HILTI COUPLER WOOD (HCW)

Technical Guide
Update: July 25

Hilti Coupler Wood HCW

A fast and efficient timber fastening system for assembling prefabricated timber elements.

Table of Content

HILTI COUPLER WOOD (HCW)

Fast and efficient timber fastening system for assembling prefabricated timber elements

System parts	Details	Benefits
Hilti Coupler Wood HCW 	Hilti Coupler Wood HCW 37x45 M12 Capable to transfer: • (Axial) Tension loads • (Axial) Compression loads • Shear loads	Designed for transferring shear and tensile loads, allowing positioning and leveling Designed for factory production with predrilled wood members ETA 21/0357 approved
Hilti Coupler Wood HCW-S 	Hilti Coupler Wood HCW-S 37x45 M12 Capable to transfer: • Shear loads • (Axial) Compression loads	Designed for transferring shear loads, allowing positioning and leveling ETA-21/0357 approved
Hilti Coupler Wood HCW-UP 	Hilti Coupler Wood HCW-UP 37x35 M12 • Not load bearing coupler	Designed for an economical upper floor positioning of timber-to-timber connections
Hilti Coupler Wood HCW-L 	Hilti Coupler Wood HCW-L 40x295 M12 HCW-L 40x375 M12 Capable to transfer: • Tension (axial) loads	Designed for tensile loads with a nail plate for higher tension requirements, allowing positioning ETA 21/0357 approved
Hanger Bolt (for Timber-to-Timber Connections) 	Hanger bolt: • Metrical thread M12 • Timber thread acc. EN 14592 • $f_{uk} \geq 400$ N/mm² • e.g. Hilti HSW M12x220/60 8.8 or Hilti Hanger Bolt M12x140 4.6	Designed for assembling and fastening prefabricated timber-to-timber structures ETA 21/0357 approved
Concrete Fasteners (for Timber-to-Concrete Connections)  	e.g. Expansion Anchor HST2 V3 M12, HST3 M12 or HST4 M12 e.g. Anchor rod HAS-U M12 in combination with Hilti HIT-HY 200-A V3 injection mortar	
Setting Tool SW HCW (S) 	Setting tool SW HCW for: • HCW • HCW-S	Quicker and more efficient setting tool for wood connectors Enhances consistency and precision

Application



Hilti HCW timber connectors enable fast and efficient assembly of prefabricated timber elements.

They are available in four variants:

- HCW – For tensile and shear loads
- HCW-S – For shear loads only
- HCW-L – For tensile loads only
- HCW-UP – for positioning only, not load bearing

The HCW and HCW-L feature an integrated clamping mechanism for easy push-to-fit installation with Hilti anchor systems.

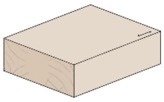
Applications:

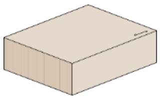
- Timber-to-timber connections using hanger bolts (e.g., Hilti HSW)
- Timber-to-concrete connections using mechanical stud anchors (e.g., HST3 M12, HST4 M12, HST2 V3 M12)
- Timber-to-concrete connections using chemical anchors (e.g., HAS-U M12 rods with injection mortar)
- Primary use: Fixing timber frames to concrete foundations with precise positioning, height leveling (using additional leveling nuts), and mortar gap filling

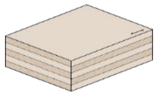
Base materials

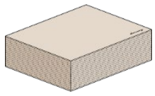

Concrete (uncracked)


Concrete (cracked)


Solid timber (EN 338/EN 14081)

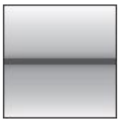

e.g. Glued Laminated Timber

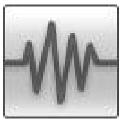

e.g. Cross Laminated Timber


e.g. Laminated Veneer Lumber

Engineered timber products (acc. to ETA-21/0357)

Load conditions


Static / quasi-static


Seismic

Other information


PROFIS Engineering for Concrete Fastener


Hilti design tool for the entire setting point (timber and concrete)


Whitepaper

Linked Approvals/Certificates and Instructions for use.

Approvals/certificates

Approval no	Application / loading condition	Authority / Laboratory	Date of issue
ETA-21/0357	Static and Seismic	Danmark A/S	31-01-2025

The instructions for use can be viewed using the link in the instructions for use table or the QR code/link in the Hilti webpage table.

Instructions for use (IFU)

Material	IFU
HCW	IFU HCW 37x45 M12
HCW-S	IFU HCW-S 37x45 M12
HCW-L	IFU HCW-L 40x45 M12
HCW-UP	IFU HCW-UP 37x35 M12

Link to Hilti Webpage

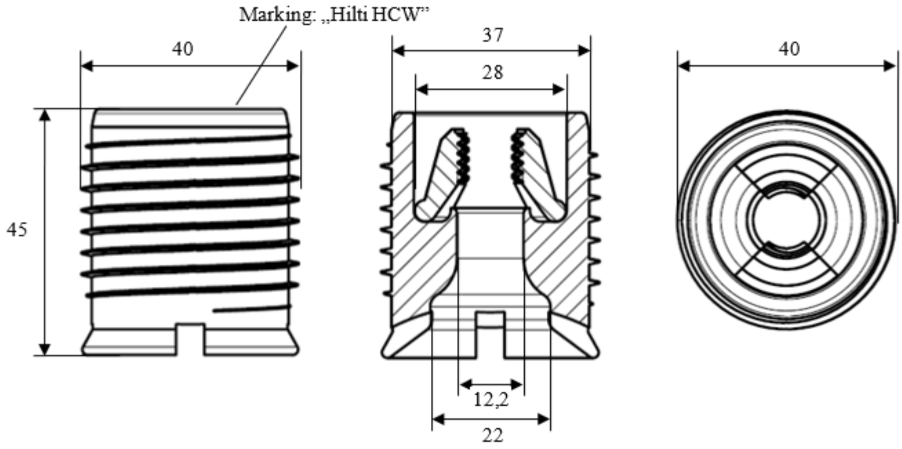
System parts						
HCW	HCW-S	HCW-L	HCW-UP	Hilti Hanger Bolt	HST3	HST4

System parts / Setting tool	
HAS-U 8.8	SW SCW

Product data

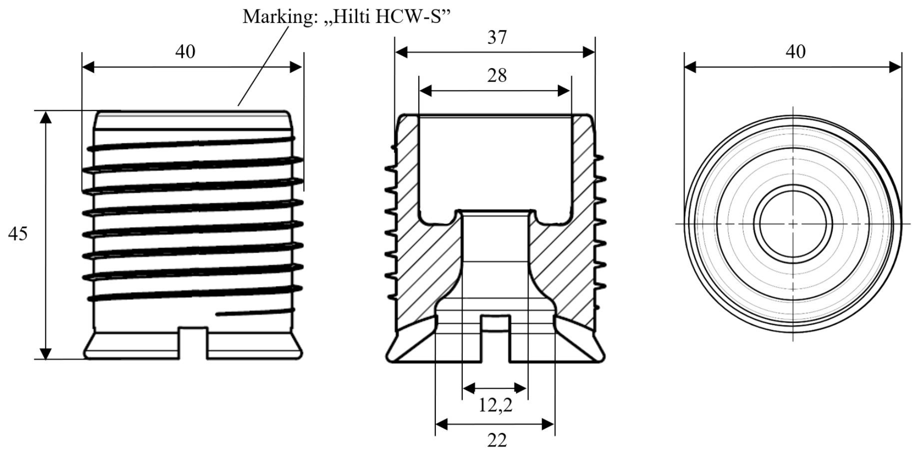
Hilti Coupler Wood HCW

Outer diameter:	40 mm
Diameter of the body:	37 mm
Length:	45 mm
Material: - Sleeve:	 11SMnPb30+C according EN 10277
- Clamping device:	11SMnPb30, 16MnCrS5+C according EN 10277 Electroplated zinc coated ≥ 5 µm
Color	Grey



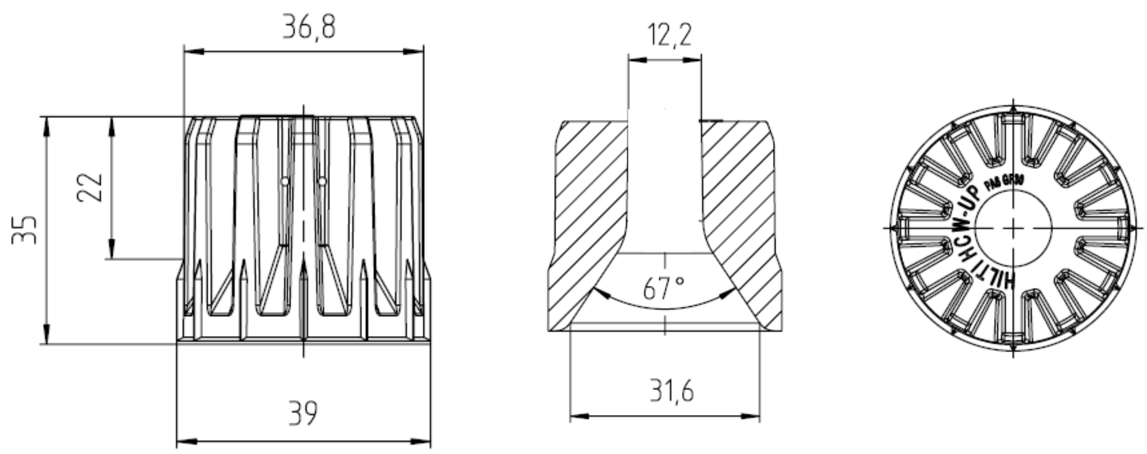
Hilti Coupler Wood HCW-S

Outer diameter:	40 mm
Diameter of the body:	37 mm
Length:	45 mm
Material: - Sleeve:	 11SMnPb30+C according EN 10277
Color	Black



