BRITISH STANDARD

BS 6262-3:2005

Glazing for buildings —

Part 3: Code of practice for fire, security and wind loading

ICS 81.040.20

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee B/520, Glass and glazing in building, to Subcommittee B/520/4, Properties and glazing methods, upon which the following bodies were represented:

British Adhesives and Sealants Association

British Plastics Federaation

British Woodworking Federation

Consumer Policy Committee of BSI

Council for Aluminium in Building

Flat Glass Manufacturers' Association

Glass and Glazing Federation

Nottingham University

Office of the Deputy Prime Minister — Building Division

Office of the Deputy Prime Minister — represented by the BRE

RICS Building Control Forum

Co-opted members

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 18 October 2005

First published as BS 973, 1941
Second edition 1945
Third edition, as CP 152, January 1960
Fourth edition, August 1966
Fifth edition, July 1972
Sixth editiion, as BS 6262, June 1982
Seventh edition, as BS 6262-3, October 2005

The following BSI references relate to the work on this British Standard:
Committee reference B/520/4

Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 46773 2

Contents

Foreword

This part of BS 6262 has been prepared by Subcommittee B/520/4. It partially supersedes BS 6262:1982, which will be withdrawn upon publication of all seven parts of the newly revised and restructured BS 6262.

BS 6262:1982 is being revised and also restructured to simplify its use and will be published in seven parts:

— *Part 1: General methodology for the selection of glazing*;

— *Part 2: Code of practice for heat, light and sound*;

— *Part 3: Code of practice for fire, security and wind loading*;

— *Part 4: Code of practice for safety related to human impact*;

— *Part 5: Code of practice for frame design considerations*;

— *Part 6: Code of practice for special applications*;

— *Part 7: Code of practice for provision of information.*

Requirements for standards of workmanship for glazing have been published separately as BS 8000-7 and, therefore, this subject is not dealt with in this standard.

Since the correct selection of materials to be used in glazing for buildings depends on many factors, the recommendations in this part of the standard should be used in conjunction with those in the other parts.

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

In particular, attention is drawn to the following statutory regulations.

The Building Regulations 2000 [1].

The Building Regulations (Northern Ireland) [2].

The Building Standards (Scotland) Regulations 2004 [3].

Summary of pages
This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 35 and a back cover.

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1 Scope

This part of BS 6262 gives information and recommendations for vertical glazing in the external walls and interiors of buildings, with respect to fire safety, security and wind loading.

These recommendations apply only when the glass is installed in a glazing system specifically designed for the purpose.

These recommendations do not apply to:

a) patent glazing (see BS 5516-1);

b) glass in non-vertical applications (see BS 5516-2)

c) glazing for commercial greenhouses (see BS 5502-21);

d) glazing for domestic greenhouses.

Requirements for standards of workmanship for glazing have been published separately as BS 8000-7 and, therefore, this subject is not dealt with in this standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 476-4, *Fire tests on building materials and structures — Part 4: Non-combustibility test for materials.*

BS 476-6, *Fire tests on building materials and structures — Part 6: Method of test for fire propagation for products.*

BS 476-7, *Fire tests on building materials and structures — Part 7: Method of test to determine the classification of the surface spread of flame of products.*

BS 476-20, *Fire tests on building materials and structures — Part 20: Method for determination of the fire resistance of elements of construction (general principles).*

BS 476-22, *Fire tests on building materials and structures — Part 22: Methods for determination of the fire resistance of non-loadbearing elements of construction.*

BS 5051-1, *Bullet-resistant glazing — Part 1: Specification for glazing for interior use.*

BS 5544, *Specification for anti-bandit glazing (glazing resistant to manual attack).*

BS 5357, *Code of practice for installation of security glazing.*

BS 6180, *Barriers in and about buildings — Code of practice.*

BS 6262-4, *Glazing for buildings — Part 4: Code of practice for safety related to human impact.*

BS 6399-2:1997, *Loading for buildings — Part 2: Code of practice for wind loads.*

BS EN 356, *Glass in building — Security glazing — Testing and classification of resistance against manual attack.*

BS EN 1063, *Glass in building — Security glazing — Testing and classification of resistance against bullet attack.*

BS EN 1363, *Fire resistance tests.*

BS EN 1364, *Fire resistance tests for non-loadbearing elements.*

BS EN 1634, *Fire resistance tests for door and shutter assemblies.*

BS EN 13123-1, *Windows, doors and shutters — Explosion resistance — Requirements and classification — Part 1: Shock tube.*

BS EN 13123-2, *Windows, doors and shutters — Explosion resistance — Requirements and classification — Part 2: Range test.*

BS EN 13124-1, *Windows, doors and shutters — Explosion resistance — Test method — Part 1: Shock tube.*

BS EN 13124-2, *Windows, doors and shutters — Explosion resistance — Test method — Part 2: Range test.*

BS EN 13501-1, *Fire classification of construction products and building elements — Part 1: Classification using test data from reaction to fire tests.*

BS EN 13501-2, *Fire classification of construction products and building elements — Part 2: Classification using data from fire resistance tests, excluding ventilation services.*

BS EN 13541, *Glass in building — Security glazing — Testing and classification of resistance against explosion pressure.*

BS EN 13823:2002, *Reaction to fire tests for building products — Building products excluding floorings exposed to the thermal attack by a single burning item.*

BS EN ISO 1182:2002, *Reaction to fire tests for building products — Non-combustibility test.*

BS EN ISO 1716:2002, *Reaction to fire tests for building products — Determination of the heat of combustion.*

BS EN ISO 9239-1:2002, *Reaction to fire tests — Horizontal surface spread of flame on floor-covering systems — Part 1: Determination of the burning behaviour using a radiant heat source.*

BS EN ISO 11925-2:2002, *Reaction to fire tests — Ignitability of building products subjected to direct impingement of flame — Part 2: Single-flame source test.*

3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

3.1
aspect ratio
ratio of the longer side of a pane to its shorter side

3.2
glazing, noun
glass or plastics glazing sheet material, for installation into a building

3.3
glazing, verb
action of installing glass, or plastics glazing sheet material, into a building

3.4
insulating glass unit
an assembly consisting of at least two panes of glass, separated by one or more spaces, hermetically sealed along the periphery, mechanically stable and durable

[BS EN 1279-1:2004, definition **3.1**]

NOTE The individual panes may be of different sizes and/or thicknesses.

3.5
insulating glass
fire resistant glass that can resist the passage of flames, smoke and heat through the glass for a period of time (normally 30 min or longer), when tested in accordance with an appropriate fire resistance test method, without the unexposed surface temperature exceeding a specified limit

NOTE 1 Appropriate fire resistance test methods are BS 476-22, BS EN 1363, BS EN 1364, BS EN 1634.

NOTE 2 See also **3.6**.

3.6
integrity only glass
fire resistant glass that can resist the passage of flames and smoke through the glass for a period of time (normally 30 min or longer), when tested in accordance with an appropriate fire resistance test

NOTE 1 Appropriate fire resistance test methods are BS 476-22, BS EN 1363, BS EN 1364, BS EN 1634.

NOTE 2 See also **3.5**.

3.7
pane
single piece of glass or plastics glazing sheet material, in a finished size ready for glazing

3.8
plastics glazing sheet material
plastics material in the form of a single sheet, or a combination of sheets laminated together, or an extruded multi-wall sheet

3.9
pane size
dimensions of a pane

NOTE See Figure 1.

3.10
sight size
dimensions of the opening which, when glazed with a transparent or translucent material, admits light

NOTE See Figure 1.

3.11
tight size
dimensions of the rebated opening

NOTE 1 This is also know as the rebated size.

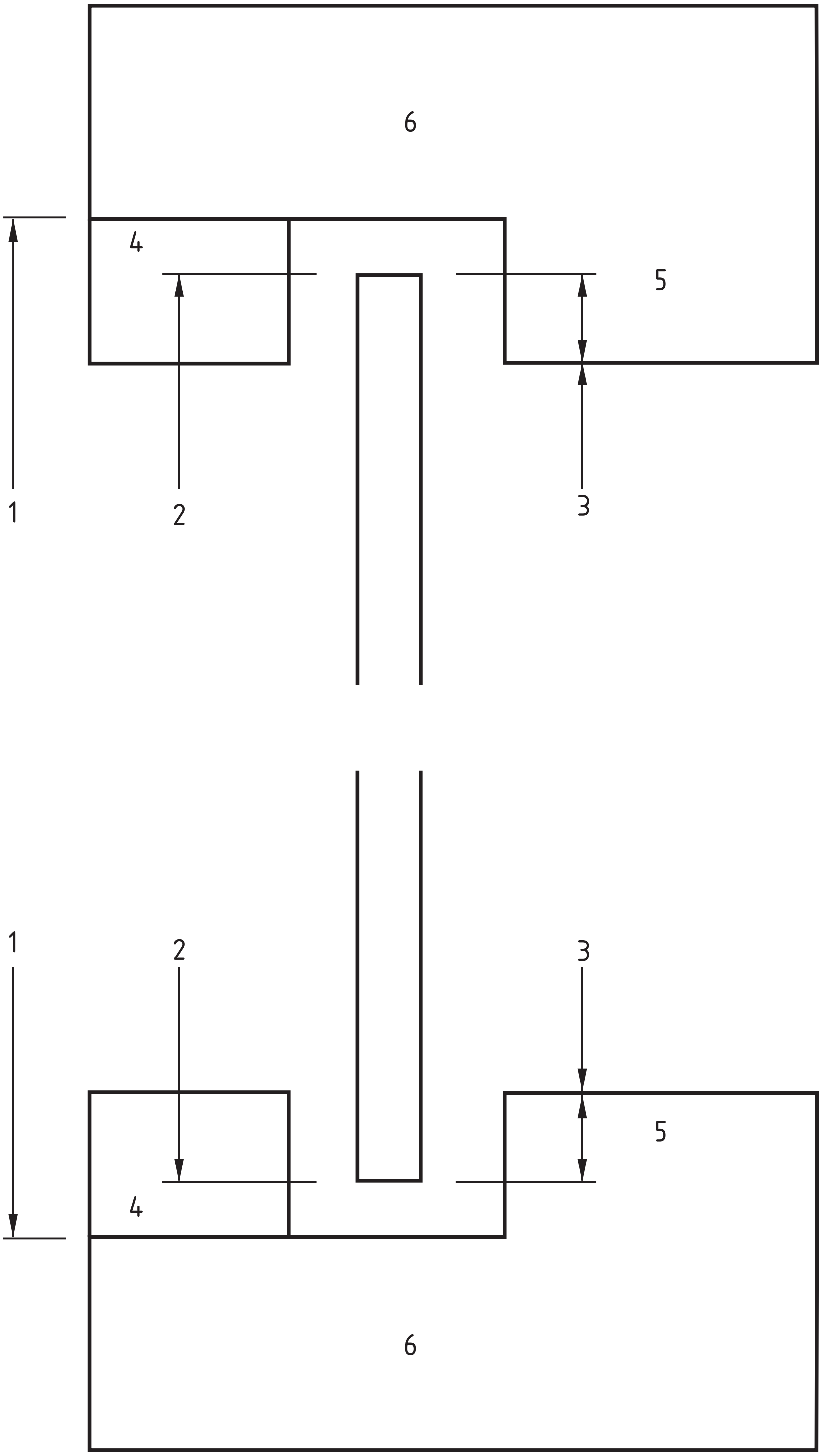
NOTE 2 See Figure 1.

3.12
edge cover
distance between the edge of the glass and the sight line

NOTE See Figure 1.

3.13
nominal dimensions
design size excluding tolerances

3.14
vertical glazing
glazing which is vertical, or within 15° of vertical



Key

1 Tight size
2 Pane size
3 Sight size
4 Bead
5 Edge cover
6 Frame

Figure 1 — Definition of size

4 Fire

4.1 Regulations and test standards

Structural fire precautions might need to consider the performance of glass and plastics glazing sheet materials. These precautions are controlled for new building work by building regulations and bylaws and by other fire safety legislation for occupied premises.

For new buildings, control is exercised separately in England (excluding Inner London) and Wales, Inner London, Scotland and Northern Ireland. The extent of control depends on the type of glass or plastics glazing sheet material and the method of specification, the particular location and the applicable regulations (see BS 6262-1:2005, Annex A) [1], [2], [3].

In determining the appropriate fire properties of glazing the tests given in Table 1 apply. Both European Standards and British Standards are accepted, but these should not be mixed and matched.

NOTE Building regulations generally only apply to the provision of reasonable standards of health and safety for people in buildings. Requirements other than regulatory ones (e.g. property protection) might need to be taken into account.

Generally, regulations are written in terms of performance under the standard fire tests but BS 5588 and other codes of practice dealing with means of escape in case of fire make specific mention in connection with the use of glass when fire resistance is required.

