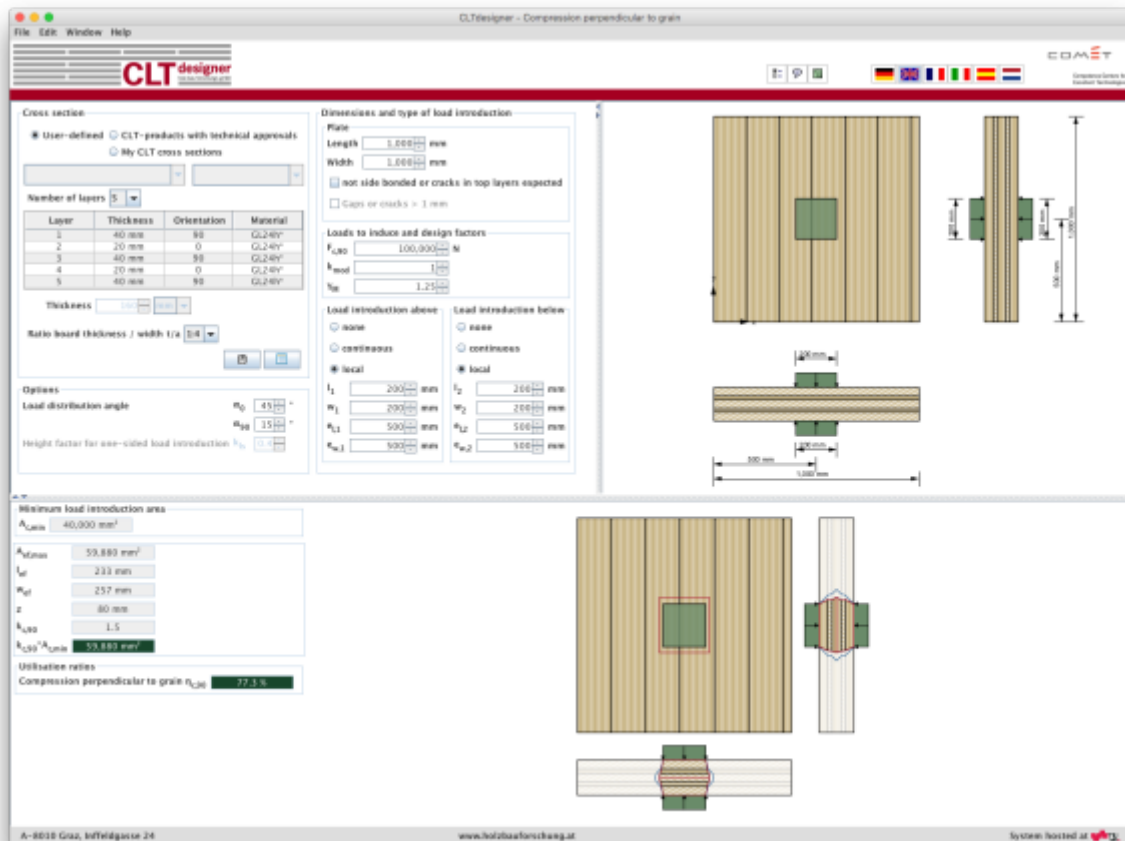




**Fix Me!** This page is not fully translated, yet. Please help completing the translation.

(remove this paragraph once the translation is finished)

