storefront & curtainwall

SUITABLE SOLUTIONS FOR BETTER BUILDINGS

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Take a look at any commercial or institutional building constructed in the last few years. Chances are, there's a lot of glass on the facade. It's easy to see why building teams make that choice: natural light penetration has proven beneficial from the perspectives of energy use, occupant health, and certainly aesthetics. On the ground floor, wide-open glazed facades provide context, communication and closeness, thanks to the view out and view in. Visibility is the currency of today's building world, in many settings.

To make the glass façade work best, what kind of framing systems should the building team choose, and how should the project team members make that choice? The first step is to lay out the options, study carefully what their benefits and challenges are, and then summarize where, when, and why each is appropriate. For a first step, let's identify the options for fully glazed facades:

- Storefront: An integrated wall assembly frequently used in street-level applications.
- Curtainwall: A non-load-bearing system that sits as the outer face of a building and is often used for an entire facade.

How do building teams choose between storefront and curtain wall? The best building professionals consider the application. In certain contexts, such as ground-floor-only uses, storefront framing systems provide a solid, reliable option -- not least because many

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Curtainwall, window wall and entrance systems – manufacturer: Tubelite Inc.; Walker, Michigan; http://www.tubeliteinc.com
Curtainwall, window wall and entrance systems – finisher: Linetec; Wausau, Wisconsin; http://linetec.com
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builders are familiar with its specification and installation. However, the system has structural, air and water infiltration limitations, among other challenges, when building taller or more extensive glass façade systems. In situations where these factors are of prime concern, a curtainwall system is the wiser and more durable, albeit more expensive, choice.

STOREFRONT BASICS AND USES

Storefront is a very common glazing system in the United States and globally, most often used in retail structures. Typically composed of extruded aluminum framing and glass infill, storefront offers a simple way to include large windows and glass doors in a ground-level façade. Despite obvious differences in particular application, there are common features and dimensions shared by most storefront-type fenestration systems. For example, glass is often centered within the depth of the wall assembly, but may be offset to the front or the back. Typical glazing dimensions are 1-¾" to 2" for sightlines with a depth of 4-½" or occasionally 6-½". The bite – which refers to the dimension of the glass captured by the framing system, typically runs from ⅜" to ½".

As its popularity suggests, there are certain contexts in which storefront can be a good choice. The relatively small scale of most ground floor retail facades makes storefront a practical and cost-effective solution for single-story or low-rise use. For example, with a 4-½" frame depth a storefront system can span up to 10 feet in height, while those with a 6-½" depth can extend up to 12 feet, which is more than adequate for most ground-floor applications.

If a building team's goal is to extend the storefront system higher than 12 feet, however, in general they're out of luck. Greater heights are not possible with typical storefront systems because their extrusions have minimal wall thickness and are not designed for large glass areas. The main issue is the wind load -- action of air pressure creating forces against the building -- could be too substantial for the extrusion elements if the glass area were larger.

WIND LOADS AND FAÇADE INTEGRITY

Wind loading in particular is a major concern for any framing system. The frequency of vertical framing members and the relatively thin glass in a storefront system mean that there is a higher potential for deflection and bending under strong winds, which can lead to glass breakage.

Industry standards and codes require a maximum deflection for a given storefront panel of ¾ inch or the length of the vertical framing span (whichever is less) divided by 175, under a specific test pressure determined by local wind speeds. Practically speaking, this means that the actual site must be inspected, and that the height of the storefront must be designed so that its potential deflection will be less than the allowed maximum, which is often given in literature and construction documents as L/175 or ¾ inch. The upshot is that storefront works best when it is limited to a single-story application.

THERMAL PERFORMANCE

Those same vertical and horizontal framing elements that impact wind load considerations are also of prime concern when it comes to thermal performance. In storefront systems, the framing elements are most commonly made of aluminum, a good material choice because it is fairly inexpensive and can be extruded into a great variety of rigid shapes to suit many different purposes and conditions.

One of the downsides of the material is its thermal performance. Aluminum has a high heat transfer coefficient; in other words, it's a good heat conductor, which means that it can lead to a high level of energy loss unless a thermal break system is used. A thermal break is a barrier between external and internal metal made of a low conductivity material. Generally, thermal break components are at least ¼" thick, although the deeper the break, generally, the better the thermal performance and condensation resistance it affords. There are different types of thermal breaks for storefront systems, including:

- pour and debridge systems
- slot components.
- clip components.

