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(Incorporating Amendment Nos 1, 2 and 3)

Australian Standard®

Glass in buildings—Selection and installation

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee BD-007, Glazing and Fixing of Glass, to supersede AS 1288—1994.

This Standard incorporates Amendment No. 1 (January 2008), Amendment No. 2 (November 2011) and Amendment No 3 (February 2016). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

The objective of this Standard is to provide uniform direction for the use and installation of glazing throughout Australia to allow its use in legislation, and to clarify technical definitions.

This Standard will be referenced in the Building Code of Australia 2006; thereby superseding AS 1288—1994, which will be withdrawn in 12 months from the date of publication of this Standard.

When revising this Standard, consideration was given to the existing human impact safety requirements of AS 1288—1994 and NZS 4223.3:1999 *Code of practice for glazing in buildings* Part 3: *Human impact safety requirements*, as well as BS 6262-4, *Glazing for buildings*, Part 4: *Safety related to human impact*.

There was also a need to recognize that accidents involving glass continued at a high rate and at a considerable cost to the community. With these factors in mind, changes were made that have resulted in the introduction of increased areas of safety glass and the reduction of areas of ordinary glass in locations where accidents are known to occur at greater frequency. The Standard has also been closely aligned with international practice by the adoption of selected criteria from international Standards.

The change to ultimate limit state design in the new wind code has necessitated the corresponding upgrading of the wind loading charts. The new charts are based on the increased ultimate limit state wind loads. The committee has taken this opportunity to improve the design charts to include basic criteria such as the influence of aspect ratio and slenderness factor. The charts are unique as they incorporate all relevant aspects that influence the performance of glass in the one chart for each glass type and thickness.

The most significant changes of this revision include the following:

(a) Change from permissible design stresses for wind loading to Ultimate Limit State design.

(b) New design charts for wind loading based on ULS and taking into consideration panel aspect ratio.

(c) Introduction of new and increased areas of safety glass in locations subject to high risk of human impact.

(d) New section on installation requirements for glass.

(e) New sections and detailed specifications for overhead glazing, balustrades, faceted glazing and fin-supported glazing.

A2 This Standard makes recommendations for design and installation practice based on proven techniques. Where materials or methods are used that are not covered in this Standard, or if alternative solutions are used, they must satisfy the relevant performance requirements of
A3 the NCC, determined and assessed in accordance with the NCC.

Notes to the text contain information and guidance. They are not an integral part of the Standard.

The terms 'normative' and 'informative' have been used in this Standard to define the application of the appendix to which they apply. A 'normative' appendix is an integral part of a Standard, whereas an 'informative' appendix is only for information and guidance.

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FOREWORD

Due to the revision of AS 1170.2—1989, *Minimum design loads on structures–Wind loads* to include limit states design, it became necessary for AS 1288 to be revised. The rationale used in the revision of AS 1288 to include the ultimate design strength of glass is given below.

A3 The National Construction Code (NCC) sets the importance levels and annual probability of exceedance for wind, snow and earthquake actions applicable to buildings and structures.

Design wind speeds depend on the importance levels of the buildings as well as the wind region for the building, resulting in increased risk of glass breakage for glazing in lower importance levels.

The previous edition of AS 1288 gave permissible design stresses for wind load as 16.7 MPa for glass ≤6 mm thickness and 15.2 MPa for glass >6 mm thickness. However, since the publication of the previous edition in 1994, further research was carried out and it was found that the stresses varied considerably with panel aspect ratio and glass thickness.

The charts in this edition are based on ULS stresses of 27.0 MPa, for the thickest glass (25 mm) and 41.0 MPa for the thinnest glass (3 mm). It was also agreed that glass edge design stresses are to be 80% of the mid-span (i.e. away from edges) stresses. The limiting design stresses for each glass thickness used in developing the design charts are given in Appendix B.

STANDARDS AUSTRALIA

Australian Standard

Glass in buildings—Selection and installation

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out procedures for the selection and installation of glass in buildings, subject to wind loading, human impact, and special applications such as overhead glazing, balustrades and glass assemblies.

Glass strength requirements are given for glazing, based on the tensile stresses developed on the surface of the glass.

This Standard does not cover the following:

(a) Glazing in lift cars and lift wells (see Note 1).

(b) Furniture glass, cabinet glass, vanities, glass basins, refrigeration units, internal glass fitments and internal wall mirrors not specifically covered by Section 5 (see Note 2).

(c) Buildings and structures with no public access intended for horticultural or agricultural use.

(d) Windows and doors in heritage buildings as defined by the relevant State or Territorial authority (see Note 3).

(e) Restoration and or repairs to existing leadlights.

(f) Special glazing applications which might fail due to the stresses other than tensile stresses, such as shear stresses.

A1 (g) Glass blocks, bricks or pavers.

NOTES:

1 For glazing in lift cars and lift wells, see AS 1735.2 (Appendix H)

2 For further guidance see HB 125.

3 The traditional use of these buildings suggests their current construction and glazing practices are acceptable. However, consideration should always be given to the brittle nature of glass and the consequences of its breakage.

4 In Australia, legislation requires products to be 'fit for purpose'. Where glazing is replaced because of breakage or any other reason, it is recommended that the replacement glass comply with the requirements of the relevant sections of this Standard, unless otherwise permitted by the relevant legislation.

1.2 APPLICATION

The thickness and type of glass required shall be determined on the basis of all the following criteria:

(a) For installations subject to wind loading, glass to be selected using either first principles as set out in Section 3, or using the simplified design as set out in Section 4.

NOTE: Section 4 may give a more conservative design solution.

(b) For human impact considerations, glass to be selected according to Section 5.

(c) For overhead glazing, glass to be selected according to Section 6.

(d) For balustrades, glass to be selected according to Section 7.

(e) For framed, unframed, and partly framed glass assemblies glass to be selected in accordance with Section 9.

Glass shall be installed in accordance with Section 8.

For a given application, the type and thickness of glass selected shall be in accordance with the most stringent relevant requirements of Sections 3 to 9 as applicable.

NOTE: For guidance on the use of this Standard for glass selection, see Appendix G.

1.3 NORMATIVE REFERENCES

The following referenced documents are indispensable for the application of this Standard.

AS

1170 Minimum design loads on structures
1170.1 Part 1: Minimum design loads on structures—Dead and live loads
1170.2 Part 2: Wind loads
1170.3 Part 3: Snow loads
1170.4 Part 4: Earthquake loads

1428 Design for access and mobility
1428.1 Part 1: General requirements for access—New building work

A2 1926 Swimming pool safety
1926.1 Part 1: Safety barriers for swimming pools

2047 Windows in building—Selection and installation

4055 Wind loads for housing

AS/NZS

1170 Structural design actions
1170.0 Part 0: General principles
1170.1 Part 1: Permanent, imposed and other actions
1170.2 Part 2: Wind actions

2208 Safety glazing materials in buildings

4666 Insulating glass units

4667 Quality requirements for cut-to-size and processed glass

BS

544 Specification for linseed oil putty for use in wooden frames

4255 Rubber used in preformed gaskets for weather exclusion from buildings
4255-1 Part 1: Specification for non-cellular gaskets

ASTM

C669 Standard specification for glazing compounds for back bedding and face glazing of metal sash

C1184 Standard specification for structural silicone sealants

C1279 Standard test method for non-destructive photoelastic measurement of edge and surface stresses in annealed, heat-strengthened, and fully tempered flat glass

C1281 Standard specification for preformed tape sealants for glazing applications

A2 E1300 Standard practice for determining load resistance of glass in buildings

A2 EN

14179 Glass in buildings—Heat soaked thermally toughened soda lime silicate safety glass

14179-1 Part 1: Definition and description

A3 ABCB

NCC National Construction Code

NOTE: Documents referenced for informative purposes are listed in Appendix H. They are not an integral part of the Standard.

1.4 DEFINITIONS

For the purpose of this Standard, the definitions in AS/NZS 4668 and those below apply.

1.4.1 Area

The area of the panel between sightlines after glazing, calculated using the sight size.

1.4.2 Arrised edge

The result of removing sharp edges.

1.4.3 Aspect ratio

The ratio of the longer side of a panel to its shorter side.

1.4.4 Balustrade

A low wall forming a parapet to a stair, ramp, balcony, raised level, or a change in levels.

1.4.5 Bead

A strip of wood, metal, sealant or other suitable material secured to the rebate to retain the glass. Also known as glazing bead or sealant bead.

1.4.6 Bite

The width of silicone used to bond the fin or frame member to the edge of the glass panel.

1.4.7 Block

A small piece of lead, rubber or other suitable material used to position the glass in the frame.

1.4.8 Buildings

1.4.8.1 *Residential*

Buildings and such portions of buildings used as separate dwelling houses and flats, but not incorporating common circulation areas in blocks of two or more flats.

1.4.8.2 *Non-residential*

Buildings other than those defined in Clause 1.4.8.1, such as hotels, hostels, motels, shops, offices, schools, public assembly buildings, and factories, and those parts of residential buildings common to a group of dwellings such as common circulation areas in blocks of two or more flats.

1.4.9 Chair rail

A fixed glazing bar, or rigid push-bar, that provides protection from human impact.

1.4.10 Crash rail

A rail, together with its fixings, capable of withstanding a load of 750 N/m length, acting in any direction without contact with the glazing material.

1.4.11 Daylight size

The clear unsupported opening size that admits light.

1.4.12 Decorated glass

Clear or patterned glass processed by craftsmen for decorative effect. Stained glass, leadlights and sandblasted, acid-etched, embossed and printed glass fall into this category. Decorative interlayers may also be incorporated in laminated glass.

1.4.13 Distance piece

Small blocks of resilient, non-absorbent material (such as extruded rubber) used to prevent the displacement of glazing compound or sealant by external loading. They are positioned opposite each other between the glass and rebate, and glass and bead.

1.4.14 Door

A hinged, sliding, or otherwise supported openable barrier providing entrance to and exit from a building, corridor, or room. Doors may be framed or unframed.

1.4.15 Double glazing

Glazing that incorporates two panels, separated with an airspace, for the purpose of sound insulation or thermal insulation, or both.

1.4.16 Edge blocks

Rubber blocks that prevent glass from moving sideways in the glazing rebate from thermal effects or vibration.

1.4.17 Edge clearance

The space between the edge of the glass and frame rebate.

1.4.18 Edge cover

The distance between the edge of the glass and the sightline.

1.4.19 Edge working

The process of removing sharp edges from the surface and/or cut edges of glass by grinding, smoothing, bevelling and/or polishing.

NOTE: For different edge finish requirements for specific applications, see AS/NZS 4668.

1.4.20 Exposed edge

A glass edge that is not covered.

NOTE: Glass with exposed edges has no protection from damage, and may cause injury to those who come in contact with it.

1.4.21 Faceted glazing

Flat panes of glass installed vertically at an angle to each other, to form a faceted curve.

1.4.22 Fin

A piece of glass positioned and fastened to provide lateral support.

1.4.23 Frame

A structure manufactured from timber, metal, glass, or other durable material or combinations of materials, such as glass fins and structural sealant, supporting the full length of a glazed panel edge.

1.4.24 Frameless glazing

See unframed glazing.

1.4.25 Fully framed glazing

Panels that have all edges framed.

1.4.26 Glazing

1 The securing of glass in prepared openings in windows, door panels, partitions, and the like.

2 Glass or plastics glazing sheet material for installation into a building.

1.4.27 Heat-strengthened laminated safety glass

Laminated safety glass utilizing two or more panels of heat-strengthened glass in the make-up.

1.4.28 Infill balustrades

Balustrades in which the supported glass resists an infill pressure and/or point load applied to the glass panel.

1.4.29 Insulating glass unit (IGU)

Two or more panels of glass spaced apart and factory sealed with dry air (hermetically) or special gases in the unit cavity. Often abbreviated to IGU or referred to as the unit.

1.4.30 Internal partition

An interior dividing wall or such portion of an interior dividing wall that is not a door, side panel, shopfront, or atrium wall.

1.4.31 Laminated glass

A composite material consisting of two or more sheets of glass permanently bonded together by a plastic interlayer material.

1.4.32 Laminated safety glass

Laminated glass that satisfies the relevant requirements for a safety glazing material in accordance with AS/NZS 2208.

1.4.33 Leadlight

A panel of individual glass pieces within a framework of lead, copper, zinc or brass cames, made in the traditional manner of small panes.

1.4.34 Maximum thickness

The thickness of a panel of glass at the maximum thickness tolerance.

1.4.35 Minimum thickness

The thickness of a panel of glass at the minimum thickness tolerance.

1.4.36 Mirror

A piece of glass silvered on one side.

1.4.37 Nominal thickness

A numeric designation, used for reference purposes, that indicates the approximate thickness of glass.

NOTE: Nominal thickness is used for description convenience only and not as an exact manufacture size.

1.4.38 Pane

Single piece of glass cut to size for glazing.

1.4.39 Panel

An assembly containing one or more panes.

NOTE: Panels may be fully framed, partly framed or fully unframed.

1.4.40 Partly framed glazing

Panels that have one or more edges unframed.

1.4.41 Patterned glass

Glass having a pattern impressed on one side or both sides.

1.4.42 Rebate

The part of a frame into which the edge of glass is installed.

A2

1.4.43 Organic-backed safety mirror

A glazing material consisting of a pane of glass mirror with a sheet of tear-resistant organic material permanently bonded to one side, which satisfies the relevant requirements for a safety glazing material in accordance with AS/NZS 2208.

1.4.44 Safety organic-coated glass

A glazing material consisting of a piece of glass coated and permanently bonded on one or both sides with a continuous polymeric coating, sheet or film, which meets the test requirements of the safety glazing Standards.

1.4.45 Setting block

A block of resilient non-absorbent material used to support the dead load of the glass on the rebate and prevent glass-to-frame contact. Normally used in pairs located at quarter points of the glass width.

A1

1.4.45(A) Shopfront

The glazed or partly glazed wall at public access level in shopping malls, arcades and similar public areas of non-residential buildings, with or without a stall board suitable or intended, or both, for the display of products or services.

1.4.46 Side panel

A panel (operable or inoperable) located adjacent to a doorway. It may or may not be in the same plane as the doorway.

1.4.47 Sightline

The perimeter of the opening, which admits daylight (also known as glazing line).

1.4.48 Sight size

The clear unsupported opening size that admits light (also known as daylight).

1.4.49 Sloped overhead glazing

Glazing that is inclined at less than 75° to the horizontal and located, wholly or partially, directly above an area that may be occupied by people.

1.4.50 Slenderness factor

Span to thickness ratio for all panels supported on four edges.

1.4.51 Span

The dimension between supports. For panels supported on all four edges, it corresponds to the smaller of the sight size dimensions.

1.4.52 Structural balustrade

Balustrade in which glass resists applied loads as required by AS 1170.1 or AS/NZS 1170.1.

1.4.53 Structural silicone glazing

The use of silicone sealant not only as a weather seal but also for the structural transfer of loads from the glazing panel to its perimeter support system.

1.4.54 Toughened laminated safety glass

A2 Laminated safety glass utilizing two or more panes of toughened safety glass in the construction.

NOTE: Toughened laminated safety glass is more correctly referred to as 'laminated toughened safety glass'.

1.4.55 Unframed glazing

Panels without framed edges.

1.4.56 Wardrobe doors

Doors that provide access to built-in storage areas, excluding those fitted to pieces of furniture that are not built into the building.

NOTE: Doors providing access to walk-in wardrobes are defined as doors.

A2 1.5 NOTATION

Symbols used in this Standard are listed below.

The dimensional units for length and stress, in all expressions or equations, shall be taken as millimetres (mm) and megapascals (MPa), respectively, unless specified otherwise.

A = area of glass ($H \times W$)

AR = aspect ratio

B = span (distance between two supports)
or
width of each faceted panel

B/t = slenderness factor

b = width of glass pane
or
breadth of fin

$C_{p,n}$ = net pressure coefficient

c_1 = glass type factor

c_2 = surface type factor

c_3 = load duration factor

d = depth of fin
or
load duration

E = effective width
or
linear elastic modulus

$(EI)_y$ = effective rigidity for bending about the minor y-axis

F = factor for facet angle

f'_t = characteristic tensile strength of the glass

A2

G = gap between façade panels
or
torsional elastic modulus

GJ = effective torsional rigidity

g_1, g_2, g_3, g_4 = slenderness factor

H = effective height of glass

i = total number of sheets or panes within the assembly

J = torsional moment of inertia

K_A = restraint stiffness

k_{pane} = load-sharing factor of pane

k_{sheet} = load-sharing factor of sheet

L_{ay} = distance between effectively rigid buckling restraints

M = bending moment

M_a = applied bending moment on the beam

M_{CR} = critical elastic buckling moment

M_t = topographic multiplier

m = number of members supported by each restraint system

n = number of equally spaced intermediate restraints

P_R = restraint force

P_s = serviceability limit state design wind pressure

P_u = ultimate limit state design wind pressure

P_z = ultimate limit state design wind pressure at a reference location, z, from ground level

R_u = nominal capacity at ultimate state

SLS = serviceability limit state

S^* = design action effect

T = thickness of the fin
or
tension load

TC = terrain category

t = minimum thickness of glass
or
minimum structural silicone bite

t_i = thickness of each sheet or pane of glass within the assembly

t_{pane} = thickness of pane

t_{sheet} = thickness of each sheet of glass

ULS = ultimate limit state

$V_{h,u}$ = ultimate limit state design gust wind speed

$V_{h,s}$ = serviceability limit state design gust wind speed

A2

W	=	width of glass *or* width of the façade panel
X	=	geometric factor
y_h	=	height above centroid of the point of load application
β	=	moment parameter
Δ_A	=	beam displacement
φ	=	capacity reduction factor
γ	=	obtuse angle between adjacent façade panels
σ_G	=	ultimate limit edge strength of glass
σ_s	=	ultimate limit stress in silicone

SECTION 2 MATERIALS

2.1 GLASS

2.1.1 General

A2 Clear ordinary annealed glass, tinted heat-absorbing glass, patterned, wired, processed, laminated and toughened glass shall be classified in accordance with AS/NZS 4667.

Glass types not otherwise specified in AS/NZS 4667, AS/NZS 4668 or this Standard, which are used in buildings, shall be classified in accordance with BS 952-1.

2.1.2 Heat-strengthened glass

A2 When tested in accordance with ASTM C1279, heat-strengthened glass shall have a surface compression of 24–52 MPa unless heat strengthened glass having a surface compression stress >52 MPa and <69 MPa is glazed in accordance with Clause 3.8.2.

NOTE: Heat strengthening associated with relatively high surface compressive stresses >52 MPa can lead to an increased risk of spontaneous glass fracture (associated with nickel sulphide). Refer to Clause 3.8 for the requirements to minimize the risk.

2.1.3 Toughened glass

Toughened glass shall have a surface compression of not less than 69 MPa.

A2 NOTES:

1. The process of toughening is used to increase the strength of glass and to produce fracture characteristics that are desirable in many situations; however, the process of toughening can also lead to an increased risk of spontaneous glass fracture (associated with nickel sulphide). Refer to Clause 3.8 for the requirements to minimize the risk.
2. For determining surface compressive stress, see ASTM C1279.

2.1.4 Safety glazing material

Safety glazing materials shall comply with AS/NZS 2208.

Where safety glazing materials comply with the relevant requirements of AS/NZS 2208, except that they are of non-standard thickness, they may be used provided the minimum thickness is marked on the glass in addition to the other marking requirements of AS/NZS 2208 and the relevant requirements of this Standard.

When applied to glazing, safety organic coatings shall extend to the edge of the glass or within 3 mm of the sightline and shall be permanently bonded to the glass.

2.1.5 Insulating glass units

Insulating glass units shall comply with AS/NZS 4666.

A2 2.1.6 Glass material properties

For the purpose of this Standard, whether the glass is annealed, heat strengthened or toughened, the glass material properties shall be based on reliable test data. In the absence of test data, the following material properties shall be used:

(a) Density = 2500 kg/m^3.

(b) Poisson's ratio = 0.22.

(c) Linear elastic modulus (E) = 70.0 GPa.

(d) Torsional elastic modulus (G) = 28.7 GPa.

2.2 OTHER GLAZING MATERIALS

2.2.1 General

Glazing materials, not otherwise specified in this Standard, shall be in accordance with the relevant requirements of BS 6262.

2.2.2 Structural sealant

The structural sealant shall be silicone complying with ASTM C1184.

The characteristic strength of the silicone shall be greater than 0.21 MPa.

2.2.3 Linseed oil putty

Linseed oil putty shall comply with BS 544 or equivalent.

2.2.4 Steel sash putty

Steel sash putty shall comply with ASTM C669 or equivalent.

2.2.5 Gaskets

Gaskets shall comply with BS 4255-1 or equivalent.

2.2.6 Preformed tape

Preformed butyl and foam tapes shall comply with ASTM C1281 or equivalent.

2.2.7 Setting blocks, location blocks, and distance pieces

Setting blocks, location blocks, and distance pieces shall be—

(a) of resilient, load-bearing, non-absorbent and rot-proof materials;

(b) compatible with all other materials that may come in contact with them; and

(c) of shore-A hardness of 80 to 90 for setting blocks and 55 to 65 for location and distance pieces.

NOTE: Specific design, sizing and installation details are critical for the performance and details for insulating glass units are given in Section 9 and AS/NZS 4666.

SECTION 3 GENERAL DESIGN CRITERIA

3.1 GENERAL

Glazing shall satisfy the design requirements for ultimate and serviceability limit states in accordance with the procedures given in this Standard, as appropriate.

NOTE: For the construction and installation of windows, sliding doors, adjustable louvres, shopfronts and window walls, refer to AS 2047.

3.2 LOADS AND OTHER ACTIONS

3.2.1 Loads

The design of a structure for strength and serviceability limit states shall account for the action effects directly arising from the following loads:

(a) Permanent and imposed, live, wind, snow actions specified in AS/NZS 1170.1, AS/NZS 1170.2, AS/NZS 1170.3 or AS 1170.3 and AS 1170.4.

(b) Other specific loads, as required.

3.2.2 Load combinations

The design load combinations for strength and serviceability limit states shall be as specified in AS/NZS 1170.0.

3.3 LIMIT STATES

3.3.1 General

The glazing and its component members (e.g. including each sheet for laminated glass) and connections shall be designed for the strength limit states as follows:

(a) The loads and actions shall be determined in accordance with Clause 3.2.1.

(b) The design action effect (S^*) resulting from the strength limit state design loads shall be determined by elastic structural analysis.

NOTE: Where membrane action will occur (for example, glass plates supported on all edges with deflections greater than 75% of the plate thickness), geometric non-linear analysis is required to predict peak stress magnitude and location.

(c) The ultimate design capacity (ϕR_u) shall be determined from the nominal capacity (R_u) determined from Clause 3.3.2, where the capacity factor (ϕ) shall be taken as 0.67.

NOTE: A lower capacity reduction factor may be used where a higher safety factor is required for specific applications where the direct consequences of failure may be severe and as deemed necessary by the designer.

(d) The characteristic capacity in regions where the distance from any edge or opening is less than the thickness of the glass shall be taken to be the characteristic capacity of the glass at the edge (see Clause 3.3.2).

(e) All members and connections shall be proportioned so that the ultimate design capacity (ϕR_u) is not less than the design action effect (S^*), i.e., $S^* \leq \phi R_u$

3.3.2 Ultimate design strength

The ultimate design capacity shall be calculated as follows:

$$\text{Ultimate design capacity} = \phi R_u = \phi c_1 c_2 c_3 [f_t' X]$$

where

ϕ = capacity reduction factor

R_u = nominal capacity

= $\phi R_u = \phi c_1 c_2 c_3 [f_t' X]$

= $c_1 c_2 c_3 [f_t' X]$

c_1 = glass type factor (see Table 3.1)

c_2 = surface type factor (see Table 3.2)

c_3 = load duration factor (see Table 3.3)

$f_t' X$ = characteristic capacity

f_t' = characteristic tensile strength of the glass, in megapascals

= $-9.85 \ln t + 71.34$ MPa away from the edge of glass panes

or

= $-7.88 \ln t + 57.07$ MPa at the edge of glass panes (including at the edges of holes in glass panes)

where

t = minimum thickness of glass, in millimetres; for example, for 3 mm nominal thickness glass, having a minimum thickness of 2.8 mm then $f_t' = 61.2$ MPa away from the edge of glass panes and $f_t' = 49.0$ MPa at the edge of glass panes

X = geometric factor (based on the size, shape and support conditions of the glass) that relates the characteristic capacity of the glazing to the characteristic strength of the glass; for example, for bending of two-edge supported glass $X = \dfrac{bt^2}{6}$

where

A2 b = width of the glass pane, in millimetres

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The bending moment shall be calculated in Nmm (newton millimetres) in order to be consistent with the MPa (megapascals) unit used for the characteristic tensile strength of the glass (f_t').

TABLE 3.1
GLASS TYPE FACTOR c_1

Glass type	c_1
Ordinary annealed	1.0
Heat-strengthened	1.6*
Toughened	2.5*
Wired	0.5

* The glass type factors for heat-strengthened and for toughened glass are based on the minimum stresses specified in Clauses 2.1.2 and 2.1.3. For higher induced stress, correspondingly higher glass type factors may be used provided the level of safety is not reduced. The glass type factor may be determined from:

c_1 = (f'_t + minimum induced surface compression stress) / f'_t.

A1

TABLE 3.2
SURFACE TYPE FACTOR c_2

Type	c_2
Untreated (flat or curved)	1.0
Sand-blasted or etched*	0.4
Acid etched*	1.0
Patterned*	1.0

* Use actual minimum thickness of glass at the deepest trough of the pattern (refer to AS/NZS 4667)

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TABLE 3.3
LOAD DURATION FACTOR (c_3)

Load combination	c_3
Short-term load duration (e.g., wind) for all glass types	1.0
Medium-term load duration (e.g., access-imposed actions on roof lights and actions on balustrades) on heat-strengthened and toughened glass (monolithic or laminated)	1.0
Medium-term load duration (e.g., access-imposed actions on roofs lights and actions on balustrades) on annealed glass (monolithic or laminated)	0.72
Long-term load duration (e.g., dead, some components of live) on heat-strengthened and toughened glass (monolithic or laminated)	0.5
Long-term load duration (e.g., dead, hydrostatic, some components of live) on annealed glass (monolithic or laminated)	0.31

NOTES:

1 Short-term load duration is any duration ≤3 seconds.

2 Medium-term load duration is any duration >3 seconds and ≤10 minutes.

3 Long-term load duration is any duration >10 minutes.

4 Where the load duration (d seconds) is accurately known then the load duration factor c_3 can be determined for annealed glass using $c_3 = (3/d)^{(1/16)}$.

3.3.3 Serviceability limit states

Glass shall be designed for the serviceability limit states by controlling or limiting deflection.

The maximum deflection for all glass under serviceability limit state actions shall be limited to—

(a) span/60 for two-, three- or four- edge supported panels; or

(b) height/30 (or cantilever length/30) for cantilevered panels such as cantilevered structural glass balustrade.

Glass designed in accordance with Section 4 and other relevant sections, as appropriate, is deemed to comply with the requirements of this Clause.

A3 For the purpose of this Clause, the serviceability loading for wind loading shall be based on a 25-year return period.

3.4 LAMINATED GLASS AND INSULATING GLASS UNITS

3.4.1 Laminated glass

The following applies:

A2 (a) For short-term and medium term load durations, the actual total minimum glass thickness, given in Table 4.1, shall be used.

NOTES:

1 Table 4.1 is applicable to both symmetrical and non-symmetrical laminates.

2 Wind is considered to be a short-term load duration.

3 Access-imposed actions on roof lights and actions on balustrades are considered to be of medium-term load duration.

4 Dead, hydrostatic and some components of live load are considered to be of long-term load duration.

(b) For long-term load durations, the strength of each sheet shall be checked where the proportion of the total load to be resisted by each sheet is k_{sheet}, taken as the larger of the following:

$$k_{\text{sheet}} = \left[\frac{t^3_{\text{sheet}}}{\sum_i t_i^3} \right]$$

or

$$k_{\text{sheet}} = \left[\frac{t^2_{\text{sheet}}}{\sum_i t_i^2} \right]$$

where

k_{sheet} = load-sharing factor of sheet being checked

t_{sheet} = thickness of sheet being checked. Unless known, minimum glass thickness, as per Clause 3.6, shall be used

t_{i} = thickness of each sheet of glass within the assembly. Unless known, minimum glass thickness, as per Clause 3.6, shall be used

i = total number of sheets within the assembly

NOTE: For laminated glass with two sheets of equal thickness, $k_{\text{sheet}} = 0.5$.

A2 Alternatively, a full non-linear analysis, modelling the glass-interlayer sheets behaviour, may be undertaken, or the ‘effective thickness method’ adopted in ASTM E1300 may be used.

3.4.2 Insulating glass units (IGU)

A2 For insulating glass units, each pane shall be checked for both the ultimate strength and serviceability limit state conditions with the load contribution to the pane determined from k_{pane}, as follows:

$$k_{\text{pane}} = \frac{1.25 t^3_{\text{pane}}}{\sum_i t_{\text{i}}^3} \leq 1$$

where

k_{pane} = load-sharing factor of pane being checked

t_{pane} = thickness of pane being checked (including laminated glass as per Clause 3.4.1 and glass thickness as per Clause 3.6 or Table 4.1)

t_{i} = thickness of each pane of glass within the assembly (see Clause 3.6)

i = total number of panes within the assembly

NOTE: For insulating glass units with two panes of equal thickness $k_{\text{pane}} = 0.625$.

3.5 FRAMES

3.5.1 General

When completely assembled and glazed, the secondary design action effects due to deflection of the frame member supporting the edge of the glass shall be allowed for.

3.5.2 Deflection limits

The following frame deflection limits under serviceability loading satisfy or are an acceptable alternative to Clause 3.5.1:

(a) Single glazing or insulating glass units, as specified in AS 2047, complying with the deflection limits of that Standard.

(b) Span/150 for all other applications.

3.5.3 Panels glazed into the building structure

A panel glazed directly into a building structure by means of appropriate beads or stops shall be considered to be framed, provided the assembly complies with the deflection requirements of Clause 3.5.2.

3.5.4 Mixed framing

Glass supported along the top and bottom edges by one means and along the vertical edges by another means shall be considered to be framed provided each frame member of the assembly complies with the deflection requirements of Clause 3.5.2.

3.6 DESIGN THICKNESS OF GLASS

3.6.1 Glass of standard nominal thickness

Limits on the standard nominal thickness of various types of glass are given in AS/NZS 4667 and Table 4.1. The design calculations shall be based on the actual glass thickness or, if that is not known, the minimum thickness of the range for the standard nominal thickness.

3.6.2 Glass of non-standard nominal thickness

Glass of any of the types listed in AS/NZS 4667, which has thickness limits falling outside the ranges given in AS/NZS 4667, shall be deemed to be of a non-standard thickness and the requirements of this Standard shall be interpolated from the appropriate tables of Sections 4, 5, 6 and 8, based on the minimum thickness.

3.6.3 Maximum area for 3 mm annealed glass

For 3 mm annealed glass the allowable area shall be not greater than—

(a) 0.85 m^2 for monolithic annealed glass; or

(b) 1.36 m^2 for IGUs.

NOTE: This allowable area is calculated based on an unfactored concentrated incidental load of 0.25 kN as specified in AS/NZS 1170.1 for minimum imposed actions for barriers.

3.7 STRUCTURAL SILICONE

3.7.1 General

Where the tensile adhesion of a sealant is the mechanism for fixing the glazing to its supports and where failure of the sealant will cause the glazing to become overstressed or fall out, structural silicone in accordance with Clause 2.2.2 shall be used.

3.7.2 Strength limit state

The design action effect (except for silicone sealants immersed in water) shall be limited to a maximum of—

(a) 0.011 MPa for dead and live long-term loads; or

(b) 0.210 MPa for ultimate limit wind loads only.

NOTES:

1 For structural silicone design example, see Appendix F.

2 The above values may not apply to structural silicones immersed in water.

3.7.3 Serviceability limit state

Structural silicone movements under all loads shall be limited so that—

(a) glazing is not displaced from setting blocks; and

(b) for butt glazing with glass fins, combined joint and frame movements meet the deflection limit requirements of Clause 3.5.2.

NOTE: For structural silicone design example, see Appendix F.

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3.8 SELECTION OF GLASS FOR MINIMIZING THE RISK DUE TO GLASS SPONTANEOUS FRACTURE

3.8.1 General

The use of toughened glass and some heat treated glasses may involve a relatively small risk of breakage resulting from nickel sulphide. In addition to the other requirements of this Standard, such glass shall be selected to minimize the risk in accordance with Clause 3.8.2.

Class 1 and Class 10 buildings are exempt from the requirements of this Clause.

3.8.2 Requirements to minimize the risk

All monolithic toughened glass and heat strengthened glass, (with a surface compression greater than 52 MPa), shall be heat soaked in accordance with Clauses 3, 5, 6 and 12 and Annex A of European Standard EN 14179-1. The heat soaked glass shall be marked in compliance with EN 14179-1. A certificate supplied by the manufacturer providing verification that the toughened glass has been heat soaked in accordance with this clause shall be a suitable alternative to marking in compliance with EN 14179-1.

A2 Heat soaking in accordance with this Clause is not required in glazing that conforms to any one of the following:

(a) No part of the glass is glazed more than 5 m from the finished floor or ground level.

(b) Suitable protection by a balcony, awning or the like is provided such that, in the event of glass fracturing, the risk of injury or property damage is minimized.

(c) Laminated glass, (including toughened laminated and heat strengthened laminated) is used.

NOTES:

1 For insulating glass units glazed vertically, greater than 5 m from the ground level, a laminated, monolithic annealed or monolithic heat strengthened outer or inner pane as appropriate may be considered to provide suitable protection.

2 For insulating glass units glazed in sloped overhead glazing greater than 3 m from the finished floor or ground level a laminated inner (lower) pane may be considered to provide suitable protection.

3 A balcony that extends from the building a minimum 2/3 of the height of the adjacent panel may be considered to be suitable to minimize the risk. For example, for a 2700 mm high panel, the balcony or protection should extend a minimum of 1800 mm from the building.

4 Heat soaking will significantly reduce but not totally eliminate the small risk of fracture due to nickel sulphide.

SECTION 4 DESIGN FOR WIND LOADING

4.1 GENERAL

This Section sets out a deemed-to-comply methodology for determining the minimum glass thickness to be used to resist the ultimate limit state design wind pressures. However, the location of the glass within the building may require additional considerations, such as human impact, which may impose either a minimum glass thickness above the basic calculation of this Section or a provision for a specific glass type or both (see Clause 1.2).

Compliance with this Section is deemed to meet, or be an acceptable solution to, the strength limit state requirements of Clause 3.3 for the ultimate wind loads determined in accordance with AS/NZS 1170.2 and the serviceability limit state deflection limit requirements of Clause 3.3.3. The limitation of area for monolithic annealed glass shall also be applicable (see Clause 3).

The simplified provisions of this Section are applicable provided the following limiting parameters are satisfied:

(a) Ultimate limit state wind pressure or other loads are of 3 s duration or less and not greater than 10.0 kPa.

(b) For laminated glass, the two sheets are of equal thickness and the interlayer material is either polyvinyl butyral (pvb) or an equivalent type of interlayer with a modulus of elasticity of 24.1 MPa and a Poisson's ratio of 0.50 at 20°C.

For laminated glass with unequal thicknesses sheets, see Section 3.

4.2 DESIGN WIND PRESSURE

A3 The design wind pressures shall be the ultimate and serviceability limit state design wind pressures determined in accordance with the NCC for the importance level of the building and the annual probability of exceedance in accordance with AS/NZS 1170.2 or AS 4055.

NOTE: Appendix A provides guidance on determining the ultimate and serviceability limit state design wind pressures from the procedures given in AS 4055 and AS/NZS 1170.2. It should be ensured that the assumptions used in these simplified determinations are applicable for the glass being designed.

4.3 INSULATING GLASS UNITS

A2 When loads are shared between panes of glass within an insulating glass unit, each pane of glass shall be checked individually for the limit state design wind pressures multiplied by the relative load-sharing factor, in accordance with Clause 3.4.2.

For 3 mm annealed glass used in IGUs, the maximum area shall not exceed 1.36 m^2.

NOTE: For insulating glass units with two panes of equal thickness, k_{pane} = 0.625.

4.4 MAXIMUM SPAN FOR GLASS PANELS SUBJECTED TO WIND LOADING

4.4.1 General

The maximum span for a given standard nominal thickness of ordinary annealed, laminated, heat-strengthened, and toughened glass for a given panel size shall be determined in accordance with Clauses 4.4.2, 4.4.3 or 4.4.4, as applicable for the relevant support conditions. For heat-strengthened laminated and toughened laminated glass, the maximum allowable span shall be determined in accordance with Clause 4.4.5. For 3 mm monolithic annealed glass, the maximum area shall not exceed 0.85 m^2.

For the purpose of this Section, the minimum thickness of the nominal glass size shall be as given in AS/NZS 4667 or Table 4.1. For non-standard glass thicknesses, the maximum allowable span (*B*), shall be the value determined from the nearest standard nominal thickness, as given in Figures 4.1 to 4.34 as appropriate, multiplied by a reduction factor, which shall be taken as the ratio of the actual minimum thickness of the glass to the minimum thickness (*t*), as given in Table 4.1.

For laminated glass composites, the combined minimum thickness of the glass sheets shall be used excluding the interlayer thickness.

4.4.2 Rectangles of glass supported along all four edges

For rectangles of glass supported along all four edges, the span (*B*) for the selected standard nominal thickness shall be determined either graphically from Figures 4.1 to 4.34 or using the formula and the corresponding constants provided below the graph for each type of glass and thickness, where *B* is the smaller rectangular glass panel dimension.

Linear interpolation is permitted between the lines for each aspect ratio. The curve for aspect ratio 5 is applicable for rectangular glass panels having an aspect ratio of 5 or greater.

Alternatively, the span *B* may be determined from the tables in AS 1288 Supp 1. It should be noted that a more economical design might be obtained by following the design procedures given in Section 3 of this Standard.

NOTE: For an example calculation, see Appendix B.

4.4.3 Rectangles of glass supported on two opposite edges

For rectangles of glass supported on two opposite edges, the minimum glass thickness for a span and a specific ultimate limit state design wind pressure shall be determined from Figures 4.1 to 4.34 for ordinary annealed, laminated, heat-strengthened, and toughened glass respectively.

Alternatively, the span *B* may be determined from the tables in to AS 1288 Supp 1. It should be noted that a more economical design might be obtained by following the design procedures given in Section 3 of this Standard.

A1 **'Text deleted'**

4.4.4 Rectangles of glass supported on three edges

For rectangles of glass supported on three edges, the minimum glass thickness shall be determined as for two-edge support spanning along the unsupported edge.

Alternatively, basic engineering principles in accordance with Section 3 shall be adopted in determining the glass thickness for all applications where only three edges of the panel are supported.

NOTE: Butt glazing of adjacent panels in the same plane should not be considered as a support when using Figures 4.1 to 4.34.

4.4.5 Heat-strengthened laminated and toughened laminated glass

For heat-strengthened laminated and toughened laminated glass, the maximum span for a given standard nominal thickness for a given panel size shall be determined from Figures 4.27 to 4.34 respectively with the design wind pressure being divided by the appropriate glass type factor, c_1 (see Table 3.1), as applicable for the relevant support conditions.

4.4.6 Serviceability checks

Glass complying with Figure 4.35 is deemed to meet, or be an acceptable solution satisfying, the serviceability deflection limits specified in Clause 3.3.3. The slenderness factor (*B*/*t*) for the selected standard nominal thickness shall be determined either graphically or using the formula and the corresponding constants provided below the graph for the appropriate aspect ratio. Linear interpolation is permitted between the lines for each aspect ratio. For rectangular glass panels having aspect ratio greater than 5, the two-edge support line shall be used.

TABLE 4.1

MINIMUM GLASS THICKNESS

Nominal thickness (mm)	Minimum thickness (mm)
Monolithic glass	
3	2.8
4	3.8
5	4.8
6	5.8
8	7.7
10	9.7
12	11.7
15	14.5
19	18.0
25	23.5
Laminated glass	
5	4.6
6	5.6
8	7.6
10	9.6
12	11.6
16	15.4
20	19.4
24	23.4
Wired glass	
6	5

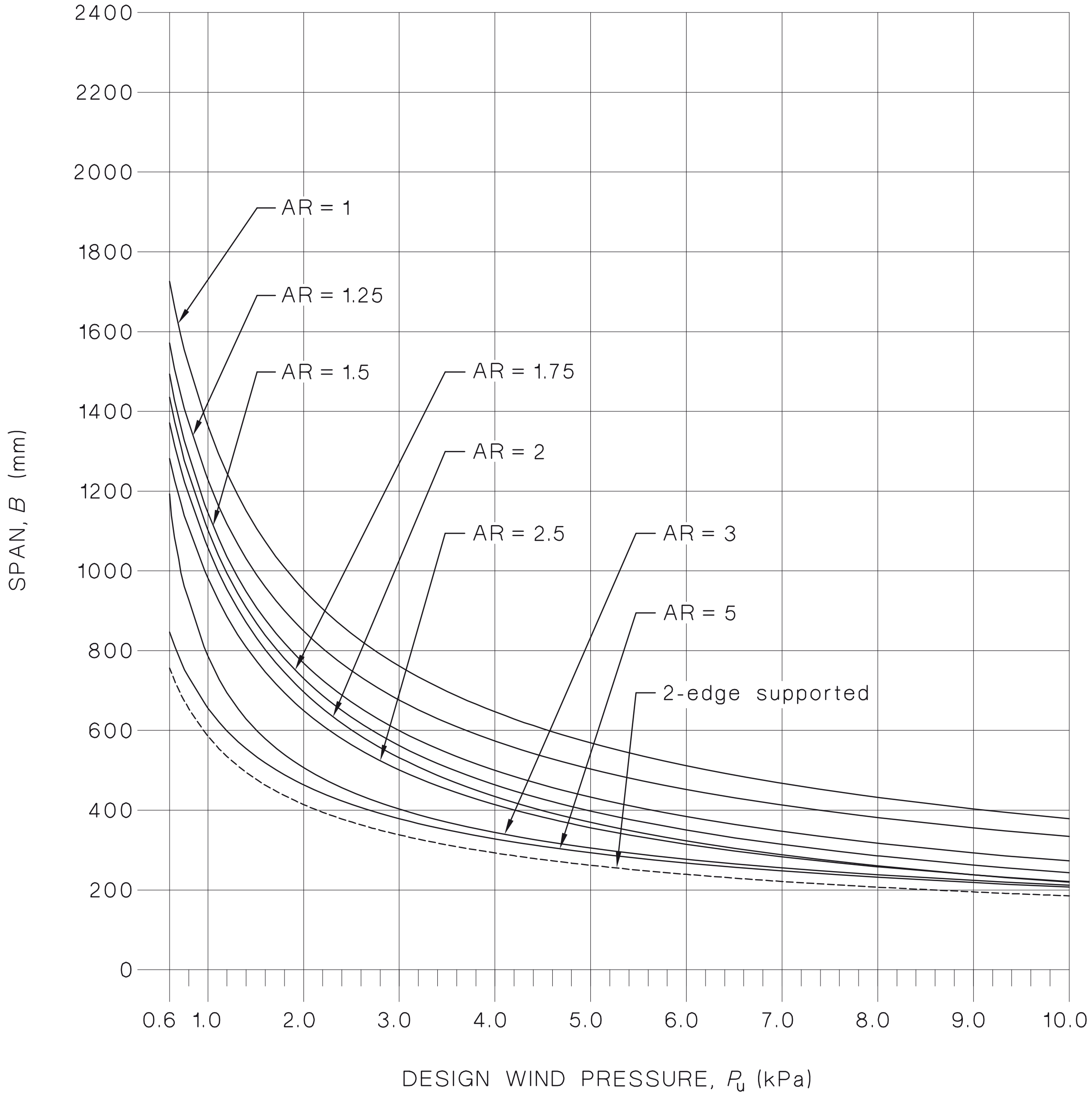
NOTES:

1 For laminated glass, the thickness of glass shown above in the Table does not include the thickness of interlayer, e.g., 6 mm may apply to 6.38 mm, 6.76 mm or 7.52 mm, etc. An explanation of the methodology used in this Section is given in Appendix B.

2 This Table applies to symmetrical and non-symmetrical glass.

4.5 ORGANIC SAFETY FILMS AND OTHER GLASS COATINGS

The structural effects of an organic safety film or other glass coatings shall be ignored in the design of glass. Organic safety film or other coated glass shall be designed as monolithic glass units.



