Designer Choices and Responsibilities in ASTM C1063 and ASTM C926 Regarding Portland Cement Plaster Wall Claddings

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Abstract

The speakers will discuss designers’ responsibilities for the effective design of Portland cement plaster (stucco) wall claddings as specified by ASTM stucco industry standards. Standards ASTM C1063 and ASTM C926 were carefully researched by two design professionals who contributed to their development. All stucco is not the same, and the range and variety of choices that designers must evaluate and select from in terms of material and detailing have implications for function, durability, and creative expression. These implications, minimum design requirements, best design practices, conclusions, and recommendations will be explored.

Speakers

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Lee Cope has extensive experience in detailing and installation of Portland cement plaster façade systems, air barriers, window systems, waterproofing, and the interfaces of envelope components. He has evaluated structures relating to the cause and/or distress of buildings’ exterior façade/curtainwall systems and building envelope systems. He is a voting member of ASTM Committee C11 on Gypsum and Related Building Materials and Systems.
INTRODUCTION/GENERAL

Brief History of the Stucco Industry Standards

The earliest stucco standards were voluntary and intended for the purpose of documenting best practices. The first stucco industry standard, from 1920, was American Concrete Institute (ACI) Standard No. 25, Standard Recommended Practice for Portland Cement Stucco. It included both lathing and plastering in one standard. This standard has significant valid content even today, nearly a century later, because the basic characteristics of Portland cement-based plaster have not really changed that much over time. A single standard continued until 1971, when the standard was bifurcated into American National Standards Institute (ANSI) Standard A42.2 for Plastering and A42.3 for Lathing.

Compliance with stucco industry standards was voluntary through these decades, but the standards were often specified as a benchmark for quality in architects’ construction documents. Caretaking of the ANSI stucco standards transitioned to the current ASTM International (ASTM) organization development process in the early 1980s. Today’s ASTM stucco industry standards have changed in character to become minimum building code requirements, not mere voluntary guidelines and, at the same time, not best practices. The current International Building Code (IBC), as adopted and enforced by many building department jurisdictions nationwide, incorporates ASTM C1063 and C926 minimum stucco cladding requirements by reference, meaning they are codified as minimum building code requirements.

ASTM standards are divided into six types, including test method, specification, classification, practice, guide, and terminology. The two primary stucco industry standards that are the basis of this paper—ASTM C1063-16a, Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement Plaster Wall Claddings—
Introduction

ASTM C1063 and C926 are specifications—minimum industry standard requirements—not guidelines. A designer, as a best practice, can and should specify higher requirements where the specific conditions and requirements of a given project warrant. Higher expectations for quality of materials and workmanship than minimum standards require should inform and direct the designer to specify higher quality materials and workmanship. Specific environmental conditions, such as coastal-zone corrosivity, should require specifications for materials that are sufficiently corrosion-resistant. Higher expectations for minimizing cracking or maximizing water management should inform and direct design decisions and specifications for all aspects of a stucco wall cladding system.

This paper is directed at the designer of Portland cement-based stucco wall cladding systems. The term “designer” is intentionally broad, and the standards are currently under revision to use the term “design authority” to describe the entity responsible for design decisions, which will also be used going forward in this paper. The design authority can be one of many entities, depending on the given context—from a traditional design professional, to the contractor, the building owner, an authority having jurisdiction (AHJ), or even a product manufacturer—and may function in a design authority role for all or a portion of the project. An objective of this paper is to assist the design authority in determining needs and expectations for stucco wall cladding systems, and help in evaluating stucco wall cladding choices, specifications, and installation requirements resulting in stucco that meets or exceeds the requirements.

The design professional stucco consultants who researched and coauthored this paper focused on the design authority requirements related to the two primary aspects of Portland cement-based exterior stucco wall cladding: lathing and plastering. At the same time both interesting and potentially confusing, C1063 is primarily about lathing, and C926, primarily about plastering. These two topics are intertwined throughout both standards. While specific text from the ASTM standards cannot be quoted in respect of copyrights, references are given for the readers’ further information and review.

