in-Charge. The drawings shall indicate the shop and field rivets, bolts and welds. The steel members shall be distinctly marked or stenciled with paint with the identification marks as given in the shop drawings.

Great accuracy shall be observed in the fabrication of various members, so that these can be assembled without being unduly packed, strained or forced into position and when built up, shall be true and free from twist, kinks, buckles, or open joints.

Wooden or metal sheet templates shall be made to correspond to each and rivet holes shall be marked accurately on them and drilled. The templates shall be laid on the steel members, and holes for riveting and bolting marked on the ends of the steel members shall also be marked for cutting. The base of steel columns and the position of anchor bolts shall be carefully set out.

All stiffeners shall be formed by pressured where practicable the metal shall not be cut and welded in making these.

13.4.3.2.2 ***Making Holes-*** 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 then the required size and reamed after assembly to the full diameter. The thickness of material punched shall be not greater than 16 mm.

Black Bolt / Rivet Holes **-** The diameter for rivets and black bolt holes shall be taken as the nominal diameter of a rivet plus 1.5 mm for rivets of nominal diameter less than or equal to 25 mm and 2.0 mm for rivets of nominal diameter exceeding 25 mm, unless specified otherwise. Holes for turned and fitted bolts shall be drilled or reamed large by 0.2 to 8 mm depending upon the dia. of bolts as shown in Appendix VIII.

Holes shall have their axis perpendicular to the surface bored through. The drilling or reaming shall be free from burrs, and the holes shall be clean and accurate. Holes for rivets and bolts shall not be formed by gas cutting process.

Holes For Counter **-** Sunk bolts shall be made in such a manner that their heads sit flush with the surface after fixing.

13.4.3.2.3 **Assembly-** The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged, and shall be so prepared that the specified cambers, if any, are provided. Before making holes in individual members, for fabrication the steel work intended to be rivetted or bolted together shall be assembled and clamped properly and tightly so as to ensure close abutting, or lapping of the surfaces of the different members. All stiffeners shall bear tightly both at top and bottom without being drawn or caulked. The abutting joints shall be cut or dressed true and straight, and fitted close together.

Web plates of girders, which have no cover plates, shall have their ends flush with the tops of angles unless otherwise required. The web plates, when spliced shall have clearance of not more than 5 mm. The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 1.5 mm. The erection clearance at the ends of beams without web cleats shall not be more than 3 mm at each end but where for practical reasons, greater clearance is necessary suitable designed seating shall be provided.

Columns splices and butt joints of struts and compression members depending on contact for stress transmission shall be accurately machined and close butted over the whole section. In column caps and bases, the ends of shafts together with the attached gussets angles, channels etc. after riveting together shall be accurately machined so that the parts connected, butt against each other over the entire surfaces of contact. Connecting angles or channels shall be fabricated and placed in position with great accuracy so that they are not unduly reduced in thickness by machining.

The ends of all bearing stiffeners shall be machined or ground to fit tightly both at top and bottom.

13.4.3.2.4 Riveting

Rivets shall be used, where so provided in the drawings, 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 rivetted connections, a service bolt shall be provided in every third or fourth hole.

The riveting shall be carried out by using machines of the steady pressure type. However where such facilities are not available hand riveting may be permitted by Engineer-in Charge. The rivets shall be heated red hot, care being taken to control the temperature of heating so as not to burn the steel. Rivets of diameter less than 10mm may be driven cold. Rivets shall be finished neat, with heads full and of equal size. The heads shall be central on shanks and shall grip the assembled members firmly. All loose, burnt, or badly formed rivets with eccentric or deficient heads shall be cut out and replaced. In cutting out rivets, care shall be taken so as not to injure the assembled members. Caulking and recapping shall not be permitted.

For testing rivets hammer weighing approx 0.25 kg. shall be used. Both heads of the rivet (Specially the machine head) shall be tapped. When so treated the rivets shall not give a hollow sound and a jar. Where so specified further test shall be carried out to ensure the soundness of rivets.

13.4.3.2.5 *Bolting*

The nominal length of the bolt shall be the distance from the underside of the head to the further end of the shank. The nominal diameter of the bolt shall be the diameter at the shank above the screwed threads. Bolts nuts and washers shall be thoroughly cleaned and dipped in double boiled linseed oil, before use. All bolt heads and nuts shall be hexagonal unless specified otherwise the screwed threads shall conform to IS:1363 (Pt I to III) --1984 and the treaded surface should not be tapered. The bolts shall be of such length as to project at least one clear thread beyond the nuts when fixed in position, and these shall fit in the holes without any shake the nuts shall fit in the threaded ends of bolts properly.

Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads and nuts of bolts a satisfactory bearing in all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a washer of sufficient thickness under the nut.

Where there is risk of the nuts being removed or becoming loose due to vibrations reversal of stresses, these shall be secured from slackening by the use of locknuts, spring washers or cross cutting as directed by the Engineer-in Charge.

13.4.3.3 ***Erection***

13.4.3.3.1 Steel work shall be hoisted and erected in position carefully, without any damage to itself, other structure and equipment and injury to workmen. The method of hoisting and erection proposed to be adopted shall be got approved from the Engineer-in Charge. Proper equipment such as derricks, lifting tackles, winches ropes etc. shall be used.

13.4.3.3.2 The work may be erected in suitable units as may be directed by the Engineer-in Charge. Fabricated members shall be lifted at such points as to avoid the deformation or excessive stress in members. The structure or the part of it placed in position shall be secured against overturning or collapse by suitable means. During execution the steel work shall be securely bolted or otherwise fastened and when necessary, temporarily braced to provide for all loads to be carried safely by the structure during erection including those due to erection equipment and its operations. The steel work shall be placed in proper position as per approved drawings. Final riveting or permanent bolting shall be done only after alignment has been obtained.

13.4.3.3.3 Trusses shall be lifted only at nodes. The trusses above 10 m in span shall not be slinged at the apex, as it will develop compression stresses in the bottom tie member. They shall be lifted by slinging at two mid points of rafters, which shall be temporarily braced by a wooden member of a suitable section. After the trusses are placed in position, purlins and wind bracings shall be fixed as soon as possible.

The ends of the truss which faces the prevailing winds shall be fixed holding down bolts. and the other and kept free to move. In case of trusses of spans up to 10m the free end of the truss shall be laid on lead sheet or steel plate as per design and the holes for holding down bolts shall be made in the form of oblong slots so as to permit the free movement of the truss end. For larger spans, the truss shall be provided with bearing as per design.

13.4.3.3.4 Columns and stanchions shall be erected truly vertical with necessary cross bracings etc. as per drawing and the base shall be properly fixed with the foundation concrete by means of anchor bolts etc. as per design.

13.4.3.3.5 Anchor bolts shall be placed in the concrete foundation. These should be held in position with a wooden template. The anchor bolts shall be provided with suitable timber mould or pipe sleeve to allow for adjustment. The timber mould or pipe shall be removed after initial set of concrete. The spaces left around anchor bolts shall have a sloping channel leading to the side of the pedestal and on the underside of the base plate to allow the spaces being grouted up after the base plate is fixed in the position along with the column footing. Grouting shall be of cement mortar 1:3 (1 cement: 3 coarse sand) or as specified.

13.4.3.3.6 Bedding of Column, Stanchions, etc**. -** Bedding shall not be carried out until the steel-work has been finally leveled, plumbed and connected together, The stanchion shall be supported on steel wedges and adjusted to make the column plumb. For multistoried buildings, the bedding shall not be done until sufficient floor beams are fixed in position. The base plates shall be wedged clear of the bases by M.S. wedges and adjusted where necessary to plumb the columns. The gaps under the base plates up to 25 mm shall then be pressure grouted with cement grouts.

With small columns, if permitted by the Engineer-in Charge, the columns base shall be floated on a thick cement grout on the concrete pedestal. The anchor bolts holes in the base plate may be made about 10 to 15 mm larger than the bolts. In such cases suitable washers shall be provided.

13.4.3.4 ***Painting –*** Before the members of the steel structure are placed in position or taken out of the workshop, these shall be painted as specified in 13.4.2.2

13.4.4 Steel Work In Built Up Section (Welded)

The steel work in built up sections (welded) such as in trusses, framed work etc. shall be covered by provisions under this para.

13.4.4.1 ***Laying out –*** It shall be as specified in 13.4.3.1

13.4.4.2 Fabrications

13.4.4.2.1 Straightening, shaping to form, cutting and assembling shall be as per 13.4.3.2.1 as far as applicable, except that the work "riveted or bolted" shall be reed as "Welded" and holes shall only be made for the bolts used for temporary fastening as shown in drawings.

13.4.4.2.2 ***Welding –*** Welding shall generally be done by electric process. The electric arc method is usually adopted and is economical. Where public electricity is not available, generators shall be arranged. Gas welding shall be resorted to using oxyacetylene flame with specific prior approval of the Engineer-in-Charge. Gas welding shall not ordinarily be permitted for structural steel work as it requires heating of the members to be welded along with the welding rod and is likely to create temperature stresses in the welded members. Precautions shall therefore be taken to avoid distortion of the members due to these temperature stresses.

The work shall be done as shown in the shop drawings which should clearly indicate various details of the joints to be welded, type of welds, shop and site welds as well as the types of electrodes to be used. Symbol for welding on plans and shop drawings shall be according to IS: 813-1961.

As far as possible every effort shall be made to limit the welding that must be done after the structure is erected so as to avoid the improper welding that is likely to be done due to heights and difficult positions on scaffolding etc. apart from the aspect of economy.

Surface which are to be welded together shall be free from loose mill scale, rust, paint, grease or other foreign matter. A coating of boiled linseed oil may be permitted.

13.4.4.2.3 ***Precautions -*** All operations connected with welding and cutting equipment stall conform to the safety requirements give in IS: 818-1968 for safety requirements and Health Provision in Electricity and Gas Welding and Cutting Operations.

13.4.4.2.4 Operations, workmanship and process of welding is described in Appendix-IX.

13.4.4.2.5 Inspection and testing of welds is described in Appendix-X.

13.4.4.2.6 ***Assembly -*** Before welding is commenced the plates shall first be brought together and firmly clamped or spot welded at specified distance. This temporary connection has to be strong enough to hold the parts accurately in place without any disturbance.

13.4.4.2.7 ***Erection -*** The specifications shall be as described in 13.3.3.3 except that while erecting a welded structure, adequate means shall be employed for temporary fastening the consist of erection bolts, tack welding or other positive devices imparting sufficient strength and stiffness to resist all temporary loads and lateral forces including wind. Owing to the small number of bolts ordinarily employed for joists which are to be welded; the temporary support of heavy girders carrying columns shall be specially attended. Different members which shall be fillet welded, shall be brought into as close contact as possible. The gap due to faulty workmanship or incorrect fit if any shall not exceed 1.5 mm. If gap exceeding 1.5mm occurs locally, the size of fillet weld shall be increased at such position by an amount equal to the width of the gap.

13.4.4.2.8 ***Painting-*** Before the members of the steel structure are placed in position or taken out of the workshop, these shall be painted as specified in 13.3.2.2.

In the case of surfaces to be welded, the steel shall not be painted or metal coated within a suitable distance of any edges to be welded if the paint specified or the metal coating would be harmful to welders or impair the quality of welds.

13.4.5 Collapsible Gates (Fig. 13-P/1)

13.4.5.1 These shall be of approved manufacture and shall be fabricated from the mild steel sections. The gates shall consist of double or single collapsible gates as may be specified in the drawings. These shall consist of vertical double channels each 20×10×2 mm at 10 cm centers braced with flat iron diagonals 20×5 mm and top and bottom rails of T-iron 40×40×6 mm with 40 mm dia ball bearing steel pulley in every fourth double channel, unless otherwise specified.

Wherever collapsible gate is not provided within the opening and is fixed along the outer surface T-iron at the top may be replaced by flat iron 40×10 mm.

The collapsible gate shall be provided with necessary bolts and nuts, locking arrangement, stoppers, handles. Any special fittings like spring, catches and locks, shall be so specified in the description of item where so required.

The gate shall open and close smoothly and easily.

13.4.5.2 ***Fixing -*** T-iron rails shall be fixed to the floor and to the lintel at top by means of anchor bolts embedded in cement concrete of floor and lintel. The anchor bolts shall be placed approximately at 45 cm centers alternatively in the two flanges of the T-iron. The bottom runner (T-iron) shall be embedded in the floor and proper groove shall be formed along the runner for the purpose. The collapsible shutter shall be fixed at sides by fixed at sides by fixing the end double channels with T-iron rails and also by holdfasts bolted to the end double channel and fixed in the masonry of the side walls on the other side.

All the adjoining work damaged in fixing of gate shall be made good match the existing work, without any extra cost.

13.4.5.3 ***Painting -*** All the members of the collapsible gate including T-iron shall be thoroughly cleaned off rust, scales, dust etc. and given a priming coat of approved steel primer, before fixing them in position.

13.4.6 M.S. Sheet sliding shutter (Fig. 13-P/2)

13.4.6.1 These shall be manufactured as per drawings and specifications. These shall be fabricated from mild sheets.

13.4.6.2 The shutters shall be double or single shutters as specified. The shutters shall be fabricated of 40×40×6 mm M.S. angle iron frame diagonally braced with the same size M.S. angle and rivetted together with 3 mm gusset plate at junction and corners to form a rigid frame. M.S. sheet of 1 mm thickness or as specified shall be fixed to the frame with rivets, as approved by the Engineer-in Charge. These shall also be provided with top and bottom guide rails of 40×40×6 mm size angles or T-iron and 25 mm diameter ball bearings at the bottom and guide block with steel pulleys at the top. The shutters shall also be provided with locking arrangements, handles, stoppers and holdfasts, other fittings as specified in the description of the item.

The guide rails shall be sufficiently long and continuous along the wall on both ends so that the sliding shutters can rest against the walls, giving full opening when so required.

13.4.6.3 ***Fixing -*** The guide rails shall be fixed to the floor by means of anchor bolts embedded in the cement concrete floor. The steel section at the top shall be suitably supported from the walls. Two channel sections shall be suitably fixed vertically below the extreme clamps in the wall and floor, to avoid the shutter from going out of the supports at top and bottom.

A suitable arrangement will be provided at either end of the opening to avoid the shutters from rolling back into the opening.

All the adjoining work damaged in fixing shall be made good to match the existing work.

13.4.6.4 ***Painting -*** All the members of the sliding shutters including fitting shall be thoroughly cleaned off rust, scales, dust etc. and given a priming coat of approved steel primer before fixing them in position.

13.4.7 M.S. Sheet Garrage Doors (Fig.13-P/3)

13.4.7.1 These shall be manufactured as per drawing and specification. These shall be fabricated from mild steel sheets and angle iron.

13.4.7.2 The doors shall be provided as double leaf shutters unless otherwise specified. The shutters shall be fabricated from M.S. frame of angle 40×40×6 mm size and two diagonal braces of the section shown in fig. 13-P/3 (i) & 13-P (ii) as may be specified in the item. The frame shall be rivetted and/or welded at the junctions. Wherever rivetting shall be done 3 mm thick gusset plate shall be provided at the junctions. M.S. sheet of 1 mm thickness or as specified, shall be fixed to the frame with rivets or welds as approved by the Engineer-in-Charge.

The outer frame shall be provided with cleats made of flat iron of section 40×10 mm and bent in the shape of angle cleats with one arm 150 mm long to be used as vertical tee and the other arm 50 mm long to be used as horizontal tee and fixed to the angle iron frame of the door with two 12 mm dia bolts and nuts and shall be provided with a hole of 24 mm dia and fixed in the projected pin of the pin clamp. For doors upto 2.40 m height, two angles cleats per door shall be provided.

13.4.7.3 ***Fittings and Fixtures -*** The shutter shall be fixed to the wall masonry, with four pin clamps (pintles) where the height of the shutter is upto 2.4 m. Each pin clamp shall consist of 50×6 mm flat iron 45 cm long bent and forked at one end and provided with 20 mm diameter M.S. pin on the other. The pin shall be firmly rivetted or welded to the pin clamp, the other end of which shall be embedded in masonry by means of cement concrete block 40×20×20 cm of 1:3:6 mix (1cement : 3sand 6 graded stone aggregate of 20 mm nominal size). It shall be so placed that the bottom pin shall face upwards and top in downwards, in order that the gate may not be removed by lifting over pins.

One hook with eye, 45 cm long of 10 mm diameter shall be provided for each shutter to keep it fixed in open position. The hook shall be fixed in wall masonry with wooden block and the eye shall be fixed on 6 mm thick M.S. plate as staple and fixed in the shutter frame with rivet or weld.

A cement concrete block 15×10×20 cm in 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size) shall be embedded in the floor at junction of two shutters so that the door shutter open only on the outside and not on the inside.

The shutters shall also be provided with locking arrangement and two handles of the shape and pattern as approved by the Engineer-in-Charge.

13.4.7.4 ***Paintings -*** All the members of the garrage door including angle iron shall be throughly cleaned off rust, scales, dust etc. and given a priming coat of approved steel primer, before fixing them in position.

13.4.8 Rolling Shutters

13.4.8.1 These shall include necessary locking arrangement and handles etc. These shall be suitable for fixing in the position as specified i.e. outside or inside on or below lintel or between jambs of the opening. The door shall be either push and pull type or operated with chain and crank device supplied by the firm.

Shutters upto 12 square meters shall be of push and pull type and shutters with an area of over 12 square meters shall generally be provided with reduction gear operated by mechanical device with chain or handle. In push-pull type rolling shutters ball bearings shall be provided for shutters above 8 square meter upto 12 square meter clear area.

13.4.8.2 **Shutters-** These shall consist of M.S. laths 1.25 mm thick and 80 mm wide laths or as specified. The laths shall be machine rolled and straightened with an effective bridge depth of 16 mm and shall be interlocked together throughout their entire length and jointed together at the end locks. These shall be mounted on specially designed pipe shaft. Each lath section shall be a continuous single strip piece without any joint.

The spring shall be preferably of coiled type. The spring shall be manufactured from high tensile spring steel wire conforming to Grade 2 of IS: 4454 (Part I) 1981 to balance the shutters in all positions. The spring, pipe shaft etc. shall be supported on strong mild steel brackets.

13.4.8.3 ***Guide Channels***

The guide channels shall be of mild steel deep channel section and of hot-rolled, pressed or built up (fabricated) construction. The thickness of the sheet used shall not be less than 3.15 mm.

The minimum depths for guide channels shall be as follows:

Clear width of shutter	Depth of Guide Channel
Upto 3.5 m	65 mm
3.5 mm upto 8 m	75 mm
8 m and above	100 mm

The gap between the two legs of the guide channel shall be 5 mm to allow the free movement of the curtain and to prevent the rattling of the curtain due to wind.

Each guide channel shall be provided with a minimum of these fixing cleats or supports for attachment to the walls or column by means of bolts or screws. The spacing of cleats shall not exceed. 0.75 m. Alternatively, the guide channels may also be provided with suitable dowels, hooks or pins for embedding in the walls.

The guide channels shall be attached to the jamb, plumb and true, either in the overlapping fashion, projecting fashion or embedded in grooves, depending on the method of fixing.

Top cover of shaft, spring etc. shall be of the same material as that of lath.

13.4.8.4 ***Bracket Plate -*** The bracket plate shall be fabricated out of mild steel of 3.15 mm thickness (minimum), thicker plates may be used depending upon the height of shutter. The size of the bracket plate for different heights if different rolling shutters shall be as follows.

Clean height	Size of Bracket Plate, Min.
	mm×mm×mm
upto 2.3	300 × 300 × 3.15
Above 2.3 and upto 2.6	325 × 325 × 3.15
Above 2.6 and upto 3.0	350 × 350 × 3.15
Above 3.0 and upto 3.5	375 × 375 × 3.15
Above 3.5 and upto 4.5	400 × 400 × 6
Above 4.5 and upto 5.5	450 × 450 × 6
Above 5.5and 6.5	500 × 500 × 10
Above 6.5	To be designed

The bracket plate shall be of hexagonal, square or circular contour. The bracket plate shall have fitted at the centre a U-shaped cast iron or mild steel clamp riveted or welded to it. It shall be held in position rigidly by means of suitable foundation bolts. In the case of push and pull shutter, extra tying of the bracket plate to the guide channel is provided by means of a square bar not less than 20 mm size (see Fig. 13-P/6)

This square bar shall be welded on to the back of the guide channel for a length of at least 20 cm. The bracket plate shall then be attached to the top of this square bar by means of 6 mm counter sunk rivets at a spacing of not more than 100 mm. An angle 40×40×6 mm split at one end shall be firmly riveted or welded at the top line of the bracket to act as a foundation holdfast. The angle shall extend at least 20 cm from the edge of the bracket plate. This angle shall be grouted firmly into the wall with split end of the angle well burried in concrete.

A stopper made out of 40×6 mm flat shall be bolted on to the square bar so that the lock plate may be arrested from going beyond the limit.

13.4.8.5 ***Roller -*** The suspension shaft of the roller shall be made of steel pipe conforming to heavy duty of IS : 1161-1979. The size of the pipe for various widths of shutters shall be as under:

Width	**Size of Pipe**
upto 2 m	32 mm nominal bore
upto 3 m	40 mm nominal bore
upto 6 m	50 mm nominal bore

The Pipes of the suspension shaft which are clamped to the brackets shall be fitted with rotatable cast iron pulleys to which the curtain is attached. The pulleys and the pipe shaft shall be connected by means of pre tensioned helical springs to counter-balance the weight of the curtain and to keep the shutter in equilibrium in any partly opened position.

13.4.8.6 ***Fixing -*** Brackets shall be fixed on the lintel or under the lintel as specified with raw-plugs and screw bolts etc. The shaft along with the spring shall then be fixed on the brackets.

The lath portion (shutter) shall be laid on ground and the side guide channels shall be bound with it with ropes etc. The shutter shall then be placed in position and top fixes with pipe shaft with bolts and nuts. The side guide channels and the cover frame shall then be fixed to the walls through the plate welded to the guides. These plugs drilled in the wall. The plates and screw bolts shall be concealed in plaster to make their location invisible. Fixing shall be done accurately in a workmen like manner so that the operation of the shutter is easy and smooth.

13.4.9 Steel Door, Windows, Ventilators And Composite Units (Fig.13-P/4 and 13-P/5)

13.4.9.1 Steel door, windows, ventilators and composite units shall be manufactured using rolled steel sections of the weights specified in IS:1038-1985 (Fig. 13-P/4). It shall be fixed, centre hung, top hung, bottom hung or composite as specified (See fig. 13-P/4). The steel shall be of S.T. 32-0 grade conforming to IS: 1977-1975 (See Para 13.3.1.1).

13.4.9.2 ***Size -*** The type, over all sizes, side opening, position of steel doors, windows and ventilators shall be either as shown in drawing or as per details given by Engineer-in-Charge. The provision of threshold or the tie bar at the bottom of the door frame shall also be specified (usually external doors are provided with threshold and internal doors with tie bars etc., as show in Fig. 13-P/4 and 13-P/5.

The steel doors and windows shall be according to the specified size and design. The actual sizes of doors, windows and ventilators shall be vary more than 1.5 mm from those given in the drawing.

13.4.9.3 ***Fabrication***

13.4.9.3.1 ***Frames -*** Both the fixed and opening frames shall be constructed of sections which have been cut to length and mitered. The corners of fixed and opening frames shall be welded to form a solid fused welded joint conforming to the requirements given below. All frames shall be square and flat. The process of welding adopted may be flash but welding or any other suitable method which gives the desired requirements.

Requirements of Welded Joints

Visual Inspection Test - When two opposite corners of the frames are cut, paint removed and inspected, the joint shall conform to the following.

a) Welds should have been made all along the place of meeting the members.

b) Welds should have been properly ground, and

c) Complete cross section of the corner shall be checked upto see that the joint is completely solid and there are no cavities visible.

Micro and Macro Examination - From the two opposite corners obtained for visual test, the flanges of the sections shall be cut with the help of a saw. The cut surfaces of the remaining portions shall be polished, etched and examined.

The polished and etched faces of the weld and the base metal shall be free from cracks and reasonably free from under cutting, over laps, gross porosity and entrapped slag.

Fillet Weld Test - The fillet weld in the remaining portion of the joint obtained shall be fractured by hammering. The fractured surfaces shall be free from slag inclusions, porosity, crack, penetration defects and fusion defects.

13.4.9.3.2 ***Door -*** The hinges shall be of 50 mm projecting type. Non-projecting type hinges may also be used if approved by the Engineer-in-Charge. The hinge pin shall be electro-galvanized steel of suitable thickness and size. Door handles shall be approved by Engineer-in-Charge. A suitable latch lock for door openable both from inside and outside shall be provided.

In the case of double doors, the first closing leaf shall be the left hand leaf locking at the door from the push side. The first closing shutter shall have concealed steel bolt at top and bottom. The bolts shall be so constructed as not to work loose or drop by its own weight.

Single and double shutter door shall be provided with a three way bolting device. Where the device is provide in the case of double shutter door concealed brass or steel bolts shall not be provided.

13.4.9.3.3 ***Windows -***

(a) For fixed windows, the frames shall be fabricated as per 13.3.9.3.1.

(b) ***Side Hung Window -*** For fixing steel hinges slots shall be cut in the fixed frame and hinges inserted inside and welded to the frame. The hinges shall be of projecting type and not less than 65 mm and not more than 25 mm wide. The hinge pin shall be of galvanized steel.

For fixing hinges to inside frame, the method described above may be adopted but the weld shall be cleaned or holes made in the inside frame and hinge rivetted.

The windows shall be fitted with peg stays which shall be either of back oxidized steel or as specified, 300 mm long with steel peg and locking brackets. The pegs stay shall have three holes to open the side hung casement in three different angles.

Side hung casement fitted with friction hinges shall not be provided with a peg stay.

13.4.9.3.4 ***Ventilators-***

(a) ***Top Hung Ventilators -*** The steel butt hinges for top hung ventilators shall be rivetted to the fixed frame or welded to it after cutting a slot in it. Hinges to the opening frame shall be rivetted or welded and cleaned off. Top hung casements shall be provided with a peg stay with three holes which when closed shall be held tightly by the locking bracket. The locking bracket shall either be fitted to the fixed frames or to the window.

(b) ***Centre Hung Ventilators -*** Central hung ventilators shall be hung on two pairs of brass cup pivots rivetted to the inner and outer frames of the ventilator to permit the ventilator shutter to swing to an angle of approximately 86°. The opening portion of the ventilator shall be so balanced that it remains open at any desired angle under normal weather condition.

A black oxidized steel spring catch approved by Engineer-in-Charge shall be fitted in the centre of the top bar of the centre hung ventilator for the operation of ventilator. This spring catch shall be secured to the frame with M.S. screws and shall close into a mild steel or malleable iron catch plate rivetted, screwed or welded to the outside of the outer window frame bar.

A black oxidised cord pulley wheel in galvanised mild steel brackets shall be fitted at the sill of the centre hung window with mild steel screws or alternatively welded to the bottom inner frame of the window in a position corresponding to that of pulley.

13.4.9.3.5 ***Composite Units-*** Composite units consist of a combination of two or more units of doors, windows and ventilators etc., as the case may be. The different units shall be coupled by using coupling sections. Coupling sections manufactured from mild steel plate 1.6 mm thickness and conforming to the dimensions shown in Fig. 13-P/5 may be used for coupling if agreed to between the purchaser and the manufacturer.

Wherever the ventilators, windows and doors shall be coupled with a coupling section mastic cement shall be applied between the junction to make the joint water-tight.

13.4.9.4 ***Blazing***

13.4.9.4.1 Ordinary glass panes of not less than 3 mm thick shall be provided. The glass panes shall be free from flaws, spacks or bubbles and shall have square corners and straight edges. The glass pane shall be so cut that it fits slightly loose in the frames.

13.4.9.4.2 Glazing shall be provided on the outside of the frame unless otherwise specified. Special metal sash putty of approved make shall be used for fixing glass panes. Putty shall be applied over the glass pane, which shall stop 2 to 3 mm from the sight line of the black rebate to enable the painting to be done upto the line, to seal the edge of the putty to the glass. The oozed out back putty shall be cleaned and putty cut to straight line. Quantity of putty shall not be less than 185 mm/ meter of glass perimeter. Putty shall be painted within 2 to 3 weeks, after glazing is fixed to avoid its acing.

Note :- Putty may be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boil linseed oil to the mixture to form a stiff paste and adding varnish to the paste at the rate of 1 litre of varnish to 18 kg of paste.

13.4.9.4.3 Four glazing clips shall be provided per glass pane for a size larger than 30 cm × 60 cm for all types. Where the glass panes size exceed 80cm×200 cm. 6 glazing clips shall be used. In case of doors, windows and ventilators without horizontal glazing bars, the glazing clips may be spaced according to the slots, in the vertical members, provided the spacing does not exceed 30 cm otherwise the spacing shall be 30 cm.

Note :- Glazing clips are not usually provided for normal size 30×60 cm. glass panes. Where large size glass panes are required to be used or where the door or window is located in heavily exposed situation, holes for glazing clips have to be drilled prior to fabrication and cannot be done at an any later stages. Use of glazing clips, where necessary shall be specified while placing the order.

13.4.9.4.4 Where specially stipulated, fixing of glass panes may be done with metal or wooden beading instead of mere putty. Where beading are proposed to be used, the manufacturers shall be intimated in advance to drill holes for head screws. Usually beads shall be fixed with screws spaced not more than 10cm from each corner and the intermediate not more than 20 cm apart. When glass panes are fixed with wooden or metal beading having mitered joints, a thin layer of putty shall be applied between glass panes and sash bars and also between glass panes and the beading.

13.4.9.5 ***Finishing -*** All steel surfaces shall be thoroughly cleaned of rust, scale and dirt. Where so specified, the steel surfaces shall be treated for rust proofing by the hot dip, zinc spray or electro-galvanizing process. A priming coat of approved steel primer shall be given. On no account shall non-ferrous parts, that is, handles, stays, catches, etc. where it can impede free action.

Note : Final finishing coat shall be given after the doors, windows and ventilators are erected and fixed in final position.

13.4.9.6 ***Fixing-***

13.4.9.6.1 Steel doors and windows shall be so stacked as to keep them in true shape without damage. Doors, windows and ventilators shall be fixed as described below.

13.4.9.6.2 Openings may be flush on bated as shown in the drawings. Those openings may have rendered finishing or a "fair faced" finish (i.e. without rendering as in case of marble or stone facing). Where openings are flush and with a rendered finish a clearance of 1.25 cm shall be provided between the steel frame and opening (See fig. 13-P/5). In case of external masonry finish "fair faced" and with rebated jambs, a minimum 1.25 cm clearance between frame and opening shall be provided (See fig. 13-p/5). Opening in steel work shall be so designed that the outer flange of the door, windows, or ventilator frame section over-laps the steel surface by 10 mm (See fig. 13-P/5).

Note : The sizes of Indian standard doors, windows and ventilators are designed for modular opening 1.25 cm larger all round than the doors, windows, etc. This gap of 1.25 cm is for the purpose of fixing of doors, windows etc. In masonry openings the gap is filled up with mastic cement and plaster after the door or window 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 1.25 cm.

13.4.9.6.3 ***Fixing In Masonry Opening***

(a) ***Fixing With Lugs -***

(i) Doors, windows and ventilators unit, shall not be built in as the work proceeds but opening shall be left out and frames fitted afterwards so that the minimum specified clearance between opening and unit frame is left all-round. The size of the opening shall first be checked and cleared of obstruction, if any,. The position of the unit and fixing holes shall be marked on the jamb. Necessary holes shall be made in the masonry and lugs not less than 10 cm long 15×3 mm size fixed in cement concrete blocks 15×15×10 cm size of 1:3:6 mix (1 cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size). The frames of units shall be sent in the opening by using wooden wedges at the jamb, head and sill, (wedges shall preferably be placed near the points where a glazing bar meets the frames and be plumbed in position)

(ii) After it, the frame shall be fixed with the lugs with 20 mm long an 6.3 mm dia G.I. counter sunk machine screws and nuts. In case of flush opening which are rendered smooth, wedges shall be removed and gap between unit and the jambs shall be filled with cement mortar (Fig. 13-P/5).

(iii) In case of flush jamb with external 'fair faced' finished the gap between the opening and frame shall be filled with mastic from inside till it oozes out on external face. The oozing gap shall be filled with mastic to about 1/3rd depth and the rest with cement mortar (Fig.13-P/5).

(iv) In case of rebated jambs and jambs finished 'fair faced' externally the masic shall be freely applied to the inside channel of frame jamb and sill, so as to ensure a water tight joint. After the unit is firmly fixed in position surplus mastic shall be cleaned and flush pointed, as shown in Fig. 13-P/5).

(b) ***Fixing With Screws and Plugs-*** In R.C.C. work where lugs cannot be embedded due to reinforcement bars, etc. raw plugs or other approved metallic fasteners may be fixed in proper position and frames fixed to them with 60 mm galvanized wood screws of designation 10.