The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

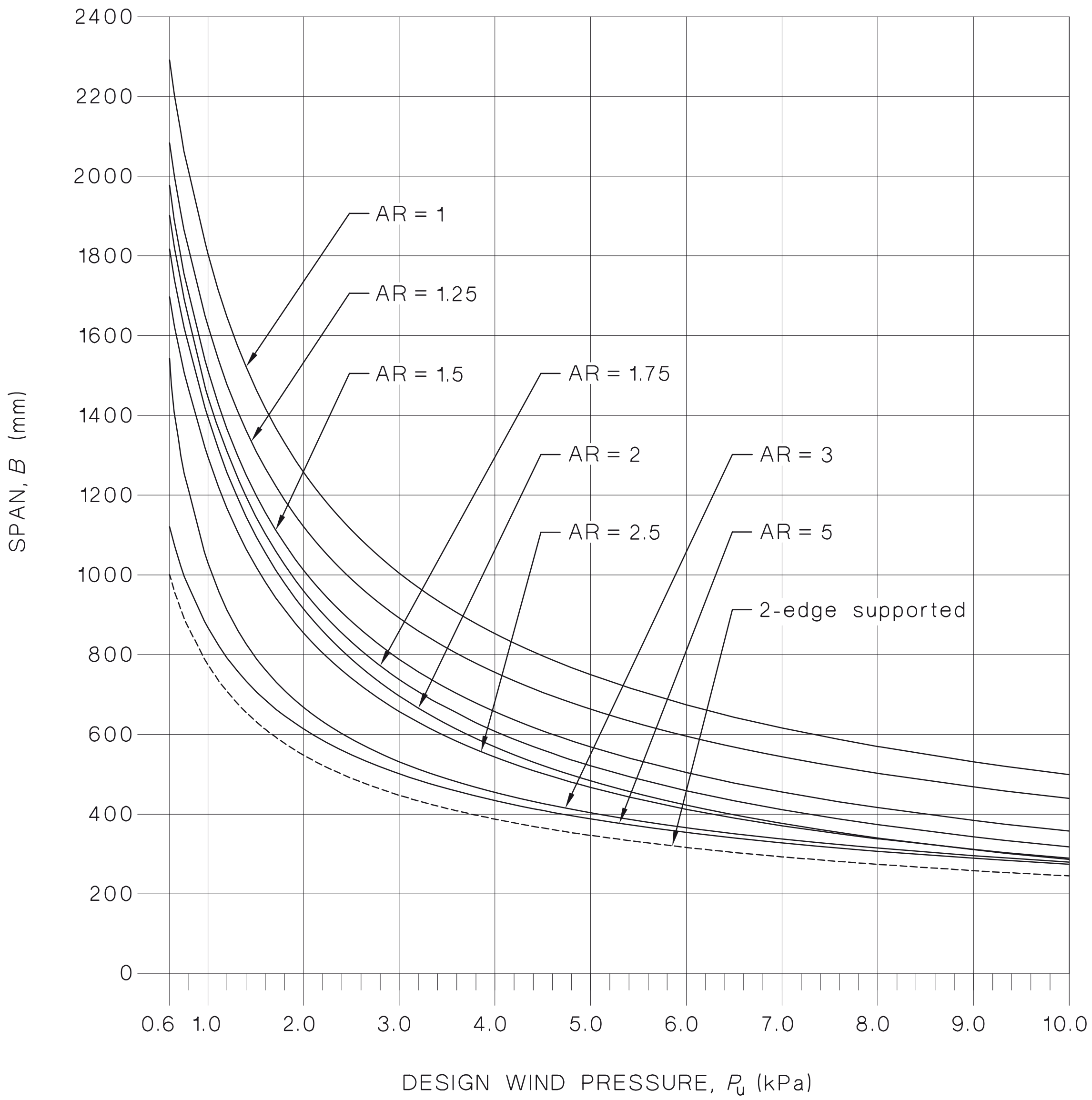
Constant	Four-edge supported annealed glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	1558.4	1373.2	1313.4	1343.4	1381.9	1184.5	667.6	655.7	585.6
k_2	0.25	0.2	0.2	0.3	0.4	0.3	–0.3	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	4.2	–1.4	–22.68	–12.6	–11.2	2.8	–8.4	0	0

A1 NOTES:

1 Maximum allowable area is 0.85 m^2 (see Clause 4.4.1).

2 Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.1 MAXIMUM SPAN FOR MONOLITHIC 3 mm ANNEALED GLASS

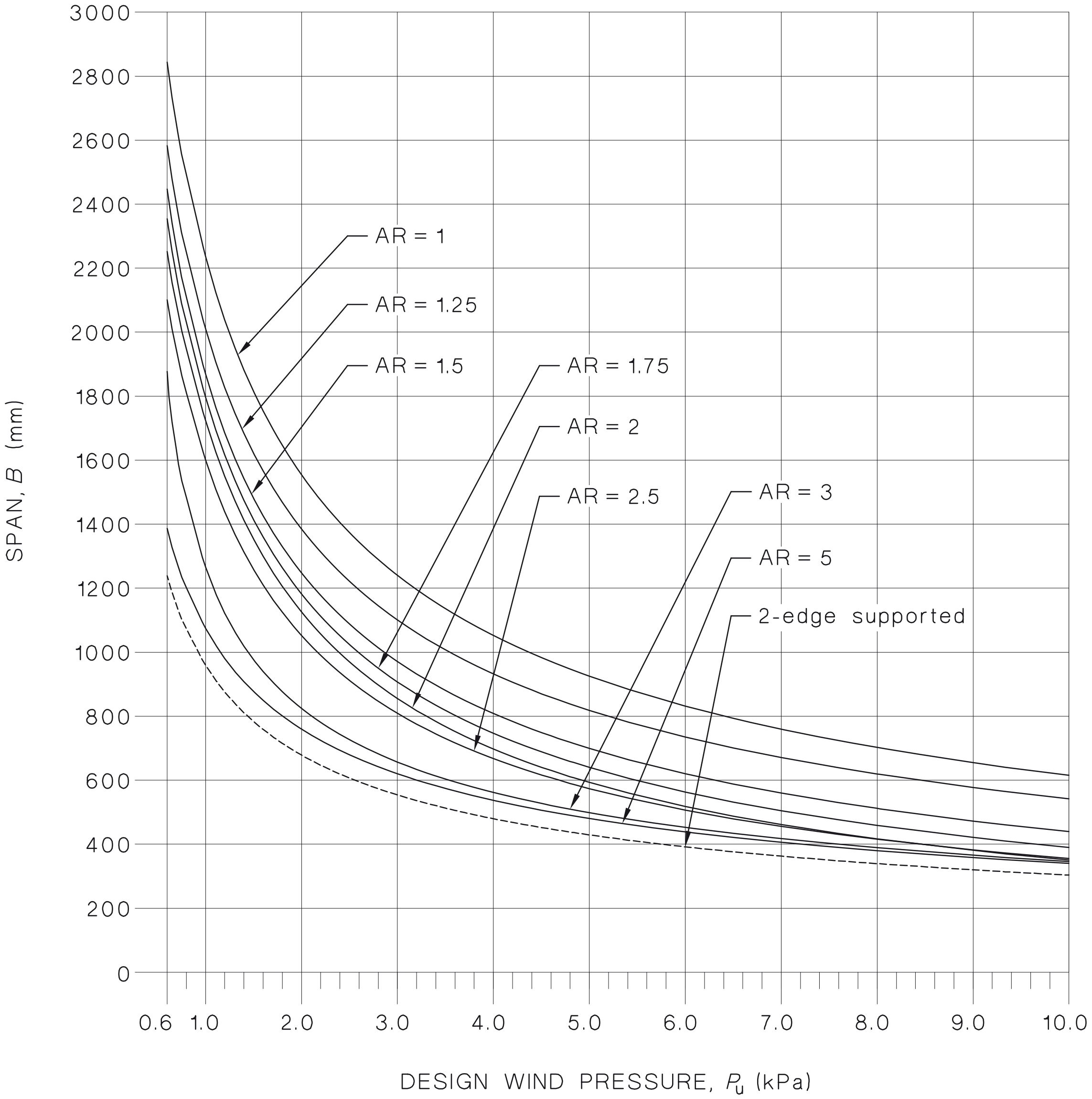


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported annealed glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	2050.7	1807.5	1725.7	1758.9	1804.6	1549.8	884.0	867.8	774.9
k_2	0.237712	0.19017	0.19017	0.285254	0.380339	0.285254	−0.28525	0	0
k_3	−0.6124	−0.6071	−0.6423	−0.7112	−0.7642	−0.7255	−0.4881	−0.5	−0.5
k_4	5.7	−1.9	−30.78	−17.1	−15.2	3.8	−11.4	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.2 MAXIMUM SPAN FOR MONOLITHIC 4 mm ANNEALED GLASS

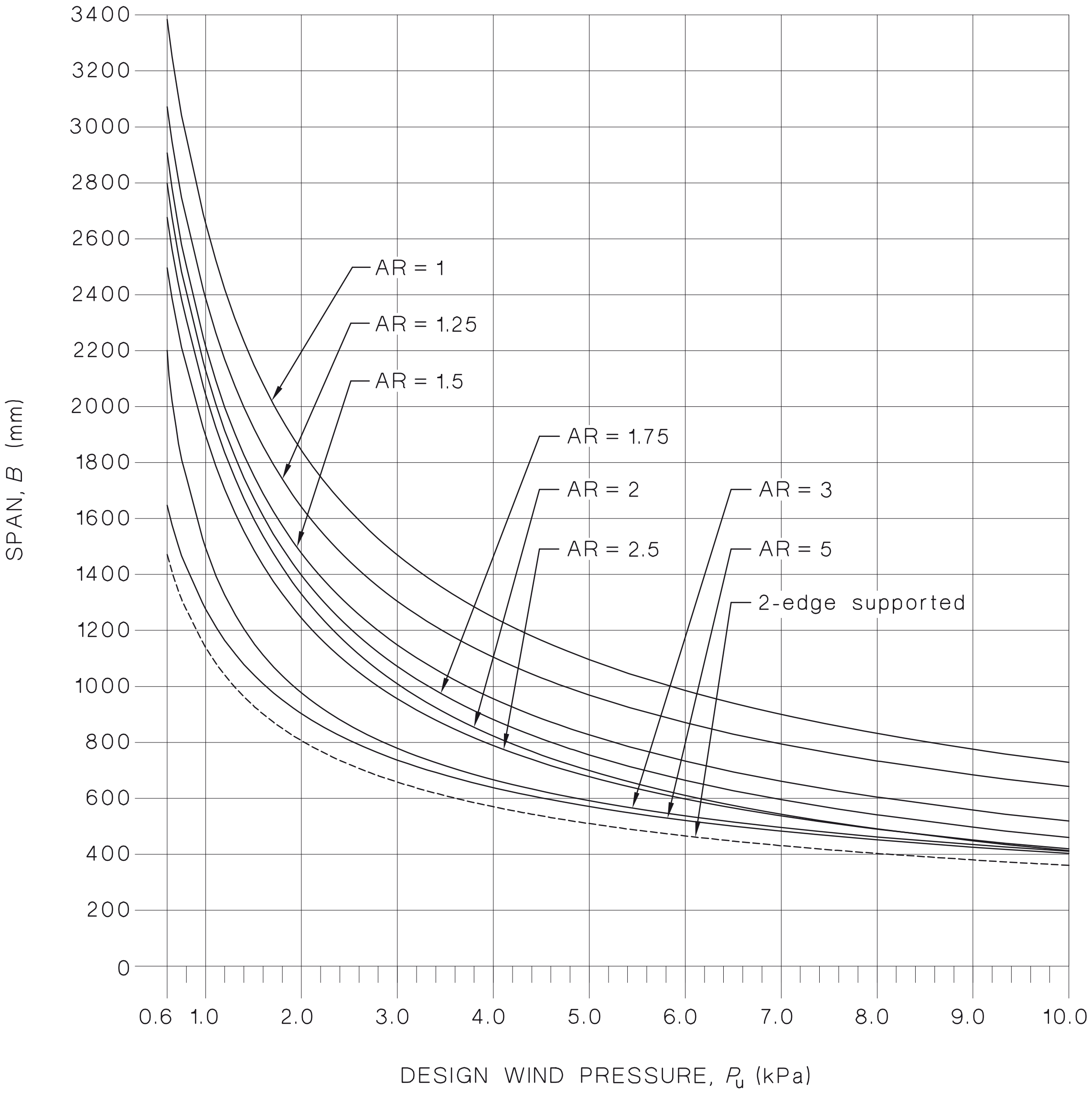


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported annealed glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	2527.1	2227.9	2124.1	2159.0	2210.3	1901.2	1094.8	1074.2	959.3
k_2	0.228312	0.182649	0.182649	0.273974	0.365299	0.273974	–0.27397	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	7.2	–2.4	–38.88	–21.6	–19.2	4.8	–14.4	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.3 MAXIMUM SPAN FOR MONOLITHIC 5 mm ANNEALED GLASS



The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported annealed glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	2990.8	2637.2	2511.3	2546.6	2602.4	2241.4	1301.2	1276.2	1139.7
k_2	0.220697	0.176558	0.176558	0.264836	0.353115	0.264836	–0.26484	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	8.7	–2.9	–46.98	–26.1	–23.2	5.8	–17.4	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.4 MAXIMUM SPAN FOR MONOLITHIC 6 mm ANNEALED GLASS

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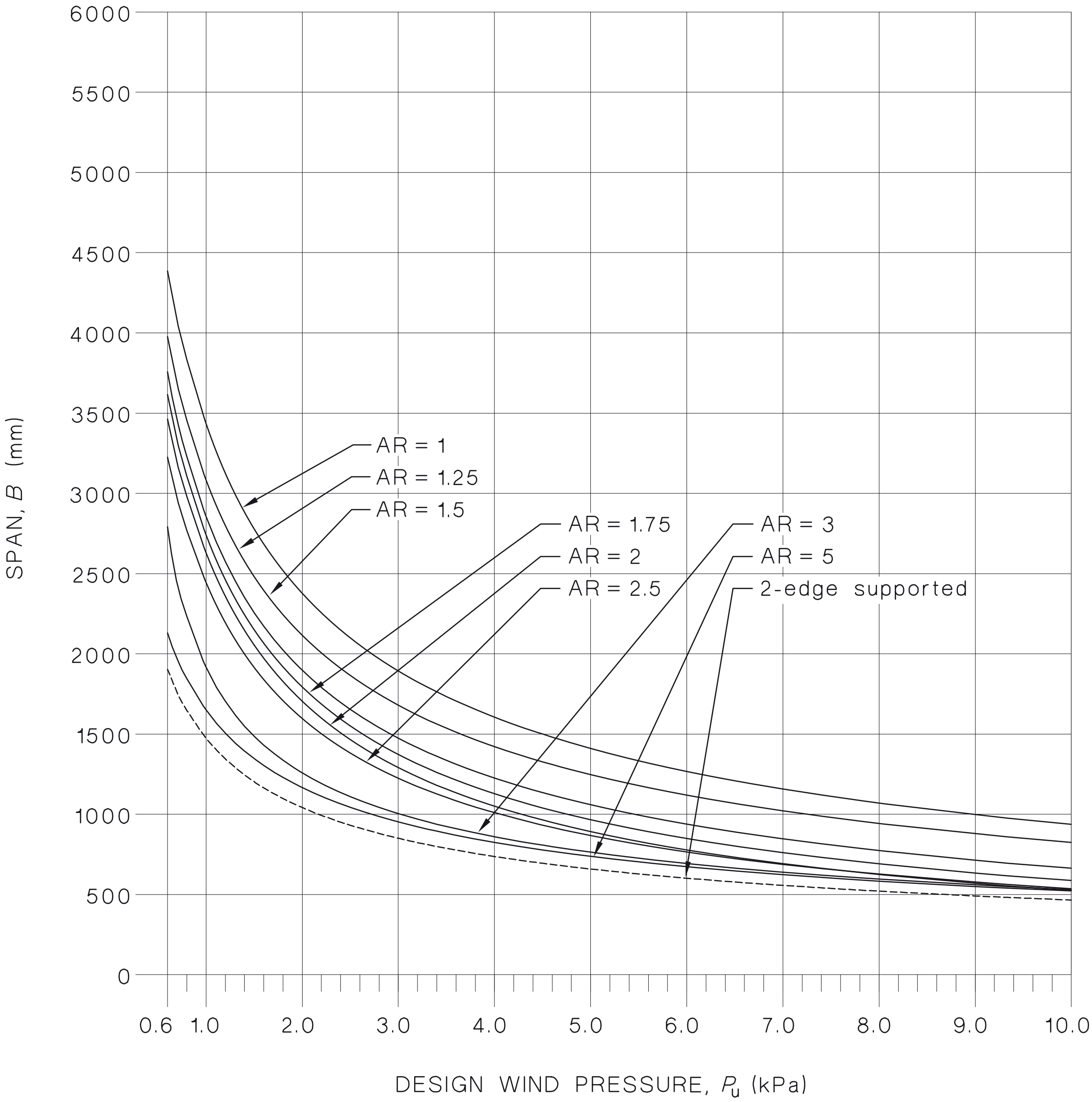
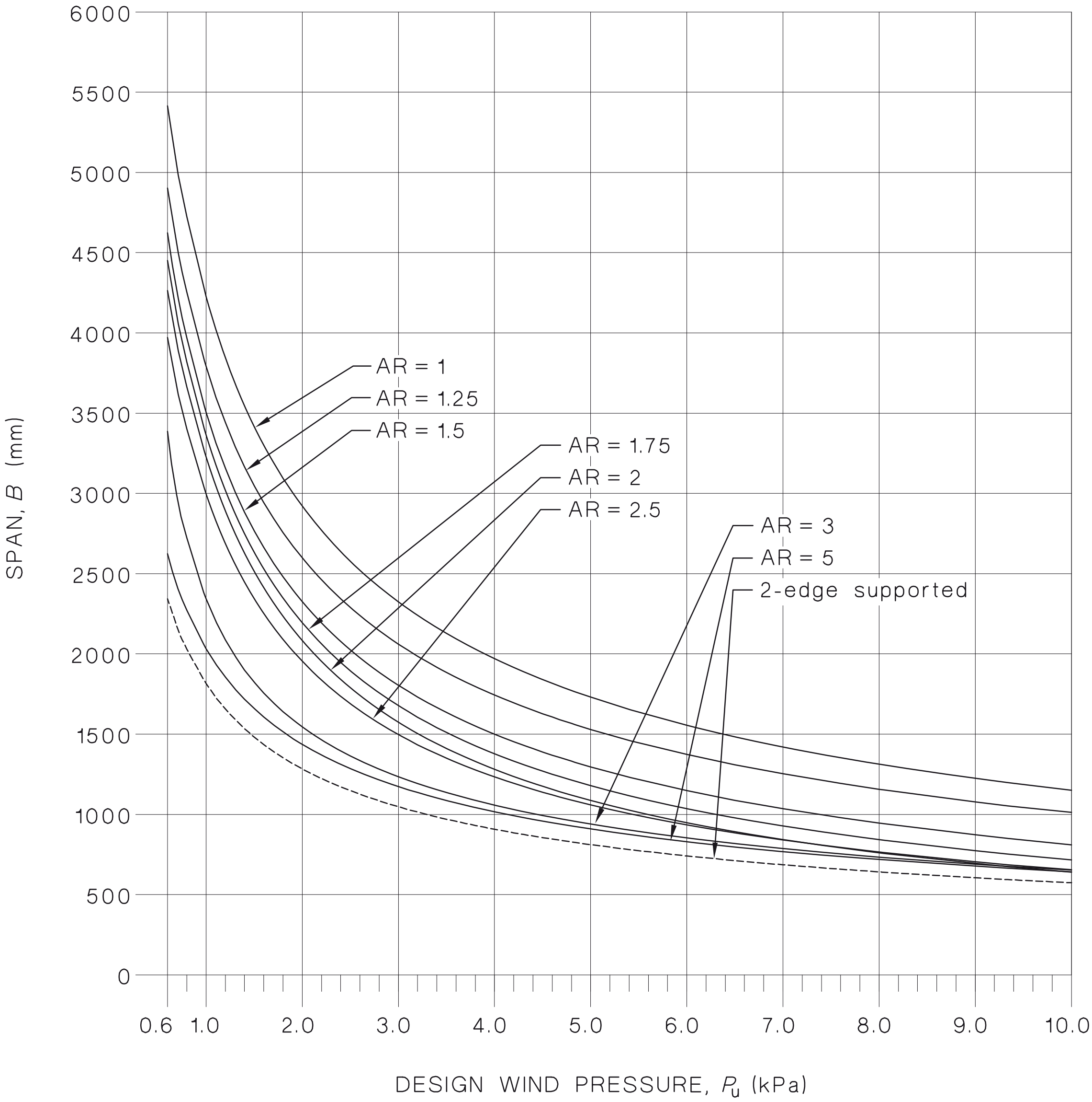


The allowable span B is given by: **Error! Objects cannot be created from editing field codes.**

Constant	Four-edge supported annealed glass parameters for each aspect ratio								Two-edge supported
	AR=1	**AR=1.25**	**AR=1.5**	**AR=1.75**	**AR=2**	**AR=2.5**	**AR=3**	**AR=5**	
k_1	3843.7	3390.2	3222.3	3255.6	3317.7	2863.4	1683.3	1649.9	1473.4
k_2	0.209295	0.167436	0.167436	0.251154	0.334872	0.251154	–0.25115	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	11.55	–3.85	–62.37	–34.65	–30.8	7.7	–23.1	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.5 MAXIMUM SPAN FOR MONOLITHIC 8 mm ANNEALED GLASS

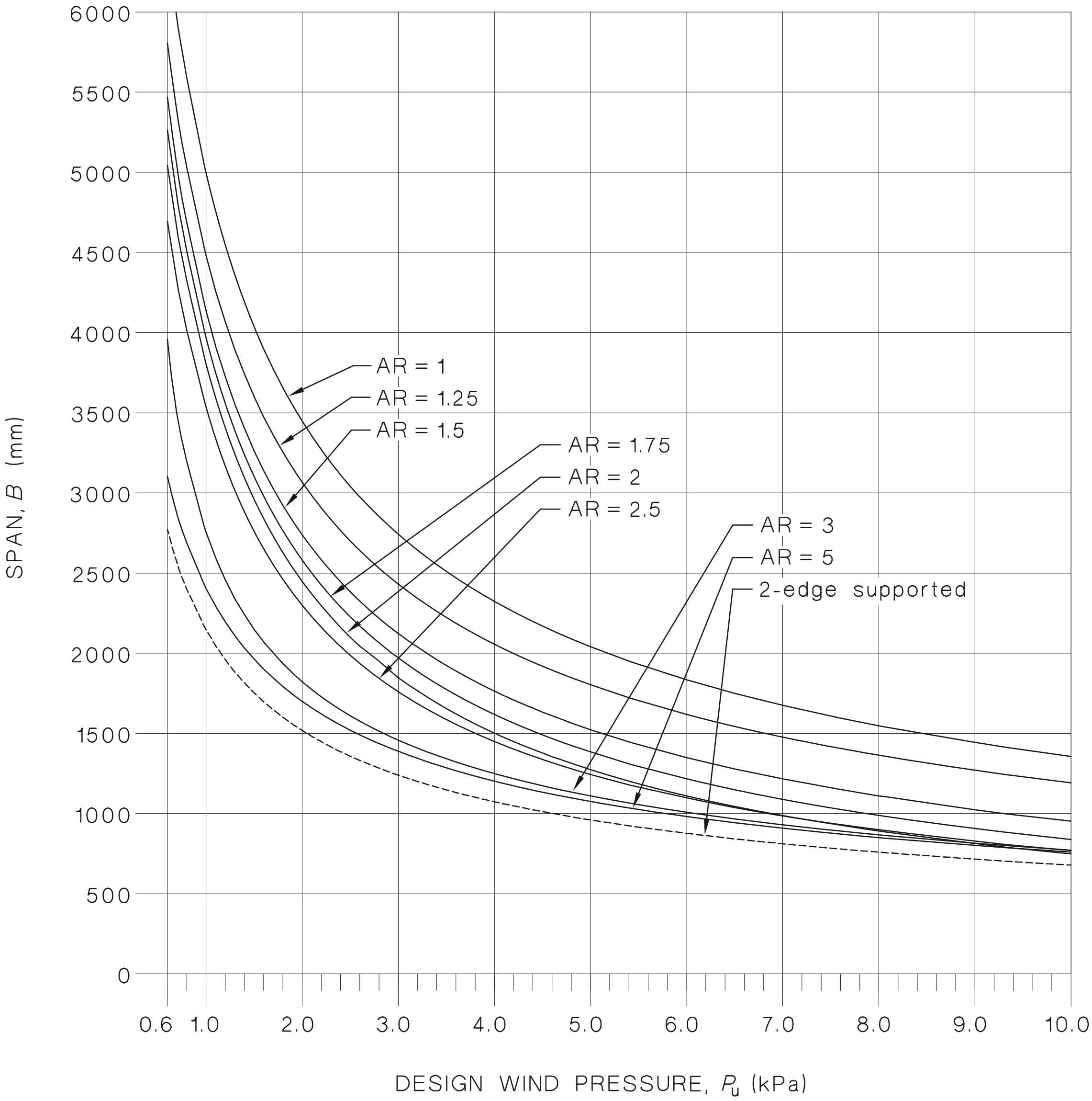


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported annealed glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	4709.2	4154.6	3942.6	3970.9	4036.8	3490.2	2074.0	2031.8	1814.4
k_2	0.200004	0.160003	0.160003	0.240005	0.320006	0.240005	–0.24	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	14.55	–4.85	–78.57	–43.65	–38.8	9.7	–29.1	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.6 MAXIMUM SPAN FOR MONOLITHIC 10 mm ANNEALED GLASS

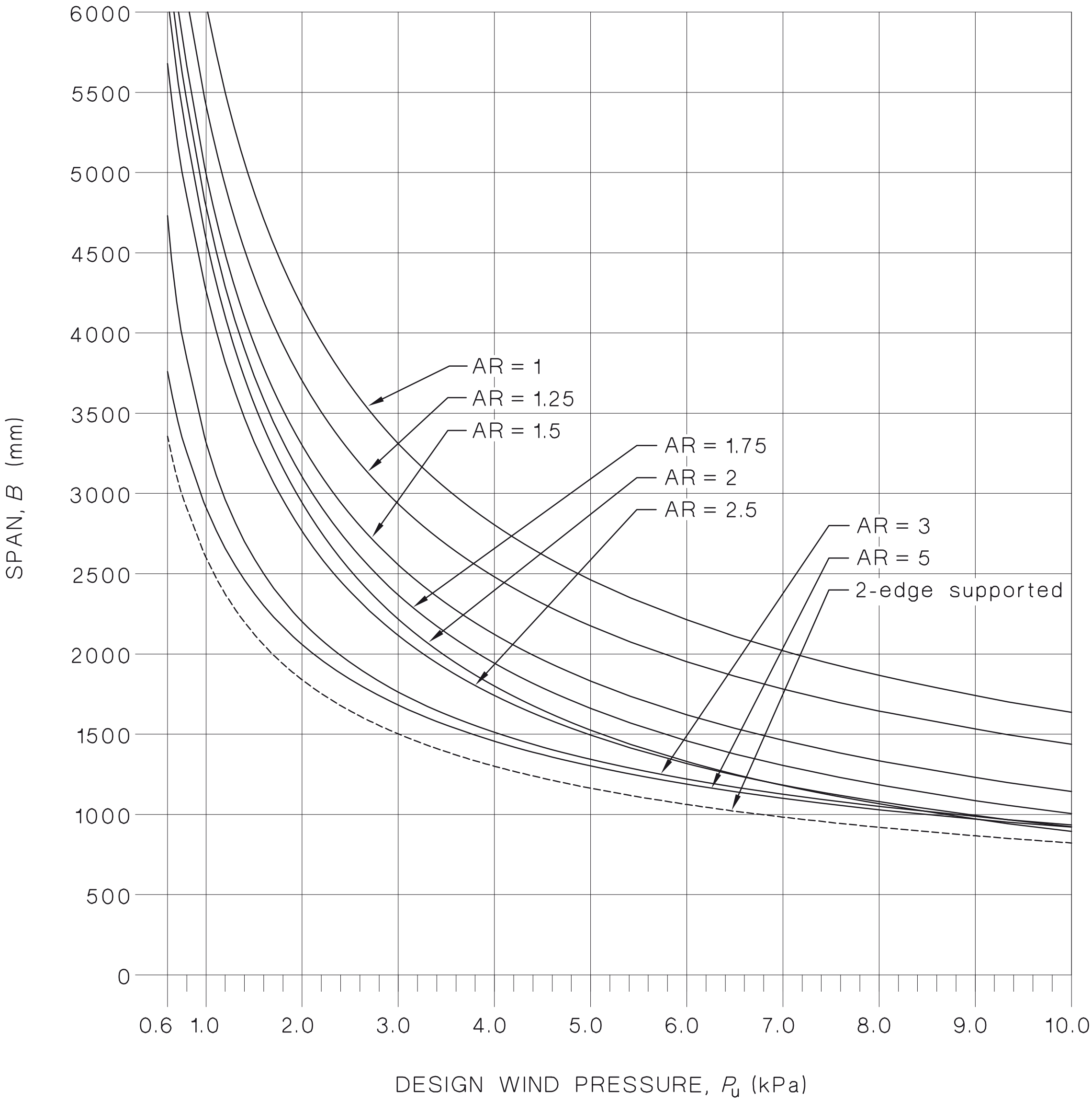


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported annealed glass parameters for each aspect ratio								Two- edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	5548.0	4895.6	4639.5	4660.5	4728.2	4094.0	2455.2	2404.1	2146.9
k_2	0.192461	0.153969	0.153969	0.230953	0.307937	0.230953	–0.23095	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	17.55	–5.85	–94.77	–52.65	–46.8	11.7	–35.1	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.7 MAXIMUM SPAN FOR MONOLITHIC 12 mm ANNEALED GLASS

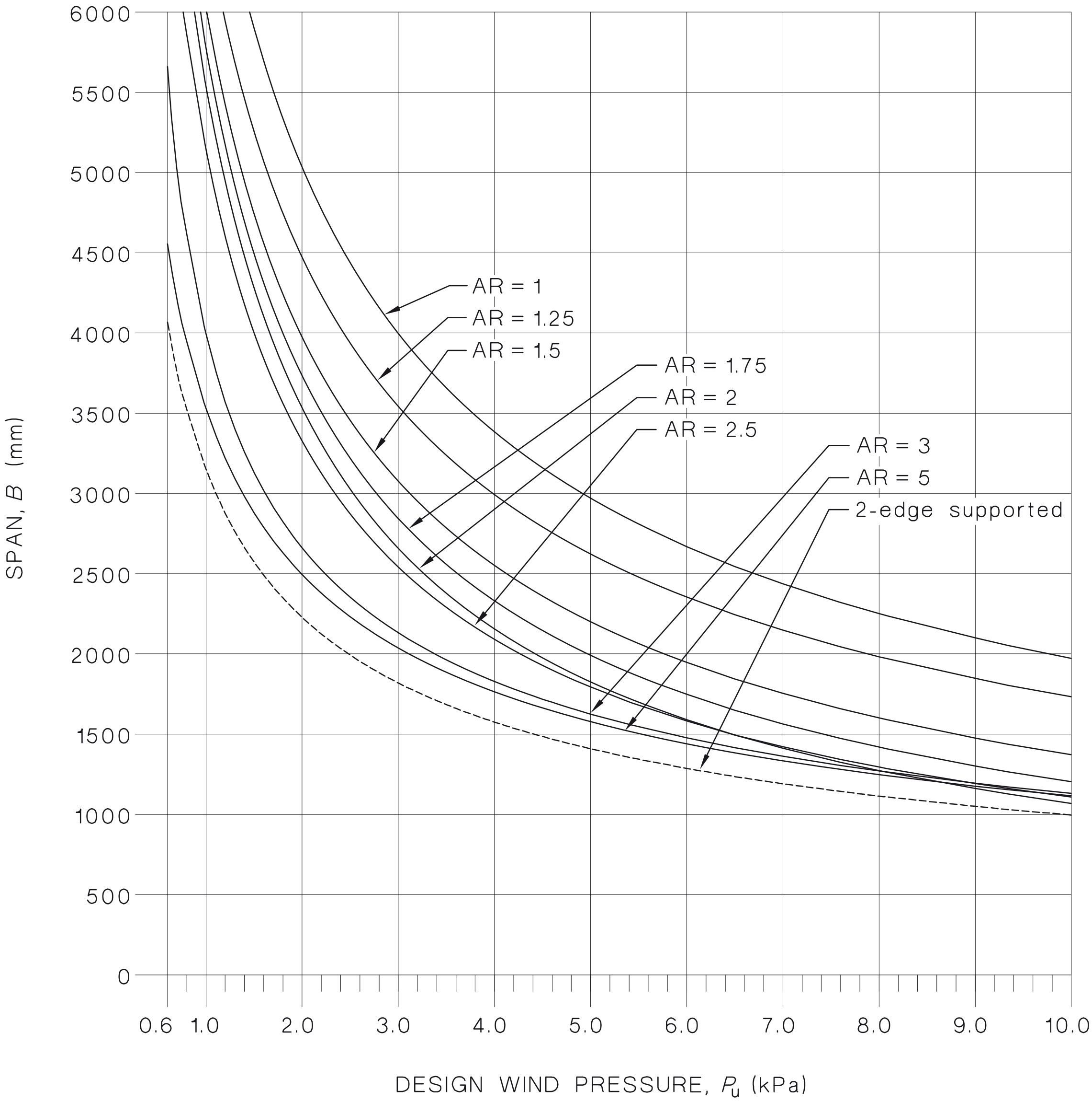


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported annealed glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	6685.2	5900.5	5582.8	5590.3	5657.8	4907.6	2975.3	2911.9	2600.3
k_2	0.183827	0.147062	0.147062	0.220593	0.294124	0.220593	–0.22059	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
$k4$	21.75	–7.25	–117.45	–65.25	–58	14.5	–43.5	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.8 MAXIMUM SPAN FOR MONOLITHIC 15 mm ANNEALED GLASS

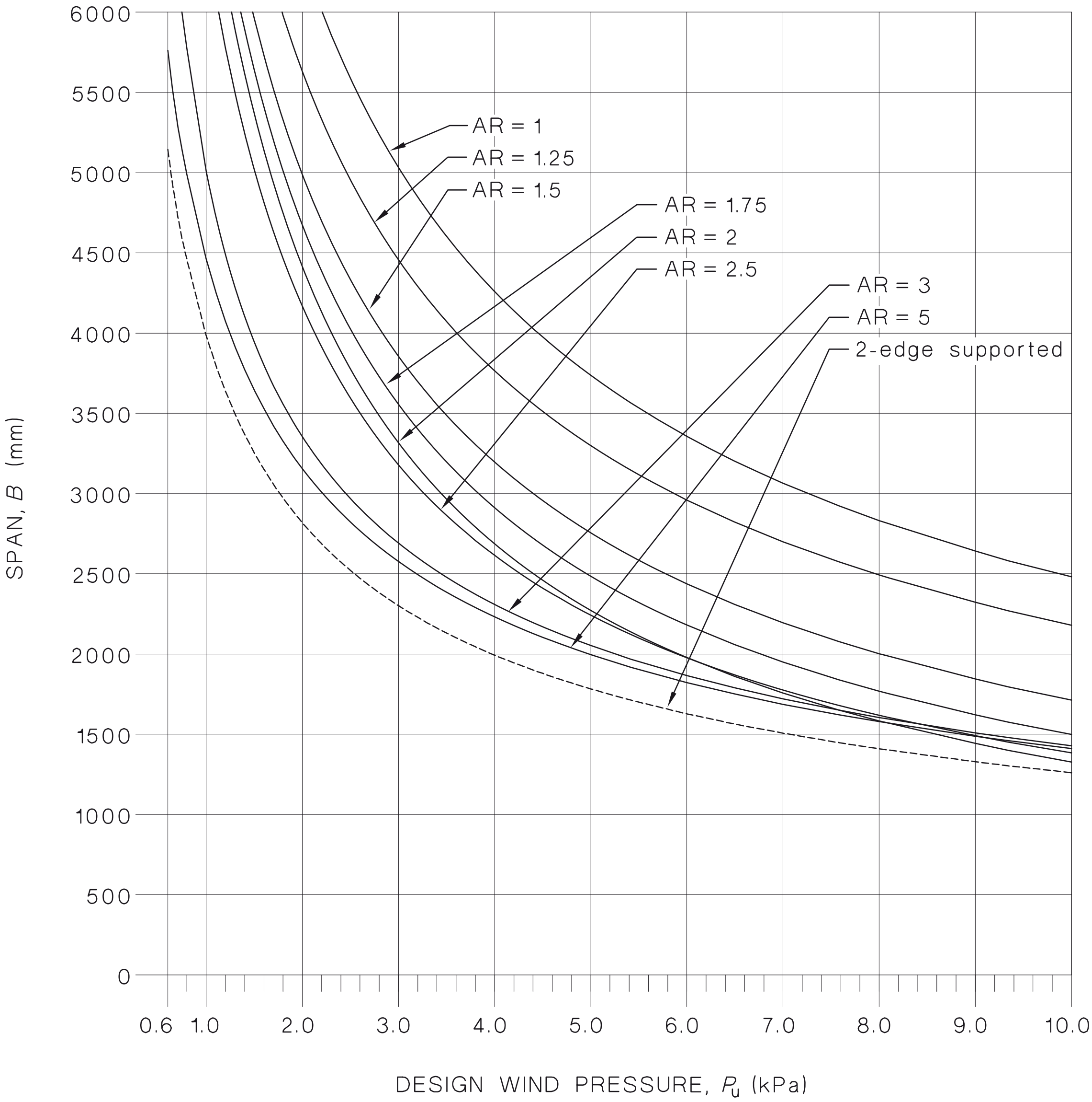


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported annealed glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	8056.1	7112.3	6717.8	6704.5	6768.0	5881.7	3607.1	3528.2	3150.6
k_2	0.175127	0.140102	0.140102	0.210152	0.280203	0.210152	–0.21015	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	27	–9	–145.8	–81	–72	18	–54	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.9 MAXIMUM SPAN FOR MONOLITHIC 19 mm ANNEALED GLASS

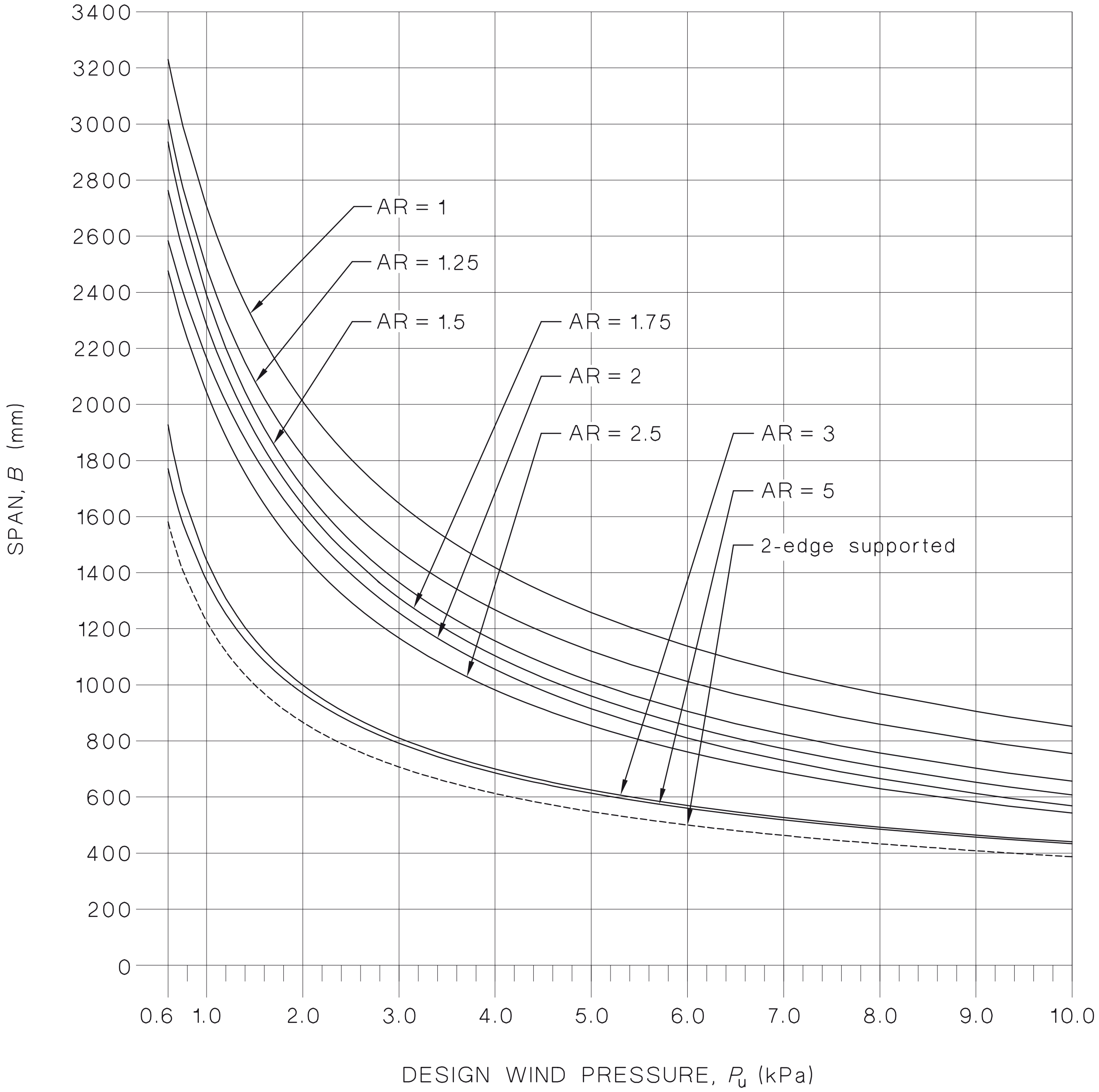


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported annealed glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	10118.2	8935.8	8421.5	8368.2	8419.2	7334.6	4566.2	4462.9	3985.3
k_2	0.164398	0.131519	0.131519	0.197278	0.263037	0.197278	–0.19728	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	35.25	–11.75	–190.35	–105.75	–94	23.5	–70.5	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.10 MAXIMUM SPAN FOR MONOLITHIC 25 mm ANNEALED GLASS

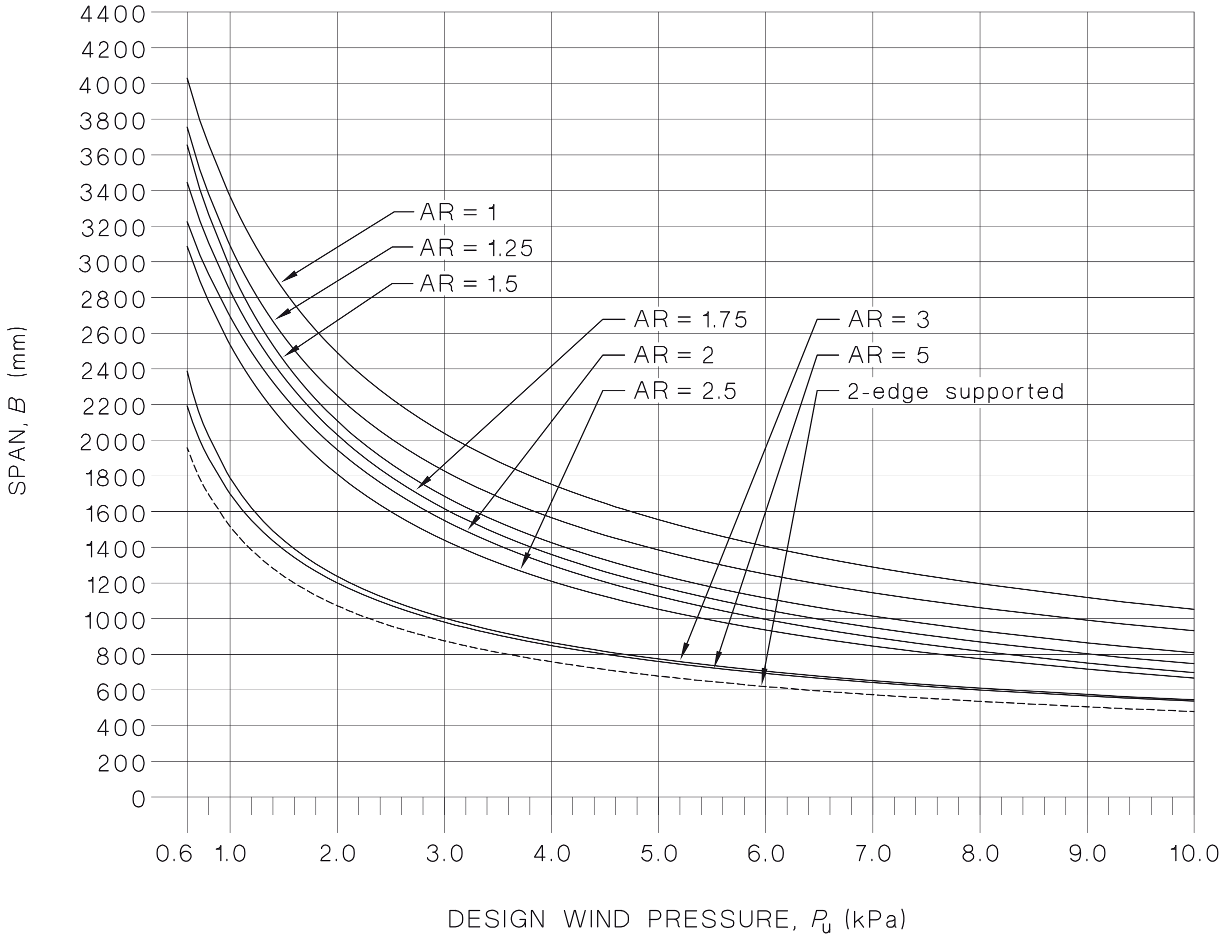


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported toughened glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	3594.2	3152.6	3108.6	3374.9	3634.8	3012.9	1382.5	1372.1	1225.3
k_2	0.59428	0.475424	0.475424	0.713136	0.950848	0.713136	−0.1	0	0
k_3	−0.6124	−0.6071	−0.6423	−0.7112	−0.7642	−0.7255	−0.4881	−0.5	−0.5
k_4	5.7	−1.9	−30.78	−17.1	−15.2	3.8	−11.4	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.11 MAXIMUM SPAN FOR MONOLITHIC 4 mm TOUGHENED GLASS

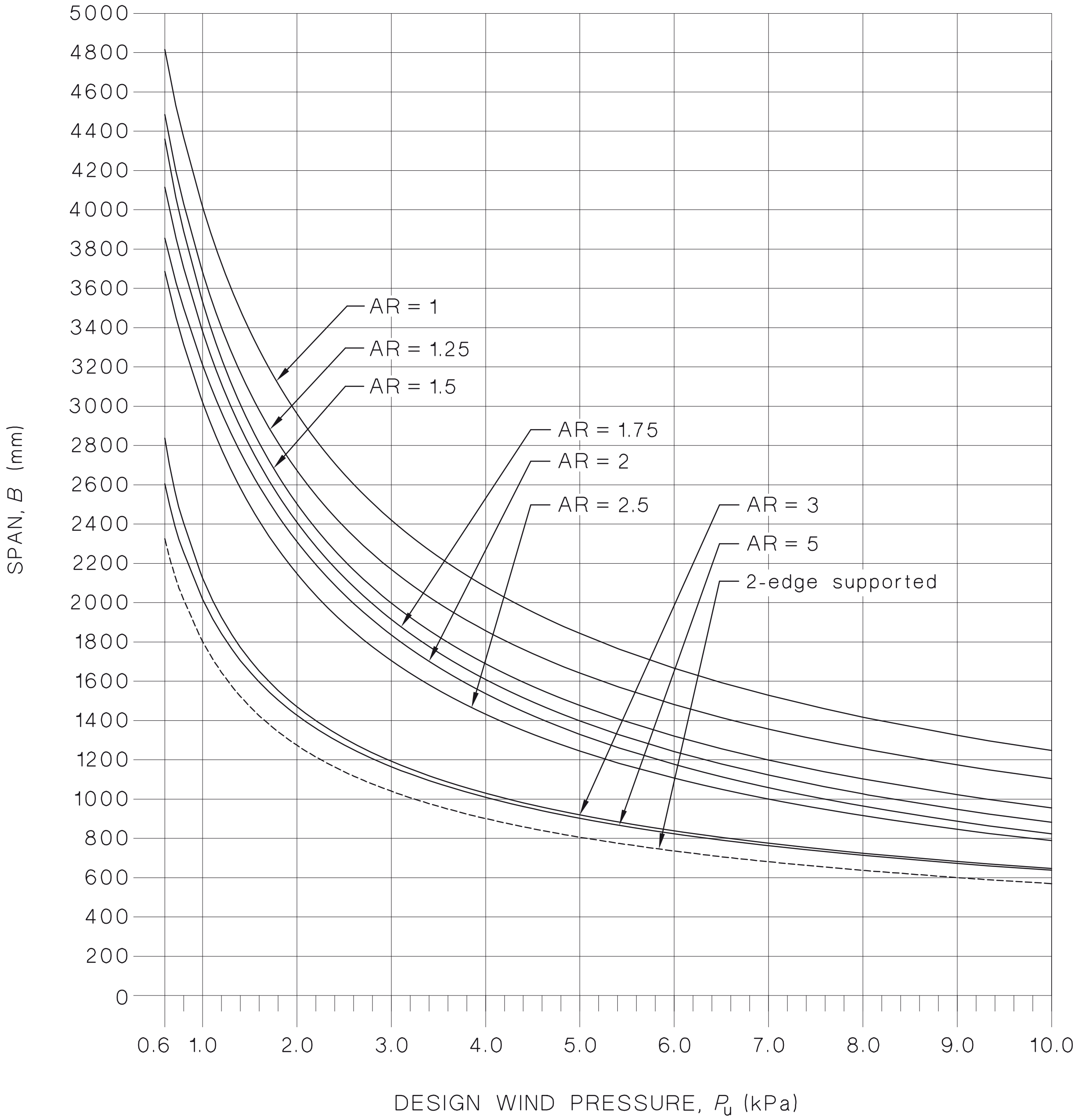


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported toughened glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	4429.2	3885.9	3826.2	4142.5	4452.0	3696.0	1712.3	1698.5	1516.8
k_2	0.57078	0.456624	0.456624	0.684935	0.913247	0.684935	–0.1	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	7.2	–2.4	–38.88	–21.6	–19.2	4.8	–14.4	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.12 MAXIMUM SPAN FOR MONOLITHIC 5 mm TOUGHENED GLASS

