Prefabricated Systems: Where Intention and Reality Collide

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ABSTRACT

With the ever-developing challenges of accelerated project schedules and reduced project costs, prefabricated components and systems are becoming more and more widespread in the marketplace. Fabricating a portion or entire system prior to installation on the project site not only assists with project schedule and costs but also increases quality control and quality assurance and other project controls. However, the success of these prefabricated assemblies can immediately become compromised after fabrication, resulting in ineffective performance, installation issues, and unforeseen additional work, which consequently undermines the benefits of these systems.

A brief history of common prefabricated building envelope assemblies will be reviewed to allow the audience to understand the origin and design of these systems. Next, the various types of modern prefabricated building envelope systems and components will be reviewed. Then, the modern prefabricated elements will be compared to their historic counterparts to emphasize the current problems in the actual effectiveness and final performance of these systems. Methods of evaluating the use of prefabricated assemblies will be provided, as well as safeguards to avoid potential performance and coordination issues. Finally, the author will provide case studies from representative projects to demonstrate the challenges that the prefabrication trend presents.

SPEAKER

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Amy Peevey is a building enclosure engineer with over 20 years of experience in the new design, investigation/evaluation, and restoration of building enclosure systems. She received her Bachelor of Science from the University of Texas at Austin and is a registered professional engineer. She spent a majority of her career performing forensic investigations and developing new designs, as well as providing expert litigation support for problems relating to below-grade and plaza waterproofing, cladding, fenestration, roofing systems, and building science. Her forensic engineering background has enabled her to understand the performance of building enclosures and causes for material-, system-, and integration-related performance failures, as well as the need to coordinate the building exterior with the other building systems (MEP, structural, civil, etc.), which in turn provides a high level of technical insight into new building enclosure design. Her new design experience has reinforced her technical knowledge and grown her understanding of new technology and innovation in materials, components, trends, construction methods, etc., as it applies to both new construction and restoration of building envelopes. Peevey is a seasoned presenter and published member of several technical trade associations and an active contributor to the building enclosure community.

Prefabricated Systems: Where Intention and Reality Collide

Prefabricated building enclosure components provide a means to reduce construction costs, accelerate schedules, and improve quality control in modern construction. They also reduce environmental impact, increase safety, and allow better project cost controls. However, without proper design, coordination, and planning, these benefits can be undermined or unrealized altogether, and unforeseen consequences can result. This paper provides insight into the author's knowledge and experience with prefabricated building enclosure components, including a brief history, design and construction considerations, system types, related challenges, and solutions to ensure their successful performance. Case studies are included to illustrate the conflicts between intent and reality when prefabricated components are not properly executed and how to avoid these problems on future projects.

HISTORY

Historically, prefabrication in building construction was utilized during times of socioeconomic distress such as colonization, industrialization, war, or economic depression. To meet low budgets, high volumes, and accelerated delivery schedules during these eras, many building components or entire buildings were prefabricated. Consequently, the term "prefabricated" within the building construction industry was often associated with "cheap," "low performance," and "short-term/temporary" mass-produced buildings that lacked individuality, creativity, and beauty.

Due to manufacturing/production efficiency, speed of installation, and reduced cost, the principles of prefabrication were initially incorporated into building construction for systems such as structural members. These repetitive and standardized structural components require little to no customization in their design, and typically, their aesthetics are not a priority. Thus, systems like roof and floor joists/trusses, glulam components, precast concrete components, etc., are often prefabricated for a specific project and then erected on site as a part of the overall building structural framing.

In the past, the application of prefabricated components to modern building enclosures was not as widely accepted due to the initial limitations when creating unique, customized designs to meet specific project and site conditions. Today, with the increasing emphasis on reducing construction schedules and project costs, the prefabrication of building enclosure systems has become more and more common. As a result of the increased acceptance of prefabricated building enclosure components, these types of systems, materials, and methods have become more prevalent.

DESIGN AND CONSTRUCTION CONSIDERATIONS

One key aspect for building enclosure prefabrication to be a feasible and cost-effective option is for the exterior to have repeatable standardized components. This uniformity of materials and their geometry (shapes/cuts/cast forms), assembly sequence and tasks, and handling and transport allows for increased quality control, reduced schedules and associated costs, increased safety, reduced environmental impact, and other advantages. Therefore, buildings with large exterior surface areas that incorporate simple, repetitive geometries are best suited for building enclosure prefabrication. The project site may also dictate an advantage for prefabricated components. Sites that are remote where construction materials and labour are not readily available, or project locations with limited or restrictive site accessibility may be good candidates for prefabricated exteriors which shift a large portion of the construction off site where materials, labour, and access are not critical factors. In contrast, traditional field-fabricated methods may be more effective for customized building enclosures with less repetitive features, those with unique conditions or geometries, as well as those with smaller surface areas and no site limitations.

