

MASONRY Information

Repair of Portland Cement Plaster (Stucco)

Portland cement plaster (stucco) is a building facing material consisting of portland cement-based materials and sand, mixed with water to form a workable mixture. Plaster is applied either by hand or machine to exterior and interior wall surfaces in two or three coats. It may be applied directly to a solid base, such as masonry or concrete walls, or it can be applied to metal lath attached to frame construction, masonry, or concrete construction.

Applied directly to concrete or masonry, plaster provides a tough, 13-mm (1/2-in.) thick facing that is integrally bonded to the substrate. When applied to metal lath, three coats of plaster form a 22-mm (7/8-in.) total thickness. The first coat is often referred to as the scratch coat, the second is the brown coat, and the third is the finish coat (Fig. 1).

Portland cement plaster has many qualities that make it a desirable facing material, including hardness, fire resistance, and attractive appearance. Plaster has proved to be a durable wall covering in all climates and has great appeal as a surface finish because of its utility, low first cost, and need for minimal maintenance.

But like all building materials, plaster deteriorates with age and exposure to the elements. Although cement plaster provides a

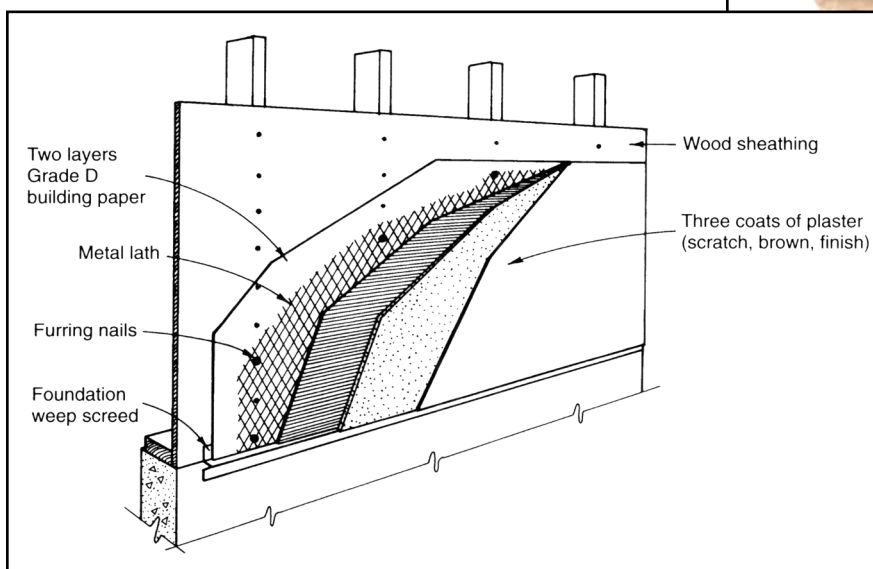


Fig. 1. Portland cement plaster is often applied to metal lath attached to frame construction.

Integrating patches into the existing plaster is one of the many challenges of plaster repair. (69912)

hard, durable cladding, it is not intended to resist building movements, such as those from settlement or the expansion of wood frame members as a result of moisture intrusion. This manual presents recommended procedures for repairing portland cement plaster. This publication does not address synthetic plaster (EIFS) systems.

Causes of Plaster Damage

Portland cement plaster can deteriorate for a variety of reasons, including inadequate design details, poor installation, or the use of improper materials. In many cases, damage results from water infiltration into the building structure either through cracks, through the roof, around chimneys, or through window and door openings. Water that gets behind the plaster can cause wood lath to rot and metal lath and nails to rust, and can cause plaster to delaminate from the substrate.

Cracking in plaster is usually shrinkage-related or the result of external loads, such as ground settlement or inadequate stiffness of the backing. Common causes of cracking are improperly placed control joints, improper lath installation, and inadequate curing.

Control joints are provided in plaster to relieve drying shrinkage stresses and to provide stress relief in areas subjected to movement, such as window and door openings. Drying shrinkage cracks are often caused by violating the rules of control joint spacing (ASTM C 1063):

- Each continuous vertical area should be no more than 13.4 m² (144 ft²).
- Distance between joints should be no more than 5.5 m (18 ft) in any direction.
- No panel should have a length-to-width ratio greater than 2-1/2 to 1.
- Joints should be positioned at movement joints in the substrate.

