ENGINEERED
WOOD CONSTRUCTION
CLT-S

Lifting points for CLT

a practical guide

Date: 06.07.2015

Lifting points for CLT

A PRACTICAL GUIDE 07/2015

Disclaimer

The present document shall give an idea about the different possibilities of lifting CLT panels along with recommended load bearing capacities for the individual lifting points. These capacities are based on European Technical Approvals, technical expertise and research reports. The capacity values shall give an idea about the possibility of lifting a panel with any of the systems presented. The contractor, attaching the panel to the crane shall be liable for the verification of the allowable lifting capacity of each panel being lifted.
The proposed allowable values need to be checked and verified by the contractor who is in charge of the lifting operations.
Stora Enso Wood Products GmbH excludes all liability for:

- the completeness or correctness of the values mentioned in this report
- the correctness and accuracy of the values stated in this document
- any damage resulting from an accident during the lifting operations
- any injury or loss of life in case of an accident during the lifting operations.

The below stated values do not constitute any warranty or representation for the product Cross-Laminated-Timber.

Table of content

ENGINEERED WOOD CONSTRUCTION
CLT-S

1. General

In order to attach a CLT panel to a crane at the construction site, lifting points need to be placed on the panel, so a crane can hook up to them. This document shall provide a survey of the most common lifting points for CLT panels, along with some capacities and basic rules.

2. Anchor with screws (Rothoblaas)

This lifting system uses a fully threaded screw as lifting point and an anchor that hook up to the screw. The maximum load capacity of such an anchor is 13 kN. The fully threaded screws for this particular lifting system are available in the length from 100 mm to 600 mm. The maximum allowable lifting load depends on the angle α and the embedment length l_g of the screw.

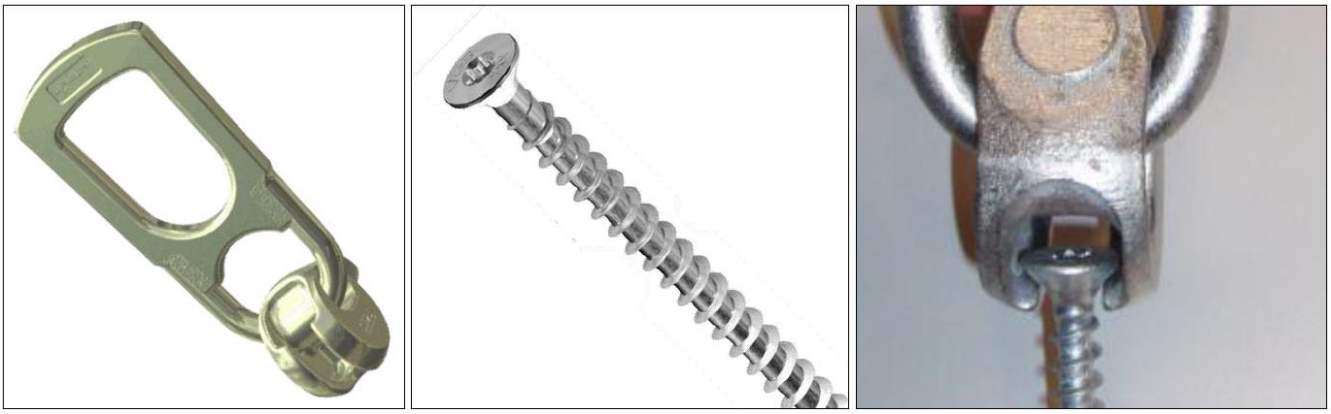
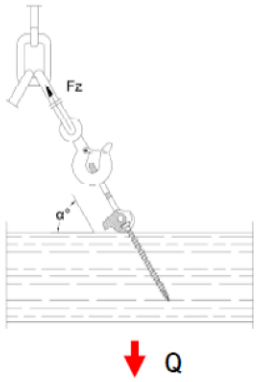


Figure 1

INSTALLATION WITH INCLINED SCREWS

Q = LOADING RESISTANCE [(1)] [kN]

	L [mm]	Lg [mm]	α=30°	α=45°	α=60°	α=75°	α=90°
VGS Ø 11	100	75	2,06	2,92	3,57	3,98	4,13
	150	125	3,44	4,86	5,95	6,64	6,88
	200	175	4,81	6,81	8,34	9,30	9,63
	250	225	6,19	8,75	10,72	11,95	12,38
	300-600	275-575	6,50	9,19	11,26	12,56	13,00



Insertion of screw inclined to the grain, in the direction of lifting system.

