Mixed isogeometric collocation method for non-prismatic planar Timoshenko-like beam models

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ABSTRACT

Non-prismatic beams are used in several engineering fields since they allow to optimize the geometry and significantly increase of the beam efficiency. Conversely, the continuous variation of the cross-section (even if smooth and with small gradients) leads the stress distribution within the cross-section to be different than the one that occurs in prismatic beams. In particular, the shear stress distribution does not vanish on the cross-section boundaries and depends explicitly on all internal forces. As a consequence, also the shear deformation depends on all internal forces, the complexity of beam constitutive-relations increases, and axial and shear-bending problems can no-longer be treated separately. The planar Timoshenko-like beam model derived in [1] tackles all the so far mentioned aspect but, unfortunately, the analytical solution can be computed only for extremely simple geometries and loads. Furthermore, the model derivation naturally leads to a mixed strong formulation of the problem (i.e., all the cross-section displacements and all the internal forces intervene as independent variables). Therefore, aiming at estimating the solution for cases of practical interest, suitable numerical tools are mandatory, but building a mixed FE for this model, dealing with the possible locking effects, may be cumbersome.

The mixed isogeometric collocation method proposed in [2] handles model strong-formulation, avoids all the problems typical of mixed FE, and therefore turns out to be the perfect numerical approach for the non-prismatic beam [1]. Aiming at opening the door to an effective prediction of the structural behavior of non-prismatic elements, this contribution uses the above mentioned numerical method for the computation of the non-prismatic beam solution demonstrating that the isogeometric collocation for non-prismatic beams is an accurate and cost-effective method.

REFERENCES

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