In wood-frame plaster construction, metal lath expands and contracts with the surrounding plaster. If lath is installed incorrectly, sufficient tensile stresses can develop within the plaster to cause it to crack. Rules for lath installation include:

- Lath should not be continuous at control joints.
- Lath should be lapped 13 mm (1/2 in.) at the sides and 25 mm (1 in.) at the ends (ASTM C 1063), with wire ties spaced 230 mm (9 in.) apart.
- If paper-backed lath is used, laps should be installed to allow a paper-paper and lath-lath lap.

Freshly placed plaster must be protected from excessive moisture loss in the first few days after application. Otherwise, early shrinkage of the plaster can result in map cracking (Fig. 2).

After the cause of deterioration has been identified, any necessary repairs to the building should be made before



Fig 2. Improper curing of plaster can result in map cracking. (69914)

repairing the plaster. These may include roof, gutter, downspout, and flashing repairs. Horizontal areas, such as the tops of parapet walls or chimneys, are particularly vulnerable to water infiltration. These areas may require modifications to their original design, such as the addition of flashing (Grimmer 1990).

Identifying Damaged Plaster



Fig. 3. Water-damaged plaster often bulges or falls away from the building. (69906)

Before beginning any repair, the plaster should be evaluated to determine the extent of damage and how much must be repaired or replaced. Some areas in need of repair are obvious, such as missing sections or layers of plaster (Fig. 3). Water-damaged plaster often bulges or falls away from the building because excessive moisture causes the coats of plaster to delaminate and the metal lath and nails to rust. Unsound or soft areas that have delaminated will make a hollow sound when tapped with a hammer.

Petrographic examination and chemical analysis (ASTM C 1324) of samples of the plaster can determine its mix components and can provide other relevant information, such as the quality of the bond between coats. This information can offer clues as to the

expected useful life of the plaster that remains and aid in determining the appropriate scope of the repair project.

Plaster Removal



Fig. 4. Soft or crumbled plaster can usually be removed with a chisel or other hand tool. (69907)

Plaster that has delaminated from the base, but is otherwise sound, may require a saw or diamond grinder to be removed. Soft or crumbled plaster can usually be removed with a chisel or other hand tool (Fig. 4). If the plaster is properly keyed into the lath, the lath may have to be cut as well. In these cases, sound plaster at the patch perimeter will have to be removed to make room for lapping the new and existing lath.

When patching the plaster, replace it in layers to the same thickness as the existing

plaster. Therefore, each succeeding coat is cut back further than the preceding one, the base coat being the smallest area, and the finish coat being the largest area to be patched (Fig. 5).

If matching the color and texture of the existing plaster is critical, one option is to use abrasive blasting to remove the finish coat of the plaster surrounding the patch. Then the patch and surrounding areas share the same finish coat upon reapplication.

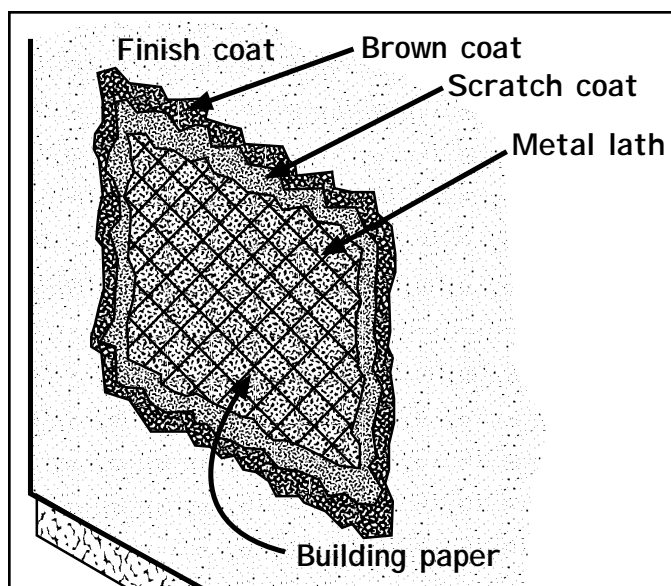


Fig. 5. When patching plaster, each succeeding coat is cut back further than the preceding coat, the base coat being the smallest area and the finish coat being the largest area to be patched.

