Mechanics of Nano, Micro and Macro Composite Structures
Politecnico di Torino, 18-20 June 2012

A. J. M. Ferreira, E. Carrera (Editors)
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1D COMPONENT-WISE MODELS FOR FAILURE ANALYSIS OF COMPOSITES

Erasmo Carrera, Marianna Maiarù and Marco Petrolo

Politecnico di Torino
Department of Aeronautics and Space Engineering
Corso Duca degli Abruzzi, 24
10129, Torino, Italy

e-mail: marianna.maiaru@polito.it, web page: http://www.mul2.com

Key words: Composites, 1D Refined Models, Failure Analysis, Unified Formulation

ABSTRACT

Failure analyses of fibre-reinforced composite structures are presented in this paper. Composite structures are increasingly adopted in aerospace and many other industries due to their better specific properties if compared to traditional metallic materials. There are still numerous open issues related to composites, a better understanding of their failure mechanism is one of the most important and challenging.
To properly understand failure of composites, different scales must be considered; so called 'global-local' [1] and 'multi-scale' approaches [2][3] have been recently introduced for this purpose. The main drawback of many multi-scale approaches proposed in literature is the large amount of degrees of freedom (DOFs) required. This paper represents an effort aimed to the development of less cumbersome models for the failure analysis of composites. A Component-Wise approach (CW) [4][5] is herein proposed. In a CW model, structural models can be built introducing components at different scales (entire laminates, laminae and components like fibre and their relative share of matrix), each component is modelled by means of the same 1D CUF element, This capability allows one to obtain a detailed description of the stress field with reduced computational costs. The CW approach is embedded in the framework of the Carrera Unified Formulation, CUF, for higher-order one-dimensional (1D) models [6] with arbitrary expansion orders. Taylor- (TE) and Lagrange-like expansions (LE) are herein exploited. In this paper, different failure criteria [7][8] are evaluated by exploiting strain/stress fields retrieved from 1D CW models. Failure can be evaluated at the fibre-matrix level or for homogenized plies.

A double fibre/matrix cell is herein considered as numerical example. 1D structural models were adopted to model this structure. Figure 1 (a) shows the fibre/matrix unit cell elements distribution using L9 and L6 elements. Figure 1 (b) shows the Failure Index corresponding to the Maximum Stress Criterion above the clamped cross-section.

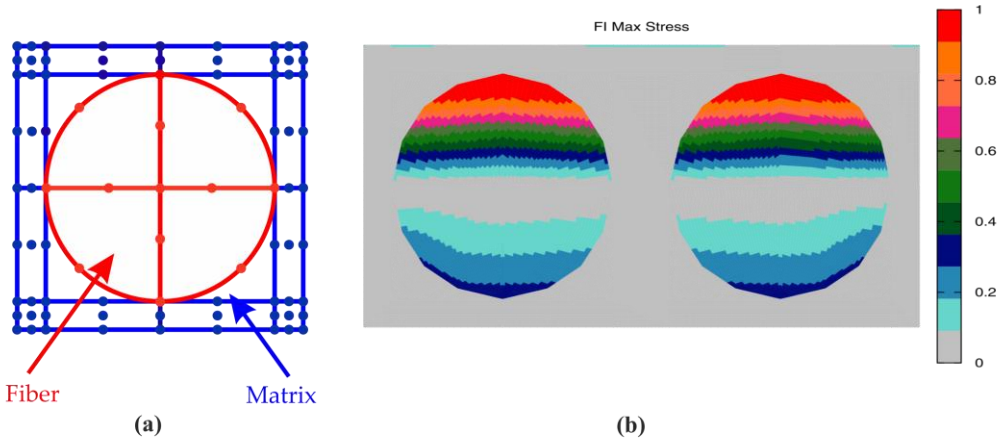

Figure 1: (a) Fiber/Matrix Unit Cell (L9+L6 distribution) (b) Failure Index above a double cell cross-section, Maximum Stress Criterion

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