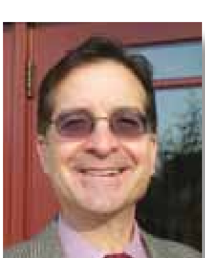
Dealing with Interfaces

Points where materials come together create great challenges and require close attention to ensure long-term success

— By Steven A. Becica, AIA, LEED AP, Becica Associates LLC

As the complexity of building design increases with growing program requirements, sustainability features, and the expanding array of building materials, the challenges of joining dissimilar materials become greater. This is especially true in the building envelope, where weather resistance, air, moisture, vapor, and thermal barriers must perform in parallel with the design features of the façade. Understanding and clearly detailing these interfacing conditions at the design phase—and following through during the construction phase—is critical to ensure the success of the building's performance.

As an architectural and engineering firm with a focus in building forensics, Becica Associates often consults with clients to sort out design and construction deficiencies related to interface issues between materials. An overlooked detail or a misunderstood material application with in the building envelope can cause air and moisture infiltration affecting the buildings energy performance as well as damage to the structure and interior finishes. These types of problems are usually difficult and costly to repair. A forensic study is often needed to gain a full understanding of the problem and to develop long-term solutions.



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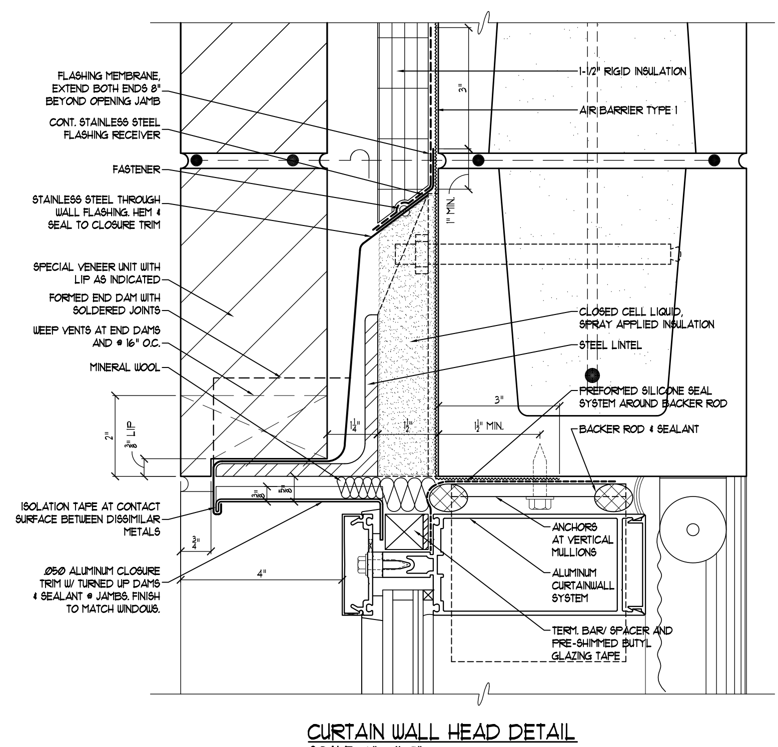


Curtain-wall applications require close attention to detail to ensure continuity of the drainage plane as well as a complete air and moisture barrier.

In reviewing building failures, team members begin with a review of the construction documents followed by an assessment of the as-constructed conditions. This phase identifies visual deviations. A more in-depth tactile investigation along with further testing may be conducted depending on the issue being addressed. Components of the building are then carefully removed, layer by layer, and examined to determine the cause of the failure.

Building-failure investigation services provide important lessons about detailing the interface of materials, and these lessons have complemented our own design efforts and showed some of the key details that often are overlooked.

Neglected Details

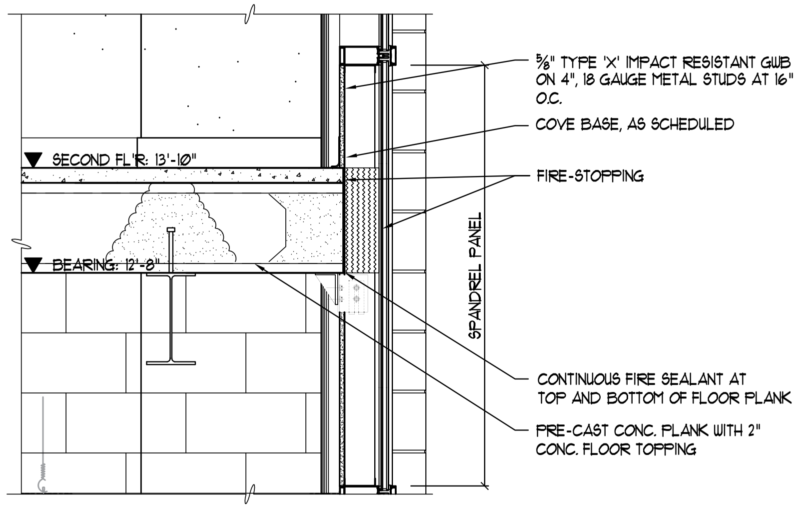
Interface issues often arise because a critical detail was not provided describing a material application or system. Aggressive project schedules are often the underlying cause impacting the time designers allocate to evaluate building systems and materials and to develop design and construction documents. Construction documents must show such detail as necessary to give a comprehensive representation of the construction contemplated. Clearly, not every possible condition encountered on a project can be detailed. The challenge is to provide the information that will ensure a successful project. Designers who rely on the drawings to generally describe materials and the specifications for the specific application are simply delaying the detailing to a later time, usually during construction when decisions need to be made in a timely fashion to avoid delays. This scenario places an additional burden on the architect during the construction phase of the project.

