

MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Environmental Effects and Spacecraft Protection (6)

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GENERIC STUDY AND SIMULATION OF IMPACT
IMPACT LOADING ON ELASTIC STRUCTURE

Abstract

Impact loading on elastic structure up to the plastic limit due to collision with foreign object is relevant for various reasons, among others to understand the load distribution, progression and the impact-damage mechanism as well as to obtain relevant performance factors for the design of components for structural protection. Earlier studies by the author and colleagues have reviewed impact processes starting from the idealized and fundamental formulation associated with impact loading of a relatively small sized rigid body onto an elastic structure to impact loading on plate-like space structure, prior to its collapse. The main objective is to assess how simple and generic modeling and analysis could be utilized to gain understanding on more general and complex situations and for preliminary design estimation. The progression of the stresses, strains and deformation due to the loading has been modeled, developed and traced using analytical and numerical method.

Following such procedure, finite element analysis has been performed to simulate beam and panel structure subject to impact for the determination of the choice of material for effective functioning of the structure. Comparative study has been carried out to look into acceptable safety margin for steel and Fiber Reinforced Polymer (FRP) beam, and the study has provided design criteria for weight, strength and energy absorption capability of each structure and material. The present work is then devoted to analyse and carry out finite element simulation of ballistic impact on panel structure of various materials and dimension to study the progression of stresses, deflection and strain, and the influence of relevant impact parameters and panel materials in exhibiting their behavior and characteristics. Three cases are considered; the first incorporates solid metallic panel, the second to incorporate an artificial and uniform panel to simulate honeycomb panel with equivalent properties, and the third incorporates Fiber Reinforced Polymer (FRP) composite panel. Parametric study is further carried out to arrive at some favorable configuration using weight, strength and energy absorption criteria. In particular, composite materials are attractive candidates for weight saving space related applications because of their high specific strength and stiffness. However, when their use in highly stressed structures is considered, their peculiar behaviour under low velocity impact need to be investigated. Furthermore, the ability of generic panels of comparable properties to simulate impact response behavior is assessed.

Keywords: Impact analysis, Structural Analysis, Structural Dynamics, Finite Element analysis, Engineering Analysis, Engineering Design, Composites