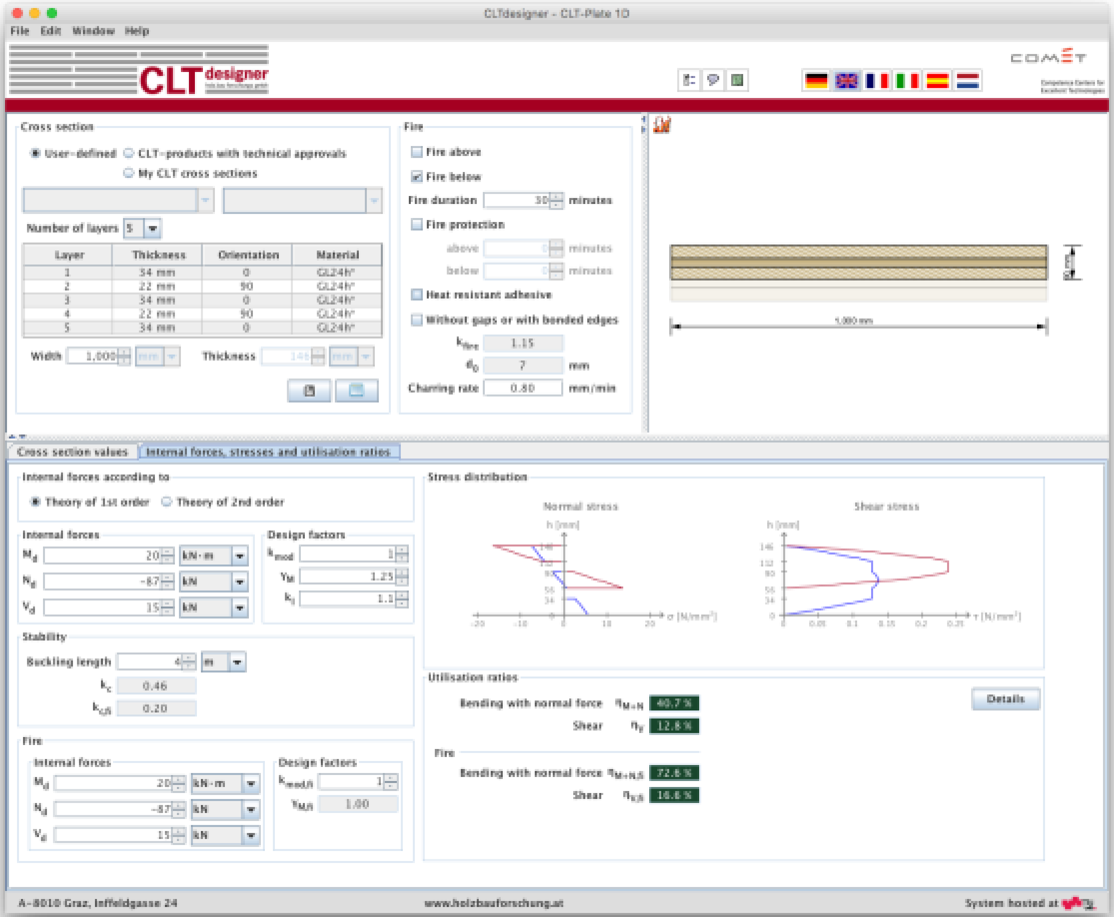
Module „CLT-Plate 1D - Internal forces“



Input data

The input is divided into:

- definitions of the cross section
- specifications concerning structural fire design
- internal forces according to the theory (of 1st or 2nd order) on which the calculations are based on
- design factors
- specifications concerning stability

