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TED SINGLETON & ASSOCIATES
CONSULTING ENGINEERS

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 0
Date: 04/04/2024	**By:** CC

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Pikasso Post &

Balcony Balustrade Design

Analysis By	Checked By
CC	C.K.

Revision	Date	Issued By	Comment
1	04/04/2024	T.S	Revised to Comments
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Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 1
Date: 04/04/2024	**By:** CC

Contents

Contents 1

Actions/Assumptions/Result Summary: 3

Actions: 3

Assumptions: 3

Result Summary: 3

Drawing Alterations: 4

Revision 01 on Report: 4

Glass Strength Calculation: 5

Balustrade Loading: 5

Wind Loading: 5

Wind Load Calculation: 5

Sketch Of System: 6

Calculations for Indoor Use only.: 7

Mid Post Check without Handrail: 7

Post Checked for 0.74kN/m Balustrade load: 7

Corner Post Check without Handrail: 8

Post Checked for 0.74kN/m Balustrade load: 8

End Post Check without Handrail: 9

Post Checked for 0.74kN/m Balustrade load: 9

Mid Post Check with Handrail: 10

Post Checked for 0.74kN/m Balustrade load: 10

Corner Post Check with Handrail: 11

Post Checked for 0.74kN/m Balustrade load: 11

End Post Check with Handrail: 12

Post Checked for 0.74kN/m Balustrade load: 12

Calculation for External Use: 13

Mid Post Check without Handrail: 13

Post Checked for 0.74kN/m Balustrade load: 13
Post Checked for 1.62kN/m2 Wind load: 14
Corner Post Check without Handrail: 15
Post Checked for 0.74kN/m Balustrade load: 15
Post Checked for 1.62kN/m2 Wind load: 16
End Post Check without Handrail: 17
Post Checked for 0.74kN/m Balustrade load: 17
Post Checked for 1.62kN/m2 Wind load: 18
Mid Post Check with Handrail: 19
Post Checked for 0.74kN/m Balustrade load: 19
Post Checked for 1.62kN/m2 Wind load: 20
Corner Post Check with Handrail: 21
Post Checked for 0.74kN/m Balustrade load: 21
Post Checked for 1.62kN/m2 Wind load: 22
End Post Check with Handrail: 23
Post Checked for 0.74kN/m Balustrade load: 23
Post Checked for 1.62kN/m2 Wind load: 24
Handrail Check: 25
Handrail Checked for Balustrade loading of 0.74kN/m: 25
Case Study 01: 26
System Sketch: 26
Glass Analysis – 10mm thickness – Toughened Glass: 27
Glass Analysis – 13.52mm thickness – PVB Interlayer: 33
Case Study 02: 39
System Sketch: 39
Glass Analysis – 10mm thickness – Toughened Glass: 40
Glass Analysis – 13.52mm thickness – PVB Interlayer: 44
Appendix A: Summary of Results for Indoor and Outdoor Applications: 48

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 3
Date: 04/04/2024	**By:** CC

Actions/Assumptions/Result Summary:

Actions:

Balustrade load = 0.74kN/m (Table 2; BS6180:2011)

Point load = 0.5kN (Table 2; BS6180:2011)

Wind Load $= 1.62\text{kN/m}^2$ (As per calculation in sheet 4)

Assumptions:

Aluminium Grade 6063 – T6

Aluminium Strength is 160N/mm^2.

Assumed Wind Peak Pressure of 0.9kN/m^2

The deflection limit is taken as being 25mm at post locations.

Post centres at maximum 1.3m c/c.

Result Summary:

The report checks end post/mid post/corner post sections for indoor and outdoor scenarios (ie a handrail load of 0.74kN/m and a wind pressure of 1.62kN/m^2) for the maximum capacity of the balustrade. The maximum spacing of the posts are outlined in the table below.

The report also carries out a check on the glass and there are two glass types checked. They are a single ply of toughened glass 10mm, and 13.52mm (6 + 1.52 + 6) toughened with PVB interlayer. These glass types were checked for a handrail, and without the handrail for the design cases of balustrade, infill loading and wind loading. It was found that both types of glass work for both strength and deflection.

Proposed Pikasso handrail sections will work at the centres shown in the table.

	Line Load Handrail Loading.	Wind Load Peak Velocity (Design Loading)	Typical Maximum c/c	Adjacent Corner Maximum c/c of posts
Indoor Aplications	0.74kN/m	---------	1300mm c/c	1100mm c/c
Outdoor Application	----------	0.9kN/m^2 (1.62kN/m^2)	1300mm c/c	650mm c/c

NOTE 01: As per EN 1993-1-1:2005 clause 7.2.2, "with reference to 1990 Annex A1.4," limits for horizontal deflections, as depicted in Figure A1.2, should be specified for each project and agreed upon with the client.

Note 02: According to EN 1990:2002 Annex A1.4.2, the serviceability criteria must be specified for each project and mutually agreed upon with the client.

Note 03: This calculation pack is based on deflection limit of 25mm.

Drawing Alterations:

The assembly drawings provided by PiKasso and Airforce indicated post centres of 1300mm c/c. The report has taken an assumed peak wind velocity of 0.9kN/m^2, and have calculated the centres of the posts to be at a maximum of 1300mm c/c and at 650mm c/c at corner locations, as per the summary sketches in sheet 6. The assembly drawings do not show that the post centres need to be reduced at corner locations.

Revision 01 on Report:

The report has been revised to consider the design case of interior loading only, as a separate case from the application outdoors. The handrail loading on this design case has been taken as 0.74kN/m and has resulted in the positioning of posts typically at 1300mm c/c and at 1100mm c/c at corner locations.

For the outdoors application, the report has reduced the wind loading to a peak wind velocity pressure of 0.9kN/m^2. This has resulted in a spacing of 1300mm c/c generally and to 650mm c/c at corner locations.

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 5
Date: 04/04/2024	**By:** CC

Glass Strength Calculation:

Balustrade Loading:

Heat Toughened.

< 5mins duration => $k_{mod} = 0.77$

$f_{gd} = (k_{mod})(k_{sp})(f_{gk})/ \gamma_{ma} + k_v(f_{bk}-f_{gk})/\gamma_{mv}$

$f_{gd} = (0.77)(1.0)(45)/1.6 + 1.0(120-45)/1.2$

$\underline{f_{gd} = 84.2N/mm^2}$

Wind Loading:

10min duration, Multiple Gust Storm => $k_{mod} = 0.74$

$f_{gd} = (k_{mod})(k_{sp})(f_{gk})/ \gamma_{ma} + k_v(f_{bk}-f_{gk})/\gamma_{mv}$

$f_{gd} = (0.74)(1.0)(45)/1.6 + 1.0(120-45)/1.2$

$\underline{f_{gd} = 83.3N/mm^2}$

Wind Load Calculation:

Peak Velocity Pressure = $q_{p(z)} = 0.9kN/m^2$, as assumed for calculation purposes.

Total Wind Load

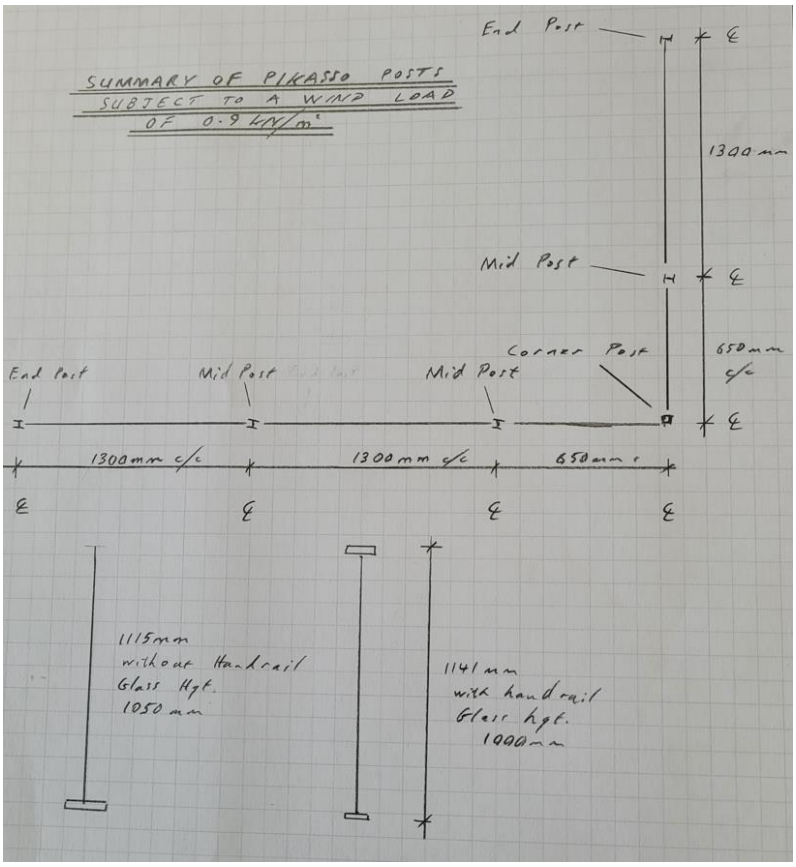
Various Factors

$Q_w = q_{p(z)} \times c_{pe}/cf = 0.9kN/m^2 \times 1.8 = 1.62kN/m^2$

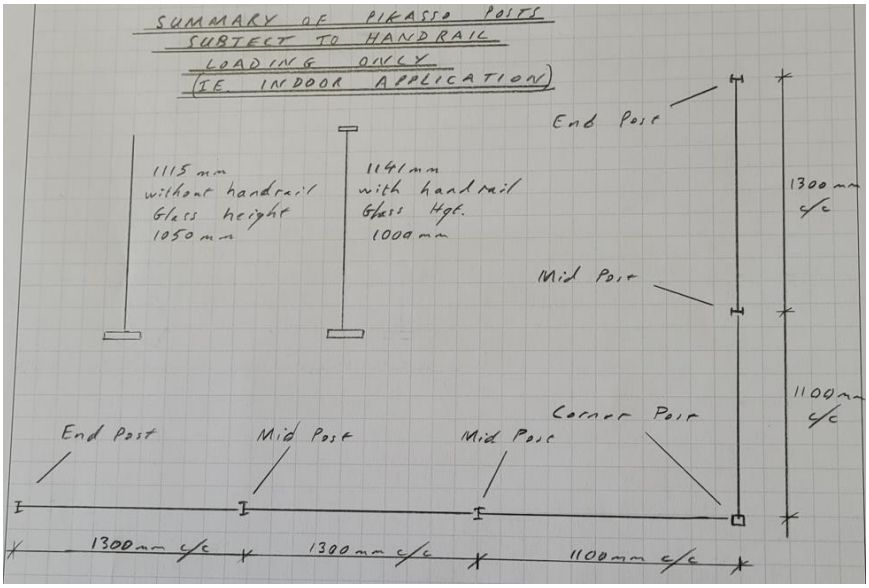
Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 6
Date: 04/04/2024	**By:** CC

Sketch Of System:

Outdoor:



Indoor:



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 7
Date: 04/04/2024	**By:** CC

Calculations for Indoor Use only.:

Mid Post Check without Handrail:

Post Checked for 0.74kN/m Balustrade load:

The post has the following particulars:

$f_y = 160\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70000\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2.5 EN 1999-1-1:2007)

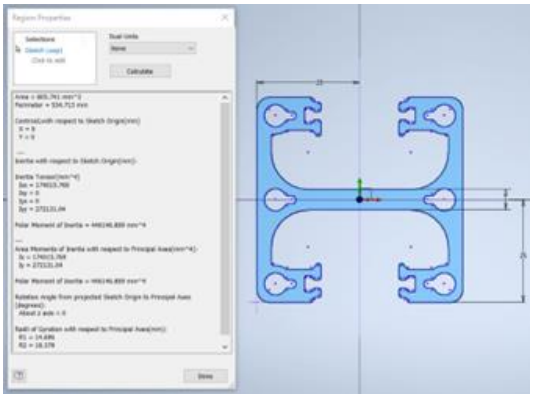
$I = 272131mm^4$ (50×50mm Pikasso Post)

$Z = 10885mm^3$ (50×50mm Pikasso Post)

$\gamma_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 1300mm

Height of Balustrade = 1115mm



Maximum Moment:

$\mathrm{M_H} = \mathrm{WL}$

$\mathrm{M_H} = 0.74\mathrm{kN/m} \times 1.5 \times 1.3\mathrm{m} \times 1.115\mathrm{m} = 1.609\mathrm{kNm}$

Maximum Stress:

$\sigma_{max} = \frac{M}{Z}$

$\sigma_{max} = \frac{1.609\times10^6}{10885} = 147.8\frac{N}{mm^2} < 160\frac{N}{mm^2}$ **Okay**

Maximum Deflection:

$\alpha = \frac{wL^3}{3EI}$

$\alpha = \frac{0.74\times1300\times1115^3}{3\times70000\times272131} = 23.35\mathrm{mm} < 25\mathrm{mm}$ **Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 8
Date: 04/04/2024	**By:** CC

Corner Post Check without Handrail:

Post Checked for 0.74kN/m Balustrade load:

The post has the following particulars:

$f_y = 160\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70000\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2.5 EN 1999-1-1:2007)

$\mathrm{I_{xx}} = 228360mm^4$ (50×50mm Pikasso Post)

$\mathrm{I_{yy}} = 228360mm^4$ (50×50mm Pikasso Post)

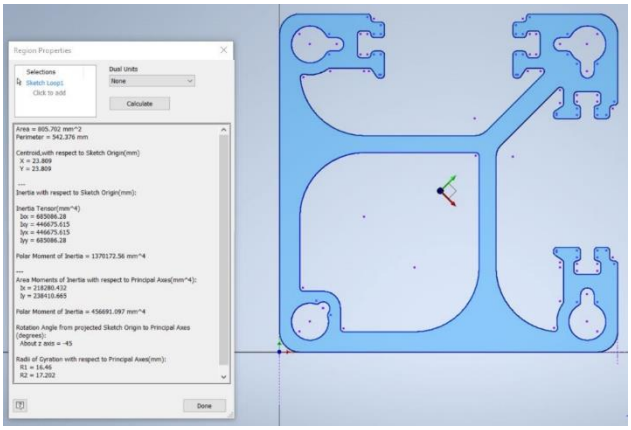
$\mathrm{Z_{xx}} = 8719mm^4$ (50×50mm Pikasso Post)

$\mathrm{Z_{yy}} = 8719mm^4$ (50×50mm Pikasso Post)

$\Upsilon_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 1100mm

Height of Balustrade = 1115mm



Maximum Moment: $\mathrm{M_H} = \mathrm{WL}$

$\mathrm{M_H} = 0.74\mathrm{kN/m} \times 1.5 \times \frac{1.1\mathrm{m}}{2} \times 1.115\mathrm{m} = 0.681\mathrm{kNm}$

Maximum Stress:

$\sigma_{max} = \frac{\mathrm{M}}{\mathrm{Z}}\mathrm{dirn1} + \frac{\mathrm{M}}{\mathrm{Z}}\mathrm{dirn2}$

