FAILURE ANALYSIS OF COMPOSITES BY A COMPONENT-WISE APPROACH

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Summary Failure of fiber reinforced composites is investigated in this paper. Analyzes were carried out by means of a component-wise approach based on refined 1D structural models. Laminae, fibers and matrices were separately modeled by using the same structural model, this permitted us to easily assemble multi-component composites with low computational costs. Results obtained are in excellent agreement with those from 3D finite elements.

An accurate failure analysis of composites requires the proper modeling of different scale components (e.g. laminae, fibers and matrices). Different analysis approaches have been recently proposed, such as '*global-local*' [1] and '*multi-scale*' [2, 3, 4] approaches. One of the most important open issues of many multi-scale approaches proposed in literature is the large amount of degrees of freedom (DOFs) required.
A novel, computationally less cumbersome modeling approach for failure analysis is presented in this paper. The method presented is based on a so-called component-wise approach (CW) [5]. In a CW model, structural models can be built introducing components at different scales (entire laminates, laminae and components like fibers and their relative share of matrix). It is important to underline that each component is modeled by means of the same 1D structural finite element. This capability allows one to obtain a detailed description of the stress field of composite structures with reduced computational costs. The CW approach is embedded in the framework of the Carrera Unified Formulation, CUF, for higher-order 1D structural models [6]. CUF models exploit different classes of polynomial expansions of the displacement field to build any-order refined models. Taylor- (TE) and Lagrange-like (LE) expansions were exploited in this work.
Failure of fiber reinforced structures was evaluated by means of different criteria [7, 8] in this paper. Homogenized laminae were coupled with fibers and matrices and different modeling approaches were evaluated as graphically shown in Fig. 1. A cantilevered laminated beam composed by a two fiber-matrix cell was considered as numerical example. Fibers

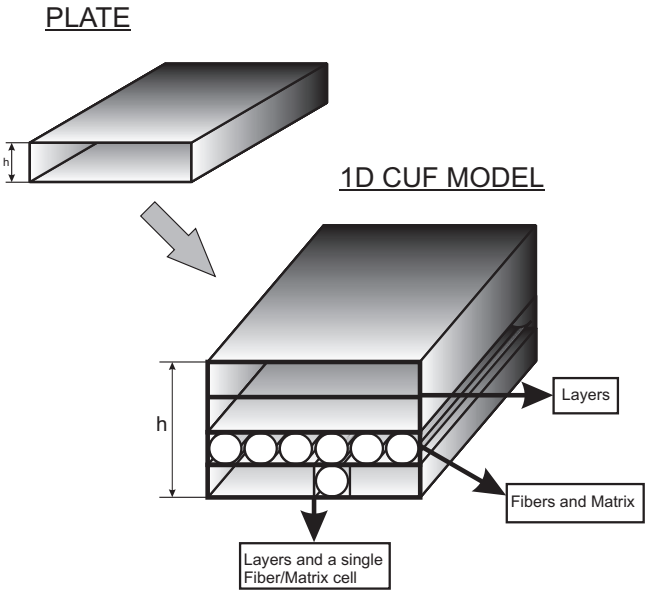

Figure 1. Component-Wise model of a laminated structure

and matrices were CW modeled via 1D structural models, the LE class was exploited. Fig. 2 shows the failure index (FI) distribution above one cross-section of the structure. The Maximum Stress criterion was considered. It can be observed how, in this case, FI is far higher above fibers than on matrix.

References

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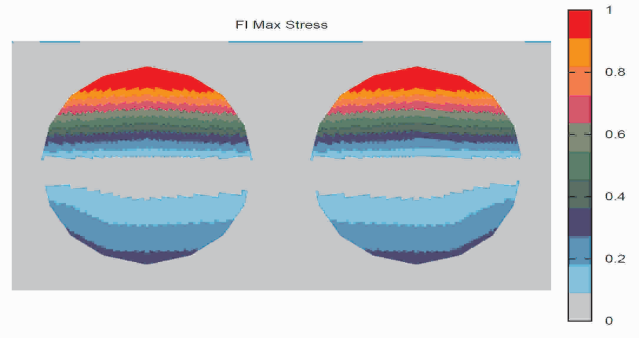

Figure 2. Failure index distribution above a two fiber-matrix cell

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