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Forensic Analysis of Construction Variances Associated with Cement Plaster (Stucco) Veneer Installed Over Wood Framing

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Abstract

The International Residential Code (IRC) provides prescriptive specifications for the installation of cement plaster (stucco) veneer on wood framing. Since 2006, the IRC has also referenced ASTM C926 (Standard Specification for Application of Portland Cement-Based Plaster) *and ASTM C1063* (Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster) *as applicable standards that provide additional specifications associated with the installation of cement plaster veneer. The IRC and the applicable code-referenced standards do not consider all available materials, designs, and/or methods of construction — nor do they consider possible alternatives or construction variances. Since there is more than one way to accomplish a goal, a forensic investigation should consider the intent and purpose of a specification (i.e., the desired performance) to determine whether an as-built alternative or construction variance is capable of accomplishing the same without adversely affecting a structure. This paper explores common construction alternatives and variances associated with the installation of cement plaster veneer (including control joints, attachment, thickness, and clearance) using methodologies for evaluating whether an alternative or variance can still achieve the intent and purpose of the specifications provided in the IRC and/or applicable code-referenced standards.*

Keywords

Alternative, analysis, ASTM, attachment, cement plaster, clearance, control joints, evaluation, international residential code, performance, stucco, specification, thickness, variances, veneer, wood framing, forensic engineering

Introduction and Background

Cement plaster veneer, often referred to as "stucco," is a common exterior cladding material used in residential and commercial construction worldwide. The International Residential Code (IRC)[1] provides prescriptive specifications for the installation of cement plaster (stucco) veneer for residential construction, and it references ASTM C926 (*Standard Specification for Application of Portland Cement-Based Plaster*)[2] and ASTM C1063 (*Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster*)[3] as additional code-referenced standards for the installation of cement plaster veneer and associated accessories.

The authors of this paper find that cement plaster veneer is often installed with alternative means/methods and/or variances from the specifications of the applicable building code and/or code-referenced standards, and some frequently consider such alternatives and variances to be construction deficiencies. One should endeavor to perform construction services in accordance with the applicable building code and/or code-referenced standards; however, meeting prescriptive code specifications after the fact is primarily academic. A forensic approach to alleged

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deficiencies should not blindly follow prescriptive specifications; instead, it should employ engineering analysis to consider the performance aspects of the construction variances before concluding that such variances are construction defects[4]. Construction alternatives and variances are commonly encountered in cement plaster veneer; such alternatives/variances require a forensic evaluation to determine if they are adequate to perform their intended function.

According to Section R104.2.2 and Section R104.2.2.3 of the 2024 IRC (similar verbiage is also presented in all preceding versions of the IRC)[1]:

> ***R104.2.2 Alternative materials, design and methods of construction and equipment.***
>
> *The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved.*
>
> ***R104.2.2.3 Compliance with code intent.***
>
> *An alternative material, design or method of construction shall comply with the intent of the provisions of this code.*

Based upon the preceding, the IRC acknowledges its prescriptive limitations. As such, it permits the use of alternative materials, designs, and construction techniques when an alternative is deemed to "comply with the intent" of the code's provisions.

In this paper, the authors explore a practical, objective forensic methodology for evaluating construction alternatives and variances in various components of cement plaster veneer to determine whether an alternative or variance can still achieve the intent and purpose of the specifications provided in the IRC and/or applicable code-referenced standards.

Drainage Mechanisms at Transitions Between Vertical and Horizontal Surfaces

Section A2.2.2 of ASTM C926-21 states the following regarding transitions between vertical and horizontal surfaces clad with cement plaster veneer (similar verbiage is also presented in all preceding versions of ASTM C926)[2]:

> ***ASTM C926-21***
>
> *A2.2.2 Where vertical and horizontal exterior plaster surfaces meet, both surfaces shall be terminated with casing beads with the vertical surface extending at least ¼ in. (6 mm) below the intersecting horizontal plastered surface, thus providing a drip edge. The casing bead for the horizontal surface shall be terminated not less than ¼ in. (6 mm) from the back of the vertical surface to provide drainage.*

According to ASTM C926-21, a functional drainage mechanism at vertical-to-horizontal transitions in the cement plaster veneer (as shown in **Figure 1**) is required to provide a means of draining water from the underlying drainage plane to the exterior[2].

Although the omission of a drainage mechanism at a vertical-to-horizontal transition in cement plaster veneer may be a consistent industry practice in some locales, it may result in staining, potential biological growth, and/or other signs of distress due to water accumulation/entrapment, as shown in **Figure 2**.

If cement plaster veneer is installed without a functional drainage mechanism at a vertical-to-horizontal transition, the as-built condition should be further evaluated to determine whether it is susceptible to damage.

