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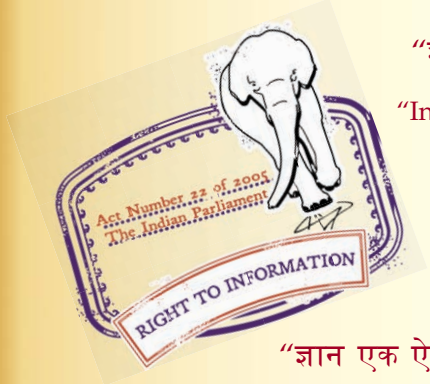
IS 4101-1 (1967): Code of practice for external facings and veneers, Part I: Stone facing [CED 13: Building Construction Practices including Painting, Varnishing and Allied Finishing]



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"Knowledge is such a treasure which cannot be stolen"

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IS : 4101 (Part I) - 1967
(Reaffirmed 2000)

Indian Standard

CODE OF PRACTICE FOR EXTERNAL FACINGS AND VENEERS

PART I STONE FACING

(First Reprint MARCH 1989)

UDC 693.69:693.15

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 5 *September* 1967

Indian Standard

CODE OF PRACTICE FOR EXTERNAL FACINGS AND VENEERS

PART I STONE FACING

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(*Continued on page* 17)

Indian Standard

CODE OF PRACTICE FOR EXTERNAL FACINGS AND VENEERS

PART I STONE FACING

0. FOREWORD

0.1 This Indian Standard (Part I) was adopted by the Indian Standards Institution on 30 March 1967, after the draft finalized by the Building Construction Practices Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Facing with stones of various types like marble, granite, sandstone, limestone, etc, is a popular external finish. However, these require careful fixing techniques involving proper preparation, appropriate choice of fixing devices and weather-proof construction. This code is intended to provide guidance with regard to such facing work. Part I of this code covers stone facing and Part II cement concrete facing.

0.2.1 Fixing accessories, such as cramps, dowels used in the facing work are commonly of copper alloys but other materials like aluminium alloy, plastics may also find use in course of time and this aspect has been considered in the formulation of this code. Galvanized mild steel, however, is not considered suitable for the fixtures.

0.2.2 The methods of fixing are also quite varied and only simple methods which are feasible for adoption at present in this country are covered.

0.3 In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country.

0.4 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*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard (Part I) covers fixing of stone facing and veneering on the exterior of walls.

2. TERMINOLOGY

2.1 Cramp — Thin piece of metal bent at each end or piece of stone used to hold blocks of stone permanently in position (*see* Fig. 3 and 6).

2.1.1 *Single Cramp* — A cramp used to hold blocks of stone permanently in position with the masonry (*see* Fig. 3E, 3F and 3G).

2.1.2 *Double Cramp* — A cramp used to hold two adjacent blocks of stone together in position (*see* Fig. 3D and 6A).

2.2 Dowel — A pin of metal inserted in holes used to hold adjacent facing units together in position (*see* Fig. 5).

2.3 Stone Facing — Stone dressed to the form of a thin slab, veneer or masonry unit and applied to the face of the wall.

2.4 Veneering — Facing work where the facing material is thin compared with exposed area of the facing unit, for example, marble veneering.

3. NECESSARY INFORMATION

3.1 For the efficient planning and design of stone facing work, the following information is necessary:

a) Dimensional details of the walls to be faced or veneered;

b) Types and conditions of backing to which the facings are to be attached; and

c) Any special precautions with regard to design which are to be taken into account depending upon local climatic and other conditions.

4. MATERIALS

4.1 Facing Stone

4.1.1 *General Quality* — The stone shall be sound, dense and free from defects which impair strength, durability and appearance. The facings may be of marble, granite, syenite, basalt, limestone, sandstone or slate (*see* Note). In the selection of stone, care shall be taken to assess the durability, dimensional change, transverse and compressive strength, porosity, permanence and stability against the effect of salt-laden solutions and acid fumes to which they are likely to be exposed. These shall be carried out in accordance with relevent Indian Standards.

Emphasis shall be placed on the past satisfactory performance of the stone in the particular locality and only in the absence of such data, recourse should be taken to assessment of performance from test data.

NOTE — Limestone slabs of thickness 20 mm and above are also sometimes used as facing stone, for example, Sahabad, Taiduran, Kotah and Yerguntla stones.

4.1.2 In the case of sandstone, patches or streaks shall not be allowed. However, scattered spots up to 1 mm diameter may be permitted.

