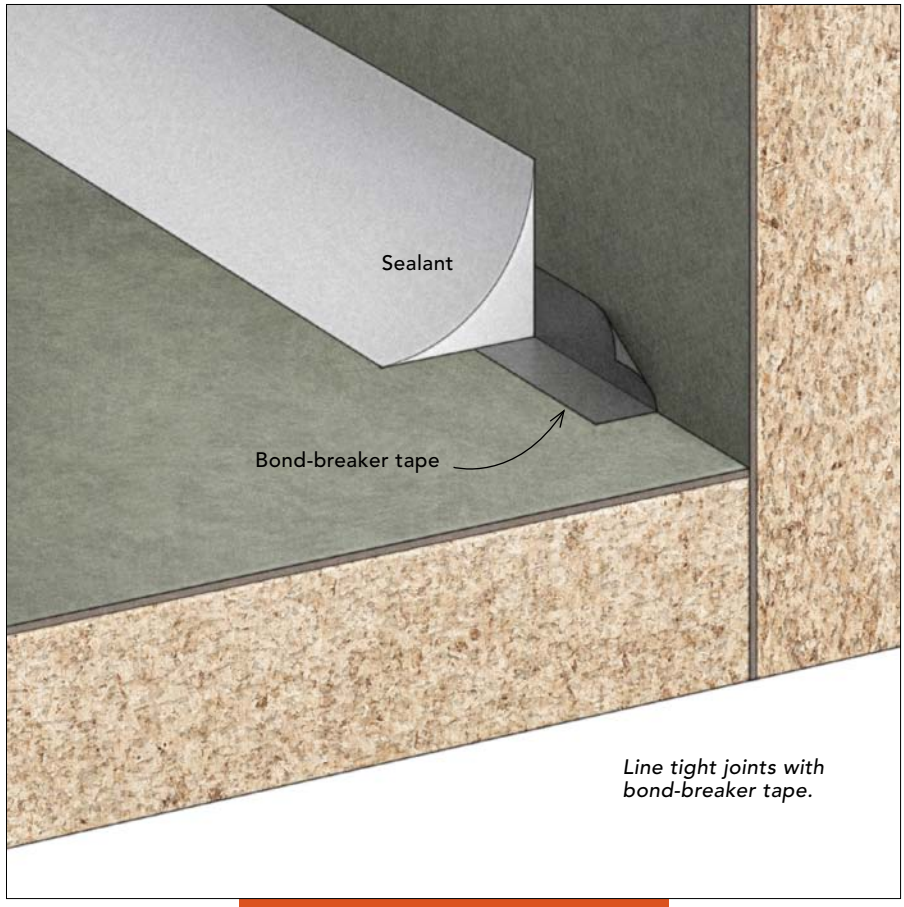
Caulk This Way

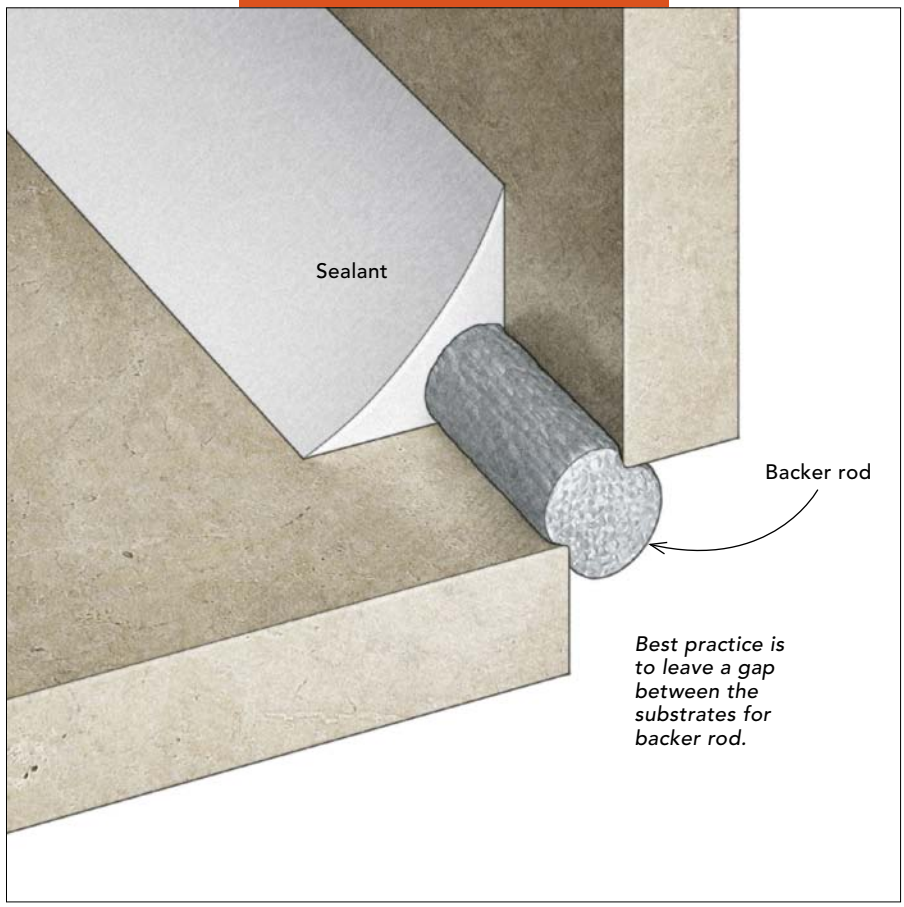
Joint design and prep may matter even more than choosing the right product

