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A NONLINEAR 1D MODEL OF LAYERED TUBULAR BEAM

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A direct nonlinear 1-dimensional model of layered tubular beam is proposed here. The model includes the possibility of changes in shape of the cross-section, such as the ovalization (or flattening) which typically occurs in tubular beams [1]. The changes in shape of the cross-section are described, as in the Generalized Beam Theory framework [2], with a linear combination of known deformation modes and unknown amplitude functions, called distortions. To cover generic independent displacement, kinematics requires the introduction of distortional and bi-distortional strains, in addition to the usual strain measures of rigid cross-section beams. The application of the Virtual Power Principle provides the balance equations, in which distortional and bi-distortional stresses, as well as distortional forces, are defined as conjugate quantities of distortional strain-rates and velocities, respectively. A coupled nonlinear hyperelastic response function is assumed for the material. Identification of the distortional terms and the constitutive law is fulfilled from a three-dimensional fiber-model of thin-walled beam [3], via comparison of relevant energy. The balance equations, obtained for several cases, specialize the Euler-Bernoulli model, adding variables which describe the cross-section distortion. They are solved via a perturbation method, after proper ordering of the parameters. The interaction occurring between global bending and cross-section distortion is analyzed.

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