TSA
TED SINGLETON & ASSOCIATES
CONSULTING ENGINEERS

Project: Privacy Screen	Contract: 1348-1
Subject: Glass Balustrade	Sheet No. 1
Date: 20/07/2020	By: R.F.

On Level Ltd.,

8, Alexandria Court
Ashton Commerce Park
Ashton-under-Lyne
Lancashire OL7 0QN
United Kingdom

Privacy Screen

1348-1 Glass Balustrade

Analysis By	Checked By
R.F.	T.S.

1	20/07/2020	T.S.	Issued
0	31/01/2020	T.S.	Issued
Revision	**Date**	**Issued By**	**Comment**

Contents

Introduction/Actions/Result Summary:

Introduction:

TSA was instructed by On Level to carry out calculations @1800mm high Privacy Screen. The balustrade load is applied @1800mm above FFL.

Actions:

Balustrade load = 0.74kN/m (Table NA.5 IS1991-1-1:2002)
Point load = 0.5kN (Table NA.4.2 IS 1991-1-1:2002)
Infill load = 1kN (Table NA.5 IS1991-1-1:2002)

Balustrade load = 1.5kN/m (Table NA.5 IS1991-1-1:2002)
Point load = 1.5kN (Table NA.6 IS1991-1-1:2002)
Infill load = 1.5kN/m2 (Table NA.6 IS1991-1-1:2002)

Assumption:

Concrete Grade = C30/37

Result Summary:

Study	Size of the Glass (m)	Glass (mm)	Interlayer	Working Line Load for System (kN/m)	Glass Deflection (mm)	Shoes Deflection (mm)		Combined TOTAL (mm)
Study 01	1.0 x 1.8	21.52	Sentry	0.74	12.15	TL 6020	6.67	18.82
Study 02	1.0 x 1.8	25.52	Sentry	0.74	7.19	TL 6030	3.58	10.77
Study 03	1.0 x 1.8	25.52	Sentry	0.74	7.19	TL 3030	3.72	10.91
Study 04	1.0 x 1.8	25.52	Sentry	1.5	14.57	TL 6030	7.26	21.83
Study 05	1.0 x 1.8	25.52	Sentry	1.5	14.57	TL 3030	7.53	22.1
Study 06	1.0 x 1.8	31.52	PVB	1.5	11.39	TL 6030	7.26	18.65
Study 07	1.0 x 1.8	31.52	PVB	1.5	11.39	TL 3030	7.53	18.92
Study 08	1.0 x 1.8	25.52	PVB	0.74	16.18	TL 6030	3.58	19.76
Study 09	1.0 x 1.8	25.52	PVB	1.5 (at 1.1m above FFL)	14.07	TL 6030	7.26	21.33

NOTE:

All combined deflection < 25mm and therefore acceptable

Glass Strength

Balustrade Loading:

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

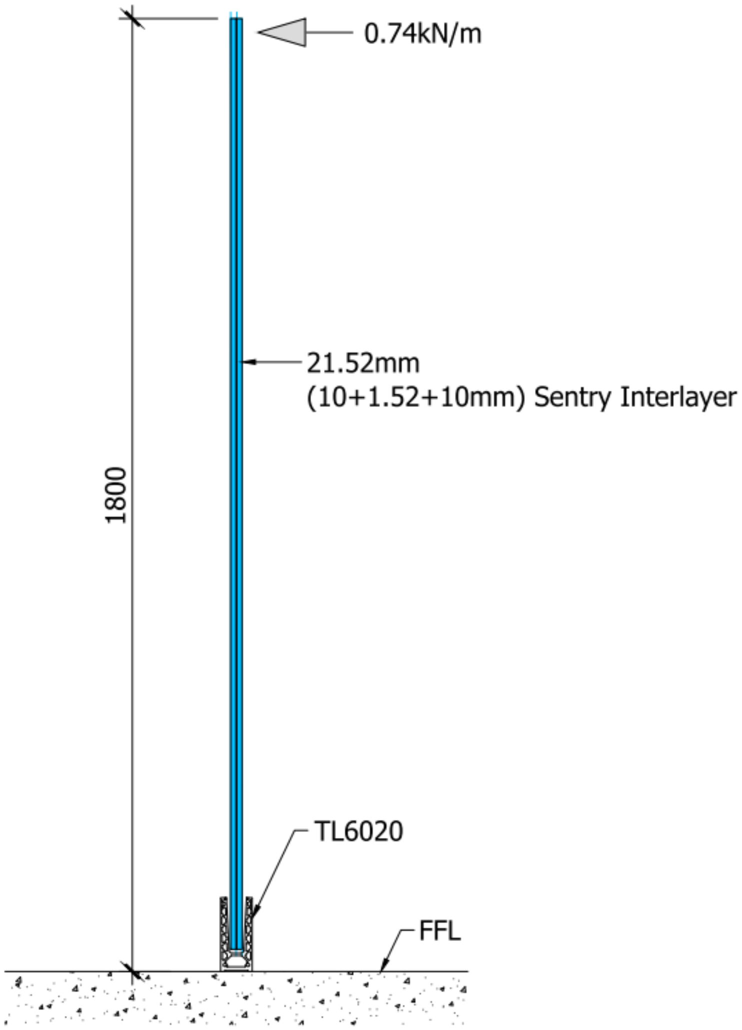
$f_{gd} = (k_{mod})(k_{sp})(f_{gk})/\ \gamma_{ma} + k_v(f_{bk}\text{-}f_{gk})/\gamma_{mv}$

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

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

Case Study 01:

Sketch - 21.52mm – 0.74kN/m (Glass) Sentry Interlayer and TL 6020:



NOTE:

- *Combined Deflection 6.67mm (Shoe) plus 12.15mm (Glass) = 18.82mm* ***OK in deflection***

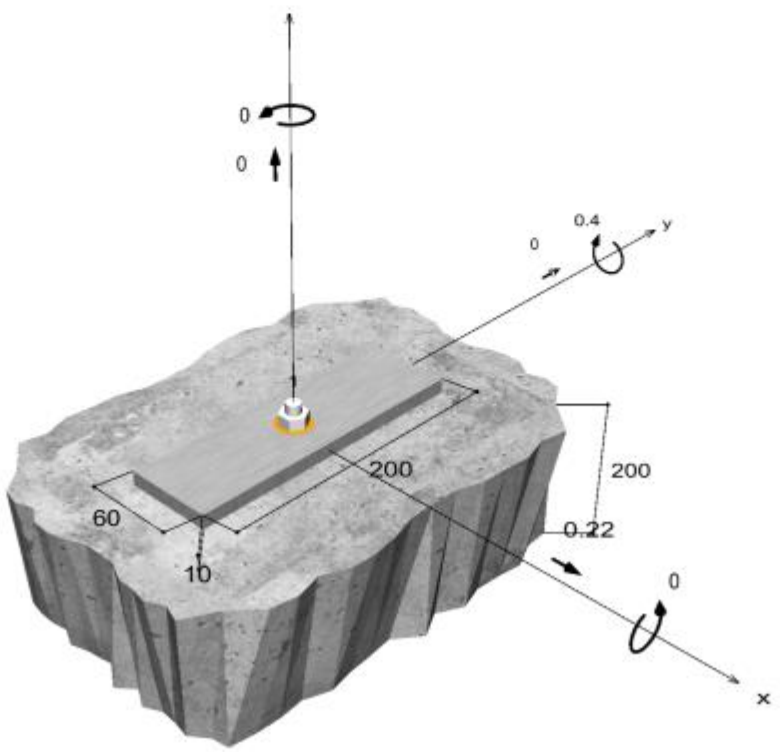
Connection To Concrete Design:

Loading at Connection:

$$\text{Shear Load} = 0.74\text{kN/m} \times 1.5 \times 0.2\text{m} = 0.222\text{kN (ULS)}$$

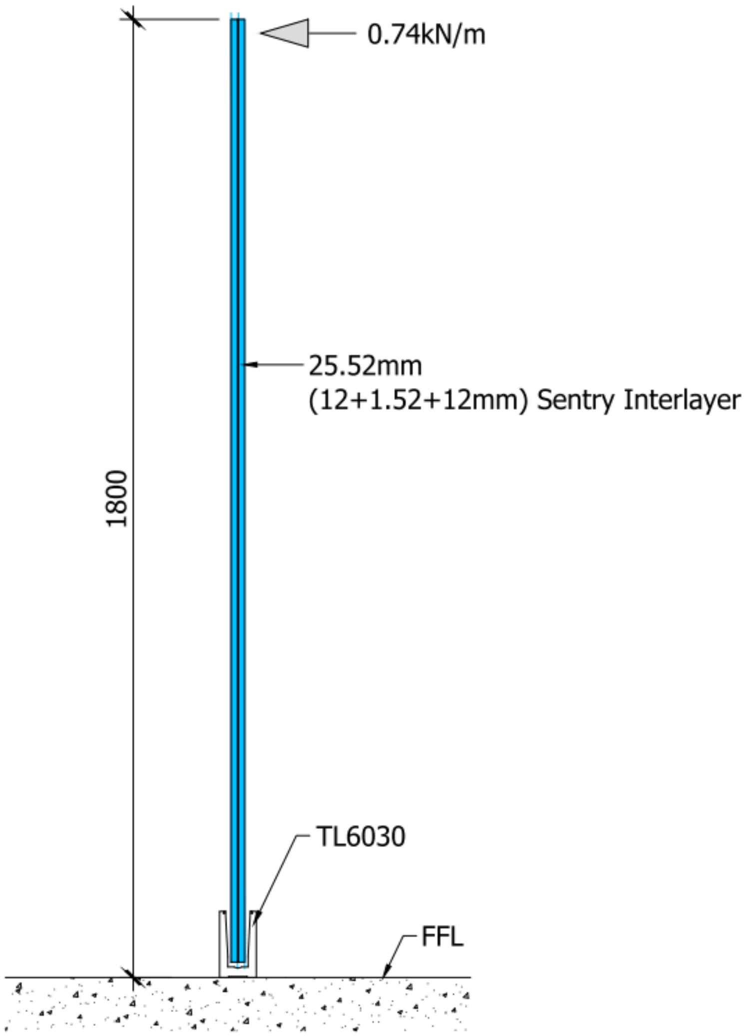
$$\text{Maximum Moment} = 0.74\text{kN/m} \times 1.5 \times 0.2\text{m} \times 1.8\text{m} = 0.4\text{kN (ULS)}$$

Therefore use 1Nr Threaded Rod FIS A M 10×150 Grade 8.8 Fischer Bolt with FIS V 360 S Chemical Resin @200mm C/C. See design in Appendix C.



Case Study 02:

Sketch - 25.52mm – 0.74kN/m (Glass) Sentry Interlayer and TL 6030:



NOTE:

- Combined Deflection 3.58mm (Shoe) plus 7.19mm (Glass) = 10.77mm **OK in deflection**

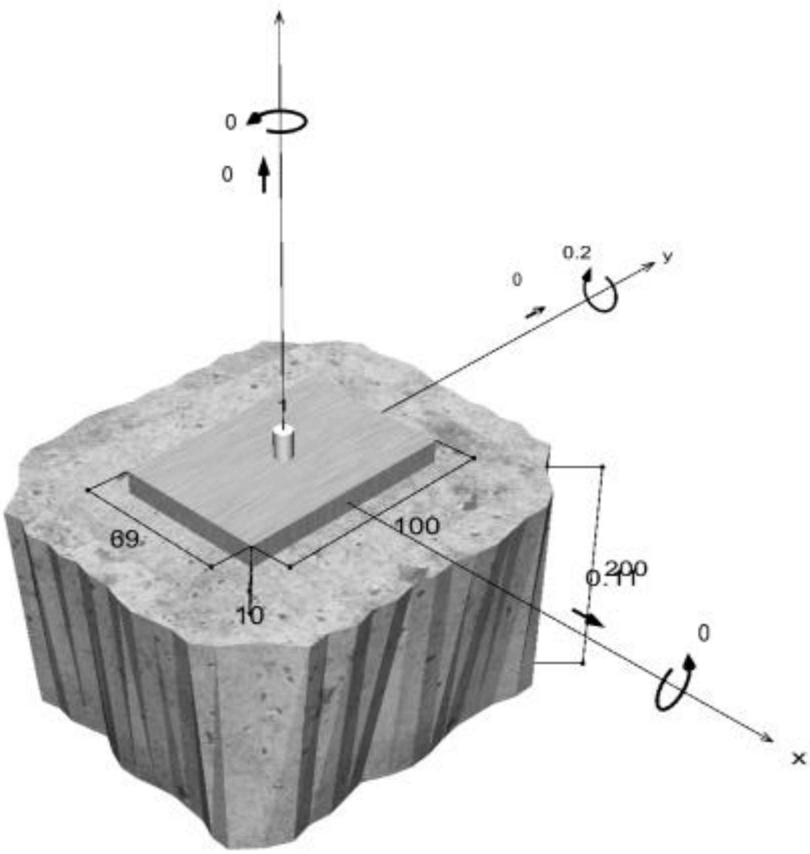
Connection To Concrete Design:

Loading at Connection:

$$\text{Shear Load} = 0.74\text{kN/m} \times 1.5 \times 0.1\text{m} = 0.111\text{kN (ULS)}$$

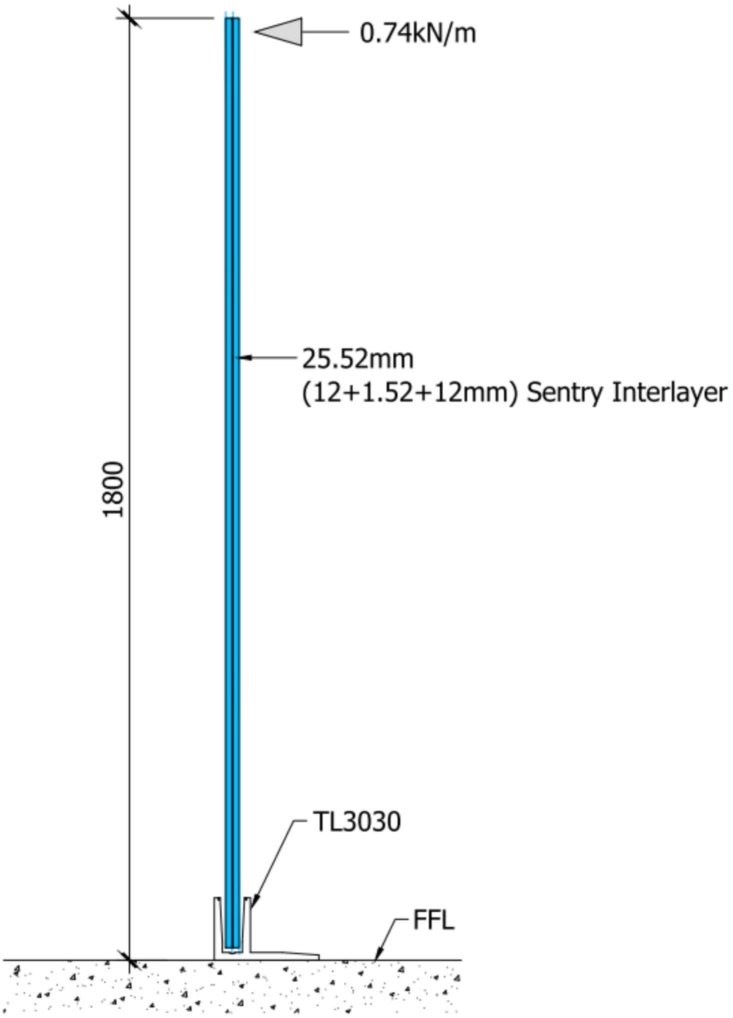
$$\text{Maximum Moment} = 0.74\text{kN/m} \times 1.5 \times 0.1\text{m} \times 1.8\text{m} = 0.2\text{kN (ULS)}$$

Therefore use 1Nr FH II 12/15 SK, Zinc Plated Steel @100mm C/C. See design in Appendix C.



Case Study 03:

Sketch - 25.52mm – 0.74kN/m (Glass) Sentry Interlayer and TL 3030:



NOTE:

- Combined Deflection 3.72mm (Shoe) plus 7.19mm (Glass) = 10.91mm **OK in deflection**

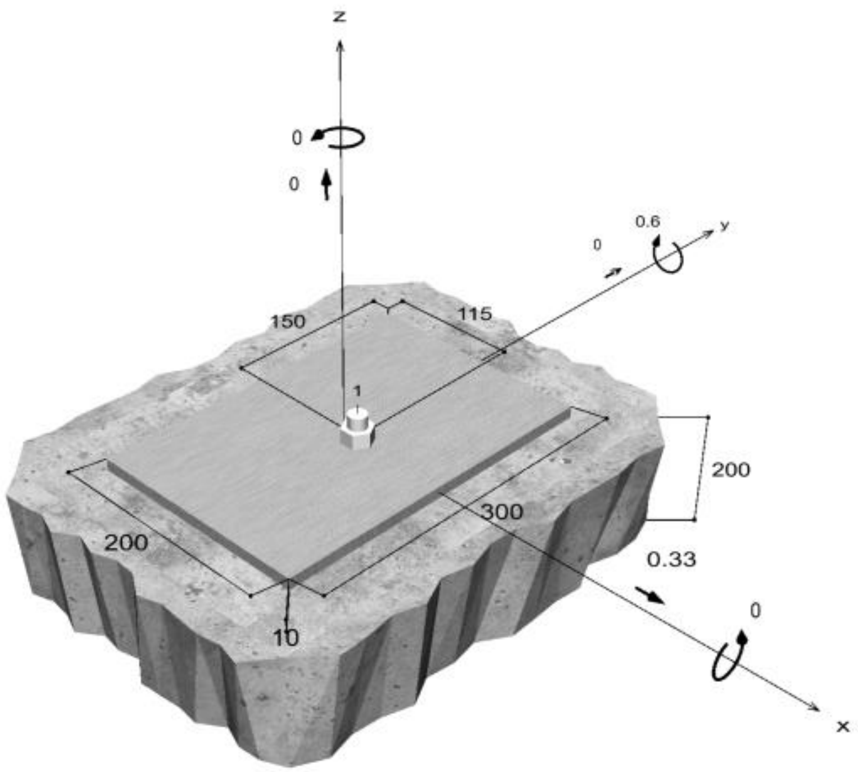
Connection To Concrete Design:

Loading at Connection:

$\text{Shear Load} = 0.74\text{kN/m} \times 1.5 \times 0.3\text{m} = 0.333\text{kN (ULS)}$

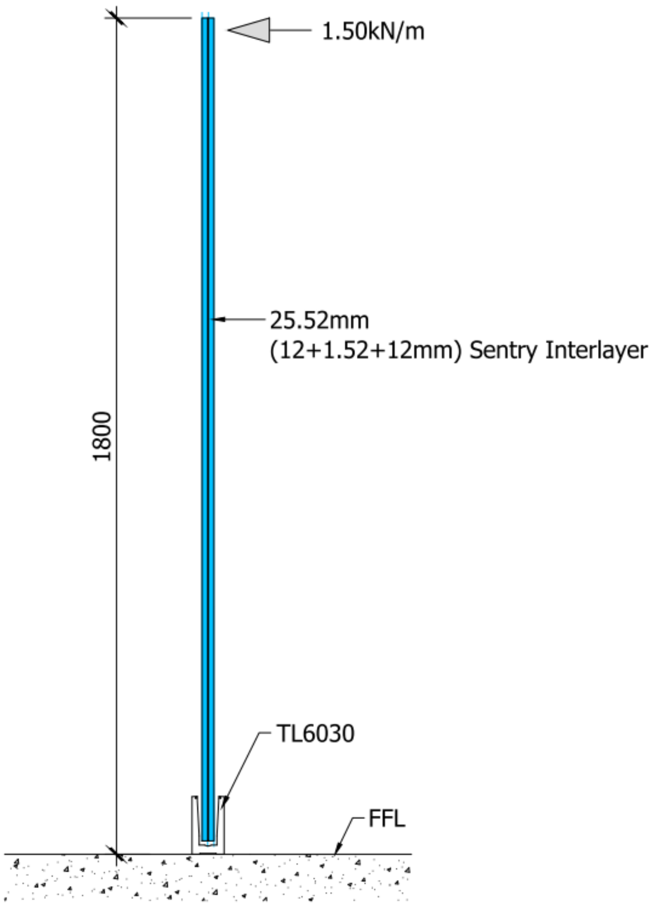
$\text{Maximum Moment} = 0.74\text{kN/m} \times 1.5 \times 0.3\text{m} \times 1.8\text{m} = 0.6\text{kN (ULS)}$

Therefore use 1Nr FAZ II 16/25, Zinc Plated Steel @300mm C/C. See design in Appendix C.



Case Study 04:

Sketch - 25.52mm – 1.5kN/m (Glass) Sentry Interlayer and TL 6030:



NOTE:

- Combined Deflection 7.26mm (Shoe) plus 14.57mm (Glass) = 21.83mm **OK in deflection**

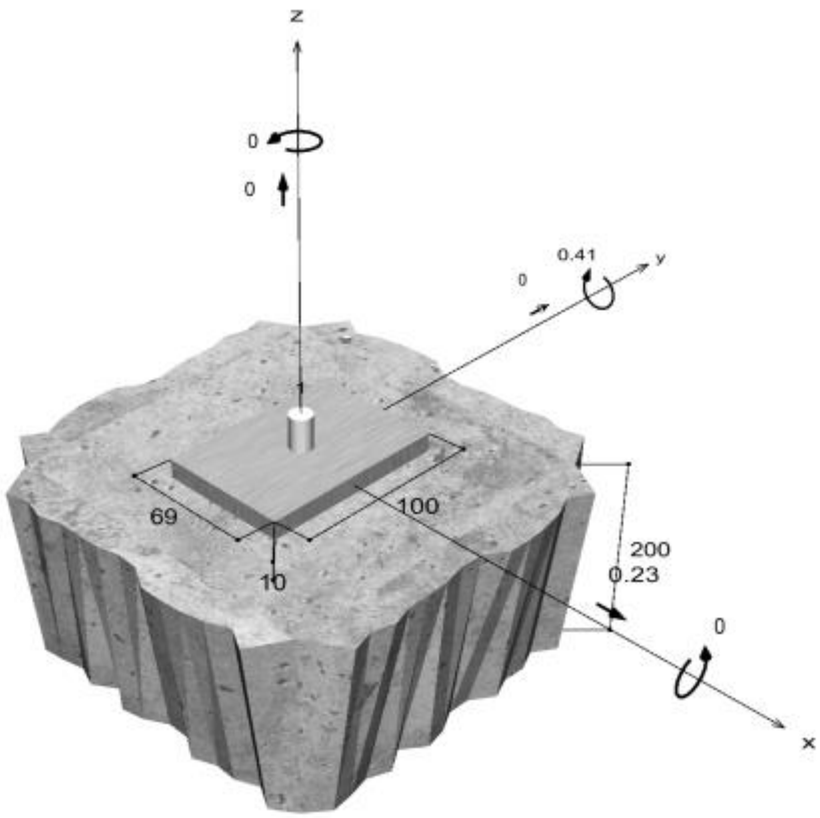
Connection To Concrete Design:

Loading at Connection:

$$\text{Shear Load} = 1.5\text{kN/m} \times 1.5 \times 0.1\text{m} = 0.23\text{kN (ULS)}$$

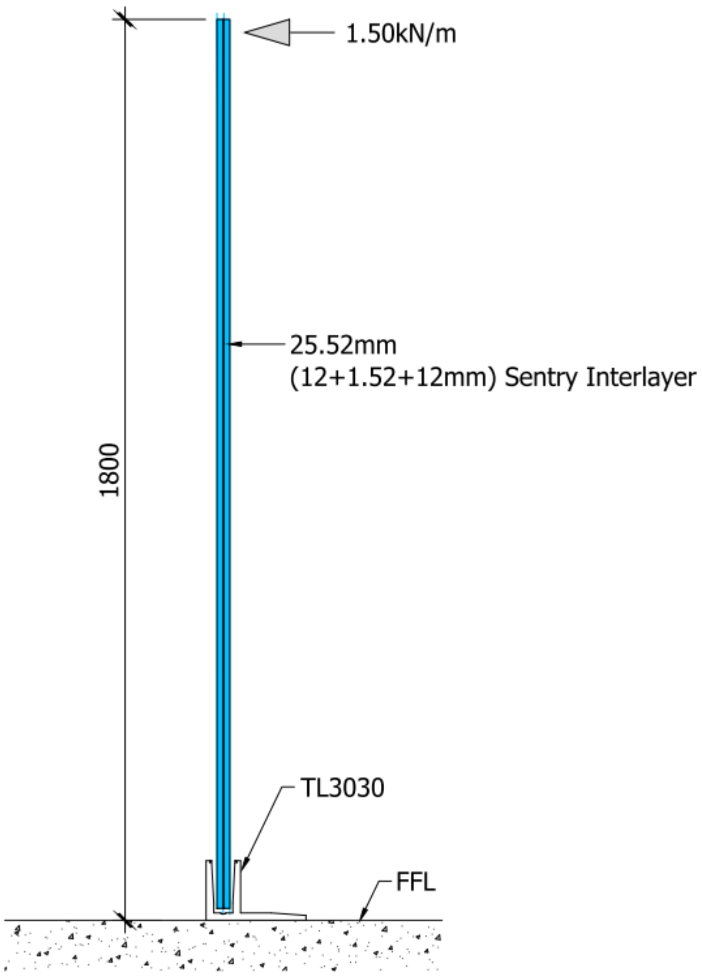
$$\text{Maximum Moment} = 1.5\text{kN/m} \times 1.5 \times 0.1\text{m} \times 1.8\text{m} = 0.41\text{kN (ULS)}$$

Therefore use 1Nr FH II 18/25, SK, Zinc Plated Steel @100mm C/C. See design in Appendix C.



Case Study 05:

Sketch - 25.52mm – 1.5kN/m (Glass) Sentry Interlayer and TL 3030:



NOTE:

- Combined Deflection 7.53mm (Shoe) plus 14.57mm (Glass) = 22.10mm **OK in deflection**

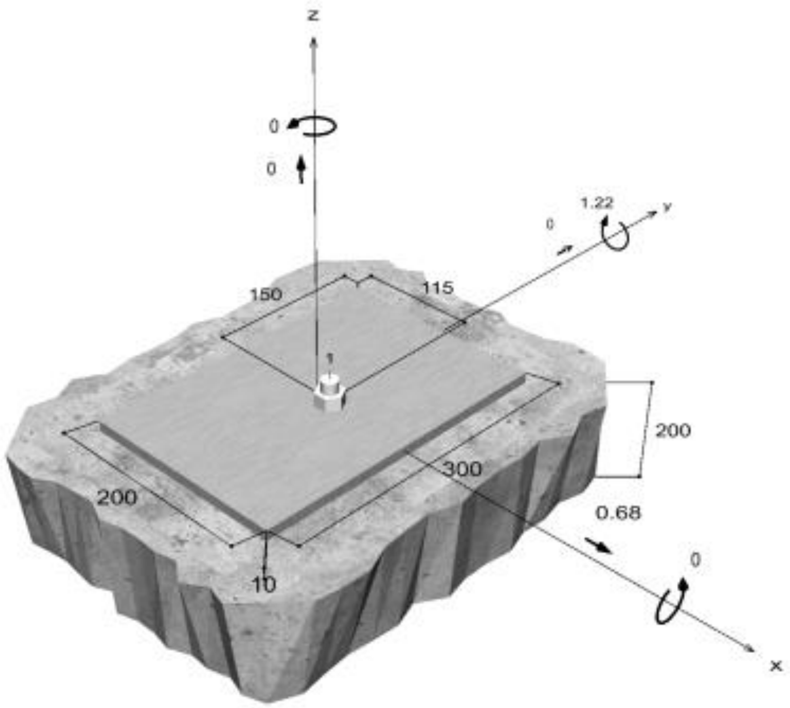
Connection To Concrete Design:

Loading at Connection:

$$\text{Shear Load} = 1.5\text{kN/m} \times 1.5 \times 0.3\text{m} = 0.0.675\text{kN (ULS)}$$

$$\text{Maximum Moment} = 1.5\text{kN/m} \times 1.5 \times 0.3\text{m} \times 1.8\text{m} = 1.22\text{kN (ULS)}$$

Therefore use 1Nr FAZ II 16/25, Zinc Plated Steel @300mm C/C. See design in Appendix C.



