IS 1661 : 1972
(Reaffirmed 2001)

Indian Standard

CODE OF PRACTICE FOR APPLICATION OF CEMENT AND CEMENT-LIME PLASTER FINISHES

(First Revision)

Fifth Reprint SEPTEMBER 1996

UDC 693.621 : 69.001.3

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

Gr 7 *August* 1972

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Indian Standard

CODE OF PRACTICE FOR APPLICATION OF CEMENT AND CEMENT-LIME PLASTER FINISHES

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 25 February 1972, after the draft finalized by the Flooring and Plastering Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Cement plaster and cement plaster gauged with lime are widely used in this country for finishing of walls and ceilings of buildings. Practice in the country with regard to the preparation, application and finishing of the plaster varies considerably from state to state and from department to department. It is the object of this standard to lay down a code of practice generally suitable to Indian conditions, and striking a workable compromise between theoretical requirements and existing practices. This standard which was first published in 1960 is now being revised taking into account the experience gained in the plastering work for the past one decade.

0.3 This code is intended chiefly to lay down requirements regarding the quality of materials, their selection and the manner of their application in plaster work.

0.4 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. This has been met by deriving assistance from BSCP 211 : 1966 published by the British Standards Institution.

0.5 This standard is one of a series of Indian Standards on plaster finishes. Other standards published so far in the series are:

IS : 2394-1965 Code of practice for application of lime plaster finish

IS : 2402-1963 Code of practice for external rendered finishes

0.6 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.

1. SCOPE

1.1 This standard covers application of cement and cement-lime plaster finishes to walls, columns, ceilings and similar surfaces on backgrounds normally met with, such as brick, stone or concrete (plain or reinforced). Lime plasters, mud plasters and other special plasters are not covered by this code.

1.2 Recommendations are laid down with regard to the minimum preparation of surfaces to receive the plaster. Different materials available, their suitable mixes and the best methods of their application are also discussed.

2. TERMINOLOGY

2.0 For the purpose of this code, the following definitions shall apply.

2.1 Materials

2.1.1 *Fat Lime* — The lime which has high calcium oxide content and is dependent for setting and hardening solely on the absorption of carbon dioxide from the atmosphere.

2.1.2 *Hydrated Lime* — A dry powder obtained by treating quicklime with water enough to satisfy its chemical affinity for water under the conditions of its hydration. It consists essentially of calcium hydroxide and magnesium hydroxide.

2.1.3 *Hydraulic Lime* — Lime containing small quantities of silica and alumina and/or iron oxide which are in chemical combination with some of the calcium oxide content, giving a putty or mortar which has the property of setting and hardening under water.

2.1.4 *Plaster* — The general term for a material used to cover surfaces, which is applied while plastic and which hardens after application. Cement-lime plaster refers to cement plaster gauged with lime.

2.1.5 *Quicklime* — A calcined material, the major part of which is calcium oxide in natural association with a relatively small amount of magnesium oxide, capable of slaking in water. Lumplime is quicklime as it comes from the kilns.

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

2.2 Tools and Accessories — For tools and accessories, such as drag or scratcher, floats, rules or battens, squares, templates, trowels and iron pan, the definitions are as given in IS : 1630-1960*.

2.2.1 *Scaffolding (Staging)* — A temporary framework of bamboo, wood or steel to provide a platform from which the mason does the plastering work.

2.3 Site Operations

2.3.1 *Finishing Coat* — The final coat in two or three coat plaster work. This is also referred to as the final coat, setting coat, face coat or skimming coat (the term ' skimming coat ' is also applied to single-coat work).

2.3.2 *Gauging* — The mixing of various constituents of a plaster. This term is also used for denoting the addition of cement to a lime-sand mix or of lime to a cement-sand mix. ' A gauging ' is the term given to an individual plaster work.

2.3.3 *Screeds* — Narrow strips or bands of plaster laid on walls or ceilings to serve as guides for bringing the whole work to a true or even surface, the screeds being incorporated in the final undercoats.

2.3.4 *Undercoats* — Plaster coats (often referred to as backing coats) the main function of which is to provide surfaces suitable for the application of succeeding coats. There are following two types of undercoats:

a) *Rendering coat* — The coat which is applied directly to the building surfaces to be plastered (also referred to as the ' first coat ').

b) *Floating coat* — The coat used in three-coat work to bring the first coat to a true and even surface before the finishing coat is applied (also referred to as the ' second coat ').

2.4 Characteristic Defects

2.4.1 *Blistering* — The development of one or more local swellings on the finished plaster surface.

2.4.2 *Cracking* — The development of one or more fissures not assignable to structural cause.

NOTE — Cracks in plaster in the vicinity of a structural crack are not assignable to structural failure unless they are in conformity with the structural crack.

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

2.4.4 *Efflorescence* — A deposit of soluble salts on the surface of the plaster or background.

*Specification for mason's tools for plaster work and pointing work.

2.4.5 *Flading* — The scaling away of patches of plaster surface due to lack or loss of adhesion with the previous coat.

2.4.6 *Grinning* — The appearance on the surface of the plaster of the pattern of joints or similar breaks in the continuity of the surface characteristics of the background.

2.4.7 *Peeling* — The dislodgement of substantial areas of plaster work from the background.

