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Ref: 11/243/ds30

11 September 2018

## **Glass Fittings / Vetro Raccordi Ltd**

### **ASSESSMENT OF FRAMELESS GLASS BALUSTRADE**

### **USING CUBOID FACE FIX SYSTEM & 13.52mm thick SGP TOUGHENED LAMINATED GLASS**



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|     | The glass balustrade had been tested to comply with AS/NZS 1170.1: 2002 Table 3.3 Minimum Imposed Actions for Barriers under Occupancy Type A, B and C3.                                                                                                                                                             |      |
|     | The glass balustrade had also been tested for max “Very High” wind load.                                                                                                                                                                                                                                             |      |
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|     | <ul style="list-style-type: none"> <li>➤ Occupancy types A, B, C3</li> <li>➤ Up to max “Very High” Wind</li> </ul>                                                                                                                                                                                                   |      |
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**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 SGP TOUGHENED LAMINATE 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

Clause(s) ..... **B1, B2, F2, F4** (Extent of Engagement) ..... 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/DS30, 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)

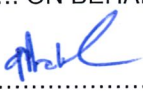
☒ CPEng ..... **251801** ..... #

☐ 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.

THIS FORM AND ITS CONDITIONS ARE COPYRIGHT TO ACENZ, IPENZ AND NZIA

## 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.<br>(NOT subject to Over Crowding) | 0.75 kN/m 0.6 kN | 1 kPa<br>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 $C_p$ = |   | 1.30 |           |
| For internal barriers use $C_p$ = |   | 0.30 |           |
| Wind Load = $q \times C_p$ =      |   | 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 SGP Toughened Laminated (Grade A) Safety Glass (6mm Toughened + 1.52mm SGP 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.

