Effect of Fabric Reinforcement on the Flexural Properties of EPS-Core Surfboard Constructions

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Introduction: The global surfboard market is dominated by polyurethane (PU) and expanded polystyrene (EPS) foam boards wrapped in an E-glass/polymer composite reinforcement. Existing research on fundamental surfboard material principles is focused on PU-core sandwich composite and sustainable/bio-based alternatives to the materials used [1-3]. The flexural properties of EPS surfboards are largely ignored despite their increasing popularity.
This paper investigates ten fabric reinforcements and their effect on the flexural behaviour and material toughness for EPS surfboards. To the authors' knowledge, this is the first study assessing the baseline flexural properties on EPS surfboards.

Method: The fabric reinforcements were chosen to represent specific categories of surfboards available. With single- and double-ply E-Glass (1EG, 2EG) representing standard board configurations, 0-90 and 45-45 weaved carbon fibre (90CF, 45CF) representing the new wave of high-performance surfboards and recycled polyethylene terephthalate (PET) representing a sustainable option for surfboard materials. All fabrics were supplied by Carbon Nexus, Geelong. For each fabric both medium (18.6kg/m^3) and high (26.9kg/m^3) density foam samples were produced as supplied by Geelong Polystyrene Products Pty Ltd. 5mm thick foam cored sandwich panels (5 x 420 x 480mm) were manufactured using a vacuum bagging process, with a single ply of fabric/resin reinforcement on either side of the foam (excluding 2EG, which had 2ply on each side). The epoxy resin matrix was the Vee-Tek 2-part SURFSET Flex resin. From each panel, six test coupons (12.8 x 120mm) were cut using an OMAX Waterjet 55100 machine. The flexural properties of each sample were determined using 4-point bend testing with a 50 kN Instron mechanical tester, following ASTM C393. From the results, the yield strength and strain were found using the 0.2% offset method. Material toughness at the point of ultimate stress was determined by the integration of stress-strain curves.

Results & Discussion: Fig. 1 presents the averaged flexural properties of the tested samples. The results indicate higher density foam offers higher flexural properties for identical fabrics. Of the composites measured H-90CF is both the stiffest and highest strength composite. When comparing other constructions, the H-1EG sample has a 7% difference in modulus to the M-45CF construction. However, the M-45CF has a 16% and 70% increase in flexural strength and material

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toughness respectively; indicating the M-45CF construction may provide greater resistance to creasing with almost identical flex.

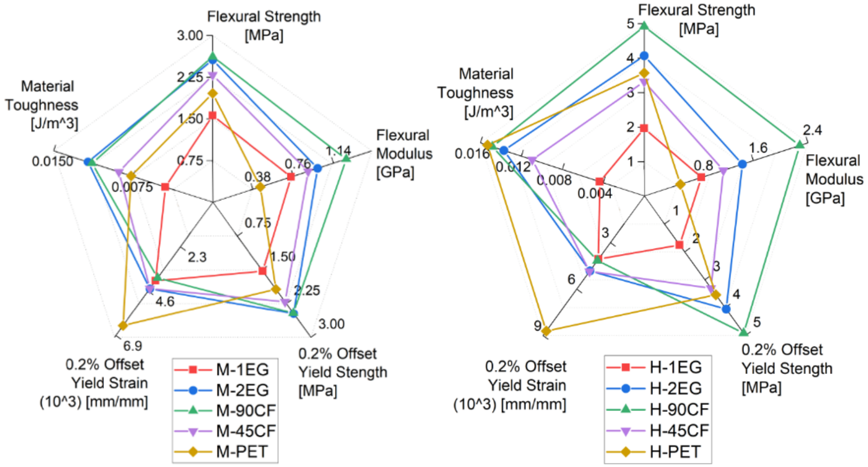

Fig. 1: Flexural properties for Medium-Density (Left) and High-Density (Right) EPS core sandwich composites.

A similar relationship is seen between H-45CF and M-90CF; here, H-45CF has only an 8% lower modulus than M-90CF but a 24% increase in strength. Conversely, a single layering of M-90CF can provide the same flexural strength as M-2EG while remaining stiffer.

Conclusion: Results reveal carbon fibre orientation significantly altered the flexural response of the foam core structure, which when orientated at a 45CF may provide a similar flexural response as traditional E-Glass while offering a higher ultimate flexural strength. Of the constructions investigated, the high-density EPS foam 90CF weave was the stiffest and highest in strength.

References:

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