TSA TED SINGLETON & ASSOCIATES CONSULTING ENGINEERS	Project: TL 6020/ 6021	Contract: 1388-1
	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

1388-1 TL 6020 / 6021

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 6020/6021 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	Interlayer	Wind Load - Qw	Height glass	Glass Deflection
	(mm)	-	(kN/m)	(m)	(mm)
1	15	PVB	1.00	1.108	6.154
2	17.52	PVB	1.00	1.108	6.931
3	21.52	PVB	1.50	1.108	5.842
4	21.52	PVB	2.00	1.108	7.79

Connection To Concrete - TL6020					
Case Study	Fischer	Shear	Moment	Holes Space	Edge
	-	(kN)	(kNm)	(mm)	(mm)
1 and 2	FAZ II 12/10 A4	0.33	0.18	200	60
3	FAZ II 12/10 A4	0.50	0.28	200	60
4	FAZ II 12/10 A4	0.66	0.37	200	60
Connection To Concrete - TL6021					
Case Study	Fischer	Shear	Moment	Holes Space	Edge
	-	(kN)	(kNm)	(mm)	(mm)
1 and 2	FH II 12/10 S A4	0.33	0.18	200	60
3	FH II 12/10 S A4	0.50	0.28	200	60
4	FH II 12/10 S A4	0.66	0.37	200	60

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

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Glass Strength

Wind Loading:

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

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

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

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

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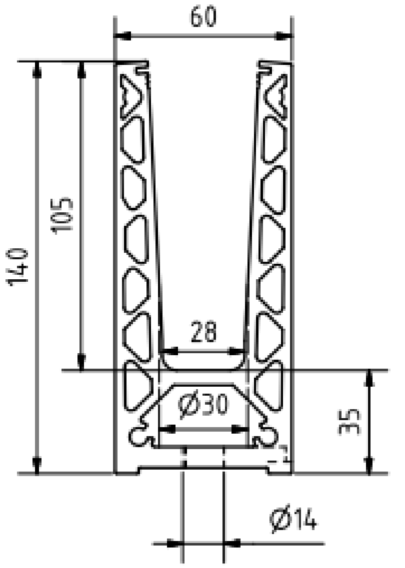
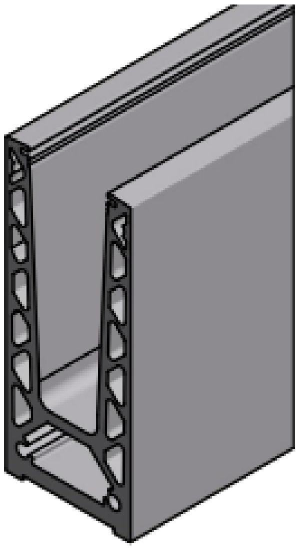
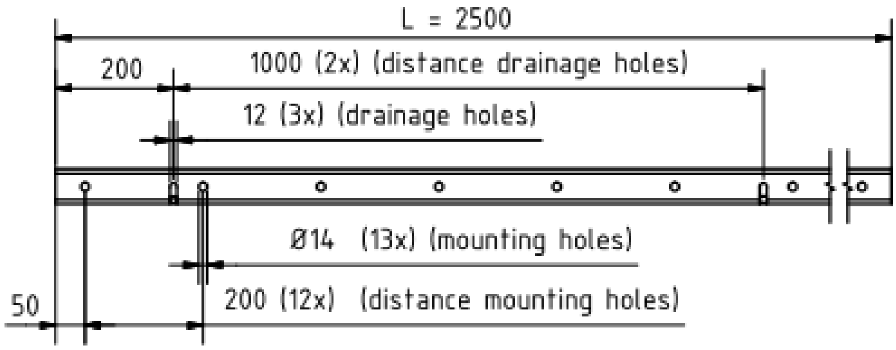
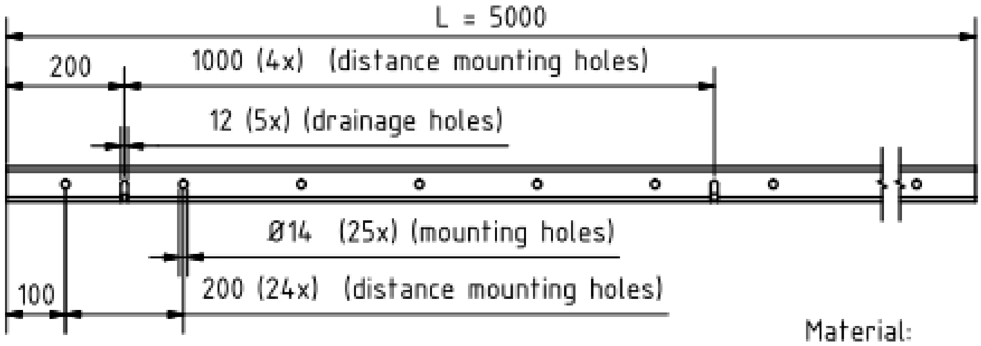
System Sketch:

Shoe TL 6020:









Material:
Aluminum 6063-T6

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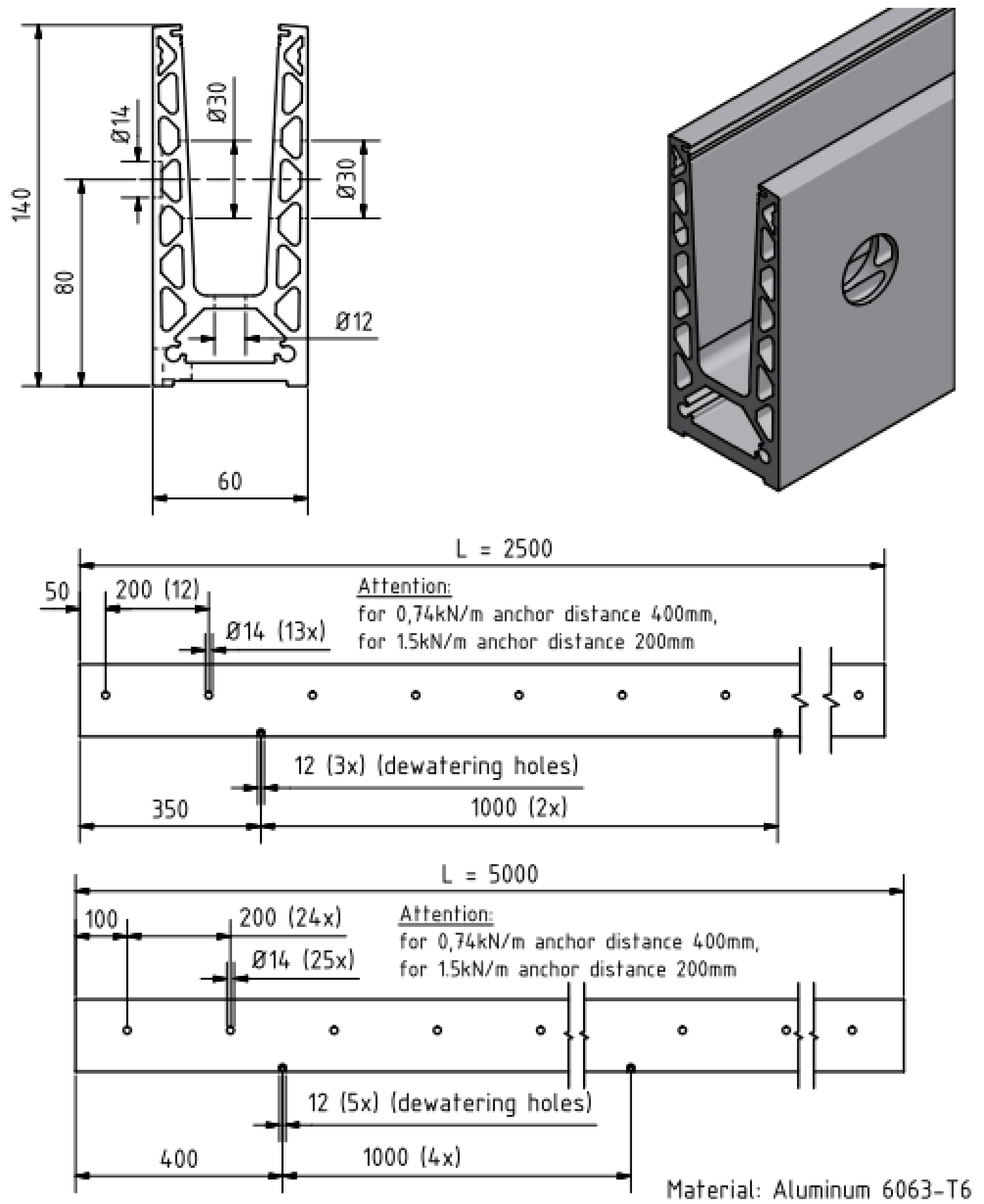
Shoe TL 6021:



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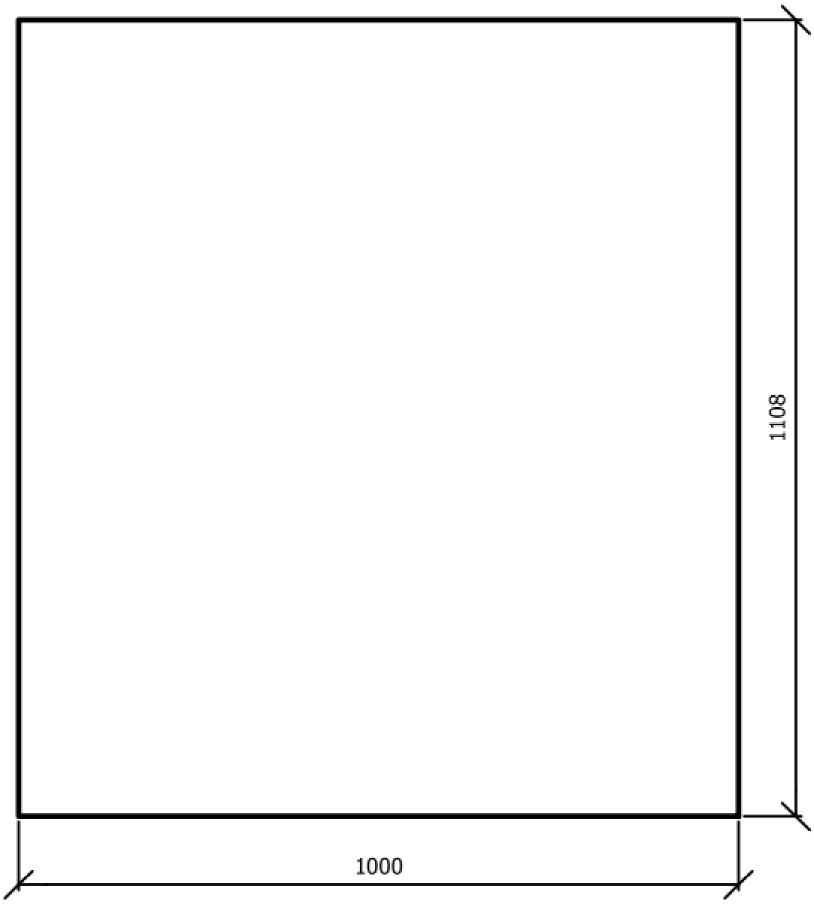
Case Study 01: 15mm Tough – 1.0x1.108m – 1.0kN/m^2:
Case Study 02: 17.52mm (TLT) – 1.0x1.108m – 1.0kN/m^2:
Case Study 03: 21.52mm (TLT) – 1.0x1.108m – 1.5kN/m^2:
Case Study 04: 21.52mm (TLT) – 1.0x1.108m – 2.0kN/m^2:



NOTE:

All deflection < 25mm and therefore acceptable.

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Glass Analysis:

Case Study 01: 15mm Tough – 1.0x1.108m – 1.0kN/m^2:

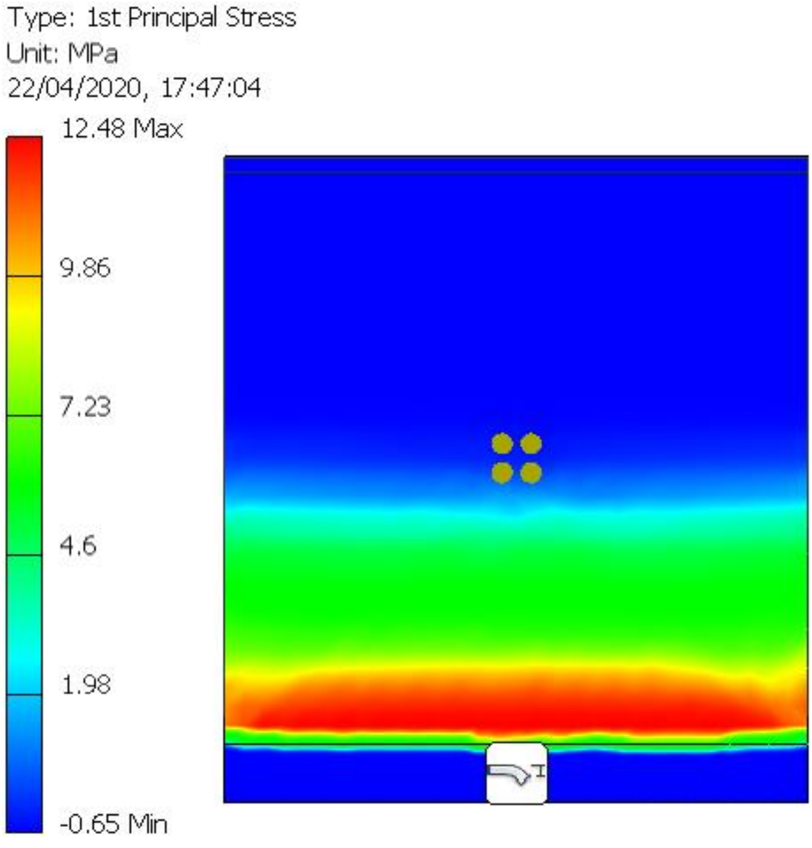
Glass Analysis - Bending Stress of Glass Panel due to 1.0kN/m2 Infill Loading:

- 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 1.108m

Result:

Max. Bending Stress = 12.48N/mm^2 x1.5 = 18.72N/mm^2 < 83.3N/mm^2

OK in Bending



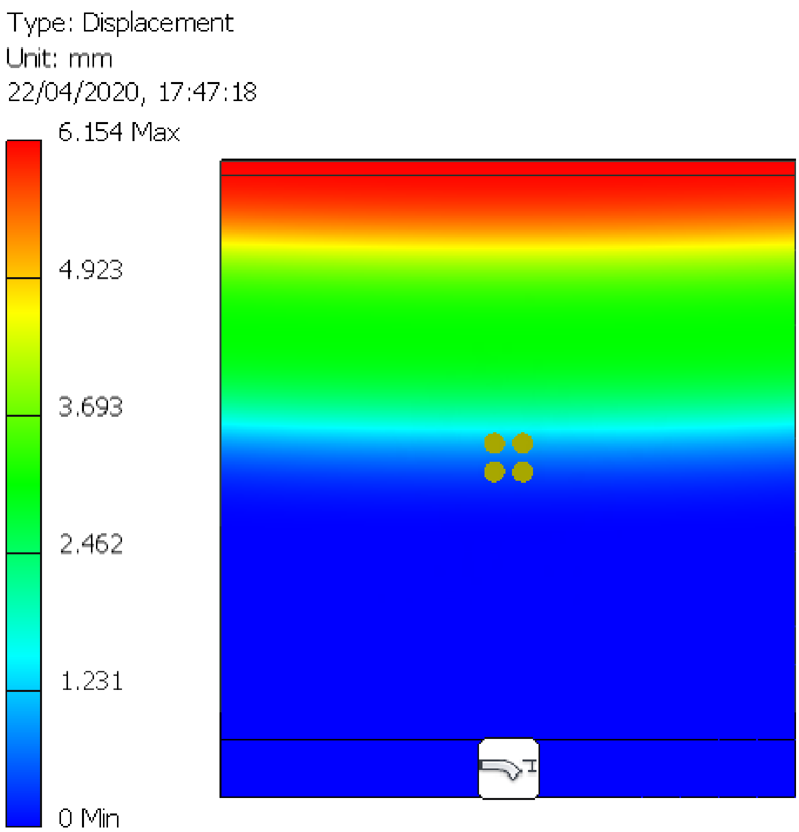
Glass Analysis - Deflection of Glass Panel due to 1.0kN/m2 Infill Loading:

- 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 1.108m

Result:

Max. Deflection = 6.154mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



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Case Study 02: 17.52mm (TLT) – 1.0x1.108m – 1.0kN/m^2:

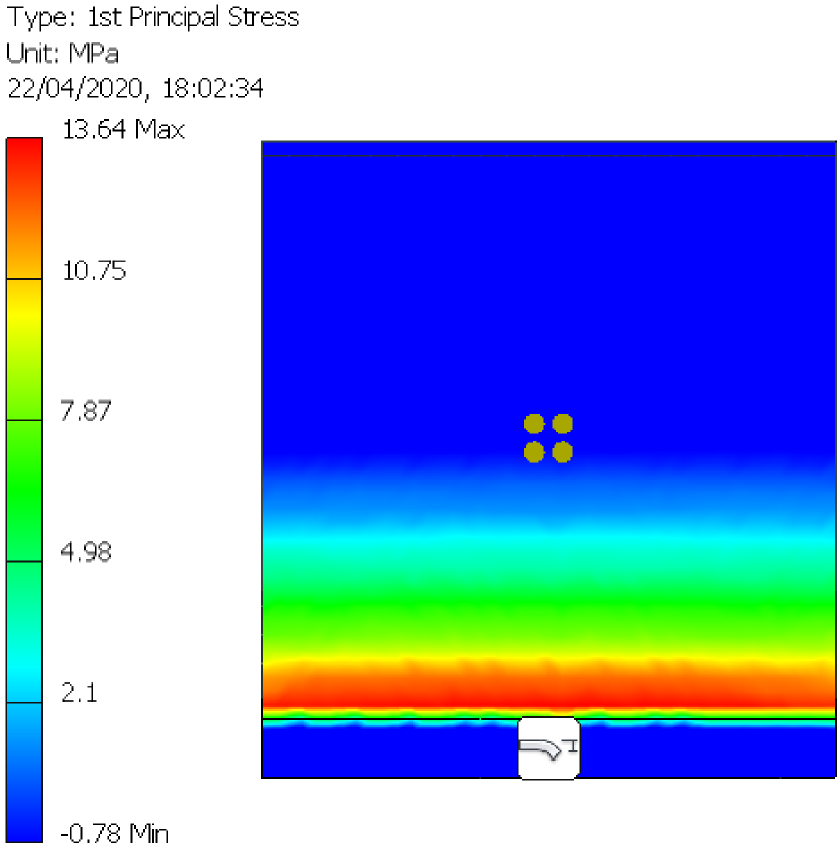
Glass Analysis - Bending Stress of Glass Panel due to 1.0kN/m2 Infill Loading:

