FGMA

FLAT GLASS MANUFACTURERS' ASSOCIATION

TECHNICAL GUIDANCE PAPER
FGMA TECHNICAL COMMITTEE

REVISION OF BS 6180, THE CODE OF PRACTICE FOR BARRIERS

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BS 6180, the British Standard code of practice in and about buildings, is one of the most commonly cited references in glass specifications. Last updated in 2011, BS 6180 is need of a significant revision, which has been acknowledged by BSI. In particular, several of the sections on glass are open to interpretation. More worryingly, some of its recommendations could be considered as being far from best practice. In this paper, the Flat Glass Manufacturers' Association (FGMA) highlights the areas that need to be addressed in any revision and proposes suggestions to improve the standard.

Introduction

BS 6180, referenced by Building Regulations through the UK, may be considered to be the most commonly applied Code of Practice for the design of glazing acting as guarding, and for glass within balustrade applications. BS 6180 may also be considered to contain several limitations, specifically with regards the guidance provided for containment, ambiguity around the application location of loads and the design methods to be applied.
With the imminent publication of both prEN 16612 and prEN 16613 [1, 2] and more consideration to risk given within the latest revision of BS 6262-4 [3]; it is essential that BS 6180 is updated to accommodate the application of these design methods and provide greater clarity on how glazing risks can be assessed.

The following issues with the standard are noted, and will be discussed;

1. Glazing installed into a wall as a window is only considered as full-height glazing, and so may be considered to be inadequately defined.
2. Containment for full-height glazing is poorly considered.
3. Modern design approaches for glass design are not considered, including load combinations.
4. Application areas for loads are poorly defined, and ambiguous.
5. Edge cover is above what may be expected for most framing systems.

Due to the complexity of glass design, it may be considered logical to restrict any reference to, or guidance on, this aspect of barrier design to a single section within BS 6180. This would allow this section to be updated more readily should associated regulations and/or guidance change in the future, and would also assist in removing some of the ambiguity where reference is made to design aspects that don't logically apply to glass as a material.

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1 Barrier Types

BS 6180, Clause 8.1.2, provides definitions for 3 types of barriers using glass;

- Full-height glazed barrier,
- Barrier with a glass infill panel
- Free-standing glass protective barrier

Glass within a framing system may also be considered as part of a “full height barrier”, where glass is “...part or whole of a wall element...”. Glass within a framing system would be considered as such.

However, the definition applied to a “barrier with a glass infill”, where “...the main of the barrier (i.e. top rail and baluster) should be designed to withstand the loads applied to the top rail and the glass should be used to form the infill panels.” Is on occasion considered by some to apply to glass within a framing system. This is based on the reasoning that the framing system mullion may perform as a baluster, and a transom as a top rail.

For clarity, the FGMA would suggest “Barrier with a glass infill panel” be redefined as “Balustrade with a glass infill panel”, which would then limit any consideration of glazing to the “Full-height barrier” application.

Full-height barriers would currently be considered to include glazing within a wall, however, design requirements may differ, specifically with residual containment requirements. Based on this, and the above, the addition of another barrier type; “Glazing within a wall” may assist the design process.

The addition of diagrams to illustrate barrier types may also assist in defining them. DIN 18008-4 provides some useful examples.