α =angle between the cord direction and the surface of the member

(1) the admissible values of the load capacity are calculated according to DIN 1052:1988.

- For characteristic values according to EN 1995-1-1:2009 the technical department *"rothoengineer"* is available for further information.

Values must be verified by the responsible engineer. We don't take responsibility for misprints or typing errors.

[1], [2]

The screws shall be placed in the face of a CLT panel.

Figure 2

3. Lifting slings

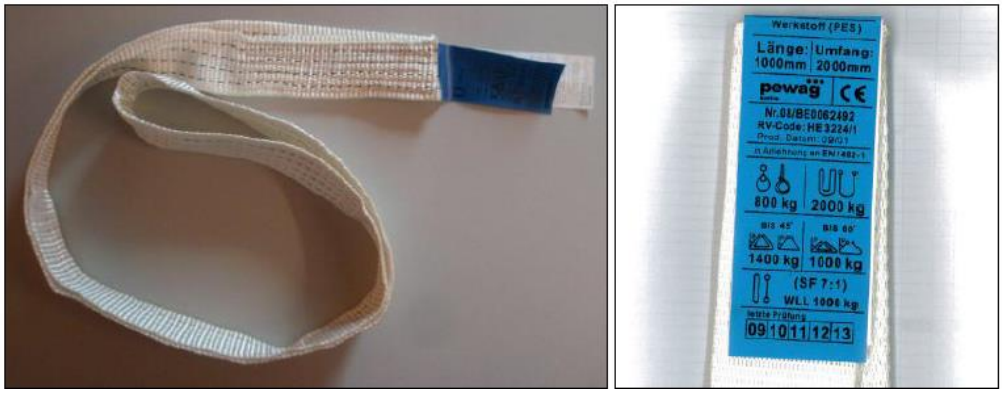


Figure 3

This system is based on a woven sling made of 100 % Polyester (PES). The effective length is 1 meter, the width is 50 mm and the thickness is about 3 mm. Depending on the lifting angle and the way of use it is possible to bear lifting loads up to 2000 kg (see figure below). This is described on each sling. The slings are for one use only. That means that it is possible to lift 3 – 6 times but a removed sling is not allowed to be used again in another place/panel.

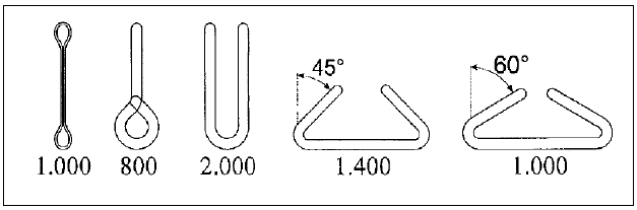


Figure 4 **[3]**

Especially wall panels are lifted with this system. Therefore the slings are threaded in holes with diameter 35 mm. The minimum distance from the edge is 200 mm measured from the beginning of at least 70 % panel thickness.

