A free-standing barrier is defined by BS 6180:2011 [1] as a barrier that is "*…clamped to the structure along its bottom edge, the handrail attached to the top edge of the glass and there should be no balusters.*"

The minimum barrier height is determined by the building occupancy, and the area of the building, as discussed in **Guards & Barriers Documents 1A and 1B**. 1100 mm is typically considered the minimum barrier height when free-standing barriers are under consideration.

HANDRAILS

BS 6180:2011 requires that a handrail be used whenever the barrier "*…protects a difference in level greater than 600 mm…*" unless a toughened laminated glass is used that would remain *in situ* if a panel fractured.

If present, a handrail should be designed to remain in place and withstand the applied line load without the glass present to allow it to bridge the gap should a panel fail and leave a void.

AREAS SUBJECTED TO LOADING

In the case of glass free-standing barriers, the entire glass pane will be expected to withstand the applied loadings. The below illustrates the location of each load for the centre panel. 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. The concentrated load will always be applied at the worst location, which will, under most conditions, be the top centre or top corner of the pane (where no handrail is present), where the maximum moments can be applied.

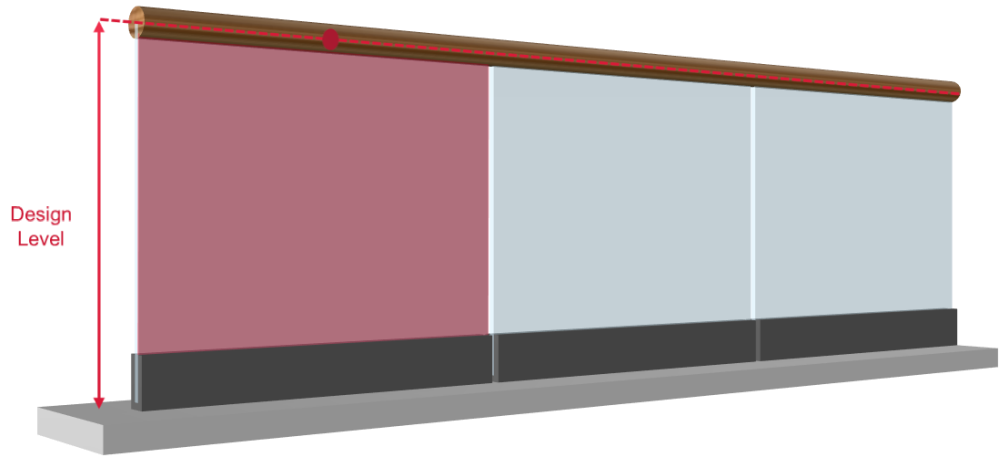

Figure 1 – Load application for a free-standing barrier with a handrail

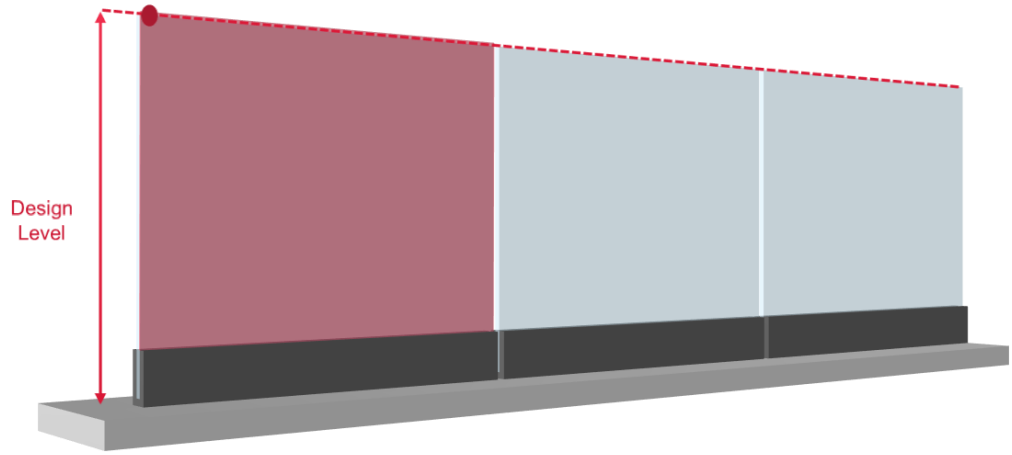

Figure 2 - Load application for a free-standing barrier without a handrail

ALLOWABLE STRESS

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

It should be noted that when designing free-standing barriers that are clamped along the bottom edge, the additional stress generated around the clamped region will usually exceed the allowable stress of annealed glass. As such, fully toughened monolithic or laminated glass is typically specified for this application. The following image illustrates a high level of stress at the clamping interface under line loading.

