



Images courtesy Simpson, Gumpertz and Heger

Scratching the Surface with Stucco Control Joints

by Jeff Bowlsby, CCS, CCCA

Portland cement plaster, also known as stucco, is a popular and common exterior wall cladding finish. One concern of this otherwise excellent material is its inherent cracking—not only causing visual blemish, but also leading to possible water intrusion that could result in concealed damage.¹

Stucco cracks are caused by numerous factors, but most are the expression of internal stress relief resulting from more movement than the finish can accommodate. The internal stresses creating cracks may derive from:

- stucco mortar shrinkage occurring shortly after installation;
- ambient in-service temperature and re-hydration cycling;
- freeze-thaw cycling; and
- similar small-scale building movements.

Where stucco control joints are installed, these forces may cause control joint movements.

These control joints are one of the stucco industry's solutions for minimizing and controlling cracking, but they can be controversial. Control joint products are not created equal—they come as sheet metals (including galvanized steel and solid zinc alloy) or extruded polyvinyl chloride (PVC), with each type offering different structural performances.

Two standard one-piece stucco control joint profiles are available—the #15 (M-fold or double-V style) and the XJ-15 (locking flange or double-J style), depicted in Figure 1. Mounting flanges are either expanded sheet metal or a solid flange in either sheet metal or PVC, with spaced round perforations that key with the stucco mortar.

Current dilemmas surrounding stucco control joints include:

- How does each different stucco control joint product perform (and which is best?)
- Should the lath be continuous or discontinuous at the control joint?
- If the lath is continuous at the control joint, what effect does its product type have on control joint performance?
- If the lath is discontinuous at the control joint, should it be fastened to supports?
- Should the control joint flanges be fastened directly to the supports or wire-tied to the lath?

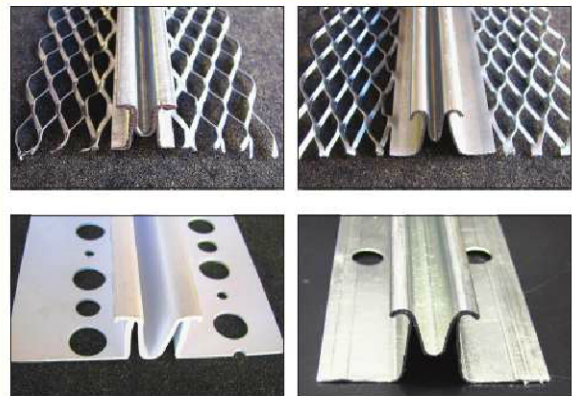
Stucco control joint performance depends on the combined influences of many variables, ranging from product characteristics and lath type to mortar properties, installation configurations, and fastening/support conditions.² However, no published control joint performance data or testing

protocols are available—not from product manufacturers, codes and standards organizations, or even the original product inventor. Consequently, this author developed a testing protocol intended to isolate and evaluate installed stucco control joint movement behavior in a laboratory.

Over the last several years, this author has conducted independent stucco and control joint research including field observations, literature reviews, and laboratory testing to collect information and evaluate stucco control joint performance characteristics. As a traditional building material, stucco has been handed down over time through the trades with little published empirical evaluation. Its behavior, cracking conditions, and crack control are complex, interrelated topics with many influencing factors.

The initial testing described in this article attempts to better understand control joint behavior and performance as an isolated component of a stucco wall finish system. However, it is important to keep in mind this testing is neither the final answer to understanding stucco control joint behavior nor a panacea for designing an effective stucco control joint system. Much more evaluation is required. This article simply intends to be a general guide for implementing an improved control joint system that further minimizes stucco cracking.

Figure 1



XJ-15 stucco control joints. Clockwise from left: galvanized steel, zinc (expanded sheet metal flanges), zinc (perforated sheet metal flanges), and PVC (perforated sheet metal flanges).

Overview of research

The purpose of the testing was to evaluate the maximum limits of stucco control joint performance, specifically stress reduction and extensibility for several products and installation configurations. As no published evaluation



Project: CSU Fullerton Recreation Center in Fullerton, CA
Products: SuperLite II-XL 90 and 120 in SAFTI[®] GPX Framing
Architect: Langdon and Wilson
Glazier: Woodbridge Glass
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Figure 2



#15 stucco control joint—extended.

criteria could be located as a reference, the maximum performance limit of the stucco control joint was declared to be the condition when it sufficiently opens or becomes disengaged from the adjoining stucco so bulk water can penetrate through or around (Figure 2).

Stucco is a composite material. When fresh portland cement mortar is applied to metal lath, the shrinking mortar and the metal lath interact throughout the curing process in a complex relationship with several continuously changing variables. When cured, the lath and mortar behave as a singular homogeneous material. To accommodate stucco stresses and resultant movements, a stucco control joint must be part of this composite, and be free to move, while at the same time not be excessively restrained by lath fasteners or supporting conditions.