# Module "Compression perpendicular to grain"

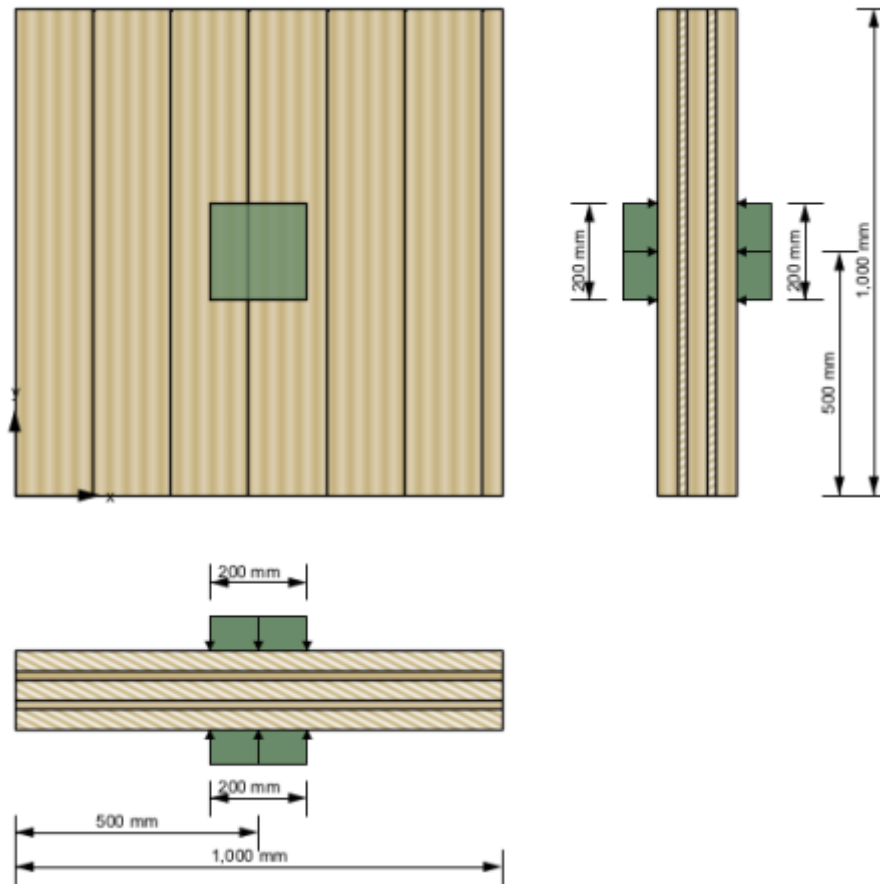


## Input data

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 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...**

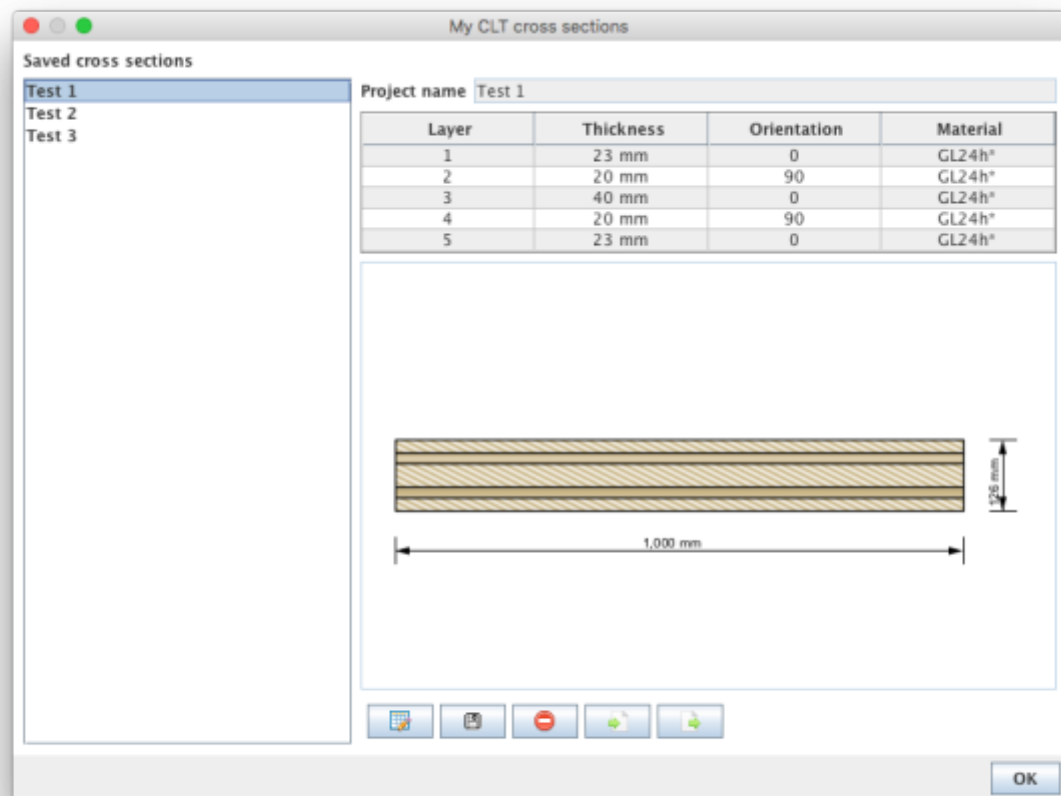
The width of the CLT plate strips can be also defined in this field. The default value is set to 1 m. The thickness of the CLT plate is calculated automatically based on the thickness of the single layers.

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

- 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

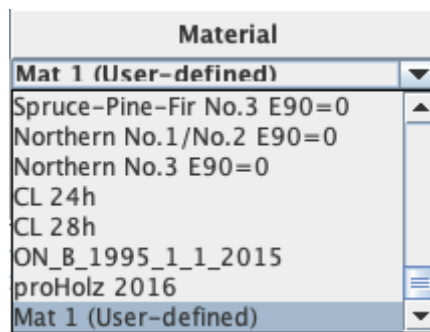
1. row: description of the parameters
  2. row: units of the parameters
  3. row: value
- delimiter: ";"




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:**

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.

