Patent glazing and sloping glazing for buildings —

Part 1: Code of practice for design and installation of sloping and vertical patent glazing

ICS 81.040.20; 91.060.50

British Standards

Committees responsible for this British Standard

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Association of Building Engineers
Consumer Policy Committee of BSI
Council for Aluminium in Building
Flat Glass Manufacturers' Association
Glass and Glazing Federation
Institution of Structural Engineers
Office of the Deputy Prime Minister – represented by BRE
Co-opted members

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Contents

Foreword

This part of BS 5516 has been prepared by Technical Committee B/520. This part of BS 5516, together with BS 5516-2:2004, supersedes BS 5516:1991, which is withdrawn. It revises all or part of Clauses **1** to **3**, **5** to **9**, **10.3** to **10.5**, **10.6.2**, **10.6.3**, **10.8**, **11** to **14**, **19**, **20.1**, **20.3**, **20.4**, **21** to **24**, **25.1**, **25.2**, **25.4**, **25.6**, **25.8**, **25.9**, **26** to **29** and Annex A to Annex F and Annex J to Annex K of BS 5516:1991.

BS 5516:1991 has been revised and restructured to simplify its use and will be published in three parts covering the following areas:

— *Part 1: Code of practice for design and installation of sloping and vertical patent glazing*;

— *Part 2: Code of practice for sloping glazing;*

— *Part 3: Special applications.*

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, attention is drawn to the recommendations in the other parts of this standard.

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.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 63 and a back cover.

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Introduction

Patent glazing is the term applied to a self-draining and ventilated system of dry glazing that does not rely entirely for its watertightness upon external glazing seals. It consists essentially of a series of longitudinal glazing bars, i.e. patent glazing bars, and an infilling of glass or other suitable infill material. Patent glazing bars are attached to and supported by structural members, either directly or indirectly.

Patent glazing systems are described by the number of edges by which the infilling is supported. They are generally unsealed, at the interface with the building substrate relying on flashings and/or formed weatherings for weathertightness. They differ from sloping curtain wall systems which form sealed airtight constructions. Curtain wall systems designed for vertical application might not be suitable for sloping application, unless they incorporate a sloping application drainage facility or are face sealed to exclude water from the glazing rebates.

a) *Two-edge systems* are those in which the infilling is fully supported by patent glazing bars on two opposite longitudinal edges only. Horizontal flashings or other weatherings are normally provided at the top and bottom edges of single tier glazing and at junctions of glazing of more then one tier.

b) *Four-edge systems* are those in which the infilling is fully supported by patent glazing bars on two opposite longitudinal edges and additionally on the other two edges by transom members.

1 Scope

This British Standard gives recommendations for the design, manufacture, installation and maintenance of sloping and vertical patent glazing systems attached to and supported by structural members of adequate strength, stiffness and stability. All recommendations apply to flat, including faceted, patent glazing and infilling. They may also apply to curved patent glazing and infilling except for the structural design where specialist advice is needed.

The patent glazing systems included in this standard comprise glazing bars of aluminium or steel, which can be clad totally or partially clad with lead or PVC-U, for two-edge support and four-edge support systems for single and double glazing or other infill. A range of transparent and opaque infillings of glass, plastics glazing sheet materials and other infill materials are included; specific information on plastics glazing sheet materials is given in BS 5516-2:2004, Annex A.

This standard covers the use of patent glazing in permanent buildings and structures, including conservatories but excludes greenhouses. Clauses that are relevant also apply to the use of patent glazing inside buildings.

This standard does not include recommendations for the design of the supporting structure to which the patent glazing is attached.

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

Since the correct selection of materials to be used in glazing for buildings depends on many factors, attention is drawn to the recommendations in the other parts of this standard.

2 Normative references

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

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 1449-1, *Steel plate, sheet and strip — Part 1: Carbon and carbon-manganese plate, sheet and strip.*

BS 1473, *Specification for wrought aluminium and aluminium alloys for general engineering purposes — Rivet, bolt and screw stock.*

BS 3382, *Specification for electroplated coatings on threaded components.*

BS 3987, *Specification for anodic oxidation coatings on wrought aluminium for external architectural applications.*

BS 4254, *Specification for two-part polysulphide-based sealants.*

BS 4842, *Specification for liquid organic coatings for application to aluminium alloy extrusions, sheet and preformed sections for external architectural purposes, and for the finish on aluminium alloy extrusions, sheet and preformed sections coated with liquid organic coatings.*

BS 4921, *Specification for sherardized coatings on iron or steel.*

BS 5215, *Specification for one-part gun grade polysulphide-based sealants.*

BS 5268, *Structural use of timber — Code of practice for permissible stress design, materials and workmanship.*

BS 5516-2:2004, *Patent glazing and sloping glazing for buildings — Part 2: Code of practice for design and installation of sloping and vertical patent glazing.*

BS 5889, *Specification for one-part gun grade silicone-based sealants.*

BS 5950, *Structural use of steelwork in building.*

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

BS 6262 (all parts), *Code of practice for glazing for buildings.*

BS 6270-3, *Code of practice for cleaning and surface repair of buildings — Part 3: Metals (cleaning only).*

BS 6338, *Specification for chromate conversion coatings on electroplated zinc and cadmium coatings.* (ISO 4520)

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

BS 6399-3, *Loading for buildings — Part 3: Code of practice for imposed roof loads.*

BS 6496, *Specification for powder organic coatings for application and stoving to aluminium alloy extrusions, sheet and preformed sections for external architectural purposes, and for the finish on aluminium alloy extrusions, sheet and preformed sections coated with powder organic coatings.*

BS 6497, *Specification for powder organic coatings for application and stoving to hot-dip galvanized hot-rolled steel sections and preformed steel sheet for windows and associated external architectural purposes, and for the finish on galvanized steel sections and preformed sheet coated with powder organic coatings.*

BS 7412, *Plastics windows made from unplasticized polyvinyl chloride (PVC-U) extruded hollow profiles — Specification.*

BS 8118-1:1991, *Structural use of aluminium — Structural use of aluminium — Part 1: Code of practice for design.*

BS EN 477, *Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors — Determination of the resistance to impact of main profiles by falling mass.*

BS EN 478, *Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors — Appearance after exposure at 150 °C — Test method.*

BS EN 479, *Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors — Determination of heat reversion.*

BS EN 485, *Aluminium and aluminium alloys — Sheet, strip and plate.*

BS EN 755, *Aluminium and aluminium alloys — Extruded rod/bar, tube and profiles.*

BS EN 1363-1, *Fire resistance tests — Part 1: General requirements.*

BS EN 1364-1, *Fire resistance tests for non-loadbearing elements — Part 1: Walls.*

BS EN 1364-2, *Fire resistance tests for non-loadbearing elements — Part 2: Ceilings.*

BS EN 3506 (all parts), *Mechanical properties of corrosion resistant stainless steel fasteners.*

BS EN 10002-1, *Tensile testing of metallic materials — Part 1: Method of test at ambient temperature.*

BS EN 10143, *Continuously hot-dip metal coated steel sheet and strip — Tolerances on dimensions and shape.*

BS EN 12056-3, *Gravity drainage systems inside buildings — Part 3: Roof drainage, layout and calculation.*

BS EN 12588, *Lead and lead alloys — Rolled lead sheet for building purposes.*

BS EN 22063, *Metallic and other inorganic coatings — Thermal spraying — Zinc, aluminium and their alloys.*

BS EN ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods.*

3 Terms and definitions

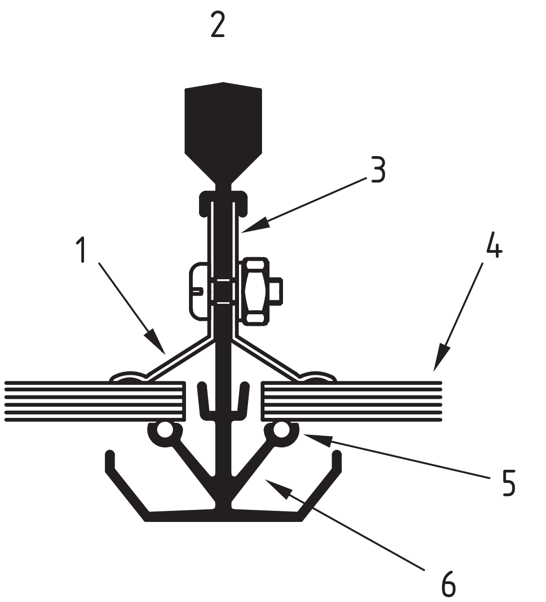
For the purposes of this British Standard, the following terms and definitions apply.

3.1
butt joint
joint between edges of adjacent panes of infilling, usually horizontal and weathered by a came or sealant

3.2
came
non-load-bearing member used to weather a horizontal butt joint in a two-edge system of patent glazing

3.3
cap
profile, fitted over a patent glazing bar or pressure plate, to retain infilling and impede direct water penetration

NOTE See Figure 1.

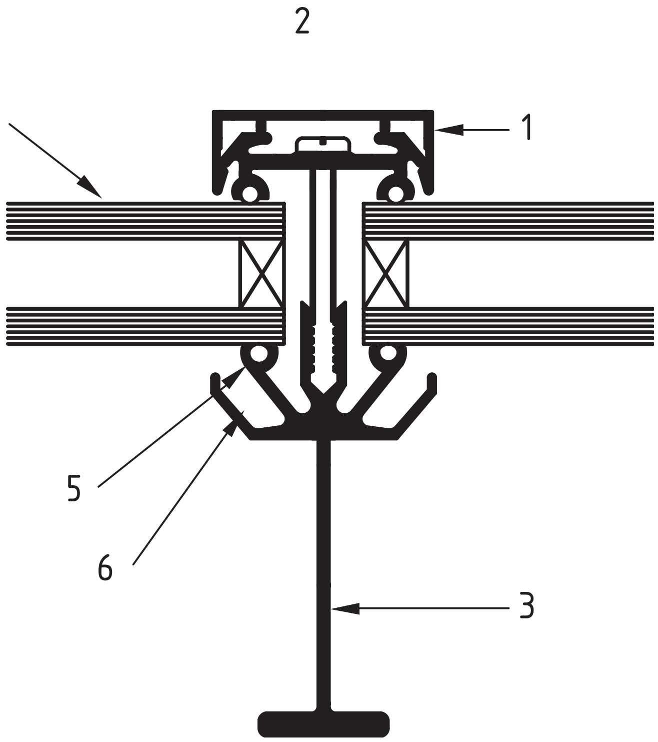


Key

1 Wing
2 Outside
3 Stalk
4 Glass or infill
5 Glazing seal
6 Drainage channel

a) Traditional bar

Figure 1 — Typical examples of patent glazing bars

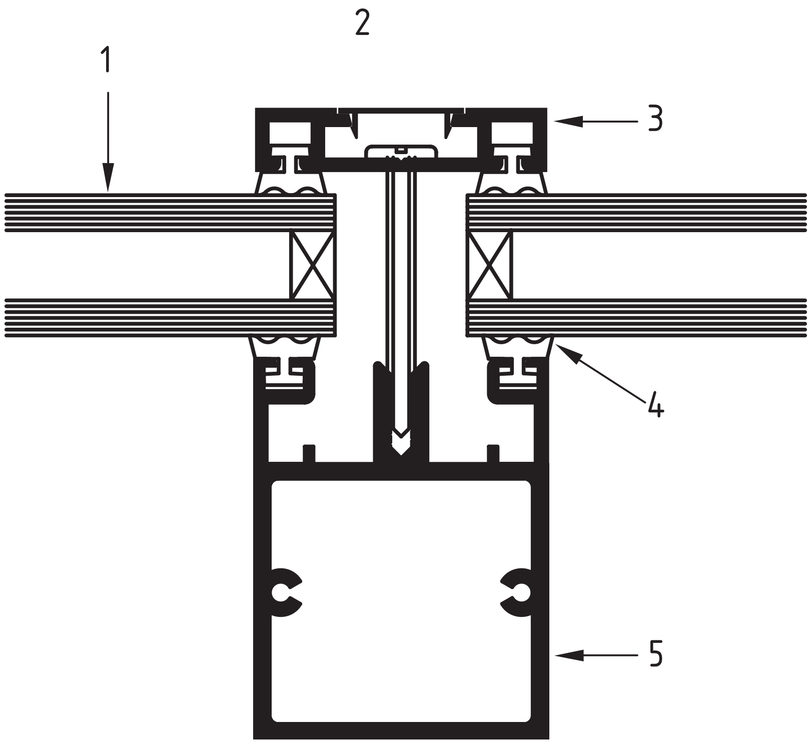


Key

1 Cap
2 Outside
3 Stalk
4 Glass or infill
5 Glazing seal
6 Drainage channel

b) Inverted bar

Figure 1 — Typical examples of patent glazing bars (*continued*)



Key

1	Glass or infill
2	Outside
3	Cap
4	Gasket
5	Box

c) Box bar

Figure 1 — Typical examples of patent glazing bars (*continued*)

3.4
conservatory
construction which has not less than three-quarters of the area of its roof and not less than one half of the area of its external walls made of translucent material, and which is attached to and has direct access from a building

3.5
coupled glazing
two panes of infilling spaced apart in an opening, either in the same frame or glazed separately, to form an unsealed cavity

3.6
drainage channel
groove formed within the section profile of a glazing bar to collect and drain water to the outside of the building, either directly or indirectly

NOTE See Figure 1.

3.7
fastener
mechanical device for securing patent glazing to the supporting structure, or for connecting or fastening one part to another

3.8
fixing
item or assembly of items which forms the attachment of patent glazing to the supporting structure

3.9
fixing bracket
fitting attached to a patent glazing bar and secured to a structural member by fasteners

NOTE Cleat, plate, shoe and slipper are deprecated terms for fixing brackets.

3.10
flashing
strip of impervious material dressed or fitted in order to exclude water from the junction between patent glazing and adjacent material or between joints in patent glazing

NOTE It is usually metal.

3.11
four-edge system
patent glazing with infilling fully supported on four edges

3.12
glazing bar
member, incorporating drainage channels, that supports and retains the edge of infilling. The longitudinal bars span between structural member supports

NOTE Examples of glazing bars are shown in Figure 1.

3.13
glazing seal
gasket or seating material fitted between the glazing bar, cap or wing and the infilling

3.14
glazing stop
fitting attached to the lower end of a patent glazing bar to prevent the infilling from sliding

3.15
head
top member in patent glazing, usually horizontal

3.16
infilling
material that occupies the space between glazing bars

3.17
pane
infilling cut to size and shape

3.18
setting blocks
pieces of resilient material used at the bottom edge of infilling

3.19
sloping patent glazing
patent glazing having a slope of 75° or less from horizontal

3.20
spacing
bar centres
perpendicular distance between the centres of two adjacent glazing bars, measured in the plane of the glazing

3.21
span of glazing bar
fixing centres
distance between the centres of attachment points of a glazing bar to a structural member

3.22
storm clip
fitting attached to a patent glazing bar to restrain the infilling against negative wind pressure, mainly used on vertical patent glazing

3.23
thermal barrier
material of low conductivity between the exterior and interior surfaces of a metal profile or an air gap to prevent cold bridging and improve the thermal conductivity of the profile or framing

3.24
transom
intermediate transverse glazing section, spanning between patent glazing bars and incorporating a drainage channel

3.25
two-edge system
patent glazing with infilling fully supported on two opposite longitudinal edges

3.26
vertical patent glazing
patent glazing which is vertical or within 15° of vertical

3.27
weatherings
closure material to control the passage of water and/or air through a joint at eaves or tiered glazing junctions in patent glazing

3.28
wing
metal strip fitted to the side of a patent glazing bar to retain infilling and impede direct water penetration

NOTE See Figure 1.

4 Provision of information

4.1 General

To ensure that the intentions of the building designer and the requirements of the patent glazing contractor are clearly understood, consultation is recommended at both the initial design and tender stages. Consideration should be given to positioning and size of supporting structure; location of adjacent materials in relation to the patent glazing; requirements for movement joints; preparation of building work by the main contractor to receive perimeter flashings, etc. See also Clause **15**.

Information normally required by the patent glazing contractor is given in **4.2** and is usually best provided in the form of drawings, specifications, bills of quantities or other related documents.