METAL LATH INSTALLATION

Metal lath and lathing accessories as a base to receive Portland cement plastering is almost solely used for stucco wall cladding systems placed over a water-resistive barrier (WRB) and framed substrate, which may or may not include continuous sheathing, continuous insulation, or a defined drainage cavity. While circumstances exist that merit direct-applied, continuously bonded stucco wall cladding onto a cementitious substrate that may require lathing and lath accessories, these are specialized conditions. The design authority is required to design lathing and lath accessories, as this paper further elaborates.

Framed Structural Support Substrates

With a Maximum Deflection of L/360.

Until recently, the structural design sections of the building code allowed L/240 for “brittle finishes,” presenting a dilemma for some design authorities, but recent changes to the IBC reflect the long-standing stucco industry requirement for L/360 as the maximum allowable substrate support deflection. Minimizing deflection of the substrate support for the relatively thin section of a stucco wall cladding is critical to minimize the potential for mid-span cracking, which may occur if the framing can bend to a greater extent than the cured Portland cement plaster membrane can resist without cracking. The L/360 deflection criteria apply to both wall stud framing and ceiling/soffit framing conditions—indeed any framed substrate support for Portland cement-based wall cladding. Reference: ASTM C926 A2.1.6.

Sufficient Slope for Drainage at Surfaces Related to Wall Cladding Surfaces, Such as at Recessed Windowsills and Wall Parapets

Stucco wall cladding systems are not inherently waterproof, and all climates and conditions where they are used are exposed to water accumulation in the form of rain, snow, or ice. Sufficient slope that uses gravity to assist with drainage is necessary in minimizing water intrusion and is a basic requirement to facilitate drainage and minimize concealed, water-related damage. However, slope must be accommodated in the design of stucco wall cladding systems and their substrate support and not left to chance. Consider also that manufacturers of polymer-finish coat materials have
specific minimum slope (often 6:12 pitch) and maximum planar dimension requirements (often 6-12 inches maximum) that affect the durability of polymer-finish coat material and are not specifically expressed in the ASTM stucco standards. The recessed windowsill detail depicted in Figure 1 may be sufficient for a cement-finish coat stucco, but not sufficient for a polymer-finish coat stucco. Reference: ASTM C926-A2.1.1.

**Flashings at Openings, Perimeters, and Terminations**

Stucco shall not be considered “waterproof” and requires the design authority to describe the requirements for furnishing and application of flashings to prevent water from getting behind the plaster and to provide drainage from behind the stucco cladding. Flashings are required to consist of corrosion-resistant materials and shall be installed at openings, perimeters, and terminations of the stucco wall cladding system. Reference: ASTM C926-A2.1.2.

A foundation weep screed shall be installed at the bottom of all steel- and wood-framed exterior walls, and the requirements regarding the position of the foundation weep screed and its installation requirements are as follows:

- The bottom edge of the weep screed shall be not less than 1 inch below the formed joint between the foundation and the framing.
- The nose of the weep screed shall be no less than 4 inches above grade, and no less than 2 inches above paved surfaces.
- The WRB and lath shall entirely cover and lap over the vertical flange of the weep screed and terminate at the top edge of the nose.

Reference: ASTM C1063-7.11.5.

- Where the drainage plane (WRB) is interrupted by a floor, supporting structure (such as a projecting balcony or soffit corner), or foundation, or when a drainage assembly is constructed above a barrier wall assembly, the design authority is required to specify an effective means of drainage (drainage screed, flashing, etc.) to drain away moisture that may get behind the stucco at the bottom of exterior drainage walls (Figure 2). Reference: ASTM C926, A2.2.1.

Specially configured, custom-fabricated flashings that are soldered or sealed watertight and provided by other suppliers/contractors—such as window head flashings and sill pan flashings (not considered to be a lath accessory)—must be integrated with the WRB to manage incidental water infiltrating behind the stucco wall cladding system.

![Figure 1 – Drainage slope at recessed windowsill with cement-finish coat.](image1)

![Figure 2 – Soffit drainage flashing at soffit corner condition.](image2)
Lath and Lath Accessories Used With Portland Cement Plaster

To the extent that a design authority designs the stucco wall cladding system, its individual components, and stucco wall cladding system details, as well as specifies stucco materials, the design needs to conform to or exceed the minimum requirements of ASTM C1063 and C926. This should be an easy-to-understand concept, but in practice, variations from this minimum requirement frequently occur.

