

## Chapter 6

### Stone Work

#### 6.0 TERMINOLOGY & PROPERTIES OF STONE

##### 6.0.1 Terminology

**Ashlar** : Stone masonry using dressed block of given dimensions having faces perpendicular to each other and laid in courses.

**Bed Joint**: The joint where one stone presses on another for example, a horizontal joint in a wall or radiating joint between the voussoirs of arch (**Fig. 6.1A/1 & 6.1A/3 and 6.9**).

##### **Hollow (Open and closed cavity) block**

A concrete masonry unit with any one of the external dimensions greater than the corresponding dimension of a brick and having one or more large holes or cavities which either pass through the block (open cavity) or do effectively pass through the block (closed cavity) and having the solid material between 50% and 75% of the total volume of the block calculated from the over-all dimensions.

##### **Solid Block**

A concrete masonry unit with external dimensions greater than corresponding dimensions of a brick and having solid material not less than 75% of the total volume of the block calculated from over all dimension.

**Bond** : An inter-locking arrangement of structural units in a wall to ensure stability.

**Bond Stone** (Through stone): Selected long stone used to hold a wall together transversely (**Fig.6.2**).

**Corbel** : Stone bonded well into the wall with part of it projecting out of the face of wall to form a bearing surfaces.

**Cornice** : A horizontal moulded projection which crowns or finishes either a wall, any horizontal division of wall, or any architectural feature (**Fig. 6.1A/3**).

**Cramp** : A small piece of metal or the hardest or toughest stone procurable sunk in mortices and fixed across joints as additional ties. The ends of metal cramps are bent at right angles and stone cramps are dovetailed (**Fig.6.1A/2**).

**Course** : A layer of stones in wall including the bed mortar.

**Dowels** : Dowels are small sections of metal, stone or pebbles bedded with mortar in corresponding mortice in bed or side joint of adjacent stones (**Fig.6.1A/1**).

**Jamb** : The part of the wall at the side of an opening.

**Joggle** : A key between the stones by providing a groove in one stone to take a corresponding concealed projection in the edges on the other stone (**Fig.6.1A/2**).

**Natural Bed** : The planes of stratification that occur in a sedimentary rock.

**Parapet** : A solid or pierced guard wall for flat stone terrace or balcony (or a bridge) or a curb wall at the lower part of a pitched roof which is exposed to atmosphere on face back and top (**Fig.6.1A/3**).

**Quoin** : A quoin is the external angle of wall or building. The term is also applied to stone specially selected and neatly dressed for forming such angle.

**Random** : Random or irregular size and shapes.

**Reveal** : The part of the jamb between the frame and the arise.

**Rubble Masonry** : Masonry built of stones either irregular in shapes as quarried or squared and only hammer dressed and having comparatively thick joints. As far as possible, stones for rubble masonry shall be angular.

**Skewback** : Sloping surface against which the springing of an arch rests (**Fig. 6.9**).

**Spandrel** : Space between the haunches below the decking level (**Fig. 6.9**).

**String Course** : A horizontal band, plain or moulded, usually projecting slightly from the face of wall (**Fig.6.1A/3**).

**Surfacing or Dressing of Stones** : The stones are dressed to have different surfaces as indicated in definitions below.

**Template or Bed Block** : A block of stone or concrete bedded on a wall to distribute the pressure from a concentrated load.

**Self Faced Surfaces** : Surfaces of stones used for roofing, flooring, lintels etc., as obtained from quarry.

**Squared Back Surface** : Means the surface shall be dressed back at right angles to the face of the stone.

**Chisel Drafted Margin :** The dressing done with a drafting chisel in narrow strips of width generally 2 to 5 cm. Chisel drafted margin shall be punch dressed.

**Hammer Dressed Surface :** A hammer dressed stone shall have no sharp and irregular corners and shall have a comparatively even surface so as to fit well in masonry. Hammer dressed stone is also known as hammer faced, quarry faced and rustic faced. The bushing from the general wall face shall not be more than 40 mm on exposed face and 10 mm on faces to be plastered (Fig.6.1B/1).

**Rock Faced Surface :** A rock face stone shall have a minimum of 25mm wide chisel drafted margin at the four edges, all the edges being in the sample plane.

**Rough Tooled Surface :** A rough tooled surface shall have a series of bands, made by means of plane chisel 4 to 5 cm wide, more or less parallel to tool marks all over the surface. These marks may be either horizontal, vertical or at an angle of 45 deg. as directed. The edges and corners shall be square and true. The depth or gap between the surface and straight edge, held against the surface shall not be more than 3mm. (Rough tooled stones are used where fairly regular plane faces are required for masonry work.)

**Punched Dressed Surface :** A rough surface is dressed by means of punch chisel to show series of parallel ridges. The depth of gap between the surface and a straight edge held against the surface shall not exceed 3 mm (Fig.6.1B/2). Punched dressed stones are used where even surfaces are required.

**Close Picked Surface :** A punched stone is further dressed by means of point chisel so as to obtain a finer surface, ridges, or chisel marks left over being very tiny. The depth of gap between the surface and a straight edge kept over the surface shall not exceed 1.5 mm (Fig.6.1B/3).

**Fine Tooled Surface :** Close picked surface is further dressed so that all the projections are removed and fairly smooth surface is obtained. The surfaces shall have 3 to 4 lines per centimeter width depending on the degree of hardness of stone and degree of fineness required (Fig.6.1B/4). This type of dressing is commonly adopted for ashlar work.

**Polished Surface :** Surfaces having a high gloss finish. Polishing of stones shall be done by rubbing them with suitable abrasive, wetting the surface where necessary with water. Alternatively polishing of stones shall be done by holding them firmly on the top of revolving table to which some abrasive material like sand or carborundum is fed. The final polishing shall be performed by rubber or felt, using oxide of lime (called by trade name as putty powder) as a polishing medium.

**Moulded:** Cut to profile of a moulding with punched dressed surfaces, unless otherwise specified.

**6.0.2 Properties of Stone :**

**6.0.2.1 Crushing Strength of Stones**

This shall be as indicated in Table 6.1. Test for crushing or compressive strength shall be carried out as prescribed in IS 1121 (Part 1).

**TABLE 6.1  
CRUSHING STRENGTH OF STONE**

TYPE OF STONE	MIN. CRUSHING STRENGTH N/mm <sup>2</sup> (kgf/cm <sup>2</sup> )
Granite	100 (1000)
Basalt	40 (400)
Lime Stone (except very soft stones)	20 (200)
Sandstone	30 (300)
Marble	50(500)
Quartzite	80 (800)
Laterite (Block)	3 (30)

**6.0.2.2 Durability :**

Requirements have been indicated in Para 6.1.1. Petrographic examination of stones may be done as per IS 1123 which helps in identifying natural stones.

**6.0.2.3 Sizes :** Normally stones used shall be small enough to be lifted and placed by hand. Unless otherwise indicated , the length of stones for stone masonry shall not exceed three times the height and breadth of base

shall not be greater than three fourth the thickness of the wall , or not less than 15 cm. The height of stone may be upto 30 cm.

In selection of stones, the situation where it is to be used shall be considered. **Table 6.2** gives the recommended use of common types of stones.

**6.0.2.4 Selection of Stones :**

**Table 6.2**

Type of Stone	Use
1. Dense stone like granite, gneiss	a) Masonry work submerged in water b) Masonry below plinth level or in contact with soil
2. Granite, quartzite	Masonry work exposed to smoke or chemical fumes
3. Sand stone	Fire resistant masonry
4. Soft stone like marble, sandstone	For carved ornamental work, arches, veneers etc.

**6.0.2.5 Type of Stone Masonry**

The following Types are in common use

- a) Random Rubble Masonry – Uncoursed and brought to course & Dry Coursed Rubble Masonry.
- b) Coursed Rubble Masonry - First and Second sorts
- c) Ashlar Masonry – Plain, Special
- d) Stone veneering.
- e) Laterite Stone Masonry / Slate Stone Masonry

**6.0.2.6 Laying of Stones – General requirements**

a) The stones should be laid so that the pressure is always perpendicular to the bed. The courses shall be built perpendicular to the pressure which the masonry will bear. In case of battered walls, the base stone and the plane courses shall be at right angles to the batter.

b) In the case of coursed rubble masonry, if the heights of the courses vary, the largest stone shall be placed in the lowest course; the thickness of courses shall also decrease gradually to the top. Vertical joints shall be staggered as far as possible. Bell shaped bond stones or headers shall not be used. All the necessary chases for joggles, dowels and cramps should be formed in the stones before hand.

c) Sufficient transverse bonds should be provided by the use of bond stones extended from the front to the back of the wall and from outside wall to the interior of thick wall and in the latter case bond stones shall overlap each other in their arrangement.

At all angular junctions, the stones at each alternate course shall be well bonded into the respective courses of adjacent wall.

d) Where there is break in the masonry work, the masonry shall be raked in

sufficiently long steps for facilitating jointing of old and new work. The stepping of the raking shall not be more than 45 deg. to the horizontal. Walls and pillars shall be carried up truly plumb or as to the specified batter.

e) No work shall be done above 1m from the ground level or the floor level as the case may be, without the aid of suitable scaffolding.

**6.0.2.7 Fixing of Door & window Frames**

Where door and window frames are to be fixed in the opening, hold fasts embedded in concrete block replacing a stone block may be used.

**6.0.2.8 Bearing of floors, Roofs and Joints**

Corbels or brackets shall be provided for resting of joists. Beams carrying heavy loads shall be supported by templates of concrete stone.

**6.0.2.9 Jointing and Pointing**

All joints shall be full of mortar. Pointing may be avoided. If unavoidable, raking is to be done and types of pointing shall be as for brick work.

**6.0.2.10 Weather protection and Curing**

Stone masonry laid in cement or lime mortar shall be protected during construction from rain and frost by suitable cover. The masonry shall be kept wet on all the faces for a period of 7 days after construction. In case of masonry work, with lime mortar, it is desirable that the work, after every height of 1.5m or less, shall be allowed to set for atleast 2 days before starting further construction over it. Stone masonry laid in mud mortar shall not be watered but shall be protected during construction from rain or from uneven drying.

**6.0.2.11** Weep holes are generally to be provided in abutments, wings and returns

and other earth retaining structures, as shown on the drawings or as directed by the Engineer. These shall be formed either by building in pipes of suitable size or by leaving holes of the required size through the masonry, with a proper fall from the back of the wall to the front. No extra payment shall be made for forming weep holes and no deduction will be made from the masonry for the gaps for weep holes

**6.1 RANDOM & UNCOURSED RUBBLE MASONRY (Refer Figure 6.2)**

**(Note :** This para describes basically Random or Uncoursed Rubble Masonry. A slight improvement in uncoursed Rubble Masonry is to bring it to course at vertical intervals of 30cm to 90 cms. Paras 6.1.3 and 6.1.4 may be referred to for details.)

**6.1.1. Stone**

The stone shall be of the type specified such as granite, trap, limestone, sand stone, quartzite etc., and shall be obtained from the

quarries, approved by the Engineer. Stone shall be hard, sound, durable and free from weathering decay and defects like cavities, cracks, flaws, sand holes, injurious veins, patches of loose or soft materials and other similar defects that may adversely affect its strength and appearance. As far as possible stones shall be of uniform colour, quality or texture. Generally stone shall not contain crystalline silica or chalk, mica and other deleterious materials like iron-oxide, organic impurities etc.,

Normally Stones with round surface shall not be used.

The compressive strength of common types of stones shall be as per **Table 6.1** and the percentage of water absorption shall generally not exceed 5% for stones other than those specified in **Table 6.3**. For laterite this percentage is 12%.

**Table 6.3  
MAX. WATER ABSORPTION OF STONES**

Type of stone	Maximum Water Absorption percentage by weight
Granite	0.5
Basalt	0.5
Lime stone (Slab & Tiles)	0.15
Sand Stone (Slab & Tiles)	2.5
Marble	0.40
Quartzite	0.40
Laterite (Block)	12

Note : Test for water absorption shall be carried out as laid down in IS:1124.

**6.1.2. Size of Stones**

Normally stones used should be small enough to be lifted and placed by hand. Unless otherwise indicated, the length of stones for stone masonry shall not exceed three times the height and the breadth or base shall not be greater than three-fourth the thickness of wall, or not less than 15 cm. The height of stone may be up to 30 cm.

**6.1.3. Categories of RR Masonry:-** Random Rubble Masonry shall be un-coursed (**Figure 6.2**) or brought to courses as specified in Para 6.1.4 Un-coursed random rubble masonry shall be constructed with stones of sizes as referred to in para 6.1.2. and shapes picked up random from the stones brought from the approved quarry. Stones having sharp corners or round surfaces shall, however, normally not be used.

**6.1.4. RR Masonry brought to course :**

Random rubble masonry brought to the course is similar to un-coursed random rubble masonry except that the courses are roughly leveled at intervals varying from 30 cm to 90 cm in height according to the size of stones used.

**6.1.5. Dressing**

Each stone shall be hammer dressed on the face, the sides and the bed. Hammer dressing shall enable the stones to be laid close to neighbouring stones such that the face shall not project more than 40 mm on the exposed face and 10 mm on the face to be plastered.

**Mortar :**

The mortar used for joining shall be as specified and should conform to IS 2250 (Refer **Chapter 26 on "Mortar"**)

**6.1.6. Laying**

All stones shall be wetted before use. Each stone shall be placed close to the stones already laid so that the thickness of the mortar joints at the face is not more than 20 mm. Face stones shall be arranged suitably to stagger the vertical joints and long vertical joints shall be avoided. Stones for hearting or interior filling shall be hammered down with wooden mallet into position and firmly bedded in mortar. Chips or spalls of stones may be used for filling of interstices between the adjacent stones in hearting and these shall not exceed 20% of the quantity of stone masonry. To form a bond between successive courses plum stones projecting vertically by about 15 to 20 cm shall be firmly embedded in the hearting at the interval of about one metre in every course. No hollow space shall be left anywhere in the masonry.

The masonry work in wall shall be carried up true to plumb or to specified batter.

Random rubble masonry shall be brought to the level courses at plinth, window sills, lintel and roof levels. Leveling shall be done with concrete comprising of one part of the mortar as used for masonry and two parts of graded stone aggregate of 20 mm nominal size.

The masonry in structure shall be carried uniformly. Where the masonry of one part is to be delayed, the work shall be raked back at an angle not steeper than 45°

#### **6.1.7. Bond Stones**

Bond or through stones running right through the thickness of walls, shall be provided in walls up to 60cm thick and in case of walls above 60 cm thickness, a set of two or more bond stones overlapping each other by at least 15 cm shall be provided in a line from face of the wall to the back. Details may be seen in **Figure 6.4**.

In case of highly absorbent types of stones (porous lime stone and sand stone etc.,) single piece bond stones may give rise to dampness. For all thicknesses of such walls, a set of two or more bond stones overlapping each other by at least 15 cm shall be provided. Length of each such bond stone shall not be less than two-third of the thickness of the wall.

Where bond stones of suitable lengths are not available pre-cast cement concrete block 1:2:4 (1 cement : 2coarse sand : 4graded stone aggregate 20 mm nominal size) of cross section not less than 225 square centimeters and length equal to the thickness of wall shall be used in lieu of bond stones. This shall however be applicable only in masonry below ground level and

where masonry above ground level is finally required to be plastered.

At least one bond stone or a set of bond stones shall be provided for every 0.5 sqm of the area of wall surface. All bond stones shall be marked suitably with paint as directed by the Engineer.

#### **6.1.8. Quoin and Jamb Stones**

The quoin and jamb stones shall be of selected stones neatly dressed with hammer or chisel to form the required angle. Quoin stones shall not be less than 0.01 cum. in volume. Height of quoins and jamb stones shall not be less than 15 cm. Quoins shall be laid header and stretcher alternatively.

#### **6.1.9. Joints**

Stones shall be so laid that all joints are fully packed with mortar and chips. Face joints shall not be more than 20 mm thick.

The joints shall be struck flush and finished at the time of laying, when plastering or pointing is not to be done. For the surfaces to be plastered or pointed, the joints shall be raked to a minimum depth of 20 mm when the mortar is still green.

#### **6.1.10. Scaffolding**

Single scaffolding having one set of vertical support shall be allowed. The supports shall be sound and strong, tied together by horizontal pieces, over which the scaffolding planks shall be fixed. The inner end of the horizontal scaffolding member may rest in a hole provided in the masonry. Such holes, however, shall not be allowed in pillars under one metre in width or near the skew back of arches. The holes left in masonry work for supporting scaffolding shall be filled and made good with cement concrete 1:3:6 (1 Cement: 3 coarse sand : 6 stone aggregate 20 mm nominal size).

