Sealants technical manual

IMPORTANT!

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WHY IS THIS STUFF IMPORTANT?

The key to completing any construction project cost-effectively is production efficiency. That's why all builders—professional and amateur alike—love shortcuts.

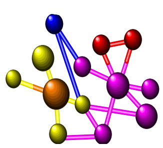
Framing carpenters know (or at least think they know) how to size framing lumber without checking the span tables—2x12s for headers, for example, or 2x10s for floor joists up to 14 feet long. Homeowners know (or think they know) that a nationally-known brand name is always a better product than its local counterpart.

Likewise, if you ask builders which sealant or adhesive is the right one for their job, chances are that they assume more than they may actually know. They think that the more expensive the sealant, the longer it will last. Simple arithmetic tells them that a 50-year sealant must be twice as good as a 25-year sealant. Sometimes, that's not a problem. Other times, it can be downright dangerous.

Residential construction has become much more sophisticated than it was even a few decades ago. Materials and techniques that were once considered radical are now part of the mainstream. Moreover, as energy efficiency has gained importance, the ability to control air and moisture infiltration has become critical. As a result, modern construction assemblies rely more than ever on sealants and adhesives.

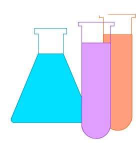
The good news is that sealants and

TO GET THE MOST OUT OF THIS BOOK, look for the symbols in the margins:

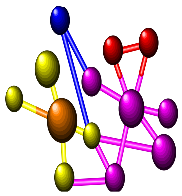


BUILDING BLOCK - This is a key point; pay close attention.

FORMULA - A summary of what you've just read.



EXERCISE - Test your knowledge before you move on to the next segment.



Your customers often don't know how important the right sealants are to a successful building project — which makes it doubly important that *you* do.

adhesives are also more sophisticated than they have ever been. Manufacturers can formulate their products for exceptional elasticity, adhesion, longevity, resistance to mildew or sunlight, and so on. The problem is that, just as a super-insulated house is superior but not practical in all situations, building all those properties into a single sealant is neither necessary nor cost effective in most residential construction.

It is critical, however, that builders choose the *right* sealant for the job, and not simply the one that is priced to match the level of quality they had in mind for the job as a whole.

The catch is that selling the appropriate product for the job can be tricky. Football coach Lou Holtz jokes about the college counselor who once told him that he not only didn't know what was going on, he didn't know there was anything going on.

The same applies to sealants and adhesives: Chances are that your customers not only don't know which product they should use, they don't realize that it makes a difference.

As a result, you'll be inclined to stick with which ever products you've used successfully in the past, regardless of whether the situation is different this time around.

In order to guide you to the right product, you need to know not only which products to use, but why. You'll have to understand the principles behind each formulations so you know how each product is designed for the application.

That's obviously a challenge, but it also represents an opportunity. Every building material salesperson learns how to sell big ticket items—doors, windows, cabinets, and even whole house packages. What separates successful salespeople from those who are merely average is the expertise to make sure that the products they sell live up to their promise long after the job is completed.

More often than not, the long-range performance of the structure as a

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CONSTRUCTION JOINTS

whole depends on the sealants and adhesives used during construction.

Many of the advances in sealant technology made over the past fifty years are the direct result of changes in the methods and materials used in commercial construction projects.

OBJECTIVES:

WHEN YOU HAVE COMPLETED THIS CHAPTER, you will be able to

- **define the difference between sealant and caulking,**
- **understand basic construction joint design, and**
- **identify the critical factors in sealant performance.**

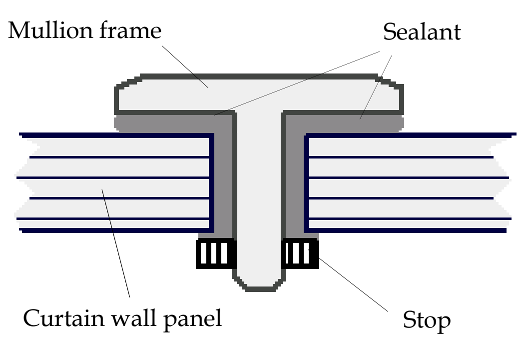
Before the 1950s, most commercial structures were built with masonry. Masonry is dimensionally an extremely stable material which doesn't expand and contract in response to temperature changes nearly as much as other materials.

