Introduction

Curtain walling is a form of vertical building enclosure which supports no load other than its own weight that of ancillary components and the environmental forces which act upon it. Although the term is sometimes restricted to metal framed curtain walls, the above definition embraces many different construction methods and materials including non-loadbearing precast concrete.

This Technical Note describes the various forms of curtain walling and the materials employed.

Description of curtain walling types

The classification of types of curtain walling varies but the following terms are commonly used:

- Stick
- Unitised
- Panelised
- Spandrel panel ribbon glazing
- Structural sealant glazing
- Structural glazing

Stick system curtain walling

The general arrangement of a stick system curtain wall is shown in Figure 1. Horizontal and vertical framing members (‘sticks’) are normally extruded aluminium protected by anodising or powder coating, but may be cold-rolled steel (for greater fire resistance) or aluminium clad with PVC-U. Members are cut to length and machined in the factory prior to assembly on site as a kit of parts: vertical mullions, which are fixed to the floor slab, are erected first followed by horizontal transoms, which are fixed in-between mullions. Mullions are typically spaced between 1.0 and 1.8m centres.

Into the framework are fitted infill units, which may comprise a mixture of fixed and opening glazing and insulated panels (which may have metal, glass or stone facings). These units are typically sealed with gaskets and retained with a pressure plate, screw-fixed every 150-300 mm, although hammer-in structural gaskets are used for some stick systems. The pressure plate is generally hidden with a snap-on cosmetic cover cap or overlapping gaskets. The screw fixings can be exposed by removing the cover, which is typically produced in six metre lengths for vertical framing elements. Fixings must be secured to the correct torque to retain the glazing/infill panels and to ensure proper compression of the gaskets for weathersealing.

Stick curtain walling is very common and versatile and can be used for anything from...
‘glass towers’ tens of storeys high to single storey shop fronts. Because of the number of joints in stick curtain walling it is generally very good at accommodating variabilities and movement in the building frame. It is also suitable for irregular shaped buildings. Assembly is slow compared with pre-assembled systems and performance (e.g. weathertightness) is dependent on knowledgeable installers who are familiar with the assembly and sealing procedures for the particular system. Some pre-assembly of stick curtain wall frames is possible by the use of ‘ladder frames’.

Many manufacturers (systems suppliers) produce standard stick systems. Insulated panels, usually designed for the project, may be faced with anything from aluminium or steel sheet, to glass or expensive stone composites. Some companies produce project-specific bespoke systems - either designing frame profiles from scratch for each job, or using standard details for some parts of the frame and simply altering some small aspect to give the appropriate structural properties or appearance. The type, complexity and budget of the project will normally determine whether a standard (i.e. ‘off-the-shelf’) or bespoke curtain wall is used.

Unitised curtain walling

Unitised systems comprise narrow, storey-height units of steel or aluminium framework, glazing and panels pre-assembled under controlled, factory conditions (Figure 2). Mechanical handling is required to position, align and fix units onto pre-positioned brackets attached to the concrete floor slab or the structural frame. Unitised systems are more complex in terms of framing system, have higher direct costs and are less common than stick systems. The smaller number of site-sealed joints in unitised curtain walling simplifies and hastens enclosure of the building, requires fewer site staff and can make such systems cost effective. If construction joints interlock consideration must be given to how damaged units could be removed and replaced. The reduced number of site-made joints compared with stick systems, generally leads to a reduction in air and water leakage resulting from poor installation.

Panellised curtain walling

Panellised curtain walling comprises large prefabricated panels of bay width and storey height, which connect back to the primary structural columns or to the floor slabs close to the primary structure (Figure 3). Fixing the panels close to the columns reduces problems due to deflection of the slab at mid span, which affect stick and unitised systems.

Panels may be of precast concrete or comprise a structural steel framework, which can be used to support most cladding materials (e.g. stone, metal and masonry). Structural steel panellised walls are known as ‘truss walls’ in North America. Aluminium or galvanised steel skins are generally fixed to the frame with insulation in the cavity. The wall construction is then completed by a plasterboard lining and external cladding.
Joints may comprise gasketed interlocking extrusions, gaskets between separate extrusions or wet applied sealant.

Consist of precast concrete panels with openings for windows.

**Spandrel panel ribbon glazing**

Spandrel panel ribbon glazing is a long or continuous run of vision units fixed between spandrel panels supported by vertical columns or the floor slabs (Figure 4).

Glazed areas may comprise:

- several standard windows fixed together on site by joining mullions,
- pre-glazed, bay width, factory-assembled frames, or
- individual framing sections and glass infill panels which are site assembled.

Ribbon glazing is often used in conjunction with spandrel panels, that is, horizontally spanning prefabricated or precast concrete units. It may also be used with spandrels comprising upstand walls faced with rainscreen panels. Care needs to be taken when detailing interfaces with adjacent elements.

Ribbon glazing/spandrel panel construction generally results in buildings having a horizontal banded or strip appearance.

**Figure 3** Panellised curtain walling

The advantages of using panellised systems stem from the high utilisation of factory prefabrication, which allows better control of quality and rapid installation with the minimum number of site-sealed joints. However to be cost effective a large number of identical panels is required.

Panellised systems are less common and more expensive than unitised construction. The size and weight of panels is limited by the practicalities of manufacture, handling, storage, transport and erection.