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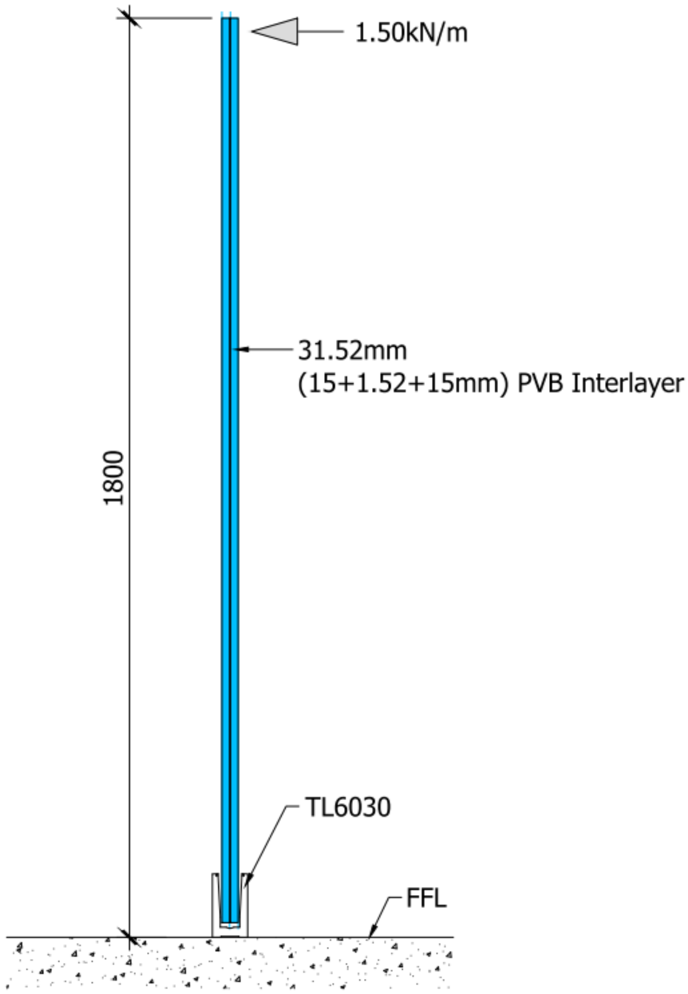
Case Study 06:

Sketch - 31.52mm – 1.5kN/m (Glass) PVB Interlayer and TL 6030:



NOTE:

- Combined Deflection 7.26mm (Shoe) plus 11.39mm (Glass) = 18.65mm **OK in deflection**

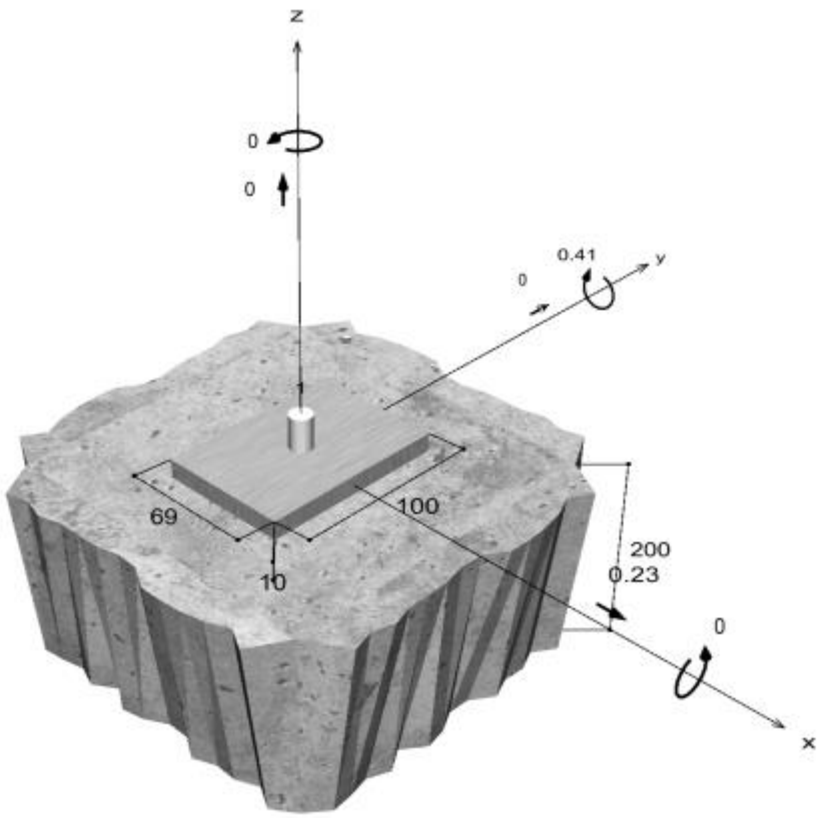
Connection To Concrete Design:

Loading at Connection:

$$\text{Shear Load} = 1.5\text{kN/m} \times 1.5 \times 0.1\text{m} = 0.23\text{kN (ULS)}$$

$$\text{Maximum Moment} = 1.5\text{kN/m} \times 1.5 \times 0.1\text{m} \times 1.8\text{m} = 0.41\text{kN (ULS)}$$

Therefore use 1Nr FH II 18/25, SK, Zinc Plated Steel @100mm C/C. See design in Appendix C.



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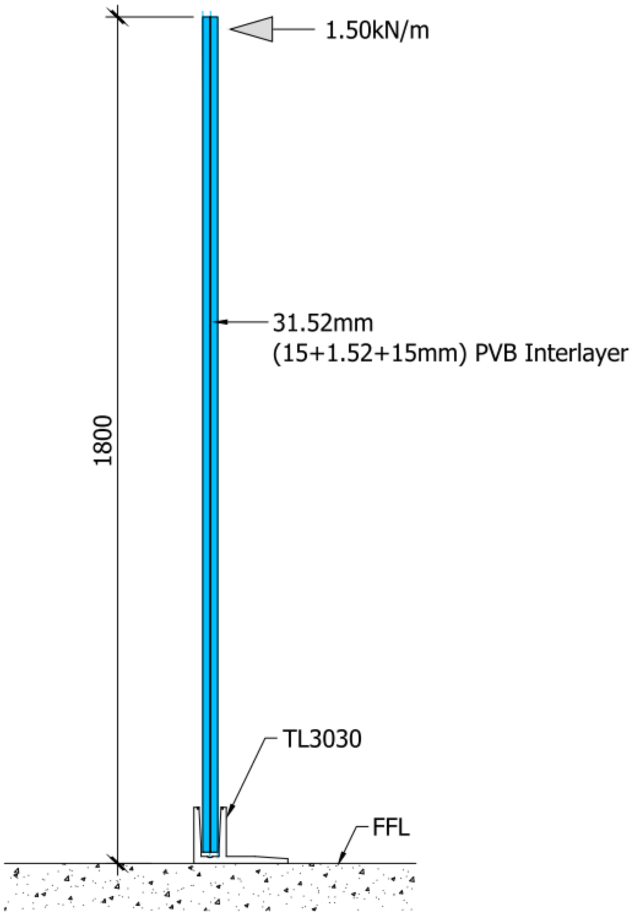
Case Study 07:

Sketch - 31.52mm – 1.5kN/m (Glass) PVB Interlayer and TL 3030:



NOTE:

- Combined Deflection 7.53mm (Shoe) plus 11.39mm (Glass) = 18.92mm **OK in deflection**

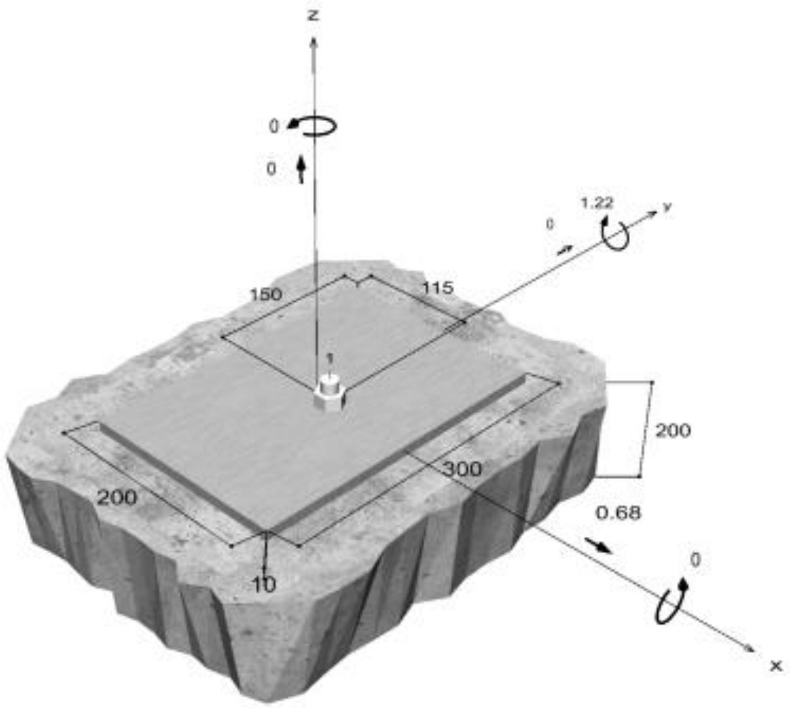
Connection To Concrete Design:

Loading at Connection:

$$\text{Shear Load} = 1.5\text{kN/m} \times 1.5 \times 0.3\text{m} = 0.0.675\text{kN (ULS)}$$

$$\text{Maximum Moment} = 1.5\text{kN/m} \times 1.5 \times 0.3\text{m} \times 1.8\text{m} = 1.22\text{kN (ULS)}$$

Therefore use 1Nr FAZ II 16/25, Zinc Plated Steel @300mm C/C. See design in Appendix C.



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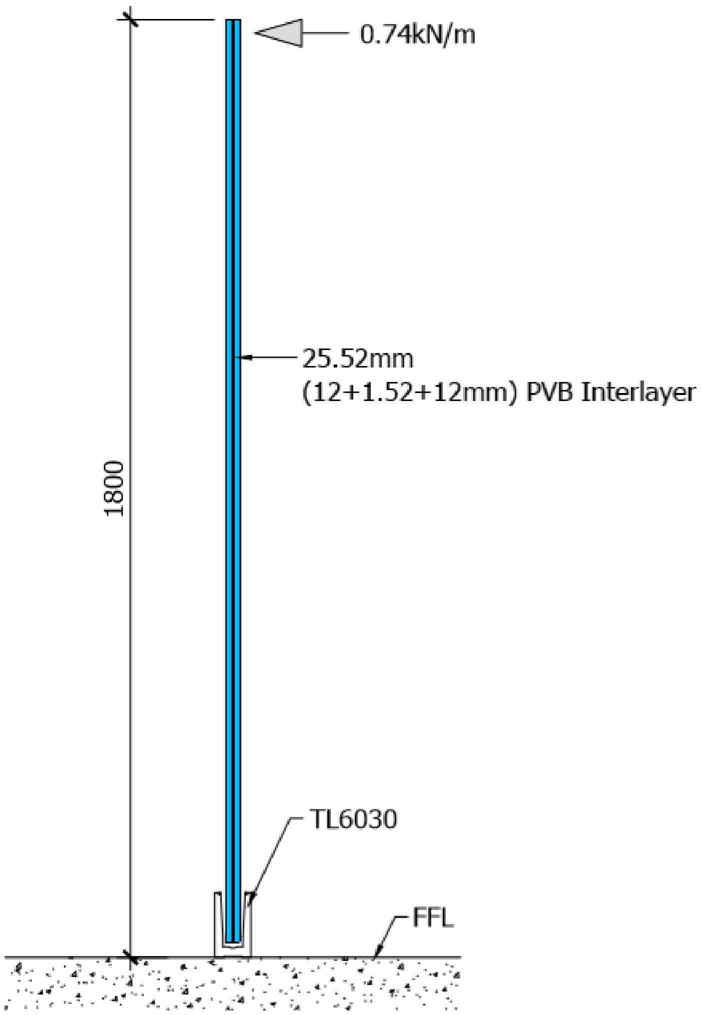
Case Study 08:

Sketch - 25.52mm – 0.74kN/m (Glass) PVB Interlayer and TL 6030:



NOTE:

- Combined Deflection 3.58mm (Shoe) plus 16.18mm (Glass) = 19.76mm **OK in deflection**

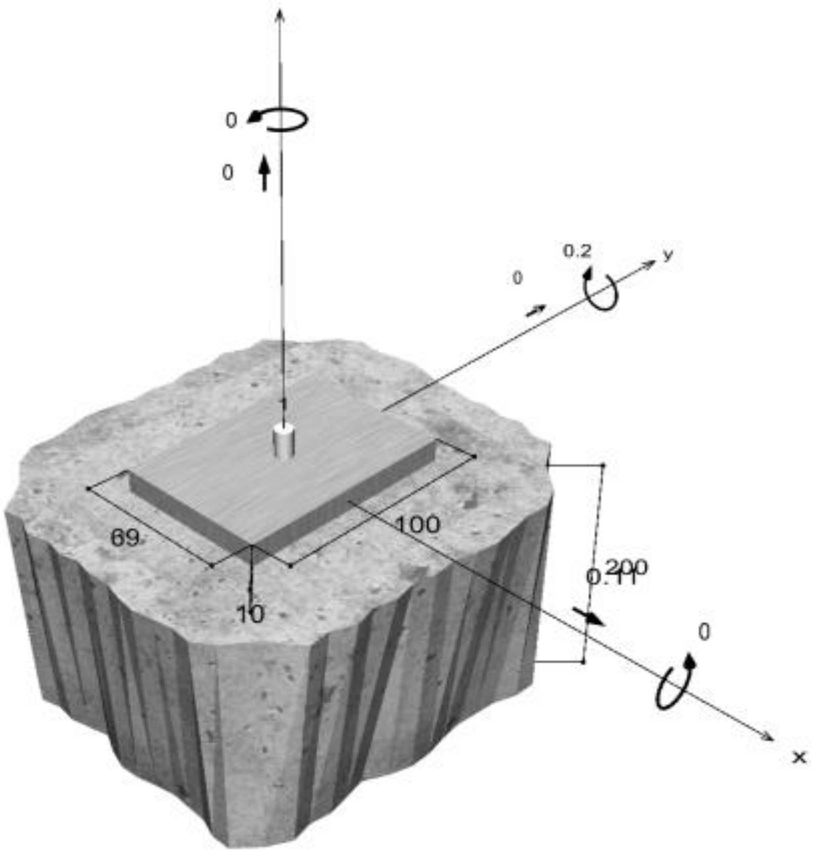
Connection To Concrete Design:

Loading at Connection:

$$\text{Shear Load} = 0.74\text{kN/m} \times 1.5 \times 0.1\text{m} = 0.111\text{kN (ULS)}$$

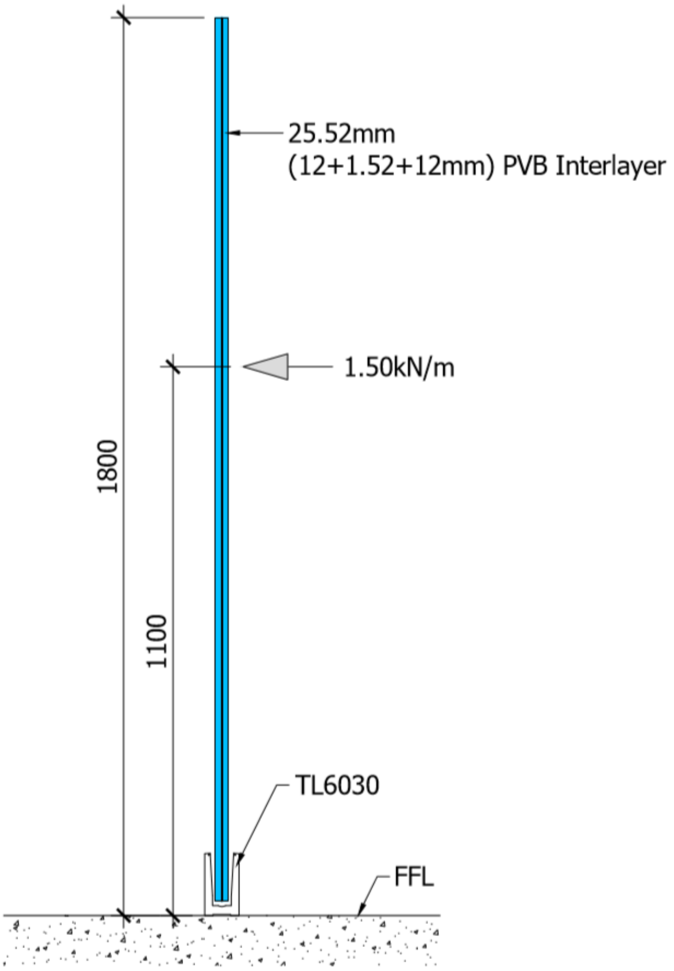
$$\text{Maximum Moment} = 0.74\text{kN/m} \times 1.5 \times 0.1\text{m} \times 1.8\text{m} = 0.2\text{kN (ULS)}$$

Therefore use 1Nr FH II 12/15 SK, Zinc Plated Steel @100mm C/C. See design in Appendix C.



Case Study 09:

Sketch - 25.52mm – 1.5kN/m (Glass) PVB Interlayer at 1.1m above the FFL and TL 6030:



NOTE:

- Combined Deflection 7.26mm (Shoe) plus 14.07mm (Glass) = 21.33mm **OK in deflection**

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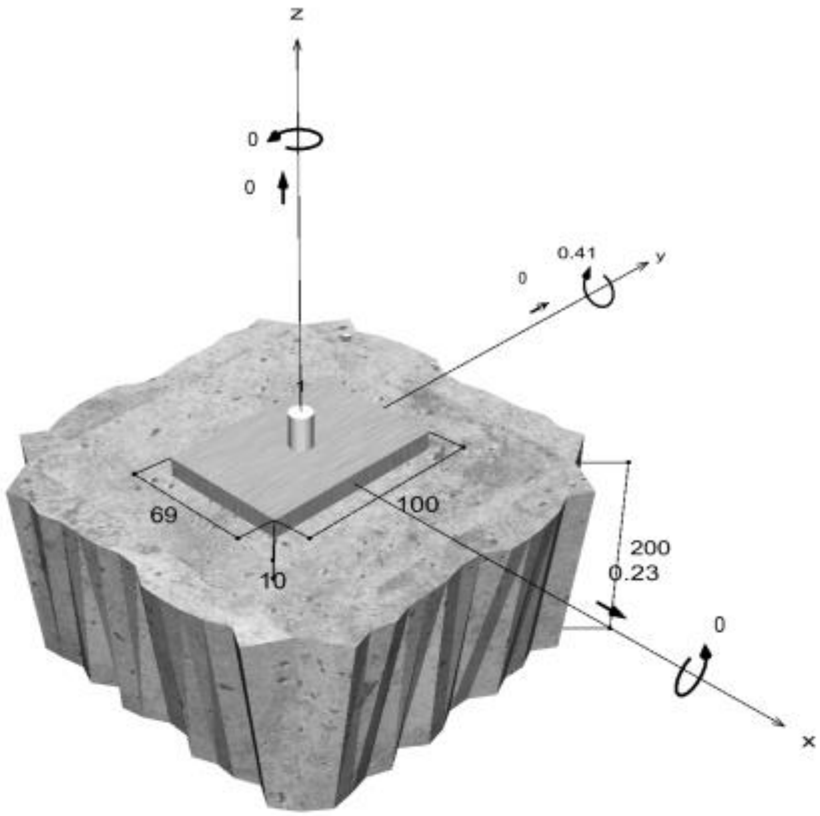
Connection To Concrete Design:

Loading at Connection:

$$\text{Shear Load} = 1.5\text{kN/m} \times 1.5 \times 0.1\text{m} = 0.23\text{kN (ULS)}$$

$$\text{Maximum Moment} = 1.5\text{kN/m} \times 1.5 \times 0.1\text{m} \times 1.8\text{m} = 0.41\text{kN (ULS)}$$

Therefore use 1Nr FH II 18/25, SK, Zinc Plated Steel @100mm C/C. See design in Appendix C.



Appendix A - Shoe Analysis

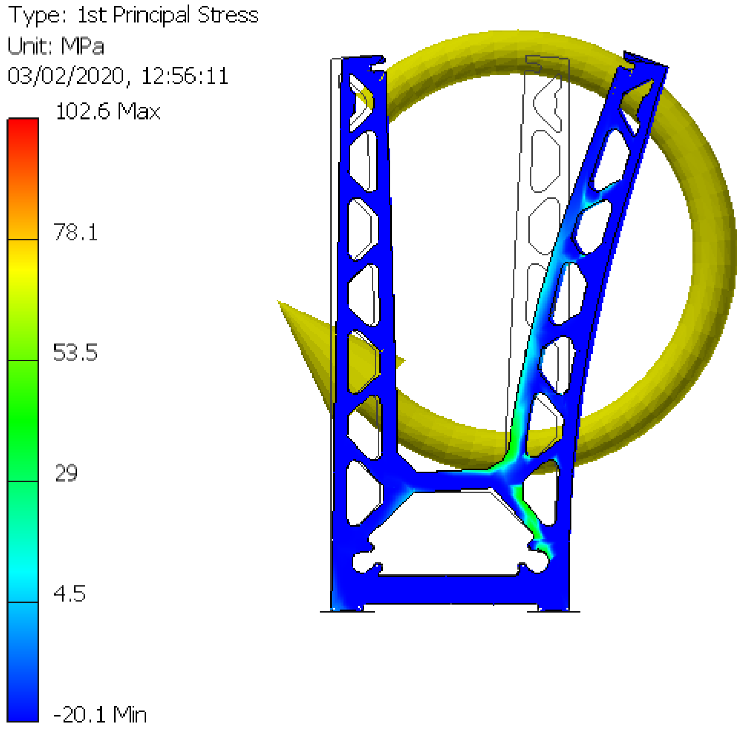
TSA provided 03 types of Shoe Analysis below

Shoe Analysis TL 6020 – 0.74kN/m

Shoe Analysis TL 6020 – Bending Stress (0.74kN/m):

Max. Bending Stress = 102.6N/mm^2 x1.5 = 153.9N/mm^2 < 180N/mm^2

Okay in Bending



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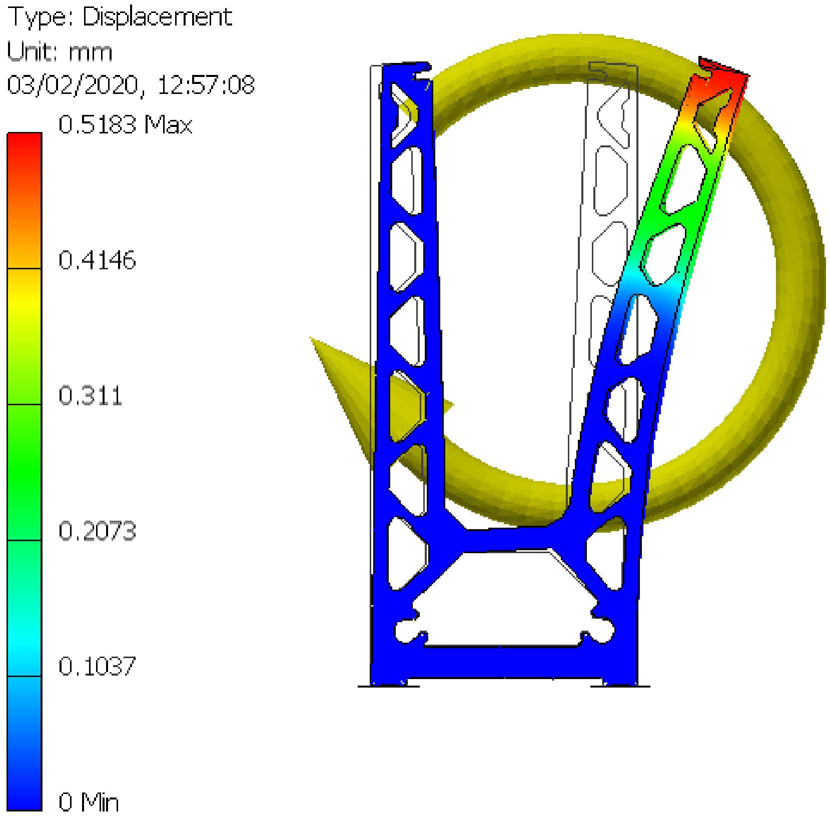
Shoe Analysis TL 6020 – Deflection (0.74kN/m):

Deflection
X = (0.5183 x 1800)/140
= 6.67mm

Okay in Deflection

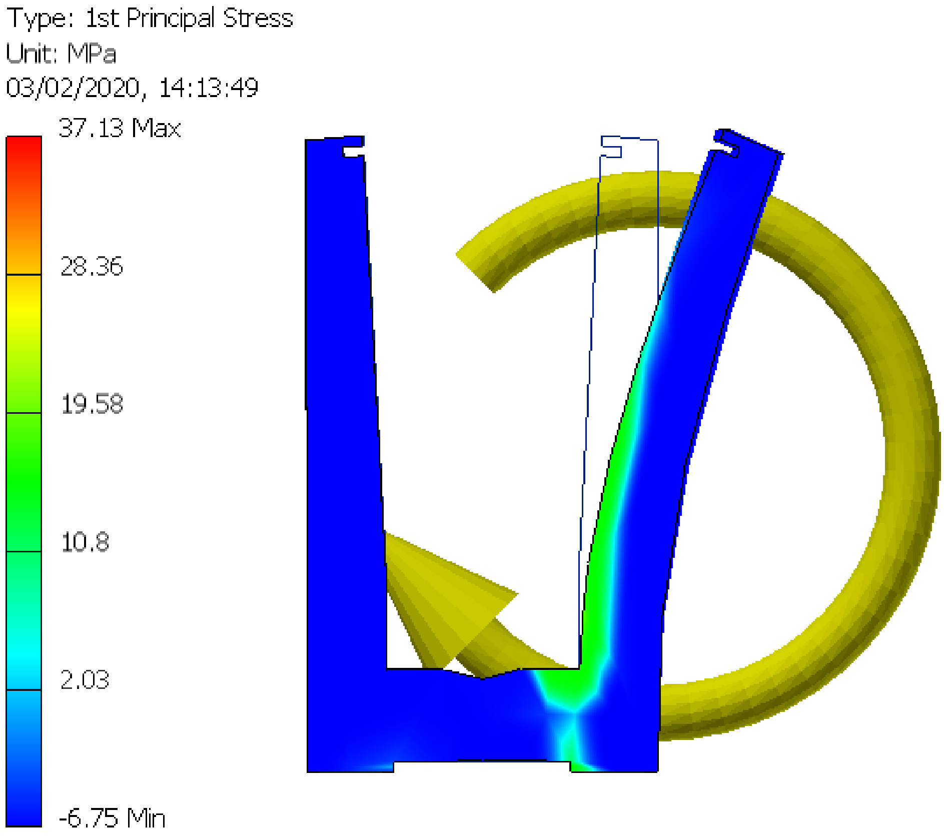


Shoe Analysis TL 6030 – 0.74kN/m

Shoe Analysis TL 6030 – Bending Stress (0.74kN/m):