BY ANDY ENGEL



Line tight joints with bond-breaker tape.

CORNER JOINTS

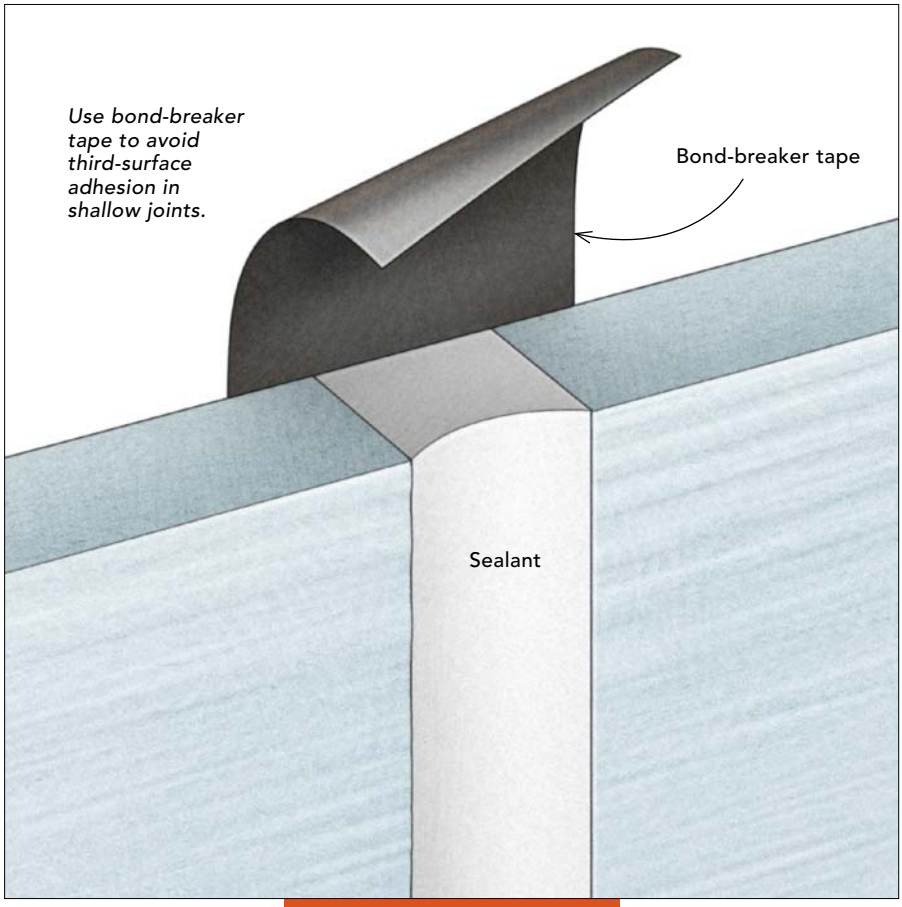


Best practice is to leave a gap between the substrates for backer rod.