Table 1 — British and European Standards

British Standards	European Standards
Reaction to fire	
BS 476-4:1970. This test determines whether building materials are non-combustible within the meaning of the definition. Determination of combustibility is made by reference to the duration of any flaming or the increase in the temperature of the sample or furnace above a defined limit. *BS 476-6:1989*. The tests provide a means of comparing the contribution of building materials to the growth of a fire by measuring the rate of heat evolution. The performance is expressed as a numerical index from 0 to 100 or more, low values indicating a low rate of heat release. *BS 476-7:1987*. The tests are used to determine the tendency of materials to support the spread of flames across their surfaces and specifies a method of classification. The performances are expressed as four classes, class 1 representing the best performance. NOTE For Class 0, Tp(a) and Tp(b) see the appropriate building regulations [1], [2], [3].	According to European Commission Decision 96/603/EC (consolidated 2003/424/EC), glass, including annealed, heat strengthened, chemically strengthened, toughened and laminated, has been classified, in accordance with BS EN 13501-2, as long as there is less than 1 % organic content, as Class A1, as provided for in European Commission Decision 2000/147/EC, without the need for testing. For plastics glazing sheet materials, reaction to fire is determined and classified in accordance with BS EN 13501-1 based on the results of the following tests. BS EN ISO 1182 to test for combustibility. BS EN ISO 1716 to test for contribution to the growth of fire. BS EN 13823, BS EN ISO 11925-2 and BS EN ISO 9239-1 to test for surface spread of flame.
Fire resistance	
BS 476-20:1987 and BS 476-22:1987. These tests determine whether elements of construction retain their integrity against the passage of hot gases and provide, where necessary, resistance to heat transmission and heat radiation. Performances are expressed in minutes to failure by appropriate criteria.	BS EN 1363, BS EN 1364 and BS EN 1634. These tests determine whether elements of construction retain their integrity against the passage of hot gases and provide, where necessary, resistance to heat transmission and heat radiation. Performances are expressed in minutes to failure by appropriate criteria. Classification should be in accordance with BS EN 13501-1.

4.2 Information

Glass and plastics glazing sheet materials might need to satisfy requirements for:

a) surface spread of flame over room linings; and

b) the fire performance of external cladding; and

c) internal fire spread.

NOTE The information in the rest of this clause relates to fire performance of glass in relation to BS 476, since there is insufficient information to generalize performance in relation to the new European Standards.

Where glass is incorporated within elements of escape routes, etc., the glazed installation should satisfy the necessary period of fire resistance in terms of the criteria specified in BS 476-22.

The ability of elements to conform to fire resistance requirements will depend on the type of material, its thickness, size, height to width ratio of pane, type of frame, method of fixing, the form of the construction surrounding the glazed area, and whether or not the element consists of a single pane.

Only certain types of glazed installations are able to satisfy the fire resistance requirements specified in terms of BS 476-22. Periods up to two hours are obtainable for integrity and insulation, or integrity only, depending on the glazed elements and the frame design. No restrictions are made on the use of glazed systems meeting the full fire resistance performance in terms of both integrity and insulation, but those systems not providing adequate insulation might be limited under BS 5588 and building regulations, e.g. when dealing with building/room compartmentation, the protection of escape routes etc.

Reference to BS 6262-4 should be made when impact safety requirements need to be taken into account in addition to fire resistance.

Information on the fire performance of glazing, i.e. glass and plastics glazing sheet materials, and of glazed systems (e.g. fire-resisting doors and partitions) should be obtained from the manufacturers of the material, component or system.

4.3 Glass

4.3.1 *Reaction to fire*

Monolithic glass is not combustible and will generate no heat and make no contribution to the spread of a fire. On the other hand, it is thin and transparent and heat from a fire can quickly transmit through it, either by radiation or conduction.

Laminated glass can contain plastics materials, which in themselves are combustible. Being a relatively small proportion of the product and being encapsulated by the glass, these plastics do not produce significant amounts of heat. As such laminated glass makes a negligable contribution to the spread of fire. (See Table 2.)

Soda lime silicate glass is classified as non-combustible when tested in accordance with BS 476-4. Laminated products in which the outer layers comprise soda lime silicate glass will have non-combustible exposed surfaces, and as such should be acceptable in any wall lining. (See Table 2.)

The fire performance properties of various types of glass are given in Table 2.

4.3.2 *Fire resistance*

4.3.2.1 *Annealed glass, e.g. float glass, patterned glass, excluding wired glass*

Under fire conditions annealed glass will crack and tend to fall from its frame. In very small panes, the cracked pieces can remain in position, depending on the framing system and glazing method, and provide limited integrity only (known as Copper light glazing).

NOTE For specific advice on maximum tested pane sizes of Copper light glazing, contact the supplier.

4.3.2.2 *Annealed glass: wired glass*

Wired glass will crack under fire conditions, but the presence of the wires tends to hold it together. Depending on the framing system and glazing method, wired glass can give considerable periods of integrity only.

Table 2 — Fire properties of glass (excluding fire resistance[a])

Type	Non-combustibility tested in accordance with BS 476-4:1984	Fire propagation index tested in accordance with BS 476-6:1989	Surface spread of flame[b] tested in accordance with BS 476-7:1987
Annealed (non-wired)	Non-combustible[c]	$I < 12$ and $i_1 < 6$	Class 1
Wired	Non-combustible[c]	$I < 12$ and $i_1 < 6$	Class 1
Toughened	Non-combustible[c]	$I < 12$ and $i_1 < 6$	Class 1
Laminated			
a) PVB (polyvinylbutyral) interlayer	Combustible	$I < 12$ and $i_1 < 6$[c]	Class 1[c]
b) intumescent interlayer	Non-combustible[c]	$I < 12$ and $i_1 < 6$	Class 1
c) gel interlayer	Non-combustible[c]	$I < 12$ and $i_1 < 6$	Class 1
d) resin interlayer[d]	—	—	—
Borosilicate	Non-combustible[c]	$I < 12$ and $i_1 < 6$	Class 1
Glass blocks	Non-combustible	$I < 12$ and $i_1 < 6$	Class 1

[a] See Table 3.
[b] The performance might be different where adhesive films have been applied.
[c] Materials termed "non combustible" satisfy the requirements for class 0 combustible materials.
[d] The performance of laminated glass constructed with resin interlayers has not been tested.

4.3.2.3 *Laminated glass*

The individual panes of laminated glass will behave in the same way as for the particular glass type described elsewhere in this standard.

If the interlayer material is a plastic, not specifically designed for fire resistance, it will quickly break down and make no effective contribution to fire resistance.

If the interlayer is specially formulated to contribute towards fire resistance, the laminated glass, depending on the framing system and glazing method, can give considerable periods of integrity and insulation.

4.3.2.4 *Toughened glass and heat soaked toughened glass*

Thermally toughened and heat soaked thermally toughened soda lime silicate glass is very resistant to thermal breakage from solar radiation, but cannot normally be expected to survive fire conditions. It will break and fall from its frame.

Modified toughened glass (highly toughened soda lime silicate glass with specially treated edges glazed in specially designed glazing systems) can give periods of integrity only.

Thermally toughened borosilicate glass is extremely resistant to thermal breakage and, depending on the framing system and glazing method, can give periods of integrity only.

4.3.2.5 *Heat strengthened glass*

Heat strengthened soda lime silicate glass will perform in the same way as annealed glass (see **4.3.2.1**).

4.3.2.6 *Glazed installations/assemblies*

Only certain types of glazed installations have performed adequately under BS 476-22:1987 test conditions or have been permitted under deemed-to-satisfy provisions in codes of practice and bye-laws.

Table 3 and Table 4 indicate the potential fire resistance of some types of glass, assuming they are glazed in an appropriate manner.

Table 3 — Fire properties of integrity only glass when tested in accordance with BS 476-22:1987 and glazed in suitably designed systems[a]

Type	Nominal thickness mm	Type of system[b]	Comments	Test results[c] integrity only
Annealed (non-wired)	6	Small panes for Copper light panels	—	30 min
Wired	6 and 7	Timber or steel frames, single or multiple panes	—	up to 2 h
Modified toughened	5 to 12	Special glazing systems[d]	This should not be confused with normal toughened glass	up to 1 h
Special fire resistant laminated	7 to 13	Timber or steel frames, single or multiple panes	Performance depends on interlayer type	up to 1 h
Borosilicate	6	Steel frames, single or multiple panes	Glass with a low coefficient of expansion	up to 2 h
Glass ceramic	5 to 10	Steel frames, single or multiple panes	Glass with a low coefficient of expansion	up to 2 h
Glass blocks	80	—	—	up to 1 h

[a] Integrity only glass should conform to BS 476-22, BS EN 1363, BS EN 1364 or BS EN 1634.
[b] The detailing of the glazing system and its fixture to the building structure plays a critical part in the fire performance of glazed walls. Glazing systems which have test-proven fire resistance with appropriate glass types should be used. The manufacturer's recommendations should be followed.
[c] This table is based on publicly available data. The levels of performance given do not represent the maximum that can be achieved, but indicate levels of performance which have been achieved using specific glazing systems and which can be substantiated with test evidence from either the glass or frame manufacturer.
[d] The edge cover can affect the fire resistance

Table 4 — Fire properties of insulated glass when tested in accordance with BS 476-22:1987 and glazed in suitably designed systems[a]

Type mm	Nominal product thickness	Type of system[b]	Test results[c] integrity and insulation
Intumescent	12 to 50	Timber or steel frames, single or multiple panes	up to 2 h
Gel interlayer[d]	22 to 74	Timber or steel frames, single or multiple panes	up to 90 min

[a] Insulated glass should conform to BS 476-22, BS EN 1363, BS EN 1364 or BS EN 1634.
[b] The detailing of the glazing system and its fixture to the building structure plays a critical part in the fire performance of glazed walls. Glazing systems which have test-proven fire resistance with appropriate glass types should be used. The manufacturer's recommendations should be followed.
[c] This table is based on publicly available data. The levels of performance given do not represent the maximum that can be achieved, but indicate levels of performance which have been achieved using specific glazing systems and which can be substantiated with test evidence from either the glass or frame manufacturer.
[d] Laminated glass incorporating inorganic interlayers, normally based on sodium silicate, that expand to several times their original thickness on exposure to fire conditions

4.4 Plastics glazing sheet materials

Table 5 gives a brief summary of the fire performance of plastics glazing sheet materials. Manufacturers should be consulted regarding the detailed performance of specific products.

Where regulations and requirements specify materials used for glazing in terms of their fire resistance performance careful note should be taken of the following points when using plastics glazing sheet materials.

a) Different plastics glazing sheet materials can have different properties. The basic types of plastics glazing sheet materials can have surface spread of flame classifications under BS 476-7:1987.

b) Some regulations have specific and arbitrary systems of classification of thermoplastics materials.

c) Where regulations have as part of their requirements reference to BS 476-4:1970 for non-combustibility (and BS 476-22 for fire resistance), it should be noted that thermoplastics glazing sheet materials do not meet this requirement.

Attention is drawn to mandatory legislation with regard to fire test information on the form and type of plastics glazing sheet materials obtained from manufacturers.

Where plastics glazing sheet materials are specified because of other design parameters described in this standard, authorization for its use might require waivers or relaxations in respect of fire performance.

Table 5 — Fire properties of plastics glazing sheet materials

Type	BS 476-6	BS 476-6	Class O[a]	TP(a[a])	TP(b)[a]
Solid sheet					
Polycarbonate	Some forms, with satisfactory results	Most Class 1	Some forms	≥ 3 mm[b]	Not applicable
PVC-U	Some forms, with satisfactory results	Most Class 1	Some forms	All	All
Acrylic	—	Class 3	—	Not applicable	All
Hollow section sheet					
Polycarbonate	Some forms, with satisfactory results	Some forms, Class 1	Some forms	Some forms, if they meet Class 1 to BS 476-7:1997	All
PVC-U	—	Some forms, Class 1	—	Some forms, if they meet Class 1 to BS 476-7:1997	All
Acrylic	—	—	—	—	All

[a] See Building Regulations England and Wales, Approved Document B [4].
[b] For smaller thicknesses, consult the manufacturer.

5 Security

5.1 General

Security glazing is used in situations where a high degree of protection either to persons or property is required, either against violent, malicious manual attack, or the use of firearms, or against the effect of explosions.

5.2 Manual attack

5.2.1 *Glass*

BS EN 356 specifies requirements, test methods and classifications for glass resistant to manual attack. Classification is by means either of a ball drop test or, for higher performance levels, by means of a hammer/axe test. There are five levels of ball drop test and three levels of hammer axe test.

5.2.2 ***Plastics glazing sheet materials***

BS 5544 specifies requirements and test methods for glazing, i.e. plastics glazing sheet materials, resistant to manual attack. It does not give different classes of performance, i.e. a material either passes or fails.

5.3 Firearm attack

5.3.1 ***Glass***

BS EN 1063 specifies requirements, test methods and classifications for glass resistant to ballistic attack. It covers three handguns, four rifles and two shotguns.

5.3.2 ***Plastics glazing sheet materials***

BS 5051 specifies performance requirements and type tests for six classes of bullet resistant glazing. The standard covers three handguns, two rifles and one shotgun.

5.3.3 ***Risk/threat***

Specialist advice should be sought on the appropriate types of weapons and ammunition for particular risk situations. Based on this knowledge the correct class of material can be specified.

5.4 Explosion resistance

BS EN 13541 specifies performance requirements and test methods for glass resistant to explosion pressure. The test is by means of a shock tube rather than by range testing.

BS EN 13123-1 and BS EN 13123-2 specifies requirements and classification for explosion resistance of windows, doors and shutters. BS EN 13124-1 and BS EN 13124-2 give the test methods for shock tube and range test.

The risk/threat should be specified by appropriate specialists. Advice on the use of special glass types and fixing systems should be obtained.

NOTE There is no specific test method for plastics glazing sheet materials. However, their performance could be determined by testing as part of a window and/or door.

5.5 Installation

BS 5357 gives recommendations for the installation within buildings of bullet resistant glazing and glazing resistant to manual attack. For explosion resistant glazing and also for security glazing intended for use in external situations, advice should be sought from the manufacturer.

5.6 Glass

Laminated glass can be designed to provide any specified degree of resistance to penetration. The composition of the laminated glass will depend on the level of protection required. The manufacturer of the laminated glass should be consulted on the design of the glazing system and the fixing procedures required.

5.7 Plastics glazing sheet material

Different types of plastics glazing sheet materials can provide varying degrees of resistance to breakage and penetration. The manufacturer of the plastics glazing sheet materials should be consulted on the design of the glazing system and the fixing procedures required. In some situations it can also be necessary to take account of the fire properties of such materials in addition to the security aspect.

