Concorde Glass Ltd.,

Linx House,

104 Waterloo Rd,

Mablethorpe,

LN12 1LE,

UK.

Glassloc Fixing & Wind Load Data

1507-1

Analysis By	Checked By
C.K. & R.F.	T.S.

0	11/03/2021	T.S.	Issued
Revision	**Date**	**Issued By**	**Comment**

Contents

Introduction/Actions/Result Summary:

Introduction:

TSA was instructed by Concorde Glass Ltd to provide a matrix of wind load for a top mounted shoe type.

Actions:

Infill load = 1.0kN/m² (Table NA.5 IS1991-1-1:2002)
Point load = 0.5kN (Table NA.5 IS1991-1-1:2002)
Wind load = 1.0kN/m²

Assumption:

Concrete Grade = C30/37

Timber Grade = C16 (minimum)

Result Summary:

Glass Analysis					
Case Study	Glass	Interlayer	Wind Load - Qw	Height glass	Glass Deflection
	(mm)	-	(kN/m²)	(m)	(mm)
1	12		1.0	1.100	11.63
2	15		1.0	1.100	5.957
3	17.52	EVA	1.0	1.100	5.222
4	21.52	EVA	1.0	1.100	2.903

Connection To Concrete – Top Mounted Shoe					
Case Study	Fischer	Shear	Moment	Holes Space	Edge
	-	(kN)	(kNm)	(mm)	(mm)
1, 2, 3 & 4	FIS V 360 S M10x110	0.33	0.18	200	45

Connection To Mild Steel		
Case Study	Fischer	Holes Space
1, 2, 3 & 4	M10 Grade 8.8 hex head bolts	600mm

Connection To Wood		
Case Study	Fischer	Holes Space
1, 2, 3 & 4	M10 Grade 8.8 hex head bolts	600mm

Glass Strength

Wind Loading:

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

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

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

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

	

Project: Concorde Glass Ltd.	**Contract:** 1507-1
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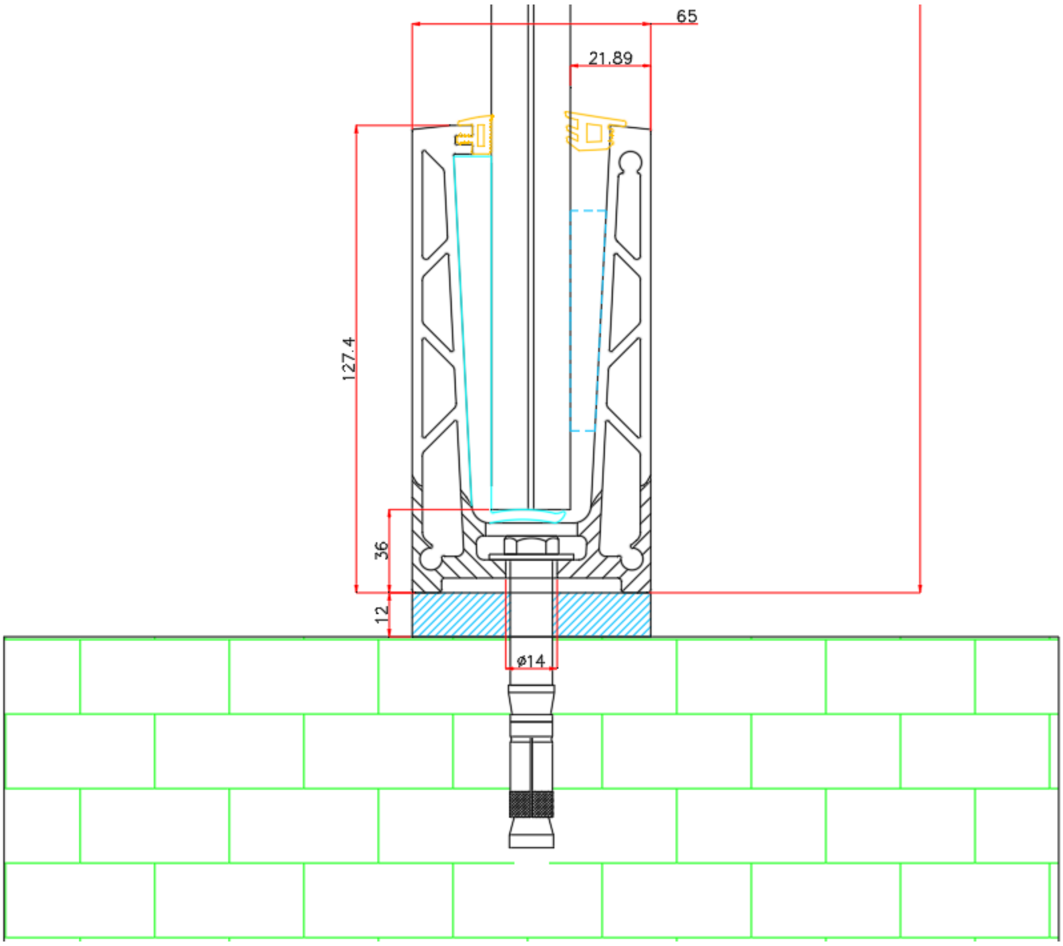
System Sketch:

Concorde Glass Ltd Top Mounted Shoe:

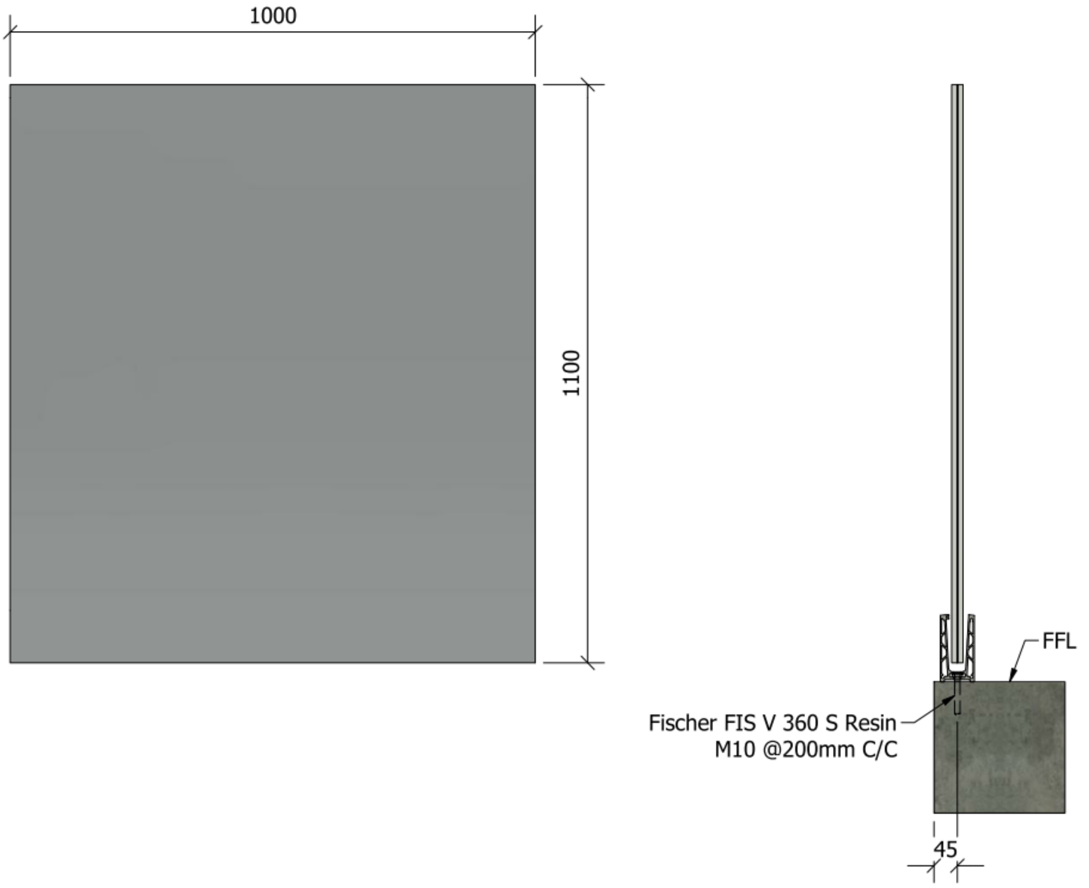


Case Study 01: 12mm Toughened Glass – 1.0x1.100m – 1.0kN/m^2

Case Study 02: 15mm Toughened Glass – 1.0x1.100m – 1.0kN/m^2

Case Study 03: 17.52mm Laminated Toughened Glass – 1.0x1.100m – 1.0kN/m^2

Case Study 04: 21.52mm Laminated Toughened Glass – 1.0x1.100m – 1.0kN/m^2



Glass & Shoe Analysis:

Glass Analysis – 12mm:

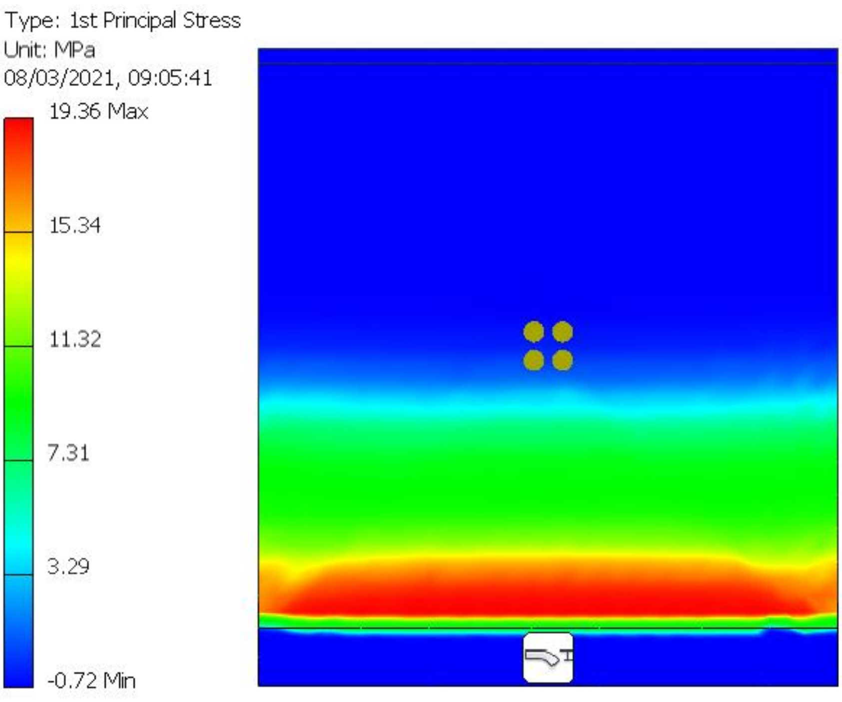
Glass Analysis - Bending Stress of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0N/m2 Infill Loading
- 12mm Toughened Glass
- Bending Stress analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Bending Stress = 19.36N/mm^2 X 1.5 = 29.04N/mm^2 < 84.2N/mm^2

OK in Bending



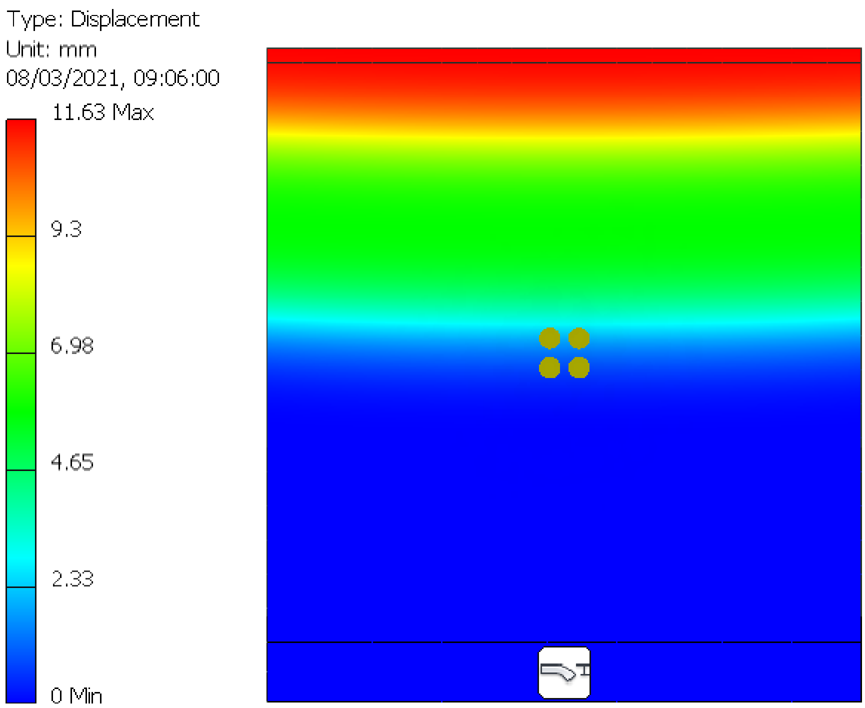
Glass Analysis - Deflection of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum deflection of the glass due to 1.0N/m2 Infill Loading
- 12mm Toughened Glass
- Deflection analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Deflection = 11.63mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



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Project: Concorde Glass Ltd.	Contract: 1507-1
Subject: Glassloc Fixing & Wind Load Data	Sheet No. 9
Date: 11/03/2021	By: C.K. & R.F.

