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Address:		Specifier:	
Phone Fax:		E-Mail:	
Design:	BBf Window Head Calc with 25mm shimming	Date:	18/10/2023
Fastening Point:			

Specifier's comments:

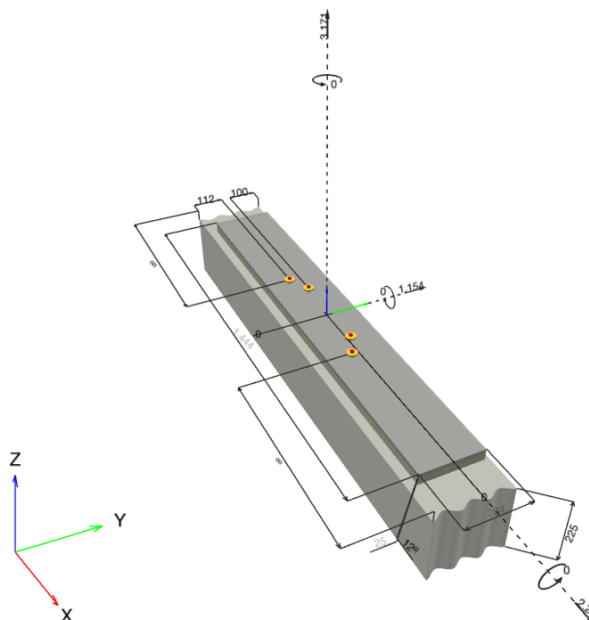
1 Input data



Anchor type and size:	HST3-R M12 hef1
Return period (service life in years):	50
Item number:	2105870 HST3-R M12x115 40/20
Hilti Filling Set or any suitable annular gap filling solution	
Effective embedment depth:	$h_{ef,opti} = 50.0 \text{ mm}$ ($h_{ef,limit} = 69.0 \text{ mm}$), $h_{nom} = 60.0 \text{ mm}$
Material:	A4
Approval No.:	ETA 98/0001
Issued Valid:	03/11/2022 -
Proof:	SOFA based on EN 1992-4, Mechanical
Stand-off installation:	without clamping (anchor); restraint level (baseplate): 2.00; $e_b = 25.0 \text{ mm}$; $t = 12.0 \text{ mm}$
	Hilti Grout: CB-G EG, epoxy, $f_{c,Grout} = 120.00 \text{ N/mm}^2$
Baseplate ^R :	$l_x \times l_y \times t = 1,444.0 \text{ mm} \times 204.0 \text{ mm} \times 12.0 \text{ mm}$; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, C20/25, $f_{c,cyl} = 20.00 \text{ N/mm}^2$; $h = 225.0 \text{ mm}$, User-defined partial material safety factor $\gamma_c = 1.500$
Installation:	hammer drilled hole, Installation condition: Dry
Reinforcement:	No reinforcement or Reinforcement spacing $\geq 150 \text{ mm}$ (any \emptyset) or $\geq 100 \text{ mm}$ ($\emptyset \leq 10 \text{ mm}$) no longitudinal edge reinforcement

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

Geometry [mm] & Loading [kN, kNm]



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1.1 Load combination

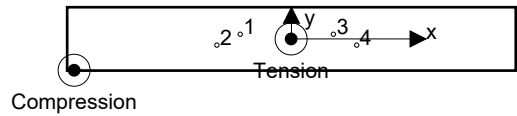
Case	Description	Forces [kN] / Moments [kNm]	Seismic	Fire	Max. Util. Anchor [%]
1	Combination 1	N = 3.171; V _x = 2.250; V _y = 1.154; M _x = 0.000; M _y = 0.000; M _z = 0.000;	no	no	17

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	0.855	0.626	0.561	0.277
2	0.619	0.625	0.564	0.271
3	0.946	0.636	0.561	0.300
4	0.755	0.642	0.564	0.306



max. concrete compressive strain: 0.00 [‰]
 max. concrete compressive stress: 0.07 [N/mm²]
 resulting tension force in (x/y)=(-1.0/-0.1): 3.176 [kN]
 resulting compression force in (x/y)=(-699.6/-100.9): 0.005 [kN]

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

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

	Load [kN]	Capacity [kN]	Utilization β_N [%]	Status
Steel failure*	0.946	30.357	4	OK
Pull-out failure*	0.946	8.117	12	OK
Concrete Breakout failure**	1.702	12.109	15	OK
Splitting failure**	1.702	18.433	10	OK

