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Surface Preparation - The Key to Proper Sealant Adhesion

By James R. Brower
General Electric Company

The key to the success of any sealant installation is the proper use of the product and attention to the instructions and recommendations provided by the manufacturer. The main cause of sealant failure is poor adhesion. The lack of adhesion is usually due to improper preparation of the surface to receive the sealant. When the substrate is dirty, damp, improperly primed, or contaminated by other construction materials, failure is assured. The importance of properly preparing the surface cannot be overstressed, especially in projects involving removal and replacement of existing sealants. The existing sealant must be carefully and completely removed from the substrate in order not to contaminate the new material and to provide a sound surface on which to install it.

The following article, excerpted from The Applicator, the newsletter of the Sealant and Waterproofers Association, outlines some of the cleaning and preparation techniques required to prepare surfaces before sealant application. These are only general notes; the project specifications should be consulted for any particular application, since primers, cleaners and techniques will change from project to project.

Recommendations are given for solvent cleaning of surfaces to remove various contaminants; however, proper cleaning is not as simple as it may seem. If a contractor uses dirty or contaminated solvents and/or rags, the result is merely recontamination of the surface he is trying to clean. For this reason, the proper techniques of cleaning are outlined and pertain to all surfaces where such cleaning is recommended.

a white rag used to clean the substrate shows when it is too dirty to use

Techniques for Solvent Cleaning.

1. Always use clean, fresh solvent, of the type recommended for the particular surfaces it will contact.
2. Use clean, white rags for cleaning.
3. Use a "two rag wipe" technique. One rag is wet with solvent; the second rag is used to wipe the wet solvent from the surface. Allowing solvent to dry on the surface without wiping with a second dry absorbent cloth merely redeposits the contaminant as the solvent dries.
4. Always pour the solvent on the rag being used. Never dip the rag in the cleaning solvent as this contaminates the solvent.
5. Always clean containers for solvent use and storage.
6. Change rags frequently, as you see that they are becoming soiled. It is

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easy to see the soiling if you use white rags.

7. Do not spread the material being removed by the solvent over the face of the area you are cleaning. Any residue left may discolor or stain the face of the panels.

Preparation of Concrete and Masonry

Concrete can have, by far, the most variable surface conditions found in the construction industry. Factors that affect the surface concrete include, but are not limited to, the concrete formulation itself, curing conditions, moisture, finishing techniques, additives, hardeners, curing compounds and form release contamination. Improper formulation, additives, curing conditions and finishing techniques can cause a weak surface condition that does not provide a sound cohesive base for sealant adhesion. Hardeners, curing agents and form release contamination can cause a surface that will inhibit proper sealant adhesion.

brushing the substrate will help remove loose particles that inhibit adhesion

Concrete or masonry that has a weak surface layer (laitance) may be cleaned by sandblasting, grinding or wire brushing until a sound, strong cohesive surface is obtained. Dust created by the cleaning step must be removed by repeated brushing with a soft bristled brush, or more effectively, by blowing the dust from the surface with oil free compressed air. Many sealant manufacturers recommend a primer to provide a better surface for adhesion.

Surfaces contaminated by hardeners, curing compounds, release agents, etc. may be cleaned by sandblasting or wire brushing the contaminant from the surface. Normally, the use of solvents on concrete is not effective as they drive the contaminants into the concrete or spread them over a wider area. Most sealant suppliers recommend that contaminants be removed completely from the surface for optimum sealant adhesion. In cases where the contaminant is especially difficult to remove, the supplier of the concrete or the particular contaminant should be contacted for specific recommendations for removal.

Moisture

Moisture in or on the surface of concrete or masonry is sometimes difficult to detect. It is usually noticeable by a surface darkening effect. In some cases the outer surface of the concrete may look or even feel dry, but there may be enough water in the body of the concrete to inhibit sealant adhesion. It is a good practice to allow concrete wet from rain or other sources of moisture to dry for at least 24 hours under good drying conditions before sealant or primer application.

Moisture in the form of frost may be present on masonry or concrete surfaces below 32 degrees F. Many sealant suppliers do not recommend

applying primer to a concrete substrate

the application of their sealants below 40 degrees F. This eliminates the danger of frost on surfaces but is not a practical limitation, as there are many cases, especially in northern climates, where buildings must be sealed at low temperatures. In these cases, the frost problem may be minimized by wiping the surface to be sealed with a solvent like isopropyl alcohol, acetone, or methyl ethyl ketone (MEK). The solvent tends to pick up the surface moisture when it evaporates. However, the sealant must be applied as soon as the solvent evaporates to prevent the re-occurrence of frost. Primer recommended by the manufacturer often helps sealant adhesion in cold.

