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A 3D tomographic investigation to elucidate the low-velocity impact resistance, tolerance and damage sequence of thin non-crimp fabric laminates: effect of ply-thickness

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Abstract

While thin-plies delay the onset of matrix cracking and improve certain in-plane mechanical properties, the effect they have on the out-of-plane response remains unclear. We compared the impact resistance, tolerance and sequence of failure events of thin laminates manufactured with thin- or standard-ply non-crimp fabrics (fibre areal weight of 67 and 134 gsm per ply). Damage initiation and propagation was detailed using (a) quasi-static indentation and impact tests at incremental energy levels and (b) X-ray tomography. The analysis revealed the damage mechanisms underlying the observed load drops in the force-displacement curves. In the indented specimens, the 3D post-process ascribed matrix cracks and delaminations to their corresponding plies/interfaces. Standard-ply samples develop more extended delaminations and delay fibre failure, improving the load-carrying capacity and increasing compression after impact (CAI) strength by 27% for impact at 14 J.

Keywords: Thin-ply, B. Impact behaviour, C. Damage mechanics, D. CT analysis

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