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THE NATIONAL BUREAU OF STANDARDS
UNITED STATES DEPARTMENT OF COMMERCE
WASHINGTON, D. C.



July 14, 1936.

RECOMMENDATIONS
FOR
PORTLAND CEMENT STUCCO CONSTRUCTION

This is a digest in part of Circular No. 311 (December 13, 1926), "Stucco Investigations at the Bureau of Standards with Recommendations for Portland Cement Stucco Construction",¹ by Frank A. Hitchcock, issued by the Bureau of Standards. The part selected deals with recommendations resulting from a study of test data.

GENERAL DESIGN AND CONSTRUCTION

Experience has shown that portland cement stucco may develop certain defects which cannot always be guarded against. But, the product may, if properly applied, be depended upon to be structurally sound, durable and capable of giving satisfactory service over long periods with low maintenance cost. Four fundamental factors upon which good stucco is dependent must be taken into consideration:

- (1) The building must be properly designed and constructed.
- (2) Stucco must be applied to a suitable base.
- (3) The mortar must be properly proportioned and carefully mixed from good materials.
- (4) The stucco must be applied by skilled workmen.

The construction should provide overhanging roofs, gutters, suitable flashings, drip grooves, cappings, etc., so as to prevent water from getting back of the stucco and the concentration of flow over the face of the walls. The importance of these requirements cannot be too strongly emphasized.

¹Available from Superintendent of Documents, Government Printing Office, Washington, D. C. (Price 15 cents)

Frame structures to be finished with stucco may or may not be sheathed. If the stucco is to be back-plastered, sheathing is omitted. Otherwise, sheathing should be used, placed horizontally and not diagonally. Special diagonal bracing should be provided in either case to prevent racking, and well built foundations should be provided to avoid settlement and cracking of the stucco surfaces. Ample rigidity may be obtained with corner bracing, and by placing the sheathing horizontally savings in both labor and material may be effected.

The sheathing should be covered with a good grade of waterproof paper, applied from bottom up, lapped 2 inches, and well secured with large head roofing nails. The metal lath should be nailed or stapled, not more than 8 inches apart, and all butted joints securely wired together. Back-plastered type of construction requires that the metal lath be nailed directly to the studs. After brown and scratch coats of stucco have been applied to the exterior, the interior side is back-plastered between the studs with the same material so as to embed the base completely and produce a thicker wall. Walls of this type lose the insulating value of sheathing and paper and, to compensate for this, a layer of felt or other insulating material is usually applied between the studs in such a manner as to form a double air space between the inside plaster and the outside stucco.

Masonry walls provide a rigid base for stucco. When stucco is applied to masonry walls, precautions should be taken in their construction to avoid settling. Units, such as cinder block, hollow tile, etc., should be reasonably straight and true and should be laid with raked joints in cement or cement lime mortar. The surface should be rough or of coarse texture and free from dust, dirt and loose particles. Old walls which have been painted or treated with waterproofing material should be covered with a metal base before stucco is applied. It is preferable to confine stucco to vertical surfaces. It should never extend lower than one foot above grade.

MATERIALS

Cement: Cement should comply with the Federal Specification for "Cement; Portland SS-C-191."¹ To obtain white or colored stucco, the latter through the addition of color pigments or yellow sand, white cement should be used for the final coat.

¹The Federal Specifications mentioned herein have been developed since the publication of Circular No. 311.

Fine Aggregate: The fine aggregate of natural sand or stone screenings to be mixed with the cement should, when dry, pass through a No. 8 square opening sieve (0.0937 inches square) and from 20 to 25 percent through a No. 50 sieve (0.0117 inches) and should be free from loam, vegetable and other injurious matter.

Water: Only water that is suitable for drinking purposes should be used.

Hydrated Lime: Hydrated lime should meet the requirements of the Federal Specification for "Lime; Hydrated (For) Structural Purposes, SS-L-351."¹ The use of lump lime may produce questionable results; therefore, it is not recommended.

Hair or Fiber: When used in scratch coat work, especially when it is to be back-plastered, hair or fiber should be of first quality, long, free from foreign matter, or long fiber well combed out. It should be carefully incorporated in the mortar to insure even distribution and freedom from clots.

