Balcony 1: 1.8m privacy screen system: ***PAGE 1*** **(B1PSWB150300BP010817RA)**

Structural Calculations for BALCONY 1: 1.8m privacy screen system: handrail with 58 x 4mm internal steel reinforcing bar, or without bar using 60 x 60 x 5 SHS posts at 1.6m centres: alternative base plate options

Our ref: B1PSWB150300BP010817RA **Original date of issue: July 2017**

Revised with new wind load parameters: October 2018

Revised with new wall fixing: January 2025

Balcony 1 privacy screen 1.8m

Balcony 1 privacy screen on one side of a 3 sided balcony

DESIGN TO EUROCODES & CURRENT BRITISH STANDARDS

Design standards:

EN 1990	Eurocode 0:	Basis of structural design.
EN 1991	Eurocode 1:	Actions on structures.
EN 1991-1-4:2002 + A1 2010 + NA	Eurocode 1:	Actions on structures – wind actions.
EN 1993	Eurocode 3:	Design of steel structures.
EN 1999	Eurocode 9:	Design of aluminium structures.
BS EN 1990:2002 + A1:2005	Eurocode:	UK National annex for Eurocode
BS 6180:2011		British Standard: Barriers in and about buildings.

Design imposed loads:
Occupancy class/es for which this design applies (Table 2: BS6180:2011)

Domestic and residential activities (i) & (ii)
Office and work areas not included elsewhere (iii), (iv) & (v)
Areas without obstacles for moving people and not susceptible to overcrowding (viii) & (ix).

Service load on handrail Q_k = 0.74 kN/m uniformly distributed line load acting 1100mm above finished floor level. (Table 2: BS6180:2011)

Service load applied to the glass infill Qk1 = A uniformly distributed load of 1.0 kN/m^2

Point load on glass infill = 0.50 kN applied to any part of the glass fill panels

Table 2 **Minimum horizontal imposed loads for parapets, barriers and balustrades**

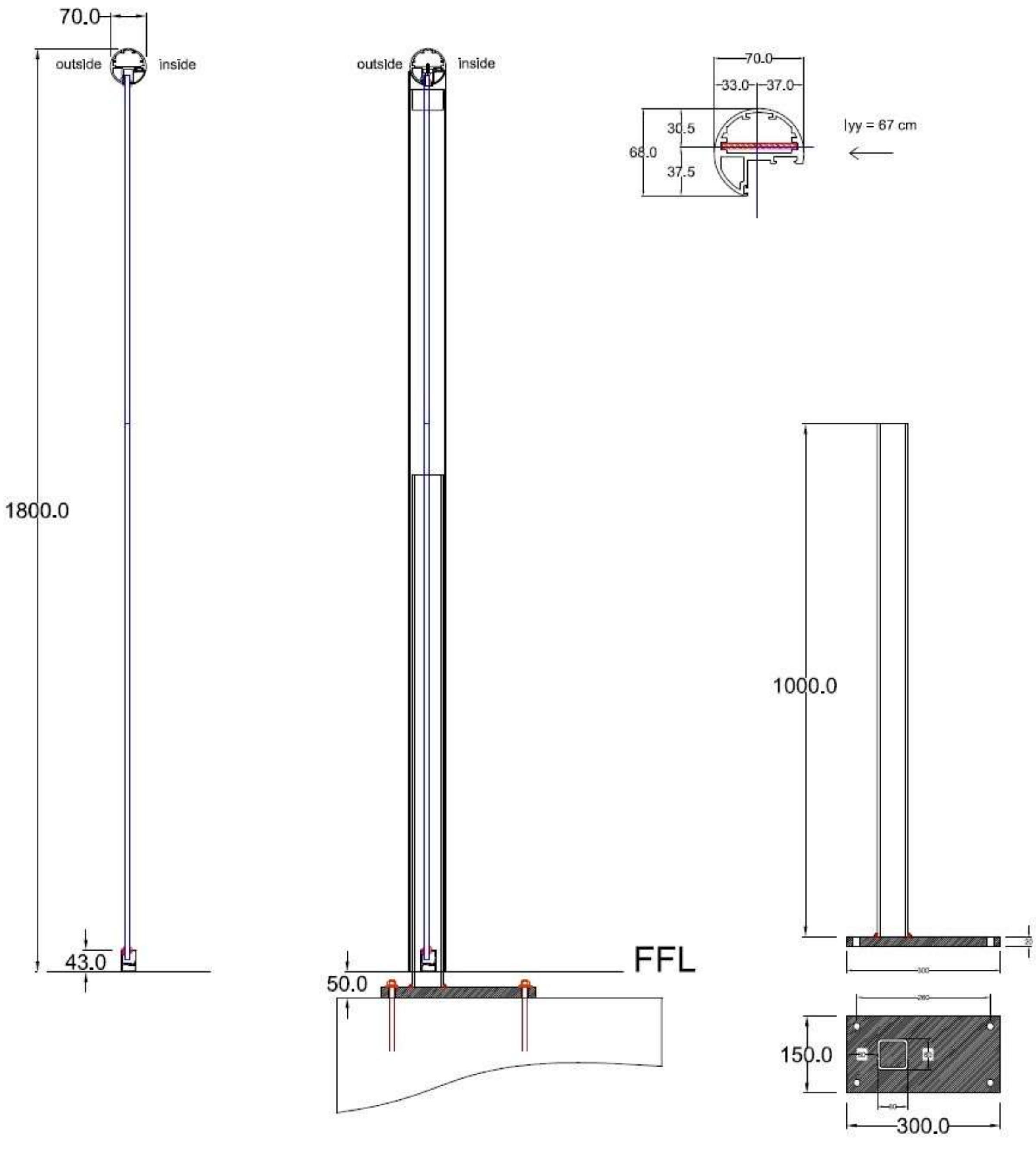
Type of occupancy for part of the building or structure	Examples of specific use	Horizontal uniformly distributed line load (kN/m)	Uniformly distributed load applied to the infill (kN/m²)	A point load applied to part of the infill (kN)
Domestic and residential activities	(i) All areas within or serving exclusively one single family dwelling including stairs, landings, etc. but excluding external balconies and edges of roofs	0.36	0.5	0.25
	(ii) Other residential, i.e. houses of multiple occupancy and balconies, including Juliette balconies and edges of roofs in single family dwellings	0.74	1.0	0.5
Offices and work areas not included elsewhere, including storage areas	(iii) Light access stairs and gangways not more than 600 mm wide	0.22	—	—
	(iv) Light pedestrian traffic routes in industrial and storage buildings except designated escape routes	0.36	0.5	0.25
	(v) Areas not susceptile to overcrowding in office and institutional buildings, also industrial and storage buildings except as given above	0.74	1.0	0.5
Areas where people might congregate	(vi) Areas having fixed seating within 530 mm of the barrier, balustrade or parapet	1.5	1.5	1.5
Areas with tables or fixed seatings	(vii) Restaurants and bars	1.5	1.5	1.5
Areas without obstacles for moving people and not susceptible to overcrowding	(viii) Stairs, landings, corridors, ramps	0.74	1.0	0.5
	(ix) External balconies including Juliette balconies and edges of roofs. Footways and pavements within building curtilage adjacent to basement/sunken areas	0.74	1.0	0.5

Table 2: BS6180:2011

- These loads are considered as three separate load cases. They are not combined. Wind loading is also considered as a separate design case.
- Factored loads are used for checking the limit state of static strength of a member.
- The service loads are multiplied by a partial factor for variable action $\gamma_{Q,1}$ of 1.5 to give the ultimate design load for leading variable action.