A forensic investigation should consider other factors such as roof cover and/or weather exposure. For example, if the roof projects beyond the exterior wall/header plane for a horizontal distance greater than the vertical height of the wall/header area above the vertical-to-horizontal transition in the veneer (as shown in **Figure 3**), the investigator

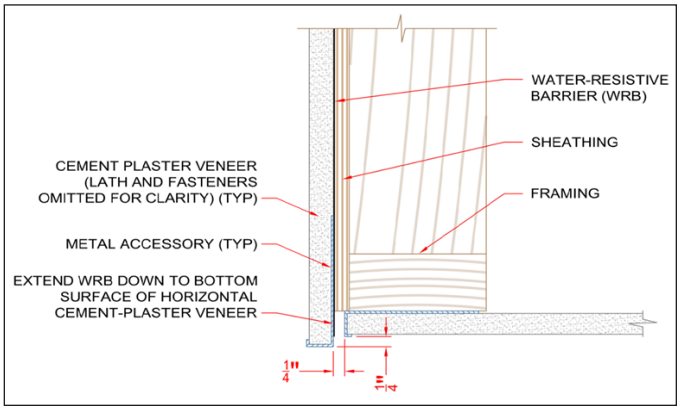

Figure 1
Example of vertical-to-horizontal transition in general compliance with ASTM C926-21.

Figure 2
Example of deteriorated wood framing at vertical-to-horizontal transition without a drainage mechanism.

Figure 3
Example of a vertical-to-horizontal transition at a covered location.

may be justified in concluding that the as-built omission of a drainage mechanism at the vertical-to-horizontal transition is not susceptible to damage because the roof overhang would serve to mitigate any potential water contact with the upper portion of the wall above the transition and significantly decrease the volume of water to be evacuated from the drainage plane underlying the veneer above the transition, if any.

In addition, a forensic investigation should consider the past performance of the cement plaster veneer at the location in question. The investigator should inspect for any salient signs of distress consistent with an accumulation of water underlying the veneer at a vertical-to-horizontal transition at a covered location. If there are no salient signs of damage consistent with water accumulation/entrapment at a location of a protected vertical-to-horizontal transition, the investigator may be justified in concluding that the as-built omission of a drainage mechanism at the vertical-to-horizontal transition is not a construction deficiency, and no remediation is necessary.

In the event that cement plaster veneer is installed without a functional drainage mechanism at a vertical-to-horizontal transition as a means of providing drainage for the wall assembly in accordance with ASTM C926-21, the as-built condition should be further evaluated to determine whether it would yield an accumulation of water behind the veneer. If the vertical-to-horizontal transition in the cement plaster veneer occurs at a location that is protected by roof cover (where water is not likely to pass behind the veneer) and the cement plaster veneer does not exhibit any salient signs of excessive cracking and/or staining associated with an accumulation of water behind the veneer (with no reason to suspect that such distress may manifest in the future), the investigator would be justified in concluding that the as-built condition is "satisfactory," as the prescribed drainage mechanism is not necessary.

On the contrary, if the vertical-to-horizontal transition in the cement plaster veneer is exposed to the elements, where water is likely to pass behind the veneer and require subsequent drainage, and/or the veneer exhibits signs of distress consistent with an accumulation of water behind the veneer (or such distress is likely to manifest in the future under typical service conditions), the investigator would be justified in concluding that the as-built condition is not capable of performing its intended function. Therefore, the construction variance is a deficiency.

Locations/Spacing of Control Joints

ASTM C1063-21 states the following regarding control joints in cement plaster veneer (similar verbiage is also presented in preceding versions of ASTM C1063)[3]:

> ***ASTM C1063-21***
>
> *7.4.10.2 Install control joint lathing accessories at locations to delineate cement plaster panel areas of 144 ft² (13 m²) maximum for walls and 100 ft² (9 m²) maximum for horizontal installations, that is, ceilings, curves, or angle type structures.*

ASTM C1063-21

7.4.10.3 Install control joint lathing accessories at locations to delineate cement plaster panel areas of 18 ft (5 m) maximum dimension, in either direction, or a maximum length-to-width ratio of 2½ to 1.

ASTM C1063-21

7.4.10.4 Install a control joint lathing accessory at locations where the ceiling framing or furring changes direction.

ASTM C1063-21

7.3.1.5 Lath shall not be continuous through control joints, but shall be stopped and tied at each side.

During a forensic investigation, the investigator should document the as-built location/spacing of control joints in the cement plaster veneer around the structure. In addition, the investigator should document the locations of distress in the cement plaster veneer and the size of substantial cracks to evaluate whether the observed cracks may be related to the placement and/or installation of control joints.

Depending upon the nature of the architecture, in conjunction with the location, orientation, and magnitude of distress, the investigator could then make a reasonable determination whether the existing control joints installed in the cement plaster veneer met the intent of ASTM C1063-21.

It should be noted that the continuity/discontinuity of metal lath behind control joint accessories in cement plaster veneer has been debated for many years, and the subject is currently up for discussion among the ASTM C1063 committee. In the past, ASTM C1063 was a voluntary standard, and its practices were not mandated by any building codes. When the 2006 IRC was released, ASTM C1063 became a referenced standard for the first time, so what was once offered as a "best practice" became a mandated practice.

Mark Fowler, the executive vice president of the Western Wall and Ceiling Contractors Association (WWCCA), and Frank Nunes, a former committee chairman of ASTM C926, co-authored an article addressing control joint installation and the need to allow for other acceptable practices[5]. In addition, the Association of the Wall and Ceiling Industry (AWCI) has issued the following statement[6]:

AWCI agrees that ASTM C1063 should be modified so that it allows and presents alternate methods for such things as installing control joints without cutting the lath. This modification will allow design professionals and contractors to include methods they know to work and avoid being penalized for not complying with the letter of the law.