#### **6.1.11. Curing**

Masonry work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of masonry with fat lime mortar, curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

#### **6.1.12. Protection**

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

#### **6.1.13. Measurements**

**6.1.14.1.** The length, height and thickness shall be measured correct to a cm. The thickness of wall shall be measured at joints

excluding the bushing. Only specified dimension shall be allowed; anything extra shall be ignored. The quantity shall be calculated in cubic metre nearest to two places of decimal.

**6.1.14.2.** The work under the following categories shall be measured separately:-

- (i) From foundation to plinth level
  - (a) Work in or under water and or liquid mud,
  - (b) Work in or under foul positions.
- (ii) From plinth level to two floor levels.
- (iii) From two floor levels above plinth level for every additional floor or part thereof.
- (iv) Stone masonry in parapet shall be measured together with the corresponding item in the wall of the storey next below.

**6.1.14.3.** No deduction shall be made nor extra payment made for the following:-

- (a) Ends of dissimilar materials (that is joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps etc.) up to 0.1 sqm in section.
- (ii) Openings each up to 0.1 sqm in area. In calculating the area of openings, any separate lintels or sills shall be included along with the size of opening but the end portions of the lintels shall be excluded and the extra width of rebated reveals, if any, shall also be excluded.
- (iii) Wall plates and bed plates, and bearing of chhajjas and the like, where the thickness does not exceed 10 cm and the bearing does not extend over the full thickness of the wall.

**Note :** The bearing of floor and roof shall be deducted from wall masonry.

- (iv) Drain holes and recesses for cement concrete blocks to embed hold-fasts for doors, windows, etc.,
- (v) Building in masonry, iron fixture, pipes up to 300mm dia, hold fasts of doors and windows etc.,
- (vi) Forming chases in masonry each up to section of 360 sq.cm.

**6.1.14.4** Masonry (excluding fixing brick work) in chimney breasts with smoke or air flues not exceeding 20 sq.dm. (0.20 sq.m.) in sectional area shall be measured as solid and no extra payment shall be made for pargetting and coring such flues. Where flues exceed 20sq.dm. (0.20 sq.m.) sectional area deduction shall be made for the same and pargetting and coring flues shall be

measured in running metres stating size of flues and paid for separately.

**6.1.14.5** Apertures for fire places shall not be deducted and no extra payment made for splaying of jambs, throating and making arch to support the opening.

**6.1.14.6** Square or Rectangular Pillars: These shall be measured as walls, but extra payment shall be allowed for stone work in square or rectangular pillars over the rate for stone work in walls. Rectangular pillar shall mean a detached masonry support rectangular in section, such that its breadth does not exceed two and a half times the thickness.

**6.1.14.7** Circular Pillars (Columns): These shall be measured as per actual dimensions, but extra payment shall be allowed for stone work in circular pillars over the rate for stone work in walls. The diameter as well as length shall be measured correct to a cm.

**6.1.14.8** Tapered wall shall be measured net, as per actual dimensions and paid for as other walls.

**6.1.14.9** Curved Masonry: Stone masonry curved on plan to a mean radius exceeding 6 metres shall be measured and included with general stone work. Stone work circular on plan to a mean radius not exceeding 6 metres shall be measured separately and shall include all cuttings and waste and templates. It shall be measured as the mean length of the wall.

#### **6.1.15 Rate**

The rate shall include the cost of materials and labour required for all the operations described above and shall include the following :

- (a) Raking out joints for plastering or pointing done as a separate item, or finishing flush as the work proceeds.
- (b) Preparing tops and sides of existing wall for raising and extending.
- (c) Rough cutting and waste for forming gables, cores, skew backs or spandrels of arches, splays at eaves and all rough cutting in the body of walling, unless otherwise specified.
- (d) Bond stones or cement concrete bond blocks.
- (e) Leading and making holes for pipes etc.,
- (f) Bedding and pointing wall plates, lintels, sills, etc., in or on walls, bedding roof tiles and corrugated sheets in or on walls.
- (g) Building in ends of joists, beams, lintels, etc.

## 6.2. COURSED RUBBLE MASONRY – FIRST SORT (Figure 6.3)

**6.2.1 General:-** Coursed Rubble Masonry is generally of First Sort or second sort. Squared Rubble Masonry is an inferior variety of coursed Rubble Masonry and a Note on this may be seen in **Figure 6.3**.

**6.2.2 Stone** - Shall be as specified in para 6.1.1.

**6.2.3 Size of Stones** - Shall be as specified in para 6.1.2.

### 6.2.4 Dressing

Face stones shall be hammer dressed on all beds and joints so as to give them approximately rectangular block shape. These shall be squared on all joints and beds. The bed joint shall be rough chisel dressed for at least 8 cm back from the face, and side joints for at least 4 cm such that no portion of the dressed surface is more than 6 mm from a straight edge placed on it. The bushing on the face shall not project more than 4 cm as an exposed face and one cm on a face to be plastered. The hammer dressed stone shall also have a rough tooling for minimum width of 2.5 cm along the four edges of the face of the stone, when stone work is exposed.

### 6.2.5 Mortar

The mortar for jointing shall be specified and shall conform to IS 2250. Refer to **Chapter 26 on Mortar**.

### 6.2.6 Laying

All stones shall be wetted before use. The walls shall be carried up truly plumb or to specified batter. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. The height of each course shall not be less than 15 cm nor more than 30 cm.

Face stones shall be laid with alternate headers and stretchers. No pinning shall be allowed on the face. No face stone shall be less in breadth than its height and at least one-third of the stones shall tail into the work for length not less than twice their height.

The hearting or the interior filling of the wall shall consist of stones carefully laid on their proper beds in mortar with chips and spalls of stone being used where necessary to avoid thick beds of joints of mortar and at the same time ensuring that no hollow spaces are left anywhere in the masonry. The chips shall not be used below the hearting stone to bring these up to the level of face stones. The use of chips shall be restricted to the filling of interstices between the adjacent

stones in hearting and these shall not exceed 10% of the quantity of stone masonry.

The masonry in a structure shall be carried up uniformly but where breaks are unavoidable, the joints shall be raked back at an angle not steeper than 45°, Toothing shall not be allowed.

### 6.2.7 Bond Stones

Shall be as specified in para 6.1.8. except that a bond stone or a set of bond stones shall be inserted 1.5 to 1.8 metres apart, in every course.

### 6.2.8 Quoins

The quoins shall be of the same height as the course in which these occur. These shall be at least 45 cm long and shall be laid as stretchers and headers alternately. These shall be laid square on the beds, which shall be rough-chisel dressed to a depth of at least 10 cm. In case of exposed work, these stones shall have a minimum of 2.5 cm wide chisel drafts at four edges, all the edges being in the same plane.

### 6.2.9 Joints

All bed joints shall be horizontal and all side joints vertical. All joints shall be fully packed with mortar. Face joints shall not be more than one cm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, joints shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

**6.2.10 Curing etc.:-** Curing, scaffolding, measurements and rates shall be as specified under Para 6.1.

## 6.3 COURSED RUBBLE MASONRY – SECOND SORT (Figure 6.3)

**6.3.1. Stone:** Shall be as specified in para 6.1.1.

**6.3.2. Size of Stones :** Shall be as specified in para 6.1.2.

### 6.3.3. Dressing

Shall be as specified in para 6.2.4 except that no portion of dressed surface shall exceed 10 mm from a straight edge placed on it.

### 6.3.4. Mortar

The mortar for jointing shall be as specified and shall conform to IS 2250. Refer to **Chapter 26 on Mortar**.

### 6.3.5. Laying

Shall be as specified in para 6.2.6 except that the use of chips shall not exceed 15% of the quantity of stone masonry and stone, in each course, need not be of the same height but not more than two stones shall be used in the height of a course.

#### **6.3.6. Bond Stone, Quoins**

Shall be as specified in paras 6.2.7 and 6.2.8 respectively.

#### **6.3.7. Joints**

All bed joints shall be horizontal and all side Joints vertical. All joints shall be fully packed with mortar. Face joints shall not be more than 2 cm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise the joints shall be raked to a minimum depth of 20 mm by raking tool during progress of work, when the mortar is still green.

**6.3.8. Curing, Scaffolding, measurement and rates:** Shall be as specified.

### **6.4. PLAIN ASHLAR MASONRY (Figure 6.5)**

**6.4.1. General :** Stone shall be of the type specified. It shall be hard, sound, durable and tough, free from cracks, decay and weathering and defects like cavities, cracks, flaws, sand holes, veins, patches of soft or loose materials etc., Before starting the work, the contractor shall get the stones approved by the Engineer.

#### **6.4.2. Size of Stones**

Normally stones used should be small enough to be lifted and placed by hand. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three-fourth of the thickness of wall nor less than 15 cm. The height of stone may be up to 30 cm.

#### **6.4.3. Dressing**

Every stone shall be cut to the required size and shape, so as to be free from waviness and to give truly vertical and horizontal joints. In exposed masonry, the faces that are to remain exposed in the final position and the adjoining faces to a depth of 6 mm shall be fine chisel dressed so that when checked with 60 cm straight edge, no point varies from it by more than 1 mm. The top and bottom faces that are to form the bed joints shall be chisel dressed so that variation from 60 cm straight edge at no point exceeds 3 mm. Faces which are to form the vertical joints should be chisel dressed so that variation at any point with 60 cm straight edge does not exceed 6mm. Any vertical

face that is to come against backing of masonry shall be dressed such that variation from straight edge does not exceed 10 mm. All angles and edges that are to remain exposed in the final position shall be true, square, and free from chippings.

A sample of dressed stone shall be prepared for approval of the Engineer. It shall be kept at the work site as a sample after being approved.

#### **6.4.4. Mortar**

The mortar for jointing shall be as specified and should conform to IS 2250. Refer to **Chapter 26 on Mortar.**

#### **6.4.5. Laying**

All stones shall be wetted before placing in position. These shall be floated on mortar and bedded properly in position with wooden mallets without the use of chips or under pinning of any sort.

The walls and pillars shall be carried up truly plumb or to batter as shown in drawings. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical.

In case of ashlar work without backing of brick work or coursed rubble masonry, face stone shall be laid headers and stretchers alternately unless otherwise directed. The headers shall be arranged to come as nearly as possible in the middle of stretchers above and below. Stone shall be laid in regular courses of not less than 15 cm in height and all the courses shall be of same height, unless otherwise specified.

For ashlar facing with backing of brick work or coursed rubble masonry (**Fig.6.6**) face stone shall be laid in alternate courses of headers and stretchers unless otherwise directed. Face stone and bond stone course shall be maintained throughout. All connected masonry in a structure shall be carried up nearly at one uniform level throughout, but where breaks are unavoidable, the joints shall be made in good long steps so as to prevent cracks developing between new and old work. Bond stone provided in the masonry shall be payable in the item of Ashlar masonry. Neither any deduction will be made from the brick masonry for embedding the bond stone in the backing nor any extra payment shall be made for any extra labour involved in making holes in brick masonry backing.

When necessary, jib crane or other mechanical appliances shall be used to hoist the heavy pieces of stones and place these into correct positions, care being taken that the corners of the stone are not damaged.



Stone shall be covered with gunny bags, before tying or rope is passed over it, and it shall be handled carefully. No piece which has been damaged shall be used in work.

#### 6.4.6. Bond Stones

Shall be as specified in para 6.1.8.

#### 6.4.7. Joints

All joints shall be full of mortar. These shall be not more than 6 mm thick. Face joints shall be uniform throughout and a uniform recess of 20 mm depth from face shall be left with the help of the steel plate during the progress of work.

#### 6.4.8. Pointing

All exposed joints shall be pointed with mortar as specified. The pointing when finished shall be sunk from stone face by 5 mm or as specified. The depth of mortar in pointing work shall not be less than 15 mm.

#### 6.4.9. Curing

Masonry work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of masonry with fat lime mortar, curing shall commence two days after laying on masonry and shall continue for at least seven days thereafter.

#### 6.4.10. Protection

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

#### 6.4.11. Scaffolding

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.

#### 6.4.12. Measurements

The finished work shall be measured correct to a centimeter in respect of length, breadth and height. The cubical contents shall be calculated in cubic metre nearest to two places of decimal.

**6.4.12.1** No deduction nor any extra payment shall be made for the following:-

(i) Ends of dissimilar materials (that is joists, beams, lintels, posts, girders, rafters, Purlins, trusses, corbels, steps etc.) up to 0.1 sqm. in section.

(ii) Openings up to 0.1 sqm. in area. In calculating the area of opening, any separate lintels or sills shall be included along with the size of the opening but the end portion of the lintels shall be excluded and extra width of

rebated reveals, if any, shall also be excluded.

(iii) Wall plates and bed plates and bearing of chhajja and the like, where the thickness does not exceed 10 cm and the bearing does not extend over the full thickness of the wall.

**Note:** The bearing of floor and roof slabs shall be deducted from wall masonry.

(iv) Drainage holes and recesses left for cement concrete blocks to embed hold-fasts for doors and windows.

v) Building in the masonry iron fixture and pipes up to 300mm diameter.

Stone walling in chimney breasts, chimney stacks, smoke or air flues not exceeding 0.20 sqm. in sectional area shall be measured as solid and no extra measurement shall be made for pargetting and coring such flues. Where flues exceed 0.20 sqm. in sectional area, deduction shall be made for the same and pargetting and coring flues paid for separately.

**6.4.12.2.** Square, Rectangular or Circular Pillars: Shall be measured and paid for as walls, but extra payment shall be allowed for such pillars and columns over the rate for stone work in walls.

Rectangular pillars shall mean a detached masonry support, rectangular in section, such that its breadth shall not exceed two and half times the thickness.

**6.14.2.3.** Curved Stone Work:- Stone work curved on a plan to a mean radius exceeding six metres shall be measured net and included with general stone work. Stone work curved in plan to a mean radius not exceeding six metres shall be measured separately and extra payment shall be allowed and shall include all cutting and waste and templates. It shall be measured as the mean length of wall.

#### 6.4.13. Rate

The rate shall include the cost of materials and labour required for all the operations described above. Stone facing or wall lining up to and not exceeding 8 cm thickness shall be paid for under "Stone work for wall lining etc., (Veneer work)". The stone work of thickness exceeding 8 cm shall be paid under relevant items of work.

### 6.5. OTHER TYPES OF ASHLAR (ORDINARY) MASONRY (Refer Figures 6.7A to 6.7E)

#### 6.5.1 Punched Ashlar Masonry (Refer Figure 6.7A)

**6.5.1.1 Stone** - Shall be as specified in para 6.4.1.

**6.5.1.2 Size of Stone** - Shall be as specified in para 6.4.2.

**6.5.1.3 Dressing**

Shall be as specified in para 6.4.3 except that the faces exposed in view shall have a fine dressed chisel draft 2.5 cm wide all round the edges and shall be rough tooled between the drafts, such that the dressed surface shall not be more than 3 mm from a straight edge placed over it.

**6.5.1.4 Other Details**

The specifications for mortar, laying and fixing, bond stone, joints, pointing, curing, protections, scaffolding, measurements and rates shall be same as specified in para 6.4.

**6.5.1.5 Ashlar Rock faced** (see **Figure 6.7B**)

a) Dressing shall be as for Plain Ashlar except that the exposed faces of the stone between the drafts shall be left rough as the stone comes from the quarry; but no rock face or bushing shall project more than 75mm from plane of drafts.

b) Other requirements shall be as for Plain Ashlar.

**6.5.1.6 Ashlar Rough Tooled** (see **Figure 6.7C**)

a) The dressing of the stone shall be similar to plain ashlar except that the face exposed to view shall have a fine chisel draft 25mm wide round the edges and shall be rough tooled between the draft such that the dressed surface shall not deviate more than 3mm from the straight edge placed over it.

b) Other requirements shall be as for Plain Ashlar.

**6.5.1.7 Ashlar Chamfered** (see **Figure 6.7D**)

a) The dressing shall be as for Plain Ashlar except that it shall be levelled off to 45 deg. for a depth of about 25mm or more as specified.

b) Other requirements shall be as for Plain Ashlar.

**6.5.1.8 Ashlar Block in Course** (see **Fig. 6.7E**)

a) The stones are dressed all squared and laid to fine joints; the faces being usually hammer dressed. The stones selected may be of larger size than plain ashlar.

b) The other requirements are as for Plain Ashlar except that the courses vary between 200-250 mm in thickness. This type of masonry is therefore superior to coursed rubble masonry.

**6.6 MOULDED, SUNK, CARVED ASHLAR MASONRY** (Refer **Figure 6.8**)

**6.6.1 Stone**

Shall be as specified in para 6.4.1.