In addition to the building architecture and site considerations, there are other factors to consider throughout the design and construction for building enclosure prefabrication. Some of these factors include system/material type; size/geometry for transport, storage, and installation; panelized component transport and erection-induced loads; field installation equipment type and access/placement; on-site construction storage; and future maintenance. For instance, some building enclosure systems simply cannot be prefabricated. These include point-supported glass systems, traditional cavity wall brick masonry, and dimensioned stone cladding systems. Also, some materials may not be suitable for transport within a prefabricated panelized component, such as delicate terra cotta. Additionally, the transport of prefabricated components imposes restrictions regarding length, width, and height, which may be further limited depending on the site. Each of these factors restricts the type of materials or systems for a specific project. Additionally, congested sites may limit the type of field access to the building enclosure, as well as the coordination of building exterior access equipment, which are other considerations when evaluating prefabricated building enclosure components.

The design and construction considerations do not end with feasibility analysis, system and material selection, and logistics. Building enclosure design and construction are complex. This complexity stems from the numerous related code and performance requirements, as well as requisite high levels of coordination with multiple systems and trades. While prefabrication shifts a portion of the construction coordination to a controlled manufacturing environment, it also necessitates a higher level of coordination during design. The designer often must provide an increased level of detailing for the integration of these systems, as well as providing additional direction regarding the fabrication, transport, erection, and installation of these systems. Additionally, as the prefabricated components are being assembled during the design process, decisions made later

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in design such as value engineering or scope modifications are dictated by the prefabricated systems. This reduced flexibility and adaptability during design also occurs during construction. As the prefabricated assemblies are already built, there is significantly less ability to adapt these systems to overcome construction phase issues such as unforeseen conditions, construction tolerances, and design or scope changes.

Therefore, the impact of prefabricating components must be fully understood from design through installation and maintenance. This increased level of design and coordination requires close collaboration among the owner, designer, contractor, and manufacturer. Often, the utilization of a building enclosure consultant is required to ensure the proper integration and performance of prefabricated building enclosure systems.

SYSTEM TYPES

Generally, prefabricated building enclosure systems can be categorized as structural, architectural, or a combination of both (hybrid). Both structural and architectural systems require additional components to complete the building enclosure. In addition to the main building structural frame, additional components typically required for prefabricated building enclosure structural-type systems are those that achieve the energy and fire ratings and those for air infiltration and water penetration resistance. For prefabricated building enclosure architectural-type systems, the main building structural frame, including the main wind-force resisting systems, are required independent from and prior to the prefabricated system installation.

Structural-type prefabricated systems are those that provide structural support for a portion of the building and enclose the exterior. These systems require the addition of other subsequent components to provide the exterior aesthetics and other building enclosure performance characteristics (air infiltration and water penetration resistance, thermal resistance, fire resistance, etc.). Examples of prefabricated structural systems include framed panels (e.g., stud wall panels), monolithic precast wall and roof panels, and composite structural wall and roof insulated panels/structural insulated panels (SIPs).

Prefabricated architectural-type systems provide the exterior aesthetics and other building enclosure performance characteristics but require separate structural systems to support them. Architectural systems require an existing framework to be in place prior to installation of the prefabricated units. Prefabricated architectural systems are typically composite in nature and include insulated metal wall and roof panel systems, modular EIFS, and unitized window wall and curtainwall.

Hybrid-type systems combine the structural and architectural aspects so that once the prefabricated system is installed, the building is predominantly enclosed, and the structure is complete. These systems provide structural and architectural performance within a single prefabricated assembly, as well as the final building aesthetics. Typically, final dry-in of the building enclosure is achieved following the installation of hybrid-type systems. Subsequent treatment or installation of transitions to adjacent exterior components and within the prefabricated system units is all that is needed for the building enclosure to perform as required. Examples of prefabricated hybrid panels are composite precast insulated wall panels, as well as more recent modular mega panels where the building enclosure is fully panelized, constructed off site, and installed in place.

MODERN CHALLENGES

Historically, prefabricated systems were designed for and served a straightforward purpose (structural or architectural) with other supplemental components provided to achieve the overall building enclosure performance. Therefore, the system performance was clearly defined, and they were fabricated to meet the requirements. Today, multiple performance requirements need to be satisfied simultaneously within a single prefabricated component, which can result in conflicts and performance issues.

For prefabricated hybrid-type systems, the architectural geometry, structural loading, local energy requirements, air infiltration and water penetration resistance, fire resistance, etc., specific for the building's unique characteristics (i.e., aesthetic features, type, and use) and project site must all be met within a single system. This results in a prefabricated, unitized/modularized system design that is specialized for a specific project. As with manufactured products, the prefabricated system performance is certified by laboratory testing for a specific assembly. The variance in even a single portion of the system's components may impact other performance requirements, resulting in certified testing that may no longer be representative for a specific project. Therefore, the impact of understanding and evaluating a system for suitability on a project requires specialized knowledge similar to, but many times more complex than, that which is required for an Underwriter's Laboratory (UL) engineering exception.