Hilti Coupler Wood HCW-UP

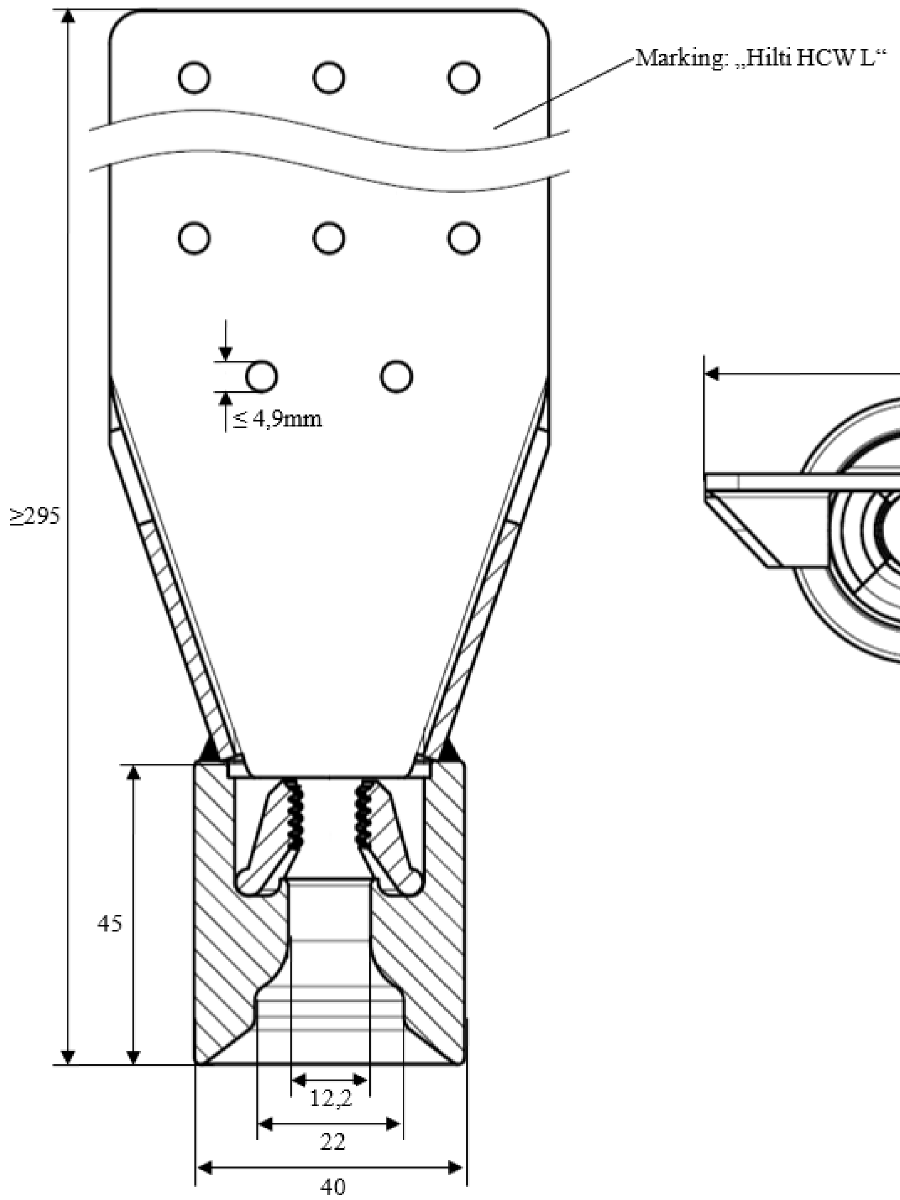
Outer diameter:	40 mm
Diameter of the body:	37 mm
Length:	35 mm
Material:	Recycled Plastic
Color	Black

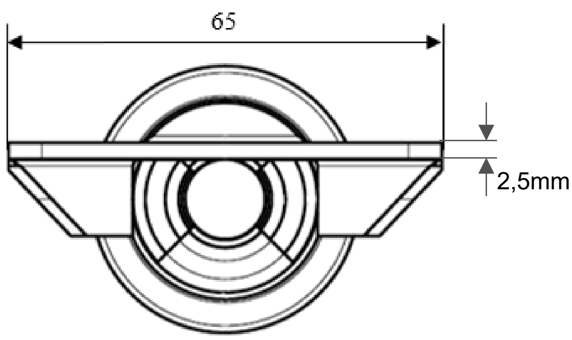


Hilti Coupler Wood HCW-L

Outer diameter, sleeve:	40 mm
Length, sleeve:	45 mm
Length:	≥ 295 mm
Width, plate:	65 mm
Thickness, plate:	2,5 mm
Hole diameter, plate:	≤ 4,9 mm
Material:	
- Sleeve and nailing plate:	S355J2 according EN 10277
- Clamping device:	16MnCrS5+C according to EN10277. Electroplated zinc coated ≥ 5 µm

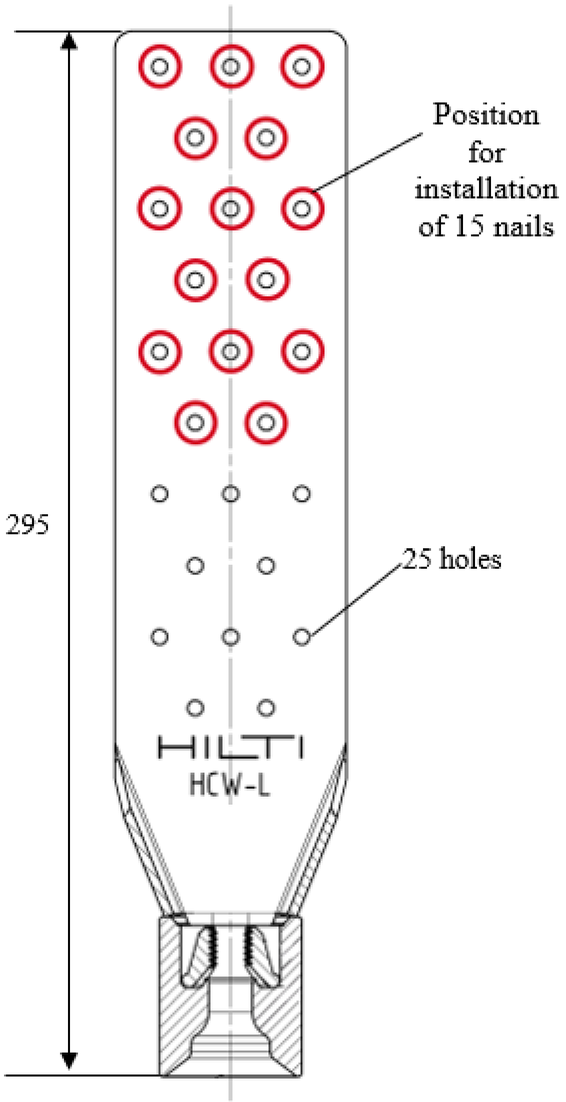
Dimensions:



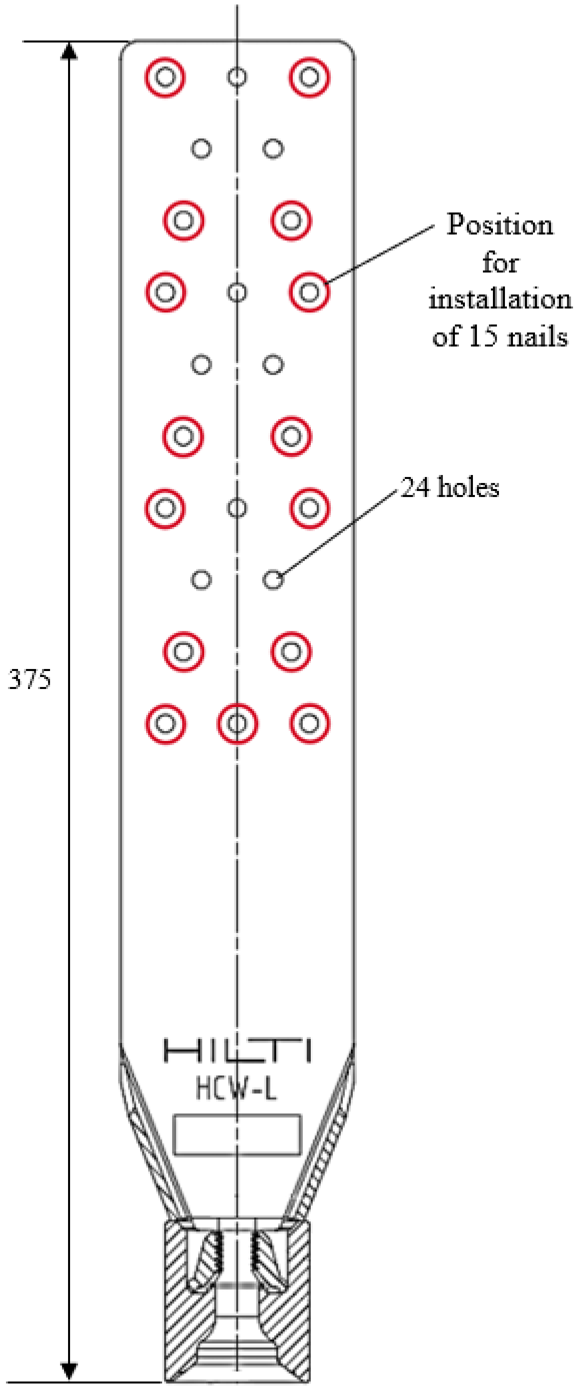


Hole patterns:
Hole patterns for HCW-L

HCW-L 40x295 M12

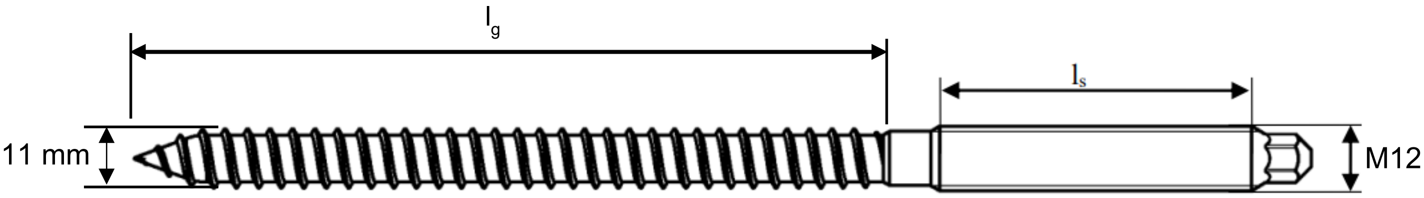


HCW-L 40x375 M12



Hanger bolt with M12 metrical thread and timber thread according to ETA or EN 14592

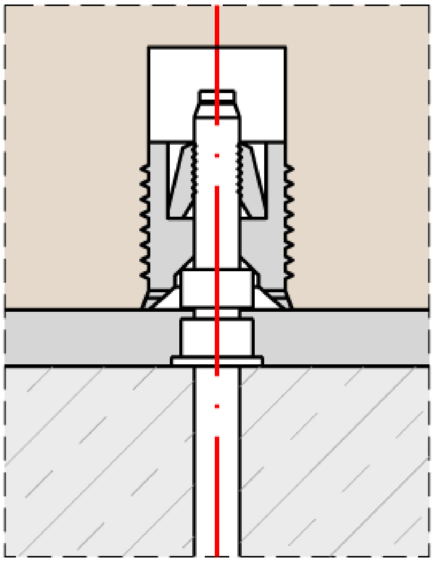
Length of metrical thread M12:	$l_s \geq 40$ mm
Length of timber thread:	$l_g \geq 6 \times d_{nom,timber}$ (for tensile and shear loads) $l_g \geq 4 \times d_{nom,timber}$ (for shear loads)
Core diameter (d_i):	8.7 mm
Material:	Steel, $f_{u,k} \geq 400$ N/mm²
Pre-drilling diameter:	8 mm