2.4.8 *Popping or Blowing* — The appearance on the surface of the plaster of conical hollows (pops or blows) in the backing and/or finishing coats.

2.5 General

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

2.5.2 *Fineness Modulus* — A numeral indicating the fineness of an aggregate, as determined by ascertaining the percentage residue, by weight or volume, remaining on each of a series of fine sieves with apertures ranging from 40 mm to 150 micron, summing, and dividing by 100.

2.5.3 *Suction* — The property of background which determines its rate of absorption of water.

3. NECESSARY INFORMATION

3.1 In the selection of materials for plasters and in their mixing and application, information is necessary on the following points and detailed consideration shall be given to them before starting plaster work:

a) Types of surface over which it is proposed to apply plaster, so that constructional details may be suitably adopted to them and the amount of subsequent preparation necessary before plastering may be minimized.

NOTE — This is of particular importance in the case of concrete soffits, and the construction details shall include the necessary provisions for adequate mechanical key left permanently embedded in or adhering to the concrete.

b) Area, types of finish and thicknesses required, together with sufficient details of the nature of the surface to be plastered.

c) Details of finish at junctions with doors, windows, and other openings, with ceilings, linings, etc, and at all corners.

d) Types of cornice, arris and return treatments desired, and of dado treatments where required.

e) Details of scaffolding (staging) for access to work in the correct sequence, together with provision for adequate protection of adjacent surfaces during plastering operations, particularly in ceiling work.

f) Details of fixing accessories, templates, etc, to be embedded in the plaster.

g) Types of surface or decorative finish to be applied over the plaster and detailed information on the compatibility of the plaster with the proposed decorative finish.

3.2 All information required in **3.1** shall be made available to those who are responsible for the plastering work. Necessary drawings and instructions for preparatory work shall also be given.

3.3 Arrangements shall be made for the proper exchange of information between those engaged in plastering and all others whose work will affect or will be affected.

4. MATERIALS, TOOLS AND ACCESSORIES

4.1 The following materials, conforming to relevant Indian Standard specifications, shown against them, shall be used:

a) Cement conforming to IS : 269-1967* or IS : 455-1967†,

b) Lime Class B and C conforming to IS : 712-1964‡, and

c) Sand conforming to IS : 1542-1960§.

4.2 The following requirements shall also be complied with where applicable:

a) *Lime Putty (or Neeru)* — This shall be obtained by slaking lime with fresh water, and sifting it. The slaking shall be done in accordance with IS : 1635-1960‖. Putty shall be kept moist until used, and the quantity prepared at a time shall be not more than what may be consumed in 7 days.

b) *Water* — The water used for mixing shall be clean, free from deleterious matter and also from unusual proportions of dissolved salts. Sea water or tidal astuary or brackish water shall not be used. Water fit for drinking is normally suitable; in case of doubt, the quality of water should be analysed to ascertain conformity with **4.3** of IS : 456-1964¶.

c) *Wood Lath* — The pieces of wood used for wood lath shall be free from all decay and insect attack. Both hard woods and soft woods

*Specification for ordinary, rapid-hardening and low heat Portland cement (*second revision*).

†Specification for Portland blastfurnace slag cement (*second revision*).

‡Specification for building limes (*revised*). (Since revised)

§Specification for sand for plaster.

‖Code of practice for field slaking of lime and preparation of putty.

¶Code of practice for plain and reinforced concrete (*second revision*).

may be used according to availability. Laths shall be free from knots or knot holes that are greater than one half the width of the lath. The timber shall be partially seasoned; and the moisture content shall not be greater than 20 percent.

d) *Metal Lathing* — Metal lathing used as background for plastering should weigh not less than 1·6 kg/m².

e) *Galvanized Wire Netting* — Where required to provide a mechanical key, galvanized wire netting of mesh not greater than 50 mm shall be used.

4.3 Tools and accessories used in plaster work may advantageously be in conformity with IS : 1630-1960*.

5. STORAGE OF MATERIALS

5.1 Cement — Cement shall be stored off the ground, under cover and away from damp surfaces so as to prevent deterioration either by moisture or by intrusion of foreign matter. If these precautions are neglected cement will be rendered less effective or useless (*see* IS : 4082-1967†).

5.2 Lime — Lime shall also be stored off the ground, under cover and away from damp surfaces. Quicklime may progressively deteriorate with keeping through absorption of atmospheric moisture and carbon dioxide. For this reason, it shall be kept in a dry place and be protected from direct contact with water, fumes from boilers or similar contamination. Hydrated lime will not develop any serious deterioration for a period of six months provided it is left undisturbed in the bag and kept in a cool dry place free from draughts, fumes from boilers or similar contamination (*see* IS : 4082-1967†).

5.3 Sand — Sand for plaster shall be stored under clean conditions to prevent contamination by soil or other deleterious substances.

6. CARE OF TOOLS AND ACCESSORIES

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

*Specification for mason's tools for plaster work and pointing work.

†Recommendations on stacking and storage of construction materials at site.

6.2 Scaffolding (Staging) — Wooden *BALLIES*, bamboos, planks, trestles and other scaffolding materials shall be sound and in accordance with local building regulations. These shall be properly examined before erection and use.

