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Yizhuo Li, Soraia Pimenta, Jordan Singgih, Stefan Nothdurfter, Karsten Schuffenhauer

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Experimental investigation of randomly-oriented tow-based discontinuous composites and their equivalent laminates

Yizhuo Li[a], Soraia Pimenta[a,*], Jordan Singgih[a], Stefan Nothdurfter[b], Karsten Schuffenhauer[b]

[a] *meComposites, Department of Mechanical Engineering, Imperial College London, South Kensington Campus, London, SW7 2AZ, UK*

[b] *Automobili Lamborghini S.p.A. Advanced Composite Research Center, Via Modena 12, 40019 Sant'Agata Bolognese (BO), Italy*

Abstract

The equivalent laminate assumption is a commonly-used method to model the random architecture of discontinuous composites, but which has never been validated experimentally. This study aims to verify the equivalent laminate assumption, focusing on tow-based discontinuous composites (TBDCs), which have higher fibre-content and thus improved modulus and strength, compared to conventional discontinuous-fibre composites. This verification was achieved by manufacturing and testing (i) actual TBDCs with randomly oriented tows and (ii) their equivalent laminates (ELs), at two different tow thicknesses. The results show that ELs exhibit the same failure mechanisms as TBDCs, and are similarly weakened by an increase in tow thickness. However, ELs lack the spatial variability in local fibre-content and local tow orientations, which makes ELs stronger than TBDCs. Therefore, the equivalent laminate assumption is suitable for predicting the modulus of discontinuous composites, but cannot predict their strength without considering the local variability in their microstructure.

Keywords: `A. Discontinuous reinforcement; B. Mechanical properties; C. Laminate mechanics; D. Microstructural analysis.`

1. Introduction

Tow-Based Discontinuous Composites (TBDCs) are a growing class of high-performance materials, composed of carbon-fibre tows randomly oriented and distributed in a polymeric matrix. Due to the discontinuous nature of the tows, these materials can be compression-moulded, which significantly improves their manufacturability. In addition, the tow-based architecture of TBDCs allows

*Corresponding author
Email address: `soraia.pimenta@imperial.ac.uk` (Soraia Pimenta)