13.52 SGP Toughened  
Laminated Glass Panel

Hydraulic  
Body Frame

Weighing  
Indicator

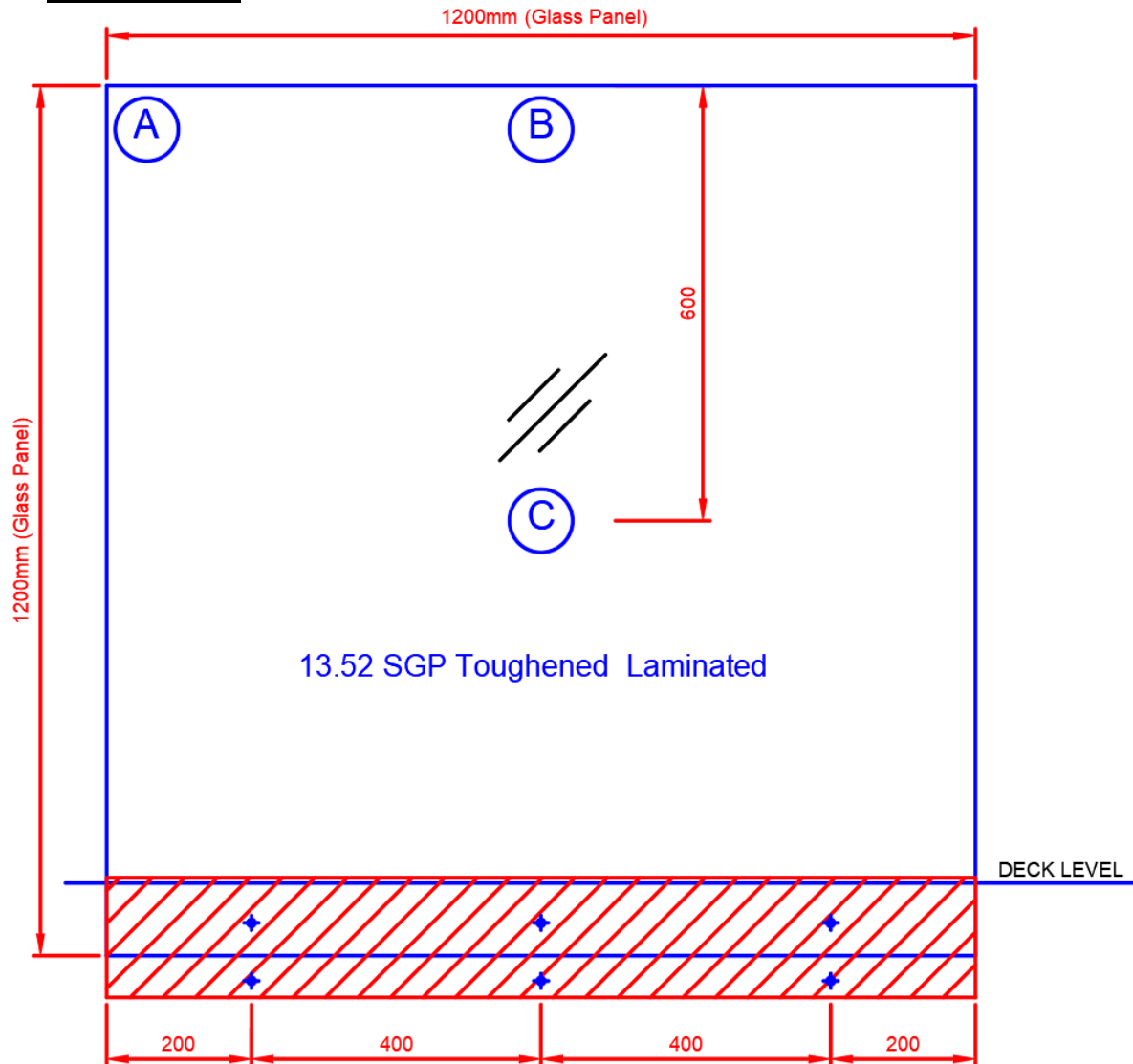


Cuboid Face Fix System

Steel Frame Assembly

## 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 ( $V_r$ ) of 10% for the glass, the variability factor  $k_t$  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                    | 14       | 14       | Passed  |
| B     | 91.7                   | 13                    | 15       | 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 SGP Toughened Laminated Grade A Safety Glass (6mm Toughened + 1.52 SGP 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 SGP 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 SGP Toughened Laminated Grade A Safety Glass (6mm Toughened + 1.52 SGP 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).

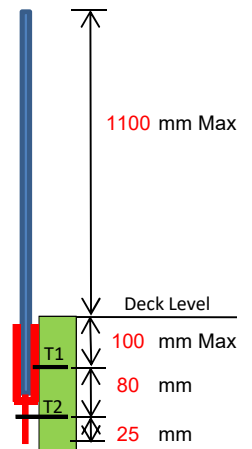
Refer to Summary Drawing ENG 01 for reference.

### 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**

|       |                 |        |                                       |                 |
|-------|-----------------|--------|---------------------------------------|-----------------|
| (V.H) | C3 loading      | 1.5Q1: | 1.5 x 0.6 kN / (no of base fixings) = | <b>0.3</b> kN   |
|       |                 | 1.5Q2: | 1.5 x 0.75kN/m x trib spacing =       | <b>0.45</b> kN  |
|       |                 | 1.5Q3: | 1.5 x 1.0kPa =                        | <b>1.5</b> kPa  |
|       | Wind - external | Wuls:  | 0.6 x 50 x 50 / 1000 x 1.3 =          | <b>1.95</b> 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/m<sup>3</sup> 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 Strength,  $f_c$  = 20MPa min  
 Concrete Edge Dist = 50mm min Considered as NON-Cracked Concrete

Using M10 Chemset Anchors with Epcon C8 Series Epoxy.

$\phi N$  = **22.70** kN **OK** CDR = 0.55 **< 1.2 OK**  
 $\phi V$  = **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

$\phi N$  = **18.56** kN **OK** CDR = 0.49 **OK**  
 $\phi V$  = **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. ( $\phi Q = \phi k_1 \times k_3 \times F_p \times A_w$ )

where:  $F_p$  = 5.3MPa (wet) or 8.9 Mpa (dry),  $\phi=0.7$ ,  $k_1=0.8$ ,  $k_3=1$