- 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 1.108m

Result:

Max. Bending Stress = 13.64N/mm^2 x1.5 = 20.46N/mm^2 < 83.3N/mm^2

OK in Bending



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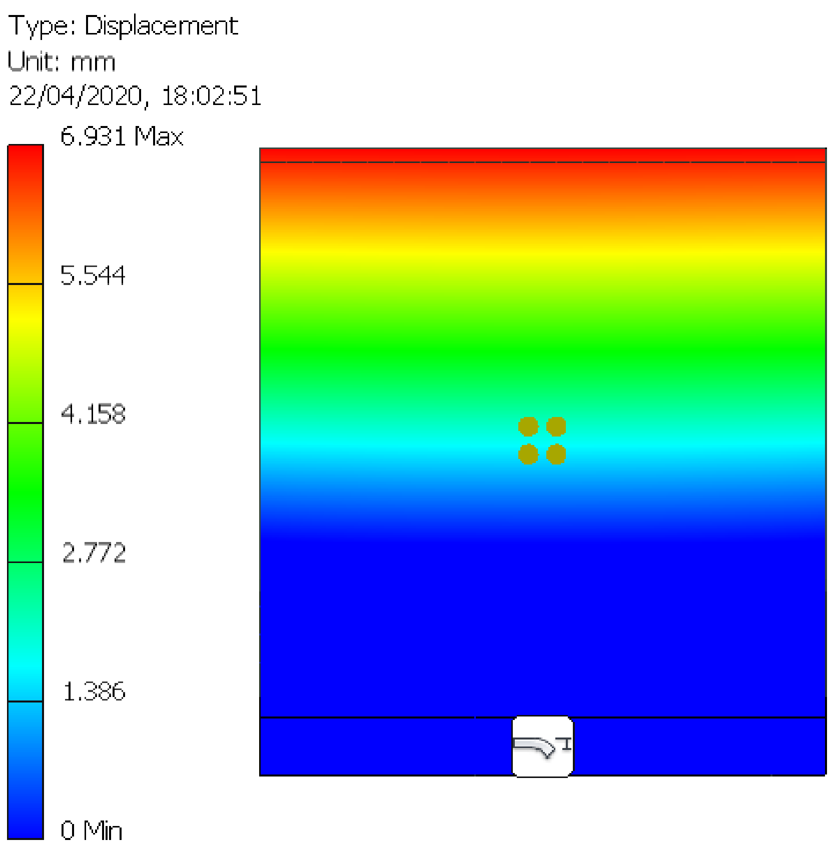
Glass Analysis - Deflection of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0N/m2 Infill Loading
- 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 1.108m

Result:

Max. Deflection = 6.931mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



Case Study 03: 21.52mm (TLT) – 1.0x1.108m – $1.5\text{kN}/\text{m}^2$:

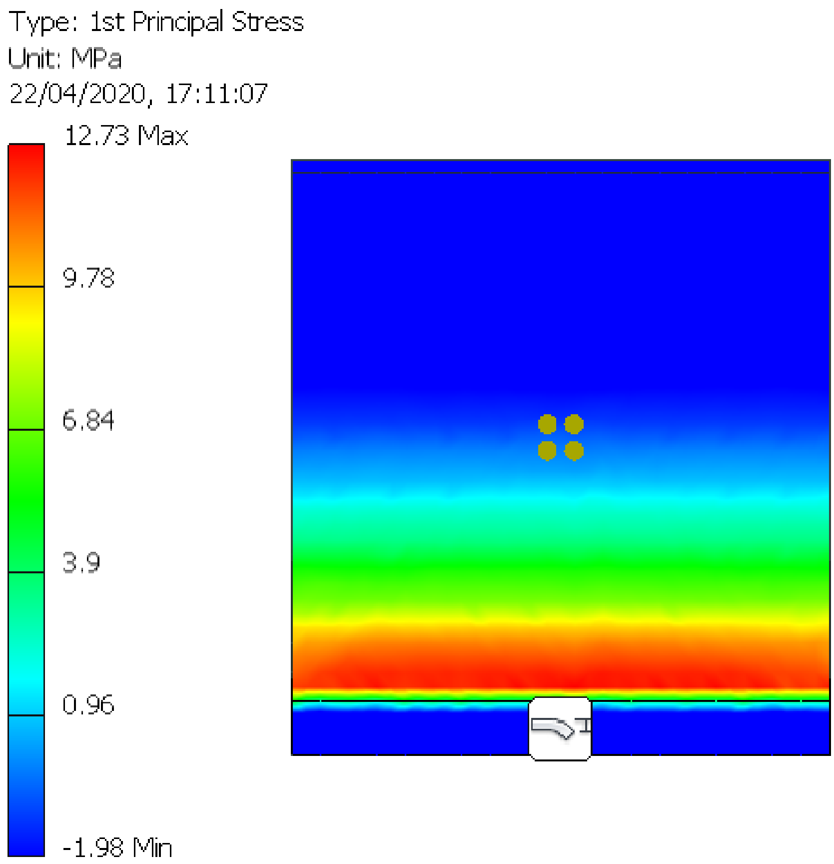
Glass Analysis - Bending Stress of Glass Panel due to 1.5kN/m2 Infill Loading:

- 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 1.108m

Result:

Max. Bending Stress = 12.73N/mm^2 x1.5 = 19.10N/mm^2 < 83.3N/mm^2

OK in Bending



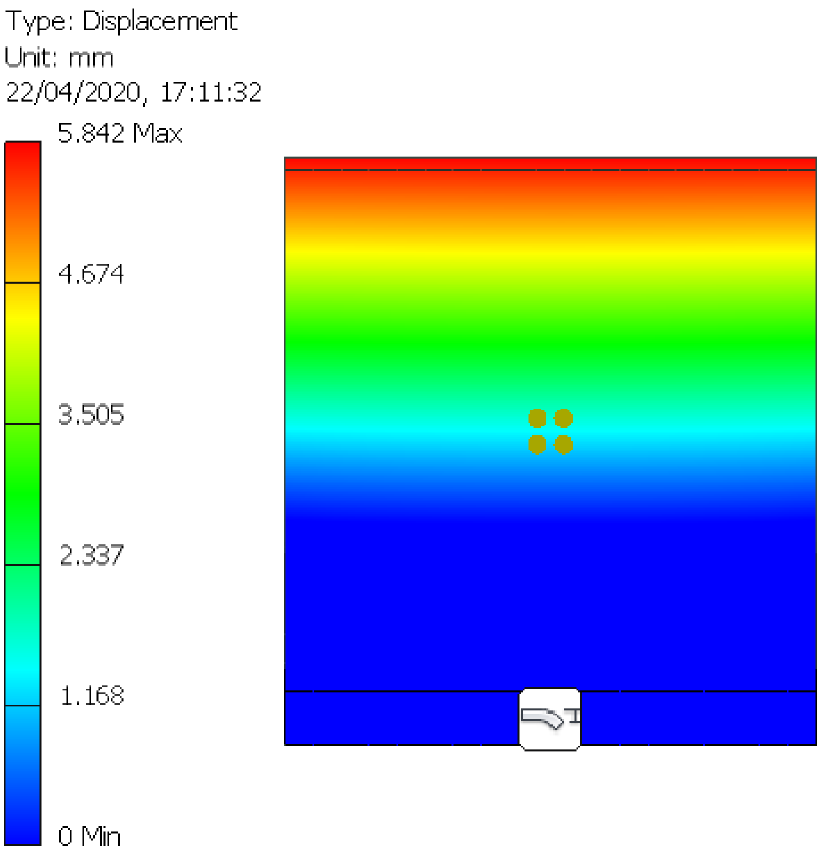
Glass Analysis - Deflection of Glass Panel due to 1.5kN/m2 Infill Loading:

- 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 1.108m

Result:

Max. Deflection = 5.842mm < 25mm {BS6180:2011 cl. 6.4.1}

OK in Deflection (Glass Only)



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Case Study 04: 21.52mm (TLT) – 1.0x1.108m – 2.0kN/m^2:

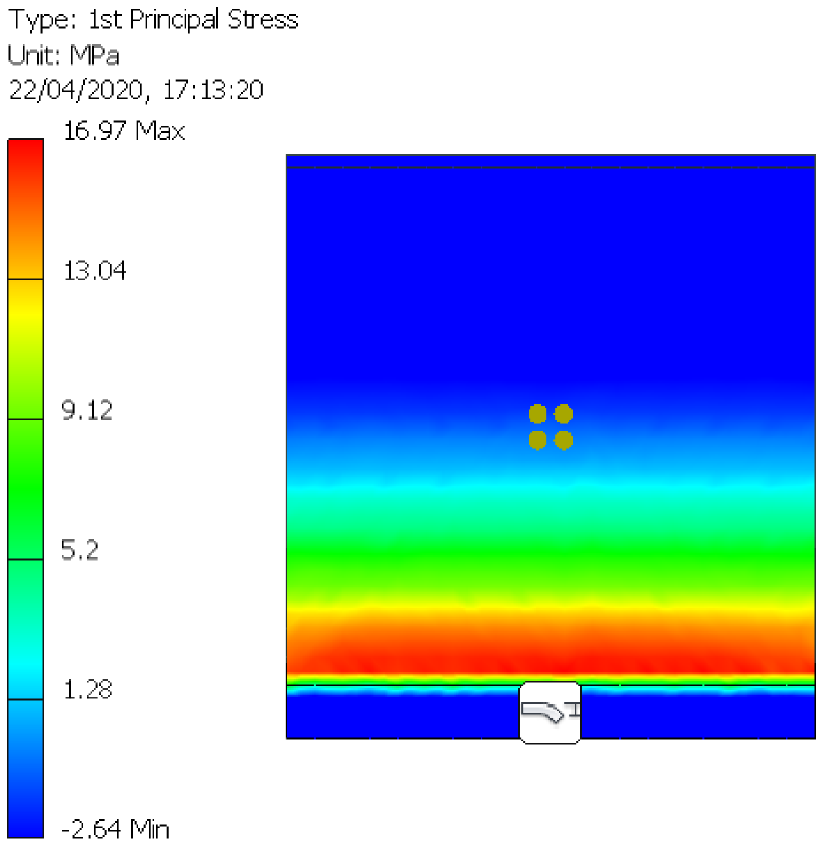
Glass Analysis - Bending Stress of Glass Panel due to 2.0kN/m2 Infill Loading:

- 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 1.108m

Result:

Max. Bending Stress = 16.97N/mm^2 x1.5 = 25.46N/mm^2 < 83.3N/mm^2

OK in Bending



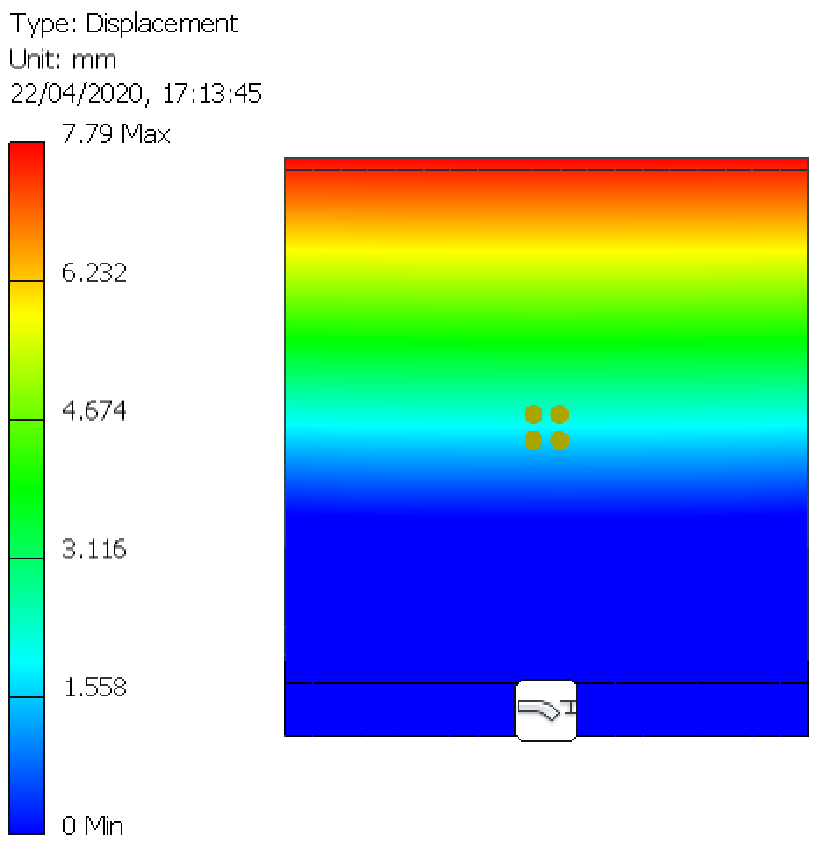
Glass Analysis - Deflection of Glass Panel due to 2.0kN/m2 Infill Loading:

- 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 1.108m

Result:

Max. Deflection = 7.79mm < 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) – 1.0x1.108m – 1.0kN/m^2:

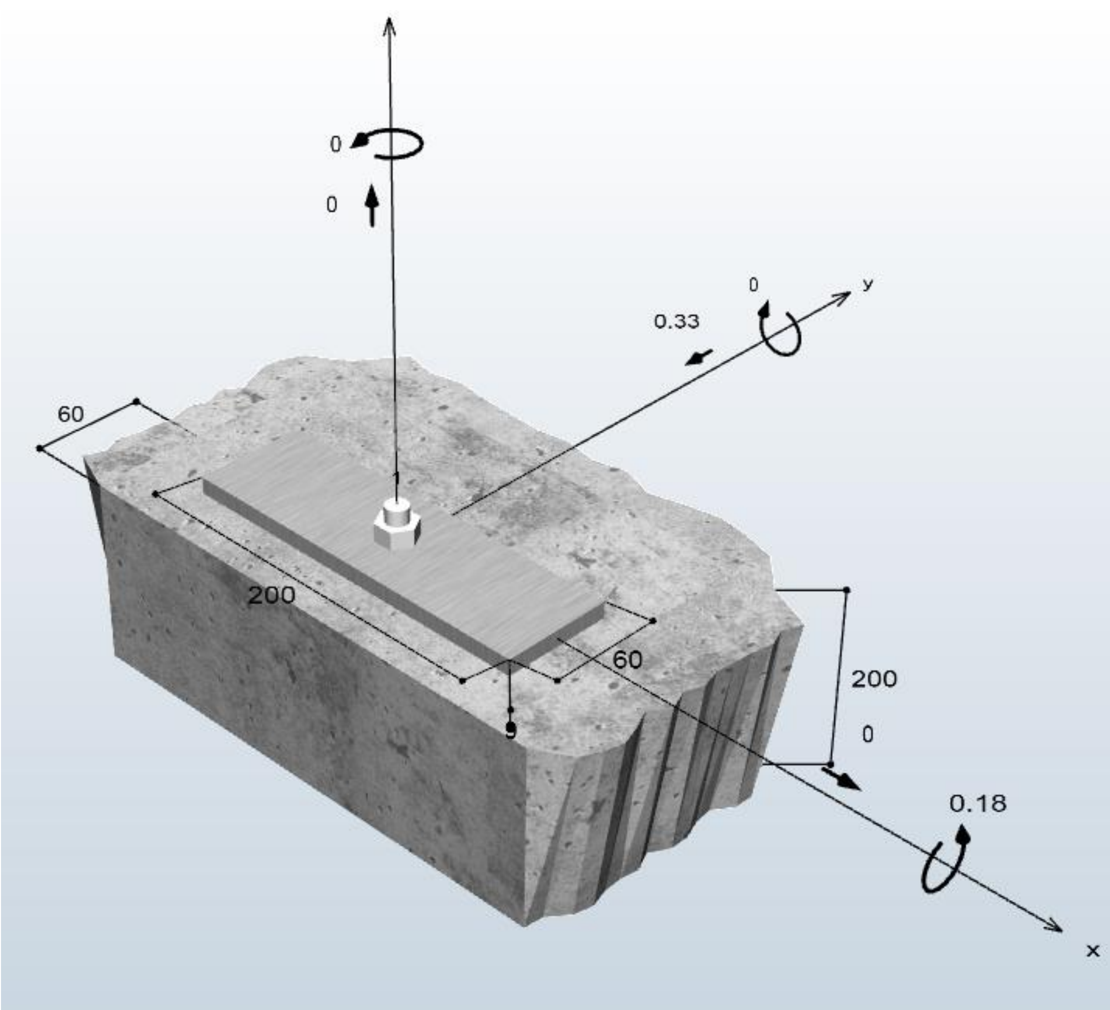
Connection to Concrete – TL 6020

$$\text{Shear Load} = 1.0\text{kN/m}^2 \times 0.2\text{m} \times 1.108\text{m} \times 1.5 = 0.33\text{kN(ULS)}$$

$$\text{Moment} = 0.33\text{kN} \times (1.108\text{m} / 2) = 0.18\text{kN m(ULS)}$$

Therefore use 1 Nr Anchor FAZ II 12/10 A4 @200mm C/C.

See design in Appendix A.