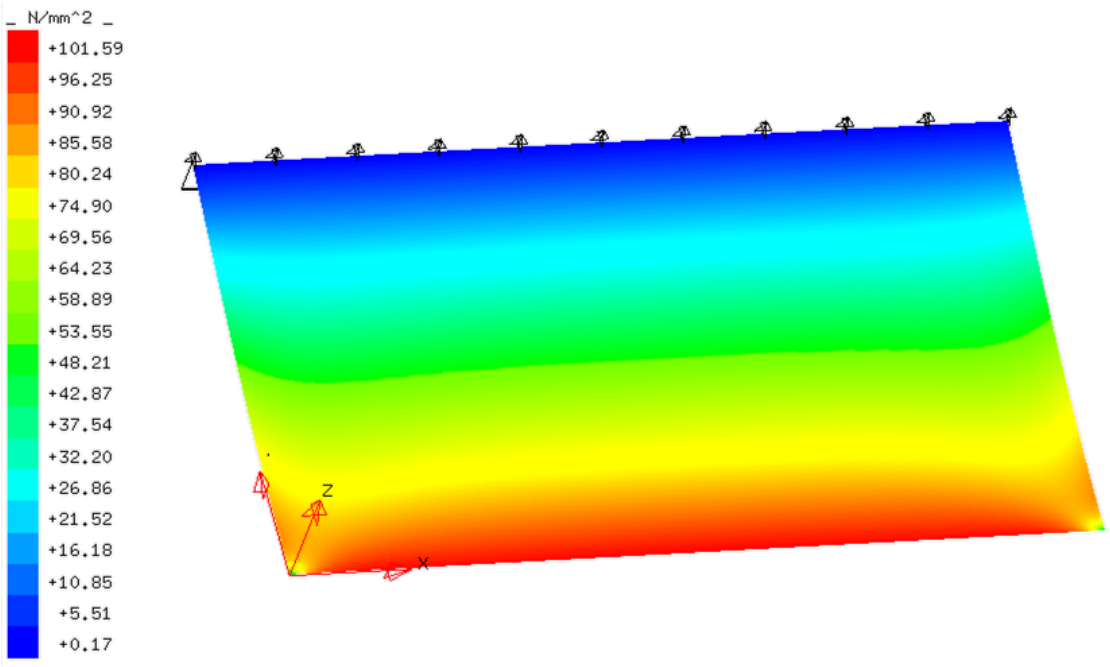

Figure 3 - Stress concentration for a bottom edge clamped free-standing barrier

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.*"

In the case of free-standing barriers, the allowable deflection is as below.

Table 1 - Allowable deflection for free-standing barriers

Barrier Type	Glass Support	Allowable Deflection (mm)
Free-Standing Glass Barrier	Bottom Edge Only (Clamped)	25

CONTAINMENT

BS 6180:2011 requires that free-standing barriers not only withstand the applied loadings with regards to stress and deflection, but also provide containment. The requirements are defined, in the form of EN 12600:2002 [2] classifications, and are dependent upon the free line distance from a permanent structure to the barrier, as below;

Table 2 - Glass types for containment requirements for free-standing barriers

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

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. For laminated glass, the CE marking declared performance characteristics must be considered.

BS 6180:2011 provides guidance for toughened, as above, whilst evidence of the performance of a toughened laminate must be provided by the manufacturer of the pane. The following glass types are typically considered suitable, depending upon design, for free-standing barriers.

Table 3 - Glass types for free-standing barriers

Glass Type	Standard
Thermally Toughened Soda Lime Silicate Glass	EN 12150-2 [3]
Heat Soaked Thermally Toughened Soda Lime Silicate Glass	EN 14179-2 [4]
Laminated Thermally Toughened Soda Lime Silicate Glass	EN 14449 [5]

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 [6] and EN 1991-1-4 [7, 8] 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] European Committee for Standardization, *EN 12600:2002 - Glass in building - Pendulum test - Impact test method and classification for flat glass,* CEN, 2002.

[3] 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.

[4] 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.

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

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

[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, *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.

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

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

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