



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.

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HILTI COUPLER WOOD (HCW)

Fast and efficient timber fastening system for assembling prefabricated timber elements

System parts	Details	Benefits
Hilti Coupler Wood HCW		
	<p>Hilti Coupler Wood HCW 37x45 M12</p> <p>Capable to transfer:</p> <ul style="list-style-type: none"> • (Axial) Tension loads • (Axial) Compression loads • Shear loads 	<p>Designed for transferring shear and tensile loads, allowing positioning and leveling</p> <p>Designed for factory production with predrilled wood members</p> <p>ETA 21/0357 approved</p>
Hilti Coupler Wood HCW-S		
	<p>Hilti Coupler Wood HCW-S 37x45 M12</p> <p>Capable to transfer:</p> <ul style="list-style-type: none"> • Shear loads • (Axial) Compression loads 	<p>Designed for transferring shear loads, allowing positioning and leveling</p> <p>ETA-21/0357 approved</p>
Hilti Coupler Wood HCW-UP		
	<p>Hilti Coupler Wood HCW-UP 37x35 M12</p> <ul style="list-style-type: none"> • Not load bearing coupler 	<p>Designed for an economical upper floor positioning of timber-to-timber connections</p>
Hilti Coupler Wood HCW-L		
	<p>Hilti Coupler Wood HCW-L 40x295 M12 HCW-L 40x375 M12</p> <p>Capable to transfer:</p> <ul style="list-style-type: none"> • Tension (axial) loads 	<p>Designed for tensile loads with a nail plate for higher tension requirements, allowing positioning</p> <p>ETA 21/0357 approved</p>
Hanger Bolt (for Timber-to-Timber Connections)		
	<p>Hanger bolt:</p> <ul style="list-style-type: none"> • Metrical thread M12 • Timber thread acc. EN 14592 • $f_{uk} \geq 400 \text{ N/mm}^2$ • e.g. Hilti HSW M12x220/60 8.8 or Hilti Hanger Bolt M12x140 4.6 	<p>Designed for assembling and fastening prefabricated timber-to-timber structures</p> <p>ETA 21/0357 approved</p>
Concrete Fasteners (for Timber-to-Concrete Connections)		
	<p>e.g. Expansion Anchor HST2 V3 M12, HST3 M12 or HST4 M12</p>	
	<p>e.g. Anchor rod HAS-U M12 in combination with Hilti HIT-HY 200-A V3 injection mortar</p>	
Setting Tool SW HCW (S)		
	<p>Setting tool SW HCW for:</p> <ul style="list-style-type: none"> • HCW • HCW-S 	<p>Quicker and more efficient setting tool for wood connectors</p> <p>Enhances consistency and precision</p>

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

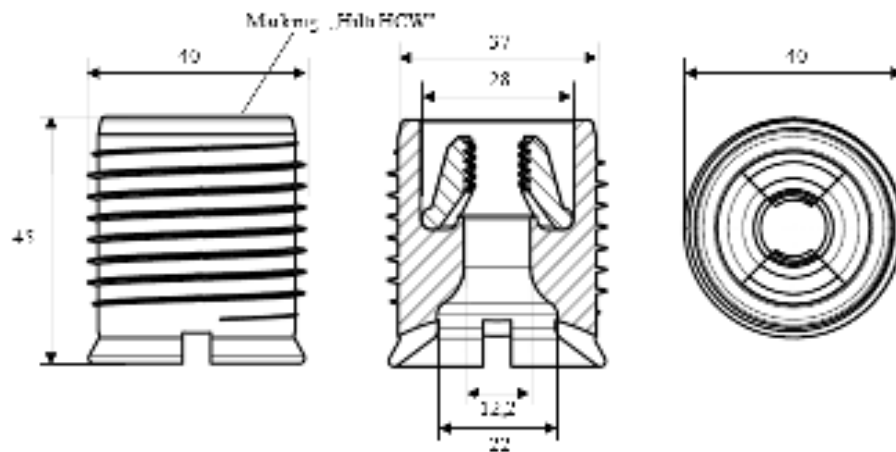
Link to Hilti Webpage

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

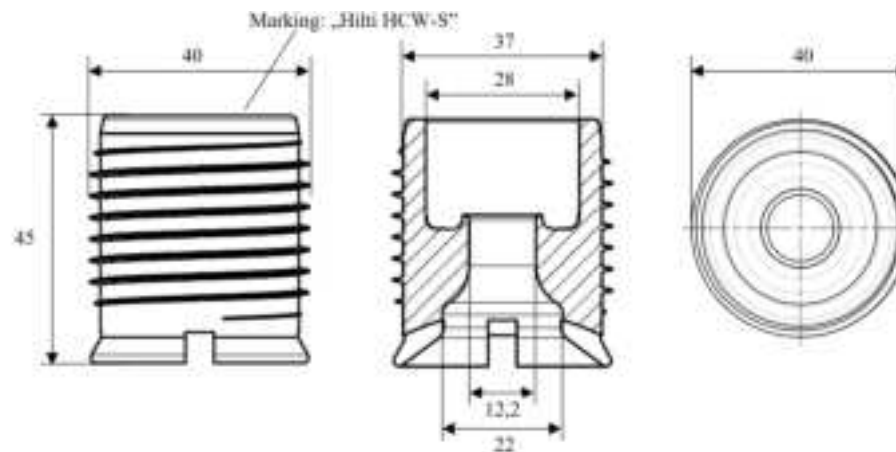
Hilti Coupler Wood HCW

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 $\geq 5 \mu\text{m}$
Color	Grey