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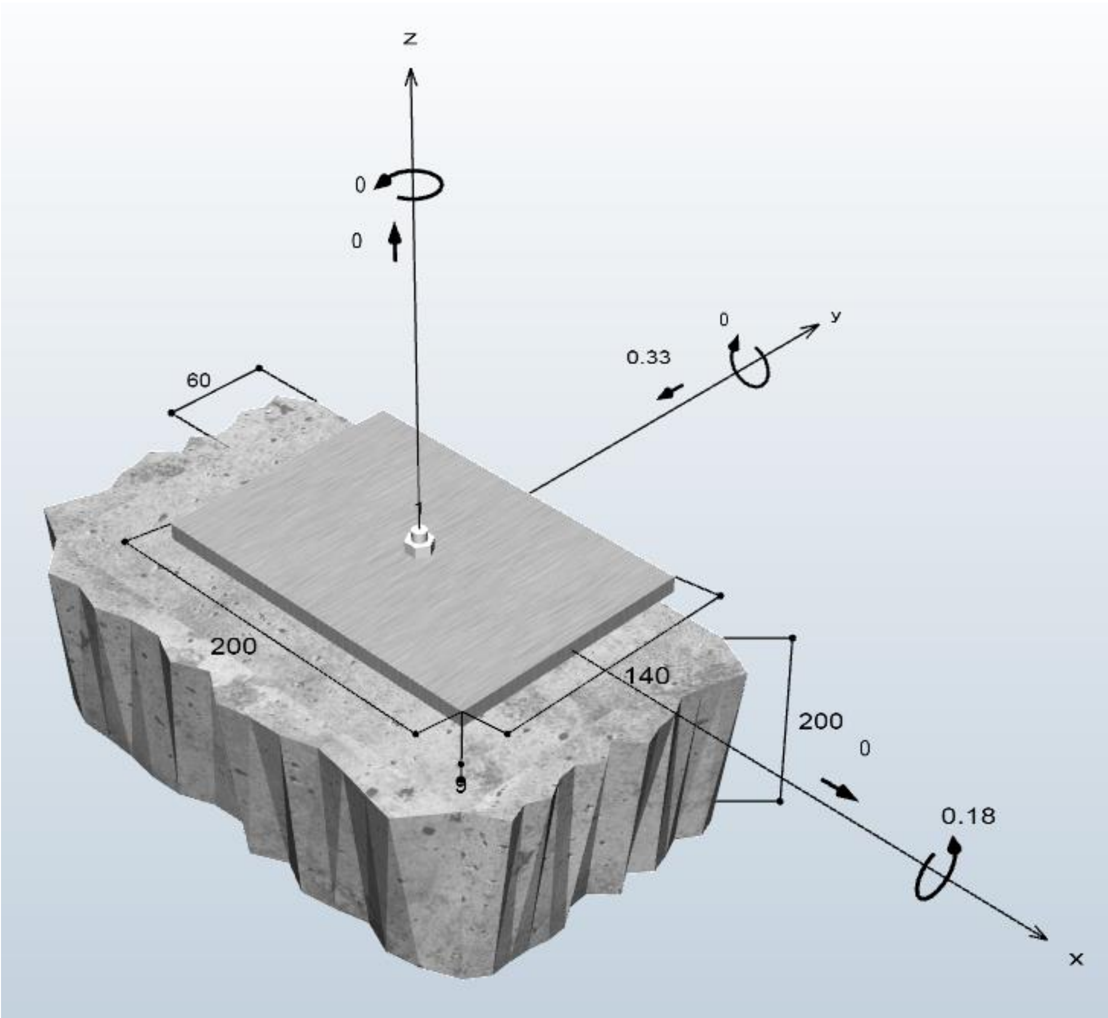
Connection to Concrete – TL 6021

$$\text{Shear Load} = 1.0\text{kN/m}^2 \times 0.2\text{m} \times 1.108\text{m} \times 1.5 = 0.33\text{kN(ULS)}$$

$$\text{Moment} = 0.33\text{kN} \times (1.108\text{m} / 2) = 0.18\text{kN m(ULS)}$$

Therefore use 1 Nr Anchor FH II 12/10 S A4 @200mm C/C.

See design in Appendix A.



Connection to Mild Steel – TL 6020:

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.

$$\mathrm{F_{t,Ed}} = \frac{\frac{1.0\mathrm{kN}}{\mathrm{m^2}} \times 1.5 \times 1.108\mathrm{m} \times 1.0\mathrm{m} \times 0.6 \times \frac{1.108\mathrm{m}}{2}}{0.030} = 18.42\mathrm{kN}$$

$$\mathrm{F_{t,Rd}} = \frac{\mathrm{K_2 F_{ub} A}}{\lambda \mathrm{m2}} \rightarrow \mathrm{F_{t,Rd}} = \frac{0.9 \times 800 \times 84.3 \times 10^{-3}}{1.25} = 48\mathrm{kN} > 18.42\mathrm{kN}$$ **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.

$$\mathrm{F_{V,Ed}} = \frac{1.0\mathrm{kN}}{\mathrm{m^2}} \times 1.5 \times 0.6 \times 1.108\mathrm{m} \times 1.0\mathrm{m} = 1.00\mathrm{kN}$$

$$\mathrm{F_{V,Rd}} = \frac{\alpha \mathrm{F_{ub} A}}{\lambda \mathrm{m2}} \rightarrow \mathrm{F_{V,Rd}} = \frac{0.6 \times 84.3 \times 800 \times 10^{-3}}{1.25} = 32\mathrm{kN} > 1.00\mathrm{kN}$$ **Okay**

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

$$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1.4F_{t,Rd}} \leq 1 \rightarrow \frac{1.00}{32} + \frac{18.42}{1.4 \times 48} = 0.31 \leq 1$$ **Okay**

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

Connection to Mild Steel – TL 6021:

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.*

$$F_{t,Ed} = \frac{\frac{1.0kN}{m^2}\times 1.5\times 1.108m\times 1.0m\times 0.6\times\frac{1.108m}{2}}{0.080} = 6.91kN$$

$$F_{t,Rd} = \frac{K_2 F_{ub} A}{\lambda m2} \rightarrow F_{t,Rd} = \frac{0.9\times 800\times 84.3\times 10^{-3}}{1.25} = 48kN > 6.91kN$$ **Okay**

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

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

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

$$F_{V,Ed} = \frac{1.0kN}{m^2}\times 1.5\times 0.6\times\ 1.108m\times\ 1.0m = 1.00kN$$

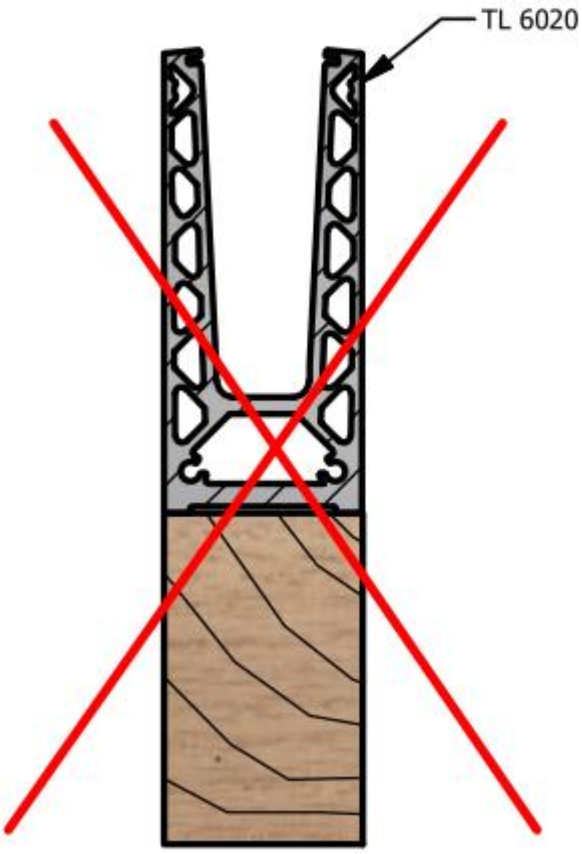
$$F_{V,Rd} = \frac{\alpha F_{ub} A}{\lambda m2} \rightarrow F_{V,Rd} = \frac{0.6\times 84.3\times 800\times 10^{-3}}{1.25} = 32kN > 1.00kN$$ **Okay**

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

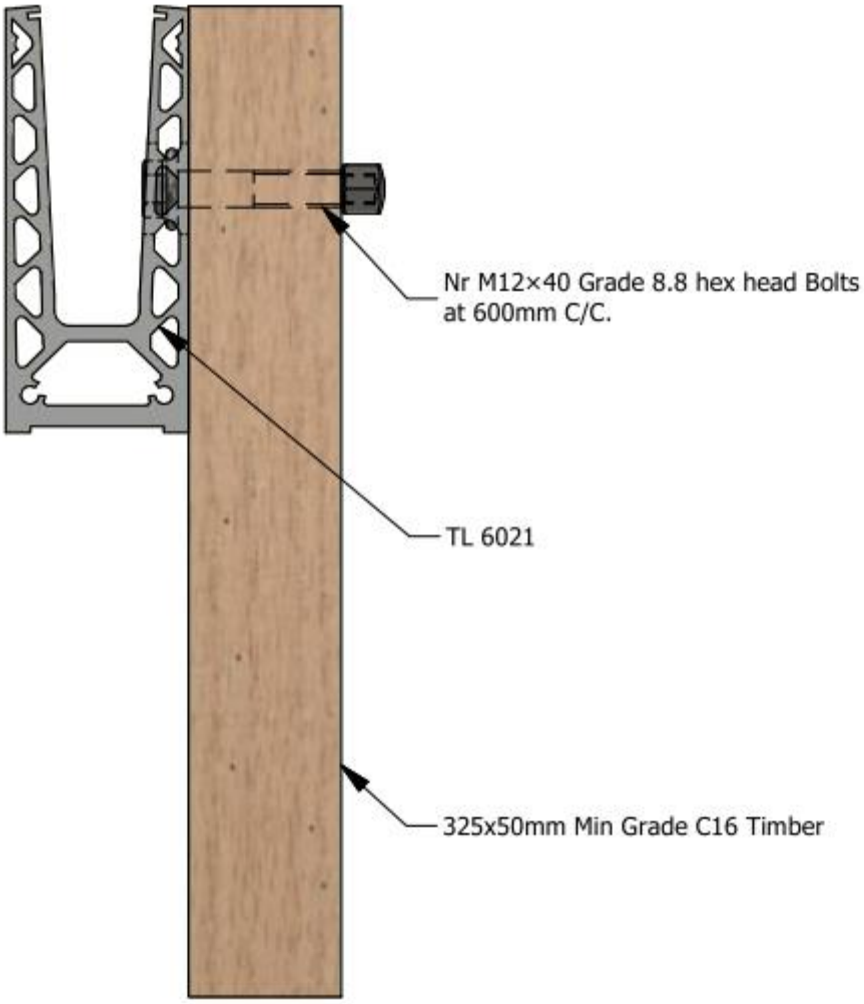
$$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1.4F_{t,Rd}} \le 1 \rightarrow \frac{1.00}{32} + \frac{6.91}{1.4\times 48} = 0.14 \le 1$$ **Okay**

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

Connection to Wood – TL 6020:



Connection to Wood – TL 6021:



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

Case Study 03: 21.52mm (TLT) – 1.0x1.108m – 1.5kN/m^2:

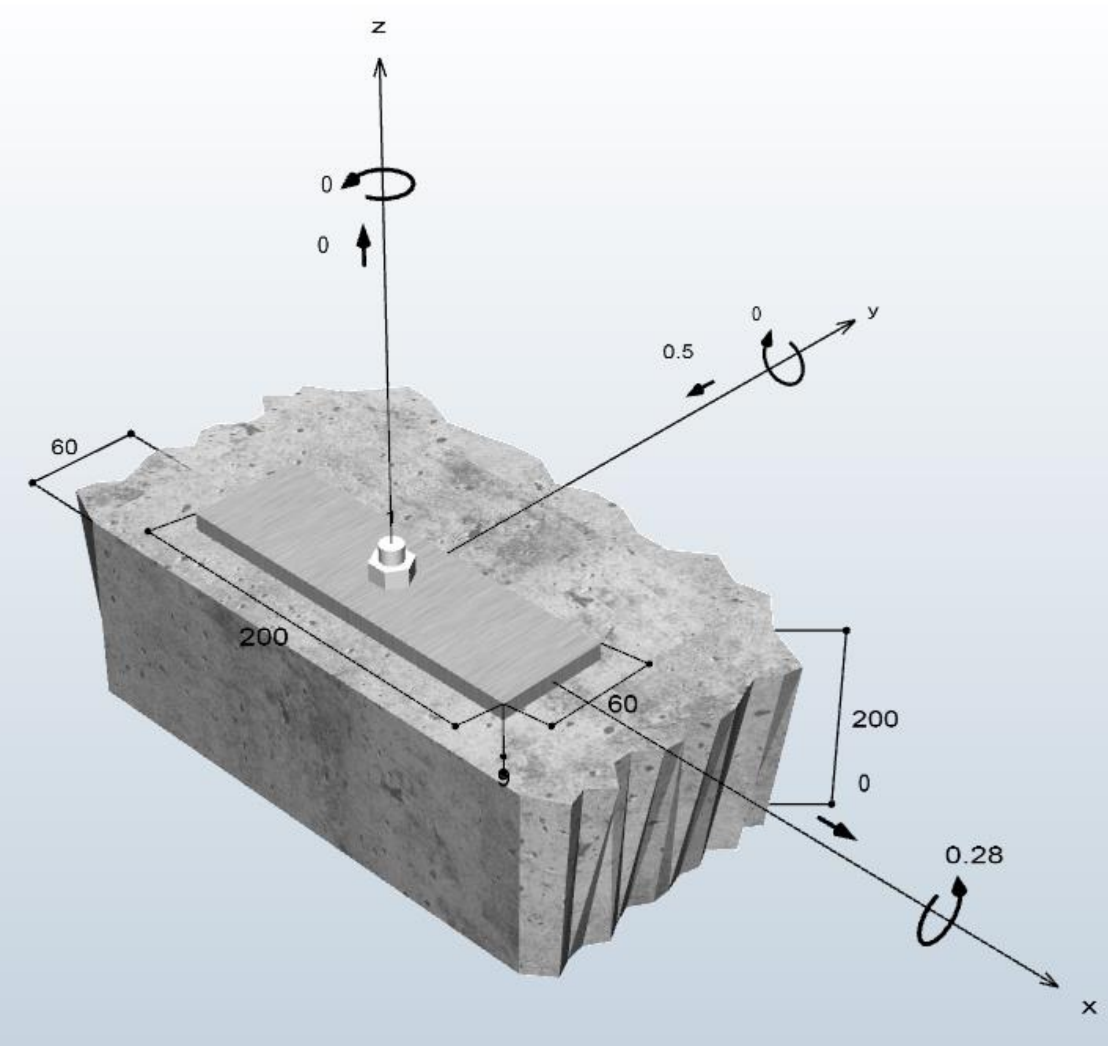
Connection To Concrete – TL 6020

$$\text{Shear Load} = 1.5\text{kN/m}^2 \times 0.2\text{m} \times 1.108\text{m} \times 1.5 = 0.50\text{kN(ULS)}$$

$$\text{Moment} = 0.50\text{kN} \times (1.108\text{m} / 2) = 0.28\text{kN m(ULS)}$$

Therefore use 1 Nr Anchor FAZ II 12/10 A4 @200mm C/C.

See design in Appendix A.



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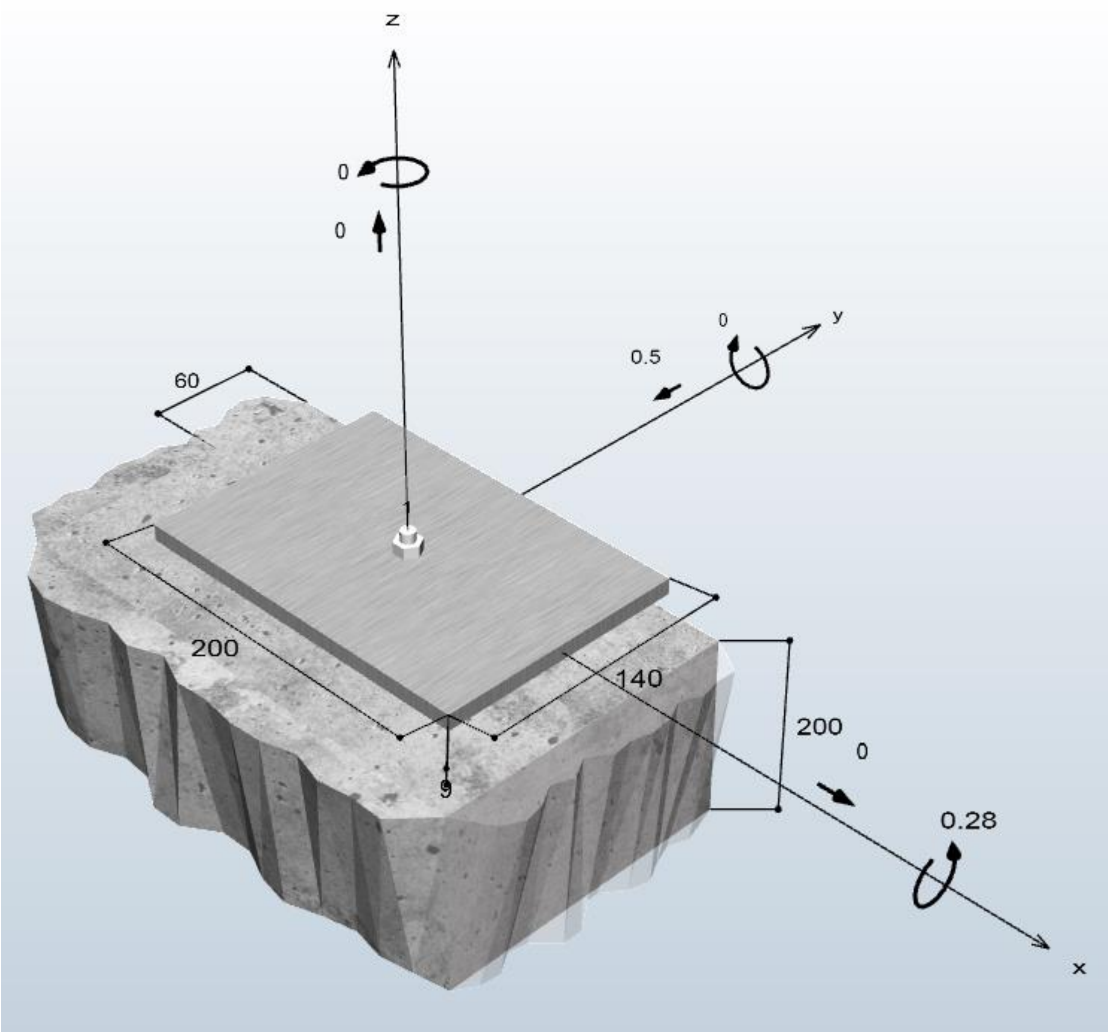
Connection To Concrete – TL 6021

$$\text{Shear Load} = 1.5\text{kN/m}^2 \times 0.2\text{m} \times 1.108\text{m} \times 1.5 = 0.50\text{kN(ULS)}$$

$$\text{Moment} = 0.50\text{kN} \times (1.108\text{m} / 2) = 0.28\text{kN m(ULS)}$$

Therefore use 1 Nr Anchor FH II 12/10 S A4 @200mm C/C.