As a result, the joints between a masonry wall and other materials used in the structure—for example, door and window frames—never moved much. Those joints could be sealed with caulking without great concern for leakage.

The advent of curtain wall construction changed all that. In a curtain wall structure, a steel frame is covered with a non-structural skin made of glass, metal, masonry, or even plastic.

The rate at which glass, metal, and plastic move in response to temperature changes—called the *coefficient of linear expansion*—is much greater than that of masonry. If those materials are to be used together, the joints between them must be sealed with a material that also moves.

TYPICAL CURTAIN WALL DETAIL (TOP VIEW)



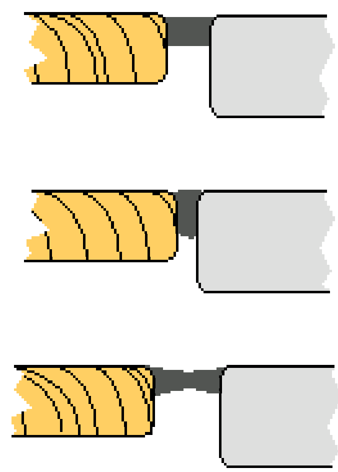
Old, reliable oil-base caulking simply won't do the job. Caulking is no more than a filler; it can be molded to an uneven gap and retain its softness for an extended period of time, but if the joint is unstable, cracks will quickly open up between caulking and the base material.

What builders needed was a product that would adhere to dissimilar materials, and expand and contract to maintain a seal as those materials moved. That demand led to the development of sealants—i.e., *elastomeric* materials that change shape without losing their structural integrity.

At first glance, it may seem that the applications residential contractors face aren't as critical as their counterparts in commercial construction. The buildings aren't as large, and the range of materials used isn't as wide.

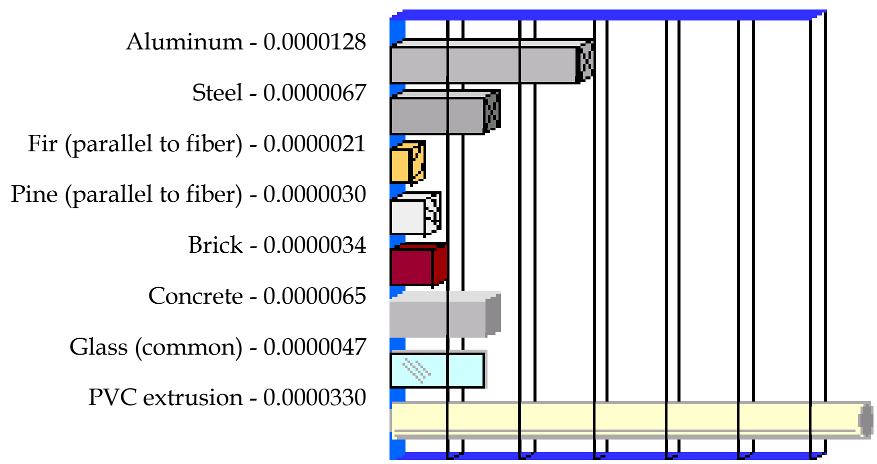
Nevertheless, their objectives are the same: to prevent damage to the

SEALANT VS. CAULKING



Unlike caulking, sealant stretches and compresses as the substrate moves.

COEFFICIENTS OF LINEAR EXPANSION FOR SELECTED BUILDING MATERIALS (IN INCHES PER DEGREE FAHRENHEIT)

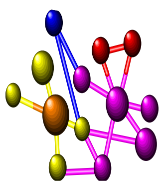


building and to maximize energy efficiency. Doing so requires an understanding of the role construction joints play in any structure.

