Glass at the cutting edge – Point Supported Glass

Introduction:

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Nothing sets a building apart like the creative use of glass, from curtain wall to skylights.

While structural glass comes with its own set of design rules, you would be amazed at what is possible, and affordable, when you have the sufficient knowledge of how it works.

From storefronts, canopies and lobbies to the most stunning signature buildings in the world, the expanses of glass continue to get bigger, taller, more complex and ever more transparent. The metaphors vary - disappearing walls, invisible structure, bringing the outside in, dissolving the boundaries between the building, the street and sky.

The current state of the art is the point supported glazing, also referred to as bolted structural glazing system. Glass, stainless steel fittings and increasingly imaginative support or back-up structures conceived and executed as an integrated unit.

Fox Plaza, Century City, CA.

The most common fitting in bolted glazing systems is the "spider" or star type. The highest quality are those made of austenitic Type 316 solid stainless steel lost wax investment castings, commonly two-point, four-point and sliding types, but many other forms and shapes are available or can be designed for specific applications. For example, a design with sliding arms to accommodate large racking displacement of glass under severe seismic events allows for movement of up to 1 inch in two directions at each glass joint. Specific fittings are also used with each of the basic types of supporting structures.

Time Warner Center, NY City

History:

In 1922 Mies van der Rohe designed a glass tower with a vast sinuous glass wall which exploited the possibilities of inter-reflection and the changing angles of light. Although this was never built, the concept of an almost seamless wall was a goal to which architects and engineers aspired.

A few years later, toughened glasses was made by heating a pane of glass and rapidly cooling it by blowing cool air onto both faces the outer surfaces contract and are pulled into compression. The resulting pane is four to five times as strong as annealed glass and, if shattered, breaks into relatively small pieces.

Toughened glass can be used without edge framing and one of the first buildings to exploit this was the Willis Faber and Dumas (now Willis Corroon) office by Foster and Partners, completed in 1975. The facade is of large faceted panes of glass, following the curve of the street; 12mm toughened bronze anti-sun glass panels, 2m wide, are suspended from the roof by bolted clamping strips and stiffened by glass fins. The only visible connections are patch fittings at the corners of the glass panes, and the coated surface a reflector by day, changing the building into a luminous lantern by night.

Framless Facades:

Architectural glass has traditionally been supported by capturing the edges of the glass. Architects and engineers aspired buildings even more transparent, engineers have developed methods of reducing the size of the supporting structures.

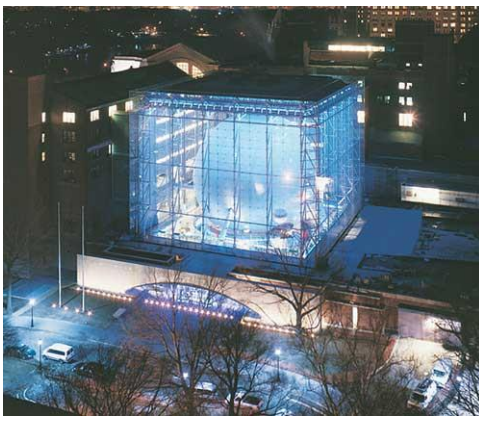
Reducing or eliminating the visible barrier between the outside and the inside of buildings required bigger openings in a building and fewer impediments to the outside view which point supported glass can offer.

It has been increasingly popular to attach the glass to the structure using bolted fittings directly connected through holes in the glass. These fittings allow improved transparency and offer additional architectural opportunities in the detailing of the bolted connections.

When designing point supported structures, it is often deflection and not the structural strength of the tempered glass that is the limiting criterion for determining the glass thickness.

Willis Corroon office - Interior

Willis Corroon office – Exterior



Rose Center for Earth and Space, American Museum of Natural History, New York City, NY.

Until recently, structural glass bolted systems were limited by the amount of deflection which was deemed acceptable by structural engineers. Schlaich Bergermann's Kempinsky Hotel in Munich broke this spell. The glass entrance wall is composed of l.5m sq panes attached at their corners to a cable net structure so delicate as to be almost invisible, yet flexible enough to move up to a meter under wind load.

A new arts complex in Philadelphia, US, by Rafael Vinoly and structural engineer Dewhurst Macfarlane, takes this idea one stage further in the search for ultimate transparency; the centre has a glass roof enclosed at its ends by a glass curtain suspended only from vertical cables.