13.4.9.6.4 ***Fixing in wood work opening -*** Openings in wood work are normally rebated and approved mastic or rubber linings shall be applied to jambs, sill and channel before fixing in position. The frames shall be sent in openings using wooden wedges as specified in 13.3.9.6.3 and fixed to the opening with 60 mm galvanized woods screws of designation 10. Extra timber fillets of hard wood to match the adjoining work shall also be provided around the frame to close the extra gap between opening and frame (Fig.13-P/5).

13.4.9.6.5 ***Fixing in steel work openings-*** Before placing the unit frame in position approved mastic shall be applied as specified in 13.4.9.6.3 (a) (iv) and a mild steel or hard wood fillet shall be provided around the frame to close the extra gap between opening and frame. The unit shall then be fixed to the opening with fixing clips or with nuts and bolts as shown in the drawings or as directed by the Engineer-in Charge (Fig.13-P/5).

13.4.9.6.6 ***Fixing of Composite Units. -*** The fixing procedure for composite units shall generally be as described under para 13.3.9.6.1 to 13.3.9.6.5 except that.

Where large units shall be formed by coupling individual units together (with coupling sections), the mullions and transoms shall be bedded in mastic to ensure water tightness. Mastic shall be applied liberally to the channels of the outside frame sections before assembly and after coupling. All oozing out mastic shall be cut out neatly (Fig.13-P/5).

13.4.9.7 ***Precautions-*** Care shall be taken that steel doors and windows, etc. are not deformed/damaged during subsequent construction. Particular care shall be taken that scaffolding do not rest on the steel door and window frames or glazing bars.

All fittings and hinges (projecting hinges) shall be protected, preferably with alkathene shets, so that these may not be damaged during execution of work.

13.4.10 T-Iron Doors, windows and ventilator (Fig.13-P/6).

13.4.10.1 T-Iron Doors, windows and ventilator frame shall be manufactured from uniform mild steel Tea section. The steel shall be of S.T. 32-0 grade conforming to IS:1977-1975 (See 13.4.1.1).

13.4.10.2 ***Size s -*** The sizes of doors, windows and ventilator frames shall be as per drawing or as decided by Engineer-in-Charge. The size of doors, windows and ventilators shall be calculated so as to allow 13 mm clearance on all sides to allow an easy fitting in opening. The actual size of doors, windows and ventilators shall not very by more than ± 2 mm than those shown in the drawings.

The height of T-section used for manufacture of doors, windows and ventilators shall not be less than those specified in IS : 1038-1983.

13.4.10.3 ***Fabrications -*** The frame shall be constructed in section which has been cut to length and mitered. the corners of the frames shall be butt welded to form a true and right angle. All frames shall be square and flat.

13.4.10.4 ***Fittings -*** Require number of holes shall be made in the frames for fixing of fitting. Detailed arrangements of fixing fittings shall be as shown in Fig. 13-P/6.

13.4.10.5 ***Fixing procedure -*** Fixing procedure for T-iron doors, windows and ventilator frames in masonry openings shall be as described in para 13.4.9.6. Fixing arrangements of shutters to such frames is shown in Fig.13-P/6.

After pretreatment of the surface, one coat of steel primer and two coats of paint, as directed by Engineer-in-Charge shall be applied to the exposed surface.

13.4.11 ***Tubular Trusses***

13.4.11.1 ***Structural Steel Tubes -*** These shall be of :

(1) hot finished welded (HFW) type, or

(2) hot finished seamless (HFS) type, or

(3) electric resistance or induction butt welded (ERW), having carbon content less than 0.03 percent, yield stress of 21.5 kg/mm (YST 22) type,

Conforming to the requirement of IS : 1161-1979. The steel tubes when analyzed in accordance with the method specified in IS : 226-1975 shall show not more than 0.06 percent sulphur and not more than 0.06 percent phosphorus.

Tubes shall be designated by their normal bore. These shall be light medium or heavy as specified, depending on the wall thickness. The standard sizes and weights of tubes are listed in Appendix-XI.

Tubes shall be cleanly finished and reasonably free from scale. They shall be free from cracks, surface flaws, laminations and other defects. The ends shall be cut cleanly and square with the axis of tube, unless other wise specified.

13.4.11.2 ***Minimum Thickness of Metals -*** The tubular steel work shall be painted with one coat of approved steel primer after fabrication. Wall thickness of tubes used for construction exposed to weather shall not be less than 4 mm, and for construction not exposed to weather it shall not be less than 3.2 mm where structures are not readily accessible for maintenance, the minimum thickness shall be 5 mm.

13.4.11.3 ***Fabrication***

13.4.11.3.1 The component parts of the structure shall be assembled in such a manner that they are neither twisted nor other wise damaged and be so prepared that the specified cambers, if any, are maintained.

13.4.11.3.2 ***Straightening -*** All material before being assembled shall be straightened, if necessary, unless required to be of a curvilinear form and shall be free from twist.

13.4.11.3.3 ***Bolting -*** Washers shall be specially shaped where necessary, or other means used, to give the nuts and the heads of bolts a satisfactory bearing.

In all cases where the full bearing area of the bolt is to be developed, the threaded portion of the bolt shall not be within the thickness of the parts bolted together, and washers of appropriate thickness shall be provided to allow the nut to be completely tightened.

13.4.11.3.4 ***Welding -*** Where welding is adopted, it shall be done as per IS : 9595-1980.

13.4.11.3.5 ***Caps And Bases for columns -*** The ends of all the tubes for columns, transmitting loads through the ends, should be true and square to the axis of the tube and should be provided with a cap or base accurately fitted to the end of the tube and screwed, welded or shrunk on. The cap or base plate should be true and square to the axis of the column.

13.4.11.3.6 ***Sealing of Tubes -*** Where the end of a tube is not automatically sealed by virtue of its connection by welding to another member, the end shall be properly and completely sealed. Before sealing, the inside of the tube should be dry and free from loose scale.

13.4.11.3.7 ***Flattened Ends -*** In tubular construction the ends of tubes may be flattened or otherwise formed to provide for welded, rivetted or bolted connections proved that the methods adopted for such flattening do n0ot injure the material. The change of sections shall be gradual.

13.4.11.3.8 ***Hoisting and Erection -*** Tubular trusses shall be hoisted and erected in position carefully, without damage to themselves, other structure, equipment and injury to workman. The method of hoisting and erection proposed to be adopted shall be got approved from the Engineer-in-Charge. The work shall be carried out in a safe and proper manner without unduly stressing the various members. Proper equipment such as derrick lifting tackles, winches, ropes, etc. as may be necessary shall be used.

13.4.12 Fan Clamps (Fig. 13-p/7)

13.4.12.1 ***Types -*** The fan clamp shall be of the following types.

(a) Fan clamp to be fixed during the laying of RCC slab, shall be of type has shown in fig. 13-P/7. This shall be made of 16 mm dia M.S. bar bent to shape with its hooked. The overall height of the clamps shall be made to suit the depth of the slab.

(b) Fan clamp for beams shall be of type II as shown in Fig. 13-P/7. It shall be similar to fan clamp, type I, except that its height shall be greater depending on the depth of the beam rib.

13.4.12.2 ***Fixing -*** Hole for inserting the fan clamps in the positions shown in the drawing or as instructed by the Engineer-in-Charge, shall be made in the shuttering after the later has been fixed in position. After steel reinforcement is tied, fan clamps shall be fixed with their loops truly vertical and at the correct depth from the underside of the slab or beam. The hooked arms and the loop shall be tied to the reinforcement, either directly or through cut places of M.S. bars with annealed steel wire 1.6 mm or 1.00 mm thick. The clamp shall neither be disturbed out of position during concreting nor shall they be bent out of shape when shuttering of slabs or beams is removed.

The exposed portion of loops of the clamp shall be given two or more coats of paint, including priming coat, of shade as ordered by the Engineer-in-Charge.

13.5 M.S. Grill Work

13.5.1 General - The M.S. grill shall be made of mild steel sections described in para 13.5.1.1.4. The M.S. sections shall be square, flat, rounds, etc. of the specified dimensions shown in the drawings. Standard screws, rivets, welding rods etc. shall be used.

13.5.2 Fabrication - The M.S. section shall be cut & shaped accurately to dimensions and pattern shown in the drawing. M.S. Sections with kinds, undesired bends & cracks shall not be used. These steel sections shall then be placed in the accurate position in the frame of the grill & welder/rivetted as shown in the drawing.

13.5.3 Fixing - The grill so formed shall be fixed into the frames of the windows, ventilators, etc. before they are erected in position. The outside strip frame of the grill shall be housed to its full thickness into the recess cut into the frame of the window, ventilator etc. The grill shall be fixed to the frame with screws at the rate of one screw per 30 cm length of the outer strip subject in a minimum of 2 Nos. each side of the frame or as indicated on the drawings. The screws shall counter sunk and shall be fixed with the tops of their heads flush with the face of the frame strip.

The grill railings shall be fastened to the floors through holdfasts welded to the railing grill by embedding the same to the sufficient depth into the floors as shown in the drawings or as directed by the Engineer-in-Charge.

13.5.4 **Painting -** The grill shall be painted one coat of red lead oil paint to prevent rusting.

13.6 BARBED WIRE FENCING

13.6.1 **Barbed wire -** The barbed wire shall be of galvanized steel and shall generally conform to IS : 278-1978. The barbed wire shall be of type 1 having line wire & point wire of 2.50 mm and 2.24 mm nominal diameter with nominal distance between two bars as 75 mm. The permissible deviation from the nominal diameter of the line wire & point wire shall not exceed ± 0.8 mm. The barbed wire shall be formed by twisting together two line wires, one containing the barbs. The barbs shall carry four points and shall be formed by twisting two point wire, each two turns, lightly round one line wire making altogether four complete turns. Other the barbs shall have a length of not less than 13 mm and not more than 18 mm. The points shall be sharp and cut an angle not greater than 35 degree to the axis of the wire faring the barbs. The length per 100 kg of barbed wire I.S. type shall be given as below.

Nominal	Minimum	Maximum
1000 metre	934 metre	1066 metre

13.6.2 R.C.C. Fencing Posts

13.6.2.1 For fencing work, the RCC posts and struts shall be of design shown in fig. 13-P/8. the length of posts being 1.5 m and that of struts being 1.6 m (unless the sizes specified otherwise in the description of the item). These shall be cast in cement concrete 1:2:4 (1 cement : 2 course sand : 4 graded stone aggregate of 12.5 mm nominal size) reinforced with 6 mm dia M.S. bars shall have a minimum concrete cover of 20 mm & shall be firmly held by means of 3 mm dia steel ties of spacers spaced at not more than 20 cm.

After placing, the concrete shall be adequately protected from shocks & running or surface water during initial setting time & shall then be cured with clean water for at least seven days.

13.6.2.2 **Tolerance -** The tolerance on the overall length of the fence posts shall be for 15 mm. The tolerance on cross-sectional dimensions shall be ± 3 mm. The tolerance on straightness of the fence post shall be 0.5 percent.

13.6.3 **Angle Iron Post and Struts-** The angle iron post shall be 1.75 m long & shall be made of M.S. angles of size as mentioned in the description of item. The braces shall be 1.9 m long. The posts shall be provided with holes at suitable heights of which the wireis to be fixed.

13.6.4 **Balli Posts & Struts -** In case of posts and struts of timber, these shall be of teakwood ballies reasonably straight & free from decay and cracks. The minimum dia of ballies shall be 120 mm.

13.6.5 **Erection of Fencing Posts**.- The fencing posts shall be set in specified mix of cement concrete/ lime concrete blocks of size mentioned in the description of item. R.C.C. post shall be set with their large face perpendicular to the line of fencing. The brace shall be placed in line with the fence so that it bears at a point not more than two thirds of the distance from the ground level to the top of the post. The other end of the brace shall bear against 1:5:10 cement concrete/lime concrete block below ground level.

13.6.6 **Fixing of Fencing Wires**

13.6.6.1 Posts shall be designed for the attachment of the fencing wire by one of the following methods. Holes cast in metal projections or clips shall be located at distances from the end of the post varying not more than ± 6 mm from the position specified.

(a) *Using Cast in Metal Projection or Clips* **-** Clips shall be embedded in the fence posts along the centre line of the post at right angle to one face of post during casting (see 13-P/8A). They shall, however, invariably be of galvanized steel or a suitable corrosion resisting material and the inner ends shall be bent or hooked to prevent extraction. The clips shall be sufficiently robust to withstand service conditions and repeated fixing and unfixing of wires. A single wire clip shall not be used for this purpose as it may be too easily broken.

(b) *Attaching Fencing Wire With Galvanised Wire* **-** Fencing wire shall be tied to the fence posts with a short peice of light wire, as shown in 13-P/8B. One end of the short wire shall be twisted round the line wire and brought around the back of the fence post, the other end shall then be pulled tight and twisted around the fencing wire on the other side of the post. If the edges of the post are chamfered, this will enable the tying wire to be pulled tighter shallow notches may also be cast in the two back edges of the post so that these will firmly house the line wire and prevent any possibility of its slipping down the post. In order to provide a choice of wire spacing, corrugations with a pitch of approximately 25 mm and depth of approximately 5 mm may be provided on one side of the posts, so that the attachment of fencing wire in chosen corrugations may be made with galvanized wire in the manner described above.

(c) *Using Holes in the posts* **-** Holes may be cast in the fencing posts through which the fencing wire could be passed (See Fig. 13-P/8C). The holes shall be formed by inserting steel rods, slightly greased, horizontally thorough the holes in the divisions of the mould and withdrawing them before the concrete sets too hard. say 4 or 5 hours after it has been placed. Holes shall have a uniform diameter of not less than 10 mm and shall be along the centre lines of the post.

They present a reasonably smooth surface. All rises shall be removed from the edges of the holes to prevent chaffing of the fencing wire. Holes shall not be provided in struts unless specified by the purchaser, and, when so specified, the holes shall take the form of long slots so that the fencing wires will not be kinked as they pass through.

Note: This method is good for plain wire, but if barbed wire is used the holes may have to be bigger which will reduce the cover of the reinforcement bars at these points, unless the section of the post is increased. For barbed wire fencing, holes may be cast in the fence posts in a direction from front to back with an indent at one end instead from side to side as for plain wire. To attach the barbed wire, a piece of plain wire shaped like a hairpin shall be passed over the barbed wire and through the hole in the post. The ends of the hair pin wire shall be twisted around a short piece of rod placed in the indent.

13.6.6.2 The fencing wire shall be tied to the M.S. angle fence posts with a short piece of light wire by passing it through hole in the angle iron post and twisting the same at ends.

13.6.6.3 In case of barbed wire fencing with teak wood ballies, the barbed wire shall be tied to the ballies with the help of short piece of light wire in the manner shown in Fig. 13-P/8B except with the difference that the concrete post shall be replaced by teak wood ballies.

13.7 WELDED STEEL WIRE FABRIC FENCING

13.7.1 Material

For R.C.C. Posts Para 13.5.2 shall apply. Welded steel wire fabric shall be 0.9 m with rectangular mesh of 75 mm×25 mm size weighing not less than 7.75 kg/m^2.

Welded steel wire fabric shall be manufactured from cold drawn steel wire "as drawn" or galvanized steel conforming to IS: 226-1975, with longitudinal and transverse wire electrical resistance welding and conforming to IS : 4948-1974. The mesh sizes of wire for square as well as oblong welded steel wire fabric shall be as indicated in the description of the item. Steel wire fabric in panels shall be in one whole piece in each panel as far as stock sizes permit.

13.7.2 Fixing of Welded Steel Wire Fabric

The width of welded steel wire fabric shall be such so as to leave the clearance of 150 mm from ground and 150 mm from the top of the posts. The welded steel wire fabric shall be stretched and fixed to the posts by means of G.I. staples fixed to wooden plugs or G.I. binding wire tied to 6 mm bar ribs fixed while casting the posts at 225 mm apart.

APPENDIX – I
PHYSICAL PROPERTIES OF REINFORCING BARS

(Para 13.3.2.2)

IS. No.	Type of Reinforce ment	Nominal Size of Bars	Character-istic strength (Yield Stress or 2 percent proof stress	Ultimate Tensile Stress	Composition of steel Conforming to IS.No.	Elongation on Gauge length of 5.65 (area) 0.5
		(mm)	(N/mm^2)	(N/mm^2)		(%)
1	2	3	4	5	6	7
432 (Part-I) 1982	Mid Steel (Grade-I)	5, 6, 8, 10, 12, 16, 20	250			
		22, 25, 28, 32, 36, 40, 45, 50	240	410	IS: 226-1975	23
	Mid Steel (Grade-II)	5, 6, 8, 10, 12, 16, 20	225			
		22, 25, 28, 32, 36, 40, 45, 50	215	370	Fe 410.0 (ST 42.0) of IS: 1977-1975	23
	Medium Tensile Steel	5, 6, 8, 10, 12, 16	350			
		20, 22, 25, 28, 32,	340	540	(St 55-HTW) of IS : 961-1975	20
		36, 40, 45, 50	330	510	-- do --	20
1786-1985	High Strength Deformed Steel	6, 8, 10, 12, 16, 18, 20, 22, 25, 28, 32, 36, 40, 45, 50	415 (for Fe 415)	10% more than the actual 0.2% proof stress	C-0.30% S-0.060% P-0.060% S & P-0.105%	(Max) 14.5
			500 (for Fe 500)	8% more than the actual 0.2% proof stress	C-0.30% S-0.055% P-0.055% S & P-0.105%	12
1566-1982	Hard-drawn steel fabric	(See Note)	As Per Is: 432 (Part III) 1982	--	--	--

Notes – 1. Mild Steel bars are supplied in the following grades :

(a) Mild Steel Bars Grade –I.

Steel for Mild steel reinforcement bars Grade-I shall be manufactured and have the chemical composition in accordance with the requirements of steel St-42 of IS: 226-1975. St-42-S shall be used for all the type of structures including those subjected to dynamic loadings and where fatigue, wide fluctuations of stress, reversal of stresses and great restraint are involved as for example crane gantry girders, road and railway bridges etc.

(b) Mild Steel Bars Grade-II

Steel Mild steel reinforcement bars grade-II shall be manufactured and have the chemical composition in accordance with the requirements of steel St-42-0 IS: 1977-1975. The grade II quality of steel designated as St-42-0 shall be used for structures, not subjected to dynamic loadings, other than wind load, where welding is not employed or/and structures not situated in earthquake zones or/and design has not been based on 'Plastic Theory'.

(C) Ordinary Quality Steel

1. Ordinary quality steel shall be manufactured and have the chemical composition in accordance with the requirements of steel St-32-0 IS: 1977-1975. The ordinary quality steel designated as St-32-0 shall be used for doors, windows, window frames, window bars, grills, hand grilling, fencing posts, tie bars etc.
2. Basically the material for deformed mild steel and medium tensile steel bars is the same as for plain mild steel and medium tensile steel bars. Therefore, the specifications for use of deformed bars has to be, as far as possible, in line with the specification for plain mild steel and medium tensile steel bars.
3. Basically the material for cold twisted steel bars is same as for plain or deformed mild steel bars. The specification for use of cold twisted steel bars shall therefore be as far as possible in line with the respective mild steel bars.
4. Hand drawn steel wire fabrics shall be manufactured and have the properties in accordance with the requirement of IS: 1566-1982 and shall be used for floor slabs (hollow black ribbed), for secondary reinforcement in developing fire resistance and in some present concrete products like pipes.

APPENDIX - II

COPY OF DESION SERIES TECHNICAL CIRCULAR NO.24
(Issued vide no. 125 / BODHI / R&C / TC / 11 / 89 dated 20.2.90)
ANCHORING AND SPLICING OF REINFORCING BARS
(Para 13.3.5.1.2 & 13.3.5.1.6)

1. GENERAL :-

When an R.C.C. member is loaded, the transfer of force between concrete and embedded steel reinforcement takes place only by virtue of the grip or bond between the two materials. The bond between concrete and steel must be sufficient to make them act jointly. In case the bond between the two materials is not proper and adequate, the R.C.C. member, when loaded, will fail as the steel reinforcement on account of imperfect bond will slip and will not contribute to resist any stresses developed in the imperfect bond will slip and will not contribute to resist any stresses developed in the member. The bond depends upon the grade of concrete, type and size of reinforcing bars, the length of embedment of bars and the cover of concrete to the reinforcement.

2. DEVELOPMENT (BOND) LENGTH

2.1 For a safe design of RCC member, it is necessary that the designed tension or compression at any section in any reinforcing bar shall be balanced by the equal bond strength developed by the sufficient length of the bar embedded in the concrete beyond that section on either side. The length, thus, required is known as bond length or development length.

Bond length or development length Ld (in mm) is given by the following expression

Ld = C.K.N,
Where, C = Constant depending upon the grade of steel & nature of Stress (i.e. tension or compression)
K= Constant depending upon the grade of concrete
N=Diameter of bar (Ø) in mm × maximum permissible Stress at section in N/mm²
Value of C & K should be adopted from Table A & B respectively.

TABLE - A
Value of 'C'

S.No.	Type of steel (Yield stress in N/mm²	Nature of stress	
		Tensile	Compressive
1	Tor-steel (415)	1.0	0.80
2	Mild-steel (250)	1.40	1.12

TABLE - B
Value of 'K'

Grade of Concrete	M15	M20	M25	M30	M35	M40
Value of 'K'	0.30	0.22	0.20	0.18	0.16	0.15

2.2 Bars Bundled In Contact :

The development length of each bar of bundled bars shall be that for the individual bars as calculated in para 2.1, increased by 10% for two bars in contact. 2-% for three bars in contact, and 33% for four bars in contact.

3. ANCHORING REINFORCING BARS

3.1 Anchoring Bars In Tension

Hooks should invariably be provided for plain bars in tension. Deformed bars may be used without end anchorages provided development length requirement is satisfied. In case, this requirement is not satisfied deformed bars may be provided with end hooks. While calculating the anchorages length of bars in tension, the hook/bend should be ignored and only the anchorage values as specified in para 3.1.1 below should be adopted.

3.1.1 *Bend and Hooks :*

Bend & hooks should conform to shape & dimensions given in Fig-1. The anchorage value of bend and hooks should be considered as follows-

i) Bend:- The anchorage value of bend should be taken as 4 times the diameter of the bar for each 45° bend subject to a maximum of 16 times the diameter of the bar.

ii) Hooks :- The anchorages value of a Standard U type hook should be equal to 16 times the diameter of the bar

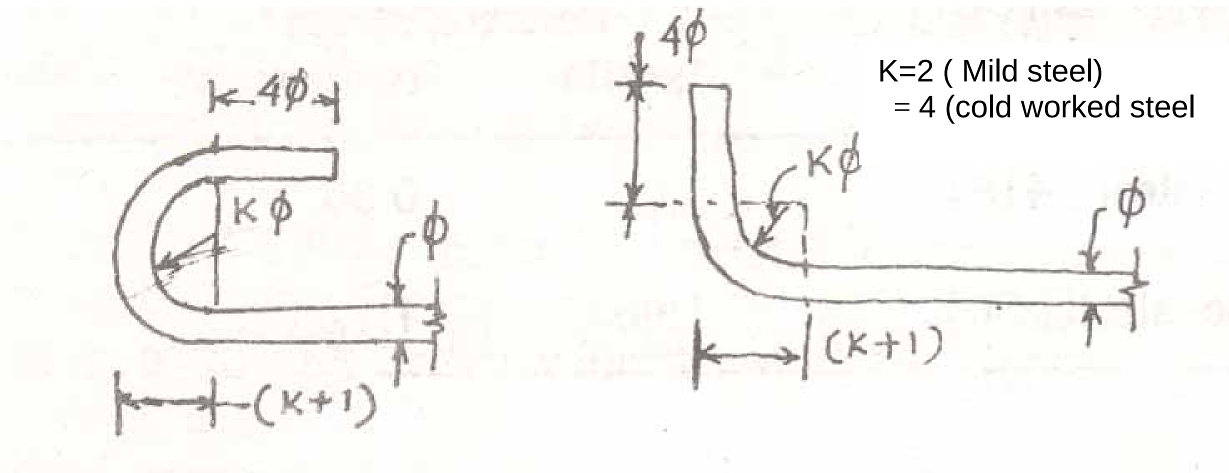


Fig-1 STANDARD HOOK AND BEND

3.2 Anchoring Bars in Compression :

The anchorage length for straight bars in compression should be equal to the development length of bars in compression as specified in para 2 above. The projected length of hooks, bends and straight lengths beyond bend, if provided, for a bar in compression should be considered for development length.

3.3 Mechanical Devices for Anchorage :

Any mechanical or other device capable of developing the strength of the bar without damage to concrete may be used as anchorage with the approval of the designer.

3.4 Anchoring shear Reinforcement :

3.4.1 ***Inclined Bars -*** The development length shall be as for bars in tension; this length shall be measured as under.

i) In tension zone, from the end of the sloping or inclined portion of the bar (see Fig. 2(a) & (b).

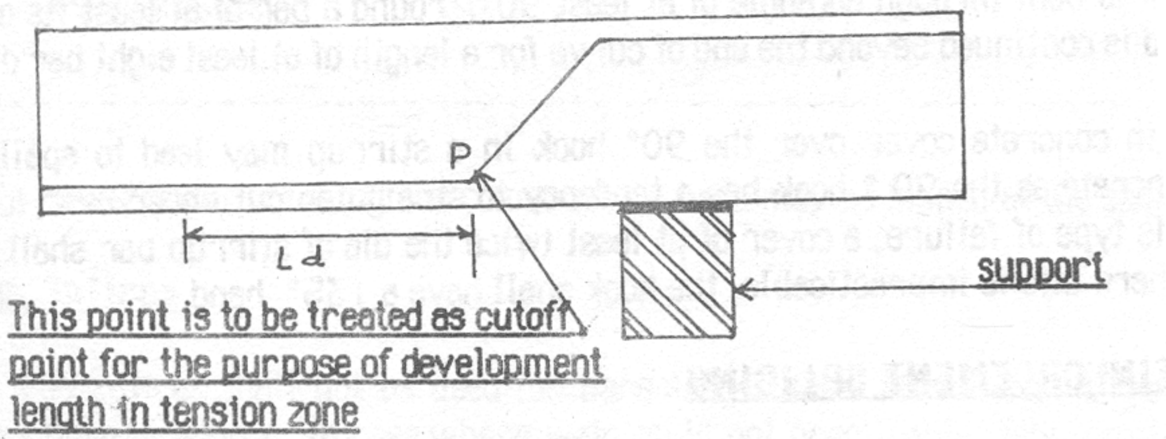


FIG.-2 (a)

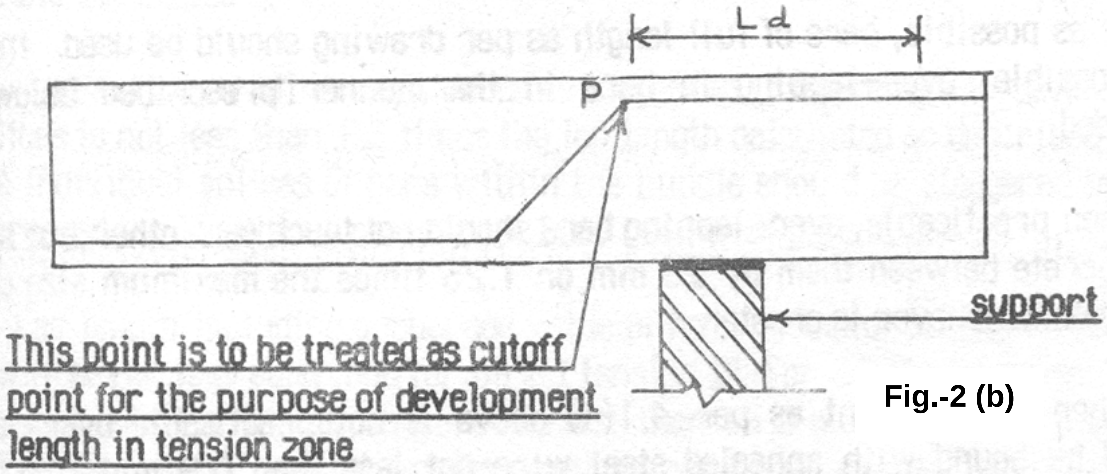


Fig.-2 (b)

Fig.2(a) & 2(b) ANCHORING INCLINED BENTUP BAR IN TENSION ZONE

iI) In the compression zone from the mid depth of the beam (see Fig.2(c)

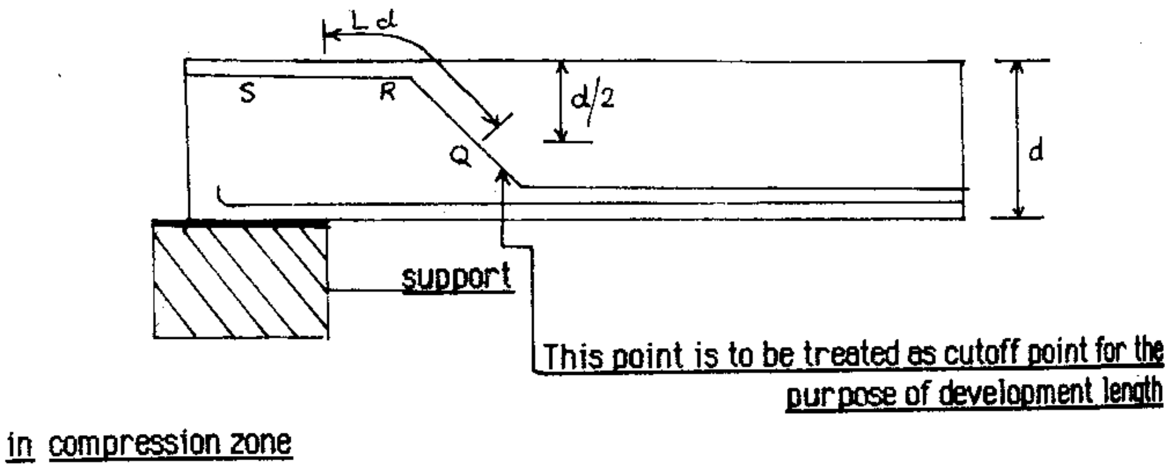


Fig.-2 (c) : ANCHORING INCLINED BENTUP BARS IN COMPRESSION ZONE

3.4.2 ***Stirrups :-***

In case of secondary reinforcement, such as stirrups and transverse ties, complete development lengths and anchorages shall be deemed to have been provided when the bar is bent through an angle of at least 90° round a bar of at least its own diameter and is continued beyond the end of curve for a length of at least eight bar diameter.

Note:- Thin concrete cover over the 90° hook in a stirrup may lead to spalling of cover concrete as the 90° hook has a tendency to straighten out under over load. To avoid this type of failure, a cover of at least twice the dia of stirrup bar shall be provided. Where this is impracticable, the hook shall have a 135° bend.

4. REINFORCEMENT SPLICING :

4.1. General Arrangements and Provisions :

As far as possible, bars of full length as per drawing should be used. In case this is not possible, over-lapping in bars in the manner prescribed below should be provided.

i) When practicable, over-lapping bars should not touch each other, but be kept apart by concrete between them by 25 mm or 1.25 times the maximum size of the coarse aggregate whichever is greater.

ii) When arrangement as per 4.1 (i) above is not practicable over-lapping bars should be bound with annealed steel wire not less than 0.9 mm (20 SWG) thick twisted tight.

iii) Splices in tension zone of flexural members should, as far as possible:-

a) Bar way from the sections of maximum stress and be staggered.

b) Should not be at sections where the bending moment is more than 50 percent of the moment of resistance and not more than half the bars shall be spliced at a section.

iv) In tension zones, where more than one-half of the bars are spliced at a section or where splices are made at points of maximum stress, special precautions should be taken, such as increasing the length of lap as per Table-C or using spirals or closely spaced stirrups around the length of the splice.

TABLE - C

Percentage increases in Lap length

Splice stress (percentage of designed stress)	Percentage of bars spliced at one point	
	50 or less	More than 50
a) 50% or less	0	30
b) more than 50%	30	70

v) In compression zone, all the compression bars may be lapped at the same section.

