

WHT

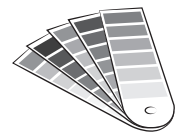
Angle bracket for tensile loads

Bright zinc plated carbon steel three-dimensional perforated plate



COMPLETE RANGE

4 sizes combined with 4 different washers determine 10 possible configurations, that can meet any static performance target



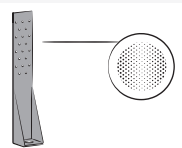
FIELD OF USE

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

- XLAM (Cross Laminated Timber)
Framed structures
(platform frame)
- wood-based panels
- LVL (Laminated Veneer Lumber)
- solid wood
- glulam (Glued Laminated Timber)

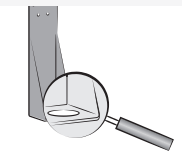
SPECIAL STEEL

S355 (Fe510) steel ensures high tensile strength



OVERSIZED HOLES

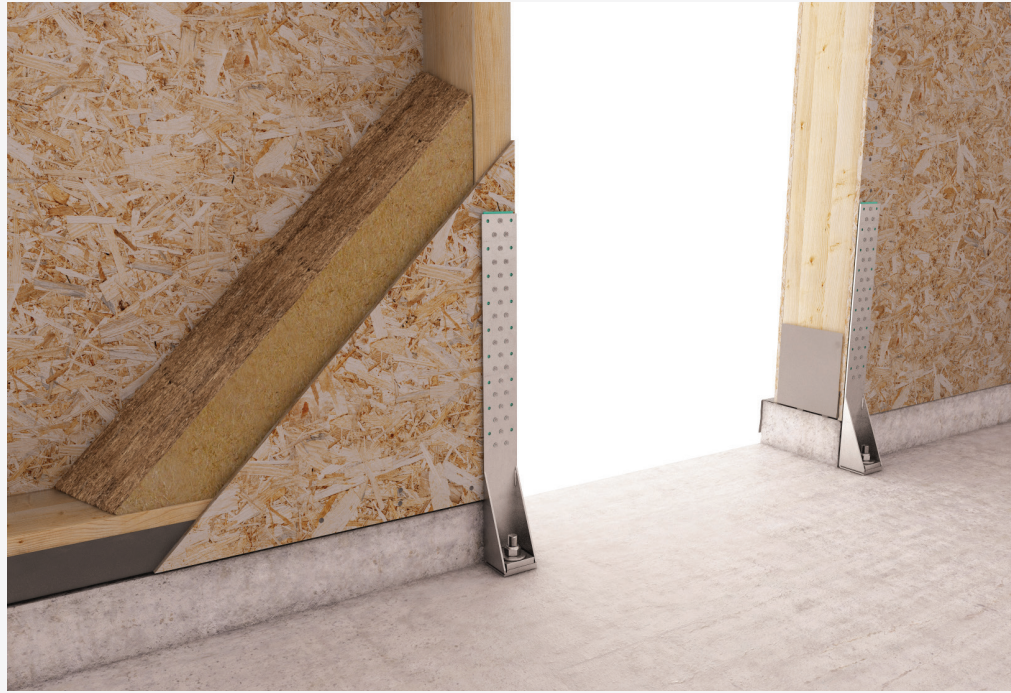
Holes with increased diameter permit to obtain higher strength values and facilitate the installation of the fastener



CERTIFIED SAFETY

Quality is proven by testing on the product and the related fasteners (nails, screws, threaded rods and resins)





OPTIMIZED APPLICATIONS

The 4 versions can be combined with one or more washers to allow designers and carpenters to find the suitable application, on both solidwood (XLAM - Cross Laminated Timber) and framed (platform frame) panels

STRENGTH

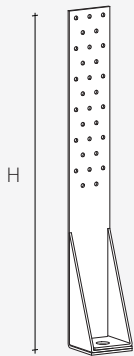
S355 steel, lateral reinforcing flanges, bigger holes and the increased number of nails on the flange ensure high strength values also in case of partial nailing