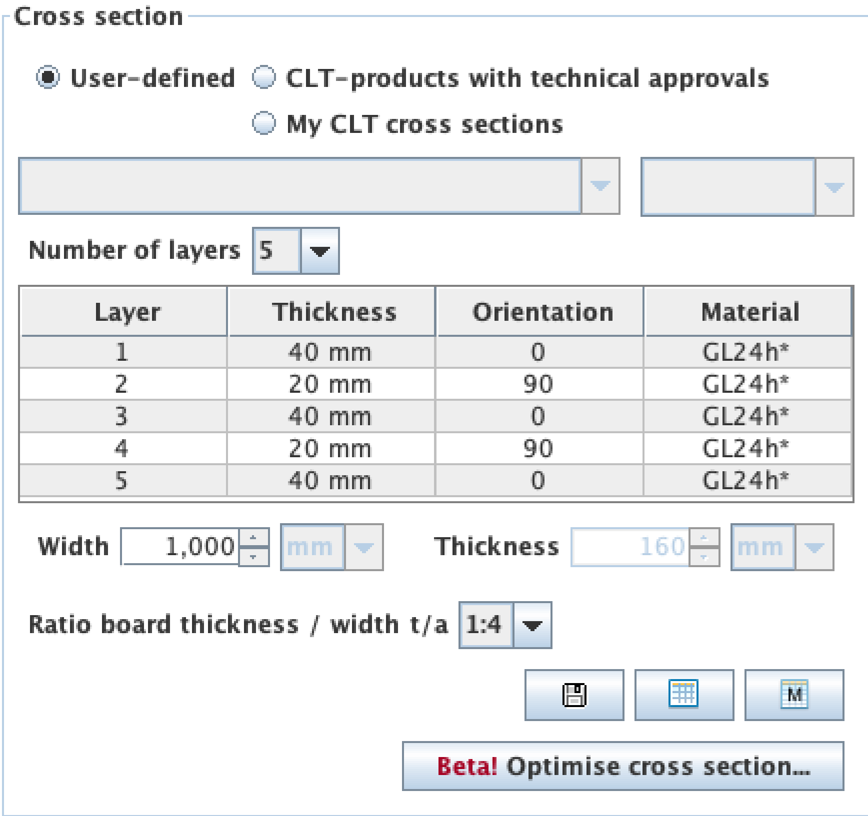
Cross section

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.

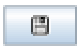
If a user-defined cross section is entered, the thickness and orientation of each layer can be changed. Furthermore, the material can be changed for all layers. The thickness of each layer has to be within the range of 6.0 mm to 45 mm. In the case of proprietary CLT products, the strength class of lumber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



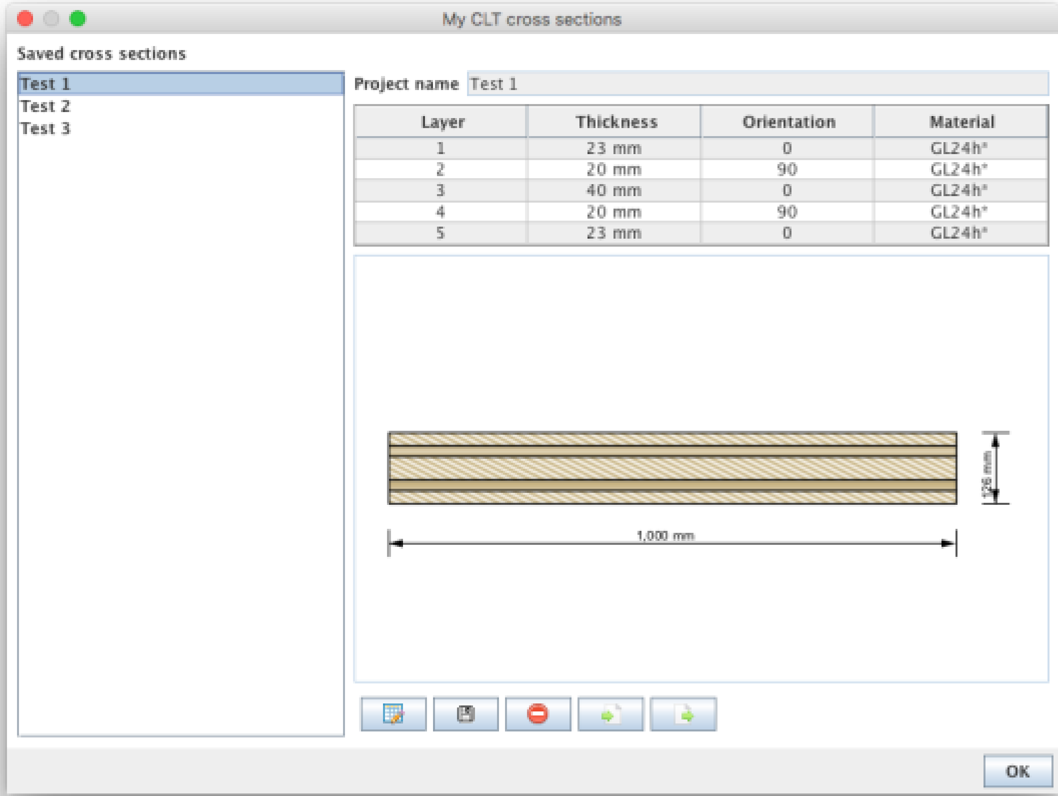
The width of the CLT plate strips can be also defined in this field. The default value is set to 1 m. The thickness of the CLT plate is calculated automatically based on the thickness of the single layers.

