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1.1.1 Load combination

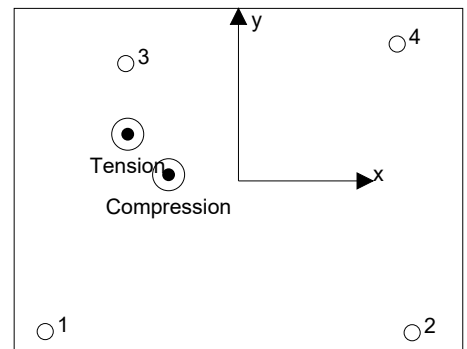
Case	Description	Forces [kN] / Moments [kNm]	Seismic	Fire	Max. Util. Anchor [%]
1	Combination 1	N = 1.324; V _x = 0.273; V _y = 1.067; M _x = 0.000; M _y = 0.630; M _z = 0.107;	no	no	17

1.2 Load case/Resulting anchor forces

Anchor reactions [kN]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	1.343	0.219	0.159	0.150
2	0.327	0.395	0.144	0.368
3	4.545	0.180	-0.010	0.180
4	0.076	0.369	-0.020	0.369



resulting tension force in (x/y)=(-96.3/40.6): 6.291 [kN]

resulting compression force in (x/y)=(-60.7/5.4): 5.347 [kN]

Anchor forces are calculated based on a component-based Finite Element Method (CBFEM)

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1.3 Tension load (ETAG, Annex C, Section 5.2.2)

	Load [kN]	Capacity [kN]	Utilization β_N [%]	Status
Steel failure*	4.545	41.875	11	OK
Pull-out failure*	4.545	28.386	17	OK
Concrete Breakout failure**	6.291	69.555	10	OK
Splitting failure**	N/A	N/A	N/A	N/A

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

1.3.1 Steel failure

N _{Rk,s} [kN]	γ _{M,s}	N _{Rd,s} [kN]	N _{Sd} [kN]
67.000	1.600	41.875	4.545

1.3.2 Pull-out failure

N _{Rk,p} [kN]	ψ _c	γ _{M,p}	N _{Rd,p} [kN]	N _{Sd} [kN]
35.000	1.217	1.500	28.386	4.545

1.3.3 Concrete Breakout failure

A _{c,N} [mm ²]	A _{c,N} ⁰ [mm ²]	c _{cr,N} [mm]	s _{cr,N} [mm]			
409,350	140,625	190.0	375.0			
e _{c1,N} [mm]	ψ _{ec1,N}	e _{c2,N} [mm]	ψ _{ec2,N}	ψ _{s,N}	ψ _{re,N}	
102.9	0.646	50.8	0.787	1.000	1.000	
k ₁	N _{Rk,c} ⁰ [kN]	γ _{M,c}	N _{Rd,c} [kN]	N _{Sd} [kN]		
8.300	70.558	1.500	69.555	6.291		

Group anchor ID

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1.4 Shear load (ETAG, Annex C, Section 5.2.3)

	Load [kN]	Capacity [kN]	Utilization β_v [%]	Status
Steel failure (without lever arm)*	0.395	25.564	2	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout failure**	1.101	167.857	1	OK
Concrete edge failure in direction **	N/A	N/A	N/A	N/A

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

1.4.1 Steel failure (without lever arm)

V _{Rk,s} [kN]	γ _{M,s}	V _{Rd,s} [kN]	V _{Sd} [kN]
34.000	1.330	25.564	0.395

1.4.2 Pryout failure

A _{c,N} [mm ²]	A _{c,N} ⁰ [mm ²]	c _{cr,N} [mm]	s _{cr,N} [mm]	k-factor	
409,350	140,625	190.0	375.0	2.000	
e _{c1,v} [mm]	Ψ _{ec1,N}	e _{c2,v} [mm]	Ψ _{ec2,N}	Ψ _{s,N}	Ψ _{re,N}
86.2	0.685	22.1	0.895	1.000	1.000
N _{Rk,c} ⁰ [kN]	γ _{M,c,p}	V _{Rd,cp} [kN]	V _{Sd} [kN]		
70.558	1.500	167.857	1.101		

Group anchor ID

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1.5 Combined tension and shear loads (ETAG, Annex C, Section 5.2.4)

