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Beyond the Building Code: A Forensic Approach to Construction Defect Evaluation Utilizing the Construction Variance Evaluation Methodology

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Abstract

The applicable building code provides prescriptive specifications that allow construction of the built environment without the need for design professionals to dictate every aspect of every project; however, the building code does not consider all available materials, designs, and/or methods of construction — nor does it 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 prescriptive specification (i.e., the desired performance) in order to determine whether an as-built construction variance is capable of accomplishing the same without adversely affecting a structure. This paper will explore the installation of cement plaster veneer and manufactured window assemblies to demonstrate how construction variances can still meet the intent and purpose of applicable prescriptive specifications. As a result, a true forensic approach to construction defect evaluation should not blindly follow prescriptive specifications. Instead, it should employ engineering analysis and a practical method such as the construction variance evaluation methodology (CVEM) to consider the performance aspects of construction variances before concluding that such variances are construction defects.

Keywords

Alternative, analysis, building code, construction, defect, deficiency, evaluation, forensic engineering, intent, investigation, methodology, performance, prescriptive, purpose, specification, variances

Introduction

A true forensic approach to construction defect evaluation should consider the intent and purpose of a prescriptive specification in order to determine whether an as-built construction variance is capable of accomplishing the same without adversely affecting a structure. The applicable building code provides prescriptive specifications to aid the construction of the built environment without the need for design professionals to dictate every aspect of every project; however, the building code does not consider all available materials, designs, and/or methods of construction. These limitations are addressed in Chapter 1 of the International Building Code (IBC) and the International Residential Code (IRC).

According to the Introduction in the Preface of the 2021 IBC[1]:

> *The International Building Code® (IBC®) establishes minimum requirements for building systems using prescriptive and performance-related provisions.*

Similarly, according to the Introduction in the Preface of the 2021 IRC[2]:

> *The International Residential Code® (IRC®) establishes minimum requirements for one- and two-family dwellings and townhouses using prescriptive provisions.*

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The aforementioned ideology is also presented in similar verbiage in all preceding versions of the IBC and IRC.

According to the Merriam-Webster Dictionary, the word "prescriptive" is an adjective that means acquired by, founded on, or determined by prescription or by long-standing custom. Therefore, the building codes can be regarded as adopted manuals of prescribed construction specifications that have a history of successful performance (i.e., based on long-standing custom). Consequently, alternative materials, designs, and construction techniques may be used in practice that can accomplish the general intent and purpose of the building codes without meeting their exact prescriptive specifications.

According to Section 101.3 of the 2021 IBC[1]:

> ***101.3 Purpose.*** *The purpose of this code is to establish the minimum requirements to provide a reasonable level of safety, health and general welfare through structural strength, means of egress, stability, sanitation, light and ventilation, energy conservation, and for providing a reasonable level of life safety and property protection from the hazards of fire, explosion or dangerous conditions, and to provide a reasonable level of safety to fire fighters and emergency responders during emergency operations.*

Similarly, according to Section R101.3 of the 2021 IRC[2]:

> ***101.3 Purpose.*** *The purpose of this code is to establish the minimum requirements to provide a reasonable level of safety, health and general welfare through affordability, structural strength, means of egress, stability, sanitation, light and ventilation, energy conservation and safety to life and property from and other hazards and to provide a reasonable level of safety to fire fighters and emergency responders during emergency operations.*

According to Section 104.11 of the 2021 IBC (similar verbiage is also presented in all preceding versions of the IBC)[1]:

> ***104.11 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. An alternative material, design or method of construction shall be approved where the building official finds that the proposed alternative meets all of the following:*
>
> *1. The alternative material, design or method of construction is satisfactory and complies with the intent of the provisions of this code,*
>
> *2. The material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code as it pertains to the following:*
>
> *2.1. Quality*
> *2.2. Strength*
> *2.3. Effectiveness*
> *2.4. Fire resistance*
> *2.5. Durability*
> *2.6. Safety*

Similarly, according to Section R104.11 of the 2021 IRC[2] (similar verbiage is also presented in all preceding versions of the IRC):

> ***R104.11 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. The building official shall have the authority to approve an alternative material, design or method of construction upon application of the owner or the owner's authorized agent. The building official shall first find that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety…*

Based upon the preceding, the building codes acknowledge their prescriptive limitations, and, as such, they permit the use of alternative materials, designs, and construction techniques when an alternative is deemed to be "satisfactory" and "complies with the intent" of the provisions of the codes, and the alternative can also provide a "reasonable level" of safety, health, and general welfare.