7. DESIGN CONSIDERATIONS

7.1 Suitability of Cement Lime Mixes

7.1.1 Plastering mixes containing lime putty dry hydrated lime, cement and sand are characterized by high workability and marked ease of application. Such properties become less pronounced as the proportion of cement increases.

7.1.2 Cement-lime mixes have a reasonably longer working time (*Max* 2 h), a fairly slow rate of strength development increasing with the amount of cement added and adequate early strength to withstand modern building conditions. They need moisture to complete the setting process and, therefore, rapid drying in the early stages should be avoided.

7.1.3 The weaker mixes of cement lime plaster containing smaller proportions of cement, shall not be used in conjunction with a strong finishing coat. Weaker mixes offer certain advantages over the stronger (richer) mixes when applied to non-rigid backgrounds, such as lathing.

7.1.4 For trowel finishes (very smooth surfaces), mixes of lime and cement shall not, in general, be used for finishing coats, as their shrinkage on drying creates a tendency for surface crazing.

7.2 Number of Plaster Coats

7.2.1 The ideal number of coats, where practicable, is two, namely, the undercoat followed by a finishing coat. It is recognized, however, that much successful work has been carried out in the past with plaster finishing coats with a single coat on reasonably plane backgrounds of brick, concrete and similar materials. However, for very rough surfaces, such as rough stone masonry, three coat plastering may be necessary. Metal lathing normally requires a three coat plaster finish for successful results. Renovation work on wood laths should also be carried out in three coats.

7.2.2 The range of coats normally employed for different backgrounds is as follows:

Background	*Number of Coats*
Brickwork or hollow clay tiles	2 or 1
Concrete, cast *in situ*	2 or 1
Building blocks	2 or 1
Wood or metal lath	3 or 2

Background	*Number of Coats*
Fibre building board (insulating board)	2 or 1
Wood wool slabs	2 or 1
Cork slabs	2 or 1
Uneven and rough stone masonry	3 or 2

7.2.2.1 A summary of background data for the internal plastering is given in Table 1 for guidance.

7.3 Thickness of Plastering

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

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

7.3.3 The thickness of an individual coat shall generally be as recommended in Table 2.

7.4 Recommended Plaster Specifications

7.4.1 A list of specifications for mixes suitable for various situations is given in Table 2, which covers single-coat work which is used generally and also two and three-coat works suitable for special situations. The lime in the mixes specified in Table 2 and in **7.4.2** is assumed to be measured as lime putty, but if it is measured as dry hydrated lime, the proportion of lime in any mix shall be slightly higher than is indicated and a suitable adjustment shall be made as indicated in **7.4.1.1.**

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

$$W_h = \frac{G}{G - 1} (W_p - 1\,000)$$

where

W_h = weight of dry hydrate in kg/m^3,

G = specific gravity of hydrate (*see* IS : 2394-1965*), and

W_p = weight of putty in kg/m^3.

*Code of practice for application of lime plaster finish.

TABLE 1 SUMMARY OF BACKGROUND DATA FOR INTERNAL PLASTERING

(*Clause* 7.2.2.1)

Sl No.	Class	Type	Drying Shrinkage Movement	Surface Characteristics	Preparation of Surface	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Solid	a) Dense clay bricks and blocks	Negligible	Low suction and poor key	May require more than raking joints, for example, bonding agents, spatterdash or wire mesh or special plasters	Spatterdash coat, 1 : 2, or 3 cement: coarse sand should be allowed to harden before applying undercoat. Wire mesh should be fixed at least 6 mm in clear of surface
		b) Normal clay brick and blocks	Negligible	Moderate to high suction and reasonable key	Rake joints unless key provided	Should be dry to minimize efflorescences
		c) Dense concrete, either precast or *in situ*	Low to high according to quality. Differential thermal movement varies with aggregate	Suction generally low, but varies according to aggregate and water / cement ratio. Poor key unless provided by special shuttering or retarder	Unless keyed, use spatterdash, bonding treatment or special plasters	Use bonding treatment or special plasters according to manufacturers' recommendations
		d) No-fines concrete	Varies from low to moderate. Varies with aggregate	Low suction and good key	None	—

(*Continued*)

TABLE 1 SUMMARY OF BACKGROUND DATA FOR INTERNAL PLASTERING — *Contd*

Sl No.	Class	Type	Drying Shrinkage Movement	Surface Characteristics	Preparation of Surface	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
		e) Open textured concrete blocks and concrete containing light-weight aggregate	Moderate to high	Low suction and good key	None	Should be dry to minimize shrinkage movement
		f) Close textured concrete blocks	Moderate to high	Variable suction	May need treatment with a bonding agent to provide key	Differential thermal movement may be high with some aggregates
		g) Aerated concrete	Moderate to high	Moderate to high suction, reasonable key	It may be necessary to reduce the suction unless special plasters are used	Should be dry to minimize shrinkage movement
ii)	Slab	a) Wood-wool	High but generally fixed dry and may also be restrained	Low suction and good key	None other than joints scrimmed	When used as permanent shuttering special precautions are necessary
		b) Strawboard	—	No key	Key can be provided by use of bonding treatment or wire netting or metal lathing. Joints should be scrimmed	—

		c) Cork	—	Low suction, key variable	If the surface provides insufficient mechanical key a 1 : 1 cement : fine sand slurry should be brushed on and wire meshed fixed	—
iii)	Boards	a) Plasterboard	Negligible	Low suction, adequate key with suitable plasters	Joints scrimmed unless gypsum lath is used	—
		b) Insulating fibreboard	High, but fixed dry and easily restrained	Low suction, adequate key with suitable plasters	Joints scrimmed	Boards must be conditioned on site
		c) Expanded plastics	—	Low suction, adequate key with suitable plasters	None, other than joint scrimming where recommended by manufacturer	Consideration should be given to the strength of the board and the possibility of impact damage
iv)	Metal lathing	Expanded metal and clay	—	Good key	None	—

