Continuum Damage Micromechanics Model for the Compressive Failure of Flax Fiber Composites and Experimental Validation

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We develop a thermodynamically consistent continuum damage micromechanics model for the compressive failure of flax fiber composites. We used a micromechanics-based constitutive model reported recently [1]. It describes the microstructure of a unidirectional composite and captures the material behavior of the fiber and matrix constituents, respectively. The description has been formulated in the reference configuration (i.e. the undeformed state of the composite) and is therefore independent of fiber rotations that may appear during the deformation of the composite. A hyperelastic finite deformation plasticity with power law hardening [3] mimics the compressive elastic-plastic stress-strain response of the fiber (reported in [2]) and the matrix. The model has been extended to account for fiber damage, resulting in a thermodynamically consistent continuum damage micromechanics model. Our results indicate that fiber damage plays an utmost role in the compressive failure of flax fiber composites – it is a major determinant of the material's compressive stress-strain response. X-ray Computed Tomography and Scanning Electron Microscopy show that fiber damage can be attributed to intra-fiber splitting and elementary fiber crushing.

References

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