4.2 Lap Splices

a) Lap splices shall not be used for bars larger than 36 mm; for larger diameters, bars may be welded; in case where welding is not practicable, lapping of bars larger than 36 mm dia may be permitted, in which case additional spirals should be provided around the lapped bars.

b) Lap splices shall be considered as staggered if the centre to centre distance of the splices is not less than 1.3 times the lap length calculated as described in para 4.2(c). The individual splices of bars within the bundle should be staggered by 1.3 times the increased lap lengths as per para 4.2(c) read with para 2.2.

c) Lap length including anchorage value of hook in flexural tension shall be Ld or 30 Ø whichever is greater and for direct tension 2Ld or 30 Ø whichever is greater. The straight length of the lap shall not be less than 15 Ø or 20 cm. (Ø denotes diameter of reinforcing bar and Ld denotes development length as per para 2 suitably modified as per para 4.1 (iv). Splices in tension members should be enclosed in spirals made of bars not less than 6 mm diameter with pitch not more than 100 mm and the spliced bars should end in hooks even in the case of ribbed or deformed bars.

d) The lap length in compression shall be equal to the development length in compression, calculated as described in para 2 but not less than 24 Ø.

e) When bars of two different diameters are to be spliced, the length shall be calculated on the basis of diameter of the smaller bar.

f) When splicing of welded wire fabric is to be carried out, lap splices of wires shall be made so that overlap measured between the extreme cross wires shall be not less than the spacing of cross wires plus 10 cm as detailed in Fig.-3.

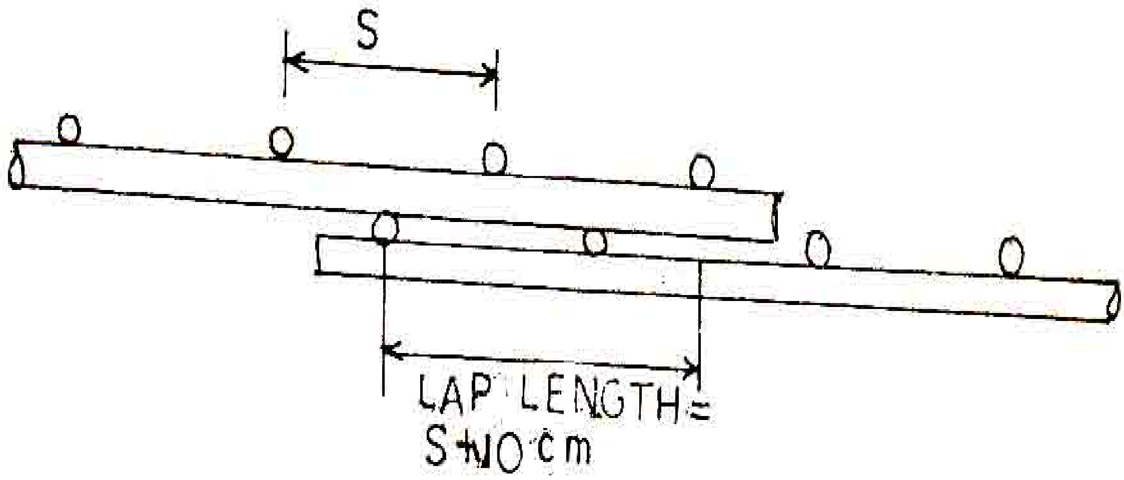


Fig. 3: LAP SPLICING OF WELDED WIRE FABRICS

4.3 Welded Splices :

Welding should not usually be preferred in splicing of the bars, chiefly because of the difficulty of detecting a faulty weld. In case it is unavoidable the relevant IS: 456-1978, IS: 2751-1979 & IS: 9417-1979 may be referred.

5. This circular supersedes instructions and all other circulars and Technical Memorandum issued on this subject in the past.

(O.N. THAPAR)
Chief Engineer
Bodhi, Bhopal

P. C. (AGARWAL)
Engineer-in-Chief
Irrigation Department,
Bhopal (M.P.)

APPENDIX - III

A NOTE ON RUST OVER REINFORCEMENT
(Para 13.3.6.1)

1. Some rust is not harmful to the bond between concrete and steel and steel and no benefits is gained by removing all the rust. However, any rust and mill scale which is not firmly attached should be removed, to ensure the development of good bond.

2. Rust increases the normal roughness of the steel surfaces and tends to augment the holding capacity of the bar, but it may reduce the effective area of the bar.

3. Usually normal handling is sufficient for removal of loose rust and scale prior to embedment of reinforcement steel. However, in some instances, it may be necessary to rub with a coarsely woven sack (gunny) or use a wire brush.

4. Sand blasting etc., which were in vogue are not required. The procedure of cleaning shall be as decided by the Engineer-in-Charge.

5. Bars that appear to have rusted beyond usefulness may be checked by cleaning and weighing them for conformance with specifications.

APPENDIX - IV

GUIDE LINES FOR SUBSTITUTION

1. **Substitution by adjusting bar spacings -**

1.1 Normally substitution should be on basis of adjusting the spacing of bars according to available diameter of bar wherever possible as per formula given below.

Spacing of substituted bar of available dia and grade of steel } = S × (da / œ)² × (Spacing of original bars being substituted)

1.2 Where it is desired for direct substitution without change in spacing of bars, the specified arrangement may be substituted either with single bar of higher grade steel having equivalent area or with bundle of bars of same grade steel rendering equivalent area as the case may be, the equivalent area may be computed as per formula.
Required equivalent area of available grade of steel } = 1/S × (Area of original bar or bars in a bundle)

In formula given in 1.1 & 1.2 above, do=dia of available bar
do=dia of original bar
S = constant to be obtained from table 1

TABLE -1 "Value of S"

Case		Value of S	
		Hydraulic Str.	Non hydraulic Str.
(i)	From M.S. to Tor	1.300	1.360
(ii)	From Tor to M.S.	0.660	0.566
(iii)	(a) From M.S. to M.S.		
	(b) From Tor to Tor	1.000	1.000

1.2.1 In case where only diameter of specified M.S. bars needs to be substituted with deformed bars (Fe415) without change in bar spacing the following Table-2 may be used.

Dia of M.S. bars	Dia of deformed bar (Grade –Fe 415)			
	For tension		For compression	
	Non Hydraulic	Hydraulic	Non Hydraulic	Hydraulic
10	8	10	8	8
12	10	12	10	12
16	10+8	2×10	2×10	2×10
18	2×10	16	16	10+12 or 16
20	16	18	2+12 or 18	2+12 or 18

Dia of M.S. bars	Dia of deformed bar (Grade –Fe 415)			
	For tension		For compression	
	Non Hydraulic	Hydraulic	Non Hydraulic	Hydraulic
22	18 or 2×12	20 or 12+16	20	20
25	20	22	22 or 2×16	22 or 2×16
28	22	25 or 2 ×16	16+18 or 25	16+18 or 25
32	25	2×20	18+20 or 28	18+20 or 28
36	28	32 or 20+22	2×22 or 32	2×22 or 32
40	32 or 2×22	2×25 or 22+25	2×25 or 36	2×25 or36

APPENDIX - V

AREAS AND WEIGHTS OF STEEL SECTIONS

ROUND AND DEFORMED BARS
(Para 13.3.7.3)

Dia (mm)	Weight per metre (Kg.)	Sectional Area (sqcm)	Perimeter (cm)		Dia (mm)	Weight per metre (Kg.)	Sectional Area (sqcm)	Perimeter (cm)
5	0.154	0.196	1.571		20	2.47	3.14	6.286
6	0.222	0.283	1.886		22	2.98	3.80	6.914
8	0.395	0.503	2514		25	3.85	4.91	7.857
10	0.617	0.785	3.143		28	4.83	6.16	8.800
12	0.888	1.13	3.771		32	6.31	8.04	10.050
16	1.58	2.01	5.029		36	7.99	10.2	11.314
18	2.00	2.54	5.657		40	9.85	12.6	12.571

NOTE : The unit weight given may be used as a guide. Actual weight of the lot of steel may be used for working out unit weight for actual use/consumption.

APPENDIX - VI

MECHANICAL PROPERTIES OF STRUCTURAL STEEL

(Para 13.4.1.1)

Steel Designation	Class of steel Product	Nominal thickness/dia (mm)	Tensile strength (Kgf/mm^2)	Yield stress Min. 5.65×(Area)½ (Kgf/mm^2)	Percentage Elongation (Gauge length)
ST-42-W & ST-42-S	Plates, sections (for example, angles, tees, beams, channels etc.) and flats	Below 6	Bend test only shall be required		
		6 upto & including 20	410-530	250	23
		over 20 upto & including 40	410-530	230	23
		over 40	410-530	220	23
	Bars (round, square and hexagonal)	Below 10	Bend test only shall be required		
		10 upto & including 20	410-530	250	23
		over 20	410-530	230	23
ST-42-0	Plates, sections (for example, angles, tees, beams, channels etc.) and flats	Below 6	Bend test only shall be required		
		6 upto & including 20	410-530	250	23
		over 20 upto & including 40	410-530	240	23
		over 40	410-530	230	23
	Bars (round, square and hexagonal)	Below 10	Bend test only shall be required		
		10 upto & including 20	410-530	250	23
		over 20	410-530	240	23
ST - 32 - 0	Plates, sections (for example, angles, tees, beams, channels etc.) and flats	Below 6	Bend test only shall be required		
		6 & above	310-430	--	26
	Bars (round, square and hexagonal)	Below 10	Bend test only shall be required		
		10 & above	310-430	--	26

APPENDIX - VII

CHEMICAL COMPOSITION OF STEEL

(Para 13.4.1.1)

Steel Designation	Max. Percentage		
	Carbon	Sulphur	Phosphorous
ST-42-W	0.200	0.055	0.055
ST-42-S	0.23/0.25*	0.055	0.055
ST-42-0	--	0.070	0.070
ST-32-0	--	0.070	0.070

*.- 0.23 for thickness or dia 20 mm & below 0.25 for thickness or dia over 20 mm

APPENDIX - VIII

HOLES FOR TURNED AND FITTED BOLTS

(Para 13.4.3.2.2

Bolt diameter (1)	**Hole diameter (2)**		**Bolt diameter (1)**	**Hole diameter (2)**
1.6	1.8		(39)	42
2	2.4		42	45
(2.2)	2.6		(4.5)	48
2.5	2.9		48	52
3	3.4		(52)	56
(3.5)	4.0		(56)	62
4	4.5		(60)	66
(4.5)	5.0		64	70
5	5.5		(68)	74
6	6.5		72	78
(7)	7.6		(76)	82
8	9.0		80	86
10	11.0		(85)	91
12	14.0		90	96
(14)	16.0		(95)	101
16	18.0		100	107
(18)	20.0		105	112
20	22.0		110	117
(22)	24.0		(115)	122
24	26.0		120	127
(27)	30.0		125	132
30	33.0		(130)	137
(33)	36.0		140	147
36	39.0		(150)	158

Note : **(1)** **All dimensions are in millimeters**
(2) **Diameters in parenthesis are to be treated as second preference.**

APPENDIX - IX

WELDING PROCESS

(Para 13.4.4.2.4)

1. General

(a) Welds shall be made in the flat position whenever practicable.

(b) Arc length, voltage and amperage shall be suited to the thickness of materials type of groove and other circumstances of the work.

(c) Freedom of movement of one member of the joint shall be allowed wherever possible. Wherever joints shall be welded allowance shall be made for the movement of one component to the order of 1.5 mm.

(d) The sequence of welding shall be such that where possible the members which offer the greatest resistance to compression are welded first.

2. Process of Welding

The electrode manipulation during welding shall be such as to ensure that :

(a) The base metal is in a fused stage when the filler metal make contact with it.

(b) The filler metal does not over flow upon any unused base metal.

(c) The base metal is not under-cut along the weld edges.

(d) The following metal floats, the slag, the oxides, and the gas bubbles to the surface behind the advancing pool. In case any of these requirements is unattainable by manipulation, the current shall be adjusted or the electrode size changed.

Each time the arc is started the electrode shall be moved in such a way that the fusion of base metal at starting point is assured. At the completion of a run the movement of electrode shall be slowed down to fill the arc creator. After every interruption of the arc except at completion of a run, the arc shall be restarted ahead of the previous deposit and then moved back to fill the crater; or such alternative technique shall be used as will ensure complete filling of the crater, or complete fusion between the new and old deposits and the base metal at the point of junction and result in continuity of weld. Before welding operation is completed, all traces of a slag shall be removed from the deposit, by chipping if necessary and the deposit and the adjoining base metal shall be wire brushed and cleaned at all points. The requirements shall apply not only to successive layers, but also the successive beads, and to the over lapping area wherever a junction is made on starting a new electrode.

(e) The welds shall be free from cracks, discontinuity in welding and other defects such as (i) under-size, (ii) over-size, (iii) under-cutting, and (iv) over-cutting in the case of fillet welds and defects (ii), (iii) & (iv) in the case of but welds.

All defective welds which shall be considered harmful to the structural strength shall be cut out and re welded.

In case of welded butt joints in steel of thickness up to 50 mm the weld joints shall be subjected to radiographic examination as described in IS: 1182-1967.

All welds shall be cleaned of slag and other deposits after completion. Till the work is inspected and approved painting shall not be done. The surface to be painted shall be cleaned of spatter, rust, loose scale, oil and dirt.

APPENDIX - X

INSPECTION AND TESTING OF WELDS

(Para 13.4.4.2.5)

1. The methods of inspection and testing shall be as under :-

   a) Visual inspection

   b) Bend testing

   c) Tensile testing

   d) Magnetic particle, radiographic testing.

2. **Visual Inspection -** Only visual inspection will be doe for small stanchion & trusses upto 10 m span unless other wise specified.

2.1 ***Dimension of Weld Deposit -*** The dimension of the weld shall be checked. The size of the weld shall be as specified and it may be slightly over but not under.

2.2 ***Shape of Profile -*** The profile of the weld is affected by the position of joint, but shall be uniform. In the case of butt and corner welds, the profile shall be slightly convex and in the case of fillet weld it is usually slightly concave.

2.3 ***Uniform of Surface -*** The height and spacing of the ripples shall be uniform these being indicative of the quality of workmanship.

2.4 ***Degree of Under Cut -*** The welded joint shall be free from under cut, but slight intermittent occurrences may be disregarded provided that such under cut is not in the form of sharp notch.

2.5 ***Smoothness of joints where welding is recommended -*** The joints in the weld run where welding has been recommended, shall be as smooth as possible and shall show no pronounced lump or crater in the weld surface.

2.6 ***Freedom From surface defects -*** The surface of the weld shall be free from porosity, cavities and burnts or scale.

2.7 ***Penetration Bead in butt welds -*** A slight penetration bead shall be present and it should be reasonably uniform in width and appearance. Intermittent occurrences of lack of penetration bead may be disregarded.

2.8 ***Inspection of Weld Fractures -*** Inspection of weld fractures given information concerning degree of fusion degree of root penetration, gas cavities and quality of weld metal.

2.9 ***Degree of Fusion -*** Fusion shall be complete over the whole area of the joint surface.

2.10 ***Degree of Root penetration - Butt and Fillets Welds -*** The defects are most likely to occur at the root of the weld and in this position they are liable to have the maximum effect in reducing the strength of the weld. A close examination of the root shall, therefore, be made. In butt welds the penetration should extend to the under side of the plates producing a penetration bead of the right size. In fillet welds with good root penetration, the weld metal should reach the corner.

Note 1 - In tube to tube branch joints, both butt and fillet welds will appear in a joint, fillets being at the cretches.

Note 2- In case of non-fusion welding of cast iron the joint shall show satisfactory penetration and adhesion.

2.11 ***Gas Cavities and Flux entrapments-*** Unless they are caused by the use of unsuitable material, they are attributable to the quality of workmanship, the desired result being, to achieve uniform appearance and freedom from cavities and flux entrapments (where flux is used). In fusion welding of mild steel, cast iron and aluminium where neutral flame is used, and in fusion welding of brass of braze welding of cast iron where oxidizing flame is used incorrect welding technique may result in rough, porous, discoloured and lustreless appearance in the fracture.

Note - In case of fusion welding or non-fusion welding of cast iron isolaed blowholes or concentration of pinholes in the weld metal shall be regarded as grounds for rejection but isolated pinholes shall not be so regarded.

3. **Bend Testing for Ductility -** The elongation shall be not less than 30 percent for stress relieved welds and not less than 25 percent for non-stress relieved welds.

4. **Tensile Testing (Reduced section tensile testing) -** The tensile strength shall be not less than that minimum of the specified tensile range of the present metal.

5. **Magnetic Particle Radiographic Test -** This shall be done as given in IS : 1182-1967.

APPENDIX - XI

STEELTUBES FOR STRUCTURAL PURPOSES

(Para 13.4.11.1)

Nominal Bore(mm)	**Outside diameter (mm)**	**Class**	**Wall thickness (mm)**	**Weight (kg/m)**
15	21.3	H	3.25	1.43
20	26.9	H	3.25	1.90
25	33.7	M	3.25	2.46
	H	4.05	2.99	
32	42.4	M	3.25	3.15
	H	4.05	3.86	
40	48.3	M	3.25	3.61
	H	4.05	4.43	
50	60.3	L.2	3.25	4.57
	M	3.65	5.10	
	H	4.50	6.17	
65	76.1	L	3.25	5.48
	M	3.65	6.53	
	H	4.50	7.92	
80	88.9	L	3.25	6.86
	M	4.05	8.48	
	H	4.85	10.10	
90	101.6	L	3.65	8.82
	M	4.05	9.75	
	H	4.85	11.60	
100	11.43	L	3.65	9.97
	M	4.50	12.10	
	H	5.40	14.50	
110	127.0	L	4.50	12.20
	M	4.85	14.60	
	H	5.40	16.20	
125	139.7	L	4.50	14.90
	M	4.85	16.20	
	H	5.40	17.90	
135	152.4	L	4.50	16.40
	M	4.85	17.70	
	H	5.40	19.50	
150	165.1	L	4.50	17.80
	M	4.85	19.20	
	H	5.40	21.20	
150	168.3	L	4.50	18.10
	M	4.85	19.60	
	H-1	5.40	21.70	
	H-2	6.30	25.30	

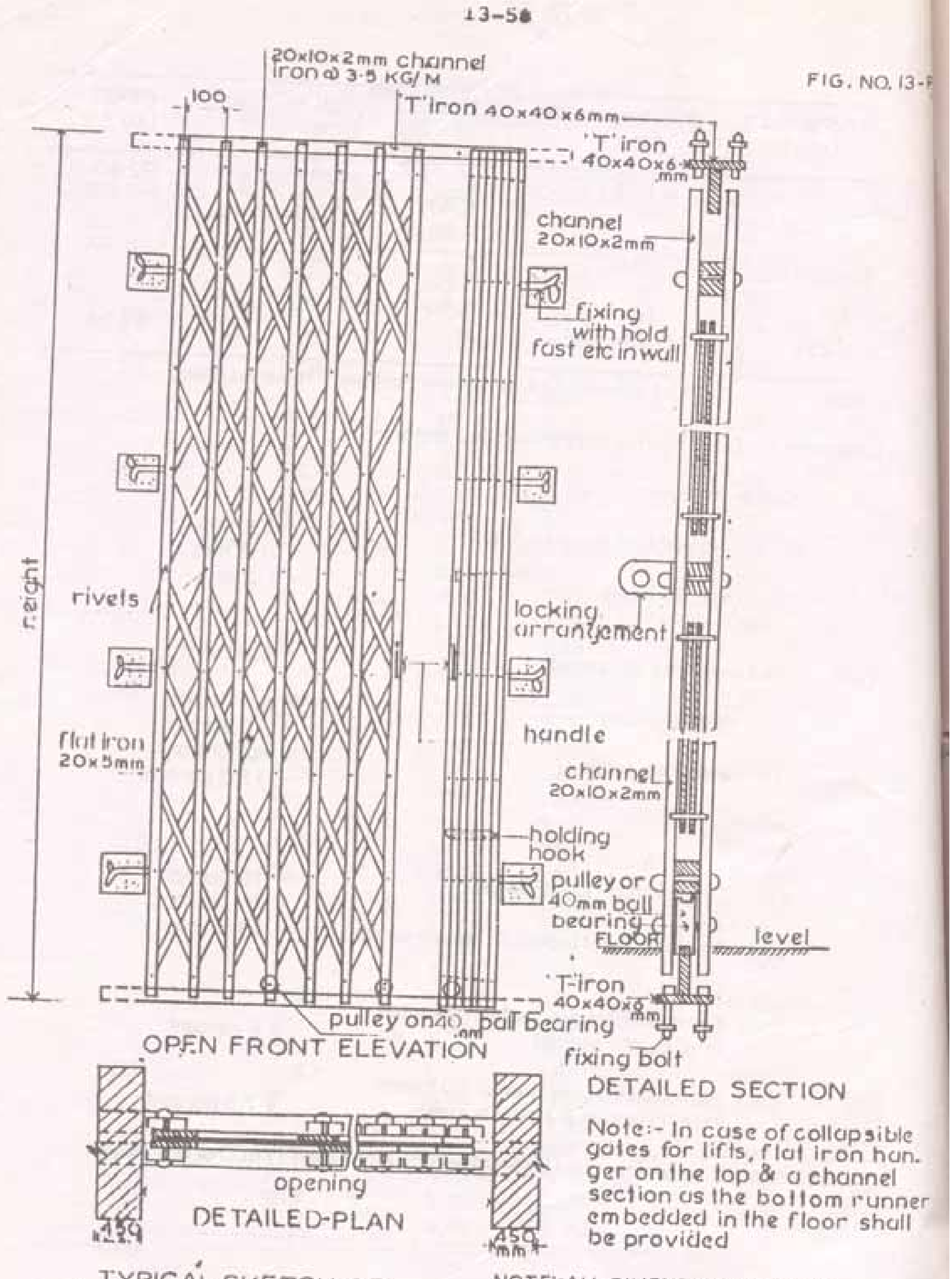
Nominal Bore(mm)	Outside diameter (mm)	Class	Wall thickness (mm)	Weight (kg/m)
175	193.7	L	4.85	22.60
	M	5.40	25.00	
	H	5.90	27.30	
200	219	L	4.85	25.70
	M	5.60	29.40	
	H	5.90	31.00	
225	224.5	H	5.90	34.20

Note: **L means Light; M Means Medium; H Mean Heavy .**

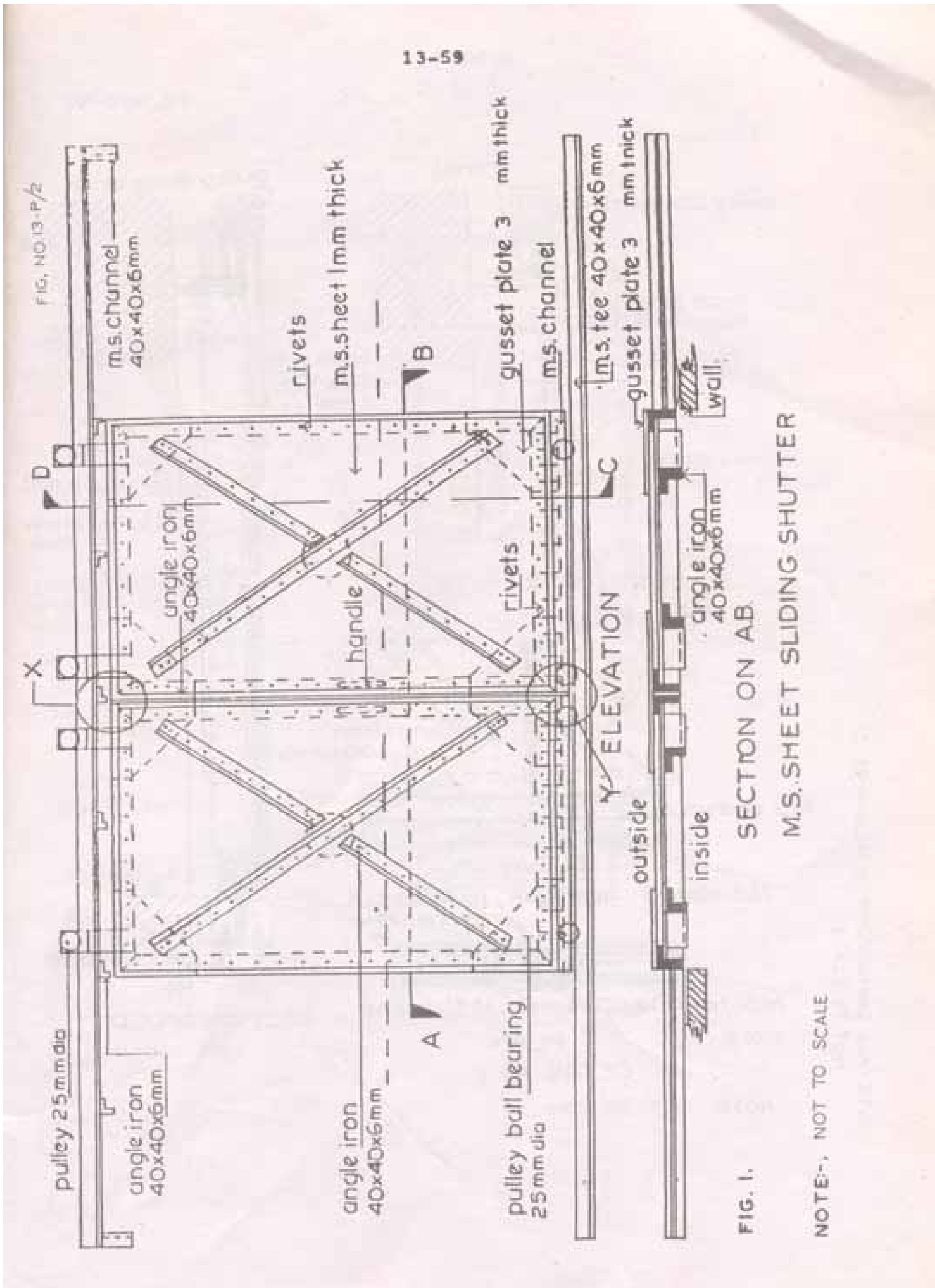
Tolerances:- The following tolerances shall apply:

(a)	Outside diameter.	
(i)	Up to and including 48.3mm	+0.4mm
(ii)	Over 48.3mm	-0.8mm
		+1.0mm
(b)	Thickness (for all sizes)	+ 1percent
(i)	Welded tubes	+Not limited
(ii)	Seamless tubes	-10 percent
		+ Not limited
		-12.5 percent
(c)	Weight	
(i)	Single tubes (Light series)	+ 10 percent
(ii)	Single tubes (Medium & heaavy series)	-8 percent
		± 10 percent
(iii)	For quantities per load of 10 tonnes Min (Light series	± 5 percent
(iV)	For quantities per load of 10 tonnes Min (Medium & heavy series)	± 7.5 percent

The tubes shall be deviate form straightness by more than 1/600 of any length



TYPICAL SKETCH OF COLLAPSIBLE STEEL GATE


13-59
FIG. NO 13-P/2
pulley 25mm dia
angle iron 40x40x6mm
m.s.channel 40x40x6mm
rivets
m.s.sheet 1mm thick
angle iron 40x40x6mm
handle
angle iron 40x40x6mm
pulley ball bearing 25 mm dia
rivets
gusset plate 3 mm thick
m.s.channel
ELEVATION
m.s.tee 40x40x6mm
gusset plate 3 mm thick
wall
angle iron 40x40x6mm
outside
inside
SECTION ON AB
M.S.SHEET SLIDING SHUTTER
FIG. 1.
NOTE:- NOT TO SCALE

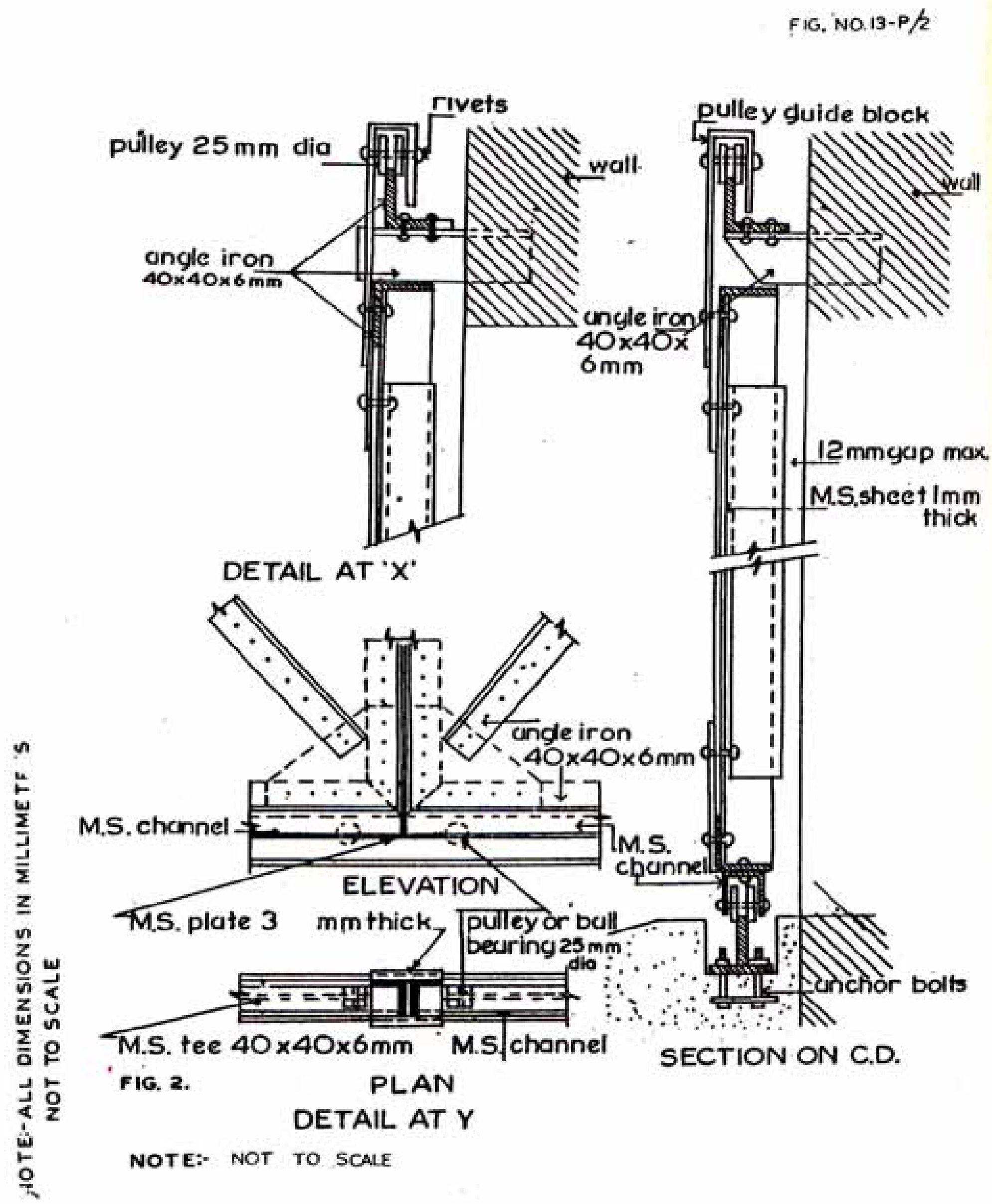


FIG. 2.

PLAN

DETAIL AT Y

NOTE:- NOT TO SCALE

FIG. NO.13-P/3

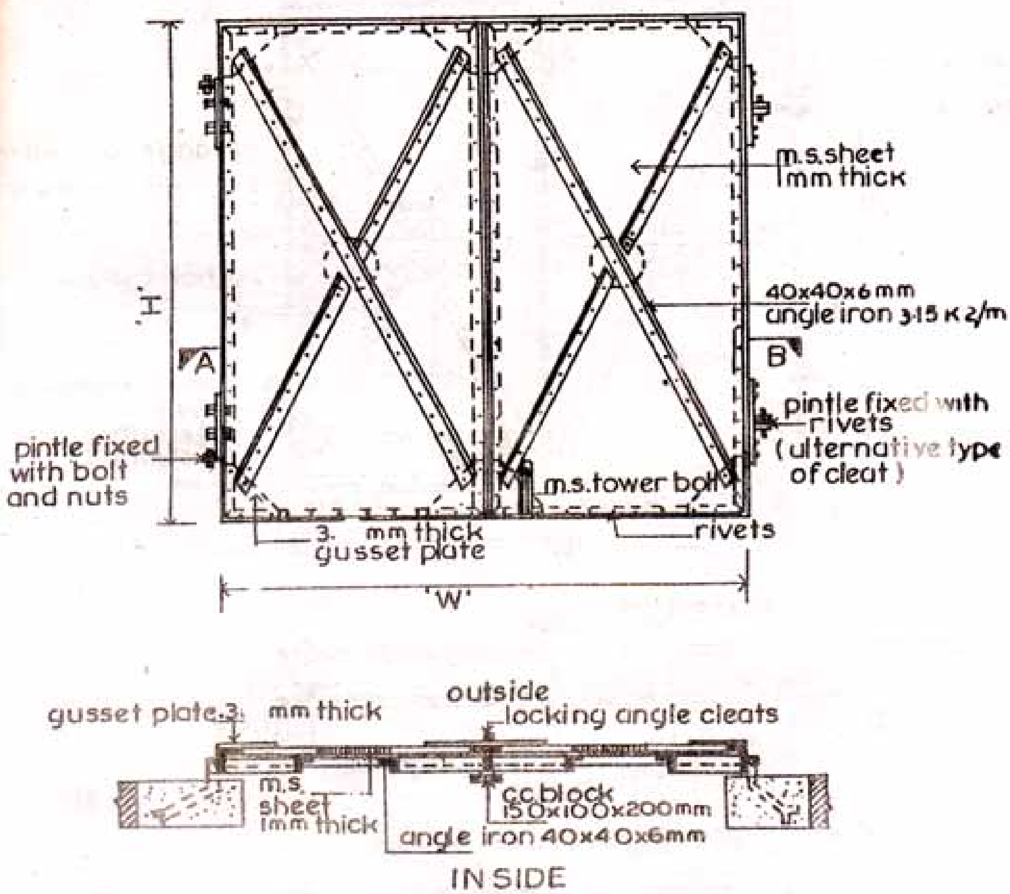


FIG. 1. PLAN ON A.B.