In addition, Technical Bulletin 6.003 (April 2014) from the Wall & Ceiling Conference (WCC) states the following regarding the continuity/discontinuity of metal lath behind control joint accessories[7]:

The ASTM C1063 compliant method for installing control joints is to do so prior to the lath installation, thereby providing discontinuous lath terminating into the joint. ASTM C1063 does not, however, explain that to do so, you must have backing at either side of the vertical joint to properly secure the discontinuous ends of the lath and the flanges of the accessory…

…Where backing is not provided for and cannot be added for scheduling or other issues, vertical control joints are surface-applied to the face of continuous lath with tie wire. Not only has this proven method been practiced for decades, The Wall and Ceiling Bureau, Northwest Wall and Ceiling Bureau and The Technical Services Information Bureau endorse this installation…

In fact, an independent study performed in Galveston, Texas by an architecture/engineering consulting firm concluded that cement plaster veneer exhibited relatively similar performance regardless of the continuity/discontinuity of metal lath behind control joint accessories[8].

Cement plaster veneer is relatively brittle and can crack when subjected to stresses exceeding its tensile strength. Cracks in cement plaster veneer are a form of stress relief resulting from internal or external stresses. Due to the water-based nature of the material, cement plaster shrinks as it cures, which may result in hairline shrinkage cracks from internal stresses during the natural curing and drying process. In addition, expansion and contraction of cement plaster with thermal variances are also internal

stresses that can result in cracks. External stresses can be caused by any transfer of force to the cement plaster assembly, including, but not limited to, differential movement of a structural supporting element and/or deflection of a structural supporting element. Although steps can be taken to minimize cracks, there is no guarantee of eliminating them.

"Technical Bulletin 4" from the Plaster Council states the following regarding cracks in cement plaster veneer[9]:

> *... The building owner should expect hairline cracks and diagonal cracks emanating from the corners of windows and doors.*
>
> *By following industry best practices, the potential for cracking can be reduced (but not eliminated)...*
>
> *... Industry practice is to repair any cracks that exceed $^{1}/_{16}$" in width, although jobsite circumstances may suggest deviations from this normal practice.*

In addition, the "Three-Coat Stucco Maintenance Guidelines" published by the Stucco Manufacturers Association (SMA) states the following regarding cracks in cement plaster veneer[10]:

> *Cracking will occur on most residential homes finished with exterior cement based plaster. Cracking is typical in cement based plaster systems and in most cases is not considered a defect... It is important to note that these cracks do not jeopardize the water resistant properties of your stucco system. The weather resistive barrier is located beneath the cement coating. This is the component that protects your home from moisture intrusion.*

A forensic investigation should consider the architecture of the structure and the locations of existing control joints (in conjunction with the location, orientation, and magnitude of distress) to determine if the observed distress is causally related to the placement/construction of control joints. In addition, an investigator should consider and rule out other potential mechanisms that may yield similar distress (e.g., differential foundation movement, integration of roofing components, etc.) before concluding that the observed distress is causally related to the placement/construction of control joints.

In the event that cement plaster veneer is installed with placement/construction of control joints that do not meet the specifications of ASTM C1063-21, the as-built condition should be further evaluated to determine whether it is capable of performing the intended function. If the cement plaster veneer is installed with control joints sufficient to accommodate expansion/contraction of the veneer, thus limiting distress to the veneer — and the veneer does not exhibit any salient signs of systematic cracking associated with inadequate placement/construction of control joints — the investigator would be justified in concluding that the as-built placement/construction of control joints is "satisfactory" and "complies with the intent" of the provisions of the IRC. Therefore, the construction variance is not a construction deficiency.

On the contrary, if the cement plaster veneer is installed with control joints that do not meet the specifications of ASTM C1063-21 — and the veneer exhibits signs of systematic distress consistent with the omission and/or improper construction of control joints — the investigator would be justified in concluding that the as-built placement/construction of control joints is not capable of performing its intended function. Therefore, the construction variance is a construction deficiency.

Thickness of Cement Plaster Veneer

Table 4 of ASTM C926-21 provides specifications regarding the thickness of cement plaster veneer (a similar table is also presented in preceding versions of ASTM C926)[2].

According to Section 7.3.1 of ASTM C926-21[2]:

> ***ASTM C926-21***
>
> *7.3.1 Portland cement plaster shall be applied by hand trowel or machine to the nominal thickness specified in Table 4. The nominal values expressed in Table 4 represent neither a maximum nor minimum value. They consider the inherent variation of thickness due to the nature of the application process, and the allowable variation of the substrate and the finished plane of the plaster.*

While the total nominal specified thickness for cement plaster veneer applied over a metal plaster base ($^{7}/_{8}$ of an inch or 0.875 inches) has remained unchanged throughout the history of ASTM C926, it has clarified that the nominal value specified represents neither a maximum

nor minimum value[2].

During a forensic investigation, an investigator may evaluate the thickness of the cement plaster veneer around the perimeter of a structure. An evaluation of cement plaster thickness may be performed either by visual, non-intrusive measurements at exposed edges of panels, or it may be performed through intrusive methods.