Figure 5

Figure 6

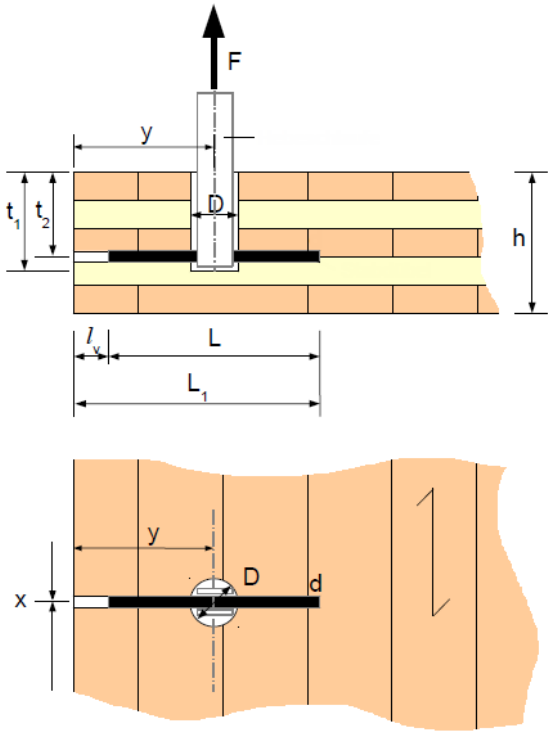
Floor or roof panels can be lifted with such slings using one or two holes with diameter 35 mm per lifting point.

Figure 7

More details regarding the product can be found in the technical data sheet from PEWAG.

3.1. Lifting sling with dowel, [4]

As alternative to the system with lifting slings and a thru hole, as described above, the lifting sling can be fastened with a dowel. This could be necessary, when transporting floor elements with a ceiling side that shall be visually exposed in the building and thru holes are no option.



D	Diameter bind hole
d	Dowel hole diameter
t_1	Depth blind hole
t_2	Dowel position (center line)
y	Edge distance for blind hole (on center)
l_v	Immersion length of dowel (= y – 150 mm)
L_1	Depth of dowel hole (= y + 150 mm)
h	Panel thickness
F	Allowable load (see table below)
x	Edge distance, perpendicular to y

Pewag lifting sling: width: 50 mm, length: 500 mm or 1000 mm (depending on blind hole depth)
Dowel: steel grade: S355, diameter: 16 mm, length: 300 mm
Drift pin with depth scale: immersion length must be met with an accuracy of ± 10 mm
Edge distance y: 200 mm (at edges with lap joint, refer to the edge of full section)
Edge distance x: min. 400 mm

The angle β of the lifting chains/cables shall be $\beta \leq 60°$

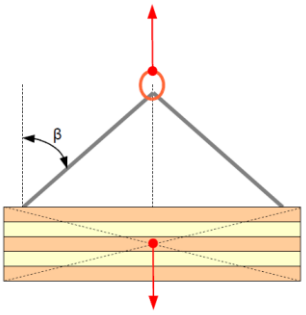


Figure 8

Panel thickness	Panel type	t_1	t_2	F
100	L3s	90 mm	70 mm	1000 kg
100	L3s-A	90 mm	70 mm	1000 kg
110	L3s	100 mm	80 mm	1000 kg
120	L3s	110 mm	90 mm	1000 kg
100	L5s	90 mm	70 mm	1000 kg
120	L5s	110 mm	80 mm	1000 kg
140	L5s	120 mm	90 mm	1000 kg
140	L5s	125 mm	95 mm	1000 kg
150	L5s	130 mm	100 mm	1200 kg
150	L5s	135 mm	105 mm	1200 kg
160	L5s	140 mm	110 mm	1200 kg
180	L5s	155 mm	125 mm	1200 kg
200	L5s	160 mm	130 mm	1200 kg
180	L7s	160 mm	140 mm	1200 kg
220	L7s	150 mm	120 mm	1200 kg
240	L7s	150 mm	120 mm	1200 kg
200	L7s-2	150 mm	120 mm	1200 kg
220	L7s-2	160 mm	130 mm	1200 kg
240	L7s-2	160 mm	130 mm	1200 kg
260	L7s-2	160 mm	130 mm	1200 kg
280	L7s-2	160 mm	130 mm	1200 kg
300	L8s-2	160 mm	130 mm	1200 kg
320	L8s-2	160 mm	130 mm	1200 kg

[4]

4. RAMPA inserts – Type BL

Rampa inserts, type BL are self-tapping screws with an outer thread and a cylindrical hole with an inner thread. The Rampa insert is being screwed into wood with the outer thread. A bolt or a lifting sling can be placed into the insert, using the inner thread.

