Balustrade Design – June 2010

This is an update of the June 2009 issue of the same document.

The changes are:

1. **the updated rules of use (below on this page) and**
2. **the addition of the GANZ member logo on each page**
3. **reference to the DBH Practice Advisory Note 10**
4. **Tables updated for clarity**
5. **Addition of two new tables**
6. **Revised based on citation of NZS 4223:2008 in June 2010**

The following resource has been produced for the use of GANZ and WANZ Members.

Please Note:
This is a valuable resource worth multiple thousands of dollars providing a very real commercial advantage to GANZ and WANZ members.

Please do not distribute copies to non-members.

These rules of use as applied from 1 June 2009:

1. Each GANZ member can reformat and Brand the tables with their own Name/Logo as required, as long as the GANZ (member) logo is also used on each page. This stops the tables being immediately identified by a TA as the formal PS2 verified tables and not asking for a producer statement for each job, (while still having a GANZ reference).

2. These reformatted tables can be given to designers and specifier's and non GANZ members, but **without** the PS2.

3. The PS2 (and engineer verified tables) are only to be used by GANZ members for their own jobs with their own PS1 or PS3

4. GANZ members can list on their website **without** the PS2 or verified tables.

Contents

Balustrade Design Tables

The GANZ Balustrade Design Tables have been prepared as follows;

1. Using Strand7 Finite Element Analysis based on Ultimate Design Capacity (stress) for both “at the edge” and “away from the edge” and short and medium term load durations in accordance with NZS 4223:Part 1:2008.
2. The tables have been calculated to comply with Building Code Compliance Document B1/VM1 (Amend 8) and the barrier actions from AS/NZS 1170.1:2002, Table 3.3, according to the type of occupancy for part of the building or structure
3. The tables have been calculated in compliance with the DBH Practice Advisory 10 Design Guidance for Barriers – November 2009
4. The tables have been calculated based on ULS design being 1.5 times the SLS actions listed in Table 3.3 of AS/NZS 1170.1
5. The tables are for glass design only and the post, rails and any structure, including their fixings are the responsibility of the system designer and/or engineer
6. The tables are not for Proprietary Design Balustrade Systems and the system supplier is responsible for this. In some cases they may be suitable if recognized by the system supplier.
7. The tables have included maximum ULS and SLS design wind pressure for the location and if the site design wind pressure exceeds these specific design is required to determine the glass thickness
8. The tables limit the glass deflection to span/60 or 30mm maximum and if tighter restrictions are required, specific design will be required
9. Each table carries notes applicable to the design type
10. The tables have been verified by an independent engineering consultant and a Producer Statement – Design Review (PS2) is attached

There are currently 9 tables as follows and more will be added as required to cover other design possibilities

SB1-Structural Balustrade - Cantilevered glass
SB2-Structural Balustrade - 2 Edge - point fixed
SB3-Structural Balustrade - 2 Edge support
SB4-Structural Balustrade - 3 Edge support
IB1-Infill Balustrade - 4 Edge support
IB2-Infill Balustrade - 2 Edge support
IB3-Infill Balustrade - 2 Edge - point fixed with handrail in front of glass
IB4-Infill Balustrade - 2 Edge - Point fixed
IB5-Infill Balustrade - 2 Edge – Clamp fixed (no holes in glass)

Producer Statements

The PS2 Design Review provided is not enough by itself for a TA approval of a balustrade system. A company specific PS1-Design or PS3-Construction will be required depending on the nature of the contract, and will need to cover compliance with F2, F4, B2, D1 and E2 as applicable.

The PS2 confirms compliance with the NZBC as an Alternative Solution based on AS/NZS 1170 and the modifications stated in B1/VM1, and NZS 4223:Part 1:2008.

GANZ - BALUSTRADE DESIGN - Version 5

Updated to comply with the B1/VM1 – 1 December 2008
Updated to include balustrade design tables (April 09)
Updated to reference DBH Practice Advisory 10 – November 2009
Update based on citation of NZS 4223:2008

NZBC
There are several parts of the NZ Building Code (NZBC) that effect the design and installation of balustrades and they are as follows

- F2 - Hazardous Materials
- F4 - Safety from Falling
- B1 - Structure
- B2 - Durability
- D1– Access Routes
- E2 – External Moisture

F2 deals with the human impact safety requirements in accordance with NZS 4223 Part 3, for fully framed and partly framed balustrades, but structural balustrades are by specific design. Safety glass is required for all balustrades.

F4 deals with barrier design and heights and the recent revised heights are as follows

Barrier Heights (Balustrades) – 3 rd edition – revised September 07

These changes plus other changes are highlighted in the following table taken from F4/AS1.

Building Type	**Location**	**Min Barrier Height**
Detached dwellings and within household units of multi-unit dwellings.	Stairs and ramps and their landings. Balconies and decks, and edges of internal floors or mezzanine floors.	900 mm 1000 mm
All other buildings and common areas of multi-unit dwellings.	Stairs and ramps. Barriers within 530mm of the front of fixed seating. All other areas.	900 mm 800 mm 1100 mm

In addition a toe hold is defined as a 15mm ledge, and if greater than 15mm a 60 degree fillet angle to the horizontal is required.

The key change is in the Acceptable Solution F4/AS1 in which the height of barriers for “all other buildings and common areas of multi-unit dwellings” (public areas) has been raised to 1100mm.
There is a problem with junction from 900 to 1100 on commercial (other) buildings and the DBH have published a Codeworks article (Issue 032) for guidance.

