PUBLISHED DOCUMENT

PD 6512-3:1987

Use of elements of structural fire protection with particular reference to the recommendations given in BS 5588 "Fire precautions in the design and construction of buildings" —

Part 3: Guide to the fire performance of glass

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Committees responsible for this Published Document

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Contents

Foreword

This Part of PD 6512 has been prepared under the direction of the Fire Standards Committee.

This document is intended to give guidance concerning the likely performance of glass in various situations, in particular with reference to the recommendations on glazed elements made in the various Parts of BS 5588.

It is intended for the guidance of those concerned with fire protection in buildings.

Since CP 153 "*Windows and rooflights*" — *Part 4*: "*Fire hazards associated with glazing in buildings*" was published in 1972, new types of glass, better framing techniques, improved glazing materials and greater appreciation of design requirements have led to an increase in the effective performance of glazed elements when subjected to fire. However, it is no longer considered appropriate to give deemed-to-satisfy solutions. For these reasons CP 153-4 was withdrawn in April 1986 in advance of the publication of this document.

Other Parts of PD 6512 are as follows.

— *Part 1: Guide to fire doors*;

— *Part 2: Examples of two designs of FD 30 rated fire doors*[1)].

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 6, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

[1)] In preparation.

1 Scope

This Part of PD 6512 provides guidance on the performance of glass under fire test conditions and notes some of the factors which need consideration in the design of glazed elements.

Areas glazed with plastics materials are not covered.

NOTE The titles of the publications referred to in this Published Document are listed on the inside back cover.

2 Definitions

For the purposes of this Part of PD 6512 the following definitions apply.

NOTE Information on the different types of soda-lime-silica glass for building purposes is given in BS 952-1.

2.1
class 0

capable of satisfying the appropriate provisions of the relevant building regulations

2.2
compartmentation

the division of a building into fire-tight compartments by fire-resisting elements of building construction in order to contain a fire within the compartment of origin

2.3
compartment wall

a fire-resisting wall used in dividing a building into separate compartments

2.4
fire door

a door or shutter provided for the passage of persons, air or things which, together with its frame and furniture as installed in a building, is intended, when closed, to resist the passage of fire and/or gaseous products of combustion and is capable of meeting specified performance criteria to those ends

2.5
fire propagation index

a comparative measure of the contribution to the growth of fire of a combustible material, as determined in accordance with BS 476-6

2.6
fire resistance

the ability of a component or construction of a building to satisfy for a stated period of time some or all of the criteria specified in the appropriate Part of BS 476, namely stability, integrity and insulation

2.7
glazed element

wall, screen, door, etc. containing glass areas

2.8
glazing

the securing of glass in prepared openings in, for example, windows, door panels, screens and partitions

2.9
non-combustible

capable of satisfying the performance requirements specified in BS 476-4

2.10
protected escape route

an escape route enclosed with (other than any part that is an external wall of a building) fire-resisting construction

2.11
protected shaft

a stairway, lift, escalator, chute, duct or other shaft which enables persons, things or air to pass from one compartment to another

3 Performance requirements for glazed areas

3.1 General

Provisions for structural fire protection are generally written in terms of performance under BS 476 test conditions for particular applications, and any glazed areas involved, where not specifically excluded, would be expected to comply.

Typically these applications are:

a) internal fire separating elements;

b) internal surfaces;

c) external walls;

d) roofs.

In certain situations, considerations additional to fire behaviour may also apply, for example thermal strength and the resistance of glass to wind loading, snow loading and impact; reference should be made to BS 6262.

3.2 Internal fire separating elements

3.2.1 *Walls, partitions and screens.* Glazed elements, when incorporated into walls, partitions and screens which are required to be fire-resisting, will need to provide an equivalent level of fire resistance (if tested in accordance with BS 476-8 or BS 476-22) as the structure into which they are installed. In those situations where full compliance has to be met (e.g. compartment walls and enclosures to protected shafts), the glazed elements will need to satisfy the criteria of integrity and insulation for the required period and, when tested in accordance with BS 476-8, the glazed element will also have to satisfy the stability criterion. Glazed elements that are unable to satisfy the insulation criterion may not be acceptable in all instances.