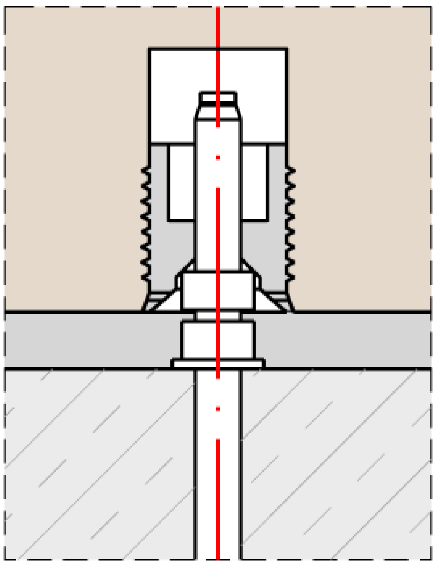
Hilti-products:

- HSW M12x220/60 8.8 ($d_{nom,timber}$ = 11mm) (# 2316491)
- Hangerbolt M12x140 4.6 ($d_{nom,timber}$ = 11mm) (# 216376)

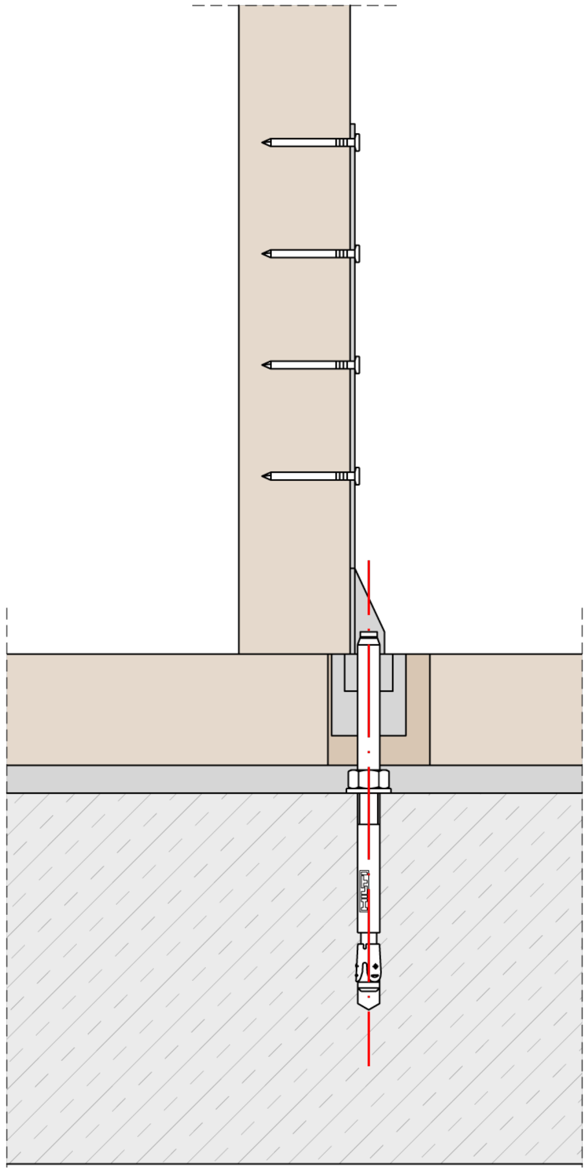
Definition of load-types $F_{ax,\alpha}$ and $F_{V,\alpha}$



HCW



HCW-S



HCW-L

System-axis

Definition of indices ax, V, α:

ax: Indicates that applied loads are acting parallel to the system-axis

V: Indicates that applied loads are acting perpendicular the system-axis (applicable for HCW and HCW-S).

α: Indicates the angle of the applied load between HCW/HCW-S/HCW-L and the grain-orientation of the connected timber-member:
α = 0°: Load is applied parallel to the grain
α = 90°: Load is applied perpendicular to the grain

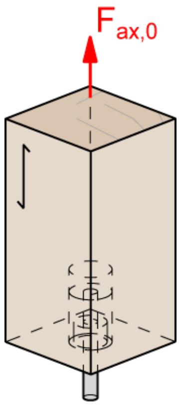
Applicable loads per connector type
(here exemplarily shown in solid timber; see also Table 2, Table 3, Table 4 and ETA-21/0357 [4])

(Axial) Tension-loads – HCW

$F_{ax,\alpha,Rk,HCW}$: Characteristic withdrawal capacity for HCW, depending on α-values:
α = 0° (parallel to the grain-direction)
α = 90° (perpendicular to the grain-direction)

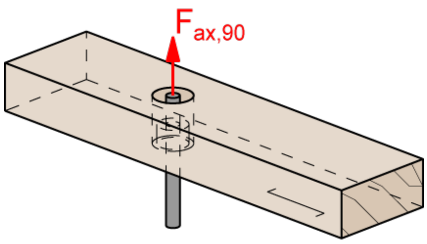
Applications in the head-grain of the timber member:

- For angles α = 0° between HCW-system-axis and grain-direction:
  $F_{ax,0,Rk}$ … see Table 2 and Table 4
  Only (axial) tension loads $F_{ax,0}$ shall be applied into the head-grain.
  The given loads for $F_{ax,0,Rk}$ shall only be applied for load-duration classes short-term (e.g. snow, wind) and instantaneous (e.g. wind, accidental loads).

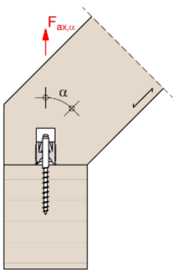


Applications in the side grain of the timber member:

- For angles 45° ≤ α ≤ 90° between HCW-setting direction and grain-direction:
  $F_{ax,\alpha,Rk,HCW} = F_{ax,90,Rk}$: see Table 2, Table 3 and Table 4



- For angles 0° < α < 45° between HCW-setting direction and grain-direction:
  $F_{ax,\alpha,Rk,HCW} = k_{ax} * F_{ax,90,Rk}$



with

$F_{ax,90,Rk}$ … see Table 2, Table 3 and Table 4

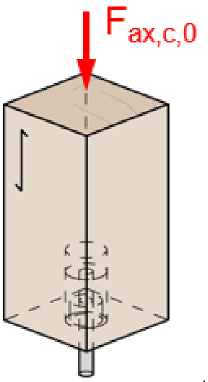
$$k_{ax} = 0.3 + \frac{0.7 * \alpha}{45°} < 1$$

(Axial) Compression-loads – HCW and HCW-S

$F_{ax,\alpha,Rk,HCW}$: Characteristic compression capacity for HCW/HCW-S, depending on α-values:
α = 0° (parallel to the grain-direction)
α = 90° (perpendicular to the grain-direction)

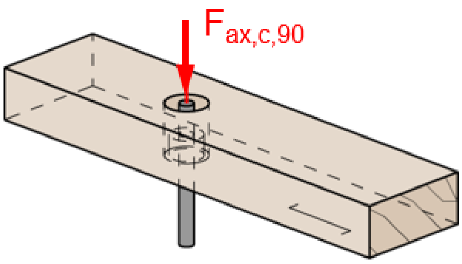
Applications in the head-grain of the timber member:

For angles α = 0° between HCW-system-axis and grain-direction:
$F_{ax,c,0,Rk} = F_{ax,0,Rk}$ … see Table 2 and Table 4
Only (axial) compression loads $F_{ax,c,0}$ shall be applied into the head-grain.
The given loads for $F_{ax,c,0,Rk}$ shall only be applied for the load-duration class short-term (e.g. during installation).



Applications in the side grain of the timber member:

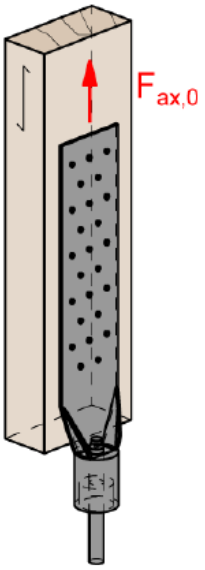
- For angles 45° ≤ α ≤ 90° between HCW/HCW-S-setting direction and grain-direction:
  $F_{ax,\alpha,Rk,HCW} = F_{ax,90,Rk} = F_{ax,90,c,Rk}$ see Table 2, Table 3 and Table 4



(Axial) Tension-loads – HCW-L

$F_{ax,\alpha,Rk,HCW\ L}$: Characteristic capacity for HCW-L, valid for α = 0° (parallel to the grain-direction)

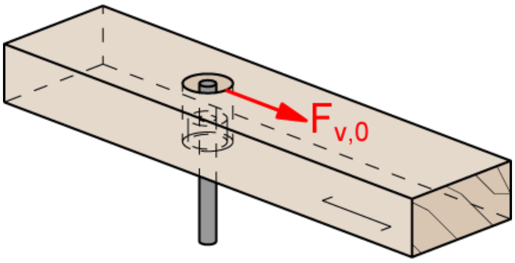
$F_{ax,0,Rk}$ given in Table 2 are tested values with 15 or 24/25 nails.
$F_{ax,0,Rk}$ can also be calculated depending on the actual used connectors (nails or screws), e.g. according to EC 5.
Only tensile (axial) loads $F_{ax,0}$ shall be applied to HCW-L



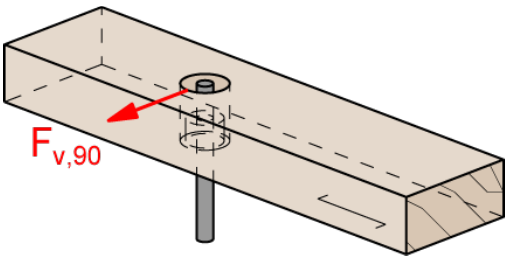
Shear loads – HCW and HCW-S

$F_{v,\alpha,Rk,HCW(-S)}$: Characteristic shear-capacity for HCW and HCW-S shall be determined for the following α-values:

α = 0° (load direction parallel to the grain)
$F_{V,0,Rk}$ … see Table 2 and Table 4



α = 90° (load direction perpendicular to the grain)
$F_{V,90,Rk}$ … see Table 2 and Table 4



Verifications of connections in concrete

For the design of connections in concrete, the provisions given in EN 1992-4 [3] can be used even though the load is introduced by the HCW, HCW-S or HCW-L and a timber element via the Hilti anchoring system to the concrete instead of a rigid baseplate as required by EN 1992-4. This can be justified since the verification is done for a single anchor.

