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Ref: 11/243/ds29
11 September 2018

Glass Fittings / Vetro Raccordi Ltd

ASSESSMENT OF FRAMELESS GLASS BALUSTRADE

USING CUBOID FACE FIX SYSTEM &
13.52mm thick EVA TOUGHENED LAMINATED GLASS

INDEX **PAGE**

Notes:

1. Any parts of the structure which are not covered by the specific design included with these calculations must comply either with the New Zealand Building Code or specific design as detailed by others. Any exceptions to this should be referred back to this Design Office.

2. The above calculations include structural work for which a Building Consent must be obtained prior to building. It is the Owner's responsibility to obtain all necessary consents.

3. It is assumed that the strength and stiffness of the substrate is sufficient to adequately resist the balustrade loads – this must be confirmed for each installation situation.

4. This design assumes that all the specified members are suitably protected from excess moisture in accordance with Section E1, E2 and E3 of the Building Code. All timber, steelwork, bolts and fasteners to be corrosion protected in accordance with the requirements of NZS 3604:2011 Chapter 4, Durability.

5. This design is for glass panels which comply with AS/NZS 2208 and accessories supplied by Glass Fittings / Vetro Raccordi Ltd.

Building Code Clause(s) B1,B2,F2,F4

PRODUCER STATEMENT – PS1 – DESIGN

(Guidance notes on the use of this form are printed on page 2)

ISSUED BY: P&P CONSULTING ENGINEERS LIMITED
(Design Firm)

TO: GLASS FITTINGS / VETRO RACCORDI LIMITED
(Owner/Developer)

TO BE SUPPLIED TO: VARIOUS
(Building Consent Authority)

IN RESPECT OF: GLASS BALUSTRADE USING CUBOID FACE FIX SYSTEM & 13.52mm thick EVA TOUGHENED LAMINATED GLASS
(Description of Building Work)

AT: VARIOUS SITES (Occupancy Type A,B,C3 and Up to max "Very High" Wind)
(Address)

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

We have been engaged by the owner/developer referred to above to provide GLASS TESTING REVIEW AND DESIGN FOR BASE FIXING services in respect of the requirements of
(Extent of Engagement)

Clause(s) B1, B2, F2, F4 of the Building Code for
All ☐ or Part only ☑ (as specified in the attachment to this statement), of the proposed building work.

The design carried out by us has been prepared in accordance with:

☑ Compliance Documents issued by the Ministry of Business, Innovation & Employment B1/VM1 or
(verification method / acceptable solution)

☐ Alternative solution as per the attached schedule

The proposed building work covered by this producer statement is described on the drawings titled GLASS FITTINGS /VETRO RACCORDI LTD/CUBOID FACE FIX and numbered REF:11/243/DS29, DRAWING ENG01;
together with the specification, and other documents set out in the schedule attached to this statement.

On behalf of the Design Firm, and subject to:

(i) Site verification of the following design assumptions REFER NOTES ON CALCULATIONS

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

I **believe on reasonable grounds** that a) 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 and that b), the persons who have undertaken the design have the necessary competency to do so. I also recommend the following level of construction monitoring/observation:

☐CM1 ☐CM2 ☐CM3 ☐CM4 ☐CM5 (Engineering Categories) or ☐ as per agreement with owner/developer (Architectural)

I, MR. P PRAKASH am:
(Name of Design Professional)

☑CPEng 251801 #

☐Reg Arch ..... .#

I am a Member of : ☑ IPENZ ☐NZIA and hold the following qualifications: B.E. (Civil), CPEng

The Design Firm issuing this statement holds a current policy of Professional Indemnity Insurance no less than $200,000*.

The Design Firm is a member of ACENZ: ☐

SIGNED BY MR. P PRAKASH ON BEHALF OF P&P CONSULTING ENGINEERS LIMITED
(Design Firm)

Date 11 SEPTEMBER 2018 (signature)

Note: This statement shall only be relied upon by the Building Consent Authority named above. Liability under this statement accrues to the Design 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.

2. DESIGN GENERAL

The glass balustrade was tested to comply with the following:

STATUTORY

NZS 4223.3:2016	Glazing In Buildings
AS/NZS 1170:2002	Loadings Code
NZS 3404:1997	Structural Steel
NZS 3101:1995	Concrete
NZS 3603:1993	Timber
AS/NZS 1664.1:1997	Aluminium Structures - Part 1 Limit State Design

LOADS (Lateral Loads Only Considered)

Live Loads (Refer to Table 3.3 of AS/NZS 1170:)

Occupancy	Specific Uses	Top Edge		Infill
A	Internal Domestic Situation Only	0.35 kN/m	0.6 kN	0.5 kPa
B & C3	External Domestic Balconies, Offices and Work Areas. (NOT subject to Over Crowding)	0.75 kN/m	0.6 kN	1 kPa or 0.5 KN

Wind Loads (VERY HIGH)

Design for Very High Winds in terms of the Wind Speed categories in NZS 3604:2011 (up to 50 m/s).

$V_{sit,\beta}$(Ultimate)	=	50.0	m/s
$V_{sit,\beta}$(Serviceability)	=	37.3	m/s
q	=	1.50	kPa (ULS)
and	=	0.83	kPa (SLS)
For external barriers use Cp =		1.30	
For internal barriers use Cp =		0.30	
Wind Load = q x Cp =		**1.95**	**kPa (ULS)**
	=	**1.08**	**kPa (SLS)**

LOAD FACTORS and DEFLECTIONS

Importance Level = 2
ULS factor = 1.5Q (Refer Section 4.2.2 of AS/NZS 1170)
Maximum Deflection = Height / 30

