Sealant Presentation for The Fifteenth Annual Westford Symposium on Building Science

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What we will talk about

- First and foremost whatever you want!
- The Basics of Sealants
- A sealants goal in life
- The Big Six of Sealant Installation
- Applications – Weatherseal and SSG
- How Joint Sealants Fail
- Common pitfalls
- What do Warranties mean?
- Most Importantly – your questions!!

What is a Sealant?

- Polymer (long chains to stretch)
- Crosslinker (links long chains)
- Fillers (strengthen)
- Pigments (color)
- Catalyst (cure rate)
- Other - UV stabilizer, biocide, plasticizers, etc.

What is the Role of a Sealant?

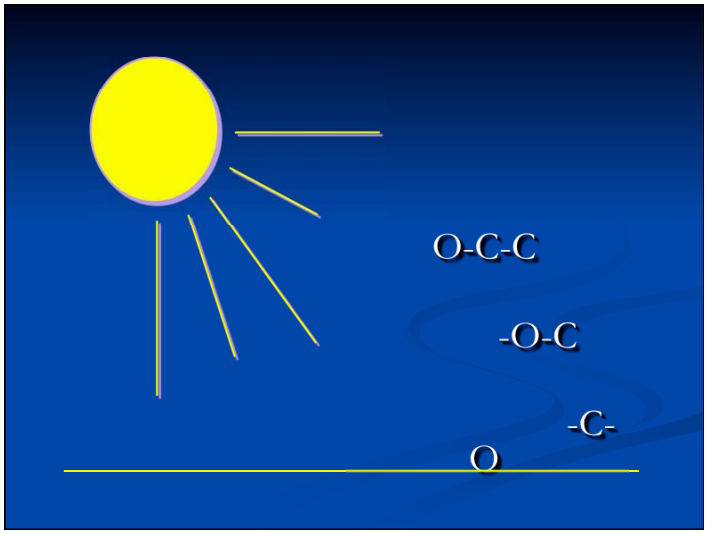
- Stop water and air intrusion
- Coefficient of Thermal Expansion
  - Glass = 0.9 x 10^{-5} mm/mm/°C
  - Concrete = 1.0 x 10^{-5} mm/mm/°C
  - Aluminum = 2.3 x 10^{-5} mm/mm/°C
  - Acrylic = 7.4 x 10^{-5} mm/mm/°C
- Sealant joints accommodate differential thermal movement, seismic movement, windloads, and other structural movements

Sealant Chemistries

- Organic (-C-C-O-C-C- Polymer)
  - Polyurethane Sealants
    - Single component
    - Multi-component
  - Polysulfide Sealants
  - Acrylic Latex Coatings and Sealants
  - Non-curing butyls
- Inorganic (-Si-O-Si-O-Si- Polymer)
  - Silicone Sealants, Coatings and Pre-cured pieces

Why Are Silicones Different?

- There is NOT enough Energy in Ultraviolet (UV) Light to Break down a Silicone Backbone.
- On the Other Hand, there is sufficient energy in UV Light to Break Down the C-C And C-O Bonds of an Organic Coating Backbone.



Sealant Reversion – Note, this happens with Coatings Too!!

