OPTIMAL DESIGN OF THIN-WALLED LAMINATED BEAMS WITH GEOMETRICALLY NONLINEAR BEHAVIOUR

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The purpose of this paper is to present a finite element model for optimal design of composite laminated thin-walled beam structures, with geometrically nonlinear behaviour, including post-critical behaviour and accounting warping deformation.

A general continuum formulation is presented for the structural nonlinear analysis, based on the virtual work principle, and using the Updated Lagrangean procedure to describe the deformation of the structure. In order of defining the post-critical behaviour, a generalized displacement control method has been implemented.

The thin-walled beam cross-section is considered as made from an assembly of flat layered laminated composite panels. The cross-section bending-torsion properties are integrals based on the cross-section geometry, on the warping function and on the individual stiffness of the laminates that constitute the cross-section.

In order to determine its bending-torsion properties, the cross-section geometry is discretized by quadratic isoparametric finite elements. Along its axial direction, the beam is modelled throughout two-node Hermitean finite elements with seven degrees-of-freedom a node.

Design sensitivities are imbedded into the finite element modelling and assembled in order to perform the design sensitivity analysis of various structural performance measures by using the adjoint method.

As design variables one considers laminate thickness, lamina orientations and the global cross-section geometry. This geometry is defined by the position of master nodes related to the cross-section finite element mesh.

Design optimization is performed throughout nonlinear programming techniques.

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