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ON THE VIBRATION TESTING OF SPACE STRUCTURES

Abstract

Vibration testing is one of the key events in the verification process of a spacecraft structure. Mechanical loads imposed during the testing phase are often significantly more severe than the actual mission loads, thus serving as the sizing load cases for the overall structure design. Even though this strategy allows mitigating risks during the mission, it might be dangerous when followed blindly, especially when applied to a protoflight model. To protect the structures from unnecessary overtesting, a notching strategy shall be defined and the behavior of the test article shall be constantly monitored. Unfortunately, this step is often too challenging, especially for the smaller space industry players.

The paper consists of two main parts: firstly, the main features of the vibration testing are addressed individually; secondly, a tool helping to take care of these aspects efficiently and consistently is presented. In the first part, the following aspects are described:

- Instrumentation
- Test prediction and its limitations
- Control strategy, fixture, and shaker influence
- Cross-axis inputs and responses
- Intermediate tests and load extrapolations
- Manual and automatic notching
- Anomaly anticipation

Test predictions, load interpolations, and test-to-prediction correlations are often performed separately, sometimes using in-house tools or spreadsheets. However, this approach does not appear to be practical and is often prone to errors. This paper proposes a solution overarching all steps related to vibration testing in a systematic yet simple way available for the industry. It presents a tool that has been developed considering the experience of vibration testing of various items ranging from the small units up to complete satellite structures.

Special attention is dedicated to the procedures of input profile refinements based on finite element predictions or intermediate test runs. Strategies for both manual and automatic notching are discussed, as well as abort strategies to protect the test article in case of an anomaly. To illustrate the concepts, some real-life examples are provided.