B1 deals with the loading requirements and defines the loadings code to use.
In the past we have designed in accordance with NZS 4203, but from
1st December 2008 the new AS/NZS 1170 applies.

The new AS/NZS 1170.1:2002 (Table 3.3) has increased the loadings on barriers and defines a new occupancy list, classified from A to D.
Domestic houses are occupancy A, but exclude balconies (external decks) which are classified as occupancy C3, and these require higher (commercial) loadings along with occupancy B and E.
There is also a new higher loading for occupancy C1, C2 and D (retail areas) and the overcrowding (panic) areas are occupancy C5
In addition there is a new point load of 0.6kN which must be applied to all occupancy classes, and an infill point load of 1.5kN for occupancies C1/C2/C5, and D.

These new loadings are very restrictive on design and in some cases higher than NZS 4203 and BS 6339 and GANZ still believe some are not justified.
In the new B1 Verification Method (B1/VM1 Amend 8, Dec 2008), which calls up these new requirements, it also defines how the loads are to be applied (clause 2.2.7) to the handrail, top rail and/or top rail of glass. They also define handrails and top rails and when they shall be used.

To help clarify the loading requirements the DBH has produced Practice Advisory 10 – Design guidance for barriers. This document details the load applications on barriers with and without rails, and for domestic and residential and other barriers.

The result of these new loadings is that many balustrade designs used in NZ will no longer comply with the Building Code and current design tables will not be suitable. As a result GANZ have prepared new design tables and these are attached.

B2 deals with durability and defines minimum durability requirements for materials and fixings used in balustrades and barriers. The requirements range from 5, 15 to 50 years depending on whether the element is structural and how difficult it is to replace. In some cases the 50 year requirement will apply to fixings for structural elements of safety barriers.

D1 defines accessible routes and how handrails are used, but they are not required if it is not an accessible route.
Interlinking handrails are recommended in many situations by some glass companies, in case of glass failure, but are not wanted by many designers or owners. However, very few, if any, injuries have occurred from a glass balustrade failure in NZ.
Heat soak toughened glass is often specified for added safety, and toughened laminated glass is being specified, but issues, such as failure mode and edge de-lamination must be considered.

E2 deals with balustrade to wall and deck drainage and junctions and balustrade fixing to ensure the building is water tight, and covers compatibility of materials.

Producer Statements

Most Territorial Authorities (TAs) are requesting Producer Statements (PS) at the building consent stage, but many proprietary product suppliers are reluctant to supply a PS1 for design, if the don't have the contract to supply.
Often the TAs do not ensure the product on the building consent (PS1-Design) matches the product installed (PS3-Construction).
Some designers get frustrated if they can not get a PS1-Design at building consent stage, but many of designs require specific design, and these services have associated costs.

Balustrade Summary

- Only designed and engineered systems will be acceptable
- Designs need to comply with NZBC B1/VM1 Amend 8
- Architects designs need to engineered to AS/NZS 1170
- Many existing balustrade design will not comply
- Current glass design charts (e.g. NZS 4223 Part 3) are not suitable
- Engineering may require Finite Element Analysis for glass design
- Product prototype testing may be required to prove compliance, if the procedures in AS/NZS 1170 are not sufficient
- There may be a cost for the design service
- External domestic decks will require thicker glass
- Higher balustrades require thicker glass
- Higher loadings require thicker glass
- Thicker glass is more expensive (increase cost of product)
- Design restrictions will apply
- Producer Statements being requested (PS1 Design, PS3 Installation)
- Increased use of handrails
- Increased use of Heat Soaked toughened
- Increased use of toughened laminates

In general, the balustrade market will become far more complex and only designed and engineered systems will be used.

Swimming Pools

F4 still refers to the old Fencing of Swimming Pool Act (FOSPA 1987) even though there is a new standard NZS 8500:2006 Safety Barriers and Fences around Swimming Pools Spas and Hot Tubs.
The DBH are likely to cite this in the future but this may take some time. However, be careful as some specifications may call up the standard and some TA's may use it for guidance for existing pools.

The new Standard NZS 8500 is performance based but does not give any guidance for glass, other than mentioning safety glass for use as an infill panel. The minimum height is still 1200mm for pool fences.

NZS 4223: Part 3 does cover fences in Clause 312 but does not make specific reference to swimming pools, other than in Table 3.8 in which it lists swimming pools with residential buildings. Clause 303.10 does mention swimming pools and spa enclosures as high risk areas and requires safety glass.

A common practice for pool fences is to design for residential loadings (occupancy A), but they should be checked for wind loads as often they are in very exposed locations and the wind loads may dominate the design of glass thickness and fixing method. However specific design in accordance with NZS 8500 may provide a more economical solution.

IPENZ ENGINEERS NEW ZEALAND | NEW ZEALAND INSTITUTE OF ARCHITECTS INCORPORATED | ACENZ

Building Code Clause(s) ..B1.....

PRODUCER STATEMENT – PS2 – DESIGN REVIEW

(*Guidance notes on the use of this form are printed on the reverse side**)

ISSUED BY: .....JNG Engineers Ltd.....
(Design Review Firm)

TO: Window Association of New Zealand & Glass Association of New Zealand
(Owner/Developer)

TO BE SUPPLIED TO: .....
(Building Consent Authority)

IN RESPECT OF: glass balustrade selection table SB1 -SB4 and IB-1- IB-5 (dated 1/5/10)
(Description of Building Work)

AT: .....
(Address)

..... **LOT**..... **DP** ..... **SO** .....