The building codes are intended to cover conventional and common construction practices by employing recipe-style measures like a cookbook (i.e., using prescribed amounts of prescribed ingredients and baking them in a prescribed manner for a prescribed amount of time will yield a standard food product). Continuing with the cookbook analogy, a construction variance from a prescriptive specification may be akin to baking a chocolate chip cookie with marginally less sugar, a substitution of whole wheat flour in lieu of white flour, or excluding a portion of one chocolate chip. In the end, the baker still achieves the desired result of a chocolate chip cookie that still has all the essential ingredients, qualities, and functions of a standard chocolate chip cookie. On the contrary, a more-significant construction variance may be akin to baking a chocolate chip cookie with a substantial reduction in the amount of sugar or the omission of chocolate chips, which would yield a product that does not conform to a standard chocolate chip cookie.

The prescriptive provisions of the building codes provide a means to the end, assuring a minimum level of performance, and the prescriptions, themselves, are not the end, nor are they the only means to the end. As a result, the building codes affirm that materials, designs, and methods of construction may deviate from the prescriptive specifications of the building codes under certain circumstances when an alternative is “satisfactory” and can accomplish the general intent and purpose of the building codes. Regardless of the building official’s involvement during the original construction of a project, the building codes contemplate the use of alternative materials, designs, and construction methods. Therefore, the same potential alternatives should be contemplated during the post-construction forensic investigation of code variances.

Post-construction forensic evaluations that are based solely upon an exacting compliance with prescriptive building code specifications can be viewed as being myopic if such evaluations do not consider the capacity of a product, element, component, or system to perform its intended function in its as-built state. As affirmed by the building codes, alternative materials, designs, and construction methods may be used in practice to accomplish the general intent and purpose of the building codes without meeting their exact prescriptive specifications. As a result, meeting prescriptive code specifications after the fact is mostly academic. Since it is the intent of the building codes to prescribe specifications that yield a standard level of acceptable performance, the actual performance of the construction variance should generally govern its evaluation.

Construction Variance Evaluation Methodology

Over the years and through the forensic investigation of thousands of structures, the authors developed the Construction Variance Evaluation Methodology (CVEM), which is illustrated in **Figure 1**, as a practical and objective method for the forensic evaluation of construction variances to determine whether or not a variance is “satisfactory” and “complies with the intent” of the provisions of the codes.

As illustrated in **Figure 1**, the CVEM is not solely based upon compliance with prescriptive specifications or failure/damage; rather, it adopts the ideology of a respected engineering pioneer, T.Y. Lin, who stated “…engineers who, rather than blindly following the codes of practice, seek to apply the laws of nature,” and it implements engineering judgement to determine whether a component or system that exhibits a construction variance is capable of performing its intended function in conjunction with the manifestation of distress (or the likelihood for the manifestation of distress in the future)[3]. When evaluating a construction variance with respect to the potential for distress to manifest in the future, one should consider the passage of time as well as any expected future catalyst (e.g., wind event, rainfall event, etc.) to determine the future ability of a component or system to perform its intended function. Through extensive forensic investigative experience, the CVEM, by applying the laws of nature and utilizing engineering judgement, has been well established as a practical and objective method for evaluating construction variances. The CVEM also provides an alternative to blindly following codes of practice — a method that may be perceived as a myopic approach used to achieve a predetermined outcome.

In a peer reviewed paper titled “Misapplication of Pressure Vessel Codes in Forensic Applications,” which was published in the *Journal of the National Academy of Forensic Engineers* (December 2020), Bart Kemper, P.E. stated the following regarding code compliance[4]:

> *…Directly analyzing a structure with respect to a code assesses “code compliance” …being “out of code compliance” does not necessarily indicate failure nor predict the failure mode.*

In addition, in a paper titled “An Expert Guide to Identifying Construction Defects,” which was published in the *International Institute of Building Enclosure Consultants Interface* (July 2016), Derek Hodgin, P.E. stated the following regarding as-built conditions[5]:

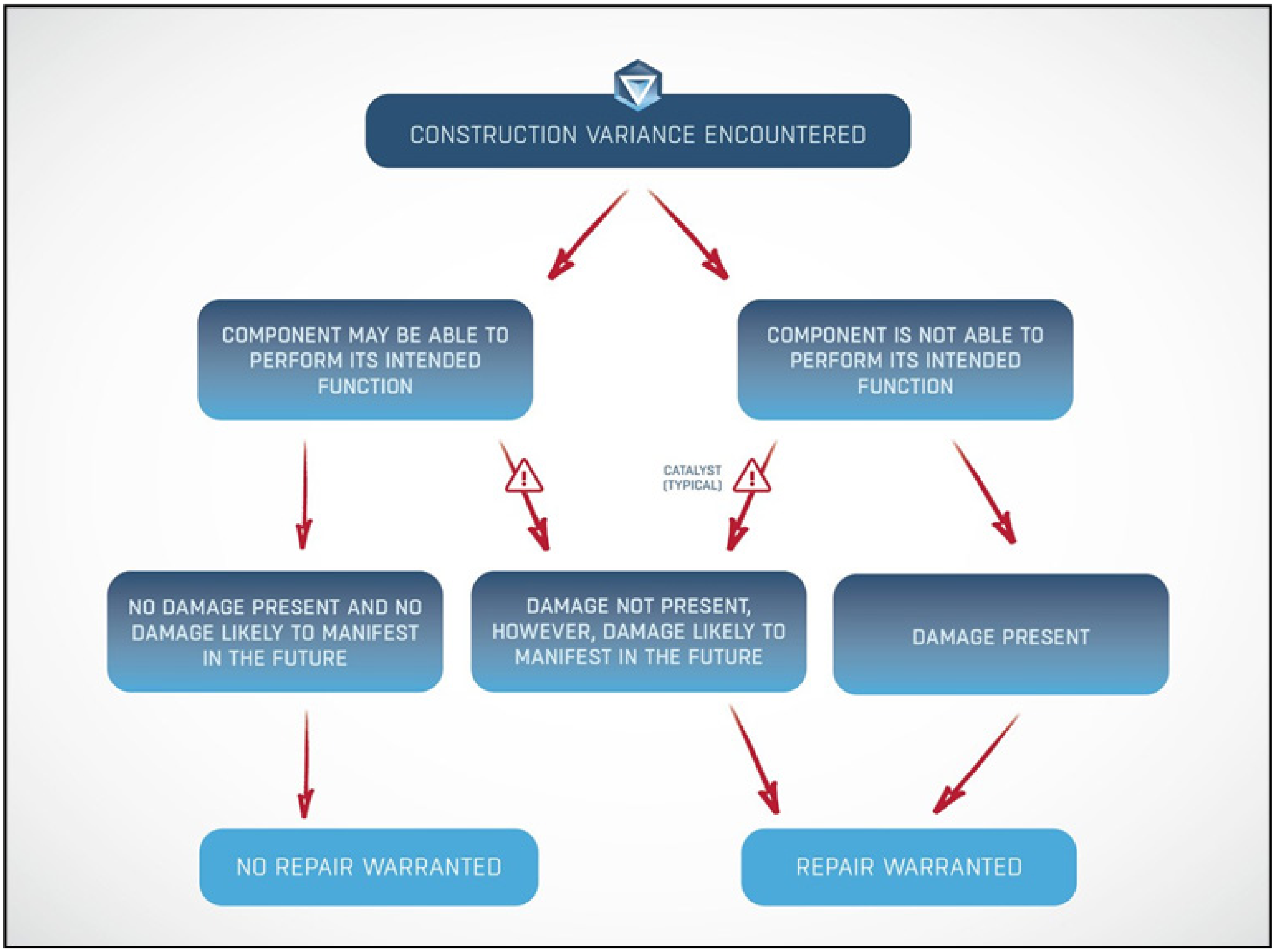

Figure 1
Construction Variance Evaluation Methodology (CVEM).

> *…The analysis of an as-built condition should be based on function, not technical deviations from specific requirements with no margin for error.*

The aforementioned ideologies expressed by Kemper and Hodgin support the forensic evaluation illustrated by the CVEM.

As examples of the application of the CVEM, this paper will explore the installation of cement plaster veneer and manufactured window assemblies to demonstrate how construction variances may or may not meet the general intent and purpose of building code and/or code-referenced standard specifications when the exact prescriptive specifications are not met.

A "deficiency" is a condition absent of something necessary for completeness or perfection, and a "defect" is a condition of an imperfection or abnormality that impairs quality, function, or utility; however, the two terms are often used synonymously. For the purpose of this paper, the authors do not make any intentional distinction between the use of "deficiency" and "defect."

Strength of Lath Attachment for Cement Plaster (Stucco) Veneer

With respect to residential structures governed by the IRC, the attachment of metal lath for cement plaster (stucco) veneer is addressed in Section R703.7.1 of the 2021 IRC as well as Section 7.10.2.2 of ASTM C 1063[2,6]:

> ***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), 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 1063-18b (version referenced in Chapter 44 of the 2021 IRC) *7.10.2.2 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).*

Similar verbiage is also presented in all preceding versions of the IRC and ASTM C 1063.

