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Computational micromechanical analysis of the influence of moisture, density and microstructure of latewood on its hydroelastic and shrinkage properties is carried out. The elastic properties of cell sublayers have been determined using the unit cell models as for fiber reinforced composites (two covered cylinders representative volume element, for S1, S2 and S3 sublayers) and rectangular embedded unit cells (for isotropic M and P sublayers). 3D hierarchical finite element models of softwood cells as a hexagon-shape-tube with multilayered walls were generated using parametric techniques. The results for elastic properties of cell sublayers obtained from the unit cell models, from the self-consistent method and Halpin-Tsai equations are compared, and good agreement between these methods was observed. A computational technique, based on the representation of moisture effect as equivalent temperature-caused effects, has been developed and employed to the modeling of the moisture-related changes of the elastic properties of cell layers. A series of computational experiments have been carried out. In the simulations, it was observed that the shrinkage coefficients of longitudinal direction increase with increasing MFAs in layer S2, while the reverse is true in the transverse plane. The shrinkage coefficients of wood depend strongly on the shape of the hexagon-shaped cells. Wood density has a strong effect on both the Young’s modulus and the transverse Young’s modulus.

General information
Publication status: Published
Organisations: Composites and Materials Mechanics, Materials Research Division, Risø National Laboratory for Sustainable Energy
Contributors: Qing, H., Mishnaevsky, L.
Pages: 310-320
Publication date: 2009
Peer-reviewed: Yes

Publication information
Journal: Computational Materials Science
Volume: 46
Issue number: 2
ISSN (Print): 0927-0256
Ratings:
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 0.993 SNIP 1.32
Web of Science (2009): Indexed yes
Original language: English
Keywords: Materials research, Light strong materials for wind turbines and for transportation
DOIs:
10.1016/j.commatsci.2009.03.008
Source: orbit
Source-ID: 248664
Research output: Contribution to journal › Journal article – Annual report year: 2009 › Research › peer-review