

ANGLE BRACKET FOR TENSILE LOADS

COMPLETE RANGE

Available in 5 sizes to be combined with 5 washers to meet all static performance requirements.

SPECIAL STEEL

S355 steel ensures high tensile strength.

HOLE DIAMETER

The hole for "big size" rods is proportioned to the system dimensions.



CHARACTERISTICS

FOCUS	tensile joints
HEIGHT	from 340 to 740 mm
THICKNESS	3,0 mm
FASTENERS	LBA, LBS, VIN-FIX PRO, EPO-FIX PLUS



MATERIAL

Bright zinc plated carbon steel, three dimensional perforated plate.

FIELDS OF USE

Timber-to-concrete and timber-to-timber tensile joints for panels and timber beams

- CLT, LVL
- solid timber and glulam
- framed structures (platform frame)
- timber based panels



CLT, TIMBER FRAME

High strength thanks to S355 steel, side reinforcement flanges and larger diameter hole at the base.

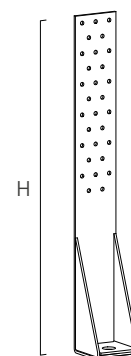
SEISMIC AND STIFFNESS

Within the SEISMIC-REV research project framework, the product and the related fastening elements were tested under static and cyclic loading, providing stiffness parameters (K_{ser}) and ductility levels.

CODES AND DIMENSIONS

WHT ANGLE BRACKET

CODE	H	hole	n _v Ø5	s	pcs
	[mm]	[mm]	[pcs]	[mm]	
WHT340	340	Ø18	20	3	10
WHT440	440	Ø18	30	3	10
WHT540	540	Ø22	45	3	10
WHT620	620	Ø26	55	3	10
WHT740	740	Ø29	75	3	1



WHTW WASHER

CODE	hole	s	WHT340	WHT440	WHT540	WHT620	WHT740	pcs
	[mm]	[mm]						
WHTW50	Ø18	10	●	●	●	-	-	1
WHTW50L	Ø22	10	-	-	●	-	-	1
WHTW70	Ø22	20	-	-	-	●	-	1
WHTW70L	Ø26	20	-	-	-	●	-	1
WHTW130	Ø29	40	-	-	-	-	●	1



XYLOFON WASHER RESILIENT PROFILE

CODE		hole	P	B	s	pcs
		[mm]	[mm]	[mm]	[mm]	
XYLW806060	WHT340					
	WHT440	Ø23	60	60	6,0	10
	WHT540					
XYLW808080	WHT620	Ø27	80	80	6,0	10
XYLW8080140	WHT740	Ø30	80	140	6,0	1



MATERIAL AND DURABILITY

WHT: S355 bright zinc plated carbon steel.

WHTW WASHER: S235 bright zinc plated carbon steel.

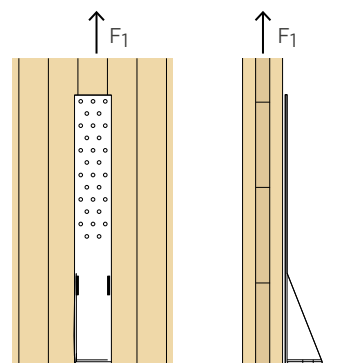
To be used in service classes 1 and 2 (EN 1995-1-1).

XYLOFON WASHER: Monolithic polyurethane compound.

FIELD OF USE

- Timber-to-concrete joints
- OSB-to-concrete joints
- Timber-to-timber joints
- Timber-to-OSB joints
- Timber-to-steel joints

EXTERNAL LOADS

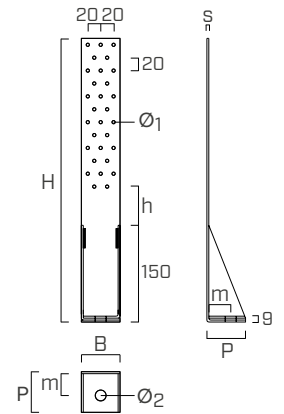


ADDITIONAL PRODUCTS - FASTENING

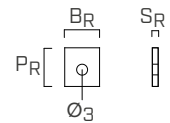
type	description		d	support	page
			[mm]		
LBA	Anker nail		4		548
LBS	screw for plates		5		552
VIN-FIX PRO	chemical anchor		M16 - M20 - M24 - M27		511
EPO-FIX PLUS	chemical anchor		M16 - M20 - M24 - M27		517
KOS	bolt		M16 - M20		526