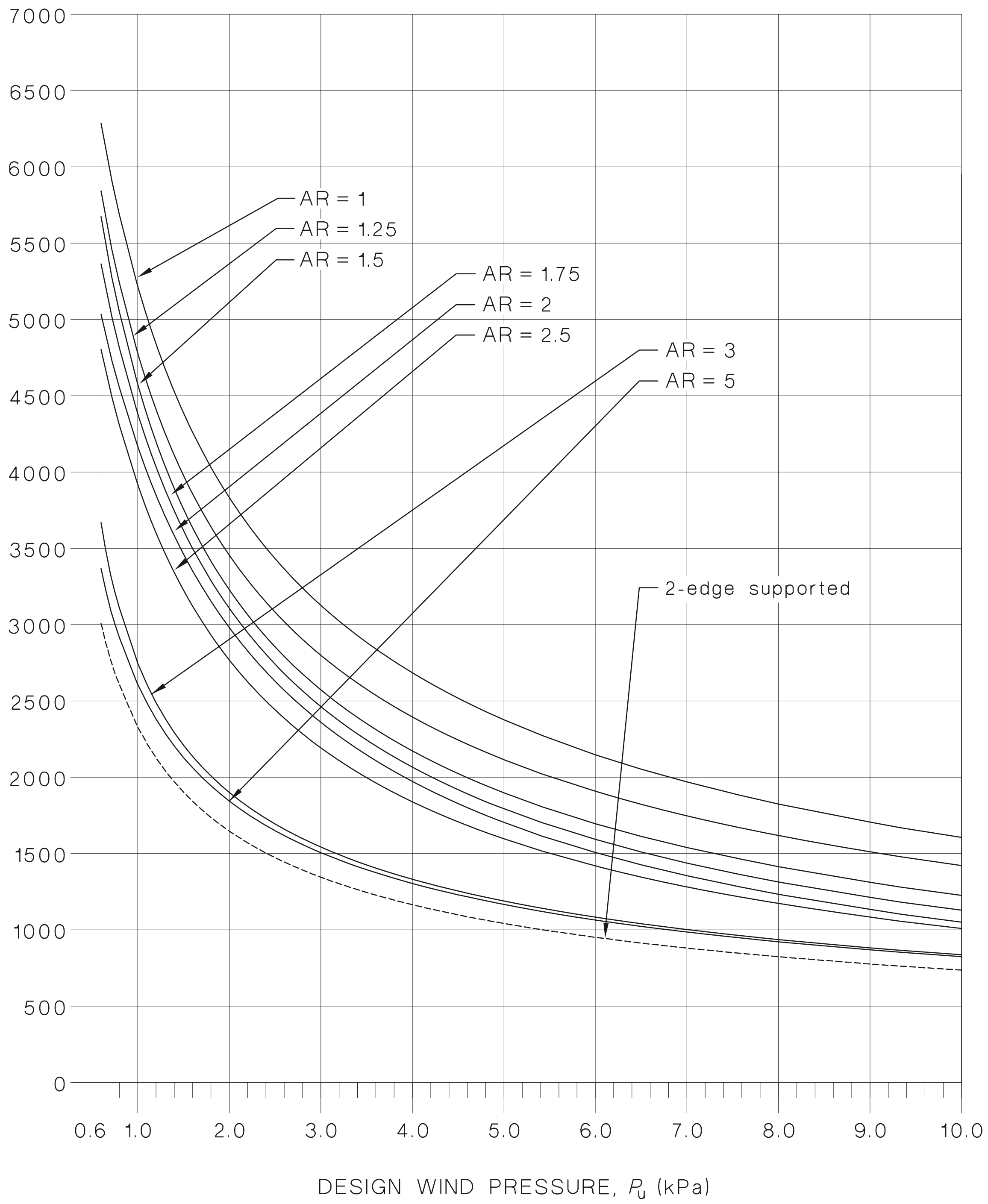


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported toughened glass parameters for each aspect ratio								Two-edge supported
	AR=1	**AR=1.25**	**AR=1.5**	**AR=1.75**	**AR=2**	**AR=2.5**	**AR=3**	**AR=5**	
k_1	5241.9	4599.7	4523.7	4886.2	5241.8	4357.5	2035.1	2017.9	1801.9
k_2	0.551743	0.441394	0.441394	0.662091	0.882788	0.662091	−0.1	0	0
k_3	−0.6124	−0.6071	−0.6423	−0.7112	−0.7642	−0.7255	−0.4881	−0.5	−0.5
k_4	8.7	−2.9	−46.98	−26.1	−23.2	5.8	−17.4	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.13 MAXIMUM SPAN FOR MONOLITHIC 6 mm TOUGHENED GLASS

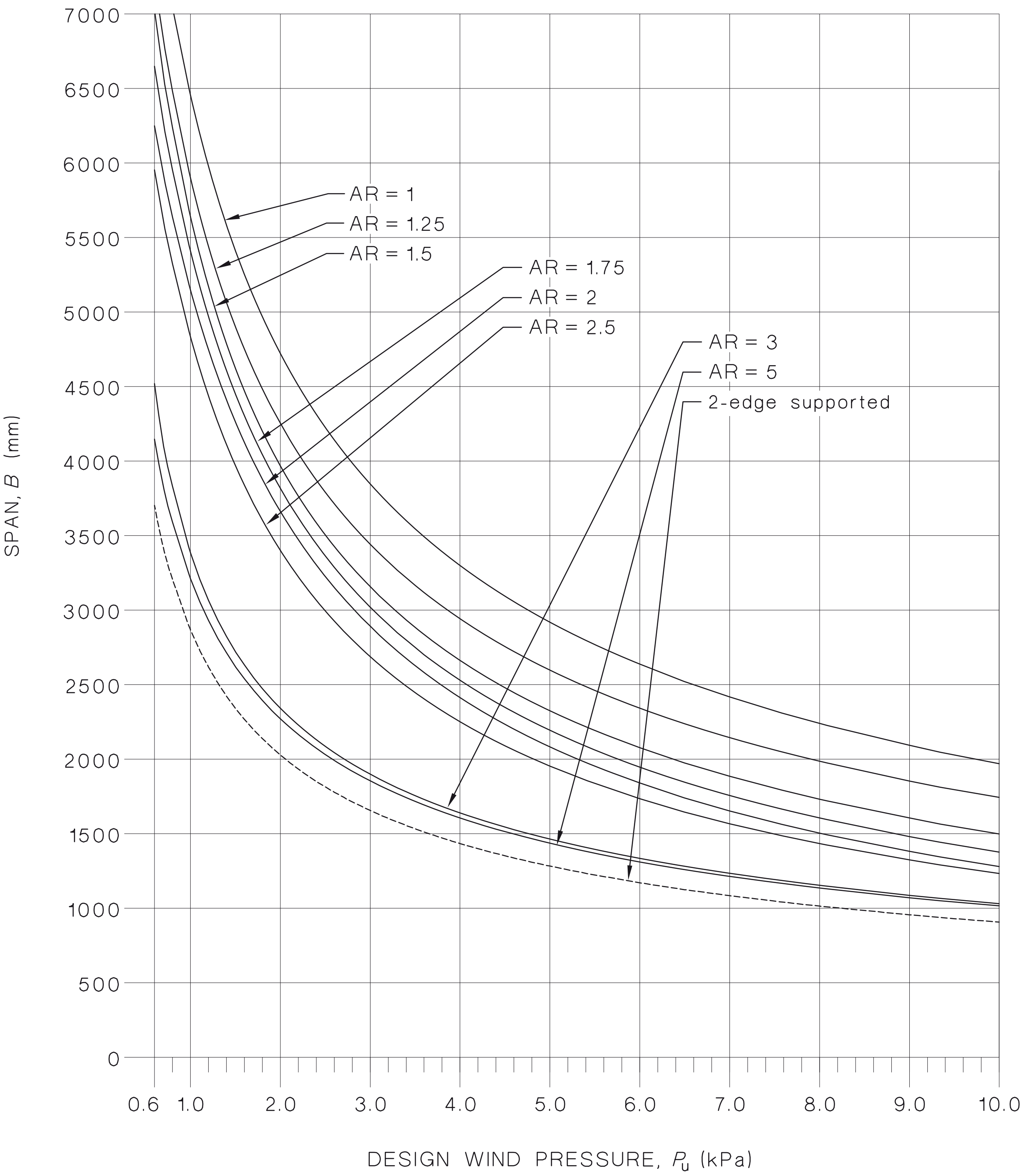


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported toughened glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	6736.6	5913.0	5804.5	6246.7	6682.5	5566.5	2632.7	2608.8	2329.6
k_2	0.523238	0.41859	0.41859	0.627885	0.83718	0.627885	–0.1	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	11.55	–3.85	–62.37	–34.65	–30.8	7.7	–23.1	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.14 MAXIMUM SPAN FOR MONOLITHIC 8 mm TOUGHENED GLASS

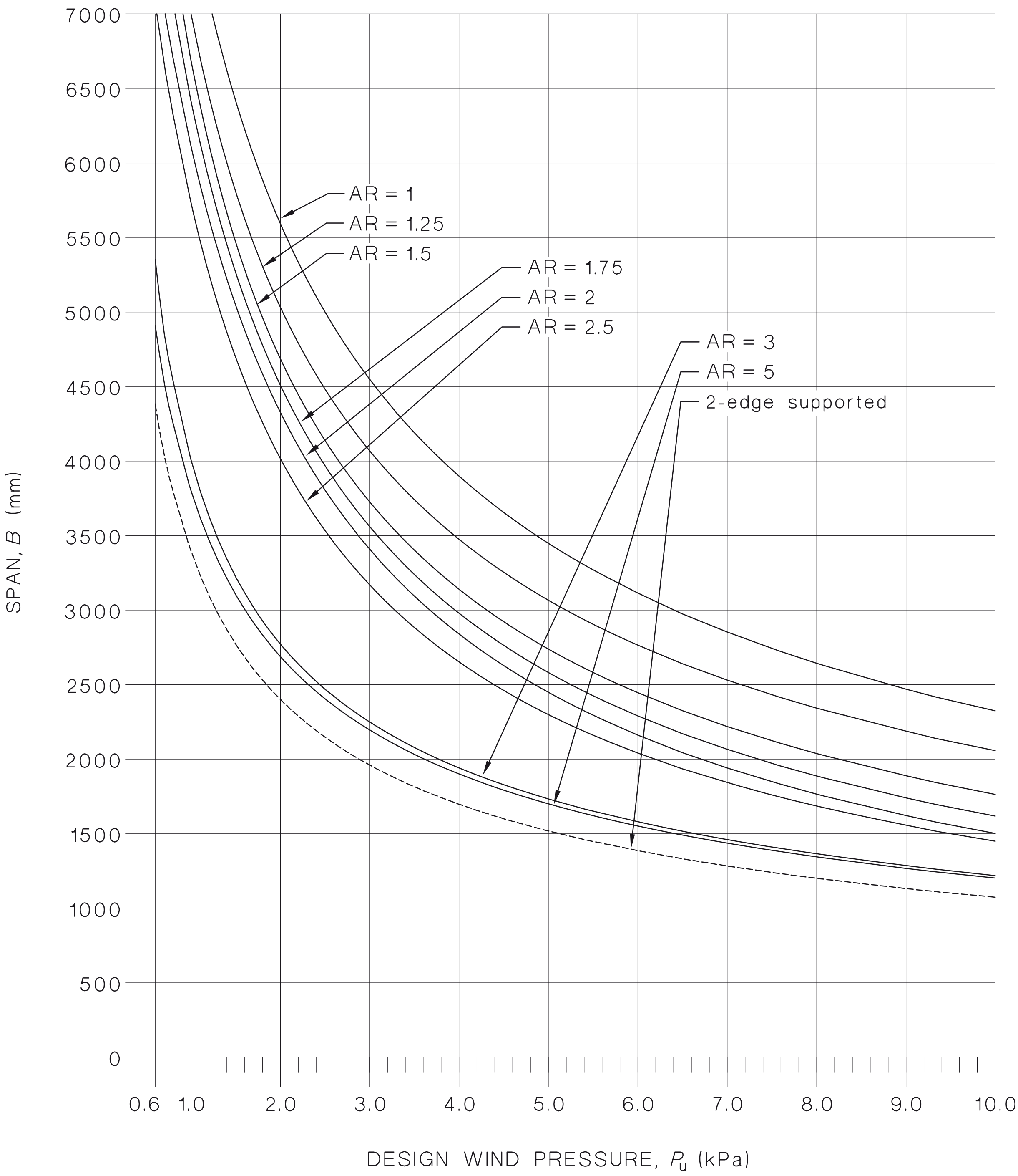


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported toughened glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	8253.7	7246.3	7101.9	7619.1	8131.1	6785.1	3243.8	3212.6	2868.8
k_2	0.50001	0.400008	0.400008	0.600012	0.800016	0.600012	–0.1	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	14.55	–4.85	–78.57	–43.65	–38.8	9.7	–29.1	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.15 MAXIMUM SPAN FOR MONOLITHIC 10 mm TOUGHENED GLASS

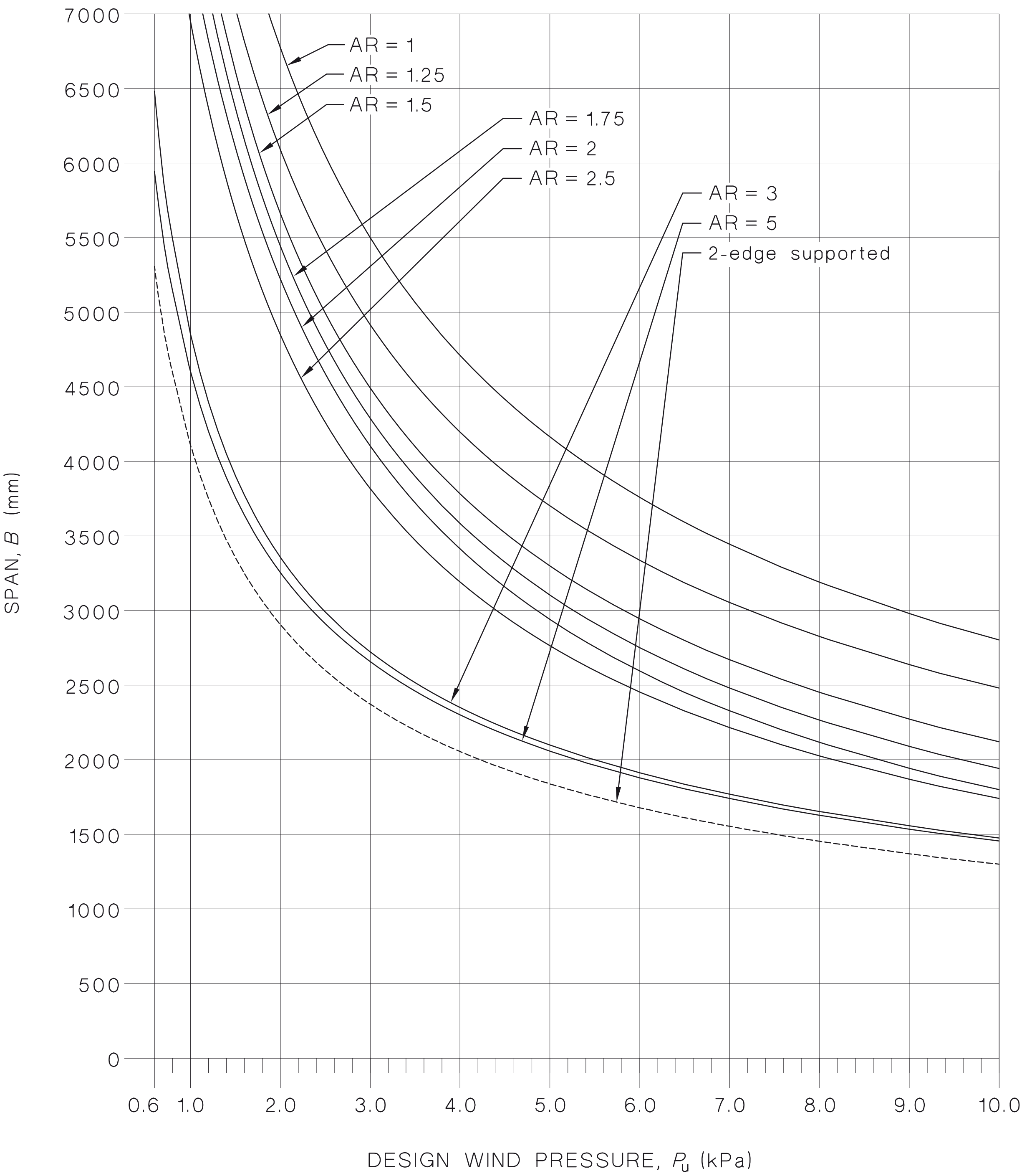


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported toughened glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	9723.8	8538.8	8357.3	8942.2	9523.6	7959.0	3839.9	3801.2	3394.5
k_2	0.481152	0.384922	0.384922	0.577382	0.769843	0.577382	–0.1	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	17.55	–5.85	–94.77	–52.65	–46.8	11.7	–35.1	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.16 MAXIMUM SPAN FOR MONOLITHIC 12 mm TOUGHENED GLASS

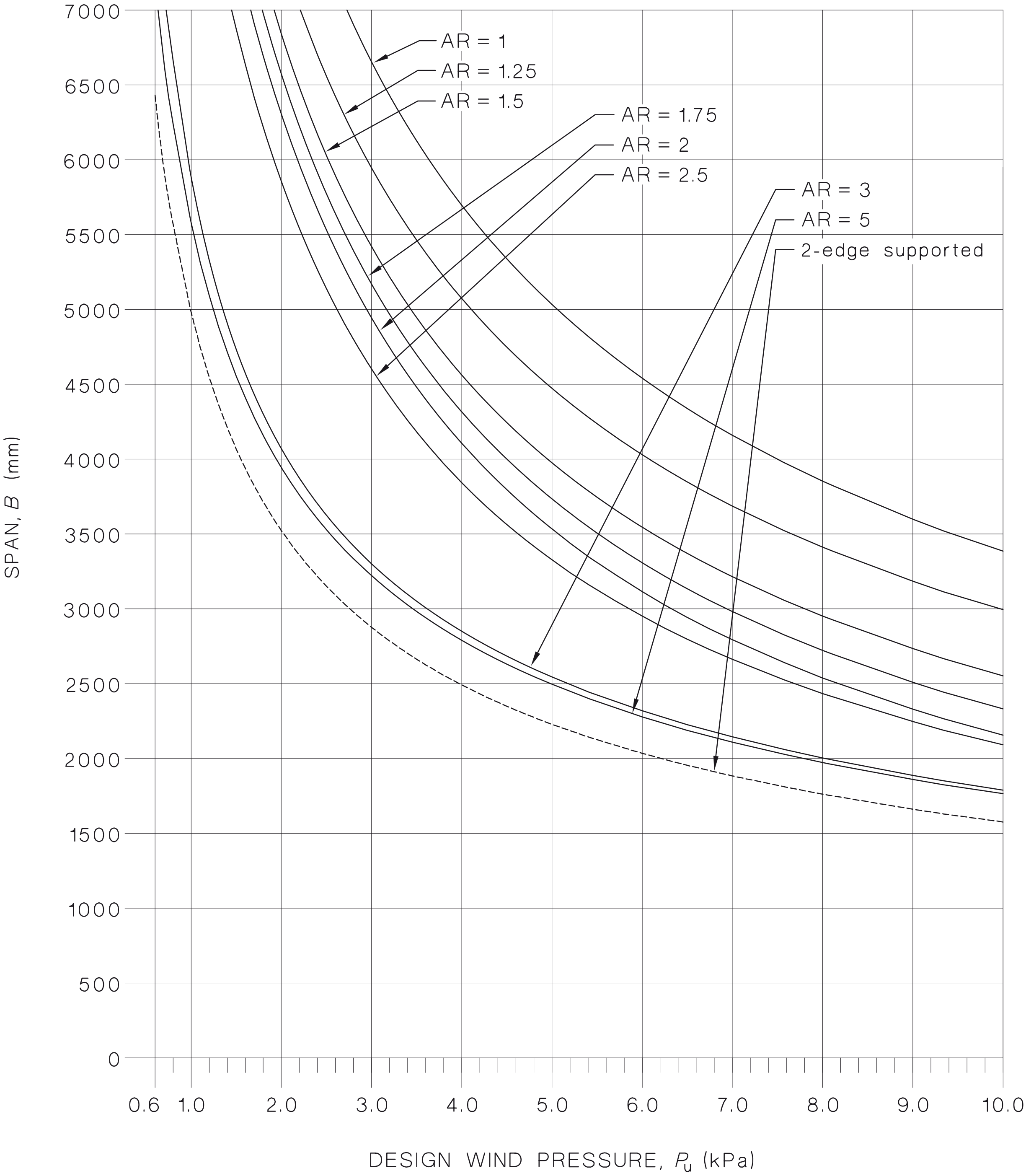


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported toughened glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	11716.9	10291.5	10056.5	10726.3	11396.0	9540.7	4653.4	4604.1	4111.4
k_2	0.459568	0.367655	0.367655	0.551482	0.735309	0.551482	–0.1	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	21.75	–7.25	–117.45	–65.25	–58	14.5	–43.5	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.17 MAXIMUM SPAN FOR MONOLITHIC 15 mm TOUGHENED GLASS

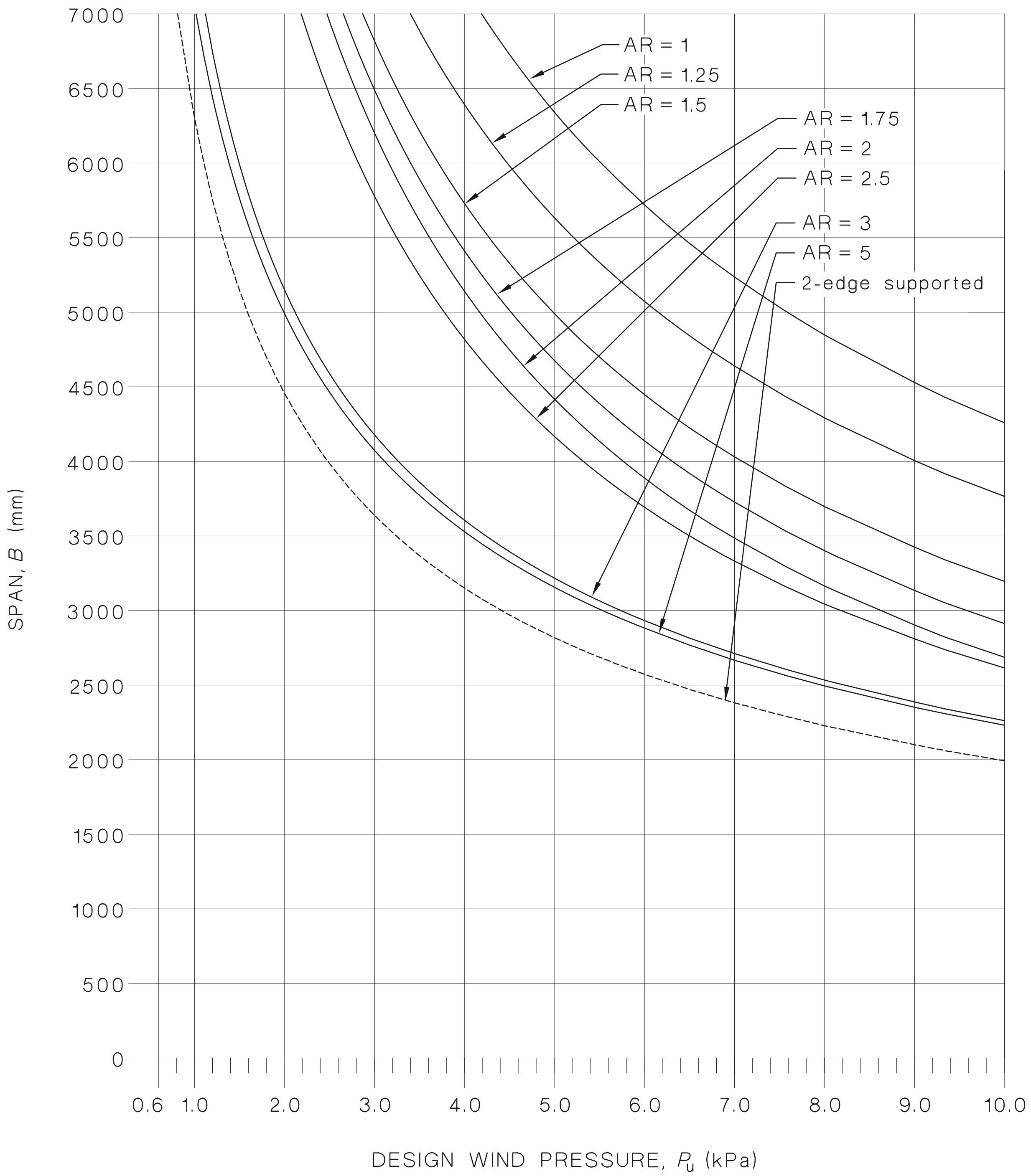


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported toughened glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	14119.6	12405.0	12101.1	12864.1	13632.2	11434.2	5641.5	5578.5	4981.6
k_2	0.437817	0.350254	0.350254	0.525381	0.700508	0.525381	–0.1	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	27	–9	–145.8	–81	–72	18	–54	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.18 MAXIMUM SPAN FOR MONOLITHIC 19 mm TOUGHENED GLASS

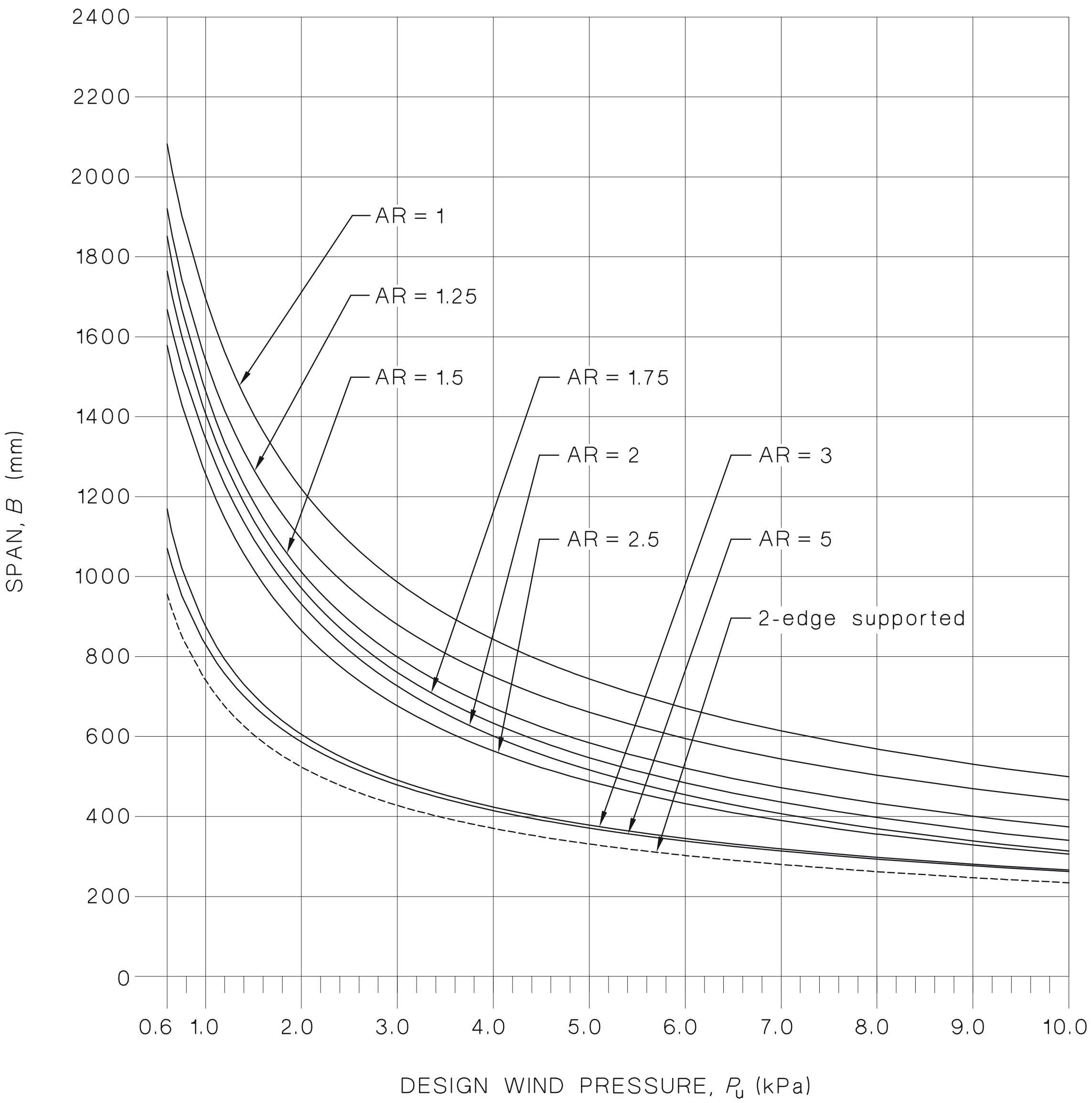


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported toughened glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	17733.9	15585.7	15170.0	16056.4	16958.2	14258.8	7141.5	7056.4	6301.3
k_2	0.410996	0.328797	0.328797	0.493195	0.657593	0.493195	−0.1	0	0
k_3	−0.6124	−0.6071	−0.6423	−0.7112	−0.7642	−0.7255	−0.4881	−0.5	−0.5
k_4	35.25	−11.75	−190.35	−105.75	−94	23.5	−70.5	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.19 MAXIMUM SPAN FOR MONOLITHIC 25 mm TOUGHENED GLASS

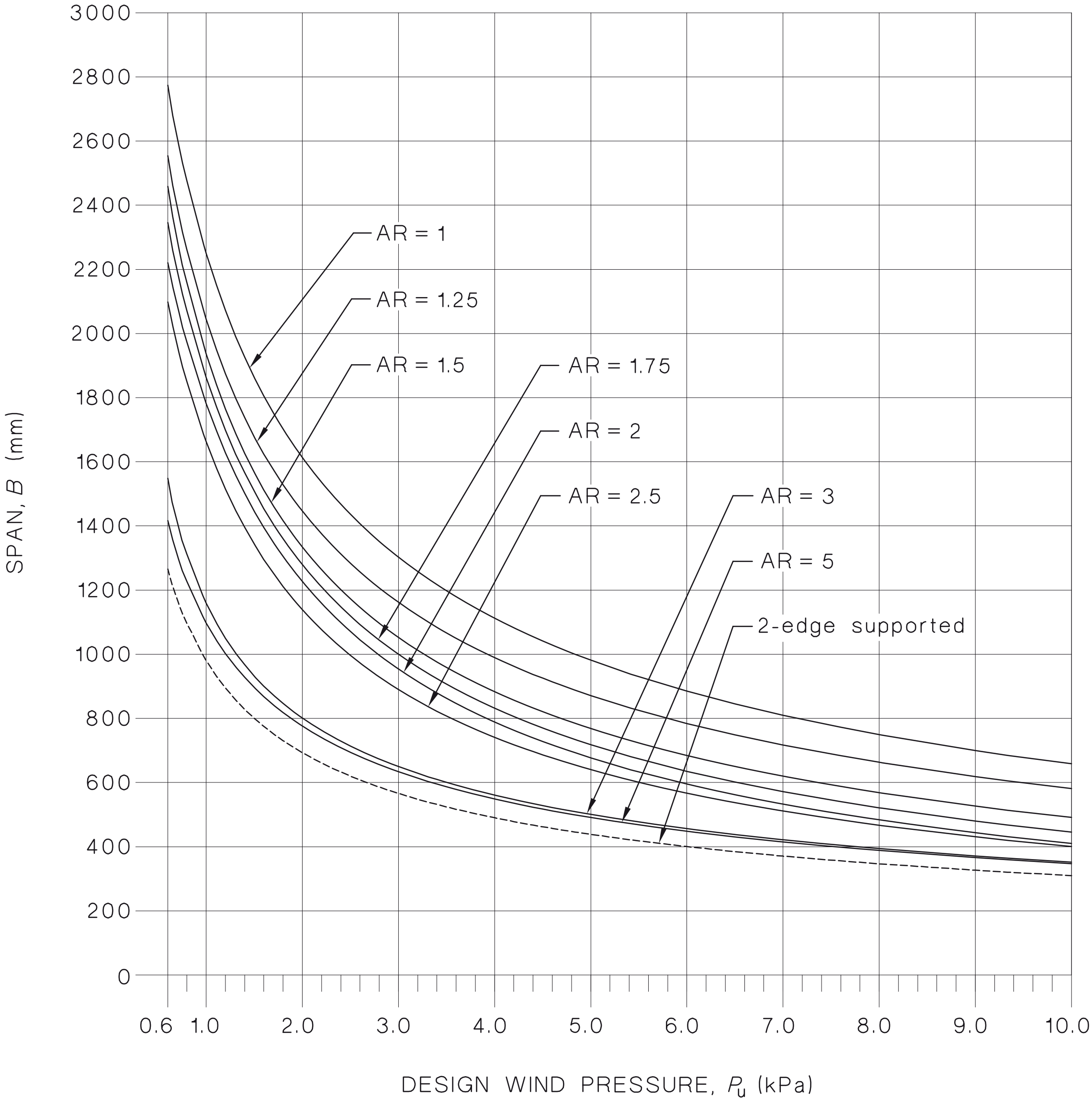


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported heat-strengthened glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	2078.2	1826.7	1776.3	1876.6	1979.1	1665.8	839.7	829.4	740.7
k_2	0.4	0.32	0.32	0.48	0.64	0.48	–0.1	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	4.2	–1.4	–22.68	–12.6	–11.2	2.8	–8.4	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.20 MAXIMUM SPAN FOR MONOLITHIC 3 mm HEAT-STRENGTHENED GLASS

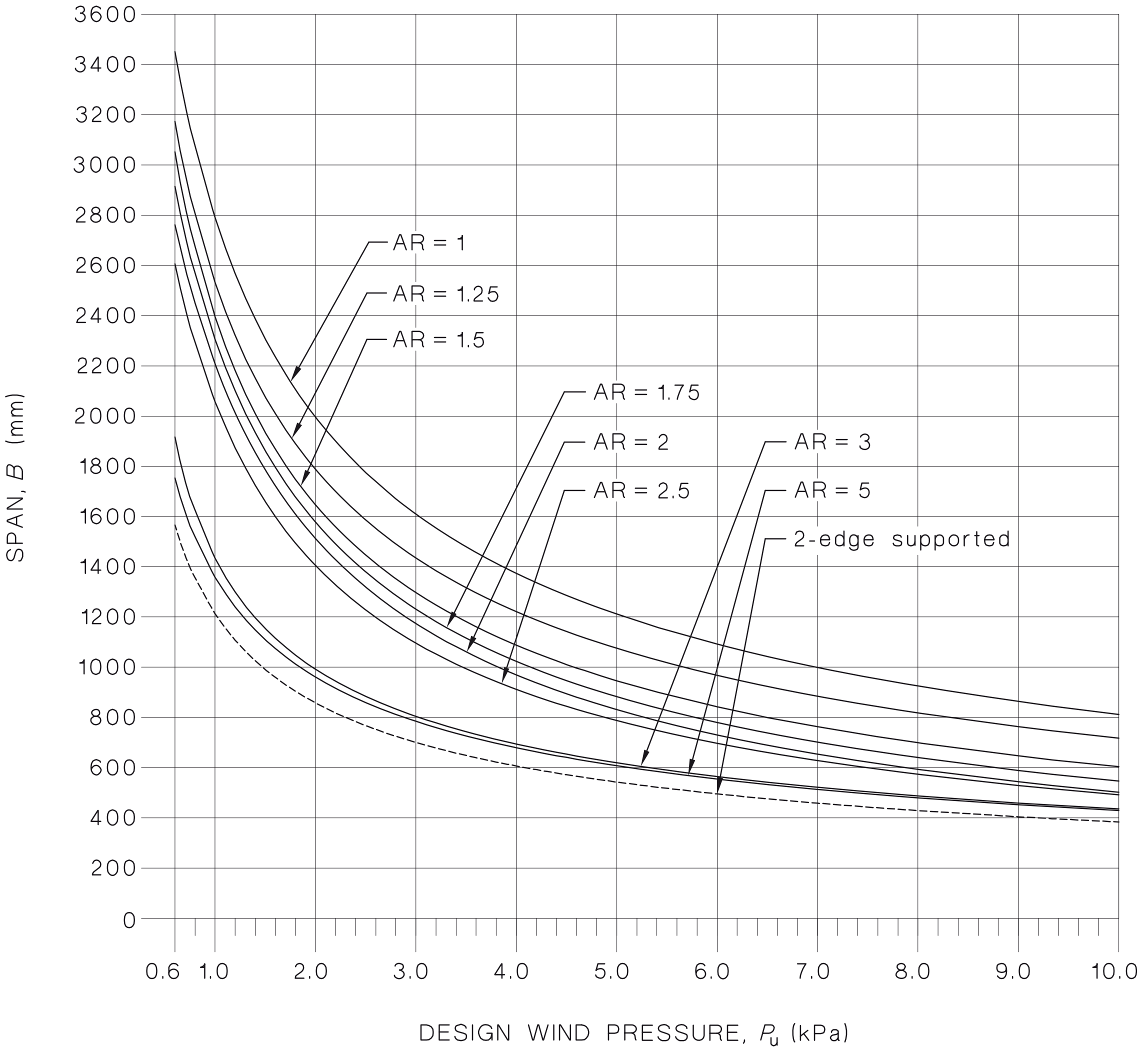


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	**Four-edge supported heat-strengthened glass parameters for each aspect ratio**								**Two-edge supported**
	AR=1	**AR=1.25**	**AR=1.5**	**AR=1.75**	**AR=2**	**AR=2.5**	**AR=3**	**AR=5**	
k_1	2734.6	2404.4	2333.9	2457.1	2584.4	2179.6	1111.9	1097.7	980.2
k_2	0.380339	0.304271	0.304271	0.456407	0.608543	0.456407	−0.1	0	0
k_3	−0.6124	−0.6071	−0.6423	−0.7112	−0.7642	−0.7255	−0.4881	−0.5	−0.5
k_4	5.7	−1.9	−30.78	−17.1	−15.2	3.8	−11.4	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.21 MAXIMUM SPAN FOR MONOLITHIC 4 mm HEAT-STRENGTHENED GLASS

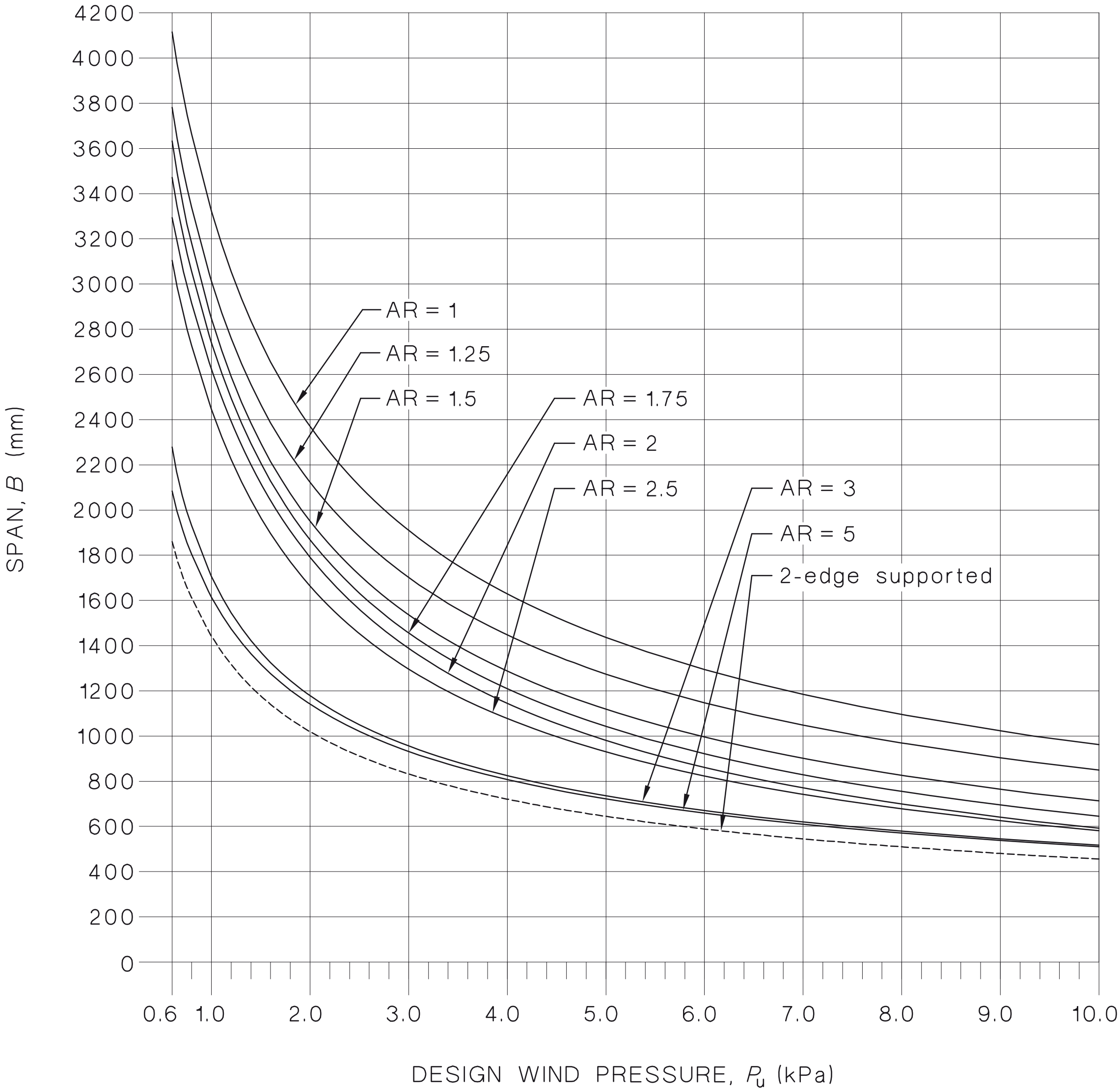


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported heat-strengthened glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	3370.0	2963.6	2872.6	3015.9	3165.4	2673.7	1377.1	1358.8	1213.4
k_2	0.365299	0.292239	0.292239	0.438359	0.584478	0.438359	–0.1	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	7.2	–2.4	–38.88	–21.6	–19.2	4.8	–14.4	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.22 MAXIMUM SPAN FOR MONOLITHIC 5 mm HEAT-STRENGTHENED GLASS

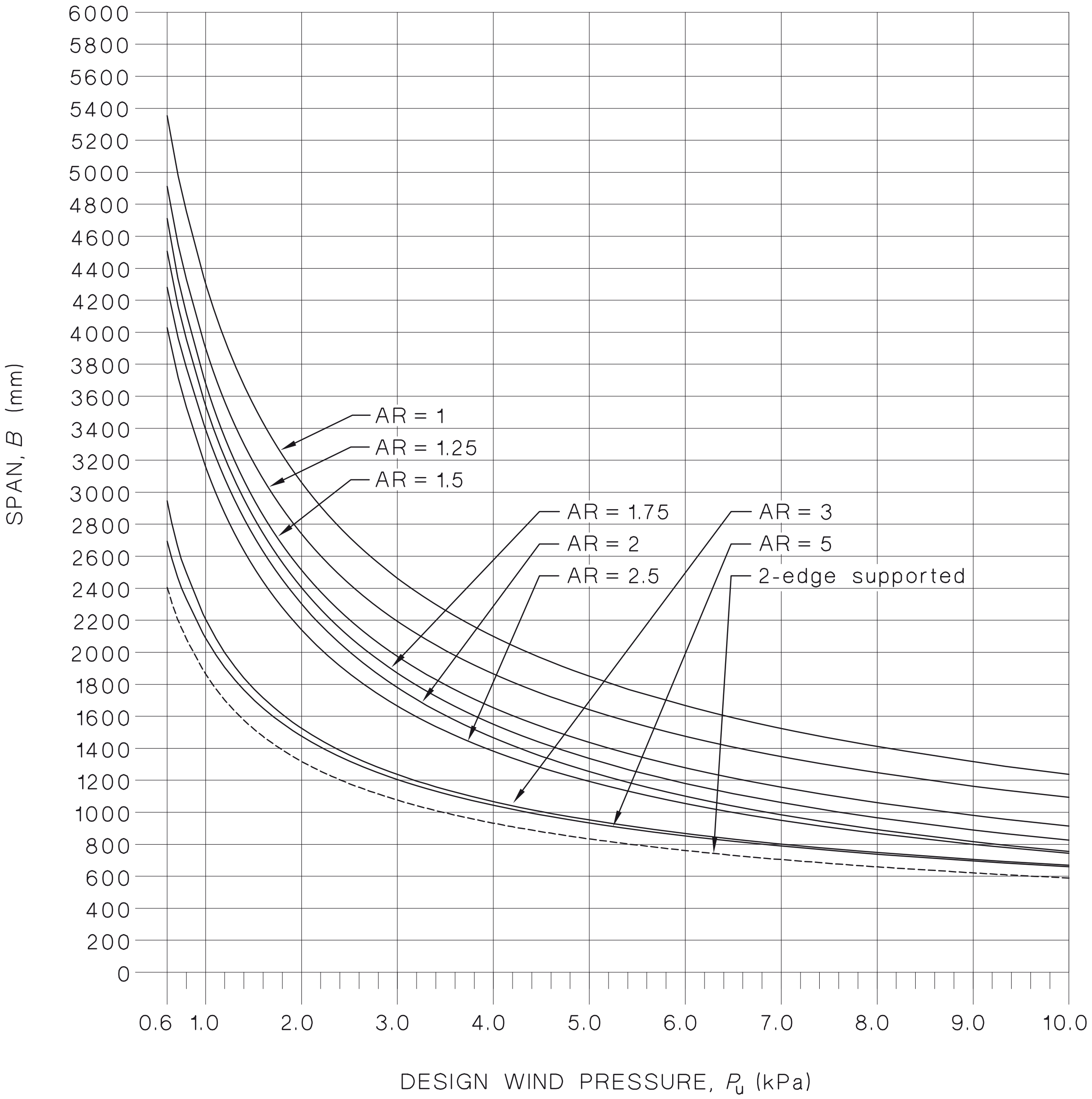


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported heat strengthened glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	3988.4	3508.0	3396.3	3557.3	3727.0	3152.2	1636.7	1614.3	1441.6
k_2	0.353115	0.282492	0.282492	0.423738	0.564985	0.423738	–0.1	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	8.7	–2.9	–46.98	–26.1	–23.2	5.8	–17.4	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.23 MAXIMUM SPAN FOR MONOLITHIC 6 mm HEAT-STRENGTHENED GLASS

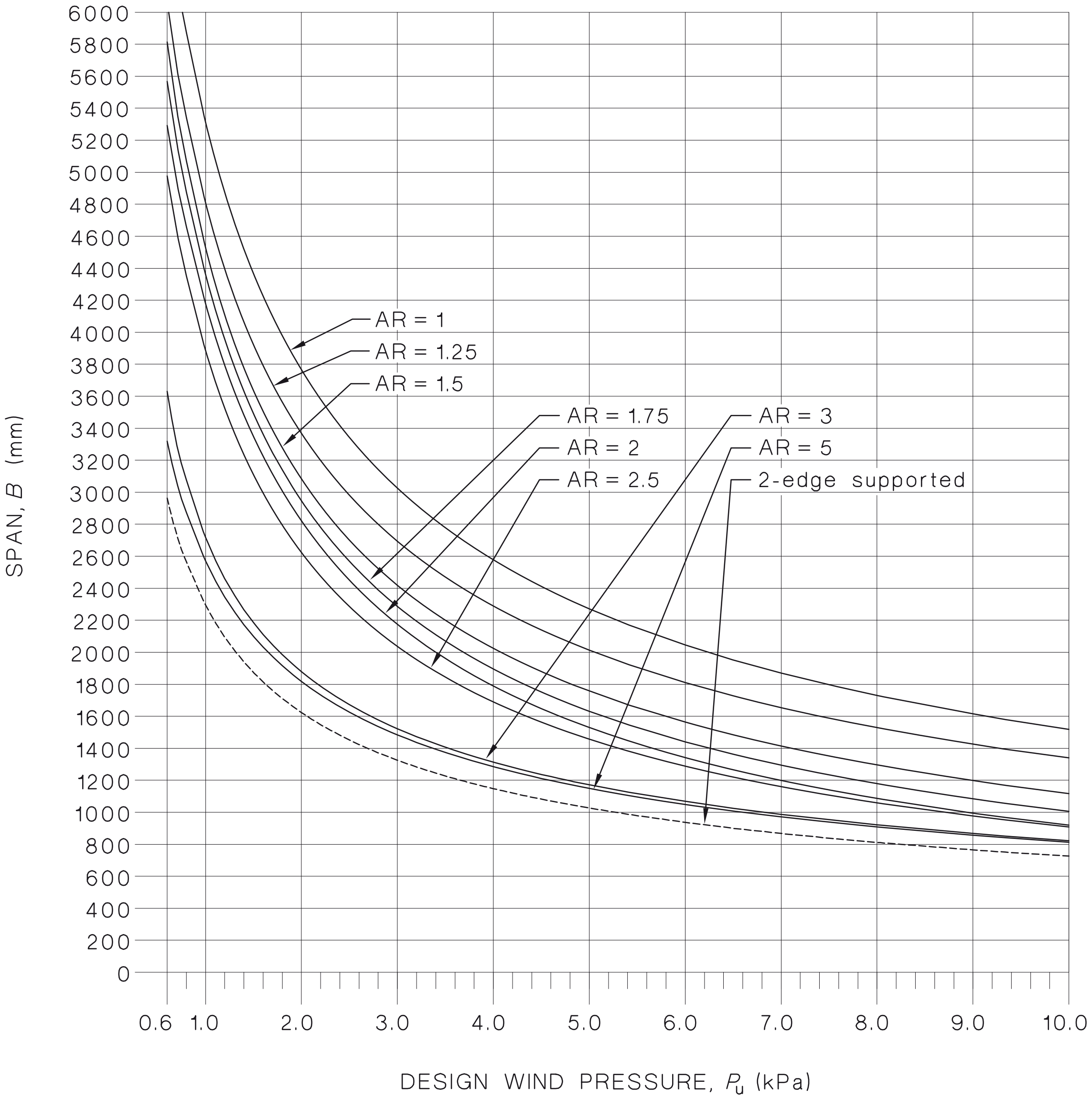


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported heat strengthened glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	5125.6	4509.6	4357.8	4547.8	4751.4	4026.9	2117.3	2087.0	1863.7
k_2	0.334872	0.267898	0.267898	0.401847	0.535796	0.401847	–0.1	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	11.55	–3.85	–62.37	–34.65	–30.8	7.7	–23.1	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.24 MAXIMUM SPAN FOR MONOLITHIC 8 mm HEAT-STRENGTHENED GLASS

