TL6501 - 0.5 kN/m Side Mount @ 0.7m

static calculation aluminium profile with anchoring

4018-19014-TL6501 rev. A

TL6501 - 0.5 kN/m Side Mount @ 0.7m

4018-19014-TL6501 rev. A

static calculation aluminium profile with anchoring

Client: **ONLEVEL GmbH**
Budberger Straße 5
46446 Emmerich am Rhein

rev.	date	ini	chk
A	2020-05-15	WG	

ing. W.L.G van de Gaar

ADVIESBUREAU BREKELMANS
ingenieurs voor bouwconstructies
wilhelminasingel 102
6221 BL maastricht
tel. +31 (0)43 3254637
e-mail info@adviesbureau-brekelmans.nl

Inhoud

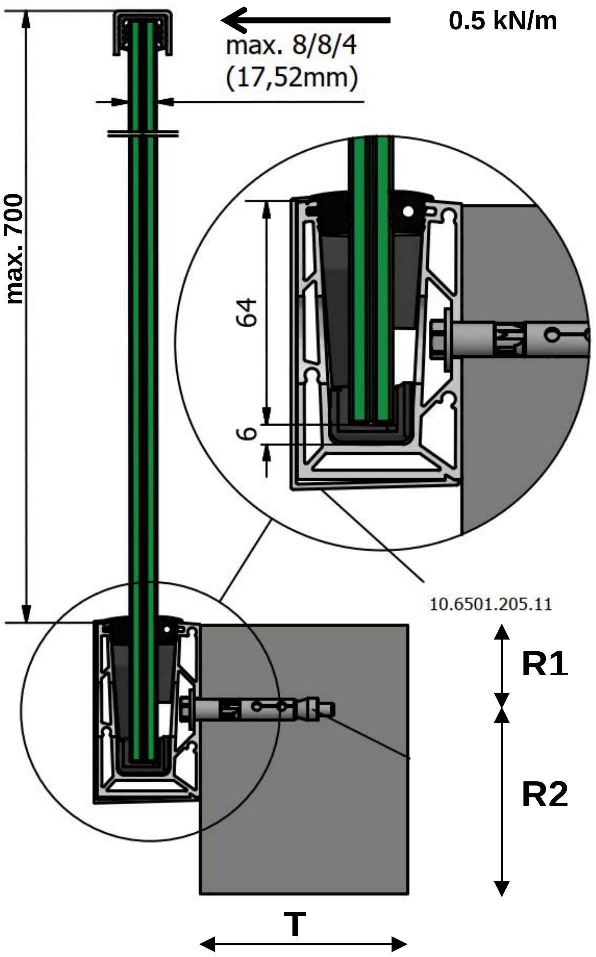
1 Applicable standards

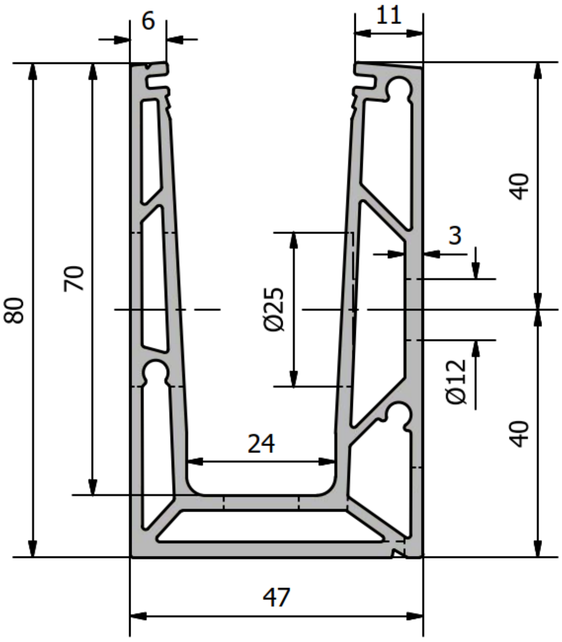
The calculation is based on the Eurocodes, in particular:

EN 1993-1-8:2011
EN 1999-1-1:2011

2 Introduction

In this report the aluminium profile "TL6501 - 0.5 kN/m Side Mount @ 0.7m" is been calculated.
This calculation does not include the calculation of the glass panels.





For the required anchors see appendix 2.

In case of lower loads and/or smaller dimensions, smaller edge distances may be possible.
This should be considered on a case-by-case basis.

3 Calculation principles

3.1 Loads and load factors

Load factor: γ_G = 1.35 γ_Q = 1.5

linear load **q_k = 0.5 kN/m** **at 0.7 m above bottom level profile**

This load is only intended to indicate the capacity of the profile.

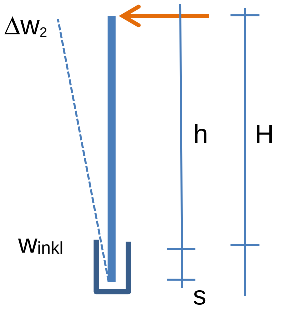
3.2 Materials used

Extruded aluminium profiels: EN AW 6063-T6
f_o = 160 N/mm^2
f_u = 195 N/mm^2

Bolts: 4.6 (in case of stainless steel: A4-50)

4 Static calculation

For the calculation of the aluminium profile itself see appendix 1.



The eff. insertion length is: s = 60 mm
H = 0.70 m: h = 700+10 = 710 mm
The relative deflection of the profile is: w_{inkl} = 0.74 mm at q_k = 0.5 kN/m
and h = 710 m

$\rightarrow$ w_{inkl} = 0.74 * 1.0/0.5 = **1.48 mm** at 1.0 kN/m @0.7m

For the calculation of the anchors see appendix 2.

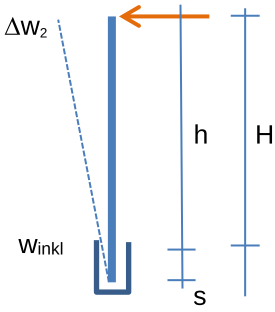
5 Conclusion and design instructions

The calculated profile with its anchors corresponds to the given load.

Horizontal deflection:
The deflection of the glass balustrade is the sum of the deflection of the glass plate itself and the deflection due to the swing effect caused by deformation of the profile.
For the calculation of the deflection of the glass balustrade, the deflection of the glass panel has to be superimposed with:

$$\Delta w_2 = w_{inkl} \cdot q_k \cdot \frac{(h+s)^2}{(710+s)\cdot s} = 1.48 \cdot q_k \cdot \frac{(h+60)^2}{710 \cdot 60} \text{ mm}$$

s = 60 mm
→ H = 0.70 m: h = 700+10 = 710 mm → **Δw_2 = 18.9*q_k** [mm]



Wind load with this profile and the corresponding anchors h.o.h. 250 mm:
This part of the calculation only applies to the Netherlands:

The maximum extreme wind pressure $q_p(z)$ in accordance with NEN-EN 1991-1-4(NB) in an outdoor application is, in relation to the line load q_k = 0.50 kN/m:

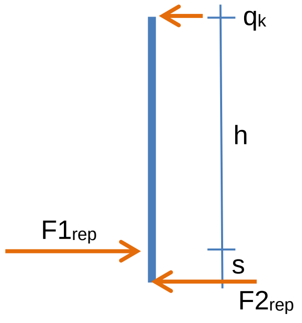
According to table NB 17-7.9 in 7.4.1 of NEN-EN 1991-1-4(NB) for parapets with converted edges:
$c_{p,net}$ = +/- 1.8 (panels within 2h of edge/angle)
$q_p(z)$ ≤ smallest {[$q_k \cdot (h_{ontw} + s)$] / [$c_{p,net} \cdot h \cdot (0.5h+s)$] ; [$q_k \cdot (H_{ontw}+0.08)$] / [$c_{p,net} \cdot (H+0.08)^2/2$]}

→ $q_p(z)$ at H = **0.70** m:
$q_p(z)$ ≤ smallest {[0.50 · (0.710+0.06)] / [1.8 · 0.710 · (0.5 · 0.710 + 0.06)] ;
[0.50 · (0.70+0.08] / [1.8 · $(0.70+0.08)^2/2$] ;
smallest {0.72 ; 0.72} = 0.72 kN/m²

→ $q_p(z)$ at H = **0.50** m:
$q_p(z)$ ≤ smallest {[0.50 · (0.710+0.06)] / [1.8 · 0.510 · (0.5 · 0.510 + 0.06)] ;
[0.50 · (0.70+0.08] / [1.8 · $(0.50+0.08)^2/2$] ;
smallest {1.23 ; 1.28} = 1.23 kN/m²

Appendix 1 – static calculation profile at 0.50 kN/m @ 0.7m

Centre distance anchors 250 mm.



q_k	=	0.50	kN/m
h	=	700+10 = 710 mm	
s	=	60	mm

The profile is calculated with a length of 250 mm and one anchor.

Resulting forces from glass clamping:

			SLS		ULS	ULS
F1	=	$q_k \cdot (h+s)/s$	= 6.42 kN/m * 1.5	=	9.62 kN/m * 0.250 = 2.406 kN =	2406 N
F2	=	$F1_k - q_k$	= 5.92 kN/m * 1.5	=	8.87 kN/m * 0.250 = 2.219 kN =	2219 N

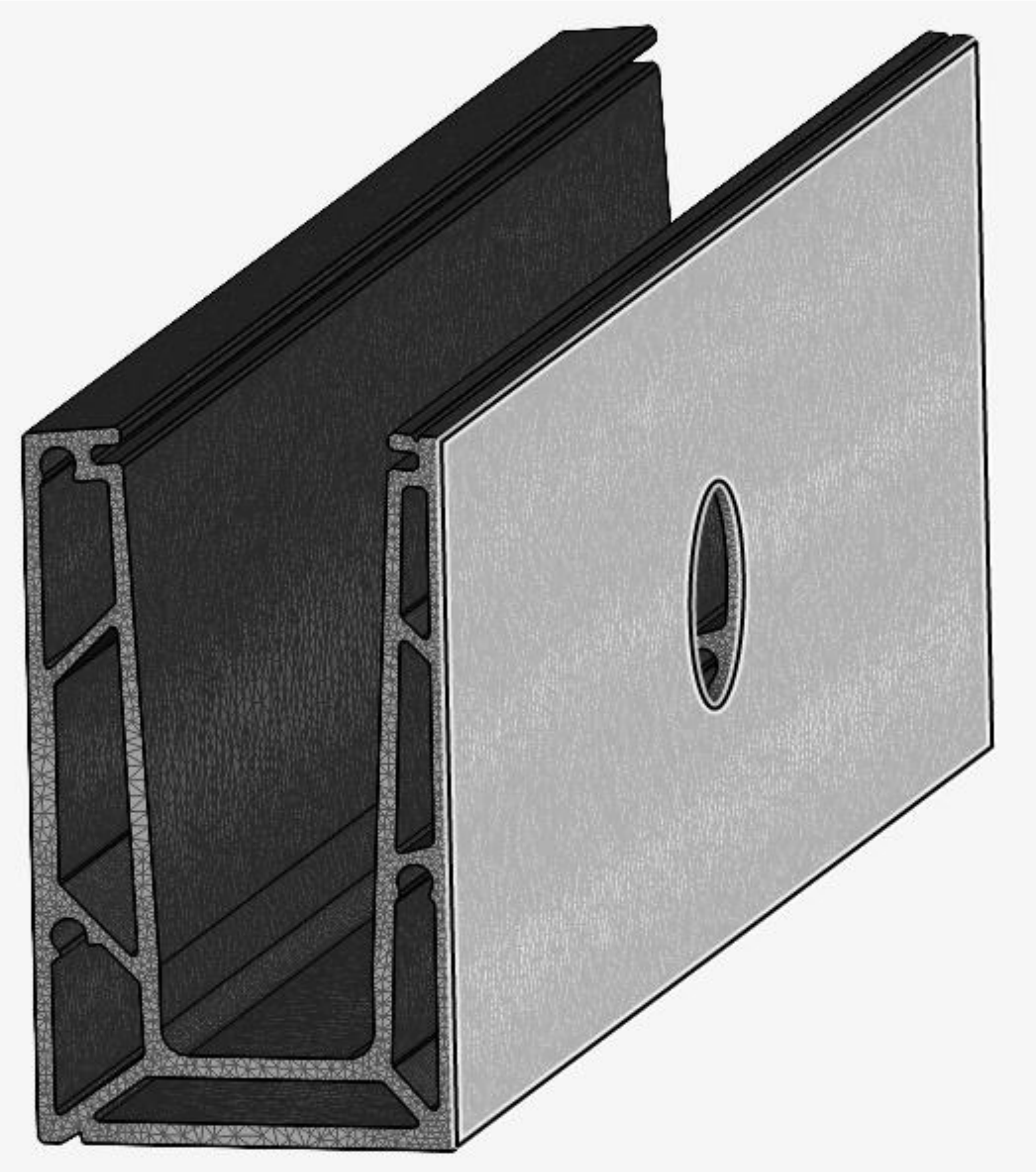
The profile is calculated with Simscale (Code-Aster solver), where a linear material calculation is performed.
Maximum stresses in LE calculation:

$1.5{*}f_o/\gamma_{M1} = 1.5{*}160/1.1$ = 218 MPa
$1.0{*}f_u/\gamma_{M2} = 195/1.25$ = 156 MPa → 156 MPa

Elastic strain: (160/1.1)/70000 = 2.08E-3

Small profiles that have no influence on the calculation have been removed.