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 [edit button]. Currently, only the name of the stored cross section can be changed.
- With [save button] the changes are saved.
- With [remove button] the chosen cross section in the sidebar can be removed from the library.
- With [import button] cross sections from a csv file can be imported.
- With [export button] the cross sections from the library can be exported to a csv file.

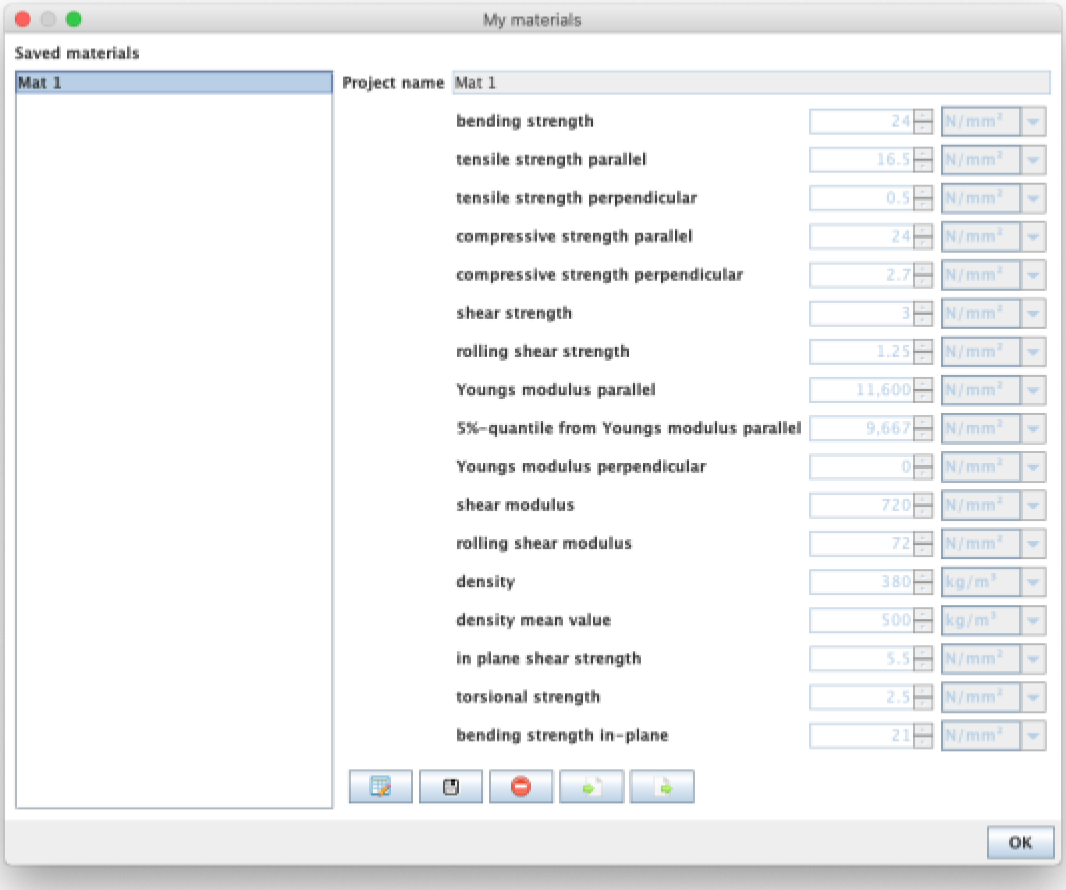
Syntax of the csv file

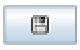
name;number of layers n;layer thickness in [m] t_1 to t_n;orientation of the layers o_1 to o_n (0 or 90);name of material

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 [M] the material library can be displayed.



