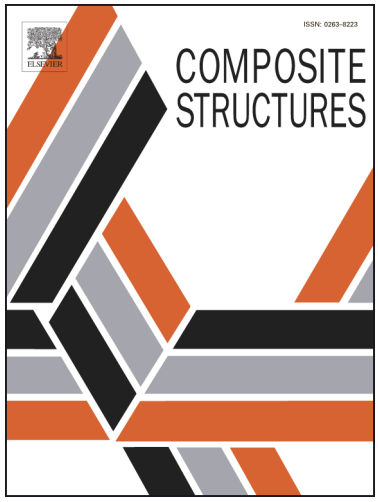

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A Beam Finite Element for Analysis of Composite Beams with the Inclusion of Bend-Twist Coupling

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Abstract

Material-induced bend-twist coupling in laminated composite beams has seen applications in engineered structures for decades, including airplane wings and turbine blades. Numerical studies and analytical formulations of the dynamics of bend-twist coupled laminated beams and plates have been investigated in recent years, yet can be cumbersome to implement quickly and efficiently. In early stages of design, employing a stiffness method approach to predict the load-deformation relationship and structural natural frequencies can be more efficient than developing a shell finite element model for each design iteration.

A weak-form approach to the development of an accurate bend-twist coupled composite laminate beam element is presented herein. Comparisons are made between the stiffness matrix terms using the presented method and a shell finite element model of an idealized beam; the proposed method shows good agreement for a suite of beams with varying degrees of bend-twist coupling. The method is then extended to the calculation of natural frequencies by combining the new stiffness matrix with a corresponding consistent mass

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