$\sigma_{max} = \frac{0.681\times10^6}{8719} + \frac{0.681\times10^6}{8719} = 156.2\frac{\mathrm{N}}{\mathrm{mm^2}} < 160\frac{\mathrm{N}}{\mathrm{mm^2}}$ **Okay**

Maximum Deflection:

$\alpha_1 = \frac{\mathrm{wL^3}}{3\mathrm{EI}} dirn\ 1 :\ \alpha_2 \frac{\mathrm{wL^3}}{3\mathrm{EI}} dirn\ 2$

$\alpha_1 = \frac{0.74 \times \frac{1100}{2} \times 1115^3}{3 \times 70000 \times 228360} = 11.77mm: \alpha_2 = \frac{0.74 \times \frac{1100}{2} \times 1115^3}{3 \times 70000 \times 228360} = 11.77\mathrm{mm}$

$\mathrm{SQRT}(11.77^2 + 11.77^2) = 16.63\mathrm{mm} < 25\mathrm{mm}$ **Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 9
Date: 04/04/2024	**By:** CC

End Post Check without Handrail:

Post Checked for 0.74kN/m Balustrade load:

The post has the following particulars:

$f_y = 160\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70000\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2.5 EN 1999-1-1:2007)

$I = 272131mm^4$ (50×50mm Pikasso Post)

$Z = 10885mm^3$ (50×50mm Pikasso Post)

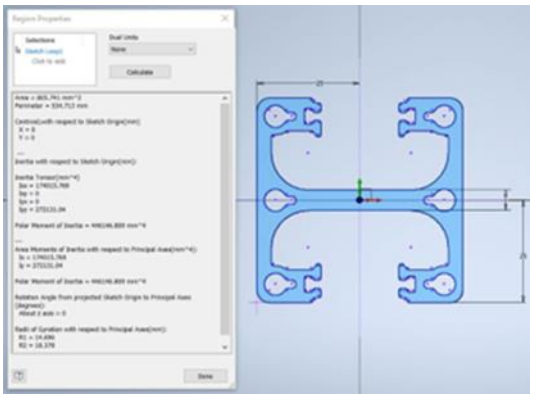
$\gamma_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 1300mm

Height of Balustrade = 1115mm

$$M_H = WL$$

$$M_H = 0.74\text{kN/m} \times 1.5 \times \frac{1.3\text{m}}{2} \times 1.115\text{m} = 0.805\text{kNm}$$



Maximum Stress:

$$\sigma_{max} = \frac{M}{Z}$$

$$\sigma_{max} = \frac{0.805\times10^6}{10885} = 73.91\frac{N}{mm^2} < 160\frac{N}{mm^2}$$

Okay

Maximum Deflection:

$$\alpha = \frac{wL^3}{3EI}$$

$$\alpha = \frac{0.681\times\frac{1300}{2}\times1115^3}{3\times70000\times272131} = 10.74\text{mm} < 25\text{mm}$$ **Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 10
Date: 04/04/2024	**By:** CC

Mid Post Check with Handrail:

Post Checked for 0.74kN/m Balustrade load:

The post has the following particulars:

$f_y = 160\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70000\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2.5 EN 1999-1-1:2007)

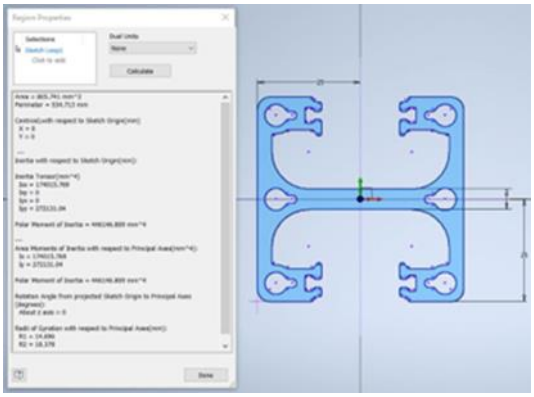
$I = 272131mm^4$ (50×50mm Pikasso Post)

$Z = 10885mm^3$ (50×50mm Pikasso Post)

$\gamma_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 1300mm

Height of Balustrade = 1141mm



Maximum Moment:

$\mathrm{M_H = WL}$

$\mathrm{M_H = 0.74kN/m \times 1.5 \times 1.3m \times 1.141m = 1.646kNm}$

Maximum Stress:

$$\sigma_{max} = \frac{M}{Z}$$

$$\sigma_{max} = \frac{1.646\times10^6}{10885} = 151.3\frac{N}{mm^2} < 160\frac{N}{mm^2}$$ **Okay**

Maximum Deflection:

$$\alpha = \frac{wL^3}{3EI}$$

$$\alpha = \frac{0.74\times1300\times1141^3}{3\times70000\times272131} = 25.01mm > 25mm$$ **Deemed Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 11
Date: 04/04/2024	**By:** CC

Corner Post Check with Handrail:

Post Checked for 0.74kN/m Balustrade load:

The post has the following particulars:

$f_y = 160\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70000\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2.5 EN 1999-1-1:2007)

$\mathrm{I_{xx}} = 228360mm^4$ (50×50mm Pikasso Post)

$\mathrm{I_{yy}} = 228360mm^4$ (50×50mm Pikasso Post)

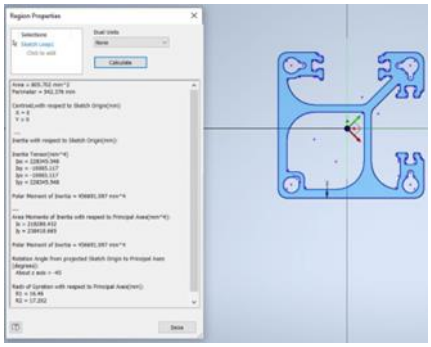
$\mathrm{Z_{xx}} = 8719mm^4$ (50×50mm Pikasso Post)

$\mathrm{Z_{yy}} = 8719mm^4$ (50×50mm Pikasso Post)

$\Upsilon_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 1100mm

Height of Balustrade = 1141mm



Maximum Moment:

$\mathrm{M_H} = \mathrm{WL}$

$\mathrm{M_H} = 0.74\mathrm{kN/m} \times 1.5 \times \frac{1.1\mathrm{m}}{2} \times 1.141\mathrm{m} = 0.697\mathrm{kNm}$

Maximum Stress:

$\sigma_{max} = \frac{\mathrm{M}}{\mathrm{Z}}\mathrm{dirn1} + \frac{\mathrm{M}}{\mathrm{Z}}\mathrm{dirn2}$

$\sigma_{max} = \frac{0.697\times10^6}{8719} + \frac{0.697\times10^6}{8719} = 159.9\frac{\mathrm{N}}{\mathrm{mm^2}} < 160\frac{\mathrm{N}}{\mathrm{mm^2}}$ **Okay**

Maximum Deflection:

$\alpha_1 = \frac{\mathrm{wL^3}}{3\mathrm{EI}} dirn\ 1 :\ \alpha_2 \frac{\mathrm{wL^3}}{3\mathrm{EI}} dirn\ 2$

$\alpha_1 = \frac{0.74\times\frac{1100}{2}\times1141^3}{3\times70000\times228360} = 12.61mm:$ $\alpha_2 = \frac{0.74\times\frac{1100}{2}\times1141^3}{3\times70000\times228360} = 12.61\mathrm{mm}$

$\mathrm{SQRT}\ (12.61^2 + 12.61^2) = 17.83\mathrm{mm} < 25\mathrm{mm}$ **Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 12
Date: 04/04/2024	**By:** CC

End Post Check with Handrail:

Post Checked for 0.74kN/m Balustrade load:

The post has the following particulars:

$f_y = 160\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70000\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2.5 EN 1999-1-1:2007)

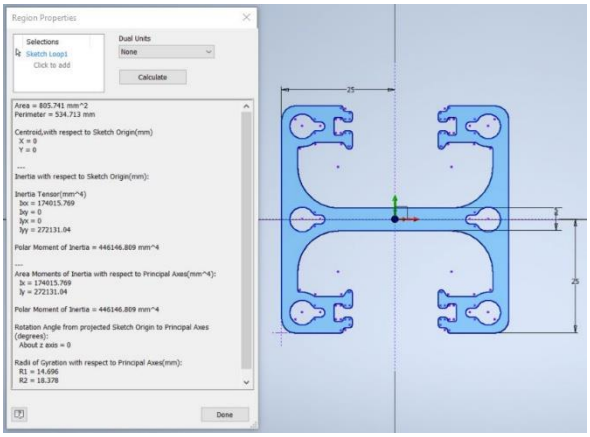
$I = 272131mm^4$ (50×50mm Pikasso Post)

$Z = 10885mm^3$ (50×50mm Pikasso Post)

$\gamma_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 1300mm

Height of Balustrade = 1141mm



Maximum Moment:

$$M_H = WL$$

$$M_H = 0.74\text{kN/m} \times 1.5 \times \frac{1.3\text{m}}{2} \times 1.141\text{m} = 0.823\text{kNm}$$

Maximum Stress:

$$\sigma_{max} = \frac{M}{Z}$$

$$\sigma_{max} = \frac{0.823\times10^6}{10885} = 75.63\frac{N}{mm^2} < 160\frac{N}{mm^2}$$ **Okay**

Maximum Deflection:

$$\alpha = \frac{wL^3}{3EI}$$

$$\alpha = \frac{0.74\times\frac{1300}{2}\times1141^3}{3\times70000\times272131} = 12.51\text{mm} < 25\text{mm}$$ **Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 13
Date: 04/04/2024	**By:** CC

Calculation for External Use:

Mid Post Check without Handrail:

Post Checked for 0.74kN/m Balustrade load:

The post has the following particulars:

$f_y = 160\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70000\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2.5 EN 1999-1-1:2007)

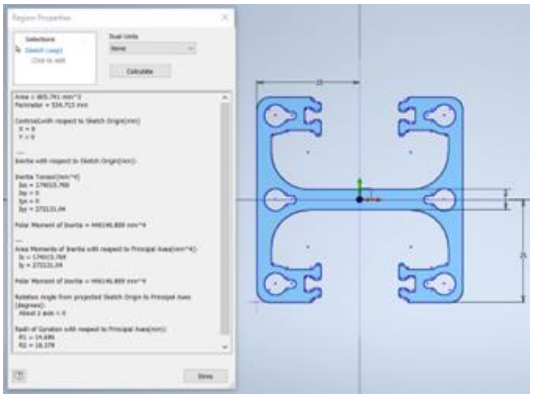
$I = 272131mm^4$ (50×50mm Pikasso Post)

$Z = 10885mm^3$ (50×50mm Pikasso Post)

$\gamma_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 1300mm

Height of Balustrade = 1115mm



Maximum Moment:

$\mathrm{M_H} = \mathrm{WL}$

$\mathrm{M_H} = 0.74\mathrm{kN/m} \times 1.5 \times 1.3\mathrm{m} \times 1.115\mathrm{m} = 1.609\mathrm{kNm}$

Maximum Stress:

$\sigma_{max} = \frac{M}{Z}$

$\sigma_{max} = \frac{1.609\times10^6}{10885} = 147.81\frac{N}{mm^2} < 160\frac{N}{mm^2}$ **Okay**

Maximum Deflection:

$\alpha = \frac{wL^3}{3EI}$

$\alpha = \frac{0.74\times1300\times1115^3}{3\times70000\times272131} = 23.35\mathrm{mm} < 25\mathrm{mm}$ **Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 14
Date: 04/04/2024	**By:** CC

Post Checked for 1.62kN/m2 Wind load:

The post has the following particulars:

$f_y = 160MPa$ (Grade 6063-T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70{,}000\ MPa$ (Grade 6063-T6 Aluminium, 3.2.5 EN 1999-1-1:2007)

$I = 272131mm^4$ (50×50mm Pikasso Post)

$Z = 10885mm^3$ (50×50mm Pikasso Post)

$\gamma_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 1300mm

Height of Balustrade = 1115mm

Converting Wind Load to line load $= 1.62\text{kN/m}^2 \times 1.3\text{m} = 2.106\text{kN/m (SLS)}$

Maximum Moment:

$$\mathrm{M_H} = \frac{\mathrm{WL^2}}{2}$$

$$\mathrm{M_H} = \frac{2.106\text{kN/m} \times 1.5 \times 1.0\text{x}1.115\text{m}}{2} = 1.761\text{kNm}$$

Maximum Stress:

$$\sigma_{max} = \frac{\mathrm{M}}{\mathrm{Z}}$$

$$\sigma_{max} = \frac{1.761 \times 10^6}{10885} = 161.8\frac{\mathrm{N}}{\mathrm{mm^2}} > 160\frac{\mathrm{N}}{\mathrm{mm^2}}$$ **Deemed Okay**

Maximum Deflection:

$$\alpha = \frac{\mathrm{WL^4}}{8EI}$$

$$\mathrm{W} = 1.62\text{kN/m}^2 \times 1.3\text{m} = 2.106\text{kN/m}$$

$$\alpha = \frac{2.106 \times 1115^4}{8 \times 70000 \times 272131} = 21.37\text{mm} < 25\text{mm}$$ **Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 15
Date: 04/04/2024	**By:** CC

Corner Post Check without Handrail:

Post Checked for 0.74kN/m Balustrade load:

The post has the following particulars:

$f_y = 160\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70000\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2.5 EN 1999-1-1:2007)

$\mathrm{I_{xx}} = 228360mm^4$ (50×50mm Pikasso Post)

$\mathrm{I_{yy}} = 228360mm^4$ (50×50mm Pikasso Post)

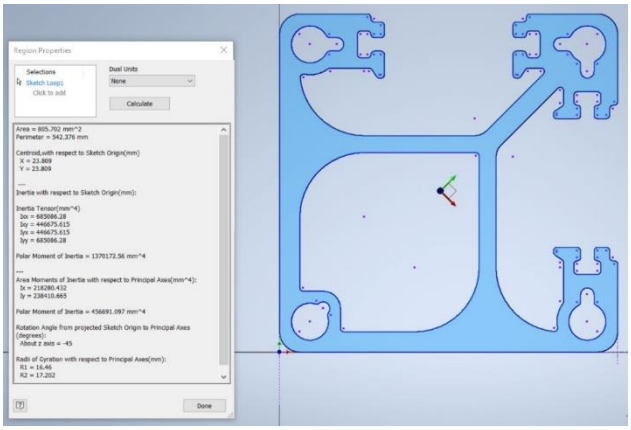
$\mathrm{Z_{xx}} = 8719mm^4$ (50×50mm Pikasso Post)

$\mathrm{Z_{yy}} = 8719mm^4$ (50×50mm Pikasso Post)

$\Upsilon_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 650mm

Height of Balustrade = 1115mm



Maximum Moment: $\mathrm{M_H} = \mathrm{WL}$

$\mathrm{M_H} = 0.74\mathrm{kN/m} \times 1.5 \times \frac{0.65\mathrm{m}}{2} \times 1.115\mathrm{m} = 0.403\mathrm{kNm}$

Maximum Stress:

$\sigma_{max} = \frac{\mathrm{M}}{\mathrm{Z}}\mathrm{dirn1} + \frac{\mathrm{M}}{\mathrm{Z}}\mathrm{dirn2}$