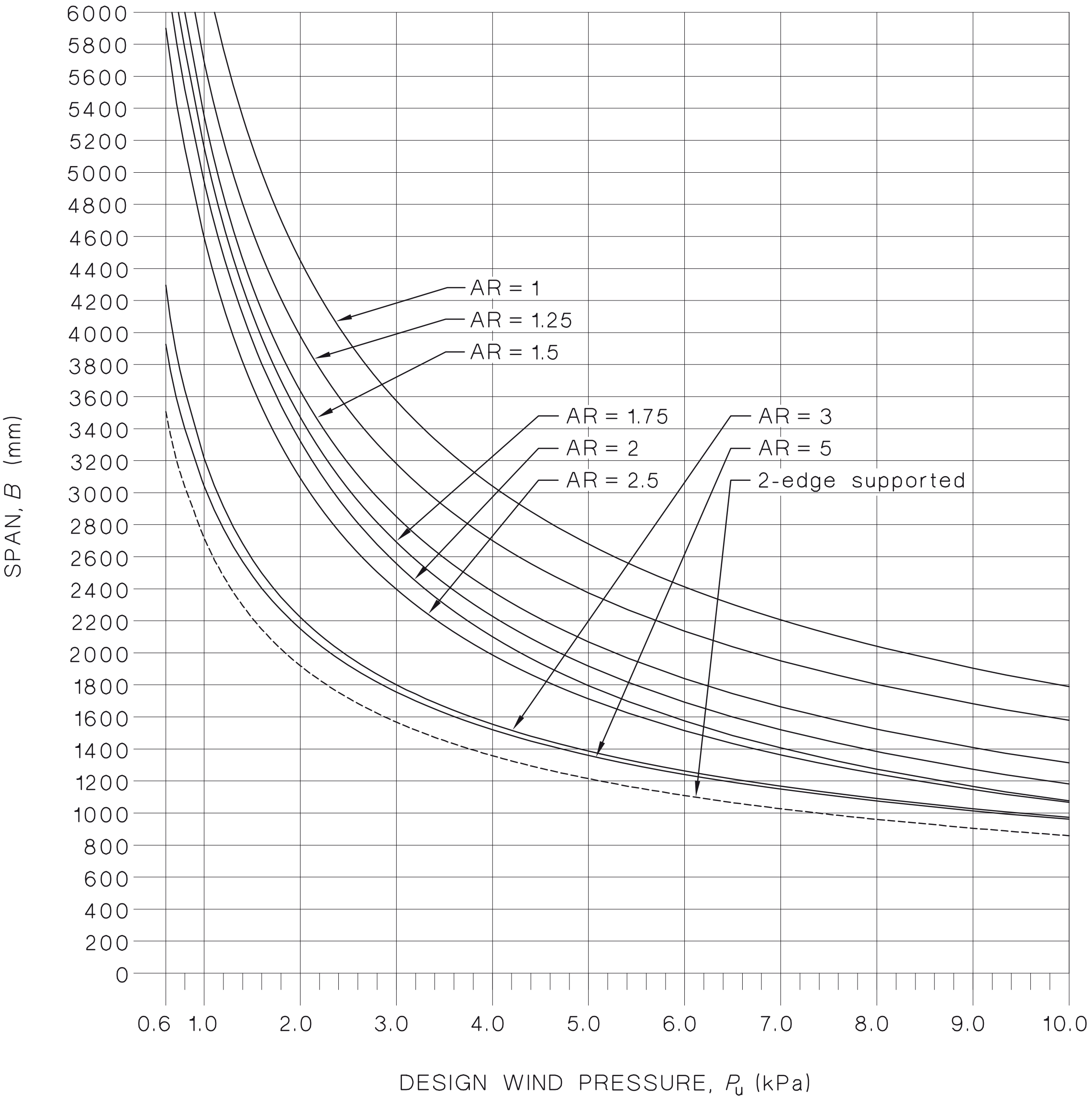


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported heat-strengthened glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	6279.9	5526.5	5331.9	5547.0	5781.4	4908.4	2608.8	2570.1	2295.1
k_2	0.320006	0.256005	0.256005	0.384008	0.51201	0.384008	–0.1	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	14.55	–4.85	–78.57	–43.65	–38.8	9.7	–29.1	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.25 MAXIMUM SPAN FOR MONOLITHIC 10 mm HEAT-STRENGTHENED GLASS

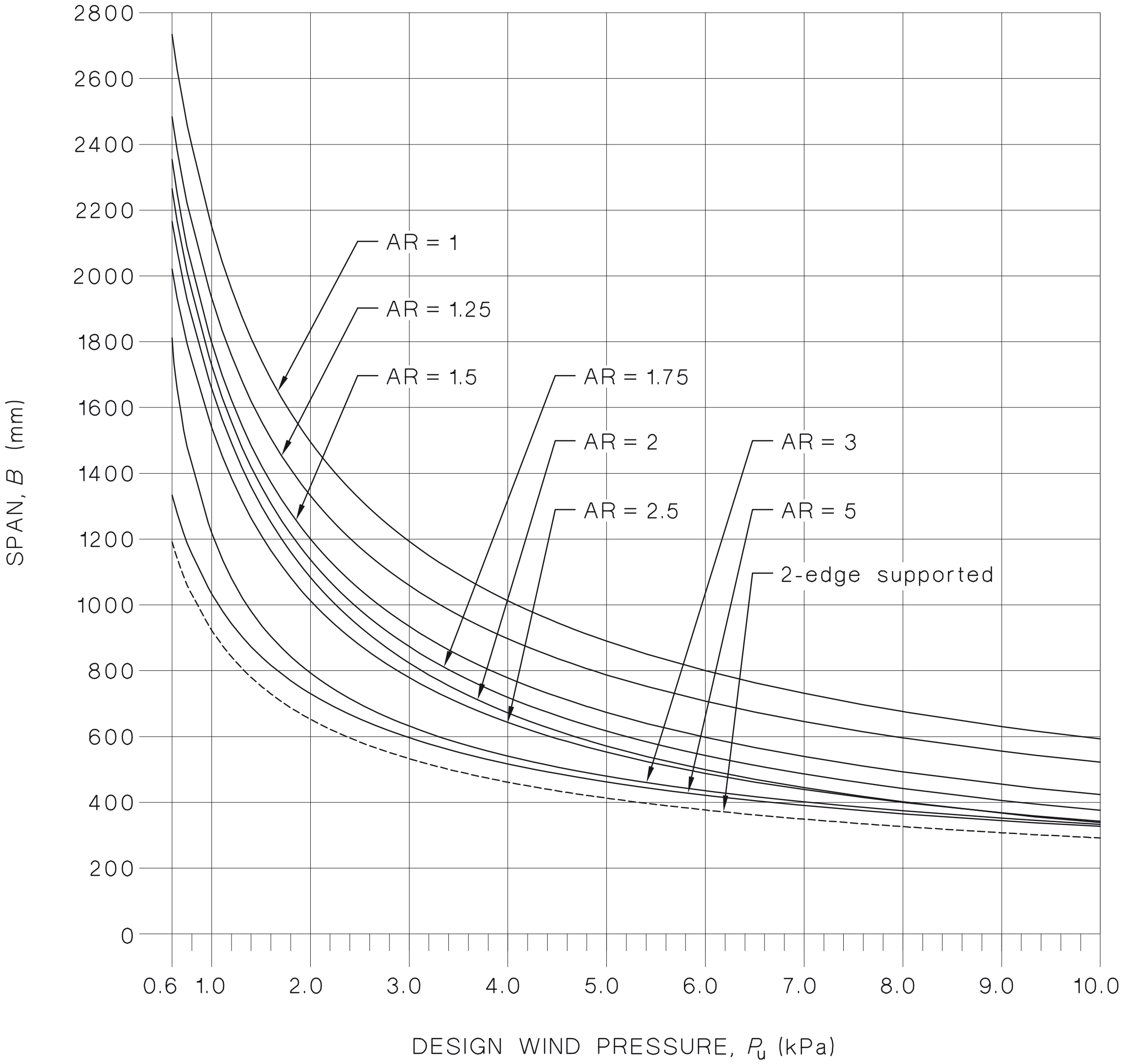


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported heat-strengthened glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	7398.5	6512.2	6274.4	6510.3	6771.5	5757.6	3088.2	3041.0	2715.6
k_2	0.307937	0.24635	0.24635	0.369525	0.4927	0.369525	–0.1	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	17.55	–5.85	–94.77	–52.65	–46.8	11.7	–35.1	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.26 MAXIMUM SPAN FOR MONOLITHIC 12 mm HEAT-STRENGTHENED GLASS

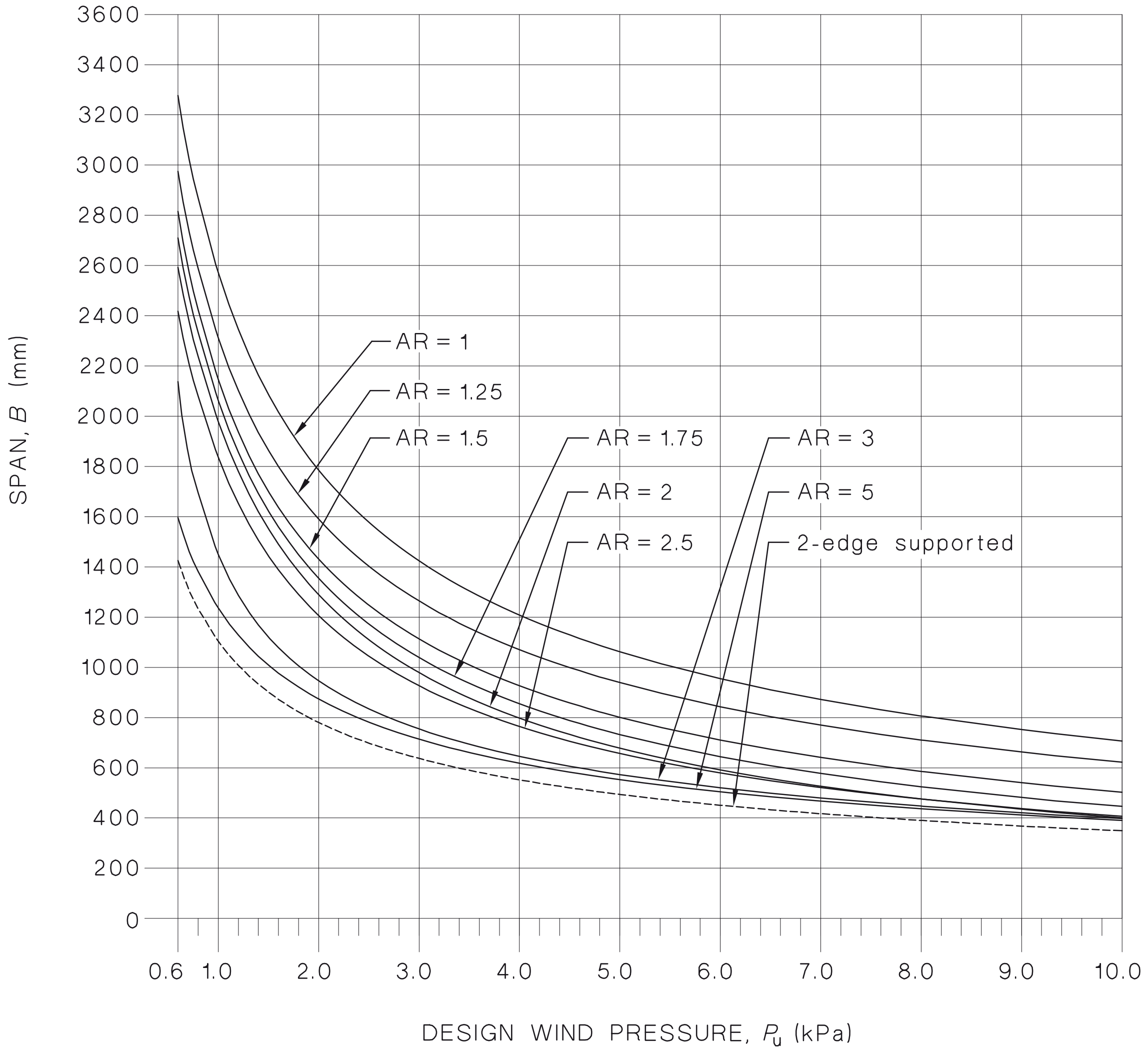


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported annealed laminated glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	2432.9	2144.8	2045.4	2080.0	2130.3	1831.9	1053.0	1033.3	922.8
k_2	0.230024	0.184019	0.184019	0.276029	0.368039	0.276029	–0.27603	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	6.9	–2.3	–37.26	–20.7	–18.4	4.6	–13.8	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.27 MAXIMUM SPAN FOR 5 mm ANNEALED LAMINATED GLASS

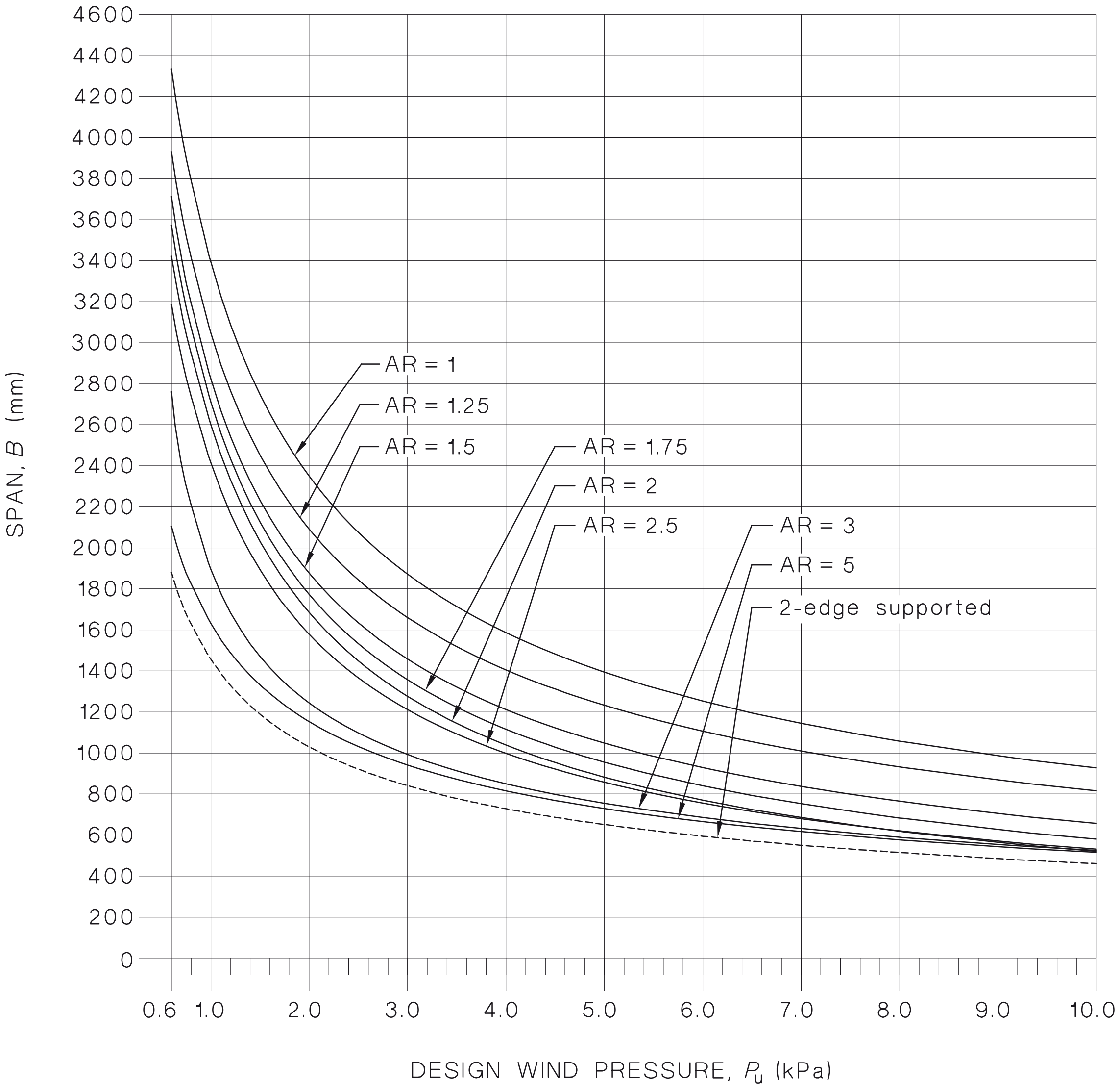


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported annealed laminated glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	2899.0	2556.1	2434.7	2469.9	2524.9	2174.2	1260.2	1236.1	1103.9
k_2	0.222109	0.177687	0.177687	0.266531	0.355375	0.266531	–0.26653	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	8.4	–2.8	–45.36	–25.2	–22.4	5.6	–16.8	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.28 MAXIMUM SPAN FOR 6 mm ANNEALED LAMINATED GLASS

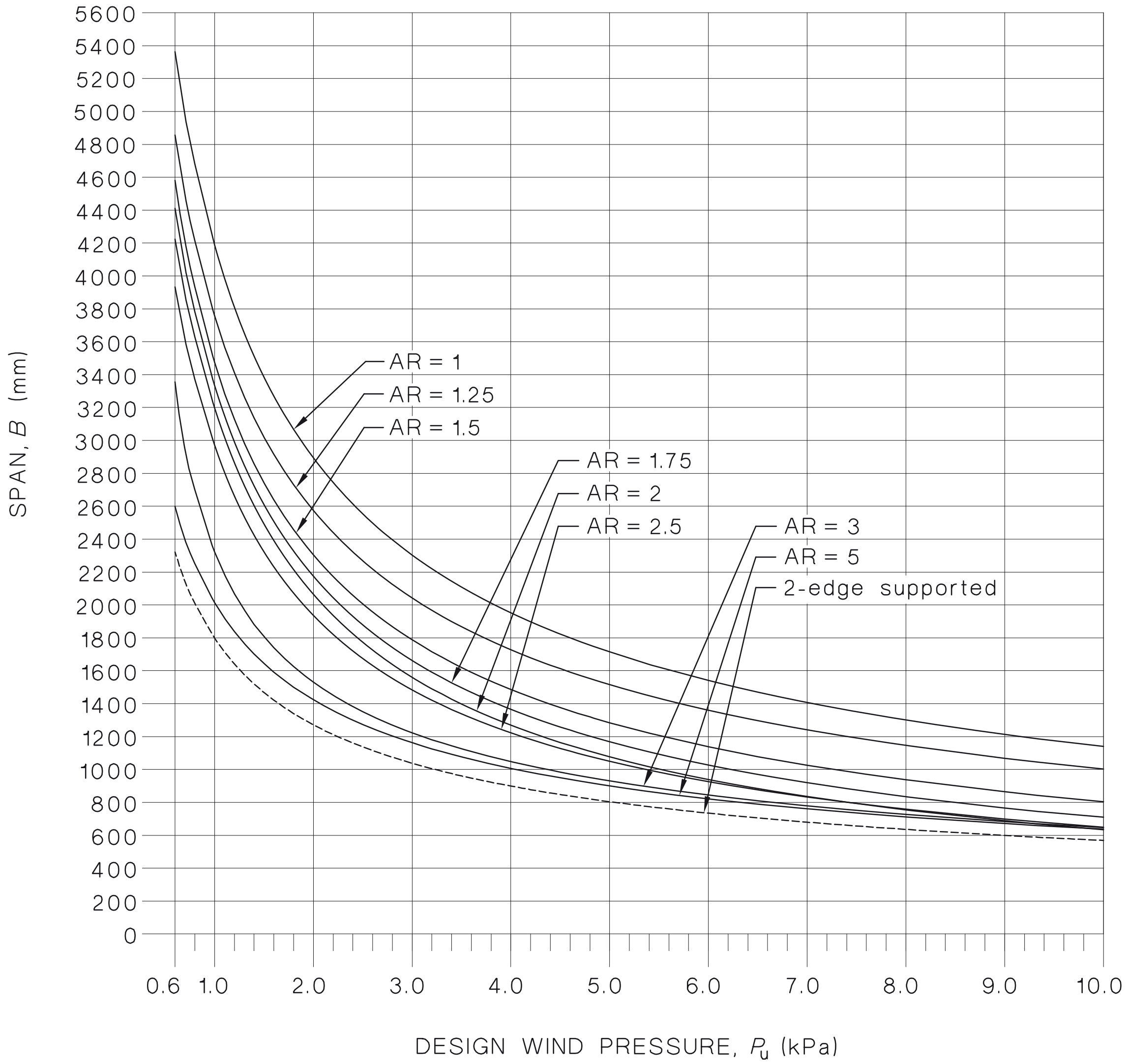


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported annealed laminated glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	3799.6	3351.2	3185.6	3219.1	3280.9	2831.3	1663.5	1630.6	1456.1
k_2	0.209821	0.167857	0.167857	0.251785	0.335714	0.251785	–0.25179	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	11.4	–3.8	–61.56	–34.2	–30.4	7.6	–22.8	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.29 MAXIMUM SPAN FOR 8 mm ANNEALED LAMINATED GLASS

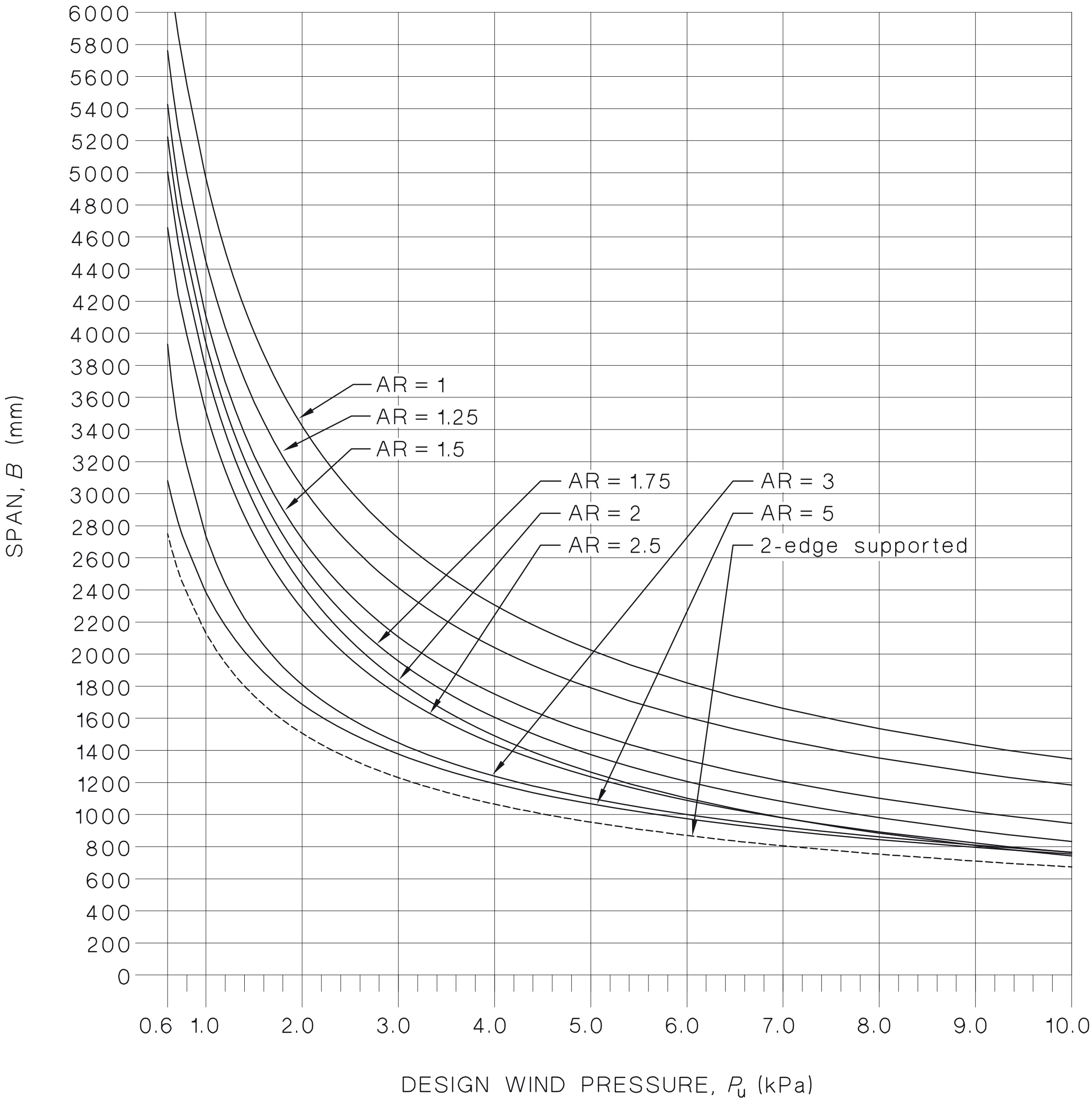


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported annealed laminated glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	4666.6	4117.0	3907.1	3935.8	4001.6	3459.4	2054.7	2013.0	1797.6
k_2	0.200421	0.160337	0.160337	0.240505	0.320673	0.240505	–0.24051	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	14.4	–4.8	–77.76	–43.2	–38.4	9.6	–28.8	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.30 MAXIMUM SPAN FOR 10 mm ANNEALED LAMINATED GLASS

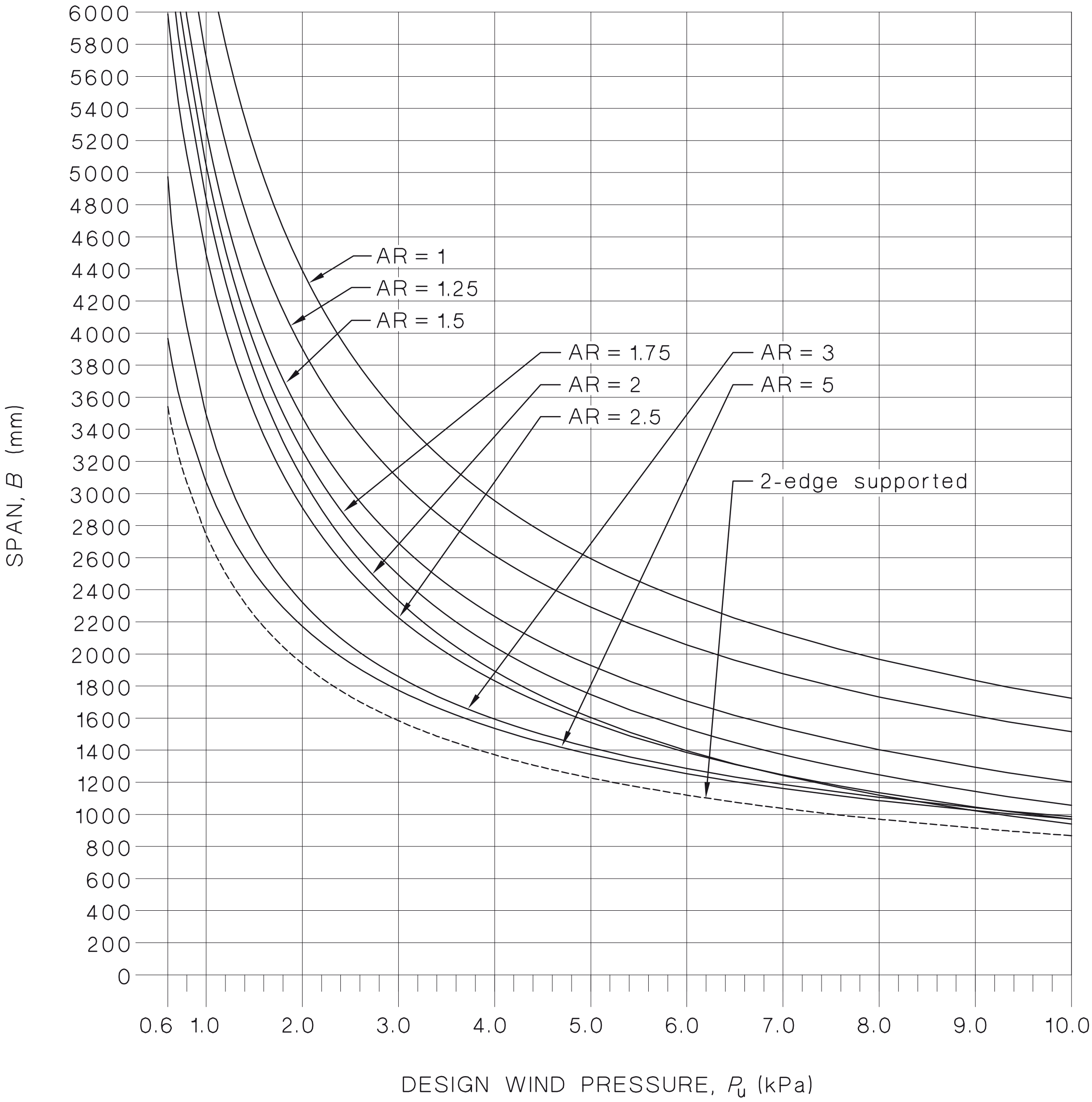


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported annealed laminated glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	5506.6	4859.1	4605.1	4626.5	4694.2	4064.3	2436.3	2385.7	2130.4
k_2	0.192806	0.154245	0.154245	0.231367	0.30849	0.231367	–0.23137	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	17.4	–5.8	–93.96	–52.2	–46.4	11.6	–34.8	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.31 MAXIMUM SPAN FOR 12 mm ANNEALED LAMINATED GLASS

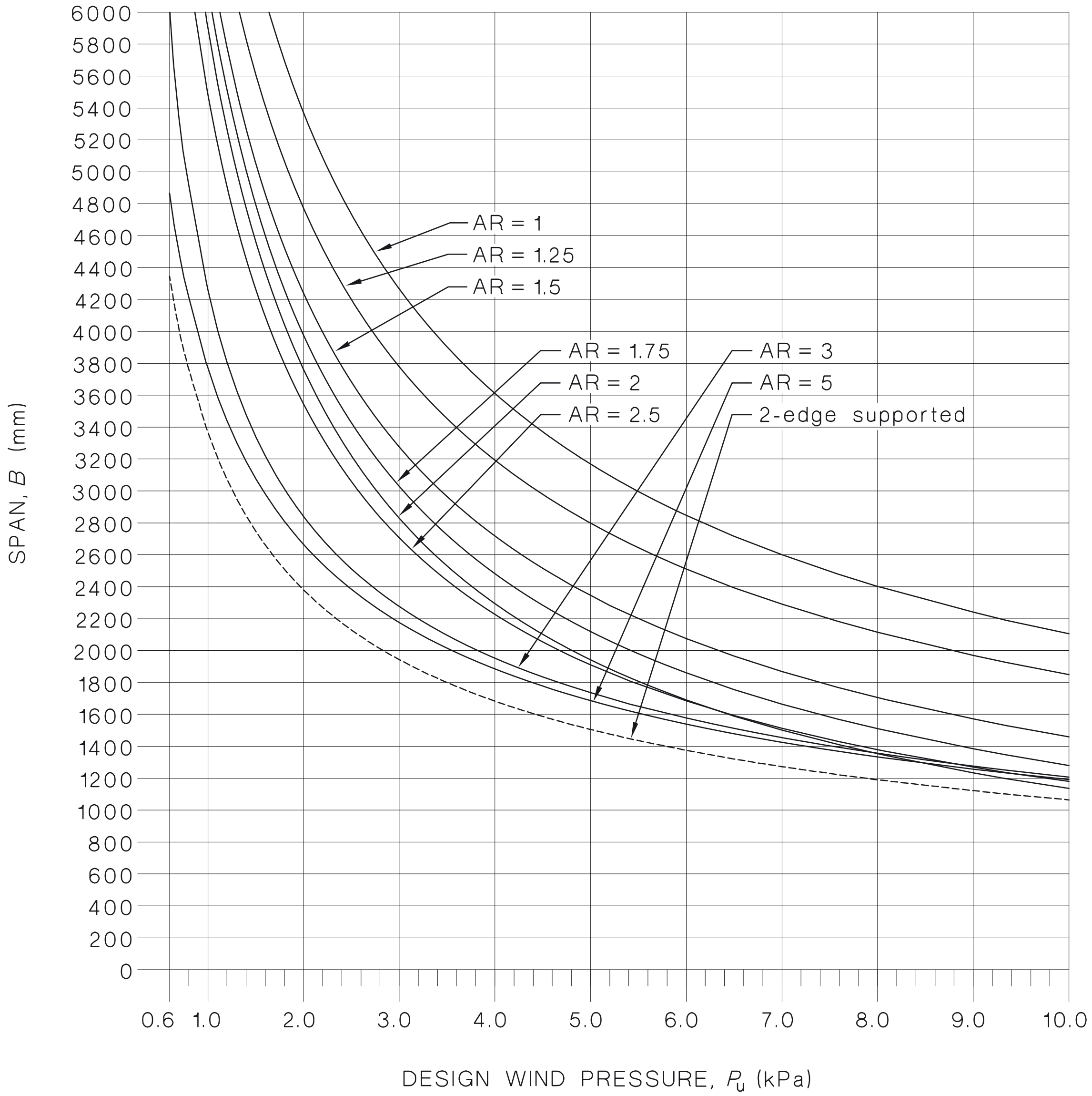


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported annealed laminated glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	7042.7	6216.4	5879.0	5881.5	5948.3	5162.3	3139.6	3072.2	2743.4
k_2	0.181404	0.145123	0.145123	0.217685	0.290247	0.217685	−0.21769	0	0
k_3	−0.6124	−0.6071	−0.6423	−0.7112	−0.7642	−0.7255	−0.4881	−0.5	−0.5
k_4	23.1	−7.7	−124.74	−69.3	−61.6	15.4	−46.2	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.32 MAXIMUM SPAN FOR 16 mm ANNEALED LAMINATED GLASS

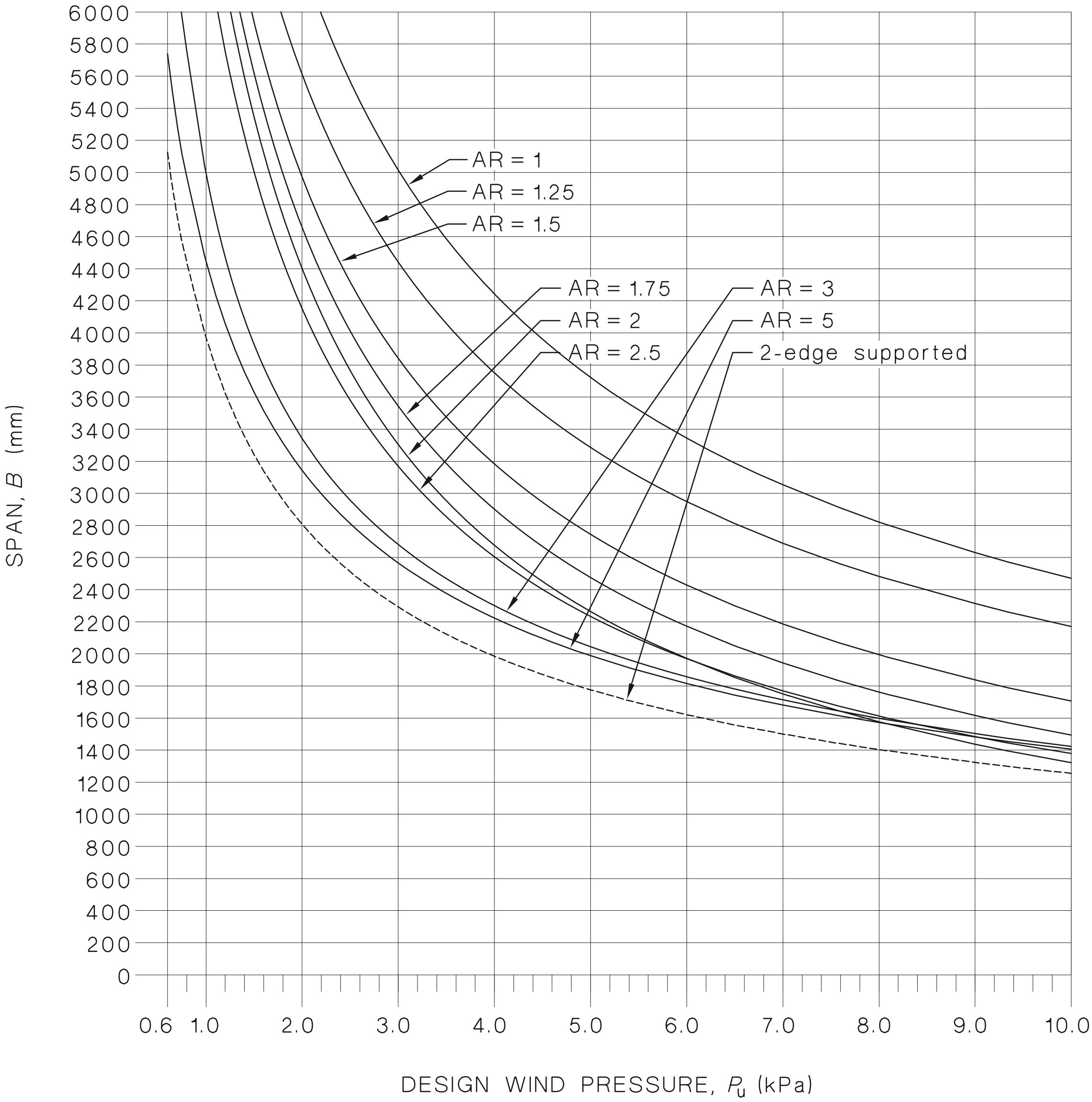


The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported annealed laminated glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	8590.8	7585.1	7160.0	7137.2	7198.3	6259.8	3854.9	3769.7	3366.3
k_2	0.172113	0.13769	0.13769	0.206536	0.275381	0.206536	−0.20654	0	0
k_3	−0.6124	−0.6071	−0.6423	−0.7112	−0.7642	−0.7255	−0.4881	−0.5	−0.5
k_4	29.1	−9.7	−157.14	−87.3	−77.6	19.4	−58.2	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.33 MAXIMUM SPAN FOR 20 mm ANNEALED LAMINATED GLASS



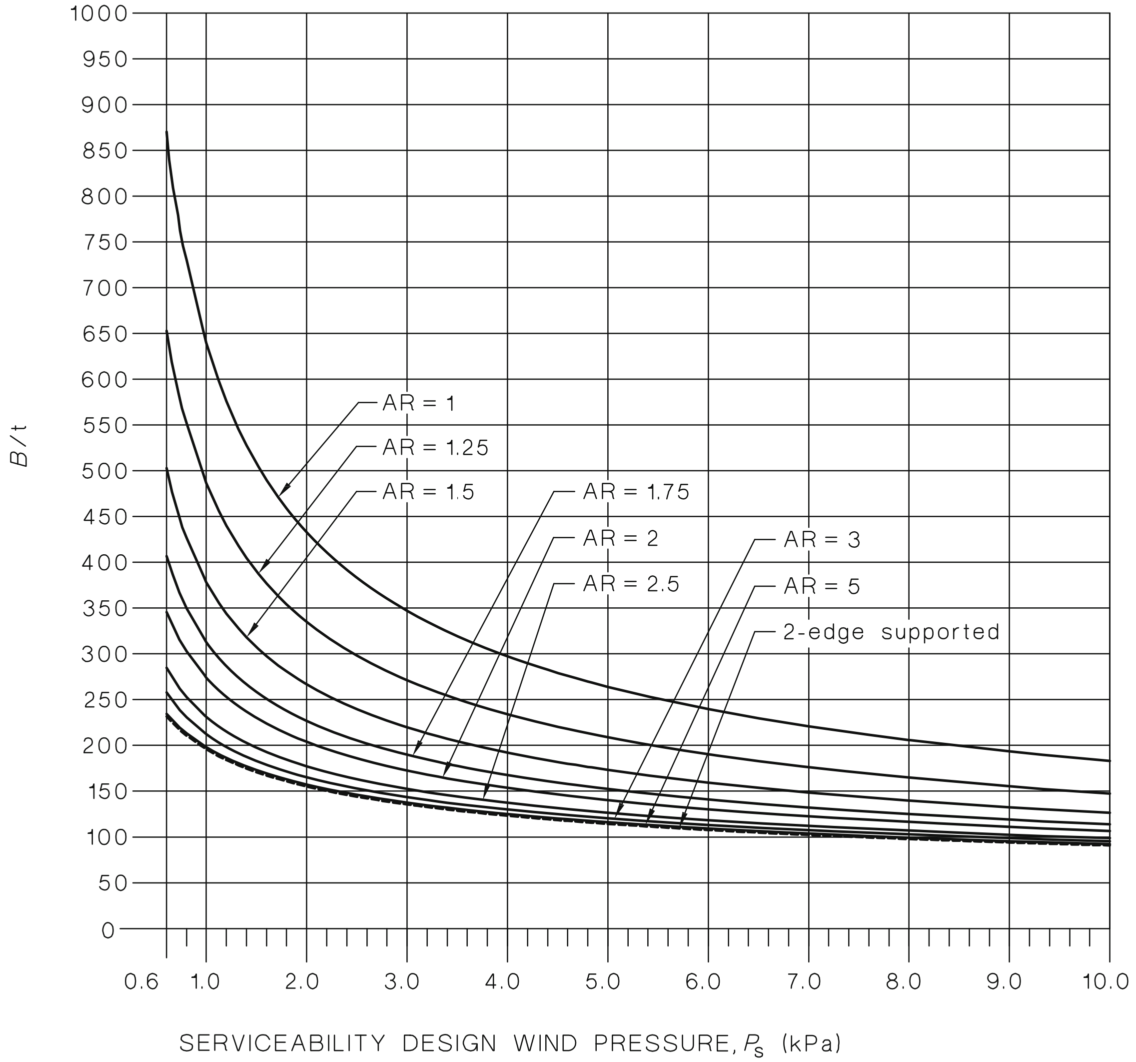
The allowable span B is given by: $B = k_1 \times (P_u + k_2)^{k_3} + k_4$

Constant	Four-edge supported annealed laminated glass parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	10081.6	8903.5	8391.3	8338.8	8390.1	7308.9	4549.1	4446.2	3970.4
k_2	0.16457	0.131656	0.131656	0.197484	0.263312	0.197484	–0.19748	0	0
k_3	–0.6124	–0.6071	–0.6423	–0.7112	–0.7642	–0.7255	–0.4881	–0.5	–0.5
k_4	35.1	–11.7	–189.54	–105.3	–93.6	23.4	–70.2	0	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.34 MAXIMUM SPAN FOR 24 mm ANNEALED LAMINATED GLASS

A1



The allowable span B is given by: $B/t = k_1 \times (P_s + k_2)^{k_3} + k_4$

Constant	Four-edge supported parameters for each aspect ratio								Two-edge supported
	AR=1	AR=1.25	AR=1.5	AR=1.75	AR=2	AR=2.5	AR=3	AR=5	
k_1	603.79	459.45	350.14	291.45	261.60	222.19	204.68	197.89	195.45
k_2	−0.1	−0.1	−0.15	−0.15	−0.1	−0.1	−0.1	0	0
k_3	−0.5247	−0.5022	−0.4503	−0.4149	−0.397	−0.3556	−0.3335	−0.332	−0.3333
k_4	1.64	2.06	1.29	0.95	1.1	0.29	−0.05	0.03	0

NOTE: Curves for AR = 1 to AR = 5 are to be used for four-edge supported glazing only.

FIGURE 4.35 CURVES FOR *B/t* ALLOWABLE FOR DEFLECTION OF GLASS LIMITED TO SPAN/60

SECTION 5 CRITERIA FOR HUMAN IMPACT SAFETY

5.1 SCOPE

A2 Where any glazing is subject to the risk of human impact, it shall comply with this Section.

Where reference is made to floor or ground level this shall mean the highest abutting finished floor or ground level.

NOTES:

1 In some circumstances the requirements of other Sections of this Standard can exceed the requirements of this Section (see Clause 1.2).

2 Accident statistics show that glazing in some locations in buildings is more vulnerable to human impact than in others. These critical locations, some of which are shown in Figure 5.1, include the following:

(a) In and around doors (particularly in side panels which may be mistaken for doors).

(b) Panels mistaken for a doorway or opening.

(c) Panels at low levels in walls and partitions.

(d) Bathrooms, spa rooms and ensuites.

(e) Buildings associated with special activities, e.g., gymnasia, enclosed swimming pools, etc,

(f) Schools and child care facilities.

A2 (g) Nursing homes and aged care facilities.

(h) All glazing, wholly or partly within 2000 mm of the floor or ground level may be subject to the risk of human impact.

3 Locations not listed in Note 2 above, where injury can occur, are addressed in specific clauses in this Section of the Standard.

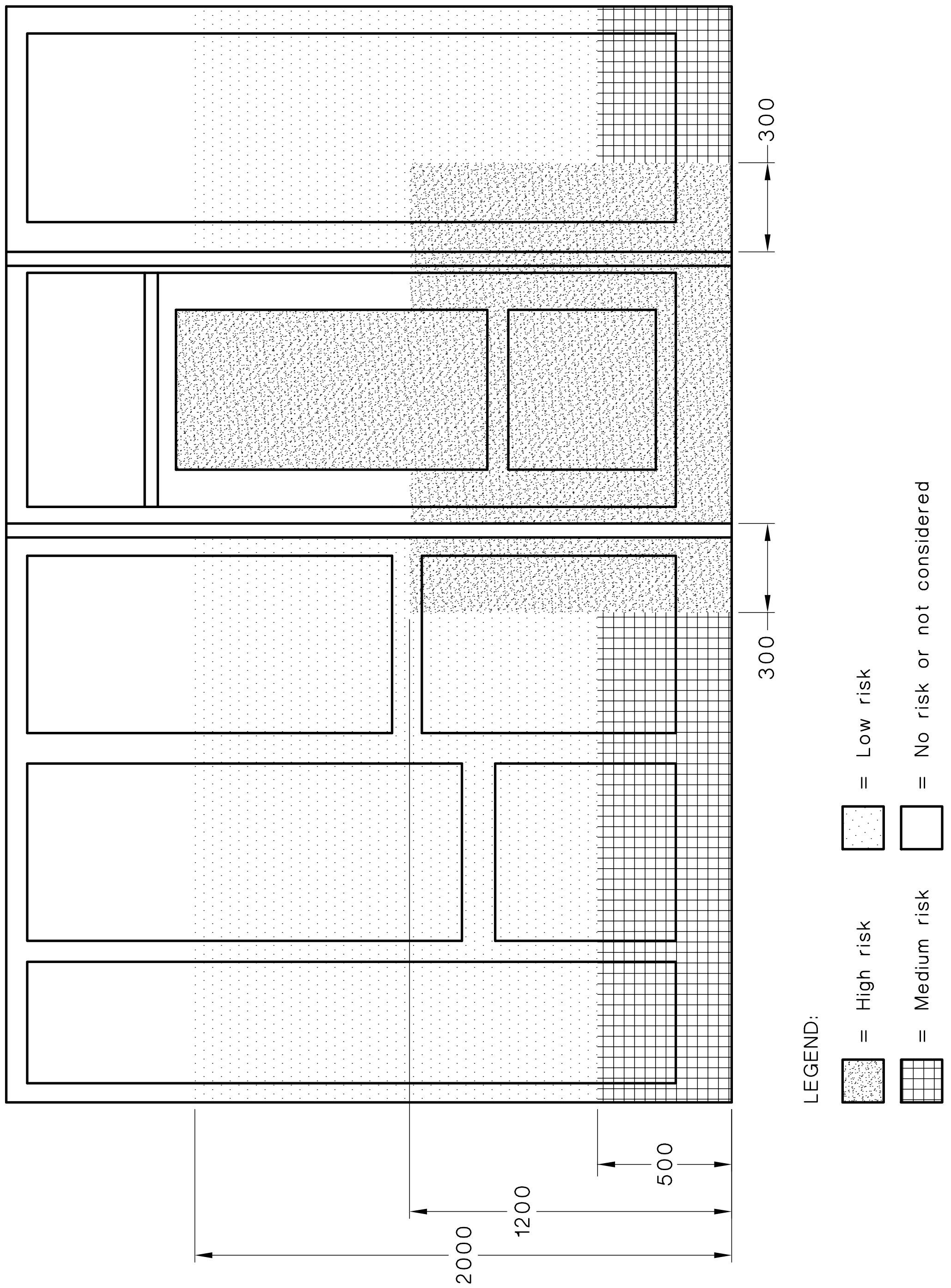
4 Precautions should be taken to reduce the risk of injuries that can result from glass breakage by—

(a) selecting glass of a suitable type, thickness and size in accordance with the requirements of this Section;

(b) enhancing a person's awareness of the presence of glass by making glass visible (manifestation, see Clause 5.19); or

(c) minimizing manual handling of large pieces of glass during installation.

