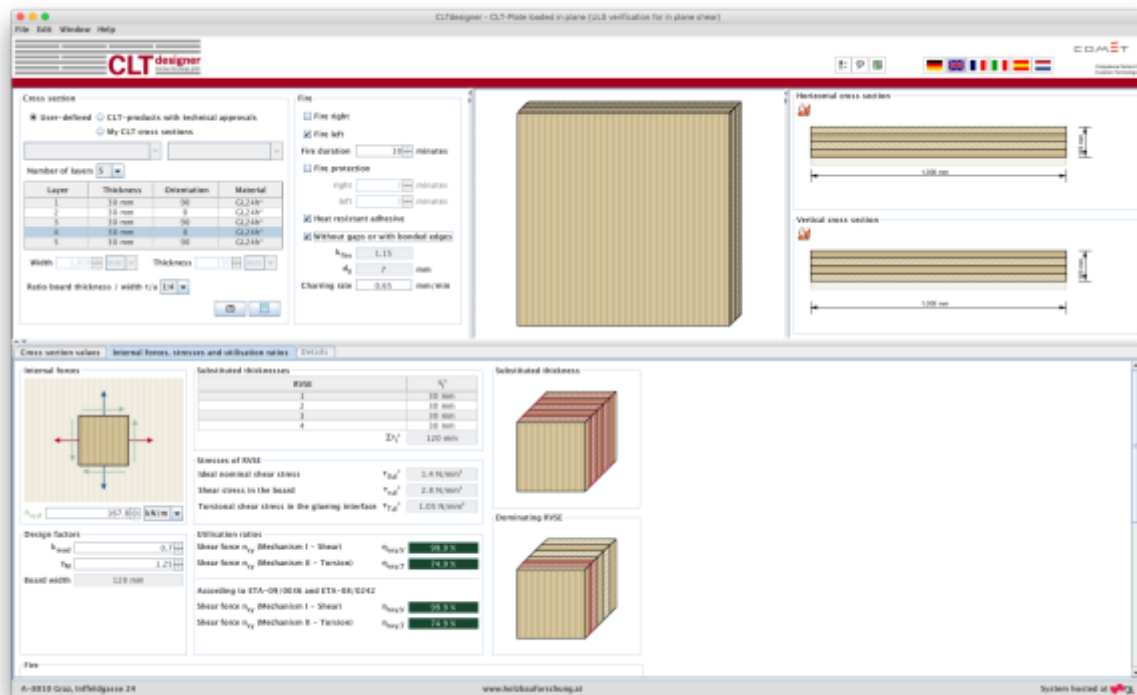


Module "CLT-Plate loaded in plane"



Input data

The input is divided into:

- definitions of the cross section
- specification of parameters concerning structural fire design
- internal forces (design values)
- definitions of design factors

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...

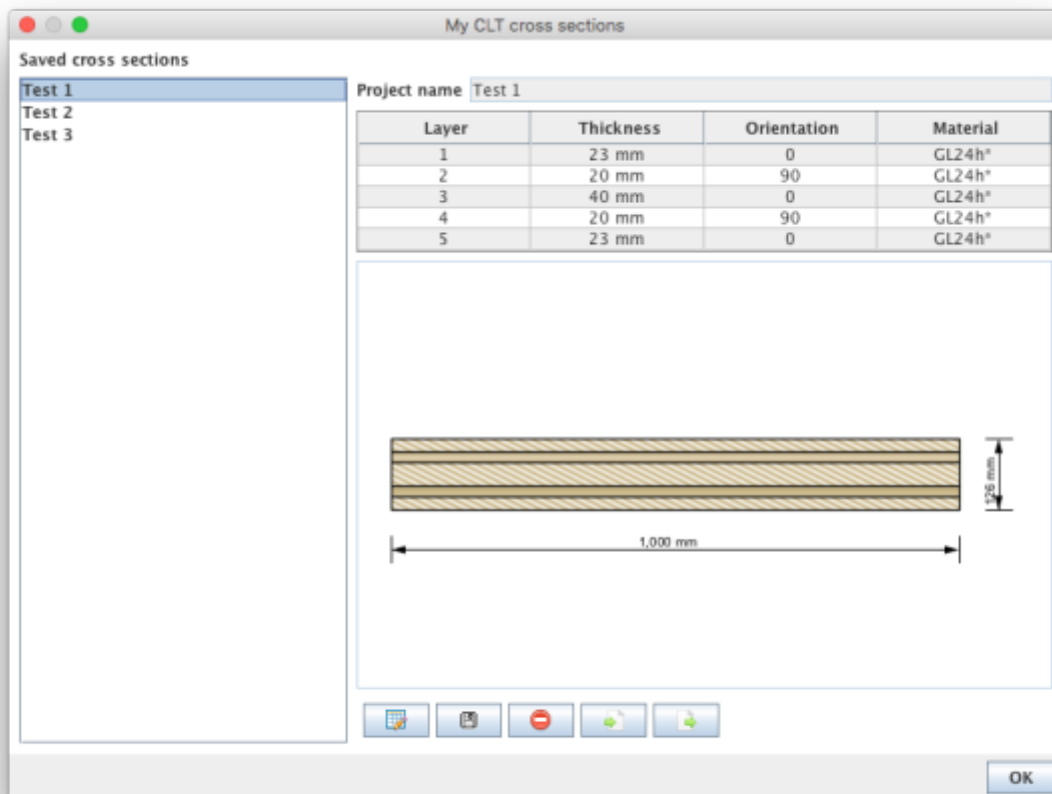
The width of the CLT plate strips can be also defined in this field. The default value is set to 1 m. The thickness of the CLT plate is calculated automatically based on the thickness of the single layers.