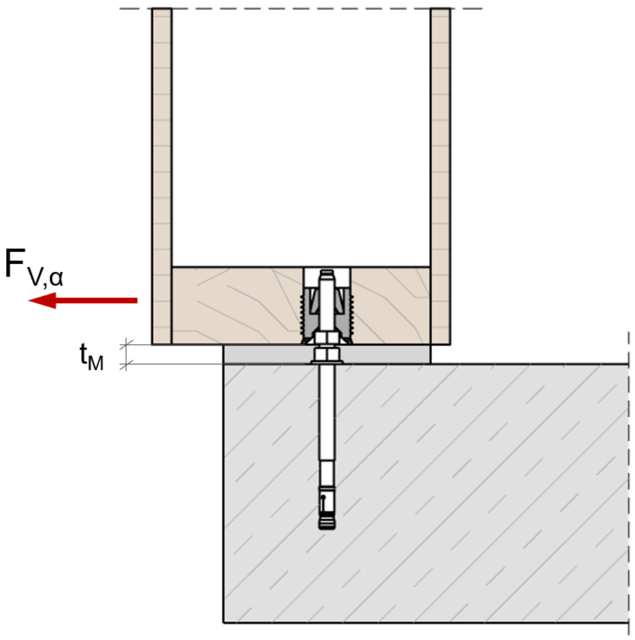
Tension loads on anchors

All verifications shall be carried out in accordance with the provisions given in EN 1992-4

$$N_{Ed} \leq \min \{N_{Rd,s};\ N_{Rd,c};\ N_{Rd,p};\ N_{Rd,sp}\}$$ (see also page 15 ff)

Shear loads on anchors

EN 1992-4 does not offer provisions for the design of shear-loaded anchors with stand-off close to an edge.

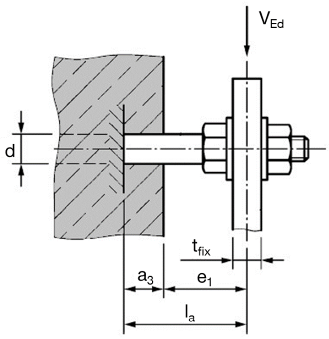


Hilti recommends specifying shear-loaded HCW/HCW-S with stand-off according to Hilti Whitepaper_HCW [6].

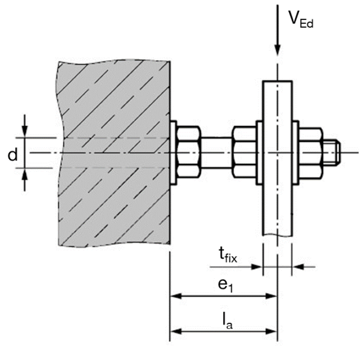
The following provisions shall be taken into consideration:

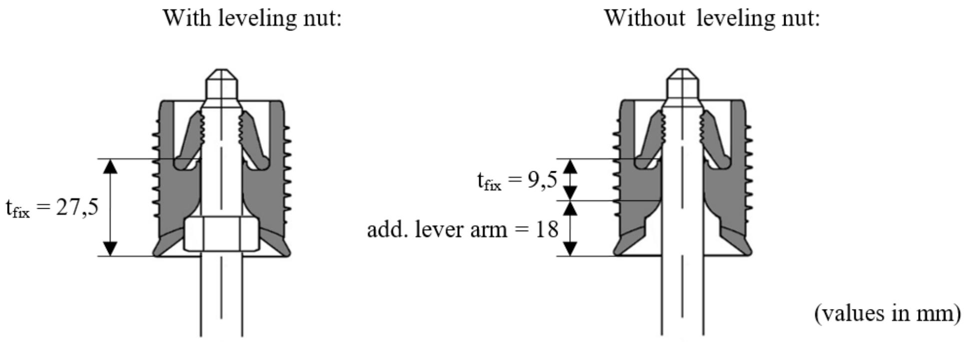
Determining the relevant lever arm l_a (according to EN 1992-4):

Situation A



Situation B





With leveling nut:

$$l_a = \frac{t_{fix}}{2} + t_M + a_3 = \frac{27{,}5}{2} + t_M + a_3$$

Without leveling nut

$$l_a = \left(\frac{t_{fix}}{2} + 18\right) + t_M + a_3 = \left(\frac{9{,}5}{2} + 18\right) + t_M + a_3 = 22{,}8 + t_M + a_3$$

With

t_M Thickness of leveling layer (e.g. mortar)

a_3 = Nominal diameter of the anchor (M12 for HCW-applications) for Situation A
(clamping at the concrete surface is not present / anchor not torqued to the concrete)

a_3 = 0 for Situation B
(clamping at the concrete surface is present / anchor torqued to the concrete)

Characteristic steel resistance of the concrete anchor under shear load with lever arm
Improved approach for stand-off according to 'White Paper HCW'

$$V_{Rk,s,M} = \left(\sqrt{\alpha_{s,M}{}^{2} + 1} - \alpha_{s,M}\right) \cdot V_{Rk,s} \leq V_{Rk,s}$$

with

$V_{Rk,s}$ = characteristic shear resistance taken from the European Technical Assessment

$\alpha_{s,M}$ = $1.5 \cdot l_a / \alpha_M \cdot d$

α_M = 1.0 (single curvature) or 2.0 (double curvature) as determined by the user

l_a = effective lever arm (see previous page)

Characteristic concrete edge resistance under shear load with lever-arm

The basic equation to calculate concrete edge failure in a stand-off configuration is taken from EN 1992-4:

$$V_{Rk,c} = V_{Rk,c}^{0} \cdot \frac{A_{c,V}}{A_{c,V}^{0}} \cdot \psi_{s,V} \cdot \psi_{h,V} \cdot \psi_{ec,V} \cdot \psi_{\alpha,V} \cdot \psi_{re,V}$$ (EN 1992-4 (7.40); [1])

To take into account the secondary overturning moment on the concrete edge breakout resistance, a reduction factor ($\psi_{b,u}$) was developed and is used as a multiplier on the concrete edge resistance.

$$V_{Rk,c-stand-off} = V_{Rk,c} \cdot \psi_{b,u}$$

with

$$\psi_{b,u} = \frac{1}{1 + \frac{C}{d^{3/4}} \cdot \frac{l_a}{\alpha_M}}$$

C = a constant representing the elastic interaction between the anchor and concrete
= 0.213 [1/mm$^{0.25}$]
l_a = effective exposed length (conservatively taken from EN 1992-4; [1])
α_M = curvature coefficient for the anchor

Application overview	Verification	Verification(s)		Page no
A) HCW-L	A1) Timber to Concrete	Tension: Shear: Interaction:	✓ – –	18
	A2) Timber to Timber	Tension: Shear: Interaction:	✓ – –	19
B) HCW in Head grain	B1) Timber to Concrete	Tension: Shear: Interaction:	✓ – –	20
	B2) Timber to Timber	Tension: Shear: Interaction:	✓ – –	21
C) HCW in Side grain	C1) Timber to Concrete	Tension: Shear: Interaction:	✓ ✓ ✓	22-24
	C2) Timber to Timber	Tension: Shear: Interaction:	✓ ✓ ✓	25-27
D) HCW-S in Side grain	D1) Timber to Concrete	Tension: Shear: Interaction:	– ✓ ✓	28-29
	D2) Timber to Timber	Tension: Shear: Interaction:	– ✓ ✓	30-31
(HCW-S in Head grain)	Not applicable			

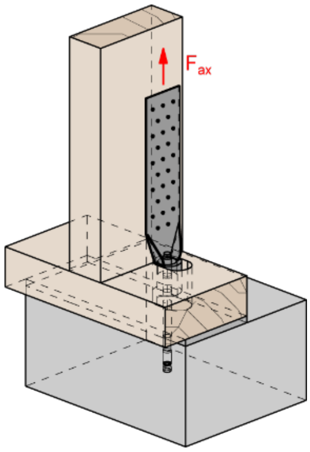
Table 1: Overview possible applications HCW/HCW-S/HCW-L

✓ Verification Possible

– not applicable

A1) HCW-L: Timber-to-Concrete

Proof of tensile load capacity



$$F_{ax,0,Ed} \leq \begin{cases} N_{Rd,HCW-L} \\ N_{Rd,Anchor} \end{cases}$$

with

$F_{ax,0,Ed}$	Applied tensile design load parallel to the grain.
$N_{Rd,HCW\text{-}L}$	Decisive HCW-L related tensile design resistance.
$N_{Rd,Anchor}$	Decisive anchor-related tensile design resistance.

Verifications for HCW-L:

$$N_{Rd,HCW-L} = min \begin{cases} \dfrac{k_{mod} * F_{ax,0,Rk}}{\gamma_M} \\ \dfrac{F_{t,Rk}}{\gamma_{M,2}} \end{cases}$$

with

Load angle **α = 0°**

$F_{ax,0,Rk}$:	Characteristic HCW-L axial strength for α = 0° see Table 2
$F_{ax,0,Rk}$	Can also be calculated depending on the actual used connectors (nails or screws), e.g. according to EN 1995-1-1:2010-12 [3]
$F_{t,Rk}$:	Characteristic tensile load capacity of HCW-L clamping mechanism see Table
k_{mod}	see EN 1995-1-1:2010-12 [3]
γ_M	see EN 1995-1-1:2010-12 [3]
$\gamma_{M,2}$	see EN 1993-1-1 Chapter 6.1 [2]

Verifications for concrete anchors in Timber-to-Concrete applications:

$$N_{Rd,Anchor} = min \begin{cases} N_{Rd,s} \\ N_{Rd,p} \\ N_{Rd,c} \\ N_{Rd,sp} \end{cases}$$

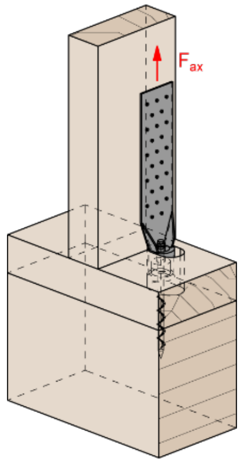
with

$N_{Rd,s} = N_{Rk,s} / \gamma_M$	Steel resistance
$N_{Rd,p} = N_{Rk,p} / \gamma_M$	Pull-out resistance for mechanical anchors
$N_{Rd,p} = N_{Rk,p} / \gamma_M$	Combined pull-out and concrete resistance for bonded anchors
$N_{Rd,c} = N_{Rk,c} / \gamma_M$	Concrete cone capacity
$N_{Rd,sp} = N_{Rk,sp} / \gamma_M$	Splitting resistance

Information about the anchor-related values is given in the related approval document (e.g. ETA) or can be determined in the HCW-Design Module in Software 'ingtools' (www.ingtools.de).

A2) HCW-L: Timber-to-Timber

Proof of tensile load capacity



$$F_{ax,0,Ed} \leq \begin{cases} N_{Rd,HCW-L} \\ N_{Rd,HB} \end{cases}$$

with

$F_{ax,0,Ed}$ Applied tensile design load parallel to the grain.
$N_{Rd,HCW-L}$ Decisive HCW-L related tensile design resistance.
$N_{Rd,HB}$ Decisive Hanger Bolt-related tensile design resistance.

