INSIDE: Our One-on-One with Roger O'Shaughnessy

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Structurally Sound

A Close Look at Structural Glazing Innovations and Developments

by Jeff Haber

W&W installed the overhead structurally glazed system at the West Midtown Ferry, Pier 79, in New York.

The Afognak project in Alaska features decorative glass screen walls that use the Planar SentryGlas plus system and a simple steel back up.

Take a walk along the streets of most any major city such as New York or Chicago and you're likely to see dazzling displays of structural glazing. These applications, which feature large amounts of glass and minimal amounts of metal, have become increasingly popular.

Pilkington Brothers Ltd. of St. Helens developed the first bolted glass assemblies back in the 1960s. Soon other companies throughout Europe followed. These early products utilized vertically tempered glass panels with tong marks and large patch fittings, which were generally made from stainless steel and suspended by carbon steel hanger bars. As glass processing equipment and more sophisticated analytical tools were developed, the product began to change—most notably through the elimination of the exterior patch fittings in favor of the countersunk bolted fitting. By the early 1980s the first insulating bolted glass unit was developed and the industry has never looked back. Today, as technology is developed, even more new processes are created.

Basic System Components

The first structural glazed systems were used for vertical enclosures only, such as main entrances or atriums. Today it's common to not only see vertical facades but also canopies, skylights, elevator enclosures, security partitions and railings. Regardless of the application, a combination of the following elements is used to create a structural glass system:

Types of glass: tempered, insulating, laminated, coated, self-cleaning, low iron or body tinted;

Hardware/connectors: Patches, countersunk bolts, splice assemblies (joining two supports together) either horizontal, vertical or X shaped, spider type castings with moving parts and articulated components for large in-plane displacements; and

Back up/support structure for the glass: Glass fins, steel tubes/pipes, trusses—either simple steel, hybrid steel with pre-stressed elements (cables or rods) or pre-stressed cable/rod, single or double cables/rods (i.e. cable nets).

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Structural glass systems all include glass, hardware (such as in the image above) and a support system. Canopies (shown left) are popular structural glass applications.

Methods of Analysis

With the advent of computers and related software, designers and engineers can now build 3D models of glazing systems, as well as each component. Architects can use renderings to better explain the design intent to both their clients and the vendors who are responsible for bringing the designs to life.

These new software tools also allow in-house glass designers and engineers to take the architect's or engineer's concept and feed information into the computer. After evaluating this information about the glazing, such as wind, seismic, impact from hurricanes or explosions, thermal expansion, live load deflection and/or snow, they can learn more about the system's performance capabilities. Companies also have developed new methods for finite element analysis that can accurately predict the effects that different loads could place on the glazing system.

For decades, engineers used test labs to validate the analytical work. Now, engineers and laboratories also look at hurricane impact (large missile and cyclic loading), bomb blast, as well as long-term weatherability of different types of laminated glass.

It's All About the Glass

To have a glazing system, you need glass. That's why the most important decision in putting together a structural glazing system is what kind of glass to use. Early in the system's availability, the choice was simple: clear, tempered glass. But today many options are available.

First, there's the decision of whether or not the glass needs to be insulating. Even after that decision is made, the options are still vast. With such innovations in processing as large coaters, flatter glass and new washing equipment, second-surface, soft-coated glasses can be utilized in drilled applications. These innovations also provide increased solar control and low U-values.