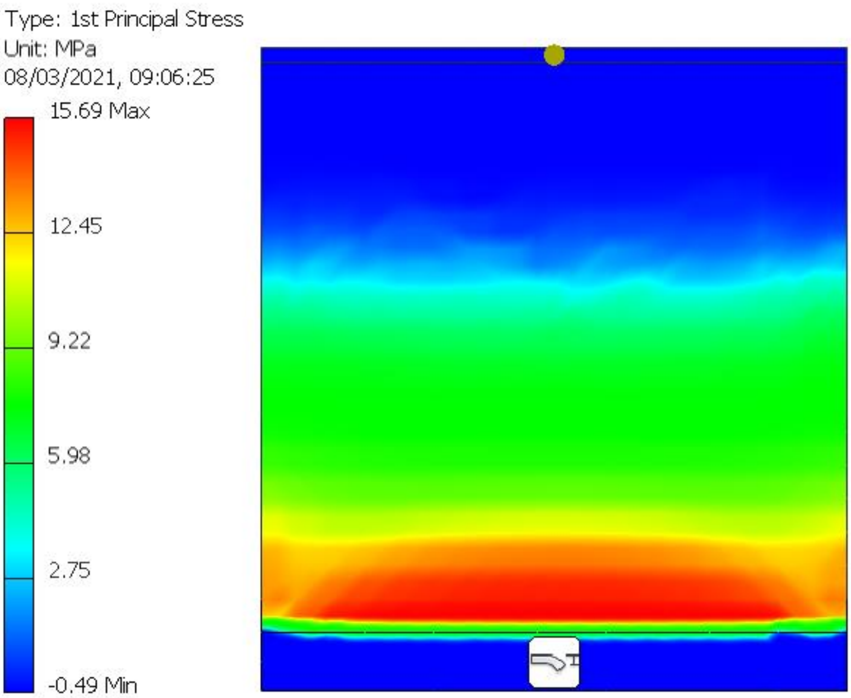
Glass Analysis - Bending Stress of Glass Panel due to 0.36kN/m Balustrade Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.36kN/m Balustrade Loading
- 12mm Toughened Glass
- Bending Stress analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Bending Stress = 15.69N/mm^2 X 1.5 = 23.535N/mm^2 < 84.2N/mm^2

OK in Bending



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Project: Concorde Glass Ltd.	Contract: 1507-1
Subject: Glassloc Fixing & Wind Load Data	Sheet No. 10
Date: 11/03/2021	By: C.K. & R.F.

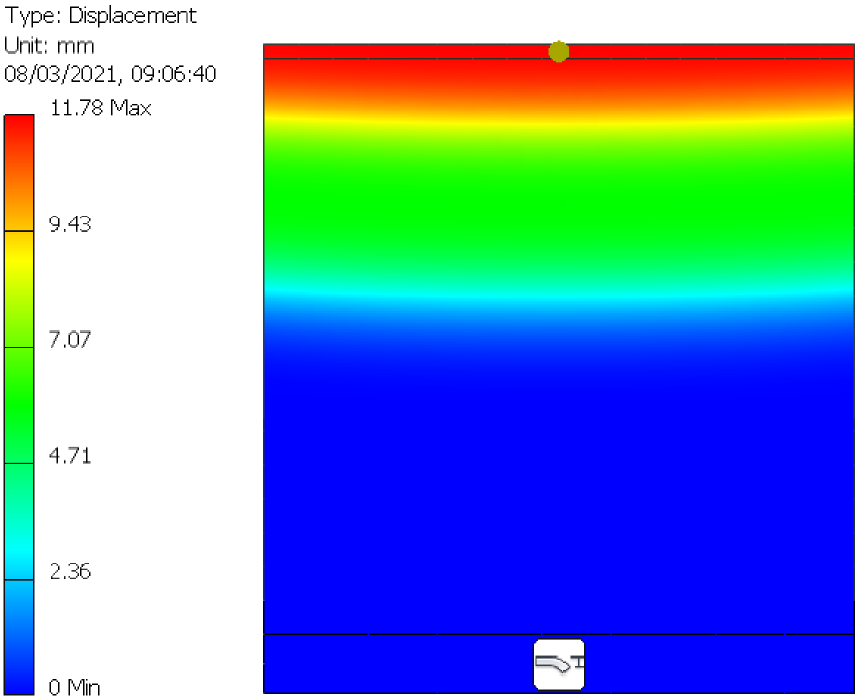
Glass Analysis - Deflection of Glass Panel due to 0.36kN/m Balustrade Loading:

- Analysis Software was used to determine maximum deflection of the glass due to 0.36kN/m Balustrade Loading
- 12mm Toughened Glass
- Deflection analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Deflection = 11.78mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



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Project: Concorde Glass Ltd.	**Contract:** 1507-1
Subject: Glassloc Fixing & Wind Load Data	**Sheet No.** 11
Date: 11/03/2021	**By:** C.K. & R.F.

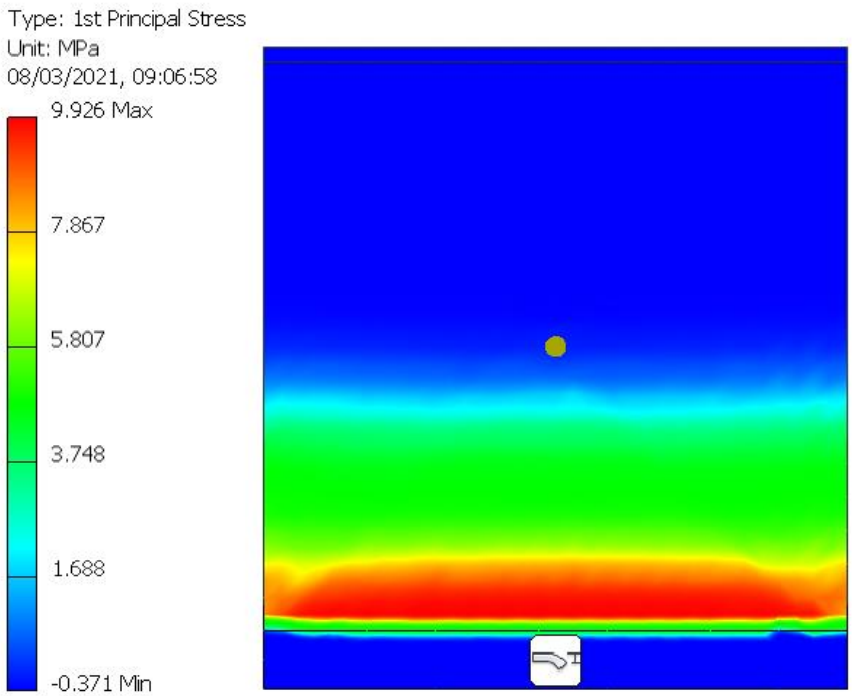
Glass Analysis - Bending Stress of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.5kN Point Load
- 12mm Toughened Glass
- Bending Stress analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Bending Stress = 9.926N/mm^2 X 1.5 = 14.889N/mm^2 < 84.2N/mm^2

OK in Bending



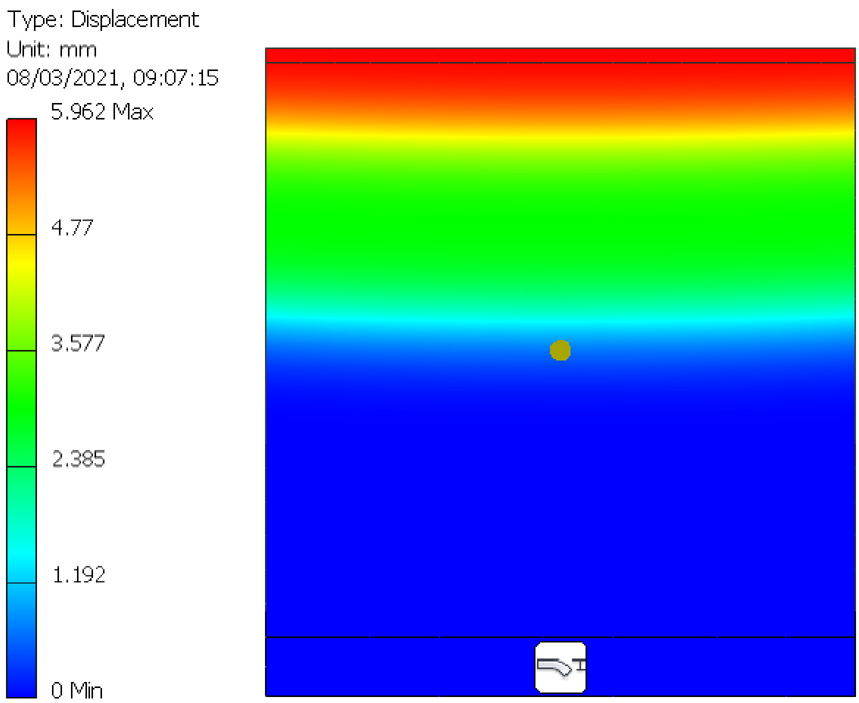
Glass Analysis - Deflection of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum deflection of the glass due to 0.5kN Point Load
- 12mm Toughened Glass
- Deflection analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Deflection = 5.962mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



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Date: 11/03/2021	By: C.K. & R.F.

Glass Analysis – 15mm:

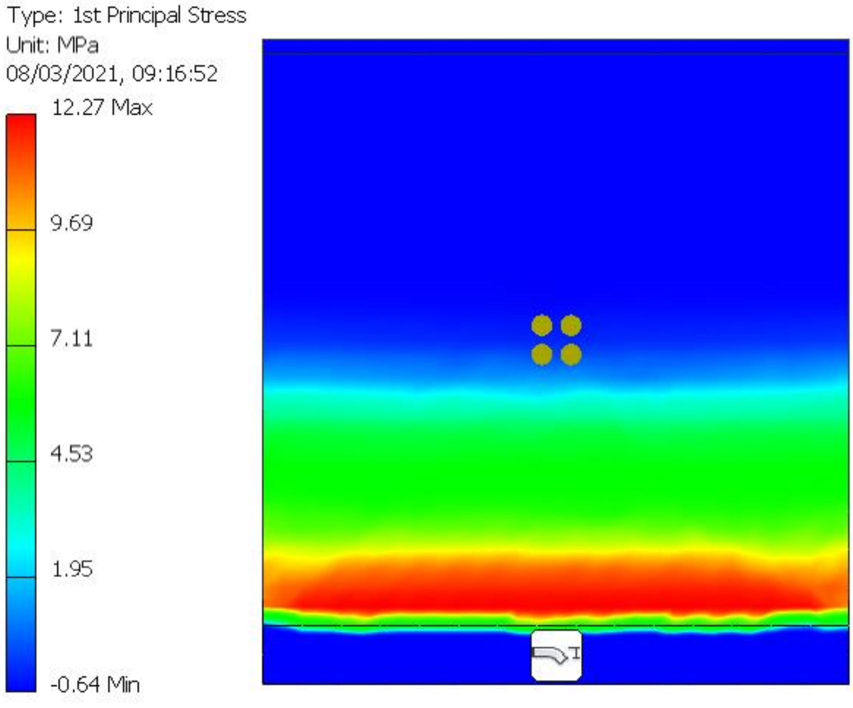
Glass Analysis - Bending Stress of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0N/m2 Infill Loading
- 15mm Toughened Glass
- Bending Stress analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Bending Stress = 12.27N/mm^2 X 1.5 = 18.405N/mm^2 < 84.2N/mm^2

OK in Bending



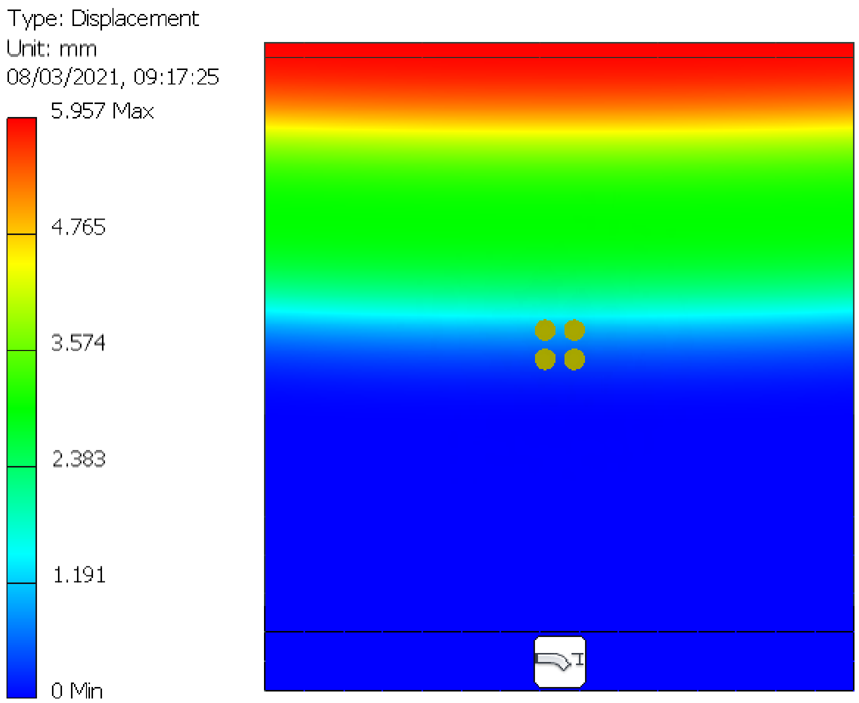
Glass Analysis - Deflection of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum deflection of the glass due to 1.0N/m2 Infill Loading
- 15mm Toughened Glass
- Deflection analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Deflection = 5.957mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



