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JOURNAL

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The Care and Preservation of Sealant Joints

Dominick Accurso, Jr., AIA and Alan P. Eddy, CDT

Sealant joints may appear to be a minor detail in the grand scale of a building project, but in fact have a vital impact on a building's life span. These elastomeric sealants prevent water from entering through the building's joints. Given the damaging impact of water intrusion, it's clear that ongoing monitoring of sealant joint performance should be a critical component of a facility manager's regular preventive maintenance program.

If sealant joints have been neglected or were improperly designed, specified, or installed during initial construction, deterioration may have progressed to the point where a complete re-sealing of all building joints must be undertaken. In some cases of minor damage, re-sealing of a limited number of joints may be possible, but it's more likely that sealant failure will be widespread rather than localized.

The swing staging high on this building carries a work crew performing remedial sealant work specified and monitored by Hoffmann Architects.

A Quick Guide to Sealant Joint Failure

- *Adhesive failure:* sealant pulls away from the material to which it is intended to bond.
- *Cohesive failure:* sealant is split within itself.
- *Discoloration, disintegration, or hardening of sealant:* evidence of sealant incompatibility with substrate, contamination, or inability to weather the elements.
- *Excessive dirt pick-up:* while some dirt pick-up is common to some silicone and other sealant types, extensive pick-up can be an indication of uncured sealant.
- And, of course, ***vandalism:*** where sealant is forcibly damaged or removed.

As Senior Architect with Hoffmann Architects, Mr. Accurso is an expert in complex building envelope rehabilitation projects. Mr. Eddy is the firm's Technical Information Specialist and directs the production of all project specifications.

Three Sources of Failure

Most sealant joint failure can be directly traced to three causes:

1. Incorrect sealant selection during design and construction: For example, if a high modulus sealant is incorrectly specified for a joint subject to normal or extreme movement, this relatively non-elastic sealant will lose cohesion (cohesive failure) and will be ripped apart over time through building movement.

2. Faulty joint design: One common error in the design process is the failure to specify a backer rod or other bond-breaking material for the back of the joint where it meets the substrate. In this case, the sealant adheres on three sides — to both sides of the joint and to the substrate. The result? The sealant's elasticity is compromised by this three-sided adhesion, causing it to tear.

Sealant replacement in progress:

1. Old sealant has been removed from the joint.

2. Installation of the backer rod.

3. New sealant is applied.

4. Sealant is tooled for a smooth finish.

3. Improper application during construction: Proper surface preparation makes all the difference in the life of sealant joints. In fact, the leading cause of sealant deterioration is poor adhesion due to poor surface preparation. All too often, joint surface preparation during construction is shoddy, spotty, or not performed at all. Sealant manufacturers stress the importance of a clean, dry application site that is free of frost, dust, and debris. All traces of the old sealant should be removed. Any type of surface contamination will cause the sealant to adhere poorly (or not at all), leading to deterioration over time — and water intrusion. (The related article, "Surface Preparation is Step One for Sealant Application," on page 5, outlines surface preparation recommendations for specific substrate materials.)

Certainly, all sealant joints will deteriorate over time, even if they have been properly installed and maintained. Be on the lookout for signs of deterioration and schedule failed joints for replacement as soon as conditions permit.

