TSA
TED SINGLETON & ASSOCIATES
CONSULTING ENGINEERS

Project: TL 4010	Contract: 1388-2
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

1388-2 TL 4010

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 Glass Ltd to provide a matrix of wind load for the TL 4010 type shoe.

Actions:

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 (mm)	Interlayer	Wind Load - Qw (kN/m)	Height glass (m)	Glass Deflection (mm)
1	15		1.00	1.25	10.52
2	17.52	PVB	1.00	1.25	10.57
3	21.52	PVB	1.50	1.25	8.982
4	21.52	PVB	2.00	1.25	11.98

Connection To Concrete - TL4010					
Case Study	Fischer	Shear (kN)	Moment (kNm)	Holes Space (mm)	Edge (mm)
1 and 2	FIS AM M10x150	1.13	0.70	600	60
3	FIS AM M10x150	1.69	1.05	600	65
4	FIS AM M10x150	1.50	0.94	400	60

Connection To Mild Steel		
Case Study	Fischer	Holes Space
1, 2, 3 and 4	M12×40 Grade 8.8 hex head	600mm

Connection To Wood		
Case Study	Fischer	Holes Space
1, 2, 3 and 4	RAMPA®-inserts type SKL M12x60	400mm

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Project: TL 4010	Contract: 1388-2
Subject: General Wind Load	Sheet No. 5
Date: 08/05/2020	By: R.F.

Glass Strength

Wind Loading:

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

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

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

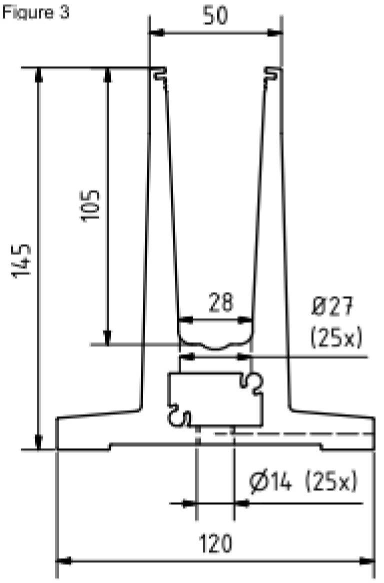
$\underline{f_{gd} = 83.3N/mm^2}$

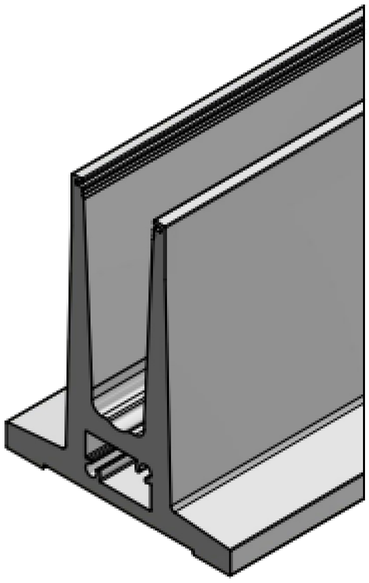
Project: TL 4010	**Contract:** 1388-2
Subject: General Wind Load	**Sheet No.** 6
Date: 08/05/2020	**By:** R.F.

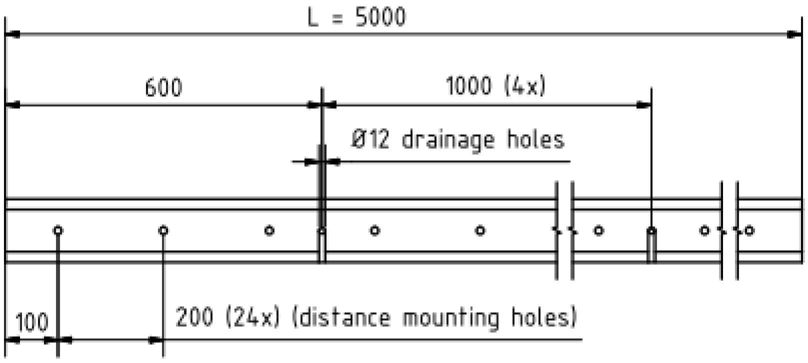
System Sketch:

Shoe TL 4010:

Figure 3







Material: Aluminum 6063-T6

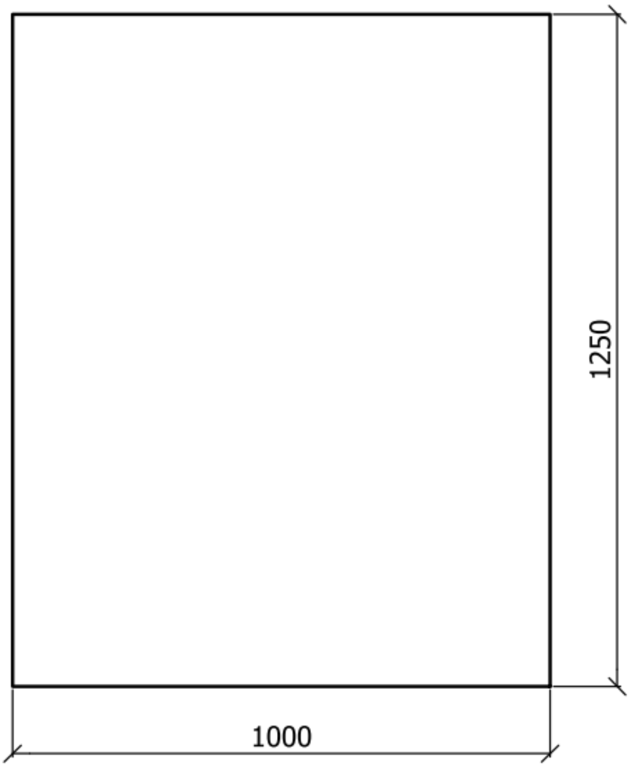
Project: TL 4010	Contract: 1388-2
Subject: General Wind Load	Sheet No. 7
Date: 08/05/2020	By: R.F.

Case Study 01: 15mm Tough – 1.0x1.25m – $1.0 kN/m^2$:

Case Study 02: 17.52mm (TLT) – 1.0x1.25m – $1.0 kN/m^2$:

Case Study 03: 21.52mm (TLT) – 1.0x1.25m – $1.5 kN/m^2$:

Case Study 04: 21.52mm (TLT) – 1.0x1.25m – $2.0 kN/m^2$:



NOTE:

All deflection < 25mm and therefore acceptable.

Glass Analysis:

Case Study 01: 15mm Tough – 1.0x1.25m – 1.0kN/m^2:

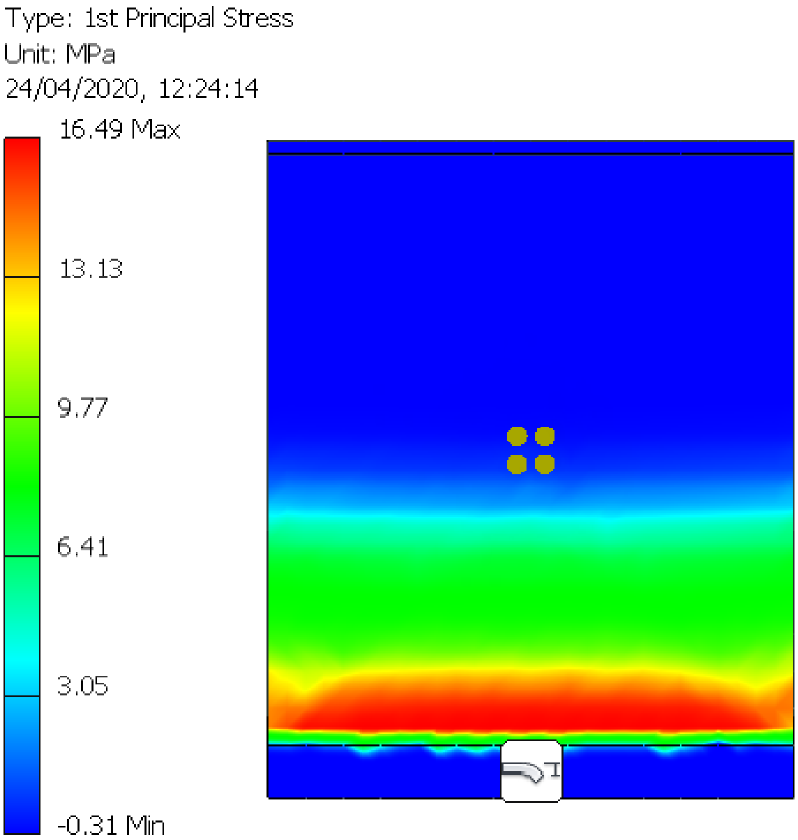
Glass Analysis - Bending Stress of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0N/m2 Infill Loading
- 15mm Tough Glass analysed, horizontally toughened Laminated
- Bending Stress analysed based on glass panel of 1.0m x 1.25m

Result:

Max. Bending Stress = 16.49N/mm^2 x1.5 = 24.74N/mm^2 < 83.3N/mm^2

OK in Bending



Project: TL 4010	Contract: 1388-2
Subject: General Wind Load	Sheet No. 9
Date: 08/05/2020	By: R.F.

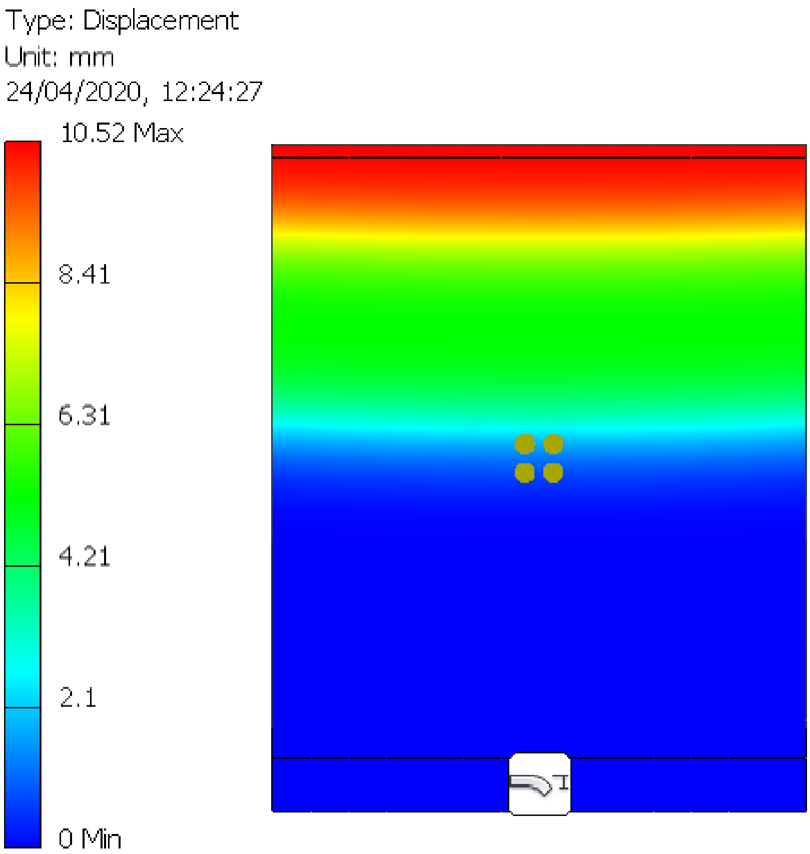
Glass Analysis - Deflection of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0kN/m2 Infill Loading
- 15mm Tough Glass analysed, horizontally toughened Laminated
- Deflection analysed based on glass panel of 1.0m x 1.25m

Result:

Max. Deflection = 10.52mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Project: TL 4010	**Contract:** 1388-2
Subject: General Wind Load	**Sheet No.** 10
Date: 08/05/2020	**By:** R.F.

