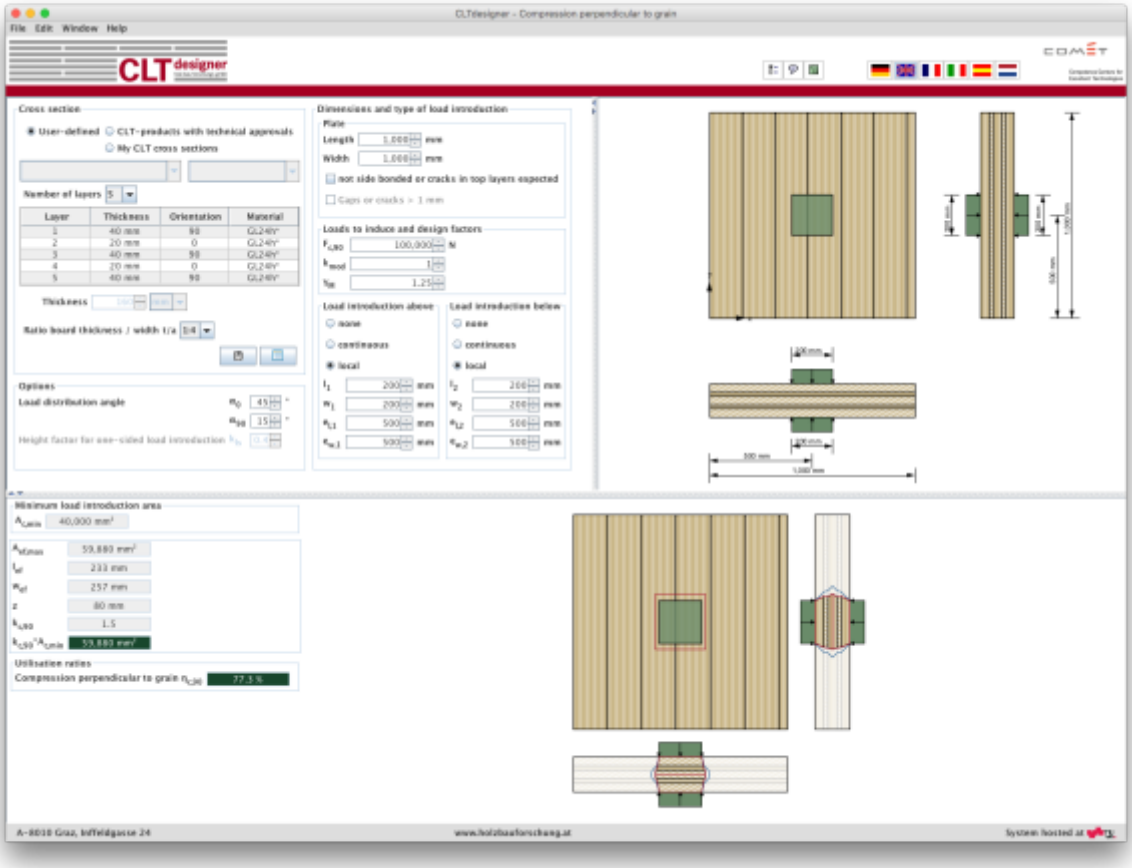
Module "Compression perpendicular to grain"

