Non-Vertical Overhead Glazing: Guide to the Selection of Glass from the Point of View of Safety

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Contents

Introduction

Whenever materials are used overhead, especially at high level, there will always be a risk, however small, of injuries to persons caused by falling material.

Glass has been used in overhead glazing for more than a hundred years, and is very safe provided that the right glass is used in the right place.

1 Scope

This GGF Data Sheet gives recommendations for the selection of glass for use in non-vertical overhead glazing with respect to the safety of persons underneath. The recommendations are intended to reduce the risk of injury from falling broken glass.

NOTE: Information is also given with respect to the use of adhesive backed polymeric film for the enhancement of the performance of existing glazing.

This GGF Data Sheet does not consider the risk of injury from objects falling through the glass. However, consideration at design stage may enable selection of suitable glazing materials/measures to mitigate this situation.

This GGF Data Sheet does not consider the risk of injury to persons who may fall onto the non-vertical (sloping) overhead glazing.

NOTE: Persons most likely to be at risk would be construction, maintenance and/or cleaning operatives. For information see BR 471.

This GGF Data Sheet does not cover the following:-

- Glazing with plastics glazing sheet materials (see BS 5516-2).
- Glazing of protective barriers / balustrades (see BS 6180, and GGF Data Sheet 7.2 Guidelines for the use of glass in protective barriers)
- Glazing for greenhouses (see BS 5502-21)
- Glazing of Conservatories (see GGF A Guide to Good Practice in the Specification and Installation of Conservatories within the United Kingdom)
- Maintenance

2 Definitions

2.1 Non-vertical overhead glazing

Glazing above head height which is either horizontal or inclined at an angle to the horizontal up to 75°, and where there is general access to the areas beneath the glazing.

2.2 Greenhouse

Glazed structure intended for horticultural use, and not for human habitation, recreation or retail activities. It may be freestanding or attached to another structure, but is not used as a means of access to a dwelling.

2.3 Protective barrier / balustrade

Any element of building or structure intended to prevent persons from falling and to retain, stop or guide persons

3 Design considerations

Glass breakage may occur for many reasons, including the following:-

- Excessive loads (wind, snow, self-weight, maintenance loads).
- Inadequate framing or other glazing systems.
- Incorrect glazing procedures.
- Impact by falling, wind-borne, or thrown objects.
- The higher thermal stresses encountered in non-vertical overhead glazing.
- Malicious attack.
- Damaged or defective glass.

NOTE: The above list is not exhaustive

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Careful design, together with proper workmanship, reduces the likelihood of problems arising.

The breakage of glass in non-vertical overhead glazing is a rare occurrence. The risk of injury from falling broken glass may be reduced in several ways and, when selecting glass to provide an appropriate degree of human safety, the designer or specifier should consider the level of risk which is acceptable in a particular situation, taking into account the intended use of the building.

Risk analysis should be based on the following:

- Likelihood of people being present beneath the glazing;
- Potential for glazing breakage;
- Post breakage behaviour of the glazing material;
- Consequences of glazing failing.

NOTE: Further information can be obtained from BR 471. BRE report entitled 'Sloping Glazing – Understanding the risks'.

4 Glass and breakage characteristics

In order to assist designers and specifiers in the selection of the most appropriate glazing, the breakage characteristics and associated properties of the most commonly used types of glass are described below:

NOTE: The applicable standards for the commonly used glass types can be found in the bibliography.

4.1 Laminated safety glass (see GGF Data Sheet 4.11: laminated glass and laminated safety glass)

When laminated safety glass is broken, the pieces of glass are held together by the interlayer(s) and are likely to remain in position, and continue to provide short-term weather resistance.

NOTE 1: "Laminated safety glass" is a laminated glass that has an impact classification in accordance with EN 12600.

NOTE 2: "Laminated safety glass" includes laminated annealed safety glass, laminated thermally treated safety glass

NOTE 3: The post breakage behaviour of laminated thermally toughened, laminated heat soaked thermally toughened and laminated heat strengthened glass needs special consideration.

4.2 Thermally treated glass (see GGF Data Sheet 4.4.1: Thermally treated soda lime silicate glass products)

This covers glass products that have been subjected to a thermal treatment process. It includes the following:

- Thermally toughened soda lime silicate safety glass;
- Heat soaked thermally toughened soda lime silicate safety glass;
- Heat strengthened soda lime silicate glass.

