

Accepted Manuscript

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Anton Shipsha, Magnus Burman, Johan Ekh



PII: S1359-8368(17)34437-2

DOI: [10.1016/j.compositesb.2018.06.022](https://doi.org/10.1016/j.compositesb.2018.06.022)

Reference: JCOMB 5752

To appear in: *Composites Part B*

Received Date: 24 December 2017

Revised Date: 4 May 2018

Accepted Date: 16 June 2018

Please cite this article as: Shipsha A, Burman M, Ekh J, Failure of cross-ply NCF composites under off-axis compressive loads - An experimental study and a new strength prediction model including fibre bundle waviness, *Composites Part B* (2018), doi: 10.1016/j.compositesb.2018.06.022.

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Failure of cross-ply NCF composites under off-axis compressive loads - an experimental study and a new strength prediction model including fibre bundle waviness

Anton Shipsha^{a,*}, Magnus Burman^a, Johan Ekh^b

^aDepartment of Aeronautical and Vehicle Engineering, KTH Royal Institute of Technology, Teknikringen 8, SE-100 44 Stockholm, Sweden

^bDepartment of Technology Consulting/Applied Mechanics, ABB AB Corporate Research, Forskargränd 7, SE-72178, Västerås, Sweden

Abstract

The design of reliable and efficient mechanical joints with non-crimp fabric (NCF) composites depends on several factors but knowledge on actual loading direction and an accurate compressive strength prediction is essential. Motivated by this, the current study is focused on the compressive strength of cross-ply NCF composites and the influence of fibre orientation in relation to the loading direction. Possible influence of stacking sequence on the compressive strength is also studied. Compression tests of cross-ply NCF composite laminates that are loaded at various off-axis angles are performed and the failure mechanisms are identified. An analytical semi-laminar based model for strength prediction of NCF composite laminates loaded in compression is then suggested. The models take in- and out-of-plane bundle waviness into account. Good agreement between the proposed model and the experiments is observed.

Keywords: A. Fabrics/textiles, B. Strength, C. Analytical modelling, D. Mechanical testing

2010 MSC: 00-01, 99-00

1. Introduction

Non-crimp fabrics, NCFs, are dry textile preforms with one or several layers of oriented fibre tows. The layered tows are stitched together with a thin yarn. NCF preforms are commonly found in combinations of 0° , 90° and $\pm 45^\circ$ oriented plies and with areal weights ranging from below $100\text{g}/\text{m}^2$ to over $1000\text{g}/\text{m}^2$.

NCF composites are heterogeneous on several scales as can be observed in Fig. 1. On micro- and macro-levels the NCF composites could be said to be similar to UD prepregs, i.e. straight and

*Corresponding author

Email address: shipsha@kth.se (Anton Shipsha)

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