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A SIMPLE TORSION-FREE NONLINEAR BEAM ELEMENT FOR MULTIBODY DYNAMICS

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Beams are frequently present in flexible mechanisms employed in many engineering applications. In some of these applications, torsional strains are very small or null, due to the slenderness of the beams or the specific type of kinematical joints that connect them with other parts of the mechanism. Nevertheless, the large displacements, typical of these type of systems, lead to nonlinear models that demand specialized numerical methods for their solution. These models are usually complex if certain level of accuracy is required, usually with a significant computational cost.

We propose in this work a very simple torsion-free beam element capable of capturing geometrical nonlinearities. The simple formulation is objective and unconditionally convergent for geometrically nonlinear models with large displacements, in the traditional sense that guarantees more precise numerical solutions for finer discretizations. The formulation does not employ rotational degrees of freedom, can be applied to two and three-dimensional problems, and it is computationally very efficient. The basic idea of the proposed model shares some similarities with the lumped parameter method [1], but the approach is different. We represent the beam as a collection of articulated trusses with the proper tensile stiffness, parametrized with the cartesian coordinates of the extremes. The bending stiffness is represented by a penalized constraint, such that a single element is composed by two segments (three nodes) that overlaps with the neighbors. The basic formulation of this idea will be presented along with some validation tests that will assess the accuracy of the model, and some exploration on potential applications.

REFERENCES

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