Using 50x50x5 Square Washers

$\phi Q$  = **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

| Input Description<br>(Strength Limit State Design)                                                                                                                                                        |  | Input Data<br>(per anchor)          |                    | Plan View - Generic<br>Dimensions in (mm)                                                                                                                                             |      | Project Details              |      |      |       |     |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-------------------------------------|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------------------------|------|------|-------|-----|-----|
| 1. Number of anchors (n)                                                                                                                                                                                  |  | n =                                 | 2                  |                                                                                                                                                                                       |      | Project Name:-               |      |      |       |     |     |
| 2. Anchor Spacing (a)                                                                                                                                                                                     |  | a =                                 | 80                 |                                                                                                                                                                                       |      | Project Site Address:-       |      |      |       |     |     |
| 3. Concrete Edge Distance (e)                                                                                                                                                                             |  | e =                                 | 50                 |                                                                                                                                                                                       |      | Company Name:-               |      |      |       |     |     |
| 4. Concrete Cylinder Strength (f'c)                                                                                                                                                                       |  | f'c =                               | 20                 |                                                                                                                                                                                       |      | Design Identification:-      |      |      |       |     |     |
| 5. Cracked Conc. (C) or Non-Cracked (N)                                                                                                                                                                   |  | C or N                              | N                  |                                                                                                                                                                                       |      | Date:-                       |      |      |       |     |     |
| 6. Effective Depth (h>6xdh)                                                                                                                                                                               |  | h =                                 | 120                |                                                                                                                                                                                       |      |                              |      |      |       |     |     |
| 7. Anchor Stud size (db) - M8 → M36                                                                                                                                                                       |  | db =                                | 10                 |                                                                                                                                                                                       |      |                              |      |      |       |     |     |
| 8. Concrete Edge Distance Corner (e1)                                                                                                                                                                     |  | e1 =                                | 50                 |                                                                                                                                                                                       |      |                              |      |      |       |     |     |
| 9. Internal to a row (I) or end of row (E)                                                                                                                                                                |  | I or E                              | E                  |                                                                                                                                                                                       |      |                              |      |      |       |     |     |
| 10. Dry Hole (D) or Wet hole (W)                                                                                                                                                                          |  | D or W                              | D                  |                                                                                                                                                                                       |      |                              |      |      |       |     |     |
| 11. Min Concrete Sub'te Thickness (bm)                                                                                                                                                                    |  | bm =                                | 150                | ChemSet™ Anchor Stud "Specification"                                                                                                                                                  |      | EPCON™ C8<br>"Specification" |      |      |       |     |     |
| 12. Anchor Stud Grade (5.8, 8.8, 316 SS)                                                                                                                                                                  |  | Grade =                             | 5.8                | Special Length - Use Typ Thr'd Rod Gr 8.8 or Diff.Size                                                                                                                                |      | C8-450                       |      |      |       |     |     |
| 13. Fixture Thickness (t)                                                                                                                                                                                 |  | t =                                 | 5                  | Hole Diameters (mm)                                                                                                                                                                   |      | Capacity Reduction Factors   |      |      |       |     |     |
| 14. Effective Length (Le)                                                                                                                                                                                 |  | Le =                                | 125                | Drill db = 12                                                                                                                                                                         |      | Concrete Tension φ = 0.56    |      |      |       |     |     |
| 15. Design Tensile Load-per anchor (N*)                                                                                                                                                                   |  | N* =                                | 8                  | Fixture dj = 12                                                                                                                                                                       |      | Concrete Shear φ = 0.6       |      |      |       |     |     |
| 16. Design Shear Load-per anchor (V*)                                                                                                                                                                     |  | V* =                                | 1                  |                                                                                                                                                                                       |      | Steel Tension/Shear φ = 0.8  |      |      |       |     |     |
| 17. Direction of Shear design load (α)                                                                                                                                                                    |  | α =                                 | 0                  |                                                                                                                                                                                       |      |                              |      |      |       |     |     |
| 18. Service Temperature (°C)                                                                                                                                                                              |  | -40°C to                            | +40°C              |                                                                                                                                                                                       |      |                              |      |      |       |     |     |
| Output Description<br>(Strength Limit State Design)                                                                                                                                                       |  | Output Data<br>(per anchor)         |                    | Elevation View - Generic<br>Dimensions in (mm)                                                                                                                                        |      | Anchor Loaded                |      |      |       |     |     |
| DESIGN O.K.                                                                                                                                                                                               |  |                                     |                    |                                                                                                                                                                                       |      |                              |      |      |       |     |     |
| Des. Red. Ult. CONC. Tensile Capacity                                                                                                                                                                     |  | φN <sub>urc</sub> = 33.5            |                    |                                                                                                                                                                                       |      |                              |      | kN   |       |     |     |
| Red. Char. Ult. STEEL Tensile Capacity                                                                                                                                                                    |  | φN <sub>us</sub> = 22.7             |                    |                                                                                                                                                                                       |      |                              |      | kN   |       |     |     |
| Des. Red. Ult. CONC. Shear Capacity                                                                                                                                                                       |  | φV <sub>urc</sub> = 2.8             |                    |                                                                                                                                                                                       |      |                              |      | kN   |       |     |     |
| Red. Char. Ult. STEEL Shear Capacity                                                                                                                                                                      |  | φV <sub>us</sub> = 14.1             |                    |                                                                                                                                                                                       |      |                              |      | kN   |       |     |     |
| Drill hole diameter                                                                                                                                                                                       |  | dh = 12                             |                    |                                                                                                                                                                                       |      |                              |      |      |       |     |     |
| TENSION O.K.                                                                                                                                                                                              |  |                                     |                    |                                                                                                                                                                                       |      |                              |      |      |       |     |     |
