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<u>**PROCEEDINGS**</u>

Vibration Analysis of Composite Periodic Beams Using Mixed Finite Elements

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ABSTRACT

This paper presents a novel mixed finite element method for the free vibration analysis of composite periodic beams. The governing state-space equations are derived based on the Hamilton's principle, treating both displacements and stresses as fundamental variables. This method uses transfer relations in the transverse direction and finite element discretization in the longitudinal direction of the beam, forming a semi-analytical computational framework. Therefore, it is able to handle general composite beam structures containing both transversely layered and axially jointed materials.

The proposed mixed finite element method ensures continuity of both displacements and stresses across material interfaces, thereby resolving interfacial stress singularity issues and providing more reliable boundary condition simulations. By treating composite beams as two-dimensional structures, the method avoids assumptions about cross-sectional deformation or stress distribution, thus improving analyzing accuracy.

Numerical examples demonstrate the method's high precision in analyzing the free vibration characteristics of steel-concrete composite beams, with an error of only 0.64% compared to existed experimental results. The parametric study reveals that material properties such as Young's modulus and density, as well as the stiffness of interfaces connecting layers, significantly affect the free vibration responses of composite beams. Furthermore, analysis of periodically distributed and bi-directional composite beams proves the method's versatility in handling different combination forms.

This proposed method provides a valuable reference for accurate vibration analysis of composite beams while ensuring stress compatibility, offering broad application prospects.

KEYWORDS

Free vibration; composite beams; mixed finite element; periodic structure

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