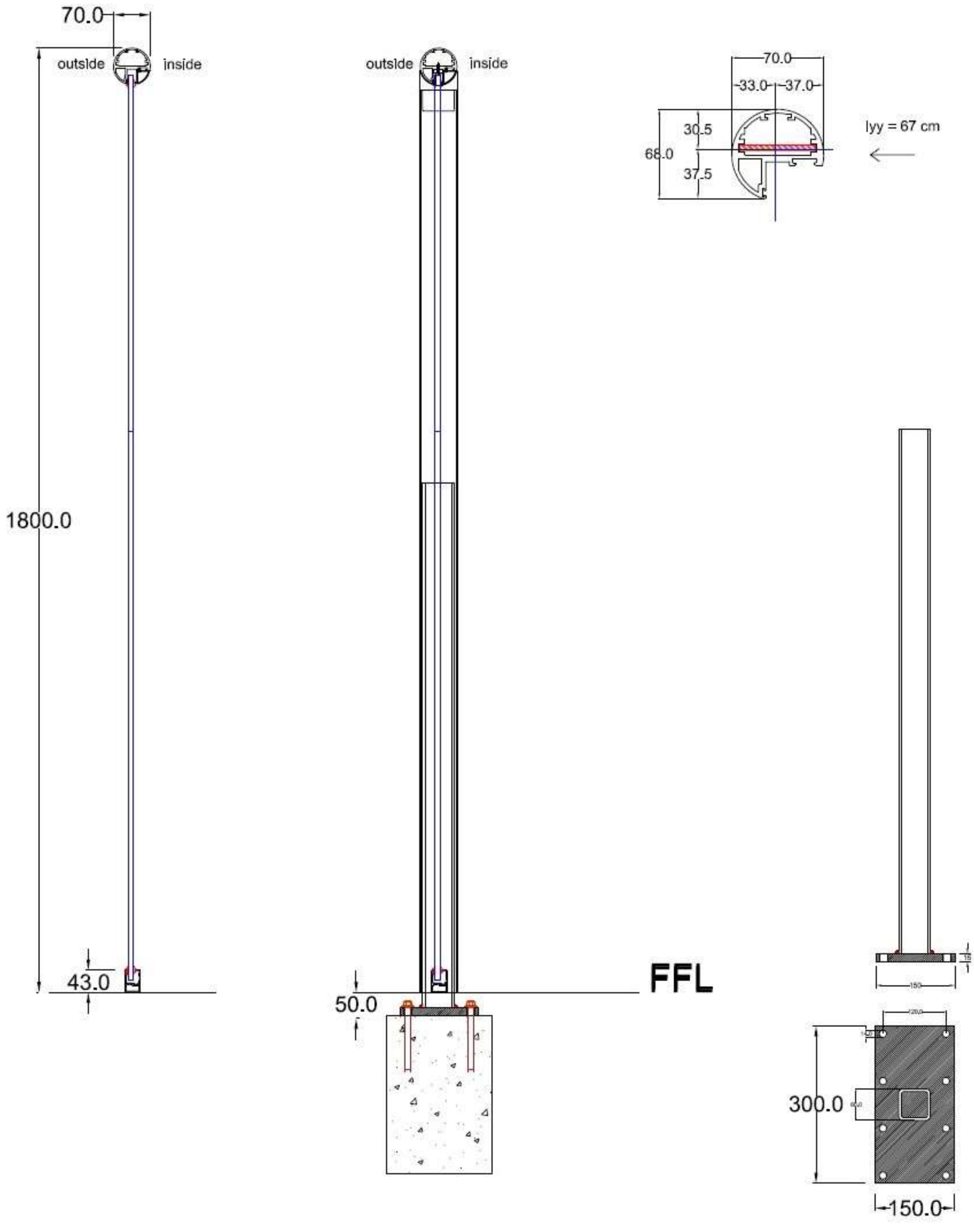
Deflection:

- All structural members deflect to some extent under load. Service loads are used to calculate deflections.
- The total displacement of any point of a barrier from its original unloaded position under the action of service loads is limited to 25mm.



Section of Balcony 1: 1.8m privacy screen system, <u>option 1</u> post and base plate details.

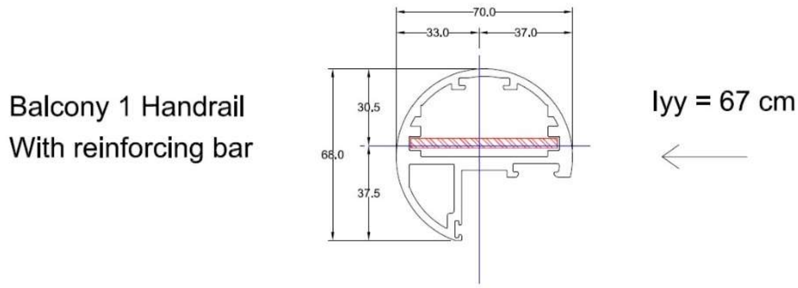
<u>Balcony 1: 1.8m privacy screen system:</u> ***PAGE 4*** **(B1PSWB150300BP010817RA)**

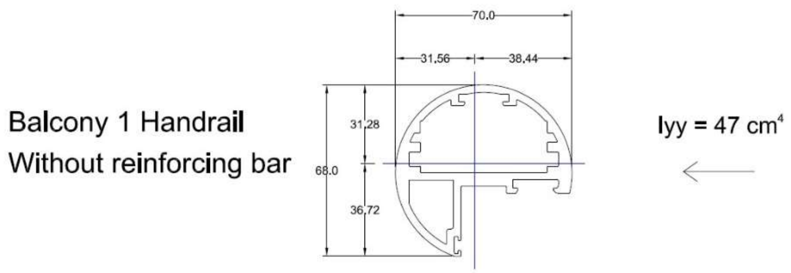


Section of Balcony 1: 1.8m privacy screen system, <u>option 2</u> post and base plate details.

Balcony 1: 1.8m privacy screens: ***PAGE 5*** **(B1PSWB150300BP010817RA)**

Section properties of handrail





Handrail with reinforcing bar:

Material type	=	Extruded aluminium type 6063 T5		
Characteristic 0.2% proof stress	=	f_o	=	130 N/mm^2
Characteristic ultimate tensile strength	=	f_u	=	175 N/mm^2
Modulus of elasticity	=	E	=	70 000 N/mm^2
Shear modulus	=	G	=	27 000 N/mm^2
Moment of inertia about the y-y axis	=	I_{yy}	=	67.0 cm^4
Least elastic modulus about the y-y axis	=	W_{el}	=	18.108 cm^3
Partial factor for material properties	=	γ_{M1}	=	1.10
Value of shape factor	=	α	=	W_{pl}/W_{el}
(conservative value assumed)			=	1.2 say
Design ultimate resistance to bending about the y-y axis	=	M_{Rd}	=	$M_{o,Rd}$

$$= \alpha W_{el} f_o / \gamma_{M1}$$

$$= \frac{1.2 \times 18.108\ cm^3 \times 130\ N/mm^2 \times (10)^{-3}}{1.1}$$

$$= \mathbf{2.568\ kNm}$$

Balcony 1: 1.8m privacy screen system: ***PAGE 6*** **(B1PSWB150300BP010817RA)**

Handrail without reinforcing bar:

Material type	=	Extruded aluminium type 6063 T5		
Characteristic 0.2% proof stress	=	f_o	=	130 N/mm^2
Characteristic ultimate tensile strength	=	f_u	=	175 N/mm^2
Modulus of elasticity	=	E	=	70 000 N/mm^2
Shear modulus	=	G	=	27 000 N/mm^2
Moment of inertia about the y-y axis	=	I_{yy}	=	47.0 cm^4
Least elastic modulus about the y-y axis	=	W_{el}	=	12.90 cm^3
Partial factor for material properties	=	γ_{M1}	=	1.10
Value of shape factor (conservative value assumed)	=	α	=	W_{pl}/W_{el}
			=	1.2 say
Design ultimate resistance to bending about the y-y axis	=	M_{Rd}	=	$M_{o,Rd}$

$$= \alpha W_{el} f_o / \gamma_{M1}$$

$$= \frac{1.2 \times 12.91\ cm^3 \times 130\ N/mm^2 \times (10)^{-3}}{1.1}$$

= **1.829 kNm**

60 x 60 x 5mm SHS posts: **properties of section:**

Steel grade	=	S275 H to EN 10210-1		
Nominal value of yield strength	=	f_y	=	275 N/mm^2
Inertia of section	=	I_{xx}	=	50.50 cm^4
Elastic modulus of section	=	W_{el}	=	16.80 cm^3
Plastic modulus of section	=	W_{pl}	=	20.90m cm^3
Partial factor for material properties	=	γ_{M1}	=	1.10
Partial factor for class 1 sections	=	γ_{MO}	=	1.00
Modulus of elasticity	=	E	=	210 000 N/mm^2

Design ultimate resistance for bending $M_{pl,Rd}$

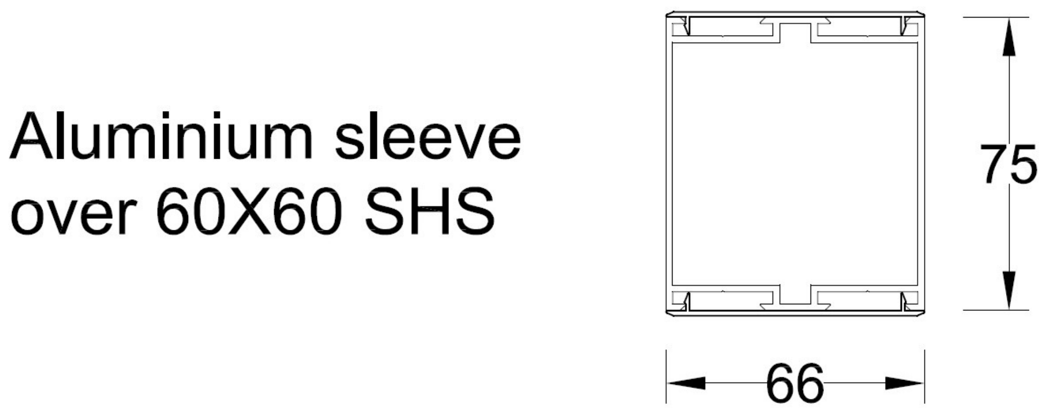
$$= \frac{f_y \times W_{pl}}{\gamma_{Mo}}$$

$$= \frac{275\ N/mm^2 \times 20.90\ cm^3 \times (10)^{-3}}{1.0}$$

= **5.75 kNm**

Balcony 1: 1.8m privacy screen system: *Page* 7 (B1PSWB150300BP010817RA)

Aluminium sleeves:



Aluminium sleeve: properties of section:

Material type		=	Extruded aluminium type 6063 T5
Characteristic 0.2% proof stress	f_o	=	130 N/mm^2
Characteristic ultimate tensile strength	f_u	=	175 N/mm^2
Modulus of elasticity	E	=	70,000 N/mm^2
Moment of inertia about the y-y axis	I_{yy}	=	43.30 cm^4
Elastic modulus about the y-y axis	W_{el}	=	13.12 cm^3
Shape factor (conservative assessment)	α	=	1.2
Moment capacity about the y-y axis	M_{RD}	=	$\frac{1.2 \times 13.12\ cm^3 \times 130\ N/mm^2 \times (10)^{-3}}{1.1}$
		=	**1.86 kNm**

Wind load design:

Design wind loads are influenced by a number of variable factors. These include site location, site altitude above sea level, type of terrain, height of privacy screen above ground level and screen geometry.

