PHASE-FIELD BASED DAMAGE MODELLING OF 3D-WOVEN COMPOSITES

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Composites with 3D-woven reinforcements have shown a number of promising characteristics. When it comes to through thickness properties, damage tolerance, and specific energy absorption, they can outperform their laminated counterparts. As the name suggests, 3D-woven composites interlace yarns in three mutually perpendicular directions, as shown in Fig. 1. The yarn architecture suppresses delamination and allows for stable and progressive damage growth in a quasi-ductile manner. With all of their benefits, 3D-woven composites are beginning to make their way into various applications, however efficient modelling techniques to predict their mechanical performance are required to further drive their use.

With the ultimate goal of developing a phenomenologically based macroscale model to predict how 3D-woven composites deform and eventually fail under mechanical loading, this work builds on past developments [1,2]. In particular in [2] the use of scalar damage variables proved to be a promising first step for capturing the progressive damage behaviour of the material. It is well known however that in a finite element (FE) model, using local damage variables to degrade the material stiffness after failure initiates, leads to mesh dependent results.

In order to circumvent this, some form of regularisation of the damage formulation is required. While this can be carried out in a number of different ways, one promising approach is the use of phase-field models [3]. Phase-field models have previously been used to model damage in laminated fibre-reinforced composites, in particular for intralaminar failure [4]. In the presented work the use of a phase-field approach to modelling the behaviour of 3D-woven composites is explored. The applicability of the model is assessed against results from mechanical experiments carried out under tensile, shear and off-axis tensile loading.

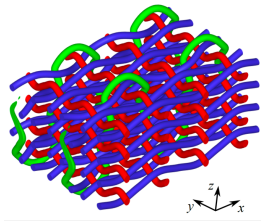

Figure 1. Sketch of the 3D-woven reinforcement

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