Case Study 02: 17.52mm (TLT) – 1.0x1.25m – 1.0kN/m^2:

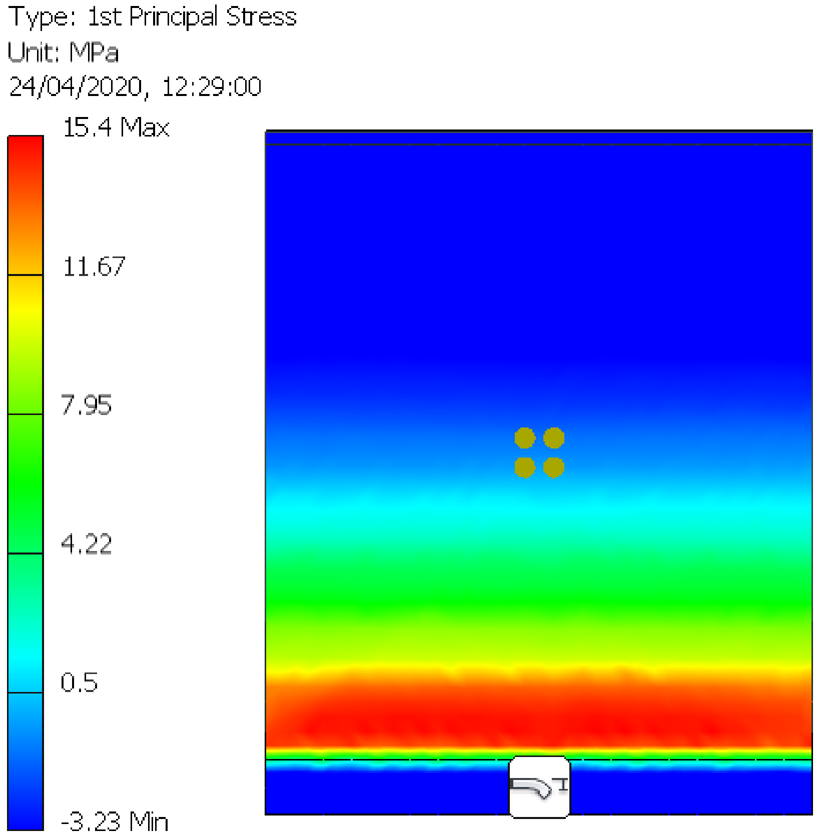
Glass Analysis - Bending Stress of Glass Panel due to 1.0kN/m2 Infill Loading:

- 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 1.25m

Result:

Max. Bending Stress = 15.40N/mm^2 x1.5 = 23.10N/mm^2 < 83.3N/mm^2

OK in Bending



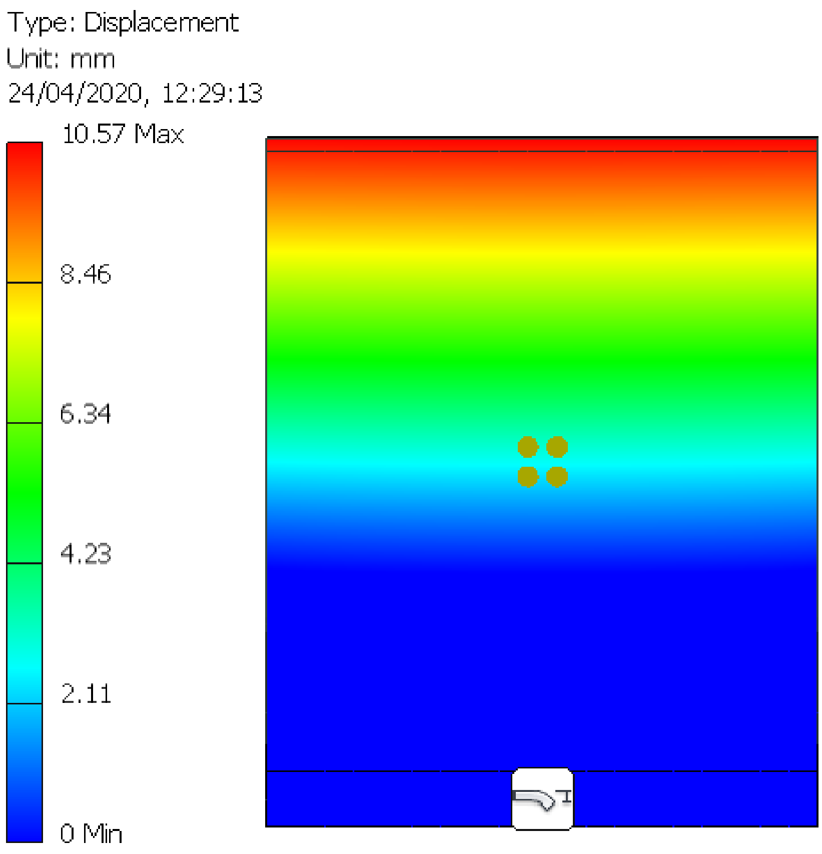
Glass Analysis - Deflection of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0N/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 1.25m

<u>Result:</u>

Max. Deflection = 10.57mm < 25mm {BS6180:2011 cl. 6.4.1}

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



Project: TL 4010	Contract: 1388-2
Subject: General Wind Load	Sheet No. 12
Date: 08/05/2020	By: R.F.

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Case Study 03: 21.52mm (TLT) – 1.0x1.25m – $1.5kN/m^2$:

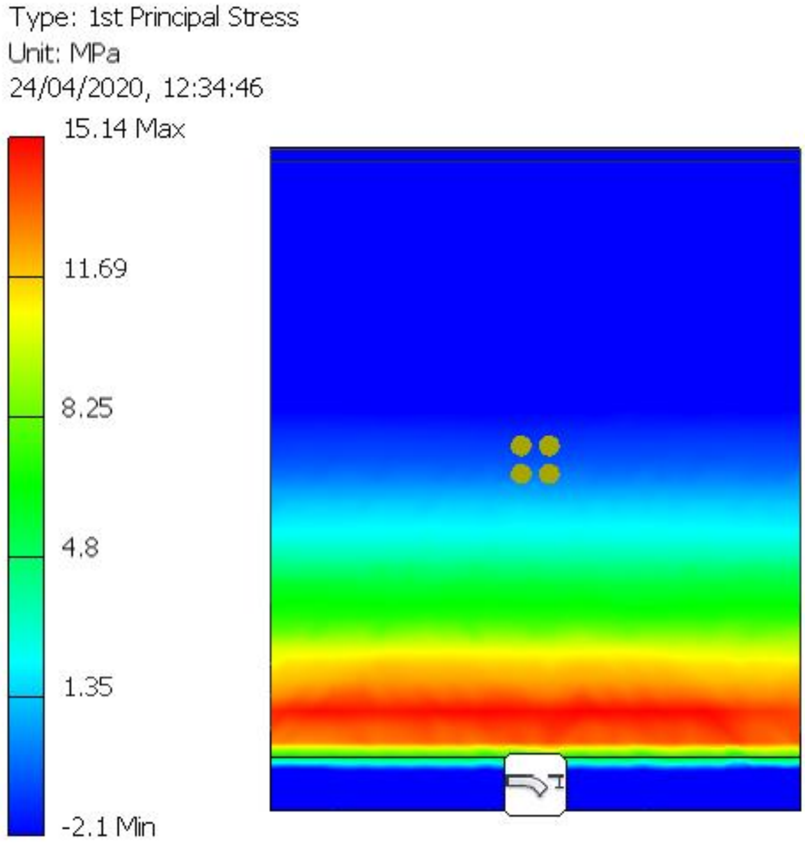
Glass Analysis - Bending Stress of Glass Panel due to 1.5kN/m2 Infill Loading:

- 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 1.25m

Result:

Max. Bending Stress = $15.14N/mm^2$ x1.5 = $22.71N/mm^2$ < $83.3N/mm^2$

OK in Bending



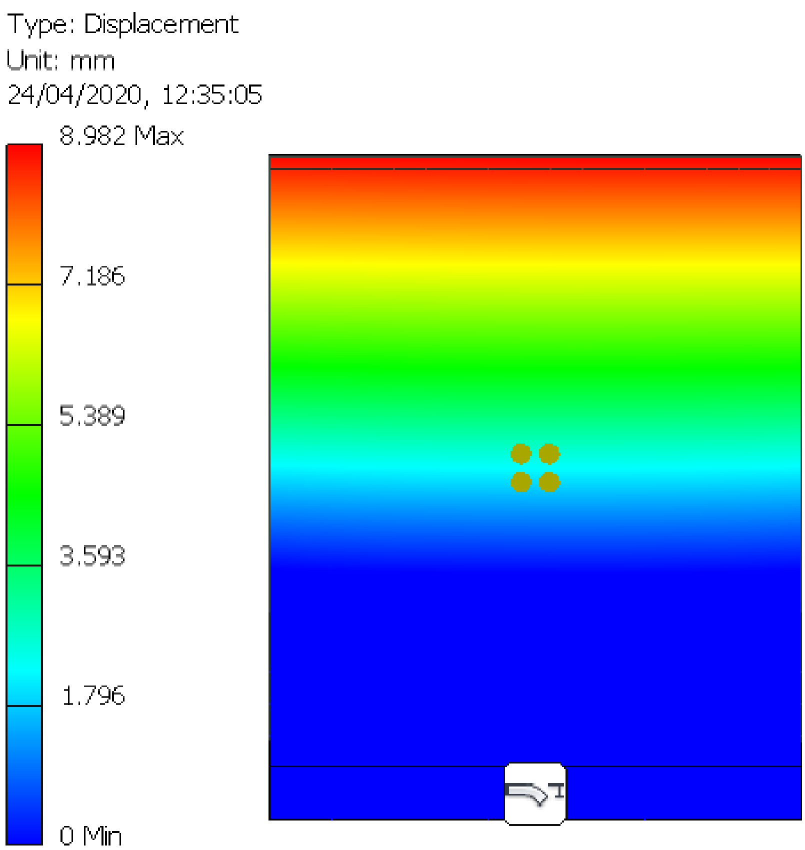
Glass Analysis - Deflection of Glass Panel due to 1.5kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.5kN/m2 Infill Loading
- 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 1.25m

Result:

Max. Deflection = 8.982mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Project: TL 4010	Contract: 1388-2
Subject: General Wind Load	Sheet No. 14
Date: 08/05/2020	By: R.F.

Case Study 04: 21.52mm (TLT) – 1.0x1.25m – $2.0\mathrm{kN/m^2}$:

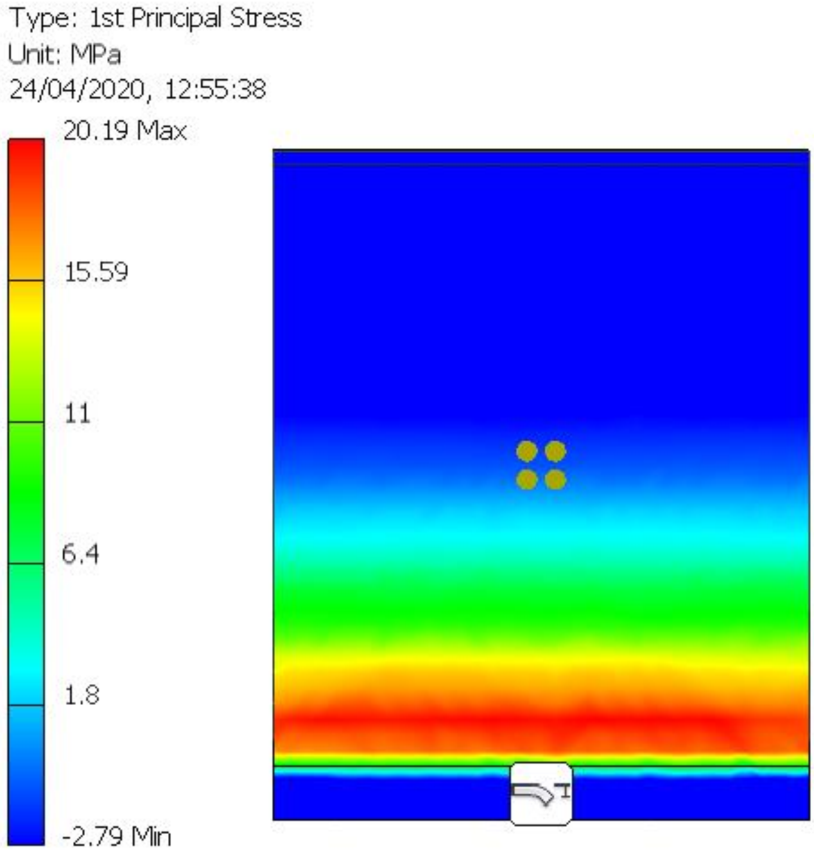
Glass Analysis - Bending Stress of Glass Panel due to 2.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 2.0kN/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 1.25m

Result:

Max. Bending Stress = 20.19N/mm^2 x1.5 = 30.29N/mm^2 < 83.3N/mm^2

OK in Bending



Project: TL 4010	Contract: 1388-2
Subject: General Wind Load	Sheet No. 15
Date: 08/05/2020	By: R.F.