5.8 Means of escape

Particular care should be taken when designing and installing security glazing systems that the means of escape from the buildings in emergency situations, e.g. in the case of fire, are not prejudiced by the enhanced security. In such cases, specialist advice should be sought and the provision of additional means of escape can be necessary.

6 Wind loading

6.1 General

This clause describes a method for determining the minimum glazing specification for resisting wind loading. The designer or specifier should also take into account any other forms of loading to which the glazing might be subjected, in particular, the recommendations of BS 6262-4 and of BS 6180 where these apply.

As a general rule a minimum wind loading of 600 N/m^2 should be applied to glazing in any location.

6.2 Method of determination of design loading

The design wind loading should be determined by the method described in BS 6399-2. If the complexities are beyond the scope of that standard, further advice should be sought.

For low-rise buildings an abbreviated method of determining the design wind loading may be used, employing Figure 2, Table 6 and Table 7, as described in **6.3**. Although the wind loading so determined might not be identical to a loading derived from BS 6399-2, it will be sufficiently accurate to be used for most low-rise buildings.

6.3 Abbreviated method of determination of design loadings for low-rise buildings

To find the design wind loading, select:

a) the basic wind speed from Figure 2;

b) the site terrain category from Table 6;

then use these to obtain the wind loading at sea level from Table 7.

To obtain the design wind loading for the site, multiply the wind loading at sea level by the factor

$$F_A = \left(1 + \frac{H_A}{1\ 000}\right)^2$$

where

H_A is the altitude of the site in metres, and also by the topographical factor F_T from Table 8. If the resulting design wind loading is less than 600 N/m^2, use a value of 600 N/m^2.

Any form of roof glazing including vertical glazing, such as dormer windows, might be subjected to higher loads than those on vertical walls. Funnelling of the wind between adjacent buildings can also affect the loading. To cope with these situations, the design wind load should be multiplied by a further factor of 1.6.

This abbreviated method assumes a combined pressure coefficient of 1.5, which takes into account that the glazed area can be exposed to pressure on one side and suction on the other.

It is recommended that if, having found the required glass or plastics glazing sheet material thickness for wind loading using this abbreviated method, the required glazed area is close to the maximum area suitable for the exposure, then the exposure should be reassessed using BS 6399-2.

The limitation of the abbreviated method is that the buildings are not more than 15 m in overall height.

If this limitation is not valid, then the method described in BS 6399-2 should be used.

Table 6 — Site terrain categories

Description	Category
Open country up to 10 km from open sea	A
Open country more than 10 km and up to 50 km from open sea	B
Open country more than 50 km from open sea	C
Town areas up to 10 km from open sea	D
Town areas more than 10 km and up to 50 km from open sea	E
Town areas more than 50 km from open sea	F
NOTE For sites less than 0.3 km from the edge of town, the site terrain category should be taken as open country.	

Table 7 — Design wind loading at sea level

Basic wind speed from Figure 2 m/s	Height of building m	Design wind loading for site terrain category (see Table 6) N/m²					
		A	B	C	D	E	F
20	≤ 5	1 001	907	850	752	660	612
	>5 and ≤10	1 178	1 101	1 038	989	918	861
	>10 and ≤15	1 272	1 232	1 152	1 088	1 026	977
21	≤ 5	829	1 000	937	829	728	675
	>5 and ≤10	1 299	1 214	1 144	1 091	1 012	949
	>10 and ≤15	1 403	1 358	1 270	1 200	1 131	1 077
22	≤ 5	910	1 097	1 028	910	799	741
	>5 and ≤10	1 426	1 332	1 256	1 197	1 111	1 042
	>10 and ≤15	1 540	1 490	1 394	1 317	1 241	1 182
23	≤ 5	995	1 199	1 124	995	873	809
	>5 and ≤10	1 559	1 456	1 373	1 308	1 214	1 139
	>10 and ≤15	1 683	1 629	1 524	1 439	1 357	1 292
24	≤ 5	1 083	1 305	1 224	1 083	951	881
	>5 and ≤10	1 697	1 585	1 495	1 424	1 322	1 240
	>10 and ≤15	1 832	1 774	1 659	1 567	1 477	1 407
25	≤ 5	1 175	1 417	1 328	1 175	1 032	956
	>5 and ≤10	1 841	1 720	1 622	1 546	1 435	1 345
	>10 and ≤15	1 988	1 925	1 800	1 700	1 603	1 527
26	≤ 5	1 271	1 532	1 436	1 271	1 116	1 034
	>5 and ≤10	1 992	1 860	1 754	1 672	1 552	1 455
	>10 and ≤15	2 150	2 082	1 947	1 839	1 734	1 651
27	≤ 5	1 371	1 652	1 549	1 371	1 204	1 115
	>5 and ≤10	2 148	2 006	1 892	1 803	1 673	1 569
	>10 and ≤15	2 319	2 245	2 100	1 983	1 869	1 781
28	≤ 5	1 474	1 777	1 666	1 474	1 294	1 200
	>5 and ≤10	2 310	2 158	2 035	1 939	1 800	1 688
	>10 and ≤15	2 494	2 414	2 258	2 133	2 010	1 915
29	≤ 5	1 581	1 906	1 787	1 581	1 389	1 287
	>5 and ≤10	2 478	2 314	2 183	2 080	1 930	1 810
	>10 and ≤15	2 675	2 590	2 423	2 288	2 157	2 055
30	≤ 5	1 692	2 040	1 912	1 692	1 486	1 377
	>5 and ≤10	2 652	2 477	2 336	2 226	2 066	1 937
	>10 and ≤15	2 863	2 771	2 593	2 448	2 308	2 199
31	≤ 5	1 807	2 178	2 042	1 807	1 587	1 470
	>5 and ≤10	2 831	2 645	2 494	2 377	2 206	2 069
	>10 and ≤15	3 057	2 959	2 768	2 614	2 464	2 348

NOTE 1 The values are rounded to the nearest whole number.

NOTE 2 N/m² = Pa.

NOTE 3 The derivation of this table is shown in Annex A.

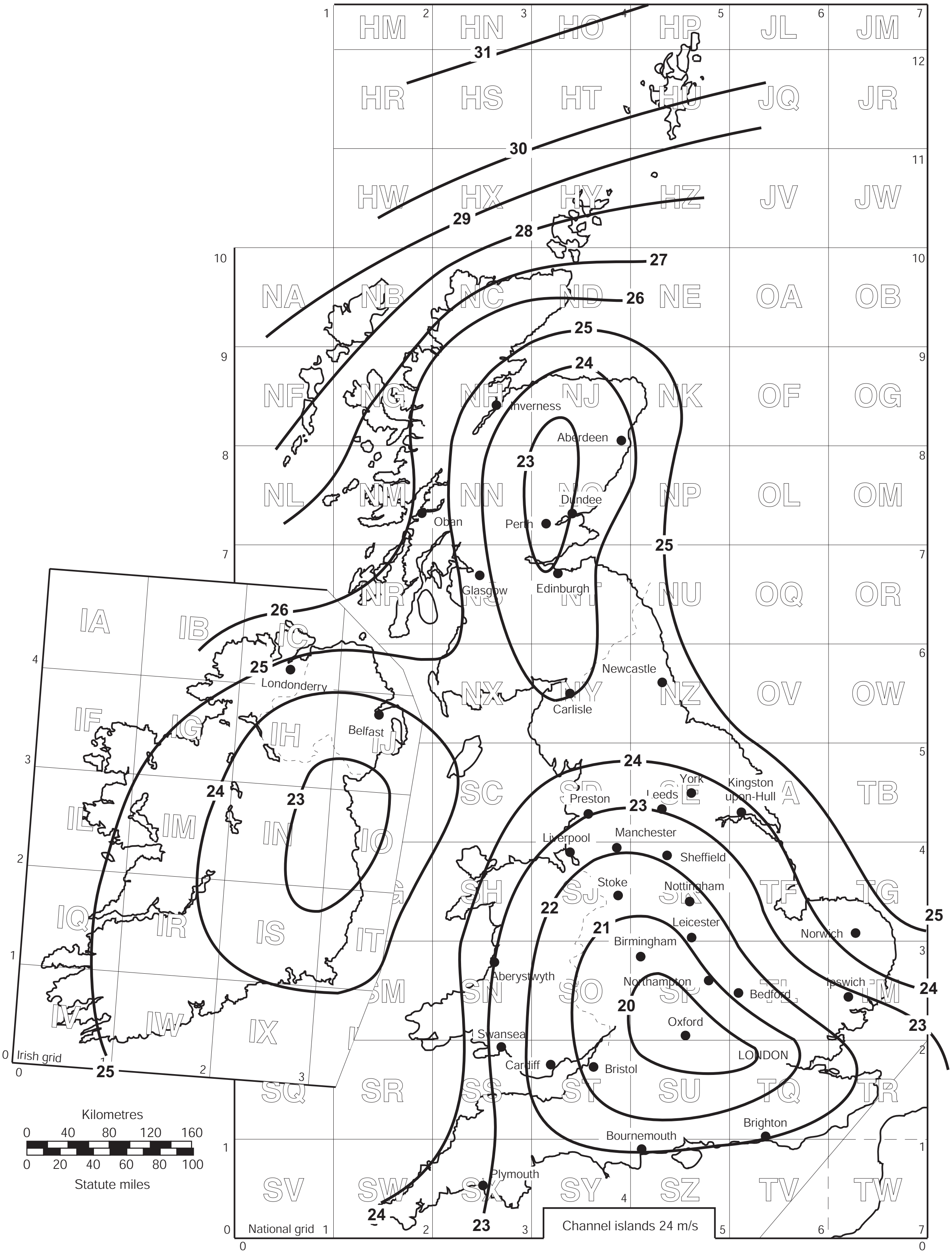
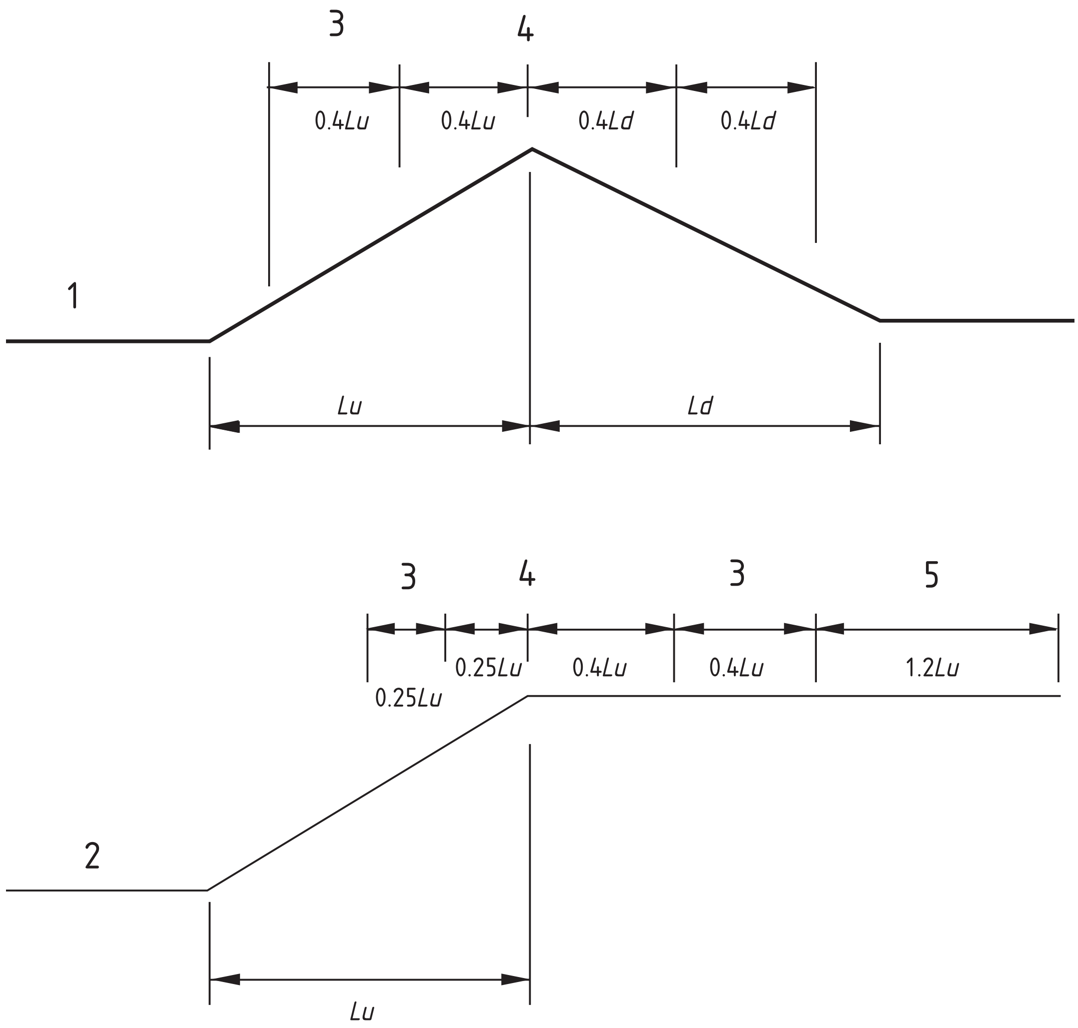


Figure 2 — Basic wind speed map (from BS 6399-2:1997)

Table 8 — Topographical factor

Topographical category and description	Factor F_T, according to zone from Figure 3			
	Zone 1	Zone 2	Zone 3	Elsewhere
Category 1: Nominally flat terrain ground slope <1/20	1.0	1.0	1.0	1.0
Category 2: Moderately steep terrain ground slope ≤1/5	1.54	1.28	1.21	1.0
Category 3: Steep terrain ground slope >1/5	1.85	1.44	1.32	1.0



Key

1 Hills and ridges

2 Cliffs and escarpments

3 Zone 2

4 Zone 1

5 Zone 3

NOTE Lu is the length of upwind slope and Ld is the length of downwind slope.

