Shear fracture energy measurement of adhesives using the cut central plies technique

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Introduction

Bonded structures in real applications are mainly subjected to shear loadings. Cohesive zone modelling (CZM) is an advanced tool in numerical assessment of the shear damage within the bondlines. One of the key parameters used in cohesive damage analysis of adhesive joints is the mode II fracture energy (G_{IIc}) of the adhesive. The most common method for measuring the GIIc of adhesive materials is the end notched flexure (ENF) test that provides reliable results but possesses some inherent problems specially for brittle adhesives [1]. Due to the lack of a standard approach, measuring the shear fracture energy of adhesives is still a challenge [1]. In this research, a new testing technique for the measuring the GIIc of adhesives is proposed based on the cut central plies (CCP) technique.

Joint geometries and tests conditions

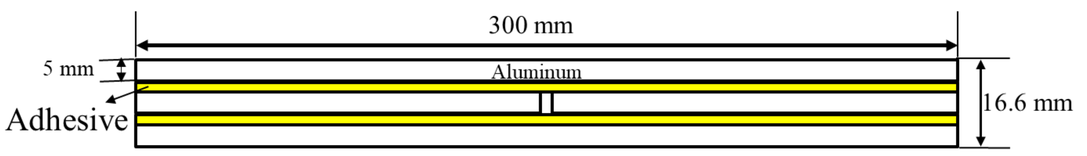


Figure 1 – Geometry of the tested joints.

