CERIS : Civil Engineering Research and Innovation for Sustainability

Analysis and advanced modelling of steel-concrete composite beams using Generalized Beam Theory (GBT)

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Summary

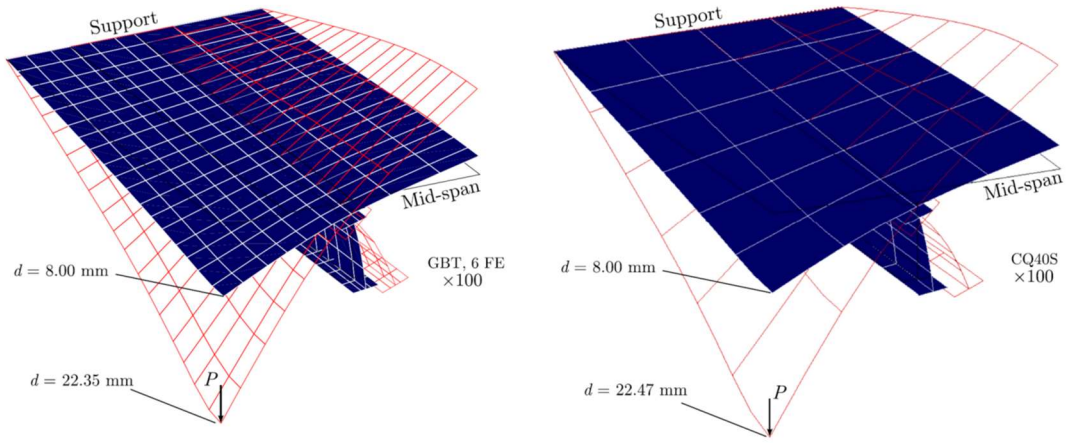
In this work it is shown that beam finite elements based on Generalized Beam Theory (GBT) constitute a viable and advantageous alternative – *i.e.*, they lead to accurate results with a reduced computational effort - to volume and shell elements, to model the linear and non-linear behaviour of steel-concrete composite beams. For this purpose, three finite elements with different application fields and levels of complexity are developed, implemented and validated.

The first element is intended to model the physically non-linear behaviour of composite beams, including pre- and post-collapse stages, considering concrete cracking and crushing, steel plasticity and shear lag. The second finite element makes it possible to determine local/distortional bifurcation loads and buckling modes of composite beams, taking into account cracking and cross-section deformation (including shear lag). Concrete creep and the sequence of construction can also be considered, although in a simplified manner. Finally, the third finite element considers creep and cracking (fixed smeared crack model) in a rigorous manner, in addition to cross-section deformation, including the shear lag effect.

The numerical examples presented clearly show that the proposed finite elements, besides being very precise, involve a very low computational cost. In addition, the unique modal decomposition features of GBT made it possible to draw some significant conclusions concerning the structural behaviour of steel-concrete composite beams and to obtain, for example, analytical formulas that quantify the elastic shear lag effect.

Keywords

Steel-concrete composite beams, Generalized Beam Theory (GBT), beam finite elements, physically non-linear analyses, cross-section deformation.



Time-dependent torsion-distortion-bending of a steel-concrete beam including cracking: initial and final deformed configurations for the GBT (6 finite elements) and CQ40S shell models.