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**Fundamentals  
of Steel  
Construction**



**The Use of  
Sealants  
in Roofing**





# THE USES OF SEALANTS IN ROOFING

BY KARL SCHAAK

**E**lastomeric sealants are used widely in conjunction with sheet metal fabrications during roof construction. A wide variety of sealants is commercially available, and each type has specific performance characteristics. Sealant types currently utilized in roofing installations include silicone, polyurethane, and butyl. Applications for sealants in roofing include caulk troughs of surface-mounted counterflashings/termination bars, penetration bonnets, coping stone joints, lap joints in sheet metal fabrications (i.e. counterflashings, copings, etc.), fillers in pitch pans, and in-seam sealers in metal panels. In order to achieve the desired performance of sealants, there are several issues regarding the design and installation that require proper attention.

## Joint Design

The optimum joint profile for elastomeric sealants, as published by the sealant industry, consists of an "hourglass-shaped" configuration applied between two parallel planes. The size of the sealant joint depends on several variables with a general rule of thumb of a width-to-depth ratio of 2:1. There are four basic rules that cover basic sealant joint dimensioning:

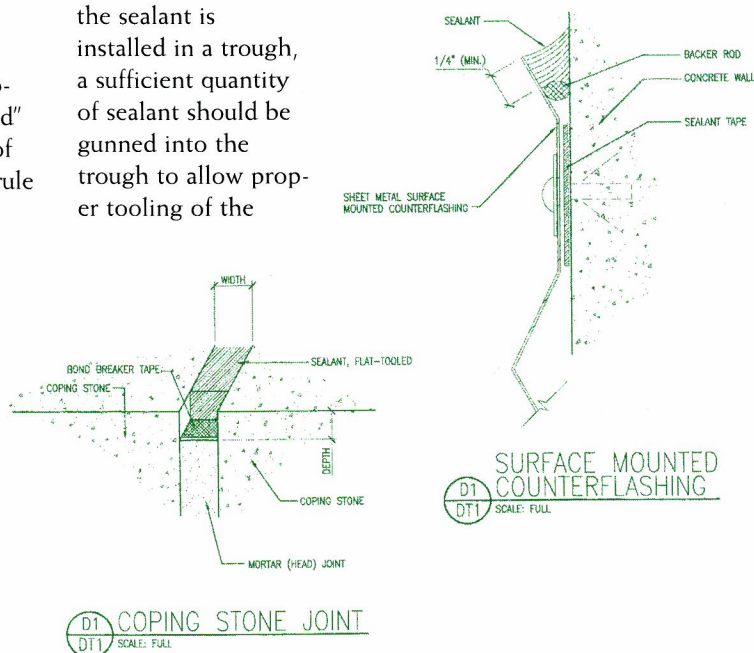
1. The minimum joint size should be 1/4-inch x 1/4-inch.
2. For joint widths of 1/4-inch to 1/2-inch, the depth should not exceed the width with a minimum depth of 1/4-inch.
3. For joint widths of 1/4-inch to 1 inch, the depth should be 3/8-inch to 1/2-inch.
4. For joint widths from 1 inch to 4 inches and up, the depth should not exceed 1/2-inch, depending on the actual width, application, and sealant type.

The actual size of the joint should be determined from the calculation of the different types of anticipated movement and allowable tolerances. Installations of

sealants in roofing consist of the material applied in triangular or fillet-shaped profiles, "cap" bead profiles, sandwiched between "plates" or lap joints, and in the hourglass configuration in butt joints.

## Fillet-shaped Profile

The fillet-shaped profile occurs in caulk troughs of surface-mounted counterflashings, termination bars (T-bars), or along the top edge of counterflashings along vertical substrates. The trough is formed as the top edge of the metal counterflashing or T-bar is bent outward at an angle of approximately 30 to 45 degrees. The depth of the trough is typically approximately 1/4 to 1/2 inch. When the sealant is installed in a trough, a sufficient quantity of sealant should be gunned into the trough to allow proper tooling of the





sealant and to achieve a "canted" profile or a profile with a sloped face. If the sealant is of insufficient quantity and cannot be tooled, then proper bonding to the substrates will not be achieved.

