Structural Engineers Registration Ltd

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Certification of the Design of Glazing Systems

1. Introduction

This Technical Bulletin is a guide to the Certification of glazing installations for domestic and commercial buildings. It is not intended as a design guide, and designers of glazing installations should not rely on it as such.

It is unlikely that a detailed check will be necessary for most domestic and many commercial buildings where the installation comes within the provision of BS 6262:2005[1] (see below). Many of these installations will be carried out by installers who may be registered under one of the fenestration self-assessment schemes by FENSA and CERTASS. Note that the schemes operated by FENSA and CERTASS only apply to replacement domestic windows

Generally glazing systems will be designed by a specialist contractor and those outside the limits of the otherwise applicable British Standards may be listed in Schedule 1 to the Design Certificate. In all cases an appropriate performance specification for the required system must be included with the application plans. On larger projects, the glazing may well form a separate design stage, in which case it must be designed and detailed before a Design Certificate is signed for that stage.

2. Glazing Systems

Glazing systems normally form part of the envelope of a building but are often used internally as part of volume dividers. They can vary in structural importance from simple windows fitted in openings provided in the envelope to curtain walling that may also provide support to other parts of the structure, and may include composite cladding systems referred to as unitised glazing. Many glazing systems include doors and may also act as pedestrian barriers.

Glazing systems are normally procured after the Building Warrant has been granted and are designed and provided by specialist contractors. The providers must be properly instructed with respect to the loadings to which the building will be subjected and the British or European Standards that apply. This information should be included with the Warrant application.

There is no general British Standard covering the design of façades, though there are many codes covering the materials used and two that cover glazing systems. These systems vary from simple windows to curtain walls and purpose designed façade systems. Façades normally need only be designed for self-weight and wind loads, though roofs, canopies and rooflights will also need to take account of superimposed loads such as normal and drifting snow, and all need consideration for maintenance access.

Glazing, in the sense of windows, for most projects, is covered by the provisions of BS 6262:2005[1]"Glazing for buildings", which satisfactorily defines the requirements for glazing for most situations, including calculation of wind loads. Guidance is given below on when it is appropriate to rely on compliance with this code.

Where more extensive areas of glazing are involved this often includes what is termed Patent Glazing; though, strictly speaking, this term refers to systems where the glazing does not rely on the external seals for watertightness. These systems use glazing support members (transoms and mullions) with drainage incorporated in the details. They are often referred to as 'stick' systems and 'curtain walling'.

For Patent Glazing the framing, which is generally formed from aluminium extrusions, is used to support the glass and resist the applied loads over long spans. The glazing can be set vertically or sloping, where it may form part of a roof surface. BS 5516:2004[2] covers the design and

installation of vertical and sloping Patent Glazing. Manufacturers provide design information and many offer a design service for the specialist contractor.

Both the above codes include instruction on calculating the wind and superimposed loadings that the glazing is required to resist. Note that the framing system and structural framing sections, be they of timber, metal, glass reinforced plastic and/or plastic, can be common to both types of glazing. Where glazing is formed from a number of large panes the framing system will require to be purpose designed.

Point Fixed glazing(sometimes also referred to as Curtain Walling), is where the glass is supported not at the edges but by bolt fixings through the glass, with weather seals provided to prevent moisture ingress.

In Point Fixed glazing the support system is generally formed from steel components, often a combination of hollow sections and rods in forms sometimes having the appearance of an exposed lattice or bowstring girders. There is no British Standard which describes such glazing, though various components are covered by materials codes.

Glass used in all these systems can be single or multiple glazing, using float (annealed), heat strengthened or toughened glass, or a combination of these, including laminated panes and panes having special surface finishes. Plastics glazing is also used. BS 6262[1] and BS 5516[2]give guidance on calculating wind loads and establishing pane thicknesses in glass and plastics. The wind load calculations are based on BS 6399-2[6] with guidance which is specific to glazing installations. Both codes are restricted in their cover and the graphs used do not extend to the larger pane sizes now available. There is no British Standard covering calculation of glass thickness for the larger panes sizes, though European Standard (DRAFT) prEN 13474[3] Parts 1 and 2 exist and give methods for calculating glass stresses for different glass types and pane thicknesses. This draft code has not yet been published in all its intended parts and, so far, only covers edge supported panes and uniformly distributed loads. It is normal in the UK to abide by the recommendations given by the glass manufacturer but it is currently unlikely that justifying calculations will be provided.

The publication “Structural use of glass in buildings”[4] is a useful reference book that gives guidance on design with glass. The paper ‘Recent developments in design methods for glass structures’[8]also gives guidance on this subject. The Certifier may find Tables 4 and 5 give useful data for rule of thumb checking where full design information is not made available.

The Certifier should be aware that most glazing systems are relatively rigid in the plane of the system and are built to much closer tolerances than the supporting structure. It is probable that the structural design of the glazing and the main structure are carried out by different parties and there is a risk that the loads and relative tolerances and movements may not be properly accounted for. Glazing systems are subject to greater temperature variation than the supporting structure and this should also be allowed for. Be particularly aware that building frames, especially in reinforced or pre-stressed concrete, can move appreciably after construction.

