TITAN PLATE C CONCRETE

PLATE FOR SHEAR LOADS

DESIGN REGISTERED | UKCA EN 14545 | CE EN 14545

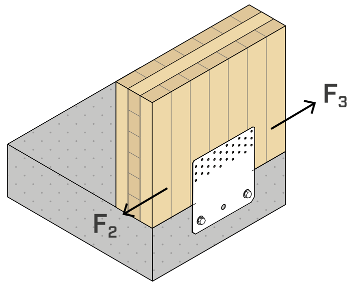
SERVICE CLASS SC1 SC2

MATERIAL

DX51D Z275 — **TCP200**: DX51D + Z275 carbon steel

S355 Fe/Zn12c — **TCP300**: S355 + Fe/Zn12c carbon steel

EXTERNAL LOADS



VERSATILE

It can be used for continuous connection to the substructure of both CLT and light timber frame walls.

INNOVATIVE

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

CALCULATED AND CERTIFIED

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

USA, Canada and more design values available online.

FIELDS OF USE

Shear joints for timber walls.
Timber-to-concrete or timber to-steel configurations.
Suitable for walls aligned to the concrete edge.

Can be applied to:

- solid timber and glulam
- timber frame
- CLT and LVL panels

ADDED STOREYS

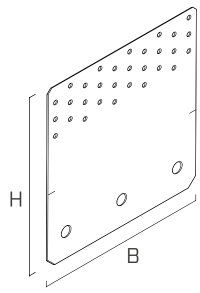
Ideal for making flat joints between concrete or masonry elements and CLT panels. Construction of continuous shear connections.

HYBRID STRUCTURES

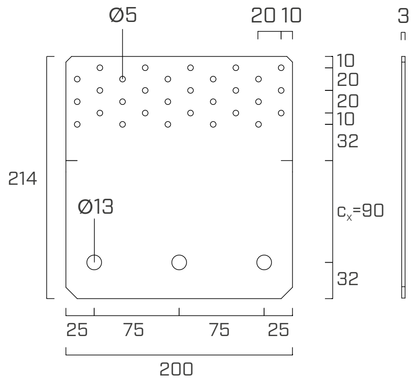
Within hybrid timber-to-steel structures, it can be used for shear connections by simply aligning the edge of the timber with the edge of the steel element.

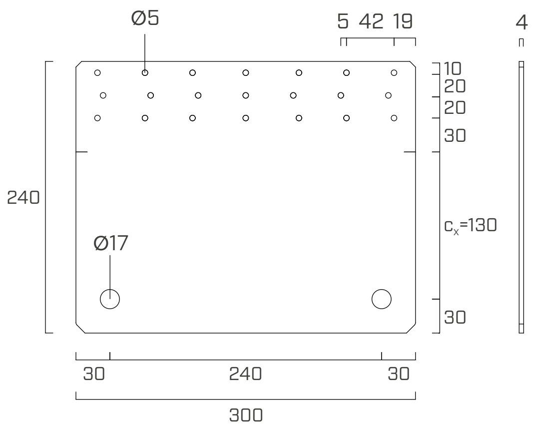
CODES AND DIMENSIONS

CODE	B [mm]	H [mm]	holes	s [mm]	*B [in]*	*H [in]*	*holes*	*s [in]*	n_V Ø5 *n_V Ø0.20* [pcs]		pcs
TCP200	200	214	Ø13	3	*8*	*8 7/16*	*Ø0.52*	*0.12*	30	●	10
TCP300	300	240	Ø17	4	*11 3/4*	*9 1/2*	*Ø0.67*	*0.16*	21	●	5



GEOMETRY





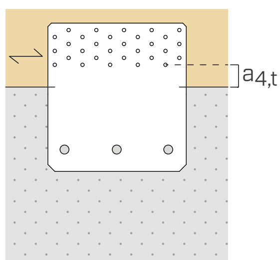
FASTENERS

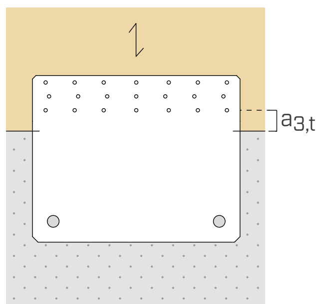
type	description		d [mm]	support	page
LBA	high bond nail		4		570
LBS	round head screw		5		571
LBS EVO	C4 EVO round head screw		5		571
SKR	screw-in anchor		12 - 16		528
VIN-FIX	vinyl ester chemical anchor		M12 - M16		545
HYB-FIX	hybrid chemical anchor		M12 - M16		552
EPO-FIX	epoxy chemical anchor		M12 - M16		557