TABLE 2 RECOMMENDED PLASTER SPECIFICATIONS

(*Clauses* 7.3.3 *and* 7.4.1)

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

Note 1 — Where two or three coat plasters are adopted, as far as possible the mix for the under coats should contain coarse sand conforming to grading zone II of IS : 383-1970† and having fineness modulus not less than 2·0.

Note 2 — For single coat plaster the fineness modulus of sand should be as far as possible 1·5 and conforming to grading zone IV of IS : 383-1970†. Where only fine sand is available the fineness modulus of sand may be improved by mixing the required percentage of coarse sand. The strength of plaster mix gets reduced with the reduction in the fineness modulus of sand.

Note 3 — Other mixes of cement/lime and sand may also be adopted depending on the quality of sand available and local conditions provided the strength conforms to any of the above mixes given in Table 2.

*Cement : lime : sand.

†Specification for coarse and fine aggregates from natural sources for concrete (*second revision*).

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

7.5 Surface Finish — Internal plasters are usually finished to a smooth surface. If textured finishes are required, special techniques may have to be employed and the success of the treatment is largely dependent on good craftsmanship.

7.6 Corrosive Effect on Metals

7.6.1 In normal circumstances, matured plaster work may be regarded as dry and therefore non-corrosive. Such dangers of corrosion as do arise should only occur during the initial drying period and subsequently during periods of heavy condensation. Plasters containing uncarbonated lime (for example, lime and cement mixes) have a protective effect on iron and steel, but are likely when persistently damp to corrode lead and aluminium unless protected by a suitable paint.

7.6.2 Plastering mixes in which sand or water contaminated with sea-salts have been used are likely to be continually damp, due to the deliquenscent or moisture-attracting nature of the salts, and may corrode metals in contact with them. Frost proofing additives containing soluble chlorides, for example, calcium chloride, are likely to have similar effects.

7.6.3 Protection may be given to steel and aluminium when necessary by means of suitable metallic or paint coatings. Sleeves of material resistant to any corrosive effects may sometimes provide a convenient means of avoiding contact of metal pipes or conduits with plasters which accelerate corrosion, or the metal may be embedded in a plastering mix of a more suitable composition. Under persistently wet conditions no form of plastering can be relied on to protect metals from corrosion.

7.6.4 With cold water service pipes the provision of an insulating sleeve serves also to avoid condensation of moisture in the plaster in their immediate vicinity during the subsequent life of the building.

7.7 Effect of Atmospheric Conditions

7.7.1 The prevailing weather at the time of plastering or during the setting, drying and hardening period may affect the finished work as follows:

a) *Frost* — The destructive effect of frost on plaster work is substantial. Unless special precautions are adopted, plastering work shall be suspended entirely during frosty weather. Recommendations have been made from time to time in countries which experience long continued periods of frosty weather and they should serve as a guide to good practice in this country.

b) *Cold* — The setting and hardening times of all plasters are appreciably lengthened by a reduction in the atmospheric temperature. Where plastering has got to be carried out in cold weather, the time intervals shall be lengthened to allow for this, and the work programmed or re-programmed accordingly.

c) *Condensation* — In certain localities condensation resulting from cold wintry conditions may be so excessive as to impair the finished plaster work. It may also retard or prevent the drying out of wet building operations for periods of week, or even months, thus presenting conditions unsuitable for plastering.

d) *Extreme dry conditions* — Under hot dry conditions the applied plaster may become dry before the setting process is sufficiently advanced. The partially set weak material often has a powdery surface which will not provide a satisfactory base for the subsequent coat or for decoration. Plasters containing cement are particularly sensitive in this respect. In such contingencies the surface should be continually kept wet during the curing period.

8. GENERAL PRECAUTION IN PLASTERING

8.1 Cleanliness and Protection of Existing Work

8.1.1 Cleanliness is essential in carrying out plaster work. Adequate protection shall be given to all existing work and fittings which are liable to be damaged, not only in the area of plastering operations, but also in the approaches thereto by covering up with boards, dust sheets, etc, as necessary.

8.1.2 *Cleaning off on Completion* — On completion, all work affected by plastering operations shall be left clean. Special care is necessary when removing set plaster from glass to avoid damaging its surface.