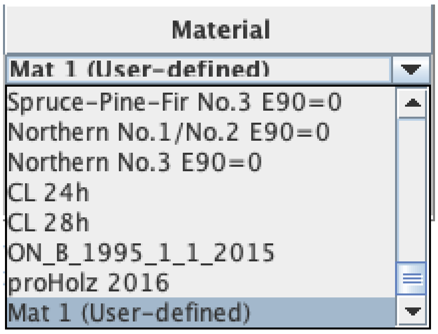
- With  the edit mode can be entered.
- With  the changes are saved.
- With  the chosen material in the sidebar can be removed from the library.
- With  materials from a csv file can be imported.
- With  the materials from the library can be exported to a csv file.

Syntax of the csv file

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

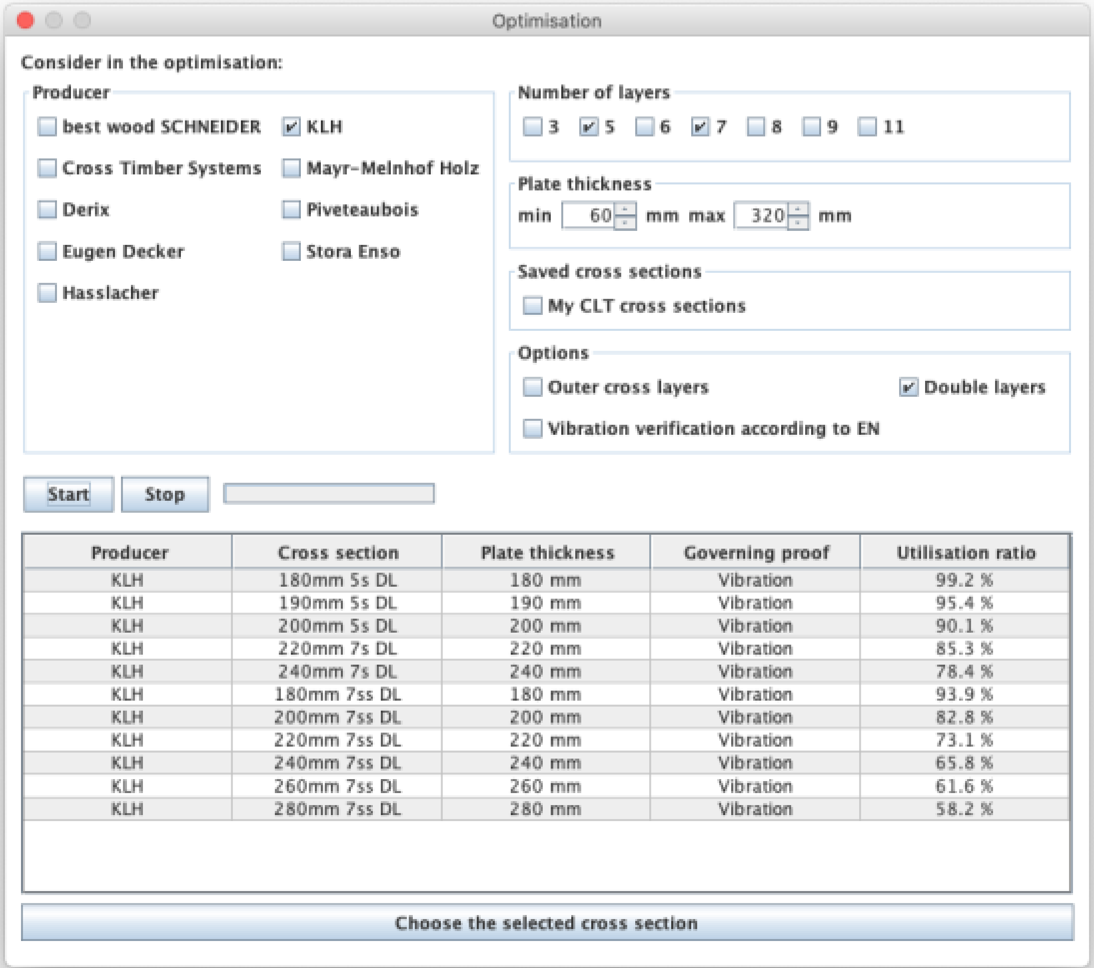
Example:
Name;f_m,k;f_t,0,k;f_t,90,k;f_c,k;f_c,90,k;f_v,k;f_r,k;E_0;E_0,05;E_90;G;G_r;rho_k;rho_mean;f_v,k,IP;f_T,k;f_m,k,IP
;N/mm2;N/mm2;N/mm2;N/mm2;N/mm2;N/mm2;N/mm2;N/mm2;N/mm2;N/mm2;N/mm2;N/mm2;kg/m3;kg/m3;N/mm2;N/mm2;N/mm2
Mat 1;24;16.5;0.5;24;2.7;3;1.25;11600;9667;0;720;72;380;500;5.5;2.5;21