The Scottish Building Standards Technical Handbooks[9] give requirements for glazing, including insulation, types of glass required in certain situations, and security requirements elsewhere than in Section 1: Structure. These are not matters which are covered by the Design Certificate, but it is prudent to recognise where these requirements apply and ensure that any physical needs are transmitted as part of the specification. There are also requirements for specific types of glass in certain locations.

3. British Standards

BS 6262:2005[1] Parts 1 to 7 cover the design and construction of vertical glazing for buildings. They cover calculation of wind loads and treatment of impact loads and include where glass fins are used structurally as part of the glazing. Although Part 4 gives guidance on ‘human impact’ at critical locations on glazed screens it does not cover situations where glazing is used as a barrier, such as over a change in level, to restrain persons, or security requirements. For barrier loadings refer to SER Technical Bulletin 5 relating to Protective Barriers, BS 6399-1[5] and BS 6180:1999[10].

It should be noted that BS 6262 Part 5 (Code of practice for frame design considerations) is not yet available and that it is unclear when it will be published.

BS 5516[2] Parts1 and 2coververtical and sloping Patent Glazing systems. They cover calculation of wind loads and the glass sizing and gives advice on the support system. As in BS 6262 they do not cover where the glazing is used as a barrier or security implications.

Both BS 6262 and BS 5516 include methods of determining the wind pressure based on BS 6399-2[6]. BS 5516 also covers imposed loading referring to BS 6399-3[7]. These requirements are interpreted specifically for window design, and tend to use the 'worst case' option to cover all elements.

Where the glazing system falls outside the provisions of these two codes the design will need to comply with material codes and good practice, though it is probable that the guidance given the codes will be relevant. Wind loads will be calculated to BS 6399-2[6].

Safety requirements for the glazing system are covered by BS 8213[11]. Security requirements will depend on the situation; the Certifier is referred to the Domestic version of the Scottish Building Standards Technical Handbooks[9], Section 4.13, where it is noted that fixings designed to meet wind and accidental impact may well comply with requirements for security.

4. The Role of the Certifier

This is essentially establishing that there is sufficient design information to ensure the structural adequacy of the glazing and making sure that potential risks have been properly addressed by the designer. Clearly glazing such as is covered by BS 6262 is generally used in situations carrying a low risk and the Certifier needs do no more than ensure that the supplier is briefed regarding the appropriate Standard provided with sufficient information to establish the wind loads. The wind design provisions in both British Standards are limited to heights above ground not exceeding 15 m.

Where requirements for security and safety apply then these should be brought to the provider's attention.

While a specific maximum window size is not given in BS 6262, guidance for pane sizing is limited to not more than 2 m^2 of glass per pane. Windows one pane high (such as continuous glazing in offices, known as 'ribbon' glazing) and rectangular units not more than two panes high, with the total of the two panes being less than 4 m^2, can be considered as coming within the code provisions and generally need no further checking. Larger units, especially where breakage could be considered a hazard, will normally require closer scrutiny.

It is expected that glazing to a house, including patio doors, will come within the provisions of BS 6262, and need no further action by the Certifier other than ensuring that the Standard is specified. Glazed walls and other large features, or locations where the minimum unsupported glazing dimension exceeds 1.2m, may require more detailed attention and the certifier should be satisfied that the window specifier (normally the architect) has been made aware of the loading conditions.

BS 5516 considers pane sizes up to 20 m^2, depending on method of support. However, systems complying with this Standard will involve some level of structural design that will require scrutiny by the Certifier. The design must include for the supporting structure, how this is attached to the primary structure, provision for tolerances and relative movement between the two and all relevant load situations.

Further, it is possible that some aspects of such glazing have special requirements, such as acting as a barrier, and provisions for compliance with these should always be subject to scrutiny.

The certifying engineer may not be sufficiently experienced in glazing systems design to undertake a check personally. It is also possible that justifying calculations by a supplier are inadequately checked, if at all. While compliance with BS 6262 and BS 5516 will be relatively straightforward to check, the Certifier will need to consider if this delivers the necessary level of reassurance appropriate to the risk. For more complex systems, and those not covered by those Standards it may be necessary to request that an independent check is carried out.

5. Certifying

The basic duties and responsibilities of the building structure certifier in relation to the design of the glazing include being satisfied regarding the following items::

a. Is the installation covered by the BS 6262 and BS 5516? If not, ensure that appropriate standards are defined. Where the building height exceeds 15 m, these codes may be relevant but the wind loads will need to comply with to BS 6399-2 or BS EN 1991-1-4.

b. Is the required glazing, or parts of it, significant enough to require special attention before sign off by the Certifier?

   i. Normal domestic glazing generally to BS 6262 will probably require no attention from the Certifier and can be included in the Certificate.

      The Warrant drawings must have sufficient information to define the system, standards and wind loads.