Figure 9

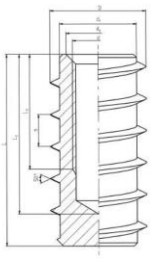


Figure 10

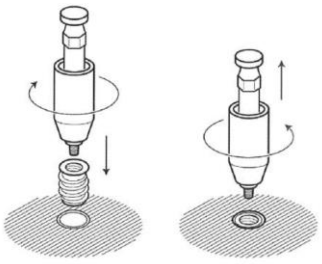


Figure 11

Rampa inserts can be placed in the face and in the narrow sides of CLT. Usually for floor panels the inserts are being placed in the face of the panel. For wall panels the inserts are usually placed in the narrow sides of the panel for a vertical installation at site.

Figure 12

Figure 13

Generally for Rampa inserts, ETA-12/0481 [5] shall apply.

4.1. Installation in the face surface of CLT (e.g.: floor panels)

When lifting floor panels, Rampa inserts are usually placed in the face of a CLT panel. In this case, the Rampa insert axis is perpendicular to the grain of the CLT lamination.
The following table shall give an idea about the capacity of a lifting point, using Rampa inserts.

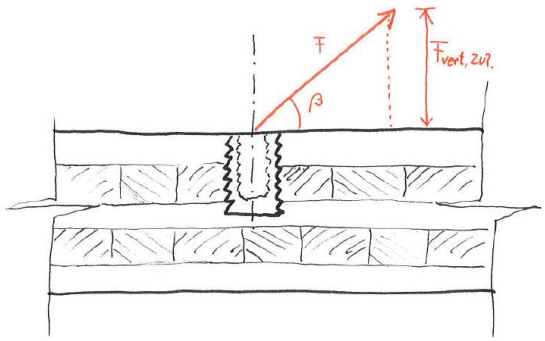


Figure 14

d_{RM}	25 mm	
ρ_k	350 kg/m³	
α	90 °	1,571 rad
M_y	182 Nm	
Φ	2,75	

l_{ef}	60 mm	60 mm	60 mm	60 mm
β	45 °	60 °	75 °	90 °
$F_{vert,allow}$	1.357 N	2.189 N	3.592 N	4.909 N
$F_{vert,allow}$	138 kg	223 kg	366 kg	500 kg

l_{ef}	80 mm	80 mm	80 mm	80 mm
β	45 °	60 °	75 °	90 °
$F_{vert,allow}$	1.755 N	2.842 N	4.715 N	6.545 N
$F_{vert,allow}$	179 kg	290 kg	481 kg	667 kg

l_{ef}	100 mm	100 mm	100 mm	100 mm
β	45 °	60 °	75 °	90 °
$F_{vert,allow}$	2.152 N	3.494 N	5.835 N	8.182 N
$F_{vert,allow}$	219 kg	356 kg	595 kg	834 kg

l_{ef}	120 mm	120 mm	120 mm	120 mm
β	45 °	60 °	75 °	90 °
$F_{vert,allow}$	2.549 N	4.145 N	6.954 N	9.818 N
$F_{vert,allow}$	260 kg	422 kg	709 kg	1.001 kg

The capacities mentioned above are derived from ETA-12/0481 [5].

The capacities mentioned above include a global factor of safety of Φ = 2,75.
This safety factor includes the partial safety coefficients on the material and load side, a k_{mod} of 1,1 and a safety factor for dynamic loading (lifting action). More details about the derivation of the safety factor can be found in the technical expertise “Festlegung der Tragfähigkeit von Transportmitteln von Brettsperrholz in Form eines Sackloch-Stabdübel-Hebeschlaufensystems in Anlehnung aqn die ÖN EN 26891” [4]
According to the research report “Brettsperrholz-Hebesystem unter Einsatz von Rampa-Muffen” [6], a capacity increase for 120 mm long inserts shall be omitted, due to the brittle failure behavior. Therefore Rampa inserts type BL M16 with a length of 60 mm shall have the same capacity as those with a length of 120 mm.