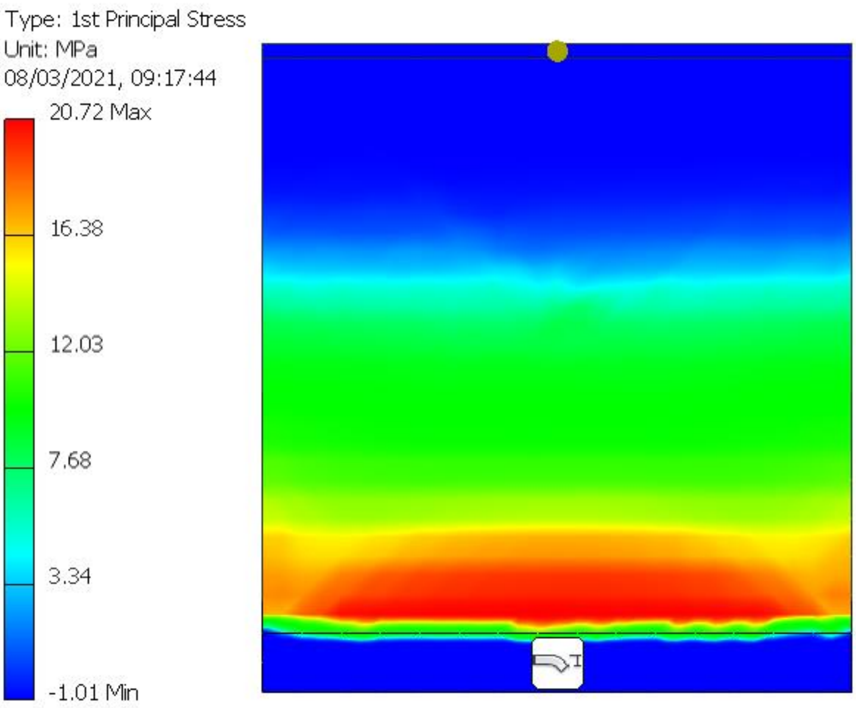
Glass Analysis - Bending Stress of Glass Panel due to 0.74kN/m Balustrade Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.74kN/m Balustrade Loading
- 15mm Toughened Glass
- Bending Stress analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Bending Stress = 20.72N/mm^2 X 1.5 = 31.08N/mm^2 < 84.2N/mm^2

OK in Bending



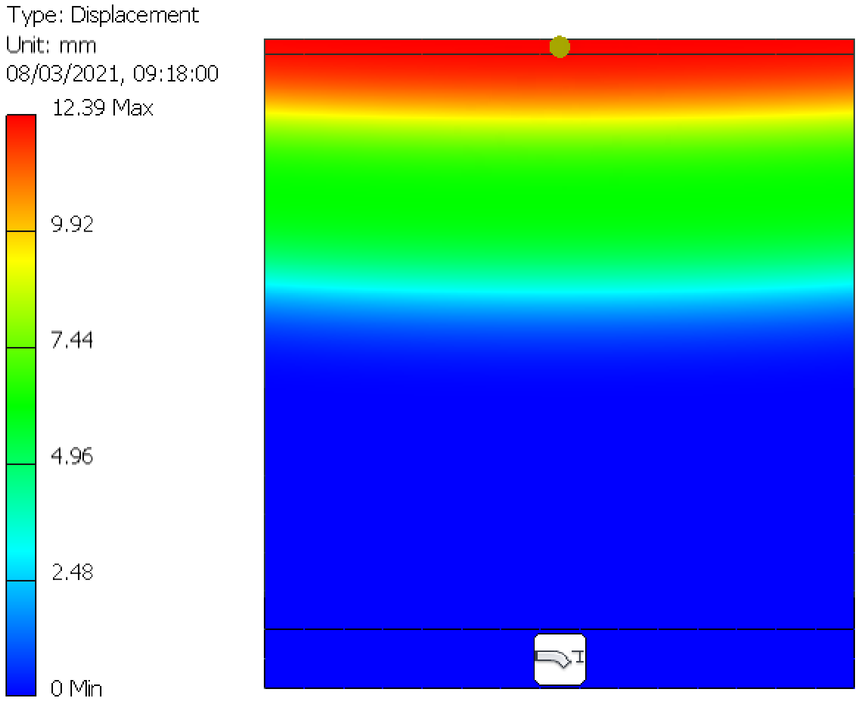
Glass Analysis - Deflection of Glass Panel due to 0.74kN/m Balustrade Loading:

- Analysis Software was used to determine maximum deflection of the glass due to 0.74kN/m Balustrade Loading
- 15mm Toughened Glass
- Deflection analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Deflection = 12.39mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



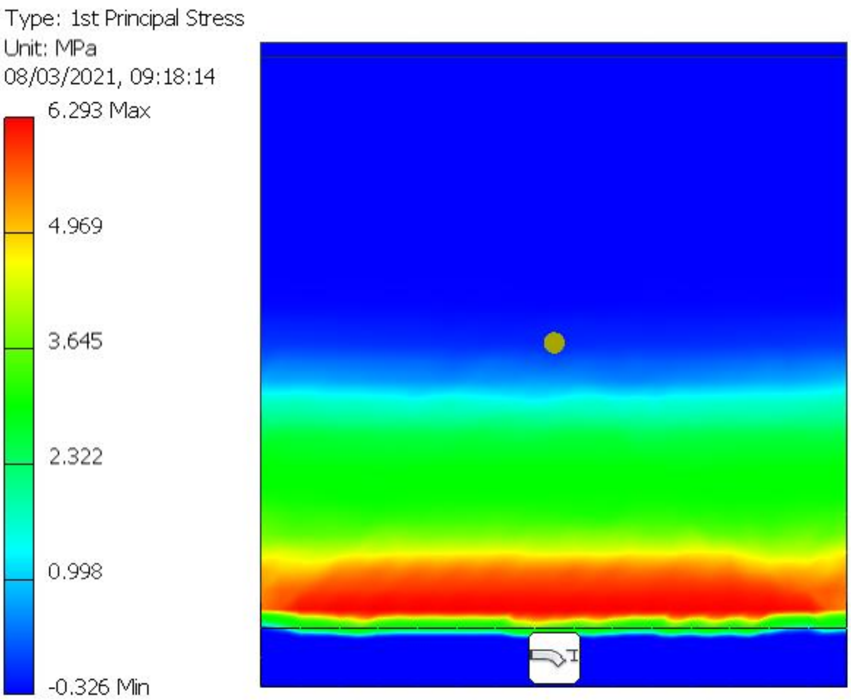
Glass Analysis - Bending Stress of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.5kN Point Load
- 15mm Toughened Glass
- Bending Stress analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Bending Stress = 6.293N/mm^2 X 1.5 = 9.4395N/mm^2 < 84.2N/mm^2

OK in Bending



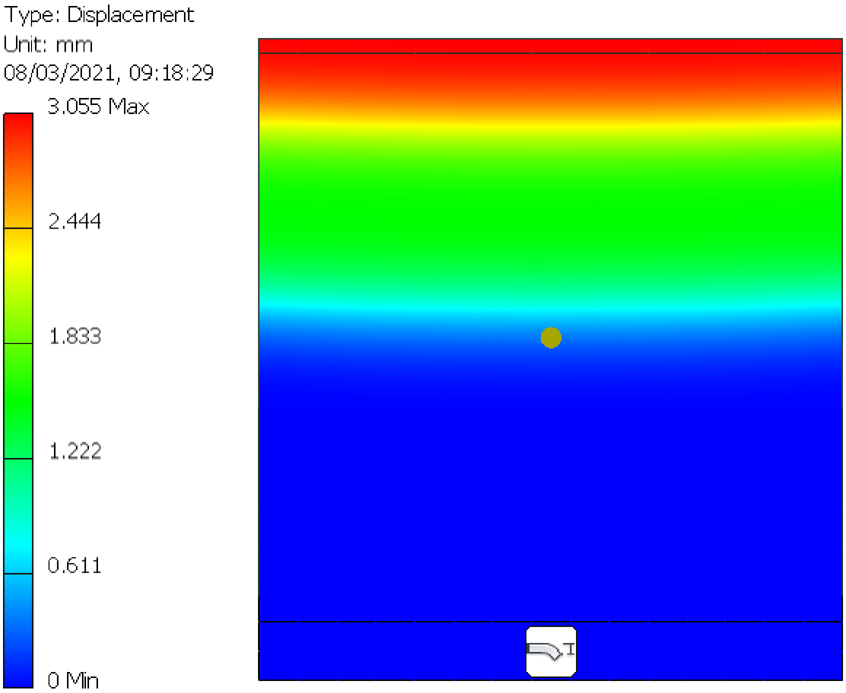
Glass Analysis - Deflection of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum deflection of the glass due to 0.5kN Point Load
- 15mm Toughened Glass
- Deflection analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Deflection = 3.055mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Glass Analysis – 17.52mm – EVA Interlayer:

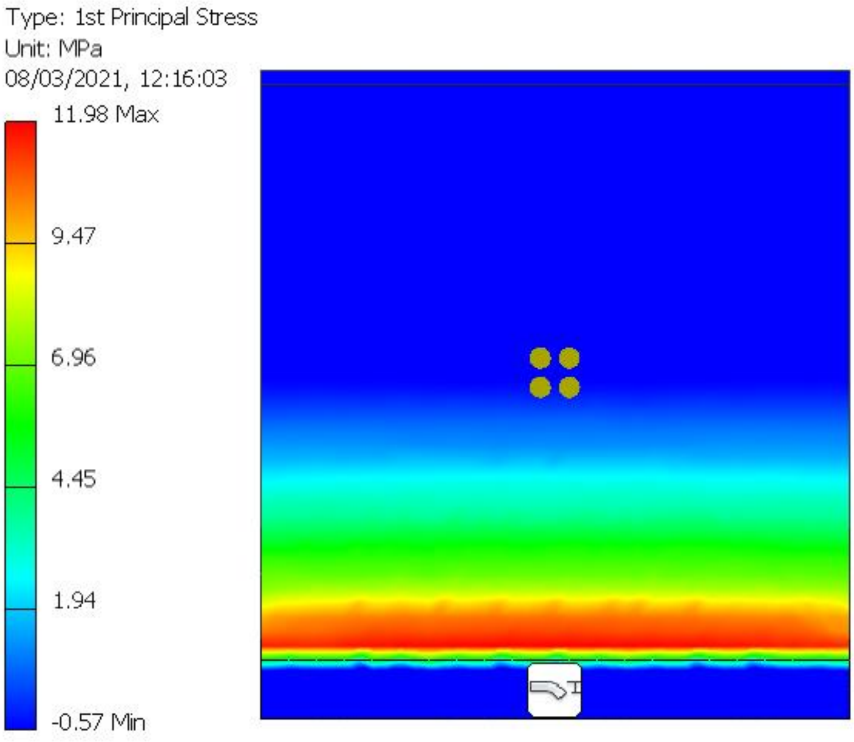
Glass Analysis - Bending Stress of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0N/m2 Infill Loading
- 8/8/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 18MPa, G = 6.82MPa EVA
- Bending Stress analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Bending Stress = 11.98N/mm^2 X 1.5 = 17.97N/mm^2 < 84.2N/mm^2

OK in Bending



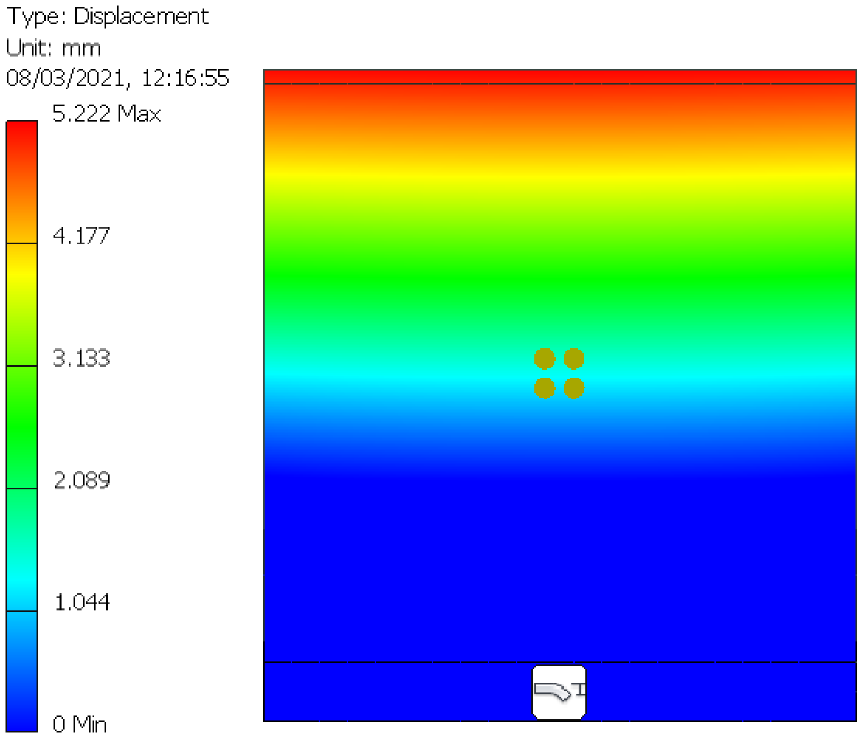
Glass Analysis - Deflection of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum deflection of the glass due to 1.0N/m2 Infill Loading
- 8/8/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 18MPa, G = 6.82MPa EVA
- Deflection analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Deflection = 5.222mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