Important Sealant Properties

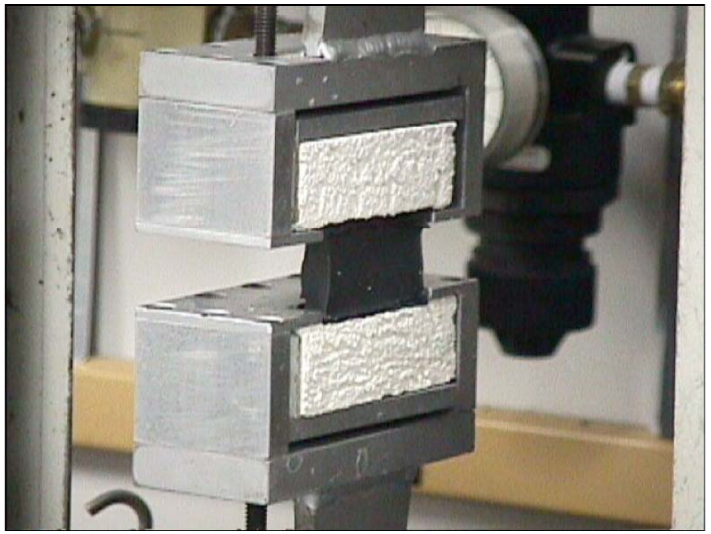
- Adhesion

Typical Substrates

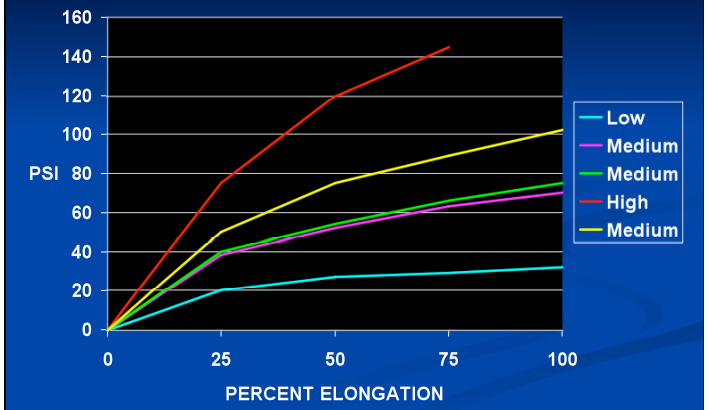
- Concrete
- Stucco
- Granite
- Limestone
- Marble
- Brick
- Mortar
- Ceramic Tile
- Painted Aluminum
- Anodized Aluminum
- Stainless Steel
- Galvanized Steel
- Glass
- Plastic
- EIFS
- Wood

Important Sealant Properties

- Adhesion
- Modulus



Sealant Modulus



Important Sealant Properties

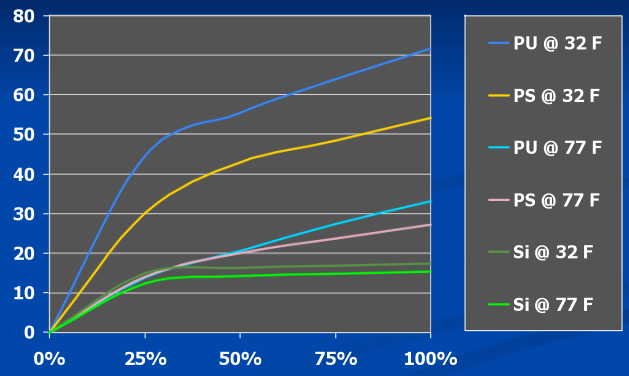
- Adhesion
- Modulus
- Movement Capability

+/- 12.5%, +/- 25%, +/- 50%, + 100/- 50%

Important Sealant Properties

- Adhesion
- Modulus
- Movement Capability
- Sealant Property Change with Temperature

Sealant Modulus vs. Temperature



Important Sealant Properties

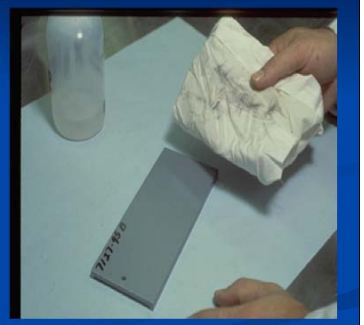
- Adhesion
- Modulus
- Movement Capability
- Sealant Property Change with Temperature
- Sealant Property Change after Weather Exposure

Sealant Installation

- Clean
- Prime
- Install Backer Material
- Install Sealant
- Tool Sealant
- Quality Control

Clean

- Must be Clean, Dry and Frost Free
- Two cloth cleaning method
- Suitable solvents: MEK, Xylene, Toluene, IPA, or other.



Why Clean?

- To gain optimum adhesion!
- Adhesion occurs at a microscopic scale.
- Much better chance of good, long term adhesion to the peaks AND valleys, rather than just the peaks.

Surface Preparation

- Concrete – new: adhesion surfaces should be sandblasted at manufacturer. Old: grind, wire wheel, saw cut, etc. Blow out with dry, oil free air!!
- EIFS – new: knock off the "chunkies", blow out with dry, oil free air. Old: not likely!! "Band-aid" or rebuild the joint.
- Metal / Glass – clean and dry.

