IS 1597-1 (1992): Construction of Stone Masonry - Code of Practice, Part 1: Rubble Stone Masonry [CED 13: Building Construction Practices including Painting, Varnishing and Allied Finishing]

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IS 1597 (Part 1) : 1992
(Reaffirmed 2002)

भारतीय मानक

पत्थर की चिनाई के निर्माण — रीति संहिता

भाग 1 रब्बल पत्थर की चिनाई

(पहला पुनरीक्षण)

Indian Standard

CONSTRUCTION OF STONE MASONRY — CODE OF PRACTICE

PART 1 RUBBLE STONE MASONRY

(First Revision)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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Price Group 6

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Building Construction Practices Sectional Committee had been approved by the Civil Engineering Division Council.

Use of stone masonry work is known and practised from the earlier days and natural stone is extensively available in many parts of this country. The types of stone masonry construction followed depends on local factors like physical characteristics of the stone, climatic conditions, workmanship, etc. Certain broad principles in laying, bonding, breaking of joints and finish should be complied with in order that the masonry develops adequate strength and presents a neat appearance.

This standard (Part 1) covers rubble masonry which is commonly used in stone work in most cases. Part 2 of the standard covers ashlar masonry.

This standard was first published in 1967. The present revision has been taken up to incorporate the improvements found necessary in light of the usage of this standard and the suggestions made by various bodies implementing it.

In the preparation of this standard several construction agencies in this country having wide experience in stone work have been consulted. Due weightage has been given to international co-ordination among the standards and practices prevailing in different countries.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

CONSTRUCTION OF STONE MASONRY — CODE OF PRACTICE

PART 1 RUBBLE STONE MASONRY

(First Revision)

1 SCOPE

1.1 This standard (Part 1) covers the design and construction of rubble stone masonry.

1.2 This standard covers only construction practices generally met with in India.

1.3 This standard does not cover:

a) stone facing and veneering work,
b) stone lintels,
c) stone stair case, and
d) masonary for dams and other massive masonary work.

2 REFERENCES

The Indian Standards listed in Annex A are necessary adjuncts to this standard.

3 TERMINOLOGY

3.0 For the purpose of this standard, the following definitions and the terms pertaining to dressing of stones and tools for masonry work, as given in IS 1805 : 1973 shall apply.

3.1 Ashlar

Stone masonry using dressed square stone blocks to given dimension and laid in courses.

3.2 Arris

A sharp edge formed by two planes (*see* Fig. 8).

3.3 Bed Joint

The joint where one stone presses on another, for example, a horizontal joint in a wall or a radiating joint between the voussoirs of an arch (*see* Fig. 8).

3.4 Bond

An interlocking arrangement of structural units in a wall to ensure stability.

3.5 Bond Stone (Through Stone)

Selected long stones used to hold a wall together transversally (*see* Fig. 4).

3.6 Natural Stone

This includes the various types of stones used in building as given in IS 1805 : 1973.

3.7 Corbel

Stone bonded well into the wall with part of it projecting out of the face of wall to form a bearing surface.

3.8 Cornice

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

3.9 Courses

A layer of stones in a wall including the bed mortar.

3.10 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 (*see* Fig. 1A).

3.11 Damp-Proof Course

An impervious layer which prevents movement of moisture.

3.12 Dowels

Dowels are small sections of metal, stone or pebbles bedded with mortar in corresponding mortice in bed or side joints or adjacent stones (*see* Fig. 1B).

3.13 Efflorescence

A powdery encrustment of salt left by evaporation. This may be visible on the surface or may be below surface.

3.14 Flashing

A sheet of impervious material fixed to a structure so as to cover an intersection or joint where water will otherwise leak through.

3.15 Apron Flashing

One piece combined cover and apron used to obtain a waterproof joint (*see* Fig. 2A).

3.16 Cover Flashing

A flashing dressed down as a cover only over a separate upstand (*see* Fig. 2B).

3.17 Hammer Dressing

Rough surfacing to a stone by means of a spall hammer.

3.18 Hearting

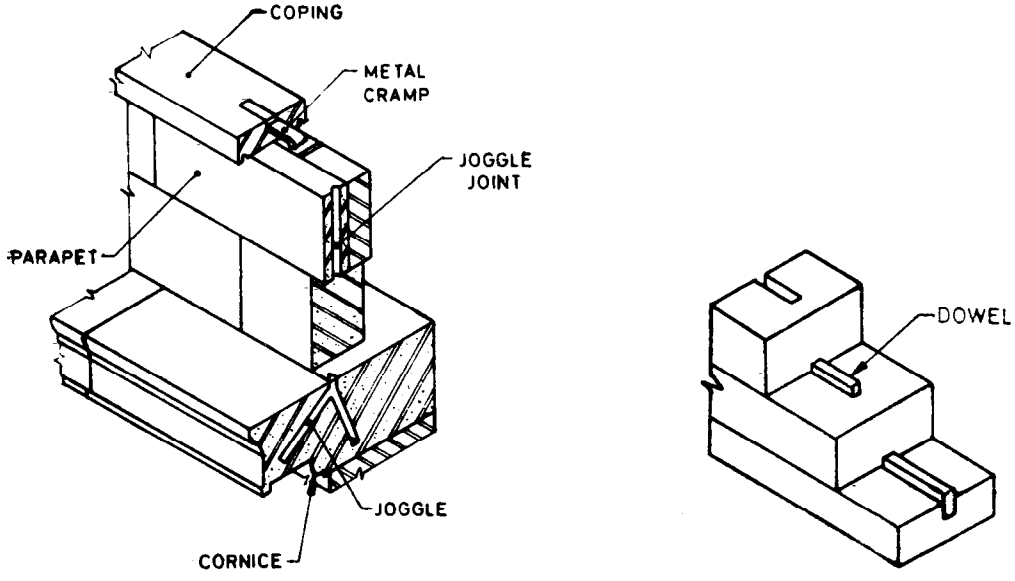
The infilling which forms the core of a rubble wall (*see* Fig. 4).