Max. Bending Stress = 37.13N/mm^2 x1.5 = 55.70N/mm^2 < 180N/mm^2

Okay in Bending



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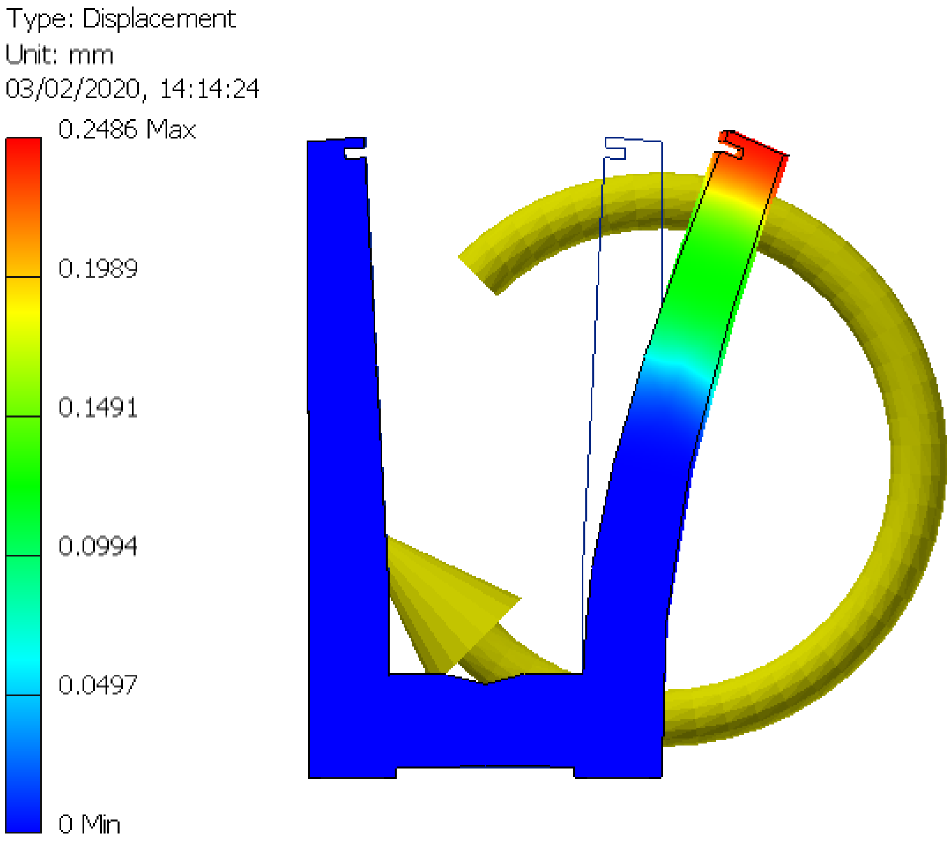
Shoe Analysis TL 6030 – Deflection (0.74kN/m):

Deflection
X = (0.2486 x 1800)/125
= 3.58mm

Okay in Deflection

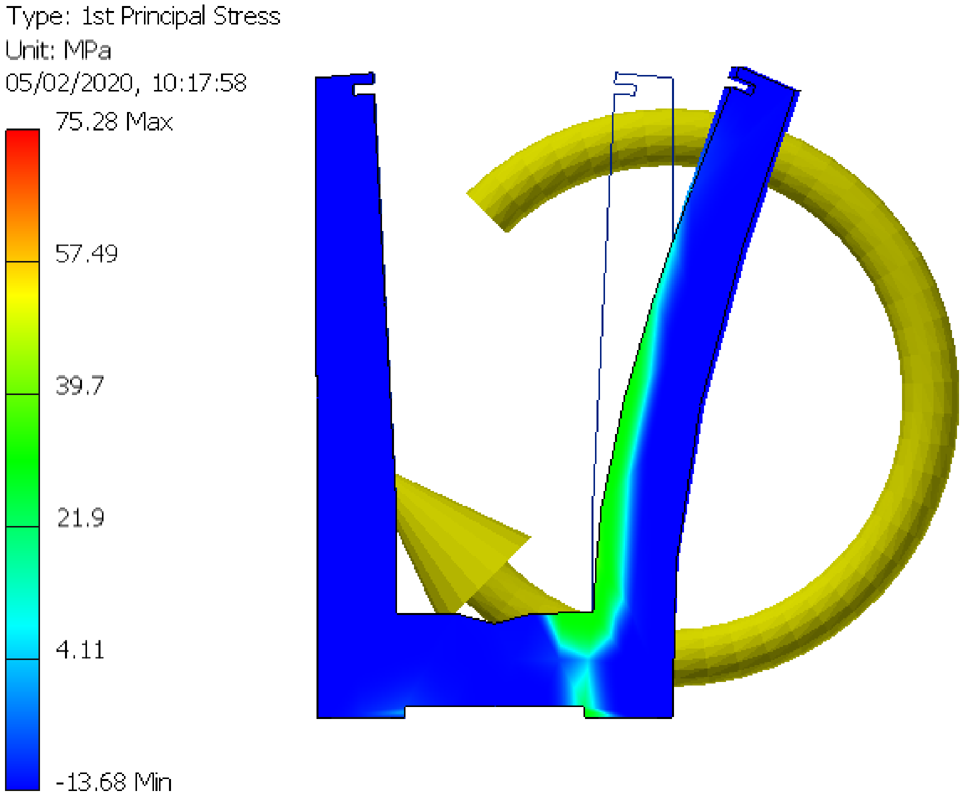


Shoe Analysis TL 6030 – 1.5kN/m

Shoe Analysis TL 6030 – Bending Stress (1.5kN/m):

Max. Bending Stress = 75.28N/mm^2 x1.5 = 112.92N/mm^2 < 180N/mm^2

Okay in Bending



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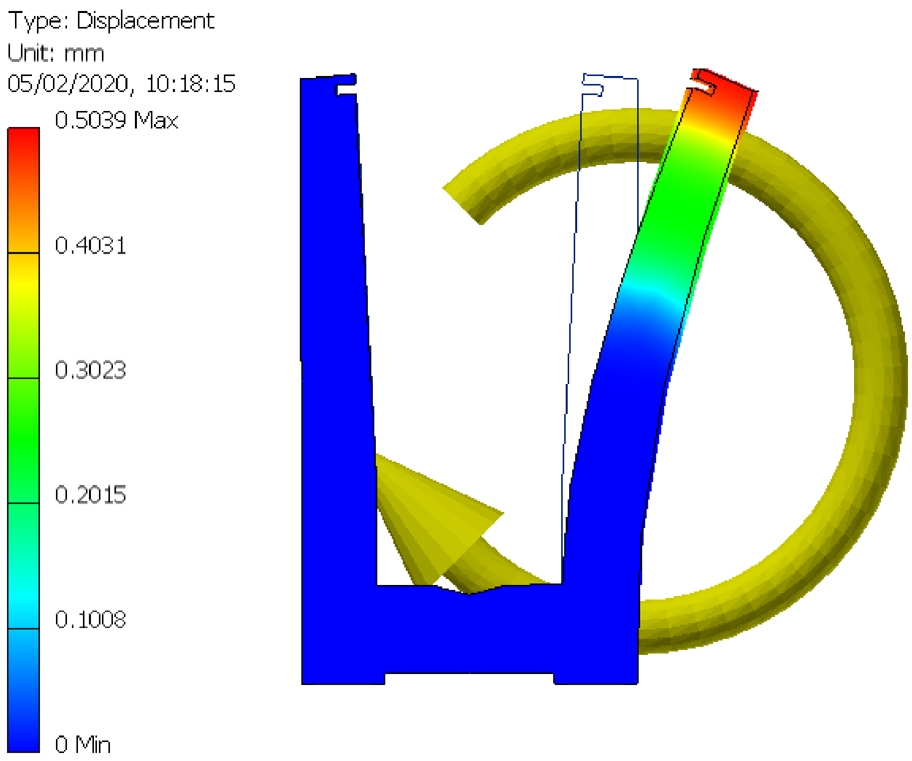
Shoe Analysis TL 6030 – Deflection (1.5kN/m):

Deflection

X = (0.5039 x 1800)/125

= 7.26mm

Okay in Deflection

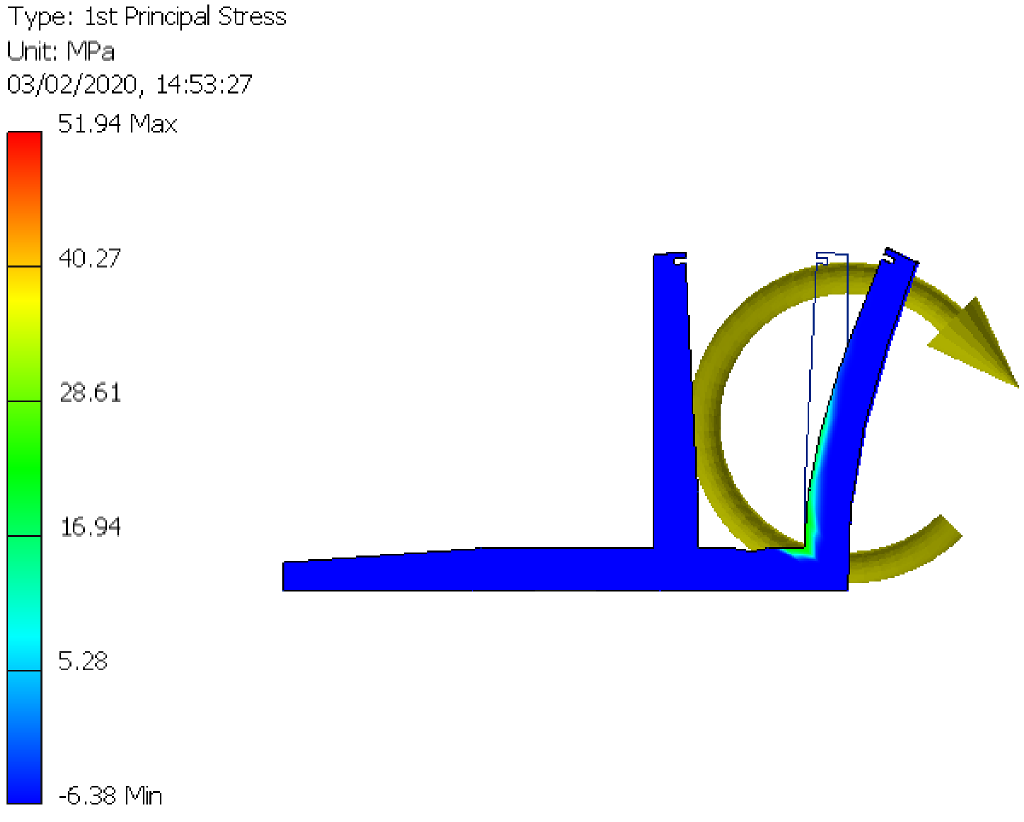


Shoe Analysis TL 3030 – 0.74kN/m

Shoe Analysis TL 3030 – Bending Stress (0.74kN/m):

Max. Bending Stress = 51.94N/mm^2 x1.5 = 77.91N/mm^2 < 180N/mm^2

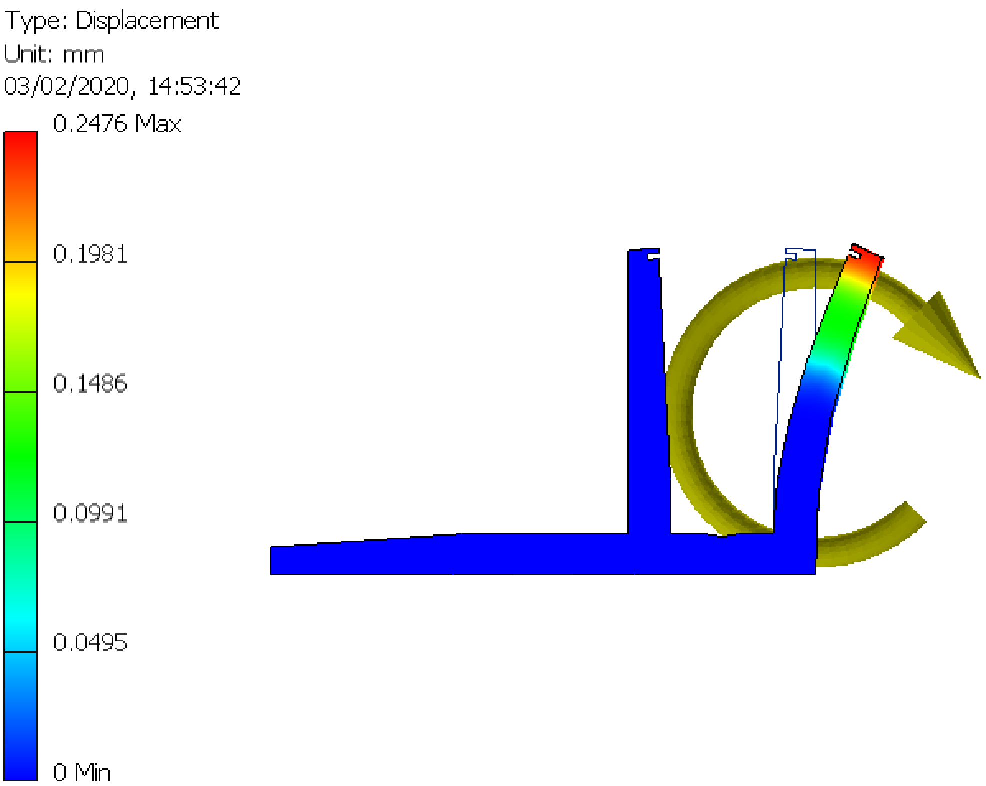
Okay in Bending



Shoe Analysis TL 3030 – Deflection (0.74kN/m):

Deflection
X = (0.2476 x 1800)/120
= 3.72mm

Okay in Deflection



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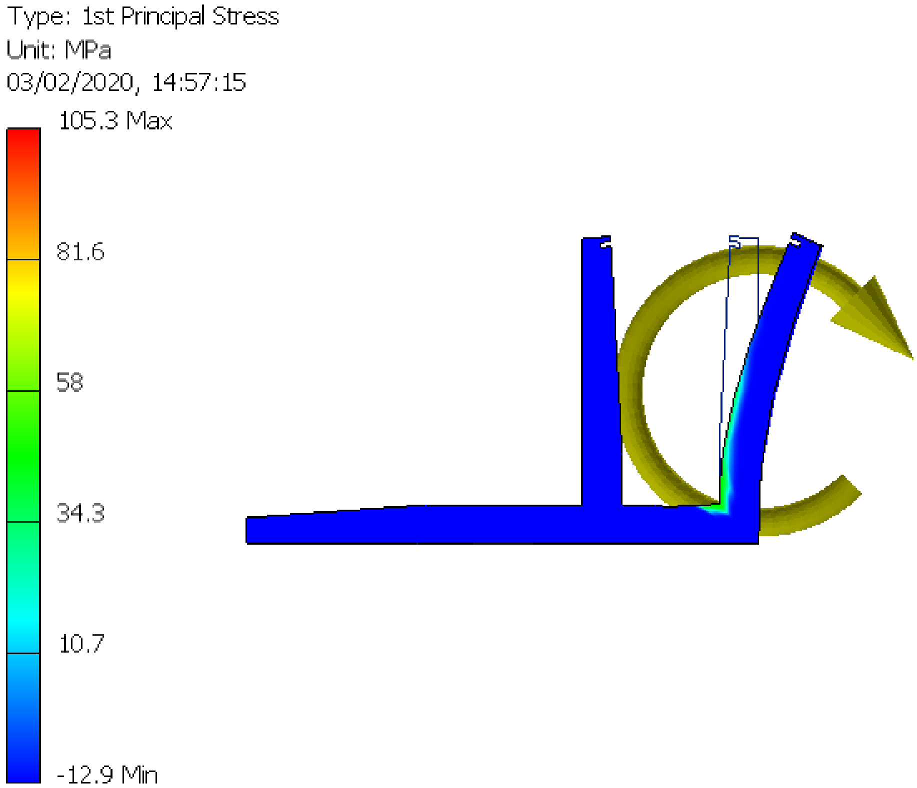
Shoe Analysis TL 3030 – 1.5kN/m

Shoe Analysis TL 3030 – Bending Stress (1.5kN/m):

Max. Bending Stress = 105.3N/mm^2 x1.5 = 157.95N/mm^2 < 180N/mm^2

Okay in Bending



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Shoe Analysis TL 3030 – Deflection (1.5kN/m):

Deflection
X = (0.502 x 1800)/120
= 7.53mm

Okay in Deflection

Appendix B – Glass Analysis

TSA provided 03 types of Glass Analysis below

21.52mm Glass Analysis – 0.74kN/m Sentry Interlayer

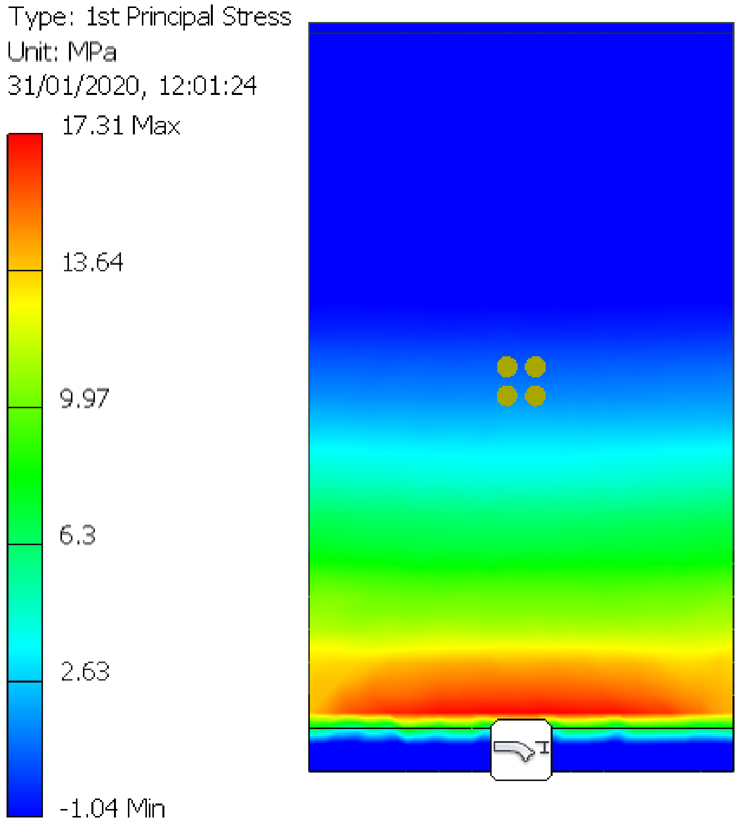
Glass Analysis - Bending Stress of Glass Panel due to 1.0kN/m2 Infill Loading:

- 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= 606 MPa, G = 203.36MPa Sentry Glass SG5000
- Bending Stress analysed based on glass panel of 1.0m x 1.8m

Result:

Max. Bending Stress = 17.31N/mm^2 x1.5 = 25.97N/mm^2 < 84.2N/mm^2

OK in Bending



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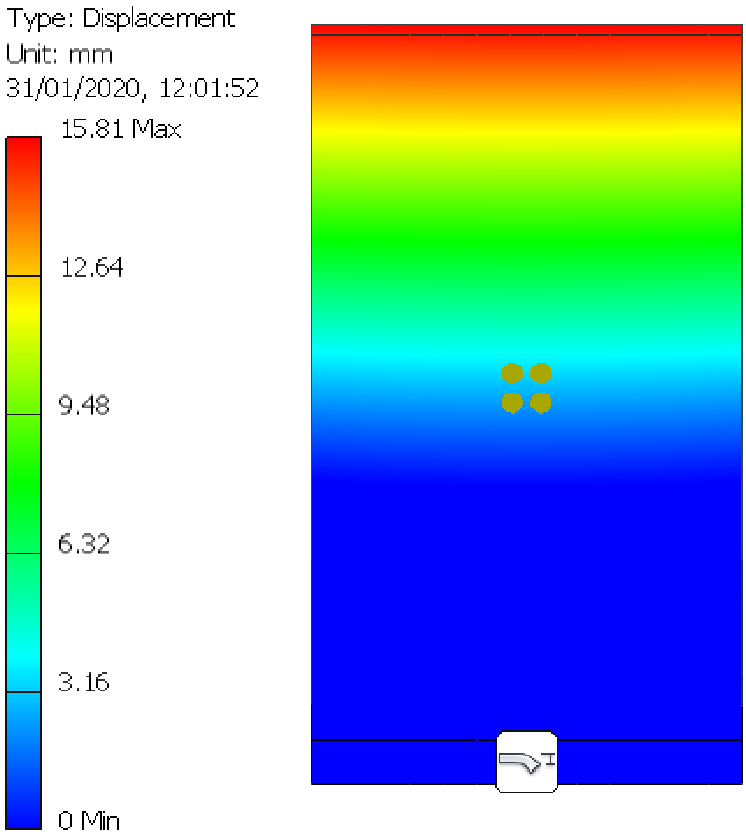
Glass Analysis - Deflection of Glass Panel due to 1.0kN/m2 Infill Loading:

- 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= 606 MPa, G = 203.36MPa Sentry Glass SG5000
- Bending Stress analysed based on glass panel of 1.0m x 1.8m

Result:

Max. Deflection = 15.81mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



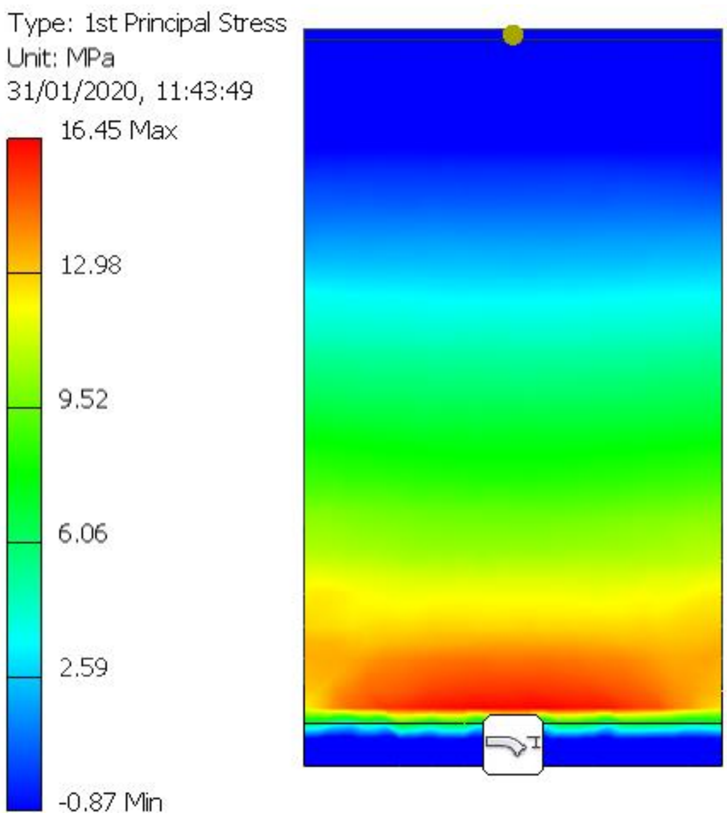
Glass Analysis - Bending Stress of Glass Panel due to 0.74kN/m Balustrade Loading:

- 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= 606 MPa, G = 203.36MPa Sentry Glass SG5000
- Bending Stress analysed based on glass panel of 1.0m x 1.8m

Result:

Max. Bending Stress = 16.45N/mm^2 x1.5 = 24.68N/mm^2 < 84.2N/mm^2

OK in Bending



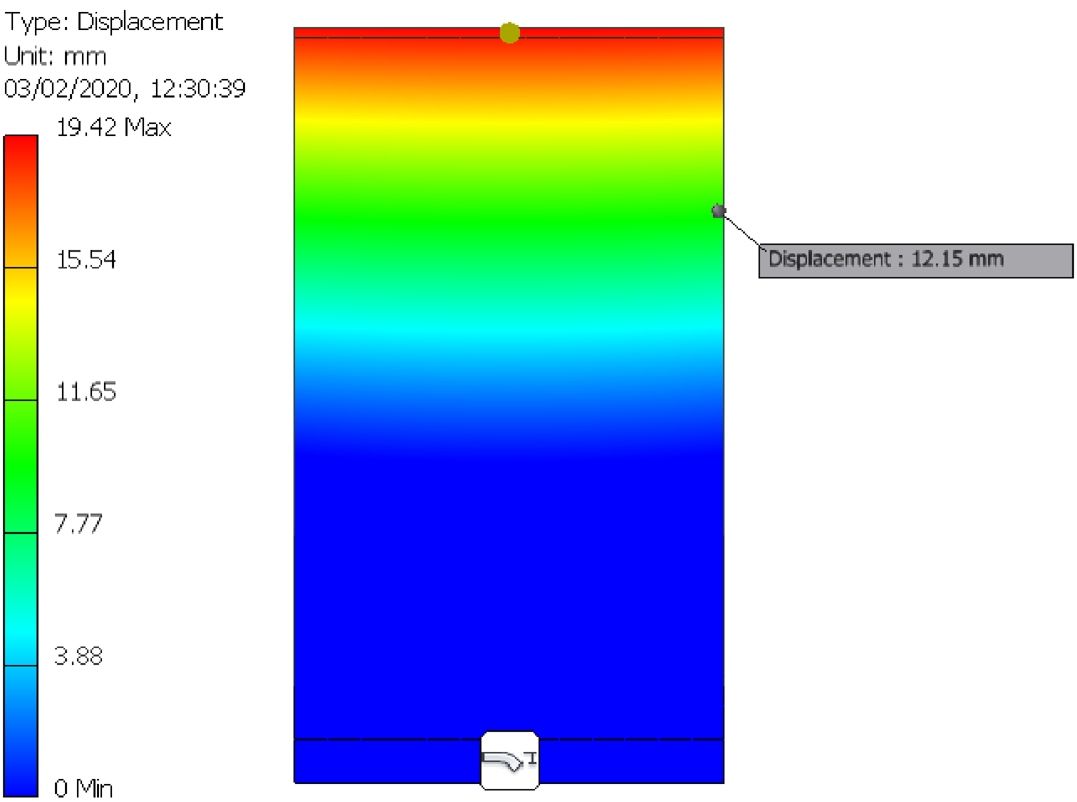
Glass Analysis - Deflection of Glass Panel due to 0.74kN/m Balustrade Loading:

- Analysis Software was used to determine maximum 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= 606 MPa, G = 203.36MPa Sentry Glass SG5000
- Bending Stress analysed based on glass panel of 1.0m x 1.8m

<u>Result:</u>

Max. Deflection = 19.42mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



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Project: Privacy Screen	Contract: 1348-1
Subject: Glass Balustrade	Sheet No. 41
Date: 20/07/2020	By: R.F.

