TSA TED SINGLETON & ASSOCIATES CONSULTING ENGINEERS

Project: Glass Adaptor and Spigot	Contract: 1388-3
Subject: General Wind Load	**Sheet No.** 1
Date: 08/05/2020	**By:** R.F.

Concorde Glass Ltd.,

Linx House,

104 Waterloo Rd,

Mablethorpe,

LN12 1LE,

UK.

General Wind Load

1388-3 Glass Adaptor and Spigot

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

0	08/05/2020	T.S.	Issued
Revision	**Date**	**Issued By**	**Comment**

Contents

Introduction/Actions/Result Summary:

Introduction:

TSA was instructed by Concorde to provide a matrix of wind load for the glass adaptor and spigot.

Actions – Loading Considerated:

Infill load = 0.42kN (per calculation)
Infill load = 1.0kN (Table NA.5 IS1991-1-1:2002)
Infill load = 1.5kN (Table NA.5 IS1991-1-1:2002)
Infill load = 2.0kN (Table NA.5 IS1991-1-1:2002)

Assumption:

Concrete Grade = C30/37

Result Summary:

Glass Analysis					
Case Study	Glass	Interlayer	Wind Load - Qw	Height glass	Glass Deflection
	(mm)		(kN/m)	(m)	(mm)
1	15		1.00	1.4	13.42
2	17.52	PVB	1.00	1.4	22.68
3	21.52	PVB	1.50	1.4	19.69
4	15		0.42	1.192	8.422
5	15		1.50	1.11	15.46

NOTE: All deflection < 25mm and therefore acceptable.

Connection To Concrete		
Case Study	Fischer	Edge (mm)
5	M10 FAZ II 10/10	100

Connection To Mild Steel		
Case Study	Fischer	Edge (mm)
5	M10x30mm Grade 8.8	70

Connection To Wood		
Case Study	Fischer	Edge (mm)
5	Rampa SKL M10x60mm	-

Glass Strength

Wind Loading:

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

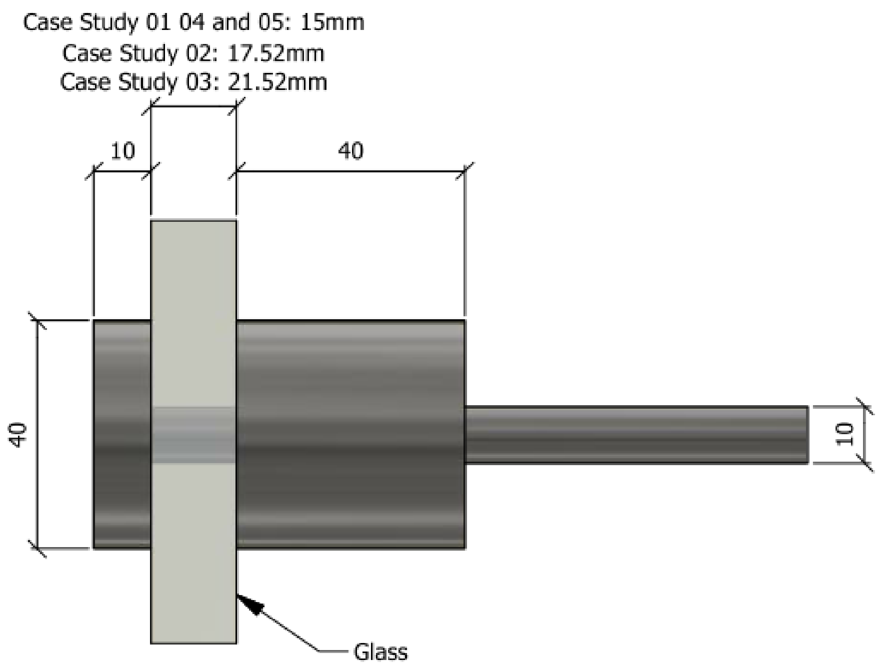
$f_{gd} = (k_{mod})(k_{sp})(f_{gk})/ \gamma_{ma} + k_v(f_{bk}-f_{gk})/\gamma_{mv}$

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

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

System Sketch:

Glass Adaptor:



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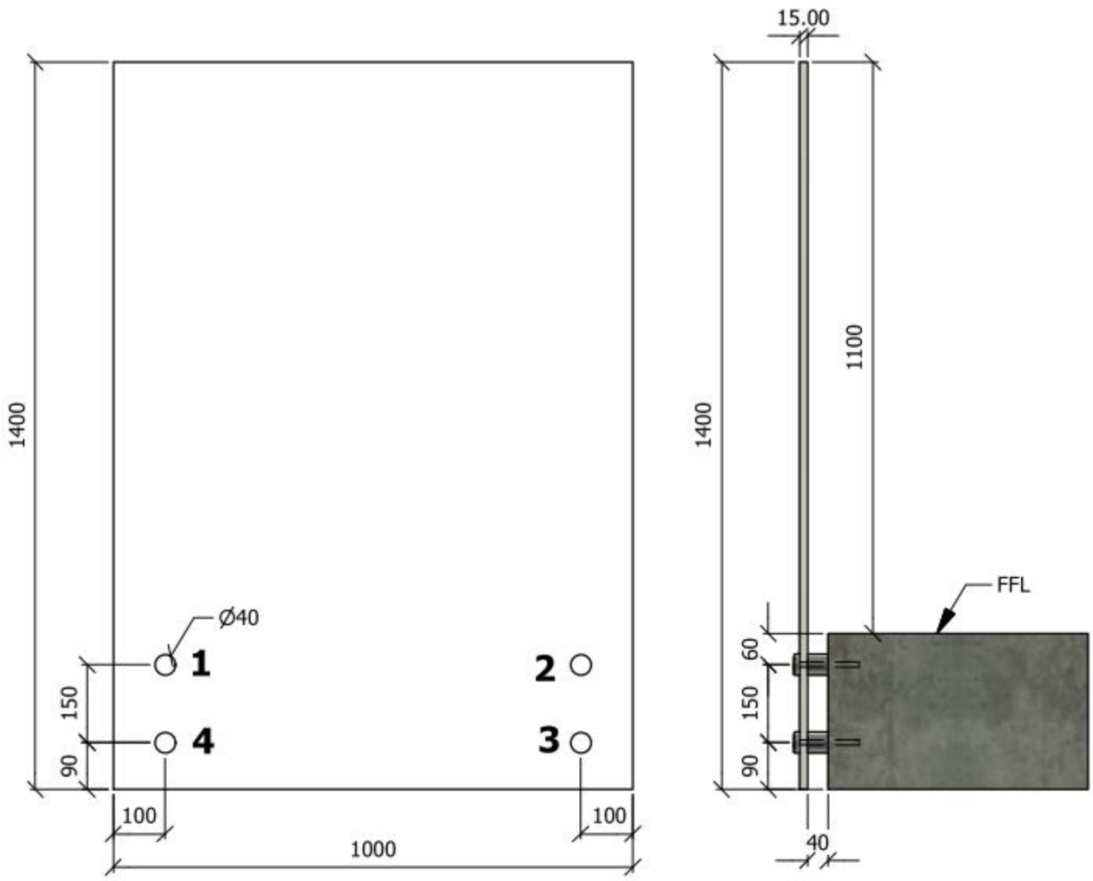
Project: Glass Adaptor and Spigot	**Contract:** 1388-3
Subject: General Wind Load	**Sheet No.** 7
Date: 08/05/2020	**By:** R.F.

Case Study 01: 15mm Tough – 1.0x1.40m – 1.0kN/m^2:



NOTE:

- Deflection on the glass 13.42mm = **OK in deflectionnessa**

Project: Glass Adaptor and Spigot	Contract: 1388-3
Subject: General Wind Load	Sheet No. 8
Date: 08/05/2020	By: R.F.

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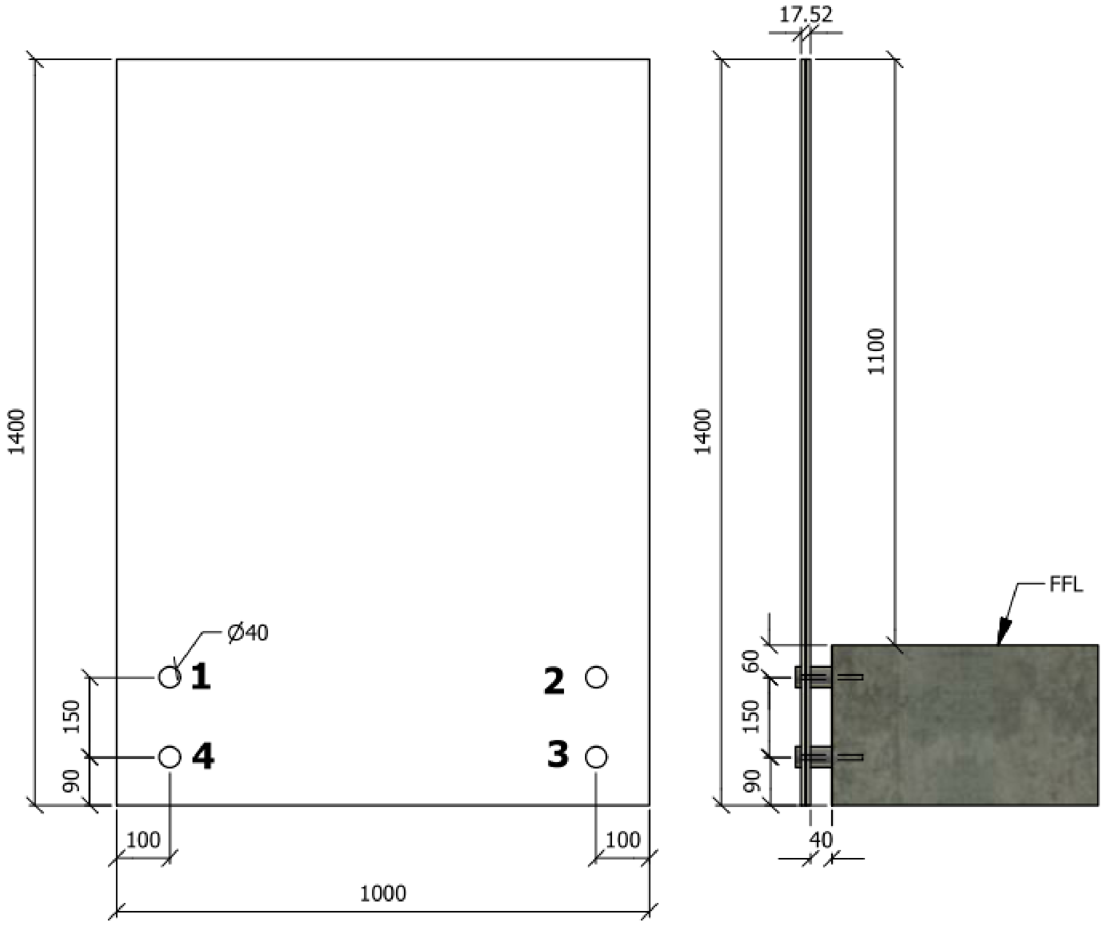
Case Study 02: 17.52mm (TLT) – 1.0x1.40m – 1.0kN/m^2:

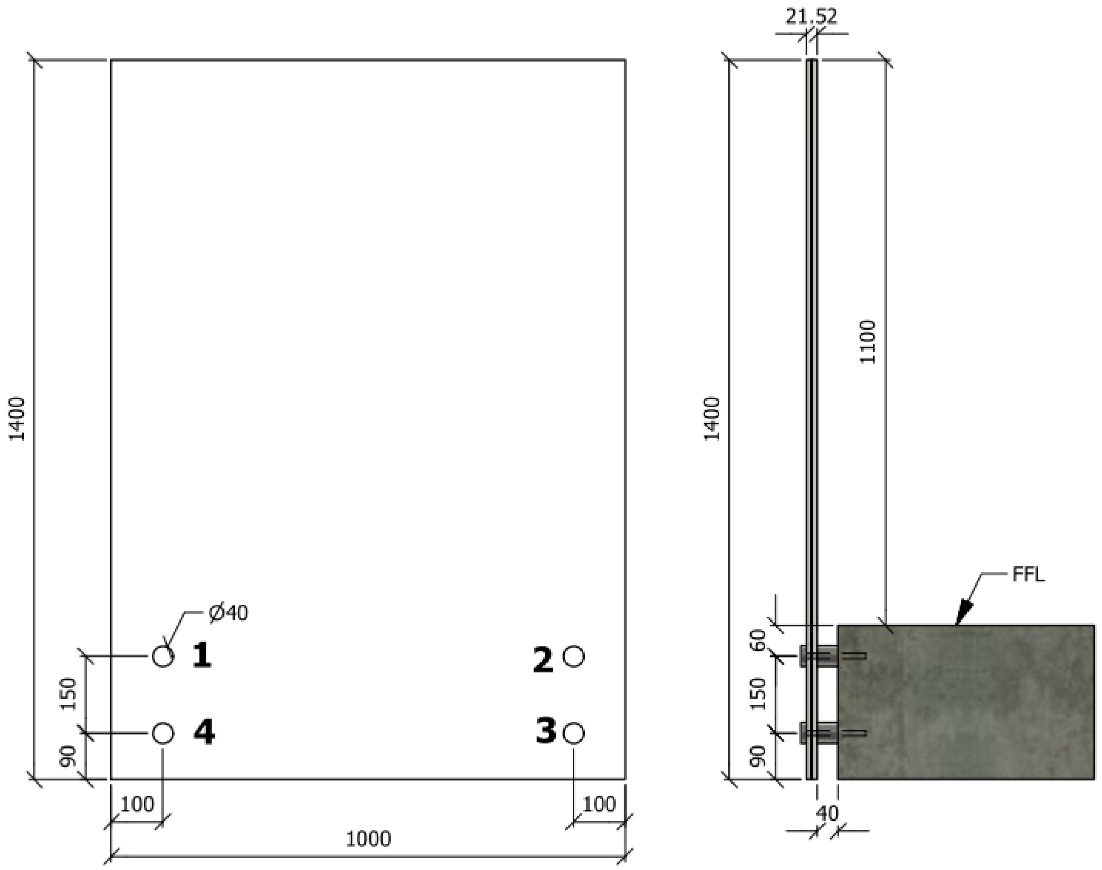


NOTE:

- Deflection on the glass 22.68mm = **OK in deflection**

TSA TED SINGLETON & ASSOCIATES CONSULTING ENGINEERS	**Project:** Glass Adaptor and Spigot	**Contract:** 1388-3
	Subject: General Wind Load	**Sheet No.** 9
	Date: 08/05/2020	**By:** R.F.