3.19 Jamb

The part of the wall at the side of an opening.

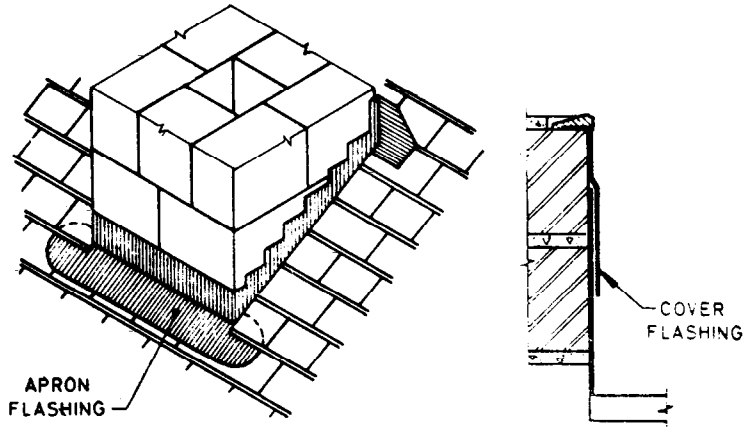
3.20 Joggle

A key between the stones by providing groove in one stone to take a corresponding concealed projection in the edges on the other stone (*see* Fig. 1A).



1A Joggle Joint 1B Dowel Joint

FIG. 1 JOGGLES, CRAMPS AND DOWELS



2A Apron Flashing 2B Cover Flashing

FIG. 2 FLASHINGS

3.21 Natural Bed

The plane of stratification that occurs in sedimentary rocks.

3.22 Parapet

A solid or pierced guard wall for flat terrace or a 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 (*see* Fig. 3)

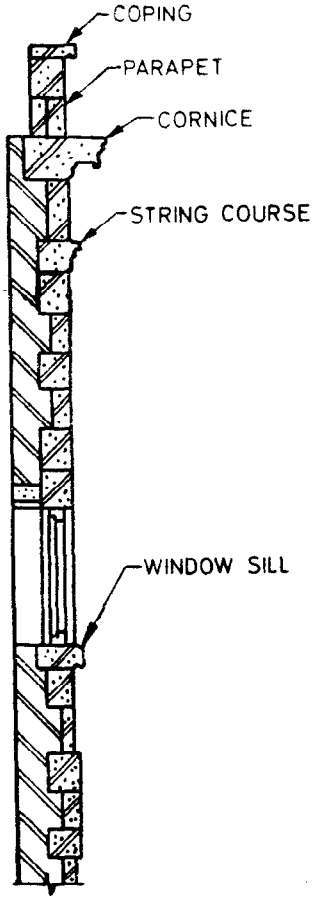


FIG. 3 SECTION OF ASHLAR WITH BRICK MASONRY

3.23 Pointing

Pointing is a finish applied to the face of mortar joints in walling.

3.24 Plum Stone (Pin-Header)

Selected long stones embedded vertically in the interior of masonry wall to form a bond between successive courses.

3.25 Quarry Sap

Quarry sap is the moisture contained in newly quarried stone.

3.26 Quion

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

3.27 Random

Of irregular sizes and shapes.

3.28 Reveal

The part of the jamb between the frame and the arris.

3.29 Rubble Walling

Walling built of stones either irregular in shape as quarried of squared and only hammer dressed and having comparatively thick joints. Stones for rubble walling are, as far as possible, angular.

3.30 Scaffold

A temporary erection of timber or steel framing with boarded platform at levels suitable for building, well in stages.

3.31 Sleeper Walls

Low walls erected at intervals between the main walls to provide intermediate supports at the lowest floor.

3.32 Storey Rod

A batten of exact height on which vertical dimensions are marked. It can also be used as a gauge-rod.

3.33 String Course

A horizontal band, plain or moulded, usually projecting slightly from the face of a wall (*see* Fig. 3).

3.34 Template or Bed Block

A block of stone or concrete bedded on a wall to distribu the pressure from a concentrated load.

4 NECESSARY INFORMATION

For efficient planning, design and execution of the work detailed information with regard to the following shall be furnished to those responsible for the work:

a) Layout plan showing the orientation of the structure;

b) Dimensioned details of the structures with details of sections (to a suitably large scale, that is, 1/20 or 1 mm = 20 mm) and levels of foundations, finished ground levels, clear floor to floor heights of rooms, sizes or openings; etc,

c) Type of stone and classes of masonry, types of bond and final finish for the masonry; the mixes of mortar to be used, etc; details of architectural features, mouldings and other special work; and

d) Location and other details of openings, chases, embedments of service lines, such as for water supply, drainage and electrical installations and location and details of hearths, flues and chimneys.

5 MATERIALS

5.1 Stone

5.1.1 *Types*

The common types of natural building stones which are generally used are, granite and other igneous rocks, lime stone (including marble), sandstone, etc. For the properties of these types of stones reference may be made to IS 1123 : 1975.

5.1.2 *Quality*

All stones used for building purposes shall be strong, hard and durable as indicated in **5.1.2.1** and **5.1.2.2.**

5.1.2.1 *Strength*

The strength of building stones should be adequate to carry the loads imposed. For ashlar and coursed rubble masonry, the strength shall be as worked in accordance with IS 1905 : 1987, taking into account, the appropriate crushing strength of stone as given in Table 1, and also the type of mortar used. For random rubble masonry, the strength value shall be specified on the basis of local experience.

