Cross Laminated Timber Beams HTB+

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Basic Documentation – Overview

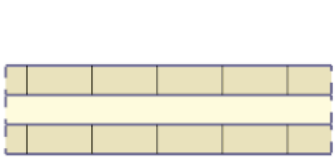
In addition to the individual program manuals, you will find basic explanations on the operation of the programs on our homepage www.frilo.com in the Campus-download-section.

Tip: Go back - e.g. after a link to another chapter/document - in the PDF with the key combination "ALT" + "Left direction key"

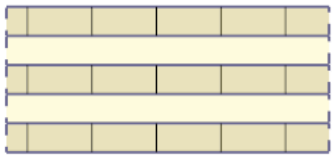
Possible applications

The HTB+ program calculates single-span or multi-span beams with or without cantilever arms made of cross laminated timber (CLT) and provides all the necessary verifications. The bay widths and the loads can be different.

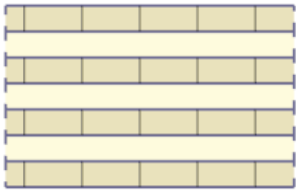
Possible cross-sectional structures are shown in Figure 1.



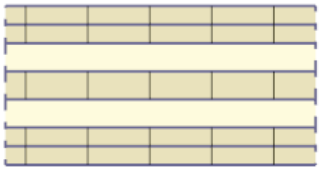
CLT 110 L3s



CLT 150 L5s



CLT 210 L7s



CLT 240 L7s-2

Figure 1: Cross-section variants (with manufacturer-neutral designation)

The program calculates cross-laminated timber elements that are "panel-like" stressed, not "disc-like" stressed ones. This excludes the use of the HTB+ for beams made of cross laminated timber beams that are stressed on edge!
The possible layer structure as well as the material parameters to be used always result from a building authority approval of the cross laminated timber manufacturer.

Standards

- DIN EN 1995:2013
- ÖNORM EN 1995:2019
- PN EN 1995:2010
- BS EN 1995:2019
- EN 1995:2014

Input

General operating instructions

Wizard

When the program starts, the Window Wizard appears automatically.
The most important key data of the system can be entered here quickly, which can then be edited in the input area and/or in the interactive graphic interface.

Entries in the Wizard:

- number of fields
- field length
- cross-section: number of layers and layer height
- permanent load
- variable load and type of action

Interactive input in the graphic

Editable parameters

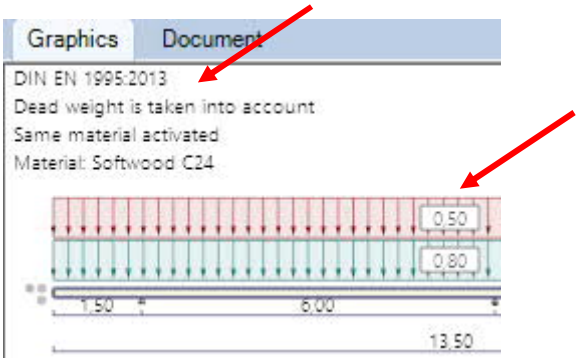
As in all Plus Programs, the dimensions and load values can also be edited in HTB+ and can be changed directly in the graphic.

The orientation of a layer can be switched over between 0° and 90° using the symbol next to the layer.

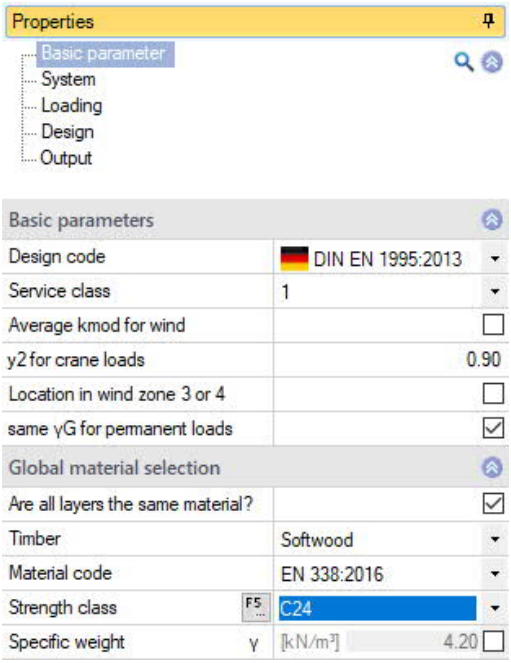
General functions (Zoom, Move, Save graphic or Print) are displayed via the Context menu (right mouse button) in a free graphic area.