4.1.3 Marble shall be uniform in colour unless specified, for mottled or verigated texture for architectural purposes. It shall be hard, sound, dense and homogeneous in texture with crystalline and coarse grains. It shall be free from stain, cracks, decay and weathering.

4.1.3.1 Marble facings shall conform to relevant Indian Standard specification for marble (blocks, slab and tiles) (*under preparation*).

4.2 Dimensions — The thickness of stone veneer used for facing shall not be less than 30 mm in the case of granite, syenite, basalt, or slate veneers. The minimum thickness in which granite stone slab for facing will generally be available will be 75 mm but thinner slabs may be available also. Veneers of limestone slab (from Sahabad, Taiduran, Kotah and Yerguntla) and sandstone veneers may be available with a minimum thickness of even 20 mm.

4.3 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.

4.3.1 The cramps may be of copper alloyed with zinc, tin, nickel, lead and aluminium, or stainless steel.

4.3.2 Aluminium alloy H 9 in W condition (*see* IS : 737-1955*) may also be used for cramps.

4.4 Metal-Angle Supports — Metal steel angles used for metal angle supports shall be clean of mill-scale and loose rust after fabrication and shall be given a protective coat preferably in the form of galvanizing or with a protective coat like phosphating and one or two coats of appropriate paint after phosphating as specified in IS : 1477 (Part I)-1959† and IS : 1477 (Part II)-1963‡ before reuse in the facings. Non-corrosive brass angles will, however, be preferable.

*Specification for wrought aluminium and aluminium alloys, sheet and strip. (for general engineering purposes).

†Code of practice for finishing of iron and steel in buildings : Painting and allied finishes : Part I Operations and workmanship.

‡Code of practice for finishing of ferrous metals in buildings : Painting and allied finishes : Part II Schedules and equipment.

4.5 Mortar Materials

4.5.1 *Cement* — Cement for use for making mortar for bedding joint shall be ordinary Portland cement conforming to IS : 269-1958*, Portland blast furnace slag cement conforming to IS : 455-1962† or Portland pozzolana cement conforming to IS : 1489-1962‡.

4.5.2 *Sand* — shall conform to IS : 2116-1965§.

4.5.3 *Lime* — shall confom to IS : 712-1964¶.

4.5.4 *SURKHI* — shall conform to IS : 1344-1959‖.

4.5.5 The water shall be clean and free from injurious amounts of deleterious materials.

4.6 Joint Sealing Compound — Joint sealing compounds may be of several types to satisfy the specific requirements relating to shrinkage, resistance, rate of hardening, resistance to cracking, oil retention, etc, and their choice will depend upon the types of facings used. Since these are specialized materials of varying compositions the manufacturers' advice to their use will be necessary.

5. DESIGN CONSIDERATIONS

5.1 Types of Stone Facing — Stone facing may be of the following two types:

a) Facings which are not integrally bonded with the backing and generally do not appreciably contribute to the stability and load bearing capacity of the wall, and

b) Facings which are integrally bonded with the backing so that both together contribute to the stability and load bearing capacity of the wall and in which at least 15 percent of the face consists of bonding stones extending up to 10 cm into the backing.

5.2 Structural Design

5.2.1 The structural design of facings and their attachments must be able to withstand without damage the pushing and pulling effect of

*Specification for ordinary, rapid-hardening and low heat Portland cement (*revised*).
†Specification for Portland blast furnace slag cement (*revised*).
‡Specification for Portland-pozzolana cement.
§Specification for sand for masonry mortar.
¶Specification for building limes (*revised*).
‖Specification for *SURKHI* for use in mortar and concrete.

positive and negative air pressure caused by winds. For design data with regard to wind loads reference may be made to IS : 875-1964*.

5.2.2 In the case of facings supported by cramps or similar attachments, the stresses induced by the weight of the facings shall also be considered in the design of the cramps and attachments. For design purposes the permissible working stresses in metal cramps may be taken as given in Table 1.