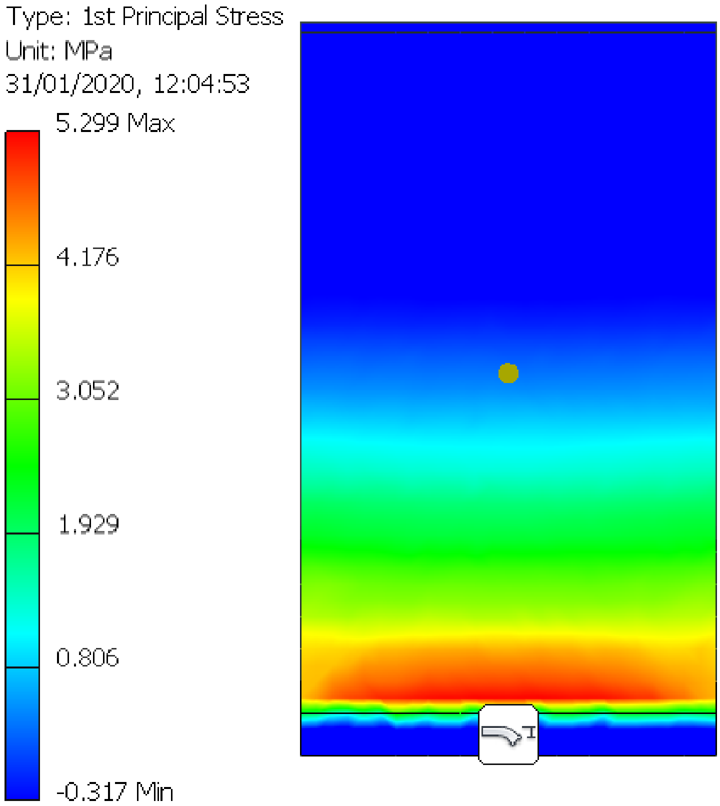
Glass Analysis - Bending Stress of Glass Panel due to 0.5kN/m Point Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.5kN/m Point Load
- 10/10/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 606 MPa, G = 203.36MPa Sentry Glass SG5000
- Bending Stress analysed based on glass panel of 1.0m x 1.8m

Result:

Max. Bending Stress = 5.299N/mm^2 x1.5 = 7.95N/mm^2 < 84.2N/mm^2

OK in Bending



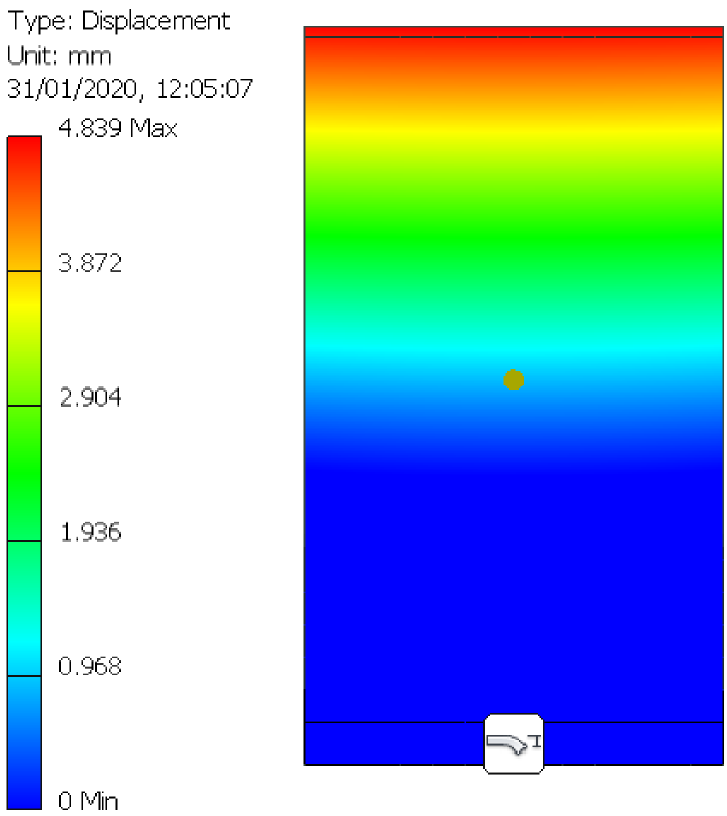
Glass Analysis - Deflection of Glass Panel due to 0.5kN/m Point Load:

- Analysis Software was used to determine maximum deflection of the glass due to 0.5kN/m Point Load
- 10/10/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 606 MPa, G = 203.36MPa Sentry Glass SG5000
- Bending Stress analysed based on glass panel of 1.0m x 1.8m

Result:

Max. Deflection = 4.839mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



25.52mm Glass Analysis – 0.74kN/m Sentry Interlayer

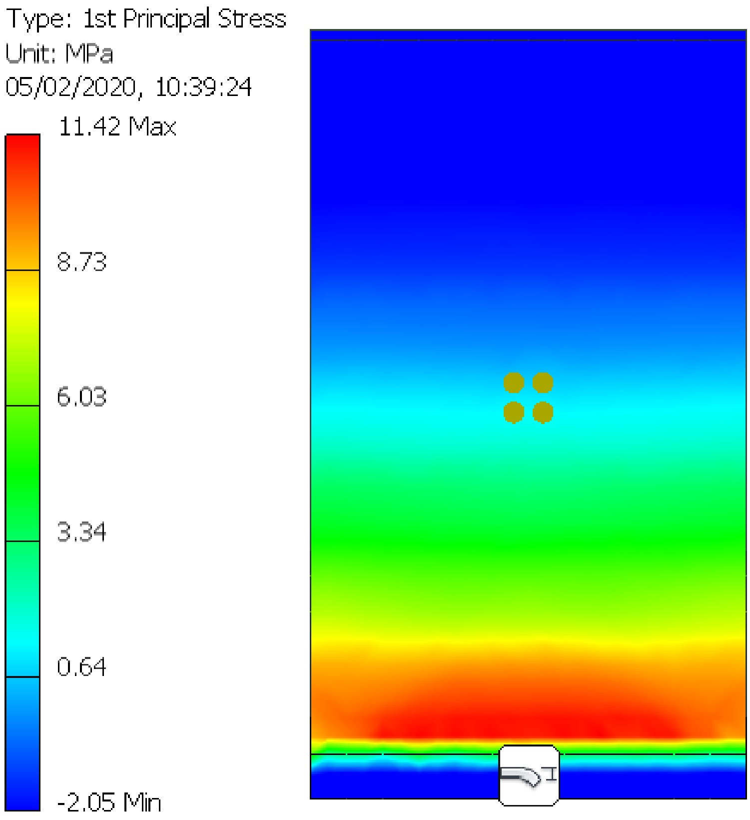
Glass Analysis - Bending Stress of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0N/m2 Infill Loading
- 12/12/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 606 MPa, G = 203.36MPa Sentry Glass SG5000
- Bending Stress analysed based on glass panel of 1.0m x 1.8m

Result:

Max. Bending Stress = 11.42N/mm^2 x1.5 = 17.13N/mm^2 < 84.2N/mm^2

OK in Bending



Project: Privacy Screen	Contract: 1348-1
Subject: Glass Balustrade	Sheet No. 44
Date: 20/07/2020	By: R.F.

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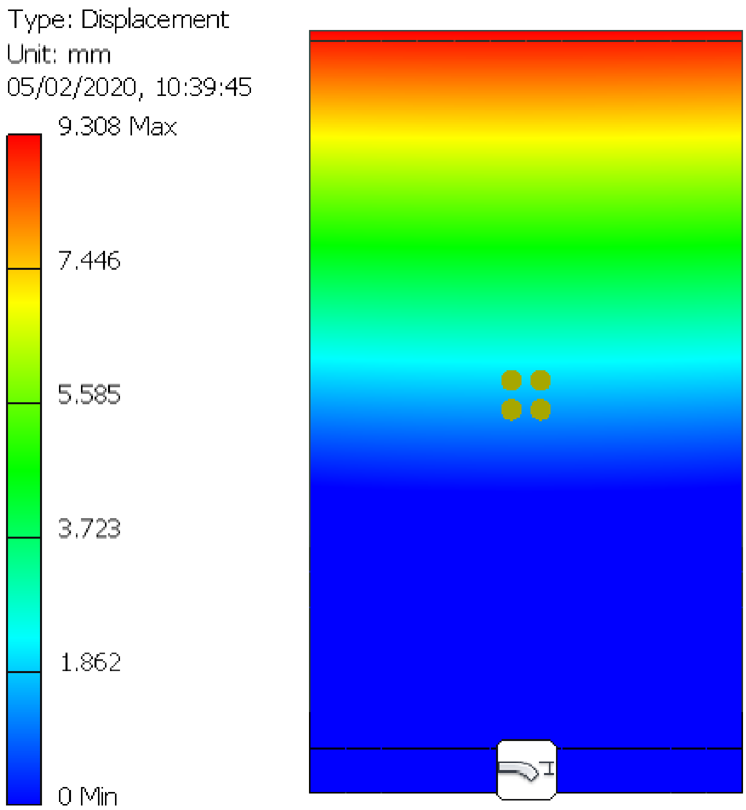
Glass Analysis - Deflection of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0N/m2 Infill Loading
- 12/12/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 606 MPa, G = 203.36MPa Sentry Glass SG5000
- Bending Stress analysed based on glass panel of 1.0m x 1.8m

Result:

Max. Deflection = 9.308mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



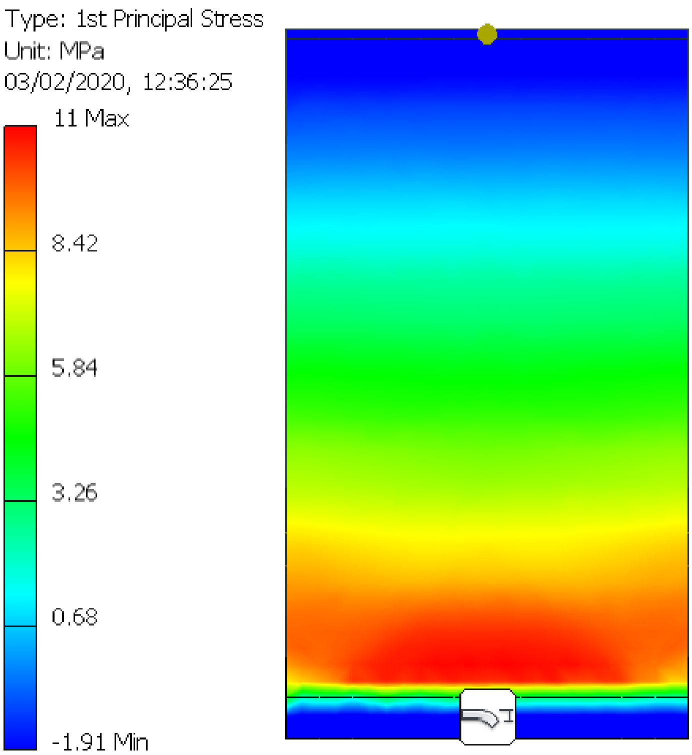
Glass Analysis - Bending Stress of Glass Panel due to 0.74kN/m Balustrade Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.74kN/m Balustrade Loading
- 12/12/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 606 MPa, G = 203.36MPa Sentry Glass SG5000
- Bending Stress analysed based on glass panel of 1.0m x 1.8m

Result:

Max. Bending Stress = 11N/mm^2 x1.5 = 16.50N/mm^2 < 84.2N/mm^2

OK in Bending



Project: Privacy Screen	Contract: 1348-1
Subject: Glass Balustrade	Sheet No. 46
Date: 20/07/2020	By: R.F.

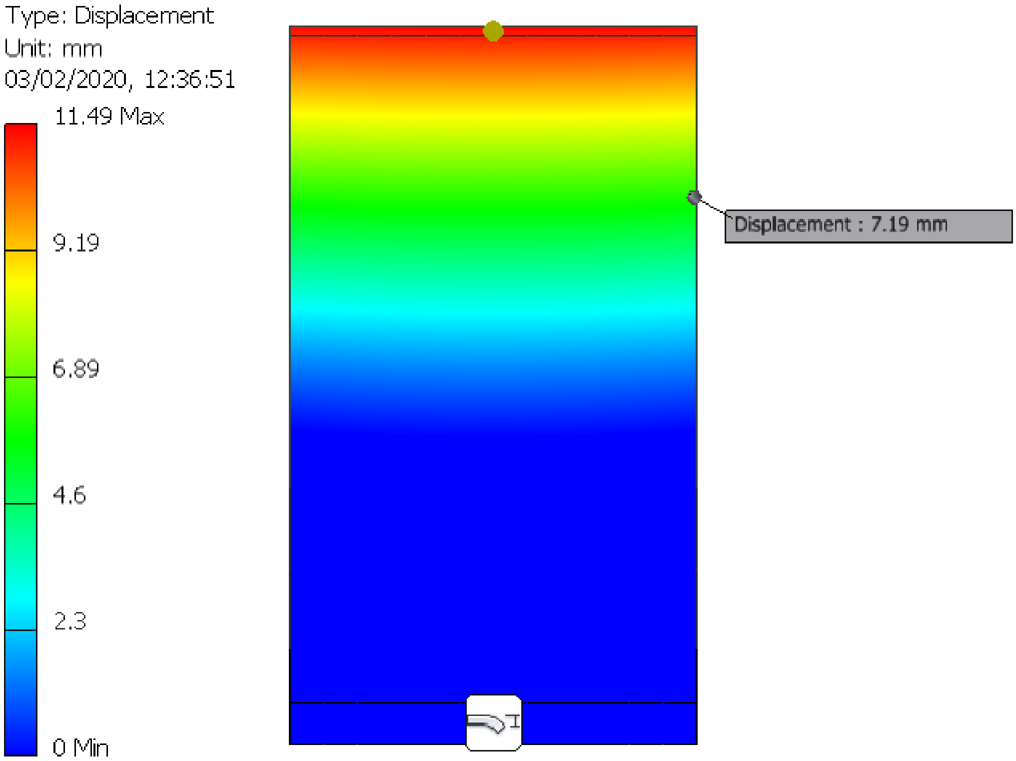
Glass Analysis - Deflection of Glass Panel due to 0.74kN/m Balustrade Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.74kN/m Balustrade Loading
- 12/12/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 606 MPa, G = 203.36MPa Sentry Glass SG5000
- Bending Stress analysed based on glass panel of 1.0m x 1.8m

Result:

Max. Deflection = 11.49mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



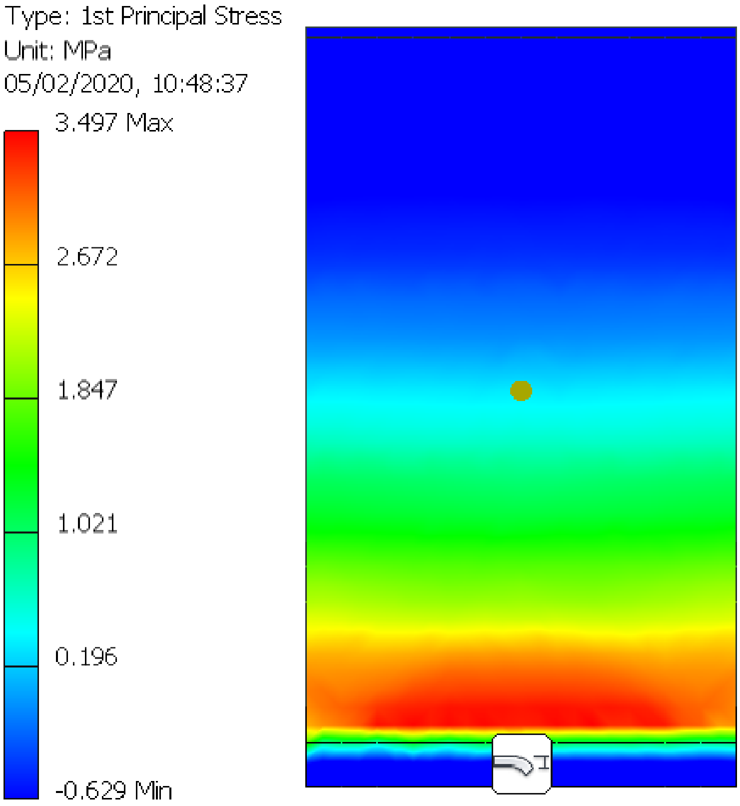
Glass Analysis - Bending Stress of Glass Panel due to 0.5kN/m Point Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.5kN/m Point Load
- 12/12/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 606 MPa, G = 203.36MPa Sentry Glass SG5000
- Bending Stress analysed based on glass panel of 1.0m x 1.8m

Result:

Max. Bending Stress = 3.497N/mm^2 x1.5 = 5.2455N/mm^2 < 84.2N/mm^2

OK in Bending



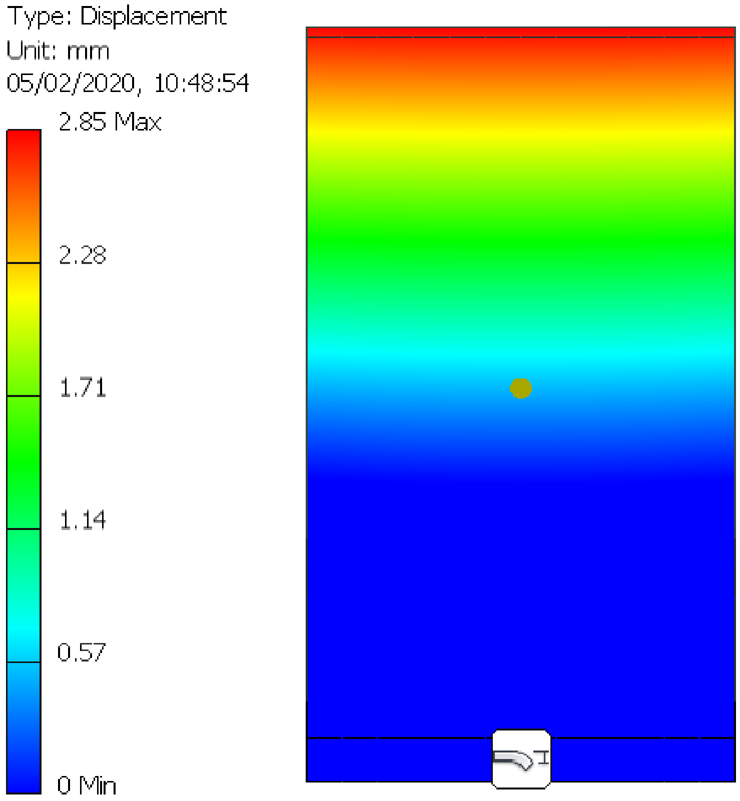
Glass Analysis - Deflection of Glass Panel due to 0.5kN/m Point Load:

- Analysis Software was used to determine maximum deflection of the glass due to 0.5kN/m Point Load
- 12/12/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 606 MPa, G = 203.36MPa Sentry Glass SG5000
- Bending Stress analysed based on glass panel of 1.0m x 1.8m

Result:

Max. Deflection = 2.85mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



25.52mm Glass Analysis – 0.74kN/m PVB Interlayer

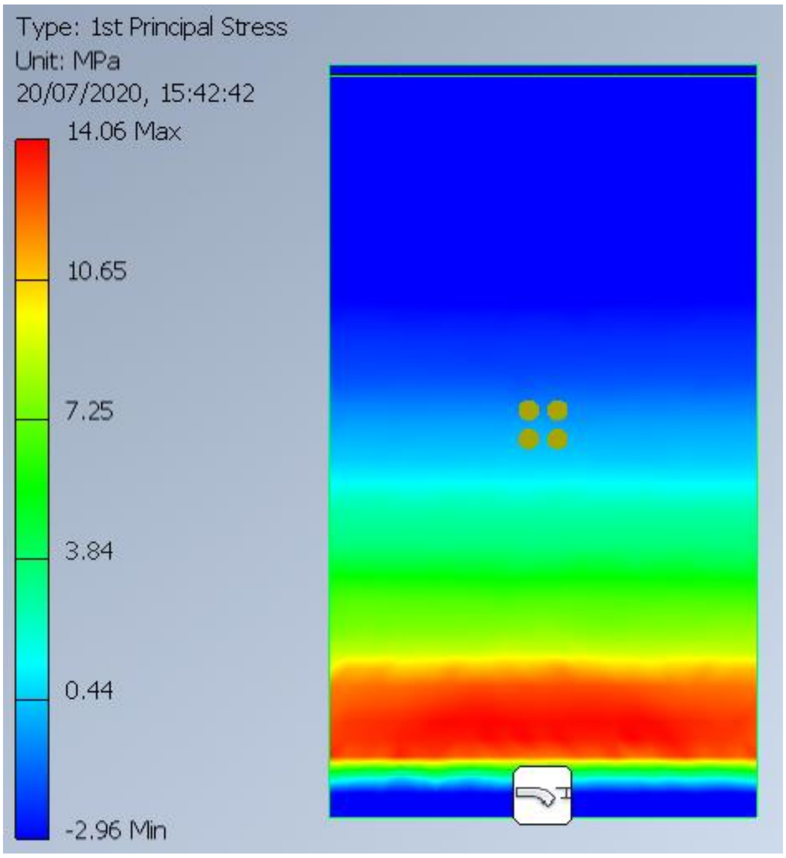
Glass Analysis - Bending Stress of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0N/m2 Infill Loading
- 12/12/1.52mm 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 1.0m x 1.8m

Result:

Max. Bending Stress = 14.06N/mm^2 x1.5 = 21.09N/mm^2 < 84.2N/mm^2

OK in Bending



Project: Privacy Screen	Contract: 1348-1
Subject: Glass Balustrade	Sheet No. 50
Date: 20/07/2020	By: R.F.

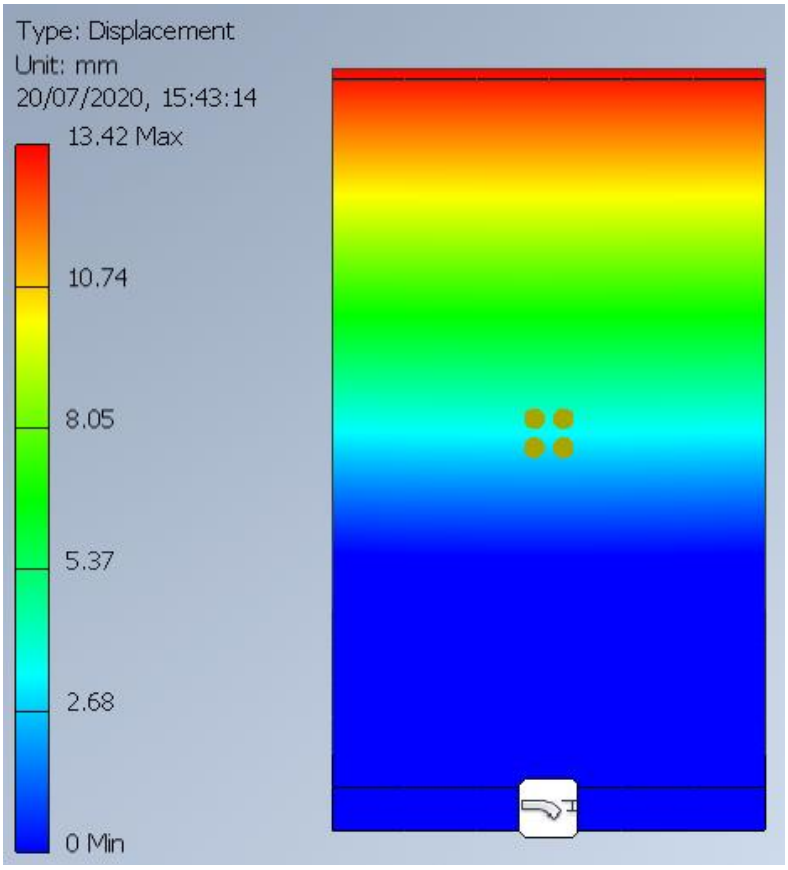
Glass Analysis - Deflection of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0N/m2 Infill Loading
- 12/12/1.52mm 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 1.0m x 1.8m

Result:

Max. Deflection = 13.42mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



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Project: Privacy Screen	Contract: 1348-1
Subject: Glass Balustrade	**Sheet No.** 51
Date: 20/07/2020	**By:** R.F.