Often sealant is applied in this location without proper tooling. Tooling of the sealant is a necessary exercise as it accomplishes important results:

1. The tooled sealant is "pushed" toward the surfaces to promote bonding to the substrate.
2. Tooling will eliminate voids within the sealant and provide a smooth finish (closed pores) on the exposed face of the sealant.
3. Tooling provides a uniform cross-section of the sealant and reduces premature failure due to in-place defects.

A finished canted profile will provide a surface that is sloped away from the vertical wall and will shed water away from the potentially vulnerable sealant bond interface. A backer rod can be inserted into the trough to minimize and control the depth of the sealant and to provide a back-up substrate to tool against. A minimum 1/4-inch-wide adhesion surface area or "bite" on both the wall and trough should be obtained for each side of the sealant to achieve proper bond.

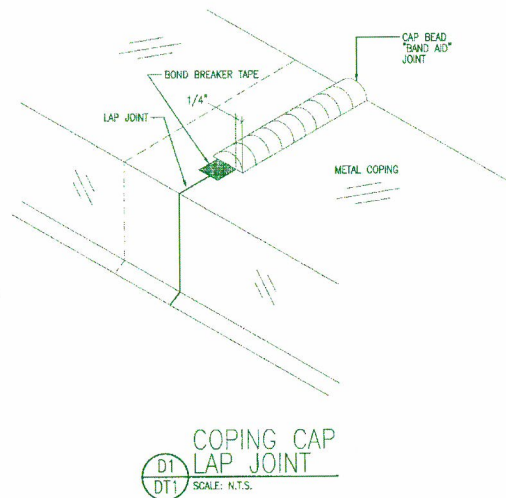
The substrates receiving the sealant should be properly cleaned prior to application. Bituminous or other adhesive-type materials from installation of the roof flashings often contaminate the wall in the area to receive the sealant. Most sealants (particularly those discussed herein) are not compatible with bitumen or other adhesives and will often degrade or disbond in

the affected areas. In addition, the sheet metal used to fabricate the counterflashing—particularly galvanized metal—may have an oily residue or film on the surface. This film could act as a bond breaker and compromise bonding of the sealant. Cleaning the contaminated substrates by solvent wiping or a more extensive abrading method may be necessary to achieve a proper surface to receive sealant.

### Cap Bead Profile

The cap bead profile, referred to as a "band-aid joint," can be applied over the exposed, leading edge of sheet metal in a lapped configuration such as a cap flashing.

Although this joint type does not meet the optimum joint profile, similar installation techniques and methods apply. Since the sealant is applied over what is classified as a moving



# WIDER.





joint, a bond breaker or bond preventative tape (1/4-1/2 inch wide polyethylene strip) should be placed directly over the edge/joint to provide a "slip" joint. The sealant should be gunned over the taped joint in sufficient quantity to achieve minimum 1/4-inch-wide attachment points on each side of the joint and a 1/8- to 1/4-inch sealant bead thickness.

The sealant should be tooled to form a convex-shaped or "cap" profile. It is recommended that masking tape be applied on the substrate (metal) surface prior to the sealant application to provide demarcation for the outer edge of the joint and to create a clean, straight, finished edge. Cap beads of sealant are also commonly applied over the heads of exposed fasteners and riveted, non-moving joints. In these applications, bond breaker tapes are not required or used.

### Sandwich Profile

Sealant is installed in a "sandwich" profile when placed between two sheet metal surfaces such as lap joints in counterflashings and copings. The sealant is gunned in a continuous bead onto the base metal layer, and the overlapping piece of metal is pressed into place. This lapping sequence compresses the sealant and spreads the bead into a thin layer of sealant. Although this joint type resembles the archetypical profile, the movement or forces transmitted on the sealant are shear in nature, in lieu of



*Installation of Band-aid joint with taped sides over seam in metal cap flashing.*

compression and tension as experienced by the archetypical profile. Sealants have poor shear strength qualities when reduced to a thin film.

One method that could aid in achieving better sealant performance involves the inclusion of spacers within the joint that would prevent metal-to-metal contact and result in a sealant with

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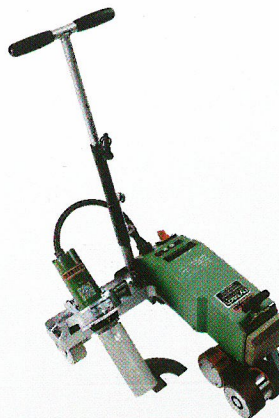
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a uniform cross section. Butler Manufacturing Co., located in Kansas City, MO, provides both its gun-grade ("Panlastic") and tape version ("Beadmastic") of butyl sealant with small pieces of nylon dispersed throughout the sealant matrix for the installation in its metal panel roof systems. These pieces of nylon function as spacers and allow the sealant to be compressed to a predetermined thickness, preventing the sealant from being "squeezed" out of the joint.