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.



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.

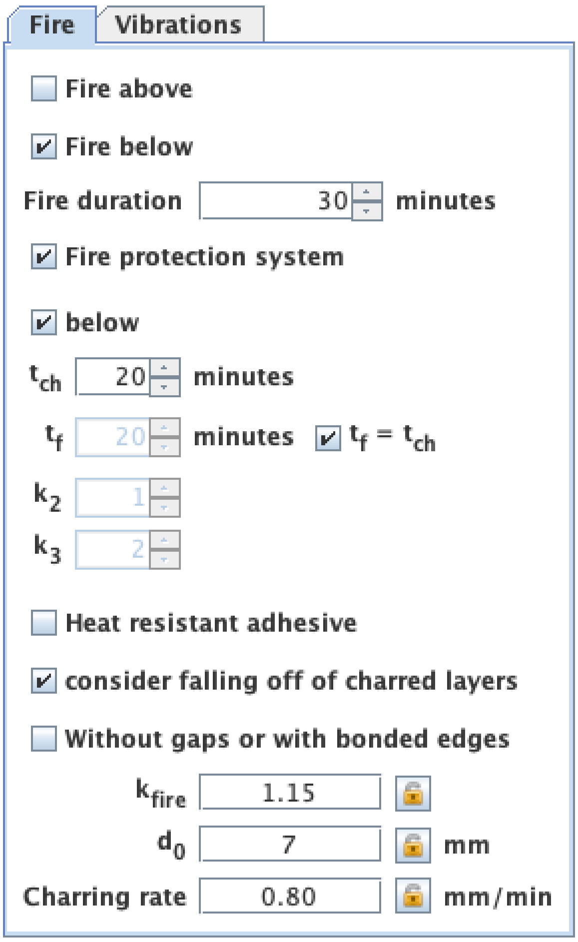
Cross section · 2017/11/14 17:11

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.