GEOMETRY

WHT			WHT340	WHT440	WHT540	WHT620	WHT740
Height	H	[mm]	340	440	540	620	740
Base	B	[mm]	60	60	60	80	140
Depth	P	[mm]	63	63	63	83	83
Thickness	s	[mm]	3	3	3	3	3
Hole position in timber	h	[mm]	40	60	40	40	-
Hole position in concrete	m	[mm]	35	35	35	38	38
Flange holes	Ø ₁	[mm]	5,0	5,0	5,0	5,0	5,0
Base hole	Ø ₂	[mm]	18,0	18,0	22,0	26,0	29,0



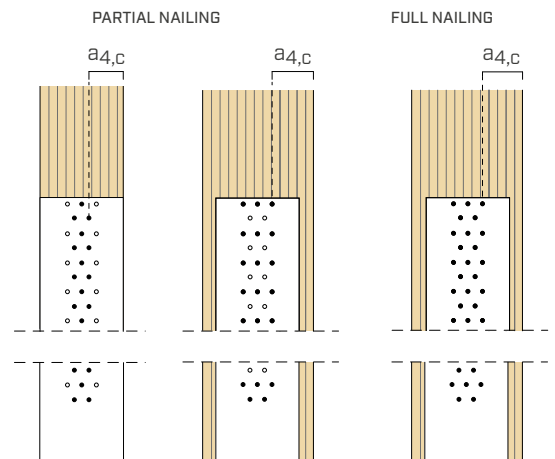
WHTW WASHER			WHTW50	WHTW50L	WHTW70	WHTW70L	WHTW130
Base	B _R	[mm]	50	50	70	70	130
Depth	P _R	[mm]	56	56	77	77	77
Thickness	s _R	[mm]	10	10	20	20	40
Washer hole	Ø ₃	[mm]	18,0	22,0	22,0	26,0	29,0



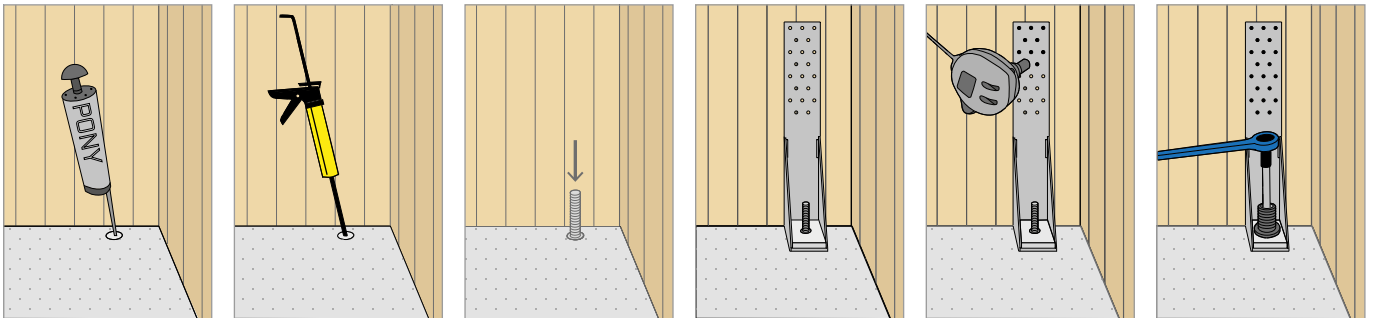
INSTALLATION

TIMBER minimum distances		nails LBA Ø4	screws LBS Ø5
C/GL	a _{4,c} [mm]	≥ 20	≥ 25
CLT	a _{4,c} [mm]	≥ 12	≥ 12,5