Another challenge with multiple performance requirements from a single prefabricated system is that the various requirements often have different thresholds and standards that conflict. This includes provisions for movement within structural components (creep, live load deflection, interstorey movement, etc.) versus those required of cladding (structural movement as well as thermal expansion/contraction, shrinkage, etc.), as well as field construction tolerance of the structural versus the building enclosure components. Specifically, in traditional field-installed building enclosure systems, the considerations for installation tolerance are limited to those related to aesthetics and exterior performance of the prefabricated component and not the structural construction tolerances. However, when the structural and architectural requirements are combined into a single unit, the prefabricated system is now required to meet the large structural construction tolerances simultaneously with those that are much smaller for the cladding/fenestration system. This results in field constructability issues and field modifications, which may negatively impact project aesthetics, cost, and schedule.

Similarly, when multiple performance requirements are mandated within a single system, the transitions within a system and between adjacent systems must meet those same requirements. As a result, the details of the integration within and between the prefabricated system and adjacent systems (aka "system joinery") must be carefully designed and coordinated. The system joinery and integration must meet the performance requirements for a single condition and accommodate the construction tolerances of both the structure and building enclosure components. A deviation in the actual field system joinery condition from the idealized design conditions can result in the inability of the system to meet one or more of the multiple performance requirements following installation.

Initially, prefabrication of the building enclosure components achieved straightforward goals across multiple systems. Currently, to accelerate project delivery schedules, these systems are being designed to meet the numerous requirements of the building enclosure assembly within a single prefabricated system. As a result of delivering so many requirements in a single system, the system design becomes more complicated, increasing the potential for conflicts as a result of changes in the project during construction, as well as increasing design and construction coordination to ensure proper performance.

CASE STUDIES

Now that the concept of prefabricated building enclosure systems is better understood, challenges for this approach are presented within two case studies. As indicated earlier, the design and construction coordination of the systems are critical to ensure the successful installation and performance of the building enclosure. When coordination is lacking, problems arise. The two case studies highlight challenges with prefabricated building enclosure components; they are a residential apartment high rise and a hotel high rise.

Figure 1 – Luxury residential high-rise, view of northwest corner during construction.

Case Study 1

A 32-storey luxury residential high-rise located in a large downtown metropolitan area was completed in late 2017 (*Figure 1*). The concrete-framed structure includes 274 luxury apartments with exposed concrete cantilevered balconies, an amenity level with open-air terrace and underlying above-grade garage parking, and retail at the ground floor. The building resides in a historic district and has a complementary brick veneer façade, including stone accents, a window wall, and punched window glazing.

To meet an accelerated project schedule, the exterior cladding and fenestration systems were partially prefabricated. As it was not feasible to prefabricate the traditional brick cavity wall veneer of the historic neighborhood, the decision was made to prefabricate the exterior cold-formed metal stud- (CFMS-) framed walls, exterior sheathing, and an air barrier. The window wall and punched windows were also prefabricated. Therefore, once the prefabricated exterior backup walls and fenestrations were in place, the building would be dried in to accelerate finish-out of the building.

For cast-in-place concrete in high-rise construction, construction tolerances can vary by inches over the height of the building (when considering cumulative tolerances) and +½ inch at each floor from plumb,[1] as well as in-and-out tolerances along the face of the building within a single floor level. However, the standard tolerances for the cladding and fenestration elements are significantly less, ¼ inch or less[2,3] from floor to floor and along a floor. As the concrete floors are exposed at the exterior (*Figure 2*) to provide the cantilevered balconies and the column placement at the building perimeter, the variation between the structural concrete tolerance and the cladding/fenestration tolerance resulted in constructability issues for the prefabricated elements. Additionally, at some locations, the installed cast-in-place concrete tolerance exceeded what is allowable. The result was a conflict in the as-installed concrete with the prefabricated exterior wall and fenestration installation tolerances. Simply put, the prefabricated exterior backup wall and fenestrations could not be installed or properly supported with the existing placement

Figure 2 – Prefabricated panelization of exterior wall system.

of the concrete structure.

Resolution of the constructability issues resulted in a large amount of rework, subsequent schedule delays, and cost overruns. As shown in *Figure 2*, the prefabricated exterior wall panels are in place (those with “blue” air barrier) at a portion of the upper floors. However, at other portions, field-installation is underway (note exposed framing and yellow exterior sheathing panels) with in-situ CFMS, exterior sheathing, and air barrier assembly. The field installation was performed predominantly at outside corners or other changes in plane, as well as select elevations (not shown) where the construction tolerance conflict was most severe.