TABLE 1 SAFE WORKING STRESS IN METAL CRAMP

Sl No.	Material	Recommended Maximum Safe Working Stress, kg/cm²	
		Tensile	Shear
(1)	(2)	(3)	(4)
i)	Copper hard drawn wire	1 000	550
ii)	70-30 Brass strip:		
	a) Annealed	300	200
	b) Half hard	1 300	750
iii)	Stainless steel, 12 percent chrome annealed	1 100	—
iv)	Stainless steel, 18 percent chrome, 8 percent nickel, annealed	1 100	—
v)	Galvanized mild steel, rolled or drawn (for internal use only)	1 100	1 000
vi)	Galvanized malleable cast iron (for internal use only)	1 100	1 000

Note 1 — The recommended maximum safe working stresses given in the table do not bear a constant relationship to the 1 percent proof stresses of the materials, but very so as to take account of the different properties of the different metals.

Note 2 — The recommended maximum safe working stress is the recommended constant working stress. It is, therefore, reasonable to allow for peak wind loading, stresses in excess of this constant working stress up to an extent of 50 percent.

5.3 Fixing the Facings with Cramps

5.3.1 Cramps may be used either:

a) to hold the facing units in position only, the weight of the unit being transferred to the facing unit beneath; or

b) to hold the units in position and in addition to support the units thus transferring the weight of the units to the backing.

*Code of practice for structural safety of buildings : Loading standards (*revised*).

5.3.1.1 Where cramps are used to hold the unit in position only, the facings shall be provided a continuous support on which they 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 a transition from thin facings below to thick facings above.

5.3.1.2 Generally the weak point about facing of high walls with load transmitting facing slabs will be the dependence on the whole upon the performance of each unit. The failure to hold a slab properly in position by accidental omission of a faulty cramp or, loosening of a cramp not properly fixed, or failure in an imperfect facing unit may result in collapse of many facings above and around the point of failure. To obviate this risk intermediate supports for facings will be essential. However, the stresses set up in the lower most facings as a result of accumulation of the load will normally be of such order that can be borne by the material. For instance, even in the case of 60 m high building the maximum stress would be only of the order 30 kg/cm^2 which the facings can generally withstand.

5.3.1.3 *Staggering* — Staggering of vertical joints may also preferably be adopted to reduce the danger of wholesale collapse.

5.3.2 *Supporting Arrangements* — Facing blocks or slab units shall be supported by means of cramps for its stability. Cramps may be attached to its sides (*see* Fig. 1A and 1B), or top and bottom (*see* Fig. 1C, 1D, 1E and 1F), or sides top and bottom (*see* Fig. 1G and 1H).

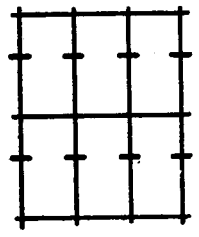
5.3.2.1 The position and number of cramps shall be fixed with regard to the type of facing, size and weight of units and the condition of workmanship obtainable in the particular situation. The minimum number of cramps required for fixing facing unit to the wall are illustrated in Fig. 1. The actual number of cramps and their selection, however, shall be as per requirements of design to carry the loads as given in **5.2.1** and **5.2.2**.

5.3.2.2 *Side attachment* — For horizontal joints of double-joggle or grouted-core type (*see* Fig. 1A) one cramp shall be attached to the both sides of facing. Alternatively two cramps shall be attached to one side of facing and one cramp to the other side (*see* Fig. 1B).

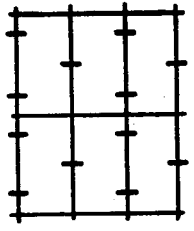
5.3.2.3 *Top and bottom attachment*

a) *With single cramps*

1) When the cramps used are unsuitable for supporting the weight of the facing units, three cramps shall be



1A Side Attachment



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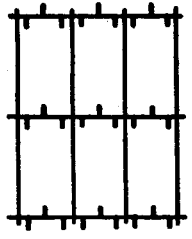
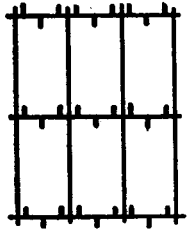
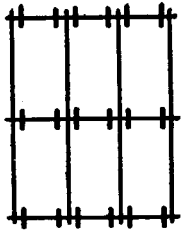


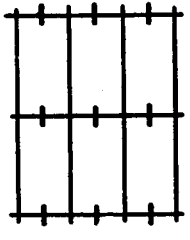
1C Top and Bottom Attachment



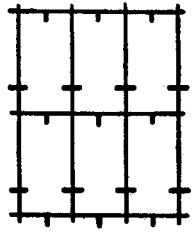
1D Top and Bottom Attachment



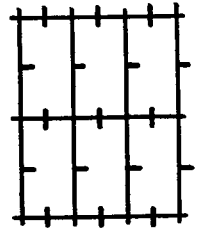
1E Top and Bottom Attachment



1F Top and Bottom Attachment



1G Side, Top and Bottom Attachment



1H Side, Top and Bottom Attachment

NOTE — Cramps shown in diagrams 'A-H' are arranged for facings with the longer sides vertical. For facings having the longer sides horizontal, cramps would be positioned to suit the altered proportions of the facings.