See design in Appendix A.



Connection To Mild Steel – TL 6020:

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.*

$$\mathrm{F_{t,Ed}} = \frac{\frac{1.5\mathrm{kN}}{\mathrm{m}^2}\times 1.5\times 1.108\mathrm{m}\times 1.0\mathrm{m}\times 0.6\times \frac{1.108\mathrm{m}}{2}}{0.030} = 27.62\mathrm{kN}$$

$$\mathrm{F_{t,Rd}} = \frac{\mathrm{K_2 F_{ub} A}}{\lambda \mathrm{m2}} \rightarrow \mathrm{F_{t,Rd}} = \frac{0.9\times 800\times 84.3\times 10^{-3}}{1.25} = 48\mathrm{kN} > 27.62\mathrm{kN}$$ **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.*

$$\mathrm{F_{V,Ed}} = \frac{1.5\mathrm{kN}}{\mathrm{m}^2}\times 1.5\times 0.6\times\ 1.108\mathrm{m}\times\ 1.0\mathrm{m} = 1.50\mathrm{kN}$$

$$\mathrm{F_{V,Rd}} = \frac{\alpha \mathrm{F_{ub} A}}{\lambda \mathrm{m2}} \rightarrow \mathrm{F_{V,Rd}} = \frac{0.6\times 84.3\times 800\times 10^{-3}}{1.25} = 32\mathrm{kN} > 1.50\mathrm{kN}$$ **Okay**

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

$$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1.4F_{t,Rd}} \leq 1 \rightarrow \frac{1.50}{32} + \frac{27.62}{1.4\times 48} = 0.46 \leq 1$$ **Okay**

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

Connection To Mild Steel – TL 6021:

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.*

$$F_{t,Ed} = \frac{\frac{1.5kN}{m^2}\times 1.5\times 1.108m\times 1.0m\times 0.6\times\frac{1.108m}{2}}{0.080} = 10.36kN$$

$$F_{t,Rd} = \frac{K_2 F_{ub} A}{\lambda m2} \rightarrow F_{t,Rd} = \frac{0.9\times 800\times 84.3\times 10^{-3}}{1.25} = 48kN > 10.36kN$$ **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.*

$$F_{V,Ed} = \frac{1.5kN}{m^2}\times 1.5\times 0.6\times\ 1.108m\times\ 1.0m = 1.50kN$$

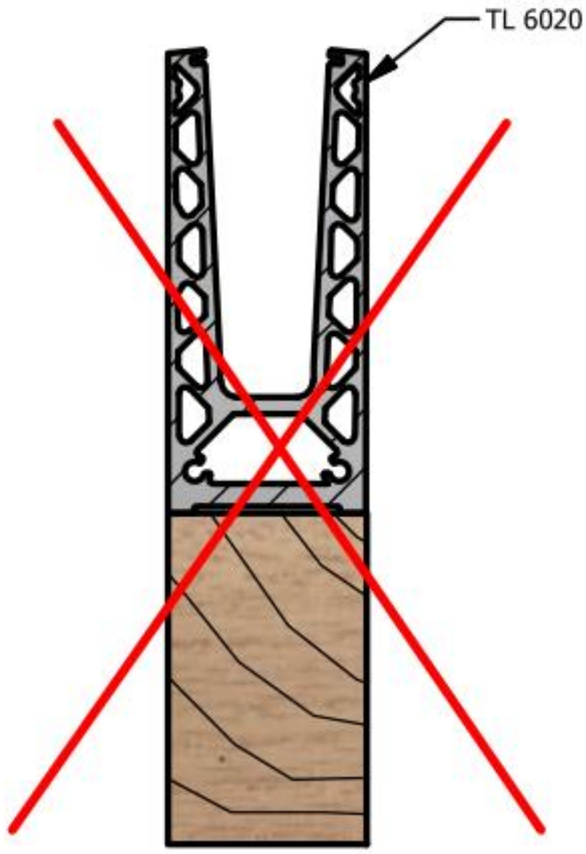
$$F_{V,Rd} = \frac{\alpha F_{ub} A}{\lambda m2} \rightarrow F_{V,Rd} = \frac{0.6\times 84.3\times 800\times 10^{-3}}{1.25} = 32kN > 0.50kN$$ **Okay**

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

$$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1.4F_{t,Rd}} \leq 1 \rightarrow \frac{1.50}{32} + \frac{10.36}{1.4\times 48} = 0.20 \leq 1$$ **Okay**

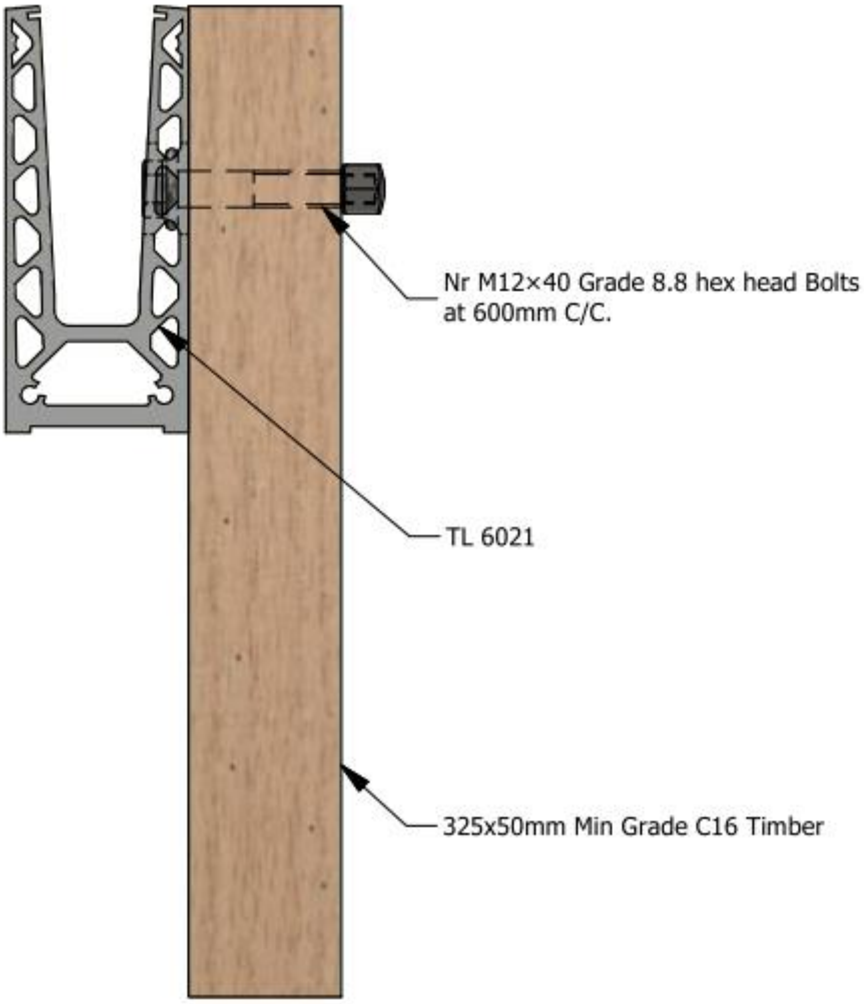
Therefore, use 1Nr M12×40 Grade 8.8 hex head Bolts at 600mm C/C.

Connection to Wood – TL 6020:



Project: TL 6020/ 6021	Contract: 1388-1
Subject: General Wind Load	Sheet No. 28
Date: 08/05/2020	By: R.F.

Connection to Wood – TL 6021:



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

Case Study 04: 21.52mm (TLT) – 1.0x1.108m – 2.0kN/m^2:

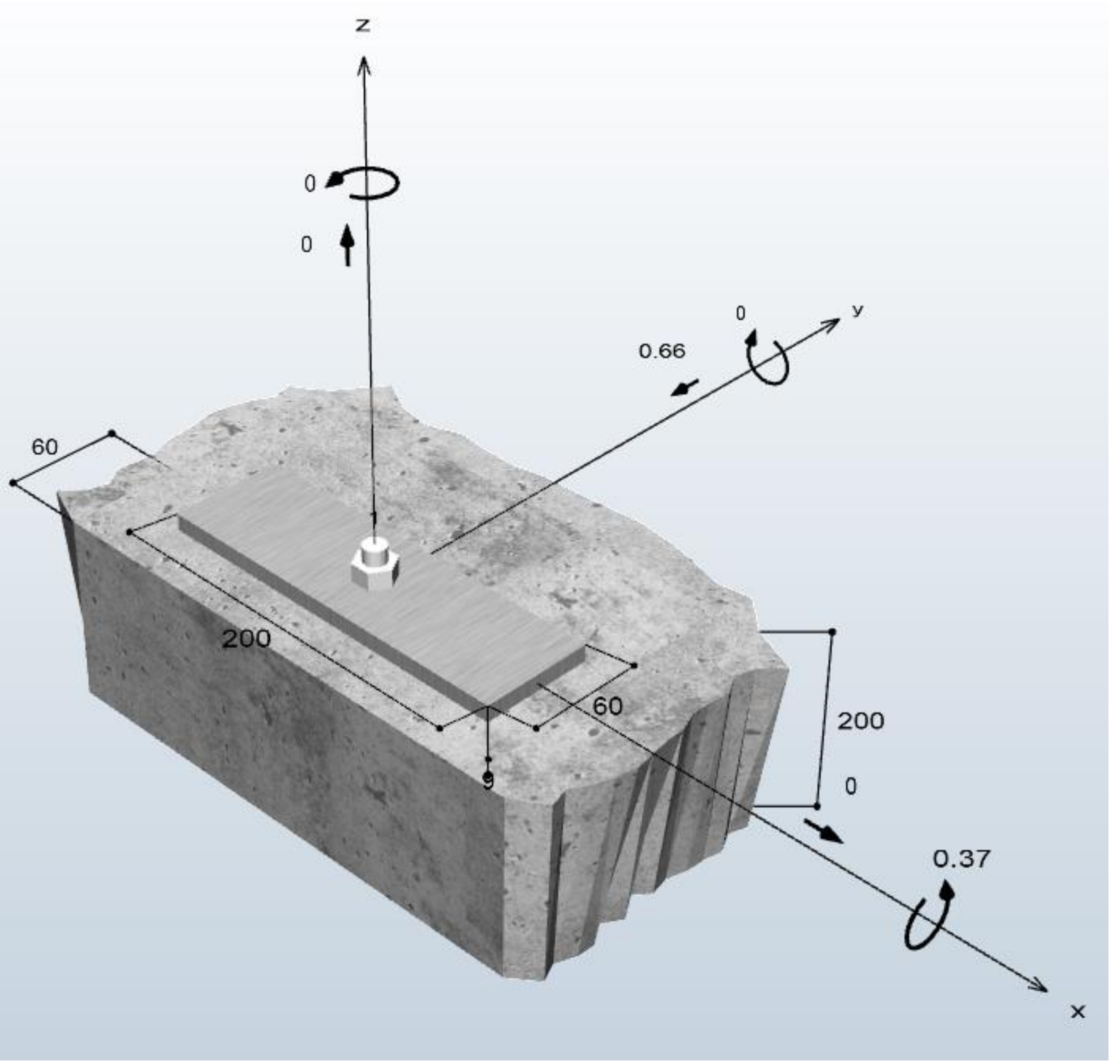
Connection To Concrete – TL 6020

$$\text{Shear Load} = 2.0\text{kN/m}^2 \times 0.2\text{m} \times 1.108\text{m} \times 1.5 = 0.66\text{kN(ULS)}$$

$$\text{Moment} = 0.66\text{kN} \times (1.108\text{m} / 2) = 0.37\text{kN m(ULS)}$$

Therefore use 1 Nr Anchor FAZ II 12/10 A4 @200mm C/C.

See design in Appendix A.



TSA TED SINGLETON & ASSOCIATES CONSULTING ENGINEERS	**Project:** TL 6020/ 6021	**Contract:** 1388-1
	Subject: General Wind Load	**Sheet No.** 30
	Date: 08/05/2020	**By:** R.F.

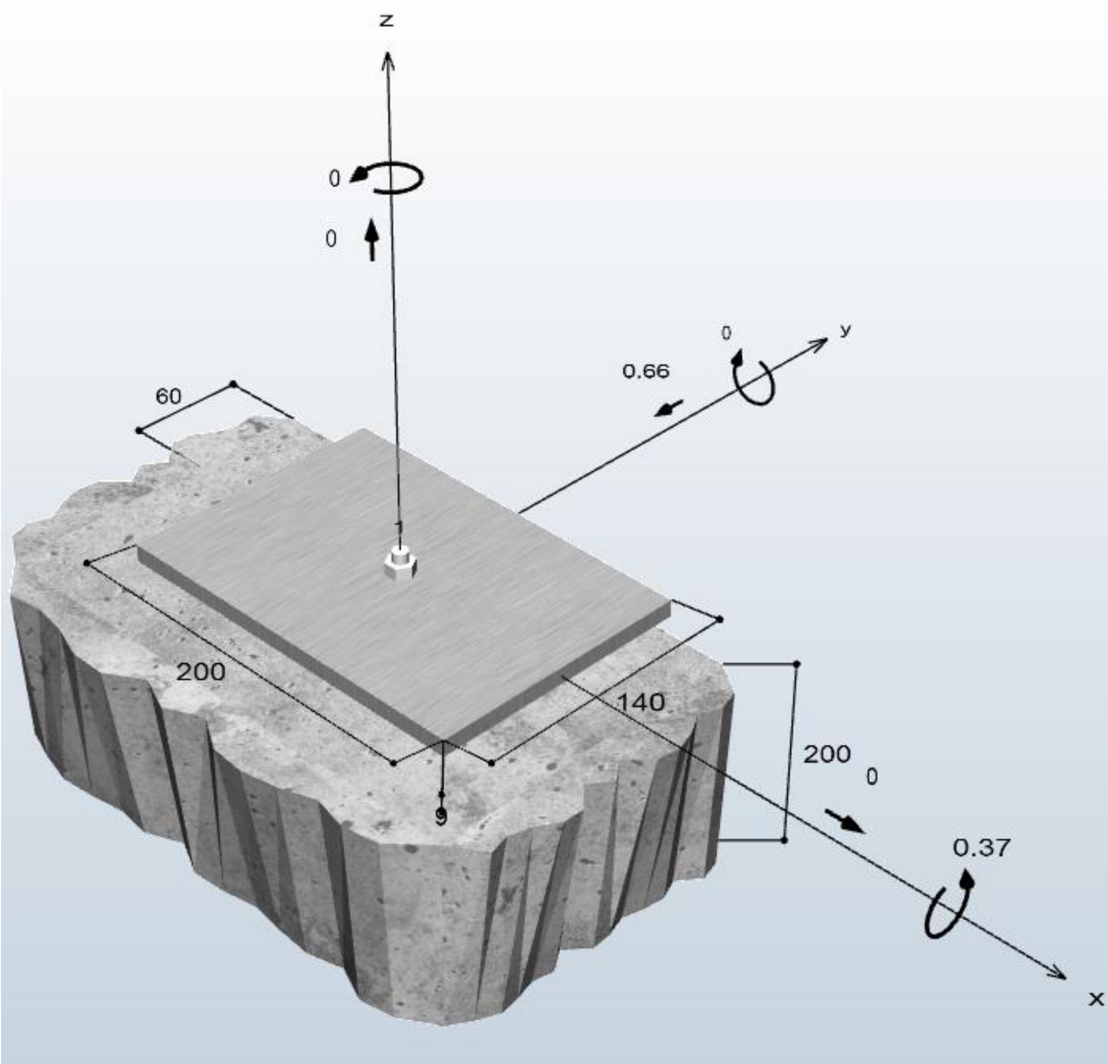
Connection To Concrete – TL 6021

$$\text{Shear Load} = 2.0\text{kN/m}^2 \times 0.2\text{m} \times 1.108\text{m} \times 1.5 = 0.66\text{kN(ULS)}$$

$$\text{Moment} = 0.66\text{kN} \times (1.108\text{m} / 2) = 0.37\text{kN m(ULS)}$$

Therefore use 1 Nr Anchor FH II 12/10 S A4 @200mm C/C.

See design in Appendix A.