Additionally, the lack of coordination between the prefabricated components resulted in performance issues once field installation was underway. The intent was clear for both the prefabricated exterior walls and windows to include allowance for movement between the floor lines, as well as construction installation tolerance. The premanufactured exterior wall panels (*Figure 6* and *Figure 3*) were to be erected at the floor lines with allowance for movement and installation tolerance at the head condition.

For the punched windows and window wall, there was allowance for movement and installation tolerance provided at the window head. However, the premanufactured components were submitted separately without coordination between them. Once installation of the already fabricated components was underway in the field, it was apparent that that there was a lack of continuity between the prefabricated exterior backup wall and window systems to allow for the installation tolerance and structural movement. Specifically, the current exterior construction did not allow for movement at the transition between the CFMS head slip joint and the window head receptor (circled in *Figure 3*). The oversight between coordination of the adjacent systems required rework and redesign to allow for movement along the vertical transition of the window head panel to adjacent jamb

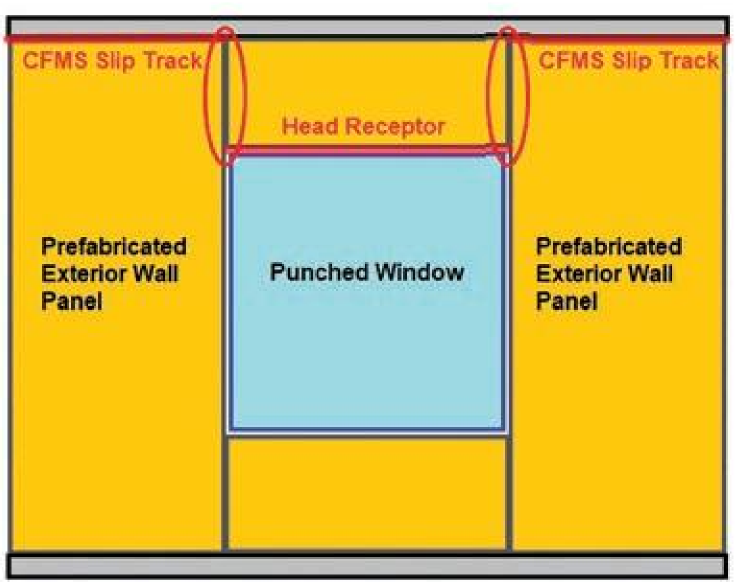


Figure 3 – Prefabricated panels with separate punched window.

Figure 4 – High-rise hotel.