Prime

- Film-former (fingernail polish) or chemical treatment (monomolecular layer)
- Prime only joint surfaces
- Follow sealant manufacturer's guidelines

Why Prime?

- If you don't need to – DON'T!
- Some substrates require "help" to gain adhesion.
- Primers create a substrate surface that is more "attractive" to the sealant.

Install Backer Rod

- Three common backer rods: closed cell polyethylene, non-gassing and open cell polyurethane
- 25% compression
- Proper depth
- Bondbreaker tape

Backer Materials

- Open Cell Polyurethane
- Closed Cell Polyethylene
- Non-gassing Polyolefin
- Bondbreaker Tape
- Compressed Foam Sealants
- Gasket Extrusions

Why use a Backer Rod, or Bond breaker tape?

- To establish joint geometry
- To prevent three sided adhesion.
- To give you something to tool against (force intimate contact).

Install Sealant

- Mix sealant if required
- Install the sealant in such a way as to completely fill the void

Tool Sealant

- Immediately after sealant installation
- Ensures proper joint shape
- No tooling aids (soap)
- Remove masking

What's wrong with "wet" tooling?

- What are you wet tooling with – solvent or soapy water, both have low surface tension … so they spread out well.
- That means that they can get to the "adhesion" surface before the sealant does and interfere with adhesion.
- With some sealants, wet tooling aid can inhibit the cure chemistry.

Quality Control

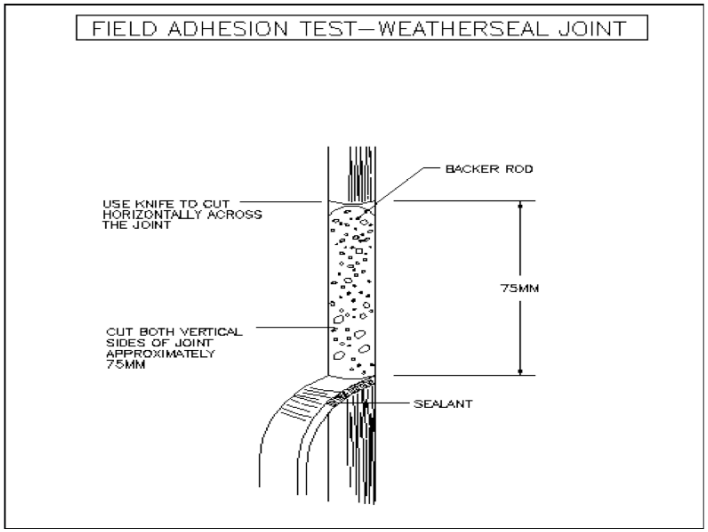
- Follow manufacturer's guidelines
- Perform field adhesion tests
- Document results of field adhesion tests

Quality Control

- Proper sealant storage (below 80 or 90 F)
- Use sealant within use-by-date - There is no re-qualification of sealant
- Field adhesion tests must be performed before, during and after project
- Every re-caulk project requires pre-job test installation
- Document field adhesion tests
- Distributors are key partners

Why would we do Quality Control?

- To assure yourself of the job you're doing!
- It's much better to locate problem areas or difficult substrates and find a workable solution BEFORE someone else finds it for you!
- Honestly, it is not "Rocket Science"! It is easy to do and easy to repair.

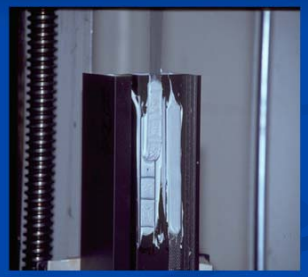


Technical Service

- Adhesion Testing

Adhesion Testing

- Metal
  - Anodized Aluminum
  - Painted Aluminum
  - Alodine Aluminum
  - NO MILL FINISH
- Glass
  - Annealed, Tempered or Heat Strengthened
  - Insulating Glass
  - Spandrel Glass



Technical Service

- Adhesion Testing
- Compatibility Testing

Compatibility Testing

Technical Service

- Adhesion Testing
- Compatibility Testing
- Stain Testing

Technical Service

- Adhesion Testing
- Compatibility Testing
- Stain Testing
- Print and Detail Review