Figure 3 — Topographic zones

6.4 Strength of glass to withstand uniform loading

6.4.1 *General*

The procedure given in **6.4.2** is for glazing with four-edge fully supported rectangular panes of glass, as described in BS 952-1. The procedure applies to single glazing, to insulating glass units and to all other forms of double glazing, whether sealed, openable or permanently ventilated.

For glass to be considered as four-edge fully supported, the deflection of each edge should be limited to glass span/125 for single glazing and glass span/175 for insulating glass units.

6.4.2 *Use of wind loading graphs to determine thickness of glass*

The design wind loadings (see note), for pressure and suction, should be determined from either **6.3** or BS 6399-2. Glass having to withstand only low wind loadings, or glass used internally, might require to be increased in thickness to keep its deflection within acceptable limits.

NOTE BS 6399-2 results in a short duration gust wind loading for use in design. The strength of glass is lower for sustained loadings. When sustained loading is liable to occur, detailed advice should be obtained from the glass manufacturer.

For four-edge fully supported panes, Figure 4, Figure 5, Figure 6, Figure 7, Figure 8, Figure 9, Figure 10 and Figure 11 (see also **6.6**) should be used for the appropriate glass type, and the procedure should be as follows.

a) Calculate the area (A), $A = a \times b$, and the aspect ratio (r), $r = a/b$, where a is the longer dimension and b is the shorter.

NOTE If r is greater than three Figure 4, Figure 5, Figure 6, Figure 7, Figure 8, Figure 9, Figure 10 and Figure 11 do not apply and the manufacturer should be consulted.

b) Calculate the shape factor for effective area (F), $F = 4r/(r + 1)^2$. Some values are given in Table 9.

Table 9 — Shape factors

r	*F*
1.0	1.000
1.25	0.988
1.5	0.960
1.75	0.926
2.0	0.889
2.5	0.816
3.0	0.750

c) Calculate the effective area of the glass $A_e = F \times A$

d) On the appropriate graph from Figure 4, Figure 5, Figure 6, Figure 7, Figure 8, Figure 9, Figure 10 and Figure 11, determine the point where the vertical line for the required wind loading intersects the horizontal line for the effective area.

e) If the point of intersection is above the line for the glass type being considered, then a stronger glass is required.

f) If the point of intersection is on or below the line for the glass type being considered, then the glass is adequate to resist the wind load.

Calculated examples are given in Annex B.