Suppose an investigator elects to evaluate the thickness of the cement plaster veneer via non-intrusive measurements at exposed edges of panels. In that case, the investigator should consider the space between the wall framing and the edge casing accessory, the thickness of the edge casing accessory, and/or the protrusion of the textured finish. The investigator should measure the thickness of the cement plaster veneer from the back edge of the edge casing accessory, rather than the face of the exterior wall framing, to obtain an accurate measurement of the cement plaster thickness. In addition, measurements should be obtained at various locations around the perimeter of the structure, as shown in **Figure 4**. The investigator should attempt to place the vertical measuring tool on edge or at a slight back-sloping angle to account for the protruding texture. By taking measurements at multiple locations, any measurement influenced by the textured finish may be mitigated.

Suppose an investigator elects to evaluate the thickness of the cement plaster veneer via intrusive methods. In that case, the investigator should consider the necessary measures to properly remediate the underlying water-resistive barrier potentially damaged during the intrusive investigation process, as shown in **Figure 4**. Similar to non-intrusive methods, measurements should be obtained at various locations around the perimeter of the structure to mitigate any influence from the textured finish and/or isolated outliers.

When reviewing the results of the thickness measurements obtained (intrusive and/or non-intrusive), the investigator should consider that ASTM C 926-21 clarifies that the nominal values specified for the total thickness of cement plaster veneer represent neither a maximum nor minimum value[2]. In addition, the investigator should consider that ASTM's use of the word "nominal" to describe the total thickness suggests that some variation is to be expected.

Based on the evaluation of the thickness of the cement plaster veneer, the investigator may determine that the average thickness of the cement plaster veneer is generally in compliance with (or within an allowable tolerance of) the nominal value for total thickness specified by ASTM C926, despite the fact that the specified nominal value is not a minimum threshold.

A forensic investigation should consider the thickness of the cement plaster veneer, in conjunction with the location and magnitude of distress, to determine if the observed distress is systematic and causally related to the thickness of the plaster.

If cement plaster veneer is installed with a total thickness that is not generally compliant with (or within an allowable tolerance of) the nominal value for total thickness specified by ASTM C926, the as-built condition should be further evaluated to determine whether the as-built condition is capable of performing the intended function. If the cement plaster veneer does not exhibit any salient signs of systemic cracking within the area in question associated with the thickness of the veneer — and the veneer has been in place for a period of time sufficient to reasonably forecast its future performance — the investigator would

Figure 4
Example of non-intrusive (left) and intrusive (center and right) cement plaster veneer thickness measurements.

be justified in concluding that the as-built thickness of the cement plaster veneer is "satisfactory" and "complies with the intent" of the provisions of the IRC. Therefore, the construction variance is not a construction deficiency. On the contrary, if the cement plaster veneer exhibits signs of systematic distress related to the thickness of the veneer, the investigator would be justified in concluding that the as-built thickness of the cement plaster veneer is not capable of performing its intended function. Therefore, the construction variance is a deficiency.

Clearance Between Cement Plaster Veneer and Underlying Concrete Surfaces

Section R703.7.2.1 of the 2024 IRC states the following regarding the clearance between cement plaster veneer and underlying surfaces (similar verbiage is also presented in all preceding versions of the IRC)[1]:

> ***R703.7.2.1 Weep screeds***
>
> *A minimum 0.019-inch (0.5 mm) (No. 26 galvanized sheet gage), corrosion-resistant weep screed or plastic weep screed, with a minimum vertical attachment flange of 3½ inches x(89 mm), shall be provided at or below the foundation plate line on exterior stud walls in accordance with ASTM C926. The weep screed shall be placed not less than 4 inches (102 mm) above the earth or 2 inches (51 mm) above paved areas and shall be of a type that will allow trapped water to drain to the exterior of the building…*

Section R703.7.2.1 of the 2024 IRC specifies that weep screeds along the bottom edges of cement plaster veneer shall be placed not less than 4 inches above the earth or 2 inches above paved areas[1]. The 2024 IRC does not explicitly include any specifications for a minimum clearance between cement plaster veneer and an underlying horizontal foundation surface (e.g., porch, patio). Still, it is often asserted in forensic investigations that such surfaces should be considered "paved surfaces," thus requiring not less than 2 inches of clearance between the horizontal foundation surface and the veneer.

It should be noted that cement plaster veneer and adhered masonry veneer are similar cladding systems, as both systems maintain the same requirements for underlying moisture management systems, and both require base coats of cement plaster installed with the same accessories (e.g., lath, edge casing accessories, corner accessories, weep screeds, etc.), where applicable. In fact, both cladding systems can be installed identically until the surface finish is applied. While cement plaster veneer is completed with an application of a finish/color coat over the cement plaster base, adhered masonry veneer is finished with an application of brick, stone, or tile adhered to the cement plaster base. The only material difference between cement plaster veneer and adhered masonry veneer is the finished surface.