4.2.1 Thermally toughened soda lime silicate safety glass (see GGF Data Sheet 4.4: Quality standard for toughened glass)

Thermally toughened soda lime silicate safety glass is stronger than ordinary annealed glass of equal thickness and is therefore comparatively difficult to break. In addition, thermally toughened soda lime silicate safety glass will withstand the maximum thermal stress associated with solar radiation.

NOTE 1: Thermally toughened soda lime silicate safety glass may contain nickel sulfide inclusions which could cause spontaneous breakage, although the risk of this happening is very low.

NOTE 2: Information on nickel sulfide inclusions can be found in GGF Data Sheet 4.4.2: Thermally treated soda lime silicate glass products – Spontaneous breakage.

4.2.2 Heat soaked thermally toughened soda lime silicate safety glass (see GGF Data Sheet 4.4.1)

Heat soaked thermally toughened soda lime silicate safety glass has the same properties and breakage characteristics as thermally toughened soda lime silicate safety glass. However, the incidence of spontaneous breakage due to nickel sulfide inclusions is negligible.

4.2.3 Heat strengthened soda lime silicate glass (see GGF Data Sheet 4.4.1: Thermally treated soda lime silicate glass products)

Heat strengthened soda lime silicate glass will withstand the thermal stresses associated with solar radiation, but it breaks in a manner similar to annealed glass.

The built-in stresses in heat strengthened soda lime silicate glass, which are lower than those in thermally toughened soda lime silicate safety glass, make it much less susceptible to spontaneous breakage due to nickel sulfide inclusions.

4.3 Wired Glass / Safety Wired Glass

When wired glass is broken, the wire will hold most pieces of the glass together, thereby preventing them from falling.

4.4 Annealed Glass

When annealed glass is broken, it tends to break into dagger-like pieces.

5 Post breakage behaviour of glass

The behaviour of glass after breakage is a major consideration when selecting an appropriate glass specification.

5.1 Laminated safety glass

Generally laminated safety glass will remain in place after breakage. However, laminated safety glass incorporating thermally treated glass has to be considered in more detail.

5.1.1 Laminated thermally toughened soda lime silicate safety glass

When thermally toughened soda lime silicate safety glass breaks it has negligible stiffness/rigidity. Therefore there is a possibility that the laminated pane may become dislodged.

NOTE: If both leafs of thermally toughened soda lime silicate safety glass are broken the laminated pane will probably fall.

5.1.2 Laminated heat soaked thermally toughened soda lime silicate safety glass

The post breakage behaviour is the same as laminated thermally toughened soda lime silicate safety glass (see 5.1.1.).

5.1.3 Laminated heat strengthened soda lime silicate glass

As heat strengthened soda lime silicate glass breaks in a manner similar to annealed glass there will be sufficient remaining stiffness/rigidity. Therefore even if both leafs are broken it should remain in place

NOTE: The ability of a broken pane to remain in situ is dependent upon the loads being applied.

5.1.4 Laminated heat strengthened /toughened glass.

A laminated glass that comprises one leaf of heat strengthened glass and one leaf of thermally toughened/heat soaked thermally toughened glass has a composite behaviour.

If the heat strengthened glass remains unbroken the laminated glass pane will remain in situ even if the thermally toughened pane is broken.

If the heat strengthened pane breaks the laminated glass will remain in situ as long as the thermally toughened pane remains unbroken.

5.2 Thermally treated glass

5.2.1 Thermally toughened soda lime silicate safety glass

When broken, thermally toughened soda lime silicate safety glass fractures into small, relatively harmless pieces, which are likely to fall. Thicker toughened glass, when broken, will exhibit a greater tendency for the small pieces to stay together and fall in a cluster.

5.2.2 Heat soaked thermally toughened soda lime silicate safety glass

The post breakage behaviour is the same as thermally toughened soda lime silicate safety glass (see 5.2.1).

5.2.3 Heat strengthened soda lime silicate glass

Heat strengthened soda lime silicate glass breaks in a manner similar to annealed glass and will therefore probably fall out.

NOTE: Depending upon the angle of the glazing and the imposed loads there is a slight possibility that the glass may lock together and not fall out.

