Module "Compression perpendicular to grain"

	CLTdesigner - Compression perpendicular to	grain
File Edit Window Help		
		EDM
CLT ^{designer}		8: 9 🖬 💻 🧱 🖬 🖬 🚍 🚞
Cross section	Dimensions and type of load introduction	
User-defined © CLT-products with technical aggressits O RFC CLT cross sections Number of Laper Number of Laper Thickness Orientation Ca2er Ca2er Ca2er S do mm S Ca2er Ca2er S do mm S Ca2er Ca2er Thickness O mm S Ca2er Thickness O	Files 1.000 Length N.000 Widzh 1.000 Image: Second	
	Cantinuous Continuous	2%mn
	e lecal e local	
Options Load distribution angle no 4510 *	1 200 mm 1 200 mm	
$a_{\mu\mu} = \frac{1}{35m} ,$ Height factor for one-sided load introduction $b_{\rm fs} = \frac{1}{100}$	N1 2001 erm V2 2001 erm N1 5001 erm 012 5001 erm R11 5001 erm 012 5001 erm R13 5001 erm 012 5001 erm R13 5001 erm 012 5001 erm	
		• (J00'mm
Winimum load introduction area		
A _{camin} 40,000 mm ¹		
Autonas 52,892 mm² Uni 222 mm Mari 257 mm		
z 80 mm		
A _{4,90} 1.5		
Acto "Acesia 59,880 mm"		
Udituation nation Compression perpendicular to grain n _{clife} 77.3.9		
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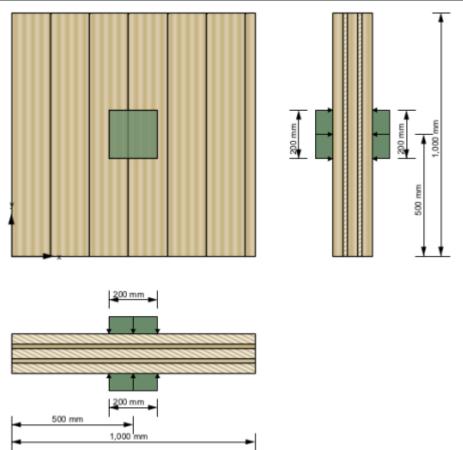
Input data

The input is divided into:

- definitions of the cross section
- definitions of the plate dimensions
- input of the loads
- type of load configuration
- calculation options

An option for a quick control of the input data is offered by a graphical representation shown on the right side.

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Cross-section

The cross section can be defined by the user or by choosing a typical cross section of a proprietary CLT product. There is also the possibility to save own CLT cross sections in a library. The elements are subdivided by the number of layers.

If a user-defined cross section is entered, the thickness and orientation of each layer can be changed. Furthermore, the material can be changed for all layers. The thickness of each layer has to be within the range of 6.0 mm to 45 mm. In the case of proprietary CLT products, the strength class of lumber and the orientation can be changed. If the orientation is changed, the whole cross section is rotated.

	O My CLT cro	ss sections	
lumber of laye	ers 5 💌		
Layer	Thickness	Orientation	Material
1	40 mm	0	GL24h*
2	20 mm	90	GL24h*
3	40 mm	0	GL24h*
4	20 mm	90	GL24h*
5	40 mm	0	GL24h*
	ickness / width t/		160 🗧 mm 🔻
acto bourd chi	citicos , matrici,		

The width of the CLT plate strips can be also defined in this field. The default value is set to 1 m. The thickness of the CLT plate is calculated automatically based on the thickness of the single layers.

The ratio of board thickness to board width can also be changed here. The default setting is 1:4.

My CLT cross sections

By clicking the button the current cross section can be stored in the library and be retrieved by selecting "My CLT cross sections" later on.

The library can be displayed with the button .

Saved cross sections				
Test 1	Project name Test 1			
Test 2	Lawer	Thickness	Orientation	Material
Test 3	Layer			
	1	23 mm	0	GL24h*
	2	20 mm	90	GL24h*
	3	40 mm	0	GL24h*
	4	20 mm	90	GL24h*
	5	23 mm	0	GL24h*
				- unit
	-	1,000 mm		256 mm

- The edit mode can be entered by clicking on . Currently, only the name of the stored cross section can be changed.
- With the changes are saved.
- With et al. the chosen cross section in the sidebar can be removed from the library.
- With cross sections from a csv file can be imported.
- With the cross sections from the library can be exported to a csv file.

