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INVESTIGATING SHOCK PROPAGATION THROUGH COMPOSITE STRUCTURES

Abstract

Shock loads, characterized by their high amplitude and short duration transient nature, pose significant challenges to the structural integrity of aerospace composite structures. These loads are often generated by pyrotechnic devices during space launches, particularly in initiating stage or fairing separations. While the spacecraft structure itself may not be susceptible to the frequency range of these shock waves, electrical components face potential damage during the launch phase. To ensure the resilience of electrical units, shock tests are conducted as part of the spacecraft's environmental mechanical test campaign during the development process. These tests validate the ability of sensitive components to withstand transient loads. Throughout spacecraft development, analysis is performed on the spacecraft model to predict its response to such loads. Subsequent tests verify the accuracy of these analyses and potentially qualify the structure for flight. Any discrepancies between the analysis and test results may necessitate redesigning the structure to accommodate necessary adjustments. Consequently, there is a critical need for a predictive method that accurately models the dynamic behaviour of spacecraft structures. Such a method would ensure the robustness of structural analyses against parameter modifications, thereby minimizing the likelihood of redesigns. The propagation of shock waves through composite structures, particularly in aerospace applications, is a critical consideration for ensuring structural integrity, due to their complex behaviour under dynamic loading conditions. In this study, an alternative approach to evaluating shock response across the entire frequency spectrum (up to 10 kHz) is proposed. The structure is described according to the Carrera's Unified Formulation (CUF), enhancing a wide class of powerful refined 2D plate theories with a unique formulation. A comparative analysis is conducted between modal analyses obtained from Finite Element Method (FEM) commercial software and the MUL2 code, which has demonstrated superior accuracy in modelling composite materials. By employing modal analysis results from MUL2, the transmissibility of the composite structure is synthesized to derive its shock response along the thickness. This study contributes to advancing the understanding of shock propagation in composite structures.