Postprint: Fluid-Structure Interaction Analysis of Sloshing Impact Effects in Aircraft Fuel Tanks Under High-G Maneuvers

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Abstract

A co-simulation fluid-structure interaction method using Abaqus and Star-CCM+ was developed to investigate the sloshing problem of a full composite fuel tank of a certain aircraft during catapult launch and arrested landing. First, the reliability of the established fluid-structure interaction analysis method was verified by simulating liquid tank sloshing experiments. Based on the aircraft fuel tank prototype, a detailed structural model of the full composite fuel tank and a fluid domain model were established. The sloshing impact effects of the fuel tank under three different filling ratios were investigated, and results including the sloshing morphology of the oil inside the tank, pressure distribution, stress and strain of the fuel tank, and deformation of the tank skin during catapult launch and arrested landing were obtained. The analysis shows that: during catapult launch and arrested landing, the oil sloshing exhibits three stages: accumulation, sloshing, and stabilization, with the fuel sloshing inside the tank concentrated within the first 1.3 s; in both operating conditions, the impact pressure generated by fuel impact on the tank increases with the filling ratio, with maximum impact pressures of 19.135 kPa and 11.102 kPa in the catapult launch and arrested landing conditions, respectively; during high overload conditions, the structural response of the fuel tank is dominated by the overload; the structural response of the fuel tank during arrested landing is greater than that during catapult launch, thus the requirements for fuel tank structural strength are more stringent for arrested landing.

Full Text

Preamble

The source material under this heading consists entirely of corrupted characters, PDF extraction artifacts (e.g., (cid:*) markers), and mathematical placeholders

lacking coherent contextual information. No meaningful Chinese content suitable for academic translation could be identified.

Note: Figure translations are in progress. See original paper for figures.