

An Analytical Model for Two-layered Composite Beams with
Partial Shear Interaction Based on a Higher Order Beam Theory

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Abstract

The application of composite structures is quite frequent in various structural engineering activities due to their super mechanical properties and structural performances. A composite beam consisting of two material layers, such as steel-concrete, steel-timber, and timber-timber is typically used in the construction industry to enhance the overall performance due to a proper utilization of two material layers in this structural system. In reality, the shear connectors such as bolts, nails or steel shear studs, commonly used to connect the two layers, are having a certain degree of deformability due to a finite stiffness of these shear connectors. This induces a shear slip at the interface between the two layers which is known as partial shear interaction. This is an important feature which needs to be considered in the modelling of composite beams. In the present study, the shear connectors are modelled as distributed shear springs along the length of composite beams in the present study.

A higher order beam theory (HBT) is used to consider the effect of transverse shear deformation accurately by taking a third order variation of the longitudinal displacement across the beam depth. Since HBT allows a true parabolic vibration of the shear stress that vanishes at the top and bottom fibres of the beam, no shear correction factor needs to be used. In addition to the prediction for the beam global response such as deflection or vibration frequency, HBT also predicts the local response such as distribution of stresses accurately, which cannot be achieved by the existing models based on Euler-Bernoulli beam theory (EBT) or Timoshenko beam theory (TBT).

In the present study, exact analytical models based on HBT are developed for the static bending response, flexural free and forced vibration response, and geometric nonlinear static flexural response of two-layered composite beams with partial shear interaction. The principle of virtual work and the Hamilton's principle are applied to derive the governing equations for static and dynamic analysis, respectively, where the Navier type solution technique is used to solve these equations analytically. In order to assess the accuracy and efficiency of the proposed analytical models, the results produced by the models are compared with the results reported in literature by previous researchers and numerical results predicted by a one dimensional finite element model based on HBT as well as by a detailed two-dimensional finite element modelling of composite beams.

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Statement of Originality

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List of Manuscript

Wen, J., Sheikh, A. H., Uddin, M. A. and Uy, B. (2017). “An analytical model for flexural response of two-layered composite beams with interfacial shear slip using a higher order beam theory.” *Composite Structures (Elsevier)*. (Revised manuscript submitted)

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