It should be noted that Section 7.10.2.2 of ASTM C 1063-18b conflicts with Section R703.7.1 of the 2021 IRC with respect to lath fasteners[2,6]. Section 7.10.2.2 of ASTM C 1063-18b specifies that lath fasteners shall penetrate wood framing members not less than ¾ of an inch; however, Section R703.7.1 of the 2021 IRC only prescribes for fasteners to align with wood framing members (or furring), but it does not specify a minimum penetration depth into the wood framing members[2,6]. In fact, the 2021 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 7.10.2.2 of ASTM C 1063-18b when lath is applied over exterior sheathing materials[6]. According to Section R102.4.1 of the 2021 IRC, where conflicts occur between the provisions of the IRC and referenced standards, the provisions of the IRC shall apply[2]. As a result, it is debatable whether or not the specifications of ASTM C 1063-18b 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 2**.

In some parts of the United States, it is a common 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 inches on center each way without any regard for the alignment of fasteners with underlying wood framing members (wall studs) as illustrated in **Figure 3**. 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 2021 IRC also provides an option to attach the metal lath "as otherwise approved"[2].

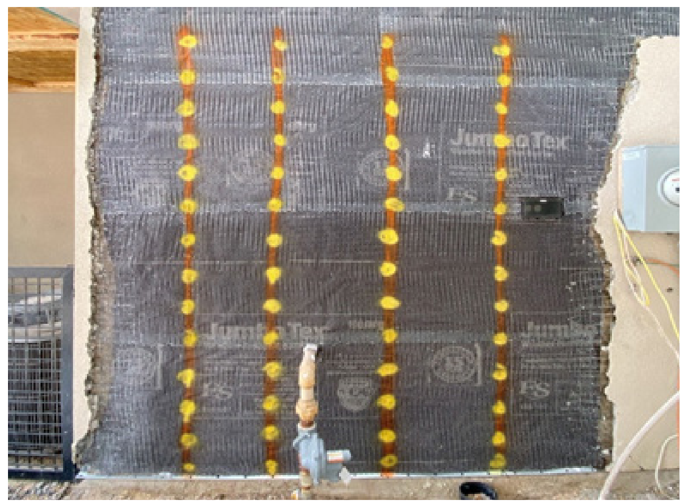

Figure 2
Installation of lath fasteners (yellow dots) aligned with underlying framing members (vertical red lines).

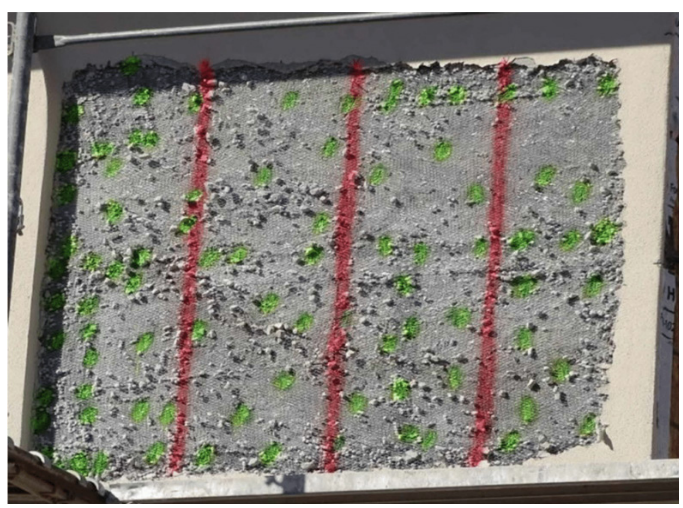

Figure 3
Installation of lath fasteners (green dots) without regard to alignment with underlying framing members (vertical red lines).

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 or not 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[7]. 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)[8]. According to the NDS, the specific gravity of OSB sheathing is generally 0.50[8]. Assuming the same staple gauge (leg diameter) for both substrates, an approximate 45 percent 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 7.10.2.2 of ASTM C 1063-18b (¾ of an inch of penetration into a wall stud with a specific gravity of 0.42)[6].

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 C 1063 can be achieved by utilizing an approximate 45 percent increase in the minimum quantity of specified fasteners when installed through $^{7}/_{16}$-inch-thick OSB sheathing by itself. In addition, the installation of $^{7}/_{8}$-inch-long staples at a spacing of approximately 6 inches on center each way would provide in excess of three times the total quantity of staples specified by Section 7.10.2.2 of ASTM C 1063-18b when exterior wall studs are spaced at 16 inches on center[6]. As a result, metal lath installed with staple fasteners spaced at approximately 6 inches on center each way would actually exhibit a higher withdrawal capacity than metal lath installed in strict compliance with ASTM C 1063-18b[6]. Although the installation of metal lath with staples spaced at 6 inches on center each way requires the use of more fasteners, it should be noted that Section R703.7.1 of the 2021 IRC explicitly states that additional fastening between wood framing members shall not be prohibited[2].