Technical Service

- Adhesion Testing
- Compatibility Testing
- Stain Testing
- Print and Detail Review
- Warranties

Local Service

- Field Adhesion Testing - Sealants and Coatings
- Coordination of Lab Testing and Custom Color requests
- Immediate Technical Support
- Materials in Stock
- Initiating Warranty Application

Calculating Joint Size

Movement = Coef. Of Linear Expansion X Temperature Range X Length

Movement = 13.2 x 10^{-6} in/in/°F X 140 °F X 120 in = 0.222 inch

Joint Size = 100/Sealant Movement Capability X Movement (in.) + Tolerances (?)

Joint Size = 100/50 X 0.222 inch + 0.125 inch = 0.569 inch or 5/8″

Applications

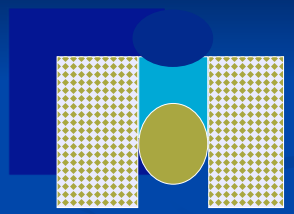
- Nonstructural (Weatherseal)
- Structural

Nonstructural Joint Design

- Hourglass Joint
- Fillet Joint
- Overlay Joint
- Double Weatherseal

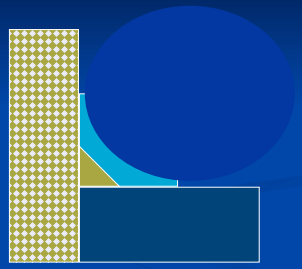
Hourglass Joint

- 2 to 1 width to depth ratio
- Avoid 3 sided adhesion
- Design within movement capability of sealant



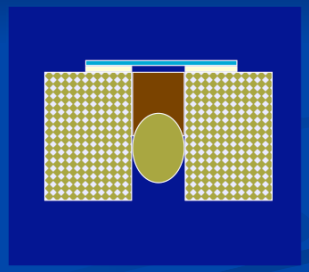
Fillet Joint

- At perpendicular surfaces
- 1/4″ (6 mm) minimum contact
- Use bondbreaker tape or triangular backer



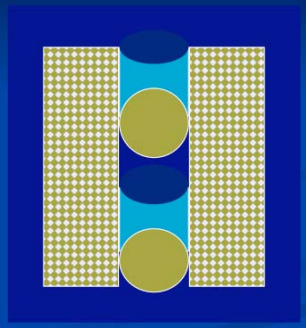
Overlay Joint

- Bridges existing sealant joint
- 1/4″ (6 mm) to 3/8″ (10 mm) minimum contact
- Use wet sealant or preformed sealant



Double Weatherseal

- Requires drainage
- Consider sealant curing process
- Use open cell backer rod if shot simultaneously
- Requires extra installation attention



Structural Attachment

- Sealant adheres glass (or other) to the structure
- Sealant allows windload to be transferred to the structure
- Sealant must be strong but flexible to accommodate thermal expansion
- Sealant must have a long life
- Only silicones can be used for structural glazing

ASTM New Standard Guide for:
Structural Silicone Glazing (Draft 19) states the following:

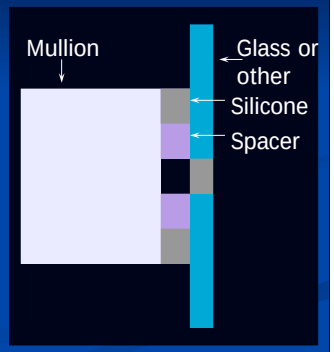
"At this time, only a **silicone sealant** formulated for a SSG applications, and recommended by the manufacturer for structural use, is acceptable and will comply with ASTM C1184"

ASTM C1184 Specification for Structural Silicone Sealants

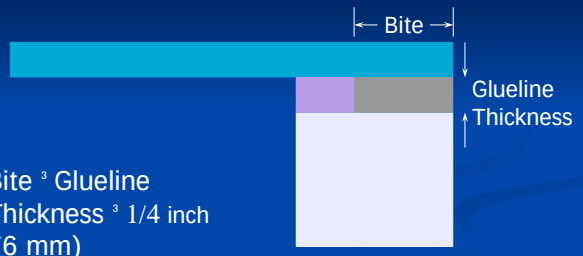
- 50 psi (345 kPa) minimum tensile strength (ASTM C1135)
- Test at 73°F (23° C), 190°F (88°C) & - 20°F (-29°C)
- 7 day water immersion
- 5000 hours of accelerated weathering

