WOOD CONNECTOR HCW

Technical Datasheet:

Update: March 2022

Hilti Connector Wood HCW

Faster and more efficient timber fastening system for the assembly of prefabricated timber elements

Table Of Contents

System-Parts

Hilti Connector Wood HCW

Hilti Connector Wood HCW 37x45 M12 and setting tool SW HCW

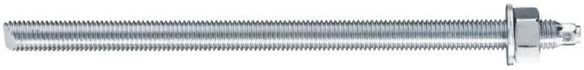
Hilti Connector Wood HCW L 40x295 M12

Hanger bolt (for fastening in timber)

Hanger bolt HSW M12x220/60 8.8

Concrete fastener

Expansion Anchor HST3 M12x …
(ETA-98/0001)

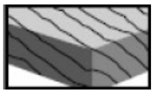


Anchor rod HAS-U M12x … in combination with HIT HY200 injectable mortar

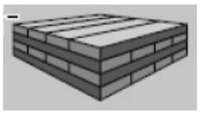
Base material

Concrete
(non-cracked)

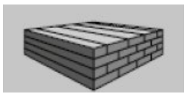
Concrete
(cracked)



Solid timber



Cross-laminated timber



Glued laminated timber

Load conditions

Static / quasi-static

Other informationen

European Technical Assessment

CE conformity

Approvals / certificates

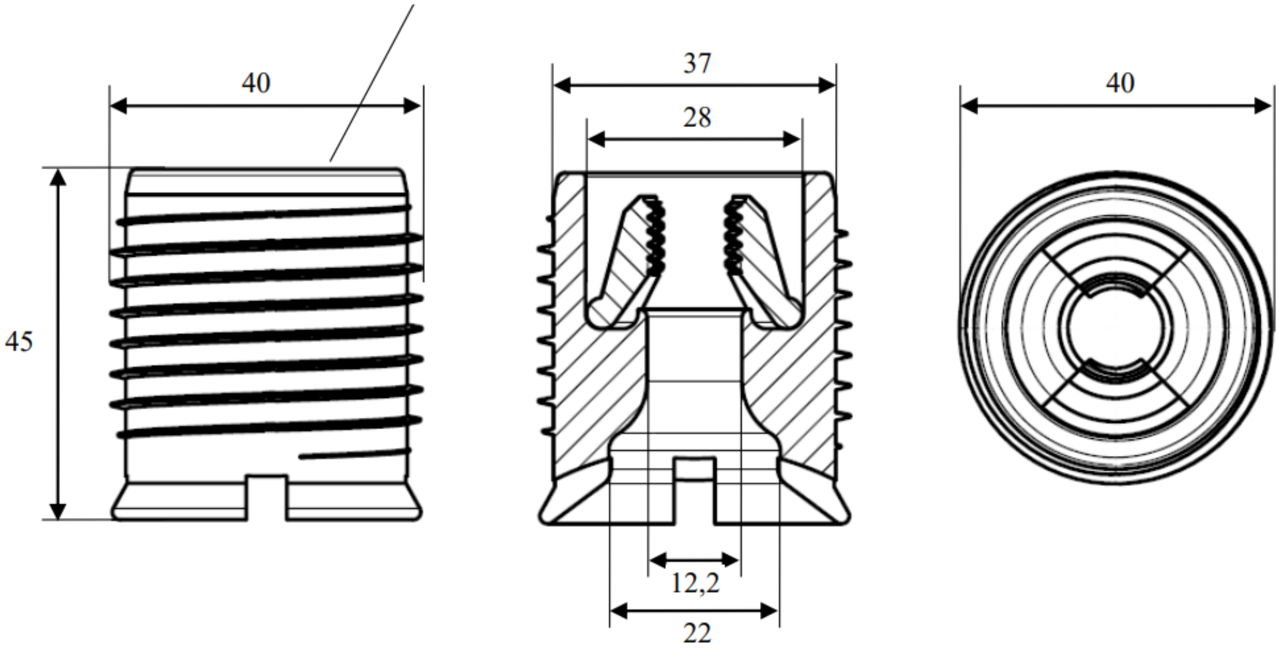
Description	Authority / Laboratory	No. / date of issue
European technical Assessment [a)]	ETA-Danmark A/S	ETA-21/0357 / 2021-04-19

a) All data given in this section according to ETA-21/0357 issue 2021-04-19.

Product size

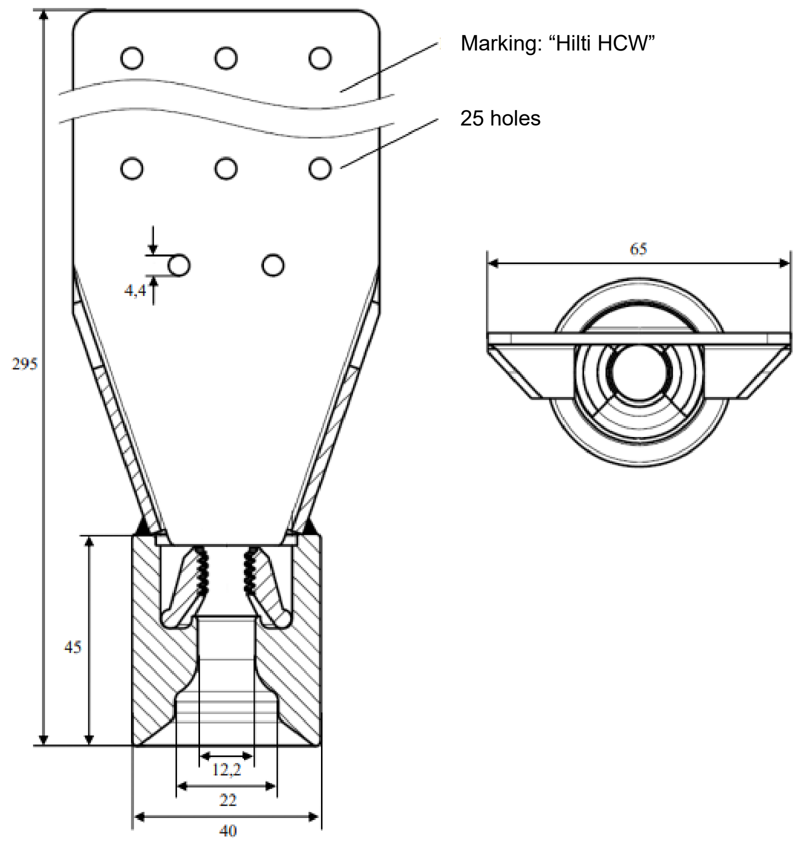
Hilti Connector Wood HCW

Outer diameter: 40 mm
Diameter of the body: 37 mm
Length: 45 mm
Material:
- Sleeve: 11SMNPB30+C according to EN10277
- Clamping device: 11SMNPB30, 16MnCrS5+C according to EN10277; Electroplated zinc coated ≥ 5 µm


Marking: “Hilti HCW”

Hilti Connector Wood HCW L

Outer diameter, sleeve:	40 mm
Length, sleeve:	45 mm
Length:	295 mm
Width, plate:	65 mm
Thickness, plate:	2,5 mm
Hole diameter, plate:	4,4 mm
Material:	
- Sleeve and nailing plate:	S335J2 according to EN10277
- Clamping device:	16MnCrS5+C according to EN10277; Electroplated zinc coated ≥ 5 µm