Mesh and material definition:



Aluminium

Material behavior	Plastic
(E) Young's modulus	7e+10 Pa
(v) Poisson's ratio	0.3
σ_{VM}	Table
Creep formulation	No creep
(ρ) Density	2700 kg/m³

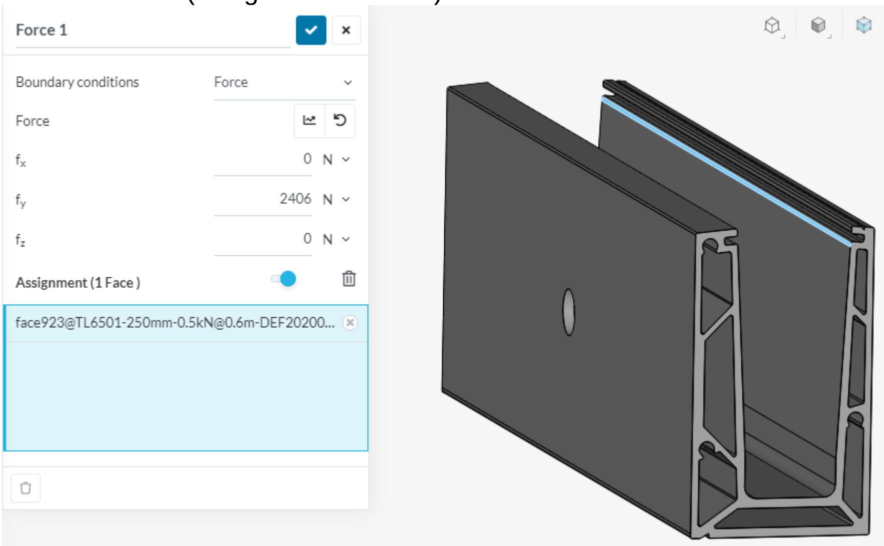
Assignment (1 Volume)

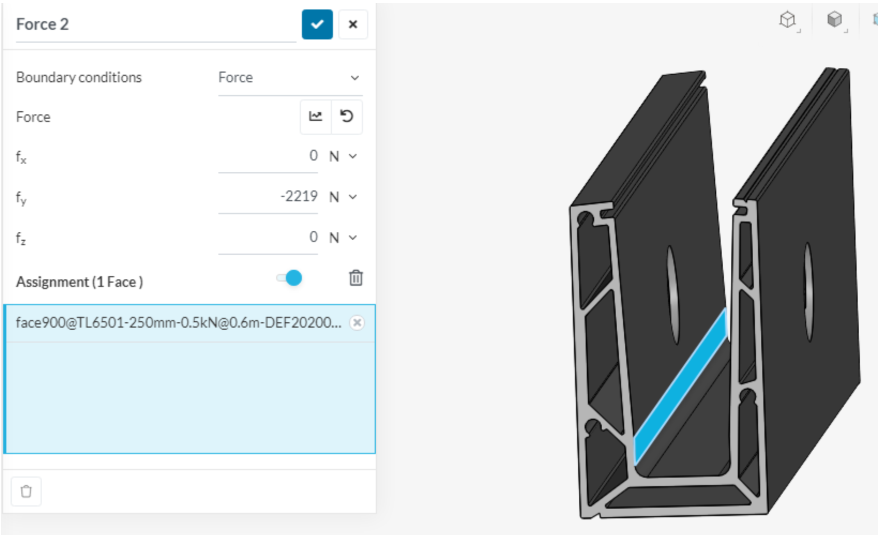
TL6501-250mm-0.5kN@0.6m-DEF20200515

Table

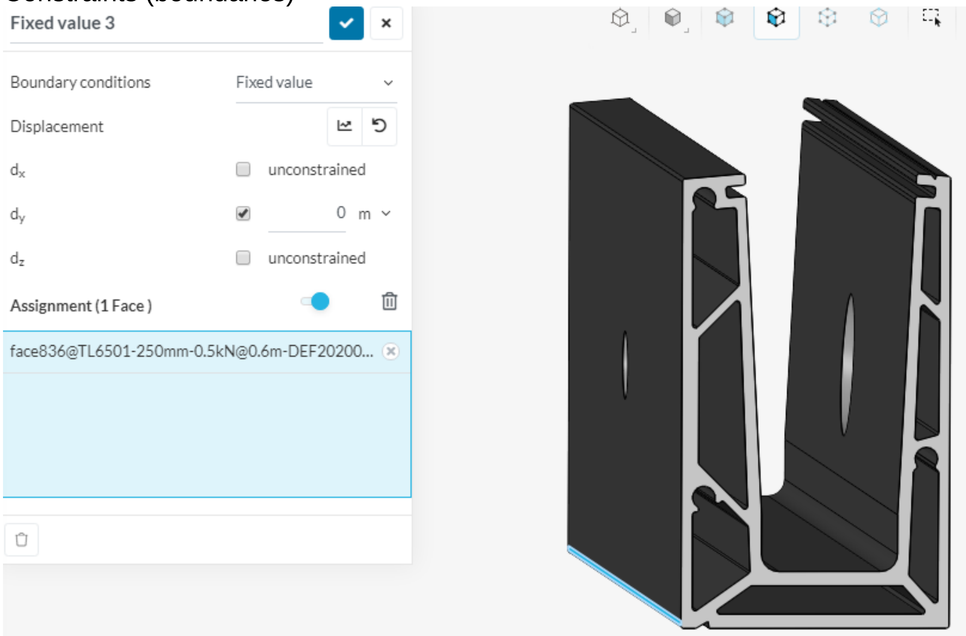
ID	ε	σ<VM>
	ε	σ<VM> Pa
1	2.07e-3	145e6
2	20e-3	156e6

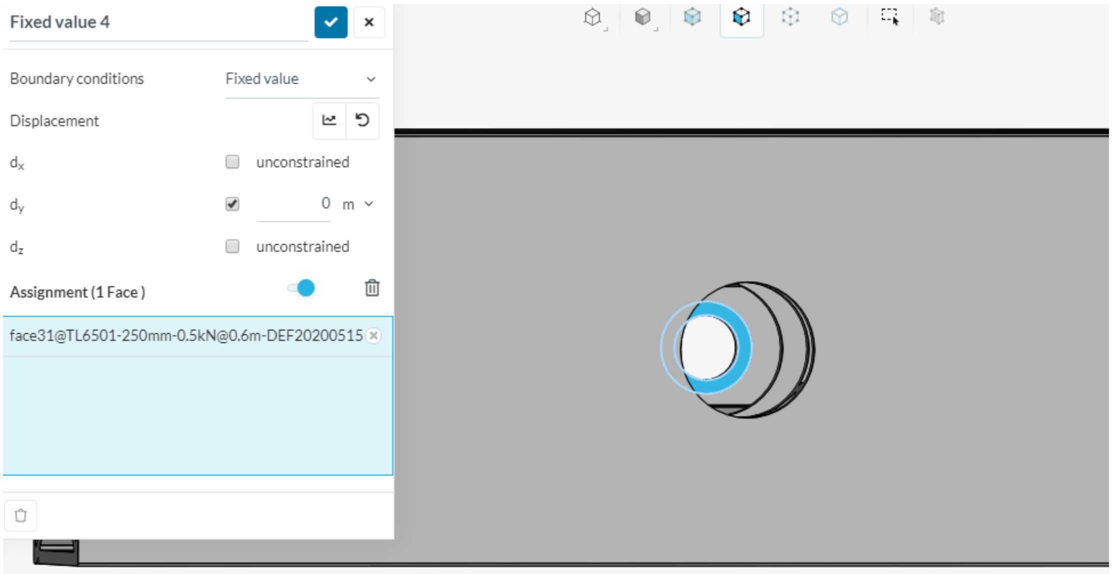
Factored loads (design values - ULS):

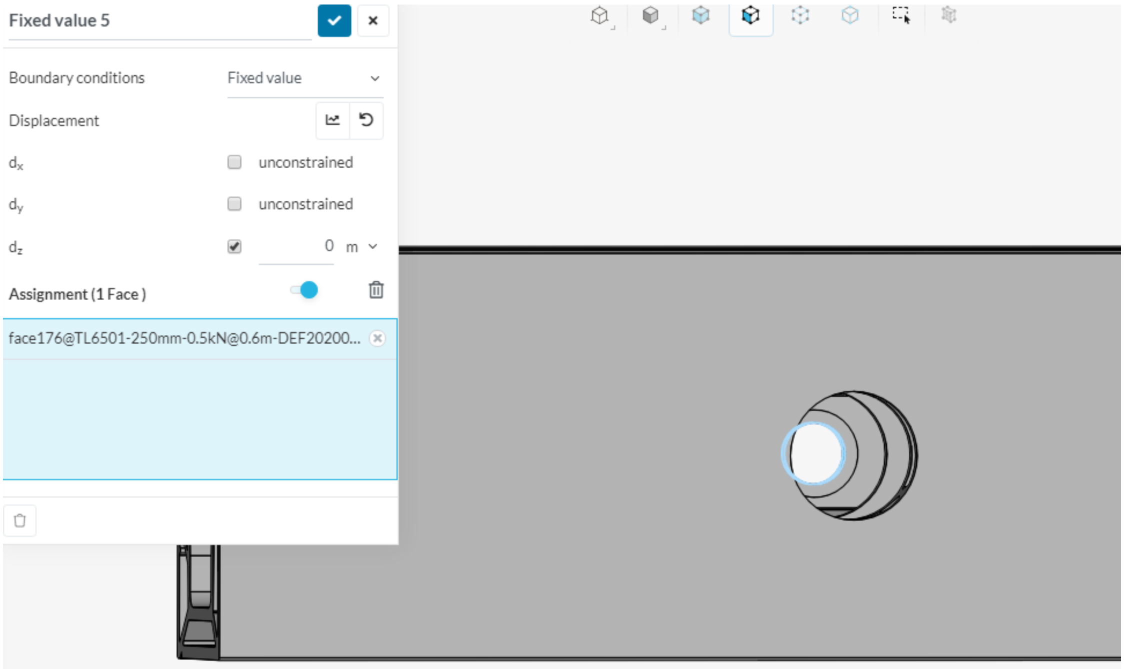


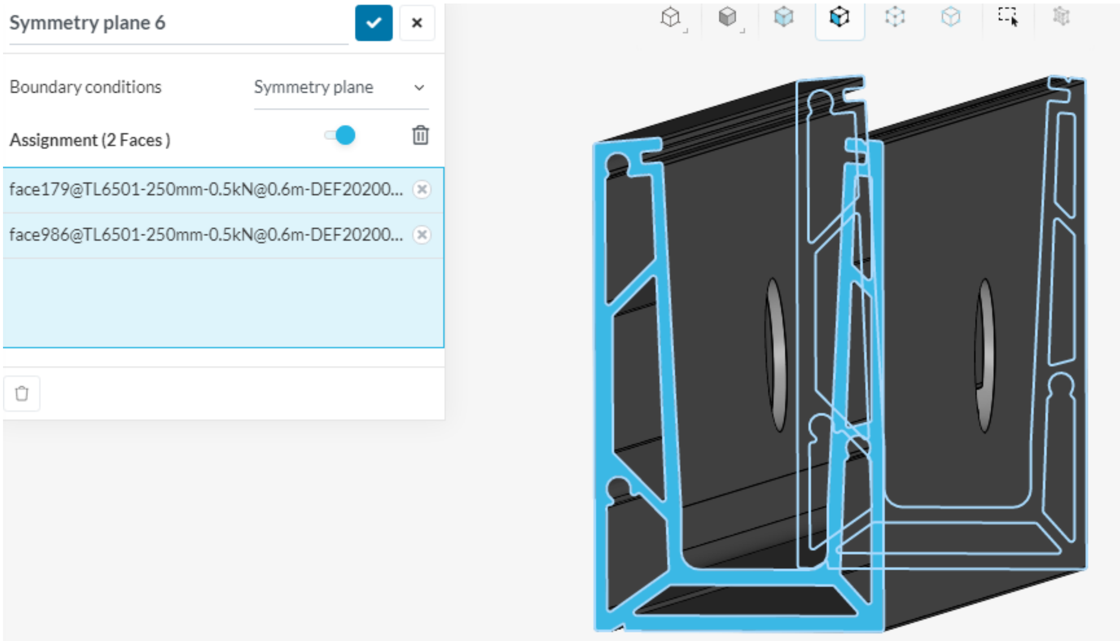


Constraints (boundaries)

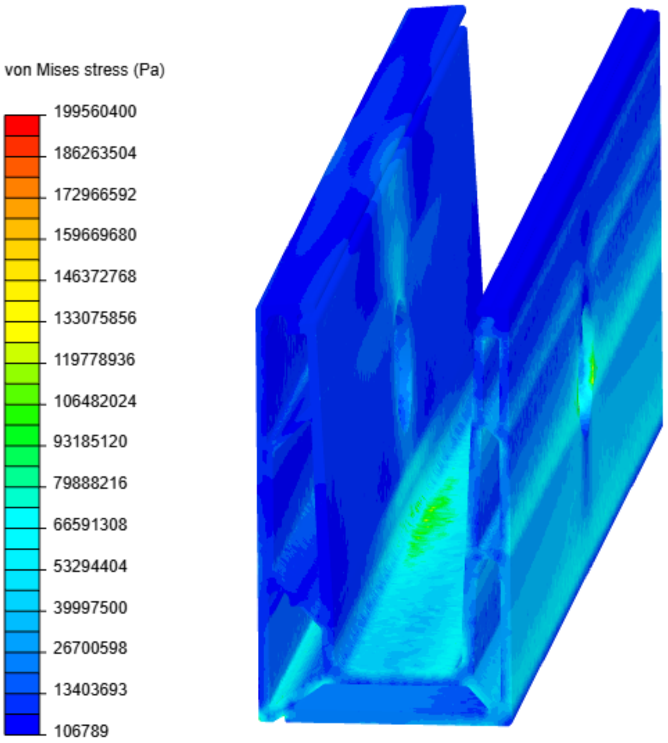




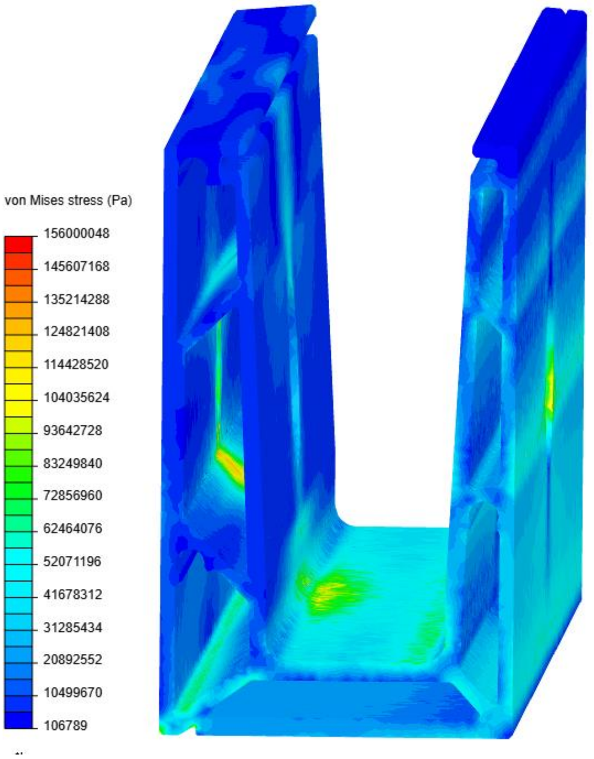

Fixed value 5
Boundary conditions
Fixed value
Displacement
d_x
unconstrained
d_y
unconstrained
d_z
0 m
Assignment (1 Face)
face176@TL6501-250mm-0.5kN@0.6m-DEF20200...


Symmetry plane 6
Boundary conditions
Symmetry plane
Assignment (2 Faces)
face179@TL6501-250mm-0.5kN@0.6m-DEF20200...
face986@TL6501-250mm-0.5kN@0.6m-DEF20200...

