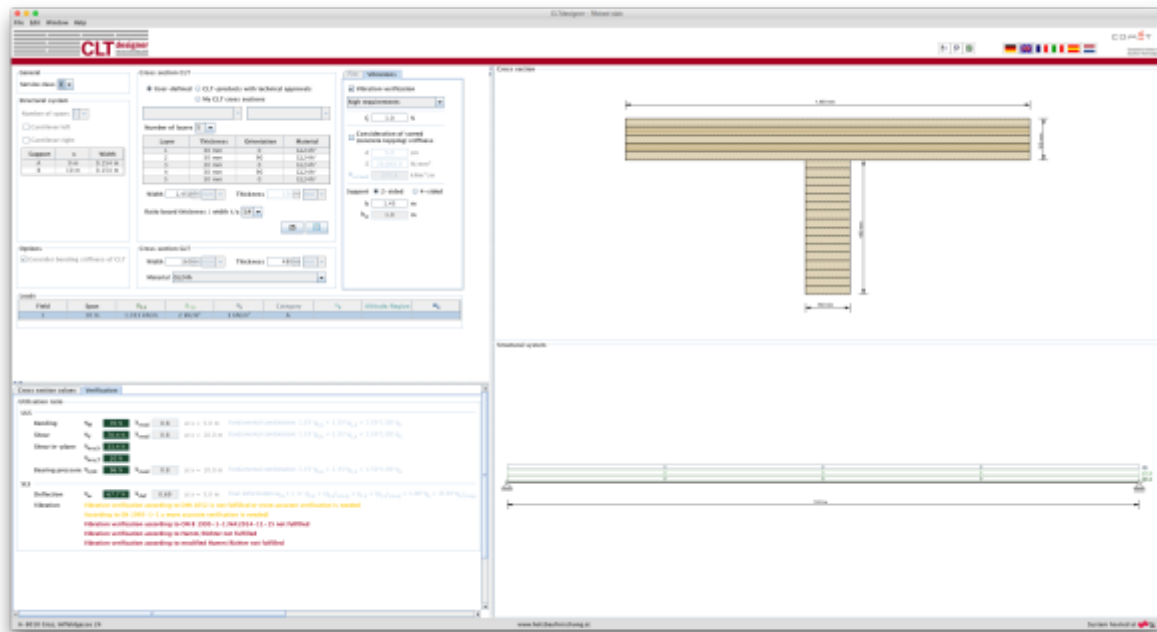


# Module "Ribbed slab"



## Input data

The input is divided into:

- general information about the project and the considered structural element
- definitions of the structural system
- definitions of the cross section
- input of the loads
- informations about vibration parameters
- calculation options

## General

The input field "General" defines the service class. It is only allowed to use CLT elements in areas of service class 1 and 2.

- Service class 1 (interior service condition) is in general consistent with a common utilisation of living spaces.
- Service class 2 (protected exterior service condition) is generally used for open but roofed structures.

**General**

Service class **1** ▼

General · 2017/11/14 17:11

## Structural system

In this release, only single span girder can be calculated. The supporting width and span (via x-value in the table) can be defined within this input field.

**Structural system**  
Number of spans   
☐ Cantilever left  
☐ Cantilever right  

Support	x	Width
A	0 m	0.154 m
B	10 m	0.154 m

## Cross section

The input of the CLT cross section 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...**