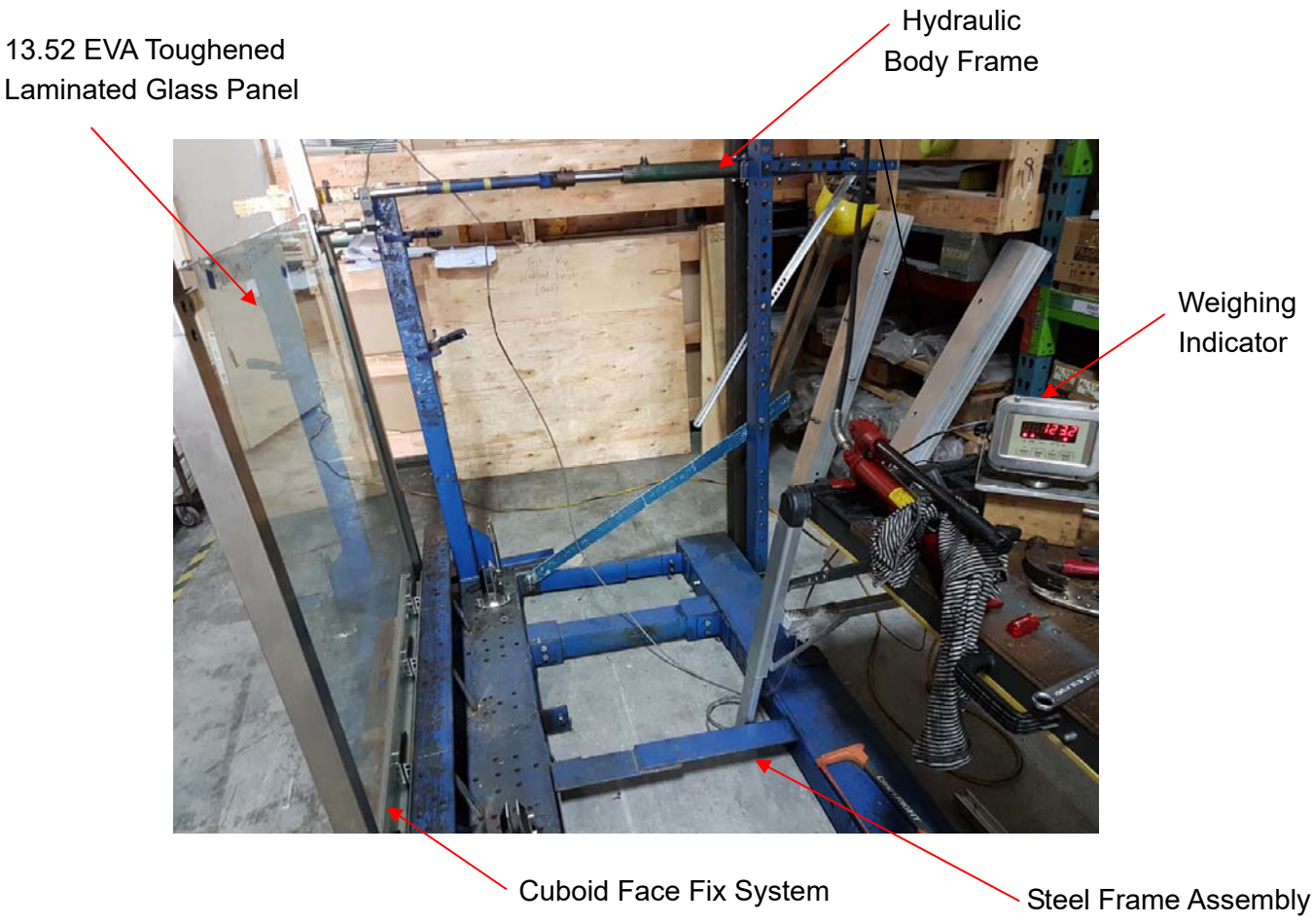
3. LOAD TESTS

Location of Tests: 49 Woodside Avenue, Auckland
Date of Tests: August 2018
Test Description: Load testing of Glass Balustrade
(Panel Tested = 1200mm wide x 1200mm high glass panel)

System Description: The glass balustrade which was supplied by Glass Fittings / Vetro Raccordi Ltd, comprised of 13.52mm thick EVA Toughened Laminated (Grade A) Safety Glass (6mm Toughened + 1.52mm EVA Interlayer + 6mm Toughened), top side clips fixed to side posts and Cuboid Face Fix System.

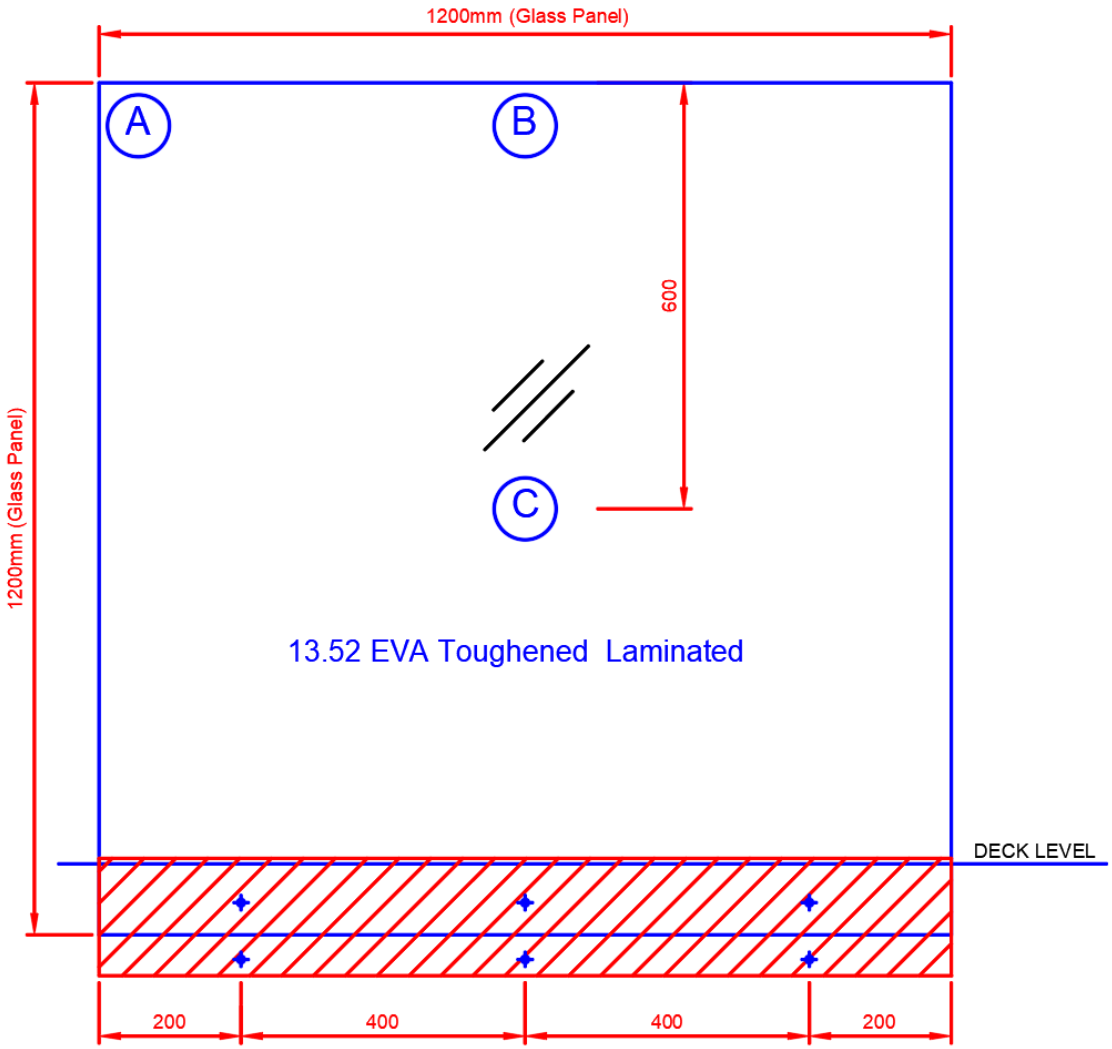
Setup / Procedure:
The balustrade was setup with different load tests as noted on page 4. The glass panel was supported at the base with Cuboid Face Fix system. This channel system was bolted to the steel frame assembly with M10 fixings as shown below. The glass panel was also clipped at each side to the supporting posts acting as the supporting neighboring glass panels.