NOTE 1 Recommendations made in connection with statutory provisions may still refer to BS 476-8 although it is to be superseded by BS 476-20, BS 476-21, BS 476-22 and BS 476-23, with the tests relevant to loadbearing elements published in Part 21, and those for non-loadbearing elements in Part 22; glazed elements are non-loadbearing and hence should be tested in accordance with Part 22.
The criterion of "stability" will be replaced by the criterion of "loadbearing capacity"; however, in line with international practice, non-loadbearing elements tested in accordance with BS 476-22 will be assessed only for integrity and insulation.
NOTE 2 A Published Document giving guidance on the different methods of fire test for building materials and elements of construction is in preparation.

Because of the inability of non-insulating fire-resisting glazed elements to afford adequate protection from radiated heat, the Parts of BS 5588 recommend limitations on their use in connection with the construction of protected escape routes, i.e. restrictions may be imposed on the total percentage area permitted or their use may be prohibited either entirely or less than 1.1 m above floor level. To minimize the risk of ignition of adjacent floorings or floor coverings, non-insulating glazed areas in fire-resisting structures should be at least 100 mm above floor level.

3.2.2 *Doors.* Fire doors are required to satisfy conditions similar to those for non-loadbearing walls, partitions and screens, except that the insulation criterion is not usually imposed in connection with provisions for structural fire protection or means of escape in case of fire. However, limitations may be made on the use of non-insulating fire-resisting glass in fire doors to protected escape routes (see **3.2.1**).

For guidance on the performance and function of fire doors see PD 6512-1; for examples of fire door constructions incorporating glazed areas see PD 6512-2[2)].

3.3 Internal surfaces

When glass forms part of internal surfaces of walls and ceilings (including windows and rooflights) exposed in rooms, circulation spaces or protected shafts, it may need to meet provisions in terms of surface spread of flame and possibly heat release. However, most types of glass satisfy the highest standard of performance (i.e. class 0).

3.4 External walls

Windows and vertical glazed elements (including glazed areas in roofs at slopes greater than 70° to the horizontal) may need to be fire-resisting where situated close to a boundary or in proximity to an external escape route.

Although limitations may be imposed on the combustibility of cladding, most types of glass satisfy the highest standard of performance (i.e. class 0).

3.5 Roofs

Although glass incorporated in roofs may need to achieve certain performance levels if tested in accordance with BS 476-3:1958, where resistance to fire external to the building is needed, all types of glass (including unwired annealed glass) at least 4 mm thick will meet the highest designated level of performance (i.e. AA).

NOTE Although BS 476-3 was revised in 1975, the 1958 edition is still cited in connection with building regulations. However, the method of test is undergoing revision and is to be published as BS 476-30. No information is available concerning the performance of glazed areas when tested in accordance with BS 476-3:1975.

Glazed areas may also need to be fire-resisting (e.g. where situated in proximity to an external escape route or where overshadowed by adjacent higher parts of the same building) and/or meet minimum performance levels for internal surfaces (see **3.3**).

4 Specification and performance of glass

The fire performance of different types of glass is given in Table 1 and Table 2. It is not feasible to give specific frame and glazing details in Table 2, as the performance of the glass under BS 476-8 test conditions is dependent on the factors outlined in clause **5**. The information in this table therefore gives only a general indication of the performance of different glass constructions, based on the state of the art, and excludes the part played by the frame and glazing system in achieving the result.

[2)] In preparation.

It is the responsibility of the end user or specifier or designer to determine by discussion with all relevant parties which glass and frame combinations meet the performance levels required.

Wherever possible, the specification for fire-resisting glazed systems should be supported by test evidence or by assessments from suitably qualified experts.

5 Fire-resisting glazed assemblies

5.1 General

The relationship between glass and its supporting structure in combination is very important when considering the performance of a glazed screen or door; the performance of different types of glass when tested in accordance with BS 476-8 or BS 476-22 cannot be looked at in isolation from the whole assembly under consideration.

In order to design fire-resisting glazed assemblies, the following points need full and careful consideration.

5.2 Glass

5.2.1 *Type.* The selection of glass is critical and is dependent on the fire performance required, based on tested constructions. In addition, the selection of glass may be influenced by a need for human body impact resistance, sound insulation, anti-bandit or bullet resistance or aesthetic appearance.

5.2.2 *Pane size.* The maximum pane size in the proposed system should be determined by testing in accordance with BS 476-8 or BS 476-22. If this information is unavailable for a given system, assessments from qualified people need to be obtained.

