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Creep of Glued Laminated Timber Beams During Four-Point Bending Test

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Abstract: Glued laminated timber beams were subjected to destructive testing in four point bending test. Three deflections (at the mid-span of the beam, and below the points of load application) were recorded. The forces due to hydraulic cylinder were transmitted into the beam over a distribution element. The loading regime assumed a step-wise increase of the force by 4 kN in about 40 s. The time variation of deflections at 110 loading levels was examined in details for the set of five beams. It can be seen that the effect of creep covers about 10 – 20 % of the overall strain.

Keywords: Glued Laminated Timber; Displacement; Creep of Timber Beams; Four-Point Bending Test.

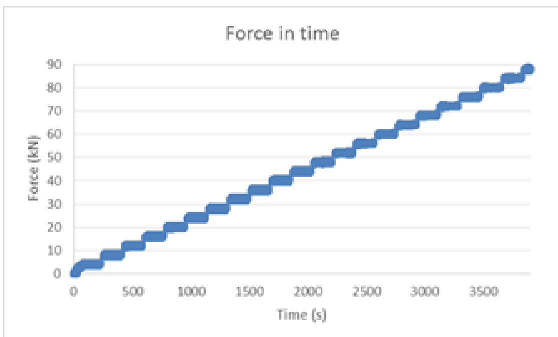
1 Introduction

The effect of long term creep in timber structures is well understood, but the effect of short term creep is practically unknown. Because the duration of the laboratory tests is usually in minutes, it is necessary to include this effect into the computational models of the tested beams.

2 Loading of Beams and Example of Creep

The experimental set-up is plotted in Fig. 1. Three deflections at the mid-span of the beam and below the points of load application were recorded. All measuring points were located at the bottom face of the beam. The forces due to hydraulic cylinder were transmitted into the beam over a distribution element. The loading regime assumed a step-wise increase of the force by 4 kN in about 40 s. At each load level the force was kept constant from 100 to 200 s prior to the next load increment. The exact length of the time interval, at which the deflection is evaluated, is determined individually for each loading step. Attention is paid to the time segments where the applied force is constant, i.e. oscillates about a specified value, see Fig. 2a. The force was recorded every 0.05 s and the duration of the entire test was about 65 min [1].

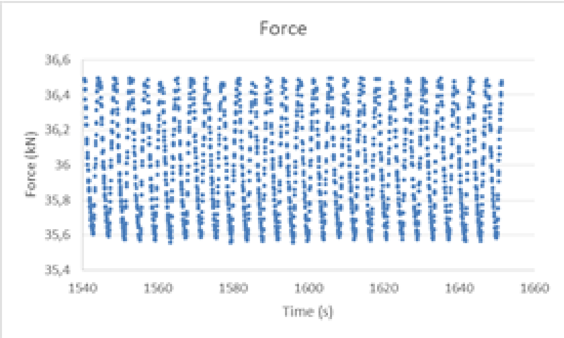
(a) four-point bending test



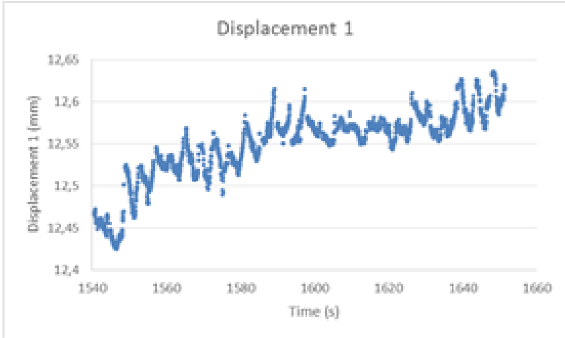
(b) time variation of the applied load

Fig. 1: Destructive testing of GLT beam in four-point bending test.

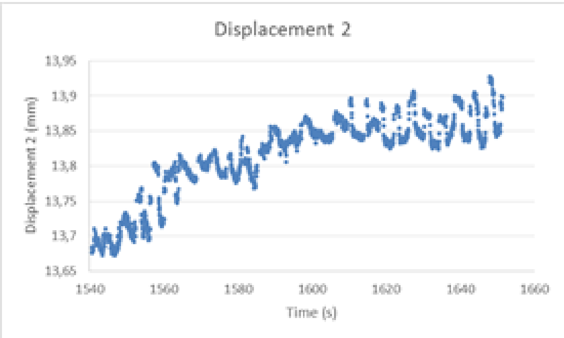
The results are provided in terms of the load-deflection diagrams. Fig. 2 show the evolution of the measured deflections during the hold period of 110 s at load level of 36 kN.