**6.6.2 Dressing**

a) Every stone shall be cut to the required size and shape and chisel dressed on all beds and joints so as to be free from any waviness and to give perfectly vertical, horizontal, radial or circular joints with adjoining stones, as the case may be. The dressed surface shall not be more than 3 mm from a straight edge placed on it. The face shall be gauged, cut, chamfered, grooved, rebated, sunk or plain moulded and fine tooled as shown in the working drawings. The joints 6 mm from the face shall also be fine tooled so that a straight edge laid along it is in contact with every point. It shall be the finest surface which can be given to a stone with the chisel and without rubbing.

b) In case of sunk or moulded masonry, the corner stone shall be dressed at true right angles or true to the shape as specified, the corners being straight and vertical.

c) For Arches (see **Fig.6.9**), dome or circular work (see **Fig.6.8**) the stone shall be dressed to required wedge shape so that joints shall be truly radial.

**6.6.2.1 Ashlar Arches**

a) Every stone shall be cut to the required size and shape and chisel dressed on all beds and joints as stipulated in Para 6.6.2 (a) and (c) above.

b) An elevation of the arch shall be drawn out on lime or cement plaster on the ground, and voussiors of different width according to the stone to be used marked thereon. Sheet templates shall then be cut out and the stones well dressed to the templates to a uniform and fine finish. This will ensure the voussiors having sides radial to the centre, and the upper and lower surfaces cut concentric.

c) All visible angles and edges shall be true, square and free from chippings as stipulated in Para 6.6.2 (a) above.

d) **Centering** : All arches shall be formed on a well constructed centering. The centering shall be so designed and shall have such a profile that with the full weight of the work on it, the correct curvature and form of the arch indicated in the drawings are obtained, and shall be of such form and dimensions as are approved by the Engineer.

Where timber centering is used all the ribs shall be of such class of timber, as the Engineer shall approve and they shall be properly jointed and fastened at the joints of all segments, ties and struts with suitable fixtures on each side and the centres shall be provided in such numbers and be used in such sets as in the opinion of the Engineer, will ensure the various works being carefully constantly and continuously carried on. Steel Centering shall be preferred to Timber centering.

In any structure of more than three spans, there shall always be sufficient sets of centres to allow taking up work on the number of arches specified by the Engineer and in any case not less than four spans shall be completely centered at one time. Where there are three spans or less, all the spans shall be completely centered before the building of any of the arches is commenced and the building of the several arches shall be simultaneously executed as directed. The centering for groined arches shall be specially constructed as directed. In erecting the ribs of centering, proper allowance must be made for settlement and

the lagging boards for every length will be required to be gauged to a uniform thickness and their upper surface shall be formed true to the proper curvature and kept perfectly clean. All arches and other works must be left true to the curvature and form indicated in the drawings. All centres for skew arches shall be constructed and set on the square. The Engineer will determine the period during which the sets of centering shall remain fixed after arches are keyed and no centering shall be eased or struck without the authority from the Engineer.

The centering shall be wedged in position so that it can be "eased" as soon as the arch has been turned and the haunches filled in.

**6.6.3 Striking of Centres and application of load:**

The centres should not be struck before one week after the completion of the arch and then too only with the permission of the Engineer. After completion of any portion of the masonry of an arch bridge, the following minimum periods of time shall be allowed to elapse before loads as specified below may be imposed on that portion of the masonry.

Class of Cement	50% of designed load	75% of designed load	Full designed load
i) Ordinary cement mortar and concrete	7 days	14 days	28 days
ii) Rapid hardening cement mortar and concrete	5 days	10 days	28 days

The expression "load" means the total calculated load with the appropriate impact allowance specified for the speed at which the load is permitted to run.

The above periods shall be suitably increased where the mean air temperature is less than 16 deg. C

**6.6.4 Ashlar Pillars:-** Pillars if made in ashlar, shall be in blocks well dressed on all sides. Unless not obtainable, these shall be atleast 75 cm deep and shall be built with 'Khaddi' (Gypsum or sweet lime) or cement. 'Khaddi' should be mixed with red colour so that its whiteness is not noticed when it has set.

**6.6.5 Ashlar Stone lintels (Pataos)**

The exposed faces shall be well dressed and other surfaces rough dressed with chisel. If the lintels are wider than 23cm, they may be made in two pieces joined together with gypsum with the vertical joint at the centre of the width. The pieces shall invariably be

clamped together with metal clamp, and if the upper surface of the 'patao' has to take roofing, this surface shall be dressed to take the slope of the 'Patti'. Under no circumstances horizontal joints are to be allowed.

**6.6.6 Moulded, sunk, carved Ashlar masonry :**

**Dressing:-Every stone shall be cut** to the required size and shape and chisel dressed on all beds and joints so as to be free from any waviness and to give perfectly vertical, horizontal, radial, or circular joints with adjoining stones as the case may be. The dressed surface shall not be more than 3mm from a straight edge placed on it. The face shall be gauged, cut, chamfered, grooved, rebated, sunk, or plain moulded and fine tooled as shown in the working drawings. The joints 6mm from the face shall also be fine tooled so that the straight edge laid along it is in contact with every point. It shall

be finest surface which can be given to a stone with chisel and without rubbing.

In case of sunk or moulded masonry the corner stone shall be dressed at true right angles or true to the shape as specified. The corners being straight and vertical.

For arch, dome, or circular work stone shall be dressed to required wedge shape so that joints shall be truly radial.

**Samples :** The full size lay out of the moulding etc., shall be prepared on platform from which sheet templates shall be cut and the stone dressed to templates to a uniform and fine finish. All the visible angles and edge shall be true square and free from chippings. A sample of dressed stone shall be prepared for approval and it shall be kept as sample after being approved by the Engineer.

In case of ashlar moulded and carved columns a full size model of the required moulding, carving etc., shall be prepared in plaster of paris and kept at site of work as sample work after being approved by the Engineer. The stones shall be moulded and carved in accordance with the approved model to a uniform and fine finish.

#### 6.6.7 Other Details

Shall be as specified in paras 6.4.4., 6.4.5. and 6.4.7 to 6.4.11.

#### 6.6.8 Centering and Shuttering for arch dome and circular moulded work

Centering and shuttering required for arch, dome or circular moulded work shall be constructed as directed by the Engineer. The stipulations for centering and shuttering for Arch work indicated in Para 6.6.2.1 shall be adopted for dome and circular moulded work as applicable.

#### 6.6.9 Measurement

The dimensions of the circumscribing rectangles of the dressed stone used in the work shall be measured correct to a cm and cubical contents shall be calculated in cubic metres, nearest to two places of decimal.

**6.6.9.1.** In case of sunk or moulded work the measurements for the work shall be taken course by course. The plain stone used in conjunction with sunk or moulded stone shall be measured and paid for under the relevant item of stone work.

**6.6.9.2.** Sunk or moulded work in rectangular, square and circular pillars, moulded cornices and string courses shall be measured under stone work sunk or moulded but extra payment shall be allowed over the general work in each case. No such

extra payment shall be allowed for moulded string and plinth course.

**6.6.9.3** In case of arch dome or circular moulded work for arches exceeding six meters in clear span extra payment for additional cost of centering shall be made on the actual area of soffit including strutting, bolting, wedging, easing, stripping and removal.

#### 6.6.10 Rate

The rate includes the cost of all materials and labour involved in all the operations described above, including centering and shuttering for arch, dome or circular moulded work.

### 6.7 STONE VENEERING WORK (Figure Nos. 6.10, 6.11 & 6.12)

**6.7.1 General:-** Stone lining up to 8 cm shall be treated as veneering work and lining of greater thickness as plain Ashlar Masonry.

#### 6.7.2 Stone

Shall be as specified in para 6.4.1.

The stone shall be cut into slabs of required thickness along the planes parallel to the natural bed of stone.

#### 6.7.3 Dressing

Shall be as specified in para 6.4.3. except that dressing at the back shall not be done, so as to ensure better grip with hearting or backing. The dressed slabs shall be of the thickness as specified, with permissible tolerance of  $\pm 2$  mm.

#### 6.7.4 Mortar

Mortar for fixing shall be as specified and should conform to IS 2250. Refer to **Chapter 26 on "Mortar"**.

#### 6.7.5 Laying

The stone shall be wetted before laying. They shall then be fixed with mortar in position without the use of chips or underpinning of any sort.

**6.7.5.1** Where so desired, the adjoining stones shall be secured to each other by means of copper pins 75 mm long and 6 mm diameter or as specified.

**6.7.5.2** Further the stones shall be secured to the backing by means of cramps. The material for cramps shall have high resistance to corrosion under conditions of dampness and against the chemical action of mortar or concrete in which cramps are usually embedded. Cramps shall be of 25mm x 6mm and 30 cm long in case of backing of stone masonry walls and brick masonry walls thicker than 230mm. In case

of backing with brick masonry walls 230mm or less thick or RCC members, cramps shall be of 25 x 6 mm and length as per requirement, made out of gun metal or any other metal specified in para 6.7.5.6. Generally the outer length of cramp in half brick work backing shall be 115mm and in one brick work backing it shall be 150mm. Typical shape and details of cramps for such backing are indicated in **Figure 6.11** for general guidance. This can be modified as directed by the Engineer if so, required at site. Cramps shall be spaced not more than 60 cm horizontally. Alternatively the stone may be secured to the backing by means of stone dowels 10 x 5 x 2.5 cm as per shape indicated in **Fig.6.10** and the adjoining stones secured to each other by means of gun metal cramps or copper pins of the specified size. Minimum one cramp/stone dowel shall be used to secure one slab to the backing.

**6.7.5.3** Cramps may be attached to the sides (see **Fig.6.12A, 6.12B**) or top and bottom (see **Fig.6.12C to F**) or sides, top and bottom (see **Fig.6.12 G & H**). The minimum number of cramps required for fixing facing unit to the wall are illustrated in **Fig.6.12** The actual number of cramps and their sections, however, shall be as per requirements of design to carry the loads.

**6.7.5.4** Where cramps are used to hold the unit in position only, the facings shall be provided with a continuous support on which the stones rest at the ground level and other storey levels, the support being in the form of projection from or recess into the concrete floor slab, or a beam between the columns or a metal angle attached to the floor slab or beams. These supports shall preferably be at vertical intervals not more than 3.5 m apart and also over the heads of all openings. Such supports shall also be provided where there is transition from thin facings below to thick facings above.

**6.7.5.5** Alternatively cramps may be used to hold the units in position and in addition to support the units thus transferring the weight of the units to the backing. Such cramps should be properly designed as per IS: 4101 (Part.1.).

**6.7.5.6** The cramps may be of gun metal or copper alloyed with zinc, tin, nickel, lead and/or stainless steel.

**6.7.5.7** The pins, cramps and dowels shall be laid in cement mortar 1:2 (1 Cement : 2 fine sand) and their samples got approved by the Engineer and kept at site.

**6.7.5.8** The walls shall be carried up truly plumb. All courses shall be laid truly horizontal and all vertical joints truly vertical. The stones shall break joints on the face for at least half the height of the course, unless otherwise shown in the drawings. The stones shall be laid in regular courses not less than 20 cm height and all the stones shall be of the same height unless otherwise specified. No stone shall be less in length than one and a half times its height unless otherwise specified.

**6.7.5.9** As far as possible the backing shall be carried up simultaneously with the face work. In case of reinforced cement concrete backing, the lining shall be secured to the backing after it has set and got cured. The cramps shall be fixed in concrete at the required positions, while laying.

### 6.7.6 Joints

The joints shall be done with composite cement lime mortar 1:1:6 (1 Cement: 1 lime putty: 6 fine sand) or as specified.

All joints shall be full of mortar. Special care shall be taken to see that the groundings for veneer work are full of mortar. If any hollow groundings are detected by tapping the face stones, these shall be taken out and re-laid. The thickness of joints shall be as small as possible, not exceeding 5 mm. For a close but jointed facing, the thickness shall not exceed 1.5 mm. The face joints shall be uniform throughout.

Where joint filler or compound is to be used, the joints shall be raked out to a depth of at least 25 mm after the mortar in the joints has set sufficiently and the filler or compound applied. The joints may be subsequently finished with a mortar suited to the appearance of the work. It is preferable to use joint sealing compounds where the facings are exposed to heavy rain fall and winds and their selections would depend upon local experience and availability of joint sealing compounds. In their absence only masonry mortars 1:1:6 (1 Cement : 1 lime putty: 6 sand) or as specified which have proved to be successful from local exposure conditions shall be used.

### 6.7.7 Other details

Specifications for pointing, curing, protections and scaffolding shall be as specified under Para 6.4.

### 6.7.8 Measurements

The length and breadth of the finished work shall be measured in metres correct to cm.

The area should be calculated in sq. metre correct to two places. of decimal.

The veneering work curved on plan shall be measured as plain work, but extra payment shall be allowed for radii not exceeding six metres on external face. For radius beyond six metres the work shall be measured as plain work only, even if the face may have to be dressed to curve. In case of plain slabs of geometrical shape other than square or rectangle or plain slabs of irregular shape, the dimensions of the circumscribing rectangle of the dressed slab used in the work shall be measured.

#### 6.7.9 Rate

The rate includes the cost of materials and labour involved in all the operations described above, except for the cost of providing and fixing pins, dowels, and metal cramps and ledges and supports, which shall be paid for separately unless otherwise stipulated in the item of work.

### 6.8 STONE CHHAJJA (Figure 6.13)

**6.8.1. General:-** Stone slabs shall be hard, sound and durable. These shall be chisel dressed on all faces which are exposed to view and rough dressed at other surfaces. Angles shall be true and edge lines straight. The finished thickness shall be as stipulated with permissible tolerance of  $\pm 2$  mm. The length of stone slabs in chhajja shall not be less than 60 cm unless otherwise specified.

**6.8.2. Construction details:-** In case of sloping chhajja, the stone shall be sloped as specified. It shall have minimum bearing of 20 cm measured horizontally on the wall and the bearing shall also be similarly sloped. Each slab shall have a hole in the center of the bearing area through which the anchoring M.S. holding down bolt shall pass. The holding down bolts shall be 12 mm in diameter and shall be bent at right angles at its lowest end and buried horizontally for at least 7 cm in a joint 30 cm below the bearing surface. Each holding down bolt shall be secured at top by suitable washer and nut.

The chajjas shall be provided with cove supports and where cove is in brick masonry, it shall project out from the wall as under:

45 cm wide chajja, cove projection 15 cm; depth of cove 3 courses.

60 cm wide chajja, cove projection 20 cm; depth of cove 4 courses.

75 cm wide chajja, cove projection 25 cm; depth of cove 5 courses.

90 cm wide chajja, cove projection 30 cm; depth of cove 6 courses.

**6.8.3.** In case of horizontal chhajja, the stone shall be fixed horizontally with a slight outer slope of about 1 cm. It shall have minimum bearing of 15 cm on the wall. Holding down bolts shall be provided, only where so specified.

#### 6.8.4. Pointing

The joints shall be pointed with 1:2 cement mortar (1 Cement: 2 stone dust /crushed stone sand) with an admixture of pigment to match the stone shade and properly cured.

#### 6.8.5. Other Details

Specifications for curing, protections and scaffolding shall be as specified under Para 6.4.

#### 6.8.6. Measurements

The length and breadth of the finished work shall be measured correct to a cm. The area of chhajja projecting beyond the wall shall be calculated in sqm. correct to two places of decimal.

In case of sloping chhajja, the sloping breadth shall be measured, the area of chhajja projecting beyond the wall shall be calculated in sqm. correct to two places of decimal.

#### 6.8.7. Rate

The rate shall include the cost of all materials and labour involved in all the operations described above. Anchoring the coves shall be deemed to be included in the rate only when it is so stipulated in the description of the item.

### 6.9. SHELVES, COPING, PLAIN CORNICES, STRING COURSES ETC.,

#### 6.9.1. Stones

Stone shall be of uniform colour and texture and of the kind as stipulated.

#### 6.9.2. Dressing

The exposed faces and sides of shelves shall be chisel dressed such that the dressed surface shall not be more than 3 mm from a straight edge placed on it. All visible angles and edges shall be free from chippings, The surfaces to be buried in the masonry shall be rough dressed.

#### 6.9.3. Laying

These shall be laid in mortar of specified mix and fixed as shown in drawing or as directed by the Engineer.

#### 6.9.4. Other Details

Specifications for pointing, curing, protections and scaffolding shall be as specified under Para 6.4.

