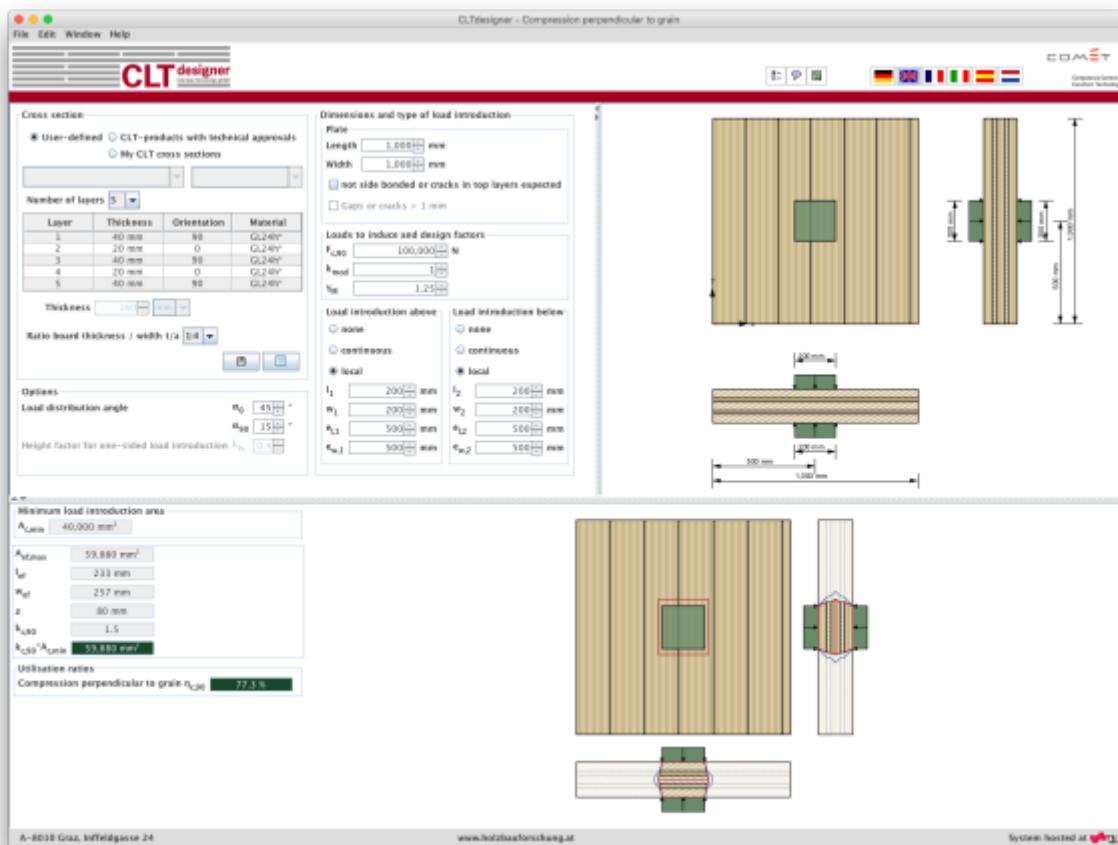




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(remove this paragraph once the translation is finished)

Module "Compression perpendicular to grain"



