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Full field image correlation at micro-scale to investigate transverse meso-scale heterogeneity of mechanical behaviour of softwood

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ABSTRACT

In transverse plane, softwood has a very anisotropic behaviour at macro scale: radial and tangential young moduli are quite different and shear modulus is very low. At meso scale, that's to say at the scale of annual rings, softwood is moreover heterogeneous: early wood is softer than late wood but the ratio between extreme stiffness differs for tangential, radial and shear modulus. Some experiments have been carried out to explain this complex behaviour thanks to the microscopic structure of spruce, i.e. thanks to the shape and dimensions of cells.

The experiments consist in different mechanical tests filmed in an ESEM. They show how cell walls move under stress. Image correlation allows quantifying full fields of displacements. It is also possible to calculate local strain and local moduli for some well chosen tests. Models and calculus then show that cell walls can't be considered as an isotropic elastic material with a homogeneous Young modulus all other the annual ring width. This model would lead to a difference of stiffness between early and late wood far greater than what tests reveal.

This work aims at choosing a simple model at micro scale based on cell dimensions and able to give realistic stiffness repartitions at meso scale for radial tangential and shear loads. Of course homogenisation also has to give correct mean moduli at macro scale.