Connection To Mild Steel – TL 6020:

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.

$$\mathrm{F_{t,Ed}} = \frac{\frac{2.0\mathrm{kN}}{\mathrm{m}^2}\times 1.5\times 1.108\mathrm{m}\times 1.0\mathrm{m}\times 0.6\times \frac{1.108\mathrm{m}}{2}}{0.030} = 36.83\mathrm{kN}$$

$$\mathrm{F_{t,Rd}} = \frac{\mathrm{K_2 F_{ub} A}}{\lambda\mathrm{m2}} \rightarrow \mathrm{F_{t,Rd}} = \frac{0.9\times 800\times 84.3\times 10^{-3}}{1.25} = 48\mathrm{kN} > 36.83\mathrm{kN}$$ **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.

$$\mathrm{F_{V,Ed}} = \frac{2.0\mathrm{kN}}{\mathrm{m}^2}\times 1.5\times 0.6\times\ 1.108\mathrm{m}\times\ 1.0\mathrm{m} = 2.00\mathrm{kN}$$

$$\mathrm{F_{V,Rd}} = \frac{\alpha\mathrm{F_{ub}A}}{\lambda\mathrm{m2}} \rightarrow \mathrm{F_{V,Rd}} = \frac{0.6\times 84.3\times 800\times 10^{-3}}{1.25} = 32\mathrm{kN} > 2.00\mathrm{kN}$$ **Okay**

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

$$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1.4F_{t,Rd}} \leq 1 \rightarrow \frac{2.00}{32} + \frac{36.83}{1.4\times 48} = 0.61 \leq 1$$ **Okay**

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

Connection To Mild Steel – TL 6021:

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)*

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

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

$$F_{t,Ed} = \frac{\frac{2.0kN}{m^2}\times1.5\times1.108m\times1.0m\times0.6\times\frac{1.108m}{2}}{0.080} = 13.81kN$$

$$F_{t,Rd} = \frac{K_2 F_{ub} A}{\lambda m2} \rightarrow F_{t,Rd} = \frac{0.9\times800\times84.3\times10^{-3}}{1.25} = 48kN > 13.81kN$$ **Okay**

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

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

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

$$F_{V,Ed} = \frac{2.0kN}{m^2}\times1.5\times0.6\times\ 1.108m\times\ 1.0m = 2.00kN$$

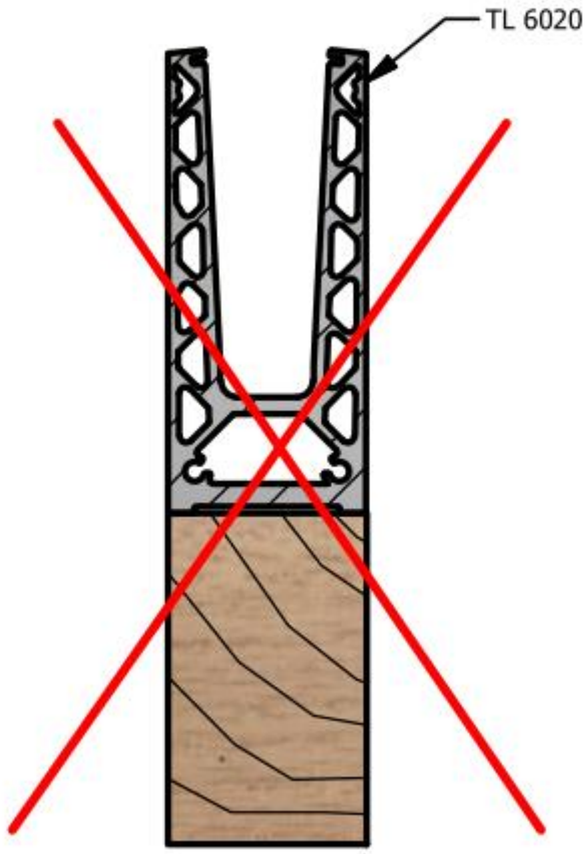
$$F_{V,Rd} = \frac{\alpha F_{ub} A}{\lambda m2} \rightarrow F_{V,Rd} = \frac{0.6\times84.3\times800\times10^{-3}}{1.25} = 32kN > 2.00kN$$ **Okay**

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

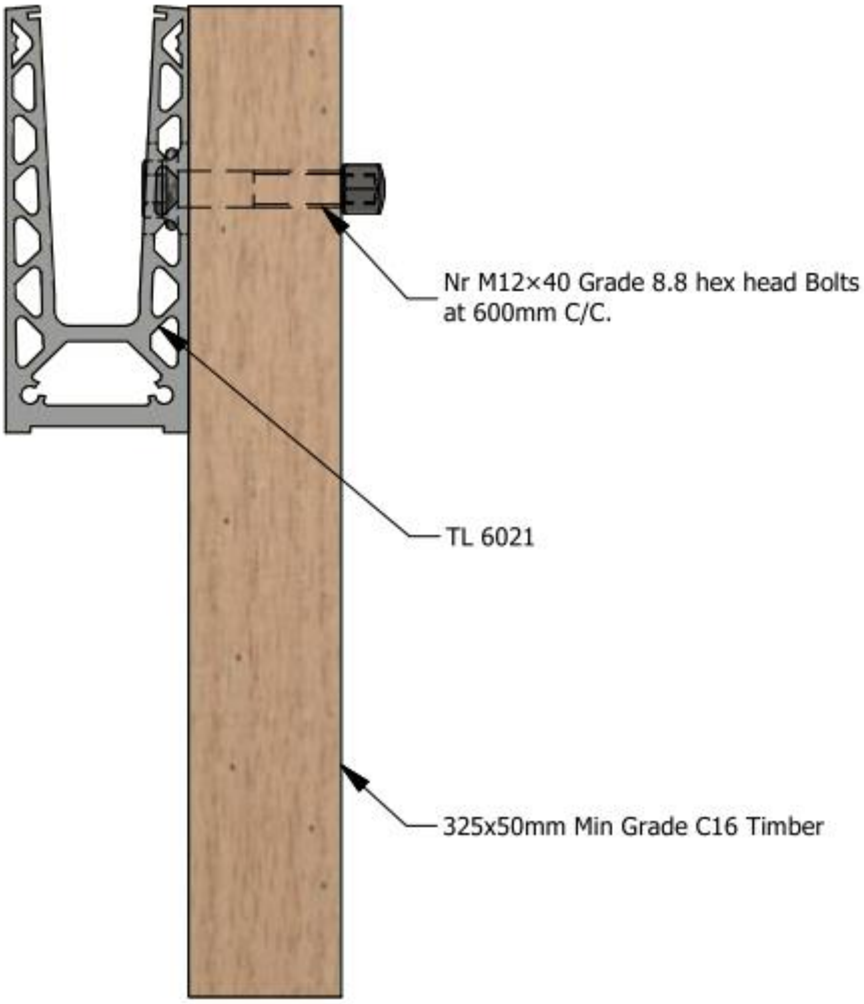
$$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1.4F_{t,Rd}} \le 1 \rightarrow \frac{2.00}{32} + \frac{13.81}{1.4\times48} = 0.27 \le 1$$ **Okay**

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

Connection to Wood – TL 6020:



Connection to Wood – TL 6021:



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

Appendix A - Fischer Reports

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

MASONRY FIXINGS

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

Comment

Case Study 01 and 02 - 1.0kNm2 Wind Load @200 - TL 6020

Design Specifications

Anchor

Anchor system	fischer Bolt anchor FAZ II
Anchor	Bolt anchor FAZ II 12/10 A4, stainless steel, property class A4
Calculated anchorage depth	60 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-05/0069, Option 1, Issued 03/07/2017

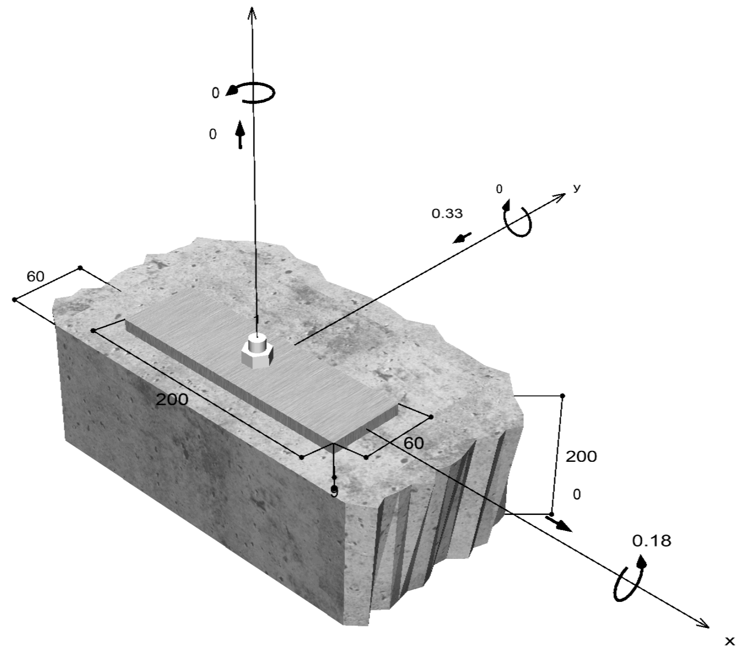
Geometry / Loads / Scale units

mm, kN, kNm

Value of design actions (including

partial safety factor for the load)

Static



Not drawn to scale

Input data

Design method	Design Method EN1992-4:2018 mechanical fastener
Base material	Normal weight concrete, C30/37, EN 206
Concrete condition	Non-cracked, dry hole
Reinforcement	Normal or no reinforcement. No edge reinforcement
Drilling method	hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap not filled
Type of loading	Static or quasi-static
Base plate location	Base plate flush installed on base material
Base plate geometry	200 mm x 60 mm x 9 mm
Profile type	None

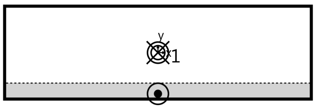
Design actions *)

#	N_{Ed} kN	$V_{Ed,x}$ kN	$V_{Ed,y}$ kN	$M_{Ed,x}$ kNm	$M_{Ed,y}$ kNm	$M_{T,Ed}$ kNm	Type of loading
1	0.00	0.00	-0.33	0.18	0.00	0.00	Static or quasi-static

*) The required partial safety factors for actions are included

Resulting anchor forces

Anchor no.	Tensile action kN	Shear Action kN	Shear Action x kN	Shear Action y kN
1	6.78	0.33	0.00	-0.33



max. concrete compressive strain :	0.20 ‰
max. concrete compressive stress :	6.6 N/mm²
Resulting tensile actions :	6.78 kN , X/Y position (0 / 0)
Resulting compression actions :	6.78 kN , X/Y position (0 / -27)

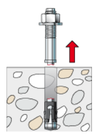
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	6.78	29.53	22.9
Pullout failure *	6.78	17.89	37.9
Concrete cone failure	6.78	14.00	**48.4**
Splitting failure	6.78	17.59	38.5

* Most unfavourable anchor

Steel failure

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

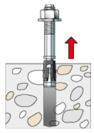


$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
44.30	1.50	29.53	6.78	22.9

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	22.9	1	$\beta_{N,s;1}$

Pullout failure

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



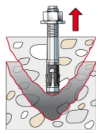
$N_{Rk,p}$ kN	Ψ_c	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
26.84	1.220	1.50	17.89	6.78	37.9

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

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	37.9	1	$\beta_{N,p;1}$

Concrete cone failure

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



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

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

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

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

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

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

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

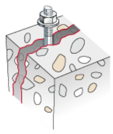
$$\Psi_{M,N} = 1.00 \geq 1 \qquad \text{Eq. (7.7)}$$

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
21.00	1.50	14.00	6.78	48.4

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	48.4	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)

$$N_{Rk,sp} = 26.84kN \cdot \frac{27{,}000mm^2}{32{,}400mm^2} \cdot 0.900 \cdot 1.000 \cdot 1.000 \cdot 1.310 = 26.38kN$$

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

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

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

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

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

$$\Psi_{h,sp} = min\left(\left(\frac{200mm}{100mm}\right)^{2/3} ;max\left(1; \left(\frac{60mm + 1.5 \cdot 60mm}{100mm}\right)^{2/3}\right);2\right) = 1.310$$

$N_{Rk,sp}$ kN	γ_{Msp}	$N_{Rd,sp}$ kN	N_{Ed} kN	$\beta_{N,sp}$ %
26.38	1.50	17.59	6.78	38.5

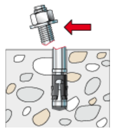
Anchor no.	$\beta_{N,sp}$ %	Group N°	Decisive Beta
1	38.5	1	$\beta_{N,sp;1}$

Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	0.33	30.64	1.1
Concrete pry-out failure	0.33	43.40	0.8
Concrete edge failure	0.33	7.03	**4.7**

* Most unfavourable anchor

Steel failure without lever arm



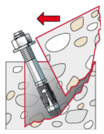
$$V_{Ed} \leq \frac{V_{Rk,s}}{\gamma_{Ms}} \quad (\mathbf{V_{Rd,s}})$$

$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 38.30kN = 38.30kN$$ Eq. (7.35)/ (7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
38.30	1.25	30.64	0.33	1.1

Anchor no.	β_{Vs} %	Group N°	Decisive Beta
1	1.1	1	$\beta_{Vs;1}$

Concrete pry-out failure



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

$$V_{Rk,cp} = k_8 \cdot N_{Rk,c} = 3.1 \cdot 21.00kN = 65.10kN$$ Eq. (7.39a)

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

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

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h^{1.5}_{ef} = 11 \cdot \sqrt{30.0N/mm^2} \cdot \left(60mm\right)^{1.5} = 28.00kN$$ 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)

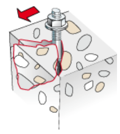
$$\Psi_{M,N} = 1.00 \geq 1$$ Eq. (7.7)

$V_{Rk,cp}$ kN	γ_{Mc}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
65.10	1.50	43.40	0.33	0.8

Anchor no.	$\beta_{V,cp}$ %	Group N°	Decisive Beta
1	0.8	1	$\beta_{V,cp;1}$

Concrete edge failure

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



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

$$V_{Rk,c} = 10.54kN \cdot \frac{16{,}200mm^2}{16{,}200mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 10.54kN$$

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

$$V^0_{Rk,c} = 2.4 \cdot \left(12mm\right)^{0.100} \cdot \left(60mm\right)^{0.072} \cdot \sqrt{30.0N/mm^2} \cdot \left(60mm\right)^{1.5} = 10.54kN$$

$$\alpha = 0.1 \cdot \sqrt{\frac{l_f}{c_1}} = 0.1 \cdot \sqrt{\frac{60mm}{60mm}} = 0.100 \qquad \beta = 0.1 \cdot \left(\frac{d_{nom}}{c_1}\right)^{0.2} = 0.1 \cdot \left(\frac{12mm}{60mm}\right)^{0.2} = 0.072$$ 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	$\beta_{V,c}$ %
10.54	1.50	7.03	0.33	4.7

Anchor no.	$\beta_{V,c}$ %	Group N°	Decisive Beta
1	4.7	1	$\beta_{V,c;1}$

Utilization of tension and shear loads

Tension loads	Utilisation βN %
Steel failure *	22.9
Pullout failure *	37.9
Concrete cone failure	**48.4**
Splitting failure	38.5

Shear Loads	Utilisation βV %
Steel failure without lever arm *	1.1
Concrete pry-out failure	0.8
Concrete edge failure	**4.7**

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N,s} = \beta_{N,s;1} = 0.23 \leq 1$$
$$\beta_{V,s} = \beta_{Vs;1} = 0.01 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.05 \leq 1$$

Eq. (7.55)

Proof successful

Utilisation concrete

$$\beta_{N,c} = \beta_{N,c;1} = 0.48 \leq 1$$
$$\beta_{V,c} = \beta_{V,c;1} = 0.05 \leq 1$$
$$\beta_N^{1.5} + \beta_V^{1.5} = \beta_{N,c;1}^{1.5} + \beta_{V,c;1}^{1.5} = 0.35 \leq 1$$

Eq. (7.56)

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof t = 9 mm

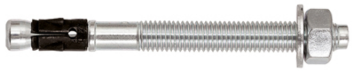
Profile type None

Technical remarks

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

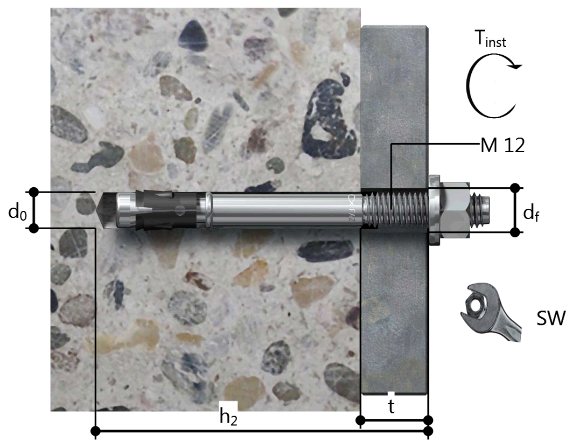
Installation data

Anchor

Anchor system	**fischer Bolt anchor FAZ II**		
Anchor	Bolt anchor FAZ II 12/10 A4, stainless steel, property class A4	Art.-No. 501413	
Accessories	Blow-out pump ABG big	Art.-No. 89300	
	SDS Plus II 12/100/160	Art.-No. 531803	
	or alternatively		
	FHD 12/200/330	Art.-No. 546597	
	Hammer drilling with or without suction		

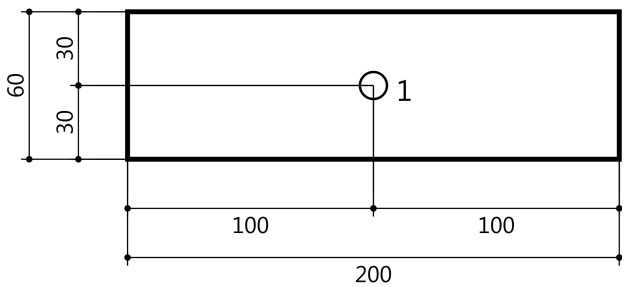
Installation details

Thread diameter	M 12
Drill hole diameter	d_0 = 12 mm
Drill hole depth	h_2 = 88 mm
Calculated anchorage depth	h_{ef} = 60 mm
Installation depth	h_{nom} = 74 mm
Drilling method	hammer drilling
Drill hole cleaning	only blow out by hand No borehole cleaning required in case of using a hollow drill bit, e.g. fischer FHD.
Installation type	Push-through installation
Annular gap	Annular gap not filled
Installation torque	T_{inst} = 60.0 Nm
Socket size	19 mm
Base plate thickness	t = 9 mm
Total fixing thickness	t_{fix} = 9 mm
Tfix,max	$t_{fix, max}$ = 20 mm



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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Comment