We .....JNG Engineers Ltd..... have been engaged by ...WANZ & GANZ.....
(Design Review Firm)

to review the design documents for this project in respect of the requirements of Clause(s) ..B1..... of the Building Code.

The Review is for ○ All ◉ Part only of the design work prepared by .....GANZ.....
(Design Firm)

as described in drawings titled ...structural glass balustrade and infill panels..... and numbered tables SB1 - SB4 and IB1 - IB5 (dated 1/5/2010)..... the specification, and other documents set out in the schedule attached to this statement according to which the building is proposed to be constructed.

The Review is in respect of ..structural glass balustrade and infill panels..... or per attached schedule.
(aspects of design)

The Review confirms that these aspects of the design are in accordance with:

☐ Compliance Documents issued by Dept of Building & Housing .....or
(verification method / acceptable solution)

☑ Alternative Solution as per attached schedule ..AS/NZS1170, B1/VM1(clause 2.2.7), NZS4223:part1:2008.....

On behalf of the firm undertaking this review, on the basis of the review undertaken, and subject to:

(i) site verification of the following design assumptions ... not applicable.....

(ii) all proprietary products meeting their performance specification requirements;

I believe on reasonable grounds the building, if constructed in accordance with the drawings, specifications, and other documents provided or listed in the attached schedule, will comply with the relevant provisions of the Building Code.

I, Joshua T K Ng @ JNG Engineers Ltd .....am: ☑ CPEng 139406.....#
(Name of Design Professional)

☐ Reg Arch .....#

I am a Member of : ☑ IPENZ ☐ NZIA and hold the following qualifications: .MIPENZ, CPENG, IntPE.....

The Design Review Firm issuing this statement holds a current policy of Professional Indemnity Insurance no less than $200,000*. The Design Review Firm is a member of ACENZ ○ **YES** ◉ **NO**

SIGNED BY Joshua T K Ng..... ON BEHALF OF ..JNG ENGINEERS LTD.....
(Name of Design Reveiw Firm)

Date 2/6/2010..... (*signature*).....

Note: This statement shall only be relied upon by the Building Consent Authority named above. Liability under this statement accrues to the Design Review Firm only. The total maximum amount of damages payable arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in contract, tort or otherwise (including negligence), is limited to the sum of $200,000.*

This form is to accompany **Form 2 of the Building (Forms) Regulations 2004** for the application of a Building Consent.

TABLE SB-1

1-May-10

STRUCTURAL BALUSTRADE - CANTILEVERED GLASS

AS/NZS 1170 Occupancy	Design load (SLS)			Wind pressure		Maximum glass height (mm)							
						Toughened safety glass				Toughened laminated safety glass			
	Line kN/m	Concentrated kN	Uniform kPa	ULS kPa	SLS kPa	10	12	15	19	10	12	16	20
A	0.35	0.6	0.5	-	-	550	1030	1500	2020	600	1000	1780	2130
A (other) & C3	0.75	0.6	1.0	2.1	1.5	550	1030	1300	1530	600	1000	1360	1620
B, E	0.75	0.6	1.0	2.1	1.5	550	1030	1300	1530	600	1000	1360	1620
C1/C2, D	1.5	1.5	1.5	2.1	1.5	-	-	-	880	-	-	400	1150
C5	3.0	1.5	1.5	2.1	1.5	-	-	-	680	-	-	400	800

NOTES

1. The base of the glass is supported by a continuous rigid clamp or channel designed to Building Code
2. Glass panels are at least 1000mm wide unless connected by an interlinking handrail
3. Heights are measured from base of top-fixed channel or clamp to top of glass, and from top of grout for glass grouted into a concrete recess
4. Do not use this table for glass supported by point fixings (such as stand-off fittings). Stresses around holes must be checked for this type of installation.
5. Glass heights have been calculated for short and medium term live loads using the minimum glass thickness and loads applied as follows:
   - Line loads are applied to top edge of glass or at 1200mm if glass is higher than 1200mm.
   - Uniform load and wind pressure are applied over whole area of glass
   - Concentrated load is applied to top corner of glass panel. If glass is higher than 1200mm load is applied at 1200mm with 50% applied to the top corner
6. Deflection of glass is limited to 30 mm excluding rotation of channel or clamp
7. Glass thicknesses are nominal thicknesses and for toughened laminated glass exclude the interlayer
8. Glass thicknesses are based on the most severe load case.
9. Design loads are in accordance with Building Code Compliance Document B1, B1/VM1 and AS/NZS 1170
10. For wind pressures exceeding those listed specific design is required
11. Ultimate design strength of glass is in accordance with NZS 4223.1:2008
12. Glass thicknesses for proprietary balustrade systems may be determined by specific design

