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

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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

Glass Strength

Wind Loading:

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

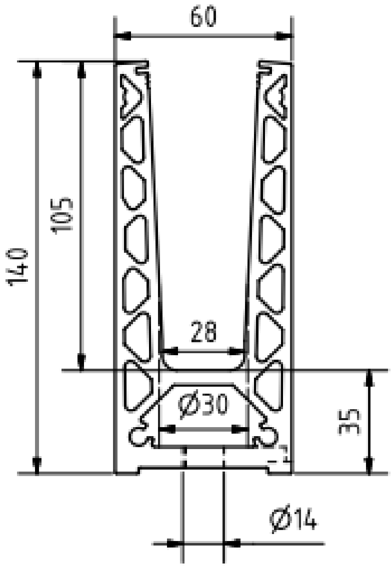
$f_{gd} = (k_{mod})(k_{sp})(f_{gk})/\ \gamma_{ma} + k_v(f_{bk}-f_{gk})/\gamma_{mv}$

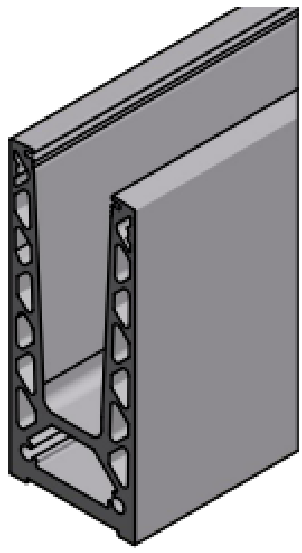
$f_{gd} = (0.74)(1.0)(45)/1.6 + 1.0(120-45)/1.2$

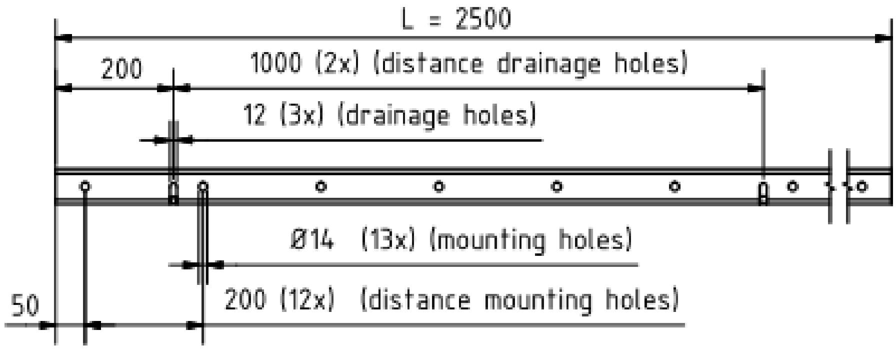
$\underline{f_{gd} = 83.3N/mm^2}$

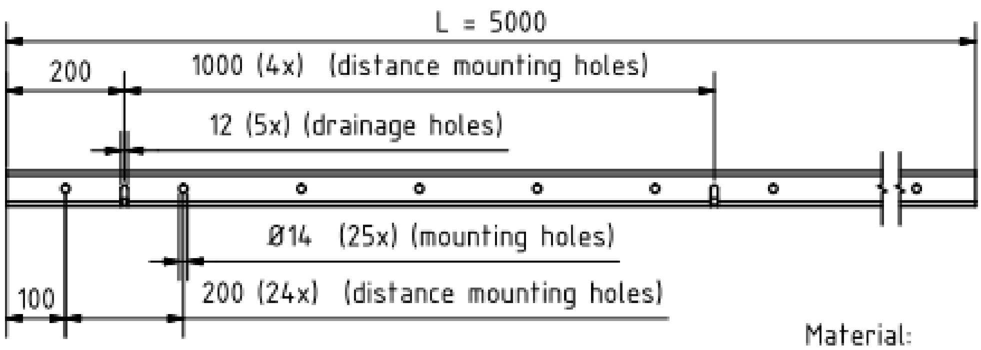
System Sketch:

Shoe TL 6020:









Material:
Aluminum 6063-T6

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Project: TL 6020/ 6021	**Contract:** 1388-1
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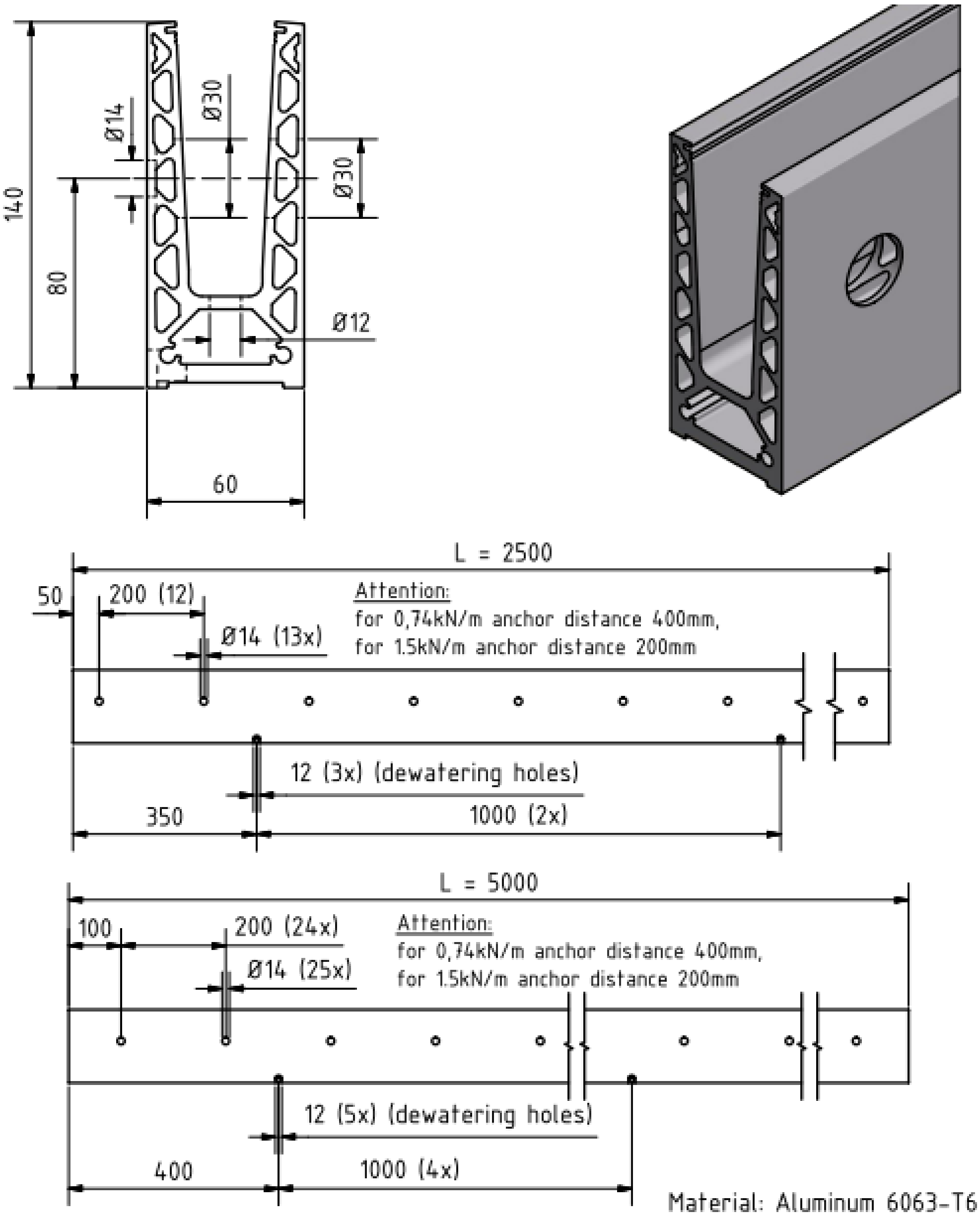
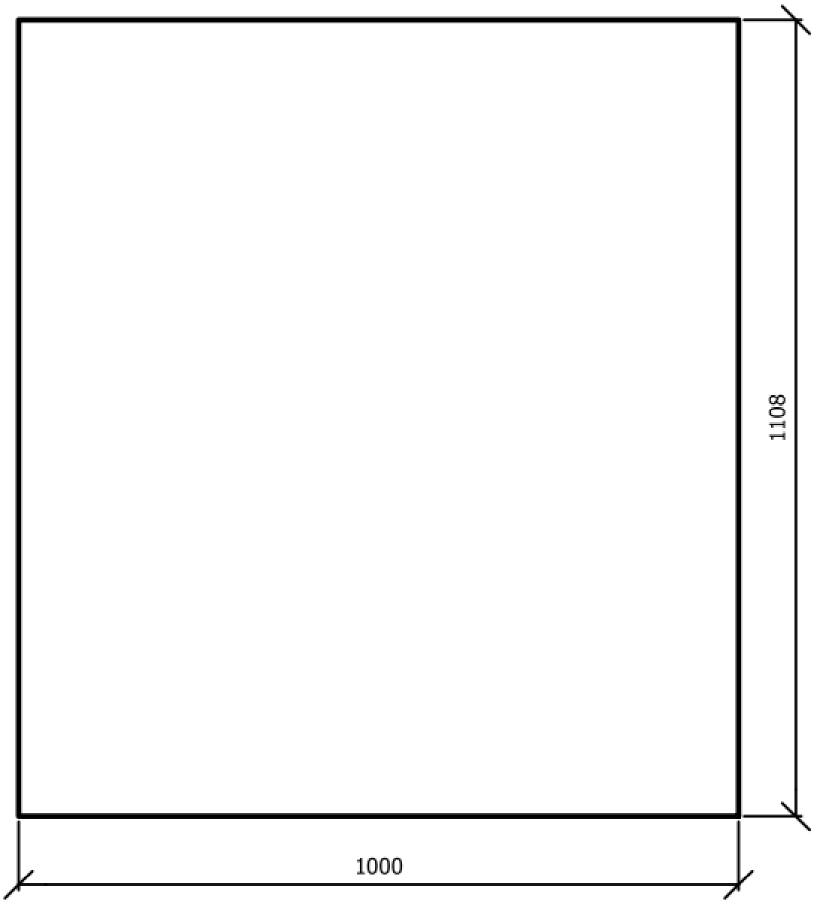
Shoe TL 6021:



Project: TL 6020/ 6021	**Contract:** 1388-1
Subject: General Wind Load	**Sheet No.** 8
Date: 08/05/2020	**By:** R.F.

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.

Glass Analysis:

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

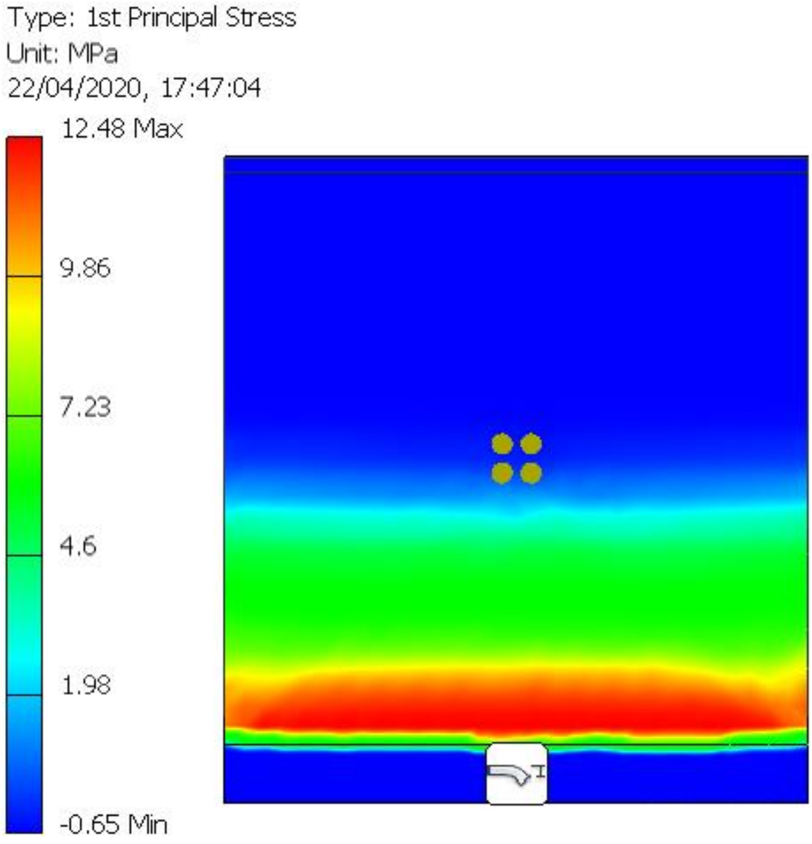
Glass Analysis - Bending Stress of Glass Panel due to 1.0kN/m2 Infill Loading:

- 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



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Project: TL 6020/ 6021	Contract: 1388-1
Subject: General Wind Load	Sheet No. 10
Date: 08/05/2020	By: R.F.

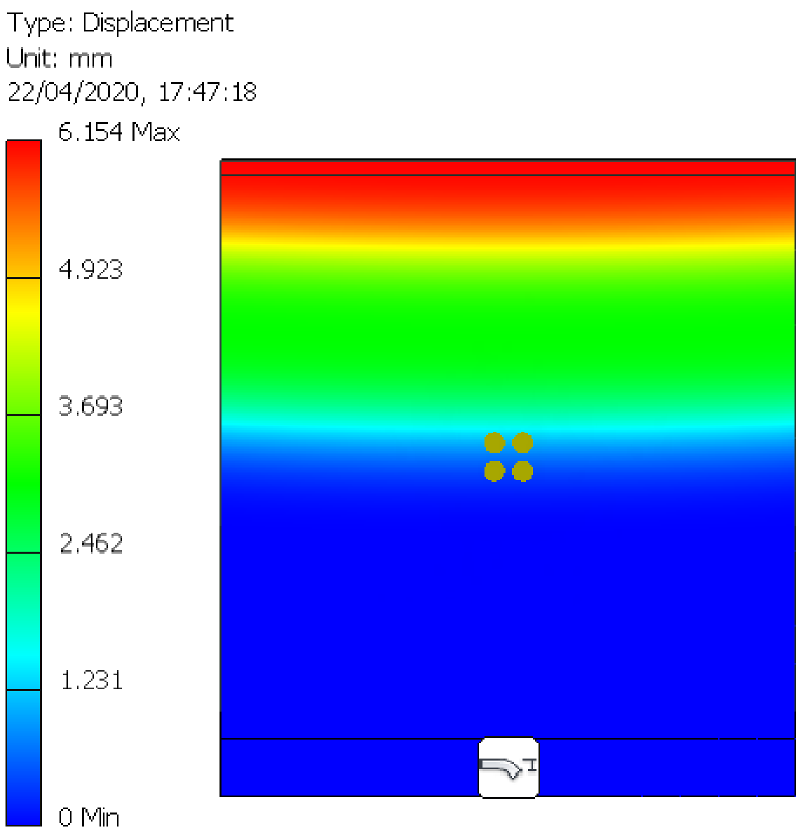
Glass Analysis - Deflection of Glass Panel due to 1.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 1.0kN/m2 Infill Loading
- 15mm Tough Glass analysed, horizontally toughened Laminated
- Deflection analysed based on glass panel of 1.0m x 1.108m

Result:

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

OK in Deflection (Glass Only)



Project: TL 6020/ 6021	**Contract:** 1388-1
Subject: General Wind Load	**Sheet No.** 11
Date: 08/05/2020	**By:** R.F.

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Case Study 02: 17.52mm (TLT) – 1.0x1.108m – $1.0\mathrm{kN/m^2}$:

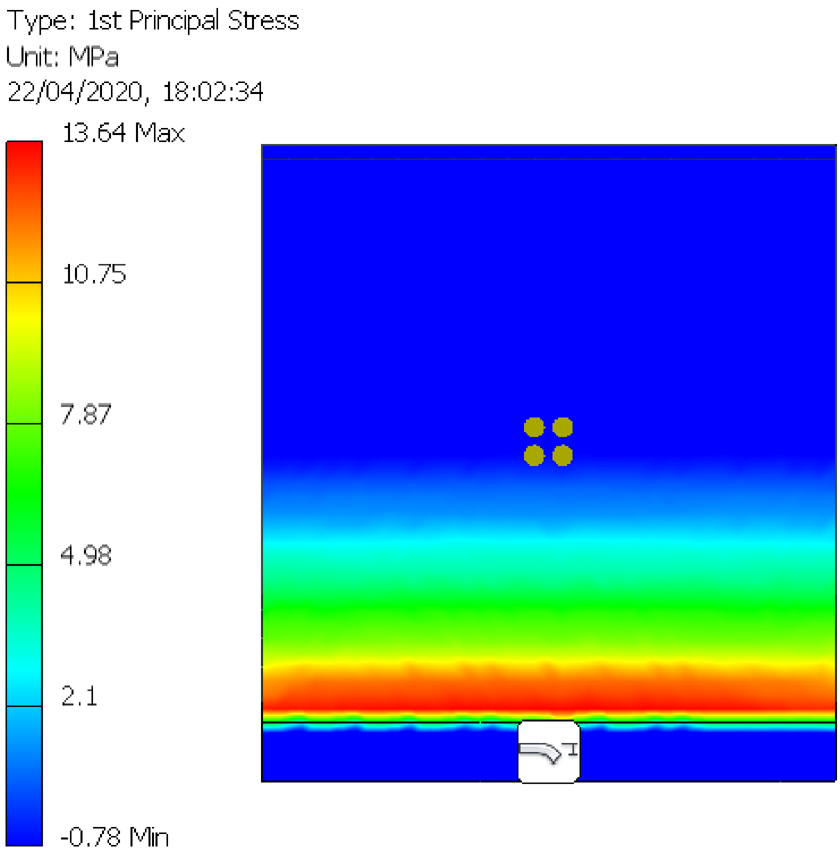
Glass Analysis - Bending Stress of Glass Panel due to 1.0kN/m2 Infill Loading:

- 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



Project: TL 6020/ 6021	Contract: 1388-1
Subject: General Wind Load	Sheet No. 12
Date: 08/05/2020	By: R.F.

