**Identifying the Reasons for Joint Sealant Restoration**
*by Howard Kowalchuk and Pete Reynolds*

Before starting any joint sealant restoration work, one should have a clear understanding of the reasons for proceeding with the project.
Joint sealants are typically restored for one or more of the following reasons:

1. A seal breach that has manifested itself as water and/or air leakage.
2. As preventative maintenance to avoid the costs and inconvenience of future seal failures.
3. For sealant that is close to the end of its service life.
4. As part of a general building maintenance package.

Regardless of the motivation for the restoration work, the existing condition of the building joint seals and the overall wall system should be documented. A visual inspection or survey of the building joints should be undertaken. This may require the use of a swing stage, man lifts, boatswain chairs or other similar types of equipment. The extent of the survey needs to be decided upon before starting the project. It may be decided that a partial survey such as one drop per elevation will provide enough information to proceed.

The survey should document the following information:

1) The joint substrate types. Appendix A gives a description of common building materials that sealants must adhere to. The substrate type is required input for joint movement calculations. It is also a consideration when selecting replacement sealant products.

2) The joint locations, spacing, approximate linear footage and joint configuration (width and depth). Record the expected temperature range for that region. Typical and nontypical details should be sketched. Note location of non- typical areas.
The joint configuration, sealant width and depth, should be determined by cutting out samples in representative areas and measuring the sealant profile.
There are four basic types of joint configurations
- Butt joint.
- Fillet or angle joint
- Lap joint.
- Bridge joint.

In the cut out areas, the condition of the joint backing should be noted, including type and size. Check joint backing for moisture retention. Does it appear dry or wet? Is there staining on the backer rod? Include any observations made on any abnormal conditions of the wall interior, and/or traces of water. Note if the substrates are in need of repair. 3) The joint sealant general condition as well as substrate condition should be documented. This includes noting the location and the amount of linear footage.

Joint sealants are required to accommodate normal building movement while still maintaining a seal. This movement combined with weathering effects can cause a gradual reduction in the sealant performance properties. The samples cut to determine joint configuration should be examined.
Comments on the sealant appearance (both on the surface and within the bead), brittleness and elastic properties should be noted. Determine the age of the sealant if possible from construction or maintenance records.

**Document the type of joint seal failures. A description of the three types is as follows.**
a) *Sealant Adhesive Bond Loss*
Sealant adhesive bond loss is when the sealant has separated cleanly from the sur- face of the substrate.
A gap may appear between the sealant and the substrate.

b) *Sealant Cohesive Tearing*
Sealant cohesive tearing is when a split or tear occurs within the body of the sealant bead. The split may go all the way through or just a portion of the bead. Generally the split is parallel to the length of the joint. This type of failure is due to excessive or restrictive movement.

c) *Substrate Cohesive Failure*
Substrate cohesive failure is when the substrate ruptures or degrades at or near the sealant bond line. The sealant remains adhered to the substrate but the substrate separates within itself.

Joint seal failures are not necessarily readily apparent by visual inspection alone. A common technique for evaluating joint seal problems is to probe the joint seal during the inspection. Probing is simply applying a localized force at the center of the joint sealant using a blunt instrument. This will simulate extension of the joint, care should be taken not to overextend the joint by use of excessive force.
Probing may uncover sealant adhesive bond loss that was not apparent using visual inspection. Probing should be done during the inspection on a defined, repetitive basis. A typical approach is to probe every 3 to 5 linear feet of seal if no failures are observed. Failure areas are probed on a continuous basis until no failure is observed.

4) General observations. An important part of the survey is to document the general state of the building exterior and to note specific areas of concern.
Take particular note of:
- Evidence of water leakage or efflorescence.
- Wall cracking patterns and locations.
- Wall panel relative positions. Are they plumb and in line?
- Evidence of previous maintenance or repairs.
- Existing deficiencies in the wall system.

**Assessing the Existing Conditions**
With the survey completed, a general picture of the existing conditions can be visualized. If a partial survey was undertaken the first assessment is to decide if further inspection is required. Are the majority of the observed problems occurring on one elevation or are they concentrated in one general area? It might be useful to per- form an extensive inspection if the problems are not isolated.