Edge distances and spacing for the installation in the face of a CLT panel:

Spacing a_1 parallel to the grain	$a_1 = 4 \cdot d$
Spacing a_2 perpendicular to the grain	$a_2 = 2{,}5 \cdot d$
Distance $a_{3,c}$ from centre of the screw-part in timber to the unloaded end grain	$a_{3,c} = 6 \cdot d$
Distance $a_{3,t}$ from centre of the screw-part in timber to the loaded end grain	$a_{3,t} = 6 \cdot d$
Distance $a_{4,c}$ from centre of the screw-part in timber to the unloaded edge	$a_{4,c} = 2{,}5 \cdot d$
Distance $a_{4,t}$ from centre of the screw-part in timber to the loaded edge	$a_{4,t} = 6 \cdot d$

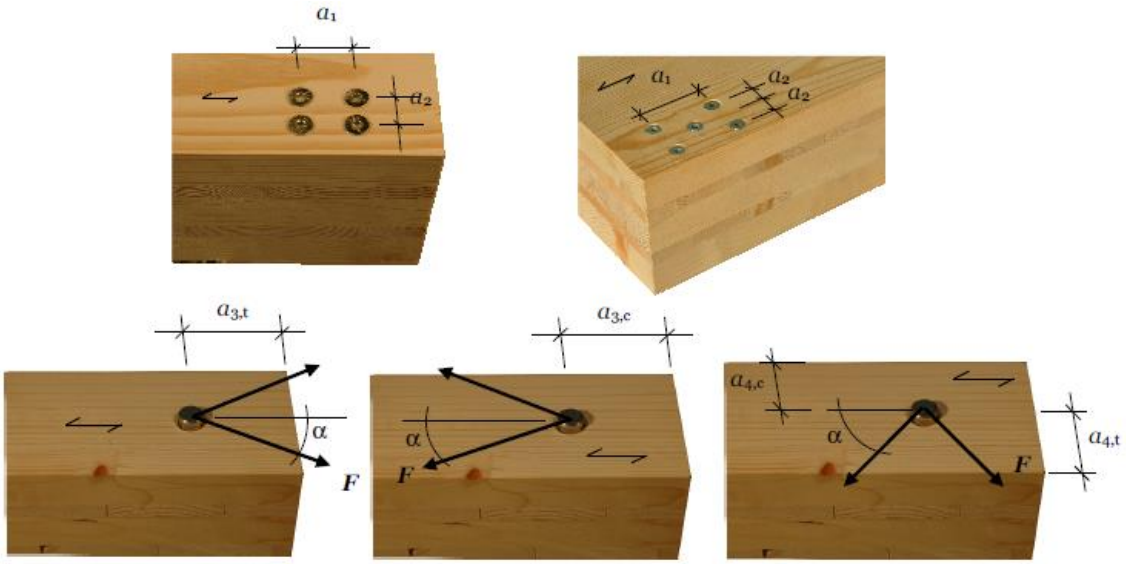


Figure 15

The image above with the edge distances and spacing shall be just symbolic. The indicated screws shall point out the location of the Rampa inserts.

4.2. Installation in the narrow sides of CLT (e.g.: wall panels)

When lifting wall panels, Rampa inserts are usually placed in the narrow sides of a CLT panel. CLT panels are usually transported horizontally. At the site, they are being lifted from horizontal position into vertical position. Therefore 2 scenarios are applicable:

- Tilting-up the panel: load acting on the lifting point is perpendicular to the plane of the CLT panel. (typical case when wall elements are being delivered in horizontal position on a truck to the site)
- Panel hanging vertically: load acting on the lifting points is in the plane of the CLT panel. (typical situation after tilting, when panel is already upright and is being lifted in place or when panels are being delivered in vertical position on a truck)

