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Competing mechanisms in the unfolding failure in composite laminates

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Abstract

Highly-curved laminates are prone to fail by delamination when they are loaded under a bending moment which tries to flatten the laminate. This failure, commonly called unfolding failure, has been traditionally associated with the tensile interlaminar stresses which appear in the laminate, due to its high curvature. However, some specimens failing by unfolding present a maximum interlaminar tensile stress, at the failure instant, much lower than other specimens with different thicknesses or stacking sequences. This fact has been commonly associated with a thickness dependence of the interlaminar tensile strength for which no physical explanation can be found in the literature, although sometimes it has been attributed to manufacturing defects, which are assumed to be higher in thinner laminates. The present work considers the idea of a second failure mechanism named induced unfolding, which assumes that an intralaminar failure is responsible for the failure onset. Therefore, in some cases, the unfolding failure starts as an intralaminar crack which, under a high enough interlaminar tensile stress, propagates instantaneously, causing the delamination and the final failure. Analysing the results of a test campaign, proofs of the occurrence of this kind of failure on L-shape CFRP laminates of UD plies are reported.

Keywords: B. Delamination, B. Strength, C. Transverse cracking, Unfolding, Interlaminar failure.