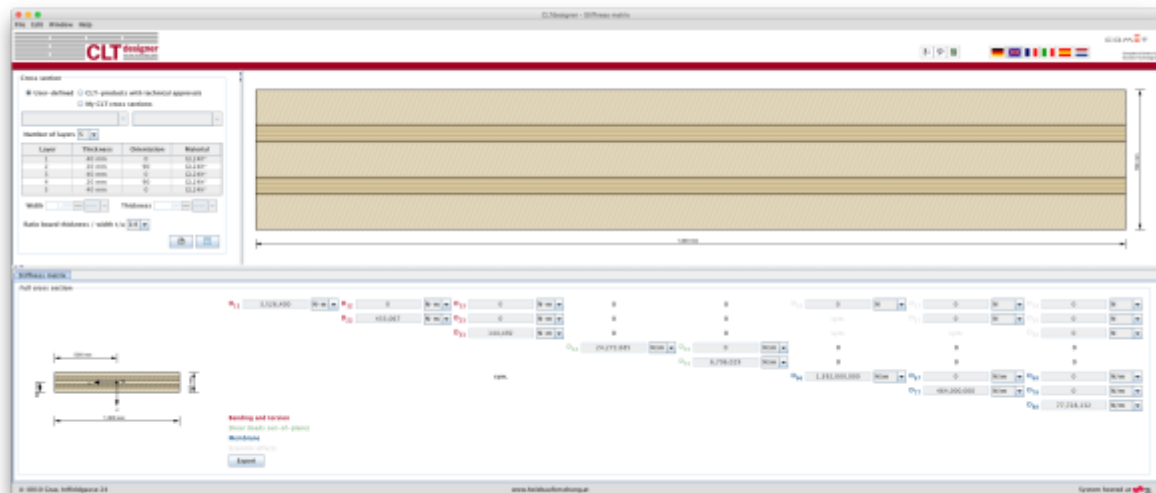


Module "Stiffness matrix"



Input data

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.

Cross section

☒ User-defined
 ☐ CLT-products with technical approvals
 ☐ My CLT cross sections

Number of layers

5

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

1,000

mm

 Thickness

160

mm

Ratio board thickness / width t/a

1:4

Beta! Optimise cross section...

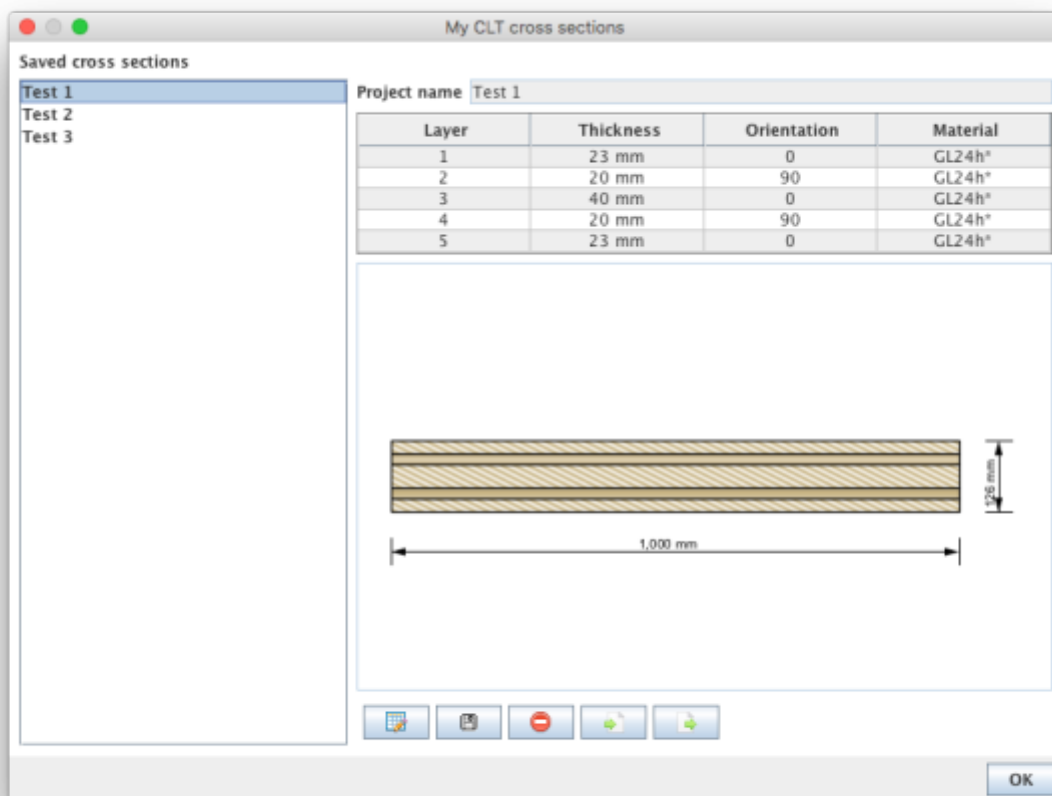
The width of the CLT plate strips can be also defined in this field. The default value is set to 1 m. The thickness of the CLT plate is calculated automatically based on the thickness of the single layers.

