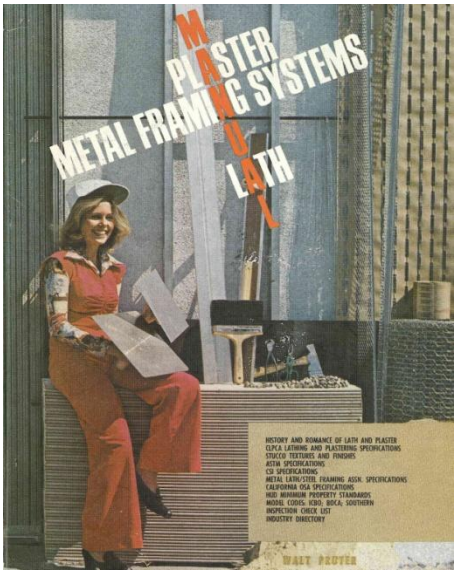
Technical Services Information Bureau

CHAPTER 3
TRADITIONAL THREE-COAT PLASTER (STUCCO)



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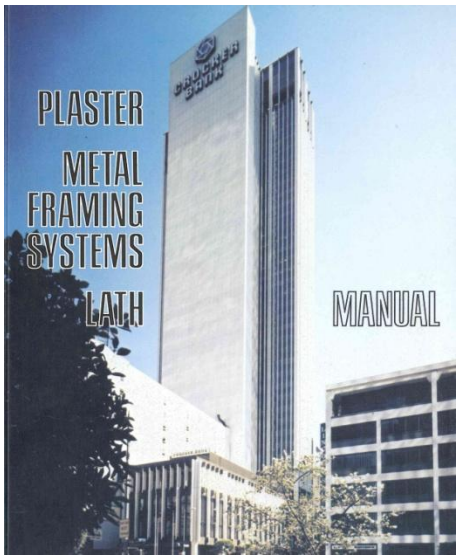

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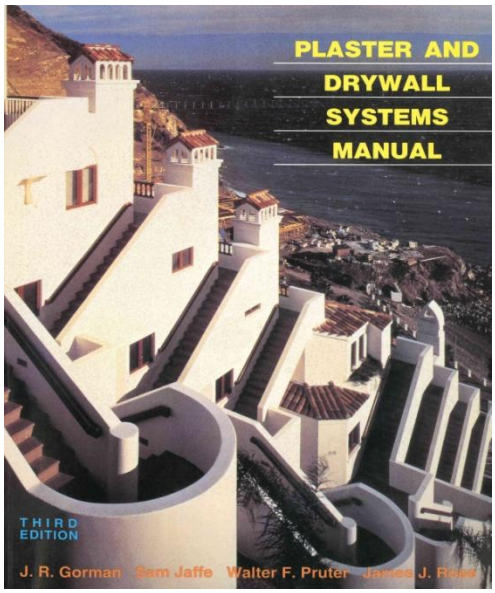

3RD EDITION

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CHAPTER 3 – THREE COAT PLASTER (STUCCO)

This chapter concentrates on traditional three-coat plaster installed over framed substrates. Much of this information can be used to effectively navigate two-coat assemblies over “mass walls”, proprietary one-coat stucco systems & “CI” plaster assemblies.

THE SCRATCH AND BROWN COAT

GENERAL PREPARATION

Adjustments are made with regard to materials, mixing and application based on method of application and climate conditions. The size of the plaster project and regional preferences will determine if the plaster will be installed by hand or machine-applied.

Lathed substrates should be checked to make sure WRB is damage-free and properly shiplapped. The metal base and accessories are correctly attached, straight and true.

When plastering directly to “Mass” walls the substrate must be free of all “bond breakers”. The plane tolerance should not be more than 1/8” in 10ft. Plaster should not be expected to “compensate” for an “out of tolerance” substrate.

The plaster schedule should not be compromised (accelerated) and plaster cure times must be recognized. Proprietary mixes with evaluation reports that have overall faster completion rates may be substituted for generic mixes.

MATERIALS

A wide range of “field” mixes are accepted due to different materials available (or not) in many regions of the country or the plastering contractor has found a workable, productive yet well-performing mix. The saying “teaching an old dog new tricks” sometimes could not be more appropriate to a plasterer. Any of the listed ASTM mixes should be accepted providing the contractor has a good track record with the mix. Approving a “tried and true “ method may be better than forcing an “unfamiliar” method. Product proportions (cement material, lime, & water) are due to variations in the sand in different regions of the country and adjustments for climate conditions during installation. Sand proportions of sand to cement ratios are usually higher (or at least the same) with the brown coat versus the scratch coat.

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FIELD MIXES & PROPRIETARY MIX

- COMMON CEMENT (C): Consists of 1 part portland cement to 0-3/4 part of lime, sand* & water
- **"**COMMON & LIME (CL): 1 part cement to ¾- 1 ½ parts of lime, sand* & water
- COMMON & MASONRY CEMENT (CM): 1 part portland and 1 part type N masonry cement , sand & water
- MASONRY CEMENT (MS): Type M or S Masonry, sand* and water
- PLASTIC CEMENT (P): 1 part plaster (stucco) cement, sand* and water – additives are not allowed
- COMMON & PLASTIC: 1 part plastic to 1 part portland, sand* and water
- PROPRIETARY MIX:
  A factory blend of plaster base coat meeting the criteria of ASTM C 926. Material may come unsanded or sanded in a bag, in "supersacks" that are dumped into a portable silo and dispersed into a cement mixer, or a fully contained "silo system. Additives not expressly recommended by the manufacturer should not be allowed.

