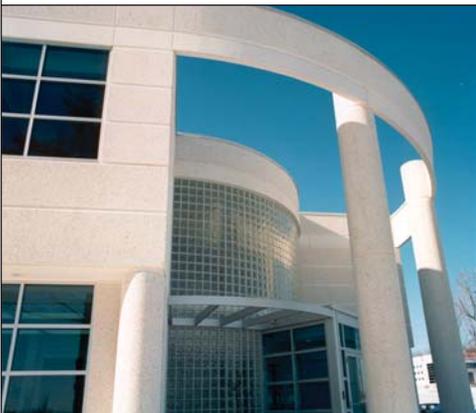


Architectural Precast Concrete Sealant & Joint Guide



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Introduction

Architectural Precast is a versatile cladding material that is ideal when superior aesthetics or construction economy is required. Precast cladding offers high durability, low maintenance, excellent fire resistance and energy efficiency.

The successful performance of an architectural precast concrete building exterior is frequently defined by its ability to separate the environments found inside a building from that found outside a building. The design versatility provided by architectural precast concrete is appropriate for use on high-rise office and residential buildings, where the emphasis is on prestige and aesthetic appeal, and low-rise industrial structures, where economy and durability are paramount. In all cases, stopping exterior or interior environment from migrating in or out through a building envelope is critical.

Custom made forms are used to create precast panels in the exact size and shape required. Reveals and joint patterns can be incorporated to achieve the required scale of a facade. Specific colour effects can be achieved through the use of various coloured sands, cements and aggregates, or by the casting in granite, marble, stone, tile or brick veneers. This allows the designer to achieve prestigious visual effects at minimal costs.

Early consultation with a CPCI member precast producer will ensure the most cost-effective approach.

One of the critical links to ensuring a weatherproof building exterior is the joint design and the correct use of sealants which ensure the continuity between like and dissimilar building materials. The design and execution of these joints is of the utmost importance and must be accomplished in a constructible, economical manner. The joint treatment also has an effect on the general appearance of a project. Selecting the right product, appropriate joint design, surface preparation and application technique is required to ensure the joint and sealant provide the desired performance.

The penetration of exterior moisture (rain, snow, water vapour) through a building envelope can occur through openings, by gravity, by capillary action, by mean (steady state) air pressure difference across the wall and by vapour pressure difference across a wall.





A properly designed and installed joint will provide a degree of water tightness consistent with its design and exposure. The design, use, size and function of a building will also determine the design requirements for panel joints.

Design criteria for joints include:

1. Structural requirements (amount of movement to be accommodated)
2. Architectural appearance
3. Interior climate of the building
4. Exterior exposure (orientation and climatic conditions)
5. Economics
6. Construction tolerances
7. Width and depth of joint

The following decisions must be made in response to the design criteria:

1. Width and depth
2. Type
3. Location
4. Number
5. Architectural treatment
6. Materials selection

Ideally, joint locations should be determined during the design development phase. Items affected by joint design are:

1. Panel size
 - Location of structural support points and tie backs
 - Manufacturing considerations and practices
 - Trucking and site hoisting considerations
2. Weathering
3. Tolerances
4. Transition between adjacent materials
5. Location of openings

Joints are required to accommodate changes in wall panel or structure dimensions caused by changes in temperature, moisture content and load.

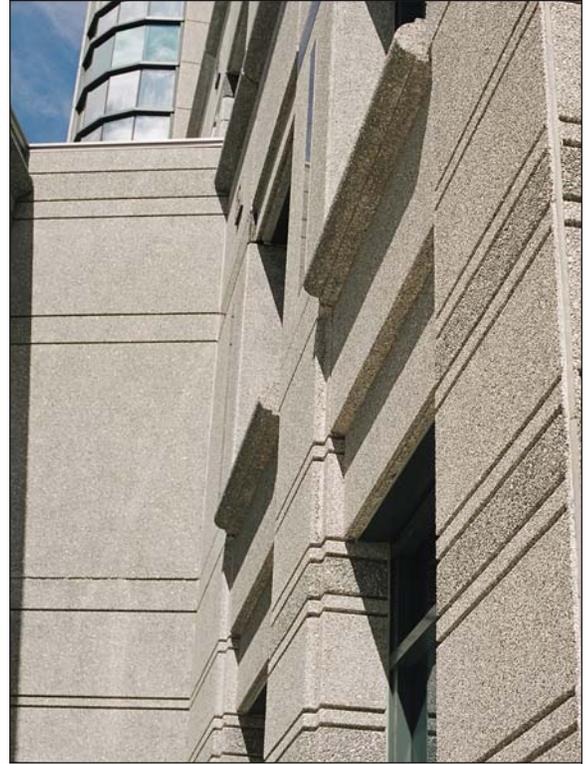
Joint sealants must, at the same time, prevent or control water and air penetration through the building envelope. The joints between panels are normally designed to accommodate local wall movements rather than cumulative movements.



Architectural Treatment

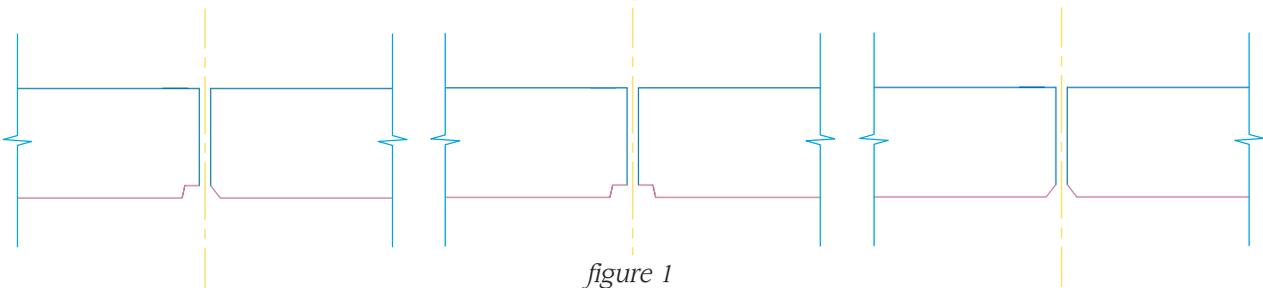
Joints should be expressed as strong visual features of architectural wall design. False joint lines can also add to the visual effect. Recessing of joints and/or sealants will help diminish the visual impact of possible variations between adjacent surfaces inherent in large wall panels. Setting the sealant back from the face of the panel also gives some protection from UV light to minimizing deterioration. By recessing the joints, the sideways flow of wind-driven rain over the sealant is reduced. Complicated edge and fenestration profiles should be avoided for economy in manufacturing and erection.

Complicated profiles are more vulnerable to damage in handling and are more difficult to make watertight.



Joints are important features in creating weathering patterns. Vertical joints help in channeling water, provided the joint is not pointed flush with sealants or gaskets. The concentration of water at these joints requires careful detailing to prevent moisture penetration.

Recommended Joint Details



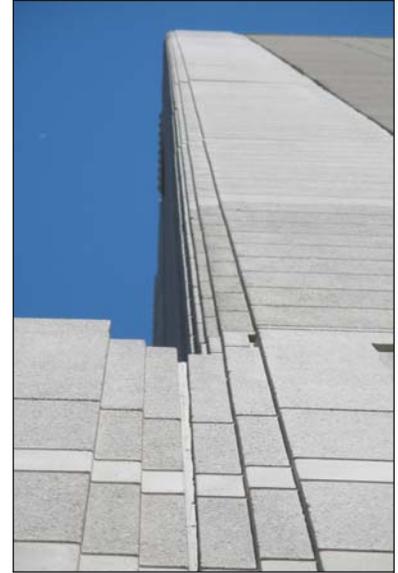
Suggestions for detailing typical architectural precast concrete panel joints, (*figure 1*) include:

1. Allow either a chamfered or reveal joint. (*figure 1*) These types of joints can accommodate the tolerances required for panel thickness. The shadows formed within these joints will minimize any adverse effects on the aesthetic appearance of the joint system. By making the joints appear wider than they actually are, visual



figure 2

differences in their width are proportionately reduced. This tends to make the difference more difficult to detect and mask slight misalignments of the joints which might otherwise be especially noticeable at intersections. The panel edges assist in sealant installation by simplifying the profile of the joints by providing a reasonable radius (chamfering). Chamfers make the edges less vulnerable to chipping. Chips disrupt water flow and concentrate dirt.



2. Avoid the use of butt joints, as the tolerance variations in panel thickness may result in the formation of unwanted shadow lines directly over the panels rather than within the joint area. This can impair the aesthetic appearance of the panel assembly. (figures 2 and 3)

3. An excellent architectural treatment of joints is the recessing of panel edges. A small draft is required for the first 19 mm or 25 mm ($\frac{3}{4}$ " or 1") of the returns. The draft is normally in the order of 4mm to 8 mm ($\frac{1}{8}$ " to $\frac{3}{8}$ "). The joint openings will be slightly tapered, a desirable feature which prevents water and snow accumulations in the joint from exerting pressure during freezing conditions.

Not Recommended Joint Detail

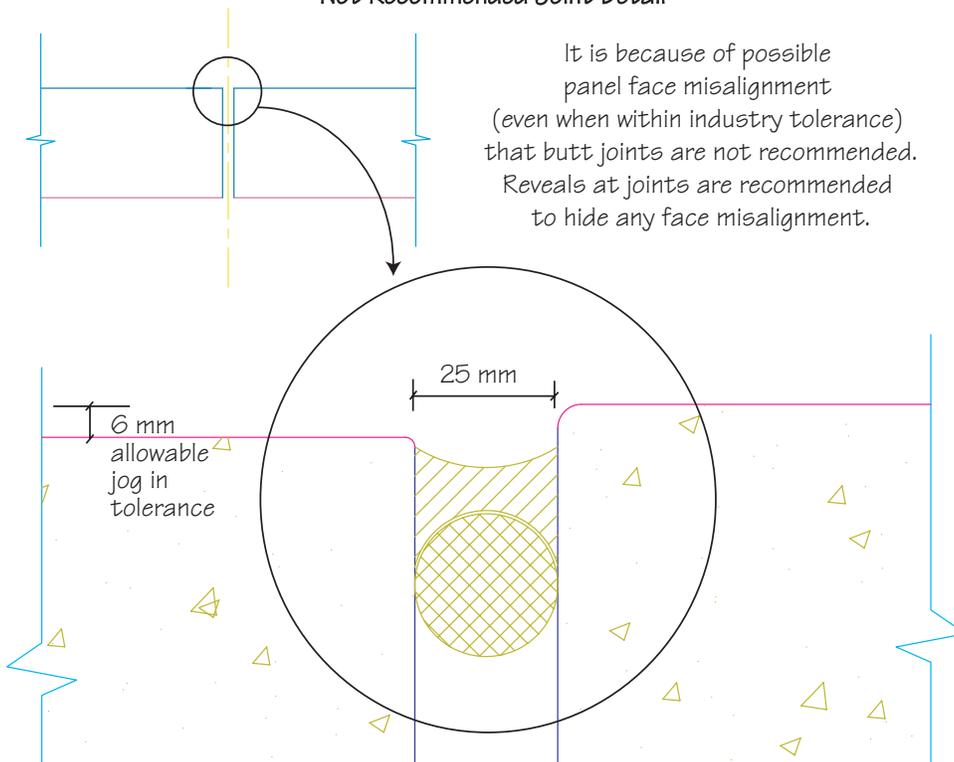


figure 3

Joint Design & Building Science Principles Behind Joint Design

Joints between precast concrete wall units may be characterized into three basic types: rain screen joints (single bead), face sealed joints (single bead) and modified rain screen joints (two stage joints).