### 6.9.5. Measurements

**6.9.5.1. Shelves:** The length and breadth shall be measured inclusive of bearings correct to a cm. The thickness shall be as specified with permissible tolerance of  $\pm 2$  mm. The area shall be calculated in sqm. correct to two places of decimal.

**6.9.5.2. Copings:** The dimensions of the circumscribing rectangles of the dressed stones as used in work shall be measured correct to a cm. The cubical contents shall be calculated correct to two places of decimal in cum.

**6.9.5.3 Plain Cornices, String Courses and Plinth Courses:** The length, breadth and depth of the stone including bearing shall be measured correct to a cm. The cubical contents shall be calculated correct to two places of decimal in cum.

**6.9.5.4.** No deduction shall be made from the masonry of wall for the bearing of stone shelves, cornices and string courses.

### 6.9.6. Rate

The rate shall include the cost of all materials and labour required in all the operations described above.

## 6.10. STONE JALI

**6.10.1. General:-** Stone shall be as specified in para 6.4.1.

### Dressing and Fixing

The stone shall be cut in to slabs of required thickness so as to make jali of the specified thickness. The jali shall be cut as per pattern shown on the drawings. All exposed faces shall be fine tooled to a uniform and smooth finish. Fixing shall be done with the adjoining work in grooves, rebates etc., as shown in the drawing or as directed by the Engineer. A tolerance of  $\pm 2$  mm shall be allowed in the specified thickness of the jali.

### 6.10.2. Measurements

The length and breadth of the stone forming the jali including its borders shall be measured correct to a cm and the area shall be calculated in square metres nearest to two places of decimal.

### 6.10.3. Rate

It includes the cost of labour and materials required for all the operations described above, it also includes the cost of making grooves or rebates in the adjoining work for fixing jali.

## 6.11. LATERITE STONE MASONRY

### 6.11.1. Dressing

Laterite stones shall be hammer dressed into rectangular blocks so that all faces are free from waviness and unevenness, and the edges are true and square. The least thickness/breadth shall be not less than height. The length shall generally be equal to twice the breadth, unless otherwise specified.

### 6.11.2. Laying

The dressed stones shall be laid in regular courses of not less than 15cm height. All courses in the masonry shall be of the same height unless otherwise directed. The stones shall be laid in alternate header stretcher fashion, with alternate courses of headers and stretchers or in any other suitable fashion as directed. The vertical joints shall break by at least 65 mm. No specific corner stones are necessary. Quoin may be provided, where so indicated.

### 6.11.3. Joints

All bed joints shall be truly vertical, the thickness of joints shall not exceed 15 mm. Each stone shall be carefully laid in place with joints completely filled with mortar. Where no plastering or pointing is required to be done, the joints shall be struck flush as the work proceeds. In other cases, joints shall be raked square to minimum depth of 15 mm by a raking tool during the progress of work while the mortar is still green.

### 6.11.4. Scaffolding, Curing and Protection

Provisions in para 6.4 shall apply.

### 6.11.5. Measurement and Rates

Provisions in para 6.4 shall apply.

## 6.12. SLATE STONE MASONRY

**6.12.1 General:-** Slate stone shall be obtained from the approved quarry, as indicated, and shall not be less than 6 cm thick. Slate stones shall be carefully hammered down into place with wooden mallet and firmly bedded with mortar. Chips and spalls shall be wedged in order to avoid thick bed joints of the mortar. Spalls and pinnings may show on face. Thickness of mortar in beds and joints shall not exceed 25 mm. No face work shall be provided.

**6.12.2 Construction details:-** Slate stone masonry shall be built un-coursed. Walls should be leveled up at the top of plinth, sill and lintel level of openings and at top with minimum amount of chips and spalls. For walls up to 45 cm thick, 25% of face area

shall be of bond stones. For walls over 45 cm thick, 10% of the face area shall be of bond stones. Quoin and jambs stones shall be laid headers and stretchers alternately.

#### **6.12.3 Scaffolding, Curing and Protection**

These shall be as specified in para 6.4.

#### **6.12.4 Measurement and Rate**

These shall be as specified in para 6.4.

### **6.13. DRY COURSED RUBBLE MASONRY**

**6.13.1 General:-** This sort of wall is particularly suitable for breast and retaining walls as in hill Railways and roads.

**6.13.2 Foundations:-** The foundations, if in moorum, should be carried down to a depth of from 60 to 90 cm below the hill slope at the outer side, and filled in with the largest blocks of stone available, carefully laid and packed in by hand with stones of smaller size. The bed of the foundation shall be excavated at right angles to the face batter and not horizontally.

**6.13.3 Stones:-** The stones used should be of the largest and best description procurable in the locality and roughly hammer dressed, so as to secure as large bedding surfaces as possible. When laid, all hollows round them should be tightly packed with smaller stones.

**6.13.4 Laying:-** The stones must be laid on their natural or quarry bed at right angles to the face batter in regular courses. Each course is to be built with proper bond and break of joints with course below. The front and rear faces of the wall shall be similar and equally well bonded with the hearting. The stones must be laid as headers as far as possible with their largest "bed" downwards. All stones in one course need not be of the same height but not more than two stones shall be used to make the full height of the course between two headers, having full depth. No course shall be of greater height than the one below it.

**6.13.5 Bond Stones:-** Bond stones, atleast 90.0 cm or for full thickness of wall, if wall is less than 90.0 cm in thickness shall be provided in each course at 150 to 180 cm apart on the face of the work, and continued through the whole width, overlapping each other by 23 cms, so as to tie the front and rear faces of the work together. These bond stones shall be of the full height of the course in the facing, atleast as broad as they are high, and of the greatest length readily procurable.

**6.13.6 Filling:-** The filling in behind the wall shall be done with waste or smaller stones,

carefully packed and rammed and carried up simultaneously with the building of the face. The filling of earth should be avoided and necessary arrangements for drainage kept.

**6.13.7 Thickness and Batter:-** The thickness and batter of walls shall be as specified in the drawings or as ordered by the Engineer. Generally for retaining ordinary earth fill without surcharge, the top wall should not be less than 60 cm wide and the batter in front not steeper than 1 in 3 (Keeping back vertical). The thickness at the top and the batter on the face may be increased at the discretion of the Engineer. For walls higher than 450 cms the top width may be suitably increased or only top built in dry masonry, the rest being masonry in mortar.

**6.13.8 Long Walls:-** Long lengths of dry rubble walls should be suitably divided into panels separated from one another by short lengths of walls (150 to 210cm) long built in mortar at intervals of, say 600 to 900 cm in order to confine subsequent damage if any, only to the panels affected.

### **6.14. PRE CAST CONCRETE STONE BLOCKS MASONRY**

#### **6.14.1 Terminology**

For the purpose of this section of specifications, the following definitions shall apply:

**6.14.1.1 Block Density** – The density calculated by dividing the mass of a block by the over all volume including holes or cavities.

**6.14.1.2 Stone Spalls** – Broken stone pieces of varying sizes obtained by breaking the natural river boulders or quarry stones.

**6.14.1.3 Concrete Stone Masonry Block** – A pre cast cement concrete solid block having stone spalls in it (25-30 percent of block volume) and cement concrete with dense stone aggregate and sand. It is 100% solid.

**6.14.1.4 Stone Face Exposed Block** – A concrete stone masonry block where the stone spalls are exposed at one of its face. In the face, which forms the exposed wall face, the wall gets the texture of stone surface exposed.

#### **6.14.2 Dimensions and Tolerances**

Concrete stone masonry block is a solid block and shall be referred to by its nominal dimensions. The term 'nominal' means that the dimensions include the thickness of the



mortar joint. Actual dimensions shall be 10 mm short of the nominal dimensions.

The nominal dimensions of concrete stone masonry block shall be as follows:-

Length	300 mm
Height	150 mm and
Width	100,150 and 200 mm

In addition, blocks shall be manufactured in one-third, half, two-third and three quarters of the full length.

The nominal dimensions of the units are so designed that taking into account the thickness of mortar joints, they will produce wall lengths and heights which will conform to the principles of modular co-ordination.

Blocks of other nominal dimensions may also be made if so directed by the Engineer.

**6.14.3 Provision of reinforcement:-** For accommodating vertical reinforcement required in earthquake resistant construction, special blocks of half width and with semi-circular recess in it (see **Fig.6.14**) shall be used. The dimensions shown in the Figure are suitable for 200 mm thick wall. Similar blocks shall be made for walls of thickness greater than 200 mm.

**6.14.4 Tolerances:-** The maximum variation in the length of the units shall not be more than  $\pm 5$  mm and maximum variation in height and width of units not more than  $\pm 3$  mm.

**6.14.5 Construction Details:-** Subject to the tolerances specified in para 6.14.4 the faces of blocks shall be flat and rectangular, opposite faces shall be parallel, and all arises shall be square. The bedding surfaces shall be at right angles to the faces of the blocks.

#### **6.14.6 Blocks with Special Faces**

Blocks with special faces shall be manufactured and supplied as specified in the Schedule item or agreement.

#### **6.14.7 Classification**

Concrete stone masonry blocks shall be classified according to their average compressive strength as given in **Table.6.5** below Para 6.14.13.4.

#### **6.14.8 Materials**

**6.14.8.1 Cement:** cement complying with any of the following Indian Standards may be used at the discretion of the Engineer IS: 269, 455, 1489, 6909, 8041 & 8043. (Refer **Chapter 26 on Mortar**)

**6.14.8.2** When cement conforming to IS: 269 is used, replacement of cement by fly-ash conforming to IS: 3812 may be permitted

up to a limit of 20%.. However, it shall be ensured that blending of fly-ash with cement is as intimate as possible, to achieve maximum uniformity.

**6.14.8.3 Stone Spalls:** The stone spalls shall be of size ranging from 50 to 250 mm in dimension. The stone spalls shall be hard, sound, round in shape, durable, free from decay and weathering. These shall not be flaky. The spalls shall have rough surface for better bond with cement concrete. Good quality stones, such as granite, sand stone and basalt shall be used. Slate shale or any other soft and flaky stone shall not be used. The spalls shall be obtained from approved quarry or by breaking river boulder. Larger size shall be broken into the required sizes and shall be stacked into two categories.

(a) 100 mm and above; and

(b) Below 100 mm.

**6.14.8.4 Aggregates:** The aggregates used in the manufacture of block shall be clean and free from all deleterious matter, and shall conform to the requirements of IS: 383.

Maximum size of the coarse aggregate shall be 10 mm. Sand used in the manufacture of blocks shall be well graded, clean and free from deleterious matter, and shall conform to the requirements of IS: 383. Besides it shall have fine particles 15 to 20% passing 300 micron I.S. Sieve and 5 to 15% passing 150 micron I.,S. Sieve.

It is recommended that the fineness modulus of the combined aggregate shall be between 3.6 and 4.

**6.14.8.5** Fly-ash conforming to IS: 3812 may be used for part replacement of fine aggregate up to a limit of 20%.

#### **6.14.9 Manufacture**

Blocks may be manufactured either at construction site or in factory on a central casting platform using steel moulds with or without surface vibration for compaction of cement concrete.

**6.14.9.1 Mould:** Moulds shall be fabricated using mild steel plates and mild steel angles for stiffening the plates.

The moulds shall be either fixed type (bolt with four side walls fixed at corners, and top and bottom open) or split type.

Split type may be either individual or gang mould type. Where the compaction of the concrete is done manually, the mould may be either fixed type or split type. When the compaction of the blocks is done with surface vibrator, the mould shall be only split type (individual or gang mould).

**6.14.10 Mix**

**6.14.10.1** The cement concrete mix for concrete stone masonry blocks shall not be richer than one part by volume of cement to 9 parts by volume of combined fine and coarse aggregates, and shall not be leaner than one part by volume of cement to 13 parts by volume of combined fine and coarse aggregates.

**6.14.10.2** In case of blocks where compaction is done manually, concrete mix of medium consistency (10 – 12 mm slump) shall be used in order to enable proper compaction and de-moulding. The consistency of the mix should be such that it may form a lump when compressed in the hand without free water being visible.

**6.14.10.3** In case of blocks where compaction is done by external vibrator, concrete mix of very low consistency (zero slump) shall be used in order to vibrate and compact the concrete under pressure.

**6.14.10.4 Mixing:** Concrete shall normally be mixed in a mechanical mixer unless otherwise permitted by the Engineer. In case of hand mixing 10% extra cement shall be used without any extra payment.

Mixing shall be continued until there is a uniform distribution of the materials, and the mass is uniform in colour and consistency.

**6.14.11 Placing and Compaction**

Depending upon the size of the stone spalls, these shall be used either in one layer or in two layers. When used in two layers, large size spalls of 100 mm and above shall be placed in the bottom and concrete poured all round and at top, and shall be tamped manually. Second layer of stone spalls of size 50 mm and above shall be placed over the first layer, and again concrete is poured all round and up to 20 to 30 mm above the top level of mould.

**6.14.11.1** Depending upon the size of block, the average volume of stone spalls used should generally be between 25 to 30%. However, in no block, it shall be less than 20% of the volume of block.

**6.14.11.2** Each stone spall shall have a minimum space of about 15 to 20 mm around it. For blocks with exposed stone texture, the stone spalls shall touch the surface of the mould.

**6.14.11.3** Blocks may be compacted manually as well as mechanically. In case of manual compaction, the concrete laid after the first layer of stone spalls shall be tamped with mason's tool and again it shall be

tamped with suitable tampers and compacted from top and finally struck off level with trowel.

In case of mechanical compaction, the mould shall be filled up to overflow, vibrated and mechanically tamped using external vibrator and struck off level.

**6.14.11.4** De-moulding shall be done 5 to 10 minutes after compaction. In case of fixed type mould it shall be pulled up with side handles while pressing down the block with the plate at top with thumb. In case of split type mould, the sides shall be removed first and the partition plates (gang mould) shall be pulled up subsequently.

**6.14.11.5** After de-moulding, the blocks shall be protected until they are sufficiently hardened to permit handling without damage.

**6.14.12 Curing**

The blocks hardened shall then be cured in a curing water tank or in a curing yard and shall be kept continuously moist for at least 14 days.

**6.14.12.1 Drying** – After curing, the blocks shall be dried for a period of two or four weeks depending upon weather before being used on the work. The blocks shall be allowed to complete their initial shrinkage before they are laid in a wall.

**6.14.13 Physical Requirements**

**6.14.13.1 General:** – All blocks shall be sound and free from cracks or other defects which may interfere with the proper placing of the unit or impair the strength or performance of the construction.

**6.14.13.2** Where blocks are to be used in exposed wall construction, the face or faces that are to be exposed shall be free of chips, cracks or other imperfections, except that not more than 5% of a consignment may contain slight cracks or small chipping.

**6.14.13.3 Dimensions:** The overall dimensions of the blocks when measured as given in Appendix A of IS: 12440 (IS Code on Precast Concrete Masonry Blocks) shall be in accordance with para 6.14.2 subject to the tolerances mentioned therein.

**6.14.13.4 Compressive Strength:** The minimum compressive strength at 28 days, being the average of eight blocks, and the minimum compressive strength at 28 days of individual blocks, when tested in the manner described in Appendix B of IS: 12440 (IS Code on Precast Concrete Stone Masonry Blocks) shall be as prescribed in **Table.6.5**.

**TABLE 6.5**  
**COMPRESSIVE STRENGTH OF CONCRETE STONE MASONRY BLOCKS**

Class Designation	Minimum average compressive strength on blocks N/mm <sup>2</sup>	Minimum strength of individual blocks N/mm <sup>2</sup>
5	5.0	3.5
6	6.0	4.2
7	7.0	5.0
9	9.0	6.3
10	10.0	7.5

\* For 100 mm wide blocks (for 100mm thick walls) the minimum strength may be 3.5 N/mm<sup>2</sup>.

**6.14.13.5 Water Absorption:** The water absorption being the average of three blocks, when determined in the manner prescribed in Appendix C of IS: 12440 shall be not more than 6% by mass.

#### **6.14.14 Tests**

**6.14.14.1** Tests as described in Appendix A of IS: 12440 shall be conducted on samples of blocks selected according to the sampling procedure given in para 6.14.14.2 to ensure conformity with the physical requirements laid down in para 6.14.13.

**6.14.14.2** A sample of 15 blocks shall be taken from a lot of 5000 or part thereof manufactured under similar conditions of the same size and batch.

#### **6.14.15 Criteria for Conformity**

**6.14.15.1** The lot shall be considered as conforming to the requirements of the specification if the conditions mentioned in paras 6.14.15.3 & 6.14.15.4 are satisfied.

**6.14.15.2** Number of blocks with dimensions outside the tolerance limit and/or with visual defects, among those inspected shall be not more than two.