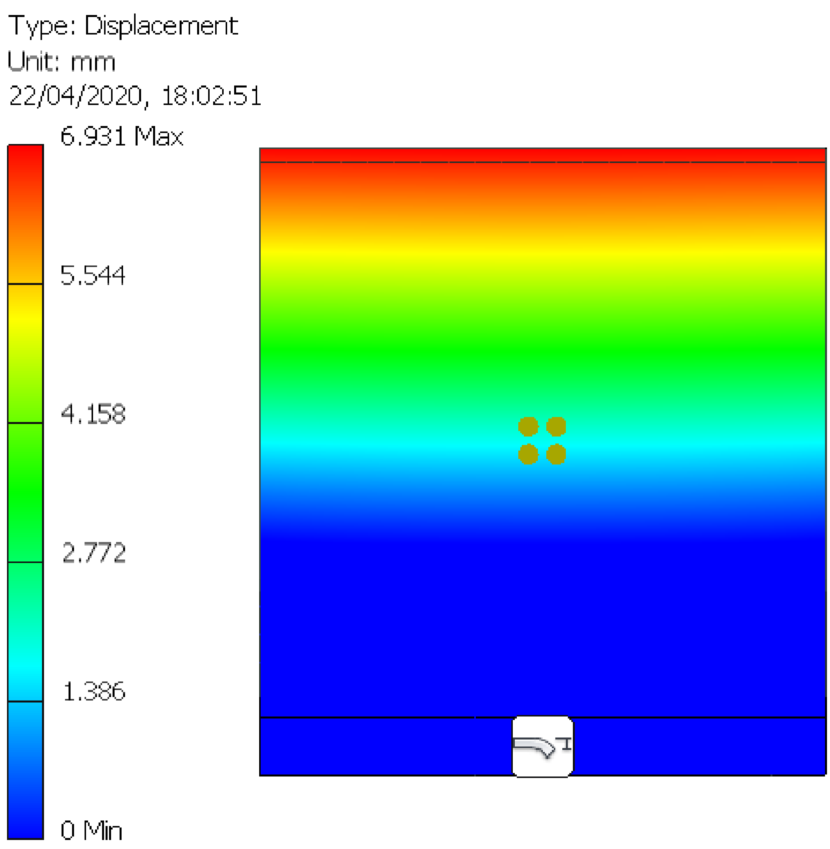
Glass Analysis - Deflection of Glass Panel due to 1.0kN/m2 Infill Loading:

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



Project: TL 6020/ 6021	**Contract:** 1388-1
Subject: General Wind Load	**Sheet No.** 13
Date: 08/05/2020	**By:** R.F.

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

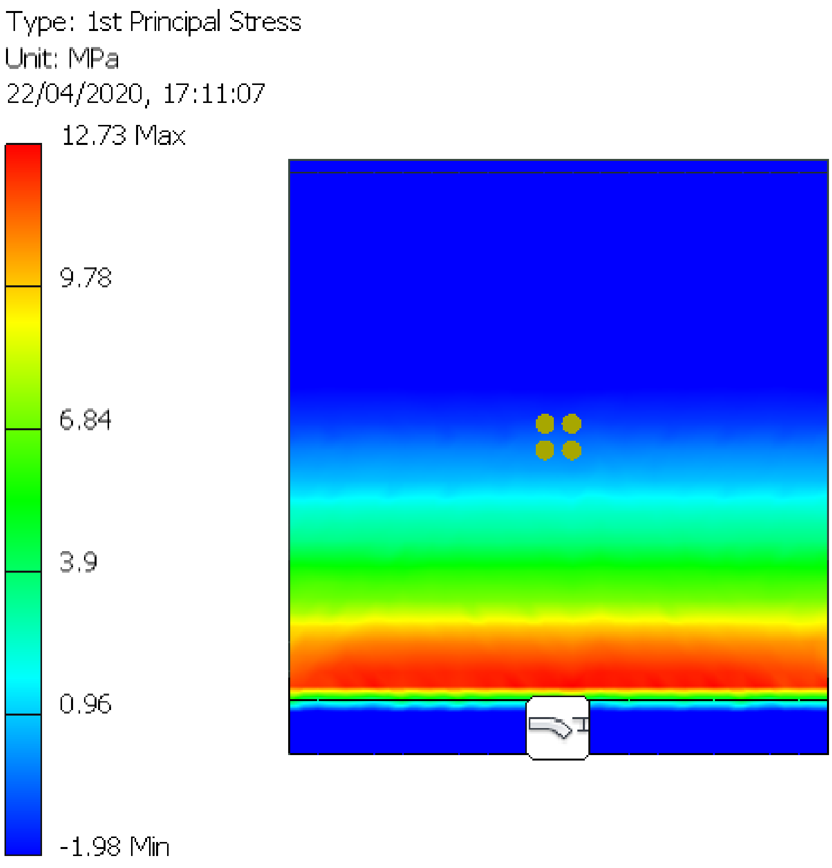
Glass Analysis - Bending Stress of Glass Panel due to 1.5kN/m2 Infill Loading:

- 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



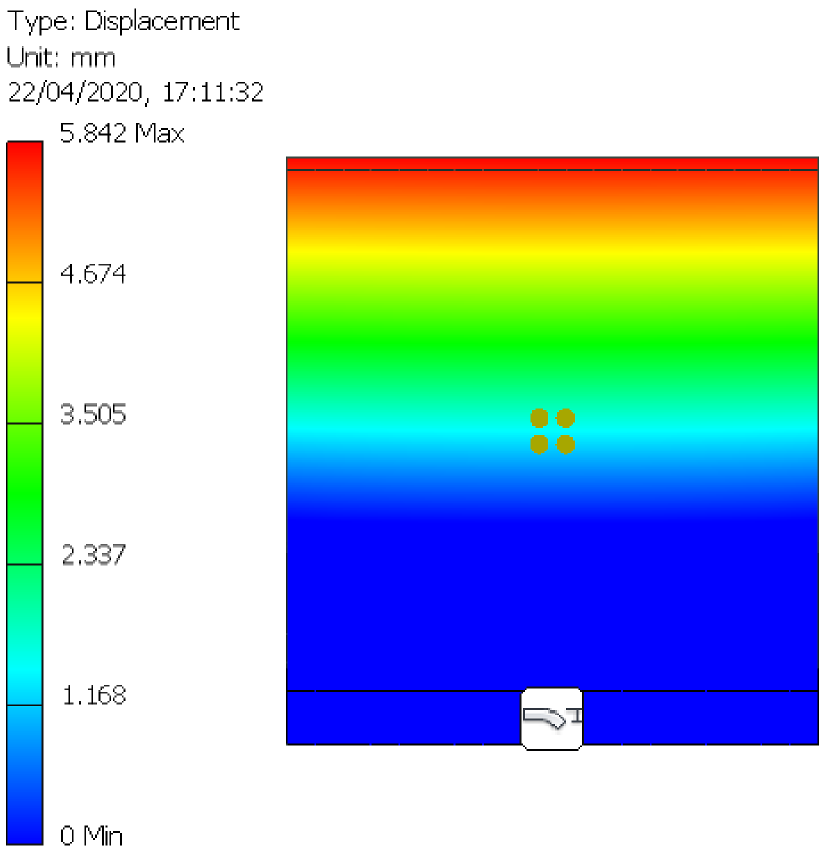
Glass Analysis - Deflection of Glass Panel due to 1.5kN/m2 Infill Loading:

- 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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Project: TL 6020/ 6021	**Contract:** 1388-1
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Case Study 04: 21.52mm (TLT) – 1.0x1.108m – 2.0kN/m^2:

