MODAL ANALYSIS AND CORRELATION OF INTERNATIONAL SPACE STATION EARLY CONFIGURATIONS

Mohamed Kaouk, Ph.D.
Shya-Ling Shein, Ph. D.
Hyoung M. Kim, Ph. D.

The Boeing Company
M/S: ZC-01
555 Gemini Ave.
Houston, TX 77058
Phone: (281) 282-5659
Fax: (281) 282-5131
E-Mail: mo.kaouk@boeing.com

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Mohamed Kaouk, Shya-Ling Shein, and Hyoung M. Kim
The Boeing Company, Houston, Texas

This paper will summarize the modal analysis and model refinement results for the International Space Station (ISS) Flight-2A mated configuration.

The on-orbit construction of the ISS has started in November 1998, and is scheduled to be completed in 91 incremental assembly stages. The ISS mated Flight-2A configuration consists of two modules with docked Space Shuttle Endeavor. One of the modules is the Functional Cargo Block (FGB), also known as Zarya, that was launched by a Russian Proton vehicle in November 1998. In December 1998, Space Shuttle Endeavor added the U.S. Node 1, also known as Unity.

To maintain structural integrity of the ISS, structural loading distributions have been rigorously analyzed through numerical simulation and taken into account during the design of the structure and mission operations. The accuracy of the analysis results is directly affected by the precision of mathematical models and estimated input forces.

A mathematical model of an ISS configuration is composed of individual component math models. Each component model is required to be correlated with ground test data. However, it is expected that on-orbit mathematical models will still contain modeling errors due to differences in boundary conditions, mass distributions, and gravitational fields. Hence, it is highly desirable to correlate on-orbit mathematical models using test data measured on orbit.

Time responses were measured during on-orbit Shuttle structural dynamic tests and Shuttle reboost. The structural responses were recorded by a combination of three instrumentation systems, including: Shuttle Inertial Measurement Unit (IMU), FGB Structural Dynamic Measurement System (SDMS), and the Shuttle payload bay video cameras.

Modal analysis was performed on the measured time data to determine frequencies, damping factors, and mode shapes. Traditional modal analysis methods using frequency response functions (FRFs) were not used since the input excitation forces were not measured. A special modal identification method that does require input force measurement was applied. Test modal parameters were then used to verify and correlate the math models.