| Design Red. Ult. Tensile Capacity                                                                                                                                                                         |  | φN <sub>ur</sub> = 22.7             |                    |                                                                                                                                                                                       |      |                              |      |      |       |     |     |
| Tension Design Check                                                                                                                                                                                      |  | N*/φN <sub>ur</sub> = 0.35          |                    |                                                                                                                                                                                       |      | < 1                          |      |      |       |     |     |
| SHEAR O.K.                                                                                                                                                                                                |  |                                     |                    |                                                                                                                                                                                       |      |                              |      |      |       |     |     |
| Design Red. Ult. Shear Capacity                                                                                                                                                                           |  | φV <sub>ur</sub> = 2.8              |                    |                                                                                                                                                                                       |      |                              |      |      |       |     |     |
| Shear Design Check                                                                                                                                                                                        |  | V*/φV <sub>ur</sub> = 0.35          |                    |                                                                                                                                                                                       |      | < 1                          |      |      |       |     |     |
| COMBINED TENSION SHEAR O.K.                                                                                                                                                                               |  |                                     |                    |                                                                                                                                                                                       |      |                              |      |      |       |     |     |
| Combined Check - N*/φN <sub>ur</sub> + V*/φV <sub>ur</sub> =                                                                                                                                              |  | 0.71                                |                    |                                                                                                                                                                                       |      | < 1.2                        |      |      |       |     |     |
| Anchor Size                                                                                                                                                                                               |  | db                                  | Metric             | 8                                                                                                                                                                                     | 10   | 12                           | 16   | 20   | 24    | 30  | 36  |
| Drill hole diameter                                                                                                                                                                                       |  | dh                                  | (mm)               | 10                                                                                                                                                                                    | 12   | 14                           | 18   | 24   | 26    | N/A | N/A |
| Stressed Area                                                                                                                                                                                             |  | A <sub>b</sub>                      | (mm <sup>2</sup> ) | 33                                                                                                                                                                                    | 53   | 79                           | 154  | 232  | 337   | N/A | N/A |
| Anchor Stud Yield Strength                                                                                                                                                                                |  | f <sub>y</sub>                      | (MPa)              | 430                                                                                                                                                                                   | 430  | 430                          | 420  | 420  | 420   | N/A | N/A |
| Red.Char. Ult. Steel Tensile Capacity                                                                                                                                                                     |  | φN <sub>us</sub>                    | (kN)               | 14.3                                                                                                                                                                                  | 22.7 | 33.8                         | 64.7 | 97.6 | 141.3 | N/A | N/A |
| Red.Char. Ult. Steel Shear capacity                                                                                                                                                                       |  | φV <sub>us</sub>                    | (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 <sub>c</sub>                      | (mm)               | 35                                                                                                                                                                                    | 40   | 50                           | 65   | 80   | 100   | N/A | N/A |
| Anchor spacing for no conc.cone reduction                                                                                                                                                                 |  | a <sub>c</sub>                      | (mm)               | 50                                                                                                                                                                                    | 60   | 75                           | 100  | 120  | 145   | N/A | N/A |
| Absolute Minimum edge dist. & anc'r spac.                                                                                                                                                                 |  | e <sub>min</sub> & a <sub>min</sub> | (mm)               | 25                                                                                                                                                                                    | 30   | 35                           | 50   | 60   | 75    | N/A | N/A |
| Effective Depth - h                                                                                                                                                                                       |  |                                     |                    | Design Reduced Ultimate tensile capacity φN <sub>ur</sub> (kN per anchor)<br>Based on edge distance (e <sub>c</sub> ) and anchor spacing (a <sub>c</sub> ) for no conc.cone reduction |      |                              |      |      |       |     |     |
| 60                                                                                                                                                                                                        |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 65                                                                                                                                                                                                        |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 70                                                                                                                                                                                                        |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 80                                                                                                                                                                                                        |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 90                                                                                                                                                                                                        |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 100                                                                                                                                                                                                       |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 110                                                                                                                                                                                                       |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 125                                                                                                                                                                                                       |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 140                                                                                                                                                                                                       |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 150                                                                                                                                                                                                       |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 160                                                                                                                                                                                                       |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 170                                                                                                                                                                                                       |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 180                                                                                                                                                                                                       |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 190                                                                                                                                                                                                       |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 220                                                                                                                                                                                                       |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 240                                                                                                                                                                                                       |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 270                                                                                                                                                                                                       |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 330                                                                                                                                                                                                       |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 350                                                                                                                                                                                                       |  |                                     |                    | (mm)                                                                                                                                                                                  |      |                              |      |      |       |     |     |
| 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. |  |                                     |                    |                                                                                                                                                                                       |      |                              |      |      |       |     |     |
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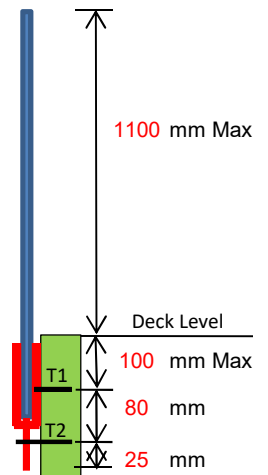
## 6.2