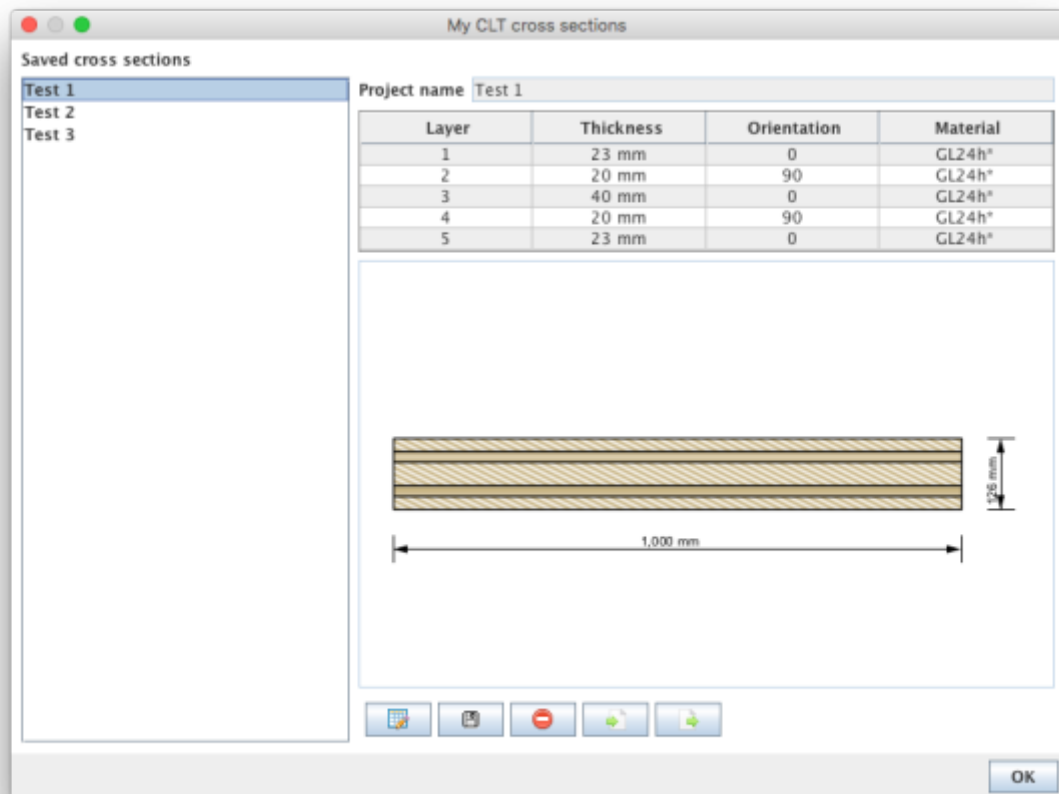
The width of the CLT plate strips can be also defined in this field. The default value is set to 1 m. The thickness of the CLT plate is calculated automatically based on the thickness of the single layers.






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  $o_1$  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

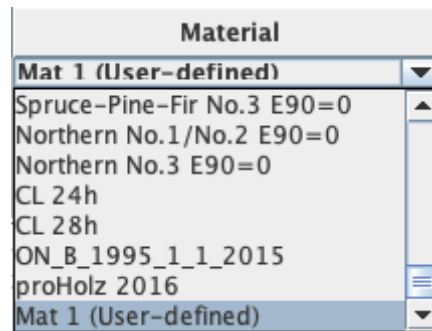
1. row: description of the parameters
  2. row: units of the parameters
  3. row: value
- delimiter: ";"