The three most common types of stucco lath are expanded sheet metal, woven wire, and welded wire. These products are further available in a range of physical properties, including tensile strength and rigidity, varying with lath direction. Each lath type provides different physical properties to a stucco composite assembly based on these contributory effects (Figure 3).

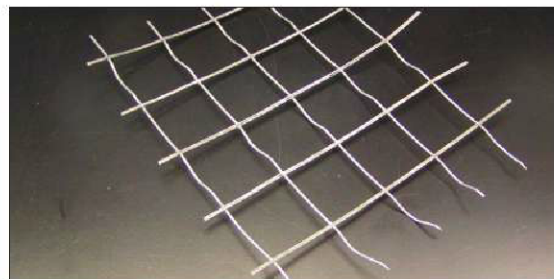
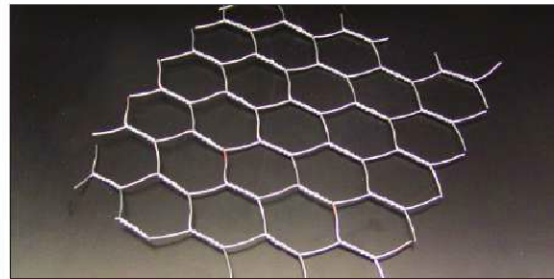
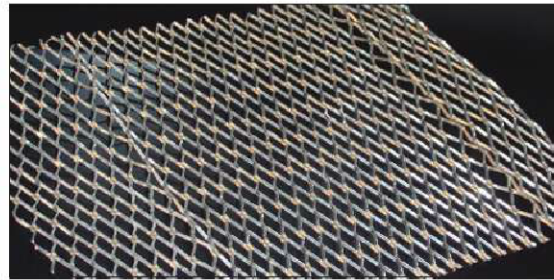
Stucco control joint installation

A few years back, esteemed stucco consultant Walter F. Pruter, CSI Member Emeritus (recently deceased) offered this insightful guidance in the pages of *The Construction Specifier*:

In the design of control and expansion joints, architects should consider portland cement plaster in the same way they would a pane of glass. Glass is never installed without relief in all directions and the same should apply to portland cement plaster.³

Pruter's analogy of stucco as isolated panels is well considered.

Figure 3



From top to bottom: Expanded sheet metal, woven wire fabric, and welded wire fabric laths.

Current requirements of building codes, industry standards, and manufacturers' literature are invariably incomplete and sometimes conflicting when describing stucco control joint installation requirements. These resources do not present a unified voice, specifically regarding lath continuity/discontinuity and fastening requirements. These factors are significant because they influence control joint performance.

In 1962, Raymond Clark obtained U.S. Patent 3,015,194, describing what is now recognized as the #15 (M-fold or double-V) stucco control joint.⁴ This patent describes his stucco control joint product invention and graphically depicts the control joint being wire-tied over continuous "expandable lath."

The invention was to accommodate movement and provide a stress-relief location for "plastic [sic] coating materials such as stucco ..." Installation requirements described in this patent are not widely recognized or promulgated by any

Figure 4



Photo courtesy Mark Fowler (WWCCA)

An example of edge curling.

known sources. Further, what constitutes an “expandable lath” is not otherwise described and movement capability of this stucco control joint invention is not presented.

ASTM International C 1063-08, *Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland-cement-based Plaster*, categorizes stucco control joints as lath accessories. It specifies lath accessories must be fabricated from certain sheet metals or plastics of specified minimum thicknesses, and be designed to accommodate a specified cement plaster thickness. (Control joints also perform a cement plaster thickness screed function.)

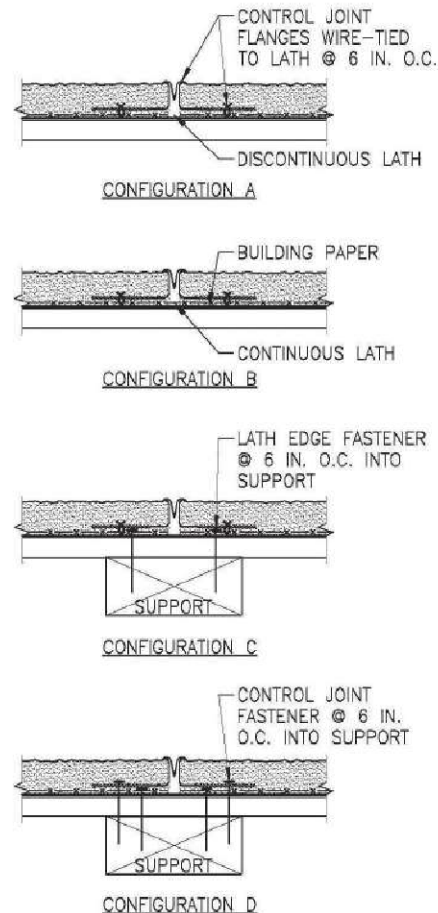
Most stucco control joint product manufacturers reference ASTM C 1063 for installation requirements. The standard specifies the installation requirement of control joints as follows:

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

ASTM C 926-06, *Standard Specification for Application for Portland-cement-based Plaster*, and other industry resources also provide control joint installation information. While helpful, they do not specify any requirement for lath edge fastening. Further, they offer no guidance on possible differences in requirements for control joint installation at various support conditions (e.g. when the control joint is installed parallel to or perpendicular to support framing), or on the influences of other factors such as wall sheathing versus unsheathed framing conditions.

Lath can be installed continuously or discontinuously at control joints. The latter option leads to the question of what to do with the cut lath edges—fasten them to the building or leave them unfastened? When not fastened to the building supports, discontinuous lath edges can contribute to the phenomenon of edge curling (Figure 4).

Figure 5



Stucco control joint installation testing.

Testing: Materials and installation






The combinations of lath types, lath fasteners, control joint products, portland cement mortar, substrate conditions, and installation configurations is nearly infinite. For the work discussed in this article, a testing plan was distilled down to a concise group of materials and installation configurations common in today’s construction environment. Accordingly, the information generated may be useful as a reference to similar conditions, but there is no guarantee of performance for every project’s particular circumstances.

As illustrated by Figure 3, three common lath types were evaluated in the study:

- 1.8 kg/m² (3.4-lb/sy) expanded sheet metal lath;
- 0.6-kg/m² (17 gage x 1.5-in.) woven wire fabric; and
- 0.6-kg/m² welded wire fabric.

Five mass-produced, one-piece control joint products were evaluated, each with a 19-mm (0.75-in.) ground dimension.

Figure 9

STUCCO CONTROL JOINT DIMENSIONAL EXTENSIBILITY					
PROFILE	#15		XJ-15		
MATERIAL	GALVANIZED STEEL	GALVANIZED STEEL	SOLID ZINC	SOLID ZINC	PVC
FLANGES	EXPANDED SHEET METAL		PERFORATED SHEET		
MAXIMUM DIMENSION AT EXTENSIBILITY LIMIT, IN.	0	0.04	0.08	0.13	0.45
SECTION					

Maximum dimensional extensibility performance.

Stress reduction and dimensional movement

For a stucco control joint to perform, it must provide a weakened plane location so stresses will be relieved at the control joint location and not elsewhere. This function is affected by the combined influences of the control joint product, lath, and stucco attributes and installation. The testing initially focused on the stress-reducing characteristics of different assemblies using the XJ-15 joint profile in galvanized sheet metal (Figure 8, page 54).

The amount of stress reduction is presented as a range for each configuration, reflecting the variable performance influences of different lath types and fastening methods. For all lath types, continuous installation at stucco control joints allowed the least stress reduction. While discontinuous lath not fastened to supports provided the greatest amount of stress reduction at the stucco control joint (*i.e.* Configuration A), the concern about edge curling necessitated selecting Configuration C for the next phase of testing.

Each of the five control joint products were installed following Configuration C and evaluated for maximum dimensional extensibility performance (Figure 9). The stucco control joint products made from the most flexible materials provided the greatest dimensional extensibility.

Observations

Each of the stucco control joint profiles opened first from the back of the joint, at the plane of the control joint flanges and the field of lath; the control joint then opened at the front exposed edge at the stucco's outer surface. Using solely the water penetration criteria, the #15 stucco control joint profile—when extended, yielding a gap between the control joint and the edge of stucco—can allow water penetration earlier in the control joints' extensibility range than the XJ-15 profile. As illustrated back in Figure 1, the XJ-15 control joint profile engages its front exposed edge of the control joint with the edge of stucco and prevents a gap between the control joint and stucco until maximum dimensional extensibility limit is reached.

Stucco control joint product characteristics have an influence on the joint's extensibility performance. Intuitively, and as indicated by the testing results, the more flexible control joint materials made from solid zinc alloy and PVC materials are capable of greater dimensional extensibility than the more rigid galvanized steel control joint products.

A continuous lath configuration restricts movement at control joint locations, minimizing stress reduction and the dimensional extensibility performance. (This is regardless of

Additional Information

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plaster standards, ASTM C 1063 and ASTM C 926. He has 25 years of experience in various roles including prime building design professional, specifier, construction contract administrator, peer reviewer of construction documents, and construction forensic scientist, with an emphasis on cement plaster. Bowsby can be contacted via e-mail at jabowsby@sgh.com.

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Abstract

This article documents cement plaster control joint behaviors and provides essential guidance concerning

the performance capabilities of control joints in various common installation conditions.