$\sigma_{max} = \frac{0.403\times10^6}{8719} + \frac{0.403\times10^6}{8719} = 92.27\frac{\mathrm{N}}{\mathrm{mm^2}} < 160\frac{\mathrm{N}}{\mathrm{mm^2}}$ **Okay**

Maximum Deflection:

$\alpha_1 = \frac{\mathrm{wL^3}}{3\mathrm{EI}} dirn\ 1 :\ \alpha_2 \frac{\mathrm{wL^3}}{3\mathrm{EI}} dirn\ 2$

$\alpha_1 = \frac{0.74 \times \frac{650}{2} \times 1115^3}{3 \times 70000 \times 228360} = 6.95mm : \alpha_2 = \frac{0.74 \times \frac{650}{2} \times 1115^3}{3 \times 70000 \times 228360} = 6.95\mathrm{mm}$

$\mathrm{SQRT}(6.95^2 + 6.95^2) = 9.83\mathrm{mm} < 25\mathrm{mm}$ **Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 16
Date: 04/04/2024	**By:** CC

Post Checked for 1.62kN/m2 Wind load:

The post has the following particulars:

$f_y = 160MPa$ (Grade 6063-T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70{,}000\ MPa$ (Grade 6063-T6 Aluminium, 3.2.5 EN 1999-1-1:2007)

$\mathrm{I_{xx}} = 228360mm^4$ (50×50mm Pikasso Post)

$\mathrm{I_{yy}} = 228360mm^4$ (50×50mm Pikasso Post)

$\mathrm{Z_{xx}} = 8719mm^4$ (50×50mm Pikasso Post)

$\mathrm{Z_{yy}} = 8719mm^4$ (50×50mm Pikasso Post)

$\gamma_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 650mm

Height of Balustrade = 1115mm

$$\text{Converting Wind Load to line load} \quad = 1.62\mathrm{kN/m^2} \times \frac{0.65\mathrm{m}}{2} = 0.527\mathrm{kN/m\ (SLS)}$$

Maximum Moment:

$$\mathrm{M_H} = \frac{\mathrm{WL^2}}{2}$$

$$\mathrm{M_H} = \frac{0.527\mathrm{kN/m} \times 1.5 \times 1.115^2\mathrm{m}}{2} = 0.492\mathrm{kNm}$$

Maximum Stress:

$$\sigma_{max} = \frac{\mathrm{M}}{\mathrm{Z}}$$

$$\sigma_{max} = \frac{0.492\times10^6}{8719} + \frac{0.492\times10^6}{8719} = 112.72\frac{\mathrm{N}}{\mathrm{mm^2}} < 160\frac{\mathrm{N}}{\mathrm{mm^2}}$$ **Okay**

Maximum Deflection:

$$\mathrm{W} = 1.62\mathrm{kN/m^2} \times \frac{0.65\mathrm{m}}{2} = 0.527\mathrm{kN/m}$$

$$\alpha_1 = \frac{527 \times 1115^3}{3 \times 70000 \times 228360} = 15.24mm: \quad \alpha_2 = \frac{527 \times 1115^3}{3 \times 70000 \times 228360} = 15.24\mathrm{mm}$$

$$\mathrm{SQRT}(15.24^2 + 15.24^2) = 21.55\mathrm{mm} < 25\mathrm{mm}$$ **Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 17
Date: 04/04/2024	**By:** CC

End Post Check without Handrail:

Post Checked for 0.74kN/m Balustrade load:

The post has the following particulars:

$f_y = 160\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70000\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2.5 EN 1999-1-1:2007)

$I = 272131mm^4$ (50×50mm Pikasso Post)

$Z = 10885mm^3$ (50×50mm Pikasso Post)

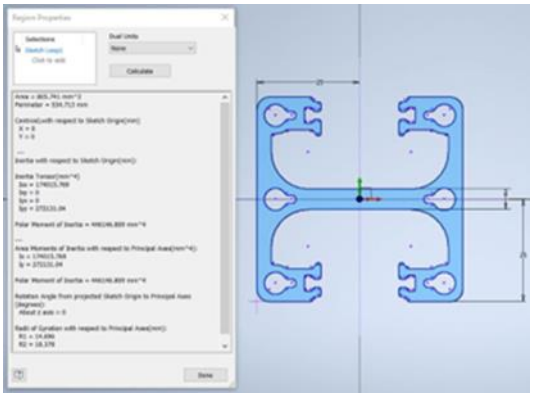
$\gamma_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 1300mm

Height of Balustrade = 1115mm

$$M_H = WL$$

$$M_H = 0.74\text{kN/m} \times 1.5 \times \frac{1.3\text{m}}{2} \times 1.115\text{m} = 0.805\text{kNm}$$



Maximum Stress:

$$\sigma_{max} = \frac{M}{Z}$$

$$\sigma_{max} = \frac{0.805\times10^6}{10885} = 73.91\frac{N}{mm^2} < 160\frac{N}{mm^2}$$

Okay

Maximum Deflection:

$$\alpha = \frac{wL^3}{3EI}$$

$$\alpha = \frac{0.74\times\frac{1300}{2}\times1115^3}{3\times70000\times272131} = 10.76\text{mm} < 25\text{mm}$$ **Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 18
Date: 04/04/2024	**By:** CC

Post Checked for 1.62kN/m2 Wind load:

The post has the following particulars:

$f_y = 160MPa$ (Grade 6063-T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70{,}000\ MPa$ (Grade 6063-T6 Aluminium, 3.2.5 EN 1999-1-1:2007)

$I = 272131mm^4$ (50×50mm Pikasso Post)

$Z = 10885mm^3$ (50x50mm Pikasso Post)

$\gamma_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 1300mm

Height of Balustrade = 1115mm

$$\text{Converting Wind Load to line load} \quad = 1.62\text{kN/m}^2 \times \frac{1.3}{2}\text{m} = 1.053\text{kN/m (SLS)}$$

Maximum Moment:

$$\text{M}_\text{H} = \frac{\text{WL}^2}{2}$$

$$\text{M}_\text{H} = \frac{1.053\text{kN/m} \times 1.5 \times 1.115^2\text{m}}{2} = 0.982\text{kNm}$$

Maximum Stress:

$$\sigma_{\max} = \frac{\text{M}}{\text{Z}}$$

$$\sigma_{\max} = \frac{0.982 \times 10^6}{10885} = 90.2\frac{\text{N}}{\text{mm}^2} < 160\frac{\text{N}}{\text{mm}^2}$$ **Okay**

Maximum Deflection:

$$\alpha \quad = \frac{\text{WL}^4}{8EI}$$

$$\text{W} = 1.62\text{kN/m}^2 \times \frac{1.3}{2}\text{m} = 1.053\text{kN/m}$$

$$\alpha \quad = \frac{1.053 \times 1115^4}{8 \times 70000 \times 272131} = 10.68\text{mm} < 25\text{mm}$$ **Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 19
Date: 04/04/2024	**By:** CC

Mid Post Check with Handrail:

Post Checked for 0.74kN/m Balustrade load:

The post has the following particulars:

$f_y = 160\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70000\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2.5 EN 1999-1-1:2007)

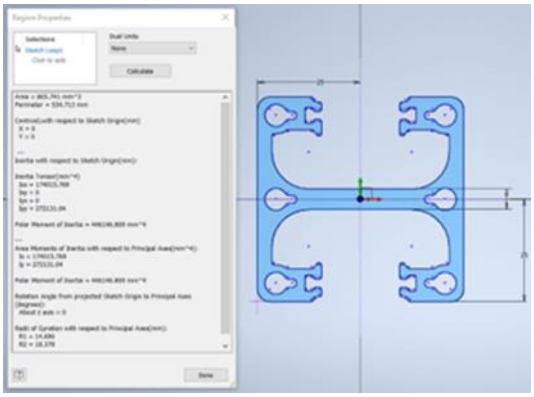
$I = 272131mm^4$ (50×50mm Pikasso Post)

$Z = 10885mm^3$ (50×50mm Pikasso Post)

$\gamma_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 1300mm

Height of Balustrade = 1141mm



Maximum Moment:

$\mathrm{M_H = WL}$

$\mathrm{M_H = 0.74kN/m \times 1.5 \times 1.3m \times 1.141m = 1.647kNm}$

Maximum Stress:

$$\sigma_{max} = \frac{M}{Z}$$

$$\sigma_{max} = \frac{1.647\times10^6}{10885} = 151.3\frac{N}{mm^2} < 160\frac{N}{mm^2}$$ **Okay**

Maximum Deflection:

$$\alpha = \frac{wL^3}{3EI}$$

$$\alpha = \frac{0.74\times1300\times1141^3}{3\times70000\times272131} = 25.01mm < 25mm$$ **Deemed Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 20
Date: 04/04/2024	**By:** CC

Post Checked for 1.62kN/m2 Wind load:

The post has the following particulars:

$f_y = 160MPa$ (Grade 6063-T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70{,}000\ MPa$ (Grade 6063-T6 Aluminium, 3.2.5 EN 1999-1-1:2007)

$I = 272131mm^4$ (50×50mm Pikasso Post)

$Z = 10885mm^3$ (50×50mm Pikasso Post)

$\gamma_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 1300mm

Height of Balustrade = 1141mm

Converting Wind Load to line load $= 1.62\text{kN/m}^2 \times 1.3\text{m} = 2.106\text{kN/m (SLS)}$

Maximum Moment:

$$\mathrm{M_H} = \frac{\mathrm{WL^2}}{2}$$

$$\mathrm{M_H} = \frac{\frac{2.106\text{kN}}{\text{m}} \times 1.5 \times 1.0x1.141\text{m}}{2} = 1.803\text{kNm}$$

Maximum Stress:

$$\sigma_{\max} = \frac{\mathrm{M}}{\mathrm{Z}}$$

$$\sigma_{\max} = \frac{1.803\times10^6}{10885} = 165.6\frac{\mathrm{N}}{\mathrm{mm^2}} < 160\frac{\mathrm{N}}{\mathrm{mm^2}}$$ **Deemed Okay**

Maximum Deflection:

$$\alpha = \frac{\mathrm{WL^4}}{8EI}$$

$$\mathrm{W} = 1.62\text{kN/m}^2 \times 1.3\text{m} = 2.106\text{kN/m}$$

$$\alpha = \frac{2.106\times1141^4}{8\times70000\times272131} = 23.43\text{mm} < 25\text{mm}$$ **Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 21
Date: 04/04/2024	**By:** CC

Corner Post Check with Handrail:

Post Checked for 0.74kN/m Balustrade load:

The post has the following particulars:

$f_y = 160\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70000\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2.5 EN 1999-1-1:2007)

$\mathrm{I_{xx}} = 228360mm^4$ (50×50mm Pikasso Post)

$\mathrm{I_{yy}} = 228360mm^4$ (50×50mm Pikasso Post)

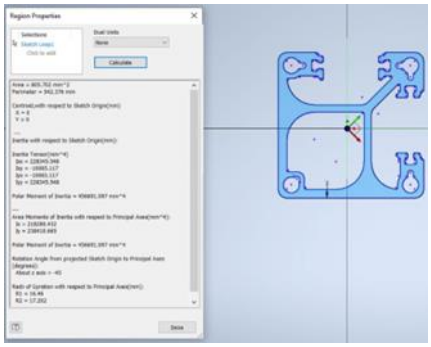
$\mathrm{Z_{xx}} = 8719mm^4$ (50×50mm Pikasso Post)

$\mathrm{Z_{yy}} = 8719mm^4$ (50×50mm Pikasso Post)

$\Upsilon_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 650mm

Height of Balustrade = 1141mm



Maximum Moment:

$\mathrm{M_H} = \mathrm{WL}$

$\mathrm{M_H} = 0.74\mathrm{kN/m} \times 1.5 \times \frac{0.65\mathrm{m}}{2} \times 1.141\mathrm{m} = 0.412\mathrm{kNm}$

Maximum Stress:

$\sigma_{max} = \frac{\mathrm{M}}{\mathrm{Z}}\mathrm{dirn1} + \frac{\mathrm{M}}{\mathrm{Z}}\mathrm{dirn2}$

$\sigma_{max} = \frac{0.412\times10^6}{8719} + \frac{0.412\times10^6}{8719} = 94.42\frac{\mathrm{N}}{\mathrm{mm^2}} < 160\frac{\mathrm{N}}{\mathrm{mm^2}}$ **Okay**

Maximum Deflection:

$\alpha_1 = \frac{\mathrm{wL^3}}{3\mathrm{EI}}dirn\ 1 :\ \alpha_2\frac{\mathrm{wL^3}}{3\mathrm{EI}}dirn\ 2$

$\alpha_1 = \frac{0.74 \times \frac{650}{2} \times 1141^3}{3 \times 70000 \times 228360} = 7.45mm$: $\alpha_2 = \frac{0.74 \times \frac{650}{2} \times 1141^3}{3 \times 70000 \times 228360} = 7.45\mathrm{mm}$

$\mathrm{SQRT}\ (7.45^2 + 7.45^2) = 10.54\mathrm{mm} < 25\mathrm{mm}$ **Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 22
Date: 04/04/2024	**By:** CC

Post Checked for 1.62kN/m2 Wind load:

The post has the following particulars:

$f_y = 160MPa$ (Grade 6063-T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70{,}000\ MPa$ (Grade 6063-T6 Aluminium, 3.2.5 EN 1999-1-1:2007)

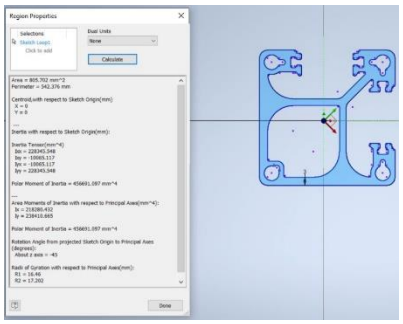
$I = 228360mm^4$ (50×50mm Pikasso Post)

$Z = 8719mm^3$ (50×50mm Pikasso Post)

$\gamma_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 650mm

Height of Balustrade = 1141mm



Converting Wind Load to line load

$$= 1.62\text{kN/m}^2 \times \frac{0.65\text{m}}{2}$$
$$= 0.527\text{kN/m (SLS)}$$

Maximum Moment:

$$\text{M}_\text{H} = \frac{\text{WL}^2}{2}$$

$$\text{M}_\text{H} = \frac{0.527\text{kN/m} \times 1.5 \times 1.141^2\text{m}}{2} = 0.514\text{kNm per side}$$

Maximum Stress:

$$\sigma_{max} = \frac{\text{M}}{\text{Z}}$$

$$\sigma_{max} = \frac{0.514\times10^6}{8719} + \frac{0.514\times10^6}{8719} = 117.9 < 160\,\frac{\text{N}}{\text{mm}^2}$$ **Okay**