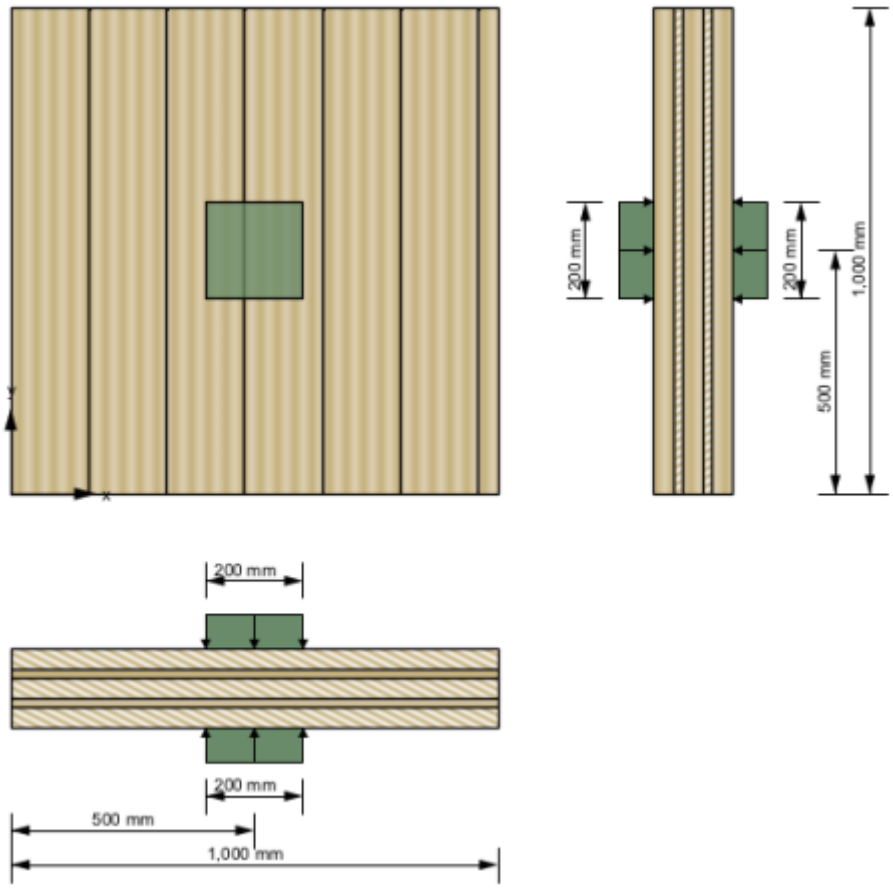


Input data

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

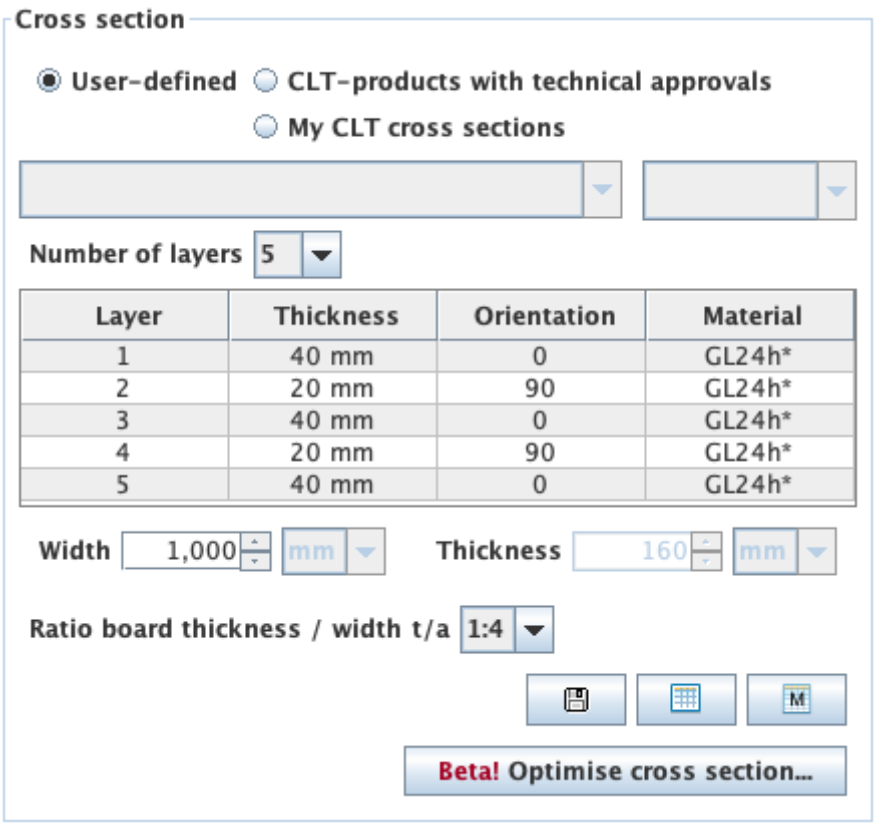
An option for a quick control of the input data is offered by a graphical representation shown on the right side.



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.