NOTE The size of pane may also be controlled by regulations and codes of practice which recommend maximum areas or a minimum height above floor level. In addition, glasses may also need to achieve certain levels of human body impact resistance as recommended in BS 6262.

5.2.3 *Pane shape.* There is little information available on the fire resistance of panes other than rectangular. However, provided a suitable framing system has been developed, the performance of different shapes of glass, for example, circular panes, when tested in accordance with BS 476-8 or BS 476-22, should not be dissimilar to those obtained on rectangular panes of equivalent area.

Table 1 — Fire performance properties of glass (excluding fire resistance[a])

Type (see note 1)	**External fire exposure**[b] (BS 476-3:1958)	**Non-combustibility** (BS 476-4)	**Fire propagation index** (BS 476-6)	**Surface spread of flame** (BS 476-7)
Annealed (non-wired)	AA	Non-combustible (see note 2)	$I \leq 12$ and $i_1 \leq 6$	Class 1
Wired	AA	Non-combustible (see note 2)	$I \leq 12$ and $i_1 \leq 6$	Class 1
Toughened	AA	Non-combustible (see note 2)	$I \leq 12$ and $i_1 \leq 6$	Class 1
Laminated				
a) PVB (polyvinyl butyral) interlayer	AA	Combustible	$I \leq 12$ and $i_1 \leq 6$ (see note 2)	Class 1 (see note 2)
b) Intumescent interlayer	AA	Non-combustible (see note 2)	$I \leq 12$ and $i_1 \leq 6$	Class 1
c) Gel interlayer	AA	Non-combustible (see note 2)	$I \leq 12$ and $i_1 \leq 6$	Class 1
d) Resin interlayer	See note 3	See note 3	See note 3	See note 3
Special composition (borosilicate)	AA	Non-combustible (see note 2)	$I \leq 12$ and $i_1 \leq 6$	Class 1
Glass blocks	AA	Non-combustible	$I \leq 12$ and $i_1 \leq 6$	Class 1

NOTE 1 The performance may be different where adhesive films have been applied.

NOTE 2 That is to say, it satisfies the requirements for class 0 combustible materials.

NOTE 3 The performance of laminated glass constructed with resin interlayers has not been tested.

[a] See Table 2.

[b] Thickness: 4 mm minimum.

When non-insulating glass is simply supported within a rebated frame, the glass aspect ratio can also play a significant role in determining the maximum pane size able to achieve a fire resistance of 60 min. However, aspect ratio is not significant where a fire resistance of 30 min is required.

5.2.4 *Number of panes.* Test evidence on single panes of glass should not be assumed to be relevant when considering a multiple paned situation.

5.2.5 *Orientation.* The performances of most fire-resisting glazed systems have been confirmed by testing in the vertical position only. If vertically tested systems are to be used in either an inclined or horizontal panel their performance under fire test conditions will be significantly reduced. In such situations, assessments from qualified people will need to be obtained.

5.3 Method of glass retention

5.3.1 *Edge cover.* The size and bead type can affect the performance of non-insulating glasses by increasing or decreasing the temperature of the glass edges: this will influence the rate at which the glass pulls out of the rebated frame, the typical failure characteristic. It is essential that specification of this parameter is based on test evidence.

For insulating glasses, the principal role of the bead is to fix the glass securely in the frame. Failure of these glass types always occurs in the body of the glass and not from pulling out of the rebated frame.

5.3.2 *Bead fixing.* It is essential that the bead is fixed in such a way that the glass pane remains secure in the rebate formed by the bead throughout the test duration.

Table 2 — Fire performance properties of glass: test results in accordance with BS 476-8[c] when glazed vertically in suitably designed systems

Type	Nominal thickness	Size of pane[d]	Type of system	Test results[d]	
				For stability and integrity only	For stability, integrity and insulation
	mm	m		h	h
Annealed (non-wired)	6	0.10 × 0.15	Multiple paned copperlight panel, max. 0.4 m^2	1	—
Wired	6	2.0 × 0.8	Single pane	1.5	—
		1.6 × 1.4	Multiple pane	1	—
		2.0 × 1.4	Multiple pane	0.5	—
Toughened (modified)	6 to 12	2.0 × 2.85	Single pane	0.5	—
Laminated (intumescent or gel interlayer)	11	1.98 × 0.8	Single pane	—	0.5
	20	2.0 × 1.4	Multiple pane	—	1
	72	1.2 × 1.6	Single pane	—	1.5
Special composition (borosilicate)	6	2.0 × 1.0	Multiple pane	2	—
Glass blocks	80	2.438 × 2.438	Blocks 240 mm × 240 mm with mortar joints and steel rod reinforcement	—	0.5[e]