Hydraulic Body Frame/Ram and load cell or weighing indicator were used to attain the required test loads.



4. TESTS ARRANGEMENT & RESULTS

4.1 BALUSTRADE



TESTS	LOAD LOCATION
A	Point Load @ Top Corner with steel round disc
B	Horizontal UDL Load @ Top with Solid Steel Beam
C	Infill & Wind Load @ Middle Centre with Framing

NOTE:
1. Assuming a coefficient of variation (Vr) of 10% for the glass, the variability factor kt is taken as 1.33 for 3 test samples.
2. The structure to which the balustrade system is attached was not tested or analysed. The strength and stiffness of the substrate structure must be specifically confirmed for each situation.

TEST RESULTS (Fracture Check)

Tests	Target Load (Kg)	Duration (mins)	Observation for Samples 1,2,3
A	122.0	16	No Fracture
B	183.0	16	No Fracture
C	380.7	16	No Fracture

TEST RESULTS (Deflection Check)

Tests	Target Load @ SLS (Kg)	Deflection @ Top (mm)			Remarks
		Sample 1	Sample 2	Sample 3	
A	61.2	12	12	12	Passed
B	91.7	14	13	14	Passed
C	159.2	11	12	12	Passed

Allowable Deflection = H/30 = 36.7 mm

Based on the testing, the glass balustrade which comprised of 13.52mm thick EVA Toughened Laminated Grade A Safety Glass (6mm Toughened + 1.52 EVA interlayer + 6mm Toughened) supported by Cuboid Face Fix System with top side clips was sufficient for the following:

- Occupancy types A, B, C3
- Up to max “Very High” Wind

5. Testing to Demonstrate Compliance of Structural Glass Barrier without an Interlinking Rail

The toughened laminated glass panel had also been tested in accordance with the requirement of Acceptable Solution B1/AS1 Clause 7.3.1 (Amendment 15).

According to this clause, to demonstrate compliance with this requirement, the toughened laminated safety glass barrier without interlinking rails, when both panes of the laminate are fractured, must resist a 0.2 kN concentrated load and must not deflect more than 250mm. The concentrated load shall be applied over an area of 100mm x 100mm and for at least one minute.

The following were used in this testing:
Laminated Glass: 6mm Toughened Glass +1.52mm EVA Interlayer +6mm Toughened Glass
System: Cuboid Face Fix System + Top side clips

Procedure: Both panes of the laminate were fractured first and then a 20kg was applied at the top center location of the glass panel using the hydraulic ram.

The test load and deflection were recorded as follows:

Load applied	Deflection at Top
20 kg	< 250mm (after 1 minute load)

Based on the testing, the 13.52mm thick EVA Toughened Laminated Grade A Safety Glass (6mm Toughened + 1.52 EVA interlayer + 6mm Toughened) supported by Cuboid Face Fix System with top side clips had complied with the load and deflection requirements of Acceptable Solution B1/AS1 Clause 7.3.1 (Amendment 15).

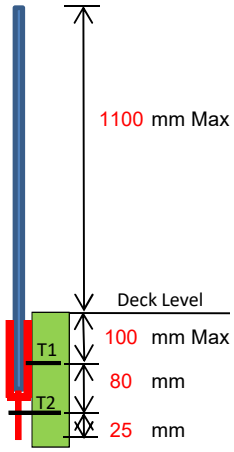
6.0 Base Fixings

Refer to Summary Drawing ENG 01 for reference.