Using a preformed sealant tape, which has a relatively higher density than gun-grade versions of sealant, can also reduce the chances of the potentially detrimental "squeezing" of the sealant from the joint. In using pre-formed sealant tapes, several precautions are urged. As with all sealants, the mating surfaces of the adjoining metal surfaces should be properly cleaned. These sealant tapes, which are double-sided/self-adhering, come in a roll with a release paper backing to prevent the material from bonding to itself.

During the installation of these products, contamination of the adhesive surface by human touch should be minimized, as the oils and dirt from the skin will reduce the bonding capabilities. Upon removal of the release paper, the mating surfaces should be adjoined immediately to prevent wind-blown moisture, dust, dirt, or other contamination of the exposed sealant from occurring. After the plates are joined, they should be maintained in a uniform compression to promote adhesion until the sealant achieves proper cure. If the metal surfaces separate from

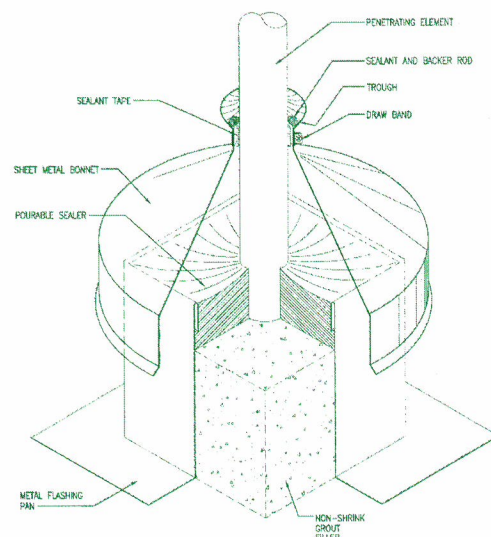
or are not in contact with the sealant tape, contamination and, subsequently, improper bond, are likely.

Sealants are also utilized in side and end lap seams of metal panel roof systems in what would be considered the sandwich profile. Hot melt, factory-applied sealants are

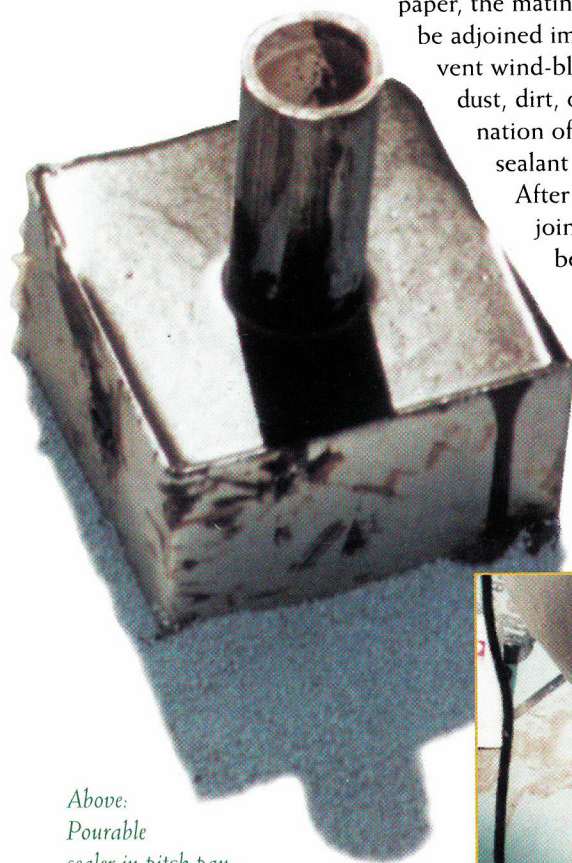
typically utilized by the manufacturer within the standing seam and are part of the panel manufacturing process. The sealant is captured within the seam and sandwiched between the metal surfaces during the seaming process. These sealants are usually either butyl- or polyisobutyl-based materials. In field-formed lap seams of metal panels, either gun-grade, pre-formed tape sealants or a combination of both is applied in a sandwich fashion to "seal" the seam.

