Project: TL6000	Contract: 1505-1
Subject: TL6000 Design	Sheet No. 1
Date: 02/03/2021	By: A.N & R.F

On Level Ltd.,

8, Alexandria Court

Ashton Commerce Park

Ashton-under-Lyne

Lancashire OL7 0QN

United Kingdom

1505-1_TL 6000 Detail Design

Analysis By	Checked By
A.N	T.S.

0	02/03/2021	T.S	Issued
Revision	**Date**	**Issued By**	**Comment**

Contents

Actions/Assumptions/Result Summary: 4

Actions:…. 4

Assumptions: 4

Result Summary: 4

Glass Strength Calculation: 5

Balustrade Loading: 5

Sketch Of System: 6

Connection To Concrete Design: 7

Loading at Connection: 7

Connection 1 For Panel 1: 7

Connection 2 For Panel 2: 7

Shoe Analysis for panel 1: 8

System Sketch – Shoe Analysis – TL 6000: 8

Bending Stress of Shoe due to Balustrade load of 0.74kN/m (SLS): 9

Deflection of Shoe due to Balustrade load of 0.74kN/m: 10

Glass Analysis: 11

System Sketch – Glass Analysis: 11

Panel 1: Bending Stress of Glass Panel due to 0.74kN/m Balustrade Load: 12

Panel 1: Deflection of Glass Panel due to 0.74kN/m Balustrade Load: 13

Panel 1: Bending Stress of Glass Panel due to 1.0kN/m^2 Infill Load: 14

Panel 1: Deflection of Glass Panel due to 1.0kN/m^2 Infill Load: 15

Panel 1: Bending Stress of Glass Panel due to 0.5kN Point Load: 16

Panel 1: Deflection of Glass Panel due to 0.5kN Point Load: 17

System Sketch – Glass Analysis: 18

Panel 2: Bending Stress of Glass Panel due to 0.74kN/m Balustrade Load: 19

Panel 2: Deflection of Glass Panel due to 0.74kN/m Balustrade Load: 20

Panel 2: Bending Stress of Glass Panel due to 1.0kN/m^2 Infill Load: 21

Panel 2: Deflection of Glass Panel due to 1.0kN/m^2 Infill Load: 22

Panel 2: Bending Stress of Glass Panel due to 0.5kN Point Load: 23

Panel 2: Deflection of Glass Panel due to 0.5kN Point Load: 24

Shoe Analysis for panel 2: 25

System Sketch – Shoe Analysis – TL 6000: 25

Bending Stress of Shoe due to Balustrade load of 0.74kN/m (SLS): 26

Deflection of Shoe due to Balustrade load of 0.74kN/m: 27

Appendix A – Fischer Reports 28

TSA
TED SINGLETON & ASSOCIATES
CONSULTING ENGINEERS

Project: TL6000	**Contract:** 1505-1
Subject: TL6000 Design	**Sheet No.** 4
Date: 02/03/2021	**By:** A.N & R.F

Actions/Assumptions/Result Summary:

Actions:

Point load = 0.5kN (Table 4 BS:6180:2011)

Infill loading = 1.0kN/m^2 (Table 4 BS:6180:2011)

Balustrade load = 0.74kN/m (Table 4 BS:6180:2011)

Assumptions:

Concrete Grade C30/37

Result Summary:

Shoe: On Level Aluminium Shoe Model TL6000.

Item	Load	Glass	Dimensions (H×W)	Max. Deflection	Bending Stress
Panel 1	0.74kN/m	15mm Toughened	1100×1000	12.39mm < 25mm	31.08N/mm^2 < 84.2N/mm^2
Panel 1	0.5kN	15mm Toughened	1100×1000	3.055mm < 25mm	9.44N/mm^2 < 84.2N/mm^2
Panel 1	1kN/m2	15mm Toughened	1100×1000	5.96mm < 25mm	18.4N/mm^2 < 84.2N/mm^2
Panel 2	0.74kN/m	19mm Toughened	1200×1000	8.144mm < 25mm	21.57N/mm^2 < 84.2N/mm^2
Panel 2	0.5kN	19mm Toughened	1200×1000	2.01mm < 25mm	6.54N/mm^2 < 84.2N/mm^2
Panel 2	1kN/m2	19mm Toughened	1200×1000	4.32mm < 25mm	14.06N/mm^2 < 84.2N/mm^2
Shoe For panel 1	0.74kN/m	N.A	TL6000	7.31+12.39 = 19.7mm < 25mm	151.05N/mm^2 < 180N/mm^2
Shoe For panel 2	0.74kN/m	N.A	TL6000	8.65+8.144 = 16.794mm < 25mm	174.15N/mm^2 < 180N/mm^2

Connection To Concrete	Worst Case Load	H1 Height FFL	Anchor Distance	Anchor Type	Grade	Minimum Concrete Edge Distance
1	0.74kN/m	1132mm	294mm	FAZ 10/12	8.8	80mm
2	0.74kN/m	1232mm	294mm	FAZ 10/12	8.8	80mm

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Project: TL6000	Contract: 1505-1
Subject: TL6000 Design	Sheet No. 5
Date: 02/03/2021	By: A.N & R.F

Glass Strength Calculation:

Balustrade Loading:

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

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

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

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

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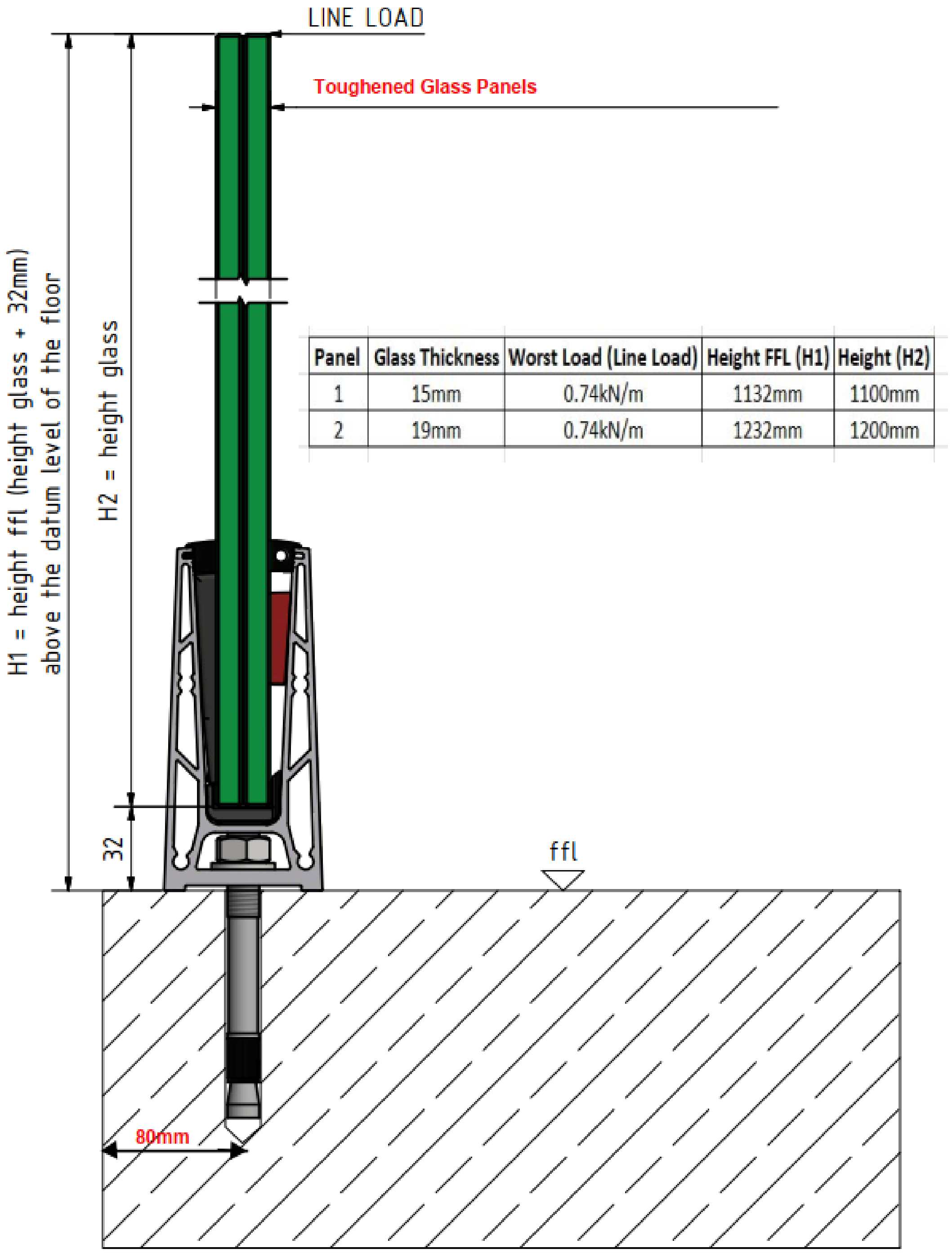
CONSULTING ENGINEERS

Project: TL6000	**Contract:** 1505-1
Subject: TL6000 Design	**Sheet No.** 6
Date: 02/03/2021	**By:** A.N & R.F

Sketch Of System:



Panel	Glass Thickness	Worst Load (Line Load)	Height FFL (H1)	Height (H2)
1	15mm	0.74kN/m	1132mm	1100mm
2	19mm	0.74kN/m	1232mm	1200mm

Project: TL6000	Contract: 1505-1
Subject: TL6000 Design	Sheet No. 7
Date: 02/03/2021	By: A.N & R.F

Connection To Concrete Design:

Loading at Connection:

Connection 1 For Panel 1:

$$\text{Shear Force} = 0.74\text{kN/m} \times 1.5 \times 0.294\text{m} = 0.33\text{kN(ULS)}$$

$$\text{Moment} = 0.74\text{kN/m} \times 1.5 \times 1.132\text{m} \times 0.294\text{m} = 0.37\text{kNm (ULS)}$$

1 Nr FAZ 12/10 Zinc Plated Steel Fischer bolts @294mm C/C.

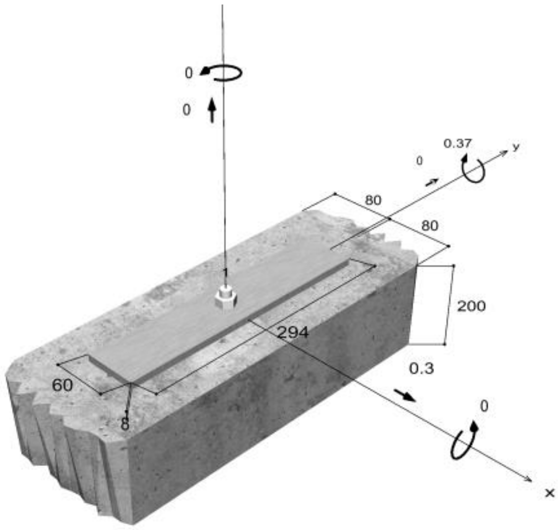


FIGURE 1-PANEL 1

Connection 2 For Panel 2:

$$\text{Shear Force} = 0.74\text{kN/m} \times 1.5 \times 0.294\text{m} = 0.33\text{kN(ULS)}$$

$$\text{Moment} = 0.74\text{kN/m} \times 1.5 \times 1.232\text{m} \times 0.294\text{m} = 0.4\text{kNm (ULS)}$$