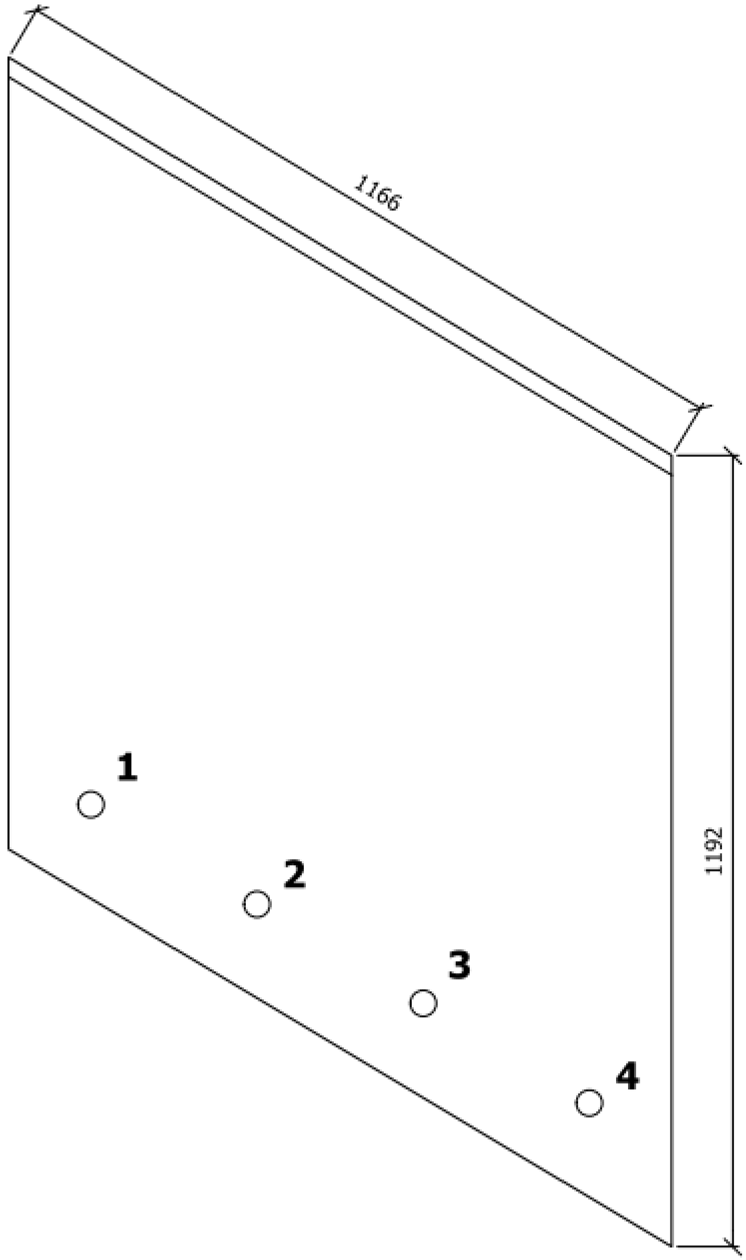
Case Study 03: 21.52mm (TLT) – 1.0x1.40m – $1.5 kN/m^2$:



NOTE:

- Deflection on the glass 19.69mm = **OK in deflection**

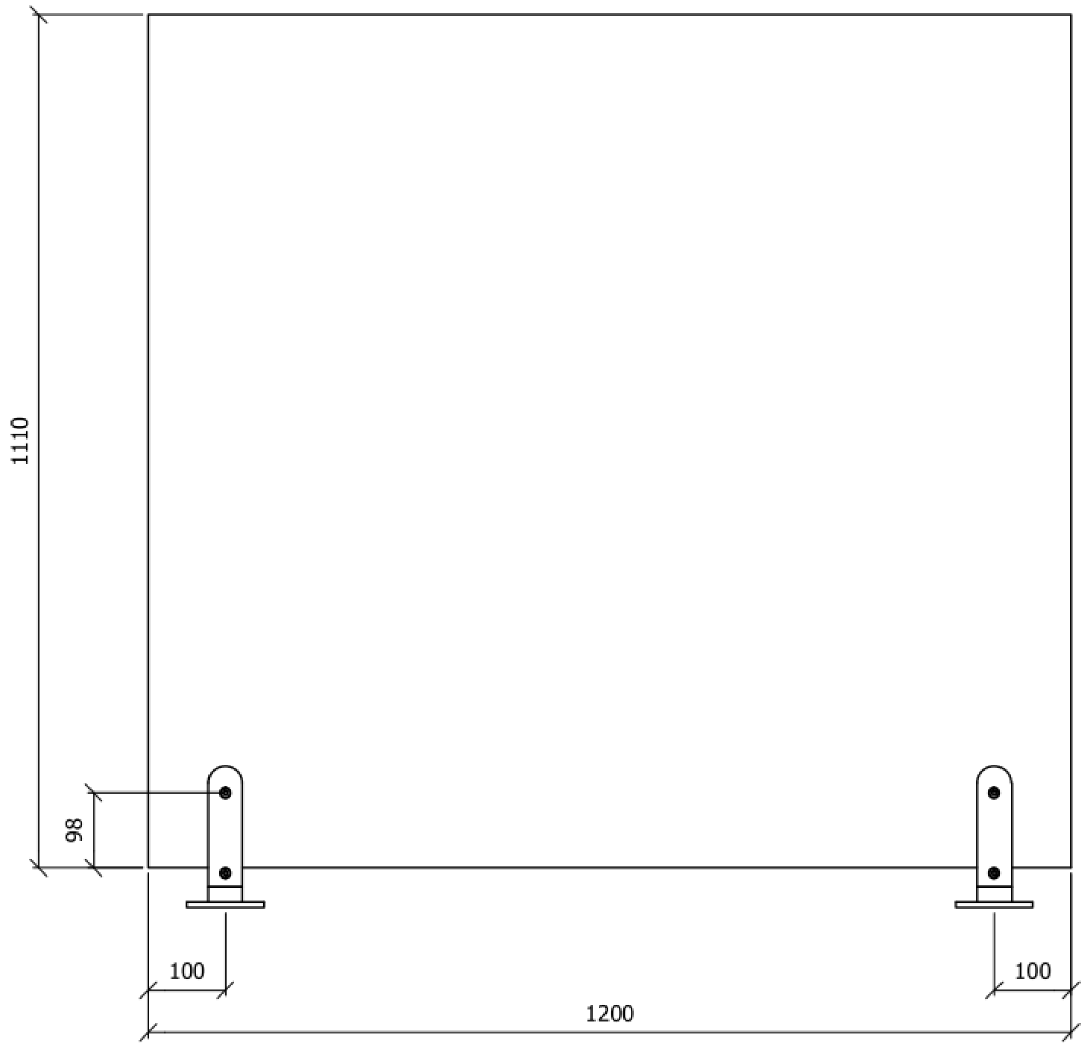
Case Study 04: 15mm Tough – 1.166x1.192m – 0.42kN:



NOTE:

- Deflection on the glass 8.422mm = **OK in deflection**

Case Study 05: 15mm Tough – 1.20x1.11m – 1.5kN/m^2:



NOTE:

- Deflection on the glass 15.46mm = **OK in deflection**

Glass Analysis:

Case Study 01: 15mm Tough – 1.0x1.40m – 1.0kN/m^2:

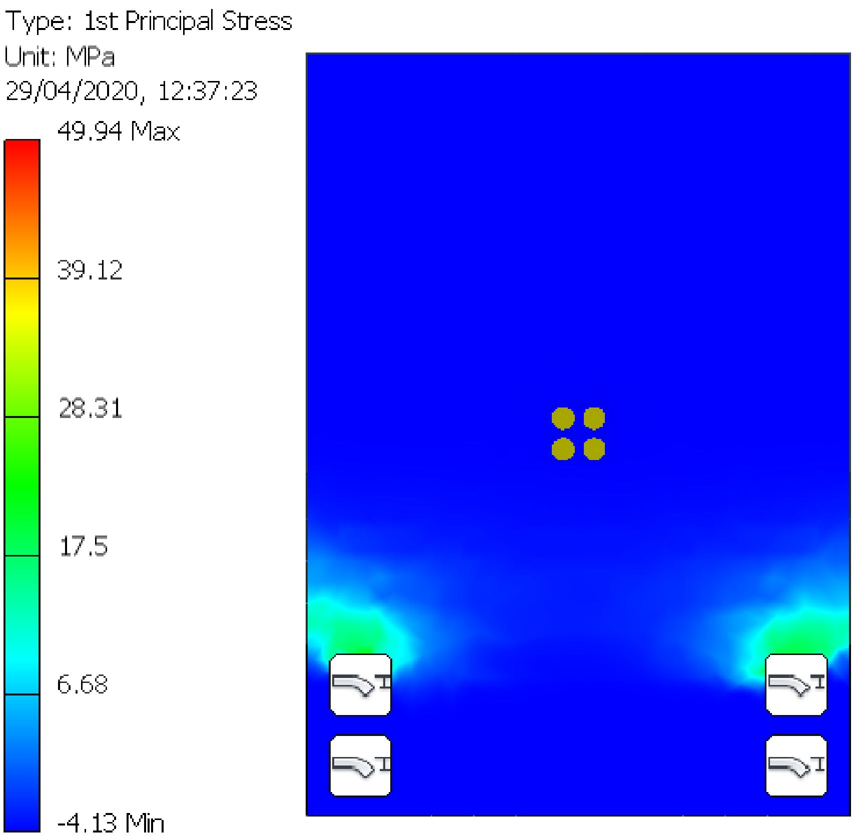
Glass Analysis - Bending Stress of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0kN/m2 Infill Loading
- 15mm Tough Glass analysed, horizontally toughened Laminated
- Bending Stress analysed based on glass panel of 1.0m x 1.40m

Result:

Max. Bending Stress = 49.94N/mm^2 x1.5 = 74.91N/mm^2 < 83.3N/mm^2

OK in Bending



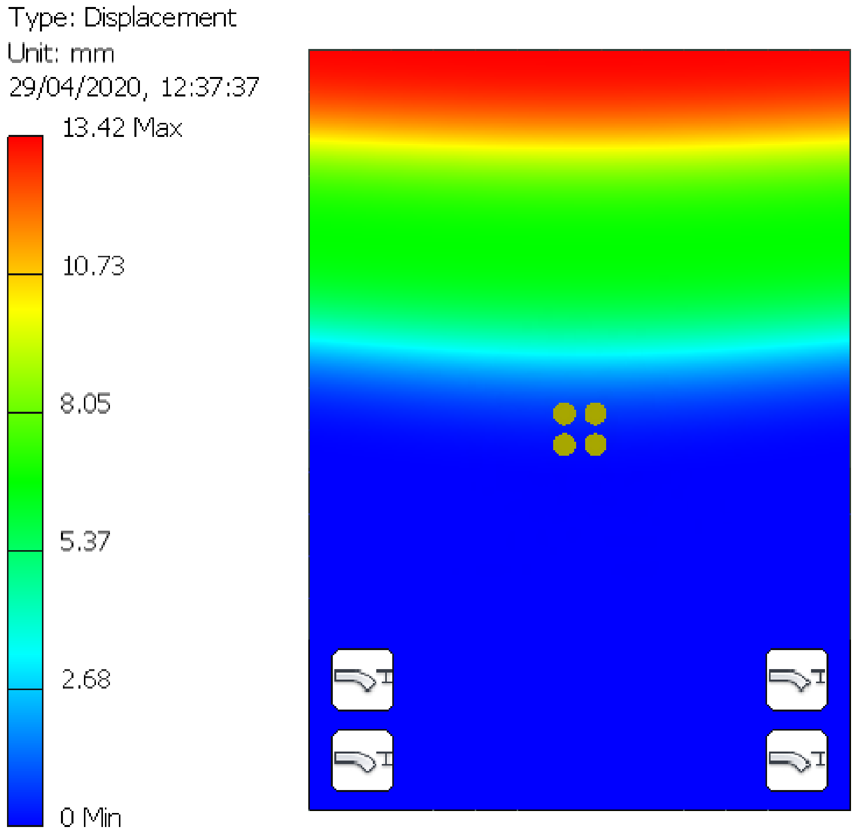
Glass Analysis - Deflection of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0kN/m2 Infill Loading
- 15mm Tough Glass analysed, horizontally toughened Laminated
- Deflection analysed based on glass panel of 1.0m x 1.40m

Result:

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

OK in Deflection (Glass Only)



Case Study 02: 17.52mm (TLT) – 1.0x1.40m – $1.0kN/m^2$:

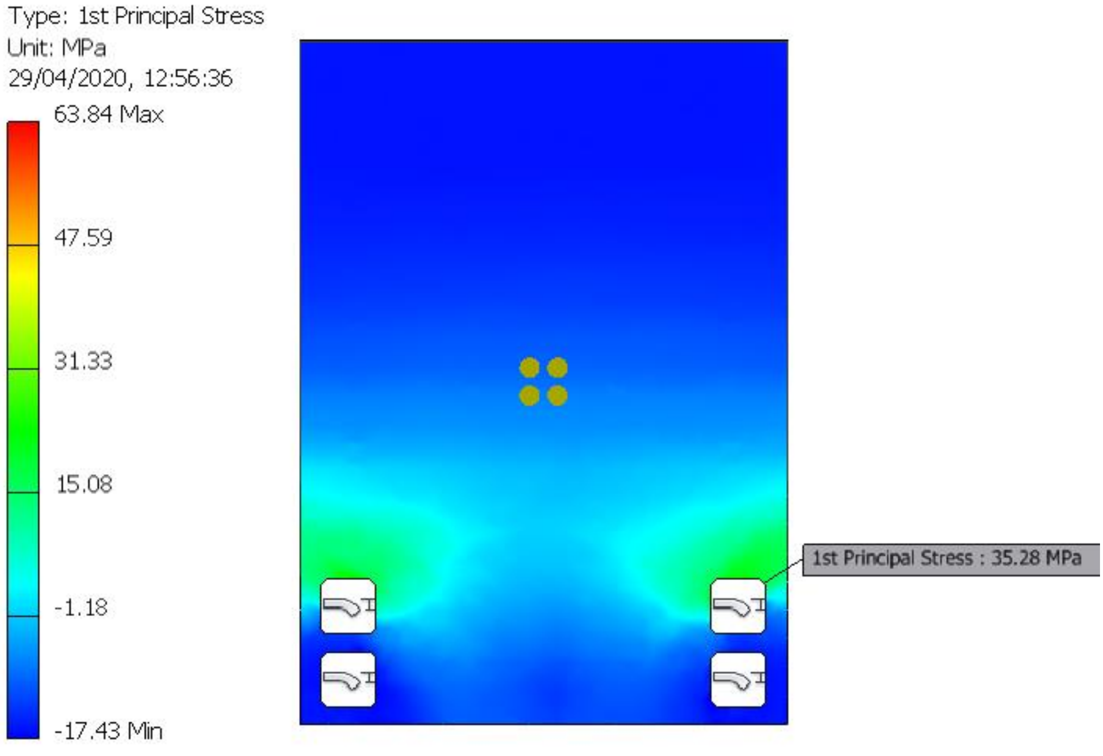
Glass Analysis - Bending Stress of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0kN/m2 Infill Loading
- 8/8/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 3MPa, G = 1MPa
- Bending Stress analysed based on glass panel of 1.0m x 1.40m

Result:

Max. Bending Stress = $35.28N/mm^2$ x1.5 = $52.92N/mm^2$ < $83.3N/mm^2$

OK in Bending



Note:

In this case the 63.84 MPa is a localised stress. The most appropriate stress to be considered is 35.28 MPa

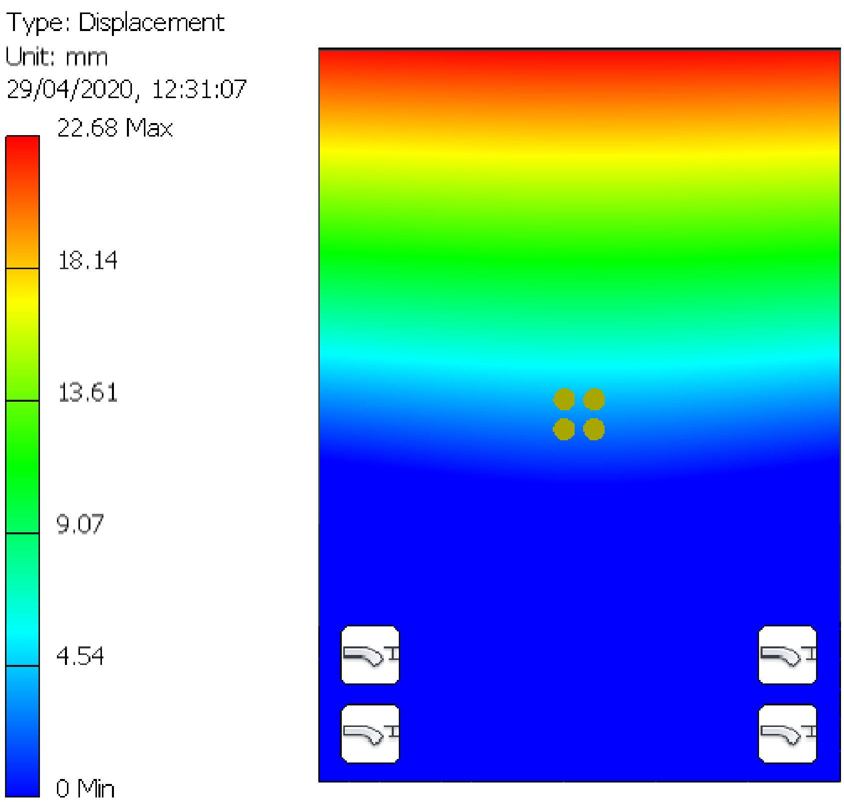
Glass Analysis - Deflection of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0kN/m2 Infill Loading
- 8/8/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 3MPa, G = 1MPa
- Deflection analysed based on glass panel of 1.0m x 1.40m