Common examples are the design omission of casing beads and sealant at stucco perimeter interfaces with dissimilar materials such as windows (C1063-7.11.3 and C926-A2.1.3), allowing lath fasteners set into sheathing only and not framing members (C1063 6.7.2, 7.8.1 et al.), and allowing continuous lath at control joints (C1063-7.10.1.5). Each of these conditions can detrimentally affect the performance and aesthetics of stucco wall claddings.

The opposite is true for any aspect of the stucco wall cladding system that is intended to exceed the minimum requirements of the stucco industry standards as a best practice. Special requirements for materials, methods, aspects, or evaluation criteria must be designed by the design authority. Examples might include a project-specific requirement for stainless steel lath, lath accessories, and fasteners as may be appropriate for a corrosive environment. The design authority needs to design details of the stucco wall cladding system deemed important to achieving the designer’s intent and expectations. (See Figure 3.) Reference: ASTM C926-6.1.

Requirements for Lath Accessories, Including Their Type, Depth, Location, and Orientation

Required lath accessories must be selected and identified, including their ground dimension requirements and location requirements within the stucco wall cladding assembly, as typically indicated in detail drawings. Lath accessory “type” can refer to things such as whether a corner bead is square-nose, plastic-nose, or bull-nose; and a material specification, such as whether it is of expanded sheet metal or plastic. “Depth” refers to the critical dimensional requirements of lath accessories, such as the ground dimension or width of a vent screed or reveal screed. The design authority must
locate required lath accessories, including drainage screens, stucco perimeter termination requirements, expansion joints, control joints, etc., and depict their installation requirements in the contract documents, such as any required framing members or blocking for fasteners. The requirement for “orientation” can mean two things: 1) any distinction in requirements for a lath accessory that is oriented vertically or horizontally on a wall; and 2) how a lath accessory is installed relative to other stucco wall cladding components, such as determining if the solid flange of a weep screed is overlapped by one or both layers of the WRB. See Figures 4 and 5. Reference: ASTM C926-A1.6.2, A2.3.1, A2.3.1.2, X1.1.6; and ASTM C1063-Section 7, A6.2.1.

**A Complete and Coordinated Stucco Wall Cladding System**

The design authority should recognize that a complete and coordinated stucco wall cladding system includes ancillary requirements such as for acceptable substrate conditions and for sealant at perimeter terminations and penetrations. The opening sentence of ASTM C1063 states that the standard describes the minimum technical requirements for lathing and furring for stucco wall cladding systems, but that the requirements of the standard do not describe a unit of work for contracting purposes. Specifiers will realize that certain requirements for a complete stucco wall cladding system—even though indicated in a stucco industry standard—are provided by craftsmen other than lathers and plasterers. For example, wood-based sheathing substrates must be gapped at panel edges (C1063, Table 3, Footnote A). While it is a minimum requirement for stucco, providing the gaps is customarily the purview of carpenters. Required perimeter sealants (C926-A2.1.3) can be installed by other trades and are typically left to the contractor to assign responsibility and coordinate. Reference: ASTM C1063-1.1

**Concrete Substrates and High-Wind or Uplift Conditions**

Furring, furring attachments, and hanger attachments into concrete substrates and any aspect of the stucco wall cladding installation (such as at suspended exterior building soffits) subject to high-wind or uplift forces, may require design (including an engineering evaluation) to determine specific requirements to resist the forces imposed on or by the stucco wall cladding system. Vertical wire hangers are used primarily for supporting the framework for suspended stucco soffits or ceilings, and embedded concrete inserts (hanger attachments) or similar devices must accommodate the full strength of the hanger. References: ASTM C1063-7.2.3, 7.7.1, Table 2, Footnotes 9 and 10.

**Special Stucco Assembly Requirements for Fire Resistivity, Sound Control, and Shear Walls**

The design authority is required to depict the “details of construction” for specialized fire-resistant, acoustical control, and shear wall assemblies that utilize stucco. Expanding the fuction of stucco may bring special requirements not normally a part of typical stucco wall cladding systems. The design authority needs to explicitly describe all special requirements, including special materials, lath fastener requirements, and field testing, in the contract documents.