With respect to residential structures governed by the IRC, required clearances between adhered masonry veneer and underlying horizontal surfaces are addressed in Section R703.12.1 of the 2024 IRC[1]:

> ***R703.12.1 Clearances***
>
> *On exterior stud walls, adhered masonry veneer shall be installed with one of the following:*
>
> *Not less than 4 inches (102 mm) above the earth.*
>
> *Not less than 2 inches (51 mm) above paved areas.*
>
> *Not less than ½ inch (12.7 mm) above exterior walking surfaces that are supported by the same foundation that supports the exterior wall.*

Section R703.12.1 of the 2024 IRC specifies that adhered masonry veneer shall be installed a minimum of 4 inches above the earth and a minimum of 2 inches above paved areas — similar to the aforementioned prescriptive specifications for cement plaster veneer. However, unlike the prescriptive specifications for cement plaster veneer, Section R703.12.1 of the 2024 IRC also explicitly specifies that adhered masonry veneer shall be installed a minimum of ½ of an inch above exterior walking surfaces that are supported by the same foundation as the exterior wall (e.g., porch, patio), as illustrated in **Figure 5**.

The 2024 IRC permits the installation of adhered masonry veneer within a distance of ½ of an inch above a monolithic porch/patio surface, apparently acknowledging that ½ of an inch of clearance at such locations is sufficient to provide adequate drainage for a cladding system comprised of cement plaster (adhered masonry veneer and/or stucco). The intent of specifications associated with

Figure 5
Adhered masonry veneer installed with not less than ½ of an inch of clearance to the foundation.

clearances between cement plaster veneer and underlying horizontal surfaces is to ensure that the moisture management system can evacuate water at the base of the wall and protect the veneer/wall assembly from contact with surficial water and/or ground movement.

In the event that cement plaster veneer is installed with a clearance of less than 2 inches to an underlying monolithic foundation surface (e.g., porch, patio), the as-built condition should be further evaluated to determine whether the as-built condition is capable of performing the intended function. If the cement plaster veneer is installed with sufficient clearance to provide adequate drainage for the moisture management system and protect the veneer/wall assembly from contact by surficial water and/or ground movement (½ of an inch is considered sufficient for similar cladding systems), and the veneer does not exhibit any salient signs of excessive cracking and/or staining associated with an accumulation of water behind the veneer (with no reason to suspect that such distress may manifest in the future), the investigator would be justified in concluding that the as-built clearance of the cement plaster veneer is "satisfactory" and "complies with the intent" of the provisions of the IRC. Therefore, the construction variance is not a construction deficiency.

On the contrary, if the cement plaster veneer is installed with less than ½ of an inch of clearance and/or the veneer exhibits signs of distress consistent with an accumulation of water behind the veneer (or such distress is likely to manifest in the future under typical usage conditions), the investigator would be justified in concluding that the as-built clearance of the cement plaster veneer is not capable of performing its intended function. Therefore, the construction variance is a deficiency. Other factors, such as roof cover, weather exposure, and grading/drainage conditions, may also be considered in the evaluation of this construction variance.

Attachment of Cement Plaster Veneer

Section R703.7.1 of the 2024 IRC and Section 7.10.2.2 of ASTM C1063-21 state the following regarding the attachment of metal lath for cement plaster veneer (similar verbiage is also presented in all preceding versions of the IRC and ASTM C1063)[1,3]:

2024 IRC

R703.7.1 Lath

Lath and lath attachments shall be of corrosion-resistant materials in accordance with ASTM C1063. Expanded metal, welded wire, or woven wire lath shall be attached to wood framing members or furring... The lath shall be attached with 1½-inch-long (38 mm), 0.120-inch-diameter (3mm), 11 gage nails having a 7/16-inch (11.1 mm) head, or $^{7}/_{8}$-inch-long (22.2 mm), 16 gage staples, spaced not more than 7 inches (178 mm) on center along framing members or furring and not more than 24 inches (610 mm) on center between framing members or furring, or as otherwise approved. Additional fastening between wood framing members shall not be prohibited…

ASTM C 1063-21

7.3.3.1 Diamond-mesh expanded metal lath, flat-rib expanded metal lath, and wire lath shall be attached to… vertical wood framing members with 6d common nails… or 1-in. (25 mm) wire staples driven flush with the plaster base. Staples shall engage not less than three strands of diamond mesh and flat rib expanded metal lath or not less than two strands of wire lath and penetrate the wood framing not less than ¾ in. (19 mm). When metal lath is installed over sheathing, use fasteners that will penetrate the framing members not less than ¾ in. (19 mm).

It should be noted that Section 7.3.3.1 of ASTM C1063-21 is not directly aligned with Section R703.7.1

of the 2024 IRC with respect to lath fasteners. Section 7.3.3.1 of ASTM C1063-21 specifies that lath fasteners shall penetrate wood framing members not less than 3/4 of an inch; however, Section R703.7.1 of the 2024 IRC only prescribes that fasteners align with wood framing members (or furring); it does not specify a minimum penetration depth into the wood framing members[1,3].

In fact, the 2024 IRC prescribes the use of $^{7}/_{8}$-inch-long staples to attach the lath, which is not consistent with the penetration depth suggested by Section 7.3.3.1 of ASTM C1063-21 when lath is applied over exterior sheathing materials. According to Section R102.4.1 of the 2024 IRC, where conflicts occur between the provisions of the IRC and referenced standards, the provisions of the IRC shall apply[1]. As a result, it is debatable whether the specifications of ASTM C1063-21 even apply to metal lath fasteners because the IRC provides its own specifications for lath attachment that take precedence over those provided elsewhere. The installation of metal lath utilizing fasteners that align with wood framing members (wall studs) is illustrated in **Figure 6**.