Verifications for HCW-L:

$$N_{Rd,HCW-L} = min \begin{cases} \frac{k_{mod} * F_{ax,0,Rk}}{\gamma_M} \\ \frac{F_{t,Rk}}{\gamma_{M,2}} \end{cases}$$

with

Load angle **α = 0°**
$F_{ax,0,Rk}$: Characteristic HCW-L axial strength for α = 0° see Table 2
$F_{ax,0,Rk}$ Can also be calculated depending on the actual used connectors (nails or screws), e.g. according to EN 1995-1-1:2010-12 [3]
$F_{t,Rk}$: Characteristic tensile load capacity of HCW-L clamping mechanism see Table 2
k_{mod} see EN 1995-1-1:2010-12 [3]
γ_M see EN 1995-1-1:2010-12 [3]
$\gamma_{M,2}$ see EN 1993-1-1 Chapter 6.1 [2]

Verification of the Hanger Bolt in Timber-to-Timber applications:

$$N_{Rd,HB} = min \begin{cases} \frac{k_{mod} * F_{ax,Rk,HB}}{\gamma_M} \\ \frac{F_{t,Rk,HB}}{\gamma_{M,2}} \end{cases}$$

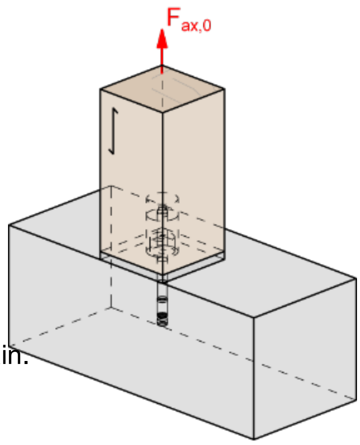
with
$F_{ax,Rk,HB}$: Characteristic axial withdrawal capacity of the hanger bolt.
$F_{t,Rk,HB}$: Characteristic tensile strength of the hanger bolt.

k_{mod} see EN 1995-1-1:2010-12 [3]
γ_M see EN 1995-1-1:2010-12 [3]
$\gamma_{M,2}$ see EN 1993-1-1 Chapter 6.1 [2]

Information about the Hanger Bolt-related values is given in Chapter: **Load resistances Hilti Hangerbolt**
or can be determined in the HCW-Design Module in Software 'ingtools' (www.ingtools.de).

B1) HCW in head grain applications: Timber-to-Concrete

Proof of tensile load capacity



$$F_{ax,0,Ed} \leq \begin{cases} N_{Rd,HCW-HG} \\ N_{Rd,Anchor} \end{cases}$$

with

$F_{ax,0,Ed}$	Applied tensile design load parallel to the grain. (only for short-term (e.g. wind) and instantaneous loads).
$N_{Rd,HCW-HG}$	Decisive HCW-related tensile design resistance in head grain.
$N_{Rd,Anchor}$	Decisive anchor-related tensile design resistance.

HCW-related verifications:

$$N_{Rd,HCW-HG} = min \begin{cases} \frac{k_{mod} * F_{ax,0,Rk}}{\gamma_M} \\ \frac{F_{t,Rk}}{\gamma_{M,2}} \end{cases}$$

with

Load angle **α = 0°** for applications in headgrain

$F_{ax,0,Rk}$:	Characteristic HCW-withdrawal capacity for α = 0° see Table 2
$F_{t,Rk}$:	Characteristic tensile load capacity of HCW-clamping mechanism see Table 2
k_{mod}	see EN 1995-1-1:2010-12 [3]
γ_M	see EN 1995-1-1:2010-12 [3]
$\gamma_{M,2}$	see EN 1993-1-1 Chapter 6.1 [2]

Concrete anchor related verifications in Timber-to-Concrete applications:

$$N_{Rd,Anchor} = min \begin{cases} N_{Rd,s} \\ N_{Rd,p} \\ N_{Rd,c} \\ N_{Rd,sp} \end{cases}$$

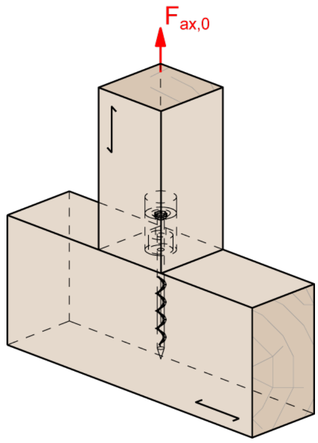
with

$N_{Rd,s} = N_{Rk,s} / \gamma_M$	Steel resistance
$N_{Rd,p} = N_{Rk,p} / \gamma_M$	Pull-out resistance for mechanical anchors
$N_{Rd,p} = N_{Rk,p} / \gamma_M$	Combined pull-out and concrete resistance for bonded anchors
$N_{Rd,c} = N_{Rk,c} / \gamma_M$	Concrete cone capacity
$N_{Rd,sp} = N_{Rk,sp} / \gamma_M$	Splitting resistance

Information about the anchor-related values is given in the related approval document (e.g. ETA) or can be determined in the Hilti-Design Software PROFIS Engineering.

B2) HCW in headgrain applications: Timber-to-Timber

Proof of tensile load capacity



$$F_{ax,0,Ed} \leq \begin{cases} N_{Rd,HCW-HG} \\ N_{Rd,HB} \end{cases}$$

with

$F_{ax,0,Ed}$	Applied tensile design load parallel to the grain. (only for short-term (e.g. wind) and instantaneous loads).
$N_{Rd,HCW-HG}$	Decisive HCW-related tensile design resistance in head grain.
$N_{Rd,HB}$	Decisive hanger bolt-related tensile design resistance.

HCW-related verifications:

$$N_{Rd,HCW-HG} = min \begin{cases} \dfrac{k_{mod} * F_{ax,0,Rk}}{\gamma_M} \\ \dfrac{F_{t,Rk}}{\gamma_{M,2}} \end{cases}$$

with

Load angle **α = 0°** for applications in headgrain

$F_{ax,0,Rk}$:	Characteristic HCW-withdrawal capacity for α = 0° see Table 2
$F_{t,Rk}$:	Characteristic tensile load capacity of HCW-clamping mechanism see Table 2
k_{mod}	see EN 1995-1-1:2010-12 [3]
γ_M	see EN 1995-1-1:2010-12 [3]
$\gamma_{M,2}$	see EN 1993-1-1 Chapter 6.1 [2]

Hanger Bolt related verifications in Timber-to-Timber applications:

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

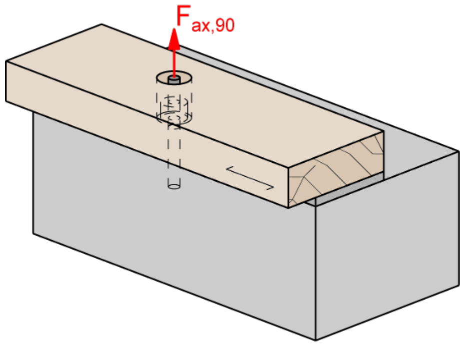
with

$F_{ax,Rk;\,HB}$:	Characteristic axial withdrawal capacity, hanger bolt
$F_{t,Rk;\,HB}$:	Characteristic tensile strength of the hanger bolt
k_{mod}	see EN 1995-1-1:2010-12 [3]
γ_M	see EN 1995-1-1:2010-12 [3]
$\gamma_{M,2}$	see EN 1993-1-1 Chapter 6.1 [2]

Information about the Hanger Bolt-related values is given in Chapter: **Load resistances Hilti Hangerbolt**
or can be determined in the HCW-Design Module in Software 'ingtools' (www.ingtools.de).

C1) HCW in side grain applications: Timber-to-Concrete

Proof of tensile load capacity



$$F_{ax,\alpha,Ed} \leq \begin{cases} N_{Rd,HCW-SG} \\ N_{Rd-Anchor} \end{cases}$$

with

$F_{ax,\alpha,Ed}$	Applied tensile design load under an angle of 0° ≤ α ≤ 90° into the side grain
$N_{Rd,HCW-SG}$	Decisive HCW-related tensile design resistance in side grain (SG)
$N_{Rd,Anchor}$	Decisive anchor-related tensile design resistance

HCW-related verifications:

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

with

$F_{ax,\alpha,Rk}$: $F_{ax,\alpha,Rk} = F_{ax,90,Rk}$ for 45°≤ α ≤ 90°
$F_{ax,\alpha,Rk} = k_{ax}$ x $F_{ax,90,Rk}$ for 0° < α < 45°

with
$F_{ax,90,Rk}$ according to Table 2, Table 3 and Table 4Table

and

$$k_{ax} = 0.3 + \frac{0.7 * \alpha}{45°} < 1$$

$F_{t,Rk}$:	Characteristic tensile load capacity of HCW-clamping mechanism see Table 2
k_{mod}	see EN 1995-1-1:2010-12 [3]
γ_M	see EN 1995-1-1:2010-12 [3]
$\gamma_{M,2}$	see EN 1993-1-1 Chapter 6.1 [2]

Concrete anchor related verifications in Timber-to-Concrete applications:

$$N_{Rd-Anchor} = min \begin{cases} N_{Rd,s} \\ N_{Rd,p} \\ N_{Rd,c} \\ N_{Rd,sp} \end{cases}$$

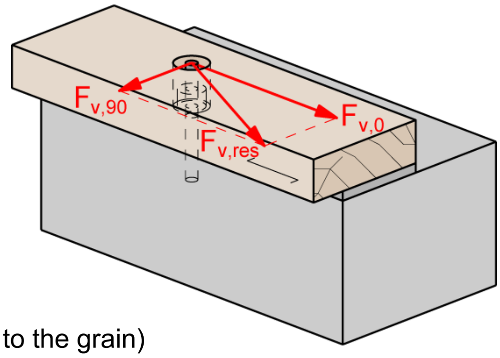
with

$N_{Rd,s} = N_{Rk,s} / \gamma_M$	Steel resistance
$N_{Rd,p} = N_{Rk,p} / \gamma_M$	Pull-out resistance for mechanical anchors
$N_{Rd,p} = N_{Rk,p} / \gamma_M$	Combined pull-out and concrete resistance for bonded anchors
$N_{Rd,c} = N_{Rk,c} / \gamma_M$	Concrete cone capacity
$N_{Rd,sp} = N_{Rk,sp} / \gamma_M$	Splitting resistance

Information about the anchor-related values is given in the related approval document (e.g. ETA) or can be determined in the HCW-Design Module in Software ‘ingtools’ (www.ingtools.de).