Preparation of Stone

Stone surfaces are normally good substrates for sealant adhesion. Naturally, they must be cohesively sound, dry and free of contaminants. Many sealant suppliers recommend primers for optimum adhesion to stone surface such as granite, limestone, marble and sandstone. Weak, dusty, or contaminated stone surfaces may be cleaned by water blasting, sandblasting, or wire brushing. Surfaces must be dry and free of dust before primer or sealant application. On dense, uncontaminated surfaces of granite or marble, a wipe with MEK solvent may be all that is required for optimum sealant adhesion.

Preparation of Glass or Porcelain

Glass or porcelain or vitrified surfaces are usually excellent surfaces for adhesion with most sealants, assuming the surfaces are clean, dry and free of contaminants. Some sealants require primers for optimum adhesion and the manufacturers literature should be consulted. Surfaces of glass to be sealed should be cleaned with methyl ethyl ketone or alcohol. The effect of these solvents on adjacent surfaces should be checked prior to their use.

Contaminants, such as paints, should be removed from the surface with a razor blade before solvent cleaning. Oily contaminants should be removed by wiping the surface with a solvent such as MEK or xylol, using proper solvent cleaning procedures outlined earlier.

Preparation of Painted or Lacquered Surfaces

Painted or lacquered surfaces can vary considerably due to formulation, weather exposure and contamination. The sealant manufacturer's literature should be consulted for recommendations on various paints and lacquers as to whether or not primers are required. If special recommendations are not available, then test applications are recommended.

On sound painted surfaces, if the sealant to be used is compatible with the paint, the surface of the paint should be cleaned by wiping with a solvent such as VM&P naptha to remove all contaminants, dust and chalk. In all cases, the effect of the solvent on the paint film should be determined, prior to the cleaning step. As a general rule, sealants should not be applied over paint that has not adhered well to the substrate. Paint that is peeling and flaking before sealant installation may continue to do so after the sealant is applied and adhesion problems will result.

sealing a stone building

Preparation of Rigid Plastics

In most cases, some type of solvent is recommended to clean the surface prior to sealant application. It is extremely important that the cleaning solvent used be approved by the plastics manufacturer as the use of the wrong solvent can result in permanent damage to the plastic material. Some sealants are incompatible with plastics and the sealant manufacturer should be consulted if there is doubt. After the proper cleaning, many sealants require the use of primers for maximum adhesion. As with paints, test applications are recommended if specific recommendations are not available.

Preparation of Flexible Plastics and Rubber

As a general rule, flexible plastics and rubber are difficult materials for sealants to adhere to. In some cases, this is a benefit, such as in certain glazing assemblies where adhesion may be undesirable. Due to the additives and variable formulations found in flexible plastics and rubber, test applications for surface preparation and adhesion are recommended. As a general rule, VM&P naptha does not harm plastics and rubber and may prove to be an adequate cleaning material. In some cases, however, other solvents such as MEK may be required to remove surface contaminants, plasticizers or release agents. One additional precaution is that plasticizers or other additives may exude from the plastic or rubber after weather exposure and cause sealant adhesion loss and/or discoloration.

Preparation of Aluminum

Mill finish aluminum may contain invisible oil film or oxide. Clean with a good degreasing solvent like xylene or trichloroethylene. In some cases, abrasion of the surface with steel wool or fine emery paper may be required for good adhesion. Many sealant suppliers recommend primers.

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Anodized aluminum usually provides an excellent surface for adhesion but may be contaminated on the job site by construction dirt, oil etc. Normally a MEK or xylene cleaning step is all that is required. Many sealant manufacturers recommend primer on anodized aluminum, but some sealants may be used without a primer on clean anodized surfaces. Due to the variability of the anodizing process, testing should be done with the particular anodized aluminum in question, especially if the intended use includes water exposure.