Result:

Max. Deflection = 22.68mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Case Study 03: 21.52mm (TLT) – 1.0x1.40m – 1.5kN/m^2:

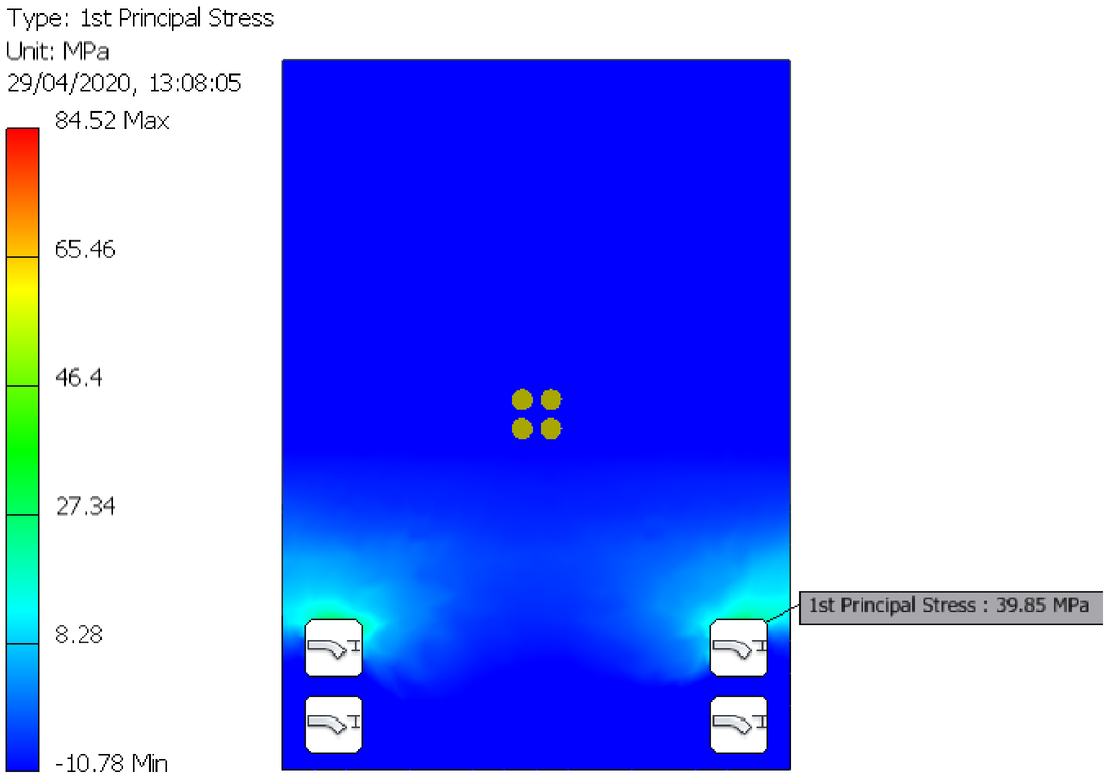
Glass Analysis - Bending Stress of Glass Panel due to 1.5kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5kN/m2 Infill Loading
- 10/10/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 3MPa, G = 1MPa
- Bending Stress analysed based on glass panel of 1.0m x 1.40m

Result:

Max. Bending Stress = 39.85N/mm^2 x1.5 = 59.78N/mm^2 < 83.3N/mm^2

OK in Bending



Note:

In this case the 84.52 MPa is a localised stress. The most appropriate stress to be considered is 39.85 MPa

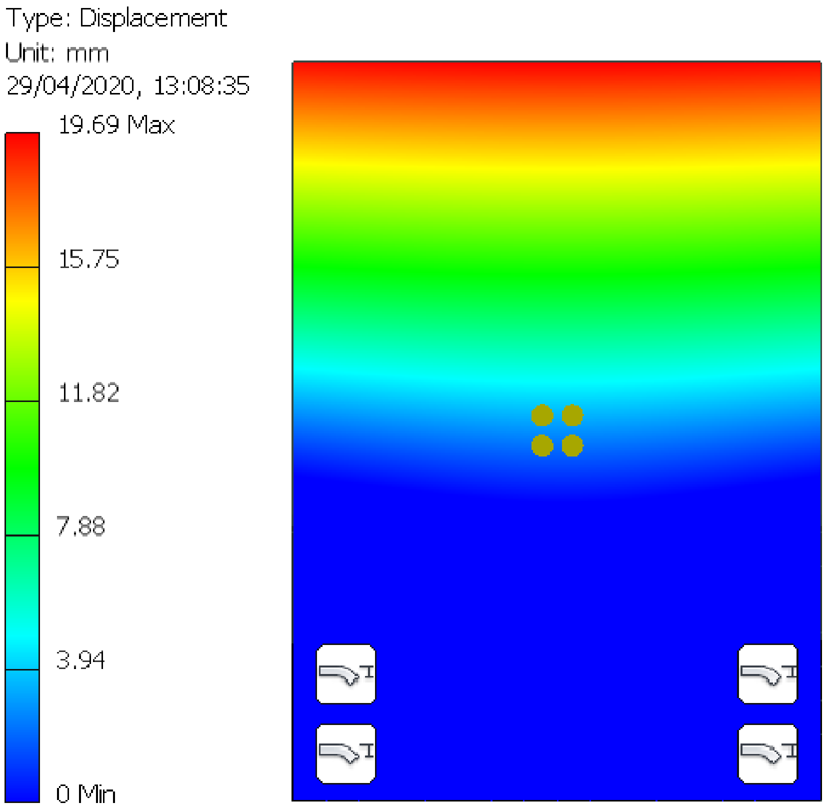
Glass Analysis - Deflection of Glass Panel due to 1.5kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5kN/m2 Infill Loading
- 10/10/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 3MPa, G = 1MPa
- Deflection analysed based on glass panel of 1.0m x 1.40m

Result:

Max. Deflection = 19.69mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Case Study 04: 15mm Tough – 1.166x1.192m – 0.42kN:

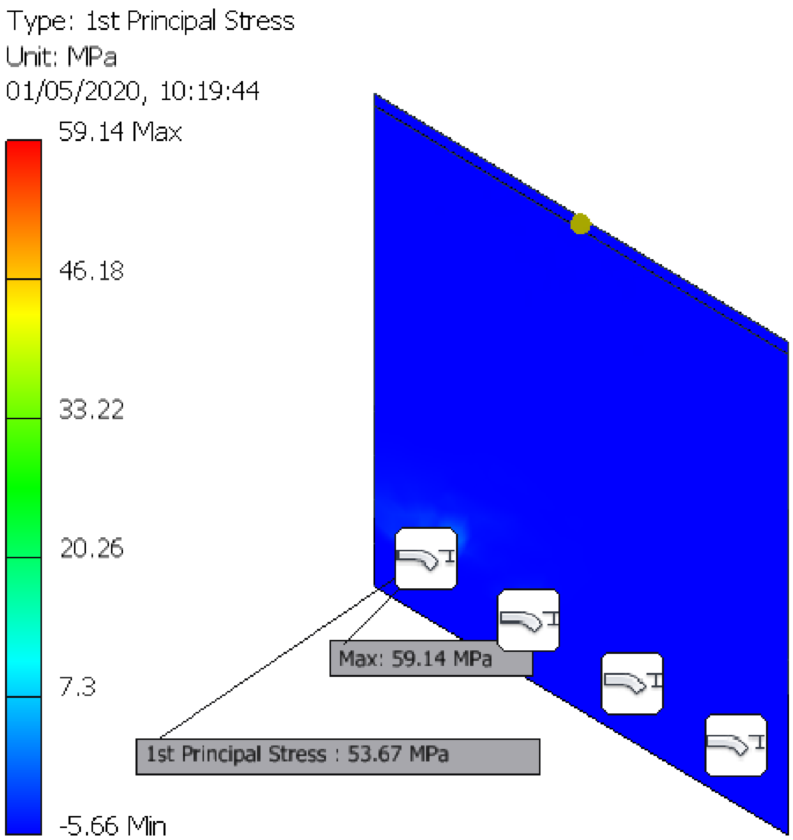
Glass Analysis - Bending Stress of Glass Panel due to 0.42kN/m Balustrade Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.42kN/m Balustrade Loading
- 15mm Tough Glass analysed, horizontally toughened Laminated
- Bending Stress analysed based on glass panel of 1.166(l)m x 1.192(h)m

<u>Result:</u>

Max. Bending Stress = 53.67N/mm^2 x1.5 = 80.51N/mm^2 < 83.3N/mm^2

<u>OK in Bending</u>



<u>Note:</u>

In this case the 59.14 MPa is a localised stress. The most appropriate stress to be considered is 53.67 MPa

Project: Glass Adaptor and Spigot	Contract: 1388-3
Subject: General Wind Load	Sheet No. 19
Date: 08/05/2020	By: R.F.

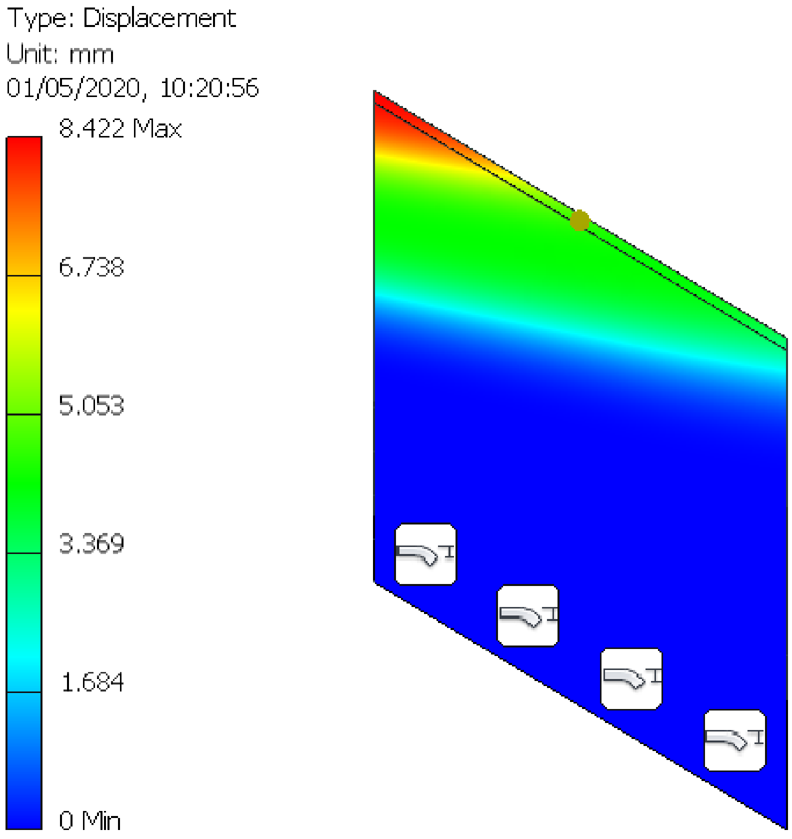
Glass Analysis - Deflection of Glass Panel due to 0.42kN/m Balustrade Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 0.42kN/m Balustrade Loading
- 15mm Tough Glass analysed, horizontally toughened Laminated
- Deflection analysed based on glass panel of 1.166(l)m x 1.192(h)m

Result:

Max. Deflection = 8.422mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Case Study 05: 15mm Tough – 1.20x1.11m – $1.5kN/m^2$:

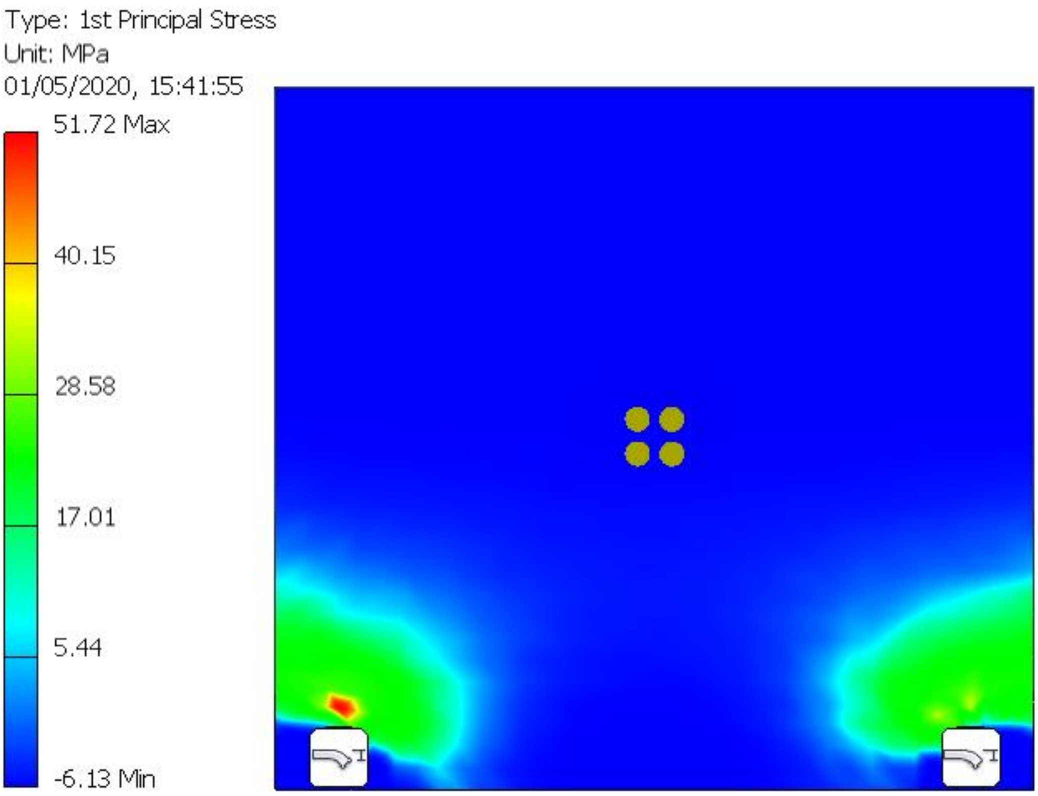
Glass Analysis - Bending Stress of Glass Panel due to 1.5kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5kN/m2 Infill Loading
- 15mm Tough Glass analysed, horizontally toughened Laminated
- Bending Stress analysed based on glass panel of 1.2m x 1.11m

Result:

Max. Bending Stress = 51.72N/mm^2 x1.5 = 77.58N/mm^2 < 83.3N/mm^2

OK in Bending



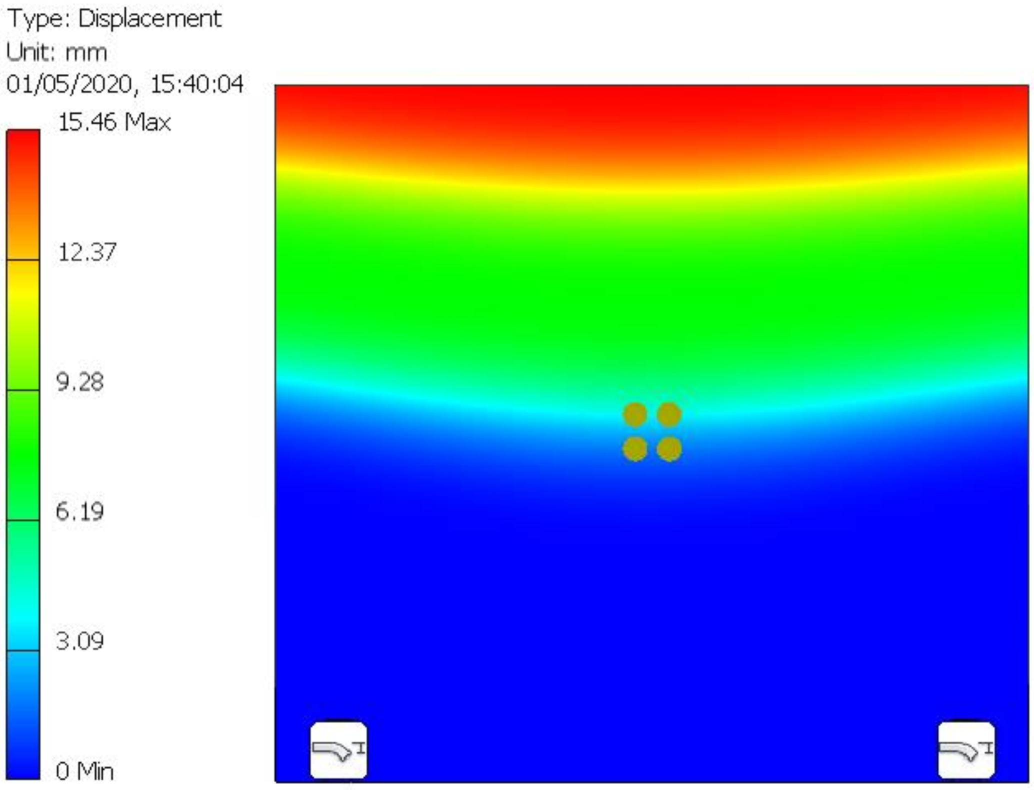
Glass Analysis - Deflection of Glass Panel due to 1.5kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5kN/m2 Infill Loading
- 15mm Tough Glass analysed, horizontally toughened Laminated
- Deflection analysed based on glass panel of 1.2m x 1.11m

Result:

Max. Deflection = 15.46mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Reactions:

Size of the Glass - 1.00(h) x 1.40(l)m			
Pressure	Reactions (N)		
	Case 01	Case 02	Case 03
1	1001	1433	2319
2	1001	1433	2319
3	-301	-733	-1269
4	-301	-733	-1269

Size of the Glass	
1.166(h) x 1.192(l)m	
Balustrade	Reactions (N)
	Case 04
1	393
2	26
3	69
4	-68

Project: Glass Adaptor and Spigot	Contract: 1388-3
Subject: General Wind Load	Sheet No. 23
Date: 08/05/2020	By: R.F.

Connection Design:

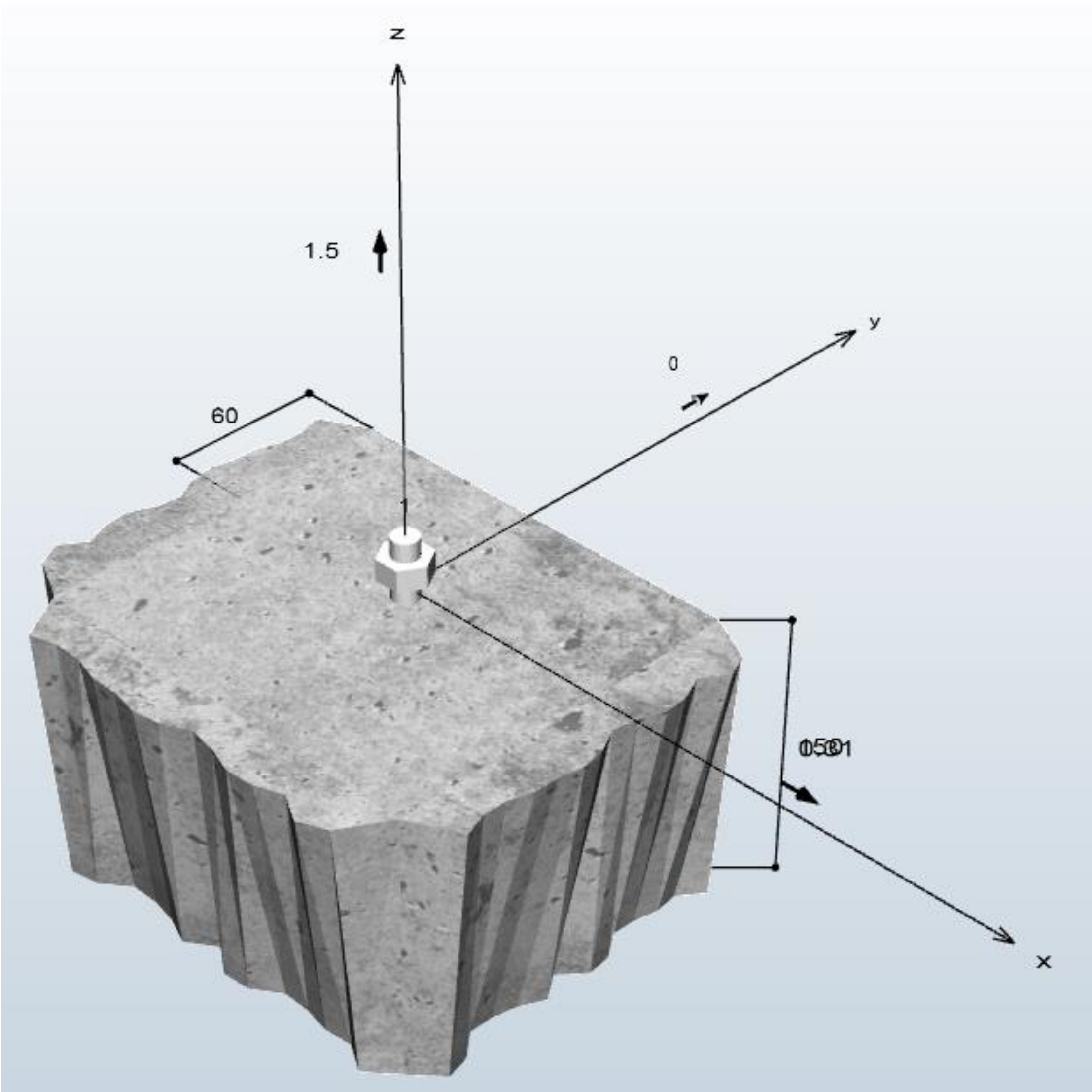
Case Study 01: 15mm Tough – 1.0x1.40m – $1.0\mathrm{kN/m^2}$:

Connection To Concrete:

$\text{Tensile Load} = 1.00\text{kN} \times 1.5 = 1.50\text{kN (ULS)}$

$\text{Shear Load} = 0.23\text{kN} \times 1.35 = 0.31\text{kN (ULS)}$

Chemical anchor FIS V 360 S M10x150 8.8. See design in Appendix A.



Connection To Mild Steel:

1Nr M10 Bolt Grade 8.8

$f_y = 210\ MPa$ *(Grade 304 Stainless Steel, Table 2.1 EN 1993-1-4:2006)*

$f_{ub} = 500\ MPa$ *(Grade 304 Stainless Steel, Table 2.2 EN 1993-1-4:2006)*

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

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

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

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

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

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

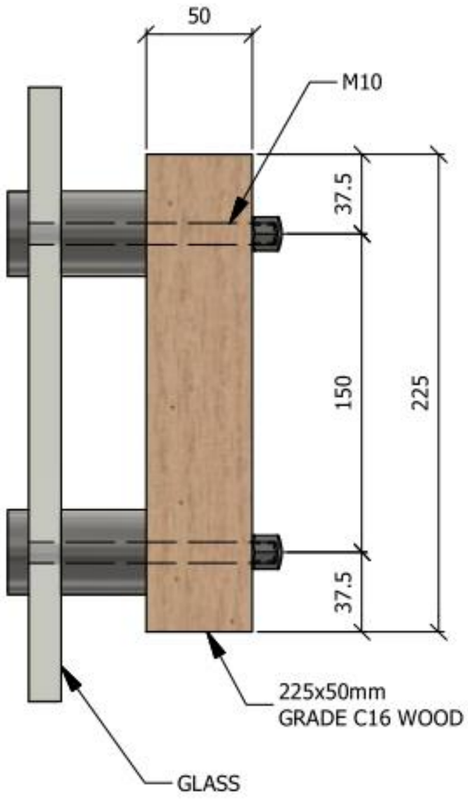
$F_{t,Rd}$: *is the design tension resistance per bolt.*

$$\mathrm{F_{t,Ed}} = \frac{1.0\mathrm{kN}}{\mathrm{m}^2} \times 1.5 \times 1.4\mathrm{m} \times 1.0\mathrm{m} \times \frac{1.4\mathrm{m}}{2} = 1.47\mathrm{kNm}$$

$$\mathrm{F_{t,Ed}} = \frac{1.47\mathrm{kN}}{0.15\mathrm{m}} \times \frac{1}{2} = 4.9\mathrm{kN\ per\ bolt}$$

$$\mathrm{F_{t,Rd}} = \frac{\mathrm{K_2 F_{ub} A}}{\lambda\mathrm{m2}} \rightarrow \mathrm{F_{t,Rd}} = \frac{0.9 \times 500 \times 58 \times 10^{-3}}{1.25} = 20.88\mathrm{kN} > 4.90\mathrm{kN}$$ **Okay**

Connection To Wood:



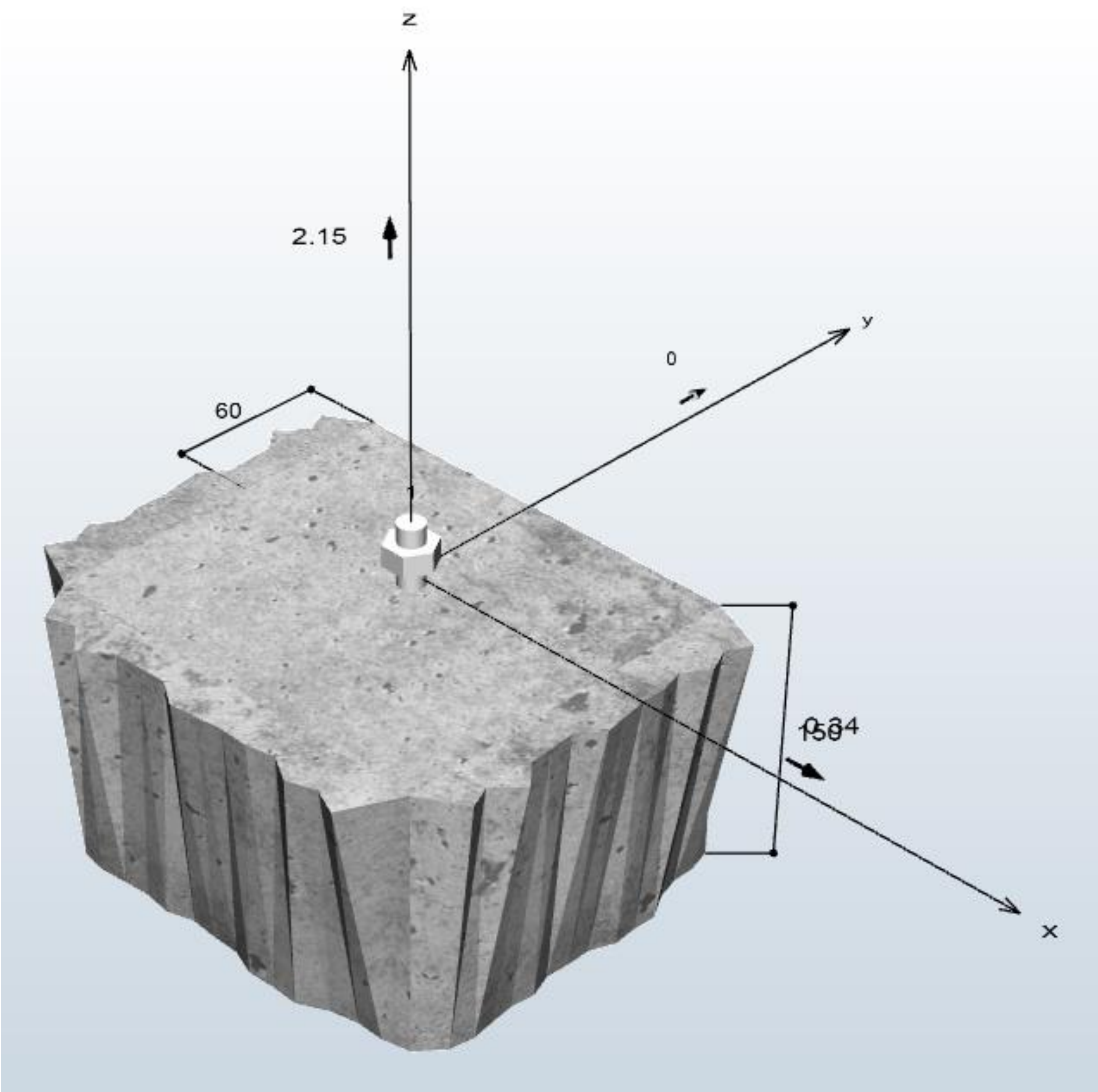
Case Study 02: 17.52mm (TLT) – 1.0x1.40m – 1.0kN/m^2:

Connection To Concrete:

$$\text{Tensile Load} = 1.43\text{kN} \times 1.5 = 2.15\text{kN (ULS)}$$

$$\text{Shear Load} = 0.26\text{kN} \times 1.35 = 0.34\text{kN (ULS)}$$

Chemical anchor FIS V 360 S M10x150 8.8. See design in Appendix A.



Project: Glass Adaptor and Spigot	Contract: 1388-3
Subject: General Wind Load	Sheet No. 27
Date: 08/05/2020	By: R.F.

Connection To Mild Steel:

1Nr M10 Bolt Grade 8.8

$f_y = 210\ MPa$ *(Grade 304 Stainless Steel, Table 2.1 EN 1993-1-4:2006)*

$f_{ub} = 500\ MPa$ *(Grade 304 Stainless Steel, Table 2.2 EN 1993-1-4:2006)*

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

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

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

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

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

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

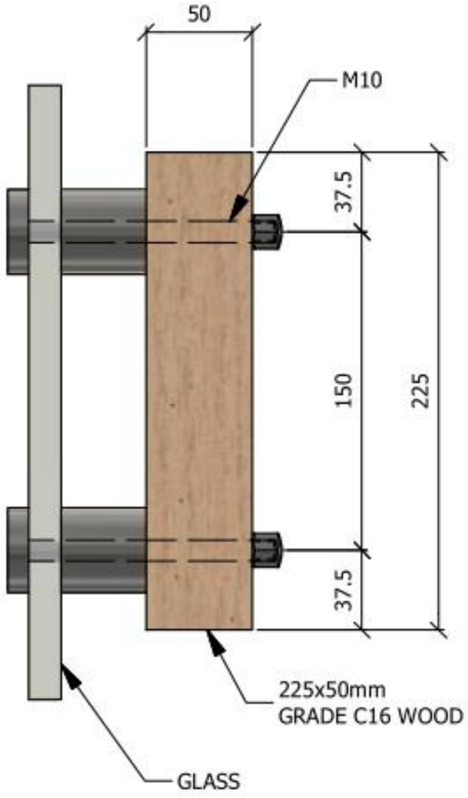
$F_{t,Rd}: is\ the\ design\ tension\ resistance\ per\ bolt.$

$$\mathrm{F_{t,Ed}} = \frac{1.5\mathrm{kN}}{\mathrm{m}^2} \times 1.5 \times 1.4\mathrm{m} \times 1.0\mathrm{m} \times \frac{1.4\mathrm{m}}{2} = 2.21\mathrm{kNm}$$

$$\mathrm{F_{t,Ed}} = \frac{2.21\mathrm{kN}}{0.15\mathrm{m}} \times \frac{1}{2} = 7.37\mathrm{kN\ per\ bolt}$$

$$\mathrm{F_{t,Rd}} = \frac{\mathrm{K_2 F_{ub} A}}{\lambda\mathrm{m2}} \rightarrow \mathrm{F_{t,Rd}} = \frac{0.9 \times 500 \times 58 \times 10^{-3}}{1.25} = 20.88\mathrm{kN} > 7.37\mathrm{kN}$$ **Okay**

Connection To Wood:



FIS A M 10x150 8.8.

