TITAN PLATE C CONCRETE

EN 14545

PLATES FOR SHEAR LOADS

VERSATILE
Suitable for a continuous fastening of both CLT (Cross Laminated Timber) panels and framed panels to the sub-structure.

INNOVATIVE
Designed to be partially or completely fastened with nails or screws. Possibility of installation even in the presence of bedding mortar.

CALCULATED AND CERTIFIED
CE marking according to EN 14545. Available in 2 versions. TCP300 with increased thickness optimised for CLT.

CHARACTERISTICS

FOCUS	shear joints on concrete
HEIGHT	200 | 300 mm
THICKNESS	3,0 | 4,0 mm
FASTENERS	LBA, LBS, VIN-FIX PRO, EPO-FIX PLUS, AB1, SKR

MATERIAL
Bright zinc plated carbon steel, two dimensional perforated plate.

FIELDS OF USE
Timber-to-concrete shear joints for panels and timber beams
- CLT, LVL
- solid timber and glulam
- framed structures (platform frame)
- timber based panels

ADDED STOREYS

Ideal for making flat joints between concrete or masonry elements and CLT panels. Construction of continuous shear connections.

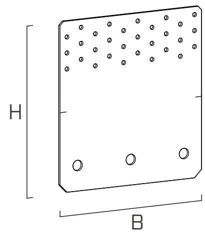
CONCRETE KERB

Versatile fastening configurations. Solutions designed, calculated, tested and certified with partial and total fastening, with horizontal or vertical fibre direction.

CODES AND DIMENSIONS

TITAN PLATE TCP

CODE	B [mm]	H [mm]	holes	n_v Ø5 [pcs]	s [mm]		pcs
TCP200	200	214	Ø13	30	3	●	10
TCP300	300	240	Ø17	21	4	●	5



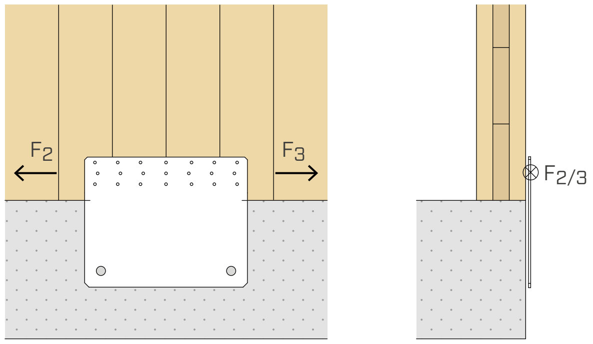
MATERIAL AND DURABILITY

TCP200: carbon steel DX51D+Z275.
TCP300: S355 bright zinc plated carbon steel.
To be used in service classes 1 and 2 (EN 1995-1-1).

FIELD OF USE

- Timber to concrete joints

EXTERNAL LOADS

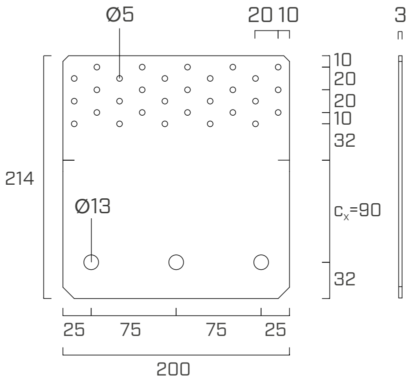


ADDITIONAL PRODUCTS - FASTENING

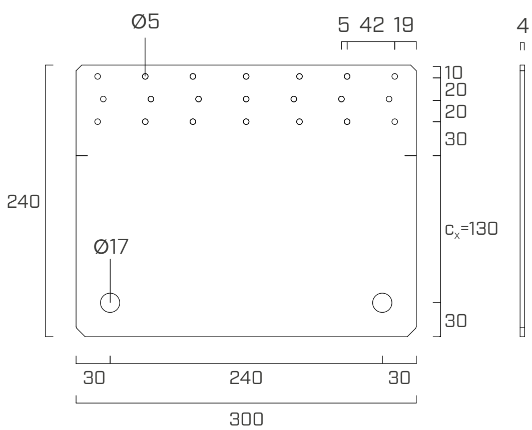
type	description		d [mm]	support	page
LBA	Anker nail		4		548
LBS	screw for plates		5		552
SKR	screw anchor		12 - 16		488
VIN-FIX PRO	chemical anchor		M12 - M16		511
EPO-FIX PLUS	chemical anchor		M12 - M16		517