1 Nr FAZ 12/10 Zinc Plated Steel Fischer bolts @294mm C/C.

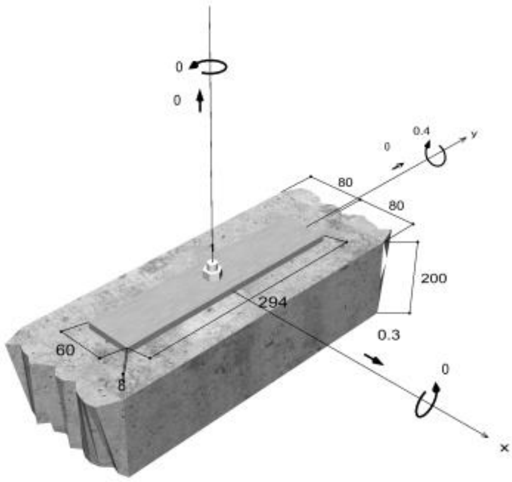
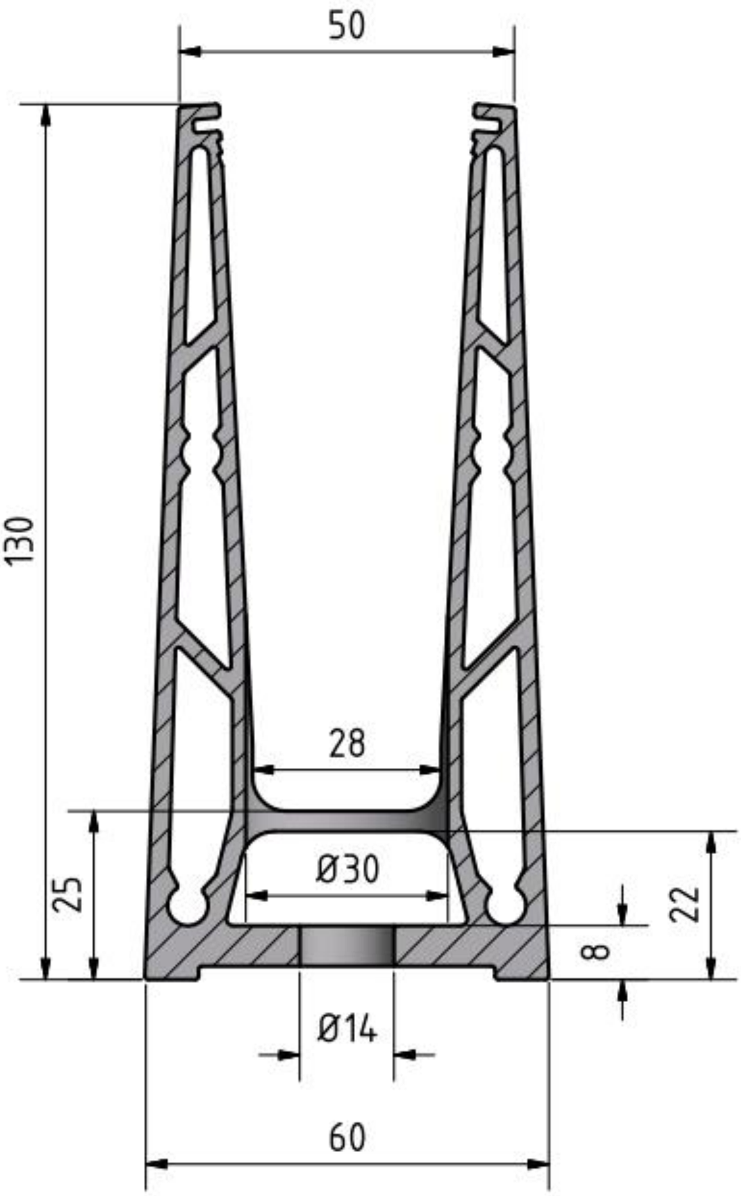


FIGURE 2-PANEL 2

Project: TL6000	Contract: 1505-1
Subject: TL6000 Design	Sheet No. 8
Date: 02/03/2021	By: A.N & R.F

Shoe Analysis for panel 1:

System Sketch – Shoe Analysis – TL 6000:



Bending Stress of Shoe due to Balustrade load of $0.74 \mathrm{kN/m}$ (SLS):

- Analysis Software was used to determine maximum bending stress of the shoe due to Balustrade load of $0.74 \mathrm{k/Nm}$ (SLS)
- On Level Aluminium Shoe Model TL6000 restrained at base.
- $\mathrm{Moment} = 0.74 \mathrm{kN/m} \times 1.1 \mathrm{m} \times 1.0 \mathrm{m} = 0.814 \mathrm{kN\ m(SLS)}$

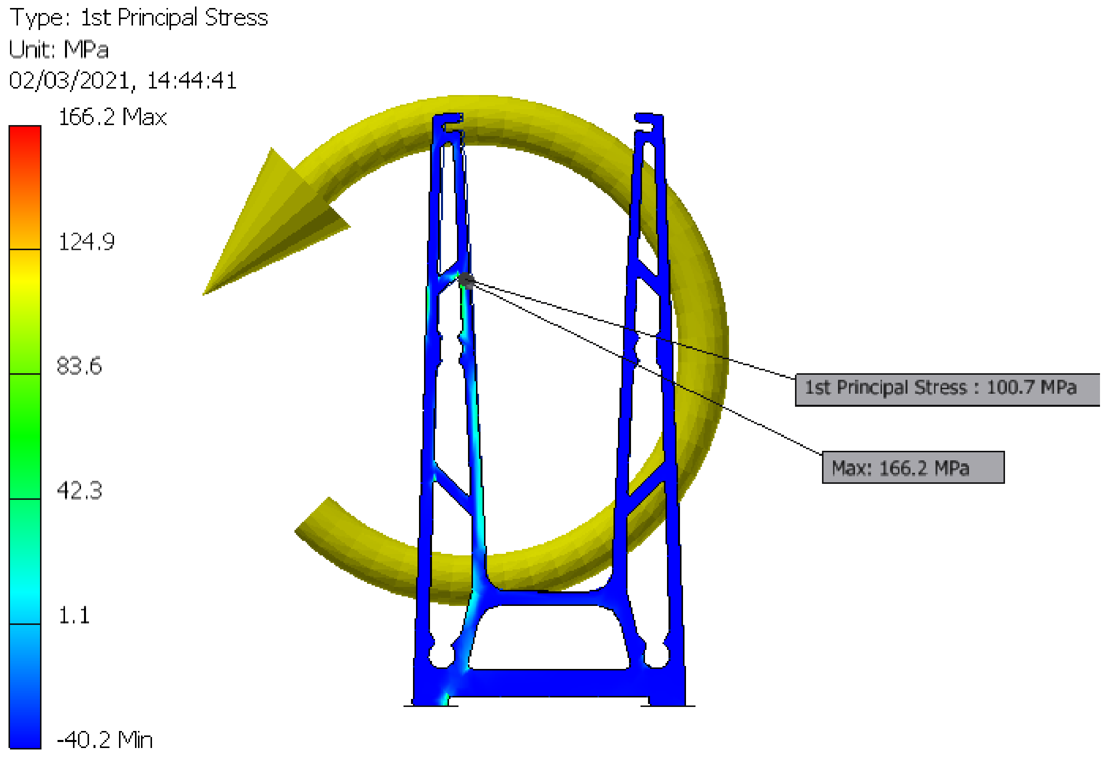
Result:

Max. Bending Stress = 100.7N/mm^2 x1.5 = 151.055N/mm^2 < 180N/mm^2

NOTE:

In this case the 166.2 MPa is a localised stress. The most appropriate stress to be considered is 100.7 MPa.

Okay in Bending



Deflection of Shoe due to Balustrade load of 0.74kN/m:

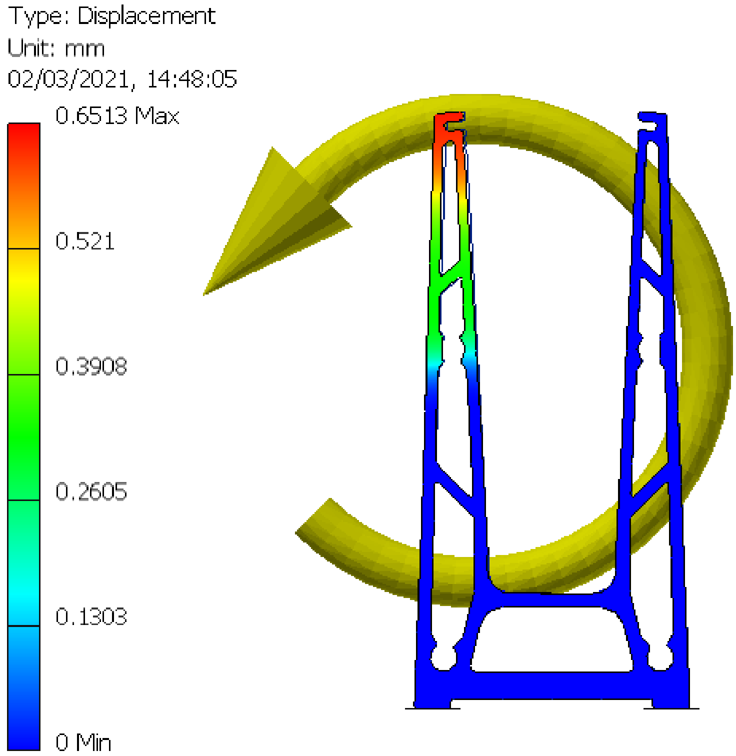
- Analysis Software was used to determine maximum Deflection of the shoe due to Balustrade load of 0.74kN/m (SLS)
- On Level Aluminium Shoe Model TL6000 restrained at base.