THE PURPOSE OF CONSTRUCTION JOINTS.

Some degree of movement occurs in all buildings, regardless of size. Changes in temperature aren't the only cause; vibration, stress between adjacent materials, fluctuating moisture content in wood, and live loads such as wind or snow all cause movement.

That's why joints are built into every structure. Those gaps allow the building to flex without damage.



Construction joints are a key component in design, because they allow the building to move in response to environmental changes, without damage.

Obviously, there will be joints wherever dissimilar building materials meet—windows and doors in a stud wall, for example. Other joints, however, are intentionally designed into the structure.

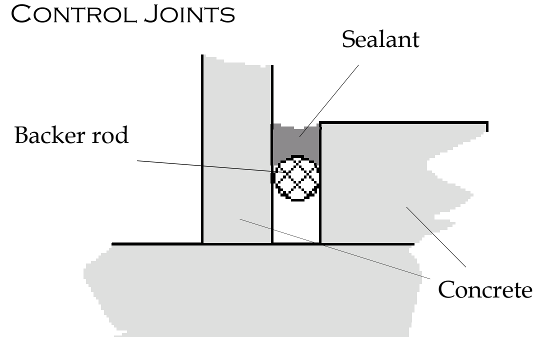
For example, roof and floor sheathing panels must be spaced apart so the sheets won't buckle when they expand with changes in humidity. Large concrete slabs are divided into sections and separated with strips of fiberboard to control cracking.

Not all joints need to be sealed, of course. But those that do must be sealed with a product designed specifically for the application. The first step in selecting the right sealant is understanding the type of construction joint that needs to be sealed.

TYPES OF CONSTRUCTION JOINTS.

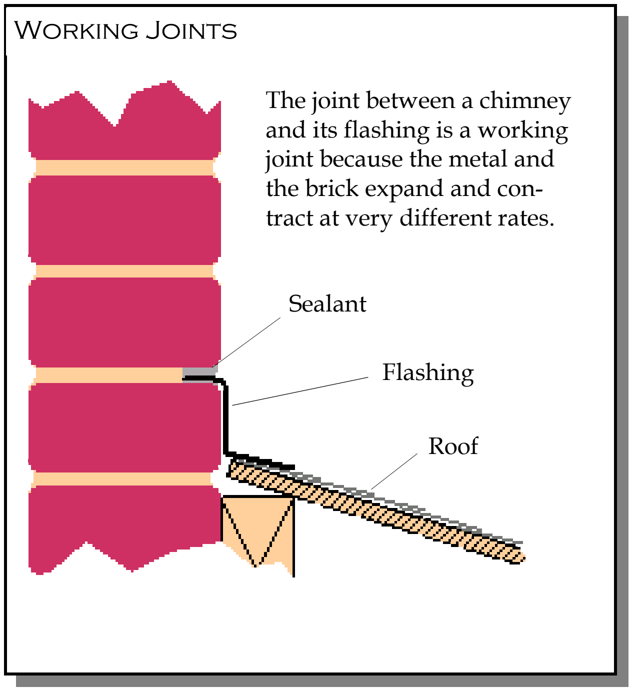
Joints that prevent crushing, warping, buckling and distortion are called *expansion* or *isolation* joints. They include, for example, the gap between a slab and a foundation wall.

CONTROL JOINTS



A control joint allows a concrete slab to move without cracking. Backer rod supports the sealant bead.

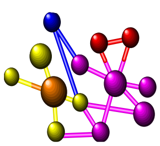
Control joints are used in situations where cracking is inevitable, to insure that cracks occur in predetermined locations.



Non-working or *static* joints are designed for situations where the stress between materials is minimal. They include the gap between a sink and countertop, for example, or between the backsplash and the wall.