Maximum Deflection:

$$\alpha = \frac{\text{WL}^4}{8EI}$$

$$\text{W} = 1.62\text{kN/m}^2 \times \frac{0.65\text{m}}{2} = 0.527\text{kN/m}$$

$$\alpha_1 = \frac{527 \times 1141^3}{3 \times 70000 \times 228360} = 16.32mm : \alpha_2 = \frac{527 \times 1141^3}{3 \times 70000 \times 228360} = 16.32\text{mm}$$

$$\text{SQRT}\,(16.32^2 + 16.32^2) = 23.09\text{mm} > 25\text{mm}$$ **Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 23
Date: 04/04/2024	**By:** CC

End Post Check with Handrail:

Post Checked for 0.74kN/m Balustrade load:

The post has the following particulars:

$f_y = 160\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70000\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2.5 EN 1999-1-1:2007)

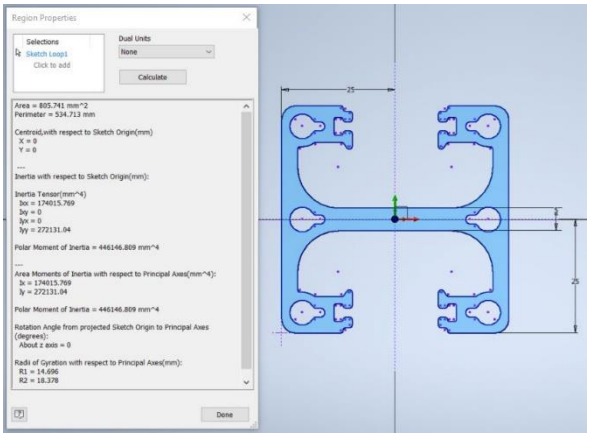
$I = 272131mm^4$ (50×50mm Pikasso Post)

$Z = 10885mm^3$ (50×50mm Pikasso Post)

$\gamma_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 1300mm

Height of Balustrade = 1141mm



Maximum Moment:

$$M_H = WL$$

$$M_H = 0.74\text{kN/m} \times 1.5 \times \frac{1.3\text{m}}{2} \times 1.141\text{m} = 0.823\text{kNm}$$

Maximum Stress:

$$\sigma_{max} = \frac{M}{Z}$$

$$\sigma_{max} = \frac{0.823\times10^6}{10885} = 75.63\frac{N}{mm^2} < 160\frac{N}{mm^2}$$ **Okay**

Maximum Deflection:

$$\alpha = \frac{wL^3}{3EI}$$

$$\alpha = \frac{0.74\times\frac{1300}{2}\times1141^3}{3\times70000\times272131} = 12.50\text{mm} < 25\text{mm}$$ **Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 24
Date: 04/04/2024	**By:** CC

Post Checked for 1.62kN/m2 Wind load:

The post has the following particulars:

$f_y = 160MPa$ (Grade 6063-T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70{,}000\ MPa$ (Grade 6063-T6 Aluminium, 3.2.5 EN 1999-1-1:2007)

$I = 272131mm^4$ (50×50mm Pikasso Post)

$Z = 10885mm^3$ (50×50mm Pikasso Post)

$\gamma_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 1300mm

Height of Balustrade = 1141mm

$$\text{Converting Wind Load to line load} \quad = 1.62\text{kN/m}^2 \times \frac{1.3}{2}\text{m} = 1.053\text{kN/m (SLS)}$$

Maximum Moment:

$$\text{M}_\text{H} = \frac{\text{WL}^2}{2}$$

$$\text{M}_\text{H} = \frac{1.053\text{kN/m} \times 1.5 \times 1.141^2\text{m}}{2} = 1.028\text{kNm}$$

Maximum Stress:

$$\sigma_{max} = \frac{\text{M}}{\text{Z}}$$

$$\sigma_{max} = \frac{1.028\times10^6}{10885} = 94.46\frac{\text{N}}{\text{mm}^2} < 160\frac{\text{N}}{\text{mm}^2}$$ **Okay**

Maximum Deflection:

$$\alpha \quad = \frac{\text{WL}^4}{8EI}$$

$$\text{W} = 1.62\text{kN/m}^2 \times \frac{1.3}{2}\text{m} = 1.053\text{kN/m}$$

$$\alpha \quad = \frac{1.053\times1141^4}{8\times70000\times272131} = 11.71\text{mm} < 25.0\text{mm}$$ **Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 25
Date: 04/04/2024	**By:** CC

Handrail Check:

Handrail Checked for Balustrade loading of 0.74kN/m:

The handrail has the following particulars:

$f_y = 160MPa$ (Grade 6063 T6 Aluminium, Table 3.2b EN 1999-1-1:2007)

$E = 70000\ MPa$ (Grade 6063 T6 Aluminium, Table 3.2.5 EN 1999-1-1:2007)

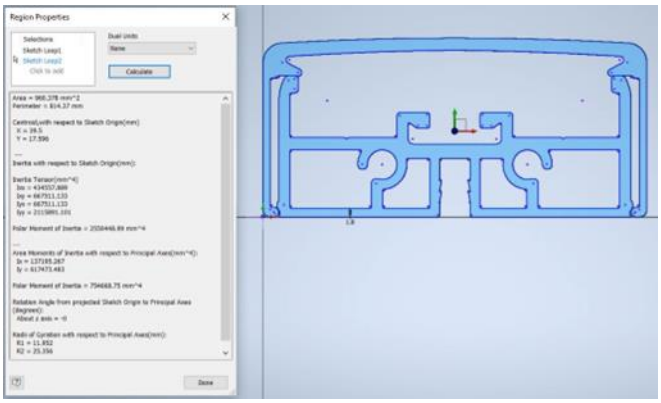
$I = 617474mm^4$ (Handrail Profile)

$Z = 5781mm^3$ (Handrail Profile)

$\gamma_Q = 1.5$ (Table 6.10 EN 1991-1-1:2002)

Span Between posts = 1300mm

Maximum Moment:



$$M_H = \frac{w \times l^2}{8}$$

$$M_H = \frac{0.74 \times 1.5 \times 1.3^2}{8} = 0.235\text{kNm}$$

Maximum Stress:

$$\sigma_{max} = \frac{M}{Z}$$

$$\sigma_{max} = \frac{0.235 \times 10^6}{5781} = 40.56 \frac{N}{mm^2} < 160 \frac{N}{mm^2}$$ **Okay**

Maximum Deflection:

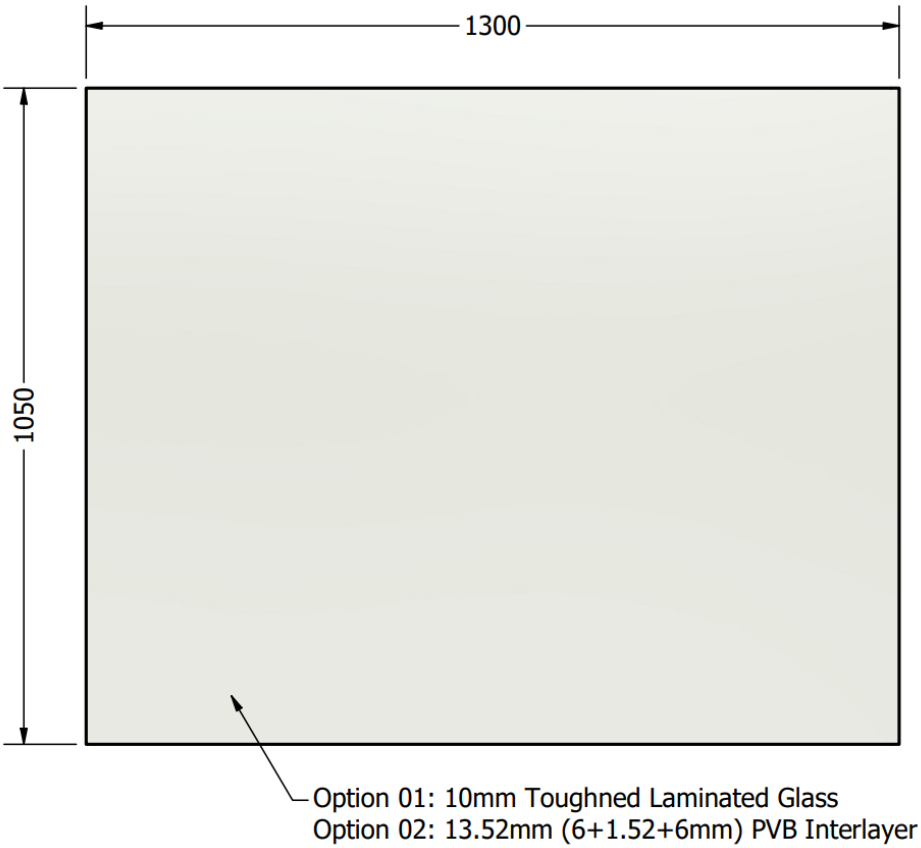
$$\alpha_H = \frac{5wl^4}{384EI}$$

$$\alpha_H = \frac{5 \times 0.74 \times 1300^4}{384 \times 70000 \times 617474} = 0.637\text{mm} < 6.5\text{mm} \rightarrow \left(\frac{1300}{200}\right)$$ **Okay**

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 26
Date: 04/04/2024	**By:** CC

Case Study 01:

System Sketch:



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 27
Date: 04/04/2024	**By:** CC

Glass Analysis – 10mm thickness – Toughened Glass:

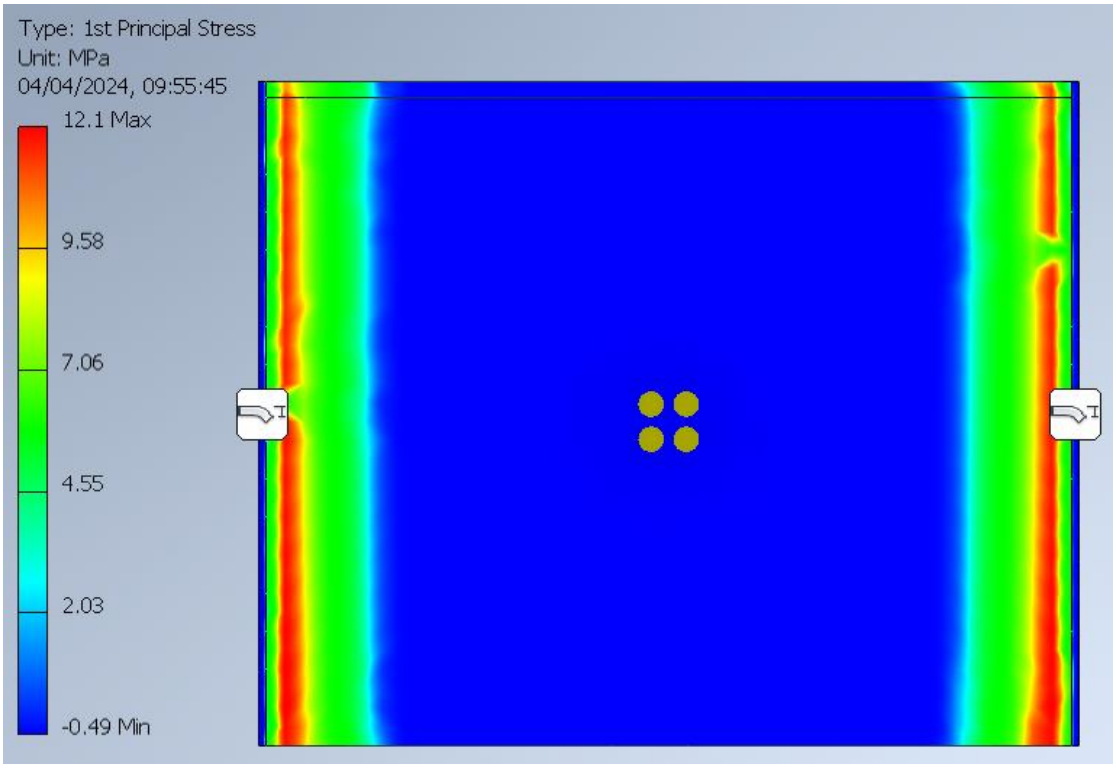
Glass Analysis - Bending Stress of Glass Panel due to 1.62kN/m2 Wind Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.62N/m2 Wind Loading
- 10mm Toughened Glass
- Bending Stress analysed based on glass panel of 1300 (l) x 1050 (h) mm

Result:

Max. Bending Stress = 12.1N/mm^2 X 1.5 = 18.15N/mm^2 < 83.3N/mm^2

OK in Bending



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 28
Date: 04/04/2024	**By:** CC

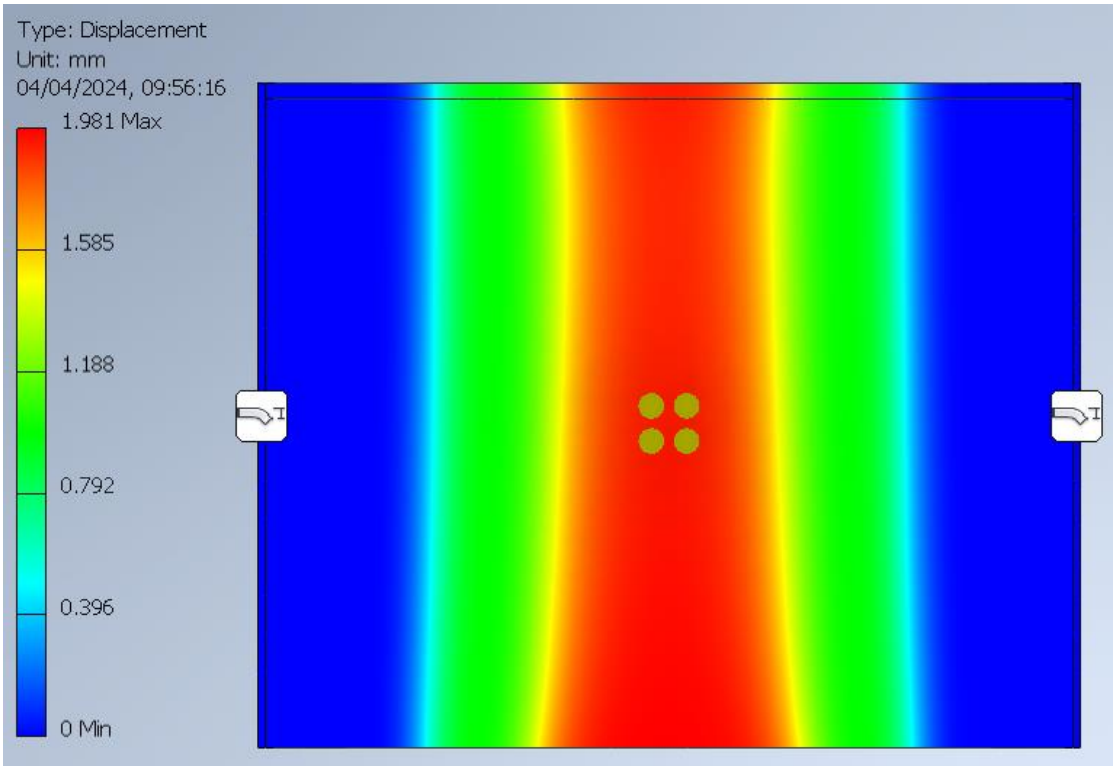
Glass Analysis - Deflection of Glass Panel due to 1.62kN/m2 Wind Loading:

- Analysis Software was used to determine maximum deflection of the glass due to 1.62N/m2 Wind Loading
- 10mm Toughened Glass
- Deflection analysed based on glass panel of 1300 (l) x 1050 (h) mm

Result:

Max. Deflection = 1.981mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 29
Date: 04/04/2024	**By:** CC

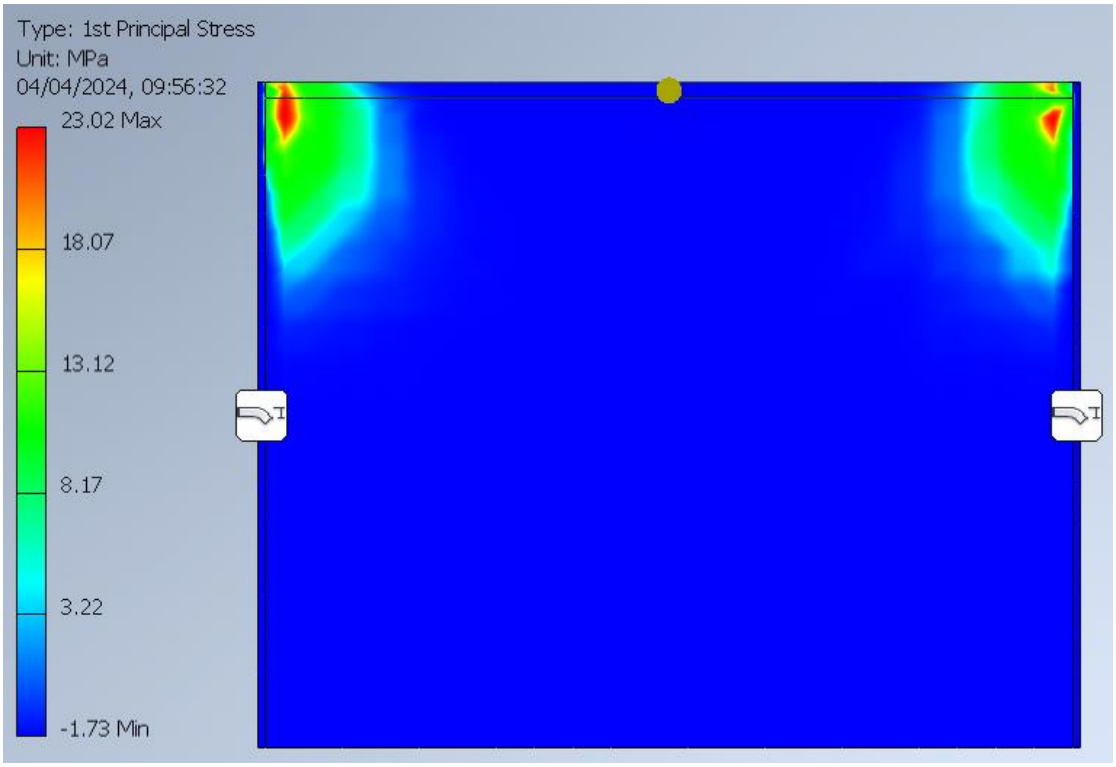
Glass Analysis - Bending Stress of Glass Panel due to 0.74kN/m Balustrade Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.74kN/m Balustrade Loading
- Actual Balustrade Load applied to the glass is 0.962 kN (0.74kN/mx1.3m)
- 10mm Toughened Glass
- Bending Stress analysed based on glass panel of 1300 (l) x 1050 (h) mm

Result:

Max. Bending Stress = 23.02N/mm^2 X 1.5 = 34.53N/mm^2 < 84.2N/mm^2

OK in Bending



TSA
TED SINGLETON & ASSOCIATES
CONSULTING ENGINEERS

Project: On Level Ltd	Contract: 1949-1
Subject: Pikasso Post & Handrail Design	Sheet No. 30
Date: 04/04/2024	By: CC

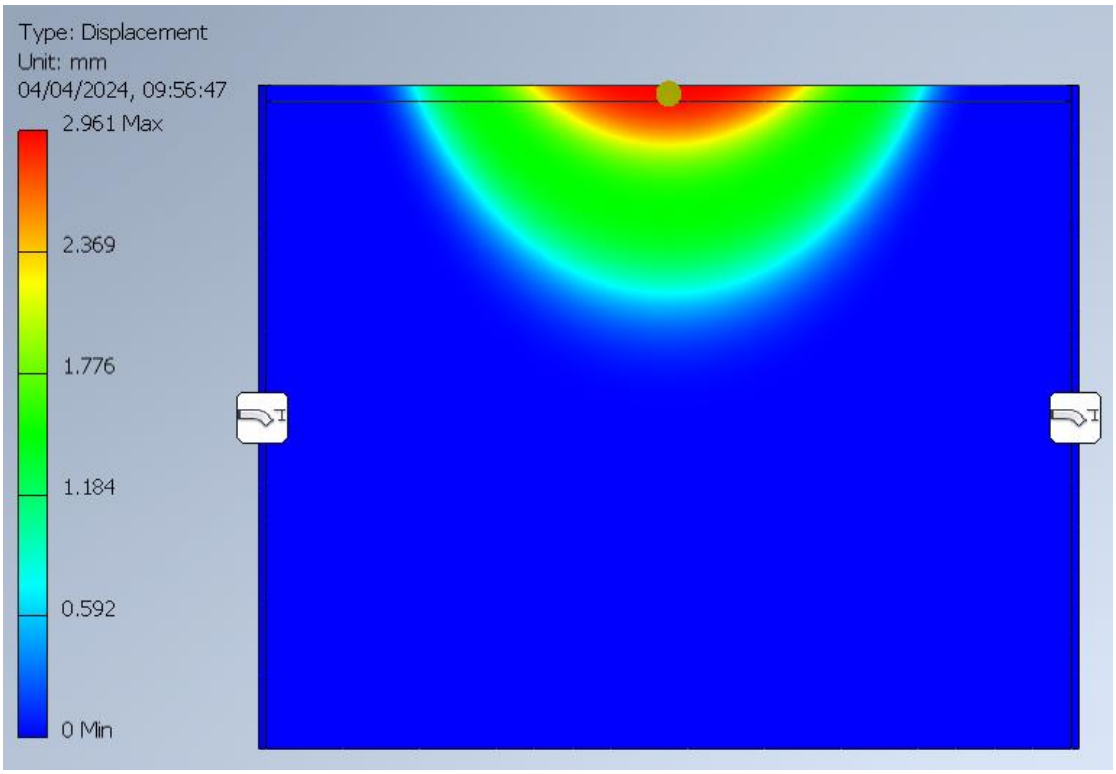
Glass Analysis - Deflection of Glass Panel due to 0.74kN/m Balustrade Loading:

- Analysis Software was used to determine maximum deflection of the glass due to 0.74kN/m Balustrade Loading
- Actual Balustrade Load applied to the glass is 0.962 kN (0.74kN/mx1.3m)
- 10mm Toughened Glass
- Deflection analysed based on glass panel of 1300 (l) x 1050 (h) mm

Result:

Max. Deflection = 2.961mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 31
Date: 04/04/2024	**By:** CC

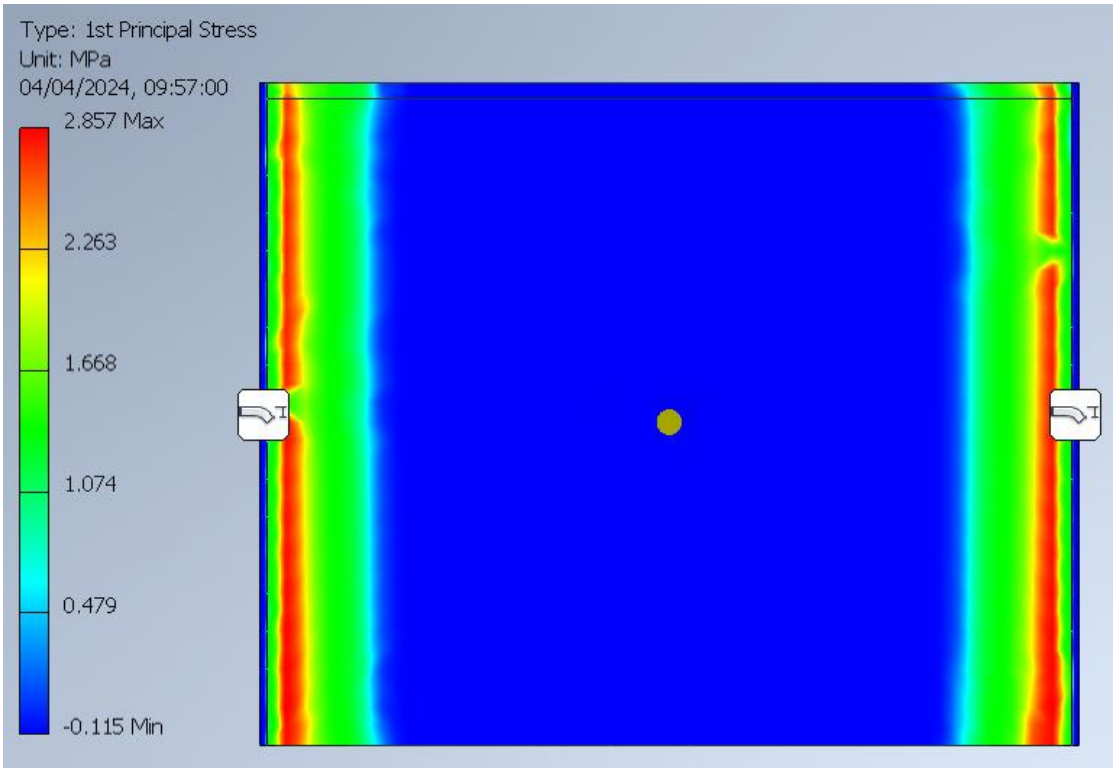
Glass Analysis - Bending Stress of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.5kN Point Load
- 10mm Toughened Glass
- Bending Stress analysed based on glass panel of 1300 (l) x 1050 (h) mm

Result:

Max. Bending Stress = 2.857N/mm^2 X 1.5 = 4.29N/mm^2 < 84.2N/mm^2

OK in Bending



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 32
Date: 04/04/2024	**By:** CC

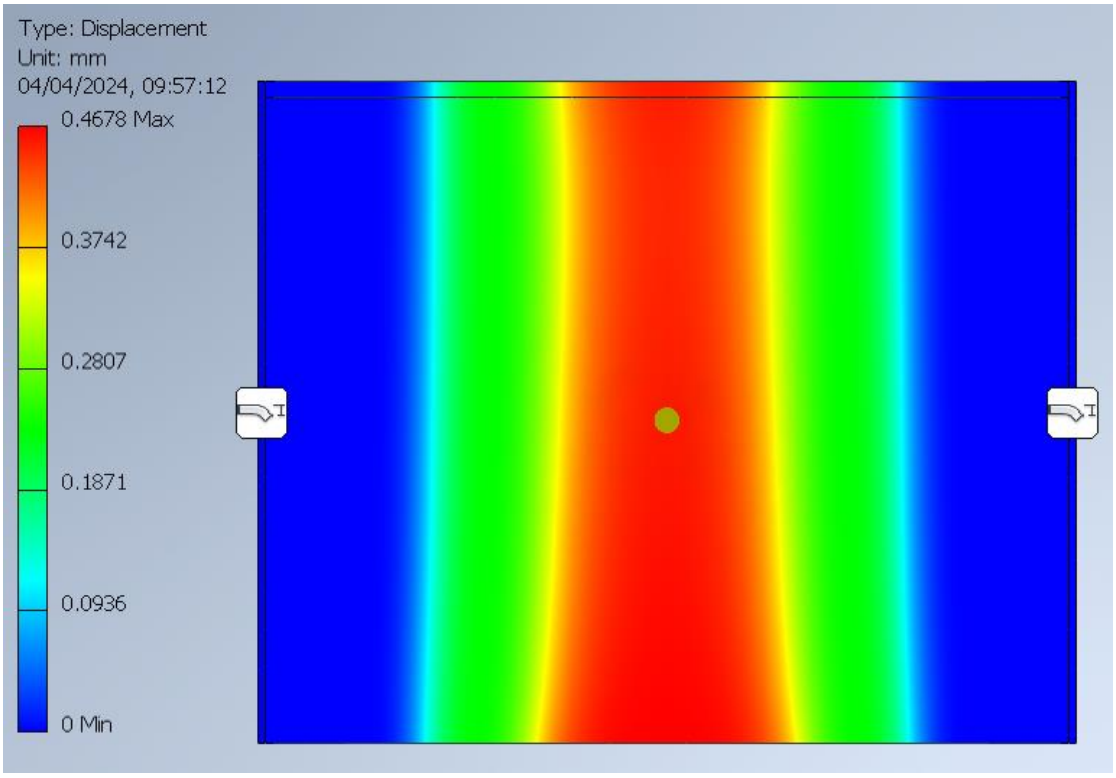
Glass Analysis - Deflection of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum deflection of the glass due to 0.5kN Point Load
  - 10mm Toughened Glass
  - Deflection analysed based on glass panel of 1300 (l) x 1050 (h) mm

Result:

Max. Deflection = 0.468mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 33
Date: 04/04/2024	**By:** CC

Glass Analysis – 13.52mm thickness – PVB Interlayer:

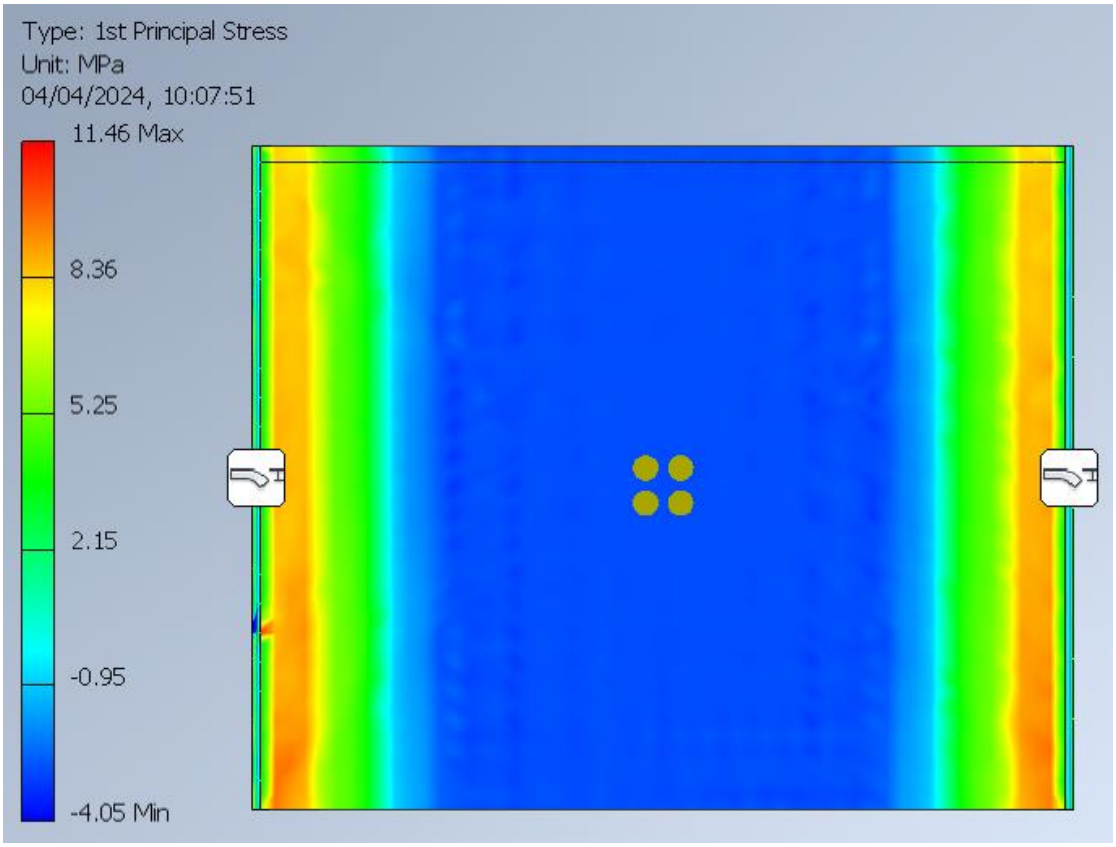
Glass Analysis - Bending Stress of Glass Panel due to 1.62kN/m2 Wind Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.62N/m2 Wind Loading
- 6/6/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 3MPa, G = 1MPa PVB
- Bending Stress analysed based on glass panel of 1300 (l) x 1050 (h) mm