For example, some tested assemblies for fire-resistivity require a full 1-in. cement plaster thickness, specific lath or lath fasteners, sheathing requirements, and stud cavity-fill materials, such as mineral wool. While C1063 and C926 do not describe these specific requirements for tested assemblies, they are indicated in other stucco industry or building code documents. Industry-recognized laboratory testing reports describing requirements necessary to achieve desired fire-resistivity and acoustical performance parameters should be reviewed and indicated as the basis of design, and their requirements incorporated into the contract documents. References: ASTM C1063-1.2, 1.3, IBC Table 2306.3(3).

**Stucco Submittals**

The common process of specifying and providing submittals for a building construction project is routine on many projects, but this construction-phase quality control procedure is not required or even mentioned in ASTM stucco standards. Submittals are essentially a communication device used to convey the contractor’s understanding of the design authority requirements to the design authority and owner. This is part of the quality assurance process to communicate that the contractor plans to provide what the design authority intended in the construction documents, and to resolve conflicts. Stucco wall cladding system submittals often include product data or actual samples of all components used, such as the WRB, lath, lath accessories, plastering materials, and a manufacturer’s standard colors brochure for finish coat color selection. A physical sample of the stucco wall cladding system (or even just the finish coat), as well as a site-constructed mock-up wall (Figure 6) may also be specified as submittals, each of which will confirm the completeness and accuracy of the design, the workmanship quality, and installation coordination. These submittals will also enhance communication amongst the project team to avoid potential misunderstandings in the final installed stucco wall cladding. To require stucco submittals, the design authority must specify the list of items to be submitted for review and acceptance.

**Stucco Shop Drawings**

Design and construction professionals know the benefits of shop drawings to a building construction project, but this standard construction phase quality control procedure is not required or even mentioned in ASTM stucco standards. Shop drawings are also a submittal to the design authority for review and acceptance, and are considered a best practice in the stucco industry. A stucco wall cladding system is often the single most prominent and, therefore, important wall cladding mate-

![Figure 6 - Stucco mock-up wall.](image-url)
Stucco can be applied to a metal plaster base (as discussed previously) or directly applied to a solid base such as masonry, precast concrete, cast-in-place concrete, or concrete masonry units (CMUs). Early signs of distress, in the form of delamination, cracking, and water intrusion, are often the result of poor surface preparation, improper mixing, defective installation, inadequate curing, or a combination of these. While the minimum industry standards for application of stucco—including surface preparation, mixing procedures, and curing requirements—are outlined in ASTM C926, the authors often observe significant inconsistencies in the application of these requirements by the various parties involved, including design architects, waterproofing consultants, contractors, and subcontractors.

Based on the authors’ experiences, these inconsistencies are frequently caused by inadequate understanding of the ASTM standards and often lead to significant deficiencies in the completed stucco cladding. Deficiencies can include cracking, separations, delaminations, and water leakage, and can result in premature maintenance costs and often costly litigation. Therefore, the following section will discuss the design authority’s responsibilities as identified in ASTM C926, as well as provide recommendations that a design authority may want to consider in his or her design to help ensure successful installation, a successful finished product, and a satisfied client. The topics discussed in this section include:

- Surface preparation
- Mix design
- Mixing and application
- Curing and crack acceptance criteria
- Provisions for drainage behind exterior stucco

**Surface Preparation for Solid Bases**

Throughout the coastal United States, directly applied stucco is a common cladding system. Unfortunately, the bonding requirements and substrate preparation are rarely specified by the design authority responsible for these cladding systems. Similarly, treatment of the stucco at dissimilar substrate materials, and requirements for addressing substrate conditions that exceed the permitted plane of ¼ inch in 10 feet, are often not identified by the design authority. Rather, the design authority frequently only references ASTM C926 in the specifications, enabling the contractor or applicator to apply the minimum requirements identified in the specification, which often results in stucco delaminations and cracking of the stucco. ASTM C926 provides a variety of design authority responsibilities regarding surface preparation for bond, treatment of dissimilar materials, and requirements to correct surfaces that are out of tolerance prior to placement of stucco. The following summarizes these responsibilities and also provides recommendations for the design authority to consider to help ensure bond is achieved.