Some authors do not differentiate between unitised and panellised systems, but panellised construction may have significant internal steel structure to support the extra weight, or may
Structural sealant glazing

Structural sealant glazing is a form of glazing that can be applied to stick curtain wall systems and windows, particularly ribbon glazing. However, it can also be used in unitised and panellised systems. Instead of mechanical means (i.e. a pressure plate or structural gasket), the glass infill panels are attached with a factory-applied structural sealant (usually silicone) to metal carrier units which are then bolted into the framing grid on site. External joints are weathersealed with a wet-applied sealant or a gasket (Figure 5).

These walls are attractive to architects as they offer a smooth or semi-smooth facade.

Structural sealant glazing has been used in the USA for around 30 years where it was initially site applied direct to the framing. However, this is no longer acceptable due to difficulties of application and replacement and all structural silicone joints are now made in a factory.

Glass replacement/resealing must be undertaken in a controlled environment using the correct materials. All elements used in the construction must be compatible with the silicone sealant.

Structural sealant glazing systems can have sealant on two opposite sides or on all four-sides with or without the weight of glass supported mechanically. Generally, the glass is mechanically supported to reduce the size of the sealant bead.

Structural sealant glazing can be used to create a building exterior that is free from protrusions, but the framing system will be visible at night when backlit. Structural sealant glazing is more widely used on ‘prestige’ buildings and may be produced as a standard system, or on a project-by-project customised basis. The framing members are often more widely spaced than for traditional stick systems.

Figure 4 Spandrel panel ribbon glazing

Figure 5 Structural sealant glazing
Any of the previous types of curtain walling and ribbon glazing could incorporate structural silicone glazed elements.

**Structural glazing - bolted assembly**

Sheets of toughened glass are assembled with special bolts and brackets and supported by a secondary structure to create a near transparent facade or roof with a flush external surface (Figure 6).

A multitude of discreet or prominent secondary structures can be designed (e.g. space frame, rigging or a series of mullions) which support the glazing through special brackets. The joints between adjacent panes/glass units are weathersealed on site with wet-applied sealant.

![Figure 6](image)

**Figure 6** Structural glazing - bolted assembly

**Structural glazing - suspended assembly**

Here the glass is fixed together with corner, rectangular, patch plates and the whole assembly is then either suspended from the top or stacked from the ground and wet-sealed on site (Figure 7).

Suspended glazing systems utilise the minimum amount of framing for a given glass area and are used as glazing features on prestige buildings, but also for prestige atria on otherwise simple buildings.

Glass fins may be used to brace the assembly. In some designs a light truss stabilises the wall and transfers wind loading, while the weight of the glass is transferred through the corner plates and suspension system.

![Figure 7](image)

**Figure 7** Structural glazing - suspended assembly

**Applications**

Stick curtain walls are used on larger office developments but may also be used on some
low-cost office or industrial units, typically for one small part, such as an entrance. Unitised or panellised curtain walling systems are generally adopted where the additional expense of factory assembly is compensated by faster installation. They are only economic where a large number of similar units or panels is required. The highest-cost bespoke curtain walling systems will generally only be used on prestige buildings, large or small.

Choice of curtain wall type is never straightforward. Dominant factors are:

- Cost
- Appearance
- Timescale
- Access limitations

The lowest cost is often achieved with a standard aluminium-framed stick system. Generally, costs increase with complexity, although factory assembly also increases costs. Increasing the number of non-standard items will increase cost, not only due to the additional ‘material’ cost but also due to additional design work required to integrate the component(s) within the system and possibly because of the need for project testing.

The importance of appearance will depend upon the desired image that the building is to project. A building situated in a highly visible or prestigious location may demand the use of more expensive materials, perhaps stone-faced insulated panels or a structural sealant or bolted glazing system with no external protrusions to interrupt the facade. A building facade may be designed to compliment, or contrast with, the surrounding built environment.

Time-scale is important because there may be contractual limitations on the time available for assembling the facade. A site-assembled stick system has the advantage that installation can start quickly, but it may then proceed more slowly than with factory-assembled units. However, systems requiring factory pre-assembly must be carefully planned so that units are available when construction of the facade is planned to start, but the units must not be manufactured or delivered too soon or storage costs will be incurred. Note that whilst the smaller number of site-made joints in pre-assembled systems simplifies installation and weatherproofing, far greater attention to the manufacturing and erection tolerances of both structure and cladding is required.

Other factors that are important include the ease of maintenance. Replacement of a glazing unit in a ribbon glazing system might be undertaken by a local glazier, whilst in a structural sealant glazing system this might require a specialist contractor, maybe the original contractor. Systems such as structural glazing must be designed so that breakage of a glass unit does not cause progressive failure of the facade. This may increase the cost of these systems.

The architect may select several different types of curtain wall for a building - for example ribbon glazing at the back of the building, a standard stick system for the front of the building, and a prestige suspended glazing for the atrium. Efforts should be concentrated on the construction interfaces during the design development and testing phases to reduce the risk of subsequent buildability and performance problems.

Summary

A wide range of types of curtain walling is in use as follows:

- Stick
- Unitised
- Panellised
- Spandrel panel ribbon glazing
- Structural silicone glazing
- Structural glazing

The choice of curtain wall type depends primarily on cost, appearance and timescale. Proprietary stick systems will generally give the lowest cost and shortest lead in time. Bespoke systems are more expensive but give more scope.
for creating an individual image on prestige structures. Prefabricated systems may have a longer lead time but may allow faster erection on site.