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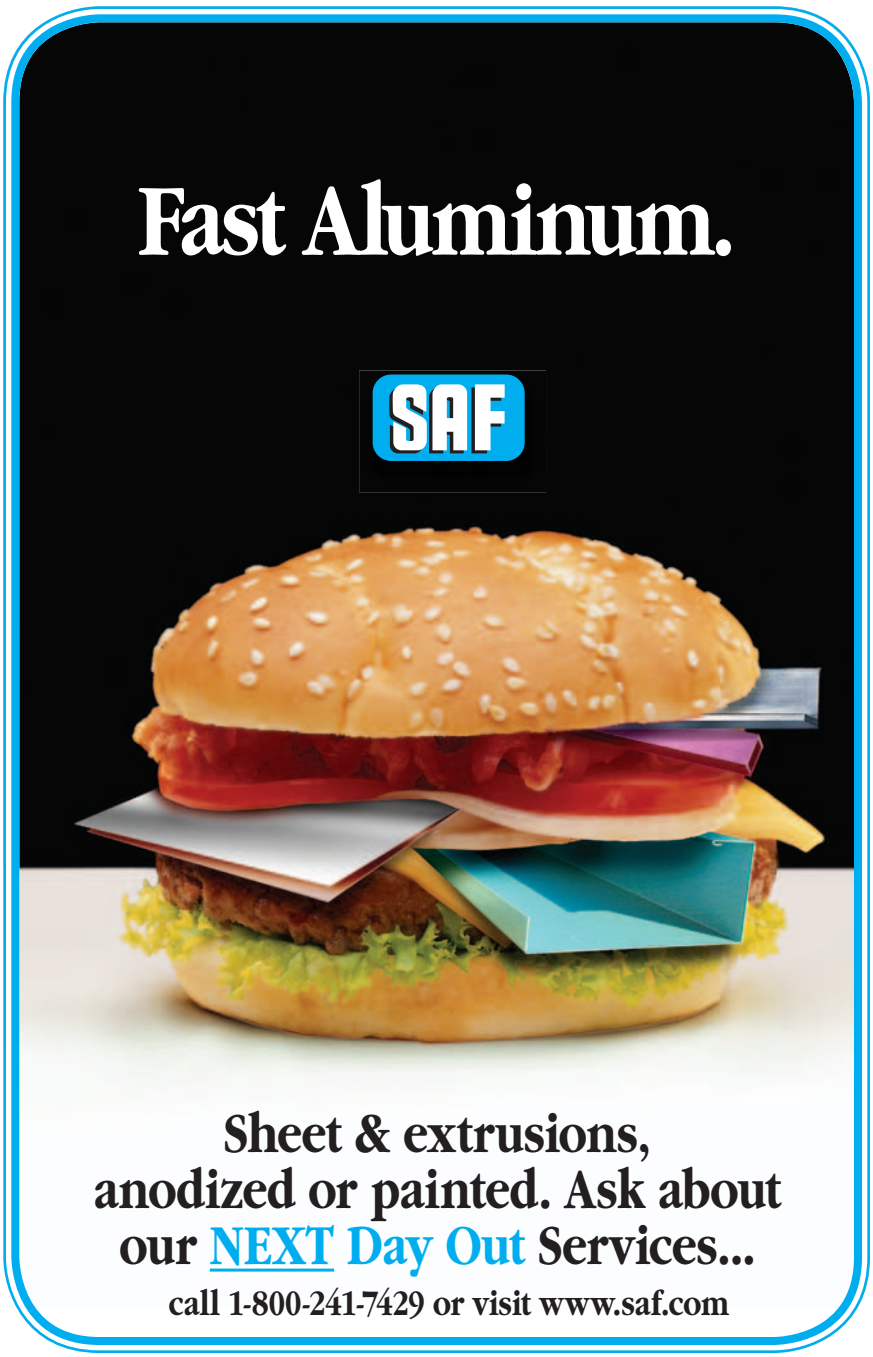
This structural glazed wall at the Tampa International Airport is supported by a series of tension trusses.



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Should laminated glass be required for security, impact, bomb-blast or aesthetic and/or acoustical purposes, a wide variety of choices are available. Traditionally, laminated glass has been constructed with either poly vinyl butyral (PVB) or cast-in-place liquid resin. But DuPont recently brought an ionoplast product to the world of structural glass. This development allows the product to bond to the surface of two glass lites, creating a mechanism for load share that results in a product up to 60 percent stronger than traditional laminated glass.

The visual quality of tempered glass has also improved dramatically in recent years. New convection furnaces with both improved roller configuration and material have the ability to produce glass that can be up to 350 percent flatter, in some cases, than that of other machines. This virtually eliminates rollerwave distortion.

Likewise, innovations in quality control have even led some manufacturers to offer a product that is safer for end-users. In the late 1980s and 1990s there were large clusters of nickel sulfide contamination in heavy tempered glass (primarily used in bolted structural glass), which had a tendency to cause spontaneous breakage after the glass had been installed. In the late 1990s and early 2000, new heat soak testing was developed to ensure the elimination of virtually all nickel sulfides. When weighed against the vast quantity of glass produced, these processes are very inexpensive over the long term.

Today and Tomorrow

Over the past few years the trend in glass structures has been toward flexible, transparent support methods. Case in Point: the cable net system.

Developed in Germany in the 1980s, this system has actually been around for quite some time. It's made up of a series of pre-stressed cables or rods attached to the perimeter of the building. The glass panels are mounted indi-

vidually by using nodes that are clamped to the cables. The original design utilized two cables that criss-crossed each other like a tennis racquet or net, hence the name "cable net." At the intersection of the two cables there would be a node or casting that acted as an anchor point to mount the glass panels. Companies have recently introduced single-span cables (vertical only), as well as a new method of clamping bolted glass or Planar-type fittings onto the cables with high strength bolts, eliminating the need for large and expensive nodes and patch fittings.

As new tempering furnaces, coaters and lamination lines make their way into the mainstream, designers are taking advantage of the increasingly large sizes of glass available. Currently, the maximum standard production size available is 8 x 16 feet (larger sizes can be made, but with a significant premium in cost). This tends to eliminate the amount of structure (metal) and makes the facades even more transparent. But with larger glass sizes comes greater deflection. The larger the unsupported span, the more deflection the glass will exhibit. Manufacturers should consider this issue carefully, especially when insulating glass is being used. If they don't recognize this possibility, it could lead to the aluminum spacer or primary seal being over-stressed, which could cause unit failure.

All of these new technologies were borne out of either a design need or a manufacturer's effort to improve production and the finished product. Expect to see more innovations evolve as the use and popularity of structural glass continues to grow. ■

Structural glazing can be found in many application types, including storefronts and entrances.

the author

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