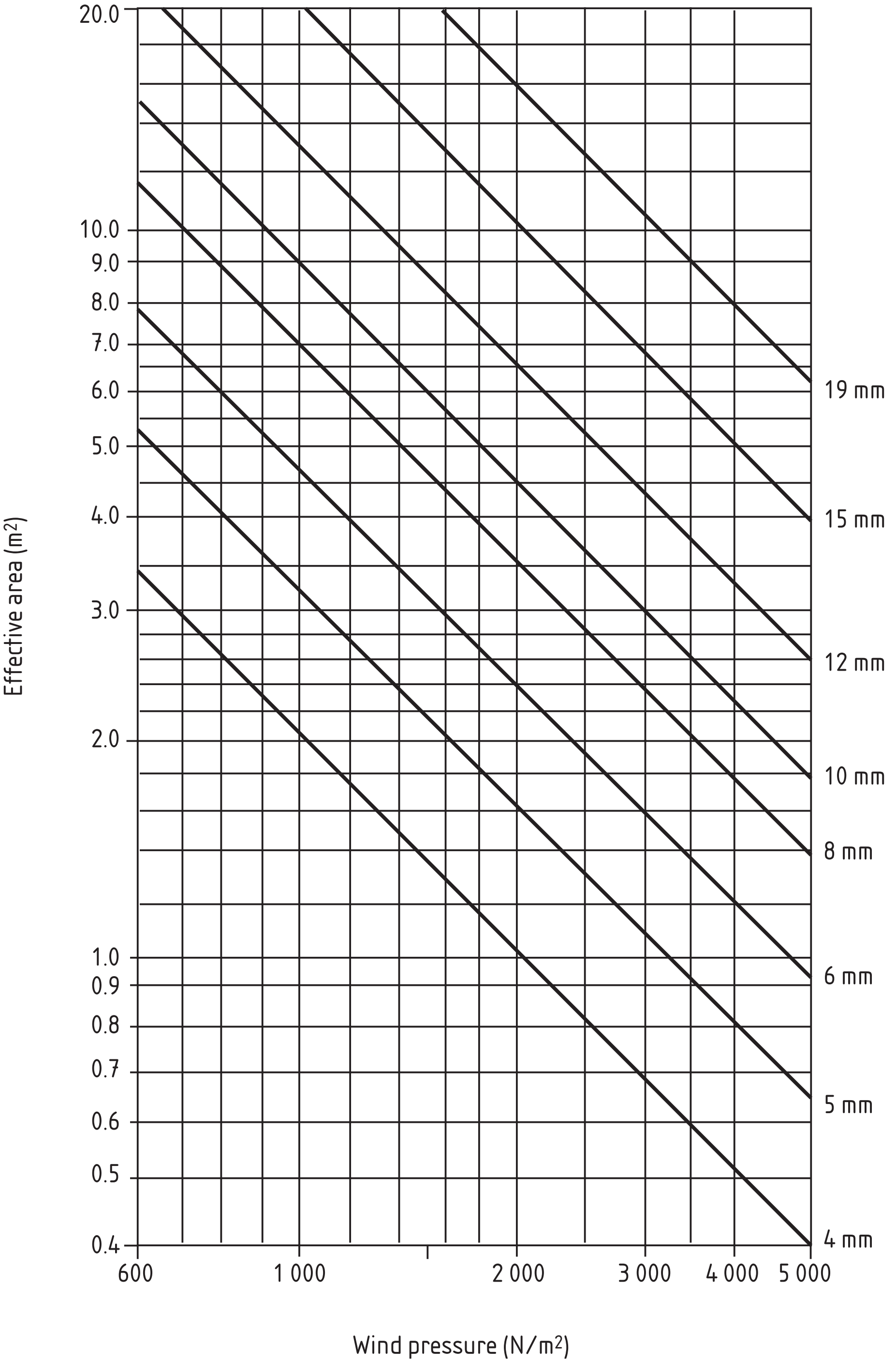


Figure 4 — Float glass wind load resistance

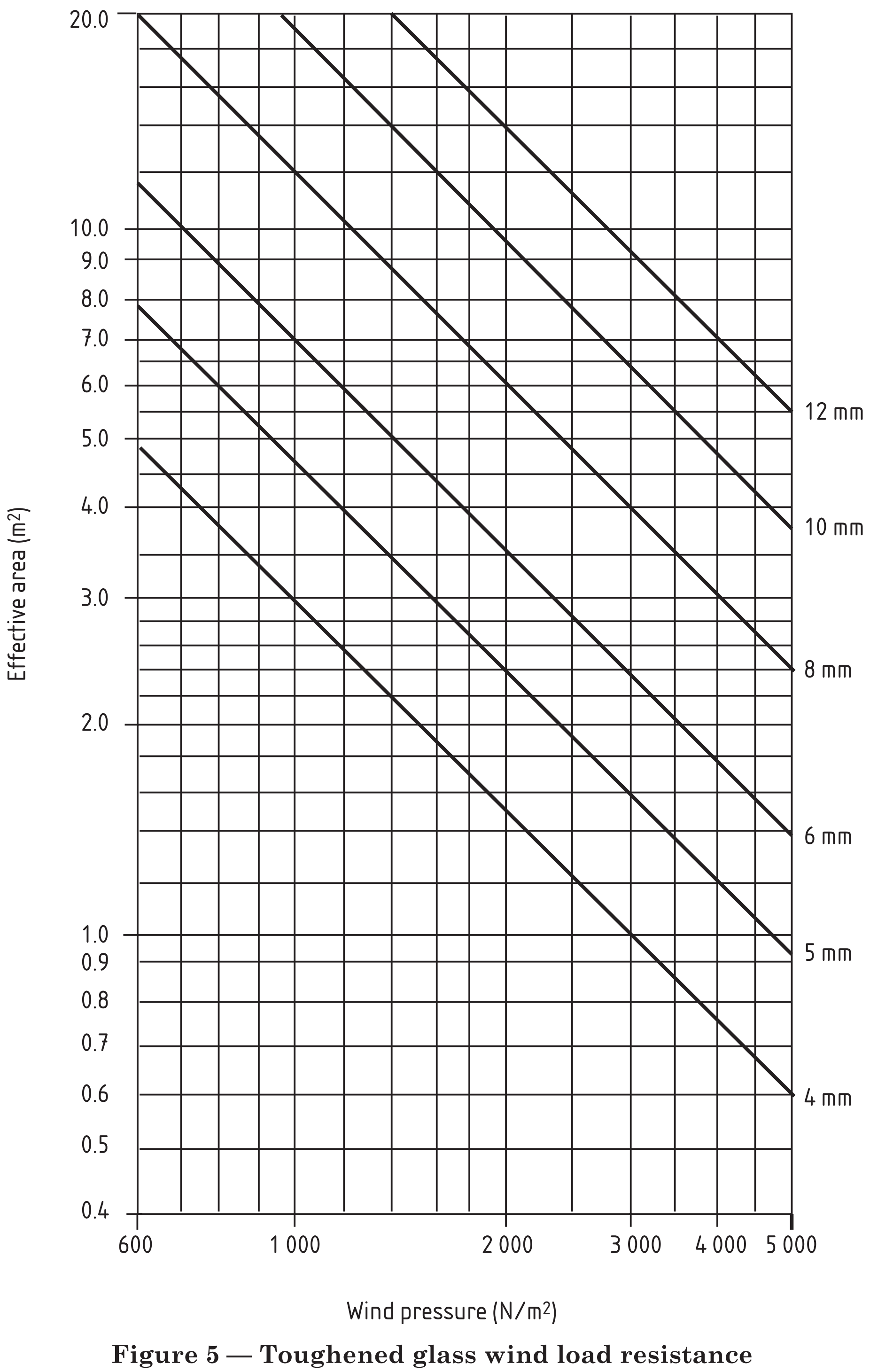


Figure 5 — Toughened glass wind load resistance

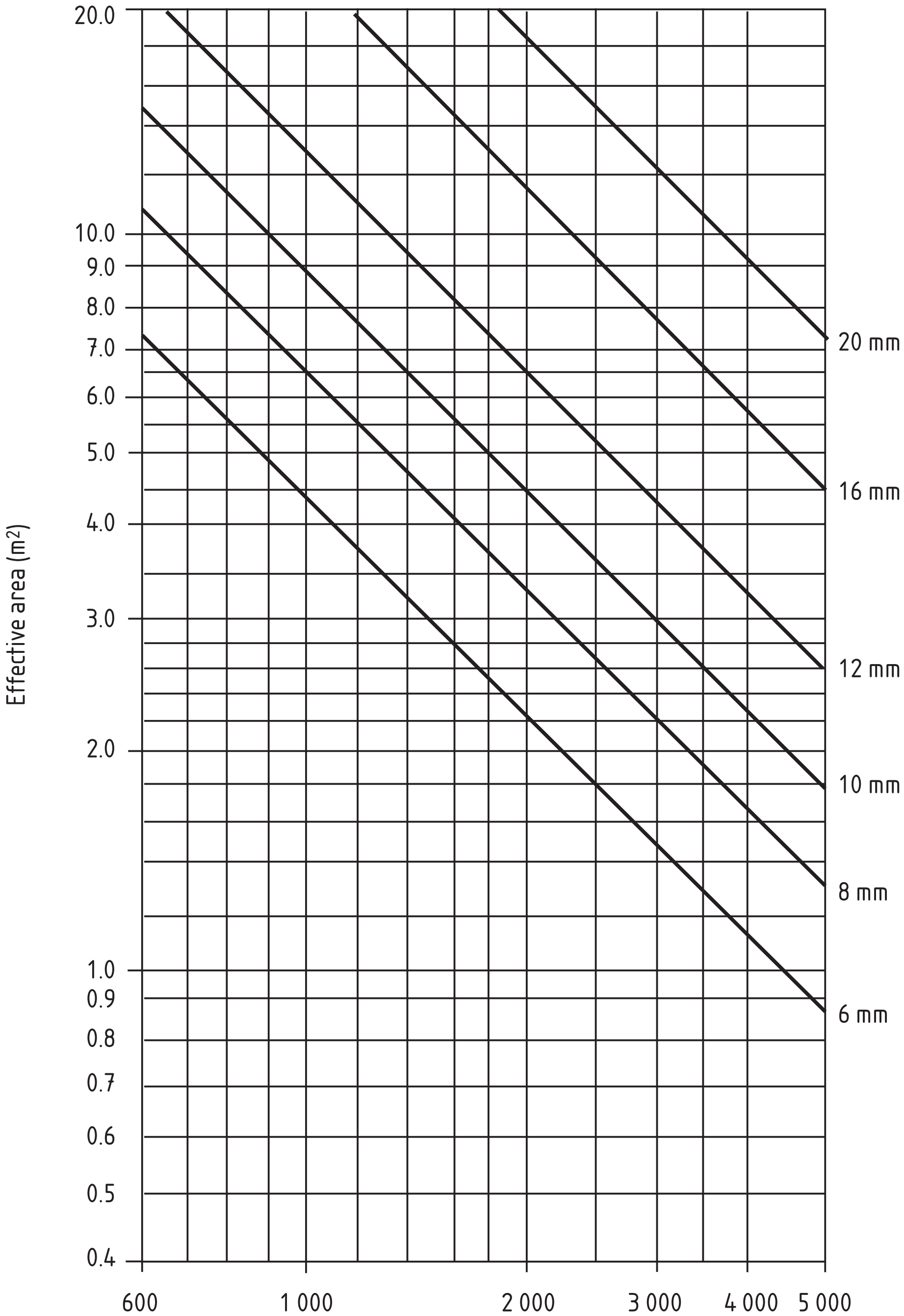
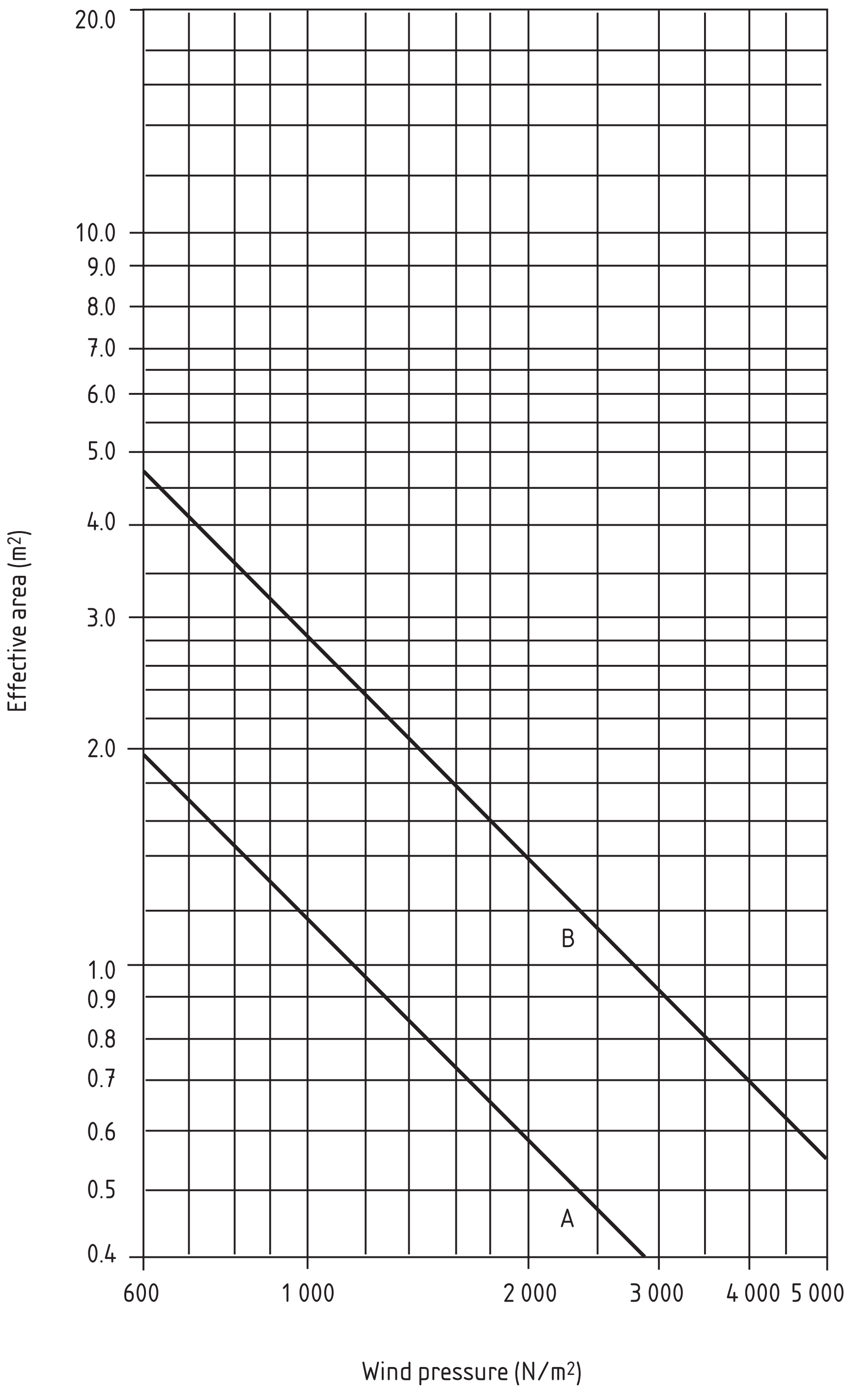


Figure 6 — Laminated glass wind load resistance



Key

A 4 mm patterned glass

B 6 mm patterned glass, 6 mm polished wired glass, 7 mm wired patterned glass

Figure 7 — Patterned glass and wired glass wind load resistance

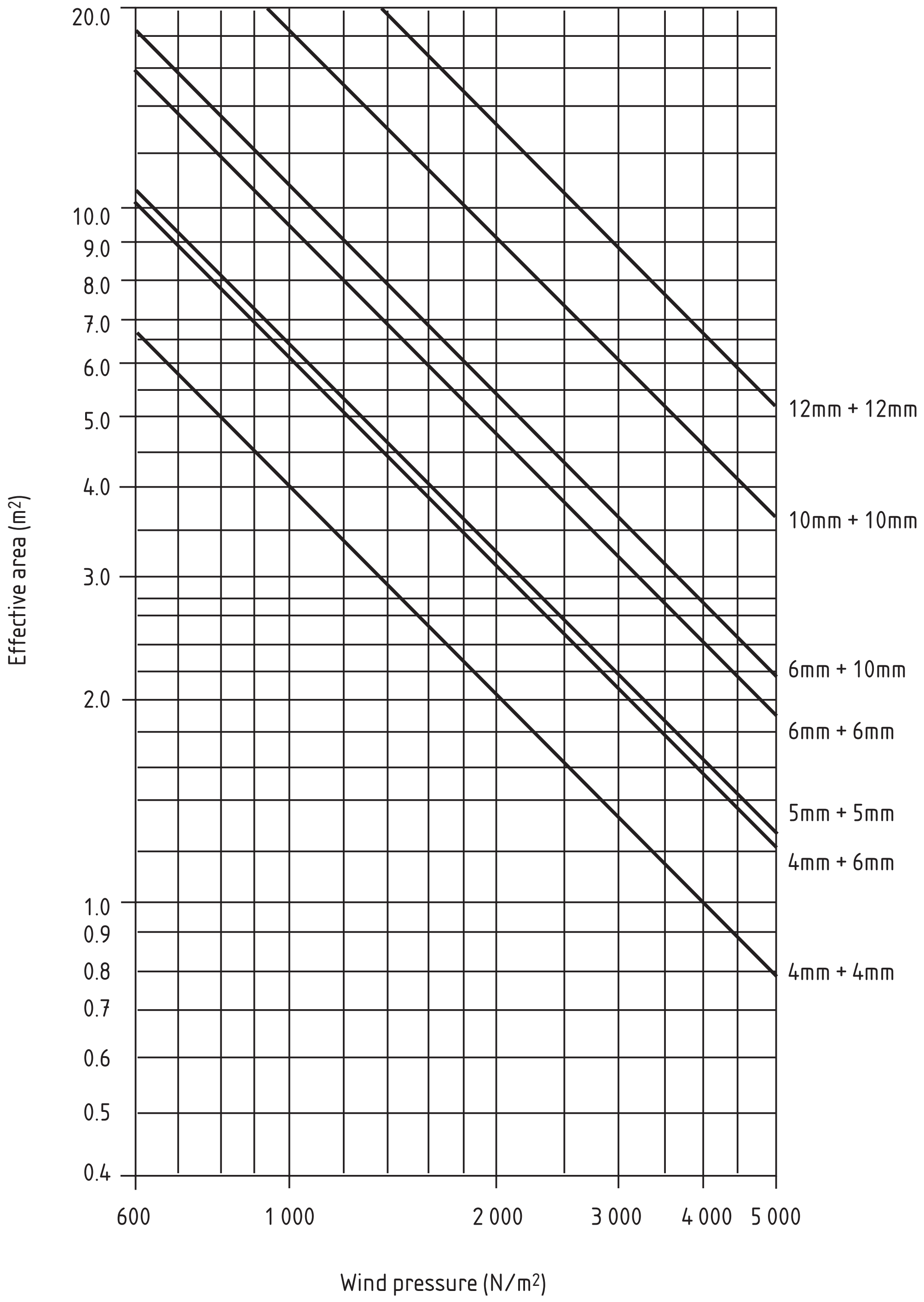


Figure 8 — Float glass insulating units wind load resistance

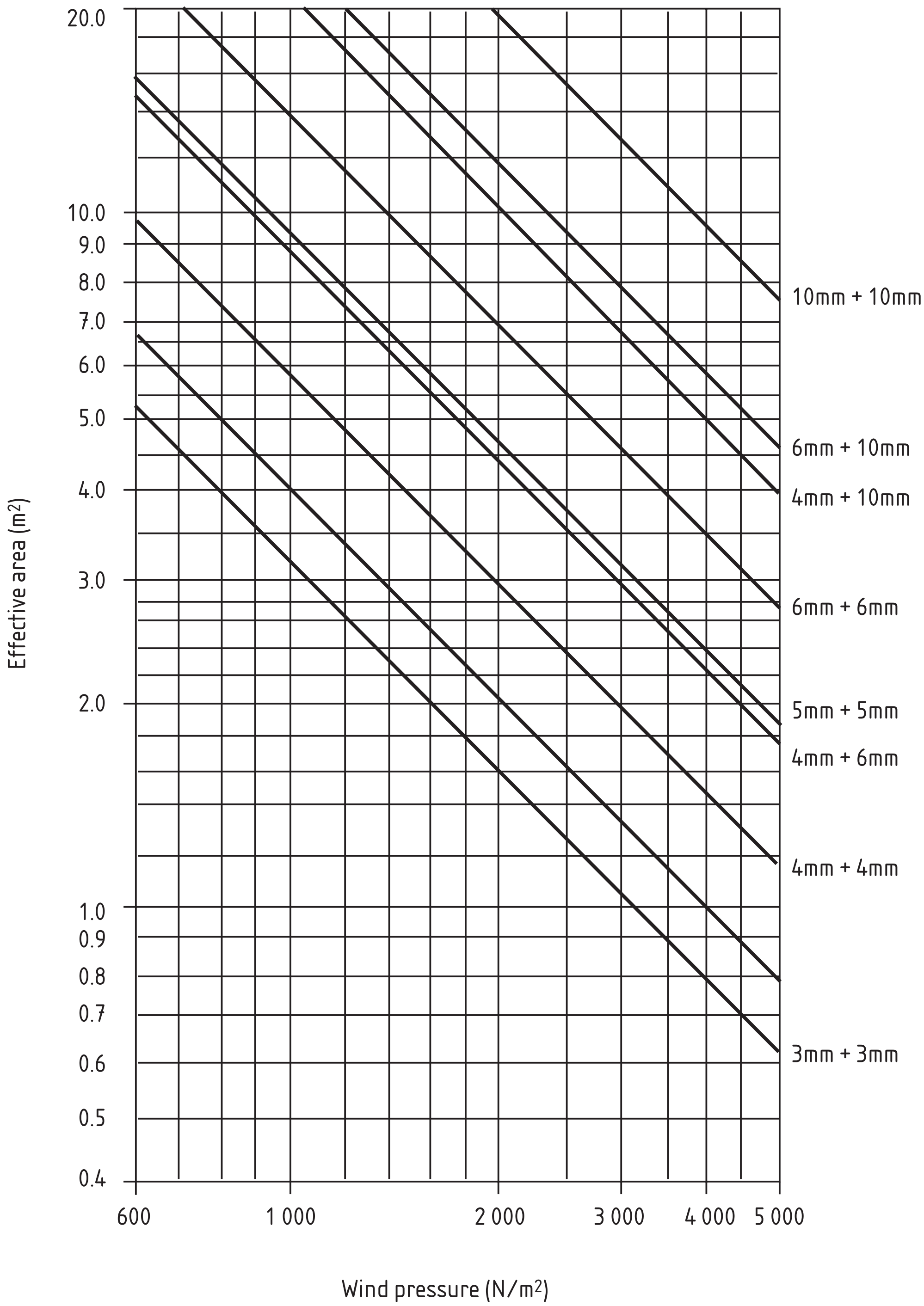
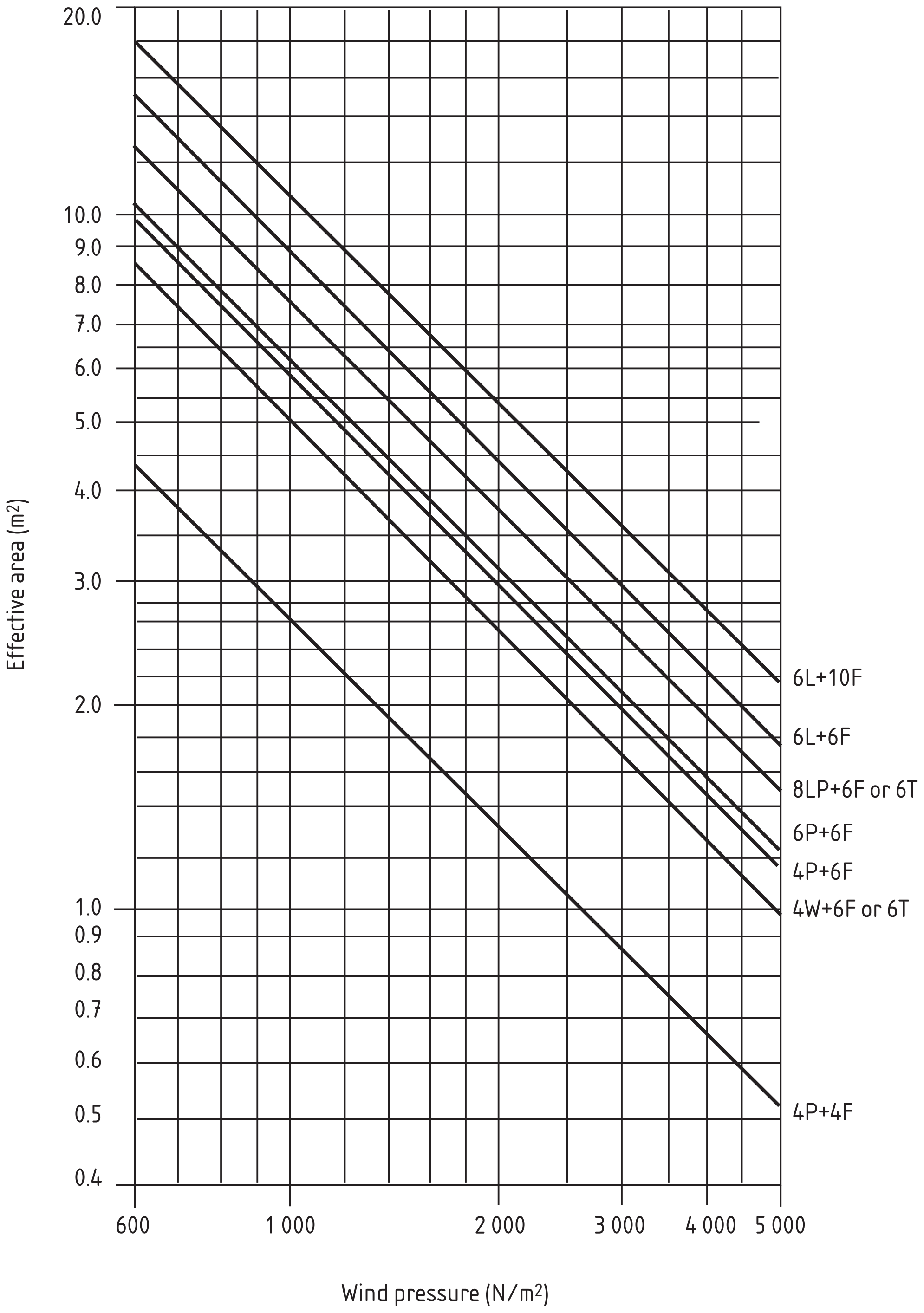


