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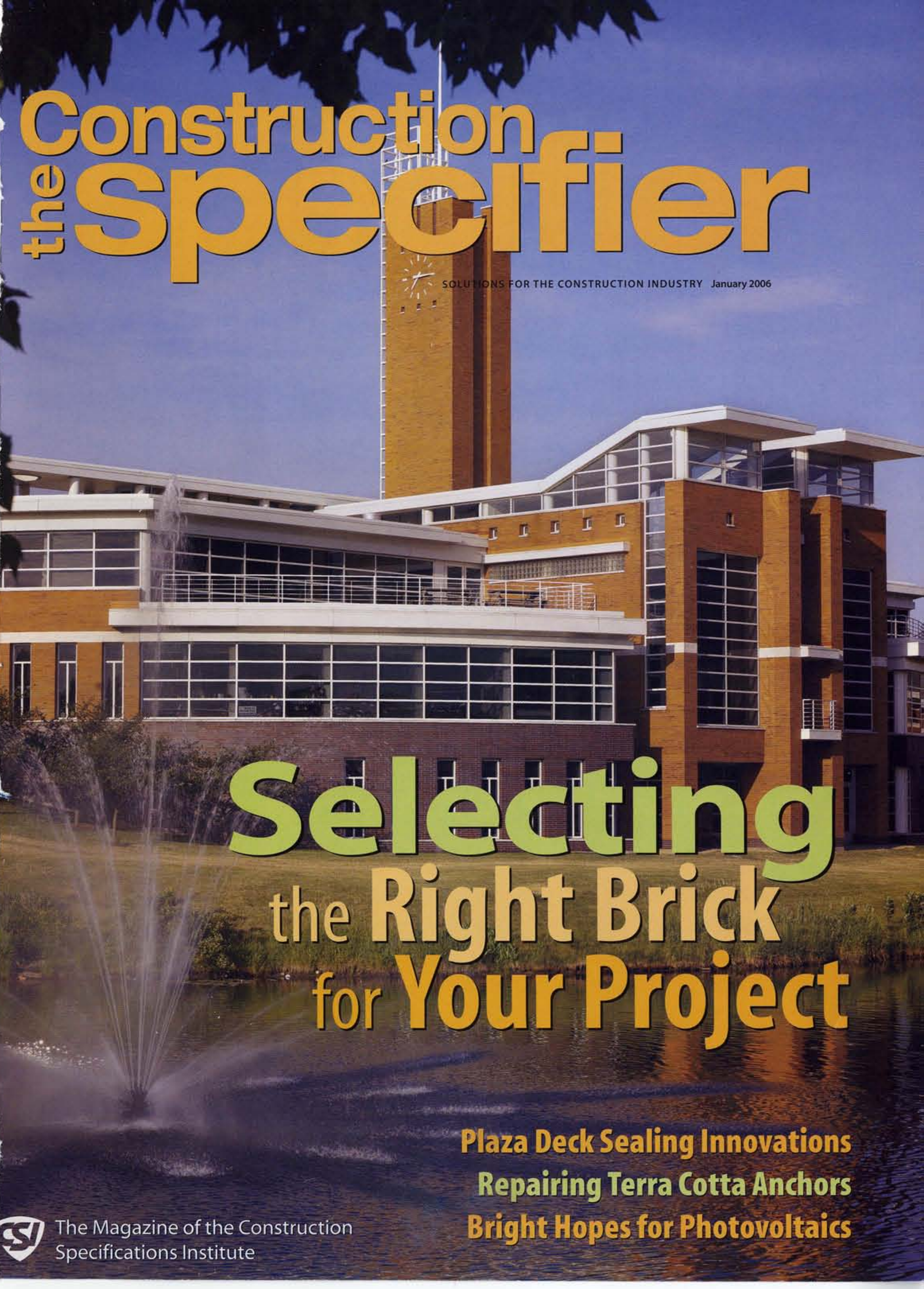

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Covering Sealants for Building Applications

by Lester Hensley

The sealing of building components and structural expansion joints is not just a matter of filling the gap. Joint sealants function as an integral component of the building envelope, protecting structures from damaging moisture ingress caused by wind, gravity, capillary force, surface tension, and air-pressure differentials. Though constituting a small percentage of construction budgets, joint sealing and other waterproofing-related issues are responsible for most post-construction complaints and requests for retrofits. Poorly designed, manufactured, or installed joint sealants often need to be replaced within two to five years of construction.[1]

Furthermore, the overall energy efficiency of a building greatly depends on joint sealants to provide thermal insulation and a barrier against air infiltration. As Tom Kuckhahn pointed out in "Exterior Wall Systems, R-Value, and Revenue" in the September 2003 issue of *The Construction Specifier,* "[heat] seeks the path of least resistance, so the R-value of an actual wall is closer to the R-value of the least insulating portion of that wall." All too often, the joint sealant proves the least insulating component, significantly degrading the effective R-value of the entire wall system.

