

Case Study

Coupled Loads Analysis Supported with Modal Testing

OVERVIEW

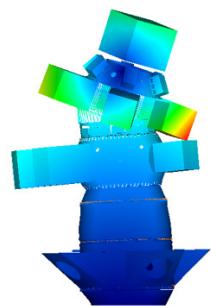
Spaceflight Industries (Spaceflight) is a launch services and mission management provider. For Spaceflight's Sun-Synchronous Orbit Mission A (SSO-A), a rocket launch provider delivered Spaceflight's integrated payload stack (IPS) to orbit. The mission included ~20 large (>50 kg) payloads, along with several dozen very small payloads. In preparation for the launch, ATA Engineering (ATA) was contracted by Spaceflight to develop a finite element model (FEM) of the IPS, conduct a modal test of the IPS with simulated payloads attached, and correlate the IPS FEM to the modal test results. The IPS model was then used to (1) provide a dynamic model of the full launch payload for use in launch analyses, and (2) determine the random vibration environment at each payload interface, for possible use by the payload suppliers to qualify their payloads for launch. The IPS was successfully launched into orbit on December 3, 2018.



Modal test of the IPS

TASKS PERFORMED & KEY OUTCOMES

- Received payload models in FEM format or in reduced Hurty/Craig-Bampton (HCB) format, reduced all payloads to HCB format, and integrated them into the overall IPS model
- Defined simulated payloads such that the IPS core structure would be properly exercised during modal testing
- Conducted modal testing with multiple-point random, Multi-Sine,¹ and modal impact hammer excitation; in total, 56 modes were extracted
- Verified two fixed-base modes not present in the mass-loaded boundary condition results via a fixed-base correction method, mathematically subtracting the flexible motion of the interface
- Updated the FEM using modal test results and ATA's Attune™ correlation software



FEM dynamic analysis of the IPS

¹ATA's patented Multi-Sine excitation method dramatically reduces ground vibration (modal) test duration.