A special case is rain screen joints (single bead) used with single wythe precast panels which are acting as an exterior rain screen assembly in a composite wall design. (*see page 18*).

Face Sealed Joints

One-stage joints provide a single bead of sealant to act as a weather seal and minimize the ingress of moisture into the wall assembly.

Face sealed joints used as a combination weather seal and air vapour seal are not recommended, as even minor sealant deficiencies will result in severe building envelope failures at a later time. The sealant bead is usually close to the exterior surface of the precast panel, as an aesthetic consideration.

Current Practice of Modified Rain Screen Joints (two stage joints)

These joints are based upon the open rain screen principle and are sometimes known as ventilated, or pressure equalization joints and are recommended for exterior wall construction across Canada. The modified rain screen principle is designed to control the forces that can move water through openings in the exterior sealant

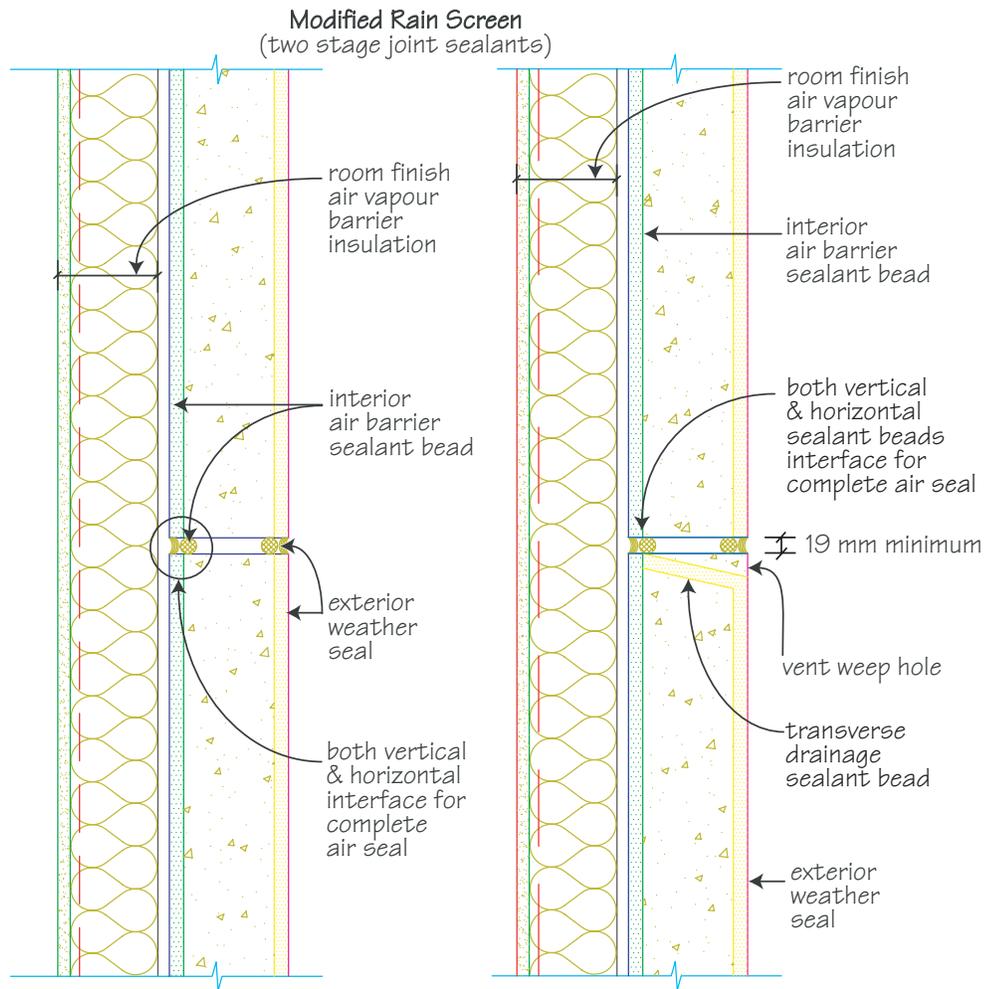
Modified rain screen joints have two sealant beads. The joint consists of a weather seal near the exterior face and an air/vapour barrier seal close to the interior face of the panel. The exterior weather barrier is designed to shed most of the water from the joint, and the interior air vapour seal is the demarcation line between outside and inside air pressure. Between the two joint sealants is an air cavity which must be vented and drained to the outside.

Vent/weep openings in exterior weather seal allow air to rapidly enter until the pressure inside the joint cavity is equal to the wind pressure acting against the outer wall and should be sized vertically to be half the size of the horizontal joint dimension. With the kinetic energy of the wind supported moisture now dissipated, water does not enter the joint cavity. The pressure difference across the exterior sealant layer is essentially zero, and wind pressure is transferred to the inner airtight seal. Rain does not penetrate into the building envelope because there is no difference in pressure forcing it through the exterior layer as the kinetic energy of the moisture which reaches this seal has already been dissipated. Any other moisture entering the joint will cling to the joint walls and be drained out by a transverse seal.

The air tightness of the air vapour barrier seal is critical, as is the sizing of the weather seal openings which govern the speed at which pressure equalization occurs. Pressure equalization must take place almost instantaneously for a rain screen joint to be effective.

Another prime function of the interior air vapour seal is on high-rise buildings which are susceptible to stack effect. This seal prevents the warm moist air moving from the building interior to the exterior, which could cause condensation once the dew point is reached. Interior air must be prevented from flowing into cold spaces in the wall and contacting cold surfaces. With winter temperatures, thermal bridges can occur and allow condensation to form as a buildup of frost on the backside of the precast wall walls. This frost can melt and runs back inside the building, giving the impression that the building is leaking.

Typical details of modified rain screen joints are shown in *figures 4,5 and 6.*

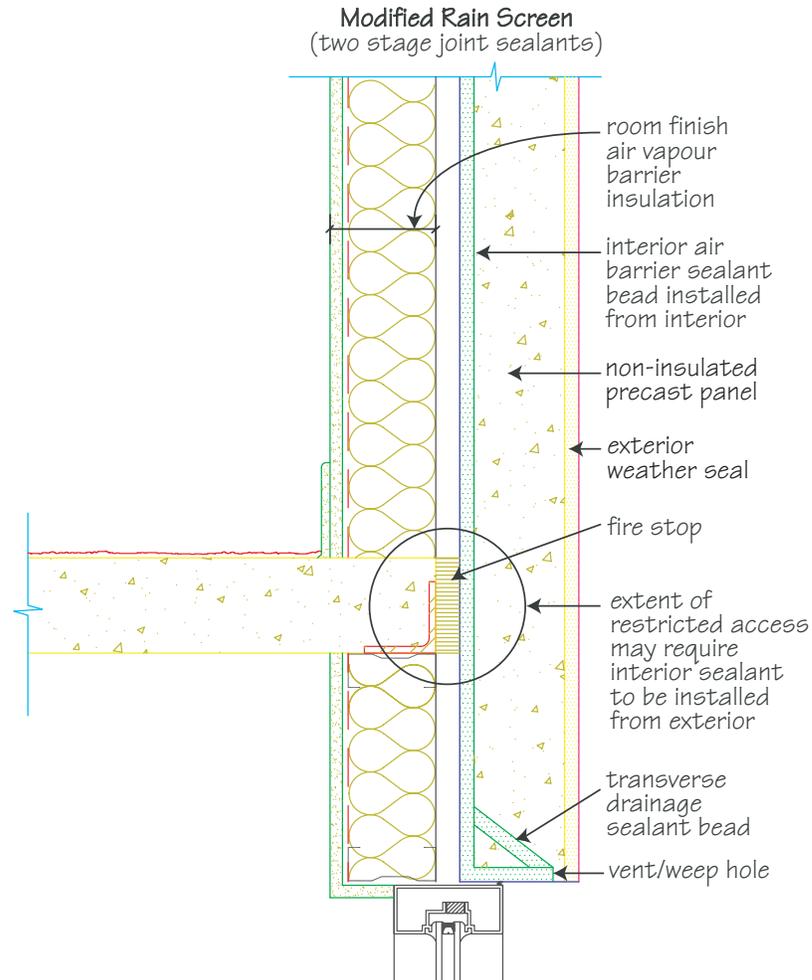


*Plan section at horizontal joint.
Use when interior face of panels
are accessible at all locations.*

figure 4

*Vertical section at vertical joint.
Use when interior face of panels
are accessible at all locations.*

figure 5

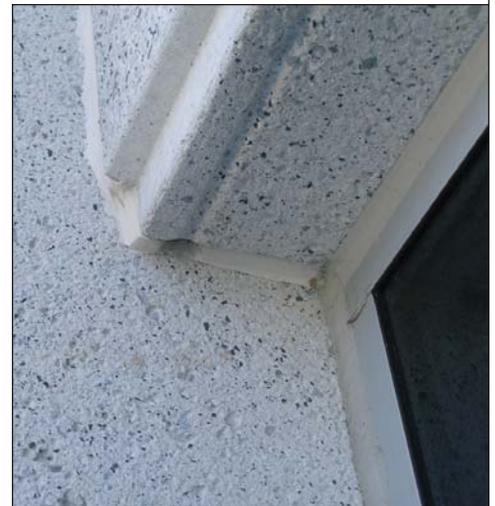


Section at vertical joint.

Use when interior face of panels are accessible.

figure 6

Water in precast panel joints, either from penetration or condensation, should be drained from the joint by proper flashing or transverse sealant bead installations. It is advisable to use these flashing details as dampers to avoid vertical movement of the air in the joint chamber caused by wind, outside air turbulence and stack effect. Flashings using the sealant should be installed at regularly spaced intervals along the height of vertical joints, usually near the junction of the horizontal and vertical joints at each floor level. Therefore, if any moisture does come out of the system, it will run down the face of the joint sealant and not over the face of the panels.