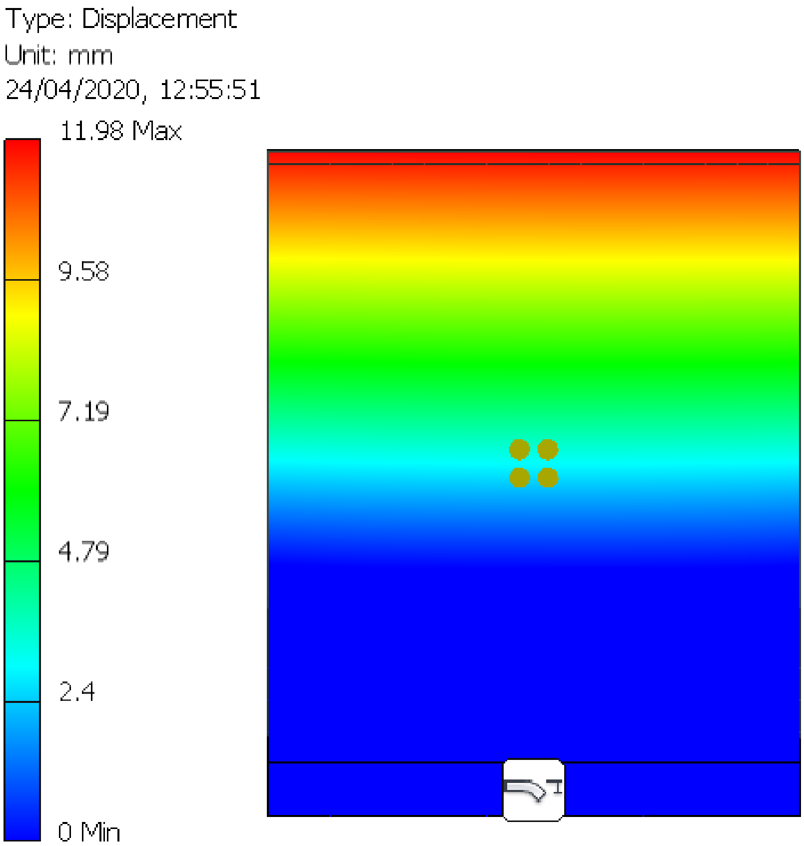
Glass Analysis - Deflection of Glass Panel due to 2.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 2.0kN/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 1.25m

Result:

Max. Deflection = 11.98mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Connection Design:

Case Study 01 and 02: 15mm Tough and 17.52mm (TLT) – 1.0x1.25m – $1.0\mathrm{kN/m^2}$:

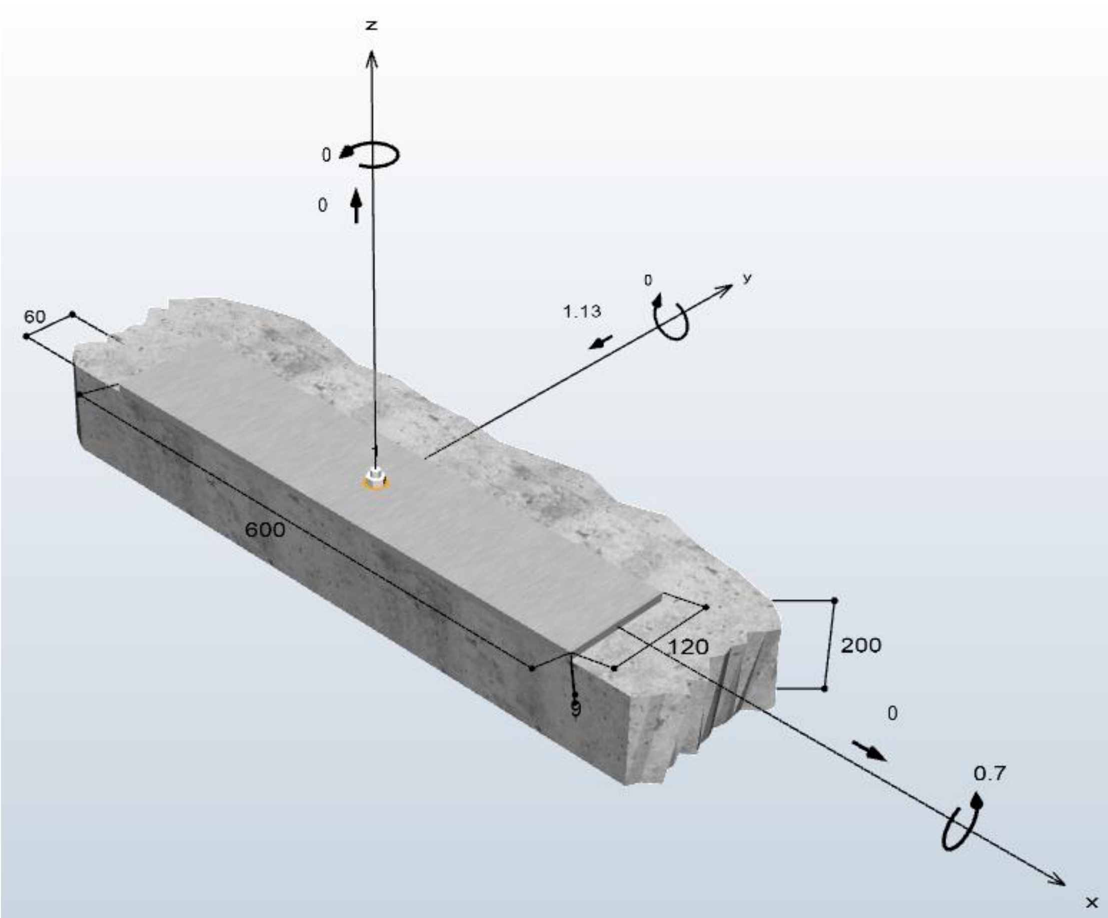
Connection To Concrete:

$$\text{Shear Load} = 1.0\mathrm{kN/m^2} \times 0.6\mathrm{m} \times 1.25\mathrm{m} \times 1.5 = 1.13\mathrm{kN(ULS)}$$

$$\text{Moment} = 1.13\mathrm{kN} \times (1.25\mathrm{m}\ /\ 2) = 0.70\mathrm{kN\ m(ULS)}$$

Therefore use 1 Nr Anchor FIS AM M10x150 @600mm C/C.

See design in Appendix A.



Connection To Mild Steel:

1Nr M12 Bolt Grade 8.8

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

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

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

$A = 84.3mm^2$ *(For M12 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.*

$$\mathrm{F_{t,Ed}} = \frac{\frac{1.0\mathrm{kN}}{\mathrm{m}^2}\times 1.5\times 1.25\mathrm{m}\times 1.0\mathrm{m}\times 0.6\times \frac{1.25\mathrm{m}}{2}}{0.060} = 11.72\mathrm{kN}$$

$$\mathrm{F_{t,Rd}} = \frac{\mathrm{K_2 F_{ub} A}}{\lambda\mathrm{m2}} \rightarrow \mathrm{F_{t,Rd}} = \frac{0.9\times 800\times 84.3\times 10^{-3}}{1.25} = 48\mathrm{kN} > 11.72\mathrm{kN}$$ **Okay**

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

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

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

$$\mathrm{F_{V,Ed}} = \frac{1.0\mathrm{kN}}{\mathrm{m}^2}\times 1.5\times 0.6\times\ 1.25\mathrm{m}\times\ 1.0\mathrm{m} = 1.13\mathrm{kN}$$

$$\mathrm{F_{V,Rd}} = \frac{\alpha\mathrm{F_{ub}A}}{\lambda\mathrm{m2}} \rightarrow \mathrm{F_{V,Rd}} = \frac{0.6\times 84.3\times 800\times 10^{-3}}{1.25} = 32\mathrm{kN} > 1.13\mathrm{kN}$$ **Okay**

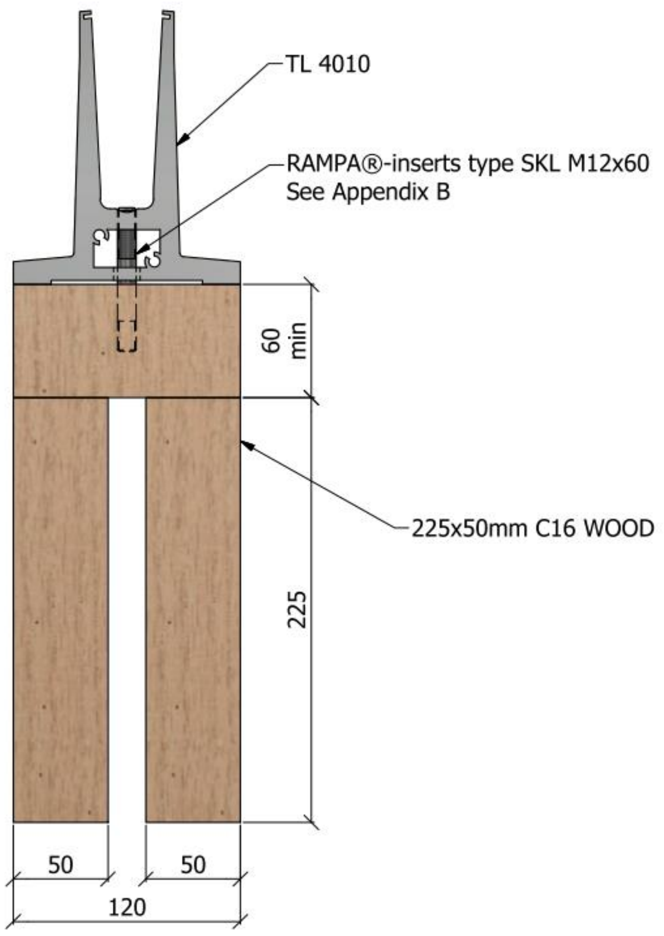
Combined Shear & Tensile Resistance Check: *(Table 3.4 EN 1993-1-8:2005)*

$$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1.4F_{t,Rd}} \leq 1 \rightarrow \frac{1.13}{32} + \frac{11.72}{1.4\times 48} = 0.21 \leq 1$$ **Okay**

Therefore, use 1Nr M12×40 Grade 8.8 hex head Bolts at 600mm C/C.

Project: TL 4010	Contract: 1388-2
Subject: General Wind Load	Sheet No. 18
Date: 08/05/2020	By: R.F.

Connection To Wood:



Suggested Fixing to Wood

Therefore, use RAMPA®-inserts type SKL M12x60 at 400mm C/C.

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Project: TL 4010	Contract: 1388-2
Subject: General Wind Load	Sheet No. 19
Date: 08/05/2020	By: R.F.

