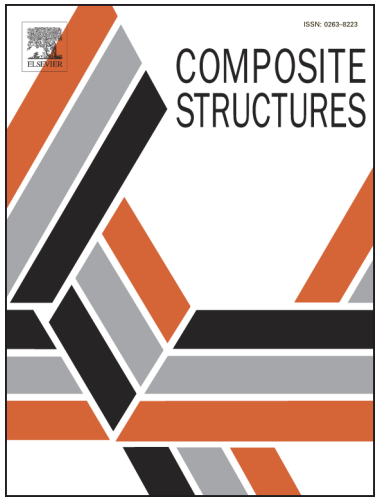

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Predictions of the frequencies of bending-torsion coupled laminated composite plates with discontinuities: novel analytical modeling and experimental validation

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Abstract

A novel analytical model that accurately represents the free vibration response of intact/damaged composite plates accounting for the bending-torsional coupling is developed. Unlike the existing models for the bending-torsion vibrations of composite plates, in the present model, the equations of motion are derived in an uncoupled form. It is then easier to derive analytical solutions for composite plates under coupled bending-torsion vibrations. In addition, for the first time, analytical solutions for the free bending and torsional vibrations of cantilever and clamped-clamped laminated composite plates with discontinuities including circular holes, rectangular holes, notches, and internal and edge cracks are easily obtained. Shifts in the natural frequencies due to discontinuities are modeled where the reductions in the plate stiffnesses are related to the amount of the energy release rate due to a defect formation. In order to verify the accuracy of the proposed model and the derived solutions, the proposed model is compared to the available conventional models. Moreover, experimental measurements of the free bending and torsional vibrations of carbon-fiber-laminated composite plates with circular holes is performed. A set of finite element analyses are carried out and compared to the experimental and the proposed model results. Then, a parametric study is presented in order to investigate the effects of the discontinuity size and location on the bending and torsional natural frequencies of laminated composite plates with various forms of discontinuities. The performed analyses demonstrate the accuracy of the proposed models to represent the free vibrations of laminated composite plates with discontinuities.

Keywords: composites, plates, defects, analytical model, free vibration, bending-torsion coupling.

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