These parameters and conditions are defined in BS EN 1991-1-4:2002 + A1: 2010 '*Actions on structures – wind actions' &* UK National Annex to EN 1991-1-4:2002 + A1:2010. We have chosen to prepare a calculation based on certain conditions, resulting in specific coefficients.

The formula applied results in an overall ***characteristic wind pressure***. The design and calculation will be relevant not only to the conditions specified herein but to any combination of factors that result in a characteristic wind pressure that is equal to or less than the one specified in the calculation. Sites that have a ***characteristic wind pressure*** that exceeds **1.00 kN/m^2** as determined on page 9 below require separate calculation.

The selected wind load coefficients are appropriate for 1.8m high screens of any length with or without return corners.

Wind load parameters:

a) Sites located geographically within the 23m/sec isopleth in Figure NA1 of the UK National Annex. This covers most of England and the eastern half of Wales.

b) Site altitude 50m maximum above sea level.

c) Top of balustrade located 8m maximum above ground level.

d) Site located in a coastal area exposed to the open sea, terrain category 0 of BS EN 1991 Table 4.1. This is the most severe exposure category. Smaller wind load coefficients apply to less exposed inland sites, terrain categories 1 to 1V.

e) Sites with no significant orography in relation to wind effects. Increased wind load factors apply to sites near the top of isolated hills, ridges, cliffs or escarpments.

f) Directional, seasonal, and probability factors are all taken as normal, for which the relevant factor is 1.0.

Wind load design:

Basic wind speed	$V_{b\ map}$	=	23 m/sec
Site altitude factor	C_{alt}	=	1.05
Directional factor	C_{dir}	=	1.0
Seasonal factor	C_{season}	=	1.0
Probability factor	C_{prob}	=	1.0
Site wind speed	V_b	=	$V_{b\ map}(C_{dir} \times C_{season} \times C_{prob})\ (C_{alt})$
		=	23 m/sec x 1.05
		=	24.15 m/sec

Wind load design (cont):

Site wind pressure	q_b	=	$0.613\ (V_b)^2$	
		=	$0.613\ (24.15)^2$	
		=	$357.5\ N/m^2$	
Exposure factor	C_e (z)	=	2.70	(Figure NA7)
Peak velocity pressure	q_p	=	q_b x C_e (z)	
(characteristic wind pressure)		=	0.357 x 2.70	
		=	$0.964\ kN/m^2$	
	say	**=**	**$1.0\ kN/m^2$**	
Partial safety factor for leading variable action	γ_{Q1}	=	1.50	
Ultimate design wind pressure		=	$1.00\ kN/m^2$ x 1.5	
		=	**$1.50\ kN/m^2$**	

For sites that come within the parameters listed on page 8 of these calculations, the specified design imposed UDL loading and the characteristic design wind loading are the same.

Summary of design ultimate loads:

Horizontal imposed line load applied 1100mm above finished floor level (ie. 1135mm above the top of the base and 30.5mm below the top of the handrail)	=	0.74 kN/m x 1.5 (load factor)
	=	1.11kN/m
Reaction on the handrail from the imposed line load	=	$\frac{1.11\ kN/m \times 1135}{1769.5}$
	=	0.712 kN/m
Imposed and wind UDL on the glass	=	$1.00\ kN/m^2$ x 1.5 (load factor)
	=	$1.50\ kN/m^2$
Reaction on the handrail from the imposed and wind load on the glass	=	$1.50\ kN/m^2$ x 0.90
	=	1.35 kN/m
Ultimate point load applied in any position	=	0.50 kN x 1.5 (load factor)
	=	0.75 kN

Glass design:

Glass panels: 12mm thick (Option 1: spans one way) or 10mm thick (Option 2: spans two ways) thermally toughened soda silicate safety glass with smooth float 'as produced' finish and polished edges.

For Option 1 the glass spans vertically between the bottom rail and the handrail. The glass panels can be of any width.

With Option 2 the glass must be in a single pane supported on all four sides.

For design purposes a nominal glass panel width of 1000mm has been used.

Design standard: Institution of Structural Engineers publication 'Structural use of glass in building (second edition) February 2014.'

Characteristic design strength of glass = 120 N/mm^2

Ultimate design stress $f_{g;d} = \dfrac{K_{mod} \times K_{sp} \times K_{g;k}}{\gamma_{M;A}} + \dfrac{k_v (f_{b;k} - f_{g;k})}{\gamma_{M;V}}$

where

K_{mod} = 30 second duration factor
= 0.89 for domestic balustrades

K_{sp} = glass surface profile factor
= 1.0 for float glass 'as produced'

$f_{g;k}$ = characteristic strength of basic annealed glass
= 45 N/mm^2

K_v = manufacturing process strengthening factor
= 1.0 for horizontal toughening

$f_{b;k}$ = characteristic bending strength of prestressed glass
= 120 N/mm^2

$\gamma_{M;A}$ = material partial factor
= 1.6 for basic annealed glass

$\gamma_{M;V}$ = material partial factor
= 1.2 for surface prestressed (toughened) glass

Ultimate design stress $f_{g;d} = \dfrac{0.89 \times 1.0 \times 45}{1.6} + \dfrac{1.0\,(120 - 45)}{1.2}$

= **87.53 N/mm^2**

Glass design:

Option 1: 12mm glass spans vertically 1.74m between bottom rail & handrail:

Elastic modulus of glass 1000mm wide x 12mm thick	W_{el}	=	$\frac{1000 \times (12)^2}{6}$	=	24000 mm^3/m
Inertia of glass 1000mm wide x 12mm thick	I_{xx}	=	$\frac{1000 \times (12)^3}{12}$	=	144000 mm^4/m
Ultimate moment capacity of glass	M_u	=	$f_{g:d} \times Z$		
1000mm wide x 12mm thick		=	87.53 N/mm^2 x 24000 x $(10)^{-6}$		
		=	**2.10 kNm/m**		
Ultimate moment on glass spanning 1.74m vertically	M	=	$\frac{1.50 \ kN/m^2 \times (1.74)^2}{8}$	=	0.568 kNm/m
		=	< 1.459 kNm/m	=	10mm glass is OK for bending stress
Design service load on glass	W_w	=	1.00 kN/m^2		
Service load deflection of glass 12mm thick spanning 1.74m	Δ	=	$\frac{5 w L^4}{384 E I}$		
		=	$\frac{5 (1000 \times 1.74) (1740)^3}{384 \times 70000 \times 144000}$	=	11.84mm
		=	< 25mm	=	OK

Option 2: 10mm glass spans 2 ways: 3000mm wide x 1740mm high:

Moment and deflection coefficients for rectangular plates supported on all 4 sides and subject to uniformly distributed loading are taken from *'Formulas for stress and strain' by Raymond J Roark, forth edition, table X, case 36.*

Width of panel	a	=	3000mm		
Height of panel	b	=	1740		
Aspect ratio	a/b	=	1.72	say	1.7
BM coefficients:	β	=	0.5430		
	α	=	0.0962		
Maximum ultimate load stress	s	=	$\frac{\beta w b^2}{t^2}$		
		=	$\frac{0.5430 \times 1.50 \ kN/m^2 \times (10)^{-3} \times (1740)^2}{(10)^2}$		
		=	24.66 N/mm^2	=	OK
Maximum service load glass deflection	y	=	$\frac{\alpha w b^4}{E t^3}$		
		=	$\frac{0.0962 \times 1.00 \ kN/m^2 \times (10)^{-3} \times (1740)^4}{70000 \times (10)^3}$		
		=	12.60mm		

Handrail: with strengthening bar:

Working load force on handrail	=	1.00 kN/m^2 x 0.90	=	0.90 kN/m
Ultimate load force on handrail	=	0.90 x 1.5	=	1.35 kN/m
Ultimate moment capacity of handrail about the y-y axis	=	2.568 kNm		

Balcony 1: 1.8m privacy screens: single span and corner system: **PAGE 12** **(B1PSWB150300BP010817RA)**

Handrail (with bar): (cont)

Allowable span of handrail between points of support based upon the moment capacity of the handrail = $\left[\frac{8 \times 2.568 \text{ kNm}}{1.35}\right]^{0.5}$ = 3.90m

Service load deflection of handrail for a simply supported span of 3.9m = $\frac{5 \times (900 \times 3.9)(3900)^3}{384 \times 70000 \times 67 \times (10)^4}$ = 57.805mm = too high

The span of the handrail is reduced from 3.9m to 3.0m to comply with service load deflection limitations.