Case Study 03: 21.52mm (TLT) – 1.0x1.25m – 1.5kN/m^2:

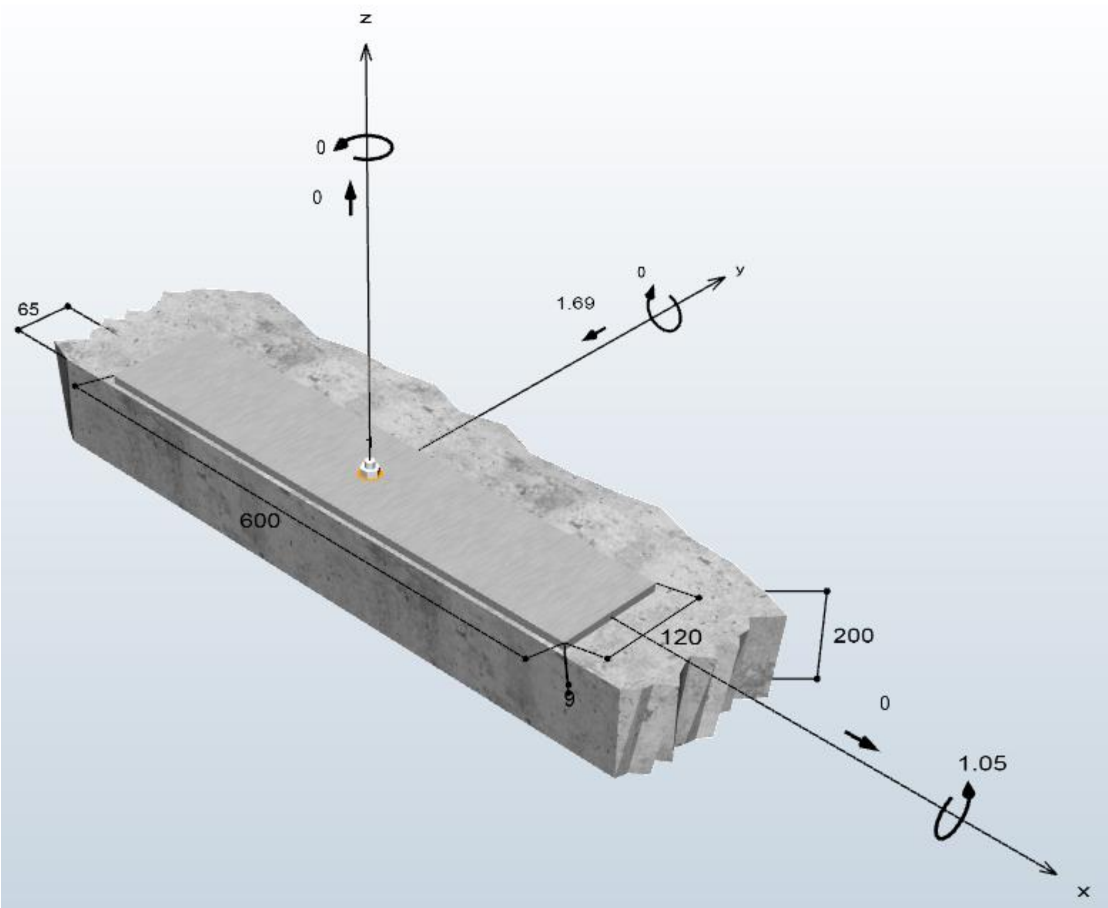
Connection To Concrete:

$\text{Shear Load} = 1.5\text{kN/m}^2 \times 0.6\text{m} \times 1.25\text{m} \times 1.5 = 1.69\text{kN(ULS)}$

$\text{Moment} = 1.69\text{kN} \times (1.25\text{m} / 2) = 1.05\text{kN m(ULS)}$

Therefore use 1 Nr Anchor FIS AM M10x150 @600mm C/C.

See design in Appendix A.



Project: TL 4010	Contract: 1388-2
Subject: General Wind Load	Sheet No. 20
Date: 08/05/2020	By: R.F.

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Connection To Mild Steel:

1Nr M12 Bolt Grade 8.8

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

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

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

$A = 84.3mm^2$ *(For M12 Bolts)*

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

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

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

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

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

$$F_{t,Ed} = \frac{\frac{1.5kN}{m^2} \times 1.5 \times 1.25m \times 1.0m \times 0.6 \times \frac{1.25m}{2}}{0.060} = 17.58kN$$

$$F_{t,Rd} = \frac{K_2 F_{ub} A}{\lambda m2} \rightarrow F_{t,Rd} = \frac{0.9 \times 800 \times 84.3 \times 10^{-3}}{1.25} = 48kN > 17.58kN$$ **Okay**

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

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

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

$$F_{V,Ed} = \frac{1.5kN}{m^2} \times 1.5 \times 0.6 \times 1.25m \times 1.0m = 1.69kN$$

$$F_{V,Rd} = \frac{\alpha F_{ub} A}{\lambda m2} \rightarrow F_{V,Rd} = \frac{0.6 \times 84.3 \times 800 \times 10^{-3}}{1.25} = 32kN > 1.69kN$$ **Okay**

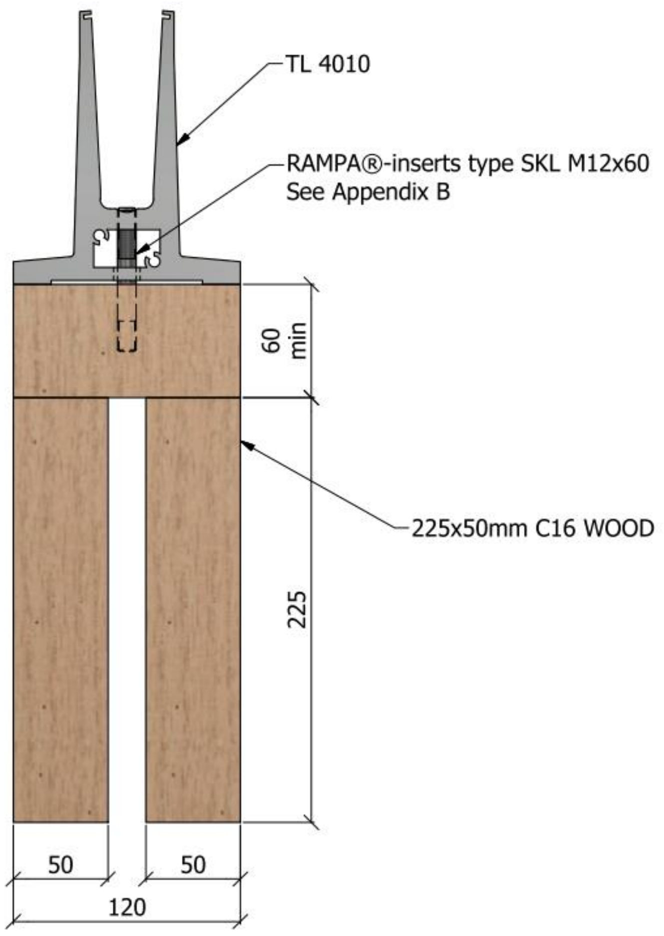
Combined Shear & Tensile Resistance Check: *(Table 3.4 EN 1993-1-8:2005)*

$$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1.4F_{t,Rd}} \leq 1 \rightarrow \frac{1.69}{32} + \frac{17.58}{1.4 \times 48} = 0.31 \leq 1$$ **Okay**

Therefore, use 1Nr M12×40 Grade 8.8 hex head Bolts at 600mm C/C.

Project: TL 4010	Contract: 1388-2
Subject: General Wind Load	Sheet No. 21
Date: 08/05/2020	By: R.F.

Connection To Wood:



Suggested Fixing to Wood

Therefore, use RAMPA®-inserts type SKL M12x60 at 400mm C/C.

Case Study 04: 21.52mm (TLT) – 1.0x1.25m – 2.0kN/m^2:

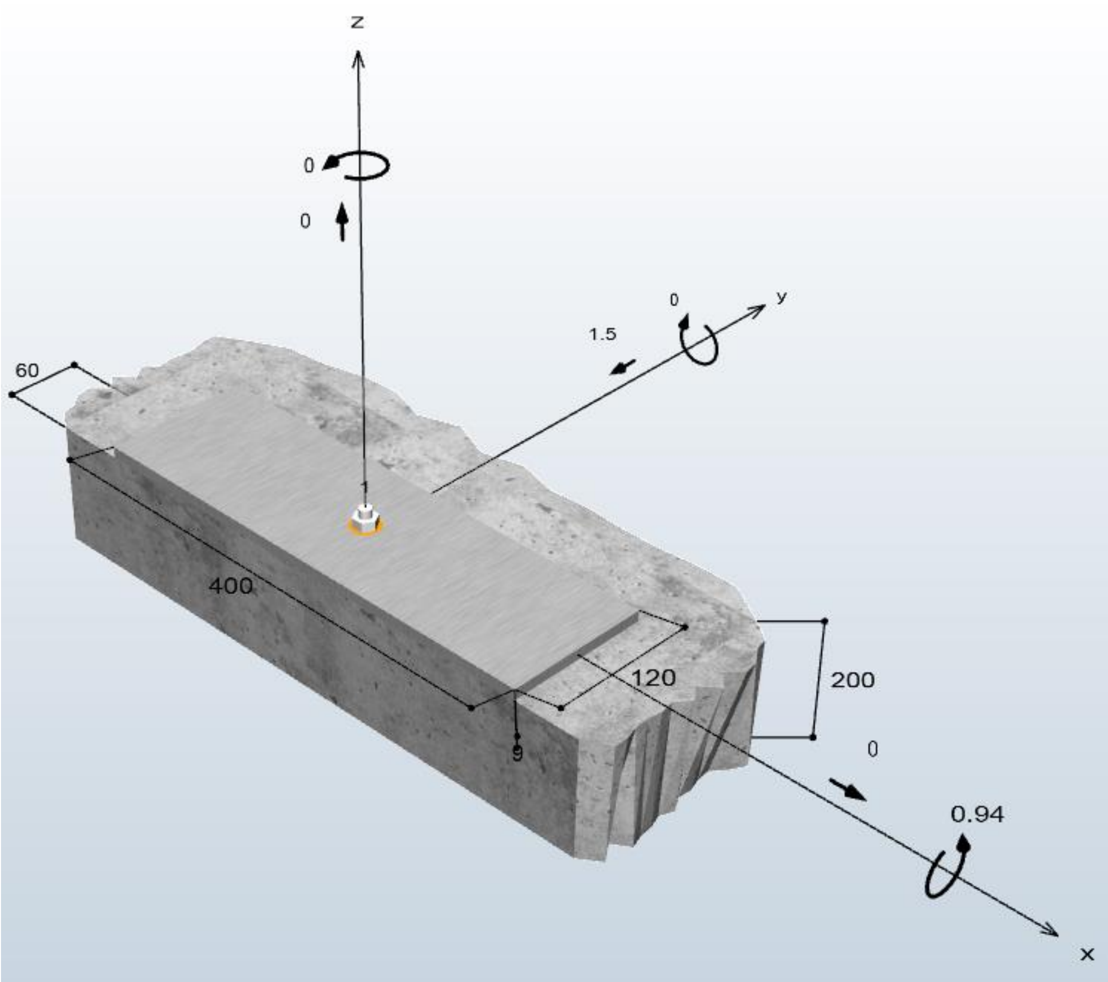
Connection To Concrete:

$$\text{Shear Load} = 2.0\text{kN/m}^2 \times 0.4\text{m} \times 1.25\text{m} \times 1.5 = 1.50\text{kN(ULS)}$$

$$\text{Moment} = 1.50\text{kN} \times (1.25\text{m} / 2) = 0.94\text{kN m(ULS)}$$

Therefore use 1 Nr Anchor FIS AM M10x150 @400mm C/C.

See design in Appendix A.



Connection To Mild Steel:

1Nr M12 Bolt Grade 8.8

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

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

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

$A = 84.3mm^2$ *(For M12 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.*

$$\mathrm{F_{t,Ed}} = \frac{\frac{2.0\mathrm{kN}}{\mathrm{m^2}}\times 1.5\times 1.25\mathrm{m}\times 1.0\mathrm{m}\times 0.6\times \frac{1.25\mathrm{m}}{2}}{0.060} = 23.44\mathrm{kN}$$

$$\mathrm{F_{t,Rd}} = \frac{\mathrm{K_2 F_{ub} A}}{\lambda \mathrm{m2}} \rightarrow \mathrm{F_{t,Rd}} = \frac{0.9\times 800\times 84.3\times 10^{-3}}{1.25} = 48\mathrm{kN} > 23.44\mathrm{kN}$$ **Okay**

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

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

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

$$\mathrm{F_{V,Ed}} = \frac{2.0\mathrm{kN}}{\mathrm{m^2}} \times 1.5 \times 0.6 \times 1.25\mathrm{m} \times 1.0\mathrm{m} = 2.25\mathrm{kN}$$

$$\mathrm{F_{V,Rd}} = \frac{\alpha \mathrm{F_{ub} A}}{\lambda \mathrm{m2}} \rightarrow \mathrm{F_{V,Rd}} = \frac{0.6\times 84.3\times 800\times 10^{-3}}{1.25} = 32\mathrm{kN} > 2.25\mathrm{kN}$$ **Okay**

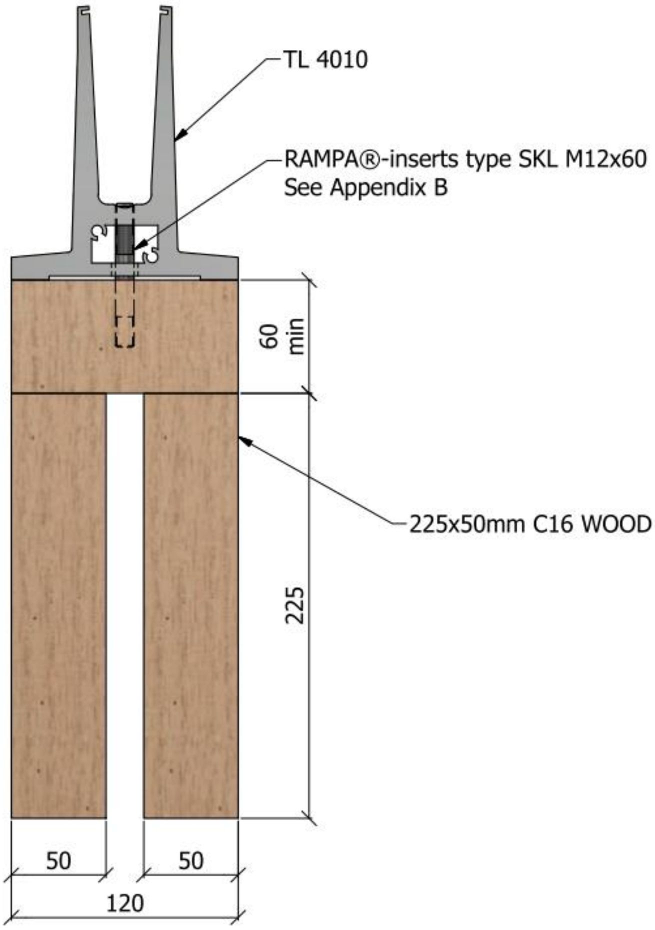
Combined Shear & Tensile Resistance Check: *(Table 3.4 EN 1993-1-8:2005)*

$$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1.4F_{t,Rd}} \leq 1 \rightarrow \frac{2.25}{32} + \frac{23.44}{1.4\times 48} = 0.42 \leq 1$$ **Okay**

Therefore, use 1Nr M12×40 Grade 8.8 hex head Bolts at 600mm C/C.

