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A UNIFIED APPROACH FOR THE NONLINEAR DYNAMICS OF RODS AND SHELLS

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ABSTRACT

Based on our previous papers [1,2], in this work we present a unified formulation for the nonlinear dynamics analysis of rods and shells. We develop a special notation and remarkably arrive at a set of expressions which is valid for both rod and shell models. Minor differences are observed only at the constitutive equation.

Appealing are the facts that (i) a special parameterization is adopted for the rotation field, with which update of the rotational degrees-of-freedom is made extremely simple, (ii) energetically conjugated cross-sectional stresses and strains are defined based upon the first Piola-Kirchhoff stress tensor and the deformation gradient and (iii) nonlinear hyperelastic materials are permitted in a totally consistent way. Time-collocation of the resulting expressions following an energy-momentum approach (see [3]) ensures exact conservation of both momentum and mechanical energy in the absence of external forces.

We believe our single set of expressions leads to a straightforward implementation of both rod and shell models within a time-integration finite element code. Computational aspects are discussed and assessment of the scheme is made by means of several numerical simulations.

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