6.1 BASE FIXINGS FOR INTERNAL BALUSTRADE

- For Occupancy types A, B, C3
- For Up to max "Very High" Wind

Maximum Tributary Spacing of Fixings = 400 mm
Number of row of base fixings per panel = 3



	C3 loading	1.5Q1:	1.5 x 0.6 kN / (no of base fixings) =	0.3	kN
		1.5Q2:	1.5 x 0.75kN/m x trib spacing =	0.45	kN
		1.5Q3:	1.5 x 1.0kPa =	1.5	kPa
(V.H)	Wind - external	Wuls:	0.6 x 50 x 50 /1000 x 1.3 =	1.95	kPa

Tension Forces (central bolts)

		T1	T2	
1.5Q1:	N*/anchor =	4.80	4.50	kN
1.5Q2:	N*/anchor =	7.20	6.75	kN
1.5Q3:	N*/anchor =	6.14	5.36	kN
Wuls:	N*/anchor =	7.98	6.97	kN

Max N*/anchor = **7.98** kN

Shear Force per Fixing (1.2G)

1.2 x Weight of Glass Panel = 1.2 x (28 kN/m3 x thickness x Area) = 0.316 kN
1.2 x Weight of Al Channel= 1.2 x (0.5 kN/m x spacing) = 0.24 kN

1.2G: V*/anchor = **0.56** kN

A. Fixing to Concrete

Refer to page 8 for design calculations.
Anchor Spacing= 80mm
Concrete Edge Dist= 50mm min
Concrete Strength, f'c = 20MPa min
Considered as NON-Cracked Concrete

Using M10 Chemset Anchors with Epcon C8 Series Epoxy.

ØN = **22.70** kN **OK** CDR= 0.55 **< 1.2 OK**
ØV = **2.80** kN **OK**

Use M10 Chemset Anchors (Grade 5.8 Steel) with Epcon C8 Series Epoxy.
Drilled hole depth to be 120 mm min into concrete.
(spacing = 400mm max centres)

B. Fixing to Steel

Using M10 Grade 4.6/S

ØN = **18.56** kN **OK** CDR= 0.49 **OK**
ØV = **9.62** kN **OK**

Use M10 Grade 4.6/S Steel Bolts with metric round washer per fixing.
(spacing = 400mm max centres)

C. Fixing to Timber Using Bolt

Capacity is controlled by bearing on washers. (ØQ = ø k1 x k3 x Fp x Aw)
where: Fp = 5.3MPa (wet) or 8.9 Mpa (dry) , Ø=0.7, k1=0.8, k3=1

Using 50x50x5 Square Washers

ØQ = **11.90** kN (dry) **OK**

Use M10 Grade 4.6/S Steel Bolts with 50x50x5 square washers.
(spacing = 400mm max centres)

Chemical Anchoring - ChemSet Anchor Stud Design Calculator

European Technical Approval ETA-10/0309

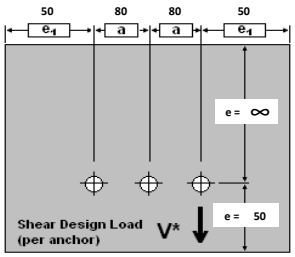
Ramset™

Non-Cracked Concrete - EPCON™ C8

Anchor Type: Anchor Stud - Gr 5.8 **Anchor Size** d_b = M 10

Input Description (Strength Limit State Design)	Input Data (per anchor)		
1. Number of anchors (n)	n =	2	-
2. Anchor Spacing (a)	a =	80	mm
3. Concrete Edge Distance (e)	e =	50	mm
4. Concrete Cylinder Strength (f'c)	f'c =	20	MPa
5. Cracked Conc. (C) or Non-Cracked (N)	C or N	N	-
6. Effective Depth (h>6xdh)	h =	120	mm
7. Anchor Stud size (d_b) - M8 → M36	d_b =	10	mm
8. Concrete Edge Distance Corner (e1)	e_1 =	50	mm
9. Internal to a row (I) or end of row (E)	I or E	E	row
10. Dry Hole (D) or Wet hole (W)	D or W	D	-
11. Min Concrete Sub'te Thickness (b_m)	b_m =	150	mm
12. Anchor Stud Grade (5.8, 8.8, 316 SS)	Grade =	5.8	Gr
13. Fixture Thickness (t)	t =	5	mm
14. Effective Length (L_e)	L_e =	125	mm
15. Design Tensile Load-per anchor (N*)	N* =	8	kN
16. Design Shear Load-per anchor (V*)	V* =	1	kN
17. Direction of Shear design load (α)	α =	0	°
18. Service Temperature (˚C)	-40˚C to	+40˚C	-

Plan View - Generic (Dimensions in (mm))



Project Details

Project Name:-

Project Site Address:-

Company Name:-

Design Identification:-

Date:-

ChemSet™ Anchor Stud "Specification"

Special Length - Use Typ Thr'd Rod Gr 8.8 or Diff.Size

EPCON™ C8 "Specification"

C8-450

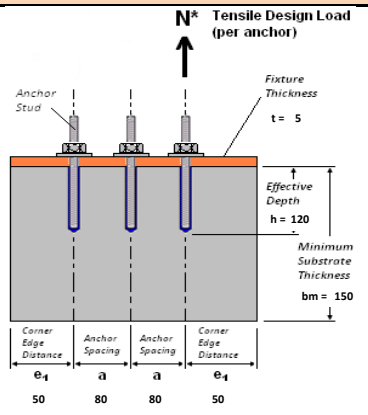
Hole Diameters (mm)		Capacity Reduction Factors	
Drill d_h =	12	Concrete Tension ϕ =	0.56
Fixture d_f =	12	Concrete Shear ϕ =	0.6
		Steel Tension/Shear ϕ =	0.8

Direction of Shear Design Load - α

α = 0˚- towards edge
α = 180˚ - away from edge

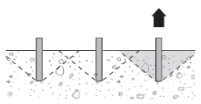
Output Description (Strength Limit State Design)	Output Data (per anchor)		
DESIGN O.K.	MIN. CRITERIA for a,e & h - O.K.		
Des. Red. Ult. CONC. Tensile Capacity	ϕN_{urc} =	33.5	kN
Red. Char. Ult. STEEL Tensile Capacity	ϕN_{us} =	22.7	kN
Des. Red. Ult. CONC. Shear Capacity	ϕV_{urc} =	2.8	kN
Red. Char. Ult. STEEL Shear Capacity	ϕV_{us} =	14.1	kN
Drill hole diameter	d_h =	12	mm
TENSION O.K.			
Design Red. Ult. Tensile Capacity	ϕN_{ur} =	**22.7**	**kN**
Tension Design Check	N*/ϕN_{ur} =	**0.35**	**< 1**
SHEAR O.K.			
Design Red. Ult. Shear Capacity	ϕV_{ur} =	**2.8**	**kN**
Shear Design Check	V*/ϕV_{ur} =	**0.35**	**< 1**
COMBINED TENSION SHEAR O.K.			
Combined Check - N*/ϕN_{ur} + V*/ϕV_{ur} =		**0.71**	**< 1.2**

