Homogenisation of linear pantographic sheets

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Abstract

This paper dealt with the mechanical behaviour of linear pantographic sheets which, in their natural configuration, are constituted by two orthogonal arrays of straight fibers interconnected by internal pivots. In the framework of small deformations, we deduce the equivalent continuous model by means of a micro-macro identification procedure based on the asymptotic homogenization method of discrete media. The rescaling of the mechanical properties and of the deformation measures is calibrated in order to complies with the specific kinematics imposed by the quasi-inextensibility of the fibers together with the large pantographic deformability. The obtained high order continuum model shows interesting and exotic features, related to its extreme anisotropy but also to the "sub-coercivity" of its deformation energy. Some first numerical simulations are presented, showing that the model can account for experimental uncommon phenomena occuring in pantographic sheets such as concentrations of deformations in narrow zones even under small deformations. The paper focuses on the precise analysis and the understanding of the effective behaviour based on a well-calibration of the extension and bending phenomena arising at the local scale. The analysis will be extended to oblique arrays, and to some analytical solutions to proposed equations. The applicability of the model to textile will be discussed in regards with the qualitative similarity of the deformation fields for specific tests.