Preferred Practice of Modified Rain Screen

(two stage joint sealants)

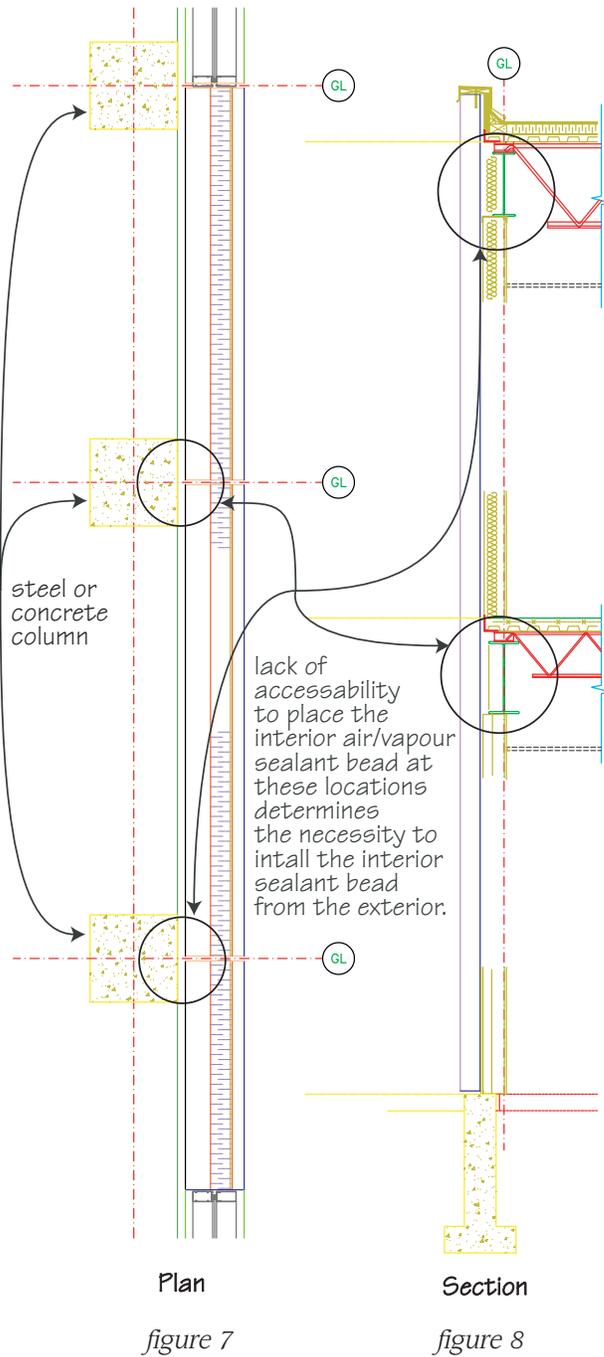
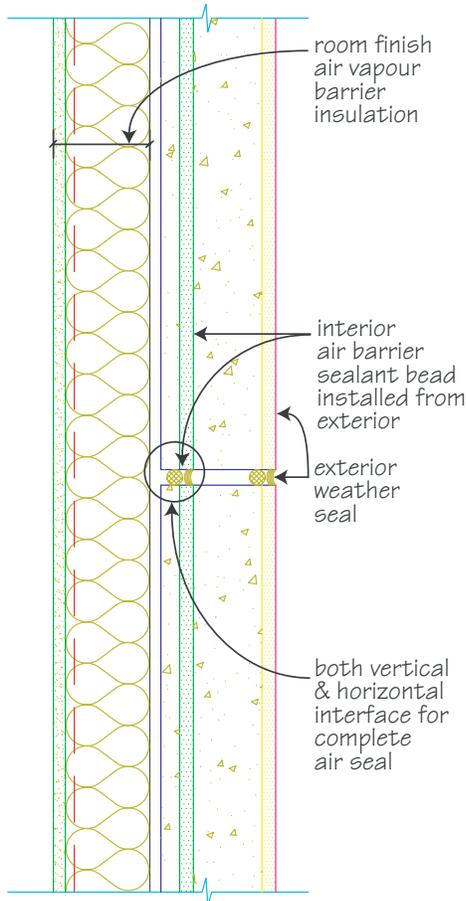


figure 9

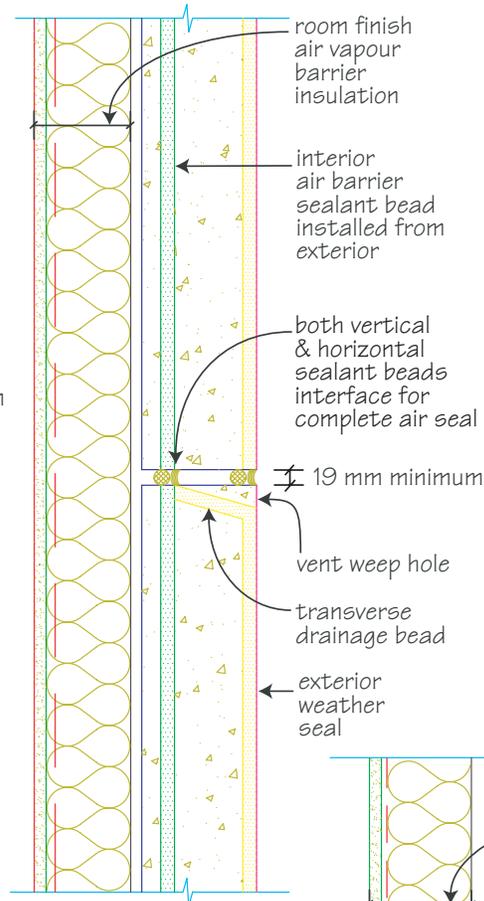
Although it has been common practice to caulk the interior seal from the building interior, this is changing, as many interior joints are not accessible from the interior. (figures 7 and 8) Attempts to close off from the exterior are prone to not being done. Considerable expense is added to proper completion of an interior seal when all precast panel connections (figure 9) must be sealed tight to prevent the transfer of air and moisture.

Modified Rain Screen (two stage joint sealants)



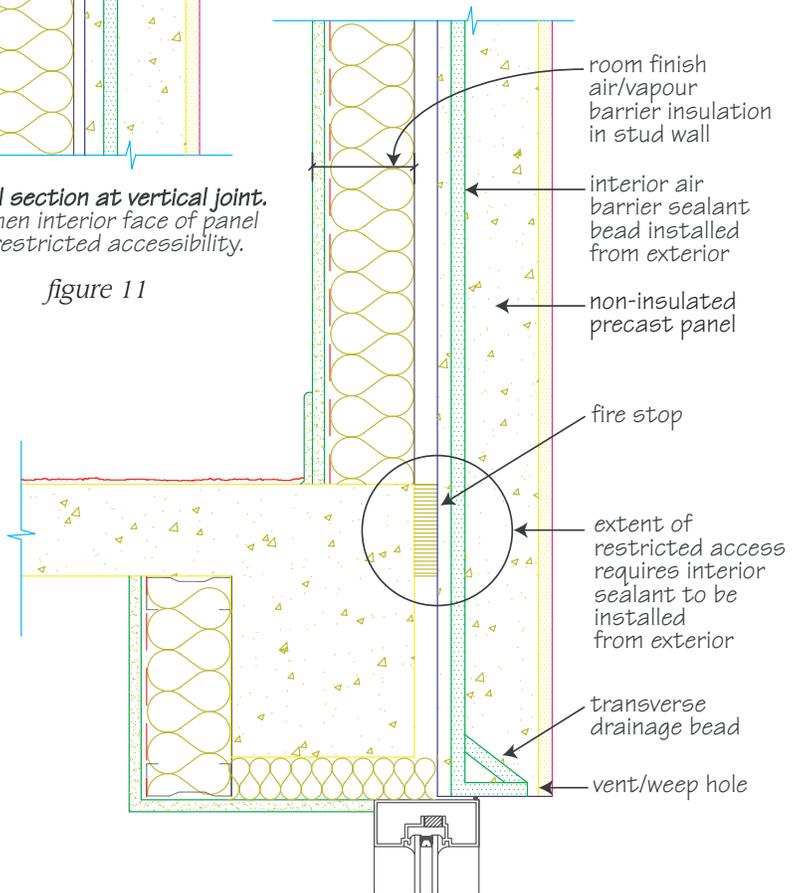
Plan section at horizontal joint.
Use when interior face of panel has restricted accessibility.

figure 10



Vertical section at vertical joint.
Use when interior face of panel has restricted accessibility.

figure 11

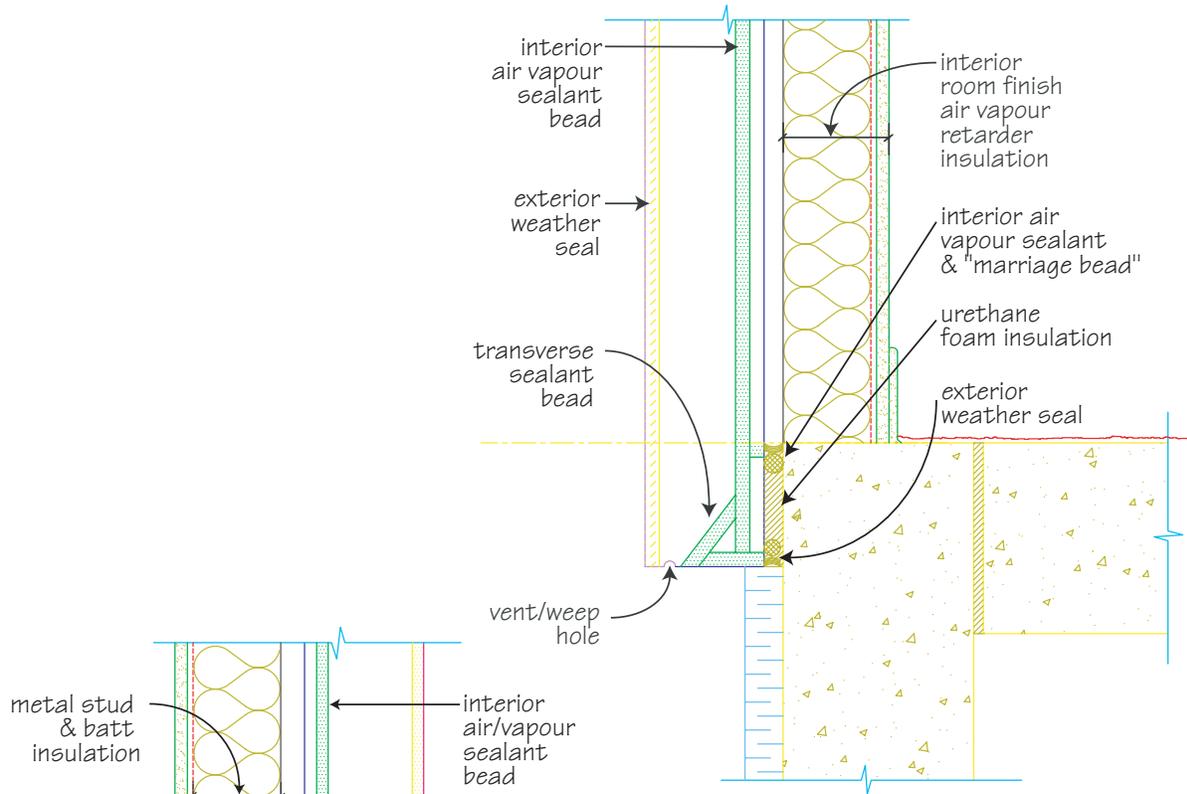


Section at vertical joint.
Use when interior face of panels are not accessible from interior.

figure 12

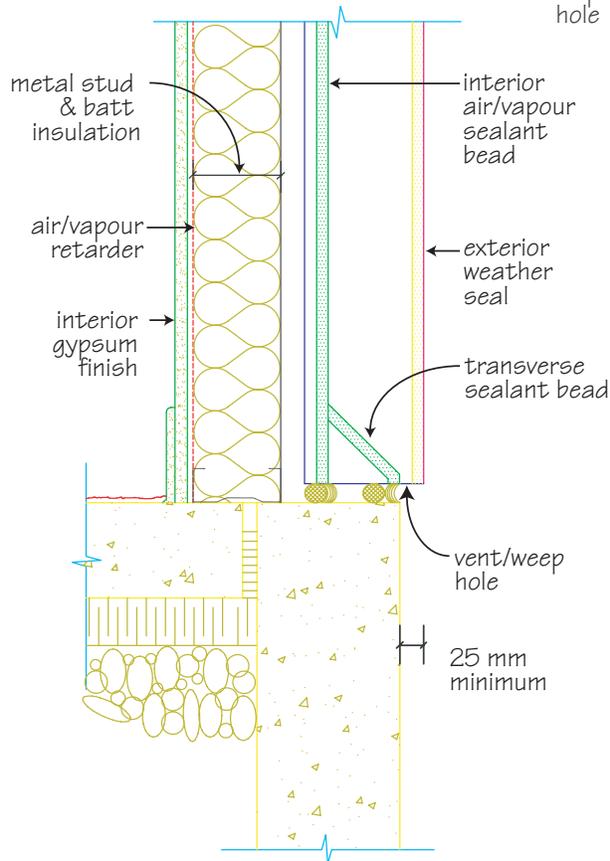
Panel configurations and joint sizes should permit a careful applicator to successfully install both the air/vapour seal and the weather barrier from the exterior. The normal positions of the backing and sealant would be reversed for the interior air seal. (figures 10 to 16). The special tools required may include an extension for the nozzle of the caulking gun and a longer tool for tooling the air/vapour seal.