Input data

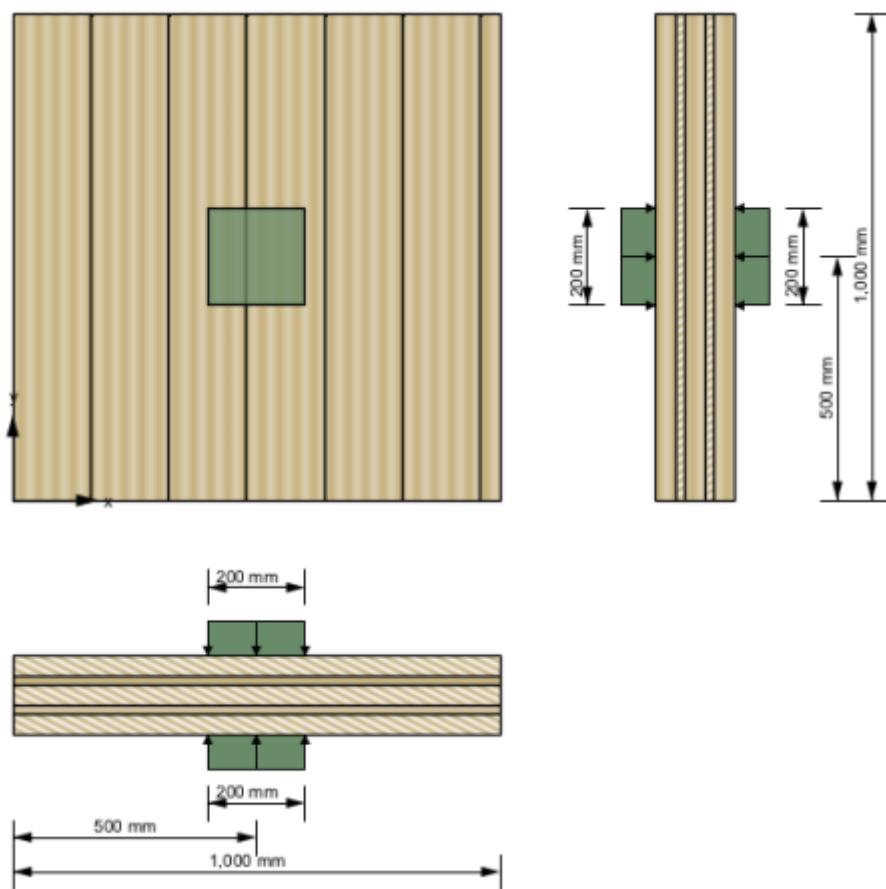
The input is divided into:

- 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	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*

Width mm Thickness mm

Ratio board thickness / width t/a

Beta! Optimise cross section...

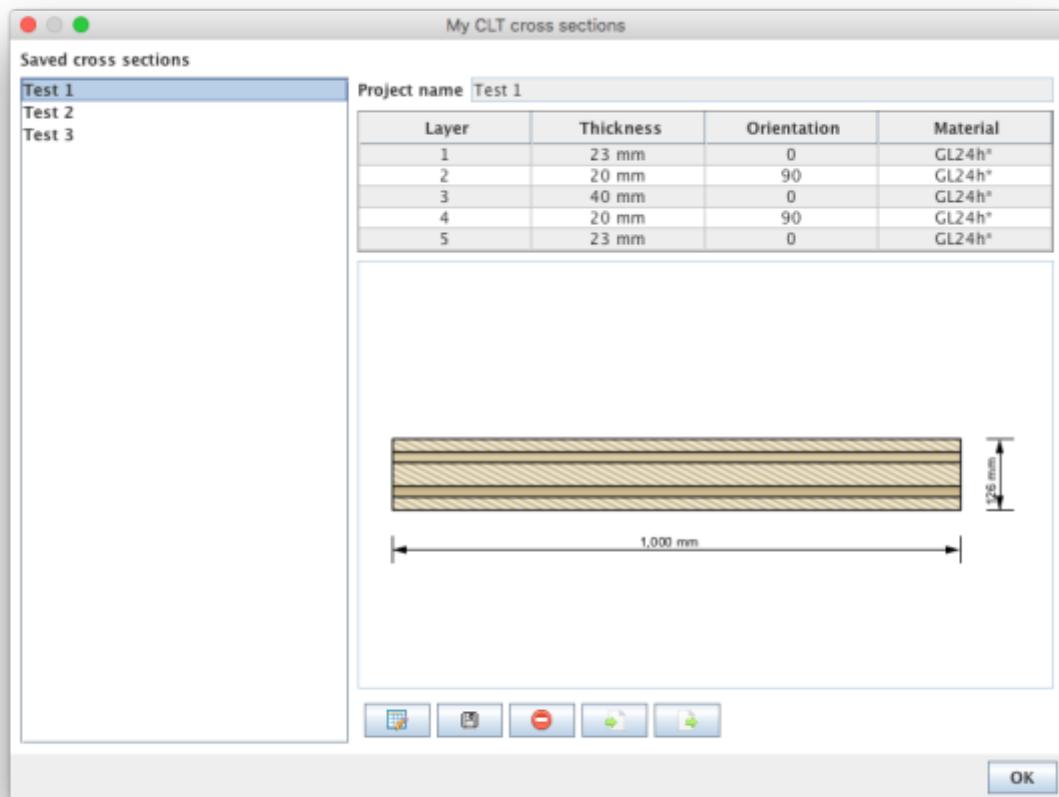
The width of the CLT plate strips can be also defined in this field. The default value is set to 1 m. The thickness of the CLT plate is calculated automatically based on the thickness of the single layers.