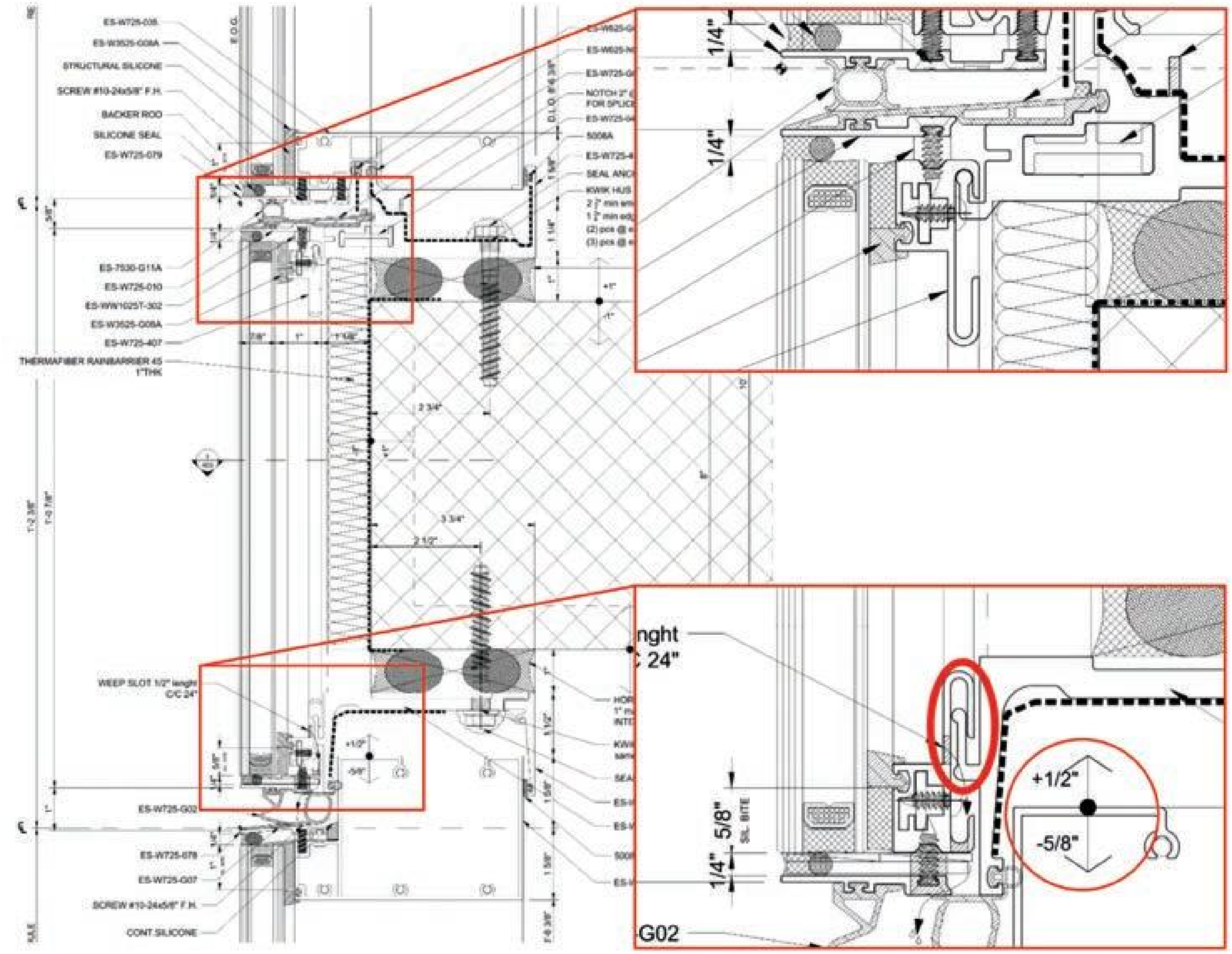


Figure 5 – Typical window wall shop drawing section detail at slab edge.

panels. The result was the inclusion of movement joints within the CFMS, exterior sheathing, air barrier, and brick cladding that were not a part of the original design.

Case Study 2

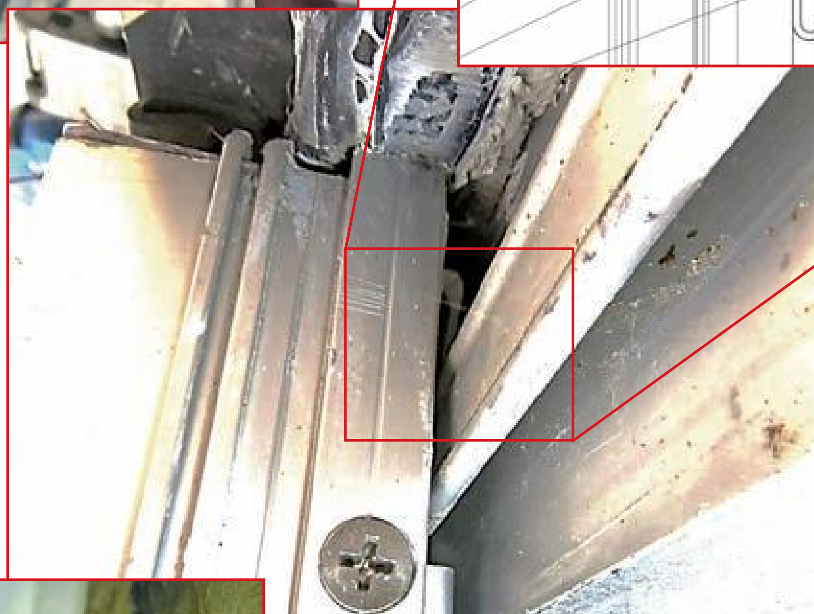
A 300+ room high-rise hotel located in a suburban area was occupied in 2018 (*Figure 4*). The 18-storey hotel consists of a cast-in-place concrete-framed structure that is clad predominantly with an aluminum-framed window wall, including rainscreen glass and metal slab edge covers. To expedite the construction schedule, the window wall system was prefabricated as a unitized system. The unitized window wall consists of a starter sill and head receptor at each floor (*Figure 2*). The starter sill and head receptor support the unitized window wall panels that interlock with two-piece mullions. Between the floor lines, the exposed concrete slab edge was treated with an air barrier system, and joint sealants were installed between the slab and the adjacent window wall head receptor and starter sill components. Additionally, the head receptor at the underlying floor and the starter sill at the overlying floor provide rails for support of the rainscreen slab edge covers (*Figure 5*). Upon final installation of the window wall system, the result was intended to be a uniform, continuous "curtainwall-type" appearance.

During construction, shop drawings were submitted for the window wall system. No field installation procedures were provided. Construction sequencing commenced with the window wall panel installation as the priority to achieve dry-in of the building and allow for finish-out to occur simultaneously with the remainder of the exterior installation. Therefore, initially the sill receptors and head receptors were placed at each floor, then the window wall unit installation followed. The rainscreen slab edge cover installation could then proceed simultaneously or at any time after the window wall installation.

