White Paper

Peeling Back the Layers

The Case for Monolithic Foam Seals in Expansion Joint Systems
Introduction

In certain applications, the use of foam seals in expansion joints provides a solid seal against the elements, providing both thermal and moisture protection. Open-cell foams provide some breathability, and are best in vertical applications. Closed-cell foams are watertight and block water from entering - whether in liquid or vapor form. They are best suited to horizontal applications where moisture could remain trapped and water penetration cannot be allowed. Closed cell can also be utilized on below-grade vertical applications as support and closure to positive side waterproofing at expansion joints.

However, differences in both design and manufacturing techniques are what quickly separate seemingly similar foam seals. In some cases delamination of layered seals can lead to material failures and water infiltration.

This white paper seeks to lay out the case for monolithic foam seals, and why wax impregnation should be the specified treatment to maximize water repellency. We will also point out the differences in fire-rated foam seal systems, and the proper method for factory transitions.

Open-Cell vs. Closed-Cell Foams

Open cell foams allow for flow-through of water and vapor. Like many exterior veneer systems, if moisture becomes trapped in a wall cavity, building systems allow the moisture to wick out. This is a good quality and a major focus to eliminate potential mold issues in vertical applications.

Closed cell foams are absolutely watertight and do not allow the moisture to enter the body of the foam. This is the best application for horizontal runs where water could pool. These are tougher to compress but can be placed under tension (or expand) well.
Laminated Foam layers vs. Monolithic Pour

Layered foam seals are produced using sections of foam laminated together, as shown here:

Laminating multiple ½” layers of foam together is a cheaper manufacturing process, but can result in a product with reduced lifecycle due to the vulnerability of:

- Delamination of the various layers from each other
- Susceptibility to splitting from shear movement

It is also important to watch out for monolithic foam lookalikes. In Fig. 1 below, you see what appears to be a monolithic foam seal. However, when the exact same seal is seen in a different light in Fig. 2, two things become apparent - the lookalike seal is made from layers, and delamination occurs.

Yes, while in a compressed state, all foams look the same. We would argue that specifications calling for foam seals made with “monolithic manufacturing methods” will avoid product
failures and claims down the road. Architects should look closely at the seal’s construction, and ask questions of the manufacturer as to the seal’s make-up.

Given batch-to-batch variations in manufacturing, the multiple layers of foam can have different qualities and can expand/compress at differing rates. They may not equalize resulting in inconsistent expansion and “bloating.” These types of layered foam failures can be seen here:

- Bowing out of plane
- Delamination of layers

The easiest way to spot a delamination failure in the field is to look for bowing, either into or out of plane with the deck or wall. Easy depression of the foam by light touch is another indicator.

- Complete failure due to delamination of layers
- Foot step depressing foam on 10” joint
Monolithic Pour foam seals (shown at right) are the superior alternative to the failure-prone layered seal. A pretty bold statement, we'll grant. However, as the name implies, by producing a seal in a single pour of the foam material, there are no layers to delaminate. It’s just that simple … and in simplicity there’s superiority. You also avoid the batch-to-batch variation inherent in layered foam seals.

This image (at left) shows the two types of foams used in expansion joint foam seals. It seems fairly apparent that the monolithic foam (below) has the higher overall material integrity, and in turn the greater longevity and performance needed for exposure to the elements.

A good rule of thumb: Limiting foam seals to application with a joint width of no more than 8 inches (200mm) or smaller is good practice. Use of foams for expansion joints larger than 8” leads to two things:

1. Exceeding the foam’s performance characteristics. Plus, the weight of “super-wide” foam seals can lead to sagging in vertical applications.

2. Exponentially higher costs compared to other expansion joint cover solutions - i.e., a four-component system with face seal, rails and back seal.
Examples of good foam seal installations

Here are foam seals used in exterior joint applications. Monolithic foam seals can provide minimal sightline interruption, and varying colors allow the seal to blend in.

It’s important to note in these next two images how well the seal works with uneven substrates. The foam expands to completely fill the joint, and the two-part epoxy adhesive provides a tight seal. Any foam seals in joints over 6” (152mm) nominal width should be epoxied in place to resist sag as well as lateral and wind loads.
Here is another example of an excellent installation, of a seal in a horizontal deck. Note how the monolithic seal maintains its integrity, and shows a well-executed horizontal splice at the lower left.

Waxed vs. Wax-Free Foam

Heavy wax impregnated foams that help keep joints watertight have been in use for about 50 years. However, some consider the addition of copious amounts of wax as old fashioned, and we would agree ... up to a point. Today, we view a 2-3% wax impregnation as the best alternative since it drastically increases the hydrophobic properties of the foam and extends the seal’s lifespan.

*Water squeezing out of a non-waxed foam seal ... once the silicone face is compromised, you can call this a sponge.*

So what if the specifier chooses to forego wax impregnation? Plain foam can act just like a sponge (as shown in the image below). In addition, plain foam assumes an unrealistic expectation of perfect installation of the silicone face in manufacturing and field perimeter
caulk seals to keep the foam protected. If the face silicone seal itself is damaged - say, by the tip of a caulk gun jammed between the foam and wall or deck material -- leaks will occur. With wax impregnation, the foam seal will remain watertight even if the silicone face seal is compromised, in good measure because wax doesn’t dry out.

Fire Rated Foam ... there are differences

There are two ways to achieve a fire rating for foam systems:

1. Have the foam be totally impregnated with fire retardant
2. Apply an intumescent coating or silicone on the face of the joint

The second method is, indeed, cheaper for the manufacturer. However, if vandals or an installer damages or tears through the intumescent facing, the entire fire rating is voided. The best solution is to specify a seal system that uses retardant impregnated foam.

Another difference is the addition of a Smoke Barrier between the opposing foam faces (see red arrow below). This stops smoke from penetrating on 2- and 3-hour rating requirements.

A fire rated pre-compressed foam material that is totally impregnated with fire retardant will maintain the specified and tested fire rated assembly even if the silicone face has been damaged. Seals that rely on their silicone or intumescent face coating will no longer achieve their UL-2079 assembly rating if either of these faces are damaged or vandalized.
The smart way to specify Factory Transitions

There are two distinct approaches to handling transitions in foam seals:

In Example 1 we illustrate what we call a Corner “Square” transition - a foam square is installed to fill the corner, and then slabs of foam are adhered to the corner square.

In Example 2, we show the V Notch Cut transition - the foam is cut only partially to allow a simple, non-stressing bend in the foam to fill the corner.

Example 1: Corner “Square” transition  Example 2: V Notch Cut transition

We recommend the V Notch Cut to our customers because we feel the Corner “square” transition introduces two distinct potential failure points:

- Three discontinuous sections of foam increases the potential for water infiltration.
- In numerous field inspections, foam sags and falls out around the ”square” because the cuts compromise the foam.

Summary

As we wrap up, here are four key points to remember:

- The use of monolithic foam expansion joint seals offers superior performance for the long haul. Conversely, laminated/layered seals have greater potential to delaminate, leading to bloat, sag and total failure. Architects would be wise to specify “monolithic manufacturing methods” for foam seals, and ask manufacturers how their seals are made.
• A small amount of wax impregnation (2-3%) within the seal greatly increases its hydrophobic properties and lifetime performance.

• Specifying fire-rated foam seals with total impregnation of fire-retardant is better and safer vs. surface-applied retardant that can fail due to face damage from wear or vandalism.

• Using simple V Notch cuts in foam seal transitions vastly reduces the risk of seals either sagging or falling out entirely over time.
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