FIG. 1 DIAGRAMMATIC ARRANGEMENTS OF CRAMPS FOR ATTACHING FACINGS TO BACKING WALL

used, of which two shall be attached at the top and one at the bottom (*see* Fig. 1C).

2) When the cramps are strong enough to bear the weight of the units, two of the three cramps shall be attached at the bottom and the third at the top (*see* Fig. 1D).

b) *With double cramps* — For a simpler arrangement and for reducing the number of cramps, instead of single cramps, double cramps which hold the facing unit both above and below may be used. The types of arrangement shall be as follows:

1) When the cramps are load bearing, four cramps shall be used (*see* Fig. 1E).

2) When the cramps are non-load bearing, and the vertical joints are grouted, two double cramps shall be used, one at the top and the other at the bottom (*see* Fig. 1F).

NOTE — The double cramps at the bottom are fixed earlier to support the top of the facing units in the course as given in **5.3.2.4.**

5.3.2.4 *Side, top and bottom attachment* — Three cramps shall be attached to the facing block to have more security for holding. Out of the three, two shall he double and one single cramp. Single cramps shall be attached at the top and double cramps shall be attached to both the sides (*see* Fig. 1G). If single cramp is attached to its side and double cramps are attached to the top and bottom, the arrangement will be unsuitable for load bearing unless an extra cramp is fixed at horizontal joint (*see* Fig. 1H).

5.3.3 *Facings Integrally Bonded to the Backing*

5.3.3.1 The attachment of facing by integral bonding may be by any of the following methods:

a) The facing unit may contain projections which are mechanically bonded into the backing and support the unit,

b) By means of masonry bond or keying to the backing, and

c) By combinations of methods (a) and (b).

5.3.3.2 In the case of stone ashlar facings the bonded facing may be considered as part of the composite wall for load-bearing and stability calculations when:

a) at least 15 percent of the face area consists of bonded stones which extend 10 cm or more into the backing and are evenly distributed on the wall face,

b) those stones which are non-bonded stones are either limited to alternate courses or are securely anchored to the backing with a suitable cramp with a strength or at least 180 kg in tension for each such non-bonded stone,

c) the thickness of non-bonded stone is not less than 7·5 cm and the height of any such stone is not more than three times its thickness, and

d) the facing is built simultaneously with the backing wall.

5.3.3.3 In the case of facing with small stone slab of size of 30 cm which are integrally bonded with the backing the following requirements shall be satisfied:

a) At least 15 percent of the face area consists of stone units which extend 10 cm or more into the backing. Such bonding units shall be spaced not farther apart than 60 cm horizontally and vertically, and

b) The thickness of the facing shall be not less than 9 cm and in no case less than half the height of the stone unit in the facing.

5.4 Joints — The joints between facing units may be finished flush, tuck, ruled, square, weathered-struck or rebated (*see* Fig. 2). Where expansion joints are formed in the structure or backing walls, these joints shall also be carried through the facing. In parapets and copings where expansion joints need be provided at close intervals (of about 8 m), the additional expansion joints of the backing need not be carried into the facing covering the parapet wall.

5.5 Use of Joint Sealing Compound — It is preferable to use joint sealing compounds where the facings are exposed to heavy rainfall and winds and their selections would depend upon local experience and availability of suitable joint sealing compounds.

5.6 Other Precautions — Where facing units are of large size compared to masonry units, the joints should accommodate considerably larger dimensional changes than in common wall masonry. Specially designed joint sealing compounds will be preferable but in their absence only masonry mortars (1 : 1 : 6 cement : lime : sand) which are proved to be successful from local exposure conditions shall be used. Generally, apart from penetration through the joints water seldom finds access through the facing unit into the background.