TYPICAL M.S. SHEET DOOR.

NOTE:- NOT TO SCALE

FIG. NO. 13-P/3

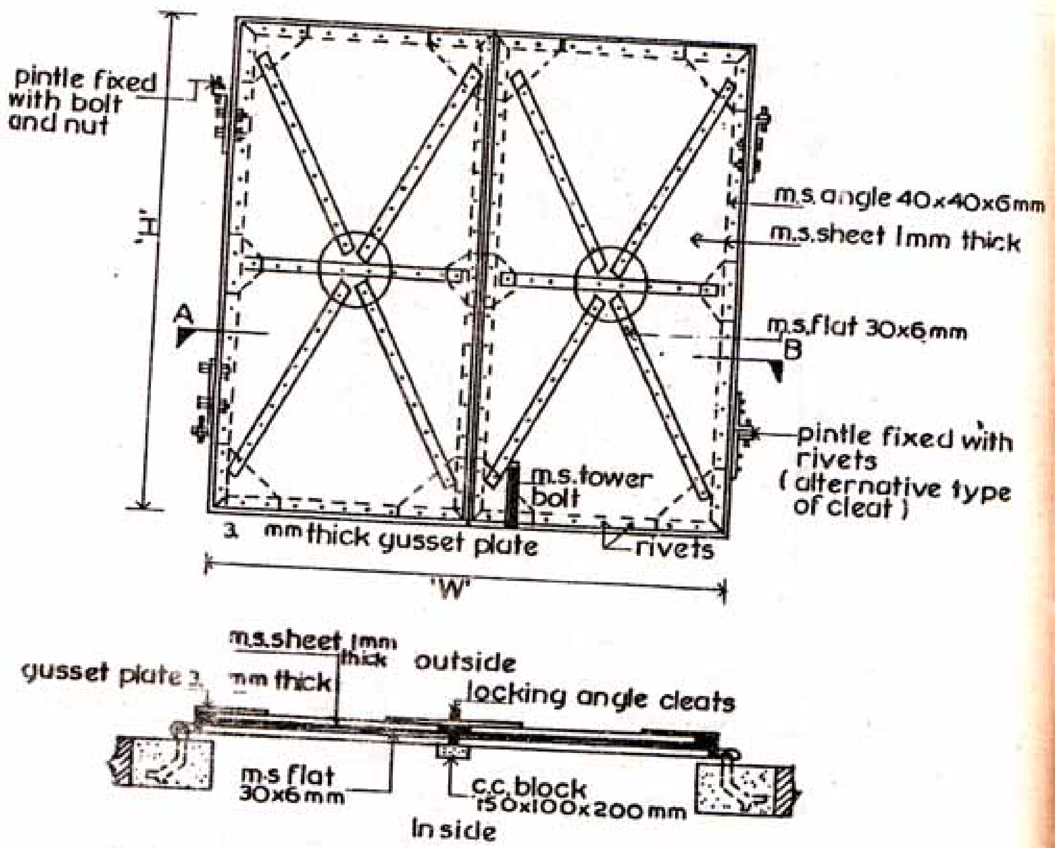


FIG. 2. PLAN ON A. B.

TYPICAL M.S. SHEET DOOR

NOTE:- ALL DIMENSIONS IN MILLIMETRES

NOT TO SCALE

FIG. NO. 13-P/4

STEEL DOORS, WINDOWS AND VENTILATORS

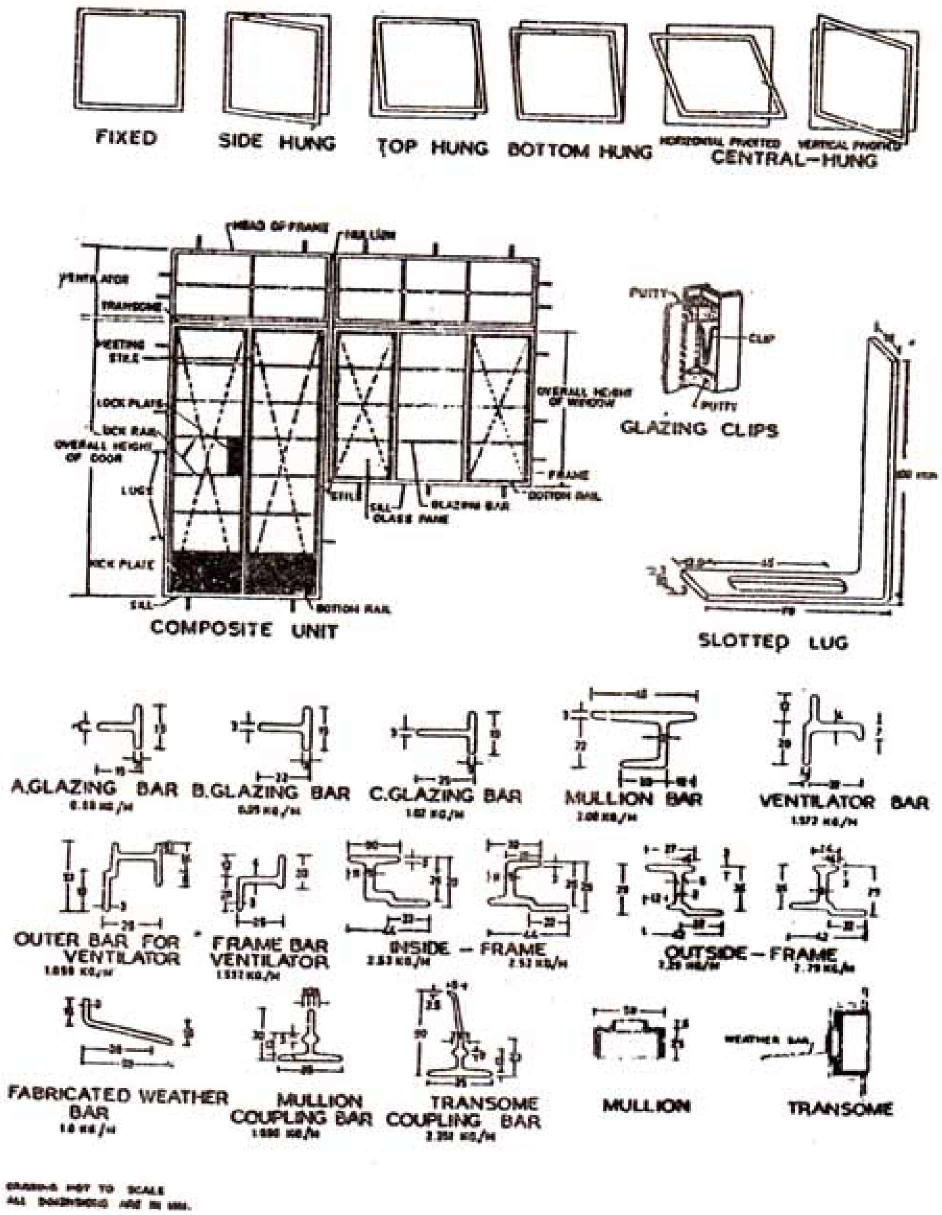
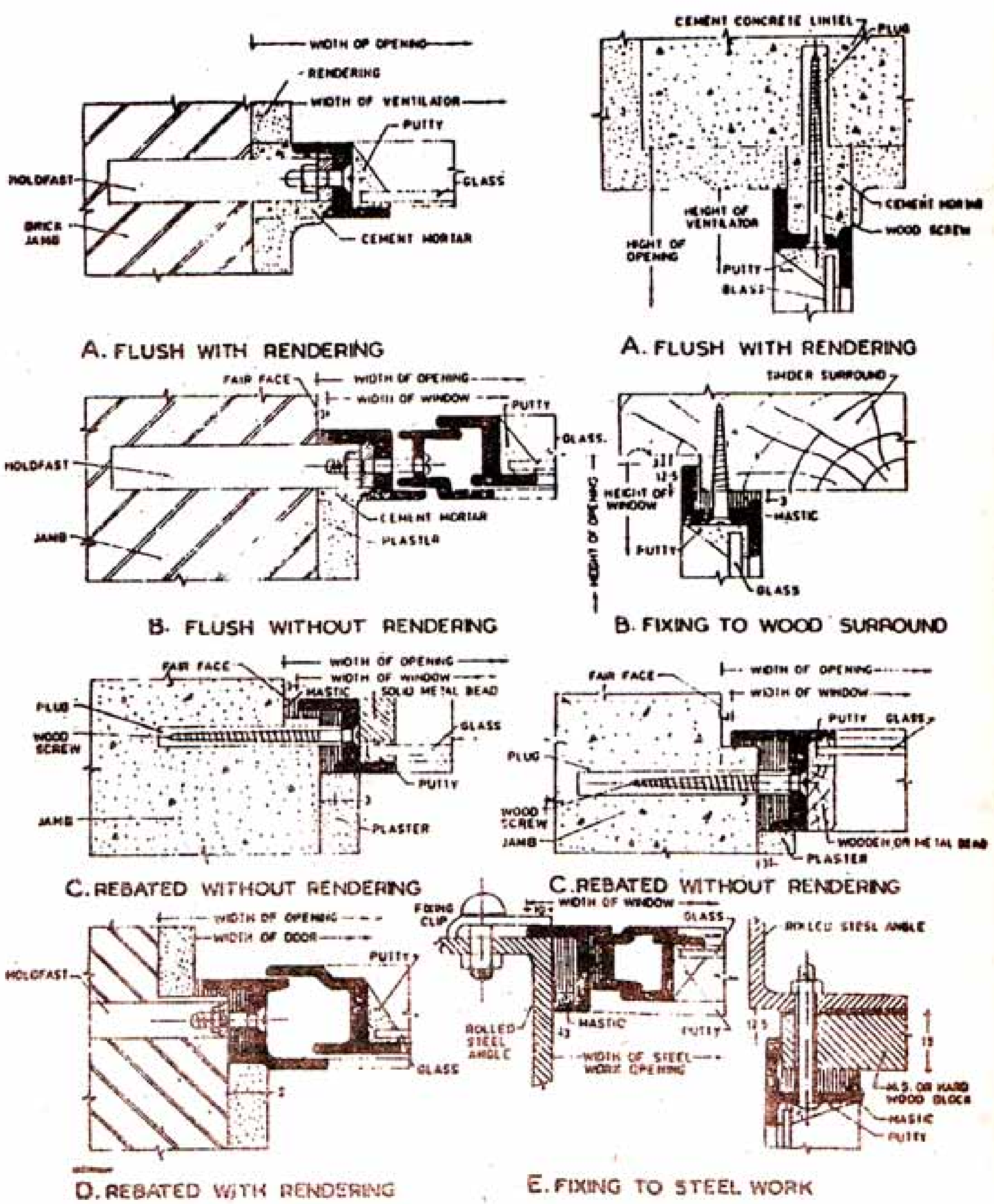


FIG. NO. 13 -P/5

STEEL DOORS, WINDOWS & VENTILATORS



DRAWING NOT TO SCALE
ALL DIMENSIONS ARE IN MM.

FIG. NO. 13-P/6

T-IRON DOOR, WINDOW FRAMES

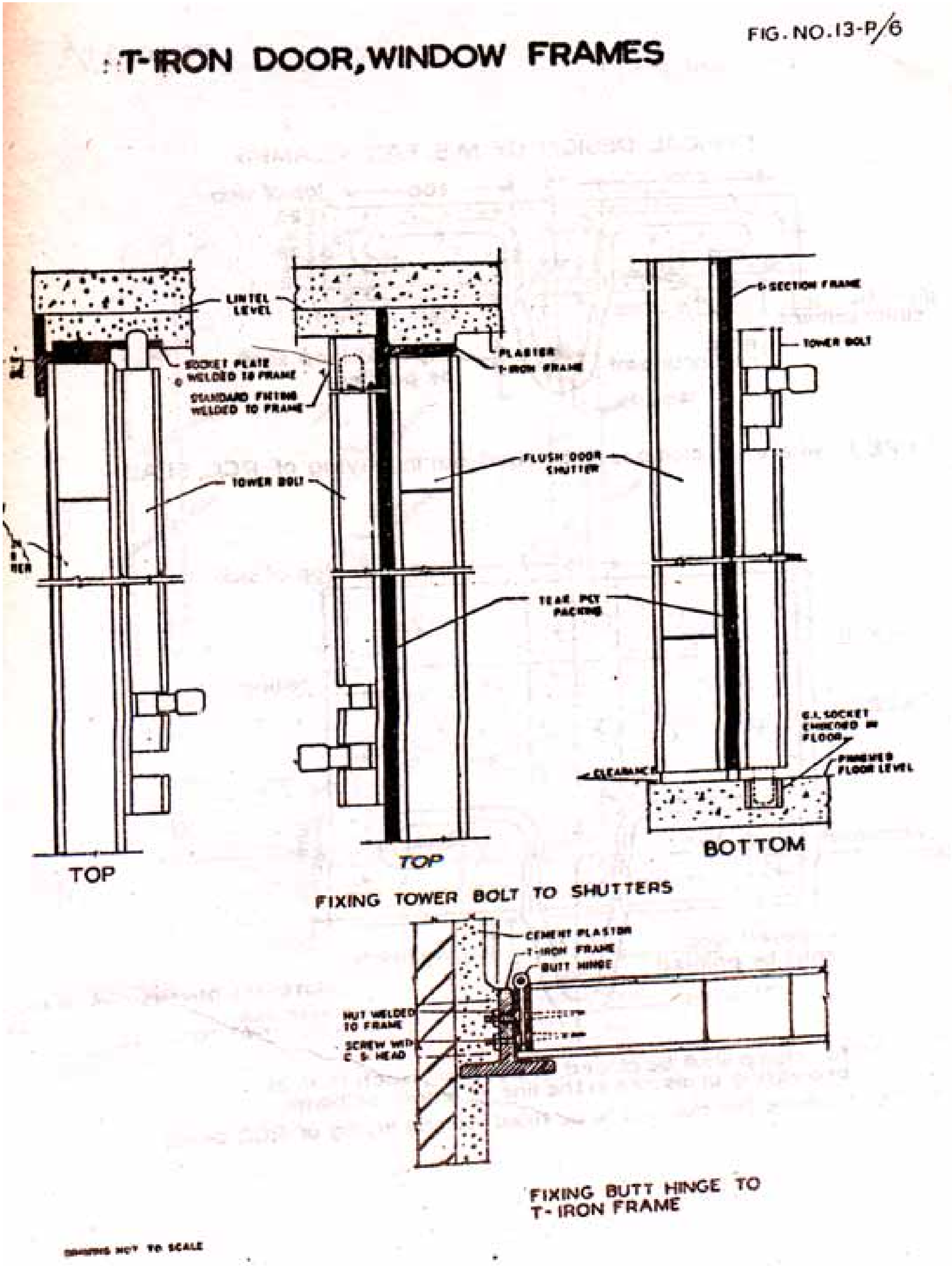
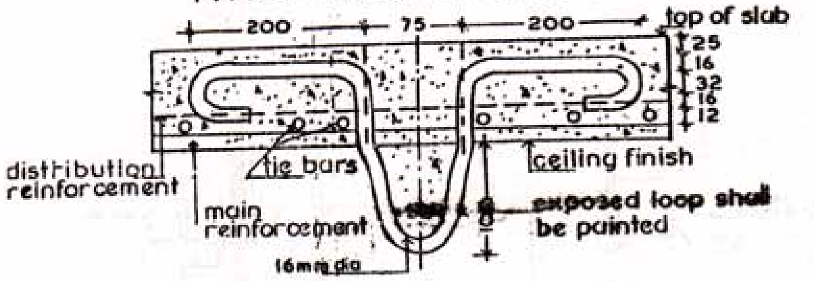
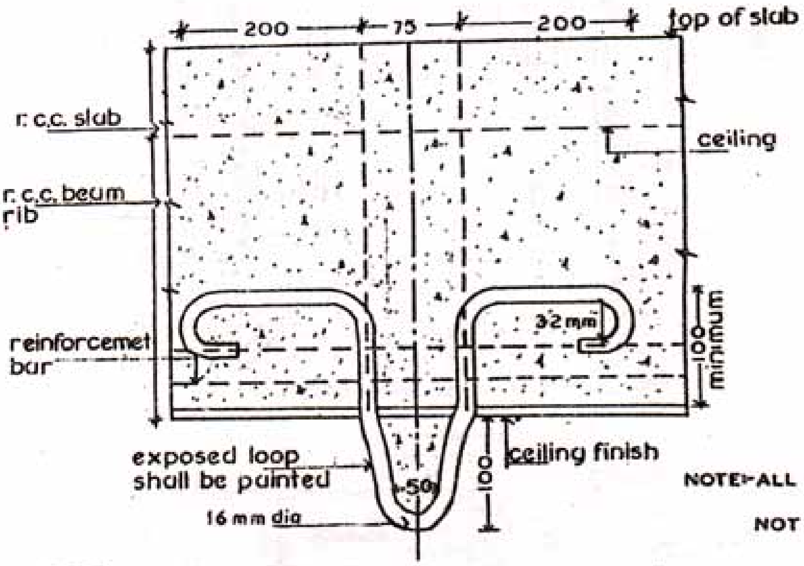


FIG. NO. 13-P/7

TYPICAL DESIGN OF M.S. FAN CLAMPS



TYPE I: where fan clamp is to be fixed during laying of RCC. SLAB



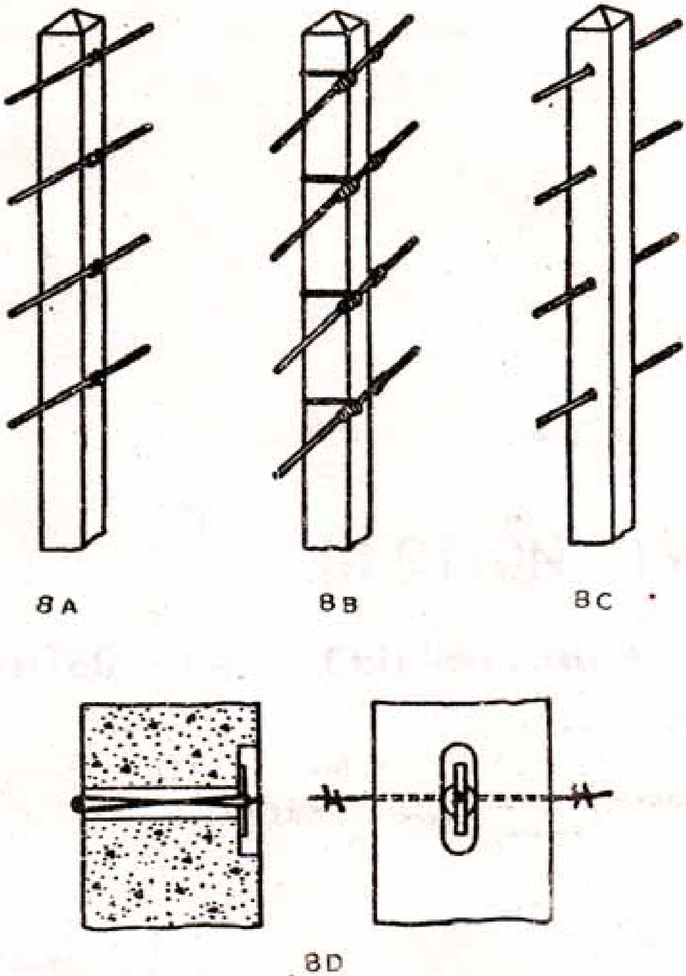
NOTE-ALL DIMENSIONS IN MILLIMETRES

NOT TO SCALE

NOTE.. fan clamp shall be placed in position, such that its projecting arms are in the line of length of beam.

TYPE:II where fan clamp is to be fixed during laying of RCC beam

FIG. NO. 13-P/8



TYPICAL ARRANGEMENT FOR FIXING FENCING WIRES

CHAPTER - 14
CEILING AND WALL BOARDING

CONTENTS

CHAPTER -14 CEILING AND WALL BOARDING

14.1 REFERENCES

IS: 287 - 1973	Recommendations for maximum permissib1e moisture content for timber used for different purposes (second revision) (with amendment No. I).
IS : 303- 1975	Plywood for genera1 purposes (second revision)(with amendment No.1 to 3).
IS : 401 - 1982	Code of practice for preservation of timber (third revision) (with amendment No.1).
IS : 419- 1967	Putty for use on window frames (first revision)(with amendment No.1) (Reaffirmed 1986).
IS: 723-1972	Steel countersunk head wire nails (second revision)(with amendment No.1 to 3) (Reaffirmed 1985).
IS: 749-1978	Handloom cotton Dungri cloth (first revision) (Reaffirmed 1987)
IS :-1141-1973	Code of practice for seasoning of timber (first revision)(with amendment No.1 & 2).
IS: 1331-1971	Cut sizes of timber (second revision).
IS: 1658-1977	Fibre hard boards (second revision).
IS : 2098- 1964	Asbestos cement buildings boards (with amendment No. 1 &2) (Reaffirmed 1987).
IS: 2441-1984	Code of practice for fixing ceiling coverings (first revision).
IS : 2818 (PU)-1971	Indian Hessian-General(First revision)(with amendment No.1).

IS: 3087-1985	Wooden particle boards (medium density) for general purposes (w1th amendment No.1).
IS: 3097-1980	Veneered partic1e boards (first revision).
IS : 3348- 1965	Fibre insulation boards (with amb11dment No.1).
IS : 5390- 1984	Code of practice for construction of timber ceilings (1st revision)
IS: 6730-1972	Felt nails (Reaffirmed 1985).
IS: 6760-1972	Slotted countersunk hes2 wood screws (with amendment No.1) (Reaffirmed 1965).

.. Specification-77 .. of Central Public Works Department.
.. Standard specifications- 77 .. of National Bui1ding Organisation.

14.2 TERMINOLOGY

Bearer - A beam supported at two or more points and provided for the purpose of carrying other members.

Decorative Veneers - Veneers having attractive appearance due to figure, colour, grain, luster, etc.

Framework - Wooden or metal framework consisting of longitudinal bearers and cross bearers by means of which the ceiling boards or coverings are supported.

Hard Stopping - A material in a stiff paste form, which is usually applied by means of knife to fill deep indentations in a surface and which dries hard throughout. It should not be confused with glazing putty which is of a different consistency and which hardens more slowly.

Particle Board - A board manufactured from particles of wood or other lignocellulose material, for example, flakes, granules, shavings and slivers or 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 and a catalyst.

Scantling - A piece of timber whose cross-sectional dimensions exceed 5 cm but do not exceed 20 cm in both directions.

Veneers - A thin sheet of wood of uniform thickness obtained by slicing, rotary cutting of sawing. .

14.3 TIMBER PLANK LININ6

14.3.1 Material

(i) Timber For Lining Framework - The size of battens shall be 50 mm X 25 mm. Other specifications shall be in accordance with Para 14.4.1(i).

(ii) Timber For Planks - The specification shall conform to Para 14.4.1(ii).

(iii) Nails - The specifications shall conform to Para 14.4.1 (iii).

(iv) Screws - The length of screws shall be twice the thickness of plank lining or 30 mm whichever is longer. Screws used shall conform to IS: 6760- 1972.

(v) Cleat - The specification shall conform to Para 14.4.1 (v).

14.3.2 Fixing

14.3.2.1 Frame - The battens of specified size shall be fixed over tapering plugs with 50 mm long wood screws. Tapering plugs shall be trapezoidal in shape having base 50 mm x 50 mm and 38 mm x 38 mm at the top, with depth of 50 mm. Plugs shall be embedded in cement mortar 1:3 and shall be spaced at 450 mm to 500 mm centres. Plugs shall be treated, with coat tar tI1<J the battens shall be treated with two coats of aproved wood preservative before use.

14.3.2.1.1 Alternatively, the frame work may be fixed with rawl plugs which shall be of hard wood cut on twist. The plugs shall be driven into the mortises cut or formed in walls etc.

14.3.2.1.2 Patent plugs, phil plugs etc. may be substituted for wood plugs if considered suitable for the purpose for which these are to be used.

14.3.2.2 Planks - The planks shall be clean sawn in the direction of the grain, cut square and straight. Each plank shall have tongued and grooved type joints or butt jointing as specified in the item of work. On the unexposed faces, the planks shall be well planed for short length of 100 mm near each end. On exposed faces, it shall be planed for full face. The unexposed f~ of planks shall be painted with two coats of approved wood preservative before fixing. The maximum length of planks in finished work shall be 1.8 m and the minimum length shall be such that It will span at least two spacings of the supporting framework except where shorter length are unavoidable depending on arrangement of the lines of beading joints Which shall be carried out to the pattern ordered.

The outer line of planks shall be accurately fixed in straight line joints. All planks shall be carefully fitted and jointed. The counter sunk wood screw holes shall be carefully fitted with putty conforming to IS: 419-1967.

Beading, where specified, shall be fixed to the lining in accordance with Para 14.1.0.

14.3.3 Finishing

Specificatlons at Para 14.4.3 sha1l apply.

14.4 TIMBER PLANK CEILING

14.4.1 Material

(i)Timber For Ceiling Frame work - Unless specified otherwise in the schedule of item, timber shall be made from selected species that are found to be satisfactory in the local practice for such use.

Timber shall be seasoned in accordance with IS: 1141-1973 and shall be treated with wood preservative in accordance with IS: 401 -1982. The size of longitudinal and cross battens supporting the ce1J1ng shall be as shown on the drawing or as directed by Engineer-in-Charge. In the absence of such details, size of batten shall range from 60 to 75 mm X 50 mm.

(ii) Timber For Planks - Planks shall be of seasoned timber of specified wood worked to required size. It shall have uniform colour and shall be free from defects such as cracks, dead knots, shakes, sapwood, etc. No individual hard and sound knot shall be more than 6 sq cm In size end the aggregate area of such knot shall not be more than 1% of the area of the piece. The plank thickness may vary from 15 to 20 mm. The width of plank shall be 100 to 150 mm. Nails - Nails used shall conform to IS : 723- 1972.

(iii) Nails: Nails used shall conform to IS: 723-1972

(iv) Screws -Screws used shall conform to IS: 6760-1972.

(v) Cleat - Mild steel cleats are used for fixing together the cross and main members of the ceiling framework and shall be of such size as to accommodate at least two screws or bolts on each side for connection. Alternatively, special1y designed clip system may also be used to connect the cross and main members of ceiling framework. Wooden cleats may also be used where required, provided they are of adequate size.

(vi) Suspenders For Ceiling Framework - This shall be fabricated from mild steel flats or other metal sections as specified. They shall preferably be in two pieces so that the length of the suspenders may be adjusted during fixing the ceiling frames. The shape at the top end shall facilitate a firm suspension from the structural floor with proper anchorage. Where ml1d steel flats are used as suspenders, they shall be of .35 to 65 mm length and 6 mm thickness and shall be painted with two coats of anti-corrosive paint

14.4.2 Fixing

14.4.2.1 Timber Frames -Suspenders used for supporting timber framework for false ceiling to RCC slab shal1 be of length sufficient to reach cell1ng frame and shall be I anchored 8dequ8tety to structural concrete above so as to obtain the required support for the ceiling. When the members of the ceiling frame work span more than 900 mm centres, additional cross battens shall be provided to stiffen them. Further, the frame shall be given two coats of preservative before planks are screwed on. The bottom surface of the frame shall be checked and corrected to true planes and slopes.

14.4.2.2 Fixing Of Planks To Timber Frames -The outer line of planks shall be accurate1y fixed in straight Line joints. The plank joints shal1 be parel1el and in perfect line. The first plank next to the wall shall be fixed careful1y and accurately very close to the wall Subsequent planks shall be careful1y jointed up. Un1ess spec1f1ed otherwise in the schedu1e of item, the longitudinal joints of the planks shal1 preferably be tongued and I grooved, white the beading joints shall be of the Square butt type and shall occur under the centre Line of the supporting joists. Beading joints in adjacent p1anks shall not be p1aced over the same joints, those in a1tern5te planks being arranged in the same line except where joints are to be concealed by beadings. Planks shall be p1aned true on the exposed side and shall be fixed to the frame above with two screws at each end joist of frame and two at every intermediate joist.

The screws shall be countersunk and the screw holes fitted w1th putty or hard stopping. The maximum 1ength of p1anks in finished work shall be 1.8 m and the minimum length shall be such that it wit1 span at least two spacings of the supporting framework except where shorter 1ength are unavoidable depending on arrangement of the Lines of beading joints which shall be carried out to the pattern ordered. The unexposed face of planks shall be painted with two coats of approved wood preservative before fixing.

Beading shall be fixed to the cei1ing in accordance with Para 14.10.

14.4.3 Finishing - Exposed side of the planks shall be truly.1evel and p1ane. The joints shall be truly para11el and / or perpendicu1ar to the wa11s.

14.5 FIBRE HARD BOARD CEILING

14.5.1 Material

(i) Timber - The Umber for making ce11tng frame work shall be of specified wood as described in schedu1e of item. The beading shall be in accordance with Para 14.10. 1.

(ii) Hard Board - Medium type hard board conforming to I S: 1658-1967 shal1 be used for ceiling purposes.

(iii) Nails and Screws - The nails and screws shall conform to IS : 723-1972 and IS : 6760-1972 respectively.

14.5.2 Handling

14.5.2.1 Boards shall be carefu11y hand1ed,stored and conditioned before use. The following precautions shall be taken :

(i) When transporting or stacking at site, the boards should be 1aid flat on an even foundation of battens and covered with' tarpaulins to prevent damage by changing weather conditions, soiling by earth, mortar, concrete or other rubbish and damage to edges and cracking.

(ii) Handling boards shall be carried on edge and not flat, to prevent buckl1ng and cracking.

(iii) Before use, the boards shall be conditioned to the humidity of the atmosphere by stocking them loosely on edge for a period of 24 to 48 hours so that air can have free access to both sides of each sheet during that period.

14.5.2.2 The hard board sheets shall be further conditioned by damping with water on the textured face before they are fixed. This shall be done by brushing the textured face evenly and carefully with a sponge or swab soaked in water. After this the sheets shall be stacked with the damped sides against each other in pairs and left to remain for a period of 24 to 48 hours. During this conditioning, the sheets should be sheltered from sun and strong heat.

14.5.3 Fixing

14.5.3.1 Frame Work

The size & spacing of longitudinal battens and cross battens supporting the ceiling shall be as shown on drawing or as directed by Engineer-in-charge. In the absence of any such detail, the size of battens shall range from 60 to 75 mm x 50 mm and the spacing shall range from 450 to 600 mm for longitudinal battens and 600 to 1200 mm for cross battens depending on the size of boards. The decision by the Engineer- in-Charge shall, however, be final.

The battens shall be treated with two coats of preservative paint, preferably odorless, before the ceiling is fixed. The preservative shall be allowed to dry up before fixing sheets.

14.5.3.2 Cutting Boards to Required Size -The boards shall be cut to the required size to conform to the pattern of panelling as shown in the detailed drawings and each panel shall be in one whole piece. The cutting shall be mne with a carpenter's panel-saw with fine teeth. The boards should be sawn with the face side up. The edge shall then be lightly sandpapered to make them smooth.

14.5.3.3 Fixing Of Ceiling Framework - Boards shall be fixed with lengths parallel to al1 joints centred over the framing members. Where joints are to be covered, the boards shall be spaced 3 to 6 mm apart. Where Joints are to be left exposed the sheets shal1 be butt laid with their edges abutting in moderate contact, but without having to force them into plt1:e. The boards shall be supported and held tight to the grounds with timber pieces, the latter being moved outwards as the nai1ing proceeds. The boards are first nailed to intermediate framing member proceeding from the centre of the board outwards, the $ being nailed last.

14.5.3.4 Where joints are to be left exposed, the outer rows of nails shall be placed at 100 mm centres and about 12 mm from edge of the sheet. The rows in the mi<t11e of the sheet shall be placed 200 mm apart. Nails in the outer rows on either side of joints shall be paired and not staggered. Nails shall be countersunk in the underside of the board with a suitable punch. Care shall be taken in driving the nails so that the sheets are not marked by hammer blows.

