MODE I FRACTURE ASSESSMENT OF ADHESIVELY BONDED NON-CRIMP FABRIC CARBON FIBER/EPOXY COMPOSITE JOINTS

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The use of carbon fiber reinforced plastic (CFRP) composite materials for lightweight automotive structures has increased during the past decades, owing to their high specific strength, stiffness and energy absorption capabilities. The recent development of heavy tow carbon fiber-based non-crimp fabric (NCF) and the associated NCF composites provide additional advantages compared to composites comprised of woven or braided textiles, including reduced manufacturing cost and improved reinforcement performance [1]. A prevailing challenge for composite structures is the design and assessment of joining methods. Adhesive bonding provides advantages over mechanical joining methods such as lower structural weight by eliminating fasteners, lower fabrication cost, and improved damage tolerance [2]. As a result, adhesive bonding is a more widely considered joining method for assembly of composite structures.

This paper aims to investigate the fracture behavior of adhesively bonded NCF-CFRP adherends under a quasi-static Mode I loading condition. Double cantilever beam (DCB) test specimens comprised of unidirectional heavy-tow NCF-CFRP adherends with a $[0_7]$ stacking sequence were bonded using a toughened epoxy (Impact Resistant Structural Adhesive 07333, 3 M Canada Company). Three different bond-line thicknesses, including 0.25 mm, 0.4 mm and 0.65 mm were considered to assess the influence on Mode I fracture behavior. Moreover, a two-dimensional finite element model was developed using ABAQUS 6.14-2 to simulate the DCB tests and calibrate the corresponding cohesive properties.

The experimental outcomes revealed that the strain energy release rate (G_{Ic}) increased with increasing bond-line thickness of the adhesive (Figure 1a), which is important for the design and application of adhesively bonded CFRP joints in lightweight structures. In addition, a comparison of the experimental and predicted force-displacement response curves for the DCB specimens with 0.4 mm bond-line thickness reveal good correlation (Figure 1b). Subsequent work will focus on the effects of loading rate on G_{Ic}, as well as assessing the Mode II fracture characteristics of NCF composite adhesive joints.

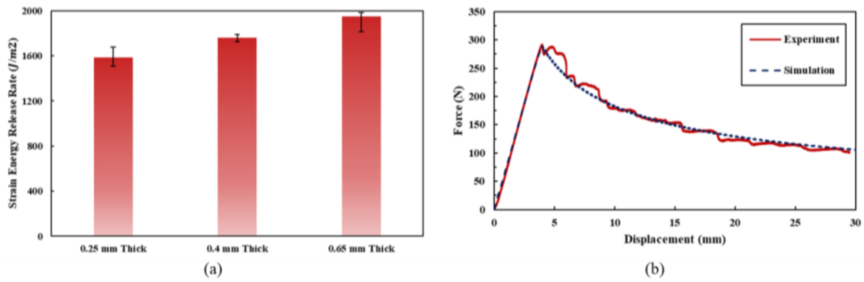

Figure 1. The comparison of (a) average G_{Ic} value for the DCB specimens with different adhesive bond-line thicknesses and (b) the experimental and numerical force-displacement response for the DCB specimen with 0.4 mm bond-line thickness.

References

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