GEOMETRY

TCP200



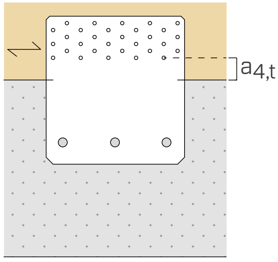
TCP300

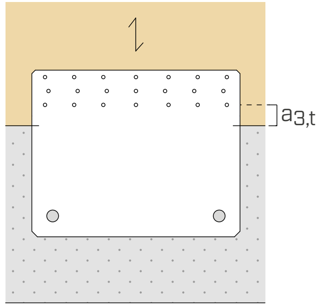


INSTALLATION

TIMBER minimum distances			nails LBA Ø4	screws LBS Ø5
C/GL	$a_{4,t}$	[mm]	≥ 20	≥ 25
CLT	$a_{3,t}$	[mm]	≥ 28	≥ 30

- C/GL: minimum distances for solid timber or glulam consistent with EN 1995-1-1 according to ETA considering a timber density $\rho_k \leq 420$ 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

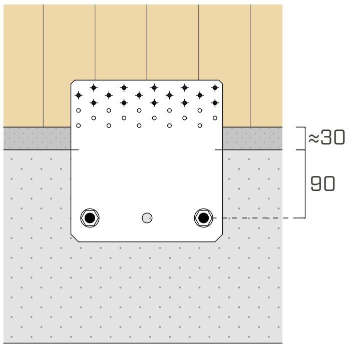




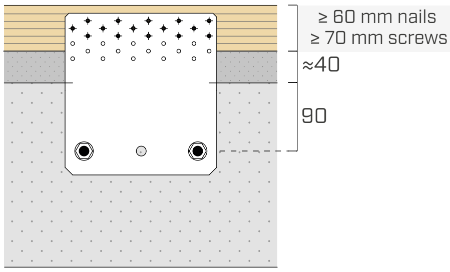
PARTIAL FASTENING

In the presence of design requirements such as varying stress values or the presence of a levelling layer between the wall and the support surface, it is possible to use pre-calculated **partial nailing** or to position the plates as required (e.g. lowered plates) taking care to respect the minimum distances indicated in the table and verify the strength of the anchor-to-concrete group taking into account the increase in distance from the edge (c_x). Below there are some examples of possible limit configurations:

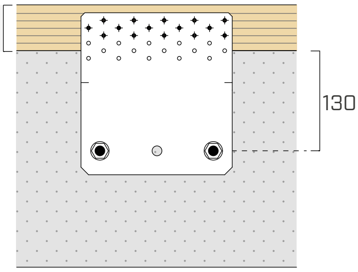
TCP200



PARTIAL 15 FASTENINGS - CLT

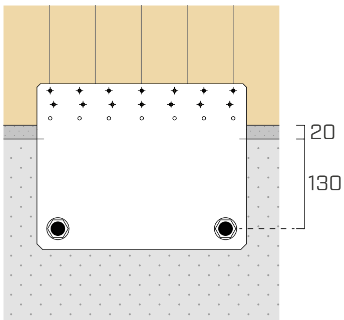


PARTIAL 15 FASTENINGS - C/GL

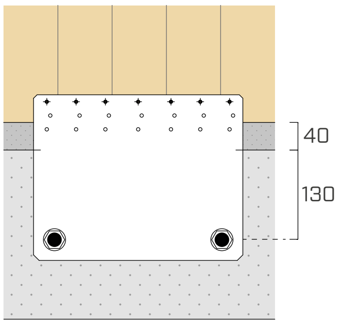


LOWERED PLATE - C/GL

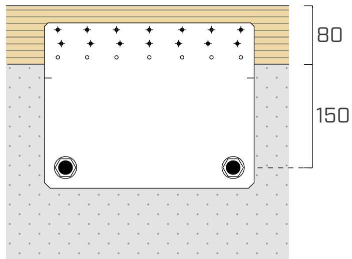
TCP300



PARTIAL 14 FASTENINGS - CLT

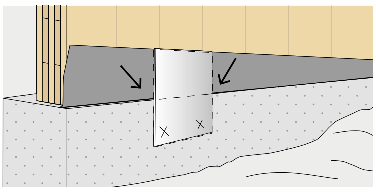


PARTIAL 7 FASTENINGS - CLT

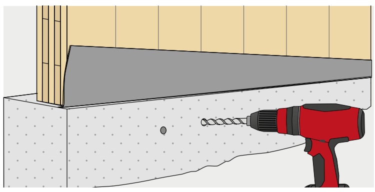


LOWERED PLATE - C/GL

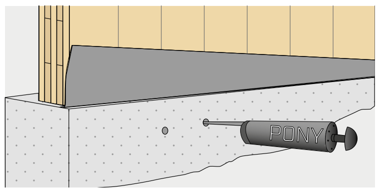
ASSEMBLY



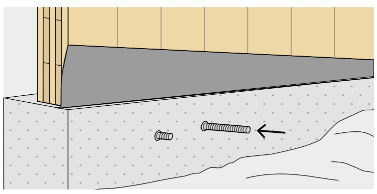
Positioning of the TITAN TCP with the dashed line at the timber-concrete interface and hole marking



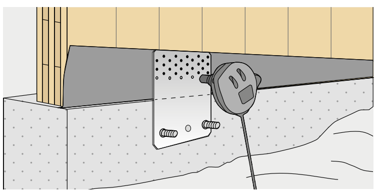
Removal of the TITAN TCP plate and drilling of the concrete support



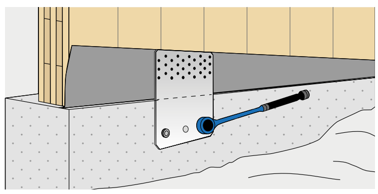
Accurate hole cleaning



Injection of the anchor and insertion of the threaded rods into the holes



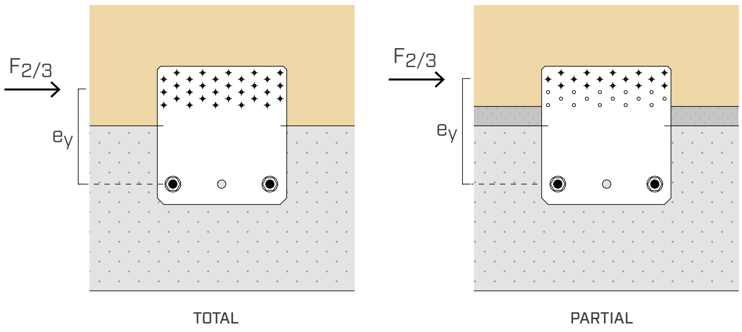
Installation of the TITAN TCP and nailing



Positioning of nuts and washers by adequate tightening

STATIC VALUES | TIMBER-TO-CONCRETE SHEAR JOINT

TCP200



TIMBER STRENGTH

	TIMBER					STEEL		CONCRETE		
configuration on timber	holes fastening Ø5			$R_{2/3,k\ timber}$ [1]	$R_{2/3,k\ CLT}$ [2]	$R_{2/3,k\ steel}$		holes fastening Ø13		e_y [3]
	type	Ø x L [mm]	n_v [pcs]	[kN]	[kN]	[kN]	γ_{steel}	Ø [mm]	n_v [pcs]	[mm]
• total fastening	LBA nails	Ø4,0 x 60	30	**55,6**	**70,8**	**21,8**	γ_{M2}	M12	2	147
	LBS screws	Ø5,0 x 60	30	**54,1**	**69,9**					
• partial fastening	LBA nails	Ø4,0 x 60	15	**27,8**	**35,4**	**20,5**	γ_{M2}			162
	LBS screws	Ø5,0 x 60	15	**27,0**	**35,0**					

CONCRETE STRENGTH

Concrete strength values of some of the possible anchoring solutions, according to the configurations adopted for fastening on timber (e_y). It is assumed that the plate is positioned with the assembly notches at the timber-to-concrete interface (distance between anchor and concrete edge c_x = 90 mm).