Base Details



Base detail panel running past foundation.
Single wythe non-insulated precast panel.

figure 14



Panel bearing on foundation
Single wythe non-insulated precast panel.

figure 13



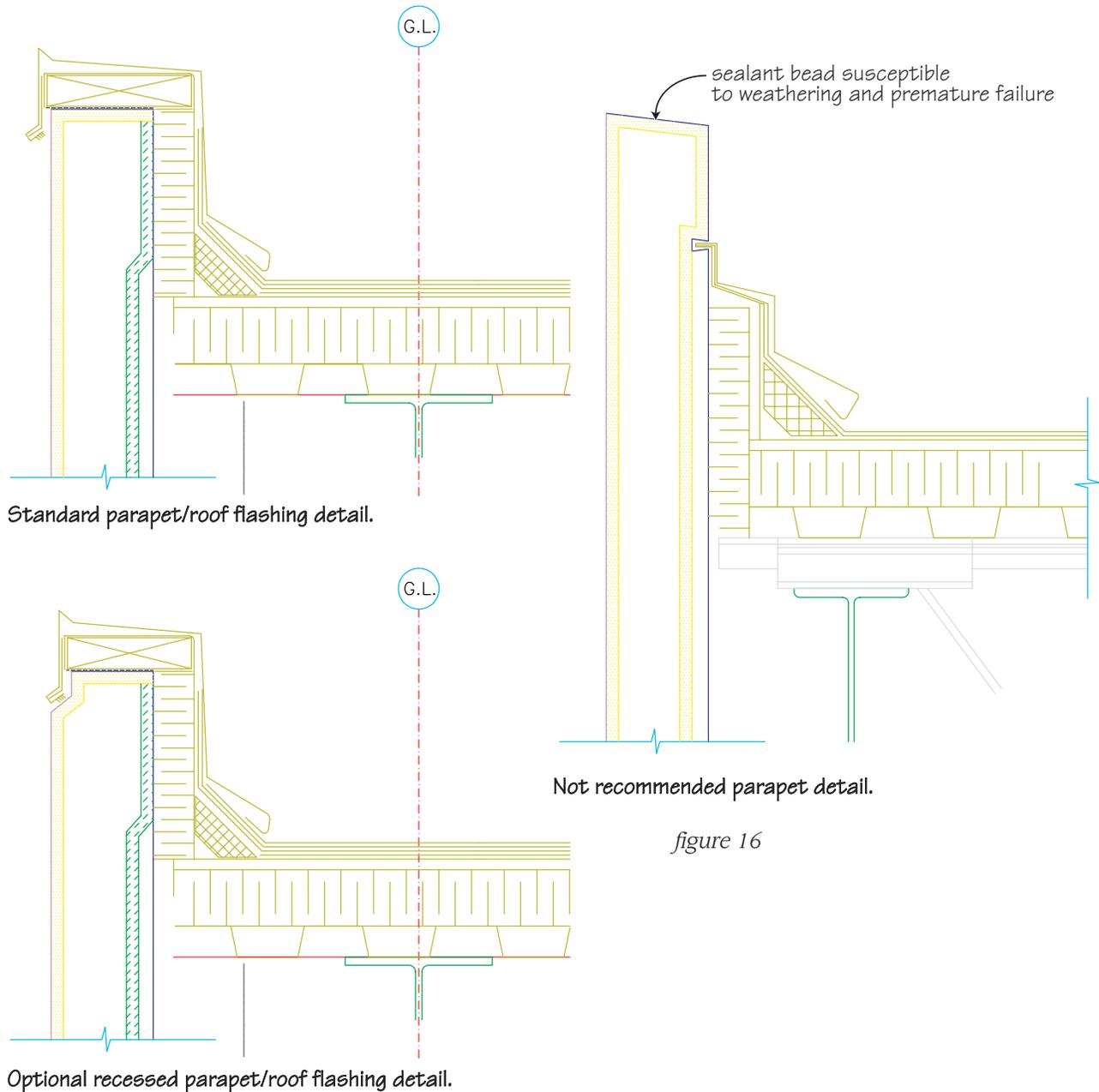


figure 16

figure 15

The architect, building science consultant, precast concrete manufacturer, erector, and sealant applicator must all understand the function of the modified rain screen joint if optimum results are to be achieved. The dimensions of the joints must be maintained at all times.

The most common mistakes in the installation of two-stage joints are:

- Leaving gaps in the air seal,
- Making the exterior weather seal airtight, and/or
- Improperly venting or draining the joint air cavity.

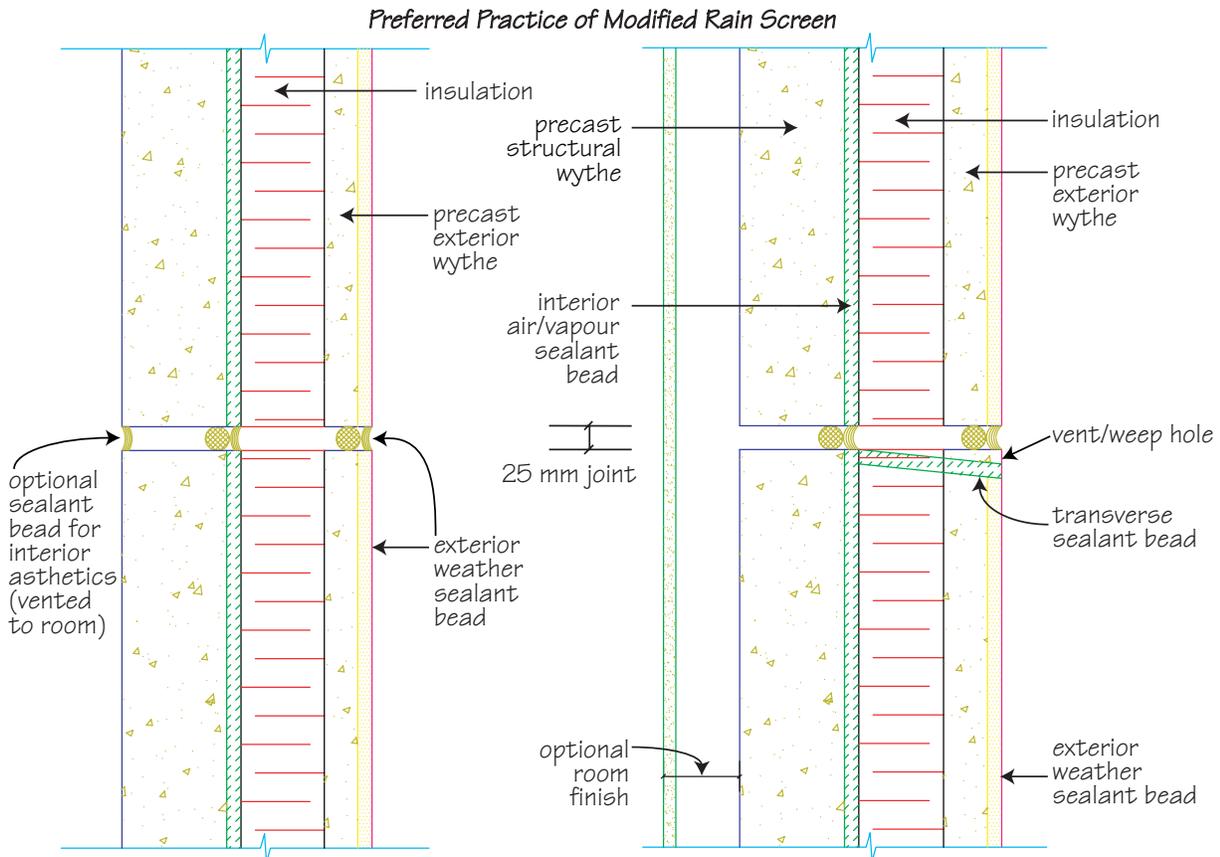
Modified Rain Screen used in Insulated Panels



Preferred Practice

All the same principles previously discussed apply. The preferred location of the interior air seal is at the back face of the insulation, or the front face of the interior structural panel element.

The placement of the interior sealant bead at the front of the interior structural panel accommodates the increased thickness of the insulated precast panel and allows the caulking contractor to properly install the interior air/vapour sealant bead. This allows for warm building air to enter the joint, keeping the structural wythe panel warm at the joint locations and moves the dew point outward. **Increased joint size is necessary to facilitate effective interior sealant bead installation.** (figures 17 to 20)