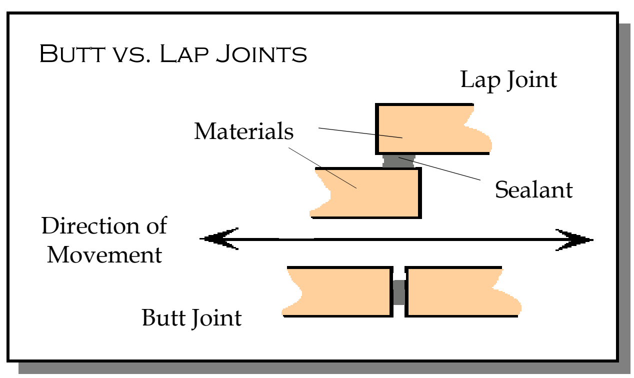
Joints that expand and contract with changes in temperature are called *working* or *dynamic joints*.

They are among the most critical joints—gaps between a window frame and the wall sheathing, for example, or between a chimney and the chimney flashing on a roof.



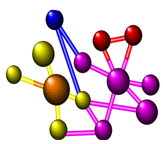
Working joints (also called dynamic joints) are the most critical, because their constant movement makes them difficult to seal.

The configuration of the joint also matters. When two materials butt against each other, the joint is called a *butt joint*. If the materials overlap, the joint is called a *lap* or *shear joint*.



These distinctions are

important because a sealant's performance is directly related to the type and configuration of the joint, and the movement that takes place over an extended period of time.



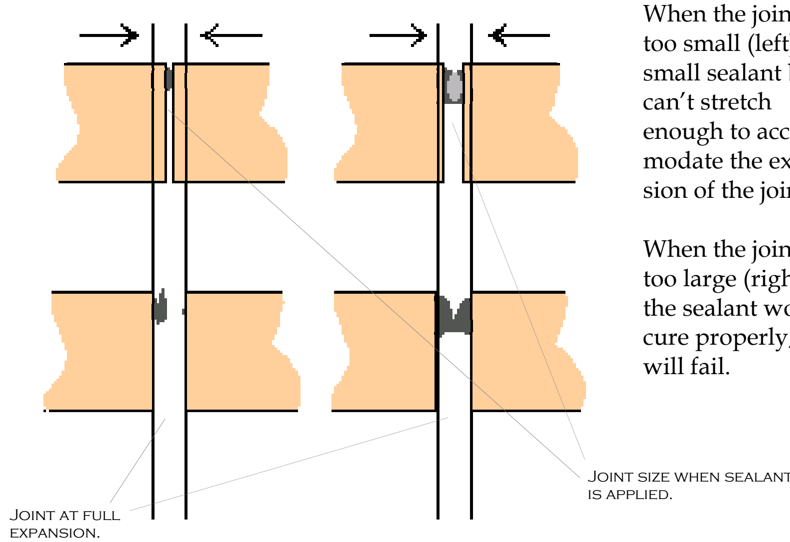
The most important consideration is the size of the joint in relation to the expected movement of the substrate. Any sealant will only expand or contract so much, so the joint must be neither too wide nor too narrow.

JOINT DESIGN.

In order to last, the sealant must adhere tightly, and therefore be compatible with all surfaces. That can pose a challenge when the materials to be sealed are dissimilar both in composition and in thermal expansion properties, for example, porous concrete and non-porous aluminum. Because the adjoining components may be so different, the design of the construction joint is an important factor in determining the performance of a sealant.

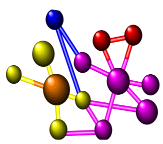
Joint Size. The most important consideration is the size of the construction joint in relation to the expected movement of the components. Any given sealant will only expand or contract so much, expressed as a percentage of the size of the bead. As a result, the joint must be neither too narrow nor too wide, or the sealant will fail.

BEAD SIZE AND ELASTICITY



When the joint is too small (left), a small sealant bead can't stretch enough to accommodate the expansion of the joint.

When the joint is too large (right), the sealant won't cure properly, and will fail.



Two characteristics — adhesion and cohesion — determine a sealant's abiliy to maintain an air- and water-tight seal.