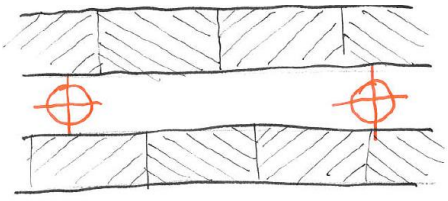


Figure 16

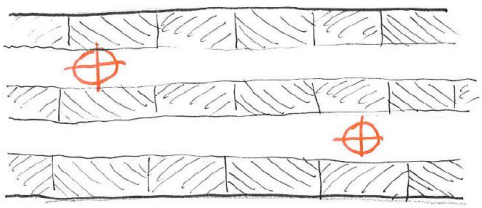


Figure 17

	$F_{vert,allow}$	$F_{tilt,allow}$	$F_{vert,allow}$	$F_{tilt,allow}$	$F_{vert,allow}$	$F_{tilt,allow}$	$F_{vert,allow}$	$F_{tilt,allow}$
l_{ef}	120 mm		120 mm		120 mm		120 mm	
β	45 °		60 °		75 °		90 °	
CLT 60 C3s	123 kg	125 kg	206 kg	125 kg	387 kg	125 kg	701 kg	125 kg
CLT 80 C3s	123 kg	125 kg	206 kg	125 kg	387 kg	125 kg	701 kg	125 kg
CLT 90 C3s	149 kg	175 kg	250 kg	175 kg	470 kg	175 kg	851 kg	175 kg
CLT 100 C3s	149 kg	250 kg	250 kg	250 kg	470 kg	250 kg	851 kg	250 kg
CLT 120 C3s	149 kg	250 kg	250 kg	250 kg	470 kg	250 kg	851 kg	250 kg
CLT 100 C5s	123 kg	125 kg	206 kg	125 kg	387 kg	125 kg	701 kg	125 kg
CLT 120 C5s	123 kg	125 kg	206 kg	125 kg	387 kg	125 kg	701 kg	125 kg
CLT 140 C5s	123 kg	125 kg	206 kg	125 kg	387 kg	125 kg	701 kg	125 kg
CLT 160 C5s	123 kg	125 kg	206 kg	125 kg	387 kg	125 kg	701 kg	125 kg

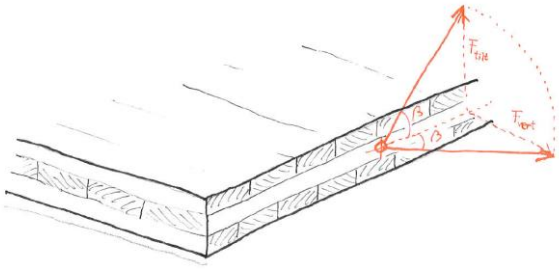


Figure 18

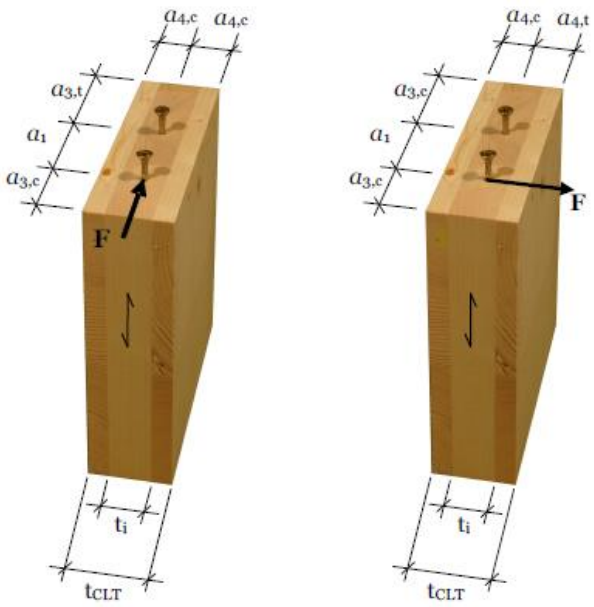
The capacities mentioned above are derived from ETA-12/0481 [5] and the research report “Brettsperrholz-Hebesystem unter Einsatz von Rampa-Muffen” [6]. The capacities do only apply to Rampa BL M16 inserts with a length of 120 mm.