Elevation View - Generic (Dimensions in (mm))

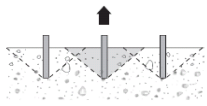


Anchor Loaded

"E" *Anchor end of a row*



"I" *Anchor internal to a row*



Anchor Size	d_b	Metric	8	10	12	16	20	24	30	36
Drill hole diameter	d_h	(mm)	10	12	14	18	24	26	N/A	N/A
Stressed Area	A_b	(mm²)	33	53	79	154	232	337	N/A	N/A
Anchor Stud Yield Strength	f_y	(MPa)	430	430	430	420	420	420	N/A	N/A
Red.Char. Ult. Steel Tensile Capacity	ϕN_{us}	(kN)	14.3	22.7	33.8	64.7	97.6	141.3	N/A	N/A
Red.Char. Ult. Steel Shear capacity	ϕV_{us}	(kN)	8.9	14.1	21.0	39.7	59.9	86.8	N/A	N/A
Edge distance for no conc.cone reduction	**e_c**	**(mm)**	**35**	**40**	**50**	**65**	**80**	**100**	**N/A**	**N/A**
Anchor spacing for no conc.cone reduction	**a_c**	**(mm)**	**50**	**60**	**75**	**100**	**120**	**145**	**N/A**	**N/A**
Absolute Minimum edge dist. & anc'r spac.	**e_m & a_m**	**(mm)**	**25**	**30**	**35**	**50**	**60**	**75**	**N/A**	**N/A**

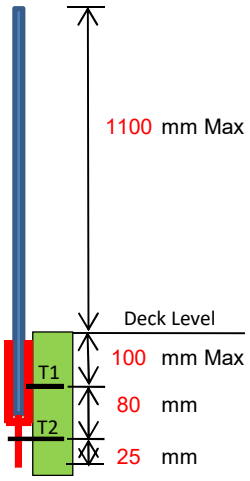
Effective Depth - h		Design Reduced Ultimate tensile capacity ϕN_{ur} (kN per anchor) Based on edge distance (e_c) and anchor spacing (a_c) for no conc.cone reduction							
60	(mm)	10.5							
65	(mm)	11.9							
70	(mm)	13.2	13.2						
80	(mm)	14.3	16.2						
90	(mm)	14.3	19.3	19.3					
100	(mm)	14.3	22.6	22.6					
110	(mm)	14.3	22.7	26.1	26.1				
125	(mm)	14.3	22.7	31.6	31.6				
140	(mm)	14.3	22.7	33.8	37.5				
150	(mm)	14.3	22.7	33.8	41.6	41.6			
160	(mm)	14.3	22.7	33.8	45.8	45.8	45.8		
170	(mm)	14.3	22.7	33.8	50.1	50.1	50.1		
180	(mm)	14.3	22.7	33.8	54.6	54.6	54.6		
190	(mm)	14.3	22.7	33.8	59.2	59.2	59.2	N/A	
220	(mm)	14.3	22.7	33.8	64.7	73.8	73.8	N/A	
240	(mm)	14.3	22.7	33.8	64.7	84.1	84.1	N/A	N/A
270	(mm)	14.3	22.7	33.8	64.7	97.6	100.4	N/A	N/A
330	(mm)	14.3	22.7	33.8	64.7	97.6	135.6	N/A	N/A
350	(mm)	14.3	22.7	33.8	64.7	97.6	141.3	N/A	N/A

The design engineer should ensure the structural element is capable of supporting these loads. Refer to Ramset™ Specifiers Anchoring Resource Book ANZ for more information or explanation of Tech. Data.

6.2 BASE FIXINGS FOR EXTERNAL BALUSTRADE

- For Occupancy types B, C3
- For Up to max "Very High" Wind

Maximum Tributary Spacing of Fixings = 400 mm
Number of row of base fixings per panel = 3



	C3 loading	1.5Q1:	1.5 x 0.6 kN / (no of base fixings) =	0.3	kN
		1.5Q2:	1.5 x 0.75kN/m x trib spacing =	0.45	kN
		1.5Q3:	1.5 x 1.0kPa =	1.5	kPa
(V.H)	Wind - external	Wuls:	0.6 x 50 x 50 /1000 x 1.3 =	1.95	kPa

Tension Forces (central bolts)

		T1	T2	
1.5Q1:	N*/anchor =	4.80	4.50	kN
1.5Q2:	N*/anchor =	7.20	6.75	kN
1.5Q3:	N*/anchor =	6.14	5.36	kN
Wuls:	N*/anchor =	7.98	6.97	kN

Max N*/anchor = **7.98** kN

Shear Force per Fixing (1.2G)

1.2 x Weight of Glass Panel = 1.2 x (28 kN/m3 x thickness x Area) = 0.316 kN
1.2 x Weight of Al Channel= 1.2 x (0.5 kN/m x spacing) = 0.24 kN

1.2G: V*/anchor = **0.56** kN

A. Fixing to Concrete

Refer to page 10 for design calculations.

Anchor Spacing= 80mm
Concrete Edge Dist= 50mm min
Concrete Strength, f'c = 20MPa min
Considered as NON-Cracked Concrete

Using M10 Chemset Anchors with Epcon C8 Series Epoxy.