Lath and Paper Repair

If the existing building paper is torn, it should be replaced with new paper that meets the requirements of *UU-B-790a, Federal Specifications for Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellent, and Fire Resistant)*. Slip the new paper behind the existing paper at the top and sides and allow it to extend over the old paper at an existing lap. Laps should be at least 100 mm (4 in.). This will help prevent water that gets behind the plaster from running down behind the paper.

Corroded or otherwise damaged lath should be cut out and replaced with a new section of lath conforming to ASTM C 847. Follow the lath lapping guidelines outlined above. Also, if using lath that comes pre-attached to a paper backing, you must separate the lath from the paper so the existing building paper is in contact with the new paper and the existing lath is in contact with the new lath. Anchor the new lath to studs at no more than 180 mm (7 in.) on center, but avoid nailing the lath to the substrate between the studs. Doing so prevents the lath from expanding and contracting with the plaster, which can cause cracking. Instead, wire-tie the new and existing lath.

Surface Preparation

Masonry or concrete substrates usually require preparation to ensure that the plaster establishes a strong bond. These surfaces should be sandblasted or mechanically abraded to remove contaminants and roughen the surface to maximize the bonding area of the new plaster. However, don't rake out masonry mortar joints to provide a "key." Doing so will create plaster of varying thickness, which can cause cracking.

If the masonry or concrete is dry, dampen the surface to prevent it from absorbing an excessive amount of water from the plaster. The prepared substrate should be at, or slightly drier than, a saturated, surface-dry (SSD) condition.



Figure 6. Applying a bonding agent can improve adhesion to the substrate and existing plaster. (69908)

The same rules that apply for a masonry or concrete substrate also apply for the edges of the existing plaster to which the patch material will bond. The edges of the existing plaster should be roughened and properly dampened.

Although plaster should bond well to a properly prepared substrate, bonding agents can also be used (Fig. 6). All bonding agents should conform to ASTM C 932.

Patch Application

The same techniques used to apply plaster in new construction are used in repair and are outlined in ASTM C 926. Apply the scratch coat at the same thickness as the surrounding scratch coat and with enough pressure to completely embed the metal lath (when present). As soon as the scratch coat becomes firm, score the surface in one direction only. Vertical wall surfaces should be scored horizontally.

After allowing the scratch coat to cure for at least 24 hours, apply the brown coat at the same thickness as the existing brown coat. Follow the same rules for applying the finish coat.

Curing Patches

Proper curing of patches is essential to avoid rapid water loss from the plaster, which can lead to cracking and debonding of the patch material from the surrounding plaster. Wind, high temperatures, and exposure to direct sunlight will accelerate water loss from the plaster. Curing procedures should maintain a relative humidity of 80% for at least 24 hours, and up to 7 days in some cases.

The plaster can be moist-cured by periodically applying a fine fog spray of water to the surface. But perhaps the most practical curing method is to install plastic film around the repaired area. Consider using an opaque film to protect the plaster from sunlight. Place the film as soon as the plaster surface has hardened enough to resist impression by contact with the film.

Crack Repair

To decide if (and how) a crack should be repaired, you must determine the cause of the crack and consider the consequences if the crack is not repaired. Most repair techniques make cracks

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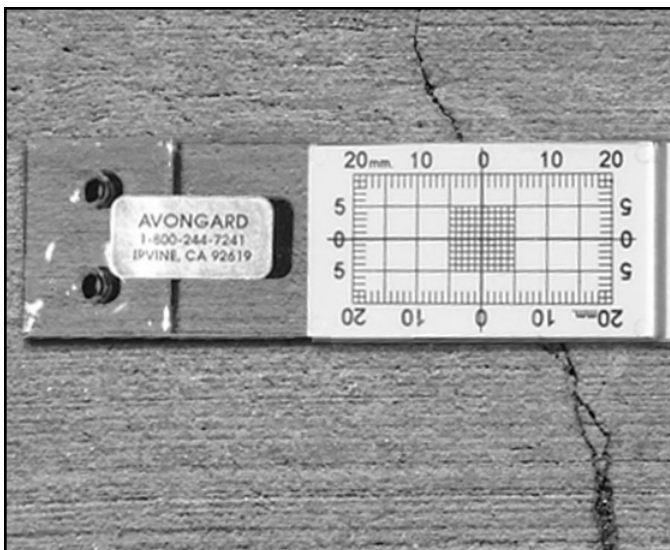