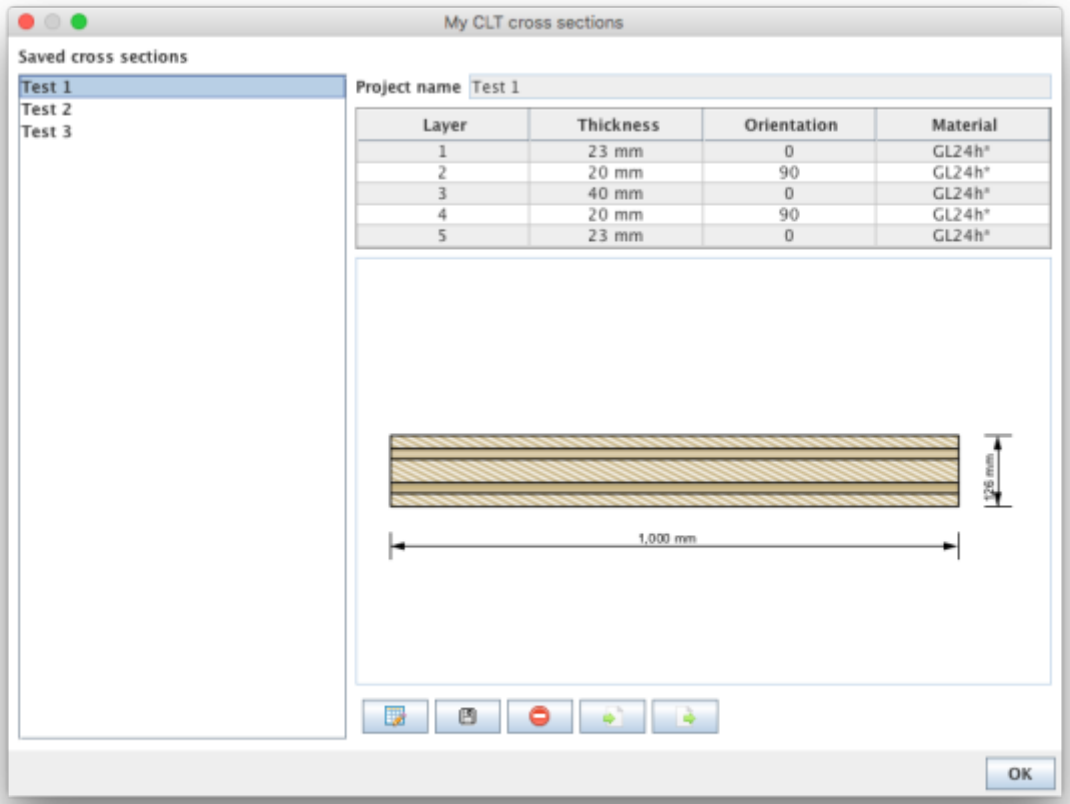
The width of the CLT plate strips can be also defined in this field. The default value is set to 1 m. The thickness of the CLT plate is calculated automatically based on the thickness of the single layers.

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.