øN = **16.80** kN **OK** CDR= 0.67 **< 1.2 OK**
øV = **2.80** kN **OK**

Use M10 Chemset Anchors (Grade 316 Stainless Steel) with Epcon C8 Series Epoxy.
Drilled hole depth to be 120 mm min into concrete.
(spacing = 400mm max centres)

B. Fixing to Steel

Using M10 Grade A4/316 SS (A4-70)

øN = **27.20** kN OK CDR= 0.24 OK
øV = **17.86** kN OK

Use M10 Grade 316 Stainless Steel (A4-70) Bolts with metric round washer per fixing.
(spacing = 400mm max centres)

C. Fixing to Timber Using Bolt

Capacity is controlled by bearing on washers. (øQ = ø k1 x k3 x Fp x Aw)

where: Fp = 5.3MPa (wet) or 8.9 Mpa (dry) , Ø=0.7, k1=0.8, k3=1

Using 65x65x5 Square S/S washer

øQ = **12.20** kN (wet) **OK**

Use M10 Grade 316 Stainless Steel (A4-70) Bolts with 65x65x5 Square S/S washers.
(spacing = 400mm max centres)

Chemical Anchoring - ChemSet Anchor Stud Design Calculator

European Technical Approval ETA-10/0309

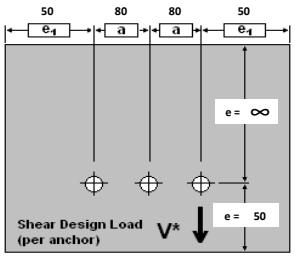
Ramset™

Non-Cracked Concrete - EPCON™ C8

Anchor Type: Anchor Stud - Gr 316 | **Anchor Size** d_b = M 10

Input Description (Strength Limit State Design)	Input Data (per anchor)		
1. Number of anchors (n)	n =	2	-
2. Anchor Spacing (a)	a =	80	mm
3. Concrete Edge Distance (e)	e =	50	mm
4. Concrete Cylinder Strength (f'c)	f'c =	20	MPa
5. Cracked Conc. (C) or Non-Cracked (N)	C or N	N	-
6. Effective Depth (h>6xdh)	h =	120	mm
7. Anchor Stud size (d_b) - M8 → M36	d_b =	10	mm
8. Concrete Edge Distance Corner (e1)	e_1 =	50	mm
9. Internal to a row (I) or end of row (E)	I or E	E	row
10. Dry Hole (D) or Wet hole (W)	D or W	W	-
11. Min Concrete Sub'te Thickness (b_m)	b_m =	150	mm
12. Anchor Stud Grade (5.8, 8.8, 316 SS)	Grade =	316	SS
13. Fixture Thickness (t)	t =	5	mm
14. Effective Length (L_e)	L_e =	125	mm
15. Design Tensile Load-per anchor (N*)	N* =	8	kN
16. Design Shear Load-per anchor (V*)	V* =	1	kN
17. Direction of Shear design load (α)	α =	0	°
18. Service Temperature (˚C)	-40˚C to	+40˚C	-

Plan View - Generic (Dimensions in (mm))



Project Details

Project Name:-

Project Site Address:-

Company Name:-

Design Identification:-

Date:-

ChemSet™ Anchor Stud "Specification"

Special Length - Use | Typ Thr'd | Rod | or Diff.Size

EPCON™ C8 "Specification"

C8-450

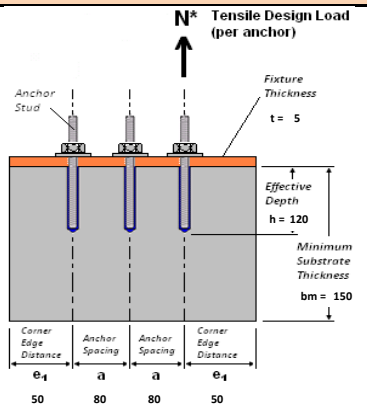
Hole Diameters (mm)		Capacity Reduction Factors	
Drill d_h =	12	Concrete Tension ϕ =	0.56
Fixture d_f =	12	Concrete Shear ϕ =	0.6
		Steel Tension/Shear ϕ =	0.8

Direction of Shear Design Load - α

α = 0˚- towards edge
α = 180˚ - away from edge

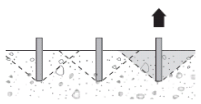
Output Description (Strength Limit State Design)	Output Data (per anchor)		
DESIGN O.K.	MIN. CRITERIA for a,e & h - O.K.		
Des. Red. Ult. CONC. Tensile Capacity	ϕN_{urc} =	16.8	kN
Red. Char. Ult. STEEL Tensile Capacity	ϕN_{us} =	23.8	kN
Des. Red. Ult. CONC. Shear Capacity	ϕV_{urc} =	2.8	kN
Red. Char. Ult. STEEL Shear Capacity	ϕV_{us} =	17.0	kN
Drill hole diameter	d_h =	12	mm
TENSION O.K.			
Design Red. Ult. Tensile Capacity	ϕN_{ur} =	**16.8**	**kN**
Tension Design Check	$N^*/\phi N_{ur}$ =	**0.48**	**< 1**
SHEAR O.K.			
Design Red. Ult. Shear Capacity	ϕV_{ur} =	**2.8**	**kN**
Shear Design Check	$V^*/\phi V_{ur}$ =	**0.35**	**< 1**
COMBINED TENSION SHEAR O.K.			
Combined Check - $N^*/\phi N_{ur} + V^*/\phi V_{ur}$ =		**0.83**	**< 1.2**

Elevation View - Generic (Dimensions in (mm))