Rampa inserts can only be placed in the center of a lamination layer with a grain orientation, perpendicular to the axial center line of the insert.

Lifting points on a 3 layer CLT panel are being placed in the center of the middle layer.
Lifting points on a 5 layer CLT panel are being placed in the center of the 2 layers, adjacent to the middle layer. E.g.: one lifting point in layer 2 and the other lifting point in layer 4 (assuming layers 1 and 5 are the cover layers and layer 3 is the middle layer).

Edge distances and spacing for the installation in the narrow side of a CLT panel:

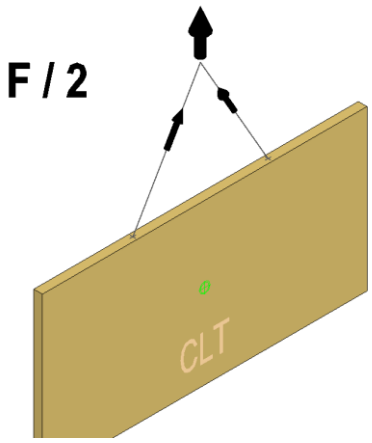
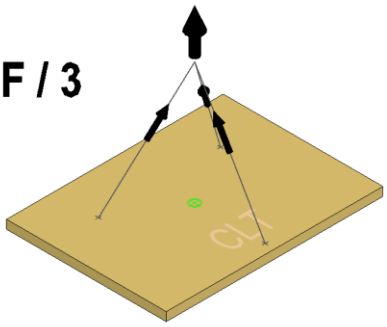
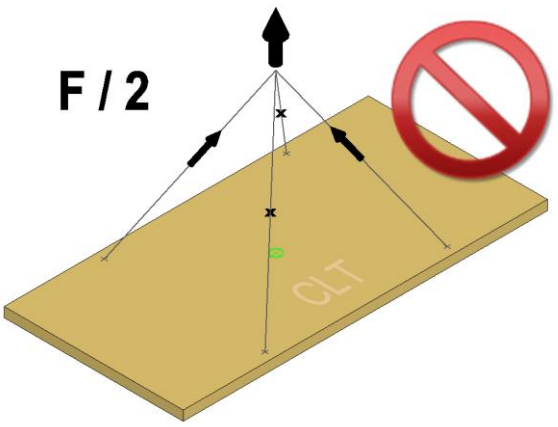
Spacing a_1 parallel to the CLT plane	$a_1 = 10 \cdot d$
Spacing a_2 perpendicular to the CLT plane	$a_2 = 4 \cdot d$
Distance $a_{3,c}$ from centre of the screw-part in timber to the unloaded end	$a_{3,c} = 7 \cdot d$
Distance $a_{3,t}$ from centre of the screw-part in timber to the loaded end	$a_{3,t} = 12 \cdot d$
Distance $a_{4,c}$ from centre of the screw-part in timber to the unloaded edge	$a_{4,c} = 3 \cdot d$
Distance $a_{4,t}$ from centre of the screw-part in timber to the loaded edge	$a_{4,t} = 6 \cdot d$