  NOTE: If proprietary mixes do not meet ASTM C926, the product should have a own code-approved evaluation report.
  (* scratch coat = 2 ½ to 4 parts, brown coat = 3 to 5 parts)

PLASTICIZERS

Traditionally hydrated lime has been used with portland cement to increase "workability" and "pumpability". Today proprietary plasticizing products are used as a substitute for lime providing they are proven to be used for this purpose and the contractor has a proven track record with the product. However, the substitution should be approved by the architect and may require local code approval. They are not intended for use with plastic or masonry cement

SAND

The code recognizes plaster aggregates should conform to ASTM C 897. The proper proportion of various aggregate (and washed) sizes proved effective throughout the years of the "hand-application" of base coats. Today, the plastering contractor has two challenges. This specific type of sand can be problematic during machine applications and finding this kind of sand has become an increasing problem. ASTM has recognized this and addresses it. If local sand cannot meet requirements the sand "shall be accepted, provided there is evidence that plasters of comparable properties made from similar aggregates from the same source has been exposed to weathering, similar to that to be encountered".[1] In other words, if the sand supply has a proven track record it should be accepted.

FIBERS

Alkaline resistant fiber shorts are marketed by various manufacturers who claim they reduce shrinkage cracking in concrete and portland cement based plaster. A variety of different types of fibers, including AR glass, nylon, polypropylene and cellulose are considered appropriate for plaster and concrete, which is also sometimes internally reinforced with carbon and/or steel fibers.

Although fiber manufacturers published literature claims an increase in flexural strength, higher impact resistance and other benefits, in addition to reducing shrinkage cracking, it is the later that we notice most consistently.

Recognized standards such as ASTM C 926 contain a reference to fibers stating, "Fiber, natural or synthetic – an elongated fiber or strand admixture added to plaster mix to improve cohesiveness or pump ability, or both." The only fibers of which we are aware that improved pump ability were asbestos fibers and they are no longer allowed to be used.

[1] ASTM® C 897

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The PCA *Portland Cement Plaster (Stucco) Manual* states:

> "Small amounts of ½ inch long fibers of alkali resistant composition such as polypropylene, nylon, alkaline resistant glass or other similar materials are sometimes added to basecoat plaster mixtures…to increase cohesiveness, tensile strength, impact resistance and to reduce shrinkage. Their effectiveness in contributing to improved performance in these areas is dependent on the composition and physical characteristics of the fibers selected. Fibers used in plaster should conform to the requirements of ASTM C 1116 for fibers used in fiber reinforced concrete and shotcrete. They should be added to the mix in accordance with the manufacturers' recommendations."

The *Guide to Portland Cement Plastering* published by the American Concrete Institute (ACI 524R) suggests, "When accepted by the project specifications, fibers conforming to ASTM C 1116 may be used. If glass fibers are used it is important that they are alkali resistant. Fibers should be added to the mix in the manner and amount recommended by the manufacturer."

Fiber manufacturers recommended proportions vary appreciably. AR Glass fiber producers recommended 1 lb. of fiber per 94 lb. sack of cement when mixed with sand and two pounds of fiber per sack of cement when lightweight aggregate such as perlite is used instead of sand. Polypropylene and nylon fibers are recommended to be used in lesser portions. Some ¼" polypropylene "fiber-short" manufacturers only recommend 1/5 lb. of fiber per sack of cement.

ADMIXTURES

Various admixes are produced for a number of reasons including adding bond strength or adding crack and water-resistance. Admixtures should be tested and proven to work with plaster and not used automatically or indiscriminately. Any specified admix should be specifically for portland cement plaster/stucco and used per manufacturer's recommendations. The use of chemical admixtures in plaster mixes that contain calcium chloride, such as Anti-hydro®, is not a recommended practice. According to the American Concrete Institute ACI 524[2] *"calcium chloride should not be used when portland cement-based plaster will come into contact with metal lath, anodized aluminum, galvanized steel, or zinc accessory products. Calcium chloride can accelerate the corrosion rate of metals."* Additionally, the Portland Cement Association EB049[3] states: *"Quality plaster that is properly cured does not need water repellent admixtures. Laboratory tests that measure time of setting and water permeability of plaster show that water repellent compounds may actually retard portland cement hydration and increase permeability".* Other admixtures for other cement or concrete-related products are sometimes specified with plaster mixtures with good intentions. However, these admixes could have the opposite effect than the intent.

WATER

When mixing portland cement plaster, it is important that the water be potable , i.e. fit for human consumption. Potable water is treated to specific standards so as to remove harmful chemicals, sediment and other particulates. Recycled, reclaimed, grey water or water from natural waterways is not approved for mixing cement stucco.

Clean water is an important factor as it relates to the properties of the hardened mixture of the cement stucco. Setting and strength development during the hydration process are probably two of the most important factors of these properties.
The mixing of the cement stucco with clean potable water allows the best conditions for setting and strength development of the stucco cladding. Another important property of stucco during the mixing and application periods is air entrainment. Air entrainment occurs during the mixing stage and contributes to the workability and overall durability of the cladding. Non potable water may contain contaminates that could kill the air content or increase it excessively which could compromise the integrity of the stucco cladding.