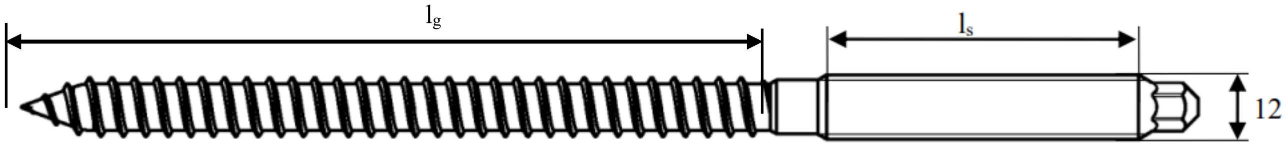


Hanger bolt HSW M12x220/60 8.8

Length l_s:	60 mm
Threaded length l_g:	140 mm
Threaded outer diameter (d):	11 mm
Core diameter (d_i):	8.7 mm
Material:	Steel, property class 8.8

⬢ 8 mm

6-8.5 mm



Design information - overview

Design load-carrying capacities in timber to timber connections

Tensile forces:

The design value of the load-carrying capacity for tensile forces is the smaller value of the following load-carrying capacities.

Proof of tensile load capacity for the Hilti Wood Connector HCW and the hanger bolt HSW:

$$F_{ax,\alpha,Ed} \leq F_{ax,\alpha,Rd}$$

$$F_{ax,\alpha,Rd} = min \begin{cases} \dfrac{k_{mod}\ F_{ax,Rk;\,HCW}}{\gamma_M} \\ \dfrac{F_{t,Rk;\,HCW}}{\gamma_{M,2}} \\ \dfrac{k_{mod}\ F_{ax,Rk;\,HSW}}{\gamma_M} \\ \dfrac{F_{t,Rk;\,HSW}}{\gamma_{M,2}} \end{cases}$$

with

$F_{ax,Rk;\ HCW}$:	Characteristic withdrawal capacity, HCW … see Table 6 and Table 7
$F_{t,Rk;\ HCW}$:	Characteristic load capacity under tensile force, HCW: $F_{t,Rk,\ HCW}$ = 37,5 kN (see ETA 21/0357)
$F_{ax,Rk;\ HSW}$:	Characteristic axial withdrawal capacity, hanger bolt … see Table 8 and Table 9
$F_{t,Rk;\ HSW}$:	Characteristic tensile strength, hanger bolt … see page 13

k_{mod}	see Table 1, Table 2 and Table 3
γ_M	see Table 4
$\gamma_{M,2}$	see EN 1993-1-1 Chapter 6.1

Lateral forces (Shear forces):

The connection is designed according EN 1995-1-1 using the Johansen yield theory for timber-to-timber connections and fasteners in single shear.

Shear proof HCW:

$$F_{v,Ed} \leq \frac{k_{mod}\ F_{v,Rk;\,HCW}}{\gamma_M}$$

Shear proof hanger bolt:

$$F_{v,Ed} \leq \frac{k_{mod}\ F_{v,Rk;\,HSW}}{\gamma_M}$$

with

$F_{v,Rk;\ HCW}$:	Characteristic shear load-carrying capacity, HCW … see Table 10
$F_{v,Rk;\ HSW}$:	Characteristic shear load-carrying capacity, hanger bolt … see Table 11, Table 12, Table 13 and Table 14

k_{mod}	see Table 1, Table 2 and Table 3
γ_M	see Table 4

Design load-carrying capacity in timber to conrete connections

Two application cases (HST3 and HIT HY200 + anchor rod HAS-U 8.8) have been considered in the following design tables. For alternative applications, please use our design software PROFIS Engineering.

Tensile forces:

Proof of tensile load capacity for the Hilti Wood Connector HCW:

$$F_{ax,\alpha,Ed} \leq F_{ax,\alpha,Rd}$$

$$F_{ax,\alpha,Rd} = min \begin{cases} \dfrac{k_{mod}\ F_{ax,Rk;\ HCW}}{\gamma_M} \\ \dfrac{F_{t,Rk;\,HCW}}{\gamma_{M,2}} \end{cases}$$

Proof of tensile load capacity for the concrete anchor:

$$N_{Ed} \leq min \begin{cases} \dfrac{N_{Rk,s}}{\gamma_{Ms}} \\ \dfrac{N_{Rk,c}}{\gamma_{Mc}} \\ \dfrac{N_{Rk,p}}{\gamma_{Mp}} \\ \dfrac{N_{Rk,sp}}{\gamma_{Msp}} \end{cases}$$

with

$F_{ax,Rk;\ HCW}$: Characteristic withdrawal capacity HCW … see Table 6 and Table 7
$F_{t,Rk;\ HCW}$: Characteristic load capacity under tensile force HCW: $F_{t,Rk,\ HCW}$ = 37,5 kN (see ETA 21/0357)

Characteristic load capacity under tensile force concrete anchor:

$N_{Rk,s}$	Characteristic value of steel resistance under tension load … see Table 15
$N_{Rk,c}$	Characteristic resistance in case of concrete cone failure under tension load … see Table 16
$N_{Rk,p}$	Characteristic resistance in case of pull-out failure under tension load … see Table 17
$N_{Rk,sp}$	Combined pull-out and concrete failure (for bonded fasteneners) … see Table 18

k_{mod}	see Table 1, Table 2 and Table 3
γ_M	see Table 4
$\gamma_{M,2}$	see EN 1993-1-1 Chapter 6.1
γ_{Ms} , γ_{Mc}, γ_{Mp} and γ_{Msp}	see Table 5

Lateral forces (Shear forces):

Shear proof HCW:

$$F_{v,Ed} \leq F_{v,Rd}$$

$$F_{v,Rd} = \frac{k_{mod}\ F_{v,Rk;\,HCW}}{\gamma_M}$$

Shear proof concrete anchor:

$$V_{Ed} \leq min \begin{cases} \dfrac{V_{Rk,s}}{\gamma_{Ms}} \\ \dfrac{V_{Rk,s,M}}{\gamma_{Ms}} \\ \dfrac{V_{Rk,cp}}{\gamma_{Mc}} \\ \dfrac{V_{Rk,c}}{\gamma_{Mc}} \end{cases}$$

$F_{v,Rk;\ HCW}$: Characteristic shear load-carrying capacity, HCW … see Table 10

Characteristic shear load capacity, concrete anchor:

$V_{Rk,s}$ Steel failure under shear load without lever arm … see Table 19
$V_{Rk,s,M}$ Steel failure under shear load with lever arm … see Table 20
$V_{Rk,cp}$ Concrete pry-out failure under shear load … see Table 21
$V_{Rk,c}$ Concrete edge failure under shear load … see Table 22

k_{mod} see Table 1, Table 2 and Table 3
γ_M see Table 4
γ_{Ms} and γ_{Mc} see Table 5

Basics of design

Basics of design according EN 1995-1-1

Information on national requirements may be included in the National Annex.