If the bead required to fill the joint is too large, the sealant won't cure properly. If it is too small, the bead may not be able to stretch and compress enough to accommodate the movement of the substrate materials.

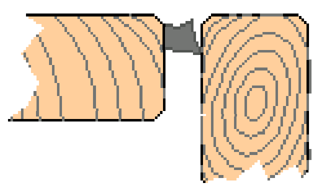
Minimum recommended bead sizes vary by product, but 1/8-inch x 1/8-inch or 1/4-inch x 1/4-inch are typical.

Finally, the type and condition of the substrate materials is a major factor in the sealant's performance. In all cases, the joint should be free of loose material. The surface may need to be cleaned with a solvent—acetone, for example—or sanded lightly to remove traces of oil or other residues. Some surfaces may also need to be primed before the sealant is applied.

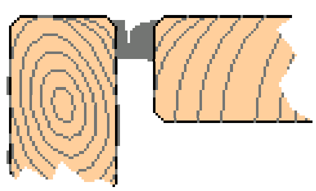
You don't need to be able to calculate coefficient of linear expansion or quote the peak elongation percentage for every sealant you stock. You do need to check the manufacturer's specifications and follow them closely.

And most important, you need to recognize when the application doesn't fit into any of the guidelines you'll learn about in this manual, so you know when to call the manufacturer for help.

ADHESION VS. COHESION FAILURE



Adhesion failure -- the sealant loses its bond with the substrate material.



Cohesion failure -- the sealant loses its internal bond.

HOW SEALANTS WORK

All sealants are made from *polymers*, or synthetic rubber molecules. The first sealants were based on polysulfide polymers, but it wasn't long before acrylics, silicone and urethane were developed. Each has specific properties which make it well suited to some applications, but not necessarily appropriate for others.

Adhesion and Cohesion. The two most important characteristics of a sealant that allow it to provide an air and water tight seal are its adhesive and cohesive qualities.

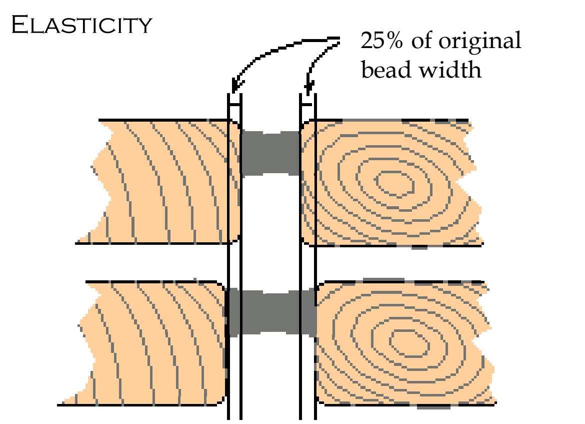
Adhesion is the ability of a sealant to bond to another material. It is measured in pounds per linear inch (PLI); sealants used in residential construction typically range from 5 to 20 PLI.

Naturally, good adhesion depends not just on the sealant, but the substrate material. If the substrate is brittle, flaky, or unsound, the sealant may cause the subtrate itself to fail.

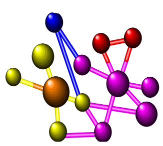
Likewise, if the substrate is contaminated with dust, moisture, chemicals or other foreign agents, the sealant may not be able to "grab onto" it.

Cohesion refers to the ability of a fully cured bead of sealant to resist splitting or tearing internally as it is stretched by the movement of the substrate material.

As important to performance as adhesion and cohesion is a sealant's elasticity—i.e., its ability to stretch and compress, to follow the movement of the substrate materials. This flexibility is expressed in terms of *cyclic movement*, a percentage of the original bead width.



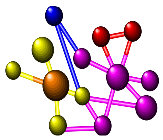
A sealant with a cyclic movement rating of ±25% will stretch a total of 50% beyond its original width, or 25% in each direction.



Elasticity is as important to a sealant's overall performance as its adhesion or cohesion properties.

