# Corner Mullions: Insights into the Unitized Curtain Wall Corner Frame

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The popularity of curtain walls in high-rise construction can't be denied. In Toronto alone, there are more than 30 high rises under construction, and many of them are using curtain wall. These towers primarily use unitized curtain wall, which are fabricated, assembled, and glazed in a factory under controlled conditions and, therefore, have higher quality control compared to stick-built curtain wall systems. Even with this level of quality control, however, one section still presents a significant challenge: the corner mullion.

## BACKGROUND

First, the definition of a unitized corner frame: the assembly of two adjacent curtain wall bays in a single prefabricated frame with a change in direction in plan, with either a 90-degree outside or inside corner (see Figure 1 on page 15).

Manufacturers tend to show the corner as single frame assembly, creating a large, opaque corner to marry the two adjacent frames, with two standard split mullions and an exterior corner metal panel (see Figure 2 on page 15). This configuration is robust, as it separates the two curtain wall panels with a unitized corner frame assembly that allows for movement without major risk. The issue here is that designers often don't like how obstructive this detail is for views. The coveted "corner office" is considered a desirable space, and for it to be marred by a large opaque corner is not ideal.

As such, the design is oftentimes changed to two panels that connect directly (removing the metal corner piece). By customizing the corner condition to a large corner frame with a single rigid vertical post instead of a unitized assembly, there's an increased risk of moisture intrusion due to system movement. This style of corner frame also eliminates the pressure-equalization chamber present in typical vertical mullions.

On a single corner frame, the horizontal mullions are continuous in-between the vertical mullions, except at the corner. Here, a 45-degree miter cut is commonly used, and the horizontal mullions are attached to each other via a chevron shaped plate screwed to both mullions (shown previously in Figure 1). In some cases, the horizontal mullions are welded together; this is more robust but also far more labour-intensive.

In either case, discontinuity of the mullion joints means there is discontinuity of the control layers, leading to the possibility of air and water leaks. This makes the application of joint sealant critical.

## ISSUES OBSERVED DURING MOCK-UPS

The issues observed during five curtain wall corner mock-ups are summarized in this section. Failures observed during mock-ups primarily involved assembly issues and were less related to design.

- In the first case, the production team was responsible for putting together the mitered horizontal mullions with the chevron plate as a first step; a task that was new to the worker. The sealant between horizontal mullions was omitted in error, resulting in a "dry joint" and subsequent water leak as soon as the mock-up was water-tested. The solution on-site was to expose the joint, apply sealant, and introduce a metal angle as a substrate for the sealant in front of the joint. This was an assembly error.
- The second mock-up had the same conditions as the first, but, this time, the worker was aware of the sealant bead required. Unfortunately, during the assembly process, the sealant was not applied properly and was discontinuous. As soon as the frame was tested, water leaks were detected. The solution was to reinstall the sealant. This was, again, an assembly error.
- The third time, the sealant was applied and inspected after assembly was completed. During the first round of water testing, the joint performed as intended. The frame was subjected to horizontal displacement and then tested again, where it failed. It was determined there was some unexpected movement of the corner assembly between the connecting chevron plate and the horizontal mullion due to fabrication tolerances. Additional sealant and a silicone transition membrane were applied as a remedial work, and the leak was solved. This was a fabrication and manufacturing error.
- The fourth and fifth mock-ups had very similar designs: a corner post secured to the horizontal mullions. Spigots were introduced to support the vertical post and additional screws were introduced at the corner connection. On both mock-ups, water was visible at the sill after both displacement testing and thermal cycling. The failure was at the head miter cut, where joinery sealant was applied. Again, additional sealant and a silicone transition membrane were applied to solve the issue. These were installation and manufacturing errors.

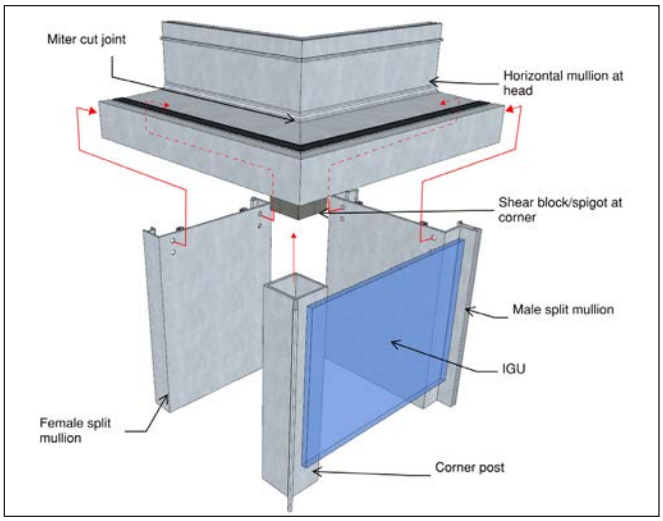


*Figure 1. A conceptual model of an outside corner mullion using a corner post. Note, some fasteners, extrusions, and gaskets have been omitted.*