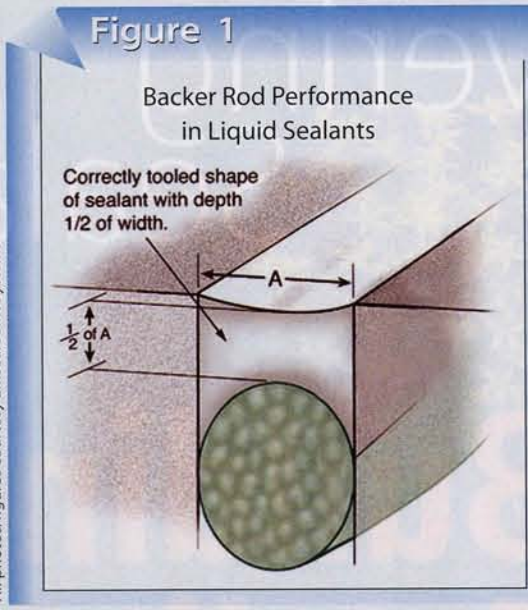
Sealant options

The waterproofing industry has many product options for joint sealing, the most common being liquid sealants, impregnated foam sealants, and hybrid sealants.

Liquid sealants

Liquid sealants are widely used because of their relatively low material cost and speed of installation. These sealants, particularly the high-performance silicone variety, provide moisture impermeability, low modulus, and ultraviolet light (UV) resistance, and retain these physical properties through changes in age and temperature. Available in a wide range of colors, they are supplied in tubes, pails, sausages, and other formats convenient for shipping.

They are extruded through a nozzle into joint gaps over a pre-placed foam backer rod. The installer then tools the sealant against the backer rod to achieve the 'hour-glass' cross-sectional shape needed for handling extension and compression movement. This shape is critical to the performance of the liquid sealant once it has cured into a solid plastic state (Figure 1, page 66). The backer rod's only purpose is to facilitate this shape, providing no thermal insulation or other benefits.



The foam backer rod provides an hour-glass shape, but offers no thermal insulation properties.

All photos/figures courtesy Emseal Joint Systems

As an adhesive, liquid sealants perform best when the basic stresses in the material are shear, not tensile. Tensile stresses present a limit on liquid sealants, both at the bond line and within the body of the cured sealant during extension movement—they should be eliminated as much as possible, at either the bond line or within the elastomer. Liquid sealant failure is accelerated by cycles of compressive stress (when the joint is closing) followed by cycles of tensile stress.

The effect of tensile stress is aggravated when the sealant is poorly installed (Figure 2). Liquid sealants are dependent on correct sizing—one cannot, for example, install 25-mm (1-in.) backer rod into a 40-mm (1.5-in.) joint-gap, tool liquid sealant over it, and expect to achieve the necessary geometry for the sealant to function. Unfortunately, it is difficult to achieve a consistent geometry. The Sealant Waterproofing and Restoration Institute (SWRI) specifies a seven- to 12-step process to ensure liquid sealants are installed properly (problems can include deviations in the depth of the backer rod, which can cause complete sealant failure). The popularity of redundant, or two-stage, sealing using double caulk and backer rod detail makes it difficult to attain a clean substrate. It also makes it extremely difficult to achieve installation to the required geometry in the second seal, deep inside the wall section.

