National Protective Security Authority

GUIDANCE

Introduction to Glass Curtain Wall Systems

Introduction

‘Curtain wall’ is a term generally applied to vertical, external elements of a building which are designed to protect the occupants and structure of that building from the effects of the external environment.

Whilst keeping out the wind and rain, a curtain wall can also provide a multitude of different options related to appearance and functionality. The external surface of a curtain wall might be 100% glass or might include other cladding materials such as stone and aluminium panels. A curtain wall may contain specific architectural features designed to enhance the appearance of the building or elements intended to manage the effects of the environment. Such features may include brise soleil and external fins designed to provide shading or photo-voltaic panels capable of generating electricity.

A modern curtain wall will be designed as a cladding element rather than a structural member and as such the removal or failure of an element or section of the curtain wall will not result in disproportionate damage to the structure.

The various types of curtain walling can fall into three main categories:

- stick systems
- unitised systems
- bolt fixed glazing

The main difference between these three is the aesthetics of the final design, the construction method and design of the system. As a minimum each system is designed to meet the building design load requirements. This does not consider blast loading and as such, if the system is subjected to a blast load, each will respond differently and may offer very different levels of protection to occupants in a building. Therefore it is important to understand the different systems that are available and being used.

The aim of this document

The aim of this document is to provide a summary of the various different types of curtain walling systems that exist and where these are typically used. Accompanying NPSA guidance is available which identified mitigation options for improving the performance for each of the systems details. This suite of guidance is available on the NPSA website.

Stick systems

Stick systems comprise individual vertical and horizontal spanning members (’stick’) known as mullions and transoms respectively. A typical system will be connected to individual floor slabs, with large glass panes providing a view to the outside and an opaque spandrel panels installed to hide the structural frame, see Figure 1.

Mullions and transoms are generally manufactured from extruded aluminium sections, which can be provided in a variety of cross sectional sizes, colours and finishes. These are connected together using angles, cleats, toggles or a simple locating pin. A variety of sections and connections are available with different load capacity to create the required design. The dimensions of the sections are governed by the horizontal span between mullions and the height between floor slabs of the building, the environmental loads i.e. wind, and the weight of the glass. The glass is designed to be compatible with the system and is typically provided by a separate glass manufacturer.

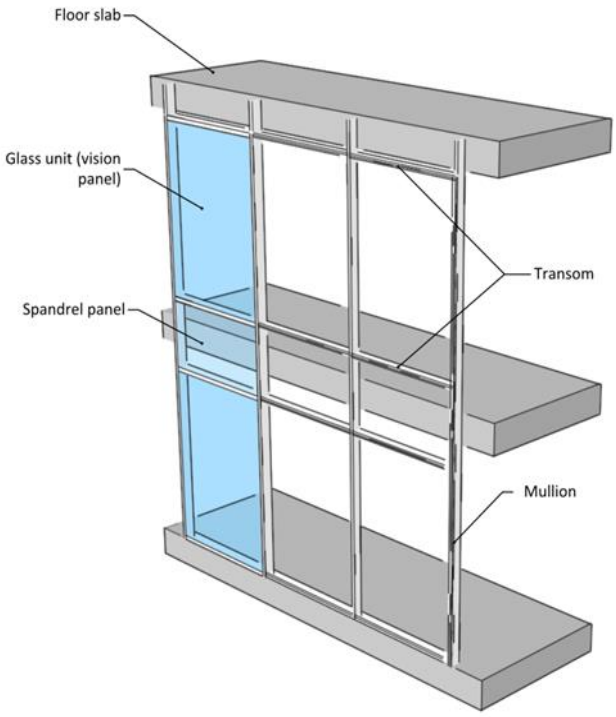

Figure 1: Elements of a curtain wall

The individual elements of a stick system are commonly fabricated (cut to length and prepared for connection) within a factory and then shipped to site as a kit of parts which is then installed by a team of specialist contractors. Once the mullion/transom grid is erected, the glass panes and spandrel panels are positioned and typically held in place by pressure plates which are masked by cover caps. An alternative method to clamp the glass is toggle glazing which uses a channel between the glass to clamp the internal laminate only. The two fixing details are shown in Figures 1, 2 and 3.

Due to its versatility and cost, these systems are typically used in shopping centres and low rise office buildings.