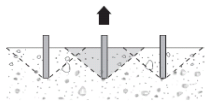


Anchor Loaded

"E" *Anchor end of a row*



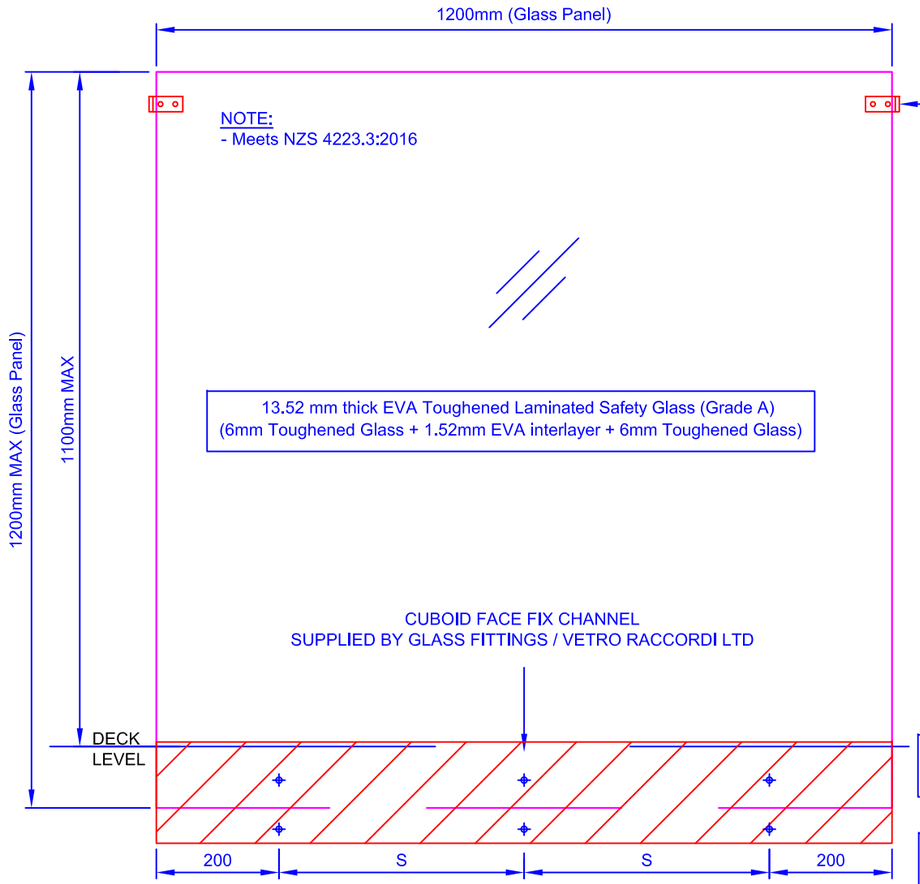
"I" *Anchor internal to a row*



Anchor Size	d_b	Metric	8	10	12	16	20	24	30	36
Drill hole diameter	d_h	(mm)	10	12	14	18	24	26	N/A	N/A
Stressed Area	A_b	(mm²)	33	53	79	154	232	337	N/A	N/A
Anchor Stud Yield Strength	f_y	(MPa)	450	450	450	450	450	450	N/A	N/A
Red.Char. Ult. Steel Tensile Capacity	ϕN_{us}	(kN)	14.9	23.8	35.3	69.3	104.6	151.4	N/A	N/A
Red.Char. Ult. Steel Shear capacity	ϕV_{us}	(kN)	10.7	17.0	25.3	49.6	74.9	108.5	N/A	N/A
Edge distance for no conc.cone reduction	**e_c**	**(mm)**	**35**	**40**	**50**	**65**	**80**	**100**	**N/A**	**N/A**
Anchor spacing for no conc.cone reduction	**a_c**	**(mm)**	**50**	**60**	**75**	**100**	**120**	**145**	**N/A**	**N/A**
Absolute Minimum edge dist. & anc'r spac.	**e_m & a_m**	**(mm)**	**25**	**30**	**35**	**50**	**60**	**75**	**N/A**	**N/A**

Effective Depth - h		Design Reduced Ultimate tensile capacity ϕN_{ur} (kN per anchor) Based on edge distance (e_c) and anchor spacing (a_c) for no conc.cone reduction							
60	(mm)	5.3							
65	(mm)	5.9							
70	(mm)	6.6	6.6						
80	(mm)	8.1	8.1						
90	(mm)	9.7	9.7	9.7					
100	(mm)	11.2	11.3	11.3					
110	(mm)	12.3	13.0	13.0	13.0				
125	(mm)	14.0	15.8	15.8	15.8				
140	(mm)	14.9	18.7	18.7	18.7				
150	(mm)	14.9	20.8	20.8	20.8	20.8			
160	(mm)	14.9	22.3	22.9	22.9	22.9	22.9		
170	(mm)	14.9	23.7	25.1	25.1	25.1	25.1		
180	(mm)	14.9	23.8	27.3	27.3	27.3	27.3		
190	(mm)	14.9	23.8	29.6	29.6	29.6	29.6	N/A	
220	(mm)	14.9	23.8	35.3	36.9	36.9	36.9	N/A	
240	(mm)	14.9	23.8	35.3	42.0	42.0	42.0	N/A	N/A
270	(mm)	14.9	23.8	35.3	50.2	50.2	50.2	N/A	N/A
330	(mm)	14.9	23.8	35.3	67.8	67.8	67.8	N/A	N/A
350	(mm)	14.9	23.8	35.3	69.3	74.1	74.1	N/A	N/A

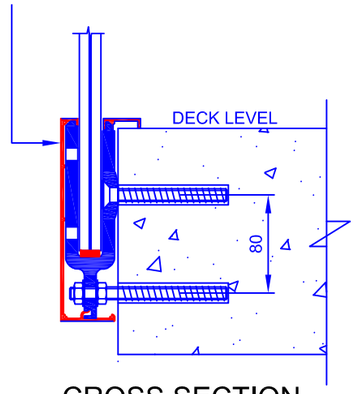
The design engineer should ensure the structural element is capable of supporting these loads. Refer to Ramset™ Specifiers Anchoring Resource Book ANZ for more information or explanation of Tech. Data.



TYPICAL ELEVATION

TOP SIDE CLIPS FIXED TO ADJACENT GLASS PANEL OR WALL (CLIPS MUST BE SPECIALIZED LAMINATED GLASS CLIPS FROM GLASS FITTINGS/ VETRO RACCORDI LTD.)

CUBOID FACE FIX CHANNEL & PACKERS AS PER GLASS FITTINGS / VETRO RACCORDI LTD.



CROSS SECTION

CUBOID FACE FIX CHANNEL

NOTE:
S = MAXIMUM SPACING OF THE SIDE FIXINGS

NOTE:
THE CUBOID FACE FIX CHANNEL MUST BE PLACED WITH FULL BEARING AGAINST THE SIDE OF THE SUPPORTING STRUCTURE.

