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Abstract: Two important failure modes in fiber reinforced composite materials in cluding layers and laminates occur under loading conditions dominated by compression in the layer direction. These two distinctly different failure modes are 1. buckling driven delamination and 2. failure by strain localization into kink bands.

The thesis falls into two parts dealing with the two failure modes. In the first part of the thesis the effects of system geometry on buckling driven delamination is investigated. Here attention is directed towards double-curved substrates, which introduces a new non-dimensional combination of geometric parameters. It is shown for a wide range of parameters that by choosing the two nondimensional parameters suitably, one of them plays a very insignificant role on the fracture mechanical parameters such as normalized energy release rate and mode mixity, which has obvious impact on the presentation of the results. In some cases, the local curvatures of the system is so high compared to the extent of the delamination that it may be better modeled as a sharp corner. One effect of the substrate corner is a decreased range of parameters for which the interface crack remains open and as a consequence a study of the effects of crack closure has been carried out.

The other part of the thesis analyzes a constitutive model developed to study kink band formation has been implemented into the finite element code ABAQUS. The analysis focuses on the performance of ABAQUS in terms of reliability and rate of convergence. The constitutive model has no intrinsic length scale for which reason the width of the band is mesh dependent. This has some impact on the convergence rate for decreasing mesh size in the load vs. end shortening response for a rectangular block of material. Especially in the immediate post critical range the convergence rate may be slow. The capabilities of the model to deal with more complicated structural and geometrical effects are demonstrated.

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