5 Glass is a brittle material. The application of this Section requiring the use of either safety glass or thicker annealed glass will reduce the risk of injury from human impact. However, this does not assume that the glass will not be broken under all human impact conditions, but rather it will not be broken under the most likely forms of human impact. When broken, the likelihood of cutting or piercing injuries will be minimized by virtue of the protection given to the glass, or by the limited size or increased thickness, or by the fracture characteristics of the glass.



DIMENSIONS IN MILLIMETRES

FIGURE 5.1 CRITICAL LOCATIONS

5.2 DOORS

Glazing in doors shall be Grade A safety glass that complies with the maximum areas of safety glazing as set out in Table 5.1.

The following are specific requirements or exceptions:

A1 (a) Wardrobe doors with mirror, as defined in Clause 1.4.56, where the mirror is not completely adhered to a solid backing, shall be Grade A safety organic-backed mirror (e.g., vinyl-backed) in accordance with Table 5.1.

(b) Doors in bathrooms, ensuites and spa rooms shall be in accordance with Clause 5.8.

(c) Unframed doors other than those incorporated into shower screens or bath enclosures shall be glazed with toughened safety glass with a minimum nominal thickness of 10 mm or laminated toughened safety glass with a minimum total thickness of 10 mm. Exposed edges shall have sharp edges removed.

(d) Roller doors, tilting doors, roller panel doors and sectional doors may use ordinary annealed glass which shall be in accordance with Column 1 of Table 5.2.

(e) Individual pieces of ordinary annealed glass incorporated in leadlights may be used, to a maximum area of 0.05 m^2 with a minimum nominal thickness of 3 mm. Larger areas of ordinary annealed glass are not permitted regardless of glass thickness.

(f) For annealed and annealed decorated glass panels in doors the following applies:

    (i) For 3 mm and 4 mm annealed glass, the maximum area shall not exceed 0.1 m^2 with a maximum panel width of 125 mm

    (ii) For 5 mm and 6 mm annealed glass, the maximum area shall not exceed 0.26 m^2 with a maximum panel width of 300 mm

(g) For annealed glass in fully framed panels with a thickness of 10 mm or greater, with or without bevelled edges, the maximum area shall not exceed 0.5 m^2.

NOTES:

1 The requirements for the glazing of doors are the same for residential and non-residential use.

2 Doors of all operational types are included, e.g., hinged, sliding, folding and stacking, etc.

5.3 SIDE PANELS

5.3.1 General

Glazing in side panels, with the nearest vertical sightlines less than 300 mm from the nearest edge of the doorway opening shall be glazed in accordance with the following:

(a) *Fully framed side panels* All fully framed glazing in side panels, wholly or partially within 1200 mm from floor or ground level, shall be of Grade A safety glass in accordance with Table 5.1, with the following exceptions:

    (i) A minimum of 5 mm ordinary annealed glass may be used up to a maximum area of 0.3 m^2.

    (ii) Individual pieces of ordinary annealed glass incorporated in leadlights may be used, to a maximum area of 0.05 m^2 with a minimum nominal thickness of 3 mm. Larger areas of ordinary annealed glass are not permitted regardless of glass thickness.

    (iii) For decorated glass the following applies:

        (A) For 3 mm and 4 mm annealed glass, the maximum area shall not exceed 0.1 m^2 with a maximum pane width of 125 mm

(B) For 5 mm and 6 mm annealed glass, the maximum area shall not exceed 0.26 m^2 with a maximum pane width of 300 mm

(iv) For annealed glass with a thickness of 10 mm or greater, with or without bevelled edges, the maximum area shall not exceed 0.5 m^2.

(b) *Unframed and partly framed side panels*:

(i) *Without exposed edges* All unframed or partly framed glazing in side panels, without exposed edges, wholly or partially within 1200 mm from the floor or ground level, shall be Grade A safety glass in accordance with Table 5.3.

NOTE: An example of unframed glass side panel without exposed edges would be flat or curved panels silicone butt-jointed and the assembled panels contained in a perimeter frame.

A1 (ii) *With exposed edges* All unframed glazing in side panels with exposed edges shall be toughened safety glass with a minimum nominal thickness of 10 mm or laminated toughened safety glass with a minimum total thickness of 10 mm in accordance with Table 5.3. Exposed edges shall have sharp edges removed.

NOTE: The values for toughened safety glass in Table 5.3 are also applicable to laminated toughened safety glass.

(iii) *Louvres in side panels* Louvres in side panels shall be glazed in accordance with Clause 5.12.

NOTES:

1 A side panel may or may not be in the same plane as the doorway

2 The requirements for glazing side panels are the same for residential and non-residential buildings.

5.4 GLAZING CAPABLE OF BEING MISTAKEN FOR A DOORWAY OR OPENING

5.4.1 General

Glazing, excluding doors and side panels glazed in accordance with Clauses 5.2 and 5.3, which may be capable of being mistaken for—

(a) a doorway;

(b) an opening that could provide access to, or egress from, one part of a building to another; or

(c) an opening between inside and outside of a building,

and can result in human impact, shall be Grade A safety glass in accordance with—

(i) Table 5.1 for framed glazing; or

(ii) Table 5.3 for unframed glazing.

5.4.2 Exceptions

A1 Glazing that conforms to any one of the following shall not be considered to be capable of being mistaken for a doorway or opening:

(a) The sight size width is less than or equal to 500 mm.

(b) The sight size height is less than or equal to 1000 mm.

A1 (c) The lowest sightline of the opening, as shown in Figure 8.1, is 500 mm or greater above the floor or ground level.

(d) The glazing is opaque, patterned, or a leadlight.

(e) Where a crash/chair rail, handrail or transom is provided and located with its upper edges not less than 700 mm or its bottom edge not more than 1000 mm above the floor level.

(f) The panels are louvres with a blade width (i.e., shortest side) not greater than 230 mm.

(g) The glazing protects a difference in level of 1000 mm or more.

A1 (h) **'Text deleted'**

5.5 LOW-LEVEL GLAZING IN RESIDENTIAL BUILDINGS

Low-level glazing, where the lowest sightline is less than 500 mm from the floor or ground level, shall be—

(a) Grade A safety glass in accordance with Table 5.1; or

(b) for fully framed glazing, ordinary annealed glass not less than 5 mm minimum nominal thickness up to a maximum area of 1.2 m^2. Larger areas of ordinary annealed glass are not permitted regardless of glass thickness.

5.6 EXTERNAL SHOPFRONTS

This Clause shall apply to all glazing in external shopfronts that are not—

(a) doors (see Clause 5.2);

(b) side panels (refer Clause 5.3.1);

(c) fins less than 500 mm in width; or

(d) capable of being mistaken for a doorway or opening (see Clause 5.4).

Glazing in external shopfronts shall be Grade A safety glass in accordance with Table 5.1 with the following exceptions:

(i) Fully framed glazing, including fin-jointed glazing, in accordance with Column 3 of Table 5.2 with a minimum thickness of 10 mm.

(ii) Partly framed glazing, with the top and bottom edges framed and one or more side edges unframed, shall be glazed in accordance with Table 5.3.

5.7 INTERNAL SHOPFRONTS AND INTERNAL PARTITIONS

5.7.1 General

This Clause shall apply to all internal shopfronts and partitions that are not doors or side panels (see Clauses 5.2 and 5.3), in all buildings.

5.7.2 Fully framed glazing

Fully framed glazing shall be Grade A safety glass in accordance with Table 5.1. For panels that cannot be mistaken for a doorway or opening, as defined in Clause 5.4, they may be glazed with ordinary annealed glass in accordance with Column 2 of Table 5.2.

5.7.3 Partly framed glazing

5.7.3.1 *Side edges, unframed*

Partly framed glazing, with the top and bottom edges framed and one or more side edges unframed, shall be glazed in accordance with Table 5.3. For panels with a lowest sightline greater than 1500 mm above floor level and a panel height not exceeding 1000 mm, they may be glazed in annealed glass in accordance with Column 2 of Table 5.2, with a minimum nominal thickness of 6 mm.

5.7.3.2 *Top edge, unframed*

Partly framed glazing framed on three sides but not on the top edge shall be glazed with Grade A safety glazing material in accordance with Table 5.1. Partly framed glazing where the top edge is 1.5 m or greater above the highest abutting finished floor level, which cannot be mistaken for a doorway or unimpeded path of travel, as defined in Clause 5.4, may be glazed with ordinary annealed glass in accordance with Column 1 of Table 5.2.

5.7.3.3 *Other unframed glazing*

All other unframed glazing shall be toughened or laminated safety glass in accordance with Table 5.3.

5.8 BATHROOM, ENSUITE AND SPA ROOM GLAZING

5.8.1 General

Glazing, including mirrors, within 2000 mm above the floor level in bathrooms, ensuites, and rooms or enclosures containing spa pools shall be Grade A safety glass or Grade B safety glass in accordance with the requirements of Table 5.1.

Ordinary annealed glass, including mirror, may be used provided it is fully backed by and completely adhered to a solid material in such a way that all pieces will remain bonded to the backing in the event of glass breaking.

A1 Ordinary annealed glass, including mirrors, may be used provided a fixed vanity or bench having a height of not less than 760 mm and a depth of not less than 300 mm that extends the full width of the glass or mirror is located in front of the glass or mirror.

NOTE: For further information on shower screen installation, see Appendix D.

5.8.2 Fully framed glazing

Fully framed glazing shall be Grade A or Grade B safety glazing material in accordance with Table 5.1.

5.8.3 Partly framed glazing

Partly framed glazing, with one unframed edge or two opposite unframed edges, shall be glazed with Grade A toughened safety glass or toughened laminated safety glass in accordance with Table 5.4. Grade A toughened safety glass with a minimum thickness of 5 mm may be used for a maximum area not exceeding 2.2 m^2.

5.8.4 Frameless glazing

Frameless shower doors or panels shall be glazed with Grade A toughened or toughened laminated safety glass with a minimum thickness of 6 mm, in accordance with Tables 5.4.

5.9 BALUSTRADES

Glazing for balustrades shall be in accordance with Section 7.

A1 5.10 SCHOOLS, EARLY CHILDHOOD CENTRES, AGED CARE BUILDINGS AND NURSING HOMES

5.10.1 General

A1 Glazing used in schools, early childhood centres, aged care buildings and nursing homes shall be in accordance with Clause 5.10.2 or 5.10.3.

The requirements of this Clause are in addition to the requirements for doors (see Clause 5.2) side panels (see Clause 5.3), openings capable of being mistaken for a doorway or opening (see Clause 5.4) and areas subject to high risk of breakage (see Clause 5.24).

All mirrors shall be glazed in accordance with Clause 5.11.

5.10.2 Schools and early childhood centres

Glazing within 1000 mm of the floor level or ground level shall be Grade A safety glass in accordance with—

(a) Table 5.1 for fully framed glazing; or

(b) Table 5.3 for unframed glazing.

NOTE: Schools refers to primary and secondary education facilities.

A1 ### 5.10.3 Aged care buildings and nursing homes

5.10.3.1 *Fully framed glazing*

Framed glazing within 1500 mm of ground or floor level shall be Grade A safety glass in accordance with Table 5.1.

5.10.3.2 *Partly unframed glazing*

Partly unframed glazing within 1500 mm of ground or floor level shall be Grade A safety glass in accordance with Table 5.3.

5.11 MIRRORS AND OTHER TYPES OF GLASS SUBJECT TO RISK OF HUMAN IMPACT

Where mirrors and other types of glass are required to be Grade A safety glass, ordinary annealed glass may be substituted when the panel is fully backed by and completely adhered to a solid material.

NOTES:

1 Examples of where full backing is provided include walls, timber cupboards or wardrobe doors.

2 Examples of other types of glass include mirror tiles and painted or ceramic frit glass.

3 It should be noted that toughened safety glass mirrors are likely to distort as a result of the toughening process.

5.12 LOUVRE BLADES SUBJECT TO RISK OF HUMAN IMPACT

A1 Where Grade A safety glass is required and louvres are used, louvres shall be Grade A toughened safety glass with a nominal thickness not less than 5 mm up to 230 mm in blade width (i.e., shortest side) and 1000 mm in blade length. Blade widths or lengths in excess of these dimensions shall be subject to specific design. In all other areas, annealed glass may be used.

NOTE: For determining the appropriate glass thickness for wind loading, see Clause 4.4.3.

5.13 WINDOW SEAT GLAZING

Where glazing forms a backrest to a window seat or similar seating arrangement with the glass extending down to within 500 mm of the seat level, the glazing shall be Grade A safety glass in accordance with Table 5.1, or ordinary annealed glass of not less than 5 mm
A2 in thickness, in accordance with Column 2 of Table 5.2.

5.14 OPERABLE WINDOWS

Glazing in operable windows shall meet the requirements of this Section in all possible operable positions.

5.15 TWO-EDGE UNFRAMED GLAZING

A1 Glazing with two horizontal edges unframed (also known as sashless windows and doors), which is subject to human impact, shall be Grade A safety glass, and shall comply with the following minimum requirements:

(a) 5 mm toughened ....1000 mm max. span.

(b) 6 mm toughened ....1200 mm max. span.

(c) 6 mm laminated ....750 mm max. span.

5.16 STAIRWAY GLAZING

Glazing, including mirrors, in stairways—

(a) within 2000 mm horizontally and at right angles to the bottom riser of each stair flight (see Figure 5.2—Area 1), and

(b) within 1000 mm and parallel to any part of the stair flight or landing (see Figure 5.2—Area 2),

shall be Grade A safety glass in accordance with Table 5.1.

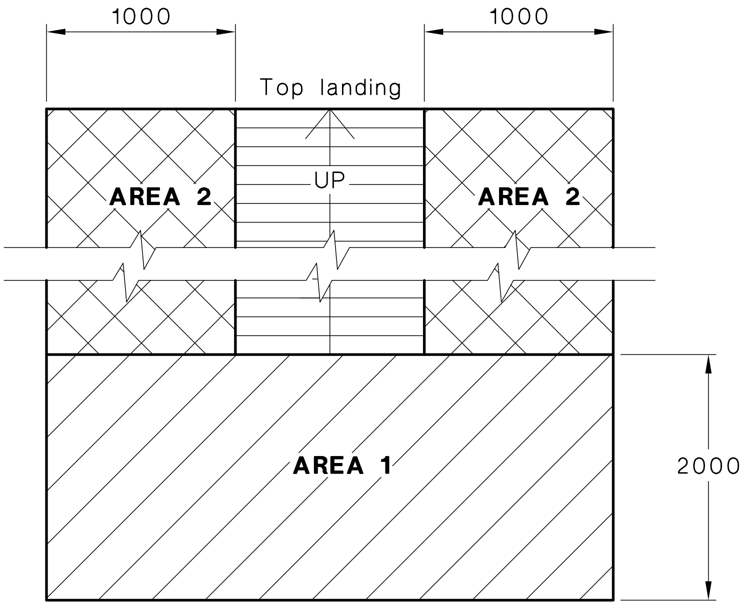
Safety glass is not required where the glazing is protected by a solid barrier not less than 1000 mm in height.

NOTES:

A3 1 Barriers that do not comply with the NCC are not to be regarded as barriers for glazing.

2 Stairways include stairwells, landings and porches.

3 For the purpose of this Clause, a stair flight is defined as having a minimum of two risers.



DIMENSIONS IN MILLIMETRES

FIGURE 5.2 PLAN FOR STAIRWAY GLAZING ZONE

5.17 LEADLIGHTS

5.17.1 General

In all buildings where leadlights are used in applications covered by this Section, the following shall apply unless the leadlight is protected by safety glass:

5.17.2 Doors and sidelights

Individual pieces of ordinary annealed glass incorporated in leadlights may be used, to a maximum area of 0.05 m^2 with a minimum nominal thickness of 3 mm. Larger areas of ordinary annealed glass are not permitted regardless of glass thickness.

5.17.3 Windows and other applications

Individual pieces of annealed glass incorporated in leadlights shall have a maximum area not exceeding 0.1 m^2 with a minimum nominal thickness of 3 mm.

5.17.4 Low level glazing other than bathrooms

For low level glazing of annealed glass incorporated in leadlights, where the lowest visible sightline is less than 500 mm from the floor or ground level, the individual pieces shall have a maximum area not exceeding 0.05 m^2 with a minimum nominal thickness of 3 mm.

5.17.5 Bathrooms

Individual pieces of annealed glass incorporated in leadlights above 1500 mm from the abutting finished floor level or standing area of a bath or shower in bathrooms and enclosures containing spa pools shall have a maximum area not exceeding 0.1 m^2 with a minimum nominal thickness of 3 mm.

Leadlights below 1500 mm from the abutting finished floor level or standing area of a bath or shower in bathrooms and enclosures containing spa pools, except where a fixed vanity unit or bench of a minimum height of 760 mm and a minimum depth of 300 mm is located in front of the glazing, shall be protected by Grade A or Grade B safety glass. Where leadlight is protected by safety glass, no area restriction applies to the individual pieces.

5.18 CURVED GLASS

Curved glass shall be acceptable if a flat panel of the same type and thickness conforms to the human impact requirements of this Section.

5.19 MAKING GLASS VISIBLE (MANIFESTATION)

A1, A2

5.19.1 General

If the presence of glass in a door or side panel is not made apparent by stiles, rails, transoms, colonial bars, other components of the glazing system, or other decorative treatment, such as being opaque or patterned, the glass shall be marked to make it visible.

A3 A2 Where the NCC requires access for people with disabilities, glazing in buildings shall be marked in accordance with AS 1428.1.

5.19.2 Panels other than doors and side panels

If a panel can be mistaken for a doorway or opening the glass shall be marked to make it visible.

5.19.3 Marking

Marking, where required, shall be in the form of an opaque band not less than 20 mm in height and located so that the vertical distance from the floor level is—

(a) not less than 700 mm from the upper edge of the band; and

(b) not more than 1200 mm to the lower edge of the band.

A1, A2 The band shall be readily apparent. This may be achieved either by ensuring that the band contrasts with the background or by increasing the height of the band.

Making glass visible by marking is not a substitute for the use of safety glazing where it is a requirement of this Section.

NOTES:

1 The application of other clauses in this Section requiring the use of either safety glass or thicker annealed glass will reduce the risk of injury from human impact and glass breakage. However, although glass may not break, injury can still occur when there is accidental human impact caused to persons unaware of the presence of glass and due in part to the transparent characteristic of glass. Where such a risk exists, consideration should be given to marking the glass to make it visible.

2 A broken line or patterns using company logos may be acceptable form of marking provided it meets the other criteria of this Clause.

5.20 UNFRAMED EDGES

All unframed glazing with exposed edges shall have sharp edges removed by edge-working the clean-cut edges. The edge of a panel that has no framed support shall be deemed an unframed edge.

NOTE: An edge may be exposed or not exposed (i.e., covered).

5.21 USE OF SAFETY GLASS OF NON-STANDARD THICKNESSES

Non-standard thicknesses of safety glass may be used if the relevant maximum areas or spans specified in the Tables in this Section are adjusted in accordance with Clause 3.6.

5.22 INSULATING GLASS UNITS

Where insulated glass units are used in situations covered by this Section then either one of the following shall apply:

(a) When an insulating glass unit is installed in a location where the glass is likely to be subjected to human impact from either side of the unit, then both panes of the unit shall meet the requirements of this Section. The maximum areas specified in this Section may be multiplied by 1.5, provided that each of the component glass of the unit otherwise complies with the relevant clauses.

(b) In situations where access is restricted to one side of the unit, then only the accessible side shall comply with the requirements of this Section without the application of the 1.5 factor given in Item (a).

NOTE: An example is where there is low-level glazing in the facade of a residential building at levels above the ground floor, but with no pedestrian access to the external faces of the unit. When safety glass is installed on only one face, identification will be necessary to ensure the unit is glazed with the safety glass to the accessible face.

5.23 IDENTIFICATION OF SAFETY GLASS

5.23.1 Original panels

Each original panel of safety glazing material shall be legibly marked in accordance with AS/NZS 2208. Marking may be by either a label of a type that cannot be removed and re-used or a permanent mark on the glass surface.

5.23.2 Cut panels

Where laminated safety glass, safety organic-coated glass, or safety mirror, or safety wired glass is cut by the distributor or installer after manufacture, the distributor or installer shall, where the cut glass is not already marked, apply a label or permanent mark to each piece, which shall state the distributor or installer's name including verification that the piece has been cut from a sheet of safety glass that was properly marked in accordance with the requirements of AS/NZS 2208. Each panel shall be marked with the minimum requirements listed in Clause 5.23.3.

Where labels are used they shall be of a type that cannot be removed intact and re-used.

5.23.3 Minimum marking requirements

Each panel shall be marked with the following minimum requirements:

(a) The name, registered trademark or code of the manufacturer or supplier.

(b) The type of safety glass material. This may be in the form of a code as defined in AS/NZS 2208, e.g., T = Toughened.

(c) The Standard to which the safety glass has been tested, e.g., AS/NZS 2208.

(d) The grade of test classification, i.e., A or B.

A1 (e) A number to indicate the nominal thickness for standard glazing material (see Table 4.1) in millimetres, or a number to indicate the minimum thickness for non-standard glazing material to the nearest tenth of a millimetre.

5.23.4 Louvre blades and small panels

Louvre blades as described in Clause 5.12 and small panels not exceeding 0.3 m^2 shall be marked with the following minimum requirements:

(a) The name, registered trade mark or code of the manufacturer or supplier.

(b) The type of safety glass material. This may be in the form of a code as defined in AS/NZS 2208, e.g., T = Toughened.

NOTES:

1 The above may be located on the edge of the glass or on the face of the glass near the edge.

2 The requirements of this Clause are less than those of Clause 5.23.3 in recognition of the need to identify the glass and the manufacturer without adversely affecting the appearance of the glazing installation.

5.23.5 Non-standard thickness panels

Where glass of non-standard thickness is used, it shall be marked in accordance with Clause 5.23.3 and, in addition, the minimum thickness in millimetres shall be marked clearly on the glass.

NOTE: Such marking is to ensure that an assessment can be made that the interpolation has been properly carried out.

5.24 AREAS SUBJECT TO HIGH RISK OF BREAKAGE

A1 In all those parts of buildings where the planned activity can generate a high risk of breakage from human impact, such as in or about gymnasiums, swimming pools and spa pools and enclosures, part of schools, halls, public viewing galleries in stadiums and the like, Grade A safety glazing material in accordance with Table 5.1 or 5.3 shall be used.

NOTE: Parts of schools referred to in the requirements of this Clause include glazing situated within 5000 mm of areas where activities such as those in relation to playgrounds, courts or marked out playing fields occur, unless otherwise protected by a permanent barrier.

5.25 FIRE DOORS

All fire-rated glazing shall conform to this Section; however, Grade B safety wired glass may be used in accordance with the maximum area specified in Table 5.1, provided the area does not exceed the fire-rated frame manufacturer's performance size limitations.

TABLE 5.1
MAXIMUM AREAS OF SAFETY GLASS

	Type of glazing	Nominal thickness (mm)	Maximum area (m^2)
Grade A safety glass*	Toughened and toughened laminated glass	3	1.0
		4	2.2
		5	3.0
		6	4.0
		8	6.0
		10	8.0
		12	10.0‡
		>12	Extrapolate
A1	Laminated and heat-strengthened laminated glass†	5	2.2
		6	3.0
		8	5.0
		10	7.0
		12	9.0‡
		>12	Extrapolate
A2	Organic-backed safety mirror	4	3.0
		5	3.5
		6	4.0
	Safety organic-coated glass	3	2.0
		4	2.0
		5	2.2
		6	3.0
		8	5.0
		10	7.0
		12	9.0
Grade B safety glass*	Wired glass	≥6	2.5

* Safety glazing material Grade A or Grade B to AS/NZS 2208.
† Based on total glass thickness only (interlayer thickness not included and should be added).
‡ This area may not be readily available.

TABLE 5.2
MAXIMUM AREA OF ANNEALED GLASS

Nominal thickness (mm)	Maximum areas (m^2)		
	Column 1	Column 2	Column 3
5	0.3	1.2	2.2
6	0.9	2.1	3.3
8	1.8	3.2	4.5
10	2.7	4.4	6.0
12	4.5	6.3	8.0
15	6.3	8.2	10.0
19	8.5	10.3	12.0
25	12.0	13.5	15.0

A1

TABLE 5.3
GLAZED PANELS WITH UNFRAMED SIDE EDGES

Height of glass*	Type of glass	Minimum nominal thickness mm	Maximum number of vertical butt joints	Maximum panel width m
≤1.2	Annealed	6.0	No limit	No limit
	Heat-strengthened	6.0	No limit	No limit
	Toughened	6.0	No limit	No limit
	Laminated	6	No limit	No limit
>1.2 ≤ 1.6	Annealed	8.0	No limit	No limit
	Heat-strengthened	8.0	No limit	No limit
	Toughened	6.0	No limit	No limit
	Laminated	6	No limit	No limit
>1.6 ≤ 2.0	Annealed	10.0	No limit	No limit
	Heat-strengthened	10.0	No limit	No limit
	Toughened	6.0	2	1.2
	Toughened	8.0	No limit	No limit
	Laminated	6	2	1.2
	Laminated	8	No limit	No limit
>2 ≤ 2.5	Annealed	10.0	1	1.0
	Heat-strengthened	10.0	1	1.2
	Toughened	8.0	2	1.2
	Toughened	10.0	No limit	No limit
	Laminated	8	2	1.2
	Laminated	10	No limit	No limit
>2.5 ≤ 2.8	Toughened	10.0	2	1.2
	Toughened	12.0	No limit	No limit
	Laminated	10	2	1.2
	Laminated	12	No limit	No limit
>2.8 ≤ 3.2	Toughened	12.0	2	1.2
	Toughened	15.0	No limit	No limit
	Laminated	12	2	1.2
	Laminated	16	No limit	No limit
>3.2 ≤ 3.6	Toughened	15.0	2	1.2
	Toughened	19.0	No limit	No limit
	Laminated	16	2	1.2
	Laminated	20	No limit	No limit

* This is equivalent to span (see Clause 1.4.51 for definition of span)

NOTES:

1 For curved glass the butt joint and maximum panel width limits may not apply.

2 The values for toughened safety glass are also applicable to laminated toughened safety glass.

A2

TABLE 5.4

FRAMELESS SHOWER DOORS AND PANELS

Type of glazing	Glass thickness (mm)	Unframed maximum panel area (m^2)
Grade A Toughened or laminated toughened safety glass	6	3.0
	8	4.5
	10	6.0
	12	7.5

SECTION 6 SLOPED OVERHEAD GLAZING

6.1 GENERAL

This Section applies to glass that is glazed overhead and sloped with an angle less than 75° to the horizontal, and operable roof light windows. It does not apply to glass louvres or vertical operable windows that are inclined at 75° or more to the horizontal in the closed position.

Glazing inclined at angles equal to or greater than 75° to the horizontal shall be designed in accordance with Section 3 and other relevant sections, as applicable.

Compliance with the requirements of Clause 6.5 is deemed to meet or be an acceptable solution to this Section.

NOTE: Refer to Appendix E for the fracture characteristics of various glass types. The selection process should include a risk assessment based on the risk of injury to persons below due to falling glass as well as the risk of injury to persons who might fall through the glazing in the event of breakage.

Where the requirements of other sections exceed the requirements of this Section, they shall be followed.

6.2 LOADS AND ACTIONS

The design of sloped overhead glazing for stability, ultimate strength and serviceability limit states shall account for the action effects directly arising from the following loads:

(a) Imposed wind actions specified in AS/NZS 1170.2

(b) Dead loads include glass weight and snow and ice actions specified in AS/NZS 1170.3

(c) Live loads (concentrated point loads) in accordance with AS/NZS 1170 applied as a uniformly distributed load over a circular area of 0.01 m^2 for glazed panels inclined at less than 30° to the horizontal.

For glazed panels inclined at greater than or equal to 30° to the horizontal, use a live load of 0.5 kN (concentrated point load) applied normal to the glass.

For IGUs, apply the point load separately to the uppermost pane.

(d) Other specific loads, as required.

NOTE: Other loads may include imposed live loads for maintenance and cleaning not covered above, which the designer may require.

6.3 LOAD COMBINATIONS

The design combinations for the stability, ultimate strength and serviceability limit states shall be those specified in AS/NZS 1170.0.

6.4 DESIGN CRITERIA

The glazing and its component members and connections shall be designed in accordance with Section 3.

A1 All sloped overhead glazing greater than or equal to 3.0 m above the floor shall be Grade A laminated safety glass with the following exceptions:

(a) Where the highest part of the overhead glazing is less than 3.0 m above floor, Grade A toughened safety glass may be used.

(b) Where the glazing consists of insulating glass more than 3.0 m above the floor, Grade A toughened safety glass may be used in the outer pane provided an appropriate laminated glass complying with the requirements of this Section is used on the inner pane.

NOTES:

1 Grade A laminated safety glass can be annealed laminate, heat-strengthened laminate or toughened laminate.

2 IGU glass combinations should be in accordance with AS/NZS 4666.

6.5 SELECTION OF OVERHEAD GLASS

6.5.1 General

The requirements of Clauses 6.2 to 6.4 are deemed to be satisfied by compliance with the requirements of Clauses 6.5.2 to 6.5.6, as appropriate.

6.5.2 Permanent, imposed and other actions

The design pressure resulting from the weight of the glass (dead loads) shall be determined from Table 6.1. This design pressure shall be used in Clause 6.5.5 to determine the ultimate limit state design pressure for the combined loads.

6.5.3 Wind actions

A3 The wind pressures shall be determined from either—

(a) AS/NZS 1170.2; or

(b) AS 4055.

The resultant ultimate limit state wind pressure shall be used in Clause 6.5.5 to determine the ultimate limit state design pressure for the combined loads.

NOTE: Appendix A provides guidance for determining the ultimate and serviceability limit state design wind pressures from the procedures given in AS 4055 and AS/NZS 1170.2. It should be ensured that the assumptions used in these simplified determinations are applicable for the glass being designed.

6.5.4 Live Load (concentrated point load) application

A1 Sloped overhead glazing with a live point load applied is deemed to comply with this Section if the glass is selected in accordance with Tables 6.2 to 6.5.

Tables 6.2 to 6.5 were prepared using the following assumptions:

(a) The point load shall be applied as a uniformly distributed load over a circular area of 0.01 m^2.

A1 (b) Glazed panels inclined at less than 30° to the horizontal shall be capable of supporting the actions incidental to maintenance (1.1 kN).

(c) Glazed panels, which are not in street awnings and inclined at 30° or more to the horizontal, shall be protected by boards or ladders laid over the glazed panels to support the actions incidental to maintenance (0.5 kN live load).

(d) For a glazed panel supported on all edges, the point loading shall be applied at the centre.

(e) For free glazing edges, the point load shall be applied adjacent to the centre of the free edge.

(f) The ultimate limit state design wind pressure shall be not greater than 1.2 kPa. For greater design wind pressures, the glass shall be separately designed to withstand wind loading in accordance with Sections 3 or 4.

6.5.5 Combined loads (dead, wind)

The combined design loads for sloped overhead glazing shall be calculated as follows:

Case 1 Dead (maximum) + wind (downward)

Case 2 Dead (minimum) + wind (upward)

6.5.6 Glass thickness

The worst load combination effect, in accordance with Clause 6.5.5, shall be taken as the ultimate limit state design pressure, which shall be used in Figures 4.1 to 4.34 to determine the glass thickness to resist the uniformly distributed loads.

A1 To determine the glass thickness required to resist the design point live loads, Tables 6.2 to 6.5 shall be used. Table 6.2 to 6.5 do not include serviceability deflection limits and the glazing selected shall be checked for deflection.

The glass thickness used shall be the highest determined to resist both the uniform design load and design point load.

The maximum spans given in Tables 6.2 to 6.5 have been restricted to 2000 mm. If larger spans are required, the glass shall be designed in accordance with Section 3.

NOTES:

1 For laminated glass the thickness of glass shown in Tables 6.2 to 6.5 does not include the thickness of the interlayer, e.g., 6 mm may apply to 6.38 mm, 6.76 mm or 7.52 mm, etc.

2 For laminated heat-strengthened or laminated toughened glass (Tables 6.4 and 6.5), not less than 0.76 mm thickness of interlayer is required to enable successful lamination.

3 Tables 6.2 to 6.4 apply only to laminated glass having two equal thickness sheets and the interlayer material being polyvinyl butyral (pvb) or equivalent. Glass panels incorporating other interlayers should be designed using engineering principles in accordance with Section 3.

TABLE 6.1

DEAD LOADS PERPENDICULAR TO THE GLASS DUE TO SELF-WEIGHT

Angle of glass to the horizontal (degrees)	Single glazing		Insulated glass unit (IGU)	
	Maximum (kPa)	Minimum (kPa)	Maximum (kPa)	Minimum (kPa)
0	0.57	0.13	1.14	0.26
5	0.57	0.13	1.13	0.26
10	0.56	0.13	1.12	0.26
15	0.55	0.13	1.10	0.26
20	0.54	0.12	1.07	0.25
25	0.52	0.12	1.03	0.24
30	0.49	0.11	0.99	0.23
35	0.47	0.11	0.93	0.22
40	0.44	0.10	0.87	0.20
45	0.40	0.09	0.81	0.19
50	0.37	0.09	0.73	0.17
55	0.33	0.08	0.65	0.15
60	0.28	0.07	0.57	0.13
65	0.24	0.06	0.48	0.11
70	0.19	0.05	0.39	0.09
75	0.15	0.03	0.29	0.07

NOTES:

1 Single glazing based on 6 mm glass, IGUs on 6 + 6 mm glass.

2 Pressures on glass = $1.2 \times 1/c_3$

3 c_3 is equal to 0.31 (from Table 3.3) and is required in the calculation of the values in the above Table to compensate for the use of these pressures when entering Figures 4.1 to 4.34, in which c_3 equals 1.0. c_3 is equal to 0.5 for heat-strengthened and toughened glass (from Table 3.3) and, therefore, values other than those given in Table 6.1 will be applicable for these glass types.

4 Maximum dead load = $1.2 \times 1/c_3 \times$ dead load of the glass = $3.9 \times$ the dead load of the glass, and Minimum dead load = $0.9 \times$ dead load of the glass.

5 For single glazing greater than 6 mm or IGUs greater than 6 + 6 mm (IGU), multiply the dead load values by the ratio of the thickness of the thicker glass divided by the thickness of the 6 mm or 6 + 6 mm (IGU), eg., for 12 mm glass, multiply the dead load values by 12/6 = 2.

TABLE 6.2

MAXIMUM SPAN OF LAMINATED ANNEALED GLASS

Live load (kN)	Nominal thickness (mm)	Maximum span (mm)			
		Four-edge support			Two-edge support
		AR = 1	AR = 2	AR = 3	
0.5 (glazing with slope ≥30°)	6	400	250	250	—
	8	1400	850	800	—
	10	2000	1900	1700	250
	12	2000	2000	1900	700
1.1 (glazing with slope <30°)	6	—	—	—	—
	8	250	—	—	—
	10	550	350	330	—
	12	1200	825	750	—
1.8 (street awning)	6	—	—	—	—
	8	—	—	—	—
	10	—	—	—	—
	12	400	275	—	—

TABLE 6.3

MAXIMUM SPAN OF LAMINATED HEAT STRENGTHENED GLASS

Live load (kN)	Nominal thickness (mm)	Maximum span (mm)			
		Four-edge support			Two-edge support
		AR = 1	AR = 2	AR = 3	
0.5 (glazing with slope ≥30°)	6	2000	1500	1200	—
	8	2000	1800	1600	800
	10	2000	2000	1800	1600
	12	2000	2000	1950	1950
1.1 (glazing with slope <30°)	6	400	250	250	—
	8	1450	950	900	—
	10	2000	2000	2000	250
	12	2000	2000	2000	800
1.8 (street awning)	6	—	—	—	—
	8	450	300	300	—
	10	1200	800	750	—
	12	2000	1950	1850	—

TABLE 6.4

MAXIMUM SPAN OF LAMINATED TOUGHENED GLASS

Live load (kN)	Nominal thickness (mm)	Maximum span (mm)			
		Four-edge support			Two-edge support
		AR = 1	AR = 2	AR = 3	
0.5 (glazing with slope ≥30°)	6 8 10 12	2000 2000 2000 2000	2000 2000 2000 2000	2000 2000 2000 2000	650 1800 2000 2000
1.1 (glazing with slope <30°)	6 8 10 12	1100 2000 2000 2000	725 2000 2000 2000	700 2000 2000 2000	— 250 850 1900
1.8 (street awning)	6 8 10 12	350 1400 2000 2000	— 925 2000 2000	— 900 2000 2000	— — — 700

TABLE 6.5

MAXIMUM SPAN OF MONOLITHIC TOUGHENED GLASS

Live load (kN)	Nominal thickness (mm)	Maximum span (mm)			
		Four-edge support			Two-edge support
		AR = 1	AR = 2	AR = 3	
0.5 (glazing with slope ≥30°)	6 8 10 12	2000 2000 2000 2000	2000 2000 2000 2000	2000 2000 2000 2000	700 1800 2000 2000
1.1 (glazing with slope <30°)	6 8 10 12	1300 2000 2000 2000	850 2000 2000 2000	800 2000 2000 2000	— 400 1000 1950
1.8 (street awning)	6 8 10 12	400 1400 2000 2000	— 925 2000 2000	— 900 2000 2000	— — 300 700

SECTION 7 BALUSTRADES

7.1 GENERAL

For the purposes of this Section, glass balustrade panels shall be classified as—

(a) structural balustrade panels; or

(b) infill balustrade panels.

NOTE: Balustrade infill panels are not required to resist line loads along their top edge as the handrail provides this resistance.

7.2 LOADS AND OTHER ACTIONS

7.2.1 Loads

The design of balustrades for the stability, ultimate strength and serviceability limit states shall account for the action effects directly arising from the following loads:

(a) Imposed live and wind load actions specified in AS/NZS 1170.0, AS/NZS 1170.1 and AS/NZS 1170.2.

(b) Other specific loads, as required.

7.2.2 Load Combinations

The design combinations for the stability, ultimate strength and serviceability limit states shall be those specified in AS/NZS 1170.0.

The actions due to wind need not be assumed to act concurrently with the loads in AS/NZS 1170.1; however, the loads causing the worst actions shall be used for design.

7.2.3 Handrails

Handrails shall be classified as follows:

(a) *Load-supporting handrails* The handrail is mechanically fixed to the structure, independent of the glass, but the glass can be connected to it. The handrail supports the loads defined in Clauses 7.2.1 and 7.2.2.

NOTE: Normally these are used with infill balustrades.

(b) *Non-load-supporting handrails* Either the top edge of the glass acts as the handrail or the glass supports a handrail that is fixed to the glass and relies on the glass for structural support. The glass supports the loads defined in Clauses 7.2.1 and 7.2.2.

(c) *Interlinking handrail* The handrail is non-load-supporting, unless a panel breakage occurs, and is connected to adjacent panels of glass, or the building, where the adjacent panels are at least 1000 mm wide and three or more panels of glass form the balustrade. If any one panel fails, then the remaining panels and handrail shall be capable of resisting the loads defined in Clauses 7.2.1 and 7.2.2.

7.3 SELECTION OF BALUSTRADE GLASS

7.3.1 General

Grade A safety glass shall be used in all balustrades. The standard nominal thickness of glass for a given situation of use shall be determined in accordance with Section 3.

Balustrades designed to Clauses 7.3.2 to 7.3.6, as appropriate, are deemed to comply with or are an acceptable solution for the resistance of the live load actions in accordance with AS 1170.1 or AS/NZS 1170.1 and AS/NZS 1170.0.

NOTE: For the fracture characteristics of various glass types, see Appendix E.

7.3.2 Structural balustrades—Cantilevered glass—Protecting a difference in level less than 1000 mm, no handrail or non-load-supporting handrail

Laminated annealed safety glass, toughened safety glass, laminated heat-strengthened safety glass, or laminated toughened safety glass shall be used with a minimum 10 mm standard nominal glass thickness in accordance with Table 7.1 (see Figure 7.1).

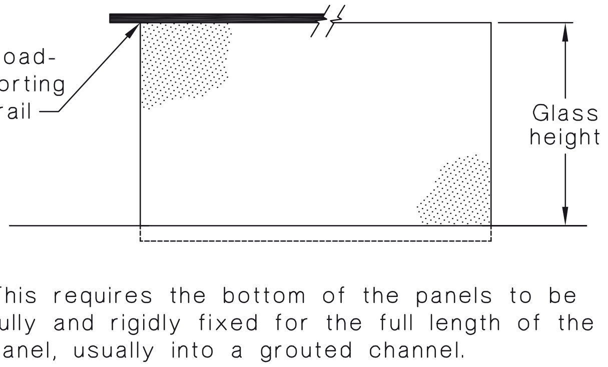


FIGURE 7.1 STRUCTURAL BALUSTRADES—CANTILEVERED GLASS PROTECTING A DIFFERENCE IN LEVEL LESS THAN 1000 mm

7.3.3 Structural balustrades—Two-edge support (two opposite edges)—Protecting a difference in level less than 1000 mm, no handrail or non-load-supporting handrail

Laminated annealed safety glass, toughened safety glass, laminated heat-strengthened safety glass, or laminated toughened safety glass shall be used with a minimum 6 mm standard nominal glass thickness in accordance with Table 7.2. The supported edges shall be more than 600 mm long (see Figure 7.2).

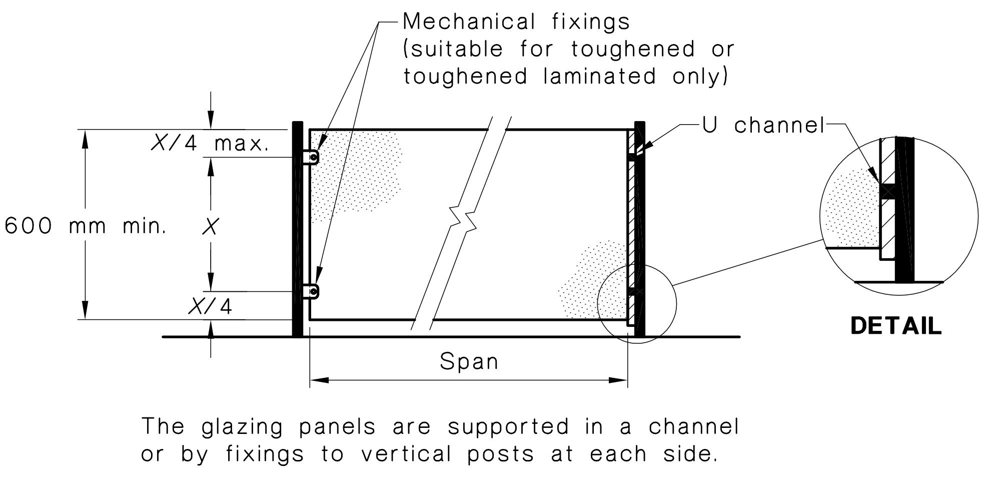
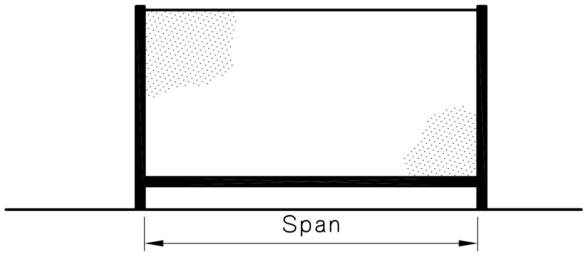


FIGURE 7.2 STRUCTURAL BALUSTRADES—TWO-EDGE SUPPORT

7.3.4 Structural balustrades—Three-edge support (bottom and two sides)—Protecting a difference in level less than 1000 mm, no handrail or non-load-supporting handrail

Laminated annealed safety glass, toughened safety glass, laminated heat-strengthened safety glass, or laminated toughened safety glass shall be used with a minimum 6 mm standard nominal glass thickness in accordance with Table 7.2 (see Figure 7.3).



NOTE: For mechanical fixing, toughened or toughened laminated glass only is to be used.

FIGURE 7.3 STRUCTURAL BALUSTRADES—THREE-EDGE SUPPORT

7.3.5 Structural balustrades—All types—Protecting a difference in level equal to or greater than 1000 mm, interlinking handrail

If an interlinking handrail is used in accordance with Clause 7.2.3(c), toughened glass, laminated heat-strengthened safety glass, or laminated toughened safety glass shall be used in accordance with Table 7.1 or 7.2, as applicable.

7.3.6 Infill balustrades—Protecting any difference in level

7.3.6.1 *Four-edge support*

Grade A safety glass, in accordance with Table 5.1, shall be used with a minimum nominal thickness of 6 mm (see Figure 7.4). The infill balustrade panels shall also comply with the requirements of the loading code AS 1170 or AS/NZS 1170, as appropriate. Glass in accordance with Table 7.3, with the maximum glass span taken as the smaller dimension, shall be deemed to comply with this requirement.

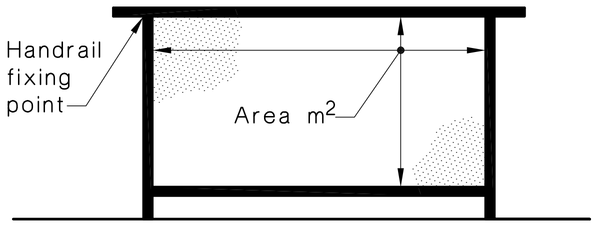
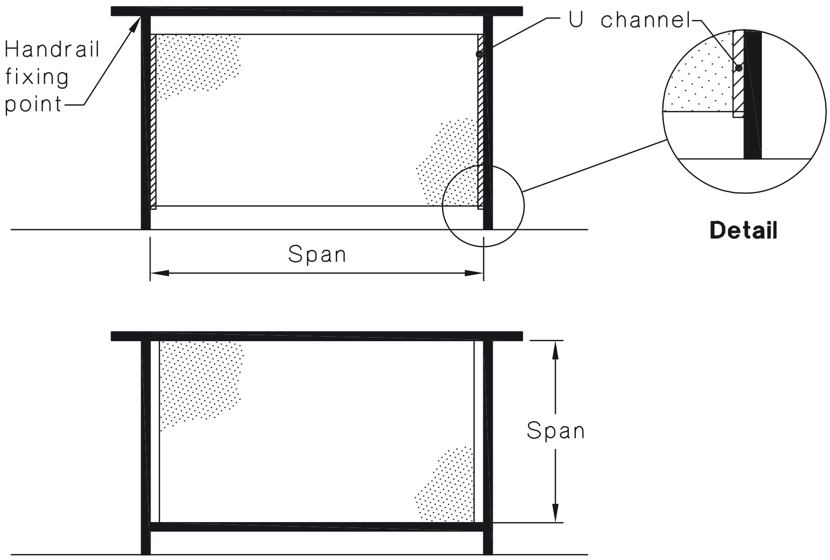


FIGURE 7.4 INFILL BALUSTRADES—FOUR-EDGE SUPPORT

7.3.6.2 *Two edge support*

Laminated annealed safety glass, toughened safety glass, laminated heat-strengthened safety glass, or laminated toughened safety glass in accordance with Table 7. 3 shall be used. Full edge support shall be provided on two opposite edges (see Figure 7.5).