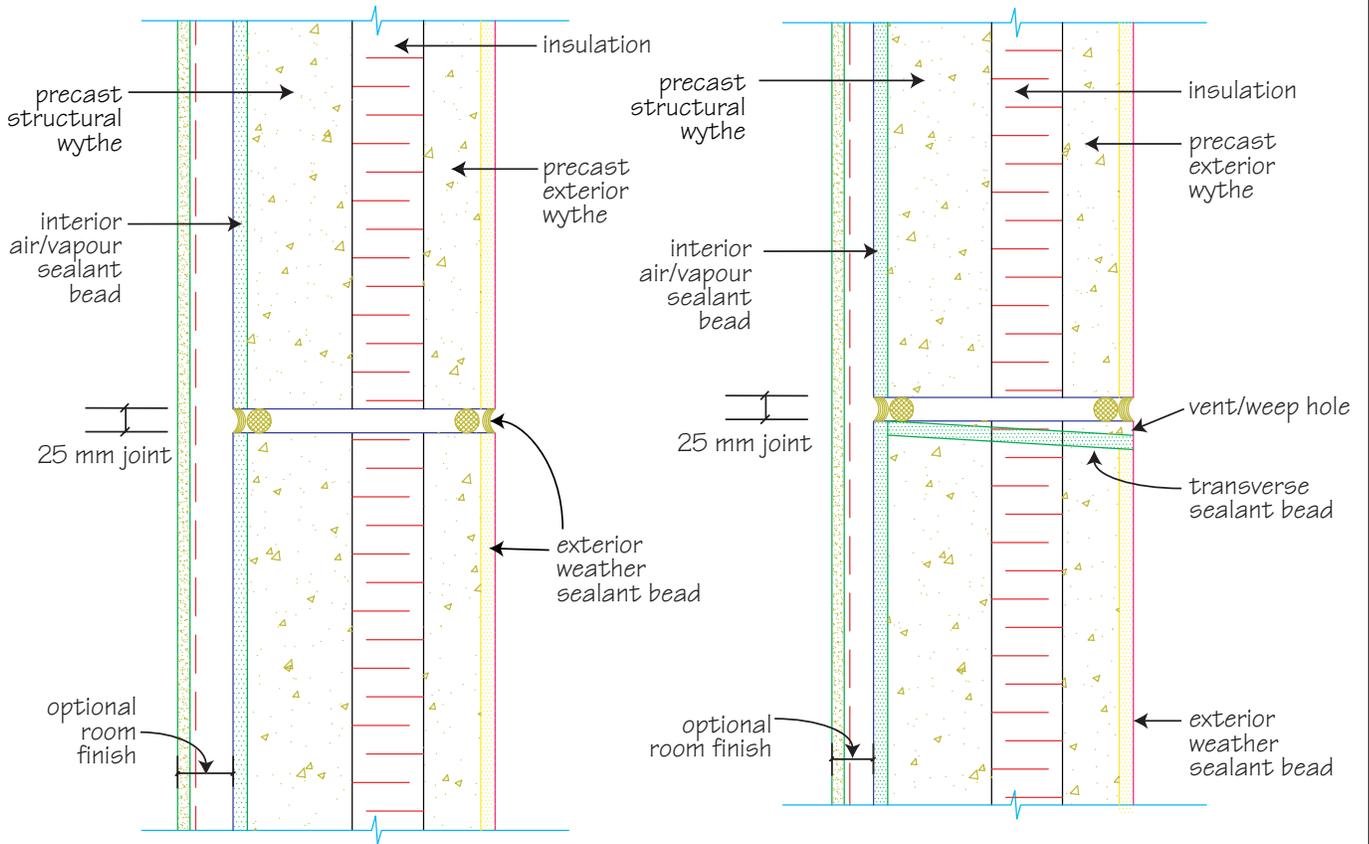
Plan section through horizontal joint.
 Access to back of panel restricted.
 Precast concrete modified rain screen detail.

figure 17

Vertical section through vertical joint.
 Access to back of panel restricted.
 Precast concrete modified rain screen detail insulated panels.

figure 18

Current Common Practice of Modified Rain Screen Joints



Plan section at horizontal joint.

Total clear access to rear of panel at joints.
 Modified rain screen insulated panels.
 (Two stage joint sealants)

figure 19

Vertical section through vertical joint.

Total clear access to rear of panel at joints.
 Precast concrete modified rain screen
 detail insulated panels.

figure 20



Precast Rain Screen Insulated Panels and their Joint Design

These insulated precast panels provide the exterior weather screen, joints, an air cavity space, insulation, air/vapour barrier and a support system for all the elements via the precast concrete backup panel. A true rain screen system is comprised of several different building materials, installed at different times, all working together to perform as a rain screen wall assembly.



figure 22



figure 21

Where precast wall panels are used with brick, granite (figure 21) or limestone exterior veneer (figure 22), it is recommended that an air space be introduced behind these veneer materials due to the increased number of joints in the veneer (granite and limestone), and the possibility of moisture migrating through due to the porosity of the facing materials. The introduction of a cavity behind the veneer material will act to drain away condensation/ moisture on the backside of the stone or brick veneer. (figures 23 and 24)



The same principles of modified rain screen for insulated panels apply to this panel construction, with special consideration going to the exterior weather seal and vent opening size to allow the cavity to pressure equalize. Horizontal and vertical air barriers are required to restrict airflow in the cavity.



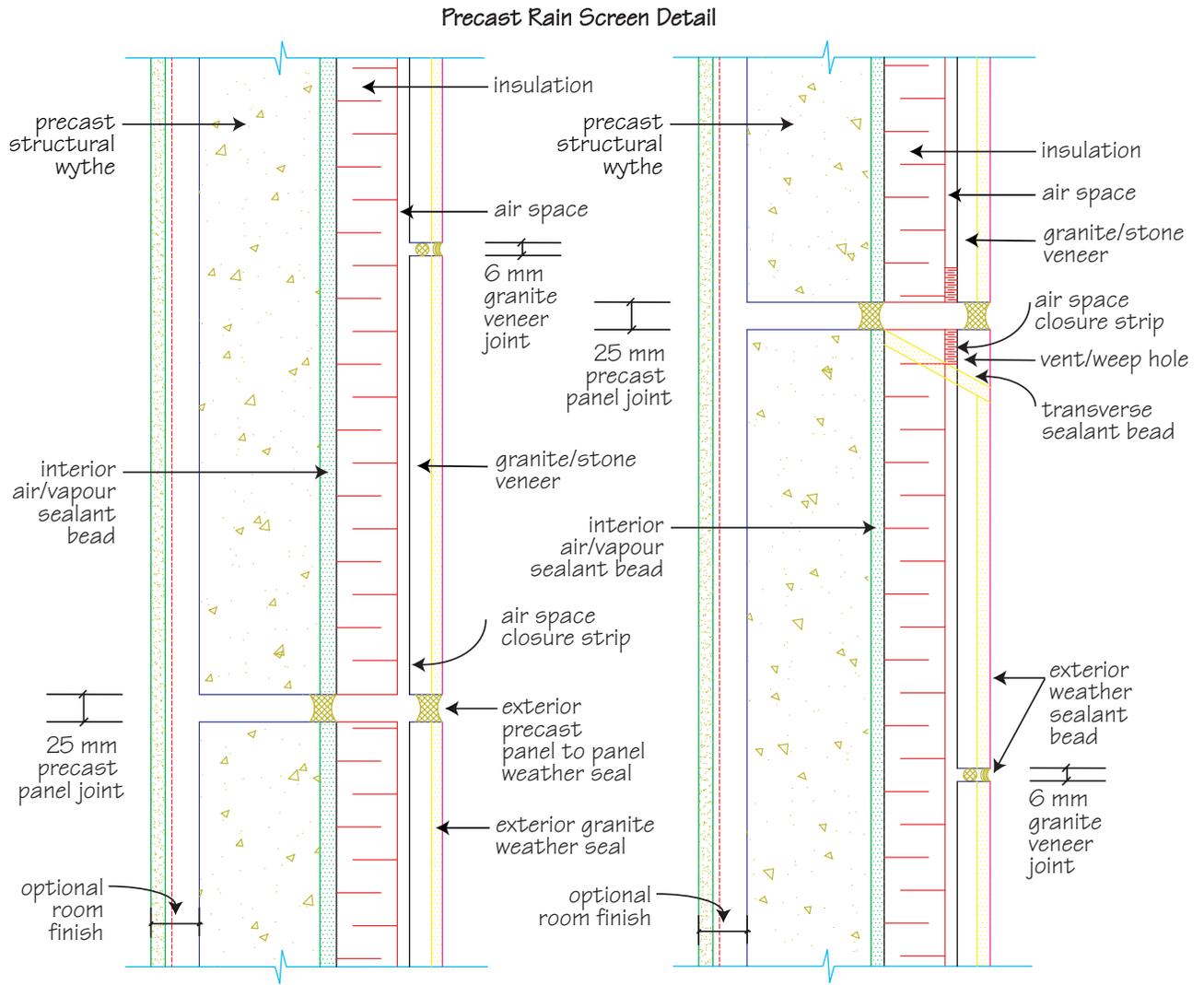
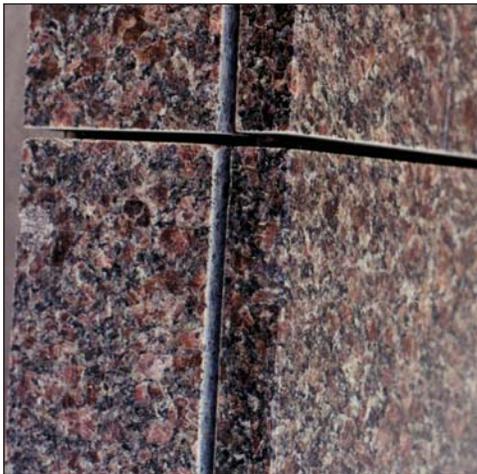


figure 23

figure 24



Special Case:

Precast Panels used as an Exterior Rain Screen Assembly in a Composite Wall Design



Rain screen joints can be used in applications where precast concrete panels are installed over a building envelope as a durable cladding material. Here, the panel system is designed to act merely as a weather barrier, protecting the building envelope (insulation, air and vapour barrier and the envelope support materials) from the elements and dissipating any direct attack on the envelope by the weather.

The same principle used in masonry cavity walls can be implemented with the brick veneer replaced with a single wythe precast panel. The weather skin of precast and a single bead of sealant provide the weather barrier for the building envelope.

Properly placed vent openings in the exterior weather sealant bead will permit an exchange of air in the cavity. Since these joints are vented, air gusts entering into the cavity equalize the pressure on both sides of the sealant bead. Sealant deficiencies are not critical as little moisture will enter the opening with a zero pressure difference.



Water, either from penetration or condensation, should be drained from the joint and air space behind the panel by proper caulking and flashing details. Horizontal and vertical movement of the air in the chamber behind the exterior panels caused by wind, outside air turbulence and air stack effect should be limited with the introduction of baffles in the air space, creating compartments.

Sealant & Joint Design

Joint Sizing

The following are general guidelines for joint sealant design. Recommendations may vary for particular sealants and applications. Please refer to individual Technical Data Sheets or your sealant supplier for specific details.

The sealant industry prescribes an absolute minimum standard of a 4:1 joint design ratio factor to accommodate thermal movement. (figures 25 and 26) Construction, fabrication and erection tolerances must be added to calculate the nominal joint size. The 4:1 joint design factor can be explained as follows:



Panel movement due to thermal fluctuations can be calculated using the following simplified formula:

$$J_w = (100 + S_m) \cdot C_t \cdot \Delta T \cdot L$$

where,

J_w = joint width

S_m = sealant movement capacity, in percent

C_t = coefficient of thermal linear expansion

(typical value for concrete $11 \times 10^{-6}/m/m/^{\circ}C$ (6×10^{-6} in/in/ $^{\circ}F$))