- C/GL: minimum distances for solid timber or glulam consistent with EN 1995-1-1 according to ETA considering a timber density $\rho_k \leq 420 \text{ kg/m}^3$
- CLT: minimum distances for Cross Laminated Timber according to ÖNORM EN 1995-1-1 (Annex K) for nails and ETA-11/0030 for screws



ASSEMBLY



Drilling of the concrete support and hole cleaning

Injection of the chemical anchor into the hole

Positioning of the threaded rod

Installation of WHT angle bracket (with washer if prescribed)

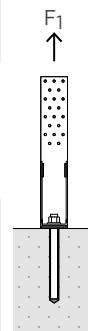
Nailing of the angle bracket

Positioning of the nut by adequate tightening

■ STATIC VALUES | TIMBER-TO-CONCRETE TENSILE JOINT

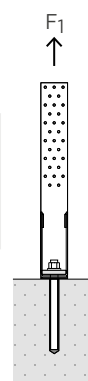
WHT340 - with or without WHTW50 washer

	R _{1,k} TIMBER				R _{1,k} STEEL		R _{1,d} CONCRETE						
configuration	holes fastening Ø5			R _{1,k} timber	R _{1,k} steel		R _{1,d} uncracked		R _{1,d} cracked		R _{1,d} seismic		
	type	Ø x L	n _v		[kN]	[kN]	γ _{steel}	VIN-FIX PRO Ø x L	[kN]	EPO-FIX PLUS Ø x L	[kN]	EPO-FIX PLUS Ø x L	[mm]
		[mm]	[pcs]	[mm]				[mm]		[mm]		[mm]	
- total fastening - washer WHTW50 - M16 anchor	LBA nails	Ø4,0 x 40	20	31,4	63,4	γ _{M2}	M16 x 190	39,0	M16 x 190	33,8	M16 x 230 M16 x 190	21,0 16,6	
		Ø4,0 x 60	20	38,6									
	LBS screws	Ø5,0 x 40	20	31,4									
		Ø5,0 x 50	20	38,6									
- partial fastening - washer WHTW50 - M16 anchor	LBA nails	Ø4,0 x 40	14	22,0	63,4	γ _{M2}	M16 x 190	39,0	M16 x 190	33,8	M16 x 230 M16 x 190	21,0 16,6	
		Ø4,0x 60	14	27,0									
	LBS screws	Ø5,0 x 40	14	22,0									
		Ø5,0 x 50	14	27,0									
- total fastening - without washer - M16 anchor	LBA nails	Ø4,0 x 40	20	31,4	42,0	γ _{M0}	M16 x 160	33,8	M16 x 160	29,3	M16 x 190 M16 x 160	17,7 14,4	
		Ø4,0 x 60	20	38,6									
	LBS screws	Ø5,0 x 40	20	31,4									
		Ø5,0 x 50	20	38,6									
- partial fastening - without washer - M16 anchor	LBA nails	Ø4,0 x 40	14	22,0	42,0	γ _{M0}	M16 x 160	33,8	M16 x 160	29,3	M16 x 190 M16 x 160	17,7 14,4	
		Ø4,0x 60	14	27,0									
	LBS screws	Ø5,0 x 40	14	22,0									
		Ø5,0 x 50	14	27,0									



WHT440 - with or without WHTW50 washer

	R _{1,k} TIMBER				R _{1,k} STEEL		R _{1,d} CONCRETE					
configuration	holes fastening Ø5			R _{1,k} timber	R _{1,k} steel		R _{1,d} uncracked		R _{1,d} cracked		R _{1,d} seismic	
	type	Ø x L	n _v		[kN]	[kN]	Y _{steel}	VIN-FIX PRO Ø x L	[kN]	EPO-FIX PLUS Ø x L	[kN]	EPO-FIX PLUS Ø x L
		[mm]	[pcs]	[mm]				[mm]		[mm]		[mm]
- total fastening - washer WHTW50 - M16 anchor	LBA nails	Ø4,0 x 40	30	47,1	63,4	Y _{M2}	M16 x 230	49,2	M16 x 230	42,7	M16 x 230	21,0
		Ø4,0 x 60	30	57,9								
	LBS screws	Ø5,0 x 40	30	47,1								
		Ø5,0 x 50	30	57,9								
- partial fastening - washer WHTW50 - M16 anchor	LBA nails	Ø4,0 x 40	20	31,4	63,4	Y _{M2}	M16 x 230 M16 x 190	49,2 39,0	M16 x 230 M16 x 190	42,7 33,8	M16 x 230 M16 x 190	21,0 16,6
		Ø4,0 x 60	20	38,6								
	LBS screws	Ø5,0 x 40	20	31,4								
		Ø5,0 x 50	20	38,6								
- partial fastening - without washer - M16 anchor	LBA nails	Ø4,0 x 40	20	31,4	42,0	Y _{M0}	M16 x 160	33,8	M16 x 160	29,3	M16 x 160	14,4
		Ø4,0x 60	20	38,6								
	LBS screws	Ø5,0 x 40	20	31,4								
		Ø5,0 x 50	20	38,6								