Preparation of Steel

Most steel found where caulking is necessary will be painted. Should the need arise to caulk unpainted steel, it should be dry and free of rust, oil or other contaminants. Sandblasting may be required to provide a sound, clean surface. Solvent cleaning should be done with xylene or naptha. It should be remembered that rust will form on steel and progress under all sealants with time on exposure to high moisture conditions and adhesion will eventually be affected.

Stainless steel may be a difficult surface for adhesion for some sealants. Normally, surface preparation consists of a MEK wipe to remove construction dirt or oils. Many sealant suppliers recommend primers for stainless steel.

Galvanized steel has historically been a problem material with regard to adhesion. Normal cleaning and degreasing should be done with xylene or toluene solvents. New galvanized steel may be harder to gain adhesion than weathered galvanized. Sealant suppliers should be consulted for specific recommendations for adhesion to galvanized steel.

testing materials beforehand will show whether proper adhesion is attained

Preparation of Unpainted Wood

Normally, unpainted wood is not a good surface for sealant adhesion. Weather exposure allows moisture entrance into the wood and eventually adhesion problems may result. Woods that are resistant to water exposure, such as teak or redwood, contain natural oils that may affect the adhesion. If application to unpainted wood is a necessity, the wood should be dry, dust free and free of contaminants. Solvent cleaning is not normally required for wood substrates.

Job Test Applications

Sealant suppliers do their utmost to provide proper recommendations for application of their products. Their actual control stops, however, with the manufacture of their product. It is important for the sealant user to realize his responsibility for the proper preparation and application of the products. One of the most effective means the sealant user has for gaining confidence that proper sealant adhesion and subsequent performance will result, is the installation of job site test applications. These on site tests determine compatibility with the actual surfaces on the job site and the degree of preparation required for adhesion. Samples may be submitted to the manufacturer's laboratory and the manufacturer will provide proper recommendations regarding cleaning and preparation methods, as well as judging the compatibility of the sealant with the substrate. Armed with this information, and with the use of proper preparation techniques, the sealant user can be confident of obtaining optimum adhesion and weathertight joints.

Representative Projects

Hoffmann Architects specializes in the analysis and solution of problems in existing buildings. Within this specialty, many different types of projects are commissioned requiring the inspection, specification and detailing of varied materials and methods. A representative few are included here.

Facade Rehabilitation

Hoffmann Architects is surveying the condition of the masonry, windows, aluminum panel curtain walls and other exterior elements of the 400,000 square foot Prentice - Hall Building in Englewood Cliffs, N.J. The building is owned by **Simon & Schuster**, a division of **Gulf + Western**.

The firm is also preparing construction documents for the repair of curtain walls at 75 Rockefeller Plaza and 10 Rockefeller Plaza, New York City for the **Rockefeller Center Management Corporation.**

Roofing

IBM has commissioned Hoffmann Architects to prepare construction documents for reroofing their office building in Hamden, CT.

Southern New England Telephone tower

For **Grumman Aerospace Corporation's** Glen Arm, Maryland plant, the firm previously surveyed and prepared construction documents for repairs and partial reroofing. The work is now going into the construction phase.

At the **Mobil** Research and Development Center in Edison, N.J., the condition of the silicone coated polyurethane foam roofs is being investigated.

Painting

Hoffmann Architects has prepared specifications for painting a transmitting tower owned by the **Southern New England Telephone Company.** The tower, one hundred feet high, is located 165 feet off the ground on top of a building in New Haven, CT.

Parking Garage

Hoffmann Architects is providing a technical review of documents for the repair of the 13 story Midwest Plaza Garage in Minneapolis, MN for **The Center Companies**, management agent for the owner, **Goldman, Sachs & Co.**

Grumman Aerospace Corporation's Glen Arm, Maryland plant

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We welcome contributions to HA/J from our clients and friends. Please send news and technical information to Ann M. Prokop, Hoffmann Architects/Journal, 3074 Whitney Avenue, Hamden, Connecticut. Address changes and requests for free subscriptions for others not receiving the publication should also be sent to the Hamden, Connecticut address.

Sealing Thin Joints

by John Farrell
Dow Corning Corporation

The problem of weathersealing 1/8-inch aluminum butt joints frequently arises in building construction.

Sealing this sheet metal poses special problems: First, 1/8-inch aluminum does not provide much contact area for bonding; second, there is often some movement of the aluminum while the sealant is curing; third, the edges of the metal are often unfinished; and fourth, it is usually impractical or impossible to install a backer rod properly.