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 Company reached a similar conclusion regarding the attachment of cement plaster veneer to an underlying wood substrate[9]:

> *The stucco clinging to the OSB sheathed walls of most residential and low rise commercial buildings is probably not going to fail due to non-ASTM compliant fastening. 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 rationale for the current ASTM C1063 requirement appears to be an antiquated stipulation that does not acknowledge the significant holding capacity of the structural sheathing used in many buildings today.*

When staples in metal lath are not aligned with framing members, some investigators may assert that the as-built condition is a construction deficiency without any further analysis simply because the observed condition does not meet the exact prescriptive specifications of the building codes; however, as affirmed by the building codes, alternative materials, designs, and construction methods may be used in practice to accomplish the general intent and purpose of the building codes without meeting their exact prescriptive specifications. Accordingly, the CVEM serves as a practical and objective method for the forensic evaluation of construction variances to determine whether or not a variance is "satisfactory" and "complies with the intent" of the provisions of the codes.

In implementing the CVEM, one should first determine the intent of the applicable building code specifications to determine whether or not the construction variance in question is capable of performing its intended function in its as-built state. 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 2021 IRC without meeting the exact prescriptive specifications of the 2021 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 codes, 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 construction deficiency.

Installation of Flanged Windows to Prevent Moisture Intrusion

With respect to residential structures governed by the IRC, the installation of window assemblies is addressed in Section R609.1 of the 2021 IRC[2]:

> ***R609.1 General.*** *This section prescribes performance and construction requirements for exterior windows and doors installed in walls. Windows and doors shall be installed in accordance with the fenestration manufacturer's written installation instructions. Window and door openings shall be flashed in accordance with Section R703.4. Written installation instructions shall be provided by the fenestration manufacturer for each window or door.*

Similar verbiage is also presented in all preceding versions of the IRC.

Section R609.1 of the 2021 IRC specifies that window assemblies shall be installed in accordance with the manufacturer's written installation instructions[2]. As a result, compliance with the manufacturer's written instructions for the installation of window assemblies and associated flashing components is apparently mandatory to achieve compliance with the 2021 IRC.

Based upon the authors' experience, written instructions for the installation of flanged window assemblies vary by manufacturer. While some window manufacturers may specify a fastener schedule relative to the prefabricated fastener holes in the mounting flanges (i.e., fasteners at every prefabricated fastener hole or fasteners at every other prefabricated fastener hole), some manufacturers specify a fastener schedule based upon a measured spacing (i.e., fasteners at 12 inches on center), which may result in some prefabricated fastener holes in the mounting flanges not being filled.

In addition, some manufacturers specify the application of sealant behind the mounting flanges of the window assembly, while others do not include any such specifications. As a result, an accurate evaluation of window installation cannot typically be performed without consulting the applicable manufacturer's written installation instructions.

The written installation instructions for vinyl window assemblies manufactured by Ply Gem®, a portion of which are provided in **Figure 4**, specify the application of sealant behind the mounting flanges to seal the window assembly to the substrate; however, the written installation instructions for vinyl window assemblies manufactured by Jeld-Wen®, a portion of which are provided in **Figure 5**, do not specify the application of sealant behind the mounting flanges[10,11].

The differences in window installation instructions, with respect to the inclusion/omission of sealant behind the mounting flanges, demonstrates an inconsistency amongst window manufacturers regarding the potential benefit of sealant applied behind the mounting flanges. Due to the fact that the 2021 IRC specifies that window assemblies shall be installed in accordance with the manufacturer's written installation instructions, the 2021 IRC consents to the installation of window assemblies in both manners. According to Section R601.1 of the 2021 IRC, the installation of vinyl window assemblies by Ply Gem® is apparently code-compliant with the application of sealant behind the mounting flanges; however, the installation of vinyl window assemblies by Jeld-Wen® is apparently code-compliant without the application of sealant behind the mounting flanges[2,10,11]. Although the two aforementioned vinyl window assemblies are similar in nature, the determination of whether or not a specific assembly complies with the exact prescriptive specifications of the IRC hinges upon the published manufacturer installation instructions available and provided at the time of construction.