Interactive textlinks

As in all PLUS Programs, the texts displayed in the graphic at the top left are interactive and can be clicked on. This enables dialogs in the graphic that are otherwise only available via the left menu.



Basic parameters



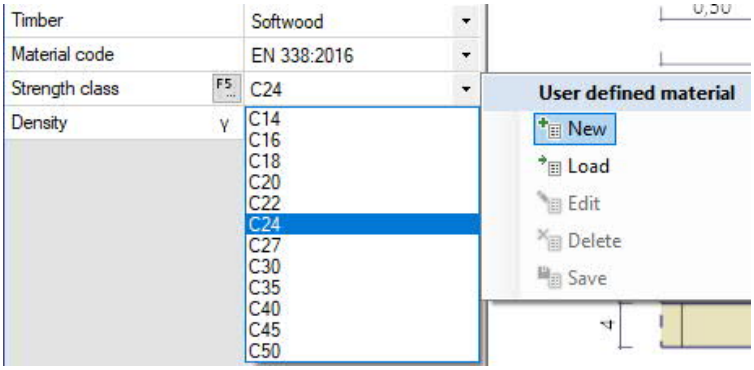
Design code	Selection of the standard with national annex.
Service class	Selection of service class 1 or 2 (influence of moisture).
Average kmod for wind	If the option is selected, the modification coefficient kmod for wind is set as the mean value for the classes of the load duration short and very short (instead of very short).
ψ2 for crane loads	Specifies the combination coefficient ψ2 for crane loads (ratio of permanent share to total crane load)
Location wind zone	Select this option if the building is located in wind zone 3 or 4. In this case the action 'snow' is not considered as an accompanying action to the leading action 'wind'.
same γG	If the option is selected, all permanent loads or load cases are applied together with the same partial safety factor (γG,sup or γG,inf), otherwise permanent loads are combined independently of one another with their lower and upper partial safety factors.

Global material selection

By default, the layers are made of the same material (the option is checked). The necessary material parameters according to the cross laminated timber approval used can be entered via a user-defined material - you call this dialog using the F5 key in the input field for the strength class.

If the materials of the individual layers are different (remove the check mark), the selection of the material or the input of a user-defined material takes place via the column "Strength class" of the layer table (F5 key).

F5 key:	Click on "New" to open a dialog for entering the nominal strengths, stiffnesses, raw density values and a designation. User defined material can be saved / loaded as a template.



Remarks

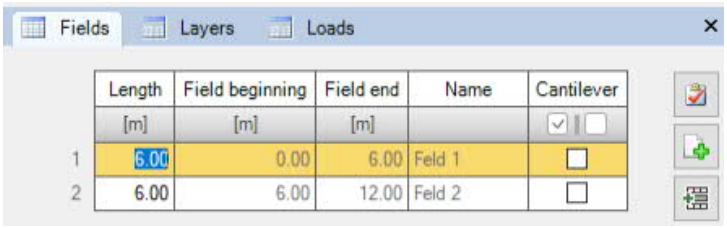
Input of your own remarks, which will then also appear in the output.

System

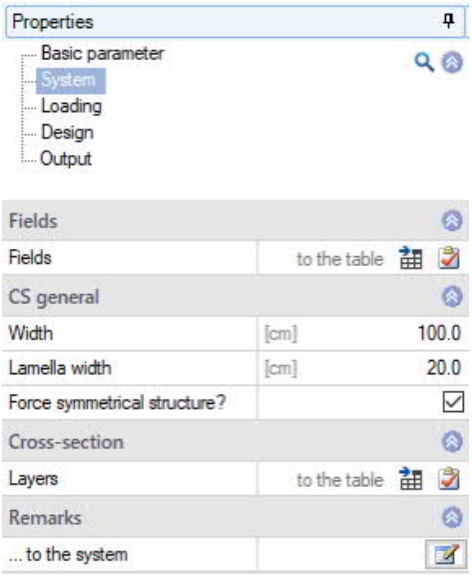
Fields

For the tabular entry click on the tab "Fields" below the graphic. You can use the buttons to the right of the table to add input lines for additional fields or delete existing lines.

Enter the length for each field. The field names are predefined but can be changed if necessary. If it is a cantilever arm, please check the box in the cantilever arm column.



	Length [m]	Field beginning [m]	Field end [m]	Name	Cantilever
1	6.00	0.00	6.00	Feld 1	☐
2	6.00	6.00	12.00	Feld 2	☐



General cross-section / layers

Enter the width of the cross-section and the width of the lamellas here.