Result:

Max. Bending Stress = 11.46N/mm^2 X 1.5 = 17.19N/mm^2 < 83.3N/mm^2

OK in Bending



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 34
Date: 04/04/2024	**By:** CC

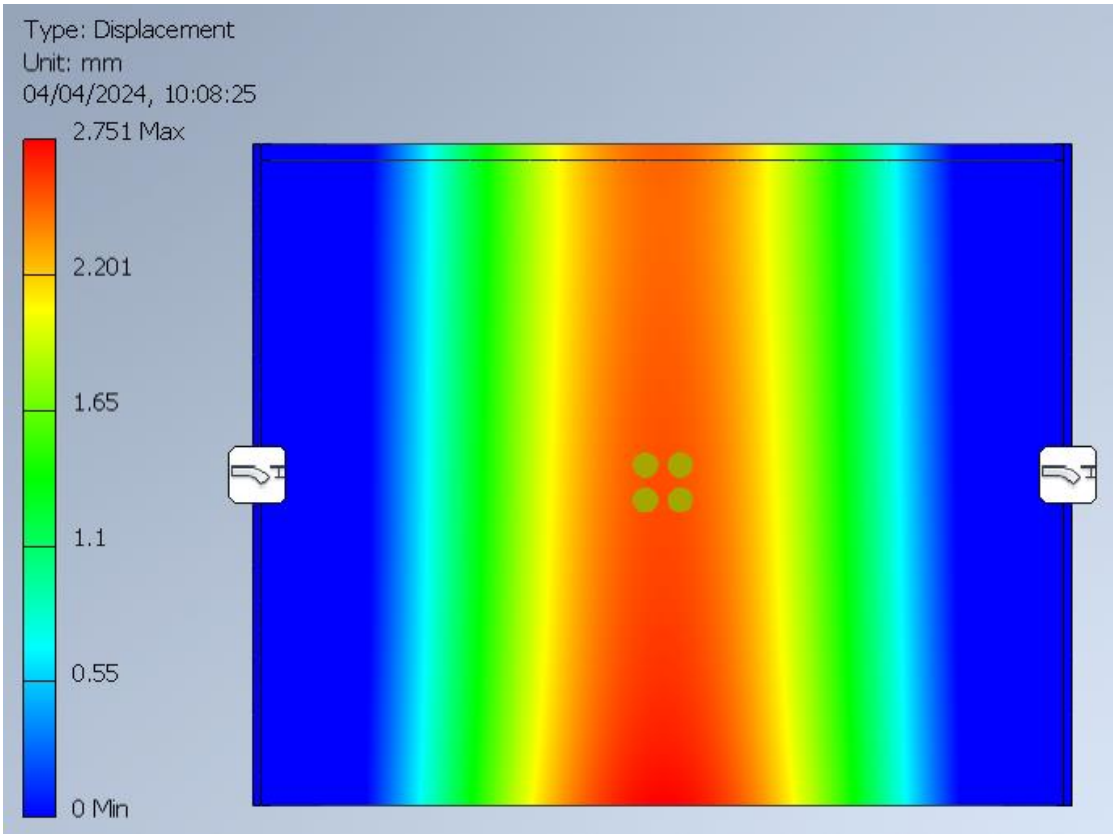
Glass Analysis - Deflection of Glass Panel due to 1.62kN/m2 Wind Loading:

- Analysis Software was used to determine maximum deflection of the glass due to 1.62N/m2 Wind Loading
- 6/6/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 3MPa, G = 1MPa PVB
- Deflection analysed based on glass panel of 1300 (l) x 1050 (h) mm

Result:

Max. Deflection = 2.751mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 35
Date: 04/04/2024	**By:** CC

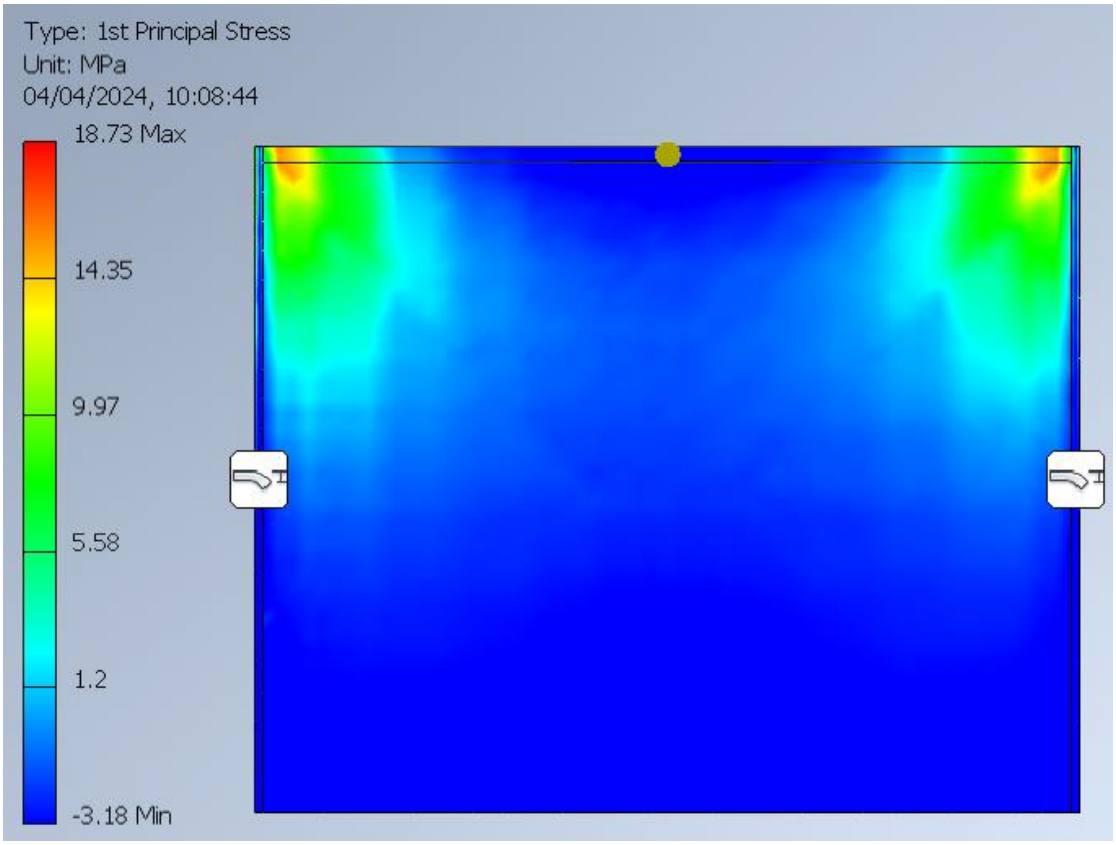
Glass Analysis - Bending Stress of Glass Panel due to 0.74kN/m Balustrade Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.74kN/m Balustrade Loading
- Actual Balustrade Load applied to the glass is 0.962 kN (0.74kN/mx1.3m)
- 6/6/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 3MPa, G = 1MPa PVB
- Bending Stress analysed based on glass panel of 1300 (l) x 1050 (h) mm

Result:

Max. Bending Stress = 18.73N/mm^2 X 1.5 = 28.10N/mm^2 < 84.2N/mm^2

OK in Bending



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 36
Date: 04/04/2024	**By:** CC

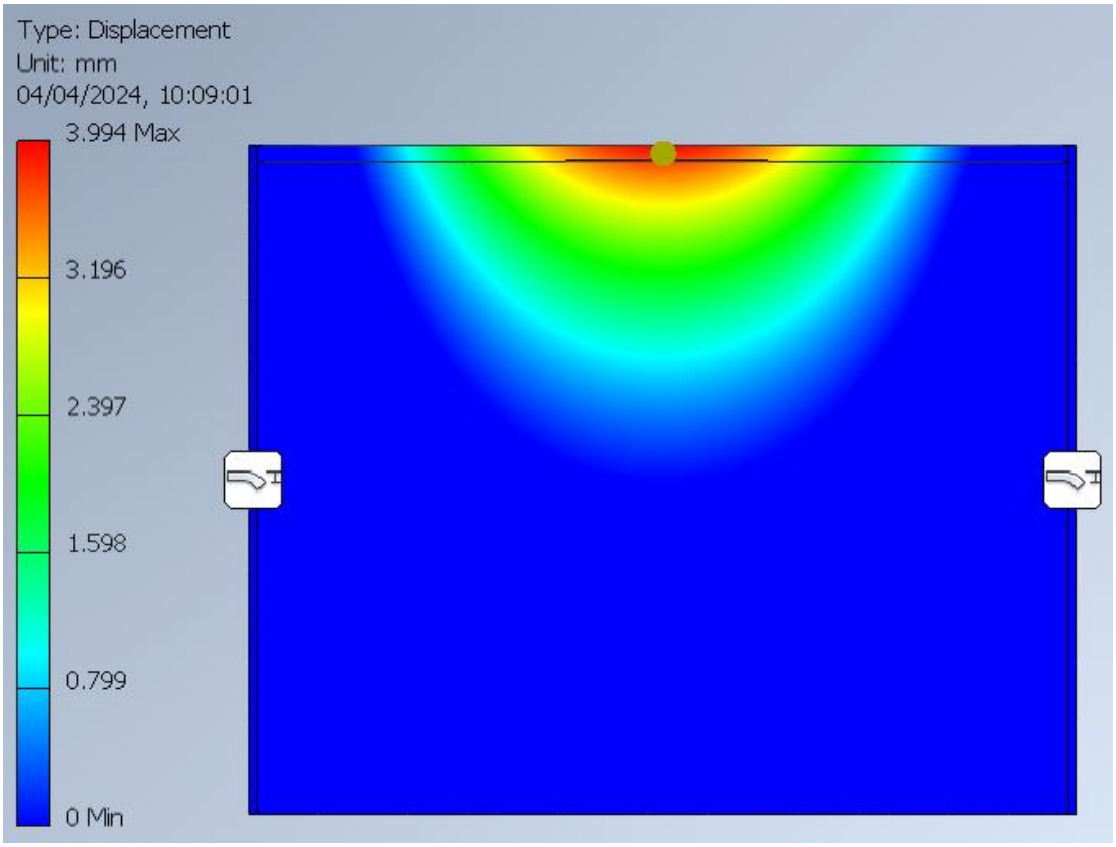
Glass Analysis - Deflection of Glass Panel due to 0.74kN/m Balustrade Loading:

- Analysis Software was used to determine maximum deflection of the glass due to 0.74kN/m Balustrade Loading
- Actual Balustrade Load applied to the glass is 0.962 kN (0.74kN/mx1.3m)
- 6/6/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 3MPa, G = 1MPa PVB
- Deflection analysed based on glass panel of 1300 (l) x 1050 (h) mm

Result:

Max. Deflection = 3.994mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 37
Date: 04/04/2024	**By:** CC

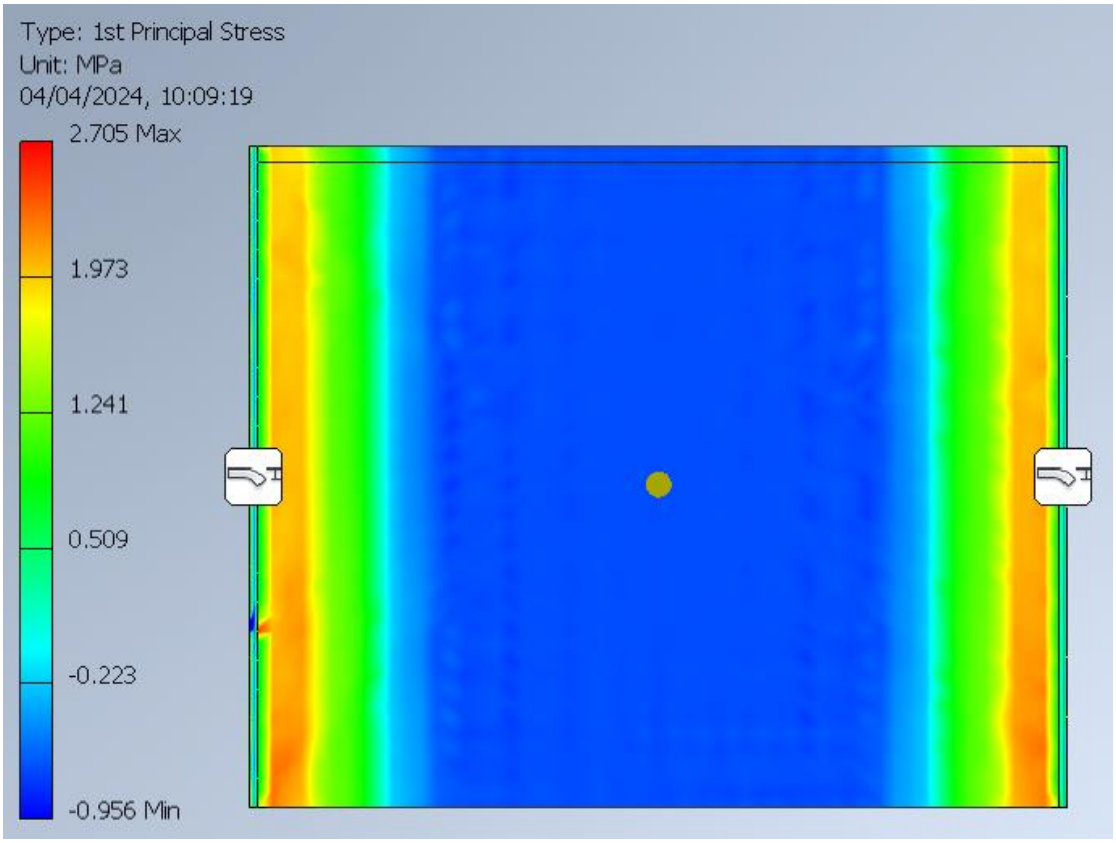
Glass Analysis - Bending Stress of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.5kN Point Load
- 6/6/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 3MPa, G = 1MPa PVB
- Bending Stress analysed based on glass panel of 1300 (l) x 1050 (h) mm

