

memo

Strength classed wood vs. bamboo

This document is written to explain more about strength classes used for wood and how this is related to bamboo mechanical properties.

Strength classes of wood

For wood there exist several kind of strength classes. Strength classes are based on several material properties of the wood like bending strength, E modulus, Density, etc. For solid wood there are C and D classes. C classes for softwood species and D classes for hardwood species. See below a strength classes table for C and D classes for solid wood materials. There are also strength classes for laminated wood (GL classes).

Table 1 — Strength classes - Characteristic values

		Softwood species												Hardwood species							
		C14	C16	C18	C20	C22	C24	C27	C30	C35	C40	C45	C50	D18	D24	D30	D35	D40	D50	D60	D70
Strength properties (in N/mm²)																					
Bending	$f_{m,k}$	14	16	18	20	22	24	27	30	35	40	45	50	18	24	30	35	40	50	60	70
Tension parallel	$f_{t0,k}$	8	10	11	12	13	14	16	18	21	24	27	30	11	14	18	21	24	30	36	42
Tension perpendicular	$f_{t90,k}$	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6
Compression parallel	$f_{c0,k}$	16	17	18	19	20	21	22	23	25	26	27	29	18	21	23	25	26	29	32	34
Compression perpendicular	$f_{c90,k}$	2,0	2,2	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3,1	3,2	7,5	7,8	8,0	8,1	8,3	9,3	10,5	13,5
Shear	$f_{v,k}$	3,0	3,2	3,4	3,6	3,8	4,0	4,0	4,0	4,0	4,0	4,0	4,0	3,4	4,0	4,0	4,0	4,0	4,0	4,5	5,0
Stiffness properties (in kN/mm²)																					
Mean modulus of elasticity parallel	$E_{0,mean}$	7	8	9	9,5	10	11	11,5	12	13	14	15	16	9,5	10	11	12	13	14	17	20
5 % modulus of elasticity parallel	$E_{0,05}$	4,7	5,4	6,0	6,4	6,7	7,4	7,7	8,0	8,7	9,4	10,0	10,7	8	8,5	9,2	10,1	10,9	11,8	14,3	16,8
Mean modulus of elasticity perpendicular	$E_{90,mean}$	0,23	0,27	0,30	0,32	0,33	0,37	0,38	0,40	0,43	0,47	0,50	0,53	0,63	0,67	0,73	0,80	0,86	0,93	1,13	1,33
Mean shear modulus	G_{mean}	0,44	0,5	0,56	0,59	0,63	0,69	0,72	0,75	0,81	0,88	0,94	1,00	0,59	0,62	0,69	0,75	0,81	0,88	1,06	1,25
Density (in kg/m³)																					
Density	ρ_k	290	310	320	330	340	350	370	380	400	420	440	460	475	485	530	540	550	620	700	900
Mean density	ρ_{mean}	350	370	380	390	410	420	450	460	480	500	520	550	570	580	640	650	660	750	840	1080
NOTE 1 Values given above for tension strength, compression strength, shear strength, 5 % modulus of elasticity, mean modulus of elasticity perpendicular to grain and mean shear modulus, have been calculated using the equations given in Annex A.																					
NOTE 2 The tabulated properties are compatible with timber at a moisture content consistent with a temperature of 20 °C and a relative humidity of 65 %.																					
NOTE 3 Timber conforming to classes C45 and C50 may not be readily available.																					
NOTE 4 Characteristic values for shear strength are given for timber without fissures, according to EN 408. The effect of fissures should be covered in design codes.																					

Table 1, from EN 338 – Structural Timber – Strength classes

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Using this table there can be made a relation between the different properties of the wood.

For example when you know a certain bending strength (e.g. 30 N/mm²), you can use the table to find the related E modulus (11.000 N/mm²), the related Density (530 kg/m³), etc. This can be done also vice versa and with other properties. The bending strength value is used in the classification. In this example D30.

Trying to compare wood classes with bamboo

When you try to compare wood classes (e.g. D30) with bamboo the following can be said:

1. D is for solid hardwood; 30 stands for bending strength of 30 N/mm²
2. Bamboo N-finity has a bending strength of 56,7 N/mm² edgewise and 50,8 flatwise. Much higher as the hardwood in D30 class.
3. But using the table and check the related E modulus belonging to D30, the E modulus of solid hardwood is 11.000 N/mm². The E modulus of Bamboo N-finity is 9721 N/mm² edgewise and 8866 N/mm² flatwise, which is a totally different E modulus.

Tables for bamboo

The tables for wood are based on data collected over many years. For bamboo the data is not (limited) available and so these tables existing.

In general bamboo has a lower E modulus compared to wood, but a high bending strength. The relation between for example bending strength and E modulus for bamboo is not the same as for wood.

For bamboo we have to collect all the information ourselves by performing tests. We have done this for Bamboo N-finity, Bamboo X-treme and for Solid High Density. For this a separate memo with (characteristic) values is made.

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