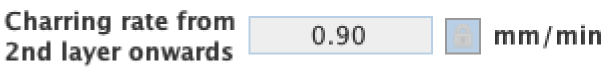


For a user-defined cross section, options are given for specifying heat resistant adhesives, presence of grooves, and whether the layers are edge-glued. For CLT products both values are set automatically and they cannot be changed.

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

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:

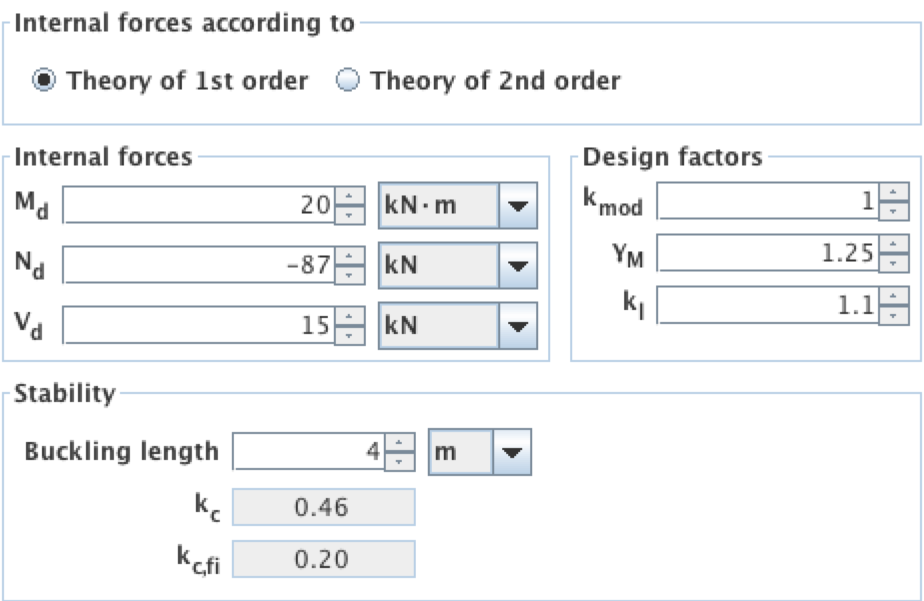


Fire · 2017/11/14 17:11

Type of calculation, internal forces, design factors and specifications concerning stability

The internal forces and the underlying type of calculation are defined in the tab „Internal forces, stresses and utilisation ratios“. Additionally, the design values are specified here.

If the internal forces result from a calculation based on a first order analysis a substitute buckling length has to be stated in case of a negative normal force ("problem of stability"). Based on this buckling length and the respective cross section the required buckling factor k_c needed for the verification is calculated automatically.