NOTES FOR SEISMIC DESIGN



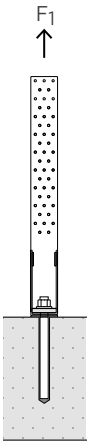
Particular attention has to be paid to the "capacity design" applied at different scale levels: the global structure and the connection system. Experimentally the ultimate strength of the LBA nail (and of the LBS screw) is notably larger than the characteristic strength evaluated according to EN 1995. E.g. LBA nail Ø4 x 60 mm: R_{v,k} ≈ 2,8 - 3,6 kN by experimental tests (variable according to the type of timber and plate thickness).

Experimental data derive from tests carried out within the Seismic-Rev research project and are reported in the scientific report: "Connection systems for timber buildings: experimental campaign to characterize stiffness, strength and ductility" (DICAM - Department of Civil, Environmental and Mechanical Engineering - UniTN).

■ STATIC VALUES | TIMBER-TO-CONCRETE TENSILE JOINT

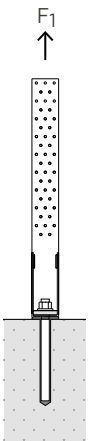
WHT540 - with WHTW50 washer (M16)

	R _{1,k} TIMBER				R _{1,k} STEEL		R _{1,d} CONCRETE					
configuration	holes fastening Ø5			R _{1,k} timber	R _{1,k} steel		R _{1,d} uncracked		R _{1,d} cracked		R _{1,d} seismic	
	type	Ø x L	n _v		[kN]	[kN]	γ _{steel}	VIN-FIX PRO Ø x L	[kN]	EPO-FIX PLUS Ø x L	[kN]	EPO-FIX PLUS Ø x L
		[mm]	[pcs]	[mm]				[mm]		[mm]		
- total fastening - washer WHTW50 - M16 anchor	LBA nails	Ø4,0 x 40	45	70,7	63,4	γ _{M2}	M16 x 190	39,0	M16 x 190	33,8	M16 x 190	16,6
		Ø4,0 x 60	45	86,9								
	LBS screws	Ø5,0 x 40	45	70,7								
		Ø5,0 x 50	45	86,9								
- partial fastening - washer WHTW50 - M16 anchor	LBA nails	Ø4,0 x 40	29	45,5	63,4	γ _{M2}	M16 x 190	39,0	M16 x 190	33,8	M16 x 190	16,6
		Ø4,0 x 60	29	56,0								
	LBS screws	Ø5,0 x 40	29	45,5								
		Ø5,0 x 50	29	56,0								



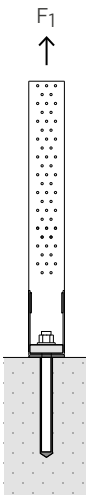
WHT540 - with washer WHTW50L (M20)

