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ANALYSIS OF COMPOSITE PLATE SUBJECT TO SPACE DEBRIS IMPACT FOR UNLIKELY PENETRATION CASE

Abstract

In the design of impact resilient structures in many Engineering Applications, one has to resort fundamental principles and take into account progress in analytical and computational approaches as well as in material science and technology. The development of high-strength, high-modulus fibers, has allowed the development of impact resistant and compliant laminates. At a sufficiently low velocity, below the critical velocity, initial stress in the laminates increase is insufficient to rupture the fibers; thus allowing transverse deflection and fiber extension time to propagate, resulting in the absorption of energy by the laminate. Fibers possessing high-tensile strengths and large failure strains can absorb considerable amounts of energy. The impact velocity will affect the performance of compliant and resilient laminates. However, the mechanisms associated with the different velocities needs to be quantified. It has been observed that higher velocities and sharper impactor tend to shearing across the fibers of compliant laminates, rather than extending them to failure. It should be noted that when fibers are struck at a sufficiently high velocity, they can rupture instantly at what has come to be known as the critical velocity. For impact compliant composite laminates, damage mechanisms are dependent on the impactor geometry and velocity, the properties of the matrix and fibers and the fiber-matrix adhesion. In addition space debris hazard has to be considered to quantify the risk and the determination of appropriate means to protect the spacecraft. An improved understanding of the debris environment, combined with the growing availability of analytic and experimental tools, could assist the assessment of the debris hazard and protection of the spacecraft. With such perspectives, this work looks at a plate structure modeled as Mindlin-Reissner plate subject to impact loading and carry out analysis and numerical simulation. The first objective of the work is to develop a computational algorithm developed earlier to analyze flat plate as a generic structure subjected to impact loading for numerical simulation and parametric study. The analysis will be based on dynamic response analysis. The second objective is to utilize the computational algorithm for direct numerical simulation, and as a parallel scheme, commercial off-the shelf numerical code is utilized for parametric study, optimization and synthesis. Through such analysis and numerical simulation, effort is devoted to arrive at optimum configuration in terms of loading, structural dimensions, material properties and composite lay-up, among others.