Typical construction tolerances were provided for within the window wall design where the head receptor accommodated movement between floors, as well as installation tolerance (*Figure 5*, circle). The rail support system for the slab edge covers also allowed for adjustment to accommodate movement and installation tolerance through slotted supports at the base of the slab edge cover panel (*Figure 5*, oval). However, it should be noted that the slab edge cover vertical allowance for movement (~+¼ in.) does not accommodate the same building movement as that within the head receptor assembly (+½ in., -⅝ in.).

However, similar to Case Study 1, there were conflicts with the structural concrete and the fenestration installation tolerances

Figure 6 – Partially unengaged glass slab edge cover.



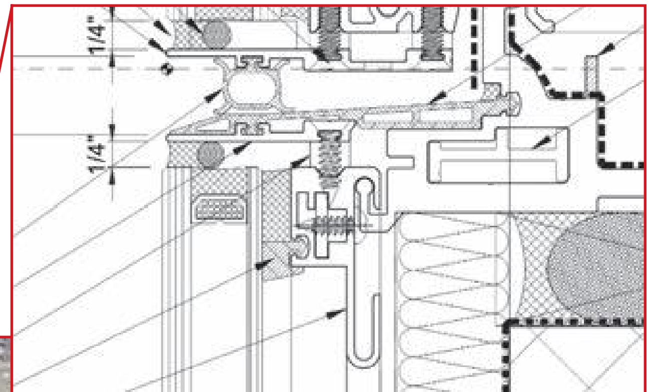


Figure 7 – Unengaged slab edge cover at top rail.

during construction. Due to the construction tolerance conflicts, as well as the lack of understanding of the window wall system installation, the placement of the supporting head receptors and starter sills was not coordinated between the window wall system and the rainscreen slab edge covers. Issues with constructability and proper support of the slab edge covers resulted. As with the exterior wall panels of the previously discussed case study, some slab edge covers could not be installed without modification or were not fully supported unless "field modified" (*Figures* 6, *7*, and *8*). Additionally, the overall appearance was not a uniform continuous curtainwall as the variable tolerance from floor to floor was accommodated mostly in the placement of slab edge covers, resulting in a non-uniform "wavy" appearance (*Figure 9*). As a result of the constructability and stability issues, the slab edge covers require evaluation and remediation.

Additionally, the transition conditions between the window wall and adjacent systems was not fully coordinated. As a result, while each cladding or fenestration system meets the design intent, the transitions between systems are unable to meet the performance requirements of the building enclosure or are not properly coordinated for future building maintenance.

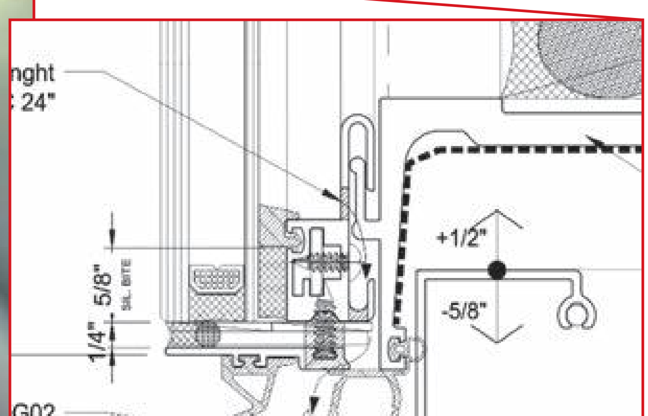


Figure 8 – Unengaged slab edge cover at bottom rail.

Figure 9 – View looking upward along elevation. Note non-uniformity in reflection of lifelines and power cord from floor to floor.

RECOMMENDATIONS

The intent of presenting challenges with prefabricated building enclosure systems is to prevent similar problems on future projects. While two problematic case studies are included herein, the author's experience also indicates that prefabricated building enclosure systems can be an effective and successful construction approach. Therefore, the following recommendations are provided to assist designers, contractors, and manufacturers with the successful design, planning/coordination, and execution of prefabricated building enclosures.

The first and most obvious step in ensuring the success of prefabricated building enclosure systems is deciding what systems or portions of the building exterior are appropriate for prefabrication. In doing so, the full impact of the prefabricated components should be studied from design and installation through maintenance. As components are being evaluated for incorporation with other field construction or prefabricated elements, they should be reviewed and coordinated to ensure uniformity and continuity of the performance requirements. For instance, the structural, air infiltration, and water penetration resistance, thermal and fire characteristics, etc., should meet or exceed the requirements as well as maintaining continuity (including minimization of changes of plane) across the building enclosure.

Once the prefabricated system(s) have been determined, a building enclosure consultant should be utilized for more complex or high-risk projects where building enclosure performance is critical. Then, the author recommends incorporating the following design, construction, and/or contract provisions into the project.