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



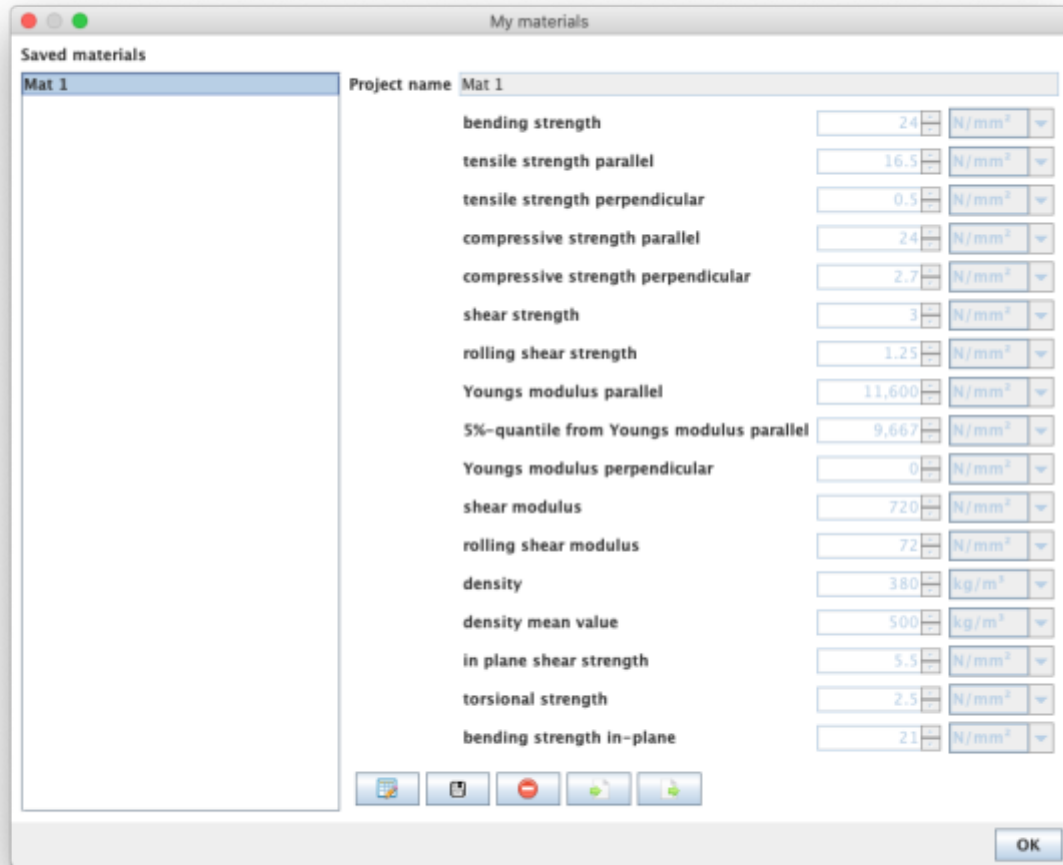
name;number of layers n ;layer thickness in [m] t_1 to t_n ;orientation of the layers α_1 to α_n (0 or 90);name of material

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

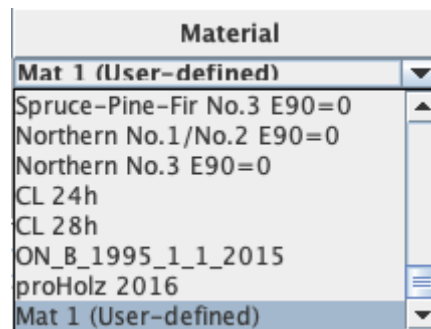
1. row: description of the parameters
 2. row: units of the parameters
 3. row: value
- delimiter: ";"



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.

