YOU’VE LOST THAT SEALING FEELING:
SEALANT RESTORATION FOR HIGH-RISE BUILDINGS

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**Abstract**

Sealant joints typically represent the smallest part of the building enclosure; however, failures at these interfaces represent the largest source for moisture and air infiltration issues. For larger facilities with miles of sealant, replacement is a major undertaking and may take months or even years to complete. The presenters will discuss methods of evaluating existing sealant joint conditions, sealant joint design best practices, mock-up installation recommendations, sealant joint preparation, application processes, and construction quality control assurance.

**Speaker**

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**You’ve Lost That Sealing Feeling: Sealant Restoration for High-Rise Buildings**

**SEALANT JOINT RESTORATION CHALLENGES**

Sealant joints typically represent the smallest part of the building enclosure; however, failures at these interfaces represent the largest source for moisture and air infiltration issues. Moisture and air infiltration issues can be detrimental to the health and structural integrity of any building. Infiltration issues such as these are often compounded in high-rise buildings due to a multitude of issues, including accessibility, occupancy, and the associated costs of remediation. Often, infiltration issues on these structures are overlooked and put on the back burner until significant remediation is required, leading to even more costly repairs.

Throughout this paper, specific focus will be placed on cold-applied elastomeric sealants. Evaluation of existing sealant joint conditions, sealant joint restoration design best practices, mock-up installation recommendations, sealant joint removal and application processes, and construction quality assurance oversight will be discussed.

**EVALUATION OF EXISTING SEALANT JOINTS**

An effective sealant restoration design begins with performing a detailed analysis of the existing sealant joints (Figure 1). Designers should evaluate existing sealant joint conditions, sealant joint restoration design best practices, mock-up installation recommendations, sealant joint removal and application processes, and construction quality assurance oversight will be discussed.

Sealant joint types can be classified as either static or dynamic. Generally, control joints, expansion joints, and isolation joints are classified as dynamic joints. Joints that experience little to no movement are classified as static joints.

In addition to determining the sealant joint type, sealant joint widths and depths should also be evaluated to ensure the installation profiles as specified are acceptable. This is often difficult to evaluate on high-rise structures, as accessibility to all areas will not likely be practical. Furthermore, variances in the joints may change from each successive floor. Designers should emphasize within the contract documents and during the preconstruction phase that any variance from the design should immediately be discussed with the designer.

Improperly evaluating a sealant joint can lead to premature failure, as the sealant joint selection must be able to accommodate the anticipated movement of the

![Figure 1 – Evaluation of sealant joint from swing stage.](image-url)
Joint. Sealant joints typically experience movement in compression, extension, longitudinal extension, and transverse extension, or a combination thereof. Thermally induced movement is typically the largest contributor to these dimensional changes. Understanding the effects of thermal movements of the various wall system components is critical in determining the anticipated joint movement. Designers should account for the lowest and highest temperatures that would normally be anticipated during the restoration project.

Typically for restoration projects, anticipated joint movement is limited to thermal movements; however, if cladding restoration work is required, consideration must also be given to moisture movement. ASTM C 1472, Standard Guide for Calculating Movement and Other Effects When Establishing Sealant Joint Width, should be used by the designer to provide procedural calculations in determining the required sealant joint width related to movement.

Evaluating sealant joint failures can be beneficial in determining future performance of the sealant joints anticipated for renovation. It is important for designers to understand how the sealant joint failed previously to reduce the likelihood of similar failure. Sealant joint failures are most often defined as adhesive or cohesive. Unexpected movement, inadequate construction tolerances, improper sealant installation, and environmental exposure are all typically linked to the cause of these failures. In addition to cohesive and adhesive failures, incompatibility with adjacent materials may lead to premature failure. This is typically identified by sealant color changes. Where sealant material color changes are observed, adhesive failure should be anticipated.

Substrate staining caused by the existing sealant should be reviewed where present, and remediation measures, if necessary, should be accounted for as part of the design. Staining of adjacent substrates is typically due to fluid movement of the sealant material. Staining of porous and nonporous substrates has been proven difficult and often impossible to remove. The substrate manufacturer and sealant manufacturer should be consulted where possible to develop a cleaning procedure to remediate the staining.