Steel failure

β_N	β_V	α	Utilization $\beta_{N,V}$ [%]	Status
0.160	0.015	1.500	7	OK

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

1.6 Warnings

- The anchor design methods in PROFIS Engineering require rigid baseplates as per current regulations (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 base plate 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!
- Checking the transfer of loads into the base material is required in accordance with ETAG 001, Annex C(2010)Section 7! The software considers that the grout is installed under the baseplate without creating air voids and before application of the loads.
- The design is only valid if the clearance hole in the fixture is not larger than the value given in Table 4.1 of ETAG 001, Annex C! For larger diameters of the clearance hole see Chapter 1.1. of ETAG 001, Annex C!
- The anchor resistances used for this design are ONLY valid if the Seismic set will be installed on the jobsite as per IFU when the Seismic washer was selected.
- 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.
- The design method SOFA assumes that no hole clearance between the anchors and the fixture is present. This can be achieved by filling the gap with mortar of sufficient compressive strength (e.g. by using the HILTI Filling set) or by other suitable means
- The compliance with current standards (e.g. EN 1993, AS 4100:1998, etc.) is the responsibility of the user
- An SLS-check is not performed for SOFA and has to be provided by the user!
- The anchor design methods in PROFIS Engineering require rigid baseplates, as per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means that the baseplate should be sufficiently rigid to prevent load re-distribution to the anchors due to elastic/plastic displacements. The user accepts that the baseplate is considered close to rigid by engineering judgment."
- The characteristic bond resistances depend on the return period (service life in years): 50

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1.7 Installation data

Baseplate, steel: S 235; $E = 210,000.00 \text{ N/mm}^2$; $f_{yk} = 235.00 \text{ N/mm}^2$
 Profile: IPBi/HEA, IPBI 160 / HE 160 A; (L x W x T x FT) = 152.0 mm x 160.0 mm x 6.0 mm x 9.0 mm

Hole diameter in the fixture: $d_f = 14.0 \text{ mm}$

Plate thickness (input): 12.0 mm

Drilling method: Hammer drilled

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

Anchor type and size: HDA-PR M12x125/30

Item number: 339347 HDA-PR M12x125/30

Maximum installation torque: 80 Nm

Hole diameter in the base material: 22.0 mm

Hole depth in the base material: 133.0 mm

Minimum thickness of the base material: 200.0 mm

Gap filling with Hilti Filling Set M12.0 mm

http://download.hilti.biz/data/techlib/help/IFU_Seismic-Filling-Set.pdf

Hilti HDA undercut anchor with 125 mm embedment, M12x125/30, Stainless steel, installation per ETA 99/0009, with annular gaps filled with Hilti Filling Set or any suitable gap solutions

1.7.1 Recommended accessories
Drilling

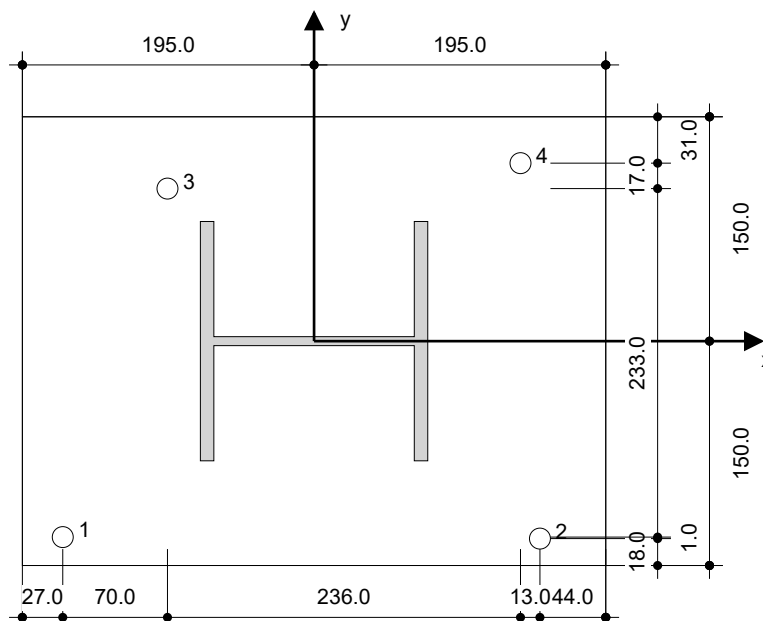
- Suitable Rotary Hammer
- Properly sized stop drill bit for specific drill depth

Cleaning

- Manual blow-out pump

Setting

- HDA-ST setting tool
- Hilti Filling Set
- Torque wrench


Coordinates Anchor [mm]

Anchor	x	y	c _{-x}	c _{+x}	c _{-y}	c _{+y}
1	-168.0	-131.0	-	-	-	-
2	151.0	-132.0	-	-	-	-
3	-98.0	102.0	-	-	-	-
4	138.0	119.0	-	-	-	-

