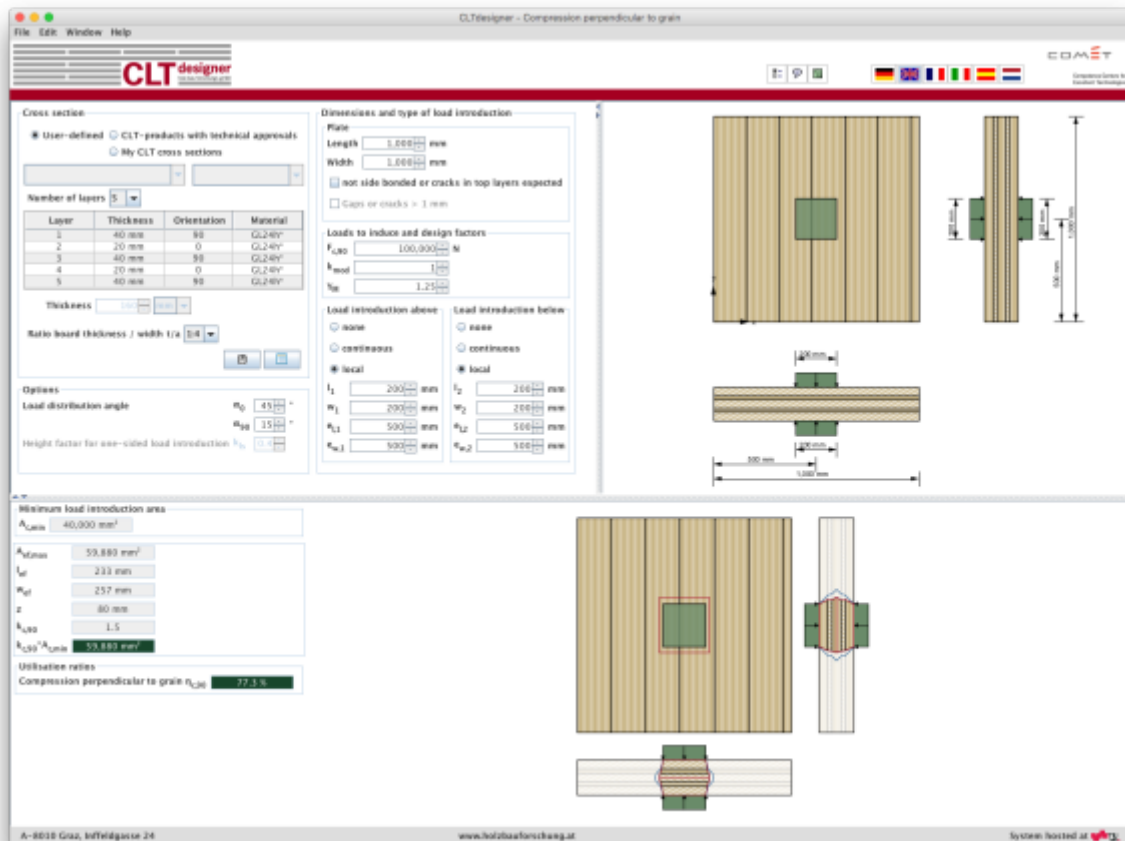




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Module "Compression perpendicular to grain"



Input data

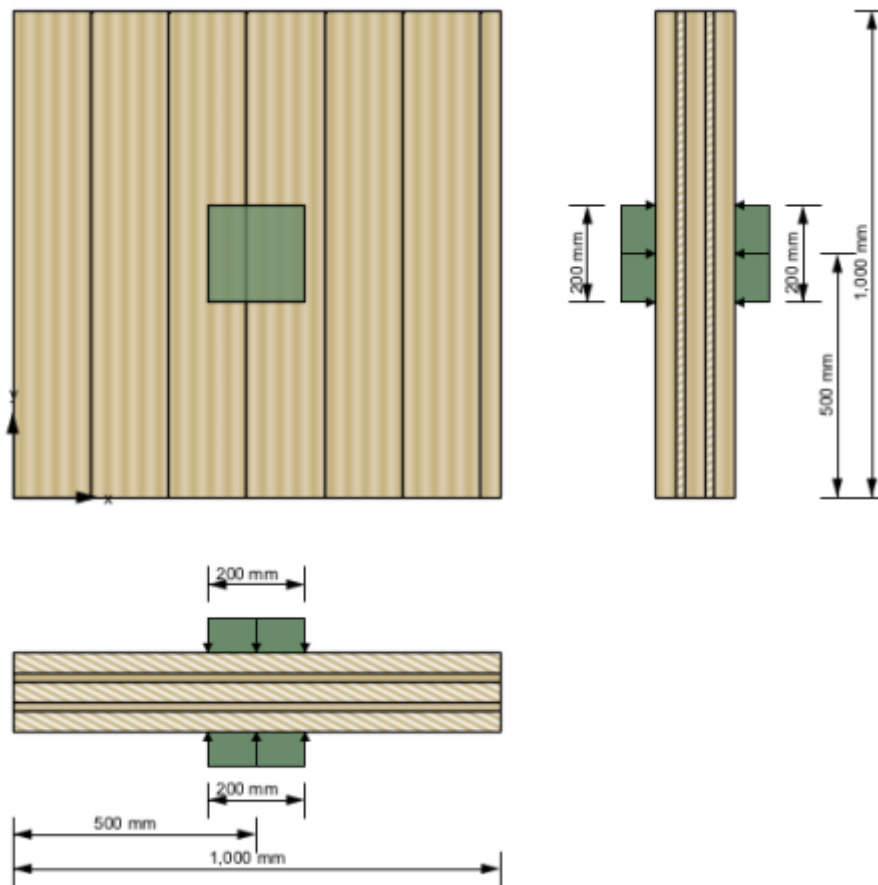
The input is divided into:

- 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.



Cross-section

The input is the same as for the [Module "CLT-Plate 1D - Continuous beam"](#).

[Show description](#)

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.

Cross section

☒ User-defined
 ☐ CLT-products with technical approvals
☐ My CLT cross sections

Number of layers

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*

Width
 Thickness

Ratio board thickness / width t/a

Beta! Optimise cross section...

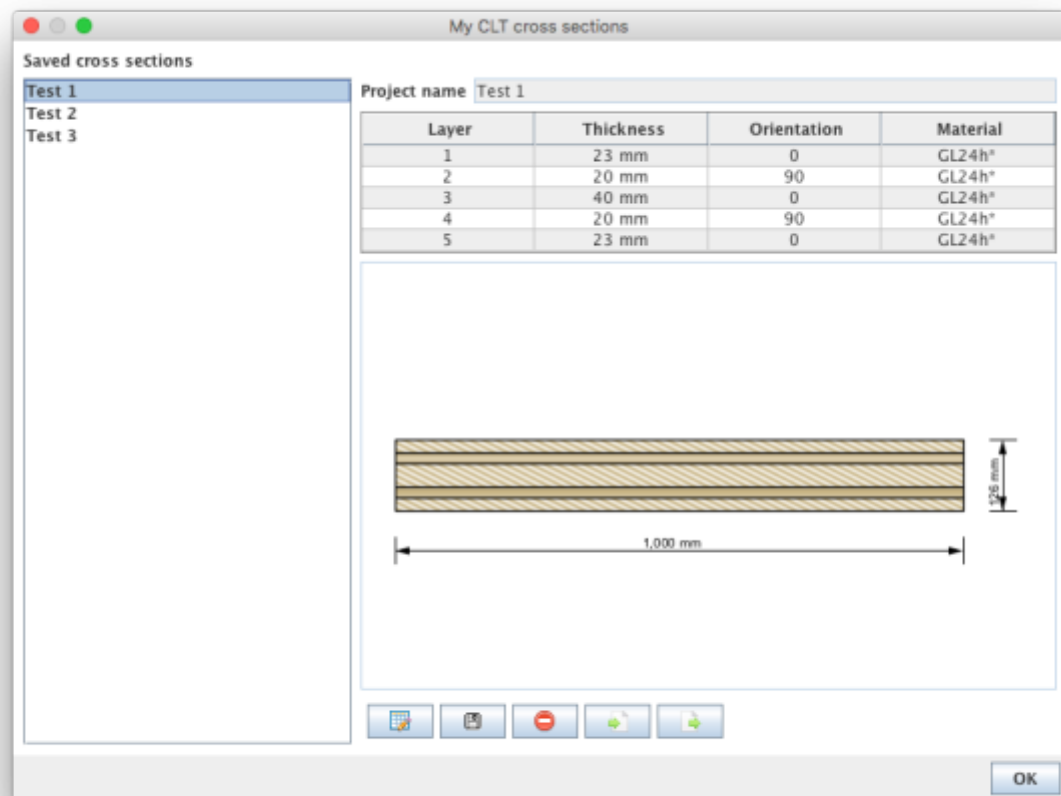
The width of the CLT plate strips can be also defined in this field. The default value is set to 1 m. The thickness of the CLT plate is calculated automatically based on the thickness of the single layers.

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 .



- 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  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 the material library can be displayed.