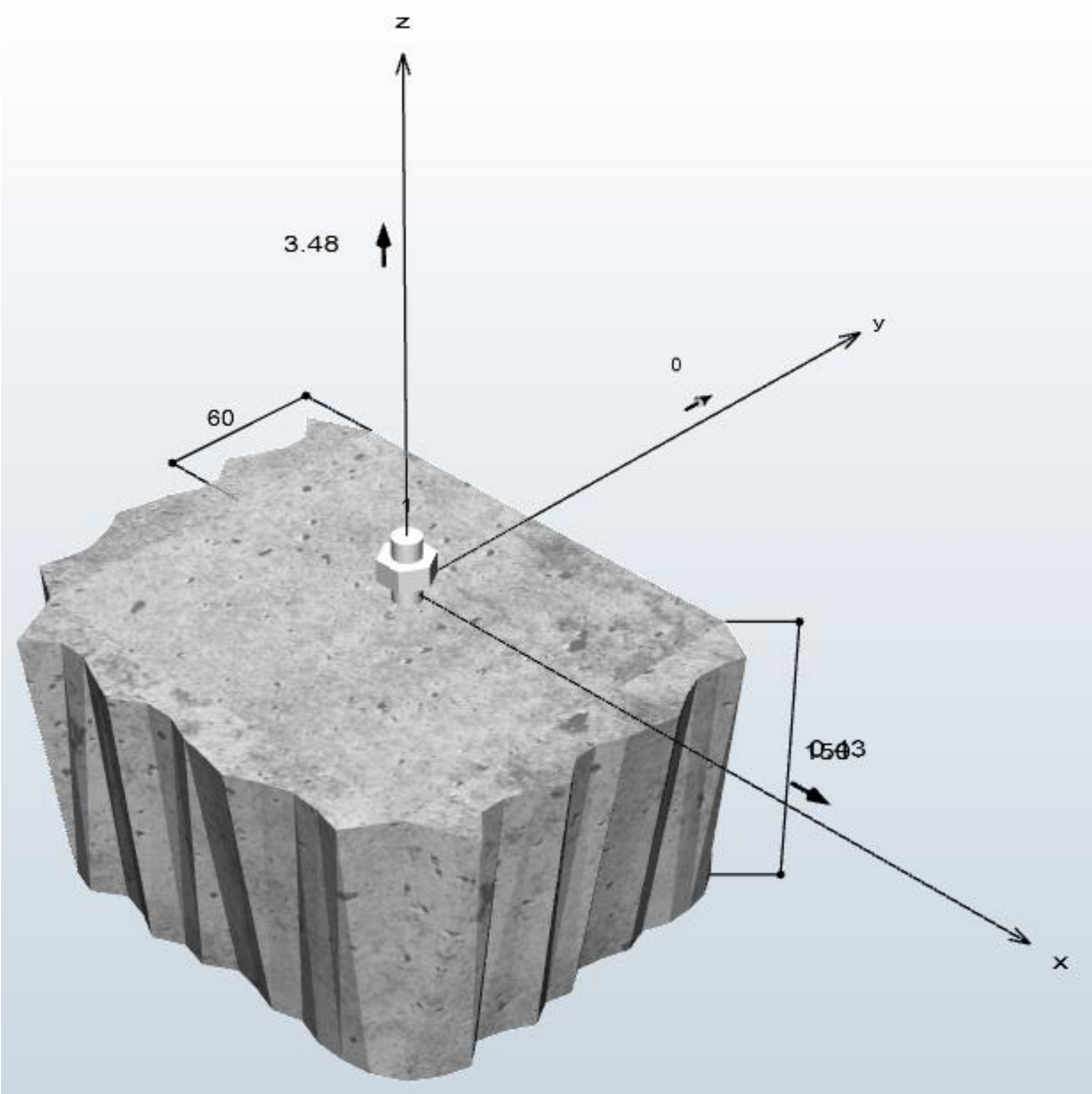
Case Study 03: 21.52mm (TLT) – 1.0x1.40m – 1.5kN/m^2:

Connection To Concrete:

$$\text{Tensile Load} = 2.32\text{kN} \times 1.5 = 3.48\text{kN (ULS)}$$

$$\text{Shear Load} = 0.32\text{kN} \times 1.35 = 0.43\text{kN (ULS)}$$

Chemical anchor FIS V 360 S M10x150 8.8. See design in Appendix A.



Project: Glass Adaptor and Spigot	Contract: 1388-3
Subject: General Wind Load	Sheet No. 30
Date: 08/05/2020	By: R.F.

Connection To Mild Steel:

1Nr M10 Bolt Grade 8.8

$f_y = 210\ MPa$ *(Grade 304 Stainless Steel, Table 2.1 EN 1993-1-4:2006)*

$f_{ub} = 500\ MPa$ *(Grade 304 Stainless Steel, Table 2.2 EN 1993-1-4:2006)*

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

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

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

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

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

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

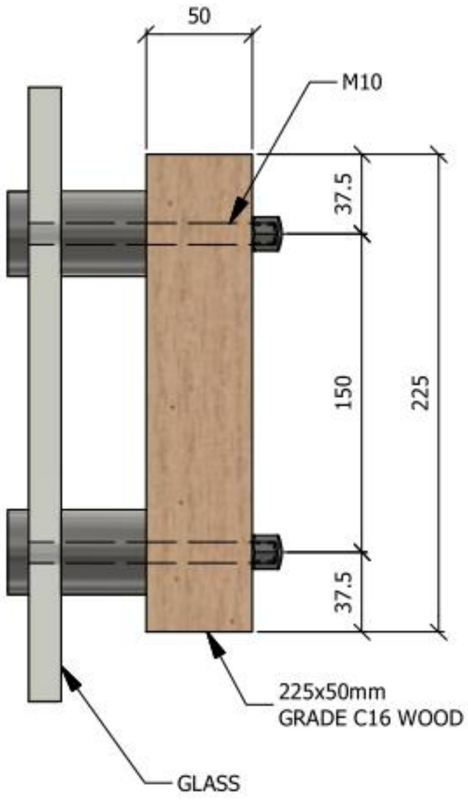
$F_{t,Rd}$: *is the design tension resistance per bolt.*

$$\mathrm{F_{t,Ed}} = \frac{2.0\mathrm{kN}}{\mathrm{m}^2} \times 1.5 \times 1.4\mathrm{m} \times 1.0\mathrm{m} \times \frac{1.4\mathrm{m}}{2} = 2.94\mathrm{kNm}$$

$$\mathrm{F_{t,Ed}} = \frac{2.21\mathrm{kN}}{0.15\mathrm{m}} \times \frac{1}{2} = 9.80\mathrm{kN\ per\ bolt}$$

$$\mathrm{F_{t,Rd}} = \frac{\mathrm{K_2 F_{ub} A}}{\lambda\mathrm{m2}} \rightarrow \mathrm{F_{t,Rd}} = \frac{0.9\times500\times58\times10^{-3}}{1.25} = 20.88\mathrm{kN} > 9.80\mathrm{kN}$$ **Okay**

Connection To Wood:

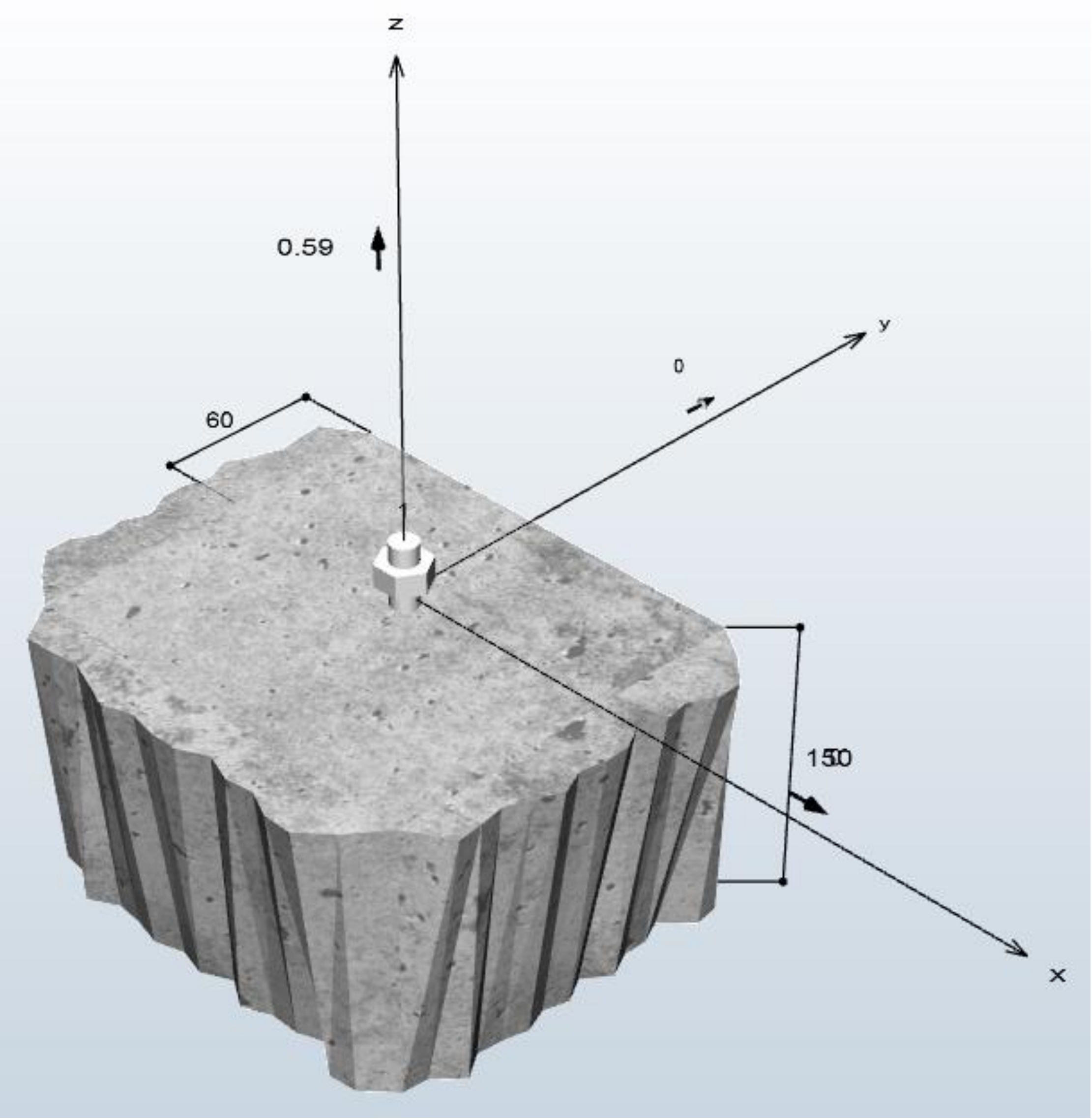


Case Study 04: 15mm Tough – 1.166x1.192m – 0.42kN:

Connection To Concrete:

$$\text{Tensile Load} = 0.393\text{kN} \times 1.5 = 0.59\text{kN (ULS)}$$

Chemical anchor FIS V 360 S M10x150 8.8. See design in Appendix A.



Connection To Mild Steel:

1Nr M10 Bolt Grade 8.8

$f_y = 210\ MPa$ *(Grade 304 Stainless Steel, Table 2.1 EN 1993-1-4:2006)*

$f_{ub} = 500\ MPa$ *(Grade 304 Stainless Steel, Table 2.2 EN 1993-1-4:2006)*

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

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

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

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

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

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

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

$$\mathrm{F_{t,Ed}} = 0.393\mathrm{kN} \times 1.5 = 0.59\mathrm{kN}\ (\mathrm{ULS})$$

$$\mathrm{F_{t,Rd}} = \frac{\mathrm{K_2 F_{ub} A}}{\lambda \mathrm{m2}} \rightarrow \mathrm{F_{t,Rd}} = \frac{0.9 \times 500 \times 58 \times 10^{-3}}{1.25} = 20.88\mathrm{kN} > 0.59\mathrm{kN}$$ **Okay**

Connection To Wood:

$f_y = 210\ MPa$ *(Grade 304 Stainless Steel, Table 2.1 EN 1993-1-4:2006)*

$f_{ub} = 500\ MPa$ *(Grade 304 Stainless Steel, Table 2.2 EN 1993-1-4:2006)*

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

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

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

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

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

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

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

$\mathrm{F_{t,Ed}} = 0.393\mathrm{kN} \times 1.5 = 0.59\mathrm{kN\ (ULS)}$

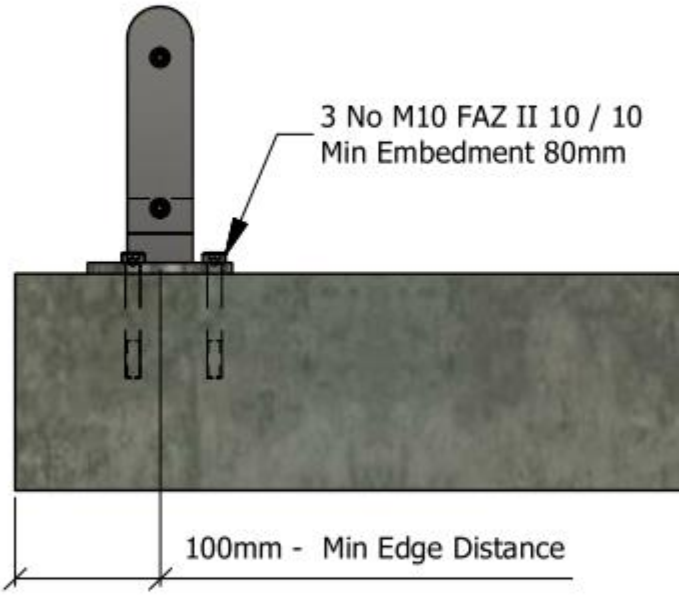
$\mathrm{F_{t,Rd}} = \frac{\mathrm{K_2 F_{ub} A}}{\lambda \mathrm{m2}} \rightarrow \mathrm{F_{t,Rd}} = \frac{0.9\times500\times58\times10^{-3}}{1.25} = 20.88\mathrm{kN} > 0.59\mathrm{kN}$ **Okay**

TSA
TED SINGLETON & ASSOCIATES
CONSULTING ENGINEERS

Project: Glass Adaptor and Spigot	Contract: 1388-3
Subject: General Wind Load	Sheet No. 35
Date: 08/05/2020	By: R.F.