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

3.1 Steel failure

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

N _{Rk,s} [kN]	γ _{M,s}	N _{Rd,s} [kN]	N _{Ed} [kN]
42.500	1.400	30.357	0.946

3.2 Pull-out failure

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

N _{Rk,p} [kN]	ψ _c	γ _{M,p}	N _{Rd,p} [kN]	N _{Ed} [kN]
12.175	1.000	1.500	8.117	0.946

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3.3 Concrete Breakout failure

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

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

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

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

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

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

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

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

$A_{c,N}$ [mm ²]	$A_{c,N}^0$ [mm ²]	$c_{cr,N}$ [mm]	$s_{cr,N}$ [mm]	$f_{c,cyl}$ [N/mm ²]		
36,375	22,500	75.0	150.0	20.00		
$e_{c1,N}$ [mm]	$\psi_{ec1,N}$	$e_{c2,N}$ [mm]	$\psi_{ec2,N}$	$\psi_{s,N}$	$\psi_{re,N}$	
4.2	0.947	2.0	0.975	1.000	1.000	
z [mm]	$\psi_{M,N}$	k_1	$N_{Rk,c}^0$ [kN]	$\gamma_{M,c}$	$N_{Rd,c}$ [kN]	N_{Ed} [kN]
705.8	1.000	7.700	12.175	1.500	12.109	1.702

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3.4 Splitting failure

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

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

$$N_{RK,sp}^0 = \min(N_{RK,p}, N_{RK,c}^0)$$

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

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

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

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

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

$A_{c,N}$ [mm ²]	$A_{c,N}^0$ [mm ²]	$c_{cr,sp}$ [mm]	$s_{cr,sp}$ [mm]	$\psi_{h,sp}$	$f_{c,cyl}$ [N/mm ²]	
49,575	32,400	90.0	180.0	1.587	20.00	
$e_{c1,N}$ [mm]	$\psi_{ec1,N}$	$e_{c2,N}$ [mm]	$\psi_{ec2,N}$	$\psi_{s,N}$	$\psi_{re,N}$	k_1
4.2	0.955	2.0	0.979	1.000	1.000	7.700
$N_{RK,sp}^0$ [kN]	γ_{Msp}	$N_{Rd,sp}$ [kN]	N_{Ed} [kN]			
12.175	1.500	18.433	1.702			

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

	Load [kN]	Capacity [kN]	Utilization β_v [%]	Status
Steel failure (without lever arm)*	0.642	24.880	3	OK
Steel failure (with lever arm)*	0.642	3.922	17	OK
Pryout failure**	1.278	36.339	4	OK
Concrete edge failure in direction y+**	1.610	16.186	10	OK

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

4.1 Steel failure (without lever arm)

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

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

$V_{Rk,s}^0$ [kN]	k_7	$V_{Rk,s}$ [kN]	$\gamma_{M,s}$	$V_{Rd,s}$ [kN]	V_{Ed} [kN]
31.100	1.000	31.100	1.250	24.880	0.642

4.2 Steel failure (with lever arm)

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

$$V_{Rk,s,M} = \frac{\alpha_M \cdot M_{Rk,s}}{l_a} \quad \text{EN 1992-4, Eq. 7.37}$$

$$M_{Rk,s} = M_{Rk,s}^0 \cdot \left(1 - \frac{N_{Ed}}{N_{Rd,s}}\right) \quad \text{EN 1992-4, Eq. 7.38}$$

$$l_a = e_c + \frac{t}{2} + a_3 \quad \text{EN 1992-4, Eq. 6.2}$$

l [mm]	α_M	$N_{Ed} / N_{Rd,s}$	$1 - N_{Ed} / N_{Rd,s}$	$M_{Rk,s}^0$ [kNm]	$M_{Rk,s} = M_{Rk,s}^0 (1 - N_{Ed} / N_{Rd,s})$ [kNm]	
37.0	2.00	0.025	0.975	0.093	0.091	
$V_{Rk,s}^M = \alpha_M \cdot M_{Rk,s} / l$ [kN]				$\gamma_{M,s}$	$V_{Rd,s}^M$ [kN]	V_{Ed} [kN]
4.902				1.250	3.922	0.642