SEISMIC AND STIFFNESS

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

CODES AND DIMENSIONS

WHT



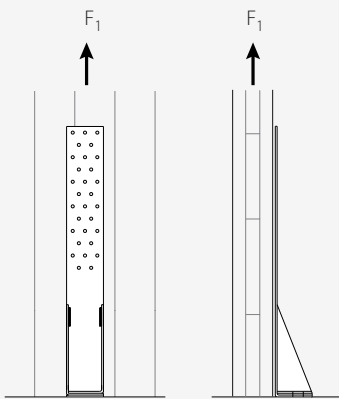
code	type	H [mm]	hole [mm]	n _v Ø5 [pcs]	s [mm]	pcs/box
WHT340	WHT340	340	Ø17	20	3	10
WHT440	WHT440	440	Ø17	30	3	10
WHT540	WHT540	540	Ø22 new	45	3	10
WHT620	WHT620	620	Ø26 new	55	3	10

WHT WASHER



code	type	hole [mm]	s [mm]	WHT340	WHT440	WHT540	WHT620	pcs/box
ULS505610	WHTBS50	Ø18	10	-	●	●	-	1
ULS505610L	WHTBS50L	Ø22 new	10	-	-	●	-	1
ULS707720	WHTBS70	Ø22	20	-	-	-	●	1
ULS707720L	WHTBS70L	Ø26 new	20	-	-	-	●	1

EXTERNAL LOADS



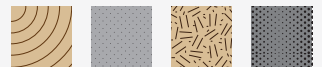
MATERIAL AND DURABILITY

WHT: S355 bright zinc plated Fe/Zn 12c carbon steel.

WHT WASHER: S235 bright zinc plated Fe/Zn 12c carbon steel. To be used in Service class 1 and 2 (EN 1995:2008).

FIELD OF USE

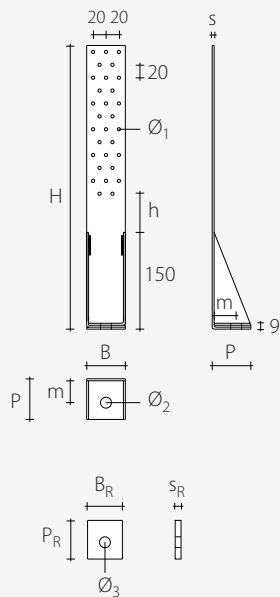
Timber to concrete joints
OSB to concrete joints
Timber to timber joints
OSB to timber joints
Steel to timber joints



ADDITIONAL PRODUCTS - FIXINGS

type	description		d [mm]	support	p.
LBA	anker nail		4		364
LBS	screw for plates		5		364
VINYLPUR	chemical anchor		M16 - M20 - M24		346
EPOPLUS	chemical anchor		M16 - M20 - M24		354
KOS	bolt		M16 - M20		54

GEOMETRY

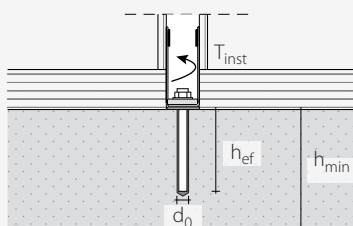
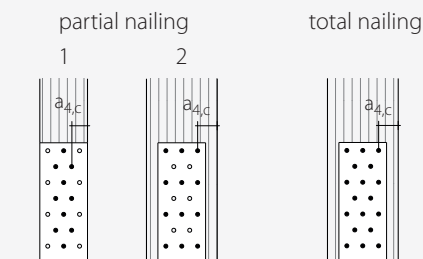


WHT ANGLE BRACKET		WHT340	WHT440	WHT540	WHT620
Height	H [mm]	340	440	540	620
Width	B [mm]	60	60	60	80
Depth	P [mm]	63	63	63	83
Thickness	s [mm]	3	3	3	3
Hole position in timber	h [mm]	40	60	40	40
Hole position in concrete	m [mm]	35	35	35	38
Flange holes	Ø ₁ [mm]	5,0	5,0	5,0	5,0
Base hole	Ø ₂ [mm]	17,0	17,0	22,0	26,0
WHT washer	type	-	WHTBS50	WHTBS50L WHTBS50	WHTBS70L WHTBS70

WHTBS WASHER		WHTBS50	WHTBS50L	WHTBS70	WHTBS70L
WHT Angle bracket	type	WHT440 / WHT540	WHT540	WHT620	WHT620
Width	B _R [mm]	50	50	70	70
Depth	P _R [mm]	56	56	77	77
Thickness	s _R [mm]	10	10	20	20
Washer hole	Ø ₃ [mm]	18,0	22,0	22,0	26,0