One or the other methods shown will generally solve the problem. If only a little movement of the aluminum members will occur while the sealant is curing, a splice plate will allow proper sealing. *(figure 1)* A bond-breaker tape is placed on the splice plate behind the joint. Also, tooling of the joint should be done with a flat putty knife, since a round nose tool will leave too little sealant in the middle of the joint.

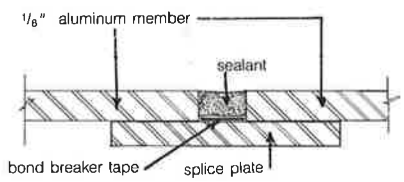


figure 1. use of a splice plate and bondbreaker tape is allowable when little movement is expected.

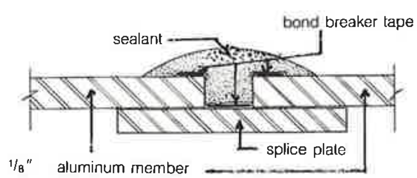


figure 2. use a band-aid joint like this when movement is expected during sealant curing.

If joint movement is expected while the sealant is curing, a band-aid application may be a better solution. *(figure 2)* Bond breaker tapes are placed on both sides of the joint and against the splice plate, and the sealant is tooled over the top of the joint. This application works very well if properly carried out with about 1/4-inch of bond width at each side of the joint.

Anticipated Joint Movement

The amount of thermal movement in a joint is dependent on how much the material used responds to a change in temperature (its coefficient of linear expansion), the length of the panel and the difference between the highest and the lowest temperatures the material is likely to experience (temperature gradient). At any given temperature gradient, different materials will expand and contract different amounts. Chart 1 shows how much different construction materials will move for a temperature gradient of 130° F. For instance, a concrete slab 100 feet long will expand and contract a full inch over the course of a year.

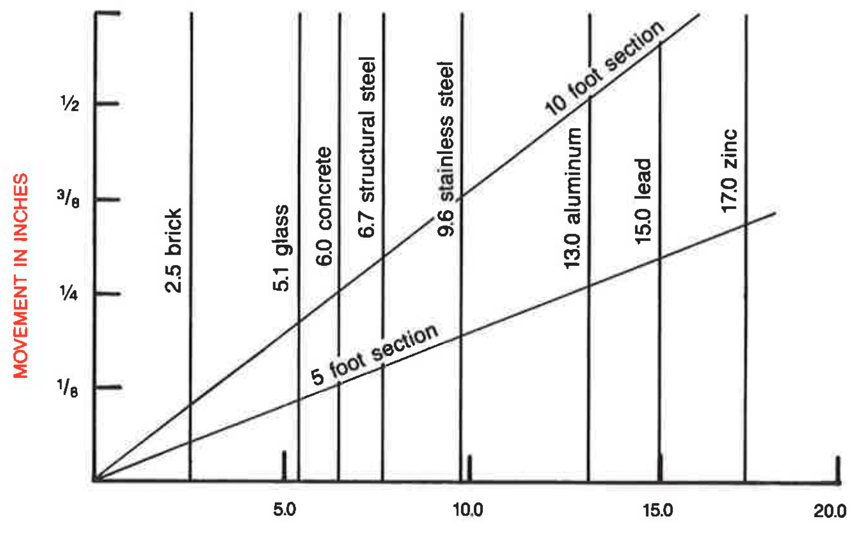
This has an important effect when two dissimilar materials are placed next to each other. Consider this. A hundred foot brick wall will only expand or contract about ½ inch over one thermal cycle. An aluminum coping one hundred feet long will move about 2-1/8 inches. If the coping is rigidly attached to the brick, and extra joints are not installed, the differential movement between the brick and the metal tear the aluminum coping apart.

Thermal movement is only one of several factors that need to be taken into consideration in joint design. One must also consider movement due to dynamic loads such as wind,

technical notes

installation and erection tolerances, and post erection changes in the material such as shrinkage in concrete or expansion in brick.