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2 Baseplate design

2.1 Input data

Baseplate:	Shape: Rectangular l _x x l _y x t = 390.0 mm x 300.0 mm x 12.0 mm Calculation: CBFEM Material: S 235; F _y = 235.00 N/mm ² ; ε _{lim} = 5.00%
Anchor type and size:	HDA-PR M12x125/30, h _{ef} = 125.0 mm
Anchor stiffness:	The anchor is modelled considering stiffness values determined from load displacement curves tested in an independent laboratory. Please note that no simple replacement of the anchor is possible as the anchor stiffness has a major impact on the load distribution results.
Design method:	EN based design using component-based FEM
Stand-off installation:	e _b = 0.0 mm (No stand-off); t = 12.0 mm
Profile:	IPBI 160 / HE 160 A; (L x W x T x FT) = 152.0 mm x 160.0 mm x 6.0 mm x 9.0 mm Material: S 235; F _y = 235.00 N/mm ² ; ε _{lim} = 5.00% Eccentricity x: 0.0 mm Eccentricity y: 0.0 mm
Base material:	Cracked concrete; C30/37; f _{c,cyl} = 30.00 N/mm ² ; h = 350.0 mm; E = 33,000.00 N/mm ² ; G = 13,750.00 N/mm ² ; ν = 0.20
Welds (profile to baseplate):	Type of redistribution: Plastic Material: S 235
Mesh size:	Number of elements on edge: 8 Min. size of element: 10.0 mm Max size of element: 50.0 mm

2.2 Summary

	Description	Profile		Baseplate		Concrete [%]	
		σ _{Ed} [N/mm ²]	ε _{Pl} [%]	σ _{Ed} [N/mm ²]	ε _{Pl} [%]	Hole bearing [%]	
1	Combination 1	30.80	0.00	28.07	0.00	1	6

2.3 Baseplate plate classification

Results below are displayed for the decisive load combinations: Combination 1

Anchor tension forces	Equivalent rigid baseplate (CBFEM)	Component-based Finite Element Method (CBFEM) baseplate
Anchor 1	1.543 kN	1.343 kN
Anchor 2	0.000 kN	0.327 kN
Anchor 3	1.637 kN	4.545 kN
Anchor 4	0.000 kN	0.076 kN

User accepted to consider the selected baseplate as rigid by his/her engineering judgement. This means the anchor design guidelines can be applied.

2.4 Profile/Stiffeners/Plate

Profile and stiffeners are verified at the level of the steel to concrete connection. The connection design does not replace the steel design for critical cross sections, which should be performed outside of PROFIS Engineering.

2.4.1 Equivalent stress and plastic strain

Limit state criteria as per EN1993-1-5 Annex C.8, (1) 2.