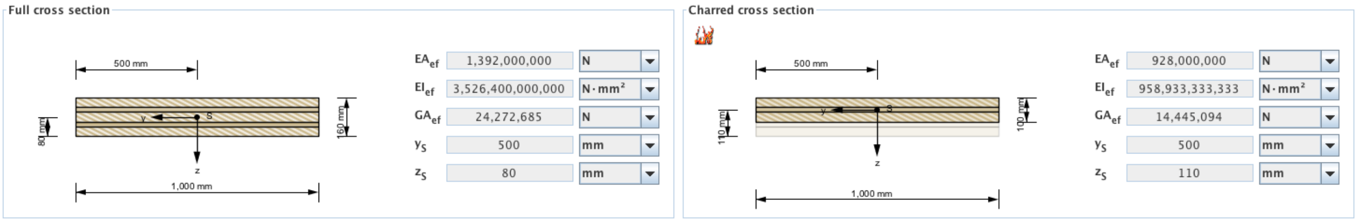
Results and output

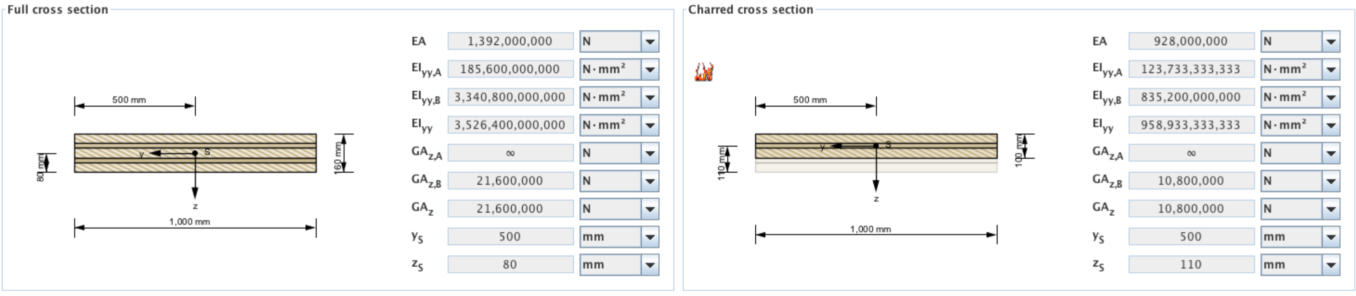
Cross section values

The output is the same as for the Module „CLT-Plate 1D - Continuous beam“.

Show description

Output values generated in the tab "Cross section values" field include the effective stiffness (depending on the chosen calculation method), the position of the centre of mass for the full cross section and also for the charred cross section in case of structural fire design.

