

## Glass & Guarding / Barriers

Glass barriers are normally designed in accordance with the relevant parts of Building Regulations Approved Document K and BS 6180. Static and impact loads the glass barrier must withstand are given in BS 6399-1. Manufacturer's guidance may also be consulted. In general, barriers must either be protected by a suitable separate barrier or use a safety glass that provides containment (ie does not break under a set force). In addition, all glass infill barriers and freestanding protective barriers protecting a drop of 600 mm should have a handrail present, which may be incorporated in the barrier.

Barrier design and glass selection may be subject to a risk assessment that includes an assessment of the risks arising once the glass has broken for whatever reason (eg due to damage or nickel sulfide inclusion). Risk assessment will vary in content and depth of coverage, as there is no clear industry guidance.

It is not sufficient in such circumstances to simply fit 'safety glass'. The glass must withstand the loads appropriate to the building usage that are detailed in BS 6180. Document K specifically requires 'containment' which means that the glass should not break under the specified load.

All barriers must be able to resist imposed design loads. Loads appropriate to the type of occupancy for the building or part of the building or structure are to be found in Table 2 of BS 6180 : 2011.

Glazing in protective barriers can be regarded as a 'safety risk' if an individual can accidentally come into contact with it. There are two specific risks that need consideration and these are:

- Cutting and piercing injuries resulting from accidental impact;
- Falling through the glazing if the impact causes breakage.

### Full height protective barrier

These can take many forms and are not necessarily composed of full floor to ceiling glass/glazing. If any part of a glazed structure, whether it forms the whole or part of a wall element, extends above the minimum barrier height it is classed as a full height barrier.



## Barrier with glass infill panel

This type of protective barrier comprises the main frame, i.e. handrail and balusters, which carry the appropriate loads. The glass is used to form the infill panel and provides no support to the main frame. Handrail loads are not transferred to the glass infill.



There are four main types of infill panels:

- Fully framed
- Two edge framed
- Clip fixed
- Bolt fixed

## Free-standing glass protective barrier

This type of protective barrier consists of glass panes affixed, e.g. clamped or bonded, to the structure along the bottom edge (see figure 4). A handrail is generally attached to the top edge of the glass and there are no balusters.



The barrier selected shall be designed so as to minimise the risk of persons falling, rolling, sliding or slipping through gaps in the barrier and/or the infill. Where barriers are used when children under five are present the gap in the barrier shall not exceed 100mm. This dimension is given with the applicable Building Regulation.

NOTE 1: The 100mm is to prevent the child being held fast by the guarding

NOTE 2: Any guarding protecting glazing has to prevent a sphere of 75mm diameter touching the glazing

NOTE 3: The break safe criteria for laminated safety glass and wired safety glass are that no opening through which a 76mm diameter sphere can pass. (see EN 12600)

The presence of protective barriers may be one of guidance for persons moving about a building. However, the majority of protective barriers are positioned to prevent persons from falling from the edges of floors, stairs, elevated walkways and roofs.

The main requirement of a protective barrier is, therefore, to provide containment. It performs this function by being able to resist the likely applied forces without excessive deflection and without being penetrated.

The forces to be resisted are generally described as follows:

- Line load is related to the possibility of persons leaning against the barrier, applying a force normal to a conventional barrier at the top edge. It is generally given in the form of kN/m run, applied at a height above finished floor level, i.e. datum, roughly equivalent to the waist height of an adult
- Uniformly distributed load (UDL) is related to the pressure exerted on the infill area (that part of the barrier below the position of application of the line load). It is generally given in the form of kN/m<sup>2</sup>, applied over the entire infill area.
- Concentrated load takes into account any non-uniformity of the load applied to the infill and may also represent a static equivalent to a localised human impact (from hand, knee, elbow, etc.). It is generally given in the form of kN, applied at the most vulnerable position on the infill area.

Barriers shall be designed to resist the most unfavourable likely imposed loads, i.e. line and concentrated; and wind loads without unacceptable deflections or distortions.

## Load Values

The value of the design loads shall relate to the building usage. Buildings with higher usage levels will generally be designed to higher load levels.

The design loads and building usage categories can be found in applicable national Building Regulations.

## Barrier heights

The heights of barriers are given below:

- Single family dwelling
  - Barriers in front of a window 800mm
  - Stairs, landings, ramps, edges of internal floors 900mm
  - External balconies, edges of roofs 1100mm
- All other uses
  - Barriers in front of a window 800mm
  - Stairs 900mm
  - Other positions 1100mm
  - Balconies and stands, etc. having fixed seating within 530mm of the barrier, 800mm

## Glass Types

The type and thickness of glass shall be chosen to suit the design of the protective barrier and the applicable loads.

The following glass types are suitable for installation into protective barriers; subject to the limitations

- Thermally toughened soda lime silicate safety glass in accordance with EN 12150-2;
- Heat soaked thermally toughened soda lime silicate safety glass in accordance with EN 14179-2;
- Laminated safety glass in accordance with EN 14449;
- Laminated thermally toughened soda lime silicate safety glass in accordance with EN 14449;
- Laminated heat soaked thermally toughened soda lime silicate safety glass in accordance with EN 14449.
- Laminated heat strengthened soda lime silicate safety glass in accordance with EN 14449
- Safety rated wired glass in accordance with EN 572-9

## Limitations

Some types of laminated safety glass can only be used fully framed, i.e. in full height glazing or in barriers with fully framed infill panels. NOTE: Laminated thermally treated glasses may be used without being fully framed. Safety rated wired glass can only be considered for fully framed full height barrier situations. All other glass types detailed above are suitable for installation in conventional systems.

