STRUCTURAL COMPONENTS

Greene Tweed's Xycomp® DLF™ and Manufacturing Process Provides GE with Bracket Weight Savings

The Background

GE Unison, a division of GE Aerospace and a Greene Tweed customer, is a leading provider of commercial and military aircraft engine components.

GE was looking to reduce weight and keep all of the required capabilities of the EBU (Engine Build-Up) bracket by going to a unique composite structure.

Composite materials continue to displace metal in new aerospace platforms due to recognized performance, life cycle, and manufacturing examples. The Airbus A350 and Boeing 787 are two commercial aircraft examples, demonstrating more than 50 percent composite content [1].

Composites are commonly specified for large primary and secondary structure applications based on cost-effective benefits from weight reduction, design freedom, and service life. However, many metallic components still remain on the aircraft, at least in part due to a product capability gap for metal-replacement of 3D complex-shape parts such as structural brackets, fittings, enclosures and fairings, or other components where injection molding lacks sufficient performance and use of traditional continuous fiber composite materials is impractical (or impossible) due to the complex component geometry.

The Challenge

EBU brackets are used to position and support mechanical and electrical components for various systems located on the engine core and/or fan case. The challenge was to design and manufacture a bracket that could withstand vibration, temperatures (long-term service and repeated cold/hot cycling), abusive loading, and chemical resistance to typical engine fluids outside of a turbofan engine core section, while providing significant weight savings.

In a collaborative development effort between Greene Tweed and Unison Industries, a wholly owned subsidiary of GE Aviation, the team proved the suitability of Discontinuous Long Fiber (DLF) brackets for production service on commercial aircraft engines using compression molded carbon/PEEK thermoplastic composite DLF materials.

The Solution

Greene Tweed's net-molded Xycomp® DLF™ material and highly automated manufacturing process enabled a redesign of net-molded DLF carbon/PEEK EBU brackets. Compression molded DLF composites continue to see successful aerospace adoption for metal replacement opportunities, providing a viable non-metallic option for cost-effective production of complex-shape components.

Compression Molded DLF Carbon/PEEK EBU Brackets

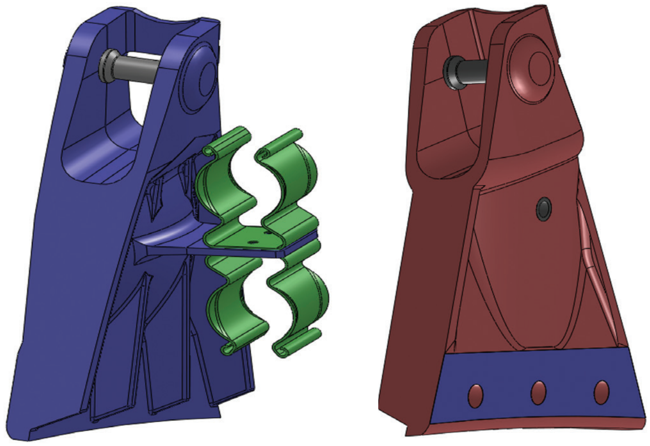
Greene Tweed's net-molded Xycomp® DLF™ material and highly automated manufacturing process enabled a redesign of net-molded DLF carbon/PEEK EBU brackets.

The key design considerations for converting metallic brackets to DLF include understanding ultimate and limit loads as well as any critical dimensions, tolerances, and application-specific “keep out” zones. The design freedom of DLF materials enabled a simplified bracket design, which could meet the requirements and functionality of the multi-piece baseline metallic part with a single net-molded DLF component.

Greene Tweed designed the Xycomp® DLF™ solution through a 3D micromechanics-based nonlinear framework for the analysis of DLF thermoplastic composite materials and structures [1]. The analysis framework is used to predict the performance of DLF brackets under different loading conditions.

Xycomp® DLF™ materials are produced by chopping high fiber content aerospace-qualified unidirectional prepreg tape into “flakes” or “chips,” followed by compression molding into net or near-net shape composite components. Heat and pressure from the molding process is used to melt the thermoplastic matrix for flow. The high viscosity of PEEK thermoplastic resin carries the reinforcement fibers uniformly throughout the mold, resulting in a random-fiber oriented composite with consistent fiber/resin fraction.

DLF brackets typically incorporate design features such as reinforcing ribs, threaded inserts, and co-molded latch pins. The design was then validated through a test program of prototype parts that simulated critical functional requirements for the desired EBU bracket application, which were determined by GE Unison Industries. These tests included insert torque tests, insert pull-out tests, and loading testing.



Redesigned Net-Molded DLF carbon/PEEK EBU Brackets

The Result

High-performance carbon/thermoplastic DLF materials offer conclusive advantages over metals, continuous fiber composites, and injection molding materials for defined complex-shape application niches. **Machining and assembly operations were eliminated or reduced, and the DLF brackets demonstrated 86 percent weight savings vs. the original metallic design.**

As the pace of composites adoption for aerospace structures continues to accelerate, there is a need for a cost-effective composite capability, allowing further elimination of complex 3D-shape metal interfacing components while providing weight savings, corrosion elimination, parts-consolidation, and other identified composite benefits. Compression molded DLF composites offer a viable, production-ready option for consideration to address this “metal replacement gap.”

[1] Technical Paper, “Complex-Shape Metallic Aircraft Engine Bracket Replacement Using Compression Molded Discontinuous Long Fiber Thermoplastic Composites,” Society for the Material and Process Engineering, 2005.

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