Syntax of the csv file



name;number of layers n;layer thickness in [m] t_1 to t_n ;orientation of the layers o_1 to o_n (0 or 90);name of material

Example: Test layup;5;0.03;0.02;0.02;0.02;0.03;90;0;90;0;90;GL24h*

My materials

With the button is the material library can be displayed.

• • •		My materials			
Saved materials					
Mat 1	Project name	Mat 1			
		bending strength	24 +	N/mm ²	ŀ
		tensile strength parallel	16.5	N/mm²	
		tensile strength perpendicular	0.5	N/mm²	ŀ
		compressive strength parallel	24 7	N/mm ²	ŀ
		compressive strength perpendicular	2.7	N/mm ²	•
		shear strength	3 👘	N/mm ²	•
		rolling shear strength	1.25	N/mm²	•
		Youngs modulus parallel	11,600 -	N/mm²	
		5%-quantile from Youngs modulus parallel	9,667	N/mm ²	•
		Youngs modulus perpendicular	0 7	N/mm ²	•
		shear modulus	720	N/mm²	•
		rolling shear modulus	72 7	N/mm ²	•
		density	380 +	kg/m³	•
		density mean value	500 -	kg/m³	•
		in plane shear strength	5.5	N/mm²	ŀ
		torsional strength	2.5	N/mm²	•
		bending strength in-plane	21	N/mm ²	ŀ
					ок

- With where the edit mode can be entered.
- With 💷 the changes are saved.
- With 💷 the chosen material in the sidebar can be removed from the library.
- With materials from a csv file can be imported.
- With the materials from the library can be exported to a csv file.

Syntax of the csv file

- 1. row: description of the parameters
- 2. row: units of the parameters
- 3. row: value
- delimiter: ";"

Example:

Name;f_m,k;f_t,0,k;f_t,90,k;f_c,k;f_c,90,k;f_v,k;f_r,k;E_0;E_0,05;E_90;G;G_r;rho_k;rho_mea n;f_v,k,IP;f_T,k;f_m,k,IP ;N/mm2;N/ Last update: 2018/04/003 en:clt:hotspot:software:cltdesigner:manual:modul_compression_perpendicular_to_grain https://www.bspwiki.at/doku.php?id=en:clt:hotspot:software:cltdesigner:manual:modul_compression_perpendicular_to_grain&rev=1522768435 17:13

The user-defined materials are then displayed in the material selection list.

Material	
Mat 1 (User-defined)	•
Spruce-Pine-Fir No.3 E90=0	
Northern No.1/No.2 E90=0	
Northern No.3 E90=0	
CL 24h	
CL 28h	
ON_B_1995_1_1_2015	
proHolz 2016	
Mat 1 (User-defined)	•

Optimization of layup

Use the button Beta! Optimise cross section... to display the window for layup optimization.

