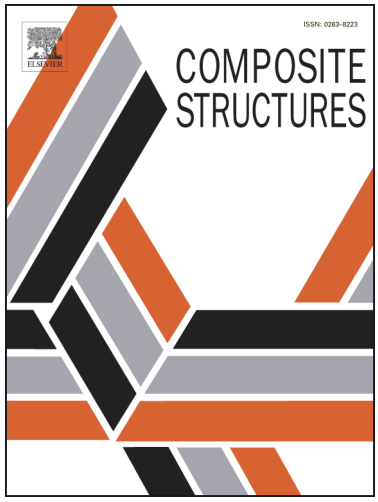

Nonlinear effects in fracture induced failure of compressively loaded fiber reinforced composites

Fabrizio Greco, Paolo Lonetti, Raimondo Luciano, Paolo Nevone Blasi, Andrea Pranno

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NONLINEAR EFFECTS IN FRACTURE INDUCED FAILURE OF COMPRESSIVELY LOADED FIBER REINFORCED COMPOSITES

FABRIZIO GRECO[(1)], PAOLO LONETTI[(1)], RAIMONDO LUCIANO[(2)], PAOLO NEVONE BLASI[(1)], ANDREA PRANNO [(1)],

[(1)] Department of Structural Engineering, University of Calabria, Cosenza, Italy

[(2)] Department of Civil and Mechanical Engineering, University of Cassino and Southern Lazio, Italy

ABSTRACT

The present paper deals with the macroscopic compressive failure of periodic elastic fiber reinforced composites related to local buckling instabilities promoted by matrix or fiber/matrix micro-cracks under unilateral self-contact. The theoretical modeling of instability and bifurcation phenomena for a microcracked composite material is firstly examined by considering a continuum homogenization approach and a rate formulation. The effects of non-standard rate contributions owing to the full finite deformation formulation adopted to model crack self-contact and depending on both the contact pressure and the deformation gradient rate are highlighted, by determining their influence on macroscopic critical loads at the onset of instability and bifurcation and on corresponding deformation modes. Numerical applications carried out by means of a coupled FE approach are provided with reference to macroscopic uniaxial loading paths and a comprehensive parametric analysis with respect to the main microstructural geometrical parameters governing the failure behavior of the composite solid is carried out. The results show the notable influence of the above non-standard contributions on both critical loads and deformation modes: if they are not included in the analysis as in simplified crack contact interface formulations, a large underestimation of the real failure load of the microcracked composite is obtained.

KEYWORDS: *Fiber-reinforced composite; Finite strain homogenization*; *Self-contact mechanics; Matrix crack; Interface crack; Buckling instability*

Nomenclature

$\boldsymbol{T}$	Cauchy stress tensor
C_e	Crack eccentricity
J'	Determinant of the 2D deformation gradient tensor
$\boldsymbol{u}_{\Gamma_{c(i)}}$	Displacement jump at the deformed crack contact interface at a contact point pair