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

Author: Dr. Marcello Remedia
Surrey Space Centre, University of Surrey, United Kingdom

Prof.Dr. Guglielmo Aglietti
Surrey Space Centre, University of Surrey, United Kingdom
Mr. Matteo Appolloni
ESA, The Netherlands
Mr. Alessandro Cozzani
The Netherlands
Mr. Andrew Kiley
United Kingdom

USING VIRTUAL TESTING AS PRE- AND POST- TEST TOOL FOR SPACECRAFT VIBRATION TESTING

Abstract

During launch, a spacecraft is subject a series of loads, ranging from quasi-static longitudinal loads to highly transient or harmonic low frequency events, from higher frequency shock loads to acoustic excitations. These loads can be reproduced in a test facility implementing fixed base sinusoidal tests, wide band acoustic loading and different regimes of shock testing. In this article, the main focus is on fixed base sinusoidal tests, particularly important for correlating the finite element model of the satellite with the actual structure. For this reason, a post-test correlation process is normally carried out, where experimental results are compared to the computational outcomes. The issue with doing this is that the trust on the test data relies on assumptions (e.g. "infinitely" stiff boundary and inertial properties of the shaker) which are not correct, as for the kind of applications treated in this article experimental results are significantly affected by boundary flexibilities, modes of the shaker/head expander and non-perfect implementation of the control algorithm in the hardware. In recent years, a relatively new approach has been developed: virtual testing, currently under investigation for pre-test response predictions and post-test correlation. In this article, both these approaches will be described, showing the advantages that can be obtained in terms of correlation and in terms of test planning having the option to predict the actual behaviour of the spacecraft before this is tested on the real facility. Practically, the satellite is mathematically modelled along with the shaker and the control system. Here simulation capabilities of longitudinal and lateral closed loop control simulations of the ESA electro-dynamic shaker (QUAD Head Expander) and the hydraulic shaker HYDRA (able to characterise inputs along six degrees of freedom simultaneously) coupled with test specimen flexible models (e.g. Bepi Colombo) are developed. This shows, on one side, how significant the differences are when looking at the analytical results from two different perspectives (standard Finite Element Analysis and Virtual Testing implementation) in terms of post-test correlation: correlation methods are used for both procedures and results show significant improvements when the satellite Finite Element Model undergoes the virtual testing approach. On the other side, it highlights the importance of doing pre-test virtual testing computations, which allow predicting unexpected dynamic behaviours of the spacecraft under test.