Paper ID: 24470
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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures I - Development and Verification (Space Vehicles and Components) (1)

Author: Mr. Huang Fan
Shanghai Institute of Satellite Engineering, China, 425013563@qq.com

THE SATELLITE TOPOLOGY OPTIMIZATION OF TRUSS STRUCTURE AND ITS SIZE SENSITIVITY ANALYSIS

Abstract

With the development of satellite structure technology, more and more design parameters will affect the satellites' structural performance. It is desirable to obtain an optimal structure design, including optimal configuration and sizes. This paper describes an optimal design of a satellite structure, including topology optimization and size optimization, aiming to reduce weight as much as possible and improving the dynamic characteristics under the design requirements.

Firstly, this paper carried out a topology optimization of the key part of a satellite structure (truss structure) . Topology optimization of truss structures commonly use discrete structure. However discrete optimization methods have many disadvantages, it's necessary to adopt continuum structure for topology optimization to find the main load-bearing path of the structure to get the optimal configuration. This paper gave a topology optimization of the truss structure using continuum structure by setting the design area, constraints and load conditions. Then, a continuum structure was optimized by the topology methods with the target of the maximum stiffness, obtaining the main load-bearing path of structure, and finally the truss structure was redesigned. The dynamic characteristics of the truss structure improved significantly via optimization, while the weight of truss structure decreased from 17.2 kg to 11.4 kg, and the basic frequency of truss structure increased from 117.3 Hz to 136.5 Hz, increased by 16.4%.

Secondly, although the topology optimization mentioned above has got the optimal configuration of truss structure, it can not obtain the optimal section dimensions. As the same, the optimal sizes of the rest structure are still not known. Therefore, this paper then do the sensitivity analysis and size optimization of 18 size parameters of the whole satellite structure and the optimal values of design parameters are achieved, which reduced the weight of the satellite structure dramatically. The weight of satellite structure decreased from 513.8 kg to 404.0 kg, decreased by 21.4%, while the basic frequency of satellite increased from 11.4 Hz to 12.0 Hz, increased by 5.3%.

The simulation result indicates that using continuum structure to do the topology optimization of truss structure is feasible. Furthermore, if combined with the sensitivity analysis and size optimization, the optimization performance will be more remarkable.