**6.14.15.3** For compressive strength, the mean value determined shall be greater than or equal to the minimum limit specified in para 6.14.13.4.

**6.14.15.4** For water absorption the mean value determined shall be equal to or less than maximum limit specified in para 6.14.13.5.

#### **6.14.16 Laying**

The laying of pre cast concrete stone block masonry shall be as per para 6.15.8.

### **6.15 HOLLOW AND SOLID CONCRETE BLOCK MASONRY**

#### **6.15.1 Hollow and solid concrete blocks**

They shall conform to the requirements of IS:2185. "Specification for hollow and solid concrete blocks" except with regard to the mix of cement concrete and sizes of aggregates which shall be as indicated. Hollow blocks shall be sound, free from cracks, broken edges, honey combing and other defects that would interfere with the proper placing of block or impair the strength or performance of construction.

#### **6.15.2 Dimensions and Tolerances**

**6.15.2.1** Concrete masonry building units shall be made in sizes and shapes to fit different construction needs. They include stretcher, corner, double corner or pier, jamb, header, bull nose, and partition block and concrete floor units.

**6.15.2.2** Concrete Block-hollow (open or closed cavity) or solid shall be referred to by its nominal dimensions.

The nominal dimensions of concrete block shall be, as follows:-

Length: 400, 500 or 600 mm

Height: 200 or 100 mm

Width: 50, 75, 100, 150, 200, 250 or 300 mm

In addition, blocks shall be manufactured in half lengths of 200, 250 or 300 mm to correspond to the full lengths.

The maximum variation in the length of the units shall be not more than  $\pm 5$  mm and maximum variation in height and width of unit, not more than  $\pm 3$  mm.

#### **6.15.3 Classification**

##### **6.15.3.1 Hollow (open and closed cavity) Concrete Blocks**

The hollow (open and closed cavity) concrete blocks shall conform to the following three grades:

(a) Grade 'A' – These are used as load bearing units and shall have a minimum block-density of 1500 kg/m<sup>3</sup>. These shall be manufactured for minimum average

compressive strengths of 3.5, 4.5, 5.5 and 7.0 N/mm<sup>2</sup>

respectively at 28 days (see **Table 6.6**).

(b) Grade 'B' – These are also used as load bearing units and shall have a block density less than 1500 kg/ m<sup>3</sup> but not less than 1000 kg/m<sup>3</sup>. These shall be manufactured for minimum average compressive strengths of 2.0, 3.0 and 5.0 N/mm<sup>2</sup>

respectively at 28 days (see **Table 6.6**).

(c) Grade 'C' - These are used as non-load bearing units and shall have a block-density less than 1500 kg/m<sup>3</sup> but not less than 1000/ m<sup>3</sup>. These shall be manufactured for

minimum average compressive strength of 1.5 N/mm<sup>2</sup> at 28 days (see **Table 6.6**).

(d) Grade 'D' – The solid concrete blocks are used as load bearing units and shall have a block density not less than 1800 kg/ m<sup>3</sup>. These shall be manufactured for minimum average compressive strengths of 4.0, and 5.0 N/mm<sup>2</sup> respectively at 28 days (see **Table 6.6**).

**6.15.4 Physical Requirements**

**6.15.4.1. Compressive Strength:** the average crushing strength of eight blocks, when determined in accordance with IS: 2185 shall be not less than that specified in Table given below:-

**TABLE 6.6  
PHYSICAL REQUIREMENTS OF HOLLOW AND SOLD CONCRETE BLOCKS**

Type	Grade	Density of Block kg/ m <sup>3</sup>	Minimum Average Compressive Strength of Units N/mm <sup>2</sup>	Minimum Strength of Individual Units N/mm <sup>2</sup>
(1)	(2)	(3)	(4)	(5)
Hollow (open & closed cavity) load bearing unit	A(3.5) A(4.5) A(5.5) A(7.0)	Not less than 1500	3.5 4.5 5.5 7.0	2.8 3.6 4.4 5.6
	B(2.0) B(3.0) B(5.0)	Less than 1500 but not less than 1000	2.0 3.0 5.0	1.6 2.4 4.0
Hollow (open & closed cavity) non-load bearing unit	C(1.5)	Less than 1500 but not less than 1000	1.5	1.2
Solid load bearing units	D(4.0) D(5.0)	No less than 1800	4.0 5.0	3.2 4.0

**6.15.4.2 Drying Shrinkage:** The drying shrinkage of the blocks (average of three blocks) when unrestrained, shall be determined in accordance with IS:2185 and shall not exceed 0.1 per cent.

**6.15.4.3 Moisture Movement:** The moisture movement (average of three blocks) when determined in the manner described in IS:2185 shall not exceed 0.09 percent.

**6.15.4.4 Water Absorption:** The water absorption (average of three blocks) when determined in the manner described in

IS:2185 shall be not more than 10 percent by mass.

**6.15.4.5** Face shells and webs shall increase in thickness from the bottom to the top of the unit. Depending upon the core moulds used, the face shells and webs shall be flared and tapered or straight tapered, the former providing a wider surface for mortar. The thickness of the face shell and web shall be not less than the values given in **Table 6.7**.

**TABLE 6.7  
MINIMUM FACE SHELL AND WEB THICKNESS**

Nominal Block width mm	Face shell Thickness Min. mm	Thickness of Web Min. mm	Total Web Thickness per Course in any 200 mm length of Walling Min.mm
(1)	(2)	(3)	(4)
100 or less	25	25	25
Over 100 to 150	25	25	30
Over 150 to 200	30	25	30
Over 200	35	30	38

**6.15.4.6** Subject to the tolerances specified in para 6.15.2.2 and the provisions of para 6.15.4.7 the face of masonry units shall be flat and rectangular, opposite faces shall be parallel, and all arises shall be square. The bedding surfaces shall be at right angles to the faces of the blocks.

**6.15.4.7** Blocks with special faces shall be manufactured and supplied as directed by the Engineer.

**6.15.5 Curing and Drying**

The blocks shall be cured in an immersion tank or in a curing yard and shall be kept continuously moist for at least 14 days. When the blocks are cured in an immersion tank, the water of tank shall be changed at least every four days.

After curing, the blocks shall be dried in shade before being used on the work. They shall be stacked with voids horizontal to facilitate through passage of air. The blocks shall be allowed to complete their initial shrinkage before they are laid in wall.

**6.15.6 Construction of Masonry**

For single storeyed buildings, the hollows of blocks in foundation and basement masonry shall be filled up with sand and only the top foundation course shall be of solid blocks. But for two or more storeyed buildings, solid concrete blocks shall be used in foundation courses, plinth and basement walls, unless otherwise indicated. If hollow blocks are used, their hollows shall be filled up with cement concrete 1:3:6 using 12.5 mm nominal size aggregates.

**6.15.7 Wetting of Blocks**

Blocks need not be wetted before or during laying in the walls. In case the climate condition so require, the top and the sides of the bocks may only be slightly moistened so as to prevent absorption of water from the mortar and ensure the development of the required bond with the mortar.

**6.15.8 Laying**

**6.15.8.1** Blocks shall be laid in mortar, as indicated and thoroughly bedded in mortar, spread over the entire top surface of the previous course of blocks to a uniform layer of not less than 10 mm and not more than 12 mm in thickness.

All courses shall be laid truly horizontal and all vertical joints made truly vertical. Blocks shall break joints with those above and below for not less than quarter of their length. Pre-cast half length closers (and not cut from full size blocks) shall be used. For battered faces, bedding shall be at right angles to the face unless otherwise directed. Care shall be taken during construction to see that edges of blocks are not damaged.

**6.15.8.2 Mortar**

(a) Hollow concrete blocks shall be embedded with a mortar which is relatively weaker than the mix used for making blocks in order to avoid formation of cracks. A rich or strong mortar tends to make a wall too rigid thus localizing the effects of movements due to temperature and moisture variations, resulting in cracking of blocks. The recommended proportion of mortar measured by volume is given in **Table 6.8**.

**Table 6.8 Mix Proportions of Mortar for Hollow Concrete Blocks**

SL	Type of Work	Normal Masonry (Cement: Lime: Sand)	Reinforced Masonry (Cement: Sand)
1	Normal Work	1:1:9 to 10	1:7 to 8
2	Exposed to severe conditions; high intensity of loads; pilasters; heavily loaded lintels and beams	1:1:6 to 7	1:4 to 5
3	Partitions of 10cm	1:1:7 to 8	1:5 to 6

Note : All mortars shall have a slump of 75 mm.

(b) Light weight blocks shall be embedded with a mortar mix, the strength of which is lower than mix for making blocks, to avoid formation of cracks. A 1:2:9 cement, lime, sand mortar may generally be used; for high intensity of load it shall be 1:1:6. Autoclaved blocks shall be embedded in mortar as specified in **Table 6.8**.

**6.15.8.3** Concrete used for filling hollow concrete block masonry when reinforced shall be 1 cement, 2 ½ sand and 3 coarse aggregate of size ranging from 4.75 mm to 10mm. The water cement ratio shall not exceed 0.6. When cells exceed 100mm on the narrower side, the proportion of mix shall be 1 cement, 2 ½ sand, 3 ½ coarse aggregate for reinforced concrete and 1:3:6 for plain concrete.

**6.15.8.4 Thickness of Walls:-** (a) For load bearing masonry built with hollow concrete blocks, the thickness of walls shall not be less than the values as obtained from IS 1905.

(b) Light weight block in load bearing masonry for external walls in framed construction shall not be less than 200mm thick. However, if they are suitably braced by lateral or vertical supports, the thickness can be 100mm. Non-load bearing hollow block walls shall be not less than 100mm thick.

(c) Autoclaved block walls in framed construction shall also be as per (b), except that for load bearing work, the minimum thickness shall be 200mm; however it can be reduced to 150mm if properly braced.

#### **6.15.8.5 Lateral Support**

Walls made of blocks shall have vertical or horizontal lateral supports at right angles to the face of the wall. Cross walls, pilasters or buttress walls shall provide the lateral support.

#### **6.15.9 Provisions for Door and Window Frames**

A course of solid concrete block masonry shall be provided under door and window openings or a 10 cm thick pre-cast concrete sill block under windows. The solid course shall extend for at least 20 cm beyond the opening on either side. For jambs of very large doors and windows either solid units are used or the hollows shall be filled in with concrete of mix 1:3:6 using 12.5 mm nominal size aggregate.

#### **6.15.10 Provisions for Roof**

The course immediately below the roof slab shall be built with solid blocks. The top of the roof course shall be finished smooth with a layer of cement and coarse sand mortar 1:3, 10 mm thick and covered with a thick coat of white wash or crude oil, to ensure free movement of slab.

#### **6.15.11 Intersecting Walls**

When two walls meet or intersect and the courses are to be laid up at the same time, a true masonry bond between at least 50% of the units at the intersection is necessary. When such intersecting walls are laid up separately, pockets with 20 mm maximum vertical spacing shall be left in the first wall laid. The corresponding course of the second wall shall be built into these pockets.

#### **6.15.12 Piers**

The top course of block in the pier shall be built in solid blocks. Hollow concrete block shall not be used for isolated piers, unless their hollows are specified to be filled with cement concrete.

**6.15.13 Fixtures etc.** Fixtures, fittings, etc. shall be built into the masonry in cement and coarse sand mortar 1:3 while laying the blocks where possible. Hold fasts shall be built into the joints of the masonry during laying.

Holes, chases, sleeves, opening etc., of the required size and shape shall be formed in the masonry with special blocks while laying for fixing pipes, service lines, passage of water etc., After service lines, pipes etc., are fixed, voids left, if any, shall be filled up with cement concrete 1:3:6 (1 cement: 3 coarse sand: 6 stone aggregate 20 mm nominal size) and neatly finished.

#### **6.15.14 Finishes**

Rendering shall not be done to the walls when walls are wet. Joints for plastering or pointing as specified shall be raked to a depth of 12 mm.

Joints on internal faces, unless otherwise indicated, shall be raked for plastering. If the internal faces of masonry are not to be plastered the joints shall be finished flush as the work proceeds or pointed flush where so indicated.

#### **6.15.15 Avoidance of Crack formation**

**6.15.15.1 General:-** One of the main problems faced in a structure constructed with hollow or cellular type blocks is development of cracks. The cracks may arise from alteration in length, curvature or orientation due to load settlement, thermal

expansion or changes in moisture content. By taking preventive measures such cracks can be avoided.

**6.15.15.2 Preventive measures**

Preventive measures to avoid cracks have been explained in detail in Chapter 4 masonry, Section 3 Construction Practices – Block work Para 6 Avoidance of Crack formation of Bureau of Indian Standards “Hand Book on Building Construction

Practices (Excluding Electrical Works) Special Publication SP 62 (S&T), 1997. The same may be referred to for dealing with specific issues. Some of the measures dealt with include provision of Bonded beams and studs used as structural members or provision of horizontal joint reinforcement which serves the same purpose as Bonded beams.

**FIGURES EXPLAINING SOME OF THE ITEMS REFERRED TO IN  
FIGURE 6.1 A & 6.1 B**

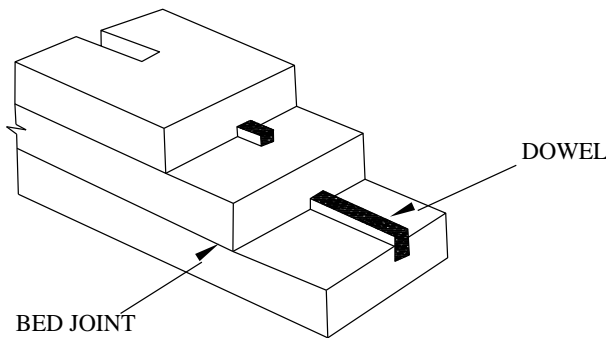


Fig. 6.1 A/1 : Dowel Joint

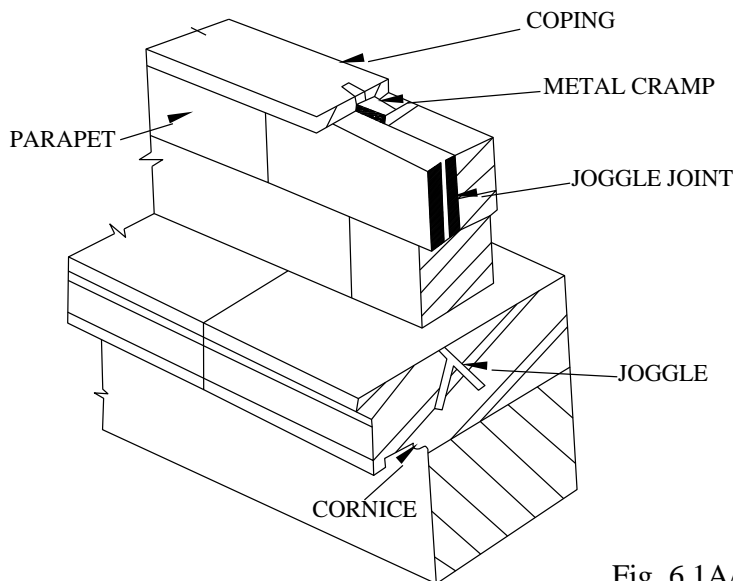


Fig. 6.1A/2 Joggle joint

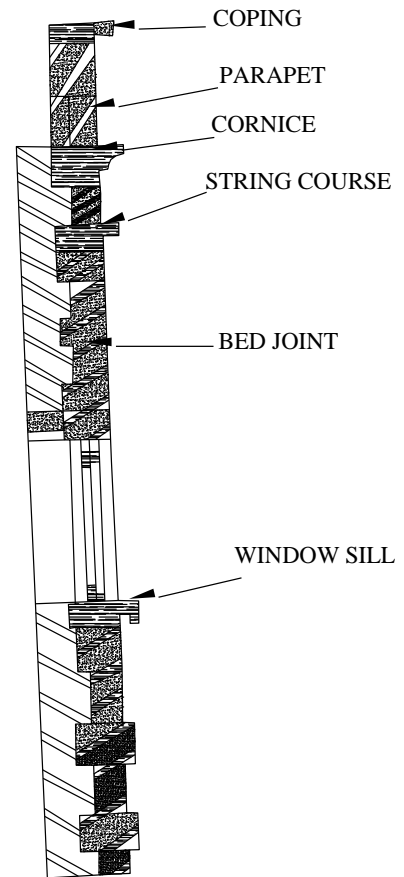


Fig. 6.1A/3 Section of Ashlar with Brick Backing

FIGURE 6.1 B

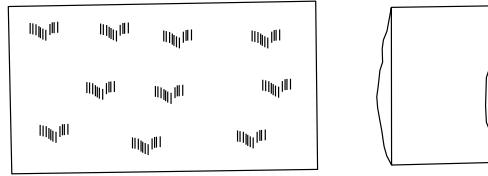


Fig. 6.1B/1 Hammer Dressed Stone Surface

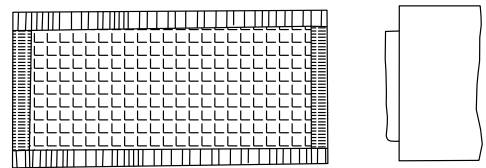
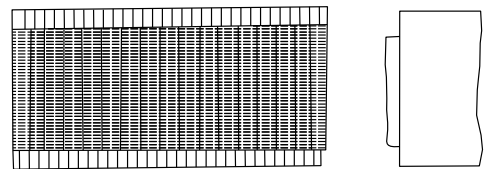