**Design Requirements Regarding Bond**

Section 6 of ASTM C926 provides minimum requirements for surface preparation to solid bases prior to placement of stucco. These requirements are as follows:

- Solid surfaces to receive stucco shall be free of form oil or other elements that may interfere with bond between the stucco and the substrate.
- Solid surfaces shall have the ability to absorb moisture, have surface roughness, or both, in order to provide the bond required for the plaster.
- Smoothing of nonabsorbent surfaces (i.e., cast-in-place concrete or precast concrete) shall be prepared in one of the following methods:
  - Sandblasting, wire-brushing, acid-etching, or chipping, or a combination
  - Application of a bonding compound suitable for exterior-exposure solid surfaces in accordance with the manufacturer’s written directions
  - Where bond cannot be obtained by one of the methods listed above, a furred or self-furring metal plaster base shall be installed per ASTM C1063. At these locations, accessories shall also be installed per ASTM C1063.

While many of these requirements could be considered means and methods and are therefore the purview of the contractor, Section A1.6.3 (Annex A1. General Information – Mandatory Information), requires the design authority to describe “the physical characteristics of solid-surface bases to receive plaster, including measures to promote bond” in the proper section of the contract documents. This section also states that form release agents shall either be compatible with the stucco or shall be completely removed from the substrate prior to the application of the stucco. Furthermore, Section A2.1.5 (Annex A2. Design Considerations – Mandatory Information), obliges the specifier to indicate in the appropriate specification section that solid bases to receive stucco shall not
be treated with “bond breakers, parting compounds to prevent adhesion, form oil, or other material that will inhibit the bond of the stucco to the base.”

Therefore, in accordance with ASTM C926, it is the design authority’s responsibility to specify what is required to achieve bond. If the specifier does not include a description of “measures to promote bond,” he or she is failing to meet the requirements of ASTM C926. Since ASTM C926 is incorporated by reference in the model building codes, the design authority has failed to meet the minimum design requirement set forth by the code. As a result, inadequate surface preparation is often provided, which frequently results in stucco delaminations.

In addition to these requirements, it is recommended that the design authority also specify the required minimal bond for directly applied stucco. While ASTM C926 does not provide quantitative bond requirements for directly applied stucco, the authors have measured bond strengths from 0 to 5 psi, to well over 100 psi. The lower bond strengths are often recorded on cast-in-place or precast concrete, as a CMU generally provides an acceptable substrate with little to no surface prep needed. It is the author’s opinion that bond strengths of less than 30 psi are likely indicative of poor surface preparation on surfaces such as cast-in-place or precast concrete, and/or poor stucco installation. However, when cast-in-place concrete is clean, free of form oil, and when the surface profile has been prepared to comply with International Concrete Repair Institute (ICRI) CSP-7, bond strengths over 50 psi can be achieved.

Requiring construction of mock-ups in the project specifications and performing bond tests to record the bond strength on these mock-ups can help verify the appropriate surface prep needed to achieve the desired bond.

**Design Requirements for Treatment of Dissimilar Base Materials**

Cracking is often observed in stucco that is directly applied over dissimilar base materials, such as the joint between the CMU infill walls and the cast-in-place concrete frame. This cracking is often the result of or a combination of improper detailing, improper installation of structural connections between the CMU and cast-in-place concrete, and incomplete placement of mortar between the CMU and cast-in-place frame. Because of these possible problems, ASTM C926 recognizes the potential risk of distress in the form of cracking along dissimilar materials.

In Section A2.3.3 (Annex A2, Design Considerations–Mandatory Information), the standard requires the design authority to specify one of the following methods be installed to treat the joint where dissimilar base materials abut and are to receive a continuous coat of stucco. The methods are as follows:

- Either a two-piece expansion joint, a casing bead placed back-to-back, or a premanufactured control-expansion joint should be used (Figure 7).
- The joint between the two dissimilar materials shall be covered with a 6-inch-wide strip of galvanized, self-furring metal plaster base, with 3 inches extending on either side of the joint (Figure 8).
- Where one of the bases is a metal plaster base, the self-furring metal plaster base shall be extended 4 inches onto the abutting base.

