SOME ASPECT OF NONLINEAR ANALYSIS OF TIMBER-FIBRE CONCRETE COMPOSITE

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Abstract

Accuracy of the numerical analysis of the timber – fibre reinforced concrete composite structures fully depends on material models used in the analysis. Therefore the implemented material models were verified on the basis of experimental results and they were used for non-linear analysis of combined timber-fibre reinforced structure after successful verification of validity.

Keywords: fibre reinforced concrete, timber, combined structures, non-linear numerical analysis

Introduction

Analysis of behaviour of structural element or structural system in nonlinear analysis can partly replace expensive experiments and become a virtual testing laboratory. The condition is implementation of material models accurately simulating real properties and simplifying assumptions that do not negatively affect results of numerical simulation with respect to the real structural behaviour.

Nonlinear analysis of timber-fibre concrete structure

The response of timber – fibre reinforced concrete combined structure is nonlinear after a certain level of loading is reached. The reasons are in physical character of the interconnection, behaviour of FRC and viscous-plastic behaviour of timber. In terms of long-term behaviour of the timber – FRC structures nonlinear effects as decrease of the timber strength in time and creep and volumetric changes of concrete play an important role. Implementation of all these nonlinearities in the complex model of the structural model or system without verification and confirmation of their plausibility in simple models can result in non-realistic simulation of the real structural behaviour.

Modelling of the interconnection

The material model of the contact is modified to reflect the decrease of the stiffness with increase of load. This can be done using the function of softening or hardening of cohesion. In this case the function of cohesion hardening with initial cohesion \( c_0 = 0.5 \) MPa

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was chosen. The approximation of the experiment can be considered excellent despite the small differences of the stiffness in the lower part of load – deflection diagram. The material model was used in numerical analysis of behaviour of the combined beam.

**Material model of fibre reinforced concrete**

Verification of derived constitutive relations of fibre reinforced concretes was performed in numerical simulation of a four-point bending test in programs ANSYS and ATENA. Details and results of analyses – see [3], [4]. The derived and verified material model of FRC was be used for the simulation of combined beam behaviour.

**Analysis of the combined girder**

Material models of the contact and fibre reinforced concrete were applied in the numerical model of combined timber – FRC T-section. The spanning of the beam was 6.5 m. The dimensions of the timber section were 0.14 x 0.24 m, depth of the FRC slab was 0.06 m and the width 0.94 m. The wood was assumed as linear elastic material.

**Conclusions**

The accurate analysis of behaviour of combined structural systems until the failure is possible only if nonlinear behaviour of material and interconnection are considered. Modelling of the interconnection using suitable material parameters of the smeared contact of the timber beam and FRC component is an acceptable alternative to discrete modelling of particular connecting elements. Verification of implemented material models by numerical analysis of experiments shall be an integral part of the nonlinear analysis of the structural system as it increases probability of correct simulation of the combined structure behaviour.

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**References**