			total fastening (e_y = 147 mm)	partial fastening (e_y = 162 mm)
configuration on concrete	holes fastening Ø13		$R_{2/3,d\ concrete}$	
	type	Ø x L [mm]	[kN]	[kN]
• uncracked	VIN-FIX PRO 5.8	M12 x 130	**14,3**	**13,0**
	SKR-E	12 x 90	**12,6**	**11,4**
	AB1	M12 x 100	**13,1**	**11,9**
• cracked	VIN-FIX PRO 5.8	M12 x 130	**10,1**	**9,2**
	SKR-E	12 x 90	**8,9**	**8,1**
	AB1	M12 x 100	**9,2**	**8,4**
• seismic	EPO-FIX PLUS 5.8	M12 x 130	**6,5**	**6,1**
	EPO-FIX PLUS 5.8	M12 x 180	**9,3**	**8,4**

NOTES:

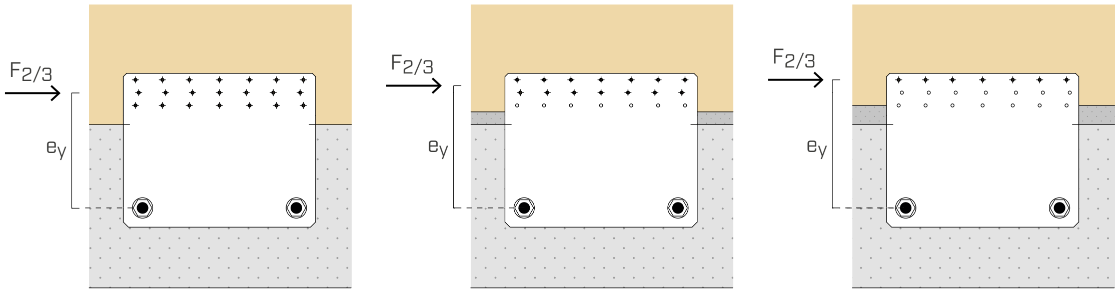
(1) Strength values for use on solid timber or glulam platform beam, calculated considering the effective number according to Table 8.1 (EN 1995 -1-1).

(2) Strength values for use on CLT.

(3) Eccentricity of calculation for verification of the anchor-to-concrete group.

STATIC VALUES | TIMBER-TO-CONCRETE SHEAR JOINT

TCP300



TOTAL | PARTIAL 14 FASTENERS | PARTIAL 7 FASTENERS

TIMBER STRENGTH

configuration on timber	TIMBER					STEEL		CONCRETE		
	holes fastening Ø5			$R_{2/3,k\ timber}$ (1)	$R_{2/3,k\ CLT}$ (2)	$R_{2/3,k\ steel}$		holes fastening Ø17		e_y (3)
	type	Ø x L [mm]	n_v [pcs]	[kN]	[kN]	[kN]	γ_{steel}	Ø [mm]	n_v [pcs]	[mm]
• total fastening	LBA nails	Ø4,0 x 60	21	**38,4**	**49,6**	**64,0**	γ_{M2}	M16	2	180
	LBS screws	Ø5,0 x 60	21	**36,9**	**48,9**					
• partial fastening 14 fasteners	LBA nails	Ø4,0 x 60	14	**25,6**	**33,0**	**60,5**	γ_{M2}			190
	LBS screws	Ø5,0 x 60	14	**24,6**	**32,6**					
• partial fastening 7 fasteners	LBA nails	Ø4,0 x 60	7	**12,8**	**16,5**	**57,6**	γ_{M2}			200
	LBS screws	Ø5,0 x 60	7	**12,3**	**16,3**					

CONCRETE STRENGTH

Concrete strength values of some of the possible anchoring solutions, according to the configurations adopted for fastening on timber (e_y). It is assumed that the plate is positioned with the assembly notches at the timber-to-concrete interface (distance between anchor and concrete edge c_x = 130 mm).