### Filler Material

Sealants are used to fill or seal pitch pans that are installed around penetrations through roof systems. The sealant in this type of application is referred to as pourable sealer. The metal pans should be a minimum of four inches above the roof surface and integrated into the roof membrane with an appropriate flashing. A cementitious, non-shrink grout or other type of material is installed into the bottom of the pan to provide not only a base for the pourable sealer to be applied but also to reduce the



D1 PENETRATION FLASHING  
DT1 SCALE: N.T.S.



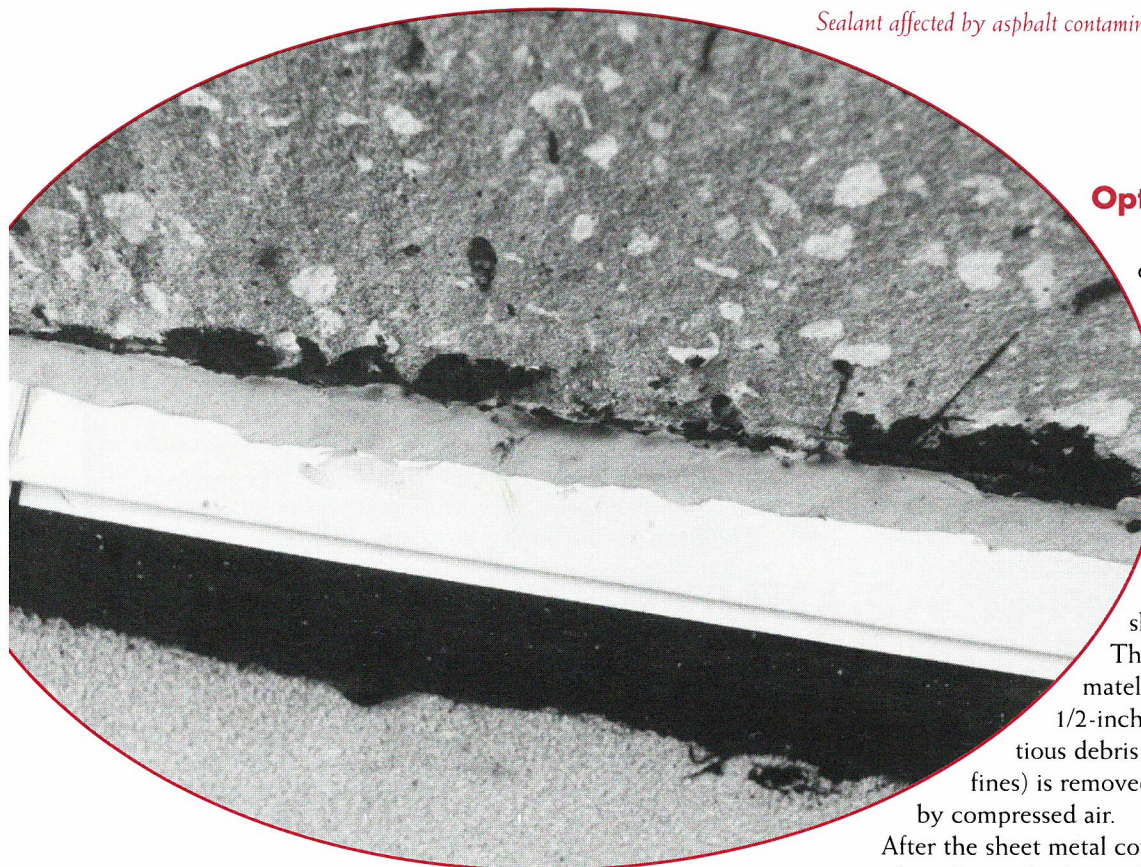
Above:  
Pourable  
sealer in pitch pan.



Right: Blending of a  
two-component sealant.



Sealant affected by asphalt contamination on concrete parapet wall.



### Optimum Joint Profile

The optimum joint profile can be encountered in roof installations at either saw-cut reglets for counterflashings or at joints between coping stones atop a parapet wall. When a reglet is saw-cut into a wall, proper sizing and preparation of the joint and installation of the sealant are essential. The saw-cut reglet must be cut to proper depth and width to accommodate both the sheet metal flashing and the sealant.

