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BE-FE ACOUSTIC-STRUCTURAL COUPLING ANALYSIS FOR DYNAMIC RESPONSE OF SPACECRAFT COMPOSITE SHELLS

Abstract

A satellite structure must fulfill various requirements, such as it must resist the loads induced by the launch environment (acceleration, acoustics, thermal), and meet all the functional performances required on orbit such as dimensional stability and structural integrity. The satellite structure must also interface with some other subsystems such as : thermal control, optical components, electronic equipment, mechanisms and the like. These requirements must be taken into account in the preliminary structural design phase at the beginning of a project when the most important mechanical trade off are carried out. Noise and Vibration should be taken as critical consideration in the design of aerospace vehicles also for fatigue of components arising from interior structural and acoustic pressure fluctuations due to external structural or acoustic loading. Lightweight structures for high-technology applications increasingly have to fulfill not only high demands on stiffness and strength but also on high damping and low sound radiation due to the rising comfort requirements. Here, composites offer a very high vibro-acoustic lightweight potential. The great number of design variables allows to synergetically fulfill high stiffness and acoustic standards. The series of work carried out by the author for unified BEM-FEM Acoustic-Structural Coupling is here reviewed, updated and adapted for the acoustic-structural dynamic response of space structure identified above. The fluid structure coupling has been addressed using BEM for the acoustic field and FEM for the structural dynamic problem, while the fluid-structure coupling has been dealt with using indirect as well as direct BEM. The present work then proceeds with the dynamic response analysis of typical and generic space shell structure subject to acoustic loading. The numerical treatment to overcome the appearance of irregular or fictitious frequencies was carried out by using a Schenk's method of Combined Helmholtz Interior Integral Equation Formulation in the FMBEM regularization scheme, which is chosen for its simplicity and computational efficiency; its applicability is investigated and validated through application to generic cases. The analysis carried out in the work is intended to contribute to the development of such low noise lightweight composite structures by analyzing the structural-dynamic response and sound radiation of composite shells, utilizing the authors developed numerical vibro-acoustic simulation models.