Resulting stresses in ULS (linear elastic calculation at full load):

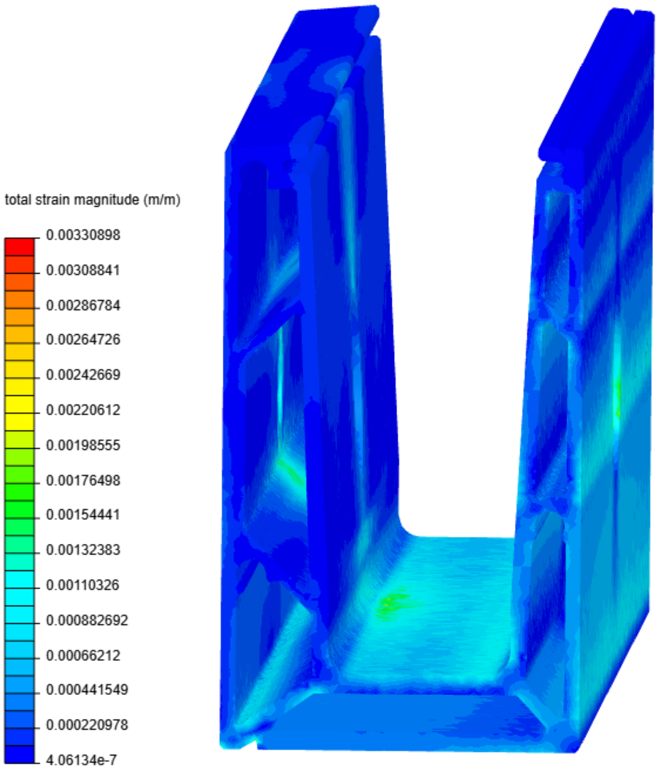


Topped at 156MPa:

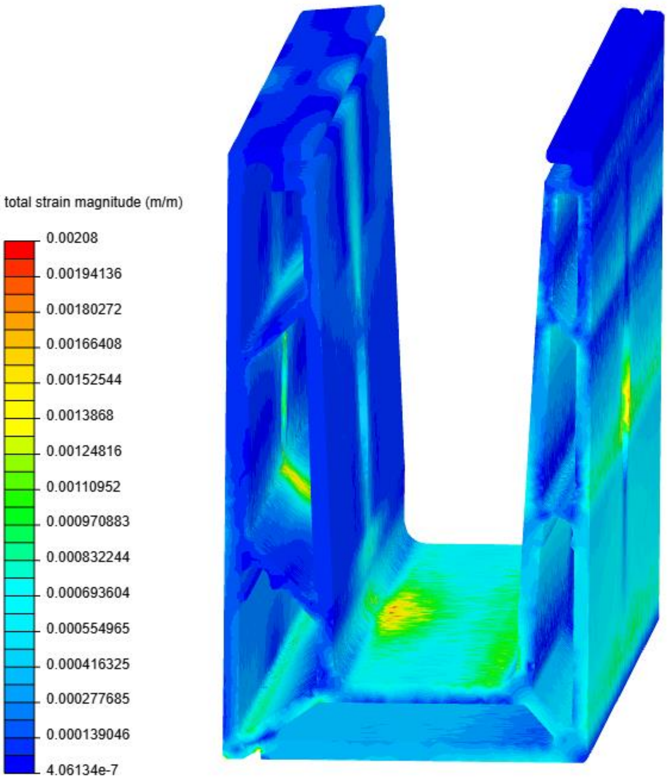


A small hotspot below the anchor occurs. This is due to the linear elastic calculation.
Due to the plastic capacity of the material this is allowable.

Corresponding strain:

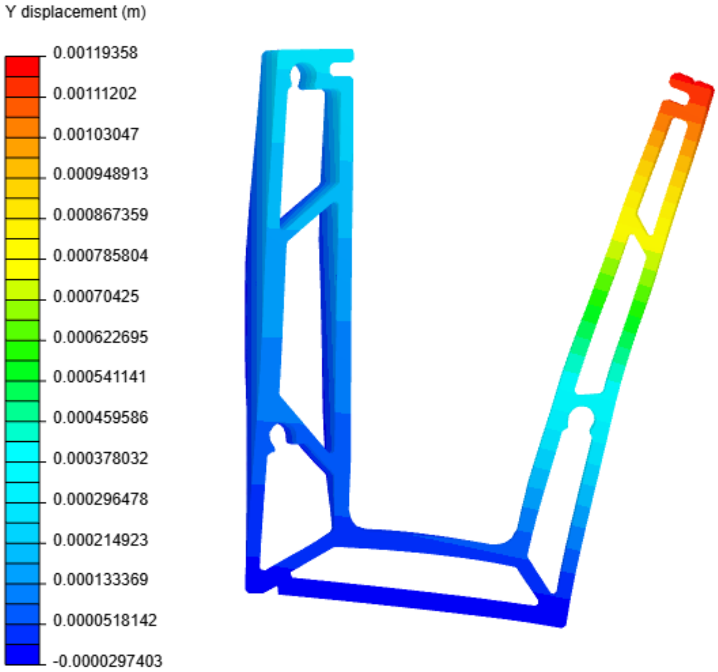


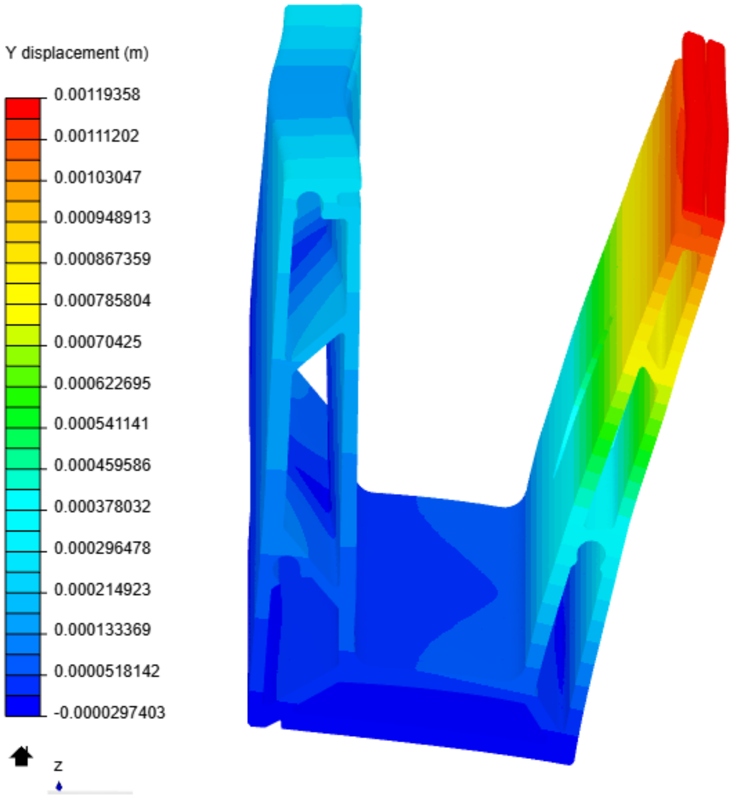
Topped at the elastic strain 2.08E-3:



Again some very small hotspots occur.
Due to the plastic capacity of the material this is allowable.

Resulting deformations in ULS:

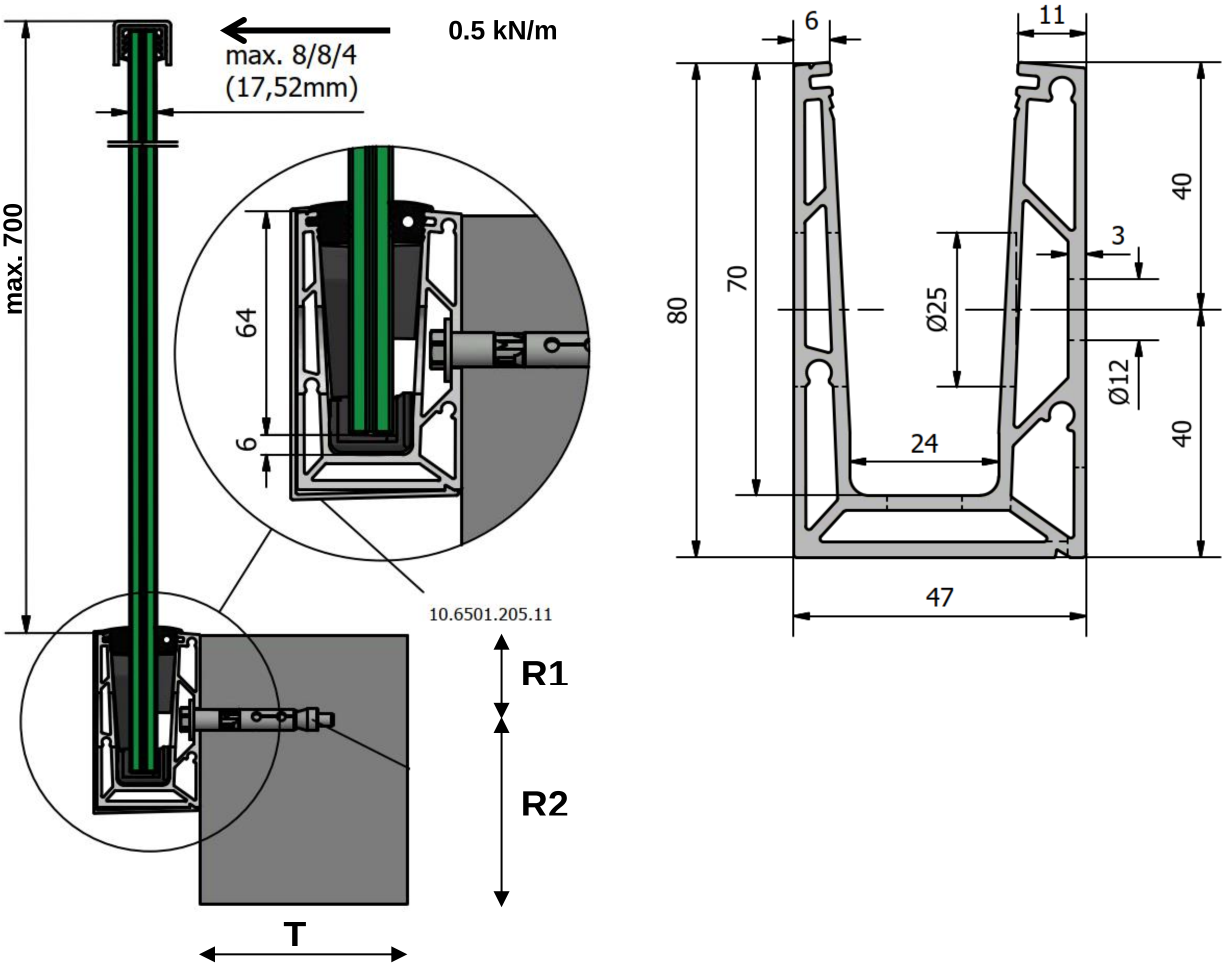




Deflection difference in points of application in SLS:

$w_{inkl} \approx (1.11\text{-}0.00)/1.5 = 0.74$ mm at 0.5 kN/m @ 0.7m

Appendix 2 - calculation anchoring materials



At line load 0.5 kN/m @ 0.7 m':
Factored design loads anchors @ 250 mm:

F_{tEd} = [1.5*0.50*(700)/(40-2)]*0.250 = 3.45 kN each
F_{vEd} = 1.35*0.40*0.250 = 0.14 kN each

Drilled anchors in concrete @ 250 mm in hammer drilled holes: (for calculation see annex 3)
minimum concrete quality and edge distances required: **C25/30 | R1 ≥ 40mm | R2 ≥ 100 mm | T ≥ 100 mm**

- **Fischer FH II 10/10 S**
- **Fischer FH II 10/10 S A4**

Alternative:
minimum concrete quality and edge distances required: C20/25 | R1 ≥ 50mm (!) | R2 ≥ 75 mm | T ≥ 140 mm

- HUS3-H 10 h_nom1 (HUS3-H 10x60)
- HUS-HR 10 h_nom3 (HUS-HR 10x95) A4

Alternative anchors may be used, provided that it has been proved by calculation based on EN 1992-4 and guidelines that the anchors are suitable for the forces occurring in the given situation.
The concrete structure must be able to withstand the occurring forces.

In case of lower loads and/or smaller dimensions, smaller edge distances might be possible.
This should be considered on a case-by-case basis.

Bolted connection on steel

min. M10 (A4-70 "outside" resp. 8.8 EV of TV "inside") @ 250 mm

F_{tRd} = 29.23 kN | F_{vRd} = 16.24 kN ✓

The steel structure must be able to withstand the occurring forces.

Bolted connection on wood

$\sigma_{c,90,Ed} \leq$ 0.8*2.5/1.3 = 1.5 MPa for **C24 wood**

$x \geq \sim$ 10 mm → $F_{tEd} \approx$ [1.5*0.50*(700)/(40-5)]*0.250 = 3.75 kN each

F_{vEd} = 1.35*0.40*0.250 = 0.14 kN each

RAMPA nut M10*70 (EV): F_{tRd} = 5.42 kN $\geq$ 3.75

Required edge distance **R1** = 3 * 18.5 = **55 mm**
R2 = 3 * 18.5 = **55 mm**

The wood structure must be able to withstand the occurring forces.