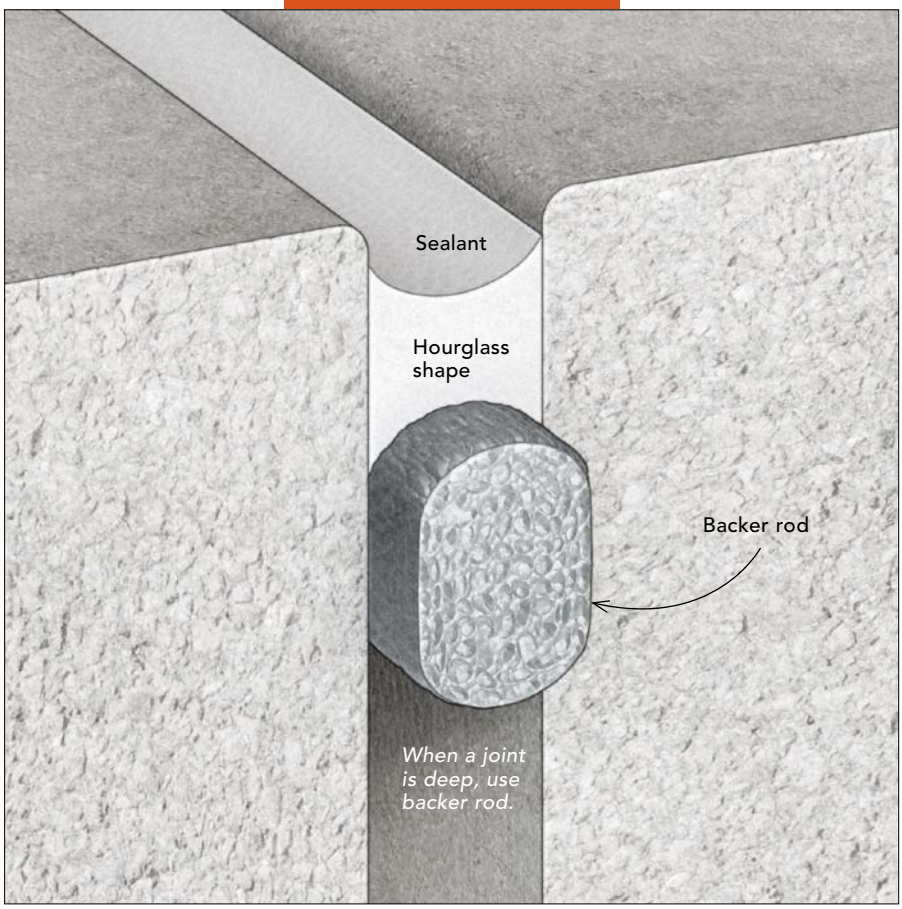
After researching and writing this article, I had an epiphany: In 35 years of doing and writing about residential construction, I have never seen a caulk joint executed properly. Most residential caulk joints I've seen have failed or are likely to. Builders, including myself, barely know which caulk or sealant to use where, and hardly anyone in residential construction knows how to execute a proper joint by considering crack width and depth and the use of backer rod or bond-breaker tape. There is a lot to know.