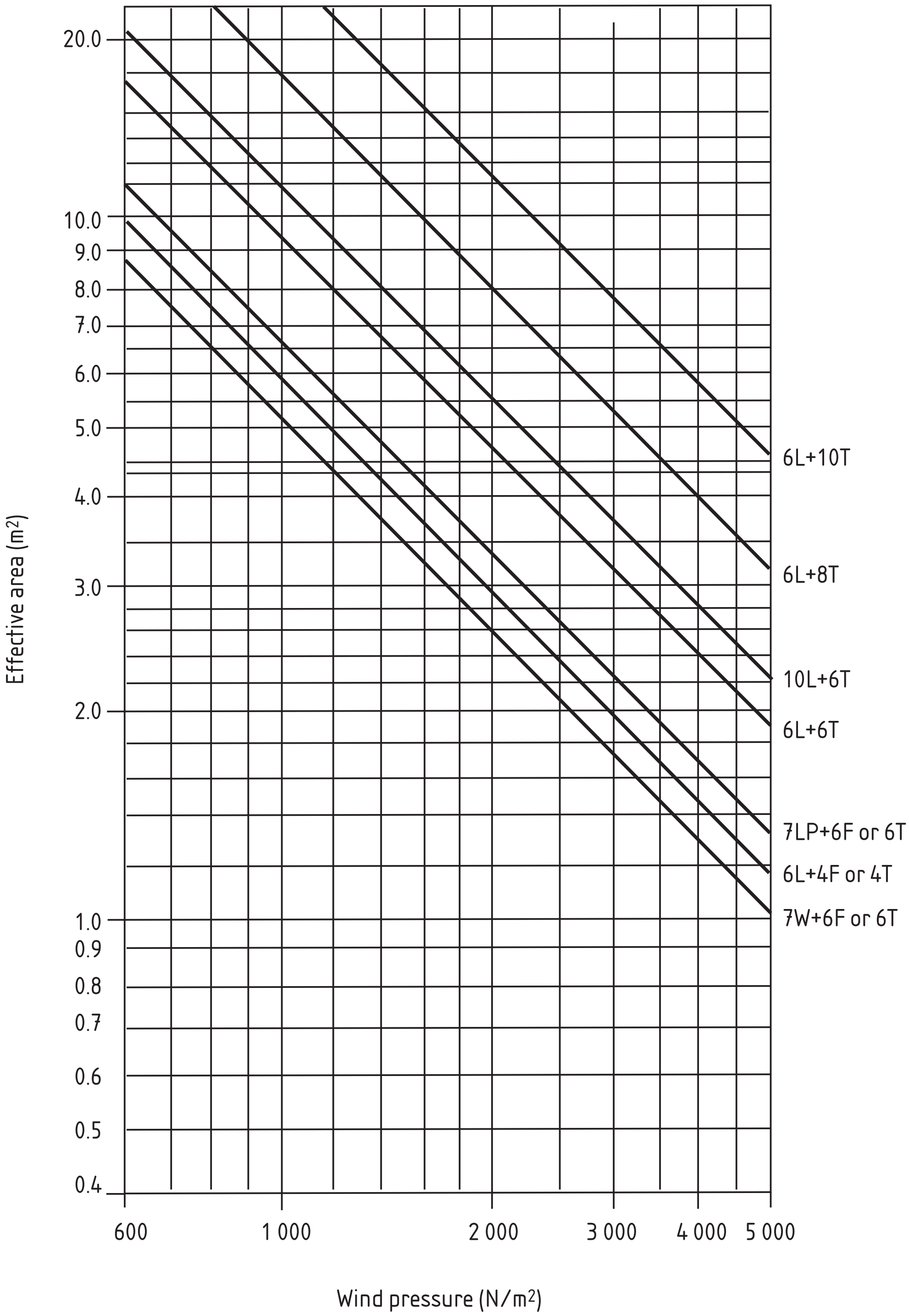
Figure 9 — Toughened glass insulating units wind load resistance



Key

F	Float glass	T	Toughened glass
L	Laminated glass	W	Wired glass
P	Patterned glass	LP	Laminated patterned glass

Figure 10 — Various insulating units wind load resistance



Key

F	Float glass	T	Toughened glass
L	Laminated glass	W	Wired glass
P	Patterned glass	LP	Laminated patterned glass

Figure 11 — Various insulating units wind load resistance

6.5 Strength of plastics glazing sheet material to withstand uniform loading

6.5.1 *General*

The recommendations given in **6.5** are for flat, plane, solid plastics glazing sheet materials of uniform thickness, as classified in BS 6262-1, in rectangular shapes glazed with all four edges fully supported. Design recommendations for other forms, including patterned and hollow section (see **6.5.4**), should be obtained from the manufacturers.

6.5.2 *Design considerations*

Failure of a pane of plastics glazing sheet material under load is most likely to be by displacement of the pane rather than by breakage. The recommendations on thickness for plastics glazing sheet material is related to the minimum size of edge cover to prevent a pane of specified thickness from springing out under loading in normal glazing conditions. The design considerations are based on this. The procedure in **6.5.3** is for vertical four-edge fully supported glazing.

The design wind loadings for pressure and suction should be determined from either **6.3** or BS 6399-2.

The values given in the sets of wind loading graphs, Figure 12, Figure 13, Figure 14, Figure 15, Figure 16 and Figure 17, have been derived from trade practice proven to be satisfactory over many years experience and experimental knowledge.

The aspect ratio of a pane has an effect on the thickness required to limit deflection under uniform load. The higher the aspect ratio the greater the resistance to deflection. For panes having an aspect ratio greater than 3.5:1 or when they are non-rectangular, the manufacturer should be consulted.

In order to limit the deflection for larger panes, the manufacturer should be consulted where areas of individual panes exceed 2 m^2.

If the absence of bowing under large increases in ambient temperature is an important aesthetic consideration, then the thermal expansion of plastics glazing sheet materials (see BS 6262-2) should be allowed for in the rebate size (see BS 6262-5).

For plastics glazing sheet materials, a minimum edge cover of 15 mm is normally recommended (see Figure 12, Figure 13 and Figure 14). To accommodate a smaller edge cover arising from small existing rebate depths, the designer should consider the possible following options:

a) use of increased thickness of glazing: Figure 15, Figure 16 and Figure 17 give thickness recommendations for 5 mm edge cover; for edge covers not given in Figure 12, Figure 13, Figure 14, Figure 15, Figure 16 and Figure 17, the manufacturer should be consulted;

b) use of tight glazing by sacrificing edge clearance and accepting the possibility of bowing at elevated temperatures;

c) use of higher quality sealants to increase edge restraint;

d) use of mechanical fixing (see BS 6262-5).

These options frequently arise in reglazing situations where plastics glazing sheet materials are used with existing rebates designed for glass, which are often inadequate for ideal glazing with these materials.

For glazing systems designed specifically for plastics glazing sheet materials, the use of an edge cover greater than 15 mm might allow the use of materials thinner than those derived from Figure 12, Figure 13, Figure 14, Figure 15, Figure 16 and Figure 17, but the manufacturer should be consulted.

6.5.3 *Use of wind loading graphs to determine thickness of solid plastics glazing sheet materials*

The following procedure should be used to determine the thickness of the plastics glazing sheet materials, in conjunction with the wind loading graphs, Figure 12, Figure 13, Figure 14, Figure 15, Figure 16 and Figure 17.

NOTE Figure 12, Figure 13 and Figure 14 are used for the normally recommended edge cover of 15 mm. Figure 15, Figure 16 and Figure 17 are used for a reduced edge cover of 5 mm.

a) Calculate the area of the pane, $A = a \times b$ and the aspect ratio, $r = a/b$, where a is the longer dimension and b is the shorter.

b) On the appropriate graph for the aspect ratio and edge cover from Figure 12, Figure 13, Figure 14, Figure 15, Figure 16 and Figure 17, determine the point where the vertical line for the required wind loading intersects the horizontal line for the required area.

c) If the point of intersection does not coincide with a thickness line, the recommended thickness for use with the corresponding size of edge cover is indicated by the line above.

The minimum pane thickness for wind loading should be derived from Figure 12, Figure 13, Figure 14, Figure 15, Figure 16 and Figure 17 using the design pressure from **6.3** or BS 6399-2. If the pane is situated where it can be subject to accidental breakage or is intended to be of a thickness to withstand vandal attack, the thickness might need to be increased or the method of glazing modified to allow for this additional loading.

A calculated example of the thickness of a plastics glazing sheet material is given in **B.3**.

6.5.4 *Design of hollow section plastics glazing sheet materials*

The stiffness of a hollow plastics glazing sheet material is determined by the material from which it is made, the overall thickness and the geometry of the sheet. The deflection characteristics of a particular hollow section plastics glazing sheet material vary according to which direction the webs run in relation to the long edges of the pane. It is not practical, therefore, to produce a set of graphs relating wind loading to hollow section sheets because of the variety of profiles and thicknesses. Advice should be obtained from the manufacturer.

6.6 Information relating to the wind loading graphs

The following information relates to the wind loading graphs, Figure 4, Figure 5, Figure 6, Figure 7, Figure 8, Figure 9, Figure 10, Figure 11, Figure 12, Figure 13, Figure 14, Figure 15, Figure 16 and Figure 17.

a) For glazing thicknesses and types not covered by the wind loading graphs, reference should be made to the manufacturer for recommendations.

b) For glazing which is not rectangular and not fully supported along all four edges, the manufacturer should be consulted.

c) Conformity of a glass or plastics glazing sheet material design to the wind loading graphs does not imply suitability of use. Other recommendations in this and other parts of this standard, as well as any other standards applicable to the glazing, should also be satisfied.

d) In preparing the graphs for glass (Figure 4, Figure 5, Figure 6, Figure 7, Figure 8, Figure 9, Figure 10 and Figure 11), the minimum tolerance on the glass thickness specified in BS 952-1 has been used.

e) The design stress used for Figure 5, Figure 6, Figure 7, Figure 8 and Figure 9 is based on fully toughened glass.

f) Insulating units should be in accordance with Figure 8, Figure 9, Figure 10 or Figure 11.

g) Stepped insulating units should be treated as though they are single glazing of the thickness of the larger pane.

h) Coupled and double windows and secondary sashes should be designed on the basis that each pane is required to carry the full wind loading. This will be the case if the cavity between the panes is ventilated, or if either of the two windows can be opened.