For calculation of resistance of RAMPA nuts see doc. 4018-12001-RAMPA rev. D:
(extract:)

Resulterende rekenwaarden uittreksterktes RAMPA moeren+bout

bout	bout min. 4.6		RAMPA			klimaatklasse 1 & 2	3
	As [mm^2]	F_{tRd} [kN]	d [mm]	l_{ef} [mm]	F_{tRk} [kN]	**F_{tRd} [kN]**	**F_{tRd} [kN]**
M10	57	11.49	18.5	50	7.75	**4.77**	3.87
M10	57	11.49	18.5	60	9.30	**5.72**	4.65
M10	57	11.49	18.5	70	10.85	**6.68**	5.42
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Karakteristieke treksterkte RAMPA moer vlg. 2.1 van ETA-12/0481 2.1

Characteristic value $F_{tens,k}$:

d = 18,5 mm (M10) : 31 kN
d = 22,0 mm (M12) : 41 kN
d = 25,0 mm (M16) : 41 kN

Uittreksterkte RAMPA moeren vlg. 2.1 van ETA-12/0481

$$F_{ax,\alpha,Rk} = \frac{n_{ef} \cdot 9 \cdot d \cdot \ell_{ef}}{1,2 \cdot \cos^2 \alpha + \sin^2 \alpha} \cdot \left(\frac{\rho_k}{350}\right)^{0,8} \quad [N]$$

Where

- $F_{ax,\alpha,RK}$ characteristic withdrawal capacity of the inserts at an angle α to the grain [N]
- n_{ef} effective number of inserts according to EN 1995-1-1:2008
- d outer thread diameter [mm]
- ℓ_{ef} Penetration length of the threaded part according to EN 1995-1-1:2008 [mm]
- α Angle between grain and screw axis ($\alpha \geq 30°$)
- ρ_k Characteristic density [kg/m³]

Berekening karakteristieke uittreksterkte op basis van:

n_{ef} = 1 (beschouwing per anker/bout)
α = 90°
ρ_k = 350 kg/m^3 (C18)

Berekening rekenwaarde uittreksterkte vlg. 8.3.12 van NEN-EN 1995-1-1:

$F_{tRd} = k_{mod} \cdot F_{tRk} / \gamma_M$

Waarin

γ_M = 1,3 vlg. tabel 2.3
k_{mod} = 0,80 klimaatklasse 1 en 2 - belastingduurklasse "kort"
k_{mod} = 0,65 klimaatklasse 3 - belastingduurklasse "kort"

Treksterkte standaard bouten

4.6 kwaliteit en verzonken bouten maatgevend (vlg. NEN-EN 1993-1-8):

$F_{tRd} = 0.63 \cdot f_{ub} \cdot A_s / \gamma_{M2} = 0.63 \cdot 400 \cdot A_s / 1.25$

Appendix 3 – anchors

fischer Benelux B.V

Amsterdamsestraatweg 45 B/C
1411 AX Naarden
Phone: +31 35 6 95 66 66
Fax: +31 35 6 95 66 99
techniek@fischer.nl
www.fischer.nl

Comment

Appendix 3

Design Specifications

Anchor

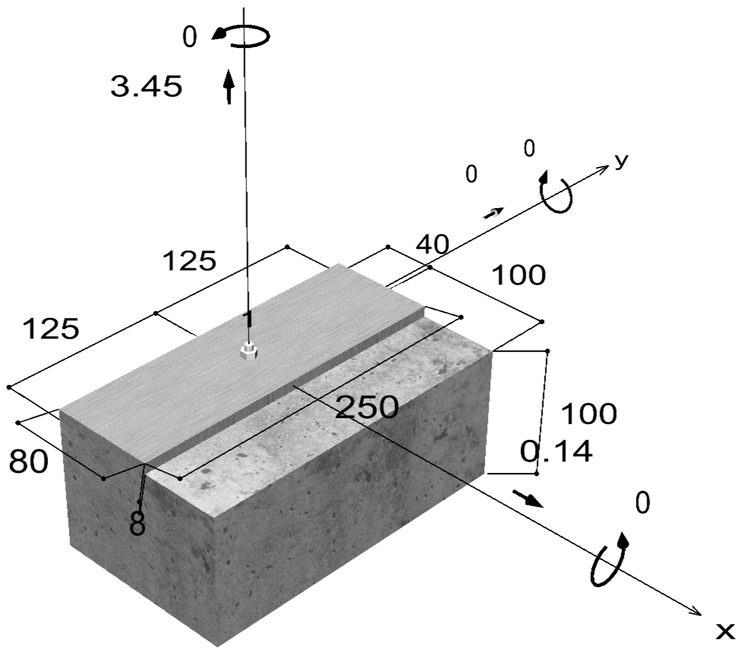
Anchor system	fischer High performance anchor FH II
Anchor	High performance anchor FH II 10/10 S, zinc plated steel
Calculated anchorage depth	40 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-07/0025, Option 1, Issued 14/05/2018

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, C25/30, EN 206
Concrete condition	Cracked, dry hole
Reinforcement	No or standard reinforcement. No edge reinforcement. Without reinforcement against splitting
Drilling method	hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap not filled
Type of loading	Static or quasi-static
Base plate location	Base plate flush installed on base material
Base plate geometry	80 mm x 250 mm x 8 mm
Profile type	None

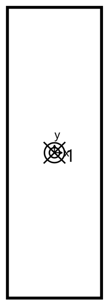
Design actions *)

#	N_{Ed} kN	$V_{Ed,x}$ kN	$V_{Ed,y}$ kN	$M_{Ed,x}$ kNm	$M_{Ed,y}$ kNm	$M_{T,Ed}$ kNm	Type of loading
1	3.45	0.14	0.00	0.00	0.00	0.00	Static or quasi-static

*) The required partial safety factors for actions are included

Resulting anchor forces

Anchor no.	Tensile action kN	Shear Action kN	Shear Action x kN	Shear Action y kN
1	3.45	0.14	0.14	0.00



max. concrete compressive strain :	0.00 ‰
max. concrete compressive stress :	0.0 N/mm²
Resulting tensile actions :	3.45 kN , X/Y position (0 / 0)
Resulting compression actions :	0.00 kN , X/Y position (0 / 0)

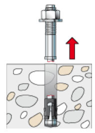
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	3.45	10.73	32.1
Pullout failure *	3.45	5.60	61.6
Concrete cone failure	3.45	4.87	70.8
Splitting failure	3.45	3.82	**90.4**

* Most unfavourable anchor

Steel failure

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

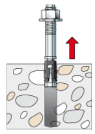


$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
16.10	1.50	10.73	3.45	32.1

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	32.1	1	$\beta_{N,s;1}$

Pullout failure

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



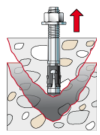
$N_{Rk,p}$ kN	Ψ_c	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
8.40	1.120	1.50	5.60	3.45	61.6

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

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	61.6	1	$\beta_{N,p;1}$

Concrete cone failure

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



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

$$N_{Rk,c} = 9.74kN \cdot \frac{12{,}000mm^2}{14{,}400mm^2} \cdot 0.900 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 7.30kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 7.7 \cdot \sqrt{25.0N/mm^2} \cdot \left(40mm\right)^{1.5} = 9.74kN \quad \text{Eq. (7.2)}$$

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} = 0.7 + 0.3 \cdot \frac{40mm}{60mm} = 0.900 \leq 1 \quad \text{Eq. (7.4)}$$

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

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

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

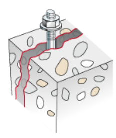
$$\Psi_{M,N} = 1.00 \geq 1$$ Eq. (7.7)

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
7.30	1.50	4.87	3.45	70.8

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	70.8	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)

$$N_{Rk,sp} = 8.40kN \cdot \frac{25{,}650mm^2}{36{,}100mm^2} \cdot 0.826 \cdot 1.000 \cdot 1.000 \cdot 1.160 = 5.72kN$$

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,sp}} = 0.7 + 0.3 \cdot \frac{40mm}{95mm} = 0.826 \leq 1$$ 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)

$$\Psi_{ec,Nx} = \frac{1}{1+\frac{2 \cdot 0mm}{190mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1+\frac{2 \cdot 0mm}{190mm}} = 1.000 \leq 1$$

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

$$\Psi_{h,sp} = min\left(\left(\frac{100mm}{80mm}\right)^{2/3}; max\left(1; \left(\frac{40mm + 1.5 \cdot 40mm}{80mm}\right)^{2/3}\right); 2\right) = 1.160$$

$N_{Rk,sp}$ kN	γ_{Msp}	$N_{Rd,sp}$ kN	N_{Ed} kN	$\beta_{N,sp}$ %
5.72	1.50	3.82	3.45	90.4

Anchor no.	$\beta_{N,sp}$ %	Group N°	Decisive Beta
1	90.4	1	$\beta_{N,sp;1}$

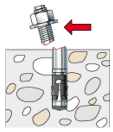
Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	0.14	14.40	1.0
Concrete pry-out failure	0.14	4.87	**2.9**
Concrete edge failure	0.14	5.45	2.6

* Most unfavourable anchor

Steel failure without lever arm

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



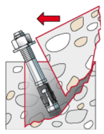
$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 18.00kN = 18.00kN$$ Eq. (7.35)/ (7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
18.00	1.25	14.40	0.14	1.0

Anchor no.	β_{Vs} %	Group N°	Decisive Beta
1	1.0	1	$\beta_{Vs;1}$

Concrete pry-out failure

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



$$V_{Rk,cp} = k_8 \cdot N_{Rk,c} = 1 \cdot 7.30kN = 7.30kN$$ 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)

$$N_{Rk,c} = 9.74kN \cdot \frac{12{,}000mm^2}{14{,}400mm^2} \cdot 0.900 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 7.30kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h^{1.5}_{ef} = 7.7 \cdot \sqrt{25.0N/mm^2} \cdot \left(40mm\right)^{1.5} = 9.74kN$$ Eq. (7.2)

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} = 0.7 + 0.3 \cdot \frac{40mm}{60mm} = 0.900 \leq 1$$ 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)

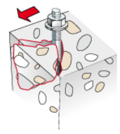
$$\Psi_{M,N} = 1.00 \geq 1$$ Eq. (7.7)

$V_{Rk,cp}$ kN	γ_{Mc}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
7.30	1.50	4.87	0.14	2.9

Anchor no.	$\beta_{V,cp}$ %	Group N°	Decisive Beta
1	2.9	1	$\beta_{V,cp;1}$

Concrete edge failure

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



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

$$V_{Rk,c} = 7.12kN \cdot \frac{14{,}000mm^2}{20{,}000mm^2} \cdot 0.820 \cdot 1.000 \cdot 2.000 \cdot 1.000 \cdot 1.000 = 8.17kN$$

$$V^{0}_{Rk,c} = k_9 \cdot d^{\alpha}_{nom} \cdot l^{\beta}_{f} \cdot \sqrt{f_{ck}} \cdot {c'}^{1.5}_{1}$$ Eq. (7.41)

$$V^{0}_{Rk,c} = 1.7 \cdot \left(10mm\right)^{0.077} \cdot \left(40mm\right)^{0.068} \cdot \sqrt{25.0N/mm^2} \cdot \left(67mm\right)^{1.5} = 7.12kN$$

$$\alpha = 0.1 \cdot \sqrt{\frac{l_f}{c'_1}} = 0.1 \cdot \sqrt{\frac{40mm}{67mm}} = 0.077 \qquad \beta = 0.1 \cdot \left(\frac{d_{nom}}{c'_1}\right)^{0.2} = 0.1 \cdot \left(\frac{10mm}{67mm}\right)^{0.2} = 0.068$$ Eq. (7.42/7.43)

$$\Psi_{s,V} = 0.7 + 0.3 \cdot \frac{c_2}{1.5c'_1} = 0.7 + 0.3 \cdot \frac{40mm}{1.5 \cdot 67mm} = 0.820 \leq 1$$ Eq. (7.45)

$$\Psi_{h,V} = max\left(1;\ \sqrt{\frac{1.5c'_1}{h}}\right) = max\left(1;\ \sqrt{\frac{1.5 \cdot 67mm}{100mm}}\right) = 1.000 \geq 1$$ Eq. (7.46)

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

$$\Psi_{ec,V} = \frac{1}{1 + \frac{2}{3}\frac{e_v}{c'_1}} = \frac{1}{1 + \frac{2 \cdot 0mm}{3 \cdot 67mm}} = 1.000 \leq 1$$ Eq. (7.47)

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

$$c'_1 = max\left(\frac{c_{2,max}}{1.5};\ \frac{h}{1.5}\right) = max\left(\frac{100mm}{1.5};\ \frac{100mm}{1.5}\right) = 67mm$$ Eq. (7.49)

$V_{Rk,c}$ kN	γ_{Mc}	$V_{Rd,c}$ kN	V_{Ed} kN	$\beta_{V,c}$ %
8.17	1.50	5.45	0.14	2.6

Anchor no.	$\beta_{V,c}$ %	Group N°	Decisive Beta
1	2.6	1	$\beta_{V,c;1}$

Utilization of tension and shear loads

Tension loads	Utilisation βN %
Steel failure *	32.1
Pullout failure *	61.6
Concrete cone failure	70.8
Splitting failure	**90.4**

Shear Loads	Utilisation βV %
Steel failure without lever arm *	1.0
Concrete pry-out failure	**2.9**
Concrete edge failure	2.6

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.32 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.01 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.10 \leq 1$$

Eq. (7.55)

Utilisation concrete

Proof successful

$$\beta_{N,sp} = \beta_{N,sp;1} = 0.90 \leq 1$$
$$\beta_{V.cp} = \beta_{V,cp;1} = 0.03 \leq 1$$
$$\frac{\beta_N + \beta_V}{1.2} = \frac{\beta_{N,sp;1} + \beta_{V,cp;1}}{1.2} = 0.78 \leq 1$$

Eq. (7.57)

Information concerning the anchor plate

Base plate details

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

Profile type — None

Technical remarks

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

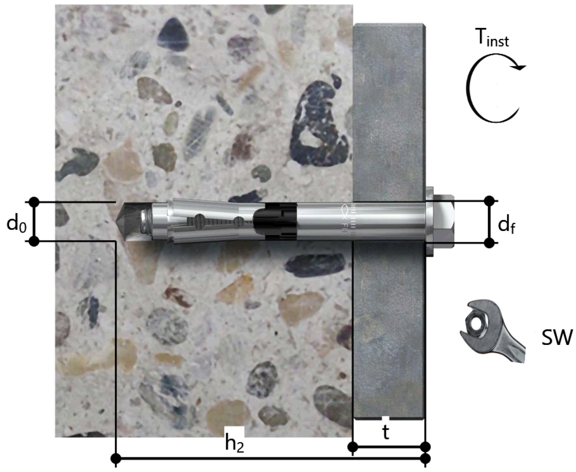
Installation data

Anchor

Anchor system	**fischer High performance anchor FH II**	
Anchor	High performance anchor FH II 10/10 S, zinc plated steel	Art.-No. 503133
Accessories	Blow-out pump ABG big	Art.-No. 89300
	Quattric II 10/100/165 XP5	Art.-No. 549924
	Erection of the drillhole by hammer drilling with or without suction cleaning	

Installation details

Thread diameter	M 6
Drill hole diameter	d_0 = 10 mm
Drill hole depth	h_2 = 65 mm
Calculated anchorage depth	h_{ef} = 40 mm
Installation depth	h_{nom} = 40 mm
Drilling method	hammer drilling
Drill hole cleaning	only blow out by hand
Installation type	Push-through installation
Annular gap	Annular gap not filled
Installation torque	T_{inst} = 10.0 Nm
Socket size	10 mm
Base plate thickness	t = 8 mm
Total fixing thickness	t_{fix} = 8 mm
Tfix,max	$t_{fix,\ max}$ = 10 mm

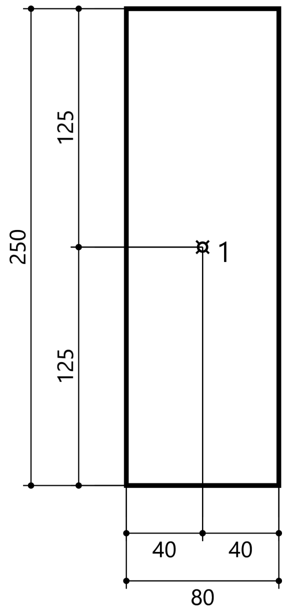


Base plate details

Base plate material	Not available
Base plate thickness	t = 8 mm
Clearance hole in base plate	d_f=12 mm

Attachment

Profile type	None



Anchor coordinates

Anchor no.	x mm	y mm
1	0	0

fischer Benelux B.V

Amsterdamsestraatweg 45 B/C
1411 AX Naarden
Phone: +31 35 6 95 66 66
Fax: +31 35 6 95 66 99
techniek@fischer.nl
www.fischer.nl