The first thing to know is that building components move. Builders don't like to acknowledge this. This may be because it feels like a reflection on their work, or because it introduces complexities in material choices and procedures they'd rather avoid, or just because it never occurred to them. Movement happens mostly because of changes in temperature and humidity. We see the results in gaps between materials. In some instances, such as with interior trim, this is only an aesthetic issue. But in other cases—the corners of a shower, the gaps around a window, expansion joints in concrete—such spaces can lead to

Drawings: Christopher Mills



FLAT JOINTS



DESIGNING JOINTS

According to Sika, a major sealant manufacturer, proper joint design and preparation eliminates 95% of callbacks for sealant failure. ASTM C920 covers joint design, including the required sealant depth where it meets the substrate, which depends on both the width of the joint and whether the surface is porous or not. Porous surfaces are found on materials such as concrete, masonry, fiber-cement siding, and raw wood. Examples of nonporous surfaces include aluminum, steel, glass, tile, painted wood, and plastics. There are three golden rules of sealant joints: They must be at least ¼ in. wide, surfaces must be clean, and the sealant must adhere only to two surfaces. Bond-breaker tape and backer rod are used to prevent the sealant from adhering to the back of the joint.

WIDTH-TO-DEPTH RATIOS

Joint width	Sealant depth
Porous substrates	
¼ in. to ½ in.	Equal to the joint width
½ in. to 1 in.	Half the joint width
Nonporous substrates	
¼ in. to ½ in.	¼ in.
½ in. to 1 in.	Half the joint width, maximum ⅜ in.

Control your sealant

While backer rod is readily available from home centers and hardware stores, bond-breaker tape is easier to find online.

crlaurence.com
nationalsealantproducts.com
sealantengineering.com

SEALANT PROPERTIES

No sealant does everything well. The trick is choosing the sealant that meets the requirements of the job and works for the conditions at hand. The properties discussed here are general, and some specific products within the category may perform better or worse than what's typical.

ACRYLIC/LATEX

Often the least expensive choice, these water-based caulks cure by evaporation. Consequently, they can shrink by a quarter to a third of their volume before they're fully cured. They hold paint well and usually can be painted within four hours. Most aren't as flexible as many other sealants, but they're a good choice for filling small gaps between interior-trim pieces.

BUTYL/RUBBER

The original modern sealant, butyl dates from the 1920s. It cures through the evaporation of organic solvents, shrinking a quarter to a third in the process. Butyl is sticky and can be harder to tool than other sealants, but it can be used in freezing weather. Best used outdoors because of its odor before curing, butyl is less common in residential construction than other sealants.

POLYETHER/SILICONE

So-called STPE (silyl-terminated polyether) sealants are similar to and sometimes superior to polyurethanes. Relatively new to the U.S. market, STPEs have been used in Japan for decades. Based on polypropylene glycol, they cure by reacting with water. The cure rate is much faster than that of polyurethanes, and STPEs can be painted sooner. They can be used on damp surfaces and in below-freezing temperatures, making them a good choice for outdoor use.

TYPE OF SEALANT	Acrylic/latex	Butyl/rubber	Hybrid polyether/silicone (STPE)
WORKING TEMPERATURE	40°F to 120°F	20°F to 100°F	0°F to 120°F
CURING METHOD	Water evaporation	Solvent evaporation	Reaction with water
TIME BEFORE PAINTING	2 to 4 hours	7 to 14 days	1 to 2 hours
MOVEMENT RANGE	12.5% to 25%	12.5% to 25%	25% to 50% typical, up to +100%/–50%
BEST FOR	Aluminum, concrete, fiber cement, masonry, vinyl, wood	Aluminum, concrete, fiber cement, masonry, steel, vinyl, wood	Aluminum, concrete, fiber cement, many plastics, masonry, steel, vinyl, wood
AVOID	Steel	N/A	N/A

serious effects by allowing unwanted air or water to enter. The solution isn't necessarily to make tighter joints, but rather to design the joints for the realities of the environment and the material, and then to install a good sealant properly.