The joint depth should be approximately one inch and the width should be 1/2-inch. After saw-cutting, the cementitious debris (mortar/masonry/concrete dust or fines) is removed from within the joint, preferably by compressed air.

After the sheet metal counterflashing is installed and secured in place, a backer rod should be inserted into the joint for proper depth control and profile shaping. The sealant should be gunned into the joint and then tooled to achieve a concave, downward, and outwardly-sloping, finished face that will promote shedding water away from the wall. It is recommended by many in the sealant industry that porous surfaces such as masonry and even concrete (particularly after saw-cutting or routing a joint) be primed prior to application of sealant in order to achieve the optimum bond.

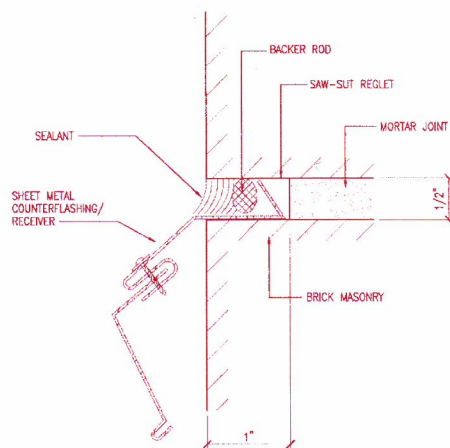
The head joints located between the ends of adjacent cementitious coping stones often require special attention during the roof renovation or new roof installation project. In pre-existing conditions, this joint will be filled with either mortar or sealant. Existing materials located within the joint should be removed to a depth to achieve the desired sealant joint profile. This author recommends that the head joints be sealed with sealant in lieu of mortar, as separation cracks are likely to occur between the mortar and

quantity of pourable sealer material required to fill the pan.

The grout or base material is installed to approximately 3/4 of the total height of the pan or within one inch of the top of the pan. The remaining depth of the pan is filled with the sealer material. These sealant products are two-part polyurethane compounds that are a pourable, self-leveling consistency. The two components—Part A and Part B—have to be properly blended in order to achieve the desired compound. If the filler is not properly blended, the compound will not cure properly and will most likely remain in a tacky, non-elastic state and not serve the intended purpose.

During the installation of roof systems (primarily bituminous-based membranes), penetrations in the roof may be “temporarily” sealed with plastic roof cement until the pitch pan is installed. Even after the pitch pan is installed, plastic cement may be placed within the pan as a temporary waterproofing method until the grout and pourable sealer are brought to the job site. These actions create two problems: 1) the plastic roof cement contaminates the surfaces to which the sealer will bond and is difficult to clean; and 2) the plastic roof cement is incompatible with the sealer and, if not removed, will have an adverse affect on the sealer.

In addition, during the mopping process of bituminous roof applications, the pan and/or the penetrating element may become covered with bitumen deposits. Steel pipe penetrations (such as equipment support structures and gas/electrical piping, particularly in reroofing applications), are commonly covered with multiple layers of paint, rust, or old filler/sealant materials. Bituminous deposits, together with other surface contaminants (i.e., paint, corrosion, etc.), should be properly removed to achieve a sound, clean substrate to receive the pourable sealant.



D1 SAW-CUT REGLET  
DT1 SCALE: FULL



stone at the bond interface. Accordingly, the mortar should be removed only to the design depth of the new sealant. This scenario creates a double joint filler, with the sealant being the primary/initial seal and the underlying mortar being the secondary seal or filler.

One option that would minimize the amount of mortar removal is to use a bond breaker tape, in lieu of backer rod, placed against the mortar prior to placement of the sealant. Using a maximum sealant joint depth of 1/2-inch, the mortar only has to be removed to that depth. The bond breaker tape will prevent three-side adhesion of the sealant. The cementitious faces to receive sealant should be cleaned (typically by grinding), and primed.

It is recommended that the horizontal top surfaces of the stone adjacent to the subject joint be masked with tape to prevent possible soiling and/or staining from either the primer or the sealant. In addition, masking of the joints will result in clean, straight, finished edges of the sealant joint. The sealant should then be gunned into the joint in sufficient quantity to result in a tooled, flat surface that is level with the top horizontal surface of the coping stones. Although the concave profile is the more desired face profile for sealants, a flat-tooled finish will function appropriately and will eliminate the possibility of ponding water within the joint, particularly on non-sloping stones.