Fig.6.1 B/2 Punched Stone Face Surface (Chisel drafted)

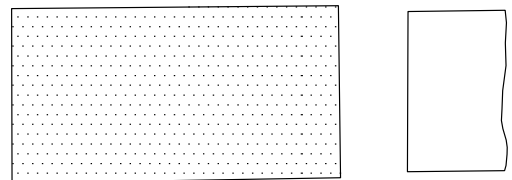


Fig.6.1 B/3 Close Picked Stone Surface

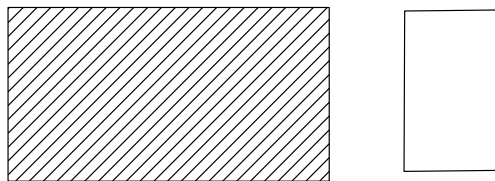
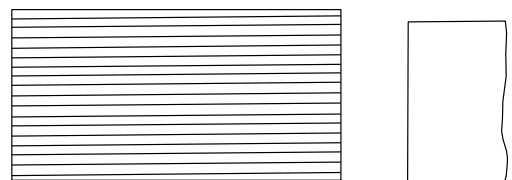
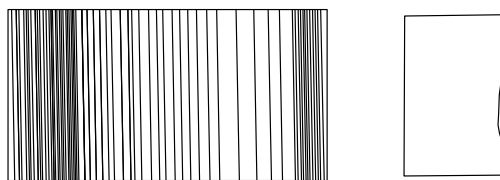
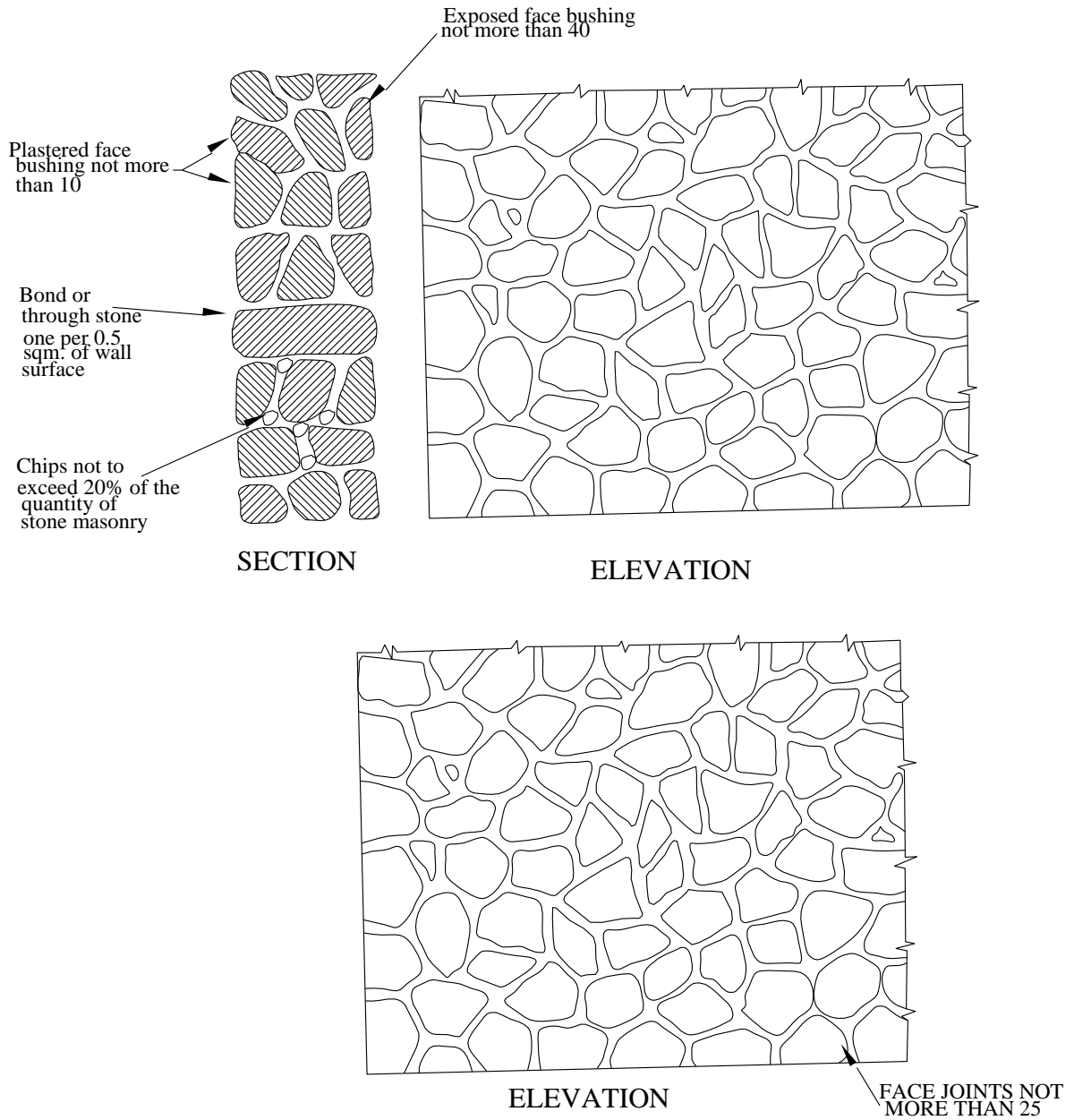


Fig.6.1 B/4 Fine Tooled Stone Surface



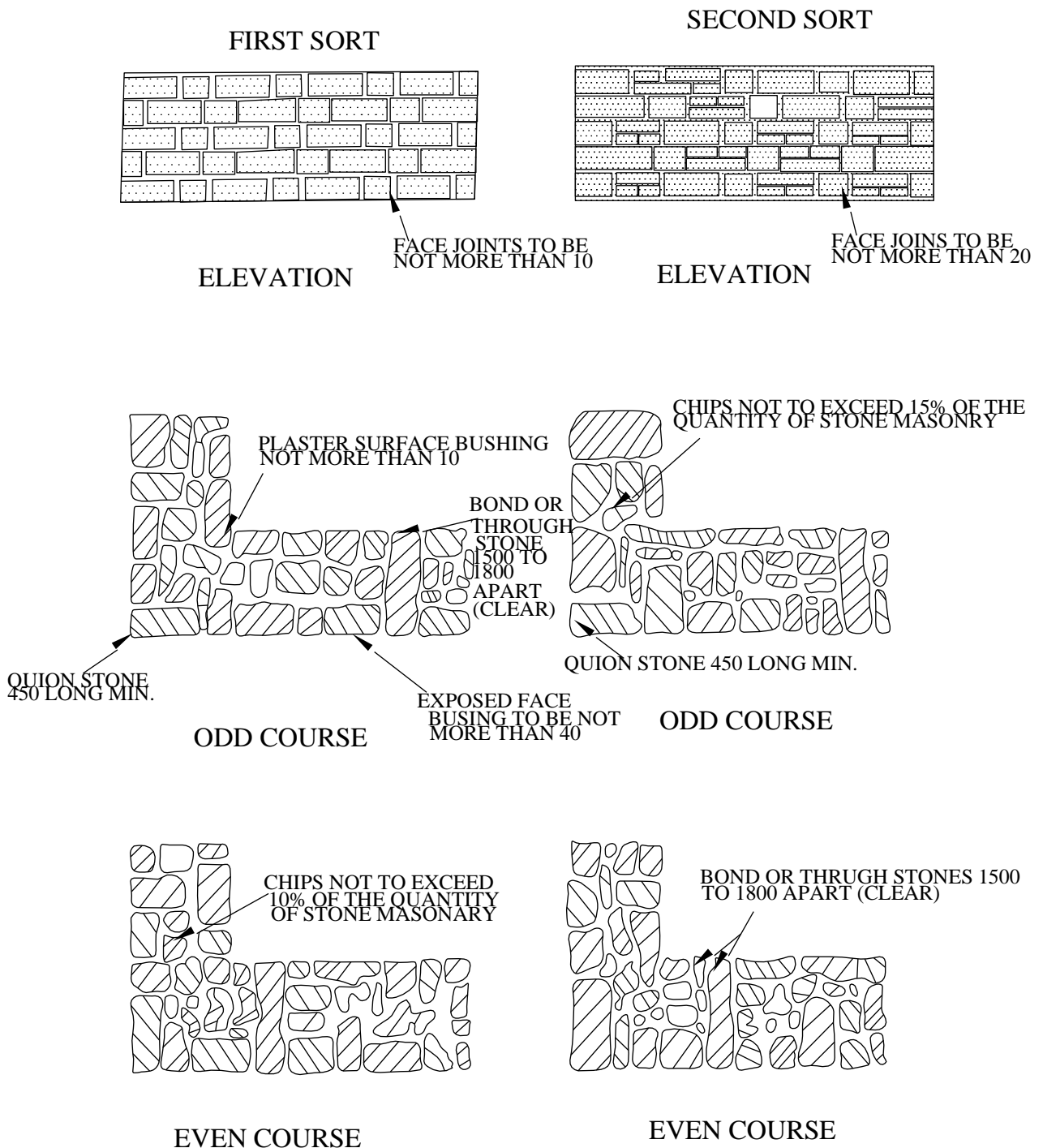
### RANDOM RUBBLE MASONRY UNCOURSED

FIGURE 6.2



### RUBBLE MASONRY - COURSED

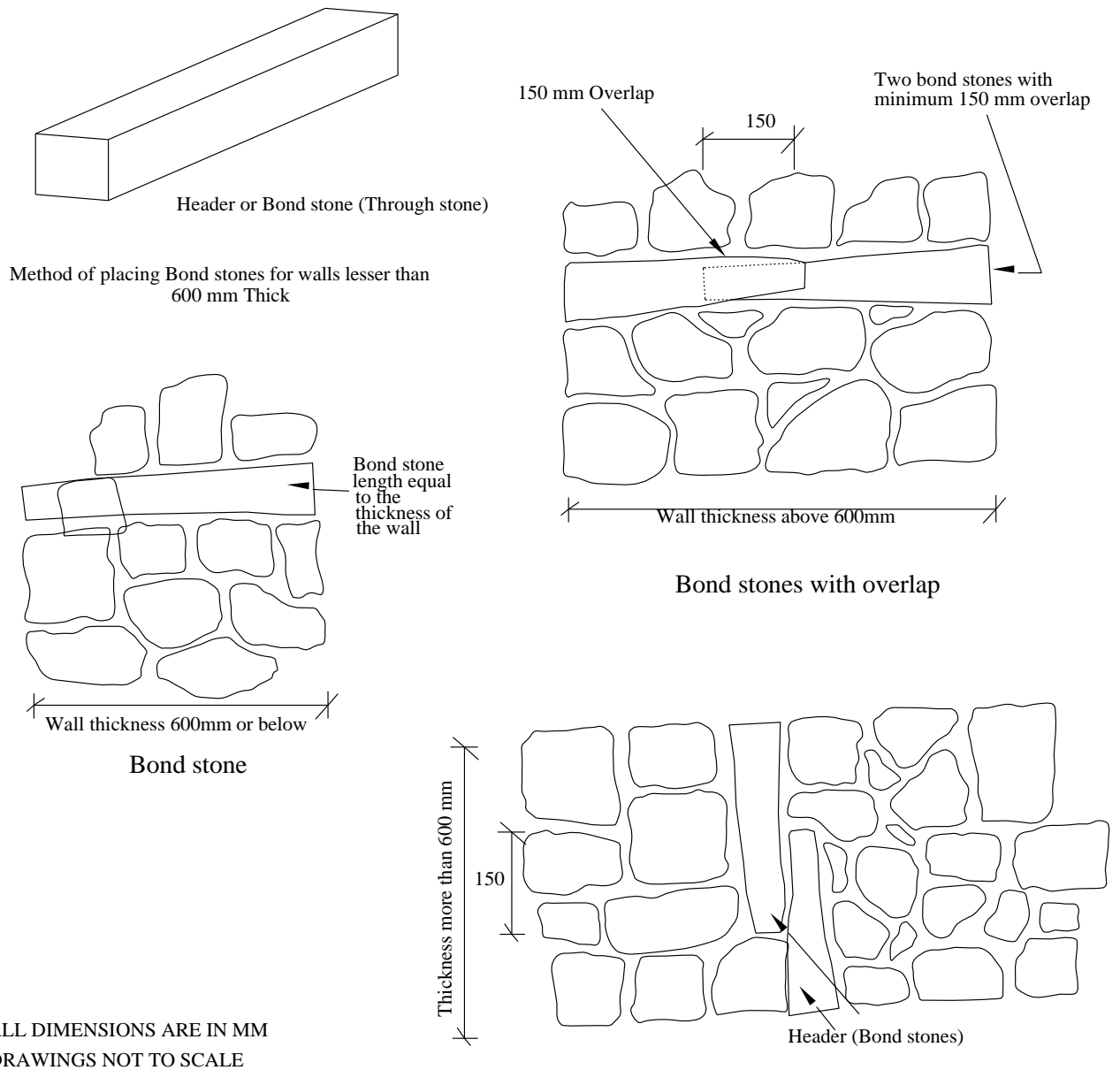
FIGURE 6.3



Note : Squared Rubble Masonry is the same as Coursed Rubble Masonry except that the stones need not be coursed throughout. The stones can be of height between 10 cm and 20 cm with a small proportion of smaller stones to fill gaps in between main stones. All stones shall be laid with horizontal bed joints. Headers shall be provided at the rate of atleast one per sqm of wall face. The work shall be brought up level throughout at every 1m of height.