I'm not arguing against good workmanship. The best caulk ever made still can't make a badly executed interior-trim joint look good, for example. But good workmanship sometimes means leaving a gap that's sized to allow a proper caulk joint. Many materials move so much with changes in temperature and humidity that no joint will stay tight, and so a flexible sealant is exactly the ticket. In fact, the manufacturers of building materials such as PVC trim, fiber-cement or wood-composite sidings, and vinyl windows actually specify gaps at joints to allow for movement and caulking. Good caulking is good workmanship, but maybe because caulking a joint feels like punting on quality—something done when a person lacks the skill or care to fit materials tightly—it gets short shrift. It's often not even clear whose job it is. The painter's? The carpenter's?

In commercial and institutional construction, caulk joints are expected to last for 10 to 20 years. In fact, the materials aren't even called caulks, but rather sealants. Joint design and sealant choice are handled by the designer (based on ASTM C1193), and the work is done by a specialty contractor. Mock-ups of building assemblies are made on-site so that the specified sealants can be tested for effectiveness with samples of the materials that will be used.

POLYURETHANE

Although urethane cures by reacting with moisture, it shouldn't be applied to wet surfaces or when rain is in the immediate forecast. An excess amount of water can cause a reaction that releases an undesirable amount of CO_2, which can cause the sealant to froth and compromise its ultimate strength. Although hard to tool, polyurethane sealants are paintable, long lasting, and abrasion resistant.

POLYURETHANE/SILICONE

These SPUR (silyl-terminated polyurethane) hybrids have characteristics similar to STPEs. Like STPEs, SPURs rely on groups of a long-chain polymer (in this case, polyurethane) for the backbone of the sealant, and groups of a second polymer (silyl or silane) for the ends. The long-chain polymer provides both elasticity and cohesive strength, while the silyl endcaps provide adhesion.

SILICONE

Early versions of silicone caulk had a so-called acid cure and released a vinegar smell. Modern silicone cures by reacting with moisture and gives off very little odor. Silicone bonds at a molecular level with glass, making it a good choice for frameless shower doors and tile. It doesn't take paint, and not even silicone sticks to where silicone has been used before, so recaulking usually requires mechanically removing some of the previous substrate.

Polyurethane	Hybrid polyurethane/silicone (SPUR)	Silicone
32°F to 100°F	41°F to 104°F	20°F to 120°F
Reaction with water	Reaction with water	Reaction with water
Up to 7 days	1 to 2 hours	Never
25% to 50% typical, up to +100%/–50%	25% to 50% typical, up to +100%/–50%	25% to 50% typical, up to +100%/–50%
Concrete, masonry, metal, stone, vinyl, wood	Aluminum, concrete, fiber cement, many plastics, masonry, steel, vinyl, wood	Aluminum, ceramic, enamel, glass, nonporous surfaces, plastics
N/A	N/A	Concrete and masonry, steel

There's usually no downside to using a more elastic caulk except that it will cost a little more. Given the small amount of caulks and sealants most projects require, spending a few bucks more on higher-quality products makes good sense.

Meanwhile, many of us in residential construction don't even know which of dozens of products to use. The marketing doesn't help; the caulk and sealant aisle is as confusing as a Marrakesh bazaar. Knowledge is the only defense. Caulks and sealants fall into just a handful of categories, and all of them are gauged by ASTM C920.

Caulks and sealants are meant to keep out air and water over the long term. To do these things, a product must balance elasticity, strength (cohesion), and adhesion—that is, it must stretch in response to material shrinkage without tearing or detaching from its substrate. It must compress when the material around it expands, and return to its original shape when the material contracts. Other important characteristics to consider when choosing a product include UV resistance, durability, paintability, and workability. Also, chemicals from a caulk or sealant might stain some surfaces, such as marble.

Understanding performance criteria

ASTM C920 provides a uniform platform for comparing sealants and is often specified on construction documents for commercial buildings. Some products provide C920 data on the tube, while for others, you have to go to the manufacturer's website. C920 incorporates 10 tests and multiple classifications, but the most important consideration is elasticity. Class 12.5 sealants can stretch and compress 12.5%, whereas Class 50 sealants can stretch and compress 50%. There are even Class 100/50 sealants that stretch 100% and compress 50%. This,

Polyurethane safety

Although health problems are more common among spray-foam installers and other workers with high exposures, anyone using a urethane-based product may be at risk. Isocyanates, the building blocks of all urethanes, are the reason. Isocyanates are chemicals that polymerize by binding with OH molecule groups such as are found in water and many organic solvents. Depending on other components, this polymerization forms a variety of useful end products such as paints, wood finishes, glues, insulating foams, and sealants.