[2] ACI 524-04 – Guide to Portland Cement Plaster – American Concrete Institute – P.O. Box 9094 Farmington Hills, Michigan 4833-9094
[3] EB 049 – Portland Cement Plaster /Stucco Manual – Portland Cement Association – 5420 Old Orchard Rd. Skokie, Illinois 60077-1083

Some of the more common contaminates found in non-potable water include chlorides, acids, alkali's, sanitary waste, sugar, silts, oils and algae. Reclaimed wash waters, such as those recycled from concrete mixers, can contain admixtures not intended for use in the stucco cladding. Chlorides found in non-potable water, could attack the embedded steel products such as lath, trims and fasteners thus compromising the integrity of the stucco cladding.

MIXING CONSIDERATIONS

WATER PROPORTIONS

The water amount in a plaster mix should always be determined by the plastering contractor. The plasterer will always adjust the water to account climate conditions, how quickly or slowly the substrate absorbs plaster moisture and variations in "field mix" materials.

SLUMP CONE TESTING

Slump cone testing of portland cement plaster for determining water-to-cement ratio is not considered applicable. Unlike concrete, where slump testing is common practice, portland cement plaster mixes utilize plasticizing admixtures for workability and pumpability. These components are added in a proven manner to suit the needs of the plastering crew. Not all admixtures affect the wet or "plastic" cement in a consistent manner. Unlike concrete mixes, you cannot get a consistent water-to-cement ratio by measuring slump in plaster. The plaster crew member mixing the plaster is in constant contact with the nozzle and rod men, who give him feedback as to how well the mix is performing. Minor adjustments are made to compensate for wet sand which affects the mix. Sand makes up to 97% of the plaster mix by weight and is therefore vital in its composition. If the mix is coming out too wet, the material will not stick to the wall or ceiling and dropouts will be frequent. If the material is too dry, the gun will pack and the operation will stop until the situation is resolved.

Because plaster is a non-structural cladding, it doesn't require the level of precision that goes into structural concrete. Plastering is an artisan craft. Therefore, the applicators and mixers rely on feel more then precision to mix and apply the product.

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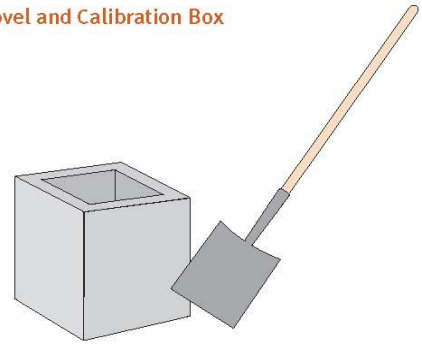
USING CALIBRATION BOXES

A calibration box is used to establish how many No. 2 shovels are required to equal one cubic foot.

- Calibration should occur at the beginning of each day or after each new delivery of sand
- Once the shovel count is established, the sand may be added to the mixer with a No. 2 shovel
- Once calibration is completed the sand can be shoveled directly into the mixer
- Bagged sand can be added directly to mixer

Shovel and Calibration Box



THE SCRATCH COAT

The "scratch" is hand or machine-applied to a nominal thickness of 3/8 inch. After the scratch coat is leveled out (rodded off) and briefly set, the surface is scored horizontally with the metal plaster base completely covered. Accessories are brushed to remove excess stucco from screed surfaces. During application "dropouts" may occur exposing some of the metal base. Once dried, at least 90% of a plaster panel's metal base should be covered.

SCRATCH COAT CURE TIMES (TWO CODE-APPROVED METHODS)

Traditional moist cure:

- Day One: the scratch coat is properly "moist cured" for 48 hours after its initial application by applying a mist over the surface. Climate conditions govern the frequency of the addition of water. Frequent misting or "wetting" is required on dry hot days and possibly minimal to no "wetting" will occur on a cold rainy day. The crew will monitor the scratch coat install for the remainder of the work day possibly "wetting" the walls.
- Day Two: the plasterer monitors the moist cure process, possibly "wetting" the walls in the morning and again in the afternoon.
- Day Three-Four: the plaster crew will have waited the minimum 48 hours and now ready to "brown".

"Double-back" method:

The plaster crew will install the scratch coat as usual. The second (brown) coat "is permitted to be applied as soon as the first coat has attained sufficiently rigidity to receive the second coat[4] . The second coat attains a chemical bond to the scratch coat versus the traditional mechanical bond. Moist curing the scratch coat is eliminated and the time between the first and second coats is also eliminated. This method is well-suited for smaller projects, additions and repairs but sometimes not feasible on larger jobs.

THE BROWN COAT

The scratch is "wetted" to slow down and even out moisture suction of the brown coat. The brown is hand or machine-applied at 3/8inch nominal thickness and "rodded off". The plasterer determines the timing as to when they will go back and "hard float" or "densify" the brown coat to a flat, open surface. The brown is moist cured (like the scratch) for 48 hours and then allowed to "sit" for an additional five days for a combined wet and dry cure of seven days. TSIB recommends the dry cure period (not the wet cure as too much water may negatively affect the assembly) be extended for as long as the schedule will allow.

Note: Regardless of what plaster mix is specified it is still the plastering contractor's responsibility to monitor the moist cure phase of the scratch and brown. They may need to start the moist curing process rather quickly after application during a hot day or during hot wind (known in Southern Ca. as "Santa Ana Winds") conditions. and may need to mist the walls up to four times a day. When temperature conditions are very mild and relative humidity is above 70%, the applicator may introduce only a sparse amount or no additional water to the moist cure process at all.