	R _{1,k} TIMBER				R _{1,k} STEEL		R _{1,d} CONCRETE					
configuration	holes fastening Ø5			R _{1,k} timber	R _{1,k} steel		R _{1,d} uncracked		R _{1,d} cracked		R _{1,d} seismic	
	type	Ø x L	n _v		[kN]	[kN]	γ _{steel}	VIN-FIX PRO Ø x L	[kN]	EPO-FIX PLUS Ø x L	[kN]	EPO-FIX PLUS Ø x L
		[mm]	[pcs]	[mm]				[mm]		[mm]		[mm]
- total fastening - washer WHTW50L - M20 anchor	LBA nails	Ø4,0 x 40	45	70,7	63,4	γ _{M2}	M20 x 240	59,3	M20 x 240 M20 x 284	50,2 62,3	M20 x 240 M20 x 284	25,1 31,1
		Ø4,0 x 60	45	86,9								
	LBS screws	Ø5,0 x 40	45	70,7								
		Ø5,0 x 50	45	86,9								
- partial fastening - washer WHTW50L - M20 anchor	LBA nails	Ø4,0 x 40	29	45,5	63,4	γ _{M2}	M20 x 240	59,3	M20 x 240 M20 x 284	50,2 62,3	M20 x 240 M20 x 284	25,1 31,1
		Ø4,0 x 60	29	56,0								
	LBS screws	Ø5,0 x 40	29	45,5								
		Ø5,0 x 50	29	56,0								



WHT620 - with WHTW70 washer (M20)

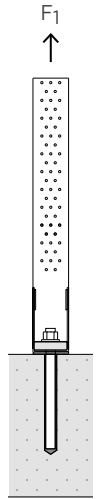
	R _{1,k} TIMBER				R _{1,k} STEEL		R _{1,d} CONCRETE					
configuration	holes fastening Ø5			R _{1,k} timber	R _{1,k} steel		R _{1,d} uncracked		R _{1,d} cracked		R _{1,d} seismic	
	type	Ø x L	n _v				VIN-FIX PRO Ø x L		EPO-FIX PLUS Ø x L		EPO-FIX PLUS Ø x L	
			[mm]	[pcs]	[kN]	[kN]	γ _{steel}	[mm]	[kN]	[mm]	[kN]	[mm]
- total fastening - washer WHTW70 - M20 anchor	LBA nails	Ø4,0 x 40	55	86,4	85,2	γ _{M2}	M20 x 240	57,15	M20 x 240	48,5	M20 x 240	24,2
		Ø4,0 x 60	55	106,2								
	LBS screws	Ø5,0 x 40	55	86,4								
		Ø5,0 x 50	55	106,2								
- partial fastening - washer WHTW70 - M20 anchor	LBA nails	Ø4,0 x 40	35	55,0	85,2	γ _{M2}	M20 x 240	57,15	M20 x 240	48,5	M20 x 240	24,2
		Ø4,0 x 60	35	67,6								
	LBS screws	Ø5,0 x 40	35	55,0								
		Ø5,0 x 50	35	67,6								



■ STATIC VALUES | TIMBER-TO-CONCRETE TENSILE JOINT

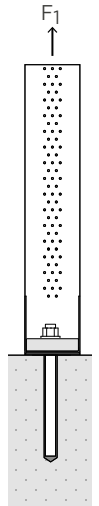
WHT620 - with WHTW70L washer (M24)

configuration	R _{1,k} TIMBER				R _{1,k} STEEL		R _{1,d} CONCRETE			
	holes fastening Ø5			R _{1,k} timber	R _{1,k} steel		R _{1,d} uncracked		R _{1,d} cracked	
	type	Ø x L	n _v		[kN]	Y _{steel}	VIN-FIX PRO Ø x L	[kN]	EPO-FIX PLUS Ø x L	[kN]
- total fastening - washer WHTW70L - M24 anchor	LBA nails	Ø4,0 x 40	55	86,4	85,2	Y _{M2}	M24 x 270	73,50	M24 x 270 M24 x 323	60,6 75,6
		Ø4,0 x 60	55	106,2						
	LBS screws	Ø5,0 x 40	55	86,4						
		Ø5,0 x 50	55	106,2						
- partial fastening - washer WHTW70L - M24 anchor	LBA nails	Ø4,0 x 40	35	55,0	85,2	Y _{M2}	M24 x 270	73,50	M24 x 270 M24 x 323	60,6 75,6
		Ø4,0 x 60	35	67,6						
	LBS screws	Ø5,0 x 40	35	55,0						
		Ø5,0 x 50	35	67,6						



