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A PRISTINE, VERSATILE AND COST-EFFECTIVE STANDARDIZED STRUCTURAL SYSTEM FOR CUBESATS

Abstract

Swayam, a 1-U pico-satellite, is designed and developed by the students of College of Engineering, Pune to demonstrate a passive attitude control system. The satellite, to be injected into a polar low-Earth orbit, hosts a simple, sturdy and versatile structural system. The structural outfit for the satellite consists of four rails and two frames. These aluminium rails hold the two frames in position and its extended part restricts the rotational degree of studs, which support the satellite. The requirements of minimized buckling, maximum strength, resistance to dynamic loads and vibrations and overall stiffness imposes a tough challenge on the design criteria. The paper attempts to explore the unique design, flexibility and cost-effectiveness Swayam's structural system has to offer. Through the process of design evolution, the structure saw a number of revisions, each incorporating minute improvements from its predecessor. The fundamental mode frequencies for the lateral axes achieved during Flight model's (FM) vibration test is in the order of 320 Hz, way above the minimum criteria of 135 Hz in the longitudinal and 70 Hz in lateral directions. This shows the vibrational robustness of the structure body. The two milling frames besides rails, even if kept unaltered can be extended to provide for a 2-U or 3-U satellite. Only change would be modifications and tests for lateral buckling of the rails for a 3-U satellite while the effect of non-symmetry and increased length wouldn't pose significant issues for a 2-U form. A 30 cm rail

for a 3-U form will show increased tendency to buckle laterally since a rail is unsymmetrical. However, lateral ties have proven to be instrumental in controlling buckling. Further, a wider flange offers greater distribution of area thereby an increased gyration radius. Beside this, the wide flanges of rails, facilitate greater edge distance and more room for fasteners and solar panels to fix. The fabrication of rails and the frame is uncomplicated and with a bare minimum increase in weight proves economical in comparison to its predecessors as well as the systems that have been employed on other Cubesats. Therefore the entire structural system transforms into an optimized solution which delivers on minimum mass-requirement, simplified assembly and greater rigidity in the overall skeleton.