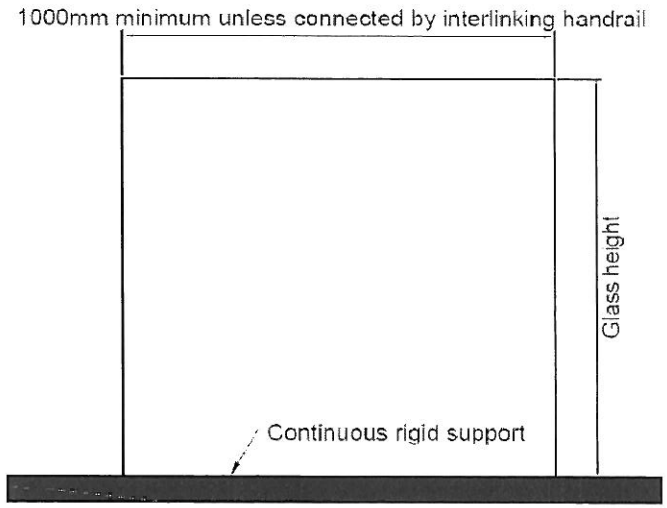


TABLE SB-2

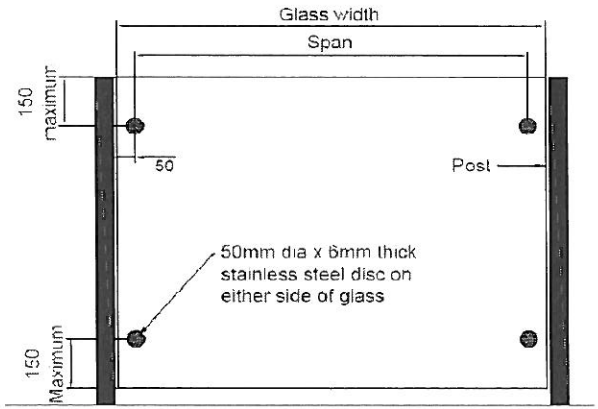
1-May-10

STRUCTURAL BALUSTRADE - 2 EDGE POINT FIXED

AS/NZS 1170 Occupancy	Design load (SLS)			Wind pressure		Maximum glass width (mm)							
						Toughened safety glass				Toughened laminated safety glass			
	Line kN/m	Concentrated kN	Uniform kPa	ULS kPa	SLS kPa	10	12	15	19	10	12	16	20
A	0.35	0.6	0.5	-	-	1550	1850	2550	2800	1450	1800	2650	2950
A (other) & C3	0.75	0.6	1.0	2.1	1.5	1200	1350	1600	1850	1150	1300	1700	1950
B, E	0.75	0.6	1.0	2.1	1.5	1200	1350	1600	1850	1150	1300	1700	1950
C1/C2, D	1.5	1.5	1.5	2.1	1.5	-	-	-	1300	-	-	-	1400
C5	3.0	1.5	1.5	2.1	1.5	-	-	-	750	-	-	-	850

NOTES

1. Two opposite edges of the glass panel are supported by steel fittings
2. Each edge is supported by at least 2 fittings located no further than 150mm from the top and bottom edges, and between 50 to 100mm in from the edge
3. Fittings are at least 50mm in diameter and 6mm thick placed on either side of the glass panel with hard gaskets and nylon bushes to prevent glass and metal contact
4. The fittings are supported by posts designed to Building Code
5. Glass panels are at least 800mm high
6. Maximum glass width is the horizontal span between fittings plus 100mm
7. Glass widths have been calculated for short and medium term live loads using the minimum glass thickness and loads applied as follows:
   - Line loads are applied to top edge of glass
   - Uniform load and wind pressure are applied over whole area of glass
   - Concentrated load is applied at corner of glass panel, or at mid-span along the edge
8. Deflection of glass is limited to span/60 up to a maximum of 30 mm. This excludes movement of the supporting posts
9. Glass thicknesses are nominal thicknesses and for toughened laminated glass exclude the interlayer
10. Glass thicknesses are based on the most severe load case.
11. Design loads are in accordance with Building Code Compliance Document B1, B1/VM1 and AS/NZS 1170
12. For wind pressures exceeding those listed above specific design is required
13. Ultimate design strength of glass is in accordance with NZS 4223.1:2008
14. Glass thicknesses for proprietary balustrade systems may be determined by specific design



GLASS ASSOCIATION GANZ MEMBER NEW ZEALAND

TABLE SB-3

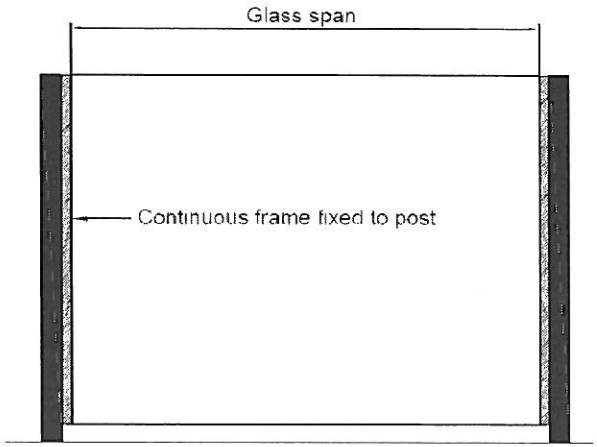
1-May-10

STRUCTURAL BALUSTRADE - 2 EDGE SUPPORT

AS/NZS 1170 Occupancy	Design load (SLS)			Wind pressure		Maximum glass span (mm)									
						Toughened safety glass					Toughened laminated safety glass				
	Line kN/m	Concentrated kN	Uniform kPa	ULS kPa	SLS kPa	8	10	12	15	19	8	10	12	16	20
A	0.35	0.6	0.5	-	-	650	1650	2450	3000	3500	610	1600	2430	3100	3700
A (other) & C3	0.75	0.6	1.0	2.1	1.5	650	1650	1930	2250	2650	610	1600	1900	2380	2800
B, E	0.75	0.6	1.0	2.1	1.5	650	1650	1930	2250	2650	610	1600	1900	2380	2800
C1/C2, D	1.5	1.5	1.5	2.1	1.5	-	-	450	1200	2430	-	-	430	1500	2580
C5	3.0	1.5	1.5	2.1	1.5	-	-	450	1200	1750	-	-	430	1450	1900