In some parts of the United States, it is a standard construction practice to attach the metal lath directly to wood structural sheathing panels, such as plywood or oriented strand board (OSB), with staples spaced at approximately 6 to 7 inches on center each way without any regard for the alignment of fasteners with underlying wood framing members (wall studs) as illustrated in **Figure 6**. Without any analysis, the aforementioned practice is often asserted to be a construction deficiency by some simply because the placement of fasteners does not strictly comply with the exact prescriptive specifications of the IRC; however, it should be noted that Section R703.7.1 of the 2024 IRC also provides an option to attach the metal lath "as otherwise approved"[1].

In consideration of metal lath installed over an exterior wall sheathed with $^{7}/_{16}$-inch-thick OSB panels, a staple fastener $^{7}/_{8}$ of an inch in length would penetrate the full depth of the sheathing panel regardless of whether the staples were aligned with framing members. According to the International Staple, Nail and Tool Association (ISANTA), the withdrawal capacity of a staple fastener in a wood substrate is a function of the staple leg diameter, the staple leg penetration depth, and the specific gravity of the wood substrate[11]. According to the National Design Specification (NDS) for Wood Construction, the specific gravity of Spruce-Pine-Fir is 0.42 (a common lumber species for wall studs in the authors' part of the country)[12]. According to the NDS, the specific gravity of OSB sheathing is 0.50[12]. Assuming the same staple gauge (leg diameter) for both substrates, a nominal increase in the specified quantity of staples would be required to penetrate $^{7}/_{16}$ of an inch into OSB sheathing with a specific gravity of 0.50 in order to yield an equivalent withdrawal capacity as the minimum quantity of staples specified in Section 7.3.3.1 of ASTM C1063-21 (¾ of an inch of penetration into a wall stud with a specific gravity of 0.42).

Assuming the presence of additional fasteners to transfer forces from the OSB sheathing to the wall studs, an equivalent withdrawal capacity that meets the intent of ASTM C1063 can be achieved by utilizing a nominal increase in the minimum quantity of specified fasteners when installed through $^{7}/_{16}$-inch thick OSB sheathing by itself. In addition, installing $^{7}/_{8}$-inch staples at approximately

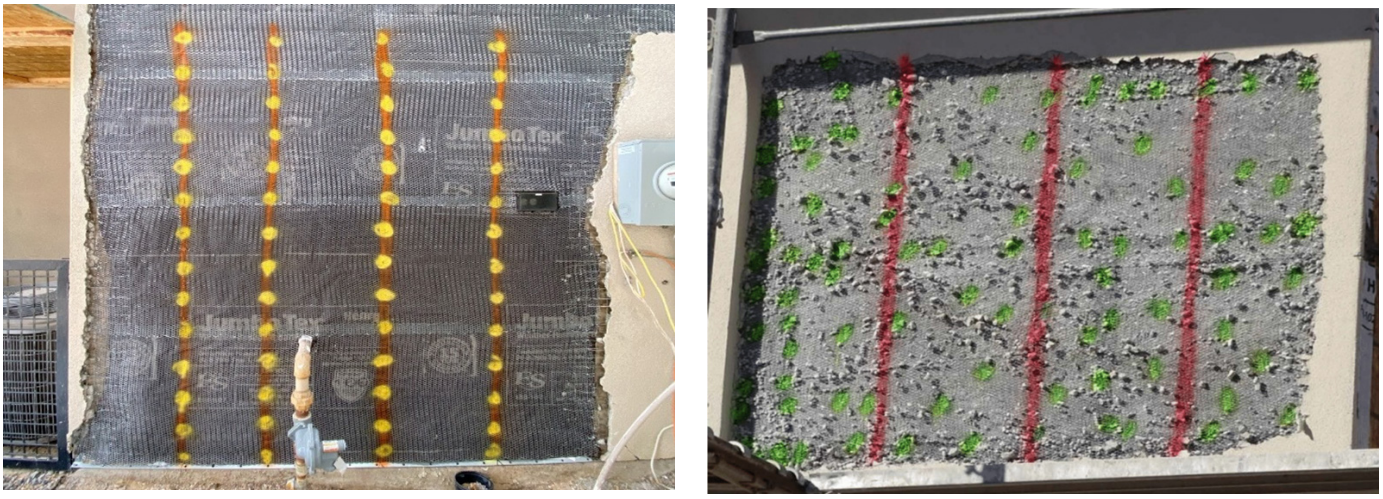

Figure 6
Installation of lath fasteners with (left) and without (right) regard to alignment with underlying framing members.

6 to 7 inches on center each way would provide more than three times the total quantity specified in Section 7.3.3.1 of ASTM C1063-21 when exterior wall studs are spaced at 16 inches on center. As a result, metal lath installed with staple fasteners spaced at approximately 6 to 7 inches on center each way would actually exhibit a higher withdrawal capacity than metal lath installed in compliance with ASTM C1063-21. Although the installation of metal lath with staples spaced at 6 to 7 inches on center each way requires the use of more fasteners, it should be noted that Section R703.7.1 of the 2024 IRC explicitly states that additional fastening between wood framing members shall not be prohibited.

