T 2844

Tensile Strength Perpendicular to Grain

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Summary

Tests with solid and glued laminated timber were carried out according to EN 1193 (December, 1994).

The orientation of the annual rings of the solid timber specimens, as shown in figure 1, revealed to have a distinct influence on the tensile strength and on the stiffness perpendicular to grain.

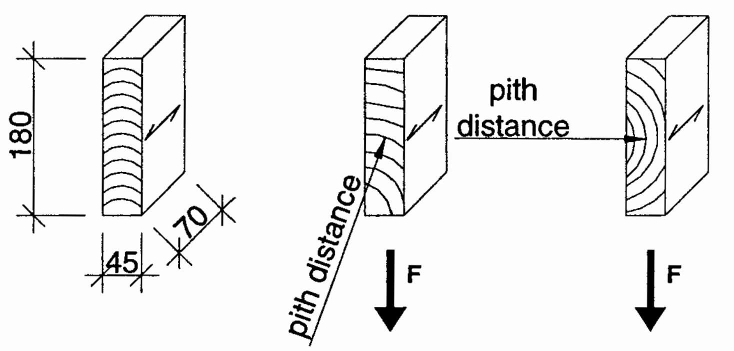

Figure 1: Orientation of annual rings within the timber specimens

Table 1 contains the tensile strength values of the solid timber test specimens.

Table 1: Tensile strengths perpendicular to grain of solid timber, separated by orientation

annual ring orientation	number	$f_{t,90,mean}$ [N/mm²]	$f_{t,90,minimum}$ [N/mm²]	$f_{t,90,maximum}$ [N/mm²]	5-percentile [N/mm²]	standard-deviation [N/mm²]
radial	24	2,55	1,84	3,19	1,84	0,485
45°	18	2,04	1,01	3,18	-	0,649
tangential rupture at bonded joint	71	1,94	0,57	2,77	1,41	0,382

Table 1 (continuation):

annual ring orientation	number	$f_{t,90,mean}$ [N/mm²]	$f_{t,90,minimum}$ [N/mm²]	$f_{t,90,maximum}$ [N/mm²]	5-percentile [N/mm²]	standard-deviation [N/mm²]
tangential rupture in wood	68	1,65	0,70	2,77	0,92	0,418
tangential all	139	1,80	0,57	2,77	0,95	0,423
including pith	6	1,02	0,45	2,03	-	0,619
all	187	1,89	0,45	3,19	0,95	0,548

The coefficient of correlation for those tangentially loaded specimens with rupture at the bond line was relatively high (r = 0,58), while for the specimens with rupture in wood it was almost zero (r = 0,095).

The correlation between the tensile strength perpendicular to grain and the density as assumed by the EN 384

$$f_{t,90,k} = 0{,}001 \cdot \rho_k \qquad (1)$$

could not be confirmed.

The tests with timber were performed with nearly clear wood specimens without visible cracks or splits, which often occur in structural size timber. Especially because of cracks, the tensile strength perpendicular to grain in structural timber will be lower than the values given in table 1.

The tests with glued laminated timber revealed that ring shake leads to a tensile strength of almost zero. Even if the defect might have been enlarged by the production of the test specimen, ring shake seems to have a very distinct influence on the tensile strength perpendicular to grain of glued laminated timber.

The tensile strengths of the test specimens of the higher strength class BS18 (comparable to GL36) were often lower than those of the specimens of the strength class BS16 (comparable to GL32).

Table 2 contains the statistical parameters of the tensile strength perpendicular to grain of glued laminated timber for the specimens with a stressed volume of V_0 = 0,01 m³.

Table 2: Statistical parameters of the tensile strength perpendicular to grain of glued laminated timber.

strength class	number	$f_{t,90,mean}$ [N/mm²]	$f_{t,90,minimum}$ [N/mm²]	$f_{t,90,maximum}$ [N/mm²]	5-per-centile [N/mm²]	standard-deviation [N/mm²]
BS11 or BS14	79	0,73	0,22	1,35	0,43	0,22
BS16	38	0,83	0,41	1,20	0,50	0,18
BS18	36	0,78	0,05	1,42	0,33	0,26
all	153	0,77	0,05	1,42	0,46	0,22

The effect of the stressed volume for short time loading, based on Weibulls probabilistic theory, seems to be more pronounced than assumed by Eurocode 5. The comparison of the tensile strengths of the tests carried out with a volume of $V_0 = 0{,}01$ m³ with the results of tests with smaller volumes as well as the fitted distributions indicate that the tensile strength of stressed volumes different from $V_0 = 0{,}01$ m³ has to be multiplied with

$$(V_0/ V_\perp)^{0,3} \qquad (2).$$

Eurocode 5 assumes an exponent of 0,2. The same exponent of 0,3 is given by Ranta-Maunus (1998).