Comment

Appendix 3

Design Specifications

Anchor

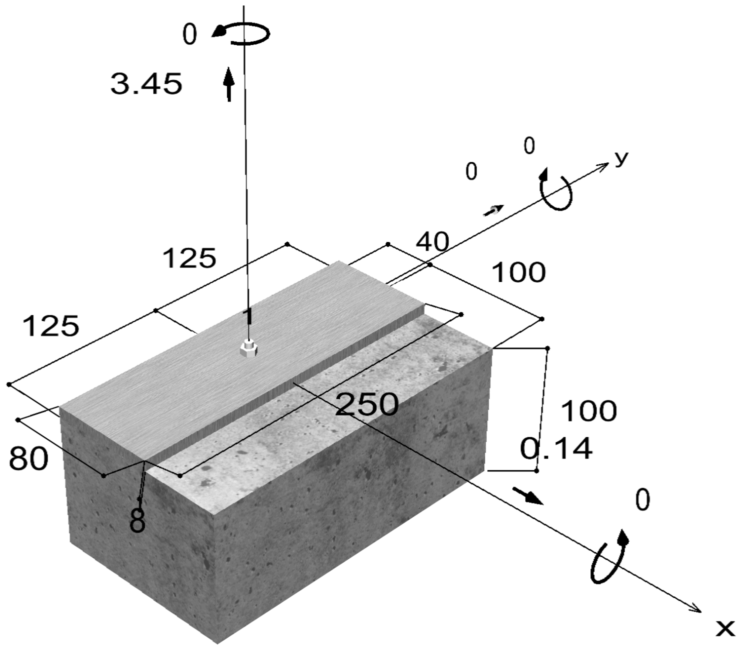
Anchor system	fischer High performance anchor FH II
Anchor	High performance anchor FH II 10/10 S A4, stainless steel, property class A4
Calculated anchorage depth	40 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-07/0025, Option 1, Issued 14/05/2018

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, C25/30, EN 206
Concrete condition	Cracked, dry hole
Reinforcement	No or standard reinforcement. No edge reinforcement. Without reinforcement against splitting
Drilling method	hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap not filled
Type of loading	Static or quasi-static
Base plate location	Base plate flush installed on base material
Base plate geometry	80 mm x 250 mm x 8 mm
Profile type	None

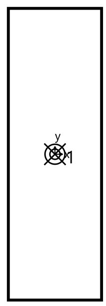
Design actions *)

#	N_{Ed} kN	$V_{Ed,x}$ kN	$V_{Ed,y}$ kN	$M_{Ed,x}$ kNm	$M_{Ed,y}$ kNm	$M_{T,Ed}$ kNm	Type of loading
1	3.45	0.14	0.00	0.00	0.00	0.00	Static or quasi-static

*) The required partial safety factors for actions are included

Resulting anchor forces

Anchor no.	Tensile action kN	Shear Action kN	Shear Action x kN	Shear Action y kN
1	3.45	0.14	0.14	0.00



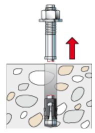
max. concrete compressive strain :	0.00	‰
max. concrete compressive stress :	0.0	N/mm²
Resulting tensile actions :	3.45	kN , X/Y position (0 / 0)
Resulting compression actions :	0.00	kN , X/Y position (0 / 0)

Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	3.45	10.06	34.3
Pullout failure *	3.45	5.60	61.6
Concrete cone failure	3.45	4.87	70.8
Splitting failure	3.45	3.82	**90.4**

* Most unfavourable anchor

Steel failure

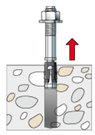


$$N_{Ed} \leq \frac{N_{Rk,s}}{\gamma_{Ms}} \quad (\mathbf{N_{Rd,s}})$$

$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Ed} kN	$\beta_{N,s}$ %
16.10	1.60	10.06	3.45	34.3

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	34.3	1	$\beta_{N,s;1}$

Pullout failure



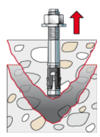
$$N_{Ed} \leq \frac{N_{Rk,p}}{\gamma_{Mp}} \quad (\mathbf{N_{Rd,p}})$$

$N_{Rk,p}$ kN	Ψ_c	γ_{Mp}	$N_{Rd,p}$ kN	N_{Ed} kN	$\beta_{N,p}$ %
8.40	1.120	1.50	5.60	3.45	61.6

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

Anchor no.	$\beta_{N,p}$ %	Group N°	Decisive Beta
1	61.6	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)

$$N_{Rk,c} = 9.74kN \cdot \frac{12{,}000mm^2}{14{,}400mm^2} \cdot 0.900 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 7.30kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 7.7 \cdot \sqrt{25.0N/mm^2} \cdot \left(40mm\right)^{1.5} = 9.74kN$$ Eq. (7.2)

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} = 0.7 + 0.3 \cdot \frac{40mm}{60mm} = 0.900 \leq 1$$ 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)

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

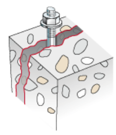
$$\Psi_{M,N} = 1.00 \geq 1$$ Eq. (7.7)

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Ed} kN	$\beta_{N,c}$ %
7.30	1.50	4.87	3.45	70.8

Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	70.8	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)

$$N_{Rk,sp} = 8.40kN \cdot \frac{25{,}650mm^2}{36{,}100mm^2} \cdot 0.826 \cdot 1.000 \cdot 1.000 \cdot 1.160 = 5.72kN$$

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,sp}} = 0.7 + 0.3 \cdot \frac{40mm}{95mm} = 0.826 \leq 1$$ 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)

$$\Psi_{ec,Nx} = \frac{1}{1+\frac{2 \cdot 0mm}{190mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1+\frac{2 \cdot 0mm}{190mm}} = 1.000 \leq 1$$

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

$$\Psi_{h,sp} = min\left(\left(\frac{100mm}{80mm}\right)^{2/3}; max\left(1; \left(\frac{40mm + 1.5 \cdot 40mm}{80mm}\right)^{2/3}\right); 2\right) = 1.160$$

$N_{Rk,sp}$ kN	γ_{Msp}	$N_{Rd,sp}$ kN	N_{Ed} kN	$\beta_{N,sp}$ %
5.72	1.50	3.82	3.45	90.4

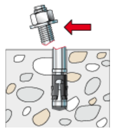
Anchor no.	$\beta_{N,sp}$ %	Group N°	Decisive Beta
1	90.4	1	$\beta_{N,sp;1}$

Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	0.14	13.53	1.0
Concrete pry-out failure	0.14	4.87	**2.9**
Concrete edge failure	0.14	5.45	2.6

* Most unfavourable anchor

Steel failure without lever arm



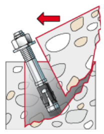
$$V_{Ed} \leq \frac{V_{Rk,s}}{\gamma_{Ms}} \quad (\mathbf{V_{Rd,s}})$$

$$V_{Rk,s} = k_7 \cdot V^0_{Rk,s} = 1.00 \cdot 18.00kN = 18.00kN$$ Eq. (7.35)/ (7.36)

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Ed} kN	β_{Vs} %
18.00	1.33	13.53	0.14	1.0

Anchor no.	β_{Vs} %	Group N°	Decisive Beta
1	1.0	1	$\beta_{Vs;1}$

Concrete pry-out failure



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

$$V_{Rk,cp} = k_8 \cdot N_{Rk,c} = 1 \cdot 7.30kN = 7.30kN$$ 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)

$$N_{Rk,c} = 9.74kN \cdot \frac{12{,}000mm^2}{14{,}400mm^2} \cdot 0.900 \cdot 1.000 \cdot 1.000 \cdot 1.000 = 7.30kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} = 7.7 \cdot \sqrt{25.0N/mm^2} \cdot \left(40mm\right)^{1.5} = 9.74kN$$ Eq. (7.2)

$$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} = 0.7 + 0.3 \cdot \frac{40mm}{60mm} = 0.900 \leq 1$$ 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)

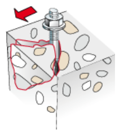
$$\Psi_{M,N} = 1.00 \geq 1$$ Eq. (7.7)

$V_{Rk,cp}$ kN	γ_{Mc}	$V_{Rd,cp}$ kN	V_{Ed} kN	$\beta_{V,cp}$ %
7.30	1.50	4.87	0.14	2.9

Anchor no.	$\beta_{V,cp}$ %	Group N°	Decisive Beta
1	2.9	1	$\beta_{V,cp;1}$

Concrete edge failure

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



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

$$V_{Rk,c} = 7.12kN \cdot \frac{14{,}000mm^2}{20{,}000mm^2} \cdot 0.820 \cdot 1.000 \cdot 2.000 \cdot 1.000 \cdot 1.000 = 8.17kN$$

$$V^0_{Rk,c} = k_9 \cdot d^{\alpha}_{nom} \cdot l^{\beta}_{f} \cdot \sqrt{f_{ck}} \cdot c'^{1.5}_1$$ Eq. (7.41)

$$V^0_{Rk,c} = 1.7 \cdot \left(10mm\right)^{0.077} \cdot \left(40mm\right)^{0.068} \cdot \sqrt{25.0N/mm^2} \cdot \left(67mm\right)^{1.5} = 7.12kN$$

$$\alpha = 0.1 \cdot \sqrt{\frac{l_f}{c'_1}} = 0.1 \cdot \sqrt{\frac{40mm}{67mm}} = 0.077 \qquad \beta = 0.1 \cdot \left(\frac{d_{nom}}{c'_1}\right)^{0.2} = 0.1 \cdot \left(\frac{10mm}{67mm}\right)^{0.2} = 0.068$$ Eq. (7.42/7.43)

$$\Psi_{s,V} = 0.7 + 0.3 \cdot \frac{c_2}{1.5c'_1} = 0.7 + 0.3 \cdot \frac{40mm}{1.5 \cdot 67mm} = 0.820 \leq 1$$ Eq. (7.45)

$$\Psi_{h,V} = max\left(1;\ \sqrt{\frac{1.5c'_1}{h}}\right) = max\left(1;\ \sqrt{\frac{1.5 \cdot 67mm}{100mm}}\right) = 1.000 \geq 1$$ Eq. (7.46)

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

$$\Psi_{ec,V} = \frac{1}{1 + \frac{2}{3}\frac{e_v}{c'_1}} = \frac{1}{1 + \frac{2 \cdot 0mm}{3 \cdot 67mm}} = 1.000 \leq 1$$ Eq. (7.47)

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

$$c'_1 = max\left(\frac{c_{2,max}}{1.5};\ \frac{h}{1.5}\right) = max\left(\frac{100mm}{1.5};\ \frac{100mm}{1.5}\right) = 67mm$$ Eq. (7.49)

$V_{Rk,c}$ kN	γ_{Mc}	$V_{Rd,c}$ kN	V_{Ed} kN	$\beta_{V,c}$ %
8.17	1.50	5.45	0.14	2.6

Anchor no.	$\beta_{V,c}$ %	Group N°	Decisive Beta
1	2.6	1	$\beta_{V,c;1}$

Utilization of tension and shear loads

Tension loads	Utilisation βN %
Steel failure *	34.3
Pullout failure *	61.6
Concrete cone failure	70.8
Splitting failure	**90.4**

Shear Loads	Utilisation βV %
Steel failure without lever arm *	1.0
Concrete pry-out failure	**2.9**
Concrete edge failure	2.6

* Most unfavourable anchor

Resistance to combined tensile and shear loads

Utilisation steel

$$\beta_{N.s} = \beta_{N,s;1} = 0.34 \leq 1$$
$$\beta_{V.s} = \beta_{Vs;1} = 0.01 \leq 1$$
$$\beta_N^2 + \beta_V^2 = \beta_{N,s;1}^2 + \beta_{Vs;1}^2 = 0.12 \leq 1$$

Eq. (7.55)

Utilisation concrete

Proof successful

$$\beta_{N,sp} = \beta_{N,sp;1} = 0.90 \leq 1$$
$$\beta_{V.cp} = \beta_{V,cp;1} = 0.03 \leq 1$$
$$\frac{\beta_N + \beta_V}{1.2} = \frac{\beta_{N,sp;1} + \beta_{V,cp;1}}{1.2} = 0.78 \leq 1$$

Eq. (7.57)

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof t = 8 mm

Profile type None

Technical remarks

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

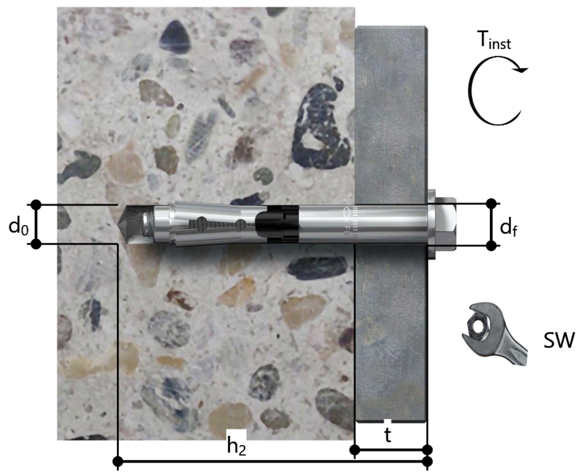
Anchor system — **fischer High performance anchor FH II**

Anchor — High performance anchor FH II 10/10 S A4, stainless steel, property class A4 — Art.-No. 510923

Accessories — Blow-out pump ABG big — Art.-No. 89300
Quattric II 10/100/165 XP5 — Art.-No. 549924
Erection of the drillhole by hammer drilling with or without suction cleaning

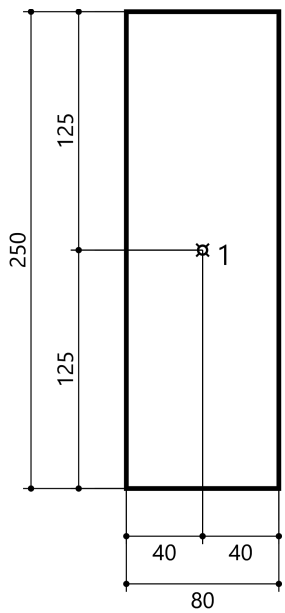
Installation details

Thread diameter	M 6
Drill hole diameter	d_0 = 10 mm
Drill hole depth	h_2 = 65 mm
Calculated anchorage depth	h_{ef} = 40 mm
Installation depth	h_{nom} = 40 mm
Drilling method	hammer drilling
Drill hole cleaning	only blow out by hand
Installation type	Push-through installation
Annular gap	Annular gap not filled
Installation torque	T_{inst} = 15.0 Nm
Socket size	10 mm
Base plate thickness	t = 8 mm
Total fixing thickness	t_{fix} = 8 mm
Tfix,max	$t_{fix, max}$ = 10 mm