NOTES

1. Two opposite edges of the glass panel are supported by continuous channel or frame (12mm minimum bite is recommended)
2. The channels, frames and posts are designed to Building Code
3. Glass panels are at least 800mm high
4. Glass spans have been calculated for short and medium term live loads using the minimum glass thickness and loads applied as follows:
   - Line loads are applied to top edge of glass
   - Uniform load and wind pressure are applied over whole area of glass
   - Concentrated load is applied at mid-span along the edge
5. Deflection of glass is limited to span/60 up to a maximum of 30 mm. This excludes movement of the supporting posts
6. Glass thicknesses are nominal thicknesses and for toughened laminated glass exclude the interlayer
7. Glass thicknesses are based on the most severe load case.
8. Design loads are in accordance with Building Code Compliance Document B1, B1/VM1 and AS/NZS 1170
9. For wind pressures exceeding those listed above specific design is required
10. Ultimate design strength of glass is in accordance with NZS 4223.1:2008
11. Glass thicknesses for proprietary balustrade systems may be determined by specific design



GLASS ASSOCIATION GANZ MEMBER NEW ZEALAND

TABLE SB-4

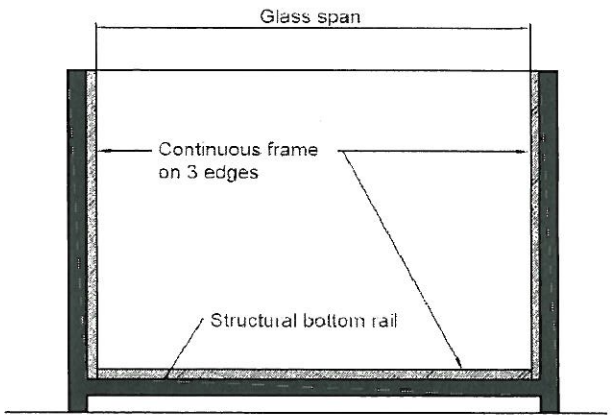
1-May-10

STRUCTURAL BALUSTRADE - 3 EDGE SUPPORT

AS/NZS 1170 Occupancy	Design load (SLS)			Wind pressure		Maximum glass span (mm)							
						Toughened safety glass				Toughened laminated safety glass			
	Line kN/m	Concentrated kN	Uniform kPa	ULS kPa	SLS kPa	8	10	12	15	8	10	12	16
A	0.35	0.6	0.5	-	-	650	2590	3350	3900	610	2570	3300	3900
A (other) & C3	0.75	0.6	1.0	2.1	1.5	650	1900	2300	2850	610	1900	2300	3050
B, E	0.75	0.6	1.0	2.1	1.5	650	1900	2300	2850	610	1900	2300	3050
C1/C2, D	1.5	1.5	1.5	2.1	1.5	-	-	450	1350	-	-	450	1950
C5	3.0	1.5	1.5	2.1	1.5	-	-	450	1350	-	-	450	1550

NOTES

1. Two opposite and bottom edges of the glass panel are supported by continuous frame or channel (12mm minimum bite recommended)
2. The posts, bottom rail and glazing frame or channel are designed to Building Code
3. Glass spans have been calculated for short and medium term live loads using the minimum glass thickness and loads applied as follows:
   - Line loads are applied to top edge of glass
   - Uniform load and wind pressure are applied over whole area of glass
   - Concentrated load is applied at mid-span along the top edge
4. Deflection of glass is limited to span/60 up to a maximum of 30 mm. This excludes movement of the supporting posts and bottom rail.
5. Glass thicknesses are nominal thicknesses and for toughened laminated glass exclude the interlayer
6. Glass thicknesses are based on the most severe load case.
7. Design loads are in accordance with Building Code Compliance Document B1, B1/VM1 and AS/NZS 1170
8. For wind pressures exceeding those listed above specific design is required
9. Ultimate design strength of glass is in accordance with NZS 4223.1:2008
10. Glass thicknesses for proprietary balustrade systems may be determined by specific design



GLASS ASSOCIATION NEW ZEALAND GANZ MEMBER

TABLE IB-1

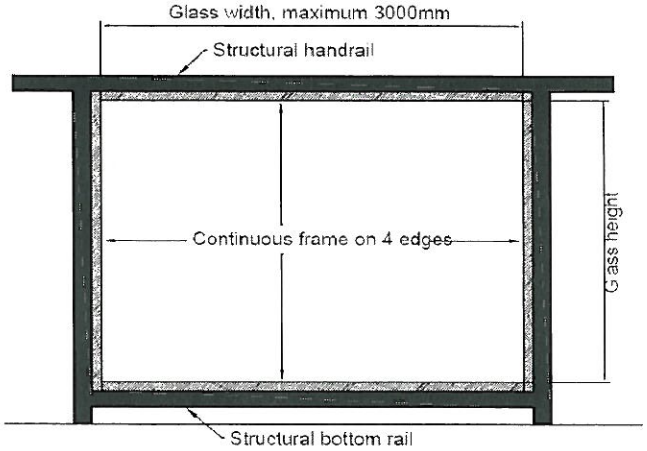
BALUSTRADE INFILL: 4-EDGE SUPPORT

1-May-10

AS/NZS 1170 Occupancy	Design load (SLS)		Wind pressure		Maximum glass span (mm)						
					Laminated safety glass				Toughened safety glass		Toughened laminated safety glass
	Concentrated kN	Uniform kPa	ULS kPa	SLS kPa	6	8	10	12	6	8 and over	8 and over
A	0.25	0.5	-	-	1000	1200	1200	1200	1200	1200	1200
A (other) & C3	0.5	1.0	2.1	1.5	-	1150	1200	1200	1100	1200	1200
B, E	0.5	1.0	2.1	1.5	-	1150	1200	1200	1100	1200	1200
C1/C2, C5 and D	1.5	1.5	2.1	1.5	-	-	-	480	700	1200	1200