ΔT = the range of minimum and maximum temperature

L = effective panel length or height

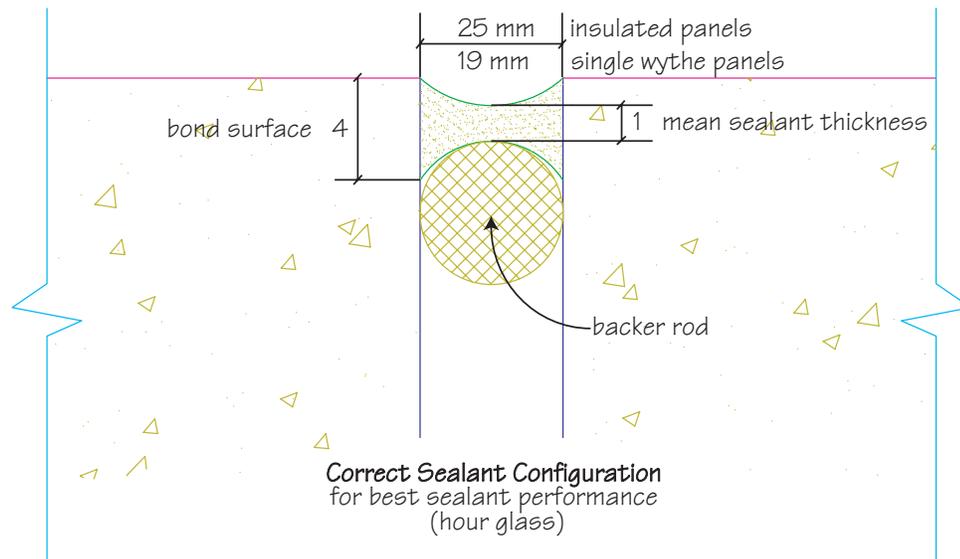


figure 25

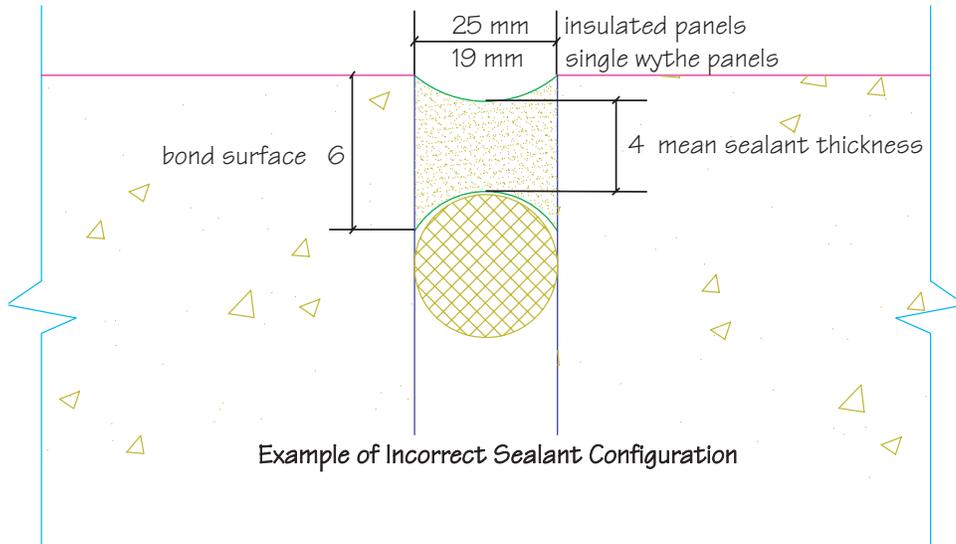
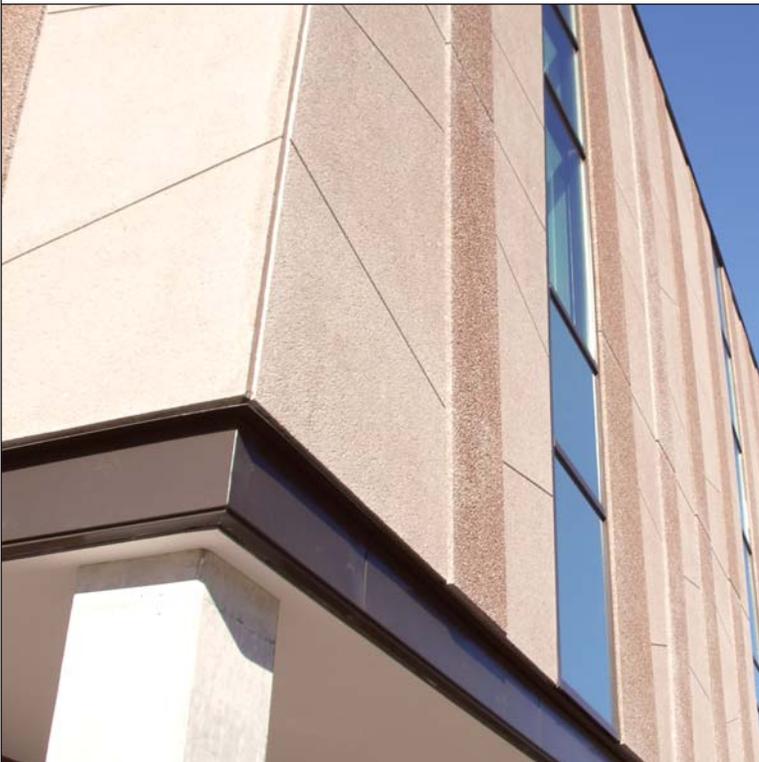


figure 26

Similar calculations can be made for the effects of moisture absorption in the precast panels, frame deflection/shortening as well as creep if panels are installed on a concrete structure. Most panel configurations will likely be governed by the minimum joints sizes (presented below) that account for construction tolerances, as well as minimum width for installation.

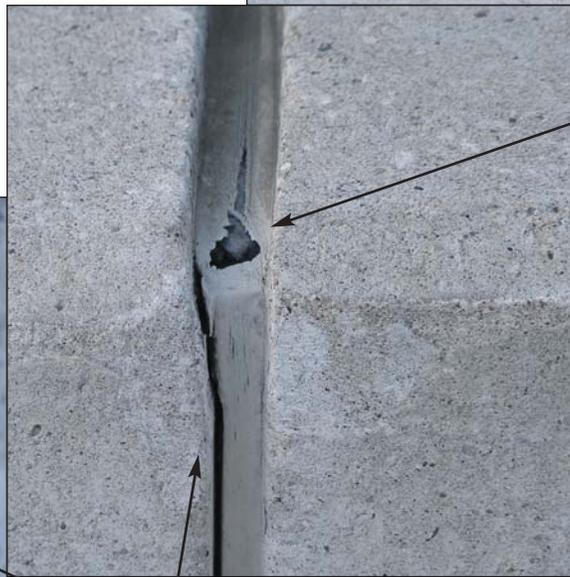
The minimum size joint that can be installed for a single-stage joint is 19 mm ($\frac{3}{4}$ inch)

wide, and for a two-stage joint, 25 mm wide (1 inch). These minimum, nominal joint widths, will account for construction tolerances to ensure that the differences in the actual shop drawing dimensions may be adaptable to actual construction. Assume that any joint can have a tolerance of ± 6 mm ($\pm \frac{1}{4}$ inch). If the joint were to be up to 6 mm ($\frac{1}{4}$ inch) narrower than required in the drawings, the joint sizes for single and double stage joints would become a minimum of 12 mm ($\frac{1}{2}$ inch) and 19 mm ($\frac{3}{4}$ inch) respectively. Corner joints can be 30 mm ($1\frac{1}{4}$ in) wide to accommodate extra movement and panel bowing expansion often experienced at this location.



Sealant Shape & Thickness

The depth of the sealant must be controlled by using a suitable sealant backing material. The backing material must also function as a bond breaker to obtain the full benefit of a well-designed shape factor. More is not better when it comes to sealant depth. If too much sealant is applied, the stresses on the sealant bead are magnified and the chance of premature failure increases (*adhesive joint failure*). If the bead is too shallow, there may be insufficient material to accommodate the joint movement and the sealant will split (*cohesive joint failure*).



Cohesive joint failure.

Adhesive joint failure.

Expansion (Contraction) Joints

The allowable joint width should be increased when using neoprene, or other gasket or compression seals. These materials are most commonly available for joint widths of 12 to 25 mm ($\frac{1}{2}$ in to 1 in). These joints are not practical for joints below 12 mm ($\frac{1}{2}$ in) and may require special orders for joints above 25 mm (1 in).

Special Joint Design

Seismic seals are a special case of expansion joints where the joints are generally quite large and are used between new and existing buildings to protect the joint from moisture and allow the structures to move due to seismic motions, thermal expansion and wind drift without damage. Seismic joints are designed to accommodate both vertical and horizontal movements. Joints are available in sizes from 50 to 300 mm (2 to 12 in). Joining seals together can accommodate wider openings.

Dimension Chart		
A	A	A *
Opening at Installation	Total Movement	Maximum Opening
6" (152 mm)	9 1/2" (241 mm)	11 1/2" (292 mm)

** Designed without stress to the systems components.
Capable of wider openings during seismic event.*

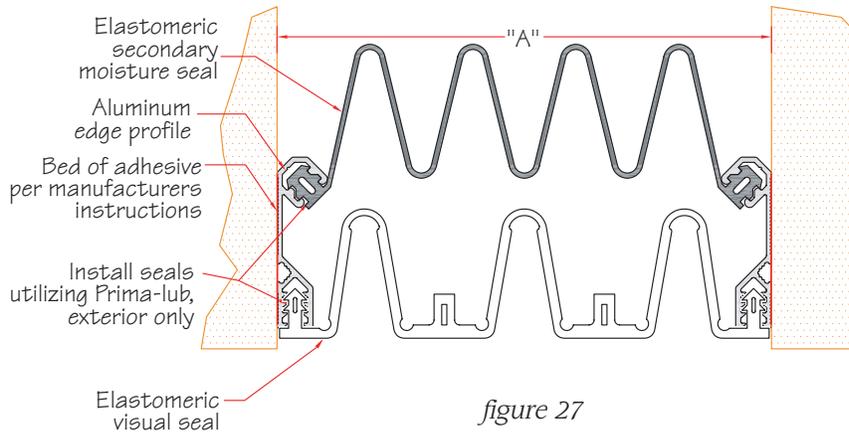


figure 27

to accommodate both vertical and horizontal movements. Joints are available in sizes from 50 to 300 mm (2 to 12 in). Joining seals together can accommodate wider openings.

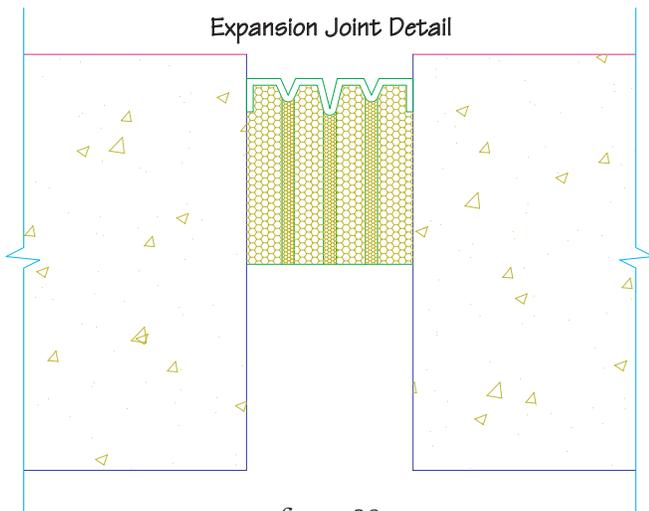


figure 28

Materials for expansion joints must be chosen for their ability to absorb appreciable movement while performing their primary function to control the movement of moisture and air. Figures 27 and 28 show bellows-type neoprene expansion seals that accommodate 50 mm (2 in) of thermal movement and 300 mm (12 in) of seismic movement. Joints must be designed first for weather protection, longevity, movement, and finally for appearance. In most cases, this requires that special gasket materials be used, rather than sealants. The requirements for expansion joints are similar to those listed above for normal joints.

Specially designed expansion joints generally accommodate cumulative movements, as well as differential expansion movements of adjacent wall materials. Joints should be designed as simply as possible since an expansion joint may have to accommodate considerable movement. Although this might result in an appearance somewhat different from a normal joint, the architect is urged to either treat it as an architectural feature or simply leave it as a different, but honest, expansion joint. Figure 29 shows a solution where the expansion joint does appear different from the normal joints without disturbing the architectural integrity of the design.



figure 29

Cold Weather Sealant Applications

The general attitude of the sealant industry toward cold weather work is expressed in the following quote from the general specification of the CGSB:

"The compounds should be applied within an air temperature range of 4°C to 27°C (40°F to 80°F) to clean and dry substrates."