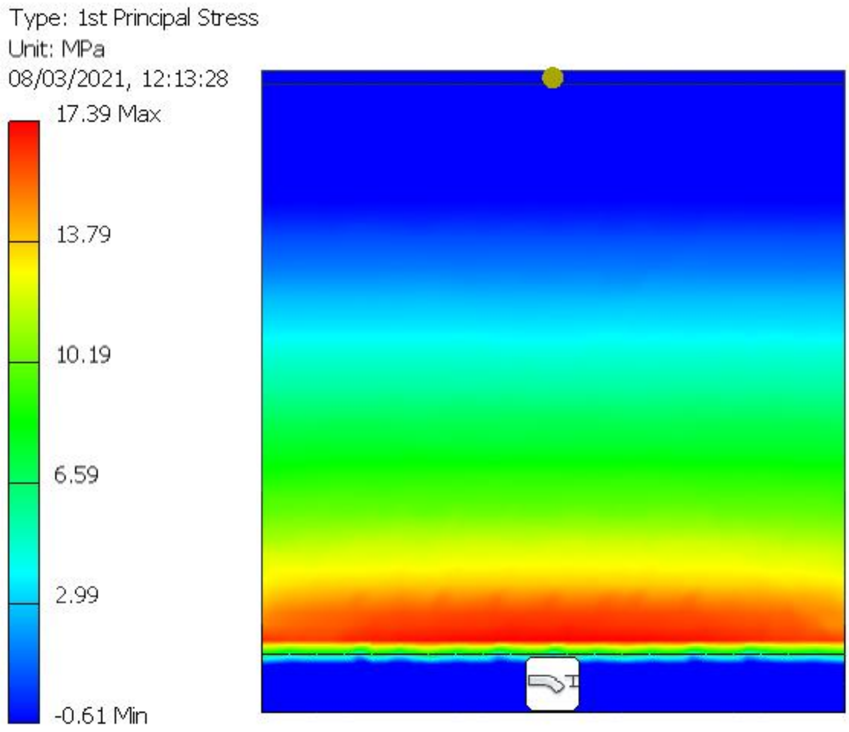
Glass Analysis - Bending Stress of Glass Panel due to 0.74kN/m Balustrade Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.74kN/m Balustrade Loading
- 8/8/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 18MPa, G = 6.82MPa EVA
- Bending Stress analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Bending Stress = 17.39N/mm^2 X 1.5 = 26.085N/mm^2 < 84.2N/mm^2

OK in Bending



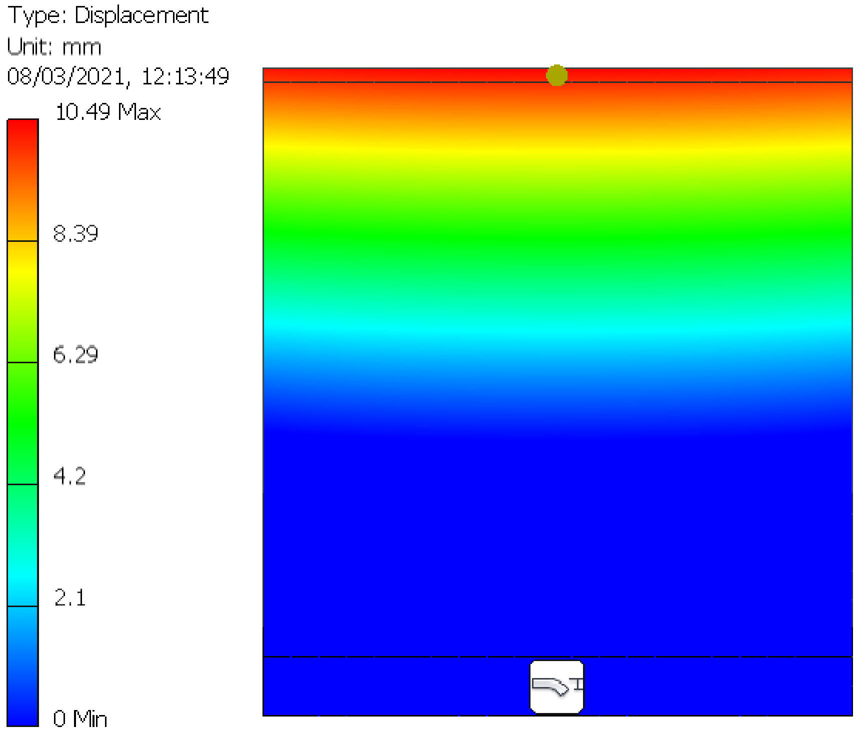
Glass Analysis - Deflection of Glass Panel due to 0.74kN/m Balustrade Loading:

- Analysis Software was used to determine maximum deflection of the glass due to 0.74kN/m Balustrade Loading
- 8/8/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 18MPa, G = 6.82MPa EVA
- Deflection analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Deflection = 10.49mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



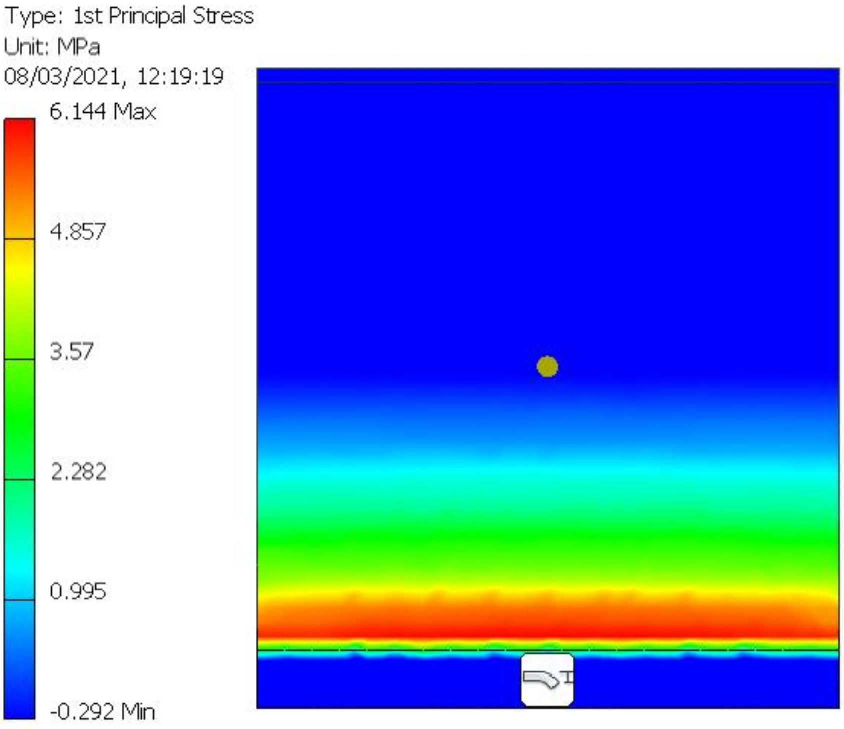
Glass Analysis - Bending Stress of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.5kN Point Load
- 8/8/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 18MPa, G = 6.82MPa EVA
- Bending Stress analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Bending Stress = 6.144N/mm^2 X 1.5 = 9.216N/mm^2 < 84.2N/mm^2

OK in Bending



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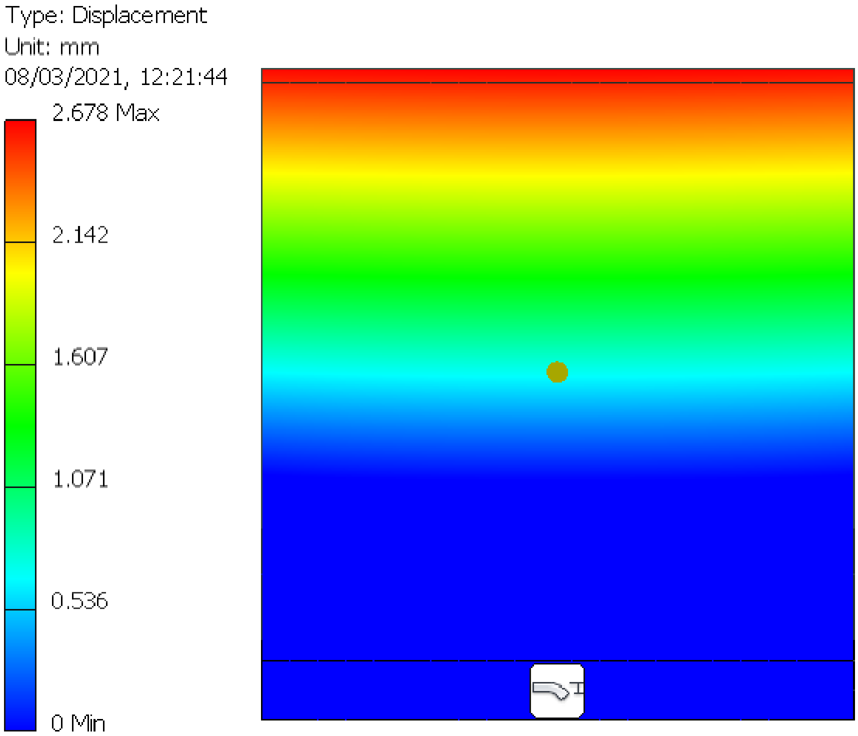
Glass Analysis - Deflection of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum deflection of the glass due to 0.5kN Point Load
- 8/8/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 18MPa, G = 6.82MPa EVA
- Deflection analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Deflection = 2.678mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Glass Analysis – 21.52mm – EVA Interlayer:

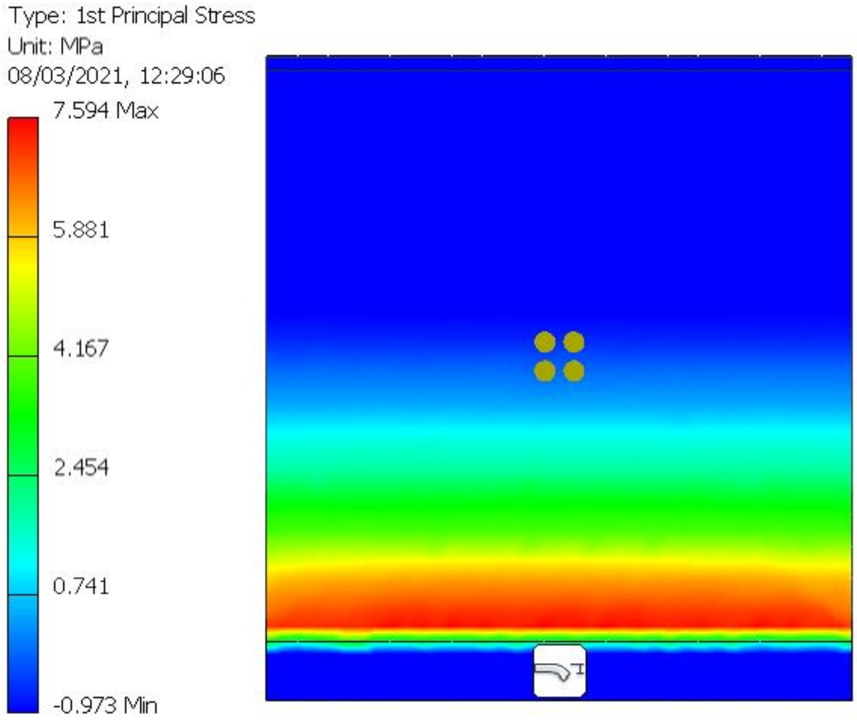
Glass Analysis - Bending Stress of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0N/m2 Infill Loading
- 10/10/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 18MPa, G = 6.82MPa EVA
- Bending Stress analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Bending Stress = 7.594N/mm^2 X 1.5 = 11.391N/mm^2 < 84.2N/mm^2

OK in Bending



TSA TED SINGLETON & ASSOCIATES CONSULTING ENGINEERS	**Project:** Concorde Glass Ltd.	**Contract:** 1507-1
	Subject: Glassloc Fixing & Wind Load Data	**Sheet No.** 26
	Date: 11/03/2021	**By:** C.K. & R.F.