**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. 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**

$F_{c,90}$   N
 $k_{mod}$  
 $Y_M$

## 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.

Load introduction above		Load introduction below	
<input type="radio"/> none		<input type="radio"/> none	
<input type="radio"/> continuous		<input type="radio"/> continuous	
<input checked="" type="radio"/> local		<input checked="" type="radio"/> local	
$l_1$	<input type="text" value="200"/> mm	$l_2$	<input type="text" value="200"/> mm
$w_1$	<input type="text" value="200"/> mm	$w_2$	<input type="text" value="200"/> mm
$e_{l,1}$	<input type="text" value="500"/> mm	$e_{l,2}$	<input type="text" value="500"/> mm
$e_{w,1}$	<input type="text" value="500"/> mm	$e_{w,2}$	<input type="text" value="500"/> mm

## Calculation options

In the calculation options, the load distribution angles for longitudinal layers  $\alpha_0$  and cross layers  $\alpha_{90}$  can be changed, and for one-sided load introduction, it can be specified, in which depth ( $= k_{ls} \cdot t_{CLT}$ ) the effective area is to be determined.

Options	
Load distribution angle	$\alpha_0$ <input type="text" value="45"/> ° $\alpha_{90}$ <input type="text" value="15"/> °
Height factor for one-sided load introduction	$k_{ls}$ <input type="text" value="0.4"/>

## Results and Output

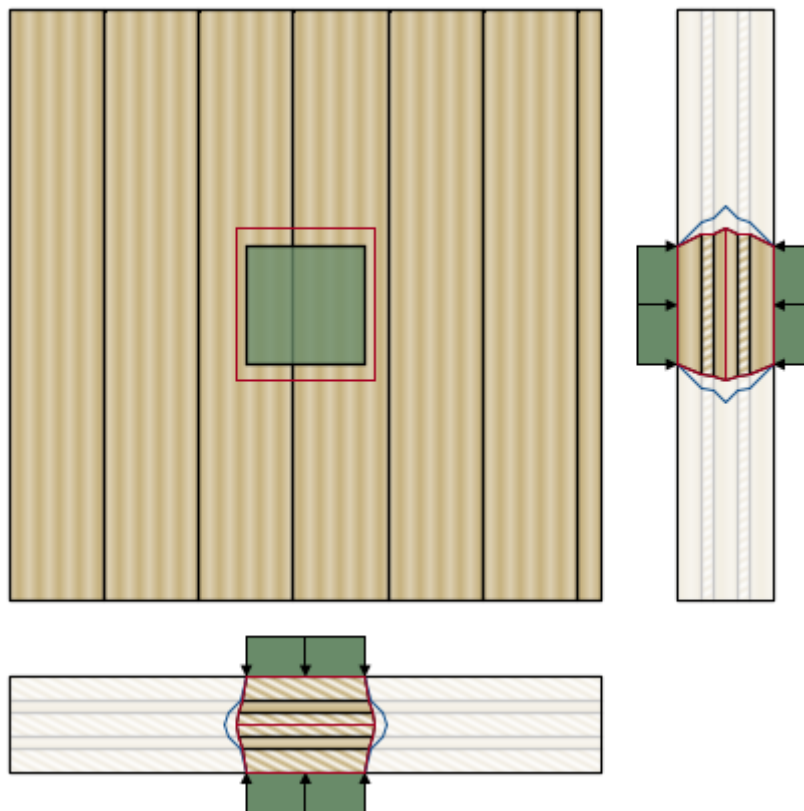
Die minimale Lasteinleitungsfläche beschreibt die Bezugsfläche, um mit dem Querdruckbeiwert  $k_{c,90}$  auf die effektive Fläche  $A_{ef,max}$  zu kommen. Bei unterschiedlichen Beanspruchungsflächen oben und unten ist es die Überschneidungsfläche der beiden Beanspruchungsflächen. Die effektive Fläche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

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



Minimum load introduction area	
$A_{C,min}$	40,000 mm <sup>2</sup>
$A_{ef,max}$	59,880 mm <sup>2</sup>
$l_{ef}$	233 mm
$w_{ef}$	257 mm
$z$	80 mm
$k_{c,90}$	1.5
$k_{c,90} \cdot A_{C,min}$	59,880 mm <sup>2</sup>
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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Last update: **2018/04/03 16:58**