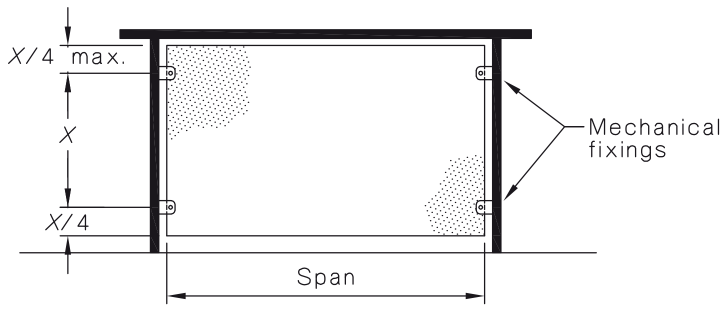
This infers that there is a handrail supporting the design loads, which may not be connected to the glass. The design tables apply for infill panel loads.

FIGURE 7.5 INFILL BALUSTRADES—TWO-EDGE SUPPORT

7.3.6.3 *Two-edge support—Mechanical fixings*

Toughened safety glass, laminated heat-strengthened safety glass, or laminated toughened safety glass shall be used in accordance with Table 7.3. There shall be a minimum of four fixings per pane. The panes shall be positioned not more than $X/4$ from the corner, where X is the span between fixings (see Figure 7.6).

NOTE: The fixing design is not covered in this Standard. Fixings should be suitable for clamping the glass into position and capable of withstanding design loads and vibration. As a guide, they are normally minimum 50 mm square or diameter and 6 mm thick plates depending on the glass thickness and bolt/screw size. Direct glass to metal contact should be avoided by the use of rubber or fibre pads and a nylon bush in the glass hole. Refer to fitting suppliers for proprietary design information.



This infers that there is a handrail supporting the design loads, which may not be connected to the glass. The design tables apply for infill panel loads.

FIGURE 7.6 INFILL BALUSTRADES—TWO-EDGE SUPPORT (MECHANICAL FIXINGS)

TABLE 7.1

STRUCTURAL BALUSTRADE—CANTILEVERED GLASS

Design load kN/m	Maximum glass height (mm)							
	Toughened safety glass				Laminated toughened safety glass			
	10 mm	12 mm	15 mm	19 mm	10 mm	12 mm	16 mm	20 mm
0.35	1100	1330	1650	2050	1070	1320	1750	2210
0.75	820	1030	1280	1590	820	1020	1360	1710
1.50	470	640	930	1260	460	630	1040	1360
3.00	250	340	460	680	230	310	520	780
0.60kN*	670	1030	1380	1850	640	1020	1490	2060

* Point load

NOTES:

1 Height is from base of channel or top point of fixing to top of glass or handrail with the handrail centred on top edge of the glass.

2 For trapezoid-shaped panels on the sides of stairways, the height is the vertical height above the fixing points.

A2 3 The heights have been calculated for medium-term live loads applied along the top edge.

4 Deflection is limited to height/30 or 30 mm maximum.

5 Glass thicknesses are nominal thickness and can be used for toughened laminated glass excluding the interlayer thickness.

6 Table 7.1 is calculated for the handrail live design load. Clause 1.2 requires glass thickness to be selected in accordance with the most stringent relevant requirements of Sections 3 to 9 as applicable.

7 The design loads applicable are to be in accordance with AS 1170 or AS/NZS 1170.

TABLE 7.2

STRUCTURAL BALUSTRADE—TWO- AND THREE-EDGE SUPPORT

Design load kN/m	Maximum glass span (mm)													
	Annealed laminated safety glass (mm)			Toughened safety glass (mm)						Laminated toughened safety glass (mm)				
	8	10	12	6	8	10	12	15	19	8	10	12	16	20
0.35	1210	1490	1770	1420	1860	2210	2550	2990	3520	1840	2200	2530	3130	3720
0.75	820	1020	1200	1240	1540	1830	2100	2470	2910	1430	1810	2090	2590	3080
1.50	580	720	850	870	1160	1460	1760	2080	2450	1140	1440	1750	2180	2590
3.00	410	510	600	690	910	1130	1330	1620	1960	910	1140	1350	1720	2110
0.60kN*	180	270	400	540	930	1630	2170	2690	3350	900	1590	2150	2860	3600

* Point load

NOTES:

1 The spans have been calculated for medium-term live loads applied along the top edge.

2 Deflection is limited to span/60 or 30 mm maximum.

3 Glass thicknesses are nominal thickness and can be used for toughened laminated glass excluding the interlayer thickness.

4 In some exposed situations, the wind load may exceed the infill design load and thicker glass may be required by the design live load.

TABLE 7.3

A1

INFILL BALUSTRADE

Balustrade infill design load	Maximum glass span (mm)												
	Laminated safety glass (mm)				Toughened safety glass (mm)					Laminated toughened safety glass (mm)			
	6	8	10	12	6	8	10	12	15	8	10	12	16
0.50 kPa	910	1210	1490	1770	1240	1640	2000	2300	2700	1620	1980	2290	2830
1.0 kPa	640	850	1050	1250	980	1300	1650	1930	2270	1290	1630	1920	2380
1.5 kPa	520	690	860	1020	860	1140	1430	1730	2050	1120	1420	1720	2150
0.25 kN	270	450	670	1250	940	1860	2410	2910	3610	1820	2390	2880	3800
0.5 kN	120	210	330	470	590	1070	1860	2310	2860	1030	1830	2290	3040
1.5 kN	40	70	110	150	210	360	540	990	1910	350	530	930	2110

NOTES:

1 The spans have been calculated for medium-term live loads.

2 Deflection is limited to span/60 or 30 mm maximum.

3 Glass thicknesses are nominal thickness and may be used for toughened laminated glass excluding the interlayer thickness.

4 In some exposed situations, the wind load may exceed the infill design load and thicker glass may be required by the design live load.

A2

7.4 SWIMMING POOL BARRIERS/FENCES

Where glass is used in a barrier/fence to a swimming pool area, the glass used shall be Grade A safety glass and shall comply with other relevant requirements of this Standard (see Clause 1.2). In addition, it shall comply with the requirements of AS 1926.1.

Where a swimming pool barrier/fence is subject to wind loading, the glass shall be selected using either—

(a) first principles, as specified in Section 3; or

(b) using the simplified design, as specified in Section 4.

Where a swimming pool barrier/fence protects a fall of 1000 mm or greater, the glass shall be designed and installed in accordance with the other relevant requirements of Section 7.

A3 NOTE: The NCC may have additional requirements concerning swimming pool barriers/fences.

SECTION 8 INSTALLATION

8.1 SCOPE

This Section sets out basic installation requirements for glass.

NOTES:

1 This section does not preclude the use of other methods or systems for glazing, provided the alternate method or system can be demonstrated to satisfy the requirements for correctly supporting the glass within the frame, or glazing system.

2 Patent and other proprietary systems are not described in this Section.

3 The installation of insulating glass units is not covered in this Section (see AS/NZS 4666).

8.2 SITE WORKING AND DAMAGE OF GLASS

Heat-strengthened and toughened glass shall not be cut or worked after heat treatment. All necessary cutting, drilling, notching, and edge-working shall be carried out to correct dimensions prior to heat treatment.

A1 Glass damaged during or prior to installation shall not be installed.

8.3 DIMENSIONAL REQUIREMENTS

8.3.1 General

The dimensions for edge clearance, edge cover, and front and back clearance, as defined in Figure 8.1, shall be not less than the values given in Table 8.1 or AS 2047 for different thicknesses of glazing materials.

8.3.2 Front putty width

The front putty width shall be not less than 10 mm for panels up to 1 m^2, and not less than 12 mm for panels between 1 m^2 and 2 m^2.

8.3.3 Dimensions of rebates and grooves

Dimensions of rebates and grooves shall accommodate the requirements of Table 8.1 and allow for the appropriate setting and location blocks as illustrated in Figures 8.2 to 8.4.

8.3.4 Glass dimensional tolerance

The glass dimensional tolerance shall meet the requirements of AS/NZS 4667.

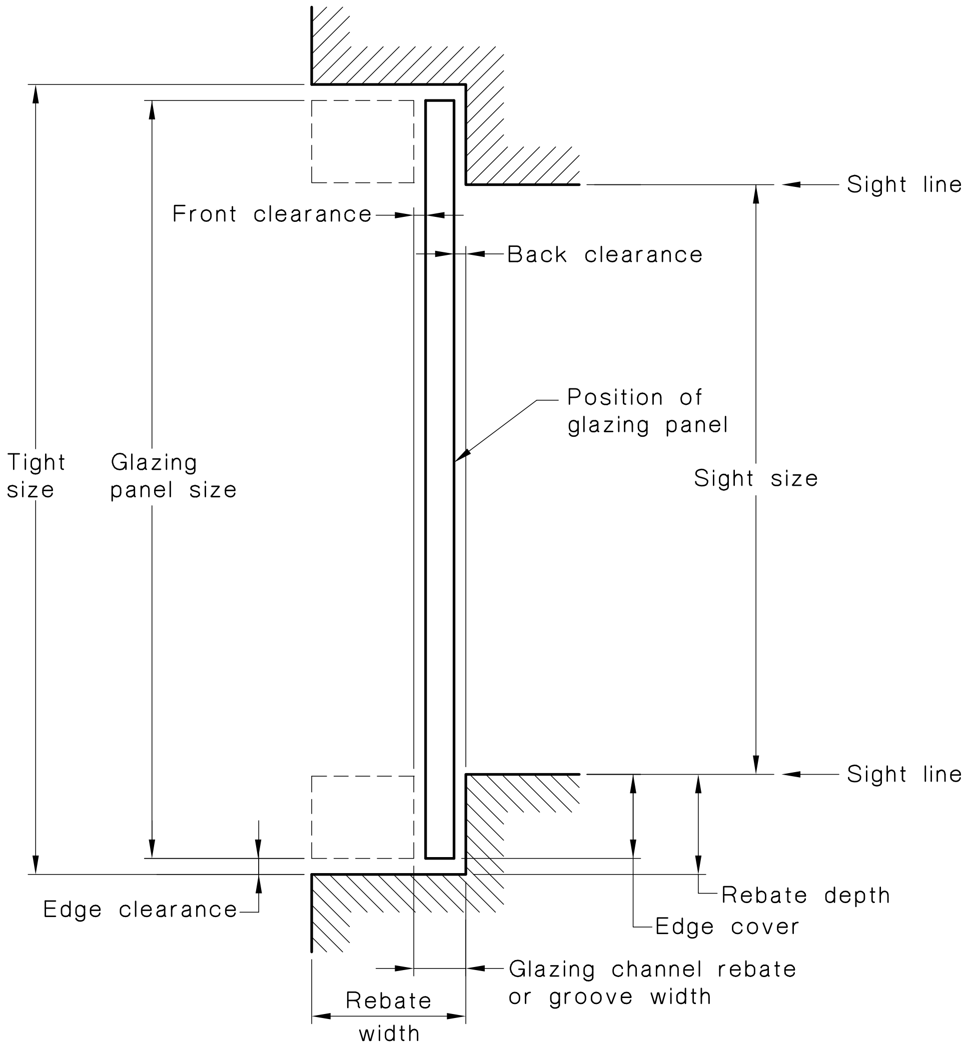


FIGURE 8.1 SIZES AND REBATES

TABLE 8.1

MINIMUM GLAZING DIMENSIONS FOR GLAZING MATERIALS

millimetres

Nominal thickness	Front and back clearance			Edge clearance	Edge cover	Rebate depth
	Type (a) (see Note 1)	Type (b) (see Note 2)	Type (c) (see Note 3)			
$3 \leq 0.1\ m^2$	2	—	—	2	4	6
$3 > 0.1\ m^2$	2	—	—	3	6	9
3	—	2	1	3	6	9
4	2	—	—	2	6	8
4	—	2	1	3	6	9
5	2	2	2	4	6	10
6	2	2	2	4	6	10
8	—	3	2	5	8	13
10	—	3	2	5	8	13
12	—	3	2	6	9	15
15	—	5	4	8	10	18
19	—	5	4	10	12	22
A1 25	—	5	4	10	15	25

NOTES:

1 Type (a) applies to linseed oil and metal casement putties.

2 Type (b) applies to non-setting glazing compounds, plastic glazing compounds, two-part rubberizing compounds, sealants and preformed strip materials.

3 Type (c) applies to gaskets made from extruded materials such as butyl strip, PVC, neoprene and sanoprene held in position by pressure upon the glass.

4 The dimensions are the minimum necessary for the structural integrity of the glass only but do not apply to insulating glass units (refer to AS/NZS 4666).

5 For non-standard glass thicknesses the nearest values of nominal thickness, shall be used.

6 Timber and PVC frames may not require the specified front and back clearances provided the waterproofing performance requirements are met.

8.4 GLAZING MATERIALS

8.4.1 Suitability of materials

A glazing material shall be used only for the purposes recommended by the manufacturer.

8.4.2 Compatibility of materials

A glazing material shall be used only where compatible with contiguous materials, including the rebate surface finish, setting or location blocks, distance pieces and glass type.

8.4.3 Application of materials

The application of glazing materials shall be in accordance with manufacturers' instructions.

8.4.4 Life expectancy of materials

A glazing material shall only be used where its life expectancy (durability) has been established.

NOTE: The manufacturers' advice should be sought for information regarding life expectancy.

8.5 SETTING BLOCKS

The number and location of setting blocks shall be as shown in Figures 8.2 and 8.4. Generally, all setting blocks shall be—

(a) positioned at quarter points or not less than 30 mm from the corner, whichever is lesser;

(b) the minimum width of each setting block shall be not less than the glass thickness; and

(c) the minimum thickness of the setting block for drained glazing systems shall be 6 mm.

Setting blocks shall be located to equally support all panes of glass, and shall be fixed to prevent displacement during installation and service.

The minimum length of each setting block (or two blocks side by side) shall be 25 mm in length for every square metre of glass area, with a minimum length of 50 mm.

Example:

For a 3.2 m^2 glass area, 3.2 × 25 mm = 80 mm long, i.e., 80 mm for each setting block.

Setting blocks shall be of resilient, load-bearing, non-absorbent, rot-proof, material that is compatible with all other glazing materials that may come into contact with the blocks.

NOTES:

1 Setting blocks are used between the bottom edge of the unit and the frame to centralize and equally support both panes of glass.

2 Setting block width and location should not restrict water drainage.

3 Extruded rubber material with 80–90 shore-A hardness is recommended.

4 Shaped setting blocks will be required for a glazing platform.

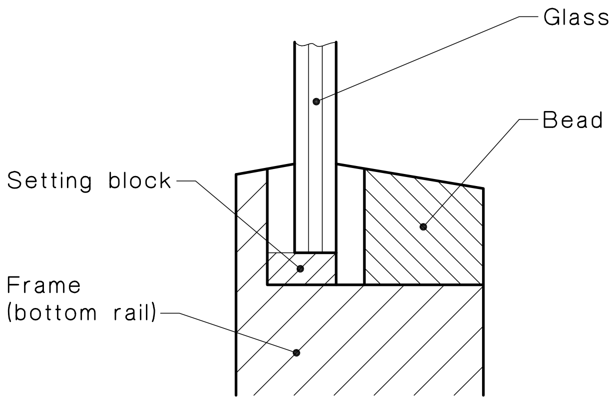


FIGURE 8.2 POSITION OF SETTING BLOCK

8.6 LOCATION BLOCKS

The number and position of location blocks shall be as shown in Figure 8.3 and Figure 8.4. Location blocks shall be—

(a) a minimum of 25 mm long;

(b) at least as wide as the glass thickness;

(c) positively located to prevent displacement in service; and

(d) sufficiently resilient to accommodate movement within the frame, without imposing stress on the glass, and of resilient, non-absorbent material.

NOTES:

1 Location blocks are used between the edges of the glass and the frame to prevent movement of the glass within the frame by thermal expansion or when the window or door is opened or closed. They are required to prevent the weight of the glass from causing the frame to become out of square.

2 Extruded rubber material with 55–65 shore-A hardness is recommended.

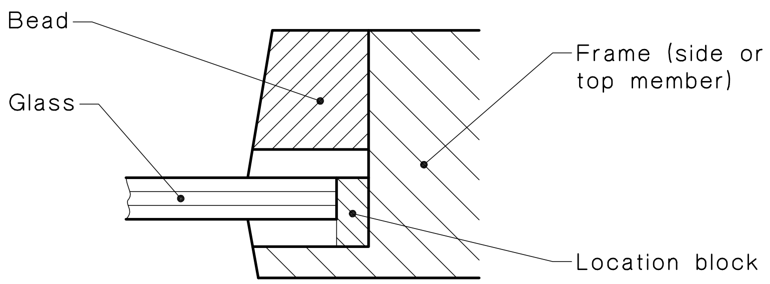


FIGURE 8.3 POSITION OF LOCATION BLOCK

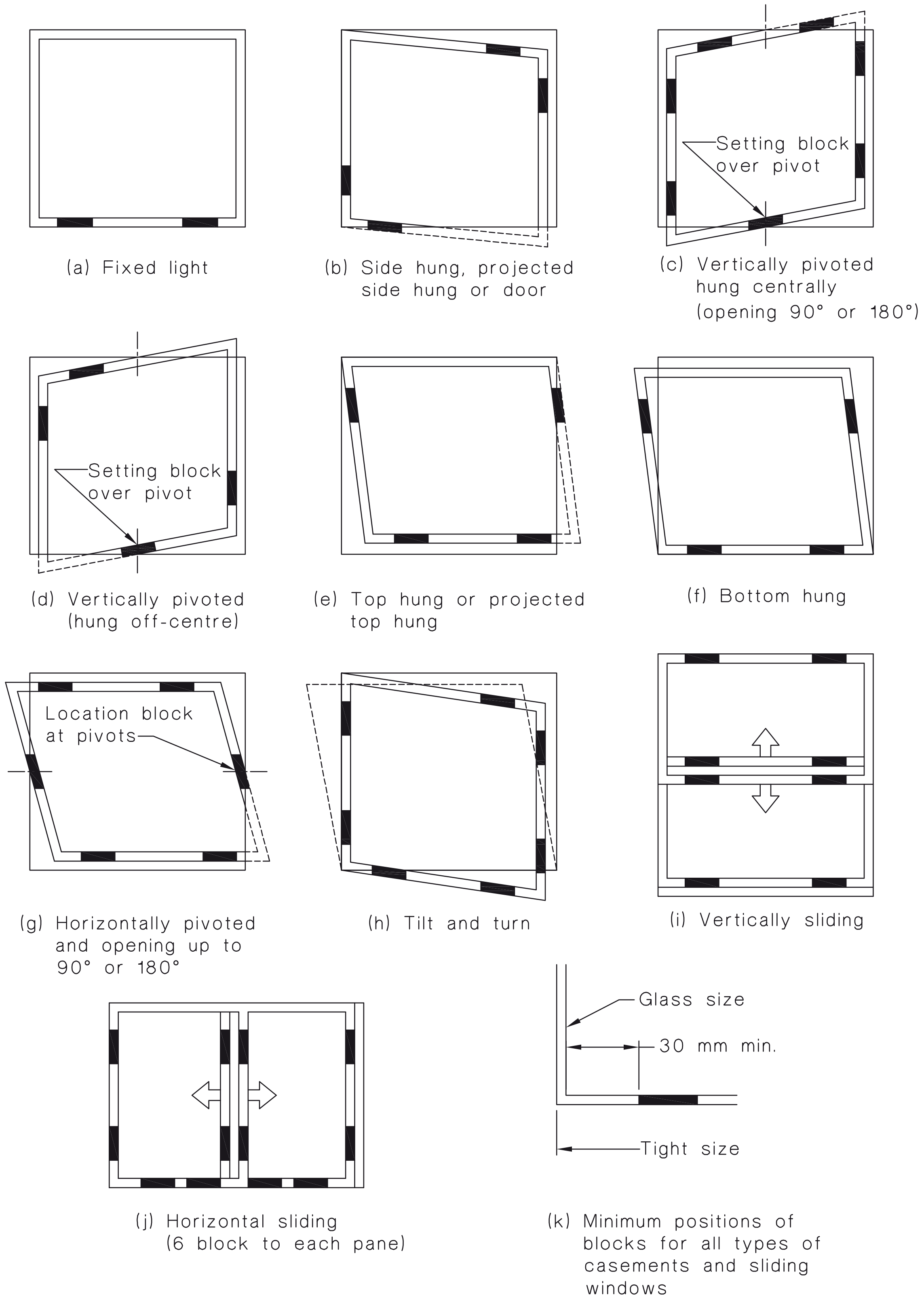


FIGURE 8.4 RECOMMENDED POSITIONS OF SETTING AND LOCATION BLOCKS FOR THE SITE GLAZING OF SOME TYPES OF DOORS AND WINDOWS

8.7 DISTANCE PIECES

Distance pieces, as shown in Figure 8.5, where required, shall be—

(a) of resilient, non-absorbent material;

(b) 25 mm long and of a height to suit the depth of the rebate and the method of glazing; and

(c) spaced opposite each other, approximately 50 mm from each corner at intervals of not more than 300 mm.

The thickness shall be equal to the front and back clearance, to retain the glass firmly in the frame.

NOTES:

1 Distance pieces are required to prevent displacement of glazing compounds or sealant by external loading, such as wind pressure.

2 Extruded rubber material with 55–65 shore-A hardness is recommended.

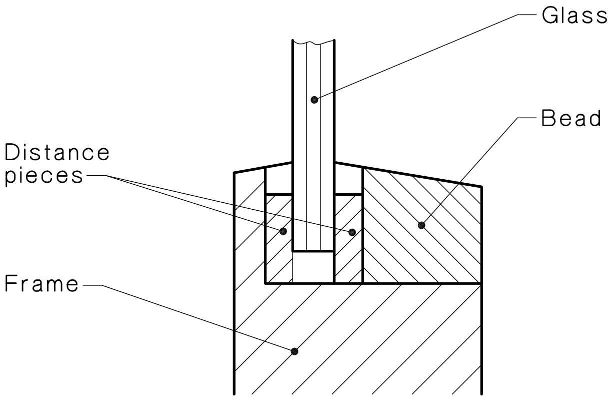


FIGURE 8.5 POSITION OF DISTANCE PIECES

8.8 PREPARATION OF REBATES AND GROOVES

Rebates, grooves and beads shall be cleaned and free from grease, moisture and other contaminants. All sealant surfaces shall be primed or sealed in accordance with the recommendations of the manufacturer of the glazing material.

The number and location of setting blocks and location blocks shall be as shown in Figures 8.2, 8.3 and 8.4, wherever necessary to maintain the requisite edge clearance. Each block shall support the full thickness of the glass.

8.9 GLAZING BEADS

Where used, glazing beads shall be capable of restraining the glass under all design actions.

8.10 STRUCTURAL SEALANTS

Structural silicone shall be installed such that a full adhesive bond to the substrate is achieved. This may require cleaning and or priming of the substrate prior to structural silicone application.

Applied structural silicones shall not be installed adjacent to other materials that may be chemically incompatible with the structural sealant and cause a loss of adhesion or adverse chemical changes within the structural silicone that could lead to a loss of strength in the structural silicone.

NOTE: For further guidance on installation of structural silicone, see Appendix F and ASTM C1401.

SECTION 9 FRAMED, UNFRAMED, AND PARTLY FRAMED GLASS ASSEMBLIES

9.1 GENERAL

This Section sets out requirements for framed, unframed, and partly framed glass assemblies that require a different installation technique to ordinary framed panels. The structural integrity of these assemblies depends upon interaction between the glass panels, the linking and supporting components and the surrounding supports. The types of assemblies covered by this Section are—

(a) faceted glazing;

(b) fin-supported glazing; and

(c) unframed toughened glass assemblies.

Where structural silicone is required, as specified in Clauses 9.3 and 9.4, the selection and application shall be in accordance with Clause 9.2.

NOTE: This Section covers only the tensile stresses in glasses.

9.2 STRUCTURAL SILICONE

9.2.1 General

Structural silicone shall be applied to adhere to both surfaces of the panels to be bonded together.

9.2.2 Selection

The structural silicone used shall be selected to ensure its design strength is in accordance with Section 3 of this Standard and that it is compatible with the glass to which it is to be applied.

9.2.3 Cleaning

Thorough and effective cleaning of the glass edges shall be carried out before the application of silicone is commenced.

9.2.4 Application

The silicone application shall be capable of providing a silicone joint that is able to carry the loads imposed by the structural glazing.

9.2.5 Silicone curing

The glass shall be appropriately supported until the silicone has cured.

9.3 FACETED GLAZING

9.3.1 General

This Clause provides a deemed to comply solution for faceted glazing. It provides the requirements for the selection and installation of faceted glazing. This Clause applies to vertical glass only.

A1 All panels shall be of equal width. Where equal panel widths are unachievable, unequal panels shall be designed using the width of the wider panel or first principle design methods. Except for 90° passing butt or lap joints, all joints shall be mitred to provide a uniform silicone joint. Structural silicone shall be used.

NOTES:

1 The structural strength of the glass and the silicone that is used to bond the adjacent panels in the vertical plane are critical elements in this type of application. Consequently, the design analysis for glass selection requires consideration of the structural adequacy of the silicone used in this of application.

2 The silicone acts as both a structural bond and a weather seal. External applications are subject to both positive and negative wind pressures and the glazing assembly performs differently when subjected to each of these pressure types.

9.3.2 Glass and silicone selection

The glass type (whether annealed, laminated safety glass, heat-strengthened or toughened safety glass) shall be selected in accordance with all the relevant requirements of this Standard, as appropriate to the location of the assembly and application. The required glass thickness for a given panel type, height and included angle may be determined from one of the methods given in Clause 9.3.3 or using first principle design methods.

A high or medium modulus structural silicone with a minimum ultimate limit stress of 0.210 MPa shall be used.

9.3.3 Design of faceted panels

9.3.3.1 *Included angles between 90° to 160°*

Panels at an included angle γ from 90° to 160° inclusive shall be designed as four-edge supported panels in accordance with Section 4 of this Standard. The minimum structural silicone bite thickness shall be determined using the following formula:

$$t = (F \times B \times P_z)/\sigma_s \qquad \ldots 9.3(1)$$

where

F = factor for facet angle

$$= \frac{1}{\{2\cos(\gamma/2)\}}$$

γ = obtuse angle between adjacent panels

B = width of each panel, in metres (distance between vertical silicone joints)

P_z = design wind pressure, in kilopascals

σ_s = ultimate limit stress in silicone, 0.21 MPa

t = minimum required bite thickness of silicone, in millimetres

The calculated bite thickness is the minimum thickness of the silicone joint. The next minimum glass thickness available to accommodate the calculated bite thickness of silicone shall be used.

NOTES:

1 For example, if a bite thickness for silicone is calculated to be 7.2 mm then the next available glass thickness of 8 mm (minimum thickness = 7.8 mm) will have to be selected.

2 Table 9.1 gives an example of facetted glazing for 135° included angle. Silicone bites less than 6 mm have been marked as 6 mm as this is the minimum nominal thickness generally used for facetted glazing. Silicone bites in excess of 23 mm have been marked ‘N/A’ as thicker glass is not generally used in faceted glazing.

The glass panel thickness shall be determined for the design wind load as a four-edge supported panel (see Section 4). It shall also comply with the requirements of Section 5.

The maximum glass thickness obtained from these methods shall be used.

9.3.3.2 *Included angles greater than 160°*

For panels having an included angle $\gamma > 160°$, a fin shall be used on each vertical silicone joint, unless the glass panels are designed to resist the required loads with unsupported vertical edges. The fins shall be designed using the methods provided in the fin design Clause (see Clause 9.4). Alternatively first principle design methods, which have been substantiated by tests, shall be used.

TABLE 9.1

MINIMUM SILICONE BITE REQUIREMENT FOR FACETED GLAZING HAVING 135° INCLUDED ANGLE

ULS	Panel width (mm)							
wind load (kPa)	300	400	500	600	700	800	900	1000
0.6	6	6	6	6	6	6	6	6
0.8	6	6	6	6	6	6	6	6
1	6	6	6	6	6	6	6	7
1.2	6	6	6	6	6	6	7	8
1.4	6	6	6	6	7	7	8	9
1.6	6	6	6	6	7	8	9	10
1.8	6	6	6	7	8	9	11	12
2	6	6	7	8	9	10	12	13
2.2	6	6	7	9	10	11	13	14
2.4	6	6	8	9	11	12	14	15
2.6	6	7	9	10	12	13	15	17
2.8	6	7	9	11	13	14	16	18
3	6	8	10	12	14	15	17	19
3.2	6	8	10	12	14	16	18	20
3.4	7	9	11	13	15	17	20	22
3.6	7	9	12	14	16	18	21	23
3.8	8	10	12	15	17	19	22	N/A
4	8	10	13	15	18	20	23	N/A
4.2	8	11	14	16	19	21	N/A	N/A
4.4	9	11	14	17	20	22	N/A	N/A
4.6	9	12	15	18	21	23	N/A	N/A
4.8	9	12	15	18	21	N/A	N/A	N/A
5	10	13	16	19	22	N/A	N/A	N/A

NOTE: Tables for faceted glazing having other included angles are given in AS 1288 Supp 1.

9.4 FIN-SUPPORTED GLAZING

9.4.1 General

This Clause provides the design methods for fin-supported glazing, in which the two adjacent vertical edges of the glass facade panels are bonded to a glass fin (mullion) using structural silicone and the other two edges, the head and sill, are conventionally glazed. A glass fin replaces a frame or mullion and is assessed as to size and thickness and securely fixed or supported at the head and sill. The fins are adhered to the facade glass with structural silicone sealant to accommodate both positive and negative loads. Any loading applied to the glass facade is transferred to the fin and then to the top and bottom fin shoes by way of a reaction load.

NOTES:

1 Inadequate fin shoe supports are a common problem. The fin shoes have to be securely anchored to the structure, frame or both and support all the loads. This means the fin has to have capped ends and setting blocks at both ends to isolate the various loads from the metal frame. The critical design parameter is the minimum fin bearing length or edge cover of the fin.

2 The amount of silicone used to bond the fin is known as the 'bite'. The depth of the joint is known as the glue line and is normally 6 mm. A high or medium modulus structural silicone with a minimum ultimate limit stress of 0.210 MPa shall be used.

This Clause is only applicable to installations up to 5 m in height and where the facade panels are of equal width. For other installations, first principle design methods shall be used.

Buckling checks shall be carried out for all glass fins.

NOTE: For a method for determining fin design to prevent buckling, see Appendix C.

For the purpose of glass selection, the facade panels may be taken as being supported on all four edges when using the methods prescribed in Clause 9.4.2. The type and thickness of glass used for the facade panels shall be selected in accordance with the other relevant sections of this Standard.

The frames supporting the head and sill shall also be designed in accordance with the relevant requirements of AS 2047. The stability and robustness of the rebates shall be such that they are able to withstand the effects of wind and glass weight.

The selection of the thickness and width of the supporting annealed glass fins may be carried out using Equations 9.4.2(1) and 9.4.2(2) or in accordance with Section 3. These Equations are based on an ultimate limit state design stress of 0.210 MPa for the structural silicone and the ultimate design edge strength capacity for the glass in accordance with Clause 3.3.2.

9.4.2 Design method

9.4.2.1 *Determination of façade panel glass type and thickness*

The glass type and thickness shall be determined using the methods prescribed in Sections 3, 4 or 5 of this Standard. The glass panels shall be considered as four-edge supported panels.

9.4.2.2 *Determination of minimum fin thickness*

The strength of the structural sealant joint depends on the width (and hence contact area) of the fin edge fixed to the glass it is required to support, dimension C (see Figure 9.1) and the effective wind pressure width (E) (see Figures 9.2 and 9.3). Dimension C depends on the gap (G) between facade panels and the thickness (T) of the fin (see Figure 9.1).

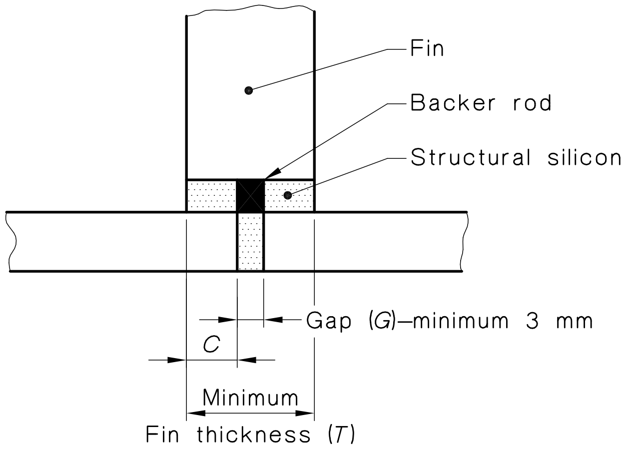


FIGURE 9.1 PLAN SECTION OF STRUCTURAL SILICONE JOINT

For situations where the height (*H*) of the facade panels is greater than their width (*W*) the effective wind pressure width (*E*) is equal to the width (*W*) of the facade panels (see Figure 9.2).

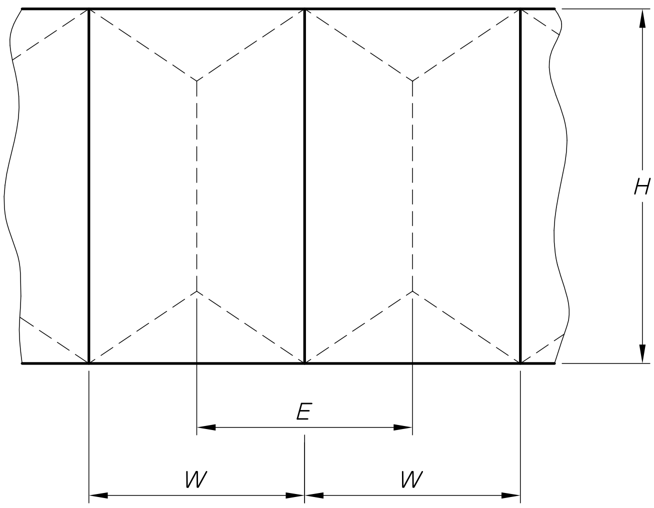


FIGURE 9.2 ELEVATION VIEW OF GLAZING PANELS TALLER THAN THEIR WIDTH

For situations where (*H*) is less than or equal to (*W*) the effective wind pressure width (*E*) is equal to the height (*H*) of the facade panels (see Figure 9.3).

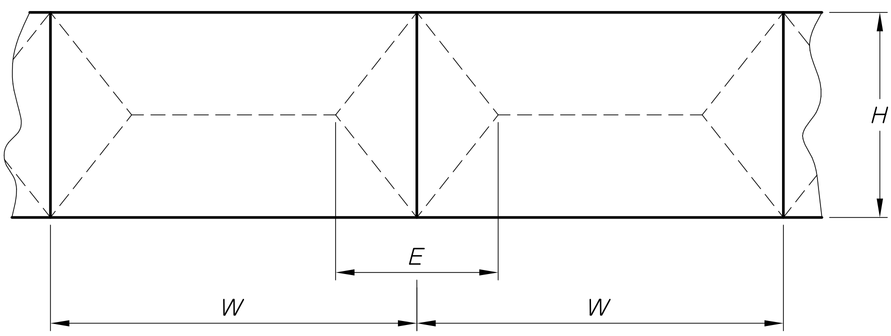


FIGURE 9.3 ELEVATION VIEW OF GLAZING PANELS WIDER THAN THEIR HEIGHT

The minimum fin thickness required shall be calculated using the following equation:

$$T = [E \times P_u/(\sigma_s)] + G \qquad \text{. . . 9.4.2(1)}$$

where

G = gap, in millimetres, ≥3 mm

T = thickness of fin, in millimetres

E = effective width, in metres

σ_s = ultimate limit stress in silicone, 0.21 MPa

P_u = ultimate limit state design pressure, in Kilopascals

The required glass thickness shall be taken as the next larger available minimum glass thickness.

Alternatively, the thickness of the fin may be determined from the tables contained in AS 1288 Supp 1.

NOTE: It should be noted that a more economical design may be obtained by following the design procedures given in this Section.

9.4.2.3 *Determination of fin depth*

Given the ultimate limit state design wind pressure (P_u), height (H) and the width (W), the depth of the fin shall be calculated using the following equation:

$$d = \sqrt{\frac{P_z H^3}{4\sigma_G t}\left(\frac{3}{R} - \frac{1}{R^3}\right)} \qquad \text{. . . 9.4.2(2)}$$

where

d = depth of fin, in metres

H = effective height, in metres

R = *H/W, (where H < W, R = 1.0)*

σ_G = ultimate limit edge strength of glass, in megapascals (see Clause 3.3.2) (e.g. σ_G = 21.57 MPa for 25 mm nominal thickness annealed glass.)

P_u = ultimate limit state design pressure, in Kilopascals

t = thickness of fin, in millimetres

Alternatively, the depth of the fin may be determined from the tables contained in AS 1288 Supp 1.

NOTE: It should be noted that a more economical design may be obtained by following the design procedures given in this Section.

9.5 UNFRAMED TOUGHENED AND TOUGHENED LAMINATED GLASS ASSEMBLIES

9.5.1 General

This Clause applies to unframed assemblies of toughened and toughened laminated glass.

NOTES:

1 Toughened glass assemblies (in the form of an all-glass facade comprising toughened glass panels, most of which are fixed panels but some of which may be doors) provide a method of glazing large openings without the use of mullions or frames. These assemblies can be either fully or partially suspended from the building structure, depending on the size of the opening to be glazed. The glass itself becomes a load-bearing material withstanding the stresses inherent in such an assembly. Toughened glass assemblies require installation techniques quite different from those of framed panels.

2 In fully suspended assemblies, each panel is suspended with adjacent panels being joined at the panel corners by patch fittings bolted together through specially designed holes or notches in the glass. Each tier of panels except the top is suspended from the tier above, and the whole assembly, except for the doors, is suspended from and rigidly connected to a substantial structural member of the building, which has to be capable of fully supporting the deadweight of the assembly in addition to the forces due to wind loading.

3 The main limiting factor on the height of the suspended assembly is the 'pull out' strength of the holes in the top tier panels. Usually two holes in the glass share the load equally, although other oversize holes may be provided to give additional frictional grip support.

4 In special situations, the glass can be stacked or supported by other means. A certificate of adequacy from an approved qualified engineer experienced in the design of toughened glass assemblies may be required by the local government authority.

9.5.2 Design considerations

9.5.2.1 *Fail-safe requirements*

The design of toughened and toughened laminated glass assemblies shall be such that breakage of any component of the assembly will not initiate progressive collapse of the remainder.

9.5.2.2 *Components*

The facade shall be of toughened or toughened laminated glass and, where required, shall be supported against wind loads by fins or stiffeners of toughened glass, not less than 12 mm thick, mounted on the edge adjacent to the facade glasses and generally located vertically. The fins shall be attached to the facade glass by patch fittings, and shall be attached to the building structure in such a way as to provide the facade with support against wind loads.

9.5.2.3 *Glass design stress*

The design stress used shall be in accordance with Section 3. The glass facade panels, the stiffening fins and the fixing points to the building structure shall be designed to withstand wind loading in accordance with AS/NZS 1170.2. To prevent buckling, unless an analysis of fin stability is carried out, the fin width shall not exceed 18 times the glass thickness.

All structural fins shall be designed to accommodate a friction grip joint. Simply bolting the cantilevered fin with high-strength structural steel bolts will not provide adequate resistance to the turning moment. Propriety adhesives may be used to enhance the coefficient of friction in the structural joint.

NOTES:

1 Suitable equations for undertaking an analysis of fin stability are given in Appendix C.

2 The maximum design stress may give rise to deflections that are unacceptable for certain applications. The maximum deflections should be limited to span/60 in the panel and span/240 for the fin at the serviceability limit state design wind loading.

9.5.2.4 *Provision for expansion and structural movement*

9.5.2.4.1 *Suspended assemblies*

Provision shall be made for thermal expansion building movement, and where required seismic movement, of a fully suspended glass facade by providing a rebate in the floor or sill for the bottom edge of the glass. Setting blocks shall not be used under the edge in this application although spacer pieces to centre the glass in the rebate shall be used. A non-hardening sealant, plastic, or neoprene rubber or propriety glazing system shall be used. The rebate shall be deep enough to provide edge cover of 1 to 1.5 times the glass thickness plus a clearance of not less than 12 mm between the lower edge of the facade glass and the bottom of the rebate (see Figure 9.4). The rebate shall be free from obstructions, and shall be strong enough to withstand safely the forces set up by wind pressures on the facade.

Rebates at each end of the facade or other adequate provision such as silicone butt-jointing shall be provided to allow for horizontal thermal expansion, and where required seismic movement, of the glass facade. The amount of edge cover and edge clearance required shall be determined for each individual assembly.

The fittings joining fins to the facade panels shall be provided with a sliding feature wherever necessary to allow for differential movement due to thermal expansion or other structural movements of the fin and the facade, while still providing full lateral support against wind loading. This sliding feature may not be required for assemblies where a vertical fin is fixed to the head of the opening and the facade glasses are similarly fixed or suspended from the head of the opening, as the expansion or movement of the fin and facade panels will be in the same direction.

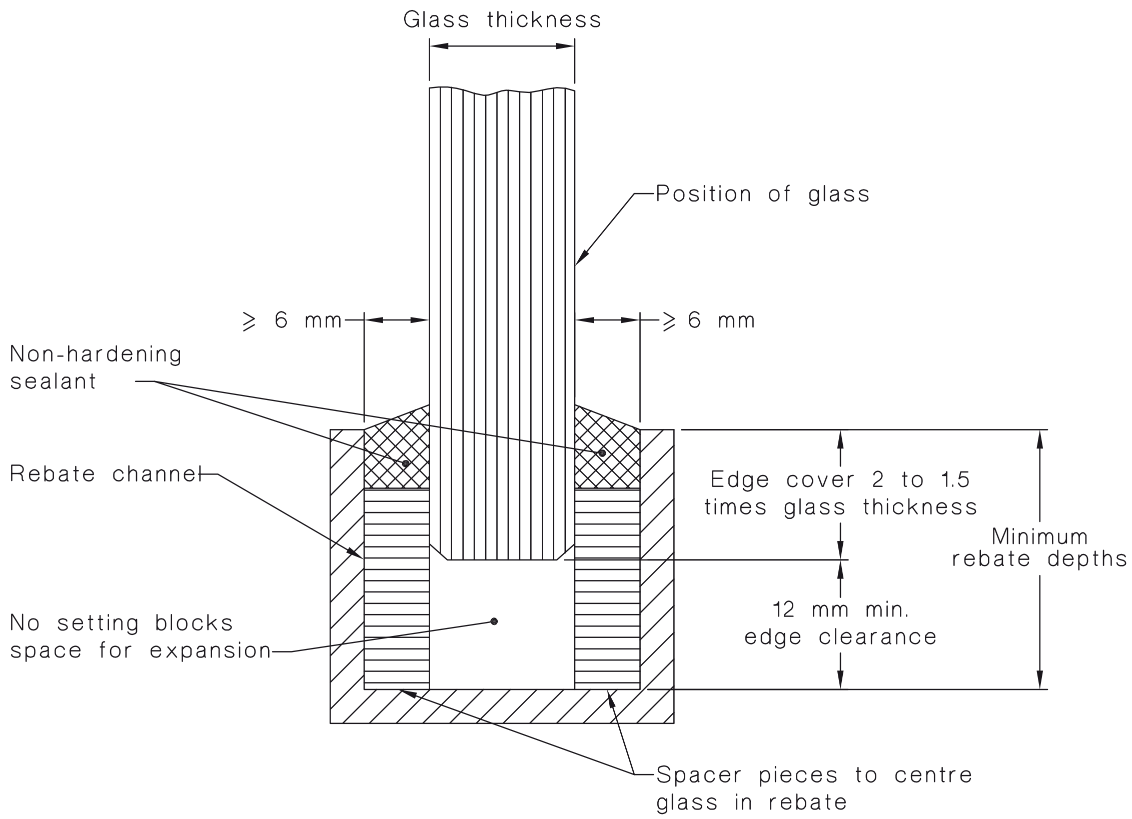


FIGURE 9.4 TYPICAL SILL GLAZING FOR SUSPENDED TOUGHENED GLASS ASSEMBLIES

9.5.2.4.2 *Doors supported directly from the floor and partially suspended assemblies*

Allowance shall be made for upwards thermal expansion of doors that are supported directly from the floor. A designed clearance of not less than 3 mm shall be allowed between the top of the door and the bottom of the transom for assemblies up to 5 m high with not less than 1 mm additional clearance for every 3 m or part thereof that the height of the assembly exceeds 5 m. The same allowance for thermal expansion shall be provided for partially suspended assemblies where the lower row of side panels is supported directly on the floor in a manner similar to doors.

9.5.2.4.3 *Adjustment*

The suspension brackets for the facade panels shall provide for vertical adjustment to overcome minor irregularities in the opening, and to take up any deflection of the sloped overhead structural support due to the weight of the glass.

9.5.3 Glazing techniques

9.5.3.1 *General*

Toughened and toughened laminated glass shall not be cut or worked after toughening. All necessary cutting, drilling, notching, and edge-working shall be carried out to correct dimensions prior to toughening.

The installation of toughened glass assemblies shall be carried out by competent tradespeople. The edges and surfaces of toughened glass shall not be damaged during fixing.

The manufacturer’s fixing instructions shall be followed explicitly.

9.5.3.2 *Sizing*

Glass size shall be verified against the opening size prior to ordering.

NOTE: The size and squareness of the opening into which the toughened glass assembly is to be glazed should preferably be accurately measured on site prior to commencement of manufacture.

9.5.3.3 *Glazing*

9.5.3.3.1 *Suspended assemblies*

A1 The metal brackets used to attach the glass fins to the building structure shall be securely bolted to the glass fin and the bolts shall be tightened accurately in accordance with the design.

Glazing shall start with the upper fins, which shall be plumbed for vertical and set with their lower edges all on one horizontal plane.

The central facade panel in the top tier shall be fitted next, followed by adjacent panels in the top tier.

After completion of the top tier, successive tiers shall be fixed again starting in the centre of the facade.

During assembly, care shall be exercised at all fixing points, and fibre bushes and gaskets shall be used to ensure that there is no glass-to-glass or glass-to-metal contact. All panels and fins shall be fixed clear of each other, leaving a nominal gap of 3 mm or greater. This gap may be weatherproofed if desired with an H-section extrusion in plastic or rubber, or a cold-curing silicone building sealant may be gunned into the gap to make a flush joint.

9.5.3.3.2 *Sill-supported assemblies*

Where panels are supported from the sill, setting blocks of neoprene or other suitable material shall be used (see Figure 9.5).