According to Christopher Weis of the National Institute of Environmental Health Sciences, "Contact with uncured isocyanates by breathing or through the skin can sensitize workers or family members. Once someone is sensitized, future exposures can cause severe asthma and skin problems." Asthma isn't just an inconvenience. People have died from isocyanate-induced asthma attacks.

But the news isn't all bad. The California Department of Public Health says, "Fully-cured polyurethanes are non-toxic, unless they are heated. Polyurethane materials give off isocyanates and other toxic substances when they are burned or abraded."

Be cautious with any polyurethane product. While activities such as spray-foam application call for a Tyvek suit, rubber gloves, and a full-face supplied-air respirator, NIOSH standards allow a regular organic-vapor cartridge-type respirator to be used for operations of a short duration. Good ventilation is also recommended, as is avoiding skin contact by wearing nitrile or neoprene gloves.

Stay safe. *Use a respirator and plastic gloves to minimize isocyanate exposure.*

by the way, is a loose way to distinguish between the terms *caulk* and *sealant*. Your local hardware store or home center sells products labeled both ways, but caulks are less flexible than sealants and may have an elasticity factor of less than the 12.5% minimum required to meet C920.

For most exterior uses, Class 25 sealants are sufficient, while for interior use, Class 12.5 might do. Not all caulks comply with C920, but one that doesn't might still perform just fine in filling trim joints so that paint will look good. With interior trim, the most important attributes are fast drying times, ease of application, and paintability. Still, there's usually no downside to using a more elastic caulk except that it costs a little more. But given the small amount of caulks and sealants most projects require, spending a few bucks more on higher-quality products makes good sense.

Some caulks or sealants claim to "meet the performance standards of ASTM C920." That's not the same as complying with ASTM C920, but it may not mean that the caulk is inferior. Often, such caulks are solvent based and shrink more during their cure than the standard allows. It's more important to know the elasticity.

One type of sealant not intended to keep out air and water or to make trim joints look good is acoustical sealant. Its purpose is to keep out sound, although it's often used in energy-efficiency applications such as sealing wall plates to subfloors and plastic vapor barriers to crawlspace foundations. Acoustical sealant never hardens, so it accommodates movement well. It remains sticky and is only used where it's unlikely to be encountered once construction is complete.

Joint size and backer rod

For a sealant to stretch and rebound and to remain adhered to the substrate, there must be enough of it in place. In general, sealants require a gap of at least ¼ in. In fact, ASTM C1193, the standard that governs sealant-joint design, states, "Under no circumstances should a liquid applied sealant [a technical term that includes caulks in a tube] be applied in a joint opening that is less than 6mm (0.25 in.) wide." The standard is concerned with joints that must be weathertight, so this doesn't apply to caulked joints along interior trim, for example. The same standard also provides depth-to-width ratios for sealant application, which are crucial to a durable joint.

Sealants are also meant to adhere to two substrates, stretching and compressing as they move. If you introduce a third surface, such as the material underlying the two substrates, adhesion to that third surface can interfere with the sealant's ability to stretch, and it may crack or detach from the surrounding materials.

Clearly, it's important to manage the depth of the sealant application. That's where backer rod and bond-breaker tape come in. Backer rod is made from open-cell or closed-cell foam and is available in diameters from ¼ in. to 6 in. Curiously, it's often stocked alongside weatherstripping products rather than caulks. Backer rod should be sized so that it's 30% to 50% wider than the joint. It pressure-fits into the joint to create a space based on what's required to achieve the correct sealant depth. It's also available in triangular shapes for corner joints where there is no space between the two substrates. Backer rod is very flexible, and sealants don't tend to stick to it, so it doesn't create third-surface adhesion problems. With proper tooling of the face of the sealant using a plastic spoon, Popsicle stick, or your finger, backer rod helps to form the sealant into an hourglass shape that optimizes both the elastic and the adhesive qualities of sealants.