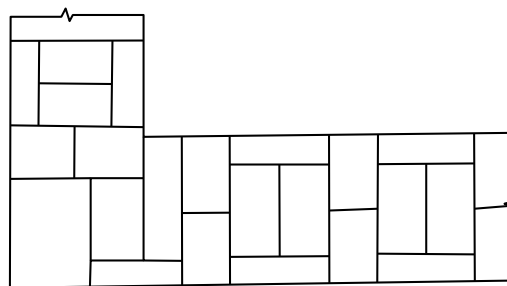
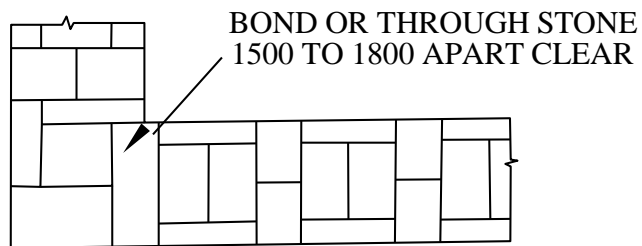
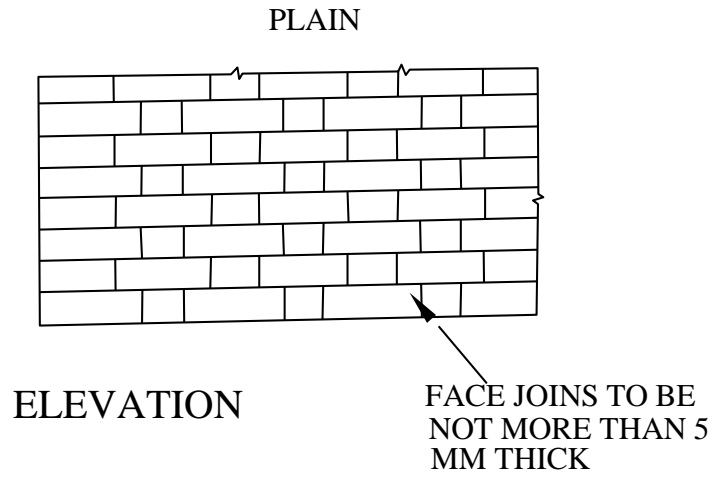
**RANDOM RUBBLE MASONRY - DIFFERENT METHODS OF PROVIDING HEADER (BOND STONES) IN A STONEMASS**

FIGURE 6.4



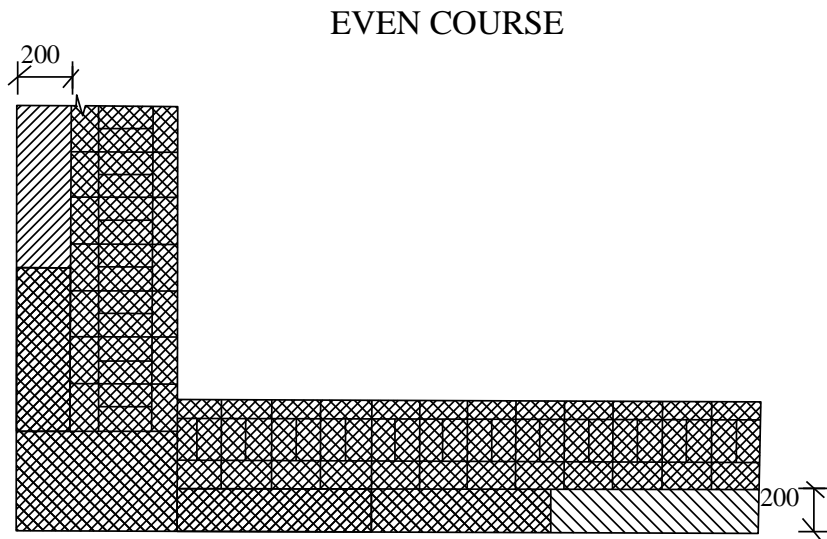
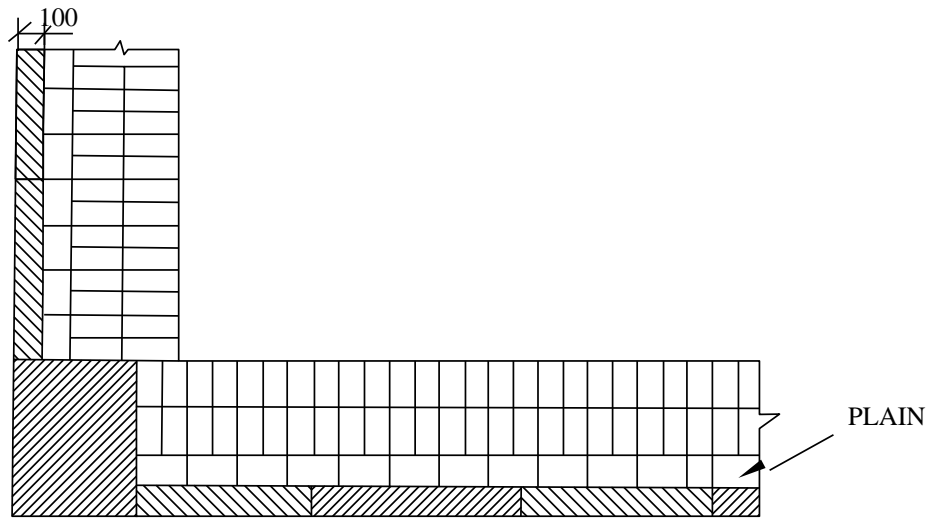
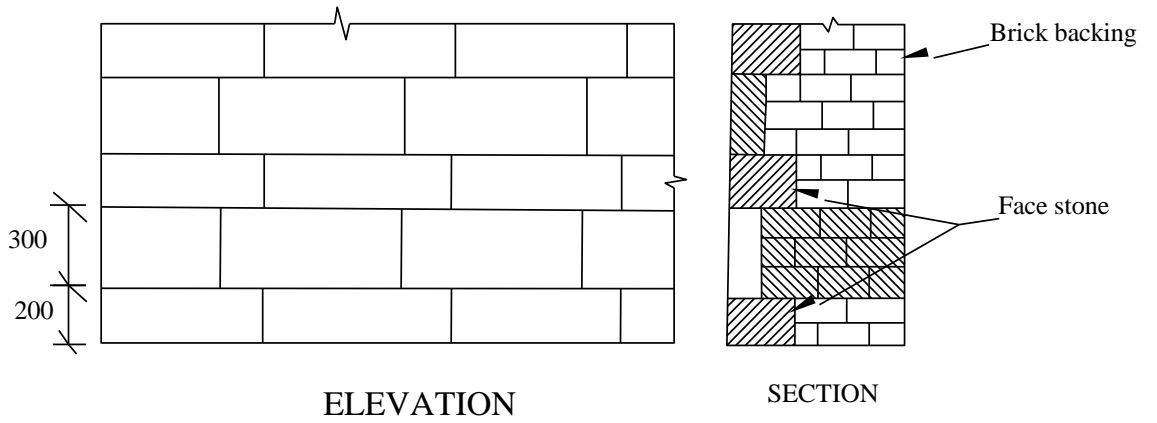
# ASHLAR STONE MASONRY - PLAIN

## FIGURE 6.5



### ASHLAR STONE MASONRY - BRICK BACKING

FIGURE 6.6



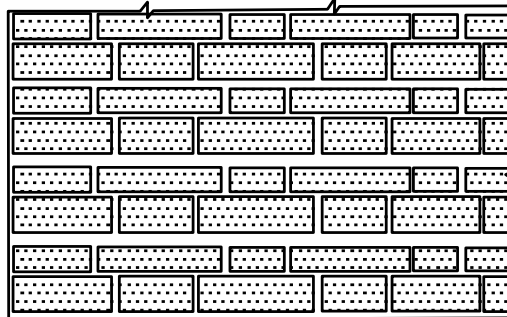
ALL DIMENSIONS ARE IN MM  
DRAWINGS NOT TO SCALE

ODD COURSE

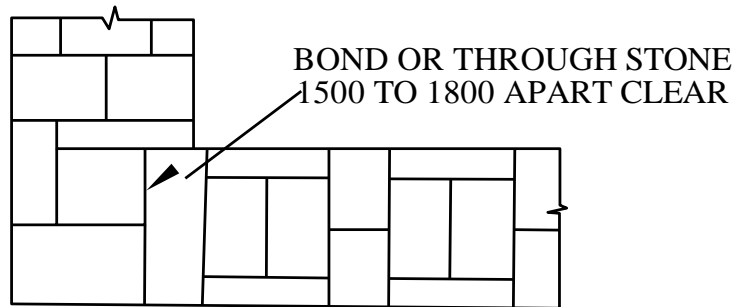
# PUNCHED ASHLAR MASONRY

FIGURE 6.7 A

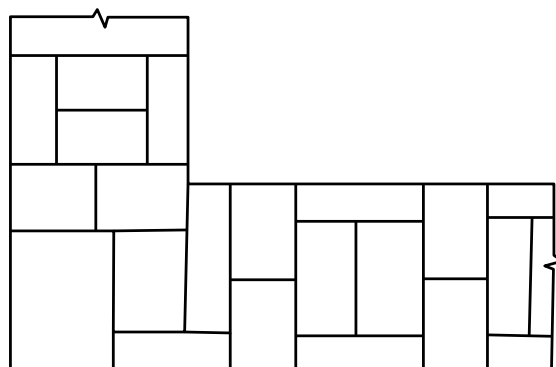
## PUNCHED (ORDINARY)



## ELEVATION



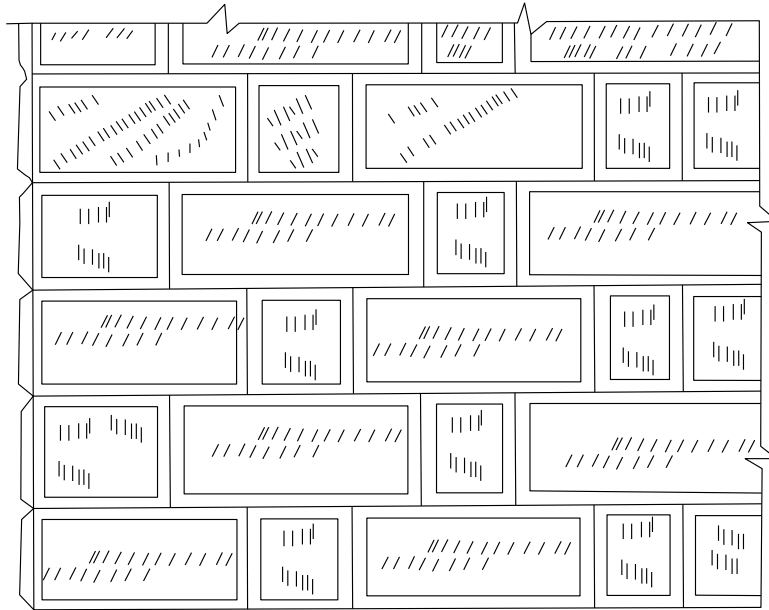
## ODD COURSE



## EVEN COURSE

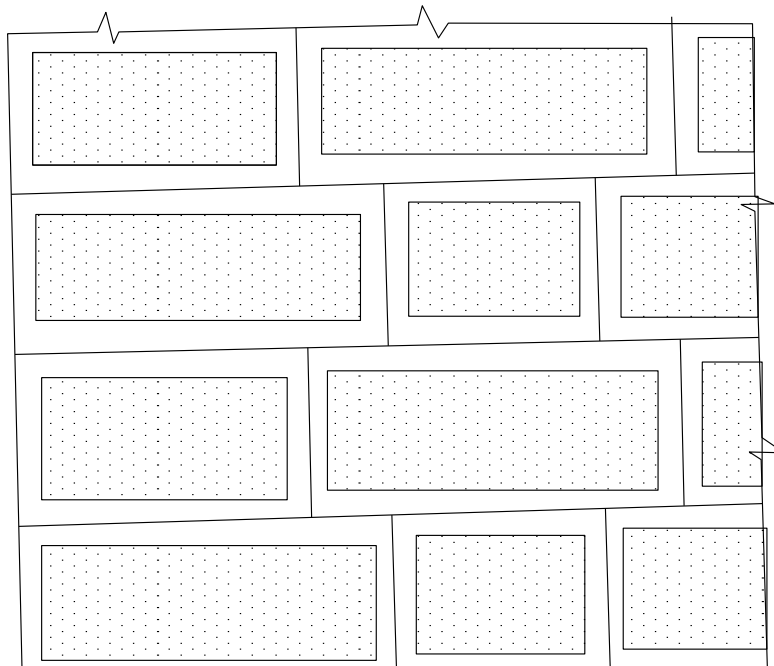
### ASHLAR - ROCK FACED

FIGURE 6.7 B



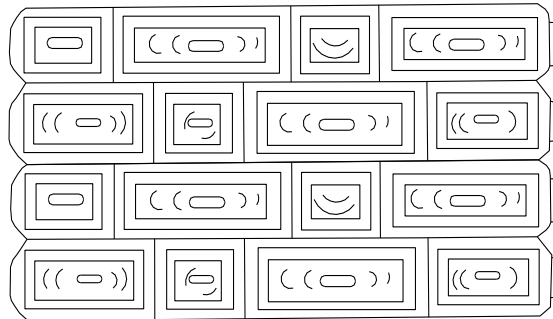
### ASHLAR - ROUGH TOOLED

FIGURE 6.7 C



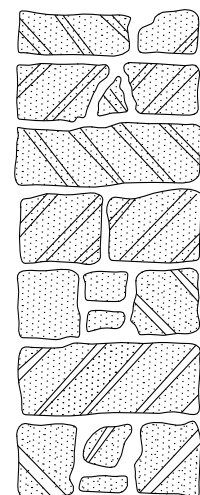
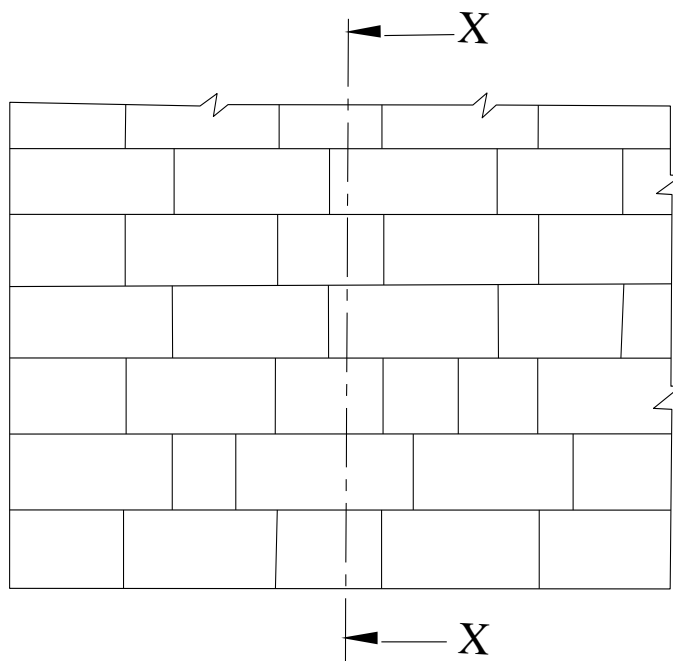
# ASHLAR - CHAMFERED

FIGURE 6.7 D



# ASHLAR - BLOCK IN COURSE

FIGURE 6.7 E

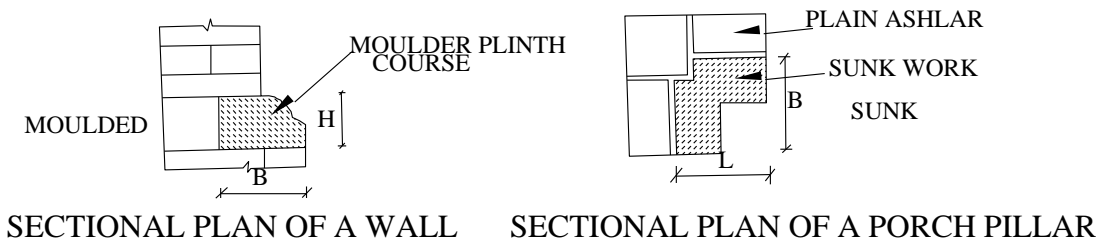
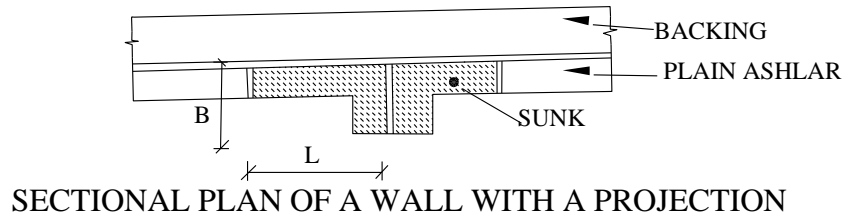
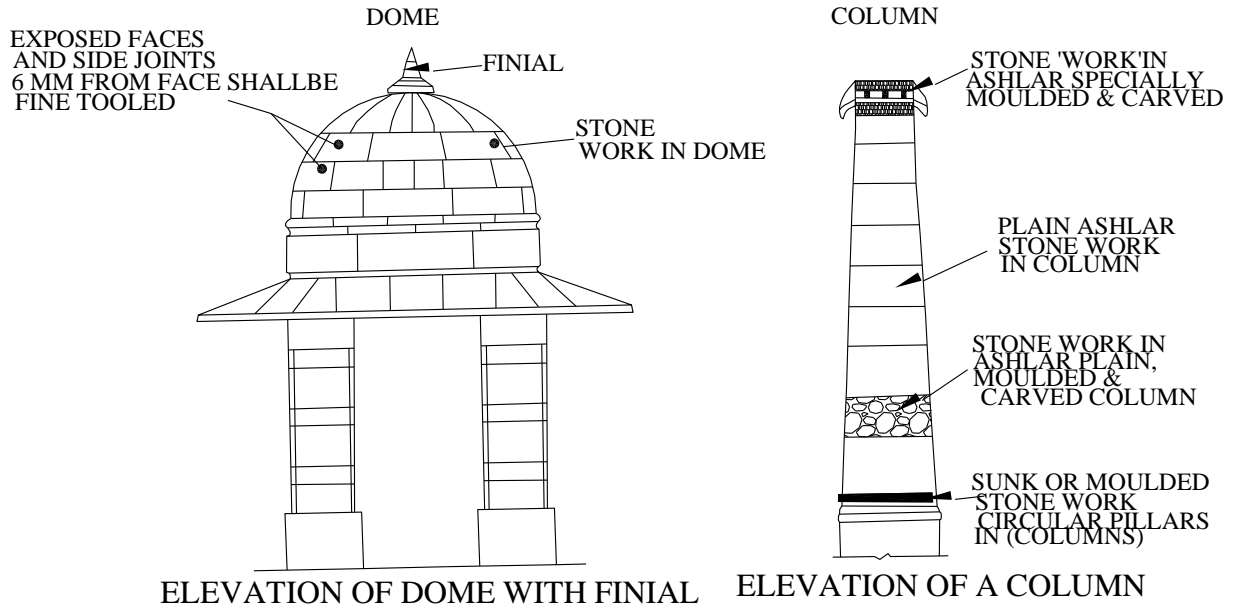