**Assessing failures**
Making a sketch of the building elevations may be very helpful in assessing the existing conditions. The sketch should identify the joint seal failure locations along with the other areas of concern such as substrate cracking patterns.

The drawings and sketches should be reviewed to identify any patterns. Are all joint failures of one type? Do they occur only in one repetitive area such as at the window corners? Has one time building movement caused a problem? Are there cracking patterns that show this?

It is here that the assessor uses his building envelope knowledge and experience to truly understand the root cause of problems.

**Potential Failure, Root Causes**
Some potential root causes of failures attributed to sealants are:

a) *Sealant Adhesive Bond Loss*
Sealant adhesive bond loss can be caused by improper substrate preparation, substrate contamination or improper sealant installation. Sealant performance is very dependent on substrate preparation. Upon inspection, is there evidence that dirt, oil, form release agents, or other contaminants are within the areas of bond loss? If a primer was used, was it applied properly? Is there evidence of excessive amounts of primer, insufficient or no primer, use of the wrong primer or primer contamination?

Was the sealant installed properly? Is the bead width to depth ratio correct? Does it have the desired hourglass shape? Is three-sided adhesion occurring?

Sealant-substrate incompatibility may show itself as sealant adhesive bond loss. Sealants do not necessarily bond to all materials equally well. For example, a sealant that bonds well to glass may not bond well to granite. If all sealant bond loss is occurring on one substrate it may be caused by an inherently weak bond.

b) *Sealant Cohesive Tearing*
Sealant cohesive tearing usually results from joint movement being greater than the movement capability of the sealant or from improperly installed sealant.

Excessive movement can be the result of poor joint design, improper sealant selection or as-built joint widths that did not meet the design specifications.

To determine whether or not the joint movement exceeds the capability of the sealant, the following information is required:

a) The existing sealant’s joint design ratio. Sealant movement capability (a :i: percent- age) alone is not the joint design ratio, other factors such as construction tolerances and installation inconsistencies are included. This mayor may not be readily available. Joint design ratio is normally stated on manufacturers’ product literature. The typical industry standard for joint design is 4 to 1 .

b) The actual joint movement. It is possible to measure actual joint movement with the use of scratch gauges or other methods. (See figure 2.10) This approach can produce valid movement dimensions provided the gauges are allowed to record movement over an annual cycle. Another approach is to calculate the theoretical joint thermal movement using the method described in Section 10, Appendix B.

If the actual joint movement exceeds the joint design ratio, cohesive tearing may occur. Another common cause of cohesive tearing is improper sealant application. Bead profiles that are too thin have a tendency to easily tear or split. Bead profiles that are too thick increase bond line stress, decreasing movement capability , resulting in tears and splits.

c) *Substrate Cohesive Failure*
In order for the substrate to fail, the adhesive and cohesive strength of the sealant must be greater than the cohesive strength of the substrate. Joint failures of this type usually appear at first glance to be sealant adhesive bond loss. Close examination of the bond line shows that the substrate is embedded in the sealant surface. Prolonged water exposure and/or freeze thaw can often be the cause of this condition.

**Indirect Failure Root Causes**
Not all joint seal failures are directly related to poor sealant application or performance. Quite often poor design, poor performance, or failures within the wall or roof components lead to building joint failures.

Poor quality windows that leak infiltrated water into a wall system may appear to be sealant problems. Building settlement or other one time movements such as seismic racking often cause joints to move much more than anticipated.

Joint seal failures resulting from indirect root causes in most cases will not be corrected by replacing the joint sealant alone. Any problem solving process must identify the root cause and correct it to truly solve the problem. If leaky windows are causing sealant adhesive bond loss in joints below them, the window leaks need to be stopped first.

Any seat failures identified during the survey should be repaired. The result of the survey assessment is an understanding of the extent of the repair required.

**The Survey Summary**
The results of the survey should be summarized to aid in choosing the appropriate joint seal restoration option.

The summary should include the following information:
The approximate linear feet, type and age of the current joint sealant.
The type, location, number and approximate linear feet of detected joint seal failures.
A description of the root cause(s) of the detected seal failures including indirect causes.

Doing a systematic existing condition survey along with a thorough assessment of the observations make choosing the restoration approach much easier.