8.2 Suction Adjustment

8.2.1 The careful adjustment of suction is very necessary for good plastering, and may be done either by wetting the backing suitably if it is dry, or by sprinkling with a cement-mix as in the case of a concrete surface with low suction. Without the aid of suction, plaster would creep and slide down due to its own weight. On the other hand, high rate of suction withdraws all moisture from the plaster and makes it weak porous and friable. Too much water makes it impossible to keep the mortar in position till it sets. A failure in bond due to excessive water leads to further failures as the pocket formed may hold water and break up the plaster when the water freezes; or if the water is salt-laden, the same results will be produced on evaporation by crystal formation.

8.2.2 The wall shall not be soaked but only damped evenly before applying the plaster. If the surface becomes dry in spots, such areas shall be moistened again to restore uniform suction. A fog-spray is recommended for this work.

8.3 Adjustment of Working to the Setting Properties of Plaster

8.3.1 Cement plasters and cement-lime plasters contain materials which set when brought into contact with water, and the fullest use of their strength producing properties is not made unless the mix is applied before the setting process has started. If retampering of such mixes is carried out after the set has commenced, an inevitable loss in strength and efficiency will result.

8.3.2 In the case of cement plasters, the commencement of the set is accompanied by a noticeable stiffening of the mix. In the case of cement plaster heavily gauged with lime, however, it is not always obvious to the operator when the set has started and it is with this type of mix that the retention of the full measure of strength afforded by the cementitious material is particularly important. Such plasters may be overworked both before and after application with resultant impairment of the set of the gauging plaster. This not only reduces the strength of the material, but also gives it the shrinkage characteristics of a pure-lime plaster with its liable accompaniment of the surface crazing. It is essential, therefore, that mixes shall be used as soon as possible after water has been added and that working periods recommended in this code shall not be exceeded.

8.4 Control of Cracking — This is normally a structural problem, but the plaster will be able to reduce the effects of structural cracking by making a trowel cut between adjacent surfaces.

8.5 Maintenance of Proper Time Intervals — Shrinkage, partly irreversible, occurs on drying, causing stresses to be set up both in the applied coat and in the undercoat or background, and in order to avoid break-down of adhesion between successive coats, it is very important that the drying shrinkage of the first coat should be materially complete before a subsequent coat is applied. The rate of drying will vary widely with conditions of temperature, humidity and ventilation. Proper time interval serves to diminish the possibility of efflorescent salts finding their way to the final plaster surface, and also of the drying and naturing shrinkage (map crazing) of the undercoat reaching the finished plaster face over a period of time. The surface then shall be allowed to set for at least a day or two depending upon the weather (one day in summer and two days in winter). During this period the surface of this coat shall be kept damp and shall not be allowed to dry.

9. PRELIMINARY PROGRAMMING OF WORK

9.1 All materials necessary for plastering shall be kept readily available at the site, in cases where lime putty is to be used, it shall be run sufficiently

in advance so as to mature before use. An adequate supply of water suitable for mixing the plaster and for curing purposes shall be available.

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

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

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

10. SEQUENCE OF OPERATIONS

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

10.2 The surfaces to be plastered shall first be prepared as described in **12.**

10.3 When the preparation has been done, arrangements may be made for a constant supply of plastering material prepared as described in **11.**

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

10.5 After a suitable time interval (preferably not more than 5 days) the second coat may be applied. Surface of the first undercoat shall be adjusted and screeds laid to serve as guides in bringing the work to an even surface. After a further suitable time interval, the finishing coat may be applied first to the ceilings and then to the walls.

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

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

10.8 Where corners and edges have to be rounded off, such rounding off shall be completed along with the finishing coat to prevent any joint marks showing out later.

11. PREPARATION OF PLASTER

11.1 Proportioning

11.1.1 The material used in the preparation of plastering mixes may be measured by volume using gauge boxes.

11.1.2 Cement shall be measured by weight. For the purpose of proportioning one cubic metre of cement shall be taken to weigh 1 440 kg approximately.

11.1.3 Proportioning of lime may be done by measurement of volume as lime putty or dry hydrated lime before the preparation of putty. The mix proportion of lime, unless otherwise stated, generally refers to the volume of putty.

NOTE 1 — Lime putty weighs about 1 280 kg/m^3.

NOTE 2 — One m^3 of dry hydrated lime normally gives about 0·8 to 0·9 m^3 of lime putty.

11.1.4 *Quantity of Water* — For general cement-plaster work with 1 : 3 proportion the quantity of water required is about 70 percent by weight of cement. This may, however, vary depending on the following factors, and adjustment shall be done as explained in IS : 2250-1965*:

a) The nature and condition of the fine aggregate;
b) The temperature and humidity at the time of working;
c) Richness of the mix, namely, whether rich or leaner than 1 : 3;
d) The varying quantities of lime in composite mortars; and
e) The use of admixtures added for improving the workability.

11.2 Mixing

11.2.1 *Cement-Lime Plaster* — The cement-lime plaster shall be prepared by mixing dry in the required proportions cement and sand. Lime putty mixed with water shall then be added to the mix and the contents mixed for sometime until a satisfactory mortar is obtained.

*Code of practice for preparation and use of masonry mortars.

11.2.2 *Cement Plaster* — Cement and sand shall be mixed dry in the required proportions to obtain a uniform colour. Water shall then be added to get the required consistency for the plaster.