4.2 Design and performance criteria

The following information should be provided by the building designer, where appropriate:

a) the design wind pressure based on BS 6399-2:1997 assessed by the building engineer or the following information:

1) the building location and distance from sea;

2) the altitude of the site;

3) the building length width and height;

4) the height of surrounding buildings;

5) the distance from surrounding buildings;

6) site category town or country or distance from the edge of town;

7) the surrounding topography;

b) the design snow load based on BS 6399-3, assessed by the building engineer or the following information:

1) the building location;

2) the altitude of the site;

3) the building dimensions;

4) the position of the glazing in relation to the rest of the building, particularly any features likely to give rise to snow drifts on the glazing;

c) the intended use and occupancy of the building together with any specific performance criteria should be considered and may include the following:

1) mechanical design (see Clause **6**);

2) safety (see Clause **7**);

3) fire (see Clause **8**);

4) ventilation (see Clause **9**);

5) heat conservation (see Clause **10**);

6) solar heat gain (see Clause **10**);

7) thermal safety (see Clause **10**);

8) condensation (see Clause **10**);

9) acoustics (see Clause **11**);

10) security (see Clause **12**);

11) durability (see Clause **13**);

12) weather resistance (see Clause **14**);

13) maintenance and cleaning (see Clause **15**);

14) transmission of light (see BS 5516-2:2004);

d) details of any environmental factors or atmospheric conditions which can have an adverse effect on the patent glazing, especially any corrosive conditions;

e) detail of any adjacent building material, e.g. copper sheet, which might contaminate rainwater run-of, onto the patent glazing;

f) position of the patent glazing on the building, the external dimensions of the building and details of any features which can affect the distribution of wind or snow;

g) design loads for the particular situation of the patent glazing;

h) details of supporting structure including the size, spacing, nature and dimensional and positional tolerances of structural members, surrounding construction and adjacent materials;

i) dimensions of the patent glazing including angle of glazing to the horizontal and preferred spacing of patent glazing bars;

j) type(s) of patent glazing bar, type(s) of infilling, type(s) of flashing and any decorative or protective finish(s) required;

k) details of any ventilation or other openings required and their method of operation;

l) details of any access equipment to be provided for cleaning/maintenance.

5 Materials, components and finishes

5.1 General

All components of a patent glazing system should be manufactured from materials or be protected by finishes which are compatible, durable and capable of resistance to corrosion and degradation in the environmental and service conditions in which they are expected to be used. The compatibility of components within patent glazing systems should also be considered. Highly corrosive conditions need attention and the patent glazing contractor should be provided with the necessary information at the initial design stage (see Clause **4**).

The selection of suitable materials and finishes should take into account performance criteria, visual considerations and the economic factors involved.

5.2 Patent glazing bars

5.2.1 *Types of patent glazing bars*

Patent glazing bars should be one of the following types.

a) *Aluminium bars*:

1) *traditional bars* in which the stalk projects to the outside and the infilling is retained either by wings of aluminium, lead or plastics, or by caps of aluminium or plastics [see Figure 1a)];

2) *inverted bars* in which the stalk does not project to the outside and the infilling is retained by caps of aluminium or plastics [see Figure 1b)], which generally provide a thermal barrier by nature of the air gap;

b) *Lead-sheathed steel bars*. These bars have a steel core encased in an extruded lead sheath with integral lead wings. Sheaths are sealed at their ends by lead burning or soldering.

c) *Plastics-sheathed steel bars*. These bars have a steel core encased in an extruded plastics sheath, which is sealed at the ends. The infilling is retained in position by an extruded plastics cap.

d) *Composite bars*. A glazing bar produced from more than one material, e.g. a bar formed from a PVC-U profile, to provide weathering and drainage with steel or aluminium reinforcement to provide adequate stiffness.

e) Glazing bars of other materials that provide the necessary structural integrity and durability to conform to this Code of Practice.

5.2.2 *Materials for patent glazing bars, caps, wings and sheaths*

Materials for patent glazing bars, caps, wings and sheaths should be as follows.

a) *Aluminium profiles*. These should be extruded from designated treated alloy 6060 or 6063 in temper T6 of BS EN 755. Other alloys and tempers might be suitable and the patent glazing contractor should be consulted as to their use.

b) *Steel bars*. These should be manufactured from hot rolled steel sections that, when tested in accordance with BS EN 10002-1, have a minimum ultimate tensile strength of 355 N/mm^2. Rust and mill-scale should be removed before fabrication (cutting to length, drilling, notching, etc.). After fabrication, prior to lead or plastics sheathing, steel cores should be protected by the application of a suitable rust inhibiting material or inert coating.

c) *Aluminium caps and wings*. These should be extruded from designated treated alloy 6060 or 6063 in temper T6 of BS EN 755, or formed from sheet or strip aluminium conforming to designation 1200 or from alloys designated 3103, 5005 or 5251 of BS EN 485, in a temper suitable for the particular type of application and degree of forming to be adopted. Other alloys might be suitable and the patent glazing contractor should be consulted as to their use.

d) *Lead wings and sheaths*. These should be extruded from lead showing a medium grain size. Lead sheaths should be not less than 0.8 mm thick.

e) *Plastics caps, wings and sheaths*. These should be extruded from unplasticized polyvinyl chloride, conforming to BS EN 477, BS EN 478 and BS EN 479. Plastic sheaths should be not less than 0.75 mm thick.

f) *Reinforcement of PVC-U*. These should conform to the requirements of BS 7412.

g) *Other materials*. These should provide the necessary structural integrity and durability to conform to the recommendations of this Code of Practice.

5.3 Flashings

Flashing materials should conform to one of the following specifications.

a) *Lead*: milled lead sheet conforming to BS EN 12588 with a minimum thickness of 1.8-mm (code No. 4).

b) *Aluminium*:

1) *site formed flashings*: sheet or strip aluminium conforming to designation 1050 0/H111 of BS EN 485 and not less than 0.8 mm thick;

2) *preformed flashings*: sheet or strip aluminium conforming to designation 1200 or alloys designated 3103, 5005 or 5251 of BS EN 485 in a temper suitable for the particular type of application and degree of forming to be adopted and not less than 0.9 mm thick.

c) *Steel*: steel sheet conforming to BS 1449-1 or galvanized steel sheet conforming to BS EN 10143 and not less than 0.7 mm thick.

d) Other suitable flashing materials. Their suitability should be checked with the patent glazing contractor.

5.4 Ancillary components

5.4.1 *Weatherings*

Weatherings such as cames, weather bars, closures and fillers, if made from one of the materials described in **5.2.2** and **5.3**, should conform to the relevant specification. Other materials should be compatible with other components of the patent glazing. Where wood is used, it should be of a durable type and, if necessary, treated with preservative of a type compatible with the other components of the patent glazing and adjacent materials.

5.4.2 *Fittings*

Fixing brackets, glazing stops, storm clips, etc. should be of materials, shapes and thickness adequate to withstand the loads imposed upon them and any likely movements.

NOTE A large variety of fittings may be used and it is not practicable to give detailed recommendations.

5.4.3 *Fasteners*

Bolts, screws, studs, nuts, rivets and other mechanical fasteners should have adequate strength for the particular condition in which they are to be used and should be made from one of the following materials.

a) *Aluminium*: bolt or screw stock alloy conforming to designation 5056A, temper H4, of BS 1473 or other suitable alloy of a composition not likely to show stress corrosion tendencies.

b) *Brass*: alloy of a composition not likely to show stress corrosion tendencies. Brass fasteners should not be used where directly in contact with aluminium.

c) *Stainless steel*: austenitic steel conforming to grades A2 or A4 of BS EN 3506.

d) *Steel*: mild steel protected either by electroplating with zinc or cadmium conforming to BS 3382 and chromate passivated and sealed in accordance with BS 6338, or by sherardizing to class 1 in accordance with BS 4921. Other protective treatments might be suitable and the patent glazing contractor should be consulted as to their use.

Where patent glazing is to be subjected to vibration, fasteners of a type that resist slackening, should be used.

5.5 Finishes

NOTE The selection of suitable finishes for aluminium and steel will depend on the degree of protection and/or decorative effect required.

5.5.1 *Finishes for aluminium*

Aluminium components should have one of the following types of finish:

a) *mill*. This is applicable to untreated aluminium surfaces;

NOTE The rate at which the original bright, metallic appearance will become dull as the surface oxidizes and develops a roughened texture depends upon environmental conditions. Mill finish might not be suitable where long-term appearance is important or where close fitting, moving parts are involved.

b) *anodized*, conforming to BS 3987;

c) *liquid organic coated*, conforming to BS 4842;

d) *polyester powder coating*, conforming to BS 6496.

5.5.2 *Finishes for steel*

Components made from steel (except stainless steel), which are not otherwise protected against corrosion, should be protected by one of the following types of finish:

a) *hot-dip galvanized*, conforming to BS EN ISO 1461;

b) *zinc sprayed*, conforming to BS EN 22063;

c) *organic coated*, conforming to BS 6497.

5.6 Infillings

5.6.1 *Maximum size*

Maximum size limits are determined more often by design considerations than by availability. Important design factors influencing size limits are loadings (e.g. wind, snow), safety, fire and security considerations. Ease of handling and means of access to vertical or sloping patent glazing are further considerations, which relate to both the weight and dimensions of the infilling.

The patent glazing contractor should be consulted about the suitability of the size of panes, shapes other than rectangles, or panes of unusual dimensions.

5.6.2 *Glass and plastics glazing sheet materials*

Glass for glazing is classified in BS 952-1. Selection of glass and plastics glazing sheet material should be according to the recommendations of BS 5516-2:2004 for sloping glazing and BS 6262 for vertical glazing.

5.6.3 ***Other materials***

Infillings made from other materials should be compatible with all adjacent components of the patent glazing and be designed to resist the applied loads.

A wide range of materials, with or without insulating backings, may be used as infillings. These include:

a) aluminium sheet;

b) coated metal sheet;

c) flat or profiled plastics sheet material;

d) composite panels.

For full technical information of these and other types of infill material, reference should be made to the manufacturer of the infilling material.

5.7 Sealing and glazing materials

5.7.1 ***General***

There is a wide range of materials available for the seating of infilling and the weather sealing of joints in patent glazing and between patent glazing and adjacent materials. These materials should be of a resilient nature, capable of accommodating any likely movements, and be compatible with the substrates to which they are applied or with which they are in contact. Care should be taken in the selection of sealing and glazing materials to ensure that they are sufficiently resistant to climatic effects, especially ultraviolet light and atmospheric pollution in the conditions in which they are to be used
(see also BS 5516-2:2004, Annex A)

Correctly positioned setting blocks of adequate size, with or without glazing materials, should be used to prevent direct contact between the bottom edge of the glass and any metal component, continuous or otherwise. Suitable materials for use as setting blocks in patent glazing include plasticized polyvinyl chloride (with a softness no. of 35 to 45; see BS 2571) and extruded unplasticized polyvinyl chloride. However, plasticized polyvinyl chloride setting blocks are not recommended for use with plastics glazing sheet materials.

5.7.2 ***Types***

5.7.2.1 *Preformed materials*

Preformed types are usually of substantially dry, non-viscous materials, commonly in reel or strip form, and include mastic tapes, greased cords synthetic rubbers and plastics sections and gaskets, either solid or cellular. Such materials, which do not normally undergo a physical or chemical change, might require to be used under pressure.

Typical material types include the following:

a) polychloroprene (CR); or

b) ethylene propylene diene monomer (EPDM); or

c) silicone (Si);

d) thermoplastic rubber (TPR); or

e) plasticized PVC (PVC-P).

NOTE Non-cellular forms of material a), b) or c) are covered by BS 4255-1. Cellular materials with open cell structure might not be suitable for use as a glazing material.

5.7.2.2 *Formed-in-place materials*

Formed-in-place types, are those at interface with building substrate or flashings, transverse butt joints between glass panes and/or used as a glazing material. They are usually of viscous material for application by hand, knife or gun and include bulk mastics, glazing compounds and sealants. Such materials may undergo a physical or chemical change after initial placing and may also have adhesive properties. Such materials should be used so as to conform to the manufacturers recommendations for joint size.

Commonly used sealants are:

— one-part gun-grade polysulfide-based sealants, which should conform to BS 5215;

— two-part polysulfide-based sealants, which should conform to BS 4254;

— silicone-based sealants, which should conform to BS 5889.

6 Mechanical design

6.1 Structural support

Patent glazing should be attached to, and supported by, structural members of adequate strength, stiffness and stability. Deflection of a structural member should be limited to 1/360 of its span unless otherwise recommended in an appropriate British Standard code of practice, e.g. BS 5950, BS 5268 or BS 8118. A patent glazing contractor should be consulted with regard to those features of members affecting the accommodation of the patent glazing.

NOTE Self-supporting glazed structures are not covered by this code of practice.

6.2 Structural function

The patent glazing system should be capable of sustaining and transmitting to the structure at its points of support the most adverse combination of loads likely to be encountered in service without damage or permanent deterioration of its performance. There should be no significant, irreversible deformation or excessive deflection of any of its parts resulting from the design loads.

The principle structural requirements of the longitudinal patent glazing bars is to resist the loads acting on the surface of the glazing in addition to its own weight and that of the infilling and to provide continuous support and retention to the longitudinal edges of the infilling against positive and negative pressure. Patent glazing bars might also be required to resist other specified loads such as those incidental to maintenance.

Transoms are intermediate, transverse secondary glazing bars in four-edge systems of patent glazing. The principal structural requirements of a transom are to act in conjunction with the patent glazing bars in resisting the loads acting on the surface of the glazing in addition to its own weight and that of the infilling and to provide continuous support and retention to the transverse edges of the infilling against positive and negative pressure. Transoms have also to resist the dead load acting downwards in the plane of the glazing.

NOTE Came joints do not provide structural support for the glass edge.

The infilling should be capable of sustaining the loads acting on the surface of the glazing in addition to its own weight and of transferring them to the glazing bars.

Fixings should be capable of withstanding the maximum support and restraint loads to which they might be subjected and of resisting any likely movements.

6.3 Loading

Patent glazing should not be subjected to loads imposed by the structure to which it is attached.

Patent glazing should be designed to resist combinations of loads due to the following.

— Wind exerted on the surface of the patent glazing, which can act either inwards (positive pressure) or outwards (negative pressure or suction) or both: negative and positive pressures are not necessarily equal in magnitude.

— Snow acting inwards on the surface of the patent glazing.

— Self-weight, usually acting inwards: the weight should also be considered as a load acting downwards in the plane of the glazing.

— Maintenance, if required, which should be taken as acting inwards on sloping patent glazing but which can act either inwards or outwards on vertical patent glazing.

6.4 Assessment of design loads

6.4.1 *Wind load*

The design wind loads, both positive and negative, for the particular situation of the patent glazing should be determined at the initial design stage (see Clause **4**).

Wind loads for external walls and roofs of normal, rectangular, clad buildings and for canopy roofs should be determined by the method described in BS 6399-2:1997. A summary of this procedure is given in Annex A.

For buildings of unusual geometric shape or site location not covered by BS 6399-2:1997 and for problems involving consideration of the excess pressure near ground level that can, in some circumstances, be generated by down-draught from tall buildings or high speed air currents such as can occur in narrow paths between buildings, the building designer should seek expert advice.

6.4.2 *Snow load*

The design snow loads on roofs for the particular situation of the patent glazing should be determined at the initial design stage (see Clause **4**).

Snow loads on roofs should be determined by the method described in BS 6399-3. A summary of this procedure is given in Annex B.

Exceptional local effects such as shelter from the wind or local configurations, which funnel the snow, can give rise to increased loading. If the building designer thinks that there might be unusual local conditions that might need to be taken into account then the nearest meteorological office or informed local sources should be consulted.

Where there is a risk of damage by impact from large masses of snow sliding off an adjoining roof at higher level, snow-guards should be fitted. The building designer should refer to BS EN 12056-3 for detailed advice.

6.4.3 *Dead load (self-weight)*

Dead loads for glazing bars and for the infilling should be calculated from the actual known mass of the materials.

When considering the dead load for glazing bars, the weight taken should be that of the glazing bar, together with that of the infill material. When considering the dead load for the infilling alone, the weight taken should be that of the infill material only (see Annex C).

Self-weight should also be considered as a dead load acting downwards in the plane of the glazing.

6.4.4 *Maintenance load*

Safe and efficient means of access for the maintenance including cleaning of patent glazing, both inside and outside, should be considered (see Clause **15**). It is essential that account should be taken of any loading on the patent glazing that might arise, incidental to maintenance, at the initial design stage (see Clause **4**).

NOTE 1 Attention is drawn to the requirements of the Construction Design and Management (CDM) regulations and the National Building Specification (NBS) *Access for cleaning and maintenance* [1] at this initial stage.

For patent glazing at low level and certain forms of patent glazing at roof level, maintenance may be carried out from the ground or adjacent areas of solid, weight-bearing roof without the need to impose any maintenance load on the patent glazing itself.

Those responsible for the maintenance of patent glazing should be made aware of any load limits on which a particular design is based so that they can ensure that such limitations are not exceeded (see Clause **15**).

NOTE 2 For glass replacement each contract needs to be individually assessed, as replacement might not be possible from a cleaning gantry.

Recommendations for maintenance loads are given in Annex D.

6.4.5 *Other loads*

Where loads other than those mentioned in **6.4.1**, **6.4.2**, **6.4.3** and **6.4.4** are anticipated, for example any permanent imposed loads or suspended loads, due allowance should be made and the patent glazing contractor should be provided with the necessary information at the initial design stage (see Clause **4**). Permanent imposed loads should never be carried directly by the infilling.

6.5 Determination of working pressures

6.5.1 *General*

In determining working pressures for patent glazing, account should be taken of the most adverse combination of design loads that is likely to occur in service in the particular location ion of the patent glazing.

6.5.2 *Glazing bars*

Working pressures for glazing bars should be determined from the recommendations in Annex E.