THIS GLASS BALUSTRADE IS SUITABLE FOR THE FOLLOWING:

LIVE LOAD:

OCCUPANCY TYPE	REFER TABLE 3.3 OF AS/NZS 1170
A	ALL AREAS WITHIN OR SERVING EXCLUSIVELY ONE DWELLING INCLUDING STAIRS, LANDINGS ETC. BUT EXCLUDING EXTERNAL BALCONIES & EDGES OF ROOFS.
B & C3	EXTERNAL DOMESTIC BALCONIES, OFFICES AND WORK AREAS. (NOT SUBJECT TO OVER CROWDING)

WIND LOAD: UP TO "VERY HIGH" (VH) WIND ZONE WITH MAXIMUM BASIC WIND SPEED OF 50 m/s.
(DESIGN WIND PRESSURE = 1.95 kPa @ ULS)

FIXINGS:

1. ALL ANCHORS MUST BE INSTALLED IN ACCORDANCE WITH MANUFACTURERS REQUIREMENTS.

2. BOLTING ARRANGEMENT MUST COMPLY WITH RELEVANT MATERIAL CODES.

3. STRENGTH & STIFFNESS OF THE SUBSTRATE STRUCTURE MUST BE SUFFICIENT FOR THE BALUSTRADE LOADS - THIS MUST BE SPECIFICALLY CHECKED BY OTHERS FOR EACH SITUATION.

DURABILITY:

1. ALL FIXINGS & STRUCTURAL STEEL MUST COMPLY WITH SECTION 4 "DURABILITY" OF NZS 3604:2011.

CONNECTION TO SUPPORTING DECK FRAMING:

1. FOR FIXING OF BOUNDARY/END JOISTS TO DECK FRAMING (STRAPS, BOLTS,ETC), REFER TO NZS3604:2011 FIGURE 7.10.

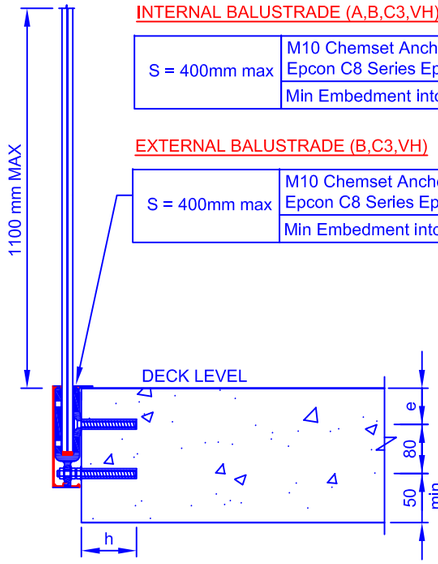
(OTHERWISE TO BE SPECIFICALLY DESIGNED BY OTHERS.)

INTERNAL BALUSTRADE (A,B,C3,VH)

S = 400mm max	M10 Chemset Anchors (Grade 5.8 Steel) with Epcon C8 Series Epoxy
	Min Embedment into Concrete, h= 120 mm

EXTERNAL BALUSTRADE (B,C3,VH)

S = 400mm max	M10 Chemset Anchors (Grade 316 SS) with Epcon C8 Series Epoxy
	Min Embedment into Concrete, h= 120 mm



	Min	Max
e	50mm	100mm

NOTE:
Min Concrete Strength f'c =20 MPa
Considered as NON-Cracked Concrete
(Eg: concrete footings/slab on grade)

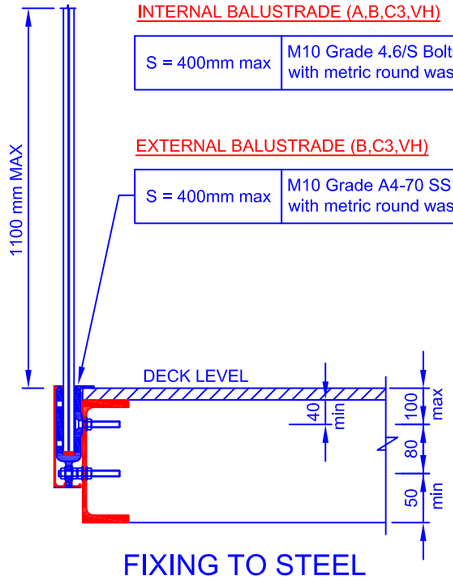
FIXING TO CONCRETE

INTERNAL BALUSTRADE (A,B,C3,VH)

S = 400mm max	M10 Grade 4.6/S Bolts with metric round washers

EXTERNAL BALUSTRADE (B,C3,VH)

S = 400mm max	M10 Grade A4-70 SS Bolts with metric round washers



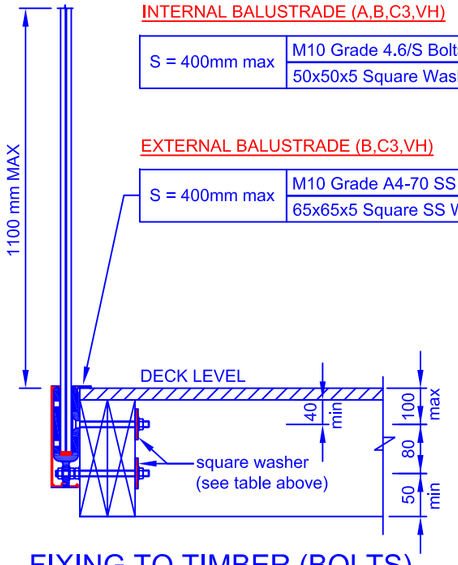
FIXING TO STEEL

INTERNAL BALUSTRADE (A,B,C3,VH)

S = 400mm max	M10 Grade 4.6/S Bolts
	50x50x5 Square Washers

EXTERNAL BALUSTRADE (B,C3,VH)

S = 400mm max	M10 Grade A4-70 SS Bolts
	65x65x5 Square SS Washers



FIXING TO TIMBER (BOLTS)

P & P CONSULTING ENGINEERS LTD
Civil and Structural Engineering
6A Montel Avenue, Henderson ph: 836-1853

GLASS FITTINGS / VETRO RACCORDI LTD - CUBOID FACE FIX

BALUSTRADE - 13.52mm thick EVA TOUGHENED LAMINATED GLASS

Scales NOT TO SCALE | Project 11/243 | Drawn JD | Date 11/9/2018 | Sheet ENG 01