Table 1 Crushing Strength of Stones

Sl No.	Type of Stones	Minimum Crushing Strength	
		(in N/mm²) (*see* Note)	(in kg/cm²)
(1)	(2)	(3)	(4)
i)	Granite	100	1 000
ii)	Basalt	40	400
iii)	Limestone (except very soft stone)	20	200
iv)	Sandstone	30	300
v)	Marble	50	500
vi)	Laterite	3	30

NOTE — The sources of information are: for (i) IS 3316 : 1974, for (ii) Bombay PWD handbook; for (iii), (iv) and (v) DIN 1053 : 1952 'Wall masonry and design execution'; and for (vi) IS 3620 : 1979.

5.1.2.2 *Durability*

The stone shall be free from defects like cavities, cracks, flaws, sandholes veins, patches of soft or loose materials, etc. The percentage of water absorption (*see* IS 1124 : 1974 for the method of test) shall generally not exceed 5 percent. Generally the stone should not contain crypto crystalline silica or chert, mica or any other deleterious material like iron oxide, organic impurities etc.

NOTES

1 The selection of stones for durability is generally based on experience. An examination of structures, at least half a century old, where the particular type of stone is used, will indicate the durability of the stone. If tool marks are visible, and the edges and corners are still sharp and true and the surface is hard and shows no signs of deterioration, the stone is durable.

2 Stone from quarries having stratification at regular intervals will be of uniform quality generally. Where there are variations in stratification, the stone shall be examined petrographically in accordance with IS 1123 : 1975.

5.1.2.3 *Size of stone*

Normally stones used in rubble masonry 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 150 mm. The height of stone for rubble masonry may be up to 300 mm.

NOTE — The selection and grading of stones for rubble masonry is largely done at site and the smaller stones are used in the hearting of the wall. Large-scale supply will be facilitated if, as far as possible, preferred standard sizes for building stone are used as covered in IS 1127 : 1970.

5.2 Mortar

Mortar to be used for stone masonry shall consist of mixes of cement and fine-aggregate; cement, lime and fine-aggregate; lime and fine aggregate of limestone pozzolana and fine aggregate. Suitable proportions and the considerations effecting the choice of mortar are described in IS 2250 : 1981.

5.2.1 *Cement*

Cement to be used for stone masonry mortar shall be ordinary Portland cement conforming to IS 269 : 1989 or blastfurnace slag cement conforming to IS 455 : 1989 or Portland-pozzolana cement conforming to IS 1489 : 1976 or masonry cement conforming to IS 3466 : 1988.

5.2.2 *Lime*

Lime to be used for masonry mortar shall conform to the requirements of IS 712 : 1984. Eminently hydraulic and semi-hydraulic lime corresponding to Class A and B types of IS 712 : 1984 are as such suitable for use in masonry mortars, whereas fat limes corresponding to

Class C will require mixing of *SURKHI* or other pozzolana. This may be used in the form of either hydrated lime or lime putty. Quick lime shall never be used for structural purposes.

5.3.2 *Pozzolana*

SURKHI shall conform to IS 1344 : 1981 and other pozzolanic materials, such as cinder and fly ash shall conform to the relevant Indian Standards.

5.2.3.1 Lime-pozzolana mixture if procured ready-made shall conform to IS 4098 : 1983.

5.2.4 Fine aggregate (sand) to be used for masonry mortar shall conform to IS 2116 : 1980. For lime stone, it is customary and desirable to use the crushed stone as aggregate.

5.2.5 *Water*

Water to be used for masonry mortar shall be clean and free from injurious amount of deleterious materials and shall conform to IS 456 : 1978.

5.3 Metal Fittings

Metal fittings shall be non-corrodible. Galvanizing or coating with bitumen affords only a temporary protection against corrosion or iron and steel. Such treatments might cause staining in a sensitive stone. No iron cramps and similar fittings shall be embedded or partially embedded on stone work.

5.4 Materials for Damp-Proof Courses

Materials for damp-proof courses shall be the same as in 5.3 of IS 2212 : 1991.

5.5 Materials for Flashing and Weathering

Materials for flashing and weathering shall be the same as in 5.4 of IS 2212 : 1991.

6 SELECTION OF STONE

In selecting a stone the situation in which it is to be used has to be considered. The recommended use of common types of stones for various situations has been shown in Table 2.

7 DESIGN CONSIDERATION

7.1 Types

The types of rubble walling may be divided as given in 7.1.1 to 7.1.4.

7.1.1 *Random Rubble*

a) *Uncoursed* (see *Fig. 4*) — This type of masonry is constructed of stones as they come from the quarry. The mason or waller selects blocks of all shapes and sizes, more or less at random, and places them in a position to obtain a good bond, while restricting cutting of the stones to the removal of inconvenient corners with a scabbling or spalling hammer.

b) *Brought to courses* (see *Fig. 5*) — This walling is similar to uncoursed random rubble except that the work is roughly levelled up to courses at intervals varying from 300 mm to 900 mm in height according to the locality and the type of stone used. The courses heights usually correspond with the heights of the quoin and jamb stones.