In our experience, the design authority generally does not like to see “picture-frame” joints in the stucco where dissimilar materials occur (joints between CMUs and cast-in-place columns and joints between CMUs and cast-in-place slabs). Therefore, expansion joints, casing beads placed back to back, or premanufactured control-expansion joints are often used to avoid these picture-frame joints.
tion joints are rarely specified or allowed or illustrated on the contract drawings. However, it is common to observe installers place a section of fiberglass reinforcing mesh or plastic/PVC mesh to “reinforce” the stucco over these joints. Unfortunately, cracking is often observed due to the conditions mentioned above, as well as substandard installation resulting in a poor key between the stucco and the mesh.

Based on the requirements of ASTM C926, the design authority shall specify how to treat the joint between dissimilar base materials in directly applied stucco. It is the authors’ opinion that if cracking is not acceptable along joints where dissimilar materials abut, a two-piece expansion joint, a casing bead placed back to back (with sealant in between), or a premanufactured control-expansion joint should be specified.

**Design Authority Requirements for Treatment of Substrates That Are Out of Tolerance**

For stucco that is directly applied to a high-rise, cast-in-place concrete frame, it is likely that the stucco will be thicker than the required nominal thicknesses specified in ASTM C926, Table 4, and sometimes substantially so. This condition is likely due to the less stringent tolerances controlled by ACI 117, *Specification for Tolerances for Concrete Construction and Materials*, compared to the substrate tolerance required by ASTM C926.

When constructing a high-rise structure that consists of a cast-in-place concrete frame, the tolerances for plumbness and horizontal variances are detailed by ACI 117. Section 4.1 of ACI 117 provides plumbness requirements for cast-in-place concrete building heights less than or equal to 83 feet, 4 inches. The permissible out-of-plumb dimension is 0.36 in., or approximately 3/8 in., or approximately 3/8 in. for the building with multiple bays, the first bay is allowed to be out of variance by +1 in. compared to the specified plan dimension, and the adjacent bay is allowed to be out of variance by -1 in., which equates to an offset in the framed floor edges of 2 in. across the two bays.

When placing stucco on a high-rise structure that consists of a cast-in-place concrete frame with CMU infill walls, the columns, edges of floors, and block walls are to be within ½ in. of the same vertical plane. This tolerance is based on Section 6.2 of ACI C926, which requires the substrate to be “straight and true within ¼ inch in 10 feet.” This section also requires that surfaces that are out of these tolerances be corrected prior to the placement of stucco.

Annex A1, General Information (Mandatory Information), Section A1.6.3 limits the tolerances of the substrate to no more than ¼ inch in 10 feet and requires that ferrous materials, such as reinforcement, tie wires, etc., shall be cut back a minimum of 1/8 in. below the surface and treated with a corrosion-resistant coating. In addition, Appendix X1, General Information (Nonmandatory Information), Section X1.1.5 states that corrective measures for surfaces outside of the tolerances specified in Section 6.2 should “include sandblasting, chipping, or grinding of the solid plaster base, application of a repair/build-out mortar, installation of a self-furring plaster base, or combination thereof.” It also states that since these measures may have structural consequences, the repair should be considered with all parties involved, with the ultimate selection left to the discretion of the design authority.

In our experience, the design authority rarely provides direction to the contractor for correcting out-of-tolerance surfaces. As a result, the authors have observed contractors using various methods to attempt to reduce planar irregularities in the finished stucco. These methods include increasing the thickness of the stucco well beyond the nominal thicknesses specified in ASTM C926 (up to 3 in. thick), use of a myriad of build-out materials, and chipping out concrete to depths that exposed reinforcing bars. Excessively thick stucco (1½ to 3 in. or more) is usually placed in several layers, which increases the possibility of a delamination occurring between the various coats. More often than not, the build-out materials utilized are not structural repairs and do not include structural anchors that help secure the build-out material to the substrate. Rather, the build-out material is often placed directly on the substrate with little to no surface preparation, which often results in poor bond of the build-out material to the substrate. Chipping out the substrate to correct the substrate tolerance frequently results in poor concrete cover over the reinforcing bars and/or exposed reinforcing without a corrosion-resistant coating. These methods often result in delamination and cracking.

