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Structural Design and Topology Optimization of a University Micro-satellite

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Abstract

BUAA-SAT is a student micro-satellite developed by Beihang University, which is designed to demonstrate the communication, imaging obtaining and compression on orbit. It consists of main-satellite and sub-satellite. The main-satellite is a rectangular, inside of which was divided into eight layered rooms for equipments installation. On-board equipments and devices were all directly integrated on the shelves of the rooms without individual shell. The sub-satellite is stowed inside the main-satellite before released. It can stretch out through the coil-compactable/deployable mast and then the main- and sub-satellite will be connected by the mast on orbit. Duralumin alloy was chosen as structure's main material.

Within the main satellite, nine shelves connected with beams and sleeves are composed as the main load bearing structure. The present structural mass is 11.667kg, which is almost one third of the total weight of the satellite (designed as 35kg). In order to improve the load capacity, topology optimization technique was applied to seek the optimal material distribution of the shelves in the main-satellite. The finite element model was established to predict the modal characteristics and stress distribution of the satellite present structure. Meanwhile, vibration tests were performed to verify the FE model through comparing the analysis and test results. After that the work turned to construct the structural optimization problem applied Altair HyperWorks, in which compliance was taken as objective function, the shelves as the design variables, and volumefrac, frequencies, Stress, displacement and on board equipments as the constraints. The results are expected to guide the design of lightening holes in the shelves to decrease the mass and meanwhile maintain the structural stiffness. Fig.1 and 2 shows the preliminary optimization results.

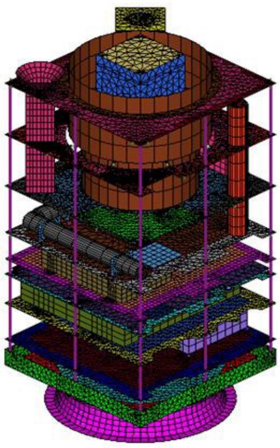

Figure 1. FEM model of BUAA-SAT

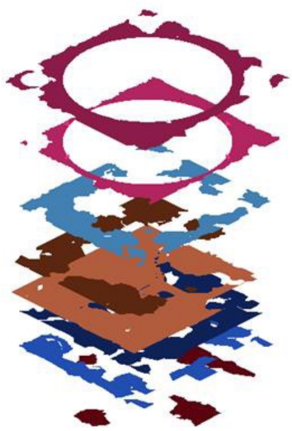

Figure 2. Density contours of shelves after topology