**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**

|       |                 |        |                                                             |                 |
|-------|-----------------|--------|-------------------------------------------------------------|-----------------|
| (V.H) | C3 loading      | 1.5Q1: | $1.5 \times 0.6 \text{ kN} / (\text{no of base fixings}) =$ | <b>0.3</b> kN   |
|       |                 | 1.5Q2: | $1.5 \times 0.75 \text{ kN/m} \times \text{trib spacing} =$ | <b>0.45</b> kN  |
|       |                 | 1.5Q3: | $1.5 \times 1.0 \text{ kPa} =$                              | <b>1.5</b> kPa  |
|       | Wind - external | Wuls:  | $0.6 \times 50 \times 50 / 1000 \times 1.3 =$               | <b>1.95</b> 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)**

$1.2 \times \text{Weight of Glass Panel} = 1.2 \times (28 \text{ kN/m}^3 \times \text{thickness} \times \text{Area}) = 0.316 \text{ kN}$   
 $1.2 \times \text{Weight of Al Channel} = 1.2 \times (0.5 \text{ kN/m} \times \text{spacing}) = 0.24 \text{ kN}$

**1.2G:**  $V^*/\text{anchor} = \underline{\underline{0.56}}$  kN

**A. Fixing to Concrete**

Refer to page 10 for design calculations.

Anchor Spacing= 80mm Concrete Strength,  $f'_c = 20 \text{ MPa}$  min  
 Concrete Edge Dist= 50mm min Considered as NON-Cracked Concrete

Using M10 Chemset Anchors with Epcon C8 Series Epoxy.

$\phi N = \underline{\underline{16.80}}$  kN **OK** CDR= 0.67 **< 1.2 OK**  
 $\phi V = \underline{\underline{2.80}}$  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)

$\phi N = \underline{\underline{27.20}}$  kN **OK** CDR= 0.24 **OK**  
 $\phi V = \underline{\underline{17.86}}$  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. (  $\phi Q = \phi k_1 \times k_3 \times F_p \times A_w$  )

where:  $F_p = 5.3 \text{ MPa}$  (wet) or  $8.9 \text{ MPa}$  (dry) ,  $\phi=0.7$ ,  $k_1=0.8$ ,  $k_3=1$