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

Results and Output

Stiffness matrix

Determination and description of the single components

Bending and torsion

D_{11}	3,526,400	N · m	D_{12}	0	N · m	D_{13}	0	N · m
			D_{22}	433,067	N · m	D_{23}	0	N · m
						D_{33}	144,492	N · m

Shear for CLT-plate loaded out-of-plane

D_{44}	24,272,685	N/m	D_{45}	0	N/m
			D_{55}	6,706,029	N/m

In-plane Stiffness values

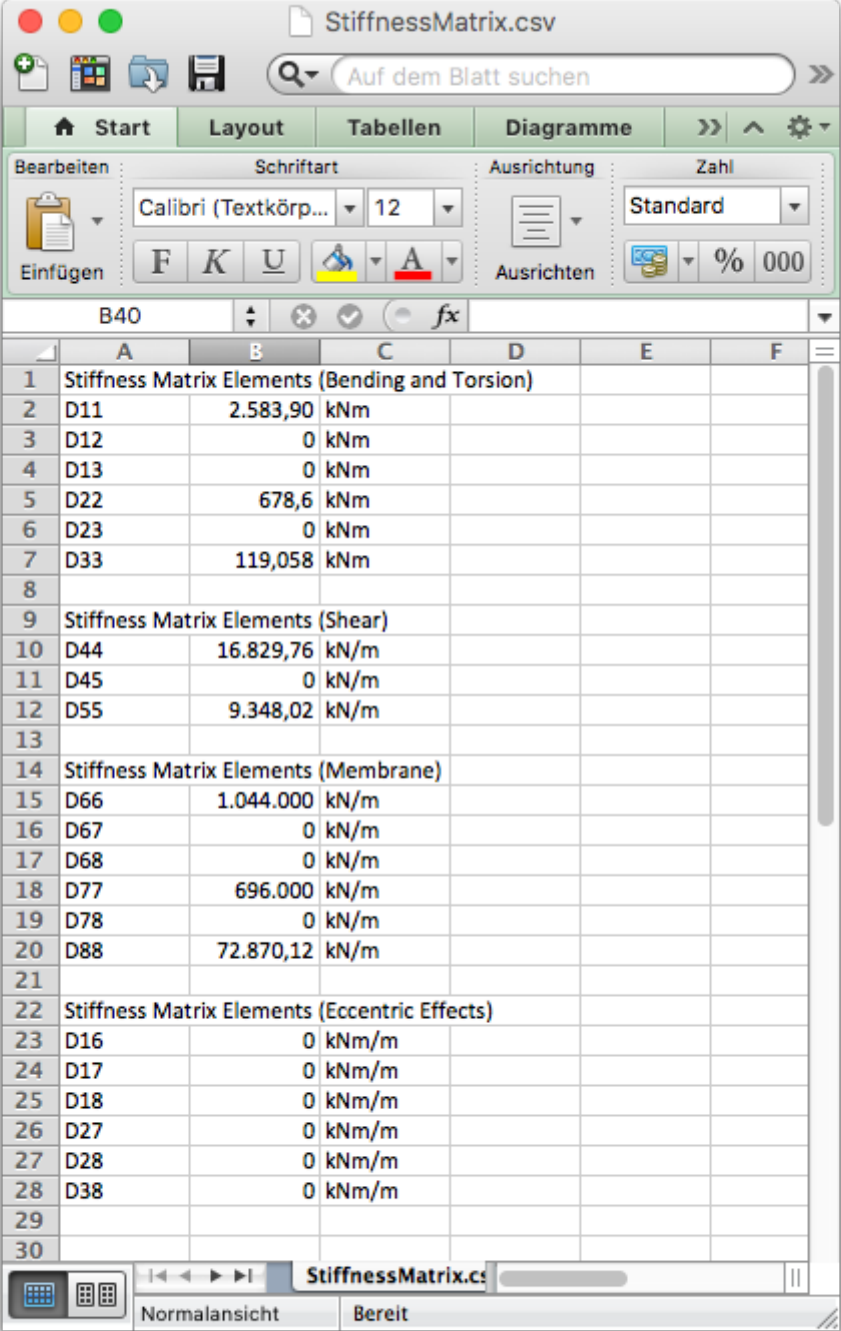
D_{66}	1,392,000,000	N/m	D_{67}	0	N/m	D_{68}	0	N/m
			D_{77}	464,000,000	N/m	D_{78}	0	N/m
						D_{88}	77,728,132	N/m