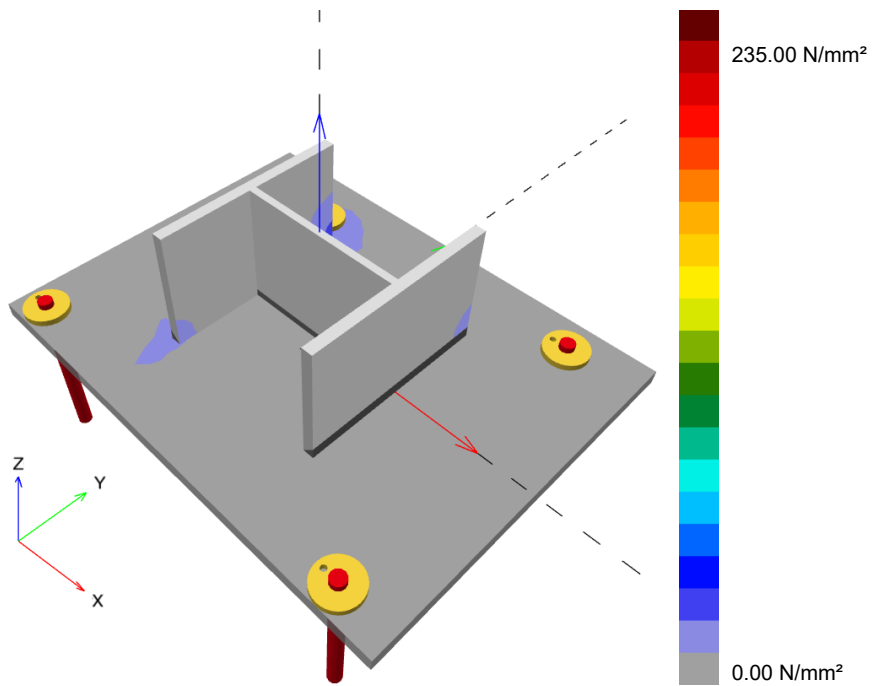
Results

Part	Load combination	Material	σ _{Ed} [N/mm ²]	ε _{Pl} [%]	f _y [N/mm ²]	γ _{MO}	f _y /γ _{MO} [N/mm ²]	ε _{lim} [%]	Status
Plate	Combination 1	S 235	28.07	0.00	235.00	1.00	235.00	5.00	OK
Profile	Combination	S 235	16.49	0.00	235.00	1.00	235.00	5.00	OK

Part	Load combination	Material	σ_{Ed} [N/mm ²]	ϵ_{Pl} [%]	f_y [N/mm ²]	γ_{M0}	f_y/γ_{M0} [N/mm ²]	ϵ_{lim} [%]	Status
Profile	1 Combination 1	S 235	30.80	0.00	235.00	1.00	235.00	5.00	OK
Profile	1 Combination 1	S 235	6.12	0.00	235.00	1.00	235.00	5.00	OK

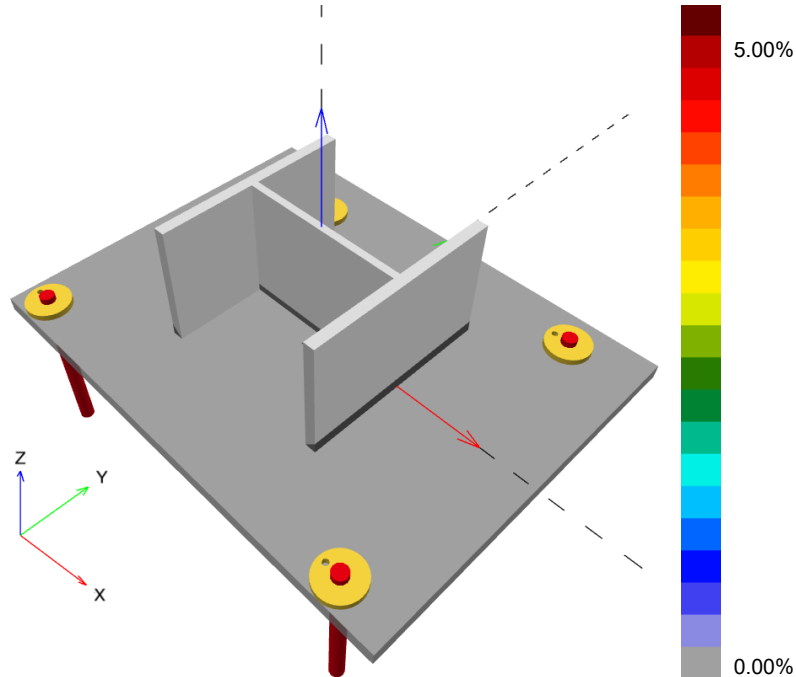
2.4.1.1 Equivalent stress

Results below are displayed for the decisive load combination: 1 - Combination 1



2.4.1.2 Plastic strain

Results below are displayed for the decisive load combination: 1 - Combination 1


2.4.2 Hole bearing

Decisive load combination: 1 - Combination 1

Plate hole bearing resistance, EN1993-1 - 8 section 3.6.1:

Equations

$$F_{b,Rd} = \frac{k_1 a_b f_u d t}{\gamma_{M2}}$$

$$\text{Utilisation} = \frac{V_{Ed}}{F_{b,Rd}}$$

Variables

	k_1	a_b	f_u [N/mm ²]	d [mm]	t [mm]	γ_{M2}
Anchor 1	2.50	0.66	360.00	12.0	12.0	1.25
Anchor 2	2.50	0.46	360.00	12.0	12.0	1.25
Anchor 3	2.50	1.00	360.00	12.0	12.0	1.25
Anchor 4	2.50	1.00	360.00	12.0	12.0	1.25

