Development of mathematical model proposed for prediction of final deformation in bending of timber beams

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Summary

This study is devoted to the development of the mathematical model applicable for prediction of final deformation of timber beams at the end of service life. The model presented in a new edition is based on the known Burger body concept. This is continued study by authors and deals with defining the limitations of numerical values for model's constants representing the influencing factors mentioned above with purpose to assess the fitness for use of model in design. Numerical values of strain obtained by treatment of theoretical model proposed are compared with the corresponding estimates from experiments performed in longterm (approximately 1.5 years) static loading of softwood (European Redwood - Pinus Sylvestris) beams in a four point bending under natural environmental conditions at the Baltic Sea region. It has been proved that the model proposed may be acknowledged as appropriate for prediction of deformations in static bending.

Keywords: DOL, creep, bending, timber beams, mathematical model, softwood lumber.

1. Introduction

The creep process leads to a time-dependent increase of deformation of structural elements that can cause inadmissible deformations and may lead to serious damages of construction. The importance of an accurate prediction of the magnitude of final deformation in the proposed adverse conditions under service loads relates to elements for which the criteria of serviceability limit state is decisive in design, i.e.., beam type elements loaded in transversal direction mainly. Time- dependent behaviour of natural wood material presents some part of uncertainty in the design of timber structures, regarding deformations in particular. In contradistinction to other materials, problems of modelling the load duration (DOL) effects of timber elements in bending for design purposes relates to very complicated physically mechanical time-dependent behaviour of wood influenced by a wide range of factors,- density and stiffness modulus of material, stress rate and loading regime, duration of load, moisture content of wood and its changes, span-depth ratio of a beam, temperature and its changes, macro- and microstructure of wood. More over almost each of influencing factors possesses particular variation of numerical values.

There are a lot of serious investigations devoted to load duration effects carried out by researchers, nevertheless an establishment of plain mathematical model applicable for design purposes requires more extensive research works.

The aim of the current study is to reveal the more significant factors affecting bending creep and to compile and affirm the mathematical model usable for predicting final deformation after loading cycles during service life. The creep model examined in this study has been developed on the base of Burger body composed by Kelvin Voigt cells correspondingly to loading cycles. The experimental deformation values from long-term test are compared with the modelled values obtained using the proposed mathematical model.

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