INSTALLATION

MINIMUM DISTANCES

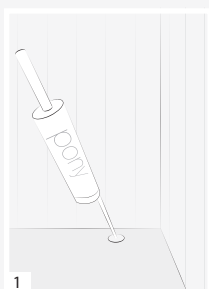


TIMBER		anker nail LBA Ø4	screw LBS Ø5
Lateral connector - Unloaded edge	a _{4,c} [mm]	≥ 5 d	≥ 20

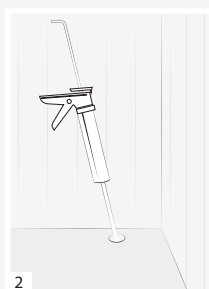
CONCRETE		chemical anchor VINYLPRO / EPOPLUS		
		M16	M20	M24
Minimum support thickness	h _{min} [mm]	h _{ef} + 2 d ₀		
Hole diameter in concrete	d ₀ [mm]	18	24	28
Tightening torque	T _{inst} [Nm]	80	120	160

h_{ef} = effective anchorage length on concrete

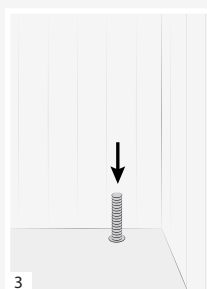
ASSEMBLING ON CONCRETE



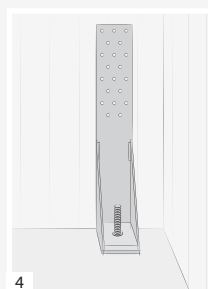
Drilling of the concrete support and hole cleaning



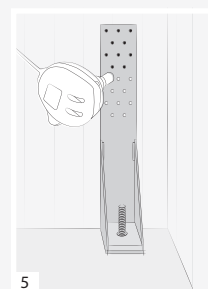
Injection of the chemical anchor into the hole



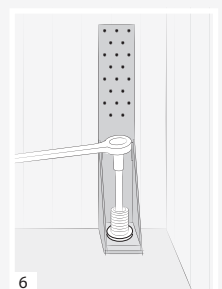
Positioning of the threaded rod



Installation of WHT angle bracket (with washer if prescribed)



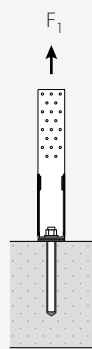
Nailing of the angle bracket



Positioning of the nut by adequate tightening

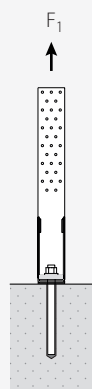
STATIC VALUES - TENSION JOINT - TIMBER-TO-CONCRETE

WHT340



CHARACTERISTIC VALUES												
configuration	R _{1,k} TIMBER				R _{1,k} STEEL			R _{1,k} UNCRACKED CONCRETE			R _{1,k} CRACKED CONCRETE	
	fasteners holes Ø5			R _{1,k} timber [kN]	washer	R _{1,k} steel		anchor VINYLPRO Ø x L [mm]	R _{1,k} cls		anchor EPOPLUS Ø x L [mm]	R _{1,k} cls
	type	Ø x L [mm]	n _v [pcs]			[kN]	γ _{steel}		[kN]	γ _{cls}		
• total fixing • without washer • M16 anchor	nails LBA	Ø4,0 x 40	20	31,4	-	42,0	γ _{m0}	M16 x 160	64,84	1,8	M16 x 160 M16 x 190	35,66 43,95
		Ø4,0 x 60	20	38,6								
	screws LBS	Ø5,0 x 40	20	31,4								
		Ø5,0 x 50	20	38,6								
• partial fixing • without washer • M16 anchor	nails LBA	Ø4,0 x 40	14	22,0	-	42,0	γ _{m0}	M16 x 160	64,84	1,8	M16 x 160 M16 x 190	35,66 43,95
		Ø4,0 x 60	14	27,0								
	screws LBS	Ø5,0 x 40	14	22,0								
		Ø5,0 x 50	14	27,0								