5.3 Wired glass / Safety Wired Glass

The wire generally will hold most pieces of the glass together, thereby preventing them from falling

5.4 Annealed glass

Broken annealed glass will fall out.

6 Selection of glass for use overhead

The minimum acceptable requirements are as given below:-

NOTE: Thermally toughened soda lime silicate safety glass or heat soaked thermally toughened soda lime silicate safety glass should not be used over swimming pools, etc, either in single glazing or as the lower pane in insulating glass units.

6.1 Glazing at a height up to five metres above floor level

6.1.1 Single glazing

This should ideally be glass that remains in position post breakage, i.e. laminated safety glass, wired glass.

The following can also be considered: thermally toughened soda lime silicate safety glass, heat soaked thermally toughened soda lime silicate safety glass.

6.1.2 Insulating glass units

The lower pane should ideally be glass that remains in position post breakage, e.g. laminated safety glass.

If the lower pane is thermally toughened soda lime silicate safety glass or heat soaked thermally toughened soda lime silicate safety glass, then the upper pane should also be one of the types of glass given in 6.1.1.

NOTE: If the lower pane of an insulating glass unit is thermally toughened soda lime silicate safety glass or heat soaked thermally toughened soda lime silicate safety glass, the upper pane must not be monolithic annealed glass nor heat strengthened glass.

6.2 Glazing at a height over five metres and up to 13 metres above floor level

6.2.1 Single glazing

This should be laminated safety glass or wired glass.

Alternatively, heat soaked thermally toughened soda lime silicate safety glass or thermally toughened soda lime silicate safety glass, provided it is not more than six millimetres thick and not more than 3 m² in area, may be considered;

6.2.2 Insulating glass units

The lower pane should be one of the types of glass given in 6.2.1 including the size and area restriction on heat soaked thermally toughened soda lime silicate safety glass and thermally toughened soda lime silicate safety glass.

If the lower pane is thermally toughened soda lime silicate safety glass or heat soaked thermally toughened soda lime silicate safety glass, then the upper pane should also be one of the types of glass given in 6.2.1.

6.3 Glazing at a height over 13m above floor level

6.3.1 Single glazing

This should be laminated safety glass;

6.3.2 Insulating glass units

The lower pane should be laminated safety glass

7. Enhancement of existing overhead glazing

Information with respect to the use of adhesive backed polymeric film for the enhancement of the performance of existing glazing can be found in GGF Data Sheets 5.18.3: GGF recommendations for adhesive backed polymeric film applied to glass: Definitions, descriptions and components, 5.18.4: GGF recommendations for adhesive backed polymeric film applied to glass in the overhead position for containment of glass in the event of failure: Types of systems and precautions in use, and 5.18.5.: GGF recommendations

for adhesive backed polymeric film applied to glass in the overhead position for containment of glass in the event of failure: Test method, These also give information on the use of edge retention systems.

Bibliography

EN 12150: Glass in building – Thermally toughened soda lime silicate safety glass

EN 14179: Glass in building – Heat soaked thermally toughened soda lime silicate safety glass

EN 14449: Glass in building – laminated glass and laminated safety glass – evaluation of conformity

EN ISO 12543: Glass in building – Laminated glass and laminated safety glass

BS 5502-21: Buildings and structures for agriculture – Part 21: Code of practice for selection and use of construction materials

GGF Data Sheets:

4.4: Quality of thermally toughened soda lime silicate safety glass for building

4.4.1: Thermally treated soda lime silicate glass products

4.4.2: Thermally treated soda lime silicate glass products – Spontaneous breakage

4.11: Laminated glass and laminated safety glass

5.18.3: GGF recommendations for adhesive backed polymeric film applied to glass: Definitions, descriptions and components

5.18.4: GGF recommendations for adhesive backed polymeric film applied to glass in the overhead position for the containment of glass in the event of failure: Types of systems and precautions in use

5.18.5: GGF recommendations for adhesive backed polymeric film applied to glass in the overhead position for the containment of glass in the event of failure: Test method

7.2: Guidelines for the Use of Glass in Protective Barriers

Other Publications:

GGF's A Guide to Good Practice in the Specification and Installation of Conservatories within the United Kingdom

BRE Report BR 471: Sloping Glazing – understanding the risks by David Kelly, Stephen Garvin and Ian Murray