Case Study 01 and 02 - 1.0kNm2 Wind Load @200 - TL 6021

Design Specifications

Anchor

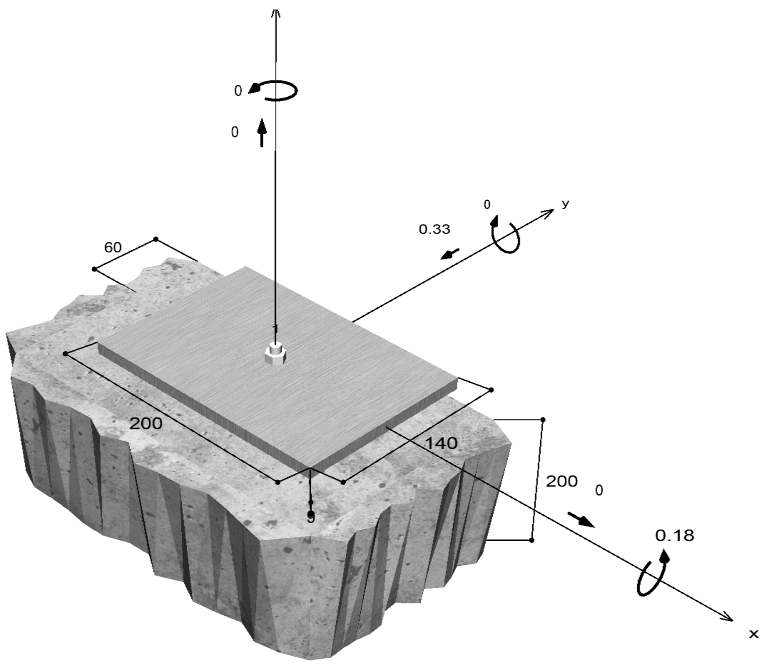
Anchor system	fischer High performance anchor FH II
Anchor	High performance anchor FH II 12/10 S A4, stainless steel, property class A4
Calculated anchorage depth	60 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-07/0025, Option 1, Issued 14/05/2018

Geometry / Loads / Scale units

mm, kN, kNm

Value of design actions (including

partial safety factor for the load)



Not drawn to scale

Input data

Design method	Design Method EN1992-4:2018 mechanical fastener
Base material	Normal weight concrete, C30/37, EN 206
Concrete condition	Non-cracked, dry hole
Reinforcement	Normal or no reinforcement. No edge reinforcement
Drilling method	hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap not filled
Type of loading	Static or quasi-static
Base plate location	Base plate flush installed on base material
Base plate geometry	200 mm x 140 mm x 9 mm
Profile type	None

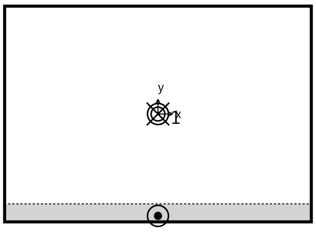
Design actions *)

#	N_{Ed} kN	$V_{Ed,x}$ kN	$V_{Ed,y}$ kN	$M_{Ed,x}$ kNm	$M_{Ed,y}$ kNm	$M_{T,Ed}$ kNm	Type of loading
1	0.00	0.00	-0.33	0.18	0.00	0.00	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	2.72	0.33	0.00	-0.33



max. concrete compressive strain :	0.07 ‰
max. concrete compressive stress :	2.3 N/mm²
Resulting tensile actions :	2.72 kN , X/Y position (0 / 0)
Resulting compression actions :	2.72 kN , X/Y position (0 / -66)

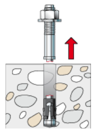
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	2.72	18.31	14.9
Pullout failure *	2.72	16.27	16.7
Concrete cone failure	2.72	14.00	19.4
Splitting failure	2.72	10.83	**25.1**

* Most unfavourable anchor

Steel failure

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

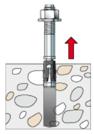


$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
29.30	1.60	18.31	2.72	14.9

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	14.9	1	$\beta_{N,s;1}$

Pullout failure

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



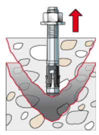
$N_{Rk,p}$ kN	Ψ_c	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
24.40	1.220	1.50	16.27	2.72	16.7

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

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	16.7	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)

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

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

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

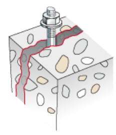
$$\Psi_{M,N} = 1.00 \geq 1$$ Eq. (7.7)

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
21.00	1.50	14.00	2.72	19.4

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	19.4	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)

$$N_{Rk,sp} = 24.40kN \cdot \frac{63{,}000mm^2}{90{,}000mm^2} \cdot 0.820 \cdot 1.000 \cdot 1.000 \cdot 1.160 = 16.25kN$$

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,sp}} = 0.7 + 0.3 \cdot \frac{60mm}{150mm} = 0.820 \leq 1$$ 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)

$$\Psi_{ec,Nx} = \frac{1}{1+\frac{2 \cdot 0mm}{300mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1+\frac{2 \cdot 0mm}{300mm}} = 1.000 \leq 1$$

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

$$\Psi_{h,sp} = min\left(\left(\frac{200mm}{120mm}\right)^{2/3} ;max\left(1; \left(\frac{60mm+1.5 \cdot 60mm}{120mm}\right)^{2/3}\right);2\right) = 1.160$$

$N_{Rk,sp}$ kN	γ_{Msp}	$N_{Rd,sp}$ kN	N_{Ed} kN	$\beta_{N,sp}$ %
16.25	1.50	10.83	2.72	25.1

Anchor no.	$\beta_{N,sp}$ %	Group N°	Decisive Beta
1	25.1	1	$\beta_{N,sp;1}$

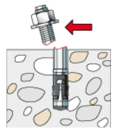
Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	0.33	24.81	**1.3**
Concrete pry-out failure	0.33	28.00	1.2

* Most unfavourable anchor

Steel failure without lever arm

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



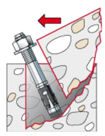
$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 33.00kN = 33.00kN$$ Eq. (7.35)/(7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
33.00	1.33	24.81	0.33	1.3

Anchor no.	β_{Vs} %	Group N°	Decisive Beta
1	1.3	1	$\beta_{Vs;1}$

Concrete pry-out failure

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



$$V_{Rk,cp} = k_8 \cdot N_{Rk,c} = 2 \cdot 21.00kN = 42.00kN$$ Eq. (7.39a)

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

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

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 11 \cdot \sqrt{30.0N/mm^2} \cdot \left(60mm\right)^{1.5} = 28.00kN$$ 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)

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

$V_{Rk,cp}$ kN	γ_{Mc}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
42.00	1.50	28.00	0.33	1.2

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

Utilization of tension and shear loads

Tension loads	Utilisation β_N %
Steel failure *	14.9
Pullout failure *	16.7
Concrete cone failure	19.4
Splitting failure	**25.1**

Shear Loads	Utilisation β_V %
Steel failure without lever arm *	**1.3**
Concrete pry-out failure	1.2

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.15 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.01 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.02 \leq 1$$

Eq. (7.55)

Utilisation concrete

Proof successful

$$\beta_{N,sp} = \beta_{N,sp;1} = 0.25 \leq 1$$
$$\beta_{V.cp} = \beta_{V,cp;1} = 0.01 \leq 1$$
$$\beta_N^{1.5} + \beta_V^{1.5} = \beta_{N,sp;1}^{1.5} + \beta_{V,cp;1}^{1.5} = 0.13 \leq 1$$

Eq. (7.56)

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof t = 9 mm

Profile type None

Technical remarks

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

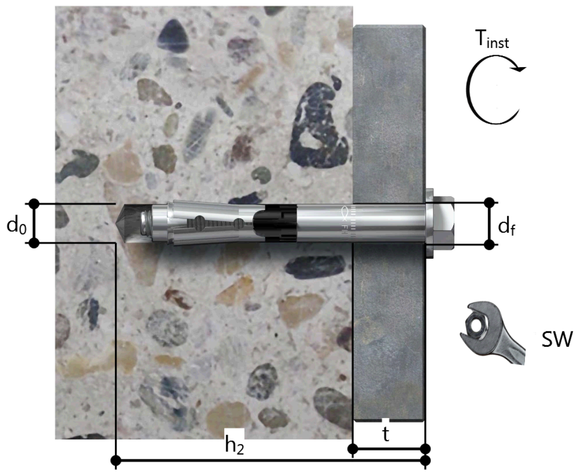
Installation data

Anchor

Anchor system	**fischer High performance anchor FH II**		
Anchor	High performance anchor FH II 12/10 S A4, stainless steel, property class A4	Art.-No. 510925	
Accessories	Blow-out pump ABG big	Art.-No. 89300	
	SDS Plus II 12/100/160	Art.-No. 531803	
	or alternatively FHD 12/200/330	Art.-No. 546597	
	Hammer drilling with or without suction		
	Erection of the drillhole by hammer drilling with or without suction cleaning		

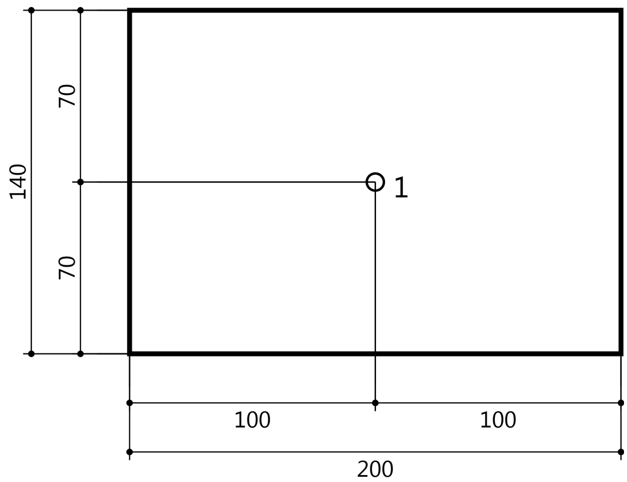
Installation details

Thread diameter	M 8
Drill hole diameter	d_0 = 12 mm
Drill hole depth	h_2 = 90 mm
Calculated anchorage depth	h_{ef} = 60 mm
Installation depth	h_{nom} = 60 mm
Drilling method	hammer drilling
Drill hole cleaning	only blow out by hand No borehole cleaning required in case of using a hollow drill bit, e.g. fischer FHD.
Installation type	Push-through installation
Annular gap	Annular gap not filled
Installation torque	T_{inst} = 25.0 Nm
Socket size	13 mm
Base plate thickness	t = 9 mm
Total fixing thickness	t_{fix} = 9 mm
Tfix,max	$t_{fix, max}$ = 10 mm



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

fischer
innovative solutions

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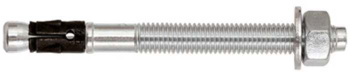
Comment

Case Study 03 - 1.5kNm2 Wind Load @200 - TL 6020

Design Specifications

Anchor



Anchor system	fischer Bolt anchor FAZ II
Anchor	Bolt anchor FAZ II 12/10 A4, stainless steel, property class A4
Calculated anchorage depth	60 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-05/0069, Option 1, Issued 03/07/2017

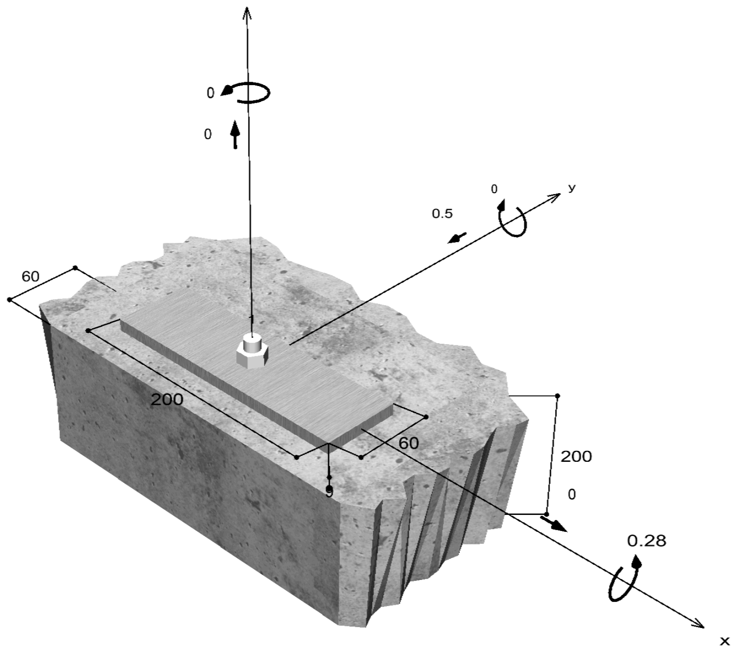
Geometry / Loads / Scale units

mm, kN, kNm

Value of design actions (including

partial safety factor for the load)

Static



Not drawn to scale

Input data

Design method	Design Method EN1992-4:2018 mechanical fastener
Base material	Normal weight concrete, C30/37, EN 206
Concrete condition	Non-cracked, dry hole
Reinforcement	Normal or no reinforcement. No edge reinforcement
Drilling method	hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap not filled
Type of loading	Static or quasi-static
Base plate location	Base plate flush installed on base material
Base plate geometry	200 mm x 60 mm x 9 mm
Profile type	None

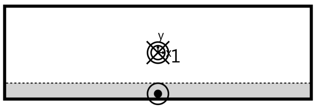
Design actions *)

#	N_{Ed} kN	$V_{Ed,x}$ kN	$V_{Ed,y}$ kN	$M_{Ed,x}$ kNm	$M_{Ed,y}$ kNm	$M_{T,Ed}$ kNm	Type of loading
1	0.00	0.00	-0.50	0.28	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	10.54	0.50	0.00	-0.50



max. concrete compressive strain :	0.31 ‰
max. concrete compressive stress :	10.2 N/mm²
Resulting tensile actions :	10.54 kN , X/Y position (0 / 0)
Resulting compression actions :	10.54 kN , X/Y position (0 / -27)

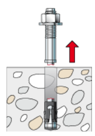
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	10.54	29.53	35.7
Pullout failure *	10.54	17.89	58.9
Concrete cone failure	10.54	14.00	**75.3**
Splitting failure	10.54	17.59	59.9

* Most unfavourable anchor

Steel failure

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

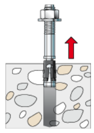


$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
44.30	1.50	29.53	10.54	35.7

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	35.7	1	$\beta_{N,s;1}$

Pullout failure

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



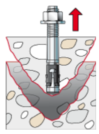
$N_{Rk,p}$ kN	Ψ_c	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
26.84	1.220	1.50	17.89	10.54	58.9

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

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	58.9	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)

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

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

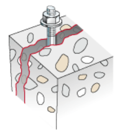
$$\Psi_{M,N} = 1.00 \geq 1$$ Eq. (7.7)

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
21.00	1.50	14.00	10.54	75.3

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	75.3	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)

$$N_{Rk,sp} = 26.84kN \cdot \frac{27{,}000mm^2}{32{,}400mm^2} \cdot 0.900 \cdot 1.000 \cdot 1.000 \cdot 1.310 = 26.38kN$$

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

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

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

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

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

$$\Psi_{h,sp} = min\Big(\Big(\frac{200mm}{100mm}\Big)^{2/3} ;max\Big(1; \Big(\frac{60mm + 1.5 \cdot 60mm}{100mm}\Big)^{2/3}\Big);2\Big) = 1.310$$

$N_{Rk,sp}$ kN	γ_{Msp}	$N_{Rd,sp}$ kN	N_{Ed} kN	$\beta_{N,sp}$ %
26.38	1.50	17.59	10.54	59.9

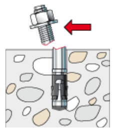
Anchor no.	$\beta_{N,sp}$ %	Group N°	Decisive Beta
1	59.9	1	$\beta_{N,sp;1}$

Resistance to shear loads

Proof	**Action** kN	**Capacity** kN	**Utilisation β_V** %
Steel failure without lever arm *	0.50	30.64	1.6
Concrete pry-out failure	0.50	43.40	1.2
Concrete edge failure	0.50	7.03	**7.1**

* Most unfavourable anchor

Steel failure without lever arm



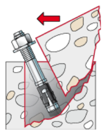
$$V_{Ed} \leq \frac{V_{Rk,s}}{\gamma_{Ms}} \quad (\mathbf{V_{Rd,s}})$$

$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 38.30kN = 38.30kN$$ Eq. (7.35)/(7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
38.30	1.25	30.64	0.50	1.6

Anchor no.	**β_{Vs}** %	**Group N°**	**Decisive Beta**
1	1.6	1	$\beta_{Vs;1}$

Concrete pry-out failure



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

$$V_{Rk,cp} = k_8 \cdot N_{Rk,c} = 3.1 \cdot 21.00kN = 65.10kN$$ Eq. (7.39a)

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

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

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 11 \cdot \sqrt{30.0N/mm^2} \cdot \left(60mm\right)^{1.5} = 28.00kN$$ 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)

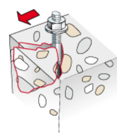
$$\Psi_{ec,N} = \frac{1}{1 + \frac{2e_n}{s_{cr,N}}} \Longrightarrow \Psi_{ec,Nx} \cdot \Psi_{ec,Ny} = 1.000 \cdot 1.000 = 1.000 \leq 1$$ Eq. (7.6)

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

$V_{Rk,cp}$ kN	γ_{Mc}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
65.10	1.50	43.40	0.50	1.2

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

Concrete edge failure



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

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

$$V_{Rk,c} = 10.54kN \cdot \frac{16,200mm^2}{16,200mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 10.54kN$$

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

$$V^0_{Rk,c} = 2.4 \cdot \left(12mm\right)^{0.100} \cdot \left(60mm\right)^{0.072} \cdot \sqrt{30.0N/mm^2} \cdot \left(60mm\right)^{1.5} = 10.54kN$$

$$\alpha = 0.1 \cdot \sqrt{\frac{l_f}{c_1}} = 0.1 \cdot \sqrt{\frac{60mm}{60mm}} = 0.100 \qquad \beta = 0.1 \cdot \left(\frac{d_{nom}}{c_1}\right)^{0.2} = 0.1 \cdot \left(\frac{12mm}{60mm}\right)^{0.2} = 0.072$$ 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	$\beta_{V,c}$ %
10.54	1.50	7.03	0.50	7.1

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

Utilization of tension and shear loads

Tension loads	Utilisation βN %
Steel failure *	35.7
Pullout failure *	58.9
Concrete cone failure	**75.3**
Splitting failure	59.9