NOTES

1. Four edges of the glass panel are supported by continuous frame or channel (12mm minimum bite recommended)
2. A structural handrail wider than 30mm in plan supported by posts is provided above the glass.
3. The handrail, posts, bottom rail and glazing frame or channel are designed to Building Code
4. Height of glass panel is not greater than 1200mm. Specific design is required for height exceeding this.
5. Width of glass panel is not greater than 3000mm. Specific design is required for width exceeding this.
6. Glass span is the smaller dimension of the height or width.
7. Do not use this table for glass supported by point fixings (such as stand-off fittings). Stresses around holes must be checked for this type of installation.
8. Glass spans have been calculated for short and medium term live loads using the minimum glass thickness and loads applied as follows:
   - Uniform load is applied over whole area of glass
   - Concentrated load is applied at the centre the glass panel
9. Deflection of glass is limited to span/60 up to a maximum of 30 mm excluding frame deflection
10. Glass thicknesses are nominal thicknesses and for toughened laminated glass exclude the interlayer
11. Glass thicknesses are based on the most severe load case
12. Design loads are in accordance with Building Code Compliance Document B1, B1/VM1 and AS/NZS 1170
13 For wind pressures exceeding the uniform pressures listed specific design is required
14. Ultimate design strength of glass is in accordance with NZS 4223.1:2008
15. Glass thicknesses for proprietary balustrade systems may be determined by specific design



Note: Span is the smaller of the height or width

TABLE IB-2

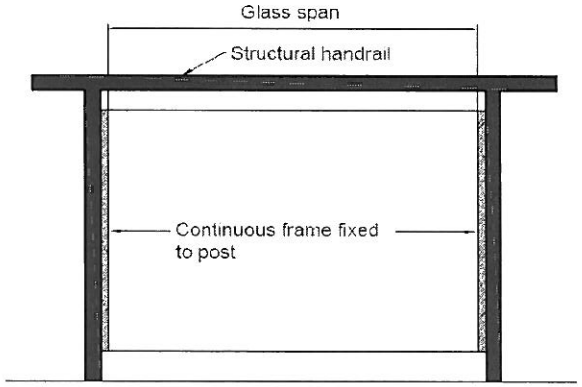
1-May-10

BALUSTRADE INFILL: TWO-EDGE SUPPORT

AS/NZS 1170 Occupancy	Design load (SLS)		Wind pressure		Maximum glass span (mm)										
					Laminated safety glass		Toughened safety glass					Toughened laminated safety glass			
	Concentrated kN	Uniform kPa	ULS kPa	SLS kPa	10	12	6	8	10	12	15	8	10	12	16
A	0.25	0.5	-	-	750	1590	1380	1870	2220	2540	3000	1850	2200	2530	3140
A (other) & C3	0.5	1.0	2.1	1.5	-	-	-	1100	1650	1930	2250	1030	1600	1900	2380
B, E	0.5	1.0	2.1	1.5	-	-	-	1100	1650	1930	2250	1030	1600	1900	2380
C1/C2, C5 and D	1.5	1.5	2.1	1.5	-	-	-	-	-	450	1230	-	-	430	1550

NOTES

1. Two opposite edges of the glass panel are supported by continuous channel or frame (12mm minimum bite recommended)
2. A structural handrail wider than 30mm in plan supported by posts is provided above the glass
3. The handrail, posts and glazing frame are designed to Building Code
4. The dimension between unsupported sides of the glass panel is at least 800mm wide
5. Do not use this table for glass supported by point fixings (such as stand-off fittings). Stresses around holes must be checked for this type of installation.
6. Glass spans have been calculated for short and medium term live loads using the minimum glass thickness and loads applied as follows:
   - Uniform load is applied over whole area of glass
   - Concentrated load is applied to the edge of glass panel at mid-span
7. Deflection of glass is limited to span/60 up to a maximum of 30 mm excluding frame deflection
8. Glass thicknesses are nominal thicknesses and for toughened laminated glass exclude the interlayer
9. Glass thicknesses are based on the most severe load case
10. Design loads are in accordance with Building Code Compliance Document B1. B1/VM1 and AS/NZS 1170
11. For wind pressures exceeding those listed above specific design is required
12. Ultimate design strength of glass is in accordance with NZS 4223.1:2008
13. Glass thicknesses for proprietary balustrade systems may be determined by specific design



