MESOSCALE MODELLING OF WOVEN COMPOSITE MATERIALS WITH MANUFACTURING DEFECTS USING MICRO-TOMOGRAPHY IMAGES.

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High speed manufacturing processes have increased the number of defects within composite parts. They can be reduced but not totally eliminated. These defects have a direct impact on the mechanical strength and performances of structures. In order to quantify the effect of defects on structural strength, a realistic description of the material geometry is necessary. In this work, the studied material is a thermoplastic matrix composite with woven carbon fiber reinforcement. The fast and automated handling of the parts during the industrial manufacturing process produces local disorientations of yarns. These defects are modelled at the mesoscopic scale, at which the reinforcement architecture is represented. Predictive numerical models of the material accounting for the presence of defects allow the estimation of their impact in comparison with pristine material. Common methods of generating representative elementary volume (REV) model of the material from computed tomography scans of the material (Figure 1a) require imaging at the micrometer scale [1] or a local topological description of the reinforcement [2]. In this work, a new automated segmentation procedure is presented using tomography scans of lower resolution (10 µm/voxel) to generate a REV model of the material with and without defects. This method relies on texture analysis of the tomography to differentiate the yarns orientations (Figure 1b). In order to generate the final mesh and identify the contact zones only the relative positioning of the yarn on the sides of the volume is used (Figure 1c). Finally, a smoothening algorithm is used on the voxelised mesh. The implementation of a finite element analysis of the failure mechanisms in the generated cell allows the validation of the approach through comparison of the results to experimental data.

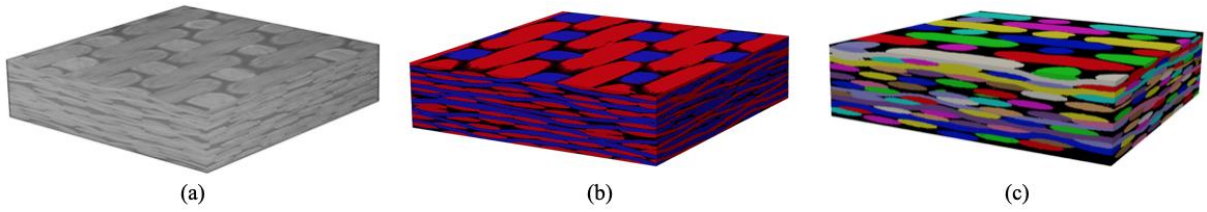

Figure 1. (a) µ-CT image, (b) Result of the yarn orientation segmentation, (c) Meshed REV

References

[1] V. Mazars, O. Caty, G. Couégnat, and al. (2017), Damage Investigation and Modeling of 3DWoven CeramicMatrix Composites from X-Ray Tomography in-Situ Tensile Tests, *ActaMaterialia*, **140**, 130–139

[2] J. Bénézech, G. Couégnat (2019) Variational segmentation of textile composite preforms from X-ray computed tomography, *Composite Structures*, **230**, 111496