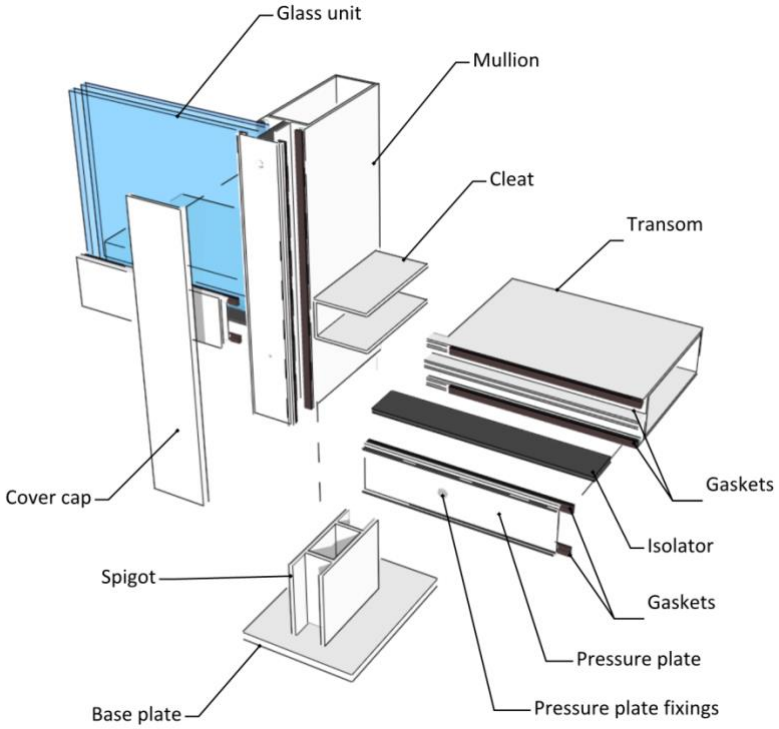

Figure 2: Components of a stick system with a button cleat connection

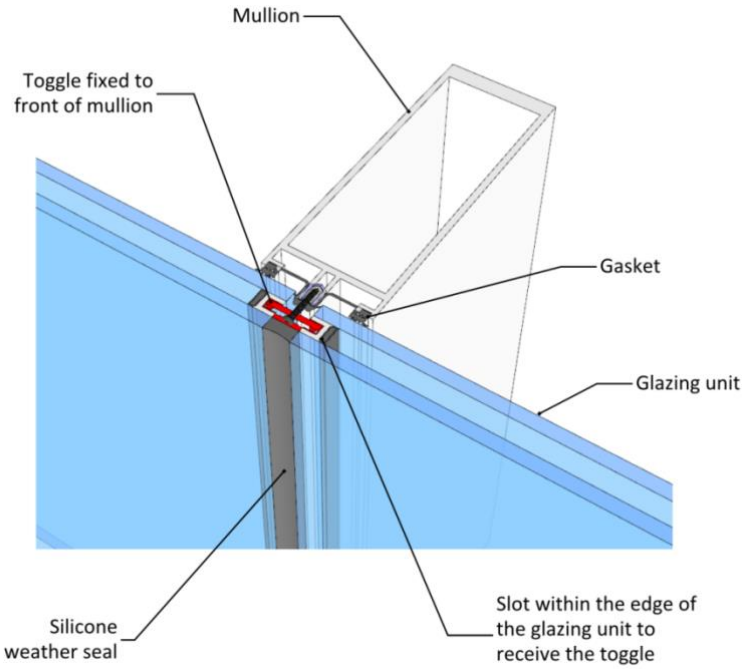

Figure 3: Components of a stick system with a toggle connection

Unitised systems

A unitised system utilises the component parts of the stick system, to create individual prefabricated units which are fully assembled in a factory environment, delivered to site and then fixed to the structure.

Factory preparation of a unitised system means that more complex designs can be achieved and they can utilise materials which require tighter quality control measures, to achieve a high quality finish. The improvement in achievable tolerances and a reduction in site-sealed joints can also contribute to an improved air and water tightness compared to stick systems.

With the minimum of on-site glazing and fabrication, a major benefit of using a unitized system is the speed of installation. When compared to stick systems, the factory assembled systems can be installed in one third of the time. Such systems are well suited to buildings requiring high volumes of cladding and where there are high costs associated with access or site labour (e.g. high-rise buildings in London and New York).

Within the unitised family of curtain wall systems, some sub-categories exist which also benefit from the increased speed of installation and the re-distribution of labour costs from construction site to factory floor. Such systems include:

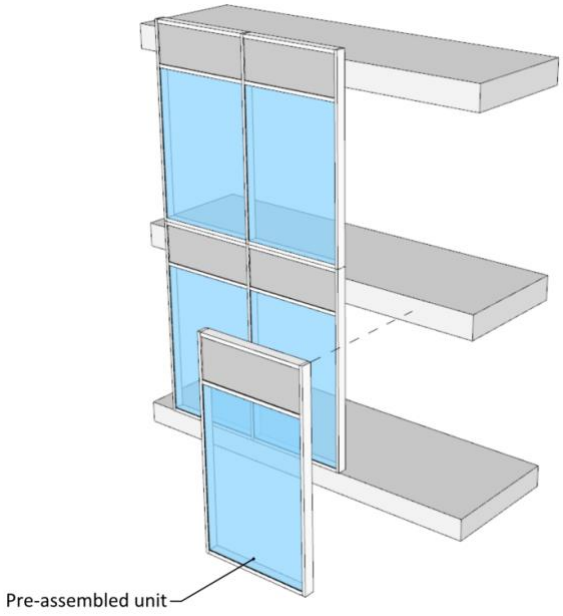

Figure 4: Unitised curtain wall

- **Panellised curtain walling**
  Panellised curtain walling uses large prefabricated glazed panels, which generally span between structural columns (often 6-9m) and a single storey in height. They are connected back to structural columns or floor slabs, like the unitised system. Due to the size of the panels, they often comprise of discrete structural steel frames within which glass panes are fixed.