WHT440



CHARACTERISTIC VALUES												
configuration	R _{1,k} TIMBER				R _{1,k} STEEL			R _{1,k} UNCRACKED CONCRETE			R _{1,k} CRACKED CONCRETE	
	fasteners holes Ø5			R _{1,k} timber [kN]	washer	R _{1,k} steel		anchor VINYLPRO Ø x L [mm]	R _{1,k} cls		anchor EPOPLUS Ø x L [mm]	R _{1,k} cls
	type	Ø x L [mm]	n _v [pcs]			[kN]	γ _{steel}		[kN]	γ _{cls}		
• total fixing • washer WHTBS50 • M16 anchor	nails LBA	Ø4,0 x 40	30	47,1	WHTBS50	63,4	γ _{m2}	M16 x 190	74,90	1,8	M16 x 190 M16 x 230	41,19 52,25
		Ø4,0 x 60	30	57,9								
	screws LBS	Ø5,0 x 40	30	47,1								
		Ø5,0 x 50	30	57,9								
• partial fixing • washer WHTBS50 • M16 anchor	nails LBA	Ø4,0 x 40	20	31,4	WHTBS50	63,4	γ _{m2}	M16 x 190	74,90	1,8	M16 x 190 M16 x 230	41,19 52,25
		Ø4,0 x 60	20	38,6								
	screws LBS	Ø5,0 x 40	20	31,4								
		Ø5,0 x 50	20	38,6								
• partial fixing • without washer • M16 anchor	nails LBA	Ø4,0 x 40	20	31,4	-	42,0	γ _{m0}	M16 x 160	64,84	1,8	M16 x 160	35,66
		Ø4,0 x 60	20	38,6								
	screws LBS	Ø5,0 x 40	20	31,4								
		Ø5,0 x 50	20	38,6								

GENERAL PRINCIPLES

- Characteristic values are consistent with EN 1995:2008 and in accordance with ETA-11/0086.
- Design values can be obtained from characteristic values as follows:

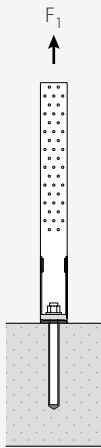
$$R_d = \min \left\{ \begin{array}{l} \frac{R_{1,k \text{ timber}} \cdot k_{mod}}{\gamma_m} \\ \frac{R_{1,k \text{ steel}}}{\gamma_{steel}} \\ \frac{R_{1,k \text{ cls}}}{\gamma_{cls}} \end{array} \right.$$

Coefficients γ_m and k_{mod} must be taken according to current Standard adopted for the design.

Coefficients γ_{steel} and γ_{cls} are listed in the table and are in accordance with the product certificates.

- For applications on XLAM (Cross Laminated Timber) the use of nails/screws with length L ≥ 60 mm is recommended. Shorter fasteners may lead to brittle failure due to "group effect" as the reduced penetration depth affects exclusively the outer layer.
- For the calculations, a timber density ρ_k = 350 kg/m³ and a concrete grade C20/25 have been considered.
- Dimensioning and verification of timber elements must be carried out separately.
- The strength values of the connection system are valid under the calculation hypotheses listed in the table; different boundary conditions (e.g., minimum edge distance) shall be verified.
- Thanks to validation via experimental testing, the strength values can be extended to the case where an OSB panel is placed between the WHT angle bracket and the timber support, providing that the minimum penetration depth and adequate OSB-to-framing fastening are guaranteed.
- Admissible values are obtained according to DIN 1052:1988.