Using 65x65x5 Square S/S washer

$\phi Q = \underline{\underline{12.20}}$  kN (wet) **OK**

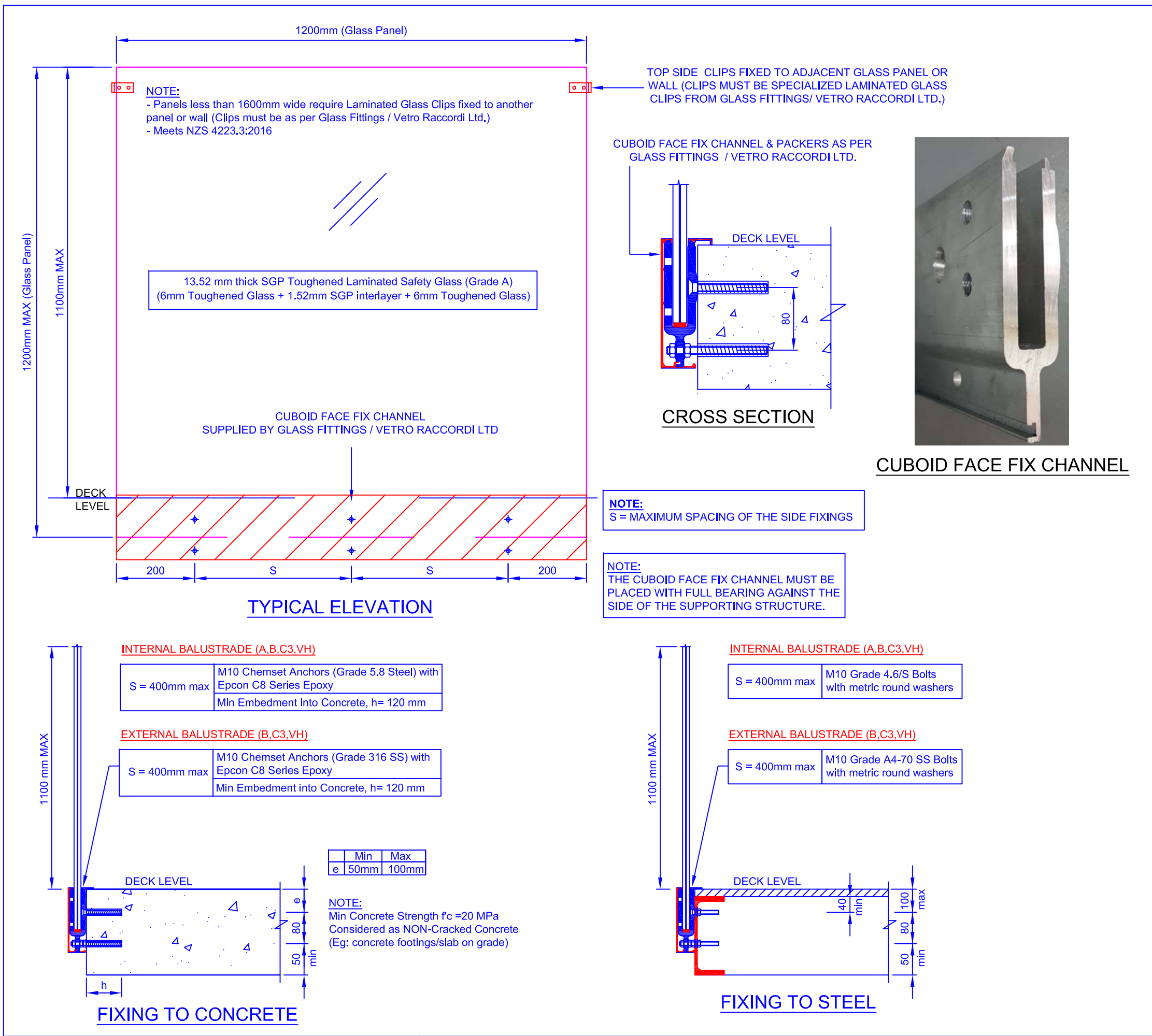
Use M10 Grade 316 Stainless Steel (A4-70) Bolts with 65x65x5 Square S/S washers.

(spacing = 400mm max centres)