configuration on concrete	holes fastening Ø17		total fastening (e_y = 180 mm)	partial fastening (e_y = 190 mm)	partial fastening (e_y = 200 mm)
			$R_{2/3,d\ concrete}$		
	type	Ø x L [mm]	[kN]	[kN]	[kN]
• uncracked	VIN-FIX PRO 5.8	M16 x 190	**34,4**	**32,7**	**31,1**
	SKR-E	16 x 130	**29,7**	**28,2**	**26,8**
	AB1	M16 x 145	**30,2**	**28,7**	**27,3**
• cracked	VIN-FIX PRO 5.8	M16 x 190	**24,4**	**23,2**	**22,0**
	SKR-E	16 x 130	**21,0**	**19,9**	**19,0**
	AB1	M16 x 145	**21,4**	**20,3**	**19,3**
• seismic	EPO-FIX PLUS 5.8	M16 x 190	**16,6**	**16,0**	**15,4**
	EPO-FIX PLUS 8.8	M16 x 230	**21,1**	**20,3**	**19,4**

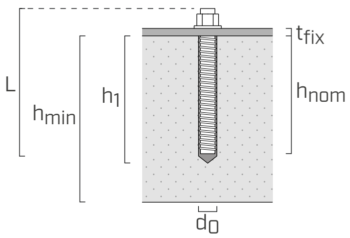
GENERAL PRINCIPLES:

General calculation principles see page 260.

ANCHORS INSTALLATION PARAMETERS | TCP200 - TCP300

installation	anchor type		t_{fix}	h_{ef}	h_{nom}	h_1	d_0	h_{min}
	type	Ø x L [mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
TCP200	VIN-FIX PRO EPO-FIX PLUS 5.8	M12 x 130	3	112	112	120	14	**150**
	SKR-E	12 x 90	3	64	87	110	10	
	AB1	M12 x 100	3	70	80	85	12	
	EPO-FIX PLUS 5.8	M12 x 180	3	161	161	170	14	**200**
TCP300	VIN-FIX PRO EPO-FIX PLUS 5.8	M16 x 190	4	164	164	170	18	**200**
	SKR-E	16 x 130	4	85	126	150	14	
	AB1	M16 x 145	4	85	97	105	16	
	EPO-FIX PLUS 8.8	M16 x 230	4	200	200	205	14	**240**

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



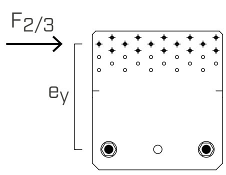
t_{fix} fastened plate thickness
h_{nom} nominal anchoring depth
h_{ef} effective anchor depth
h_1 minimum hole depth
d_0 hole diameter in the concrete support
h_{min} concrete minimum thickness

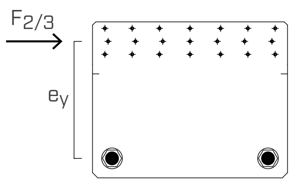
ANCHORS FOR CONCRETE VERIFICATION | TCP200 - TCP300

Fastening to concrete using anchors must be verified on the basis of the stressing forces of the anchors, which depend on the timber fastening configuration.
The position and number of nails/screws determine the e_y eccentricity value, understood as the distance between the centre of gravity of the nailing and that of the anchors.

The anchor group must be verified for:

$V_{Sd,x} = F_{2/3,d}$
$M_{Sd,z} = F_{2/3,d} \times e_y$





GENERAL PRINCIPLES:

- Characteristic values according to EN 1995-1-1. The design values of the anchors for concrete are calculated in accordance with the respective European Technical Assessments.