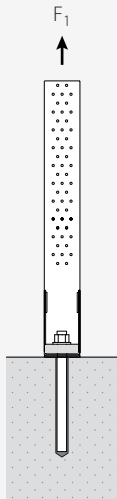
WHT540



CHARACTERISTIC VALUES													
	R _{1,k} TIMBER				R _{1,k} STEEL			R _{1,k} UNCRACKED CONCRETE			R _{1,k} CRACKED CONCRETE		
configuration	fasteners holes Ø5			R _{1,k} timber [kN]	washer	R _{1,k} steel		anchor VINYLPRO Ø x L [mm]	R _{1,k} c/s		anchor EPOPLUS Ø x L [mm]	R _{1,k} c/s	
	type	Ø x L [mm]	n _v [pcs]			[kN]	[kN]		γ _{steel}	[kN]		γ _{cls}	[kN]
• total fixing • washer WHTBS50L • M20 anchor	nails LBA	Ø4,0 x 40	45	70,7	WHTBS50L	63,4	γ _{m2}	M20 x 240	120,63	1,8	M20 x 240 M20 x 290 ⁽¹⁾	60,32 75,39	2,1 2,1
		Ø4,0 x 60	45	86,9									
	screws LBS	Ø5,0 x 40	45	70,7									
• partial fixing • washer WHTBS50L • M20 anchor		Ø5,0 x 50	45	86,9									
	nails LBA	Ø4,0 x 40	27	42,4	WHTBS50L	63,4	γ _{m2}	M20 x 240	120,63	1,8	M20 x 240 M20 x 290 ⁽¹⁾	60,32 75,39	2,1 2,1
		Ø4,0 x 60	27	52,1									
	screws LBS	Ø5,0 x 40	27	42,4									
		Ø5,0 x 50	27	52,1									
• total fixing • washer WHTBS50 • M16 anchor	nails LBA	Ø4,0 x 40	45	70,7	WHTBS50	63,4	γ _{m2}	M16 x 190	74,89	1,8	M16 x 190	41,19	1,8
		Ø4,0 x 60	45	86,9									
	screws LBS	Ø5,0 x 40	45	70,7									
• partial fixing • washer WHTBS50 • M16 anchor		Ø5,0 x 50	45	86,9									
	nails LBA	Ø4,0 x 40	27	42,4	WHTBS50	63,4	γ _{m2}	M16 x 190	74,89	1,8	M16 x 190	41,19	1,8
		Ø4,0 x 60	27	52,1									
	screws LBS	Ø5,0 x 40	27	42,4									
		Ø5,0 x 50	27	52,1									

⁽¹⁾ Length obtainable from MGS threaded rods (to be cut to measure)

WHT620

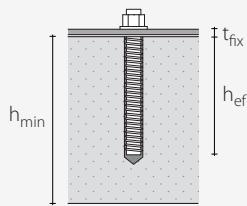


CHARACTERISTIC VALUES													
	R _{1,k} TIMBER				R _{1,k} STEEL			R _{1,k} UNCRACKED CONCRETE			R _{1,k} CRACKED CONCRETE		
configuration	fasteners holes Ø5			R _{1,k} timber [kN]	washer	R _{1,k} steel		anchor VINYLPRO Ø x L [mm]	R _{1,k} c/s		anchor EPOPLUS Ø x L [mm]	R _{1,k} c/s	
	type	Ø x L [mm]	n _v [pcs]			[kN]	[kN]		γ _{steel}	[kN]		γ _{ds}	[kN]
• total fixing • washer WHTBS70L • M24 anchor	nails LBA	Ø4,0 x 40	55	86,4	WHTBS70L	85,2	γ _{m2}	M24 x 270	148,98	1,8	M24 x 270 M24 x 330 ⁽¹⁾	70,57 90,93	2,1 2,1
		Ø4,0 x 60	55	106,2									
	screws LBS	Ø5,0 x 40	55	86,4									
		Ø5,0 x 50	55	106,2									
• partial fixing • washer WHTBS70L • M24 anchor	nails LBA	Ø4,0 x 40	33	51,8	WHTBS70L	85,2	γ _{m2}	M24 x 270	148,98	1,8	M24 x 270 M24 x 330 ⁽¹⁾	70,57 90,93	2,1 2,1
		Ø4,0 x 60	33	63,7									
	screws LBS	Ø5,0 x 40	33	51,8									
		Ø5,0 x 50	33	63,7									
• total fixing • washer WHTBS70 • M20 anchor	nails LBA	Ø4,0 x 40	55	86,4	WHTBS70	85,2	γ _{m2}	M20 x 240	114,35	1,8	M20 x 240	57,17	2,1
		Ø4,0 x 60	55	106,2									
	screws LBS	Ø5,0 x 40	55	86,4									
		Ø5,0 x 50	55	106,2									
• partial fixing • washer WHTBS70 • M20 anchor	nails LBA	Ø4,0 x 40	33	51,8	WHTBS70	85,2	γ _{m2}	M20 x 240	114,35	1,8	M20 x 240	57,17	2,1
		Ø4,0 x 60	33	63,7									
	screws LBS	Ø5,0 x 40	33	51,8									
		Ø5,0 x 50	33	63,7									

⁽¹⁾ Length obtainable from MGS threaded bars (to be cut to measure)