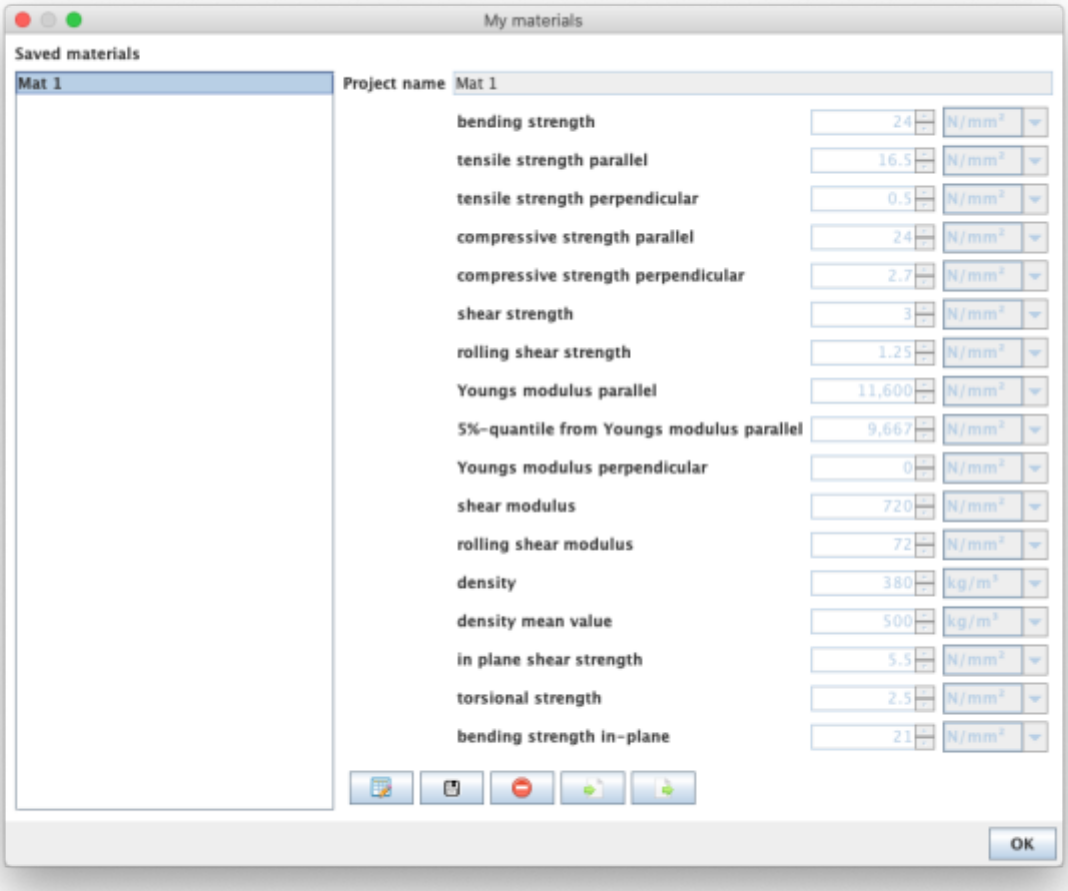
Syntax of the csv file

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.



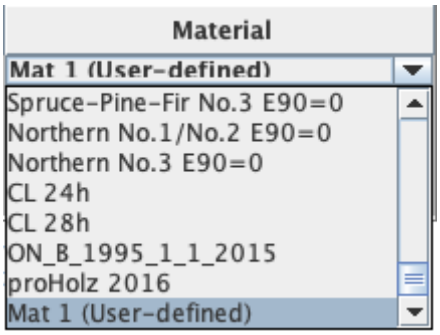
- With the edit mode can be entered.
- With the changes are saved.
- With the chosen material in the sidebar can be removed from the library.
- With materials from a csv file can be imported.
- With the materials from the library can be exported to a csv file.

Syntax of the csv file

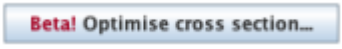
1. row: description of the parameters
2. row: units of the parameters
3. row: value
delimiter: ";"

