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A NEW RVE GENERATION PROCEDURE FOR EXTENDED FINITE ELEMENT SIMULATIONS OF TEXTILE-REINFORCED COMPOSITES

Bernard Sonon[1], Badadjida Wintiba[1] and Thierry J. Massart[1]

[1] Building, Architecture & Town Planning CP 194/2, Université Libre de Bruxelles (ULB), Avenue F.D. Roosevelt 50, 1050 Brussels, Belgium, thmassar@ulb.ac.be, http://batir.ulb.ac.be

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This contribution presents a new framework for the computational homogenization of the mechanical properties of textile reinforced composites. A critical point in such computational procedures is the definition and discretization of realistic representative volume elements (RVEs) [1].

A geometrically-based weave generator is developed to produce realistic geometrical configurations of the reinforcing textile. This generator incorporates the contact conditions between the yarns in the reinforcement by means of an iterative scheme, taking into account the tension in the yarns in an implicit manner. To avoid interpenetration between the reinforcing yarns, the shape of the yarns cross sections can also be adapted as a function of the contact conditions using a level set-based post-processor [2].
The RVE generation is illustrated by means of different types of RVEs of increasing complexity. Starting from simple reinforcing schemes, RVEs containing high volume fractions of reinforcement were generated, including 3D reinforcements and illustrating the flattening effect obtained when introducing a clearance between yarns, see Figure 1a.

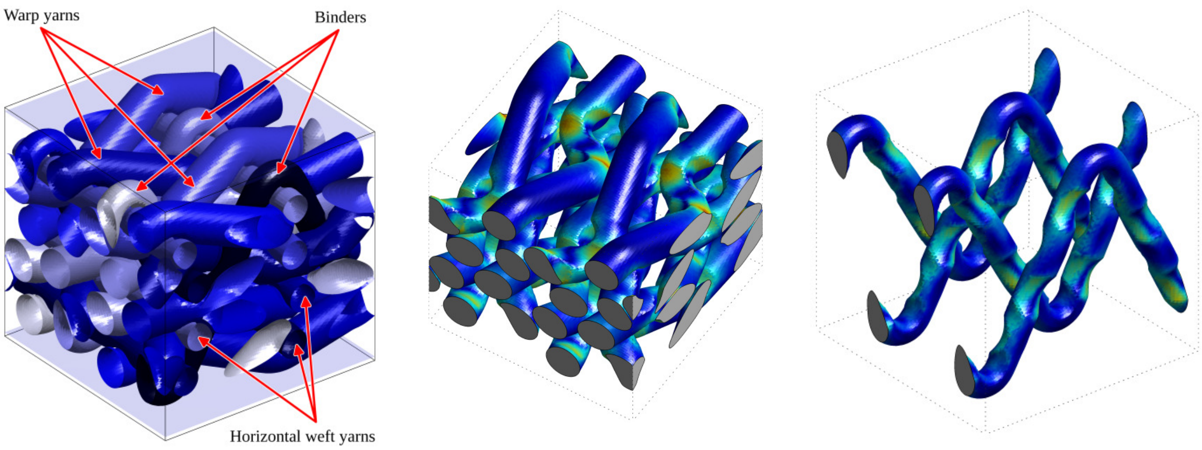

Figure: **(a)** 3D-reinforced RVE generated with level set post-processor, **(b)** Interfacial tangential stress level at the warp-matrix interface, **(c)** Interfacial tangential stress level at the thickness binders-matrix interface

The use of the a level set-based post-processor further allows a seamless transition towards an extended finite element scheme, in which the obtained reinforcement geometry is subsequently exploited to derive the mechanical properties of the composite system using computational homogenization. Extended finite element simulations can then performed as illustrated in Figures 1b and 1c for various reinforced composites in order to compare their homogenized elastic behavior and the corresponding local stress fields at the yarns-matrix interface.

The proposed methodology can be used in future developments to incorporate features of the yarns material behavior in the RVE generation procedure, as well as to account for yarns-matrix debonding in the extended finite element mechanical simulations.

REFERENCES

[1] F. Stig and S. Hallstrom, A modelling framework for composites containing 3D-reinforcement. *Composite Struct*., Vol. **94**, pp. 2895–2901, 2012.

[2] B. Sonon and T.J. Massart, A Level-Set based Representative Volume Element generator and XFEM simulations for textile and 3D-reinforced composites. *Materials*, Vol. **6(12)**, pp. 5568-5592, 2013.