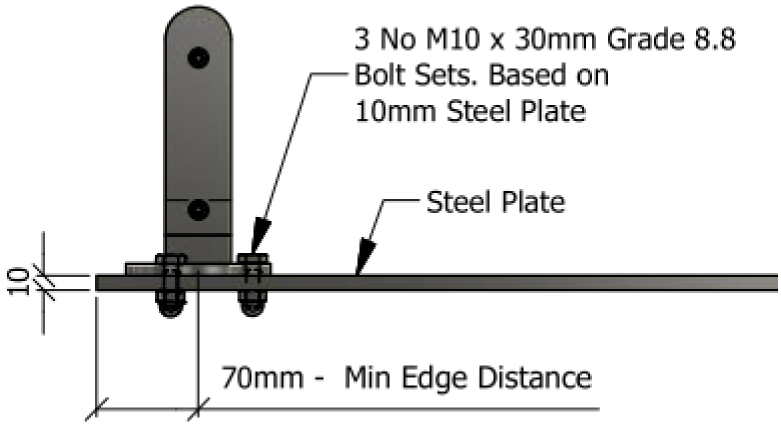
Case Study 05: 15mm Tough – 1.20x1.11m – $1.5\mathrm{kN/m^2}$:

Connection To Concrete:



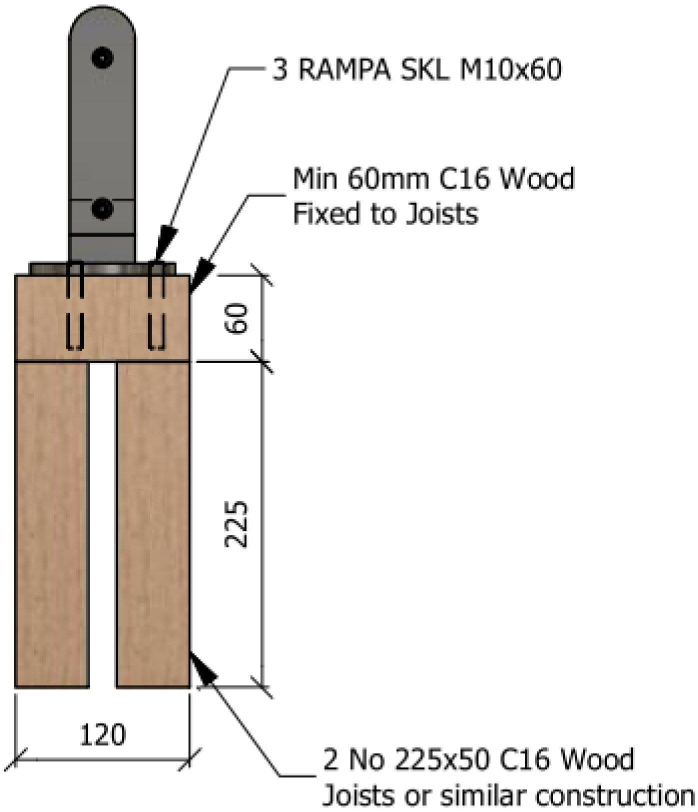
Project: Glass Adaptor and Spigot	**Contract:** 1388-3
Subject: General Wind Load	**Sheet No.** 36
Date: 08/05/2020	**By:** R.F.

Connection To Mild Steel:



Project: Glass Adaptor and Spigot	**Contract:** 1388-3
Subject: General Wind Load	**Sheet No.** 37
Date: 08/05/2020	**By:** R.F.

Connection To Wood:



Appendix A - Fiscer Reports

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

MASONRY FIXINGS

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

Comment

Case Study 01: 15mm Tough – 1.0x1.40m:

Design Specifications

Anchor

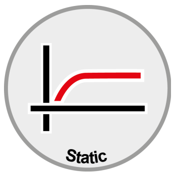
Anchor system	fischer Injection system FIS V
Injection resin	FIS V 360 S
Fixing element	Threaded rod FIS A M 10 x 150 8.8, zinc plated steel, property class 8.8
Calculated anchorage depth	60 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-02/0024, Option 1, Issued 02/01/2020

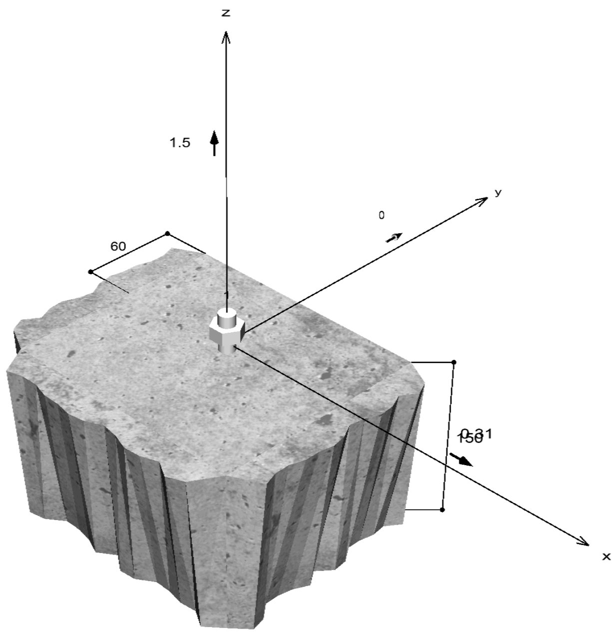
Geometry / Loads / Scale units

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	Non-cracked, dry hole
Temperature range	24 °C long term temperature, 40 °C short term temperature
Reinforcement	Normal or no reinforcement. No edge reinforcement
Drilling method	hammer drilling
Installation type	Push-through installation
Type of loading	Static or quasi-static

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	1.50	0.31	0.00	0.00	0.00	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	1.50	0.31	0.31	0.00

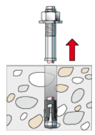
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	1.50	31.33	4.8
Combined pull-out and concrete cone failure	1.50	11.40	**13.2**
Concrete cone failure	1.50	14.00	10.7
Splitting failure	1.50	19.92	7.5

* Most unfavourable anchor

Steel failure

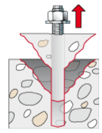
$$N_{Ed} \leq \frac{N_{Rk,s}}{\gamma_{Ms}} \quad (\mathbf{N_{Rd,s}})$$



$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
47.00	1.50	31.33	1.50	4.8

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	4.8	1	$\beta_{N,s;1}$

Combined pull-out and concrete cone failure



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

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

$$N_{Rk,p} = 22.81kN \cdot \frac{27{,}000mm^2}{32{,}400mm^2} \cdot 0.900 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 17.11kN$$

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

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

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

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

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

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

$$\Psi_{s,Np} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}} = 0.7 + 0.3 \cdot \frac{60mm}{90mm} = 0.900 \leq 1$$ Eq. (7.20)

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

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

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

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

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

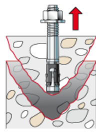
$$\Psi_{ec,Npx} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Npy} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1$$

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

$N_{Rk,p}$ kN	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
17.11	1.50	11.40	1.50	13.2

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	13.2	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)

$$N_{Rk,c} = 28.00kN \cdot \frac{27{,}000mm^2}{32{,}400mm^2} \cdot 0.900 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 21.00kN$$

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

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} = 0.7 + 0.3 \cdot \frac{60mm}{90mm} = 0.900 \leq 1$$ 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)

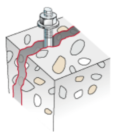
$$\Psi_{ec,Nx} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1$$

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

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
21.00	1.50	14.00	1.50	10.7

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	10.7	1	$\beta_{N,c;1}$

Splitting failure due to loading



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

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

$$N_{Rk,sp} = 22.81kN \cdot \frac{14{,}400mm^2}{14{,}400mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.310 = 29.89kN$$

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,sp}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{60mm}{60mm}\right) = 1.000 \leq 1$$ Eq. (7.4)

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

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

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

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

$$\Psi_{h,sp} = min\left(\left(\frac{150mm}{100mm}\right)^{2/3} ;max\left(1; \left(\frac{60mm+1.5 \cdot 60mm}{100mm}\right)^{2/3}\right);2\right) = 1.310$$

$N_{Rk,sp}$ kN	γ_{Msp}	$N_{Rd,sp}$ kN	N_{Ed} kN	$\beta_{N,sp}$ %
29.89	1.50	19.92	1.50	7.5

Anchor no.	$\beta_{N,sp}$ %	Group N°	Decisive Beta
1	7.5	1	$\beta_{N,sp;1}$

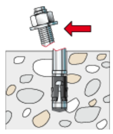
Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	0.31	18.40	1.7
Concrete pry-out failure	0.31	22.81	1.4
Concrete edge failure	0.31	13.65	**2.3**

* Most unfavourable anchor

Steel failure without lever arm

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



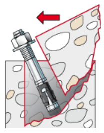
$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 23.00kN = 23.00kN$$ Eq. (7.35)/ (7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
23.00	1.25	18.40	0.31	1.7

Anchor no.	β_{Vs} %	Group N°	Decisive Beta
1	1.7	1	$\beta_{Vs;1}$

Concrete pry-out failure

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



$$V_{Rk,cp} = k_8 \cdot N_{Rk,p} = 2 \cdot 17.11kN = 34.21kN$$ Eq. (7.39c)

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

$$N_{Rk,p} = 22.81kN \cdot \frac{27{,}000mm^2}{32{,}400mm^2} \cdot 0.900 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 17.11kN$$

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

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

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

$$\Psi_{s,Np} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}} = 0.7 + 0.3 \cdot \frac{60mm}{90mm} = 0.900 \leq 1$$ Eq. (7.20)

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

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

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

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

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

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

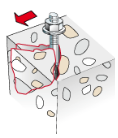
$$\Psi_{re,Np} = 1.000$$ Eq. (7.5)

$V_{Rk,cp}$ kN	γ_{Mcp}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
34.21	1.50	22.81	0.31	1.4

Anchor no.	$\beta_{V,cp}$ %	Group N°	Decisive Beta
1	1.4	1	$\beta_{V,cp;1}$

Concrete edge failure

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



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

$$V_{Rk,c} = 10.24kN \cdot \frac{16,200mm^2}{16,200mm^2} \cdot 1.000 \cdot 1.000 \cdot 2.000 \cdot 1.000 \cdot 1.000 = 20.48kN$$

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

$$V^0_{Rk,c} = 2.4 \cdot \left(10mm\right)^{0.100} \cdot \left(60mm\right)^{0.070} \cdot \sqrt{30.0N/mm^2} \cdot \left(60mm\right)^{1.5} = 10.24kN$$

$$\alpha = 0.1 \cdot \sqrt{\frac{l_f}{c_1}} = 0.1 \cdot \sqrt{\frac{60mm}{60mm}} = 0.100 \qquad \beta = 0.1 \cdot \left(\frac{d}{c_1}\right)^{0.2} = 0.1 \cdot \left(\frac{10mm}{60mm}\right)^{0.2} = 0.070$$ Eq. (7.42/7.43)

$$\Psi_{s,V} = 0.7 + 0.3 \cdot \frac{c_2}{1.5c_1} = 0.7 + 0.3 \cdot \frac{90mm}{1.5 \cdot 60mm} = 1.000 \leq 1$$ Eq. (7.45)

$$\Psi_{h,V} = max\left(1; \sqrt{\frac{1.5c_1}{h}}\right) = max\left(1; \sqrt{\frac{1.5 \cdot 60mm}{150mm}}\right) = 1.000 \geq 1$$ Eq. (7.46)

$$\Psi_{\alpha,V} = \sqrt{\frac{1}{\left(cos\ \alpha_V\right)^2 + \left(0.5 \cdot sin\ \alpha_V\right)^2}} = \sqrt{\frac{1}{\left(cos\ 90.0\right)^2 + \left(0.5 \cdot sin\ 90.0\right)^2}} = 2.000 \geq 1$$ Eq. (7.48)

$$\Psi_{ec,V} = \frac{1}{1 + \frac{2}{3}\frac{e_v}{c_1}} = \frac{1}{1 + \frac{2 \cdot 0mm}{3 \cdot 60mm}} = 1.000 \leq 1$$ Eq. (7.47)

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

$V_{Rk,c}$ kN	γ_{Mc}	$V_{Rd,c}$ kN	V_{Ed} kN	$\beta_{V,c}$ %
20.48	1.50	13.65	0.31	2.3

Anchor no.	$\beta_{V,c}$ %	Group N°	Decisive Beta
1	2.3	1	$\beta_{V,c;1}$

Utilization of tension and shear loads

Tension loads	Utilisation βN %
Steel failure *	4.8
Combined pull-out and concrete cone failure	**13.2**
Concrete cone failure	10.7
Splitting failure	7.5

Shear Loads	Utilisation βV %
Steel failure without lever arm *	1.7
Concrete pry-out failure	1.4
Concrete edge failure	**2.3**

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.05 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.02 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.00 \leq 1$$ Eq. (7.55)

Utilisation concrete

Proof successful

$$\beta_{N,p} = \beta_{N,p;1} = 0.13 \leq 1$$
$$\beta_{V.c} = \beta_{V,c;1} = 0.02 \leq 1$$
$$\beta_N^{1.5} + \beta_V^{1.5} = \beta_{N,p;1}^{1.5} + \beta_{V,c;1}^{1.5} = 0.05 \leq 1$$ Eq. (7.56)

Information concerning the anchor plate

No plate

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.

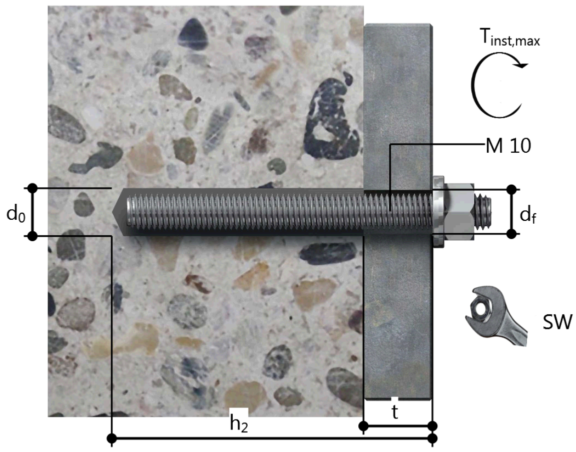
Installation data

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
	Cleaning brush BS 12	Art.-No. 78179
	SDS Plus II 12/100/160	Art.-No. 531803
	or alternatively	
	FHD 12/200/330	Art.-No. 546597
	Hammer drilling with or without suction	

Installation details

Thread diameter	M 10
Drill hole diameter	d_0 = 12 mm
Drill hole depth	h_2 = 68 mm
Calculated anchorage depth	h_{ef} = 60 mm
Drilling method	hammer drilling
Drill hole cleaning	4 times blowing, 4 times brushing, 4 times blowing required activities according the given instruction in the approval No borehole cleaning required in case of using a hollow drill bit, e.g. fischer FHD.
Installation type	Push-through installation
Maximum torque	$T_{inst,max}$ = 20.0 Nm
Socket size	17 mm
Total fixing thickness Tfix,max	t_{fix} = 8 mm
Volume of resin per drill hole	6 ml/3 scale divisions



fischer innovative solutions

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Comment

Case Study 02: 17.52mm (TLT) – 1.0x1.40m:

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	60 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-02/0024, Option 1, Issued 02/01/2020

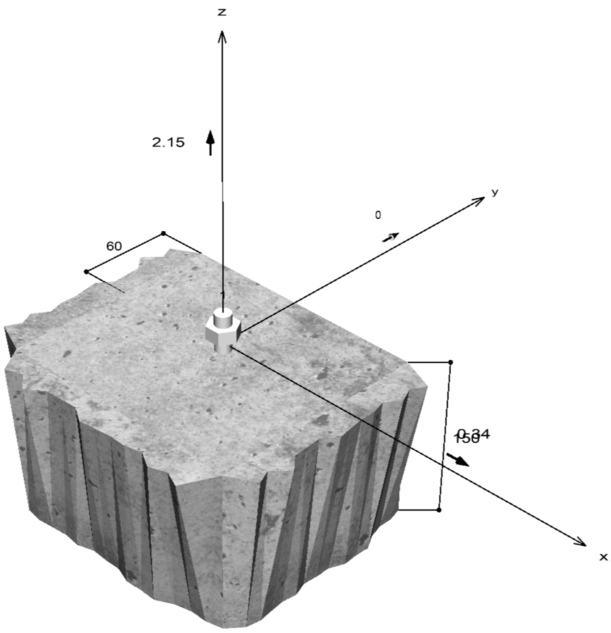
Geometry / Loads / Scale units

mm, kN, kNm

Value of design actions (including

partial safety factor for the load)