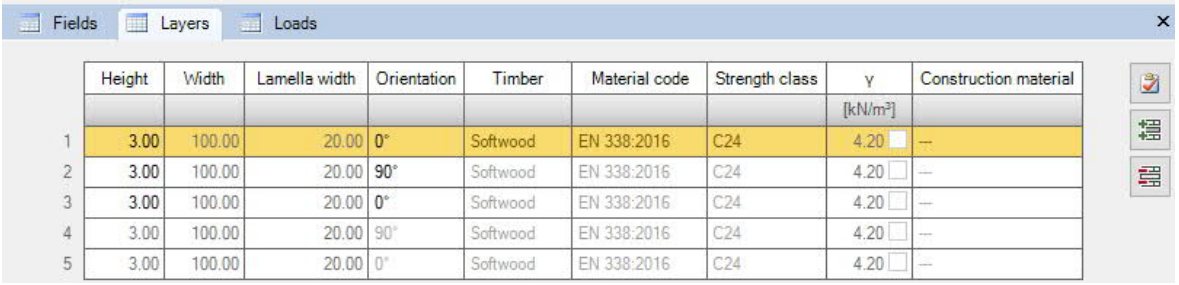
You can force a symmetrical structure - in the following shift table the corresponding entries are then "grayed out" and can no longer be edited.

Click on the “Layers” tab under the graphic.

Based on the entries in the Wizard, you can enter the individual layer thickness, the associated orientation of the lamellas (0° or 90°), the type of wood, material standard and strength class in accordance with the cross-laminated timber approval used in the table.

The number of layers can be changed using the buttons  on the right.

In the "Strength class" column, you can enter a user-defined material using the F5 key.

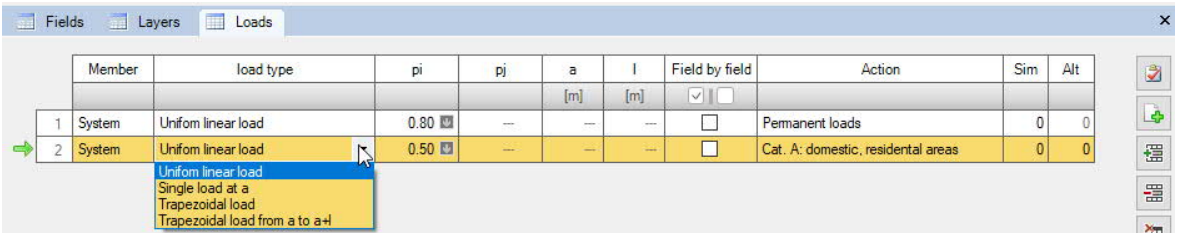


	Height	Width	Lamella width	Orientation	Timber	Material code	Strength class	γ [kN/m³]	Construction material
1	3.00	100.00	20.00	0°	Softwood	EN 338:2016	C24	4.20	---
2	3.00	100.00	20.00	90°	Softwood	EN 338:2016	C24	4.20	---
3	3.00	100.00	20.00	0°	Softwood	EN 338:2016	C24	4.20	---
4	3.00	100.00	20.00	90°	Softwood	EN 338:2016	C24	4.20	---
5	3.00	100.00	20.00	0°	Softwood	EN 338:2016	C24	4.20	---

Load

First choose whether you want to calculate with or without dead load.

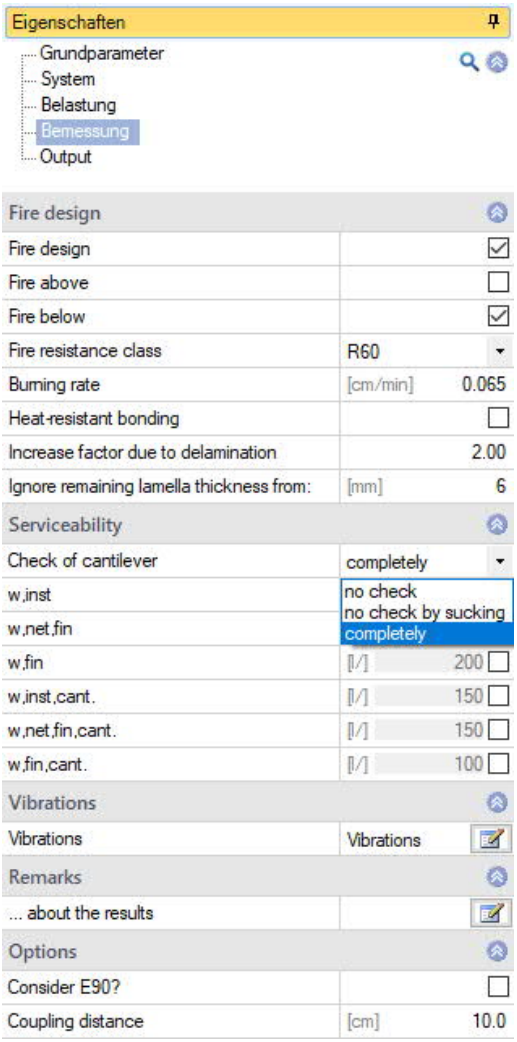
The load table is displayed via the "Loads" tab.