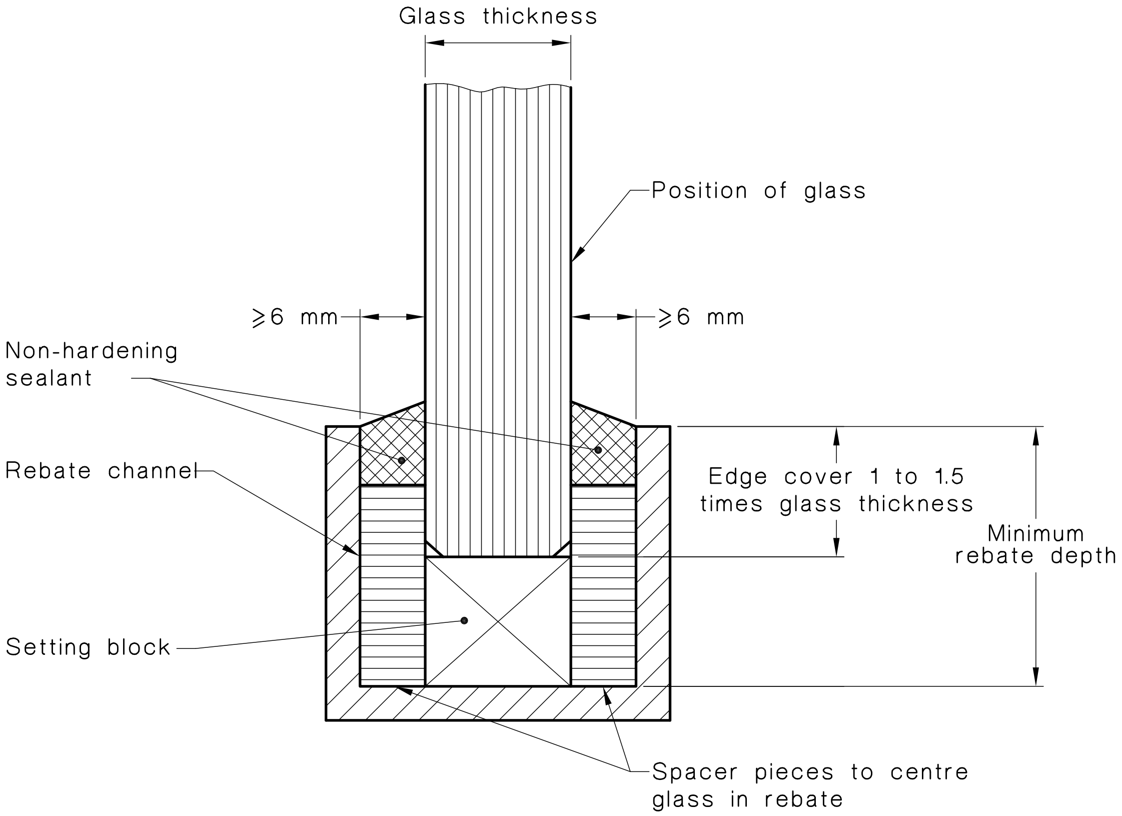


FIGURE 9.5 SILL GLAZING FOR SILL-SUPPORTED TOUGHENED GLASS ASSEMBLIES

A3

APPENDIX A

SIMPLIFIED METHOD FOR DETERMINING ULTIMATE AND SERVICEABILITY LIMIT STATE DESIGN WIND PRESSURES

(Informative)

A1 GENERAL

The design wind pressures set out in this Appendix have been determined from the procedures given in AS 4055 for housing, or AS/NZS 1170.2 for other buildings. The definitions for wind regions, terrain category and topographic classification are given in the abovementioned Standards. Although the design wind pressures set out in this Appendix were determined from a general application of the procedures given in AS 4055 for housing, or AS/NZS 1170.2 for other buildings, they might be more conservative than those given by specific calculation using those Standards. Therefore, this Appendix should be used as a conservative interpretation of AS 4055 or AS/NZS 1170.2. The design wind pressures given in this Appendix should not be used if there are any changes to either AS 4055 or AS/NZS 1170.2 after the date of publication of this Appendix.

A2 DESIGN WIND PRESSURES

The ultimate and serviceability limit state design wind pressures contained in this Appendix are subject to the limitations set out in either Table A1 for housing or Table A3 for other buildings. The ultimate and serviceability design wind pressures obtained by the use of this Appendix may be used to determine the required thickness for a given glass size in accordance with Section 4 and Section 6 of this Standard.

A3 WIND LOADING FOR HOUSING

The design wind pressure for housing should be determined in accordance with the NCC for the importance level of the building and the annual probability of exceedance and either of the following:

(a) AS 4055—the ultimate and serviceability limit state design wind pressures for glass in walls, within the wind classification system for housing used in AS 4055 are given in Table A2. The criteria and limitations used in developing the design wind pressures applicable to Table A2 are provided in Table A1.

(b) AS/NZS 1170.2—the ultimate and serviceability limit state design wind pressures for glass in walls that are outside the criteria and limitations of AS 4055 are determined from AS/NZS 1170.2 and are given in Table A4. The criteria and limitations used in developing the design wind pressures applicable to Table A4 are provided in Table A3.

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TABLE A1

BUILDING GEOMETRY LIMITATIONS APPLICABLE TO TABLE A2

Aspect	Limit
Design wind pressure	Windows in walls and roofs only
Height to top of roof (see AS 4055)	≤8.5 m
Height to eaves (see AS 4055)	6.0 m
Maximum building width, excluding the eaves (see AS 4055)	16.0 m
Length of building	Not greater than 5 times building width
Roof pitch	Not greater than 35°
Floor plan	Rectangular or combination of rectangular units
Building importance level in accordance with the NCC	Level 2—500 year return

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TABLE A2

ULTIMATE AND SERVICEABILITY LIMIT STATE DESIGN WIND PRESSURES FOR HOUSING ONLY

Wind classification	Design gust wind speed m/s		Design pressures, kPa									
			Walls				Roofs					
	$V_{h,u}$	$V_{h,s}$	Greater than 1.2 m from corners		Up to 1.2 m from the corner		Any position		General away from edges		Up to 1.2 m from edges	
			$K_cC_{p,n}$ = 0.9		$K_cC_{p,n}$ = −1.35		$K_cC_{p,n}$ = 0.63		$K_cC_{p,n}$ = −0.99		$K_cC_{p,n}$ = −1.8	
	ULS	SLS	ULS	SLS	ULS	SLS	ULS	SLS	ULS	SLS	ULS	SLS
N1	34	26	0.62	0.37	−0.94	−0.55	0.44	0.26	−0.69	−0.4	−1.25	−0.73
N2	40	26	0.86	0.37	−1.3	−0.55	0.6	0.26	−0.95	−0.4	−1.73	−0.73
N3	50	32	1.35	0.55	−2.03	−0.83	0.95	0.39	−1.49	−0.61	−2.7	−1.11
N4	61	39	2.01	0.82	−3.01	−1.23	1.41	0.57	−2.21	−0.90	−4.02	−1.64
N5	74	47	2.96	1.19	−4.44	−1.79	2.07	0.84	−3.25	−1.31	−5.91	−2.39
N6	86	55	3.99	1.63	−5.99	−2.45	2.8	1.14	−4.39	−1.80	−7.99	−3.27
			$K_cC_{p,n}$ = −1.2	$K_cC_{p,n}$ = 0.9	$K_cC_{p,n}$ = −1.8	$K_cC_{p,n}$ = −1.35	$K_cC_{p,n}$ = −0.95	$K_cC_{p,n}$ = 0.63	$K_cC_{p,n}$ = −1.44	$K_cC_{p,n}$ = −0.99	$K_cC_{p,n}$ = −2.25	$K_cC_{p,n}$ = −1.8
			ULS	SLS	ULS	SLS	ULS	SLS	ULS	SLS	ULS	SLS
C1	50	32	1.8	0.55	−2.7	−0.83	1.43	0.39	−2.16	−0.61	−3.38	−1.11
C2	61	39	2.68	0.82	−4.02	−1.23	2.12	0.57	−3.21	−0.90	−5.02	−1.64
C3	74	47	3.94	1.19	−5.91	−1.79	3.12	0.84	−4.73	−1.31	−7.39	−2.39
C4	86	55	5.33	1.63	−7.99	−2.45	4.22	1.14	−6.39	−1.80	−9.98	−3.27

NOTES:

1 The pressures have been calculated using the net pressure coefficients provided in AS 4055.

2 The design gust wind speeds for each classification has been obtained from AS 4055.

3 For walls, the 'greater than 1.2 m from corners' pressures have been determined using the pressure coefficients provided in AS 4055 for walls in general.

4 For roofs, all locations have to be able to resist both positive and negative net pressures. The positive net pressures apply to any position on the surface. At corners (within 1200 mm of both edges), refer to AS 4055.

5 For glass with 25% or more of the width of a single panel or pane within 1200 mm of the building edge, use the corner pressures.

6 In order to use the internal pressures in the wind classifications in this Table, all of the cladding elements including windows, doors and garage doors need to be designed to resist the design winds.

A3

A4 WIND LOADING FOR ALL BUILDINGS OTHER THAN HOUSING

The design wind pressure for all buildings other than housing should be determined in accordance with the NCC for the importance level of the building and the annual probability of exceedance.

The design wind pressures for glass in walls of buildings, in accordance with AS/NZS 1170.2, are given in Table A4. The criteria and limitations used in developing the design wind pressures applicable to Table A4 are provided in Table A3.

NOTE: The wind loads for buildings less than 10 m in height given in this Appendix are based on the relevant design wind speeds and terrain/height multipliers given in AS/NZS 1170.2 with an average roof height of 10 m.

The ULS and SLS design wind pressures given in Table A4 have been determined for corner locations in buildings and may be conservative if applied to other locations. Lower design wind pressures could be obtained for other locations in the buildings by using the criteria specified in AS/NZS 1170.2.

TABLE A3

BUILDING GEOMETRY LIMITATIONS APPLICABLE TO TABLES A4 AND A5

Aspect	Limit
Design wind pressure	Windows in walls and roofs only
Average roof height	≤10.0 m
Floor plan	Rectangular or combination of rectangular units
Internal pressures	Two or three walls equally permeable, other walls impermeable
Building importance level in accordance with the NCC	SLS—25 years ULS—500 years
Building shielding	NS—No shielding PS—Partial shielding (minimum one building of equal height providing shielding)
Topographic multiplier	See AS/NZS 1170.2 (Table 4.4)
Wind direction	All directions

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TABLE A4

ULTIMATE AND SERVICEABILITY LIMIT STATE DESIGN WIND PRESSURES FOR WINDOWS IN WALLS OF BUILDINGS WITH LIMITATIONS AS DETAILED IN TABLE A3

Region	Terrain category		Ultimate and serviceability design wind pressure, kPa									
			Topographic multiplier (M_t)									
			<0.05		0.05		0.1		0.2		0.3	0.45
			PS	NS	PS	NS	PS	NS	PS	NS	NS	NS
A	TC3	ULS	1.07	1.13	1.25	1.32	1.45	1.52	1.87	1.97	2.48	3.30
		SLS	0.73	0.76	0.85	0.89	0.98	1.03	1.27	1.33	1.67	2.23
	TC2.5	ULS	1.32	1.39	1.54	1.62	1.78	1.87	2.30	2.42	3.04	4.06
		SLS	0.89	0.94	1.04	1.09	1.20	1.26	1.55	1.64	2.06	2.74
	TC2	ULS	1.56	1.64	1.82	1.91	2.10	2.21	2.72	2.86	3.59	4.80
		SLS	1.05	1.11	1.23	1.29	1.42	1.49	1.84	1.93	2.43	3.24
	TC1.5	ULS	1.96	2.06	2.28	2.40	2.63	2.77	3.41	3.59	4.51	6.02
		SLS	1.32	1.39	1.54	1.62	1.78	1.87	2.30	2.42	3.05	4.07
	TC1	ULS	1.96	2.06	2.28	2.40	2.63	2.77	3.41	3.59	4.51	6.02
		SLS	1.32	1.39	1.54	1.62	1.78	1.87	2.30	2.42	3.05	4.07
B	TC3	ULS	1.72	1.81	2.01	2.11	2.32	2.44	3.00	3.16	3.97	5.30
		SLS	0.81	0.85	0.94	0.99	1.09	1.14	1.41	1.48	1.86	2.48
	TC2.5	ULS	2.12	2.23	2.47	2.60	2.85	3.00	3.69	3.88	4.88	6.51
		SLS	0.99	1.04	1.16	1.22	1.33	1.40	1.73	1.82	2.28	3.05
	TC2	ULS	2.50	2.63	2.92	3.07	3.37	3.54	4.36	4.59	5.76	7.70
		SLS	1.17	1.23	1.37	1.44	1.58	1.66	2.04	2.15	2.70	3.60
	TC1.5	ULS	2.50	2.63	2.92	3.07	3.37	3.54	4.36	4.59	5.76	7.70
		SLS	1.17	1.23	1.37	1.44	1.58	1.66	2.04	2.15	2.70	3.60
	TC1	ULS	3.14	3.30	3.66	3.85	4.22	4.44	5.47	5.75	7.23	9.65
		SLS	1.47	1.55	1.71	1.80	1.98	2.08	2.56	2.69	3.39	4.52
C	TC3	ULS	3.40	3.57	3.96	4.17	4.57	4.81	5.92	6.23	7.83	10.45
		SLS	1.17	1.23	1.37	1.44	1.58	1.66	2.04	2.15	2.70	3.60
	TC2.5	ULS	4.17	4.39	4.87	5.12	5.62	5.91	7.27	7.65	9.62	12.84
		SLS	1.44	1.51	1.68	1.77	1.94	2.04	2.51	2.64	3.32	4.43
	TC2	ULS	4.93	5.19	5.75	6.05	6.63	6.98	8.59	9.04	11.36	15.17
		SLS	1.70	1.79	1.98	2.09	2.29	2.41	2.96	3.12	3.92	5.23
	TC1.5	ULS	4.93	5.19	5.75	6.05	6.63	6.98	8.59	9.04	11.36	15.17
		SLS	1.70	1.79	1.98	2.09	2.29	2.41	2.96	3.12	3.92	5.23
	TC1	ULS	6.18	6.51	7.21	7.59	8.32	8.75	10.78	11.34	14.25	19.02
		SLS	2.13	2.24	2.49	2.62	2.87	3.02	3.72	3.91	4.92	6.56

(*continued*)

A3

TABLE A4 (*continued*)

Region	Terrain category		Ultimate and serviceability design wind pressure, kPa									
			Topographic multiplier (M_t)									
			<0.05		0.05		0.1		0.2		0.3	0.45
			PS	NS	PS	NS	PS	NS	PS	NS	NS	NS
D	TC3	ULS	5.48	5.76	6.39	6.72	7.37	7.75	9.54	10.04	12.62	16.85
		SLS	1.49	1.57	1.74	1.83	2.01	2.11	2.60	2.73	3.43	4.58
	TC2.5	ULS	6.73	7.08	7.85	8.26	9.06	9.53	11.73	12.33	15.51	20.70
		SLS	1.83	1.93	2.14	2.25	2.46	2.59	3.19	3.36	4.22	5.63
	TC2	ULS	7.95	8.36	9.27	9.76	10.70	11.25	13.85	14.57	18.32	24.46
		SLS	2.16	2.28	2.52	2.65	2.91	3.06	3.77	3.96	4.98	6.65
	TC1.5	ULS	7.95	8.36	9.27	9.76	10.70	11.25	13.85	14.57	18.32	24.46
		SLS	2.16	2.28	2.52	2.65	2.91	3.06	3.77	3.96	4.98	6.65
	TC1	ULS	9.97	10.49	11.63	12.24	13.42	14.12	17.38	18.28	22.98	30.68
		SLS	2.71	2.85	3.16	3.33	3.65	3.84	4.73	4.97	6.25	8.35

LEGEND:
ULS = Ultimate limit state
SLS = Serviceability limit state

NOTES:

1 The design wind pressures have been calculated using the regional wind speeds of AS/NZS 1170.2 with an average recurrence interval of 500 years for ULS and 25 years for SLS.

2 The design wind pressures have been calculated on the basis of generalized assumptions. Detailed calculations based on specific buildings might yield higher or lower pressures.

3 The multipliers and factors used are as follows:

(a) Direction multiplier (M_d) .... 1.0 (any direction).

(b) Terrain/height multiplier ($M_{z,cats}$) based on an average building height of 10 m:

(i) For Terrain Category 3 .... 0.83.

(ii) For Terrain Category 2.5 .... 0.92.

(iii) For Terrain Category 2 .... 1.0.

(iv) For Terrain Category 1.5 .... 1.06.

(v) For Terrain Category 1 .... 1.12.

(c) Shielding multiplier (M_s):

(i) For all terrain categories (no shielding) .... 1.0.

(ii) For all terrain categories (partial shielding) .... 0.975.

(d) Topographic multiplier (M_t) for slopes:

(i) <0.05 (flat ground) .... 1.0.

(ii) 0.05 .... 1.08.

(iii) 0.1 .... 1.16.

(iv) 0.2 .... 1.32.

(v) 0.3 .... 1.48.

(vi) 0.45 .... 1.71.

(e) Net aerodynamic shape factor C_{fig}:

(i) For regions A and B, and C and D (SLS only) .... 1.35.

(ii) For regions C and D (ULS only) .... 1.8.

(f) Combination factor K_c .... 0.9 (external and internal).

4 In order to use the pressures in this Table, all of the cladding elements including windows, doors and garage doors need to be designed to resist the design winds.

TABLE A5

ULTIMATE AND SERVICEABILITY LIMIT STATE DESIGN WIND PRESSURES FOR ROOFS OF BUILDINGS WITH LIMITATIONS AS DETAILED IN TABLE A3

Region	Terrain category	Location		Ultimate and serviceability design wind pressure, kPa											
				Topographic multiplier (M_t)											
				<0.05		0.05		0.1		0.2		0.3		0.45	
				PS	NS	PS	NS	PS	NS	PS	NS	PS	NS	PS	NS
A	TC3	General	SLS	0.34	0.36	0.40	0.42	0.46	0.48	0.59	0.62	0.74	0.78	0.99	1.04
			ULS	0.50	0.53	0.58	0.62	0.67	0.71	0.87	0.92	1.10	1.16	1.47	1.54
		Edges	SLS	−0.97	−1.02	−1.13	−1.19	−1.30	−1.37	−1.69	−1.77	−2.12	−2.23	−2.83	−2.98
			ULS	−1.43	−1.51	−1.67	−1.76	−1.93	−2.03	−2.50	−2.63	−3.14	−3.30	−4.19	−4.41
	TC2.5	General	SLS	0.42	0.44	0.49	0.51	0.56	0.59	0.73	0.76	0.91	0.96	1.22	1.28
			ULS	0.62	0.65	0.72	0.76	0.83	0.87	1.07	1.13	1.35	1.42	1.80	1.89
		Edges	SLS	−1.19	−1.25	−1.39	−1.46	−1.60	−1.68	−2.07	−2.18	−2.61	−2.74	−3.48	−3.66
			ULS	−1.76	−1.85	−2.05	−2.16	−2.37	−2.49	−3.07	−3.23	−3.85	−4.05	−5.15	−5.41
	TC2	General	SLS	0.49	0.52	0.57	0.60	0.66	0.70	0.86	0.90	1.08	1.13	1.44	1.51
			ULS	0.73	0.77	0.85	0.89	0.98	1.03	1.27	1.33	1.59	1.68	2.13	2.24
		Edges	SLS	−1.41	−1.48	−1.64	−1.72	−1.89	−1.99	−2.45	−2.58	−3.08	−3.24	−4.11	−4.32
			ULS	−2.08	−2.19	−2.42	−2.55	−2.80	−2.94	−3.62	−3.81	−4.55	−4.79	−6.08	−6.40
	TC1.5	General	SLS	0.62	0.65	0.72	0.76	0.83	0.87	1.08	1.13	1.35	1.42	1.80	1.90
			ULS	0.91	0.96	1.06	1.12	1.23	1.29	1.59	1.67	2.00	2.10	2.67	2.81
		Edges	SLS	−1.76	−1.85	−2.06	−2.16	−2.37	−2.50	−3.07	−3.23	−3.86	−4.06	−5.16	−5.42
			ULS	−2.61	−2.74	−3.04	−3.20	−3.51	−3.69	−4.54	−4.78	−5.71	−6.01	−7.63	−8.02
	TC1	General	SLS	0.62	0.65	0.72	0.76	0.83	0.87	1.08	1.13	1.35	1.42	1.80	1.90
			ULS	0.91	0.96	1.06	1.12	1.23	1.29	1.59	1.67	2.00	2.10	2.67	2.81
		Edges	SLS	−1.76	−1.85	−2.06	−2.16	−2.37	−2.50	−3.07	−3.23	−3.86	−4.06	−5.16	−5.42
			ULS	−2.61	−2.74	−3.04	−3.20	−3.51	−3.69	−4.54	−4.78	−5.71	−6.01	−7.63	−8.02

(continued)

TABLE A5 (*continued*)

Region	Terrain category	Location		Ultimate and serviceability design wind pressure, kPa											
				Topographic multiplier (M_t)											
				<0.05		0.05		0.1		0.2		0.3		0.45	
				PS	NS	PS	NS	PS	NS	PS	NS	PS	NS	PS	NS
B	TC3	General	SLS	0.38	0.40	0.44	0.46	0.51	0.53	0.66	0.69	0.82	0.87	1.10	1.16
			ULS	0.80	0.85	0.94	0.99	1.08	1.14	1.40	1.47	1.76	1.85	2.35	2.47
		Edges	SLS	−1.08	−1.13	−1.25	−1.32	−1.45	−1.52	−1.87	−1.97	−2.36	−2.48	−3.15	−3.31
			ULS	−2.30	−2.42	−2.68	−2.82	−3.09	−3.25	-4.00	−4.21	−5.03	−5.29	−6.72	−7.07
	TC2.5	General	SLS	0.46	0.49	0.54	0.57	0.62	0.65	0.81	0.85	1.01	1.07	1.35	1.42
			ULS	0.99	1.04	1.15	1.21	1.33	1.40	1.72	1.81	2.16	2.28	2.89	3.04
		Edges	SLS	−1.32	−1.39	−1.54	−1.62	−1.78	−1.87	−2.30	−2.42	−2.90	−3.05	−3.86	−4.07
			ULS	−2.82	−2.97	−3.29	−3.46	−3.80	−4.00	−4.92	−5.17	−6.18	−6.51	−8.26	−8.68
	TC2	General	SLS	0.55	0.57	0.64	0.67	0.74	0.77	0.95	1.00	1.20	1.26	1.60	1.68
			ULS	1.17	1.23	1.36	1.43	1.57	1.65	2.03	2.14	2.56	2.69	3.41	3.59
		Edges	SLS	−1.56	−1.64	−1.82	−1.92	−2.10	−2.21	−2.72	−2.86	−3.42	−3.60	−4.57	−4.80
			ULS	−3.34	−3.51	−3.89	−4.09	−4.49	−4.72	−5.81	−6.11	−7.31	−7.69	−9.75	−10.26
	TC1.5	General	SLS	0.69	0.72	0.80	0.84	0.92	0.97	1.19	1.26	1.50	1.58	2.00	2.11
			ULS	1.46	1.54	1.71	1.80	1.97	2.07	2.55	2.68	3.21	3.37	4.28	4.50
		Edges	SLS	−1.96	−2.06	−2.28	−2.40	−2.64	−2.77	−3.41	−3.59	−4.29	−4.51	−5.73	−6.03
			ULS	−4.18	−4.40	−4.88	−5.13	−5.63	−5.92	−7.29	−7.67	−9.17	−9.64	−12.24	−12.87
	TC1	General	SLS	0.69	0.72	0.80	0.84	0.92	0.97	1.19	1.26	1.50	1.58	2.00	2.11
			ULS	1.46	1.54	1.71	1.80	1.97	2.07	2.55	2.68	3.21	3.37	4.28	4.50
		Edges	SLS	−1.96	−2.06	−2.28	−2.40	−2.64	−2.77	−3.41	−3.59	−4.29	−4.51	−5.73	−6.03
			ULS	−4.18	−4.40	−4.88	−5.13	−5.63	−5.92	−7.29	−7.67	−9.17	−9.64	−12.24	−12.87

(*continued*)

A3

TABLE A5 (*continued*)

Region	Terrain category	Location		Ultimate and serviceability design wind pressure, kPa											
				Topographic multiplier (M_t)											
				<0.05		0.05		0.1		0.2		0.3		0.45	
				PS	NS	PS	NS	PS	NS	PS	NS	PS	NS	PS	NS
C	TC3	General	SLS	0.55	0.58	0.64	0.67	0.74	0.77	0.95	1.00	1.20	1.26	1.60	1.68
			ULS	1.79	1.89	2.09	2.20	2.41	2.54	3.12	3.29	3.93	4.13	5.24	5.51
		Edges	SLS	−1.56	−1.64	−1.82	−1.92	−2.10	−2.21	−2.72	−2.86	−3.42	−3.60	−4.57	−4.81
			ULS	−4.25	−4.47	−4.95	−5.21	−5.71	−6.01	−7.40	−7.78	−9.30	−9.78	−12.42	−13.06
	TC2.5	General	SLS	0.67	0.71	0.78	0.82	0.90	0.95	1.17	1.23	1.47	1.55	1.96	2.07
			ULS	2.20	2.32	2.57	2.70	2.96	3.12	3.84	4.04	4.82	5.08	6.44	6.77
		Edges	SLS	−1.92	−2.02	−2.24	−2.36	−2.58	−2.72	−3.34	−3.52	−4.20	−4.42	−5.61	−5.90
			ULS	−5.22	−5.49	−6.08	−6.40	−7.02	−7.38	−9.09	−9.56	−11.43	−12.02	−15.25	−16.05
	TC2	General	SLS	0.79	0.84	0.93	0.97	1.07	1.12	1.38	1.45	1.74	1.83	2.32	2.44
			ULS	2.60	2.74	3.04	3.19	3.50	3.68	4.53	4.77	5.70	6.00	7.61	8.00
		Edges	SLS	−2.27	−2.39	−2.65	−2.78	−3.05	−3.21	−3.95	−4.16	−4.97	−5.23	−6.63	−6.98
			ULS	−6.16	−6.48	−7.19	−7.56	−8.29	−8.72	−10.74	−11.30	−13.50	−14.20	−18.02	−18.96
	TC1.5	General	SLS	1.00	1.05	1.16	1.22	1.34	1.41	1.73	1.83	2.18	2.29	2.91	3.06
			ULS	3.26	3.43	3.81	4.01	4.39	4.62	5.69	5.98	7.15	7.52	9.55	10.04
		Edges	SLS	−2.84	−2.99	−3.32	−3.49	−3.83	−4.03	−4.96	−5.21	−6.23	−6.56	−8.32	−8.75
			ULS	−7.73	−8.13	−9.02	−9.49	−10.40	−10.94	−13.47	−14.17	−16.93	−17.81	−22.61	−23.78
	TC1	General	SLS	1.00	1.05	1.16	1.22	1.34	1.41	1.73	1.83	2.18	2.29	2.91	3.06
			ULS	3.26	3.43	3.81	4.01	4.39	4.62	5.69	5.98	7.15	7.52	9.55	10.04
		Edges	SLS	−2.84	−2.99	−3.32	−3.49	−3.83	−4.03	−4.96	−5.21	−6.23	−6.56	−8.32	−8.75
			ULS	−7.73	−8.13	−9.02	−9.49	−10.40	−10.94	−13.47	−14.17	−16.93	−17.81	−22.61	−23.78

(*continued*)

TABLE A5 (*continued*)

Region	Terrain category	Location		Ultimate and serviceability design wind pressure, kPa											
				Topographic multiplier (M_t)											
				<0.05		0.05		0.1		0.2		0.3		0.45	
				PS	NS	PS	NS	PS	NS	PS	NS	PS	NS	PS	NS
D	TC3	General	SLS	0.70	0.73	0.81	0.85	0.94	0.98	1.21	1.27	1.52	1.60	2.03	2.14
			ULS	2.89	3.04	3.37	3.55	3.89	4.09	5.04	5.30	6.33	6.66	8.45	8.89
		Edges	SLS	−1.99	−2.09	−2.32	−2.44	−2.67	−2.81	−3.46	−3.64	−4.35	−4.58	−5.81	−6.11
			ULS	−6.85	−7.20	−7.99	−8.40	−9.21	−9.69	−11.93	−12.55	−15.00	−15.78	−20.02	−21.06
	TC2.5	General	SLS	0.85	0.90	1.00	1.05	1.15	1.21	1.49	1.57	1.87	1.97	2.50	2.63
			ULS	3.55	3.74	4.14	4.36	4.78	5.03	6.19	6.51	7.78	8.18	10.39	10.92
		Edges	SLS	−2.44	−2.57	−2.85	−3.00	−3.28	−3.46	−4.25	−4.47	−5.35	−5.62	−7.14	−7.51
			ULS	−8.41	−8.85	−9.81	−10.32	−11.32	−11.91	−14.66	−15.42	−18.42	−19.38	−24.60	−25.87
	TC2	General	SLS	1.01	1.06	1.18	1.24	1.36	1.43	1.76	1.85	2.21	2.33	2.95	3.10
			ULS	4.20	4.41	4.89	5.15	5.65	5.94	7.31	7.69	9.19	9.67	12.27	12.91
		Edges	SLS	−2.88	−3.03	−3.36	−3.54	−3.88	−4.08	−5.02	−5.29	−6.32	−6.65	−8.43	−8.87
			ULS	−9.94	−10.45	−11.59	−12.19	−13.37	−14.07	−17.32	−18.22	−21.77	−22.90	−29.06	−30.57
	TC1.5	General	SLS	1.27	1.33	1.48	1.55	1.70	1.79	2.21	2.32	2.77	2.92	3.70	3.89
			ULS	5.26	5.54	6.14	6.46	7.08	7.45	9.17	9.65	11.53	12.13	15.39	16.19
		Edges	SLS	−3.62	−3.81	−4.22	−4.44	−4.87	−5.12	−6.30	−6.63	−7.92	−8.34	−10.58	−11.13
			ULS	−12.47	−13.11	−14.54	−15.30	−16.77	−17.65	−21.72	−22.85	−27.31	−28.72	−36.45	−38.35
	TC1	General	SLS	1.27	1.33	1.48	1.55	1.70	1.79	2.21	2.32	2.77	2.92	3.70	3.89
			ULS	5.26	5.54	6.14	6.46	7.08	7.45	9.17	9.65	11.53	12.13	15.39	16.19
		Edges	SLS	−3.62	−3.81	−4.22	−4.44	−4.87	−5.12	−6.30	−6.63	−7.92	−8.34	−10.58	−11.13
			ULS	−12.47	−13.11	−14.54	−15.30	−16.77	−17.65	−21.72	−22.85	−27.31	−28.72	−36.45	−38.35

LEGEND:
ULS = Ultimate limit state
SLS = Serviceability limit state

A3 NOTES TO TABLE A5:

1 The design wind pressures have been calculated using the regional wind speeds of AS/NZS 1170.2 with an average recurrence interval of 500 years for ULS and 25 years for SLS.

2 The design wind pressures have been calculated on the basis of generalized assumptions. Detailed calculations based on specific buildings may yield higher or lower pressures.

3 All locations have to be able to resist both positive and negative net pressures. The positive net pressures apply to any position on the surface. The negative net pressures apply to any location up to 1.2 m from edges. At corners (within 1200 mm of both edges), refer to AS/NZS 1170.2.

4 The multipliers and factors used are as follows:

(a) Direction multiplier (M_d) .... 1.0 (any direction).

(b) Terrain/height multiplier ($M_{z,cat}$) based on an average building height of 10 m:

(i) Terrain category 3 .... 0.83.

(ii) Terrain category 2.5 .... 0.92.

(iii) Terrain category 2 .... 1.00.

(iv) Terrain category 1.5 .... 1.06.

(v) Terrain category 1 .... 1.12.

(c) Shielding multiplier (M_s):

(i) All terrain categories, no shielding .... 1.0.

(ii) All terrain categories, partial shielding .... 0.975.

(d) Topographic multiplier (M_t):

(i) <0.05 (flat ground) .... 1.

(ii) 0.05 .... 1.08.

(iii) 0.1 .... 1.16.

(iv) 0.2 .... 1.32.

(v) 0.3 .... 1.48.

(vi) 0.45 .... 1.71.

(e) Pressure coefficients:

(i) For regions A and B, and C and D (SLS only):

(A) $C_{p,e}$ .... −0.9.

(B) .... 0.4.

(C) $C_{p,i}$ .... 0.2.

(D) .... −0.3.

(ii) For regions C and D (ULS only):

(A) $C_{p,e}$ .... −0.9.

(B) .... 0.4.

(C) $C_{p,i}$ .... 0.7.

(D) .... −0.65.

(f) Combination factor K_c .... 0.9 (external and internal).

(g) Local pressure factors K_l:

General .... 1.0 Positive pressures, all areas.

RA2, RA4 .... 2.0 Negative pressures, roof edges, ridges and hips.

(h) Net aerodynamic shape factor $K_c C_{fig}$:

(i) For regions A and B, and C and D (SLS only):

(A) General .... 0.63.

(B) Roof edges, ridges and hips .... −1.80.

(ii) For regions C and D (ULS only):

(A) General .... 0.95.

(B) Roof edges, ridges and hips .... 2.25.

5 In order to use the pressures in this Table, all of the cladding elements including windows, doors and garage doors need to be designed to resist the design winds.

APPENDIX B

WORKED EXAMPLES TO SECTION 4 WIND LOADING REQUIREMENTS

(Informative)

B1 TECHNICAL BASIS FOR THE DEVELOPMENT OF THE DESIGN GRAPHS

B1.1 Analysis methodology

For rectangular glass supported on four edges, a geometric non-linear finite element analysis was carried out on a number of glass sizes and thicknesses under differing wind loads. The results of these analyses form the basis of the four-sided support curves and equations.

For rectangular glass supported on two edges, the standard linear elastic simple beam equation was used ignoring the small membrane effects that may develop in a wide beam.

B1.2 Design stress

The design graphs in Section 4 were developed using the limiting design stresses as shown in Table B1. These stresses were generated from the characteristic tensile strength of annealed glass, which varies with the thickness of the glass together with a capacity reduction factor of 0.67 and the appropriate glass type factors, surface factor and load duration factor as detailed in Section 3.

B1.3 Deflection limit

Separate design charts have also been developed using the deflection limit of span/60 for the glass based on the serviceability limit state design wind pressure (see Figure 4.35).

B1.4 Edge supports

Edge supports used in the analysis provided out-of-plane restrain only. No in-plane membrane action was directly resisted by the edge supports. Although the edges might be supported at their sight line by the frames, the analysis was based on the restraint being at the edge of the glass. Thus, the stresses that can occur at the glass edges under these restraint conditions were taken into account in the development of the design charts.

TABLE B1

ULTIMATE LIMIT STATE DESIGN STRESSES FOR GLASS SUBJECTED TO WIND LOADING

Glass type	Nominal thickness (mm)	Ultimate limit state design stress at locations shown	
		Away from edge (MPa)	At edge (MPa)
Annealed	3	41.00	32.80
	4	38.99	31.19
	5	37.45	29.96
	6	36.20	28.96
	8	34.33	27.46
	10	32.80	26.24
	12	31.57	25.25
	15	30.15	24.12
	19	28.72	22.98
	25	26.96	21.57
Toughened	4	97.47	77.97
	5	93.61	74.89
	6	90.49	72.39
	8	85.82	68.65
	10	82.01	65.61
	12	78.91	63.13
	15	75.37	60.30
	19	71.81	57.45
	25	67.41	53.93
Heat-strengthened	3	65.60	52.48
	4	62.38	49.90
	5	59.91	47.93
	6	57.91	46.33
	8	54.92	43.94
	10	52.48	41.99
	12	50.51	40.40
Annealed laminated	5	37.73	30.18
	6	36.43	29.14
	8	34.41	27.53
	10	32.87	26.30
	12	31.62	25.30
	16	29.75	23.80
	20	28.23	22.58
	24	26.99	21.59

NOTES:

1 The surface of the glass within a distance equal to the glass thickness is considered to be at the edge.

2 3 mm toughened glass is not included in Table B1 as it is not generally available in toughened form.

B2 EXAMPLES

B2.1 Example 1

It is desired to find the nominal thickness of ordinary annealed glass, 1200 mm × 1200mm, supported along all four edges, required for an ultimate limit state (ULS) design wind pressure of 2.8 kPa.

The steps are as follows:

(a) First calculate the glass area, in this case the area is 1.44m^2.

As the area exceeds the maximum area for 3 mm monolithic annealed glass, thus 4 mm is the minimum thickness that might be used.

(b) Select the appropriate graph to use. In this case it is Figures 4.1 to 4.10 giving ‘Curves for the span B for monolithic annealed glass’.

(c) Calculate the aspect ratio. AR = 1200/1200 = 1.0

(d) Commencing with Figure 4.2 in this case (which is applicable to 4 mm glass thickness), draw a vertical line at ULS designed wind pressure = 2.8 kPa (see Figure B1 for a marked up example).

(e) Draw a horizontal line at the intersection of the AR = 1 curve and the vertical line at 2.8 kPa ULS pressure.

(f) Read the span B from the left hand side of the graph. In this case span B = 1044 mm.

As the required span is more than this value, then 4 mm annealed glass cannot be used and, therefore it is necessary to repeat the process on the next chart for thicker glass.

(g) From Figure 4.3 (chart for 5 mm glass the next highest minimum thickness) for 2.8 kPa and AR = 1, the maximum span is found to be 1289 mm.

As the required span is less than 1289 mm, therefore the minimum nominal glass thickness required is 5 mm.

(h) Finally, by using Figure 4.35, check that the deflection limits are not exceeded. For 5 mm glass (4.8 mm minimum thickness) and a span of 1200 mm, the slenderness factor (B/t) is 250. Draw a horizontal line drawn on figure 4.35 at this slenderness factor until it reaches the AR = 1 curve. Then draw a vertical line from this point of intersection to find the maximum acceptable serviceability wind pressure (5.6 kPa). In this case it is well above the ULS design pressure and therefore using 5 mm annealed glass for this panel size will not exceed the deflection limits.

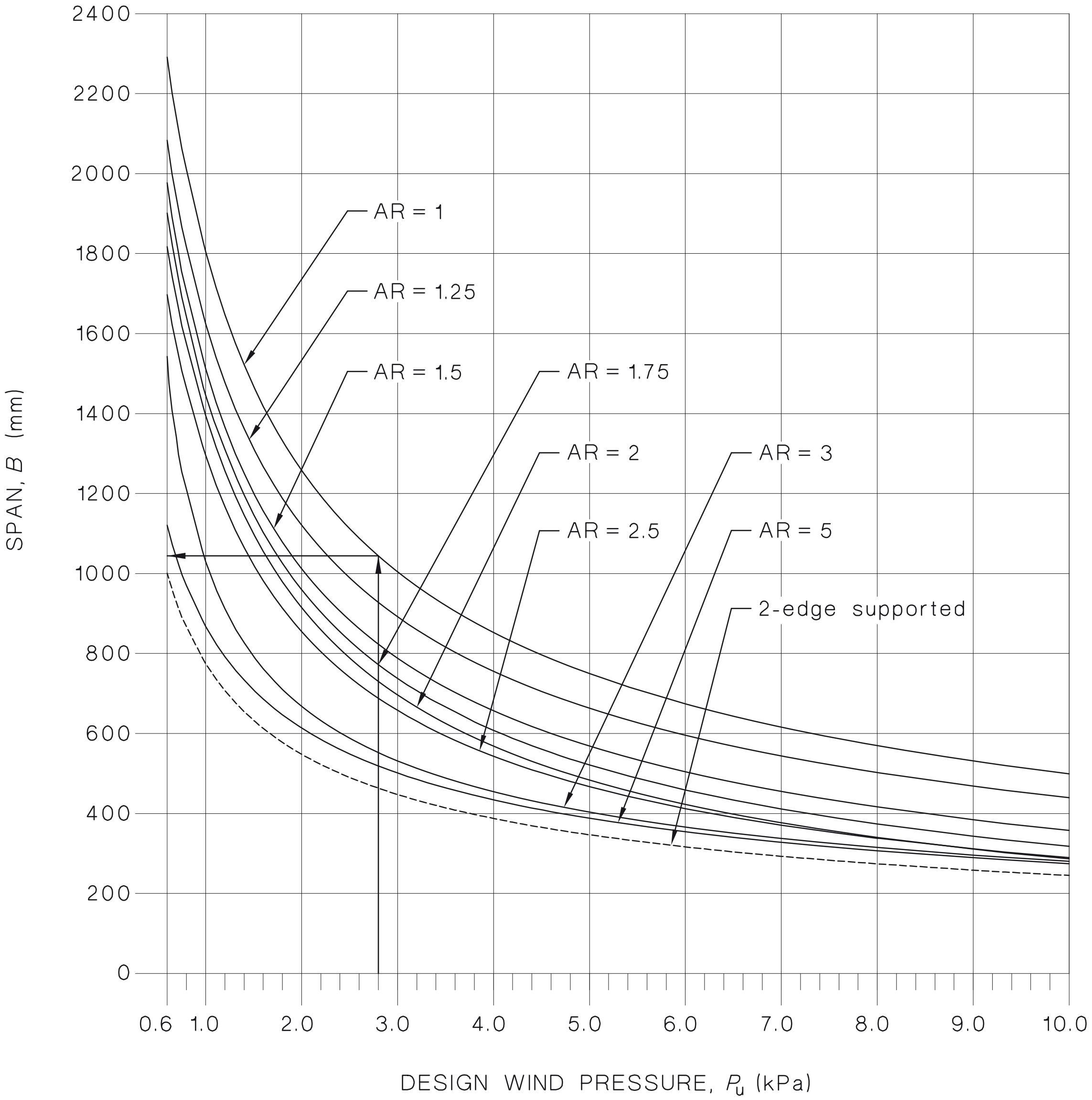


FIGURE B1 EXAMPLE 1

B2.2 Example 2

It is desired to find the nominal thickness of toughened glass, 2050 mm × 1500 mm, supported along all four edges, required to be used in wind region A with an ultimate limit state design wind pressure of 3.2 kPa (with a corresponding serviceability design wind pressure of 2.1 kPa).

(a) First select the appropriate graphs to use. In this case Figures 4.11 to 4.19 'Curves for allowable span for monolithic toughened glass,

(b) Calculate the Aspect Ratio, AR = 2050/1500 = 1.37.

NOTE: There is no curve for AR = 1.37. We must therefore interpolate between the next highest AR (AR = 1.5) and the next lowest AR (AR = 1.25).

(c) Starting with Figure 4.11, draw a vertical line at ULS design wind pressure = 3.2 kPa.

(d) Draw 2 horizontal lines. One at the intersection of AR = 1.5 and ULS = 3.2 kPa, and the other at the intersection of AR = 1.25 and ULS = 3.2 kPa. [See Figure B2 (a)]

(e) Reading the spans, B from the left-hand side of the graph (or by using the formula below the graphs) gives:

For AR = 1.25, B = 1428 mm

For AR = 1.5, B = 1316 mm

(f) Interpolating between these 2 values gives

Span, B = 1316 + ((1.5 – 1.37) / (1.50 – 1.25)) × (1428 − 1316) = 1374.

As the required span is 1500 mm, then 4 mm toughened glass cannot be used for this size and design pressure and, therefore, it is necessary to repeat the process on the next chart for thicker glass.

(g) From Figure 4.12, the horizontal lines drawn at the intersection of the vertical line at 3.2 kPa with the AR = 1.25 and AR = 1.5 curves gives (by using the formula below the graphs):

For AR = 1.25, B = 1766 mm.

For AR = 1.5, B = 1625 mm

Interpolating between these two values gives;

Span, B = 1625 + ((1.5 – 1.37) / (1.50 – 1.25)) × (1766 – 1625) = 1698 mm

Therefore, as the required span is less than this, the minimum nominal thickness of toughened glass required is 5 mm to satisfy the strength requirements.

(h) Finally, by using Figure 4.35, check that the deflection limits are not exceeded. Draw a vertical line at the serviceability design wind pressure = 2.1 kPa. Then draw two horizontal lines. One at the intersection of AR = 1.5 and 2.1 kPa, and the other at the intersection of AR = 1.25 and 2.1 kPa. Then, reading the slenderness factors, B/t from the left hand side of the graph (or by using the formula below the graphs) gives;

For AR = 1.25, B/t = 326.4

For AR = 1.5, B/t = 260.5

Interpolating between these two values gives the maximum allowable slenderness factor;

B/t = 260.5 + ((1.5 – 1.37) / (1.50 – 1.25)) × (326.4 − 260.5) = 294.8

For 5 mm glass (4.8 mm minimum thickness) and a span of 1500 mm, the slenderness factor (B/t) is 312.5. Therefore, 5 mm toughened glass cannot be used in this case as the deflection would be excessive. The next highest thickness (6 mm) has a minimum thickness of 5.8 mm and thus the slenderness ratio would be 1500/5.8 = 258.6 and therefore the deflection criteria would not be exceeded using 6 mm toughened glass for this panel.

(i) Therefore, the nominal thickness of toughened glass required in order to meet both the deflection and strength criteria for this glass size is 6 mm.

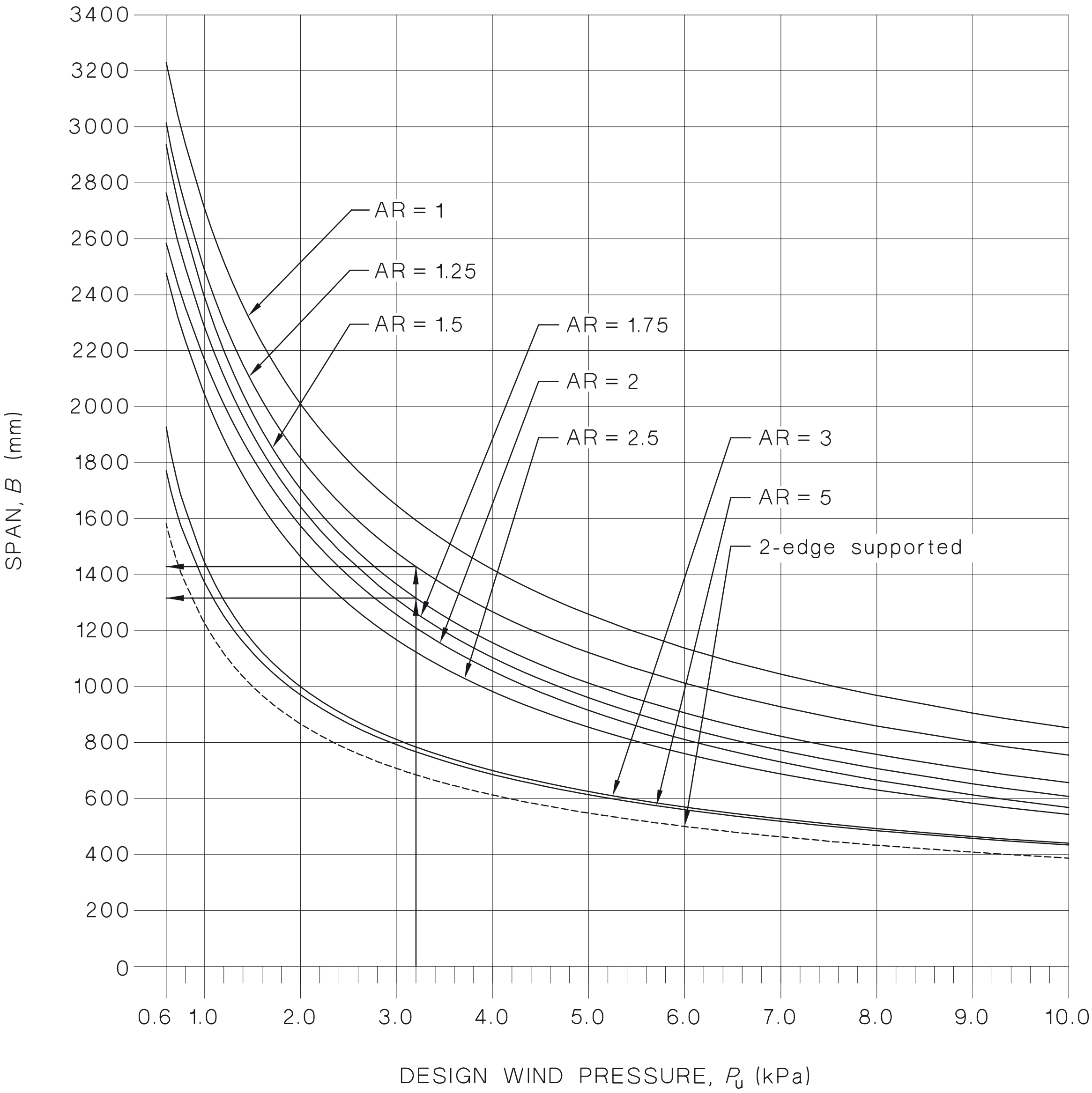


FIGURE B2(A) EXAMPLE 2

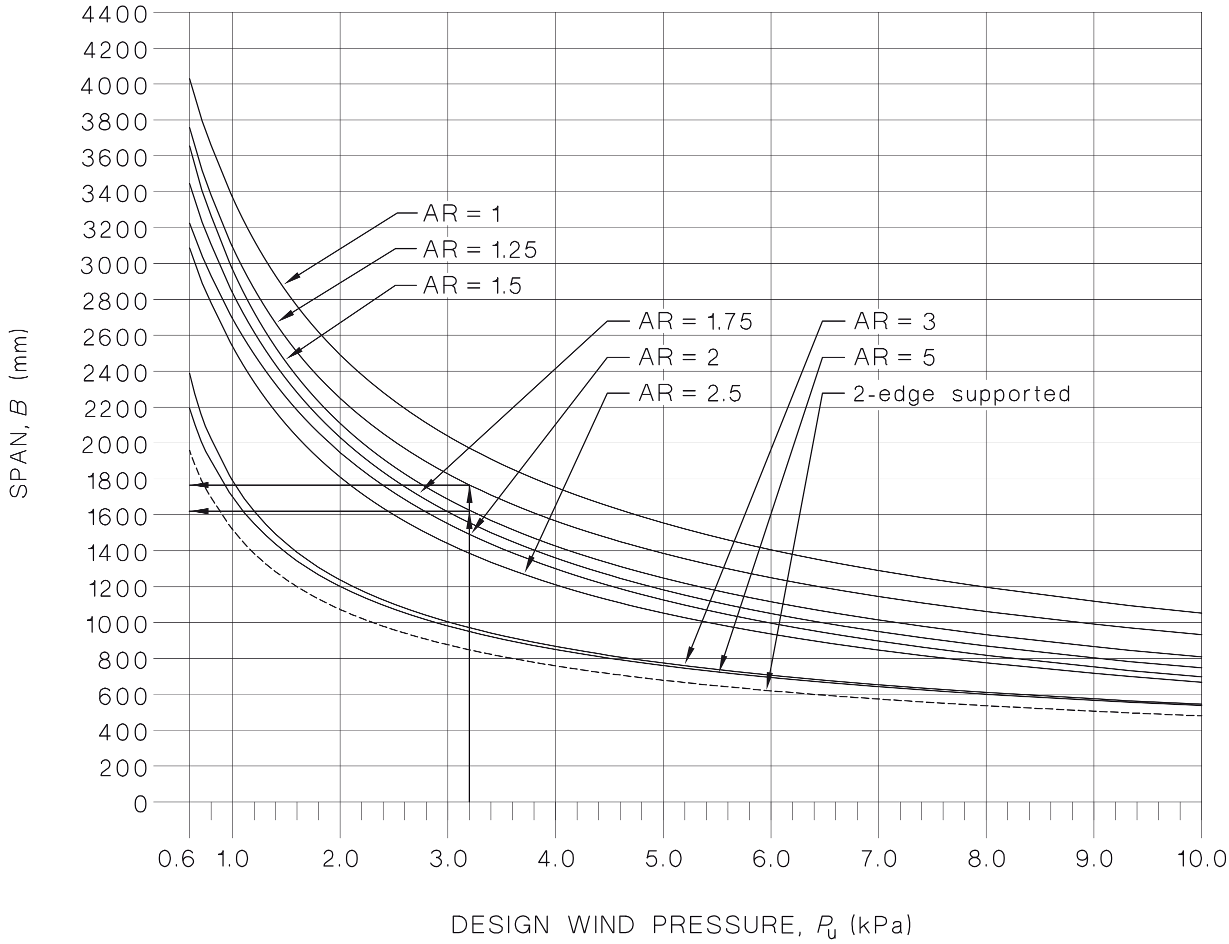


FIGURE B2(B) EXAMPLE 2

APPENDIX C

BASIS FOR DETERMINATION OF FIN DESIGN TO PREVENT BUCKLING

(Informative)

C1 INTRODUCTION

In glass facades that use glass stiffening fins located on the inside to provide the necessary support for the facade panels, it is necessary to ensure that buckling of the fin will not occur when it is subjected to the design loads.