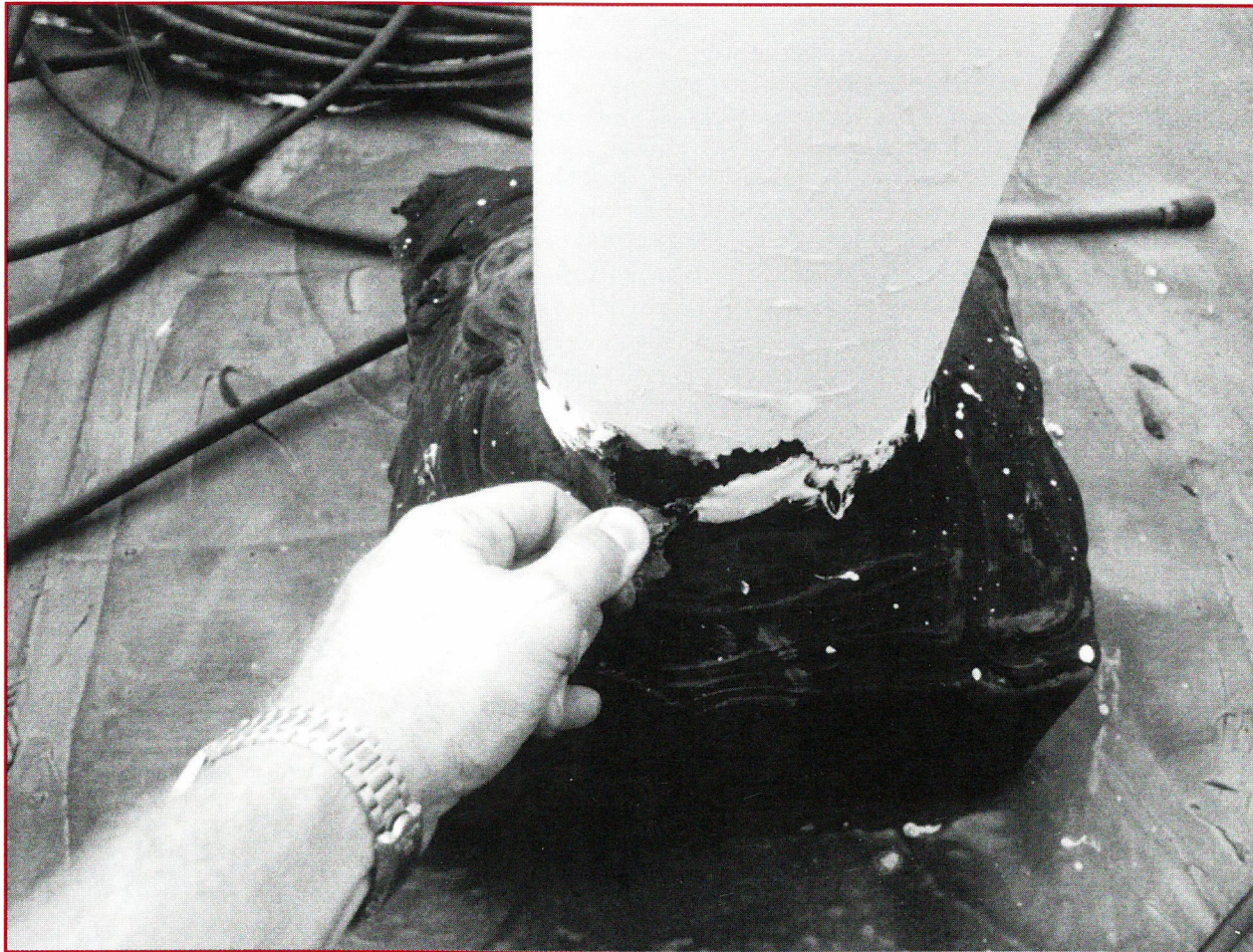
### Sealant Types

The three basic sealant types discussed herein each have particular performance/installation requirements. Silicone-based sealants are made from silicone polymers, fillers, cross-linkers, and other additives and are considered to be inorganic materials. These compounds will perform satisfactorily for many years of exposure without significant degradation (hardening, shrinkage). Silicone sealant manufacturers will offer a 20-year material warranty on the sealant.