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4.3 Pryout failure

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

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

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

$$N_{Rk,c}^0 = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} \quad \text{EN 1992-4, Eq. (7.2)}$$

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

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

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

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

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

$A_{c,N}$ [mm ²]	$A_{c,N}^0$ [mm ²]	$c_{cr,N}$ [mm]	$s_{cr,N}$ [mm]	k_8	$f_{c,cyl}$ [N/mm ²]		
36,375	22,500	75.0	150.0	2.780	20.00		
$e_{c1,v}$ [mm]	$\psi_{ec1,N}$	$e_{c2,v}$ [mm]	$\psi_{ec2,N}$	$\psi_{s,N}$	$\psi_{re,N}$	$\psi_{M,N}$	
0.1	0.999	0.2	0.998	1.000	1.000	1.000	
k_1	$N_{Rk,c}^0$ [kN]	$\gamma_{M,c,p}$	$V_{Rd,cp}$ [kN]	V_{Ed} [kN]			
7.700	12.175	1.500	36.339	1.278			
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4.4 Concrete edge failure in direction y+

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

$$V_{Rk,c} = k_T \cdot \psi_{b,g} \cdot V_{Rk,c}^0 \cdot \frac{A_{c,V}}{A_{c,V}^0} \cdot \psi_{s,V} \cdot \psi_{h,V} \cdot \psi_{\alpha,V} \cdot \psi_{ec,V} \cdot \psi_{re,V}$$

$$\psi_{b,g} = \frac{1}{\alpha_{b,g}} = \frac{1}{1 + \frac{C \cdot t_g}{d^{\frac{3}{4}}}} \quad \text{Hilti Method for anchor design in grouted stand-off connections, Hilti, 2023}$$

$$V_{Rk,c}^0 = k_g \cdot d_{nom}^\alpha \cdot l_f^\beta \cdot \sqrt{f_{ck}} \cdot c_1^{1.5} \quad \text{EN 1992-4, Eq. (7.41)}$$

$$\alpha = 0.1 \cdot \left(\frac{l_f}{c_1}\right)^{0.5} \quad \text{EN 1992-4, Eq. (7.42)}$$

$$\beta = 0.1 \cdot \left(\frac{d_{nom}}{c_1}\right)^{0.2} \quad \text{EN 1992-4, Eq. (7.43)}$$

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

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

$$\psi_{h,V} = \left(\frac{1.5 \cdot c_1}{h}\right)^{0.5} \geq 1.00 \quad \text{EN 1992-4, Eq. (7.46)}$$

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

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

l_f [mm]	d_{nom} [mm]	k_g	α	β	$f_{c,cyl}$ [N/mm ²]	
50.0	12.00	1.700	0.071	0.065	20.00	
$\psi_{b,g}$	$C \left[\frac{1}{mm^4}\right]$	d [mm]	t_g [mm]			
0.857	0.043	12.0	25.0			
c_1 [mm]	$A_{c,V}$ [mm ²]	$A_{c,V}^0$ [mm ²]				
100.0	90,000	45,000				
$\psi_{s,V}$	$\psi_{h,V}$	α_V [°]	$\psi_{\alpha,V}$	$e_{c,V}$ [mm]	$\psi_{ec,V}$	$\psi_{re,V}$
1.000	1.000	44.20	1.254	5.5	0.964	1.000
$V_{Rk,c}^0$ [kN]	k_T	$\gamma_{M,c}$	$V_{Rd,c}$ [kN]	V_{Ed} [kN]		
11.707	1.0	1.500	16.186	1.610		

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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
0.031	0.026	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
0.141	0.099	1.500	9	OK

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

6 Displacements (highest loaded anchor)

Short term loading:

N_{Sk}	=	0.701 [kN]	δ_N	=	0.0460 [mm]
V_{Sk}	=	0.471 [kN]	δ_V	=	0.1033 [mm]
			δ_{NV}	=	0.1131 [mm]

Long term loading:

N_{Sk}	=	0.701 [kN]	δ_N	=	0.1838 [mm]
V_{Sk}	=	0.471 [kN]	δ_V	=	0.1536 [mm]
			δ_{NV}	=	0.2396 [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 5216:2021, 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!
- Design is only valid if hole is filled to remove clearance, clearance as per EN 1992-4 Table 6.1
- 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) the minimum concrete cover defined in the design settings is used as the concrete cover of the edge reinforcement.
- The characteristic bond resistances depend on the return period (service life in years): 50



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Fastening meets the design criteria!