Table 2 Recommended Use of Common Types of Stones

(*Clause* 6)

Sl No.	Specific Use	Type of Stone Recommended
(1)	(2)	(3)
i)	Masonry work submerged in water	*Dense stones like granite and gneisses
ii)	Masonry work exposed to smoke and chemical fumes	*Granite, quartzite
iii)	For fine resistant masonry	Sandstone
iv)	For carved or ornamental works, arches, etc	Soft stone like marble, sandstone, etc
v)	For masonry below plinth course or in contact with soil	Dense stone like *granite, gneisses

*For the recommended use of granite stones, IS 3316 : 1974 may be referred to.

7.1.2 *Squared Rubble*

a) *Uncoursed* (see *Fig. 6*) — In this type, the stone are roughly squared as risers or jumpers and stretchers with varying heights; and are laid uncoursed.

b) *Brought to courses* (see *Fig. 7*) — The stones are similar to those used for uncoursed rubble but the work is levelled up to courses of varying depth from 300 mm to 900 mm according to the locality and the type of stone used.

c) *Coursed* (*first and second sort*) (see *Fig. 8*) — Coursed walling is built in courses which may vary in height from 100 mm to 300 mm but the stones in any one course are roughly squared to the same height. The faces of the stones may be pitched to give a rockface appearance or may be dressed smooth. A variant of this type of walling may be formed by the introduction of pinnings, that is, smaller stones in the same courses, at intervals, producing a chequered effect.

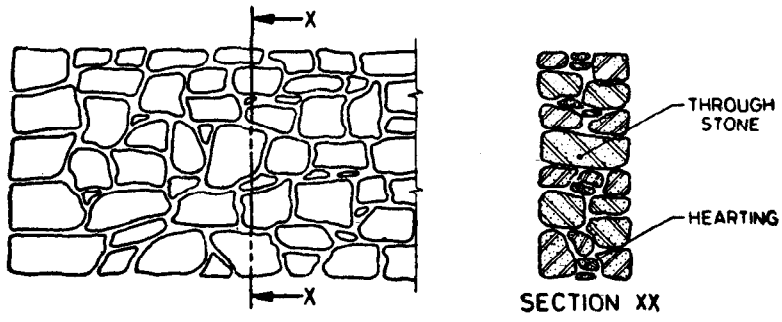


FIG. 4 RANDOM RUBBLE UNCOURSED MASONRY

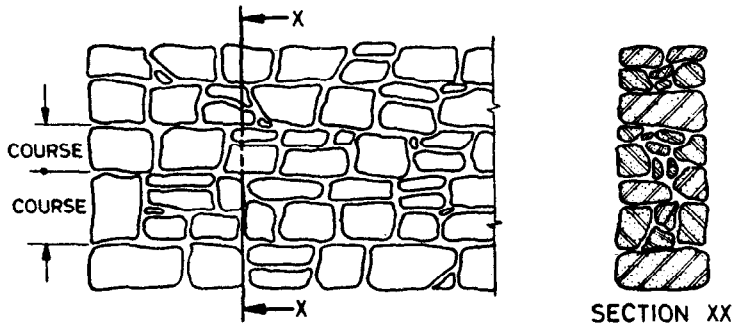


FIG. 5 RANDOM RUBBLE MASONRY BROUGHT TO COURSES

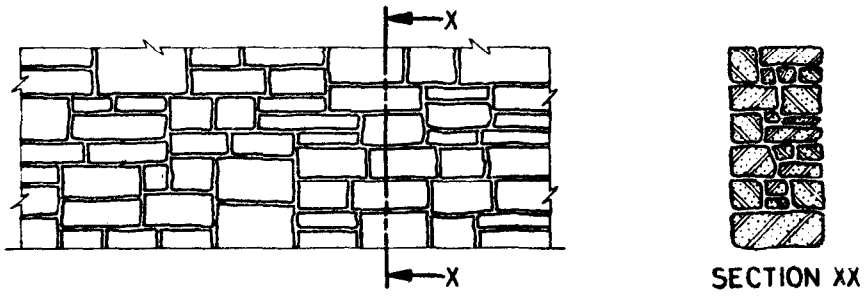


FIG. 6 SQUARED RUBBLE UNCOURSED MASONRY

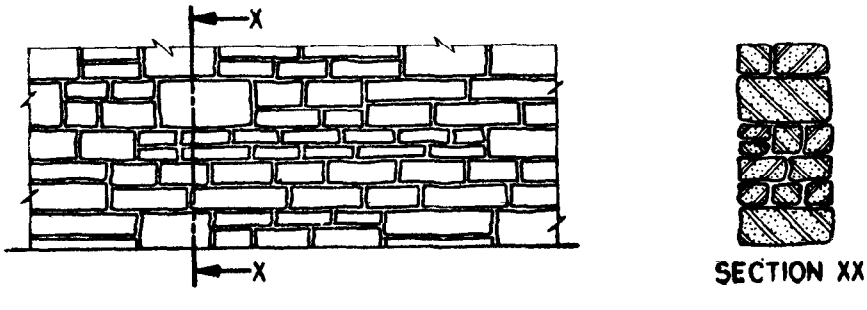


FIG. 7 SQUARED RUBBLE MASONRY BROUGHT TO COURSES

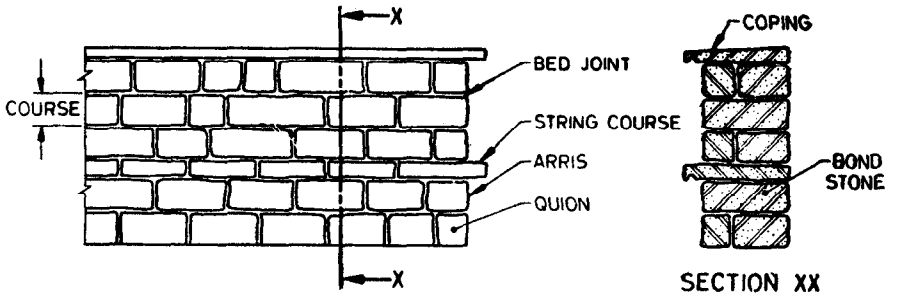


FIG. 8 SQUARED RUBBLE COURSED MASONRY

7.1.3 *Polygonal Rubble Walling* (see *Fig. 9*)

Stone with no pronounced stratification is roughly hammer-pitched into irregular polygonal shapes, and bedded to show the face-joints running irregularly in all directions.