Service load deflection of handrail for a simply supported span of 3.0m = $\frac{5 (900 \times 3.0)(3000)^3}{384 \times 70000 \times 67 \times (10)^4}$ = 20.24mm

The overall combined displacement of any point of the screen from its original unloaded position is limited to 25mm under service load conditions. Maximum displacement occurs at mid-height of the screen due to glass deflection + half x handrail deflection.

Maximum displacement using 12mm glass spanning vertically = $11.84\text{mm} + \frac{20.24}{2}$ = 21.96mm OK

Maximum displacement using 10mm glass spanning 2 ways = $12.60\text{mm} + \frac{20.24}{2}$ = 22.72mm = OK

Summary: On single span and corner screens without posts, the Balcony 1 handrail with 58 x 4mm internal steel reinforcing bar, is adequate to support the design loading for handrail spans up to 3.0m between points of support. ie. a handrail wall fixing or a handrail corner joint. Alternative options for the thermally toughened safety glass are considered:

Option 1: 12mm thick glass spanning between the bottom rail and the handrail. With this option the glass panels may be of any width.
Option 2: 10mm thick glass spanning 2 ways. With this option the glass panel must be a single pane supported on all 4 sides.
Both options satisfy service load deflection limitations.

Longer screens with posts:
On longer screens posts are introduced at 1.6m maximum centres to support the handrail. A typical design is considered that covers the majority of sites in the UK. Sites where the design wind loading is greater require separate consideration.

Structural system: Option 1:

Handrail: Balcony 1 system without internal reinforcing bar.

Posts: 60 x 60 x 5mm structural hollow steel posts (SHS) 1.0m high at 1.6m centres, with 75 x 66 x 1.7mm aluminium sleeves. The aluminium sleeve continues approximately 800mm above the SHS to the top of the screen.

Glass: Option 1: 12mm thick thermally toughened safety glass spanning vertically between the bottom rail and the handrail. The design is the same as for the single span and corner balconies on page 11.

Option 2: 10mm thick thermally toughened safety glass spanning 2 ways. The design is similar to that for the single span and corner balconies on page 11, except that moments and deflections of the glass are reduced because the width of each panel is 1534mm instead of 3000mm.

Balcony 1: 1.8m privacy screens: longer screens with posts:

Combined deflection: posts at 1.6m centres and 12mm thick glass spanning vertically 1.74m

Service load design pressure on glass		=	1.00 kN/m^2		
Partial safety factor	γ_{Q1}	=	1.50		
Ultimate design pressure	w	=	1.00 kN/m^2 x 1.50	=	1.50 kN/m^2
Inertia of 12mm glass x 1000mm wide	I_{xx}	=	144000mm^4		
Modulus of glass 12mm x 1000mm	W^{el}	=	24000mm^3		
Moment capacity of glass 12 x 1000mm	M_{Rd}	=	2.10 kNm		
Ultimate BM on glass spanning 1.74m vertically	Mu	=	$\frac{1.50 \text{ kN/m}^2 \times (1.74)^2}{8}$		
		=	0.568 kNm/m		OK
Service load deflection of glass 12mm thick spanning 1.74m	Δ	=	$\frac{5 w L^4}{384 E I}$		
		=	$\frac{5 (1000 \times 1.74) (1740)^3}{384 \times 70000 \times 144000}$		
		=	11.84mm		

Handrail (no bar):

Moment of inertia about the y-y axis	I_{yy}	=	47 cm^4		
Least modulus about the y-y axis	W_{el}	=	12.90 cm^3		
Moment capacity about the y-y axis	M_{Rd}	=	1.829 kNm		
Ultimate BM on handrail on a simply supported span of 1.6m	Mu	=	$\frac{1.35 \text{ kN/m} \times (1.6)^2}{8}$	=	0.432 kNm
Service load deflection of handrail	Δ	=	$\frac{5 w L^4}{384 E I}$		
		=	$\frac{5 (1000 \times 1.6) (1600)^3}{384 \times 70000 \times 47 \times (10)^4}$		
		=	2.59mm		

Sleeve

Projection of sleeve above SHS		=	800mm
Effective cantilever span		=	850mm say
Service point load applied to top of sleeve		=	0.90 kN/m x 1.6
		=	1.44 kN

Sleeve (cont):

Service load deflection of sleeve as an 850mm cantilever with a 1.44 kN point load applied at the end		=	$\frac{P L^3}{3 E I}$
		=	$\frac{1440 \times (850)^3}{3 \times 70000 \times 43.3 \times (10)^4}$
		=	9.73mm

SHS post:

Service load deflection at top of SHS as a 1000mm cantilever with a 1.44kN point load applied at the end	Δ	=	$\frac{1440 \times (1000)^3}{3 \times 210000 \times 50.5 \times (10)^4}$
		=	4.53mm

Combined deflection:

Combined deflection of handrail + post	Δ	=	4.53 (post) + 9.73(sleeve) + 2.59(handrail)	
+ sleeve at top of screen		=	16.85mm	
		= <	25mm	OK
Combined deflection at mid-height		=	11.84 (glass) + 4.53 (post) + 1.30 (handrail)	
Glass + post + ½ x handrail deflection		=	17.67mm	
		= <	25mm	OK

Summary: Option 1:

On longer balconies where 60 x 60 x 5 SHS posts with aluminium sleeves are installed at a maximum spacing of 1.6m to support the handrail, the Balcony 1 system handrail without internal steel reinforcing bar, in conjunction with 12mm thick thermally toughened safety glass spanning vertically between the handrail and the bottom rail, is adequate to resist the design ultimate imposed and wind loading in terms of both moment capacity and service load deflection limitations.

Option 2: 10mm glass spanning 2 ways and supported on all 4 sides:

Characteristic design imposed and wind pressure = $1.00\ kN/m^2$

Ultimate design imposed and wind pressure = $1.50\ kN/m^2$

Moment and deflection coefficients for rectangular plates supported on all sides and subject to UDL loading are taken from *'Formulas for stress and strain' by Raymond J Roark, fourth edition, Table X, case 36.*

Height of panel	=	a	=	1740mm
Width of panel	=	b	=	1534mm
Aspect ratio	=	a/b	=	1.134 say = 1.2
BM coefficient	=	β	=	0.3762
Maximum ultimate design stress	=	s_b	=	$\frac{\beta w b^2}{t^2}$
			=	$\frac{0.3762\ (1.50\ kN/m^2)(10)^{-3}\ (1534)^2}{(10)^2}$
			=	$13.28\ N/mm^2$
			= <	$87.53\ N/mm^2$ OK
Deflection coefficient	=	α	=	0.0616
Maximum glass deflection due to service load of $1.0\ kN/m^2$	=	y	=	$\frac{\alpha w b^4}{E t^3}$
			=	$\frac{0.0616\ (1.0kN/m^2)\ (10)^{-3}\ (1534)^4}{70000 \times (10)^3}$
			=	4.87mm

The 2 way spanning panels are approximately square. Consequently a Δ load approximately equal to ¼ of the total load on the panel is applied to the supporting structure on each side.

Total ultimate load on panel = $1.50\ kN/m^2 \times 1.8 \times 1.6$

(including handrail & posts) = 4.32 kN

Handrail (no bar) supports Δ ultimate load = 1.08 kN

Balcony 1: 1.8m privacy screens: longer screens with posts: ***PAGE*** **15** **(B1PSWB150300BP010817RA)**

Option 2: 10mm glass spanning 2 ways supported on all 4 sides:

Characteristic design imposed and wind pressure = 1.00 kN/m^2
Ultimate design imposed and wind pressure = 1.50 kN/m^2

Moment and deflection coefficients for rectangular plates supported on all sides and subject to UDL loading are taken from *'Formulas for stress and strain' by Raymond J Roark, fourth edition, Table X, case 36.*

Height of panel = a = 1740mm
Width of panel = b = 1534mm
Aspect ratio = a/b = 1.134 say = 1.2
BM coefficient = β = 0.3762
Maximum ultimate design stress = s_b = $\frac{\beta\, w\, b^2}{t^2}$

= $\frac{0.3762\,(1.50\text{ kN/m}^2)(10)^{-3}\,(1534)^2}{(10)^2}$

= 13.28 N/mm^2

= < 87.53 N/mm^2 OK

Deflection coefficient = α = 0.0616
Maximum glass deflection due to service load of 1.0 kN/m^2 = y = $\frac{\alpha\, w\, b^4}{E\, t^3}$

= $\frac{0.0616\,(1.0\text{kN/m}^2)\,(10)^{-3}\,(1534)^4}{70000 \times (10)^3}$

= 4.87mm

The 2 way spanning panels are approximately square. Consequently a Δ load approximately equal to ¼ of the total load on the panel is applied to the supporting structure on each side.

