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DIRECT PROCEDURE FOR THE DETERMINATION OF CONVENTIONAL MODES WITHIN THE GBT APPROACH

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The Generalised Beam Theory (GBT) is a method of analysis widely used for thin-walled members (TWM). With this approach, TWMs are considered as an assembly of thin plates, free to bend in the plane orthogonal to the member axis. GBT differs from the classical Vlasov theory [1] because it is able to account for the deformability of the cross-section. In the spirit of the Kantorovich's semi-variational method, GBT transforms a three-dimensional continuous problem into a vector-valued one-dimensional problem. This is achieved by representing the displacement field of the TWMs as a linear combination of assumed deformation modes, defined at the cross-section in terms of in-plane and warping components, and amplitude functions describing how these modes vary along the member length. In this context, the use of GBT can be subdivided into two stages: a cross-sectional analysis where the deformation modes relevant to a particular thin-walled section are evaluated and selected, and a member analysis which makes use of these modes to determine the overall structural response defined in terms of the amplitude functions. This falls within the Kantorovich's semi-variational method [2], in which the dimensionality of a problem is reduced by the use of partially-assumed modes. The fundamental task to be performed for adequate modelling with the GBT consists of the identification of an appropriate and suitable set of deformation modes.

The present paper presents a one-step procedure for the evaluation of an orthogonal basis for the conventional modes based on the dynamic approach. [3] For the purpose of this study, the conventional modes include, consistently with the definition provided in reference [4], the rigid-body modes, the distortional ones, the local (bending) ones complemented, when dealing with closed sections, with a shear mode related to the case of pure torsional shear flow.

The basic idea of the paper relies on the fact that, according to the semi-variational method, a complete basis of deformation modes needs to be identified. This can be chosen as formed by the eigenvectors of any positive definite eigenvalue problem defined on the domain of the cross-section, provided the warping components are made slaves of the in-plane displacement components. For this purpose, a new functional is defined, with warping expressed in terms of the in-plane components, regardless of its physical meaning, whose stationarity condition identifies the eigenvalue problem generating the sought basis of modes. The continuous boundary value problem, however, is not solved exactly but, as usually carried out within the GBT approach, is implemented by means of a numerical method, discretising the cross-section with the finite element approach. Solution to the eigenvalue problem provides the profiles of the in-plane deformation modes, the corresponding warping terms being easily calculated in the post-processing stage.

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