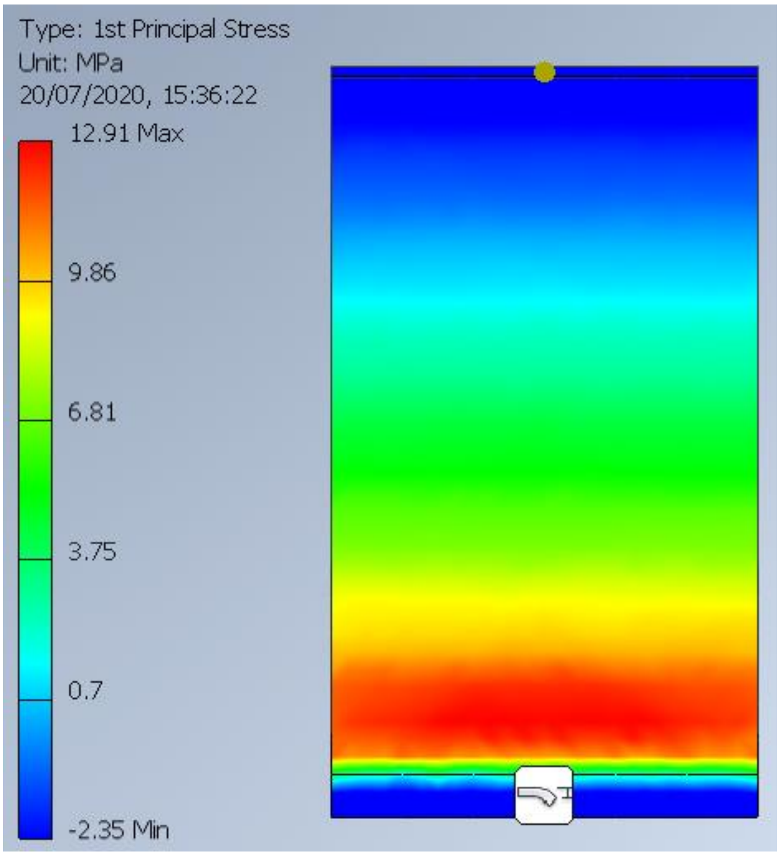
Glass Analysis - Bending Stress of Glass Panel due to 0.74kN/m Balustrade Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.74kN/m Balustrade Loading
- 12/12/1.52mm 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 1.0m x 1.8m

Result:

Max. Bending Stress = 12.91N/mm^2 x1.5 = 19.365N/mm^2 < 84.2N/mm^2

OK in Bending



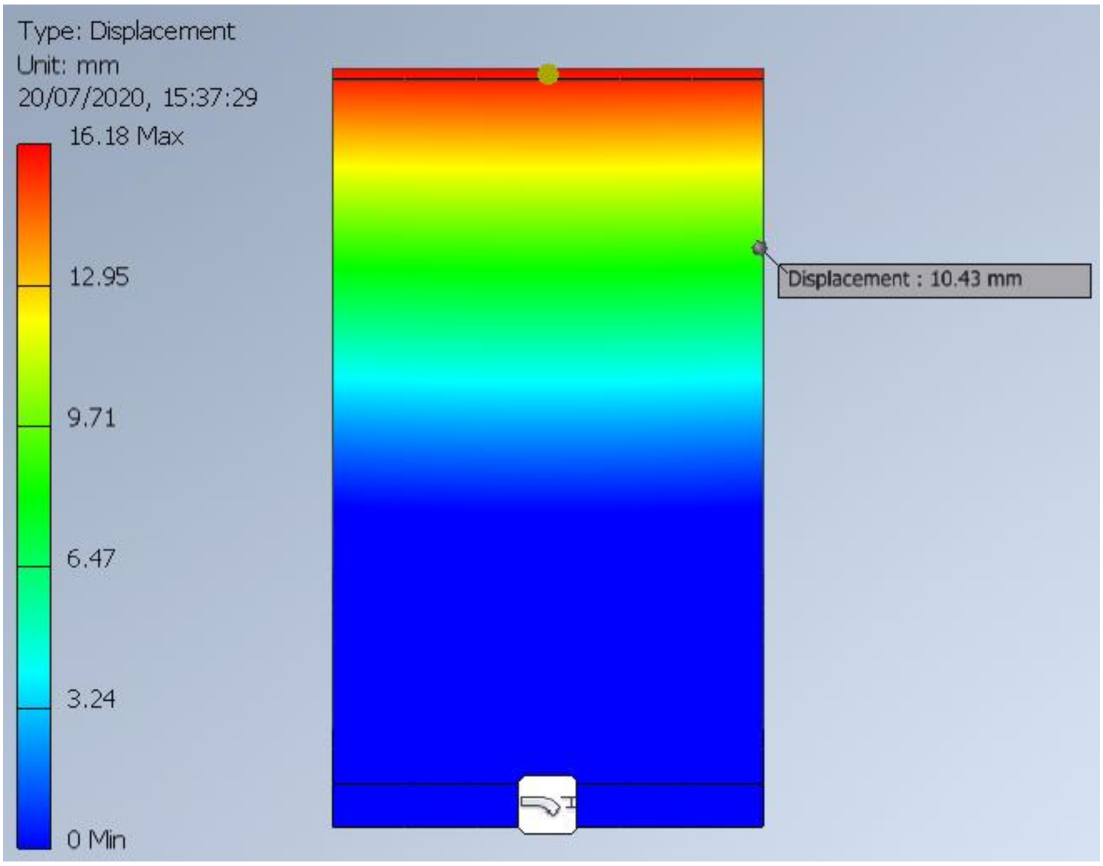
Glass Analysis - Deflection of Glass Panel due to 0.74kN/m Balustrade Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.74kN/m Balustrade Loading
- 12/12/1.52mm 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 1.0m x 1.8m

Result:

Max. Deflection = 16.18mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



TSA TED SINGLETON & ASSOCIATES CONSULTING ENGINEERS	**Project:** Privacy Screen	**Contract:** 1348-1
	Subject: Glass Balustrade	**Sheet No.** 53
	Date: 20/07/2020	**By:** R.F.

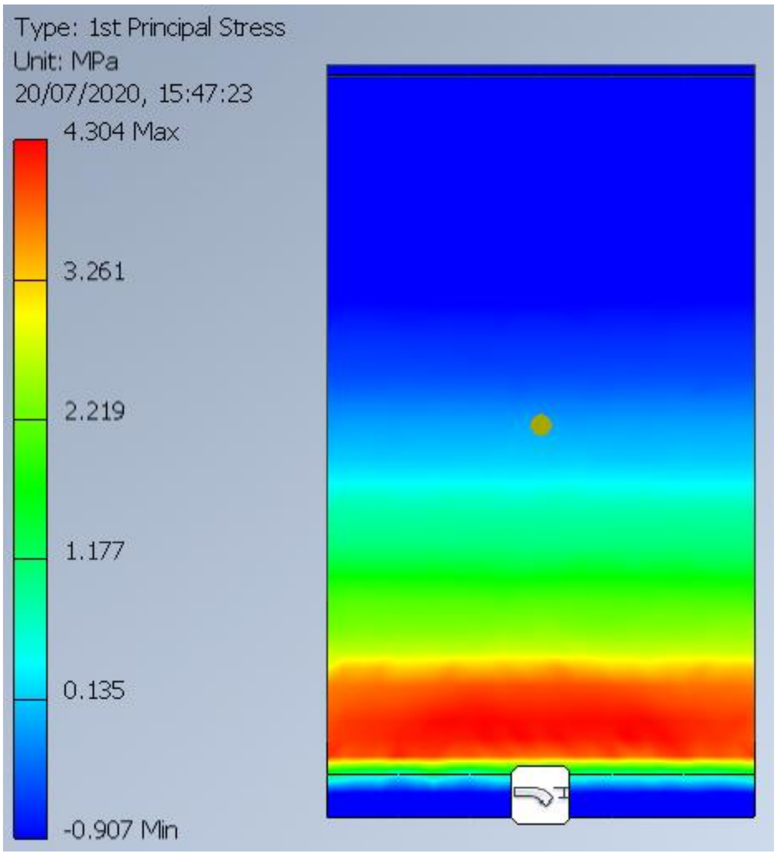
Glass Analysis - Bending Stress of Glass Panel due to 0.5kN/m Point Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.5kN/m Point Load
- 12/12/1.52mm 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 1.0m x 1.8m

Result:

Max. Bending Stress = 4.304N/mm^2 x1.5 = 6.456N/mm^2 < 84.2N/mm^2

OK in Bending



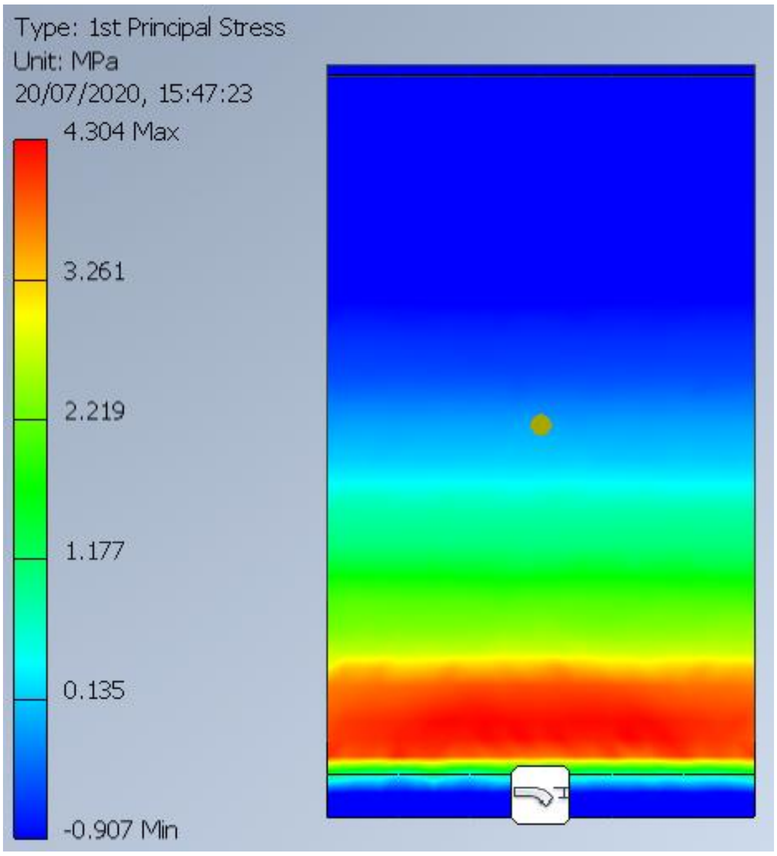
Glass Analysis - Deflection of Glass Panel due to 0.5kN/m Point Load:

- Analysis Software was used to determine maximum deflection of the glass due to 0.5kN/m Point Load
- 12/12/1.52mm 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 1.0m x 1.8m

Result:

Max. Deflection = 4.304mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



25.52mm Glass Analysis – 1.5kN/m Sentry Interlayer

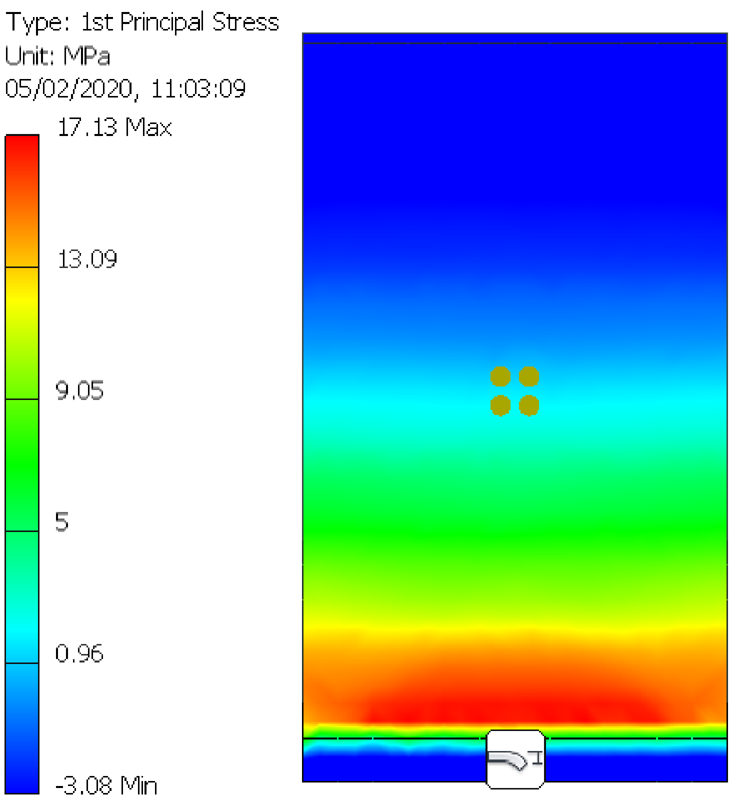
Glass Analysis - Bending Stress of Glass Panel due to 1.5kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5N/m2 Infill Loading
- 12/12/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 606 MPa, G = 203.36MPa Sentry Glass SG5000
- Bending Stress analysed based on glass panel of 1.0m x 1.8m

<u>Result:</u>

Max. Bending Stress = 17.13N/mm^2 x1.5 = 25.70N/mm^2 < 84.2N/mm^2

<u>OK in Bending</u>



	Project: Privacy Screen	Contract: 1348-1
TSA TED SINGLETON & ASSOCIATES CONSULTING ENGINEERS	Subject: Glass Balustrade	Sheet No. 56
	Date: 20/07/2020	By: R.F.

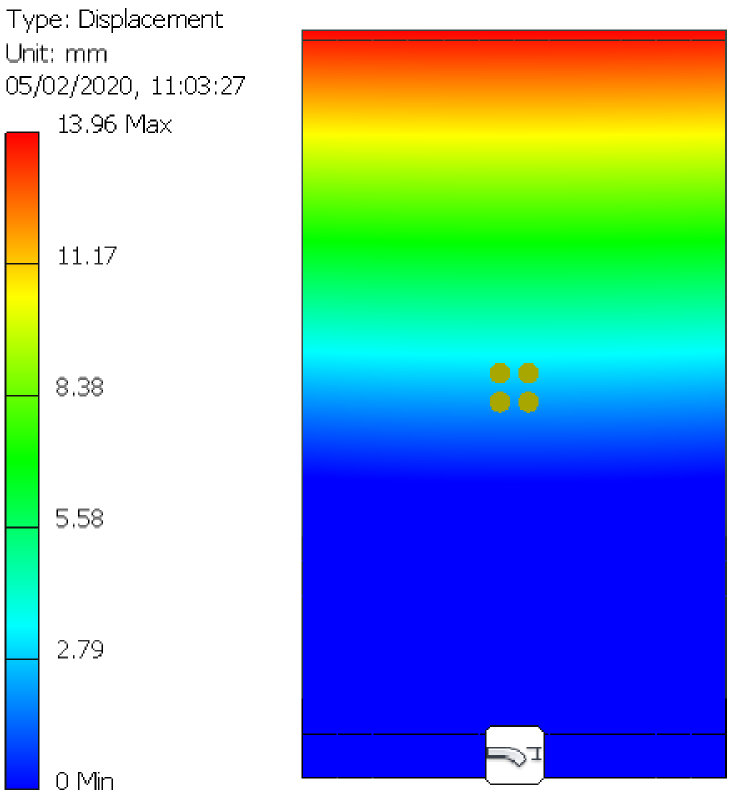
Glass Analysis - Deflection of Glass Panel due to 1.5kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5N/m2 Infill Loading
- 12/12/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 606 MPa, G = 203.36MPa Sentry Glass SG5000
- Bending Stress analysed based on glass panel of 1.0m x 1.8m

Result:

Max. Deflection = 13.96mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



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Project: Privacy Screen	**Contract:** 1348-1
Subject: Glass Balustrade	**Sheet No.** 57
Date: 20/07/2020	**By:** R.F.

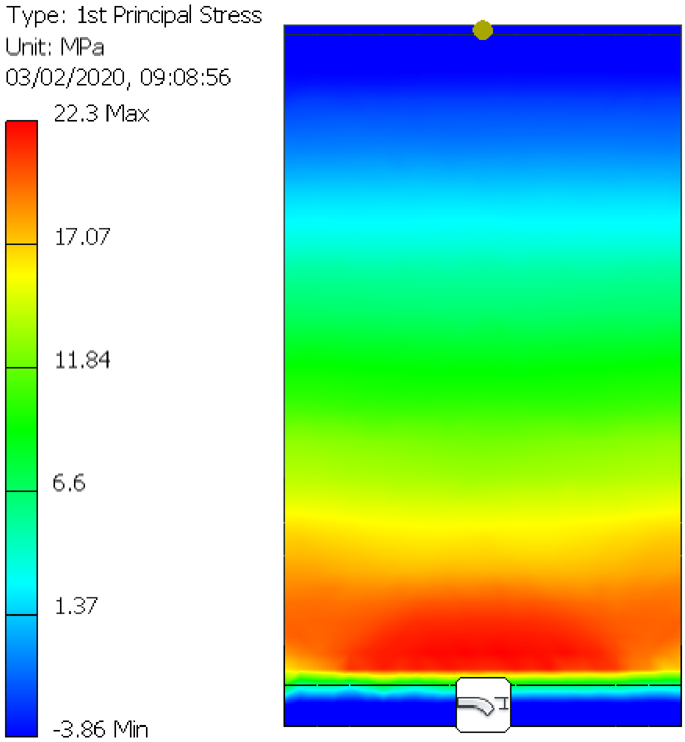
Glass Analysis - Bending Stress of Glass Panel due to 1.5kN/m Balustrade Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5kN/m Balustrade Loading
- 12/12/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 606 MPa, G = 203.36MPa Sentry Glass SG5000
- Bending Stress analysed based on glass panel of 1.0m x 1.8m

Result:

Max. Bending Stress = 22.3N/mm^2 x1.5 = 33.45N/mm^2 < 84.2N/mm^2

OK in Bending



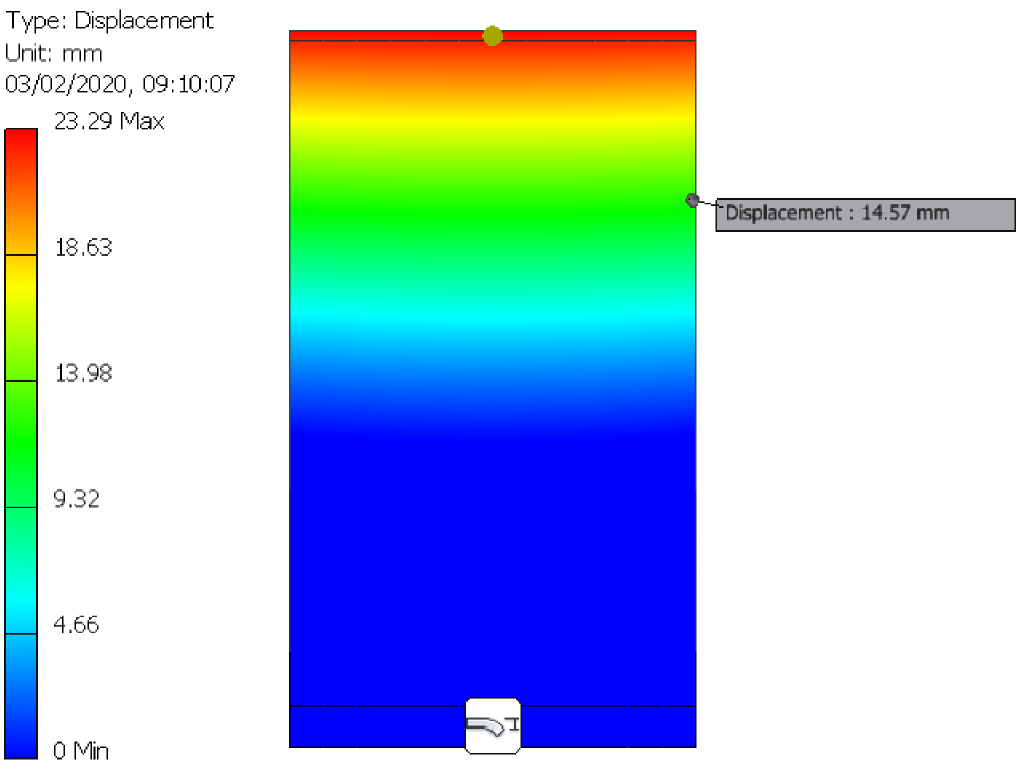
Glass Analysis - Deflection of Glass Panel due to 1.5kN/m Balustrade Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5kN/m Balustrade Loading
- 12/12/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 606 MPa, G = 203.36MPa Sentry Glass SG5000
- Bending Stress analysed based on glass panel of 1.0m x 1.8m

Result:

Max. Deflection = 23.29mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



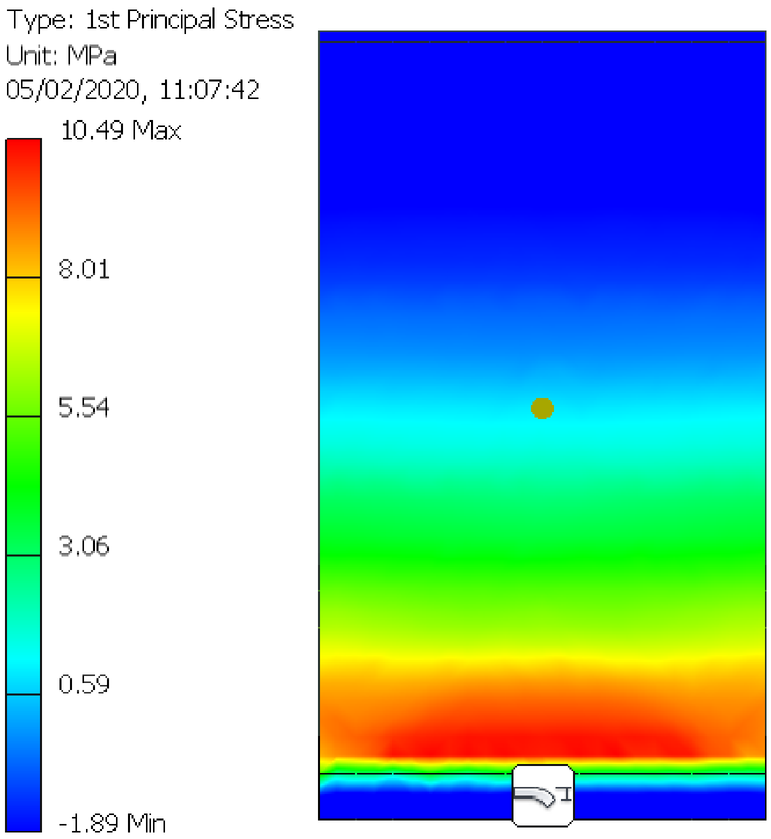
Glass Analysis - Bending Stress of Glass Panel due to 1.5kN/m Point Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5kN/m Point Load
- 12/12/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 606 MPa, G = 203.36MPa Sentry Glass SG5000
- Bending Stress analysed based on glass panel of 1.0m x 1.8m

Result:

Max. Bending Stress = 10.49N/mm^2 x1.5 = 15.74N/mm^2 < 84.2N/mm^2

OK in Bending



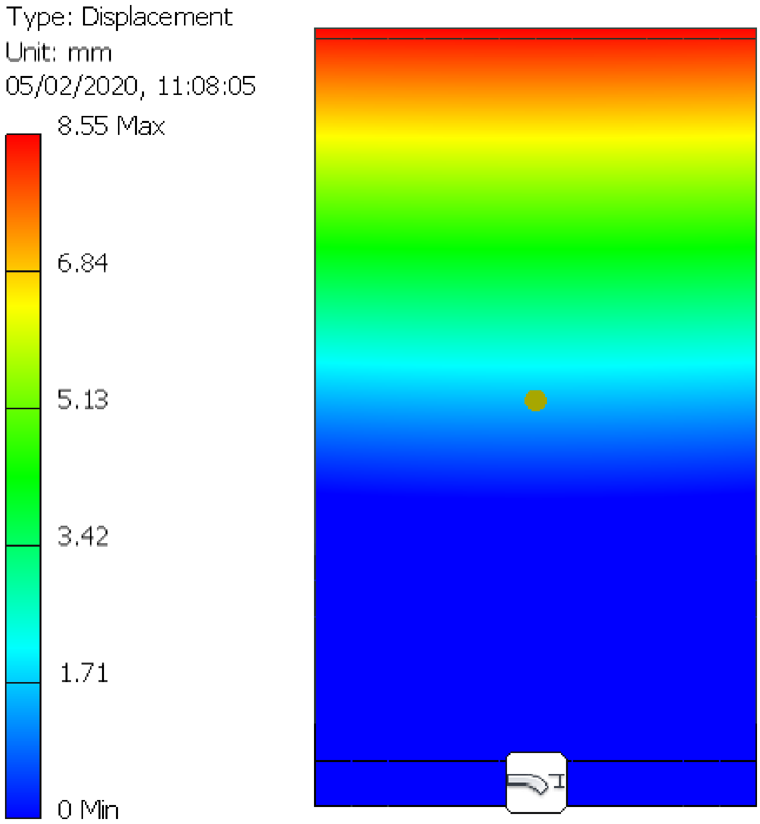
Glass Analysis - Deflection of Glass Panel due to 1.5kN/m Point Load:

- Analysis Software was used to determine maximum deflection of the glass due to 1.5kN/m Point Load
- 12/12/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 606 MPa, G = 203.36MPa Sentry Glass SG5000
- Bending Stress analysed based on glass panel of 1.0m x 1.8m

Result:

Max. Deflection = 8.55mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



25.52mm Glass Analysis – 1.5kN/m PVB Interlayer at 1.1m above FFL

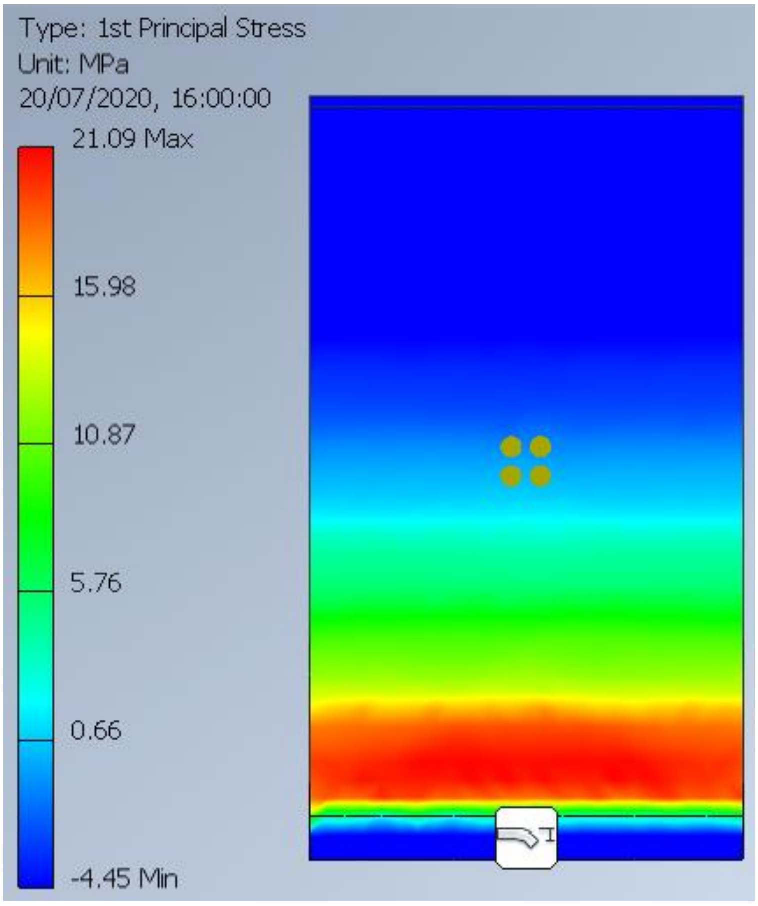
Glass Analysis - Bending Stress of Glass Panel due to 1.5kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5N/m2 Infill Loading
- 12/12/1.52mm 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 1.0m x 1.8m

Result:

Max. Bending Stress = 21.09N/mm^2 x1.5 = 31.64N/mm^2 < 84.2N/mm^2

OK in Bending



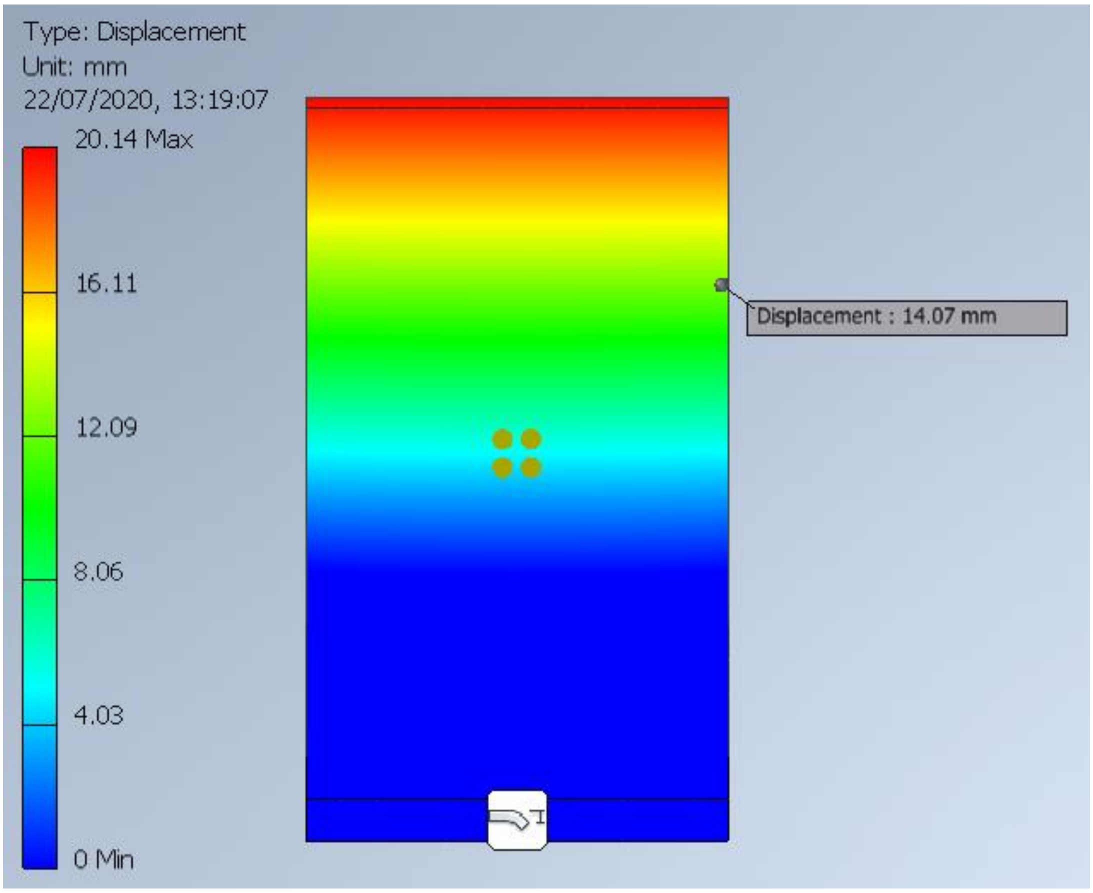
Glass Analysis - Deflection of Glass Panel due to 1.5kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5N/m2 Infill Loading
- 12/12/1.52mm 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 1.0m x 1.8m

Result:

Max. Deflection = 14.07mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



NOTE:

The most appropriate deflection to be considered is 14.07mm at 1100mm above the FFL.