Fig. 7. A crack movement monitor is a useful tool for determining if a crack undergoes movements that are greater than would be expected from normal thermal cycling. (69913)

Selecting a Patch Material

Table 1 shows scratch coat, brown coat, and finish coat mix proportions that are recommended by ASTM C 926 and have demonstrated successful performance in service. In many cases, plaster mixes containing these material proportions will make a suitable patching material. Latex or acrylic polymer modifiers may also be added to the mix water to improve plaster properties. A wide range of colored pigments is also available for creating colored finish coats. The pigments should conform to ASTM C 979. In addition, prepackaged plaster materials are available from several manufacturers.

Selecting an appropriate mix for patching plaster presents two additional challenges that are not factors in new construction: (1) matching the color and texture of the existing plaster, and (2) physical compatibility of the new and existing plaster.

Matching Color and Texture

A common approach to disguising the different appearance of new and old plaster is to simply apply a coating over the entire surface. But a coated plaster surface may not be desirable and, although coatings will hide color differences, they may not conceal differences in surface texture.

It's virtually impossible to place plaster patches that blend in perfectly with the surrounding plaster. Exposure to the elements results in fading, erosion, and other changes in appearance that occur only over time. Nevertheless, you can take steps to reduce the contrast between new and old plaster.

A good place to start is to perform petrographic examination and chemical analysis (ASTM C 1324) on a sample of the existing plaster to determine its mix components. In most cases, you'll want to use a similar mix for the patch material, assuming it provides acceptable durability. The texture of plaster is greatly influenced by the amount and type of aggregate used in the mix. When choosing materials—especially for the finish coat—consider using aggregate with the same size and shape as the existing plaster. Also, colored masonry cements are available in many regions, or white portland cement (or a mixture of white and gray portland cement) can be blended with pigments (ASTM C 979) to match colored plaster. After materials are chosen, a skilled craftsman is required to match the application technique of the existing plaster as closely as possible.

It's a good idea to construct small samples, or mockups, of the patch material using mixes with varying color and texture and allow them to cure and weather for as long as possible next to the existing plaster. The change in appearance of the mockups over time will allow selection of the mix design that, when put into service, will most closely match the surrounding plaster. In addition, consider cleaning the existing plaster before comparing it to the mockups to provide an accurate assessment of the true color and texture differences.

Physical Compatibility

Another factor to consider when selecting a patch mix is the interaction of new and old plaster when they are bonded together in service. If the physical properties of the two materials are not similar, differing expansion and contraction in response to changing temperatures and loads will create stresses at the bond line, which can lead to cracking.

Most plaster structures built over the last 50 years will likely contain similar materials to those recommended today. In these cases, differences in physical properties between the new and old plaster should be minimal, and the selection of a patch material can be based on durability and appearance. But some older buildings were constructed with lime-based plaster or other materials that are much softer and more flexible than modern-day plaster, so compatibility of the old and new materials can be a concern. In these cases, the challenge is to develop a patch mix that has similar physical properties as the existing plaster, but still provides acceptable durability. If a relatively small area of plaster requires repair, this would be the preferred approach. If, however, a significant percentage of a wall section requires repair, it may be appropriate to re-plaster the entire section, especially if the location is highly visible. By taking this approach, the challenges of matching the existing plaster are eliminated (or at least reduced) and the more straightforward rules of new plaster construction apply.