In Appendix X1, Section X1.1.5, ASTM C926 recognizes that multiple parties can be responsible for out-of-tolerance substrates on solid bases, and indicates that, since repairing the substrate may have structural consequences, the ultimate discretion of the repairs should rest with the design authority. In addition, Section 6.2 and Appendix A1 state that the plane tolerances shall be no more than ¼ inch in 10 feet, and that the substrate shall be repaired prior to the application of the plaster.

Therefore, it is the responsibility of the design authority to specify how substrates shall be prepared if substrates are out of the required tolerances. In addition, to avoid extensively thick stucco, the authors recommend that the design authority specify the maximum stucco thickness allowed.

**Surface Preparation for Metal Plaster Bases**

Outside of the coastal United States, the majority of stucco is applied to metal plaster bases. The minimal code requirements for installation of the metal plaster bases and accessories used to receive plaster are provided in ASTM C1063. The design authority’s responsibilities as per ASTM C1063 were discussed previously in this paper.

**Stucco Mix Design**

The requirements for mix designs are discussed in Section 7, Application, of ASTM C926. Section 7.1 states that all stucco shall be mixed and proportioned in accordance with Tables 1, 2, and 3 of ASTM C926. Table 1 provides mix design, as mix symbols, based on the type of plaster base. Tables 2 and 3 provide proportions of the various stucco constituents for the base coat and finish coat, respectively. In the authors’ experience, the two most common mixes specified include mix designs with mix symbols C and CL for the base coats.
Poor mixing due to improper proportion are common sources of distress in stucco. Although the design authorities continue to specify a mix containing Portland cement, sand, and lime in accordance with ASTM C926, proprietary preblended, prebagged mixes are increasingly being utilized for stucco applications. There are several advantages to using the prebagged mixes rather than specifying on-site mixing. These prebagged mixes are generally easy to use and often only require the addition of water. Instructions are also typically printed on the bag, reducing the risk of mixing errors. Therefore, quality control is typically improved when weighing of ingredients is performed in a controlled environment rather than on a jobsite. Additionally, the batches are more consistent (assuming that the same amount of water is used in each batch) when they solely require the addition of water.

The disadvantage is that these bags contain proprietary blends of ingredients. The safety data sheets don’t often have enough information to determine the materials that may be present in the bag, let alone the proportions of these ingredients. If the design authority specifies or accepts the use of particular products on jobs, they should also be aware that masonry cement, plastic cement, fly ash, gypsum, limestone, plasticizers, waterproofing additives, and many other ingredients may also be present or used as substitutions in these prebagged mixes, in addition to Portland cement, sand, and lime. The effects of each of these ingredients on the workability, bond, or shrinkage of the stucco is unknown until each proprietary blend is fully tested in the laboratory or from successful performance in the field. While these blends may adhere to ASTM C926, Standard Specification for Application of Portland Cement-Based Plaster, the design authority cannot be assured of their suitability until they are more fully characterized. While the use of these materials may be advantageous, the unknown ingredients are cause for some concern.

**Mixing and Application of Stucco**

Poor mixing and application of stucco are common sources of distress in stucco. Poor mixing due to improper proportioning and mixing of ingredients can result in cracking. Poor application can also result in cracking, as well as delaminations and separations between the stucco and accessories. ASTM C926 recognizes these potential problems and provides requirements on both mixing and application. These requirements are primarily the responsibility of the contractor. However, to help ensure that the contractor is qualified, the authors recommend the design authority require the stucco contractor to submit qualifications. Typically, these qualification submittals should include evidence that the stucco applicator’s company has a minimum of five years of continuous experience in similar stucco work. The qualifications could require the contractor to list a minimum of five representative projects with similar scope and size, including the project name, owner’s name, description of work, materials used, project supervisor, total cost of the stucco work and total cost of the project, and completion date. In addition, it is recommended that the design authority require the contractor to submit the mix design, including proportions of ingredients and sieve analysis for the aggregate to help ensure that it meets the requirements of ASTM C987 as required by ASTM C926.

To help ensure that the stucco to be used on a project is properly mixed and is of good quality, the design authority can specify that petrographic and chemical analysis in accordance with ASTM C1324, Standard Test Method for Examination and Analysis of Hardened Mortar, be performed during the mock-up phase of a project. The results of the analysis can be used to determine the final mix proportions. The construction of the mock-up and the application of the stucco can also be reviewed to help ensure correct installation.

