Whitesales Rooflights

Europa House, Alford Road, Cranleigh, GU6 8NQ
www.whitesales.co.uk
Rob Hamblen, Tel: +44 (0)1483 917580, rob.hamblen@whitesales.co.uk

CPD Article

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Structural Roof Glazing – Design Considerations

Glazed rooves are an aesthetically-pleasing and durable way of bringing considerable natural light to a structure. However, as with all elements of the end-to-end design and construction phase of a building, glazing requires compliance with certain critical performance standards, to ensure that the completed design is robust, durable, and safe for purpose.

With multiple options for glass types, it's important to be aware of the recommended materials for construction of glazed roofing. It's also key to ensure that standards are considered early in the design process, to ensure that the completed building can be approved.

Key Learning outcomes

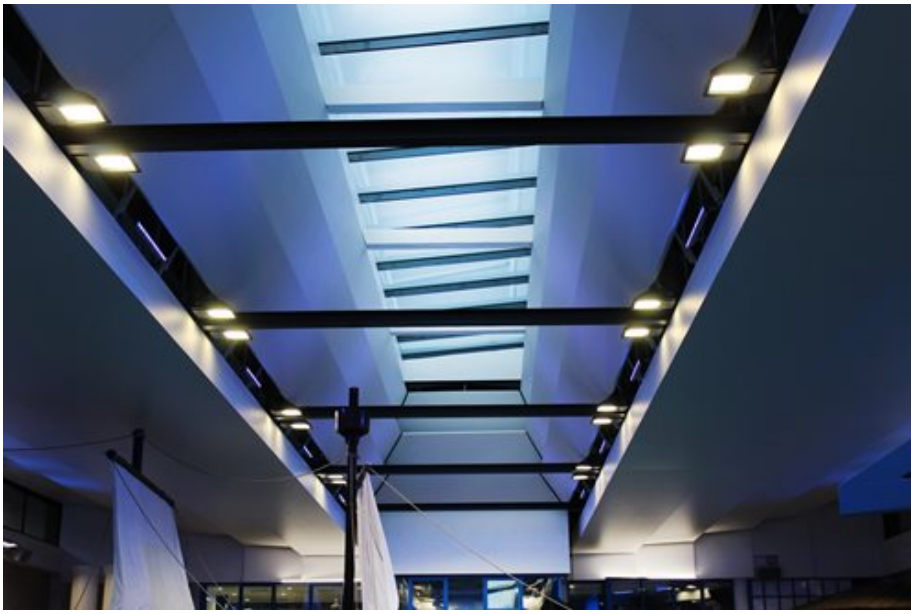
- Know how to define structural and size parameters
- Understand the various glass types for different building uses
- Recognise the required performance standards
- Learn how to incorporate smoke ventilation into structural roof glazing
- Appreciate the advantages of modern bespoke designs

1.0 Defining ‘structural’ and size parameters

The term structural glazing can take many forms but is generally defined as glazing that supports its own weight and span with the glazing bar box section systems and continuous pressure plate profiles. Structural glazing often is a key element in the building envelope and large areas of structural glazing may constitute the whole ‘roof’ of the building.

In the design phase of construction for glazed roofing, it’s important to consider the parameters of the roof area to be glazed, and the implications of future maintenance. While assessing the plans for the construction, potential costs such as transportation of the panes, maintenance and the expenditure required in the event of breakage should be factored into the budget.

As a general rule, glass roofing of up to 6m can be self-supporting, whereas anything larger than this surface area will require additional support to maintain the weight of the glass compliantly and safely. When it comes to selecting the ideal size of glass pane, the designer needs to weigh up the practicalities of construction and maintenance, against the benefits of implementing a stunning design.



Rooflight over main pool at Coral Reef Waterworld in Bracknell was designed with fewer glazing bars to give a low frame factor and enhance the feeling of open sky.

2.0 Glass types for different building uses

The type of glass deployed for a glass roof depends upon the proposed use. For example, if the roof is to be constructed above living accommodation, it will require characteristics such as acoustic glazing for noise control, and solar control to reduce heat gain (calculated as the G-Value). For structures such as art galleries or museums, the panes will require high solar control, and the addition of specialist filters for the purposes of either reducing, or fully eliminating, UV light, in order to protect the artwork, etc. below.

The G-Value for glass calculates window solar factors. These represent the fraction of incident solar radiation transmitted by glass, expressed as a number between 1 and 0, where 1 indicates the maximum possible solar heat gain, and 0 indicates no gain. Solar heat gain is dependent upon the angle of incidence of solar radiation on the glazing, and the spectral make-up of the radiation. Manufacturers generally supply a spectrally-averaged solar heat gain coefficient. Using this, it's possible to apply standard equations to estimate values for other angles and for diffused solar radiation.

The traditional method of measuring a window's performance is through its U-value.

There are three types of U-value that can be quoted:

• The value measured through the centre of a glazing unit
• The value of the window frame, alone
• The overall U-value of the window including glazing unit and frame.