Shear Loads	Utilisation βV %
Steel failure without lever arm *	1.6
Concrete pry-out failure	1.2
Concrete edge failure	**7.1**

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.36 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.02 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.13 \leq 1$$ Eq. (7.55)

Proof successful

Utilisation concrete

$$\beta_{N,c} = \beta_{N,c;1} = 0.75 \leq 1$$
$$\beta_{V.c} = \beta_{V,c;1} = 0.07 \leq 1$$
$$\beta_N^{1.5} + \beta_V^{1.5} = \beta_{N,c;1}^{1.5} + \beta_{V,c;1}^{1.5} = 0.67 \leq 1$$ Eq. (7.56)

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof t = 9 mm

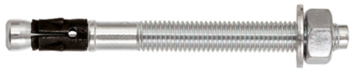
Profile type None

Technical remarks

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

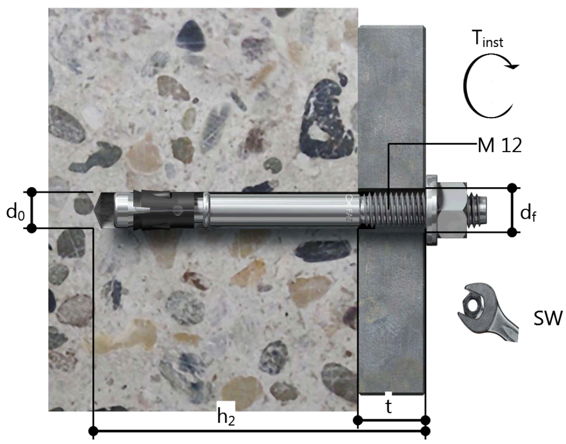
Installation data

Anchor

Anchor system	**fischer Bolt anchor FAZ II**		
Anchor	Bolt anchor FAZ II 12/10 A4, stainless steel, property class A4	Art.-No. 501413	
Accessories	Blow-out pump ABG big	Art.-No. 89300	
	SDS Plus II 12/100/160	Art.-No. 531803	
	or alternatively		
	FHD 12/200/330	Art.-No. 546597	
	Hammer drilling with or without suction		

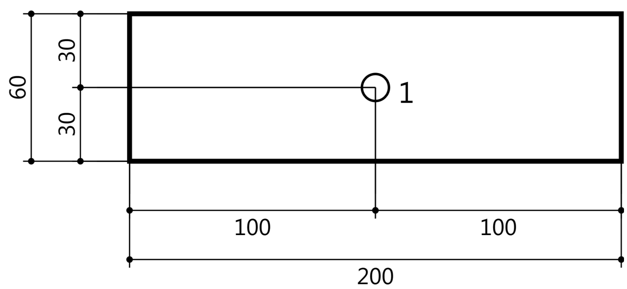
Installation details

Thread diameter	M 12
Drill hole diameter	d_0 = 12 mm
Drill hole depth	h_2 = 88 mm
Calculated anchorage depth	h_{ef} = 60 mm
Installation depth	h_{nom} = 74 mm
Drilling method	hammer drilling
Drill hole cleaning	only blow out by hand No borehole cleaning required in case of using a hollow drill bit, e.g. fischer FHD.
Installation type	Push-through installation
Annular gap	Annular gap not filled
Installation torque	T_{inst} = 60.0 Nm
Socket size	19 mm
Base plate thickness	t = 9 mm
Total fixing thickness	t_{fix} = 9 mm
Tfix,max	$t_{fix, max}$ = 20 mm



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

fischer innovative solutions

MASONRY FIXINGS

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Dublin 10
Phone: +353 1 642 6700
Fax: +353 1 626 2197
technical@masonryfixings.ie
www.masonryfixings.ie

Comment

Case Study 03 - 1.5kNm2 Wind Load @200 - TL 6021

Design Specifications

Anchor

Anchor system	fischer High performance anchor FH II
Anchor	High performance anchor FH II 12/10 S A4, stainless steel, property class A4
Calculated anchorage depth	60 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-07/0025, Option 1, Issued 14/05/2018

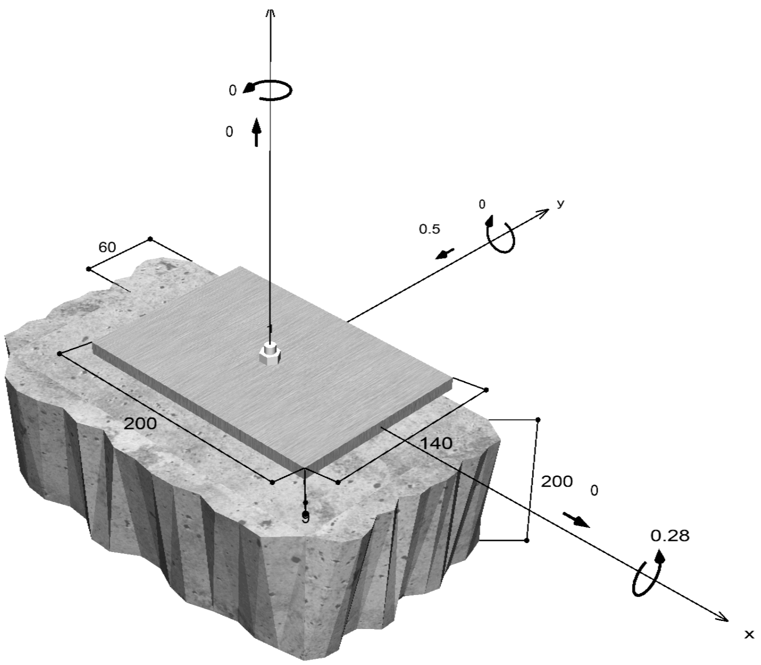
Geometry / Loads / Scale units

mm, kN, kNm

Value of design actions (including

partial safety factor for the load)

Static



Not drawn to scale

Input data

Design method	Design Method EN1992-4:2018 mechanical fastener
Base material	Normal weight concrete, C30/37, EN 206
Concrete condition	Non-cracked, dry hole
Reinforcement	Normal or no reinforcement. No edge reinforcement
Drilling method	hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap not filled
Type of loading	Static or quasi-static
Base plate location	Base plate flush installed on base material
Base plate geometry	200 mm x 140 mm x 9 mm
Profile type	None

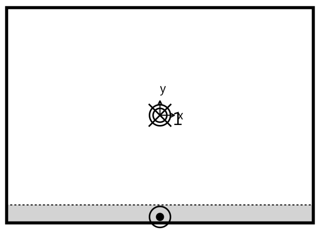
Design actions *)

#	N_{Ed} kN	$V_{Ed,x}$ kN	$V_{Ed,y}$ kN	$M_{Ed,x}$ kNm	$M_{Ed,y}$ kNm	$M_{T,Ed}$ kNm	Type of loading
1	0.00	0.00	-0.50	0.28	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	4.24	0.50	0.00	-0.50



max. concrete compressive strain :	0.11 ‰
max. concrete compressive stress :	3.6 N/mm²
Resulting tensile actions :	4.24 kN , X/Y position (0 / 0)
Resulting compression actions :	4.24 kN , X/Y position (0 / -66)

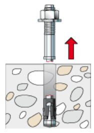
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	4.24	18.31	23.1
Pullout failure *	4.24	16.27	26.0
Concrete cone failure	4.24	14.00	30.3
Splitting failure	4.24	10.83	**39.1**

* Most unfavourable anchor

Steel failure

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

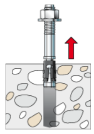


$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
29.30	1.60	18.31	4.24	23.1

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	23.1	1	$\beta_{N,s;1}$

Pullout failure

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



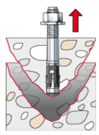
$N_{Rk,p}$ kN	Ψ_c	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
24.40	1.220	1.50	16.27	4.24	26.0

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

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	26.0	1	$\beta_{N,p;1}$

Concrete cone failure

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



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

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

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

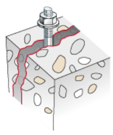
$$\Psi_{ec,Nx} = \frac{1}{1+\frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1+\frac{2 \cdot 0mm}{180mm}} = 1.000 \leq 1$$

$$\Psi_{M,N} = 1.00 \geq 1$$ 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	4.24	30.3

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	30.3	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)

$$N_{Rk,sp} = 24.40kN \cdot \frac{63{,}000mm^2}{90{,}000mm^2} \cdot 0.820 \cdot 1.000 \cdot 1.000 \cdot 1.160 = 16.25kN$$

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,sp}} = 0.7 + 0.3 \cdot \frac{60mm}{150mm} = 0.820 \leq 1$$ 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)

$$\Psi_{ec,Nx} = \frac{1}{1+\frac{2 \cdot 0mm}{300mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1+\frac{2 \cdot 0mm}{300mm}} = 1.000 \leq 1$$

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

$$\Psi_{h,sp} = min\left(\left(\frac{200mm}{120mm}\right)^{2/3} ;max\left(1; \left(\frac{60mm + 1.5 \cdot 60mm}{120mm}\right)^{2/3}\right);2\right) = 1.160$$

$N_{Rk,sp}$ kN	γ_{Msp}	$N_{Rd,sp}$ kN	N_{Ed} kN	$\beta_{N,sp}$ %
16.25	1.50	10.83	4.24	39.1

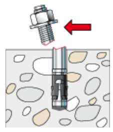
Anchor no.	$\beta_{N,sp}$ %	Group N°	Decisive Beta
1	39.1	1	$\beta_{N,sp;1}$

Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	0.50	24.81	**2.0**
Concrete pry-out failure	0.50	28.00	1.8

* Most unfavourable anchor

Steel failure without lever arm



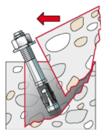
$$V_{Ed} \leq \frac{V_{Rk,s}}{\gamma_{Ms}} \quad (\mathbf{V_{Rd,s}})$$

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

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
33.00	1.33	24.81	0.50	2.0

Anchor no.	β_{Vs} %	Group N°	Decisive Beta
1	2.0	1	$\beta_{Vs;1}$

Concrete pry-out failure



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

$$V_{Rk,cp} = k_8 \cdot N_{Rk,c} = 2 \cdot 21.00kN = 42.00kN$$ Eq. (7.39a)

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

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

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 11 \cdot \sqrt{30.0N/mm^2} \cdot \left(60mm\right)^{1.5} = 28.00kN$$ 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)

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

$V_{Rk,cp}$ kN	γ_{Mc}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
42.00	1.50	28.00	0.50	1.8

Anchor no.	$\beta_{V,cp}$ %	Group N°	Decisive Beta
1	1.8	1	$\beta_{V,cp;1}$

Utilization of tension and shear loads

Tension loads	Utilisation β_N %
Steel failure *	23.1
Pullout failure *	26.0
Concrete cone failure	30.3
Splitting failure	**39.1**

* Most unfavourable anchor

Shear Loads	Utilisation β_V %
Steel failure without lever arm *	**2.0**
Concrete pry-out failure	1.8

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.23 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.02 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.05 \leq 1$$ Eq. (7.55)

Utilisation concrete

Proof successful

$$\beta_{N,sp} = \beta_{N,sp;1} = 0.39 \leq 1$$
$$\beta_{V.cp} = \beta_{V,cp;1} = 0.02 \leq 1$$
$$\beta_N^{1.5} + \beta_V^{1.5} = \beta_{N,sp;1}^{1.5} + \beta_{V,cp;1}^{1.5} = 0.25 \leq 1$$ Eq. (7.56)

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof t = 9 mm

Profile type None

Technical remarks

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

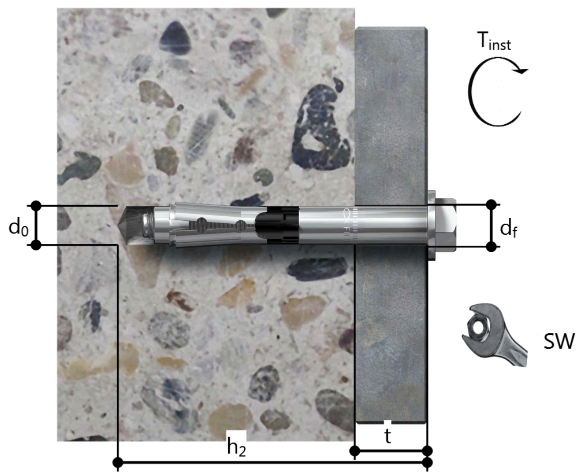
Installation data

Anchor

Anchor system	**fischer High performance anchor FH II**	
Anchor	High performance anchor FH II 12/10 S A4, stainless steel, property class A4	Art.-No. 510925
Accessories	Blow-out pump ABG big	Art.-No. 89300
	SDS Plus II 12/100/160	Art.-No. 531803
	or alternatively	
	FHD 12/200/330	Art.-No. 546597
	Hammer drilling with or without suction	
	Erection of the drillhole by hammer drilling with or without suction cleaning	

Installation details

Thread diameter	M 8
Drill hole diameter	d_0 = 12 mm
Drill hole depth	h_2 = 90 mm
Calculated anchorage depth	h_{ef} = 60 mm
Installation depth	h_{nom} = 60 mm
Drilling method	hammer drilling
Drill hole cleaning	only blow out by hand No borehole cleaning required in case of using a hollow drill bit, e.g. fischer FHD.
Installation type	Push-through installation
Annular gap	Annular gap not filled
Installation torque	T_{inst} = 25.0 Nm
Socket size	13 mm
Base plate thickness	t = 9 mm
Total fixing thickness	t_{fix} = 9 mm
Tfix,max	$t_{fix, max}$ = 10 mm

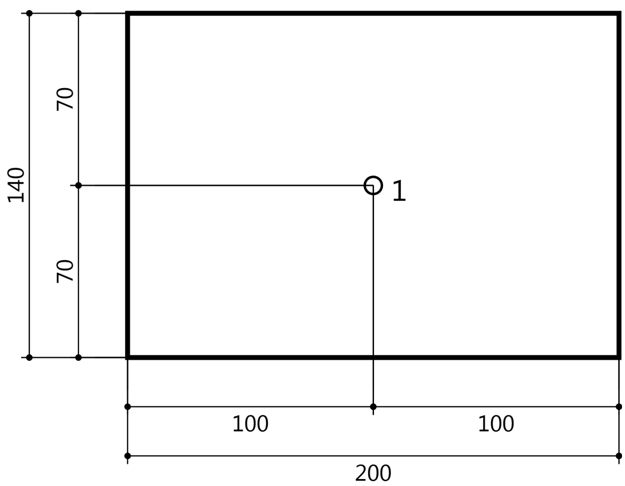


Base plate details

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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Comment

Case Study 04 - 2.0kNm2 Wind Load @200 - TL 6020

Design Specifications

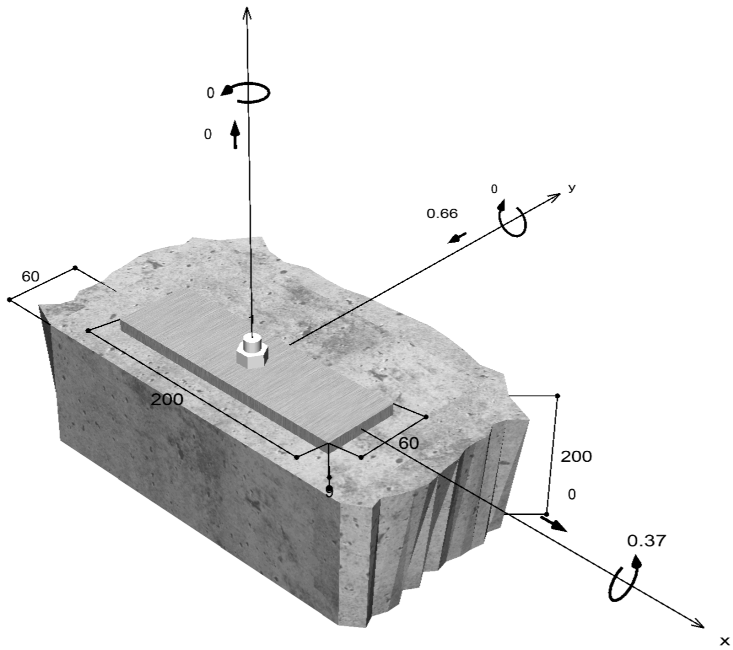
Anchor

Anchor system	fischer Bolt anchor FAZ II
Anchor	Bolt anchor FAZ II 12/10 A4, stainless steel, property class A4
Calculated anchorage depth	60 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-05/0069, Option 1, Issued 03/07/2017

Geometry / Loads / Scale units

mm, kN, kNm

Value of design actions (including partial safety factor for the load)



Not drawn to scale

Input data

Design method	Design Method EN1992-4:2018 mechanical fastener
Base material	Normal weight concrete, C30/37, EN 206
Concrete condition	Non-cracked, dry hole
Reinforcement	Normal or no reinforcement. No edge reinforcement
Drilling method	hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap not filled
Type of loading	Static or quasi-static
Base plate location	Base plate flush installed on base material
Base plate geometry	200 mm x 60 mm x 9 mm
Profile type	None

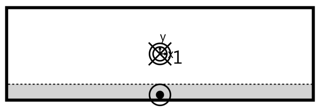
Design actions *⁾

#	N_{Ed} kN	$V_{Ed,x}$ kN	$V_{Ed,y}$ kN	$M_{Ed,x}$ kNm	$M_{Ed,y}$ kNm	$M_{T,Ed}$ kNm	Type of loading
1	0.00	0.00	-0.66	0.37	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	13.93	0.66	0.00	-0.66



max. concrete compressive strain :	0.41 ‰	
max. concrete compressive stress :	13.5 N/mm²	
Resulting tensile actions :	13.93 kN ,	X/Y position (0 / 0)
Resulting compression actions :	13.93 kN ,	X/Y position (0 / -27)

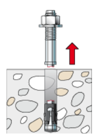
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	13.93	29.53	47.2
Pullout failure *	13.93	17.89	77.8
Concrete cone failure	13.93	14.00	**99.5**
Splitting failure	13.93	17.59	79.2

* Most unfavourable anchor

Steel failure

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

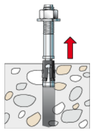


$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
44.30	1.50	29.53	13.93	47.2