Pour-and-debridge thermal breaks are among the most common types, and they consist of a two-part, chemically curing resin that is poured into a cavity in the extrusion, and in which some of the metal is cut away after curing to create a "break." A slot system requires the removal of 1" wide x 6" long sections of the extrusion, with only 1" left between the resulting slots. Last, a clip system is made up of a plastic clip component that separates interior and exterior metal.

An additional thermal consideration with aluminum is material expansion and contraction. Over a 100-degree temperature change, aluminum can expand or contract by up to ¼ inch. As a result, when storefront is specified it is often necessary to use expansion joints with lineal runs of longer than 16 feet to account for this movement.

Modern high-performance thermal storefront systems incorporate two pour-and-debridge cavities improving U-values by 36% and condensation resistance by 30% over comparable single-cavity systems.

MOISTURE PENETRATION

Another important consideration when selecting, specifying and designing storefront framing systems relates to moisture infiltration. Storefront works best when it is protected from the elements by an overhang or is set back from the front of the building. Also, because every panel ends in a horizontal element -- and because individual

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Architect: Huckabee; Fort Worth, Texas; http://www.huckabee-inc.com

General contractor: Byrne Construction Services; Fort Worth, Texas; http://www.tsbyrne.com

Glazing contractor: Texas Commercial Glass Concepts, L.P.; Weatherford, Texas; http://www.texascommercial-glass.com

Glazing systems – finisher: Linetec; Wausau, Wisconsin; http://www.linetec.com

Glazing systems – manufacturer: Tubelite Inc.; Walker, Michigan; http://www.tubeliteinc.com

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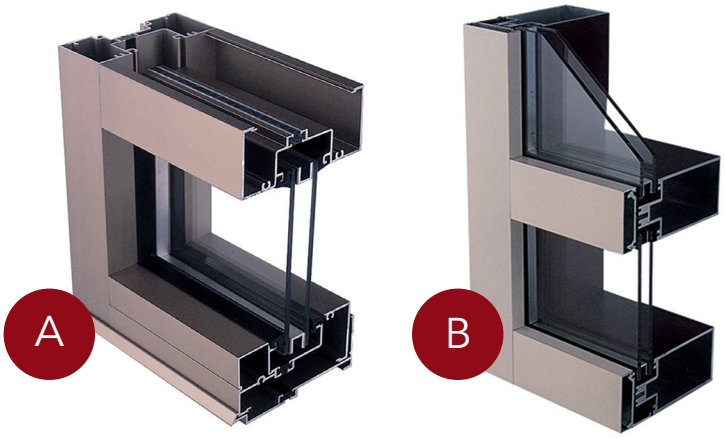

panels are relatively small -- storefront systems require a significant amount of flashing and sealing.

As one might expect, it becomes important to maintain a clear path for evacuation of any water that enters the storefront framing members. Such a path can be created and improved through the use of water diverters -- also known as water deflectors -- that direct water to the sub sill or sill flashing. A water diverter should be installed at every intersection of intermediate vertical and horizontal elements, and should be sealed at every joint except for the outside corner, so that water will be moved to the sill and not towards the interior of the building. In other words, while it is critical to seal the ends and back of the sill, along with the anchors, it is equally important to ensure that the outer edge of the subsill has weep holes (openings inside the framing) to allow for drainage.

In the design process, when it comes to moisture management a good directive to keep in mind is “down and out”: water should always be channeled down towards the ground and out away from the building. It is especially important to follow this principle during construction so that the subsill is always installed sloping in the correct direction. With water deflection measures in place, moisture penetration will be kept to a minimum. But over the surface area of a large application -- such as a façade of multiple stories -- this can be expensive and unsightly, and the use of an overhang can become impractical.

As issues relating to moisture infiltration and wind load demonstrate, storefront framing remains a cost-effective and relatively reliable choice for single-floor applications, but it may present significant limitations when used on larger-scale, multiple story applications. In these situations, a curtainwall system is often a wiser and more effective choice because it tends to meet higher standards -- and perform better -- in regard to moisture, wind load, and structural issues.

