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POLYETHER SULFONE INTERLEAVED GLASS/CARBON HYBRID COMPOSITE UNDER IMPACT LOADING

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ABSTRACT

Composite materials have high specific stiffness and strength and their use has been rapidly growing in engineering applications. However, poor impact performance is the major drawback for wider application of laminated these materials. Barely visible impact damage (BVID) severely reduces composite material's capacities and it is necessary to consider the presence of this damage already at the design stage [1]. Three main damages were highlighted in the literature as the main damage mechanisms in low-velocity impact of laminated composites: intra-ply cracking, delamination and fibre failure [2]. Delamination is the most common failure mode in laminated composite materials [3]. There are a lot of radical proposed ideas to reduce delamination of composites as a way to improve impact performance of composite laminates. These include matrix toughening [4], optimization of stacking sequence [5], etc. Use of these techniques to arrest delamination leads to weight and cost increase or reduces in-plane mechanical properties.

An interesting method, that can mitigate these problems, is interleaving the plies interfaces with ductile materials to improve the toughness and reduce delamination. These ductile materials can be categorized into particles (such as different types of micro and nanoparticles) and films (such as thermoplastic Nanofibres mats [6-8]. In order to have an efficient reinforcement effect, a careful consideration is required in the manufacturing, materials selection and reinforcement content and percentage. In addition, even if some had shown a significant improvement they might not be cost effective.

Carbon or Glass fibre reinforced polymer (GFRP or CFRP) composites have been widely used in different engineering industries for a long time due to their high strength to weight ratio and non-corrosive properties. However, to a certain extent, the strength of GFRPs is not strong enough to be primary structural components, while CFRPs may be too strong but relatively expensive. Hybrid composites made of GFRP and CFRP moderate the shortcoming of both fibres and maintain the superiority of both fibres, i.e. benefit from the high strength and light weight of Carbon fibre, and the low cost of glass fibre. However, the design of materials and structures becomes a key challenge on how to fully utilize the benefits of these fibres to make a structure strong enough to withstand different loads imposed on it.

This work presents an attempt to improve the low velocity impact performance of Carbon/Glass hybrid composites by interleaving with tough polyether sulfone (PES) membranes. The hybrid composite was made of a glass/epoxy block that was sandwiched between two carbon/epoxy blocks. The PES reinforced hybrid composite was compared with an unmodified hybrid composite. Experimental results showed that the PES results in an increase in toughness and can reduce damage propagation in the investigated composite panels during an impact event. Figure 1 shows cross-sectional side view of the impacted samples under different energy levels to reflect the damage status of the samples after the tests. The results showed that for low impact energy levels (6J, 12J and 18J), adding the PES membrane reduced the damage area compared to the virgin laminate by an average of 67%. However, by increasing the impact energy level (24J and 32J), fibre breakage was the dominant failure mode and the PES didn't have a significant effect on the impact performance. These findings

have implications in the design of impact resistant composite parts for civil, wind energy, aerospace and automotive applications.

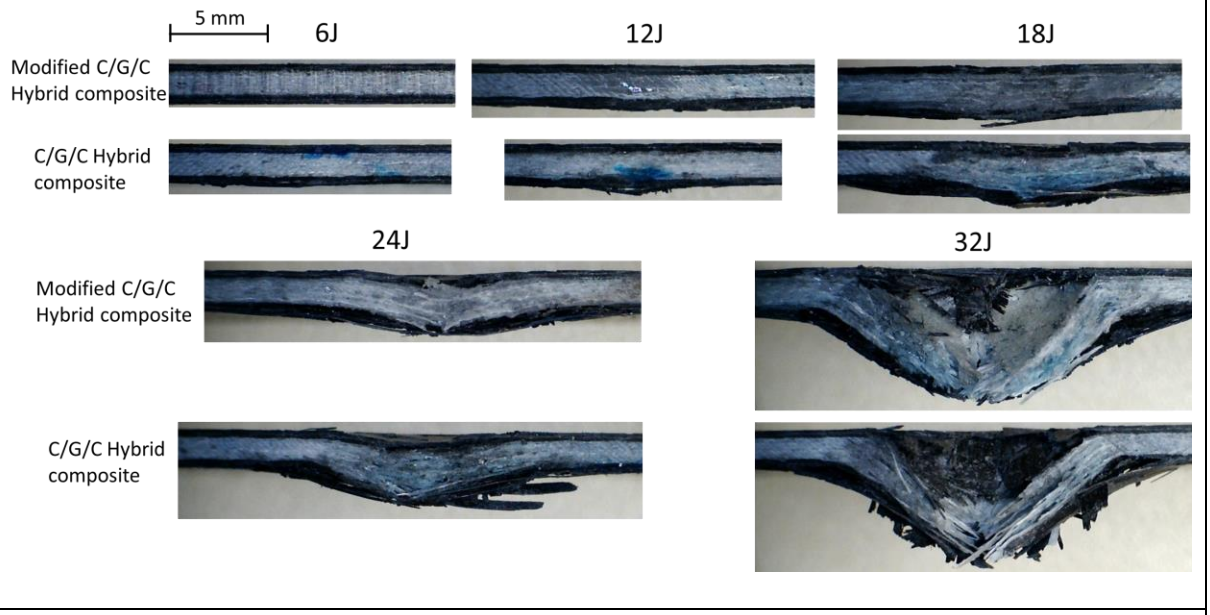

Figure 1: Cross-sectional image of the damaged specimens for different impact energy levels.

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