Eccentric effects

D_{16}	0	N	D_{17}	0	N	D_{18}	0	N
sym.			D_{27}	0	N	D_{28}	0	N
sym.			sym.			D_{38}	0	N

Export possibilities

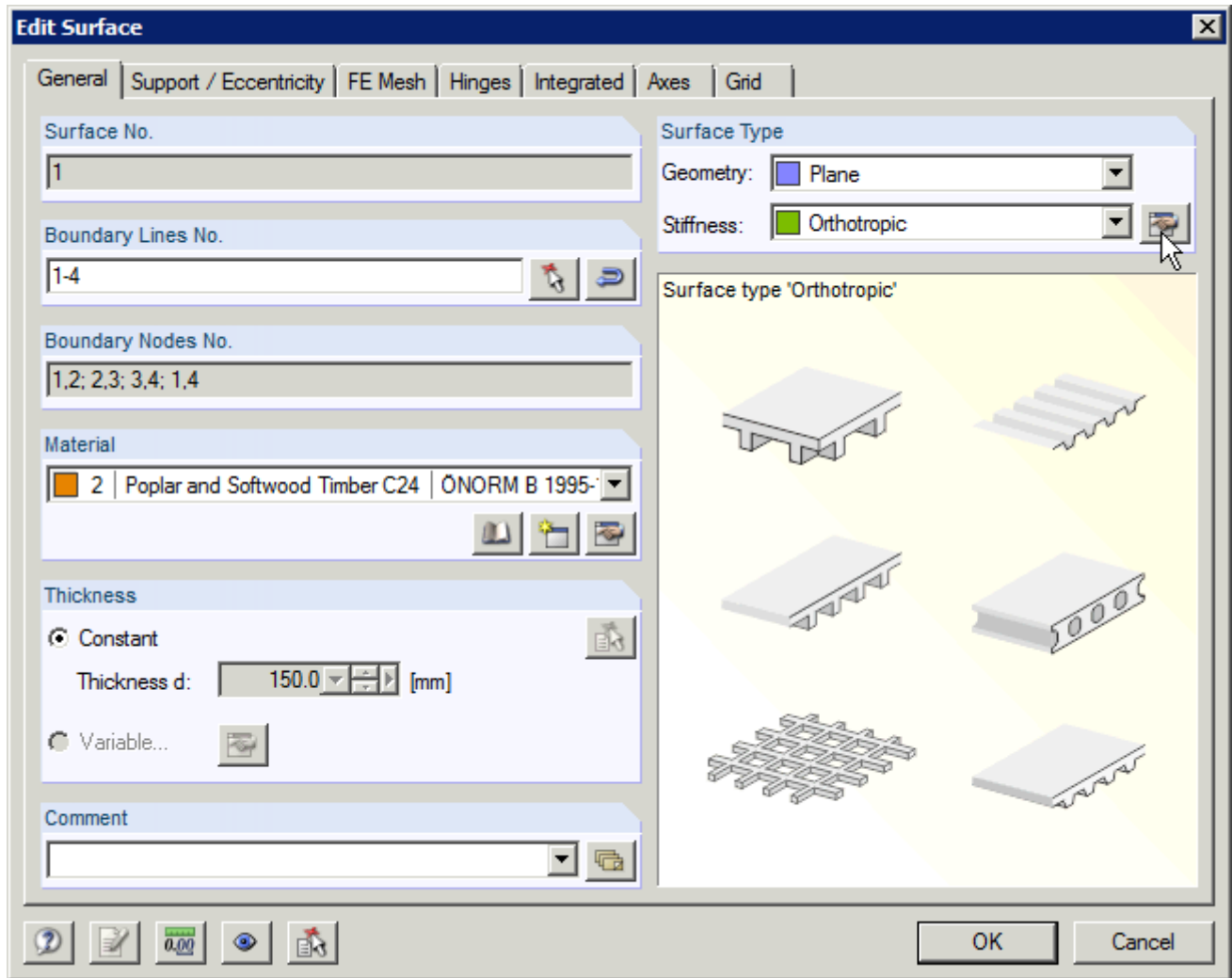
By clicking on the button  a csv file will be created, which contains the input data for RFEM 5.