For high performance sealants, this is modified to include temperatures as low as -29°C (-20°F).

Problems encountered while working in low temperatures can be related to the following three situations that can cause either difficulty in work or poor bonding to a substrate:

1. The substrate may be covered with frost or a thin film of ice - possibly too thin to be easily visible.
2. The sealant may be too cold to properly wet the substrate.
3. The sealant may be too stiff to gun or tool at extreme low temperatures.

Of these, only number one can be a real problem. The last two are solved by warming the sealant to the suggested temperature range of 15°C to 27°C (60°F to 80°F) before use.

The placement of a sealant on a substrate with a temperature below 0°C (32°F) is always subject to frost. Even if the ice or frost is melted, the resulting film of water may remain and act as a separator and then simply freeze again.

The application of sealants to wet substrates is not recommended.

Good work can be done at low temperatures if proper care is taken to avoid the problems mentioned above. A clean and dry substrate is fundamental for achieving good adhesion of a primer or sealant. This can be accomplished by wiping the substrate clean of ice using acetone or methyl ethyl ketone (MEK) or by wire brushing the surfaces immediately before application, making sure to clean the surface of any dirt and debris.

Please refer to specific product data sheets for further surface preparation instructions.



Sealant Selection

There is typically more than one type of sealant that can meet the primary performance requirements of a particular project.

The primary performance requirements include:

- Adhesion and compatibility with the substrates involved,
- Accommodating actual joint movements, and
- Delivering the required aesthetics over the expected service life of the sealant.



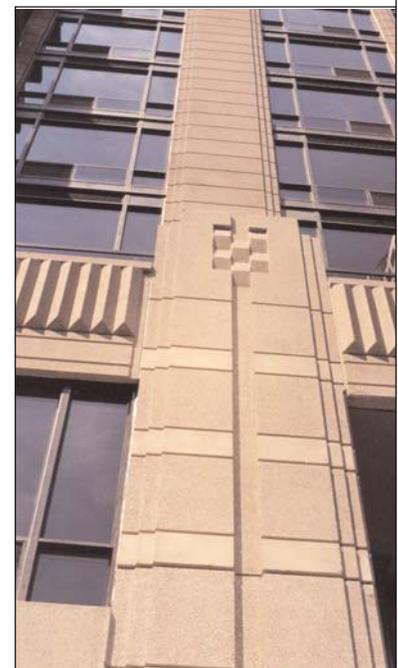
Typical sealant materials used for sealing precast concrete panel joints are polyurethane (single and multi component) as well as single component silicone. Polysulfide sealants, widely used in the past, are rarely used today.

Sealants are either neutral cure, moisture cure or solvent release.

When different sealants applied are in contact with each other, it is necessary to review the compatibility of sealants.

Product data sheets give typical guidelines on adhesion to most common substrates. Two products are compatible when two objects are in contact with each other and no adverse reactions or loss of performance properties occurs. Most common substrates are compatible with most sealants; however, it is recommended that they be checked before proceeding.

Sealants used for specific purposes are often installed by different subcontractors. For example, the window subcontractor normally installs sealants around windows, whereas a precast concrete subcontractor typically is responsible for installing sealants between panels. A designer must select and coordinate all of the sealants used on a project for chemical compatibility and adhesion to each other. In general, contact between different sealant types should be avoided by having one sealant contractor do both panel and window sealant application using the same sealant material.



Substrate & Sealant Material Testing

It may be desirable to conduct pre-project adhesion tests in accordance with ASTM C794 "Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants" and field adhesion tests using ASTM C1521, "Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints" to determine the adhesion of the sealant with each contact surface.

Adhesion (ASTM C794 or C1521), and stain testing (ASTM C510 or C1248) of the substrates and sealants in the early project planning (pre-construction) stage of a building are recommended by most sealant manufacturers. This early testing will prevent most problems before they start and will give the construction team the assurance of a problem-free job.

Even when performed on a limited basis, evaluating sealants during installation significantly improves the probability it will be installed in accordance with the contract documents. Performing this evaluation early in the project provides a method for obtaining feedback on installation workmanship. Modifications or corrections can be implemented before any problem becomes widespread.

ASTM C 1521 provides guidance for two tests. The first is non-destructive, and consists of applying pressure to the surface of the sealant at the center of the joint and the bond line with a probing tool. The second procedure involves removing sealant to evaluate adhesion and cohesion. The latter test offers 'tail' and/or 'flap' procedures, depending on whether similar or different substrates are present on adjacent surfaces of a sealant joint. Applying new sealant to the test area should repair the sealant pulled from the test area. Assuming good adhesion was obtained, use the same application procedure to repair areas originally sealed. Care should be taken to ensure that the original sealant is in contact with the original sealant so that a good bond between the new and old sealants will be obtained.

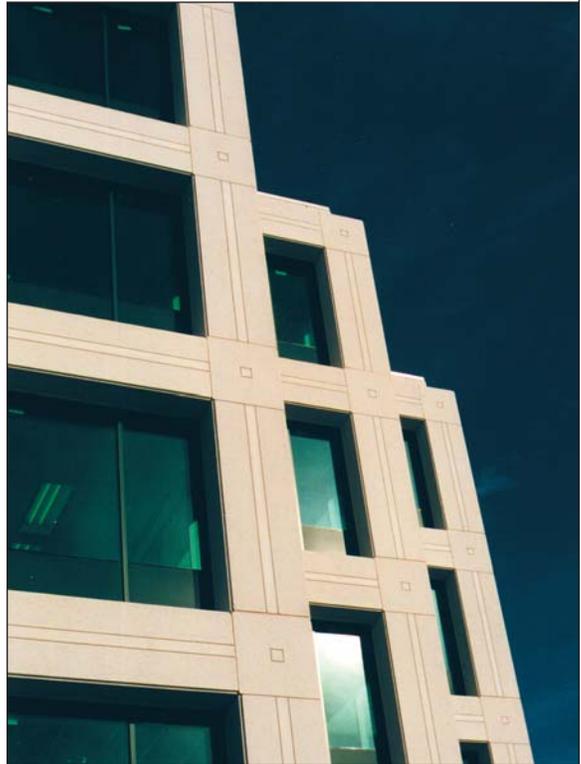
ASTM C1521 can be used to evaluate the sealant during mock-ups at the start of work to confirm application methods and throughout the work to confirm installation consistency. ASTM C1521 provides guidelines for the frequency of destructive testing when the evaluation is part of a quality control program for a new installation. All results should be recorded, logged and sent to the sealant manufacturer for warranty issuance.

The actual field construction techniques must be used in the construction of a mockup for water penetration testing. If a leak develops, usually at the window to precast concrete interface, the details need to be examined and modified. Putting more sealant on to make the system pass the test is not acceptable, as this will generally not occur during construction.

Joint Backing/Bond Breaking

For sealants to perform to their optimum movement parameters, they must adhere only to the joint sides and never to the base. Closed-cell expanded polyethylene, open-cell polyurethane, or non-gassing polyolefin sealant backing are recommended backing materials for horizontal and vertical joints under a minimum 25% compression. Adequate compression is necessary so that the rod will stay in the opening and not be dislodged or moved by sealant installation. Proper selection and use of backing material is essential for the satisfactory performance of watertight joints. Length-wise stretching, twisting or braiding of the tube or rod stock should be avoided. When inserting a polyethylene foam sealant backing, a blunt tool should be used to avoid skin puncture of the rod and possible out-gassing which may cause blistering of the sealant.

Joint backing must be thoroughly dry. Do not install more joint backing-bond breaker than can be sealed in one working day.



Prudent contractors wishing to close in the building envelope have had the interior precast joints closed off with the use of backer rod installed from the inside of the building. At a later date when weather conditions allow, the caulking contractor can stage and begin installing the sealants from the exterior. Meanwhile, heat loss and the elements entering the building have been minimized.



Sealant Staining & Dirt Pick-Up

In the past, some sealants, such as those based on certain silicone technologies, have a propensity to hold atmospheric dirt on their surface. Certain light coloured silicone sealants turned dark grey with dirt over time. It was not uncommon for rain to wash off some of the dirt, resulting in visible dirt streaking at or near the joints.



Precast remained clean, sealant has retained atmospheric dirt.

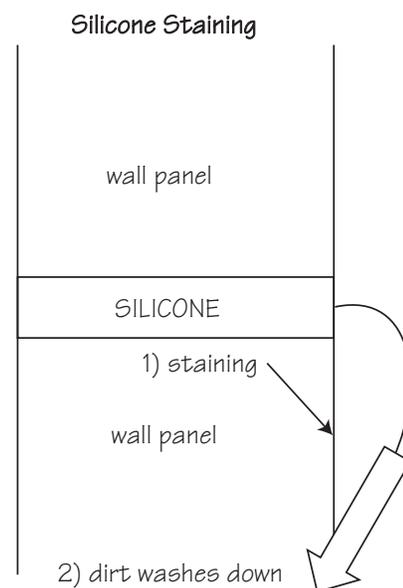
Some silicone technologies released oils into porous substrates that permanently stained the exterior wall surface. Beautiful architectural results can be ruined if the sealant used stains the substrate or causes ugly dirt wash down patterns.

Sealant manufacturers will perform testing to investigate possible staining free of charge.

Recent advances in silicone technologies have led to the development of non-bleed, non-staining formulations. This silicone chemistry eliminates the potential of staining of porous substrates such as granite, limestone, sandstone and marble as well as reducing dirt pick-up on the sealant bead. **Non staining silicone sealants for porous substrate applications should be used as recommended by the sealant manufacturer.**

Silicone Staining

1. Migrating plasticizers in silicone enter porous substrates then attract atmospheric dirt which becomes embedded in substrate
2. Wash down of atmospheric dirt is picked up on sealant bead and then onto substrates below causing staining



Joint Preparation

A sealant joint is no better than the surface to which it is attached. The edges of the precast concrete units and the adjacent materials must be sound, smooth, clean, and dry. Surfaces must also be free of frost, dust, laitance or other contaminants that may affect adhesion such as form release agents, retarders, or sealers. These materials must be removed, if necessary, by sandblasting or grinding. It may be more economical and effective to prepare joint surfaces prior to erection if a large number of units require surface preparation.



Primers

Some sealants require primers on all substrates; others require primer for specific substrates or none at all. Absence of the required primer can cause premature sealant adhesion failure. A primer often helps sealant adhesion in cold weather. Primers are recommended by the sealant manufacturer for the following reasons:

1. To enhance adhesion of sealants to porous surfaces, such as concrete, or to reinforce the surface.
2. To promote adhesion of sealants to surfaces such as porcelain enamel, unusual types of glass, certain metals and finishes, and wood.
3. To promote adhesion of sealants to an existing surface treatment which is difficult to remove.

Special care must be exercised to avoid staining the visible face of the precast concrete unit since some primers leave an amber-colored stain if brushed along the surface. This stain may have to be mechanically removed which is expensive. The primer should be allowed to cure before application of the sealant. Sealants must be applied the same day the surfaces are primed. The sealant and primer should always be supplied by the same manufacturer.

