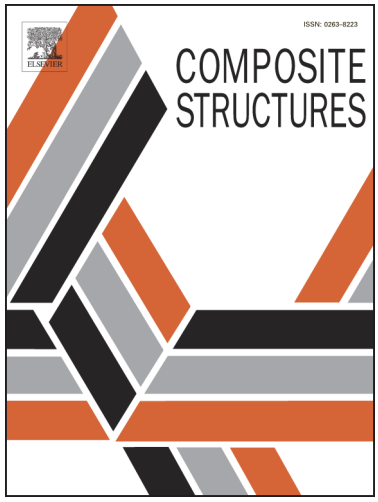

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An Enhanced Inverse Finite Element Method for Displacement and Stress Monitoring of Multilayered Composite and Sandwich Structures

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Abstract: The inverse finite element method (iFEM) is an innovative framework for dynamic tracking of full-field structural displacements and stresses in structures that are instrumented with a network of strain sensors. In this study, an improved iFEM formulation is proposed for displacement and stress monitoring of laminated composite and sandwich plates and shells. The formulation includes the kinematics of Refined Zigzag Theory (RZT) as its baseline. The present iFEM methodology minimizes a weighted-least-squares functional that uses exact set of strain measures of RZT. The main advantage of the current formulation is that highly accurate through-the-thickness distributions of displacements, strains, and stresses are attainable using simple C^0-continuous displacement interpolation functions. Moreover, a relatively small number of strain gauges is required. A three-node inverse-shell element, named i3-RZT, is developed based on the current iFEM formulation. Two example problems are examined in detail: (1) a simply supported rectangular laminated composite plate and (2) a wedge structure with a hole near one of the clamped ends. The numerical results demonstrate the superior capability and potential applicability of the i3-RZT/iFEM methodology for performing accurate shape and stress sensing of complex composite structures.