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Junbo Xie, Guodong Fang, Zhen Chen, Jun Liang

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An anisotropic elastoplastic damage constitutive model for 3D needled C/C-SiC composites

Junbo XIE, Guodong FANG[1], Zhen CHEN, Jun LIANG

Science and Technology on Advanced Composites in Special Environments Key Laboratory, Harbin Institute of Technology, Harbin, 150001, PR China

Abstract:

This paper established a combined elastoplastic damage model to analyze the nonlinear mechanical behavior of 3D needled C/C-SiC composites. Inelastic deformation and stiffness degradation of the composite were characterized by the plasticity and damage theories. An innovative plastic potential function containing variable parameters was proposed to consider particularly the anisotropy of plastic deformation in each material direction. Based on the Weibull statistical distribution of the material strength, an exponential damage state function was established to characterize stiffness degradation for the composite in each material direction. Parameters of this constitutive model were determined from experiments data. It can be found that the nonlinear stress-strain curves for the composite under off-axis tensile and shear loadings can be accurately described by the model. The yield and damage surfaces of the composite were also studied. Finally, the constitutive model was validated by analyzing the mechanical behavior of a composite plate containing a center-hole subjected to tensile load.

Keywords: Needled C/C-SiC composite; Constitutive model; Plastic potential function; Damage variable

1. Introduction

3D needling (or needle-punching) technology can efficiently produce the carbon fiber preforms with low manufacturing costs [1-3]. The current 3D needling technologies for manufacturing advanced composite preforms are reviewed in [4]. The needled carbon fiber preforms can be used to manufacture the C/C and C/C-SiC

[1] Corresponding author. Address: Science and Technology on Advanced Composites in Special Environments Laboratory, Harbin Institute of Technology, Building A Science Park of HIT, No.2 Yi-Kuang Street, Nan-Gang District, Harbin, 150001, PR China. Tel./fax:+86 45186412613

E-mail address: fanggd@hit.edu.cn