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NODE-DEPENDENT KINEMATIC MODELS FOR THE COUPLED LOAD ANALYSIS OF SPACE STRUCTURES

Abstract

Space structures are subject to high mechanical loads during the launch phase and the atmospheric flight. The design of the interface between the payload and the launcher requires an accurate description of the dynamic response of both the components. The use of complex FEM models for both launcher and payload would require a huge computational cost, that is, reduced models have been developed in the last decades. Dynamic coupled load analyses are mandatory for the developing and the verification of the payload design. Classical analysis approaches aim to reduce the model of the launcher from million to a few degrees of freedom able to describe the dynamic of the whole structure at the interface with the payload. This approach uses different techniques such as sub-structuring, Modal synthesis, etc. The present work aims to present a new approach for the coupling load analysis based on the use of refined FEM elements with node-dependent kinematic capabilities. Refined beam models have been successfully used to study the dynamic response of a launcher structure. These models can provide accurate results with a large reduction in the computational cost. The introduction of the node-dependent kinematic, NDK, formulation allows the kinematic approximation of the finite element to be varied node-by-node. This approach has two main advantages: the former is the reduction of the computational cost increasing the accuracy of the model only where it is required, the latter is the possibility to easily connect different elements imposing the same kinematic approximation a the interface. These models, derived in the frameworks of the Carrera Unified Formulation, have been used to develop a reduced model of a launcher structure, then, exploiting the NDK capabilities the model of a payload has been connected with the launcher to evaluate the interface solicitations. The results show that the present model provides accurate results with an affordable computational cost. A fully three-dimensional solution has been obtained for both the launcher and the payload.