That which fits the mold: a braided composite wing

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Abstract

In this design study, a model airplane wing, partially constructed from braided composite panels, was made for the purpose of demonstrating the applications of braided composites for aerospace components. Fibres of Kevlar® were braided together along a tubular surface, then subsequently cut and unrolled to form two planar sheets of interlaced yarns that could be laid down in a 3D printed mold to later be coated in resin. The mold consisted of four parts: two female parts to shape the composite wing panels and two male parts to compress the composite. When connected together they form a fused core. A fibre sheet was draped over each female part, and its extraneous edges were folded inward to form a second layer as reinforcement. Each sheet was then laid up with Ecopoxy® resin and allowed to cure while sandwiched between the female mold and its corresponding male component. Upon disassembly of the mold system, a braided composite wing panel had formed upon both halves of the 3D printed core. The external portion of each panel was found to be smooth with few irregularities that could potentially compromise their aerodynamic performance. The mold was constructed to facilitate the process of cold-curing rather than curing at an elevated temperature. For heated cure process, the use of metal would be recommended because it generally deforms negligibly through heating and cooling. A metal mold would also be used to ease the process of debonding from the composite materials.Care should be taken to ensure that fibre orientation is consistent. The results illustrate how a mold can be fabricated to facilitate the process of curing braided composites, and can serve to improve the quality of products that require a higher strength to weight ratio.

Key words:

Braided composites, aerospace, mold prototype, 3D print, airplane wing, wing prototype, Kevlar, ecopoxy

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Introduction

- Composites are used to improve and develop products under certain parameters (durability, weight, and shape) [1]
- Aramid, or Kevlar® strands are interlaced to form a braided tube, then manipulated to form a sheet
- Braided composite is coated in resin and then, depending on the type of resin, is cured under elevated temperatures or at room temperature (cold-cured), to harden and reinforce it (fig.1)
- The applicability and manufacturability of this process is tested through the construction of a model airplane wing

Fig 1: Braided composite tube segment

Objectives

- Design an aerodynamic model airplane wing using composite materials manufacturing methods, demonstrating realistic applications of braided composite materials
- Identify materials that can be used in alternative curing processes

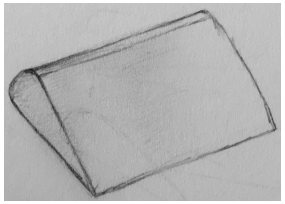

Fig 2: A concept design of plane wing. Air on top of the wing will move faster than air on the bottom of the wing, generating lift.

Methods

A draft of the wing mold was designed, while ensuring an aerodynamic shape (fig. 2). The steep top curve allows less resistance (drag) to be experienced.

Using SOLIDWORKS®, a 3D computer-aided design (CAD) software, model airplane wing mold was drafted (fig. 3).

The prepared 3D printed mold was used to lay the braided portion of Kevlar® down to then apply the resin (fig. 4). The wing begins to take shape.

The solid centres were pressed down to compress the layers and ensure an even spread of resin (fig. 5).

The two halves were cold cured for approximately two days and then joined to form a wing shape.

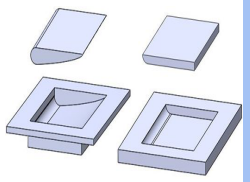

Fig 3: Compression mold of upper and lower wing halves

Fig 4: braided composite, sliced and laid flat

Fig 5: prepared for curing

Conclusions

- With SOLIDWORKS®, a model airplane wing mold was made
- The mold adequately sustained the process of material and resin application
- From a concave view, the fibre layout was misaligned slightly; although it resulted in a smooth, even exterior
- Future considerations of using a metal mold may encourage debonding in the event of opting for a heated cure [2]
- The nature of the plane wing may be better suited for a weaving machine rather than the tubular braiding machine
- The results demonstrate versatility in having produced aerospace parts

Literature Cited

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[2] .H. Vangerko, "Composite tooling for composite components," *Composites*, vol. 19, no. 6, pp. 483–484, Nov. 1988.

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