14.5.3.5 Where joints are to be covered with beadings, felt nails shall be used instead of lost head nails. The spacing of the nails in the interior rows in boards shall be the same as in 14.5.3.4. In the outer rows at edges to be covered by beadings, the nails shall be spaced at 200 mm centres in each row but with the nails staggered. The beadings shall then be fixed over the sheets with screws at 200 mm centres in each row with screws in two rows staggered and passing through beading, sheet and framing, so that ultimately the facing of the fixing (nails and screws taken together) in each row shall be 100 mm centres so far as the sheets and frames are concerned.

14.5.3.6 The screws shall be rust-less and greased before fixing, steel screws if used, shall be coated with brass or nickel. The length of screws shall be 25 mm for 3 to 6 mm thick board and 30 or 35 mm for 8 to 12 mm thick board.

14.5.4 Finishing

The exposed side of the board shall be truly level. and plane without any local bulges or sags. The joints shall be truly parallel and I or perpendicular to the walls. The width of joints shall be uniform. Care shall be taken to see that the uniformity of the colour of boards is not spoilt during the fixing operations.

Where the joints are required to be covered, beading shall be fixed as in 14.10. The ceiling shall be treated as required with suitable finishing materials.

14.6 INSULATING BOARD CEILING

14.6.1 Materials

(i)Timber- The specification at Para 14.5.1 (1) shall apply.

(ii)Insulating Board - This shall be particle boards conforming to IS :3129 -1965 or fibre insulating boards conforming to IS: 3348- 1965 as may be specified in the description of Item.

(iii) Nails - Nails shall conform to IS: 723-1972. The length of nails shall generally be equal to the thickness of the board plus 25 mm so that their grip on the frame scantling will not be less than 25 mm. Galvanized lost head nails of diameter 2.80 mm conforming to 15:6738- 1972 may be used when joints are left exposed. Where joints are to be covered with beading, galvanized felt nails of 2.50 mm diameter conforming to IS: 6730-1972 may be used.

(iv) Screws - If screws are used, they shall conform to IS:6760-1972.

14.6.2 Handling

The specifications at Para 14.5.2. I shall apply.

14.6.3 Fixing

Specifications at Para 14.5.3 shall apply.

14.6.4 Finishing

Specification at Para 14.5.4 shall apply.

14.7 WOOD PARTICLE BOARD, VENEERED PARTICLE BOARD AND DECORATIVE VENEERED PARTICLE BOARD IN CEILING.

The work shall be carried out as per Para 14.6 except Para 14.6.1 (i1) which shall read as under:

Wood Particle Board -This shall be conforming to IS: 3087 -1985.

Veneered Particle Board- This shall be conforming to IS: 3097 -1980.

14.8 ASBESTOS CEMENT SHEET CEILING

14.8.1 Materials

(i) Timber- Specifications at Para 14.5.1 (i) shall apply.

(ii) Asbestos Cement Sheet / Building B08rd - This shall conform to IS: 2098- 1964.

(iii) Screws- The screws shall conform to IS : 6760-1972.

14.8.2 Fixing

14.8.2.1 Frame Work - This shall be as per details given in Para 14.5.3.1.

14.8.2.2 Ceiling - The asbestos cement building boards shall be laid truly parallel or perpendicular to the walls and shall be fixed to the battens with screws. In fixing the A.C. boards care shall be taken to avoid rigid fixing as this may cause cracking if the supporting structure 'expands or Shrinks. Holes in the Boards shall be drilled and on no account be punched. The screw holes shall be drilled slight1y larger than screw. 'No hole shall be 'nearer!' than 12 mm to the edge of the sheet. The board shall be butt jointed with screws at 150 mm intervals at edges and 300 mm intervals in the middle. Screws shall be countersunk and covered by plaster of Paris. A gap of 3 to 6 mm shall be kept between the adjoining edges of the sheets. The joints where required may be covered with wooden beading 55 described in 14. : 0 or with plain strips out from the sheets of the same material.

14.8.2.3 Finishing - The cel11ng, when completed, shall present a neat and uniform appearance. Care shall be taken to see that the asbestos cement boards are not dirted during construction. Usually no finishing treatment of asbestos cement building board ceiling is needed. Ceiling may, if specified, be painted to the desired shade.

14.9 ASBESTOS CEMENT SHEET IN LINING

14.9. 1 Generally the work shall be carried out as per Para 14.8.

14.9.2 Asbestos cement sheets may also be advantageously fixed on to wans with a cement plaster backing where specified.

14.10 WOODEN COYER FILLETS (BEADING)

14.10.1 Materials

The Beading shall be of the specified wood. Unless specified otherwise in the description of item, the size of beading shall be 12 mm x 40 mm. The beading shall be planed, smooth over all exposed faces and true on rear face.

14.10.2 Fixing

The beadings shall be fixed centrally over the butt joints between the two timber planks or boards with screws in two rows on either side of the joint. The spacing of the screws in each row shall be 200 mm centers. The screws shall pass through the beading, timber plank or ce11ing board and into the ceiling rafters, with a minimum grip of 25 mm in the latter and where the beading is to be fixed to the board above for ornamental purposes there being no framework scantling above, then the beading shall be fixed with screws which shall be driven through the full depth of the board and their spacing shall be the same as before. The screws shall be oiled before insertion and shall be screwed in by means of a screw driver and in no case the use of a hammer for fixing the screws is permissible. The screws shall be driven slightly countersunk below the surface of the beading.

The junction of the beading shall be of the fu11y mitred or of partly mitred kind as required by the Engineer-in-charge. Where joints are to be fully mitred both the longitudinal as we11 as cross beadings shall be to the exact length as required by the panel arrangements. Where the joints are partly mitred variety and the length of the beading in one direction can run continuously over more than one panel and not in the middle of the panel side.

14.10.3 Finishing

The beading shell be finished smooth and fixed with such f3 workmanship that there is absolutely no gap left between the beading and the ceiling board or in the joint faces. The beading I1nes shall be absolutely straight and paralle1. The plane of the underside of the beading shall be uniform.

CHAPTER - 15 ROOFING

CONTENTS

CHAPTER 15 - ROOFING

15.1 REFERENCES

IS: 73- 1961 Paving bitumen (revised) (with amendments No.1 and 2)

15:269-1989 Specification for 33 grade ordinary portland cement (fourth revision)

15:277-1985 Galvanized Steel sheets (plain end corrugated) (Fourth revision)

15:280- 1978 Mild steel wire for general engineering purposes (third revision) (Reaffirmed 1987)

15:-155-1976 Specification for portland slag cement (third revision)(Amendment No. 1,2,3,4,5,6& 7)

15:459-1970 Un-reinforced corrugated and semi-corrugated asbestos cement sheets (second revision with amendment NO.1)(Reaffirmed 1987)

15:513-1986 Specification for low carbon cold rolled carbon steel sheets and strips (third revision)

15:654-1972 Clay roofing tiles. mangalore pattern (second revision) (with amendment Nos. 1 to 3) (reaffirmed 1 979)

IS: 702- 1988 Specification for industrial bitumen (~ revision)

IS: 712- 1984 Specification for building limes (third revision)

15:723-1972 Steel countersunk head wire nails (second revision) (with 3 amendments)

IS: 790-1978	Hook bolts for corrugated sheet roofing (second revision) (with amendment NO.1) (Reaffirmed 1985)
15:883- 1970	Code of practice for design of structural timber in building (third revision)
IS: 1079-1988	Specification for hot rolled Carbon steel sheet and strip (third revision)
IS: 1121 (P2)	Methods of test for determination of strength properties of natural 1974 building stones: Part 2 transverse strength (first revision) (Reaffirmed 1987)
IS: 1322-1982	Bitumen felts for water proofing and clamp-proofing (third revision) (Reaffirmed 1987)
IS: 1344-1981	Specification for calcined puzzolana (second revision)
IS: 1345-1976	Code of practice for water proofing of roofs with bitumen felts (iind revision)
IS: 1464-1973	Cley ridge and ceiling tiles(first revision)(with amendment No 1) (reaffirmed 1979)
IS: 1635-1975	Code of practice for field slaldng of building lime and preparation of putty.,
IS:2527-1984	Code of practice for fixing rain-water gutters and down pipes for roof drainage (first revision)
15:2690-(Pt.I)	Specification for burnt clay fiat terracing tiles Part 1: Machine made (first revision)((Amendment No.1)
15:2690-(Pt. II)	Specification for burnt clay flat terracing tiles Part 2: Hand made - 1975 (amendment No.1)
IS:2792-1964	Code of practice for design and construction of stone slab over joist floor .
IS:2858-1984	Code of practice for roofing with mangalore tiles (first revision)
IS:3007(Pt.I)	Code of practice for laying of asbestos cement sheets -1964

IS:3036-1980 Code of practice for laying lime concrete for a water proofed roof Finish (first revision)

15:306 7-1988 Code of practice for general design, details and preparatory work for damp-proofing and water proofing of buildings (first revision)

IS:3068-1986 Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete (first revision)

IS:3384-1986 Bitumen primer for use in water proofing and demp proofing (first revision)

IS:4098-1983 Specification for Lime pozzolana mixture (first revision)
(amendment No 1)

15:6733-1972 Wall and roofing nails (with amendment No. 1)(Reaffirmed 1985)

IS:6745-1972 Methods for determination of weight of zinc coated iron and steel articles

IS:6 760-1972 Slotted countersunk head wood screws (with 2 amendments)

IS:8869-1978 Washers for corrugated sheet roofing.

15:891 0-1978 General technical delivery requirements for steel and steel products

Standard specifications, Building and Communication Department, Government of Maharashtra

Standard Specifications, National Building Organisation

Specification 77, Central Public Works Department.

Bombay P.W.D hand book

TERMINOl0GY

Accessories - Purpose made fittings, such as ridge capping, ridge finials, apron flashing pieces, eaves filler pieces, barge boards, expansion pieces, ventilators, skylights and similar fittings, with which the roof is furnished.

Apron Flashing Piece - Flashing, the lower edge of which is lapped over the roof covering.

Barge Board - In the case of a gable roof where there is no gable parapet and the roof projects beyond the gable, the barge boards are planks running down from the ridge to the eaves covering the outer most rafters.

Battens or Reapers - Horizontal timber members of small section on which tiles are supported

Bitumen Primer - A liquid bitumen of low viscosity which penetrates into a prepared surface, upon application.

Drip - Projection which keeps rains from parts below.

Eaves - The lower edge of an inclined roof.

Eaves filler or Closure Piece - Asbestos cement accessory Used to fill or close the corrugation spaces under the roof sheeting at the eaves.

Eaves Board - A thin plank at the eaves covering the lower ends of common rafters.

Finial or Ridge End - Asbestos cement accessory to form welter proof covering at the end of a ridge.

Flashing - A strip of impervious material, usually metal, used to exclude water from the junction between a roof covering and another part of the structure.

Flat Tile - A hand made or machine pressed burnt clay tile laid In one or more courses as an under-layer for roofing.

Flat Roof - A practically level roof surface with only a small slope for purpose of drainage; the term is used in contrast with pitched or sloped roof.

Gable - Part of a wall above the general eaves level at the end of a ridged or partlally hipped roof.

Gutter - Any form of roof-water channel.

Hip - Raking salient angle formed by the intersection of two inclined roof surfaces.

Hip Ridge or Capping - Asbestos cement accessory used to form waterproof covering to a hip.

Mitre - Cutting the joining surfaces of two sheets at an angle.

Pent Roof - A roof with slope on one side only.

Pitch - Angle of inclination with the horizontal of the rafters or substructure surface on which the roof covering is laid.

Pitched Roof - A roof the pitch of which is greater than 10° to the horizontal.

Rafters

Common Rafters - The structural members which form the principal framework for the slopes of the roof I and support the reapers or boarding which carry the roof covering.

Hip Rafters - The structural members of the roof at the intersection of two roof surfaces forming 6 hip.

Jack Rafters - The rafters that are shorter than the common rafters running from a hip to the eaves or from a ridge to the valley, and cut against the hip and ridge.

Valley Rafters - The structural members of the roof at the intersection of the two roof surfaces forming a valley.

Ridge - The horizontal intersection of two rising roof surfaces inclined in opposite directions.

Ridge Capping - Asbestos cement accessory to form a waterproof covering to a ridge.

Ridge Tile - A machine pressed clay roofing tile usually angular shaped used at the ridges and hips of roofs, and with its size corresponding to the size of the roofing tile:

Roof Finish - The top part of a fl6t roof which contributes protection and durability to it, without itself being a structural or supporting element in the roof.

Roof Parapet - The part of the structure of the side walls of the building rising above the eave level of the roof.

Tilting Fillet - A fillet or batten fixed over the rafter on shorter side so as to provide an extra rise to the lower most course of the tile and bring its slope in conformity with the general pitch of the roof. Sometimes the top edge of the eaves board may itself be made to serve the function of the tilting fillet.

Valley - Re-entrant racking angle formed by the intersection of two inclined roof surfaces.

Verge - Free edge of a roof surface finishing at a gable.

15.3 SINGLE / DOUBLE LAYER COUNTRY TILE ROOFING

15.3.1 General - The item includes, providing and fixing roof covering with a single or double layer of country tiles, with or without slopping battens. The sloping battens shall be used if tiling is to be done over galvanized iron corrugated sheet or teak planking.

15.3.2 Materials

15.3.2. 1 Country Tiles - The country tiles shall be of a uniform colour and shall be well burnt. They shall show a fine grained uniform end dense structure on fracture and shall be free from lumps of lime, laminations, cracks, soluble salts, or other defects which may impair their shape, strength, durability or usefulness.

Tiles shall give a ringing note when struck together. The tiles shall be 25 cm. long, 12 mm thick with 80 mm inner diameter at large end and 75 mm. for small end unless other sizes are approved by the Engineer-in-charge. The tiles shall generally be of uniform size throughout. Tiles shall be so turned as to allow an overlap of about 5.00 cm After 24 hours immersion in water, absorption by weight shall not exceed 20 per cent. of the dry weight of tile.

15.3.2.2 Battens - The horizontal battens shall be either of timber of species mentioned in the item or of whole bamboos as may be specified with item.
The timber battens shall be of the finished size 50 mm x 20 mm and timber shall generally conform to the specifications laid down in Chapter 12 - "Woodwork & Joinery". The bamboo battens shall be of whole bamboos of 25 mm to 12 mm diameter.

15.3.2.3 Iron Work - All nails shall conform to IS: 723- 1972 and screws shall conform to IS:6760-1972.

15.3.3 Construction

15.3.3.1 Woodwork - The woodwork shall generally conform to the specifications laid down in Ch.12 "Woodwork &: Joinery. Each batten shall be at least as long as to cover four common rafters. The batten shall be secured to common rafters or sloping battens if provided by nailing. The clear distance between the battens shall be 5 cm. If so mentioned in the item sloping battens 40 x 40 mm shall be provided and nailed to 'the teak planking below at45 to 50 cm centre or in case of corrugated galvanized Steel sheets below sloping battens shall be fixed over the ridge of corrugation with screws. Horizontal battens then shall be nailed to the sloping battens.
15.3.3.2 Laying of Country Tiles- The tiles shall be laid in single or double layer as mentioned in the item.

The tile shall be laid at right angles to the eaves to fit one into the other. Each tile shall project about 2.5 cm beyond the batten. Each tile shall have an overlap of at least 5 ctn., over the other. The tiles at the eaves shall be secured by a batten 40 mm x 25 mm. properly leveled and fixed with 6 mm. bolts and nuts to the rafters. The tiles near the ridge shall abut tight against the ridge. The tiles at hips and valleys shall be set in such a way as to enable proper fixing of hip and ridge tiles. The ridge and hip tiles shall be set dry with j0ints p0inted with cement mortar of specified mix.

The second layer If included in the Item shall be laid in the same manner as the first layer.

15.3.3.3 Oiling- The battens where exposed shall be oiled with one coat of linseed oil as per relevant para of Ch. 18 "Painting". Battens embedded in masonry shall be coal tarred.

15.4 TILED ROOFING WITH MANNGLORE TILES

15.4.1 Material

15.4.1.1 Mangalore Tile - The roofing tiles shall be made from suitable clay of even texture and shall be well burnt. They shall be free from irregularities, such as twists, bends, crakes and laminations.

The roofing tiles shall be free from impurities like particles of stone, lime or other foreign materials visible to naked eye on the surface or on the fractured face of the tile obtained by breaking the tile. However, occasional particles upto 2 mm in size may be permissible. When struck, the tile shall give a characteristic ringing sound and when broken the fracture shall be clean and sharp at the edges. When the roofing the Is placed on either face OA'a plane surface, the gap at the corners shall be not more than 6 mm. The class M tHe as per classiftcatton given below, shall be of uniform color.

Roofing tiles, Mangalore pattern, shall be of two classes, namely class M and class A and shall be classified as per the characteristics specified in Table 1 below:

TABLE - 1 Classification of Roofing Tiles

S. No.		Characteristic	Requirement	
			Class AA	Class A
(1)		(2)	(3)	(4)
(i)		Water absorption percent, maximum	19	24
(ii)		Breaking load, Kg. Minimum:		
	a	Average	102	82
	b	Individual	91	68

Dimensions and Tolerances:

Dimensions - There shall be three sizes of tiles, with principal dimensions as given in table 2 below:

Table 2		
S.NO	Overall Length	Overall Width
	mm	mm
(1)	(2)	(3)
i)	410	235
ii)	420	250
iii)	425	260

Note: If the maximum over laps are kept, the tile at Sl.No.(i) is used for batten spacing upto 320 mm ,5lNo.(in Upto 350 mm and Sl.No.(iii) upto 360 mm.
However, by reducing suitably overlaps in the tiles at 5l.No.(1) and (11) these can also be used for batten spacing upto 350 and 360 mm respectively. The minimum overlap shall be 60 mm length wise and 25 mm widthwise for each type of tiles.

Tolerance - Tolerance shall be ± 6 mm for effective length and ± 3 mm for effective width.

15.4.1.2 Mortar - The mortars for use in bedding ridge tiles as well as Mangalore tiles shall be:

Either composite mortar 1:2:9 (one part of cement conforming to 15:269- 1989 or IS: 1489- 1976 or 15:455- 1976, two parts of lime conforming to 15:712-1973 and 9 parts sand) or lime mortar 1:3 (one part lime conforming to 15:712- 1973 and three parts sand). Water used for making mortar shall conform to para 7.3." of Ch.7&16 "filling foundation and RCC & form Work". In general potable water can be used.

15.4.1.3 Ridge Tiles - These shall conform to IS: 1464-1973.

15.4.1.4 Nails for fixing battens - Nail is used for fixing battens or rafters shall be plain head nails of size 2.5 mm or 2.2" mm conforming to 15:723 - 1972. The nail Is shall be galvanized.

15.4.1.5 Sheet Metal for Valley Gutters - This shall be of galvanized metal and shall not be lass than 1.25 mm thick and shall be 1.2 m wide.

15.1.1.6 Battens - Batten shall be of any species of structural Umber given in 15:883-1910 or as specified in item and quality of timber shall conform to relevant para of Ch.12 "Woodwork and Joinery". The size shall be 50 x 25 mm.
Battens shall be treated for protection against decay and termites in accordance with relevant para of Ch. 18 "Painting".

15.4.1.1 Wire For Tying Down the Tiles - The wire shall be galvanized and shall conform to 15:280- 1918.

15.4.2 Preparation for Laying

Before taking up the work of roof covering the roof framework shall have been completed and the battens nailed into position ready for supporting the roof covering. Before use in the roofing, the tiles shall first be prepared by immersing in water for two hours and air drying before laying.

15.4.3 Fixing of Battens

The battens shall be fixed over the rafters at the specified or designed spacing and nailed. The nails shall penetrate at least 2 cm into the rafters.
They shall extend at least over a length of three spans between the rafters. The battens shall be nailed to the rafters by means of plain headed nails. Their length shall be extended only by means of butt joint. The joint shall occur only over the rafters. The joints of no two adjacent rows of battens shall come over the same rafter. At the eaves a tilting fillet shall be fixed, if necessary.

15.4.4 Laying of Mangalore Tiles

15.4.4.1 The tiles shall be laid down from the eves towards the ridge property interlocked according to the design of the tile. The tile shall be laid either directly over the battens or over an undercover. The tile shall be laid breaking joint, that is the left channel of the upper tile shallbie in the right channel of that below and shall fit properly one to another the catches resting fully Bgainst battens. The tiles shall be laid with both head lap and side lap as fixed by the design of tile. If the heed lap is not fixed by the design of tile, it shall not be less than 75 mm. The hips and ridges of the roof shall be covered with ridge tiles which shall be edge-bedded in mortar.
Mortar shall be as specified under para 15.4. 1.2. The mortar in edge bedding shall be further finished with plaster or paint to match with the colour of the tiles. If the courses of roof tiles adjacent to the hip or to the ridge 00 not finish exactly underneath the ridge tiles, either purpose made tiles or tiles cut to suitable shapes shall be used. While finishing joints gaps in the troughs of the roof tiles giving ridge or hip, if large enough, shall be neatly packed watertight using small pieces of chips or broken tiles and mortar. At eaves the lower most course of the tlles shall overhang the tilting fillet by a distance sufficient to ensure that the water drained off from the roof discharges clear off the eaves into the gutter.

15.4.4.1.1 Protective Measures Against Wind- A suitable arrangement shall be made to secure the ends of lower most coarse of tiles to the roof structure for preventing the tiles from being blown up by wind. At least the bottom most layer of tiles, and preferably more number of layers above it, shall be tied to the battens or other roof elements by means of galvanized wire. The tiles at the eaves shall also be protected against lifting by means of a mild steel flat of size 40 x 3 mm fixed to the roof. If so specified or directed by the Engineer-in-charge, mortar bands 200 to 250 mm wide 60 to 65 mm deep shall also be provided over the tiled roof at a spacing of 2.5 to 3 m for additional protection against wind. The mortar bands shall run along the roof slope.

15.4.4.1.2 Laying Mangalore Tiles over flat tile under cover- The flat tiles shall first be prepared by immersing in water for two hours and dried before laying.
The underside of flat tiles shall also be dipped in whitewash mixed to creamy consistency and dried. The flat tiles shall then be laid over the batten. The mortar layer shall be spread over the flat tile to a thickness of not less then 25 mm. The Mangalore tile shall also be soaked for two hours before laying in the roof. When the mortar layer is spread, the soaked Mangalore tiles shall be laid so as to be fully embedded in the mortar over the flat tiles. Where the pitch of the roof is more than 30°, additional fillets shall be fixed to the battens at a spacing of about one metre centers, so that

the flat tiles laid between them are retained in position. The Mangalore tiles may also be fixed over flat tiles without mortar bedding if the work is so specified.

1.5.4.4.2 Alignment - The finished slope of the roof shall be uniform ridge eaves. The eaves line and the ridge line shall be perfectly straight, horizontal and parallel to each other.

15.4.4.3 Junction between Ridges and Hips- The joint between hip and ridge tiles shall be grouted so as to be leek proof. A metal saddle not less than 45 sqm area may, if directed be used underneath such junctions as additional protection against leakage.

15.4.4.4 Work at Valleys - Since valley is a particularly vulnerable part of the roof as its pitch Is several degrees less than that of the general roof surface and it has to provide a channel for the water running down into it from two slopes on either side, special care shall be taken that a clear and an unobstructed channel is formed. Undercover shall be provided for the courses of tiles adjacent to the valley.

The valley gutters shall be of galvanized steel sheet of minimum 1.25 mm thickness and 1.2 m wide. A 300 mm overlap shall be given at joints, if any. down the slope.

The valley gutters shall be laid over the battens and not nailed on to them from underneath. Two additional battens of section 50 x 25 mm shall be fixed over the metal sheets, 150 mm aw~ from the centre line of the valley on either side, so as to retain the tiles and mortar against falling into the gutter of the valley. On either side of the valley, the roof shall be plastered with mortar to a thickness of 12 mm so that rain water from the gutter is prevented from percolating through the tiles or the undercover to the underside of the roof.

15.4.5 Treatment of Junctions With Wall

Junctions of the roof with walls shall preferably be treated for waterproofing in accordance with para 15. 12. Wherever special features like roof gutters and flashings are not provided between the junctions of the roof and wall, the tiles shall be let into the wall to a depth of not Jess than 50 mm and a drip moulding shall be provided at about 100 mm height above the roof surface, and joints between the roof and the wall shall be grouted with a waterproofing mortar or such other materials (See fig. 1 below).

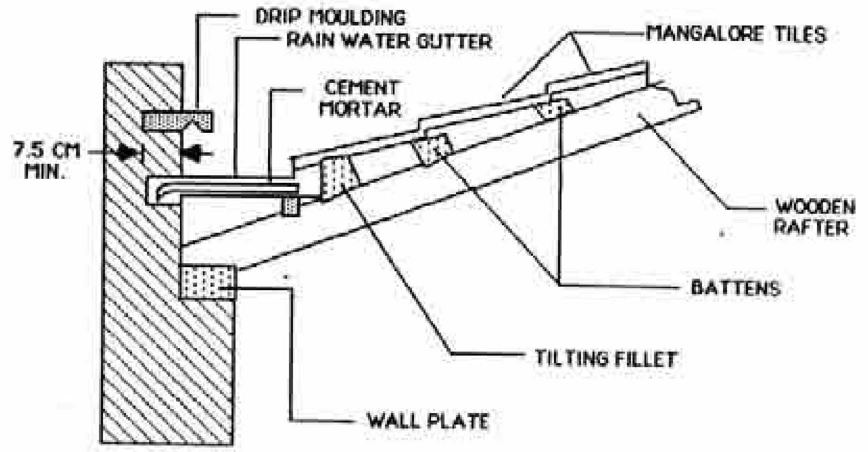


FIG. 1 DETAIL AT THE JUNCTION OF THE ROOF WITH WALL
(WHERE TILES THEMSELVES ARE USED FOR ROOF DRAINAGE)

15.4.6 Inspection

Inspection shall be done to avoid unsatisfactory construction which may result in one or more of the following defects:

Stage	Particulars of inspection	Type of failure that may occur if (2) is not satisfactory.
1	2	3
laying of battens	No joint between the battens shall occur except over' the joist. At eaves the tilting fillet shall be fixed to the correct height.	Sagging or cracking
laying of tiles	Where Mangalore tiles are laid over flat tiles, their joints shall not, as far as possible, occur over the joints of the tiles. Where Mangal0re tiles are laid as such over' battens; or over ceiling tiles, interlocking of tiles shall be ensured.	Unsightly fall of roof surface near the eaves.

15.5 SINGLE ALLAHABAD TILE ROOFING

15.5. 1 Allahabad Tiles

The tiles shall be superior type, and free from warps and twists and of close grained, homogeneous texture. Size of tiles shall be 300 x 340 mm. trough shaped flat tiles and 150 x 300 mm half round tiles (slightly tapering).

15.5.2 Fixing of Battens

Wooden battens of size 50 mm x 25 mm section shall be fixed over ~ the common rafters at 300 mm centres to support the tiles. The l0west eaves batten shall be thicker than the battens above it by the thickness of a tile so that the slope of ;
the tiles from the edge to the eaves is continuous. The battens shall be nailed to I rafters with wire nails(plain head)70mmx2.5mm.The under faces of the battens shall be planed smooth before fitting up. The minimum length of battens to be used shall be such that the battens shall cover at least 3 spacings of rafters and the joints in battens come over the rafters. The joints of two adjacent rows of battens shall not come over the same rafter". The spacing of rafter for the above size of battens shall not exceed 900 mm. The finished top surfaces of battens shall be plain and uniform.

The top surface of battens on which tlles are to slt and the embedded portl0ns of the battens shell be coal tarred two coats.

15.5.3 Laying of Tiles

15.5.3.1 Single tiling shall consist of a layer of flat trough shaped tiles 300 mm x 340 mm in size and laid on battens, the edges of every two adjacent tiJes being covered with semi-cylindrical tile 150 mm x 300 mm in size slightly tapering, towards one end.

15.5.3.2 The flat tiles must lap accurately one over the other. The moulded niche at the lower end of each flat tile must fit completely into the head of the tile next below it 'and the catches at the upper end must have a firm hold on the battens fixed to receive them.

15.5.3.3 Each semi-cylindrical the shall fit exactly in its position both on the flat tiles under' it, end also into and on the next semi-cylindrical the, respectively above and below it. The lower edges of the tiles shall sit properly on the flat tiles below. A steel rasp shall be used for filing off where necessary but no tile shall be I rasped to such an extent as to render it thin or weak.

I 15.5.3.4 Screwing eaves tiles to battens shall be done with 50 mm iron screw designation No. 12, with washers. TheSe will be provided one in eoch tile after drilling holes.

15.5.3.5 The hollows under semi-cylindrical tiles at the eaves, shaJl be fiJled for half their length with Lime mortar. 1:3 (1 lime:3 sand) or composite mortar 1:2:9 (1 cement: 2 lime: 9 sand).

15.5.3.6 Ridges And Hips - These shall be covered by tiles specially manufactured to suit their position. Samples of these tiles shall be got approved by the Engineer-in-Charge. The tiles shall be laid in time mortar - 1:3 (1 Lime: 3 sand) or composite mortar 1 :2:9 (1 cement: 2 Lime : 9 sand).

15.5.3.7 Work At Valleys- The provisions as in para 15.4.4.6 shall apply.

15.5.4 Treatment of Junctions with Wall

The provisions as in para 15.4.5shall apply.

15.5.5 Inspection

The provisions as in para 15.4.6 shall apply.

15.6 GALVANISED STEEL SHEET ROOFING (Fig.of PLATE:2/CH-15)

15.6. 1 Material

15.6. 1. 1 General- General requirement relating to the supply of galvanized sheets and strips shall conform to 15:8910-1978.

15.6.1.2 Quality or Sheet - The sheets shall be free from cracks, split edges, twists, surface flaws, etc. They shall be clean, bright and smooth. The galvanizing shall be uninjured and in perfect condition. The sheets shall not show signs of rust or white powdery deposits on the surface. The corrugations shall be uniform in depth and pitch and parallel with the sides.

15.6.1.3 Zinc Coating - The zinc coating shall conform to the requirement of any one of the grades prescribed in table 3. The mass of coating referred shall represent the total mass of zinc, both sides inclusive.

Table - 3 Mass of coating (Total both sides)

Grade of coating	Minimum average coating (Trip le spot test) gm/m2	Minimum coating Triple spot Test gm/m2
750	625	550
600	500	425
450	350	300
375	275	250
300	225	200
250	200	175
200	175	150
175	120	100

Determination of Mass of Zinc Coating - The average masses of zinc coating of samples selected as per IS:277-1988 shall be determined by the method given, in IS:6 745-1972 and shall conform to both the values specified in table 3.

15.6.1.4 Dimensions and Tolerances

15.6.1.4. 1 . Size of plain sheets - Plain sheets shall be supplied in any combination of the following lengths. widths and thickness.

(a) length- 1800. 2200. 2500. 2800 &: 3000 mm
(b) Width - 750, 900 and 1000 mm
(c) Thickness - 0.40,0.50,0.63,0.80,1.00,1.25 & 1.60mm

15.6.1.4.2 Corrugated Sheets

(a) Length - The length of the corrugated sheets shall be as follows:
1800 I 2200 I 2500, 2800, 3000 & 3050 mm

(b) Depth and Pitch of the Corrugations - The depth and pitch of corrugation shall be as follows (sea fig 2)

Grade	Depth of corrugation	Pitch of corrugation
A	17.5	75
B	12.5	75

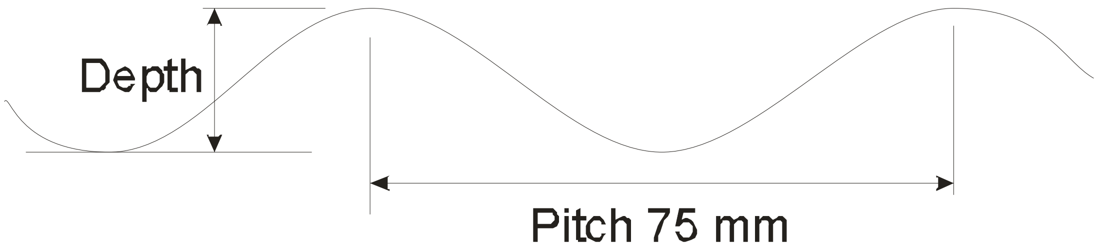


FIG. 2 DEPTH AND PITCH OF CORRUGATIONS

(c) Number of Corrugations - The number of corrugations shall be 8,10 or 11 depending on the width of the sheet. The overall width of the corrugated sheet before and after corrugation shall be as shown in table 4.