1. The prefabricated systems are to be developed as a delegated design performed by a licensed professional in the project jurisdiction for all the loads incurred by the prefabricated unit including, but not limited to, packaging and storage (orientation, stacking, etc.), transport, erection, and final use. For example, twin-span precast concrete units or unitized curtainwall undergo significant loads during transport and erection (*Figure 10*). Furthermore, these delegated designs should be reviewed by the building enclosure consultant and/or structural engineer.
2. The performance of preconstruction laboratory testing should be incorporated into the project to

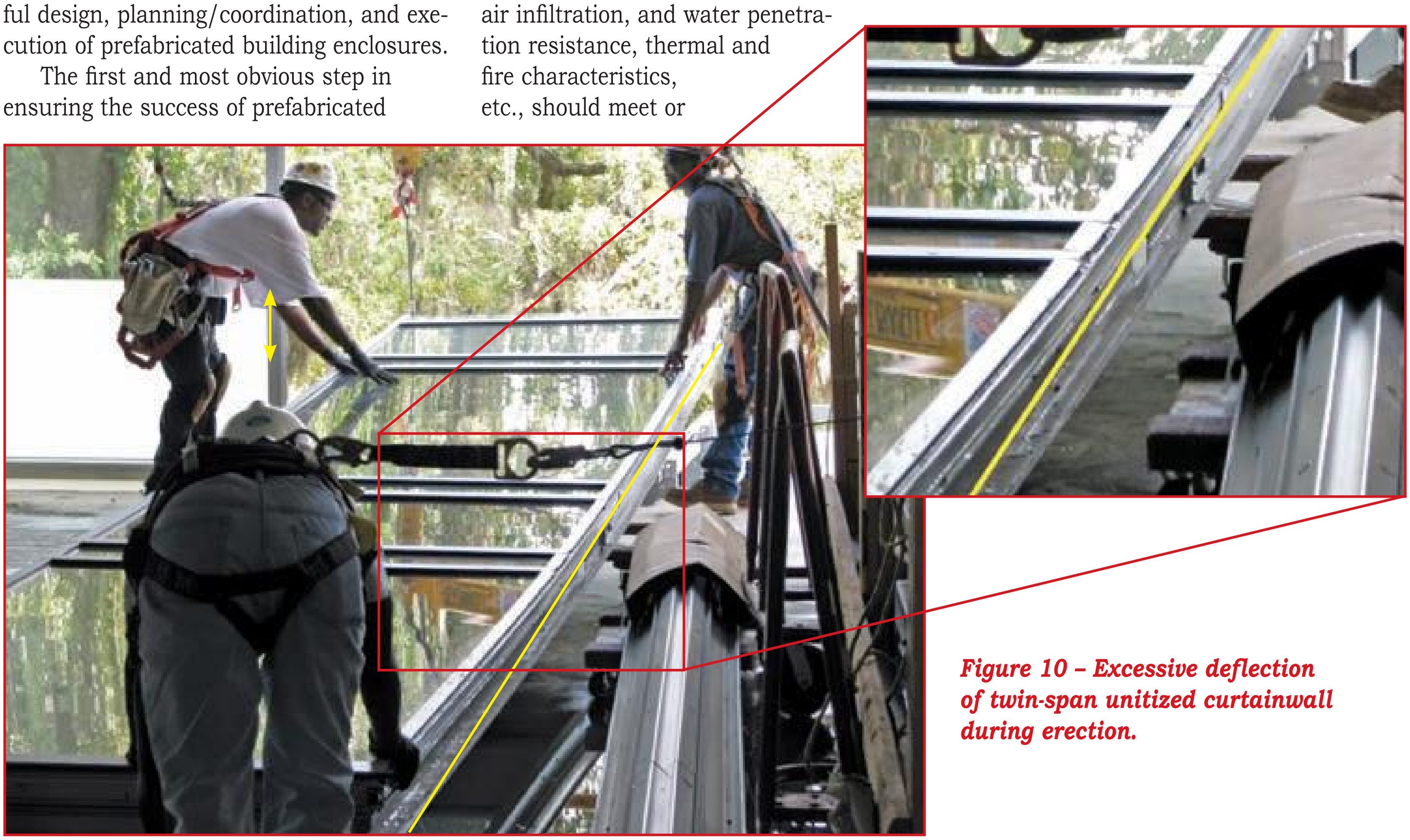


Figure 10 – Excessive deflection of twin-span unitized curtainwall during erection.

Figure 11 – Air exfiltration (smoke) at project-specific conditions during laboratory mock-up testing.

ensure performance meets the design intent and to assist with planning and coordination between systems. As previously indicated, the existing certified testing of the system may not be representative of the project-specific conditions. In addition, only the system itself, not the project-specific detailing and transitions, is included in the certified testing (*Figure 11*). Therefore, project-specific preconstruction laboratory testing should be performed. Also, include elements of the prefabricated system that require replacement and repair during its life cycle into the testing as the replaced/repaired conditions are typically not a part of the manufacturer's standard certified testing. Finally, as similar planning and coordination of the laboratory mock-up is required for the project site, the provisions for the preconstruction laboratory mock-up construction should include that the same personnel responsible for the on-site oversight of the project installation be those responsible for the mock-up. If preconstruction laboratory testing is not feasible, then engage a building enclosure consultant to assist with the review and requirements for the prefabricated building enclosure systems.