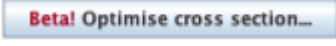
Example:

```
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 contains the following sections:

- 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
- 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 %
- 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

Die Definition des Rippenquerschnittes (Rechteckquerschnitt aus BSH oder Vollholz) erfolgt über die Eingabe der Höhe und Breite der Rippe sowie Auswahl des Materials.

**Cross section GLT**

Width

Thickness

Material

## Loads

The input is the same as for the [Module "CLT-Plate 1D - Continuous beam"](#), but limited to distributed loads.

[Show description](#)

The loads are divided into the dead load (weight of the plate) ( $g_{0,k}$ ), permanent loads ( $g_{1,k}$ ), imposed load ( $q_k$ ), snow load ( $s_k$ ) and wind load ( $w_k$ ). This classification is necessary to automatically carry out calculations for different load case combinations.

The plate weight is calculated automatically. The calculation method can be selected in the settings/preferences window. The default calculation method is in accordance with ON B 1991-1-1. A unit weight of 5.5 kN/m<sup>3</sup> is assumed in the calculation. However, the unit weight may also be calculated using:

- calculation based on the mean value of density of the chosen material
- calculation based on a user-defined density

When entering the imposed loads, one of the following categories has to be chosen:

- A: Areas for domestic and residential activities
- B: Office areas
- C: Areas where people may congregate (with the exception of areas defined under category A, B and D)
- D: Shopping areas
- E: Areas for storage and industrial activities
- F: Traffic and parking areas for light-duty vehicles
- G: Traffic and parking areas for medium-duty vehicles
- H: Roofs

When entering the snow load, the country code or an altitude above sea level where the structure will be located has to be specified:

- < 1000 m
- > 1000 m
- FIN, IS, N, S

The span of each field can also be modified in the table of distributed loads.

Concentrated loads can be entered in the second table. The position can be defined whether by the local or global x-coordinate.

Loads

Field	Span	$g_{0,k}$	$g_{1,k}$	$q_k$	Category	$s_k$	Altitude/Region	$w_k$
1	3.5 m	0.55 kN/m	0.58 kN/m <sup>2</sup>	1.2 kN/m <sup>2</sup>	A			
2	4 m	0.55 kN/m	0.58 kN/m <sup>2</sup>	1.2 kN/m <sup>2</sup>	A			
3	4.25 m	0.55 kN/m	0.58 kN/m <sup>2</sup>	1.2 kN/m <sup>2</sup>	A			

Field	$x_{global}$	$x_{local}$	$G_{1,k}$	$Q_k$	Category	$s_k$	Altitude/Region	$w_k$

+

-

[Loads](#) · 2017/11/14 17:11

## Fire

In this module, currently no structural fire design is possible.

## Vibrations

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

[Show description](#)

The tab "Vibrations" allows for vibration verification.



Fire

Vibrations

☒ Vibration verification

normal requirements

$\zeta$  3.0 %

☒ Consideration of screed (concrete topping) stiffness

d 6.0 cm

