Kinematical enrichment to high order: transversal compression of beams

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Textile yarns used in technical textiles are subject to large transverse deformations due to their weak transverse stiffness. In order to simulate the mechanical behaviour of 3D interlock fabrics at the scale of constitutive yarns, the beam model used to represent each yarn should have a kinematics of sufficient high order to reproduce these deformations.

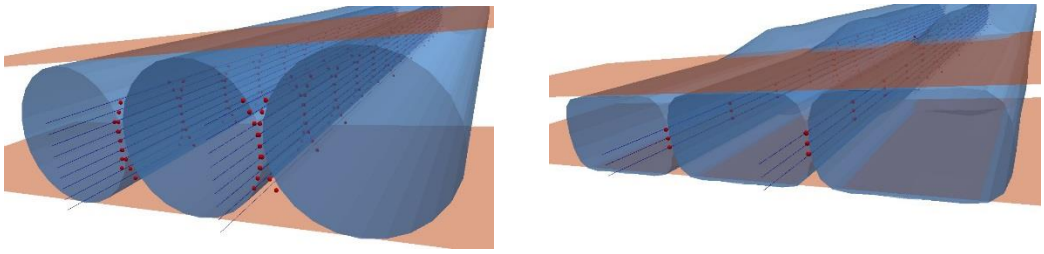
To address this requirement a beam kinematics based on a polynomial expansion with respect to transverse coordinates at any order is expressed in the following way:

$$u(\xi) = \sum_p^N \sum_q^p \xi_1^{p-q}\, \xi_2^q U^{p-q,q}(\xi_3) = \Pi_r U_r \quad (1)$$

The beam model is formulated within a finite strains framework and implemented in a finite element code with an implicit solver. The computation time of the numerical integration across beams cross-sections is optimized by means of pre-computed operators.

Because of the large deformations considered, contact between beams, and between beams and rigid planes, must be viewed as a surface phenomenon. To account for frictional contact interactions, a fictitious ribbon is created for each proximity zone between beams, and discrete contact elements linking two material particles on beam surfaces, are distributed according a given discretization on this ribbon.

Results of transversal compressions of beams induced by contact interactions will be presented for different orders of the beam kinematical model in order to determine an optimal value satisfying the trade-off between computational cost and accuracy.



beams before (left) and after (right) transversal compression, ribbon of contact (blue) and pairs of contact particles (red)

REFERENCES

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