Evaluation of the substrate materials should also be considered when preparing a sealant restoration design. Designers should evaluate the substrate materials’ structural stability in order to determine if any repairs or replacement will be required. Due to lack of accessibility of the high-rise structure, many deficient conditions may not be observed during the evaluation. The designer should account for unforeseen repairs in the contract documents by providing unit price allowances.

**SEALANT JOINT RESTORATION DESIGN BEST PRACTICES**

A properly designed sealant restoration project must include thorough and concise project documents, including specifications and detail drawings. Reliance on the American Institute of Architects’ MasterSpec should be avoided, as standard language presented within the document can be improperly interpreted and unclear when utilized by inexperienced design professionals. It is more critical that designers have a thorough understanding of the various environmental conditions, sealant joint materials and accessories, sealant joint types, and sealant joint preparation requirements.

There are a multitude of sealant joint materials on the market today with various physical and chemical properties. Selecting sealant joint materials can often prove to be one of the most difficult decisions for designers. Elastomeric sealant joints are typically classified by type, grade, and class and can be comprised of either single or multiple components. Properties of the various elastomeric sealant joint materials are defined in ASTM C920, Standard Specification for Elastomeric Joint Sealants.

It is critical that the design professional understand the limitations of each sealant material in order to ensure that the sealant materials specified are capable of meeting the environmental conditions of the project. Due to the various performance capabilities and chemistry compositions of the sealants on the market, it is recommended that the designer consult with sealant joint manufacturers, experienced specification writers, and knowledgeable sealant contractors to provide additional insight into properly specifying the correct sealant joint materials for the project.

Along with providing the proper material selection for the project, proper planning and coordination of the staging activities should be reviewed. Typically, this scope of work is borne by the contractor; however, on high-rise buildings, the logistics of staging and pedestrian protection will directly impact how the project is delivered. When discussing the anticipated required project staging and protection activities with the building owner, it is suggested that the entire project processes and sequences, from the beginning to the end, are evaluated. Simple daily tasks, such as those provided below, will significantly affect the project schedule:

- Workforce parking
- Material deliveries
- Building occupant schedules
- Adjacent public sidewalk usage

Many items will require early attention and planning, as long lead times and policy decisions (such as jurisdictional approvals for temporary street closures for crane, lift access, or material deliveries; sidewalk closings for scaffolding and/or suspended scaffolding above; etc.) may significantly affect the project schedule. These decisions should be coordinated by the project team and approved by the local code jurisdictions early in the project development phase in order to limit delays. Many local code jurisdictions will not only require permitting for the scope of the project but also for the public protections, such as public sidewalk protection, etc.

The project safety protocols and procedures should be clearly defined and outlined within the project documents. Job-specific training programs should also be a requirement within the project documents, as generally there are countless moving parts and procedures on a sealant replacement project for high-rise structures.

**MOCK-UP INSTALLATION RECOMMENDATIONS**

Prior to the commencement of new sealant installation on the building enclosure, it is highly recommended that all the removal and installation processes, applications, and materials be performed/installed as an on-site mock-up. The mock-up meeting should be attended by the entire project team, including, but not limited to, supervisors, project managers, sealant installation crew, third-party inspectors, building owners, manufacturers’ representatives, etc. The mock-up process exists as an example for quality control and expectations for all specified work. Furthermore, it allows all parties involved to observe the complete removal and
Mock-ups provide building occupants with expected levels of noise and vibrations due to grinding of the porous substrates. Grinding is messy, generates a significant amount of dust, is noisy, and generally produces vibration to adjacent building materials/structures. Vibrations from simple hand grinders can travel many floors, both upwards and downwards (Figure 2).

In addition to addressing the concerns of grinding existing joints, building pressurization must also be taken into consideration. This can be difficult to assess, as too much positive pressure can tend to blow out backing material, while too much negative pressure can pull the backing material too far back into the joint. Additionally, negative pressure will inadvertently pull the aforementioned solvent materials and dust from grinding into the building’s interior, causing discomfort to the building occupants. It is generally recommended that the building’s engineer be consulted to determine how best to address the pressurization of the building.

The mock-up stage of the work is a crucially important stage in the project. Removal of the existing sealant and backer materials is much more involved than simply cutting and pulling the old materials out. Removal of sealant and backer materials is typically performed by electric or hand blades, knives, scrapers, and/or grinders, depending on the adjacent materials from which the sealant is being removed. More porous materials, such as stone and concrete, require grinding. Site personnel should be made aware of OSHA and other regulatory requirements concerning silica dust and other harmful airborne materials generated during the removal phase. Removal procedures should be reviewed and followed during the removal phase. Metals and less-porous materials are typically scraped free of the existing sealant, although maintaining and not damaging the finish of the material from which the sealant is being removed should be considered.