Load-duration classes		
Load-duration class	**Order of accumulated duration of characteristic load**	**Examples of loading**
Permanent	more than 10 years	self-weight
Long-term	6 months – 10 years	storage
Medium-term	1 week – 6 months	imposed floor load, snow
Short-term	less than one week	snow, wind
Instantaneous		wind, accidental load

Table 1: Load-duration classes and examples of load-duration assignment (EN 1995-1-1 Table 2.1 und 2.2)

Service classes
Service class 1 is characterised by a moisture content in the materials corresponding to a temperature of 20 °C and the relative humidity of the surrounding air only exceeding 65 % for a few weeks per year. NOTE: In service class 1 the average moisture content in most softwoods will not exceed 12 %.
Service class 2 is characterised by a moisture content in the materials corresponding to a temperature of 20 °C and the relative humidity of the surrounding air only exceeding 85 % for a few weeks per year. NOTE: In service class 2 the average moisture content in most softwoods will not exceed 20 %.
Service class 3 is characterised by climatic conditions leading to higher moisture contents than in service class 2.

Table 2: Service classes (EN 1995-1-1 Chapter 2.3.1.3)

Values of k_{mod}							
Material	**Standard**	**Service class**	**Load-duration class**				
			Permanent action	**Long term action**	**Medium term action**	**Short term action**	**Instanta-neous action**
Solid timber	EN 14081-1	1	0.60	0.70	0.80	0.90	1.10
		2	0.60	0.70	0.80	0.90	1.10
		3	0.50	0.55	0.65	0.70	0.90
Glued laminated timber	EN 14080	1	0.60	0.70	0.80	0.90	1.10
		2	0.60	0.70	0.80	0.90	1.10
		3	0.50	0.55	0.65	0.70	0.90
LVL	EN 14374, EN 14279	1	0.60	0.70	0.80	0.90	1.10
		2	0.60	0.70	0.80	0.90	1.10
		3	0.50	0.55	0.65	0.70	0.90
Plywood	EN 636 Part 1, 2, 3	1	0.60	0.70	0.80	0.90	1.10
	Part 2, 3	2	0.60	0.70	0.80	0.90	1.10
	Part 3	3	0.50	0.55	0.65	0.70	0.90

Table 3: Values of k_{mod} (EN 1995-1-1 Table 3.1)

Recommended partial factors γ_M	
Fundamental combinations:	
Solid timber	1.3
Glued laminated timber	1.25
LVL, plywood, OSB	1.2
Particleboards	1.3
Fibreboards, hard	1.3
Fibreboards, medium	1.3
Fibreboards, MDF	1.3
Fibreboards, soft	1.3
Connections	1.3
Punched metal plate fasteners (Steel properties)	1.25
Accidental combinations	1.0

Table 4: Recommended partial factors γ_M for material properties and resistances (EN 1995-1-1 Table 2.3)

Basics of design according EN 1993-1-1

Information on national requirements may be included in the National Annex.

$\gamma_{M2} = 1.25$ …. partial factor for resistance of cross-sections in tension to fracture according EN 1993-1-1 Chap. 6.1

Basics of design according EN 1992-4

Information on national requirements may be included in the National Annex.

Failure modes	**Partial factor**	
	Permanent and transient design situations	**Accidental design situation**
Steel failure – fasteners		
Tension	$\gamma_{Ms} = 1.50$ a)	
Shear	$\gamma_{Ms} = 1.25$ a)	
Concrete related failure		
Concrete cone failure, concrete edge failure,	$\gamma_{Mc} = \gamma_c \cdot \gamma_{inst}$	$\gamma_{Mc} = \gamma_c \cdot \gamma_{inst}$
	$\gamma_c = 1.5$ for seismic repair and strengthening of existing structures see the EN 1998 series	$\gamma_c = 1.2$ for seismic repair and strengthening of existing structures see the EN 1998 series
concrete blow-out, concrete pry-out failure	$\gamma_{inst} = 1.0$ a)	
Concrete splitting failure	$\gamma_{Msp} = \gamma_{Mc}$	
Pull-out and combined pull-out and concrete failure	$\gamma_{Mp} = \gamma_{Mc}$	
a) see ETA-98/0001 and ETA-11/0493		

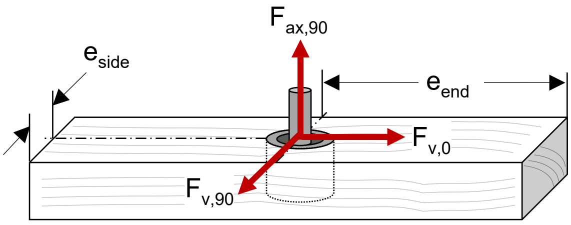
Table 5: Recommended values of partial factors (EN 1992-4 Table 4.1)

Information Hilti Wood Connector HCW and HCW-L

The values of the withdrawal or shear capacity for the HCW in the following pages were assumed for the following standard application:

▨ cross section

→ Loading direction



Cross section ≥ 100x45 mm^2
e_{end} ≥ 200mm
e_{side} ≥ 40mm

For non-standard applications, refer to ETA 21/0357 for the load-bearing capacity values.

Load resistance

Withdrawal capacity HCW & HCW-L for solid timber, cross-laminated timber and glued laminated timber

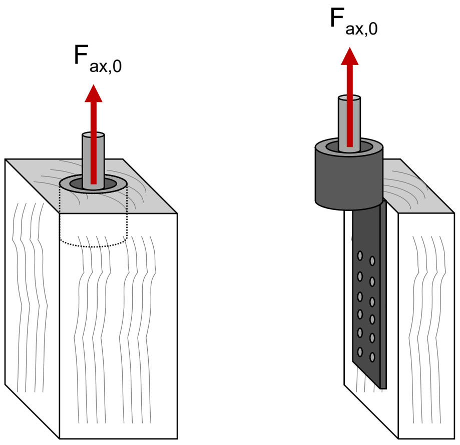


Figure 1: Withdrawal capacity HCW(-L)
Force-fiber-angle α = 0°

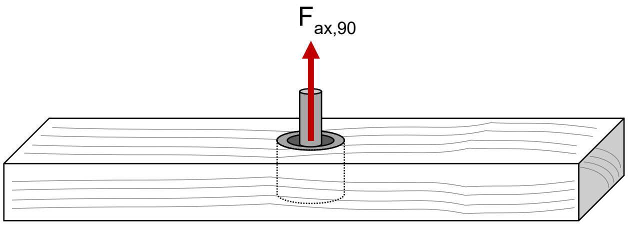


Figure 2: Withdrawal capacity HCW
Force-fiber-angle α = 90°

The withdrawal capacity dependig on the density of wood is determined as follows:

$$F_{ax,\alpha,Rk,\rho_a;\,HCW} = \left(\frac{\rho_k = 350}{\rho_a}\right)^{0,8} \cdot F_{ax,\alpha,Rk;\,HCW} \qquad \text{(ETA-21/0357, Annex C)}$$

with:

$F_{ax,0,Rk;\,HCW}$ = 10.4 kN
and
$F_{ax,90,Rk;\,HCW}$ = 12.7 kN
with a density of ρ_k = 350kg/m^3

(ETA-21/0357)