C1) HCW in side grain applications – Timber-to-Concrete

Proof of shear load capacity



HCW-related verifications:

$$F_{V,0,Ed} \leq F_{v,0,Rd-HCW} = \frac{k_{mod} * F_{V,0,Rk-HCW}}{\gamma_M}$$

with

$F_{V,0,Ed}$	Applied design shear load parallel to the grain
$F_{V,0,Rd\text{-}HCW}$:	Design HCW-shear capacity for α = 0° (parallel to the grain)
$F_{V,0,Rk\text{-}HCW}$:	Characteristic HCW-shear capacity for α = 0° (parallel to the grain) see Table 2 and Table 4
k_{mod}	see EN 1995-1-1:2010-12 [3]
γ_M	see EN 1995-1-1:2010-12 [3]

$$F_{V,90,Ed} \leq F_{v,90,Rd-HCW} = \frac{k_{mod} * F_{v,90,Rk-HCW}}{\gamma_M}$$

with

$F_{V,90,Ed}$	Applied design shear load perpendicular to the grain
$F_{V,90,Rd\text{-}HCW}$:	Design HCW-shear capacity for α = 90° (perpendicular to the grain)
$F_{V,90,Rk\text{-}HCW}$:	Characteristic HCW-shear capacity for α = 90° (perpendicular to the grain) see Table 2 and Table 4
k_{mod}	see EN 1995-1-1:2010-12 [3]
γ_M	see EN 1995-1-1:2010-12 [3]

Concrete anchor related verifications in Timber-to-Concrete applications:

$$F_{V,\alpha,Ed} \leq V_{Rd,anchor} = min\begin{cases} V_{Rd,s,M} \\ V_{Rd,cp} \\ V_{Rd,c} \end{cases}$$

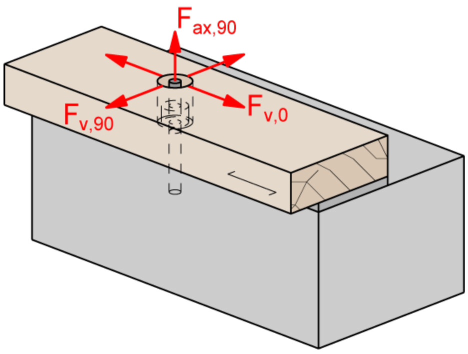
with

$F_{V,\alpha,Ed}$	Resulting design shear load; $F_{V,\alpha,Ed} = \sqrt{F_{V,90,Ed}^2 + F_{V,0,Ed}^2}$
$V_{Rd\text{-}Anchor}$	Decisive design resistance of the anchor
$V_{Rd,s,M} = V_{Rk,s,M} / \gamma_M$	Steel resistance with lever arm (according to Whitepaper [6])
$V_{Rd,cp} = V_{Rk,cp} / \gamma_M$	Pry-out resistance
$V_{Rd,c} = V_{Rk,c} / \gamma_M$	Concrete edge resistance (according to Whitepaper [6])

Information about the anchor-related values is given in the related approval document (e.g. ETA) or can be determined in the HCW-Design Module in Software 'ingtools' (www.ingtools.de).

C1) HCW in side grain applications – Timber-to-Concrete

Interaction



In case of combined shear- and tension-forces transferred from HCW into the timber member/concrete the following verifications shall be verified:

HCW (Timber)

$$\left(\frac{F_{ax,90,Ed}}{F_{ax,90,Rd}}\right)^2 + \left(\frac{F_{V,0,Ed}}{F_{V,0,Rd}}\right)^2 + \left(\frac{F_{V,90,Ed}}{F_{V,90,Rd}}\right)^2 \leq 1$$

Anchor (Concrete)

$$\left(\frac{F_{ax,90,Ed}}{\min\{N_{Rd,p}; N_{Rd,c}; N_{Rd,sp}\}}\right)^{1.5} + \left(\frac{F_{v,\alpha,Ed}}{\min\{V_{Rd,cp}; V_{Rd,c}\}}\right)^{1.5} \leq 1$$

or

$$\left(\frac{F_{ax,90,Ed}}{\min\{N_{Rd,p}; N_{Rd,c}; N_{Rd,sp}\}}\right) + \left(\frac{F_{V,\alpha,Ed}}{\min\{V_{Rd,cp}; V_{Rd,c}\}}\right) \leq 1.2$$

At least one of both equations shall be verified!

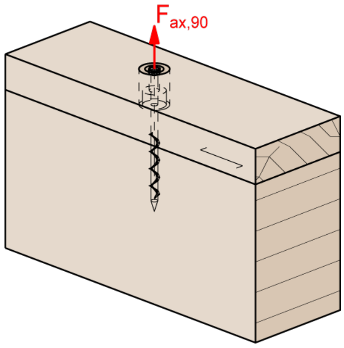
Anchor (Steel-resistance in stand-off condition)

According to Hilti-method (see Whitepaper [6]):

$$\left(\frac{F_{ax,90,Ed}}{N_{Rd,s}}\right)^2 + \frac{F_{v,\alpha,Ed}}{V_{Rd,s,M}} \leq 1$$

C2) HCW in side grain applications – Timber-to-Timber

Proof of tensile load capacity



$$F_{ax,\alpha,Ed} \leq \begin{cases} N_{Rd,HCW-SG} \\ N_{Rd-HB} \end{cases}$$

with

$F_{ax,\alpha,ED}$	Applied tensile design load under an angle of 0° ≤ α ≤ 90° into the side grain.
$N_{Rd,HCW-SG}$	Decisive HCW-related tensile design resistance in side grain (SG)
N_{Rd-HB}	Decisive Hanger-Bolt related tensile design resistance.

HCW-related verifications:

$$N_{Rd,HCW-SG} = min \begin{cases} F_{ax,90,Rd-HCW} = \dfrac{k_{mod} * F_{ax,\alpha,Rk}}{\gamma_M} \\ \dfrac{F_{t,Rk}}{\gamma_{M,2}} \end{cases}$$

with

$F_{ax,\alpha,Rk}$: $F_{ax,\alpha,Rk} = F_{ax,90,Rk}$ for 45°≤ α ≤ 90°
$F_{ax,\alpha,Rk} = k_{ax} \times F_{ax,90,Rk}$ for 0° < α < 45°

with
$F_{ax,90,Rk}$ according to Table 2, Table 3 and Table 4Table

and

$$k_{ax} = 0.3 + \frac{0.7 * \alpha}{45°} < 1$$

$F_{t,Rk}$:	Characteristic tensile load capacity of HCW-clamping mechanism see Table 2
k_{mod}	see EN 1995-1-1:2010-12 [3]
γ_M	see EN 1995-1-1:2010-12 [3]
$\gamma_{M,2}$	see EN 1993-1-1 Chapter 6.1 [2]

Hanger Bolt related verifications in Timber-to-Timber applications:

$$N_{Rd-HB} = min \begin{cases} F_{ax,90,Rd-HB} = \dfrac{k_{mod} * F_{ax,90,RK-HB}}{\gamma_M} \\ \dfrac{F_{t,Rk-HB}}{\gamma_{M,2}} \end{cases}$$

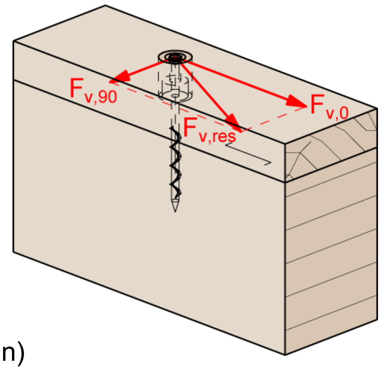
with

N_{Rd-HB}	Decisive design resistance of the Hanger Bolt
$F_{ax,90,Rd-HB}$	Design withdrawal capacity Hanger Bolt
$F_{ax,90,Rk-HB}$	Characteristic withdrawal capacity Hanger Bolt
$F_{t,Rk-HB}$:	Characteristic steel capacity Hanger Bolt
k_{mod}	see EN 1995-1-1:2010-12 [3]
γ_M	see EN 1995-1-1:2010-12 [3]
$\gamma_{M,2}$	see EN 1993-1-1 Chapter 6.1 [2]

Information about the Hanger Bolt-related values is given in Chapter: **Load resistances Hilti Hangerbolt**
or can be determined in the HCW-Design Module in Software 'ingtools' (www.ingtools.de).

C2) HCW in side grain applications – Timber-to-Timber

Proof of shear load capacity



HCW-related verifications:

$$F_{V,0,Ed} \leq F_{V,0,Rd-HCW} = \frac{k_{mod} * F_{V,0,Rk-HCW}}{\gamma_M}$$

with

$F_{V,0,Ed}$	Applied design shear load parallel to the grain (α = 0°)
$F_{V,0,Rd\text{-}HCW}$:	Design HCW-shear capacity for α = 0° (parallel to the grain)
$F_{V,0,Rk\text{-}HCW}$:	Characteristic shear capacity of HCW for α = 0° (parallel to the grain) see Table 2 and Table 4
k_{mod}	see EN 1995-1-1:2010-12 [3]
γ_M	see EN 1995-1-1:2010-12 [3]

$$F_{V,90,Ed} \leq F_{v,90,Rd-HCW} = \frac{k_{mod} * F_{V,90,Rk-HCW}}{\gamma_M}$$

with

$F_{V,90,Ed}$	Applied design shear load perpendicular to the grain (α = 0°)
$F_{V,90,Rd\text{-}HCW}$:	Design HCW-shear capacity for α = 90° (perpendicular to the grain)
$F_{V,90,Rk\text{-}HCW}$:	Characteristic shear capacity of HCW for α = 90° (perpendicular to the grain) see Table 2 and Table 4
k_{mod}	see EN 1995-1-1:2010-12 [3]
γ_M	see EN 1995-1-1:2010-12 [3]

Hanger Bolt related verifications in Timber-to-Timber applications:

$$F_{V,\alpha,Ed} \leq F_{V,Rd,HB} = k_{mod} * \frac{F_{V,Rk,HB}}{\gamma_M}$$

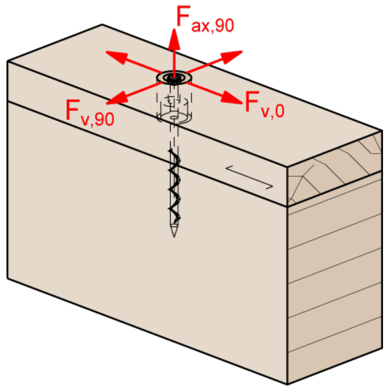
with

$F_{V,\alpha,Ed}$	Resulting design shear load; $F_{v,\alpha,ED} = \sqrt{F_{V,90,Ed}^2 + F_{V,0,Ed}^2}$
$F_{V,Rd,HB}$	Design shear resistance Hanger Bolt
$F_{V,Rk,HB}$	Characteristic shear resistance Hanger Bolt
k_{mod}	see EN 1995-1-1:2010-12 [3]
γ_M	see EN 1995-1-1:2010-12 [3]

Information about the Hanger Bolt-related values is given in Chapter: **Load resistances Hilti Hangerbolt**
or can be determined in the HCW-Design Module in Software 'ingtools' (www.ingtools.de).

