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ACCURATE ANALYSIS OF LAUNCHER STRUCTURES BY MEANS OF REFINED ONE DIMENSIONAL MODEL

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1. Abstract

The use of reinforced structures is mandatory in the aerospace field, because thin-walled structures reinforced with longitudinal and transversal component make it possible to meet the requirements of lightness and strength. The high number of reinforced structures that compose space structures, as a launcher, increases the complexity of the analysis when the Solid (3D) Finite Element (FE) models are used. The solid FE models require a large number of degrees of freedoms (DOFs) and therefore the analyses are computational expensive [1]. The use of reduced models permits to reduce the number of DOFs and the computational costs. In the FE analyses the classical reduced elements are the two-dimensional (2D) elements (plate and shell) and the (1D) one-dimensional elements (rod and beam). A reinforced structure can be obtained coupling one- and two-dimensional elements, in fact normally, the shell elements are used for the skin while the beam elements substitute the stringers. The present work uses a refined 1D model based on the Carrera Unified Formulation [2] to analyse whole structures of launcher. Thanks to its refined cinematic the present model can be used to represent both skin and stringers. In the present refined one dimensional models, the unknowns are only displacements therefore a complex structure can be obtained connecting simpler one-dimensional structures, this approach is called Component-Wise (CW) [3]. Static and dynamic analysis of parts and whole space launcher are considered, including the effects of the solid fuel mass. Isotropic as well as composite materials have been taken into account. The outline of the launcher has a geometry inspired to the 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 of the analyses show the quasi-3D capabilities of the present model and the CW approach has been proved to be a competitor of the solid FE models. In conclusion the refined 1D model introduced in this work appears suitable for the analysis of slender reinforced thin-walled structures, it provides accurate results reducing the computational costs with respect the classical approaches.

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