Structural Attachment

- 2 sided silicone structural attachment
- 4 sided silicone structural Attachment
- Same guidelines for 2 and 4 sided SSA



Structural Attachment Design



Bite ³ Glueline Thickness ³ 1/4 inch (6 mm)

Bite = $\frac{\text{1/2 Lite Shortspan x Design Windload}}{\text{Sealant Design Strength}}$

Glass Stressed to Failure

Organic Sealed IG unit Structurally Glazed after a Typhoon – Where is the Outboard Lite?

Structural Attachment Techniques

- Construction Site Attachment (Stick System)
- Shop Attachment (Unitized Curtainwall)

Other Structural Attachment Applications

- Impact Resistant Glazing
- Bomb Blast Windows
- Slope Glazing
- Structural Attachment
  - Aluminum Panel Stiffener
  - Synthetic Panel Attachment
  - Stone
  - Ceramic Tile

How Sealant Joints Fail

- Adhesively
- Cohesively
- Deterioration

How Sealants Fail

- Adhesively
  - Surface prep
  - Primer
  - Bondline stress
  - Moisture
  - Poor tooling
  - Joint profile
  - Substrate

How Sealants Fail

- Cohesively
  - Movement
  - Joint profile
  - Hardening
  - Chalking
  - Tear resistance

How Sealants Fail

- Deterioration
  - Hardening
  - Chalking
  - Compression set
  - Moisture
  - Reversion

Critical elements, and "Pitfalls" in Sealant application

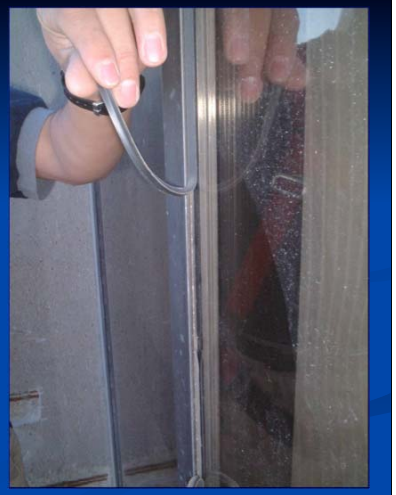
- Be assured that the surface is clean and dry!
- DO NOT install the backer rod BEFORE cleaning or priming!
- When priming, more is NOT necessarily BETTER!
- DO NOT wait too long to tool, or tool improperly, or "wet tool"!
- Make certain of ¼" MINIMUM sealant BITE!
- 2:1 W/D Ratio up to ¾" wide joint, after that, NO MORE than 3/8" sealant thickness at the center.
- Sealants will require 7 – 14 days to cure, AND adhesion is the last thing to develop – SO DON'T let anyone pull on your sealant job in less than 14 days!
- If you have questions or issues – CALL US!!

Problem: Inadequate contact surface for a fillet bead wet seal (<1/4")

Solution: Use a pre-cured piece to span onto face of window frame or use sealant in a similar manner

Or accept it as non-warrantable condition

Dow Corning requires a minimum ¼" contact for all moving weatherseals



Problem: Gasket shrinkage **Solution**: Remove gasket and provide a continuous fillet wet seal joint

Problem: Poorly tooled joint – sealant has not wet out sides of joint

Solution: Remove and replace sealant

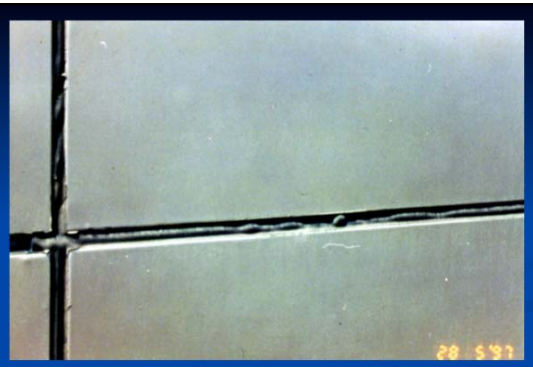
Problem: Peeling coating **Solution**: Locate the water intrusion, remove all loose coating, then coat with a product that has superior moisture vapor permeabiity