5.6.1 For prevention of travel of moisture from the backing to the facing where such trouble is envisaged, sometimes it may be useful to attach the facing unit with only dabs of mortar instead with application of mortar to the whole of the backing. However, this procedure

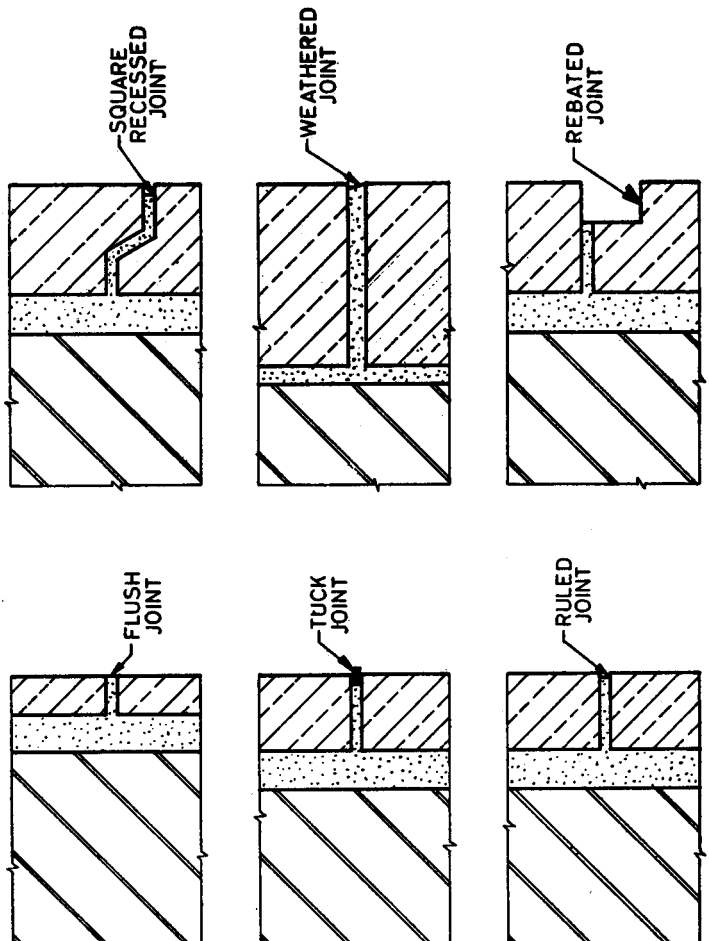


FIG. 2 TYPES OF FINISHES FOR JOINTS

will have disadvantages compared to solid filling, such as less protection against impact, tendency to warping and less security of cramp fixing.

5.6.2 Use of string courses or other features for deflecting water from the face of high buildings will considerably reduce the incidence of moisture penetration both at the joints and at the facing unit. However, vertical and horizontal joints around such features shall be properly sealed with a water-proofing compound (*see* Note).

NOTE — Generally bitumens of Grade 250 to 500 will be suitable for such sealing (*see* also IS : 1834-1961*).

6. PROGRAMMING THE WORK WITH REFERENCE TO CONSTRUCTION OF BACKING WALL

6.1 The facing work shall be so programmed that as far as possible it is not necessary to make holes in the backing other than at the joints to correspond with the positions of attachment of the facing.

7. FIXING OF NATURAL STONE FACINGS

7.1 General Precautions — The stone facing shall be well wetted before laying. While applying mortar for fixing the facings in position, no chips or fillings of any sort shall be used.

7.2 The facings may be fixed according to the different types of arrangements described in **5.3.2**, and illustrated in Fig. 3. In the case of load-bearing cramps, where necessary, the holes in the backing shall be enlarged to improve the anchorage of the cramp. Double cramps which are anchored into the backing require very accurate positioning; inaccuracies will result in difficulties in the fixing and alignment of the joints also. In such cases the dowel holes for the facing which are normally drilled at the factory will not be corresponding to the fixing positions at site and further drilling may be necessary. During fixing cramps shall not be further bent unless provided for in the design; such bending will weaken them.

7.2.1 The use of stone dowels and metal pins are illustrated in Fig. 4.

7.2.2 The cramps illustrated in Fig. 5A shall not be used for load carrying purposes.

7.2.3 A typical arrangement of fixing stone veneering to a wall with cramp and pin is shown in Fig. 4A. An alternative arrangement of fixing stone veneering to the wall with stone dowel and pin is shown in Fig. 4B. The details of copper pin dowel used in the above arrangement are shown in Fig. 5, and the details of metal and stone cramps are shown in Fig. 6.

*Specification for hot applied sealing compounds for joints in concrete.