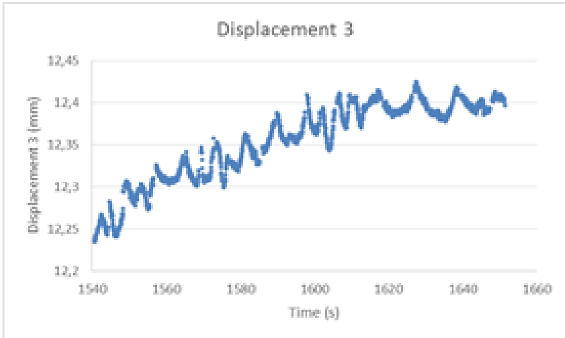
(a) 110 s hold period at load level of 36 kN



(b) measured deflections below the left force



(c) measured deflections at the mid-span of the beam



(d) measured deflections below the right force

Fig. 2: Time variation of the measured deflections at load level of 36 kN.

3 Results

Tab. 1 stores the measured deflections at the center of one of the analyzed beams. The meaning of individual parameters is evident from Fig. 3 (parameter a can be found in the 5$^{\text{th}}$ column and parameter c in 6$^{\text{th}}$ column, respectively).

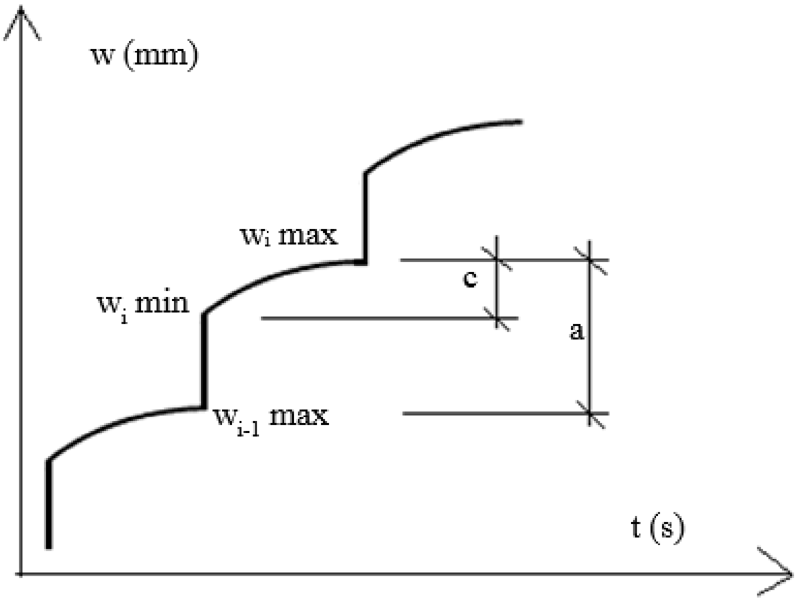


Fig. 3: Meaning of individual parameters.

The first 12 loading steps, i.e. up to load level of 48 kN, were characterized by the distribution of loading force during the hold period according to Fig. 2a. For larger forces the interval of constant force was shorter as it took more time to stabilize the force at a given level. Creep results at larger forces should just be analyzed with caution.

The 2nd and 3rd columns in Tab. 1 also confirm the linear dependence of deflection on loading, except for the last loading step when measurements were already carried out on damaged beam.

Tab. 1: Resulting deflections at the center of the beam No. 3, recall Fig. 3 for their decription.

i	F [kN]	w_i max [mm]	w_i min [mm]	w_i max - w_{i-1} max [mm]	w_i max - w_i min [mm]	%
1	4	1.26	1.38	1.26	0.12	9
2	8	2.91	3.05	1.67	0.14	8
3	12	4.57	4.73	1.68	0.16	9
4	16	6.11	6.26	1.53	0.15	10
5	20	7.54	7.72	1.46	0.18	12
6	24	9.03	9.22	1.5	0.19	13
7	28	10.55	10.79	1.57	0.25	16
8	32	12.1	12.31	1.52	0.21	14
9	36	13.67	13.93	1.62	0.26	16
10	40	15.27	15.51	1.58	0.24	15
11	44	16.86	17.10	1.59	0.24	15
12	48	18.54	18.69	1.58	0.15	9
13	52	20.17	20.26	1.57	0.09	6
14	56	21.74	21.8	1.54	0.05	3
15	60	23.34	23.42	1.63	0.08	5
16	64	24.96	25.04	1.62	0.09	5
17	68	26.53	26.7	1.65	0.17	10
18	72	28.21	28.34	1.64	0.12	7
19	76	29.81	29.99	1.66	0.18	11
20	80	31.45	31.6	1.61	0.15	9
21	84	33.95	34.1	2.5	0.15	6
22	88	37.14	37.16	3.06	0.02	1

4 Conclusion

Preliminary loading tests curried out on laminated beams indicate a certain creep effect noticeable at each loading step. This effect covers about 10 – 20 % of the overall strain. It follows that this phenomenon must be taken into account when properly evaluating mechanical material parameters of the model [2].

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