Mock-ups also allow team members the ability to evaluate various sealants, backer materials, and substrate preparation in order to ensure adhesive performance. Sealant materials should be allowed to properly cure—typically 7 to 21 days—followed by adhesion testing. Destructive testing of the sealant using either the tail or flap procedure (depending upon the adjacent substrates) in accordance with ASTM C1521, Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints, is typically utilized to ensure material adhesion performance. Documentation should be provided in order to evaluate the performance of the various installation procedures and materials anticipated for installation.

**CONSTRUCTION QUALITY ASSURANCE OVERSIGHT/SEALANT JOINT REMOVAL AND APPLICATION PROCESSES**

Construction quality assurance oversight throughout the project is highly recommended, as accessibility to these areas is difficult to achieve once the staging is removed. Simple repairs due to poor-quality work and/or repairs that were not caught during the remediation can prove to be expensive and may not be evidenced for years down the road.

Reviewing the sealant joint(s)/opening(s) and back-up material removal should be provided as part of the construction quality oversight to ensure that no residual sealant and/or backing materials are present (Figure 3). This is often one of the most overlooked processes during remediation due to the time required to get it right. Installers are typically expected to achieve a certain lineal footage of sealant installation per day, so cleaning of the joints is often rushed, which can lead to premature failure of the joint.

The project team should also review the concealed substrate conditions upon sealant removal. Building components such as stone and metal panel clips, support purlins, air barriers, etc. can easily be observed during this stage of a project for any deficiencies that may also be adding to the building owner’s issues. This type of review is typically not included in a sealant joint remediation project’s scope of work. However, this level of service adds significant value for the building owner, as these conditions will likely only be observable during the sealant remediation.

Once the existing sealant and back-up materials are removed, sealant joints should next be prepped for new sealant installation. Generally, the industry standard is to employ the use of the “two-cloth method” to clean the sealant joints. The two-cloth method is defined by wiping the first cloth (soaked with an approved cleaner, such as isopropyl alcohol) along all surfaces of the...
existing joint materials that are to receive the new sealant. This process cleans substrate materials of oils, dirt, and debris. A second clean cloth is then wiped on the same surfaces to removed excess cleaner and debris from the joint surfaces. It should be noted that sufficient time for the cleaner to “flash-off” or dissolve should be allocated. Care should be taken to ensure the solvent is removed prior to drying, as failure to do so may result in a residue on the substrate. Cloths used for this method should be clean, white, and lint-free to avoid contaminants from being introduced to the prepared surface. Additionally, cloths should not be dipped in solvent material, as this could place contaminants in the solvent.

Preparation of the joints may also require the installation of primers to help aid in adhesion. Sealant adhesion testing should be used to verify if primers are needed. When utilized, proper installation guidelines as provided by the manufacturer should be followed. In order to avoid staining, primer installation should be limited to the amount of area to which sealant can be installed daily and only installed on substrates to which the sealant will be applied. Shelf life of the material should always be reviewed, as expired priming materials could affect performance. Furthermore, sensitivity to moisture could affect the material properties; therefore, packaging should remain sealed when not in use.

Following the cleaning and preparation procedures outlined above, backer material is installed. To appropriately set the backer material correctly, the depth that the sealant is to be installed on top of this backer must be considered. Sealant joint installation should accommodate seasonal compression and extension cycles. Accommodation for the aforementioned is typically provided through properly sizing the sealant joint width-to-depth ratio. In general, for joints less than ½ inch, the minimum width of a sealant joint should be ¼ inch. The width-to-depth ratio should be 2:1, with a constant depth over the length of the joint not less than ¼ inch. For sealant joint widths less than ½ inch, the sealant joint depth should not be more than ¼ inch. For sealant joints greater than 1 inch, sealant depth should be not more than ½ inch. It should be noted that width-to-depth ratios may vary, depending on the manufacturer. Additionally, all sealant joints on the building will not be the same; therefore, a firm understanding of the specified sealant manufacturer’s requirements relative to variable joint thickness, chemical compatibility, and adhesive compatibility with adjacent materials is important.