NOTE 1 Conventional toughened glass will not usually achieve the minimum (30 min) performance level for fire resistance.
NOTE 2 The use of PVB laminates to combine one or more of the above glasses may increase or decrease the performance depending on the glass(es) combined and the installation.
NOTE 3 There is no information available on performance where resin interlayers are used for combining glasses.

[c] Results should not differ substantially when tested in accordance with BS 476-22.

[d] This table is based on publicly available data. The levels of performance given do not represent the maximum that can be achieved, but do indicate levels of performance which have been achieved using a specific glazing system and which can be substantiated by test evidence available from either the glass or glazing system manufacturer. The use of a different glazing system may result in an increased or reduced level of performance.

[e] Tested in accordance with BS 476-1; insulation criterion met for approximately 15 min only. BS 476-1 was withdrawn in 1972 on the publication of BS 476-8.

5.3.3 *Ignition.* Materials used for beading, if combustible, may need additional protection from radiated and/or conductive heat when used in conjunction with non-insulating glasses.

Correct specification of glazing materials based on test evidence can be critical to glass performance.

5.4 Main frame structure

The following parameters, based on test information, need to be considered both individually and collectively because deflection or erosion of the frame is critical to the performance of the whole assembly:

a) the materials used for the frame structure, in particular:

1) their thermal conductivity and coefficient of expansion;

2) if relevant, their rates of char;

b) the structure itself, in particular:

1) its ability to support the mass of the glass whilst the glazed structure is subjected to fire, including where relevant the rates of char of beadings, transoms, and mullions;

2) if relevant, the provision of expansion joints.

5.5 Door structures

The inclusion of a glazed panel in a fire door tested unglazed in accordance with BS 476-8 or BS 476-22 may significantly reduce its fire resistance. Where possible, only doors tested with glazed panels should be used. Alternatively, where there is a lack of test information, an assessment of the proposed construction should be sought from suitably qualified people.

6 Conclusions

The performance of glazed systems in terms of fire resistance and external fire exposure should wherever possible be confirmed by test evidence. Where this cannot be provided, or where the proposed glass size is greater than that able to be tested, an assessment should be obtained.

Increased levels of fire resistance and/or larger glass sizes than those already tested in accordance with BS 476-8 are possible, provided suitable frames and glazing methods are employed.

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Publications referred to

BS 476, *Fire tests on building materials and structures.*
BS 476-3, *External fire exposure roof test*[3)].
BS 476-4, *Non-combustibility test for materials.*
BS 476-6, *Method of test for fire propagation for products.*
BS 476-7, *Surface spread of flame tests for materials.*
BS 476-8, *Test methods and criteria for the fire resistance of elements of building construction.*
BS 476-20, *Method for determination of the fire resistance of elements of construction (general principles)*[4)].
BS 476-21, *Method for determination of the fire resistance of loadbearing elements of construction*[4)].
BS 476-22, *Method for determination of the fire resistance of non-loadbearing elements of construction*[4)].
BS 476-23, *Method for determination of the contribution of components to the fire resistance of a structure*[4)].
BS 476-30, *Method for measuring the performance of flat and sloping roofs exposed to an external fire*[4)].
BS 952, *Glass for glazing.*
BS 952-1, *Classification.*
BS 5588, *Fire precautions in the design and construction of buildings.*
BS 6262, *Code of practice for glazing for buildings.*
PD 6512, *Use of elements of structural fire protection with particular reference to BS 5588 "Fire precautions in the design and construction of buildings".*
PD 6512-1, *Guide to fire doors.*
PD 6512-2, *Examples of two designs of FD 30 rated fire doors*[4)].

[3)] Although BS 476-3 was revised in 1975, the 1958 edition is still cited in connection with building regulations; purchasers should ensure when ordering the 1958 edition that they quote the number BS 476-3/58. The 1975 edition of BS 476-3 is itself undergoing revision and will be replaced by BS 476-30.
[4)] In preparation.

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