WHT740 - with WHTW130 washer

configuration	R _{1,k} TIMBER				R _{1,k} STEEL		R _{1,d} CONCRETE			
	holes fastening Ø5			R _{1,k} timber	R _{1,k} steel		R _{1,d} uncracked		R _{1,d} cracked	
	type	Ø x L	n _v		[kN]	Y _{steel}	EPO-FIX PLUS Ø x L	[kN]	EPO-FIX PLUS Ø x L	[kN]
- total fastening - M27 anchor - washer WHTW130	LBA nails	Ø4,0 x 40	75	117,8	158,6	Y _{M2}	M27 x 400	153,3	M27 x 400	109,0
		Ø4,0 x 60	75	144,8						
	LBS screws	Ø5,0 x 40	75	117,8						
		Ø5,0 x 50	75	144,8						
- partial fastening - M27 anchor - washer WHTW130	LBA nails	Ø4,0 x 40	45	70,7	158,6	Y _{M2}	M27 x 300	122,6	M27 x 300	70,5
		Ø4,0 x 60	45	86,9						
	LBS screws	Ø5,0 x 40	45	70,7						
		Ø5,0 x 50	45	86,9						



GENERAL PRINCIPLES:

- Characteristic values are consistent with EN 1995-1-1 and in accordance with ETA-11/0086. The design values of the anchors for concrete are calculated in accordance with the respective European Technical Assessments. The connection design strength value is obtained from the values on the table as follows:

$$R_d = \min \left\{ \begin{array}{l} \frac{R_{k, \text{timber}} \cdot k_{\text{mod}}}{Y_M} \\ \frac{R_{k, \text{steel}}}{Y_{\text{steel}}} \\ R_{d, \text{concrete}} \end{array} \right.$$

The coefficients k_{mod} , Y_M and Y_{steel} should be taken according to the current regulations used for the calculation.

- The calculation process used a timber characteristic density of $\rho_k = 350 \text{ kg/m}^3$ and a C25/30 concrete strength class with a thin reinforcing layer, where there is no edge-distance and minimum thickness indicated in the installation parameters tables.

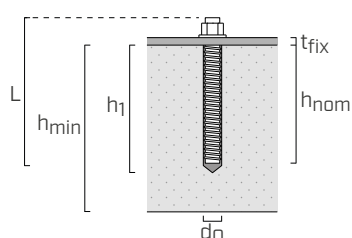
- Concrete design strength values are supplied for uncracked ($R_{1,d \text{ uncracked}}$), cracked ($R_{1,d \text{ cracked}}$) concrete and in case of seismic verification ($R_{1,d \text{ seismic}}$) for use of chemical anchor with threaded rod in steel class 5.8.
- Seismic design in performance category C2, without ductility requirements on anchors (option a2) elastic design according to EOTA TR045.
- Dimensioning and verification of timber and concrete elements must be carried out separately.
- For applications on CLT (Cross Laminated Timber) it is recommended to use nails/screws of adequate length to ensure that the fixing depth involves a sufficient timber thickness to prevent fragile failure for group effects.
- The strength values are valid for the calculation hypotheses defined in the table; for boundary conditions different from the ones in the table (e.g. minimum distances from the edge), the anchors-to-concrete can be verified using MyProject calculation software according to the design requirements.

CHEMICAL ANCHORS INSTALLATION PARAMETERS⁽¹⁾

type of rod	WHT type	type of washer	t _{fix}	h _{nom} = h _{ef}	h ₁	d ₀	h _{min}	
Ø x L [mm]				[mm]	[mm]	[mm]	[mm]	
M16	160	WHT340	-	9	132	140	18	200
	190	WHT340 / WHT440	-	9	162	170		200
		WHT340 / WHT440 / WHT540	WHTW50	19	152	160		200
	230	WHT340 / WHT440	WHTW50	19	192	200		240
M20	240	WHT540	-	9	206	215	22	240
		WHT540	WHTW50L	19	196	205		240
		WHT620	WHTW70	29	189	195		240
	min 284	WHT540	WHTW50L	19	243	250		300
	M24	270	WHT620	WHTW70L	29	215		220
min 323		WHT620	WHTW70L	29	268	275	320	
M27	min 300	WHT740	WHTW130	49	223	230	30	300
	400	WHT740	WHTW130	49	310	315		380