In order for sealant joints to properly function, the installation of backing materials is typically required. Backing materials generally consist of various widths of cylindrical closed-cell, open-cell, bi-cellular backer material, and bond-breaker tape. Cylindrical backing materials provide acceptable depth and profiles of sealant materials, deter three-sided adhesion, and provide the necessary base in order to properly tool the sealant joint. Sealant compatibility with backing materials utilized on the project should be verified with the sealant manufacturer.

When installing backer material, it is important that the material be properly
ly sized. Industry standards for backer material thickness vary; however, it is generally considered a best practice to select a backer material that fits snugly within the joint. Backer rods should be inserted into the joint gently using a blunt object to the required depth and be placed consistently and continuously along the entire joint. Backer rods should never be installed by using a sharp object and should not be allowed to bind, twist, or distort. Once installed, the backer rod should remain in place by compression, generally a minimum of 25 percent.

Where the sealant joints are too shallow or obstructions within the joint—such as shims or panel clips—do not allow for the backer rod to remain continuous, bond-breaker tape is typically utilized. Similar to backer rod materials, bond-breaker tape is used to deter three-sided adhesion, as sealant joint materials will not adhere to the bond-breaker tape. Because bond-breaker tape is typically self-adhering, best practice has indicated that the bond-breaker tape should span the obstruction within the sealant joint and be overlapped onto the backer rod (Figure 4).

The installation of the sealant, as with the previous joint-preparation steps, requires skilled applicators to achieve long-term performance. Sealant installation is typically performed utilizing a pressurized or pneumatic caulking gun (Figure 5). When applying sealant, it is best practice to install runs of sealant continuously with the appropriate sealant gun tip to completely fill the joint, taking care not to over- or under-fill. Once the sealant material is installed, tooling of the joint is performed to ensure a smooth, concave surface.

Tooling is typically provided by using either a wood or metal spatula (Figure 6).
Tooling should be performed prior to the sealant “skinning over,” as once the sealant has skinned, it is usually too late to tool the sealant. Only manufacturers’ approved additives should be utilized to aid in tooling sealant, but they are generally discouraged, as they can alter the adhesion of the sealant as designed. Wet tooling or licking one’s fingers to smooth the sealant is also discouraged, as the oils from an applicator’s fingers can alter the formulation of the sealant and deter adhesion as originally designed. For vertical application where large areas or lengths of sealant are being reinstalled, the general best practice is to install sealant from below and work up. This allows sealant material to be installed in a shingle lap fashion.

The tooled joint is generally all that is visible to a building owner at the completion of a sealant installation project, and should not be the only evaluative criteria that is used to judge the quality of the work installed. Building owners should have only experienced sealant installation contractors perform their sealant installation projects. Many contractors can tool sealant to “look” acceptable; however, if proper installation techniques are not provided and followed, systemic premature adhesive or cohesive sealant failure could occur. It is usually a best practice for a building owner to require that a potential sealant contractor looking to bid the work provides references from past clients and examples of previous projects that they have worked on with a similar scope of work and scale, as well as have at least five years of comparable experience installing sealant systems comparable to the system intended to be installed on the project. Building owners can also contact the sealant manufacturer for their recommendation of skilled sealant applicators, although this information should only be relied upon if the recommendation is from recent work and the recommending party has had a direct working relationship with the company and the work crew to be employed.

Another best practice for a building owner to gain additional confidence in the sealant installation is to employ a building envelope consultant as a third party to observe the installation of all phases of the project and provide daily reports of findings, including documentation of deficiencies and locations and quantities. A building owner may choose to request periodic or full-time third-party observations; however, one should remember that a lot of sealant can be applied in one day’s time. It is usually a requirement of the sealant manufacturer for the contractor to perform destructive testing of the sealant using either the tail or flap procedure, depending upon the adjacent substrates in accordance with ASTM C1521, Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints (Figure 7). Third-party observers can also be contracted to perform the testing at random, which is more likely to detect a deficient installation technique or practice and allow for timely correction.

CONCLUSION

Every restoration project comes with its own unique set of challenges. This is especially true when it comes to high-rise buildings. Sealant maintenance and restoration on these buildings is often dangerous, time-consuming, intrusive for the building’s occupants, and expensive. By providing a detailed analysis, proper design techniques, and oversight throughout the restoration project, shortcomings often experienced on these projects can likely be avoided.