Result:

Deflection 0.6513mm at the top of shoe

Max. Deflection at 900mm above pitch line = (0.6513 x 1100)/98 = 7.31mm

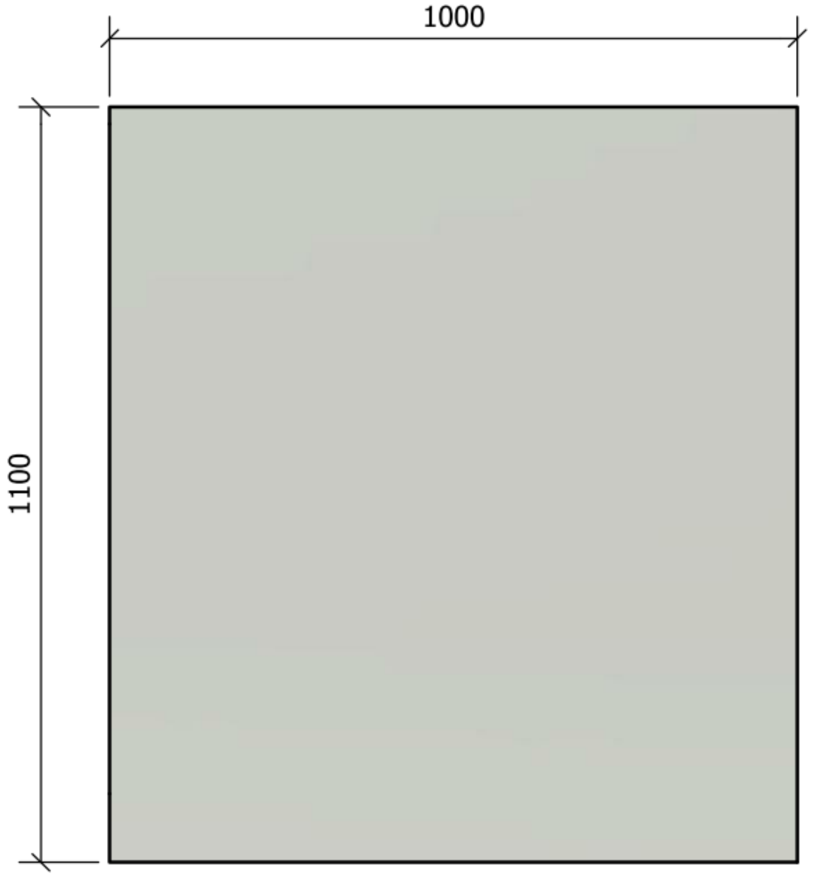
Okay in Deflection (Shoe Deflection only)



Project: TL6000	**Contract:** 1505-1
Subject: TL6000 Design	**Sheet No.** 11
Date: 02/03/2021	**By:** A.N & R.F

Glass Analysis:

System Sketch – Glass Analysis:



TSA TED SINGLETON & ASSOCIATES CONSULTING ENGINEERS	**Project:** TL6000	**Contract:** 1505-1
	Subject: TL6000 Design	**Sheet No.** 12
	Date: 02/03/2021	**By:** A.N & R.F

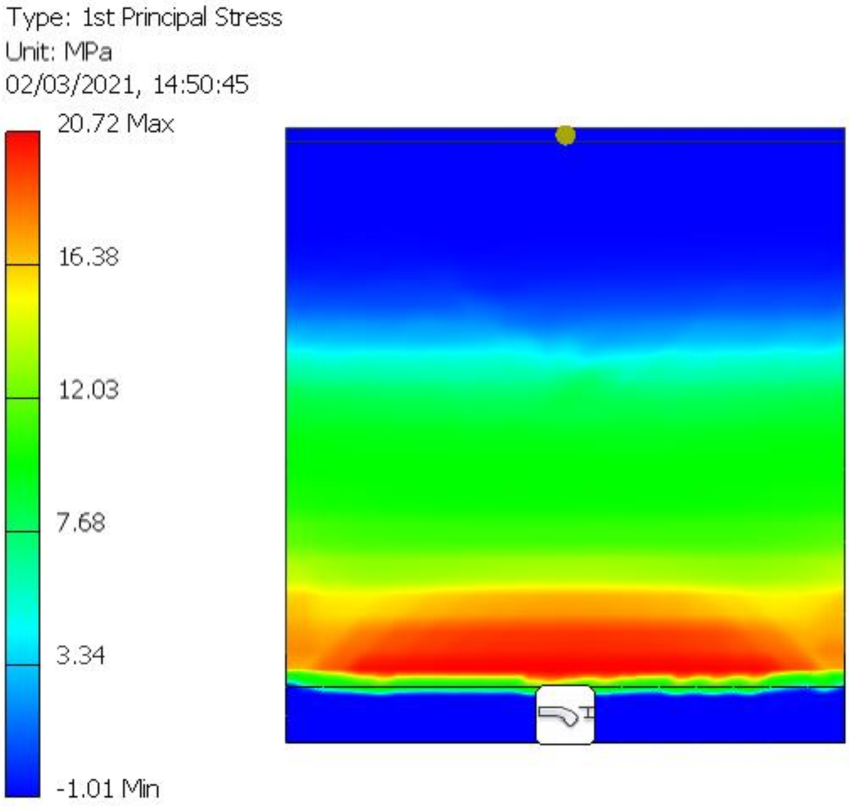
Panel 1: Bending Stress of Glass Panel due to 0.74kN/m Balustrade Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.74kN/m Balustrade Load.
- 15mm Toughened Glass Panel.
- Bending stress analysed based on glass panel 1100mm X 1000mm (H×W).

Result:

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

OK in Bending



Project: TL6000	Contract: 1505-1
Subject: TL6000 Design	Sheet No. 13
Date: 02/03/2021	By: A.N & R.F

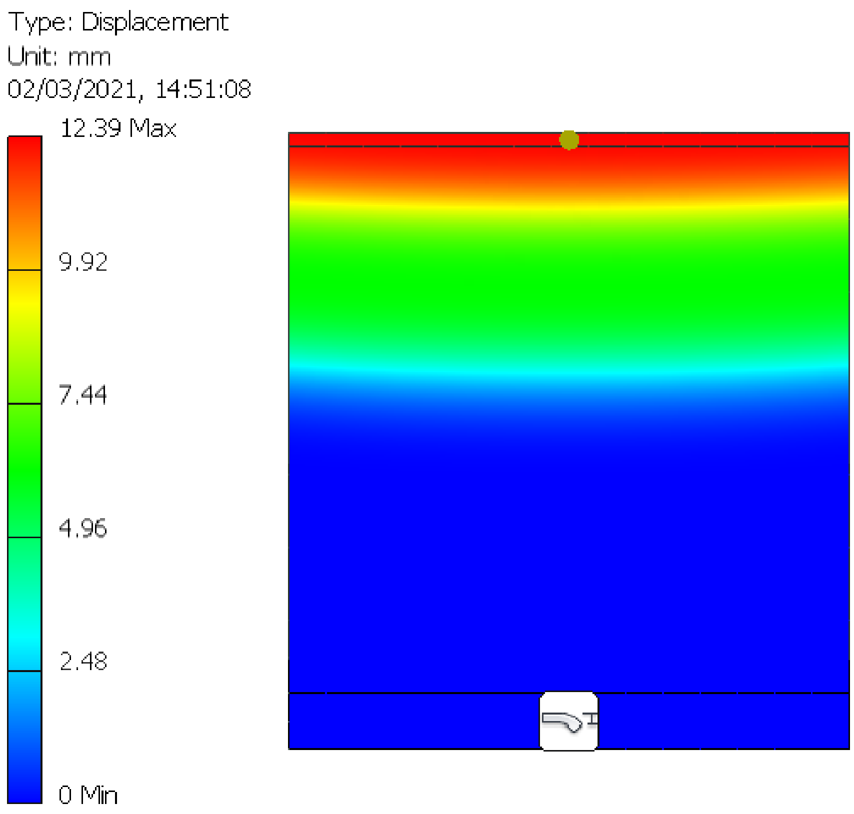
Panel 1: Deflection of Glass Panel due to 0.74kN/m Balustrade Load:

- Analysis Software was used to determine maximum deflection of the glass due to 0.74kN/m Balustrade load.
- 15mm Toughened Glass Panel.
- Deflection analysed based on glass panel 1100mm X 1000mm (H×W).

Result:

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

OK in Deflection (Glass Only)



Project: TL6000	Contract: 1505-1
Subject: TL6000 Design	Sheet No. 14
Date: 02/03/2021	By: A.N & R.F

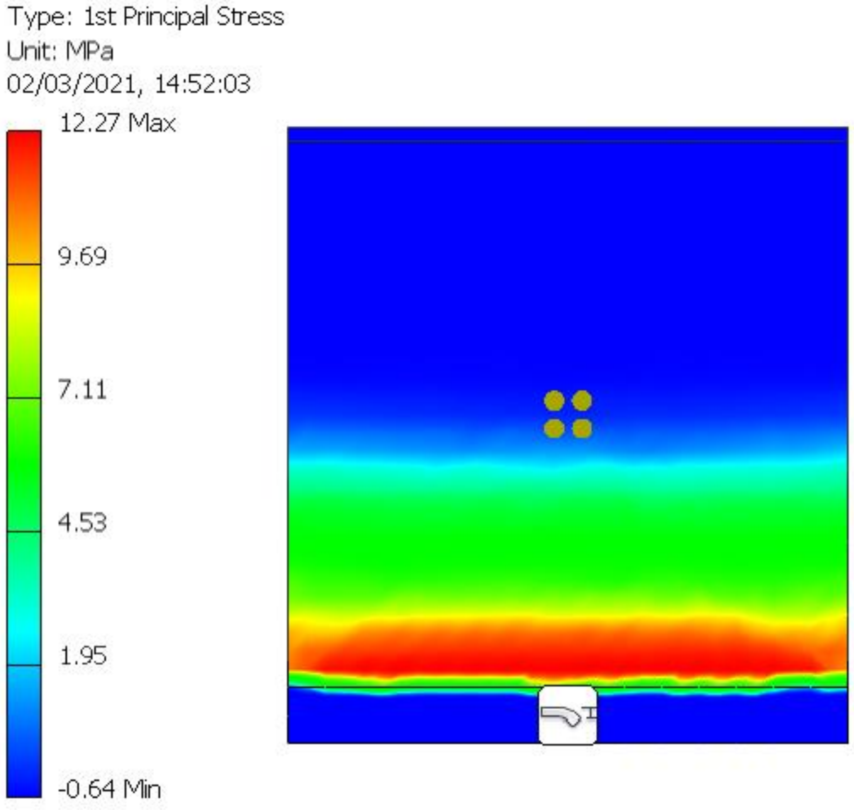
Panel 1: Bending Stress of Glass Panel due to 1.0kN/m^2 Infill Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0kN/m^2 Infill Load.
- 15mm Toughened Glass Panel.
- Bending stress analysed based on glass panel 1100mm X 1000mm (H×W).

Result:

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

OK in Bending



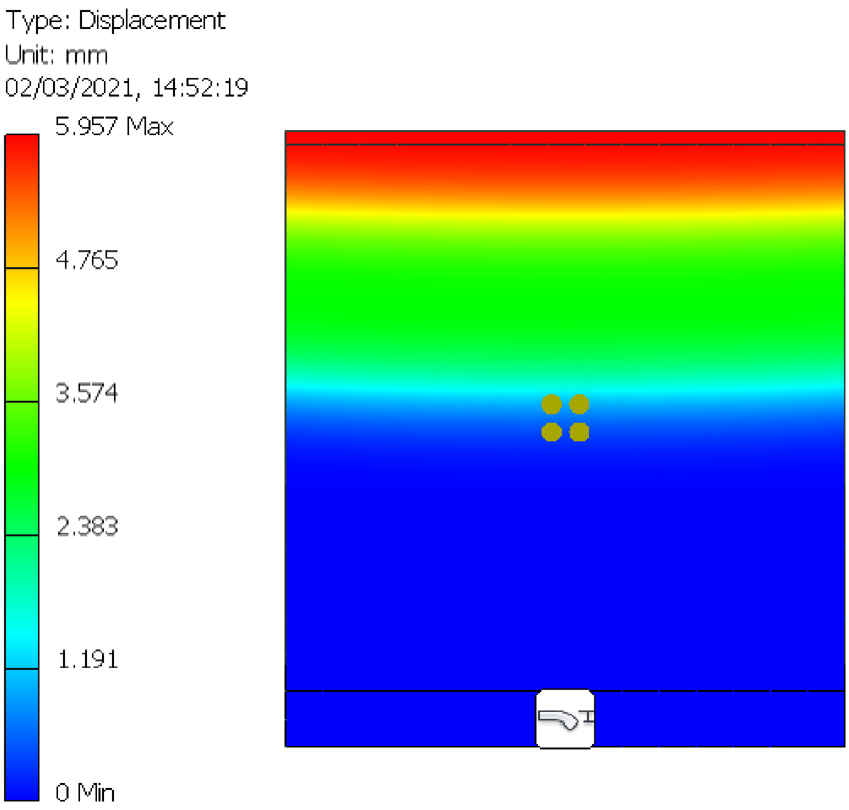
Panel 1: Deflection of Glass Panel due to 1.0kN/m^2 Infill Load:

- Analysis Software was used to determine maximum deflection of the glass due to 1.0kN/m^2 Infill load.
- 15mm Toughened Glass Panel.
- Deflection analysed based on glass panel 1100mm X 1000mm (H×W).