Add paint to the caulk tube. *Measure out the specified amount of paint with the supplied syringe, then cap and shake.*

Add activator to the tube and shake. *The activator causes the caulk, which is very liquid until now, to thicken.*

Caulk neatly. *After allowing 30 minutes for the activator to thicken the caulk to a normal consistency, fill the joint.*

Color-matched caulks

Responding to the increasing popularity of factory-painted siding and trim, some manufacturers of caulks and sealants make products in hundreds of colors to match the palettes offered by siding manufacturers. In most cases, these products are purchased from the siding supplier.

Two companies, Red Devil and Sashco, offer tintable caulks. Simply add the specified amount of the paint you're matching to the special caulk tube, shake it like Elvis after a triple espresso, and caulk away. You can even match faded paint by taking a sample to a paint store and requesting a small quantity of color-matched paint.

Color-matched sealants can be a boon when you're caulking materials with high coefficients of expansion. In some cases, although you can easily find a sealant that will handle the movement, no paint is that flexible. The paint will crack and reveal the caulk below. By using a color-matched sealant, the problem goes away.

Although backer rod made of closed-cell foam has few drawbacks and is the type commonly found in retail outlets, backer rod made of open-cell foam can be helpful with moisture-cure sealants such as STPE, polyurethane, and silicone. In dry climates, or in cases when you want a faster cure, open-cell backer rod may allow moisture to reach the back side of the sealant to accelerate a full cure. It's also more malleable than closed-cell backer rod, making it a better choice for irregular joints. That said, ASTM C920 advocates caution when using the open-cell product in horizontal applications because it can wick and retain water.

Bond-breaker tape is harder to find than backer rod; I could only buy it online. In joints too shallow to accommodate backer rod, bond breaker tape applied to the rear or bottom substrate prevents three-sided adhesion. Inside corners are another application, and ¼-in. bond-breaker tape allows very shallow fillets of sealant.

Surface prep is crucial

It doesn't matter which caulk or sealant you use or how much money you spend on it; if you apply it to a dirty, loose, wet, or contaminated surface, it won't adhere. For example, any building material that spent time in a lumberyard warehouse is likely to be contaminated with oily soot from diesel trucks and forklifts. The prep varies with the surface. Wood should be fresh and clean. A light sanding followed by vacuuming or blowing off the dust with compressed air should be sufficient. Painted wood, plastic (such as PVC trim or vinyl windows), and aluminum trim or window cladding need a dusting (microfiber cloth does a great job) and should then be wiped down with a solvent such as MEK, acetone, or mineral spirits. Test the solvent on a small area to be sure it doesn't damage the substrate. Wipe the surface with a solvent-saturated rag, then follow up with a clean, dry rag before the solvent evaporates. Change the rags frequently. Old caulk joints, masonry, and concrete might require scraping, grinding, wire brushing, and a blast of compressed air. Leave no loose material.

Silicone leaves a residue that not even silicone will stick to. Mechanical cleaning such as sanding or wire brushing is usually required, although Sashco's Charis Babcock reports success in removing silicone with McKanica Silicone Caulk Remover (mckanica.com).

Site conditions matter as much as prep. Many sealants specify a minimum application temperature of 40°F. There are several reasons for this, but perhaps the most important is simply that the surface-wetting characteristics of most substances decreases at colder temperatures. Simply put, most sealants don't stick well to cold surfaces. Additionally, many sealants don't flow well from the tube when they're cold, and inconsistent application can create voids that weaken the bond. Finally, cold temperatures can slow curing, exposing the soft sealant joint to damage. That said, there are some sealants whose manufacturers allow application in cold or wet conditions, but no one claims these conditions are optimal. If possible, wait for a nice day. □

Andy Engel is a senior editor. Photos by Rodney Diaz.