A novel theory of beam and plate and the finite element implementation

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Abstract

Based on the definitions of generalized displacements, the in-plane displacements are expressed in an orthogonal form with the aid of the assumptions and conditions. With the generalized stresses and strains defined, the uncoupled constitutive relations are derived respectively for beam and plate. The principles of virtual work are then proposed for beam and plate. Finite element formulations are finally established and higher-order and lower-order elements are constructed for beam and plate. Typical examples show that the present lower-order element can provide more accurate results than the previous ones based on the Timoshenko theory for beam or the Mindlin theory for plate while the corresponding higher-order element can capture the jump at the clamped boundary or at the concentrated load point.

Keywords: uncoupled constitutive relations; theory of beam and plate; higher-order element; lower-order element.