Total ultimate load on panel = 1.50 kN/m^2 x 1.8 x 1.6
(including handrail & posts) = 4.32 kN

Handrail (no bar) supports Δ ultimate load = 1.08 kN

BM due to Δ load on handrail M = $\frac{W\,L}{6}$ = $\frac{1.08 \times 1.6}{6}$ = 0.288 kNm

Moment capacity of handrail M_{Rd} = 1.829 kNm = OK

I_{yy} of handrail (no bar) I_{yy} = 47 cm^4

Service load deflection of handrail (no bar) Δ = $\frac{W\,L^3}{60\,E\,I}$

= $\frac{1829 \times (1600)^3}{60 \times 70000 \times 47 \times (10)^4}$ = 3.80mm

Posts:

60 x 60 x 5 SHS 1.0m high with a 75 x 66 aluminium sleeve extending up to the handrail.

Ultimate point load applied by handrail = 1.08 kN
Ultimate Δ load applied over the height of the post + sleeve = 2.16 kN (centroid at mid height)

Maximum ultimate BM on post = (1.08 x 1.8) + (2.16 x 0.90)
= 3.89 kNm
say = 4.00 kNm

Balcony 1: 1.8m privacy screens: longer screens with posts: ***PAGE* 16** **(B1PSWB150300BP010817RA)**

Posts (cont):

Moment capacity of post MRc = 5.75 kNm = OK

Maximum ultimate BM on sleeve = (1.08 x 0.85) + (1.08 x 0.283)
= 1.224 kNm

Moment capacity of sleeve = 1.86 kNm = OK

Service load deflection:
For the purposes of assessing service load deflection, the point load applied at the top of the sleeve is taken in conjunction with the remaining loads considered as a UDL.

Aluminium sleeve
Projection of sleeve above SHS = 800mm
Effective cantilever height = 850mm

Service load deflection of sleeve as an 850mm cantilever

$$= \frac{PL^3}{3EI} + \frac{WL^3}{8EI}$$

$$= \frac{720 \times (850)^3}{3 \times 70000 \times 43.3 \times (10)^4} + \frac{720 \times (850)^3}{8 \times 70000 \times 43.3 \times (10)^4}$$

$$= 4.86 + 1.82$$

$$= 6.68\text{mm}$$

SHS post
Service load deflection at 1.8m height due to an equivalent UDL on the 1.0m high SHS

$$= \frac{W a^3}{8 EI} \left\{1 + \frac{4b}{3a}\right\}$$

where a = height of SHS = 1000mm
b = height of sleeve above SHS = 800mm

$$\Delta = \frac{1080 \times (1000)^3}{8 \times 210000 \times 50.5 \times (10)^4} \left\{1 + \frac{4 \times 800}{3 \times 1000}\right\}$$

$$= 1.27 \times 2.07$$

$$= 3.34\text{mm}$$

Service load deflection at 1.8m height due to point load imposed on the SHS by the sleeve

$$= \frac{P a^3}{3 E I} \left\{1 + \frac{3b}{2a}\right\}$$

where P = 1.44 kN
a = height of SHS = 1000mm
b = height of sleeve above SHS = 800mm

$$\Delta = \frac{1440 (1000)^3}{3 \times 210000 \times 50.5 \times (10)^4} \left\{1 + \frac{3 \times 800}{2 \times 1000}\right\}$$

$$= 4.526 \times 2.20$$

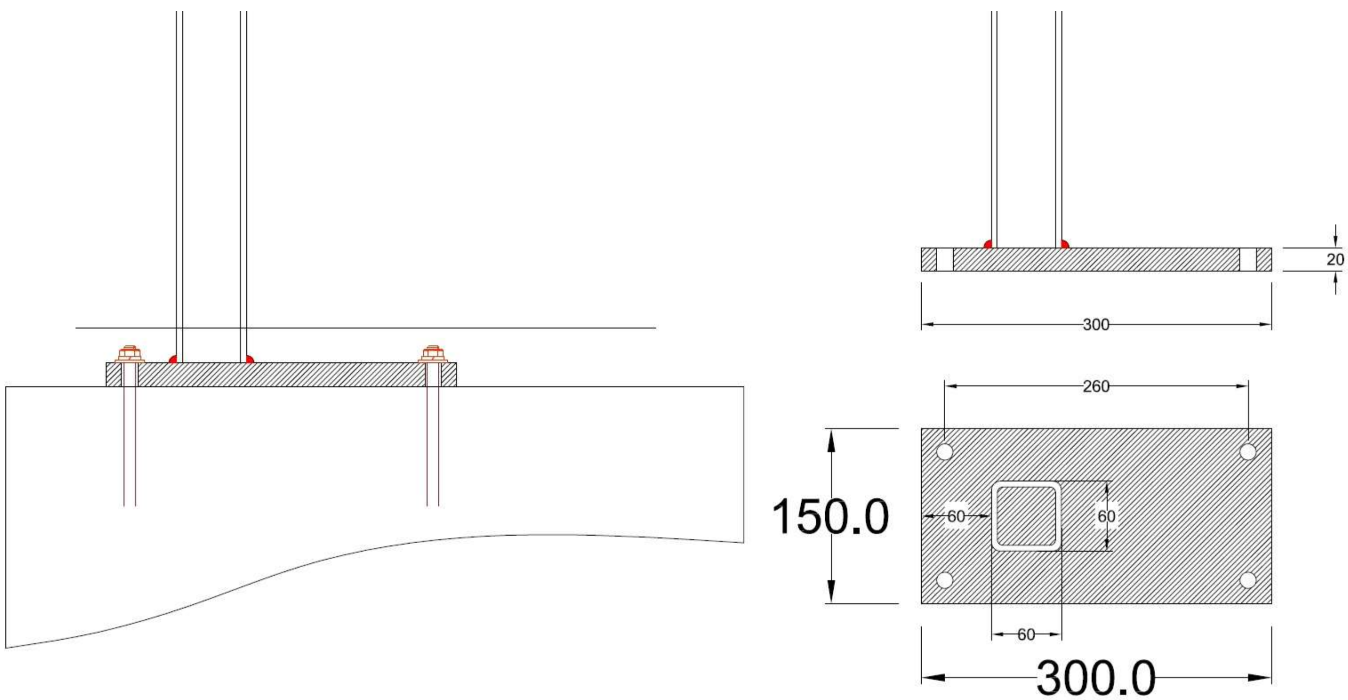
$$= 9.96\text{mm}$$

Total displacement at the top of the screen from its original unloaded position
= deflection of handrail + SHS + sleeve
= 3.80 (handrail) + 9.96 (SHS) + 3.34 (SHS) + 6.68 (sleeve)
= 23.78mm
= < 25mm = OK

Summary: longer screens with posts: Option 2:

On longer balconies where 60 x 60 x 5 SHS posts with aluminium sleeves are installed at a maximum spacing of 1.6m to support the handrail, the Balcony 1 system handrail without internal steel reinforcing bar, in conjunction with 10mm thick thermally toughened safety glass designed to span 2 ways between the handrail, the bottom rail, and the posts on either side, is adequate to resist the design ultimate imposed and wind loading in terms of both moment capacity and service load deflection limitations.

Base plates: Option 1:



Base plate = option 1: 300 x 150 x 20mm

)

Ultimate load BM on posts at 1.6m centres	=	$1.50\ kN/m^2 \times 1.6 \times 1.8 \times 0.95$ = 4.104 kNm		
Service load moment on posts at 1.6m c/c	=	$\frac{4.104}{1.5}$ kNm	=	2.736 kNm
Lever arm between the centres of bolts	=	260 mm		
Service load bolt tension on 2 No. bolts	=	$\frac{2.736\ kNm}{2\ No. \times 0.26}$	=	5.26 kN/bolt
Ultimate load bolt tension	=	5.26 x 1.5	=	7.89 kN/bolt
		say	**=**	**8.0 kN/bolt**

Base plate: Option1 (cont):

BS 6180:2011, section 6.5, recommends that barrier fixings, attachments and anchorages should be designed to withstand a greater load than the design loading for the barrier generally. This is intended to ensure that under an extreme load condition, barriers show indications of distress by distortion, before there is any possibility of sudden collapse due to failure of the fixings. A 50% increase in the design load on fixings is recommended.

Applying the 50% increase in loads on fixings recommended in BS 6180:2011, the ultimate bolt load becomes 8.0 x 1.5 = 12.0 kN/bolt (8.0 kN/bolt working load), which should be achievable using M12 drilled resin anchor bolts or similar, or by drilling through and anchoring to the underside of a suitable concrete slab.

The nominal tension capacity of M12 (8.8 grade) bolts is 37.80 kN/bolt. Higher bolt forces can therefore be achieved by direct bolting to a suitable steel frame.

Separate consideration is required where it is proposed to use other types of fixings, or where fixings are to be inserted into weaker materials.

The installers should satisfy themselves that the fixing bolts chosen are suitable to resist these loads, and also that the structure into which they are installed can support these loads.