Result:

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

OK in Deflection (Glass Only)



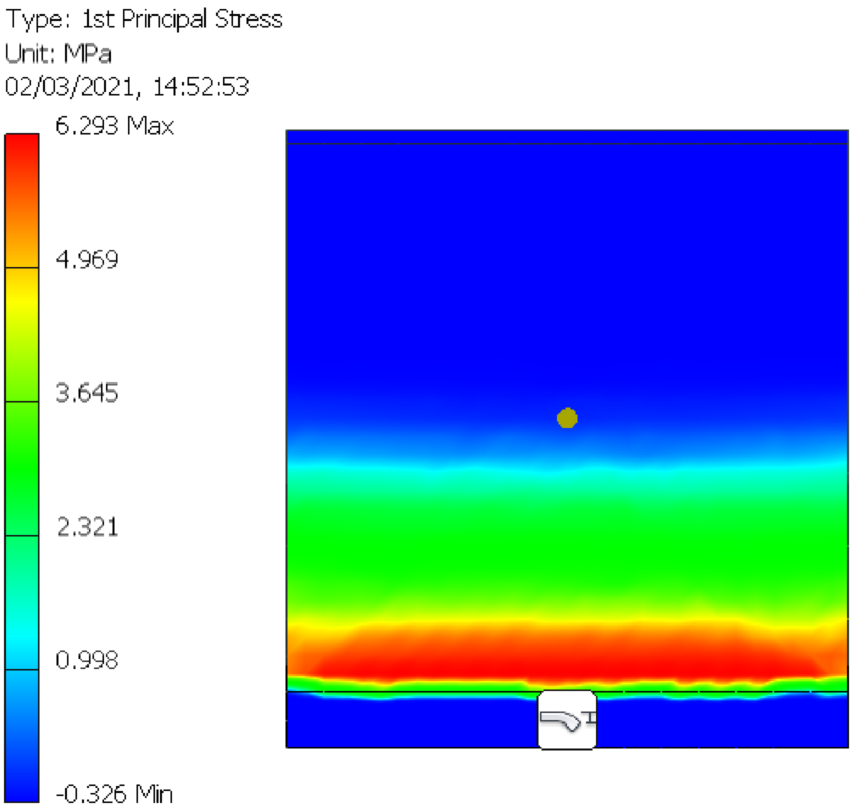
Panel 1: Bending Stress of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.5kN Point Load.
- 15mm Toughened Glass Panel.
- Bending stress analysed based on glass panel 1100mm X 1000mm (H×W).

Result:

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

OK in Bending



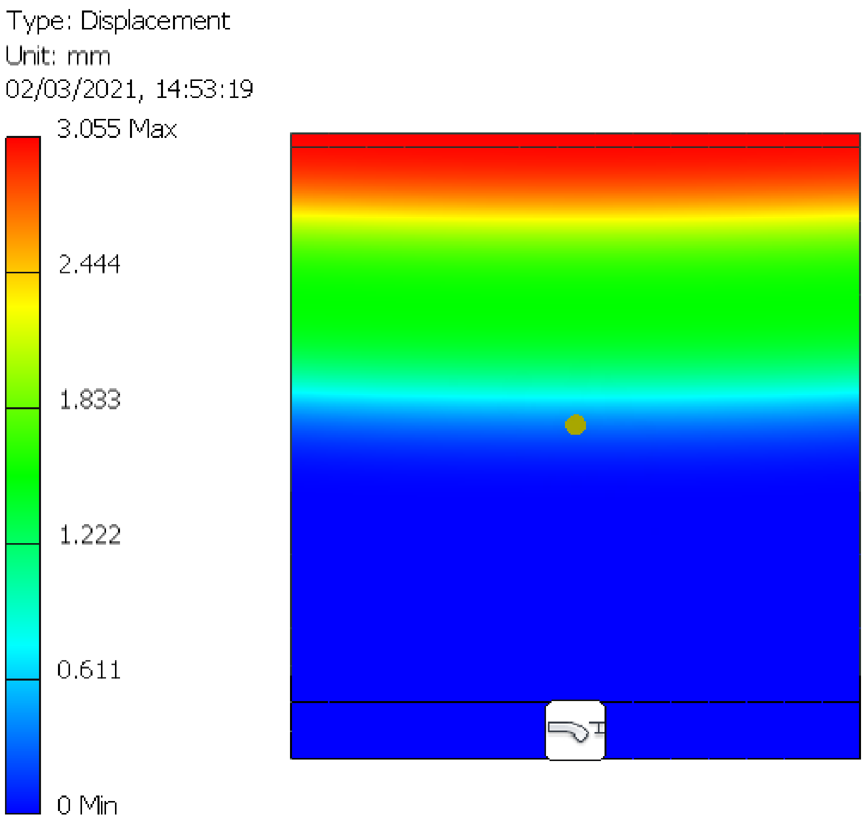
Panel 1: Deflection of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum deflection of the glass due to 0.5kN Point load.
- 15mm Toughened Glass Panel.
- Deflection analysed based on glass panel 1100mm X 1000mm (H×W).

<u>Result:</u>

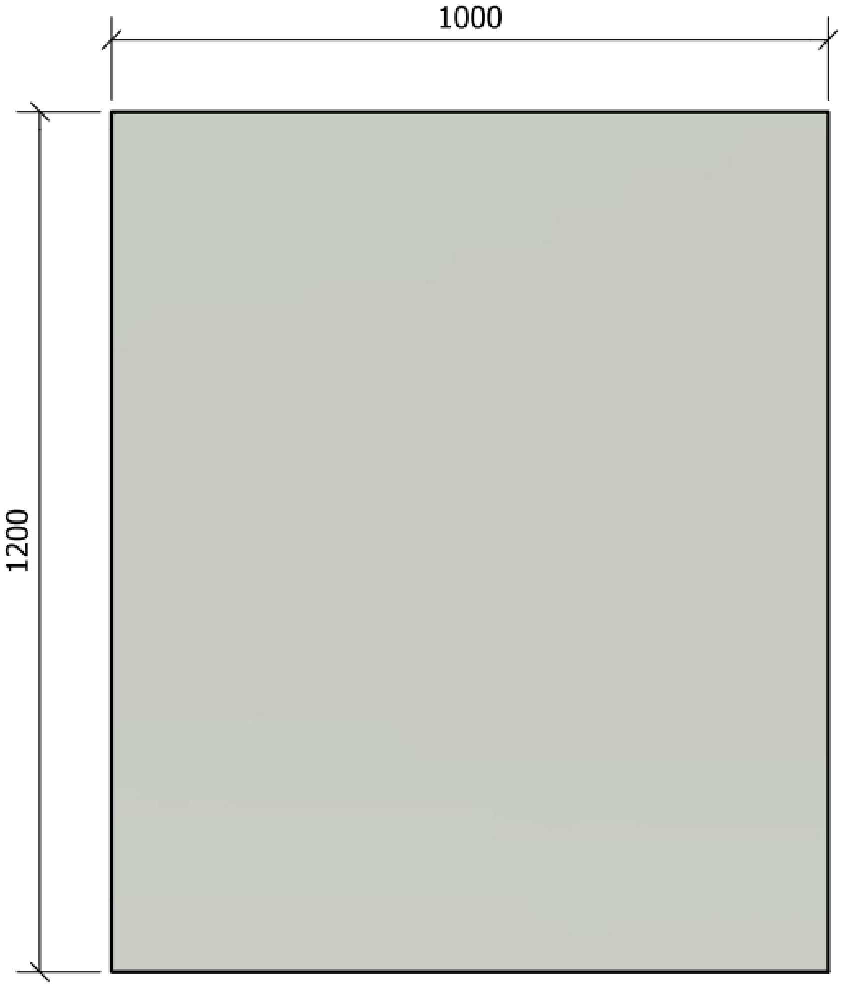
Max. Deflection = 3.055mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Project: TL6000	**Contract:** 1505-1
Subject: TL6000 Design	**Sheet No.** 18
Date: 02/03/2021	**By:** A.N & R.F

System Sketch – Glass Analysis:



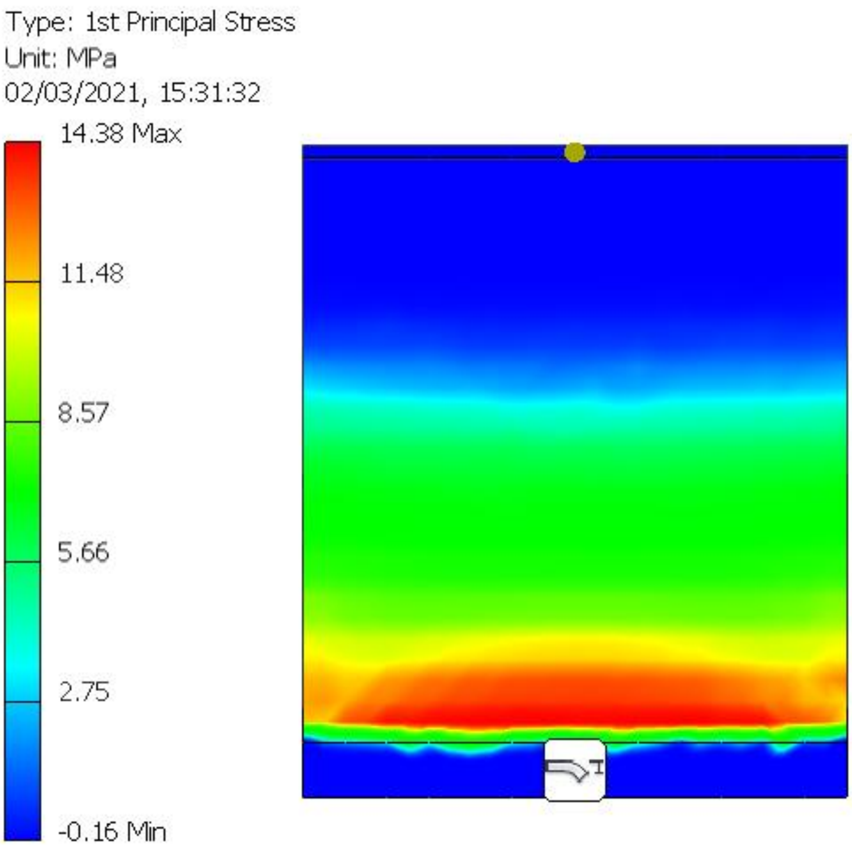
Panel 2: Bending Stress of Glass Panel due to 0.74kN/m Balustrade Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.74kN/m Balustrade Load.
- 19mm Toughened Glass Panel.
- Bending stress analysed based on glass panel 1200mm X 1000mm (H×W).