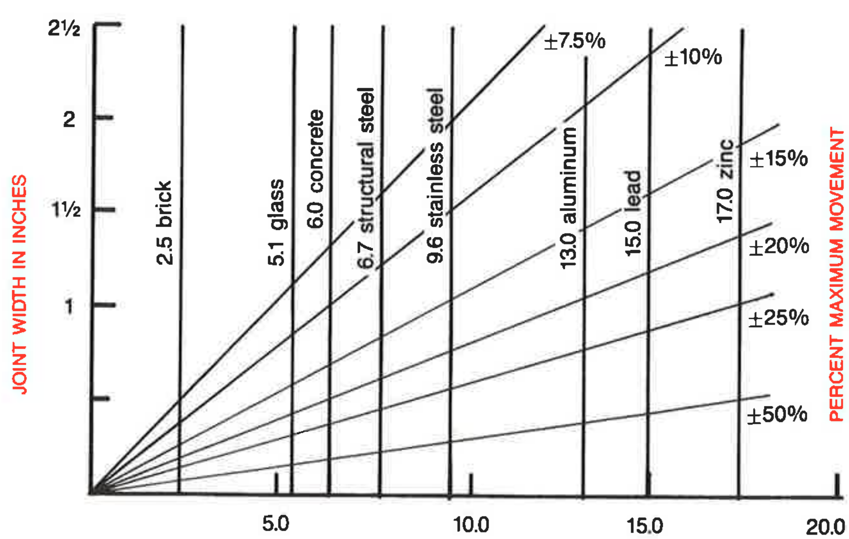
If a one inch wide joint is desired in a building with ten foot wide precast concrete panels, a medium performance sealant with a minimum of 10% movement capability is enough. If the panels were aluminum, a sealant with double the movement capability would be required to maintain a one inch joint without failure.



BUILDING MATERIALS COEFFICIENT OF LINEAR EXPANSION IN. / IN. / °F x 10 - 6

Joint Width for Various Building Materials

The performance capability of a sealant is the amount that the sealant can expand and contract without failure. The capability is expressed as a percentage of the original size. For instance, a sealant with ±25% movement capability in a one inch wide joint can contract to ¾ inch or expand to 1-¼ inches wide without rupturing. Some high performance sealants, notably some silicones, are able to stretch and relax as much as 50%. These are generally used where movement capability is the overriding selection factor, such as for weather sealing metal curtain walls. Low performance sealants, which may have as little as 5% movement capability, such as butyl or acrylic caulks, are generally only used as space fillers.



BUILDING MATERIALS COEFFICIENT OF LINEAR EXPANSION IN. / IN. / °F x 10 - 6

staff news

Contract Alert

A change made to the industry standard AIA General Conditions means less flexibility to the client and greater say to the Contractor regarding the role of the Architect during construction. The 1987 edition of AIA Document A201, General Conditions of the Contract for Construction, says, "Duties, responsibilities and limitations of authority of the Architect as set forth in the Contract Documents shall not be restricted, modified or extended without written consent of the Owner, *Contractor* and Architect." (our italics)

This means that clients may not have the flexibility to wait until bids are in before deciding whether or not they will have the Architect involved in administering the Contract for construction, since the *Contractor must agree* in writing to accept changes in the role of the Architect. Owners may wish to consider the implications of the Contractor ruling on their decisions.

Also, any change to the role of the Architect may impact on the construction cost. Bids are based on the information available in the bidding documents. If a change is made after the fact, it opens the door for the Contractor to modify the price due to the changes to the conditions under which he will perform the work.

The services of the Architect during construction can be quite valuable to the Owner. Just the review of the pay requests and observation of construction alone can save the Owner from worse problems later on. Also, the Owner's best interests are served when the Architect is available to answer questions that invariably come up during construction and to evaluate changes to the work. So, the decision should not be whether to retain services, but rather when. If the A201 is involved, the answer should be right up front. ■□□□

Staff News

Hoffmann Architects is pleased to announce the appointment of **Charles D. Fleischman, P.E.** as General Manager. Prior to joining Hoffmann Architects, Mr. Fleischman was Manager of Maintenance and Construction at the Bridgeport, Connecticut facility of General Electric Company. He received a BS in Engineering from the University of Rochester and an MBA from Long Island University.

Ann M. Prokop has joined the firm as Marketing Coordinator. Previously, she taught computer applications at the Center for Advanced Data Processing in New York City and received her MBA from the University of New Haven.

Brian W. Schafer has been promoted to the position of Director, Business Development following the retirement of Peter Borgemeister in December. Brian was previously Marketing Manager.

John J. Hoffmann, AIA has been elected president of the Building Owners and Managers Association of Southern Connecticut for the 1989 year.

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