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Mechanical modelling of reinforcement fabrics using a virtual fiber approach with hybrid elements

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We propose a new modeling strategy based on hybrid elements for virtual fiber modeling (also known as the digital element method) to predict both kinematics as well as mechanics of woven fabrics. We show that through the development of a modeling strategy based on hybrid elements, we are able to impose correct properties in the fiber direction as well as a correct bending stiffness. This approach is then used to model the through-thickness compression of a 2x2 twill woven glass fiber fabric (Fig. 1). Both kinematically, as well as mechanically, good agreement between experiment (micro-CT, pressure-vol% curves, …) and simulation is obtained. The key here was the implementation of a correct bending stiffness for the virtual fibers as through-thickness compression was governed by out-of-plane loads like bending of the yarns. Earlier methods based on elements without bending stiffness (e.g. [1]) were not capable of correctly dealing with these out-of-plane loads. Hence, this approach allows to predict the mechanical response of a (woven) fabric through a near-microscale modelling technique for which the experimental input can usually be found in the datasheet of the fibers/yarns. This opens up possibilities to faster prototyping, technical textiles as well as forming modelling for composites.

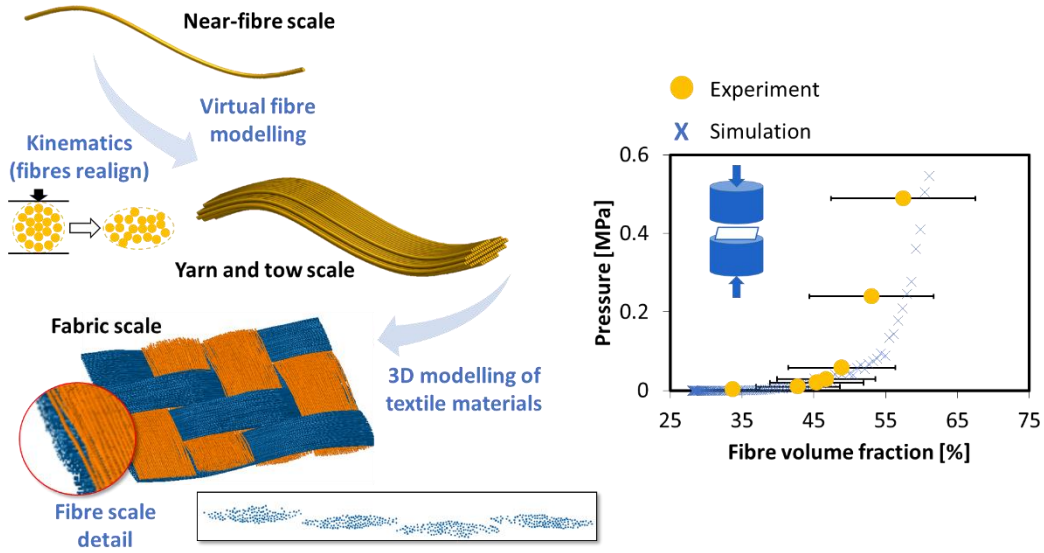

Figure 1 – Virtual fiber approach with hybrid elements for through-thickness compression modelling.

REFERENCES

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