Result:

Max. Bending Stress = 14.38N/mm^2 X 1.5 = 21.57N/mm^2 < 84.2N/mm^2

OK in Bending



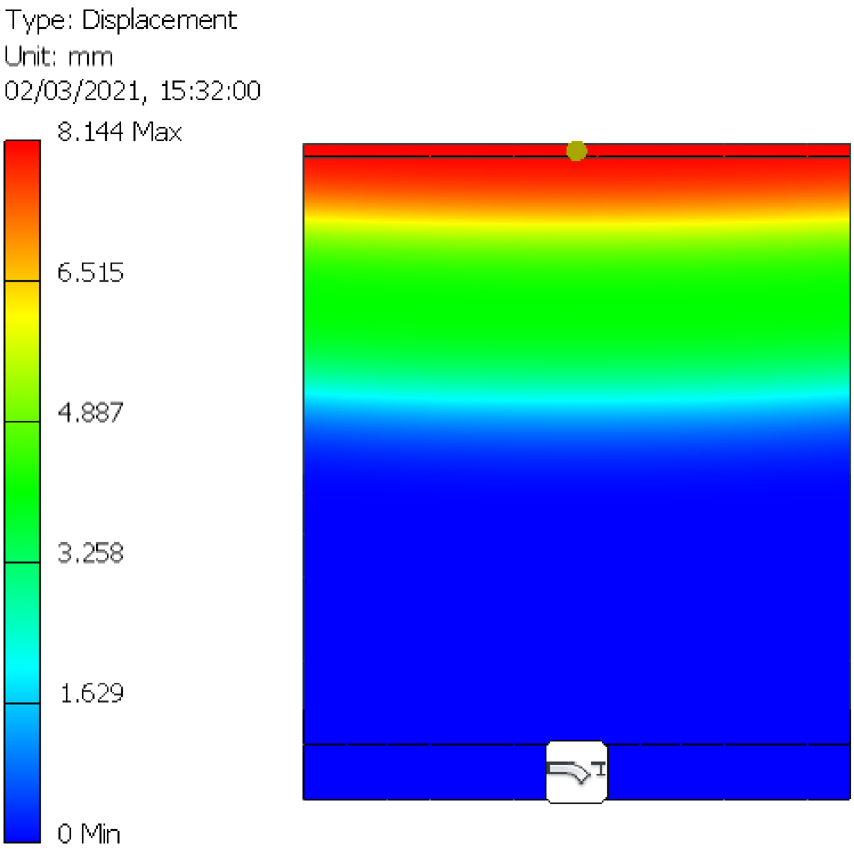
Panel 2: Deflection of Glass Panel due to 0.74kN/m Balustrade Load:

- Analysis Software was used to determine maximum deflection of the glass due to 0.74kN/m Balustrade load.
- 19mm Toughened Glass Panel.
- Deflection analysed based on glass panel 1200mm X 1000mm (H×W).

Result:

Max. Deflection = 8.144mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



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Project: TL6000	**Contract:** 1505-1
Subject: TL6000 Design	**Sheet No.** 21
Date: 02/03/2021	**By:** A.N & R.F

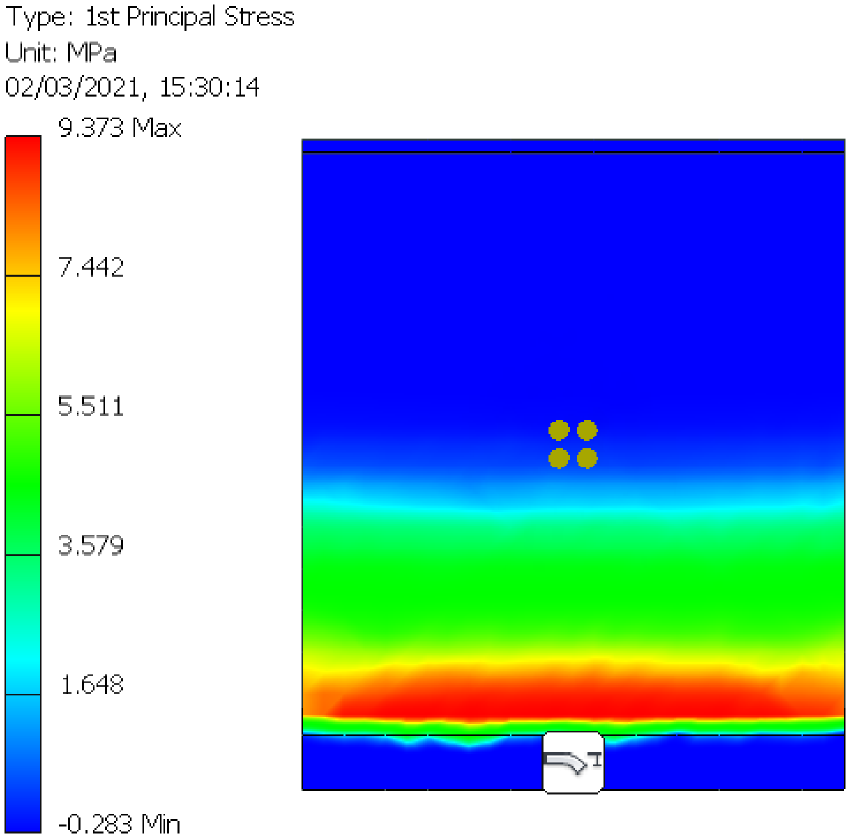
Panel 2: Bending Stress of Glass Panel due to 1.0kN/m^2 Infill Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0kN/m^2 Infill Load.
- 19mm Toughened Glass Panel.
- Bending stress analysed based on glass panel 1200mm X 1000mm (H×W).

Result:

Max. Bending Stress = 9.373N/mm^2 X 1.5 = 14.0595N/mm^2 < 84.2N/mm^2

OK in Bending



Project: TL6000	Contract: 1505-1
Subject: TL6000 Design	Sheet No. 22
Date: 02/03/2021	By: A.N & R.F

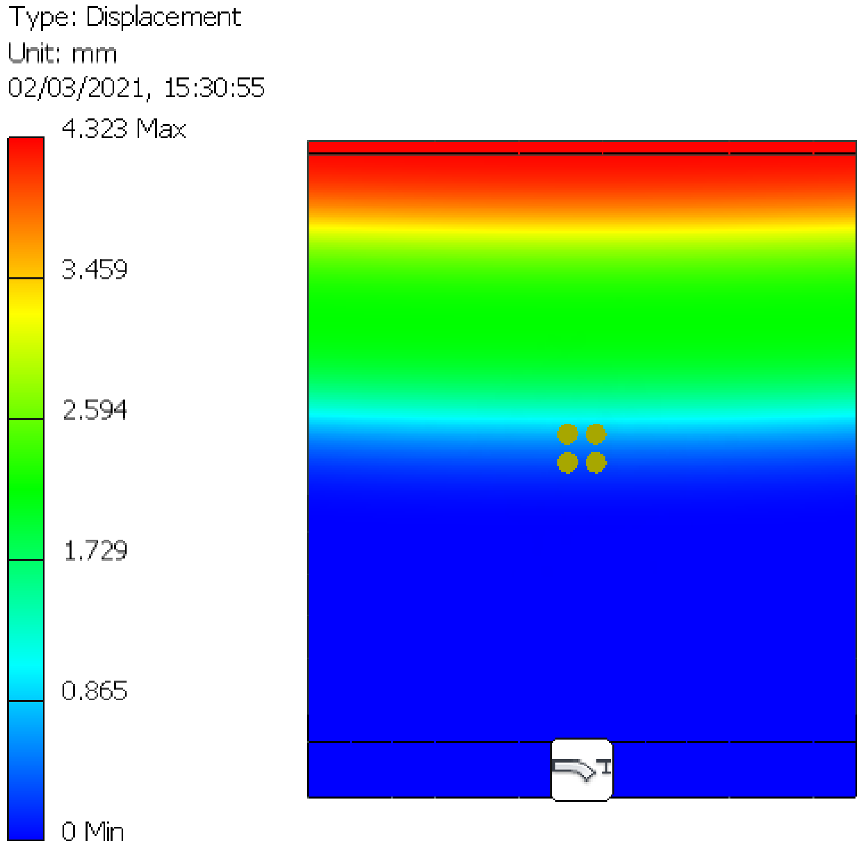
Panel 2: Deflection of Glass Panel due to 1.0kN/m^2 Infill Load:

- Analysis Software was used to determine maximum deflection of the glass due to 1.0kN/m^2 Infill load.
- 19mm Toughened Glass Panel.
- Deflection analysed based on glass panel 1200mm X 1000mm (H×W).

Result:

Max. Deflection = 4.323mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Project: TL6000	Contract: 1505-1
Subject: TL6000 Design	Sheet No. 23
Date: 02/03/2021	By: A.N & R.F

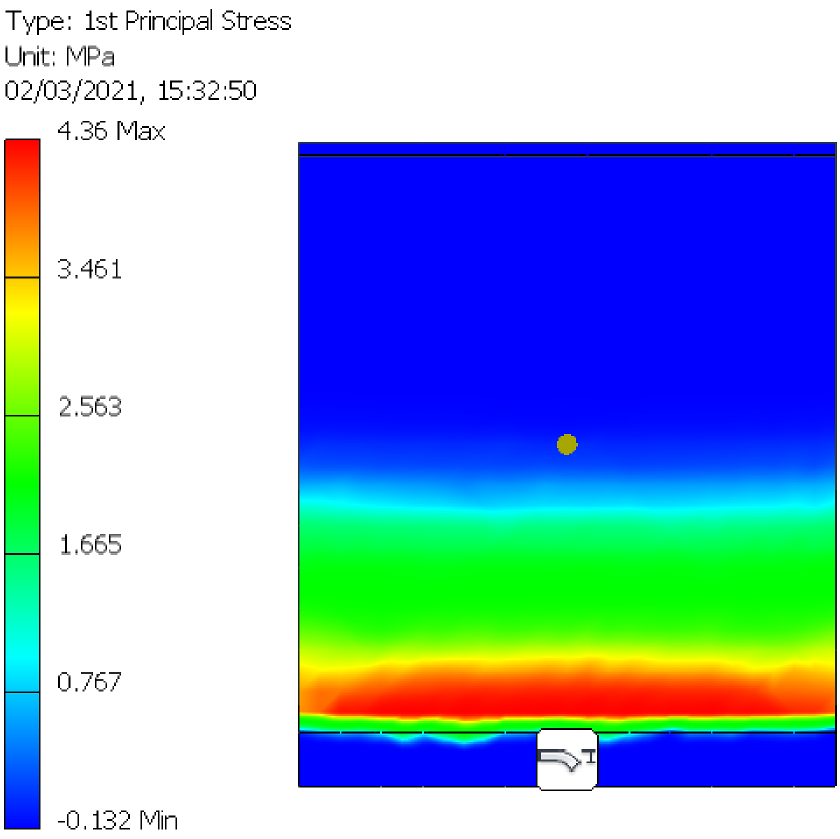
Panel 2: Bending Stress of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.5kN Point Load.
- 19mm Toughened Glass Panel.
- Bending stress analysed based on glass panel 1200mm X 1000mm (H×W).