[4] Chapter 25, 2009 International Building Code

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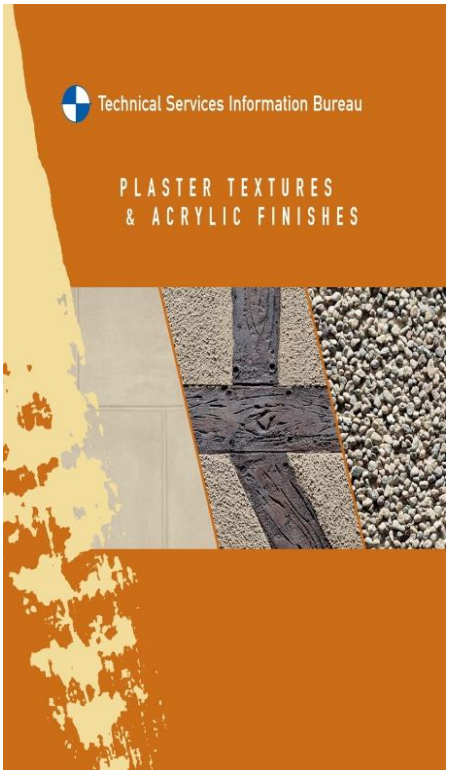
FINISHES (CEMENT STUCCO & ACRYLIC FINISH)

Portland cement plaster has traditionally been a three-coat cement system as described by current and past building codes. Within the last decade, acrylic finish has become popular as an alternative finish coat to the traditional portland cement “stucco” finish. Both finish coats are suitable finish materials for cement base coats, can be integrally colored and are vapor permeable. In this document, the term stucco refers to a cement finish coat. Regions of the United States seem to have a preference to one or the other finish coat material. For example, traditional cement finish coats are more popular in the southwest and acrylic finish coats tend to be more popular in the north. However, both finish materials may be used in either region. Designers must choose which finish material is most appropriate for the building and best meets the desires of their client. A checklist of the properties is one good way to help decide which material is best suited to a project. Each product has strong points to consider. Neither product is the answer for all projects.

TEXTURE:

Cement finish has practically an unlimited variety of textures from a Santa Barbara/mission finish, lace texture, dash, sand finish, old English to comb texture. While acrylics have some range of texture, most acrylics are applied in a sand finish texture, and the wide-range of texture choices is not their strongest suit. Smooth finish is possible in both materials, but not recommended as a smooth finish tends to crack and the smooth texture highlights minor imperfections. Designers are encouraged to select a finish with some texture to hide minor hand applied imperfections and cracks that are inherent with cement plaster systems. For more information on textures please refer to TSIB’s “Plaster Textures and Acrylic Finishes” brochure.



COLOR:

Acrylic finishes can come in just about any color imaginable and can be matched to almost any shade desired. The consistency of color is very good with acrylics, even in darker shades. Stucco, being cement based can only hold so much pigment, and dark color tones are not recommended. Stucco works best in light pastel shades, and some slight variation in color shade should be expected. This is particularly true with stucco sand finish-texture. The water needed to float the sand texture can cause colors to migrate and be blotchy, the darker the color, the more blotches. Colored cement stucco can be “fog” coated, which is a good method to improve the color consistency in cement finish coats

APPLICATION:

Stucco is a natural cement-based material; acrylic finish is a synthetic man-made coating. Stucco cures to a hardened state while acrylics dry to a hardened state. This is a critical difference when considering environmental conditions during application. Acrylics should be thought of as a quality thick paint with an aggregate added for texture. Acrylics dry from the outside in and can be sensitive to environmental conditions and should not be applied in temperatures below 40 degrees F (4°C). Air circulation is as important for drying as the temperature, especially in humid conditions. Cement stucco finish “cures” as opposed to drying and can be applied in temperatures as low as 35 degrees F (2°C).

Cement finish coats are a nominal 1/8 inch thick and have the ability to fill small imperfections in the base coat. Acrylic finish coats are paint-like in their characteristics and have very little fill capability. This same paint-like characteristic makes a light colored (white) acrylic difficult to cover some darker base coats and the use of a primer over the base coat may be advisable.

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For acrylics or cement finish, the portland cement plaster base coat must be cured a minimum of seven days before applying the finish, but a longer cure time is beneficial. It gives the building additional time to “find itself” or settle before the finish coat is applied. When the construction schedule can allow the added time, TSIB recommends a 14 to 21 day interval between application of the brown coat and finish.

WATER REPELLENCY:

Traditional cement stucco, like all cement products, will absorb surface moisture and darken when wet. Acrylics, similar to a nylon stocking, will repel surface moisture, but moisture will pass through as a vapor. Acrylics should never be mistakenly used or sold as a method to “seal” the building from water intrusion. Properly applied portland cement plaster base coat will keep moisture out while remaining vapor permeable. It is advisable that all finish coat materials, including paint, be a “breathable” membrane. Acrylic finish should never be used on horizontal surfaces or other areas susceptible to ponding water, as they can soften with prolonged exposure to moisture. An advantage of acrylic finish is that they retain their color when wet which is a consideration in wet climates. Many cement stucco manufacturers offer clear sealers that will provide the same water repellant benefit as acrylics. Most only last a year or two and may have to be reapplied every few years. This is a simple procedure and not very expensive.

FLEXIBLE:

Cement finish coats are not flexible and hairline cracks will transfer through the finish. Acrylic finish coats are more flexible when initially installed and tend to hide minor hairline cracking. However, acrylic finish coats are not considered an elastomeric paint coating. After exposure to the sun, the acrylics may harden slightly and hairline cracks may appear at a later time. The TSIB cautions designers about the use of elastomeric coatings over stucco, true elastomeric coatings tend to be vapor barriers and can hinder membrane drainage.