Facade Re-sealing Techniques and Tips

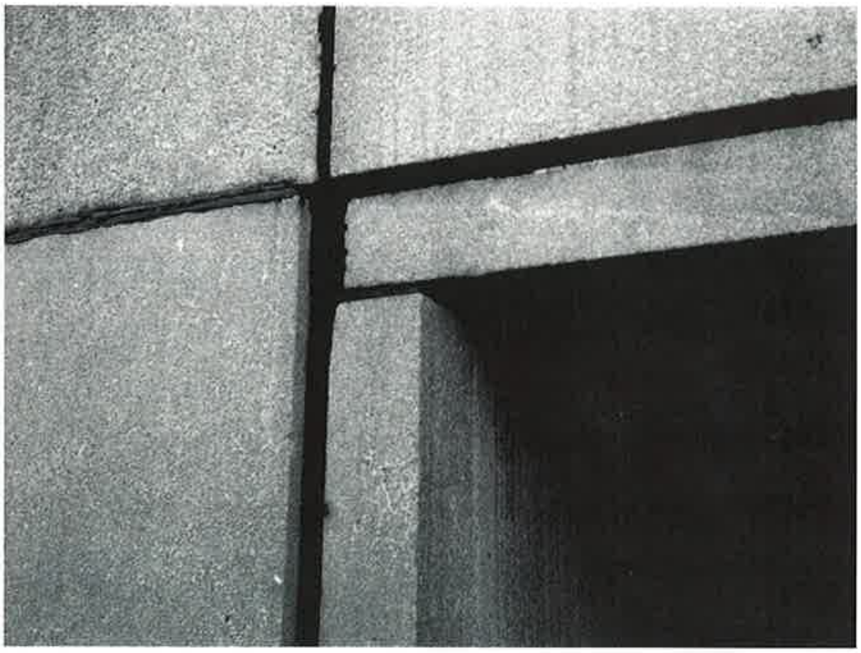
Usually, replacement of sealant joints is a full-scale facade re-sealing project. Although this is an extensive undertaking, it does have its advantages. The biggest plus is that re-sealing will allow you to correct many of the original flaws that caused the initial deterioration problem. Of course, this type of retrofit can't correct poor joint configuration and spacing, both causes of sealant failure. But most causes of adhesive and cohesive failure can be remedied by choosing the right sealant and properly preparing the surface prior to installation.

Begin the repair work by removing all existing sealant down to the substrate. If it's not possible to remove all traces of the sealant, be sure to check for compatibility between the old and new sealants. For example, silicone will adhere to most cured sealants, but cured silicone will act as a bond-breaker with most other sealant types.

The next step is to prepare the surface according to the sealant manufacturer's specifications, which could include sandblasting or grinding, solvent-cleaning, priming, or a combination of these three. New backer rods are then installed, and the sealant applied.

Be aware that re-sealing projects require specific temperature and weather conditions. Humidity levels, temperature extremes, and even temperature swings during curing can adversely affect the new sealant's performance.

An example of adhesive failure between the sealant and the concrete block and between the sealant and the painted metal window edge.



Cohesive failure is evident at both the horizontal and vertical joints to the left of the window opening.

It's also important to select the right sealant for each type of joint. Sealants are manufactured with varying degrees of elasticity to accommodate different joint expansion requirements. A qualified architect or engineer can help in evaluating these requirements and in determining which sealant should be used.

Pre-testing of Sealant

Many sealant manufacturers will test their product for compatibility with your building's specific substrate material. This testing includes evaluation of how well the sealant adheres, its compatibility, and its stain resistance. The latter test is important for porous substrates such as marble and limestone, as the sealant will penetrate these stone surfaces and cause unsightly stains. Testing services are usually provided free-of-charge by the manufacturer and can add another level of security to a re-sealing project.

In addition to lab testing, on-site test applications should be conducted before re-sealing. These job-site tests are highly effective in assuring proper adhesion and compatibility, and establish proper surface preparation standards that should be followed during installation. For example, the architect can direct that certain test joints be prepared with or without primer, with sealant then applied and tested for adhesion and peel after seven days. (Please see the article, "Lab Testing vs. Job-Site Testing for Sealant Performance," on page 4 for more detail on testing procedures.)

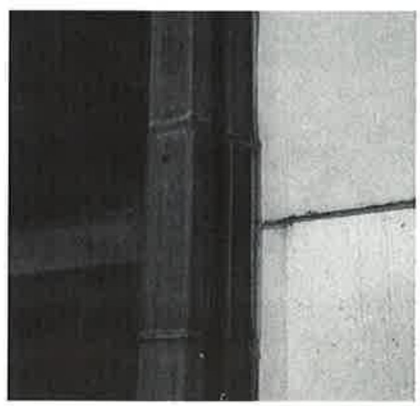
Of Special Concern

Sealant deterioration can be hastened or exacerbated by improper flashing details. Stone coping joints are notorious locations where sealant failure increases the risk of water intrusion into the building. Deteriorating parapets can often be traced directly to sealant failure and lack of flashing. It's vital that horizontal joints be able to withstand water infiltration from rain, ice, and snow. In addition, these joints must be able to endure the effects of the sun's full-arc exposure. Special diligence in detailing, sealant selection, installation, and maintenance is warranted for these vulnerable joints.