Axial withdrawal capacity HCW and HCW-L for solid timber and cross-laminated timber					
		HCW		HCW-L	
Force-fiber-angle		**0°**	**90°**	**0°, 15 Nails**	**0°, 25 Nails**
Solid timber / CLT	**Density ρ_k [kg/m^3]**	$F_{ax,0,Rk}$	$F_{ax,90,Rk}$	$F_{ax,0,Rk}$	$F_{ax,0,Rk}$
C14	290	8.9	10.9	21.1	30.2
C16	310	9.4	11.5	22.2	31.9
C18	320	9.7	11.8	22.8	32.7
C20	330	9.9	12.1	23.4	33.5
C22	340	10.2	12.4	23.9	34.3
C24	350	10.4	12.7	24.5	35.1
C27	360	10.6	13.0	25.1	35.9
C30	380	11.1	13.6	26.2	37.5
C35	390	11.3	13.8	26.7	38.3
C40	400	11.6	14.1	27.3	39.1
C45	410	11.8	14.4	27.8	39.8
C50	430	12.3	15.0	28.9	41.4

Table 6: Characteristic values of the axial withdrawal capacity HCW in solid timber or cross-laminated timber in dependence of the density of wood in kN

Axial withdrawal capacity HCW and HCW-L for glued laminated timber					
		HCW		HCW-L	
Force-fiber-angle		**0°**	**90°**	**0°, 15 Nails**	**0°, 25 Nails**
Glued laminated timber	**Denstiy ρ_k [kg/m^3]**	$F_{ax,0,Rk}$	$F_{ax,90,Rk}$	$F_{ax,0,Rk}$	$F_{ax,0,Rk}$
GL24h	385	11.2	13.7	26.4	37.9
GL28h	425	12.1	14.8	28.6	41.0
GL30h	430	12.3	15.0	28.9	41.4
GL32h	440	12.5	15.3	29.4	42.2
GL24c	365	10.8	13.1	25.3	36.3
GL28c	390	11.3	13.8	26.7	38.3
GL30c	390	11.3	13.8	26.7	38.3
GL32c	400	11.6	14.1	27.3	39.1

Table 7: Characteristic values of the axial withdrawal capacity HCW in glued laminated timber in dependence of the density of wood in kN

Axial withdrawal capacity of the hanger bolt for solid timber, glued laminated timber and cross-laminated timber

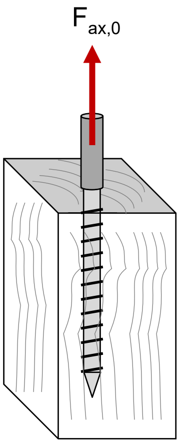


Figure 3: Axial withdrawal capacity of the hanger bolt
Force-fiber-angle α = 0°

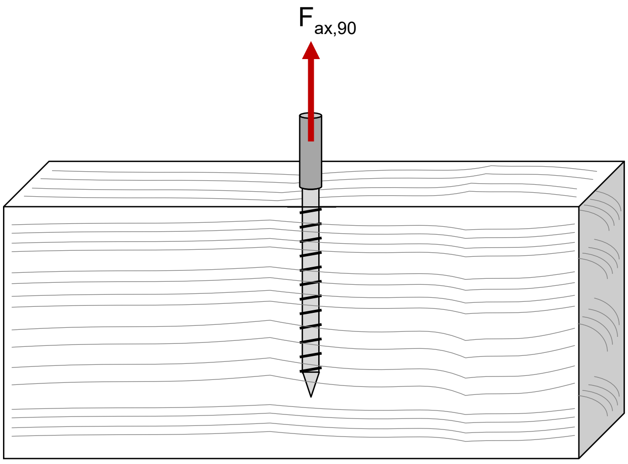


Figure 4: Axial withdrawal capacity of the hanger bolt
Force-fiber-angle α = 90°

Analysis according EN 1995-1-1:

Force-fiber-angle α = 90°:

$$F_{ax,\alpha,Rk;\,HSW} = \frac{n_{ef} \cdot f_{ax,k} \cdot d \cdot l_{ef}}{1{,}2 \cdot cos^2\alpha + sin^2\alpha} \left(\frac{\rho_k}{\rho_a}\right)^{0.8}$$ (EN 1995-1-1 (8.40a))

with

$$f_{ax,k} = 0{,}52\, d^{-0{,}5} l_{ef}^{-0{,}1} \rho_k^{0{,}8}$$ (EN 1995-1-1 (8.39))

Force-fiber-angle α = 0°:[1]

$$F_{ax,\alpha,Rk;\,HSW} = \frac{k_{ax} \cdot n_{ef} \cdot f_{ax,k} \cdot d \cdot l_{ef}}{1{,}2 \cdot cos^2\alpha + sin^2\alpha} \left(\frac{\rho_k}{\rho_a}\right)^{0.8}$$ ETA 21/0357 Annex C

with

$$k_{ax} = 0{,}3 + \frac{0{,}7 \cdot \alpha}{45°} < 1$$ ETA 21/0357 Annex C

[1] Valid only for load-duration class short-term or instantaneous

Axial withdrawal capacity of the hanger bolt HSW for solid timber and cross-laminated timber											
Embedment depth l_{ef} [mm]		**60**		**80**		**100**		**120**		**140**	
Force-fiber-angle		**0°**	**90°**	**0°**	**90°**	**0°**	**90°**	**0°**	**90°**	**0°**	**90°**
Solid timber / CLT	**Density ρ_k [kg/m³]**	$F_{ax,0,Rk}$	$F_{ax,90,Rk}$	$F_{ax,0,Rk}$	$F_{ax,90,Rk}$	$F_{ax,0,Rk}$	$F_{ax,90,Rk}$	$F_{ax,0,Rk}$	$F_{ax,90,Rk}$	$F_{ax,0,Rk}$	$F_{ax,90,Rk}$
C14	290	1.9	6.4	2.5	8.3	3.0	10.2	3.6	12.0	4.1	13.7
C16	310	2.0	6.8	2.6	8.8	3.2	10.7	3.8	12.6	4.3	14.5
C18	320	2.1	6.9	2.7	9.0	3.3	11.0	3.9	12.9	4.5	14.9
C20	330	2.1	7.1	2.8	9.2	3.4	11.3	4.0	13.3	4.6	15.2
C22	340	2.2	7.3	2.8	9.4	3.5	11.5	4.1	13.6	4.7	15.6
C24	350	2.2	7.5	2.9	9.7	3.5	11.8	4.2	13.9	4.8	16.0
C27	360	2.3	7.6	3.0	9.9	3.6	12.1	4.3	14.2	4.9	16.3
C30	380	2.4	8.0	3.1	10.3	3.8	12.6	4.5	14.9	5.1	17.1
C35	390	2.4	8.1	3.2	10.5	3.9	12.9	4.5	15.2	5.2	17.4
C40	400	2.5	8.3	3.2	10.7	3.9	13.1	4.6	15.5	5.3	17.8
C45	410	2.5	8.5	3.3	11.0	4.0	13.4	4.7	15.8	5.4	18.1
C50	430	2.6	8.8	3.4	11.4	4.2	13.9	4.9	16.4	5.7	18.8

Table 8: Characteristic values of the withdrawal capacity of the hanger bolt for solid timber or cross-laminated timber in dependence of the density and thread length in kN; Values for a force-fiber-angle 0° are only valid for load-duration class short-term or instantaneous