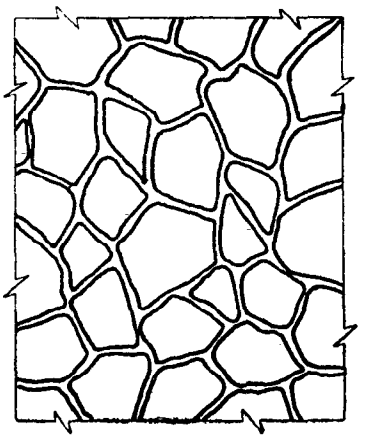


FIG. 9 POLYGONAL RUBBLE WALLING

7.2 Weather Protection

An external rendering would contribute substantially to the weather resistance of solid wall. Depending upon local conditions, the wall may be of solid construction with or without exterior/interior protection. The practice that is found to be satisfactory for the local environments shall be adopted. However, as a general guidance the recommendations given in Table 3 may be followed.

NOTE — Table 3 gives the suitability or otherwise of various types of some wall construction not less than 400 mm thick for the different conditions of exposure (for explanation of the terms, sheltered, moderate, severe, *see* Table 3 of IS 2212 : 1991).

7.3 Rain Protection

Protection against rain penetration would depend upon the rate of absorption of water by stone or by the mortar and also the extent of cracks present in the masonry. Penetration through body of the masonry is possible only when the water absorbed at the external face is sufficient to fill certain portion of the pores in the masonry unit and normally this will occur only during the long spells of exceptionally wet weather. Cracks in the masonry provide seepage paths for running penetration. Where the stone is subject to attack by atmosphere, the penetrating moisture carries soluble sulphuric fumes and deposits them at the inner face of the wall, where they may cause disfiguration or decay.

Table 3 Suitability of Rubble Walls for Various Exposure Conditions

(*Clause* 7.2)

Construction	Exposure Conditions		
	Sheltered	Moderate	Severe
Solid	R	N	N
Solid, rendered externally	R	R	N

NOTE — R denotes recommended and N denotes not recommended.

7.4 Types of Mortar

The choice of mortar shall essentially be based on local experience and practice for use with the stone selected and the climatic conditions prevailing. The mortar shall also be duly workable, stand up well on the towel and spread out easily, shall stiffen up quickly as the rubble is laid, shall adhere strongly to the wall unit and shall develop sufficient compressive strength on the masonry work. For details of mortar to be used in masonry work, reference may be made to IS 2250 : 1981.

7.5 Architectural Features

7.5.1 All projecting architectural features, such as plinth projections, string courses, or cornices shall be effectively bonded by tailing into the stone work to ensure stability. Such architectural features shall be set straight and true into the finished joints as far as possible.

7.5.2 When such features are not to be plastered over, they shall be built with stone which have high durability and resistance to moisture penetration. Stones specially made to required

shape with the help of templates cut out of sheets, shall be used.

7.5.3 Sun shades and projecting features which depend on the weight of masonry over them, for their stability shall be kept supported till such time when the masonry above is built and hardened sufficiently.

7.5.4 All coping shall be dowelled or cramped. String courses shall tail at least 250 mm into the work and shall be throated on the underside.

7.6 Damp-Proof Course

For the function, materials to be used, and the places where damp-proof course is provided, reference be made to **6.8** of IS 2212 : 1991.

7.7 Structural and Functional Characteristics

7.7.1 *Structural Stability and Strength*

Reference may be made to IS 1905 : 1987, IS 1893 : 1984 and IS 4326 : 1976 for design with regard to structural stability.

8 GENERAL REQUIREMENTS FOR MASONRY CONSTRUCTION

8.1 Setting Out

Details of setting out is the same as in **8** of IS 2212 : 1991.

8.2 Dressing of Stones

The dressing of stone shall be as specified for individual types of masonry work and it shall also conform to the general requirements for dressing of stone covered in IS 1129 : 1972. Other specific requirements are covered separately with respect to particular types of rubble stone work (*see* **9**).

8.3 Scaffolding

Single scaffolding, except as mentioned in **8.3.1**, having one set of vertical support shall be used and the other end of the horizontal scaffolding member shall rest in a hole provided in the masonry. The support shall be sound and strongly tied together with horizontal pieces over which the scaffolding planks shall be fixed. The holes which provide resting space for horizontal members shall not be left in pillars under one metre in width or immediately near the skew backs of arches. The holes left in the masonry work for supporting the scaffolding shall be filled and made good with concrete of M-15 before plastering. The scaffolding shall be strong enough to withstand all loads likely to come upon it and shall meet the requirements specified in IS 2750 : 1964.

8.3.1 For pillars less than one metre in width or for first class masonry or for a building having more than two storeys, double scaffolding having two sets of vertical support shall be provided.

8.4 Handling

The use of grip in the tops of stones is preferable to any method of holding the stone at the end, because it enables the stone to be set in final position before the tackle is released. Due care shall be taken to protect finished surfaces and edges of stone against danger during handling. The various methods employed in different situations for lifting stone are shown in Fig. 10.