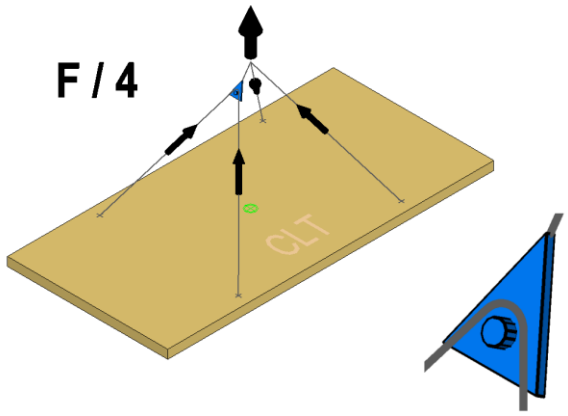
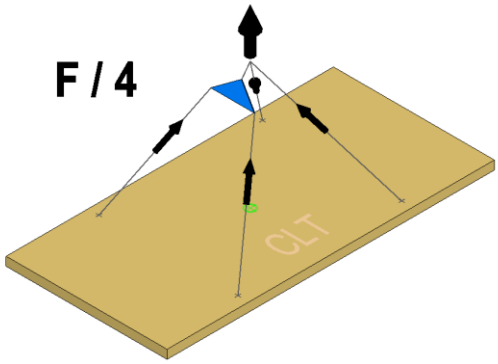
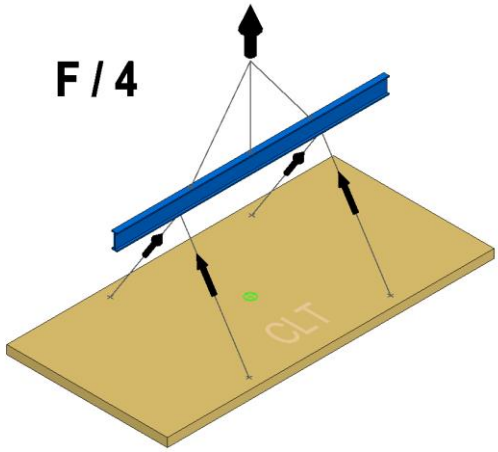


The image above with the edge distances and spacing shall be just symbolic. The indicated screws shall point out the location of the Rampa inserts.

5. Lifting

The load (**F**) has to be distributed according to the center of gravity of each panel. Depending on the crane tools the total load is being distributed to the individual lifting points. The analysis for this has to be done according to the following instructions. The angle β (angle between vertical and the lifting chain/cable) shall be less than 60°. The lifting speed should not exceed 90 m/min and the exposure to load has to be considered as “very short”.

	The load is distributed to 2 lifting points.
	The load is distributed to 3 lifting points.
	This system shall not be used: The load is distributed only to 2 lifting points and the other 2 lifting points have to be considered as a redundant and stabilizing system.

	The load is distributed to all 4 lifting points using a deflexion roller.
	The load is distributed to all 4 lifting points using a triangle distribution device.
	The load is optimal distributed on all 4 lifting points using a spreader bar.

	Long panels might have to be supported on 6 lifting points. In this case 4 of the 6 lifting points are attached to 2 triangle distribution device, providing equal support reaction at 4 lifting points. The 2 remaining lifting points are attached to a special triangle distribution device that is adjustable. The length of the special triangle distribution device will be adjusted in a way that all 6 lifting points take equal load.

[7]

Thomas Demschner
R&D Engineer
Stora Enso Wood Products GmbH

Ybbs a.d. Donau, 06.07.2015

Bibliography

[1] R. (Rothoengineer), "ANCHORAGE FOR TIMBER ELEMENTS TRANSPORT".

[2] I. A. A. (Rothoblaas), "Calculation of laod bearing capacity of anchorage for timber element transport," Rothoblaas, Cortaccia, 2011.

[3] Pewag, "Technisches Datenblatt Einweghebeband - rohweiß A 50x1000/1000, Artikel 72811".

[4] G. Schickhofer, "Gutachtliche Stellungnahme: Festlegung der Tragfähigkeit von Transportmitteln von Brettsperrholz in Form eines Sackloch-Stabdübel-Hebeschlaufensystems in Anlehnung aqn die ÖN EN 26891," TU Graz, Graz, 2012.

[5] E. D. A/S, "ETA-12/0481: RAMPA Inserts Type SKL and," 2013.

[6] T. G. A. Thiel, "Brettsperrholz-Hebesystem unter Einsatz von Rampa-Muffen; Focus_sts_3.2.4_1SF_12," 2014.

[7] D. G. -. I. Verkleidungslösungen, "Produktkatalog - Transportankersysteme für Betonfertigteile," http://www.drgrau.de/Ankerkatalog0.pdf.