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COMPRESSION BEHAVIOUR OF COMPOSITE SANDWICH PANELS IMPACTED AT EXTREME TEMPERATURES FOR SPACE APPLICATIONS

Abstract

Composite materials are best known for their excellent mechanical and thermal properties and their lightness which make them good candidates for space applications. Composite sandwich panels are considered for the fabrication of lunar exploration rovers. However, composite sandwich panels are sensitive to out-of-plane loadings such as impacts. On the moon, the rover will operate on a rugged terrain with limited visibility of the real nature of the ground due to the presence of a thick layer of loose lunar dust. This can lead to possible impacts between the rover and its surroundings. Moreover, on the moon, the rover will be exposed to extreme temperatures for an extended period of time. During the lunar night, temperatures can go as low as -150°C. It is therefore important to understand the effect of extreme low temperatures on the behaviour under low-velocity impacts of composite sandwich panels for space applications. More specifically, the focus of this paper is on the effect of temperature during impact when looking at the compression behaviour after impact of composite sandwich panels. Damages induced by impact, more specifically delaminations, are indeed known for their detrimental effect on compression behaviour. Compression behaviour is something that will be seen as the rover continues operating on uneven and rough surfaces after an impact.

The sandwich panels studied are made of carbon-epoxy woven composite skins and a Nomex honeycomb core with hexagonal cells: [(±45)/(0/90)/(0/90)/(±45)/core/ (±45)/(0/90)/(0/90)/(±45)]. The resin used is a 977-2 epoxy. The constituents of the panels were chosen because they fulfilled requirements for space applications.

Impact tests are performed at -150°C, -70°C, and room temperature on a drop weight tower with a modified thermal chamber. Five impact conditions are tested. Two sizes of semi-hemispherical impactor are used with a possibility of three different impact weights. All the impact tests are performed with an initial velocity of 1m/s. Compression after impact tests are performed at room temperature with a mounting that prevents global buckling of the specimens.

Results of the impact tests showed that the level of damage increased with decreasing temperature. Those observations should be reflected in the compression after impact results. Moreover those tests will provide a better understanding of the role of temperature on the damage process during impact and on the effect of those damages on the mechanical behaviour after impact.