СЕКЦІЯ 2.
ТЕХНОЛОГІЇ ДЕРЕВООБРОБКИ І МЕБЛЕВОГО ВИРОБНИЦТВА

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THE SHORT-TERM BEECH WOOD CREEP TEST BY MEANS OF DYNAMIC MECHANICAL ANALYSIS (DMA)

Physical, mechanical and rheological properties of wood are among the constitutive properties while using it as a building material. They have decisive importance to the manufacture of wooden building constructions and elements including CLT panels, etc. as directly effect on performance of the product. Moreover, one of the better-known aspects of designing with wood or wood-based products is that the strength of these products depends on time under stress.

The best characterizes mentioned above wood properties its creep performance. Creep is not only an important phenomenon in viscoelasticity, but is also of great significance in design of wood based products for load-carrying applications. Consequently, creep in wood and wood structures can lead to serviceability problems due to excessive deformations or to safety problems due to strength reduction [2]. Evaluating creep behaviour of a product, however, takes a great deal of time and cost. For example, to evaluate the long-term performance of some timber material, ASTM D 6815 [1] requires the applied load for the long-term (min 90-day) specimens to be based on 55% of the 5th percentile parametric point estimate of the short-term bending load using matched specimens. Furthermore, in such conditions seems almost impossible to investigate creep behaviour under variable temperature and stress level [3, 4].

The main objective due to investigation is to study the effects of stress level and temperatures on the creep behaviour of wood beech by means of dynamic mechanical analysis.

The commercial device, a Gabo Eplexor 25N Dynamic Mechanical Analyser (DMA) [5], was used to study the viscoelastic response of a specimen under constant loads in creep tests between 20 and 75°C (Fig. 1). The DMA has the advantage of quickly giving results, and, it does allow for control of the relative humidity in the measuring chamber.

Fig.1 – Overall view of the DMA Gabo Eplexor.

Creep experiments for tension on the DMA were done using GABO software [5]. The sample is mounted in the clamps and the clamps are tightened using screws with adjustable torque (Fig. 2). Full load was rapidly and smoothly applied to the specimen, mainly in 1 to 5s, soak time before starting the measurement under the static load was 300s. A constant load was applied to a specimen in selected loading configurations (tension) at constant temperature and the deformation was measured as a function of time [2]. The sample creeps for 3 hours than recovers for 6 hours. The data is read and manipulated by the on-line computer system and the results were displayed as the experiment progresses.

Fig. 2 – DMA tension clamps

Experiments were performed at Time Sweep and Temperature Sweep module with the fixed constant frequency (close to 0 -0.001Hz). In order to construct master curves for the prediction of long-term behaviours, a series of 180-minute isothermal creep tests were conducted at various temperatures and stresses, and the corresponding creep strains were measured. The range of selected temperatures was from +25°C to +75°C with a 25°C increment.

Time to equilibrate the temperature rate was calculated based on range of heating, which was near 5°C / min. To insure that behaviour of test specimens remains within the linear range, loads in the 20% to 25% range of the short-term ultimate strength were from 5 to max. 20N with Δ5N. Tolerance of static load were between 0.1-0.2N. No load was applied during temperature ramp, and the temperature equilibrating time was 5 minutes for each temperature. All these parameters are entered using the “CREEP 25N©” template available in the GABO software.

The investigations were carried out on wood samples taken from a single beech tree. The rectangular beech wood samples, cut from oven dried blanks, were conditioned for at least 2 weeks before measurements at constant climate room with a temperature 20±2°C and relative humidity of approx. 60%. Few different types with different dimensions of DMA specimens have been used: 1 - geometry measured approximately 60 mm in length, 12 mm in width and 0.6 mm in thickness, and the span of the test is 35 mm; 2 – 50mm length, 5 mm width and approx. 0.16mm thickness, span of the test 35 mm. Specimen dimension is a compromise between the load magnitude that can be applied (25N using tension clamps) and the size that would be representative of the species. For this study, 22 samples of each dimension were tested.

Description of the main obtained results. As a result of short term creep test, have been obtained Tensile-Creep curves as well as Creep-Modulus curves at different load values and temperatures. Figure 3 shows a representative plot of the creep strain from a 180-minute creep tests at 22°C and 20N. Figure 5 shows a representative plot of the creep strain from a series of 180 minute creep tests at various temperatures from +22 to +75°C with an increment of apporx. 25°C. The effect of temperature can be observed in that the creep strain increased with elevating temperatures, and the strain increment also increased nonlinearly with respect to temperature. This may imply that, at a lower temperature, the effect of temperature was linear. At a lower temperature, the creep strain did not increase considerably; whereas, the strain increased more and more significantly with elevating temperature.