Result:

Max. Bending Stress = 4.36N/mm^2 X 1.5 = 6.54N/mm^2 < 84.2N/mm^2

OK in Bending



Project: TL6000	Contract: 1505-1
Subject: TL6000 Design	Sheet No. 24
Date: 02/03/2021	By: A.N & R.F

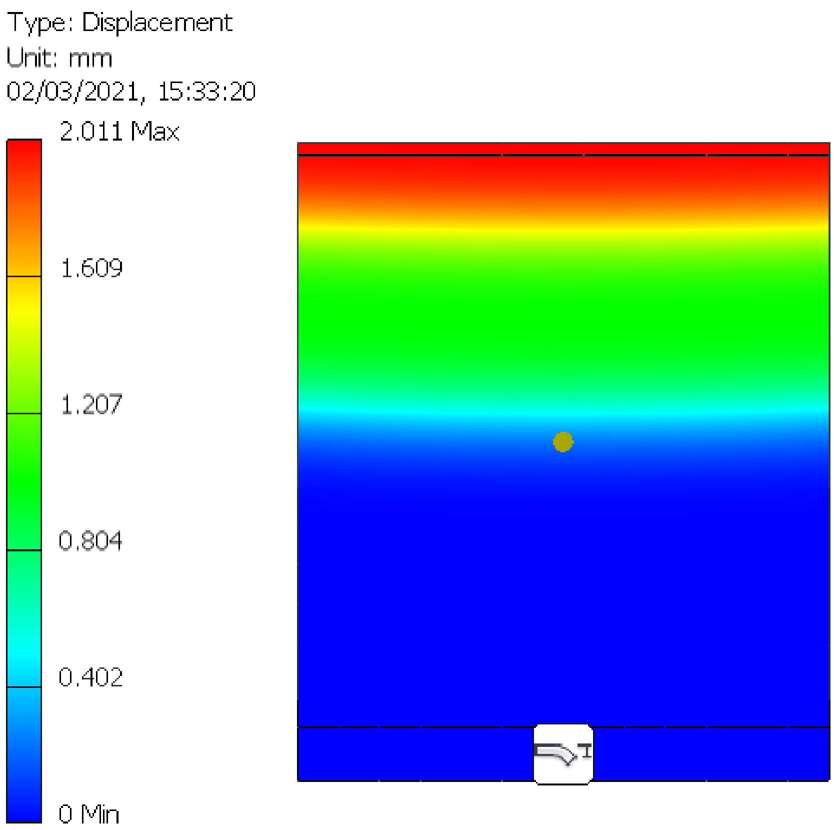
Panel 2: Deflection of Glass Panel due to 0.5kN Point Load:

- Analysis Software was used to determine maximum deflection of the glass due to 0.5kN Point load.
- 19mm Toughened Glass Panel.
- Deflection analysed based on glass panel 1200mm X 1000mm (H×W).

Result:

Max. Deflection = 2.011mm < 25mm {BS6180:2011 cl. 6.4.1}

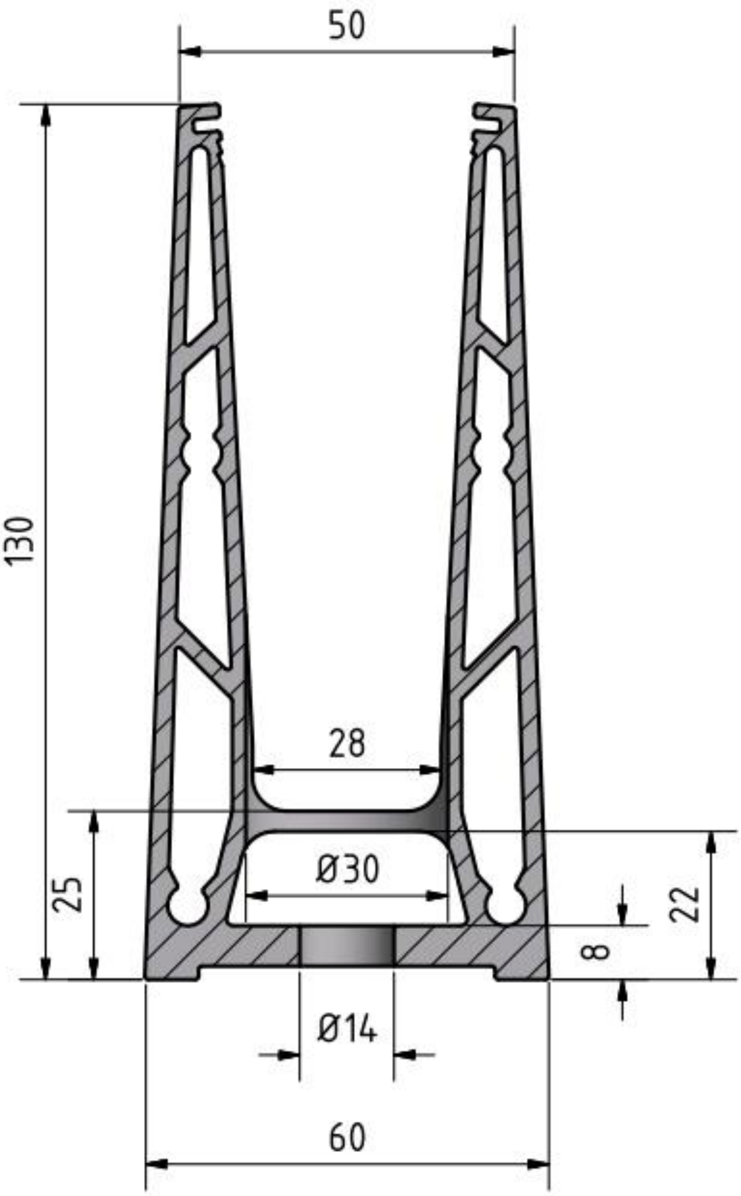
OK in Deflection (Glass Only)



Project: TL6000	**Contract:** 1505-1
Subject: TL6000 Design	**Sheet No.** 25
Date: 02/03/2021	**By:** A.N & R.F

Shoe Analysis for panel 2:

System Sketch – Shoe Analysis – TL 6000:



Bending Stress of Shoe due to Balustrade load of 0.74kN/m (SLS):

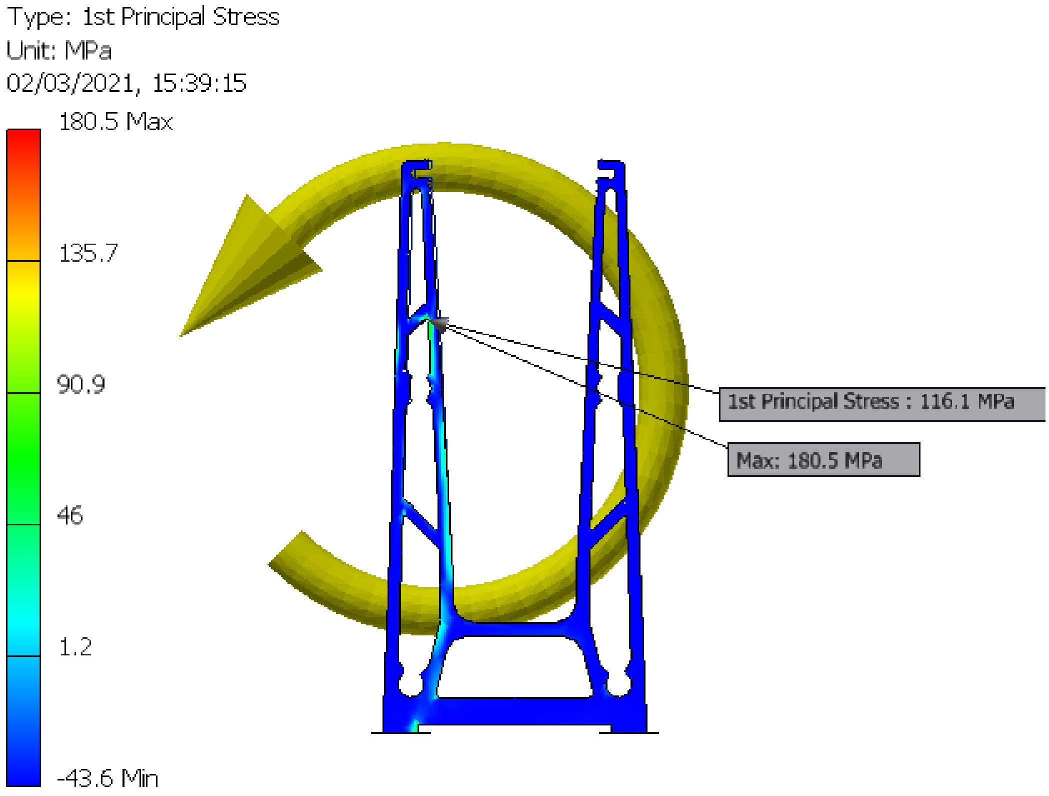
- Analysis Software was used to determine maximum bending stress of the shoe due to Balustrade load of 0.74k/Nm (SLS)
- On Level Aluminium Shoe Model TL6000 restrained at base.
- $\text{Moment} = 0.74\text{kN/m} \times 1.2\text{m} \times 1.0\text{m} = 0.888\text{kN m(SLS)}$

Result:

Max. Bending Stress = 116.1N/mm^2 x1.5 = 174.15N/mm^2 < 180N/mm^2

NOTE:

In this case the 180.5 MPa is a localised stress. The most appropriate stress to be considered is 116.1 MPa.



Project: TL6000	Contract: 1505-1
Subject: TL6000 Design	Sheet No. 27
Date: 02/03/2021	By: A.N & R.F

Deflection of Shoe due to Balustrade load of 0.74kN/m:

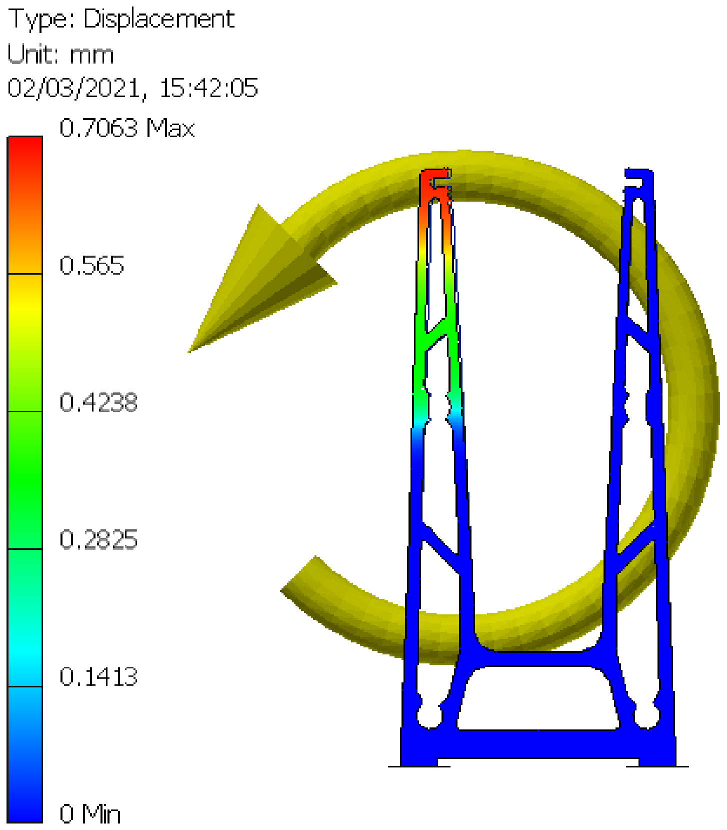
- Analysis Software was used to determine maximum Deflection of the shoe due to Balustrade load of 0.74kN/m (SLS)
- On Level Aluminium Shoe Model TL6000 restrained at base.