# Chemical Anchoring - ChemSet Anchor Stud Design Calculator

European Technical Approval ETA-10/0309

| Input Description<br>(Strength Limit State Design)                                                                                                                                                        |  | Input Data<br>(per anchor)          |                    | Plan View - Generic<br>Dimensions in (mm)                                                                                                                                             |      | Project Details              |      |       |       |     |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-------------------------------------|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------------------------|------|-------|-------|-----|-----|
| 1. Number of anchors (n)                                                                                                                                                                                  |  | n =                                 | 2                  |                                                                                                                                                                                       |      | Project Name:-               |      |       |       |     |     |
| 2. Anchor Spacing (a)                                                                                                                                                                                     |  | a =                                 | 80                 |                                                                                                                                                                                       |      | Project Site Address:-       |      |       |       |     |     |
| 3. Concrete Edge Distance (e)                                                                                                                                                                             |  | e =                                 | 50                 |                                                                                                                                                                                       |      | Company Name:-               |      |       |       |     |     |
| 4. Concrete Cylinder Strength (f'c)                                                                                                                                                                       |  | f'c =                               | 20                 |                                                                                                                                                                                       |      | Design Identification:-      |      |       |       |     |     |
| 5. Cracked Conc. (C) or Non-Cracked (N)                                                                                                                                                                   |  | C or N                              | N                  |                                                                                                                                                                                       |      | Date:-                       |      |       |       |     |     |
| 6. Effective Depth (h>6xdh)                                                                                                                                                                               |  | h =                                 | 120                |                                                                                                                                                                                       |      |                              |      |       |       |     |     |
| 7. Anchor Stud size (db) - M8 → M36                                                                                                                                                                       |  | db =                                | 10                 |                                                                                                                                                                                       |      |                              |      |       |       |     |     |
| 8. Concrete Edge Distance Corner (e1)                                                                                                                                                                     |  | e1 =                                | 50                 |                                                                                                                                                                                       |      |                              |      |       |       |     |     |
| 9. Internal to a row (I) or end of row (E)                                                                                                                                                                |  | I or E                              | E                  |                                                                                                                                                                                       |      |                              |      |       |       |     |     |
| 10. Dry Hole (D) or Wet hole (W)                                                                                                                                                                          |  | D or W                              | W                  |                                                                                                                                                                                       |      |                              |      |       |       |     |     |
| 11. Min Concrete Sub'te Thickness (bm)                                                                                                                                                                    |  | bm =                                | 150                | ChemSet™ Anchor Stud "Specification"                                                                                                                                                  |      | EPCON™ C8<br>"Specification" |      |       |       |     |     |
| 12. Anchor Stud Grade (5.8, 8.8, 316 SS)                                                                                                                                                                  |  | Grade =                             | 316                | Special Length - Use                                                                                                                                                                  |      | Typ Thr'd                    |      |       |       |     |     |
| 13. Fixture Thickness (t)                                                                                                                                                                                 |  | t =                                 | 5                  | Rod                                                                                                                                                                                   |      | or Diff.Size                 |      |       |       |     |     |
| 14. Effective Length (Le)                                                                                                                                                                                 |  | Le =                                | 125                | Hole Diameters (mm)                                                                                                                                                                   |      | Capacity Reduction Factors   |      |       |       |     |     |
| 15. Design Tensile Load-per anchor (N*)                                                                                                                                                                   |  | N* =                                | 8                  | Drill db = 12                                                                                                                                                                         |      | Concrete Tension φ = 0.56    |      |       |       |     |     |
| 16. Design Shear Load-per anchor (V*)                                                                                                                                                                     |  | V* =                                | 1                  | Fixture dj = 12                                                                                                                                                                       |      | Concrete Shear φ = 0.6       |      |       |       |     |     |
| 17. Direction of Shear design load (α)                                                                                                                                                                    |  | α =                                 | 0                  |                                                                                                                                                                                       |      | Steel Tension/Shear φ = 0.8  |      |       |       |     |     |
| 18. Service Temperature (°C)                                                                                                                                                                              |  | -40°C to                            | +40°C              |                                                                                                                                                                                       |      |                              |      |       |       |     |     |
| Output Description<br>(Strength Limit State Design)                                                                                                                                                       |  | Output Data<br>(per anchor)         |                    | Elevation View - Generic<br>Dimensions in (mm)                                                                                                                                        |      | Anchor Loaded                |      |       |       |     |     |
| DESIGN O.K.                                                                                                                                                                                               |  |                                     |                    |                                                                                                                                                                                       |      |                              |      |       |       |     |     |
| Des. Red. Ult. CONC. Tensile Capacity                                                                                                                                                                     |  | φN <sub>urc</sub> = 16.8            |                    |                                                                                                                                                                                       |      |                              |      | kN    |       |     |     |