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 1995:2014 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 1995:2014 (Annex K) for nails and ETA-11/0030 for screws



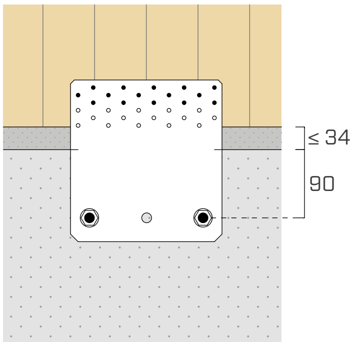


FASTENING PATTERNS

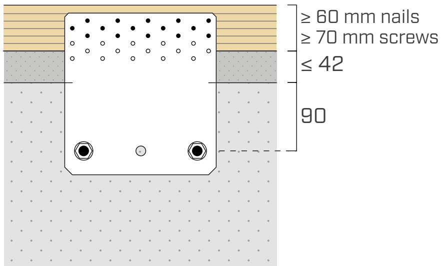
PARTIAL FASTENING

In the presence of design requirements such as varying stress values or the presence of a grout between the wall and the support surface, it is possible to use pre-calculated **partial nailing patterns** or to position the plates as required (e.g. lowered plates). Take 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:

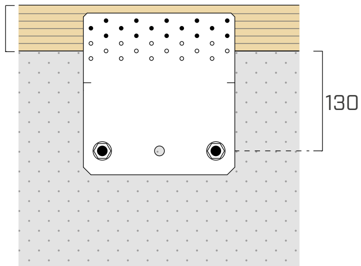
TCP200



partial 15 fasteners - CLT

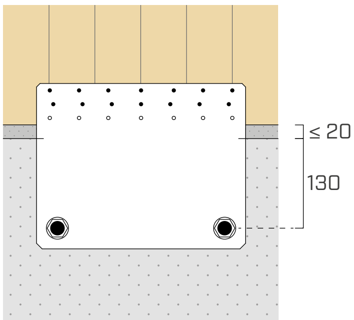


partial 15 fastenings - C/GL

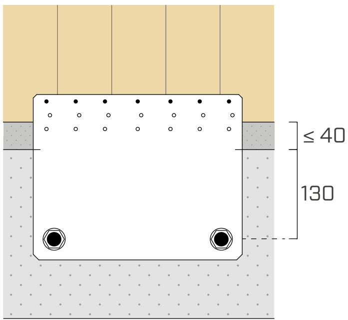


lowered plate - C/GL

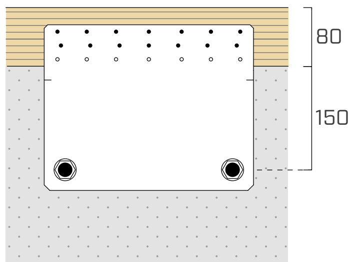
TCP300



partial 14 fastenings - CLT

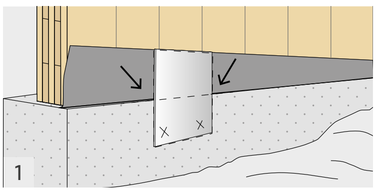


partial 7 fastenings - CLT

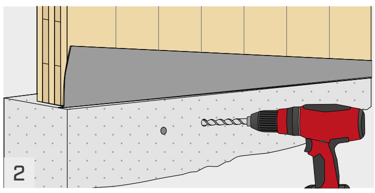


lowered plate - C/GL

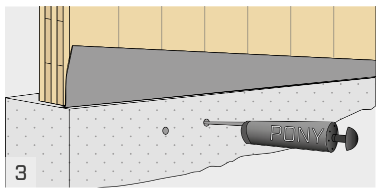
MOUNTING



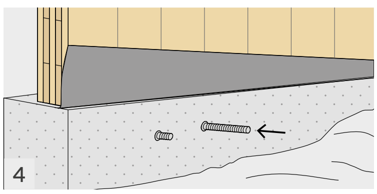
Positioning of the TITAN TCP with the dashed line at the timber-concrete interface and hole marking.



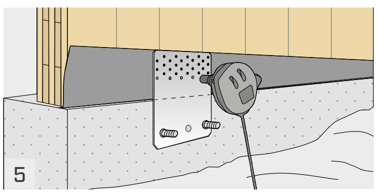
Removal of the TITAN TCP plate and drilling of the concrete support.



