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Fabric based strength criterion and its application on a layered snowpack

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An existing orthotropic elasto-plastic model, which takes the microstructure fabric of trabecular bone into consideration, is extended for snow and used to study the stress response in a layered snowpack. The mean intercept length, determined from X-ray tomography, represents the microstructure fabric in the macroscopic constitutive law. The yield surface for snow accounts for strength asymmetry of snow in tension and compression and shows isotropic hardening till ultimate strength is reached and then softens till complete failure. Tomographic image dataset of various snow types in conjunction with 3D μ- FE analysis of these snow types was used to evaluate the elastic and failure criteria constants in the model. The macroscopic law is implemented as a user subroutine FE code to predict the stress-strain response of snow samples and shows good agreement with the μ-FE based data.

The stress-strain law is used to study stresses in a snowpack of length 5m and thickness between 0.11 to 0.81m with a strong layer of round grain and a weak layer of faceted grains. A plane strain finite element analysis is performed. The density of the strong and weak layers is approximately 210kg/m^3, and 118kg/m^3, respectively. The snowpack was subjected to gravity, and a skier loads (80kg) and stresses were investigated for slope angles of 0^o, 30^o, and 90^o. The variation of compressive stress normal to slope and shear stress along the snowpack's length for different thicknesses of the strong layer is computed. The maximum normal compressive stress and shear stresses are observed at the centre of the weak layer. The normal compressive stress pattern obtained is in agreement with the previous studies.