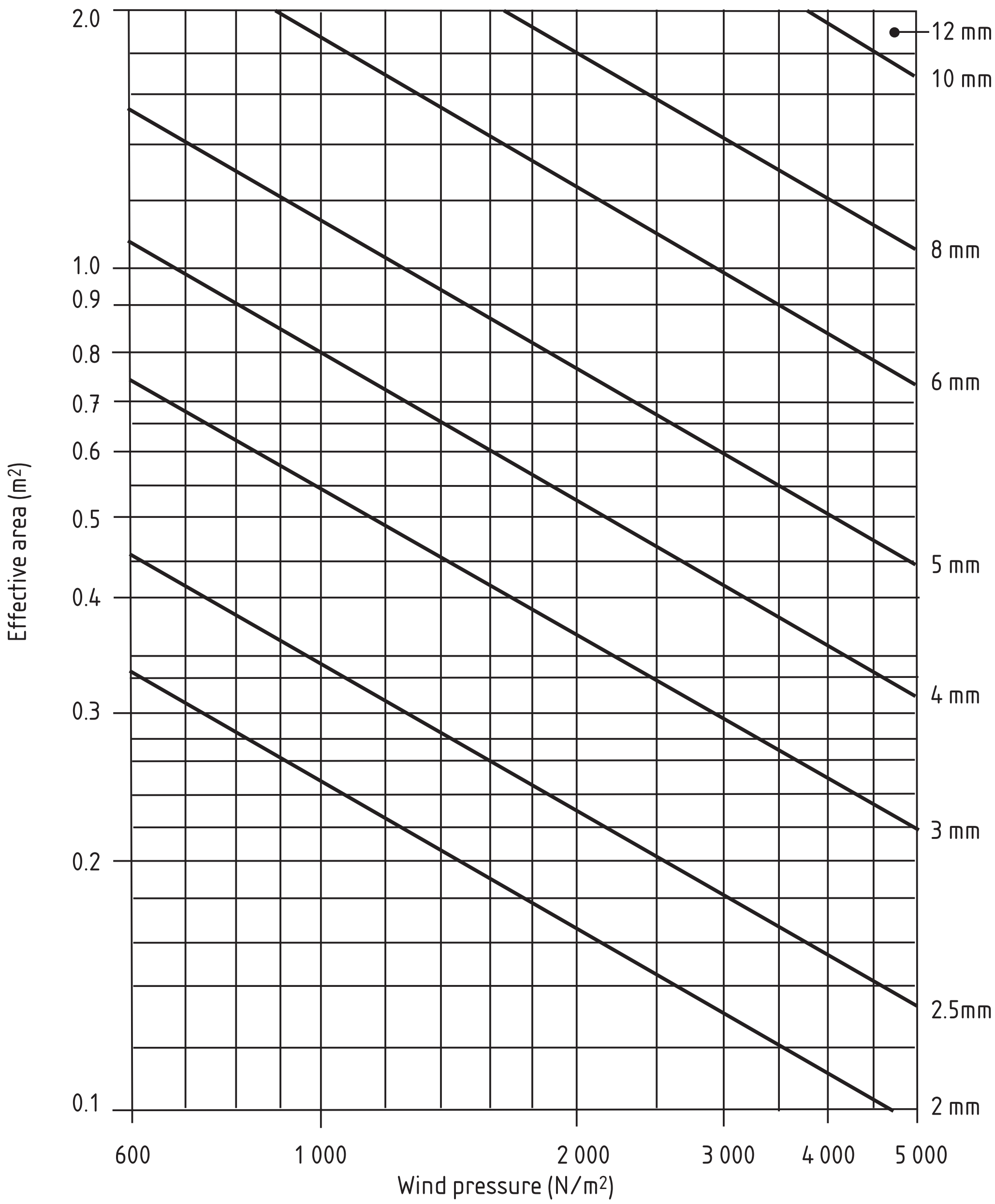


Figure 12 — Wind loading graph for plastics glazing sheet materials, 15 mm edge cover, aspect ratio 1.0 to 1.5

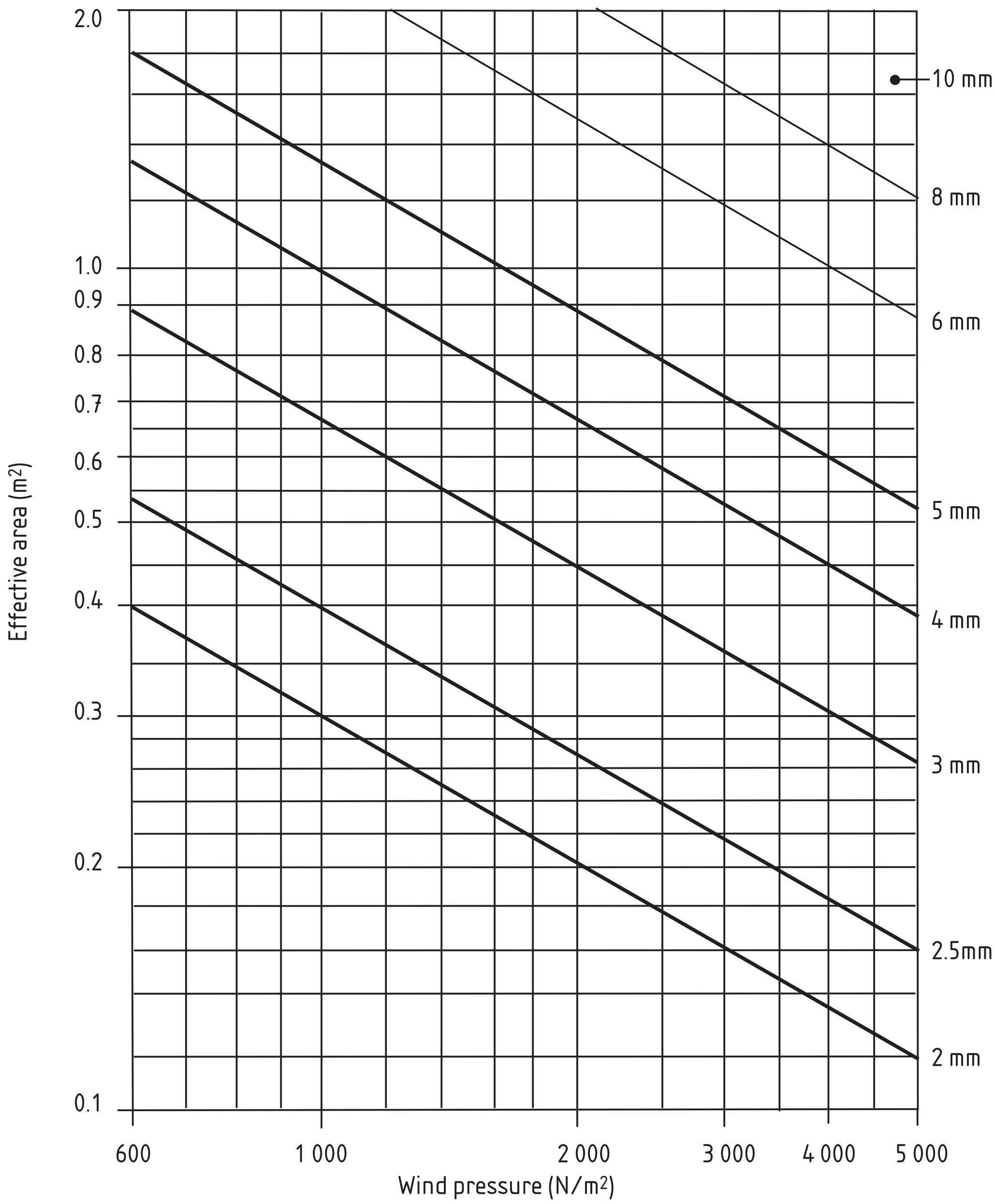


Figure 13 — Wind loading graph for plastics glazing sheet materials, 15 mm edge cover, aspect ratio greater than 1.5 up to and including 2.5

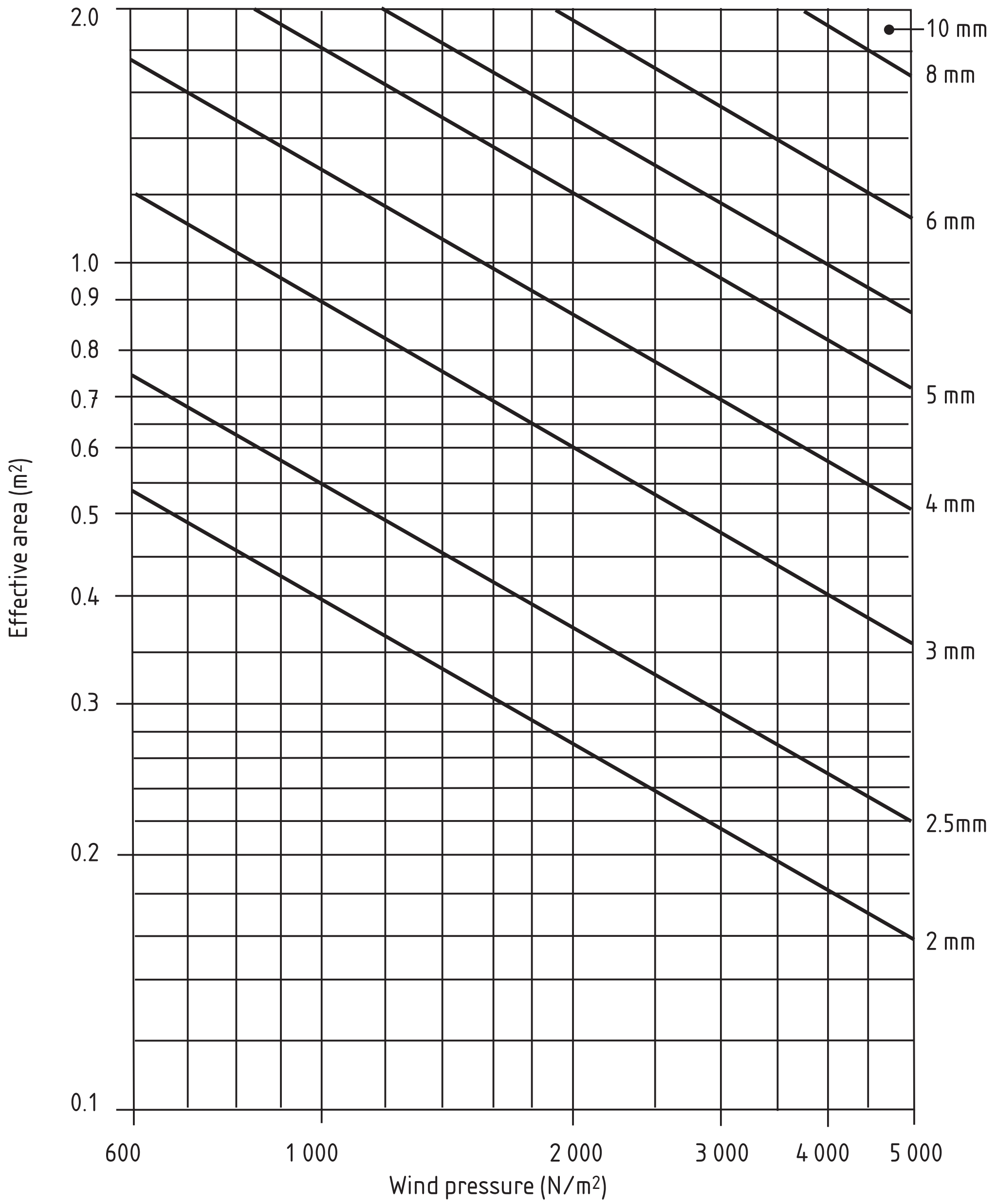


Figure 14 — Wind loading graph for plastics glazing sheet materials, 15 mm edge cover, aspect ratio greater than 2.5 up to and including 3.5

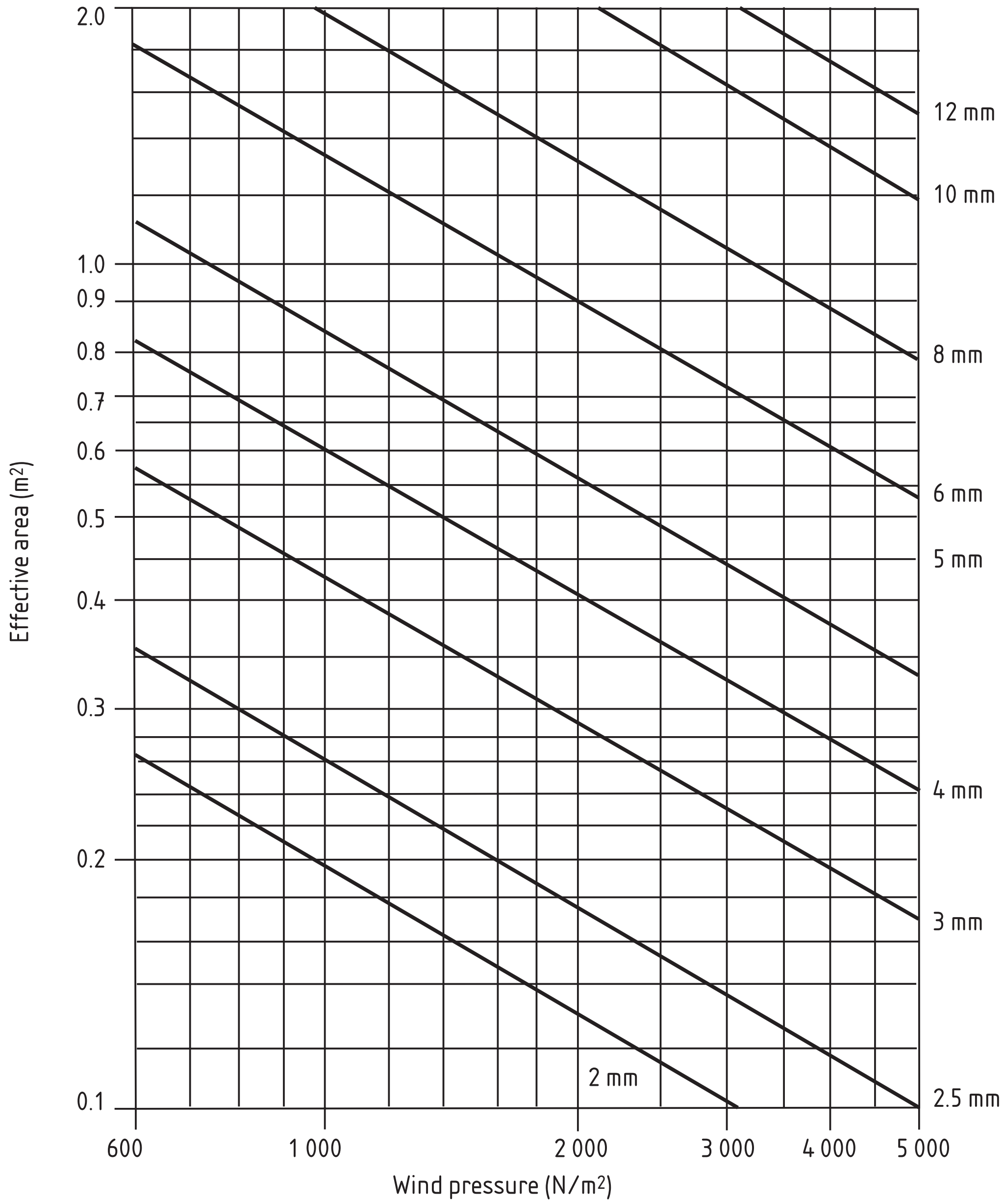


Figure 15 — Wind loading graph for plastics glazing sheet materials, 5 mm edge cover, aspect ratio 1.0 to 1.5