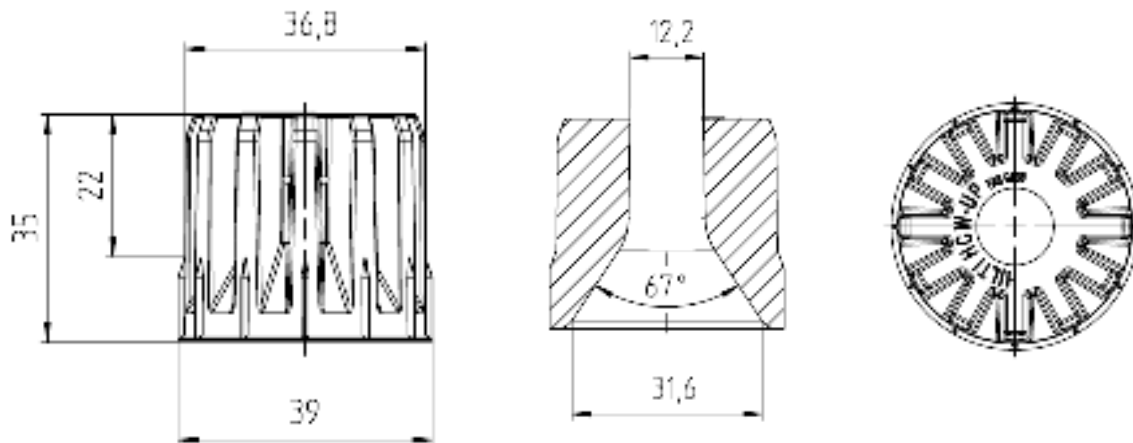
Hilti Coupler Wood HCW-S

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

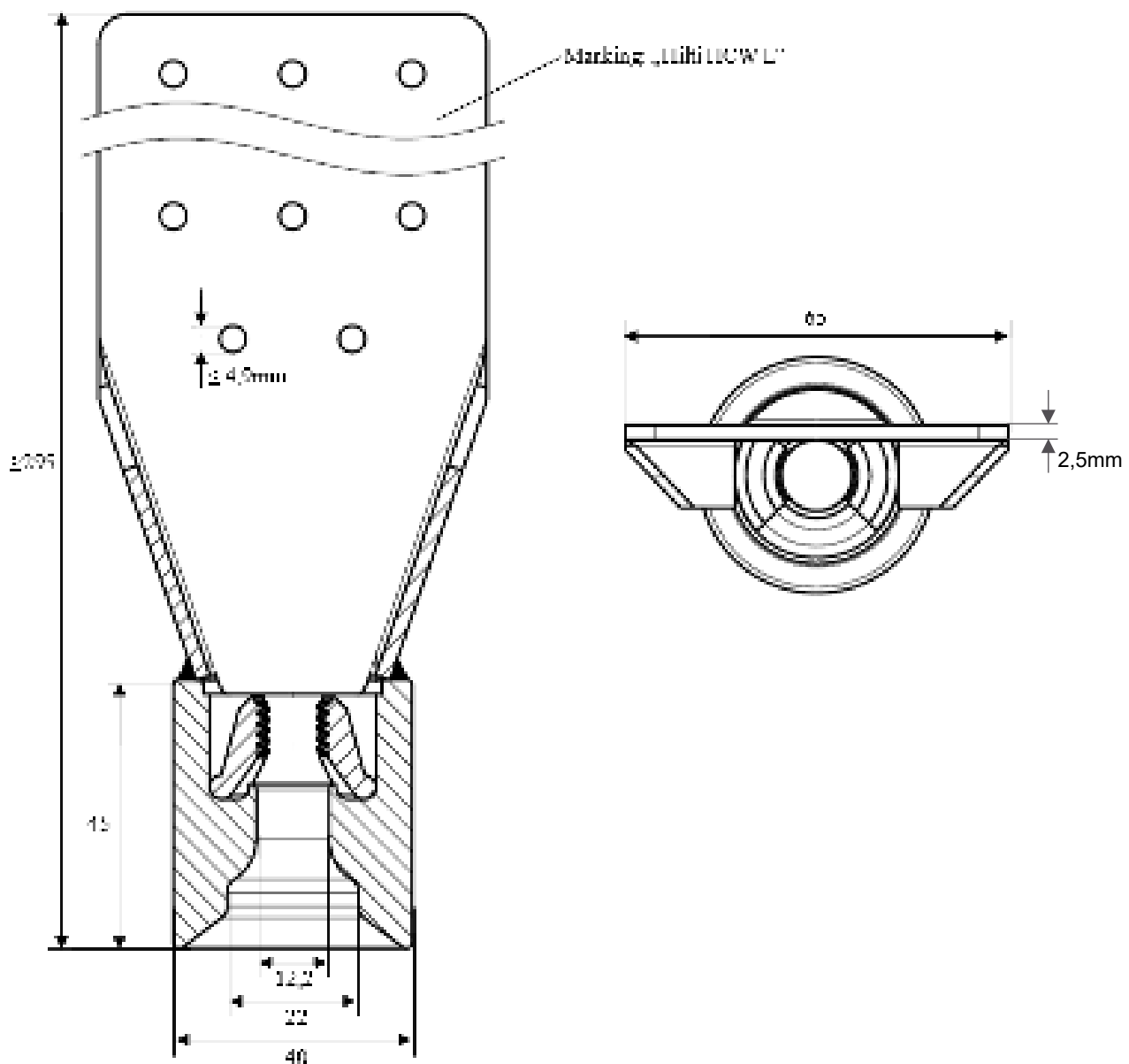
Outer diameter:	40 mm
Diameter of the body:	37 mm
Length:	35 mm
Material:	Recycled Plastic
Color	Black



Hilti Coupler Wood HCW-L

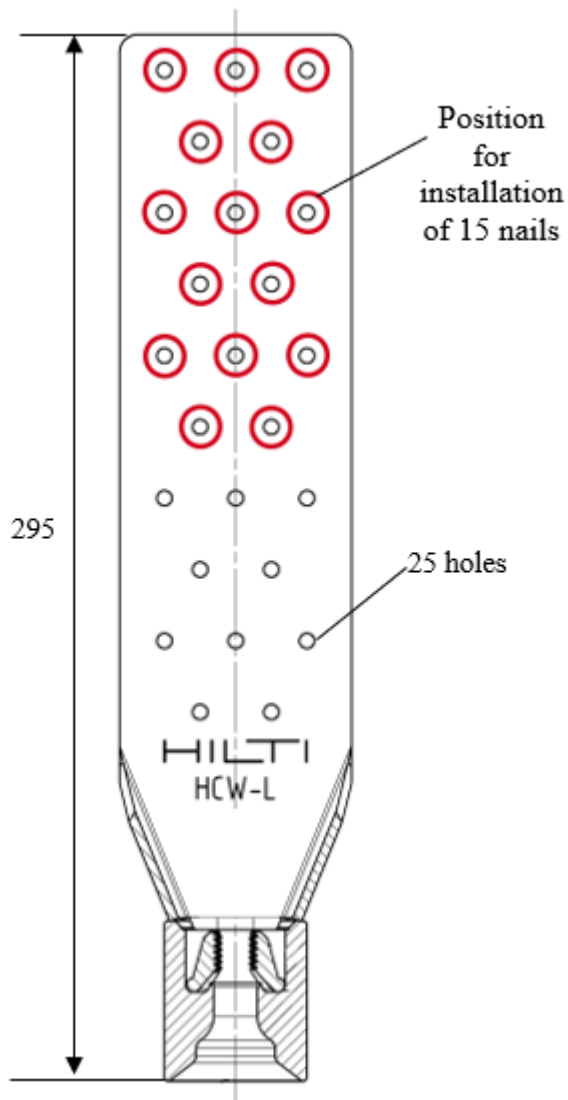
Outer diameter, sleeve:	40 mm
Length, sleeve:	45 mm
Length:	≥ 295 mm
Width, plate:	65 mm
Thickness, plate:	2,5 mm
Hole diameter, plate:	$\leq 4,9$ mm
Material:	
- Sleeve and nailing plate:	S355J2 according EN 10277
- Clamping device:	16MnCrS5+C according to EN10277. Electroplated zinc coated $\geq 5 \mu\text{m}$