MAINTENANCE:

Both stucco and acrylic finishes are relatively low maintenance and both can be painted when a change of color is desired. Acrylics have proven to work well over the last ten to fifteen years. The life expectancy of a stucco finish coat has been proven to be several decades. Acrylics have been applied to cement basecoats for over 25 years and many of these original acrylic finish coats are holding up well. Colored cement finish tends to darken over time, while acrylic finish will lighten over time.

CAVEAT:

The exterior reinforcement (corner aids or corner beads) should be compatible with the finish coat selected. For cement finish, it is recommended to use a traditional wire nose. With acrylicfinish coats used in high humidity/moisture areas, a plastic nose or PVC corner is recommended to prevent rusting. A primer may also be applied over the wire nose. Plastic nose products are not recommended for cement finish as the finish may flake or spall off the PVC nose.

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POST-INSTALLATION CONSIDERATIONS

JUDGING THE FINISHED PRODUCT

Applying plaster is and always has been a skill-intensive trade. The quality will depend largely on the knowledge and skill of the plasterers applying the plaster mix. Unlike a machine or factory-fabricated product, expecting machinelike perfection is impracticable and unreasonable. Applying plaster requires skilled tradesmen to apply the matrix in various weather conditions and often under unfavorable circumstances. The skill of the plasterer, weather conditions, time allowed to work, substrate quality and available materials all play a part in the quality of the finished appearance. Most plaster bureaus use a set of unwritten guidelines and try to be neutral in judging. It is very difficult to remain objective.

STANDARDS:

There are a few recognized standards for the installation of plaster and plaster assemblies with regard to flatness. However, regardless of established and recognized tolerances, one should not see "eye catching" discrepancies or variations in the finished workmanship. A mock-up or sample wall should be approved by the owner before the project is started.

VIEWING:

Normal viewing distance is considered 10 to 15 feet from the surface to be judged. You should be able to observe some uniformity in the overall texture and color of the finished surface. For instance, there may be noticeable swirl marks in a float finish, and when they are consistent, they become uniform and acceptable. However, the finish may be deemed unacceptable when there are random areas where the float was dragged straight and the plaster has a "grain." Judging should be done under normal lighting conditions and cannot be limited to brief periods of time when the suns' angle to the plastered surface creates a critical light condition. No plaster wall is perfectly flat. Strong light casting across the surface at just the right angle will make a good wall look bad, sometimes really bad. Sconce or up-lighting can have the same effect to the wall. Owners, architects and contractors should be forewarned and wary of "up" or "down" lighting fixtures on walls.

8 AM TO 8:45 AM **REST OF THE DAY**

AN EXAMPLE OF A WALL AFFECTED BY "CRITICAL LIGHT"

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TOLERANCES:

For flatness, International Building Code requirements are set at 1/4 inch in five feet. Most plaster industry experts agree that 1/4 inch in ten feet is an obtainable, acceptable quality of workmanship within the plaster panel. Very often flatness is "measured" from the center of the plaster panel and over a reveal or joint. If a straight edge "rocks" over the joint, many perceive plaster flatness as unacceptable. However, the design, waterproofing and framing conditions will ultimately affect plaster "flatness" at the joints, especially over cement plaster smooth finish. While it is likely that many installations would not pass a ¼ inch in 10 foot tolerance, it is the plaster job as a whole that must be judged, not individual portions. There should not be areas in the finish that are readily apparent as problematic, even to the casual onlooker. Perceived problems in a plaster finish that may be acceptable, such as, those which are inherent in the hand application and visible only upon close scrutiny. While not "forgiving, a wall that is "out of tolerance', an imperfect wall the is not "eye-catching" should be acceptable. Plaster must be taken in as an entire assembly, and not looked at under microscope. Remember, this is a hand wrought material that will show the characteristics of the craftsman applying it. No two plaster finishes will look exactly the same. Specifying plaster tolerances of 1/8" in ten feet is not realistic and almost impossible to achieve.

COLOR AND TEXTURE:

Texture is an important part of the aesthetics of plaster. The texture should be uniform and consistent. Some textures have random characteristics, such as the Santa Barbara or Mission finishes but they should maintain a similarity throughout the wall when viewed in totality. Color for cement finish plaster may have some variations that are inherent in pigmented, cementitious applications. For more uniformity, the cement color finish may be fog coated or painted. Acrylic finish should be uniform in color unless specifically designed for a mottled appearance. "Smooth " finishes of all types are susceptible to "color mottling."Clear communication, mockups and hiring qualified contractors will go a long way to keeping everyone happy.

PLASTER CRACKING

Plaster assemblies (Stucco), similar to all portland cement products, is susceptible to occasional cracking. Building code officials recognize this fact and classify plaster as a "brittle" material and require framed walls to be built with limited (less) deflection in an attempt to minimize the stresses placed upon the relatively thin cement membrane. Fortunately, most cracking in stucco is hairline and only of a cosmetic concern. An excessive number or wide cracks in stucco should be investigated by persons qualified to investigate stucco assemblies. Plaster is used worldwide in all climates on all types of structures over a wide variety of substrates. All stucco walls and ceilings are susceptible to cracking, no matter how good the structure, the design, engineering, mix, application and site supervision. Minor cracking in a stucco assembly is not an automatic indication of an improper stucco application.