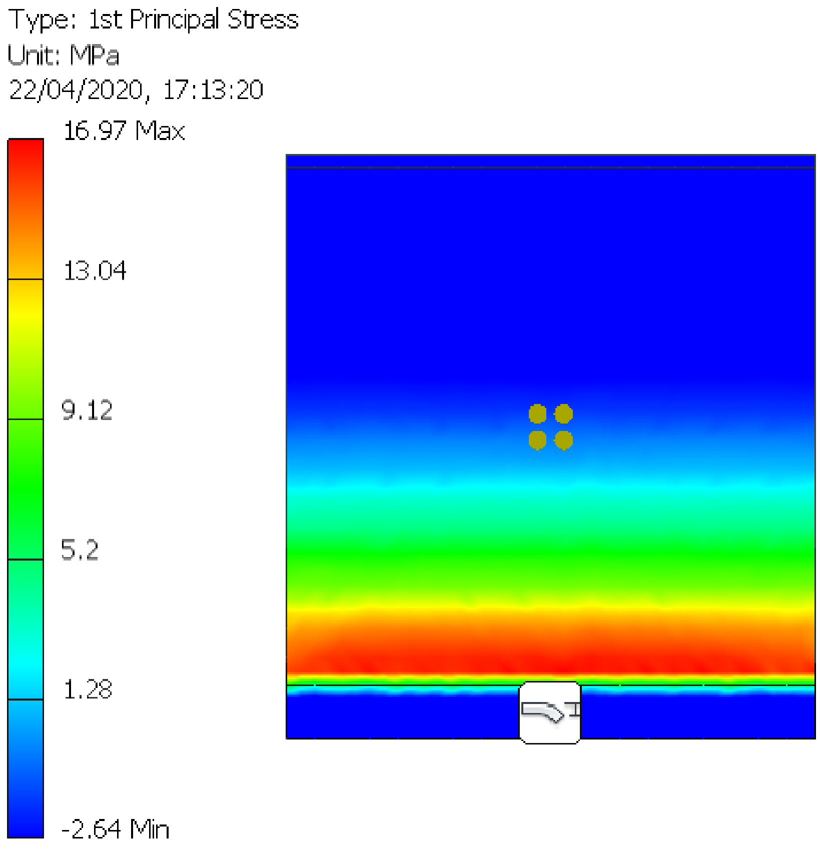
Glass Analysis - Bending Stress of Glass Panel due to 2.0kN/m2 Infill Loading:

- 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



Project: TL 6020/ 6021	Contract: 1388-1
Subject: General Wind Load	Sheet No. 16
Date: 08/05/2020	By: R.F.

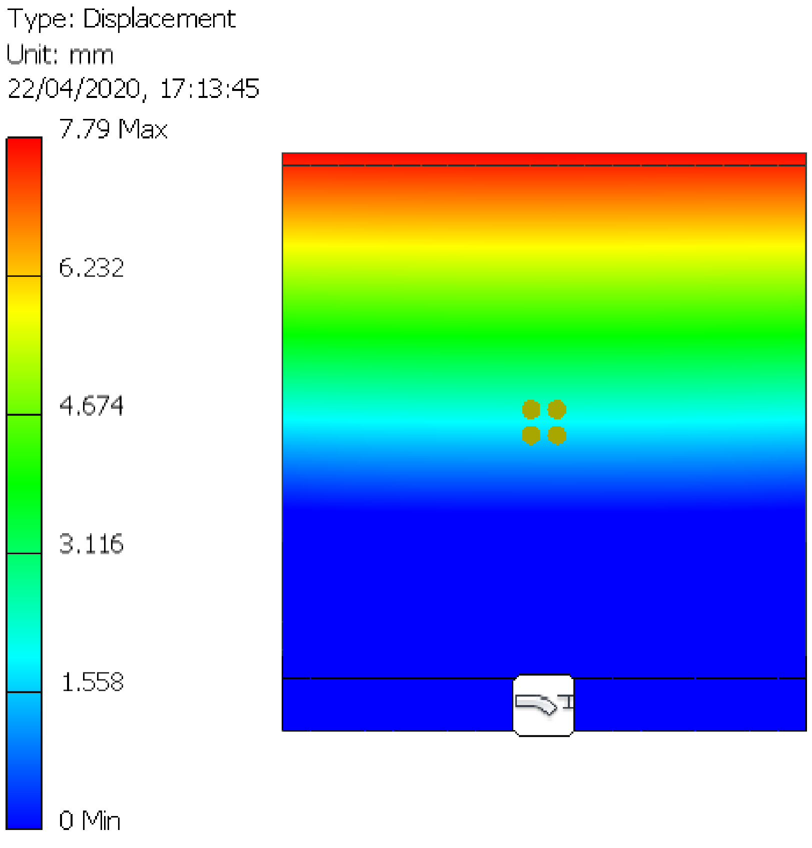
Glass Analysis - Deflection of Glass Panel due to 2.0kN/m2 Infill Loading:

- Analysis Software was used to determine maximum bending stress of the glass due to 2.0kN/m2 Infill Loading
- 10/10/1.52mm T/L/T Glass analysed, horizontally toughened Laminated
- Interlayer Properties used for analysis, E= 3MPa, G = 1MPa
- Deflection analysed based on glass panel of 1.0m x 1.108m

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:

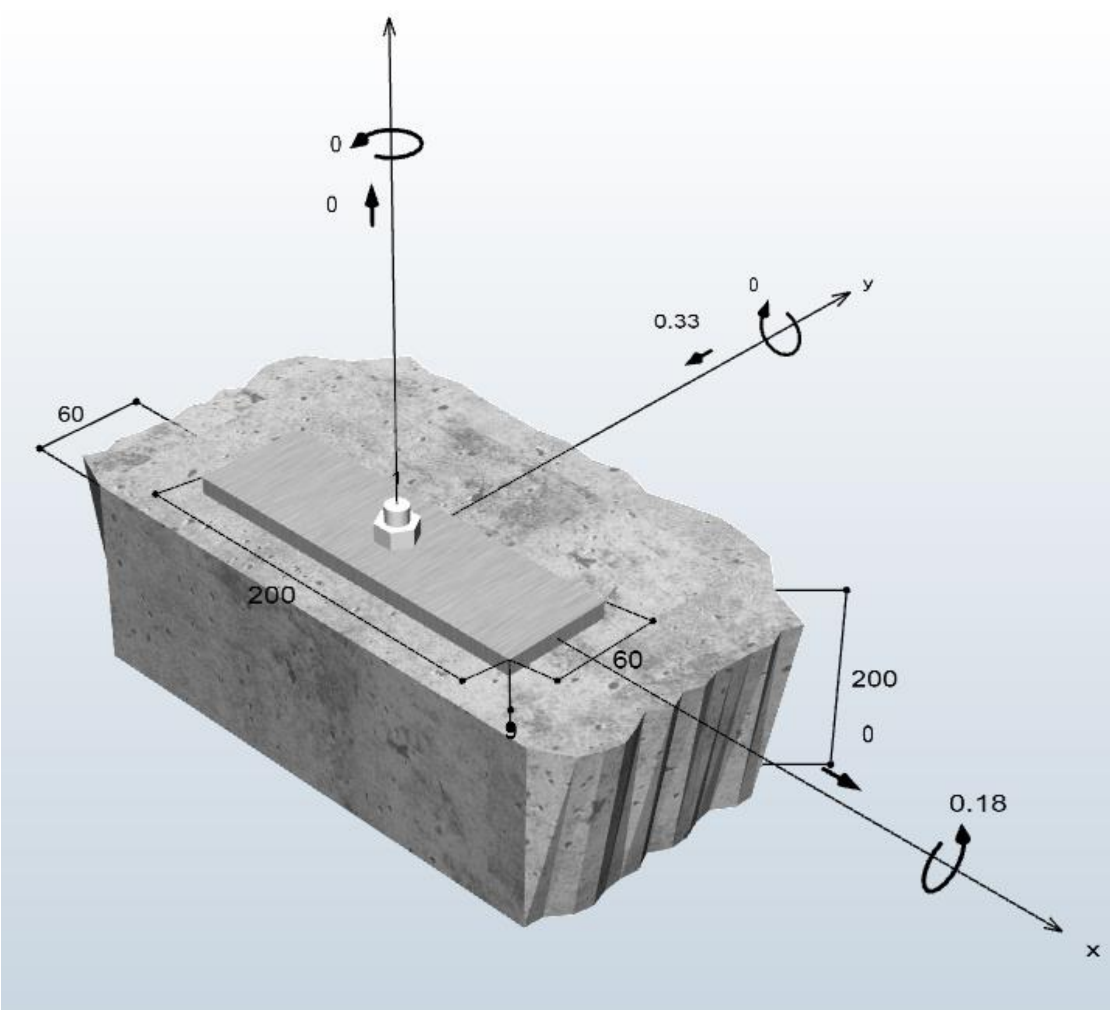
Connection to Concrete – TL 6020

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

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

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

See design in Appendix A.