Result:

Deflection 0.7063mm at the top of shoe

Max. Deflection at 900mm above pitch line = (0.7063 x 1200)/98 = 8.65mm

Okay in Deflection (Shoe Deflection only)



Appendix A – Fischer Reports

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

Connection to Concrete Panel 1

Design Specifications

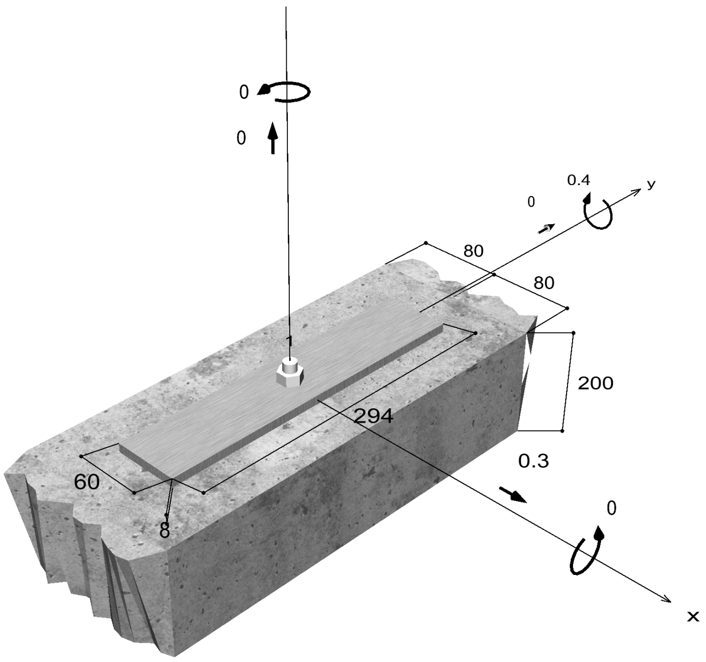
Anchor

Anchor system	fischer Bolt anchor FAZ II
Anchor	Bolt anchor FAZ II 12/10, zinc plated steel
Calculated anchorage depth	50 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-05/0069, Option 1, Issued 24/04/2020

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 mechanical fastener
Base material	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	60 mm x 294 mm x 8 mm
Profile type	None

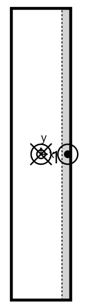
Design actions *⁾

#	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	0.30	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	14.78	0.30	0.30	0.00



max. concrete compressive strain :	0.35 ‰	
max. concrete compressive stress :	11.4 N/mm²	
Resulting tensile actions :	14.78 kN ,	X/Y position (0 / 0)
Resulting compression actions :	14.78 kN ,	X/Y position (27 / 0)

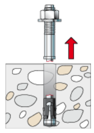
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	14.78	28.80	51.3
Pullout failure *	14.78	16.27	**90.9**
Concrete cone failure	14.78	16.29	90.7

* Most unfavourable anchor

Steel failure

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

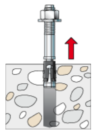


$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
43.20	1.50	28.80	14.78	51.3

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	51.3	1	$\beta_{N,s;1}$

Pullout failure

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



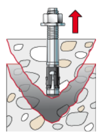
$N_{Rk,p}$ kN	Ψ_c	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
24.40	1.220	1.50	16.27	14.78	90.9

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

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	90.9	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)

$$N_{Rk,c} = 14.91kN \cdot \frac{22{,}500mm^2}{22{,}500mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.639 = 24.44kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 7.7 \cdot \sqrt{30.0N/mm^2} \cdot \left(50mm\right)^{1.5} = 14.91kN$$ Eq. (7.2)

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{80mm}{75mm}\right) = 1.000 \leq 1$$ 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)

$$\Psi_{ec,Nx} = \frac{1}{1+\frac{2 \cdot 0mm}{150mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1+\frac{2 \cdot 0mm}{150mm}} = 1.000 \leq 1$$

$$\Psi_{M,N} = 2 - \frac{z}{1.5 \cdot h_{ef}} = 2 - \frac{27mm}{1.5 \cdot 50mm} = 1.64 \geq 1$$ Eq. (7.7)

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
24.44	1.50	16.29	14.78	90.7

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	90.7	1	$\beta_{N,c;1}$

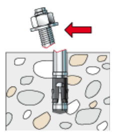
Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	0.30	24.48	1.2
Concrete pry-out failure	0.30	50.51	0.6
Concrete edge failure	0.30	7.07	**4.2**

* Most unfavourable anchor

Steel failure without lever arm

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



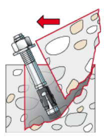
$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 30.60kN = 30.60kN$$ Eq. (7.35)/(7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
30.60	1.25	24.48	0.30	1.2

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

Concrete pry-out failure

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



$$V_{Rk,cp} = k_8 \cdot N_{Rk,c} = 3.1 \cdot 24.44kN = 75.77kN$$ 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)

$$N_{Rk,c} = 14.91kN \cdot \frac{22{,}500mm^2}{22{,}500mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.639 = 24.44kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 7.7 \cdot \sqrt{30.0N/mm^2} \cdot \left(50mm\right)^{1.5} = 14.91kN$$ Eq. (7.2)

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{80mm}{75mm}\right) = 1.000 \leq 1$$ 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)

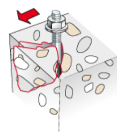
$$\Psi_{M,N} = 2 - \frac{z}{1.5 \cdot h_{ef}} = 2 - \frac{27mm}{1.5 \cdot 50mm} = 1.64 \geq 1$$ Eq. (7.7)

$V_{Rk,cp}$ kN	γ_{Mc}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
75.77	1.50	50.51	0.30	0.6

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

Concrete edge failure

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



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

$$V_{Rk,c} = 10.60kN \cdot \frac{28{,}800mm^2}{28{,}800mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 10.60kN$$

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

$$V^0_{Rk,c} = 1.7 \cdot \left(12mm\right)^{0.079} \cdot \left(50mm\right)^{0.068} \cdot \sqrt{30.0N/mm^2} \cdot \left(80mm\right)^{1.5} = 10.60kN$$

$$\alpha = 0.1 \cdot \sqrt{\frac{l_f}{c_1}} = 0.1 \cdot \sqrt{\frac{50mm}{80mm}} = 0.079 \qquad \beta = 0.1 \cdot \left(\frac{d_{nom}}{c_1}\right)^{0.2} = 0.1 \cdot \left(\frac{12mm}{80mm}\right)^{0.2} = 0.068$$ Eq. (7.42/7.43)

$$\Psi_{s,V} = 0.7 + 0.3 \cdot \frac{c_2}{1.5c_1} = 0.7 + 0.3 \cdot \frac{120mm}{1.5 \cdot 80mm} = 1.000 \leq 1$$ Eq. (7.45)

$$\Psi_{h,V} = max\left(1;\ \sqrt{\frac{1.5c_1}{h}}\right) = max\left(1;\ \sqrt{\frac{1.5 \cdot 80mm}{200mm}}\right) = 1.000 \geq 1$$ Eq. (7.46)

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

$$\Psi_{ec,V} = \frac{1}{1 + \frac{2\ e_v}{3\ c_1}} = \frac{1}{1 + \frac{2 \cdot 0mm}{3 \cdot 80mm}} = 1.000\ \leq\ 1$$ Eq. (7.47)

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

$V_{Rk,c}$ kN	γ_{Mc}	$V_{Rd,c}$ kN	V_{Ed} kN	$\beta_{V,c}$ %
10.60	1.50	7.07	0.30	4.2

Anchor no.	$\beta_{V,c}$ %	Group N°	Decisive Beta
1	4.2	1	$\beta_{V,c;1}$

Utilization of tension and shear loads

Tension loads	Utilisation β_N %
Steel failure *	51.3
Pullout failure *	**90.9**
Concrete cone failure	90.7

Shear Loads	Utilisation β_V %
Steel failure without lever arm *	1.2
Concrete pry-out failure	0.6
Concrete edge failure	**4.2**

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.51 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.01 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.26 \leq 1$$ Eq. (7.55)

Utilisation concrete

Proof successful

$$\beta_{N,p} = \beta_{N,p;1} = 0.91 \leq 1$$
$$\beta_{V.c} = \beta_{V,c;1} = 0.04 \leq 1$$
$$\frac{\beta_N + \beta_V}{1.2} = \frac{\beta_{N,p;1} + \beta_{V,c;1}}{1.2} = 0.79 \leq 1$$ Eq. (7.57)

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof t = 8 mm

Profile type None

Technical remarks

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

actions introduced by the anchors. For these verifications the additional provisions given in the current design method shall be taken into account.
As a pre-condition the anchor plate is assumed to be flat when subjected to the actions. Therefore, the plate (if present) must be sufficiently stiff. The C-Fix anchor plate design is based on a proof of stresses and does not allow a statement about the stiffness of the plate. The proof of the necessary stiffness is not carried out by C-Fix.

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)

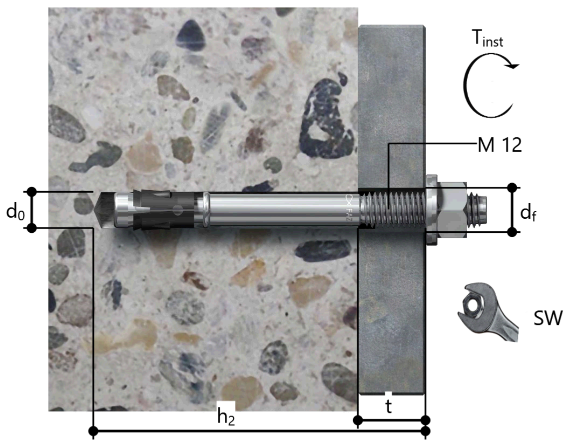
Installation data

Anchor

Anchor system	**fischer Bolt anchor FAZ II**		
Anchor	Bolt anchor FAZ II 12/10, zinc plated steel	Art.-No. 95419	
Accessories	Blow-out pump ABG big	Art.-No. 89300	
	SDS Plus II 12/100/160	Art.-No. 531803	
	or alternatively		
	FHD 12/200/330	Art.-No. 546597	
	Hammer drilling with or without suction		

Installation details

Thread diameter	M 12
Drill hole diameter	d_0 = 12 mm
Drill hole depth	h_2 = 99 mm
Calculated anchorage depth	h_{ef} = 50 mm
Installation depth	h_{nom} = 64 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} = 60.0 Nm
Socket size	19 mm
Base plate thickness	t = 8 mm
Total fixing thickness	t_{fix} = 8 mm
Tfix,max	$t_{fix,\ max}$ = 30 mm



Base plate details

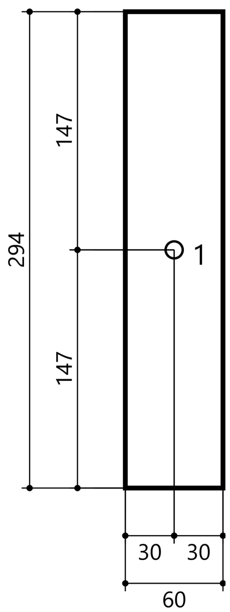
Base plate material	Not available
Base plate thickness	t = 8 mm
Clearance hole in base plate	d_f=14 mm