Dimensions:

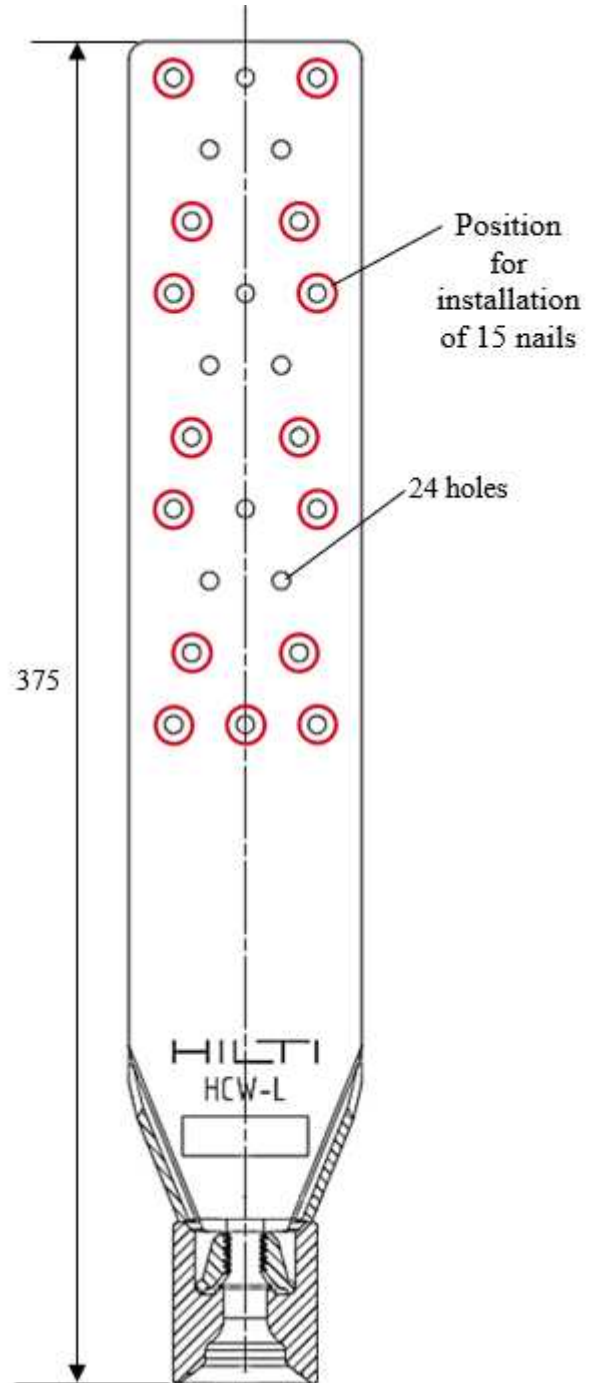


Hole patterns:
Hole patterns for HCW-L

HCW-L 40x295 M12

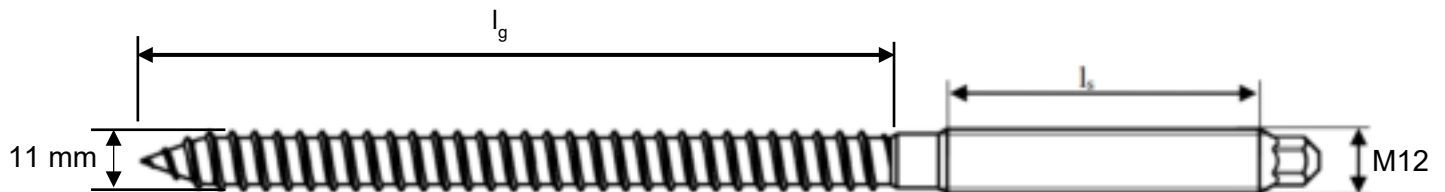


HCW-L 40x375 M12



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

Length of metrical thread M12:	$l_s \geq 40 \text{ mm}$
Length of timber thread:	$l_g \geq 6 \times d_{\text{nom, timber}}$ (for tensile and shear loads) $l_g \geq 4 \times d_{\text{nom, timber}}$ (for shear loads)
Core diameter (d_i):	8.7 mm
Material:	Steel, $f_{u,k} \geq 400 \text{ N/mm}^2$
Pre-drilling diameter:	8 mm

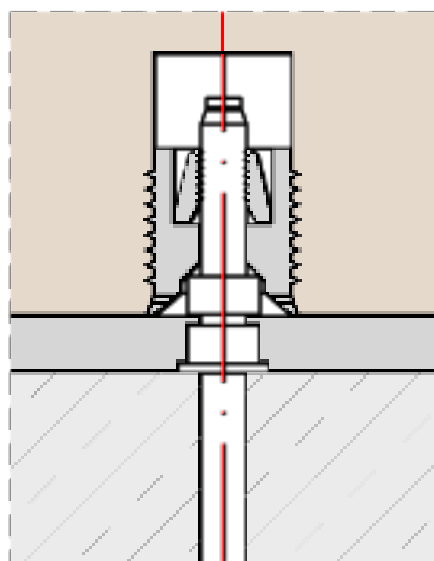


Hilti-products:

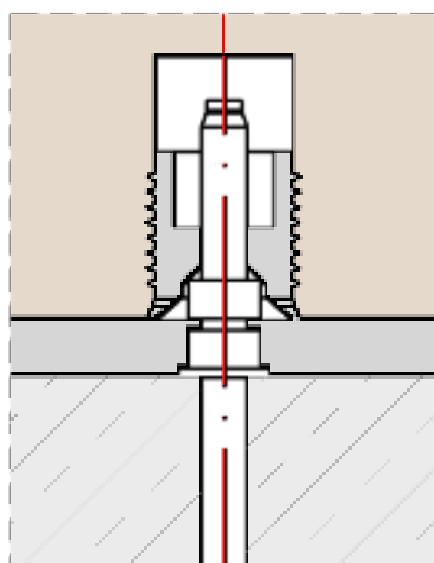
- HSW M12x220/60 8.8 ($d_{\text{nom, timber}} = 11\text{mm}$) (# 2316491)
- Hangerbolt M12x140 4.6 ($d_{\text{nom, timber}} = 11\text{mm}$) (# 216376)

Design information

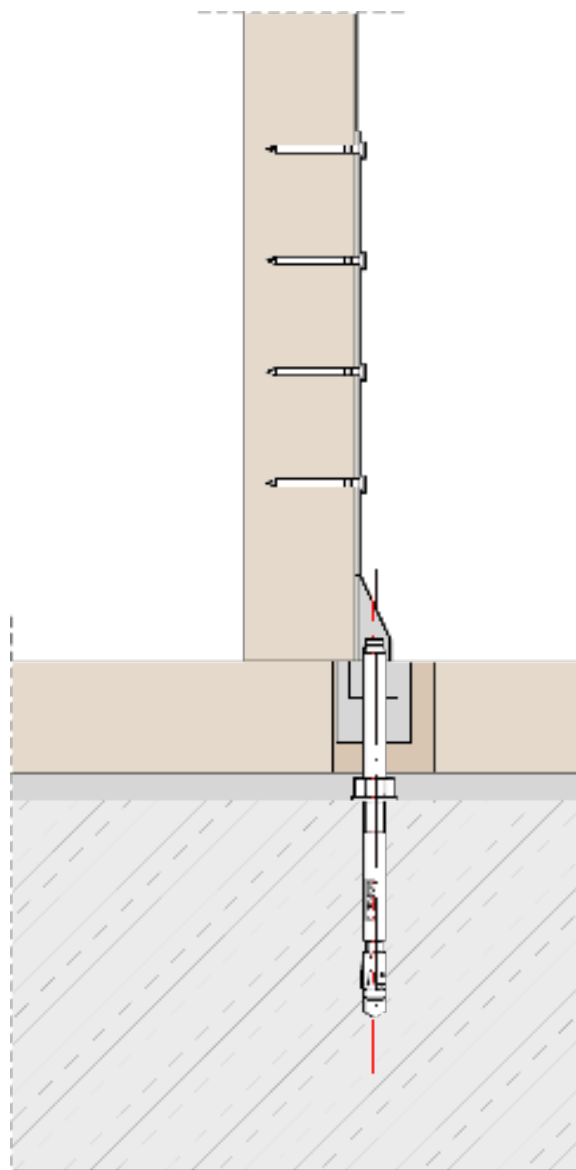
Definition of load-types $F_{ax,\alpha}$ and $F_{V,\alpha}$



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:
 - $\alpha = 0^\circ$: Load is applied parallel to the grain
 - $\alpha = 90^\circ$: Load is applied perpendicular to the grain

Applicable loads per connector type

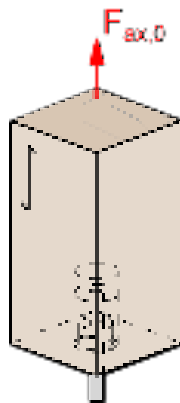
(here exemplarily shown in solid timber; see also Table 2, Table 3, Table 4 and ETA-21/0357 [4])

(Axial) Tension-loads – HCW

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

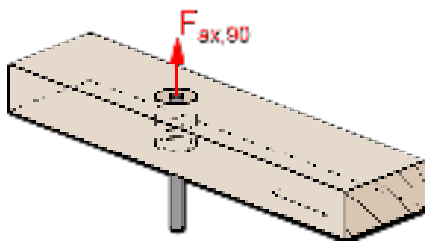
Applications in the head-grain of the timber member:

- For angles $\alpha = 0^\circ$ 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 $45^\circ \leq \alpha \leq 90^\circ$ 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 $0^\circ < \alpha < 45^\circ$ 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

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

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

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

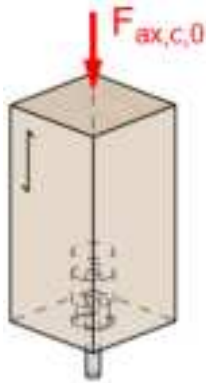
Applications in the head-grain of the timber member:

For angles $\alpha = 0^\circ$ between HCW-system-axis and grain-direction:

$F_{ax,c,0,Rk} = F_{ax,0,Rk}$... see Table 2 and Table 4

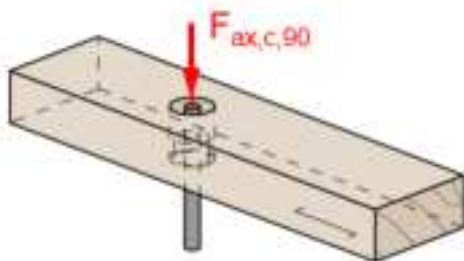
Only (axial) compression loads $F_{ax,c,0}$ shall be applied into the head-grain.

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 $45^\circ \leq \alpha \leq 90^\circ$ 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



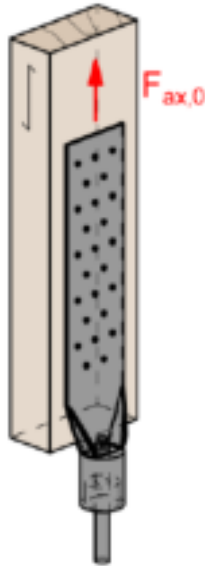
(Axial) Tension-loads – HCW-L

$F_{ax,\alpha,Rk,HCW-L}$: Characteristic capacity for HCW-L, valid for $\alpha = 0^\circ$ (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

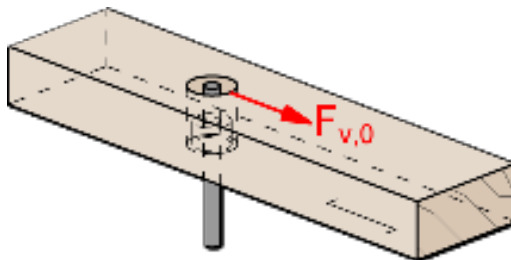


Shear loads – HCW and HCW-S

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

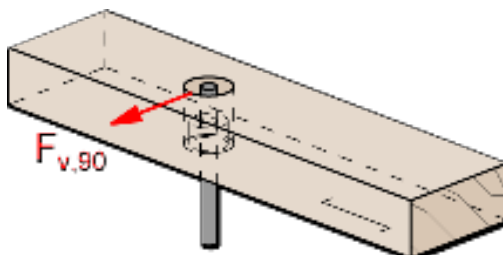
$\alpha = 0^\circ$ (load direction parallel to the grain)

$F_{v,0,Rk}$... see Table 2 and Table 4



$\alpha = 90^\circ$ (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.