The screenshot shows a window titled "StiffnessMatrix.csv" with a spreadsheet interface. The table contains stiffness matrix elements for bending and torsion, shear, membrane, and eccentric effects. The columns are labeled A, B, C, D, E, and F. The rows are numbered 1 to 30. The data is as follows:

	A	B	C	D	E	F
1	Stiffness Matrix Elements (Bending and Torsion)					
2	D11	2.583,90 kNm				
3	D12	0 kNm				
4	D13	0 kNm				
5	D22	678,6 kNm				
6	D23	0 kNm				
7	D33	119,058 kNm				
8						
9	Stiffness Matrix Elements (Shear)					
10	D44	16.829,76 kN/m				
11	D45	0 kN/m				
12	D55	9.348,02 kN/m				
13						
14	Stiffness Matrix Elements (Membrane)					
15	D66	1.044.000 kN/m				
16	D67	0 kN/m				
17	D68	0 kN/m				
18	D77	696.000 kN/m				
19	D78	0 kN/m				
20	D88	72.870,12 kN/m				
21						
22	Stiffness Matrix Elements (Eccentric Effects)					
23	D16	0 kNm/m				
24	D17	0 kNm/m				
25	D18	0 kNm/m				
26	D27	0 kNm/m				
27	D28	0 kNm/m				
28	D38	0 kNm/m				
29						
30						

The csv file can be imported into RFEM 5 via "Edit Surface" and the tab "Stiffness Matrix".



Edit Surface Stiffness - Orthotropic

General | Defined by stiffness matrix | **Stiffness Matrix** | Transformed Stiffness Matrix

Stiffness Matrix Elements (Bending and Torsion)

D₁₁ : 2583.900 [kNm] D₁₂ : 0.000 [kNm] D₁₃ : 0.000 [kNm]
 D₂₂ : 678.600 [kNm] D₂₃ : 0.000 [kNm]
 D₃₃ : 131.625 [kNm]

Stiffness Matrix Elements (Shear)

D₄₄ : 16776.700 [kN/m] D₄₅ : 0.000 [kN/m]
 D₅₅ : 12058.300 [kN/m]

Stiffness Matrix Elements (Membrane)

D₆₆ : 1.0440E+06 [kN/m] D₆₇ : 0.000 [kN/m] D₆₈ : 0.000 [kN/m]
 D₇₇ : 696000.000 [kN/m] D₇₈ : 0.000 [kN/m]
 D₈₈ : 85362.200 [kN/m]

Stiffness Matrix Elements (Eccentric Effects)

D₁₆ : 0.000 [kNm/m] D₁₇ : 0.000 [kNm/m] D₁₈ : 0.000 [kNm/m]
 D₂₇ : 0.000 [kNm/m] D₂₈ : 0.000 [kNm/m]
 D₃₈ : 0.000 [kNm/m]

$$\begin{bmatrix}
 D_{11} & D_{12} & D_{13} & 0 & 0 & D_{16} & D_{17} & D_{18} \\
 & D_{22} & D_{23} & 0 & 0 & \text{sym.} & D_{27} & D_{28} \\
 & & D_{33} & 0 & 0 & \text{sym.} & \text{sym.} & D_{38} \\
 & & & D_{44} & D_{45} & 0 & 0 & 0 \\
 & & & & D_{55} & 0 & 0 & 0 \\
 & \text{sym.} & & & & D_{66} & D_{67} & D_{68} \\
 & & & & & & D_{77} & D_{78} \\
 & & & & & & & D_{88}
 \end{bmatrix}$$

$D_{11} \dots D_{33}$ [Nm]
 $D_{44} \dots D_{88}$ [N/m]
 $D_{16} \dots D_{38}$ [Nm/m]

OK Cancel

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Last update: 2020/03/26 11:46

