MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Interactive Presentations (IP)

Author: Dr. Xinyu Zhang
Beijing Institute of Aerospace Systems Engineering, China Aerospace Science and Technology Corporation (CASC), China, univerchang@hotmail.com

Dr. Guo-hui WANG
Beijing Institute of Aerospace Systems Engineering, China Aerospace Science and Technology Corporation (CASC), China, mr_qifeng@hotmail.com
Dr. Hong Lin
Beijing Institute of Aerospace Systems Engineering, China Aerospace Science and Technology Corporation (CASC), China, LinhongCalt@163.com
Dr. Huilian Peng
Beijing Institute of Aerospace Systems Engineering, China Aerospace Science and Technology Corporation (CASC), China, huilian.peng@gmail.com
Mr. Yaoxiang Zeng
China, zengyaoxiang01@163.com
Mr. Mingzhe Wang
Beijing Institute of Aerospace Systems Engineering, China Aerospace Science and Technology Corporation (CASC), China, csleon3@163.com
Mr. Yi Chen
Beijing Institute of Aerospace Systems Engineering, China Aerospace Science and Technology Corporation (CASC), China, chenycalt@gmail.com
Mr. Xueyan AN
Beijing Institute of Aerospace Systems Engineering, China Aerospace Science and Technology Corporation (CASC), China, luwei.spacecraft@gmail.com
Dr. Qi Tang
Beijing Institute of Aerospace Systems Engineering, China Aerospace Science and Technology Corporation (CASC), China, TangqCalt@163.com
Mr. Qun Zhang
Beijing Institute of Aerospace Systems Engineering, China Aerospace Science and Technology Corporation (CASC), China, zhangqun_09@163.com

A NEW APPROACH FOR THE ENVIRONMENTAL ADAPTABILITY DESIGN, ANALYSIS AND VERIFICATION OF A LARGE SPACECRAFT

Abstract

A '3-step' environmental adaptability analysis and verification procedure for a large spacecraft was proposed:
1)The FEA model of the spacecraft (SV) was established and then combined with the launch vehicle (LV) model. The coupled load analysis was then developed by which the internal node transient acceleration responses and the dynamic interface forces of the spacecraft were obtained. The structural components and the equipment items were designed to bear the design load reflecting the dynamic forces and the

vibration test conditions reflecting the vibration environments, respectively.
2)A system level vibration test with low input level was conducted to get the frequency responses and the damping characteristics of the spacecraft .Through the low frequency vibration test of the whole spacecraft, the response characteristics of each measuring node along the main structures were obtained, and the calculation accuracy of the finite element model was verified. Simultaneously, it was proved that the damping ratio of the calculation model was conservative, and the damping ratio increased with the input level raised.
3) Static strength calculations for all structure components were carried out and relative weaknesses were found out. Then real static tests just on the relative weakness conditions were developed to bear the design loads. The low-frequency vibration testing of the equipment items were accomplished to prove the mechanical environment adaptability, with the test conditions from step 1, which enveloped the shock response spectrum (Q=20) of the corresponding transient acceleration responses.

Thus, the environmental adaptability of the whole spacecraft was finished, mainly based upon simulation and analysis.The spacecraft acceptance and qualification vibration test were not adopted as the design basis.This approach reduced the damages to the structure products and equipment items in the vibration test of the whole spacecraft as the input level was restricted.The static test was carried out to verify the bearing capacity of the weaknesses in the structural components identified by the static analysis. By means of individual vibration test, the equipment could ensure the environment adaptability in the launching period. The structure products which had experienced vibration tests and static tests were used for the real flight mission and performed successfully.