Conclusion

Today, a wide selection of sealant types and colors are readily available. Product research and industry demands have prompted manufacturers to improve sealant performance and endurance. A knowledgeable architect can capitalize on these advances, with the building owner reaping the benefit in sealant longevity. Just remember these four steps for long-lasting, water-tight sealant joints:

1) pre-test for adhesion and material compatibility prior to re-sealing any joint,
2) faithfully follow the manufacturer's surface preparation requirements,
3) diligently monitor the contractor's performance during installation, and
4) perform regular, preventive maintenance of the newly sealed joints. ■



Poor joint design has placed dissimilar materials together; differing expansion/contraction rates increase stress on the sealant joint, leading to sealant failure.

Lab Testing vs. Job-Site Testing for Sealant Performance

Should you conduct on-site job tests for sealant performance or pursue more refined laboratory procedures to determine how well a proposed sealant will perform?

The answer is often one of project timing — longer project lead times will allow for laboratory testing, a luxury more often afforded in new construction.

On renovations of older buildings, job-site tests can be more timely and more revealing. Over the course of a building's life, repair techniques and materials may have varied widely. Field testing of multiple substrate situations for sealant compatibility is a much simpler process than lab testing would be, as tests can be specifically applied to questionable areas. However, lab tests may help solve compatibility questions for unusual substrate and primer materials.

In either case, both testing procedures are tests to destruction. Their basic purpose is to demonstrate the ability of the cured sealant to adhere to a particular substrate under a variety of conditions.

Field Testing Procedure

The adhesion check is a simple hand-pull test which is conducted after the sealant has fully cured, usually in 14 to 21 days. The following guidelines apply only to vertical joints; separate tests are available for horizontal joints.

1. Select a small area of substrate that's typical of the building conditions where sealant will be applied.

2. Set up the test area using two or three proposed surface preparation techniques and two or three proposed primers (if any). Most manufacturers recommend that at least one test area include an abrasive surface preparation (sandblasting, grinding, or wire brushing), if appropriate for the surface.

3. Be sure to clearly label and identify each test site by type of cleaning, surface preparation, primer, and sealant.

4. Apply the new backer rod and sealant, and allow to cure as directed by the manufacturer.

Illustration A:
High modulus
adhesion test

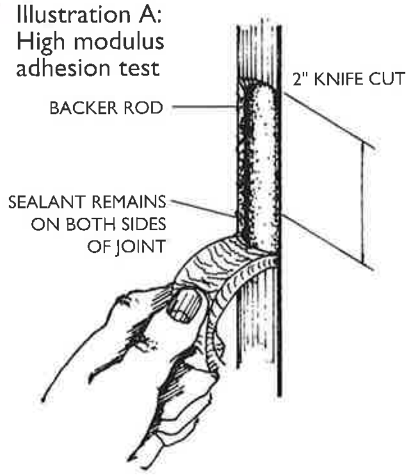
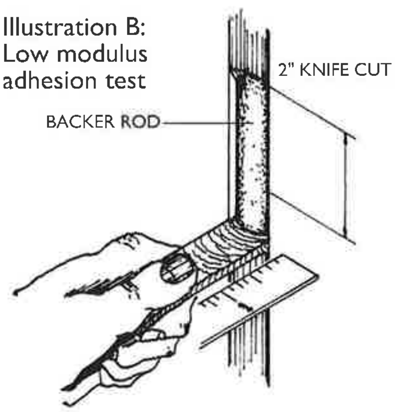


Illustration B:
Low modulus
adhesion test



5. The hand-pull test begins by cutting the sealant horizontally across the joint. Next, make two 2"-long vertical cuts at the sides of the joint, beginning at the horizontal cut and cutting downward.

6. To test high modulus sealant, firmly grasp the 2" sealant strip and pull it away from the joint at a 90° angle, trying to pull the <u>uncut</u> sealant from the joint. Adhesion is acceptable if the sealant tears first before it pulls away from the substrate. (See Illustration A.)