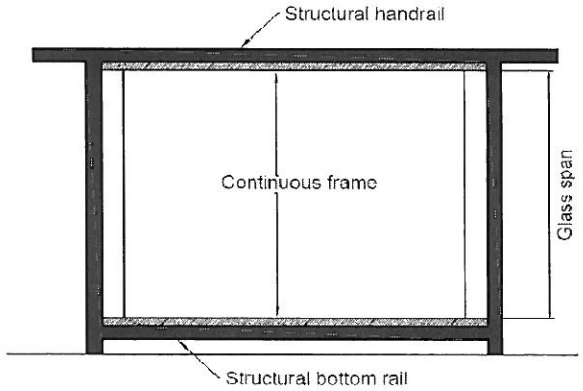


TABLE IB-3

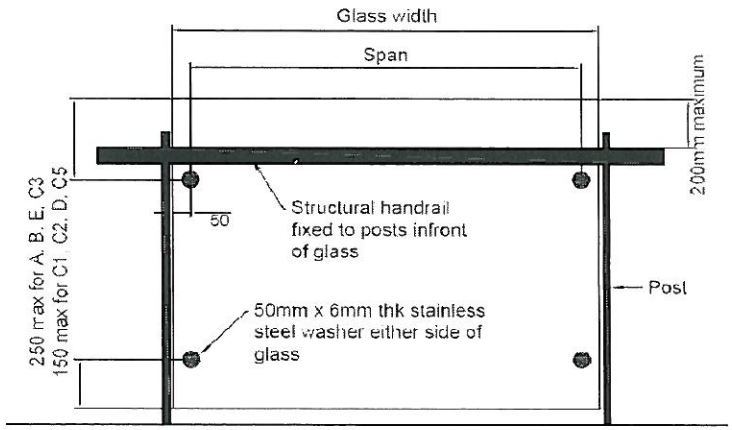
1-May-10

BALUSTRADE INFILL - 2 EDGES POINT FIXED, STRUCTURAL HANDRAIL INFRONT OF GLASS

AS/NZS 1170 Occupancy	Design load (SLS)			Wind pressure		Maximum glass width (mm)							
						Toughened safety glass				Toughened laminated safety glass			
	Line kN/m	Concentrated kN	Uniform kPa	ULS kPa	SLS kPa	10	12	15	19	10	12	16	20
A	0.35	0.25	0.5	-	-	2050	2250	2600	2850	2050	2250	2700	2950
A (other) & C3	0.75	0.5	1.0	2.1	1.5	1350	1500	1650	1850	1350	1500	1700	1900
B, E	0.75	0.5	1.0	2.1	1.5	1350	1500	1650	1850	1350	1500	1700	1900
C1/C2, D	1.5	1.5	1.5	2.1	1.5	-	-	-	1300	-	-	-	1400
C5	3.0	1.5	1.5	2.1	1.5	-	-	-	1300	-	-	-	1400

NOTES

1. Two opposite edges of the glass panel are supported by steel fittings
2. Each edge is supported by at least 2 fittings located no further than 250mm from the top and bottom edges for occupancy A, B, E and C3, and 150mm for C1/C2, D and C5, and between 50 to 100mm in from the edge
3. Fittings are at least 50mm in diameter and 6mm thick placed on either side of the glass panel with hard gaskets and nylon bushes to prevent glass and metal contact
4. A structural handrail wider than 30mm in plan is provided in front of the glass not more than 200mm from the top edge
5. The handrail and fittings are supported by the posts
6. The posts, handrail and fittings are designed to Building Code
7. Glass panels are at least 800mm high
8. Maximum glass width is the horizontal span between fittings plus 100mm
9. Glass widths have been calculated for short and medium term live loads using the minimum glass thickness and loads applied as follows:
   - 100 % of the line load is applied to the structural handrail
   - 50 % of the line load is applied to top edge of glass
   - Uniform load and wind pressure are applied over whole area of glass
   - Concentrated load is applied at corner of glass panel, and at mid-span along the edge
10. Deflection of glass is limited to span/60 up to a maximum of 30 mm. This excludes movement of the supporting posts
11. Glass thicknesses are nominal thicknesses and for toughened laminated glass exclude the interlayer
12. Glass thicknesses are based on the most severe load case.
13. Design loads are in accordance with Building Code Compliance Document B1, B1/VM1 and AS/NZS 1170
14. For wind pressures exceeding those listed above specific design is required
15. Ultimate design strength of glass is in accordance with NZS 4223.1:2008
16. Glass thicknesses for proprietary balustrade systems may be determined by specific design



GLASS ASSOCIATION GANZ MEMBER NEW ZEALAND

TABLE IB-4

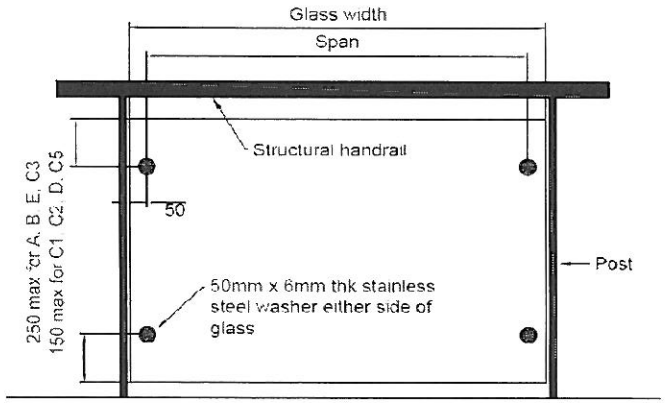
1-May-10

BALUSTRADE INFILL - 2 EDGES POINT FIXED

AS/NZS 1170 Occupancy	Design load (SLS)		Wind pressure		Maximum glass width (mm)							
					Toughened safety glass				Toughened laminated safety glass			
	Concentrated kN	Uniform kPa	ULS kPa	SLS kPa	10	12	15	19	10	12	16	20
A	0.25	0.5	-	-	2050	2250	2600	2850	2050	2250	2700	2950
A (other) & C3	0.5	1.0	2.1	1.5	1350	1500	1650	1850	1350	1500	1700	1900
B, E	0.5	1.0	2.1	1.5	1350	1500	1650	1850	1350	1500	1700	1900
C1/C2, D	1.5	1.5	2.1	1.5	-	-	-	1300	-	-	-	1400
C5	1.5	1.5	2.1	1.5	-	-	-	1300	-	-	-	1400

