

A family of total Lagrangian Petrov–Galerkin Cosserat rod finite element formulations

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Abstract

The standard in rod finite element formulations is the Bubnov–Galerkin projection method, where the test functions arise from a consistent variation of the ansatz functions. This approach becomes increasingly complex when highly nonlinear ansatz functions are chosen to approximate the rod's centerline and cross-section orientations. Using a Petrov–Galerkin projection method, we propose a whole family of rod finite element formulations where the nodal generalized virtual displacements and generalized velocities are interpolated instead of using the consistent variations and time derivatives of the ansatz functions. This approach leads to a significant simplification of the expressions in the discrete virtual work functionals. In addition, independent strategies can be chosen for interpolating the nodal centerline points and cross-section orientations. In this talk, we discuss three objective interpolation strategies and present an in-depth analysis concerning locking and convergence behavior for the whole family of rod finite element formulations.