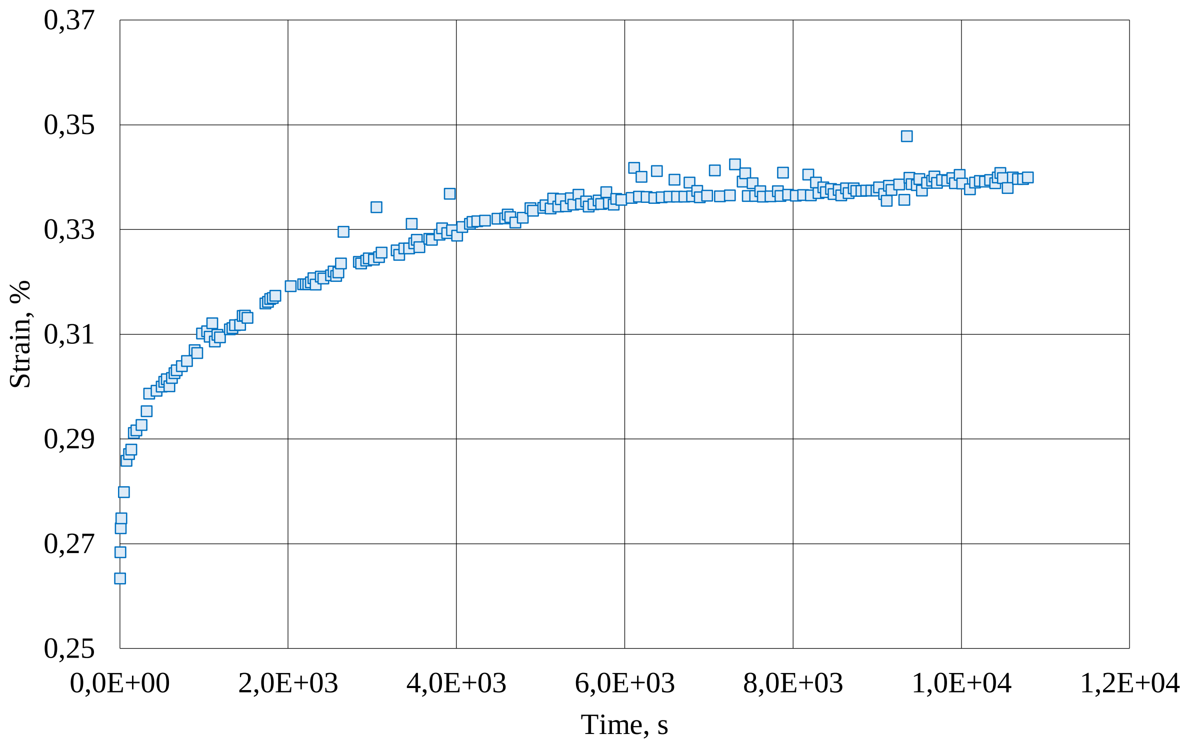

Fig. 3 – Tensile-creep curve of beech at 20N and 22°C. Creep strain versus time

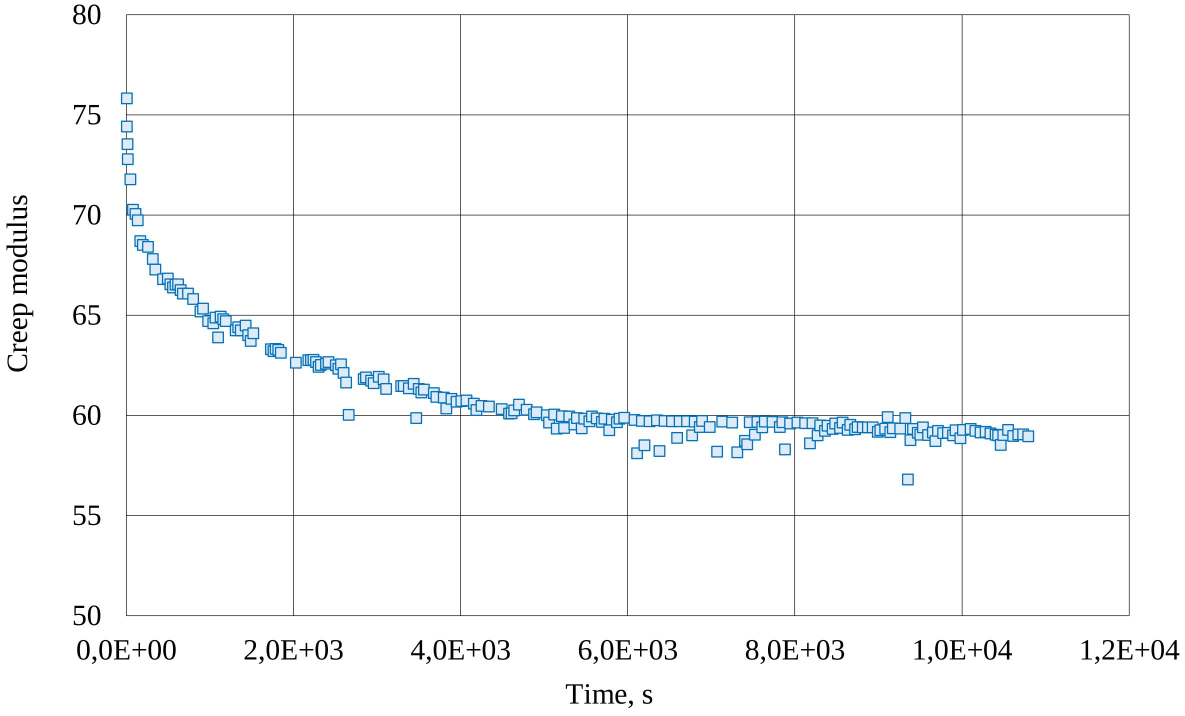

Fig. 1 – Creep modulus of beech at 20N and 22°C. Creep modulus versus time

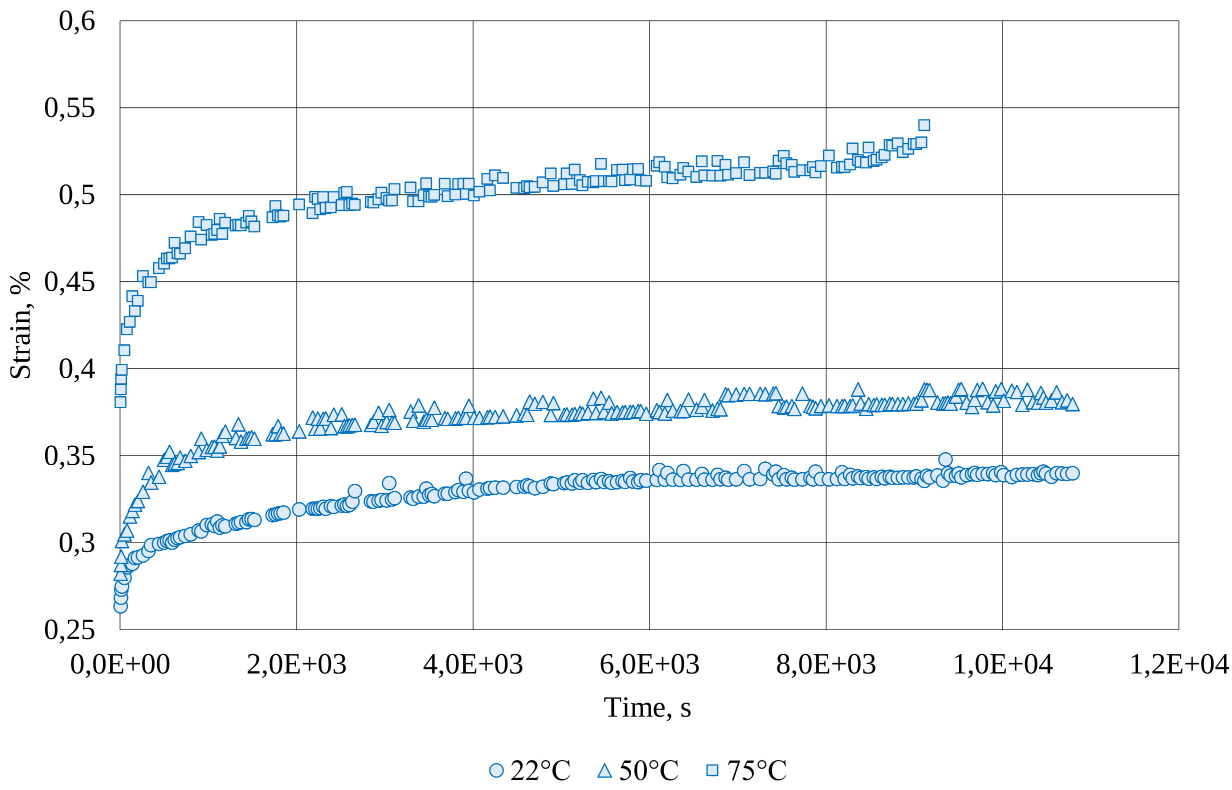

Fig. 2 – Tensile-creep curve of beech at 20N and 22°C, 50°C and 75°C respectively. Creep strain versus time

Conclusions. This applied investigations were devoted to verify possibility of Dynamic mechanical analysis using to investigate short-term creep behavior of beech wood. Short-term creep tests in tension have been conducted to obtain creep compliance curves at different temperatures and load level while maintaining a constant moisture content. The corresponding graphical dependencies characterizing the creep behavior of beech wood have been obtained. It should be noted, currently there is no standard testing method to properly evaluate the creep behaviour of wood using DMA, nevertheless the obtained results are in good agreement with the results obtained by other standard methods. Based on the results obtained, we can summarize DMA can be quite acceptable for predicting the shortterm creep behavior of wood materials. For a better quantitative assessment, it is necessary to carry out more thorough experimental studies taking into account all the factors described above.

References

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