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EXPERIMENTATIONS WITH LSDYNA VALIDATION OF SPACE DEBRIS HYPERVELOCITY IMPACTS ON MULTIPLE COMPOSITE BUMPERS

Abstract

Space debris hypervelocity impacts in LEO region is a serious concern for the spacecraft structural engineers to deal with especially when the advanced and upgraded composite material technology is involved.This paper deals with the hypervelocity impact of space debris in the lowEarthorbit environment on the composite structures especially when the angle of impact is oblique and multiple bumpers being used in different orientations with predefined standoff distance to check the effect on space debris propagations and carbonepoxy composites effectiveness.Lastly LSDYNA simulation with its special SPH module was done to find out the correlation among experimental and simulated results.CU125NS prepreg was selected being superior on the basis of previous experimentations, with the stacking sequence of [(0/45/90)2]s in 16layers.The laminate with average dimensions of 120x120mm2 was manufactured in autoclave by adopting standard procedures followed by its exposure to LEO environment where they were exposed to high vacuum of 10-6to10-7 torr.Simultaneously the specimens were exposed to UV radiation,atomicOxygen and thermal cycling. Lastly, the space debris impact was achieved by using light gas gun with Helium and Air within the velocity range of 1500+-500m/s.The total mass loss in composite specimens after exposure to LEO environment was found 0.40% on average.Afterwards the impact experiments were done on multiple composite bumpers in normal and oblique configurations.The velocity before and after the impact on specimens were measured by laser and magnetic intervalometers which then converted to energy.The specific energy absorption pattern for double bumper with standoff distance was found on average 33% and 45% higher in comparison to that of single bumpers and double bumpers with no standoff distance respectively.In the end,LSDYNA software with special SmoothParticlehydrodynamics(SPH) module was used to validate the experimental results for the space debris propagation and its effect on the composite bumpers.The materials card used were SPH_MAT_59.The properties were calculated for the laminate on the basis on composite mechanics from prepreg properties and then provided in the software for the simulation but for the Al2017-T4projectile,MAT_ELASTIC_PLASTIC_HYDRO card was used with Gruneisen equation of state (EOS) for high strain rate effect.The experimental results concluded that the orientation of first bumper plays a critical role in the space debris propagation. The energy absorption was mostly done by fiber breakage and their deformation and matrix fracture. The simulated results showed how the space debris propagates in the real time environment.It took only fraction of micro-sec to penetrate the composite bumpers with the complete damage of specimen.