Result:

Max. Bending Stress = 2.705N/mm^2 X 1.5 = 4.06N/mm^2 < 84.2N/mm^2

OK in Bending



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 38
Date: 04/04/2024	**By:** CC

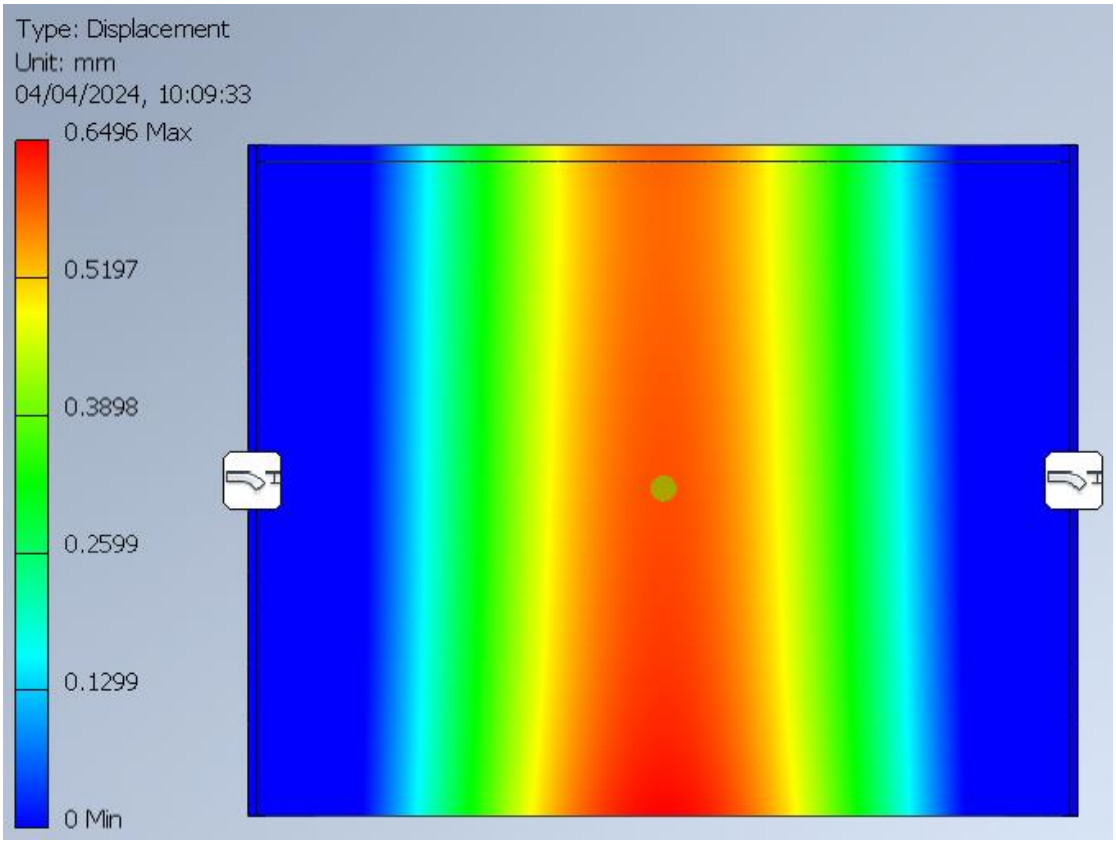
Glass Analysis - Deflection of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum deflection of the glass due to 0.5kN Point Load
  - 6/6/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
  - Interlayer Properties used for analysis, E= 3MPa, G = 1MPa PVB
  - Deflection analysed based on glass panel of 1300 (l) x 1050 (h) mm

Result:

Max. Deflection = 0.6496mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)

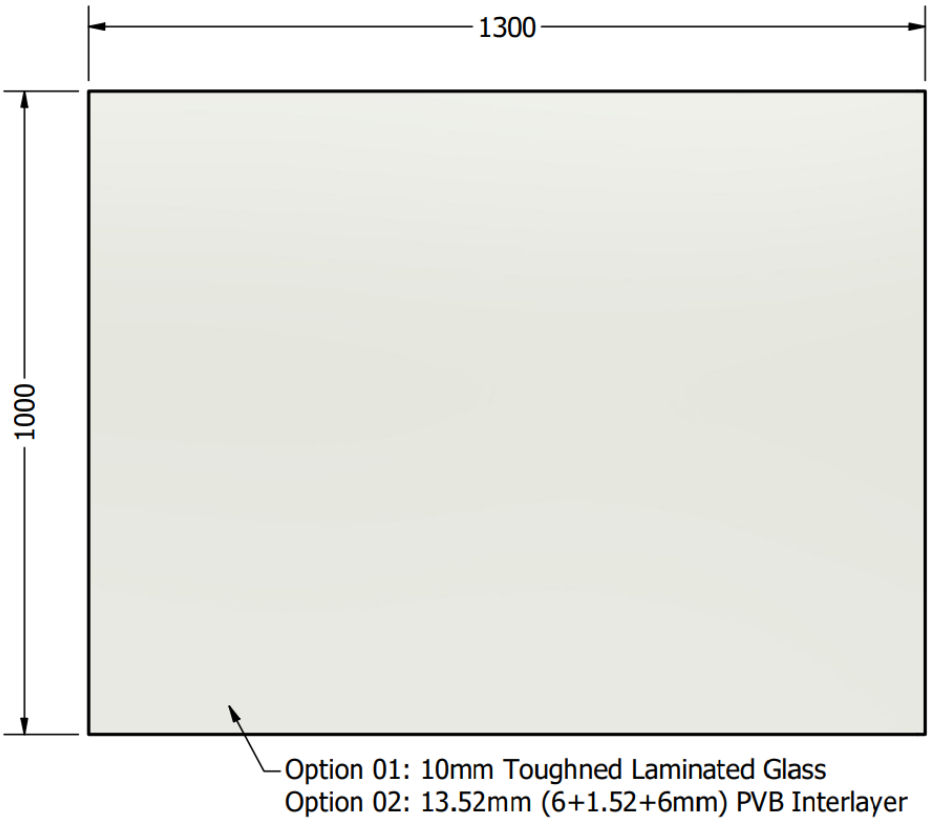


TSA
TED SINGLETON & ASSOCIATES
CONSULTING ENGINEERS

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 39
Date: 04/04/2024	**By:** CC

Case Study 02:

System Sketch:



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 40
Date: 04/04/2024	**By:** CC

Glass Analysis – 10mm thickness – Toughened Glass:

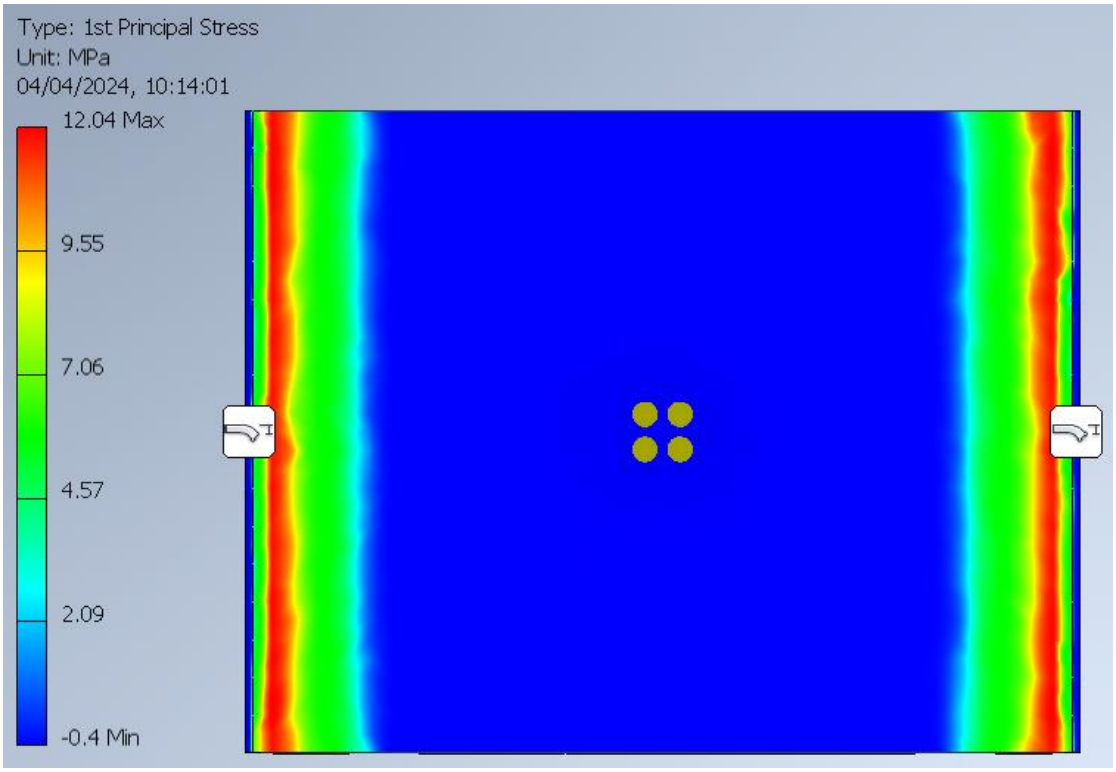
Glass Analysis - Bending Stress of Glass Panel due to 1.62kN/m2 Wind Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.62N/m2 Wind Loading
- 10mm Toughened Glass
- Bending Stress analysed based on glass panel of 1300 (l) x 1000 (h) mm

Result:

Max. Bending Stress = 12.04N/mm^2 X 1.5 = 18.06N/mm^2 < 83.3N/mm^2

OK in Bending



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 41
Date: 04/04/2024	**By:** CC

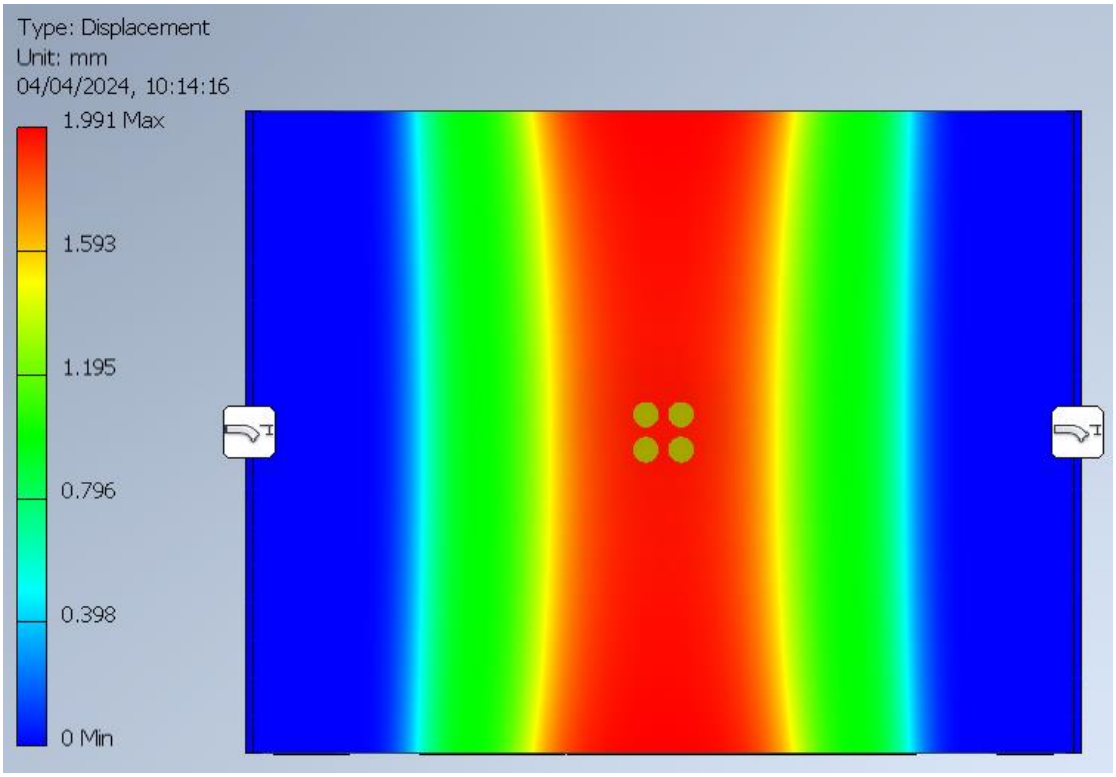
Glass Analysis - Deflection of Glass Panel due to 1.62kN/m2 Wind Loading:

- Analysis Software was used to determine maximum deflection of the glass due to 1.62N/m2 Wind Loading
- 10mm Toughened Glass
- Deflection analysed based on glass panel of 1300 (l) x 1000 (h) mm

Result:

Max. Deflection = 1.991mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 42
Date: 04/04/2024	**By:** CC

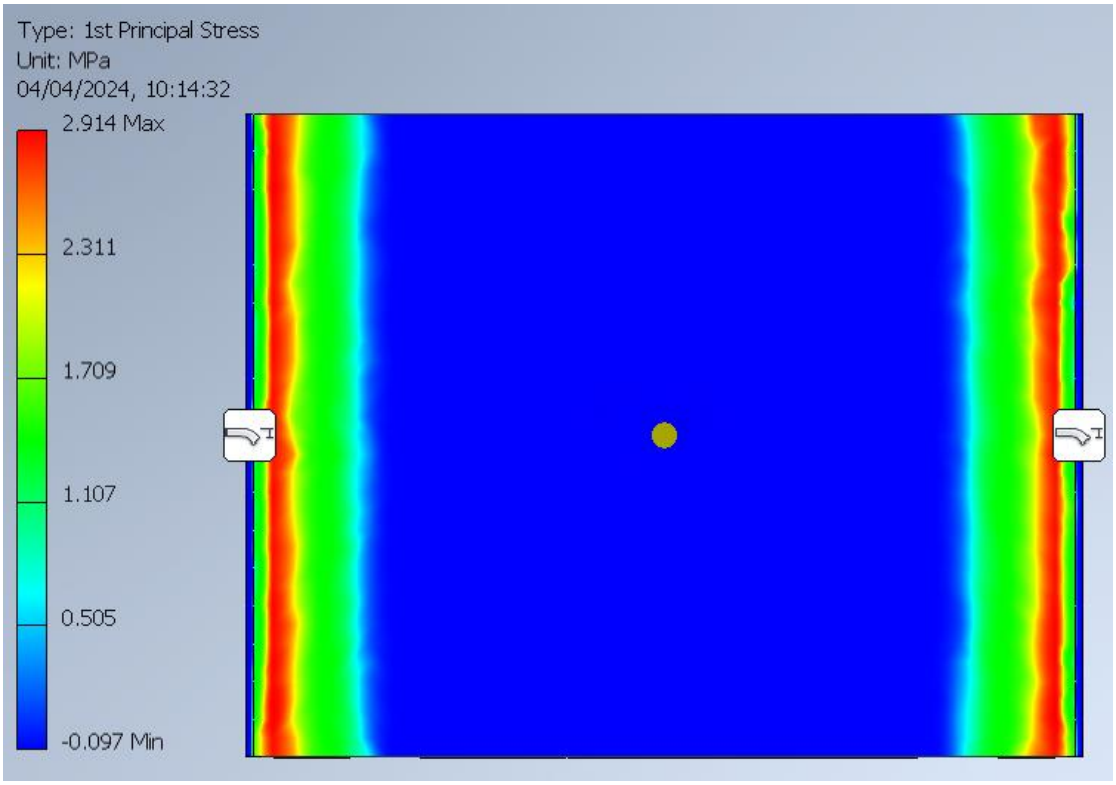
Glass Analysis - Bending Stress of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.5kN Point Load
- 10mm Toughened Glass
- Bending Stress analysed based on glass panel of 1300 (l) x 1000 (h) mm

