ASSESEMENT OF DIFFERENT MESO-MODELLING TECHNIQUES FOR 2D WOVEN COMPOSITES

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ABSTRACT

An increasing number of structural applications for textile composites requires reliable and efficient multi-scale design tools for the virtual material assessment and optimization. To determine the composite response on the macro-scale, an accurate model of the internal structure on the meso-level is required, as well as a scale-transition method. This work focuses on the meso-level structure and evaluates different modelling techniques to estimate the homogenised properties of the textile composites.

The representative volume element (RVE) of the composite can be either precisely defined using micro-CT analysis or can be constructed with a simplified idealised geometry based on averaged measurements. Both RVEs are constructed and computed homogenised properties are compared against available experimental data.

An idealised model containing one ply of a plain weave carbon/epoxy composite is constructed using WiseTex software [1]. The dimensions of the unit cell, diameters of yarns and the inter-yarn spacing in weft and warp directions are extracted from the material micrographs. A numerical homogenization is performed using the Simcenter™ VMC ToolKit (part

of Siemens PLM Software): a set of software tools developed for virtual material characterization [2]. The tool is used to obtain homogenised properties of the impregnated yarns on the micro-scale and subsequently link them to meso–level in order to compute the homogenised properties of plies. As a reference model, a high-fidelity 3D model is constructed based on µ-CT measurements. The reference model features realistic intra-yarn volume fractions, varying yarn cross-sections and the use of hyper-elliptical curves for the yarn heart-line to avoid yarn interpenetrations [3].

In both models, it is challenging to obtain a good quality mesh in the narrow matrix pockets which is consistent with the mesh of the yarns. A Mesh Superposition Method (MSP), also known as Embedded Element technique is a promising alternative to continuum mesh methods in meso-FE modelling of composite textiles. In the MSP model, yarns are embedded in the matrix mesh, using coupling equations between translation degrees of freedom of two meshes. The volume redundancy of embedded elements and yarn interpenetrations are eliminated during simulation as proposed in [4].

The homogenised stiffness properties, strain/stress fields and profiles are compared between the different continuous (or full) and MSP models.

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