In a white paper titled "Questioning the Stucco Lath Fastening Requirements of ASTM C1063," which was published in the *Journal of Architectural Engineering* (March 2010), Brett D. Newkirk, P.E. of Alta Engineering The company reached a similar conclusion regarding the attachment of cement plaster veneer to an underlying wood substrate[14]:

> *In fact, the analysis shows that when consideration is given to the greater frequency of fasteners naturally occurring through implementation of the hand rule, the attachment to the sheathing alone is superior to the attachment to the framing members alone.*

The intent of specifications associated with the attachment of metal lath in cement plaster veneer is to ensure that the cement plaster veneer is adequately attached to the structure for safety and durability. As previously discussed, it is possible to attach metal lath to a wood structural sheathing panel in a manner that provides an equivalent (or greater) withdrawal capacity than the prescriptive specifications of 2024 IRC without meeting the exact prescriptive specifications of the 2024 IRC (i.e., without aligning the fasteners with framing members).

In the event that metal lath for cement plaster veneer is attached to the substrate in a manner that does not meet the exact prescriptive specifications of the building code, the as-built condition should be further evaluated to determine whether the as-built condition is capable of performing the intended function. If the metal lath is attached to the substrate in a manner to provide a withdrawal capacity equivalent to (or better than) the withdrawal capacity provided by the prescriptive specifications of the IRC, and there are no salient signs of excessive cracking, out-of-plane cracking, and/or detachment from the substrate (with no reason to suspect that such distress may manifest in the future), the investigator would be justified in concluding that the as-built attachment of the cement plaster veneer is "satisfactory" and "complies with the intent" of the provisions of the IRC. Therefore, the construction variance is not a construction deficiency. On the contrary, if the metal lath is attached to the substrate in a manner that yields associated distress in the veneer (or such distress is likely to manifest in the future under typical usage conditions), the investigator would be justified in concluding that the as-built attachment of the cement plaster veneer is not capable of performing its intended function. Therefore, the construction variance is a deficiency.

Sheathing Gap Behind Cement Plaster Veneer

Section 6.1.4 of ASTM C1063-21 states the following regarding the installation of structural sheathing panels underlying cement plaster veneer with respect to the potential for future expansion of the panels[3]:

> ***ASTM C 1063-21***
>
> *6.1.4 Plywood and oriented strand board sheathing panels shall be installed with $^1/_8$ in. (3 mm) minimum panel edge gaps, and panel edges shall be offset 4 in. (10 cm) minimum from wall opening reentrant corners…*
>
> *NOTE 2 – This $^1/_8$-in. (3 mm) gap is intended to accommodate expansion. Linear expansion that is not accommodated by an expansion gap can cause stress on the stucco membrane resulting in stucco cracks.*

Plywood and oriented strand board (OSB) are wood structural panels that will expand and contract slightly with variations in moisture content. If the wood structural panels are tightly butted during installation, there is no room available to accommodate subsequent panel expansion. Any subsequent expansion of a tightly butted panel will yield an internal compressive stress within the panel, which may result in the panel bowing or buckling between supports in an attempt to relieve the stress.

As stated in Note 2 of Section 6.1.4 of ASTM C1063-21, the $^1/_8$-inch separation between adjoining sheathing panels is intended to accommodate potential expansion of the panels without bowing or buckling. APA - The Engineered Wood Association (APA) provides a similar recommendation to implement a $^1/_8$-inch spacing between panel ends and edges during the installation of wall, floor, and

roof sheathing panels; however, the APA's recommendation is accompanied by the following note [bold emphasis provided by the authors of this paper][14]:

> *Panel spacing is an **APA RECOMMENDATION**, to provide installers with a means of minimizing the potential for panel buckling; however, it is not a requirement… Panel buckling may be an aesthetic or serviceability issue but is not a structural deficiency. **There is no reason to expect this recommended space to be maintained when the panel becomes acclimated.** Gaps that were initially present may have closed due to normal moisture-related expansion…*

During a post-construction forensic evaluation, an investigator should understand that the referenced 1/8-inch spacing between adjacent sheathing panels applies to the installation of sheathing at the time of original construction, and it is not intended to be utilized as a standard for the evaluation of the sheathing years following construction of the structure. As acknowledged by the APA, there is no reason to expect the recommended space to be maintained when the panel becomes acclimated, and gaps that were initially present may have closed due to normal moisture-related expansion.

A forensic investigation should consider the spacing between sheathing panels, in conjunction with the location and magnitude of distress, to determine if the observed distress is systematic and causally related to the joints between sheathing panels.

In the event that a post-construction investigation of cement plaster veneer uncovers joints between underlying wood structural sheathing panels that are less than $^1/_8$ of an inch in width, the observed condition should be further evaluated to determine whether the as-built spacing of sheathing panels actually caused and/or contributed to distress in the veneer. If the spacing of sheathing panels is less than $^1/_8$ of an inch — yet the cement plaster veneer does not exhibit any salient signs of systematic cracking corresponding with the joints of sheathing panels — the investigator would be justified in concluding that the as-built spacing of sheathing panels was originally adequate to accommodate expansion/contraction of the panels. This is because there is no reason to expect an original as-built spacing to be maintained once the panel becomes acclimated, and the current condition is not a construction deficiency. On the contrary, if the spacing of sheathing panels is less than $^1/_8$ of an inch, and the cement plaster veneer exhibits signs of systematic distress corresponding with the joints of panels, the investigator would be justified in concluding that the as-built joint spacing between sheathing panels is causally related to the observed distress. Therefore, the current condition is a deficiency.

