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Author: Dr. xuan sun
China

ANALYSIS OF IMPACT DAMAGE ON STIFFENED COMPOSITE PANELS OF SPACECRAFT

Abstract

In order to develop a structure of spacecraft which is more damage-tolerant, it is necessary to understand how the damage is caused and how it affect residual performance. Many investigations of impact damage in carbon-fiber composites were usually testing on small laminates rather than full-scale structures. Several important issues regarding simulation of composite structure due to impact were investigated including damage initiation and the corresponding change of stiffness. The finite element model (FEM) of low-velocity impact damage on the composite structure was established via the nonlinear finite element method, combined with the user-defined materials subroutine (VUMAT) of the ABAQUS software. The structural elements chosen for the investigation comprised a series of stiffened composite panels of spacecraft. By impacting the panels at different positions relative to the ribs, the effect of relative position of ribs was found out. Then the simulation results were compared with experiments data . The effects of physical and geometrical parameters such as initial potential energy of the impactor, location of the impacted site on the stiffened composite panels and the material density of the core on dynamic response of stiffened composite panels had been researched.The structure geometry decided the structure's damage resistance. The incident energy was absorbed mainly through elastic of structure when impact in the bay. However, it was absorbed through damage of stringer when impact on the substructure. The proximity of substructure would significantly affect energy absorption and damage mechanism. They depend on the complex interaction of these structural details. It is necessary to understand the way how the structure influence damage. When impacting happened, the kinetic energy of the impacting should be transmit to structure, fully or partly. These may be elastic deformation of structure, vibration of structure and damage of structure. The impactor rebound because that the energy transmitted through elastic deformation is recoverable, but the damage can't recover. It includes three type of damage mechanisms: fibre broken, matrix cracking, delamination. The first damage type is matrix cracking. But delamination is most concerned damage type in low-velocity impact. Although it is not visible, it also can cause a significant reduction in CAI(compressive after impact). Because of complicated damage type, the damage extent is not exactly reflecting the degree of damage, so the residual strength is not directly related to the impact damage size.The paper is helpful for the design of stiffened composite structures of spacecraft.