8.5 Tools

Tools that are required for stone masonry work, such as plumb bob and line, straight edges, mason's square, spirit level and trowel are described in IS 1630 : 1984 and various types of mason's hammer and chisels in IS 1129 : 1972.

8.6 Watering

Stones shall be sufficiently wetted before laying to prevent absorption of water from mortar.

8.7 In all types of masonry, the particulars given in **8.7.1** to **8.7.12** shall be complied with.

8.7.1 The stone shall be laid so that the pressure is always perpendicular to the natural bed.

8.7.2 The courses (if any) shall be built prependicular to the pressure which the masonry will bear. In case of battered walls, the base of stone and the plane of courses (if any) shall be at right angles to the batter.

NOTE — In the case of a bridge pier having batter on both sides, the courses shall be horizontal.

8.7.3 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.

8.7.4 Vertical joints shall be staggered as far as possible.

8.7.5 Bell shaped bond stones or headers shall not be used.

8.7.6 All necessary chases for joggles, dowels, and cramps should be formed in the stones before hand.

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

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

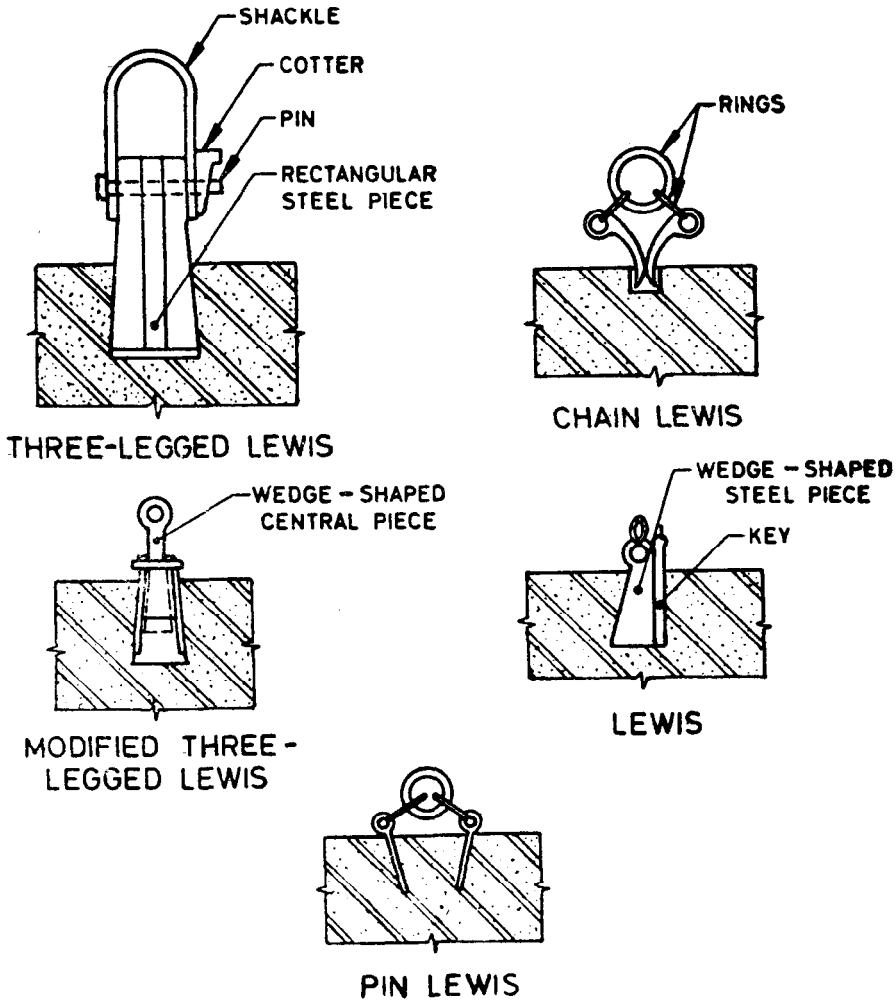


FIG. 10 TYPICAL DETAILS OF LIFTING APPLIANCES OF STONES

8.7.9 Where there is a break in masonry work the masonry shall be raked in sufficiently long steps for facilitating joining of old and new work. The stepping of the raking shall not be more than 45° with the horizontal.

8.7.10 Masonry construction with too thin faces, tied up with occasional through stones or filled up with dry packing or small size aggregate shall be strictly prohibited.

8.7.11 The walls and pillars shall be carried up truly plumb or to specified batter.

8.7.12 Storey rods showing the heights of all doors and windows and other necessary information should be used at the time of construction of masonry.

8.8 Fixing of Frames

Where door or window frames of timber are fixed in the openings, the fixing shall be done generally with hold-fasts of adequate size and strength, securely embedded in the stone work preferably in chases filled up by cement concrete (*see* Fig. 11). Iron holdfasts shall be given a protective coat of bitumen to avoid rusting. Wood work faces in contact with stone work shall be treated with wood preservatives to prevent attack from insects and termites. The frames shall preferably be fixed simultaneously as the masonry work proceeds, as this construction will ensure proper bond without gaps between the masonry and the frames.

8.9 Bearing of Floors, Roofs and Joints

It is not desirable to embed any structural timber in stone work as it is liable to be affected by dry rot. The ends of timber joints shall preferably rest on corbels or brackets but when built into a wall these shall be treated with preservative and in addition, space shall be left around them for free circulation of air. The ends of beams carrying heavy loads and of trusses shall be supported on templates of concrete or stone.