For example, a highly elastic sealant may be able to stretch or compress as much as 50% overall, or 25% in each direction. Thus, its cyclic movement rating would be ±25%.

The major factor which affects joint movement the most in residential construction is the expansion and contraction of the building materials. In the case of wood, most expansion and contraction is a result of moisture gain or loss from the wood itself. In the case of most other building products, expansion and contraction results from temperature changes in the materials



The best sealant in the world won't perform if it is applied improperly, or to the wrong substrate in the wrong conditions. As a result, service life is meaningful only as a means of comparing different types of sealants.

themselves and the ambient temperature inside or outside the structure.

Natually, substrates that have the potential for high expansion rates should be sealed with sealants that have high elasticity ratings.

Ultraviolet (UV) radiation resistance. The ability to withstand ultraviolet (UV) radiation is an important factor in the performance of any sealant that will be used in exterior applications. UV resistance is typically achieved by adding stabilizers to the sealant formula.

Curing. The overall performance of a sealant may be affected by its curing characteristics, which may be greatly influenced by the weather conditions in which it is applied.

Most sealants cure by evaporation of their volatile compounds (water or solvent). Some shrinkage may be noticeable, depending on the formulation.

Water based sealants obviously will not cure in below freezing conditions and should not be applied in these circumstances. Some sealants cure by a chemical reaction with humidity in the air. They do not shrink as much as water-based sealants, but may cure poorly in arid conditions, or in a combination of high humidity and high temperature.

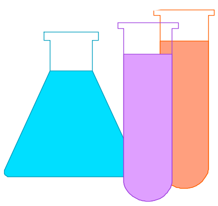
Also, carbon dioxide emissions which occur during the curing process of polyurethanes may cause the formation of voids thereby reducing the cohesiveness of the product.

Service life. Much is made of a sealant's service life. Manufacturers often claim 25-, 35-, and 50-year ratings for their products, and professionals tend to use those ratings as an indicator of the overall quality of one product versus another.

In fact, the effective life of any sealant depends on all the factors described above. The best sealant in the world won't perform if it is applied improperly, or to the wrong substrate in the wrong conditions.

As a result, service life is relatively meaningless except as a means of comparison between similar types of sealants.

Summary



- The demand for sealants that would move with the movement of the substrate led to the development of *elastomeric* sealants that can change shape without losing structural integrity.

- There are three basic types of joints: 1) *Control* joints control the locations of cracks; 2) *Non-working* or *static* joints are designed for minimal movement in the substrate; 3) *Working* or *dynamic* joints are designed for situations where there is significant movement in the substrates.

- Joints may be designed in two configurations: 1) *Butt* joints, where the substrates meet end to end, and 2) *Lap* or *shear* joints, where the substrates meet face to face.

- The most important consideration in joint design is the size of the joint. If the sealant bead is too small, it can't stretch as the joint moves; if it is too large, the sealant won't cure properly.

- Adhesion is the ability of a sealant to bond to another material; cohesion is its ability to maintain internal structural integrity.

- A sealant's elasticity is expressed in terms of cyclic movement — i.e., its ability to stretch in width, as measured in a percentage of the bead's original size.

- Depending on the type, a sealant may cure by evaporation of its volatile compounds (water or solvent), or by a chemical reaction that occurs when the sealant is exposed to humidity in the air or to oxygen.

- The rated service life of a sealant (for example, 25 or 50 years) is meaningful only as a means of comparison between types of sealants.

Exercises

1. List three static joints and three dynamic joints that occur in the typical home.

2. Check around your site and find locations where sealants have been used in the construction (for example, doors and windows, or around the sink in the rest rooms). Try and find areas where the sealant has failed, then identify the failures as either adhesion or cohesion.

3. Make a list of the sealants at your store. For each one, check the label to see if it tells you a) the cyclic movement rating of the product, and b) the way that it cures (evaporative or chemical). Write your findings next to the name of the sealant on your list.