Result:

Max. Bending Stress = 2.914N/mm^2 X 1.5 = 4.371N/mm^2 < 84.2N/mm^2

OK in Bending



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 43
Date: 04/04/2024	**By:** CC

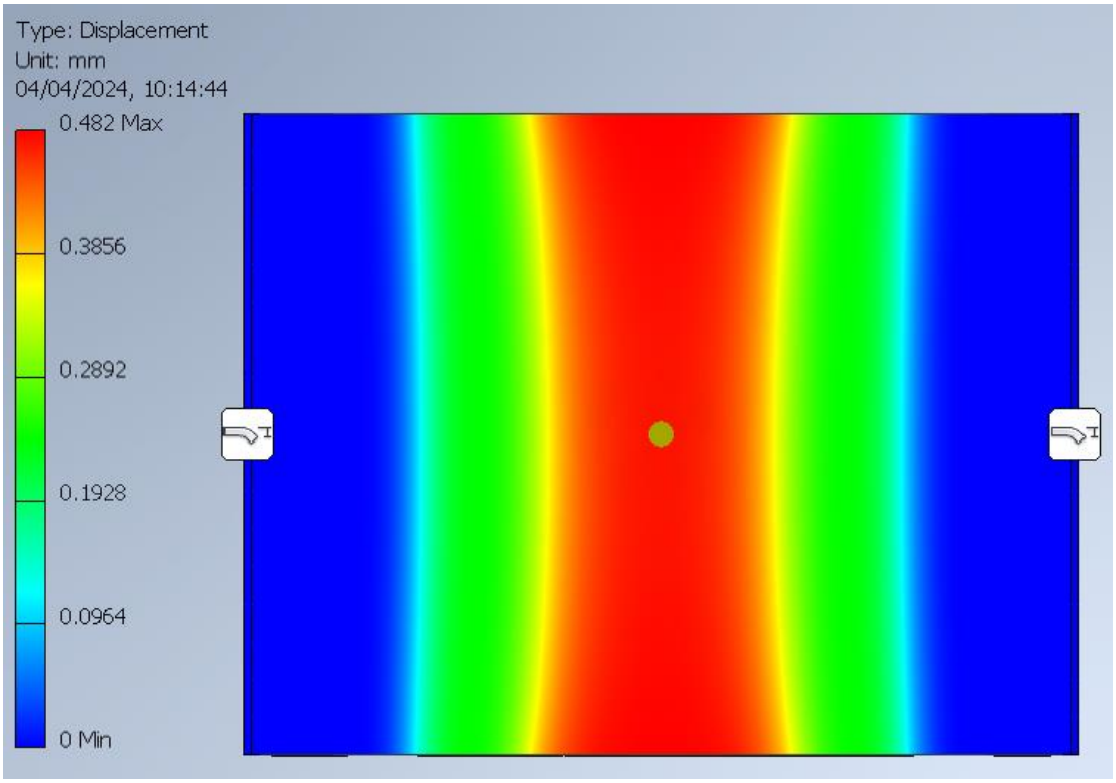
Glass Analysis - Deflection of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum deflection of the glass due to 0.5kN Point Load
  - 10mm Toughened Glass
  - Deflection analysed based on glass panel of 1300 (l) x 1000 (h) mm

Result:

Max. Deflection = 0.482mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 44
Date: 04/04/2024	**By:** CC

Glass Analysis – 13.52mm thickness – PVB Interlayer:

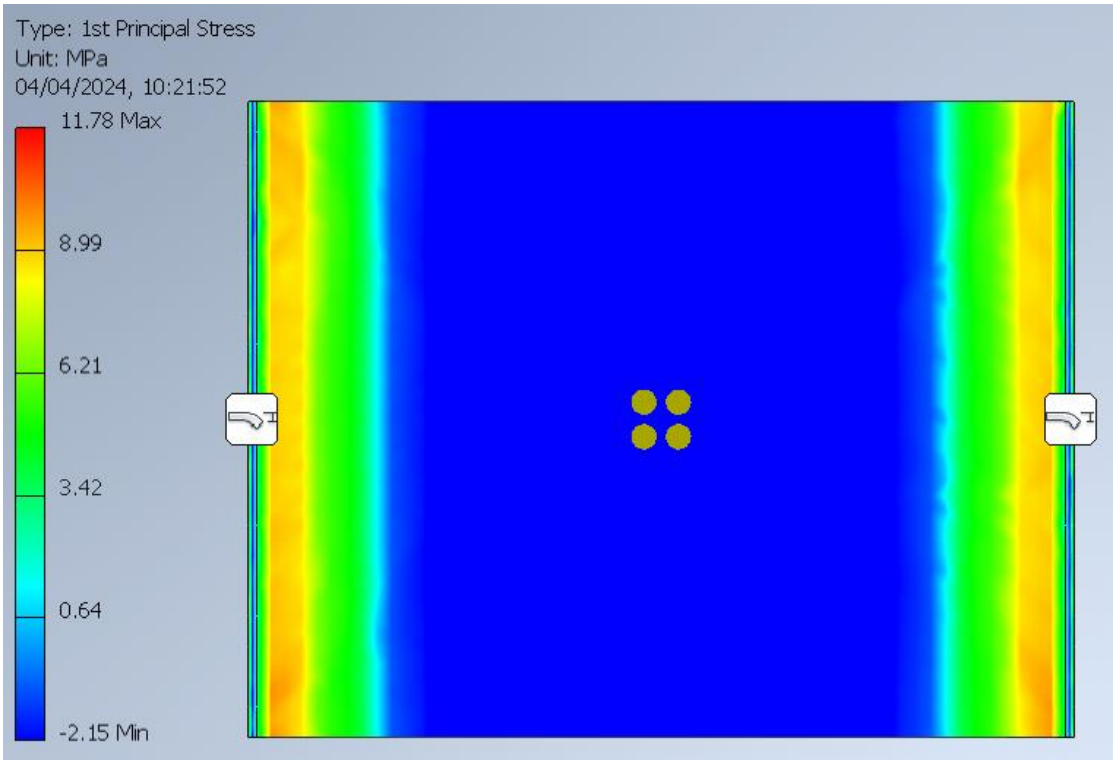
Glass Analysis - Bending Stress of Glass Panel due to 1.62kN/m2 Wind Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.62N/m2 Wind Loading
- 6/6/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 3MPa, G = 1MPa PVB
- Bending Stress analysed based on glass panel of 1300 (l) x 1000 (h) mm

Result:

Max. Bending Stress = 11.78N/mm^2 X 1.5 = 17.67N/mm^2 < 83.3N/mm^2

OK in Bending



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 45
Date: 04/04/2024	**By:** CC

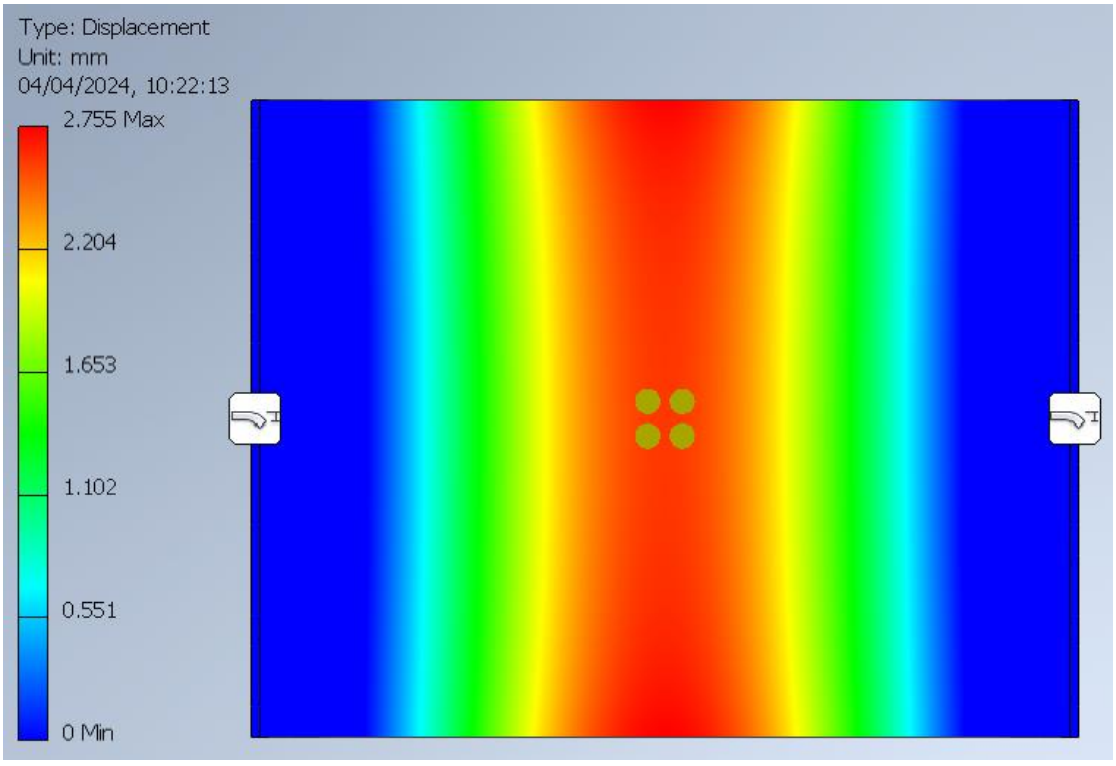
Glass Analysis - Deflection of Glass Panel due to 1.62kN/m2 Wind Loading:

- Analysis Software was used to determine maximum deflection of the glass due to 1.62N/m2 Wind Loading
- 6/6/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 3MPa, G = 1MPa PVB
- Deflection analysed based on glass panel of 1300 (l) x 1000 (h) mm

Result:

Max. Deflection = 2.755mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 46
Date: 04/04/2024	**By:** CC

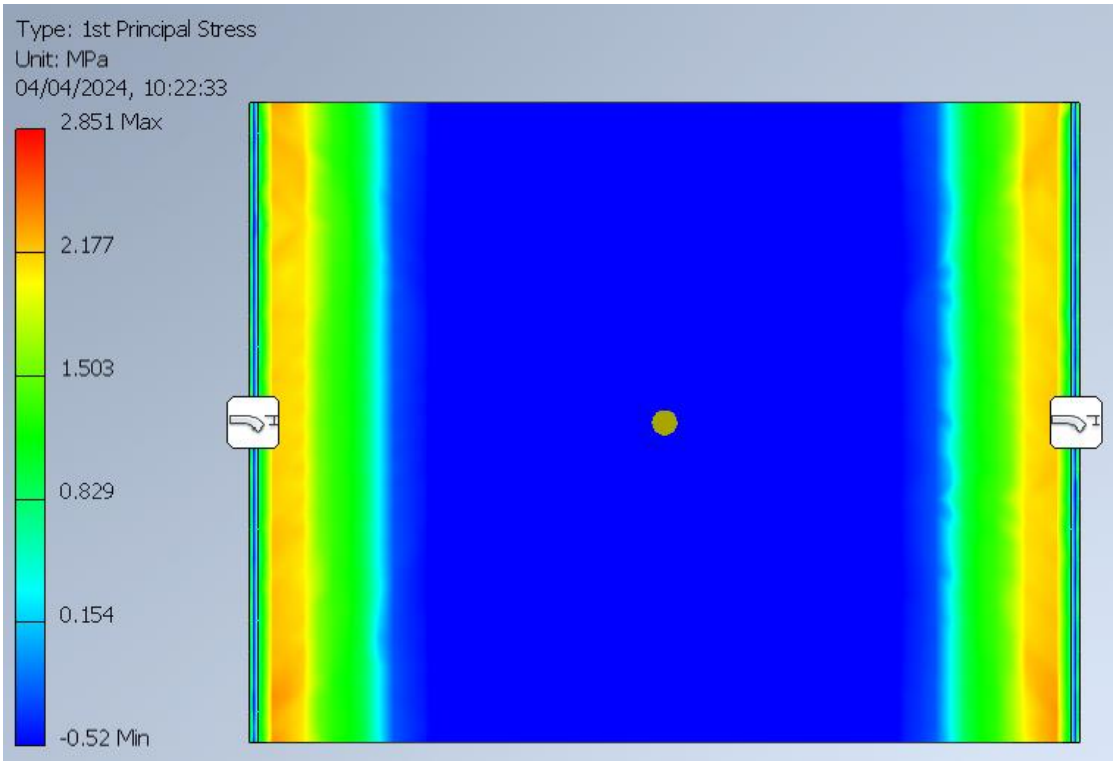
Glass Analysis - Bending Stress of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.5kN Point Load
- 6/6/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 3MPa, G = 1MPa PVB
- Bending Stress analysed based on glass panel of 1300 (l) x 1000 (h) mm

Result:

Max. Bending Stress = 2.851N/mm^2 X 1.5 = 4.28N/mm^2 < 84.2N/mm^2

OK in Bending



Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 47
Date: 04/04/2024	**By:** CC

Glass Analysis - Deflection of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum deflection of the glass due to 0.5kN Point Load
  - 6/6/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
  - Interlayer Properties used for analysis, E= 3MPa, G = 1MPa PVB
  - Deflection analysed based on glass panel of 1300 (l) x 1000 (h) mm

Result:

Max. Deflection = 0.6669mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)

Project: On Level Ltd	**Contract:** 1949-1
Subject: Pikasso Post & Handrail Design	**Sheet No.** 48
Date: 04/04/2024	**By:** CC

Appendix A: Summary of Results for Indoor and Outdoor Applications:

	Line Load Handrail Loading.	Wind Load Peak Velocity (Design Loading)	Typical Maximum Post c/c	Adjacent Corner Maximum c/c of posts
Indoor Aplications	0.74kN/m	---------	1300mm c/c	1100mm c/c
Outdoor Application	----------	0.9kN/m^2 (1.62kN/m^2)	1300mm c/c	650mm c/c

Note: The above spacings are maximum and lesser dimensions can be used in both typical spans and at corner locations.