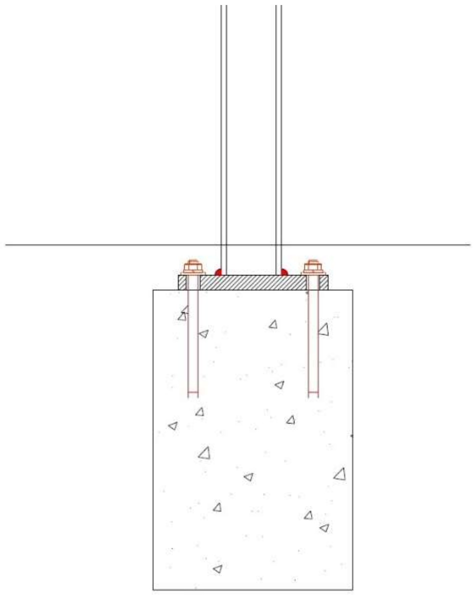
Base plates – option 1: 300mm long x 150mm wide x 20mm thick with 4 M12 bolts:

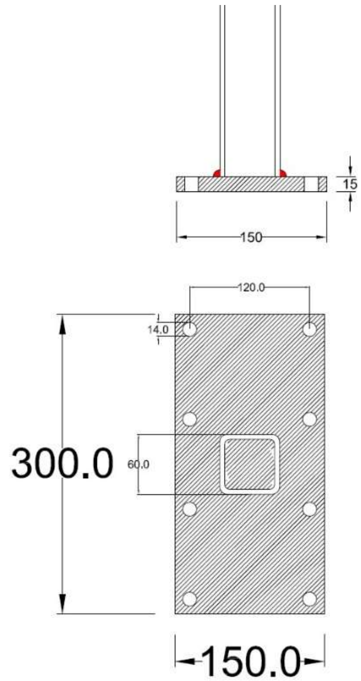
Ultimate load moment on posts at 1.6m maximum c/c	M_a	=	4.104 kNm		
Plastic modulus of base 150mm wide x 20mm thick	W_{pl}	=	$\frac{150 \times (20)^2}{4}$	=	15000mm^3
Ultimate moment capacity of base in steel grade S275	Mu	=	$\frac{275\ N/mm^2 \times 15000 \times (10)^{-6}}{1.0}$	=	4.125 kNm
Distance from centre of HD bolts to face of post	d	=	300 – 20 – 60 - 60	=	160mm
Ultimate load bolt tension (not including BS 6180 50% increase)	T	=	8.00 kN		
Ultimate moment on base at face of post	M	=	8.00 kN x 2 No. x 0.16	=	2.56 kNm
(not including BS 6180 50% increase on bolt loads, which only applies to fixings, not other structural elements)		=	< 4.125 kNm	=	OK

Base plates 300mm long x 150mm wide x 20mm thick in steel grade S275 are adequate.

Balcony 1: 1.8m privacy screen system with posts at 1.6m centres: ***PAGE 19*** **(B1PSWB150300BP010817RA)**

Base plate – option 2: 300 wide x 150 deep x 15mm thick with 8 M12 bolts.





Tension pull-out loads on fixing bolts:

Ultimate load moment on posts at 1.6m maximum c/c	M_a	=	4.104 kNm		
Distance between bolt centres	d	=	120mm		
Ultimate load bolt tension on 4 No. bolts	T_u	=	$\frac{4.104 \text{ kNm}}{4 \text{ No. x } 0.12}$	=	8.55 kN/bolt
Working load bolt tension	T_w	=	8.55 / 1.5	=	5.70 kN/bolt

Applying the 50% increase in design loads on fixings recommended in BS 6180: 2011, the design working load bolt tension becomes **8.55 kN/bolt**, which should be achievable using M12 drilled resin anchor bolts or similar, or by drilling through and anchoring to the underside of a suitable concrete slab.

The nominal tension capacity of M12 (8.8 grade) bolts is 37.80 kN. Higher bolt forces can therefore be achieved by direct bolting to a suitable structural steel frame.

Separate consideration is required where it is proposed to use other types of fixings, or where fixings are to be inserted into weaker materials.

Base plates – 300 wide x 150 deep x 15mm thick:

Plastic modulus of base 300 wide x 15mm thick	W_{pl}	=	$\frac{300 \text{ x } (15)^2}{4}$	=	$16875mm^3$
Moment capacity of base in steel grade S275	M_c	=	$275 \text{ N/mm}^2 \text{ x } 16875 \text{ x } (10)^{-6}$		
		=	4.64 kNm		
Distance from centre of bolts to face of 60 x 60 SHS post	d	=	60 – 30	=	30mm

Balcony 1: 1.8m privacy screen system with posts at 1.6m centres: ***PAGE 20*** **(B1PSWB150300BP010817RA)**

Base plate: Option 2: (cont):

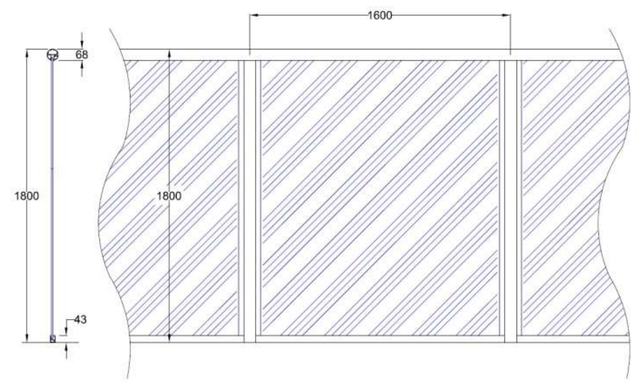
Ultimate load bolt tension (not including the 50% increase as BS 6180)	T_u	=	8.55 kN/bolt		
Ultimate moment on base at face of 60 x 60 post (not including BS 6180 50% increase, which applies only to fixings, not other structural elements)	M_u	=	8.55 kN x 4 No. x 0.03	=	1.03 kNm
		=	< 4.64 kNm	=	OK

Base plates 300 wide x 150 deep x 15mm thick in steel grade S275 with 8 M12 bolts are adequate.

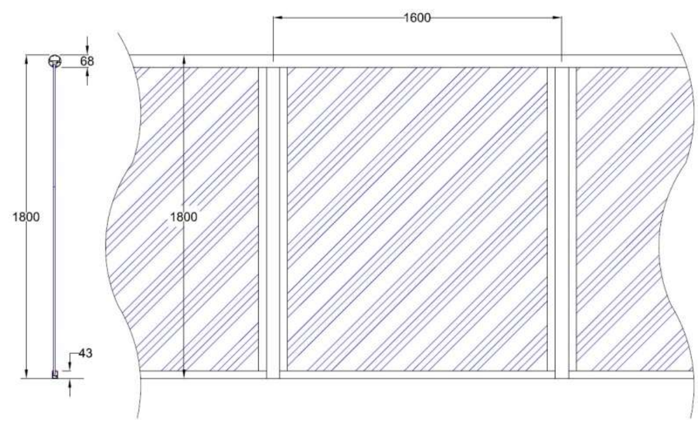
Welded connection between post & base plate:
The 60 x 60 x 5 SHS posts are welded to the top of the base by means of a full strength butt and/or fillet weld.

Elastic section modulus of post	W_{el}	=	16.80 cm^3		
Maximum ultimate elastic bending stress on post	$\frac{M_a}{W_{el}}$	=	$\frac{4.104 \times (10)^6}{16.80 \times (10)^3}$	=	244.29 N/mm^2
		=	1.221 kN/mm on 5mm thick section		
Transverse capacity of 8mm fillet weld		=	1.54 kN/mm	=	OK

A continuous 8mm fillet weld around the perimeter of the post, or a full strength butt weld, or a combination of welds that achieve a full strength connection, are adequate.



The diagram above shows option 1 for the glass infill, 12mm glass panels spanning between handrail and bottom rail



The diagram above shows option 2 for the glass infill, 10mm glass panels held on all 4 sides

On single span and corner screens the 10mm thick glass panels span vertically and can be of any width. For the purposes of design a nominal glass panel width of 1.0m simply supported between the bottom rail and the handrail has been used.

On longer screens where posts are installed at 1.6m maximum centres, alternative options are considered.

Option 1 uses 12mm thick glass panels spanning between the bottom rail and the handrail. The glass panels can be of any width. For the purposes of design a nominal glass panel width of 1.0m has been used. Option 2 uses 10mm thick glass designed to span 2 ways. With this option each panel must be a single pane supported on all 4 sides.(ie. by both posts, bottom rail, & handrail).