E 26,000.0 N/mm<sup>2</sup>

EI<sub>screed</sub> 468 kNm<sup>2</sup>/m

Support ☐ 2-sided ☒ 4-sided

b 5.0 m

b<sub>w</sub> 3.13 m

For the vibration verification the following specifications are of importance:

- high or normal requirements? This choice will have an influence on the limit values.
- modal damping factor
- consideration of the screed (concrete topping) stiffness
  - thickness of the screed (concrete topping)
  - modulus of elasticity of the screed (concrete topping)
- support (2-sided or 4-sided)
- room width  $b$  perpendicular to the load carrying direction

The effective width  $b_w$  of the chosen cross section used by the stiffness criteria will be specified.

Vibrations · 2017/11/14 17:11

## Results and Output

### Cross section values

The stiffness values of the CLT-plate and the GLT-beam as well as the shear spring, which are shown in the upper section of the tab "cross-section values" are parameters for the determination of the effective width.

#### Stiffness values CLT-plate

$c_x$  1,044,000 kN/m   
  $c_y$  696,000 kN/m   
  $c_{xy}$  72,870 kN/m   
  $K_{CLT}$  2,584 kN·m

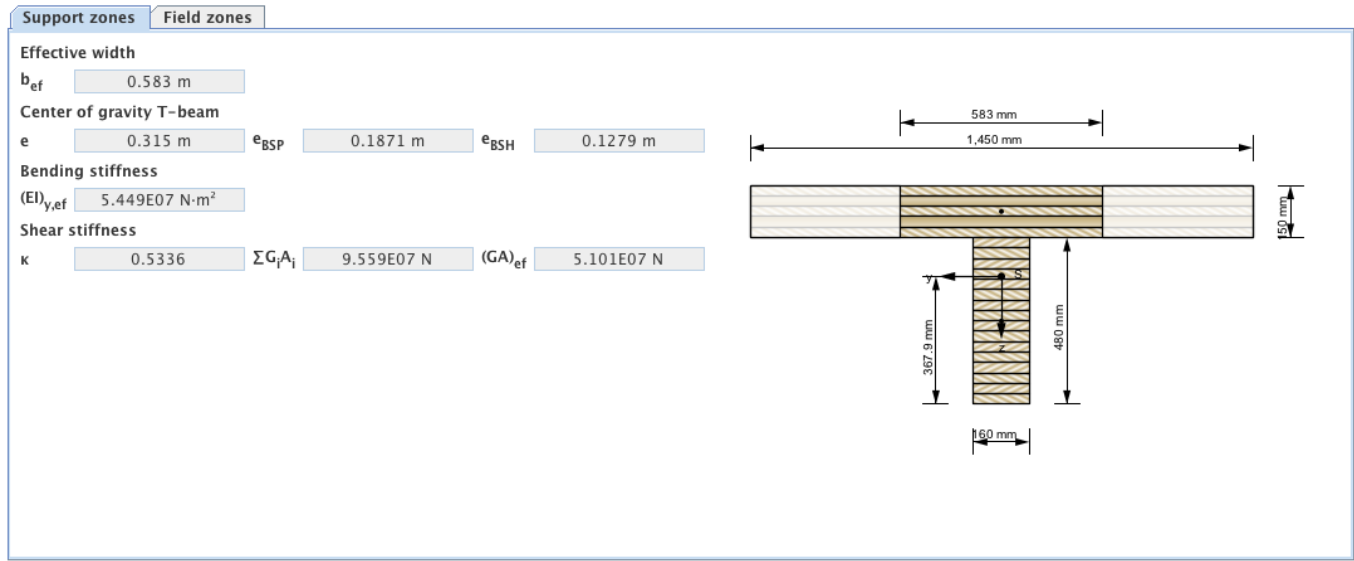
#### Stiffness values GLT-beam

EA 890,880 kN   
 EI 17,105 kN·m<sup>2</sup>

#### Stiffness of the shear spring

k 646,957 kN/m<sup>2</sup>

Underneath, the effective width, the center of gravity as well as the bending and shear stiffness of the T-beam at the supports and in between are shown.

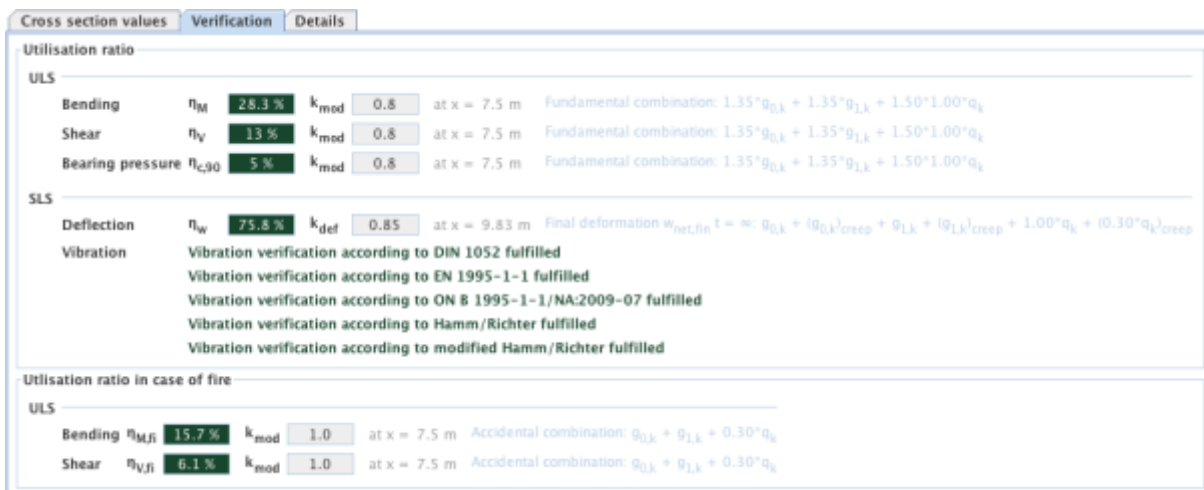