Results

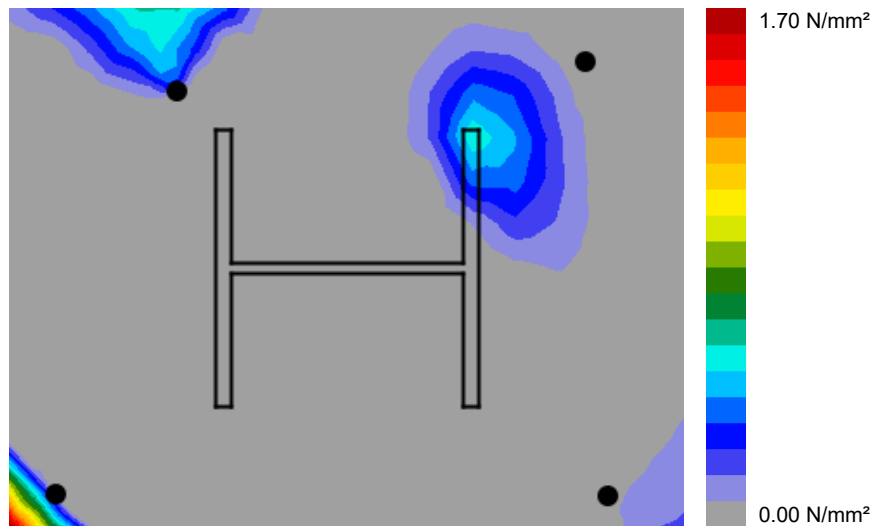
	V_{Ed} [kN]	$F_{b,Rd}$ [kN]	Utilisation [%]	Status
Anchor 1	0.219	68.361	1	OK
Anchor 2	0.395	47.710	1	OK
Anchor 3	0.180	103.680	1	OK
Anchor 4	0.370	103.680	1	OK

2.5 Concrete

Decisive load combination: 1 - Combination 1

According to EN1992-1-1 section 6.7(4), the concrete should have sufficient reinforcement to take into account the tensile forces that develop due to the fixture attachment. The definition of the reinforcement in the concrete is not within the scope of PROFIS Engineering.

2.5.1 Compression in concrete under the baseplate



2.5.2 Verification of compression in concrete under the baseplate around the profile as per EN1992-1 section 6.7 and EN1993-1-8, section 6.2.5

Equations

$$f_{jd} = \frac{\beta_j k_j \alpha_{cc} f_{ck}}{\gamma_c}$$

$$\sigma = \frac{N}{A_{eff}}$$

$$Utilisation = \frac{\sigma}{f_{jd}}$$

Variables

N [kN]	A _{eff} [mm ²]	β _j	k _j	α _{cc}	f _{ck} [N/mm ²]	γ _c
5.347	2,757	0.67	3.00	0.85	30.00	1.50

Results

σ [N/mm ²]	f _{jd} [N/mm ²]	Utilisation [%]	Status
1.94	34.17	6	OK

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2.6 Symbol explanation

a_b	Factor
α_{cc}	Long-term effects on maximum strength of concrete
A_{eff}	Effective area
β_j	Joint coefficient β_j
d	Nominal diameter of the bolt
ε_{lim}	Limit plastic strain
ε_{pl}	Plastic strain from CBFEM results
$F_{b,Rd}$	Plate bearing resistance EN 1993-1-8 tab. 3.4
f_{ck}	Characteristic compressive concrete strength
f_{jd}	The ultimate bearing strength of the concrete block
f_u	Ultimate strength
f_y	Yield strength
γ_c	Service factor - SP 16, Table 41
γ_{M0}	Steel safety factor gamma M0
γ_{M2}	Steel safety factor gamma M2
k_1	Factor for edge distance and bolt spacing perpendicular to the direction of load transfer - EN 1993-1-8 - Table 3.4
k_j	Concentration factor
N	Resulting compression force
σ	Average stress in concrete
σ_{Ed}	Equivalent stress
t	Thickness of the baseplate
V_{Ed}	Anchor shear force

2.7 Warnings

- By using the CBFEM calculation functionality of PROFIS Engineering you may act outside the applicable design codes and your specified baseplate may not behave rigidly. Please, have the results validated by a professional designer and/or structural engineer to ensure suitability and adequacy for your specific jurisdiction and project requirements.
- The anchor is modelled considering stiffness values determined from load displacement curves tested in an independent laboratory. Please note that no simple replacement of the anchor is possible as the anchor stiffness has a major impact on the load distribution results.



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3 Summary of results

Design of the baseplate, anchor, welds and other elements are based on CBFEM (component based finite element method) and Eurocode regulations.

	Load combination	Max. utilisation	Status
Anchors	Combination 1	17%	OK
Baseplate	Combination 1	12%	OK
Concrete	Combination 1	6%	OK
Profile	Combination 1	14%	OK

Fastening meets the design criteria!



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4 Remarks; Your Cooperation Duties

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