Precut INA threaded rod, with nut and washer: see page 520

MGS threaded rod class 8.8 to be cut to size: see page 534



t _{fix}	fastened plate thickness
h _{nom}	nominal anchoring depth
h _{ef}	effective anchor depth
h ₁	minimum hole depth
d ₀	hole diameter in the concrete support
h _{min}	concrete minimum thickness

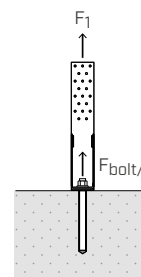
DIMENSIONING OF ALTERNATIVE ANCHORS

Fastening elements to the concrete through anchors not listed in the table, shall be verified according to the load acting on the anchors, which can be evaluated through the k_{t//} coefficients. The axial load acting on the anchor can be obtained as follows:

$$F_{\text{bolt//},d} = k_{t//} \cdot F_{1,d}$$

k_{t//} coefficient of eccentricity
F₁ axial load on the WHT angle bracket

	k _{t//}
WHT340	1,00
WHT440	1,00
WHT540	1,00
WHT620	1,00
WHT740	1,00



The anchor check is satisfied if the design tensile strength, obtained considering the boundary effects, is greater than the design external load: R_{bolt //,d} ≥ F_{bolt //,d}.

NOTES:

⁽¹⁾ Valid for the strength values shown in the table.

CONNECTION STIFFNESS

EVALUTATION OF SLIP MODULUS K_{ser}

- $K_{1,ser}$ experimental average value for WHT joints on GL24h Glulam and on CLT

WHT type	configuration	fastening type	n_v [pcs]	$K_{1,ser}$ [N/mm]	
		$\varnothing \times L$ [mm]		GL24h	CLT
WHT340	• total fastening • without washer	LBA nails $\varnothing 4,0 \times 60$	20	-	3440
	• total fastening • with washer	LBA nails $\varnothing 4,0 \times 60$	20	5705	7160
	• partial fastening • with washer	LBA nails $\varnothing 4,0 \times 60$	12	-	5260
WHT440	• total fastening • with washer	LBA nails $\varnothing 4,0 \times 60$	30	6609	10190
	• partial fastening • with washer	LBA nails $\varnothing 4,0 \times 60$	20	-	8060
WHT540	• total fastening • with washer	LBA nails $\varnothing 4,0 \times 60$	45	-	11470
	• partial fastening • with washer	LBA nails $\varnothing 4,0 \times 60$	29	-	9700
WHT620	• total fastening • with washer	LBA nails $\varnothing 4,0 \times 60$	52/55	13247	13540
	• partial fastening • with washer	LBA nails $\varnothing 4,0 \times 60$	30/35	9967	10310



Seismic-REV experimental campaign on GL24h glulam (DICAM-University of Trento and CNR-IVALSA San Michele All'Adige, 2015).

- K_{ser} according to EN 1995-1-1 for timber-to-timber joint nails* GL24h/C24

Nails (without pre-drilling hole) $\frac{\rho_m^{1,5} \cdot d^{0,8}}{30}$ (EN 1995 § 7.1)

WHT type	fastening type	n_v	K_{ser}
	$\varnothing \times L$ [mm]	[pcs]	[N/mm]
WHT340	LBA nails $\varnothing 4,0 \times 60$	14	12177
		20	17395
WHT440	LBA nails $\varnothing 4,0 \times 60$	20	17395
		30	26093
WHT540	LBA nails $\varnothing 4,0 \times 60$	29	25223
		45	39139
WHT620	LBA nails $\varnothing 4,0 \times 60$	35	30442
		55	47837

* For steel-to-timber connections the reference standard indicates the possibility of doubling the value of K_{ser} listed in the table (7.1 (3)).



Experimental campaign on CLT panels (C24) (CNR-IBE San Michele All'Adige, 2020).