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8 Installation data

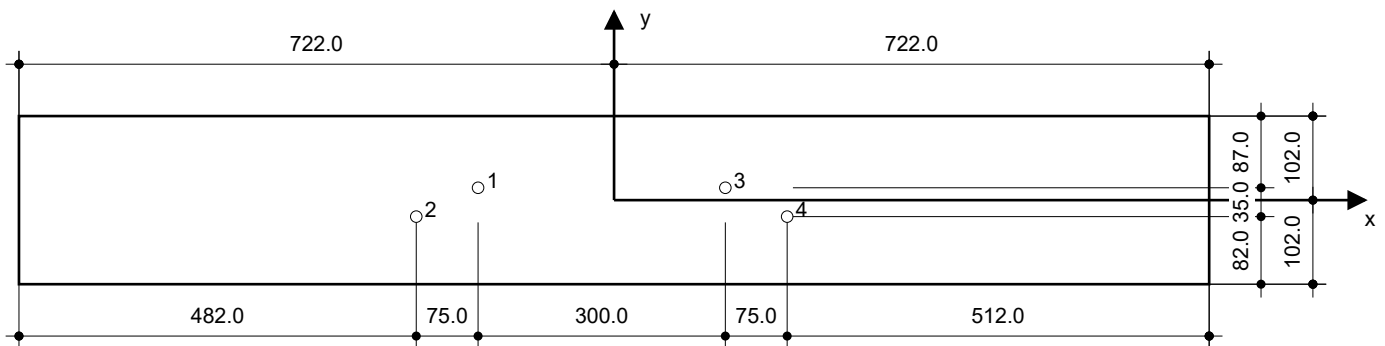
Baseplate, steel: S 235; E = 210,000.00 N/mm²; f_{yk} = 235.00 N/mm²
 Profile: no profile
 Hole diameter in the fixture: d_f = 14.0 mm
 Plate thickness (input): 12.0 mm
 Recommended plate thickness: not calculated
 Drilling method: Hammer drilled
 Cleaning: No cleaning of the drilled hole is required

Anchor type and size: HST3-R M12 hef1
 Item number: 2105870 HST3-R M12x115 40/20
 Maximum installation torque: 60 Nm
 Hole diameter in the base material: 12.0 mm
 Hole depth in the base material: 80.0 mm
 Minimum thickness of the base material: 100.0 mm

Hilti HST3 stud anchor with 50 mm embedment, M12 hef1, Stainless steel, installation per ETA 98/0001, with annular gaps filled with Hilti Filling Set or any suitable gap solutions

8.1 Recommended accessories

Drilling	Cleaning	Setting
<ul style="list-style-type: none"> • Suitable Rotary Hammer • Properly sized drill bit 	<ul style="list-style-type: none"> • No accessory required 	<ul style="list-style-type: none"> • Hilti SIW 6AT-A22 + SI AT-A22 • Torque wrench • Hammer



Coordinates Anchor [mm]

Anchor	x	y	c _{-x}	c _{+x}	c _{-y}	c _{+y}
1	-165.0	15.0	-	-	147.0	100.0
2	-240.0	-20.0	-	-	112.0	135.0
3	135.0	15.0	-	-	147.0	100.0
4	210.0	-20.0	-	-	112.0	135.0







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9 Drilling and installation

HST3 (-R) subject to:

Anchor size	M8	M10	M12	M16	M20	M24
Hammer drilling* 	TE2(-A) – TE30(-A)			TE40 – TE70		
Diamond core drilling* 	DD-30W, DD-EC1					
Setting tool* 	Setting tool HS-SC				-	
Hollow drill bit drilling* 	-		TE-CD, TE-YD			
Seismic Set/ Filling Set** 	Seismic/Filling Set M8-M20 (Carbon and Stainless Steel A4)					-
Impact Wrench and Adaptive Torque Module 	Impact Wrench SIW 6AT-A22 and adaptive torque module SI-AT-A22					-

*Installation methods provided in ETA-98/0001

**Seismic set needed to fill the annular gap between anchor and fixture:
 No annular gap, double design resistance (agap=1)



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10 Remarks; Your Cooperation Duties

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