C2) HCW in side grain applications – Timber-to-Timber

Interaction



In case of combined shear- and tension-forces transferred from HCW Into the timber members the following verifications shall be fulfilled:

HCW (Timber)

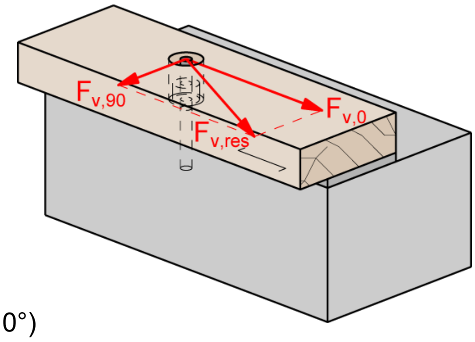
$$\left(\frac{F_{ax,90,Ed}}{F_{ax,90,Rd-HCW}}\right)^2 + \left(\frac{F_{V,0,Ed}}{F_{V,0,Rd}}\right)^2 + \left(\frac{F_{V,90,Ed}}{F_{V,90,Rd}}\right)^2 \leq 1$$

Hanger Bolt (Timber)

$$\left(\frac{F_{ax,90,Ed}}{N_{Rd-HB}}\right)^2 + \left(\frac{F_{V,\alpha,Ed}}{F_{V,\alpha,Rd-HB}}\right)^2 \leq 1$$

D1) HCW-S in side grain applications – Timber-to-Concrete

Proof of shear load capacity



HCW-S related verifications:

$$F_{V,0,Ed} \leq F_{v,0,Rd-HCW-S} = \frac{k_{mod} * F_{V,0,Rk-HCW-S}}{\gamma_M}$$

with

$F_{V,0,Ed}$	Applied design shear load parallel to the grain (α = 0°)
$F_{V,0,Rd\text{-}HCW\text{-}S}$:	Design shear capacity of HCW-S for α = 0°(parallel to the grain)
$F_{V,0,Rk\text{-}HCW\text{-}S}$:	Characteristic shear capacity of HCW-S for α = 0° (parallel to the grain) see Table 2 and Table 4
k_{mod}	see EN 1995-1-1:2010-12 [3]
γ_M	see EN 1995-1-1:2010-12 [3]

$$F_{V,90,Ed} \leq F_{V,90,Rd-HCW-S} = \frac{k_{mod} * F_{V,90,Rk-HCW-S}}{\gamma_M}$$

with

$F_{V,90,Ed}$	Applied design shear load perpendicular to the grain
$F_{V,90,Rd\text{-}HCW\text{-}S}$:	Design shear capacity of HCW-S for α = 90° (perpendicular to the grain)
$F_{V,90,Rk\text{-}HCW\text{-}S}$:	Characteristic shear capacity of HCW-S for α = 90° (perpendicular to the grain) see Table 2 and Table 4
k_{mod}	see EN 1995-1-1:2010-12 [3]
γ_M	see EN 1995-1-1:2010-12 [3]

Concrete anchor related verifications in Timber-to-Concrete applications:

$$F_{V,\alpha,Ed} \leq V_{Rd,anchor} = min\begin{cases} V_{Rd,s,M} \\ V_{Rd,cp} \\ V_{Rd,c} \end{cases}$$

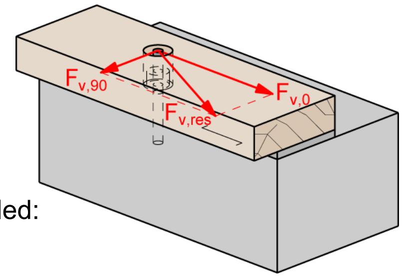
with

$F_{V,\alpha,Ed}$	Resulting design shear load; $F_{V,\alpha,Ed} = \sqrt{F_{V,90,Ed}^2 + F_{V,0,Ed}^2}$
$V_{Rd\text{-}Anchor}$	Decisive design resistance of the anchor
$V_{Rd,s,M} = V_{Rk,s,M} / \gamma_M$	Steel resistance with lever arm (according to Whitepaper [6])
$V_{Rd,cp} = V_{Rk,cp} / \gamma_M$	Pry-out resistance
$V_{Rd,c} = V_{Rk,c} / \gamma_M$	Concrete edge resistance (according to Whitepaper [6])

Information about the anchor-related values is given in the related approval document (e.g. ETA) or can be determined in the HCW-Design Module in Software 'ingtools' (www.ingtools.de).

D1) **HCW-S in side grain applications – Timber-to-Concrete**

Interaction



In case of combined shear- and tension-forces transferred from HCW-S
Into the timber member/concrete the following verifications shall be fulfilled:

HCW-S (Timber)

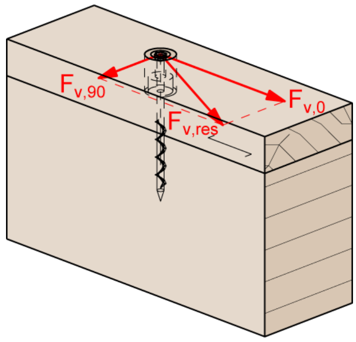
$$\left(\frac{F_{V,0,Ed}}{F_{V,0,Rd-HCW-S}}\right)^2 + \left(\frac{F_{V,90,Ed}}{F_{V,90,Rd-HCW-S}}\right)^2 \leq 1$$

Anchor (Concrete) – no interaction required (no tensile load)

Anchor (Steel-resistance in stand-off condition) – no interaction required (no tensile load)

D2) HCW-S in side grain applications – Timber-to-Timber

Proof of shear load capacity



HCW-S-related verifications:

$$F_{V,0,Ed} \leq F_{v,0,Rd-HCW-S} = \frac{k_{mod} * F_{V,0,Rk-HCW-S}}{\gamma_M}$$

with

$F_{V,0,Ed}$	Applied design shear load parallel to the grain (α = 0°)
$F_{V,0,Rd-HCW-S}$:	Design shear capacity of HCW-S for α = 0°(parallel to the grain)
$F_{V,0,Rk-HCW-S}$:	Characteristic shear capacity of HCW-S for α = 0° (parallel to the grain) see Table 2 and Table 4
k_{mod}	see EN 1995-1-1:2010-12 [3]
γ_M	see EN 1995-1-1:2010-12 [3]

$$F_{V,90,Ed} \leq F_{V,90,Rd-HCW-S} = \frac{k_{mod} * F_{V,90,Rk-HCW-S}}{\gamma_M}$$

with

$F_{V,90,Ed}$	Applied design shear load perpendicular to the grain
$F_{V,90,Rd-HCW-S}$:	Design shear capacity of HCW-S for α = 90° (perpendicular to the grain)
$F_{V,90,Rk-HCW-S}$:	Characteristic shear capacity of HCW-S for α = 90° (perpendicular to the grain) see Table 2 and Table 4
k_{mod}	see EN 1995-1-1:2010-12 [3]
γ_M	see EN 1995-1-1:2010-12 [3]

Hanger Bolt related verifications in Timber-to-Timber applications:

$$F_{V,\alpha,Ed} \leq F_{V,\alpha,Rd,HB} = k_{mod} * \frac{F_{V,Rk,HB}}{\gamma_M}$$

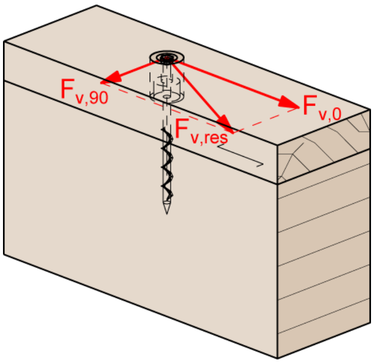
with

$F_{V,\alpha,Ed}$	Resulting design shear load; $F_{v,\alpha,ED} = \sqrt{F_{V,90,Ed}^2 + F_{V,0,Ed}^2}$
$F_{V,Rd,HB}$	Design shear resistance Hanger Bolt
$F_{V,Rk,HB}$	Characteristic shear resistance Hanger Bolt
k_{mod}	see EN 1995-1-1:2010-12 [3]
γ_M	see EN 1995-1-1:2010-12 [3]

Information about the Hanger Bolt-related values is given in Chapter: **Load resistances Hilti Hangerbolt** or can be determined in the HCW-Design Module in Software 'ingtools' (www.ingtools.de).

D2) HCW-S in side grain applications – Timber-to-Timber

Interaction



In case of combined shear-forces transferred from HCW-S
Into the timber members the following verification shall be fulfilled:

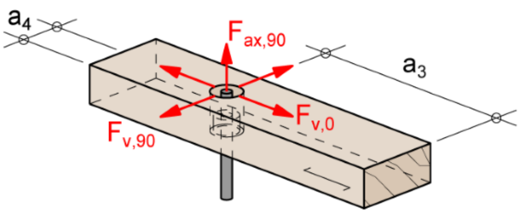
HCW (Timber)

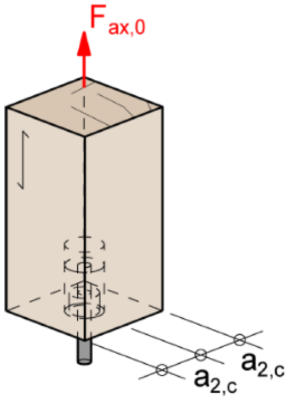
$$\left(\frac{F_{V,0,Ed}}{F_{V,0,Rd-HCW-S}}\right)^2 + \left(\frac{F_{V,90,Ed}}{F_{V,90,Rd-HCW-S}}\right)^2 \leq 1$$

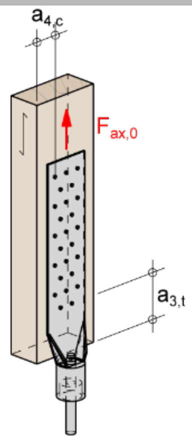
Hanger Bolt (Timber) – no interaction required

Design basics

Load resistances for HCW, HCW-S, HCW-L in C24 and engineered timber products (ρ_k = 350 kg/m³), e.g. CLT, GL 24 h/c