However, silicone sealants have a reputation of difficulty in obtaining proper bonding to certain substrates. Silicone sealants also have particular limitations regarding the types of substrate

in relation to staining the substrate. Silicones are not compatible with substrates that contain oils or solvents. The substrate that is proposed to receive silicone sealants may require testing to see if the sealant will result in staining. Furthermore, the installation of silicone sealant may require an extensive and laborious process in order to achieve a properly cleaned substrate to receive the sealant.

Silicone sealants are gun-grade and available in individual cartridges in a variety of standard colors. Custom colors are also available. Silicone sealants are produced in low, medium, and high modulus variations to meet particular performance criteria. The predominant manufacturers of silicone sealants include Dow



*Disbonding scale, paint and sealer material from corroded penetrating element.*

Corning ("790/795 Series"), Pecora ("895 Building Sealant"), and General Electric ("Silpruf"). These manufacturers also provide silicone in a preformed strip. This product can be utilized for exterior wall applications but could also be used for roofing applications such as coping stone joints.

Polyurethane-based sealants are composed of urethane polymers combined with fillers, plasticizers, solvent, and other additives. They have only a fair resistance to weathering exposure elements (i.e. UV, heat, moisture, etc.) and may experience crazing, hardening, etc. These sealant materials have a service life of 7 to 10 years. They are considered to be a multi-purpose sealant as they have the tendency to readily bond to many different substrates, particularly concrete, masonry, and metal.



The polyurethane sealants are available in either one- or two-component grades. One-part sealants are easier to install and require less skill from the applicator. Two-part sealants require proper mixing and application with a bulk gun but will provide better long-term service. Typical polyurethane sealants used in roofing include Sonneborn's "NP-1," Tremco's "Dymeric," Sika's "SikaFlex," and Pecora's "Dynatrol."

Butyl-based sealants are made from butyl rubber and modified with solvents and/or oils. These types of sealants show good adhesion to most substrates and are installed in concealed joint conditions or where non-hardening cure is desired. Direct exposure of these sealants will result in rapid deterioration. However, if a butyl sealant is retained in a concealed condition, the material will remain in a pliable/elastic state and retain the bonding tenacity for many years (20+). Butyl sealants are available in both gun-grade and pre-formed tapes.

## Summary

Some common standards for sealants include the following: ASTM C-1193, "Standard Guide for Use of Joint Sealants"; ASTM C-717, "Standard Terminology of Building Seals and Sealants"; and ASTM C-920, "Standard Specification for Elastomeric Joint Sealants."

These sealants can perform satisfactorily for many years if used properly. However, the waterproofing and/or weathertightness of a roof assembly or related flashing details should not rely solely on the integrity of the sealant.

A roof assembly and associated details should be designed and installed so that the sealant is not the primary weatherproofing element. The sealant should be either the second or third level of defense against water infiltration or should be the initial line of defense with underlying secondary and third levels of defense.

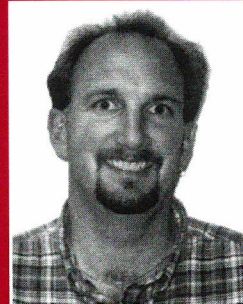
Sealant is often used as "dressing-up" and is superficially applied ("smeared") over improperly- or poorly-fitted joints and/or junctures of materials—either different or of the same composition. Various sealant types are commonly used on projects at similar or adjoining locations. The sealants discussed herein are not compatible with one other. If contact of two different sealants occurs, either degradation or disbonding will likely result. ■

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1. "Joint Sealers," CSI Monograph Series, Dec. 1991.
2. "Sealants: The Professionals' Guide," SWRI, 1990.

## ABOUT THE AUTHOR

**Karl A. Schaack, RRC, PE**, is Vice President of Operations for Price Consulting Inc., Houston, Texas. He has a bachelor of science degree in Civil Engineering from Clemson University and is a professional engineer in the states of South Carolina, North Carolina, and Texas. Karl is also a Registered Roof Consultant and has contributed frequently to *Interface*.



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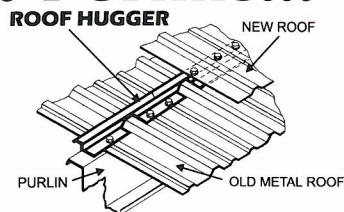
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