6.5.3 *Infilling*

6.5.3.1 *Glass and plastics glazing sheet materials*

Glass and plastics glazing sheet materials should be selected according to the recommendations of BS 5516-2:2004 for sloping applications and BS 6262 for vertical applications.

6.5.3.2 *Other infill materials*

For the determination of appropriate working pressures for other infill materials the manufacturer should be consulted.

6.6 Strength and stiffness of glazing bars

6.6.1 *General*

Glazing bars should be strong enough to withstand the working pressure without permanent bending or yielding of their material. They should also be stiff enough to restrict deflection to an amount likely to be visually acceptable and prevent damage to, or displacement of, the infilling and other adjacent materials and components, or cause impairment to the functional performance of the patent glazing system.

Formulae for determining the required properties of section in a direction of bending normal to the plane of the glazing for straight glazing bars in two-edge and four-edge systems of patent glazing should be based on uniformly loaded simply supported beams, using the deflection limitations given in **6.6.3**.

The required properties of section for transverse glazing bars in four-edge systems of patent glazing should also take into account the dead load acting downwards in the plane of the glazing; usually this will be transmitted by setting blocks as two equal and symmetrically placed point loads.

These loads might not be directed through an axis of symmetry of the section and the required geometric properties about the neutral axis in a direction of bending parallel to the plane of the glazing should be determined from appropriate engineering formulae.

Example calculations for patent glazing bars are given in Annex F.

6.6.2 *Strength*

The glazing bars of a patent glazing systems, which are principally uniformly loaded and simply supported, should be designed to conform to the limit state design requirements of BS 8118.

NOTE 1 Glazing bars designed for integration or replacement of existing systems may be designed to resist bending stresses to conform to the obsolete BS CP 118, which will usually be satisfactory in respect of other mechanical stresses.

When patent glazing is used in self supporting roof lights, e.g. skylights and lantern lights, the structural element of the framing should be designed in accordance with BS 8118, BS 5950, BS 5268 and suitable stresses adopted. The design of the infilling should be in accordance with this standard, however.

NOTE 2 In the context of this code, glazing bars should not be considered as structural members. Lateral instability of patent glazing bars is not a criterion due to the restraint provided by the infilling.

6.6.3 ***Stiffness***

For glazing bars carrying glass and other similar infill material, the maximum allowable deflection normal to the plane of the glazing is usually determined by considerations of appearance as well as the flexibility of the infilling. To restrict stresses in the infill material, the following deflection limits (in millimetres) should not be exceeded.

a) For two-edge systems:

1) for single glazing and for coupled glazing:

$$d_{all} = \frac{S^2}{180} \times 10^3$$

or $d_{all} = 50$ mm

whichever is the less;

where S is the span of the glazing bar; and

d_{all} is the maximum deflection;

2) for hermetically sealed insulating glass units:

$$d_{all} = \frac{S^2}{540} \times 10^3$$

or $d_{all} = 20$ mm

whichever is the less.

b) For four-edge systems:

1) for single glazing and coupled glazing when the span is less than or equal to three metres:

$$d_{all} = \frac{S}{125} \times 10^3$$

2) for single glazing and coupled glazing when the span is greater than three metres:

$$d_{all} = \left[\frac{S}{250} \times 10^3\right] + 12$$

or $d_{all} = 40$ mm

whichever is the less;

3) for hermetically sealed insulating glass units:

$$d_{all} = \frac{S}{175} \times 10^3$$

or $d_{all} = 20$ mm

whichever is the less.

When designing to these maximum values, account should be taken of the magnitude of deflection under sustained loading and of the possible effect on adjacent materials and finishes. If lower deflection limits are required, the building designer should specify them and the patent glazing contractor should be provided with the necessary information at the initial design stage (see Clause **4**).

For other infilling materials, especially those with inflexible coverings, the amount of deflection might need to be reduced and the manufacturer should be consulted.

Maximum recoverable deflection in the plane of the glazing of a transom member when carrying its full design load should not be such as to reduce design edge clearance between that member and the edge of the infilling or any other part immediately below it by more than 25 % and generally should not exceed 1/400 of the span of the member or three millimetres, whichever is the less. Certain types of ventilators or fittings can make it necessary to reduce the amount of this deflection.

6.7 Strength and stiffness of infilling

6.7.1 *Glass and plastics glazing sheet materials*

Glass and plastics glazing sheet materials should be selected according to the recommendations of BS 5516-2 for sloping applications and BS 6262 for vertical applications.

6.7.2 *Other infill materials*

Strength and stiffness characteristics and the minimum thickness/maximum size of other infill materials should be obtained from the manufacturer.

6.8 Fixings

The combination of loads which induce critical stress in fixings might not be the same as those for glazing bars and infilling and should be determined separately.

The structural design of mechanical fixings will depend on the materials from which they are made, the way in which the loads are applied, the stresses involved (which might be a combination of stresses) and the method of attachment. If necessary, a detailed analysis should be made to ascertain the actual requirements in a particular case.

Fasteners, which secure patent glazing to the supporting structure, should be capable of sustaining and transmitting all design loads imposed upon them. The material to which they are attached should be capable of resisting all the forces exerted by the fasteners.

7 Safety

The risk of human injury arising from fracture and/or penetration of the infilling by impact should be considered. Hazard categories should be limited to areas of patent glazing from which people might be at risk in the course of the normal use of the building. Areas which are used only for the purpose of maintenance need not be considered. When assessing the risk of human injury, a reasonable standard of human behaviour should be assumed for appropriate age groups.

Consideration should be given to the type of infill materials for use in the following six areas of hazard, which can be associated with patent glazing:

a) *overhead sloping glazing*, where there is normal access to areas below the infilling;

b) *doors, door side panels and low level glazing*, where the infilling might be subject to accidental human impact;

c) *bathing areas*, where the infilling is adjacent to or surrounding private or public swimming pools;

d) *special risk areas*, where the planned activity generates a special risk;

e) *inwardly sloping glazing*, where the infilling might be subjected to inadvertent head impact;

f) *barriers which provided the guarding*, where there is a difference in level as defined by BS 6180.

Infill material of a suitable type, thickness and size should be selected to provide an appropriate degree of human safety, taking into account the intended use of the building.

Recommendations for selection are given in BS 5516-2:2004 for sloping applications and BS 6262 for vertical applications.

In addition the following criteria should be taken into account:

— loading, i.e. wind, snow, maintenance, self-weight and any other imposed loads (see Clause **6**); and

— fire (see Clause **8**).

8 Fire

8.1 General

Where necessary, patent glazing, when used in roofs and walls of buildings, should incorporate glazing bars and infill materials, which have specific external and/or internal fire performance properties.

The performance requirements are dictated by various parameters including purpose group, location, situation, size and special design requirements.

8.2 Fire resistance

Where elements of the structure require a level of fire resistance, only certain types of patent glazing systems will be suitable, i.e. lead clothed, steel cored glazing bars with the infilling, perimeter sealing, fixings and supporting structure all meeting the same fire resistance. These should be tested in accordance with BS 476-20 and BS 476-22 or BS EN 1363-1 and BS EN 1364-1 or BS EN 1364-2.

Resistance to fire is not necessarily fire rating, patent glazing bars with wired or toughened glass can be demonstrated to resist furnace temperatures in test situations up-to and exceeding 30 min and demonstrate some resistance in fire. Fire rating, for 30 or 60 min, requires test certification, of resistance to fire demonstrating a specific fire rating to BS 476-20 and BS 476-22 or BS EN 1363-1 and BS EN 1364-1 or BS EN 1364-2.

8.3 Other fire performance properties

Recommendations for glass and plastics glazing sheet material infilling are given in BS 5516-2 for sloping applications and BS 6262 for vertical applications.

For other materials and components, manufacturers should be consulted for information on the appropriate fire performance properties of their material.

8.4 Smoke temperatures

In reaction to fire situations, aluminium and steel patent glazing bars, at 600 mm centres glazed with six millimetre thick wired glass or toughened glass, in sloping applications, have been shown to perform satisfactorily when tested to the requirements of BS 7346-3 at smoke temperatures up to 600 °C. The patent glazing contractor should provide test data.

9 Ventilation and openings

9.1 General

The performance of ventilators, windows and doors, including their fittings, should be appropriate for their particular requirement and usage and the patent glazing contractor should be consulted at the design stage (see Clause **4**).

All forms of ventilators, windows and doors, including their fittings, should be capable of resisting the same design loads as the surrounding patent glazing. Any additional loads due to their own weight or operation should be taken into consideration.

Window opening lights fitted into sloping patent glazing should be of a type designed specially for use in sloping or roof situations.

9.2 Ventilation

One or more of the following systems can provide ventilation, permanently open and/or adjustable.

a) *Top-hung opening lights*: of patent glazing construction, one or two panes wide and usually a maximum of 1 200 mm deep; more often used in sloping patent glazing but may also be fitted into vertical patent glazing.

b) *Inserted windows and louvres*: most types of framed opening windows, e.g. top and side-hung, pivoted, sliding, etc., may be inserted into vertical patent glazing. Louvres with fixed or adjustable blades may also be fitted.

c) *Natural and mechanical ventilating units*: various forms of proprietary ventilating units, for air movement or smoke exhaust, may be fitted into sloping or vertical patent glazing, according to their design.

d) *Permanent ventilation*: may be provided but the design and location should be carefully considered, as absolute watertightness in extreme conditions of driving rain or snow might not be practical.

Power fans for inlet or extraction, made of metals, plastics or other materials, may be incorporated into patent glazing, either vertical or sloping, according to the design of the component. In sloping patent glazing, however, such fans should never be mounted directly in a pane of glass.

When considering the installation of heavy-duty power fans or other ventilators with high dead loads, it might be necessary to support these independently on suitable trimmer frames, which are fixed directly to the main structural members. In such cases, the patent glazing contractor should be consulted at the initial design stage (see Clause **4**).

9.3 Entrances

Doors of various types, including hinged, pivoted or sliding, with their frames, may be incorporated within an area of vertical patent glazing either as integral doors or as separate door composites. Where patent glazing incorporates an entrance, including one not extending to the full height of the patent glazing, it might be necessary to provide an additional supporting frame for the patent glazing around the entrance. This should be fixed to the main structure to ensure that vibration or other loads are not transmitted to the patent glazing.

10 Heat

10.1 General

Attention to the levels of insulation provided by careful choice of infill materials will reduce heat loss to a minimum with consequent reduction in the amount of heat required from the heating system. The patent glazing should have thermal insulation and solar control appropriate to the requirements of the building.

All materials allow heat to flow by conduction from the warmer surface to the colder, at a rate dependent on their thermal conductance.

Patent glazing and the role of infilling with respect to heat is viewed in several ways:

— thermal comfort (see BS 5516-2:2004 for sloping glazing and BS 6262-2 for vertical glazing);

— solar heat gain (see BS 5516-2:2004 for sloping glazing and BS 6262-2 for vertical glazing);

— heat loss (see BS 5516-2:2004 for sloping glazing and BS 6262-2 for vertical glazing);

— condensation (see **10.2**);

— heat balance (see BS 5516-2:2004 for sloping glazing and BS 6262-2 for vertical glazing);

— thermal safety (see BS 5516-2:2004 for sloping glazing and BS 6262-2 for vertical glazing);

— thermal movement (see **10.3**, also BS 5516-2:2004 for sloping glazing and BS 6262-2 for vertical glazing).

10.2 Condensation

10.2.1 *General*

Condensation will occur on any surface with a temperature less than the dew point of the atmosphere near the surface (see BS 5250). Thus, when the surface temperature of any part of the patent glazing and the relative humidity of the atmosphere reach a critical combination, condensation will occur. Ground frost, cold rain and low temperature with high wind will exacerbate the formation of condensation. Adequate ventilation will serve to reduce condensation.

Inside buildings, the humidity is commonly increased by the release of moisture from processes, including cooking, and swimming pools and by the presence of people. It can reach high values where ventilation is inadequate.

Condensation can intensify bimetallic corrosion (see **13.8**).

Where necessary, provision should be made for any condensate to be collected and discharged to the outside of the building.

Glazing bars incorporating thermal barriers will assist in reducing condensation. In extreme or exacting conditions, parts of the patent glazing in contact with the interior atmosphere might need to be covered with insulating material.

The possibility of condensation forming on glass and/or plastics glazing sheet materials may be minimized by the use of an appropriate form of double glazing.

In cases where condensation is likely to occur on the inside of sloping patent glazing, account should be taken of the surface tension of the infill material as this relates to the likelihood of the condensation dripping down from the infilling. Generally, where the slope of the patent glazing is 30° or more to the horizontal and condensation is not severe, the condensate will usually flow down glass without dripping; though with dirty and/or patterned glass, the condensate can sometimes drip at much steeper slopes. With plastics glazing sheet materials, surfaces may be treated to reduce surface tension and hence decrease the incidence of dripping.

10.2.2 *Room side condensation*

As thermal insulation of glazing improves, the susceptibility to condensation on the room face of glazing is reduced.

10.2.3 *Interstitial condensation*

In insulating glass units, condensation in the cavities is minimized by hermetically sealing and dehydrating the cavity.

In coupled glazing, interstitial condensation problems can be reduced in the UK by venting the cavity to the outside.

10.2.4 *Exterior condensation*

On rare occasions, condensation can occur on the outermost glass surface of highly insulating glazing, e.g. low E glass, as a result of the reduction of heat conduction to the outside. This effect will only be prevented at low sky temperature, i.e. a clear sky, when there is a heavy dew, and is more likely to occur on sloping glazing than on vertical glazing, since a larger proportion of the sky is able to cool the glazing.

10.3 Thermal movement

Where thermal or other movement joints are required in a building it might be necessary to incorporate corresponding expansion joints in the patent glazing. They should be considered at the design stage as to the specific movements involved, in order that these can be accommodated within the patent glazing system.

11 Acoustic performance

Materials reduce noise by acting as a barrier to the transmission of sound (insulation) and by damping sound reflection from surfaces (absorption). Consideration should be given to the frequency spectrum of the sound to be reduced.

Sound insulation generally increases with the physical mass of the material. In sealed insulating glass units, the insulation effect is only marginally improved by increasing the cavity width. Interlayers in laminated glass can improve the damping effect. While solid and hollow section plastics glazing sheet materials have a lower mass than glass, and therefore a lower insulation value, they have a greater damping effect.

For sound reduction values of infill material, the appropriate manufacturer should be consulted.

Sound insulation is impaired by openings and gaps, which provide alternative pathways for airborne sound transmission. Sound insulation may be improved by the use of continuous, resilient gaskets and sealing materials.

In patent glazing applications, four edge support systems with sealed perimeter joints will provide a better solution.

Guidance related to source of noise, specification of acoustic performance, acoustic indices and sound reduction of glass and plastics glazing sheet materials are given in BS 5516-2:2004 for sloping applications and BS 6262-2 for vertical applications.

12 Security

Where a high level of security is required, the patent glazing contractor should be consulted.

For example, the security of patent glazing in vulnerable or accessible situations is improved by using:

— internal caps/wings; or

— caps secured from the inside; or

— an external cap with secure fasteners such as non-return screws; and

— an infilling material with a higher resistance to attack.

For patent glazing at roof level (roof, lantern and dome lights), security bars may be installed below the patent glazing in accordance with the appropriate section of BS 8220-2.

Guidance related to the following aspects is given in BS 5516-2:2004 for sloping applications and BS 6262-3 for vertical applications:

a) manual attack;

b) firearm attack;

c) explosion resistance;

d) installation;

e) glass;

f) plastic glazing sheet materials;

g) means of escape.

13 Installation

13.1 General

Installation of patent glazing is a specialized service and should always be carried out by a specialist contractor using experienced personnel.

NOTE Attention is drawn to Health and Safety Executive (HSE) *Health and safety in roof work* [2].

13.2 Safety

Personnel installing patent glazing should wear protective clothing and work with appropriate equipment.

During installation it is undesirable to allow access to the area directly beneath the patent glazing. This should be cordoned off and appropriate signs posted. If it is impractical to keep such areas clear, measures should be taken to protect persons below.

13.3 Storage of materials on site

Glazing bars, flashings and ancillary components should be stored in a dry prepared storage area and be suitably protected against mechanical and chemical attack. Materials supplied with protective masking should be stored out of direct sunlight.

Recommendations for site storage of glass and plastics glazing sheet materials are given in BS 5516-2:2004 for sloping applications and BS 6262 for vertical applications.