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Project: Privacy Screen	**Contract:** 1348-1
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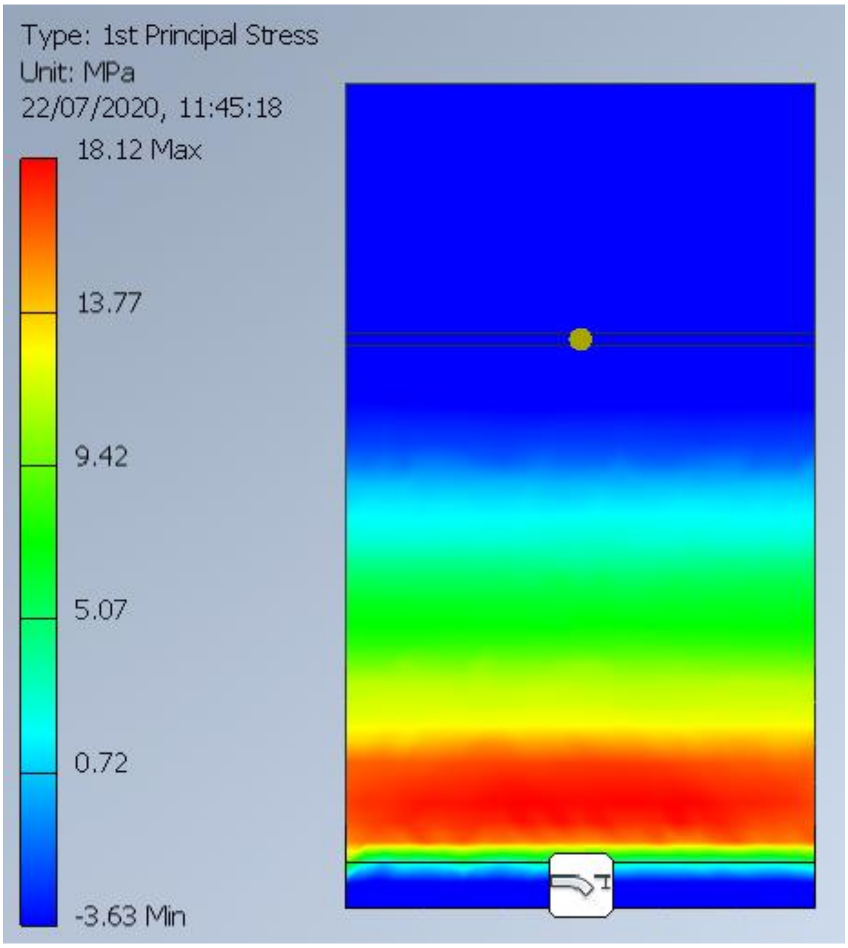
Glass Analysis - Bending Stress of Glass Panel due to 1.5kN/m Balustrade Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5kN/m Balustrade Loading
- 12/12/1.52mm 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 1.0m x 1.8m

Result:

Max. Bending Stress = 18.12N/mm^2 x1.5 = 27.18N/mm^2 < 84.2N/mm^2

OK in Bending



Project: Privacy Screen	**Contract:** 1348-1
Subject: Glass Balustrade	**Sheet No.** 64
Date: 20/07/2020	**By:** R.F.

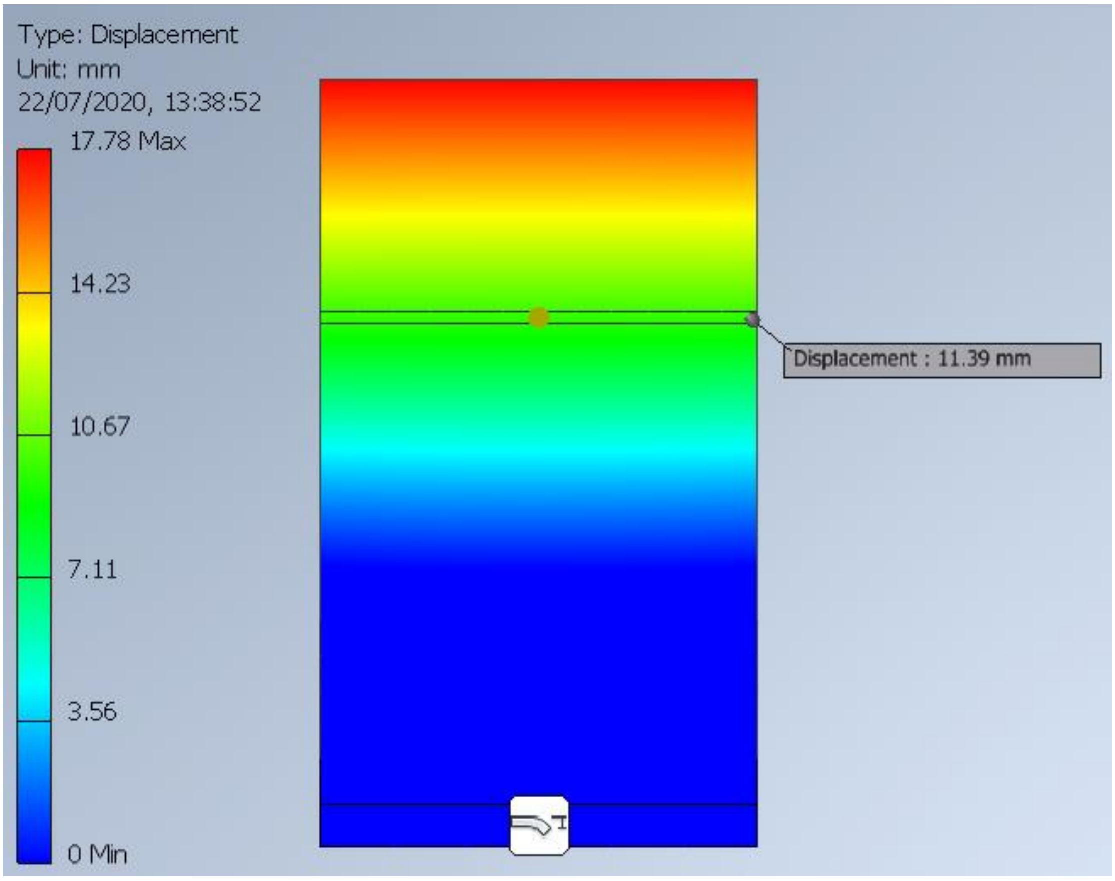
Glass Analysis - Deflection of Glass Panel due to 1.5kN/m Balustrade Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5kN/m Balustrade Loading
- 12/12/1.52mm 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 1.0m x 1.8m

Result:

Max. Deflection = 11.39mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



NOTE:

The most appropriate deflection to be considered is 11.39mm at 1100mm above the FFL.

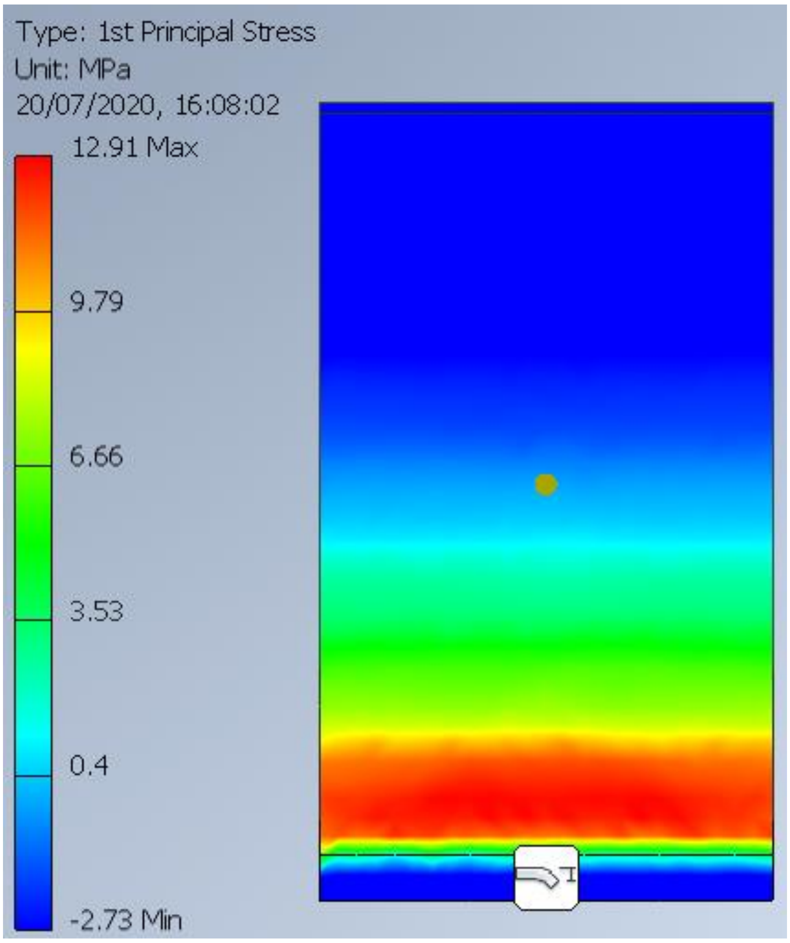
Glass Analysis - Bending Stress of Glass Panel due to 1.5kN/m Point Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5kN/m Point Load
- 12/12/1.52mm 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 1.0m x 1.8m

Result:

Max. Bending Stress = 12.91N/mm^2 x1.5 = 19.37N/mm^2 < 84.2N/mm^2

OK in Bending



Project: Privacy Screen	Contract: 1348-1
Subject: Glass Balustrade	Sheet No. 66
Date: 20/07/2020	By: R.F.

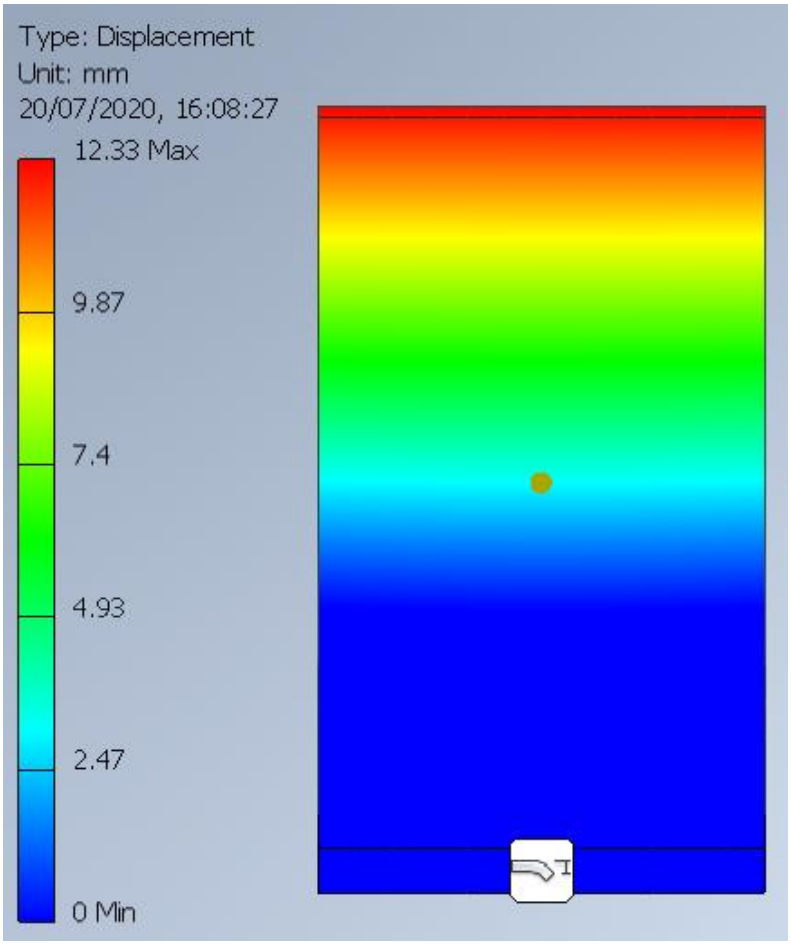
Glass Analysis - Deflection of Glass Panel due to 1.5kN/m Point Load:

- Analysis Software was used to determine maximum deflection of the glass due to 1.5kN/m Point Load
- 12/12/1.52mm 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 1.0m x 1.8m

Result:

Max. Deflection = 12.33mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



31.52mm Glass Analysis – 1.5kN/m PVB Interlayer

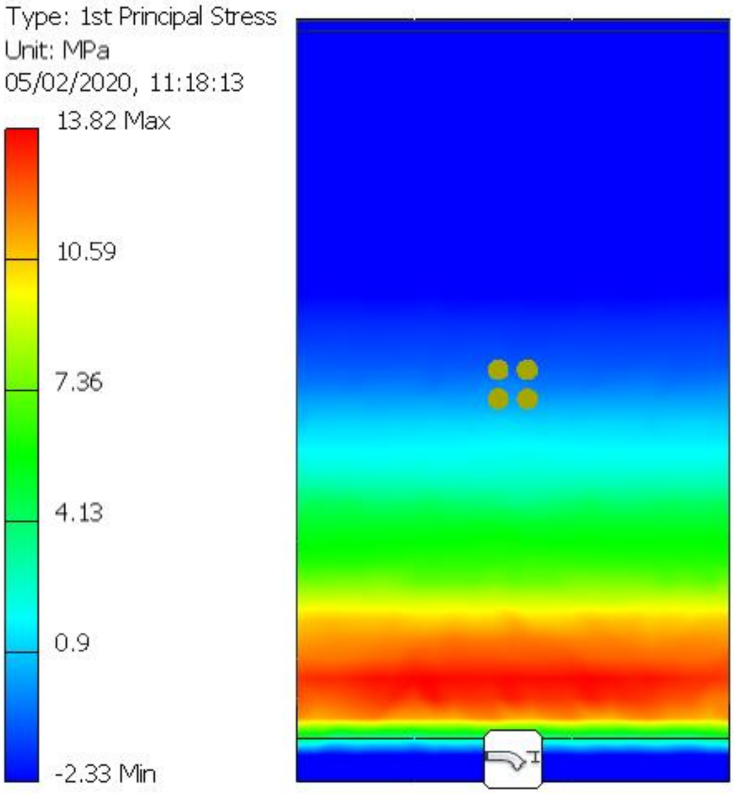
Glass Analysis - Bending Stress of Glass Panel due to 1.5kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5N/m2 Infill Loading
- 15/15/1.52mm 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 1.0m x 1.8m

Result:

Max. Bending Stress = 13.82N/mm^2 x1.5 = 20.73N/mm^2 < 84.2N/mm^2

OK in Bending



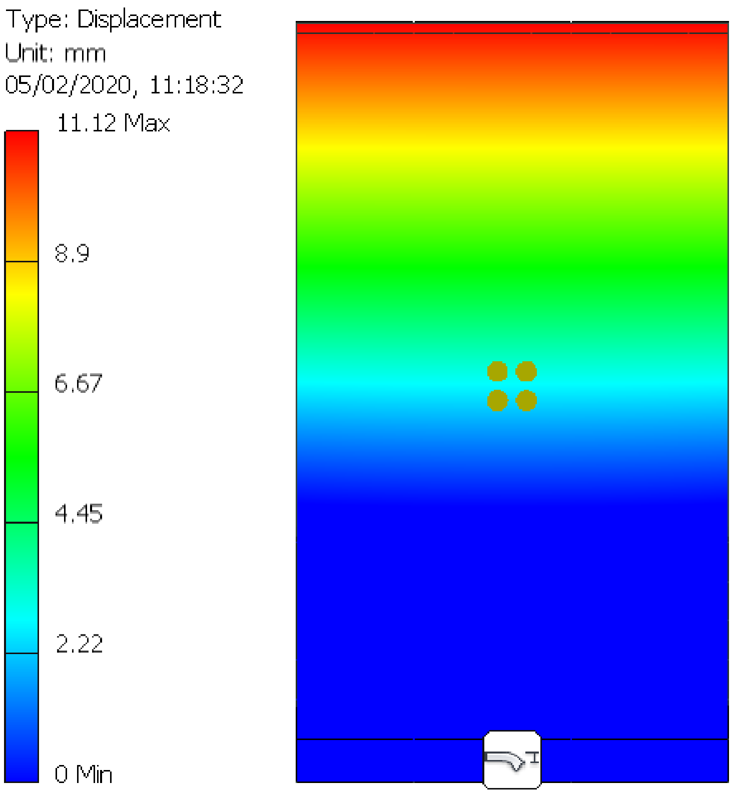
Glass Analysis - Deflection of Glass Panel due to 1.5kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5N/m2 Infill Loading
- 15/15/1.52mm 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 1.0m x 1.8m

<u>Result:</u>

Max. Deflection = 11.12mm < 25mm {BS6180:2011 cl. 6.4.1}

<u>OK in Deflection (Glass Only)</u>



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Project: Privacy Screen	**Contract:** 1348-1
Subject: Glass Balustrade	**Sheet No.** 69
Date: 20/07/2020	**By:** R.F.

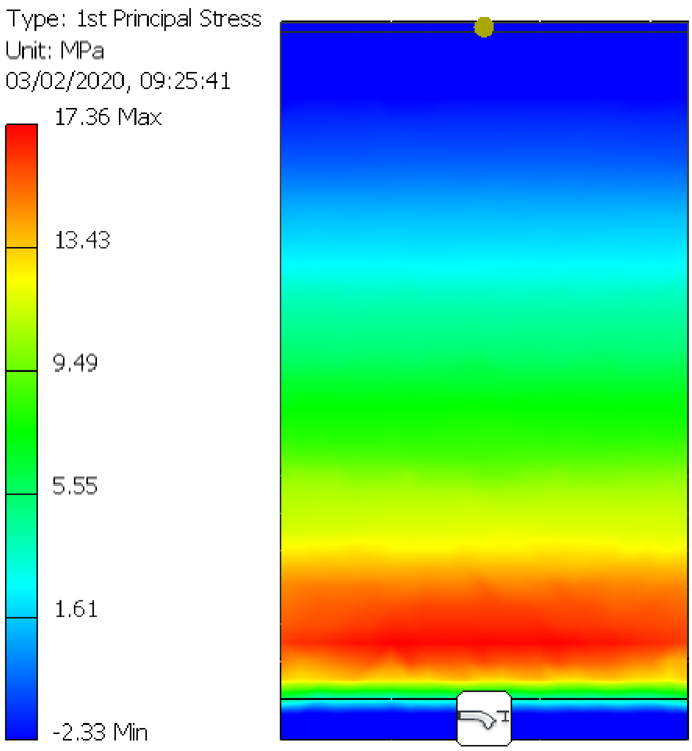
Glass Analysis - Bending Stress of Glass Panel due to 1.5kN/m Balustrade Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5kN/m Balustrade Loading
- 15/15/1.52mm 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 1.0m x 1.8m

<u>Result:</u>

Max. Bending Stress = 17.36N/mm^2 x1.5 = 26.04N/mm^2 < 84.2N/mm^2

<u>OK in Bending</u>



Project: Privacy Screen	Contract: 1348-1
Subject: Glass Balustrade	Sheet No. 70
Date: 20/07/2020	By: R.F.

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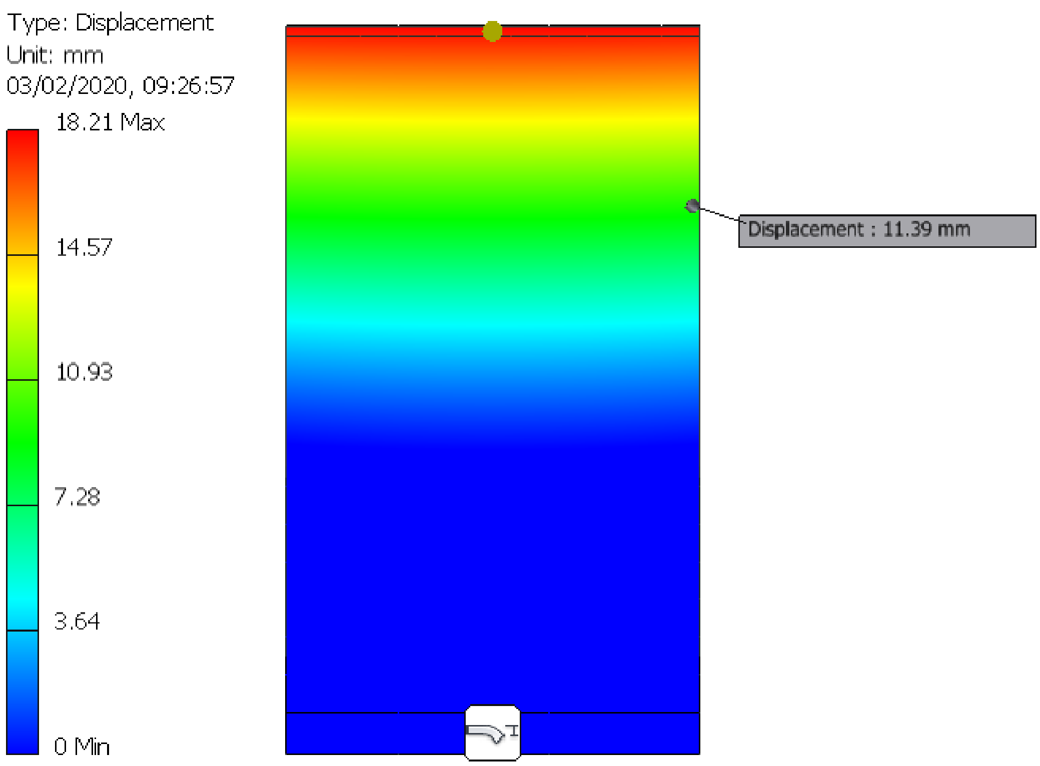
Glass Analysis - Deflection of Glass Panel due to 1.5kN/m Balustrade Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5kN/m Balustrade Loading
- 15/15/1.52mm 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 1.0m x 1.8m

Result:

Max. Deflection = 18.21mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Project: Privacy Screen	Contract: 1348-1
Subject: Glass Balustrade	Sheet No. 71
Date: 20/07/2020	By: R.F.

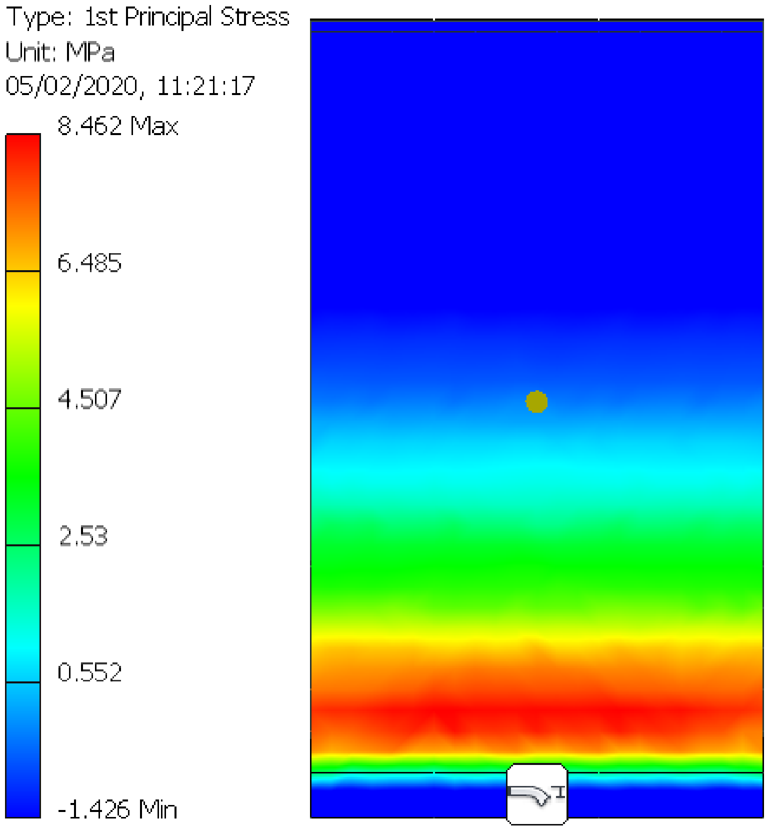
Glass Analysis - Bending Stress of Glass Panel due to 1.5kN/m Point Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5kN/m Point Load
- 15/15/1.52mm 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 1.0m x 1.8m

Result:

Max. Bending Stress = 8.462N/mm^2 x1.5 = 12.693N/mm^2 < 84.2N/mm^2

OK in Bending



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Project: Privacy Screen	**Contract:** 1348-1
Subject: Glass Balustrade	**Sheet No.** 72
Date: 20/07/2020	**By:** R.F.

