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Static and dynamic analysis of composite box beam based on geometrically exact nonlinear model considering non-classical effects ☆

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Abstract

In order to accurately predict the static and dynamic behavior of composite box beam, the Geometrically Exact Nonlinear Model (GENM) of composite box beams with arbitrary material distribution and large deflection was performed based on the Hodges' generalized Timoshenko beam theory. The strain of any point in the deformed beam was calculated by the rotational tensor decomposition. Then, the asymptotic variational method was used to determine the arbitrary sectional warping. The generalized Timoshenko strain energy was derived from the second-order asymptotically exact strain energy using the equilibrium equation. The motion equations of GENM were established by using the Hamilton's generalized principle. Finally, the proposed model was applied to the static and dynamic analysis of the composite box beam and verified by comparison with the experimental data. The influence of non-classical effects of sectional warping and transverse shear deformation on the composite box beam were further investigated. The results show that the sectional warping has significant effects on the static deformation and natural frequencies of composite box beams, and the influence of transverse shear deformation on the static deformation and the natural frequencies are related to the aspect ratio of beam length to section dimension.

☆This paper is contributed by all authors

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