13.4 Preparatory work

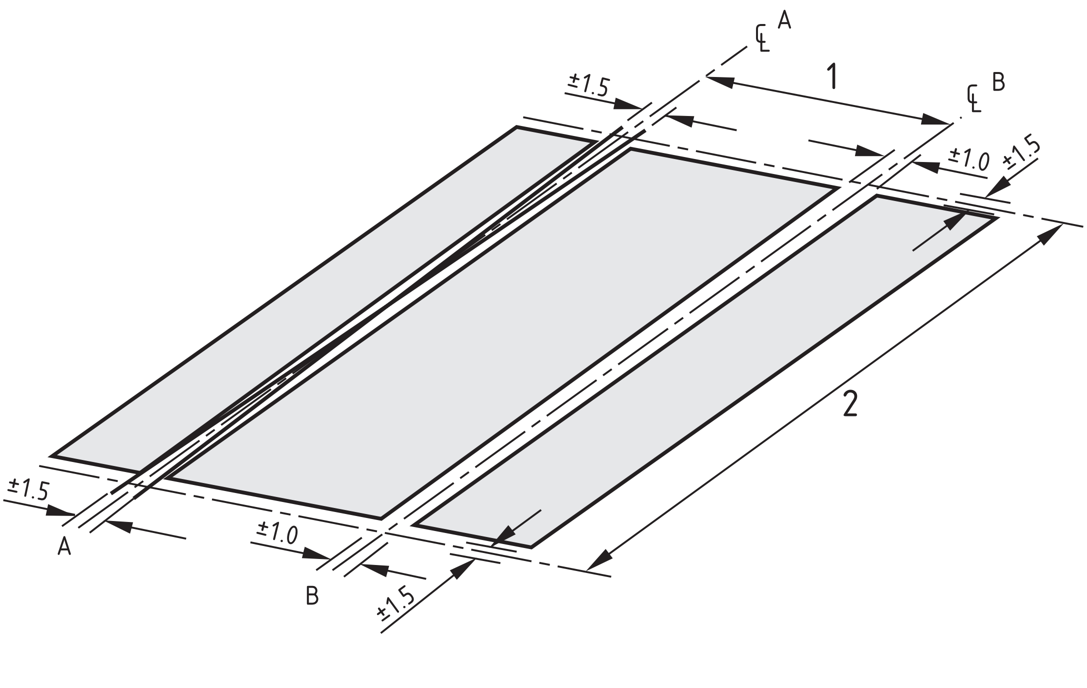
Before patent glazing is installed the supporting structure should be erected and/or lined and levelled to agreed tolerances. Adjacent masonry should be prepared as necessary to accommodate flashings and/or other weatherings.

Where holes in steelwork are pre-drilled, or where inserts are provided in concrete, holes and inserts should be positioned to agreed details.

Where pre-drilled holes or inserts are not provided, the building designer should be consulted to ensure that the supporting structure is not adversely affected by subsequent drilling. The additional time involved for site drilling should be allowed for in the site programme.

The dimensional and positional tolerance of patent glazing should be as given in Figure 2.

NOTE Some adaptation of the patent glazing to overcome minor discrepancies in the supporting structure and adjacent materials might be possible; this will depend upon the particular patent glazing system and materials used.



Key

1 Design spacing of bars

2 Design centre-line for spacing for holes

NOTE 1 Alignment of patent glazing bars, A – A.

NOTE 2 Dimensions are not cumulative and are based on the design position of each glazing bar, B – B.

Figure 2 — Dimensional and positional tolerances of patent glazing

13.5 Patent glazing bars and other glazing bars

Patent glazing should be securely attached to and supported by suitable pre-positioned structural members, e.g. steel, concrete or timber.

The glazing bars should be correctly spaced and aligned to ensure adequate support and retention of the infilling without having any adverse effect on weather resistance or movement capability.

13.6 Infilling

The infill material should be positioned correctly and secured between the glazing bars. All seals and weatherings should be firmly placed and all fasteners properly tightened.

Where the surfaces of the infill material differ, e.g. in texture (smooth/rough), the manufacturer's instructions should be followed. As a general rule, the smoother surface should be outside to maximize self-cleaning.

Surface coated glasses and surface coated plastics glazing sheet materials might be required to be installed a particular way around. Care should be taken to ensure that these infillings are correctly installed following the designer's or manufacturer's recommendations.

When cutting hollow section plastics glazing sheet materials to size, any swarf entering the hollows should be removed before installation.

13.7 Flashing

Two types of flashing are used with patent glazing systems: site formed (lead, soft aluminium, etc.) and preformed (aluminium or steel sheet profiled for the particular application) (see also **5.3**).

Where site formed flashings intended to overlap the patent glazing are prefixed to the building, these should be dressed down onto the patent glazing by the patent glazing contractor. Capillary paths should be broken by incorporating an air space [see **14.2**d)].

When dressing down site formed flashings, great care should be taken to avoid damaging the infill material and, where necessary, retaining clips should be used to restrain the free edges of the flashing against wind uplift. Lapped joints should overlap by at least 100 mm.

Preformed flashings should be fixed with lapped or butt joints and sealed. Butt straps at least 100 mm wide should be used with butt joints.

13.8 Ancillary components

Where local atmospheric conditions are likely to promote a reaction between dissimilar metals, isolation material should be used between the untreated surfaces. (See also Clause **16**.)

13.9 Protective taping

If materials are supplied with protective tape, this should be peeled back sufficiently to prevent entrapment during installation. Taping should be completely removed as soon as practically possible after installation, as environmental effects can make it increasingly difficult to remove.

NOTE On plastics glazing sheet materials, a time limit is sometimes printed on the sheet product.

14 Weather resistance and performance testing

14.1 General

The degree of exposure and the particular situation of the patent glazing should be taken into account when considering weather resistance and the type of system to be employed.

Consideration should also be given to the intended use and occupancy of the building, together with any specific performance criteria. The patent glazing contractor should be provided with the necessary information at the initial design stage (see Clause **4**).

14.2 Means of achieving weather resistance

The principal factors affecting the weather resistance of patent glazing systems are as follows.

a) *Slope*. The recommended minimum slope for patent glazing is 15° to the horizontal. For slopes below the recommended minimum, or in situations where a large volume of water is likely to be encountered, all weatherings should be sealed to the infilling.

Four-edge systems of patent glazing should be designed to discourage the accumulation of standing water on transverse members. This is particularly important with sloping patent glazing.

Discharges from down pipes or other concentrations of rainwater should not be allowed to flow over sloping patent glazing. Separate drainage gutters should be provided.

b) *Drainage channels*. Drainage channels should be provided in patent glazing bars and transoms to collect and drain away to the outside of the building, either directly or indirectly, any water that can penetrate beyond the wings, caps or other external weatherings. Outlets from drainage channels should be of adequate size to ensure proper drainage and should be free of obstruction so as not to provide places for silt to lodge.

Where excessive dust, grit or dirt, from sources such as the main stack of a solid-fuel-burning boiler-house, stone and cement works, is likely to silt up the drainage channels, suitable cleaning maintenance precautions should be taken.

c) *Glazing seals*. All supported edges of the infilling should be set on resilient glazing material throughout their full lengths.

d) *Flashings*. Flashings which provide the weathering at the top of patent glazing should overlap the infilling by a nominal 75 mm. With flashings that are likely to produce a capillary path for water, the path should be broken by incorporating an air space or otherwise effectively sealed.

Site formed flashings should be properly dressed down and secured as necessary.

e) *Weather bars*. On two-edge systems of patent glazing, weather bars are provided between patent glazing bars at the bottom edge of the infilling to prevent the penetration of windblown water, snow and dust. Additional weather bars may be provided at the top of vertical patent glazing when preformed flashings are used.

f) *Bottom overhang*. On two-edge systems of sloping patent glazing, the bottom edge of the infilling should overhang at least 75 mm beyond the weather bar. In conditions of extreme exposure or when the slope of the patent glazing is less than the recommended minimum of 15°, the overhang should be increased.

g) *Joints*. Joints, which are not designed to be drained by drainage channels, should be fully protected against water penetration into the building.

14.3 Performance testing and classification

The procedure for performance testing unsealed patent glazing with exposure classifications is given in Annex G.

For fully sealed four edge systems, the performance testing procedures recommended for sloping curtain wall should apply.

14.4 Site water testing

Recommendations for site water testing are given in Annex H.

15 Maintenance

15.1 General

For safety reasons, maintenance should not be carried out in adverse weather conditions such as strong winds or when there is snow lying on sloping glazing. The clearing of snow from roofs containing fragile or non-load bearing materials, especially glass, is not recommended. Partial removal of snow can adversely affect the structural stability of the roof.

15.2 Access for maintenance and cleaning

15.2.1 *General*

Those engaged on maintenance work should use suitable equipment (see BS 8213).

Permanent and/or temporary access to both sides of patent glazing for inspection, cleaning and repair should be taken into account at the initial design stage (see Clause **4**)

NOTE Attention is drawn to the Construction Design and Management Regulations, the Construction (Working Places) Regulations 1966, SI 64 [3] the NBS specification *Access for cleaning and maintenance* [1] and the HSE publication *Health and safety in roof work* [2].

Patent glazing should never be stood or walked upon without the use of fall arrest harness restraint systems and crawling boards. Equipment should be so constructed that the restraint system is independent of the patent glazing and the weight of operative is well distributed and over at least two patent glazing bars.

15.2.2 *Reason for access*

There are several reasons why direct access should be provided to areas of sloping or vertical patent glazing, both to internal and to external surfaces. Primarily these are inspection, cleaning and repair or renewal.

15.2.3 *Temporary access*

Temporary access, if required, may be achieved by the use of ladders, crawling boards and scaffolding of various forms suitable for the particular type of building and the location of the glazing. Such forms of access should be removed shortly after use.

Ladders and crawling boards may be used safely without imposing any loading on the glazing provided that they are supported at a purlin or other structural member. Spreader boards should be properly secured and should rest on at least two glazing bars. Stops might need to be provided on the glazing bars to locate crawling boards, etc. and to prevent them from slipping. Maintenance loads should never be carried directly by the infilling, unless it is specifically designed for the purpose.

Temporary access may also be gained through the use of specialist systems, such as manual or powered cradles or gantries. Motorized working platforms are particularly useful on the inside of a building provided that there is good access and sufficient room to manoeuvre. They may also be effectively used outside. Care should always be exercised to ensure that firm and level areas are provided from which to operate.

15.2.4 *Permanent access*

Systems of permanent access may be either fixed or moving platforms on some form of tracking, re-locatable within a pre-set pattern.

Walkways or platforms should be completely independent of the patent glazing. Such systems may be designed to suit sloping or vertical patent glazing and allow for access to external and/or internal surfaces.

15.3 Inspection

Periodic visual inspection of patent glazing should be carried out by those responsible for the maintenance of the building and the patent-glazing contractor should provide an inspection and maintenance manual.

Particular attention should be given to:

- — the tightness of bolts and fasteners;
- — joint seals and junctions between different materials;
- — moving parts such as ventilators.

The frequency of inspection/cleaning for particular components or finishes may also be determined by the requirements of the terms and conditions of a manufacturer's warranty.

Where it is known that there is a particular risk from atmospheric pollution, e.g. from certain production processes or close proximity to the sea, more frequent inspection might be necessary.

15.4 Cleaning

15.4.1 ***General***

Regular cleaning to remove atmospheric grime and pollution will maintain the appearance, durability and performance of patent glazing. Cleaning therefore contributes considerably to the effective life of the patent glazing. The frequency of cleaning of internal as well as external surfaces depends upon the following:

a) the current use being made of the building;

b) the particular situation of the patent glazing on the building;

c) the building location and the local environmental conditions;

d) the type of infill material, its surface texture and finish;

e) the materials used for glazing bars, flashings, ancillary components and their surface texture and finish;

f) the attitude of the client/owner to the general appearance and maintenance of the building;

to conform to the terms of guarantee provided by the metal finishers.

15.4.2 ***Infilling***

Infilling should be cleaned regularly and at time intervals depending upon the accumulation of dirt.

If excessive dirt is allowed to accumulate, it will lead to:

a) reduction of light transmission leading to an unsatisfactory level of illumination which can affect occupants and their safety;

b) increase in the absorption of solar radiation, which, with glass, can cause an increase in the thermal stress.

15.5 Glazing bars, flashings and ancillary components

15.5.1 ***General***

During cleaning, care should be taken not to disturb any weatherings including wings, caps or flashings, or to dislodge any other ancillary components.

Outlets from drainage channels should be cleared as necessary.

15.5.2 ***Cleaning materials***

A solution of mild detergent in water, applied with a clean soft non-abrasive cloth, followed by a thorough clean water rinse should be used for routine cleaning. Care should be exercised to avoid rubbing dirt into any surface.

The removal of stains and marks, other than those, which are removed by the method described above, should be discussed with the manufacturer of the material to be cleaned.

For treatment of specific surface finishes to metal, reference should be made to BS 6270-3.

15.6 Other maintenance

Any damaged or missing components located during period inspection should be replaced as soon as possible and any loose items secured as necessary.

Where replacement or repair work is necessary, the patent glazing contractor responsible for the original installation should preferably carry this out.

16 Durability

16.1 General

The durability of a patent glazing system depends upon the conditions of exposure, the materials and finishes used in the component parts, and the frequency and thoroughness of cleaning and maintenance. Relevant information can be obtained from BS 7543 and BS 8213-1. The patent glazing contractor should be notified at the initial design stage of any aggressive factor, either inside or outside the building (see Clause **4**). A classification of atmospheric pollution is given in BS 7543.

All components should be designed to withstand the expected natural exposure conditions and atmospheric pollution.

16.2 Patent glazing bars, other glazing bars, components and finishes

In urban exposure conditions and mild industrial atmospheres, all the materials described in Clause **6** for the components of patent glazing systems may be used. More severe conditions, either internally or externally, can place a restriction on the use of certain materials.

Aluminium should not be used where alkaline pollution is expected. Protection should be provided against alkaline solutions formed when rainwater passes over "green" concrete or newly cement-rendered surfaces, and onto aluminium. Acidic atmospheres formed in heavily industrialized environments and/or severe marine conditions can be too aggressive for untreated aluminium to withstand for a long time.

The drainage of water from copper or copper alloys onto aluminium or zinc based alloys causes corrosion and should be prevented. Similarly, the presence of copper in paints and in abrasive cleaning agents should be avoided.

No two metals able to set up marked bimetallic corrosion should be used in proximity to one another. In locations where condensation can occur bimetallic corrosion can be intensified. Relevant information about bimetallic corrosion is given in PD 6484. Protection may be achieved by anodizing, stove painting or other suitable measures (see **5.5**).

Care should be taken with the use of lead in the presence of some chemicals, e.g. acetic acid.

The effects of excessive heat and/or ultraviolet exposure should be considered. This is particularly relevant where plastics are used.

16.3 Infillings

16.3.1 *Glass*

Glass classified in BS 952-1 is generally suitable for use in most exposure conditions. Care should be taken to avoid alkaline solutions running onto the glass surface. Special consideration should be given to the use of wired glass and certain types of coated glass in marine or severe industrial atmospheres.

The sealant used in the manufacture of insulating glazing units should be compatible with the expected environmental conditions and, if exposed to high levels of ultraviolet radiation, the sealant should be resistant to such exposure.

Further guidance is given in BS 5516-2 for sloping applications and BS 6262 for vertical applications.

16.3.2 *Plastics glazing sheet materials*

Plastics glazing sheet materials are known to perform satisfactorily in service but it has not been possible to derive a test that accurately predicts their durability. Information is available from manufacturers.

The choice of a particular plastics glazing sheet material may be dictated by the environmental conditions specified. Account should be taken of possible corrosion and of contamination by any extracted chemicals that may be rain-washed over the infilling.

Further guidance is given in BS 5516-2:2004 for sloping applications and BS 6262 for vertical applications.

16.3.3 *Other infillings*

For other types of infilling, the manufacturer's recommendations should be obtained, relevant to the anticipated weathering and environmental conditions.

16.4 Sealing and glazing materials

Due to the large variety of materials available no specific advice can be offered and the manufacturer of the product should be consulted about its durability.

Further guidance is given in BS 5516-2:2004 for sloping applications and BS 6262 for vertical applications.

Annex A (normative) Wind load

A.1 Summary of BS 6399-2:1997

The maximum one hour mean wind speed likely to be exceeded on average only once in 50 years at a height of 10 m above ground in open, level country is determined for the district where the building is located. This basic wind speed is multiplied by appropriate factors to take account of altitude, topography, ground roughness, building life and wind direction to give the site wind speed.

The site wind speed is then multiplied by a terrain and building factor, relating to the height of the building and the distance of the site from the sea and from the edges of towns, to give the reference gust wind speed.

The reference wind speed is then converted to a dynamic pressure, expressed in Newtons per square metre, from the standard relationship given in SI units. The maximum inward (positive) pressure and the maximum outward (negative) pressure exerted at any point on the surface of the sloping glazing are obtained by multiplying the resulting dynamic pressure by appropriate pressure coefficients based on the worst possible combination of the sloping glazing being subjected simultaneously to positive pressure on one surface and negative pressure on the other.

For external walls and roofs of clad buildings, the value of these pressure coefficients is the difference between an external pressure coefficient which is dependent on the shape and size of the building, wind direction and the position of the sloping glazing under consideration, and an internal pressure coefficient evaluated on the basis of the size and distribution of openings in the building. For roofs of freestanding, open-sided canopies combined overall pressure coefficients are used depending on the shape of the roof, the degree of obstruction under the canopy and the position of the sloping glazing under consideration.

