CONSTRUCTION CANADA

Overcoming Product Limitations

Waterproofing with Hybrid sealants

By Lester Hensley

When Captain R. King established King Ranch in Southern Texas in 1853, the only cattle able to survive the harsh climate and scrubby terrain were known as Indian Brahmans or Longhorns. Although Longhorns thrived in hot climates, they were lean and did not produce great beef. Conversely, British Short-Horn cattle made great beef but could not tolerate the heat. King decided to cross the two breeds and the result was the first-ever American breed of cattle—the Santa Gertrudis. Combining the best of both worlds, the Santa Gertrudis produces high quality beef in a hot, arid climate.

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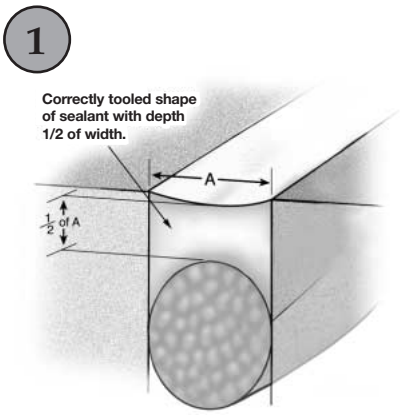
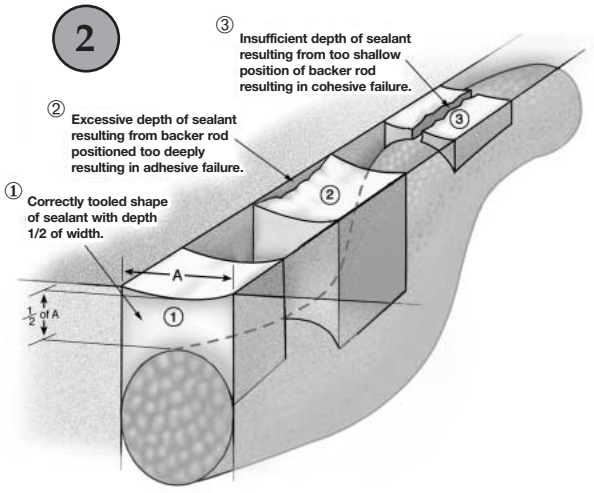
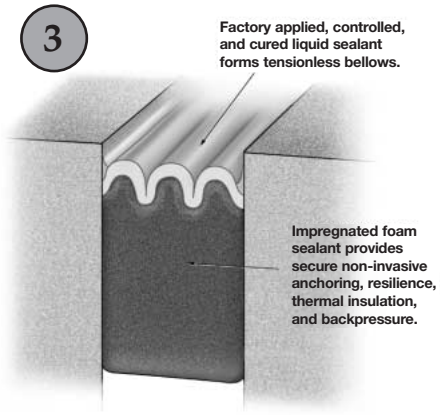
Not unlike King's frustration with finding the right cattle, the sealing and waterproofing industry has become frustrated with the performance of sealant material options. As the limitations of individual technologies became apparent, hybrids emerged to create more effective products. These new products preserve the best features of the component materials







