DETERMINATION OF THE MODULUS OF ELASTICITY OF VARIOUS WOOD SPECIES ON THE BASIS OF THE MEASUREMENT OF FREE VIBRATION PARAMETERS

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ABSTRACT: The paper demonstrates how a simple, short and cheap dynamic testing can be used to calculate the modulus of elasticity of planks made from oak, pine, spruce and larch wood.

KEYWORDS: dynamic, vibration frequency, damping, logarithmic damping decrement, modulus of elasticity.

1 INTRODUCTION

The papers [2], [5] called attention to the option of the selection of wood to construct a structure on the basis of dynamic vibration. The author suggests measuring the free vibration parameters of elements made of wood in order to learn its properties instead of the commonly used long-term testing. The recognition of wood features in the dynamic testing yields unique results. The choice of best planks basing on visual inspection used to date or the long-term testing is insufficient. It is worth recommending short dynamic tests to select the wood necessary to build a structure, also to detect damaged elements in building facilities already constructed.

In her research work, the author deals with the analysis of the fitness of wood and wood-based materials for the construction of prestigious structures on the grounds of dynamic testing. This paper describes the examples of how to determine the stiffness of elements and the modulus of longitudinal elasticity E out of various wood species. The testing of the models out of the following wood species: pine, spruce, larch and oak, and the determination of their dynamic parameters were described. The testing was performed on dry models and after the 24-hour-long soaking in water. The aim of the testing was to determine the variations of the modulus of elasticity of various wood species due to the moisture.

2 DESCRIPTION OF THE TESTING

The models of dry and wet planks, of the 10x40mm section, 1200 mm long, were prepared for the testing. Before the experiment, the planks were weighed in the dry-air state. After the dynamic testing of dry planks, they were soaked in water for 24 hours. After soaking, the planks were re-weighed, and their humidity by weight was calculated. The planks loaded bracket-wise, were put in vibrating movement. The forcing load was applied at the bracket end perpendicularly to the plane of the beam’s lower stiffness.

The values obtained and calculated as the result of the testing: the circular frequency of free vibration $\omega$ [rad/s] and the damping $\rho$ [1/s] were used to calculate the actual stiffness and the longitudinal modulus of elasticity of the tested beams. The results are listed in the tables.

The relationships between the stiffness $K$, mass $m$, vibration rate $\omega$, and the damping $\rho$ were specified. Skipping the viscosity $\eta$, the local effective stiffness $K_{ef}$ of the bar can be estimated from the formula:

$$K_{ef} = m \cdot \alpha^2$$  \hspace{1cm} (1)

$$E = \frac{K_{ef} \cdot l^3}{3J}$$  \hspace{1cm} (2)

3 CONCLUSIONS

On the grounds of the vibration parameters the fitness of wood of the tested models can be classified for the application in the construction according to the listing: pine, spruce, larch, oak wood. The least reduction in the wood’s modulus of elasticity due to the moisture can be
adopted as a criterion of the wood fitness for a long-term operation in construction.

On the grounds of the dynamic testing of elements made out of dry and wet wood species, their physical properties can be forecast, thus their fitness for the application in construction.

The dynamic testing can be used for various objectives, including, for instance, to select the planks for the construction of a structure, especially building facilities of prestige. The planks of a higher damping should be rejected and those that show higher frequencies, a lower damping and a lower logarithmic damping decrement should be applied when a higher endurance of the structure is required.

REFERENCES