



Impact Properties of Three-Dimensional Orthogonal Woven Composites with Ramie/Glass Fiber Grid Hybridization

Han Shaokun, Yang Chunbing, Chen Wei, Zhang Liwen, Xu Fujun*

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ABSTRACT

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To enhance the damage tolerance of ramie fiber reinforced composites, a novel three-dimensional (3D) orthogonal structure with graded ramie/glass fiber hybridization (warp/weft gradient hybridization, Z-direction glass fiber reinforcement) was proposed. After the 3D orthogonal woven fabrics as preforms woven by a self-built 3D woven loom, the composites penetrated by epoxy resin were fabricated via vacuum-assisted resin transfer molding (VARTM). In this work, the impact properties of three-dimensional orthogonal woven composites with ramie/glass fiber grid hybridization were investigated. Compared to pure glass fiber reinforced three-dimensional orthogonal composites and traditional laminates, the grid hybrid composites showed highest peak force and smallest damage area under 15 J impact. Furthermore, the post-impact residual strength of grid hybrid composites showed highest strength retention rate (over 90%), indicating its superior ability to preserve load-bearing capacity after impact. Notably, the GH-3DOWC demonstrated superior damage tolerance, reducing the damage area by 61.5% and maintaining a compressive strength retention rate of over 90% under 15 J impact. This study demonstrated the advantages of the grid hybrid 3D composites reinforced by ramie and glass fibers, providing new insights for developing low-cost, high-damage-tolerance green engineering materials.