Static



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	Non-cracked, dry hole
Temperature range	24 °C long term temperature, 40 °C short term temperature
Reinforcement	Normal or no reinforcement. No edge reinforcement
Drilling method	hammer drilling
Installation type	Push-through installation
Type of loading	Static or quasi-static

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	2.15	0.34	0.00	0.00	0.00	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	2.15	0.34	0.34	0.00

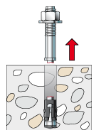
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	2.15	31.33	6.9
Combined pull-out and concrete cone failure	2.15	11.40	**18.9**
Concrete cone failure	2.15	14.00	15.4
Splitting failure	2.15	19.92	10.8

* Most unfavourable anchor

Steel failure

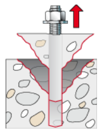
$$N_{Ed} \leq \frac{N_{Rk,s}}{\gamma_{Ms}} \quad (N_{Rd,s})$$



$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
47.00	1.50	31.33	2.15	6.9

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	6.9	1	$\beta_{N,s;1}$

Combined pull-out and concrete cone failure



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

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

$$N_{Rk,p} = 22.81kN \cdot \frac{27{,}000mm^2}{32{,}400mm^2} \cdot 0.900 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 17.11kN$$

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

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

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

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

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

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

$$\Psi_{s,Np} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}} = 0.7 + 0.3 \cdot \frac{60mm}{90mm} = 0.900 \leq 1$$ Eq. (7.20)

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

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

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

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

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

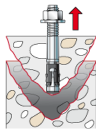
$$\Psi_{ec,Npx} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Npy} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1$$

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

$N_{Rk,p}$ kN	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
17.11	1.50	11.40	2.15	18.9

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	18.9	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)

$$N_{Rk,c} = 28.00kN \cdot \frac{27{,}000mm^2}{32{,}400mm^2} \cdot 0.900 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 21.00kN$$

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

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} = 0.7 + 0.3 \cdot \frac{60mm}{90mm} = 0.900 \leq 1$$ 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)

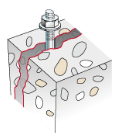
$$\Psi_{ec,Nx} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1$$

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

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
21.00	1.50	14.00	2.15	15.4

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	15.4	1	$\beta_{N,c;1}$

Splitting failure due to loading



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

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

$$N_{Rk,sp} = 22.81kN \cdot \frac{14{,}400mm^2}{14{,}400mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.310 = 29.89kN$$

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,sp}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{60mm}{60mm}\right) = 1.000 \leq 1$$ Eq. (7.4)

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

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

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

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

$$\Psi_{h,sp} = min\Big(\big(\frac{150mm}{100mm}\big)^{2/3} ;max\Big(1; \big(\frac{60mm+1.5 \cdot 60mm}{100mm}\big)^{2/3}\Big);2\Big) = 1.310$$

$N_{Rk,sp}$ kN	γ_{Msp}	$N_{Rd,sp}$ kN	N_{Ed} kN	$\beta_{N,sp}$ %
29.89	1.50	19.92	2.15	10.8

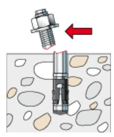
Anchor no.	$\beta_{N,sp}$ %	Group N°	Decisive Beta
1	10.8	1	$\beta_{N,sp;1}$

Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	0.34	18.40	1.8
Concrete pry-out failure	0.34	22.81	1.5
Concrete edge failure	0.34	13.65	**2.5**

* Most unfavourable anchor

Steel failure without lever arm



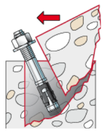
$$V_{Ed} \leq \frac{V_{Rk,s}}{\gamma_{Ms}}$$ **($V_{Rd,s}$)**

$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 23.00kN = 23.00kN$$ 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	0.34	1.8

Anchor no.	β_{Vs} %	Group N°	Decisive Beta
1	1.8	1	$\beta_{Vs;1}$

Concrete pry-out failure



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

$$V_{Rk,cp} = k_8 \cdot N_{Rk,p} = 2 \cdot 17.11kN = 34.21kN$$ Eq. (7.39c)

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

$$N_{Rk,p} = 22.81kN \cdot \frac{27{,}000mm^2}{32{,}400mm^2} \cdot 0.900 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 17.11kN$$

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

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

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

$$\Psi_{s,Np} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}} = 0.7 + 0.3 \cdot \frac{60mm}{90mm} = 0.900 \leq 1$$ Eq. (7.20)

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

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

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

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

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

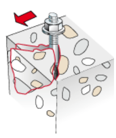
$$\Psi_{ec,Np} = \frac{1}{1 + \frac{2e_n}{s_{cr,Np}}} = \Psi_{ec,Npx} \cdot \Psi_{ec,Npy} = 1.000 \cdot 1.000 = 1.000 \leq 1$$ Eq. (7.21)

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

$V_{Rk,cp}$ kN	γ_{Mcp}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
34.21	1.50	22.81	0.34	1.5

Anchor no.	$\beta_{V,cp}$ %	Group N°	Decisive Beta
1	1.5	1	$\beta_{V,cp;1}$

Concrete edge failure



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

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

$$V_{Rk,c} = 10.24kN \cdot \frac{16{,}200mm^2}{16{,}200mm^2} \cdot 1.000 \cdot 1.000 \cdot 2.000 \cdot 1.000 \cdot 1.000 = 20.48kN$$

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

$$V^0_{Rk,c} = 2.4 \cdot \left(10mm\right)^{0.100} \cdot \left(60mm\right)^{0.070} \cdot \sqrt{30.0N/mm^2} \cdot \left(60mm\right)^{1.5} = 10.24kN$$

$$\alpha = 0.1 \cdot \sqrt{\frac{l_f}{c_1}} = 0.1 \cdot \sqrt{\frac{60mm}{60mm}} = 0.100 \qquad \beta = 0.1 \cdot \left(\frac{d}{c_1}\right)^{0.2} = 0.1 \cdot \left(\frac{10mm}{60mm}\right)^{0.2} = 0.070$$ Eq. (7.42/7.43)

$$\Psi_{s,V} = 0.7 + 0.3 \cdot \frac{c_2}{1.5c_1} = 0.7 + 0.3 \cdot \frac{90mm}{1.5 \cdot 60mm} = 1.000 \leq 1$$ Eq. (7.45)

$$\Psi_{h,V} = max\left(1; \sqrt{\frac{1.5c_1}{h}}\right) = max\left(1; \sqrt{\frac{1.5 \cdot 60mm}{150mm}}\right) = 1.000 \geq 1$$ Eq. (7.46)

$$\Psi_{\alpha,V} = \sqrt{\frac{1}{\left(cos\ \alpha_V\right)^2 + \left(0.5 \cdot sin\ \alpha_V\right)^2}} = \sqrt{\frac{1}{\left(cos\ 90.0\right)^2 + \left(0.5 \cdot sin\ 90.0\right)^2}} = 2.000 \geq 1$$ Eq. (7.48)

$$\Psi_{ec,V} = \frac{1}{1 + \frac{2}{3}\frac{e_v}{c_1}} = \frac{1}{1 + \frac{2 \cdot 0mm}{3 \cdot 60mm}} = 1.000 \leq 1$$ Eq. (7.47)

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

$V_{Rk,c}$ kN	γ_{Mc}	$V_{Rd,c}$ kN	V_{Ed} kN	$\beta_{V,c}$ %
20.48	1.50	13.65	0.34	2.5

Anchor no.	$\beta_{V,c}$ %	Group N°	Decisive Beta
1	2.5	1	$\beta_{V,c;1}$

Utilization of tension and shear loads

Tension loads	Utilisation βN %
Steel failure *	6.9
Combined pull-out and concrete cone failure	**18.9**
Concrete cone failure	15.4
Splitting failure	10.8

Shear Loads	Utilisation βV %
Steel failure without lever arm *	1.8
Concrete pry-out failure	1.5
Concrete edge failure	**2.5**

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.07 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.02 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.01 \leq 1$$

Eq. (7.55)

Utilisation concrete

Proof successful

$$\beta_{N,p} = \beta_{N,p;1} = 0.19 \leq 1$$
$$\beta_{V.c} = \beta_{V,c;1} = 0.02 \leq 1$$
$$\beta_N^{1.5} + \beta_V^{1.5} = \beta_{N,p;1}^{1.5} + \beta_{V,c;1}^{1.5} = 0.09 \leq 1$$

Eq. (7.56)

Information concerning the anchor plate

No plate

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.

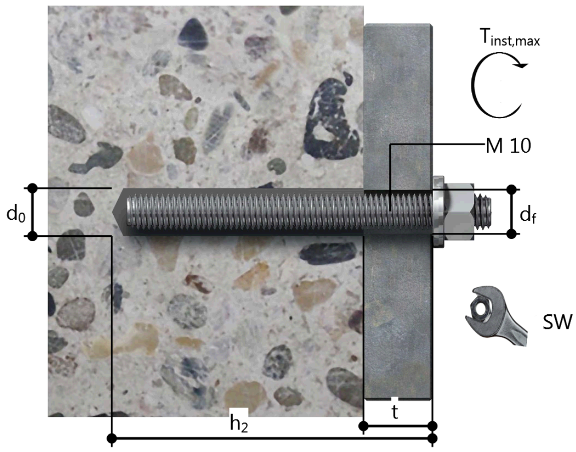
Installation data

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
	Cleaning brush BS 12	Art.-No. 78179
	SDS Plus II 12/100/160	Art.-No. 531803
	or alternatively	
	FHD 12/200/330	Art.-No. 546597
	Hammer drilling with or without suction	

Installation details

Thread diameter	M 10
Drill hole diameter	d_0 = 12 mm
Drill hole depth	h_2 = 68 mm
Calculated anchorage depth	h_{ef} = 60 mm
Drilling method	hammer drilling
Drill hole cleaning	4 times blowing, 4 times brushing, 4 times blowing required activities according the given instruction in the approval No borehole cleaning required in case of using a hollow drill bit, e.g. fischer FHD.
Installation type	Push-through installation
Maximum torque	$T_{inst,max}$ = 20.0 Nm
Socket size	17 mm
Total fixing thickness Tfix,max	t_{fix} = 8 mm
Volume of resin per drill hole	6 ml/3 scale divisions



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Comment

Case Study 03: 21.52mm (TLT) – 1.0x1.40m:

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	60 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-02/0024, Option 1, Issued 02/01/2020

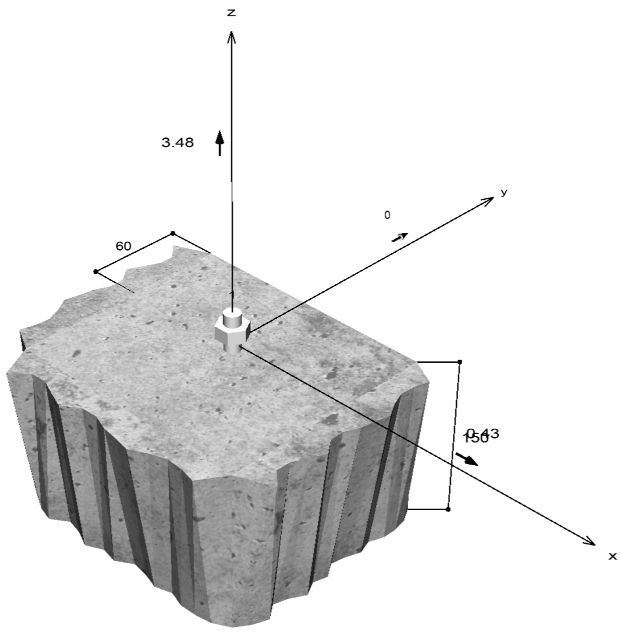
Geometry / Loads / Scale units

mm, kN, kNm

Value of design actions (including

partial safety factor for the load)

Static



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	Non-cracked, dry hole
Temperature range	24 °C long term temperature, 40 °C short term temperature
Reinforcement	Normal or no reinforcement. No edge reinforcement
Drilling method	hammer drilling
Installation type	Push-through installation
Type of loading	Static or quasi-static

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	3.48	0.43	0.00	0.00	0.00	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	3.48	0.43	0.43	0.00

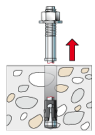
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	3.48	31.33	11.1
Combined pull-out and concrete cone failure	3.48	11.40	**30.5**
Concrete cone failure	3.48	14.00	24.9
Splitting failure	3.48	19.92	17.5

* Most unfavourable anchor

Steel failure

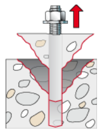
$$N_{Ed} \leq \frac{N_{Rk,s}}{\gamma_{Ms}} \quad (N_{Rd,s})$$



$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
47.00	1.50	31.33	3.48	11.1

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	11.1	1	$\beta_{N,s;1}$

Combined pull-out and concrete cone failure



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

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

$$N_{Rk,p} = 22.81kN \cdot \frac{27{,}000mm^2}{32{,}400mm^2} \cdot 0.900 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 17.11kN$$

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

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

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

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

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

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

$$\Psi_{s,Np} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}} = 0.7 + 0.3 \cdot \frac{60mm}{90mm} = 0.900 \leq 1$$ Eq. (7.20)

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

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

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

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

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

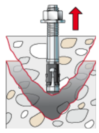
$$\Psi_{ec,Npx} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Npy} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1$$

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

$N_{Rk,p}$ kN	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
17.11	1.50	11.40	3.48	30.5

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	30.5	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)

$$N_{Rk,c} = 28.00kN \cdot \frac{27{,}000mm^2}{32{,}400mm^2} \cdot 0.900 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 21.00kN$$

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

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} = 0.7 + 0.3 \cdot \frac{60mm}{90mm} = 0.900 \leq 1$$ Eq. (7.4)

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

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

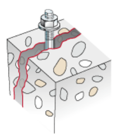
$$\Psi_{ec,Nx} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1$$

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

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
21.00	1.50	14.00	3.48	24.9

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	24.9	1	$\beta_{N,c;1}$

Splitting failure due to loading



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

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

$$N_{Rk,sp} = 22.81kN \cdot \frac{14{,}400mm^2}{14{,}400mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.310 = 29.89kN$$

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,sp}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{60mm}{60mm}\right) = 1.000 \leq 1$$ Eq. (7.4)

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

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

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

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

$$\Psi_{h,sp} = min\Big(\Big(\frac{150mm}{100mm}\Big)^{2/3};max\Big(1; \Big(\frac{60mm+1.5 \cdot 60mm}{100mm}\Big)^{2/3}\Big);2\Big) = 1.310$$

$N_{Rk,sp}$ kN	γ_{Msp}	$N_{Rd,sp}$ kN	N_{Ed} kN	$\beta_{N,sp}$ %
29.89	1.50	19.92	3.48	17.5

Anchor no.	$\beta_{N,sp}$ %	Group N°	Decisive Beta
1	17.5	1	$\beta_{N,sp;1}$

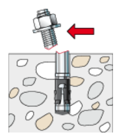
Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	0.43	18.40	2.3
Concrete pry-out failure	0.43	22.81	1.9
Concrete edge failure	0.43	13.65	**3.1**

* Most unfavourable anchor

Steel failure without lever arm

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

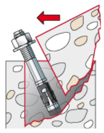


$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 23.00kN = 23.00kN$$ Eq. (7.35)/(7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
23.00	1.25	18.40	0.43	2.3

Anchor no.	β_{Vs} %	Group N°	Decisive Beta
1	2.3	1	$\beta_{Vs;1}$

Concrete pry-out failure



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

$$V_{Rk,cp} = k_8 \cdot N_{Rk,p} = 2 \cdot 17.11kN = 34.21kN$$ Eq. (7.39c)

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

$$N_{Rk,p} = 22.81kN \cdot \frac{27{,}000mm^2}{32{,}400mm^2} \cdot 0.900 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 17.11kN$$

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

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

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

$$\Psi_{s,Np} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}} = 0.7 + 0.3 \cdot \frac{60mm}{90mm} = 0.900 \leq 1$$ Eq. (7.20)