Table 1. Portland Cement Plaster Mix Proportions

Base Coats¹

Plaster mix symbols	Parts by volume ²							
	Cementitious materials					Volume of aggregate per sum of separate volumes of cementitious materials		
	Portland cement or blended cement	Plastic cement	Masonry cement ⁴		Lime	Scratch coat	Brown coat 2nd ³ coat	Finish coat ⁵
			N	M or S				
C	1	—	—	—	0 – 3/4	2-1/2-4	3-5	—
CL	1	—	—	—	3/4-1-1/2	2-1/2-4	3-5	—
M	—	—	1	—	—	2-1/2-4	3-5	—
CM	1	—	1	—	—	2-1/2-4	3-5	—
MS	—	—	—	1	—	2-1/2-4	3-5	—
P	—	1	—	—	—	2-1/2-4	3-5	—
CP	1	1	—	—	—	2-1/2-4	3-5	—

Finish Coat¹

F	1	—	—	—	3/4-1-1/2	—	—	1-1/2-3
FL	1	—	—	—	1-1/2-2	—	—	1-1/2-3
FM	—	—	1	—	—	—	—	1-1/2-3
FCM	1	—	1	—	—	—	—	1-1/2-3
FMS	—	—	—	1	—	—	—	1-1/2-3
FP	—	1	—	—	—	—	—	1-1/2-3

¹The mix proportions for plaster coats to receive ceramic tile shall be in accordance with the applicable requirements of ANSI A108.1 series applicable to specified method of setting time.

²Variations in lime, sand, and perlite contents are allowed due to variation in local sands and insulation and weight requirements. A higher lime content will generally support a higher aggregate content without loss of workability. The workability of the plaster mix will govern the amounts of lime, sand, or perlite.

³The same or greater sand proportion shall be used in the second coat than is used in the first coat.

⁴Additional portland cement is not required when Type S or M masonry cement is used.

⁵In areas not subject to impact, perlite aggregate shall be permitted to be used over base-coat plaster containing perlite aggregate.



Fig. 8. Static cracks can be filled with a rigid material, such as a plaster finish coat or elastomeric coating. (69909)

more noticeable, so if appearance is the only issue, you might be better off leaving the crack alone. However, if a crack is leaking or may otherwise allow additional damage to the structure, it should be repaired.

To select an appropriate crack repair method, you must determine if the crack is “static” or “moving.” Static cracks are stable and do not provide necessary stress relief for the building. As a result, they can be filled with a rigid material such as a plaster finish coat or elastomeric coating (Fig. 8). They can also be repaired by following the procedures for patching described above.

Moving cracks provide necessary stress relief for the plaster. They are often the result of improperly spaced or located control joints. Because these cracks are acting essentially as control joints, they must be allowed to open and close. If the crack is filled with a rigid material, recurrent cracking is likely. A crack movement monitor is a useful tool for determining if a crack undergoes movements that are greater than would be expected from normal thermal cycling (Fig. 7).

The most common repair method for moving cracks is routing and sealing. The crack is widened with a saw or grinder, and the resulting groove is filled with an elastomeric sealant. Cracks

should usually be routed to their full depth; the width of the groove is determined by the amount of movement at the crack and the flexibility of the sealant. Consult with the sealant manufacturer to determine the proper dimensions of the sealant reservoir.

Some manufacturers offer acrylic polymer sealants marketed specifically for repairing plaster cracks. These products are often referred to as “brush grade” (for narrow cracks) and “knife grade” (for wider cracks). In addition, many manufacturers offer a variety of pigmented sealants to match the color of the plaster as closely as possible.

After the crack is repaired, the cured sealant will be glossy, which will contrast with the roughened plaster texture, making it very noticeable. One way to disguise this contrast is to broadcast silica sand onto the applied sealant immediately after tooling to give the sealant a roughened texture.

Cleaning Plaster

Much of the color difference between patches and the surrounding plaster is unavoidable due to different mix proportions, age, and the effects of weathering. But some of this visual contrast can be reduced by cleaning the building so the existing plaster more closely matches the freshly placed repairs.

A good rule of thumb for cleaning plaster is to use the least aggressive method that still provides sufficient cleaning. Evaluate the cleaning method on a test area before committing the entire project to the method. This is especially true when cleaning an unfamiliar substrate or using an unfamiliar cleaning technique.