| Red. Char. Ult. STEEL Tensile Capacity                                                                                                                                                                    |  | φN <sub>us</sub> = 23.8             |                    |                                                                                                                                                                                       |      |                              |      | kN    |       |     |     |
| Des. Red. Ult. CONC. Shear Capacity                                                                                                                                                                       |  | φV <sub>urc</sub> = 2.8             |                    |                                                                                                                                                                                       |      |                              |      | kN    |       |     |     |
| Red. Char. Ult. STEEL Shear Capacity                                                                                                                                                                      |  | φV <sub>us</sub> = 17.0             |                    |                                                                                                                                                                                       |      |                              |      | kN    |       |     |     |
| Drill hole diameter                                                                                                                                                                                       |  | dh = 12                             |                    | mm                                                                                                                                                                                    |      |                              |      |       |       |     |     |
| TENSION O.K.                                                                                                                                                                                              |  |                                     |                    |                                                                                                                                                                                       |      |                              |      |       |       |     |     |
| Design Red. Ult. Tensile Capacity                                                                                                                                                                         |  | φN <sub>ur</sub> = 16.8             |                    | kN                                                                                                                                                                                    |      |                              |      |       |       |     |     |
| Tension Design Check                                                                                                                                                                                      |  | N*/φN <sub>ur</sub> = 0.48          |                    | < 1                                                                                                                                                                                   |      |                              |      |       |       |     |     |
| SHEAR O.K.                                                                                                                                                                                                |  |                                     |                    |                                                                                                                                                                                       |      |                              |      |       |       |     |     |
| Design Red. Ult. Shear Capacity                                                                                                                                                                           |  | φV <sub>ur</sub> = 2.8              |                    | kN                                                                                                                                                                                    |      |                              |      |       |       |     |     |
| Shear Design Check                                                                                                                                                                                        |  | V*/φV <sub>ur</sub> = 0.35          |                    | < 1                                                                                                                                                                                   |      |                              |      |       |       |     |     |
| COMBINED TENSION SHEAR O.K.                                                                                                                                                                               |  |                                     |                    |                                                                                                                                                                                       |      |                              |      |       |       |     |     |
| Combined Check - N*/φN <sub>ur</sub> + V*/φV <sub>ur</sub> =                                                                                                                                              |  | 0.83                                |                    | < 1.2                                                                                                                                                                                 |      |                              |      |       |       |     |     |
| Anchor Size                                                                                                                                                                                               |  | db                                  | Metric             | 8                                                                                                                                                                                     | 10   | 12                           | 16   | 20    | 24    | 30  | 36  |
| Drill hole diameter                                                                                                                                                                                       |  | dh                                  | (mm)               | 10                                                                                                                                                                                    | 12   | 14                           | 18   | 24    | 26    | N/A | N/A |
| Stressed Area                                                                                                                                                                                             |  | A <sub>b</sub>                      | (mm <sup>2</sup> ) | 33                                                                                                                                                                                    | 53   | 79                           | 154  | 232   | 337   | N/A | N/A |
| Anchor Stud Yield Strength                                                                                                                                                                                |  | f <sub>y</sub>                      | (MPa)              | 450                                                                                                                                                                                   | 450  | 450                          | 450  | 450   | 450   | N/A | N/A |
| Red.Char. Ult. Steel Tensile Capacity                                                                                                                                                                     |  | φN <sub>us</sub>                    | (kN)               | 14.9                                                                                                                                                                                  | 23.8 | 35.3                         | 69.3 | 104.6 | 151.4 | N/A | N/A |
| Red.Char. Ult. Steel Shear capacity                                                                                                                                                                       |  | φV <sub>us</sub>                    | (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 <sub>c</sub>                      | (mm)               | 35                                                                                                                                                                                    | 40   | 50                           | 65   | 80    | 100   | N/A | N/A |
| Anchor spacing for no conc.cone reduction                                                                                                                                                                 |  | a <sub>c</sub>                      | (mm)               | 50                                                                                                                                                                                    | 60   | 75                           | 100  | 120   | 145   | N/A | N/A |
| Absolute Minimum edge dist. & anc'r spac.                                                                                                                                                                 |  | e <sub>min</sub> & a <sub>min</sub> | (mm)               | 25                                                                                                                                                                                    | 30   | 35                           | 50   | 60    | 75    | N/A | N/A |
| Effective Depth - h                                                                                                                                                                                       |  |                                     |                    | Design Reduced Ultimate tensile capacity φN <sub>ur</sub> (kN per anchor)<br>Based on edge distance (e <sub>c</sub> ) and anchor spacing (a <sub>c</sub> ) 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. |  |                                     |                    |                                                                                                                                                                                       |      |                              |      |       |       |     |     |
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**THIS GLASS BALUSTRADE IS SUITABLE FOR THE FOLLOWING:**

**LIVE LOAD:**

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

**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.)