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




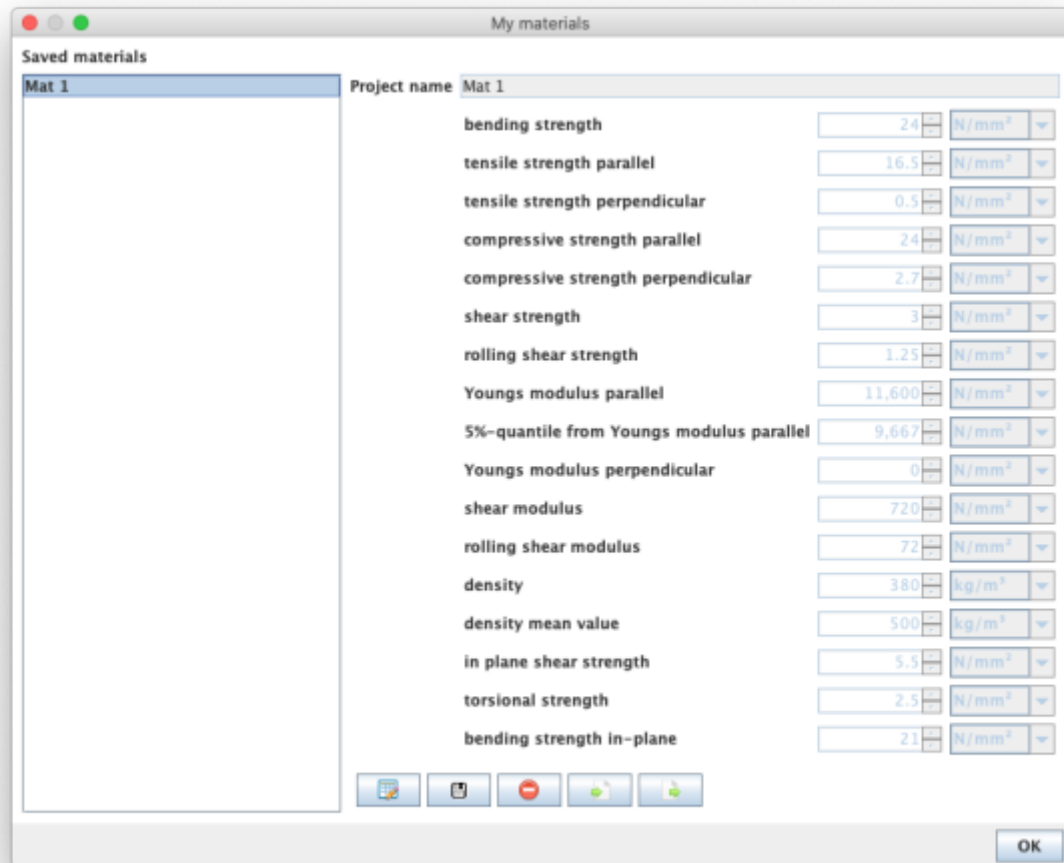
name;number of layers n ;layer thickness in [m] t_1 to t_n ;orientation of the layers α_1 to α_n (0 or 90);name of material






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

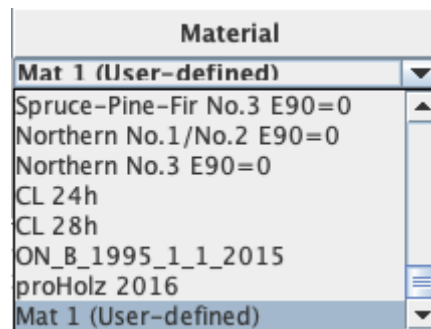
1. row: description of the parameters
 2. row: units of the parameters
 3. row: value
- delimiter: ";"



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;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 **Beta! Optimise cross section...** to display the window for layup optimization.

Optimisation

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

Start **Stop**

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

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

In this module it is not possible to change the cross sectional width.