Project: TL 4010	Contract: 1388-2
Subject: General Wind Load	Sheet No. 24
Date: 08/05/2020	By: R.F.

Connection To Wood:



Suggested Fixing to Wood

Therefore, use RAMPA®-inserts type SKL M12x60 at 400mm C/C.

Appendix A - Fischer Reports

TSA is Both the Designer and the Specifier of the Fixings innovative solutions

MASONRY FIXINGS

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

Comment

Case Study 01 and 02 - 1.0kNm2 Wind Load @200 - TL 4010

Design Specifications

Anchor

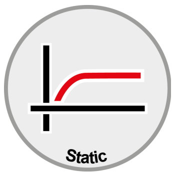
Anchor system	fischer Injection system FIS V
Injection resin	FIS V 360 S
Fixing element	Threaded rod FIS A M 10 x 150 8.8, zinc plated steel, property class 8.8
Calculated anchorage depth	71 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-02/0024, Option 1, Issued 02/01/2020

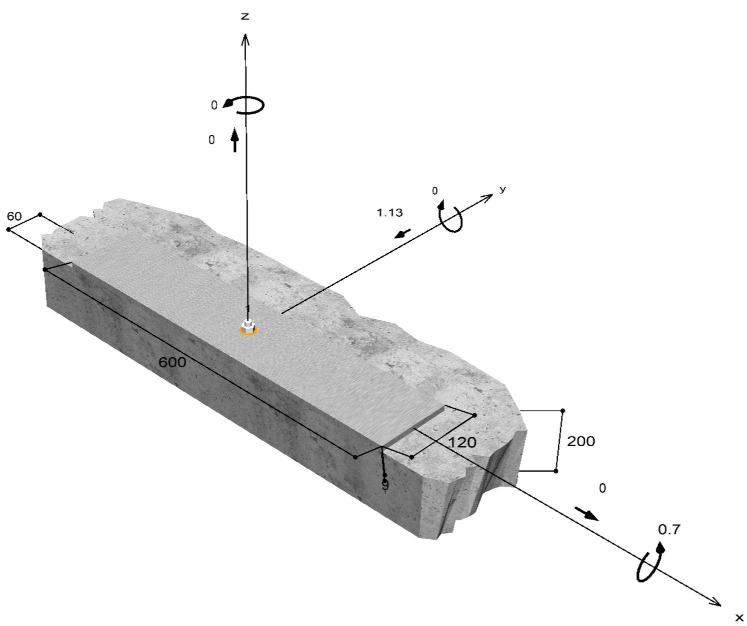
Geometry / Loads / Scale units

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
Annular gap	Annular gap filled
Type of loading	Static or quasi-static
Base plate location	Base plate flush installed on base material
Base plate geometry	600 mm x 120 mm x 9 mm
Profile type	None

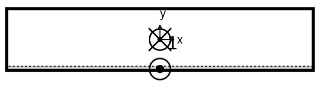
Design actions *)

#	N_{Ed} kN	$V_{Ed,x}$ kN	$V_{Ed,y}$ kN	$M_{Ed,x}$ kNm	$M_{Ed,y}$ kNm	$M_{T,Ed}$ kNm	Type of loading
1	0.00	0.00	-1.13	0.70	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	12.21	1.13	0.00	-1.13



max. concrete compressive strain : 0.15 ‰
max. concrete compressive stress : 5.1 N/mm²
Resulting tensile actions : 12.21 kN , X/Y position (0 / 0)
Resulting compression actions : 12.21 kN , X/Y position (0 / -57)

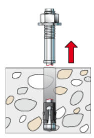
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	12.21	31.33	39.0
Combined pull-out and concrete cone failure	12.21	12.22	**99.9**
Concrete cone failure	12.21	16.32	74.8
Splitting failure	12.21	21.60	56.5

* Most unfavourable anchor

Steel failure

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

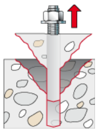


$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
47.00	1.50	31.33	12.21	39.0

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	39.0	1	$\beta_{N,s;1}$

Combined pull-out and concrete cone failure

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



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

$$N_{Rk,p} = 26.99kN \cdot \frac{35{,}465mm^2}{45{,}369mm^2} \cdot 0.869 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 18.33kN$$

$$N^0_{Rk,p} = \Psi_{sus} \cdot \pi \cdot d \cdot h_{ef} \cdot \tau_{Rk} = 1.00 \cdot \pi \cdot 10mm \cdot 71mm \cdot 12.1N/mm^2 = 26.99kN$$ 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)

$$s_{cr,Np} = min\left(7.3 \cdot 10mm \cdot \left(1.00 \cdot 11.0N/mm^2\right)^{0.5}; 3 \cdot 71mm\right) = 213mm$$

$$c_{cr,Np} = \frac{S_{cr,Np}}{2} = \frac{213mm}{2} = 107mm$$ Eq. (7.16)

$$\Psi_{s,Np} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}} = 0.7 + 0.3 \cdot \frac{60mm}{107mm} = 0.869 \leq 1$$ Eq. (7.20)

$$\Psi_{g,Np} = max\left(1; \Psi^0_{g,Np} - \sqrt{\frac{s}{s_{cr,Np}}} \cdot \left(\Psi^0_{g,Np} - 1\right)\right) = 1.000 - \sqrt{\frac{0mm}{213mm}} \cdot \left(1.000 - 1\right) = 1.000 \geq 1$$ 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)

$$\Psi^0_{g,Np} = max\left(1; \sqrt{1} - \left(\sqrt{1} - 1\right) \cdot \left(\frac{12.1N/mm^2}{16.2N/mm^2}\right)^{1.5}\right) = 1.000 \geq 1$$

$$\tau_{Rk,c} = \frac{k_3}{\pi \cdot d}\sqrt{h_{ef} \cdot f_{ck}} = \frac{11}{3.14 \cdot 10mm}\sqrt{71mm \cdot 30.0N/mm^2} = 16.2N/mm^2$$ 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)

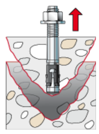
$$\Psi_{ec,Npx} = \frac{1}{1 + \frac{2 \cdot 0mm}{213mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Npy} = \frac{1}{1 + \frac{2 \cdot 0mm}{213mm}} = 1.000 \leq 1$$

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

$N_{Rk,p}$ kN	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
18.33	1.50	12.22	12.21	99.9

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	99.9	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)

$$N_{Rk,c} = 36.04kN \cdot \frac{35{,}465mm^2}{45{,}369mm^2} \cdot 0.869 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 24.49kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 11.0 \cdot \sqrt{30.0N/mm^2} \cdot \left(71mm\right)^{1.5} = 36.04kN$$ Eq. (7.2)

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} = 0.7 + 0.3 \cdot \frac{60mm}{107mm} = 0.869 \leq 1$$ 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)

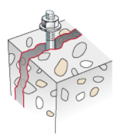
$$\Psi_{ec,Nx} = \frac{1}{1 + \frac{2 \cdot 0mm}{213mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1 + \frac{2 \cdot 0mm}{213mm}} = 1.000 \leq 1$$

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

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
24.49	1.50	16.32	12.21	74.8

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	74.8	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)

$$N_{Rk,sp} = 26.99kN \cdot \frac{18{,}602mm^2}{20{,}164mm^2} \cdot 0.954 \cdot 1.000 \cdot 1.000 \cdot 1.365 = 32.40kN$$

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,sp}} = 0.7 + 0.3 \cdot \frac{60mm}{71mm} = 0.954 \leq 1$$ 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)

$$\Psi_{ec,Nx} = \frac{1}{1 + \frac{2 \cdot 0mm}{142mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1 + \frac{2 \cdot 0mm}{142mm}} = 1.000 \leq 1$$

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

$$\Psi_{h,sp} = min\left(\left(\frac{200mm}{101mm}\right)^{2/3} ;max\left(1; \left(\frac{71mm + 1.5 \cdot 60mm}{101mm}\right)^{2/3}\right);2\right) = 1.365$$

$N_{Rk,sp}$ kN	γ_{Msp}	$N_{Rd,sp}$ kN	N_{Ed} kN	$\beta_{N,sp}$ %
32.40	1.50	21.60	12.21	56.5

Anchor no.	$\beta_{N,sp}$ %	Group N°	Decisive Beta
1	56.5	1	$\beta_{N,sp;1}$

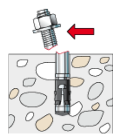
Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	1.13	18.40	6.1
Concrete pry-out failure	1.13	24.45	4.6
Concrete edge failure	1.13	7.05	**16.0**

* Most unfavourable anchor

Steel failure without lever arm

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



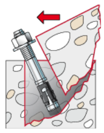
$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 23.00kN = 23.00kN$$ Eq. (7.35)/ (7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
23.00	1.25	18.40	1.13	6.1

Anchor no.	βVs %	Group N°	Decisive Beta
1	6.1	1	$\beta_{Vs;1}$

Concrete pry-out failure

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



$$V_{Rk,cp} = k_8 \cdot N_{Rk,p} = 2 \cdot 18.33kN = 36.67kN$$ 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)

$$N_{Rk,p} = 26.99kN \cdot \frac{35{,}465mm^2}{45{,}369mm^2} \cdot 0.869 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 18.33kN$$

$$N^0_{Rk,p} = \Psi_{sus} \cdot \pi \cdot d \cdot h_{ef} \cdot \tau_{Rk} = 1.00 \cdot \pi \cdot 10mm \cdot 71mm \cdot 12.1N/mm^2 = 26.99kN$$ Eq. (7.14)

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

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

$$\Psi_{s,Np} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}} = 0.7 + 0.3 \cdot \frac{60mm}{107mm} = 0.869 \leq 1$$ 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)

$$\Psi_{g,Np} = max\left(1;\ 1.000 - \sqrt{\frac{0mm}{213mm}} \cdot \left(1.000 - 1\right)\right) = 1.000 \geq 1$$

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

$$\Psi^0_{g,Np} = max\left(1;\ \sqrt{1} - \left(\sqrt{1} - 1\right) \cdot \left(\frac{12.1N/mm^2}{16.2N/mm^2}\right)^{1.5}\right) = 1.000 \geq 1$$

$$\tau_{Rk,c} = \frac{k_3}{\pi \cdot d}\sqrt{h_{ef} \cdot f_{ck}} = \frac{11}{3.14 \cdot 10mm}\sqrt{71mm \cdot 30.0N/mm^2} = 16.2N/mm^2$$ Eq. (7.19)

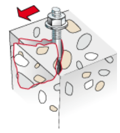
$$\Psi_{ec,Np} = \frac{1}{1 + \frac{2e_n}{s_{cr,Np}}} = \Psi_{ec,Npx} \cdot \Psi_{ec,Npy} = 1.000 \cdot 1.000 = 1.000 \leq 1$$ Eq. (7.21)

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

$V_{Rk,cp}$ kN	γ_{Mcp}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
36.67	1.50	24.45	1.13	4.6

