Paper ID: 25368
student

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

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HIGH VELOCITY IMPACT BEHAVIOR OF COMPOSITE SANDWICH PANELS WITH SELF-HEALING CAPABILITIES

Abstract

In this study, the high velocity impact behavior of dual-plate sandwich panels composed by a carbon fiber reinforced plastic (CFRP) laminate and an ionomer thermoplastic resin plate is investigated, a unique characteristic of this sandwich panel is the ability to auto-repair holes generated by impacts. This is due to the ionomer layer, which has been observed to self-repair holes following an impact event. Besides the self-healing ability, the sandwich panel is also a structural element since it includes a CFRP laminate layer, which is widely used for structural applications due to its mechanical properties. The objective of this work is to study the damage induced on the target by the projectile, and the protective capabilities of the sandwich panel under various impact conditions. Furthermore, the tests presented herein provide additional information on the self-healing capacity of the ionomer when applied in a multilayer plate configuration subjected to high velocity impacts. An experimental campaign was conducted using two different diameters for the projectiles, namely, 2.3 and 3.5 millimeters. All projectiles were made of aluminum and had a spherical shape. The impact velocities of the projectiles were in the range of 2-3 km/s. All impacts were normal to the target and impacts on each side of the panel were investigated (i.e. impact on CFRP and on ionomer). The damage on the target was estimated through the measurement of the hole diameter, visible damage on the target surfaces and delamination of the interior layers. This latter parameter was detected and measured via an ultrasound flaw detector. The protective capability of the panel was assessed by studying the debris cloud ejected from its rear side. This includes the cloud velocity, damage potential and momentum of the fragments cloud. The velocity of the debris cloud was determined by analysing the high speed camera films of the impacts. The damage on the witness plate was used to describe the damage potential of the fragments. A ballistic pendulum was used to determine the momentum transfer of the debris cloud to the witness plate. As a result, it was observed that the ionomer exhibits self-healing abilities under the conditions applied herein, resulting in partial or complete reparation of the hole. Furthermore, empirical equations were derived to correlate the impact damage parameters and the test conditions. Such correlations are useful to design optimized sandwiches for structural and protective applications.