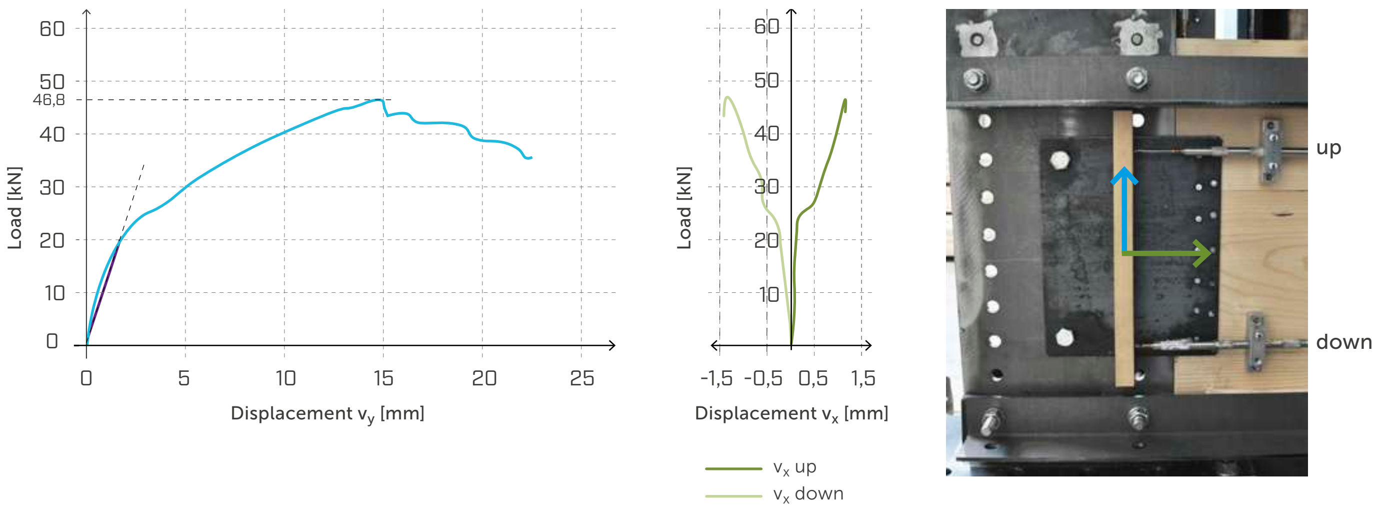
  The connection design strength value is obtained from the values on the table as follows:

$$R_d = min \begin{cases} \frac{(R_{k,\,timber} \text{ or } R_{k,\,CLT}) \cdot k_{mod}}{\gamma_M} \\ \frac{R_{k,\,steel}}{\gamma_{steel}} \\ R_{d,\,concrete} \end{cases}$$

  The coefficients k_{mod}, γ_M and γ_{steel} should be taken according to the current regulations used for the calculation.
- The calculation process used a timber characteristic density of ρ_k = 350 kg/m^3 and C25/30 concrete with a thin reinforcing layer and minimum thickness indicated in the table.
- Dimensioning and verification of timber and concrete elements must be carried out separately.
- 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.
- Seismic design in performance category C2, without ductility requirements on anchors (option a2) elastic design according to EOTA TR045. For chemical anchors it is assumed that the annular space between the anchor and the plate hole is filled (α_{gap}=1).

EXPERIMENTAL INVESTIGATIONS | TCP300

In order to calibrate the numerical models used for the design and verification of the TCP300 plate, an experimental campaign was carried out in collaboration with the Institute for BioEconomy (IBE) - San Michele all'Adige.
The connection system, nailed or screwed to CLT panels, has been shear stressed through monotonic tests in displacement control registering the load, displacement in the two main directions and collapse mode.
The results obtained were used to validate the analytical calculation model for the TCP300 plate, based on the hypothesis that the shear centre is placed at the centre of gravity of the fastenings on timber and therefore that the anchors, usually the weak point of the system, are stressed not only by the shear actions but also by the local moment.
The study in different fastening configurations (Ø4 nails/Ø5 screws, full nailing, partial nailing with 14 connectors, partial nailing with 7 connectors) shows that the mechanical behaviour of the plate is strongly influenced by the **relative stiffness of the connectors** on timber compared to that of the anchors, in tests simulated by bolting on steel.
In all cases a shear failure mode of the timber fasteners has been observed that does not result in evident plate rotation. Only in some cases (full nailing) the non-negligible rotation of the plate leads to an increase in stress on the timber fasteners resulting from a redistribution of the local moment with consequent stress relief on the anchors, which represent the limiting point of the overall strength of the system.



Load-to-displacement diagrams for TCP300 specimen with partial nailing (no. 14 LBA Ø4 x 60 mm nails).

Further investigations are necessary in order to define an analytical model that can be generalized to the different configurations of use of the plate that is able to provide the actual stiffness of the system and the redistribution of stresses as the boundary conditions (connectors and base materials) vary.