      However large glazed areas must be checked; refer to section 4 above.

   ii. Glazing to BS 5516 will require some level of checking, as the supporting framing will be custom designed to the situation.

   iii. Glazing outside these codes will require a detailed check.

c. Have the design requirements of the system been properly defined? These should include:

   i. The site wind speed, location, altitude and exposure data or sufficient information to establish these, the design wind speed and wind loads.

   ii. Any particular requirements such as barrier loads, maintenance and impact loads. (Note: maintenance loading also applies to vertical glazing)

   iii. Any other relevant loadings.

   iv. All the building movements and deflections, both long and short term, where these may affect the glazing system. (Note: this should not be necessary for domestic glazing to BS 6262)

   v. Any load testing requirements.

   vi. Any clear risk presented by the design.

   vii. Any specific requirements for laminated and/or toughened glass.

   viii. That the support details properly accommodate the loads and the relative movements between the system and the supporting structure.

   ix. Are the requirements for the glazing properly given on the Warrant Drawings and Specification? Refer to SER Technical Bulletins numbered1, 2,4 and 5.

d. All relevant information should be properly shown on the information provided to the installer and included within the Warrant Application documents.

e. Where the glazing system structure forms part of load bearing elements carrying other parts of the building, establish who is responsible for designing the different parts of the structure. Where the responsibility is split between different design Engineers and the Supplier, it is the Certifiers responsibility to ensure compatibility of the overall design. This may require a Staged Certificate.

f. Have the fixing requirements to the supporting structure been adequately designed, checked and detailed, or, where the where the work is listed in Schedule 1, covered by a performance specification.

g. Where a design has been received before the Certificate is prepared this can be checked and covered appropriately in the Certificate.

The actions to be undertaken before issuing a Form Q for Glazing listed in Schedule1 include:

h. Assess that the design been prepared by a competent person and it has been checked. The competence required of the designer will depend on the complexity of the design. Most specialist contractors have in house expertise or access to an external designer.

i. Check that the framing systems are properly designed and supported, and the support details properly allow for differential movement between glazing and the building frame. The check should also cover glass thicknesses provided and how these were arrived at.

j. Check that the type of glass has been properly specified.

k. Check that the glazing and support systems properly meet the load requirements, particularly on matters such as snow drifting on roofs and canopies, maintenance and in areas of higher wind loads, especially where uplift can occur.

l. Check that fixings to the structure are adequate, especially at peak wind load situations, and allow for possible differential movements. Check that the supporting structure is designed for the loads.

m. If the system required is outside the code provisions, it will be necessary to check the structural design and stability of the support framing and its interaction with the structure. Of particular importance is ensuring that the designer of the main structure has properly allowed for the loads imposed by the glazing system.

n. Where reliance on test certification is introduced check that individual components are being used appropriately.

6. Bibliography

Eurocode equivalents are given where known. National Annexes are referred to as NA.

1. BS 6262:2005 “Glazing for buildings”.
   - Part 1: General methodology for the selection of glazing
   - Part 2: Code of practice for energy, light and sound
   - Part 3: Code of practice for fire, security and wind loading
   - Part 4: Code of practice for safety related to human impact
   - Part 5: Code of practice for frame design considerations (not yet published)
   - Part 6: Code of practice for special applications
   - Part 7: Code of practice or the provision of information
2. BS 5516:2004 “Patent glazing and sloping glazing for buildings”
   - Part 1: Code of practice for design and installation of sloping and vertical patent glazing
   - Part 2: Code of practice for sloping glazing
3. DRAFT prEN 13474 “Glass in buildings – Design of glass panes”
   - Part 1: General basis of design
   - Part 2: Design of uniformly distributed loads
4. “Structural use of glass in buildings” published by the Institution of Structural Engineers; 1999
5. BS 6399-1:1996: “Loading for buildings – Code of practice for dead and imposed loads” (superseded by: BS EN 1991-1-1:2002: and NA –“Actions on structures. General Actions. Densities, self-weight, imposed loads for buildings” but still in use.)
6. BS 6399-2:1997: Loading for buildings – Code of practice for wind loads (superseded by: “BS EN 1991-1-4:2005: and NA - Actions on structures. General Actions. Wind actions” but still in use.)
7. BS 6399-3:1988: Loading for buildings – Code of practice for imposed roof loads (superseded by: “BS EN 1991-1-3:2003: and NA - Actions on structures. General Actions. Snow Loads” but still in use.)

8. Overend, M: 'Recent developments in design methods for glass structures' Structural Engineer, 88 (14) 20th July 2010, p18-26.

9. Scottish Building Standards Technical Handbooks.
   Domestic Buildings: 2010
   Non-domestic buildings: 2010

10. BS 6180:2011 "Barriers in and about buildings. Code of practice"

11. BS 8213: "Windows doors and rooflights".
    Part 1:2004: Design for Safety in use and during cleaning of windows, including door-height windows and roof windows. Code of Practice.
    Part 2: 2007: Code of practice for the survey and installation of windows and external doorsets.

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