However, if the glass lite deflects laterally by more than half its thickness, then large deflection, non-linear plate theory must be used when analyzing the strength and deflection of the glass. Simple four sided plate theory does not take into account the membrane stresses that will occur, especially near the holes at the corners of the glass.

Hardware:

Point supported hardware is offered by several manufacturers. Some are a simple bolt and patch plate system, countersunk bolt, with flexible washers and gaskets within the supporting structure or using articulated bolts. All of these hardware systems have been successfully used for facades and canopy structures, but the structural glass must be designed and fabricated properly to comply with hardware specifications

Façade Applications:

Point supported glass can be used for vertical, sloped, and overhead cladding. Vertical glazing can use monolithic, insulating glass units of heat strengthened/ tempered glass, and possibly even annealed laminated glass depending on imposed thermal and load stresses.

While sloped glazing and overhead canopies often require heat treated laminated glass.

The fundamental difference between sloped/overhead glazing and vertical glazing is that sloped/ overhead glazing is subject to permanent gravity load from its self-weight,

Cairo Airport – Terminal 1 -Exterior

Cairo Airport – Terminal 1 -Interior

Spider Fixed to Steel Post

live load during regular cleaning and maintenance, as well as the potential for and the weight of thrown or fallen objects.

Vertical facades can be floor-loaded/stacked or suspended. If a façade with a height greater than about 10.7 m (35 feet) is desired, then it will probably need to be suspended from above. The dead load of the glass for high vertical walls can cause lateral buckling of the lites, if they are stacked too high. Suspended facades have been constructed over 30.5 m (100 feet) in height.

It is most important that the façade designer has a clear idea of how the whole structure will behave under all imposed loads, including wind, seismic, and blast loading.

Deflection and construction tolerances must be incorporated into the façade design and connections to the building structure.

Facade Illumination:

Point holder with integrated RGB LED light source is newly introduced in the market which provides colored accentuation and illumination of outdoor glass facades.

The RGB LED technology is housed in the point holder system and thus protected against environmental influences.

This new point holder can provide multimedia facades, interactive glass facade illumination, dynamic color change, and large-surface image projection.

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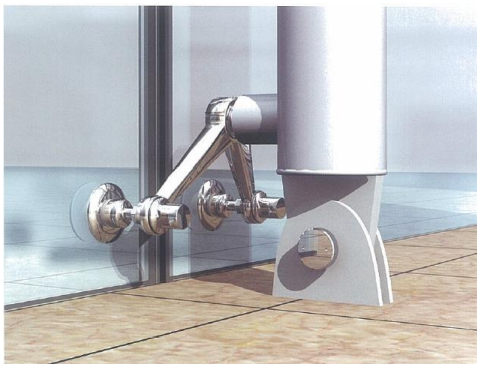
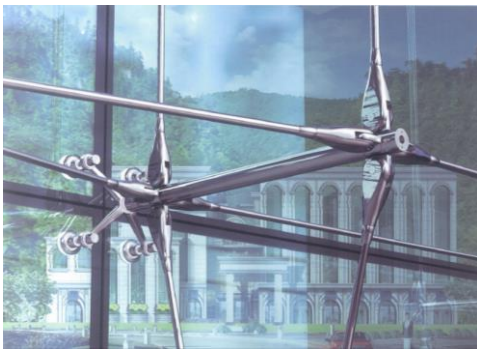
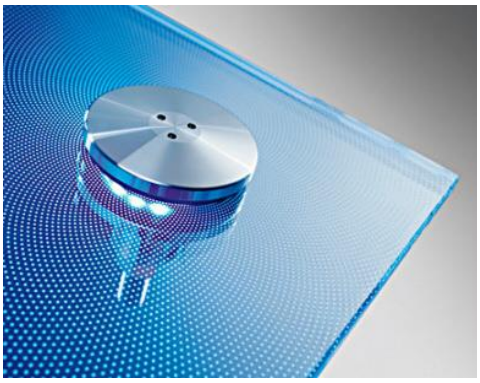


Spider Fixed to Steel Post –Base Detail



Spider with Post Tension Rod

Spider with Glass Fin



Point holder with integrated RGB LED light