Relying on the contractor to issue a request for information (RFI) is not a failsafe solution. The importance of a particular detail may not be recognized by the contractor. Problems occur when a critical detail is overlooked or if the contractor attempts to resolve the condition in the field. In the absence of a specific question, the contractor may proceed with the work as he understands it based on the construction documents. While standard details and manufacturers' recommendations often provide necessary guidance, they may not address every field condition or geometry of a material interface.

If the interface condition is covered with other materials, a potential problem may go unnoticed until a failure occurs.

In the Seventh Edition of the *PCI Design Handbook*, section 13.5.3, key questions are suggested that can apply to any interface that can help when considering the level of detailing needed for a specific project. These include:

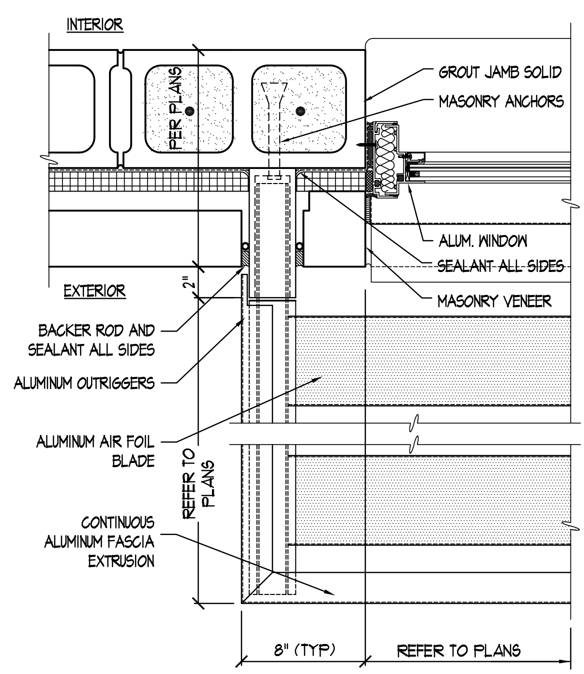
1. What specifically is to be interfaced?
2. How does the interface function?
3. Is there provision for adjustment upon installation?
4. How much adjustment can occur without rework?
5. What are the consequences of an interface tolerance mismatch (i.e., what rework requirements in labor and materials will be needed and what rejection point is there)?
6. What are the highest material cost elements of the interface?
7. What are the highest labor cost elements of the interface?
8. What are the normal tolerances associated with the system to be interfaced?



PRE-CAST @ CURTAIN WALL INTERFACE
SCALE: 3/4" = 1'-0"

Connecting two dissimilar materials, such as curtain wall and precast concrete planks, require detailing to ensure the joints don't allow energy loss or moisture penetration.

An overlooked detail or a misunderstood material application can affect the performance of the building envelope.



SUNSHADE PLAN DETAIL
SCALE: 1-1/2" = 1'-0"

As accessories such as sun shades and light shelves are added to building exteriors, detailing must be provided to show their connection methods.

Precast wall panels provided a one-component barrier-wall or face-sealed design solution at the Mitchell H. Cohen Court House in Camden, N.J.

9. Are the system-interface tolerances simple planar tolerances or are they more complex and three-dimensional?
10. Do all of the products of this type have the same interface-tolerance requirements?

Connection Details

Connections or anchors for components onto the building exterior are a key area where interfaces often are not delineated. The importance of these details increases as designers introduce new materials and sustainable features into buildings such as sun shades and light shelves.

Anchorage and interfacing these elements as part of the building façade has added yet another challenge for the designer. Drawings must define how these structures will be connected to the building structure, penetrations through the building facade and interface with water proofing elements. Embeds or other advance preparations may make these structures easier to attach and create a longer-lasting and serviceable connection.

Expansion and contraction joints must also be properly detailed. The properties of each material and the direction of the anticipated movement must be understood to ensure that a sufficiently sized and configured joint is provided. It is also important to use high-quality, long-lasting sealants to help reduce any potential for long-term problems. Sealants must be compatible with the adjoining materials. Adhesion testing and certifications are always good ideas and should be made part of the submittal and mock up requirement for the project.