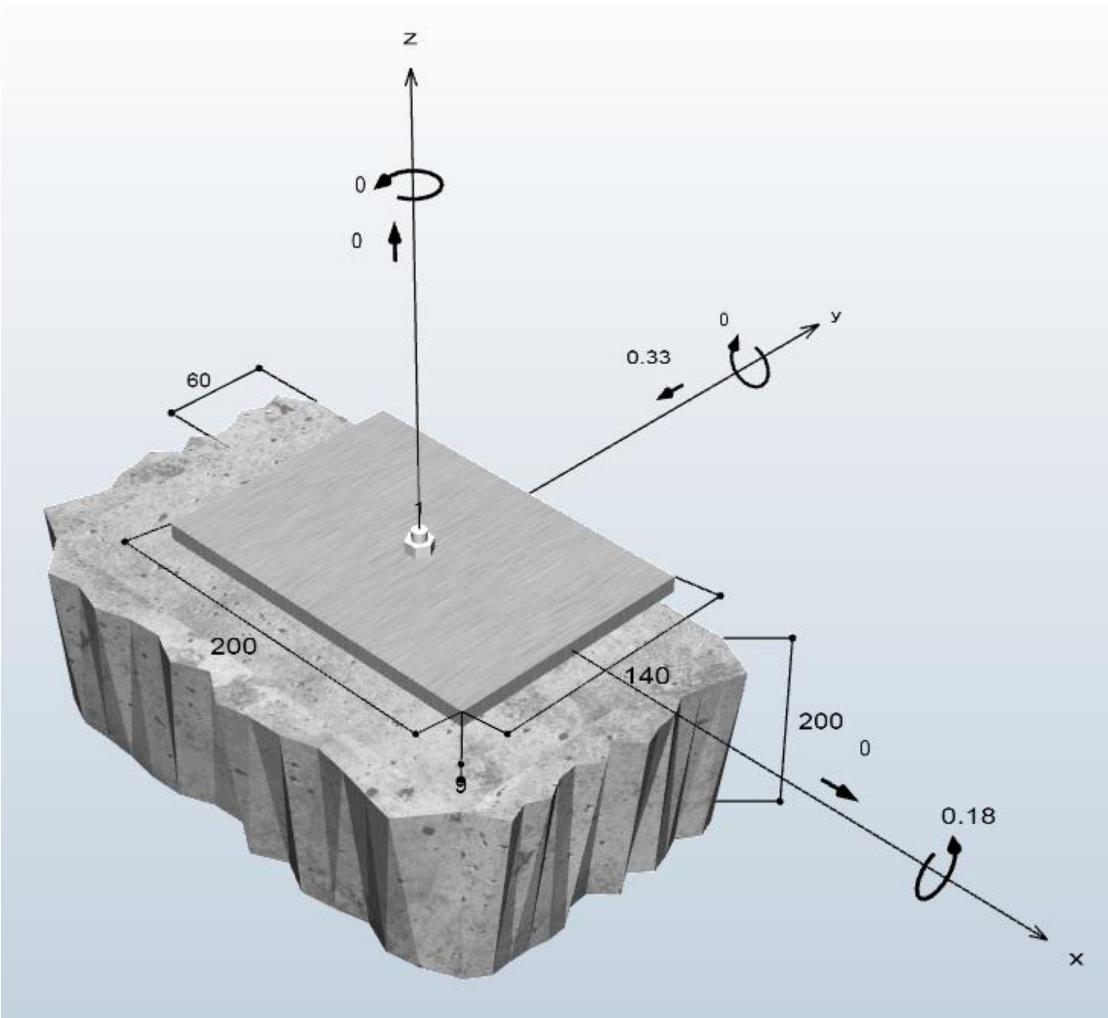
Connection to Concrete – TL 6021

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

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

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.*

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

$$\mathrm{F_{t,Rd}} = \frac{\mathrm{K_2F_{ub}A}}{\lambda\mathrm{m2}} \rightarrow \mathrm{F_{t,Rd}} = \frac{0.9\times 800\times 84.3\times 10^{-3}}{1.25} = 48\mathrm{kN} > 18.42\mathrm{kN}$$ **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)*

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

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

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Project: TL 6020/ 6021	**Contract:** 1388-1
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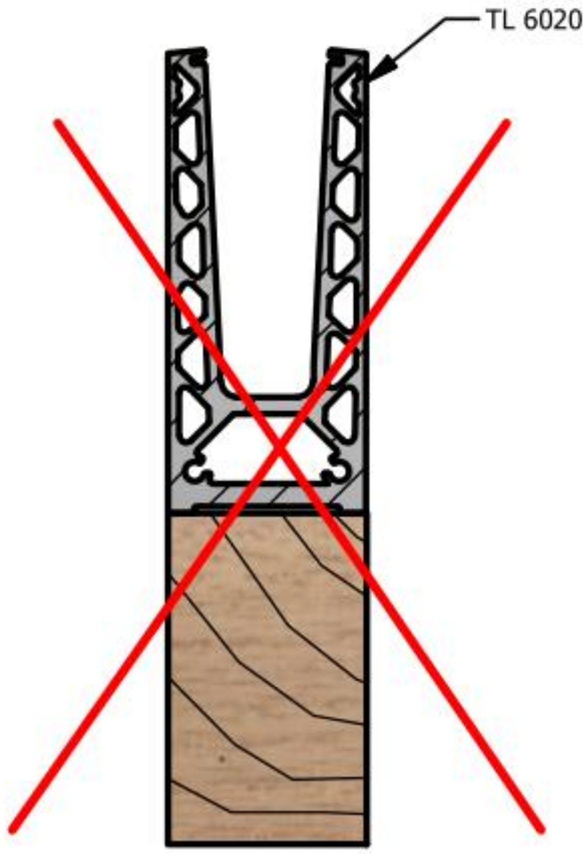
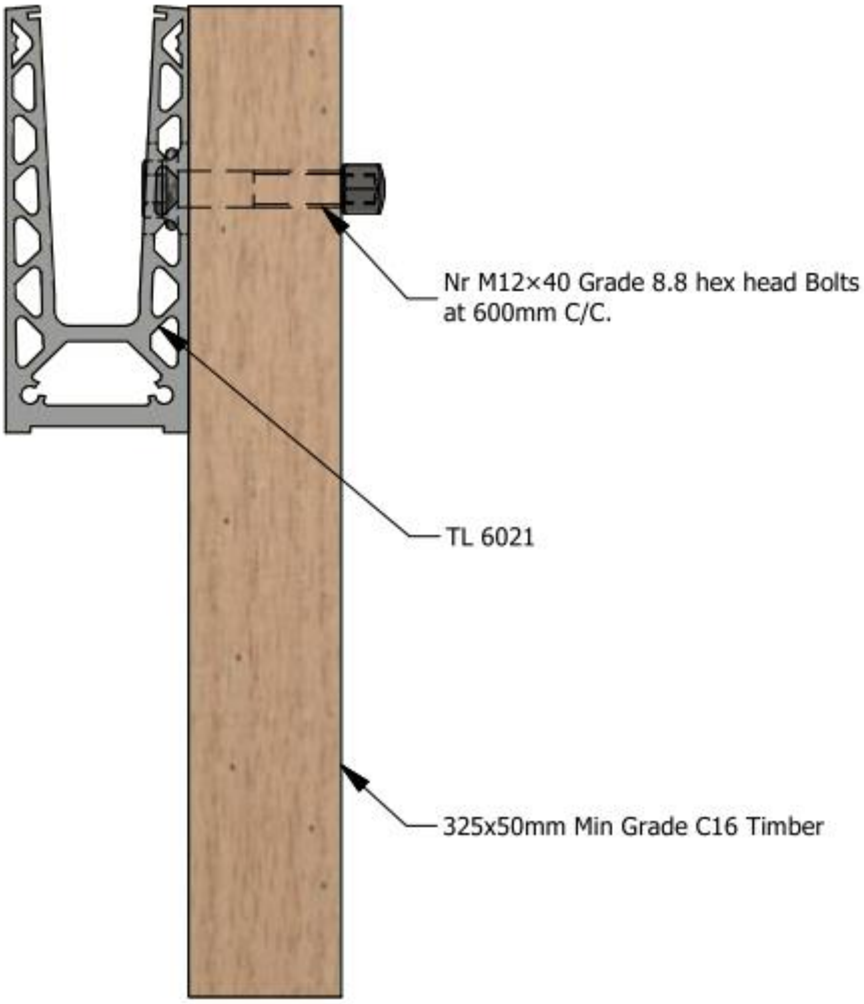
Connection to Wood – TL 6020:



Connection to Wood – TL 6021:



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

Project:	Contract:
TL 6020/ 6021	1388-1
Subject: General Wind Load	**Sheet No.** 23
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Case Study 03: 21.52mm (TLT) – 1.0x1.108m – $1.5\mathrm{kN/m^2}$:

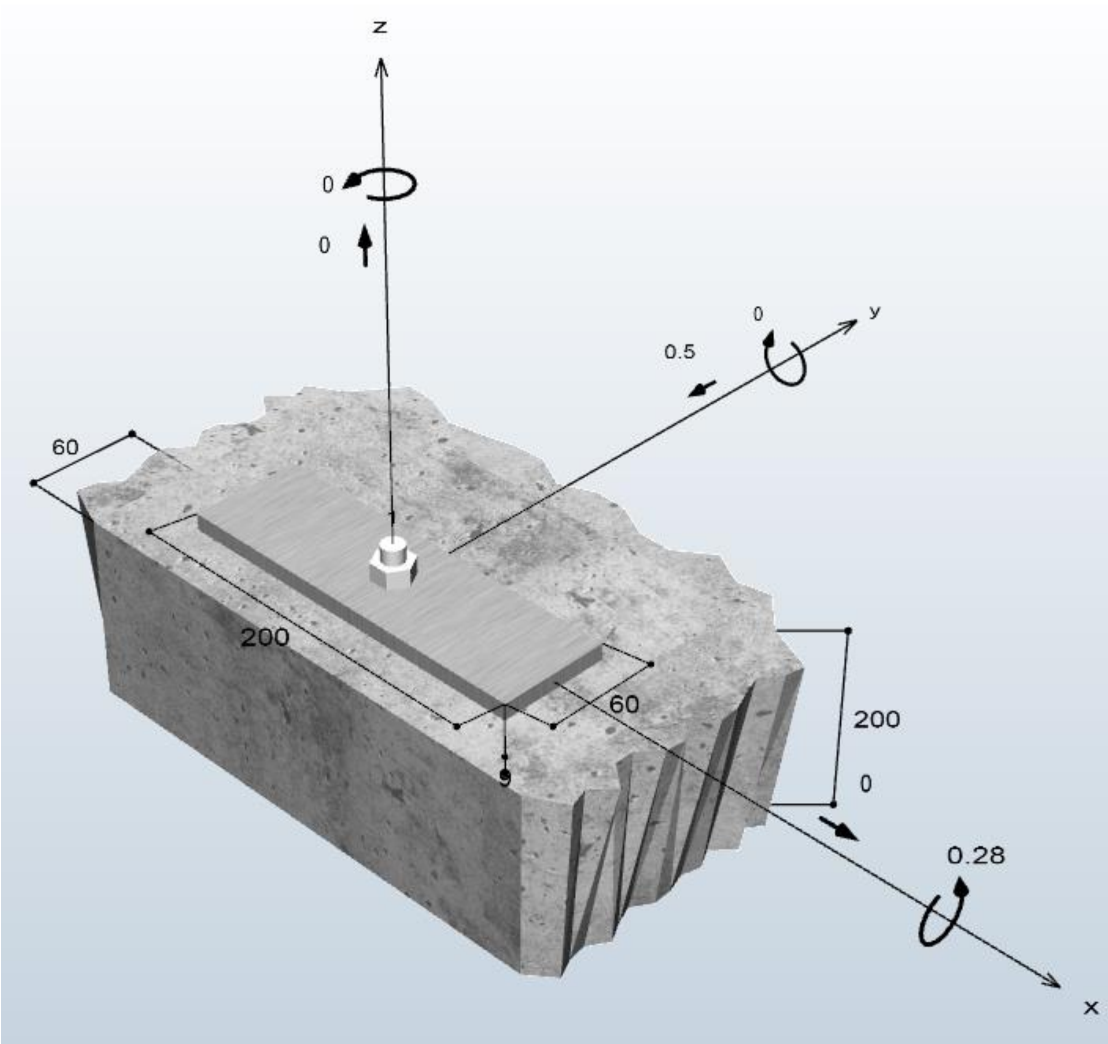
Connection To Concrete – TL 6020

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

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

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

See design in Appendix A.



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Project: TL 6020/ 6021	Contract: 1388-1
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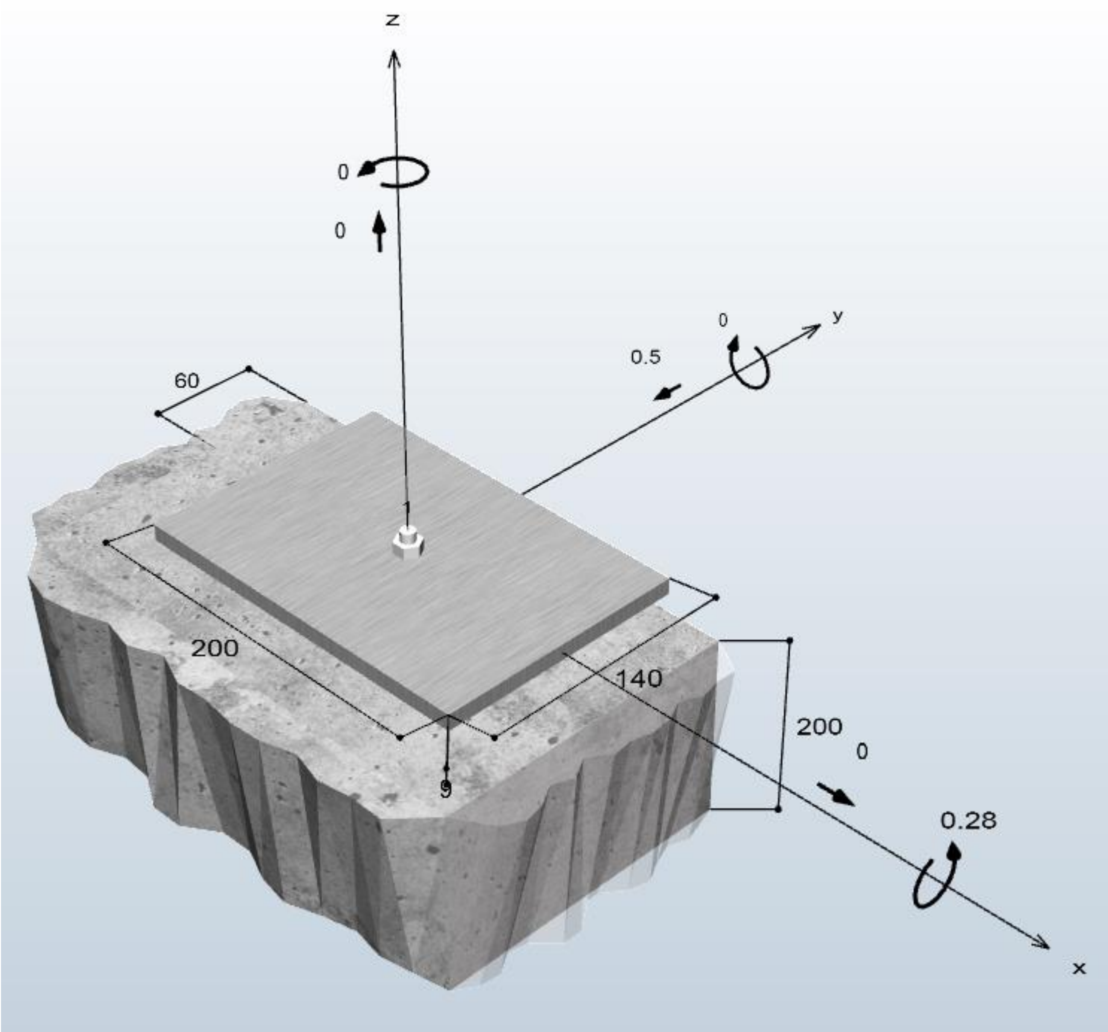
Connection To Concrete – TL 6021

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

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

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)*

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

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

$$F_{t,Ed} = \frac{\frac{1.5kN}{m^2}\times1.5\times1.108m\times1.0m\times0.6\times\frac{1.108m}{2}}{0.080} = 10.36kN$$

$$F_{t,Rd} = \frac{K_2 F_{ub} A}{\lambda m2} \rightarrow F_{t,Rd} = \frac{0.9\times800\times84.3\times10^{-3}}{1.25} = 48kN > 10.36kN$$ **Okay**