7. To test low modulus sealant, begin by marking the sealant tab one inch from the bottom, as shown in Illustration B. Firmly grasp the sealant tab just above the one-inch mark and pull at a 90° angle; place a ruler along this extended sealant tab. Pull the tab until the one-inch mark meets the four-inch mark on the rule, and hold in position for one minute. The sealant will perform in 50% joint expansion if the one-inch mark can be pulled that far (300% elongation) without the sealant pulling away from the joint.

Standard Laboratory Test Method for Adhesion-In-Peel

The lab test differs from the field test in several aspects, primarily in the use of a machine to exert the pull needed to test the sealant adhesion and in the type of conditions the sealant is subjected to during and after curing. As with the field test, the laboratory test is a pass-fail exam, but can provide more sophisticated and in-depth information about the sealant's performance under a wide range of conditions.

1. The substrate to be tested is prepared and primed as recommended for its material type and following stringent ASTM guidelines.

2. Two test samples are done for the substrate type, using a sample of the actual building material. Cloth strips are embedded in the sealant, which is applied to a depth of 1/16".

3. The samples are cured for 14 days if testing two-component sealants, and for 21 days if testing single-component sealants. The curing process is a set schedule of rigorously controlled temperatures and humidity levels.

4. Once cured, sections of the test area are cut away to be used for additional test procedures, including UV exposure and water immersion.

5. The samples are then placed in the tension-testing machine. This machine pulls back the embedded cloth from the substrate at a 180° angle and measures the force exerted on the cured sealant and measures the sealant's separation from the substrate. These measurements include the average peel strength and the percentage loss in bond and cohesion. ■

(Source: ASTM C-794-92)

Surface Preparation is Step One for Sealant Application

Poor adhesion is the leading cause of sealant failure, and is typically the result of improper surface preparation. If sealant is applied to a substrate that's dirty, dusty, damp, improperly primed, or otherwise contaminated, sealant failure is virtually guaranteed. In retrofit projects, extra care must be taken to remove all old sealant in order to give the new sealant a sound installation surface — and a fighting chance for survival.

Proper Cleaning Techniques

Different substrate materials require different surface preparation techniques. The following guidelines should be followed for the appropriate substrates. Proper cleaning techniques should also be followed. Clean, white rags should be used to avoid contaminating the surface that's being prepared; fresh, clean solvent (appropriate for the specific surface) should also be used. The recommended cleaning technique is to apply solvent with one rag and use a second, clean rag to wipe up the solvent. Don't allow solvent to dry on the surface, and change to fresh rags frequently.

The following surface preparation guidelines offer a general look at the best techniques to achieve optimum adhesion for a variety of substrate materials. As always, the manufacturer should be consulted in questionable situations and test applications conducted first.

Solvents for Surface Preparation
(Used prior to re-sealing joints)

Substrate Surface	Solvent	NIOSH*
(To remove moisture or frost from surface)	isopropyl alcohol (IPA)** acetone	yes yes
(To remove silicone sealant residue)	acetone	yes
Stone	xylene	yes
Glass or porcelain	methyl ethyl ketone (MEK) isopropyl alcohol (IPA)**	yes yes
Painted surfaces	xylene	yes
Aluminum	xylene	yes
Stainless steel	xylene	yes

* NIOSH: listed in *Pocket Guide to Chemical Hazards*, published by the National Institute for Occupational Safety and Health (includes respirator requirements, first aid procedures, etc.)

** Alcohol: Do not use any type of alcohol prior to use of urethane sealants.

Concrete and Masonry

The variable surfaces of concrete and masonry make it a challenge to prepare for proper sealant adhesion. In many cases, the problem is weak surface conditions, caused by additives, poor formulation, curing conditions, and finishing techniques. Sandblast*, grind, or wire brush until a sound, strong cohesive surface is created. Dust raised by this cleaning process should be removed by brushing the surface repeatedly with a soft-bristled brush or by blowing the dust with oil-free compressed air. A surface primer is often recommended by manufacturers to create better adhesion.

Other types of surface contamination are caused by hardeners, curing agents, and form release sprays. Again, sandblasting or wire brushing will help in the clean-up. Do not use solvents, as they will only drive contaminants deeper into the concrete or spread them over a wider area. In very difficult cases, contact the concrete supplier or manufacturer of the contaminant material for specific removal recommendations.

