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The Effect of Arbitrary Support Conditions on the Static Behavior of Curved Beams Using the Finite Element Method

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Abstract : This study presents a finite curved element for analyzing the static behavior of curved beams within the elastic range. The objective is to enhance accuracy while reducing the number of elements by incorporating first-order shear deformations of Timoshenko beams. Initially, finite element formulations are developed by considering polynomial initial functions for axial, shear, and rotational deformations for a three-node element. Subsequently, nodal interpolation functions for this element are derived, followed by the construction of the element stiffness matrix. To enable the utilization of the stiffness matrix in the static analysis of curved beams, the constructed matrix in the local coordinates of the element is transformed to the global coordinate system using the rotation matrix. A numerical benchmark example is investigated to assess the accuracy and effectiveness of this method. Moreover, the influence of spring stiffness on the rotation of the endpoint of a clamped beam is examined by substituting each support reaction of the beam with a spring. In the parametric study, the effect of the central angle of the beam on the rotation of the beam's endpoint in a cantilever beam under a concentrated load is examined. This research encompasses various mechanical, geometrical, and boundary configurations to evaluate the static characteristics of curved beams, thus providing valuable insights for their analysis and examination.

Keywords : curved beam, finite element method, first-order shear deformation theory, elastic support
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