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

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

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

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

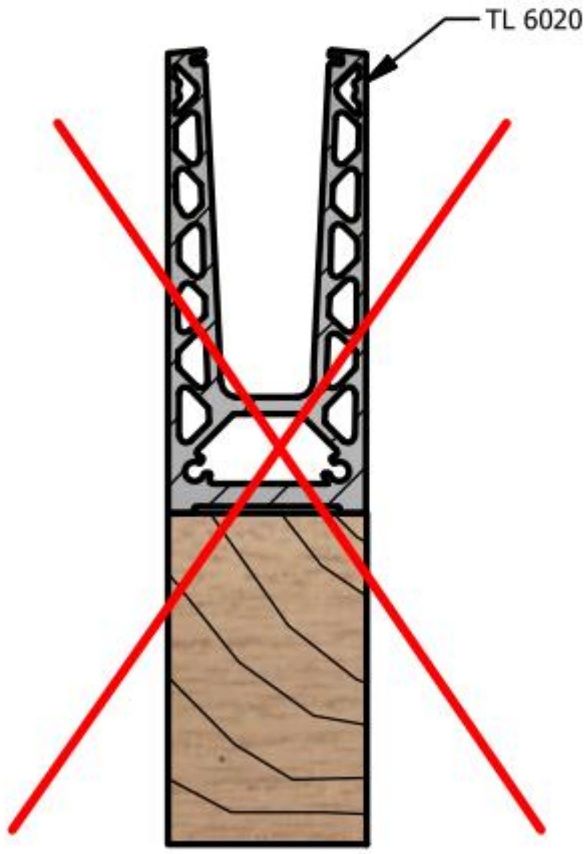
$$F_{V,Rd} = \frac{\alpha F_{ub} A}{\lambda m2} \rightarrow F_{V,Rd} = \frac{0.6\times84.3\times800\times10^{-3}}{1.25} = 32kN > 0.50kN$$ **Okay**

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

$$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1.4F_{t,Rd}} \leq 1 \rightarrow \frac{1.50}{32} + \frac{10.36}{1.4\times48} = 0.20 \leq 1$$ **Okay**

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

Connection to Wood – TL 6020:



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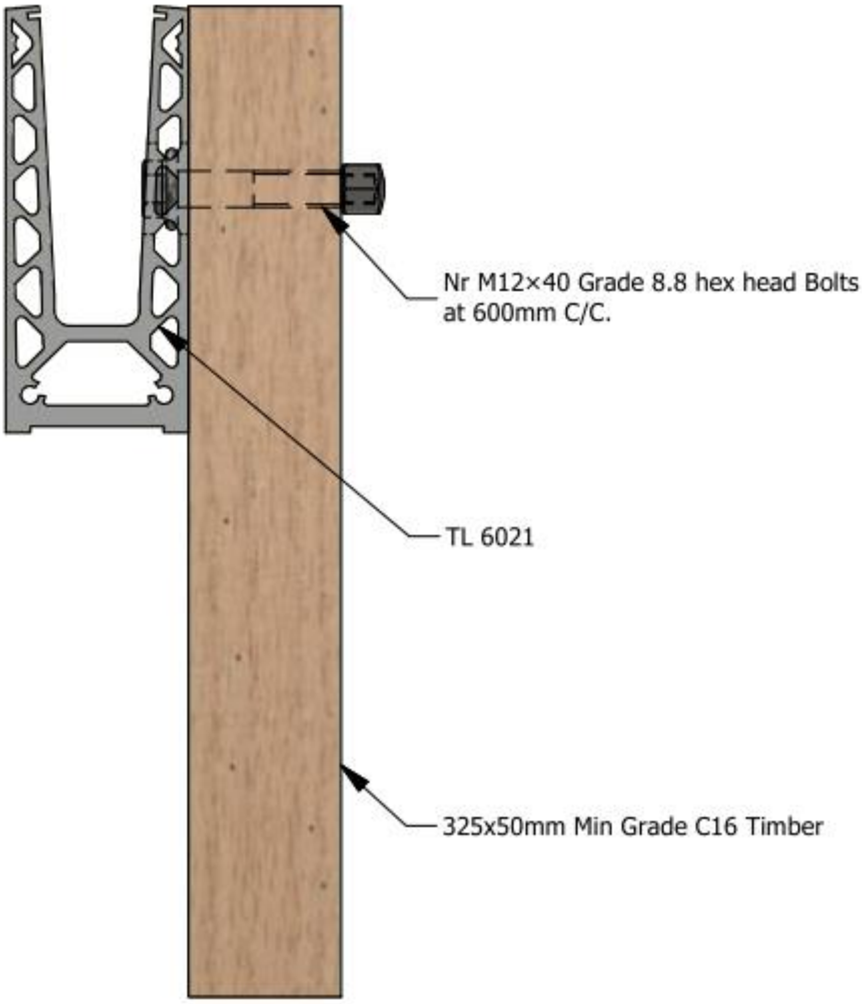
Connection to Wood – TL 6021:



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:

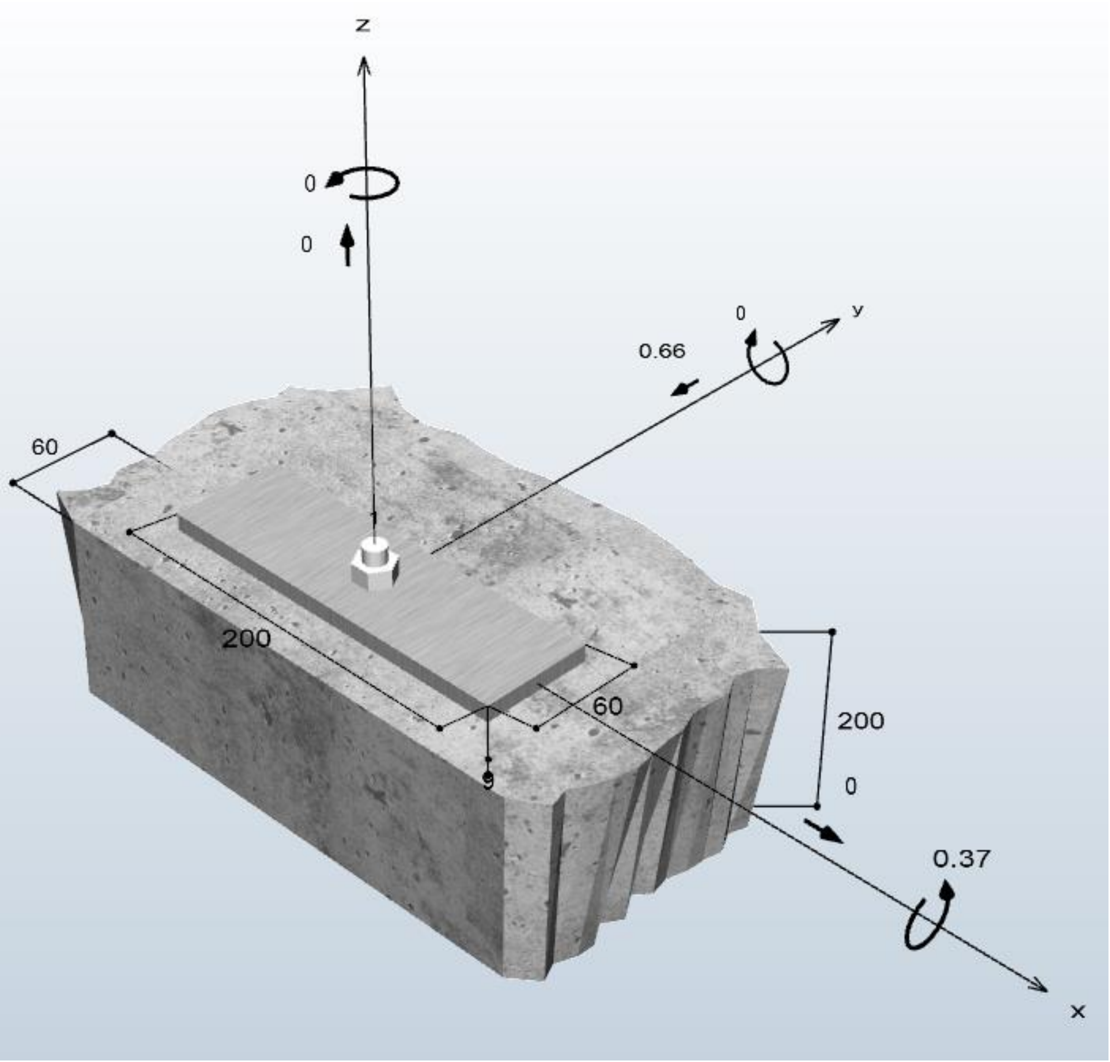
Connection To Concrete – TL 6020

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

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

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

See design in Appendix A.



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Date: 08/05/2020	By: R.F.

