Abstract of Ph.D. Thesis

"Crack growth initiation and propagation due to a closing pore in a natural quasi-brittle orthotropic solid"

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Abstract

This thesis discusses the mechanics of crack formation, the initiation of its growth and eventual propagation leading to fracture due to a closing pore in pine wood (*Pinus radiata*). A closing pore situation begins with the compression of a specimen with an open pore which gradually closes by pore surfaces coming into contact. Thereafter, cracks form near the pore which grows and eventually fracture the specimen. The combined action of contact and fracture mechanics due to a closing pore is the first novelty addressed in this thesis using experiments and FEM simulations.

The simulations of closing pore situation in wood requires the determination of elastic and fracture properties of wood. This is extremely more challenging compared to synthetic materials due to natural occurrence, quasi-brittle nature and macroscopic orthotropy of wood. Experiments have been conducted on wood samples to determine it's elastic properties in tension, shear and compression. Thereafter, fracture properties like critical energy release rate and traction-separation relations have been experimentally determined for mode I and II using multi-specimen approach. The use of multi-specimen approach for calculating the fracture toughness of wood is the second novelty of this work.

Thereafter, experiments are conducted for wood samples containing central pores along the grain direction. The pore/grain orientation and surface roughness between pore surfaces are two parameters which are studied using overall mechanical response. Finally, FEM simulations are conducted for closing pore situation in pine wood by incorporating its elastic and fracture properties. Several observations from experiments are reproducible using these simulations under the constraint of linear elasticity.

The findings of this thesis can be extended to other naturally occurring quasi-brittle orthotropic solids like bone.