Other Considerations



Finish requirements may also influence joint details. The sealant must be applied to a relatively smooth surface, as it is difficult to tool the sealant to achieve intimate contact with an irregular surface. Thus, the sealant must be held back from the face of the exposed aggregate and that portion along the joint should present a smooth, clean surface for the application of the sealant.

This is particularly true when interfacing with windows. This requirement is simple to comply with when the design includes recessed external joints, however, when exposed aggregate surfaces come together at an inside corner, the situation is more difficult. Special attention must be paid to finish and joint details. Also, for maximum performance, sealants should not be applied to beveled or chamfered surfaces, but should be applied beyond the beveled area.



Do not carry exposed aggregate finish beyond window interface.



Sandblast finish does not require the same consideration

Fire Protective Treatment

Joints between wall panels are similar to openings. Most building codes do not require openings to be protected against fire if the openings constitute only a small percentage of the wall area and if the spatial separation is greater than some minimum distance. In such cases, the joints will not require protection. In other cases, openings, including joints, may require a fire resistant sealant.

Air Barriers

Some designers are requiring the factory installation of peel and stick sheet membranes to augment the precast to window joints on precast insulated walls panels to be used by following trades for continuity of membranes. It is believed this type of detailing may help ensure a continuous air vapour barrier between dissimilar materials. This type of detail is prone to damage in storage, during panel installation, is non-continuous at panel joints and corners, and requires a great deal of membrane patch work in the field. Therefore the factory installation of peel and stick sheet membranes are not recommended.

Installation



The recommendations of sealant manufacturers should always be followed regarding mixing, surface preparation, priming, application life, and application procedures. Good workmanship by qualified sealant applicators is the most important factor required for satisfactory performance. Sealant installation should be specified to meet the requirements of the product manufacturers.

Caulking guns should have a nozzle of proper size and should provide sufficient pressure to completely fill the joints. Joint filling should be done carefully and completely, by thoroughly working the sealant into the joint. Under-filling of joints normally leads to adhesion loss. After joints have been completely filled, they should be neatly tooled to eliminate air pockets or voids, and to ensure good substrate wetting for optimum adhesion. Tooling also provides a slightly concave joint surface which improves the sealant

performance and achieves a visually satisfactory finish. Joint tooling should be performed within the allowable time limit for the particular sealant. The surface of the sealant should be a full, smooth bead, free of ridges, wrinkles, sags, air pockets and embedded impurities.

The application temperature can be dictated by frost formation on the joint edges, which can begin to occur below 5°C (40°F). Joints should be sealed when the joint surface is cool (spring and fall) and will experience minimum temperature changes, typically in the late afternoon or early evening. Large daily temperature swings during curing (warm days, cold nights) can cause adhesive failure.

It is recommended that tools be used dry. Tooling solutions such as water, soaps, oil or alcohols should not be used unless specifically approved by the sealant manufacturer as they may interfere with sealant cure and adhesion and create aesthetic issues.

It is imperative that uncured silicone or polyurethane sealants not be allowed to contact non-abradable surfaces such as polished granites, metal or glass. These surfaces should be masked or extreme care must be taken to prevent any sealant from contacting them during sealant application. Excess sealant cannot be completely removed with organic or chlorinated solvents. Once an uncured sealant contacts an exposed surface it will leave a film that may change the aesthetic surface characteristics of the substrate.

Surfaces soiled with sealant materials should be cleaned as work progresses. Removal is difficult after the sealant has cured. A solvent or cleaning agent recommended by the sealant manufacturer should be used.

The Most Common Problems with Existing Procedures

Bond

- Panels manufactured early in the year (January, February, March) are erected and caulked while concrete is still 'green'.
- Precast joints surfaces may not be properly dried or contain frost at time of sealant installation.

Recommendation: Provide temporary construction joint and install sealants in warmer weather.

Sealant Cracking / Splitting at Outside Corners

- During late fall and early spring there may be excessive movement at corners before sealant has cured and /or excessive movement due to anchor positions.

Recommendation: Provide temporary construction joint and install sealants in warmer weather.

Sealant Failure on Large Spandrels

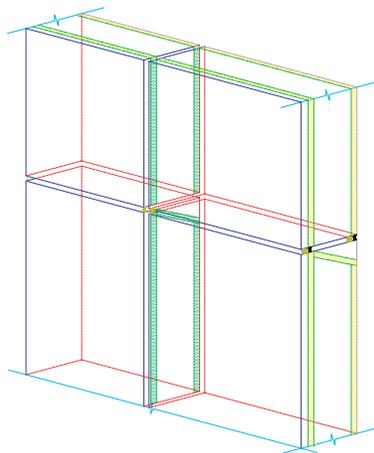
- Excessive movement - sealant is overly compressed and loses memory.

Recommendation: Increase joints sizes to accommodate expected joint compression.

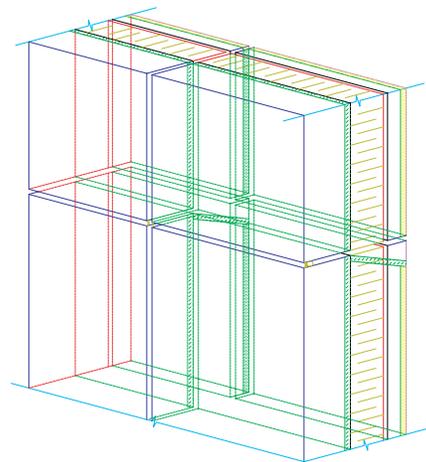
Designing a 3D System in 2D

- Some wall designs handle water properly in two-dimensional blueprints but fail in three-dimensional reality.

Recommendation: Isometric drawings should be used to show the proper intersection of horizontal and vertical seals and flashings. These intersections are a prime source of water problems. The second line of sealant placed must run continuously across the intersection.



Isometric of single wythe panel.



Isometric of insulated panel.

Sealant Selection

The following products are first choice as recommended by each manufacturer for performance and quality when used on precast concrete wall assemblies.

Sealants	- Cost +			
	+/-25%	+40/-25%	+/-50%	+100/-50%
Degussa	1●	2●	3●	4◆
Sika	1●	2●	3●	4●
Tremco	1●	2●	3■	4■
Dow	-	-	-	4■
GE	-	-	3■	4■

●Urethane ■Silicone ◆MS Polymer

1 Degussa NP1
Sikaflex 1A
Tremco Dymeric

2 Degussa NP2
Dymeric 240
Sikaflex 2c

3 Degussa NP2
Sikaflex 2cNS
GE Silpruf NB SCS9000
Silpruf SCS2000
Tremco Spectrem 3
Spectrem 4

4 Degussa 150 vlm
Sikaflex 15 lm
Dow 790
Tremco Spectrem 1
GE Silpruf LM SCS2700

Durability of Sealants

The general life span of urethane sealants can be expected to be seven to ten years and silicone sealants twenty years. Once either type of sealant material has reached 75% of its life expectancy, building joints should be inspected for potential degeneration and possible failure and be repaired as needed.



Sample Specification

SEALANTS – SECTION 07900

Architectural Precast Concrete Panels

PART 1 – GENERAL

1.1 Guarantee

- .1 Provide a written guarantee, signed and issued in the name of the Owner, stating that caulking work of this section is guaranteed against leakage, cracking, crumbling, melting, shrinkage, running, loss of adhesion, or other failure, staining adjacent surfaces, for a period of two years from the date of Certificate of Substantial Performance

1.2 Product Delivery, Handling

- .1 Deliver and store materials in original storage wrappings and containers with manufacturer's seals and labels intact. Protect from freezing, moisture and water.

1.3 Environmental and Safety Requirements

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials; and regarding labelling and provision of material safety data sheets acceptable to Human Resources Development Canada.
- .2 Conform to manufacturer's recommended temperatures, relative humidity and substrate moisture content for application and curing of sealants including special conditions governing use.
- .3 Architect will arrange for ventilation system to be operated on maximum outdoor air and exhaust during installation of caulking and sealants. Ventilate area of work as directed by Architect by use of approved portable air supply and exhaust fans.

PART 2 – PRODUCTS

2.1 Sealant Materials

- .1 Sealants shall conform to CGSB specifications
 - .2 Sealant colour to Architect's selection
- Spec Note: add in detailed list of preferred materials*

2.2 Back-up Materials

- .1 Polyolefin, polyethylene, urethane, neoprene or vinyl foam
 - .1 Extruded closed cell foam backer rod.
 - .2 Size: oversize 25%

- .3 Chemically compatible with primers and sealants.
- .4 Round solid rod, Shore A hardness 70

.2 Bond breaker tape

- .1 Polyethylene bond breaker tape that will not bond to sealant

2.3 Joint Cleaner

- .1 Non-corrosive and non-staining type, compatible with joint forming materials and sealant recommended by sealant manufacturer.

2.4 Primer

- .1 Primer: as recommended by manufacturer.

PART 3 – EXECUTION

3.1 Extent of work

- .1 Install sealants in all locations shown on drawings and as detailed on drawings. Caulking contractor to attend a pre-installation site meeting to review design and quality issues
- .2 Install sealant at the perimeter of all precast to precast concrete joints and to other materials in place at time of precast concrete installation.
- .3 Provide a minimum of two continuous beads of sealant at all joint locations. Caulking to be as detailed on drawings.
- .4 All caulking to be installed from exterior of building. Precast to precast joints are designed to be 19 mm for single wythe panels and 25 mm wide for insulated panels to facilitate the caulking of the two interior beads of sealant from the exterior.

3.2 Preparation of Joint Surfaces

- .1 Examine joint sizes and conditions to establish correct depth-to-width relationship for installation of back-up materials and sealants.
- .2 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil, grease and other matter that may impair work.
- .3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent or other coatings, unless tests have been performed to ensure compatibility of materials. Remove coatings as required
- .4 Ensure joint surfaces are dry and frost-free.
- .5 Prepare surfaces in accordance with manufacturer's directions.

3.3 Priming

- .1 Where necessary to prevent staining, mask adjacent surfaces prior to priming and sealing.
- .2 Prime sides of joints in accordance with sealant manufacturer's instructions immediately prior to sealing.

3.4 Back-up Material

- .1 Apply bond breaker tape where required to by manufacturer's instructions.
- .2 Install joint filler to achieve correct joint depth and shape.

3.5 Mixing

- .1 Mix materials in strict accordance with sealant manufacturer's instructions.

3.6 Application

- .1 Sealant:
 - .1 Apply sealant in accordance with manufacturer's instructions.
 - .2 Apply sealant in continuous beads.
 - .3 Apply sealant using gun to proper size nozzle.
 - .4 Use sufficient pressure to fill voids and joints solidly.
 - .5 Form surface of sealant with full bead, smooth, and free from ridges, wrinkles, sags, air pockets, and embedded impurities.
 - .6 Tool exposed surfaces to give slightly concave shape.
 - .7 Remove excess compound promptly as work progresses and on completion.
- .2 Curing:
 - .1 Cure sealants in accordance with sealant manufacturer's instructions.
 - .2 Do not cover up sealants until proper curing has taken place,
- .3 Clean-up:
 - .1 Clean adjacent surfaces immediately and leave work neat and clean.
 - .2 Remove excess and droppings, using recommended cleaners as work progresses.

End of Section 07900



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