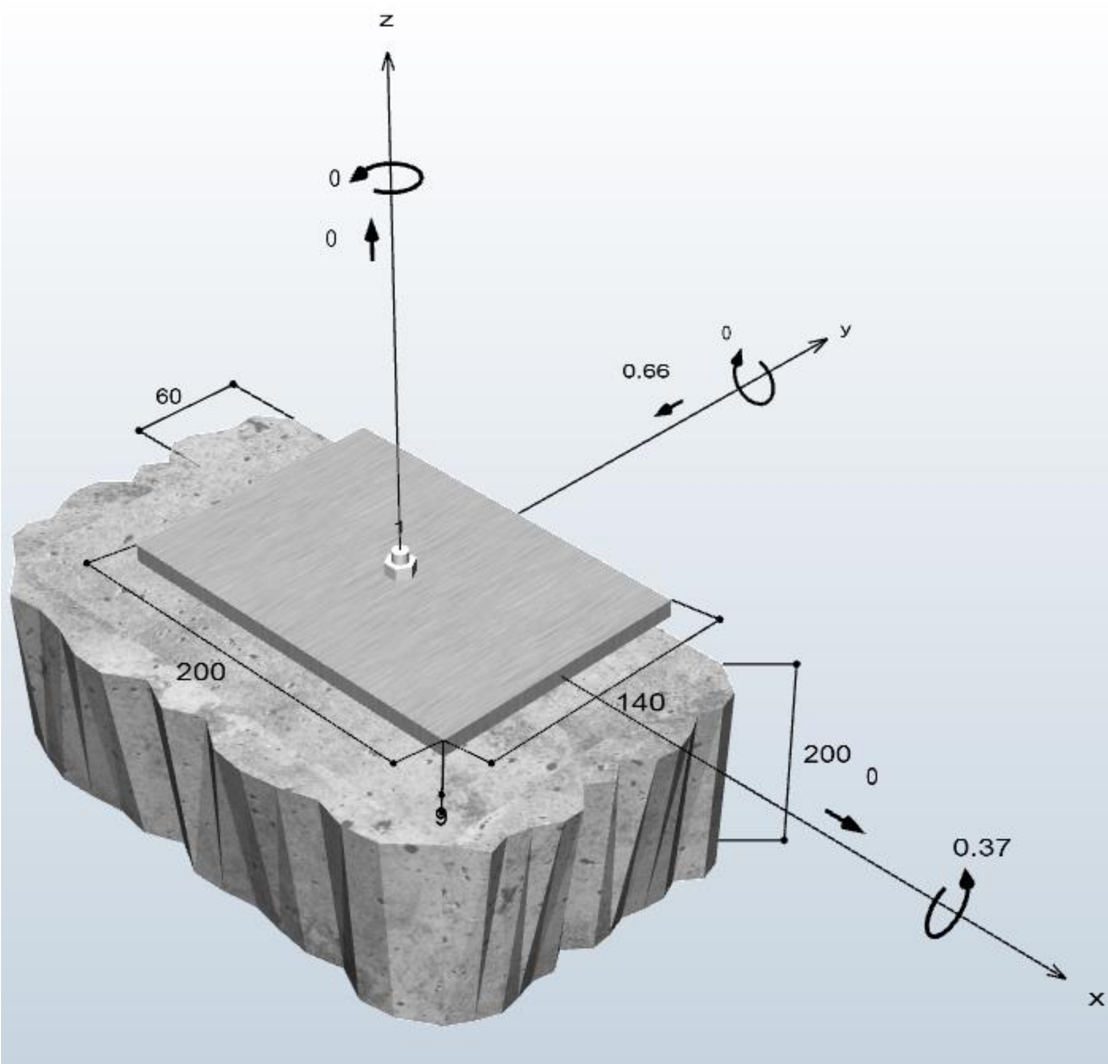
Connection To Concrete – TL 6021

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

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

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.*

$$F_{t,Ed} = \frac{\frac{2.0kN}{m^2}\times 1.5\times 1.108m\times 1.0m\times 0.6\times \frac{1.108m}{2}}{0.080} = 13.81kN$$

$$F_{t,Rd} = \frac{K_2 F_{ub} A}{\lambda m2} \rightarrow F_{t,Rd} = \frac{0.9\times 800\times 84.3\times 10^{-3}}{1.25} = 48kN > 13.81kN$$ **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.*

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

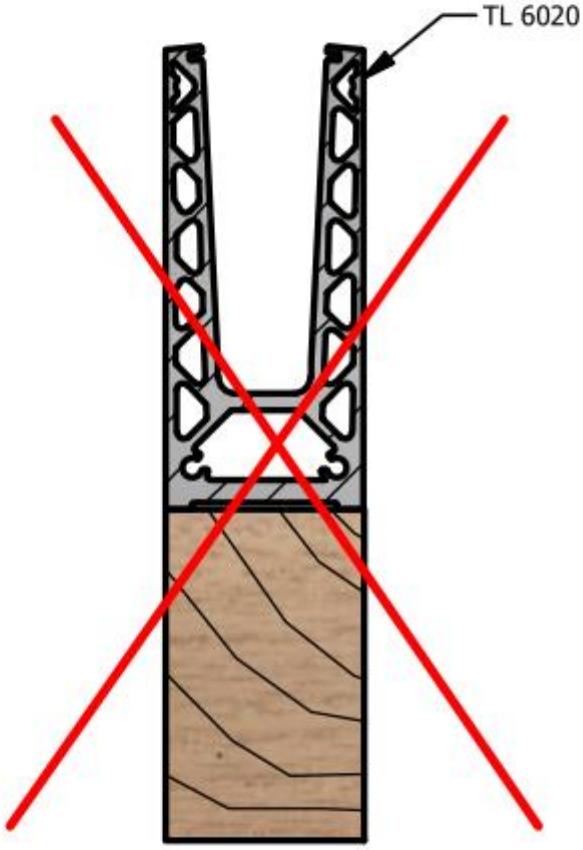
$$F_{V,Rd} = \frac{\alpha F_{ub} A}{\lambda m2} \rightarrow F_{V,Rd} = \frac{0.6\times 84.3\times 800\times 10^{-3}}{1.25} = 32kN > 2.00kN$$ **Okay**

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

$$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1.4F_{t,Rd}} \leq 1 \rightarrow \frac{2.00}{32} + \frac{13.81}{1.4\times 48} = 0.27 \leq 1$$ **Okay**

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

Connection to Wood – TL 6020:



TSA
TED SINGLETON & ASSOCIATES
CONSULTING ENGINEERS

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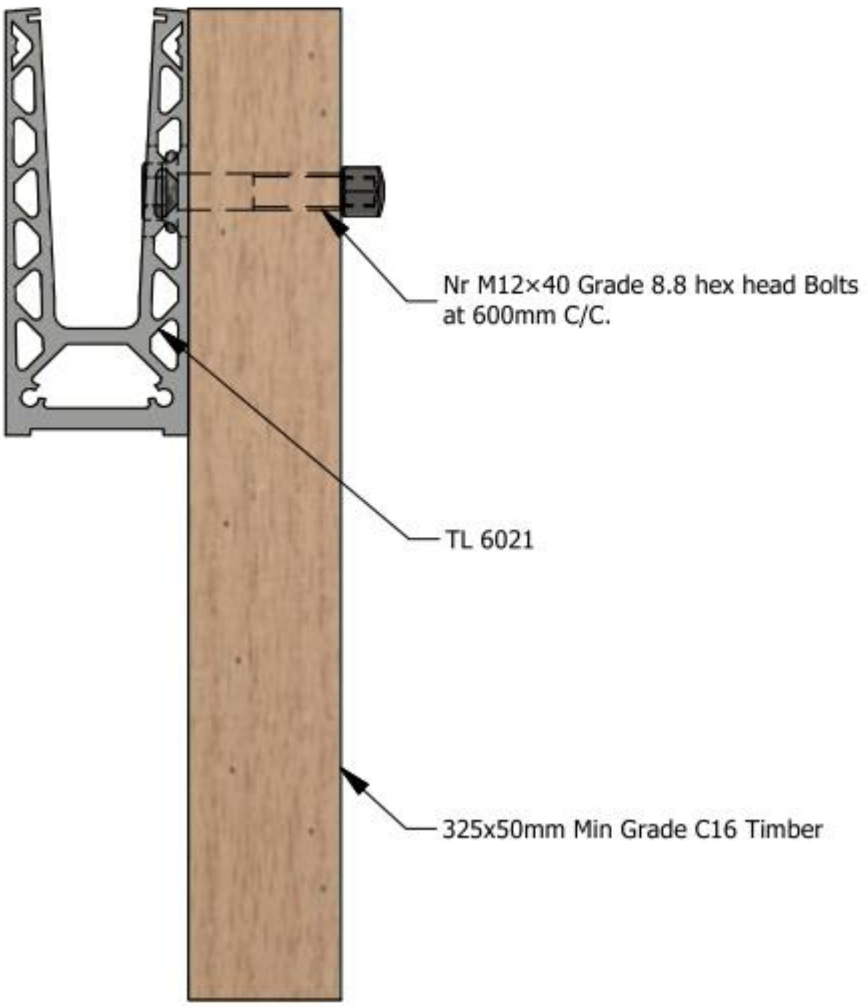
Connection to Wood – TL 6021:



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.