A negative sign prefixing a pressure coefficient indicates a suction (negative pressure) as distinct from a positive pressure and the design wind loads p_w thus derived, which can be both positive and negative, act in a direction normal to the surface of the sloping glazing.

It may be noted that extremes of internal pressure can arise when a building is only partially clad during its construction. The building designer will be aware of the proposed sequence of construction and should consider the problem so that the most vulnerable conditions of partial cladding and dangerous structural shapes are avoided.

A.2 Abbreviated method of determination of design wind load for low rise buildings

To find the design wind loading, select:

a) the basic wind speed from Figure A.1;

b) the site terrain category from Table A.1;

then use these to obtain the dynamic wind pressure at sea level equivalent from Table A.2.

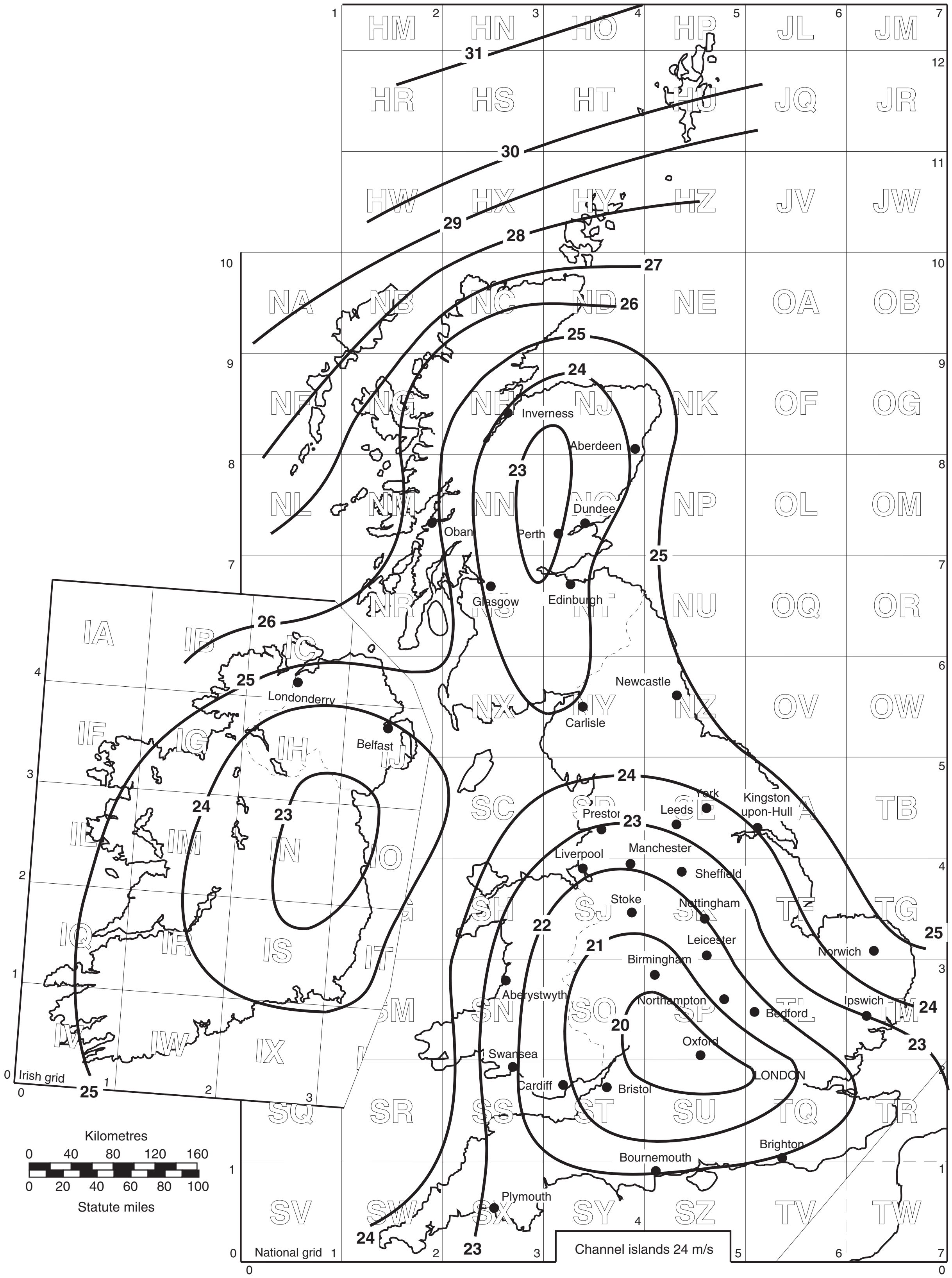


Figure A.1 — Basic wind speed map (from BS 6399-2:1997)

Table A.1 — 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 on the outskirts of towns not sheltered by other buildings, the site terrain category should be taken as open country.	

To obtain the dynamic wind pressure for the site, multiply the dynamic wind pressure 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 A.3.

$$q = q_0 F_A F_T$$

Select the appropriate net pressure coefficients, C_p, both suction (upward) and pressure (downward), from Table A.4. Multiply the dynamic wind pressure for the site by the pressure coefficients to obtain the design wind pressures acting downwards and upwards on the glazing.

$$p_w = qC_p$$

For vertical glazing, C_p should be taken as 1.5 for suction (outward) or 1.1 for pressure (inward).

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 6399-2:1997 should be used.

An example of the abbreviated calculation method is given in Annex F.

Table A.2 — Dynamic wind pressure

Basic wind speed m/s From Figure A.1	Height of building m	Design wind loading (N/m²) for site terrain category (see Table A.1)					
		A	B	C	D	E	F
20	≤ 5	668	604	567	501	440	408
	>5 and ≤ 10	786	734	692	659	612	574
	>10 and ≤ 15	848	821	768	725	684	651
21	≤ 5	736	666	625	553	485	450
	>5 and ≤ 10	866	809	763	727	675	633
	>10 and ≤ 15	935	905	847	800	754	718
22	≤ 5	808	731	685	607	533	494
	>5 and ≤ 10	951	888	837	798	741	695
	>10 and ≤ 15	1 026	994	930	878	827	788
23	≤ 5	883	799	749	663	582	540
	>5 and ≤ 10	1 039	971	915	872	810	759
	>10 and ≤ 15	1 122	1 086	1 016	959	904	862
24	≤ 5	961	870	816	722	634	588
	>5 and ≤ 10	1 131	1 057	997	950	881	827
	>10 and ≤ 15	1 222	1 182	1 106	1 045	985	938
25	≤ 5	1 043	944	885	783	688	638
	>5 and ≤ 10	1 228	1 147	1 081	1 030	956	897
	>10 and ≤ 15	1 325	1 283	1 200	1 133	1 068	1 018
26	≤ 5	1 128	1 021	957	847	744	690
	>5 and ≤ 10	1 328	1 240	1 170	1 115	1 034	970
	>10 and ≤ 15	1 434	1 388	1 298	1 226	1 156	1 101
27	≤ 5	1 217	1 102	1 032	914	802	744
	>5 and ≤ 10	1 432	1 337	1 261	1 202	1 116	1 046
	>10 and ≤ 15	1 546	1 497	1 400	1 322	1 246	1 187
28	≤ 5	1 308	1 185	1 110	983	863	800
	>5 and ≤ 10	1 540	1 438	1 356	1 293	1 200	1 125
	>10 and ≤ 15	1 663	1 609	1 506	1 422	1 340	1 277
29	≤ 5	1 404	1 271	1 191	1 054	926	858
	>5 and ≤ 10	1 652	1 543	1 455	1 387	1 287	1 207
	>10 and ≤ 15	1 784	1 726	1 615	1 525	1 438	1 370
30	≤ 5	1 502	1 360	1 275	1 128	991	918
	>5 and ≤ 10	1 768	1 651	1 557	1 484	1 377	1 291
	>10 and ≤ 15	1 909	1 848	1 728	1 632	1 539	1 466
31	≤ 5	1 604	1 452	1 361	1 205	1 058	980
	>5 and ≤ 10	1 888	1 763	1 663	1 584	1 471	1 379
	>10 and ≤ 15	2 038	1 973	1 846	1 743	1 643	1 565

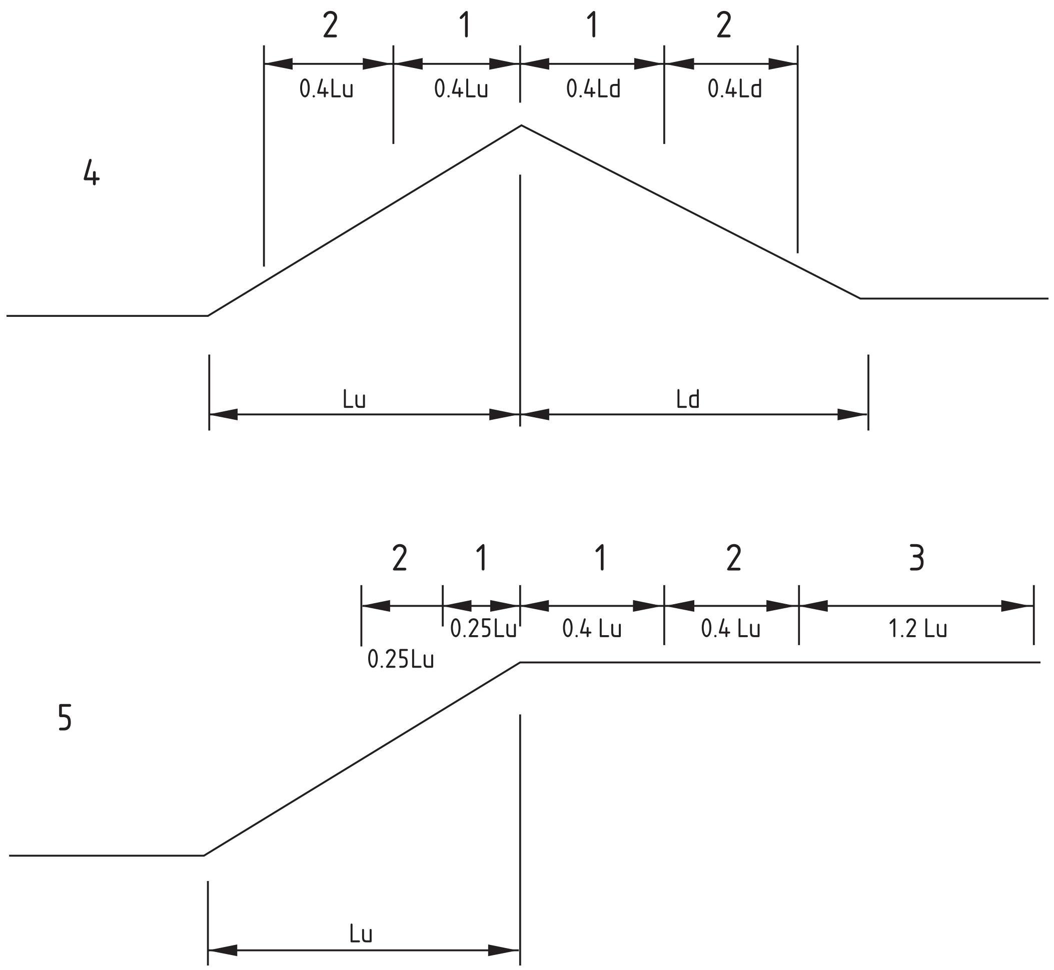
NOTE 1 The values are rounded.

NOTE 2 N/m^2 = Pa.

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

Table A.3 — Topographical factor

Topographical category and description	Factor F_T according to zone from Figure A.2			
	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 Zone 1
2 Zone 2
3 Zone 3
4 Hills and ridges
5 Cliffs and escarpments

Figure A.2 — Topographic zones

Table A.4 — Combined pressure coefficients

Glazing position[a]		Mono pitch roofs[b]		Duo pitch roofs[b]	
Pressure direction		Suction	Pressure	Suction	Pressure
Roof pitch in degrees	–45°			–1.2	0.5
	–30°			–1.4	0.5
	–15°			–2.4	0.5
	–5°			–2.0	0.5
	0°	–1.7	0.5	–1.7	0.5
	5°	–2.0	0.5	–1.7	0.5
	15°	–2.5	0.5	–1.3	0.5
	30°	–2.0	1.0	–0.9	1.1
	45°	–1.2	1.0	–0.9	1.1
	60°	–0.9	1.0	–0.9	1.1
	75°	–0.9	1.0	–0.9	1.1

Glazing positional[a]		Mono pitch canopies			Duo pitch canopies		
Pressure direction		Suction		Pressure	Suction		Pressure
		No blockage	Fully blocked		No blockage	Fully blocked	
Roof pitch in degrees	–20°	—	—	—	–1.6	–2.7	1.7
	–10°	—	—	—	–1.6	–2.5	1.5
	0°	–1.4	–2.2	1.8	–1.4	–2.2	1.8
	10°	–2.1	–2.7	2.4	–1.5	–2.0	1.8
	20°	–2.9	–2.9	2.9	–2.0	–1.7	1.9
	30°	–3.8	–2.5	3.2	–2.0	–1.6	1.9

[a] For the purposes of this table, a roof is glazed into a closed building with relatively impermeable walls on all sides. A canopy is the roof of a structure with at least one wall mainly absent.

[b] The net pressure coefficients given for roofs are based on the assumption that all the external walls of the building have similar permeability, i.e. similar numbers and sizes of opening doors and windows etc. If external walls do not have similar permeability, or if in doubt, then increase the suction values by –0.5.

A.3 Derivation of the dynamic wind pressure in Table A.2

The values of dynamic wind pressure are derived from BS 6399-2:1997. The symbols and terminology below are described in BS 6399-2:1997.

Basic wind speed, V_b, is derived from Figure 6 of BS 6399-2:1997 (reproduced as Figure A.1 in this standard).

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

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): $H_o = 0.6\ H$ i.e. H_e = 3 m or 6 m or 9 m.

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

Table A.5 — Building factors

Site terrain category from Table A.1	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, $V_e = V_s S_b$.

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

Annex B (normative) Snow load

B.1 Summary of BS 6399-3

The load intensity of undrifted snow at ground level likely to be exceeded on average only once in 50 years at an altitude of 100 m in a sheltered area is determined for the district where the building is located. This basic snow load on the ground is adjusted on a regional basis for locations whose altitude is above 100 m and to take account of building life to give the characteristic snow load on the ground.

The snow load on the sloping glazing is obtained by multiplying the characteristic snow load on the ground by an appropriate shape coefficient based on the worst load case applicable. The value of this shape coefficient is dependent on the external shape of the roof, the position and height of any surrounding roofs and the position of the sloping glazing under consideration. Two primary loading conditions should be considered: that resulting from a uniform layer of snow and that resulting from an uneven distribution of snow. Uneven distribution can result from the transport of snow by the wind from one side of a roof to the other side or from the accumulation of drifted snow against vertical obstructions and in valleys.

The resultant snow load on the sloping glazing is assumed to act vertically and refer to a horizontal projection of the area of the glazing. For the derivation of the design snow load p_s (in N/m^2) the component of the snow load on the sloping glazing perpendicular to and measured in the plane of the glazing is required. This may be found from the following equation:

$$p_s = s_d 10^3 \cos^2 \alpha$$

where s_d is the snow load (in kN/m^2).

It is recommended that load cases involving local drifting of snow be treated as exceptional snow loads because of the rarity with which they are expected to occur. In such cases, the value obtained for the snow load on the roof, s_d, may be multiplied by a factor of 0.8 when deriving the design snow load, p_s, for use in calculations involving the strength of sloping glazing.

B.2 Abbreviated method of determining the snow load

To determine the design snow load, select the basic snow load, s_b, in kN/m^2 from the map in Figure B.1.

Determine the altitude factor for the site from the altitude of the site, A, in metres:

$$s_{alt} = 1.0 s_b + 0.09.$$

Determine the site snow load, s_0, in kN/m^2.

— For site altitudes lower than 100 m: $s_0 = s_b$.

— For site altitudes above 100 m: $s_0 = s_b + s_{alt} \dfrac{A - 100}{100}$.

Determine the design snow load, s_d, in kN/m^2 as follows:

$$s_d = 0.8 s_0.$$

Where there is a possibility of drifting, the following design snow loads should also be considered.

a) For roofs with valleys of depth h, in metres, drift loads which are the lesser of:

$s_d = 2h$ and $s_d = 5s_0$.

b) For canopies and lower roofs, extending outwards up to five metres, abutting a structure of height h_1, in metres, above the level of the canopy or roof, drift loads which are the lesser of:

$s_d = 2h_1$ and $s_d = 5s_0$.

c) For canopies and lower roofs, extending outwards more than five metres, abutting a structure of height h_2, in metres, above the level of the canopy or roof, drift loads which are the lesser of:

$s_d = 2h_2$ and $s_d = 8s_0$.

NOTE Drift loads can decrease rapidly away from the maximum load calculated. For the glazing bars, frames or other supporting structure, advantage of this may be taken by using the calculation methods in BS 6399-3. For glass or plastics glazing sheet material, the maximum drift load should be assumed to be applied as a uniformly distributed load over the whole surface of each pane.