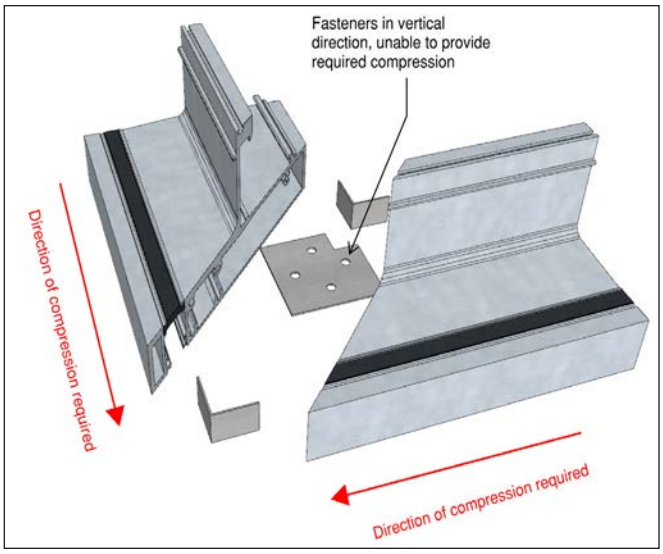


*Figure 2. A standard corner detail. Note the four split mullions. Note, some fasteners, extrusions, and gaskets have been omitted.*

In all corner mock-ups, the joinery is relying on one sealant bead for watertightness; there is no back-up around the exposed joint, redundancy, or secondary line of defense. As the aesthetic requirements often trump the ability to include a back-up system, this makes the workmanship of this sealant joint critical. It's important to mention that not all corner conditions failed on each specimen, but on all specimens, at least one corner condition failed, indicating the importance of consistency during fabrication, assembly, glazing, and installation.

With respect to design, it's common to see corner mullion systems using the same compression configuration as a vertical-to-horizontal system; however, the compression required between corner mullions is different due to the angled connection. On a typical vertical-to-horizontal mullion connection, fasteners evenly compress the vertical mullion to the horizontal mullion. On a horizontal mitered connection with a chevron plate, manufacturers will increase the number of screws (sometimes double compared to a vertical-to-horizontal connection). The screws are perpendicular to the chevron and horizontal mullion though, so screw torque isn't necessarily increasing the compression between horizontal mullions (see Figure 3 to the right).

The success of the corner mullion condition can be managed with a few different strategies:

1. Removing the issue entirely: Use a corner vertical split mullion and have a two-frame corner following standard details that have already been tested successfully. Two-frame systems are more resistant to movement and thermal cycling.
2. Improve the joint sealant design: Introduce redundancy through a silicone membrane at all exposed mitered joints to the exterior, or where the mitered joint is part of the air / vapour control layer. When the corner assembly allows, introduce a backup foam block inside the assembly to maintain the sealant position.
3. Assembly instructions: Develop a clear set of assembly instructions to allow manufacturing to build and review the corner frames and maintain consistency throughout the project. Assembly instructions should be complete, including reference details, 3D sequential details, blow-out details, information on all surface preparation work, sealants, fasteners, membranes, plates, etc.

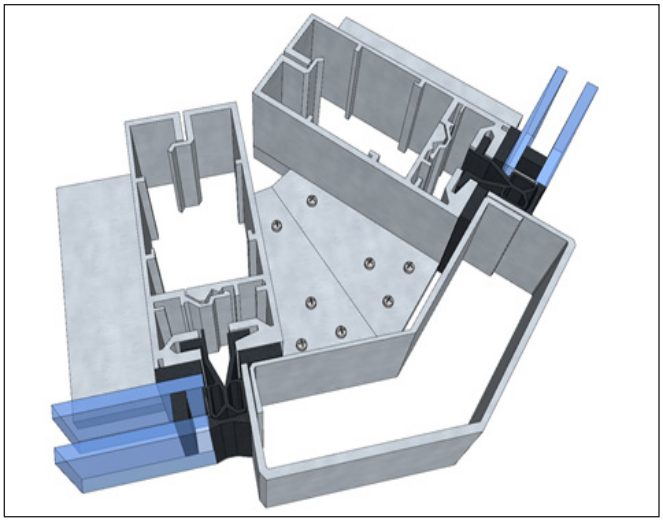

*Figure 3. Ineffective fasteners at the corner mullion.*

## CONCLUSION

Unless your building doesn't have corners (which is entirely possible!), there will be challenges with watertightness when curtain wall mullions change directions. The geometry of the corners from contemporary minimalist styles commonly results in mullions that depend entirely on a sealant joint for watertightness, with no redundancy. The quality of the installation becomes critical to the success of the curtain wall system. This can be avoided by using a more robust system such as a two-frame corner—at the expense of a larger obstruction to the view of the corner. No matter what is chosen, as long as curtain walls are around, the corners will be a point of contention. ■

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