### Summary of the results

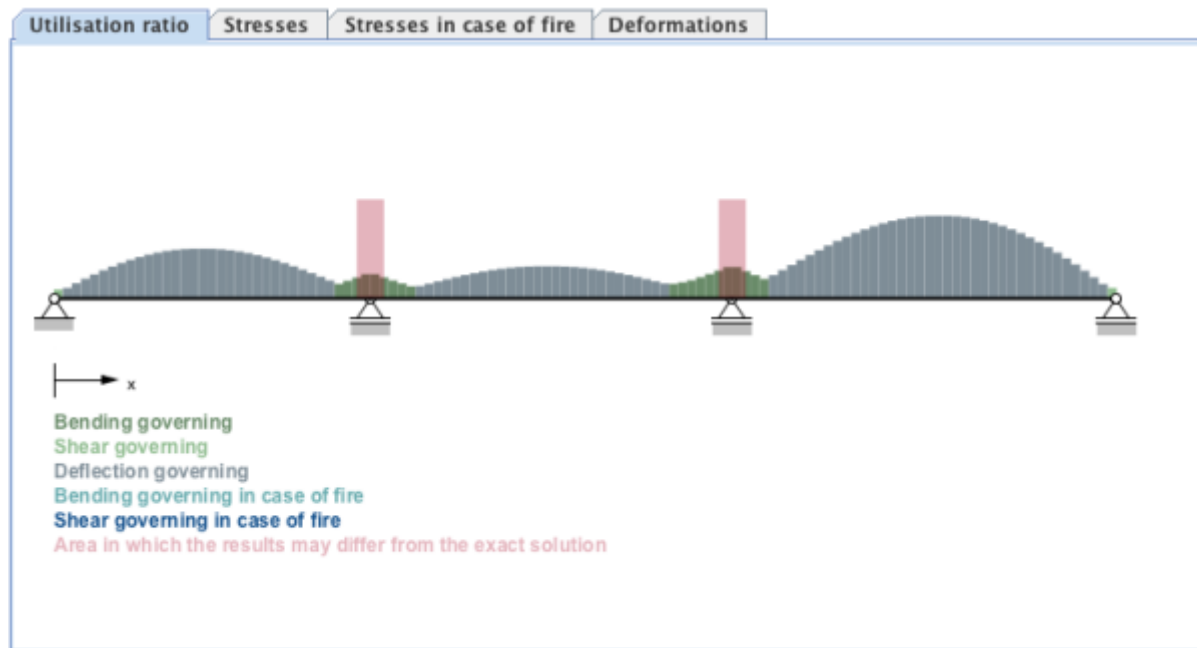
The summary of the results is analogous to the [Module "CLT-Plate 1D - Continuous beam"](#).

[Show description](#)

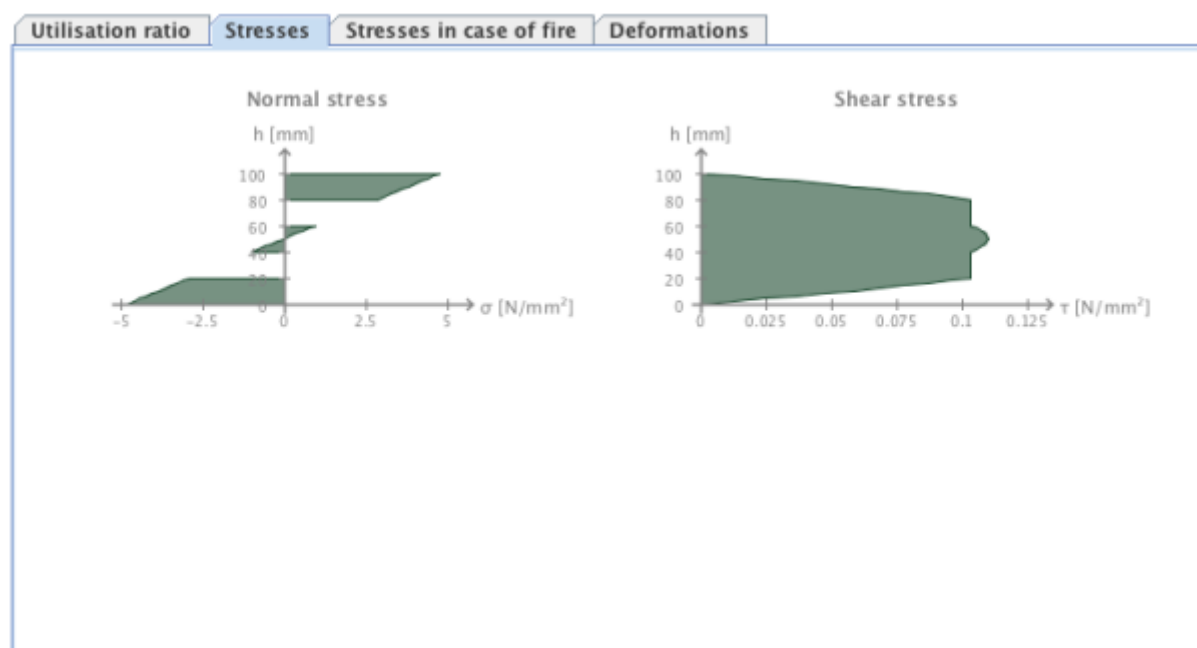
A summary of the verifications can be retrieved via the tab "Verifications". The utilisation ratios for various limit states are colour-coded indicating if the verification is fulfilled (green), not fulfilled (red) or a more accurate verification is needed (yellow). The locations of the maximum utilisation ratio and the governing combinations are compiled in the same way.



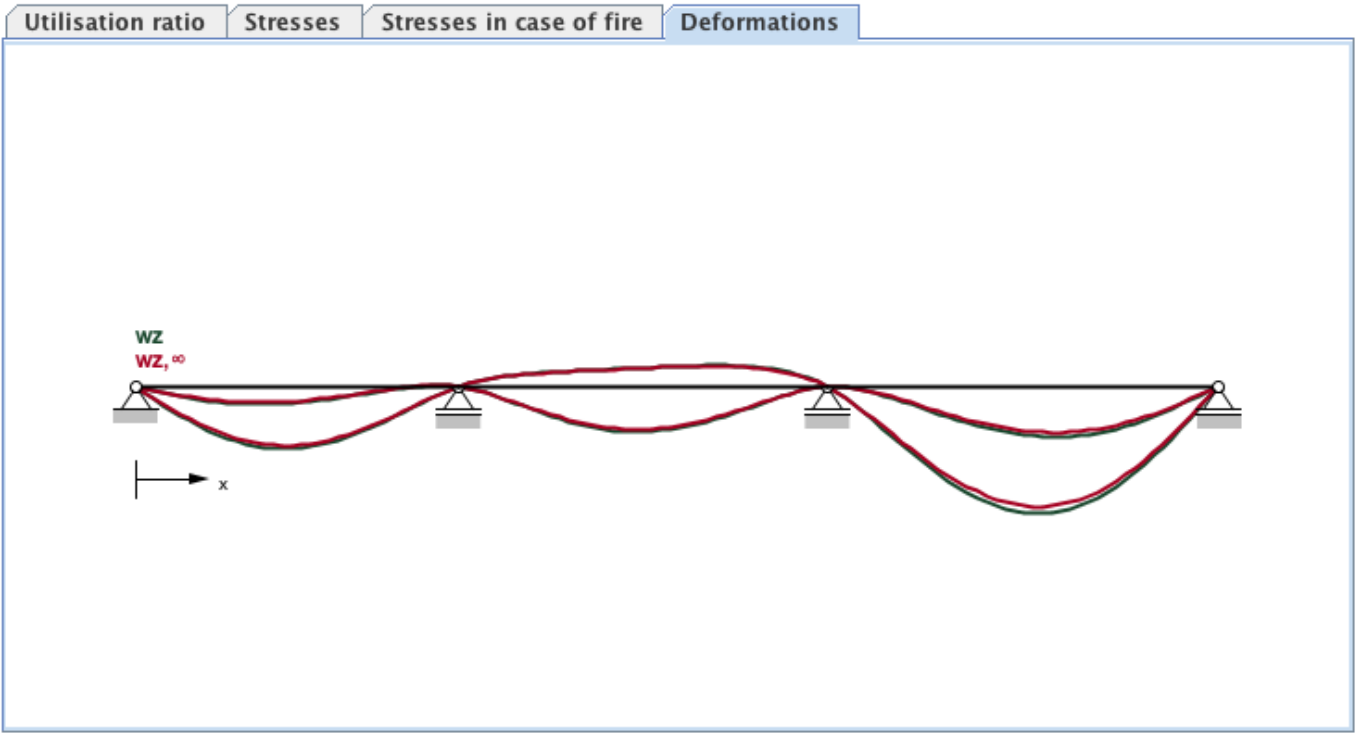
The tab "Utilisation" shows the distribution of the governing utilisation ratios along the beam. Areas in which the results may differ from the exact solution are marked here.



The tab "Stresses" shows the governing stresses resulting from the ULS verification. If a structural fire design was carried out, the governing stresses in case of fire are shown in the tab "Stresses in case of fire"



The tab "Deformations" shows the deformed system or the envelope given by the minimum and maximum deformation resulting from the governing SLS verification.



Summary of the results · 2017/11/14 17:11

However, there are differences for ULS - shear, since for the CLT-flange also the in-plane shear has to be considered.

Utilisation ratio									
ULS									
Bending	$\eta_M$	70 %	$k_{mod}$	0.8	at x = 5.0 m	Fundamental combination: $1.35 \cdot g_{0,k} + 1.35 \cdot g_{1,k} + 1.50 \cdot 1.00 \cdot q_k$			