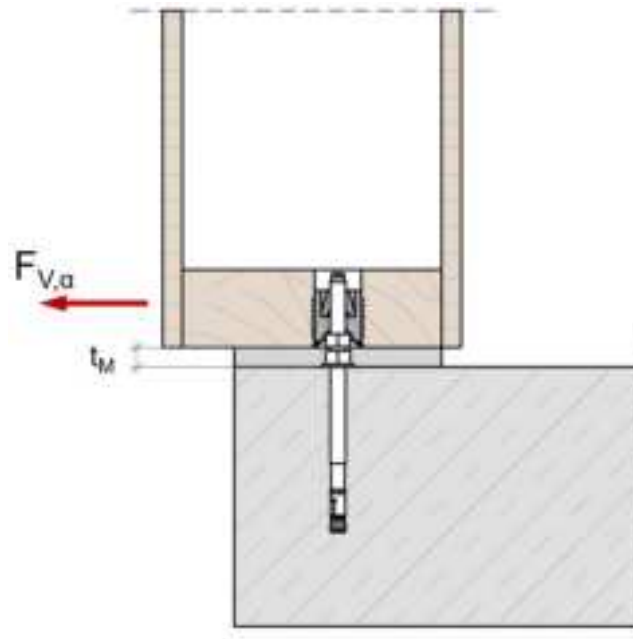
Tension loads on anchors

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

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

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.

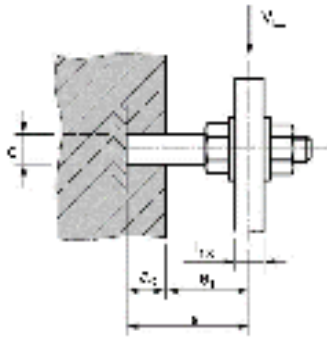


Hilti recommends specifying shear-loaded HCW/HCW-S with stand-off according to Hilti Whitepaper_HCW [6].

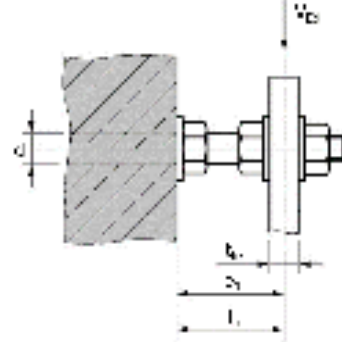
The following provisions shall be taken into consideration:

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

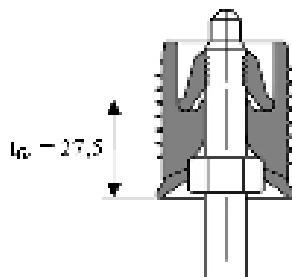
Situation A



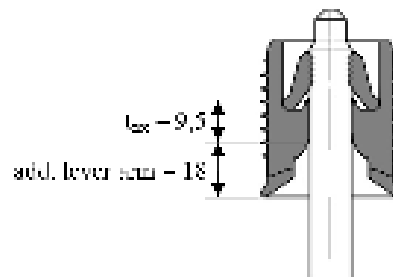
Situation B



With leveling nut:



Without leveling nut:



(values in mm)

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:

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

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

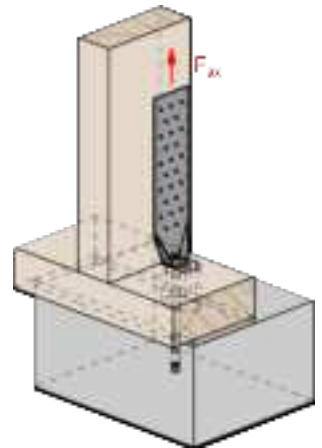
A1) HCW-L: Timber-to-Concrete

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.
$N_{Rd,HCW-L}$	Decisive HCW-L related tensile design resistance.
$N_{Rd,Anchor}$	Decisive anchor-related tensile design resistance.



Verifications for HCW-L:

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

with

Load angle $\alpha = 0^\circ$

$F_{ax,0,Rk}$:	Characteristic HCW-L axial strength for $\alpha = 0^\circ$ 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).

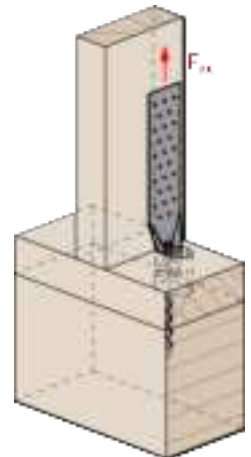
A2) HCW-L: Timber-to-Timber

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 $\alpha = 0^\circ$

$F_{ax,0,Rk}$:	Characteristic HCW-L axial strength for $\alpha = 0^\circ$ 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).

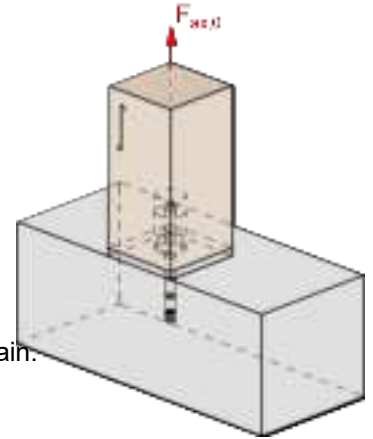
B1) HCW in head grain applications: Timber-to-Concrete

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 $\alpha = 0^\circ$ for applications in headgrain

$F_{ax,0,Rk}$:	Characteristic HCW-withdrawal capacity for $\alpha = 0^\circ$ 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.