Cracking in plaster/stucco is simply a form of stress relief. A stucco membrane will continue to gain strength over the years. However, the most vulnerable time for stucco to crack is in the first few months as it is gaining its ultimate strength. Unfortunately, this is also the time the building is being subjected to abnormally high stresses from a variety of sources. The following is a partial list of stresses the stucco membrane is subject to:

- Shrinkage stress as the stucco initially sets
- Building and ground settlement
- Seismic movement
- Wind loads and racking
- Structural loading (live and dead loads)
- Thermal expansion and contraction
- Warping, shrinkage, swelling of lumber or wood-based sheathing
- Vibrations from heavy equipment and/or ongoing construction

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Of all the stresses a plaster membrane endures, the applicator has control only over the first source of stress. Plaster is often and typically subjected to more than one of the previous-stated stresses at the same time. Stucco can withstand a certain amount of stress, but all stucco has its breaking point. Some cracks are easily identified and the source of stress is obvious, more often than not the TSIB finds there are multiple sources of stress and pinpointing the precise source of stress that caused the crack is all but impossible. The most common location for cracks to appear is at the corners of window and door penetrations, as this is where stresses tend to concentrate. These types of cracks are known as re-entrant cracks and why the industry typically recommends control joints at these locations.

STRUCTURAL CRACKS:

When TSIB refers to a crack as "structural," this is not meant to impugn structural design or any inadequacy in the framing. It is simply to identify the source of the stress. Minor hairline cracking in stucco is not a reason for undue concern.

Very often "to much cracking" is a subjective question or why one building cracks more than the building next door. Excessive stress cracks my tolerated and left alone in "low traffic" areas but, a small hairline crack at a main entrance may be completely unacceptable.

EFFLORESCIENCE

Efflorescence is a whitish bloom that can appear on the surface of plaster, masonry or concrete. This "bloom" may appear in a powder form. It may also appear as an unattractive green or brown stain. It must be noted that usually these stains do no physical harm to the plaster assembly and are typically a cosmetic concern. Efflorescence is the exudation of soluble salts to the surface of a cement product. The salts may be present in the cement, sand or even in the water used to make concrete, mortar, brick or plaster. Efflorescence is not an indication of inferior products or improper application. The products previously mentioned are natural products and as such they may contain soluble salts. The major source of efflorescence is calcium hydroxide from hydrated portland cement. When calcium hydroxide leaches to the plaster surface, it combines with carbon dioxide in the air (carbonation) to form a salt-calcium carbonate.

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HOW DOES IT GET TO THE SURFACE?

The transport mechanism is water. Water will bring the salts to the surface and as the water evaporates, the salt is left on the surface as a whitish bloom. This is why efflorescence tends to be more of a problem in the rainy seasons. Typically, efflorescence will diminish over time. The presence of efflorescence does not necessarily mean water is penetrating plaster or washing down the backside. Site investigations have discovered what is more likely to happen is the rain water runs down the outside face of the wall and soaks into a hairline crack, often without even reaching the building paper behind the plaster. The water will sit in the crack and absorb the trace amounts of calcium hydroxide. As the sun comes out and heats the wall surface, the cracks are typically the last areas to dry out. Water with the soluble salts is drawn to the outer surface by the sun. This is why spring rains followed by a warm sun is the most common precursor for efflorescence to appear on newly applied stucco. Dark colors are more prone to the efflorescence problem. The evaporation process is faster on sun drenched walls with a dark color and this rapid acceleration draws the salt laden moisture out faster as opposed to a slower evaporation and the salts returning to the plaster. The dark colors also tend to highlight the efflorescence more than light colors.

CLEANING OPTIONS:

Often the efflorescence on the surface of stucco walls is washed away by the rain or simply by hosing it off. It is best to start with simple procedures and then graduate to more intense measures if the simple procedure fails. First attempts to clean should be lightly brushing and/or hosing the bloom off. Because efflorescence is an alkali, removal and chemical neutralization may be achieved by the addition of an acid based “solution: mix.

Solutions:

- Solutions may be used to remove efflorescence. Some are proprietary products and available at plaster materials dealers. The manufacturer’s instructions must be closely followed when using the products.
- Vinegar and muriatic (hydrocholric acid) may also be used and has been shown to work well. Both must be diluted with water. Most plastering contractors have had best results with a muriatic acid mixture. The recommended ratio is 1 part muriatic acid to 10 to 12 parts water. Caution should be exercised as muriatic is extremely caustic and corrosive.
- Do not inhale fumes.
- Wear protection. (safety glasses, gloves, boots and long sleeve clothing)
- Protect plants and shrubs.

Procedure:

Always test the acid solution in an inconspicuous part of the wall to make sure it won’t harm the appearance. The area should be pre-wet, this includes the surrounding areas and where “run-off” is anticipated. The area to be cleaned will likely have a slight change in color shade and cleaning should be from architectural break to architectural break. Pre-wet wall from bottom to top. A Hudson or Chapin type sprayer may be used to apply the 10:1 solution to the surface. It may be necessary to use a stiff bristle brush and lightly scrub the affected area. Rinse the wall thoroughly with clean water. The run-off area must be kept wet at all times and also rinsed thoroughly. It is also not uncommon for a slight stain to be left on the surface when the efflorescence is removed.

CHAPTER 3 – THREE COAT PLASTER (STUCCO)

WATER TESTING THREE-COAT PLASTER

No designer or contractor wants a leaky wall assembly. Unfortunately, due to some experimental design and poor construction practices, the industry experienced a rash of leaky buildings in the 1990's. The new International Code and the 2010 California Building code in an attempt to address the concerns and allow for innovation, re-wrote Chapter 14, *Exterior Walls.* Section 1403, *Performance Requirements,* establishes basic design and construction ground rules for exterior walls.