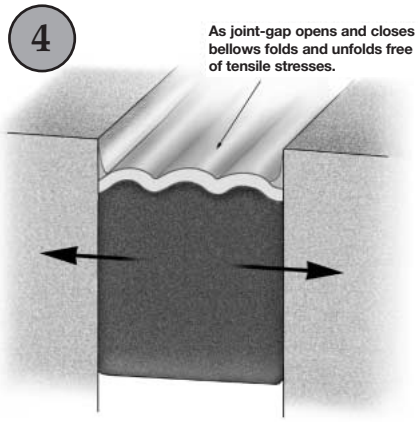


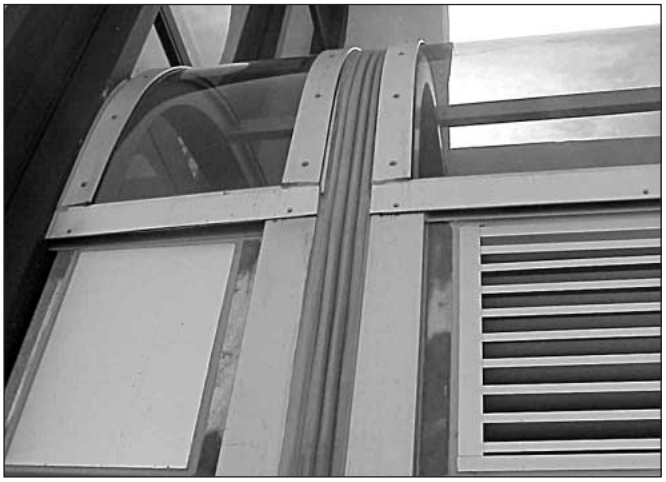
Figure 1: Proper positioning of backer rod and tooling of liquid sealant to achieve a functional joint.

Figure 2: Limited by the presence of tensile stresses at the bond line and within the body of the cured sealant during extension movement, liquid sealants are aggravated when installed in a shape other than the specifically required hourglass.

Figure 3: Composition of silicone/impregnated foam hybrid seal.

Figure 4: Hybrid sealant in extension. Silicone bellows unfolds free of tension either at the bond line or within the material.

Hybrid silicone/impregnated foam sealant is inserted into joint-gap.



Silicone liquid-sealant and impregnated foam hybrid in hard-to-seal outside radius of skylight system.

and eliminate the weaknesses that caused those original technologies to stagnate.

Liquid sealants, for example, suffer numerous installation and material challenges in getting them to work properly, and pre-formed sealant alternatives are tricky to size and install. By acknowledging the strengths and weaknesses of both liquid and pre-formed sealants, hybridization has created a new alternative for the sealing and waterproofing industry—hybrid silicone/impregnated foam sealants.

Liquid sealants

Available in tubes, pails, sausages, or other forms convenient for shipping, liquid sealants are extruded through a nozzle into joint-gaps over a pre-placed foam backer. 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. The achievement of this hour-glass shape is critical to the performance of the liquid sealant when it cures into a solid plastic state (Figure 1).

Liquid sealants are limited, however, by the presence of

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tensile stresses at the bond line and within the body of the cured sealant during extension movement. The negative effect of these tensile stresses is aggravated when the sealant is installed in a shape other than the specifically required hourglass (Figure 2). Alteration of the geometry, as well as changes in the sealant-material state resulting from movement in the joint-gap prior to full cure, further limits the functionality of the finished product.

Pre-formed sealants

Impregnated, open-cell foam sealants are a type of pre-formed material that are produced by partially filling the cells of high quality open-cell polyurethane foam with non-drying, water-repelling adhesive agents. Combining this impregnation treatment with compression creates a sealant material that is always in compression. Pre-formed sealants, by contrast, are supplied ready for installation in their finished, functional state. Historically, impregnated foam sealants have been limited by the need for correct sizing to maintain a suitable level of compression for sealing, the relatively high up-front cost of the products, and the lack of colour choice.

Sizing is also an issue with liquid sealants if the goal is a functional sealant. You cannot install 25 mm- (1 in.-) backer rod into a 40 mm- (1.5

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in.-) joint-gap, tool liquid sealant over it, and expect to achieve the necessary geometry for the sealant to function.

The colour selection of standard impregnated foam sealants, black or gray, is widely incorporated in design to create a shadow-line effect. However, when the aesthetic effect preferred is to make the material blend or co-ordinate with the colour of a substrate, then this limited colour selection becomes an issue.

What if one could develop a sealant that combines the best features of liquid sealants and impregnated foam sealants while eliminating their

weaknesses? This question was answered with the development of the hybrids currently on the market, and it continues to drive the development of next-generation products to suit an increased number of applications.

Overcoming product limitations

To maximize the positive attributes while eliminating the disadvantages of both impregnated foam and liquid sealants, the two are combined in the form of bellows (Figure 3). The opening and closing movement of the joint-gap (Figure 4) results in the folding and unfolding of the surface sealant (rather than stretching and compressing), which eliminates substrate bond-line stresses and failure or composition changes caused by pre-cure joint-gap movements.

The seal is made by partially factory compressing the foam followed by applying the silicone, which is applied to a factory-controlled thickness. It is then cured under controlled conditions free of dirt, temperature change and movement of the substrates. Once the silicone coating has cured, the material is compressed to an installation dimension comfortably less than the field-measured joint-gap. It is held in this pre-compressed state by its packaging until immediately prior to insertion in the intended joint-gap (Figure 5).

