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THE INFLUENCE OF THE VIBRATION TEST FACILITY IN THE RESONANCE FREQUENCIES MEASURED ON A SATELLITE STRUCTURE, INTRODUCING FACILITY MECHANICAL IMPEDANCE IN FEA AND FACILITY CHARACTERIZATION.

Abstract

The importance of considering test facility mechanical impedance has become increasingly evident, especially from the experimental observation of discrepancies in the resonance frequencies between FEA and experimental testing results.

A conventional method of measuring the resonances of the satellite considers the transfer functions between the measuring points and the mounting flange of the satellite. However, this method overlooks crucial factors such as the dynamic effects of the moving mass and rigidity inherent in the vibration test facility. A discrepancy source between FEA and experimental results has been identified, revealing a non-negligible feature of the vibration testing facility.

This study proposes replacing the conventional one-degree-of-freedom (1DOF) model with a "semi-defined two-degree-of-freedom model" for satellite vibration testing. Despite remaining a single degree of freedom dynamically, this model offers a more accurate representation by accounting for the influence of the facility's moving mass to satellite mass ratio on natural frequencies. By addressing the limitations of the 1DOF model, this research enhances fidelity and relevance, shedding light on the dynamic of the system under investigation.

Moreover, this research explores how a mechanical slip table can be specifically set to match a mechanical impedance more suitable for the specific satellite under testing. This will improve the correlation between experimental and FEA outcomes.

Employing purely mechanical slip tables not only improves testing sustainability by eliminating the need for power and oil but also facilitates a more suitable definition of facility dynamic features through the mechanical impedance. This improves testing accuracy, especially when testing on the slip table of the shaker system.

So far, facility dynamic specifications consider first frequency and maximum cross axis acceleration, this study evaluate the mechanical impedance as a more proper feature to be specified for a vibration testing facility. This value would be useful for FEA correlation.

In conclusion, this breakthrough improves satellite vibration testing accuracy and could be also used for a better integration of launch vehicle mechanical impedance into satellite FEA, enhancing load factor and stress computations.

Key-words: Vibration testing, Slip table rigidity, Finite Element Analysis correlation, Semi-defined Two-degree-of-freedom model, Facility mechanical impedance.