Section 1403.2 requires exterior walls to be weather-resistant. The envelope shall include flashing, per 1405.3 and allow for drainage of water with a water-resistive barrier per section 1404.2. This criteria will protect interior from "water condensation" and allow moisture that may enter behind exterior veneer to exit out the assembly.
Three coat cement plaster over building paper and installed over steel or wood-framed substrates fully complies with 1403.2 and does not require water testing. Masonry and concrete walls do not require water –resistive barriers per section 1404.2.

Walls that do not have flashing (1405.3) and drainage provisions (1404.2), basically walls that fail to meet 1403.2, will need to verify passing a water test per ASTM E 331. Barrier EIFS (barrier systems) would fall under these criteria.
There is no specific test designed for water or weather resistance of exterior wall envelopes that incorporate a water-resistant barrier per 1404.2 and flashings per 1405.3. There are water resistance tests for masonry walls, curtain wall construction and windows. The water resistance test used on curtain wall and windows is most commonly ASTM E 1105 and may be used on exterior walls with drainage per the protocol of ASTM E 2128. ASTM E 2118 is protocol specifically designed for finding and determining known water leakage problems. The protocol calls for site review procedures, review of construction documents and the interview procedure of building occupants. If the source of the leak cannot be determined, then the water test of ASTM E 1105 is appropriate to find the leak. It is recommended to use established Design Pressures and time limits for water testing, but if those limits are not able to verify the source of the leak, higher pressure and longer time periods are permissible.

Mock-Up Testing

Some designers and or consultants have felt it necessary to test drainage type wall assemblies that are compliant with section 1403.2. While this is not required, it is also not prohibited. If mock-up testing is desired, the differential pressure would be what the Components and Claddings section of the code requires for that project. There are four criteria needed to determine the correct differential pressure.

1. Height of the Building (average of the roof eave and the highest point of the roof)
2. Importance Factor of the Building (Building Categories I-IV)
3. Wind Stagnation Pressure of the building (3-second wind gust from the code Wind Speed Map)
4. Exposure (the determination of building exposure A-D)

Mock-up Caveat:
Water penetration testing of exterior walls with drainage and flashing provisions should be done with the insulation in the wall cavity and the gypsum wallboard installed and taped on the inside. This will replicate a "real life" scenario test with the code approved differential pressure. The interior finish is removed after the test to verify if an uncontrolled leak has occurred. While ASTM E 1105 states the interior finish may be removed to view for leaks, this is intended for windows and doors only, and meant to view window leaks and leaks between the window frame and adjacent exterior sidings.
This is appropriate for each test, as the gypsum wallboard being in place will have little to no effect on window and the window flashings during normal service life. However, exterior claddings will be greatly affected by the presence or absence of gypsum wallboard (interior finishes).

Construction Caveat:
No designer or contractor can be found guilty of neglect for following the code, standards and industry recommendations. Designers and contractors "MAY" be found guilty for experimental designs that could have unintentional consequences. An example would be using sealant around fastener penetrations to secure lath to framed walls.

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This is not code required or a recommended practice by the plaster industry. Medium and long term detrimental effects of the sealant against the asphaltic building paper, felt or synthetic house wrap is unknown. Some sealants can leach the bitumen out of the building paper resulting in premature failure. TSIB recommends following codes, standards and known best practices for your protection, and the protection of the building owner and occupants.

Conclusion

If plaster assemblies or any wall systems deviate from section 1404.2, then an ASTM E331 test should be performed. Three-coat plaster assemblies complying with Chapter 25 of the code and properly flashed should not require testing unless a leak is detected AFTER completion of the assembly/system. If the cause of leak cannot be detected through a visual observation, TSIB recommended testing under ASTM E 1105.

FINAL DECORATION - PAINTING AND/OR FOG COATING

For a variety of reasons integral-colored stucco or acrylic finishes may require an additional “final decoration”:

- Not all colors are achievable with cement stucco products
- Monolithic color can be difficult with integral colored “smooth” finishes
- Changing weather conditions during installation can affect integral color
- Patching or repairing walls can be problematic
- A desire to change or “update” existing finish
-

PAINT

An alkaline-resistant, acrylic paint should always be used over finished surfaces. Elastomeric paint can be used but all paints should be vapor permeable so they do not trap bulk water.

New stucco finish should cure for a minimum of a week to 30 days to allow the finish to air cure. More importantly, cement is highly alkaline when applied and the stucco should drop to a point where the pH changes from its high of 12.4 to about 8.

Prior to applying any paint the surface alkalinity of the wall should be checked. This can be very simply accomplished by using a pH tester in the form of litmus paper.

ELASTOMERIC PAINT “BLISTERING”

The paint manufacturer should also be consulted for specific painting limitations. The manufacturer may also recommend an approved surface "conditioner" can be used to increases the surface hardness and density, while isolating the high pH of portland cement plaster applications.

FOG COAT

Fog Coat is a cement-based finish that in simple terms is stucco without the sand. It can be made in any stucco color (except the very darkest colors) and allows for patching, blending, freshening up, and re-coloring stucco. Paint has become so widely used that stucco is too often painted over, rather than using Fog Coat for its many advantages over paint. Won't peel or flake off in a few years. Fog coat becomes part of the stucco, because they share the same cement base.

