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Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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MODELISATION OF THERMALLY INDUCED JITTER IN A SLENDER STRUCTURE

Abstract

The thermomechanical interactions of onboard space vehicles is an interesting field of research and study. Since the pioneering paper by Bruno Boley, published in 1954, many authors have given their relevant contribution to the comprehension of phenomena not otherwise investigable if not with a cross-sectoral approach and a multidisciplinary methodology. The anomaly that occurred to the spacecraft Alouette 1, in 1962 marked the beginning of a long series of unexpected events due to unconceivable coupling between the mechanical and thermal behaviour of the system. This work aims to emphasize, by means of a simple model, the basic mechanism responsible for elastic vibrations induced by a thermal shock. This is a widespread event experienced by a spacecraft during the transitions shadow-Sun and vice-versa or when a flexible appendage, previously shadowed by the spacecraft's main body, comes to the light as a consequence of an attitude maneuver [Ulysses, 1990]. For the investigation, a very slender structure has been considered in order to make the thermal and mechanical characteristic times comparable and realize the conditions of strong coupling. The accurate thermal analysis provides an equivalent thermal bending moment, depending on time, which appears as a boundary condition in the subsequent modal analysis of the structural element, where it plays the role of a trigger of elastic transverse vibrations. The research presents a new design guideline for analyzing the thermal jitter of a thin spacecraft structure, which is a common occurrence in space engineering. A simplified modelization provides a step-by-step procedure for studying and analyzing the phenomenon of thermal jitter. Matlab is used to solve the proposed method analytically. The thermomechanical analysis of the slender structure is the focus of the research.