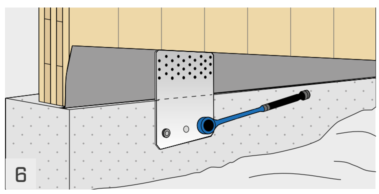
Accurate hole cleaning.



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

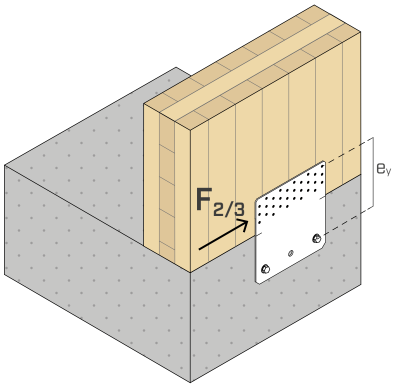


Installation of the TITAN TCP and nailing.

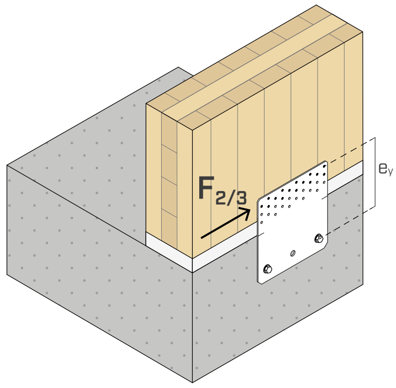


Positioning of nuts and washers by adequate tightening.

STRUCTURAL VALUES | **TCP200** | TIMBER-TO-CONCRETE | $F_{2/3}$



total fastening



partial fastening

TIMBER STRENGTH

	TIMBER					STEEL		CONCRETE		
configuration on timber	**fastening holes Ø5**			$R_{2/3,k\ timber}$ (1)	$R_{2/3,k\ CLT}$ (2)	$R_{2/3,k\ steel}$		**fastening holes Ø13**		
	type	**Ø x L**	n_V					**Ø**	n_V	e_y (3)
		[mm]	[pcs]	[kN]	[kN]	[kN]	γ_{steel}	[mm]	[pcs]	[mm]
total fastening	LBA	Ø4 x 60	30	**62,9**	**84,9**	**21,8**	γ_{M2}	M12	2	147
	LBS	Ø5 x 60	30	**54,0**	**69,8**					
partial fastening	LBA	Ø4 x 60	15	**31,5**	**42,5**	**20,5**	γ_{M2}			162
	LBS	Ø5 x 60	15	**27,0**	**34,9**					

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	**fastening holes Ø13**		$R_{2/3,d\ concrete}$	$R_{2/3,d\ concrete}$
	type	**Ø x L**		
		[mm]	[kN]	[kN]
uncracked	VIN-FIX 5.8	M12 x 140	**12,6**	**11,5**
		M12 x 195	**13,4**	**12,2**
	SKR	12 x 90	**11,3**	**10,3**
	AB1	M12 x 100	**13,1**	**11,9**
cracked	VIN-FIX 5.8	M12 x 140	**8,9**	**8,1**
		M12 x 195	**9,5**	**8,7**
	SKR	12 x 90	**8,0**	**7,3**
	AB1	M12 x 100	**9,2**	**8,4**
seismic	HYB-FIX 8.8	M12 x 140	**6,6**	**6,1**
		M12 x 195	**8,1**	**7,4**
	EPO-FIX 8.8	M12 x 140	**7,6**	**6,9**

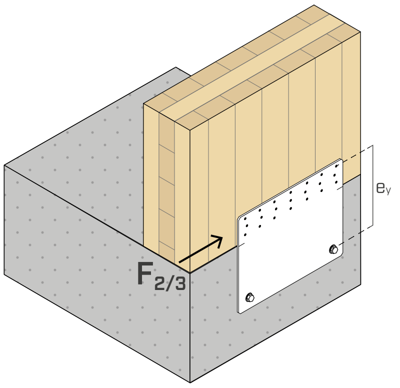
NOTES

(1) Strength values for use on solid timber or glulam platform beam, calculated considering the effective number according to Table 8.1 (EN 1995:2014).

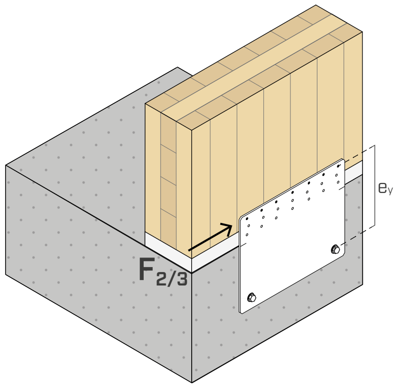
(2) Strength values for use on CLT.