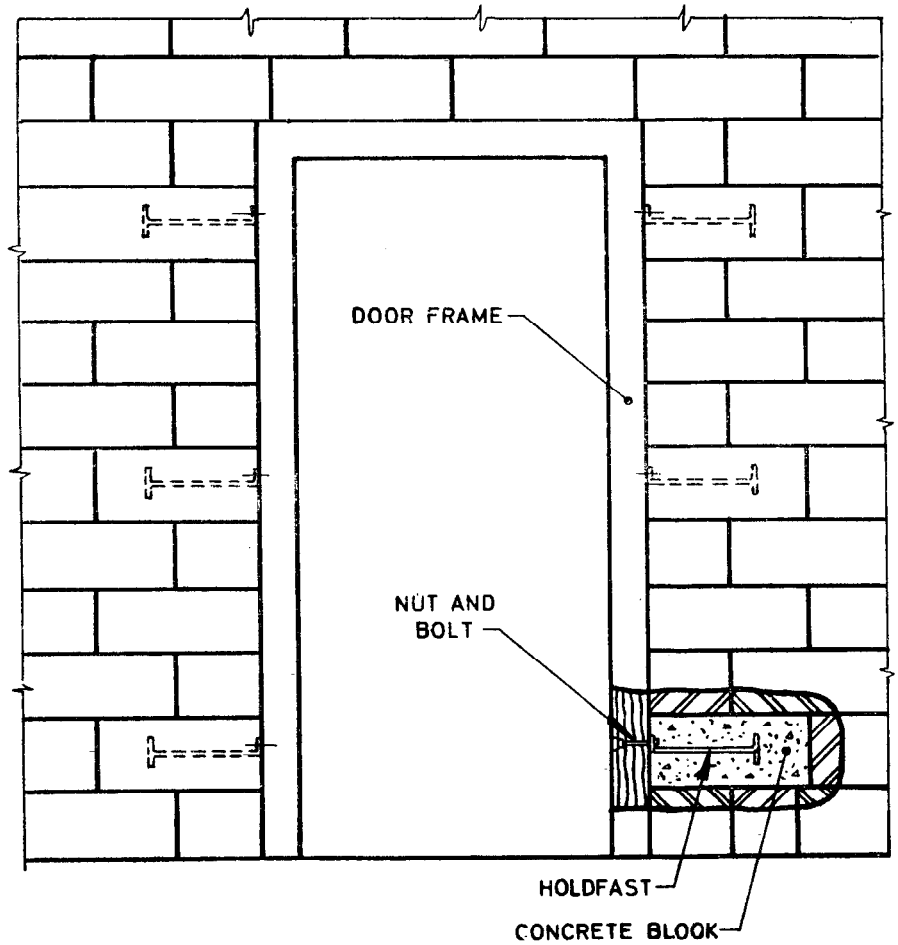


FIG. 11 POSITION OF HOLDFASTS TO DOOR FRAME

Bed blocks should be set true to level and bedded in the same mortar as that used for walling. The ends of the steel beams or trusses embedded in masonry shall be built in with space all around for repainting or shall be protected with a thick bituminous coat and shall be encased in rich concrete of M-15. The ends shall generally be supported on templates of plain or RCC of M-15 concrete or stone.

NOTE — In case of timber ground floor, the ends of the open-spaced timber joints supporting the floor boards should be nailed to wall plated on top of 125 mm walling, built either as an offset to wall or as a separate sleeperwall.

8.10 Jointing and Pointing

All joints shall be full of mortar. Pointing shall be avoided as far as possible, but where unavoidable it shall be carried out as the work proceeds using the same mortar as for bedding. If carried out by raking out the joint later on after hardening, specially prepared mortars shall be used. The maximum thickness of joints shall be 20 mm for random rubble and 10 mm for square rubble. The various types of pointing are shown in Fig. 10 of IS 2212 : 1991.

8.11 Covering

Green work shall be protected from rain by suitable covering. Masonry work and cement of composite mortar shall be kept constantly moist on all the faces for a minimum period of seven days. The top of the masonry work shall be left flooded with water, with the close of the day. Watering shall be done carefully so as not to disturb or wash out green mortar and use of perforated rose spout may be suitable. In the case of lime mortar, curing should commence two days after the laying of masonry and shall continue for seven days.

9 CONSTRUCTION

9.1 Random Masonry (Uncoursed and Brought to Course)

9.1.1 *Dressing*

Stone shall be hammer-dressed on the face, the sides and the beds to enable it to come in proximity with the neighbouring stone. The bushing on the face shall not be more than 40 mm on an exposed face.

9.1.2 *Insertion of Chips*

Chips and spalls of stones shall be used wherever necessary to avoid thick mortar beds or joints and it shall also be ensured that no hollow spaces are left anywhere in the masonry. The chips shall not be used below hearting stones 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 20 percent of the quantity of a stone masonry.

9.1.3 *Hearting Stones*

The hearting or interior filling of a wall face shall consist of rubble stones not less than 150 mm in any direction, carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar. The hearting should be laid nearly level with facing and backing.

9.1.4 *Bond Stones*

Through bond stones shall be provided in walls up to 600 mm thickness, a set of two or more bond stones overlapping each other by at least 150 mm shall be provided in a line from face to back. In case of highly absorbent types of stones (porous lime stone and sand stone, etc) the bond stone shall extend about two-third into the wall, as through stones in such cases may give rise to damp penetration and, therefore, for all thickness of such walls a set of two or more bond stones overlapping each other by at least 150 mm shall be provided. Each bond stone or a set of bond stones shall be provided for every 0·5 m^2 of the wall surface and shall be provided at 1·5 m to 1·8 m apart clear in every course.

9.1.5 *Quoin-Stone*

Quoin stone shall not be less than 0·03 m^3 in volume.