Problem: Paint peeling from silicone sealant joint

Solution: None – Organic paints do not adhere to silicone AND DO NOT have the same movement capability as the sealant. Only silicone adheres to silicone. Consider a Silicone **Coating**

Problem: Large sealant joint. Solution: Not a problem if the sealant depth is ½" or less. Requires significant applicator skill. Choice of backer is important.

Problem: Bubbles in sealant **Solution**: Do not puncture closed cell backer rod or use a different backer rod type



Problem: Movement during cure **Solution**: Use open cell BR to speed cure and keep sealant depth at 1/8" to 1/4"

Problem: Dirt rundown **Solution**: None with current design – Water must be channeled away from the face of the panel

Problem: Sealant discoloration **Solution**: Isolate from contact with asphaltic waterproofing membrane

Problem: Leaking Parapet **Solution**: Pre-cured silicone adhered with wet sealant

How long do Sealants Last?

- How long do you want them to last?
- It varies somewhat around the world. In Boston – an organic (Polyurethane, Polysulfide, Acrylic, Butyl, etc) will be hard pressed to "perform" more than five (5) to eight (8) years. There are many examples of less than two (2) years.
- Silicones will perform much longer (remember Silicones offer 20 year Sealant Warranties and 10 year Coating Warranties).
- It does depend to some degree on your expectations of the sealant (is the movement of the joint within the movement capability of the sealant, etc.?).

What happens when Sealant needs replacing?

- Be prepared to spend lots of money – to replace a sealant costs anywhere from four (4) to ten (10) times what it cost to install the sealant in a new project (Rigging access, removing old sealant, tenant disruptions, etc.).
- Rigging the building is cumbersome, inhibiting, an eyesore.
- Removing the old sealant is noisy, dirty, invasive.

Craftsmanship Issues: Color Selection

- Most Sealants are available (sometimes with extra lead time and cost) in a wide variety of colors.
- Generally the colors are specified by the Architect or Building Owner

Craftsmanship Issues: "Sanding" Joints

- Talk to the Sealant Manufacturer.
- With Dow Corning Sealants: 1) Prepare the joint normally (clean dry substrate), 2) install the sealant, 3) dry tool, 4) immediately (before the sealant begins to skin over) cast, imbed, shoot, etc. the particulate into the sealant, 5) Quality Control – allow the sealant to fully cure before evaluating the adhesion of the sealant to the underlying substrate or the adhesion of the particle to the sealant.
- If done correctly, this procedure will not effect the warrantability of the sealant.

Craftsmanship Issues: Recessed Sealant Joints

- Recessing the joint offers an aesthetic look.
- Issue: more difficult to clean, back, shoot, tool, and quality control.
- Issue: a recess can provide a location (ledge) for dirt to collect, thus, potentially, a greater "run-down" situation.

Craftsmanship Issues: Uniformity of Joint Surface

- Uniformity (the aesthetic) is important.
- But, from a long term sealant performance standpoint – what is behind (width to depth ratio, is the substrate clean and dry, etc.) is of greater importance.
- Point: if a contractor is "sloppy" about the aesthetics, they may be sloppy about the above.

Craftsmanship Issues: Smallest and Largest Joints

- Smallest: ¼" – anything less than that is too difficult to clean, pack, shoot, tool, and Quality Control. What about movement capability?
- Largest: it is up to you … Dow Corning does not have a problem with up to four (4) inch wide joints. Issue: Sealant width to depth ratio (thickness at the center should not be greater than $^{3}/_{8}$" to ½"). Issue: anything over 1" is an aesthetic, and installation, "challenge" for the applicator.

What do Warranties Really Mean?

- Good Question … Warranties themselves are not worth a lot (they are written in "legalese") – what is more important is the "track record" of the company that is offering the Warranty.
- Take some time, go out and look at products that you have installed – are they really performing the way the warranty would suggest?