Finite element modelling of moisture related and visco-elastic deformations in inhomogeneous timber beams

Wood is a hygro-mechanical, non-isotropic and inhomogeneous material concerning both modulus of elasticity (MOE) and shrinkage properties. In stress calculations associated with ordinary timber design, these matters are often not dealt with properly. The main reason for this is that stress distributions in inhomogeneous glued laminated members (glulam) and in composite beams exposed to combined mechanical action and variable climate conditions are extremely difficult to predict by hand. Several experimental studies of Norway spruce have shown that the longitudinal modulus of elasticity and the longitudinal shrinkage coefficient vary considerably from pith to bark. The question is how much these variations affect the stress distribution in wooden structures exposed to variable moisture climate. The paper presents a finite element implementation of a beam element with the aim of studying how wooden composites behave during both mechanical and environmental load action. The beam element is exposed to both axial and lateral deformation. The material model employed concerns the elastic, shrinkage, mechano-sorption and visco-elastic behaviour of the wood material. It is used here to simulate the behaviour of several simply-supported and continuous composite beams subjected to both mechanical and environmental loading to illustrate the advantages this can provide. The results indicate clearly both the inhomogeneity of the material and the variable moisture action occurring to have had a significant effect on the stress distribution within the cross-section of the products that were studied.