9.1.6 *Plum Stone*

The plum stone at about 900 mm interval shall be provided.

9.1.7 *Laying*

The masonry shall be laid with or without courses as the case may be as per general requirement (*see* **8.7**). The quoins shall be laid header and stretcher alternatively. Every stone shall be carefully fitted to the adjacent stone so as to form neat and close joint. Face stone shall extend and bond well in the back. These shall be arranged to break joints, as much as possible, and to avoid long vertical lines of joints.

9.2 Squared Rubble — Coursed Rubble (First Sort)

9.2.1 *Dressing*

Face stone shall be hammer-dressed on all beds and joints so as to give them approximately rectangular shape. These shall be square on all joints and beds. The bed joints shall be chisel drafted for at least 80 mm back from the face and for the side joints at least 40 mm. No portion of the dressed surface shall show a depth of gap more than 6 mm from a straight edge placed on it. The remaining unexposed portion of the stone shall not project beyond the surface of bed and side joints. The requirements regarding bushing shall be the same as for random rubble masonry (*see* **9.1.1**).

9.2.2 *Hearting Stones*

The hearting or the interior filling of the wall shall consist of flat bedded stone carefully laid on their proper beds in mortar. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 10 percent of the quantity of masonry. While using chips it shall be ensured that no hollow spaces are left anywhere in the masonry.

9.2.3 *Bond Stones*

The requirements regarding through or bond stone shall be same as for random rubble masonry but these shall be provided at 1·5 m to 1·8 m apart clear in every course.

9.2.4 *Quoin Stone*

The quoin which shall be of the same height as the course in which these occur, shall not be less than 450 mm in any direction.

9.2.5 *Face Stone*

Face stone shall tail into the work for not less than their heights and at least one thirds of the stones shall tail into the work for a length not less than twice their height. These should be laid headers and stretchers alternatively.

9.2.6 *Laying*

All courses shall be laid truly, horizontal and all vertical joints shall be truly vertical. The quoin stones shall be laid stretchers and headers alternatively and shall be laid square on their beds, which shall be rough chisel dressed to a depth of at least 100 mm.

9.3 Square Rubble — Coursed Rubble (Second Sort)

All requirements are the same as for coursed rubble masonry (first sort) except that no portion of dressed surface of joints shall show a depth of gap more than 10 mm from a straight edge placed on it and use of chips shall not exceed 15 percent of the quantity of the stone masonry.

9.4 Squared Rubble — Uncoursed Rubble

All requirements are the same as for coursed rubble masonry (first sort) except that stones (risers of jumpers and stretchers), which are of varying heights are laid uncoursed and in general, the risers shall not be more than 250 mm in height and stretchers shall not exceed two-thirds the height of the adjoining risers.

9.5 Square Rubble — Brought to Courses

9.5.1 All requirements are the same as for squared rubble uncoursed except that the work is levelled up to courses of varying depth from 300 mm to 900 mm and the courses usually correspond with the quoin or jamb stone.

9.6 Polygonal Rubble Walling

All requirements are the same as for course rubble masonry (first sort) except that masonry is not laid in courses and more or less regular polygon shaped stones are used instead of square rubble.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
269 : 1989	Specification for 33 grade ordinary Portland cement (*fourth revision*)
455 : 1989	Specification for Portland slag cement (*fourth revision*)
456 : 1978	Code of practice for plain and reinforced concrete (*second revision*)
712 : 1984	Specification for building limes (*third revision*)
1123 : 1975	Method for petrographical examination of natural building stones (*first revision*)
1124 : 1974	Method of test for water absorption, apparent specific gravity and porosity of natural building stones
1127 : 1970	Recommendations for dimensions and workmanship of natural building stones (*first revision*)
1129 : 1972	Recommendations for dressing of natural building stones (*first revison*)
1344 : 1981	Specification for calcined clay pozzolana (*second revision*)
1489 : 1976	Specification for Portland pozzolana cement (*second revision*)
1630 : 1984	Specification for mason's tools for plaster work and pointing work (*first revision*)
1805 : 1973	Glossary of terms relating to building stones, quarrying and dressing (*first revision*)
1893 : 1984	Criteria for earthquake resistant design of structures (*fourth revision*)
1905 : 1987	Code of practice for structural use of reinforced masonry (*third revision*)
2116 : 1980	Specification for sand for masonry mortars (*first revision*)
2212 : 1991	Code of practice for brickwork (*first revision*)
2250 : 1981	Code of practice for preparation and use of masonry mortars (*first revision*)
2750 : 1964	Specification for steel scaffoldings
3316 : 1974	Specification for structural granite (*first revision*)
3466 : 1988	Specification for masonry cement (*second revision*)
3620 : 1979	Specification for laterite stone block for masonry (*first revision*)
4098 : 1983	Specification for lime pozzolana mixture (*first revision*)
4326 : 1976	Code of practice for earthquake resistant design and construction of buildings (*first revision*)

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Amendments Issued Since Publication

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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 331 01 31, 331 13 75

Telegrams : Manaksanstha
(Common to all offices)

Regional Offices :	Telephone
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002	331 01 31 331 13 75
Eastern : 1/14 C. I.T. Scheme VII M, V. I. P. Road, Maniktola, CALCUTTA 700054	37 84 99, 37 85 61 37 86 26, 37 86 62
Northern : SCO 335-336, Sector 34-A, CHANDIGARH 160022	60 38 43 60 20 25
Southern : C. I. T. Campus, IV Cross Road, MADRAS 600113	235 02 16, 235 04 42 235 15 19, 235 23 15
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