POTENTIAL ENERGY APPROACH FOR LARGE DEFLECTION ANALYSIS OF BEAMS UNDER GENERAL LOADING AND DIFFERENT END CONDITIONS USING OPTIMIZATION TECHNIQUES

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ABSTARCT

This study applies the minimum potentail energy approach and the variational principle for modeling the large deflection behavior of beams with different boundary conditions loaded with follower type loads and for compliant mechanisms and structures. This method states that the total potential energy along the deflected beam axis, or that stored in the system, has a minimum value at equilibrium. This potential energy consists of the elastic strain energy and the work done by the external loading. The beam deflection model is based on defining the deflection angle of the beam's neutral axis by a polynomial equation along the arc length of the beam. The angular deflection relation is integrated to obtain the stored elastic energy and the variation of the work done by the external loads. The beam end conditions are imposed as equality constraints using Lagrange multipliers. Since the follower forces are considered as non-conservative forces, the variational principle is applied by equating the variations of the elastic energy along with the constraints to the variations of the external work. The potential energy minimization approach is developed to model compliant mechanisms and flexible structures consiting from several flexible beams. In these formulations, an improved four segments Pseudo Rigid-Body Model (PRBM) is used to model the beams' deflection behavior. Verification examples are presented to validate the devloped formulations.