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



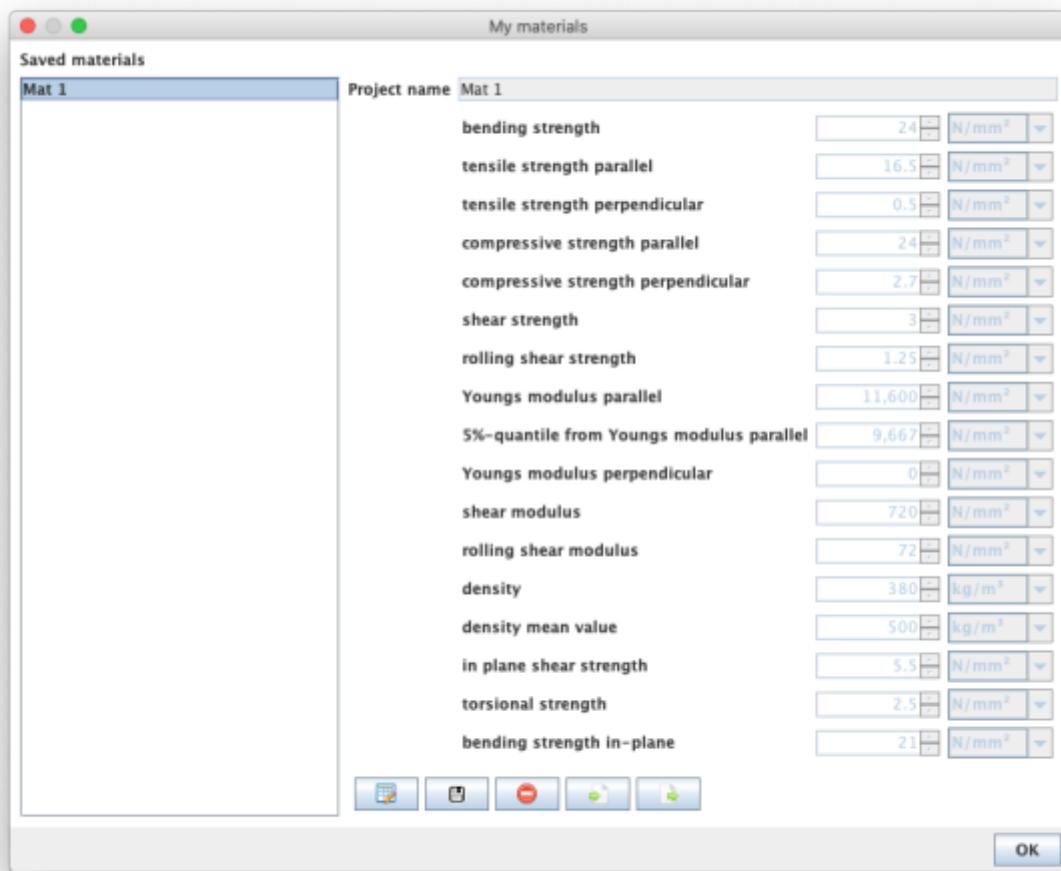
name;number of layers n;layer thickness in [m] t₁ to t_n;orientation of the layers o₁ to o_n (0 or 90);name of material

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.



- 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

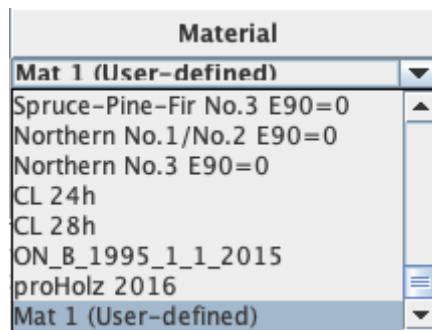
1. row: description of the parameters
2. row: units of the parameters
3. row: value
delimiter: ";"



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;N/mm2;N/mm2;kg/m3;kg/m3;N/mm2;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 **Beta! Optimise cross section...** to display the window for layup optimization.