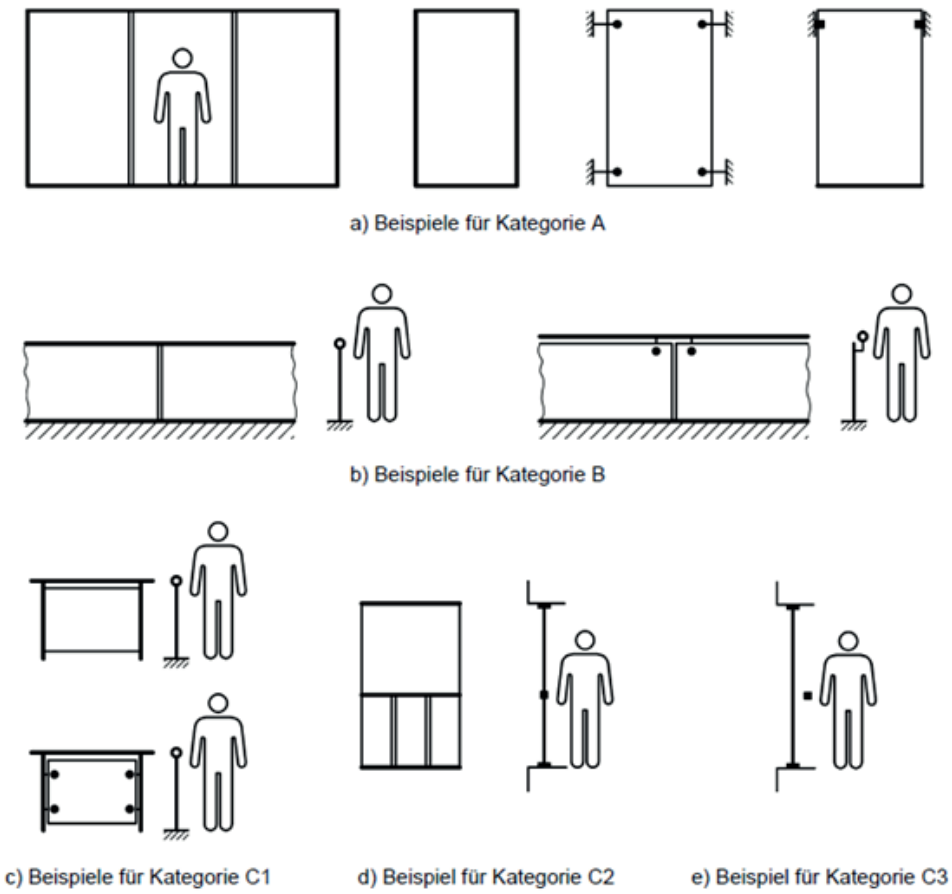

Bild 1 — Beispiele für Kategorie A, B und C

Figure 1 1 - DIN 18008-4 [4], Figure 1, Barrier by Category

2 Load Application and Design

There are several issues noted with the definitions of load applications areas, how glazing should be treated in specific circumstances when acting as full height glazing, and load combinations.

2.1 Minimum Barrier Heights

Table 1 within BS 6180 provides minimum barrier heights, but fails to make specific reference to glazing acting as guarding within a wall, i.e. "full-height glazing", as with Building Regulations Approved Document K [5], Diagram 3.1.

In the case of both "Single-family dwelling" and "All other uses" barrier heights for full-height glazing should be aligned more clearly with those within Building Regulations;

2.2 Point Load Application Position

Within Section 6.3.1, the statement "Point load should be applied at the most onerous point anywhere on the barrier structure" Is in contradiction with the statement "...point load applied to part of the infill", which would be expected to be any area at or beneath the design height. This latter text is also within Table 2.

Whilst it may be considered to be the case that the "barrier structure" is in reference to any element that is not the infill, this section could be clarified to ensure that the point load application to glass infill panels is limited to the region below the line load height, i.e. the infill.

2.3 Point Load Application Area

Application areas of both 50 mm x 50 mm and 100 mm x 100 mm have been provided in specification requirements, as no industry standard has yet to be adopted. It may be advised that the most onerous load application area of 50 mm x 50 mm be applied, unless other requirements are deemed applicable by the designer. This may be outside the scope of this standard, and for inclusion in an additional part of the BS 6262 series.

2.4 Line Load Application

Section 6.3.1. states that the "Horizontal uniformly distributed line load should be applied at design height as presented in Table 1 or at design level (1100 mm) for barriers higher than the design height.", where the design height may be less than 1100 mm from finished floor level.