In some cases, a garden hose will do the trick (Fig. 9). When washing the wall, pre-wet the entire wall surface, starting at the bottom and continuing to the top. Wetting the wall from bottom to top prevents dirty wash water from being absorbed by plaster



Fig. 9. Directing a high-pressure stream of water from a garden hose may be all that is needed to clean plaster. (69910)

lower on the wall. Direct a high-pressure stream of water against the wall to loosen the dirt. Start at the top and wash the dirt down the wall to the bottom. Then flush the remaining dirt off the wall with a follow-up application of water.

If greater cleaning action is required, consider power washing the plaster. Fan-type spray tips producing 15- to 40-degree fan spray patterns have proven most effective for cleaning plaster surfaces. Other tips that produce a concentrated stream of water may damage the

surface. When pressure washing, keep the stream of water moving over the surface to prevent erosion of the plaster.

Use of a chemical in conjunction with water reduces both the chemical concentrations and the water volume required. Mild detergents can be used to remove oil-based contaminants and stains. Cleaners containing organic solvents can remove caulking compound residues and bituminous materials, and acids or alkalis will remove soot, fly ash, hydrocarbon residues, biological growth, and stains due to polluted environments. Special commercial cleaners are also available. In most cases, chemical cleaning should be preceded and followed by thorough water rinsing. Keep in mind that cleaning chemicals may present health and environmental hazards. Read the material safety data sheets supplied by the manufacturer and take all recommended precautions to provide a safe working environment.

For more information on cleaning and stain removal, see *Removing Stains and Cleaning Concrete Surfaces*, IS214, Portland Cement Association.

Surface Protection

One of the primary aesthetic appeals of portland cement plaster is its rough, natural texture. Therefore, painting or coating plaster is often discouraged. However, applying some form of surface protection may be advisable to provide water repellence, fill narrow cracks, or disguise color differences. Regardless of the type of product used, it's important to ask the manufacturer how long patches must cure before the product is applied.

Thin latex paints are an inexpensive option, but they provide the least amount of protection and durability. Elastomeric acrylic or silicone coatings provide better water repellence and durability than thinner paints and can also bridge narrow cracks (Fig. 10). A potential drawback of their water repellence, however, is that some elastomeric coatings, while not vapor barriers, may slow the passage of water vapor. This reduces the plaster's ability to "breathe," or dry out through evaporation, potentially trapping water in the wall.



Fig. 10. Coatings provide water repellence, fill narrow cracks, and disguise color differences. (69911)

Another option is to apply a cementitious coating. Although these products may not provide the water repellence of elastomeric coatings, they are breathable and have the added benefit of retaining the natural look of plaster better than polymer-based paints.

A fog coat is a type of cementitious coating that is often applied to repaired walls. A fog coat is a dilute mixture of cement and water (or cement, lime, and water) that is mixed to a milky consistency and usually sprayed onto the surface. The primary purpose of a fog coat is to disguise color variations rather than to provide water repellence.

Instead of using film-forming paints and coatings, consider applying a penetrating water repellent to the surface. Some water repellents contain pigments or stains to hide plaster color differences. Water repellents do not provide as glossy a finish as most paints and coatings.

For more information, see *Painting Concrete*, IS134, Portland Cement Association.

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5420 Old Orchard Road
Skokie, Illinois 60077-1083 USA

Phone: 847.966.6200

Fax: 847.966.9781

Internet: www.portcement.org

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WARNING: Contact with wet (unhardened) concrete, mortar, cement, or cement mixtures can cause **SKIN IRRITATION, SEVERE CHEMICAL BURNS (THIRD-DEGREE), or SERIOUS EYE DAMAGE.** Frequent exposure may be associated with irritant and/or allergic contact dermatitis. Wear waterproof gloves, a long-sleeved shirt, full-length trousers, and proper eye protection when working with these materials. If you have to stand in wet concrete, use waterproof boots that are high enough to keep concrete from flowing into them. Wash wet concrete, mortar, cement, or cement mixtures from your skin immediately. Flush eyes with clean water immediately after contact. Indirect contact through clothing can be as serious as direct contact, so promptly rinse out wet concrete, mortar, cement, or cement mixtures from clothing. Seek immediate medical attention if you have persistent or severe discomfort.

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