Property	Value	Unit
bending strength	24	N/mm ²
tensile strength parallel	16.5	N/mm ²
tensile strength perpendicular	0.5	N/mm ²
compressive strength parallel	24	N/mm ²
compressive strength perpendicular	2.7	N/mm ²
shear strength	3	N/mm ²
rolling shear strength	1.25	N/mm ²
Youngs modulus parallel	11,600	N/mm ²
5%-quantile from Youngs modulus parallel	9,667	N/mm ²
Youngs modulus perpendicular	0	N/mm ²
shear modulus	720	N/mm ²
rolling shear modulus	72	N/mm ²
density	380	kg/m ³
density mean value	500	kg/m ³
in plane shear strength	5.5	N/mm ²
torsional strength	2.5	N/mm ²
bending strength in-plane	21	N/mm ²

- With  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

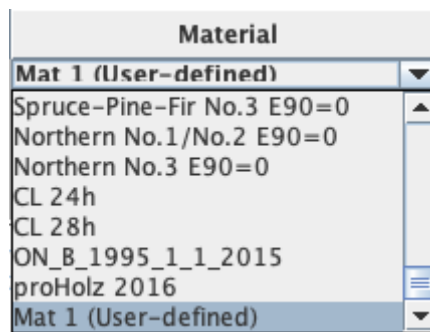
1. row: description of the parameters
 2. row: units of the parameters
 3. row: value
- delimiter: ";"