Balcony 1: 1.8m privacy screen system with posts at 1.6m centres: ***PAGE 21*** **(B1PSWB150300BP010817RA)**

Glass design: Single span and corner screens: 12mm glass spans vertically 1.74m say 1.8m between the bottom rail and the handrail. Separate design loading conditions on the infill are considered:

Ultimate UDL pressure on the infill of 1.50 kN/m²

Ultimate moment on glass due to UDL on span of 1.8m	M	=	$\frac{2.43\ kN/m^2 \times (1.8)^2}{8}$	=	0.984 kNm/m
Section modulus of glass 12mm thick x 1000mm wide	W_{el}	=	$\frac{1000 \times (12)^2}{6}$	=	24000mm³
Moment capacity of glass 12mm thick x 1000mm wide	M_u	=	$87.53\ N/mm^2 \times 24000 \times (10)^{-6}$	=	2.10 kNm
				=	OK
Service wind load on glass	F_w	=	$1.62\ kN/m^2$		
2nd moment of area of glass 12mm thick x 1000mm wide	I_{xx}	=	$\frac{1000 \times (12)^3}{12}$	=	144000mm⁴
Service load deflection of glass on a simply supported span of	Δ	=	$\frac{5\ w\ L^4}{384\ E\ I_{xx}}$		
1.8m (bottom rail to handrail)		=	$\frac{5\ (1620 \times 1.8)\ (1800)^3}{384 \times 70000 \times 144000}$	=	21.97mm
		=	< 25mm and < span/65	=	OK

Point load on the infill of 0.5 kN

Point load on the glass	=	0.5 kN point load applied in any position		
Worst case for bending stress on the glass due to point load	=	point load applied at mid-height of glass		
Ultimate moment on glass due to point load	=	$\frac{0.5\ kN \times 1.5 \times 1.8m}{4}$	=	0.3375kNm

Conservatively, it is assumed that this bending moment is carried by a 500mm wide vertical strip of glass.

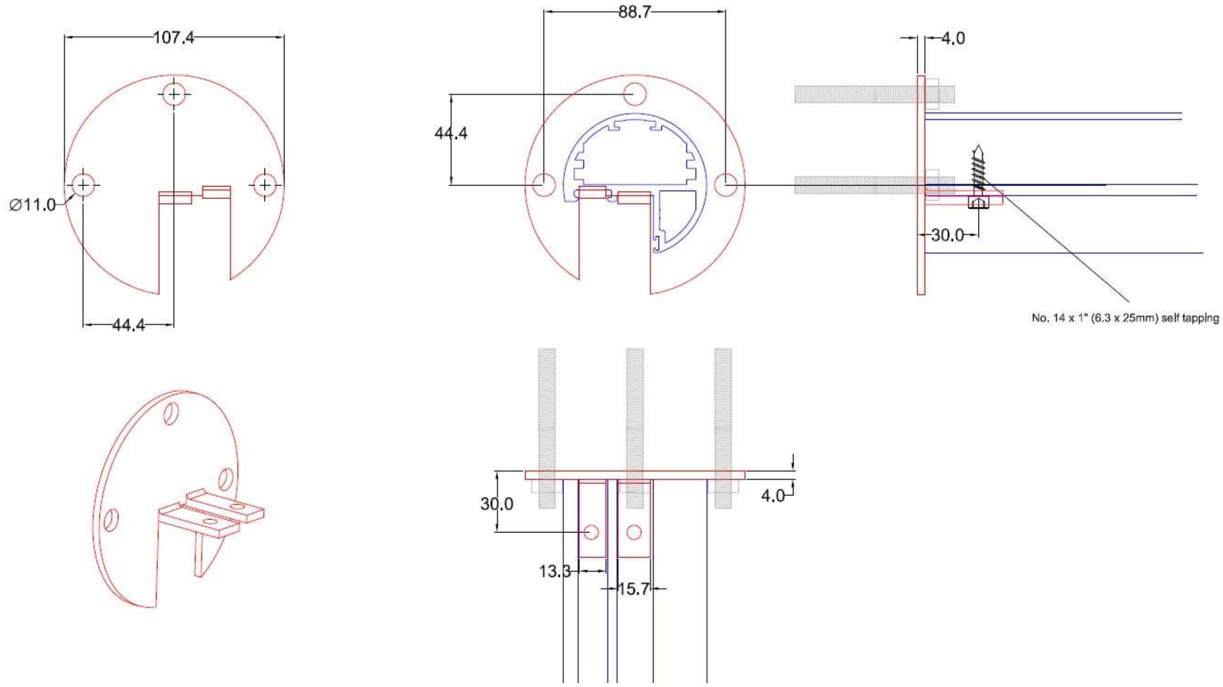
Moment capacity of 500mm	=	2.10 kNm/m x 0.5	=	1.05 kNm
x 12mm thick strip of glass	=	> 0.3375kNm	=	OK
Service load deflection due to a point load of 0.5 kN	=	$\frac{P\ L^3}{48\ E\ I}$		
applied at mid-span	=	$\frac{500 \times (1800)^3}{48 \times 70\,000 \times 144\,000}$		
	=	6.03mm < $\frac{span}{65}$	=	OK

Imposed ultimate line load of 1.11 kN/m applied 1100mm above FFL.

Ultimate BM on glass	=	$\frac{1.11\ kN/m \times 1.1 \times 0.7}{1.8}$	=	0.475kNm/m
			=	OK
Service load deflection	=	$\frac{P\ L^3}{48\ E\ I} \left\{ \frac{3a}{L} - 4\left(\frac{a}{L}\right)^3 \right\}$		
	=	$\frac{740\ (1800)^3}{48 \times 70000 \times 144000} \left\{ \frac{3 \times 700}{1800} - 4\left(\frac{700}{1800}\right)^3 \right\}$		
	=	8.31mm	=	OK

Balcony 1: 1.8m privacy screen system: *PAGE 22* **(B1PSWB150300BP010817RA)**

Wall fixings:



The handrail wall fixing consists of a 4mm thick stainless steel angle bolted to the wall with 3 No. M8 stainless steel drilled resin anchor bolts or similar and secured to the handrail with 2 No. 4.8mm diameter stainless steel Phillips self-tapping screws.

The max simply supported span of the handrail with internal reinforcing bar between points of support is 3.0m.

Service load on the wall = (1.00 kN/m^2 x 0.90) x 1.5m → 0.8 kN Shear SLS & 0.5kN Tension SLS/fixing fixing for a span of 3.0m

This load is transferred to the angle bracket by means of 2 No. 4.8mm diameter stainless steel Phillips self-tapping screws located 34.5mm from the back of the angles. The wall fixing bolts are 24mm apart horizontally.

Ultimate shear force on self-tapping screws = $\frac{1.35 \times 1.5}{2\text{No.}}$ = 1.01 kN/screw

Applying the 50% increase in loads on fixings recommended in BS 6180:2011, this becomes 1.515 kN/screw, **say = 1.52 kN/screw.**

The ultimate shear loads on self-tapping screws are taken from the table in Lindab's technical literature.

Thickness of aluminium in the handrail at screw positions = 2.5mm

Thickness of stainless steel brackets (Nom t mm) = 4.0 mm

Balcony 1: 1.8m privacy screen system: ***PAGE 23*** **(B1PSWB150300BP010817RA)**

Wall fixing:

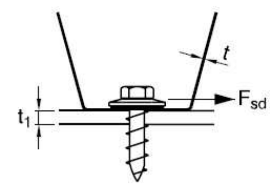
Ultimate shear capacity of 4.8mm diameter screws, safety class 1 = 3.64 kN/screw

For safety classes 2 and 3 this value is divided by 1.1 and 1.2 respectively. Safety class 3 is the highest safety class and has been assumed to apply to privacy screens. The shear capacities given in Lindab's table are based upon material having a tensile yield limit of 350 N/mm^2. The values given in the table have been adjusted to allow for the yield stress of stainless steel type 304 (290 N/mm^2).

The ultimate shear capacity of 3.64 kN/screw has therefore been reduced by 290/350 and divided by 1.2 to represent safety class 3 and 290 N/mm^2 yield stress rather than 350 N/mm^2. The adjusted ultimate shear capacity is then 2.51 kN/screw, compared with the design value of 1.52 kN/screw, and is therefore adequate.

Shearing force, construction screws

Dimensioning value F_{sd} kN/screw. Attention is paid both to failure of the edge of the hole and shearing failure in the screw. Safety class 1.



Nom t mm	When calculating t mm	Tensile yield limit N/mm^2	Screw diameter 4.2 mm		Screw diameter 4.8 mm		Screw diameter 5.5 mm		Screw diameter 6.3 mm	
			t_1 =t	t_1 = 2.5 t	t1 =t	t_1 = 2.5 t	t_1 =t	t_1 = 2.5 t	t_1 =t	t_1 = 2.5 t
0.4	0.32	250	0.26	0.54	0.28	0.61	0.30	0.70	0.32	0.81
0.5	0.41	250	0.38	0.69	0.40	0.79	0.43	0.90	0.46	1.03
0.6	0.52	250	0.52	0.86	0.56	0.98	0.60	1.12	0.64	1.29
0.7	0.60	350	0.93	1.41	1.00	1.61	1.07	1.85	1.14	2.12
0.8	0.73	350	1.25	1.72	1.34	1.96	1.43	2.25	1.53	2.58
1.0	0.93	250	1.29	1.56	1.38	1.79	1.47	2.05	1.58	2.34
1.0	0.93	350	1.80	2.19	1.93	2.50	2.06	2.86	2.21	3.28
1.2	1.13	350	2.41	2.66	2.58	3.04	2.76	3.48	2.95	3.99
1.5	1.42	250	2.39	2.39	2.60	2.73	2.78	3.12	2.97	3.58
1.5	1.42	350	3.03*	3.03*	3.63	3.82 / 3.64	3.89	4.37	4.16	5.01
2.0	1.91	350	3.03*	3.03*	4.16 / 3.64	4.16 / 3.64	5.72 / 5.20	5.72 / 5.20	6.49	6.74
2.5	2.40	350	3.03*	3.03*	4.16 / 3.64	4.16 / 3.64	5.72 / 5.20	5.72 / 5.20	7.80 / 6.76	7.80 / 6.76

In the area of number pairs in the table and marked *, shearing failure in the screw is decisive.