- No sandblasting: To repaint walls, it is often necessary to sandblast loose paint off first, which is environmentally hazardous. If the stucco is maintained with Fog Coat, sandblasting is never needed.
- Won't trap moisture. Paint can trap moisture that can cause mold growth and lead to paint peeling off. Fog Coat becomes part of the cement matrix in the stucco. Preserves stucco texture. Fog Coat is applied in a light mist and is absorbed into the stucco surface, preserving the original stucco texture. Paint can obscure the texture and hide the natural appearance of the stucco.
- Easy to apply. Mix dry Fog Coat with water and you are ready to go. The only tool needed is a "Hudson" sprayer.
- Economical. Using Fog Coat is about the same cost as painting and is required less often than painting.
- Vapor permeable. Many paints block water vapor from exiting the building, which can lead to mold growth. Stucco and Fog Coat readily allow water vapor out of the structure.
- Match most any color. Using the manufacturer's color number, you can purchase the same color Fog Coat as the stucco on your home. And if you wish to change the color, your contractor will be able to purchase Fog Coat to match a wide range of paint colors—really any object can be matched.

PATCHING AND REPAIRS

Cracks

Minor cracking in a stucco assembly is not an automatic indication of an improper stucco application, but there are methods to "repair" or "address" cracking if the cracks are unacceptable.

The following methods are recommendations that have been successful on other projects for the repair of plaster (stucco) cracks:

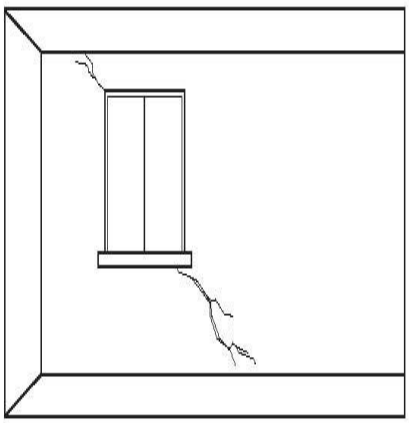
- Patching small hairline cracks (smaller than .020") is not recommended. Small cracks will not accept aggregate material, and the resulting patch will detract from the natural beauty of the stucco and will serve no useful purpose. The subsequent "scar" will appear more obtrusive than the hairline crack. If the appearance of the crack is not acceptable, painting the surface is recommended. First, the paint should be forced into the cracks with a brush and then followed with a roller applied coat of acrylic paint. The entire panel should be painted to achieve color uniformity. Please be aware the thickness of the paint will affect the stucco texture and will not match perfectly with the existing integral colored stucco.

- For cracks larger than 020", patching materials consisting of a "slurry coat" of stucco finish and a bonding agent should be used. To prevent the appearance of a scar and depending on what texture is specified, the entire panel should be "rescrubbed" or "dusted".

- If plaster crack appears to occur beyond finish (cracks through plaster membrane), the crack should be "grouted out" and repaired with a "slurry" coat consisting of portland cement, plasticizing agent, sand consisting of a #60 grit aggregate and a bonding agent all mixed with water. The slurry mix with the bonding agent will allow patch materials to chemically bond with existing plaster. Entire panel should be refinished to eliminate the appearance of a patch.

- Acrylic "Lamina": One very successful and increasing popular method is to properly remove any potential "bond breaking" elements off the existing finish and apply a polymer-modified cement "skim" coat over the entire surface and embed into the wet skim coat a 4-5 oz psy. fiberglass mesh. A finish compatible with polymer-modified base coat is applied as the final decoration and all components will have added crack resistance to the exterior membrane.

Note; Crack repair methods listed or otherwise, should not be considered a guaranty cracking will not return or prevent future cracking.



Re-entrant crack

Scaffold Ties

Scaffolding over a certain height requires some form of attachment to the structure. This is typically done with wires and all-thread rods. The wires keep the scaffolding from pulling away, while the all-thread rods hold the scaffolding away from the building at a predetermined distance. Other systems incorporate both the "pull away" and "stand off" components in one, engineered pole or rod configuration. Regardless of the system, the attachment must penetrate the plaster lamina to attach to the building and has to remain installed until the day the scaffolding comes down. This leaves holes in the finish that must be addressed for both moisture resistance and aesthetics.

Patching the hole must occur in conjunction with tearing down the scaffolding so the method used typically must be able to complete the work all the way to the finish in a short period of time.

- Cut the wires as close to the connection source as possible and treat the ends for corrosion resistance.
- Back out the all thread rods.
- Fill the residual hole to below the finish line of plaster with a polyurethane-based sealant that can cure in a sealed environment.
- Apply a base-coat material above the sealant leaving room for the finish. Proprietary, rapid setting materials should be used to complete the operation.
- Follow with a finish material to match the surround texture/color.

Note: Scaffolding tie patches will never be completely inconspicuous, but should not be so noticeable that the patch is the first thing you see. It is always good practice to include a few scaffolding patches in the jobsite mock-up to allow the architect to review and approve the level of patch the contractor is capable of providing, with the specified texture and color.

CHAPTER 3 – THREE COAT PLASTER (STUCCO)

General Patching

Large cracks, chips and holes can be patched using similar materials to the installed assembly. The severity of the damage will determine the sequence of repairs. For instance, if the WRB (water-resistive barrier) has been compromised, the entire damaged assembly will be removed in order to integrate new WRB with existing WRB, new lath overlapped with existing etc. The most difficult process is finishing a patched wall so that the patch is no longer visible. Often this process may require the entire plaster panel to be refinished ("rescrubbed").

Patching should not be done by a handyman or a maintenance supervisor. Only a thoroughly experienced plasterer will consistently achieve good results. They will have picked up their own special methods, secrete and "tricks to the trade where the patched area may "disappear" from view.