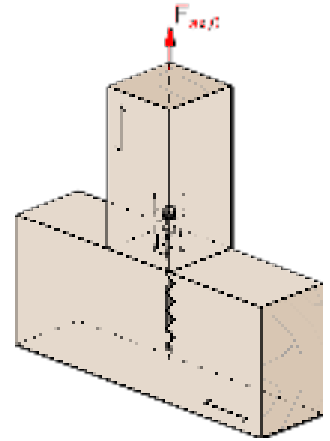
B2) HCW in headgrain applications: Timber-to-Timber

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:

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

with

Load angle $\alpha = 0^\circ$ for applications in headgrain

$F_{ax,0,Rk}$:	Characteristic HCW-withdrawal capacity for $\alpha = 0^\circ$ 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:

$$N_{Rd,HB} = \min \left\{ \begin{array}{l} \frac{k_{mod} * F_{ax,Rk; HB}}{\gamma_M} \\ \frac{F_{t,Rk; HB}}{\gamma_{M,2}} \end{array} \right.$$

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]

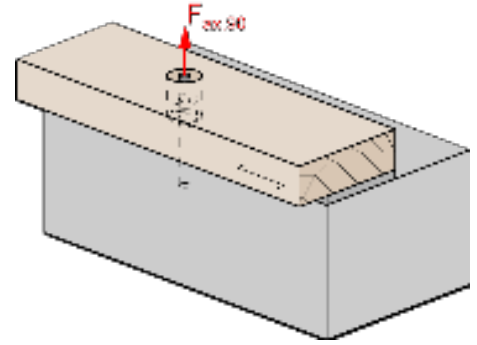
Information about the Hanger Bolt-related values is given in Chapter: **Load resistances Hilti Hangerbolt**

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 $0^\circ \leq \alpha \leq 90^\circ$ 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:

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

with

$F_{ax,\alpha,Rk}$: $F_{ax,\alpha,Rk} = F_{ax,90,Rk}$ for $45^\circ \leq \alpha \leq 90^\circ$
 $F_{ax,\alpha,Rk} = k_{ax} \times F_{ax,90,Rk}$ for $0^\circ < \alpha < 45^\circ$

with

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

and

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

$F_{t,Rk}$: 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

$F_{V,0,Rd-HCW}$:

Design HCW-shear capacity for $\alpha = 0^\circ$ (parallel to the grain)

$F_{V,0,Rk-HCW}$:

Characteristic HCW-shear capacity for $\alpha = 0^\circ$ (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

$F_{V,90,Rd-HCW}$:

Design HCW-shear capacity for $\alpha = 90^\circ$ (perpendicular to the grain)

$F_{V,90,Rk-HCW}$:

Characteristic HCW-shear capacity for $\alpha = 90^\circ$ (perpendicular to the grain)

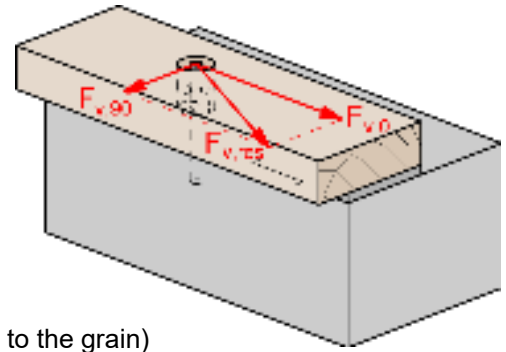
see Table 2 and Table 4

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; $F_{V,\alpha,Ed} = \sqrt{F_{V,90,Ed}^2 + F_{V,0,Ed}^2}$

$V_{Rd-Anchor}$

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

$V_{Rd,c} = V_{Rk,c} / \gamma_M$

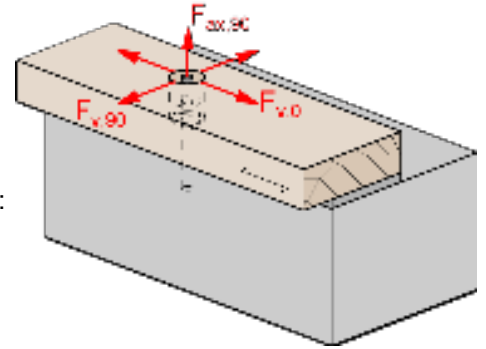
Concrete edge resistance (according to Whitepaper [6])

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)

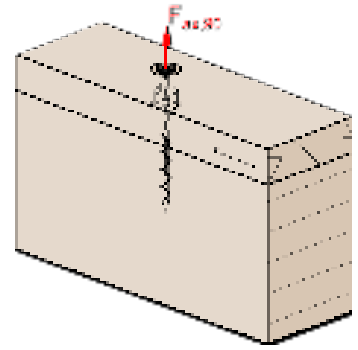
According to Hilti-method (see Whitepaper [6]):

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

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 $0^\circ \leq \alpha \leq 90^\circ$ 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:

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

with

$F_{ax,\alpha,Rk}$: $F_{ax,\alpha,Rk} = F_{ax,90,Rk}$ for $45^\circ \leq \alpha \leq 90^\circ$
 $F_{ax,\alpha,Rk} = k_{ax} \times F_{ax,90,Rk}$ for $0^\circ < \alpha < 45^\circ$

with

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

and

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

$F_{t,Rk}$: 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:

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

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 ($\alpha = 0^\circ$)

$F_{V,0,Rd-HCW}$:

Design HCW-shear capacity for $\alpha = 0^\circ$ (parallel to the grain)

$F_{V,0,Rk-HCW}$:

Characteristic shear capacity of HCW for $\alpha = 0^\circ$ (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 ($\alpha = 90^\circ$)

$F_{V,90,Rd-HCW}$:

Design HCW-shear capacity for $\alpha = 90^\circ$ (perpendicular to the grain)

$F_{V,90,Rk-HCW}$:

Characteristic shear capacity of HCW for $\alpha = 90^\circ$ (perpendicular to the grain)

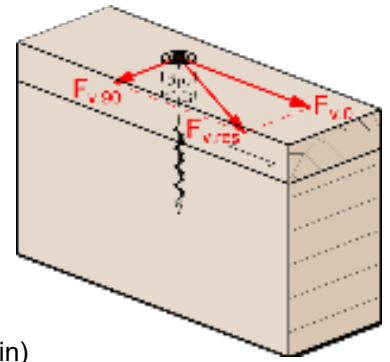
see Table 2 and Table 4

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

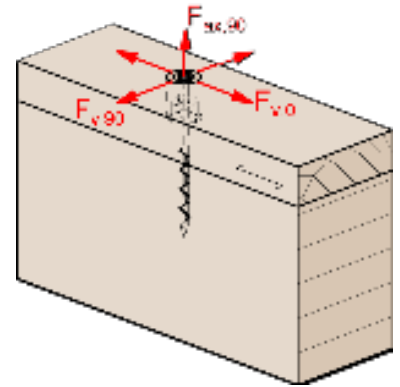
In case of combined shear- and tension-forces transferred from HCW into the timber members the following verifications shall be fulfilled:

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 ($\alpha = 0^\circ$)

$F_{V,0,Rd-HCW-S}$:

Design shear capacity of HCW-S for $\alpha = 0^\circ$ (parallel to the grain)

$F_{V,0,Rk-HCW-S}$:

Characteristic shear capacity of HCW-S for $\alpha = 0^\circ$ (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 $\alpha = 90^\circ$ (perpendicular to the grain)

$F_{V,90,Rk-HCW-S}$:

Characteristic shear capacity of HCW-S for $\alpha = 90^\circ$ (perpendicular to the grain)

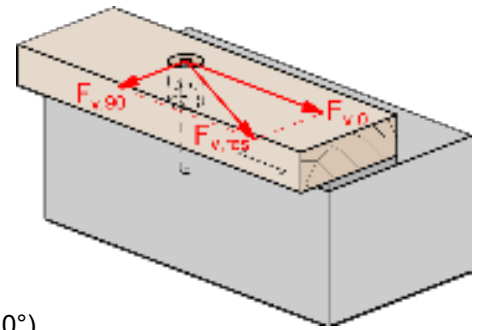
see Table 2 and Table 4

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; $F_{V,\alpha,Ed} = \sqrt{F_{V,90,Ed}^2 + F_{V,0,Ed}^2}$

$V_{Rd-Anchor}$

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

$V_{Rd,c} = V_{Rk,c} / \gamma_M$

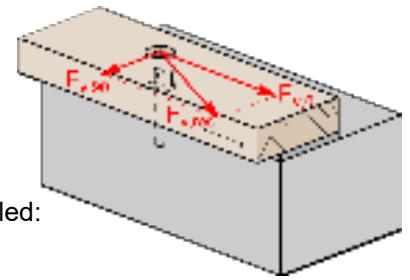
Concrete edge resistance (according to Whitepaper [6])

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 ($\alpha = 0^\circ$)

$F_{V,0,Rd-HCW-S}$:

Design shear capacity of HCW-S for $\alpha = 0^\circ$ (parallel to the grain)

$F_{V,0,Rk-HCW-S}$:

Characteristic shear capacity of HCW-S for $\alpha = 0^\circ$ (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 $\alpha = 90^\circ$ (perpendicular to the grain)

$F_{V,90,Rk-HCW-S}$:

Characteristic shear capacity of HCW-S for $\alpha = 90^\circ$ (perpendicular to the grain)

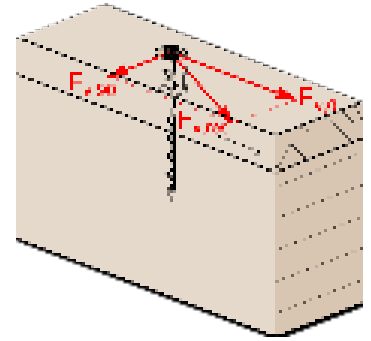
see Table 2 and Table 4

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

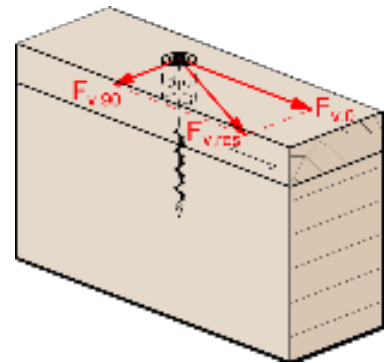
Interaction

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

HCW (Timber)

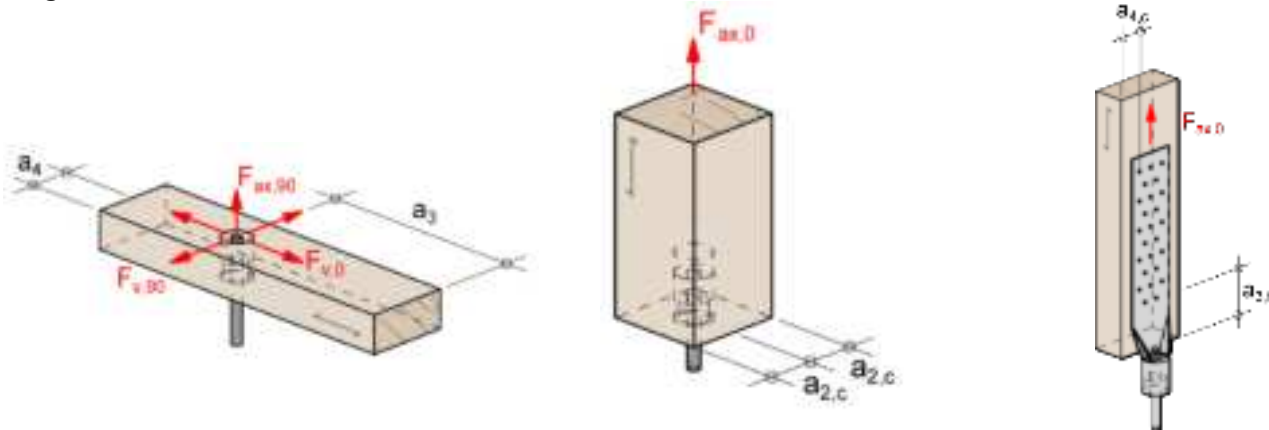
$$\left(\frac{F_{V,0,Ed}}{F_{V,0,Rd-HCW-S}} \right)^2 + \left(\frac{F_{V,90,Ed}}{F_{V,90,Rd-HCW-S}} \right)^2 \leq 1$$

Hanger Bolt (Timber) – no interaction required



Design basics

Load resistances for HCW, HCW-S, HCW-L in C24 and engineered timber products ($\rho_k = 350 \text{ kg/m}^3$), e.g. CLT, GL 24 h/c



Parameter	Type	Fastener type		Timber		Characteristic Load carrying capacities [kN]	
		Nails/Screws	Rod	Edge distance [mm]	Min cross-section [mm ²]		
Tension Strength	HCW-L	-	M12, 4.6	-	-	F _{t,Rk}	30,0
	HCW	-	M12, 8.8	-	-		42,0
	HCW-S	-	-	-	-		-
Axial Strength	HCW-L 40x295	15 nails ²⁾	M12, ≥ 4.6	a _{3,t} ≥ 58,5 ⁵⁾	45 x 80	F _{ax,0,Rk}	39,0
		25 nails ²⁾		a _{4,c} ≥ 20			45,0
	HCW-L 40x375	15 nails ²⁾	M12, ≥ 4.6	a _{3,t} ≥ 60	45 x 80	F _{ax,0,Rk}	39,0
		24 nails ²⁾		a _{4,c} ≥ 20			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	-	M12, ≥ 4.6	a ₄ ≥ 40 ¹⁾	45 x 80	F _{v,0,Rk}	24,4
	HCW-S			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 ($\rho_k = 350 \text{ kg/m}^3$), 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: $d \times l = 4 \times 50 \text{ mm}$ 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 $d = 8 \text{ mm}$.