11.2.3 Cement-lime plaster shall be used within two hours after the addition of water to cement provided it is kept agitated or turned over at intervals of at least 20 min. Cement plasters shall be used within half an hour after the addition of water. Any mortar or plaster which is partially set shall be rejected and removed forthwith from the site.

11.2.4 Mixing may be done either manually or mechanically. 'Hand mixing' shall be carried out on a clean, water-tight platform. During mixing, the mortar shall be heed back and forth for 10 to 15 min after the water is added. In 'machine mixing' the mixer shall run at least 5 min after placing all the ingredients in the drum.

11.2.4.1 Machine mixing is preferable to hand mixing for all mortars.

12. PREPARATION OF BACKGROUND FOR APPLICATION OF PLASTER

12.1 For the durability of the plaster or rendering, it is vital to obtain a satisfactory bond between the background and the first plaster coat and also to ensure that the bond is maintained subsequently. The requirements of good background in this respect are explained in **12.1.1** to **12.1.7.2.** Necessary preparation of the background shall be done to fulfil these requirements. The preparation for different types of backgrounds is individually dealt with in **12.2** to **12.4.**

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

12.1.2 *Roughness* — The roughness of the background may generally improve the bond of the plaster. A smooth surface may be roughened by wire brushing, if it is not hard; or by hacking or bush-hammering if it is hard. Alternatively, to obtain a rough surface, a mortar 1 cement : 1½ to 3 coarse sand by volume prepared to a wet consistency may be forcibly

dashed or to the surface (spatterdash treatment) by suitable means on to a hard surface like concrete. After roughening the surface, care shall be taken to moisten the surface sufficiently before plastering, as otherwise the surface may tend to absorb considerable amount of water from the plaster. In addition to general roughness in the masonry, the joints shall also be raked to a depth of about one centimetre for providing key to the plaster. On a soft smooth surface after hacking a thin coat of cement slurry (1 : 1 : : cement : fine sand) may be applied. In special cases wire netting, etc, may be fixed to improve further the key to the plaster.

12.1.3 *Suitable Suction* — The adjustment of suction of the background during the application of plaster is already dealt with in **8.2.** The amount of water introduced in the bockground during its construction has an important bearing and adequate drying intervals shall be allowed between erection and plastering to bring the surface suitable for suction adjustment.

12.1.4 *Evenness* — The background shall be even in order to avoid variations in the thickness of the plaster. Any unevenness must be levelled before the plaster is applied. Local projections in brickwork are serious from the point of view of plastering. For three-coat plaster work, the local projection shall not exceed 1·2 cm proud of the general surface as determined by the periphery of the surface concerned and local depression shall not exceed 2·0 cm. For two-coat plaster, a local projection shall not exceed 0·6 cm and local depression 1·2 cm.

12.1.5 *Strength and Elasticity* — The strength and elasticity of the plaster shall be compatible with that of the background. The recommendations given in this standard already cover this aspect.

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

12.1.7 *Precaution Against Discontinuity in Backgrounds* — Cracking of walls or of plaster is often caused by discontinuity, for instance changing from concrete to brickwork, from clay brickwork to lightweight concrete blockwork or even changing from one type of brick to another. Differential drying shrinkage is probably the main cause but difference in thermal movements may also contribute. Reinforcement of the plaster by metal lathing or scrim over the junction is not always successful. The best treatment may be to separate the two portions by a neat cut through the

plaster at the junction. The junction may be masked, if so desired, by fixing a cover strip to one side.

12.1.7.1 A change from wall to ceiling can be regarded as a discontinuity. To provide for the crack, a cornice that would allow slight movement without cracking or a straight cut through the plaster at the junction may be provided.

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

12.2 Surface Preparation for Brickwork or Hollow Block Masonry — The masonry shall be allowed to dry out for sufficient period so that initial drying shrinkage is fairly complete, and suction adjustment is possible during plastering (*see* **12.1.3** *and* **12.1.6**).

12.2.1 Joints of new brickwork or block masonry, if particularly the bricks or blocks are smooth, shall be raked out as the work proceeds (*see* **12.1.2**). Projecting bricks shall be trimmed off where necessary (*see* **12.1.4**).

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

12.3 Surface Preparation for *in situ* Concrete

12.3.1 The surface shall be cleaned and roughened as in **12.1.1** and **12.1.2.**

12.3.2 Concrete surfaces shall have sufficient roughness to provide proper adhesion (*see* **12.1.2**). The surface shall be evenly wetted (not saturated) to provide correct suction (*see* **12.1.3**).

12.3.2.1 If a chemical retarder has been applied to the formwork, a roughened surface may be formed by wire-brushing and all the resulting dust and loose particles cleaned off, and care shall be taken that none of the retarders is left on the concrete or on other surfaces, as it may interfere with the set of the plaster or with other building operations.

12.3.2.2 Where mechanical key-forming devices have been used in the concrete, these shall be stripped off if still adhering and the resulting surface cleaned down.

12.3.3 Ridges or fins left on soffits or on the sides of concrete beams by shuttering imperfections shall be removed before cleaning down, to be compatible with the plaster finish particularly when it is not thicker than one centimetre.

12.4 Boards and Slabs — When the boards or slabs are fixed in accordance with relevant Indian Standard for fixing wall coverings and fixing ceiling coverings, 'scrimming' (*see* **12.1.7**) is all the preparation that is necessary.