Thermal transmittance of glass (Ug) has to be paired with both the light transmission and solar factor, to gain an accurate assessment of compliance.

To minimise UV light transmission, diffused glazing with a satinovo white laminate was utilised, protecting the artwork below from solar glare.

3.0 Performance standards for glazed roofing

There are distinct performance standards to consider when constructing a glazed roof, to ensure that the completed building is safe, compliant, and meets all required criteria for performance and durability.

Overhead glazing must withstand a greater range of loadings than vertical glazing and presents specific design and function issues. As with vertical glazing in construction, any overhead glazing is required to withstand the stress and deflection created by wind loads. This can constitute positive pressure, or (through wind suction) negative pressure.

Additional consideration for glazed roofing relates to the loads present as a result of the formation of both ice and snow (and standing water) which adds additional load pressure in conjunction with the weight of the glazed panel itself. The load of the glass is a permanent gravitational load. With the additional weights applied through elements, such as snow, which can be imposed over time), can weaken glass which is more susceptible to sustained loadings than those of short duration.

As a result, it's essential that the duration of potential loads is taken into account when selecting glass for roofing. Designers also need to consider safe access for maintenance activity. Loadings for overhead glazing are obtained from BS 6399 (part 2) Code of Practice for Wind Loads and BS 6399 (part 3) Code of practice for imposed roof loads.
Fire safety is also an important consideration within design and construction. Increase of temperature normally results in the reduction of mechanical properties of the materials, such as compression/tensile strength and modulus of elasticity. Thermal expansion may also be caused by fire. It induces large deformation to the structural elements, potentially even those far from the fire compartment.

When the structure cools after a fire, it suffers more damage due to element shrinkage from the rapid temperature drop. Fire safety requirements are often based on fire development (the standard fire curve). Glass roofing is subject to regulations detailed in Building Regulations Approved Document B (2007) for fire safety of buildings. These can be met by achieving specific ratings to either British (BS 476) or European (BS EN 13501) standards.

In 2002, new legislation enforced standards of building air tightness. This was to: lower running costs; verify standards of materials, components and workmanship; prevent drafts and avoid condensation. Air permeability and breathability qualities for glass roofing are subject to specific regulations. The testing requirements are set out in BS EN 1026:2000 2 and BS EN 12207:2000.

High-specification rooflights to newly-refurbished Gramophone Works included many features, such as non-fragility to CWCT Class 2, solar control glazing with G-Value of 0.38 and spread of ratings to BS 4761.

4.0 Incorporating smoke ventilation into structural roof glazing

Effective and compliant smoke ventilation is a key requirement for glazed roofing, to ensure that risks associated with smoke inhalation and hampered exit routes are managed and mitigated as far as possible. By using continuous roof glazing over atrium spaces, stairwells and similar, it's possible to incorporate smoke ventilation systems which maximise smoke control and safety.

Options for compliant ventilation include deployment of glazed panels or louvres, and both mechanical and natural solutions. These features also assist with providing a comfortable environment, releasing warm air and cooling the living space. Louvred glazed smoke ventilators are primarily designed to improve climate control through efficient airflow in summer, whilst maintaining the insulation required during the winter. The systems offer effective fire safety with units tested for use as smoke ventilators to EN 12101-2.

Modern glazed panels are specifically designed for seamless integration into inclined and vertical glazing systems. They afford both temperature regulation and effective smoke ventilation. They feature low-permeability and low profiles, making them suitable for installation at almost any gradient within the glazed roofing design.

Harris Beckenham Academy designed with large three-storey hall and dining space able to accommodate 600 students constructed with large glazing units incorporating ventilation for smoke control and comfort cooling.

5.0 The advantages of modular vs bespoke design for glass roofing

When it comes to selecting the ideal solution for glazed roofing, it's important to note that both modular and bespoke designs have relative advantages. Selection criteria will depend upon the proposed use of the building, the age of the structure, and the budget allocated for construction purposes.

Modular designs are ideal for new-build projects, where the size and shape of the glass roof can be determined prior to construction commencing, with the designer factoring in the proposed solution. Due to the standard specification and design, modular solutions are more cost-effective than a bespoke design. Standardisation also means that modular designs are more prompt to produce, and quicker to install, maximising the convenience for the construction phase.

Bespoke designs obviously proffer significant advantages in terms of flexibility for the building. The designer can specify the ideal shape, size, and glazing bar width. They can also choose to customise the opening sections, slope pitch, design and all other elements of the solution. Bespoke designs tend to be ideal for refurbishment projects, where the size and shape of the rooflight cannot be easily altered.

Custom-designed glass roofing can be made to suit any on-site application – maximising flexibility and adaptation to the ideal specification. They also afford much greater control of features and styles, allowing the designer to remain faithful to the original structure by retaining a particular period style.

In most refurbishment projects, such as Somerset House, a bespoke rooflight design is the only feasible option, allowing replication of existing styles whilst achieving modern standards.