Member	Select here whether the entry relates to the entire system or to a single field.
Load type	Selection of the load type: uniformly distributed, concentrated or trapezoidal load over the length or a range (a to a+l).
pi	Load value or Load value at the beginning of the line/trapezoidal load.
pj	Load value at the end of the line/trapezoidal load.
a	Distance of a single load from the left start of the beam.
l	Length of the line load.
Field by field	Here you choose whether loads that are entered over several fields are to be applied field by field by the program or are only taken into account in combination.
Action	Selection of the action from a list.
Sim	Loads of a simultaneous group are always put together.
Alt	Only one of the loads of an alternative group is ever applied. A load over several fields is considered to be one load and is not used as an alternative field by field. Whether a field-by-field load is applied depends on the entry in the alternative column.

Design

Here you can optionally activate the fire protection design and the vibration verification as well as control the shear stress verification.



Fire protection design

Optional proof under fire exposure. The corresponding input fields for verification method, fire resistance class, burn sides and rates are displayed.

Calculation basis

The proof of the load-bearing capacity is carried out with the ideel residual cross-section. Since the protective charcoal layer can fall off ("delamination") due to the large area of fire exposure when using non-heat-resistant adhesive bonds, the so-called staircase model is used: For the first 25 mm of an inner layer, an increased burn rate is assumed due to the lack of the fallen charcoal layer, then the normal burn rate for the remaining layer thickness due to the now existing charcoal layer.

Heat-resistant bonding / increase factor through delamination

Heat-resistant bonding can be taken into account within the programme to prevent the effect of "delamination". Furthermore, a self-defined increase factor of the burn rate until a protective charcoal layer of 25 mm has formed again can be defined.

Ignore remaining lamella thickness

If only a small thickness of the outermost layer remains due to the burn-off, this can be neglected in the dimensioning if desired.

Serviceability

Check of cantilever — Select what check of serviceability for cantilevers is performed.
no check: cantilevers are not checked.
no check when lifting: cantilevers are only checked if the deformation is not lifting.
complete: cantilevers are always checked.

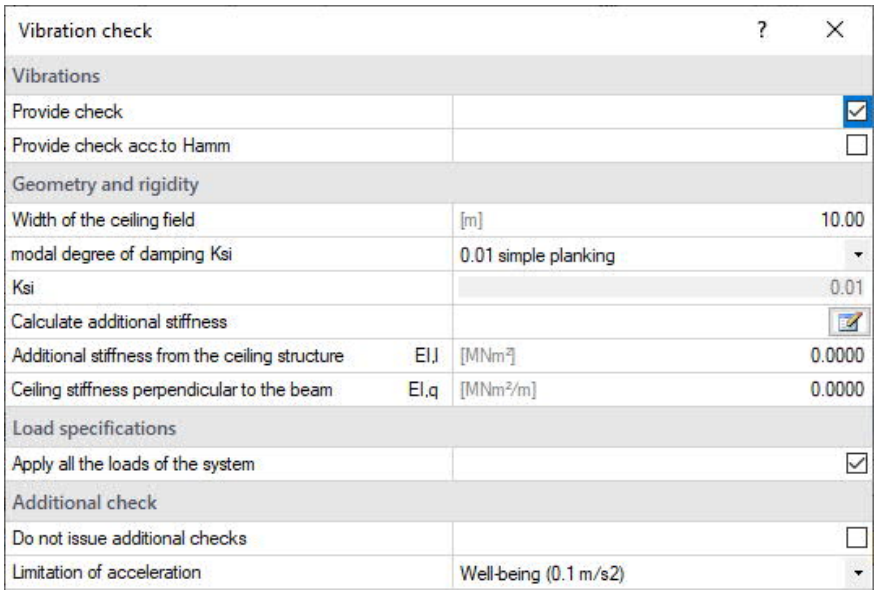
Entering the limit values (LV) of the deformations:

w,inst	LV of the elastic deflection of a single-span beam
w,net,fin	LV of the sum of elastic deflection and creep deformation of a single-span beam
w,fin	LV of the final deformation of a single-span beam
w,inst,cant.	LV the elastic deflection of a cantilever
w,net,fin,cant.	LV of the sum of elastic deflection and creep deformation of a cantilever
w,fin,cant.	LV of the final deformation of a cantilever

Vibrations

You can select the oscillation analysis on the "Design" tab.

 this button allows you to access the dialog for the oscillation analysis.



