Non-local multiscale analyzes of composite laminates based on a damage-enhanced mean–field homogenization formulation

L. Wu, L. Noels, L. Adam, I. Doghri

Université de Liège CM3, B-4000 Liège, Belgium
e-Xstream Engineering, Rue du Bosquet, 7, 1348 Louvain-la-Neuve, Belgium
Université Catholique de Louvain, Bˆatiment Euler, 1348 Louvain-la-Neuve, Belgium

Properties of carbon fiber reinforced epoxy laminates are studied using an anisotropic gradient–enhanced continuum damage model embedded in a mean–field homogenization (MFH) procedure. The fibers are assumed to remain elastic, and the matrix material obeys an elasto–plastic behavior enhanced by the proposed damage model.

The resulting multi– scale model is then applied to study the damage process at the meso–scale of laminates, and in particular the damaging of plies in a composite stack. By using the gradient–enhanced continuum damage model, the problem of losing uniqueness and strain localization, which happens in classical finite element simulations when strain softening of materials is involved, is avoided.

As a demonstration a stack with a hole is studied and it is shown that the model predicts the damaging process in bands oriented with the fiber directions, accordingly to the conducted experimental results.