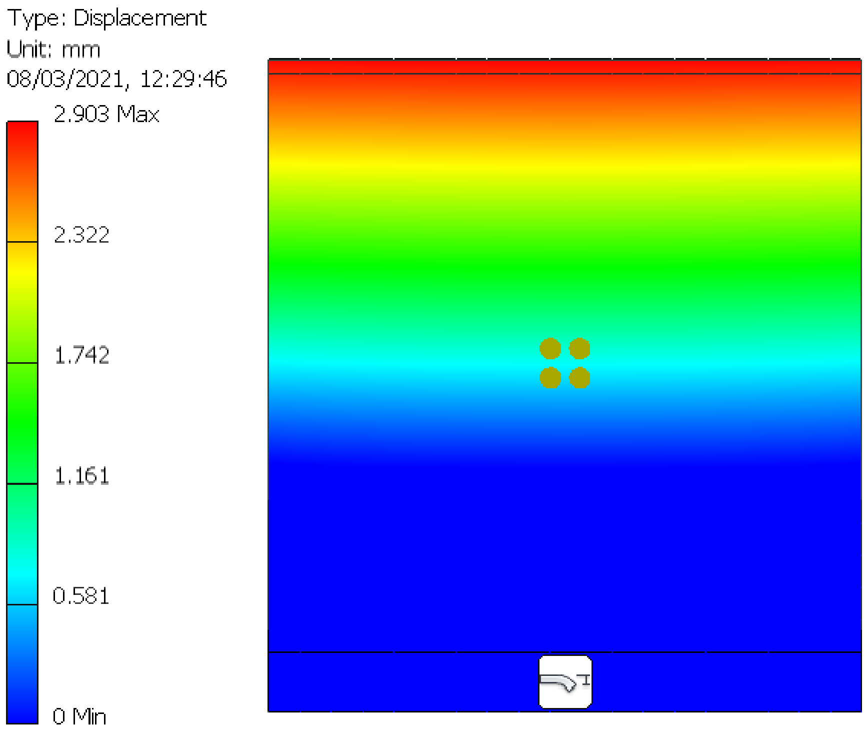
Glass Analysis - Deflection of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum deflection of the glass due to 1.0N/m2 Infill Loading
- 10/10/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 18MPa, G = 6.82MPa EVA
- Deflection analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Deflection = 2.903mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



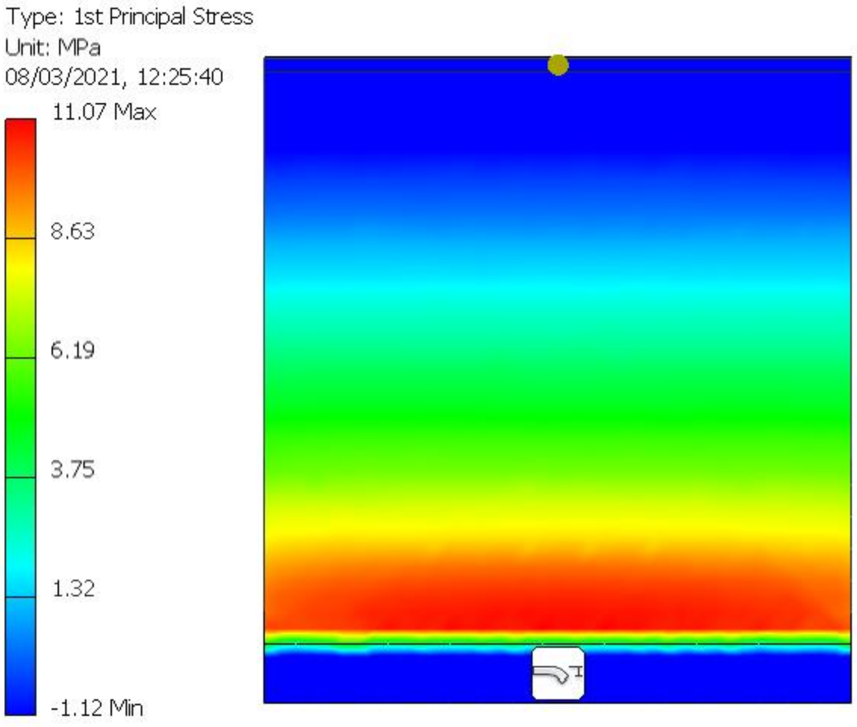
Glass Analysis - Bending Stress of Glass Panel due to 0.74kN/m Balustrade Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.74kN/m Balustrade Loading
- 10/10/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 18MPa, G = 6.82MPa EVA
- Bending Stress analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Bending Stress = 11.07N/mm^2 X 1.5 = 16.605N/mm^2 < 84.2N/mm^2

OK in Bending



TSA TED SINGLETON & ASSOCIATES CONSULTING ENGINEERS	**Project:** Concorde Glass Ltd.	**Contract:** 1507-1
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	Date: 11/03/2021	**By:** C.K. & R.F.

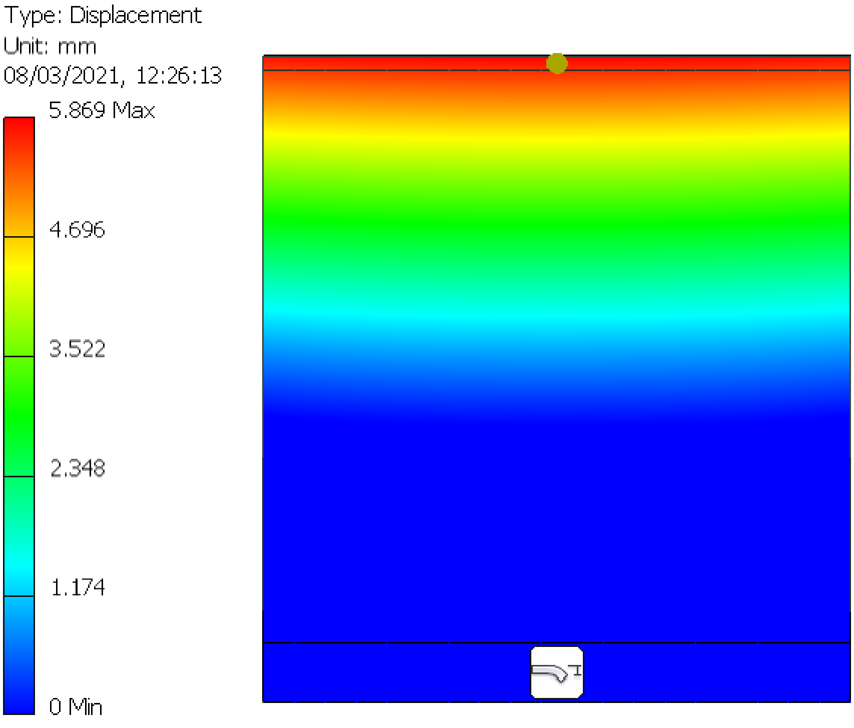
Glass Analysis - Deflection of Glass Panel due to 0.74kN/m Balustrade Loading:

- Analysis Software was used to determine maximum deflection of the glass due to 0.74kN/m Balustrade Loading
- 10/10/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 18MPa, G = 6.82MPa EVA
- Deflection analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Deflection = 5.869mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



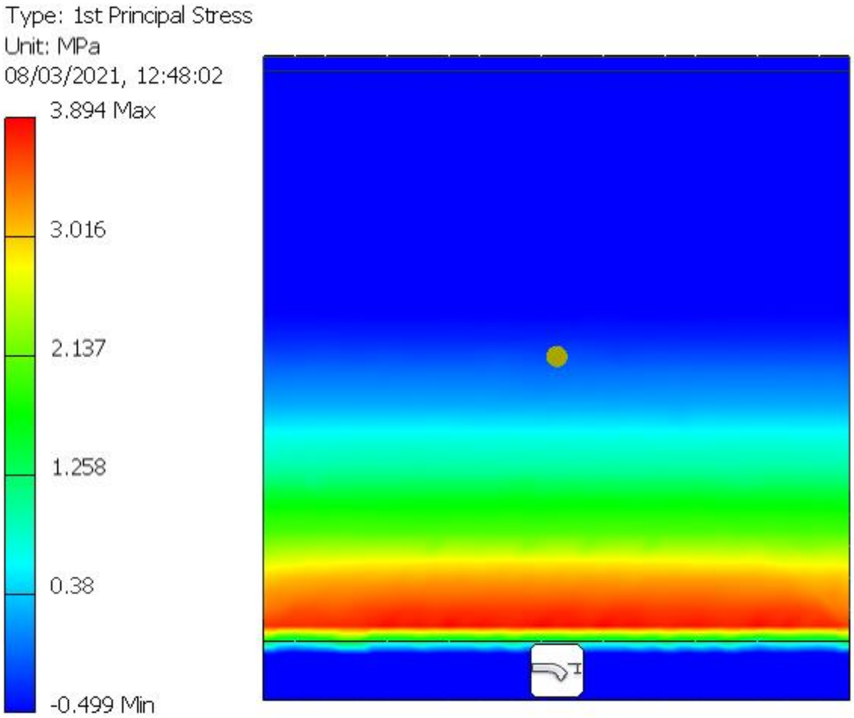
Glass Analysis - Bending Stress of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.5kN Point Load
- 10/10/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 18MPa, G = 6.82MPa EVA
- Bending Stress analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Bending Stress = 3.894N/mm^2 X 1.5 = 5.841N/mm^2 < 84.2N/mm^2

OK in Bending



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CONSULTING ENGINEERS

Project: Concorde Glass Ltd.	**Contract:** 1507-1
Subject: Glassloc Fixing & Wind Load Data	**Sheet No.** 30
Date: 11/03/2021	**By:** C.K. & R.F.

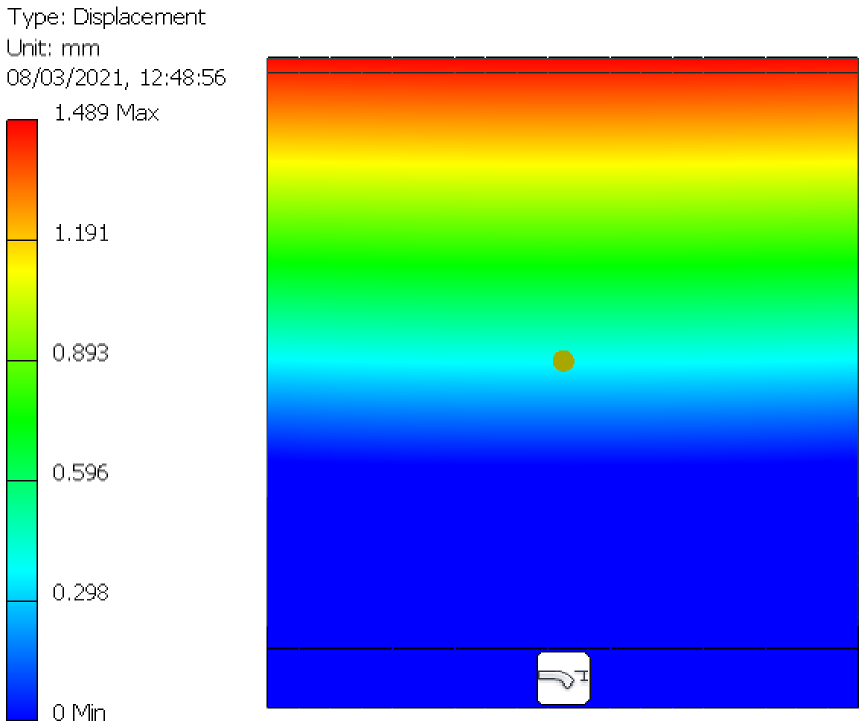
Glass Analysis - Deflection of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum deflection of the glass due to 0.5kN Point Load
- 10/10/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 18MPa, G = 6.82MPa EVA
- Deflection analysed based on glass panel of 1000 (l) x 1100 (h) mm

Result:

Max. Deflection = 1.489mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Shoe Analysis – Shoe – Balustrade Load 0.36kN/m:

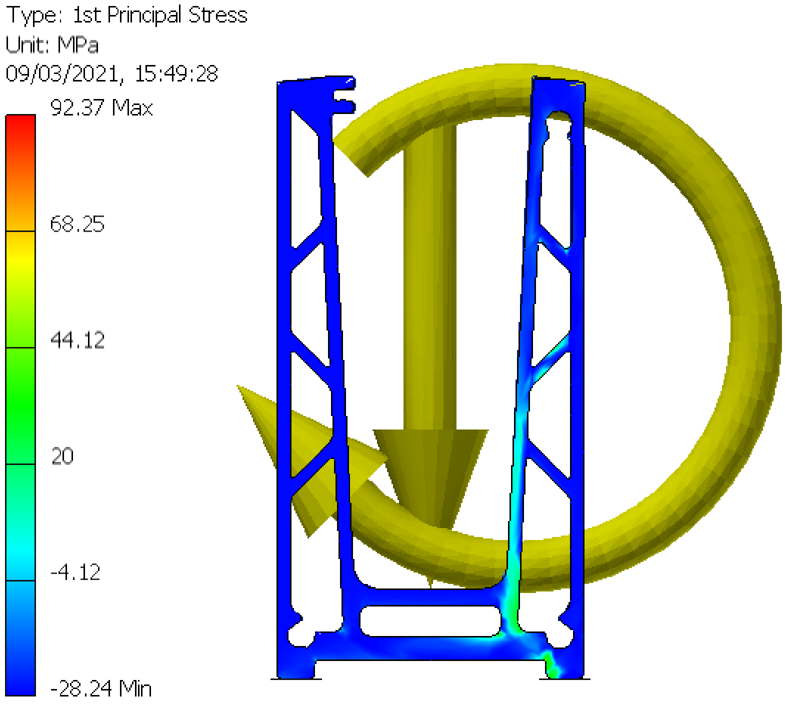
Bending Stress:

- Analysis Software was used to determine maximum bending stress of the shoe due to maximum Moment
- $\text{Moment} = 1.0\text{kN/m2} \times 1.0\text{m} \times 1.10\text{m} \times \frac{1.10\text{m}}{2} = 0.61\text{kN m(SLS)}$
- $\text{Weight (12mm)} = 287.76\text{N (SLS)}$