Check the desired option for the oscillation analysis.

Analysis in accordance with Hamm:

Hamm, P.; Richter, A.: Bemessungs- und Konstruktionsregeln zum Schwingungsnachweis von Holzdecken. Symposia on timber construction 2009. Leinfelden-Echterdingen.

Geometry and stiffness

- Width of the ceiling span
- Modal damping ratio Ksi
- Calculate additional stiffness in a separate dialog, you can define the additional stiffnesses
- EI,l displays the additional stiffness from the ceiling structure
- EI,q displays the ceiling stiffness perpendicular to the beam

Load specifications

You can accept the system loads or optionally enter the loads manually (uncheck the box).

g0 permanent area load

q0 variable area load

You can select an action group in the selection list on the right.

Additional checks

Do not issue additional checks special examinations at frequencies greater than 8 Hertz are not issued.

Limitation of acceleration predefined limit values or self-defined limit value (for EN 1995)

Notes:

f resonance frequency

f > 8 Hz: in this case, the following requirements should be complied with for residential ceilings:

- limitation of the deflection $\frac{w}{F} \leq a$ mm/KN

- limitation of the speed of oscillation v caused by the unit pulse $v \leq \beta^{(f1 \cdot \zeta - 1)}$ m/(Ns²)

f ≤ 8 Hz: in this case, a separate examination should be carried out for residential ceilings.

In this connection, two additional verifications are performed that correspond to the approach described in reference /1/.

/1/ Blaß, H. J. Erläuterungen zu DIN 1052-2004-08 , Bruderverlag March 2005

- limitation of the speed of oscillation v caused by footfall $v \leq 6 \cdot \beta^{(f1 \cdot \zeta - 1)}$ m/(Ns²)

- limitation of the acceleration $a_{vert} \leq 0{,}1 \text{ m/s}^2 - 0{,}4 \text{ m/s}^2$

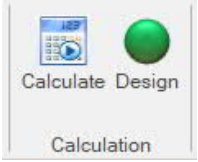
Options

E90	Optionally, it can be taken into account whether the modulus of elasticity perpendicular to the fibre is taken into account in the calculation.
Coupling distance	Distance between the coupling points of the virtual beams of the shear analogy method: the smaller the distance, the more precise the internal forces are with increased computing time.

Output

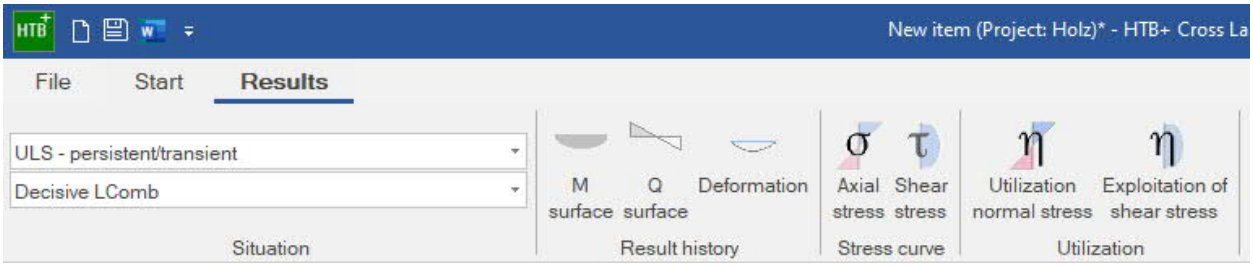
Before the output click on the calculate symbol.

After the calculation, the capacity is displayed at the bottom right in the graphics window and offers a good overview of the economic efficiency of the system entered.



Results

You can view the result graphics via the Results tab.



Output scope

By clicking on the various output options, you determine the scope of the output. You can also define output cuts here.

Output as a PDF document

The output document is displayed in PDF format via the "Document" tab and can be printed.

See also Output and Printing.pdf