(continued on page 6)

* Be sure to mask the surface of any substrate that will be sandblasted, leaving only the sealant joint exposed. Otherwise, sandblasting may make the substrate more porous and allow water absorption to occur more readily.

A third problem for concrete is moisture in or on the surface. While difficult to detect, moisture is usually indicated by a darkening of the surface, even if it feels dry to touch. Let concrete dry under good conditions for 24 hours before applying primer or sealant. In northern climates, where most buildings are sealed at low temperatures, frost problems can be minimized by first wiping the surface with the appropriate solvent. Apply the sealant immediately after the solvent evaporates to prevent frost from recurring.

Stone

Stone provides a sound substrate for sealant adhesion, as long as the substrate is cohesively sound, dry, and contaminant-free. Application of a primer is recommended to provide optimum adhesion for such surfaces as granite, limestone, marble, and sandstone. Use sandblasting, water blasting, or wire brushing to clean weak, dusty, or contaminated surfaces. Do not, however, use steel wire brushes on porous stone such as limestone or marble; pieces of the steel wire will break off and become embedded in the stone, causing unattractive rust spots. Make sure surfaces are thoroughly dry and free of dust before primer or sealant is applied. Uncontaminated surfaces of dense stones, such as granite or marble, are easier to prepare for sealant: a simple, quick wipe with solvent on a clean rag will provide an optimal surface for adhesion.

Glass and Porcelain

Vitrified surfaces, including glass and porcelain, are usually excellent surfaces for sealant adhesion, as long as they are clean, dry, and free of contaminants. Paint and surface contaminants should be removed with a razor blade; the solvent MEK (methyl ethyl ketone) will remove oily contaminants. In either case, follow up with a thorough surface cleaning using a solvent. Test the selected solvent for compatibility with

(continued on page 8)

The Facility Manager's Bookshelf: **Sealants**

If your company does not have a source for ordering copies of these articles, call Michigan Information Transfer Source (313-763-5060) at the University of Michigan, Ann Arbor, MI to inquire about their document delivery services.

A. Basic References

1. *Sealants: The Professional's Guide.* $14.95.
   To order: Sealant Waterproofing and Restoration Institute, 3101 Broadway, Suite 585, Kansas City, MO 64111. (816) 651-8230.

2. *Guide to Joint Sealants for Concrete Structures.* 1990. 43 pp.
   Order Code: 504R-90.CT94. $51.25.
   To order: American Concrete Institute, Customer Service Department, (313) 532-2600. MasterCard and VISA accepted.

3. *FGMA Sealant Manual.* 1990. $23.00.
   To order: Flat Glass Marketing Association, 3310 Harrison, Topeka, KS 66611. (913) 266-7013.

B. General Reading

1. Klosowski, Jerome M. *Sealants in Construction.* New York and Basel: Marcel Dekker, 1988. $110.00

2. Panek, Julian R. and John Philip Cook. *Construction Sealants and Adhesives.* 3rd ed. 400 pp. New York: Wiley, 1991. $59.95.

C. Construction Specifications Institute
Specifier Reprints
601 Madison Street
Alexandria, VA 22314-1791
(703) 684-0300

Cost: $4.00 each, $10.00 minimum.

1. Brewer, Wilfred B. "Avoiding Sealant Failure with Pre-formed Expanded Foam." *The Construction Specifier.* December 1986, p. 23.

2. Brower, James R. "Surface Preparation — The Key to Proper Sealant Adhesion." *The Construction Specifier.* July 1976, p. 46.

3. Gibbs, J. F. "Hidden, But Essential." *The Construction Specifier.* March 1980, p. 40.

4. Malloy, Fred. "Some Factors Affecting Sealant Selection." *The Construction Specifier.* Part One - March 1970, p. 52; Part Two - April 1970, p. 46; Part Three - June 1970, p. 41.

5. Miller, Michael H. "Selecting the Right Sealant." *The Construction Specifier.* January 1984, p. 72.

6. Nicastro, David. "Parameters for Comparing High-Performance Sealants." *The Construction Specifier.* April 1989, p. 122.