13. APPLICATION OF UNDERCOATS

13.1 The Rendering or First Coat

13.1.1 The rendering coat shall be 10 to 15 mm thick and carried to the full length of the wall or to natural breaking points like doors or windows. Before the rendering coat hardens, it shall be roughened to provide mechanical key for the second coat.

13.1.2 Masonry walls on which plaster is to be applied directly, shall be properly set and cured with the joints raked to a depth of at least 10 mm. Before applying the rendering coat, the surface shall be cleaned and damped evenly to control suction, an essential treatment for securing first class work. The rendering coat shall be trowelled hard and tight, forcing it into surface depressions to obtain a permanent bond.

13.1.3 On smooth concrete walls, the surface shall be roughened according to **12.1.2** and the rendering coat shall be dashed on to ensure adequate bond. The dashing of the rendering coat shall be done using a strong whipping motion at right angles to the face of the wall, or it may be applied with a plaster-machine or cement-gun. In either case, the plaster shall be projected on to the surface with considerable force.

13.2 The Floating or Second Coat — Before starting to apply the second coat, the surface of the rendering coat shall be damped evenly as described in **8.2**. The second coat shall be approximately 3 to 8 mm thick. It shall be brought to a true, even surface and then roughened to provide bond for the finishing coat. Each under coat shall be damp-cured for at least two days.

14. APPLICATION OF FINISHING COAT

14.1 Before starting to apply the finishing coat, the second coat shall be damped evenly as described in **8.2**. Whenever possible, textures shall be applied from top to bottom in one operation to eliminate joining marks.

14.2 Coloured Cement Work

14.2.1 This work may be classified under two categories as follows:

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

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

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

14.2.2 In the case of coloured cement plastering, it is necessary to add an integral waterproofer in the undercoats to minimize the risk of efflorescence. Where a coloured cement plastering is to be done on an already existing mortar base, it is recommended to apply a surface water-proofer on the base and also mix an integral water-proofer with the coloured cement plaster for the finishing coat.

14.3 Special Finishing Textures — Various types of special textures for rendered surfaces may be obtained by using special tools for the application of the final coat. The special finishes shall be applied in accordance with the details given in IS : 2402-1963*.

15. TRUENESS OF PLASTERING SYSTEM

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

16. CURING

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

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

17. INSPECTION AND DIAGNOSIS

17.1 Interrelation of Various Factors

17.1.1 It is essential to determine the cause of any defects of plaster-work before any attempt is made to remedy or repair them and unless the

*Code of practice for external rendered finishes.

cause is properly dealt with, the majority of defects will continue to recur after repair. The interpretation of defects of plasterwork and the determination of their causes can only be done by approaching the subject in a systematic and logical manner.

17.1.2 Since it is the final plaster finish which claims the attention of the casual observer, it is a common error to blame only the plastering materials or workmanship for all defects. Actually, these, although perhaps the most important, are not the only factors that may influence the final result.

17.1.3 Every defect in plastering is more or less connected with the whole history and treatment of the background. Consideration shall be given not only to the plastering material used and to the quality of workmanship, but also the climatic conditions prior to, during and after the plastering process, and to the correct choice of the plastering system.

17.1.4 Detailed consideration has already been made in **7** and **8** or several factors in this connection such as:

a) the possible causes for lack of bond between successive coats of plaster and between the first undercoat and the background concerned,

b) the possible effect of inadequate time intervals in promoting severe efflorescence or ' map crazing ' on the finished surface, and

c) the effect of climatic conditions in causing or aggravating the above as well as other troubles.

17.1.4.1 Besides, the active influences of the various atmospheric conditions, the effect of the physical properties of the building surface prior to plastering shall also receive due consideration.

18. PLASTERING DEFECTS AND THEIR REMEDIES

18.1 General — It is not possible to give simple rules for the correction of all plastering defects or failures. Many serious defects may be shown to have causes outside the materials or techniques used in the plastering operations and it is often useless to repair or even replace the plaster without first having discovered and corrected the primary fault.

18.1.1 Thus, penetration of moisture through an external wall may cause blistering, efflorescence, flaking or complete disintegration of the plaster. To patch or to replaster such a wall without first taking steps to prevent further damp penetration would be useless. Again, plastered ceilings may develop cracks because the ceiling construction permits excessive deflection, and no plaster repair could be expected to be effective in preventing it. Recurrent surface dampness may be associated with the presence of deliquescent salts in the plasterwork, but it would not

necessarily be effective to renew the plaster. The salts may also be in the background and would probably migrate into the new plaster and bring about a renewal of the trouble. This type of defect usually traced to the use of an unwashed estuarine or sea sand, is best corrected by battening out and erecting a new plaster base out of capillary contact with the affected area.

18.1.2 Defects caused by the use of unsuitable plastering materials or by faulty technique may be corrected by means of an appropriate repair.

18.2 Typical Plastering Defects

18.2.1 *Blistering* — This is due to intense local relative movement of the final coat, where the component of the splitting force at right angles to the plaster surface exceeds the bond strength at the inter-face, which is aggravated by the absence of an adequate key between the final coat and undercoat. The most common cause is local exposure to radiant heat.

