IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Interactive Presentations - IAF MATERIALS AND STRUCTURES SYMPOSIUM (IPB)

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CONTACT AND IMPACT DYNAMICS BETWEEN A SPACE FLEXIBLE NET AND AN INFLATABLE BOOM

Abstract

More and more flexible net systems are studied for capturing large space debris and failed satellites in space. Meanwhile, more and more inflatable structures are implemented in space vehicles, such as inflatable rigidized solar panels, inflatable booms and inflatable deployable habitation pod. Therefore, there is a new need to study the contact and impact dynamics between a space flexible net and an inflatable structure. Compared to the contact and impact problem between a space flexible net and a rigid object, the contact and impact dynamics is more complicated due to the interaction between two full-flexible objects, which has not been paid much attention. In this paper, the contact and impact dynamics of a space flexible net with flexible inflatable boom is studied by the method of nonlinear finite element dynamic simulation. The software ABAQUS is used for this aim. The inflatable boom is modeled by M3D3 and M4D4 membrane elements. In addition, considering that the rope of net can only withstand tensile loads, but not compressive load and bending load, the truss elements which can only withstand axial tension force are used to model the flexible net. The contact and friction interaction between the net and the inflatable boom are defined and the Dynamic/Explicit analysis module of ABAQUS is used to solve the dynamics problems. The detailed contact and impact behaviors of the two flexible structures are obtained. The effect of initial impact velocity, the relative attitude and the air pressure of the inflatable boom are analyzed and discussed. The differences between the contact impact process of two flexible bodies and the process of a rigid with a flexible net are found. The deformation of the net, the contact force, the structural stress and the reaction force at the boom root during the impact procedure are also given. The simulation results show that the inflatable boom will eventually bounce off the space net and it largely affects the capturing result. The pressure inside the boom gives the basic structure stiffness and is identified as a main factor influencing the contact force and reaction force to satellite main body. This study can give a reference for the future design of the space flexible net for capturing space objects with inflatable structures.