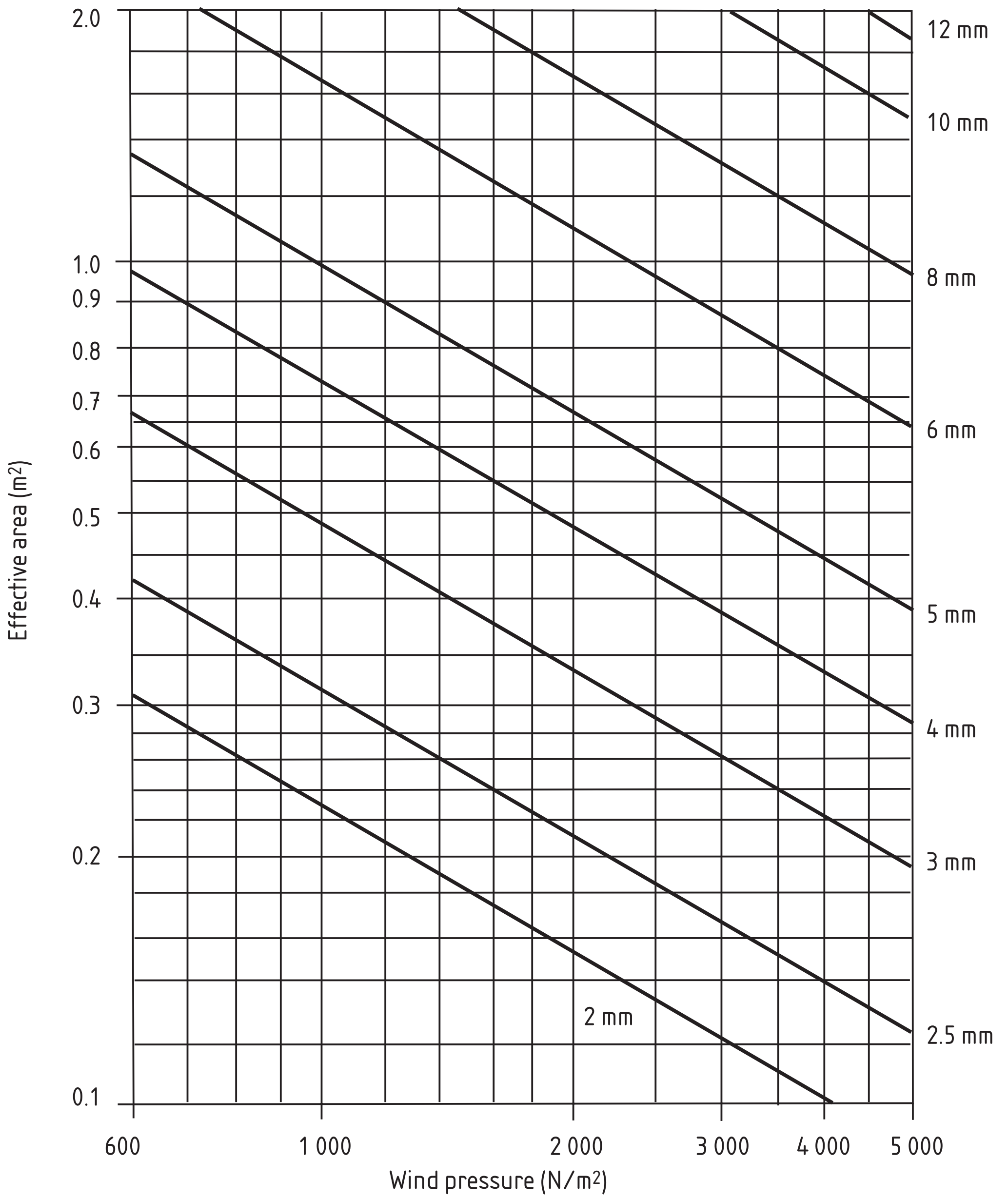


Figure 16 — Wind loading graph for plastics glazing sheet materials, 5 mm edge cover, aspect ratio greater than 1.5 up to and including 2.5

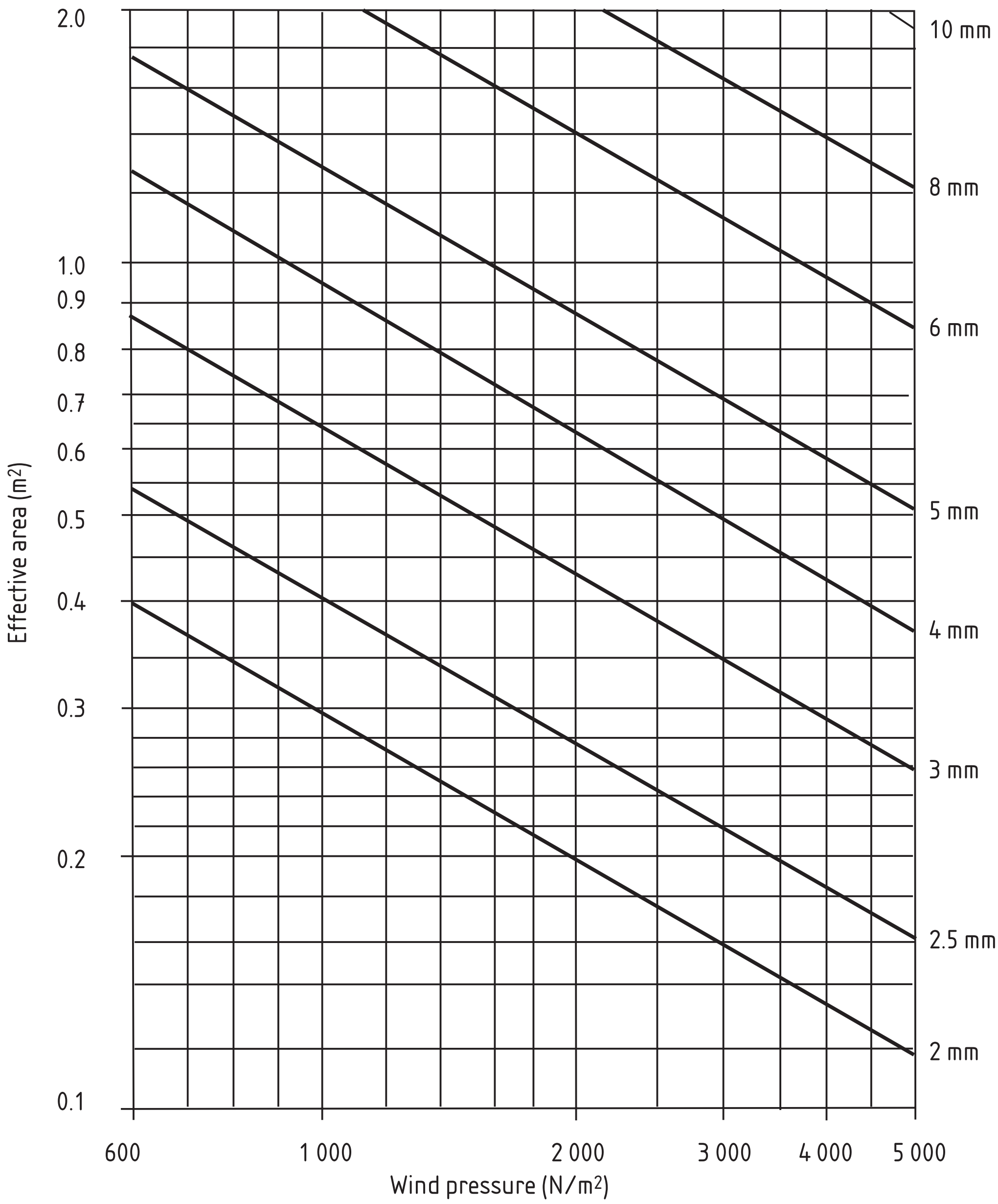


Figure 17 — Wind loading graph for plastics glazing sheet materials, 5 mm edge cover, aspect ratio greater than 2.5 up to and including 3.5

Annex A (normative)
Derivation of the design wind pressure in Table 7

The values of dynamic wind pressure are derived from BS 6399-2. The symbols and terminology below are described in BS 6399-2.

Basic wind speed, V_b, is obtained from Figure 6 of BS 6399-2:1997 (reproduced as Figure 2 in this standard).

Effective wind speed, $V_e = V_b \times S_a \times S_d \times S_s \times S_p \times S_b$

where $S_a = 1.0$ $S_d = 1.0$ $S_s = 1.0$ $S_p = 1.0$

Three building heights, H, of up to 5 m, up to 10 m and up to 15 m high have been considered. Effective height, H_e, depends on the surroundings.

Open country:	$H_e = H$,	i.e. H_e = 5 m or 10 m or 15 m;
Town (with buildings around):	$H_o = 0.6$	i.e. H_e = 3 m or 6 m or 9 m.

From Table 4 of BS 6399-2:1997, for components of dimension 5 m or less, the terrain and building factors, S_b, in Table A.1 were calculated.

Table A.1 — Building factors

Site terrain category from Table 6	S_b for building height		
	5 m	10 m	15 m
A	1.65	1.79	1.86
B	1.57	1.73	1.83
C	1.52	1.68	1.77
D	1.43	1.64	1.72
E	1.34	1.58	1.67
F	1.29	1.53	1.63

The reference wind speed, V_e, = $V_s \times S_b$;

The dynamic wind pressure at sea level, q_0, = $0.613V_e^2$;

Combined pressure coefficient, C_P, = 1.5;

Design wind pressure at sea level, P, = $q_0 \times C_P$.

Annex B (informative)
Examples of calculations of thickness required

B.1 What is the thinnest float glass recommended?

It is required to glaze a pane size 1 230 mm × 1 640 mm to withstand a wind load of 1 500 N/m^2. The following example details how to find the thinnest float glass recommended in this situation.

a) Refer to the float glass graph (Figure 4).

b) Calculate the area of the opening, in this case 1.23 × 1.64 = 2.02 m^2.

c) Calculate the aspect ratio, in this case 1 640/1 230 = 1.33.

d) Calculate the shape factor, in this case F = 4 × 1.33/(1.33 + 1)2 = 0.980.

e) Calculate the effective area, in this case A_e = 0.980 × 2.02 = 1.98 m^2.

f) Find the point at which the horizontal line representing 1.98 m^2 intersects with the vertical line representing 1 500 N/m^2.

g) The point lies in between the 4 mm and 5 mm diagonal lines. The thicker 5 mm glass should be used.

B.2 Will a particular type of glass be strong enough?

Is an insulating unit comprising 4 mm float glass + 4 mm float glass appropriate for a pane size 1 460 mm × 2 190 mm to withstand a wind load of 1 600 N/m^2? The following example details how to determine whether or not this particular type of glass will be strong enough in this situation.

a) Refer to the float glass insulating units graph (Figure 8).

b) Calculate the area of the opening, in this case 1.46 × 2.19 = 3.20 m^2.

c) Calculate the aspect ratio, in this case 2 190/1 460 = 1.50.

d) Calculate the shape factor, in this case, from Table 8, F = 0.960.

e) Calculate the effective area, in this case A_e = 0.960 × 3.20 = 3.07 m^2.

f) Find the point at which the horizontal line representing 3.07 m^2 intersects with the vertical line representing 1 600 N/m^2.

g) The point lies above the 4 mm + 4 mm diagonal line. A 4 mm float + 4 mm float insulating unit is therefore not strong enough. The solution will depend on the circumstances. 4 mm toughened glass used in each pane would increase the strength of the unit (see Figure 9). Alternatively thicker float glass, e.g. 5 mm float + 5 mm float or 4 mm float + 6 mm float, would also give adequate resistance against the wind load.

B.3 What is the thinnest solid plastics glazing sheet material recommended?

It is required to glaze a pane size 775 mm × 1 040 mm, using a normal (15 mm) edge cover, to withstand a wind load of 1 500 N/m^2. The following example details how to determine the thinnest solid plastics glazing sheet material recommended in this situation.

a) Calculate the area of the opening, in this case 0.775 × 1.04 = 0.81 m^2.

b) Calculate the aspect ratio, in this case 1 040/775 = 1.34.

c) Refer to the graph for 15 mm edge cover with aspect ratio of 1:1 to 1:1.5 (Figure 12).

d) Find the point at which the horizontal line representing 0.81 m^2 intersects with the vertical line representing 1 500 N/m^2.

e) The point lies in the area between the 4 mm and 5 mm diagonal bands. The thicker 5 mm plastics glazing sheet material should be used.

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BS 5357:1995, *Code of practice for installation of security glazing.*

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BS 6262-1:2005, *Glazing for buildings — Part 1: General methodology for the selection of glazing.*

BS 6262-2:2005, *Glazing for buildings — Part 2: Code of practice for energy, light and sound.*

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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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[2] GREAT BRITAIN: The Building Regulations (Northern Ireland) Statutory Rules 2000, SR 2000, No.389.

[3] GREAT BRITAIN: The Building Standards (Scotland) Regulations 2004, SI 2004, No. 406, as amended. London: The Stationery Office.

[4] The Building Regulations Approved Document B: Fire Safety (as amended). London: The Stationery Office, 2000.

Further reading

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