This method should not be used for sites at altitude above 500 m.

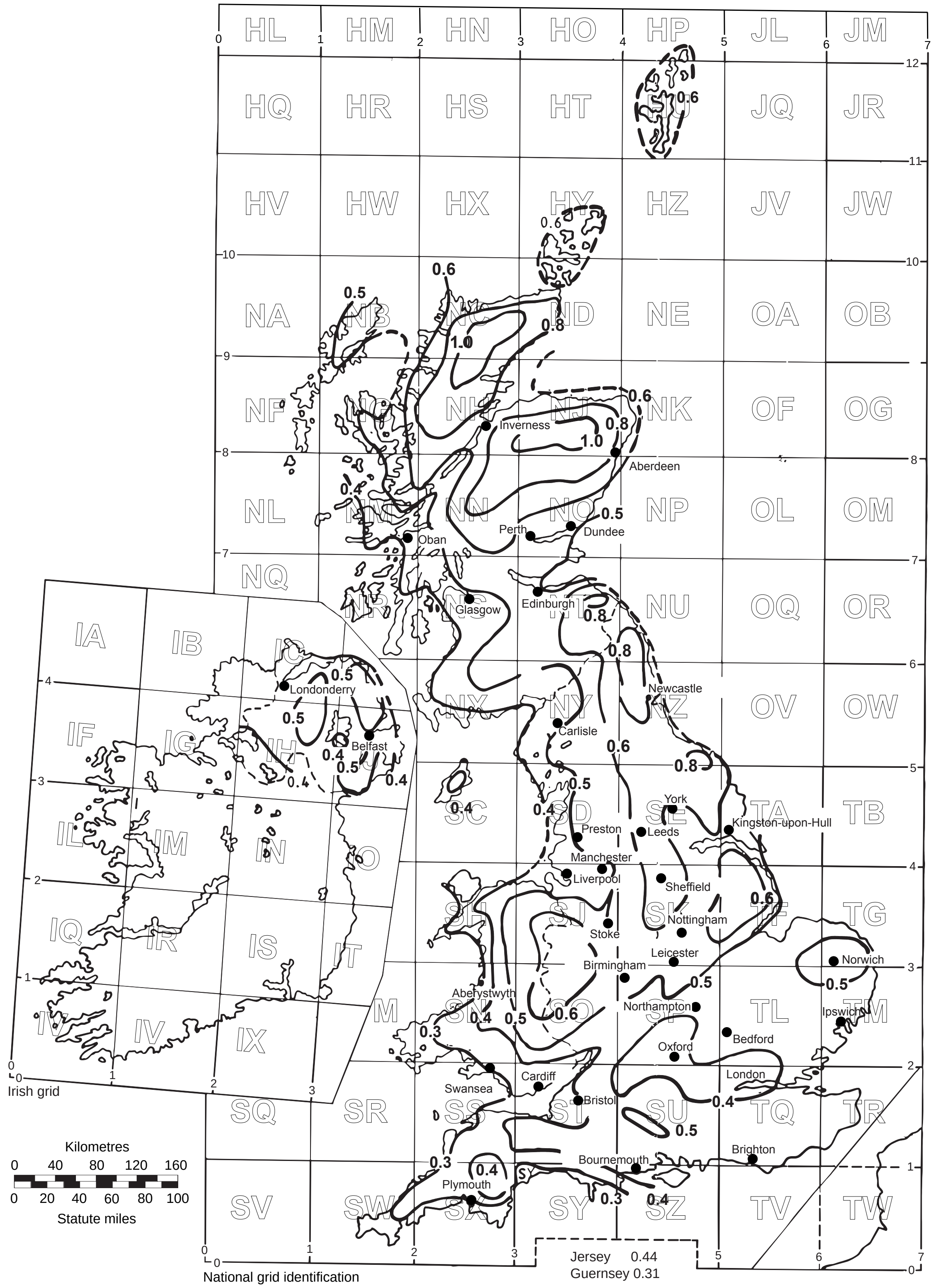


Figure B.1 — Basic snow load map (from BS 6399-3:1997)

Annex C (normative) Self-weight

Dead load for a supporting member should be based on the combined weight of the supporting member and of the infilling (both panes in double glazing). Dead load for the infilling alone should be based on the weight of the infill material only, the mass of hermetically sealed double glazing units and of laminated glass should be taken as the sum of the nominal mass of the individual glasses.

For the derivation of design dead load for a supporting member, p_{dm} (in N/m^2), and for the infilling, p_{di} (in N/m^2), the component of the weights perpendicular to the plane of the glazing is required and use may be made of the following equations:

$$p_{dm} = g_{im} \cos \alpha$$

$$p_{di} = g_i \cos \alpha$$

where

g_{im} is the weight per unit area of the supporting member and infilling (in N/m^2);

g_i is the weight per unit area of the infilling (in N/m^2).

NOTE (Kilogram mass per square metre) × 9.81 = weight per unit area (N/m^2).

Annex D (normative) Maintenance load

Where maintenance loads might have to be carried by the patent glazing, suitable provision should be made in the design.

The assessment of loads incidental to maintenance requires assumptions on the nature of the loads and how they are likely to be applied. For normal, routine maintenance, such as cleaning or repair work, the patent glazing bars (longitudinal glazing bars) should be capable of sustaining with safety to themselves and to the infilling a central point load sufficient to represent the effect of a ladder or crawling board leaning against or resting on at least two patent glazing bars and supporting the weight of a man. On sloping patent glazing, the maintenance load is unlikely to be other than in an inward direction; with vertical patent glazing, the load might be inward (positive) or outward (negative). Based on these assumptions, the following central point load on each patent glazing bar has been estimated:

a) for sloping patent glazing, a vertical load of 695 N;

b) for vertical patent glazing, a horizontal load of 172 N.

For the derivation of design maintenance load m (in newtons), the component of the load perpendicular to the plane of the glazing is required. This may be obtained from the following equations:

1) for sloping patent glazing, $m = 695 \cos \alpha$;

2) for vertical patent glazing.

Maintenance loads should never be carried directly by the infilling.

Where other more severe maintenance loads are anticipated, suitable provision should be made and the patent glazing contractor should be provided with the necessary information at the initial design stage (see Clause **5**).

Annex E (normative) Determination of working pressures for patent glazing

E.1 General

Depending upon the particular situation, patent glazing might be exposed to more than one of the types of loading described in **6.3**. Some of these loads can act simultaneously, either in the same direction or in opposite directions. In determining working pressures for patent glazing, an assessment of their effects should be carried out in such a way as to account for all possible loading combinations that are likely to occur in service.

For safety reasons, maintenance should not be carried out in strong winds or when there is much snow lying on the patent glazing and it is unnecessary therefore to treat maintenance load as additive when considering wind load and snow load. For similar reasons, the clearing of snow from roofs containing fragile or non-loadbearing materials, especially glass, is not recommended. Furthermore, partial removal of snow can adversely affect the structural stability of the roof.

All the design loads discussed in Annex A, Annex B, Annex C and Annex D have been expressed finally in terms of the design loads perpendicular to the plane of the glazing. The various combinations of design loads that have to be considered may now be expressed algebraically, with a positive or a negative sign prefixing the design wind load p_w to distinguish between inward (+) and outward (–) pressure.

For examples of working pressure for slope glazing, refer to BS 5516-2:2004, Annex E.

E.2 Sloping patent glazing

For the calculation of stresses and deflections in the patent glazing bars of sloping patent glazing, the combinations of positive loads acting inwards that usually have to be considered are thus:

a) for glazing bars, the higher of either:	$(+ p_w + 0.6p_s + p_{dm})$
or:	$(+ 0.6p_w + p_s + p_{dm})$
b) and for the infilling, the higher of either:	$(+ p_w + 0.6p_s + p_{di})$
or:	$(+ 0.6p_w + p_s + p_{di})$
If required to take account of maintenance load, the combination of loads is:	$(p_{dm} + m)$.

On those parts of the building subject to wind suction, the maximum negative loads acting outwards that result are the following combinations:

a) for glazing bars:	$(- p_w + p_{dm})$
b) and for the infilling:	$(- p_w + p_{di})$.

E.3 Vertical patent glazing

For vertical patent glazing, the magnitude of loads incidental to maintenance is likely to be small compared with the probable maximum wind loading both positive and negative and, as it is assumed that extensive maintenance would not be carried out in very windy conditions, any possible maintenance loads can usually be ignored. However, there might be instances, for example in sheltered situations with very low wind loading, where maintenance load and dead load can give rise to critical loading and this should be considered in determining working pressure for patent glazing bars.

Generally, therefore, for vertical patent glazing the maximum resultant positive loads acting inwards are usually the following:

— for glazing bars and for the infilling: $(+ p_w)$

If required to take account of maintenance load:

— for patent glazing bars: $(p_w + m)$.

Where sliding or drifting snow is likely to accumulate against vertical patent glazing, then the resultant snow load should be taken into account in determining the maximum positive loads acting inwards.

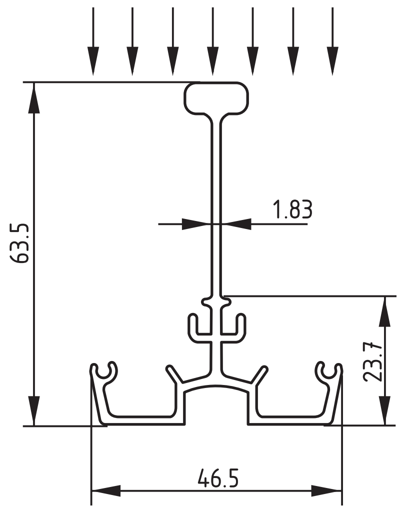
On those parts of the building subject to wind suction, the maximum negative loads acting outwards are likely to be the following:

— for glazing bars and for the infilling: $(- p_w)$.

In addition, self-weight should also be considered as a dead load acting downwards in the plane of the glazing in respect of transverse glazing bars and fixings.

Annex F (informative)
Typical structural calculation for glazing bars to the requirements of BS 8118

Code ref.	Calculation	Remarks/output
	A. Typical calculation for vertical glazing supports at ultimate limit state 1. Design for aluminium bars supporting vertical two-edge single glazing. Assume aluminium alloy designation 6063 temper T6 conforms to Table 4.1 of BS 8118-1:1999.	
Table 4.1, BS 8118-1:1991	Take p_o= 160 N/mm^2 E = 70 000 N/mm^2	
	2. Support members assumed to span 2 m (S) with a spacing of 0.60 m (W) **Loading** Assume worst case loading is due to wind pressure. In practice maintenance load is unlikely to be applied simultaneously with maximum wind pressure. Assume:	
Annex A BS 5516-1:2004	• Basic wind seed = 23 m/s • Height 5 m • Site terrain category E (Table A.1) • Altitude of site 60 m From Table A.2 → Dynamic wind pressure at sea level q_0 = 0.582 kN/m^2. Altitude factor $F_A = \left(1 + \frac{60}{1\,000}\right)^2 = 1.1236$. Assume topographical factor F_T = 1.0. Dynamic wind pressure at site $q = q_0 F_A F_T$ $= 0.582 \times 1.236 \times 1.0$ $= 0.654$ kN/m^2 From **A.2** the net pressure coefficient, C_p, is 1.5 for vertical glazing. Design wind loading $p_w = qC_p = 0.654 \times 1.5 = 0.981$ kN/m^2. Characteristic load $\varpi_{cl} = p_w W = 0.981 \times 0.6 = 0.59$ kN/m. For wind load, take safety factor $\gamma_f = \gamma_{f1} \times \gamma_{f2}$	
Table 3.1 and Table 3.2, BS 8118-1:1991	$= 1.2 \times 1.0 = 1.2$ Ultimate load, $\omega_{UI} = \bar{\omega}_{cl}\gamma_f = 0.59 \times 1.2 = 0.71$ kN/m.	
	→ Ultimate moment = $\frac{\omega_{UI} S^2}{8} = \frac{0.71 \times 2.0^2}{8} = 0.36$ kN/m.	Assuming bar is simply supported

Code ref.	Calculation	Remarks/output
	WIND LOADING  Section properties Area = 314.4 mm² I = 166 814 mm⁴ Z = 4 427 mm³ Glazing bar cross-section	
	Moment of resistance at ultimate limit state stability issues **(a) Lateral torsional buckling**	
6.6.2, BS 5516-1:2004	Lateral instability of glazing bar section is not a criterion due to the restraint provided by the infilling. → Ignore lateral torsional buckling effects.	
	(b) Local buckling Check susceptibility to local buckling for internal/outstand elements within the compression zone.	
4.3, BS 8118-1:1991	Under wind loading, main stem of glazing bar will be in compression → check local buckling capacity of its element. Treat stem as "un-reinforced" flat element initially (ignoring top lip):	
4.3.2.2, BS 8118-1:1991	Slenderness parameter, $\beta = \frac{b}{t} = \frac{(63.5 - 23.7)}{1.83} = 21.7$. By inspection, even if the maximum reduction factor (h) = 0.4, is applied for a "reinforced" flat element, slenderness parameter reduces to (0.4 × 21.7) = 8.7.	
4.3.2.3 and Figure 4.4, BS 8118-1:1991 Table 4.3, BS 8118-1:1991	This value is approximately equal to the limiting value, $\beta_0 = 7 \times \varepsilon = 7 \times \sqrt{\frac{250}{160}} = 8.75$. **→ Treat section as slender**	

Code ref.	Calculation	Remarks/output
4.5.2.2, BS 8118-1:1991	**Moment resistance** M_{RS} For an un-welded slender section: $M_{RS} = \frac{p_o \times Z_e}{M} = \frac{160 \times 4\ 427 \times 10^{-6}}{1.2} = 0.6\ \text{kNm}$ Applied moment > 0.36 kN/m **Glazing bar is adequate in bending** **Deflection** (Serviceability limit state) Maximum deflection of glazing bar, d_{max}: $d_{max} = \frac{5\bar{\omega}_{Cl} \times S^4}{384 \times E_M \times I_{xx}} = \frac{5 \times 0.59 \times 2\ 000^4}{384 \times 70\ 000 \times 166\ 814} = 10\ \text{mm}$. Max. allowable deflection d_{all}:	γ_m =1.2, Table 3.3, BS 8118-1:1991
6.6.3, BS 5516-1:2004	$d_{all} = \frac{S^2}{180} \times 10^3 = \frac{2.0^2}{180} \times 10^3 = 22\ \text{mm}$. Actual deflection > 10 mm **Deflection under service loading is within allowable limit**	

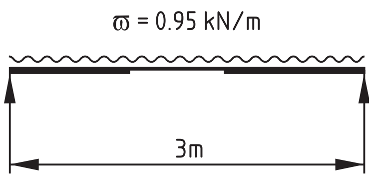
Code ref.	Calculation	Remarks/output
	B. Typical calculation for sloping glazing supports at ultimate limit state	
	1. Aluminium box glazing member for sloping two edge support single glazing assume aluminium alloy designation 6063, Temper T6 extrusion) conforms to Table 4.1 of BS 8118-1:1999.	Assume 15° min
	Take p_o = 160 N/mm^2.	
	E = 70 000 N/mm^2.	
	2. Support members assumed to span 3 m (S) with spacing of 0.6 m (W)	
	Loading	
	Consider two Load cases: Snow + dead load	
	Wind uplift load	
	(Ignore maintenance load as in example A)	
	1. Snow load and dead load	
Annex B, BS 5516-1:2004 and BS 6399-3	• Take design snow load = 0.75 kN/m^2	
	→ Characteristic load	
	= 0.75 × 0.6 cos^2 (15) = 0.420 kN/m	
BS 8118-1:1991 Table 3.1 and Table 3.2	For snow load, $\gamma_f = \gamma_{f1} \times \gamma_{f2}$ = 1.33 × 1.0 = 1.33	
	→ Ultimate load 0.420 × 1.33 = 0.56 kN/m	
	• Take self weight and infill (glazing) = 0.5 kN/m^2	
	→ Characteristic load	
	= 0.5 × 0.6 cos(15) = 0.290 kN/m	
	For dead load $\gamma_f = \gamma_{f1} \times \gamma_{f2}$ = 1.2 × 1.0 = 1.2	
	→ Ultimate load = 0.29 × 1.2 = 0.35 kN/m	
	Take self weight of box bar = 0.03 kN/m	
	For dead load $\gamma_f = \gamma_{f1} \times \gamma_{f2}$ = 1.2 × 1.0 = 1.2	
	→ Ultimate load = 0.03 × 1.2 = 0.04 kN/m	
	Total ultimate ULD = 0.56 + 0.35 + 0.04 = 0.95 kN/m	
	Total characteristic load = 0.42 + 0.29 + 0.03 = 0.74 kN/m	

<table>
<tr><th>Code ref.</th><th>Calculation</th><th>Remarks/output</th></tr>
<tr><td>Annex A,
BS 5516-1:2004</td><td>

2. Wind uplift load

Assume: Basic wind speed = 23 m/s
Height of building < 5 m
Sight terrain category E (Table A.1)

