Ground-Based Preparatory Activities (13)
Ground-Based Preparatory Activities - IP Session (IP)

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STRUCTURAL DYNAMICS DESIGN AND VALIDATION THROUGH TESTING OF PSLV PAYLOAD FAIRING

Abstract

PSLV, the versatile workhorse launch vehicle and maiden operational launch vehicle of India have emerged as a very reliable and versatile launch vehicle by successfully launching satellites, both Indian and foreign, into Polar Orbit, Geo-synchronous Transfer orbit (GTO) etc. PSLV-C11 / Chandrayaan-1 mission and PSLV-C25 / Mars Orbiter Mission herald a new era by launching the satellites for deep space missions.

Mission objectives for expendable unmanned space mission involves inserting the spacecraft in the intended orbit. The spacecraft is shielded inside the payload fairing (PLF) against thermal and acoustic load as it traverses through the atmosphere. Beyond the atmosphere, the PLF serves no functional purpose and hence using pyro techniques through zip chord, the PLF halves are jettisoned away from the ongoing launch vehicle. A ground test is necessitated to prove the integrated Payload fairing system and dynamics before actual flight.

The chemical energy from the pyro is intended for pure rigid body motion of PLF. The PLF due to its geometry and material of construction, exhibits flexibility and as a result some of the input energy gets converted into strain energy. It is critical to compute the energy lost due to flexibility from the total zip chord energy and compute the actual energy available for rigid motion. The flexible motion of PLF reduces the static radial gap with ongoing vehicle and can cause collision. A detailed structural dynamic response analysis is performed to compute the energy lost due to flexibility. Additionally the influences of dispersion in the material properties and input energy is also considered for the analysis. This completes the total design cycle of PLF and takes care of the uncertainties in manufacturing in total energy of pyro charge.

Ground test environment is different from flight due to the presence of atmospheric pressure. Atmospheric pressure causes pressure differential across the PLF due to volumetric expansion and needs to be considered during response analysis.

The purpose of present work is to estimate the energy lost due to flexibility of the PLF. For this purpose, structural dynamic response analysis is carried out to find energy balance, estimate the strain energy due to flexibility to ensure collision free separation. Flexible motion will then be superimposed on rigid body motion to get the resultant motion of the fairing. The results will help the designer to check for adequacy of input energy and structural design of PLF for collision free separation.