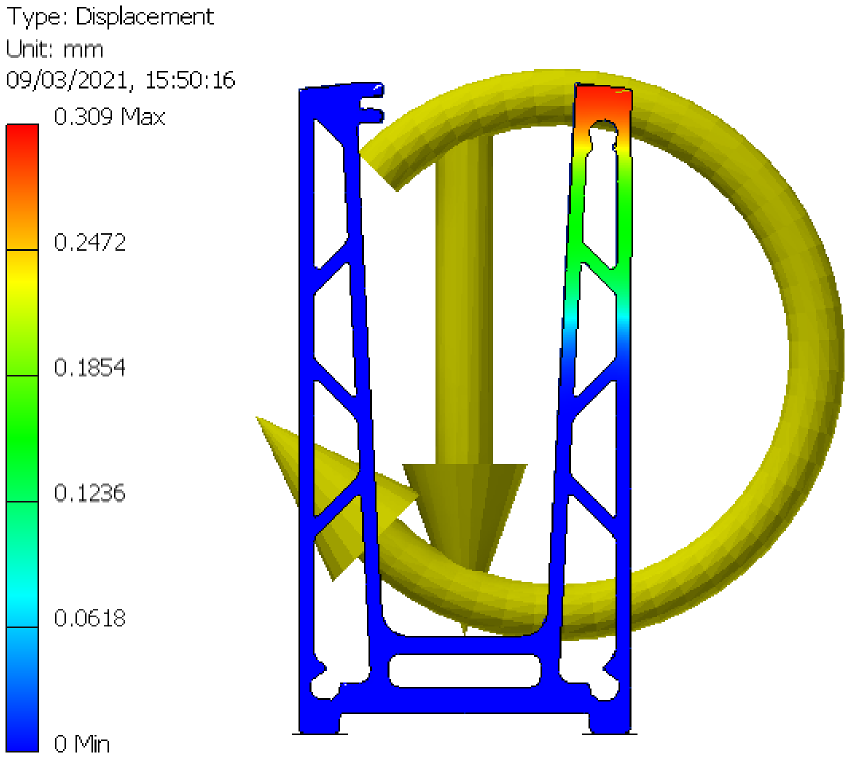
Result:

Max. Bending Stress = 92.37N/mm^2 x1.5 = 138.555N/mm^2 < 180N/mm^2

Okay in Bending



Deflection:



NOTE:

- Deflection 0.309mm at the top of shoe
- Max. Deflection at 900mm above pitch line = (0.309 x 1100)/91 = 3.74mm

Shoe Analysis – Shoe – Balustrade Load $0.74kN/m$:

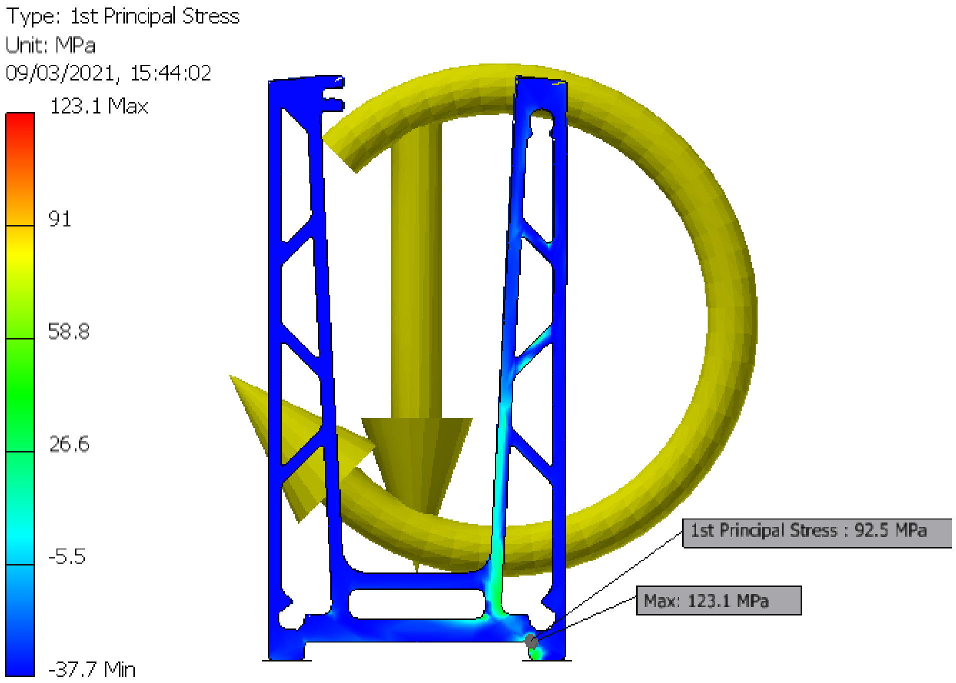
Bending Stress:

- Analysis Software was used to determine maximum bending stress of the shoe due to maximum Moment
- $\text{Moment} = 0.74\text{kN/m} \times 1.0\text{m} \times 1.10\text{m} = 0.814\text{kN m(SLS)}$
- $\text{Weight (21.52mm)} = 495.48\text{N (SLS)}$

Result:

Max. Bending Stress = 92.5N/mm^2 x1.5 = 138.75N/mm^2 < 180N/mm^2

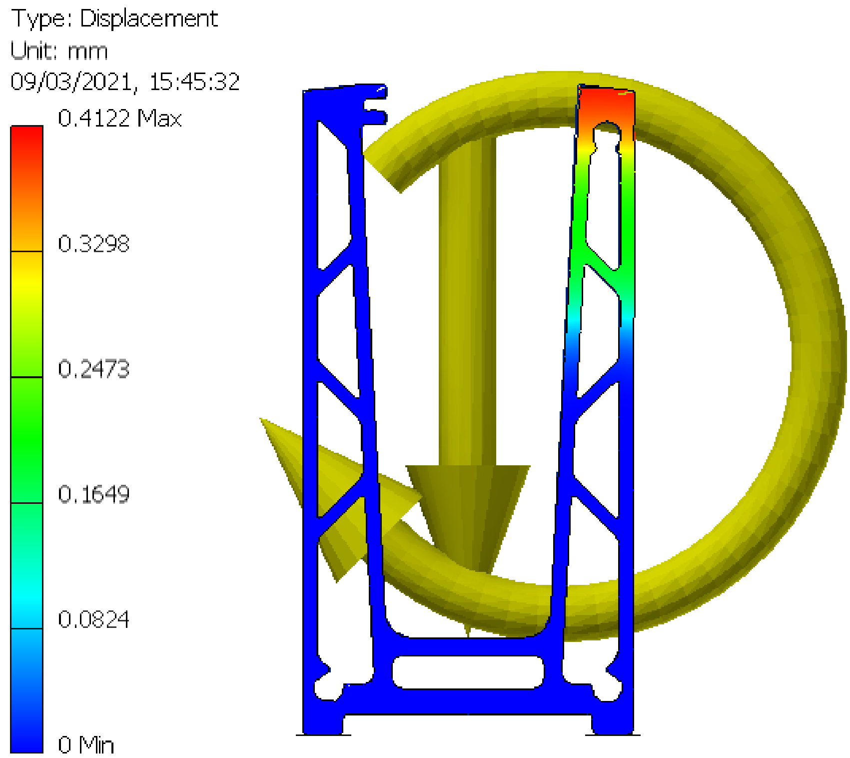
Okay in Bending



NOTE:

In this case the 123.1 MPa is a localised stress. The most appropriate stress to be considered is 92.5 MPa.

Deflection:



NOTE:

- Deflection 0.4122mm at the top of shoe
- Max. Deflection at 900mm above pitch line = (0.4122 x 1100)/91 = 4.98mm

Connection Design:

Case Study 01: 12mm Toughened Glass – 1.0x1.100m – 1.0kN/m^2

Case Study 02: 15mm Toughened Glass – 1.0x1.100m – 1.0kN/m^2

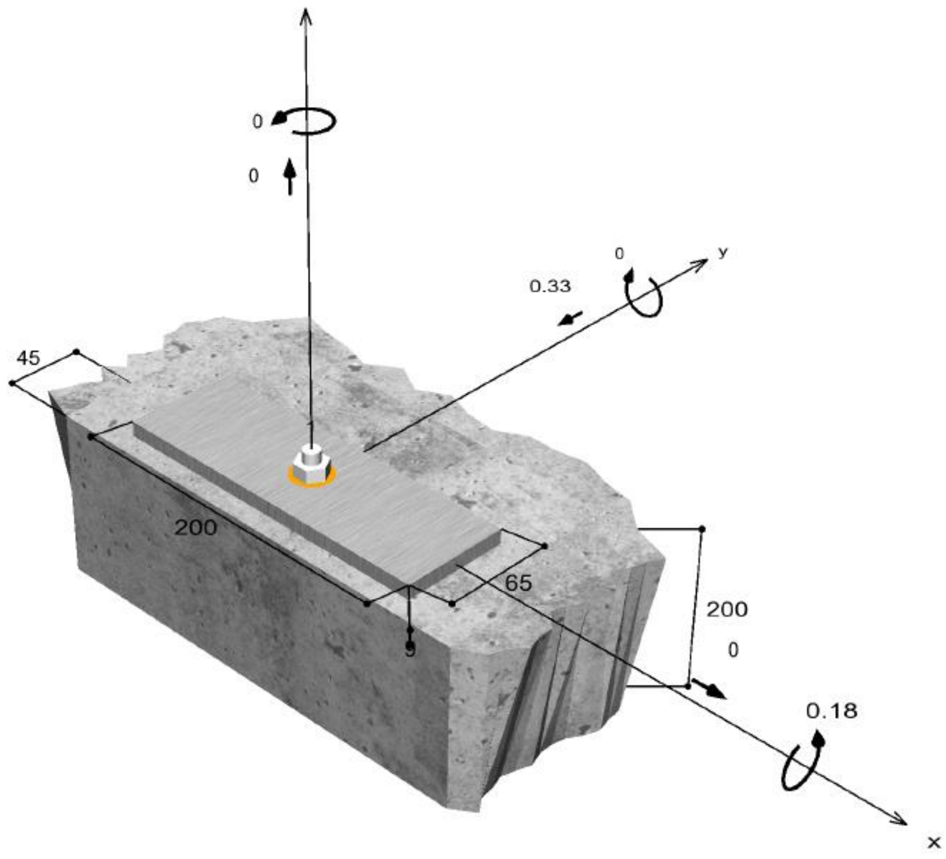
Case Study 03: 17.52mm Laminated Toughened Glass – 1.0x1.100m – 1.0kN/m^2

Case Study 04: 21.52mm Laminated Toughened Glass – 1.0x1.100m – 1.0kN/m^2

Connection to Concrete – Top Mounted Shoe

$$\text{Shear Load} = 1.0\text{kN/m}^2 \times 0.2\text{m} \times 1.100\text{m} \times 1.5 = 0.33\text{kN (ULS)}$$

$$\text{Moment} = 0.33\text{kN} \times (1.100\text{m} / 2) = 0.18\text{kNm (ULS)}$$



Therefore, use 1 Nr Anchor FIS V 360 S M10 x 110 @ 200mm c/c.

See design in Appendix A.

Connection to Mild Steel – Top Mounted Shoe:

1Nr M10 Bolt Grade 8.8

$f_y = 640\ MPa$ *(Grade 8.8 Mild Steel, Table 3.1 EN 1993-1-8:2005)*

$f_{ub} = 800\ MPa$ *(Grade 8.8 Mild Steel, Table 3.1 EN 1993-1-8:2005)*

$\alpha = 0.6$ *(Table 3.4 EN 1993-1-8:2005)*

$A = 58mm^2$ *(For M10 Bolts)*

$K_2 = 0.9$ *(Table 3.4 EN 1993-1-8:2005)*

$\lambda_{m2} = 1.25$ *(Table 5.1 EN 1993-1-4:2006)*

Tensile Resistance Check: *(Table 3.4 EN 1993-1-8:2005)*

$F_{t,Ed}$: *is the design tensile force per bolt for the ultimate limit state.*

$F_{t,Rd}$: *is the design tension resistance per bolt.*

$$F_{t,Ed} = \frac{\frac{1.0kN}{m^2} \times 1.5 \times 1.100m \times 1.0m \times 0.6 \times \frac{1.100m}{2}}{0.0325} = 16.75kN$$

$$F_{t,Rd} = \frac{K_2 F_{ub} A}{\lambda m2} \rightarrow F_{t,Rd} = \frac{0.9 \times 800 \times 58 \times 10^{-3}}{1.25} = 33.41kN > 16.75kN$$ **Okay**

Shear Resistance Check: *(Table 3.4 EN 1993-1-8:2005)*

$F_{v,Ed}$: *is the design shear force per bolt for the ultimate limit state.*

$F_{v,Rd}$: *is the design shear resistance per bolt.*

$$F_{V,Ed} = \frac{1.0kN}{m^2} \times 1.5 \times 0.6 \times 1.100m \times 1.0m = 0.99kN$$

$$F_{V,Rd} = \frac{\alpha F_{ub} A}{\lambda m2} \rightarrow F_{V,Rd} = \frac{0.6 \times 58 \times 800 \times 10^{-3}}{1.25} = 22.27kN > 0.99kN$$ **Okay**

Combined Shear & Tensile Resistance Check: *(Table 3.4 EN 1993-1-8:2005)*

$$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1.4F_{t,Rd}} \leq 1 \rightarrow \frac{0.99}{22.27} + \frac{16.75}{1.4 \times 33.41} = 0.4 \leq 1$$ **Okay**

Therefore, use 1Nr M10 Grade 8.8 hex head Bolts at 600mm c/c.