18.2.2 *Bond Failure or Loss of Adhesion* — This, according to its severity, results in 'hollow' patches, flaking of top coats, or peeling of substantial areas. It is essential to prevent moisture penetration from the outside, as otherwise peeling will eventually occur.

18.2.3 *Cracking* — This is usually caused by movement in the background or the surrounding structure. Shrinkage movement in undercoats based on cement or lime or the use of unsuitable grades of sand may cause cracking of the final coat.

18.2.4 *Crazing* — The effect of this may, however, be reduced to tolerable or even to negligible proportions by attention to the points enumerated in **18.2.4.1** and **18.2.4.2**.

18.2.4.1 Cement plaster or cement-lime plaster, attempts to shrink on hardening but is restrained by bond with the background which, either has already undergone most of the shrinkage if of concrete, or is practically immune from movement, if of brick or stone. This restraint to shrinkage causes tensile stress in the plaster which is maximum at the skin. If the shrinkage is great, these failures develop into cracks which exist through the whole depth of the plaster. In order to prevent this formation, it is necessary to limit the differences in shrinkage and thereby reduce the tensile stress to within safe limits.

18.2.4.2 Attention to the following points will reduce the tendency to surface crazing to a minimum:

a) Use of well-graded sand and the most suitable proportions of cement and sand as recommended in this code;

b) Avoidance of overworking of cement finishings so that excess cement may not be drawn to the surface to cause skrinkage at the top layer;

c) Observance of adequate time intervals between undercoats and subsequent finishing coat, so that each successive coat undergoes a portion of its shrinkage before the next is applied and thus, reduces the skin tension in the preceding coat; and

d) Suitable control over variations in moisture-content and temperature subsequent to plastering.

18.2.5 *Efflorescence* — This is caused by the presence of soluble salts, such as sulphates of sodium, calcium and magnesium normally in the background, and sufficient water to carry these to the surface as the structure dries.

18.2.5.1 *Remedy* — Sealing coats may not effectively hold back strong efflorescence. Dry brushing of the growth as it appears is the only remedy. Efflorescent salts shall not be removed by washing with water as it may carry some of the salts back into the pores. On redrying, efflorescence may be even worse than before if the salts were still present in the structure. Efflorescence will continue as long as there is sufficient water in the structure or plaster backings to carry the soluble salts forward and it is useless to attempt to seal the moisture by the paint film on the surface. The treatment of an old wall with silicone solution will frequently stop the efflorescence as the liquid blocks the passage for movement of moisture. In the case of efflorescence due to the rising of salt solutions through capillary action from sub-soil the only remedy is to provide bitumen or metallic seals in the walls above the ground level so that an effective barrier to the capillary action is created.

18.2.6 *Grinning* — Grinning is generally caused by marked differences in suction of the background which are not masked by the procedure of adjusting the suction, and which are manifested as areas of varying texture on the plaster surface. Such differences are often caused by the use of a mortar having suction characteristics markedly different from those of the bricks or blocks with which it is used. Grinning is more usually associated with single coat work (two coat work is normally provided on most solid backgrounds and with this thickness of plasterwork grinning is rare).

18.2.7 *Irregularity of Surface Texture* — This may be caused by faulty workmanship, but even a skilled craftsman may be unable to prevent it on backgrounds exhibiting varying suction characteristics unless three coat plastering is employed.

18.2.8 *Popping or Blowing* — These occasionally occur in plaster mixes which contain particles of materials which may keep on expanding even after the plaster coat has set. The expansive force is sufficiently great to push out the plaster in front of the particles, leaving a conical hole known as a ' Pop or Blow '. Insufficiently slaked and unmatured lime is frequently the source of unsound particles causing popping or blowing. Popping may also be caused by the presence of particles of coal or other oxidizable material contained in the sand used for the plaster mix.

18.2.9 *Recurrent Surface Dampness* — The presence of deliquescent salts as occur in sea-water will bring about recurrent dampness in plaster finishes when the atmospheric humidity is high. It may also be caused by condensation of moisture in chimney flues with a permeable lining, for example, where slow combustion stoves are employed.

18.2.10 *Softness or Chalkiness* — This may result from excessive suction of the background, undue thinness of the finishing coat, working past the setting point, or subsequent exposure of the finishing coat to excessive heat or draught during setting.

19. MAINTENANCE

19.1 Plastering work shall be protected at all stages of its life from persistent attack by water or moisture either through the undercoats or through the outer surface. The matter is particularly important during the interval between plastering and decorating. Subsequent decoration on the whole surface may be vitiated by a persistent stream of water down on particular part due to flooding of upper floors under construction, delay in provision of gutters, etc. This would be particularly serious if conditions are favourable to formation of efflorescence. In extreme cases, the plaster surface may be softened or badly channelled, necessitating local repair.

BUREAU OF INDIAN STANDARDS

Headquarters:
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Fax : 91 11 3234062, 91 11 3239399

Telegrams : Manaksanstha
(Common to all Offices)

	Telephone
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‡Sales Office is at 'F' Block, Unity Building, Narashimaraja Square, BANGALORE 560002 — 222 39 71

Printed at New India Printing Press, Khurja, India