STATIC VALUES - TENSION JOINT - TIMBER-TO-CONCRETE

CHEMICAL ANCHOR INSTALLATION PARAMETERS



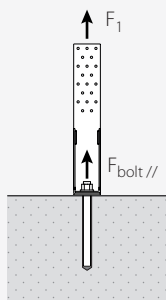
type of bar Ø x L [mm]	code	steel class	type WHT	type of washer	t _{fix} [mm]	h _{ef} [mm]	h _{min} [mm]
M16	160	FE210116 ⁽²⁾	5.8	WHT340	-	9	129
	190	FE210118 ⁽²⁾	5.8	WHT340 / WHT440 WHT440 / WHT540	- WHTBS50	9 19	159 149
	230	FE210121 ⁽²⁾	5.8	WHT440	WHTBS50	19	189
M20	240	FE210117 ⁽²⁾	5.8	WHT540 WHT620	- WHTBS50L WHTBS70	9 19 29	202 192 182
	290	MGS M20 ⁽³⁾	4.8 / 8.8	WHT540	WHTBS50L	19	240
	270	FE210122 ⁽²⁾	5.8	WHT620	-	9	228
M24	330	MGS M24 ⁽³⁾	4.8 / 8.8	WHT620	WHTBS70L	29	268
							330

⁽²⁾ Precut INA threaded rod, with nut and washer

⁽³⁾ When employing threaded rods that are cut on size, the use of MUT DIN934 nut and ULS DIN 125 washer is recommended

DIMENSIONING OF ALTERNATIVE ANCHORS

Fixing elements to the concrete ringbeam by means of anchors that are not listed in the table, shall be verified according to the load acting on the anchor, which can be evaluated through the $k_{t//}$ coefficients. The axial load acting on the anchor can be obtained as follows:



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

$k_{t//}$ = coefficient of eccentricity

F_1 = axial load on the WHT angle bracket

	$k_{t//}$
WHT340	1,00
WHT440	1,00
WHT540	1,00
WHT620	1,00

The anchor check is satisfied if the design tensile strength, obtained considering the boundary effects, is greater than the design external load:

$$R_{bolt//,d} \geq F_{bolt//,d}$$

NOTES for seismic design



Particular attention has to be paid to the "capacity design" applied at different scale levels: the global structure and the WHT 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

Ex. LBA nail Ø4 x 60 mm: $R_{vk} = 1,93$ kN according to EN1995 / $R_{vk} = 2,8 - 3,6$ kN from experimental tests (it varies depending on the timber properties). Experimental data derive from tests carried out within the X-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).

ADMISSIBLE VALUES - UNCRACKED CONCRETE

TYPE WHT	TYPE WASHER	type	hole fixing Ø5 Ø x L [mm]	n _v [pcs]	chemical anchor VINYLPRO Ø x L [mm]	N _{1,adm} [kg]
WHT340	-	nails LBA	Ø4,0 x 60	20	M16 x 160	1428
WHT440	WHTBS50	nails LBA	Ø4,0 x 60	30	M16 x 190	2142
WHT540	WHTBS50L	nails LBA	Ø4,0 x 60	45	M20 x 240	3213
WHT620	WHTBS70L	nails LBA	Ø4,0 x 60	55	M24 x 270	3927

CONNECTION STIFFNESS

EVALUATION OF SLIP MODULUS K_{ser}

- K_{ser} experimental average value for WHT joints on GL24h Glulam

TYPE WHT	configuration	fastener type $\emptyset \times L$ [mm]	n_v [pcs]	K_{ser} [N/mm]
WHT340	• total fixing • with WHTBS50 washer	nails LBA $\emptyset 4,0 \times 60$	20	5705
WHT440	• total fixing • with WHTBS50 washer	nails LBA $\emptyset 4,0 \times 60$	30	6609
WHT540	-	-	-	-
WHT620	• partial fixing • with WHTBS70 washer	nails LBA $\emptyset 4,0 \times 60$	30	9967
	• partial fixing • with WHTBS70 washer	nails LBA $\emptyset 4,0 \times 60$	52	13247

- K_{ser} according to EN 1995:2008 for nails in a steel-to-timber (GL24h) joint

Nails (without predrill) $\frac{\rho_m^{1,5} d^{0,8}}{30}$ (EN 1995:2008 § 7.1)

TYPE WHT	fastener type $\emptyset \times L$ [mm]	n_v [pcs]	$K_{ser, max}$ [N/mm]
WHT340	screws LBA $\emptyset 4,0 \times 60$	14	12177
		20	17395
WHT440	screws LBA $\emptyset 4,0 \times 60$	20	17395
		30	26093
WHT540	screws LBA $\emptyset 4,0 \times 60$	27	23484
		45	39139
WHT620	screws LBA $\emptyset 4,0 \times 60$	33	28702
		55	47837