onsider in the optimisatio	n:			
Producer		Number of laye	ers	
best wood SCHNEIDER	✓ KLH	3 🖌 5	6 🖌 7 🗌 8 🛄 9	11
Cross Timber Systems	🔲 Mayr-Melnhof Holz	Plate thickness	5	
Derix	Piveteaubois	min 60 -	mm max 320 ÷ mm	
Eugen Decker	Stora Enso	Saved cross se	ctions	
Hasslacher		My CLT cro		
		Options		
		Outer cross	a layers	Double layers
		Vibration v	erification according to I	EN
Start Stop				
Producer	Cross section	Plate thickness	Governing proof	Utilisation ratio
		Plate thickness	Governing proof Vibration	Utilisation ratio 99.2 %
Producer	Cross section			
Producer	Cross section 180mm 5s DL	180 mm	Vibration	99.2 %
Producer KLH KLH	Cross section 180mm 5s DL 190mm 5s DL	180 mm 190 mm	Vibration Vibration	99.2 % 95.4 %
Producer KLH KLH KLH	Cross section 180mm Ss DL 190mm Ss DL 200mm Ss DL	180 mm 190 mm 200 mm	Vibration Vibration Vibration	99.2 % 95.4 % 90.1 %
Producer KLH KLH KLH KLH	Cross section 180mm 5s DL 190mm 5s DL 200mm 5s DL 220mm 7s DL	180 mm 190 mm 200 mm 220 mm	Vibration Vibration Vibration Vibration	99.2 % 95.4 % 90.1 % 85.3 %
Producer KLH KLH KLH KLH KLH	Cross section 180mm 5s DL 190mm 5s DL 200mm 5s DL 220mm 7s DL 240mm 7s DL	180 mm 190 mm 200 mm 220 mm 240 mm	Vibration Vibration Vibration Vibration Vibration	99.2 % 95.4 % 90.1 % 85.3 % 78.4 %
Producer KLH KLH KLH KLH KLH KLH KLH KLH	Cross section 180mm 5s DL 190mm 5s DL 200mm 5s DL 220mm 7s DL 240mm 7s DL 180mm 7ss DL 200mm 7ss DL 240mm 7ss DL 200mm 7ss DL 200mm 7ss DL	180 mm 190 mm 200 mm 220 mm 240 mm 180 mm	Vibration Vibration Vibration Vibration Vibration Vibration Vibration	99.2 % 95.4 % 90.1 % 85.3 % 78.4 % 93.9 % 82.8 % 73.1 %
Producer KLH KLH KLH KLH KLH KLH KLH	Cross section 180mm 5s DL 190mm 5s DL 200mm 7s DL 220mm 7s DL 240mm 7s DL 180mm 7ss DL 200mm 7ss DL	180 mm 190 mm 200 mm 220 mm 240 mm 180 mm 200 mm	Vibration Vibration Vibration Vibration Vibration Vibration Vibration	99.2 % 95.4 % 90.1 % 85.3 % 78.4 % 93.9 % 82.8 % 73.1 % 65.8 %
Producer KLH KLH KLH KLH KLH KLH KLH KLH	Cross section 180mm 5s DL 190mm 5s DL 200mm 5s DL 220mm 7s DL 240mm 7s DL 180mm 7ss DL 200mm 7ss DL 220mm 7ss DL 220mm 7ss DL 260mm 7ss DL 260mm 7ss DL	180 mm 190 mm 200 mm 220 mm 240 mm 180 mm 200 mm 220 mm	Vibration Vibration Vibration Vibration Vibration Vibration Vibration	99.2 % 95.4 % 90.1 % 85.3 % 78.4 % 93.9 % 82.8 % 73.1 % 65.8 % 61.6 %
Producer KLH KLH KLH KLH KLH KLH KLH KLH	Cross section 180mm Ss DL 190mm Ss DL 200mm Ss DL 220mm 7s DL 240mm 7s DL 240mm 7ss DL 200mm 7ss DL	180 mm 190 mm 200 mm 220 mm 240 mm 180 mm 200 mm 220 mm 220 mm	Vibration Vibration Vibration Vibration Vibration Vibration Vibration Vibration	99.2 % 95.4 % 90.1 % 85.3 % 78.4 % 93.9 % 82.8 % 73.1 % 65.8 %
Producer KLH KLH KLH KLH KLH KLH KLH KLH	Cross section 180mm 5s DL 190mm 5s DL 200mm 5s DL 220mm 7s DL 240mm 7s DL 180mm 7ss DL 200mm 7ss DL 220mm 7ss DL 220mm 7ss DL 260mm 7ss DL 260mm 7ss DL	180 mm 190 mm 200 mm 220 mm 240 mm 180 mm 200 mm 220 mm 240 mm 260 mm	Vibration Vibration Vibration Vibration Vibration Vibration Vibration Vibration Vibration	99.2 % 95.4 % 90.1 % 85.3 % 78.4 % 93.9 % 82.8 % 73.1 % 65.8 % 61.6 %

With the help of this tool, the possible layups can be determined for the given system and load situation. The optimization can be restricted with regard to producers, number of layers or by means of limits for the panel thickness. Furthermore, outer cross layers or double layers can be included or excluded. With the option "Vibration verification according to EN" the base document is included in the vibration check or not.

With the buttons "Start" and "Stop" the calculation is controlled. Please be patient, depending on the selected parameter the calculation may take a little longer.