Anchor no.	$\beta_{V,cp}$ %	Group N°	Decisive Beta
1	4.6	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)

$$V_{Rk,c} = 10.57kN \cdot \frac{16,200mm^2}{16,200mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 10.57kN$$

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

$$V^0_{Rk,c} = 2.4 \cdot \left(10mm\right)^{0.109} \cdot \left(71mm\right)^{0.070} \cdot \sqrt{30.0N/mm^2} \cdot \left(60mm\right)^{1.5} = 10.57kN$$

$$\alpha = 0.1 \cdot \sqrt{\frac{l_f}{c_1}} = 0.1 \cdot \sqrt{\frac{71mm}{60mm}} = 0.109 \qquad \beta = 0.1 \cdot \left(\frac{d}{c_1}\right)^{0.2} = 0.1 \cdot \left(\frac{10mm}{60mm}\right)^{0.2} = 0.070$$ 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)

$$\Psi_{h,V} = max\left(1; \sqrt{\frac{1.5c_1}{h}}\right) = max\left(1; \sqrt{\frac{1.5 \cdot 60mm}{200mm}}\right) = 1.000 \geq 1$$ Eq. (7.46)

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

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

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

$V_{Rk,c}$ kN	γ_{Mc}	$V_{Rd,c}$ kN	V_{Ed} kN	$\beta_{V,c}$ %
10.57	1.50	7.05	1.13	16.0

Anchor no.	$\beta_{V,c}$ %	Group N°	Decisive Beta
1	16.0	1	$\beta_{V,c;1}$

Utilization of tension and shear loads

Tension loads	Utilisation βN %
Steel failure *	39.0
Combined pull-out and concrete cone failure	**99.9**
Concrete cone failure	74.8
Splitting failure	56.5

Shear Loads	Utilisation βV %
Steel failure without lever arm *	6.1
Concrete pry-out failure	4.6
Concrete edge failure	**16.0**

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.39 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.06 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.16 \leq 1$$

Eq. (7.55)

Utilisation concrete

Proof successful

$$\beta_{N,p} = \beta_{N,p;1} = 1.00 \leq 1$$
$$\beta_{V.c} = \beta_{V,c;1} = 0.16 \leq 1$$
$$\frac{\beta_N + \beta_V}{1.2} = \frac{\beta_{N,p;1} + \beta_{V,c;1}}{1.2} = 0.97 \leq 1$$

Eq. (7.57)

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof t = 9 mm

Profile type None

Technical remarks

The transmission of the anchor loads to the supports of the concrete member shall be shown for the ultimate limit state and the serviceability limit state; for this purpose, the normal verifications shall be carried out under due consideration of the actions introduced by the anchors. For these verifications the additional provisions given in the current design method shall be taken into account.
As a pre-condition the anchor plate is assumed to be flat when subjected to the actions. Therefore, the plate 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
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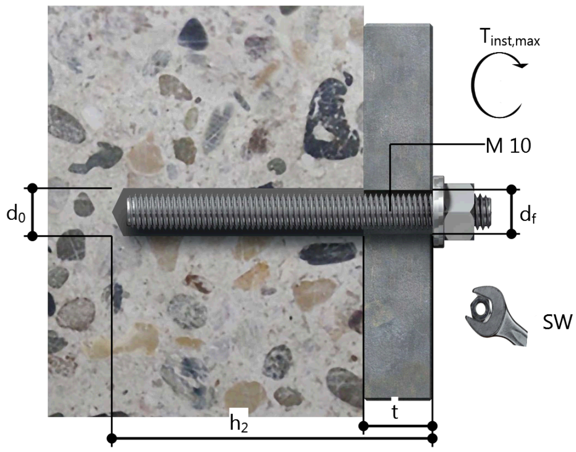
Installation data

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		

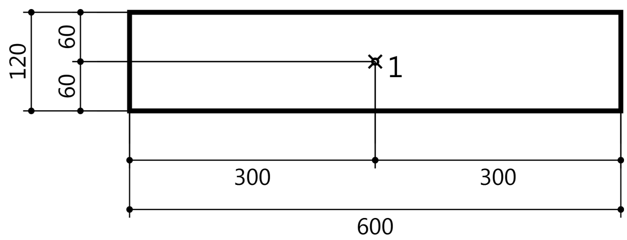
Installation details

Thread diameter	M 10
Drill hole diameter	d_0 = 12 mm
Drill hole depth	h_2 = 80 mm
Calculated anchorage depth	h_{ef} = 71 mm
Drilling method	hammer drilling
Drill hole cleaning	4 times blowing, 4 times brushing, 4 times blowing required activities according the given instruction in the approval No borehole cleaning required in case of using a hollow drill bit, e.g. fischer FHD.
Installation type	Push-through installation
Annular gap	Annular gap filled
Maximum torque	$T_{inst,max}$ = 20.0 Nm
Socket size	17 mm
Base plate thickness	t = 9 mm
Total fixing thickness Tfix,max	t_{fix} = 9 mm
Volume of resin per drill hole	6 ml/3 scale divisions



Base plate details

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



Attachment

Profile type	None

Anchor coordinates

Anchor no.	x mm	y mm
1	0	0

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MASONRY FIXINGS

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Dublin 10
Phone: +353 1 642 6700
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technical@masonryfixings.ie
www.masonryfixings.ie

Comment

Case Study 03 - 1.5kNm2 Wind Load @200 - TL 4010

Design Specifications

Anchor

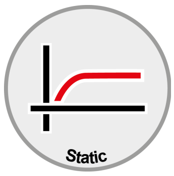
Anchor system	fischer Injection system FIS V
Injection resin	FIS V 360 S
Fixing element	Threaded rod FIS A M 10 x 150 8.8, zinc plated steel, property class 8.8
Calculated anchorage depth	111 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-02/0024, Option 1, Issued 02/01/2020

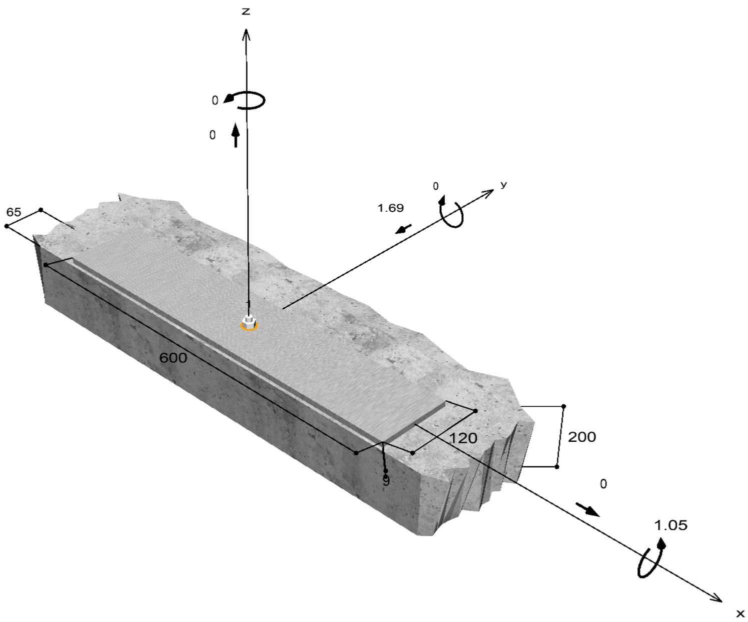
Geometry / Loads / Scale units

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
Annular gap	Annular gap filled
Type of loading	Static or quasi-static
Base plate location	Base plate flush installed on base material
Base plate geometry	600 mm x 120 mm x 9 mm
Profile type	None

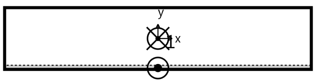
Design actions *)

#	N_{Ed} kN	$V_{Ed,x}$ kN	$V_{Ed,y}$ kN	$M_{Ed,x}$ kNm	$M_{Ed,y}$ kNm	$M_{T,Ed}$ kNm	Type of loading
1	0.00	0.00	-1.69	1.05	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	18.32	1.69	0.00	-1.69



max. concrete compressive strain : 0.23 ‰
max. concrete compressive stress : 7.6 N/mm²
Resulting tensile actions : 18.32 kN , X/Y position (0 / 0)
Resulting compression actions : 18.32 kN , X/Y position (0 / -57)

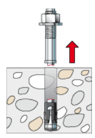
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	18.32	31.33	58.5
Combined pull-out and concrete cone failure	18.32	18.62	**98.4**
Concrete cone failure	18.32	26.68	68.6
Splitting failure	18.32	21.09	86.9

* Most unfavourable anchor

Steel failure

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

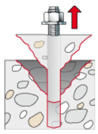


$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
47.00	1.50	31.33	18.32	58.5

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	58.5	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)

$$N_{Rk,p} = 42.19kN \cdot \frac{45{,}012mm^2}{58{,}564mm^2} \cdot 0.861 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 27.93kN$$

$$N^0_{Rk,p} = \Psi_{sus} \cdot \pi \cdot d \cdot h_{ef} \cdot \tau_{Rk} = 1.00 \cdot \pi \cdot 10mm \cdot 111mm \cdot 12.1N/mm^2 = 42.19kN$$ 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)

$$s_{cr,Np} = min\left(7.3 \cdot 10mm \cdot \left(1.00 \cdot 11.0N/mm^2\right)^{0.5}; \, 3 \cdot 111mm\right) = 242mm$$

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

$$\Psi_{s,Np} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}} = 0.7 + 0.3 \cdot \frac{65mm}{121mm} = 0.861 \leq 1$$ Eq. (7.20)

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

$$\Psi^0_{g,Np} = max\left(1; \, \sqrt{1} - \left(\sqrt{1} - 1\right) \cdot \left(\frac{12.1N/mm^2}{20.2N/mm^2}\right)^{1.5}\right) = 1.000 \geq 1$$

$$\tau_{Rk,c} = \frac{k_3}{\pi \cdot d}\sqrt{h_{ef} \cdot f_{ck}} = \frac{11}{3.14 \cdot 10mm}\sqrt{111mm \cdot 30.0N/mm^2} = 20.2N/mm^2$$ 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)

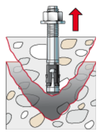
$$\Psi_{ec,Npx} = \frac{1}{1 + \frac{2 \cdot 0mm}{242mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Npy} = \frac{1}{1 + \frac{2 \cdot 0mm}{242mm}} = 1.000 \leq 1$$

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

$N_{Rk,p}$ kN	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
27.93	1.50	18.62	18.32	98.4

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	98.4	1	$\beta_{N,p;1}$

Concrete cone failure



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

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

$$N_{Rk,c} = 70.46kN \cdot \frac{77{,}090mm^2}{110{,}889mm^2} \cdot 0.817 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 40.02kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 11.0 \cdot \sqrt{30.0N/mm^2} \cdot \left(111mm\right)^{1.5} = 70.46kN$$ Eq. (7.2)

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} = 0.7 + 0.3 \cdot \frac{65mm}{167mm} = 0.817 \leq 1$$ 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)

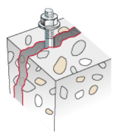
$$\Psi_{ec,Nx} = \frac{1}{1 + \frac{2 \cdot 0mm}{333mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1 + \frac{2 \cdot 0mm}{333mm}} = 1.000 \leq 1$$

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

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
40.02	1.50	26.68	18.32	68.6

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	68.6	1	$\beta_{N,c;1}$

Splitting failure due to loading



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

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

$$N_{Rk,sp} = 42.19kN \cdot \frac{64{,}939mm^2}{90{,}721mm^2} \cdot 0.829 \cdot 1.000 \cdot 1.000 \cdot 1.262 = 31.63kN$$

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,sp}} = 0.7 + 0.3 \cdot \frac{65mm}{151mm} = 0.829 \leq 1$$ 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)

$$\Psi_{ec,Nx} = \frac{1}{1 + \frac{2 \cdot 0mm}{301mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1 + \frac{2 \cdot 0mm}{301mm}} = 1.000 \leq 1$$

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

$$\Psi_{h,sp} = min\left(\left(\frac{200mm}{141mm}\right)^{2/3} ;max\left(1; \left(\frac{111mm + 1.5 \cdot 65mm}{141mm}\right)^{2/3}\right);2\right) = 1.262$$

$N_{Rk,sp}$ kN	γ_{Msp}	$N_{Rd,sp}$ kN	N_{Ed} kN	$\beta_{N,sp}$ %
31.63	1.50	21.09	18.32	86.9