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_mean;f_v,k,IP;f_T,k;f_m,k,IP
;N/mm2;N/mm2;N/mm2;N/mm2;N/mm2;N/mm2;N/mm2;N/mm2;N/mm2;N/mm2;N/mm2;N/mm2;N/mm2;kg/m3;kg/m3;N/mm2;N/mm2;N/mm2
Mat 1;24;16.5;0.5;24;2.7;3;1.25;11600;9667;0;720;72;380;500;5.5;2.5;21
```

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



Optimization of layup

Use the button  to display the window for layup optimization.

The 'Optimisation' window is shown with the following settings:

- Consider in the optimisation:**
 - Producer:** ☐ best wood SCHNEIDER, ☒ KLH, ☐ Cross Timber Systems, ☐ Mayr-Melnhof Holz, ☐ Derix, ☐ Piveteaubois, ☐ Eugen Decker, ☐ Stora Enso, ☐ Hasslacher.
 - Number of layers:** ☐ 3, ☒ 5, ☐ 6, ☒ 7, ☐ 8, ☐ 9, ☐ 11.
 - Plate thickness:** min mm max mm.
 - Saved cross sections:** ☐ My CLT cross sections.
 - Options:** ☐ Outer cross layers, ☒ Double layers, ☐ Vibration verification according to EN.
- Buttons:** Start, Stop, and a progress bar.
- Table of results:**

Producer	Cross section	Plate thickness	Governing proof	Utilisation ratio
KLH	180mm 5s DL	180 mm	Vibration	99.2 %
KLH	190mm 5s DL	190 mm	Vibration	95.4 %
KLH	200mm 5s DL	200 mm	Vibration	90.1 %
KLH	220mm 7s DL	220 mm	Vibration	85.3 %
KLH	240mm 7s DL	240 mm	Vibration	78.4 %
KLH	180mm 7ss DL	180 mm	Vibration	93.9 %
KLH	200mm 7ss DL	200 mm	Vibration	82.8 %
KLH	220mm 7ss DL	220 mm	Vibration	73.1 %
KLH	240mm 7ss DL	240 mm	Vibration	65.8 %
KLH	260mm 7ss DL	260 mm	Vibration	61.6 %
KLH	280mm 7ss DL	280 mm	Vibration	58.2 %
- Footer:** Choose the selected cross section

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.

Die Platte wird durch ihre Dimensionen in x- und y-Richtung beschrieben. Die Länge der Platte ist die Abmessung in x-Richtung und die Breite die in y-Richtung.

Plate
Length mm
Width mm
☒ not side bonded or cracks in top layers expected
☐ Gaps or cracks > 1 mm



In addition to plate dimensions, the analysis also considers the way the lamellas are joined into individual layers. In this regard, when it comes to outer layers, one should differ:

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

Neben der Plattenabmessungen geht auch die Fugenausführung in die Berechnung ein. Bezüglich der Fugenausführung ist zu unterscheiden ob die Decklagen

- seitenverklebt sind,
- nicht seitenverklebt, aber Mann an Mann (ohne planmäßige Fugen) bzw. ob Risse zu erwarten sind und
- ob Fugen oder Risse mit größer 1 mm auftreten können.

Load data and design factors

Hier können die einzuleitende Kraft $F_{c,90}$ (Bemessungswert) in [N] sowie die Bemessungsfaktoren angegeben werden.

Loads to induce and design factors	
$F_{c,90}$	100,000 N
k_{mod}	1
Y_M	1.25

Load configuration

Die Lastsituation wird durch die Lasteinleitung oben und unten beschrieben. Dabei kann die Lasteinleitung lokal oder kontinuierlich (über gesamte Plattenfläche) erfolgen oder auch keine Lasteinleitung vorhanden sein.

Bei lokaler Lasteinleitung sind die Abmessungen der Beanspruchungsfläche (Länge in x-Richtung $l_{1,2}$ und Breite in y-Richtung $w_{1,2}$) sowie die Lage einzugeben. Die Lage wird durch den Abstand des Mittelpunktes der Beanspruchungsfläche zum Koordinatenursprung (Eckpunkt der Platte links unten) beschrieben. Derzeit sind die Mittelpunkte der Beanspruchungsflächen oben und unten gekoppelt und können nicht gegeneinander verschoben werden.

Load introduction above	Load introduction below
☐ none	☐ none
☐ continuous	☐ continuous
☒ local	☒ local
l_1 200 mm	l_2 200 mm
w_1 200 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 den Berechnungsoptionen können die Lastausbreitungswinkel für Längslagen α_0 und für Querlagen α_{90} verändert werden sowie bei einseitiger Lasteinleitung kann angegeben werden, in welcher Höhe ($= k_{ls} \cdot t_{CLT}$) die effektive Fläche bestimmt werden soll.

Options	
Load distribution angle	α_0 45 °
	α_{90} 15 °
Height factor for one-sided load introduction	k_{ls} 0.4

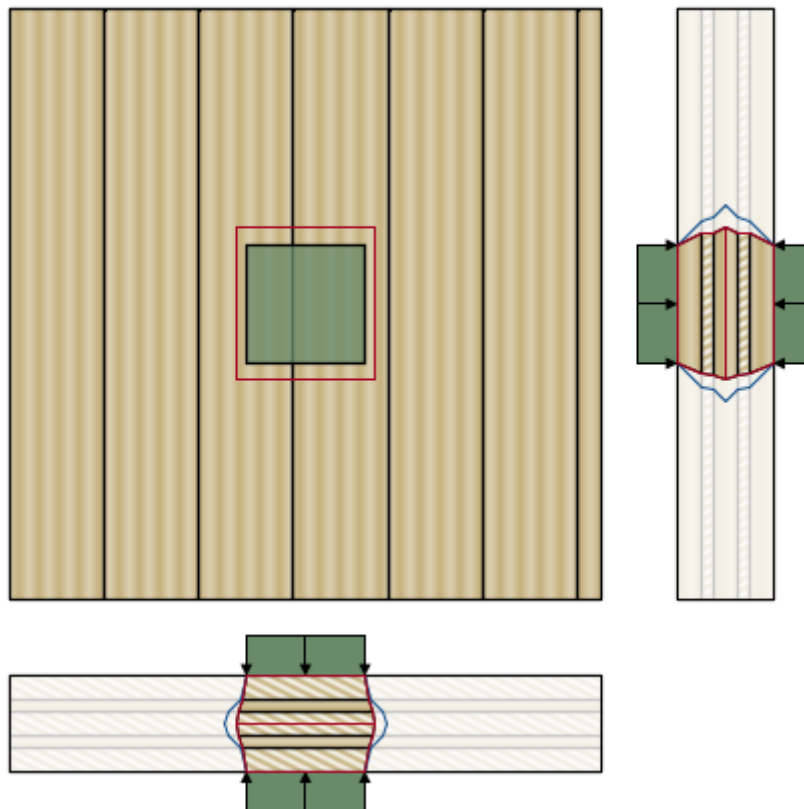
Results and Output

Die minimale Lasteinleitungsfläche beschreibt die Bezugsfläche, um mit dem Querdruckbeiwert $k_{c,90}$ auf die effektive Fläche $A_{ef,max}$ zu kommen. Bei unterschiedlichen Beanspruchungsflächen oben und unten ist es die Überschneidungsfläche der beiden Beanspruchungsflächen. Die effektive Fläche $A_{ef,max}$ wird durch l_{ef} und w_{ef} in der Höhe z beschrieben.

Die Ausnutzung auf Querdruck wird durch den Ausnutzungsgrad $\eta_{c,90}$ in [%] angegeben.

Minimum load introduction area	
$A_{c,min}$	40,000 mm ²
$A_{ef,max}$	59,880 mm ²
l_{ef}	233 mm
w_{ef}	257 mm
z	80 mm
$k_{c,90}$	1.5
$k_{c,90} \cdot A_{c,min}$	59,880 mm ²
Utilisation ratios	
Compression perpendicular to grain $\eta_{c,90}$	77.3 %

In der folgenden Skizze wird der Verlauf der effektiven Fläche $A_{ef,max}$ über die Querschnittshöhe (rote Linie) sowie der Verlauf der angenommenen Lastausbreitung (blaue Linie) angezeigt.



Implemented calculation methods

Compression perpendicular to grain - Verification

Model for the determination of the $k_{c,90}$ factor

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https://www.bspwiki.at/doku.php?id=en:clt:hotspot:software:cltdesigner:manual:modul_compression_perpendicular_to_grain&rev=1513687347

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