When sealant is not specified to be installed behind the mounting flanges of window assemblies, self-adhering flashing membranes are typically specified to be installed over the mounting flanges of the windows to provide a weather-tight seal between the window and the underlying substrate. Regardless of a manufacturer's specification to include/omit sealant behind the mounting flanges, the authors have found that properly applied self-adhering

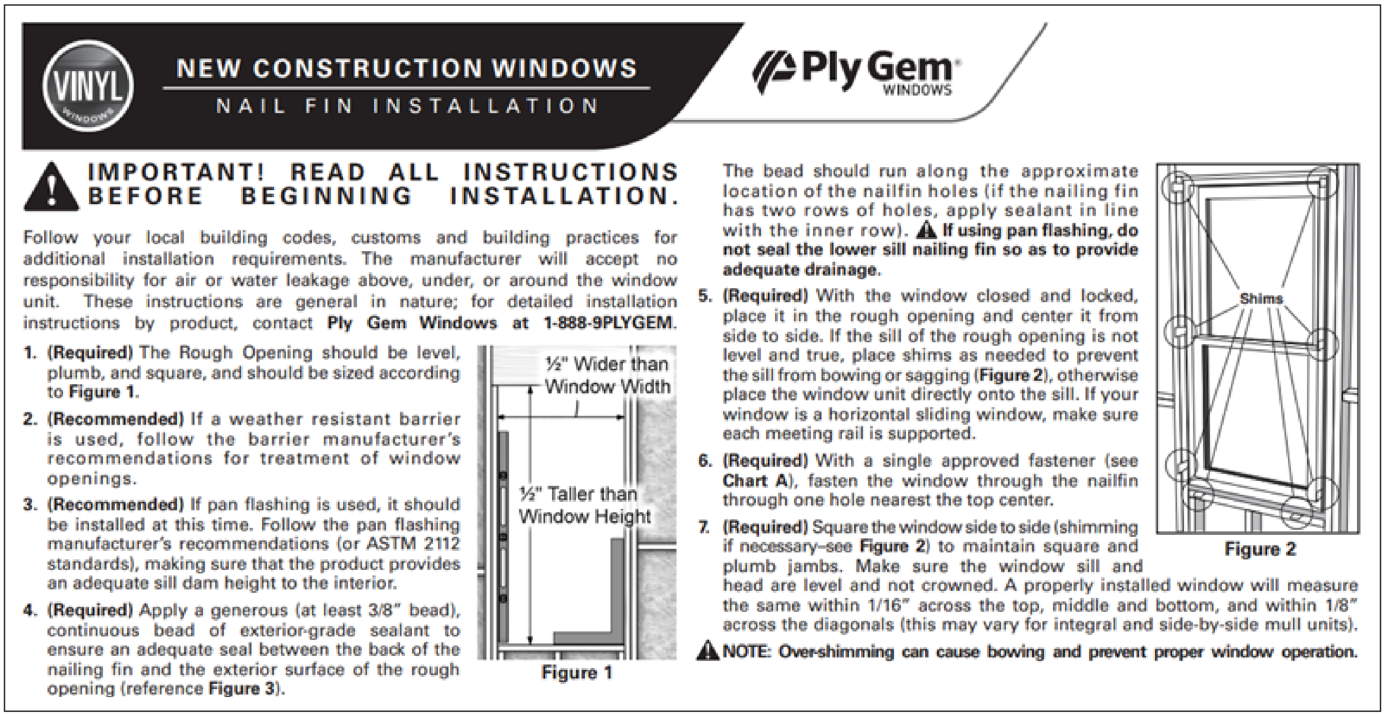

Figure 4
Window installation instructions by Ply Gem®[9].

