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Mikkelsen, Lars Pilgaard

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Lars P. Mikkelsen

Composite and Materials Mechanics, DTU Wind Energy Technical University of Denmark

The compression strength of uni-directional composite materials is mainly governed by the fiber-misalignment and the plasticity of the matrix material [1]. Therefore, in order to improve the compression behavior of uni-directional composite materials, a focus on those terms is necessary. In the present work, the influence of the mechanical properties of the matrix material on the compression strength is studied by changing the temperature during mechanical testing and thereby making it possible changing the matrix properties keeping all other properties in the experimental setup constant. It is demonstrated how going from the more ductile high temperature case to the brittle low temperature case will increase the compression strength significantly with more than 30%. This behavior are validated experimentally as well as numerically using a non-linear smeared out composite material law [2] implemented in the commercial finite element code Abaqus [3]. In addition, in a supplementary study, taken into account the length scale effect of the yielding behavior using a strain gradient dependent plasticity law [4] implemented as a user element [5], it is possible investigating the scale effect on the yielding behavior sub-micron small region between the fibers in a conventional composite material. During this, the effect of higher order boundary condition suppressing the plastic deformation at the fiber/matrix interfaces is analyzed. It is demonstrated that taken such effects into account significantly enhanced the stresses level during shear deformation. Shear deformation governing the compressive failure mechanism in uni-directional composite materials.

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