Anchor no.	$\beta_{N,sp}$ %	Group N°	Decisive Beta
1	86.9	1	$\beta_{N,sp;1}$

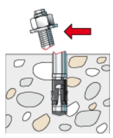
Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	1.69	18.40	9.2
Concrete pry-out failure	1.69	37.24	4.5
Concrete edge failure	1.69	8.01	**21.1**

* Most unfavourable anchor

Steel failure without lever arm

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

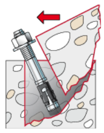


$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 23.00kN = 23.00kN$$ Eq. (7.35)/ (7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
23.00	1.25	18.40	1.69	9.2

Anchor no.	β_{Vs} %	Group N°	Decisive Beta
1	9.2	1	$\beta_{Vs;1}$

Concrete pry-out failure



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

$$V_{Rk,cp} = k_8 \cdot N_{Rk,p} = 2 \cdot 27.93kN = 55.86kN$$ 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)

$$N_{Rk,p} = 42.19kN \cdot \frac{45{,}012mm^2}{58{,}564mm^2} \cdot 0.861 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 27.93kN$$

$$N^0_{Rk,p} = \Psi_{sus} \cdot \pi \cdot d \cdot h_{ef} \cdot \tau_{Rk} = 1.00 \cdot \pi \cdot 10mm \cdot 111mm \cdot 12.1N/mm^2 = 42.19kN$$ Eq. (7.14)

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

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

$$\Psi_{s,Np} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}} = 0.7 + 0.3 \cdot \frac{65mm}{121mm} = 0.861 \leq 1$$ Eq. (7.20)

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

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

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

$$\Psi^0_{g,Np} = max\left(1;\ \sqrt{1} - \left(\sqrt{1} - 1\right) \cdot \left(\frac{12.1N/mm^2}{20.2N/mm^2}\right)^{1.5}\right) = 1.000 \geq 1$$

$$\tau_{Rk,c} = \frac{k_3}{\pi \cdot d}\sqrt{h_{ef} \cdot f_{ck}} = \frac{11}{3.14 \cdot 10mm}\sqrt{111mm \cdot 30.0N/mm^2} = 20.2N/mm^2$$ Eq. (7.19)

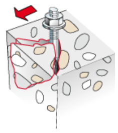
$$\Psi_{ec,Np} = \frac{1}{1 + \frac{2e_n}{s_{cr,Np}}} = \Psi_{ec,Npx} \cdot \Psi_{ec,Npy} = 1.000 \cdot 1.000 = 1.000 \leq 1$$ Eq. (7.21)

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

$V_{Rk,cp}$ kN	γ_{Mcp}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
55.86	1.50	37.24	1.69	4.5

Anchor no.	$\beta_{V,cp}$ %	Group N°	Decisive Beta
1	4.5	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)

$$V_{Rk,c} = 12.02kN \cdot \frac{19{,}013mm^2}{19{,}013mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 12.02kN$$

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

$$V^0_{Rk,c} = 2.4 \cdot \left(10mm\right)^{0.111} \cdot \left(80mm\right)^{0.069} \cdot \sqrt{30.0N/mm^2} \cdot \left(65mm\right)^{1.5} = 12.02kN$$

$$\alpha = 0.1 \cdot \sqrt{\frac{l_f}{c_1}} = 0.1 \cdot \sqrt{\frac{80mm}{65mm}} = 0.111 \qquad \beta = 0.1 \cdot \left(\frac{d}{c_1}\right)^{0.2} = 0.1 \cdot \left(\frac{10mm}{65mm}\right)^{0.2} = 0.069$$ Eq. (7.42/7.43)

$$h_{ef} = min\left(h_{ef};\ 8 \cdot d\right) = min\left(111mm;\ 8 \cdot 10mm\right) = 80mm$$

$$\Psi_{s,V} = 0.7 + 0.3 \cdot \frac{c_2}{1.5c_1} = 0.7 + 0.3 \cdot \frac{98mm}{1.5 \cdot 65mm} = 1.000 \leq 1$$ Eq. (7.45)

$$\Psi_{h,V} = max\left(1;\ \sqrt{\frac{1.5c_1}{h}}\right) = max\left(1;\ \sqrt{\frac{1.5 \cdot 65mm}{200mm}}\right) = 1.000 \geq 1$$ Eq. (7.46)

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

$$\Psi_{ec,V} = \frac{1}{1 + \frac{2}{3}\frac{e_v}{c_1}} = \frac{1}{1 + \frac{2 \cdot 0mm}{3 \cdot 65mm}} = 1.000 \leq 1$$ Eq. (7.47)

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

$V_{Rk,c}$ kN	γ_{Mc}	$V_{Rd,c}$ kN	V_{Ed} kN	$\beta_{V,c}$ %
12.02	1.50	8.01	1.69	21.1

Anchor no.	$\beta_{V,c}$ %	Group N°	Decisive Beta
1	21.1	1	$\beta_{V,c;1}$

Utilization of tension and shear loads

Tension loads	Utilisation βN %
Steel failure *	58.5
Combined pull-out and concrete cone failure	**98.4**
Concrete cone failure	68.6
Splitting failure	86.9

Shear Loads	Utilisation βV %
Steel failure without lever arm *	9.2
Concrete pry-out failure	4.5
Concrete edge failure	**21.1**

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.58 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.09 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.35 \leq 1$$

Eq. (7.55)

Utilisation concrete

Proof successful

$$\beta_{N,p} = \beta_{N,p;1} = 0.98 \leq 1$$
$$\beta_{V.c} = \beta_{V,c;1} = 0.21 \leq 1$$
$$\frac{\beta_N + \beta_V}{1.2} = \frac{\beta_{N,p;1} + \beta_{V,c;1}}{1.2} = 1.00 \leq 1$$

Eq. (7.57)

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof t = 9 mm

Profile type None

Technical remarks

The transmission of the anchor loads to the supports of the concrete member shall be shown for the ultimate limit state and the serviceability limit state; for this purpose, the normal verifications shall be carried out under due consideration of the actions introduced by the anchors. For these verifications the additional provisions given in the current design method shall be taken into account.
As a pre-condition the anchor plate is assumed to be flat when subjected to the actions. Therefore, the plate 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.

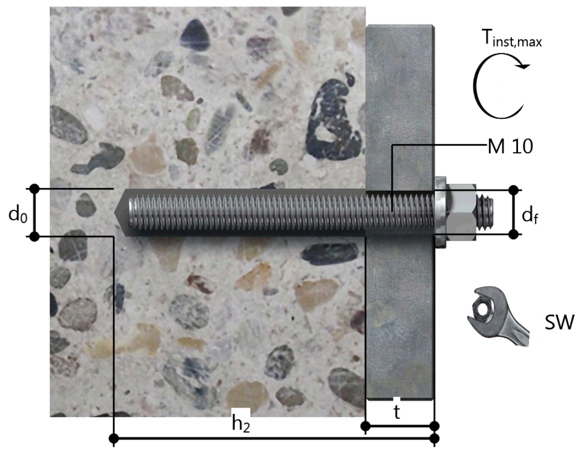
Installation data

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
	BSD 12	Art.-No. 1490
	SDS Chuck with internal thread M8	Art.-No. 530332
	SDS Plus II 12/150/210	Art.-No. 531804
	or alternatively	
	FHD 12/200/330	Art.-No. 546597
	Hammer drilling with or without suction	

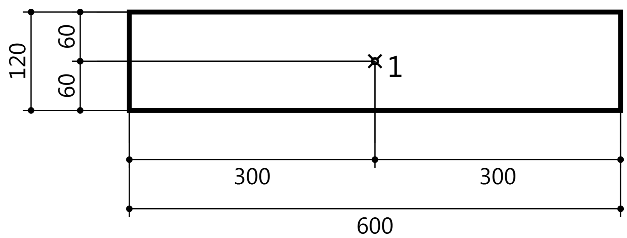
Installation details

Thread diameter	M 10
Drill hole diameter	d_0 = 12 mm
Drill hole depth	h_2 = 120 mm
Calculated anchorage depth	h_{ef} = 111 mm
Drilling method	hammer drilling
Drill hole cleaning	4 times blowing, 4 times brushing, 4 times blowing required activities according the given instruction in the approval No borehole cleaning required in case of using a hollow drill bit, e.g. fischer FHD.
Installation type	Push-through installation
Annular gap	Annular gap filled
Maximum torque	$T_{inst,max}$ = 20.0 Nm
Socket size	17 mm
Base plate thickness	t = 9 mm
Total fixing thickness Tfix,max	t_{fix} = 9 mm
Volume of resin per drill hole	10 ml/5 scale divisions



Base plate details

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



Attachment

Profile type	None

Anchor coordinates

Anchor no.	x mm	y mm
1	0	0

MASONRY FIXINGS

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www.masonryfixings.ie

Comment

Case Study 04 - 2.0kNm2 Wind Load @200 - TL 4010

Design Specifications

Anchor

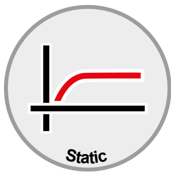
Anchor system	fischer Injection system FIS V
Injection resin	FIS V 360 S
Fixing element	Threaded rod FIS A M 10 x 150 8.8, zinc plated steel, property class 8.8
Calculated anchorage depth	104 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-02/0024, Option 1, Issued 02/01/2020

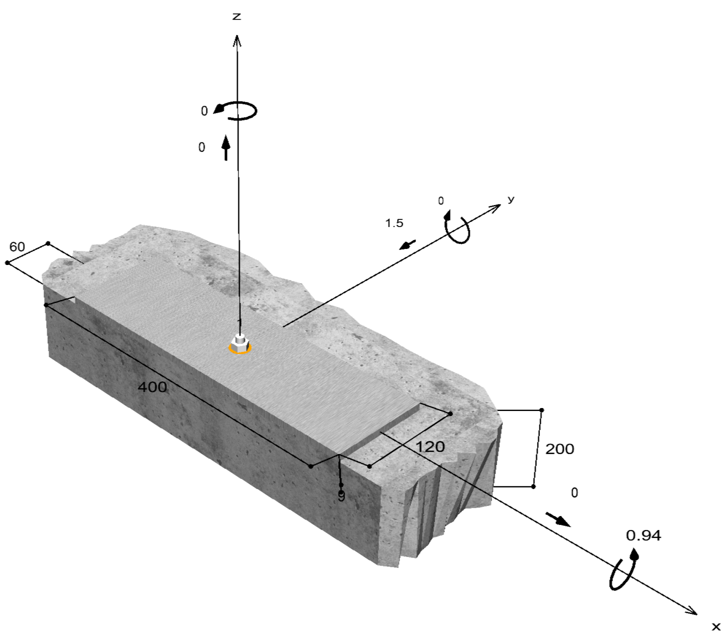
Geometry / Loads / Scale units

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
Annular gap	Annular gap filled
Type of loading	Static or quasi-static
Base plate location	Base plate flush installed on base material
Base plate geometry	400 mm x 120 mm x 9 mm
Profile type	None

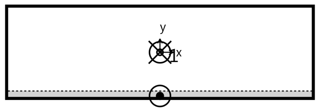
Design actions *⁾

#	N_{Ed} kN	$V_{Ed,x}$ kN	$V_{Ed,y}$ kN	$M_{Ed,x}$ kNm	$M_{Ed,y}$ kNm	$M_{T,Ed}$ kNm	Type of loading
1	0.00	0.00	-1.50	0.94	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	16.56	1.50	0.00	-1.50



max. concrete compressive strain : 0.26 ‰
max. concrete compressive stress : 8.6 N/mm²
Resulting tensile actions : 16.56 kN , X/Y position (0 / 0)
Resulting compression actions : 16.56 kN , X/Y position (0 / -57)

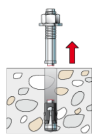
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	16.56	31.33	52.8
Combined pull-out and concrete cone failure	16.56	16.73	**98.9**
Concrete cone failure	16.56	24.05	68.8
Splitting failure	16.56	21.65	76.5

* Most unfavourable anchor

Steel failure

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

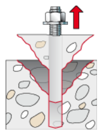


$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
47.00	1.50	31.33	16.56	52.8

