

PROCEEDINGS

Deformation and Damage of Composite Casings Under Blade Impact: A Comparison of Carbon and Organic Fiber Composites

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ABSTRACT

Composite materials exhibit excellent application potential in aerospace structures such as aero-engine fan casings, due to their light weight and high strength. Aero-engine casings are required to possess blade containment capability, namely the ability to resist the impact of fractured blades rotating at high speed. Carbon fiber-reinforced resin matrix composites have been practically applied to fan casings of aero-engine models including GENx and Leap. Organic fibers such as aramid, PBO and polyimide (PI) also show promising prospects for application in such impact-resistant protective structures due to their excellent toughness, enabling further weight reduction or cost cutting.

In this paper, containment tests on simulated composite casing specimens under high-speed rotating blade impact were carried out on a high-speed spin test rig. Combined with experimental observations and simulation analysis, the deformation and damage characteristics of composite casings under rotating blade impact were investigated (see Fig.1). In addition, the protective performance and behavioral characteristics of carbon fiber composites and organic fiber composites during impact were compared (see Fig.2). The research results reveal that both carbon fiber and organic fiber composite casings deliver satisfactory containment performance and an extremely prominent elastic deformation capacity under high-speed rotating blade impact. Fiber fracture, large deformation and vibration occur simultaneously in the casing, jointly dissipating the impact energy of the blade. Compared with organic fiber composites, carbon fiber composites are dominated by matrix cracking and brittle fiber fracture, with regular-shaped damage openings. By contrast, organic fiber composites are characterized by matrix yielding, fiber deformation/pull-out and progressive tearing, featuring irregular damage openings and a hairy surface formed by extensive fiber fracture and pull-out. Comparative results under different impact energies indicate that organic fiber composite casings possess better containment capacity than carbon fiber composite casings at the same thickness. The research findings provide a technical basis and support for material selection, structural design and containment performance optimization of composite engine casings.

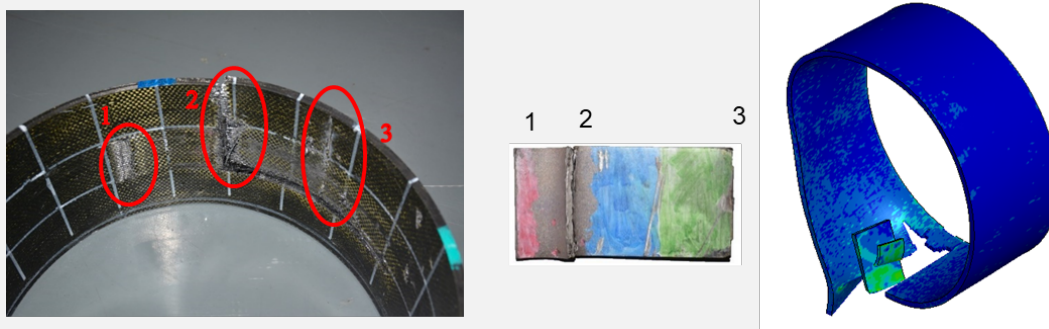


Fig.1. Experimental results and simulation analysis of composite casing damage under rotating blade impact



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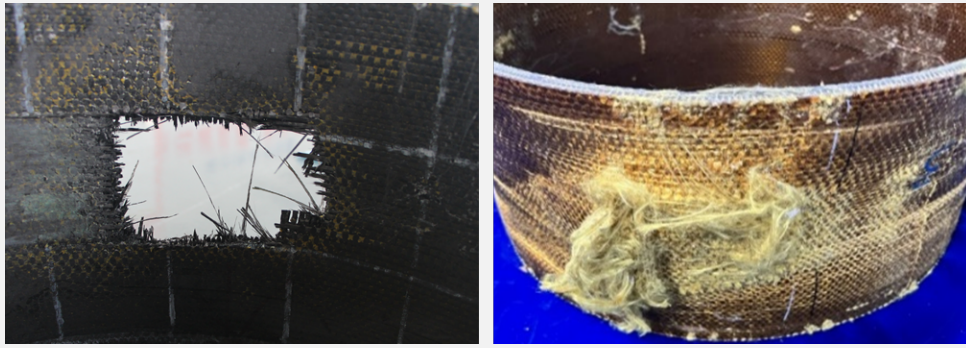


Fig.2. Impact damage comparison between carbon fiber and organic fiber composite casings

KEYWORDS

Composite casing; impact; rotating blade; carbon fiber; organic fiber; deformation; damage

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