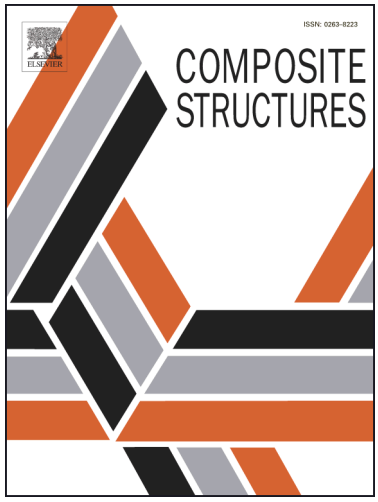

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An efficient three-field mixed finite element model for the linear analysis of composite beams with deformable shear connection

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Abstract

In this paper, we develop a new and efficient finite element for the linear static analysis of composite beams with deformable shear connection. We adopt a 3-field mixed approach, based on the Hu-Washizu principle, combined with the enhanced strain concept. Our proposal includes the possibility of systematically choosing interpolating functions of increasing order for certain generalized stresses and for the enhanced strains. Another distinctive feature of our approach is the fact that only three generalized stresses are directly approximated. As in many mixed formulations, the degrees of freedom associated with the approximation of generalized stresses and enhanced strains can be condensed out at the element level at negligible cost, leading to discrete systems involving only the displacement degrees of freedom. For benchmarking purposes, a conventional displacement-based conforming finite element is also briefly derived. Several illustrative examples demonstrate the mixed element's ability to perform very well on the coarsest of meshes – often consisting of a single finite element –, even when the material data exhibits a jump discontinuity in its interior, in sharp contrast with the displacement-based conforming element. This is particularly true when it comes to the estimation of generalized stresses, often the variables of most interest to designers.

Keywords: composite beams, three-field mixed elements

1. Introduction

A composite structural member may be defined as one with longitudinally disposed components of different materials, interconnected so as to limit the

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