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Mode Identification Applied in Size Optimization with Frequency Constraints

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Abstract

Satellite structure supports all the functional components that are housed in it. If the natural frequency of the satellite structure overlaps the excited frequency coming from the engine of launch vehicle, resonance will happen and high-amplitude vibration transmitting through the satellite structure will cause destruction to the payloads inside. Therefore, the significant performance requirements for the satellite structure are frequency constraints, such as the first-order lateral and the first-order vertical natural frequency, which must be above the targets to avoid the resonance and increase the safety of payloads.

For the problem of mode exchange in size optimization of satellite structure with dynamic constraints, it is hard to apply the traditional optimization model which considers fixed order mode frequencies as constraints in optimization calculation. A new optimization model is established, in which the dynamic constraints were changed as frequencies of structural principal vibrations. The order of the principal vibrations is recognized through modal identification in the optimization process, and the constraints will be updated to make the optimization calculation executed smoothly. A new optimization process is designed, which achieves the purpose of overcoming mode exchange problem at the cost of increasing several structural analyses. Optimization system is developed by using Nastran to perform structural analysis and sensitivity analysis and two-level multipoint approximation algorithm as optimizer. Numerical results verified that the presented method is effective and reasonable.