Influence of ply clustering on residual strength of 5HS woven composite laminates subjected to low velocity impacts

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ABSTRACT

Composite material is increasingly used in transport industry due to its high stiffness-to-weight and strength-to-weight ratios that allow reduce structure weight obtaining important economic and environmental benefits.

To increase the use of composite materials it is essential to understand its behavior when subjected to different types of loading, even in such extreme conditions as impacts, crash or explosion.

Concerning to impacts, it has been shown that low velocity impacts of large masses could induce different failure mechanisms such as matrix cracking, delamination and fiber failure. The apparition of these damages produces a decrease in the residual strength of the composite laminate that could affect the serviceability of the structure.

There are several laminate parameters that could affect residual strength properties. This work focused in the influence of ply clustering in residual strength of 5HS woven composite laminates subjected to low velocity impacts, using a combined experimental and numerical methodology.

In order to analyze the influence of ply clustering, it has been manufactured AGP 280-5HS woven coupons with three different stacking sequences: [(+-45)/(0/90)]4S, [(+-45)2/(0/90)2]2S, and [(+-45)4/(0/90)4]S.

Experimentally, laminates have been subjected to low velocity impact using a INSTRON-CEAST Fractovis 6875 drop weight tower and monitoring its behaviour using high speed Digital Image Correlation.

Experimental tests have been done according to ASTM standards (D7136 and D7137).

Numerically, the material model for the woven laminate considers different intralaminar failure mechanism, such as fiber failure or in-plane shear based on a Continuum Damage Approach; the use of cohesive interactions allows reproducing the interlaminar damage.