From Example A, take dynamic wind pressure at the site
= 0.654 kN/m^2
From Table A.4 for uplift pressure take pressure coefficient = 2.5
→ UDL due to uplift pressure = 2.5 × 0.654 × 0.6
= 0.981 kN/m
For wind load, $\gamma_f = \gamma_{f1} \times \gamma_{f2} = 1.2 \times 1.0 = 1.2$
→ Ultimate load = 0.981 × 1.2 = 1.18 kN/m
Total ultimate UDL = 1.18 (wind) – 0.39 (dead) = 0.79 kN/m
Therefore: Load case 1 (snow + dead load) is the worst case
Loading diagram:

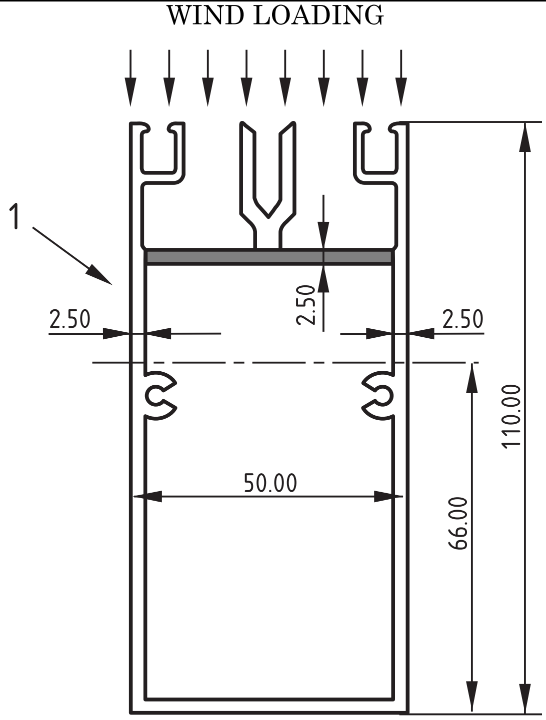


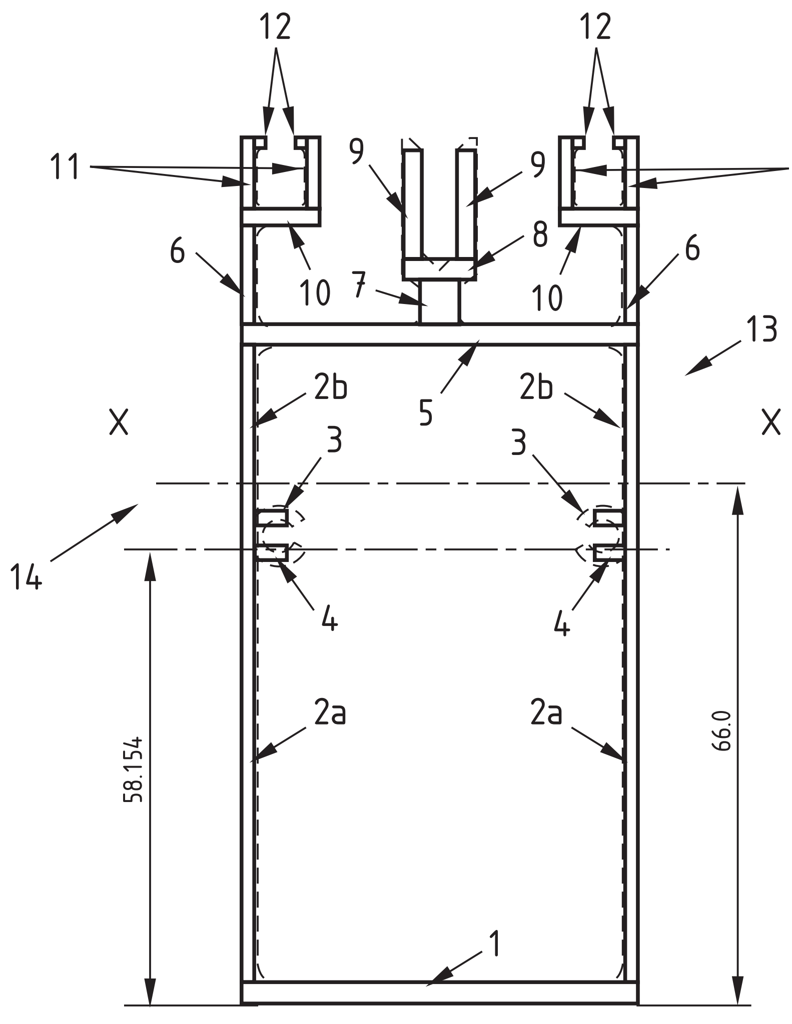
Ultimate moment assuming glazing bar is simply supported

$$M_U = \frac{0.95 \times 3.0^2}{8} = 1.1 \text{ kNm}.$$

</td><td></td></tr>
</table>

<table>
<tr><th>Code ref.</th><th>Calculation</th><th>Remarks/output</th></tr>
<tr><td></td><td>Moment of resistance at ultimate limit state stability issues
a) Lateral torsional buckling
As stated in 6.6.2, BS 5516-1 “Lateral instability is not a criterion due to the restraint provided by the infilling”.
→ Ignore lateral torsional buckling effect
b) Local buckling</td><td></td></tr>
<tr><td>4.3,
BS 8118-1:1991</td><td>Need to check susceptibility to local buckling for internal/outstand elements within compression zone.</td><td></td></tr>
<tr><td>Figure 4.1,
BS 8118-1:1991</td><td>Check upper horizontal element of the box bar under compression (shaded on profile cross-section), ignoring the reinforcing effect of the protruding lip:
$\beta = \frac{b}{t} = \frac{(50-5)}{2.5} = 18$ (conservative)
$\beta_1 = 18\left(\frac{250}{160}\right)^{1/2} = 22.5$ (internal element)</td><td></td></tr>
<tr><td>Table 4.3,
BS 8118-1:1991</td><td>→ $\beta < \beta_1$ → Section is fully compact.</td><td></td></tr>
<tr><td>4.5.2.2,
BS 8118-1:1991</td><td>For an un-welded fully compact section
Moment resistance, M_{RS}
$M_{RS} = \frac{p_o \times S_n}{\gamma_M}$
S_n = plastic modulus of section (assuming bending takes place about equal area axis)
• Calculation of plastic modulus of section is shown at the end of this annex.</td><td></td></tr>
</table>

Code ref.	Calculation	Remarks/output
		
	Key 1 Equal are axis approximately top of lips Section properties Area = 993.6 mm^2 I = 1 343 568 mm^4 Z = 23 103 mm^3	
	Profiles cross-section	
	S_n = 31 313 mm^3	
	$M_{RS} = \frac{160 \times 31\ 313 \times 10^{-6}}{1.2} = 4.2$ kN/m	
	1.1 kN/m applied moment	
	→ **Glazing bar is adequate in bending**	
	Deflection (serviceability Limit State)	
	Maximum deflection of glazing bar, d_{max}:	
	$d_{max} = \frac{5 \times \omega l \times S^4}{384 E_M I_{xx}}$ $(\omega_{Cl} = 0.78)$	
	$= \frac{5 \times 0.74 \times 3\ 000^4}{384 \times 70\ 000 \times 1\ 343\ 568} = 8$ mm	
6.5.4.3, BS 5516-1:1991	Max allowable deflection, d_{all}:	
	$d_{all} = \frac{S^2 \times 10^3}{540} = \frac{3^2 \times 10^3}{540} = 17$ mm	
	> 8 mm	
	Deflection under service loading is within allowable limit	

Code ref.	Calculation	Remarks/output
	Calculation of plastic section modulus of box glazing bar profile **Theory** The plastic section modulus *S* is the algebraic sum of the first moment of area about the equal area axis (X–X) For this example, the glazing bar section is modelled as a number of rectangular elements as shown in sketch below:  **Key** 14 Centroid 15 Equal area axis Profile cross-section	

Code ref.	Calculation	Remarks/output
	Location of the equal-area axis	
	Total area = 994 mm^2 (as given by manufacturer)	
	→ Area below X – X:	
	1 = 50 × 3 = 150	
	2a = 63 × 2.5 × 2 No. = 315	
	3 = 4 × 2 × 2 No. = 16	
	4 = 4 × 2 × 2 No. = 16	
	Total = 497 mm^2	
	→ Area below X – X:	
	2b = 18 × 2.5 × 2 No. = 90	
	5 = 50 × 3 = 150	
	6 = 12.5 × 2 × 2 No. = 50	
	7 = 5.5 × 3 = 17	
	8 = 9 × 2 = 18	
	9 = 16 × 2.5 × 2 No. = 80	
	10 = 10 × 2 × 2 No. = 40	
	11 = 9 × 2 × 4 No. = 44	
	12 = 1.5 × 1.2 × 2 No. = 8	
	Total = 497 mm^2	

Code ref.	Calculation					Remarks/output
	Plastic section modulus S_x					
	Element	**No.**	A	y[a]	A_y	
			mm^2	mm	mm^3	
	1	1	150	64.5	9 675	
	2a	2	157.5	31.5	9 922.5	
	2b	2	45	9	810	
	3	2	8	4	64	
	4	2	8	8	128	
	5	1	150	19.25	2 887.5	
	6	2	25	26.75	1 337.5	
	7	1	17	23.25	395.25	
	8	1	18	2.7	48.6	
	9	2	40	32.5	2 600	
	10	2	20	34	1 360	
	11	4	11	39.5	1 738	
	12	4	2	43.4	347.2	
				994 mm^2	31 313 mm^3	

[a] y = Distance between centroid of element and equal area axis (X – X).
S_x = 31 313 mm^3.

Annex G (normative) Method of test for watertightness of unsealed patent glazing systems

G.1 Principle

The test method is intended for unsealed slope patent glazing systems from 15° to 45° slope from the horizontal and should be tested at the most vulnerable slope angle of 15° from the horizontal, unless specified otherwise to suit project specification requirements.

The test is undertaken in four test sequences:

— a deluge test with no wind;

— a high rainfall low wind speed test;

— a medium rainfall medium wind speed test; and

— a low rainfall high wind speed test.

This is consistent with the observations that peak rainfall occurs with little or no wind and peak wind is accompanied by only moderate rainfall.

The test is not suitable for slope angles of less than 5° from horizontal.

G.2 Test apparatus

G.2.1 *Test apparatus*, consisting of a specimen mounting panel, adjustable to the appropriate angle of slope, an airtight box or chamber, which may be pressurized or depressurized and allow inspection of the underside of the specimen. A water spray system should be positioned over the test specimen to provide both a uniformly distributed water spray and run-off flow along the top edge of the specimen. A wind generator should be positioned adjacent to the foot of the test specimen to provide a uniform horizontal airflow directed towards the lower edge of the test specimen and along its central axis.

G.3 Calibration of water spray system

Check the ability of the test apparatus to deliver the required volume and uniformity of water by using a catch-box, the opening face of which should be located horizontally below the position of the face of the specimen. The catch-box should be designed to receive only water impinging on the plane of the test specimen and exclude run-off from above.

The catch-box should be between 600 mm and 800 mm square, divided into four equal square areas. The water impinging on each area should be captured separately. There should be a cover provided to prevent water entering the boxes before and after the observation period of five minutes. A spray that provides at least 3.75 litre per minute per square metre of plan area, for the four areas and not less than 80 % of the rate nor more than twice that rate in any one square should be acceptable.

Calibrate the water spray system at all four-corners and at the mid-point of the roof specimen at the specified roof pitch and for each test sequence condition.

G.4 The test specimen

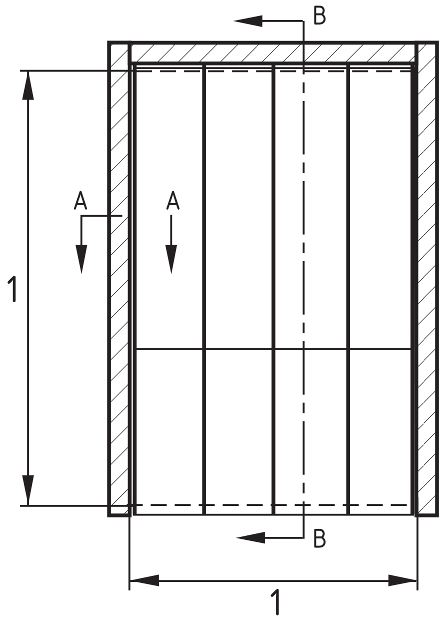
Mount the test specimen on the mounting panel with a minimum exposed dimensions of 2.5 m wide by 2.8 m long. It should include a minimum of three longitudinal glazing bars (see Figure G.1). For system type testing, typical transverse glazing junctions commonly used in the system should be included in the specimen. Typical system or project flashing and weatherings should be incorporated to resist water leakage at the specimen perimeter and any sealed joints, i.e. glass butt joints, should be allowed to cure before commencing the testing.

G.5 Preparation

Record the test chamber ambient air and water temperature.

Before turning on the wind generator and water spray, apply three positive air pressure pulses by reducing the pressure on the back of the test sample; the pressure rise time should not be less than one second and the pressure should be maintained for at least three seconds. The preparation pressure should be 600 Pa.

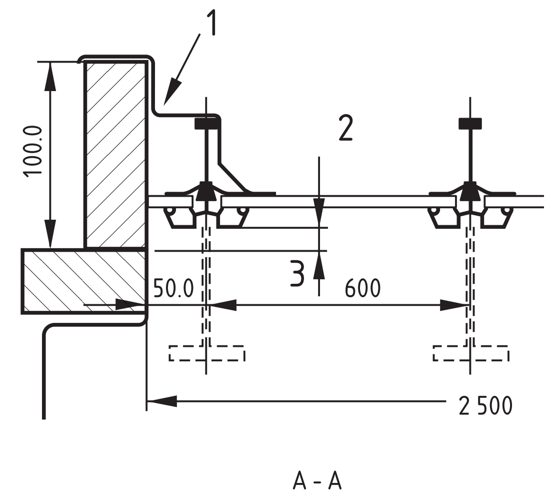
With the pressure reduced to zero, open and close all the operating parts of the slope glazing system five times, then firmly secure them in the closed position.



Key

1 Rig opening

a) Plan view of specimen and mounting panel



Key

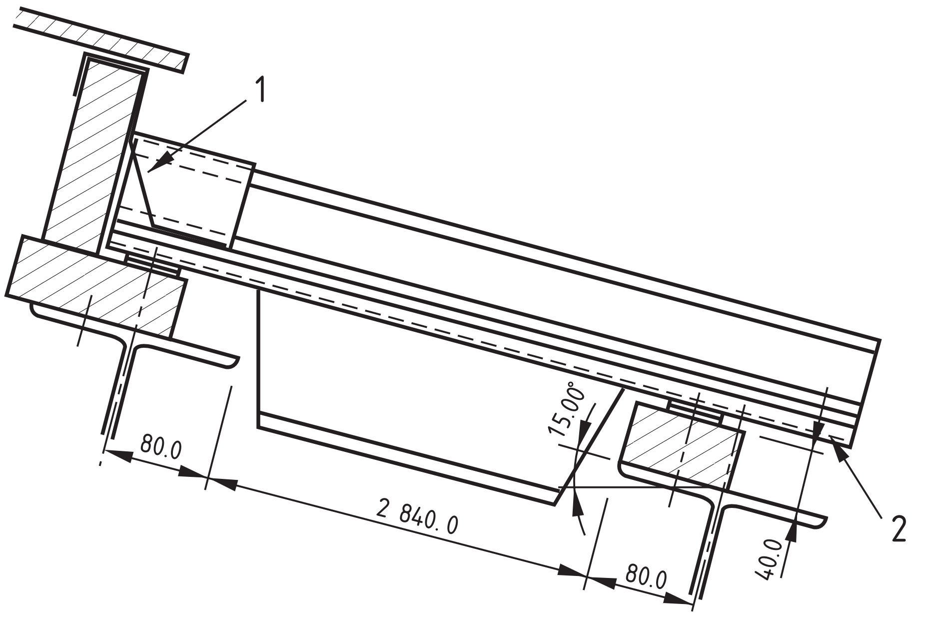
1 Flashing to manufacturer's detail

2 Notional glazing bars

3 10.0 nominal

b) Section A-A through specimen and mounting panel

Figure G.1 — Typical specimen details



Key

1 Flashing to manufacturer's detail

2 Weathering

c) Section B-B through specimen and mounting panel

Figure G.1 — Typical specimen details (*continued*)

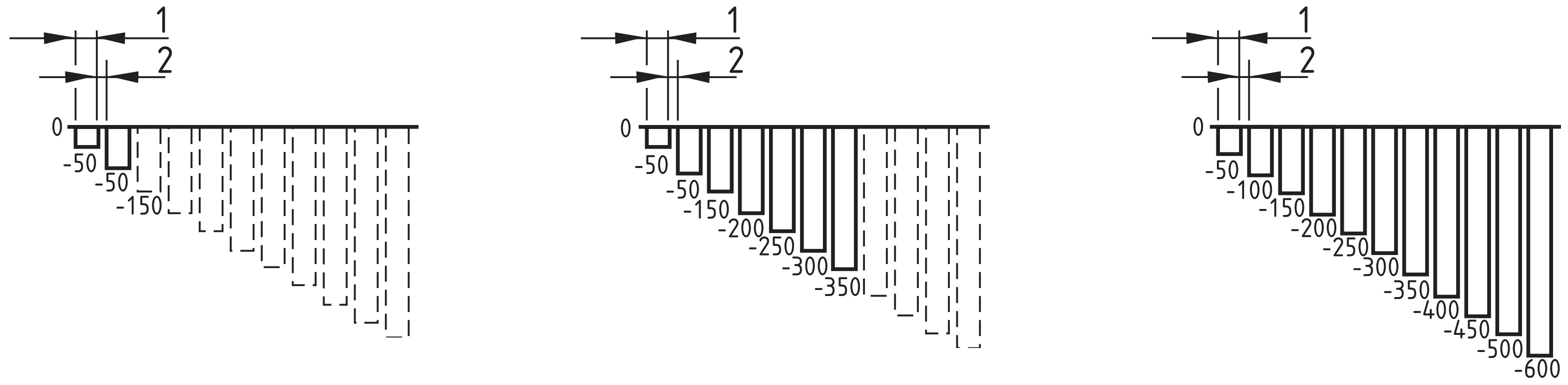
G.6 Test sequence

Deluge test
Rainfall rate of: 225 mm/h for 10 min duration.
Wind speed: zero
Pressure difference: zero

Test 1 High rainfall, low wind speed (Figure G.2)
Rainfall rate of: 128 mm/h
Wind speed: 5 m/s
Pressure difference, in pascals:
(for five minute duration, returning to zero for 30 s between each increment)
0, –50, –100, (*–150 continue as Test 3 where required*)

Test 2 Medium rain falls, medium wind speed (Figure G.2)
Rainfall rate of: 40 mm/h
Wind speed: 14.5 m/s
Pressure difference, in pascals:
(for five minute duration, returning to zero for 30 s between each increment)
0, –50, –100, –150, –200, –250, –300, (*–350 continue as Test 3 where required*)

Test 3 Low rainfall, high wind speed (Figure G.2)
Rainfall rate of: 5 mm/h
Wind speed: 25.0 m/s
Pressure difference, in pascals:
(for five minute duration, returning to zero for 30 s between each increment)
0, –50, –100, –150, –200, –250, –300, –350, –400, –450, –500, –600.