Axial withdrawal capacity of the hanger bolt HSW for glued laminated timber											
Embedment depth l_{ef} [mm]		60		80		100		120		140	
Force-fiber-angle		0°	90°	0°	90°	0°	90°	0°	90°	0°	90°
Glued laminated timber	Density ρ_k [kg/m^3]	$F_{ax,0,Rk}$	$F_{ax,90,Rk}$	$F_{ax,0,Rk}$	$F_{ax,90,Rk}$	$F_{ax,0,Rk}$	$F_{ax,90,Rk}$	$F_{ax,0,Rk}$	$F_{ax,90,Rk}$	$F_{ax,0,Rk}$	$F_{ax,90,Rk}$
GL24h	385	2.4	8.0	3.1	10.4	3.8	12.7	4.5	15.0	5.2	17.2
GL28h	425	2.6	8.7	3.4	11.3	4.1	13.8	4.9	16.2	5.6	18.7
GL30h	430	2.6	8.8	3.4	11.4	4.2	13.9	4.9	16.4	5.7	18.8
GL32h	440	2.7	8.9	3.5	11.6	4.3	14.2	5.0	16.7	5.8	19.2
GL24c	365	2.3	7.7	3.0	10.0	3.7	12.2	4.3	14.4	5.0	16.5
GL28c	390	2.4	8.1	3.2	10.5	3.9	12.9	4.5	15.2	5.2	17.4
GL30c	390	2.4	8.1	3.2	10.5	3.9	12.9	4.5	15.2	5.2	17.4
GL32c	400	2.5	8.3	3.2	10.7	3.9	13.1	4.6	15.5	5.3	17.8

Table 9: Characteristic values of the withdrawal capacity of the hanger bolt for glued laminated timber in dependence of the density and thread length in kN; Values for a force-fiber-angle 0° are only valid for load-duration class short-term or instantaneous

Characteristic tensile strength of the hanger bolt

Analysis according EN 1995-1-1:

$$F_{t,Rk;\,HSW} = n_{ef} \cdot f_{tens,k} \qquad \text{(EN 1995-1-1 (8.40c))}$$

$$f_{tens,k} = 300 \cdot \pi \cdot \frac{d_i^2}{4} = 300 \cdot \pi \cdot \frac{8.7^2}{4} \cdot 10^{-3} = 17.83\ kN \qquad \text{(DIN 20000-6: 2015-02 (8))}$$

$$F_{t,Rk;HSW} = 1 \cdot 17.83 = 17.83\ kN$$

HCW shear load-carrying capacity (embedment strength) for solid timber, glued laminated timber and cross-laminated timber (CLT)

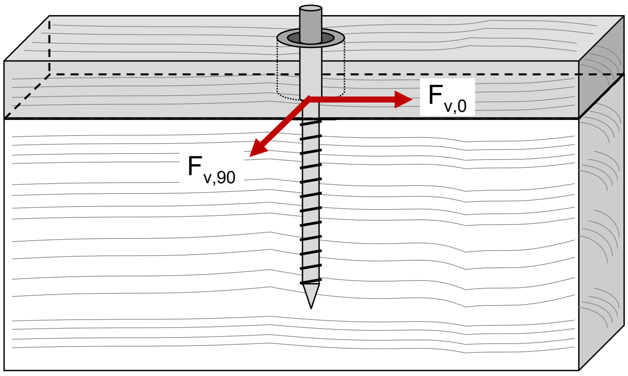


Figure 5: Shear load-carrying capacity HCW: force-fiber-anlge 90°

Values according ETA 21/0357:

Shear load-carrying capacity HCW for solid timber, glued-laminated timber and cross-laminated timber		
Force-fiber-angle	**0°**	**90°**
	$F_{v,0,Rk}$	$F_{v,90,Rk}$
	28.8	12.5

Table 10: Characteristic values of the shear load-carrying capacity HCW for solid timber, glued-laminated timber or cross-laminated timber in kN

Shear load-carrying capacity of the hanger bolt for solid timber, cross-laminated timber and glued laminated timber

Analysis according EN 1995-1-1 Chapter 8.2.3 (Steel-to-timber connections)

$$F_{v,Rk;\,HSW} = min\begin{cases} f_{h,k}\, t_1\, d \\ f_{h,k}\, t_1\, d\left[\sqrt{2+\frac{4\, M_{y,Rk}}{f_{h,k}\, d\, t_1^2}}-1\right]+\frac{F_{ax,Rk}}{4} \\ 2.3\,\sqrt{M_{y,Rk}\, f_{h,k}\, d}+\frac{F_{ax,Rk}}{4} \end{cases} \qquad \text{(EN 1995-1-1 (8.10)}$$

with

$$f_{h,\alpha,k} = \frac{f_{h,0,k}}{k_{90}\, sin^2\alpha + cos^2\alpha} \qquad \text{(EN 1995-1-1 (8.31))}$$

$$f_{h,0,k} = 0{,}082(1-0{,}01d)\rho_k \qquad \text{(EN 1995-1-1 (8.32))}$$

$$d = d_{ef} = 1.1 \cdot d_i \qquad \text{(EN 1995-1-1 Chap. 8.7.1)}$$

$$k_{90} = \begin{cases} 1{,}35+0{,}015\, d & \text{for softwoods} \\ 1{,}30+0{,}015d & \text{for LVL} \\ 0{,}90+0{,}015d & \text{for hardwoods} \end{cases} \qquad \text{(EN 1995-1-1 (8.33))}$$

$$M_{y,Rk} = 0.3\, f_{u,k}\, d^{2.6} \qquad \text{(EN 1995-1-1 (8.30))}$$

with the ultimate strength of steel $f_{u,k}$ = 400 N/mm^2 (DIN 20000-6: 2015-02, Chap. 3.3.3)

In the equation 8.10 (d) and (e), the first term on the right hand side is the load-carrying capacity according to the Johansen yield theory, whilst the second term $F_{ax,Rk}/4$ is the contribution from the rope effect. The contribution to the load-carrying capacity due to the rope effect should be limited to 100 percent of the contribution according to Johansen yield theory.

Shear load-carrying capacity of the connection for solid timber and cross-laminated timber, embedment depth t_1=80mm			
		HCW	
Force-fiber-angle		**0°**	**90°**
Solid timber / CLT	**Density ρ_k [kg/m^3]**	**min $F_{v,0,Rk}$**	**min $F_{v,90,Rk}$**
C14	290	6.6	7.0
C16	310	6.9	7.3
C18	320	7.0	7.4
C20	330	7.1	7.6
C22	340	7.2	7.7
C24	350	7.3	7.8
C27	360	7.4	8.0
C30	380	7.7	8.2
C35	390	7.8	8.3
C40	400	7.9	8.5
C45	410	8.0	8.6
C50	430	8.2	8.8

Table 11: Characteristic minimum values of the shear load-carrying capacity of the connection in kN for solid timber or cross-laminated timber at an embedment depth of the hanger bolt of t_1 = 80mm

Shear load-carrying capacity of the connection for glued laminated timber, embedment depth t_1=80mm			
		HCW	
Force-fiber-angle		**0°**	**90°**
Glued laminated timber	**Density ρ_k [kg/m^3]**	**min $F_{v,0,Rk}$**	**min $F_{v,90,Rk}$**
GL24h	385	7.7	8.3
GL28h	425	8.1	8.8
GL30h	430	8.2	8.8
GL32h	440	8.3	9.0
GL24c	365	7.5	8.0
GL28c	390	7.8	8.3
GL30c	390	7.8	8.3
GL32c	400	7.9	8.5

Table 12: Characteristic minimum value of the shear load-carrying capacity of the connection in kN for glued laminated timber at an embedment depth of the hanger bolt of t_1 = 80mm