## Conformity with U.K. Building Regulations

The Building Regulations in the United Kingdom incorporate requirements to provide barriers when it is necessary to protect people in and about buildings from falling. The following tables have been prepared to summarise the requirements. However, they are not part of the Building Regulations.

## Building occupancy classes

The Building Regulations classify building types and usage with relationship to applicable imposed

loads for protective barriers. The Table below shows occupancy types that have the same applied loads.

<b>Class</b>	<b>Occupancy</b>
1	Domestic and Residential - single family dwellings Office and Work Areas – light pedestrian traffic routes
2	Domestic and Residential – multi-occupancy, balconies and edges of roofs Office and Work Areas – areas not susceptible to over crowding Areas without obstacles for moving people and not susceptible to over crowding – stairs, landing, corridors, and balconies
3	Areas where people might congregate – areas having fixed seating within 530mm of the barrier Areas with tables or fixed seating – restaurants and bars Areas susceptible to over crowding – footways or footpaths less than 3 metres wide, adjacent to sunken areas Retail areas – all retail areas including banks, building societies or betting shops
4	Areas susceptible to over crowding – theatres, cinemas, shopping malls, assembly areas. Footways or pavements greater than 3 metres wide adjacent to sunken areas

The Table below gives the applicable loadings dependant upon the building occupancy classification

<b>Building Occupancy Class</b>	<b>Design Loads</b>		
	<b>Line load in kN/m run applied 1100mm above finished floor level</b>	<b>UDL in kN/m<sup>2</sup> applied to the whole of the infill panel below the line load height</b>	<b>Concentrated load in kN applied to any part of the infill panel below the line load height</b>
1	0.36	0.5	0.25
2	0.74	1.0	0.5
3	1.5	1.5	1.5
4	3.0	1.5	1.5

The Table below gives information on the maximum allowable pane size for single glazed full height barriers.

<b>Building Occupancy Class</b>	<b>Nominal Glass thickness (mm)</b>	<b>Area in M<sup>2</sup> for glass types</b>		
		<b>Laminated Safety Glass</b>	<b>Thermally Toughened Safety Glass</b>	<b>Safety Wired Glass</b>
1	6	3.2	3.6	2.8
	8	5.7	5.8	
	10	9.0	9.0	
	12	12.2	12.2	
	≥ 15	No limit	No Limit	
2	6	1.0	2.4	n/a
	8	3.6	4.0	
	10	6.2	6.2	
	12	9.	9.6	
	15	-	12.2	
	16	12.2	-	

	≥ 19	No limit	No limit	
3	6	n/a	n/a	n/a
	8	n/a	0.5	
	10	n/a	4.0	
	12	0.8	5.7	
	15	-	9.0	
	16	0.2	-	
	19	-	15.2	
	20	17.6	-	
	≥ 24	No limit	No limit	
4	any	n/a	n/a	n/a

The table below gives information on allowable thickness for fully framed infill panels. It covers toughened safety glass and laminated safety glass.

Infill loading criteria		Nominal glass thickness mm		Maximum size mm
Concentrated Load kN	UDL kN/m <sup>2</sup>	Toughened safety glass	Laminated safety glass	
0.25	0.5	6	6.4	2.0
0.5	1.0	6	8.4	2.0
1.5	1.5	10	12.4	0.8

The table below gives information on allowable spans for two-edge framed thermally toughened safety glass infill panels

Infill loading		Panel Width mm	Span Limits mm			
UDL kN/m <sup>2</sup>	Concentrated Load kN		6mm *	8mm *	10mm	12mm
0.5	0.25	300	900	1450	1900	2300
		500	1150	1750	2100	2400
		700	1350	1750	2100	2400
		900	1350	1750	2100	2400

1.0	0.5	300	600	1000	1450	1800
		500	750	1250	1750	2050
		700	900	1450	1750	2050
		900	950	1450	1750	2050
1.5	1.5	300	n/a	n/a	550	900
		500	n/a	n/a	950	1400
		700	n/a	n/a	1150	1600
		900	n/a	n/a	1300	1700

\* Possibly not suitable for free paths greater than 1500mm, unless the glass complies with EN 12150 and have a classification according to EN 12600 of I (C) I.

The table below gives information on thickness of glass required for single glazed free standing glass protective barriers. The glasses used are thermally toughened soda lime silicate safety glass or laminated thermally toughened soda lime silicate safety glass. They may be heat treated.

Thermally toughened soda lime silicate safety glass shall have a handrail to give protection in case of glass breakage.

Laminated thermally toughened soda lime silicate safety glass may be installed without a handrail as the design incorporates two panes of glass. If the pane is broken the unbroken pane will continue to give containment.

The glass thickness are based on glass width of 1200mm, exposed glass height of 1100mm and suitable base clamp.

Building Occupancy Class	Thickness in mm for glass type				
	Thermally Toughened Safety Glass	Toughened Laminated Safety Glass using PVB interlayer		Toughened Laminated Safety Glass using SGB interlayer	
	With Handrail	With Handrail	Without Handrail	With Handrail	Without Handrail
1	12	15.5	17.5	13.5	17.5
2	15	19.5	21.5	15.5	19.5

3	19	23.5	31.5	19.5	25.5
4	25	28.5	39.5	25.5	31.5

NOTE: Compliance with the above tables does not necessarily indicate suitability for purpose. The thickness and type of glass pane that can be used may also be affected by other criteria e.g. wind loads, and these should also be taken into account when selecting glass