NOTES

1. Two opposite edges of the glass panel are supported by steel fittings
2. Each edge is supported by at least 2 fittings located no further than 250mm from the top and bottom edges for occupancy A, B, E and C3, and 150mm for C1/C2, D and C5, and between 50 to 100mm in from the edge
3. Fittings are at least 50mm in diameter and 6mm thick placed on either side of the glass panel with hard gaskets and nylon bushes to prevent glass and metal contact
4. A structural handrail wider than 30mm in plan is provided above the glass
5. The handrail and fittings are supported by posts
6. The posts, handrail and fittings are designed to Building Code
7. Glass panels are at least 800mm high
8. Maximum glass width is the horizontal span between fittings plus 100mm
9. Glass widths have been calculated for short and medium term live loads using the minimum glass thickness and loads applied as follows:
   - 100 % of the line load is applied to the structural handrail
   - Uniform load and wind pressure are applied over whole area of glass
   - Concentrated load is applied at corner of glass panel, and at mid-span along the edge
10. Deflection of glass is limited to span/60 up to a maximum of 30 mm. This excludes movement of the supporting posts
11. Glass thicknesses are nominal thicknesses and for toughened laminated glass exclude the interlayer
12. Glass thicknesses are based on the most severe load case.
13. Design loads are in accordance with Building Code Compliance Document B1, B1/VM1 and AS/NZS 1170
14. For wind pressures exceeding those listed above specific design is required
15. Ultimate design strength of glass is in accordance with NZS 4223.1:2008
16. Glass thicknesses for proprietary balustrade systems may be determined by specific design



GLASS ASSOCIATION GANZ MEMBER NEW ZEALAND

TABLE IB-5

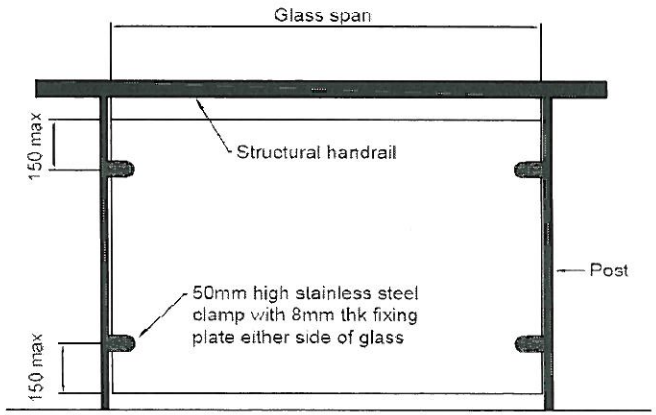
01-May-10

BALUSTRADE INFILL - 2 EDGES CLAMPED (NO HOLES IN GLASS)

AS/NZS 1170 Occupancy	Design load (SLS)		Wind pressure		Maximum glass span (mm)			
					Toughened safety glass		Toughened laminated safety	
	Concentrated kN	Uniform kPa	ULS kPa	SLS kPa	10	12	10	12
A	0.25	0.5	-	-	2100	2300	2100	2300
A (other) & C3	0.5	1.0	2.1	1.5	1450	1700	1400	1650
B, E	0.5	1.0	2.1	1.5	1450	1700	1400	1650
C1/C2, D	1.5	1.5	2.1	1.5	-	-	-	-
C5	1.5	1.5	2.1	1.5	-	-	-	-

NOTES

1. Two opposite edges of the glass panel are supported by stainless steel clamps without holes in glass
2. Each edge is supported by at least 2 clamps located no further than 150mm from the top and bottom edges
3. Clamps are at least 50mm high with 8mm thick fixing plates on either side of glass panel and gasket to prevent glass and metal contact. Glass to be clamped at least 40mm in from the edge
4. A set of 4 clamps should be able to support a weight of 100 kg. Glass width should not exceed the manufacturer's limitation
5. A structural handrail wider than 30mm in plan is provided above the glass
6. The posts, handrail and clamps are designed to Building Code
7. Glass panels are at least 800mm high
8. Glass spans have been calculated for short and medium term live loads using the minimum glass thicknesses and loads applied as follows:
   - 100 % of the line load is applied to the structural handrail
   - Uniform load and wind pressure are applied over whole area of glass
   - Concentrated load is applied at corner of glass panel, and at mid-span along the edge
9. Deflection of glass is limited to span/60 up to a maximum of 30 mm. This excludes movement of the supporting posts
10. Glass thicknesses are nominal thicknesses and for toughened laminated glass exclude the interlayer
11. Glass thicknesses are based on the most severe load case.
12. Design loads are in accordance with Building Code Compliance Document B1, B1/VM1 and AS/NZS 1170
13. For wind pressures exceeding those listed above specific design is required
14. Ultimate design strength of glass is in accordance with NZS 4223.1:2008
15. Glass thicknesses for proprietary balustrade systems may be determined by specific design



GLASS ASSOCIATION GANZ MEMBER NEW ZEALAND