Table 4 - Overall Width and Corrugations of Sheets

Number of corrugation	Grade	Overall width of sheet before corrugation	After corrugation
8	A	750	660
10	A	900	810
11	A	1000	910
8	B	750	680
10	B	900	830
11	B	1000	930

(d) Thicknes - 0.40,0.50,0.63,0.80, 1.00 ,1.25 and 1.60 mm

15.6.1.4.3 Tolerances

(a) Length - No sheet shall be smaller in length than that specified. Tolerances on length on plus side shall be 15 mm or 0.5 percent of length, whichever is greeter.

(b) The diagonal distance between opposite corners of any sheet shall not differ by more than 20 mm.

(c)Width - No plain sheet shall be smaHer in width than that specified. The positive tolerances on width shall be 10 mm.

(d) Thickness - The tolerance on thickness of sheet shall be according to table 5 given below:

Table 5 - Tolerances on Thickness of Sheets

Nominal thickness (mm)	**Tolerance for width upto 1250 mm (mm)**
Above 0.40 upto 0.60	±0.05
Above 0.60 upto 0.80	±0.06
Above 0.80 upto 1.00	±0.08
Above 1.00 upto 1.25	±0.09
Above 1.25 upto 1.60	±0.11

(e) The tolerances on dimensions of corrugation sheets shall be as given in table 6 below:

Table 6 - Tolerance on Dimensions of Corrugated Sheets

Dimension	**Tolerance**
Depth of corrugation	±2.5 mm
Pitch of corrugation	±5 mm
Overall width after corrugation	±25 mm * * Aver. of 4 measurements

(f) Tolerance on Mass - The tolerance on mess of individual sheet calculated in accordance with procedure laid down in 15:277-1985 shall be within ±10 percent and tolerance on mess of each bundle of sheet shall be ±5%.

15.6.2 Purlins

15.6.2.1 Wooden purlins of the specified wood or M.S. rolled sections of requisite size shall be fixed over the principal rafters.

15.6.2.2 Spacing of Purlins- One purlin shall be provided on the ridge and one at the spacing of other purlins shall not exceed those indicated in the table 7.

TABLE - 7

Thickness of C.G.S.. sheet	**Maximum spacing of purlins**
1.25 mm	2.40 metre
1.00 mm	2.00 metre
0.80 mm	1.80 metre
0.63 mm	1 .60 metre

Purlin shall coincide with the centre line of the end lap. The ridge purlin should be placed in such a Wt1i/ that the ridges can be fixed properly. The portion overhanging the wan support should not be more than one fourth of the spacing of the purlins.

The top surfaces of the purlins shall be uniform and plane. They shall be painted before other sheets are fixed over them. Embeded portions of wooden purlin shall be coal tarred with two coats.

15.6.3 Slope

Unless otherwise shown in drawings, roof shall not be pitched at a nauer slope than 1 vertical to 5 horizontal. The normal pitch opted shall usually be 1 verticel to 3 horizontal.

15.6.4 LAYING AND FIXING

15.6.4.1 Unless otherwise shown in the drawings or directed by the Engineer-in-charge, the sheets shall be laid and fixed in the manner described below.

15.6.4.2 The sheets shall be laid on the purlins to a true plane, with the lines of corrugation truly parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

15.6.4.3 The sheets shall be laid with a minimum lap of 15 cm at the ends and 2 ridges of corrugations at each side. The above minimum end lap of 15 cm shall apply to slopes of I vertical to 2 horizontal and steeper slopes. For flatter slopes the minimum permissible end lap shall be 20 cm. The minimum lap of sheets with ridge hips and valleys shall be 32.5 cm measured at right angles to the line of the ridge, hip and valley respectively. These sheets shall be cut to suit the dimensions or shape of the roof either along hips and valleys. They shall be cut carefully with a strai(l1t ed]e and chisel to give a smooth and straight finish.

15.6.4.4 Sheets shall not generally be built into gables and parapets. They shC2ll be bent up along their side edges close to the w3H and the junction Shall be protected by suitable flashing or by a projecting drip course the latter to cover the Junction by at least 7.5 cm.

15.6.4.5 The laying operation shall include all scaffolding work involved.

15.6.4.6 Sheets shall be fixed to the purHns or other roof members such as hip or valley rafters etc. with galvanized J or L hook bans and nuts, 8 mm diameter, with bitumen or G. I. limpet washer or with a limpet. washer filled with white lead as directed by the Engineer- in-Charge. The length of the hook bolt shall be varied to suit the particular requirements. The bans shall be sufficiently long so that after fixing they project above the top of the nuts by not less than 12 mm. The grip of J or L hook bolt on the side of the purlin shall not be less than 25 mm. There shall be a minimum of three hook bolts placed C2t the ridges of corrugations in each sheet 'in every purlins and their spacing shall not exceed 30 cm. Coach screws shall not be used for fixing sheets to purlins.

15.6.4.7 Where slopes of roofs are less than 21.5 degrees (1 vertical to 2.5 horizontal) sheets shall be joined together at the side laps by galvanized iron boUs and nuts 25 x 6 mm size, each bolt with a bitumen and a G.I. limpet washer or G.I. limpet washer filled with white lead. As the overlap at the sides extends to two corrugations, these bolts shall be placed zigzag over the two overlapping corrugations, so that the ends of the over lapping sheets shall be drawn tightly to each other. The spacing of these seam bolts shall not exceed 60 cm along each of the staggered rows. Holes for all bolts shall be drilled and not punched in the ridges of the corrugations from the underside while the sheets are on the ground. The holes in the sheet shall be at least 5 cm from the edge.

15.6.4.8 Sheets with wrongly drilled holes shall be rejected.

15.6.4. 9 The holes in the washers shall be of the exact diameter of the hook bolts or the seam bolts. The nuts shall be tightened from above to give a leak proof roof.

15.6.5 Wind Ties

Wind ties shall be of 40 mm x 6 mm flat iron section or of other size as specified in the item. These shall be fixed at the two eaves ends of the sheet. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. Slot holes will be cut in the wind ties to allow for expansion and contraction due to variation of temperature.

15.6.6 Finish

The roof when oompleted shall be true to lines, and slopes and shall be leak proof.

15.6.7 Ridges and Hips Of Plain galvanized Steel Sheets

15.6.7.1 Ridges and Hips - Ridges and hips of roofs shall be covered with ridge and hip sections of plain sheet with a minimum lap of 2.5 cm on either side over the sheets. The end laps of the ridges and hips, and between ridges end hips shall also be not less than 22.5 cm. The edges and hips shall be of 60 cm overall width plain sheets 0.6 mm or 0.8 mm thick as given in the description of item and shall be properly bent to shape.

15.6.7.2 Fixing

15.6.7.2.1 Ridges shall be fixed to the purlins below with the same 8 mm dia. GI hook bolts and nuts and bitumen and GI Limpet washers which fix the sheets to the purlins.

15.6.7.2.2 Similarly, hips shall be fixed to the roof members below such as purlins, hip and valley rafters with the same 8 mm dia. G.I. hook bolts and nuts and bitumen end GI limpet washers which fix the sheets to these roof members.

15.6.7.2.3 At least one of the fixing bolts shall pass through the end laps of ridges and hips, on either side. If this is not possible extra hook bolts shall be provided.

15.6.7.2.4 The end laps of ridges and hips shall be joined together by galvanized Iron seam bolts 25 x 6 mm size each with a bitumen and G.I. limpet washer filled with white lead as directed by the Engineer-in-charge. There shall be at least two such bolts in each end lap.
.
15.6.7.3 Finish- The edges of the ridges end hips shell be straight from end to end and their surfaces should be plane and parallel to the general plane of the roof.
The ridges end hips shall fit in squarely on the sheets.

15.6.8 Valleys and Flashing Of Plain Galvanized G.I Sheets

15.6.8.1 Valley and Flashing - Valleys shall be 90 cm wide overall plain sheet of thickness not Jess then 1.6 mm bent to shape end fixed. They shall lap with the corrugated galvanized sheets not less then 25 an width on either side. The end laps of valleys shell also be not less then 25 cm.

Valley sheets shall be laid over wooden planks of specified thickness.

Flashing shall be of plain G.I. sheet of 40 cm overall width 1.25 mm thick or 1.00 mm thick as specified in the item bent to shape end fixed. They shall lap not less then 15 an over the roofing sheets. The end laps between flashing pieces shall not be less than 25 cm.

15.6.8.2 Laying and Fixing- Valley sheets shall be fixed to the roof members below, such as purlin and valley rafters, with the same 8 mm dia. G.I. hook bolts end nuts end bitumen and G.I. limpet washer which fix the sheets to these roof members.

At least one of the fixing bolts shall pass through the end laps of the valley pieces, on either side. If this is not possible extra hook bolts shall be provided.

15.6.8.3 Finish - The edges of valleys alid fleshing should be straight from end to end. The surfaces should be true end without bulges end depressions. J

15.6.9 Gutters of Plain Galvanized Steel Sheets

15.6.9.1 Gutters- Gutters shall be fabricated from plain a.s. sheets 1.25 mm thick or other size as specified in the item.

Eaves gutters shall be of the shape and section specified in the description of the item. The overall width of the sheet referred to therein shall mean the peripheral width of the autter including the rounded edges. The longitudinal edges shall be turned back to the extent of 12 mm. end beaten to form a rounded edge. The ends of the sheets at junctions of pieces shall be hoolced into each other end beaten flush to avoid leakage.

15.6.9.2 Slope- Gutters shall be laid with a minimum slope of 1 in 150.

15.6.9.3 Laying and Fixing

15.6.9.3. 1 Gutters shall be supported on and fixed to M.S. flat iron brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1.20 metres.

15.6.9.3.2 Where these brackets ere to be fixed to the sides of rafters, they shall be of 40 x 3 mm section bent to shape end fixed rigidly to the sides of rafters with 3 Nos. 10 mm dia. bans, nuts end washers. The brackets shall overlap the rafter not less than 30 cm and the connecting bolts shall be at 12 cm centers (see fig.of PLATE:3/CH-151

15.6.9.3.3 Where the brackets are to be fixed to the purlins, the brackets shall consists of 50 x 3 M.S. flat iron bent to shape. with one end turned at right angle and fixed to the purlins face with a 10 mm dia. bolt, nut and washer. The perpendicular over hung portion of the 50 x 3 mm flat bent to right angle shape with its longer leg connected to the bracket with 2 Nos. 6 mm dia. M.S. baits, nuts and washers and its shorter lag fixed to face of pur Un with 1 No.1 0 mm dia. bolt, nut and washer. The overhang of the vertical portion of the flat iron bracket from the face of the purlins shall not exceed 20 cm with this arrangement

15.6.9.3.4 The gutters shall be fixed to the brackets with 2 Nos. e.i. bolts and nuts 6 mm dia. each fitted with a pair of a.1. and bitumen washers. The connecting bolts shall be above the water line of the gutters.

15.6.9.3.5 For connection to down take pipes, a proper drop end or funnel shaped connecting piece shall be made out of G.S. sheet of the same thickness as the gutter and riveted to the gutter, the other end tailing into the socket of the rain-water pipe.
Wherever necessary stop ends, angles, etc. should be provided (see Fig.of PLATE:3/CH-15).

15.6.9.4 Finish - The gutters when fixed shall be true to line and slope and shall be leak proof.

15.7 ASBESTOS CEMENT CORRUGATED SHEET ROOFING
(fig.of PLATE:4/CH-15)

15.7. 1 Materials

15.7.1. 1. 1 General- General requirements, relating to composition, coloring and quality of sheets shall conform to IS 459- 1910.

15.7. 1.2 Dimensions and Tolerances -The sheets shell conform to dimensions and tolerance given in table 8 and figure 3.

TABLE:8

Dimensions and Tolerences of Corrugated Sheets

(All dimensions in millimetres)

Type of Sheet	Depth of Corrugation		Pitch of Corrugation		Overall Width		Effective Width		Nominal Thickness		Length of Sheet*	
	D	Tolerences	P	Tolerences•	B	Tolerences	C	Tolerences	T	Tolerences	A	Tolerence
1	2	3	4	5	6	7	8	9	10	11	12	13
Corrugated Sheets	48	+ 3 − 5	146	+ 6 − 2	1050	+ 10 − 5	1010	+ 10 − 5	6	+ Free − 0.5	1750 2000 2500 or 3000	+ 5 − 10

*Intermediate metric sizes may also be manufactured by mutual agreement between the manufacturer and consumer.

•Tolerence given in this table for pitch of corrugation relates to measurement over six pitches.

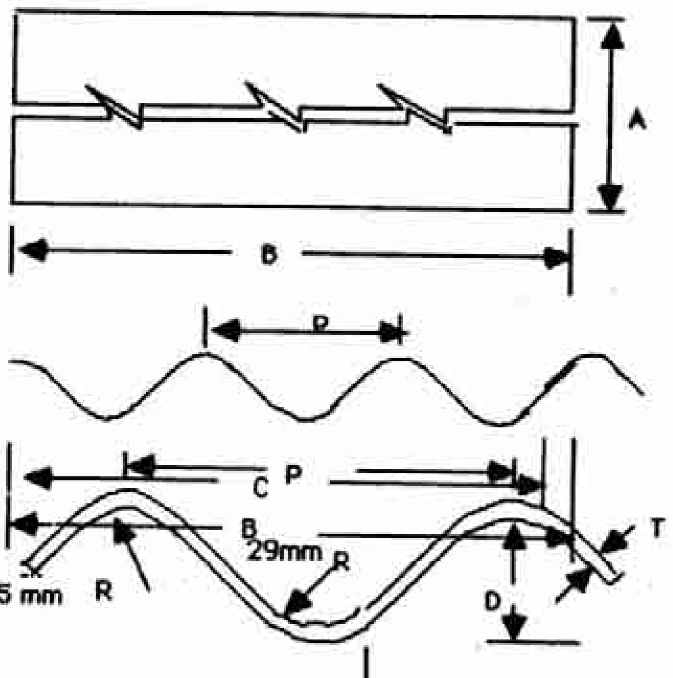


FIG 3 CORRUGATED SHEETS

15.7.1.2.1 For the purpose of measuring thickness, depth and pitch, procedure as laid down in IS 459-1970 shall befollowed. .

15.7.1.3 Physical and Mechanical Characteristics

15.7. 1.3. I Load Bearing Capacity - The load bearing capacity of corrugated sheet shall not be less then 5 N/mm (O.5kgf/mm) width of specimen tested.

15.7. 1.3.2 Water Absorption - The percentage of water absorption shall not exceed 28 percent of their dry weight.

15.7.1.3.3 Impermeability- The specimens shall not show during 24 hours of test any formation of drops of water except traces of moisture on the lower surface.

15.7.1.3.4 Acid Resistance - The amount of acetic acid used in testing shall not exceed 1150 g/sqrn

15.7.1.3.5 Frost Cracking test - When so required by the purchaser in special situations only, the samples of corrugated sheets shall be subjected to frost cracking test and they shall not show any signs of cracking or surface alteration.

I 5. 7. 1. 4 Finish - The finished products when delivered shall have a rectangular shape, smooth surface on the exposed side, appearance end shell be free from visible defects. The corrugation shall be true and regular. The edges of the sheets shall be straight and clean.

15.7.1.5 Sampling and Criteria for Conformity - Sampling and criteria for conformity shall be as per procedure laid down in IS 459-1970.

I 5.7.2 Design Consideration

1 5.7.2.1 Pitch of The Roof - The pitch of roofs shall, wherever possible. be preferably not less than 1 8. . Should it, however, be found desirable to adopt roofs with a pitch less than 18., the values prescribed in para 15.7.2.5 for the end Laps between adjacent sheets shall be correspondingly increased and/or the joints suitably sealed in accordance with the manufacturer's recommendations or the instructions of the Engineer- in-Charge.

15.1.2.2 Purlins - All purlins shall be in one plane and shall be properly anchored to the supporting structure. Special C$3f'e shall be taken that the sheets do not deflect at the intermediate purlins in an attempt to make the sheets bear on such purlins.

15.7.2.2.1. Spacing of Purlins - The spacing of purlins shall be arranged to suit the standard lengths of sheets but shall not exceed the following:

Thickness of Sheet (mm)	Distance Between For roof covering (m)	Purlin Centers For side cladding (m)
6	1.4	1.7

Ridge purlins shall be fixed 75 mm to 115 mm from the apex of the roof, that is, from the bolt point.

15.7.2.3 Additional trimmers or bridging shall be used between purlins at 811 points where considerable roof traffic is likely to occur, for example, adjoining valley or box gutters, below glazing and around chimneys, ventilators or other uptakes. This should be done on new roofs end when recovering or repairing existing roofs. Similarly. when a course of sheets of smaller length necessitating closer purlin sp6Cing 15 required to make up a roof slope. it is desirable to arrange the closer purlin spacing at eaves rather than at edges, as this will bring additional support where it is most required.

15.7.2.4 Hip and valley runners should be provided, fixed flush with the top face of purlins and spanning between them, to give adequate support to the raking cut edges of roof sheets at hips and valleys. The runners should run parallel to the edge of the sheeting and pieced so as to permit the fixing of the sheets end hip covering accessories.

15.7.2.5 Laps- The sheets shall be laid with a side lap of half corrugation (See rigI5-P/4A) For normal roof pitches (that is, inclinations greater than or equal to 18°), the end laps (Fig15-P4B) In sheets shall not be less than 150 mm. for low roof pitches (that is, inclinations Less than 18° or for normal pitched roof in exposed positions, the end laps shall be increased and it is desirable to consult the manufactures in such cases. The side lap shall as far as possible be sheltered from the prevailing wind direction.

Wherever four corners of sheets overlap two of them shall be mitred in the manner described in 15.7.3.3.4 and 15.7.3.3.5 in order to secure a perfect fil

15.7.2.6 In order to avoid undue width of flashing, the sheets should finish at abutments as far as possible with an upturned edge.

15.7.2.7 Over Hang - The free overhang at eaves measured as the length of sheet from Its lower edge to the centre of bolt holes shall not be more than 30 cm.

15. 7.3 LAYING AND FIXING OF SHEETS

15.7.3. 1 Sewing and Drilling - Sheets shall be cut as necessary with a wood saw. Holes in the sheets shall be drilled; they shall on no account be punched. The later method not only splays out the aperture thus weakening the material at vulnerable points, but is also likely to commence a fracture of the sheet which will ultimately open out in weathering. The hole for fixing shall be 2 mm larger than the diameter of the fixing bolts, and shall always be drilled through the crown of the corrugation and not on the valleys.

15.7.3. 1. 1 Holes for fixing the sheeting shall be drilled in the centre of the end lap of sheets to suit the purlins, that is, on the centre line of the purlins if these are of timber and square head coach screws are used, or as close as possible to the back of the purlins if J- or L -bans are used with steel angles or pre-cast concrete or timber purlins. It Is recommended, therefore, to drill the holes on the roof with the sheeting laid in the correct position. No hole shall be nearer than 40 mm to any edge of a sheet or en accessory.

15.1.3.2 Fixing Accessories

15.7.3.2.1 The satisfactory service of the roofing depends to a great extent upon the efficiency of fixing accessories. It Is,- therefore, important that particular ,attention is paid to the proper selection end-,use of fixing accessories. The fixing accessories shell conform to the requirements of IS: 730- 1978.

15.7.3.2.2 Galvanized Iron J-type hook bolts or cranked hook bolts, end nuts \ bearing on Qalvenlzed Iron washers end bitumen washers shall be used for working sheets on angle iron purlins.

15.7.3.2.3 Galvanized Iron l-type hook bolts and nuts bearing on galvanized iron washers end bitumen washers shall be used for fixing sheets on R.S. joist, precast concrete or timber purlins.

15.1.3.2.4 Galvanized iron 00BCh screws bearing on galvanized Iron washers end bitumen washers shall be used for fixing sheets on timber purlins.

15.7.3.2.5 Galvanized iron roof bolts and nuts bearing on galvanized iron nat washers and bitumen washers shall be used for stitchIng on the Sheets, fixtures, Like ridge cappings, corner pieces, ventilators, northlight curves, etc.

15.7.3.2.6 Where sheets ere laid on tubular purlins the fixing bolt should be designed to encompass at least half the tube periphery and precautions should be taken to prevent Its rotation. Sections other than angles and tubes may require an adopted form of hook boll

Direct fixing of sheets to drilled metal framework or by stud welding is undesirable as it tends to restrain movement of sheets.

15.7.3.2.7 It is essential that the bolt holes ere made watertight by the use of bituminous felt washers in conjunction with suitable galvanized iron washers. These form essential accessories to 0J0d fixing work. fixing bolts and screws shall be 8 mm or more in diameter and the nuts of the hook crank bolts (or heeds of coach screws) shall bear on galvanized iron washers(flat, curved or diamond pattern) which in turn shall be embedded on bituminous felt washers (round or diamond pattern corresponding to the shape of galvanized iron washer). The screws or nuts shell be tightened sufficiently only to see the bitumen washer over the corrugations, so that natural movement in the sub-structure of the roof may not damage the sheeting.

The Length of the J-bolt or crank bolt shall be 75 mm longer than the depth of the purlin for single sheet fixing end 90 mm longer than the depth of the purlin where two sheets overlap or where ridges or other accessories ere to be fixed with the sheet. The minimum length of square head coach screw for timber purlins shall be 110 mm. The number and length of bolts end the number of bitumen end galvanized Iron washers for fixing asbestos cement corrugated sheets shall be as given in Table 9.

Table - 9

Number And Length of Bolts and Number of Bituminous felt and Galvanized Iron Washers

S.No.	**Situation**	**No. of Bolts And Bituminous Washers And Galvanized Iron Washers**	**Length of bolt**
1	At horizontal end laps of sheets. At eaves when filler pieces are used At ridge when corrugated sheets and ridge pieces are secured by the same bolt.	Twice the number of sheets in one horizontal course	Depth of purlin plus 90 mm
2	At eaves when filler pieces are not used. At ridge when corrugated sheet and ridge pieces are not secured by the same bolt	Twice the number of sheets in one horizontal course	Depth of purlin plus 75 mm
3	At Intermediate purlins Where horizontal laps do not occur.	Twice the number of sheets in one horizontal course	Depth of purlin plus 75 mm

15.7.3.2.8 The galvanized iron flat washer shall generally be 25 mm in diameter and 1.6 mm thick with hole to suit the required size of fixing ~ and the bitumen washer shall be 35 mm in diameter and 1.5 mm thick with hole to suit the required size of fixing accessory. for other shapes of galvanized iron and bitumen washers suitable Si2eS as approved by the Engineer-in-Charge may be used

15.7.3.2.9 Ridge cappings shall, as far as possible, be secured to the ridge purJins by the same bolts which secure the sheeting. Other asbestos cement accessories such as barrge b0ards, eaves filter pieces and apron flashing pieces, shall be secured either to the supporting structure or to the sheeting by roofing bolts.

15.7.3.3 Laying the Sheets

15.7.3.3.1 Before the actual Laying of sheets is started. the purlin spacing and the length of the sheets shall be checked to ensure that the arrangement will provide the laps required and the specified overhang at the eaves.

15.7.3.3.2 The sheets shall be laid with the smooth side upwards and with the side and end laps 85 given in 15.7.2.5(Fig A of PLATE:4/CH-15) The courses of sheets shall be so laid that the corrugations run in continuous straight lines.

15.7.3.3.3 If a building is in an exposed position and is subject to driving winds and rains. it is advisable to commence laying the sheets from the end opposite to the direction of prevailing winds.

-

15.7.3.3.4 Asbestos cement corrugated sheets shall t be laid, starting at the eaves either from left to right or from right to left depending upon the prevailing direction of the wind. If laid from left to right (Fig.A of PLATE:5/CH-15), the first sheet shall be laid uncut, but the remaining sheets fn the bottom row shall have the top left-hand corners cut or mitred. The sheets in the second and other intermediate rows shall have the bottom right-hand corner of the first sheet cut, all other sheets except the last sheet shall have both the bottom right-hand corner and top left-hand corner cut; the last sheet shall have only the top left-hand corner cut. The last or the top row sheets shall all have the bottom right hand corner cut with the exception of the last sheet which shall be laid uncut. If the sheets are laid from right to left the first sheet shall be laid uncut and the remaining procedure shall be reversed.

15.7.3.3.5 The mitre described in 15.7.3.3.4 is necessary to provide a snug fit where four sheets meet at a lap. It is cut from a point 15 cm (or whatever the length of the end lap may be) up the vertical side of the sheet to a point 4.5 cm along the horizontal edge. Thus cutting shall be done with an ordinary wood saw at site.

15.7.3.3.6 The ends of all sheets at the eaves shall be supported and the support shall be placed as near to the margin of the sheets as practicable. The maximum free overhang at the eaves shall be not more than the limits specified in 15.7.2.5.

15.7.3.3.7 Hook-bolts, crank bolts or square head coach screws of at least 8 mm size shall be fitted with a galvanized Iron washer and a bituminous washer of suitable shape to fit the outer face of sheets and inserted through holes of corresponding size drilled in the crown of the corrugation. One bolt or screw shall be used on each side of side lap (Fig.A of PLATE:4/CH-15). Nuts or screws shall be tightened lightly at first, and then fully tightened when a dozen or more sheets have been laid. On no account shall the fixing screws or the nuts on fixing bolts be screwed down too tightly, and care shall be taken not to deflect sheets at the intermediate purlins in an attempt to make the sheets bear on such purlins.

15.7.3.4 Fixing of Accessories

15.7.3.4. I General - Moulded asbestos cement accessories should be selected as far as possible from the range of standard patterns. Special fittings, If required, should be designed to conform closely to the sheet profile. When the use of moulded accessories is impracticable, other methods as approved by the Engineer-in-Charge may be employed.

Roofing accessories should be secured to the roof or wan cladding as far CIS possible, by the same bolts which secure the sheets.

15.7.3.4.2 Ridge Capping - Ridge capping should also be secured to the ridge purlins as far as possible by the same bolts which secure the sheets. Where this is not possible, each wing of the ridge capping should be adequately secured to the sheets by roofing bolts.

I 5.7.3.4.2.1 Close fitting Adjustable Ridge Capping - The close fitting adjustable ridge capping shall be designed to fit the corrugations of standard sheets laid with a side lap of half corrugation , and shall be secured with the fixing accessories used to fasten the sheets to the ridge purUns (fig.C of PlATE:4/CH-15). Correct positioning of the sheets is necessary, and Fig.Acf PLATE:7/CH-15 illustrates how to fit each wing of the ridge when sheets are laid either from left to right or from right to left.

It will be seen from the illustrations that the pitch of the corrugations at the side lap joint of roof sheets shall be 134 mm as in Fig.A of PlATE:4/CH-15 . Correct fitting of the ridge capping wm be automatic, If a template is used when fixing the roofing sheets.

The work shall be started from the left-hand verge, placing first small roll wing (inner) and positioning it in such a way that the first valley on the right hand side of the ridge wing fits into the valley at side lap of roof sheeting. It may be necessary to let a piece of ridge project beyond the verge whilst fitting and cut off the unrequired portion afterwards. In the case of large roll wing, the wing shall be positioned so that the first valley on the left hand side of the ridge wing fits into the valley at the side lap of the roof sheeting. The ridge wing shall be trimmed at verge to suit requirements.

15.7.3.4.2.2 Serrated Adjustable Ridge Capping - Serrated adjustable type ridge cappings are supplied in pairs; the inner and the outer being made easily distinguishable (fig.A of PlATE:6/CH-15) These ridges have certain serrations suitably painted for distinction and when fixing, these serrations shall be arranged at side lap joints of the sheets, in which case the stagger-lapping of the two wings of this ridge will be automatic(Fig. 8 of PlATE:6/CH- t 5}.

15.7.4.2.3 Fixture with a typical north-tight two piece adjustable ridge is illustrated in Fig.A of PLATE:9/CH-IS.

15.7.3.4.3 Ridge Finial- One piece ridge finial should be secured by one roofing bolt through the crown. Two-piece ridge finial should be secured to the ridge capping and roof sheeting by one bolt through each wing of the fitting; in addition, they should be secured to the ridge capping by one roofing bolt at the crown (Fig.B of PLATE:8/CH15)

15.7.3.4.4 Hip Capping or Hip Tiles - The roof sheeting at hips should be cut to the required miter and be close butted. The hip joint may be covered with two-piece plain wing hip tiles (Fig.B of PLATE:S/CH-15), one piece socketed plain wing angular hip tiles, or heavy half-round hip tiles. Alternatively, an apron type of capping may be used for scribing on site, over the corrugations. Where the substructure is of metal or concrete, the plain wing ridge should be secured through the roof sheets to the hip runners by one bon on each side immediately above the socket. Each half-round hip tile should be secured with a single bolt at the centre, the bolt being secured at its lower end by a metal bridging p late whose ends bear on the underside of the sheeting. On a Umber roof, the hip tile should be fixed to the r6fter by me6ns of coach screws.

A neat three way m are should be made at the intersection of the two hips with the ridge and the joint made waterproof by the provision of a lead saddle.

15.7.3.4.5 Eaves Verges and Gable Ends -Asbestos cement accessories may be used to close the corrugations at eaves (Fig.B of PLATE:9/CH-15), above glazing and at the bottom of vertical sheeting. Alternatively, sheeting at the eaves may be bedded in mortar if the walls of the building are of brick:, block:, or similar construction.

l5.7.3.4.6 Top Edges and Abutments - At top edges against walling, asbestos cement apron flashing pieces should generally be used (Fig.B of PLATE:8/CH-15).If the wall consists of vertical sheeting, it should lap over the up stand of the flashing piece, and the apron should lap over the roof sheeting; no metal flashing is required.

If, however, the wall is of brick or masonry, the apron should be secured to the' sheeting, and metal or felt cover flashing should be used over the upstand of the flashing piece.

At a sloping abutment, if the direction of the corrugations, is parallel to or running away from the wan face, metal or felt flashings may be used. The flashing should be dressed as an apron over the roof sheeting to cover at least the fir-st full corrugation of the sheeting and should be not less than 150 mm wide; the upstand should be provided wah cover flashings or should be turned into and secured to the wall. If the corrugations run into the wall face, the edge of the sheeting should be kept back at least 125 mm clear of the wall face and a suitable gutter should be provided.

15.7.3.4.7 Other fittings- Other asbestos cement accessories, such as corner rolls and barge boards (Fig.B of PLATE: 7/CH-15) should be secured either to the structure or to the sheeting with the help of roofing bolts.

15.7.3.5 Gutters And Rain Water Pipes

Gutters and rain-water pipes shall be fixed in accordance with the recommendations of relevant Indian Standard Codes of Practice.

For pipes passing through roofs and walls, soaker flange sheets suitable for the different pipe diameters and roof pitches may be used. When such accessories are not suitable for the specific purpose, the positions of any necessary perforations of the sheeting should be considered in relation to the position of the end laps so that the length of flashing above the pipe outlet will not be unduly extended.

15.7.3.6 Finish - The complete roof shall present a neat and uniform appearance and be leak proof.

15.8 STONE SLAB ROOFING

15.8.1 Materials

15.8.1.1 Slone Slab

15.8.1. I. 1 Quality- Stone slabs shall be of specified variety and shall be hard, sound, durable tough, free from cracks, decay, sand holes, flaws and weathering. The stone slabs shall be sawn or split in a plane parallel to the natural bed of the stone obtained from the quar-ry. The slab shall not absorb more than 5 percent of water.

The stone shall have a strength of not less than 55 kg/cm2 when tested for transverse strength in accordance with the procedures laid down in IS: 1121 (Part 2)- 1974. Angles shall be true and edge lines straight. The slabs shall be self faced on top and bottom. Before starting the work, samples of stone slab shall be approved by the Engineer-in-Charge.

Stone slabs may be generally of one of the following types of natural building stones:

(a) Granite (b) Sand stone including quartzite (c) Lime stone and (d) Slate

15.8.1.1.2 Dimensions and Tolerances:

(a) Width -The width of each slab shall not be less than 25 cm nor more than 35 cm.

(b) Length & thickness - The thickness of a slab at every point shall not be less than what 15 specified for use in accordance with structural calculations subject to 8 minimum of 3 cm. However for guidance the thickness may be as given in tab Ie 10 for various spans un less otherwise specified.

TABLE: 10

Span	**Thickness**
For clear span upto 2 m	7.5 to 10 cm
For clear span exceeding 2 m and upto 2.5 m	10 cm and upto 12.5 cm
for overall span 52.5 cm	4 cm
for overall Span 60 cm	4.5 cm
for overall span 68 cm	5 cm

Tolerances - The tolerance of stone slab dimensons shall be as under:

(a) Length and Breadth + 5mm
- 10 mm
(b) Thickness ±5mm

15.8.1.2 Mortar - Mortar shall conform to Chapter 6 "Mortar",

15.8.2 Dressing of Slabs

Every slab shall be cut to required size and shape and rough chisel dressed on the top, so that the dressed surface shall not be more than 6 mm from the straight edge placed on n.