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

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

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

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

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

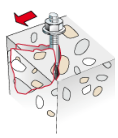
$$\Psi_{ec,Np} = \frac{1}{1 + \frac{2e_n}{s_{cr,Np}}} = \Psi_{ec,Npx} \cdot \Psi_{ec,Npy} = 1.000 \cdot 1.000 = 1.000 \leq 1$$ Eq. (7.21)

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

$V_{Rk,cp}$ kN	γ_{Mcp}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
34.21	1.50	22.81	0.43	1.9

Anchor no.	$\beta_{V,cp}$ %	Group N°	Decisive Beta
1	1.9	1	$\beta_{V,cp;1}$

Concrete edge failure



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

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

$$V_{Rk,c} = 10.24kN \cdot \frac{16{,}200mm^2}{16{,}200mm^2} \cdot 1.000 \cdot 1.000 \cdot 2.000 \cdot 1.000 \cdot 1.000 = 20.48kN$$

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

$$V^0_{Rk,c} = 2.4 \cdot \left(10mm\right)^{0.100} \cdot \left(60mm\right)^{0.070} \cdot \sqrt{30.0N/mm^2} \cdot \left(60mm\right)^{1.5} = 10.24kN$$

$$\alpha = 0.1 \cdot \sqrt{\frac{l_f}{c_1}} = 0.1 \cdot \sqrt{\frac{60mm}{60mm}} = 0.100 \qquad \beta = 0.1 \cdot \left(\frac{d}{c_1}\right)^{0.2} = 0.1 \cdot \left(\frac{10mm}{60mm}\right)^{0.2} = 0.070$$ Eq. (7.42/7.43)

$$\Psi_{s,V} = 0.7 + 0.3 \cdot \frac{c_2}{1.5c_1} = 0.7 + 0.3 \cdot \frac{90mm}{1.5 \cdot 60mm} = 1.000 \leq 1$$ Eq. (7.45)

$$\Psi_{h,V} = max\left(1; \sqrt{\frac{1.5c_1}{h}}\right) = max\left(1; \sqrt{\frac{1.5 \cdot 60mm}{150mm}}\right) = 1.000 \geq 1$$ Eq. (7.46)

$$\Psi_{\alpha,V} = \sqrt{\frac{1}{\left(cos\ \alpha_V\right)^2 + \left(0.5 \cdot sin\ \alpha_V\right)^2}} = \sqrt{\frac{1}{\left(cos\ 90.0\right)^2 + \left(0.5 \cdot sin\ 90.0\right)^2}} = 2.000 \geq 1$$ Eq. (7.48)

$$\Psi_{ec,V} = \frac{1}{1 + \frac{2}{3}\frac{e_v}{c_1}} = \frac{1}{1 + \frac{2 \cdot 0mm}{3 \cdot 60mm}} = 1.000 \leq 1$$ Eq. (7.47)

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

$V_{Rk,c}$ kN	γ_{Mc}	$V_{Rd,c}$ kN	V_{Ed} kN	$\beta_{V,c}$ %
20.48	1.50	13.65	0.43	3.1

Anchor no.	$\beta_{V,c}$ %	Group N°	Decisive Beta
1	3.1	1	$\beta_{V,c;1}$

Utilization of tension and shear loads

Tension loads	Utilisation βN %
Steel failure *	11.1
Combined pull-out and concrete cone failure	**30.5**
Concrete cone failure	24.9
Splitting failure	17.5

Shear Loads	Utilisation βV %
Steel failure without lever arm *	2.3
Concrete pry-out failure	1.9
Concrete edge failure	**3.1**

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.11 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.02 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.01 \leq 1$$ Eq. (7.55)

Proof successful

Utilisation concrete

$$\beta_{N,p} = \beta_{N,p;1} = 0.31 \leq 1$$
$$\beta_{V.c} = \beta_{V,c;1} = 0.03 \leq 1$$
$$\beta_N^{1.5} + \beta_V^{1.5} = \beta_{N,p;1}^{1.5} + \beta_{V,c;1}^{1.5} = 0.17 \leq 1$$ Eq. (7.56)

Information concerning the anchor plate

No plate

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.

fischer
innovative solutions

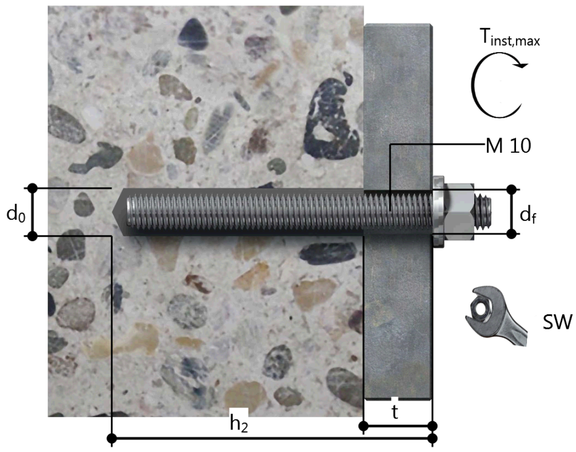
Installation data

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
	Cleaning brush BS 12	Art.-No. 78179
	SDS Plus II 12/100/160	Art.-No. 531803
	or alternatively	
	FHD 12/200/330	Art.-No. 546597
	Hammer drilling with or without suction	

Installation details

Thread diameter	M 10
Drill hole diameter	d_0 = 12 mm
Drill hole depth	h_2 = 68 mm
Calculated anchorage depth	h_{ef} = 60 mm
Drilling method	hammer drilling
Drill hole cleaning	4 times blowing, 4 times brushing, 4 times blowing required activities according the given instruction in the approval No borehole cleaning required in case of using a hollow drill bit, e.g. fischer FHD.
Installation type	Push-through installation
Maximum torque	$T_{inst,max}$ = 20.0 Nm
Socket size	17 mm
Total fixing thickness Tfix,max	t_{fix} = 8 mm
Volume of resin per drill hole	6 ml/3 scale divisions



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Comment

Case Study 04: 15mm Tough – 1.166x1.192m:

Design Specifications

Anchor

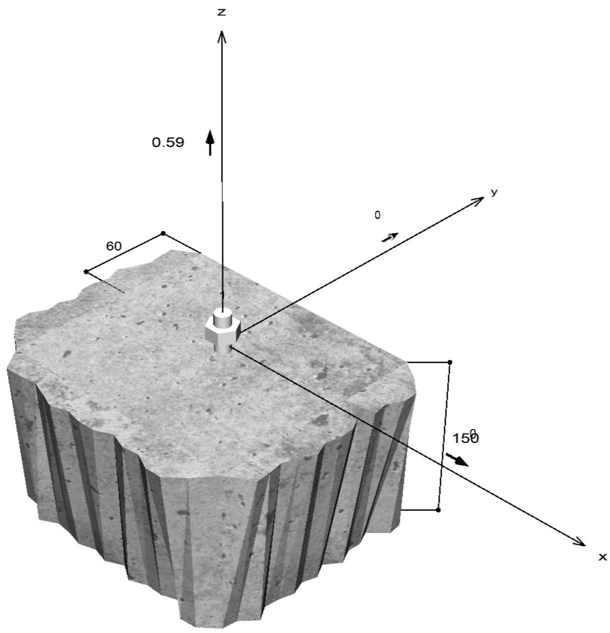
Anchor system	fischer Injection system FIS V
Injection resin	FIS V 360 S
Fixing element	Threaded rod FIS A M 10 x 150 8.8, zinc plated steel, property class 8.8
Calculated anchorage depth	60 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-02/0024, Option 1, Issued 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	Non-cracked, dry hole
Temperature range	24 °C long term temperature, 40 °C short term temperature
Reinforcement	Normal or no reinforcement. No edge reinforcement
Drilling method	hammer drilling
Installation type	Push-through installation
Type of loading	Static or quasi-static

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	0.59	0.00	0.00	0.00	0.00	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	0.59	0.00	0.00	0.00

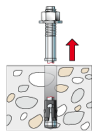
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	0.59	31.33	1.9
Combined pull-out and concrete cone failure	0.59	11.40	**5.2**
Concrete cone failure	0.59	14.00	4.2
Splitting failure	0.59	19.92	3.0

* Most unfavourable anchor

Steel failure

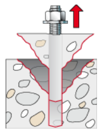
$$N_{Ed} \le \frac{N_{Rk,s}}{\gamma_{Ms}} \quad (N_{Rd,s})$$



$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
47.00	1.50	31.33	0.59	1.9

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	1.9	1	$\beta_{N,s;1}$

Combined pull-out and concrete cone failure



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

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

$$N_{Rk,p} = 22.81kN \cdot \frac{27{,}000mm^2}{32{,}400mm^2} \cdot 0.900 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 17.11kN$$

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

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

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

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

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

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

$$\Psi_{s,Np} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}} = 0.7 + 0.3 \cdot \frac{60mm}{90mm} = 0.900 \leq 1$$ Eq. (7.20)

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

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

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

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

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

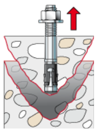
$$\Psi_{ec,Npx} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Npy} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1$$

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

$N_{Rk,p}$ kN	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
17.11	1.50	11.40	0.59	5.2

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	5.2	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)

$$N_{Rk,c} = 28.00kN \cdot \frac{27{,}000mm^2}{32{,}400mm^2} \cdot 0.900 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 21.00kN$$

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

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} = 0.7 + 0.3 \cdot \frac{60mm}{90mm} = 0.900 \leq 1$$ 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)

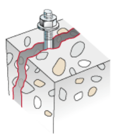
$$\Psi_{ec,Nx} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1 + \frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1$$

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

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
21.00	1.50	14.00	0.59	4.2

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

Splitting failure due to loading



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

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

$$N_{Rk,sp} = 22.81kN \cdot \frac{14{,}400mm^2}{14{,}400mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.310 = 29.89kN$$

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,sp}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{60mm}{60mm}\right) = 1.000 \leq 1$$ Eq. (7.4)

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

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

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

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

$$\Psi_{h,sp} = min\Big(\Big(\frac{150mm}{100mm}\Big)^{2/3} ;max\Big(1; \Big(\frac{60mm+1.5 \cdot 60mm}{100mm}\Big)^{2/3}\Big);2\Big) = 1.310$$

$N_{Rk,sp}$ kN	γ_{Msp}	$N_{Rd,sp}$ kN	N_{Ed} kN	$\beta_{N,sp}$ %
29.89	1.50	19.92	0.59	3.0

Anchor no.	$\beta_{N,sp}$ %	Group N°	Decisive Beta
1	3.0	1	$\beta_{N,sp;1}$

Resistance to combined tensile and shear loads

$$\beta_N = \beta_{N,p;1} = 0.05 \leq 1$$

Proof successful

Information concerning the anchor plate

No plate

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.

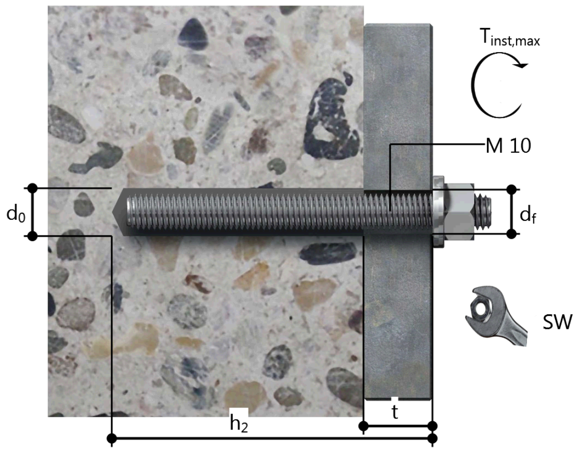
Installation data

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
	Cleaning brush BS 12	Art.-No. 78179
	SDS Plus II 12/100/160	Art.-No. 531803
	or alternatively	
	FHD 12/200/330	Art.-No. 546597
	Hammer drilling with or without suction	

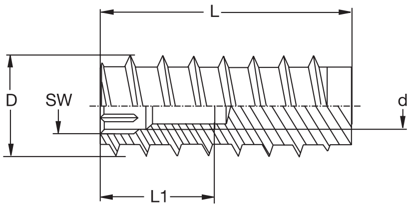
Installation details

Thread diameter	M 10
Drill hole diameter	d_0 = 12 mm
Drill hole depth	h_2 = 68 mm
Calculated anchorage depth	h_{ef} = 60 mm
Drilling method	hammer drilling
Drill hole cleaning	4 times blowing, 4 times brushing, 4 times blowing required activities according the given instruction in the approval No borehole cleaning required in case of using a hollow drill bit, e.g. fischer FHD.
Installation type	Push-through installation
Maximum torque	$T_{inst,max}$ = 20.0 Nm
Socket size	17 mm
Total fixing thickness Tfix,max	t_{fix} = 8 mm
Volume of resin per drill hole	6 ml/3 scale divisions



Appendix B – Rampa

TSA is Specifier of the Fixings



RAMPA®-Muffen Typ SKL
mit Innensechskant und Sacklochgewinde, leichtes Einschrauben durch schlanke Flanken am Außengewinde und den Führungsansatz

RAMPA®-inserts type SKL
with hex socket drive and threaded blind hole, easy assembly by means of slim flanks and the unthreaded lead support

SKL

Art.	D	L	d	SW HD	L1	Vorbohrung* Pilot hole*	CE 1034 ETA	Stahl verzinkt Steel zinc plated	Stahl rostfrei Stainless steel 1.4305	Stahl rostfrei Stainless steel 1.4571
011 625 ___	12	25	M 6	6	18	9,0 – 9,5	•	•		
011 630 ___	12	30	M 6	6	20	9,0 – 9,5	•	•		
011 640 ___	12	40	M 6	6	20	9,0 – 9,5	•	•		
011 650 ___	12	50	M 6	6	21	9,0 – 9,5	•	•	•	•
011 660 ___	12	60	M 6	6	21	9,0 – 9,5	•	•	•	•
011 680 ___	12	80	M 6	6	21	9,0 – 9,5	•	•	•	•
011 830 ___	16	30	M 8	8	20	12,5 – 13,0	•	•		
011 840 ___	16	40	M 8	8	22	12,5 – 13,0	•	•		
011 850 ___	16	50	M 8	8	22	12,5 – 13,0	•	•		
011 860 ___	16	60	M 8	8	22	12,5 – 13,0	•	•		
011 870 ___	16	70	M 8	8	22	12,5 – 13,0	•	•		
011 880 ___	16	80	M 8	8	23	12,5 – 13,0	•	•	•	•
011 800 ___	16	100	M 8	8	23	12,5 – 13,0	•	•	•	•
011 130 ___	18,5	30	M 10	10	21	15,0 – 15,5	•	•		
011 140 ___	18,5	40	M 10	10	21	15,0 – 15,5	•	•		
011 150 ___	18,5	50	M 10	10	21	15,0 – 15,5	•	•		
011 160 ___	18,5	60	M 10	10	21	15,0 – 15,5	•	•		
011 170 ___	18,5	70	M 10	10	21	15,0 – 15,5	•	•		
011 180 ___	18,5	80	M 10	10	23	15,0 – 15,5	•	•		
011 100 ___	18,5	100	M 10	10	23	15,0 – 15,5	•	•		
011 260 ___	22	60	M 12	12	25	18,5 – 19,0	•	•		
011 280 ___	22	80	M 12	12	25	18,5 – 19,0	•	•		
011 210 ___	22	100	M 12	12	25	18,5 – 19,0	•	•		
011 661 ___	25	60	M 16	14	25	21,5 – 22,0	•	•		
011 681 ___	25	80	M 16	14	25	21,5 – 22,0	•	•		
011 601 ___	25	100	M 16	14	25	21,5 – 22,0	•	•		
Bitte ergänzen für / Please complete for							CE 1034	601	63	67

*Hinweis: Bei Weichholz bitte den geringeren Vorbohrdurchmesser verwenden
*Please note: for softwood please use the lower pilot hole value

Mehr Informationen zur ETA 12/0481

More information about ETA 12/0481