Base plate details

Base plate material	Not available
Base plate thickness	t = 8 mm
Clearance hole in base plate	d_f=12 mm



Attachment

Profile type — None

Anchor coordinates

Anchor no.	x mm	y mm
1	0	0

www.hilti.nl

Company:		Page:	1
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	4018-19015-TL6501-hoh250-0.5kN/m@0.7m	Date:	15-5-2020
Fastening Point:	Appendix 3		

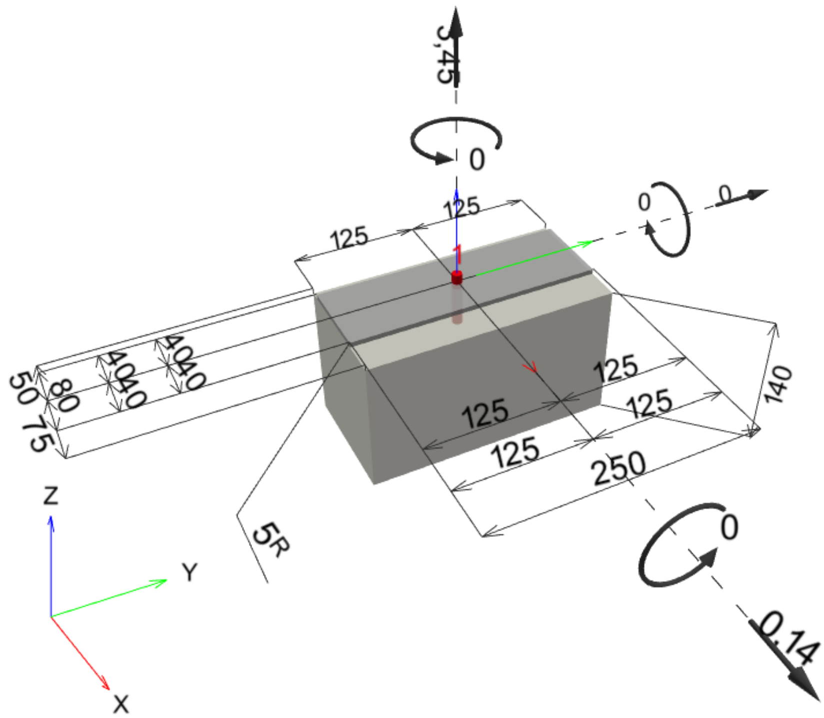
Specifier's comments:

1 Input data

Anchor type and size:	**HUS3-H 10 h_nom1**
Return period (service life in years):	50
Item number:	2079911 HUS3-H 10x60 5/-/-
Effective embedment depth:	h_{ef} = 41.6 mm, h_{nom} = 55.0 mm
Material:	1.5525
Approval No.:	ETA-13/1038
Issued I Valid:	22-7-2019 | -
Proof:	Design Method EN 1992-4, Mechanical
Stand-off installation:	e_b = 0.0 mm (no stand-off); t = 5.0 mm
Baseplate[R] :	l_x x l_y x t = 80.0 mm x 250.0 mm x 5.0 mm; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, C20/25, $f_{c,cyl}$ = 20.00 N/mm^2; h = 140.0 mm
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	No reinforcement or Reinforcement spacing >= 150 mm (any Ø) or >= 100 mm (Ø <= 10 mm)
	no longitudinal edge reinforcement

[R] - The anchor calculation is based on a rigid baseplate assumption.

Geometry [mm] & Loading [kN, kNm]



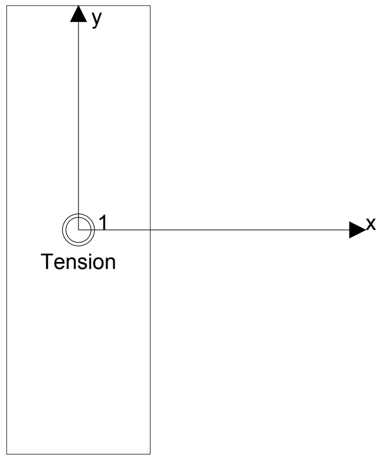
www.hilti.nl

Company:		Page:	2
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	4018-19015-TL6501-hoh250-0.5kN/m@0.7m	Date:	15-5-2020
Fastening Point:	Appendix 3		

1.1 Load combination

Case	Description	Forces [kN] / Moments [kNm]	Seismic	Fire	Max. Util. Anchor [%]
1	Combinatie 1	N = 3.450; V_x = 0.140; V_y = 0.000; M_x = 0.000; M_y = 0.000; M_z = 0.000;	no	no	67

2 Load case/Resulting anchor forces



Anchor reactions [kN]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	3.450	0.140	0.140	0.000

max. concrete compressive strain:	- [‰]
max. concrete compressive stress:	- [N/mm^2]
resulting tension force in (x/y)=(0.0/0.0):	3.450 [kN]
resulting compression force in (x/y)=(0.0/0.0):	0.000 [kN]

Anchor forces are calculated based on the assumption of a rigid baseplate.

3 Tension load (EN 1992-4, Section 7.2.1)

	Load [kN]	Capacity [kN]	Utilization β_N [%]	Status
Steel failure*	3.450	44.429	8	OK
Pull-out failure*	N/A	N/A	N/A	N/A
Concrete Breakout failure**	3.450	5.217	67	OK
Splitting failure**	3.450	5.618	62	OK

* highest loaded anchor **anchor group (anchors in tension)

3.1 Steel failure

$N_{Ed} \leq N_{Rd,s} = \dfrac{N_{Rk,s}}{\gamma_{M,s}}$ EN 1992-4, Table 7.1

$N_{Rk,s}$ [kN]	$\gamma_{M,s}$	$N_{Rd,s}$ [kN]	N_{Ed} [kN]
62.200	1.400	44.429	3.450

3.2 Concrete Breakout failure

$N_{Ed} \leq N_{Rd,c} = \dfrac{N_{Rk,c}}{\gamma_{M,c}}$ EN 1992-4, Table 7.1

$N_{Rk,c} = N^0_{Rk,c} \cdot \dfrac{A_{c,N}}{A^0_{c,N}} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec1,N} \cdot \psi_{ec2,N} \cdot \psi_{M,N}$ EN 1992-4, Eq. (7.1)

$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1,5}$ EN 1992-4, Eq. (7.2)

$A^0_{c,N} = s_{cr,N} \cdot s_{cr,N}$ EN 1992-4, Eq. (7.3)

$\psi_{s,N} = 0.7 + 0.3 \cdot \dfrac{c}{c_{cr,N}} \leq 1.00$ EN 1992-4, Eq. (7.4)

$\psi_{ec1,N} = \dfrac{1}{1 + \left(\dfrac{2 \cdot e_{N,1}}{s_{cr,N}}\right)} \leq 1.00$ EN 1992-4, Eq. (7.6)

$\psi_{ec2,N} = \dfrac{1}{1 + \left(\dfrac{2 \cdot e_{N,2}}{s_{cr,N}}\right)} \leq 1.00$ EN 1992-4, Eq. (7.6)

$\psi_{M,N} = 1$ EN 1992-4, Eq. (7.7)

$A_{c,N}$ [mm^2]	$A^0_{c,N}$ [mm^2]	$c_{cr,N}$ [mm]	$s_{cr,N}$ [mm]	$f_{c,cyl}$ [N/mm^2]
14,028	15,575	62.4	124.8	20.00

$e_{c1,N}$ [mm]	$\psi_{ec1,N}$	$e_{c2,N}$ [mm]	$\psi_{ec2,N}$	$\psi_{s,N}$	$\psi_{re,N}$
0.0	1.000	0.0	1.000	0.940	1.000

z [mm]	$\psi_{M,N}$	k_1	$N^0_{Rk,c}$ [kN]	$\gamma_{M,c}$	$N_{Rd,c}$ [kN]	N_{Ed} [kN]
0.0	1.000	7.700	9.239	1.500	5.217	3.450

Group anchor ID
1

3.3 Splitting failure

$N_{Ed} \leq N_{Rd,sp} = \frac{N_{Rk,sp}}{\gamma_{Msp}}$ EN 1992-4, Table 7.1

$N_{Rk,sp} = N^0_{Rk,sp} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec1,N} \cdot \psi_{ec2,N} \cdot \psi_{h,sp}$ EN 1992-4, Eq. (7.23)

$N^0_{Rk,sp} = \min\left(N_{Rk,p}, N^0_{Rk,c}\right)$

$A^0_{c,N} = s_{cr,sp} \cdot s_{cr,sp}$ EN 1992-4, Eq. (7.3)

$\psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,sp}} \leq 1.00$ EN 1992-4, Eq. (7.4)

$\psi_{ec1,N} = \frac{1}{1 + \left(\frac{2 \cdot e_{N,1}}{s_{cr,sp}}\right)} \leq 1.00$ EN 1992-4, Eq. (7.6)

$\psi_{ec2,N} = \frac{1}{1 + \left(\frac{2 \cdot e_{N,2}}{s_{cr,sp}}\right)} \leq 1.00$ EN 1992-4, Eq. (7.6)

$\psi_{h,sp} = \left(\frac{h}{h_{min}}\right)^{2/3} \leq \max\left\{1; \left(\frac{h_{ef} + 1.5 \cdot c_1}{h_{min}}\right)^{2/3}\right\} \leq 2.00$ EN 1992-4, Eq. (7.24)

$A_{c,N}$ [mm^2]	$A^0_{c,N}$ [mm^2]	$c_{cr,sp}$ [mm]	$s_{cr,sp}$ [mm]	$\psi_{h,sp}$
14,950	16,900	65.0	130.0	1.108

$e_{c1,N}$ [mm]	$\psi_{ec1,N}$	$e_{c2,N}$ [mm]	$\psi_{ec2,N}$	$\psi_{s,N}$	$\psi_{re,N}$	k_1
0.0	1.000	0.0	1.000	0.931	1.000	7.700

$N^0_{Rk,sp}$ [kN]	$\gamma_{M,sp}$	$N_{Rd,sp}$ [kN]	N_{Ed} [kN]
9.239	1.500	5.618	3.450

Group anchor ID
1

4 Shear load (EN 1992-4, Section 7.2.2)

	Load [kN]	Capacity [kN]	Utilization β_V [%]	Status
Steel failure (without lever arm)*	0.140	20.000	1	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout failure**	0.140	5.217	3	OK
Concrete edge failure in direction y+**	0.140	4.875	3	OK

* highest loaded anchor **anchor group (relevant anchors)

4.1 Steel failure (without lever arm)

$V_{Ed} \leq V_{Rd,s} = \frac{V_{Rk,s}}{\gamma_{M,s}}$ EN 1992-4, Table 7.2

$V_{Rk,s} = k_7 \cdot V^0_{Rk,s}$ EN 1992-4, Eq. (7.35)

$V^0_{Rk,s}$ [kN]	k_7	$V_{Rk,s}$ [kN]	$\gamma_{M,s}$	$V_{Rd,s}$ [kN]	V_{Ed} [kN]
30.000	0.800	30.000	1.500	20.000	0.140

4.2 Pryout failure

$V_{Ed} \leq V_{Rd,cp} = \frac{V_{Rk,cp}}{\gamma_{M,c,p}}$ EN 1992-4, Table 7.2

$V_{Rk,cp} = k_8 \cdot N_{Rk,c}$ EN 1992-4, Eq. (7.39a)

$N_{Rk,c} = N^0_{Rk,c} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec1,N} \cdot \psi_{ec2,N} \cdot \psi_{M,N}$ EN 1992-4, Eq. (7.1)

$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1,5}$ EN 1992-4, Eq. (7.2)

$A^0_{c,N} = s_{cr,N} \cdot s_{cr,N}$ EN 1992-4, Eq. (7.3)

$\psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} \leq 1.00$ EN 1992-4, Eq. (7.4)

$\psi_{ec1,N} = \frac{1}{1 + \left(\frac{2 \cdot e_{V,1}}{s_{cr,N}}\right)} \leq 1.00$ EN 1992-4, Eq. (7.6)

$\psi_{ec2,N} = \frac{1}{1 + \left(\frac{2 \cdot e_{V,2}}{s_{cr,N}}\right)} \leq 1.00$ EN 1992-4, Eq. (7.6)

$\psi_{M,N} = 1$ EN 1992-4, Eq. (7.7)

$A_{c,N}$ [mm^2]	$A^0_{c,N}$ [mm^2]	$c_{cr,N}$ [mm]	$s_{cr,N}$ [mm]	k_8	$f_{c,cyl}$ [N/mm^2]
14,028	15,575	62.4	124.8	1.000	20.00

$e_{c1,V}$ [mm]	$\psi_{ec1,N}$	$e_{c2,V}$ [mm]	$\psi_{ec2,N}$	$\psi_{s,N}$	$\psi_{re,N}$	$\psi_{M,N}$
0.0	1.000	0.0	1.000	0.940	1.000	1.000

k_1	$N^0_{Rk,c}$ [kN]	$\gamma_{M,c,p}$	$V_{Rd,cp}$ [kN]	V_{Ed} [kN]
7.700	9.239	1.500	5.217	0.140

Group anchor ID
1

Company:		Page:	6
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	4018-19015-TL6501-hoh250-0.5kN/m@0.7m	Date:	15-5-2020
Fastening Point:	Appendix 3		

4.3 Concrete edge failure in direction y+

$V_{Ed} \leq V_{Rd,c} = \frac{V_{Rk,c}}{\gamma_{M,c}}$ EN 1992-4, Table 7.2

$V_{Rk,c} = k_T \cdot V^0_{Rk,c} \cdot \frac{A_{c,V}}{A^0_{c,V}} \cdot \psi_{s,V} \cdot \psi_{h,V} \cdot \psi_{\alpha,V} \cdot \psi_{ec,V} \cdot \psi_{re,V}$ EN 1992-4, Eq. (7.40)

$V^0_{Rk,c} = k_9 \cdot d^{\alpha}_{nom} \cdot l^{\beta}_f \cdot \sqrt{f_{ck}} \cdot c_1^{1,5}$ EN 1992-4, Eq. (7.41)

$\alpha = 0.1 \cdot \left(\frac{l_f}{c_1}\right)^{0,5}$ EN 1992-4, Eq. (7.42)

$\beta = 0.1 \cdot \left(\frac{d_{nom}}{c_1}\right)^{0,2}$ EN 1992-4, Eq. (7.43)

$A^0_{c,V} = 4.5 \cdot c_1^2$ EN 1992-4, Eq. (7.44)

$\psi_{s,V} = 0.7 + 0.3 \cdot \frac{c_2}{1.5 \cdot c_1} \leq 1.00$ EN 1992-4, Eq. (7.45)

$\psi_{h,V} = \left(\frac{1.5 \cdot c_1}{h}\right)^{0,5} \geq 1.00$ EN 1992-4, Eq. (7.46)

$\psi_{ec,V} = \frac{1}{1 + \left(\frac{2 \cdot e_V}{3 \cdot c_1}\right)} \leq 1.00$ EN 1992-4, Eq. (7.47)