The unevenness on the surface on 6CCOunt of depressions or projections shall be smoothed out by chisel dressing the edge in a slant. The sides shall also be chisel dressed to a minimum depth of 20 mm so that the dressed edge shall at no place be more than 3 mm from the straight edge butted against it. Beyond this depth the sides may be dressed slightly splayed so as to form an inverted 'v' shaped joint with adjoining slab. The surface shall be reasonably true and plane and all the angla3 & edges shall be square and free from chippings.

15.8.3 Laying

The slabs sham be washed clean and soaked in water for 2 hours before being laid. The stone slabs shall be placed over the beams or rafters. The bearing of slabs over the beam or rafters shall not be less than 25 mm. for bearing over the wall, the stone slabs shall be bedded over a layer of mortar of mix 1:3 (1 cement: 3 sand) of thickness not less than 12 mm. The slab shall be set in rows close to each other and the width of joints between two adjoining slabs shall not exceed 25 mm. The joints grouted with cement sand mortar of mix 1:3 (1 cement:3 sand). The mortar shell be of stiff consistency and shall be pressed into the joints. It may be desirable to treat the mortar with crude oil, the ratio of crude 0il being 5 percent that of the weight of the cement. On the underside the joints shall be flush pointed as per specifications laid Down in Chapter 11 "Plastering & Pointing".

15.8.4 finish

The finished surface shall be true, level or slopped as shown in the plan or DS directed by the Engineer-in-Charge. It shall be cleaned 'off aH mortar droppings and cement markings both on top and on the under side.

15.8.5 Curing

The slabs and their joints shall be kept wet during progress of work and for seven days after com p let ion.

15.9 WATER PROOFING OF ROOFS

15.9. 1 General - In selecting the type of water proofing treatment, consideration shall be given to the type and construction of buildings. Climatic end atmospheric conditions and the degree of permanence required.

For laying water proofing treatment following salient factors should be taken into consideration.

(a) Shape of the roof such as flat sloping or curved,

(b) Type of roof.

(c) Type of finish required,

(d) Type of thermal insulation treatment

(f) Drainage arrangement,

(g) Intensity of rainfall. and

(h)Total weight of the water proofing treatment on the roof.

Following treatment are generally done for water proofing:

(i) Painting of Roof slabs with hot bitumen

(ij) laying lime concrete for a water proofed finish terracing)

(iii) Water proofing treatment with bitumen felt.

(iv) Water proofing roofs with plastic roofing compound

15.9.2 Preparation of Surface for Concrete and Masonry Roofs

15.9.2.1 Well defined cracks other than hair-cracks in the roof structure shall be cut to 'V' :section cleaned and filled up flush with cement-:sand slurry or with bitumen conforming to 15:702-1988. The surface to be treated sham have a minimum slope of 1 1n 120. This grading shall be carried out pri0r to the application of water proofing treatment by cement mortar or lime surkhi mortar or as specified in the description of item.

15.9.2.2 The surface of roof, part of the parapet and gutters ,drain mouths, etc.

over which the water proofing treatment is to be applied shall be cleaned of all foreign matters namely fungus, moss and dust by wire brushing and dusting. In case of lime concrete treatment the structural roof surface shall be finished rough to provide adequate bond.

15. 9.2.3 Drain out-let shall be suitably placed with respect to the roof gradient to ensure rapid drainage and prevent local accumulation of water of the roof surface. Masonry drain mouths shall be widened two-and a half times the diameter of the drain and rounded with cement mortar.

15.9.2.4 For cast iron drain outlets a groove shall be cut all round to tuck-in the treatment.

15.9.2.5 When a pipe passes through a roof on which water proofing treatment is to be laid, a cement concrete angle-fillet shall be built round it and the water proofing treatment taken over the fillet (Figure 4A and 4B).

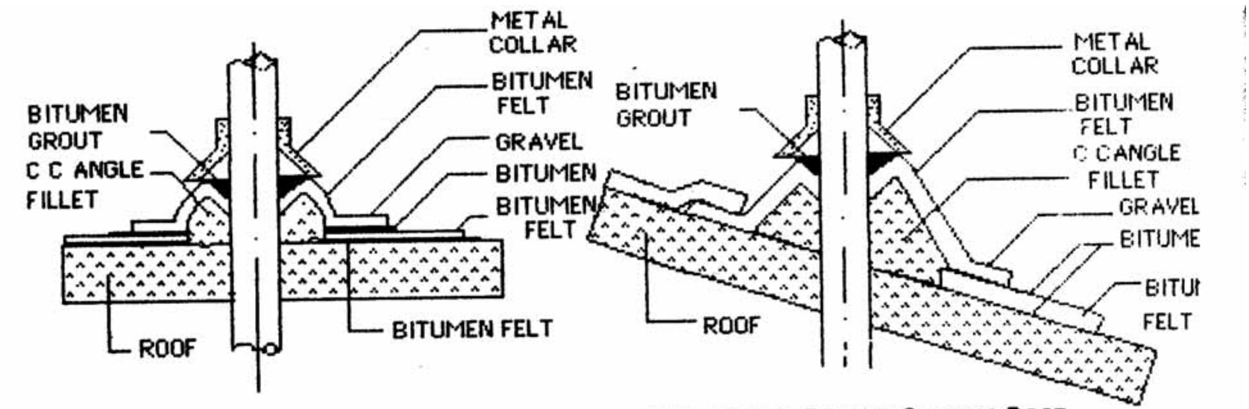


FIG 4A PROJECTING PIPE ON FLAT ROOF   FIG 4B PROJECTING PIPE ON SLOPING ROOF

FIG 4 WATERPROOFING TREATMENT WHEN A PIPE PASSES THROUGH A CONCRETE ROOF

15.9.2.6 In case of parapet walls over 450 mm in height, for tucking in the water proofing treatment a horizontal groove 75 mm wide and 65 mm deep at minimum height of 150 mm above roof level shall be left in the vertical face at the time of construchon. The horizontal face of the groove shall be shaped with cement mortar 1:4 (See figure 5A).

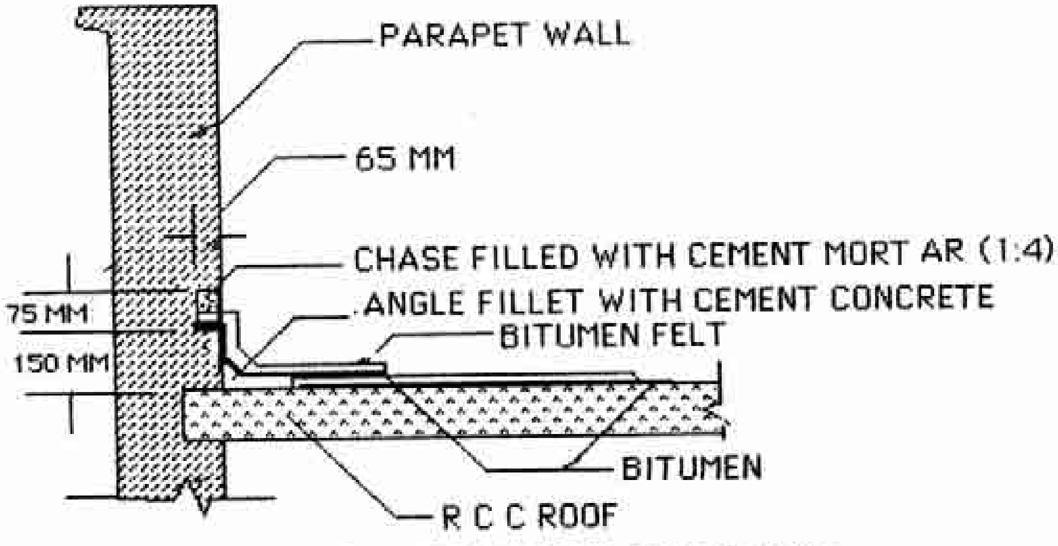


FIG 5A PARAPET WALL OVER 450MM IN HEIGHT

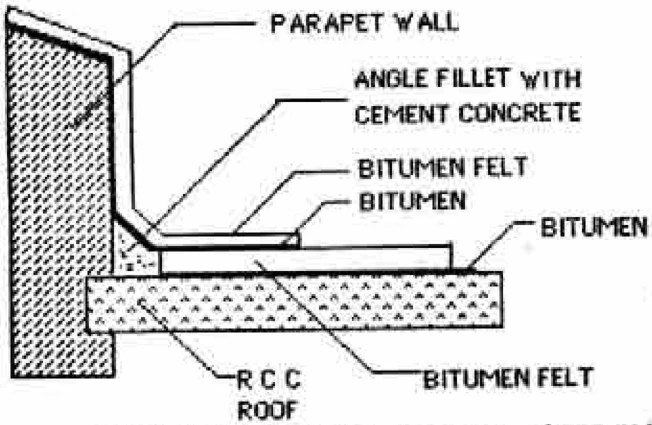


FIG 5B PARAPET WALL 450 MM OR LESS IN HEIGHT

FIG 5 WATERPROOFING TREATMENT JUNCTION ON ROOF AND PARAPET WALL

15.9.2.7 In case of low parapets where the height 00es not exceed 450 mm, no grooves shall be provided and the water proofing treatment shall be caried right over the top (See fig5B above).

15.9.2.8 In the case of existing RC.C. and stone walls, cutting the chase for tucking in the water proofing treatment is not recommended. In such case, tre6tment as given in para 15.9.2.9 below shal! be done.

15.9.2.9 At the junction between the roof anti the vertical face of the parapet wall, a fmet (OOLA) 75 mm in radius shall be constructed as per specifications at para15.9.3.2.5 (fig.6).

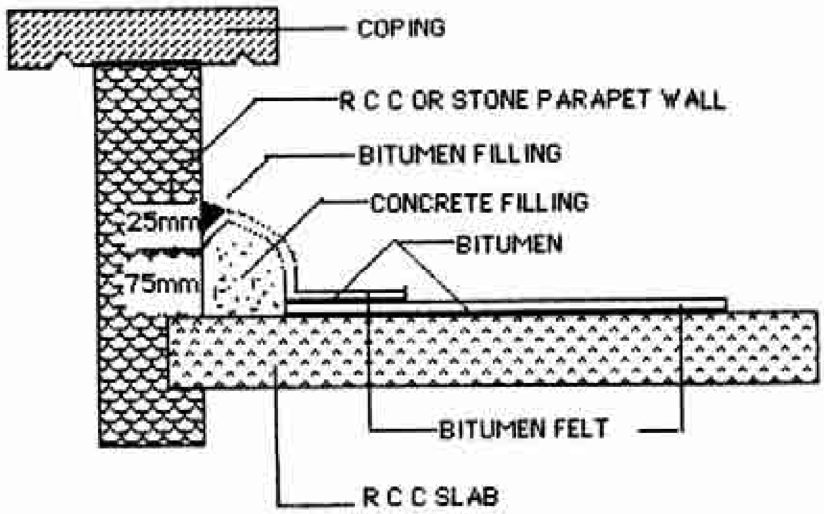


FIG 6 DETAILS OF WATERPROOFING TREATMENT IN PARAPET WALL WHERE CUTTING OF GROOVE IS NOT POSSIBLE

15.9.2.10 At the drain mouths the fillet shall be 5uitab ly cut back, and rounded off for easy application of the water proofing treatment end easy now of water.

15.9.2. 11 Out Jets at every low dividing wall, say less than 300 mm in height, shall be cut open to full depth and the bottom and sides shall be rendered smooth and corners rounded off for easy application of water proofing treatment.

15.9.3 Water Proofing Treatment

15.9.3. I Painting of Roof Slab with Hot Bitumen - This treatment is done for mild conditions.

15.9.3. 1. 1 Material

a) Bitumen - Bitumen shall consist of blown type bitumen conforming to 15:702-1961 or residual bitumen conforming to 15:73-1961 or a mixture thereof, selected to withstand local conditions of prevailing temperature and gradient of roof surface. The penetration of bitumen shall not be more then 40 when tested in accordance with IS: 1203- 1958.

b) Coarse Sand -It shall be dry, hard round and free from dust and dirt etc.

15.9.3. 1.2 Preparation of surface - The surface shall be painted when it is thoroughly dry. The surface to be painted shall be cleaned with wire brushes and cotton or gunny cloth. AHI00se materials and scales shall be removed and the surface shall be further cleaned with a piece of cloth lightly soaked in kerosene oil.

15.9.3.1.1 spreading of sand - Immediately after painting coarse sand at the rate of 0.006 cum per sq.m shall be evenly spread and leveled over the surface when the bitumen is still hot. On flashing and drain mouths the coarse aggregate shall be omitted and a finish of two coats of hot applied bitumen at the rate of 1.2 Kg/m2 minimum shall be applied.

15.9.3..2 Laying Lime Concrete For II Waterproofed Finish (Lime Terracing)

15.9.3.2.1 Material

a)Lime -As far as possible class C-lime (fat lime) or hydrated Lime (packed in bags) conforming to IS: 712-1984 shall be used. Quick lime shall be slaked in accordance with IS: 1635-1975.

b)Pozzolanic material - Surkhi shall be made from bricks burnt to 600 to 800. C and ground to fineness specified in IS: 1344- 1981. Lime pozzolana mixture when used shall conform to LP 40 of IS:4098- 1983.

c)Aggregate - Well graded and well burnt broken brick having a maximum size of 25 mm conforming to IS:3068- 1986 shall be used.

d)Water - Water used for making concrete shall be clean and free from injurious amounts of deleterious materials. Preferably, potable water shall be used.

15.9.3.2.2 Preparation of" L imaO:7ncrete - One part of slaked lime and two parts of reactive surkhi (or lime pozzolana mixture) by volume shall be mixed on a water tight platform. This shall be sprinkled with the required quantity of water and shall be well ground in a mortar mm or using mechanical grinders. Hand pounding may be done for small quantities. Burnt brick aggregate of size 25 mm shall be soaked in water for a period not less than six hours before use in the concrete mix. The lime concrete shall be prepared by thoroughly mixing the aggregate and lime surkhi mortar in the proportion of 21/2: 1 by volume 12 kg of washing soap and 4 kg of alum dissolved In water shall be 00ed to each cubic metre of lime concrete.

15.9.3.2.3 Laying

15.9.3.2.3.1 The lime concrete shall be used within 36 hours of the preparation of lime mortar, Laying of Lime concrete shall be started from a corner of the roof and proceed diagonally towards centre and other sides considering the slopes required for draining the rain-water smoothly. The average thickness of lime concrete shall not be less than 10 cm. In case the thickness is more than 10 cm each layer shall not be more than 10 to 12.5 cm. If the roof is flat the slope required for' drainage shall be given in the lime concrete, but the minimum compacted thickness of the concrete Layer shall nowhere be Jess than 7.5 cm.

15.9.3.2.3.2 After the Iime concrete is laid, it shall be initially rammed with a rammer weighing not more than 2 kg and the finish brought to the required evenness and slope.The further consolidation shall be done with wooden THAPIES with rounded edges. The mazdoors who will sit close together and beat the surface lightly and in rhythm and move forward gradually. The beating shall be carried on for at least seven days until the THAPPI makes no impression on the surface and rebounds, readily from it when struck. During compaction by hand beating the surface shall be sprinkled liberally with lime water and small proportion of sugar solution prepared by mixing 3 Kg of Jaggery and 1.5 Kg of "BAEL" fruit to 100 11tres of water or a solution prepared by soaking in water dry nuts of "Terminalis Chebula", The solution of "Terminala" chebula (KADUKAI) shall be prepared as follows-

The dry nuts shall be broken to small pieces and showed to soak in water. A solution shall be made of 600 grams of KADUKAI, 200 gms of Jaggery and 40 Litres of water for 10 sq.m. of work and brewed for 12 hours. The resulting liquor shall be decanted and added to lime water.

15.9.3.2.3.3 On completion of beating, the mortar coming out of the top shall be trowelled with the addition of sugar solution if necessary, and finished smooth. The finished surface shall be even with slope as directed.

15.9.3.2.4 Curing - The lime concrete after compaction shall be cured for a minimum of six days or until it hardens by covering with a thin layer of Grass or straw which shall be kept wet continuously.

15.9.3.2.5 Treatment at Junction Between Roof finish and Parapets (Gola or Fillet)

The height of the gola at the wall face shall not at any point be less than 75 mm. The section of the gola shall be quadrant of a circle with 75 mm radius at top and sloping to 90 to 100 mm at the base.

The brick face of the parapet and the tile brick face of terrace where the Gola will be formed shall be scrubbed clean of all dirt, dust and other foreign matter and well wetted. The concrete will then be laid along the junction of the terrace and the parapet and well compacted and formed to shape with wooden THAPIES until the mortar cream comes to the surface. The Gola shall then be rounded and finished smooth with the lime plaster of specified mix.

The bottom line of the gola shall be straight and the surface should be smooth and uniform.

15.9.3.2.6 Finish - The protection against water penetration for the roof finish is enhanced-by efficient drainage of surface water.

For this purpose, the slope of the terrace with lime concrete and tile finish shall not be less than 1 in 60 anq the slope in the case of plain lime concrete finish shall not be less than 1 in 50 .

For every 50 5q.m. of roof area one 100 mm dia. rain water pipe shall be provided.

15.9.3.3 Waterproofing Treatment with Bitumen Felt

15.9.3.3.1 Material

a) Materials for Regrading of Roof Surface- Regrading shall be carried out with a suitable cement mortar, lime concrete or cement concrete with mix proportions as specified in the item and of appropriate specifications.
b)Bitumen Primer - Primer shall conform to the requirements laid down in 15:3384-1986. -

c)Bitumen Felts - This shall comply with the requirements laid down in IS: 1322-1982 and IS: 7193- 1974.

d)Bonding Material - These shall consist of blown type bitumen conforming to 15:702-1988 or residual bitumen conforming to 15:73-1961 or a mixture thereof, selected to withstand the local conditions of prevailing temperature and gradient of roof surface. The penetration of bitumen used shall , not be more than 40 when tested in accordance with IS: 1203-1958.

e)Stone Grit And Pea-Sized Gravel - Stone grit shall be 6 mm and down size. Where pea-sized gravel is used, it shall be hard, round and free from dust, dirt etc.

Where pea-sized gravel or grit are not available, coarse sand may be used.

15.9.3.3.2 Waterproofing Treatment

General - In selecting the combination of layers and grades of felt to be used, consideration shall be given to the type and construction of buildings.
climatic and atmospheric conditions and the degree of permanence required.

Concrete and Masonry Roofs, (Flat or Sloping)- The following treatments are recommended.

(a)Normal Treatment - Four courses for moderate conditions;

Primer conforming to 15:3384-1986 to be applied to the roof surface:

1) Hot applied bitumen at the rate of 1.2Kg/m2, Minimum;
2) Hessian-base self finished felt, Type 3 Grade 1 or glass fibre base Type 2,Grade 1;

3) Hot applied bitumen at the rate of 1.2 kg/m2 I Min; and

4) Pea-sized gravel or grit at the rate of 0.006 m3/ m2.

"OR"

Floating Treatment

1) Fibre base bitumen saturated underlay, Type 1 ;

2) Hot applied bitumen at the rate of 1.2 kg/m2 ,Minimum;

3) Fibre base self-finished felt Type 2,Gr'ade 1 or Grade 2;

4) Hot applied bitumen at the rate of 1.2 kg/m2; and

5) Pea-sized gravel or grit at the rate of 0.008 m3/m2.

b) Heavy Treatment - Six courses for severe conditions; Primer conforming to IS:3384-1986 to be applied to the roof surface:

1) Hot applied bitumen at the rate of 1.2 r-g/m2 ,Minimum;

2) Hessian-base self-finished felt, Type 3, Grade 1 or glass fibre base felt Type 2 I Grade 1;

3) Hot appliedd bitumen at the rate of 1.2 kg/m2, Minimum;

4) Hessian-base self-finished felt, Type 3, Grade 1 or glass fibre base felt Type 2, Grade 1;

5) Hot applied bitumen at the r'ate of 1.2 kg/m2, Minimum; and

6) Pea-sized gravel or grit at the rate of 0.006 m3/m2.

"OR"

1) Hot applied bitumen at the rate of 1.2 kg/m2 ,Minimum;

2) Fibre-base self-finished felt,Type 2, Grade 1 or Grade 2;

3) Hot applied bitumen at'the rate of 1.2 kg/m2,Minimum;

4) Fibre-base self-finished felt, Type 2, Grade 1 or Grade 2 ;

5)Hot applied bitumen at the rate of 2.5 kg/m2, Minimum; and

6) Pea-sized gravel or grit at the rate of 0.008 m3/m2.

"OR"

Floating Treatment

1) Fibre-base bitumen saturated underlay. Type 1 ;

2) Hot app lied bitumen at the rate of 1.2 kg/m2 ,Minimum;

3) Fibre-base self-finished felt, Type 2, Gr'ade I or Grade 2;

4) Hot applied bitumen at the rate of 1.2 kg/m2 ,Minimum;

5) Fibre-base self-finished felt, Type 2, Grade I or Grade 2;

6) Hot app lied bitumen at the rate of 2.5 kg/ m2 , Minimum; and

7) Pea-sized gravel or grit at the rate of 0.008 m3/m2.

c) Extra Heavy Treatment - Eight courses for very severe conditions, primer confo,,'ming to IS:3384-1986 to be apliied to the roof surface:

1) Hot applied bitumen at the rate of 1.2 kg/m2,Mintmum;

2) Hessian-base self-finished felt, Type 3, Grade 1 or glass fibre base bitumen felt Type 2 Grade1;

3) Hot applied bitumen at the rete of 1.21cglm2, Minimum;

4) Hessian-base self-finished felt, Type 3, Grade 1 or' glass fiber base bitumen felt Type 2, Grade 1 ;

5) Hot applied bitumen at the rate of 1.2 kg/m2, Min;

6) Hessian-base self-finished felt, Type 3, Grade 1 or glass fibre base bitumen felt Type 2 Grade 1 ;

7) Hot applied bitumen at the rate of 1.2 kg/m2, Minimum and

8) Pee-sized gravel or grit at the rate of 0.006 m3/m2.

"OR"

1) Hot applied bitumen at the rate of 1.2kg/m2, Minimum;

2) Fibre-base self-finished felt, Type 2. Grade t or 6rada 2,

3) Hot applied bitumen at the rate of 1.2 kg/m2.

Minimum;

4) Fibre-base self finished felt. Type 2. Grade 1 or Grade 2;

5) Hot applied bitumen at the rate of 1.2kg/m2, Minimum;

6) Fibre-base self finished felt, Type 2, Grade 1 or Grade 2

7) Hot applied bitumen at the rate of 2.51cg/m2, Min; end

8) Pee-sized gravel or grit et the rate of 0.008 cum/m2

15.9.3.3.3 Method of Laying Water Proofing Treatment

15. 9.3.3.3. 1 Sequence of Operation for All Types of Roofs

a) Preparatory work

b) Collecting end storing of materials end tools;

c) Cleaning roof surface of foreign matter;

d)Treatment of gutters and drain mouths;

e)Treatment of the main roof, (net or sloping) f)Treatment of tlashings end/projecting pipes;

g)Top dressing, that is gravel or grit, fixing or laying of tne or concrete protection; and

h)Cleaning and removal of surplus materials.

15.9.3.3.3.2 Concrete and Masonry Roofs, Flat - Prior to laying, the preparatory works as described in para 15.9.2 shall be completed and the cement or Iime work allowed to set & dry. The surface of roof and that part of the parapet & gutters, drain mouths, etc. over which the water proofing treatment is to be applied, shall be cleaned of all foreign matter, namely fungus, moss, dust etc. by wire brushing and dusting.

The felt Is normally laid in lengths at right angles to the direction of the run-off gradient, commencing at the lowest level and working up to the crest. In this way, the overlaps of the adjacent layers of felt offers the minimum obstruction to the now-off water.

If a bituminous primer has been recommended, this shall first be brushed over the roof surface & allowed to dry. 6enerellyequentity of 0.2 to 0.'" Iitres.lm2 is recommended.

The bitumen bonding material shell be prepared by heating to the correct working temperature and conveyed to the point of work in a bucket or pouring can.

The felt shall be first cut to required length brushed clean of dusting materials and laid out flat on the roof. This serves to eliminate curls and subsequent stretching. Each length of felt prepared for laying as described above shall be laid in position and rolled up for a distance of helf of its length. The hot bonding material shall be poured on to the roof across the full width of the rolled felt as the latter is steadily rolled out and pressed down. The excess bonding material is squeezed out at the ends and is removed as the laying proceeds.

When the first half of the strip of felt has been bonded to the roof, the other half shall be rolled up and then unrolled on to the hot bonding material In the same way.
Minimum overlaps of 100 and 75 mm shall be all0wed at the end & the sides of strips of felt. Allover laps shall be firmly bonded with hot bitumen.

The laying of the second layer of fen shall be so arranged that the joints are staggered with those of the layer beneath it.

In case of pent roofs where the type of treatment consists of one layer of fen only, as in normal treatment an additional layer of fen shall be provided at the ridge which shall cover a minimum length of the slope of 250 mm on both sides of tile ridge.

Flashings - felt shall be laid 85 flashings in widths wherever junctions of vertical & horizontal structures occur with minimum overlap of 100 mm. The lower edge of flashing shall overlap the felt laid on flat portion of the roof and the upper edge of the flashing shall be tucked into the groove of size 75 mm wide and 65 mm deep made in the parapet on the vertical face of the wall. Each layer shall be so arranged that the joints are staggered with those of the layer beneath it.

After all the layers specified have been laid and the flashings properly bonded, the groove shall be filled up with cement lime mortar (normally 1:1:6), cement mortar (1 :4) or cement concrete (1 :2:4) with 6 mm nominal size of Aggregate which, when set, wm satisfactorily secure the treatment to the wall The groove filling shall be cured by watering for at least 4 days after filling to ensure satisfactory strength and to avoid shrinkage cracks. "

Drain Mouths - Drain mouths shall be widened and other items of work completed. felt shall be generally laid as on the other portions of the roof excepting that the treatment shal~ be carried inside the drain pipes overlapping at least 100 mm.

Gutters - The treatment to be laid in the gutters shall provide for one layer of roofing fen more than is provided on the roof proper. Hence at least two layers of felt shall be laid in the gutters even when only one layer" of felt has been specified for the roof as in normal treatment under para 15.9.3.3.2.1 A priming coat shall first be applied. Over this, the first layer of felt shall be bonded with hot bitumen followed by successive layers of felt securely bonded together and finalty painted with a coat of hot bitumen at not less than 1.5 kg/m2.

The felt layers laid separately in the gutters shall be overlapped with the corresponding layers on the roof proper.

The felt treatment in the gutters shall be carried down into the outlet pipes to a minimum depth of 100 mm. Where there are walls, grooves shall be cut at a reasonable height and the felt tucked in the grooves which shall then be filled in with cement mortar.

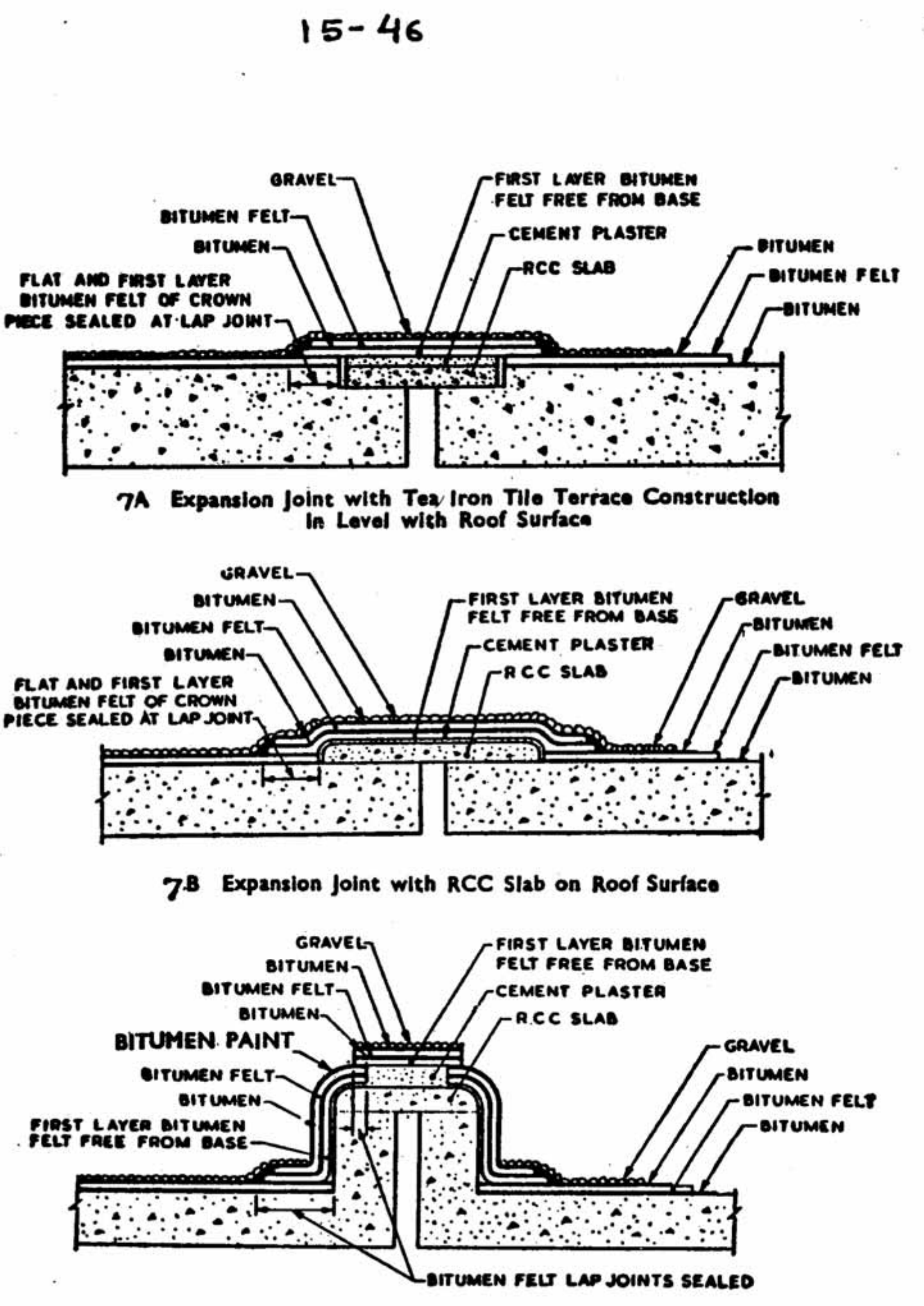
For gutters in pent roofs, the flashings shall be laid separately at the sides and carried weH under the caves of the pent roofs.

15.9.3.3.3.3 Water Proofing Treatment on Shell Roof - In the case of shell roofs, an additional layer of felt shall be provided for the valley gutter for normal treatment and for other types of treatment, the number of felts in the valley gutters shall be one layer extra. The treatment on the valley gutter shall be laid first and the height to which the felt is to be taken shall be at least 150 mm above the anticipated standing water in the gutter. For normal treatment on pent roof or shell roofs; the felt shall be laid parallel to the direction of the run off gradient. The felt in case of shell roofs shall be laid from one edge of the valley gutter to the other, that is, round the curvature. In the case of north light cylindrical shells, it can either start from the valley gutter or from the upper edge. The upper edge shall be securely anchored at the edge of the shell.

Where insulation has been specified, the insulating materials, shall be applied on the top of the shell surface and plastered, if necessary, with cement mortar to provide adequate base for application of the water proofing treatment.

When felt is laid parallel to the direction of runoff gradient that is, round the curvature in case of shell roof, side over lap should be 100 mm and over lap at the end should be 75 mm (minimum) that is side over lap and over lap at end should interchange with those as in the case when felt is laid across the runoff gradient.

15.9.3.3.3,4 Expansion Joints - Where the expansion Joints are provided In the slabs, the joints and their cover slabs shall be suitably treated with water proofing. A typical sketch of an expansion joint with the RCC slabs on either side of the joint turned vertically up Be covered with precast RCC cover slabs is given in figure 7 . The cover slabs covering the vertical turned up dwarf walls shall be not less then 7.5 cm and are provided with throatings on their under side along their length. The water proofing treatment shall be taken up on the sloping junction fillets and the vertical faces of the wall to the underside of the cover slabs. The cover slabs; ~re given the water proofing treatment like the roof slabs, after the cross joints between adjacent cover slabs or first sealed with 15 cm width of roofing felt struck to them' with bitumen. The water proofing treatment shall be carried down to the sides of the cover slabs to their full thickness. Care shall be taken to see that overlaps if any, in the roofing over the cover slabs stagger with the joints between cover slabs.



