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ANALYSIS OF COMPOSITE SPACE STRUCTURES SUBJECTED TO LOADING FACTOR

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Key words: One-dimensional model, Component-wise, Space Structure, CUF, composite, thin-walled, loading factor, reinforced structures.

1. Abstract

Reinforced structures are mandatory in the space structures on which the lightweight is the main project parameter. The coupling between simple thin-walled plate and different systems of ribs or beams along one or more directions make it possible to meet the requirements of lightness and strength. During the project phase a structure is usually analysed via Finite Element Method (FEM), where different approaches can be used but the pointed out one common essential characteristic, a mesh discretization of a continuous domain into a set of discrete subdomains, usually called elements. Three main finite elements (FEs) are widely used in the commercial code, but only the Solid (3D) FE represents more faithfully the behaviour of a real structure. The solid FE models require a large number of degrees of freedoms (DOFs) and therefore the analyses are computational expensive [1]. For these reason that usually the reduced models are used as substitute of solid models. The reduced models are made using shell (2D) and beam (1D) FEs, and they are suitable to build a reinforced structure, in fact the shell are used for the skin and the beam for the stringers. The present work uses a refined 1D model based on the Carrera Unified Formulation (CUF) [2] to analyse space structures made coupling skin and stringers. Thanks to its refined cinematic the present model can be used to represent both skin and stringers. The whole structure is obtained connecting simple one-dimensional structures using a new approach called Component-Wise (CW) [3]. This is possible because the unknowns are only displacements. Free-vibration analysis of isotropic and composite space structures with non-structural masses and loading factor are considered. A space vehicle is inspired to Arian 5 with a central body, on which the cryogenic fuel and the payload are accommodated, and two lateral boosters, on which solid fuel is stored. The results show the quasi-3D capabilities of the present 1D CUF model and the coupling with the CW approach provide accurate results nearest to solid FE results than the classical refined FEs models. In conclusion the present 1D refined model appears suitable for the analysis of reinforced thin-walled structures,

it provides accurate results with the benefit to reduce the computational costs with respect to the classical refined FE approaches.

References

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