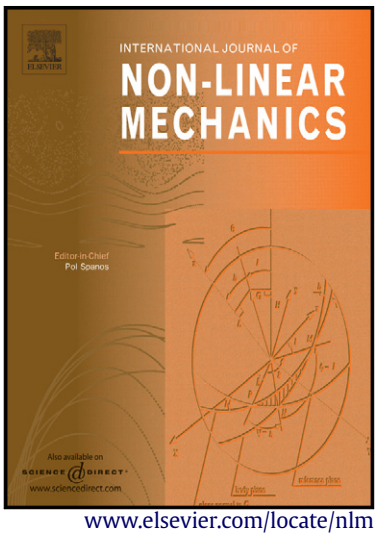

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Plastic bifurcation analysis of a two-layer shear-deformable beam-column with partial interaction

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Abstract

This paper deals with the plastic buckling behavior of two-layer shear-deformable beam-columns with partial interaction. The Timoshenko kinematic hypotheses are considered for both layers and the shear connection (no uplift is permitted) is represented by a continuous relationship between the interface shear flow and the corresponding slip. A set of differential equations is obtained from a general 3D plastic bifurcation analysis, using the above assumptions. Original closed-form expressions of the buckling loads and the corresponding modes of the composite beams under axial compression are derived for various boundary conditions, considering that both layers (or possibly only one) behave plastically at the critical point. The particular case of Euler-Bernoulli beams can be deduced from these general expressions by neglecting the influence of shear deformability. The proposed analytical solutions are favorably compared against the predictions of a FE model based on a co-rotational two-layer beam formulation which accounts for interlayer slip and inelasticity. Parametric analyses are performed and the effect of the elastoplastic moduli is particularly emphasized.

Key words: Plastic buckling, Two-layer beam-column, Partial interaction, Transverse shear, Closed-form expressions, Finite element validation

1. Introduction

Composite beams are widely used in civil engineering. Such structures involve two layers composed of different materials, like steel and concrete, in order to optimize the global mechanical behavior. Due to the technical solutions employed to assemble the two layers, relative displacements generally occur at the interface resulting in the so-called partial interaction. Whereas the transverse separation is often small in practice and can thus be neglected, the interface slip may often influence the behavior of the composite beams insomuch it must be considered for a more reliable modeling analysis.

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