Compiled by Alan P. Eddy, Records and Technical Information Specialist ■

REPRESENTATIVE PROJECTS

Sealant Joint Rehabilitation

Hoffmann Architects specializes in the rehabilitation of the exteriors of existing facilities. A primary focus of the firm's work is on the diagnosis and resolution of sealant joint failure, a critical yet commonplace problem facing many facilities today.

In helping clients resolve sealant joint problems, Hoffmann Architects' services include investigation of existing conditions, preparation of construction documents, and administration of construction contracts for renovation and restoration.

The firm's project architects and engineers take a three-part approach to resolving sealant joint problems: identifying and remedying the root cause of sealant failure, developing a comprehensive program for replacement, and providing guidance and recommendations for long-term preventive maintenance for the new sealant. Each project is approached with an eye toward building life cycle costs and other budget considerations, as well as the unique characteristics of the facility.

28 State Street, Boston, Massachusetts (Prudential Insurance Company of America)

Hoffmann Architects has provided sealant joint rehabilitation services for numerous corporate and institutional facilities. Among these are the following:

733 Third Avenue
New York, New York
(The Durst Organization)

335 Madison Avenue
New York, New York
(Cushman & Wakefield, Inc.)

United States Capitol
Washington, D.C.
(The Architect of the Capitol)

Northpoint Office Building
Horsham, Pennsylvania
(Prudential Insurance Company of America)

Atochem Building
Philadelphia, Pennsylvania
(Goldman, Sachs & Company)

SNET Headquarters
227 Church Street
New Haven, Connecticut
(Southern New England Telephone Company)

GE Building, New York, New York (Rockefeller Center Management Corporation)

120 Bloomingdale Road
White Plains, New York
(NYNEX)

1251 Avenue of the Americas
New York, New York
(Mitsui Fudosan (New York), Inc.)

633 Third Avenue
New York, New York
(The Travelers Companies)

1900 Market Street
Philadelphia, Pennsylvania
(Goldman, Sachs & Company)

250 Broadway
New York, New York
(Sarakreek USA)

International Building
New York, New York
(Rockefeller Center Management Corporation) ■

adjoining surfaces before using. Primer may be required for some sealants.

Painted or Lacquered Surfaces

The quality of these surfaces can vary widely based on formulation, weather damage, and contaminants. A primer coat may be needed to ensure adhesion with certain paints and lacquers; consult the sealant manufacturer's recommendations and perform on-site test applications. Sealant should not be applied to paint that's peeling, cracking, or flaking from the substrate. All painted surfaces should be cleaned first with a solvent (test first for interaction with the paint film) prior to applying the sealant.

Rigid Plastics

While solvent cleaning is usually required, permanent damage can result from using the wrong solvent on these plastics. Consult the plastics manufacturer in choosing the right cleaner. Many sealants will require a primer coat for maximum adhesion.

Rubber and Flexible Plastics

It is difficult to achieve good sealant adhesion to rubber and flexible plastics, which is one reason why they're often used in glazing assemblies where adhesion is undesirable. As well, plasticizers and other additives may exude from the rubber or plastic over time and cause adhesion loss and sealant discoloration. If sealant adhesion is necessary, on-site test applications for adhesion should be done.

Aluminum

Mill-finish aluminum should be cleaned with a degreasing solvent to remove any oxides or oil film. Surface abrasion with stainless steel wool or fine emery paper may be needed to improve sealant adhesion, and primers are often recommended by sealant manufacturers.

Anodized aluminum is an excellent adhesion surface, but must be cleaned of job-site contaminants first. A cleaning with solvent should remove any dirt and oils. Primer may be required, although test applications with specific sealants may indicate good adhesion directly on the clean anodized surface.

Steel and Stainless Steel

Steel in caulked areas is usually painted. Don't forget that rust will form on unpainted steel in high-moisture situations — even under the sealant — and will eventually destroy the adhesive bond. Although stainless steel is not an optimum surface for sealant adhesion, a solvent wipe and primer application can help ensure good performance. ■

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Editor: Emily D. Dowden
Graphic Services: MossWarner Communications, Inc.
Editorial Services: Jonelle Lawhorn Hobbs Communications

Hoffmann Architects
432 Washington Avenue
North Haven, Connecticut 06473
(203) 239-6660

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