However, Figure 1 states that "In design, the horizontal uniformly distributed line load acts at a height of 1.1 m above datum level, irrespective of the actual height of the element."

FGMA would advise that this is clarified to avoid ambiguity.

2.5 Load Combinations

Section 6.1 states that "Barriers should be designed to resist the most unfavourable likely imposed loads and wind loads separately (see 6.3) without unacceptable deflections or distortions (see 6.4)."

With the publication of prEN 16612, as well as existing CWCT TU14 [6] guidance, consideration to combinations imposed loads and wind loads needs to be permitted.

2.6 Working and Characteristic Loads

With the introduction of prEN 16612 for glass, it may be expected that a limit state design methodology may need to be applied to all glazing assessments, and as such, the use of loads within BS 6180 as "working loads" would then lack validity.

2.7 Design Standards

It may be expected that BS 6180 would provide references to applicable "appropriate" British Standards, including adopted EN documents, for various materials in use. In the case of glass, this will likely be "EN 16612".

BS 6180 will need to be updated to reflect this should prEN 16612 be published before the BS 6180 revision. In the event that it's not published, reference should be made to current relevant Nationally adopted design standards.

2.8 Load Definitions

Whilst reference is made to BS EN 1991-1-4 [7] for applied wind loads, no reference is made to BS EN 1991-1-1, the UK National Annex and PD 6688-1-1 [8, 9, 10] for occupancy loads. These references could potentially replace Table 2 should this also be suitable for all other materials. This would need wider discussion with representatives for other materials.

3 Deflection Limits

Deflection limits are defined by barrier type, but could be clearer within the standard.

3.1 Definition of "L"

Section 6.4.1 states that "Where the infill of a barrier is subjected to imposed loads given in Table 2, or if appropriate, other calculated design loads, the displacement of any point of the barrier should not exceed L/65 or 25 mm, whichever is the smaller where L is the given in 8.3, 8.4 or defined in 8.5. A suitable fracture load, factored by a minimum partial safety factor of 4.0 (as recommended in BS 4592-0) should be obtained from the material manufacturer when considering glass barrier design."

Where "L" is being referenced, this needs to be better defined, as Section 8.3, 8.4 and 8.5 fail to defined which dimension of the glazing should be considered. Guidance could be provided for each barrier type in a tabulated form.

3.2 Deflection Under Combined Loads

If load combinations are considered, then the deflection limits, in some cases, may be considered too onerous. With consideration to wind and occupancy load combinations, it may be considered that deflection limits could be based on the loads applied. For example, the lesser of L/65 or 25 mm where occupancy loads are considered alone, and where in combination with climatic loads, the lesser of L/65 or 50 mm.
Tables of allowable deflection criteria for glass could be included, and should be based on deflection of the glass only, not including movement of fixings, which needs to be considered separately.

4 Stress Limits

Section 6.4.1 states that "A suitable fracture load, factored by a minimum partial safety factor of 4.0 (as recommended in BS 4592-0) should be obtained from the material manufacturer when considering glass barrier design". BS 4592-0 [11] is relevant to stair treads and handrails, not specifically to glass, and so the recommendation for the application of a partial safety factor of 4.0 for glass, without consideration to a design approach, makes little sense and should be removed.

It may be suggested that with the introduction of prEN 16612, this may be referenced as the design approach to be adopted, inclusive of partial safety factors.

5 Fixing of Glass

Consideration needs to be given for full-height, balustrade and free-standing types.

5.1 Full-Height Glazing

Section 8.2.3 defines edge cover as at least 15 mm. CWCT TN99 [12] discusses edge cover, and based on this the reduction of the limit from the current 15 mm to 12 mm, may be considered as a suitable value for fully edge supported insulating glass units. For single glazing, the current edge cover limit of 15 mm, unless a lesser value can be proven by calculation, may be advised.