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

STRUCTURAL VALUES | **TCP300** | TIMBER-TO-CONCRETE | $F_{2/3}$



total fastening



partial fastening

TIMBER STRENGTH

	TIMBER					STEEL		CONCRETE		
configuration on timber	**fastening holes Ø5**			$R_{2/3,k\ timber}$ (1)	$R_{2/3,k\ CLT}$ (2)	$R_{2/3,k\ steel}$		**fastening holes Ø17**		
	type	**Ø x L**	n_V					**Ø**	n_V	e_y (3)
		[mm]	[pcs]	[kN]	[kN]	[kN]	γ_{steel}	[mm]	[pcs]	[mm]
total fastening	LBA	Ø4 x 60	21	**43,4**	**59,4**	**64,0**	γ_{M2}	M16	2	180
	LBS	Ø5 x 60	21	**36,8**	**48,9**					
partial fastening 14 fasteners	LBA	Ø4 x 60	14	**29,0**	**39,6**	**60,5**	γ_{M2}			190
	LBS	Ø5 x 60	14	**24,6**	**32,6**					
partial fastening 7 fasteners	LBA	Ø4 x 60	7	**14,5**	**19,8**	**57,6**	γ_{M2}			200
	LBS	Ø5 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).

			total fastening (e_y = 180 mm)	partial fastening (e_y = 190 mm)	partial fastening (e_y = 200 mm)
configuration on concrete	**fastening holes Ø17**		$R_{2/3,d\ concrete}$	$R_{2/3,d\ concrete}$	$R_{2/3,d\ concrete}$
	type	**Ø x L**			
		[mm]	[kN]	[kN]	[kN]
uncracked	VIN-FIX 5.8	M16 x 195	**29,6**	**28,3**	**27,0**
	SKR	16 x 130	**26,0**	**24,8**	**23,7**
	AB1	M16 x 145	**30,2**	**28,7**	**27,3**
cracked	VIN-FIX 5.8	M16 x 195	**21,0**	**20,0**	**19,1**
	SKR	16 x 130	**18,4**	**17,6**	**16,8**
	AB1	M16 x 145	**21,4**	**20,3**	**19,3**
seismic	HYB-FIX 8.8	M16 x 195	**16,8**	**16,2**	**15,6**
		M16 x 245	**18,6**	**17,7**	**16,9**
	EPO-FIX 8.8	M16 x 195	**17,8**	**17,0**	**16,9**

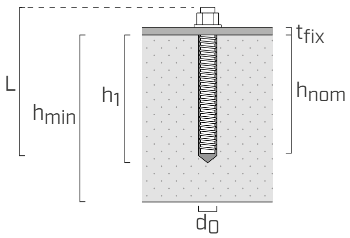
GENERAL PRINCIPLES

For the GENERAL PRINCIPLES of calculation, see page 306.

ANCHORS INSTALLATION PARAMETERS

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 5.8 HYB-FIX 8.8 EPO-FIX 8.8	M12 x 140	3	112	112	120	14	150
	SKR	12 x 90	3	64	87	110	10	
	AB1	M12 x 100	3	70	80	85	12	
	VIN-FIX 5.8	M12 x 195	3	170	170	175	14	200
	HYB-FIX 8.8							
TCP300	VIN-FIX 5.8 HYB-FIX 8.8 EPO-FIX 8.8	M16 x 195	4	164	164	170	18	200
	SKR	16 x 130	4	85	126	150	14	
	AB1	M16 x 145	4	85	97	105	16	
	HYB-FIX 8.8	M16 x 245	4	210	210	215	18	250

Precut INA threaded rod, with nut and washer: see page 562.
MGS threaded rod class 8.8 to be cut to size: see page 174.