**Curing**

Good curing practices that maintain sufficient moisture in the stucco mix to permit continuous hydration of the cementitious materials can help prevent or reduce the risk of excessive shrinkage cracking. The premature loss of water from the stucco caused by high temperatures and exposure to wind and sun can result in early hydration and excessive cracking.

It should be noted that stucco can actually dry out faster in cool weather when exposed to direct sunlight and wind than it will on hot days when not exposed to direct sunlight and wind. Because environmental conditions can play a large role in when and how to cure the stucco, the responsibility of curing, per ASTM C926, relies heavily on the contractor. ASTM C926 states that the method of curing can be one or a combination of the following:

1. Moist curing by applying a fine fog spray of water as frequently as required, generally twice daily in the morning and evening. Care must be exercised to avoid erosion damage to Portland cement-based plaster surfaces. Except for severe drying conditions, the wetting of finish coat should be avoided; that is, wet the base coat prior to the application of the finish coat.

2. Plastic film, when taped or weighted down around the perimeter of the plastered area, can provide a vapor barrier to retain moisture between the membrane and plaster. Care must be exercised in placing the film: if too soon, the film may damage surface texture; if too late, the moisture may have already escaped.

3. Canvas, cloth, or sheet material barriers can be erected to deflect sunlight and wind, both of which will reduce the rate of evaporation. If the humidity is very low, this option alone may not provide adequate protection.

The amount of water or the length of time the curing should be performed are not defined in ASTM C926; however, the Portland Cement Association (PCA) recommends maintaining 80 percent relative humidity for at least 24 hours and, in some cases, up to seven days. Therefore, to help ensure that stucco is properly cured, the authors recommend the design authority specify the curing method and the minimum curing time.

In addition to the minimum moist curing time, since most finishes for stucco consist of a decorative finish (acrylic paint, elastomeric coatings, or proprietary finish coats), the authors also recommend that the design authority specify the required time for the stucco to fully cure and/or the acceptable pH level of the stucco prior to the placement of the finish. Most manufacturers require a total of 28 to 30 days of total curing or a pH level less than 7 (neutral) prior to the placement of the finish.
Crack Acceptance Criteria

While ASTM C926 and C1063 provide the minimum requirements for the design and construction of a stucco assembly, they do not provide information regarding crack acceptance criteria. While it may be assumed by the owner that no cracking is allowed, some amount of cracking is typically present in most stucco applications. Cracks form in stucco when forces or stresses within the stucco exceed the tensile strength of the stucco. Although these stresses can be the result of external forces, such as building displacement, wind, seismic, impact, etc., our experience is that cracks are more frequently caused by deficiencies in the design and installation of metal lath and stucco. These cracks can be categorized as extensive cracking, isolated cracking, or separations.

Stipulating crack acceptance criteria (such as crack viewing distance, critical lighting, crack types [patterns], locations, and crack widths) in the project specifications can help improve the overall quality of the stucco-related work, as well as clarify what cracking (if any) is acceptable. If cracking is not acceptable, repairs to the cracks can be performed during the construction phase. Allowing the stucco to cure until it reaches the acceptable pH to receive the finish will allow the contractor to identify and repair areas of cracking prior to placing the finish.

CONCLUSION

When properly designed and installed, stucco has proven to be a durable and an aesthetically pleasing cladding material that requires minimal regular maintenance. ASTM C1063 and C926 are specifications for the installation of lathing and furring to receive Portland cement-based plaster and the application of Portland cement-based plaster. These specifications are incorporated into the model building codes by reference, and provide the minimum requirements for stucco wall cladding system design and application.

Unfortunately, in our experience, there is often confusion as to what should be provided by the design authority versus what is left to the contractor. This confusion frequently leads to inadequate information provided by the design authority in the project specifications and drawings, including a failure to design or specify elements required by the ASTM standards. In an effort to clarify some of the more frequently ignored responsibilities of the design authority, we have reviewed both ASTM C926 and C1063 and discussed these responsibilities, as well as provided additional recommendations for the design authority to consider. These recommendations are more demanding requirements that can improve the minimum standards presented in the specifications.

REFERENCES

4. ASTM C926-16a, Standard Specification for Application of Portland Cement-Based Plaster. ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959.