5.2 Balustrade Infill Panels

The fixing details provided in Annex B should be removed. A statement should be present to the effect that fixings should be evidenced to perform through testing.

5.3 Free-Standing Barriers

Section 8.5.2. relates to handrail attachment and a requirement for the handrail to be attached to the building structure in order to be considered independent of the glass for support may be considered.

6 Containment

Containment is discussed in section 8.6.

6.1 Full-Height Glazing

For full height glazing, consideration should be given to defining requirements based on perceived risk. As per previous comments, glazing within a wall and full-height barriers could be defined separately. At present, the standard will allow for two thermally toughened panes within a full height glazing unit, which may be considered to offer no residual containment in the event of fracture. It may be considered that this is only suitable for small first floor windows, but not full-height glazing at several floors up. Risk assessments should consider the potential for both panes to fail, as well as the strength of a single pane to act as a barrier in the event of the failure of another. An impact classification for glass types within an insulating glass unit comprising only thermally toughened monolithic glass would be advised, as with balustrade infills. A glass type with a suitable declared EN 12600 [13] performance, annealed or heat-strengthened laminated glass would be considered to offer the greatest level of residual containment, and requirements for laminated glasses in specific situations, such as overcrowding occupancies, may be advised. For single pane applications, such as internal barriers, it would be advised that this be limited to laminated glass types only when acting as guarding.

6.2 Balustrade Infill Panels & Free-Standing Barriers

The required glass types for both balustrade infill panels and free-standing barriers should be aligned.

For these applications, the limitations imposed for free-standing barriers where a handrail is not present should also apply to balustrade infill panels where no handrail is used. Effectively, this would require a laminated configuration in the absence of a suitable handrail.

7 Annex B

Annex B provides indicative drawings of balustrade designs, and these may be considered outdated. It should be considered if this Annex is removed in its entirety.

8 References

[1] European Committee for Standardization, prEN 16612:2017 - Glass in Building - Determination of the load resistance of glass panes by calculation and testing, CEN, 2017.
[2] European Committee for Standardization, prEN 16613:2017 - Glass in Building - Laminated glass and laminated safety glass - Determination of interlayer mechanical properties, CEN, 2017.
[3] British Standards Institute, BS 6262-4:2018 - Glazing for buildings - Code of practice for safety related to human impact, BSI, 2018.
[4] Deutsches Institut für Normung, DIN 18008-4:2013-07 - Glas im Bauwesen – Bemessungs- und Konstruktionsregeln – Teil 4: Zusatzanforderungen an absturzsichernde Verglasungen, Beuth, 2013.
[5] HM Government, The Building Regulations 2010 - Approved Document K - Protection from falling, collision and impact, 2013.
[6] CWCT, Technical Update 14 - Load Combinations, CWCT, 2009.
[7] European Committee for Standardization, EN 1991-1-4:2005+A1:2010 - Eurocode 1. Actions on structures. General actions. Wind actions, CEN, 2005/2010.
[8] European Committee for Standardization, EN 1991-1-1:2002 - Eurocode 1. Actions on structures. General actions. Densities, self-weight, imposed loads for buildings, CEN, 2002.
[9] European Committee for Standardization, NA to BS EN 1991-1-1:2002 - UK National Annex to Eurocode 1. Actions on structures. General actions. Densities, self-weight, imposed loads for buildings, CEN, 2002.
[10] British Standards Institute, PD 6688-1-1:2011 - Recommendations for the design of structures to BS EN 1991-1-1, 2011: BSI.
[11] British Standards Institute, BS 4592-0:2006 - Flooring, stair treads and handrails for industrial use. Common design requirements and recommendations for installation, BSI, 2006.
[12] CWCT, Technical Note 99 - Design of Glazed Barriers, CWCT, 2018.
[13] European Committee for Standardization, EN 12600:2002 - Glass in building - Pendulum test - Impact test method and classification for flat glass, CEN, 2002.

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