Shear load-carrying capacity of the connection for solid timber and cross-laminated timber, embedment depth t_1=140mm			
		HCW	
Force-fiber-angle		0°	90°
Solid timber / CLT	Density ρ_k [kg/m³]	min $F_{v,0,Rk}$	min $F_{v,90,Rk}$
C14	290	7.0	8.4
C16	310	7.3	8.7
C18	320	7.4	8.9
C20	330	7.6	9.1
C22	340	7.7	9.2
C24	350	7.8	9.4
C27	360	7.9	9.6
C30	380	8.2	9.9
C35	390	8.3	10.1
C40	400	8.4	10.2
C45	410	8.5	10.4
C50	430	8.7	10.7

Table 13: Characteristic minimum values of the shear load-carrying capacity of the connection in kN for solid timber or cross-laminated timber at an embedment depth of the hanger bolt of t_1 = 140mm

Shear load-carrying capacity of the connection for glued laminated timber, embedment depth t_1=140mm			
		HCW	
Force-fiber-angle		0°	90°
Glued laminated timber	Density ρ_k [kg/m³]	min $F_{v,0,Rk}$	min $F_{v,90,Rk}$
GL24h	385	8.2	10.0
GL28h	425	8.7	10.6
GL30h	430	8.7	10.7
GL32h	440	8.9	10.9
GL24c	365	8.0	9.7
GL28c	390	8.3	10.1
GL30c	390	8.3	10.1
GL32c	400	8.4	10.2

Table 14: Characteristic minimum values of the shear load-carrying capacity of the connection in kN for glued laminated timber at an embedment depth of the hanger bolt of t_1 = 140mm

Characteristic value of steel resistance of the concrete dowel under tension load

Concrete anchor	Standards	$N_{Rk,s}$ [kN]
HST3 M12	ETA-98/0001	45.0
HIT HY200 with anchor rod HAS-U 8.8 M12	ETA-11/0493	67.4

Table 15: Characteristic value of the tensile load-carrying capacity of the concrete anchor – steel failure of the concrete anchor under tension load

Characteristic resistance of the concrete anchor in case of concrete cone failure under tensile load

Analysis accroding EN 1992-4 Chapter 7.2.1.4

$$N_{Rk,c} = N_{Rk,c}^{0} \cdot \frac{A_{c,N}}{A_{c,N}^{0}} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec,N} \cdot \psi_{M,N} \qquad \text{(EN 1992-4 (7.1))}$$

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

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

$$s_{cr,N} = 2c_{cr,N} = 3h_{ef}$$

$$A_{c,N} = (c_1 + s_1 + 0.5 \cdot s_{cr,N}) \cdot (c_2 + s_2 + 0.5 \cdot s_{cr,N})$$

if

$$c_1 \text{ and } c_2 \leq c_{cr,N}$$
$$s_1 \text{ and } s_2 \leq s_{cr,N}$$

Concrete anchor	Standards	h_{ef} [mm]	c_1 and c_2 [mm]	$N_{Rk,c}$ [kN]
HST3 M12	ETA-98/0001	70	55	10.0
HIT HY200 with anchor rod HAS-U 8.8 M12	ETA-11/0493	70	50	9.3

Table 16: Characteristic value of the tensile load-carrying capacity of the concrete anchor – concrete cone failure under tension load for cracked concrete C20/25

Characteristic resistance in case of pull-out failure of the concrete anchor (Expanasion Anchor)

Concrete anchor	Standards	h_{ef} [mm]	$N_{Rk,p}$ [kN]
HST3 M12	ETA-98/0001	70	20.0

Table 17: Characteristic value of the tensile load-carrying capacity of the concrete anchor – pull-out failure of the concrete anchor under tension load for cracked concrete C20/25

Combined pull-out and concrete failure (for bonded fasteneners)

Analysis according EN 1992-4 Chapter 7.2.1.6

$$N_{Rk,p} = N^0_{Rk,p} \cdot \frac{A_{p,N}}{A^0_{p,N}} \cdot \psi_{g,Np} \cdot \psi_{s,Np} \cdot \psi_{re,N} \cdot \psi_{ec,Np} \qquad \text{(EN 1992-4 (7.13))}$$

$$N^0_{Rk,p} = \psi_{sus} \cdot \tau_{Rk} \cdot \pi \cdot d \cdot h_{ef} \qquad \text{(EN 1992-4 (7.14))}$$

$$s_{cr,Np} = 7.3d(\psi_{sus}\tau_{Rk})^{0.5} \leq 3h_{ef} \qquad \text{(EN 1992-4 (7.15))}$$

$$c_{cr,Np} = \frac{s_{cr,Np}}{2} \qquad \text{(EN 1992-4 (7.16))}$$

$$\psi_{g,Np} = \psi^0_{g,Np} - \left(\frac{s}{s_{cr,Np}}\right)^{0.5} \cdot \left(\psi^0_{g,Np} - 1\right) \geq 1 \qquad \text{(EN 1992-4 (7.17))}$$

with

$$\psi^0_{g,Np} = \sqrt{n} - \left(\sqrt{n} - 1\right) \cdot \left(\frac{\tau_{Rk}}{\tau_{Rk,c}}\right)^{1.5} \geq 1 \qquad \text{(EN 1992-4 (7.18))}$$

$$\tau_{Rk,c} = \frac{k_3}{\pi \cdot d}\sqrt{h_{ef} \cdot f_{ck}} \qquad \text{(EN 1992-4 (7.19))}$$

$$\psi_{s,Np} = 0.7 + 0.3 \cdot \left(\frac{c}{c_{cr,Np}}\right) \leq 1 \qquad \text{(EN 1992-4 (7.20))}$$

$$\psi_{ec,Np} = \frac{1}{1 + 2 \cdot (\frac{e_N}{s_{cr,Np}})} \leq 1 \qquad \text{(EN 1992-4 (7.21))}$$

Concrete anchor	Standards	h_{ef} [mm]	$\tau_{Rk,cr}$ [N/mm²]	c_1 and c_2 [mm]	$N_{Rk,p}$ [kN]
HIT HY200 with anchor rod HAS-U 8.8 M12	ETA-11/0493	70	8.5	50	11.2

Table 18: Characteristic value of the tensile load-carrying capacity of the concrete anchor – Combined pull-out and concrete failure for cracked concrete C20/25 with Ψ_{sus}=1

Characteristic values of steel resistance of the concrete anchor under shear load without lever arm

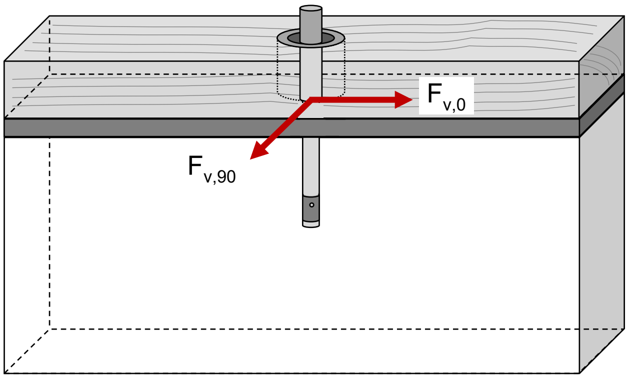
Analysis according EN 1992-4 Chapter 7.2.2.3.1