Repairs to Cement Plaster Veneer

ASTM C926-21 states the following regarding the installation of cement plaster veneer[2]:

> ***ASTM C926-21***
>
> *7.3.5 Each plaster coat shall be applied to an entire wall or ceiling panel without interruption to avoid cold joints and abrupt changes in the uniform appearance of succeeding coats. Wet plaster shall abut set plaster at naturally occurring interruptions in the plane of the plaster, such as corner angles, rustications, openings, expansion joints, and control joints where this is possible. Joinings, where necessary, shall be cut square and straight and not less than 6 in. (152 mm) away from a joining in the preceding coat.*

The following specification/definition is applicable to Section 7.3.5 of ASTM C926-21[2]:

> ***ASTM C926-21***
>
> *3.2.12 cold joint ("joining" or "jointing"), n – the juncture of fresh plaster application adjacent to set plaster, in the same plane.*

Following a forensic investigation, an investigator may recommend repairs and/or removal/replacement of portions of the cement plaster veneer. The authors of this paper have encountered some investigators who claim that localized repairs to cement plaster veneer is "not allowed," and they claim it is a "requirement" for the cement plaster veneer to be replaced in full panels (i.e., between control joints, from a corner to a control joint, from edge to edge of a continuous panel, etc.). When considering remedial recommendations, the investigator should be aware that ASTM C926 is a code-referenced standard for applying new cement plaster veneer, and it does not explicitly address repairs to existing cement plaster veneer. Nevertheless, ASTM C926 acknowledges "joinings" or "cold joints" in the same plane as the veneer, and it provides specifications for implementing "joinings" where necessary.

The Portland Cement Plaster/Stucco Manual by the Portland Cement Association (PCA) provides the following guidance for performing repairs to existing cement plaster veneer[15]:

> *Apply patching materials in thin consecutive layers, troweling each layer until firm, and continue applying thin layers until the base-coat plaster has been replaced (Figure 27). The finish-coat plaster then can be applied and textured to match the surrounding plaster.*

Figure 27 from the aforementioned document is shown as **Figure 7**, which depicts the recommended preparation of existing cement plaster veneer to receive a new patch[15].

Based upon the preceding, in conjunction with the authors' experience in the design, construction, and forensic investigation of cement plaster veneer construction, it has been found that patching cement plaster veneer is an accepted industry practice, and replacement of entire panels from corner-to-corner is not typically warranted for localized repairs. Although it is not a "requirement" for cement plaster veneer to be repaired/replaced in full panels, it may be necessary to do so in some climate zones to avoid hairline cracks between the original cement plaster and the newer cement plaster due to differential expansion/contraction associated with freeze-thaw cycles. As a result, the investigator should consider the geographic location of a project when determining an appropriate scope of remediation.

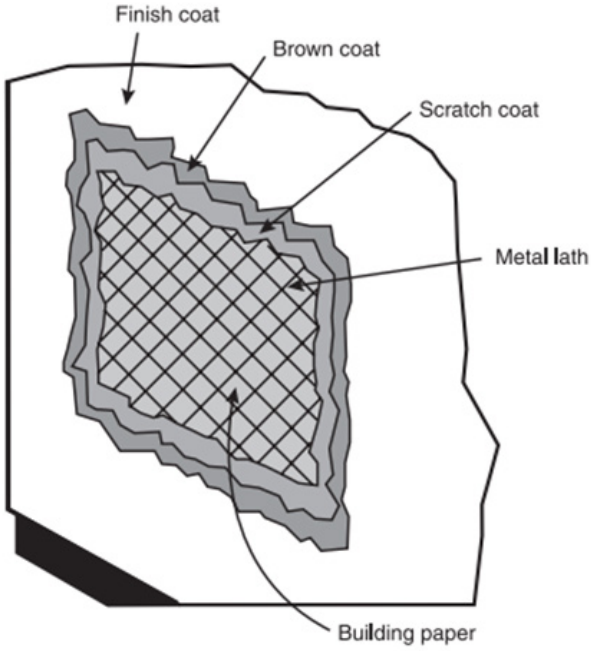

Figure 27. When patching plaster, each succeeding coat is cut back farther than the preceding coat, the base coat being the smallest area and the finish coat being the largest area to be patched.

Figure 7
Figure 27 from the Portland Cement Plaster/Stucco Manual by the PCA[15].

Summary and Conclusions

Cement plaster veneer is regularly installed with alternatives or variances with respect to the prescriptive specifications of the applicable building code and/or applicable code-referenced standards. A forensic evaluation should consider the intent and purpose of a specific construction specification, in conjunction with the as-built construction and resultant conditions, to provide a thorough evaluation for determination of whether an alternative or variance constitutes a construction deficiency. Depending upon the evaluation results, a reasonable and economical scope of remedial measures should be proposed to address alternatives and variances that are determined to be unable to perform their intended function.

As demonstrated by various aspects of cement plaster veneer construction, a construction alternative or variance requires a thorough forensic investigation to determine whether it constitutes a construction deficiency. An investigator should consider the as-built condition, the presence of distress, and the likelihood for distress to manifest in the future prior to opining whether remediation is necessary.

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