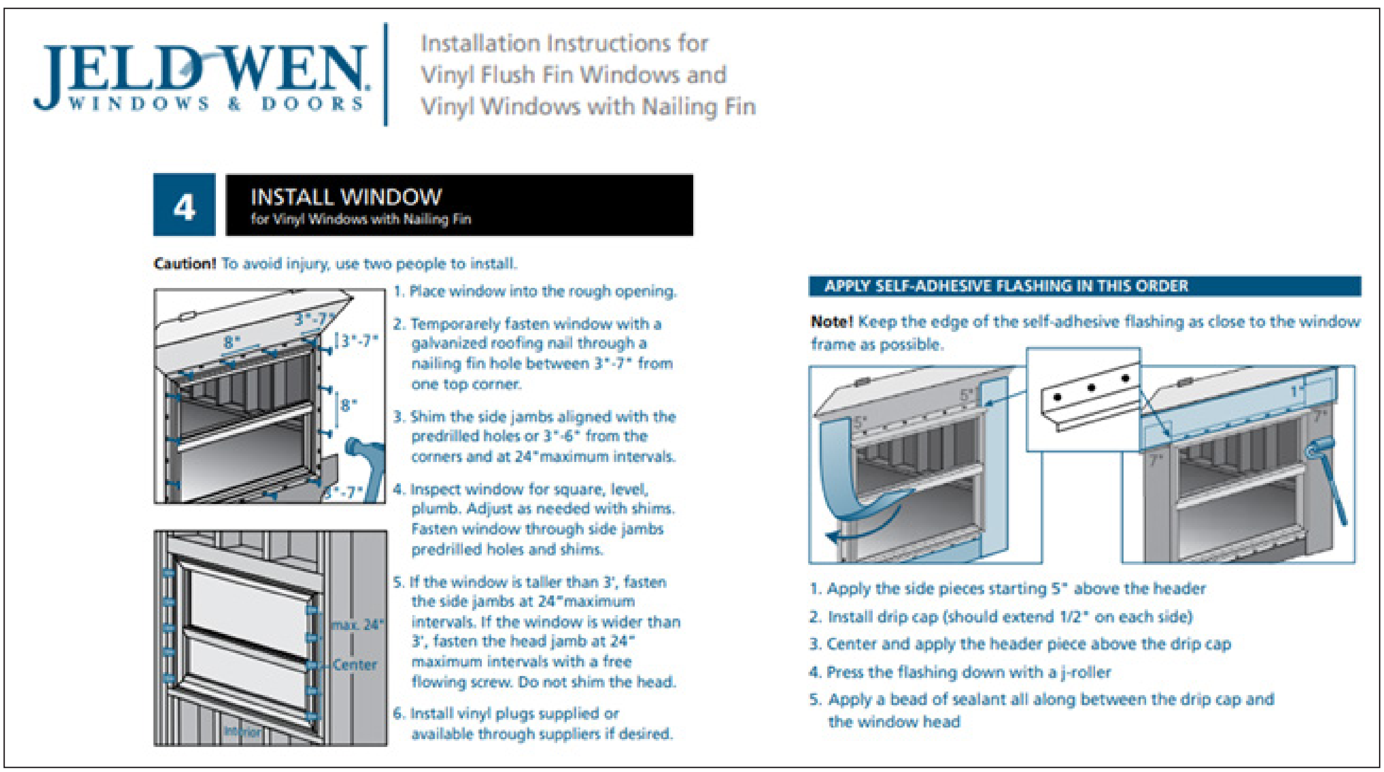

Figure 5
Window installation instructions by Jeld-Wen®[10].

flashing membranes over the mounting flanges would negate the need for sealant behind the mounting flanges.

When window assemblies are installed without an application of sealant behind the mounting flanges, some investigators may assert that the as-built condition is a construction deficiency without any further analysis; however, as affirmed by the building codes, alternative materials, designs, and construction methods may be used in practice to accomplish the general intent and purpose of the building codes without meeting their exact prescriptive specifications. Accordingly, the CVEM serves as a practical and objective method for the forensic evaluation of construction variances to determine whether or not a variance is "satisfactory" and "complies with the intent" of the provisions of the codes.

In implementing the CVEM, one should first determine the intent of the applicable building code specifications to determine whether or not the construction variance in question is capable of performing its intended function in its as-built state. The intent of specifications associated with the installation of window assemblies is to ensure that the assemblies are adequately attached to the structure for safety, durability, and weather-resistance. As previously discussed, the 2021 IRC does not explicitly state whether or not sealant must be applied behind the mounting flanges of window assemblies, and it consents to the installation of window assemblies with and without the application of sealant behind the mounting flanges, depending upon the manufacturer of the window assembly.

In the event that a flanged window assembly by any manufacturer is installed into a rough opening without an application of sealant behind the mounting flanges, the as-built condition should be further evaluated to determine whether the as-built condition is capable of performing the intended function. If the installation of the non-sealed window assembly includes other measures, such as self-adhering flashing membranes, to prevent the passage of air and/or water behind the flanges — and there are no salient signs of water intrusion adjacent to the window assembly (with no reason to suspect that water intrusion may manifest in the future) — the investigator would be justified in concluding that the as-built installation of the window assembly 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 installation of the non-sealed window assembly does not include other measures to prevent the passage of water behind the flanges — and signs of water intrusion are extant and adjacent to the window opening — the investigator would be justified in concluding that the as-built installation of the window assembly is not capable of performing its intended function; therefore, the construction variance is a construction deficiency.

Clearance Below Cement Plaster Veneer for Drainage Provisions

With respect to residential structures governed by the IRC, required clearances between cement plaster (stucco) veneer and underlying horizontal surfaces are addressed in Section R703.7.2.1 of the 2021 IRC[2]:

> ***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 (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…*

Similar verbiage is also presented in all preceding versions of the IRC.

