Within a building a full height barrier is defined by BS 6180:2011 [1] as glass which "*…forms part or whole of a wall element… if any part of the glass comes below the minimum barrier height.*" Therefore, any glazing present between finished floor level (FFL) and the minimum barrier height must meet the load requirements specified by the standard.

The minimum barrier height is determined by the building occupancy, and the area of the building, as discussed in **Guards & Barriers Documents 1A & 1B**. For glazing, Building Regulations Approved Document K, Table 3.1 [2] would define the barrier height for glazing as anything within 800 mm from finished floor level. However, BS 6180, Table 1 [1], lists barrier heights based on position, and doesn't specifically reference glazing. As such, an "*edge of roof*" scenario, which may be interpreted to be an edge of floor guarding against a fall externally, may be considered, which gives a minimum barrier height of 1100 mm from finished floor level.

Where there is any ambiguity with regards the applicable minimum barrier height, 1100 mm is generally considered as this will present the most onerous requirement. However, this determination would be expected to be made by the architect/designer. Based on the requirements of BS 6180:2011, glazing units which would be considered to be acting a full height barriers are illustrated below, and highlighted in red:

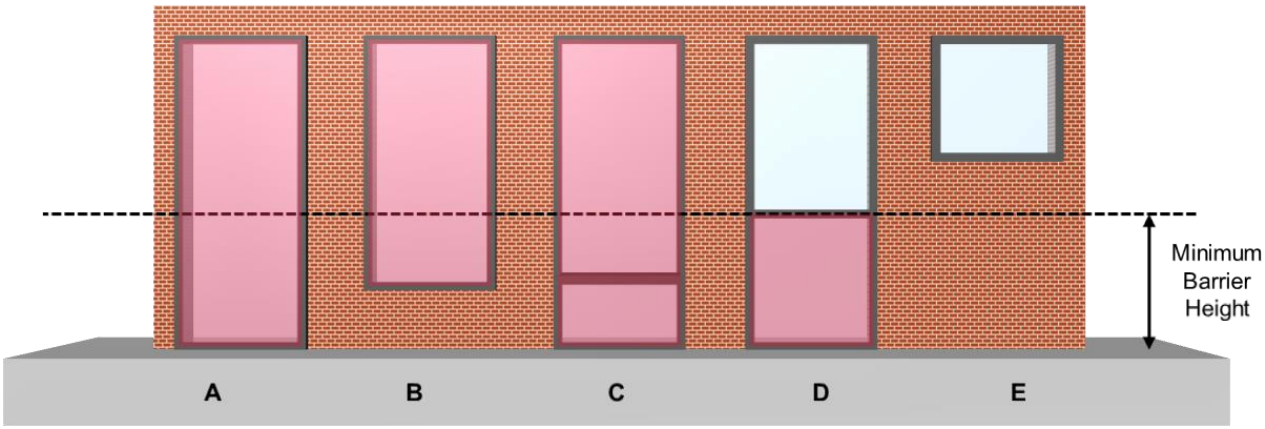

Figure 1 – Areas acting as full-height barriers

AREAS SUBJECTED TO LOADING

BS 6180:2011 states that "*Any part of a glass pane below the minimum barrier height should sustain the infill loads.*" with the infill loads being the uniformly distributed load (UDL) and the concentrated point load. In addition, "*Where there is glass at the minimum barrier height…, the glass should also sustain the line load applied at the design level.*"

It is often considered that there is some ambiguity within BS 6180:2011 with regards the application of the uniformly distributed line load. The Code states in Section 6.3.1 that "*Horizontal uniformly distributed line load should be applied at design height…,or at design level (1100 mm) for barriers higher than the design height.*". With the design height being the minimum barrier height, this would indicate that the line load can be applied at a level below 1100 mm. However, the annotation within Figure 1 of the standard states; "*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.*", which would appear to preclude the application of the line load at any other height, other than the design level. For

the purposes of assessment, line load is therefore taken at the design level of the top of the glass, as each would likely be expected to be the worst case scenario.

The below illustrates the areas under loading and the associated location of each load. The UDL is indicated by the shaded red region, the concentrated load by the red dot, and the line load is applied at the design level.

Again, some ambiguity exists within BS 6180:2011, which states "*Point load should be applied at the most onerous point anywhere on the barrier structure.*", which would appear to indicate anywhere on the glazing. However, within the table of loads, the following statement is present; "*A point load applied to part of the infill*", which would indicate that the location of the concentrated load is limited to the infill, i.e. the region below the design level. To assess worst case, the concentrated load will always be applied at the worst location, which will, under most conditions, be the centre of the pane, or as close to the centre as possible.