The value to the left in each number pair relates to carbon steel screws, while the number to the right relates to stainless steel screws.

Shear force on wall fixing bolts

Working load shear force on the 3 No. fixing bolts based upon a handrail span of 3.0m	=	$\frac{1.35\text{ kN}}{2\text{ No.}}$	→	0.8 kN/bolt

This shear load should be within the working load capacity of M8 drilled resin anchor bolts or similar into good quality concrete or brickwork. Separate consideration is required when drilling into weaker materials or when using other less robust types of fixings.

Pull-out forces on wall fixings

The horizontal load on the handrail is applied to the fixing angles through the Phillips stainless steel self-tapping screws, located 34.5mm from the back of the angles. The wall fixing bolts are 24mm apart horizontally. The wind load is considered to act either inwards or outwards.

Working load pull-out force on each of the 3 No. anchor bolts for a span of 3.0m	=	$1.35\text{ kN} \times \frac{34.5}{24}$	→	0.6kN/bolt

Wall fixing brackets:

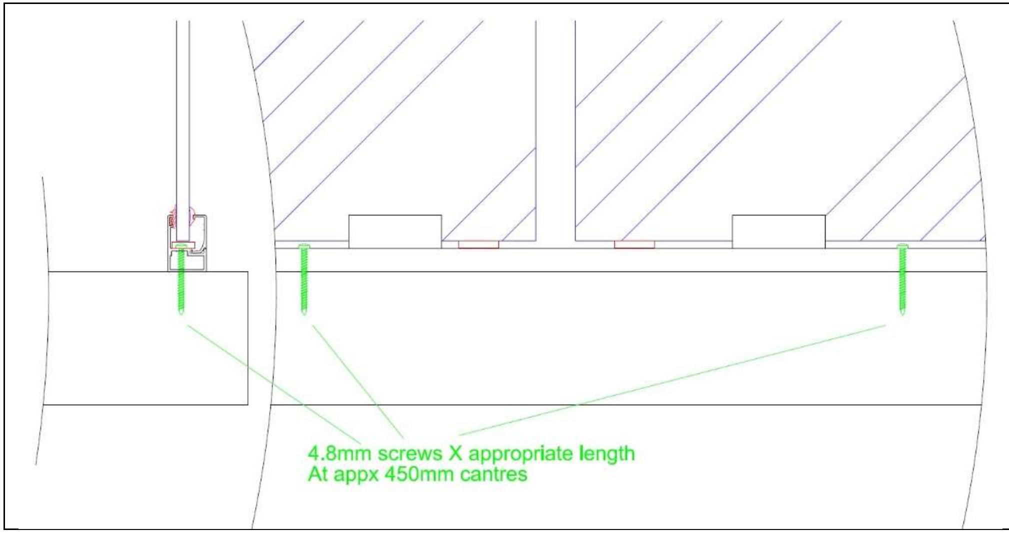
Material type	=	stainless steel grade 304
Characteristic ultimate tensile strength	=	621 N/mm^2
Characteristic 0.2% proof stress	=	290 N/mm^2

The horizontal part of the bracket measures 45.9mm wide x 3mm thick.

Plastic modulus of 45.9 x 3mm section for horizontal loads	=	$\frac{3 \times (45.9)^2}{4}$	=	1580mm^3
Resistance moment of section	=	290 N/mm^2 x 1580mm^3 x $(10)^{-6}$		
for horizontal loads	=	0.458 kNm		
For a simply supported span of 3.0m:	=	1.35 kN/m x 1.5	=	2.025 kN
ultimate load on end bracket		say	=	2.0 kN
Ultimate horizontal moment	=	(2.0 kN) (0.03)	=	0.06 kNm
applied to the bracket	=	< 0.458 kNm	=	OK
Shear capacity of section 45.9mm wide x 3mm thick	=	$\frac{A_v (f_y/\sqrt{3})}{\gamma_{M0}}$		
	=	$\frac{(45.9 \times 3)(290/1.732)}{1.1}$	=	20960 N
			=	OK

The wall fixing brackets are adequate.

Bottom rail fixing:

	The standard bottom rail fixing consists of 4.8mm diameter screws at 450mm centres. The worst case for design loading on the fixings is when the design service point load of 0.50 kN on the glass acts at the position of a fixing. The fixing screw is then subjected to a working load shear force of 0.50 kN/screw.

The allowable load on the fixing screws varies depending upon the type and thickness of the material into which the screws are inserted.

As an example, fixing to a balcony deck comprising 15mm thick plywood strength class C16, group 1, the basic allowable working load single shear value given in BS 5268 : Part 2 : 1996 for a No. 10 (4.8mm) screw 45mm long is 0.519 kN.

Where a pre-drilled steel component of adequate strength is screwed to a timber member, the basic lateral load of 0.519 kN is multiplied by a modification factor of 1.25, making an allowable shear value of 0.648 kN, which is adequate in relation to the design working shear load shear force of 0.50 kN.

Other values of allowable shear loads on fixings will apply where the deck material is of different strength and/or thickness.

The installers should ensure that where the deck material has a lower strength than 15mm thick plywood, class C16, group 1, the spacing of the fixing screws is reduced accordingly.

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BALCONY 1: 1.8m privacy screen system: Handrail with 58 x 4mm steel internal reinforcing bar, or without bar using 60 x 60 x 5mm SHS posts at 1.6m maximum spacing. 75 x 66mm aluminium sleeves to posts. 2 base plate options:

1) For sites within the parameters listed on page 8 of these calculations, and/or have a characteristic wind pressure that does not exceed **1.00 kN/m^2**, wind loading and the specified imposed loading are the same for privacy screens 1.8m high. Sites that do not come within these parameters require separate consideration.

2) On single span and corner balconies, the Balcony 1 system handrail with internal steel reinforcing bar is capable of supporting the ultimate design loads over spans up to **3.0 metres** between points of support. i.e. a handrail wall fixing, or a handrail corner joint.

3) On longer balconies where the length of the balustrade exceeds 3.0 metres, vertical posts are installed at a maximum spacing of **1.6m** between post centres. The posts are **60 x 60 x 5mm** square hollow steel sections (SHS) in steel grade **S 275 H** enclosed in 75 x 66mm aluminium sleeves.

4) The handrail profile without internal reinforcing bar has a moment of inertia of 47 cm^4 about the y–y axis and the internal reinforcing bar is not required where posts are installed at a maximum spacing of 1.6m between post centres.

5) The SHS posts are welded (full strength butt or 8mm fillet welds) to steel base plates. Two options for base plates are considered.

   Option 1 is 300mm deep x 150mm wide x 20mm thick with 4 No. M12 (8.8 grade) HD bolts. The design working pull-out force on the HD bolts is **8.0 kN/bolt.**
   Option 2 is 150mm deep x 300mm wide x 15mm thick with 8 M12 (8.8 grade) HD bolts. The design working pull-out load on the holding down bolts is **8.55 kN/bolt.**

6) These loads should be achievable using M12 drilled resin anchor bolts or similar into good quality concrete, or by drilling through and anchoring to the underside of a sound concrete slab. However, the installers should satisfy themselves that the fixing bolts chosen are suitable to resist the specified loads, and also that the structure into which they are installed can support these loads.

7) Higher bolt loads could be achieved where fixings are made direct to a substantial structural steel frame. Lower bolt forces would most likely need to be taken where fixings are made into materials having a lower strength than good quality concrete.

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8) For the maximum span of **3.0 metres** on single span and corner privacy screens, the horizontal working load shear force on the wall fixing bolts is **0.8 kN/bolt**, and the working load pull-out force is **0.5 kN/bolt**. Holes are provided in the wall fixing brackets for 3 No. M8 drilled anchor bolts or similar. The design loads should be achievable where bolts are installed into good quality concrete or brickwork.

9) The 4.8mm diameter self-tapping stainless steel screws connecting the handrail to the stainless steel angle brackets at wall and post fixings are adequate to support the specified design loads. The 3mm thick stainless steel brackets are also adequate to support the design wall fixing loads.

10) The standard bottom rail fixing comprises 4.8mm diameter screws inserted into the balcony deck at 450mm centres. At this spacing the fixings are required to have a working load shear capacity of 0.50 kN/screw. The installers should satisfy themselves that the screws chosen are suitable to resist this load when inserted into the particular deck material present on a specific project. Where the deck material is of reduced strength and/or thickness the spacing of the screws should be reduced accordingly.

11) On single span and corner screens, and also on longer screens with posts, two options for the thermally toughened safety glass are considered:

    Option 1: 12mm thick glass spans vertically between the bottom rail and the handrail. With this option the glass panels may be of any width.

    Option 2: 10mm thick glass spans two ways supported on all 4 sides. With this option each panel of glass must be a single pane.

    Both glass options are adequate to support the specified design loads.

Original report 2017 prepared for and on behalf of Balconette by
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