Section R703.7.2.1 of the 2021 IRC specifies that weep screeds along the bottom edges of cement plaster (stucco) veneer shall be placed not less than 4 inches above the earth or 2 inches above paved areas[2]. The 2021 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), but 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 (stucco) veneer and adhered masonry veneer are similar cladding systems as both systems maintain the same requirements for underlying moisture management systems, and both systems require base coats of cement plaster installed with the same plaster 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 application of the surface finish. While cement plaster (stucco) 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 (stucco) 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 2021 IRC[2]:

> ***R703.12.1 Clearances.*** *On exterior stud walls, adhered masonry veneer shall be installed:*
>
> *Minimum of 4 inches (102 mm) above the earth;*
>
> *Minimum of 2 inches (51 mm) above paved areas; or*
>
> *Minimum of 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 2021 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 (stucco) veneer. However, unlike the prescriptive specifications for cement plaster (stucco) veneer, Section R703.12.1 of the 2021 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 6**[2].

Due to the fact that the 2021 IRC permits the installation of adhered masonry veneer within a distance of ½ of an inch above a monolithic porch/patio surface, the IRC apparently acknowledges the fact 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).

Figure 6
Adhered masonry veneer installed with not less than ½ of an inch of clearance to the foundation.

When cement plaster (stucco) veneer is installed with a clearance of less than 2 inches to an underlying porch/patio surface, some investigators may assert that the as-built condition is a construction deficiency without any further analysis simply because the observed condition does not meet the exact prescriptive specifications of the building codes. However, as affirmed by the building codes, alternative materials, designs, and construction methods may be used in practice to accomplish the general intent and purpose of the building codes without meeting their exact prescriptive specifications. Accordingly, the CVEM serves as a practical and objective method for the forensic evaluation of construction variances to determine whether or not a variance is "satisfactory" and "complies with the intent" of the provisions of the codes.

In implementing the CVEM, one should first determine the intent of the applicable building code specifications to determine whether or not the construction variance in question is capable of performing its intended function in its as-built state. The intent of specifications associated with clearances between cement plaster (stucco) 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 by surficial water and/or ground movement. As previously discussed, the 2021 IRC permits the installation of a similar cladding system (adhered masonry veneer) within a distance of ½ of an inch above a monolithic porch/patio surface, which indicates that ½ of an inch at such locations is sufficient to provide adequate drainage for a cladding system comprised of a cement plaster base.

In the event that cement plaster (stucco) 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 (stucco) 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 (stucco) 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 construction deficiency. Other factors such as roof cover, weather exposure, and grading/drainage conditions may also be considered in the evaluation of this construction variance as well.

Summary

As demonstrated through examples associated with the installation of cement plaster veneer and window assemblies, a construction variance is not necessarily a construction defect simply because the as-built condition does not meet the exact prescriptive specifications of the building codes and/or code-referenced standards. As affirmed by the building codes, alternative materials, designs, and construction techniques may deviate from the prescriptive provisions under certain circumstances when an alternative is deemed to be "satisfactory" and "complies with the intent" of the provisions of the codes. Fasteners utilized to attach metal lath to a substrate for the application of cement plaster veneer can achieve an equivalent (or better) withdrawal capacity than the prescriptive specifications of the building codes despite the fact that fasteners may not align with framing members as specified. In addition, the installation of flanged window assemblies installed without an application of sealant behind the mounting flanges can provide adequate water-resistance despite the fact that sealant may be specified in the installation instructions by some manufacturers. Further, a clearance between cement plaster veneer and an underlying foundation surface (e.g., porch, patio) may still provide adequate drainage for the moisture management system and protect the veneer/wall assembly from contact by surficial water and/or ground movement despite the fact that such clearance may not be consistent with the prescriptive specifications of the applicable building codes.

The examples discussed herein are simply a small sample of common construction variances to demonstrate the need for additional evaluation of a construction variance prior to concluding that a construction variance is a construction defect.

Conclusion

Post-construction forensic evaluations that are based solely upon an exacting compliance with prescriptive building code specifications can be viewed as being myopic if such evaluations do not consider the capacity of a product, element, component, or system to perform its intended function in its as-built state. As affirmed by the building codes, alternative materials, designs, and construction methods may be used in practice to accomplish the general intent and purpose of the building codes without meeting their exact prescriptive specifications.

Meeting building code specifications after the fact simply for the sake of complying with building code specifications is mostly academic. Since it is the intent of the building codes to provide specifications that yield a standard level of acceptable performance, the actual performance of the disputed item should generally govern its evaluation. Remediation of a construction variance in which the remediated condition would not yield any salient improvement in performance beyond that which is already provided by the current as-built condition can be considered economic waste.

The CVEM developed by the authors serves as a practical and objective method for the forensic evaluation of construction variances to determine whether or not a variance is "satisfactory" and "complies with the intent" of the provisions of the applicable codes. The CVEM provides a guide through which additional analysis and engineering judgement can be utilized to determine whether a component or system that exhibits a construction variance is capable of performing its intended function as an alternative to blindly following codes of practice.

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