ON DETERMINATION OF PERIODIC UNIT CELL FOR PLAIN WEAVE FABRIC COMPOSITES: GEOMETRICAL MODELING OF REAL WORLD MATERIALS

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In this contribution, we present the final outcome of the program, initiated in [23], aimed at the determination of a periodic unit cell for plain weave composites with reinforcement imperfections. The emphasis is put on a realistic geometrical description of these material systems utilizing the information provided by in-situ two-dimensional micrographs. Complex geometry of an analyzed composite is approximated using a two-layer periodic unit cell allowing for a mutual shift as well as nesting of individual layers. The parameters of the idealized unit cell are derived via matching appropriate statistical descriptors related to the real material and the idealized geometrical model. Once the optimal geometry of the unit cell is determined, it can be converted to a CAD model and used to generate the periodic finite element mesh applicable in the subsequent numerical treatment. The individual steps of this procedure are demonstrated in detail for a real world carbon-carbon composite system.

Key words: *balanced woven composites, image processing techniques, random microstructure, quantification of microstructure morphology, periodic unit cell, CAD modeling*

1. Introduction

A rapid development in image analysis hardware in the last two decades opened a way for a substantial improvement of the modeling of mechanical response of complex material systems such as composites. Often used assumption about well-defined geometrical arrangement of reinforcements in the fiber/matrix composite aggregate fails when inspecting the high-resolution images of cross-sections of such systems on different length scales; see, e.g. [1, 18, 20, 21] and Fig. 1b). However, a natural choice of detailed numerical analysis of large material samples with the observed geometry has been found inadequate. First, a computer power is still lacking the efficiency required to solve such a complex task particularly when examining the response of materials beyond their elastic limits. Second, even large samples of real world microstructures may not reveal all microstructural details of the entire composite. Accepting a random nature of such systems thus becomes a necessity when searching for tools that would allow a reliable description of actual materials with disordered microstructures from both geometrical and mechanical points of view.

Exploiting geometrical statistics of real material systems in the formulation of representative volume elements (RVEs) used for numerical estimates of the true material response has

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