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

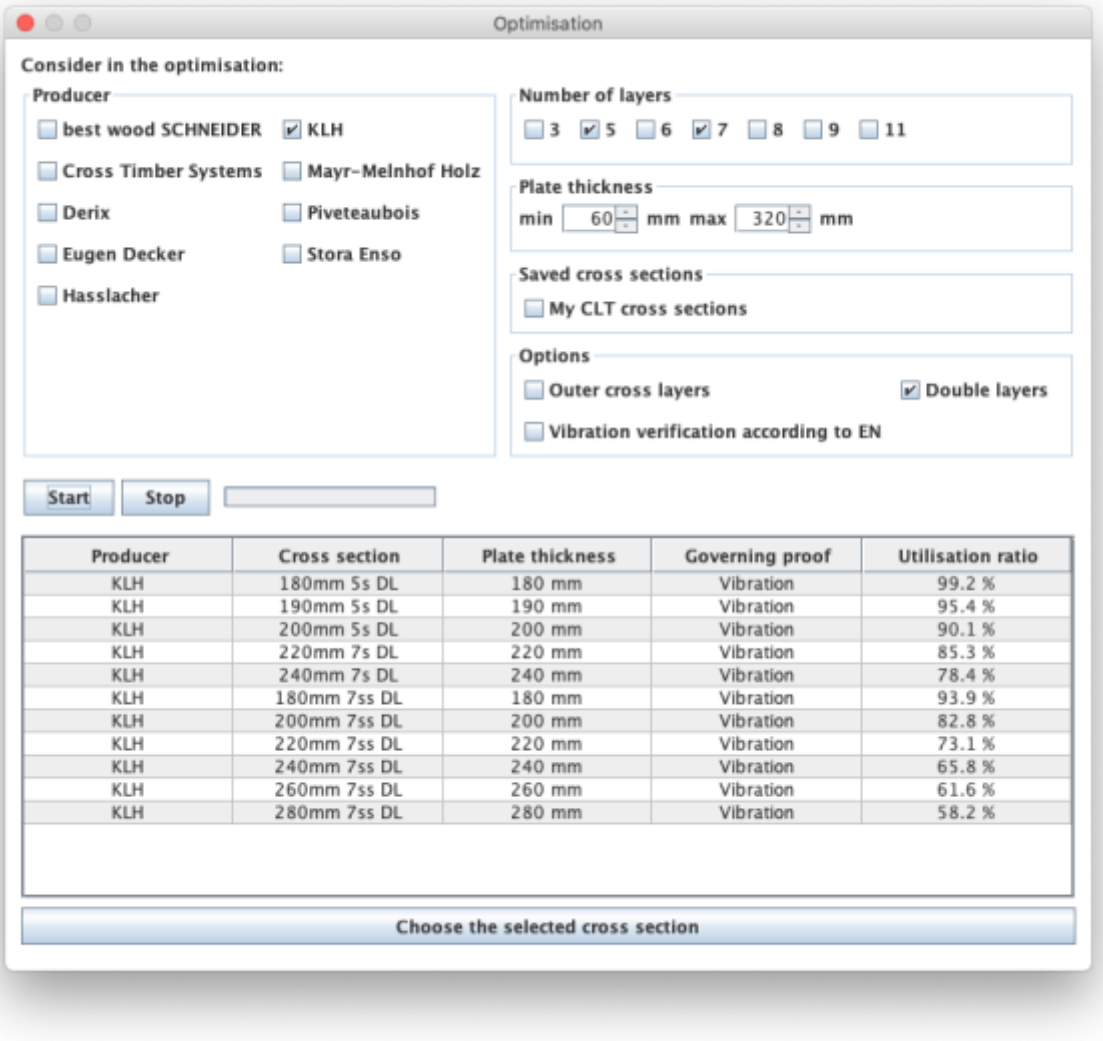
The user-defined materials are then displayed in the material selection list.



Optimization of layup

Use the button 

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

Plate dimensions and gap execution

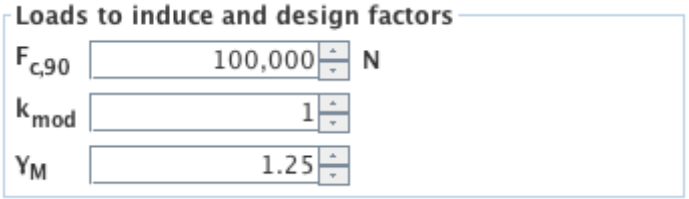
The plate is specified with its dimensions in x and y direction. The plate length is defined with dimension in x direction and the plate width with dimension in y direction.

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 scheduled gaps or the expected occurrence of cracks and
- possible occurrence 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.

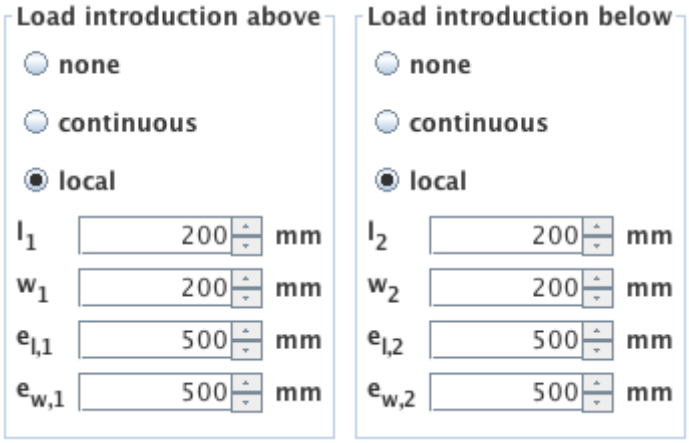


Load configuration

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).

