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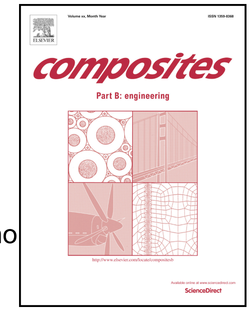

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NONLINEAR COMPRESSIVE FAILURE ANALYSIS OF BIAXIALLY LOADED FIBER REINFORCED MATERIALS

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ABSTRACT

The compressive failure behavior of defected periodic fiber-reinforced composites subjected to macroscopic biaxial loadings is here analyzed from both the theoretical and numerical point of view. The coupled effects of local fiber buckling and matrix or fiber/matrix interface microcracks under unilateral self-contact are included in the analysis by adopting an original full finite deformation approach. The obtained uniqueness and stability conditions associated with a continuum rate formulation of the microscopic equilibrium problem, contain unusual nonlinear contributions arising from crack interface self-contact mechanisms whose significance for an accurate evaluation of macroscopic critical loads at the onset of instability and bifurcation is then investigated in an innovative way. To this end by using a nonlinear FE model and analytical developments, the composite failure domains are determined for radial macroscopic loading paths, ranging from biaxial compression to combined axial compression and lateral expansion, and for different microgeometrical parameters. Comparisons with stability and uniqueness domains obtained when simplified crack contact interface approaches are adopted, show the notable role of the above mentioned crack interface contributions for a realistic prediction of the real failure behavior of the composite solid.

KEYWORDS: *Fiber-reinforced composite; Microcracked material; Nonlinear homogenization*; *Macroscopic failure load; Crack contact mechanisms*

1. Introduction

In the last decade, fiber or particle reinforced composite materials are considered as the most promising materials to be used in many advanced engineering applications [1–4]. Specifically