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	52.8	1	$\beta_{N,s;1}$

Combined pull-out and concrete cone failure

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



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

$$N_{Rk,p} = 39.53kN \cdot \frac{43{,}802mm^2}{58{,}564mm^2} \cdot 0.849 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 25.10kN$$

$$N^0_{Rk,p} = \Psi_{sus} \cdot \pi \cdot d \cdot h_{ef} \cdot \tau_{Rk} = 1.00 \cdot \pi \cdot 10mm \cdot 104mm \cdot 12.1N/mm^2 = 39.53kN$$ 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)

$$s_{cr,Np} = min\left(7.3 \cdot 10mm \cdot \left(1.00 \cdot 11.0N/mm^2\right)^{0.5}; 3 \cdot 104mm\right) = 242mm$$

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

$$\Psi_{s,Np} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}} = 0.7 + 0.3 \cdot \frac{60mm}{121mm} = 0.849 \leq 1$$ Eq. (7.20)

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

$$\Psi^0_{g,Np} = max\left(1; \sqrt{1} - \left(\sqrt{1} - 1\right) \cdot \left(\frac{12.1N/mm^2}{19.6N/mm^2}\right)^{1.5}\right) = 1.000 \geq 1$$

$$\tau_{Rk,c} = \frac{k_3}{\pi \cdot d}\sqrt{h_{ef} \cdot f_{ck}} = \frac{11}{3.14 \cdot 10mm}\sqrt{104mm \cdot 30.0N/mm^2} = 19.6N/mm^2$$ 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)

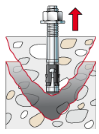
$$\Psi_{ec,Npx} = \frac{1}{1 + \frac{2 \cdot 0mm}{242mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Npy} = \frac{1}{1 + \frac{2 \cdot 0mm}{242mm}} = 1.000 \leq 1$$

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

$N_{Rk,p}$ kN	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
25.10	1.50	16.73	16.56	98.9

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	98.9	1	$\beta_{N,p;1}$

Concrete cone failure



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

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

$$N_{Rk,c} = 63.90kN \cdot \frac{67{,}392mm^2}{97{,}344mm^2} \cdot 0.815 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 36.07kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 11.0 \cdot \sqrt{30.0N/mm^2} \cdot \left(104mm\right)^{1.5} = 63.90kN$$ Eq. (7.2)

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} = 0.7 + 0.3 \cdot \frac{60mm}{156mm} = 0.815 \leq 1$$ 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)

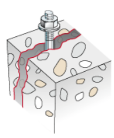
$$\Psi_{ec,Nx} = \frac{1}{1 + \frac{2 \cdot 0mm}{312mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1 + \frac{2 \cdot 0mm}{312mm}} = 1.000 \leq 1$$

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

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
36.07	1.50	24.05	16.56	68.8

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	68.8	1	$\beta_{N,c;1}$

Splitting failure due to loading



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

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

$$N_{Rk,sp} = 39.53kN \cdot \frac{42{,}245mm^2}{56{,}074mm^2} \cdot 0.852 \cdot 1.000 \cdot 1.000 \cdot 1.280 = 32.48kN$$

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,sp}} = 0.7 + 0.3 \cdot \frac{60mm}{118mm} = 0.852 \leq 1$$ 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)

$$\Psi_{ec,Nx} = \frac{1}{1 + \frac{2 \cdot 0mm}{237mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1 + \frac{2 \cdot 0mm}{237mm}} = 1.000 \leq 1$$

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

$$\Psi_{h,sp} = min\left(\left(\frac{200mm}{134mm}\right)^{2/3} ;max\left(1; \left(\frac{104mm + 1.5 \cdot 60mm}{134mm}\right)^{2/3}\right);2\right) = 1.280$$

$N_{Rk,sp}$ kN	γ_{Msp}	$N_{Rd,sp}$ kN	N_{Ed} kN	$\beta_{N,sp}$ %
32.48	1.50	21.65	16.56	76.5

Anchor no.	$\beta_{N,sp}$ %	Group N°	Decisive Beta
1	76.5	1	$\beta_{N,sp;1}$

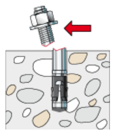
Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	1.50	18.40	8.2
Concrete pry-out failure	1.50	33.46	4.5
Concrete edge failure	1.50	7.22	**20.8**

* Most unfavourable anchor

Steel failure without lever arm

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



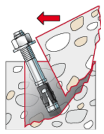
$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 23.00kN = 23.00kN$$ Eq. (7.35)/ (7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
23.00	1.25	18.40	1.50	8.2

Anchor no.	β_{Vs} %	Group N°	Decisive Beta
1	8.2	1	$\beta_{Vs;1}$

Concrete pry-out failure

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



$$V_{Rk,cp} = k_8 \cdot N_{Rk,p} = 2 \cdot 25.10kN = 50.19kN$$ 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)

$$N_{Rk,p} = 39.53kN \cdot \frac{43{,}802mm^2}{58{,}564mm^2} \cdot 0.849 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 25.10kN$$

$$N^0_{Rk,p} = \Psi_{sus} \cdot \pi \cdot d \cdot h_{ef} \cdot \tau_{Rk} = 1.00 \cdot \pi \cdot 10mm \cdot 104mm \cdot 12.1N/mm^2 = 39.53kN$$ Eq. (7.14)

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

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

$$\Psi_{s,Np} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}} = 0.7 + 0.3 \cdot \frac{60mm}{121mm} = 0.849 \leq 1$$ Eq. (7.20)

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

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

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

$$\Psi^0_{g,Np} = max\left(1;\ \sqrt{1} - \left(\sqrt{1} - 1\right) \cdot \left(\frac{12.1N/mm^2}{19.6N/mm^2}\right)^{1.5}\right) = 1.000 \geq 1$$

$$\tau_{Rk,c} = \frac{k_3}{\pi \cdot d}\sqrt{h_{ef} \cdot f_{ck}} = \frac{11}{3.14 \cdot 10mm}\sqrt{104mm \cdot 30.0N/mm^2} = 19.6N/mm^2$$ Eq. (7.19)

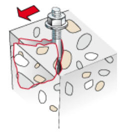
$$\Psi_{ec,Np} = \frac{1}{1 + \frac{2e_n}{s_{cr,Np}}} = \Psi_{ec,Npx} \cdot \Psi_{ec,Npy} = 1.000 \cdot 1.000 = 1.000 \leq 1$$ Eq. (7.21)

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

$V_{Rk,cp}$ kN	γ_{Mcp}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
50.19	1.50	33.46	1.50	4.5

Anchor no.	$\beta_{V,cp}$ %	Group N°	Decisive Beta
1	4.5	1	$\beta_{V,cp;1}$

Concrete edge failure



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

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

$$V_{Rk,c} = 10.83kN \cdot \frac{16{,}200mm^2}{16{,}200mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 10.83kN$$

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

$$V^0_{Rk,c} = 2.4 \cdot \left(10mm\right)^{0.115} \cdot \left(80mm\right)^{0.070} \cdot \sqrt{30.0N/mm^2} \cdot \left(60mm\right)^{1.5} = 10.83kN$$

$$\alpha = 0.1 \cdot \sqrt{\frac{l_f}{c_1}} = 0.1 \cdot \sqrt{\frac{80mm}{60mm}} = 0.115 \qquad \beta = 0.1 \cdot \left(\frac{d}{c_1}\right)^{0.2} = 0.1 \cdot \left(\frac{10mm}{60mm}\right)^{0.2} = 0.070$$ Eq. (7.42/7.43)

$$h_{ef} = min\left(h_{ef};\ 8 \cdot d\right) = min\left(104mm;\ 8 \cdot 10mm\right) = 80mm$$

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

$$\Psi_{h,V} = max\left(1;\ \sqrt{\frac{1.5c_1}{h}}\right) = max\left(1;\ \sqrt{\frac{1.5 \cdot 60mm}{200mm}}\right) = 1.000 \geq 1$$ Eq. (7.46)

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

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

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

$V_{Rk,c}$ kN	γ_{Mc}	$V_{Rd,c}$ kN	V_{Ed} kN	$\beta_{V,c}$ %
10.83	1.50	7.22	1.50	20.8

Anchor no.	$\beta_{V,c}$ %	Group N°	Decisive Beta
1	20.8	1	$\beta_{V,c;1}$

Utilization of tension and shear loads

Tension loads	Utilisation βN %
Steel failure *	52.8
Combined pull-out and concrete cone failure	**98.9**
Concrete cone failure	68.8
Splitting failure	76.5

Shear Loads	Utilisation βV %
Steel failure without lever arm *	8.2
Concrete pry-out failure	4.5
Concrete edge failure	**20.8**

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.53 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.08 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.29 \leq 1$$

Eq. (7.55)

Utilisation concrete

Proof successful

$$\beta_{N,p} = \beta_{N,p;1} = 0.99 \leq 1$$
$$\beta_{V.c} = \beta_{V,c;1} = 0.21 \leq 1$$
$$\frac{\beta_N + \beta_V}{1.2} = \frac{\beta_{N,p;1} + \beta_{V,c;1}}{1.2} = 1.00 \leq 1$$

Eq. (7.57)

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof t = 9 mm

Profile type None

Technical remarks

The transmission of the anchor loads to the supports of the concrete member shall be shown for the ultimate limit state and the serviceability limit state; for this purpose, the normal verifications shall be carried out under due consideration of the actions introduced by the anchors. For these verifications the additional provisions given in the current design method shall be taken into account.
As a pre-condition the anchor plate is assumed to be flat when subjected to the actions. Therefore, the plate 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.

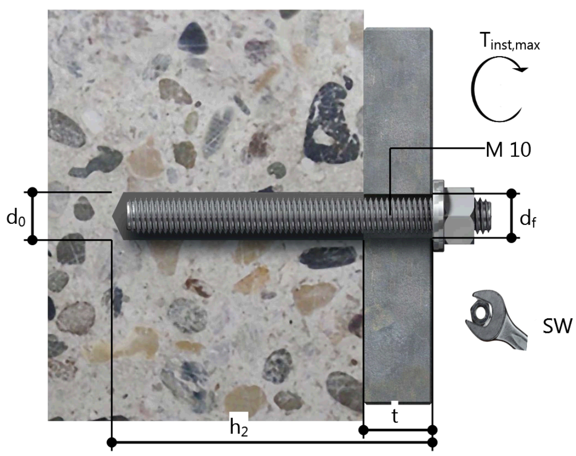
Installation data

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	
	BSD 12	Art.-No. 1490	
	SDS Chuck with internal thread M8	Art.-No. 530332	
	SDS Plus II 12/150/210	Art.-No. 531804	
	or alternatively		
	FHD 12/200/330	Art.-No. 546597	
	Hammer drilling with or without suction		

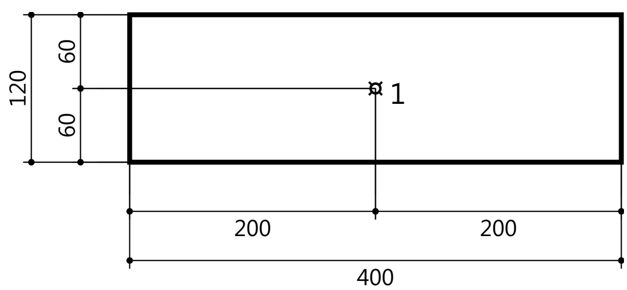
Installation details

Thread diameter	M 10
Drill hole diameter	d_0 = 12 mm
Drill hole depth	h_2 = 113 mm
Calculated anchorage depth	h_{ef} = 104 mm
Drilling method	hammer drilling
Drill hole cleaning	4 times blowing, 4 times brushing, 4 times blowing required activities according the given instruction in the approval No borehole cleaning required in case of using a hollow drill bit, e.g. fischer FHD.
Installation type	Push-through installation
Annular gap	Annular gap filled
Maximum torque	$T_{inst,max}$ = 20.0 Nm
Socket size	17 mm
Base plate thickness	t = 9 mm
Total fixing thickness Tfix,max	t_{fix} = 9 mm
Volume of resin per drill hole	8 ml/4 scale divisions



Base plate details

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



Attachment

Profile type	None

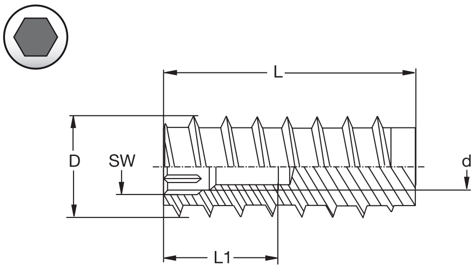
Anchor coordinates

Anchor no.	x mm	y mm
1	0	0

Appendix B – Rampa

TSA is Specifier of the Fixings

RAMPA®
Good idea. Let's make it!



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

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