For the top pane of glazing unit D, which is above the minimum barrier height, this would be excluded from the application of the line load as it is not acting as a barrier.

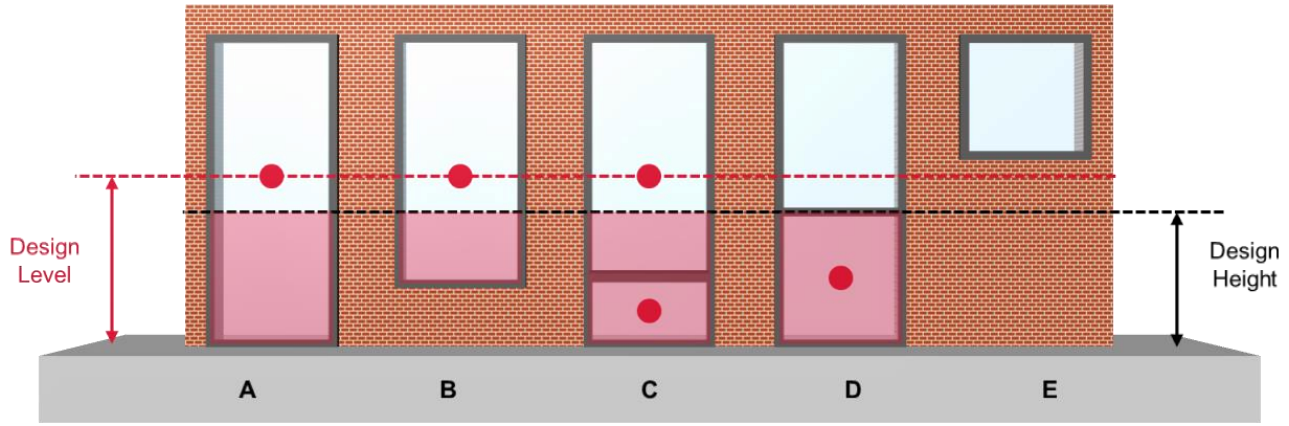

Figure 2 – Load locations based on design level and design height

As previously stated, if there is any uncertainty over the minimum barrier height, 1100 mm can be used. This results in all glazing at this height is subjected to the line load, and the worst case UDL and concentrated loads. In addition, in the case of glazing unit D in these illustrations, the top pane is now also acting as a barrier.

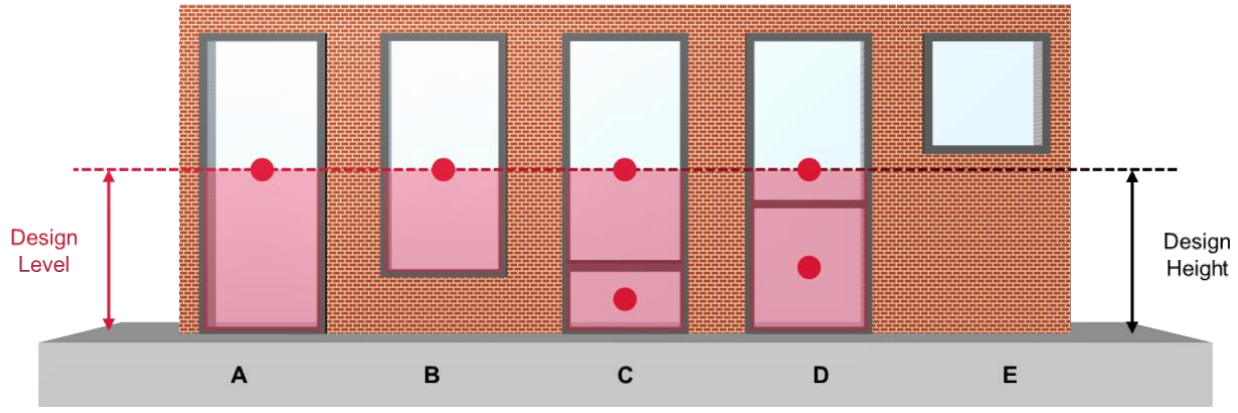

Figure 3 – Load locations based on design level equalling design height

ALLOWABLE STRESS

Allowable stress is based on partial or global safety factors, and is discussed in **Guards & Barriers Document 4A**.