$\psi_{\alpha,V} = \sqrt{\frac{1}{(\cos \alpha_V)^2 + (0.5 \cdot \sin \alpha_V)^2}} \geq 1.00$ EN 1992-4, Eq. (7.48)

$c_1' = \max\left(\frac{c_{2,max}}{1.5}, \frac{h}{1.5}, \frac{s_{2,max}}{3}\right)$ EN 1992-4, Eq. (7.50)

l_f [mm]	d_{nom} [mm]	k_9	α	β	$f_{c,cyl}$ [N/mm^2]
41.6	10.00	1.700	0.067	0.064	20.00

c_1 [mm]	c_1' [mm]	$A_{c,V}$ [mm^2]	$A^0_{c,V}$ [mm^2]
125.0	93.3	17,500	39,200

$\psi_{s,V}$	$\psi_{h,V}$	$\psi_{\alpha,V}$	$e_{c,V}$ [mm]	$\psi_{ec,V}$	$\psi_{re,V}$
0.807	1.000	2.000	0.0	1.000	1.000

$V^0_{Rk,c}$ [kN]	k_T	$\gamma_{M,c}$	$V_{Rd,c}$ [kN]	V_{Ed} [kN]
10.147	1.0	1.500	4.875	0.140

5 Combined tension and shear loads (EN 1992-4, Section 7.2.3)

Steel failure

β_N	β_V	α	Utilization $\beta_{N,V}$ [%]	Status
0.078	0.007	2.000	1	OK

$\beta_N^\alpha + \beta_V^\alpha \leq 1.0$

Concrete failure

β_N	β_V	α	Utilization $\beta_{N,V}$ [%]	Status
0.661	0.029	1.500	55	OK

$\beta_N^\alpha + \beta_V^\alpha \leq 1.0$

6 Displacements (highest loaded anchor)

Short term loading:

N_{Sk} = 2.556 [kN]		δ_N = 0.1793 [mm]	
V_{Sk} = 0.104 [kN]		δ_V = 0.0296 [mm]	
		δ_{NV} = 0.1818 [mm]	

Long term loading:

N_{Sk} = 2.556 [kN]		δ_N = 0.1793 [mm]	
V_{Sk} = 0.104 [kN]		δ_V = 0.0444 [mm]	
		δ_{NV} = 0.1848 [mm]	

Comments: Tension displacements are valid with half of the required installation torque moment for uncracked concrete! Shear displacements are valid without friction between the concrete and the baseplate! The gap due to the drilled hole and clearance hole tolerances are not included in this calculation!

The acceptable anchor displacements depend on the fastened construction and must be defined by the designer!

7 Warnings

- The anchor design methods in PROFIS Engineering require rigid baseplates per current regulations (AS 5216:2018, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the baseplate are not considered - the baseplate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required baseplate thickness with CBFEM to limit the stress of the baseplate based on the assumptions explained above. The proof if the rigid baseplate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- In general, the conditions given in ETAG 001, Annex C, section 4.2.2.1 and 4.2.2.3 b) are not fulfilled because the diameter of the clearance hole in the fixture acc. to Annex 3, Table 3 is greater than the values given in Annex C, Table 4.1 and AS5126 for the corresponding diameter of the anchor. Therefore the design resistance for anchor groups is limited to twice the steel resistance (of a single anchor) in accordance with the approval.
- Checking the transfer of loads into the base material is required in accordance with EN 1992-4, Annex A!
- The design is only valid if the clearance hole in the fixture is not larger than the value given in Table 6.1 of EN 1992-4! For larger diameters of the clearance hole see section 6.2.2 of EN 1992-4!
- The accessory list in this report is for the information of the user only. In any case, the instructions for use provided with the product have to be followed to ensure a proper installation.
- For the determination of the $\psi_{re,v}$ (concrete edge failure) a concrete cover of the edge reinforcement c = 30 mm is assumed
- The characteristic bond resistances depend on the return period (service life in years): 50

Fastening meets the design criteria!

8 Installation data

Baseplate, steel: S 235; E = 210,000.00 N/mm^2; f_{yk} = 235.00 N/mm^2

Profile: no profile

Hole diameter in the fixture: d_f = 14.0 mm

Plate thickness (input): 5.0 mm

Recommended plate thickness: not calculated

Drilling method: Hammer drilled

Cleaning: Clean the drill hole. Under the conditions - according to fastener size and drilling direction - given in the ETA and MPII (IFU), the cleaning of the drill hole may be omitted.

Anchor type and size: HUS3-H 10 h_nom1

Item number: 2079911 HUS3-H 10x60 5/-/-

Installation torque: Hilti SIW 22T-A

Hole diameter in the base material: 10.0 mm

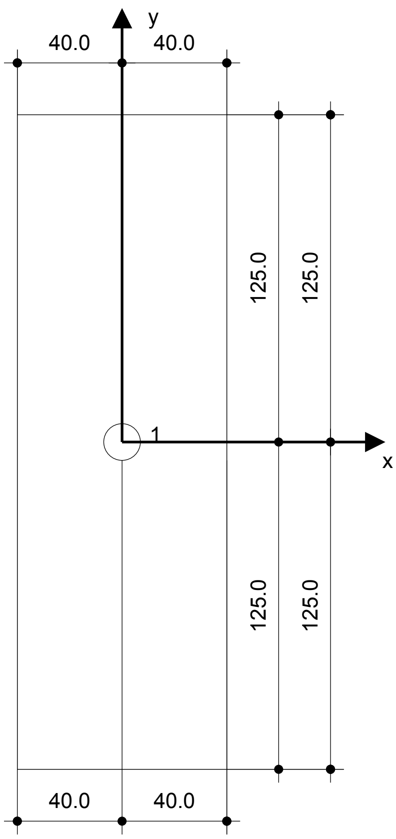
Hole depth in the base material: 65.0 mm

Minimum thickness of the base material: 100.0 mm

Hilti HUS screw anchor with 55 mm embedment, 10 h_nom1, Steel galvanized, installation per ETA-13/1038

8.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• Manual blow-out pump	• Hilti SIW 22T-A impact screw driver



Coordinates Anchor mm

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	0.0	0.0	50.0	75.0	125.0	125.0

9 Remarks; Your Cooperation Duties

- Any and all information and data contained in the Software concern solely the use of Hilti products and are based on the principles, formulas and security regulations in accordance with Hilti's technical directions and operating, mounting and assembly instructions, etc., that must be strictly complied with by the user. All figures contained therein are average figures, and therefore use-specific tests are to be conducted prior to using the relevant Hilti product. The results of the calculations carried out by means of the Software are based essentially on the data you put in. Therefore, you bear the sole responsibility for the absence of errors, the completeness and the relevance of the data to be put in by you. Moreover, you bear sole responsibility for having the results of the calculation checked and cleared by an expert, particularly with regard to compliance with applicable norms and permits, prior to using them for your specific facility. The Software serves only as an aid to interpret norms and permits without any guarantee as to the absence of errors, the correctness and the relevance of the results or suitability for a specific application.
- You must take all necessary and reasonable steps to prevent or limit damage caused by the Software. In particular, you must arrange for the regular backup of programs and data and, if applicable, carry out the updates of the Software offered by Hilti on a regular basis. If you do not use the AutoUpdate function of the Software, you must ensure that you are using the current and thus up-to-date version of the Software in each case by carrying out manual updates via the Hilti Website. Hilti will not be liable for consequences, such as the recovery of lost or damaged data or programs, arising from a culpable breach of duty by you.

www.hilti.nl

Company:		Page:	1
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	4018-19015-TL6501-hoh250-0.5kN/m@0.7m	Date:	15-5-2020
Fastening Point:	Appendix 3		

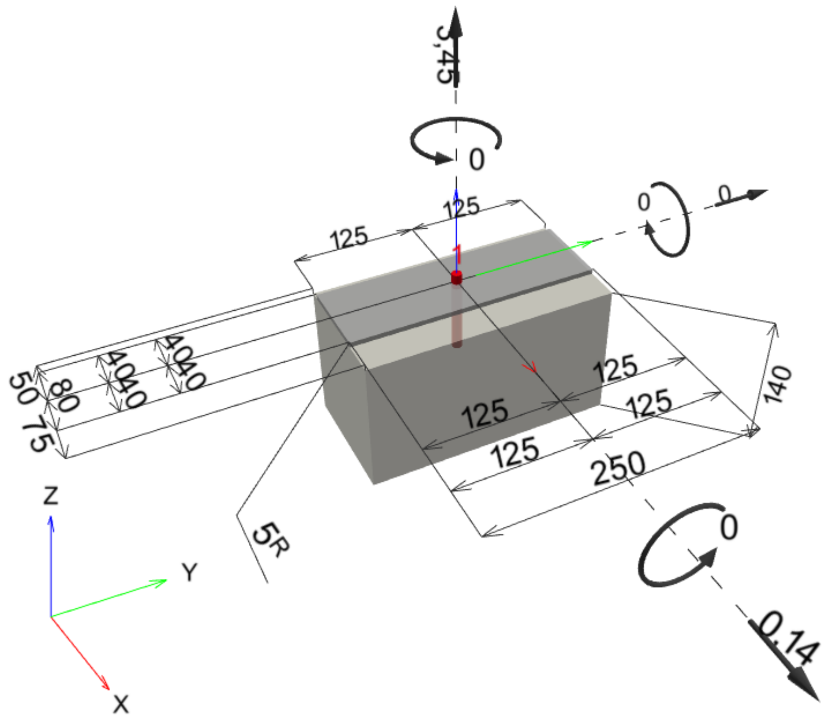
Specifier's comments:

1 Input data

Anchor type and size:	**HUS-HR 10 h_nom3**
Return period (service life in years):	50
Item number:	290068 HUS-HR 10x95 35/25/5
Effective embedment depth:	h_{ef} = 71.0 mm, h_{nom} = 90.0 mm
Material:	A4
Approval No.:	ETA 08/0307
Issued I Valid:	23-8-2018 | -
Proof:	Design Method EN 1992-4, Mechanical
Stand-off installation:	e_b = 0.0 mm (no stand-off); t = 5.0 mm
Baseplate^R :	l_x x l_y x t = 80.0 mm x 250.0 mm x 5.0 mm; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, C20/25, $f_{c,cyl}$ = 20.00 N/mm^2; h = 140.0 mm
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	No reinforcement or Reinforcement spacing >= 150 mm (any Ø) or >= 100 mm (Ø <= 10 mm)
	no longitudinal edge reinforcement

^{R} - The anchor calculation is based on a rigid baseplate assumption.

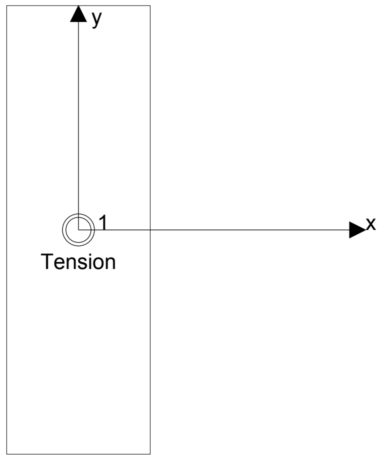
Geometry [mm] & Loading [kN, kNm]



1.1 Load combination

Case	Description	Forces [kN] / Moments [kNm]	Seismic	Fire	Max. Util. Anchor [%]
1	Combinatie 1	$N = 3.450$; $V_x = 0.140$; $V_y = 0.000$; $M_x = 0.000$; $M_y = 0.000$; $M_z = 0.000$;	no	no	95

2 Load case/Resulting anchor forces



Anchor reactions [kN]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	3.450	0.140	0.140	0.000

max. concrete compressive strain:	- [‰]
max. concrete compressive stress:	- [N/mm^2]
resulting tension force in (x/y)=(0.0/0.0):	3.450 [kN]
resulting compression force in (x/y)=(0.0/0.0):	0.000 [kN]

Anchor forces are calculated based on the assumption of a rigid baseplate.

3 Tension load (EN 1992-4, Section 7.2.1)

	Load [kN]	Capacity [kN]	Utilization β_N [%]	Status
Steel failure*	3.450	37.571	10	OK
Pull-out failure*	3.450	8.889	39	OK
Concrete Breakout failure**	3.450	5.648	62	OK
Splitting failure**	3.450	3.644	95	OK

* highest loaded anchor **anchor group (anchors in tension)

3.1 Steel failure

$$N_{Ed} \leq N_{Rd,s} = \frac{N_{Rk,s}}{\gamma_{M,s}}$$ EN 1992-4, Table 7.1

$N_{Rk,s}$ [kN]	$\gamma_{M,s}$	$N_{Rd,s}$ [kN]	N_{Ed} [kN]
52.600	1.400	37.571	3.450

3.2 Pull-out failure

$$N_{Ed} \leq N_{Rd,p} = \frac{\psi_c \cdot N_{Rk,p}}{\gamma_{M,p}}$$ EN 1992-4, Table 7.1

$N_{Rk,p}$ [kN]	ψ_c	$\gamma_{M,p}$	$N_{Rd,p}$ [kN]	N_{Ed} [kN]
16.000	1.000	1.800	8.889	3.450

3.3 Concrete Breakout failure

$N_{Ed} \leq N_{Rd,c} = \frac{N_{Rk,c}}{\gamma_{M,c}}$ EN 1992-4, Table 7.1

$N_{Rk,c} = N^0_{Rk,c} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec1,N} \cdot \psi_{ec2,N} \cdot \psi_{M,N}$ EN 1992-4, Eq. (7.1)

$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1,5}$ EN 1992-4, Eq. (7.2)

$A^0_{c,N} = s_{cr,N} \cdot s_{cr,N}$ EN 1992-4, Eq. (7.3)

$\psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} \leq 1.00$ EN 1992-4, Eq. (7.4)

$\psi_{ec1,N} = \frac{1}{1 + \left(\frac{2 \cdot e_{N,1}}{s_{cr,N}}\right)} \leq 1.00$ EN 1992-4, Eq. (7.6)

$\psi_{ec2,N} = \frac{1}{1 + \left(\frac{2 \cdot e_{N,2}}{s_{cr,N}}\right)} \leq 1.00$ EN 1992-4, Eq. (7.6)

$\psi_{M,N} = 1$ EN 1992-4, Eq. (7.7)

$A_{c,N}$ [mm²]	$A^0_{c,N}$ [mm²]	$c_{cr,N}$ [mm]	$s_{cr,N}$ [mm]	$f_{c,cyl}$ [N/mm²]
26,625	45,369	106.5	213.0	20.00

$e_{c1,N}$ [mm]	$\psi_{ec1,N}$	$e_{c2,N}$ [mm]	$\psi_{ec2,N}$	$\psi_{s,N}$	$\psi_{re,N}$
0.0	1.000	0.0	1.000	0.841	1.000

z [mm]	$\psi_{M,N}$	k_1	$N^0_{Rk,c}$ [kN]	$\gamma_{M,c}$	$N_{Rd,c}$ [kN]	N_{Ed} [kN]
0.0	1.000	7.700	20.601	1.800	5.648	3.450