Since there are many possible configurations for glass stiffening fins, it is not practicable to provide a simplified design approach. Consequently, each design must be analysed in accordance with accepted engineering principles.

The analysis requires a knowledge of the critical elastic buckling moment (M_{CR}), and values for particular situations can be obtained from standard texts on structural analysis. However, as an aid to design, some values of the critical elastic moment are presented in this Appendix.

A2 The ultimate limit state design moment for a particular structural situation shall not exceed the critical elastic buckling moment (M_{CR}) divided by a factor of safety of 1.14.

The following recommendations are applicable to end-supported beams of bisymmetrical cross-section for which the contribution of warping stiffness to the buckling strength may be neglected.

The ends at supports are assumed to be effectively restrained against twisting. This condition will be satisfied if the supports possess a torsional stiffness in excess of 20 *GJ/L*, where *GJ* is the torsional rigidity of the beam and *L* is its length.

NOTE: For information on more general sections, including the effects of warping stiffness, refer to NETHERCOT, D.A. AND ROCKNEY, K.C. Unified Approach to the Elastic Lateral Buckling of Beams, *The Structural Engineer*, Vol. 49, No. 7, July 1971, pp. 321–30. (For erratum, see Vol. 51, No. 4, April 1973, pp. 138–9.)

C2 BEAMS WITH INTERMEDIATE BUCKLING RESTRAINTS

The critical elastic value of the maximum moment between two buckling restraints may be taken as—

$$M_{CR} = (g_1 / L_{ay})\left[(EI)_y (GJ)\right]^{1/2} \quad \text{. . . C2(1)}$$

where

M_{CR} = critical elastic buckling moment

g_1 = constant obtained from Table C1

L_{ay} = distance between effectively rigid buckling restraints

$(EI)_y$ = effective rigidity for bending about the minor axis

(GJ) = effective torsional rigidity

In computing the effective torsional rigidity of beams of solid rectangular cross-section, the value of the torsional moment of inertia (J) may be taken as—

$$J = \frac{db^3}{3}\left(1 - 0.63\frac{b}{d}\right)$$

where

d and b are the depth and breadth of the fin respectively.

A2 For values of the torsional elastic modulus (G) and the linear elastic modulus (E), see Clause 2.1.6.

TABLE C1

COEFFICIENTS FOR SLENDERNESS FACTOR OF BISYMMETRICAL BEAMS WITH INTERMEDIATE BUCKLING RESTRAINTS

Moment parameter (β) (see Figure C1(c))	Slenderness factor (g_1)	
	Free restraint condition*	Fixed restraint condition*
1.0	3.1	6.3
0.5	4.1	8.2
0.0	5.5	11.1
−0.5	7.3	14.0
−1.0	8.0	14.0

* The buckling restraints must prevent rotation of the beam about the z-axis. The terms 'free' and 'fixed' restraint condition refer to the possibility for rotation of the beam about y-y axis at the restraint locations, as shown in Figure C1.

C3 BEAMS WITH NO INTERMEDIATE BUCKLING RESTRAINTS

The critical elastic value of maximum moment of beams with no intermediate buckling restraints may be taken as —

A1

$$M_{CR} = (g_2 / L_{ay})\,[(EI)_y (GJ)]^{1/2}\,[1 - g_3 (y_h / L_{ay})[(EI)_y /(GJ)]^{1/2}] \quad \ldots \text{C3(1)}$$

where

M_{CR} = critical elastic buckling moment

g_2, g_3 = constants obtained from Table C2

L_{ay} = distance between effectively rigid buckling restraints (span of beam)

$(EI)_y$ = effective rigidity for bending about the minor axis

(GJ) = effective torsional rigidity

y_h = height above centroid of the point of load application

NOTE: In Table C2, the values of the coefficients g_2 and g_3 apply to beams with lateral restraints only at their end points. However, these coefficients may be used for any other beam load system that has a similar shape of bending moment diagram between points of lateral restraint.

C4 CONTINUOUSLY RESTRAINED BEAMS

For beams of bisymmetrical cross-section continuously restrained against lateral displacement at a distance y_o from the neutral axis, the critical elastic moment M_{CR} may be taken as—

$$M_{\mathrm{CR}} = \frac{\left(\pi / L_{\mathrm{ay}}\right)^2 (EI)_{\mathrm{y}} \left[\frac{d^2}{12} + y_0^2\right] + (GJ)}{\left(2y_0 + y_{\mathrm{h}}\right)} \quad \ldots \mathrm{C4(1)}$$

where

M_{CR} = critical elastic buckling moment

L_{ay} = distance between points of effective rigid rotational restraints

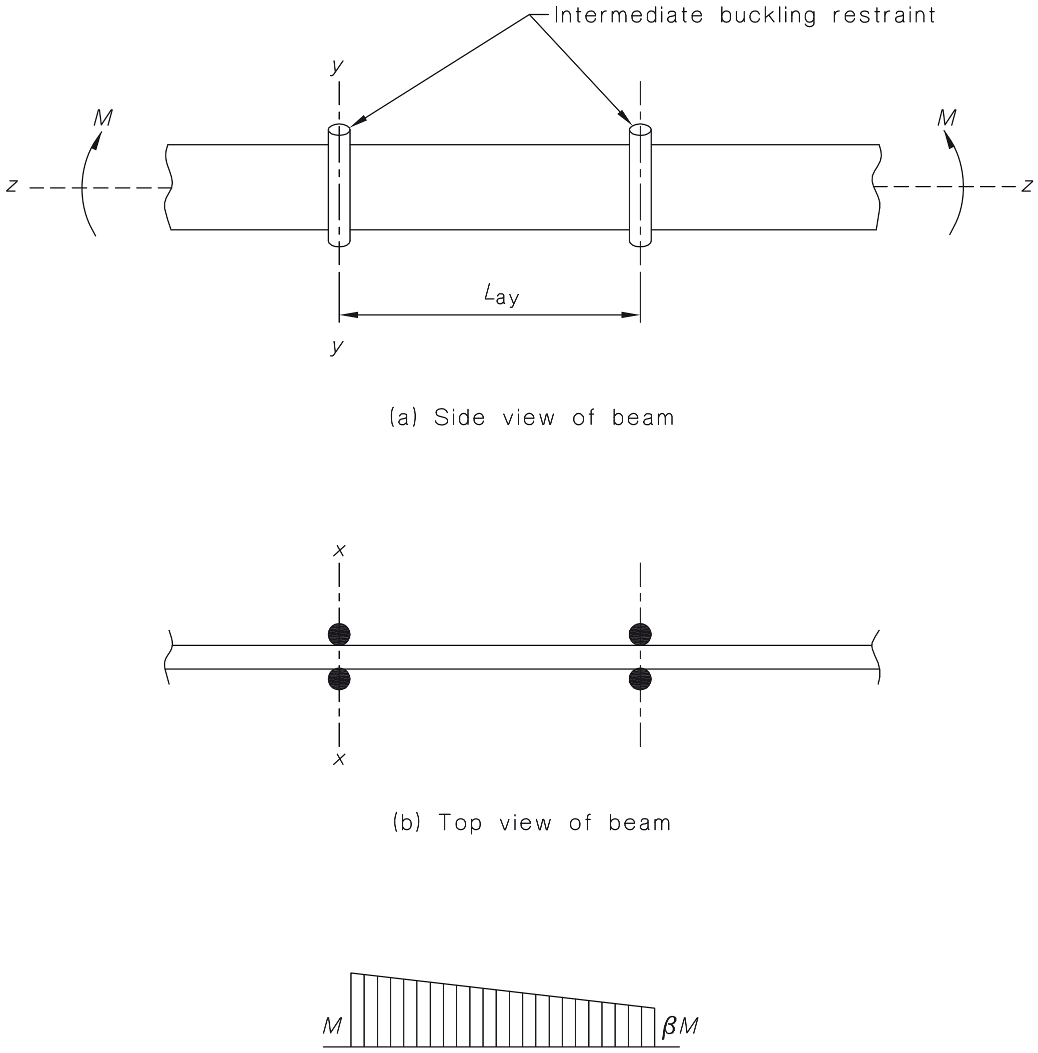
$(EI)_{\mathrm{y}}$ = effective rigidity for bending about the minor axis

d = depth of beam

(GJ) = effective torsional rigidity

y_{h} = location from the neutral axis of the loading point [see Figure C2(a) and C2(b)].

NOTE: The parameter y_{h} may take on negative values, subject to the direction of the applied load and the position of the restraint.



(a) Side view of beam

(b) Top view of beam

(c) Diagram of bending moment between buckling restraints

FIGURE C1 NOTATION FOR BEAMS WITH INTERMEDIATE BUCKLING RESTRAINTS

C5 BUCKLING RESTRAINTS

For most design situations, no check need be made on the effectiveness of buckling restraints. However, for an unusually light restraint system being used for a critical (i.e., non-load-sharing) engineered structure, it may be advisable to assess the effect and the capacity of the restraints.

For a design of slender beams having equally spaced buckling restraints, the restraint system is considered a lateral one as shown in Figure C2 where the restraint stiffness (K_A) is defined as follows:

$$P_R = K_A\ \Delta_A \quad \text{. . . C5(1)}$$

where

P_R = restraint force

K_A = restraint stiffness

Δ_A = beam displacement

The restraint force (P_R) occurs when the point of attachment of the restraint to the beam undergoes a displacement (Δ_A). It is assumed that the ends of beams are effectively restrained against torsional rotation.

For members of rectangular section and for box beams, the design force (P_R) on the lateral restraints is given by the following equation:

$$P_R = \frac{0.1 M_a}{d(n+1)} g_4 \qquad \text{. . . C5(2)}$$

where

M_a = the applied bending moment on the beam

g_4 = constant

= lesser of (m + 1)/2 and 5

d = depth of beam

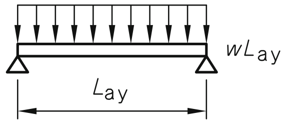
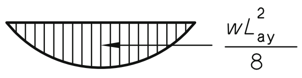
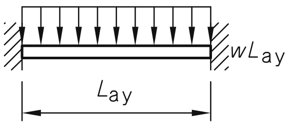
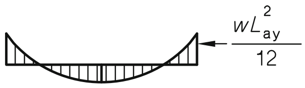
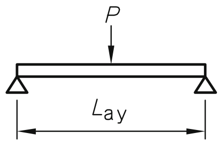
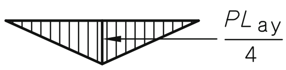
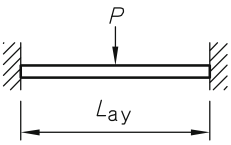
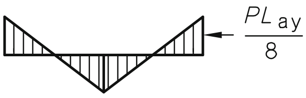
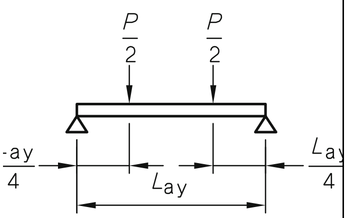
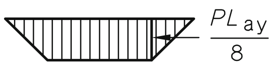
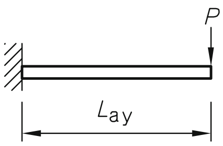
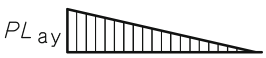
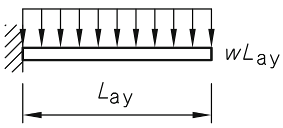
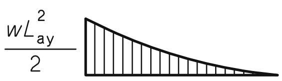
n = number of equally spaced intermediate restraints

m = number of members supported by each restraint system

A2

TABLE C2

COEFFICIENTS FOR SLENDERNESS FACTORS OF BISYMMETRICAL BEAMS WITH NO INTERMEDIATE BUCKLING RESTRAINTS

Loading	Bending moment (M)	Condition of end restraint against rotation about y-y axis	Slenderness factors g_2	Slenderness factors g_3
		Free Fixed	3.6 6.1	1.4 1.8
		Free Fixed	4.1 5.4	4.9 5.2
		Free Fixed	4.2 6.7	1.7 2.6
		Free Fixed	5.3 6.5	4.5 5.3
		Free Fixed	3.3 —	1.3 —
		Fixed	4.0	2.0
		Fixed	6.4	2.0

* For direction of the y-y axis, see diagram in Figure C1 (free ends of cantilevers expected).

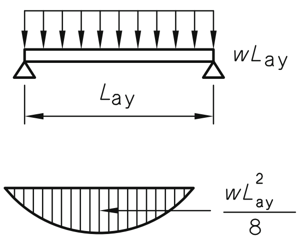


FIGURE C2 BEAM LATERAL RESTRAINTS

APPENDIX D

RECOMMENDATIONS FOR SHOWER SCREEN INSTALLATION

(Informative)

The following recommendations are provided for the benefit of screen fabricator and installer, and the home owner/user:

(a) Shower screen installation should comply with AS 3740.

(b) To ensure stability and safe performance of frameless shower screens, glass gussets, braces and supports at the head of the frameless glass may be necessary.

(c) While patch fittings provide required strength and appearance, the fixed glass panels in a frameless shower screen may be attached to the wall and floor with a securely fixed channel. The glass should be anchored firmly to the channel with glazing wedges or structural grade silicone.

(d) The hardware design should be such that the 'cut-outs' or fixing holes in toughened safety glass anchor the glass to the fittings thus reducing the potential for a hinged frameless door to sag, which can result in glass to glass and glass to floor contact. The hardware design should also include gaskets to prevent glass to metal contact.

(e) Unframed doors should be installed in such a manner as to avoid the edge of the glass, which is the part of glass most vulnerable to breakage, from coming into contact with the stile or floor.

(f) A frameless glass wall panel up to 2100 mm high should have a minimum of two mechanical fixings to the wall at 1700 mm maximum spacing. Panels exceeding 2100 mm high require additional fixings at 1700 mm maximum spacing. This is in addition to silicone, which provides some stability to the glass as well as sealing of glass to wall tiles, etc. Screens can be attached to the floor allowing for minimum 3 mm clearance with either structural silicone or minimum 2 mechanical fixings at a maximum spacing of 1700 mm.

It is recommended that homeowners regularly inspect the following aspects of the operation of a frameless shower screen:

(i) Ensure a minimum of 3 mm clearance is maintained between all edges of a frameless glass door and the fixed panel and or wall and the floor.

(ii) Check the tightness of the screws and clamp/patch and hinge fittings.

(iii) Check the operation of the hinges to ensure that they hinge freely and are not bound.

(iv) Replace scratched or damaged glass.

(v) Ensure that, when making alterations to a shower area, frameless shower screen glass door/s do not make contact with objects that may cause the frameless glass door to fracture.

When reglazing or replacing glass it is recommended that Grade A safety glass be used.

APPENDIX E

SLOPED OVERHEAD GLAZING FRACTURE CHARACTERISTICS

(Informative)

E1 SAFETY WHEN ACCESSING SLOPED OVERHEAD GLASS

Glass in sloped overhead glazing may be susceptible to impact damage from people walking or falling on the glass or from falling objects. If the building has human access space directly beneath the sloped glazing, then the safety of the occupants beneath the glazing should be considered as well as the safety of the workers above the glazing who may make contact with the glazing. For this reason, only safety glazing material is permitted to be used in sloped overhead glazing. However, different types of safety glazing materials have different breakage characteristics, and it is therefore important to choose the most appropriate glass type for the particular conditions applicable to the building in question.

E2 TOUGHENED SAFETY GLASS

In the event of glass breakage, toughened safety glass fractures into small harmless fragments relative to annealed glass. However, once fractured, this glass will not prevent penetration of the impacting object (or person) and the object (or person) would fall to the floor level below. Access to toughened overhead glass is unsafe unless suitable protection such as roof ladders, walk boards, safety mesh, or fall arrest systems are used.

The breaking behaviour of toughened glass is generally characterized by the formation of small relatively harmless particles. However, under certain conditions, depending on the method of framing and means of breakage, there can be clumping together of small particles or the formation of long splines of glass. If these breakage patterns occur, they may increase the risk of injury. The use of toughened glass is accordingly limited in area and limited to low height applications above less frequently occupied spaces.

E3 LAMINATED SAFETY GLASS

In the event of glass breakage, laminated safety glass tends to adhere to the plastic interlayer and not to fly or fall apart. The likelihood of glass falling out in large pieces is limited provided that the glass is fully framed and the impact that causes the breakage is not great.

The post-breakage performance of laminated glass may be improved by increasing the thickness of the plastic interlayer.

E4 HEAT-STRENGTHENED LAMINATED SAFETY GLASS

Heat-strengthened laminated safety glass has a similar performance to laminated safety glass as the breakage pattern of heat-strengthened glass is close to that of ordinary annealed glass. Heat-strengthened laminated glass has a strength advantage over ordinary annealed laminated glass and will be less susceptible to accidental and thermal breakage.

E5 TOUGHENED LAMINATED SAFETY GLASS

Toughened laminated safety glass may not have the same post breakage performance as laminated and heat-strengthened laminated safety glass as it breaks into small particles. In the event of simultaneous breakage of both toughened glass sheets, it is possible for the entire toughened laminated panel to sag and fall out of the frame.

E6 SAFETY WIRED GLASS

In the event of glass breakage, the embedded wire mesh of safety wired glass tends to hold the glass pieces together. The likelihood of glass falling out in large pieces is limited, provided that the glass is fully framed and the impact that causes the breakage is not great. It is possible for the entire safety wired glass panel to sag and fall out of the frame.

APPENDIX F
STRUCTURAL SILICONE GLAZING
(Informative)

F1 STRENGTH DESIGN OF STUCTURAL SILICONE

The minimum required structural silicone bite may be calculated as follows:

$$t = \frac{T}{0.210}$$

where

t = minimum structural silicone bite, in millimetres (See Figure F1.)

T = tension load newton per millimetres

$$= \frac{P_z \times B}{2}$$

where

P_z = ultimate design wind pressure, in kilopascals

B = span

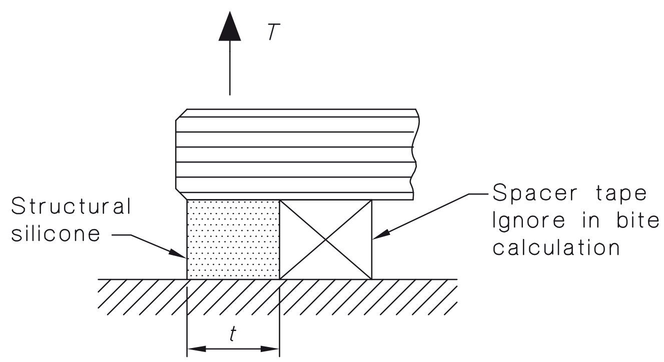


FIGURE F1 STRUCTURAL SILICONE BITE

Example 1:

For a structurally glazed piece of glass 2.0 m × 1.2 m under a wind load of 2.0 kPa is applied. The minimum structural silicone bite is calculated as follows:

$$T = 2.0 \times 1.2/2 = 1.2 \text{ N/mm}$$

$$t = \frac{1.2}{0.210} = 5.7$$

Allowing for installation tolerances, select a structural silicone bite of 8 mm.

F2 MOVEMENT DESIGN OF STUCTURAL SILICONE

Movement design of structural silicone is complicated as the structural silicone is anisotropic, i.e., it moves different amounts depending upon the load direction.

In an application where setting blocks are not used to support the weight of the glass panels, there could be a combined shear and tension loading on the silicone joint, and it is recommended to calculate the movement based upon the resultant force and the shear movement capacity.

Example 1:

A structural silicone with a movement capacity of 12% is applied in a joint of 8 mm depth. What is the movement capacity under tension loading?

Tension movement = 0.12 × 8 mm = 0.96 mm.

Example 2:

A glass panel 1200 × 1000mm × 6mm thick is to be supported without setting blocks. Calculate the minimum required joint depth.

Mass of glass = 1.2 m × 1.0 m × 15 kg/m^2 × 9.81 N = 176 N

Capacity of silicone = 0.011 MPa

Minimum joint depth = 176/[0.011 × 2 (1200 + 1000)] = 3.64 mm

F3 INSTALLATION OF STUCTURAL SILICONE

F3.1 General

Silicone will bond very well to glass provided the surface of the glass is clean. Unfortunately, surfaces within a factory or building site will be contaminated by residue from other materials and activities. In such environments, it is essential that the glass surfaces be cleaned thoroughly just before the application of structural silicone. If silicone is applied to glass surfaces that have not been cleaned then the adhesive bond may become contaminated (e.g., with dust) and greatly increase the risk of sealant joint failure.

Because of the above, it is recommended that structural silicone be applied under factory conditions where quality is easier to control.

Selecting the right silicone is critical to a successful application. Use of an unsuitable silicone can have serious consequences. For example, some silicones are not compatible with the interlayer of laminated glass. There are numerous grades of silicone available, all with different performance characteristics. The manufacturers of these products have the best understanding of the performance capabilities of their products so their advice on which product to use should be sought for each application.

F3.2 Cleaning

Thorough and effective cleaning of the glass surfaces shall be carried out before the application of silicone is commenced.

Successful cleaning of the glass surfaces is dependent on the use of an effective cleaning agent and the use of an appropriate method. An effective cleaning agent can only be chosen if the nature of the contaminant is known. The removal of dust, dirt and cutting oils can be achieved using a solvent such as acetone blends, alcohol blends or trichloroethane. The installer must take suitable safety precautions when handling such solvents.

As the success of the silicone bond with the glass is totally reliant on the cleanliness of the glass edge, the procedure used for the cleaning is the responsibility of the glazier. It is recommended that clean lint-free cloths or clean paper towels be used to apply the cleaner to the surface. The object is to remove the contaminants from the surface and not simply move them around and reapply them.

A possible cleaning procedure is as follows:

(a) Pour solvent onto a cloth or towel. Do not dip the cloth or towel into the solvent as this can contaminate the solvent.

(b) Wipe the glass surface to remove the contaminant. This will cause the cloth to become soiled.

(c) Take a second clean cloth with solvent poured onto it again and wipe the surface. If the cloth is soiled then use a third cloth until the cloth wipes clean.

(d) Dispose of dirty cloths or towels.

F3.3 Silicone application

The silicone application must provide a silicone joint, that is capable of carrying the loads imposed by the structural glazing.

A possible application procedure is as follows:

(a) Cut the silicone tube nozzle so that it is able to just enter the gap between the edges of the glass. Apply the silicone with a silicone gun into the join so that it wets both edges of the glass, oozing out on both the far and near sides of the joint. It is essential that no air pockets be formed while the silicone is being gunned into the join.

(b) For tooling off the joint, select a tool that will minimize the concave shape of the finished surface of the silicone. This will ensure the maximum strength of the joint.

(c) Tool off the silicone so that it is forced into the joint. This will further ensure that the edges of the glass are properly wetted. Each side will require to be tooled several times, as tooling will force some silicone out the other side of the join. Tooling must be completed before the silicone has formed a skin.

(d) Scrape away the excess silicone, taking care not to spread the silicone or scratch the glass. Use a rag dampened with methylated spirit to wipe up the remainder. It is much easier to remove excess silicone before it has cured as trying to do so after curing greatly increases the risk of glass damage. It is possible to mask glass either side of a joint to ease clean-up. If excess silicone has cured then it can be cut away using a blade and the remainder then has to be abraded away.

F3.4 Silicone curing

The glass has to be properly supported until the silicone has cured.

There are two basic cure mechanisms for structural silicone, as follows:

(a) Two part silicones, which include all the reactants within the silicone mix and can cure in a matter of hours.

(b) One part silicones, which are air-cured and may take some time to cure. A rule of thumb is 1 mm of cure per day.

Whichever type of silicone is used, the required curing time should be obtained from the silicone manufacturer.

Any movement of a structural silicone joint prior to a full cure being achieved may reduce the section area of the silicone and reduce the strength of the join. Support should therefore be maintained until the silicone has adequately cured.

F3.5 Structural silicone monitoring

Some approving authorities require provision of quality assurance records and ongoing monitoring of structural silicone applications.

APPENDIX G

FLOW CHARTS

(Informative)

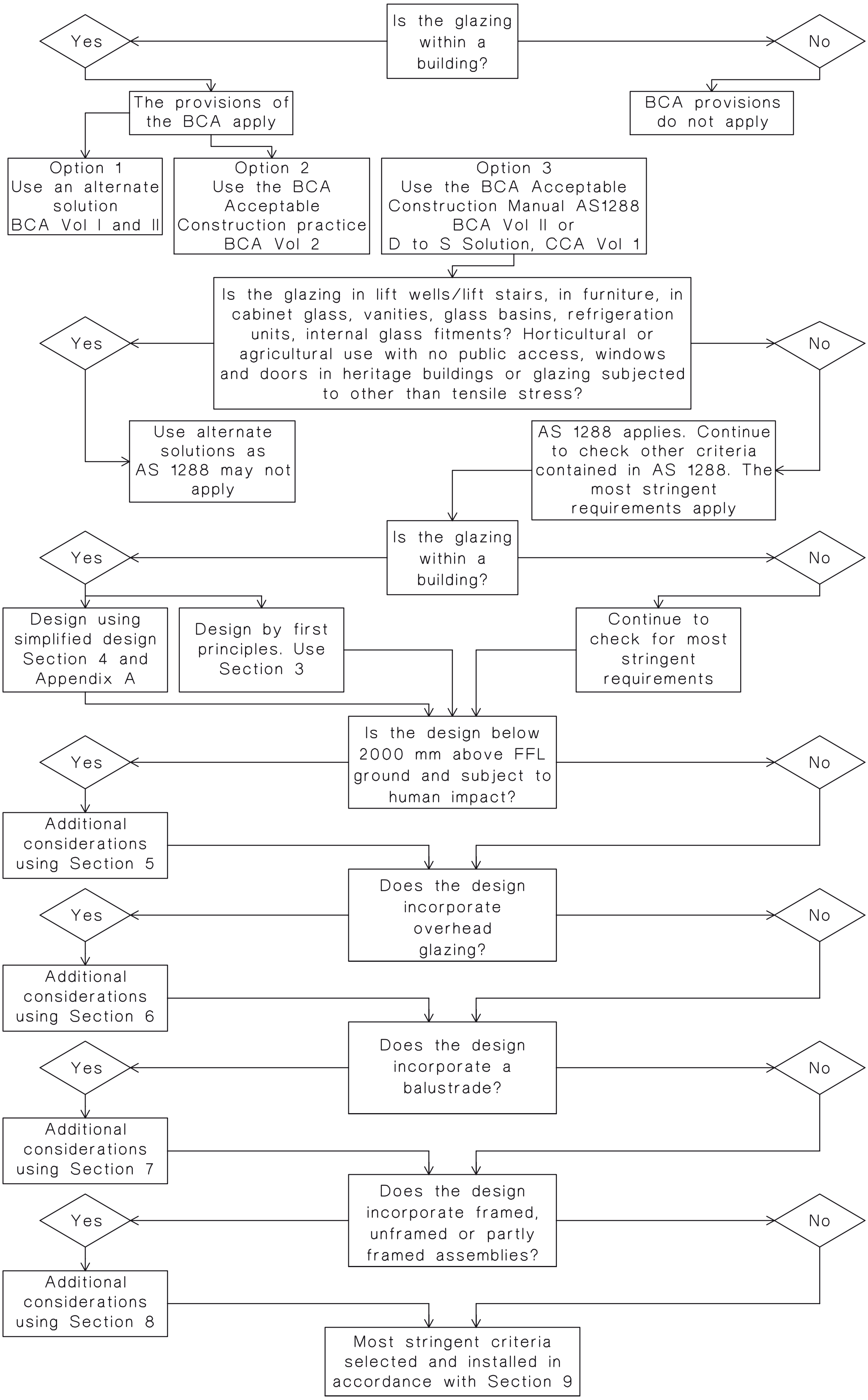
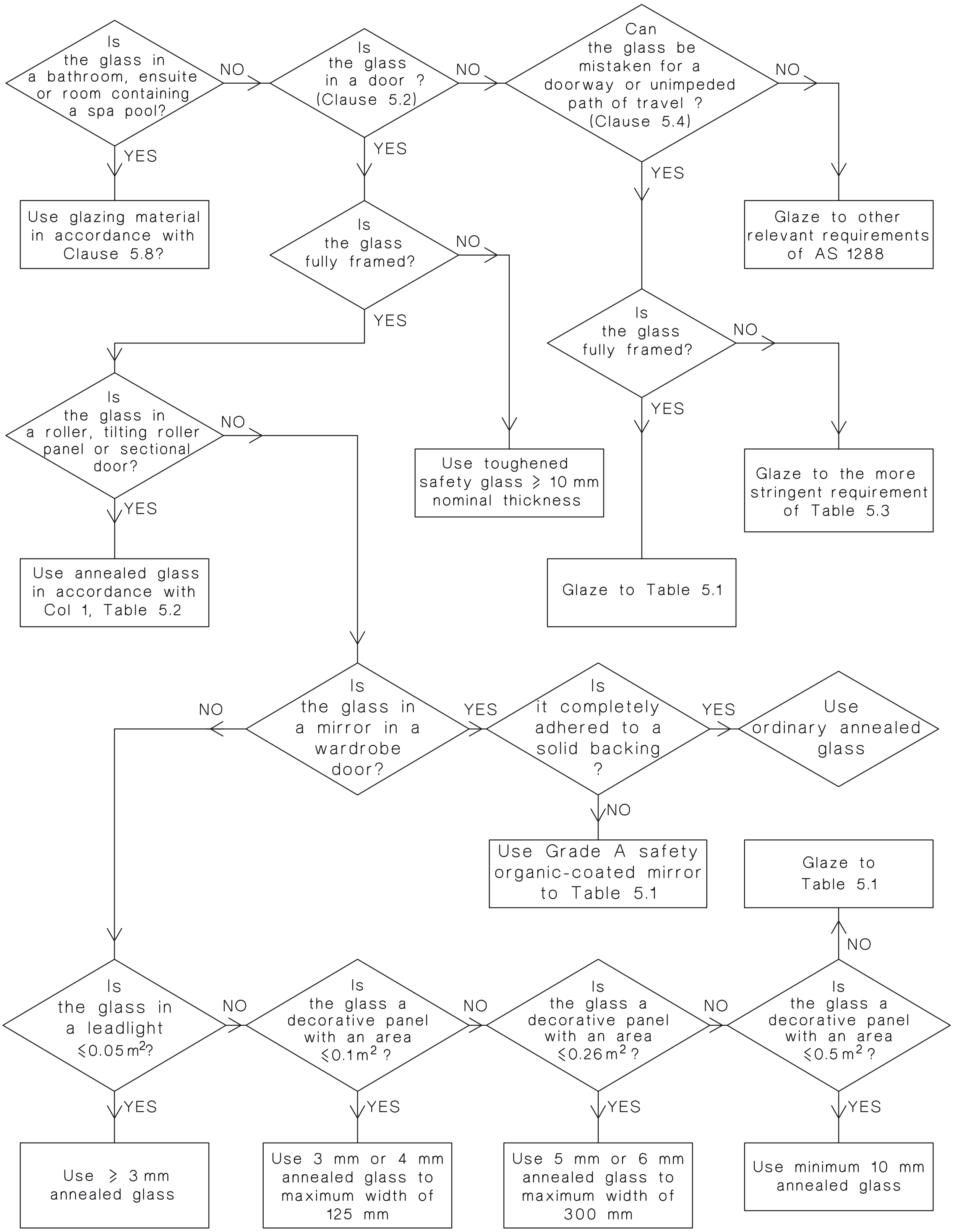
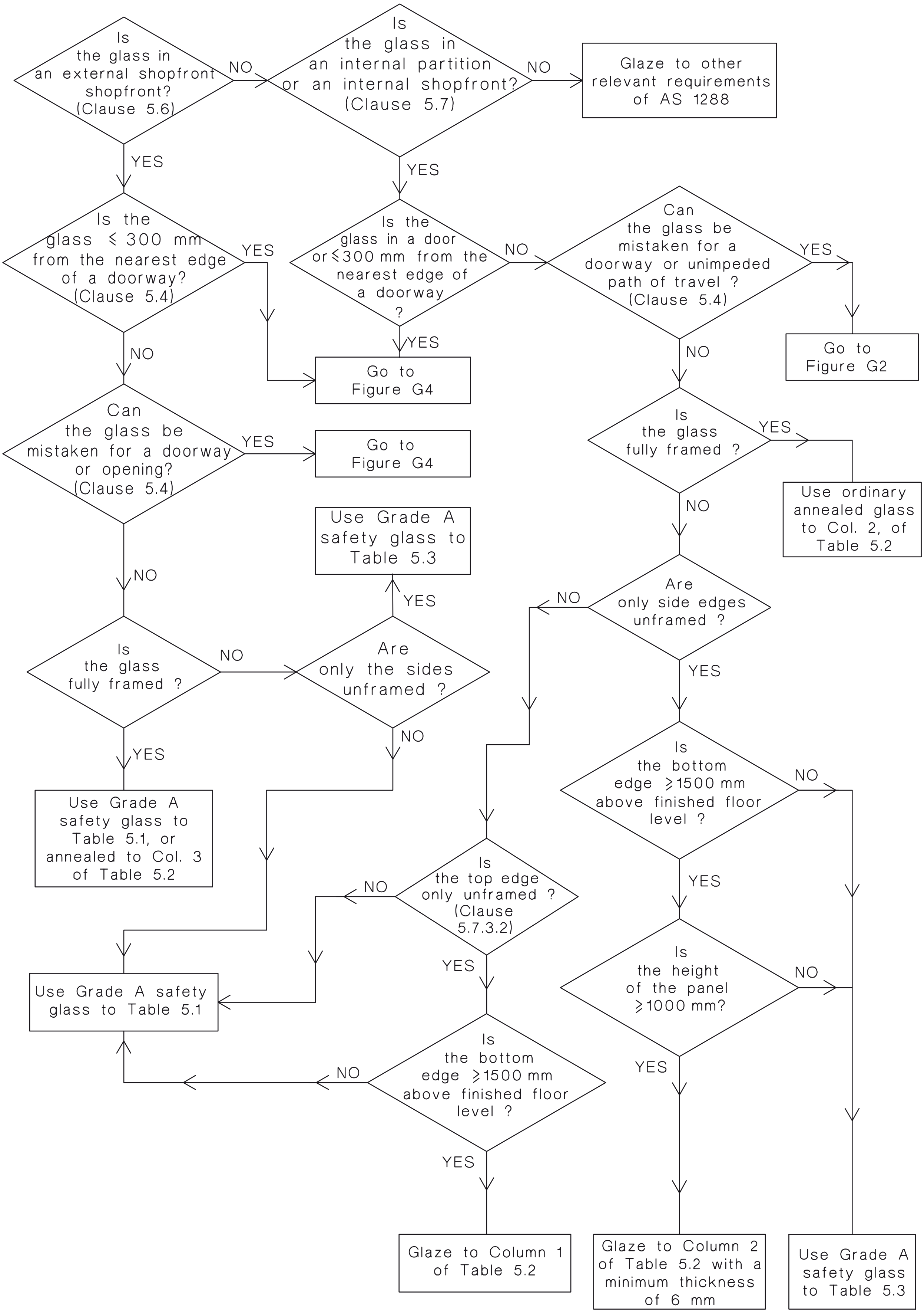


FIGURE G1 FLOW CHART FOR GLASS SELECTION



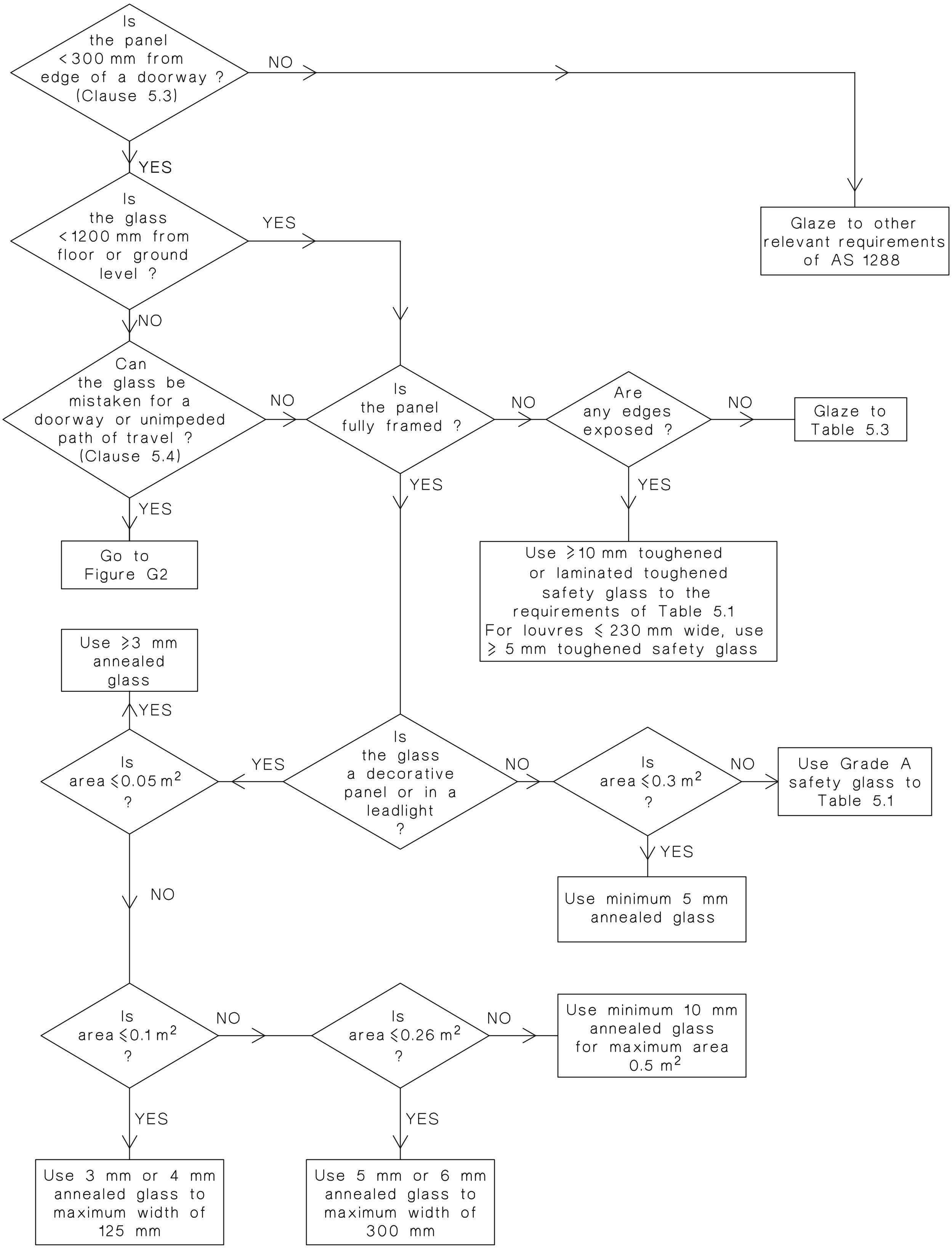
A1

FIGURE G2 FLOW CHART FOR DOORS



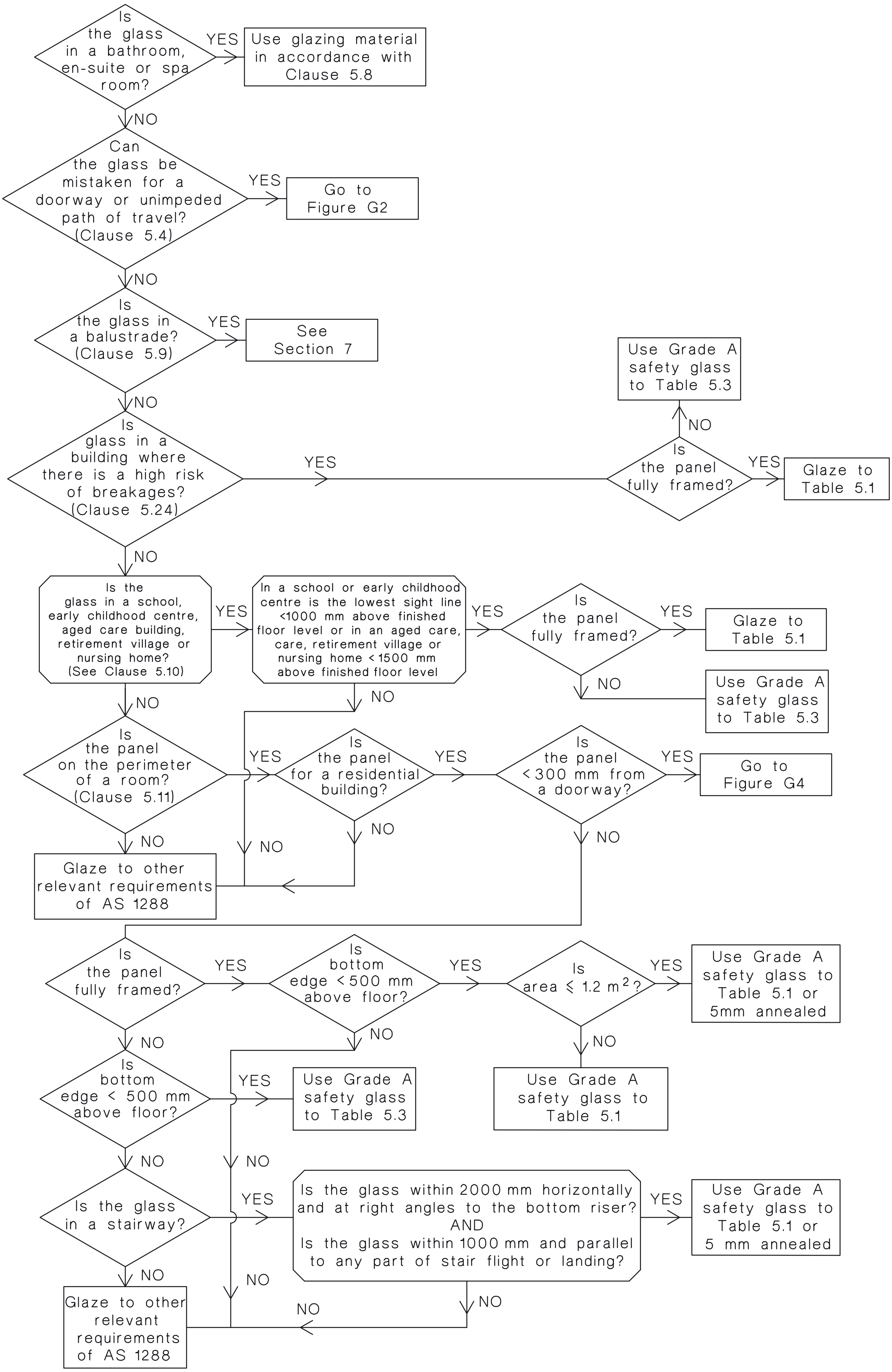
A1

FIGURE G3 FLOW CHART FOR SHOPFRONTS AND PARTITIONS



A1

FIGURE G4 FLOW CHART FOR SIDE PANELS



A1

FIGURE G5 FLOW CHART FOR OTHER GLAZING

APPENDIX H

BIBLIOGRAPHY

(Informative)

The documents listed in this Appendix are for informative purposes. They are not an integral part of this Standard.

AS

1735	Lifts, escalators and moving walks	
1735.2	Part 2:	Passenger and goods lifts—Electric
3740	Waterproofing of wet areas within residential buildings	

AS/NZS

1170	Structural design actions	
1170.3	Part 3:	Snow loads
4668	Glossary of terms used in the glass and glazing industry	

NZS

4223	Code of practice for glazing in buildings	
4223.3	Part 3:	Human impact safety requirements

ASTM

C1401	Standard Guide for Structural Sealant Glazing

BS

952	Glass for glazing	
952-1	Part 1:	Classification
6262	Glazing for buildings	

HB

125	The glass and glazing handbook

AMENDMENT CONTROL SHEET

AS 1288—2006

Amendment No. 1 (2008)

CORRECTION

SUMMARY: This Amendment applies to Clauses 1.1, 1.4.45(A) (new), 4.4.3, 5.2, 5.3.1, 5.4.2, 5.8.1, 5.10, 5.10.1, 5.10.3, 5.12, 5.15, 5.19, 5.23.3, 5.24, 6.4, 6.5.4, 6.5.6, 8.2, 9.3.1, 9.5.3.3.1, Appendix G, Tables 3.2, 5.1, 5.3, 7.3, 8.1, Figure 4.1, 4.35 and Equation C3(1).

Published on 31 January 2008.

Amendment No. 2 (2011)

REVISED TEXT

SUMMARY: This Amendment applies to the Preface, Clauses 1.3, 1.4.43, 1.4.54, 1.5 (new), 2.1.1, 2.1.2, 2.1.3, 2.1.6 (new), 3.3.2, 3.4.1, 3.4.2, 3.8 (new), 4.3, 5.1, 5.13, 5.19, 7.4 (new), Tables 3.3, 5.1, 5.4 and 7.1, Figure 4.5 and Appendix C.

Published on 11 November 2011.

Amendment No. 3 (2016)

REVISED TEXT

SUMMARY: This Amendment applies to the Foreword, Clauses 1.3, 3.3.3, 4.2, 6.5.3 and Appendix A.

Published on 29 February 2016.