Fire

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

[Show description](#)

By choosing "Fire above" and/or "Fire below" in the tab "Fire" a structural fire design has to be carried out. The "Fire duration" is specified in minutes and can be increased (or decreased) by increments of 30 minutes by pressing the up (or down) arrows, or defined by entering a specific duration between 0 minutes and 240 minutes in the allotted box. By ticking the box next to "Fire protection system" a layer of fire protection is added to the plate. Furthermore, the position ("above" and/or "below") must be declared and the parameters t_{ch} , t_f , k_2 and k_3 must be specified. In case the failure time of the fire protection system is equal to the time until the protected component starts to burn, the option " $t_f = t_{ch}$ " shall be checked.

Fire

Vibrations

☐ Fire above
☒ Fire below
 Fire duration minutes
☒ Fire protection system
☒ below
 t_{ch} minutes
 t_f minutes ☒ $t_f = t_{ch}$
 k_2
 k_3
☐ Heat resistant adhesive
☒ consider falling off of charred layers
☐ Without gaps or with bonded edges
 k_{fire}
 d_0 mm
 Charring rate mm/min

For a user-defined cross section, options are given for specifying heat resistant adhesives, presence of grooves, and whether the layers are edge-glued. For CLT products both values are set automatically and they cannot be changed.

Some manufacturers offer CLT elements with different adhesives, so instead of selecting "Heat resistant adhesive", it is also possible to select the adhesive.

Adhesive ☒ PUR ☐ MUF

The values k_{fire} (conversion factor 20%-quantiles) and d_0 (layer thickness to take into consideration the influence of temperature exposure) are pre-set and cannot be changed. The charring rate is dependent on the option edge glued or without groove. For a user-defined cross section this value can be changed.

In some approvals or design proposals a different charring rate is expected from the 2nd layer onwards. This will show up as follows:

Charring rate from 2nd layer onwards mm/min

Fire · 2017/11/14 17:11

Fire left / right instead of fire above and below.

Internal forces and design factors

In the tab „internal forces, stresses and utilization ratio“ it is possible to define the shear force in plane per unit length $n_{xy,d}$, as well as the design factors. The design method is based on a board width which is chosen when defining the cross section.

Internal forces

$n_{xy,d}$

Design factors

k_{mod}

γ_M

Board width

Results and Output

Cross section values

The effective stiffnesses of a plate loaded in plane are given in the tab "cross section values" for the full cross section and in case of structural fire design for the charred cross section.

Full cross section

D_x

D_y

D_{xy}

Charred cross section

D_x

D_y

D_{xy}





The small differences between the extensional stiffnesses D_x and D_y and the effective extensional stiffness EA_{ef} in the module CLT-Plate 1D result from the negligence of the extensional stiffness of the cross layers in this module.

Summary of the results

The calculated substituted thicknesses, stresses as well as utilization ratios of the two mechanisms (Mechanism I – shear and Mechanism II – torsion) are given in the tab "internal forces, stresses and utilization ratios".

Furthermore, the utilization ratios, that were calculated based on ETA-08/242 [1] and ETA-09/0036 [2] are given.

Substituted thicknesses

RVSE	t_i^*
1	30 mm
2	30 mm
3	30 mm
4	30 mm
Σt_i^*	120 mm

Stresses of RVSE

Ideal nominal shear stress	$\tau_{0,d}^*$	1,4 N/mm ²
Shear stress in the board	$\tau_{v,d}^*$	2,8 N/mm ²
Torsional shear stress in the glueing interface	$\tau_{T,d}^*$	1,05 N/mm ²

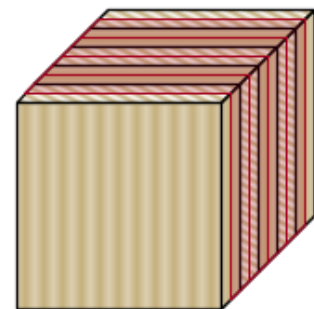
Utilisation ratios

Shear force n_{xy} (Mechanism I – Shear)	$\eta_{nxy,V}$	99,9 %
Shear force n_{xy} (Mechanism II – Torsion)	$\eta_{nxy,T}$	74,9 %

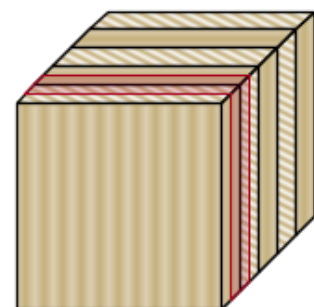
According to ETA-09/0036 and ETA-08/0242

Shear force n_{xy} (Mechanism I – Shear)	$\eta_{nxy,V}$	99,9 %
Shear force n_{xy} (Mechanism II – Torsion)	$\eta_{nxy,T}$	74,9 %

Substituted thickness



Dominating RVSE



[1] ↑ Europäische Technische Zulassung ETA-08/0242: HMS - Element. Berlin. 11.03.2009. gültig bis 10.03.2014.

[2] ↑ Europäische Technische Zulassung ETA-09/0036: MM - BSP. Wien. 23.03.2009. gültig bis 22.03.2014.

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