The possible setups are then displayed in the table and the selected setup can be transferred to the main window by clicking the "Choose the selected cross section" button.

Cross section · 2017/11/14 17:11

Plate dimensions and gap execution

The plate is specified with its dimensions in x and y direction. The plate length is defined with dimension in x direction and the plate width with dimension in y direction.

Plate	
Length	1,000 - mm
Width	1,000 - mm
not	side bonded or cracks in top layers expected
Gap:	s or cracks > 1 mm

In addition to plate dimensions, the analysis also considers the way the lamellas are joined into individual layers. Regarding to the joining of the outer layers, one should differ:

- side gluing of lamellas,
- assembly without adhesive where lamellas are placed side by side without the sheduled gaps or the expected occurence of cracks and
- possible occurence of gaps or cracks wider than 1 mm.

Load data and design factors

The applied force $F_{c,90}$ (design value) in [N], as well as the design factors can be specified here.

Loads to induce and design factors				
F _{c,90}	100,000 - N			
k _{mod}	1			
YM	1.25			

Load configuration

The load situation is described by specifying the load introduction above and below. Thereby, one can define if the load is even applied, and if so, if it is applied locally or continuously (over entire surface).

If the load is applied locally, it needs to be defined by entering the dimensions of the load surface (length $I_{1,2}$ in direction x and width $w_{1,2}$ in direction y) and the position. The position is defined as the distance between the center of a load surface and the origin of the coordinate system (lower left

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corner of the plate). Currently, centers of the top and the bottom load surface are coupled and cannot be moved relative to each other.

Load introduction above	Load introduction below		
one	one		
Continuous	Continuous		
Iocal	Iocal		
I ₁ 200 [▲] mm	I ₂ 200 <u>↑</u> mm		
w ₁ 200 $\frac{1}{2}$ mm	w ₂ 200 – mm		
e _{l,1} 500 - mm	e _{l,2} 500 ÷ mm		
e _{w,1} 500 - mm	e _{w,2} 500 ÷ mm		

Calculation options

In the calculation options, the load distribution angles for longitudinal layers α_0 and cross layers α_{90} can be changed, and for one-sided load introduction, it can be specified, in which depth (= $k_{Is} \cdot t_{CLT}$) the effective area is to be determined.

Options		
Load distribution angle	α0	45 ÷ °
	α ₉₀	15 * *
Height factor for one-sided load introduction	k _{ls}	0.4 🗧

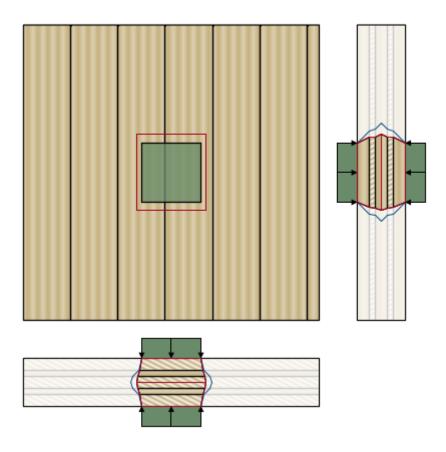
Results and Output

The minimum load introduction area $A_{c,min}$ describes the reference area in order to get the effective area $A_{ef,max}$ by multiplying with the factor $k_{c,90}$. For different load introduction areas on each side it is the intersection of these two areas. The effective area $A_{ef,max}$ is described by I_{ef} and w_{ef} in depth z.

The utilisation ratio for compression perpendicular to grain is indicated by $\eta_{c,00}$ in [%].

	ad introduction ar 0,000 mm²	ea	
A _{ef,max}	59,880 mm ²		
l _{ef}	233 mm		
w _{ef}	257 mm		
z	80 mm		
k _{c,90}	1.5		
k _{c,90} *A _{c,min}	59,880 mm²		
Utilisation r Compressio	ratios on perpendicular to	grain η _{c,90}	77.3 %

The following figure shows the distribution of the effective area $A_{ef,max}$ over the cross section (red line) as well as the assumed load distribution (blue line).



Implemented calculation methods

Compression perpendicular to grain - Verification

Model for the determination of the kc,90 factor

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