The screenshot shows the "Optimisation" window with the following settings:

- Consider in the optimisation:** Producer: best wood SCHNEIDER (checked), KLH (checked), Cross Timber Systems, Derix, Eugen Decker, Hasslacher; Mayr-Melnhof Holz, Piveteaubois, Stora Enso.
- Number of layers:** 3, 5, 6, 7, 8, 9, 11 (checkboxes). Selected: 5, 7.
- Plate thickness:** min 60 mm, max 320 mm.
- Saved cross sections:** My CLT cross sections (checkbox) is checked.
- Options:** Outer cross layers (checkbox), Double layers (checkbox) is checked, Vibration verification according to EN (checkbox).

Start and **Stop** buttons are at the bottom left. A table of results is shown below:

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 %

Choose the selected cross section button is at the bottom right.

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	1,000 <input type="button" value="▼"/> mm
Width	1,000 <input type="button" value="▼"/> mm
<input checked="" type="checkbox"/> not side bonded or cracks in top layers expected	
<input type="checkbox"/> 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 lamellas,
- assembly without adhesive where lamellas are placed side by side without the scheduled gaps or the expected occurrence of cracks and
- possible occurrence of gaps or cracks wider than 1 mm.

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

- seitenvorklebt sind,
- nicht seitenvorklebt, 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



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

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	
γ_M	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 $l_{1,2}$ 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 corner of the plate). Currently, centers of the top and the bottom load surface are coupled and cannot be moved relative to each other.

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	
<input type="radio"/> none	<input type="radio"/> continuous	<input type="radio"/> none	<input type="radio"/> continuous
<input checked="" type="radio"/> local			
l_1	200	l_2	200
w_1	200	w_2	200
$e_{l,1}$	500	$e_{l,2}$	500
$e_{w,1}$	500	$e_{w,2}$	500

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 <input type="text" value="45"/> °
	α_{90} <input type="text" value="15"/> °
Height factor for one-sided load introduction	k_{ls} <input type="text" value="0.4"/>

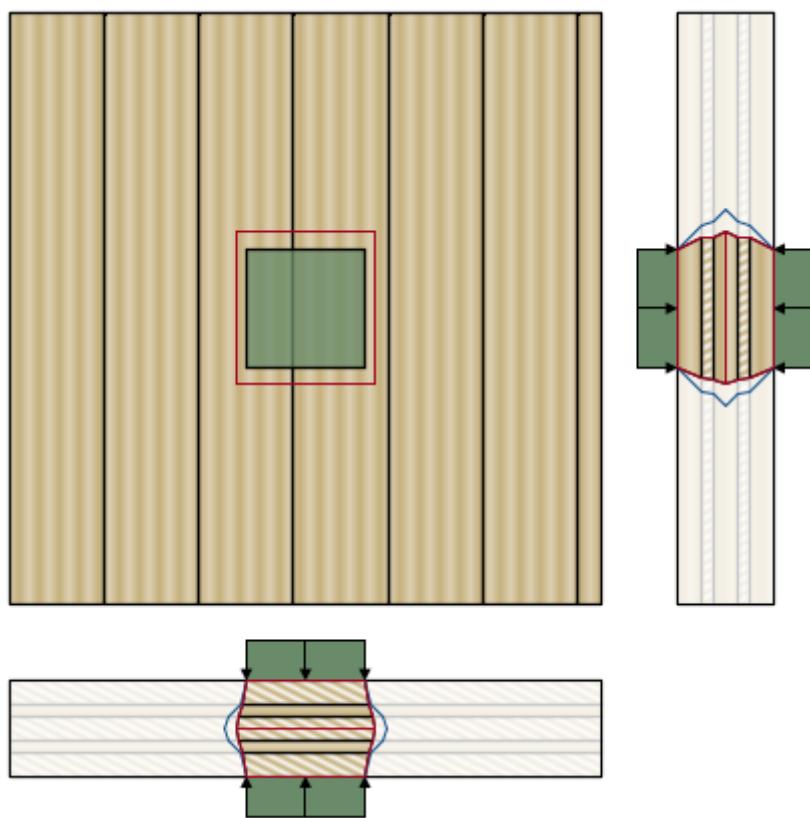
Results and Output

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 kc,90 factor](#)

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