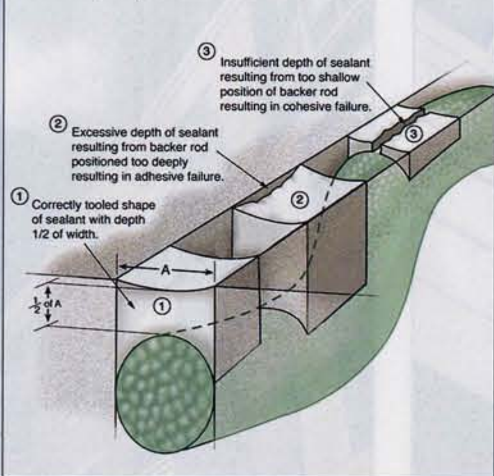
Impregnated foam sealants

The preformed, impregnated foam sealants, in contrast to liquid sealants, are supplied ready for installation in their finished, functional state. They are produced by partially filling the cells of cellular polyurethane foam with non-drying, water-repelling adhesive agents. Impregnation treatment, followed by compression of the fully expanded material to as much as one-fifth its size, creates a sealant material always in compression when installed in a joint.

Impregnated foam sealants can provide thermal insulation in addition to moisture impermeability. R-values up to 3.28 per inch of depth are typical, meaning that in an average 75-mm (3-in.) joint, the R-value at the structural joint gap of a wall sealed with impregnated foam is 3.28 x 3.5 per inch

Figure 2

Improper Backer Rod Installation



When poorly installed, the foam backer rod can cause complete sealant failure. Redundant sealing can make attainment of a clean substrate particularly difficult.

(the depth of seal of the impregnated foam sealant) or R-11.48. This compares favorably to a 63.5 mm (2.5 in.) thick exterior-insulated façade (R-4 to 5.6 per inch of thickness), as well as a typical insulated precast panel, usually R-12.

Preformed impregnated foam sealants, by virtue of their depth, density, and adhesive-infused cellular composition, also resist air-pressure differentials caused by the Bernoulli Effect (the higher a fluid's velocity, the lower the pressure), stack effect, and/or HVAC loading. Like liquid sealants, impregnated foam sealants require correct sizing to maintain a suitable level of compression.

Standard impregnated foam sealants are available in black or gray, and are widely used for shadow-line effects. However, when one wishes to make the material blend/ coordinate with the color of a substrate, this limited color selection becomes problematic.

Hybrid sealants

Hybrid sealants combine factory-applied and cured silicone bellows with an impregnated, expanded-foam sealant backing, which overcome the fatigue and potential cohesion-failure of liquid sealants. Hybrid seals are made by partial factory-compression of the foam, followed by application of silicone to an applied thickness. The silicone is then cured under conditions free of dirt, temperature change, and substrate movement. Following curing, the material is compressed to an installation dimension less than the field-measured joint-gap size. It is held in this pre-compressed state by its packaging until immediately prior to insertion in the joint-gap.

Hybrids provide non-invasive anchoring, eliminating the need to drill or screw into sensitive substrates. This removes the risk of spalling and enables installation into inside corners that are impossible to seal with aluminum rail and rubber strip-seals, among other options. Figure 3 (page 70) shows acrylic-impregnated foam sealant combined with factory-applied, ultra-low modulus silicone liquid sealant, in the form of a bellows. The opening/closing movement of the joint gap (Figure 4, page 70) results in the surface sealant folding and unfolding (rather than stretching and compressing), thereby eliminating

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Hybrid joint sealants can be effective for applications where joints result between abutting buildings, or where additions have been made to a pre-existing structure. Their non-invasive anchoring means no drilling or screwing is required.

Hybrid sealants will not damage a sensitive substrate, which allows them to be installed into inside corners that cannot be sealed by conventional methods.

substrate bond-line stresses, as well as failure or composition changes caused by pre-cure joint-gap movements.

Hybrid joint sealants can be effective for a variety of applications including movement joints, large joints over 25 mm (1 in.), applications demanding resilience and/or resistance to air-pressure/thermal differentials, and anywhere a mid-span structural joint is designed. They can also be effective where joints result between abutting buildings or where additions are made to existing structures.

Recent product developments, juxtaposed against new criteria for durability and energy efficiency driven by air-barrier codes and sustainable design criteria, make hybrids for joints as small as 8 mm (0.375 in.) increasingly justifiable. For example, one to 10 points for the U.S. Green Building Council's (USGBC's) Leadership in Energy and Environmental Design® (LEED®) program are attainable in the Energy & Atmosphere (EA) Credit 1, *Optimize*

Though hybrid sealants can be applied in a wide variety of projects, they are less well-known than liquid sealants, which possess a far broader global profile.