Test 1 pressure increments

Test 2 pressure increments

Test 3 pressure increments

Key

1 5 min duration

2 30 s duration

Figure G.2 — Test pressure difference increments

To commence each test, apply the water spray for a five minute period before pressure and wind velocity are applied.

G.7 Procedure

At each stage a sparge bar should be provided along the upper edge of the test specimen, to provide a uniform water flow down the face of the specimen equal to the run-off flow from a 10 m roof area above the specimen. A uniform water spray should then be provided over the plan area of the test specimen and the wind generator should be set to give the required mean horizontal air velocity immediately upstream of the test specimen. Control the pressure in the test chamber to give the required overall positive pressure differential (the static pressure in the test chamber is to be stated amount less than the static pressure measured at the centre of the top face of the specimen).

NOTE The water spray is defined in mm/h on a plan area, this spray rate may be divided by 60 to give the flow in litres per minute per m^2 of plan.

G.8 Classification

For the purpose of classification, record any leakage that occurs from any element of the test specimen if it falls into the inspection chamber. Water that falls into the drainage channels of the glazing bar and runs safely to the exterior drainage point does not constitute a leak, since this is how the systems are designed to operate.

Deluge test: Classifications 1, 2 and 3 requirement no leakage in this test.

In Tests 1, 2 and 3, record the pressure difference at which a leak is first observed. These pressure differences may then be classified according to the design performance pressures given in Table G.1. The method allows for a system that meets the required classification to be selected for a "Zone" of the country identified from map shown in Figure G.3.

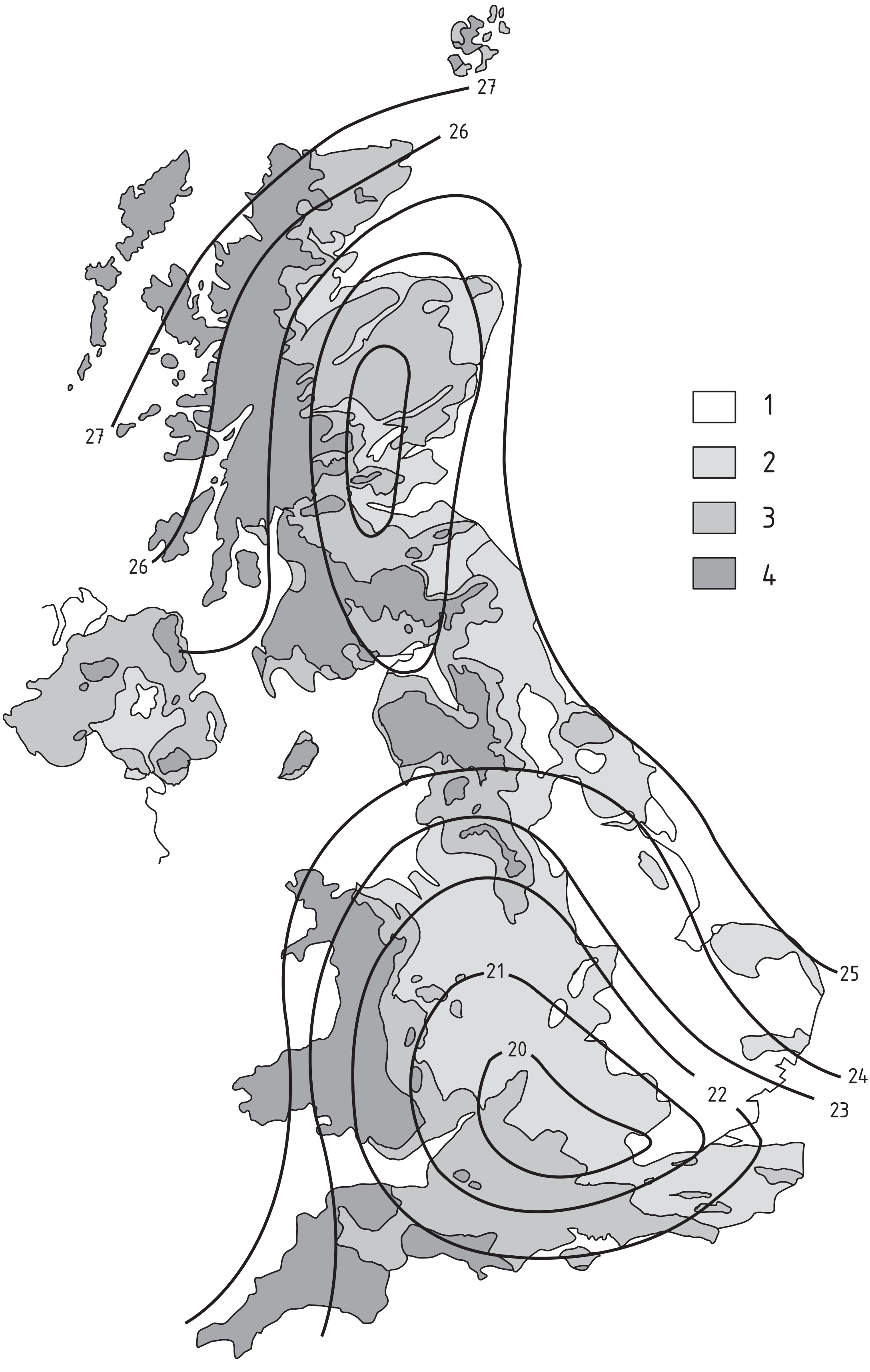


Figure G.3 — Classification exposure map

Driving rain zones, with 50 year design mean wind speed in m/s.

Overall the system is required to achieve a pass result in the deluge test. For Tests 1, 2 and 3, the overall classification of suitable geographical zones is determined from the lowest classification in the three individual tests.

Table G.1 — Watertightness classification requirements

Classification	Deluge test	Test 1	Test 2	Test 3
0	No requirement			
I (Zone 1 and 2)	No leakage	No leakage at –50 Pa	No leakage at –150 Pa	No leakage at –300 Pa
II (Zone 3 and 4)	No leakage	No leakage at –50 Pa	No leakage at –250 Pa	No leakage at –500 Pa
Special	No leakage	No leakage at project pressure difference		

NOTE This classification is related to a "pressure difference" for a five minute duration, for buildings of effective height up to 10 m. For effective heights greater than 10 m and exposed situations, i.e. a building at the top of a cliff, a more detailed approach might be necessary as described in **G.10**.

G.9 Interpreting the test results

The test has been derived from an assessment of combined rainfall and wind speed data. From data for a number of sites of varying exposure it has been possible to fit a curve that relates rainfall to five minute mean wind speed (a five minute wind period is more relevant to rainfall than a typical three second gust speed). Test 1, 2 and 3 use combinations of the air speed and water flow-rate derived for the curve. Moreover, the fitted curve relates to wind speeds measured 10 m above ground level.

The air speeds are based on the five minute mean wind speed at which rain most commonly occurs (5 m/s, Test 1), the five minute mean wind speed for a Zone 4 exposure (25 m/s, Test 3) and the two speeds (15 m/s, Test 2). The water flow rates are then determined from the curve.

To relate the test conditions to the actual site exposure it is required that the Standard Method for assessing wind load BS 6399-2:1997 has been applied, to derive the following data:

— the building effective height, H_e (**1.7.3**);

— the altitude factor, S_a (**2.2.2.2**);

— the terrain and building height factor, S_b (Table 4);

— the notional building height factor for an effective height of 10 m, S_{b10} (Table 4);

— the most positive external pressure coefficient for the slope glazed elevation, C_{pe} (Table 9 to Table 15);

— the most negative internal pressure coefficient for the slope glazed elevation, C_{pi} (Table 16);

— the exposure zone Z, from map Figure G.3 (this map is based on the more detailed data given in BS 8104:1992)

— the zone adjustment factor, K_z from Table G.2.

Table G.2 — K_z factor table

Zone Z	Factor K_z
1	0.6
2	0.7
3	0.8
4	1.0

The following steps are then required:

— convert the basic wind speeds used in Test 1 (5 m/s), Test 2 (15 m/s) and Test 3 (25 m/s) to site wind speeds using formula:

$$V_{\mathrm{SITE}} = V_{\mathrm{BASICSa}} \left(\frac{S_{\mathrm{b}}}{S_{\mathrm{b10}}}\right)$$

— convert each wind speed to site dynamic pressure using formula:

$$q_{\mathrm{SITE}} = 0.613\left(V_{\mathrm{SITE}}\right)^2$$

— correct each site dynamic pressure to a site static pressure using the formula:

$$p_{\mathrm{SITE}} = q_{\mathrm{SITE}} \left(C_{\mathrm{pe}} - C_{\mathrm{pi}}\right) K_{\mathrm{z}}$$

— round each site static pressure up to the nearest 50 Pa.

G.10 Example classification selection calculation

A building with an effective height of 15 m is to be built in open country, near Bristol, at an altitude of 10 m on level ground with insignificant topography, 10 km from the sea, with 15° slope glazed mono-pitch roof. The data obtained from BS 6399-2:1997 is:

— the building effective height, H_{e} = 10 m;

— the altitude factor, S_{a} = 1.01;

— the building height factor, S_{b} = 1.82;

— the building height factor for an effective height of 10 m, S_{b10} = 1.73;

— the most positive external pressure coefficient for the slope glazed elevation, C_{pe} = +0.2;

— the most negative internal pressure coefficient for the slope glazed elevation, C_{pi} = –0.3.

From the BRE report *Thermal insulation: avoiding risks* (second edition) [4], the exposure zone, Z is zone 3 and so the zone adjustment factor, K_{z}, is 0.8.

For the 5 m/s speed (Test 1):

$$V_{\mathrm{SITE}} = 5.0 \times 1.01 \times \left(\frac{1.82}{1.73}\right) = 5.31 \text{ m/s}$$

$$q_{\mathrm{SITE}} = 0.613 \times (5.31)^2 = 17.3 \text{ Pa}$$

$$p_{\mathrm{SITE}} = 17.3 \times [0.2 - (-0.3)] \times 0.8 = 6.9 \text{ Pa}$$

Similarly, for the 15 m/s speed (Test 2):

p_{SITE} = 62.3 Pa

And for the 25 m/s speed (Test 3):

p_{SITE} = 173.0 Pa

Rounding each of these values up to the nearest 50 Pa requires that the patent glazing system achieves a pass at pressures of 50 Pa, 100 Pa and 200 Pa, in Test 1, Test 2 and Test 3 of the tests respectively, with a pass in the deluge test.

Annex H (normative) Site water testing

H.1 Scope

This test is a method for site testing the watertightness of unsealed slope glazing systems using a sparge bar. It is intended to assess the watertightness of the slope glazing systems, particularly at features where the flow of water over the face of the system is considered to be a onerous condition. This can include penetration through the system, joint flashing and joints around opening lights, which are unsuited to hose testing.

H.2 Information needed by the test authority

The identification of those parts of the patent glazing system that requiring testing.

H.3 Test apparatus

H.3.1 *Test apparatus*, comprising a water spray bar with nozzles spaced at 400 mm centres, with supports to maintain the nozzles in an orientation perpendicular to the face of the glazing, with the tip of each nozzle 250 mm from the plane of the face of the glazing. The nozzles should not be directed at any joint within the area tested.

The nozzles should provide a full spray cone spray, with spray angle of 120°. The water flow rate should be adjusted to be 2 l/min per nozzle, at a nominal pressure of 3 bar, and should be capable of being measure to within ±10 %.

H.4 Preparation of the patent glazing

Before the test is conducted, allow sufficient time to permit all chemically curing sealants to achieve their proper cure as recommended by the sealant manufacturer.

Before the test is begun, thoroughly wash the area using a mild, additive-free detergent, and then rinse it.

The indoor side of the patent glazing system in the area to be tested should be unobstructed, permitting the full length and all joints to be examined from the indoor side.

H.5 Procedure

H.5.1 Set up the sparge with the centre-line of the nozzles between 250 and 400 mm above the top of the area to be tested. The length of the sparge bar should include at least one nozzle beyond each edge of the area to be tested.

H.5.2 Turn on the water supply and adjust to provide a constant flow for 30 min, equivalent to 2 l/min per nozzle, within an accuracy of ±10 %.

H.5.3 Observe from the inside of the patent glazing system and note the position and time, since commencement of spraying, of any water penetration.

H.5.4 After 30 min spraying turn off the water supply and continue to observe for water penetration for a further 30 min.

H.5.5 If water penetration is observed, investigate as appropriate to identify the point(s) at which water enters the outside of the patent glazing. If no water penetration is observed, proceed to the next test area.

H.6 Remedial work and re-testing

H.6.1 Wherever leakage has occurred, make the joints watertight to satisfy the requirements of the specification. Allow the jointing compound to set for one week before the test section is retested.

H.6.2 After all necessary remedial work has been completed and the required curing time, if any, has elapsed, test all repaired joints again, following the same procedure in **G.5**. Should any leakage still be found, take any further remedial measurers and repeat all testing until all joints in the designated area are found to be satisfactory.

Bibliography

Standards publications

BS 952-1:1995, *Glass for glazing — Part 1: Classification.*

BS 2571:2001, *General purpose acrylonitrile-butadiene rubber compounds — Specification.*

BS 4255-1:1986, *Rubber used in preformed gaskets for weather exclusion from buildings — Part 1: Specification for non-cellular gaskets.*

BS 5250:2002, *Code of practice for control of condensation in buildings.*

BS 7346-3:1990, *Components for smoke and heat control systems — Part 3: Specification for smoke curtains.*

BS 7543:2003, *Guide to durability of buildings and building elements, products and components.*

BS 8000-7:1990, *Workmanship on building sites — Part 7: Code of practice for glazing.*

BS 8104:1992, *Code of practice for assessing exposure of walls to wind-driven rain.*

BS 8213-1:1991, *Windows, doors and rooflights — Part 1: Code of practice for safety in use and during cleaning of windows and doors (including guidance on cleaning materials and methods).*

BS 8220-2, *Guide for security of buildings against crime — Part 2: Offices and shops.*

BS CP 118:1969, *The structural use of aluminium.*

PD 6484:1979, *Commentary on corrosion at bimetallic contacts and its alleviation.*

Other publications

[1] National Building Specification (NBS). *Access for cleaning and maintenance*. NBS National Building Specification Subscription Service. Work Section N25: Permanent Access and Safety Equipment, August 2002.

[2] *Health and safety in roof work*. HSG33. ISBN 0-7176-1425-5 (1980). HSE Books. PO Box 1999. Sudbury, Suffolk. CO10 2WA.

[3] GREAT BRITAIN. Construction Design and Management Regulations, the Construction (Working Places) Regulations 1966, SI 64.

[4] BRE Report BR 262. *Thermal insulation: avoiding risks*. Second edition. BRE: 1994.

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