Connection To Wood:

$f_y = 640\ MPa$ *(Grade 8.8 Mild Steel, Table 3.1 EN 1993-1-8:2005)*

$f_{ub} = 800\ MPa$ *(Grade 8.8 Mild Steel, Table 3.1 EN 1993-1-8:2005)*

$f_u = 800\ MPa$ *(6.2 EN 1993-1-4:2006)*

$\alpha v = 0.6$ *(6.2 EN 1993-1-4:2006)*

$\alpha b = 1$ *(Table 3.4 EN 1993-1-8:2005)*

$A = 58mm^2$ *(For M10 Bolts)*

$K_1 = 2.5$ *(Table 3.4 EN 1993-1-8:2005)*

$K_2 = 0.9$ *(Table 3.4 EN 1993-1-8:2005)*

d = 5mm *(Minimum)*

t = 9mm

$\lambda_{m2} = 1.25$ *(Table 5.1 EN 1993-1-4:2006)*

Tensile Resistance Check: *(Table 3.4 EN 1993-1-8:2005)*

$F_{t,Ed}$: *is the design tensile force per bolt for the ultimate limit state.*

$F_{t,Rd}$: *is the design tension resistance per bolt.*

$$\mathrm{F_{t,Ed}} = 16.75\mathrm{kN\ (ULS)}$$

$$\mathrm{F_{t,Rd}} = \frac{\mathrm{K_2 F_{ub} A}}{\lambda \mathrm{m2}} \rightarrow \mathrm{F_{t,Rd}} = \frac{0.9\times800\times58\times10^{-3}}{1.25} = 33.41\mathrm{kN} > 16.75\mathrm{kN}$$ **Okay**

Bearing Resistance Check: (Table 3.4 EN 1993-1-8:2005)

$F_{b,Rd}$: *is the design bearing resistance per bolt.*

$$\mathrm{F_{b,Rd}} = \frac{\mathrm{K_1 \alpha b F_u d t}}{\lambda \mathrm{m2}} \rightarrow \mathrm{F_{b,Rd}} = \frac{2.5\mathrm{x}1\mathrm{x}800\mathrm{x}5\mathrm{x}9}{1.25} = 72\mathrm{kN} > 16.75\mathrm{kN}$$ **Okay**

Therefore, use 1Nr M10 Grade 8.8 hex head Bolts at 600mm c/c.

Appendix A - Fischer Reports

TSA is Both the Designer and the Specifier of the Fixings.

MASONRY FIXINGS

Unit 83, Cherry Orchard Industrial Estate
Dublin 10
Phone: +353 1 642 6700
Fax: +353 1 626 2197
technical@masonryfixings.ie
www.masonryfixings.ie

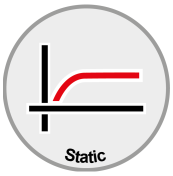
Design Specifications

Anchor

Anchor system	fischer Injection system FIS V
Injection resin	FIS V 360 S
Fixing element	Threaded rod FIS A M 10 x 110, zinc plated steel, Property Class 5.8
Calculated anchorage depth	60 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-02/0024, Option 1, Issued 13/05/2020

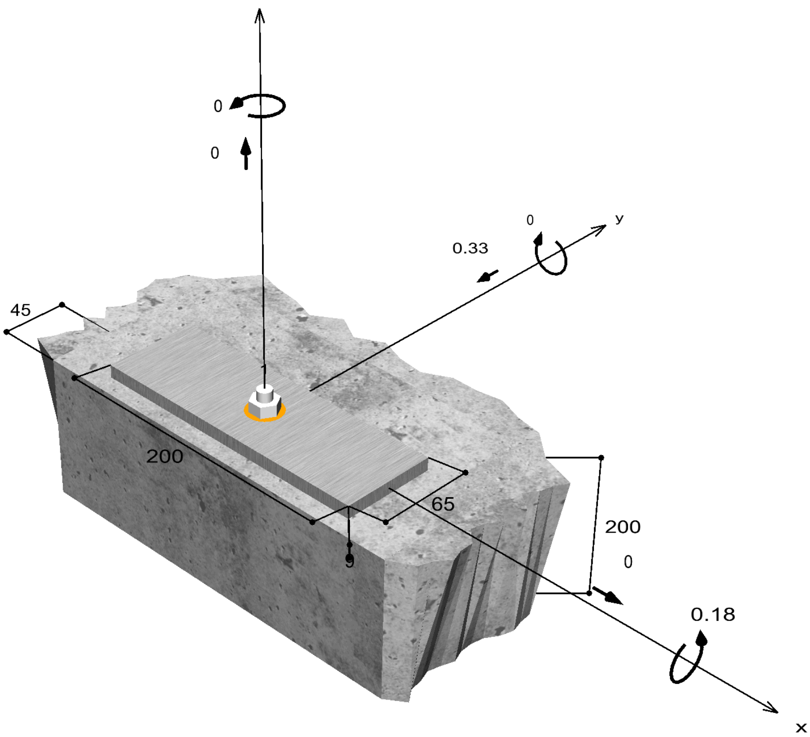
Geometry / Loads / Scale units

mm, kN, kNm



Value of design actions (including

partial safety factor for the load)



Not drawn to scale

Input data

Design method	Design Method EN1992-4:2018 bonded fastener
Base material	C30/37, EN 206
Concrete condition	Non-cracked, dry hole
Temperature range	24 °C long term temperature, 40 °C short term temperature
Reinforcement	Normal or no reinforcement. No edge reinforcement
Drilling method	Hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap filled
Type of loading	Permanent-Transient/Static
Base plate location	Base plate flush installed on base material
Base plate geometry	200 mm x 65 mm x 9 mm
Profile type	None

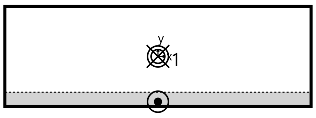
Design actions *)

#	N_{Ed} kN	$V_{Ed,x}$ kN	$V_{Ed,y}$ kN	$M_{Ed,x}$ kNm	$M_{Ed,y}$ kNm	$M_{T,Ed}$ kNm	Type of loading
1	0.00	0.00	-0.33	0.18	0.00	0.00	Permanent-Transient/Static

*) The required partial safety factors for actions are included

Resulting anchor forces

Anchor no.	Tensile action kN	Shear Action kN	Shear Action x kN	Shear Action y kN
1	6.12	0.33	0.00	-0.33



max. concrete compressive strain :	0.20 ‰
max. concrete compressive stress :	6.6 N/mm²
Resulting tensile actions :	6.12 kN , X/Y position (0 / 0)
Resulting compression actions :	6.12 kN , X/Y position (0 / -29)

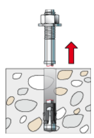
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	6.12	19.33	31.7
Combined pull-out and concrete cone failure	6.12	9.69	**63.1**
Concrete cone failure	6.12	11.90	51.4
Splitting failure	6.12	14.47	42.3

* Most unfavourable anchor

Steel failure

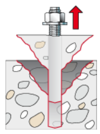
$$N_{Ed} \leq \frac{N_{Rk,s}}{\gamma_{Ms}}$$ **($N_{Rd,s}$)**



$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
29.00	1.50	19.33	6.12	31.7

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	31.7	1	$\beta_{N,s;1}$

Combined pull-out and concrete cone failure



$$N_{Ed} \leq \frac{N_{Rk,p}}{\gamma_{Mp}} \quad (N_{Rd,p})$$

$$N_{Rk,p} = N^0_{Rk,p} \cdot \frac{A_{p,N}}{A^0_{p,N}} \cdot \Psi_{s,Np} \cdot \Psi_{g,Np} \cdot \Psi_{ec,Np} \cdot \Psi_{re,Np}$$ Eq. (7.13)

$$N_{Rk,p} = 22.81kN \cdot \frac{24{,}300mm^2}{32{,}400mm^2} \cdot 0.850 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 14.54kN$$

$$N^0_{Rk,p} = \Psi_{sus} \cdot \pi \cdot d \cdot h_{ef} \cdot \tau_{Rk} = 1.00 \cdot \pi \cdot 10mm \cdot 60mm \cdot 12.1N/mm^2 = 22.81kN$$ Eq. (7.14)

$$\Psi_{sus} = 1.00$$ Eq. (7.14a)

$$\alpha_{sus} = 0.00 \leq \Psi^0_{sus} = 0.74$$

$$s_{cr,Np} = min\left(7.3 \cdot d \cdot \left(\Psi_{sus} \cdot \tau_{Rk,ucr}\right)^{0.5}; 3 \cdot h_{ef}\right)$$ Eq. (7.15)

$$s_{cr,Np} = min\left(7.3 \cdot 10mm \cdot \left(1.00 \cdot 11.0N/mm^2\right)^{0.5}; 3 \cdot 60mm\right) = 180mm$$

$$c_{cr,Np} = \frac{S_{cr,Np}}{2} = \frac{180mm}{2} = 90mm$$ Eq. (7.16)

$$\Psi_{s,Np} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}} = 0.7 + 0.3 \cdot \frac{45mm}{90mm} = 0.850 \leq 1$$ Eq. (7.20)

$$\Psi_{g,Np} = max\left(1; \Psi^0_{g,Np} - \sqrt{\frac{s}{s_{cr,Np}}} \cdot \left(\Psi^0_{g,Np} - 1\right)\right) = 1.000 - \sqrt{\frac{0mm}{180mm}} \cdot \left(1.000 - 1\right) = 1.000 \geq 1$$ Eq. (7.17)

$$\Psi^0_{g,Np} = max\left(1; \sqrt{n} - \left(\sqrt{n} - 1\right) \cdot \left(\frac{\tau_{Rk}}{\tau_{Rk,c}}\right)^{1.5}\right)$$ Eq. (7.18)

$$\Psi^0_{g,Np} = max\left(1; \sqrt{1} - \left(\sqrt{1} - 1\right) \cdot \left(\frac{12.1N/mm^2}{14.9N/mm^2}\right)^{1.5}\right) = 1.000 \geq 1$$

$$\tau_{Rk,c} = \frac{k_3}{\pi \cdot d}\sqrt{h_{ef} \cdot f_{ck}} = \frac{11}{3.14 \cdot 10mm}\sqrt{60mm \cdot 30.0N/mm^2} = 14.9N/mm^2$$ Eq. (7.19)

$$\Psi_{ec,Np} = \frac{1}{1 + \frac{2e_n}{s_{cr,Np}}} = \Psi_{ec,Npx} \cdot \Psi_{ec,Npy} = 1.000 \cdot 1.000 = 1.000 \leq 1$$ Eq. (7.21)

$$\Psi_{ec,Npx} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Npy} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1$$

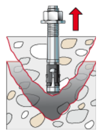
$$\Psi_{re,Np} = 1.000$$ Eq. (7.5)

$N_{Rk,p}$ kN	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
14.54	1.50	9.69	6.12	63.1

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	63.1	1	$\beta_{N,p;1}$

Concrete cone failure

$$N_{Ed} \leq \frac{N_{Rk,c}}{\gamma_{Mc}} \quad (N_{Rd,c})$$



$$N_{Rk,c} = N^0_{Rk,c} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \Psi_{s,N} \cdot \Psi_{re,N} \cdot \Psi_{ec,N} \cdot \Psi_{M,N}$$ Eq. (7.1)

$$N_{Rk,c} = 28.00kN \cdot \frac{24{,}300mm^2}{32{,}400mm^2} \cdot 0.850 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 17.85kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 11.0 \cdot \sqrt{30.0N/mm^2} \cdot \left(60mm\right)^{1.5} = 28.00kN$$ Eq. (7.2)

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} = 0.7 + 0.3 \cdot \frac{45mm}{90mm} = 0.850 \leq 1$$ Eq. (7.4)

$$\Psi_{re,N} = 1.000$$ Eq. (7.5)

$$\Psi_{ec,N} = \frac{1}{1 + \frac{2e_n}{s_{cr,N}}} \Longrightarrow \Psi_{ec,Nx} \cdot \Psi_{ec,Ny} = 1.000 \cdot 1.000 = 1.000 \leq 1$$ Eq. (7.6)

$$\Psi_{ec,Nx} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1$$

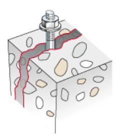
$$\Psi_{M,N} = 1.00 \geq 1$$ Eq. (7.7)

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
17.85	1.50	11.90	6.12	51.4

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	51.4	1	$\beta_{N,c;1}$

Splitting failure due to loading

$$N_{Ed} \leq \frac{N_{Rk,sp}}{\gamma_{Msp}} \quad (N_{Rd,sp})$$



$$N_{Rk,sp} = N^0_{Rk,sp} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \Psi_{s,N} \cdot \Psi_{re,N} \cdot \Psi_{ec,N} \cdot \Psi_{h,sp}$$ Eq. (7.23)

$$N_{Rk,sp} = 22.81kN \cdot \frac{12{,}600mm^2}{14{,}400mm^2} \cdot 0.925 \cdot 1.000 \cdot 1.000 \cdot 1.176 = 21.71kN$$