Rain-Screen Designs

The use of lightweight rain-screen wall systems as exterior cladding has further expanded the level of detail needed in construction documents. Rain screens require several components such as the exterior skin, clip brackets and trim pieces, drainage and venting, sub framing, and anchorage system.

The rain-screen principal is to equalize and reduce the effect that wind and air pressure have on the façade by allowing air and moisture to enter behind the cladding and using gravity to carry the moisture out of the system. Waterproofing and controlling the amount of air that gets in are critical. Compartmentalizing areas behind the cladding balances the pressure and helps to ensure moisture is not forced in through the façade and into the building interior.

Rain-screen design presents numerous challenges. The primary issue is to ensure that continuity of the air/moisture barrier, or the vapor barrier depending on the thermal design of the wall, is maintained at all penetrations, from the moisture/vapor barrier at the roof to a point where water drainage can exit the wall system. Fortunately, air, moisture and vapor barriers are becoming more commonly used and better understood as their importance has been recognized.

In some cases, vapor retarders take the form of thin sheets or coatings applied to the structural assembly. One recent approach has been to apply emulsified or solvent-based moisture barriers in the back-up plane of the drainage cavity or to use new types of spray foam on the interior side of the rain screen panel, allowing it to serve as the vapor retarder as well as adding some insulation value.

Face-sealed systems, such as precast concrete, help to reduce many of these concerns. The concept is to prevent air and moisture from breeching the outermost surface of the wall system. For example, in most applications, precast concrete serves as an air and moisture barrier without requiring additional treatments.

Thermal Protection

As requirements for insulation continue to grow, providing the necessary insulation for a building can create significant interfacing challenges. A wide range of insulation options are available, but ensuring complete, continuous insulation requires close attention to detail in both design and construction. No gaps or bridging can occur through the insulation or the desired energy performance characteristics of the project may not be achieved.

A key problem arises with connectors and framing elements, which provide conduction points that allow heat loss. Minimizing these or disrupting this conductive property is critical to ensuring high energy efficiency.

In this regard, precast concrete sandwich wall panels offer a significant benefit by creating panels with several inches of insulation sandwiched between two wythes of concrete. Most precast concrete systems today run this insulation to the edges of the panel. The insulated panel can provide finished exterior and interior faces, creating quick installation and ensuring high energy efficiency without worries about interfaces between the insulation and the structural exterior wall.

Additional components can be installed in the precast concrete pieces at the precaster's plant.

Precast Concrete Benefits

Precast concrete also offers benefits in providing a monolithic material that can combine a variety of design elements. Using several textures, colors and/or finishes of precast within the same architectural panel can avoid creating joints or interfaces between materials. This helps to eliminate the long-term maintenance requirements due to the expansion and contraction effect of different materials. Lintels, for instance can be created in the panel and colored as an accent piece rather than having to be attached at a later time, eliminating joints and cracks around these key openings.

Similarly, using embedded thin brick cast directly into the precast panel face alleviates concerns about long-term durability of mortar joints that can cause moisture penetration if not maintained.

The Mitchell H. Cohen Court House in Camden, N.J., included an elevated pedestrian walkway to the adjacent parking structure, creating interfacing challenges for the precast concrete façade.

There is no cookie-cutter approach.

Precast concrete floor plank often interfaces with reinforced concrete masonry bearing walls, creating a mix of materials that must be addressed, either in design or in the field.

Additional components also can be installed in the precast concrete pieces at the precaster's plant. These include windows, conduit, interior finishes, and more. Discuss these issues with local precasters to see what materials can be provided in advance to alleviate interface problems at the site and speed construction once materials arrive.

Mechanical interfaces with precast concrete components are critical to design in advance of construction. Because of the variety of mechanical and electrical penetrations that are needed, utility pathways for duct work, piping and electrical conduits must be located in advance so the penetrations can be provided by the precaster during the casting phase. Targeting these areas on the construction documents and having the contractor confirm them during the shop drawing phase as a coordination effort is critical to ensuring no problems arise on the site at these interfaces.

Modeling Opens Opportunities

Building Information Modeling (BIM) opens the opportunity to ensure interface details are not lost in the shuffle and to enhance coordination efforts. BIM techniques are gaining ground rapidly as a design and construction tool that can be utilized by designers and contractors to develop more detailed building information early on to avoid clashes in the field and work out solutions to key challenges before construction begins.

An argument can be made that BIM simply reassigns design time, theoretically reducing the amount of time spent during the construction phase responding to questions and RFI's and coordination issues. Thereby increasing the time available during the design phase to address details and develop a comprehensive set of construction documents ultimately for the benefit the overall project.

New technologies are introducing design techniques and materials that can help create dramatic, efficient, and aesthetically pleasing projects. But these new technologies do not lessen the need to pay attention to the details of how building materials and systems interact and join together at their interfaces.

For more information on these or other projects, visit www.pci.org/ascent