Parameter	Type	Fastener type: Nails/ Screws	Fastener type: Rod	Timber: Edge distance [mm]	Timber: Min cross-section [mm²]	Characteristic Load carrying capacities [kN]	
Tension Strength	HCW-L HCW	-	M12, 4.6	-		$F_{t,Rk}$	30,0
			M12, 8.8				42,0
	HCW-S	-	-	-			-
Axial Strength	HCW-L 40x295	15 nails[2]	M12, ≥ 4.6	$a_{3,t}$ ≥ 58,5[5] $a_{4,c}$ ≥ 20	45 x 80	$F_{ax,0,Rk}$	39,0
		25 nails[2]					45,0
	HCW-L 40x375	15 nails[2]	M12, ≥ 4.6	$a_{3,t}$ ≥ 60 $a_{4,c}$ ≥ 20	45 x 80	$F_{ax,0,Rk}$	39,0
		24 nails[2]					45,0
Withdrawal capacity parallel to the grain direction	HCW	-	M12, ≥ 4.6	$a_{2,c}$ ≥ 50	100 x 100	$F_{ax,0,Rk}$[7]	11,8
Withdrawal capacity perpendicular to the grain	HCW	-	M12, ≥ 4.6	a_4 ≥ 40[1]	45 x 80	$F_{ax,0,Rk}$[7]	12,3
				a_4 ≥ 50[1]	45 x 100		12,9
				a_4 ≥ 60[1]	38[6] x 120		8,1[6]
Shear strength parallel to the grain direction	HCW HCW-S	-	M12, ≥ 4.6	a_4 ≥ 40[1]	45 x 80	$F_{V,0,Rk}$	24,4
				a_4 ≥ 50[1]	45 x 100		28,2
				a_4 ≥ 60[1]	38[6] x 120		28,2[6]
Shear strength perpendicular to the grain direction	HCW HCW-S	-	M12, ≥ 4.6	a_4 ≥ 40[1]	45 x 80	$F_{v,90,Rk}$	6,8
				a_4 ≥ 45[1]	-[4]		15,0[4]
				a_4 ≥ 50[1]	45 x 100		8,5
							11,8[3]
				a_4 ≥ 60[1]	38[6] x 120		8,9[6]
				a_4 ≥ 70[1]	45 x 140		11,8
				a_4 ≥ 80[1]	45 x 140		14,8

Table 2: Load carrying capacities for C24 and engineered timber products (ρ_k = 350 kg/m³), e.g. CLT, GL 24 h/c

Notes:
[1] End- distance (a_3) is ≥ 200 mm. checks on the net cross sections have to be considered in accordance to EN 1995-1-1 [3]
[2] Valid for nails: d x l = 4 x 50 mm acc. to EN 14592;
For other types, lengths or number of nails (or screws), calculations according to EN 1995-1-1 shall be done.
[3] Shear capacity with tension perpendicular to grain, reinforced with 2 fully threaded screws with a diameter of d = 8 mm.
[4] Shear capacity ($F_{v,90}$) in CLT C24 walls.
[5] Minimum distance $a_{3,t}$ is 50 mm for CLT.
[6] Technical data for 38 mm height are not covered in the ETA 21/0357, issued 31st of January 2025
[7] Also applicable for compression load-cases for HCW and HCW-S (e.g. during installation before the compression force is transferred to the mortar-layer; refer also to chapter 'Design information')

Parameter	**Type**	**Type of fastener** **Threaded rod**	**Timber C24** **Distances (a_3) and (a_4) [mm]**	**Characteristic Load carrying capacities [kN]**	
Withdrawal capacity perpendicular to the grain	HCW	M12, ≥ 4.6	$a_3 \geq 50$ mm $a_4 \geq 50$ mm	$F_{ax,90,Rk}$[1)]	11,5
			$a_3 \geq 58$ mm $a_4 \geq 40$ mm	$F_{ax,90,Rk}$[1)]	6,6

Table 3: HCW load carrying capacities with reduced end- and side distances for C24 and engineered timber products (ρ_k = 350kg/m³), e.g. CLT, GL 24h/c

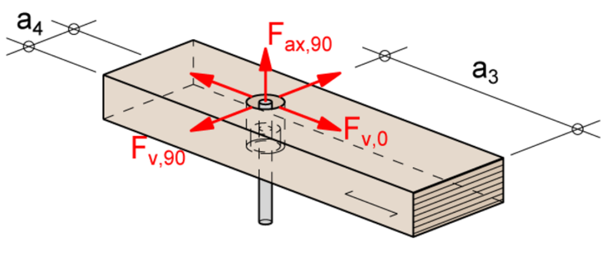
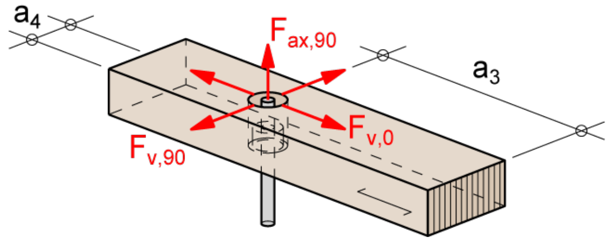
[1)] Also applicable for compression load-cases for HCW and HCW-S (e.g. during installation before the compression force is transferred to the mortar-layer; refer also to chapter 'Design information')

$F_{ax,\alpha,Rk}$ for timber member with lower or higher strength class as C24 (EN 338): EN 1995-1-1, 8.7 has to be applied.

$$F_{ax,\alpha,Rk,\rho_a} = \left(\frac{\rho_k}{\rho_a = 350 kg/m^3}\right)^{0,8} \times F_{ax,\alpha,Rk}$$ (ETA-21/0357)

ρ_a … associated characteristic density in kg/m³ for the strength class differing of C24

Load resistances for HCW and HCW-S in LVL and GLVL (ρ_k = 480 kg/m³)

Flatwise surface	Edgewise surface
	
Flatwise surface	Edgewise surface

Load direction in LVL and GLVL applications for HCW

Parameter	Fastener type: Type	Fastener type: Rod	Timber: Type	Timber: Edge distance (a₄)[1] [mm]	Timber: Min cross-section [mm²]	Characteristic Load carrying capacities [kN]	
Tension Strength	HCW	M12, 4.6	-	-	-	$F_{t,Rk}$	30,0
		M12, 8.8	-				42,0
Withdrawal capacity flatwise surface	HCW	M12, ≥ 4.6	LVL-P[2]	≥ 60	120 x 45	$F_{ax,90,Rk}$[3]	14,84
			LVL-C[2]				10,27
Withdrawal capacity edgewise surface	HCW	M12, ≥ 4.6	GLVL-P[2]	≥ 60	120 x 45	$F_{ax,90,Rk}$[3]	13,82
			GLVL-C[2]				9,56
Shear strength parallel to the grain direction flatwise surface	HCW/ HCW-S	M12, ≥ 4.6	LVL-P[2]	≥ 60	120 x 45	$F_{V,0,Rk}$	58,77
			LVL-C[2]	≥ 60			47,36
Shear strength parallel to the grain direction edgewise surface			GLVL-P[2]	≥ 60			36,77
			GLVL-C[2]	≥ 60			26,60
				≥ 40	80x 45		16,92
Shear strength perpendicular to the grain direction flatwise surface	HCW/ HCW-S	M12, ≥ 4.6	LVL-P[2]	≥ 60	120 x 45	$F_{V,90,Rk}$	18,33
			LVL-C[2]	≥ 60			29,15
Shear strength perpendicular to the grain direction edgewise surface			GLVL-P[2]	≥ 60			10,51
			GLVL-C[2]	≥ 60			9,58
				≥ 40	80 x 45		4,79

Table 4: Load carrying capacities for LVL and GLVL (ρ_k = 480 kg/m³)

Notes: [1] End- distance (a_3) is ≥ 200 mm.

[2] P – Parallel layers; C – crosswise layers.

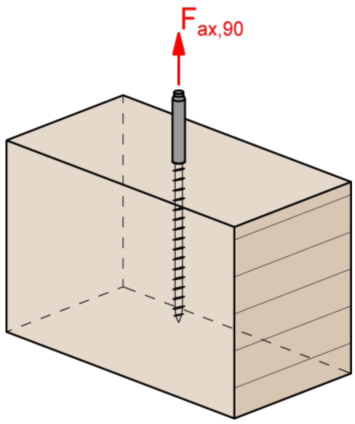
[3] Also applicable for compression load-cases for HCW and HCW-S (e.g. during installation before the compression force is transferred to the mortar-layer; refer also to chapter ‘Design information’)

$F_{ax,\alpha,Rk}$ for LVL-P/C member with lower or higher characteristic gross density ρ_k =480 kg/m3 has to be applied according to the following equation:

$$F_{ax,\alpha,Rk,\rho_a} = \left(\frac{\rho_k}{\rho_a = 480\ kg/m^3}\right)^{0,8} \times F_{ax,\alpha,Rk} \qquad \text{(ETA-21/0357)}$$

ρ_a … associated characteristic density in kg/m³

Load resistances Hilti Hangerbolt



Analysis according EN 1995-1-1:

Force-fiber-angle 45°≤α≤90°:

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

Axial withdrawal capacity for Hanger Bolts M12 ($f_{u,k}$ ≥ 400 N/mm², $d_{nom,timber}$ = 11mm)					
Solid timber / CLT	Density ρ_k [kg/m³]	Embedment depth $l_{ef,timber}$ [mm]			
		80	100	120	140
		$F_{ax,90,Rk}$	$F_{ax,90,Rk}$	$F_{ax,90,Rk}$	$F_{ax,90,Rk}$
Solid timber C24	350	9.7	11.8	13.9	16.0
GL24h	385	10.4	12.7	15.0	17.2

Table 5: 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

Characteristic tensile strength of the hanger bolt

Hilti HSW – analysis according EN 1995-1-1:

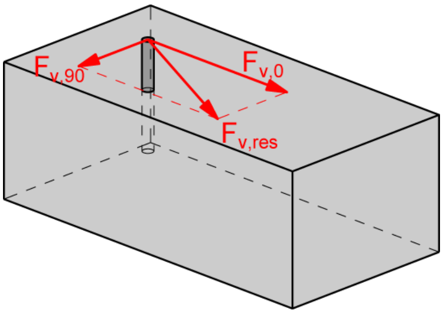
$$F_{t,Rk;HB} = n_{ef} \cdot f_{tens,k}$$ (EN 1995-1-1 (8.40c))

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

Hanger Bolt	Standards	$F_{t,Rk}$ [kN]
M12x220/60 8.8	EN 1995-1-1	17.8

Table 6: Hanger Bolt – Characteristic steel resistance (tension)

<u>Shear load capacity for Hilti HSW</u>



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

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

with

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

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

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

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

$$M_{y,Rk} = 0.3 \cdot f_{u,k} \cdot d_i^{2.6}$$ (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 the Johansen yield theory.

Hanger Bolt	Standards	a_4 [mm]	$F_{v,Rk}$ [kN]
M12x220/60 8.8	EN 1995-1-1	50	5.4[1)]
M12x140/60 4.6			

Table 7: Hanger Bolt - Characteristic shear load capacity

[1)] Rope effect not considered

References

Standards and ETA-Documents used.

[1] EN 1992-4:2019-04 Eurocode 2: Design of concrete structures – Part 4

[2] EN 1993-1-1:2010-12 Eurocode 3: Design of steel structures – Part 1-1

[3] EN 1995-1-1:2010-12 Eurocode 5: Design of timber structures – Part 1-1

[4] ETA-21/0357 of 2024/03/01 Fastening Element Hilti HCW, HCW L

[5] 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

[6] Whitepaper Hilti Coupler Wood
Timber-to-concrete connections using HCW and post-installed anchors