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

Steel failure, shear load without lever arm					
Concrete anchor	Standards	Effective embedment-depth [mm]	Characteristic resistance $V^0_{Rk,s}$ in [kN]	Ductility-factor k_7 [-]	Characteristic resistance $V_{Rk,s}$ in [kN]
HST3 M12	ETA-98/0001	70	35.4	1.0	35.4
HIT HY200 with anchor rod HAS-U 8.8 M12	ETA-11/0493	70	33.7	1.0	33.7

Table 19: Characteristic values of the load-bearing capacity on shear of the concrete anchor – steel failure without lever arm

Characteristic values of steel resistance of the concrete anchor under shear load with lever arm

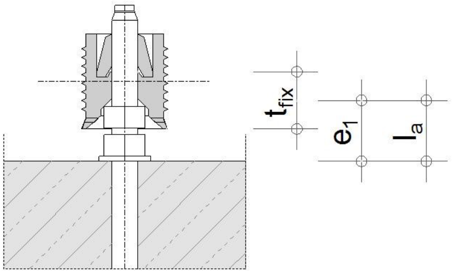


Analysis according EN 1992-4 Chapter 7.2.2.3.2

$$V_{Rk,s,M} = \frac{\alpha_M \cdot M_{Rk,s}}{l_a} \qquad \text{(EN 1992-4 (7.37))}$$

with

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



$$l_a = a_3 + e_1 \qquad \text{(EN 1992-4 (6.2))}$$

$$a_3 = 0 \qquad \text{(EN 1992-4 Chapter 6.2.2.3)}$$

$$e_1 = \frac{t_{fix}}{2} + t_{Grout}$$

$$\alpha_M = 2.0 \qquad \text{(EN 1992-4 Chapter 6.2.2.3)}$$

For the HCW: $t_{fix} = 27.5\ \mathrm{mm}$

Concrete anchor	Standards	Characteristic bending resistance $M^0_{Rk,s}$ in [Nm]	Thickness-leveling mortar t_{Grout} [mm]	Effective lever arm l_a [mm]	Characteristic shear resistance with lever arm $V_{Rk,s,M}$ [kN]
HST3 M12	ETA-98/0001	105.0	10	23.75	8.8
			20	33.75	6.2
			30	43.75	4.8
HIT HY200 with anchor rod HAS-U 8.8 M12	ETA-11/0493	104.6	10	23.75	8.8
			20	33.75	6.2
			30	43.75	4.8

Table 20: Characteristic values of the load-bearing capacity on shear of the concrete anchor – steel failure with lever arm (with N_{Ed}=0)

Characteristic resistance of the concrete anchor under shear load – concrete pry-out failure

Analysis according EN 1992-4 Chapter 7.2.2.4

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

Concrete anchor	Standards	h_{ef} [mm]	c_1 and c_2 [mm]	$V_{Rk,cp}$ [kN]
HST3 M12	ETA-98/0001	70	55	27.9
HIT HY200 with anchor rod HAS-U 8.8 M12	ETA-11/0493	70	50	18.5

Table 21: Characteristic values of the load-bearing capacity on shear of the concrete anchor – concrete pry-out failure

Characteristic resistance of the concrete anchor under shear load – concrete edge failure

Analysis according EN 1992-4 Chapter 7.2.2.5

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

$$V_{Rk,c}^{0} = k_9 \cdot d_{nom}^{\alpha} \cdot l_f^{\beta} \cdot \sqrt{f_{ck}} \cdot c_1^{1.5} \qquad \text{(EN 1992-4 (7.41))}$$

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

$$\beta = 0.1 * \left(\frac{d_{nom}}{c_1}\right)^{0.2} \qquad \text{(EN 1992-4 (7.43))}$$

Concrete anchor	**Standards**	**h_{ef} = l_f [mm]**	**$V_{Rk,c}$ [kN]**
HST3 M12	ETA-98/0001	70	4.7
HIT HY200 with anchor rod HAS-U 8.8 M12	ETA-11/0493	70	4.1

Table 22: Characteristic values of the load-bearing capacity on shear of the concrete anchor – concrete edge failure for cracked concrete C20/25

List of abbreviations (Symbols used)

Latin upper case letters

A_s	Stressed cross section of a fastener
$F_{\mathrm{ax,Ed}}$	Design axial force on fastener
$F_{ax,Rd}$	Design value of axial withdrawal capacity of the fastener
$F_{\mathrm{ax,Rk}}$	Characteristic axial withdrawal capacity of the fastener
$F_{\mathrm{t,Rk}}$	Characteristic load capacity of the connection under tensile force
$F_{\mathrm{v,Rk}}$	Characteristic load-carrying capacity per shear plane per fastener
$M_{\mathrm{y,Rk}}$	Characteristic yield moment of fastener
$N_{Rk,c}$	Characteristic resistance in case of concrete cone failure under tension load
$N_{Rk,p}$	Characteristic resistance in case of pull-out failure under tension load
$N_{Rk,s}$	Characteristic value of steel resistance of a fastener or a channel bolt under tension load
$V_{Rk,c}$	Characteristic resistance in case of concrete edge failure under shear load
$V_{Rk,cp}$	Characteristic resistance in case of concrete pry-out failure under shear load
$V_{Rk,s}$	Characteristic value of steel resistance of a fastener or a channel bolt under shear load
$V_{Rk,s,M}$	Characteristic resistance in case of steel failure with lever arm under shear load
W_{el}	Elastic section modulus calculated from the stressed cross section

Latin lower case letters

c_1	Edge distance in direction 1
c_2	Edge distance in direction 2, where direction 2 is perpendicular to direction 1
$c_{cr,N}$ ($c_{cr,V}$)	Characteristic edge distance for ensuring the transmission of the characteristic resistance of a single fastener or anchor of an anchor channel in case of concrete break-out under tension loading (concrete edge failure under shear loading)
d	Diameter of fastener bolt or thread diameter
d_{nom}	Outside diameter of a fastener
e_1	Distance between shear load and concrete surface
$f_{\mathrm{ax,k}}$	Characteristic withdrawal parameter for nails
f_{ck}	Nominal characteristic compressive cylinder strength (150 mm diameter by 300 mm height)
$f_{\mathrm{h,i,k}}$	Characteristic embedment strength of timber member i
$f_{tens,k}$	Characteristic tensile strength of the screw
f_{uk}	Charakteristik ultimate strength of steel
h_{ef}	Effective embedment depth
k_{d}	Dimension factor for panel
k_{mod}	Modification factor for duration of load and moisture content
l_a	effective lever arm of the shear force acting on a fastener or on an anchor channel used in the calculation

l_{ef}	Effective length; Effective length of distribution
n_{ef}	Effective number of fasteners in line parallel to the grain
t	Thickness
t_{fix}	Fastening thickness (Thickness of the fixture)
t_i	Thickness; the wood or wood-based material thickness or embedment depth, with i either 1 or 2
t_{grout}	Thickness of grout layer