ALLOWABLE DEFLECTION

The allowable deflection of glazing under loading is restricted based on occupant comfort, based on BS 6180:2011, "*…a barrier that is structurally safe should not possess sufficient flexibility to alarm building users when subject to normal service conditions.*"

Table 1 - Allowable deflection for full-height barriers

Barrier Type	Glass Support	Allowable Deflection (mm)	Definition of L
Full Height Barrier	3 or 4 Edge Supported	L/65 or 25	Longest Dimension
	2 Edge Supported		Span Between Supports

CONTAINMENT

BS 6180:2011 also provides guidance on glass barriers that protect people from hazards, which will include falling from height. For full height barriers, this containment clause (8.6.3.1) states that "*The glass in full height barriers should be selected to resist the appropriate design loads…, and for its impact performance in accordance with the safety glazing recommendations given in BS 6262 (all parts).*"

BS 6262-4:2005 "*Glazing for buildings. Code of practice for safety related to human impact*" [3] provides guidance on glass types suitable for use in full height barriers. This also relates the requirements of Building Regulations Approved Document K Section 5: Protection against impact with glazing [2], which states that glazing in critical locations should also be a safety glass.

Table 2 - Safety glass types for containment (where certified)

Glass Type	Standard
Thermally Toughened Soda Lime Silicate Glass	EN 12150-2 [4]
Heat Soaked Thermally Toughened Soda Lime Silicate Glass	EN 14179-2 [5]
Laminated Safety Glass	EN 14449 [6]
Laminated Thermally Toughened Soda Lime Silicate Glass	
Laminated Heat Strengthened Soda Lime Silicate Glass	
Safety Rated Wired Glass	EN 572-9 [7]

More defined requirements, in the form of EN 12600:2002 [8] classifications, apply to balustrade infill panels and free-standing barriers, depending upon the free line distance from a permanent structure to the glazing. Whilst not specifically required full height barriers, they can be considered if required.

When considering the breakage of toughened glass, the glass must not break to provide containment, as such, the 3rd of the 3 values should be considered. BS 6180:2011 provides guidance for toughened, as below. For laminated glass, the CE marking declared performance characteristics must be considered.

Table 3 - Glass types for infill panels where containment is required

Free Line (mm)	EN 12600 Class	Glass Type	Thickness
≤1500	3	Toughened	6
		Annealed Laminated	6.8
>1500	1	Toughened	10
		Annealed Laminated	6.8

WIND LOADING

Under normal circumstances, external glazing will also be subjected to wind loading. These loadings are typically considered separately from barrier loadings as per BS 6180:2011; "*Barriers should be designed to resist the most unfavourable likely imposed loads and wind loads separately*".

However, consideration should be given to worst case scenarios where wind loads act unfavourably in concert with barrier loads. The requirements of EN 1990 [9] and EN 1991-1-4 [10, 11] should also be taken into account where applicable.

REFERENCES

[1] British Standards Institute, *BS 6180:2011 - Barriers in and about buildings. Code of practice,* BSI, 2011.

[2] HM Government, *The Building Regulations 2010 - Approved Document K - Protection from falling, collision and impact,* 2013.

[3] British Standards Institute, *BS 6262-4:2005 - Glazing for buildings - Code of practice for safety related to human impact,* BSI, 2005.

[4] European Committee for Standardization, *EN 12150-2:2004 - Glass in building. Thermally toughened soda lime silicate safety glass. Evaluation of conformity/Product standard,* CEN, 2004.

[5] European Committee for Standardization, *EN 14179-2:2005 - Glass in building. Heat-soaked thermally-toughened soda lime silicate safety glass. Evaluation of conformity/product standard,* CEN, 2005.

[6] European Committee for Standardization, *EN 14449:2005 - Glass in building. Laminated glass and laminated safety glass. Evaluation of conformity/product standard,* CEN, 2005.

[7] European Committee for Standardization, *EN 572-9:2004 - Glass in building. Basic soda lime silicate glass products. Evaluation of conformity/Product standard,* CEN, 2004.

[8] European Committee for Standardization, *EN 12600:2002 - Glass in building - Pendulum test - Impact test method and classification for flat glass,* CEN, 2002.

[9] European Committee for Standardization, *EN 1990:2002 - Basis of structural design,* CEN, 2002.

[10] European Committee for Standardization, *EN 1991-1-4:2005+A1:2010 - Eurocode 1. Actions on structures. General actions. Wind actions,* CEN, 2005/2010.

[11] European Committee for Standardization, *NA to BS EN 1991-1-4:2005+A1:2010 - UK National Annex to Eurocode 1. Actions on structures. General actions. Wind actions,* CEN, 2005/2010.