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

Pullout failure

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



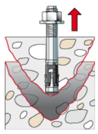
$N_{Rk,p}$ kN	Ψ_c	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
26.84	1.220	1.50	17.89	13.93	77.8

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

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	77.8	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)

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

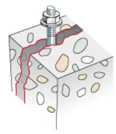
$$\Psi_{M,N} = 1.00 \geq 1$$ Eq. (7.7)

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
21.00	1.50	14.00	13.93	99.5

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	99.5	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)

$$N_{Rk,sp} = 26.84kN \cdot \frac{27{,}000mm^2}{32{,}400mm^2} \cdot 0.900 \cdot 1.000 \cdot 1.000 \cdot 1.310 = 26.38kN$$

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

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

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

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

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

$$\Psi_{h,sp} = min\Bigg(\left(\frac{200mm}{100mm}\right)^{2/3} ;max\left(1; \left(\frac{60mm + 1.5 \cdot 60mm}{100mm}\right)^{2/3}\right);2\Bigg) = 1.310$$

$N_{Rk,sp}$ kN	γ_{Msp}	$N_{Rd,sp}$ kN	N_{Ed} kN	$\beta_{N,sp}$ %
26.38	1.50	17.59	13.93	79.2

Anchor no.	$\beta_{N,sp}$ %	Group N°	Decisive Beta
1	79.2	1	$\beta_{N,sp;1}$

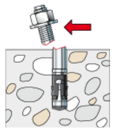
Resistance to shear loads

Proof	**Action** kN	**Capacity** kN	**Utilisation β_V** %
Steel failure without lever arm *	0.66	30.64	2.2
Concrete pry-out failure	0.66	43.40	1.5
Concrete edge failure	0.66	7.03	**9.4**

* Most unfavourable anchor

Steel failure without lever arm

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



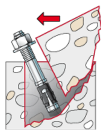
$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 38.30kN = 38.30kN$$ Eq. (7.35)/(7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
38.30	1.25	30.64	0.66	2.2

Anchor no.	β_{Vs} %	**Group N°**	**Decisive Beta**
1	2.2	1	$\beta_{Vs;1}$

Concrete pry-out failure

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



$$V_{Rk,cp} = k_8 \cdot N_{Rk,c} = 3.1 \cdot 21.00kN = 65.10kN$$ Eq. (7.39a)

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

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

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 11 \cdot \sqrt{30.0N/mm^2} \cdot \left(60mm\right)^{1.5} = 28.00kN$$ 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)

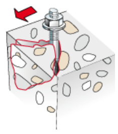
$$\Psi_{M,N} = 1.00 \geq 1$$ Eq. (7.7)

$V_{Rk,cp}$ kN	γ_{Mc}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
65.10	1.50	43.40	0.66	1.5

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

Concrete edge failure

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



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

$$V_{Rk,c} = 10.54kN \cdot \frac{16,200mm^2}{16,200mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 10.54kN$$

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

$$V^0_{Rk,c} = 2.4 \cdot \left(12mm\right)^{0.100} \cdot \left(60mm\right)^{0.072} \cdot \sqrt{30.0N/mm^2} \cdot \left(60mm\right)^{1.5} = 10.54kN$$

$$\alpha = 0.1 \cdot \sqrt{\frac{l_f}{c_1}} = 0.1 \cdot \sqrt{\frac{60mm}{60mm}} = 0.100 \qquad \beta = 0.1 \cdot \left(\frac{d_{nom}}{c_1}\right)^{0.2} = 0.1 \cdot \left(\frac{12mm}{60mm}\right)^{0.2} = 0.072$$ 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	$\beta_{V,c}$ %
10.54	1.50	7.03	0.66	9.4

Anchor no.	$\beta_{V,c}$ %	**Group N°**	**Decisive Beta**
1	9.4	1	$\beta_{V,c;1}$

Utilization of tension and shear loads

Tension loads	Utilisation βN %
Steel failure *	47.2
Pullout failure *	77.8
Concrete cone failure	**99.5**
Splitting failure	79.2

Shear Loads	Utilisation βV %
Steel failure without lever arm *	2.2
Concrete pry-out failure	1.5
Concrete edge failure	**9.4**

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.47 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.02 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.22 \leq 1$$

Eq. (7.55)

Utilisation concrete

Proof successful

$$\beta_{N,c} = \beta_{N,c;1} = 0.99 \leq 1$$
$$\beta_{V.c} = \beta_{V,c;1} = 0.09 \leq 1$$
$$\frac{\beta_N + \beta_V}{1.2} = \frac{\beta_{N,c;1} + \beta_{V,c;1}}{1.2} = 0.91 \leq 1$$

Eq. (7.57)

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof — t = 9 mm

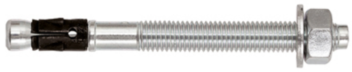
Profile type — None

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.

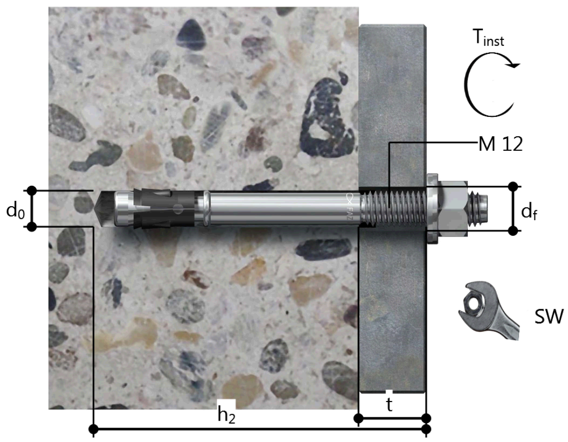
Installation data

Anchor

Anchor system	**fischer Bolt anchor FAZ II**		
Anchor	Bolt anchor FAZ II 12/10 A4, stainless steel, property class A4	Art.-No. 501413	
Accessories	Blow-out pump ABG big	Art.-No. 89300	
	SDS Plus II 12/100/160	Art.-No. 531803	
	or alternatively		
	FHD 12/200/330	Art.-No. 546597	
	Hammer drilling with or without suction		

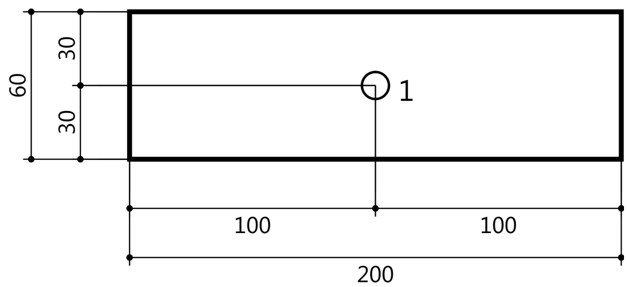
Installation details

Thread diameter	M 12
Drill hole diameter	d_0 = 12 mm
Drill hole depth	h_2 = 88 mm
Calculated anchorage depth	h_{ef} = 60 mm
Installation depth	h_{nom} = 74 mm
Drilling method	hammer drilling
Drill hole cleaning	only blow out by hand No borehole cleaning required in case of using a hollow drill bit, e.g. fischer FHD.
Installation type	Push-through installation
Annular gap	Annular gap not filled
Installation torque	T_{inst} = 60.0 Nm
Socket size	19 mm
Base plate thickness	t = 9 mm
Total fixing thickness	t_{fix} = 9 mm
Tfix,max	$t_{fix, max}$ = 20 mm



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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Comment

Case Study 04 - 2.0kNm2 Wind Load @200 - TL 6021

Design Specifications

Anchor

Anchor system	fischer High performance anchor FH II
Anchor	High performance anchor FH II 12/10 S A4, stainless steel, property class A4
Calculated anchorage depth	60 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-07/0025, Option 1, Issued 14/05/2018

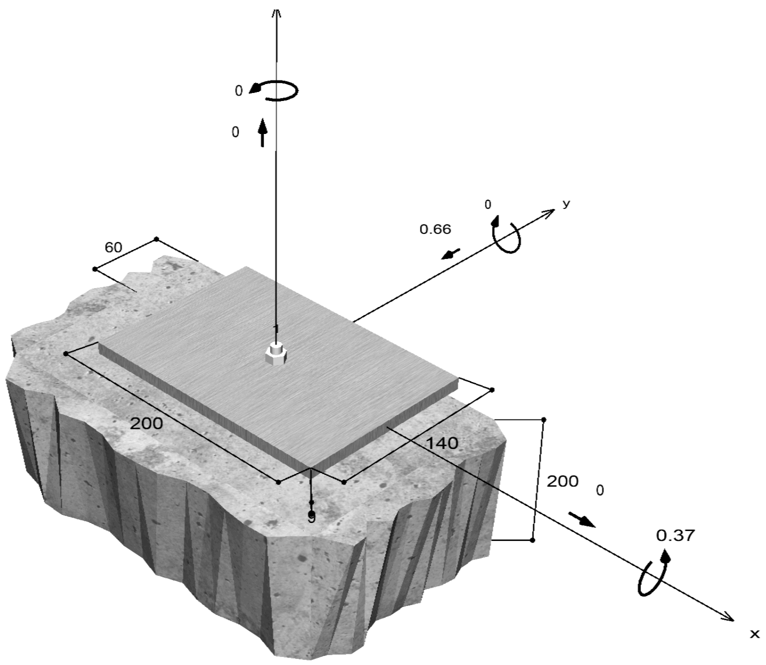
Geometry / Loads / Scale units

mm, kN, kNm

Value of design actions (including

partial safety factor for the load)

Static



Not drawn to scale

Input data

Design method	Design Method EN1992-4:2018 mechanical fastener
Base material	Normal weight concrete, C30/37, EN 206
Concrete condition	Non-cracked, dry hole
Reinforcement	Normal or no reinforcement. No edge reinforcement
Drilling method	hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap not filled
Type of loading	Static or quasi-static
Base plate location	Base plate flush installed on base material
Base plate geometry	200 mm x 140 mm x 9 mm
Profile type	None

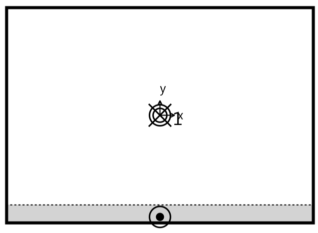
Design actions *)

#	N_{Ed} kN	$V_{Ed,x}$ kN	$V_{Ed,y}$ kN	$M_{Ed,x}$ kNm	$M_{Ed,y}$ kNm	$M_{T,Ed}$ kNm	Type of loading
1	0.00	0.00	-0.66	0.37	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	5.60	0.66	0.00	-0.66



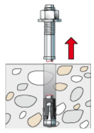
max. concrete compressive strain : 0.15 ‰
max. concrete compressive stress : 4.8 N/mm²
Resulting tensile actions : 5.60 kN , X/Y position (0 / 0)
Resulting compression actions : 5.60 kN , X/Y position (0 / -66)

Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	5.60	18.31	30.6
Pullout failure *	5.60	16.27	34.4
Concrete cone failure	5.60	14.00	40.0
Splitting failure	5.60	10.83	**51.7**

* Most unfavourable anchor

Steel failure

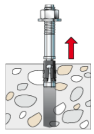


$$N_{Ed} \leq \frac{N_{Rk,s}}{\gamma_{Ms}}$$ **($N_{Rd,s}$)**

$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
29.30	1.60	18.31	5.60	30.6

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	30.6	1	$\beta_{N,s;1}$

Pullout failure



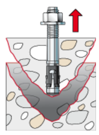
$$N_{Ed} \leq \frac{N_{Rk,p}}{\gamma_{Mp}}$$ **($N_{Rd,p}$)**

$N_{Rk,p}$ kN	Ψ_c	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
24.40	1.220	1.50	16.27	5.60	34.4

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

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	34.4	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)

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

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

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

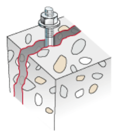
$$\Psi_{M,N} = 1.00 \geq 1$$ Eq. (7.7)

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
21.00	1.50	14.00	5.60	40.0

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	40.0	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)

$$N_{Rk,sp} = 24.40kN \cdot \frac{63{,}000mm^2}{90{,}000mm^2} \cdot 0.820 \cdot 1.000 \cdot 1.000 \cdot 1.160 = 16.25kN$$

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,sp}} = 0.7 + 0.3 \cdot \frac{60mm}{150mm} = 0.820 \leq 1$$ 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)

$$\Psi_{ec,Nx} = \frac{1}{1+\frac{2 \cdot 0mm}{300mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1+\frac{2 \cdot 0mm}{300mm}} = 1.000 \leq 1$$

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

$$\Psi_{h,sp} = min\left(\left(\frac{200mm}{120mm}\right)^{2/3}; max\left(1; \left(\frac{60mm + 1.5 \cdot 60mm}{120mm}\right)^{2/3}\right); 2\right) = 1.160$$

$N_{Rk,sp}$ kN	γ_{Msp}	$N_{Rd,sp}$ kN	N_{Ed} kN	$\beta_{N,sp}$ %
16.25	1.50	10.83	5.60	51.7

Anchor no.	$\beta_{N,sp}$ %	Group N°	Decisive Beta
1	51.7	1	$\beta_{N,sp;1}$

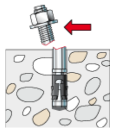
Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	0.66	24.81	**2.7**
Concrete pry-out failure	0.66	28.00	2.4

* Most unfavourable anchor

Steel failure without lever arm

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



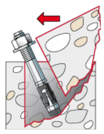
$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 33.00kN = 33.00kN$$ Eq. (7.35)/(7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
33.00	1.33	24.81	0.66	2.7

Anchor no.	β_{Vs} %	Group N°	Decisive Beta
1	2.7	1	$\beta_{Vs;1}$

Concrete pry-out failure

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



$$V_{Rk,cp} = k_8 \cdot N_{Rk,c} = 2 \cdot 21.00kN = 42.00kN$$ Eq. (7.39a)

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

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

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 11 \cdot \sqrt{30.0N/mm^2} \cdot \left(60mm\right)^{1.5} = 28.00kN$$ 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)

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

$V_{Rk,cp}$ kN	γ_{Mc}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
42.00	1.50	28.00	0.66	2.4

Anchor no.	$\beta_{V,cp}$ %	Group N°	Decisive Beta
1	2.4	1	$\beta_{V,cp;1}$

Utilization of tension and shear loads

Tension loads	Utilisation β_N %
Steel failure *	30.6
Pullout failure *	34.4
Concrete cone failure	40.0
Splitting failure	**51.7**

Shear Loads	Utilisation β_V %
Steel failure without lever arm *	**2.7**
Concrete pry-out failure	2.4

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.31 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.03 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.09 \leq 1 \qquad \text{Eq. (7.55)}$$

Utilisation concrete

Proof successful

$$\beta_{N,sp} = \beta_{N,sp;1} = 0.52 \leq 1$$
$$\beta_{V.cp} = \beta_{V,cp;1} = 0.02 \leq 1$$
$$\beta_N^{1.5} + \beta_V^{1.5} = \beta_{N,sp;1}^{1.5} + \beta_{V,cp;1}^{1.5} = 0.37 \leq 1 \qquad \text{Eq. (7.56)}$$

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof t = 9 mm

Profile type None

Technical remarks

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

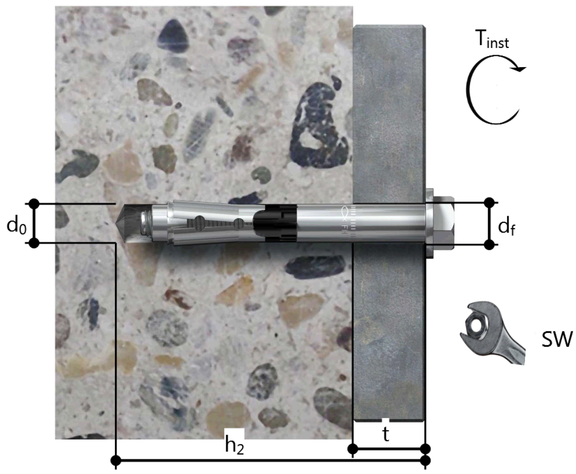
Installation data

Anchor

Anchor system	**fischer High performance anchor FH II**	
Anchor	High performance anchor FH II 12/10 S A4, stainless steel, property class A4	Art.-No. 510925
Accessories	Blow-out pump ABG big	Art.-No. 89300
	SDS Plus II 12/100/160	Art.-No. 531803
	or alternatively	
	FHD 12/200/330	Art.-No. 546597
	Hammer drilling with or without suction	
	Erection of the drillhole by hammer drilling with or without suction cleaning	

Installation details

Thread diameter	M 8
Drill hole diameter	d_0 = 12 mm
Drill hole depth	h_2 = 90 mm
Calculated anchorage depth	h_{ef} = 60 mm
Installation depth	h_{nom} = 60 mm
Drilling method	hammer drilling
Drill hole cleaning	only blow out by hand No borehole cleaning required in case of using a hollow drill bit, e.g. fischer FHD.
Installation type	Push-through installation
Annular gap	Annular gap not filled
Installation torque	T_{inst} = 25.0 Nm
Socket size	13 mm
Base plate thickness	t = 9 mm
Total fixing thickness	t_{fix} = 9 mm
Tfix,max	$t_{fix, max}$ = 10 mm

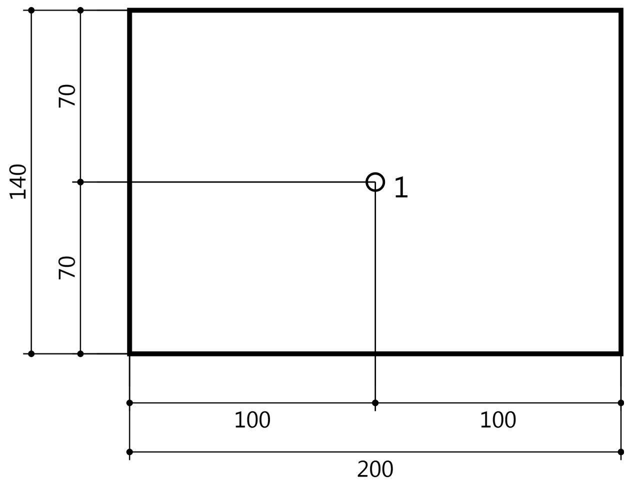


Base plate details

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