IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Interactive Presentations - IAF MATERIALS AND STRUCTURES SYMPOSIUM (IP)

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LAUNCH ENVIRONMENT STRUCTURAL SURVIVABILITY VERIFICATION FOR THEOS-2 SMALLSAT STRUCTURAL QUALIFICATION MODEL (SQM) BY STRUCTURAL DYNAMIC ANALYSIS AND VIBRATION TESTING.

Abstract

THEOS-2 SmallSAT is a newly built 100 kg Thai earth observation satellite, scheduled for launch into the low-earth orbit by Q1 next year, developed by Surrey Satellite Technology Limited (SSTL) in UK with a group of engineers from Geo-Informatics and Space Technology Development Agency (GISTDA) from Thailand. This isn't just a regular spacecraft development project focusing on a proto-flight model (PFM) spacecraft for in-orbit operation, but also includes a structural qualification model (SQM) spacecraft being developed and built in Thailand. The SQM will serve as a commissioning test article for a new vibration test facility at GISTDA and a learning opportunity for new astronautical engineers in the country. Furthermore, this will mark the first time of a microsatellite structural vibration test campaign in Thailand.

This paper focuses on a verification process of the SQM spacecraft to withstand and survive mechanical dynamic environments of a launcher in the market using a structural analysis and a vibration test. In this instance, a qualification vibration test specification suggested by Vega launch vehicle for rideshare payload is selected for demonstration purpose.

In structural design and analysis phase, a Finite Element Model has been created to predict structural dynamic behaviours of the spacecraft in launch configuration including modal frequencies, shapes, and effective mass using NASTRAN modal analysis solver. Besides, static and frequency response analysis are also performed to predict maximum stresses occurring on each item of the spacecraft structure. The maximum tension/shear forces at fastener joints subjected to quasi-static accelerations and random vibration loading during launch are also assessed. To take into account a set of uncertainly factors, a margin of safety has also been calculated from maximum predicted stresses and forces in accordance with ECSS-E-HB-32-26A and ECSS-E-HB-32-23A guidelines to indicate conservative endurance factors of structure & joints against mechanical failures.

Finally, the SQM spacecraft has been subjected to a qualification vibration test campaign on a 180 kN electrodynamic shaker in each orthogonal axis to confirm if the structure will remain intact and meet the launch requirements. The test includes a quasi-static up to 10g axially using a low-frequency sine sweep

profile, random vibration up to 6.81 gRMS, and pre & post low-level sine sweep to capture if there are any structural dynamic changes during high-level test and to detect any anomalies.