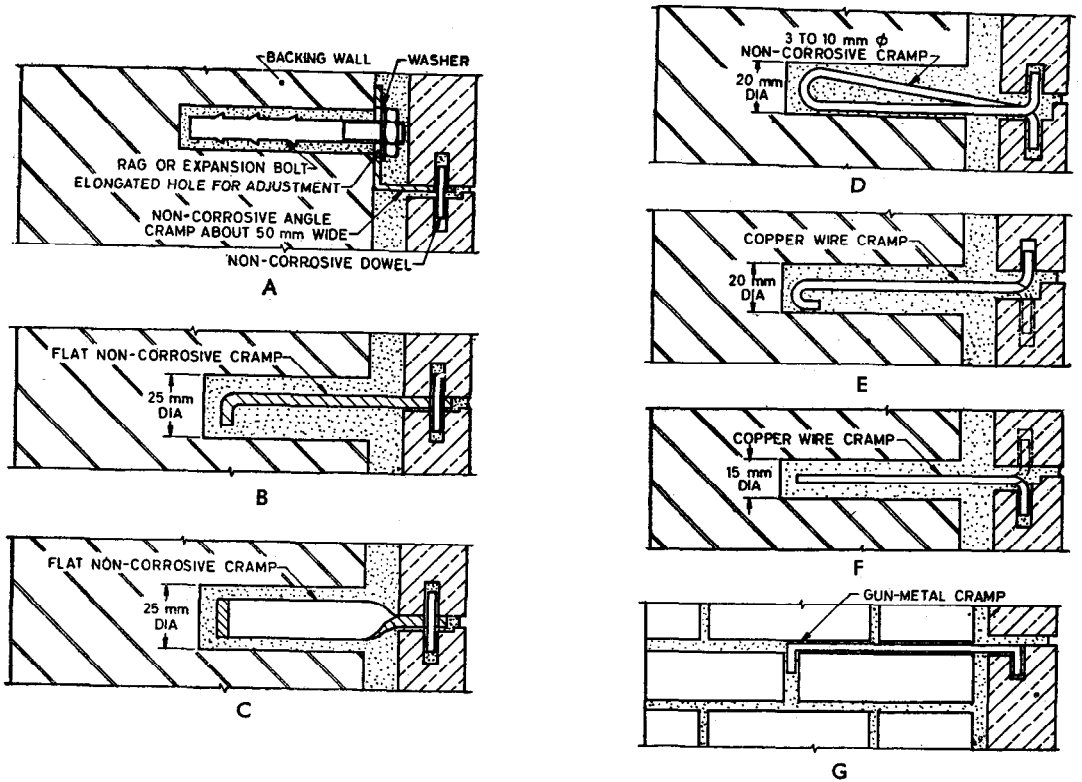


FIG. 3 TYPES OF CRAMPS FOR STONE FACINGS

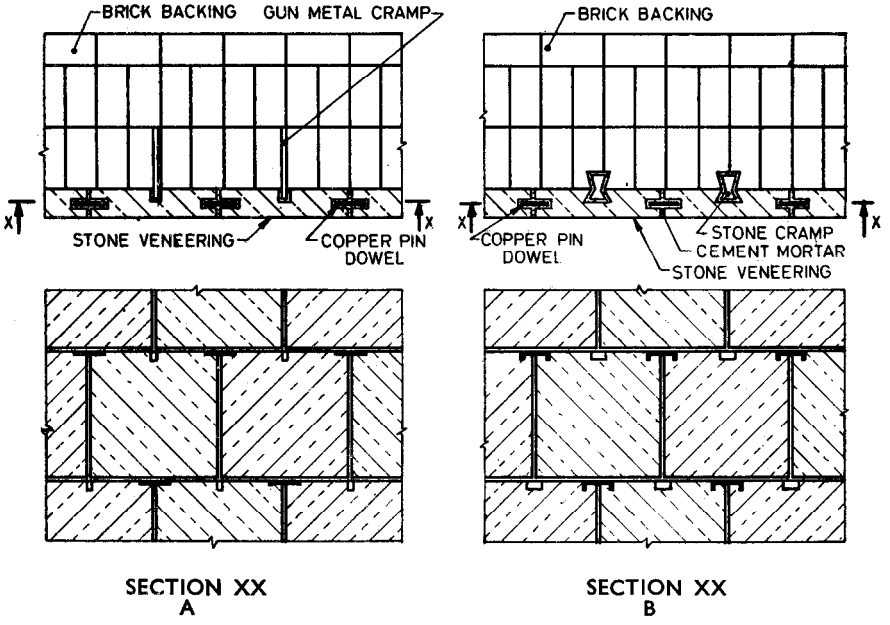


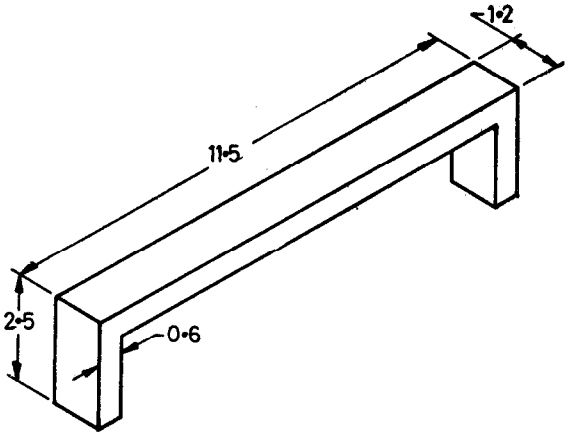
FIG. 4 DETAILS OF FIXING STONE VENEERING

7.3 Work at Joints — Exposed joints shall be pointed with mortar as specified. The thickness of joints shall be as small as possible not exceeding 6 mm. For a close butt jointed facing the thickness shall not exceed 1·5 mm. Mortar used for jointing shall be cement : lime : sand 1 : 2 : 9 mix. Crushed stone sand from the same stone as the facing unit will be better for use as aggregate in the pointing mortar.

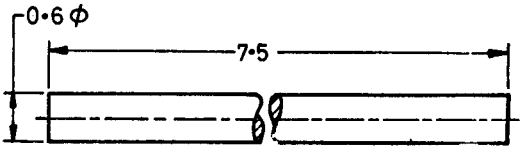
7.3.1 Where distinct joints are necessary a wiping of white cement slurry or tinted white linseed putty may be applied to the tightly butting slabs. However, this type of jointing shall not be recommended for severely exposed positions.

7.4 Facing with Ashlar Masonry — For details of construction with regard to ashlar facing built integrally with the backing wall reference may be made to the requirements of IS : 1597 (Part II)*.

*Code of practice for construction of stone masonry : Part II Ashlar masonry (*under preparation*).



