Dejan Zupan

The velocity-based beam formulation with energy preservation

We present an energy-preserving numerical formulation for velocity-based geometrically exact three-dimensional beams. The algebra of quaternions is used as a suitable tool to express the governing equations and relate rotations with their derivatives, while the finite-element discretization is based on interpolation of velocities in a fixed frame and angular velocities in a moving frame description. The proposed time discretization of governing equations directly relates the energy conservation constraint with the time-discrete kinematic compatibility equations. We show that a suitable choice of primary unknowns together with a convenient choice of the frame of reference for quantities and equations is beneficial for the conservation of energy and enables admissible approximations in a simple manner and without any additional effort. The result of this study is simple and efficient, yet accurate and robust numerical model.