Installation essentially involves inserting the factory-made "stick" into the joint opening, and a corner-bead of liquid silicone locks the bellows to the substrate. The resulting system:

- is watertight;
- moves free of tensile stresses at the bond line;
- moves free of tensile stresses within the material;
- is anchored without drilling;

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• movement joints
• large joints over 25 mm (1 in.)
• where resilience or the need to resist air-pressure and thermal differentials is essential
• anywhere a structural or new-to-existing gap needs filling and sealing"

- is anchored positively by three means: mechanical backpressure, pressure-sensitive adhesion of the impregnation agent, and corner bead;
- combats spalling of the substrate by virtue of its backpressure;
- is resilient and resists the effects of air-pressure differentials;
- thermally insulates;
- is difficult to vandalize;
- is cost-effective on installed-cost basis; and
- is cost-effective on long-term performance basis.

Conclusion

Due to its non-invasive anchoring, watertightness, colour choice, and tensionless movement, hybrid bellowed sealants outperform liquid sealants or traditional impregnated foam sealants alone and excel in installation and performance over extruded-rubber compression seals (particularly combination metal rail and rubber gland "strip seals"). Hybrid sealants available today shine in many applications including:

- movement joints
- large joints over 25 mm (1 in.)

Liquid Sealant (silicone)		Impregnated Foam Sealant	
Disadvantage	**Advantage**	**Advantage**	**Disadvantage**
Tensile stresses on bond line	WIDE COLOR RANGE	ALWAYS IN COMPRESSION	Color choice limited to black and dark gray
Tensiles stresses within cured polymer	MOISTURE IMPERMEABLE	MOISTURE IMPERMEABLE	Movement range of +25%, -25% (Total 50%) of nominal material size
Need for field forming of "hour-glass" performance shape	LOW MODULUS	NON-INVASIVE ANCHORING	Perceived cost
Intolerant of movement in joint-gap before sealant cures into proper shape	RETAINS PHYSICAL PROPERTIES WITH AGE AND OVER TEMPERATURE CHANGE	RESISTS AIR PRESSURE DIFFERENTIALS	Need to maintain compression through careful sizing
Inability to handle large movement joints	UV STABLE	THERMALLY INSULATES	
Tensile stresses on bond line	TOTAL MOVEMENT CAPABILITY EXCEEDING 100% OF NOMINAL JOINT SIZE	SUPPLIED IN VIRTUALLY FINISHED, FUNCTIONAL STATE	

Hybrid Sealant

WIDE COLOR RANGE
MOISTURE IMPERMEABLE
LOW MODULUS
RETAINS PHYSICAL PROPERTIES WITH AGE AND OVER TEMPERATURE CHANGE
UV STABLE
ALWAYS IN COMPRESSION
NON-INVASIVE ANCHORING
RESISTS AIR PRESSURE DIFFERENTIALS
THERMALLY INSULATES
SUPPLIED IN VIRTUALLY FINISHED, FUNCTIONAL STATE
TOTAL MOVEMENT CAPABILITY EXCEEDING 100% OF NOMINAL JOINT SIZE

Summary of advantages and limitations of liquid and pre-formed sealants and the resulting combination of advantages in the hybrid.

- where resilience or the need to resist air-pressure and thermal differentials is essential
- anywhere a structural or new-to-existing gap needs filling and sealing

Small-size hybrids for mass production and for use in window and panel perimeters are under development and promise to make their use as cost-effective as current liquid-sealant and backer rod options. Other hybrids under development throughout the world include combinations of:

- chemically-resistant liquid sealants and impregnated foam sealants for use in wastewater, caustic and other harsh environments
- materials to provide fully fire-rated, watertight movement joints
- hydrophilic or hydrophobic materials with impregnated foam sealants to handle below-grade and head-of-water applications

Whether in the cattle business in the 1800s, or in the sealant, waterproofing and building restoration industry in the new millennium, innovation is inevitable as long as problems exist. New hybrids will develop as long as there continues to be innovation. Often the solution to problems we face lies not in the search for radically new materials, but in the creative combination of existing technologies.

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