TEXTILE-ELASTOMER COMPOSITES: IN-DEPTH COMPARISON OF EXPERIMENTAL RESULTS AND FIBER SCALE SIMULATIONS

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Abstract

Textile cords are widely used to reinforce elastomers. Their dimension and the complexity of their architecture, though, often limit to the macro-scale the information that can be extracted experimentally. Finite element analysis allows access to filament-scale quantities, revealing the mechanisms behind the filament's response, deeply linked to the architecture, when the composite is loaded.

Textile cords are constituted by many filaments which are entangled in a hierarchical organization and subjected to large deformations. All these reasons call for dedicated algorithms for an efficient solving. In this work, the in-house code *Multifil* (1) is used. Each filament is modeled with a 1D kinematically enriched finite strain beam model, frictional-contact interactions are modeled with ad-hoc strategies for efficient contact detections and an implicit solver is used to solve the global non-linear problem, under quasi-static assumptions.

The successive twistings of the cord are closely reproduced in numerical simulation, this is crucial to represent the complexity of the entanglement between filaments. The main steps of the numerical manufacturing are: *a)* Single ply twisting, fundamental to reproduce the migration phenomena (2) *b)* Two-ply cord twisting, to create a balanced cord *c)* Glueing process, to model the glue network on the outer contour of the cord *d)* Calendaring, coupling of the filaments with the composite matrix.

Once the composite sample has been numerically generated, it can be subjected to various loads to analyze the filament response. Particular attention is given to the dialogue between experiments and simulations. The latter being able to reproduce experimental results for standard testing (traction until rupture, compression, flexion response, etc.) and for peculiar phenomena (e.g. buckling instabilities), only observable at the micro-scale using x-ray tomography.

(1) D. Durville, *Contact-friction modeling within elastic beam assemblies : an application*

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to knot tightening, , Comput Mech, **49**, 2012, p. 687-707.
(2) W. E. Morton, K. C. Yen, *The arrangement of fibres in fibro yarns,* Journal of the Textile Institute Transactions, **43**, 1952, p. 60-66.