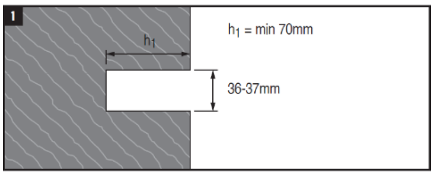
Greek lower case letters

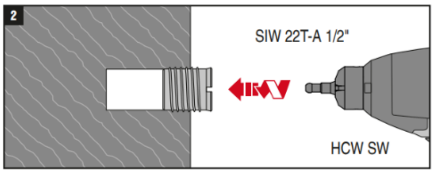
α	Angle between the x-direction and the force for a punched metal plate; Angle between a force and the direction of grain; Angle between the direction of the load and the loaded edge (or end)
β	Angle between the grain direction and the force for a punched metal plate
γ_M	Partial factor for material properties, also accounting for model uncertainties and dimensional variations
$\gamma_{M,c}$	Partial factor for concrete cone, concrete edge, concrete blow-out and concrete pry-out failure modes
$\gamma_{M,s}$	Partial factor for steel failure
γ_{M2}	Partial factor for resistance of cross-sections in tension to fracture
$\psi_{ec,N}$	Factor taking into account the group effect when different tension loads are acting on the individual fasteners of a group in case of concrete cone failure
$\psi_{ec,Np}$	Factor taking into account the group effect when different tension loads are acting on the individual fasteners of a group in case of combined pull-out and concrete failure of bonded fasteners
$\psi_{ec,V}$	Factor taking into account the group effect when different shear loads are acting on the individual fasteners of a group in case of concrete edge failure
$\psi_{g,Np}$	Factor taking into account a group effect for closely spaced bonded fasteners
$\psi_{h,V}$	Factor taking into account the fact that concrete edge resistance does not increase proportionally to the member thickness
$\psi_{M,N}$	Factor taking into account the effect of a compression force between the fixture and concrete in case of bending moments with or without axial force
$\psi_{s,N}$	Factor taking into account the disturbance of the distribution of stresses in the concrete due to the proximity of an edge in the concrete member in case of concrete cone failure
$\psi_{s,Np}$	Factor taking into account the disturbance of the distribution of stresses in the concrete due to the proximity of an edge in the concrete member in case of combined pull-out and concrete failure of bonded fasteners
$\psi_{s,V}$	Factor taking into account the disturbance of the distribution of stresses in the concrete due to the proximity of further edges in the concrete member in case of concrete edge failure
ρ_a	Associated value of the density
ρ_k	Characteristic density

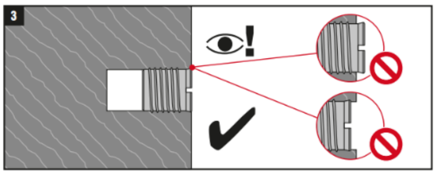
Installation instruction Hilti HCW and HCW-L

Setting HCW

1. **Mill the cutout in timber**
2. **Set HWC wood connector using the setting tool**
3. **Check and verify**

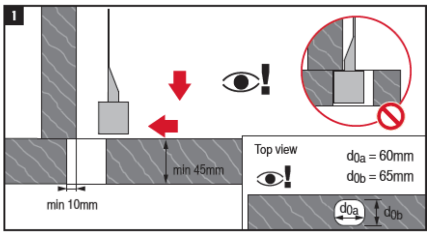


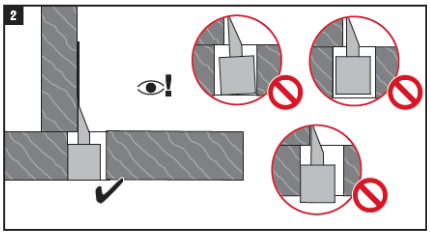


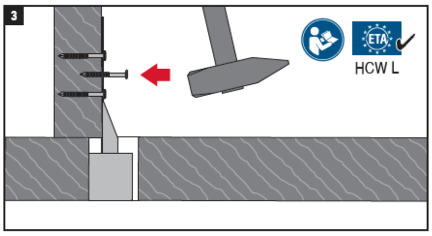


Setting HCW-L

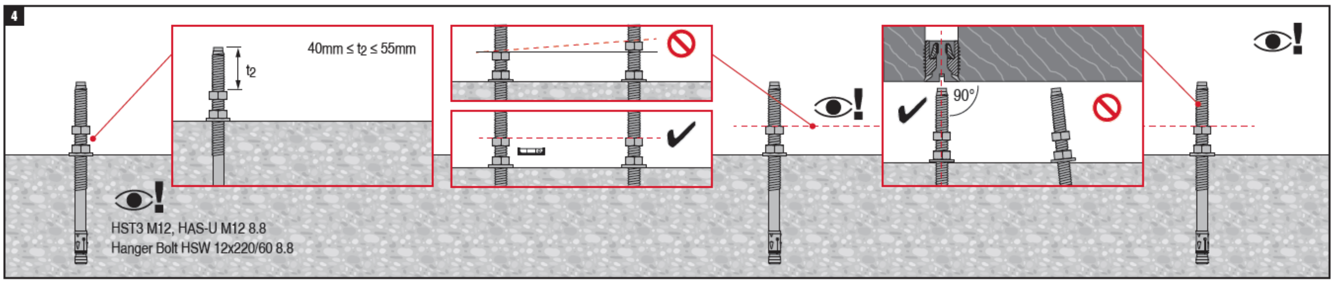
1. **Position the HCW-L**
2. **Check and verify**
3. **Fasten the nail plate**



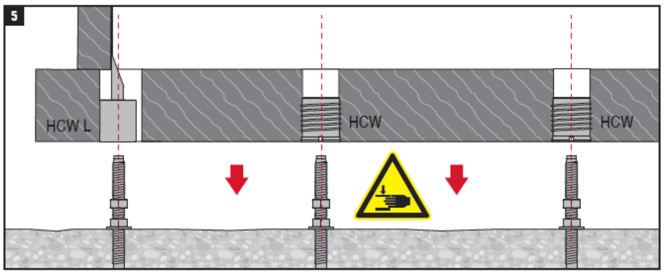


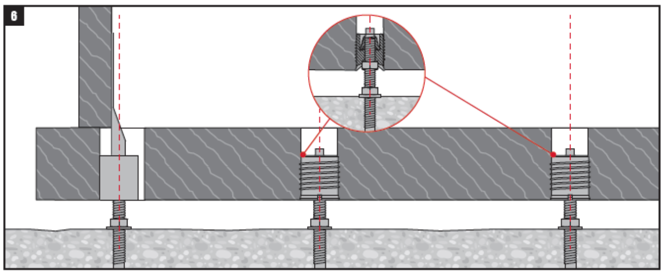


4. **Check and level the installed dowel / hanger bolt**



5. **Connect wall element with pre-assembled HCW Wood Connector to the dowel / hanger bolt**





References

Standards and ETA-Documents used

EN 1992-4:2019-04	Eurocode 2: Design of concrete structures – Part 4
EN 1993-1-1:2010-12	Eurocode 3: Design of steel structures – Part 1-1
EN 1995-1-1:2010-12	Eurocode 5: Design of timber structures – Part 1-1
ETA-98/0001 of 2021/05/04	Hilti stud anchor HST, HST-R, HST-HCR, HST3, HST3-R
ETA-11/0493 of 2020/12/14	Injection system Hilti HIT-HY 200-A
ETA-21/0357 of 2021/04/19	Fastening Element Hilti HCW, HCW L
DIN 20000-6:2015-02	Application of construction products in structures – Part 6: Dowel-type fasteners and connectors according to DIN EN 14592 and DIN EN 14545