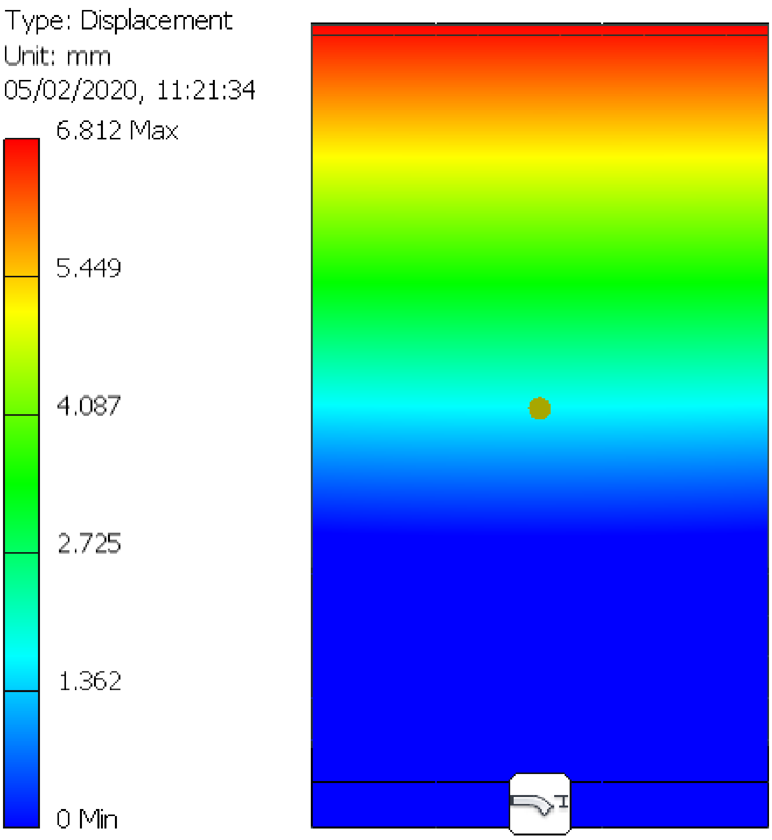
Glass Analysis - Deflection of Glass Panel due to 1.5kN/m Point Load:

- Analysis Software was used to determine maximum deflection of the glass due to 1.5kN/m Point Load
- 15/15/1.52mm 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 1.0m x 1.8m

Result:

Max. Deflection = 6.812mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Appendix C -Fiscer Reports

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

fischer
innovative solutions

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

Comment

Case 1

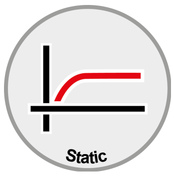
Design Specifications

Anchor

Anchor system	fischer Injection system FIS V
Injection resin	FIS V 360 S
Fixing element	Threaded rod FIS A M 10 x 150 8.8, zinc plated steel, property class 8.8
Calculated anchorage depth	107 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-02/0024, Option 1, Issued 02/01/2020

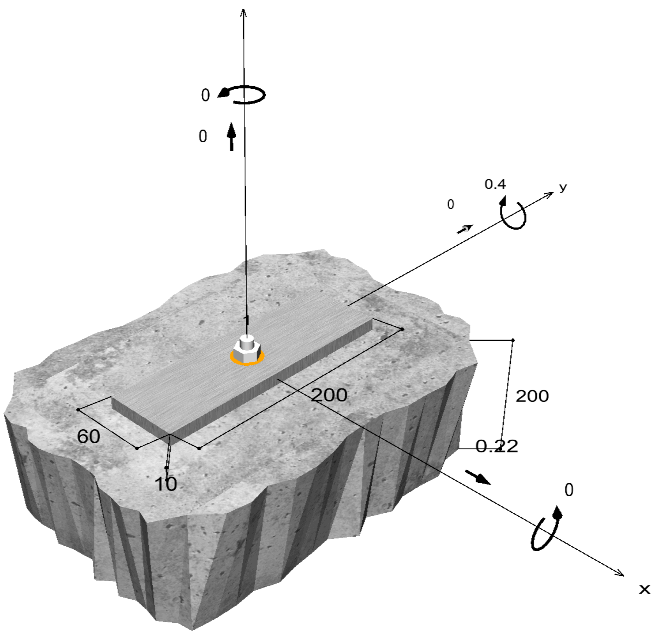
Geometry / Loads / Scale units

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	Normal weight concrete, C30/37, EN 206
Concrete condition	Cracked, dry hole
Temperature range	24 °C long term temperature, 40 °C short term temperature
Reinforcement	No or standard reinforcement. No edge reinforcement. With reinforcement against splitting
Drilling method	hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap filled
Type of loading	Static or quasi-static
Base plate location	Base plate flush installed on base material
Base plate geometry	60 mm x 200 mm x 10 mm
Profile type	None

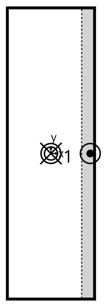
Design actions *⁾

#	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	0.22	0.00	0.00	0.40	0.00	Static or quasi-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	14.79	0.22	0.22	0.00



max. concrete compressive strain : 0.51 ‰
max. concrete compressive stress : 16.7 N/mm²
Resulting tensile actions : 14.79 kN , X/Y position (0 / 0)
Resulting compression actions : 14.79 kN , X/Y position (27 / 0)

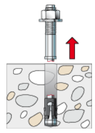
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	14.79	31.33	47.2
Combined pull-out and concrete cone failure	14.79	14.79	**100.0**
Concrete cone failure	14.79	57.00	25.9

* Most unfavourable anchor

Steel failure

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

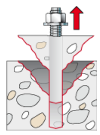


$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
47.00	1.50	31.33	14.79	47.2

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	47.2	1	$\beta_{N,s;1}$

Combined pull-out and concrete cone failure

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



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

$$N_{Rk,p} = 22.19kN \cdot \frac{58{,}564mm^2}{58{,}564mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 22.19kN$$

$$N^0_{Rk,p} = \Psi_{sus} \cdot \pi \cdot d \cdot h_{ef} \cdot \tau_{Rk} = 1.00 \cdot \pi \cdot 10mm \cdot 107mm \cdot 6.6N/mm^2 = 22.19kN \qquad \text{Eq. (7.14)}$$

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

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

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

$$s_{cr,Np} = min\left(7.3 \cdot 10mm \cdot \left(1.00 \cdot 11.0N/mm^2\right)^{0.5}; 3 \cdot 107mm\right) = 242mm$$

$$c_{cr,Np} = \frac{S_{cr,Np}}{2} = \frac{242mm}{2} = 121mm \qquad \text{Eq. (7.16)}$$

$$\Psi_{s,Np} = min\left(1; 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}}\right) = min\left(1; 0.7 + 0.3 \cdot \frac{\infty}{121mm}\right) = 1.000 \leq 1 \qquad \text{Eq. (7.20)}$$

$$\Psi_{g,Np} = max\left(1; \Psi^0_{g,Np} - \sqrt{\frac{s}{s_{cr,Np}}} \cdot \left(\Psi^0_{g,Np} - 1\right)\right) = 1.000 - \sqrt{\frac{0mm}{242mm}} \cdot \left(1.000 - 1\right) = 1.000 \geq 1 \qquad \text{Eq. (7.17)}$$

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

$$\Psi^0_{g,Np} = max\left(1; \sqrt{1} - \left(\sqrt{1} - 1\right) \cdot \left(\frac{6.6N/mm^2}{13.9N/mm^2}\right)^{1.5}\right) = 1.000 \geq 1$$

$$\tau_{Rk,c} = \frac{k_3}{\pi \cdot d}\sqrt{h_{ef} \cdot f_{ck}} = \frac{7.7}{3.14 \cdot 10mm}\sqrt{107mm \cdot 30.0N/mm^2} = 13.9N/mm^2 \qquad \text{Eq. (7.19)}$$

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

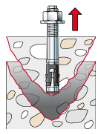
$$\Psi_{ec,Npx} = \frac{1}{1+\frac{2 \cdot 0mm}{242mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Npy} = \frac{1}{1+\frac{2 \cdot 0mm}{242mm}} = 1.000 \leq 1$$

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

$N_{Rk,p}$ kN	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
22.19	1.50	14.79	14.79	100.0

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	100.0	1	$\beta_{N,p;1}$

Concrete cone failure



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

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

$$N_{Rk,c} = 46.68kN \cdot \frac{103{,}041mm^2}{103{,}041mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.831 = 85.49kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 7.7 \cdot \sqrt{30.0N/mm^2} \cdot \left(107mm\right)^{1.5} = 46.68kN$$ Eq. (7.2)

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{\infty}{161mm}\right) = 1.000 \leq 1$$ 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)

$$\Psi_{ec,Nx} = \frac{1}{1+\frac{2 \cdot 0mm}{321mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1+\frac{2 \cdot 0mm}{321mm}} = 1.000 \leq 1$$

$$\Psi_{M,N} = 2 - \frac{z}{1.5 \cdot h_{ef}} = 2 - \frac{27mm}{1.5 \cdot 107mm} = 1.83 \geq 1$$ Eq. (7.7)

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
85.49	1.50	57.00	14.79	25.9

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	25.9	1	$\beta_{N,c;1}$

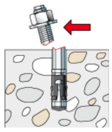
Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation βv %
Steel failure without lever arm *	0.22	18.40	**1.2**
Concrete pry-out failure	0.22	29.58	0.7

* Most unfavourable anchor

Steel failure without lever arm

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



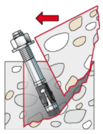
$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 23.00kN = 23.00kN$$ Eq. (7.35)/ (7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
23.00	1.25	18.40	0.22	1.2

Anchor no.	β_{Vs} %	Group N°	Decisive Beta
1	1.2	1	$\beta_{Vs;1}$

Concrete pry-out failure

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



$$V_{Rk,cp} = k_8 \cdot N_{Rk,p} = 2 \cdot 22.19kN = 44.37kN$$ 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)

$$N_{Rk,p} = 22.19kN \cdot \frac{58{,}564mm^2}{58{,}564mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 22.19kN$$

$$N^0_{Rk,p} = \Psi_{sus} \cdot \pi \cdot d \cdot h_{ef} \cdot \tau_{Rk} = 1.00 \cdot \pi \cdot 10mm \cdot 107mm \cdot 6.6N/mm^2 = 22.19kN$$ Eq. (7.14)

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

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

$$\Psi_{s,Np} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{\infty}{121mm}\right) = 1.000 \leq 1$$ 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)

$$\Psi_{g,Np} = max\left(1;\ 1.000 - \sqrt{\frac{0mm}{242mm}} \cdot \left(1.000 - 1\right)\right) = 1.000 \geq 1$$

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

$$\Psi^0_{g,Np} = max\left(1;\ \sqrt{1} - \left(\sqrt{1} - 1\right) \cdot \left(\frac{6.6N/mm^2}{13.9N/mm^2}\right)^{1.5}\right) = 1.000 \geq 1$$

$$\tau_{Rk,c} = \frac{k_3}{\pi \cdot d}\sqrt{h_{ef} \cdot f_{ck}} = \frac{7.7}{3.14 \cdot 10mm}\sqrt{107mm \cdot 30.0N/mm^2} = 13.9N/mm^2$$ 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	$\beta_{V,cp}$ %
44.37	1.50	29.58	0.22	0.7

Anchor no.	$\beta_{V,cp}$ %	Group N°	Decisive Beta
1	0.7	1	$\beta_{V,cp;1}$

Utilization of tension and shear loads

Tension loads	Utilisation β_N %
Steel failure *	47.2
Combined pull-out and concrete cone failure	**100.0**
Concrete cone failure	25.9

Shear Loads	Utilisation β_V %
Steel failure without lever arm *	**1.2**
Concrete pry-out failure	0.7

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.47 \leq 1$$

$$\beta_{V.s} = \beta_{Vs;1} = 0.01 \leq 1$$

$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.22 \leq 1$$ Eq. (7.55)

Utilisation concrete

Proof successful

$$\beta_{N,p} = \beta_{N,p;1} = 1.00 \leq 1$$

$$\beta_{V.cp} = \beta_{V,cp;1} = 0.01 \leq 1$$

$$\frac{\beta_N + \beta_V}{1.2} = \frac{\beta_{N,p;1} + \beta_{V,cp;1}}{1.2} = 0.84 \leq 1$$ Eq. (7.57)

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof t = 10 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 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.

During the design process, the following hints and warnings were issued:

- For loads with momentum and tension forces load combinations without bending moment should also be checked.

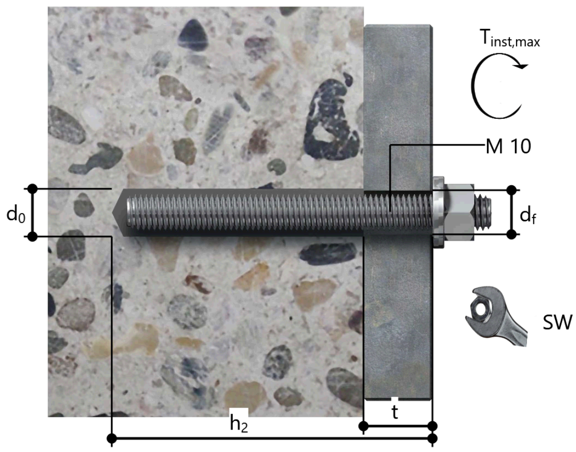
Installation data

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 150 8.8, zinc plated steel, property class 8.8	Art.-No. 517935
Accessories	Dispenser FIS DM S	Art.-No. 511118
	Blow-out pump ABG big	Art.-No. 89300
	BSD 12	Art.-No. 1490
	SDS Chuck with internal thread M8	Art.-No. 530332
	SDS Plus II 12/150/210	Art.-No. 531804
	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 = 117 mm
Calculated anchorage depth	h_{ef} = 107 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 = 10 mm
Total fixing thickness Tfix,max	t_{fix} = 10 mm
Volume of resin per drill hole	10 ml/5 scale divisions



Base plate details

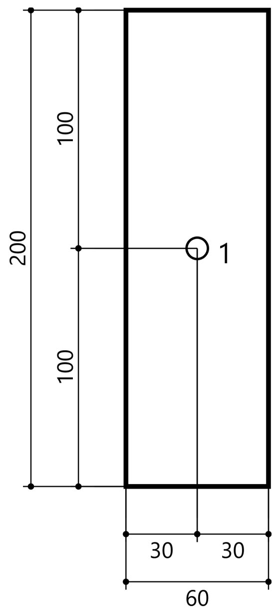
Base plate material	Not available
Base plate thickness	t = 10 mm
Clearance hole in base plate	d_f=14 mm

Attachment

Profile type	None

Anchor coordinates

Anchor no.	x mm	y mm
1	0	0



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www.masonryfixings.ie

Comment

Case 2 & 8

Design Specifications

Anchor

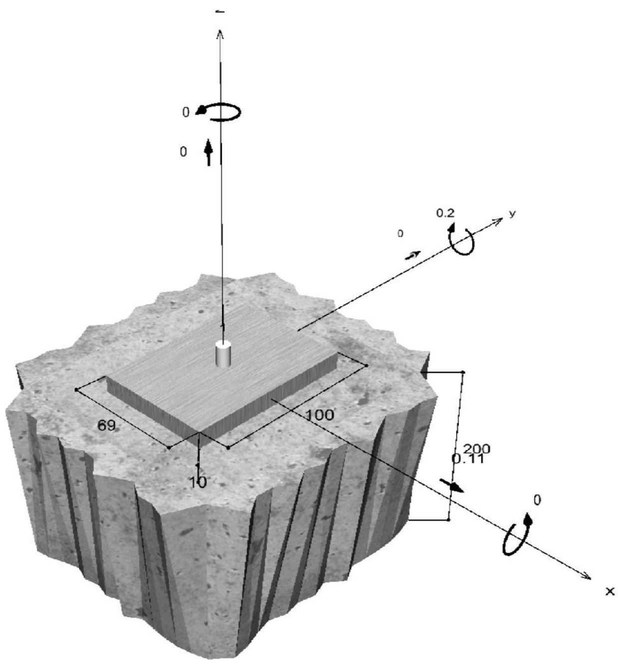
Anchor system	fischer High performance anchor FH II
Anchor	High performance anchor FH II 12/15 SK, zinc plated steel
Calculated anchorage depth	60 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-07/0025, Option 1, Issued 14/05/2018

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 mechanical fastener
Base material	Normal weight concrete, C30/37, EN 206
Concrete condition	Cracked, dry hole
Reinforcement	No or standard reinforcement. No edge reinforcement. With reinforcement against splitting
Drilling method	hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap not filled
Type of loading	Static or quasi-static
Base plate location	Base plate flush installed on base material
Base plate geometry	69 mm x 100 mm x 10 mm
Profile type	None

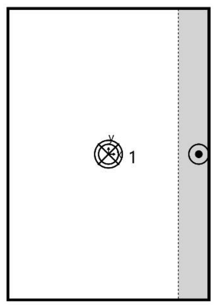
Design actions *⁾

#	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	0.11	0.00	0.00	0.20	0.00	Static or quasi-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	6.46	0.11	0.11	0.00



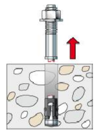
max. concrete compressive strain :	0.37 ‰
max. concrete compressive stress :	12.2 N/mm²
Resulting tensile actions :	6.46 kN , X/Y position (0 / 0)
Resulting compression actions :	6.46 kN , X/Y position (31 / 0)

Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	6.46	19.53	33.1
Pullout failure *	6.46	9.76	**66.2**
Concrete cone failure	6.46	21.64	29.8

* Most unfavourable anchor

Steel failure

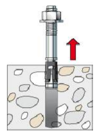


$$N_{Ed} \leq \frac{N_{Rk,s}}{\gamma_{Ms}} \quad (\mathbf{N_{Rd,s}})$$

$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
29.30	1.50	19.53	6.46	33.1

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	33.1	1	$\beta_{N,s;1}$

Pullout failure



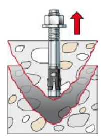
$$N_{Ed} \leq \frac{N_{Rk,p}}{\gamma_{Mp}} \quad (\mathbf{N_{Rd,p}})$$

$N_{Rk,p}$ kN	Ψ_c	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
14.64	1.220	1.50	9.76	6.46	66.2

The given Psi,c-factor may has been determined by interpolation.

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	66.2	1	$\beta_{N,p;1}$

Concrete cone failure



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

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

$$N_{Rk,c} = 19.60kN \cdot \frac{32{,}400mm^2}{32{,}400mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.656 = 32.46kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 7.7 \cdot \sqrt{30.0N/mm^2} \cdot \left(60mm\right)^{1.5} = 19.60kN$$ Eq. (7.2)

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{\infty}{90mm}\right) = 1.000 \leq 1$$ Eq. (7.4)

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

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

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

$$\Psi_{M,N} = 2 - \frac{z}{1.5 \cdot h_{ef}} = 2 - \frac{31mm}{1.5 \cdot 60mm} = 1.66 \geq 1$$ Eq. (7.7)

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
32.46	1.50	21.64	6.46	29.8

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	29.8	1	$\beta_{N,c;1}$

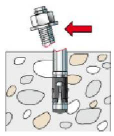
Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	0.11	26.40	**0.4**
Concrete pry-out failure	0.11	43.28	0.3

* Most unfavourable anchor

Steel failure without lever arm

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



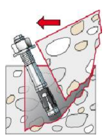
$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 33.00kN = 33.00kN$$ Eq. (7.35)/ (7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
33.00	1.25	26.40	0.11	0.4

Anchor no.	β_{Vs} %	Group N°	Decisive Beta
1	0.4	1	$\beta_{Vs;1}$

Concrete pry-out failure

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



$$V_{Rk,cp} = k_8 \cdot N_{Rk,c} = 2 \cdot 32.46kN = 64.91kN$$ Eq. (7.39a)

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

$$N_{Rk,c} = 19.60kN \cdot \frac{32{,}400mm^2}{32{,}400mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.656 = 32.46kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 7.7 \cdot \sqrt{30.0N/mm^2} \cdot \left(60mm\right)^{1.5} = 19.60kN$$ Eq. (7.2)

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{\infty}{90mm}\right) = 1.000 \leq 1$$ 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)

$$\Psi_{M,N} = 2 - \frac{z}{1.5 \cdot h_{ef}} = 2 - \frac{31mm}{1.5 \cdot 60mm} = 1.66 \geq 1$$ Eq. (7.7)

$V_{Rk,cp}$ kN	γ_{Mc}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
64.91	1.50	43.28	0.11	0.3

Anchor no.	$\beta_{V,cp}$ %	Group N°	Decisive Beta
1	0.3	1	$\beta_{V,cp;1}$

Utilization of tension and shear loads

Tension loads	Utilisation βN %
Steel failure *	33.1
Pullout failure *	**66.2**
Concrete cone failure	29.8

Shear Loads	Utilisation βV %
Steel failure without lever arm *	**0.4**
Concrete pry-out failure	0.3

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.33 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.00 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.11 \leq 1$$ Eq. (7.55)

Utilisation concrete

Proof successful

$$\beta_{N,p} = \beta_{N,p;1} = 0.66 \leq 1$$
$$\beta_{V.cp} = \beta_{V,cp;1} = 0.00 \leq 1$$
$$\beta_N^{1.5} + \beta_V^{1.5} = \beta_{N,p;1}^{1.5} + \beta_{V,cp;1}^{1.5} = 0.54 \leq 1$$ Eq. (7.56)

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof | t = 10 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 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.

During the design process, the following hints and warnings were issued:

- The factor $\psi_{M,N}$ is taking into account the effect of a compression force between the fixture and concrete in case of bending moments with or without axial force. If the bending moment does not act continuously, please also check this load case. See EN 1992-4, 7.2.1.4 (7)

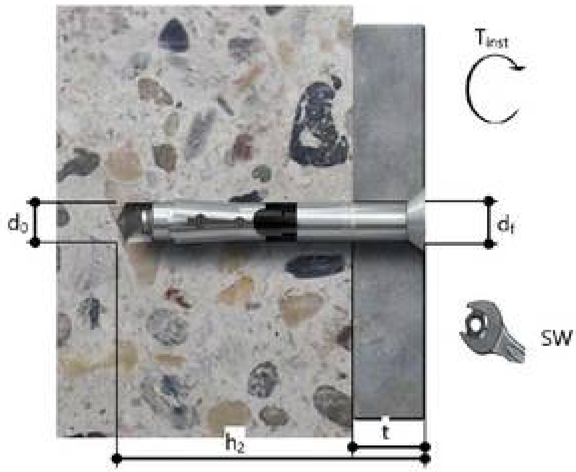
Installation data

Anchor

Anchor system	**fischer High performance anchor FH II**		
Anchor	High performance anchor FH II 12/15 SK, zinc plated steel	Art.-No. 44917	
Accessories	Blow-out pump ABG big	Art.-No. 89300	
	SDS Plus II 12/100/160	Art.-No. 531803	
	Erection of the drillhole by hammer drilling with or without suction cleaning		

Installation details

Thread diameter	M 8
Drill hole diameter	d_0 = 12 mm
Drill hole depth	h_2 = 95 mm
Calculated anchorage depth	h_{ef} = 60 mm
Installation depth	h_{nom} = 60 mm
Counter-sink size	22 mm x 6 mm
Drilling method	hammer drilling
Drill hole cleaning	only blow out by hand
Installation type	Push-through installation
Annular gap	Annular gap not filled
Installation torque	T_{inst} = 22.5 Nm
Internal hexagon socket size	5 mm
Base plate thickness	t = 10 mm
Total fixing thickness	t_{fix} = 10 mm
Tfix,max	$t_{fix,\,max}$ = 15 mm



Base plate details

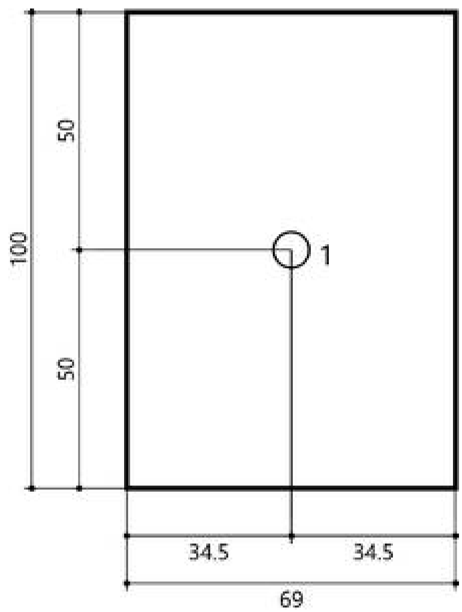
Base plate material	Not available
Base plate thickness	t = 10 mm
Clearance hole in base plate	d_f=14 mm

Attachment

Profile type	None

Anchor coordinates

Anchor no.	x mm	y mm
1	0	0



fischer
innovative solutions

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technical@masonryfixings.ie
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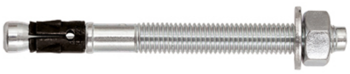
Comment

Case 3

Design Specifications

Anchor

Anchor system	fischer Bolt anchor FAZ II
Anchor	Bolt anchor FAZ II 16/25, zinc plated steel
Calculated anchorage depth	65 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-05/0069, Option 1, Issued 03/07/2017

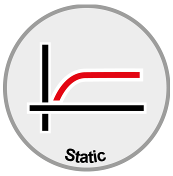


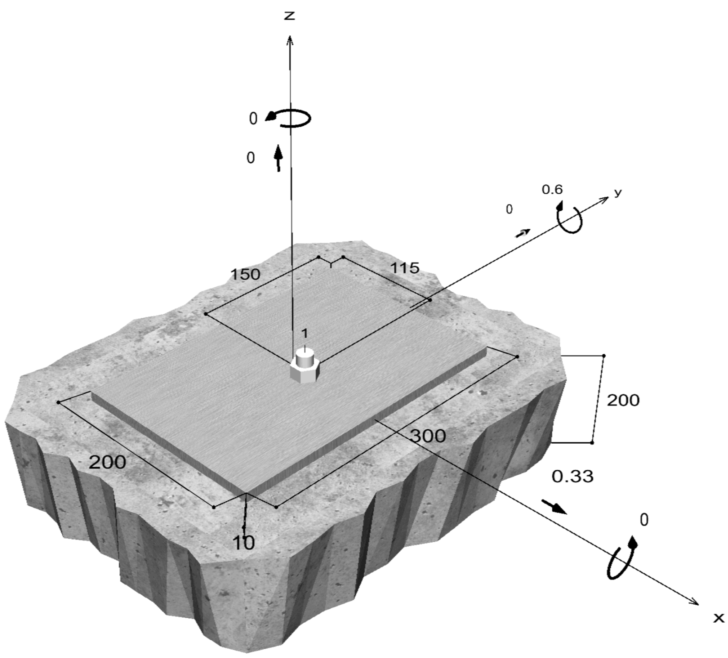
Geometry / Loads / Scale units

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 mechanical fastener
Base material	Normal weight concrete, C30/37, EN 206
Concrete condition	Cracked, dry hole
Reinforcement	No or standard reinforcement. No edge reinforcement. With reinforcement against splitting
Drilling method	hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap not filled
Type of loading	Static or quasi-static
Base plate location	Base plate flush installed on base material
Base plate geometry	200 mm x 300 mm x 10 mm
Profile type	None

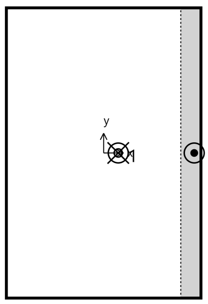
Design actions *⁾

#	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	0.33	0.00	0.00	0.60	0.00	Static or quasi-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	7.68	0.33	0.33	0.00



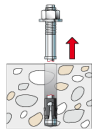
max. concrete compressive strain :	0.08 ‰
max. concrete compressive stress :	2.5 N/mm²
Resulting tensile actions :	7.68 kN , X/Y position (15 / 0)
Resulting compression actions :	7.68 kN , X/Y position (93 / 0)

Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	7.68	44.67	17.2
Concrete cone failure	7.68	17.67	**43.5**

* Most unfavourable anchor

Steel failure

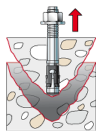


$$N_{Ed} \leq \frac{N_{Rk,s}}{\gamma_{Ms}}$$ **($N_{Rd,s}$)**

$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
67.00	1.50	44.67	7.68	17.2

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	17.2	1	$\beta_{N,s;1}$

Concrete cone failure



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

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

$$N_{Rk,c} = 22.10kN \cdot \frac{38{,}025mm^2}{38{,}025mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.199 = 26.50kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 7.7 \cdot \sqrt{30.0N/mm^2} \cdot \left(65mm\right)^{1.5} = 22.10kN$$ Eq. (7.2)

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{\infty}{98mm}\right) = 1.000 \leq 1$$ Eq. (7.4)

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

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

$$\Psi_{ec,Nx} = \frac{1}{1 + \frac{2 \cdot 0mm}{195mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1 + \frac{2 \cdot 0mm}{195mm}} = 1.000 \leq 1$$

$$\Psi_{M,N} = 2 - \frac{z}{1.5 \cdot h_{ef}} = 2 - \frac{78mm}{1.5 \cdot 65mm} = 1.20 \geq 1$$ Eq. (7.7)

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
26.50	1.50	17.67	7.68	43.5

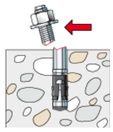
Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	43.5	1	$\beta_{N,c;1}$

Resistance to shear loads

Proof	**Action** kN	**Capacity** kN	**Utilisation β_V** %
Steel failure without lever arm *	0.33	44.00	**0.8**
Concrete pry-out failure	0.33	56.54	0.6

* Most unfavourable anchor

Steel failure without lever arm



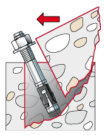
$$V_{Ed} \leq \frac{V_{Rk,s}}{\gamma_{Ms}} \qquad (\mathbf{V_{Rd,s}})$$

$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 55.00kN = 55.00kN$$ Eq. (7.35)/ (7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
55.00	1.25	44.00	0.33	0.8

Anchor no.	**β_{Vs}** %	**Group N°**	**Decisive Beta**
1	0.8	1	$\beta_{Vs;1}$

Concrete pry-out failure



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

$$V_{Rk,cp} = k_8 \cdot N_{Rk,c} = 3.2 \cdot 26.50kN = 84.81kN$$ Eq. (7.39a)

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

$$N_{Rk,c} = 22.10kN \cdot \frac{38{,}025mm^2}{38{,}025mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.199 = 26.50kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 7.7 \cdot \sqrt{30.0N/mm^2} \cdot \left(65mm\right)^{1.5} = 22.10kN$$ Eq. (7.2)

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{\infty}{98mm}\right) = 1.000 \leq 1$$ 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)

$$\Psi_{M,N} = 2 - \frac{z}{1.5 \cdot h_{ef}} = 2 - \frac{78mm}{1.5 \cdot 65mm} = 1.20 \geq 1$$ Eq. (7.7)

$V_{Rk,cp}$ kN	γ_{Mc}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
84.81	1.50	56.54	0.33	0.6

Anchor no.	$\beta_{V,cp}$ %	Group N°	Decisive Beta
1	0.6	1	$\beta_{V,cp;1}$

Utilization of tension and shear loads

Tension loads	Utilisation β_N %
Steel failure *	17.2
Concrete cone failure	**43.5**

Shear Loads	Utilisation β_V %
Steel failure without lever arm *	**0.8**
Concrete pry-out failure	0.6

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N,s} = \beta_{N,s;1} = 0.17 \leq 1$$
$$\beta_{V,s} = \beta_{Vs;1} = 0.01 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.03 \leq 1$$ Eq. (7.55)

Utilisation concrete

$$\beta_{N,c} = \beta_{N,c;1} = 0.43 \leq 1$$
$$\beta_{V,cp} = \beta_{V,cp;1} = 0.01 \leq 1$$
$$\beta_N^{1.5} + \beta_V^{1.5} = \beta_{N,c;1}^{1.5} + \beta_{V,cp;1}^{1.5} = 0.29 \leq 1$$ Eq. (7.56)

Proof successful

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof t = 10 mm

Profile type None

Technical remarks

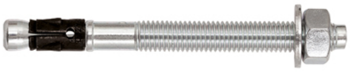
The transmission of the anchor loads to the supports of the concrete member shall be shown for the ultimate limit state and the serviceability limit state; for this purpose, the normal verifications shall be carried out under due consideration of the actions introduced by the anchors. For these verifications 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 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.