Group anchor ID
1

3.4 Splitting failure

$N_{Ed} \leq N_{Rd,sp} = \frac{N_{Rk,sp}}{\gamma_{Msp}}$ EN 1992-4, Table 7.1

$N_{Rk,sp} = N^0_{Rk,sp} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec1,N} \cdot \psi_{ec2,N} \cdot \psi_{h,sp}$ EN 1992-4, Eq. (7.23)

$N^0_{Rk,sp} = \min\left(N_{Rk,p}, N^0_{Rk,c}\right)$

$A^0_{c,N} = s_{cr,sp} \cdot s_{cr,sp}$ EN 1992-4, Eq. (7.3)

$\psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,sp}} \leq 1.00$ EN 1992-4, Eq. (7.4)

$\psi_{ec1,N} = \frac{1}{1 + \left(\frac{2 \cdot e_{N,1}}{s_{cr,sp}}\right)} \leq 1.00$ EN 1992-4, Eq. (7.6)

$\psi_{ec2,N} = \frac{1}{1 + \left(\frac{2 \cdot e_{N,2}}{s_{cr,sp}}\right)} \leq 1.00$ EN 1992-4, Eq. (7.6)

$\psi_{h,sp} = \left(\frac{h}{h_{min}}\right)^{2/3} \leq \max\left\{1; \left(\frac{h_{ef} + 1.5 \cdot c_1}{h_{min}}\right)^{2/3}\right\} \leq 2.00$ EN 1992-4, Eq. (7.24)

$A_{c,N}$ [mm^2]	$A^0_{c,N}$ [mm^2]	$c_{cr,sp}$ [mm]	$s_{cr,sp}$ [mm]	$\psi_{h,sp}$
31,250	62,500	128.0	256.0	1.000

h'_{ef} [mm]	$c'_{cr,sp}$ [mm]	$s'_{cr,sp}$ [mm]
69.3	125.0	250.0

$e_{c1,N}$ [mm]	$\psi_{ec1,N}$	$e_{c2,N}$ [mm]	$\psi_{ec2,N}$	$\psi_{s,N}$	$\psi_{re,N}$	k_1
0.0	1.000	0.0	1.000	0.820	1.000	7.700

$N^0_{Rk,sp}$ [kN]	$\gamma_{M,sp}$	$N_{Rd,sp}$ [kN]	N_{Ed} [kN]
16.000	1.800	3.644	3.450

Group anchor ID
1

4 Shear load (EN 1992-4, Section 7.2.2)

	Load [kN]	Capacity [kN]	Utilization β_V [%]	Status
Steel failure (without lever arm)*	0.140	22.000	1	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout failure**	0.140	13.554	2	OK
Concrete edge failure in direction y+**	0.140	5.288	3	OK

* highest loaded anchor **anchor group (relevant anchors)

4.1 Steel failure (without lever arm)

$V_{Ed} \leq V_{Rd,s} = \frac{V_{Rk,s}}{\gamma_{M,s}}$ EN 1992-4, Table 7.2

$V_{Rk,s} = k_7 \cdot V^0_{Rk,s}$ EN 1992-4, Eq. (7.35)

$V^0_{Rk,s}$ [kN]	k_7	$V_{Rk,s}$ [kN]	$\gamma_{M,s}$	$V_{Rd,s}$ [kN]	V_{Ed} [kN]
33.000	1.000	33.000	1.500	22.000	0.140

4.2 Pryout failure

$V_{Ed} \leq V_{Rd,cp} = \frac{V_{Rk,cp}}{\gamma_{M,c,p}}$ EN 1992-4, Table 7.2

$V_{Rk,cp} = k_8 \cdot N_{Rk,c}$ EN 1992-4, Eq. (7.39a)

$N_{Rk,c} = N^0_{Rk,c} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec1,N} \cdot \psi_{ec2,N} \cdot \psi_{M,N}$ EN 1992-4, Eq. (7.1)

$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1,5}$ EN 1992-4, Eq. (7.2)

$A^0_{c,N} = s_{cr,N} \cdot s_{cr,N}$ EN 1992-4, Eq. (7.3)

$\psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} \leq 1.00$ EN 1992-4, Eq. (7.4)

$\psi_{ec1,N} = \frac{1}{1 + \left(\frac{2 \cdot e_{V,1}}{s_{cr,N}}\right)} \leq 1.00$ EN 1992-4, Eq. (7.6)

$\psi_{ec2,N} = \frac{1}{1 + \left(\frac{2 \cdot e_{V,2}}{s_{cr,N}}\right)} \leq 1.00$ EN 1992-4, Eq. (7.6)

$\psi_{M,N} = 1$ EN 1992-4, Eq. (7.7)

$A_{c,N}$ [mm^2]	$A^0_{c,N}$ [mm^2]	$c_{cr,N}$ [mm]	$s_{cr,N}$ [mm]	k_8	$f_{c,cyl}$ [N/mm^2]
26,625	45,369	106.5	213.0	2.000	20.00

$e_{c1,V}$ [mm]	$\psi_{ec1,N}$	$e_{c2,V}$ [mm]	$\psi_{ec2,N}$	$\psi_{s,N}$	$\psi_{re,N}$	$\psi_{M,N}$
0.0	1.000	0.0	1.000	0.841	1.000	1.000

k_1	$N^0_{Rk,c}$ [kN]	$\gamma_{M,c,p}$	$V_{Rd,cp}$ [kN]	V_{Ed} [kN]
7.700	20.601	1.500	13.554	0.140

Group anchor ID
1

4.3 Concrete edge failure in direction y+

$V_{Ed} \leq V_{Rd,c} = \frac{V_{Rk,c}}{\gamma_{M,c}}$	EN 1992-4, Table 7.2
$V_{Rk,c} = k_T \cdot V^0_{Rk,c} \cdot \frac{A_{c,V}}{A^0_{c,V}} \cdot \psi_{s,V} \cdot \psi_{h,V} \cdot \psi_{\alpha,V} \cdot \psi_{ec,V} \cdot \psi_{re,V}$	EN 1992-4, Eq. (7.40)
$V^0_{Rk,c} = k_9 \cdot d^{\alpha}_{nom} \cdot l^{\beta}_f \cdot \sqrt{f_{ck}} \cdot c_1^{1,5}$	EN 1992-4, Eq. (7.41)
$\alpha = 0.1 \cdot \left(\frac{l_f}{c_1}\right)^{0,5}$	EN 1992-4, Eq. (7.42)
$\beta = 0.1 \cdot \left(\frac{d_{nom}}{c_1}\right)^{0,2}$	EN 1992-4, Eq. (7.43)
$A^0_{c,V} = 4.5 \cdot c_1^2$	EN 1992-4, Eq. (7.44)
$\psi_{s,V} = 0.7 + 0.3 \cdot \frac{c_2}{1.5 \cdot c_1} \leq 1.00$	EN 1992-4, Eq. (7.45)
$\psi_{h,V} = \left(\frac{1.5 \cdot c_1}{h}\right)^{0,5} \geq 1.00$	EN 1992-4, Eq. (7.46)
$\psi_{ec,V} = \frac{1}{1 + \left(\frac{2 \cdot e_V}{3 \cdot c_1}\right)} \leq 1.00$	EN 1992-4, Eq. (7.47)
$\psi_{\alpha,V} = \sqrt{\frac{1}{(\cos \alpha_V)^2 + (0.5 \cdot \sin \alpha_V)^2}} \geq 1.00$	EN 1992-4, Eq. (7.48)
$c_1' = \max\left(\frac{c_{2,max}}{1.5}, \frac{h}{1.5}, \frac{s_{2,max}}{3}\right)$	EN 1992-4, Eq. (7.50)

l_f [mm]	d_{nom} [mm]	k_9	α	β	$f_{c,cyl}$ [N/mm^2]
71.0	10.00	1.700	0.087	0.064	20.00

c_1 [mm]	c_1' [mm]	$A_{c,V}$ [mm^2]	$A^0_{c,V}$ [mm^2]
125.0	93.3	17,500	39,200

$\psi_{s,V}$	$\psi_{h,V}$	$\psi_{\alpha,V}$	$e_{c,V}$ [mm]	$\psi_{ec,V}$	$\psi_{re,V}$
0.807	1.000	2.000	0.0	1.000	1.000

$V^0_{Rk,c}$ [kN]	k_T	$\gamma_{M,c}$	$V_{Rd,c}$ [kN]	V_{Ed} [kN]
11.007	1.0	1.500	5.288	0.140

5 Combined tension and shear loads (EN 1992-4, Section 7.2.3)

Steel failure

β_N	β_V	α	Utilization $\beta_{N,V}$ [%]	Status
0.092	0.006	2.000	1	OK

$\beta_N^{\alpha} + \beta_V^{\alpha} \leq 1.0$

Concrete failure

β_N	β_V	α	Utilization $\beta_{N,V}$ [%]	Status
0.947	0.026	1.000	82	OK

$(\beta_N + \beta_V) / 1.2 \leq 1.0$

6 Displacements (highest loaded anchor)

Short term loading:

N_{Sk} = 2.556 [kN] δ_N = 0.2434 [mm]

V_{Sk} = 0.104 [kN] δ_V = 0.0112 [mm]

δ_{NV} = 0.2436 [mm]

Long term loading:

N_{Sk} = 2.556 [kN] δ_N = 0.4462 [mm]

V_{Sk} = 0.104 [kN] δ_V = 0.0159 [mm]

δ_{NV} = 0.4465 [mm]

Comments: Tension displacements are valid with half of the required installation torque moment for uncracked concrete! Shear displacements are valid without friction between the concrete and the baseplate! The gap due to the drilled hole and clearance hole tolerances are not included in this calculation!

The acceptable anchor displacements depend on the fastened construction and must be defined by the designer!

7 Warnings

- The anchor design methods in PROFIS Engineering require rigid baseplates per current regulations (AS 5216:2018, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the baseplate are not considered - the baseplate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required baseplate thickness with CBFEM to limit the stress of the baseplate based on the assumptions explained above. The proof if the rigid baseplate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- In general, the conditions given in ETAG 001, Annex C, section 4.2.2.1 and 4.2.2.3 b) are not fulfilled because the diameter of the clearance hole in the fixture acc. to Annex 3, Table 3 is greater than the values given in Annex C, Table 4.1 and AS5126 for the corresponding diameter of the anchor. Therefore the design resistance for anchor groups is limited to twice the steel resistance (of a single anchor) in accordance with the approval.
- Checking the transfer of loads into the base material is required in accordance with EN 1992-4, Annex A!
- The design is only valid if the clearance hole in the fixture is not larger than the value given in Table 6.1 of EN 1992-4! For larger diameters of the clearance hole see section 6.2.2 of EN 1992-4!
- The accessory list in this report is for the information of the user only. In any case, the instructions for use provided with the product have to be followed to ensure a proper installation.
- For the determination of the $\psi_{re,v}$ (concrete edge failure) a concrete cover of the edge reinforcement c = 30 mm is assumed
- The characteristic bond resistances depend on the return period (service life in years): 50

Fastening meets the design criteria!

Company:		Page:	10
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	4018-19015-TL6501-hoh250-0.5kN/m@0.7m	Date:	15-5-2020
Fastening Point:	Appendix 3		

8 Installation data

Baseplate, steel: S 235; E = 210,000.00 N/mm^2; f_{yk} = 235.00 N/mm^2

Profile: no profile

Hole diameter in the fixture: d_f = 14.0 mm

Plate thickness (input): 5.0 mm

Recommended plate thickness: not calculated

Drilling method: Hammer drilled

Cleaning: Manual cleaning of the drilled hole according to instructions for use is required.

Anchor type and size: HUS-HR 10 h_nom3

Item number: 290068 HUS-HR 10x95 35/25/5

Installation torque: 45 Nm

Hole diameter in the base material: 10.0 mm

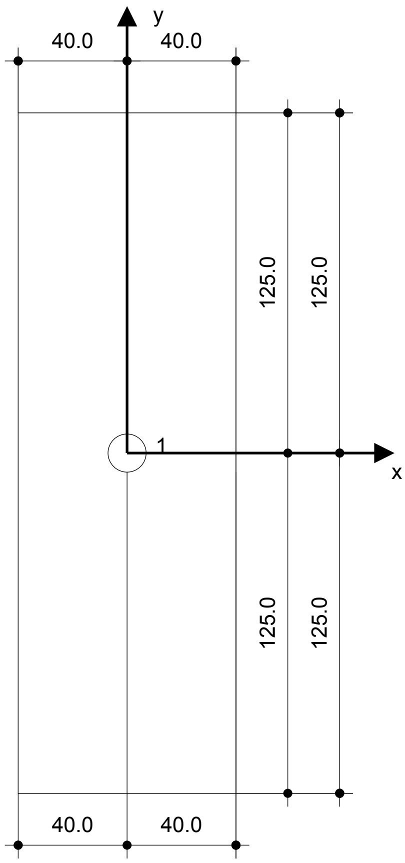
Hole depth in the base material: 100.0 mm

Minimum thickness of the base material: 140.0 mm

Hilti HUS screw anchor with 90 mm embedment, 10 h_nom3, Stainless steel, installation per ETA 08/0307

8.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• Manual blow-out pump	• Hilti SIW 22T-A impact screw driver



Coordinates Anchor mm

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	0.0	0.0	50.0	75.0	125.0	125.0

9 Remarks; Your Cooperation Duties

- Any and all information and data contained in the Software concern solely the use of Hilti products and are based on the principles, formulas and security regulations in accordance with Hilti's technical directions and operating, mounting and assembly instructions, etc., that must be strictly complied with by the user. All figures contained therein are average figures, and therefore use-specific tests are to be conducted prior to using the relevant Hilti product. The results of the calculations carried out by means of the Software are based essentially on the data you put in. Therefore, you bear the sole responsibility for the absence of errors, the completeness and the relevance of the data to be put in by you. Moreover, you bear sole responsibility for having the results of the calculation checked and cleared by an expert, particularly with regard to compliance with applicable norms and permits, prior to using them for your specific facility. The Software serves only as an aid to interpret norms and permits without any guarantee as to the absence of errors, the correctness and the relevance of the results or suitability for a specific application.
- You must take all necessary and reasonable steps to prevent or limit damage caused by the Software. In particular, you must arrange for the regular backup of programs and data and, if applicable, carry out the updates of the Software offered by Hilti on a regular basis. If you do not use the AutoUpdate function of the Software, you must ensure that you are using the current and thus up-to-date version of the Software in each case by carrying out manual updates via the Hilti Website. Hilti will not be liable for consequences, such as the recovery of lost or damaged data or programs, arising from a culpable breach of duty by you.