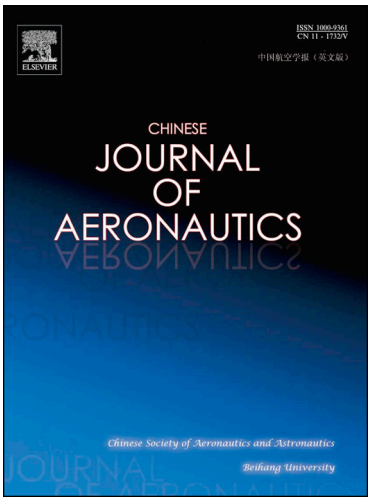
Accepted Manuscript



Compressive failure analysis of unidirectional carbon/epoxy composite based on micro-mechanical models

Wei Sun, Zhidong Guan, Zengshan Li, Mi Zhang, Yongjie Huang

PII: S1000-9361(17)30224-8
DOI: https://doi.org/10.1016/j.cja.2017.10.002
Reference: CJA 919

To appear in: *Chinese Journal of Aeronautics*

Received Date: 24 November 2016
Revised Date: 24 February 2017
Accepted Date: 1 August 2017

Please cite this article as: W. Sun, Z. Guan, Z. Li, M. Zhang, Y. Huang, Compressive failure analysis of unidirectional carbon/epoxy composite based on micro-mechanical models, *Chinese Journal of Aeronautics* (2017), doi: https://doi.org/10.1016/j.cja.2017.10.002

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

Compressive failure analysis of unidirectional carbon/epoxy composite based on micro-mechanical models

Wei SUN, Zhidong GUAN, Zengshan LI*, Mi ZHANG, Yongjie HUANG

School of Aeronautic Science and Engineering, Beihang University, Beijing 100083, China

Received 24 November 2016; revised 24 February 2017; accepted 1 August 2017

Abstract

A 2D micro-mechanical model was proposed to study the compressive failure of UniDirectional (UD) carbon/epoxy composite. Considering the initial imperfection and strength distribution of the fiber, the plasticity and ductile damage of the matrix, the failure of T300/914 UD composite under longitudinal compression and in-plane combined loads was simulated by this model. Simulation results show that the longitudinal compressive failure of the UD composite is caused by the plastic yielding of the matrix in kink band, and the fiber initial imperfection is the main reason for it. Under in-plane combined loads, the stress state of the matrix in kink band is changed, which affects the longitudinal compressive failure modes and strength of UD composite. The failure envelope of σ_1 - τ_{12} and σ_1 - σ_2 are obtained by the micro-mechanical model. Meanwhile, the compressive failure mechanism of the UD composite is analyzed. Numerical results agree well with the experimental data, which verifies the validity of the micro-mechanical model.

Keywords: micro-mechanical model; unidirectional composite; initial imperfection; matrix plasticity; ductile damage; kink band

1. Introduction

Composites are widely used in aerospace engineering industry because of their advantages, e.g. light weight, high strength and excellent fatigue resistance. With the demand of lightening weight for the structures in aerospace engineering, the amount of the composite materials used in commercial airliners reaches more than 50% of the total weight. Accordingly, more and more primary structures made of metal are being replaced by composite structures. However, the longitudinal compressive strength of the UniDirectional (UD) composite is only 50%-60% of its tensile strength, which is a significant problem for engineering applications of composite materials. Therefore, the methods for forecasting the compressive strength of the UD composites need to be investigated by researchers and engineers.

Compressive failure of UD composites has been studied by a large number of scholars. The compression micro-buckling of the fiber was proposed by Rose [1] firstly and then the initial imperfection of the fiber [2-3] was found to be an important factor of compressive strength in further study. Generally, the fiber initial imperfection can be caused by various factors. The micro-buckling of a single fiber during the curving process of the matrix was observed by Jochum and Grandidier [4]. Through a series of experimental studies, Effendi et al. [5] found that kink band is the main compressive failure mode of UD carbon/epoxy composites. The compressive failure mode of composite was observed in the experiment, and typical geometry features of kink band include band width w, band angle β and fiber angle α, as shown in Fig. 1(a).[6] However, the typical kink band failure mode is difficult to be observed in the compression experiment of the UD composite. The catastrophic fracture of the CCF300/5228A UD composite is shown in Fig.1(b).[7] The failure mode of

Download English Version:

https://daneshyari.com/en/article/7153863

Download Persian Version:

https://daneshyari.com/article/7153863

Daneshyari.com