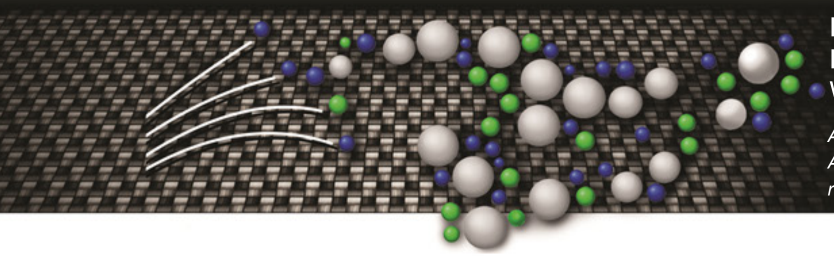
Skin-core Debonding in Resin-infused Sandwich Structures



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Introduction

As a result of their superior specific properties, sandwich structures based on low density core materials and strong, stiff composite skins are finding increasing use in a wide range of high-performance engineering structures. One particular area that is attracting significant interest relates to the design and manufacture of lightweight wind turbine blades for use in the energy-generation sector. Techniques for modifying and enhancing the interfacial fracture properties of foam-based sandwich structures are investigated in this study.

Objective

The objective of this research is to investigate the skin core interfacial fracture and compression properties by reinforcing perforations in a foam core.

Methodology

Holes were drilled into a PET foam in order to facilitate resin flow during the VARTM process. Glass fibers were inserted into the perforations in an attempt to increase the interfacial fracture toughness of the sandwich structure. The results are then compared to data generated from tests on a plain PET core as well as on samples in which no fiber reinforcement was incorporated into the holes. Tests were undertaken on the six types of sandwich structure designs.

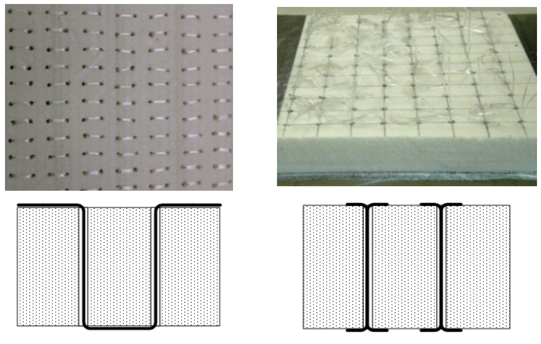

Figure 1:Schematic and pictures of the patterns for the through-thickness fiber reinforcement in the PET foam.

Material	Hole separation d (mm)	Hole fiber volume fraction %	Core density (kg/m^3)
A	n/a	n/a	130
B	25.4	0	153
C	12.7	0	203
D-S	12.7	1.5	205
D-D	12.7	3.0	207
E-S	25.4	1.5	157
E-D	25.4	3.0	159
F-S	25.4	1.5	163
F-D	25.4	3.0	167

Table 1: Summary of hole separation, fiber volume fraction in the perforations and overall core density for the various materials.

All of the sandwich panels were fabricated using the VARTM manufacturing technique. A schematic of the lay-up arrangement for the VARTM process is shown.

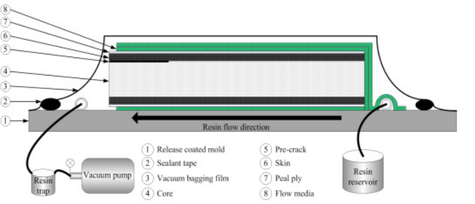

Figure 2:Schematic of the VARTM process

Results

Initial compression tests on sandwich structures based on the perforated foam cores indicated that the incorporation of either plain resin-filled perforations or fiber-reinforced perforations served to increase the compression strength of the foam.

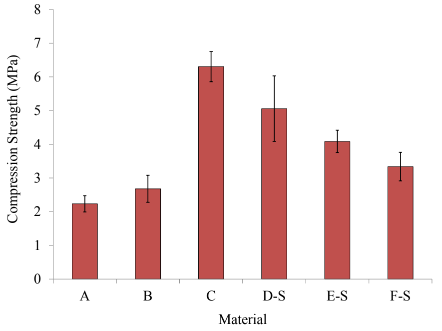

Figure 3: Summary of the compression strength of the core materials

The inclusion of fibers in the through-thickness holes served to increase the skin-core interfacial fracture toughness of the sandwich structures. Here, it was noted the highest values of fracture toughness were more than double the value measured on the plain foam system.

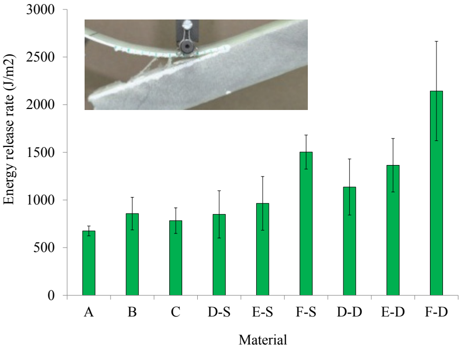

Figure 4: Summary of the interfacial fracture properties of the sandwich structures

Conclusions

The presence of resin-filled perforations increased the compression strength of the core. Introducing small amounts of glass fiber through the core resulted in a 300% increase in interfacial fracture toughness. The through-thickness fibers served to act as bridges that arrested and subsequently stabilized the crack.