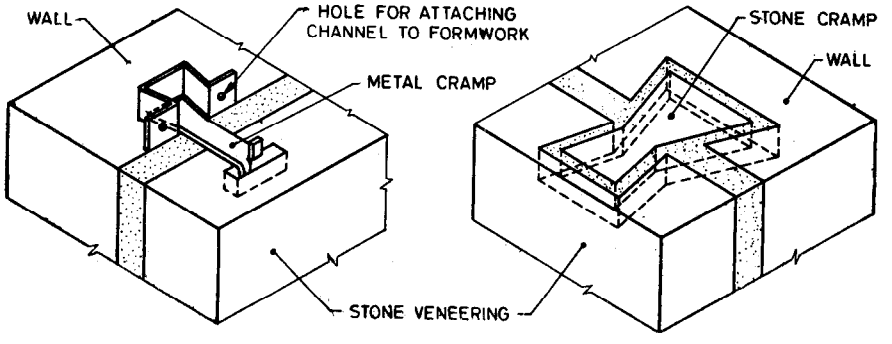
A



B

All dimensions in centimetres.

FIG. 5 COPPER PIN DOWELS



6A Metal Cramp 6B Stone Cramp

FIG. 6 CRAMPS

7.4.1 Fixing cramps where necessary shall be embedded at appropriate positions for the facing work while the backing wall is built.

7.4.2 The joints shall be done with weak composite mortar, such as 1 : 1 : 5 to 6 (cement : lime : sand). The thickness of joints shall be between 6 to 12 mm. Where joint filler or compound is to be used, the joints shall be raked out to a depth of at least 2·5 cm 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.

8. CONTROL OF ALIGNMENT

8.1 The appearance of the finished wall face with a plain surface will easily show inaccuracies of alignment.

8.1.1 Accuracy of alignment will be achieved by control of uniform size and freedom from wraping in the stone slabs and accuracy in fixing with cramps.

8.1.2 Inaccuracies in alignment of slabs to some extent may be masked by the treatment of the joints such as by the use of chamfered slightly rounded or rebated edge in place of simple squared edge.

(*Continued from page* 2)

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