7C Raised Type Expansion Joint

FIG. 7 EXPANSION JOINTS

15.9.3.3.3.5 Treatment of Bubble Formation:- If ballooning occurs which does 'not in fact adversely affect the efficiency of the waterproofing treatment but is unsightly to look at, the defect may be rectified as given below:

Remove the gravel on the ballooned surface. Then cut open and squeeze out the trapped vapor by firm pressure applied by hand. Seal the bitumen felt so Lifted back on the surface by applying additional bitumen. Finally seal the cut with a piece of bitumen felt with bitumen application and reapply the gravel finish over it to make the surface look uniform with the rest.

15.9.3.3.3.6 Surface finishing - In all the above treatment under para 15.9.3.3.2 finish of pea-sized rounded gravel or grit at the rate of 0.006 cum/sqm shall be provided as "measure of protection to the treatment and increase its durability. On flashings and at drain mouths, the gravel or grit shall be omitted and a finish of two coats of bituminous primer or hot applied bitumen at the rate of 1.2 kg/m2 minimum, shall be applied.

When roof surfaces are subject to foot traffic or are required for temporary I habitation I a cement mortar or lime SURKHI, slurry shall .be applied over the roofing treatment and over this, a layer of cement concrete flooring tiles according to specifications under para 10.3 of Chapter 10 "flooring" or two layers burnt clay flat terracing tiles (conforming to IS:2690-1975) shall be applied and cement pointed. Alternatively a screeding of cement and sand 45 mm thick may laid over the roofing treatment and marked off into Squares 600 mm wide with expansion joints provided at a distance of 3 m.

Instead of the normal bituminous gravel finish the surface may be finished as follow:

(a) with two coats of bituminous aluminium paint, or (b)one layer of aluminium foil stuck with hot bitumen, or (c)one layer of cold applied bitumen with gavel or coarse sand.

15.9.3.4 Waterproofing or Roofs With Plastic Roofing Compound

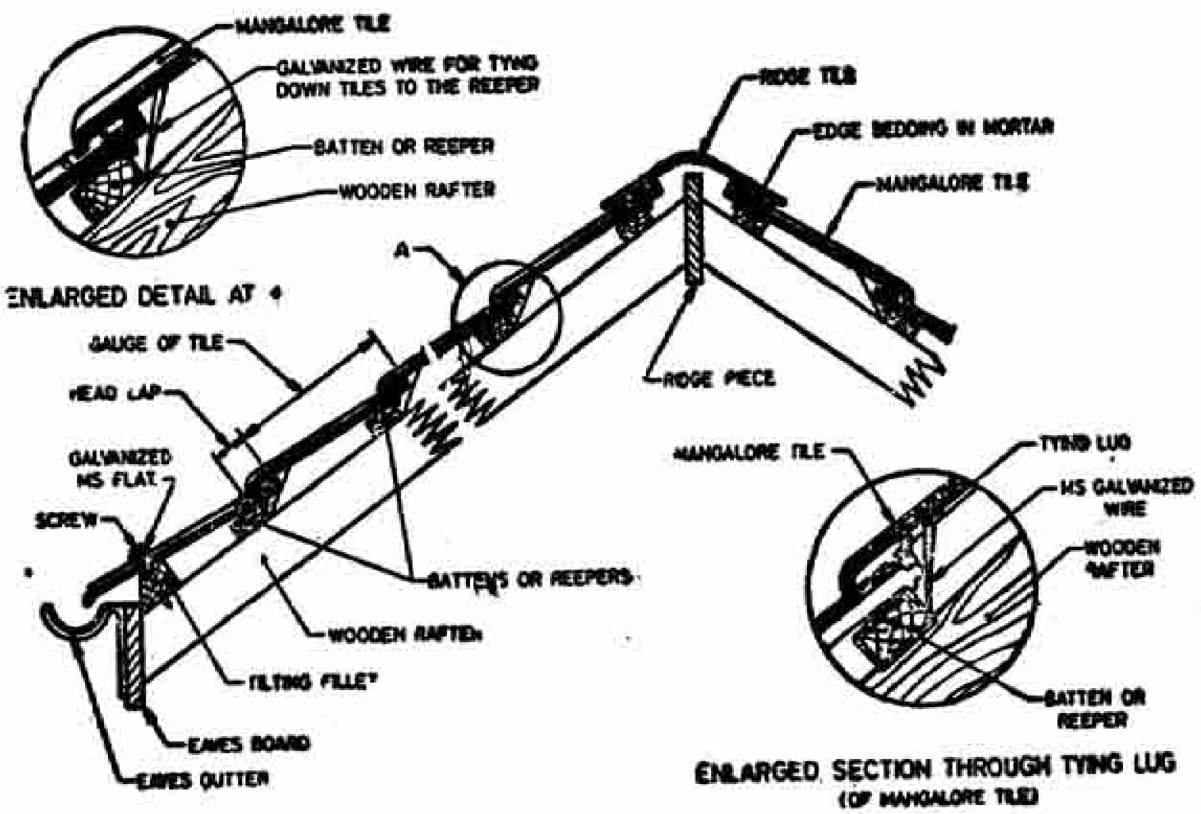
15.9.3.4.1 Preparation of Surface- The roof surface and vertical wall surfaces upto 250 mm from roof level shall be thoroughly cleaned with wire brushes. All loose scales shall be removed and all cracks exposed and widened and made into V shape 25 mm wide at top and 12 to 20 mm deep. The surface shall be dusted off and the exposed cracks filled with plastic roofing compound "Standard block" and spread upto 75 mm on either side. When the compound settles down, more of it shall be filled in and leveled with the rest of the roof.

15.9.3.4.2 Laying - The compound shall be applied when the surface is thoroughly dry. The roof and wall surface upto 250 mm shall then be painted with cold rooflng primer liquid at the rate of 0.24 litre/sq.m. without leaving any blank patches.

Plastic roofing compound b lack shall then be uniform ly spread and leveled over the roofing and flashing area at the rate of 2.75 Kg per 5q.m. Coarse Sand shall be spread over the roof surface at the rate of 0.006 cum per sq. metre rolled with wooden roller so that the sand gets integrated with the compound. The surface shall not be used till it has set.

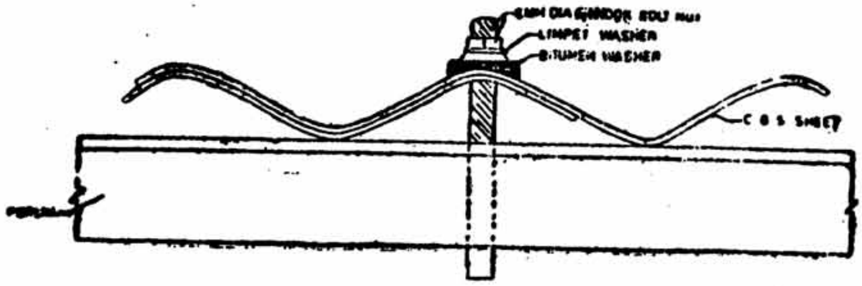
1.5--48

PLATE:1/CH-15

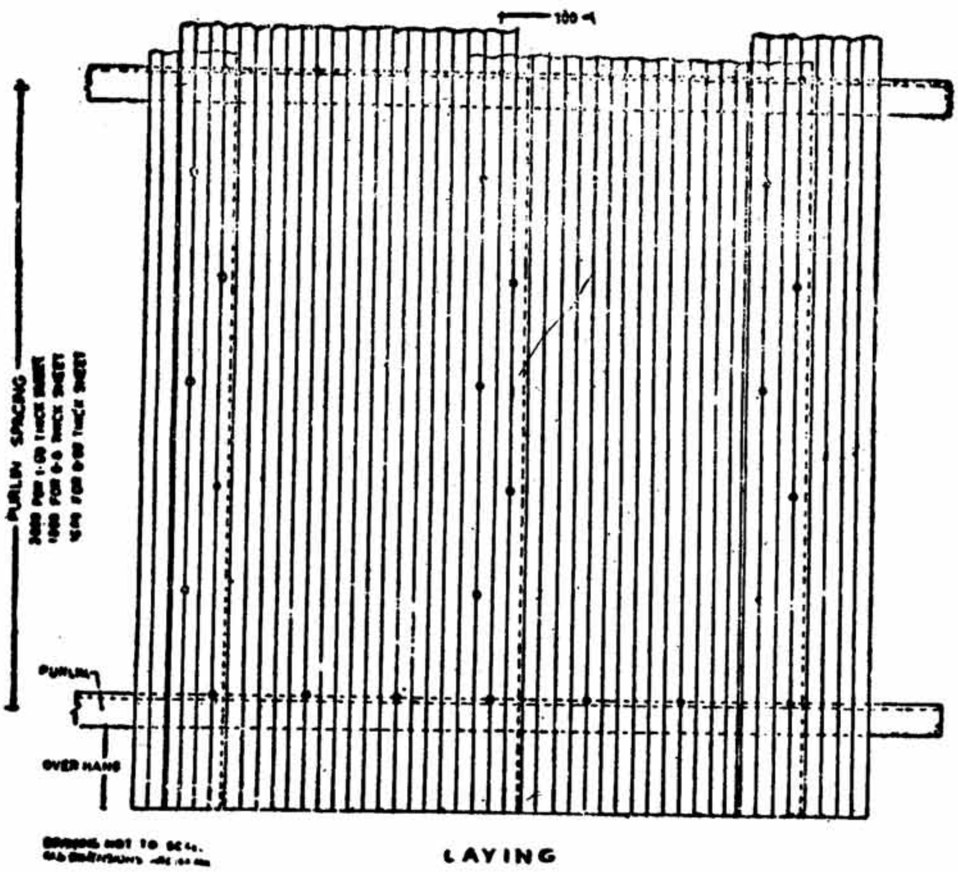


DETAIL OF MANGALORE TILES LAID ON REEPERS

PLATE: 2/CH-15



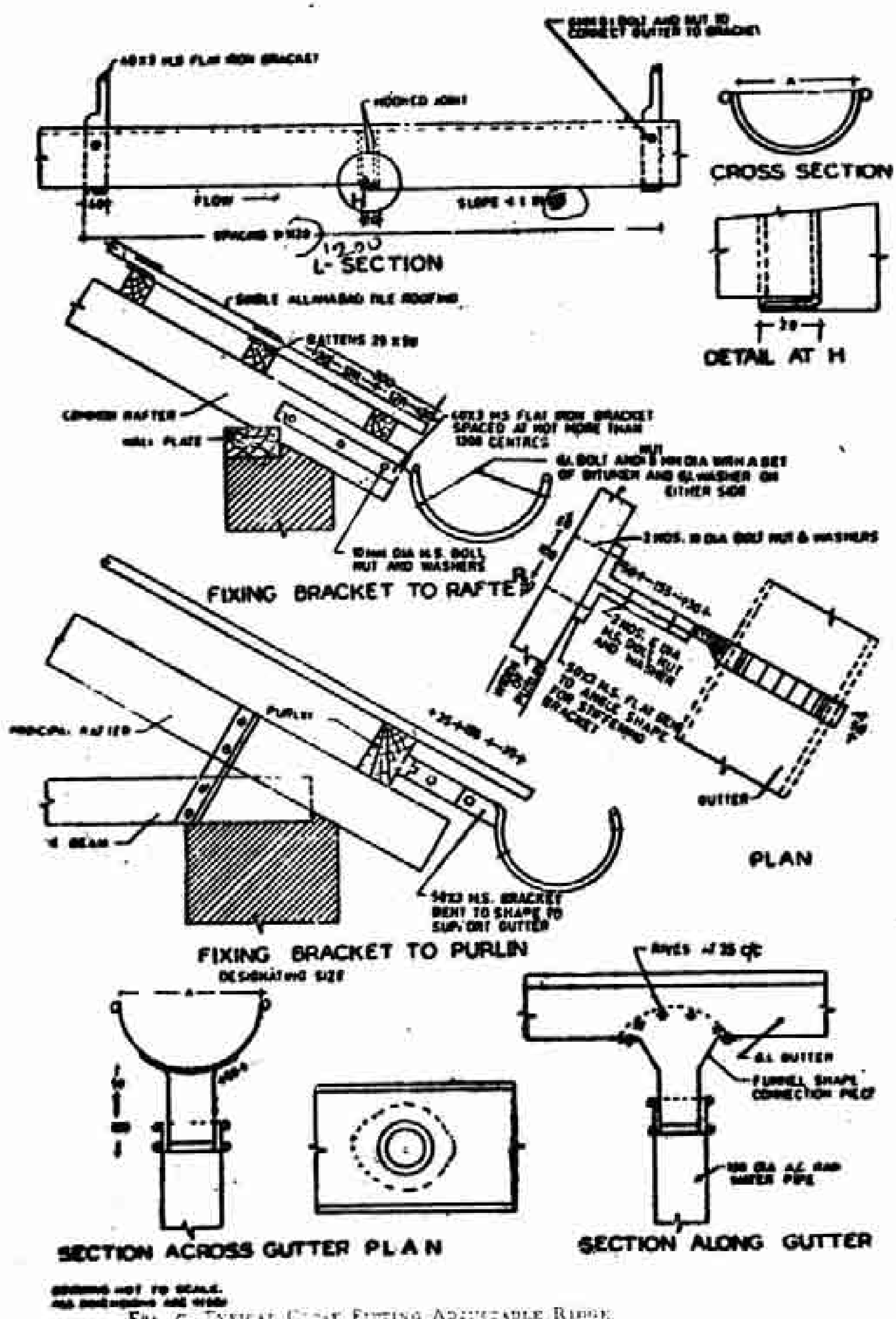
SIDE LAP



LAYING

C. G. S. SHEETS

PLATE: 3/CH-15



GALVANISED STEEL SHEET GUTTER

15-51

15-50

PLATE:4/CH- 15

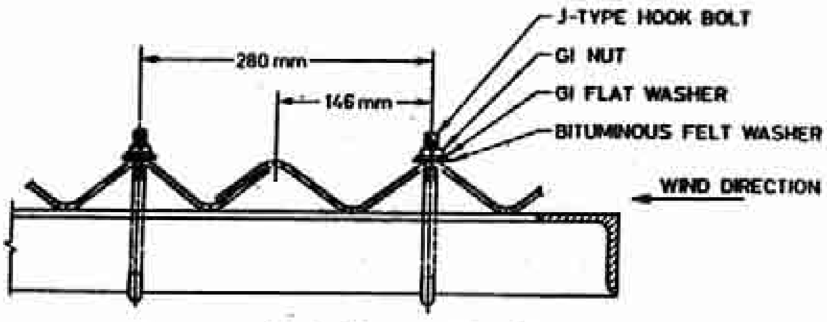


Fig. A Detail of Side Lap

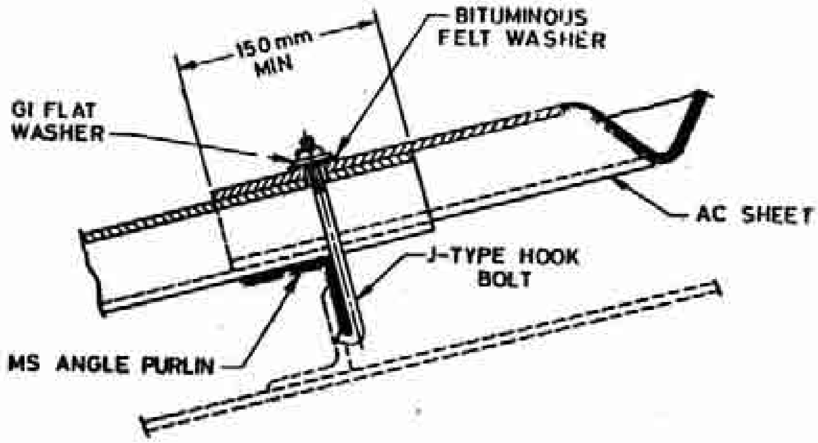


Fig. B Detail of End Lap

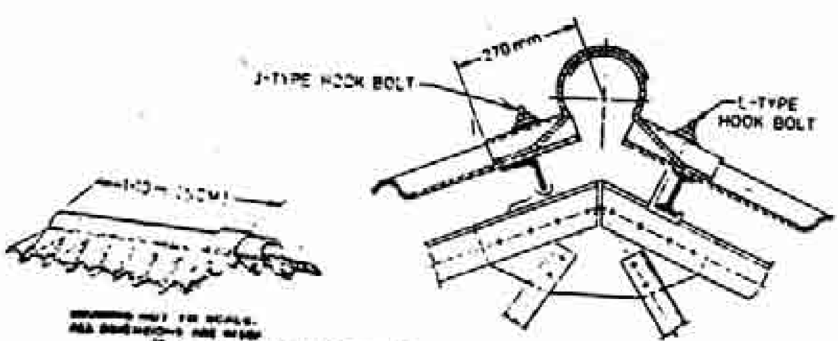
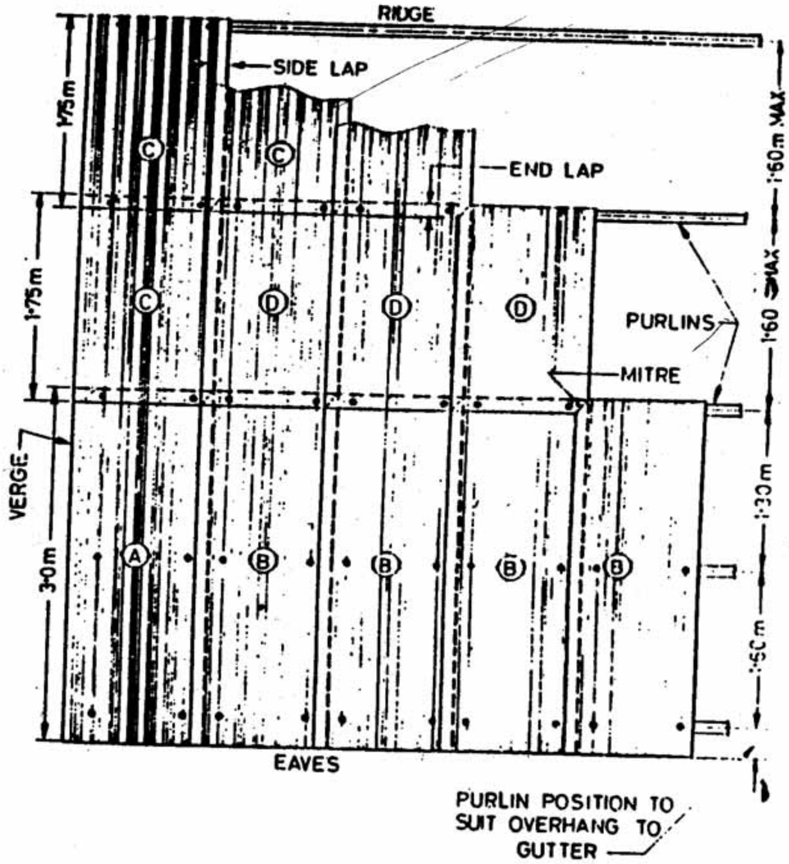


Fig. C Typical Close Fitting Adjustable Ridge

GALVANISED STEEL SHEET GUTTER

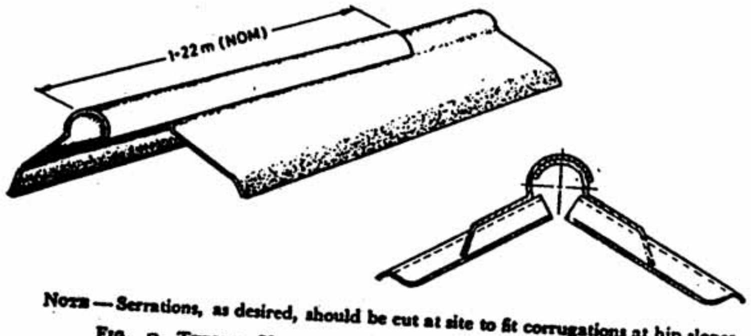
15-52

PLATE 15/ CM-15



A = Uncut sheet
B = Top left-hand corner cut
C = Bottom right-hand corner cut
D = Top left-hand corner and bottom right-hand corner cut

Fig. A Laying of Sheets
(Sheets Laid from Left to Right)



Note — Serrations, as desired, should be cut at site to fit corrugations at hip slopes.

Fig. B Typical Unserrated Adjustable Ridge for Hips

PLATE: 6/CH-15

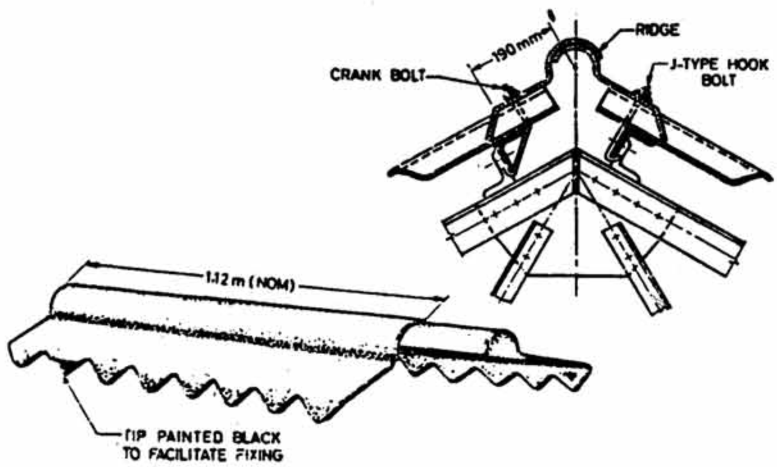


FIG. A TYPICAL SERRATED ADJUSTABLE RIDGE

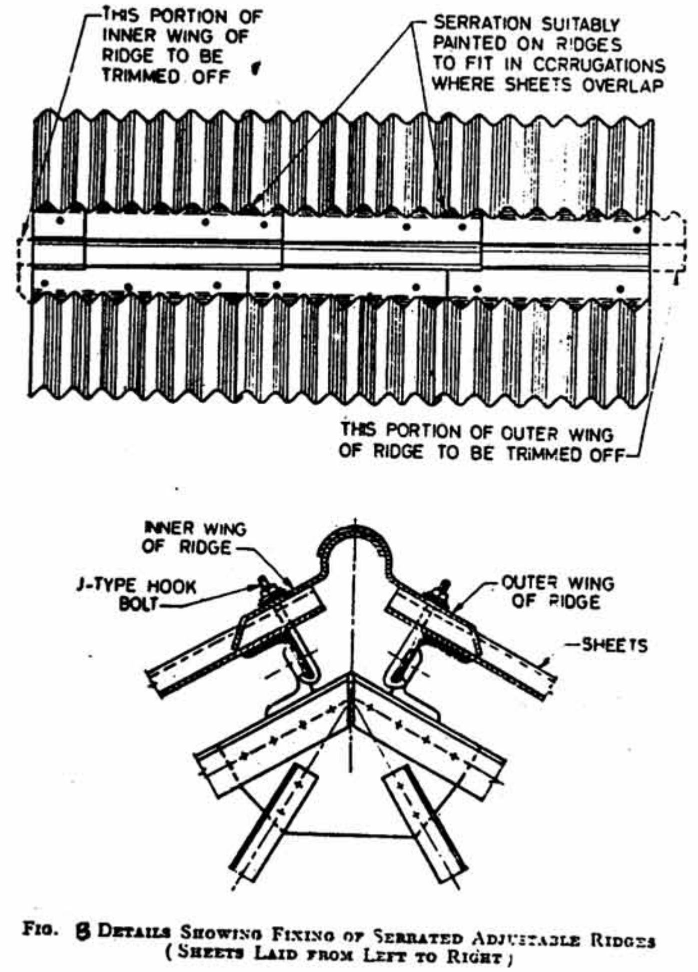


FIG. B DETAILS SHOWING FIXING OF SERRATED ADJUSTABLE RIDGES
(SHEETS LAID FROM LEFT TO RIGHT)

15-54

PLATE: 7/CH-15

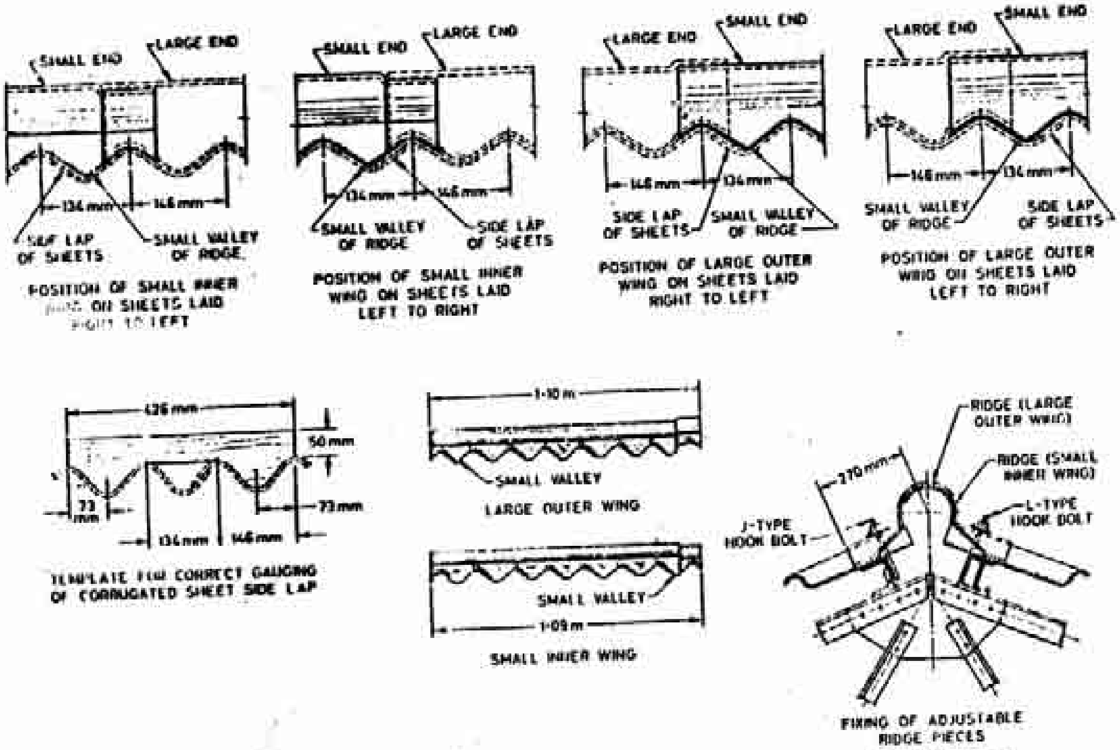


FIG. A DETAILS SHOWING METHOD OF FIXING CLOSE FITTING ADJUSTABLE RIDGE PIECES

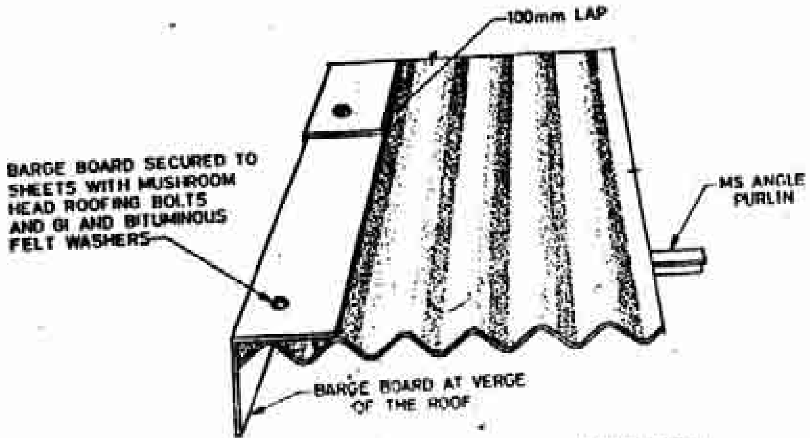


FIG. B TYPICAL DETAILS OF BARGEBOARD OR CORNER PIECE
(VIEW FROM EAVES)

PLATE: 8/CH-15

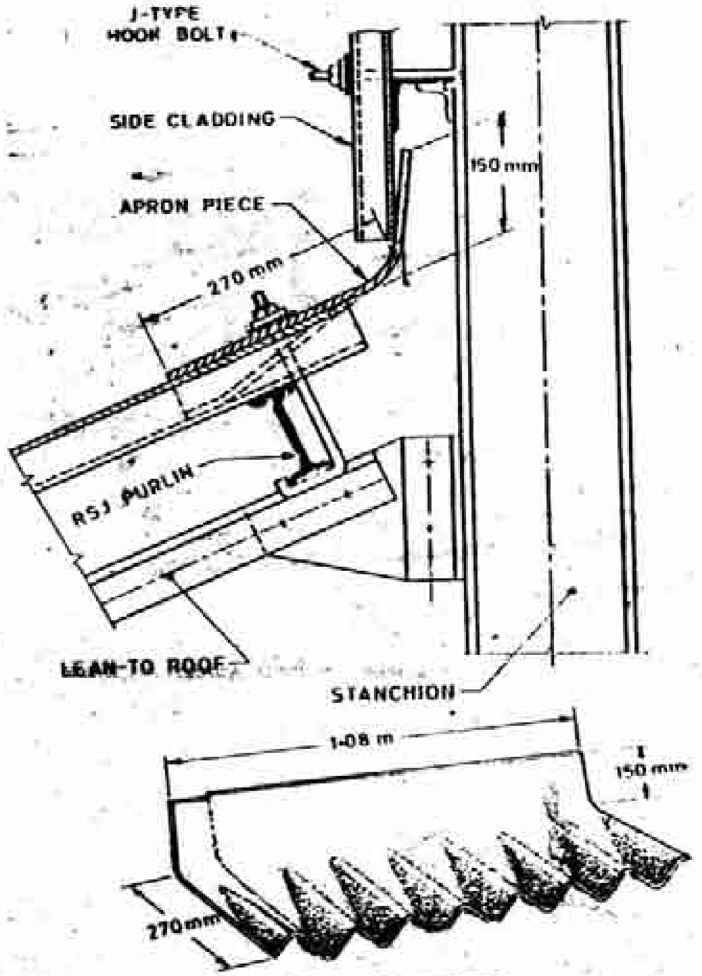
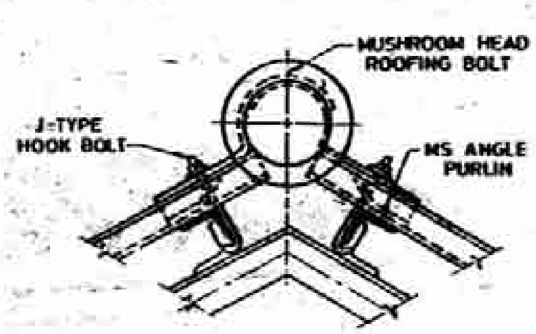


FIG. A TYPICAL APRON PIECE



ELEVATION
(BARGE BOARD REMOVED)

FIG. B TYPICAL RIDGE FINIAL

PLATE:9/CH-15

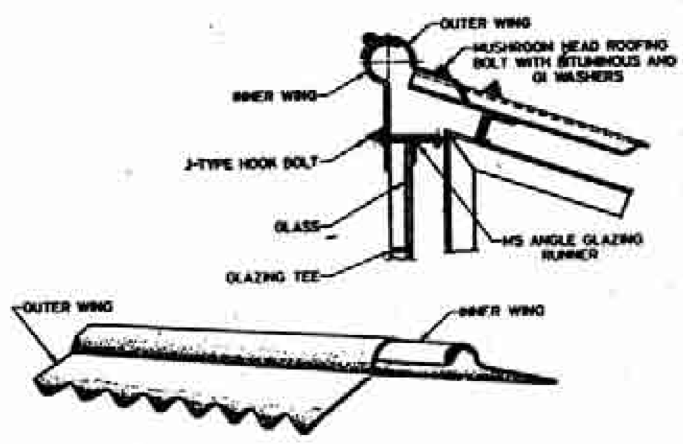


FIG. A TYPICAL NORTHLIGHT TWO-PIECE ADJUSTABLE RIDGE

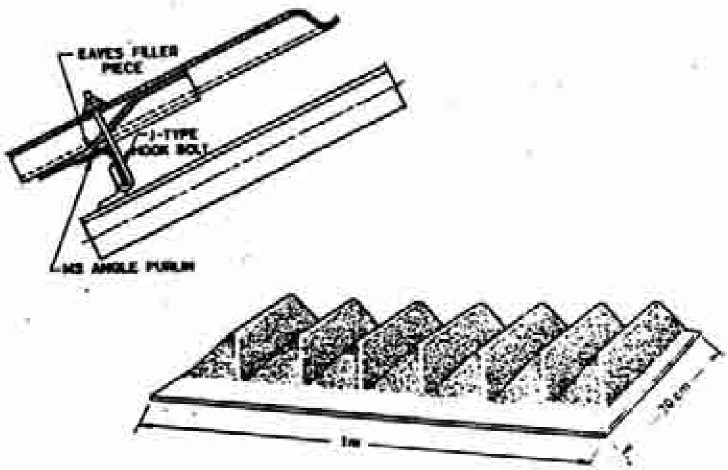


FIG. B TYPICAL EAVES FILLER PIECE

Government Central Press, Bhopal.