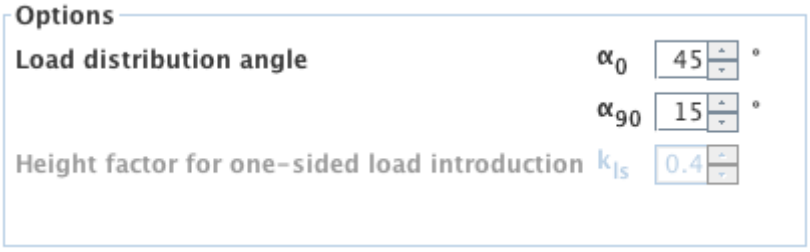
If the load is applied locally, it needs to be defined by entering the dimensions of the load surface (length $l_{1,2}$ in direction x and width $w_{1,2}$ in direction y) and the position. The position is defined as the

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.



Calculation options

In the calculation options, the load distribution angles for longitudinal layers α_0 and cross layers α_{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.



Results and Output

The minimum load introduction area $A_{c,min}$ describes the reference area in order to get the effective area $A_{ef,max}$ by multiplying with the factor $k_{c,90}$. For different load introduction areas on each side it is the intersection of these two areas. The effective area $A_{ef,max}$ is described by l_{ef} and w_{ef} in depth z.

The utilisation ratio for compression perpendicular to grain is indicated by $\eta_{c,90}$ in [%].

Minimum load introduction area

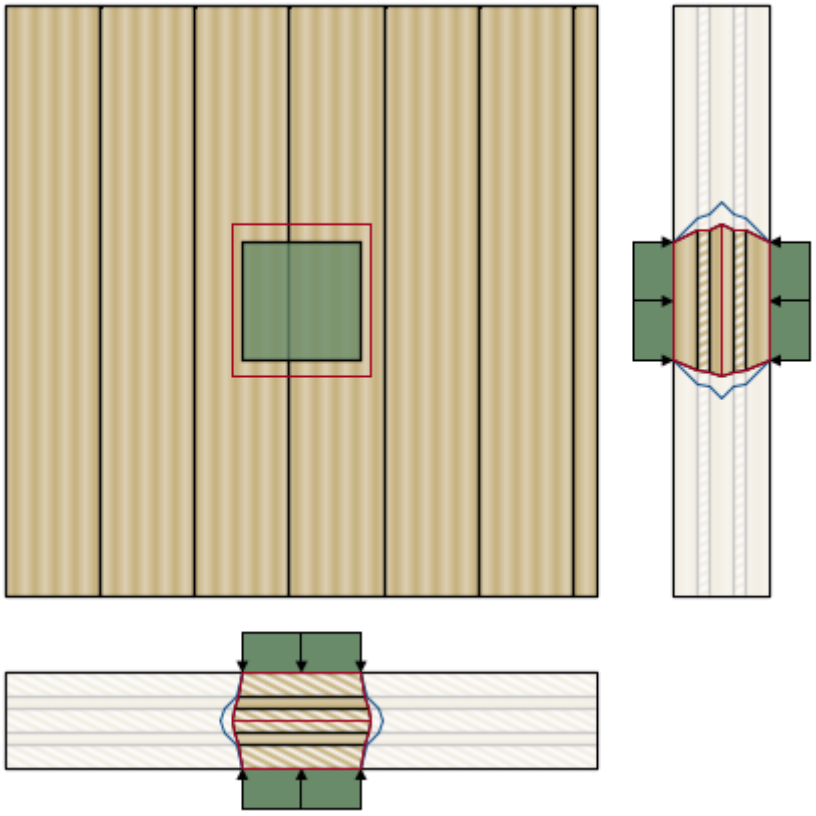
$A_{c,min}$	40,000 mm²

$A_{ef,max}$	59,880 mm²
l_{ef}	233 mm
w_{ef}	257 mm
z	80 mm
$k_{c,90}$	1.5
$k_{c,90}$*$A_{c,min}$	59,880 mm²

Utilisation ratios

Compression perpendicular to grain $\eta_{c,90}$	77.3 %

The following figure shows the distribution of the effective area $A_{ef,max}$ over the cross section (red line) as well as the assumed load distribution (blue line).



Implemented calculation methods

Compression perpendicular to grain - Verification

Model for the determination of the kc,90 factor

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