During the design process, the following hints and warnings were issued:

• For loads with momentum and tension forces load combinations without bending moment should also be checked.

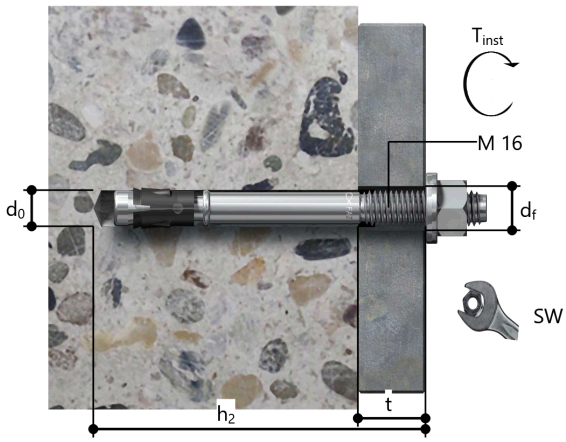
Installation data

Anchor

Anchor system	**fischer Bolt anchor FAZ II**		
Anchor	Bolt anchor FAZ II 16/25, zinc plated steel	Art.-No. 95836	
Accessories	Blow-out pump ABG big	Art.-No. 89300	
	Pointer M 16x100/400	Art.-No. 543634	
	or alternatively		
	FHD 16/250/380	Art.-No. 546599	
	Hammer drilling with or without suction		
	Erection of the drillhole by hammer drilling with or without suction cleaning		

Installation details

Thread diameter	M 16
Drill hole diameter	d_0 = 16 mm
Drill hole depth	h_2 = 98 mm
Calculated anchorage depth	h_{ef} = 65 mm
Installation depth	h_{nom} = 83 mm
Drilling method	hammer drilling
Drill hole cleaning	only blow out by hand 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 not filled
Installation torque	T_{inst} = 110.0 Nm
Socket size	24 mm
Base plate thickness	t = 10 mm
Total fixing thickness	t_{fix} = 10 mm
Tfix,max	$t_{fix,\ max}$ = 45 mm

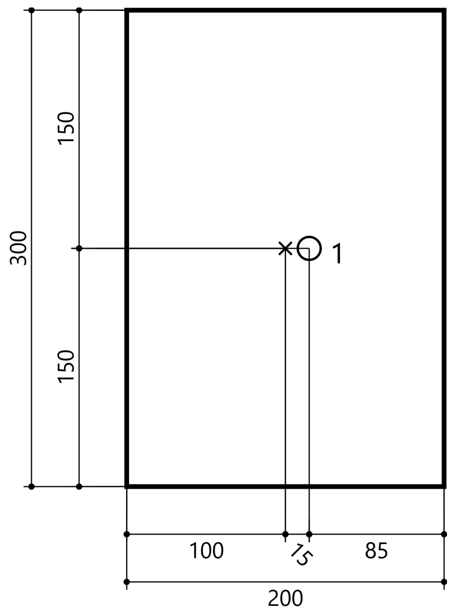


Base plate details

Base plate material	Not available
Base plate thickness	t = 10 mm
Clearance hole in base plate	d_f=18 mm

Attachment

Profile type	None



Anchor coordinates

Anchor no.	x mm	y mm
1	15	0

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Comment

Case 4 & 6 & 9

Design Specifications

Anchor

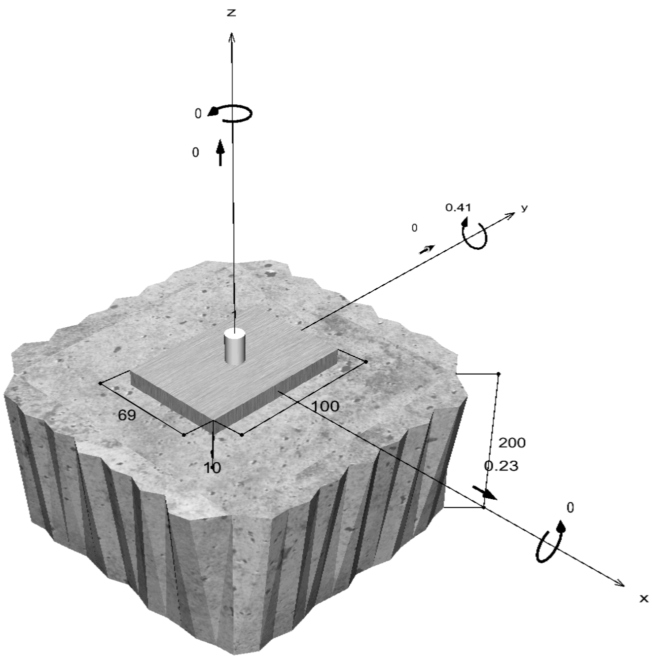
Anchor system	fischer High performance anchor FH II
Anchor	High performance anchor FH II 18/25 SK, zinc plated steel
Calculated anchorage depth	80 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-07/0025, Option 1, Issued 14/05/2018

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 mechanical fastener
Base material	Normal weight concrete, C30/37, EN 206
Concrete condition	Cracked, dry hole
Reinforcement	No or standard reinforcement. No edge reinforcement. With reinforcement against splitting
Drilling method	hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap not filled
Type of loading	Static or quasi-static
Base plate location	Base plate flush installed on base material
Base plate geometry	69 mm x 100 mm x 10 mm
Profile type	None

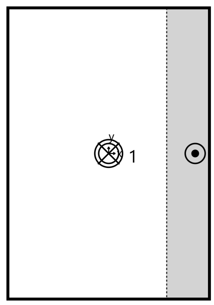
Design actions *⁾

#	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	0.23	0.00	0.00	0.41	0.00	Static or quasi-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	13.84	0.23	0.23	0.00



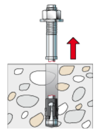
max. concrete compressive strain :	0.58 ‰	
max. concrete compressive stress :	18.9 N/mm²	
Resulting tensile actions :	13.84 kN ,	X/Y position (0 / 0)
Resulting compression actions :	13.84 kN ,	X/Y position (30 / 0)

Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	13.84	44.93	30.8
Pullout failure *	13.84	20.33	**68.1**
Concrete cone failure	13.84	35.27	39.2

* Most unfavourable anchor

Steel failure

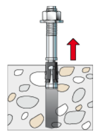


$$N_{Ed} \leq \frac{N_{Rk,s}}{\gamma_{Ms}}$$ **($N_{Rd,s}$)**

$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
67.40	1.50	44.93	13.84	30.8

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	30.8	1	$\beta_{N,s;1}$

Pullout failure



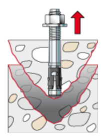
$$N_{Ed} \leq \frac{N_{Rk,p}}{\gamma_{Mp}}$$ **($N_{Rd,p}$)**

$N_{Rk,p}$ kN	Ψ_c	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
30.50	1.220	1.50	20.33	13.84	68.1

The given Psi,c-factor may has been determined by interpolation.

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	68.1	1	$\beta_{N,p;1}$

Concrete cone failure



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

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

$$N_{Rk,c} = 30.18kN \cdot \frac{57{,}600mm^2}{57{,}600mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.753 = 52.91kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 7.7 \cdot \sqrt{30.0N/mm^2} \cdot \left(80mm\right)^{1.5} = 30.18kN$$ Eq. (7.2)

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{\infty}{120mm}\right) = 1.000 \leq 1$$ Eq. (7.4)

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

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

$$\Psi_{ec,Nx} = \frac{1}{1+\frac{2 \cdot 0mm}{240mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1+\frac{2 \cdot 0mm}{240mm}} = 1.000 \leq 1$$

$$\Psi_{M,N} = 2 - \frac{z}{1.5 \cdot h_{ef}} = 2 - \frac{30mm}{1.5 \cdot 80mm} = 1.75 \geq 1$$ Eq. (7.7)

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
52.91	1.50	35.27	13.84	39.2

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	39.2	1	$\beta_{N,c;1}$

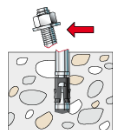
Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	0.23	27.20	**0.8**
Concrete pry-out failure	0.23	70.54	0.3

* Most unfavourable anchor

Steel failure without lever arm

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



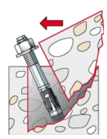
$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 34.00kN = 34.00kN$$ Eq. (7.35)/(7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
34.00	1.25	27.20	0.23	0.8

Anchor no.	β_{Vs} %	Group N°	Decisive Beta
1	0.8	1	$\beta_{Vs;1}$

Concrete pry-out failure

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



$$V_{Rk,cp} = k_8 \cdot N_{Rk,c} = 2 \cdot 52.91kN = 105.81kN$$ Eq. (7.39a)

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

$$N_{Rk,c} = 30.18kN \cdot \frac{57{,}600mm^2}{57{,}600mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.753 = 52.91kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 7.7 \cdot \sqrt{30.0N/mm^2} \cdot \left(80mm\right)^{1.5} = 30.18kN$$ Eq. (7.2)

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{\infty}{120mm}\right) = 1.000 \leq 1$$ Eq. (7.4)

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

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

$$\Psi_{M,N} = 2 - \frac{z}{1.5 \cdot h_{ef}} = 2 - \frac{30mm}{1.5 \cdot 80mm} = 1.75 \geq 1$$ Eq. (7.7)

$V_{Rk,cp}$ kN	γ_{Mc}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
105.81	1.50	70.54	0.23	0.3

Anchor no.	$\beta_{V,cp}$ %	Group N°	Decisive Beta
1	0.3	1	$\beta_{V,cp;1}$

Utilization of tension and shear loads

Tension loads	Utilisation βN %
Steel failure *	30.8
Pullout failure *	**68.1**
Concrete cone failure	39.2

Shear Loads	Utilisation βV %
Steel failure without lever arm *	**0.8**
Concrete pry-out failure	0.3

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.31 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.01 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.09 \leq 1$$ Eq. (7.55)

Utilisation concrete

Proof successful

$$\beta_{N,p} = \beta_{N,p;1} = 0.68 \leq 1$$
$$\beta_{V.cp} = \beta_{V,cp;1} = 0.00 \leq 1$$
$$\beta_N^{1.5} + \beta_V^{1.5} = \beta_{N,p;1}^{1.5} + \beta_{V,cp;1}^{1.5} = 0.56 \leq 1$$ Eq. (7.56)

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof t = 10 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 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.

During the design process, the following hints and warnings were issued:

- The factor $\psi_{M,N}$ is taking into account the effect of a compression force between the fixture and concrete in case of bending moments with or without axial force. If the bending moment does not act continuously, please also check this load case. See EN 1992-4, 7.2.1.4 (7)

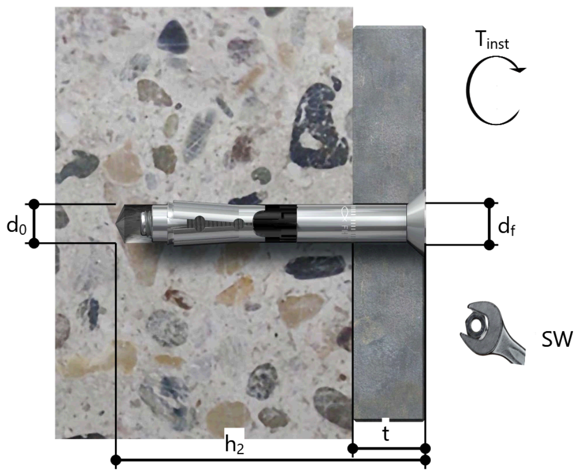
Installation data

Anchor

Anchor system	**fischer High performance anchor FH II**	
Anchor	High performance anchor FH II 18/25 SK, zinc plated steel	Art.-No. 44924
Accessories	Blow-out pump ABG big	Art.-No. 89300
	SDS Plus II 18/150/200	Art.-No. 531836
	or alternatively	
	FHD 18/320/450	Art.-No. 546600
	Hammer drilling with or without suction	
	Erection of the drillhole by hammer drilling with or without suction cleaning	

Installation details

Thread diameter	M 12
Drill hole diameter	d_0 = 18 mm
Drill hole depth	h_2 = 130 mm
Calculated anchorage depth	h_{ef} = 80 mm
Installation depth	h_{nom} = 80 mm
Counter-sink size	32 mm x 8 mm
Drilling method	hammer drilling
Drill hole cleaning	only blow out by hand 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 not filled
Installation torque	T_{inst} = 80.0 Nm
Internal hexagon socket size	8 mm
Base plate thickness	t = 10 mm
Total fixing thickness	t_{fix} = 10 mm
Tfix,max	$t_{fix, max}$ = 25 mm

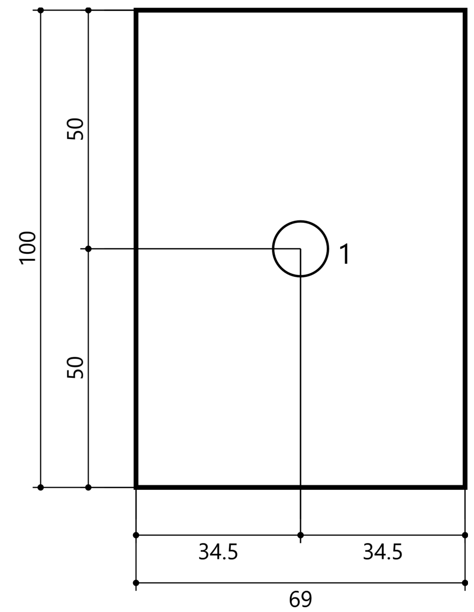


Base plate details

Base plate material	Not available
Base plate thickness	t = 10 mm
Clearance hole in base plate	d_f=20 mm

Attachment

Profile type	None



Anchor coordinates

Anchor no.	x mm	y mm
1	0	0

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Comment

Case 5 & 7

Design Specifications

Anchor

Anchor system	fischer Bolt anchor FAZ II
Anchor	Bolt anchor FAZ II 16/25, zinc plated steel
Calculated anchorage depth	65 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-05/0069, Option 1, Issued 03/07/2017

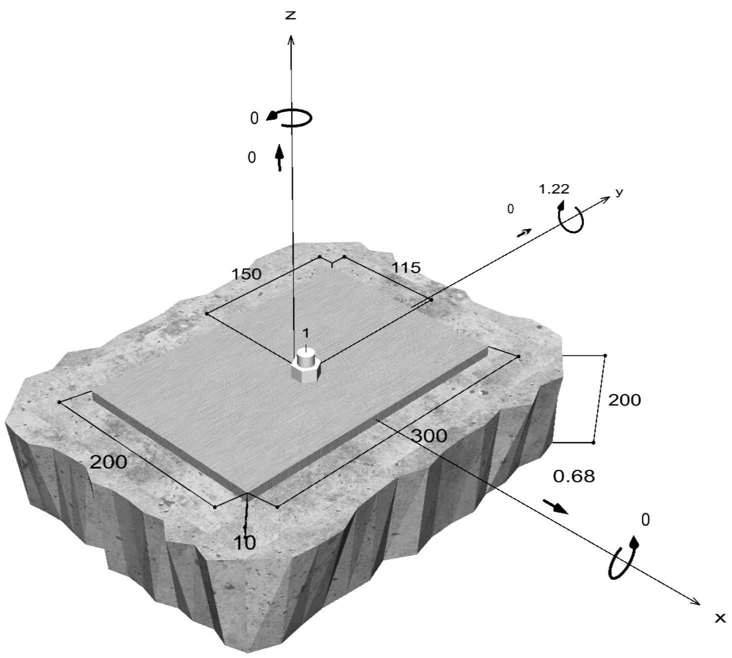
Geometry / Loads / Scale units

mm, kN, kNm

Value of design actions (including

partial safety factor for the load)

Static



Not drawn to scale

Input data

Design method	Design Method EN1992-4:2018 mechanical fastener
Base material	Normal weight concrete, C30/37, EN 206
Concrete condition	Cracked, dry hole
Reinforcement	No or standard reinforcement. No edge reinforcement. With reinforcement against splitting
Drilling method	hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap not filled
Type of loading	Static or quasi-static
Base plate location	Base plate flush installed on base material
Base plate geometry	200 mm x 300 mm x 10 mm
Profile type	None

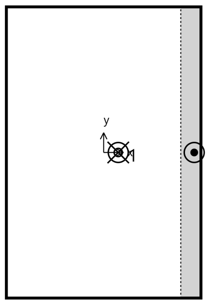
Design actions *⁾

#	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	0.68	0.00	0.00	1.22	0.00	Static or quasi-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	15.62	0.68	0.68	0.00



max. concrete compressive strain : 0.15 ‰
max. concrete compressive stress : 5.0 N/mm²
Resulting tensile actions : 15.62 kN , X/Y position (15 / 0)
Resulting compression actions : 15.62 kN , X/Y position (93 / 0)

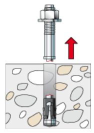
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	15.62	44.67	35.0
Concrete cone failure	15.62	17.67	**88.4**

* Most unfavourable anchor

Steel failure

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

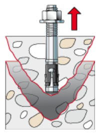


$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
67.00	1.50	44.67	15.62	35.0

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	35.0	1	$\beta_{N,s;1}$

Concrete cone failure

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



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

$$N_{Rk,c} = 22.10kN \cdot \frac{38{,}025mm^2}{38{,}025mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.199 = 26.50kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 7.7 \cdot \sqrt{30.0N/mm^2} \cdot \left(65mm\right)^{1.5} = 22.10kN$$ Eq. (7.2)

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{\infty}{98mm}\right) = 1.000 \leq 1$$ 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)

$$\Psi_{ec,Nx} = \frac{1}{1 + \frac{2 \cdot 0mm}{195mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1 + \frac{2 \cdot 0mm}{195mm}} = 1.000 \leq 1$$

$$\Psi_{M,N} = 2 - \frac{z}{1.5 \cdot h_{ef}} = 2 - \frac{78mm}{1.5 \cdot 65mm} = 1.20 \geq 1$$ Eq. (7.7)

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
26.50	1.50	17.67	15.62	88.4

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	88.4	1	$\beta_{N,c;1}$

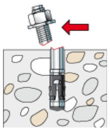
Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	0.68	44.00	**1.5**
Concrete pry-out failure	0.68	56.54	1.2

* Most unfavourable anchor

Steel failure without lever arm

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



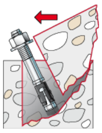
$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 55.00kN = 55.00kN$$ Eq. (7.35)/(7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
55.00	1.25	44.00	0.68	1.5

Anchor no.	β_{Vs} %	Group N°	Decisive Beta
1	1.5	1	$\beta_{Vs;1}$

Concrete pry-out failure

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



$$V_{Rk,cp} = k_8 \cdot N_{Rk,c} = 3.2 \cdot 26.50kN = 84.81kN$$ Eq. (7.39a)

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

$$N_{Rk,c} = 22.10kN \cdot \frac{38{,}025mm^2}{38{,}025mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.199 = 26.50kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h^{1.5}_{ef} = 7.7 \cdot \sqrt{30.0N/mm^2} \cdot \left(65mm\right)^{1.5} = 22.10kN$$ Eq. (7.2)

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{\infty}{98mm}\right) = 1.000 \leq 1$$ 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)

$$\Psi_{M,N} = 2 - \frac{z}{1.5 \cdot h_{ef}} = 2 - \frac{78mm}{1.5 \cdot 65mm} = 1.20 \geq 1$$ Eq. (7.7)

$V_{Rk,cp}$ kN	γ_{Mc}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
84.81	1.50	56.54	0.68	1.2

Anchor no.	$\beta_{V,cp}$ %	Group N°	Decisive Beta
1	1.2	1	$\beta_{V,cp;1}$

Utilization of tension and shear loads

Tension loads	Utilisation βN %
Steel failure *	35.0
Concrete cone failure	**88.4**

Shear Loads	Utilisation βV %
Steel failure without lever arm *	**1.5**
Concrete pry-out failure	1.2

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.35 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.02 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.12 \leq 1$$ Eq. (7.55)

Utilisation concrete

Proof successful

$$\beta_{N,c} = \beta_{N,c;1} = 0.88 \leq 1$$
$$\beta_{V.cp} = \beta_{V,cp;1} = 0.01 \leq 1$$
$$\frac{\beta_N + \beta_V}{1.2} = \frac{\beta_{N,c;1} + \beta_{V,cp;1}}{1.2} = 0.75 \leq 1$$ Eq. (7.57)

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof t = 10 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 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.

During the design process, the following hints and warnings were issued:

• For loads with momentum and tension forces load combinations without bending moment should also be checked.

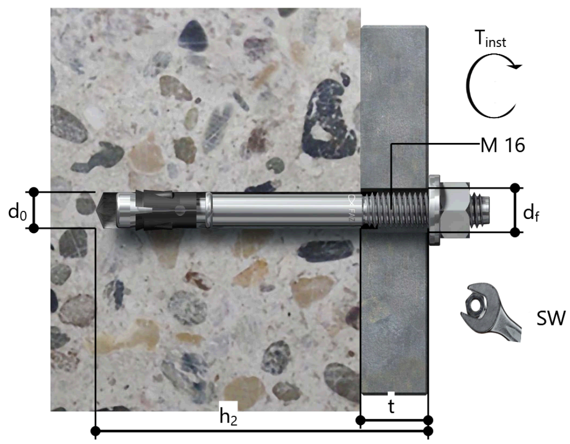
Installation data

Anchor

Anchor system	**fischer Bolt anchor FAZ II**		
Anchor	Bolt anchor FAZ II 16/25, zinc plated steel	Art.-No. 95836	
Accessories	Blow-out pump ABG big	Art.-No. 89300	
	Pointer M 16x100/400	Art.-No. 543634	
	or alternatively		
	FHD 16/250/380	Art.-No. 546599	
	Hammer drilling with or without suction		
	Erection of the drillhole by hammer drilling with or without suction cleaning		

Installation details

Thread diameter	M 16
Drill hole diameter	d_0 = 16 mm
Drill hole depth	h_2 = 98 mm
Calculated anchorage depth	h_{ef} = 65 mm
Installation depth	h_{nom} = 83 mm
Drilling method	hammer drilling
Drill hole cleaning	only blow out by hand 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 not filled
Installation torque	T_{inst} = 110.0 Nm
Socket size	24 mm
Base plate thickness	t = 10 mm
Total fixing thickness	t_{fix} = 10 mm
Tfix,max	$t_{fix, max}$ = 45 mm

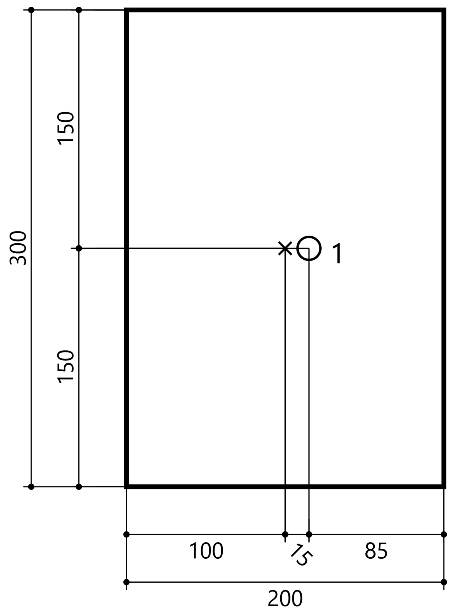


Base plate details

Base plate material	Not available
Base plate thickness	t = 10 mm
Clearance hole in base plate	d_f=18 mm

Attachment

Profile type	None



Anchor coordinates

Anchor no.	x mm	y mm
1	15	0