Attachment

Profile type	None

Anchor coordinates

Anchor no.	x mm	y mm
1	0	0



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Comment

Connection to Concrete Panel 2

Design Specifications

Anchor

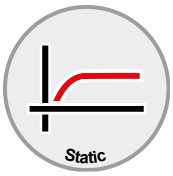
Anchor system	fischer Bolt anchor FAZ II
Anchor	Bolt anchor FAZ II 12/10, zinc plated steel
Calculated anchorage depth	50 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-05/0069, Option 1, Issued 24/04/2020

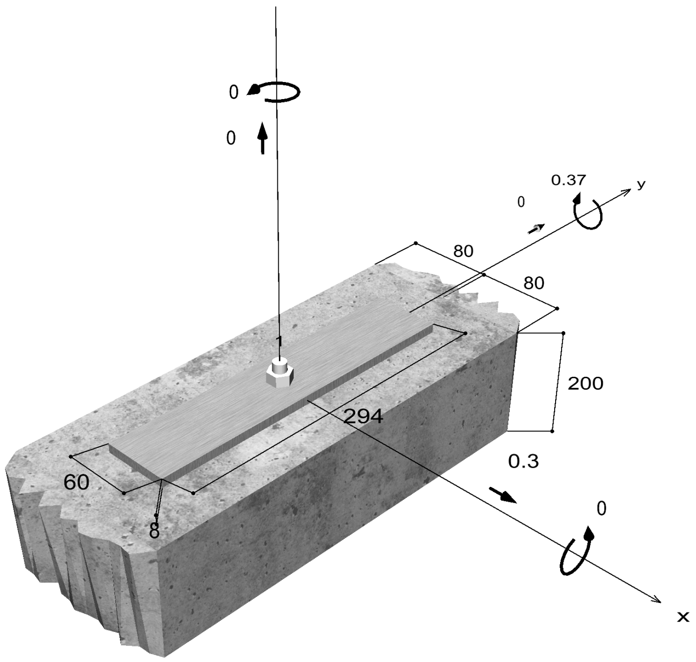
Geometry / Loads / Scale units

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 mechanical fastener
Base material	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	60 mm x 294 mm x 8 mm
Profile type	None

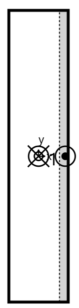
Design actions *)

#	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	0.30	0.00	0.00	0.37	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	13.67	0.30	0.30	0.00



max. concrete compressive strain :	0.32 ‰	
max. concrete compressive stress :	10.6 N/mm²	
Resulting tensile actions :	13.67 kN ,	X/Y position (0 / 0)
Resulting compression actions :	13.67 kN ,	X/Y position (27 / 0)

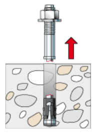
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	13.67	28.80	47.5
Pullout failure *	13.67	16.27	**84.1**
Concrete cone failure	13.67	16.29	83.9

* Most unfavourable anchor

Steel failure

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

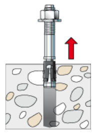


$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
43.20	1.50	28.80	13.67	47.5

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	47.5	1	$\beta_{N,s;1}$

Pullout failure

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



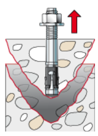
$N_{Rk,p}$ kN	Ψ_c	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
24.40	1.220	1.50	16.27	13.67	84.1

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

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	84.1	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)

$$N_{Rk,c} = 14.91kN \cdot \frac{22{,}500mm^2}{22{,}500mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.639 = 24.44kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h^{1.5}_{ef} = 7.7 \cdot \sqrt{30.0N/mm^2} \cdot \left(50mm\right)^{1.5} = 14.91kN$$ Eq. (7.2)

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{80mm}{75mm}\right) = 1.000 \leq 1$$ 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)

$$\Psi_{ec,Nx} = \frac{1}{1+\frac{2 \cdot 0mm}{150mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1+\frac{2 \cdot 0mm}{150mm}} = 1.000 \leq 1$$

$$\Psi_{M,N} = 2 - \frac{z}{1.5 \cdot h_{ef}} = 2 - \frac{27mm}{1.5 \cdot 50mm} = 1.64 \geq 1$$ Eq. (7.7)

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
24.44	1.50	16.29	13.67	83.9

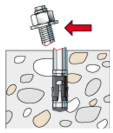
Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	83.9	1	$\beta_{N,c;1}$

Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	0.30	24.48	1.2
Concrete pry-out failure	0.30	50.51	0.6
Concrete edge failure	0.30	7.07	**4.2**

* Most unfavourable anchor

Steel failure without lever arm



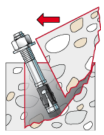
$$V_{Ed} \leq \frac{V_{Rk,s}}{\gamma_{Ms}} \quad (\mathbf{V_{Rd,s}})$$

$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 30.60kN = 30.60kN$$ Eq. (7.35)/(7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
30.60	1.25	24.48	0.30	1.2

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

Concrete pry-out failure



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

$$V_{Rk,cp} = k_8 \cdot N_{Rk,c} = 3.1 \cdot 24.44kN = 75.77kN$$ 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)

$$N_{Rk,c} = 14.91kN \cdot \frac{22{,}500mm^2}{22{,}500mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.639 = 24.44kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 7.7 \cdot \sqrt{30.0N/mm^2} \cdot \left(50mm\right)^{1.5} = 14.91kN$$ Eq. (7.2)

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{80mm}{75mm}\right) = 1.000 \leq 1$$ Eq. (7.4)

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

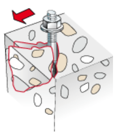
$$\Psi_{ec,N} = \frac{1}{1 + \frac{2e_n}{s_{cr,N}}} \Longrightarrow \Psi_{ec,Nx} \cdot \Psi_{ec,Ny} = 1.000 \cdot 1.000 = 1.000 \leq 1$$ Eq. (7.6)

$$\Psi_{M,N} = 2 - \frac{z}{1.5 \cdot h_{ef}} = 2 - \frac{27mm}{1.5 \cdot 50mm} = 1.64 \geq 1$$ Eq. (7.7)

$V_{Rk,cp}$ kN	γ_{Mc}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
75.77	1.50	50.51	0.30	0.6

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

Concrete edge failure



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

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

$$V_{Rk,c} = 10.60kN \cdot \frac{28{,}800mm^2}{28{,}800mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 10.60kN$$

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

$$V^0_{Rk,c} = 1.7 \cdot \left(12mm\right)^{0.079} \cdot \left(50mm\right)^{0.068} \cdot \sqrt{30.0N/mm^2} \cdot \left(80mm\right)^{1.5} = 10.60kN$$

$$\alpha = 0.1 \cdot \sqrt{\frac{l_f}{c_1}} = 0.1 \cdot \sqrt{\frac{50mm}{80mm}} = 0.079 \qquad \beta = 0.1 \cdot \left(\frac{d_{nom}}{c_1}\right)^{0.2} = 0.1 \cdot \left(\frac{12mm}{80mm}\right)^{0.2} = 0.068$$ Eq. (7.42/7.43)

$$\Psi_{s,V} = 0.7 + 0.3 \cdot \frac{c_2}{1.5c_1} = 0.7 + 0.3 \cdot \frac{120mm}{1.5 \cdot 80mm} = 1.000 \leq 1$$ Eq. (7.45)

$$\Psi_{h,V} = max\left(1;\ \sqrt{\frac{1.5c_1}{h}}\right) = max\left(1;\ \sqrt{\frac{1.5 \cdot 80mm}{200mm}}\right) = 1.000 \geq 1$$ Eq. (7.46)

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

$$\Psi_{ec,V} = \frac{1}{1 + \frac{2}{3}\frac{e_v}{c_1}} = \frac{1}{1 + \frac{2 \cdot 0mm}{3 \cdot 80mm}} = 1.000 \leq 1$$ Eq. (7.47)

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

$V_{Rk,c}$ kN	γ_{Mc}	$V_{Rd,c}$ kN	V_{Ed} kN	$\beta_{V,c}$ %
10.60	1.50	7.07	0.30	4.2

Anchor no.	$\beta_{V,c}$ %	Group N°	Decisive Beta
1	4.2	1	$\beta_{V,c;1}$

Utilization of tension and shear loads

Tension loads	Utilisation βN %
Steel failure *	47.5
Pullout failure *	**84.1**
Concrete cone failure	83.9

Shear Loads	Utilisation βV %
Steel failure without lever arm *	1.2
Concrete pry-out failure	0.6
Concrete edge failure	**4.2**

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.47 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.01 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.23 \leq 1$$ Eq. (7.55)

Proof successful

Utilisation concrete

$$\beta_{N.p} = \beta_{N,p;1} = 0.84 \leq 1$$
$$\beta_{V.c} = \beta_{V,c;1} = 0.04 \leq 1$$
$$\frac{\beta_N + \beta_V}{1.2} = \frac{\beta_{N,p;1} + \beta_{V,c;1}}{1.2} = 0.74 \leq 1$$ Eq. (7.57)

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof — t = 8 mm

Profile type — None

Technical remarks

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

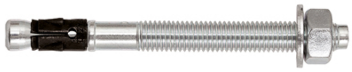
actions introduced by the anchors. For these verifications the additional provisions given in the current design method shall be taken into account.
As a pre-condition the anchor plate is assumed to be flat when subjected to the actions. Therefore, the plate (if present) must be sufficiently stiff. The C-Fix anchor plate design is based on a proof of stresses and does not allow a statement about the stiffness of the plate. The proof of the necessary stiffness is not carried out by C-Fix.

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)

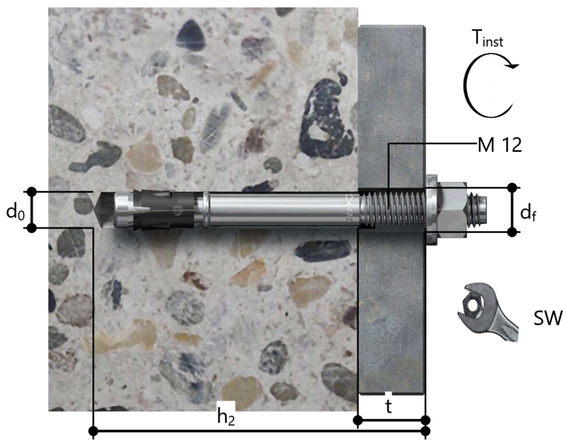
Installation data

Anchor

Anchor system	**fischer Bolt anchor FAZ II**		
Anchor	Bolt anchor FAZ II 12/10, zinc plated steel	Art.-No. 95419	
Accessories	Blow-out pump ABG big	Art.-No. 89300	
	SDS Plus II 12/100/160	Art.-No. 531803	
	or alternatively		
	FHD 12/200/330	Art.-No. 546597	
	Hammer drilling with or without suction		

Installation details

Thread diameter	M 12
Drill hole diameter	d_0 = 12 mm
Drill hole depth	h_2 = 99 mm
Calculated anchorage depth	h_{ef} = 50 mm
Installation depth	h_{nom} = 64 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} = 60.0 Nm
Socket size	19 mm
Base plate thickness	t = 8 mm
Total fixing thickness	t_{fix} = 8 mm
Tfix,max	$t_{fix,\ max}$ = 30 mm



Base plate details

Base plate material	Not available
Base plate thickness	t = 8 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