Coloring Materials: For the coloring of stucco, the use of mineral pigments incorporated in the mix is advisable. Available color materials are briefly listed below, many tones or shades of which may be obtained by various combinations:

- Natural iron oxides - red, brown, chocolate
- Iron hydroxide - yellow
- Manganese dioxide - black (grayish)
- Carbon gas black - black
- Ultramarine - blue
- Chrome oxide - green

Metal Bases: Expanded metal lath should be galvanized or painted and weigh not less than 3.4 pounds per square yard and should be not less than 24 gage in thickness.²

Woven wire lath may be either galvanized or painted and have 2 1/2 meshes to the inch. The wire used should be not lighter than 19 gage.

MIXING AND APPLICATION

Mixing: Thorough mixing of stucco mortar is of first importance. Dry mixing should be continued until the mix is uniform in color and wet mixing until it is of a uniform consistency. Each batch should

¹The Federal Specifications mentioned herein have been developed since the publication of Circular No. 311.

²The present specification recognizes three weights and three thicknesses less than the number given here.

be carefully measured and proportioned exactly alike in order that consistency and color be maintained throughout the work. Machine mixing should be run for at least five minutes and hand mixing from 10 to 15 minutes after the water has been added.

Proportions: A recommended proportion is 1 sack of cement to 3 cubic feet of sand or stone screenings and 10 pounds of lime.

Quantities of Materials: The following table gives approximate quantities of materials necessary to cover 100 square feet of wall surface:

Thickness of Coat	Proportions 1:3 with one-tenth hydrated lime		
	Cement Sacks	Lime Pounds	Sand Cubic feet
1/4 inch	0.73	7.0	2.20
3/8 inch	1.10	10.3	3.30
1/2 inch	1.47	13.8	4.40
3/4 inch	2.22	20.8	6.60
1 inch	2.94	27.6	8.80

Consistency: Only enough water should be used in mixing to produce a mortar that may be readily worked and applied. The exact amount for the materials at hand is determined by trial and when once determined should be closely adhered to in all the mixes.

Retempering: Mortar should not be retempered by the addition of water.

Waterproofing Materials: In properly proportioned and applied stucco, waterproofing materials do not appear necessary nor have tests shown that any benefit is derived by waterproofing studs in back-plastered construction.

Number and Thickness of Coats: First class work requires three coats of stucco on frame structures and two coats on masonry. However, when the masonry wall is not true, three coats may be desirable.

The first or scratch coat should thoroughly cover the base and be bonded firmly to it. It should be at least one-fourth inch thick

over the face of the base and have fairly deep and rough scoring. The second or brown coat should be applied the following day and should have an average thickness of from three-eighths to one-half inch. After this coat has been straightened and has partially stiffened, it should be gone over with a wooden float to compact it and then lightly scored to receive the third or finish coat, which should be about one-fourth inch thick.

Wetting of Surfaces: Immediately preceding the application of the scratch coat, the surface of the wall (particularly masonry walls) should be wetted down, but not saturated, so that there will be free water on the surface. Too dry a surface absorbs water from the mortar before it has set. On the other hand, a wall completely saturated loses its absorptive power or "suction". Only a slight amount of suction is necessary for proper bonding, which suction tends to draw fine cement particles into the pores of the wall. Upon this action, the bond of the stucco depends. The wetting of each coat is necessary before applying the succeeding coat. The same precautions apply to wetting of each coat before applying the next as apply to wetting a wall.

Application of Coats: Coats should be applied continuously in one general direction without allowing the stucco to dry at the edges. If impossible to work the full width of the wall at one time, the jointing should be made to come at some natural division of the surface, such as the side of a door or window opening.

Curing and Protecting: To obtain best results, stucco should be thoroughly wetted nights and mornings for several days after the final coat is applied and after it has sufficiently hardened to allow spraying with water. Freshly applied work should be protected from sun, rain and freezing weather. No exterior plastering should be attempted when the temperature is below 40°F unless some protection is given the stucco for at least 48 hours.