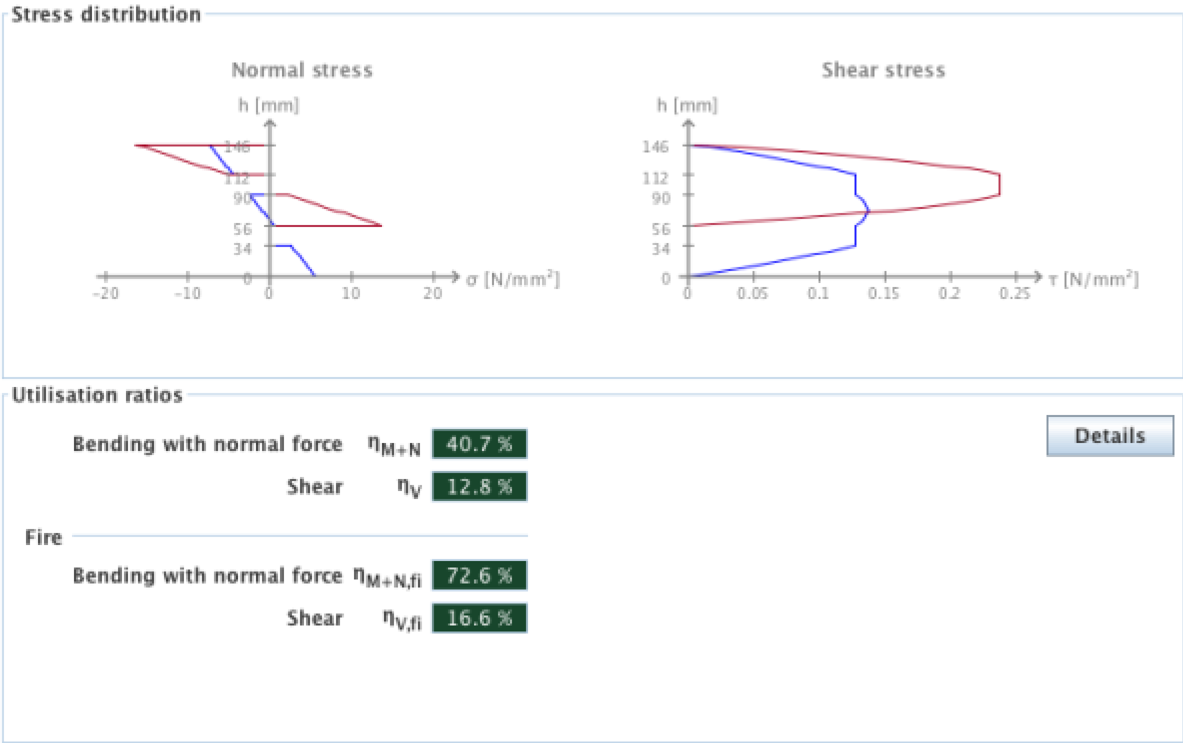




Cross section values · 2017/11/14 17:11

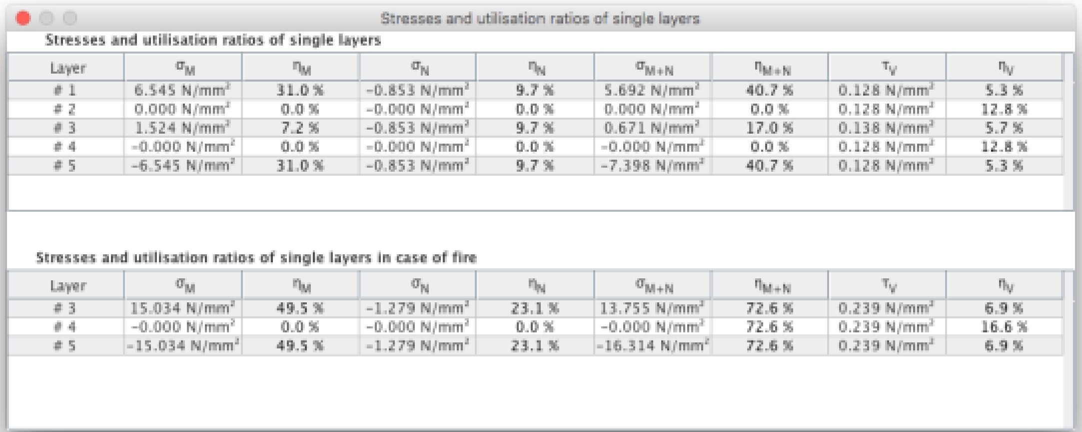
Summary of the results

The stress distributions and the governing utilisation ratios are shown in the tab "Internal forces, stresses and utilisation ratios".



Detailed results

Stresses and utilisation ratios of the single layers are shown when clicking on the "Details" button.



Stresses and utilisation ratios of single layers

Stresses and utilisation ratios of single layers

Layer	σ_M	η_M	σ_N	η_N	σ_{M+N}	η_{M+N}	τ_V	η_V
# 1	6.545 N/mm²	31.0 %	-0.853 N/mm²	9.7 %	5.692 N/mm²	40.7 %	0.128 N/mm²	5.3 %
# 2	0.000 N/mm²	0.0 %	-0.000 N/mm²	0.0 %	0.000 N/mm²	0.0 %	0.128 N/mm²	12.8 %
# 3	1.524 N/mm²	7.2 %	-0.853 N/mm²	9.7 %	0.671 N/mm²	17.0 %	0.138 N/mm²	5.7 %
# 4	-0.000 N/mm²	0.0 %	-0.000 N/mm²	0.0 %	-0.000 N/mm²	0.0 %	0.128 N/mm²	12.8 %
# 5	-6.545 N/mm²	31.0 %	-0.853 N/mm²	9.7 %	-7.398 N/mm²	40.7 %	0.128 N/mm²	5.3 %

Stresses and utilisation ratios of single layers in case of fire

Layer	σ_M	η_M	σ_N	η_N	σ_{M+N}	η_{M+N}	τ_V	η_V
# 3	15.034 N/mm²	49.5 %	-1.279 N/mm²	23.1 %	13.755 N/mm²	72.6 %	0.239 N/mm²	6.9 %
# 4	-0.000 N/mm²	0.0 %	-0.000 N/mm²	0.0 %	-0.000 N/mm²	72.6 %	0.239 N/mm²	16.6 %
# 5	-15.034 N/mm²	49.5 %	-1.279 N/mm²	23.1 %	-16.314 N/mm²	72.6 %	0.239 N/mm²	6.9 %