SECTION XX



MOULDED SUNK, CURVED ASHLAR MASONRY

FIGURE 6.8

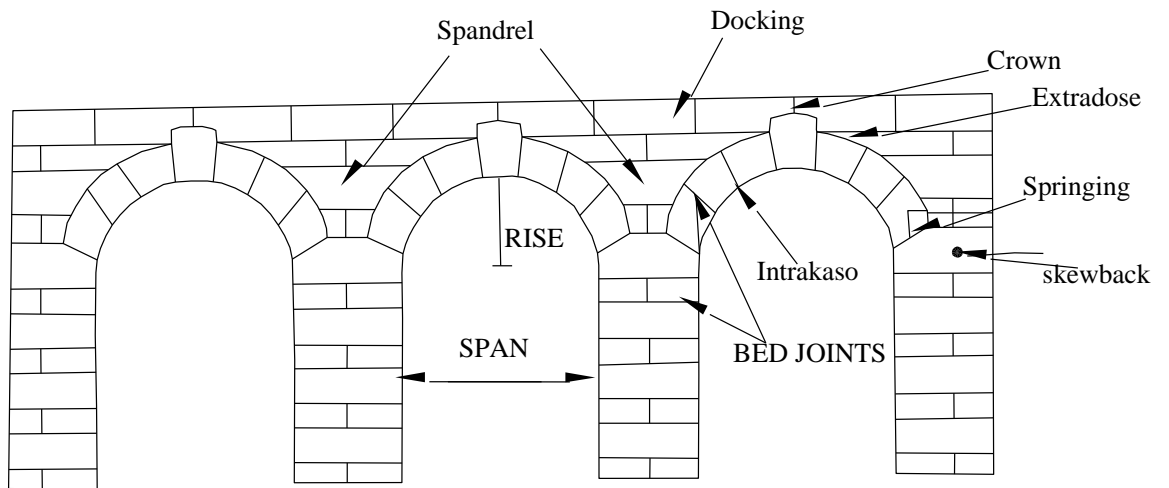


Note: Sunk or moulded stone work shown shaded, to be measured as 1xbxh

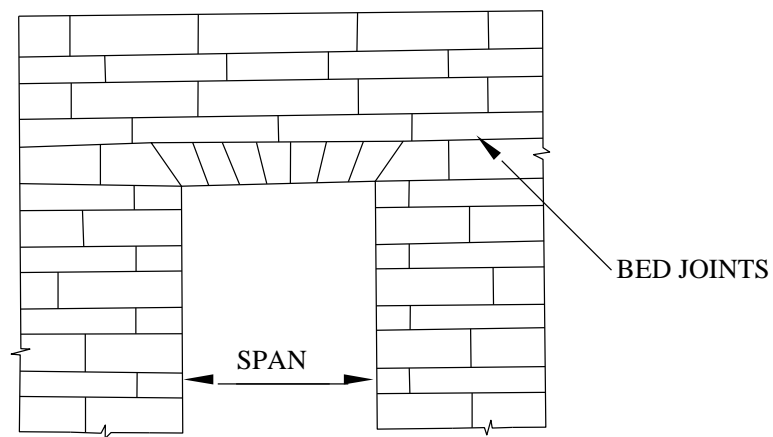
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DRAWINGS NOT TO SCALE

## STONE WORK IN ARCHES - ASHLAR MASONRY

FIGURE 6.9



CIRCULAR ARCH

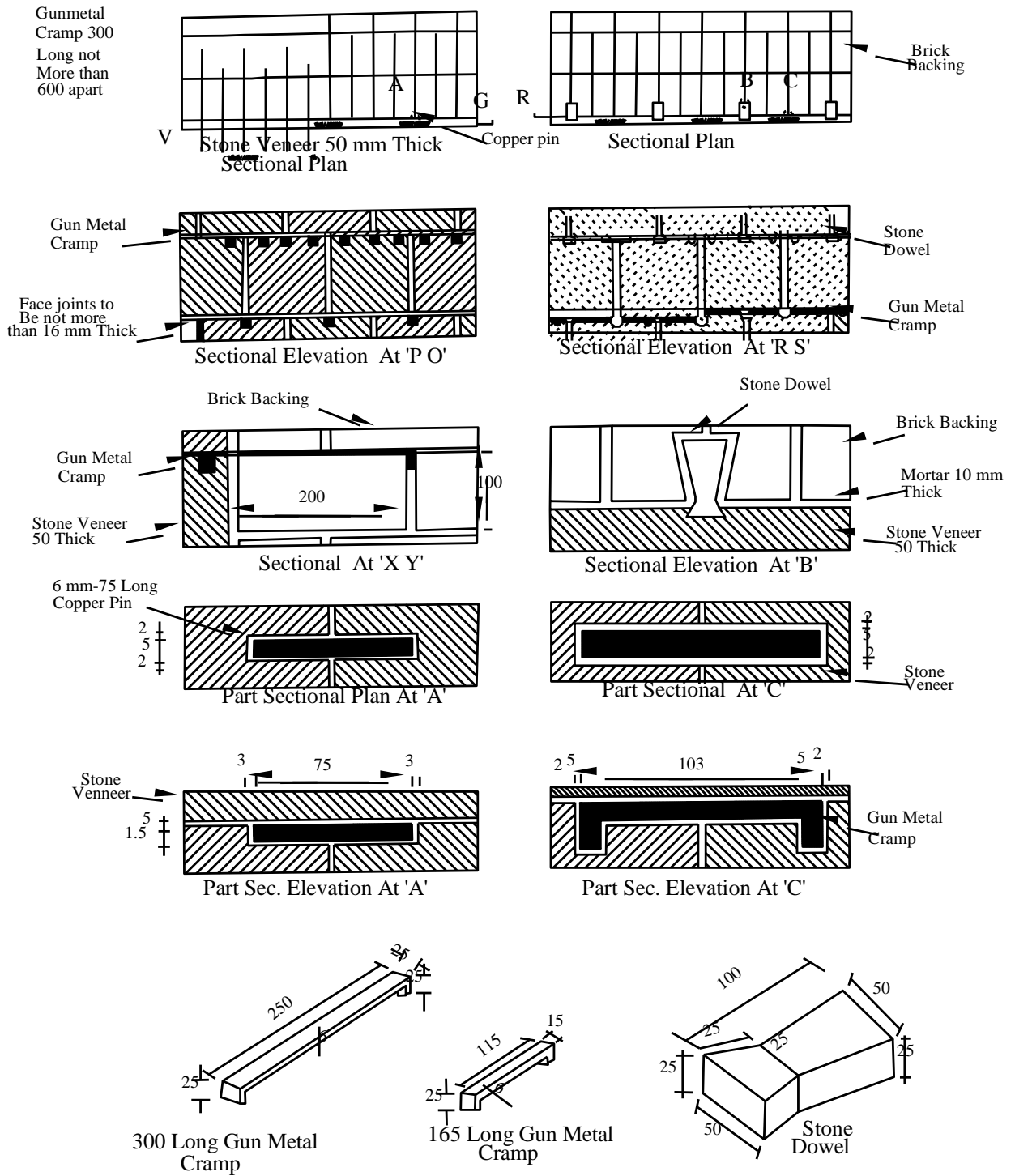


FLAT ARCH

ALL DIMENSIONS ARE IN MM  
DRAWINGS NOT TO SCALE

# STONE VENEERING - GENERAL FIXING ARRANGEMENTS

FIGURE 6.10



ALL DIMENSIONS ARE IN MM  
DRAWINGS NOT TO SCALE

## STONE VENEERING - TYPICAL FIXING ARRANGEMENTS

FIGURE 6.11

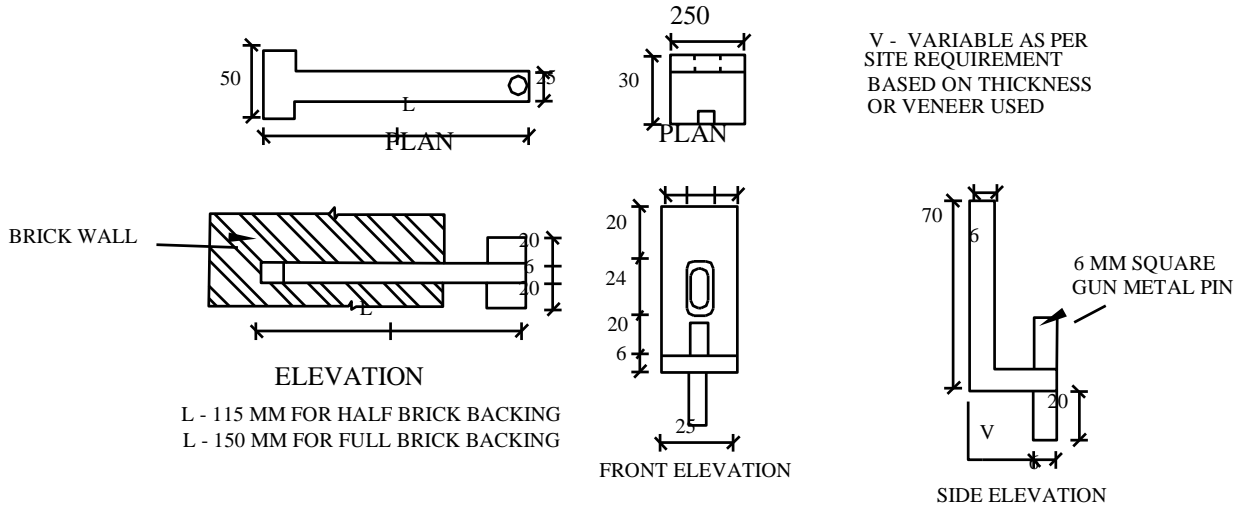


Fig. 6.11: Cramp for Brick Backing

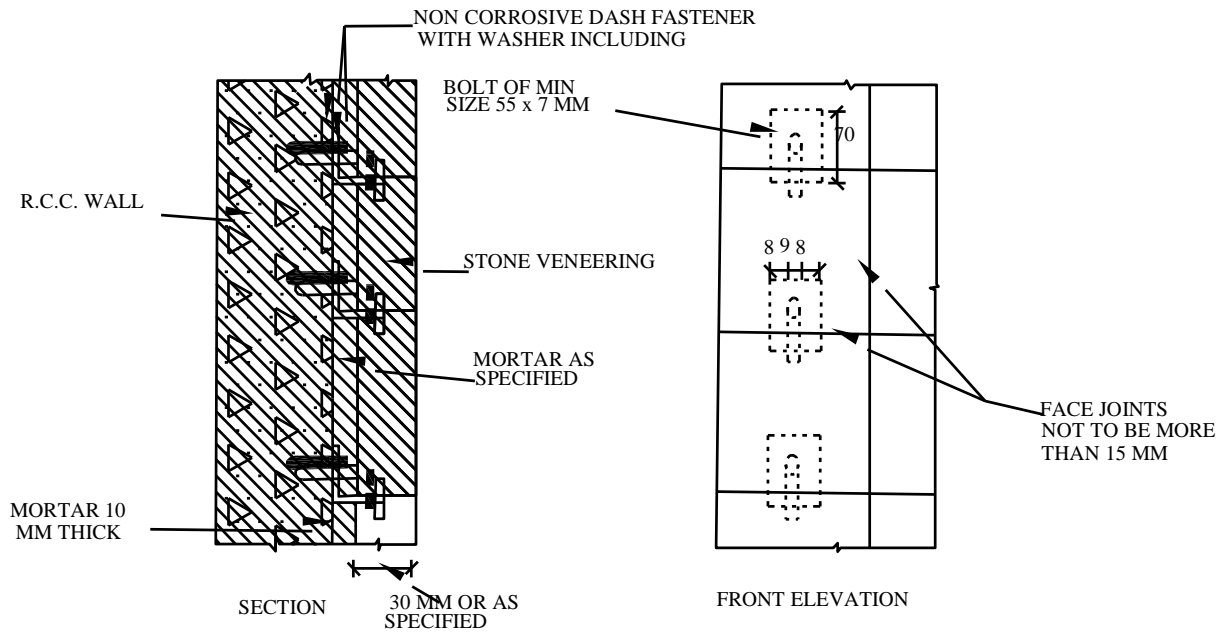


Fig. 6.11 : Cramp for R.C.C. Work Backing

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DRAWINGS NOT TO SCALE

## STONE VENEERING - GENERAL ARRANGMENT AND CRAMPS

FIGURE 6.12

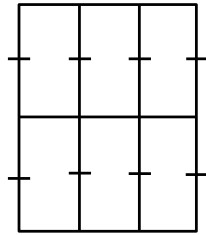


Fig 6-12 A

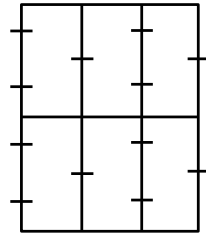


Fig 6-12 B

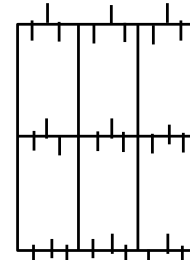


Fig 6-12 C

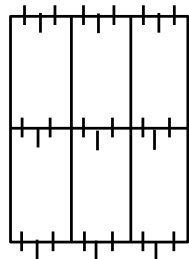


Fig 6-12 D

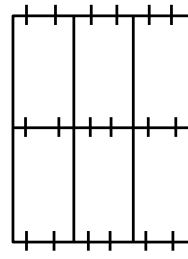


Fig 6-12 E

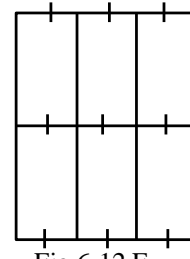


Fig 6-12 F

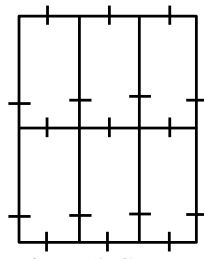


Fig 6-12 G

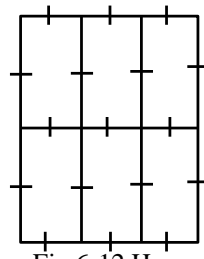


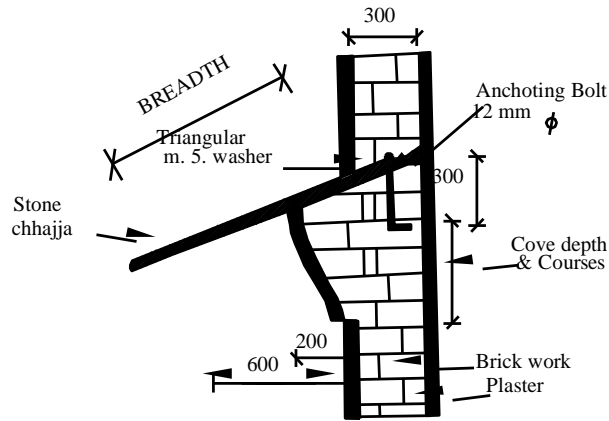
Fig 6-12 H

NOTE : CRAMPS ARRANGMENT IS SHOWN ABOVE FOR VENEERINGS WITH LONGER SIDES VERTICAL FOR VENEERINGS HAVING THE LONGER SIDES HORIZONTAL CRAMPS WOULD BE ARRANGED TO SUIT THE ALTERED POSITIONS

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DRAWINGS NOT TO SCALE

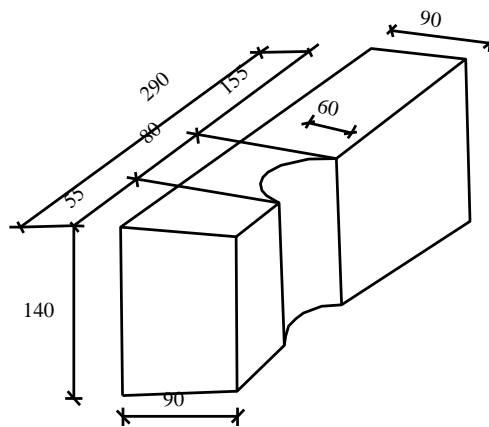
### STONE CHHAJJAS

FIGURE 6.13



### SPECIAL BLOCK FOR EMBEDDING VERTICAL STEEL REINFORCEMENT

FIGURE 6.14



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DRAWINGS NOT TO SCALE