Paper ID: 34839
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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures I - Development and Verification (Space Vehicles and Components) (1)

Author: Mr. Sumit Jain
Indian Institute of Technology, India

Mr. Anjan Patel
Indian Institute of Technology, Bombay, India
Mr. Ratnesh Mishra
India
Mr. Akshay Raut
Indian Institute of Technology, India

STRUCTURAL DESIGN, ANALYSIS AND TESTING OF LAUNCH VEHICLE INTERFACE FOR SMALL SATELLITE, PRATHAM, IIT BOMBAY

Abstract

'Pratham' is the first satellite of IIT Bombay's Student Satellite Project. The scientific application of the satellite is to measure the total electron count in the ionosphere. Pratham is a small satellite of dimensions 294 X 315 X 460 mm. The launch of Pratham will be facilitated by Indian Space Research Organisation's (ISRO's) Polar Satellite Launch Vehicle (PSLV). Due to its unorthodox size, requirement of in-house launch vehicle interface was imperative as suggested by Vikram Sarabhai Space Center (VSSC). Further, one of the preconditions for the satellite to obtain flight clearance is to pass qualification level testing consisting of vibration loads (to ensure structural integrity) at ISRO Satellite Center (ISAC).

During vibration testing, the satellite is placed on a 3-axis shaker table and the launch conditions are simulated as per the loads prescribed by VSSC. 'Fixture' is the interface with shaker table which was designed by the team to be used during vibration testing of satellite. After various iterative analyses, the design of fixture was modelled considering assembly constraints, structural load transfer capability and frequency constraints. The fixture used for testing consisted of two parts made of AL-6061-T651, mating each other forming one single fixture.

To simulate loads and boundary conditions, Workbench software was used where the satellite CAD model is imported. For modelling, 'Fixed Joint' (feature available in Workbench, which means no relative motion can take place at the joint position) was used after analyzing various types of joint conditions. Further, all possible combinations of various static, harmonic and random vibration simulations were performed to ensure sufficient factor of safety.

Before vibration testing, characterisation of fixture for low level random vibration and sine test was carried out for longitudinal and lateral axis. Accelerometer responses at different locations were observed and analysed to compare with simulation results. In order to avoid interference, fundamental frequency of fixture should be at least five times the satellite frequency.

It was realized that for various loadings, the results obtained from vibration testing and simulations manifested good correlation and were found to satisfy the above criteria. Similar design methodology can be utilized by other small satellites to check the performance of satellite against vibration loads expected during launch.