APPLICATIONS OF CURTAIN WALL

What exactly is the best way to understand curtainwall? Essentially, it’s a non-loadbearing external wall cladding that is hung to the exteriors of a building, usually spanning floor to floor. Generally curtainwall is best used for second-floor or higher applications, but it can also be used as a high-performance system on the ground floor of a building. As with storefront, curtain walls tend to be framed with aluminum and contain a glass infill, although the infill can also be of metal or other materials. In contrast to storefront, the framing in a curtainwall system is attached to the outside of the building structure.

The structural members of a curtainwall system include several elements. The first is the backmember, or the heavy wall extrusion that forms the framework for holding the glass and anchoring it to the building. Pressure plates are the screw-applied stops that hold the

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Architect: Perkins+Will; Dallas; http://www.perkinswill.com/
Assisting Architect: Selser Schaefer Architects; Tulsa, Oklahoma; http://www.selserschaefer.com/
General Contractor: CMS Willowbrook; Oklahoma City; http://www.cmswillowbrook.com/
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Entrance Systems – Finisher: Linetec; Wausau, Wisconsin; http://linetec.com/
Photography: *Charles Davis Smith, AIA, architectural photographer; Dallas*

glass in place and form the air and water seal. The face covers are trim pieces that conceal the screw fasteners on the pressure plates, yielding a clean look.

There are two main types of curtainwall, classified by method of fabrication and installation: The first is a stick system, in which the frame and infill panels are installed and connected piece-by-piece on-site. The second type is a unitized or modular system, in which large units of panels are assembled and glazed at the production facility and then installed at the site. Unitized systems may present a better choice for very large applications, because the installation requirements and other worksite costs are reduced.

In addition to different methods of fabrication and installation, there are two types of glazing systems—interior and exterior. Interior glazing allows for infill installation from the building interior, and is often specified for high-rise projects where logistics of exterior installation present a concern. Exterior glazing is most common on low-rise construction where access to the façade is not an issue.

THERMAL PERFORMANCE

Thermal performance is also a vital consideration. As with storefronts, curtainwall systems usually use aluminum for the mullions and other framing elements, so the same thermal break strategies apply here as well. In the case of curtain wall, separating the pressure plate from the backmembers with a low-conductivity material is an important design feature.

Curtainwall framing systems are available in a wide variety of thermal break and infill thickness options. Some new thermally broken curtainwall products exceed today's stringent energy codes, with a variety of assembly options. Modern high performance curtainwall systems incorporate polyamide thermal breaks and accomodate triple insulating glass infills. These systems can reach U-values as low as 0.20, making them ideal for International Energy Conservation Code (IECC), ASHRAE/IESNA 90.1, 189.1 NFRC U-value and state codes. The leading systems made with aluminum, fiberglass or polyamide composition will list NFRC-simulated U-value and AAMA 1503 CRF information. High-performing glass options include low-E double glazing with argon fill.

Some systems also have dual thermal struts to decrease U-factors and increases CRF significantly over many current thermal barrier systems. In these types, the glass is positioned to the system exterior for enhanced resistance to rainwater, and they can accommodate insulating glass or panels of 1 inch to 1-¾ inches in thickness. The vertical members can be steel-reinforced for high performance against strong windloads.

When specifying glass and metal curtainwall, savvy building teams look for testing by independent laboratories, which can ensure that the systems are of the highest quality possible.

MOISTURE PENETRATION AND WATER DRAINAGE

In general, it's safe to say that properly erected curtainwall systems are less likely to suffer from moisture penetration than storefront systems, all things equal. One reason is that the larger sizes of the curtainwall panels mean that there will be fewer sections of flashing than in an equivalently sized storefront system. Of course, as with a storefront system, thorough and proper sealing is essential for each horizontal-to-vertical joint of the curtain wall expanse.

Drainage management is also a critical consideration with cur-

tainwall. Just as with a storefront system, a good drainage system will collect water and drain it to the exterior through a series of weep holes. Unlike a storefront system, though, which directs all water to the sill, curtainwall drains at each individual lite of glass through the weep holes because the greater height of most curtainwall systems means there will be more water than a single subsill could handle.