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	Characteristic Load carrying capacities [kN]	
			Distances (a ₃) and (a ₄) [mm]		
Withdrawal capacity perpendicular to the grain	HCW	M12, ≥ 4.6	a ₃ ≥ 50 mm a ₄ ≥ 50 mm	F _{ax,90,Rk} ¹⁾	11,5
			a ₃ ≥ 58 mm a ₄ ≥ 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 ($\rho_k = 350 \text{ kg/m}^3$), e.g. CLT, GL 24h/c

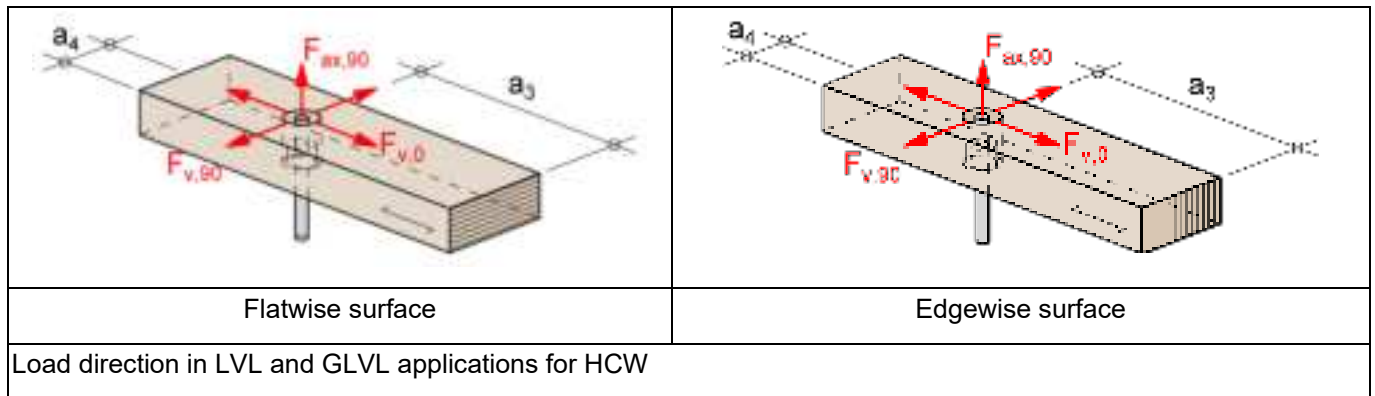
¹⁾ Also applicable for compression load-cases for HCW and HCW-S (e.g. during installation before the compression force is transferred to the mortar-layer; refer also to chapter 'Design information')

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

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

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 ($\rho_k = 480 \text{ kg/m}^3$)



Parameter	Fastener type		Timber		Min cross-section [mm ²]	Characteristic Load carrying capacities [kN]	
	Type	Rod	Type	Edge distance (a_4) ¹⁾ [mm]			
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 ($\rho_k = 480 \text{ kg/m}^3$)

Notes: ¹⁾ End- distance (a_3) is $\geq 200 \text{ mm}$.

²⁾ P – Parallel layers; C – crosswise layers.

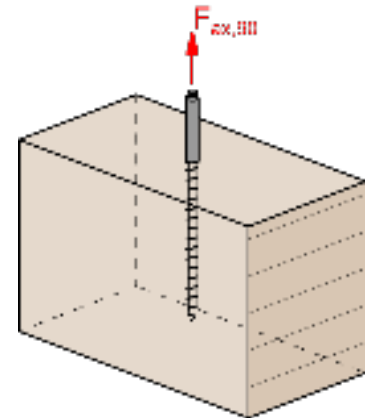
³⁾ Also applicable for compression load-cases for HCW and HCW-S (e.g. during installation before the compression force is transferred to the mortar-layer; refer also to chapter 'Design information')

$F_{ax,\alpha,Rk}$ for LVL-P/C member with lower or higher characteristic gross density $\rho_k = 480 \text{ kg/m}^3$ has to be applied according to the following equation:

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

ρ_a ... associated characteristic density in kg/m^3

Load resistances Hilti Hangerbolt



Analysis according EN 1995-1-1:

Force-fiber-angle $45^\circ \leq \alpha \leq 90^\circ$:

$$F_{ax,\alpha,Rk;HB} = \frac{n_{ef} \cdot f_{ax,k} \cdot d \cdot l_{ef}}{1,2 \cdot \cos^2 \alpha + \sin^2 \alpha} \left(\frac{\rho_k}{\rho_a} \right)^{0,8} \quad (\text{EN 1995-1-1 (8.40a)})$$

With

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

Axial withdrawal capacity for Hanger Bolts M12 ($f_{u,k} \geq 400 \text{ N/mm}^2$, $d_{nom,timber} = 11\text{mm}$)					
Solid timber / CLT	Density ρ_k [kg/m ³]	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:

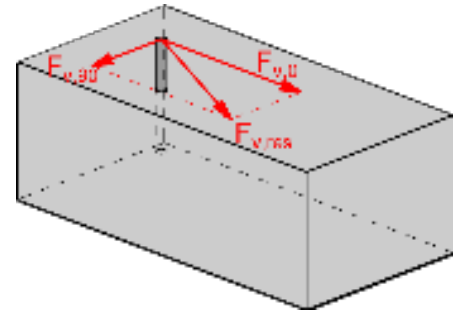
$$F_{t,Rk;HB} = n_{ef} \cdot f_{tens,k} \quad (\text{EN 1995-1-1 (8.40c)})$$

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

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)

Shear load capacity for Hilti HSW



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

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

with

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

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

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

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

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

with the ultimate strength of steel $f_{u,k} = 400 \text{ N/mm}^2$

(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 |