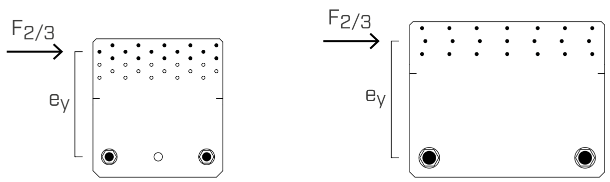
t_{fix} fastened plate thickness
h_{nom} nominal anchoring depth
h_{ef} effective anchoring depth
h_1 minimum hole depth
d_0 hole diameter in the concrete support
h_{min} concrete minimum thickness

ANCHORS VERIFICATION FOR STRESS LOADING $F_{2/3}$

Fastening to concrete using anchors must be verified on the basis of the load acting on the anchors, which depend on the timber fastening configuration.
The position and number of nails/screws determine the ey 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:

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



GENERAL PRINCIPLES

- Characteristic values according to EN 1995:2014.
- Design values can be obtained from characteristic values as follows:

$$R_d = min \begin{cases} \dfrac{(R_{k,\,timber} \text{ or } R_{k,\,CLT}) \cdot k_{mod}}{\gamma_M} \\ \dfrac{R_{k,\,steel}}{\gamma_{M2}} \\ R_{d,\,concrete} \end{cases}$$

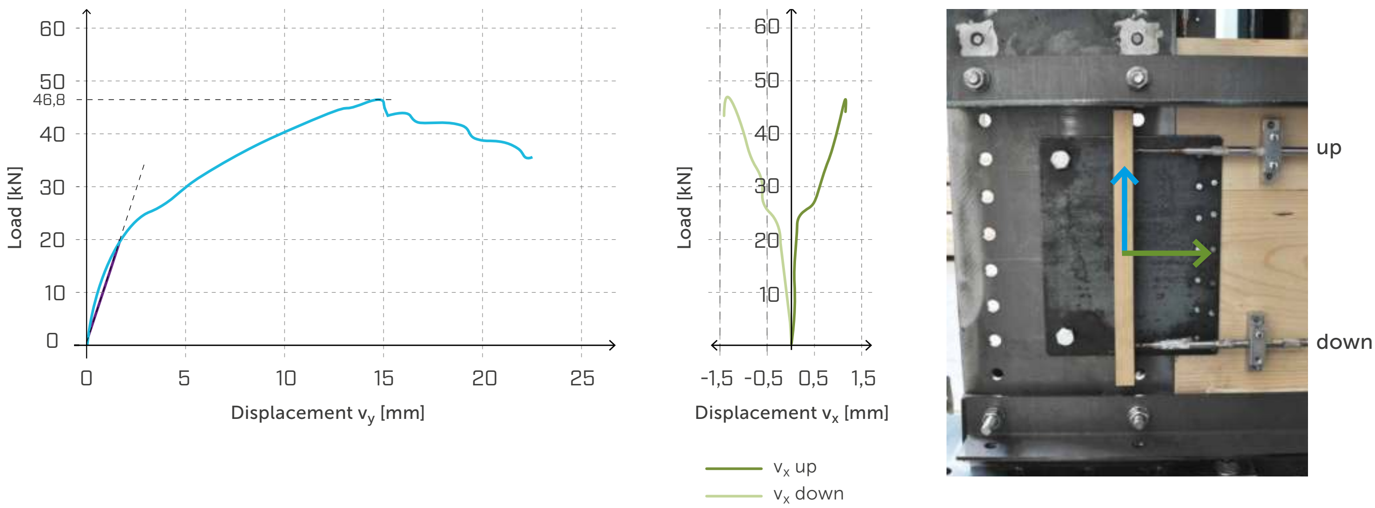
  The coefficients k_{mod}, γ_M and γ_{M2} should be taken according to the current regulations used for the calculation.
- The calculation process used a timber characteristic density of ρ_k = 350 kg/m^3 and C25/30 concrete with a thin reinforcing layer and minimum thickness indicated in the table.
- Dimensioning and verification of timber and concrete elements must be carried out separately.
- The strength values are valid for the calculation hypothesis 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) and elastic design according to EN 1992:2018. For chemical anchors it is assumed that the annular space between the anchor and the plate hole is filled (α_{gap} = 1).
- The product ETAs for the anchors used in the concrete-side strength calculation are indicated below:
  - VIN-FIX chemical anchor according to ETA-20/0363;
  - HYB-FIX chemical anchor according to ETA-20/1285;
  - EPO-FIX chemical anchor according to ETA-23/0419;
  - SKR screw-in anchor according to ETA-24/0024;
  - AB1 mechanical anchor according to ETA-17/0481 (M12);
  - AB1 mechanical anchor according to ETA-99/0010 (M16).

INTELLECTUAL PROPERTY

- TITAN PLATE C plates are protected by the following Registered Community Designs:
  - RCD 002383265-0003;
  - RCD 008254353-0014.

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. 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, which 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.