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,sp}} = 0.7 + 0.3 \cdot \frac{45mm}{60mm} = 0.925 \leq 1$$ Eq. (7.4)

$$\Psi_{re,N} = 1.000$$ Eq. (7.5)

$$\Psi_{ec,N} = \frac{1}{1 + \frac{2e_n}{s_{cr,sp}}} = \Psi_{ec,Nx} \cdot \Psi_{ec,Ny} = 1.000 \cdot 1.000 = 1.000 \leq 1$$ Eq. (7.6)

$$\Psi_{ec,Nx} = \frac{1}{1 + \frac{2 \cdot 0mm}{120mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1 + \frac{2 \cdot 0mm}{120mm}} = 1.000 \leq 1$$

$$\Psi_{h,sp} = min\left(\left(\frac{h}{h_{min}}\right)^{2/3}; max\left(1; \left(\frac{h_{ef} + 1.5\ c_1}{h_{min}}\right)^{2/3}\right); 2\right)$$ Eq. (7.24)

$$\Psi_{h,sp} = min\left(\left(\frac{200mm}{100mm}\right)^{2/3}; max\left(1; \left(\frac{60mm + 1.5 \cdot 45mm}{100mm}\right)^{2/3}\right); 2\right) = 1.176$$

$N_{Rk,sp}$ kN	γ_{Msp}	$N_{Rd,sp}$ kN	N_{Ed} kN	$\beta_{N,sp}$ %
21.71	1.50	14.47	6.12	42.3

Anchor no.	$\beta_{N,sp}$ %	Group N°	Decisive Beta
1	42.3	1	$\beta_{N,sp;1}$

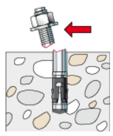
Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	0.33	13.60	2.4
Concrete pry-out failure	0.33	19.39	1.7
Concrete edge failure	0.33	4.67	**7.1**

* Most unfavourable anchor

Steel failure without lever arm

$$V_{Ed} \leq \frac{V_{Rk,s}}{\gamma_{Ms}}$$ **($V_{Rd,s}$)**



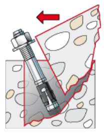
$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 17.00kN = 17.00kN$$ Eq. (7.35)/ (7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
17.00	1.25	13.60	0.33	2.4

Anchor no.	β_{Vs} %	Group N°	Decisive Beta
1	2.4	1	$\beta_{Vs;1}$

Concrete pry-out failure

$$V_{Ed} \leq \frac{V_{Rk,cp}}{\gamma_{Mc}} \quad (\mathbf{V_{Rd,cp}})$$



$$V_{Rk,cp} = k_8 \cdot N_{Rk,p} = 2 \cdot 14.54kN = 29.08kN$$ Eq. (7.39c)

$$N_{Rk,p} = N^0_{Rk,p} \cdot \frac{A_{p,N}}{A^0_{p,N}} \cdot \Psi_{s,Np} \cdot \Psi_{g,Np} \cdot \Psi_{ec,Np} \cdot \Psi_{re,Np}$$ Eq. (7.13)

$$N_{Rk,p} = 22.81kN \cdot \frac{24{,}300mm^2}{32{,}400mm^2} \cdot 0.850 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 14.54kN$$

$$N^0_{Rk,p} = \Psi_{sus} \cdot \pi \cdot d \cdot h_{ef} \cdot \tau_{Rk} = 1.00 \cdot \pi \cdot 10mm \cdot 60mm \cdot 12.1N/mm^2 = 22.81kN$$ Eq. (7.14)

$$\Psi_{sus} = 1.00$$ Eq. (7.14a)

$$\alpha_{sus} = 0.00 \leq \Psi^0_{sus} = 0.74$$

$$s_{cr,Np} = min\left(7.3 \cdot d \cdot \left(\Psi_{sus} \cdot \tau_{Rk,ucr}\right)^{0.5}; 3 \cdot h_{ef}\right)$$ Eq. (7.15)

$$s_{cr,Np} = min\left(7.3 \cdot 10mm \cdot \left(1.00 \cdot 11.0N/mm^2\right)^{0.5}; 3 \cdot 60mm\right) = 180mm$$

$$c_{cr,Np} = \frac{S_{cr,Np}}{2} = \frac{180mm}{2} = 90mm$$ Eq. (7.16)

$$\Psi_{s,Np} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}} = 0.7 + 0.3 \cdot \frac{45mm}{90mm} = 0.850 \leq 1$$ Eq. (7.20)

$$\Psi_{g,Np} = max\left(1; \Psi^0_{g,Np} - \sqrt{\frac{s}{s_{cr,Np}}} \cdot \left(\Psi^0_{g,Np} - 1\right)\right)$$ Eq. (7.17)

$$\Psi_{g,Np} = max\left(1; 1.000 - \sqrt{\frac{0mm}{180mm}} \cdot \left(1.000 - 1\right)\right) = 1.000 \geq 1$$

$$\Psi^0_{g,Np} = max\left(1; \sqrt{n} - \left(\sqrt{n} - 1\right) \cdot \left(\frac{\tau_{Rk}}{\tau_{Rk,c}}\right)^{1.5}\right)$$ Eq. (7.18)

$$\Psi^0_{g,Np} = max\left(1; \sqrt{1} - \left(\sqrt{1} - 1\right) \cdot \left(\frac{12.1N/mm^2}{14.9N/mm^2}\right)^{1.5}\right) = 1.000 \geq 1$$

$$\tau_{Rk,c} = \frac{k_3}{\pi \cdot d}\sqrt{h_{ef} \cdot f_{ck}} = \frac{11}{3.14 \cdot 10mm}\sqrt{60mm \cdot 30.0N/mm^2} = 14.9N/mm^2$$ Eq. (7.19)

$$\Psi_{ec,Np} = \frac{1}{1 + \frac{2e_n}{s_{cr,Np}}} = \Psi_{ec,Npx} \cdot \Psi_{ec,Npy} = 1.000 \cdot 1.000 = 1.000 \leq 1$$ Eq. (7.21)

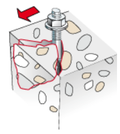
$$\Psi_{re,Np} = 1.000$$ Eq. (7.5)

$V_{Rk,cp}$ kN	γ_{Mcp}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
29.08	1.50	19.39	0.33	1.7

Anchor no.	$\beta_{V,cp}$ %	Group N°	Decisive Beta
1	1.7	1	$\beta_{V,cp;1}$

Concrete edge failure

$$V_{Ed} \leq \frac{V_{Rk,c}}{\gamma_{Mc}} \quad (V_{Rd,c})$$



$$V_{Rk,c} = V^0_{Rk,c} \cdot \frac{A_{c,V}}{A^0_{c,V}} \cdot \Psi_{s,V} \cdot \Psi_{h,V} \cdot \Psi_{\alpha,V} \cdot \Psi_{ec,V} \cdot \Psi_{re,V}$$ Eq. (7.40)

$$V_{Rk,c} = 7.01kN \cdot \frac{9{,}113mm^2}{9{,}113mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 7.01kN$$

$$V^0_{Rk,c} = k_9 \cdot d^{\alpha} \cdot l_f^{\beta} \cdot \sqrt{f_{ck}} \cdot c_1^{1.5}$$ Eq. (7.41)

$$V^0_{Rk,c} = 2.4 \cdot \left(10mm\right)^{0.115} \cdot \left(60mm\right)^{0.074} \cdot \sqrt{30.0N/mm^2} \cdot \left(45mm\right)^{1.5} = 7.01kN$$

$$\alpha = 0.1 \cdot \sqrt{\frac{l_f}{c_1}} = 0.1 \cdot \sqrt{\frac{60mm}{45mm}} = 0.115 \qquad \beta = 0.1 \cdot \left(\frac{d}{c_1}\right)^{0.2} = 0.1 \cdot \left(\frac{10mm}{45mm}\right)^{0.2} = 0.074$$ Eq. (7.42/7.43)

$$\Psi_{s,V} = 0.7 + 0.3 \cdot \frac{c_2}{1.5c_1} = 0.7 + 0.3 \cdot \frac{68mm}{1.5 \cdot 45mm} = 1.000 \leq 1$$ Eq. (7.45)

$$\Psi_{h,V} = max\left(1; \sqrt{\frac{1.5c_1}{h}}\right) = max\left(1; \sqrt{\frac{1.5 \cdot 45mm}{200mm}}\right) = 1.000 \geq 1$$ Eq. (7.46)

$$\Psi_{\alpha,V} = \sqrt{\frac{1}{\left(cos\ \alpha_V\right)^2 + \left(0.5 \cdot sin\ \alpha_V\right)^2}} = \sqrt{\frac{1}{\left(cos\ 0.0\right)^2 + \left(0.5 \cdot sin\ 0.0\right)^2}} = 1.000 \geq 1$$ Eq. (7.48)

$$\Psi_{ec,V} = \frac{1}{1 + \frac{2}{3}\frac{e_v}{c_1}} = \frac{1}{1 + \frac{2 \cdot 0mm}{3 \cdot 45mm}} = 1.000 \leq 1$$ Eq. (7.47)

$$\Psi_{re,V} = 1.000$$

$V_{Rk,c}$ kN	γ_{Mc}	$V_{Rd,c}$ kN	V_{Ed} kN	$\beta_{V,c}$ %
7.01	1.50	4.67	0.33	7.1

Anchor no.	$\beta_{V,c}$ %	Group N°	Decisive Beta
1	7.1	1	$\beta_{V,c;1}$

Utilization of tension and shear loads

Tension loads	Utilisation βN %
Steel failure *	31.7
Combined pull-out and concrete cone failure	**63.1**
Concrete cone failure	51.4
Splitting failure	42.3

Shear Loads	Utilisation βV %
Steel failure without lever arm *	2.4
Concrete pry-out failure	1.7
Concrete edge failure	**7.1**

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.32 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.02 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.10 \leq 1$$

Eq. (7.55)

Utilisation concrete

Proof successful

$$\beta_{N,p} = \beta_{N,p;1} = 0.63 \leq 1$$
$$\beta_{V.c} = \beta_{V,c;1} = 0.07 \leq 1$$
$$\beta_N^{1.5} + \beta_V^{1.5} = \beta_{N,p;1}^{1.5} + \beta_{V,c;1}^{1.5} = 0.52 \leq 1$$

Eq. (7.56)

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof t = 9 mm

Profile type None

Technical remarks

The transmission of the anchor loads to the supports of the concrete member shall be shown for the ultimate limit state and the serviceability limit state; for this purpose, the normal verifications shall be carried out under due consideration of the actions introduced by the anchors. For these verifications the additional provisions given in the current design method shall be taken into account.
As a pre-condition the anchor plate is assumed to be flat when subjected to the actions. Therefore, the plate (if present) must be sufficiently stiff. The C-Fix anchor plate design is based on a proof of stresses and does not allow a statement about the stiffness of the plate. The proof of the necessary stiffness is not carried out by C-Fix.

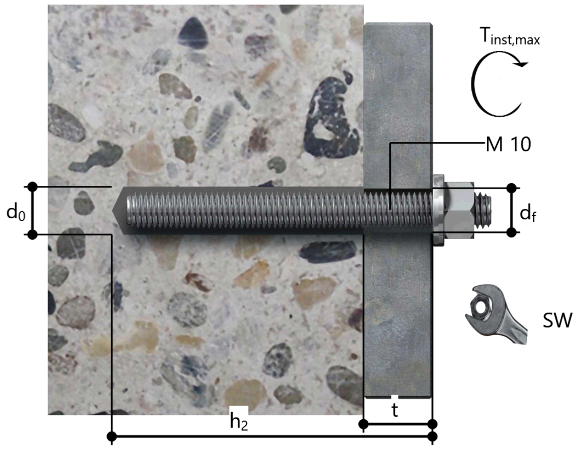
Installation data

Anchor

Anchor system	**fischer Injection system FIS V**	
Injection resin	FIS V 360 S (other cartridge sizes available)	Art.-No. 94405
Fixing element	Threaded rod FIS A M 10 x 110, zinc plated steel, Property Class 5.8	Art.-No. 90278
Accessories	FIS MR Plus	Art.-No. 545853
	Dispenser FIS DM S	Art.-No. 511118
	Blow-out pump ABG big	Art.-No. 89300
	Cleaning brush BS 12	Art.-No. 78179
	SDS Plus II 12/100/160	Art.-No. 531803
	or alternatively	
	FHD 12/200/330	Art.-No. 546597
	Hammer drilling with or without suction	

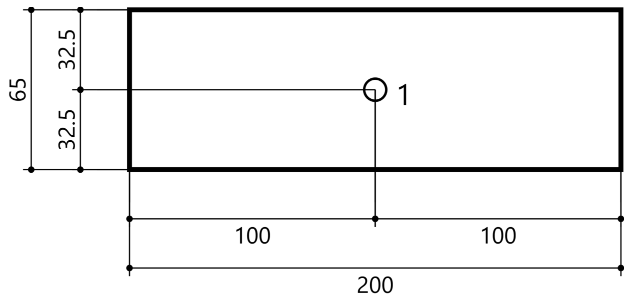
Installation details

Thread diameter	M 10
Drill hole diameter	d_0 = 12 mm
Drill hole depth	h_2 = 69 mm
Calculated anchorage depth	h_{ef} = 60 mm
Drilling method	Hammer drilling
Drill hole cleaning	4 times blowing, 4 times brushing, 4 times blowing required activities according the given instruction in the approval No borehole cleaning required in case of using a hollow drill bit, e.g. fischer FHD.
Installation type	Push-through installation
Annular gap	Annular gap filled
Maximum torque	$T_{inst,max}$ = 20.0 Nm
Socket size	17 mm
Base plate thickness	t = 9 mm
Total fixing thickness Tfix,max	t_{fix} = 9 mm
Volume of resin per drill hole	6 ml/3 scale divisions



Base plate details

Base plate material	Not available
Base plate thickness	t = 9 mm
Clearance hole in base plate	d_f=14 mm



Attachment

Profile type	None

Anchor coordinates

Anchor no.	x mm	y mm
1	0	0