Energy Performance. The use of higher R-value hybrids can contribute to the optimization of energy use while durability of the sealant system can be expected to improve due to absence of tensile stress. A LEED point is also attainable from Indoor Environmental Quality (EQ) Credit 4.1, *Low-emitting Materials: Adhesive & Sealants.*

Hybrid installation involves removal of the sealant from the hardboard and shrink-wrap packaging that holds it compressed to less than the joint size. The sealant is inserted into the joint opening, being recessed at least deep enough to accommodate a fillet-bead of sealant applied later. A pressure-sensitive mounting adhesive on one face holds the material in place while it slowly expands to fill the joint. A fillet-bead of liquid silicone then locks the bellows to the substrate. While field-applied, this fillet-bead is never in tension, and ensures the bellows is sealed to the substrates.

Perhaps the primary reason why hybrid sealants are used less widely

Figure 3 Hybrid

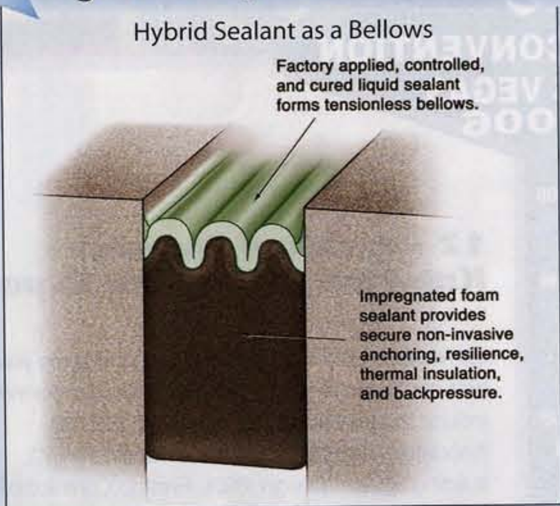
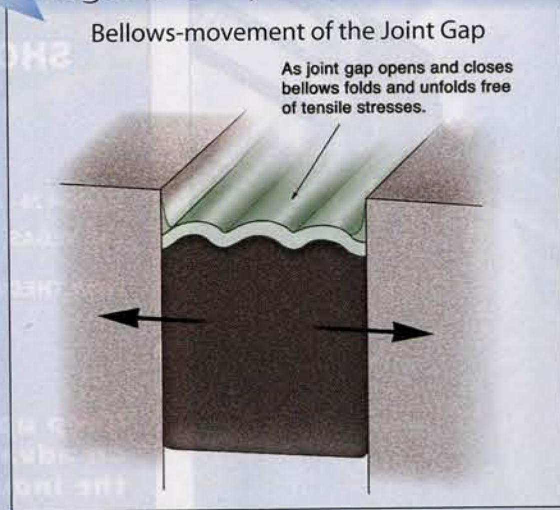


Figure 4 Hybrid Extension



Hybrid sealants provide non-invasive anchoring, and can be used for a variety of applications, including joints over 25 mm (1 in.). The bellows structure allows the sealant to fold, rather than stretch and compress, eliminating bond-line stress.

than liquid sealants is market exposure. Though hybrids are developed, produced, and promoted by well-established, mid-sized, independent manufacturers, those companies have nowhere near the global profile of multinational liquid sealant producers.

Conclusion

Choosing the right joint sealant requires a full understanding of the advantages and limitations for each material option. Hybrid sealants combine the best features of both liquid and traditional impregnated foam sealants (at comparable cost), but cannot match their availability. As architects, specifiers, and contractors perform against the elevated criteria of LEED, air-barrier codes, and energy legislation, one should seriously consider both proven technologies and practical innovations.

Notes

[1]According to the Construction Industry Research and Information Association (CIRIA), the treatment of movement-joint gaps in buildings is grossly underemphasized. In "Report from CIRIA" (*Civil Engineer International* July 1995), the association says, "Although they are a minor component of the building envelope, joints with sealants are often responsible for defects and failures—sometimes after only a couple of years."

Additional Information

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Abstract

Depending on the application, choosing an appropriate joint sealant can mean the difference between long-term performance and early, expensive maintenance. Liquid and impregnated foam sealants are traditional options with opposing advantages and disadvantages. Newer hybrid sealants can sometimes offer the best of both worlds.