3. Manufacturer plant visits conducted periodically by the owner, designer, and contracting team should be performed during prefabrication. It is often the assumption that because there are better controls in the prefabrication manufacturing of these systems, that there is a higher assurance of quality in their assembly. However, just as in the field, the utilization of consistent quality assurance and quality control provisions are required to ensure the assembly achieves and continues to sustain the required performance. As periodic monitoring of the field installation is performed throughout construction, the same periodic observations should be performed during the assembly of the prefabricated systems at the

Figure 12 – Significant colour variation in glazed-in metal panels within twin-span unitized curtainwall.

manufacturing facility. One example is from a twin-span curtainwall project where metal and glass were pre-glazed into the system. During prefabrication, colour inconsistencies in the metal panels (*Figure 12*) were not apparent until installed in the field. With proper QA/QC provisions and manufacturer site visits, the resulting over-cladding and subsequent schedule delays and cost overruns could have been avoided.

A similar situation arose on a commercial high-rise office building in the Houston Galleria area. The glass units were installed inside out. Therefore, the low-e coating placement and visual appearance were impacted, resulting in field re-glazing hundreds of glass units. With proper QA/QC provisions and manufacturer site visits, the resulting re-glazing and subsequent schedule delays and cost overruns could have been avoided. *Figure 13* shows the incorporation of re-glazed units within the laboratory specimen to certify the performance of the re-glaze procedure. Since such a substantial portion of the façade was re-glazed to correct the incorrect glazing orientation, the field testing of the re-glazed units was able to meet the specified performance requirements as the re-glazing had been verified prior to construction. It should be noted that revisions to the manufacturer's standard published re-glazing procedure were required to achieve successful performance during the project's laboratory performance mock-up testing. Had this testing not been incorporated into the preconstruction laboratory testing, widespread water infiltration would have occurred at the re-glazed units.

4. Require the submittal of the project-specific fabrication instructions and field installation procedures. These submittals are to include related shop drawings and quality assurance/quality control provisions. As with Case Study 2, review of the procedures in conjunction with the shop drawings can avoid conflicts or omissions in planning and coordination.
5. Include coordinated shop drawing submittals for each of the respective building enclosure systems to understand the interrelationship between each of the building enclosure systems. For both case studies, the inclusion of coordinated shop drawings to better coordinate and understand the interrelationship between the systems could have avoided conflicts and performance issues.
6. Conduct a building enclosure coordination meeting for the project. Following initial submittal and review of the project submittals and shop drawings, a meeting of all trades that perform the building enclosure work, as well as those that impact that work, should be conducted. Therefore, the typical parties in attendance are the owner, designer, building enclosure consultant, general contractor, building enclosure subcontractors, and ancillary contractors. This meeting is typically a half to full day in duration. It begins with the ancillary trades such as lightning protection, MEP, and lighting subcontractors to ensure their systems are properly integrated with the building enclosure systems to

Figure 13 – Re-glazing at preconstruction mockup test specimen.

Figure 14 – Independent phased field mock-up of exterior wall and fenestration transitions.

ensure performance and proper warranty. Then the meeting continues, releasing the trades with less direct building enclosure-related work after their portion of the scope is reviewed, and concludes with the designer, building enclosure consultant, general contractor, and main building enclosure subcontractors reviewing the coordinated shop drawings and collaborating on the transitions between systems.

7. Include field mock-ups and field quality control/quality assurance testing during initial field installation and throughout construction. To facilitate collaboration and understanding of the constructability and sequencing of the building enclosure, field mock-ups should be incorporated into the project (*Figure 14*). The mock-ups should be performed prior to installation on the building overall and can be independent or in situ as a part of the final building enclosure. The scope of the mock-up should include prefabricated and field-fabricated components with focus on the sequencing of installation and the transitions, including all direct and indirect work related to the building enclosure.

CLOSING

In the ever-evolving construction industry, there is innovation to achieve greater value, such as higher performance at a lower cost. One approach is to prefabricate building enclosure components. Historically, building prefabrication has been successfully performed for other building components. As this application is still under development for the building enclosure systems, there have been problems that can override the benefits of utilizing these systems, result in costly remediation, and impact the design and performance of the building. This is where intent and reality collide. Through adapting from our past experiences, the industry will further develop the building enclosure prefabrication process to ensure its success. As a part of that effort, incorporating the recommended practices developed from the author's previous projects will help facilitate information sharing and collaboration throughout the construction process to ensure the success of the building enclosure.

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