In order to prevent water from penetrating a curtainwall system, experts stress that, "Weeping is critical and requirements vary with product types and manufacturers. It is essential to follow manufacturer's installations instructions to ensure proper performance," according to Jim Oberlin, the Eastern/Midwestern region sales manager for Tubelite, Inc. He adds that field failures of curtainwall systems are most often "directly due to improperly sealed zone dams or incorrectly placed or missing weep holes." Clearly, even the smallest design choices matter.

WIND LOAD AND DEAD LOAD

Just as for storefront systems, wind load is an important factor to consider when selecting, designing and specifying curtainwall. Since wind load is a horizontal force, it is transferred from the curtainwall panels to the main building structure. Any deflection of the curtainwall can impact the building itself, so limiting deflection should be top of mind. At the same time, savvy designers understand that it's impossible to prevent deflection; predicting and minimizing it is the key.

Using steel-reinforced framing members can help limit and control deflection. The need for such reinforcement depends on the wind conditions at the particular site, as well as the particulars of the system design. The connections that anchor the curtainwall to the building structure must be able to allow for some movement without permanently deforming; for this reason, careful attention is given to joint and connection details.

Naturally wind load isn't the only kind of stress a curtainwall system will face. Dead load, also known as static load, is a structural load that remains constant over time and includes the weight of structural elements like walls, roofs and flooring. Since curtainwall is non-load-bearing, the dead load it must handle is essentially limited to the weight of the glass, the framing system, and related materials, with a safety factor that is based on the selected system design. Because the curtainwall is not structural, however, its weight is supported by the anchors that connect it to the building structure and that form the point where loads are transferred to the building structure. For this reason, properly designed anchors are a key to success for any curtainwall system.

STOREFRONT AND CURTAIN WALL: FIRST COST AND OPERATING COSTS

Cost is almost always a consideration in building projects, and when choosing a glazing system it's important to be aware of the differences in cost between storefront and curtainwall. As noted above, storefront is generally the less expensive of the two options due to its smaller area of coverage and the lighter weight of its materials. Although costs vary significantly by labor market and by the particular materials, finished and infill types chosen, building teams can typically expect to spend about $30.00 or more per square foot for the glass and framing, according to one fabricator-contractor. Curtainwall tends to cost more, about $100 per square foot, based on recent surveys of manufacturers and glazing contractors.

There is more to the cost equation, however. For example, many building projects seek certification by the U.S. Green Building Council's LEED program or other bodies that rate building projects for sustainability.

LEED CREDITS AND OTHER GREEN BENEFITS

If a building team is looking to earn LEED credits with a building that includes one or more glazing systems, there are certain strategies they can employ with storefront and curtainwall. Simply using either of these metal-and-glass systems inherently increases interior daylighting and reduces aspects of energy use. If the chosen system has high thermal performance that reduces energy use further, the building team might consider applying for the LEED credit Environmental Quality (EQ) 7.1. EQ 7.1, which requires the building envelope to meet the requirements of ASHRAE Standard 55-2004, Thermal Comfort Conditions for Human Occupancy. Demonstrating design compliance in accordance with the Section 6.1.1 Documentation of this standard will earn the team the credit.

Building project teams can also explore options for using recycled aluminum, which may qualify their project for MR (Materials & Resources) Credits 3.1 and 3.2 for Materials Reuse. Both credits require the use of salvaged, refurbished or reused materials that constitutes at least 5% (for 3.1) and an additional 5% (for 3.2), based on cost, of the total value of construction materials on the project. Additionally, MR Credits 4.1 and 4.2 also offer one point each for the use of 10% and 20% (respectively, based on cost of materials) with recycled content. The total must be such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes at least 10% (based on cost) of the total value of the materials in the project.

As these benefits for green building demonstrate, initial costs are not everything for selection of a building façade system. To assess the benefits of using the sophisticated, high-performance architectural aluminum and glass systems available on the market today, building teams start on the project planning phase by laying out the project needs. Often, these early discussions lead to the selection of an easy-to-install, durable framing approach for the storefront or curtainwall application. Installers in this field have a long and well understood track record, a history of dependable performance based on not only proper system engineering but also an experienced community of manufacturers, consultants and contractors.