- **Spandrel ribbon glazing**
  In ribbon glazing, the spandrel panels are connected together to form long lengths of panels, which are delivered and installed on site. The spandrels are the panel(s) of a facade located between vision areas of windows, as shown in Figure 1, and often comprise glass panels which are painted or have an opaque interlayer to conceal the structure. Spandrels may also be made of other materials, including GFRC (glass fibre reinforced concrete), terracotta or aluminium with insulation situated behind.

Bolt fixed glazing

Bolt fixed or 'Planar' glazing is typically specified to glaze areas of a building which an architect or client has reserved to create a special feature e.g. entrance lobby, main atrium, scenic lift enclosure, shop front.

Rather than having infill panels supported by a frame on 4 sides i.e. aluminium mullions and transoms, the glass panels are supported by bolts, typically at the corners or along the edge of the glass. These bolt fixings are highly engineered components capable of spanning significantly large panes of glass between points of support.

The glass panels are delivered to site with pre-drilled holes along with the stainless steel bolt fittings. The system is then assembled on site.

The different types of glazing specified for use in traditional curtain wall (toughened, insulated, laminated glass) can also be used in bolt fixed glazing if the manufacturer is sufficiently skilled to have developed and tested such technologies. Annealed glass is not used in bolt fixed glazing because the holes in the glass are too weak. The thickness of the glass will typically be thicker too, due to the minimal number of support points.

Fixings which attach through the holes in bolted glazing are designed to allow relative movement between the glass and the building structure. Movement could be caused by settlement, live load or thermal expansion and contraction. Bolt fixed glazing will require a structural frame to support it, and this could be a steel trusses, glass fins or stainless steel tension systems. Since the performance of the glass is critical to the overall performance of such systems, it is important that risk assessments are undertaken to ensure the failure of one glass panel cannot lead to the progressive collapse of the entire structure.

Once installed, the bolt fixed systems are typically weather proofed by a silicone weather seal applied between the adjacent glass panels.

Bolt fixed systems are offered to the market in different forms ranging from complete systems in which the glass and fittings are designed, manufactured, and supplied from a sole source, through to products which are designed by a structural engineer and sourced as individual items. When sourcing bolt fixed glazing as individual components, it is essential that the system is evaluated and coordinated by a suitably qualified contractor or engineer.

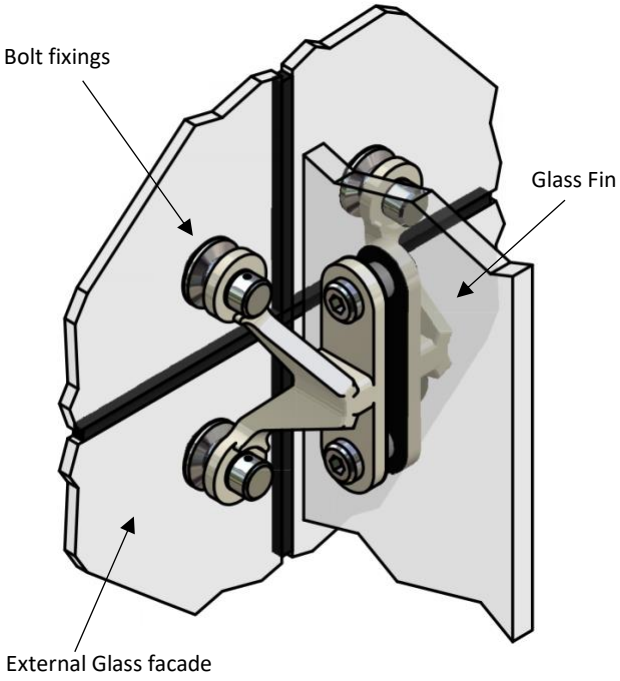

Figure 5: Bolt fixing

Doors within glass façade

For each of the three curtain walling systems, doors will need to be incorporated within the façade. The doors are typically made from a single pane of glass, and can be single leaf, double leaf or a turnstile. The doors will be fixed to the supporting frame, which will be fixed directly to the structure and the façade incorporated around it. The door leafs themselves can be framed i.e. support on 4 sides with a metal frame around the door leaf, or unframed where the glass edges are exposed.

Against a blast, it is expected that the doors within a glass façade will be the weakest element and may fail first. Whilst strengthening measures can be adopted, reducing the distance at which the doors are projected into the internal space may be a more pragmatic approach. Further guidance on mitigation measures for doors within facades will be able on the NPSA website.