Shear	$\eta_V$	70.4 %	$k_{mod}$	0.8	at x = 10.0 m	Fundamental combination: $1.35 \cdot g_{0,k} + 1.35 \cdot g_{1,k} + 1.50 \cdot 1.00 \cdot q_k$			
Shear in-plane	$\eta_{n_{xy,V}}$	33.4 %							
	$\eta_{n_{xy,T}}$	20 %							
Bearing pressure	$\eta_{c90}$	96 %	$k_{mod}$	0.8	at x = 10.0 m	Fundamental combination: $1.35 \cdot g_{0,k} + 1.35 \cdot g_{1,k} + 1.50 \cdot 1.00 \cdot q_k$			
SLS									
Deflection	$\eta_w$	67.7 %	$k_{def}$	0.69	at x = 5.0 m	Final deformation $w_{fin} \ t = \infty$ : $g_{0,k} + (g_{0,k})_{creep} + g_{1,k} + (g_{1,k})_{creep} + 1.00 \cdot q_k + (0.30 \cdot q_k)_{creep}$			
Vibration	Vibration verification according to DIN 1052 is not fulfilled or more accurate verification is needed According to EN 1995-1-1 a more accurate verification is needed! Vibration verification according to ON B 1995-1-1/NA:2014-11-15 not fulfilled Vibration verification according to Hamm/Richter not fulfilled Vibration verification according to modified Hamm/Richter not fulfilled								

## Implemented calculation methods

Effective width of T-beams made of CLT and GLT

Calculation example concerning the effective width of T-beams made of CLT and GLT

From:

<https://www.bspwiki.at/> - **BSP Wiki**

Permanent link:

[https://www.bspwiki.at/doku.php?id=en:clt:hotspot:software:cltdesigner:manual:modul\\_tbeam](https://www.bspwiki.at/doku.php?id=en:clt:hotspot:software:cltdesigner:manual:modul_tbeam)

Last update: **2020/03/26 11:46**