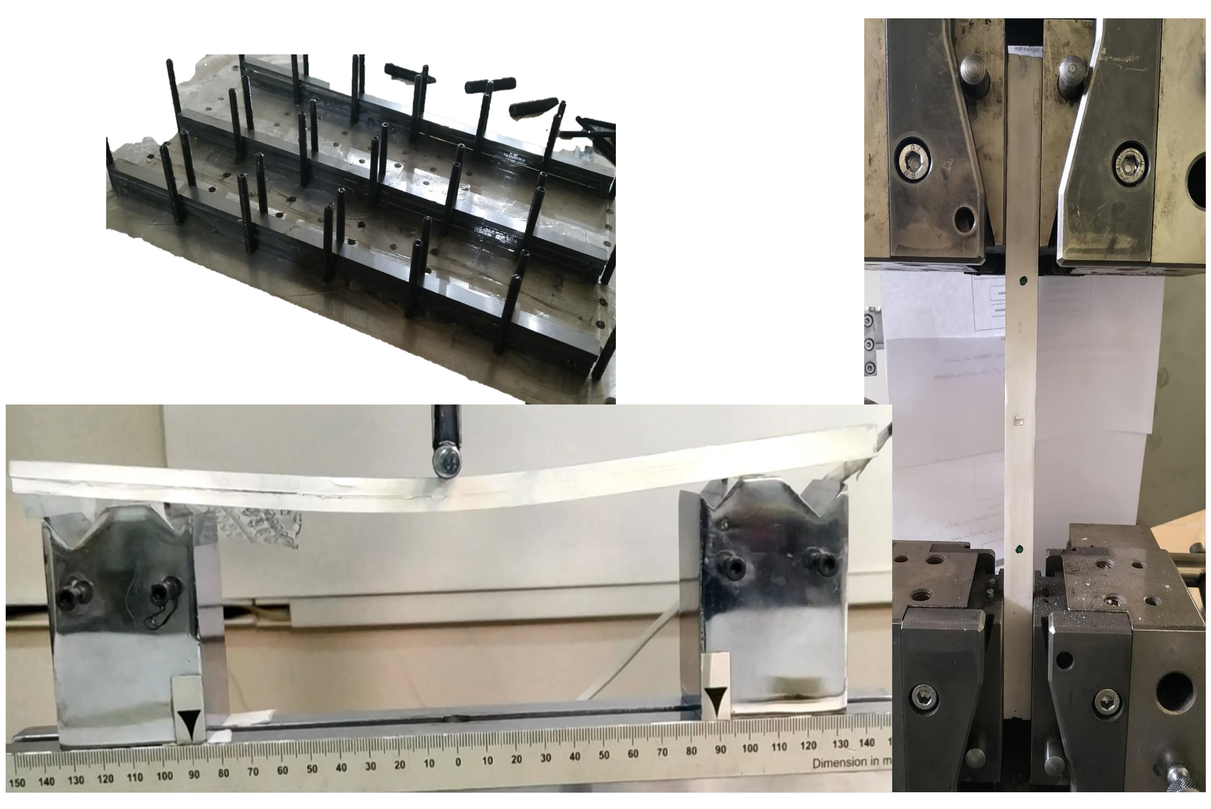


Figure 2 – CCP and ENF specimens (manufacturing and testing)

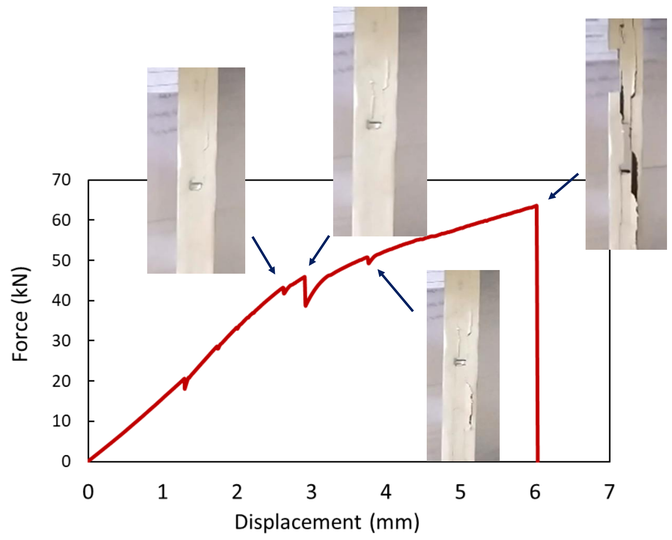
Fracture tests were carried out on adhesively bonded steel CCP specimens. Effects of adhesive thickness on the obtained fracture energy was also analyzed. The different adhesive thicknesses considered in this study are listed in Table 1.

Table 1– Adhesive thicknesses considered.

Joint type	t=0.2	t=0.4	t=0.8
ENF joint	-	-	✓
CCP joint	✓	✓	✓

Discussion

The CCP results were compared with the shear fracture energy obtained using ENF specimens. Numerical simulations based on the CZM approach were also successfully conducted.



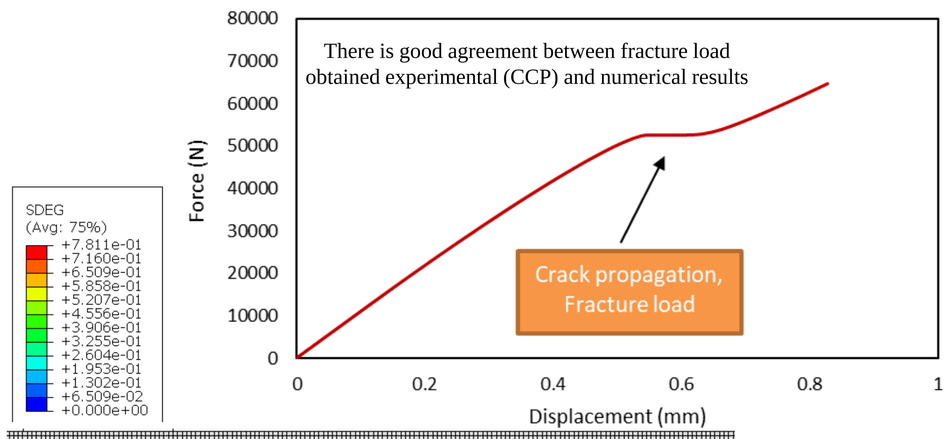


Figure 4 – (a) Typical load displacement behavior of specimens in static conditions; (b) Typical load-displacement behavior of specimens in dynamic conditions

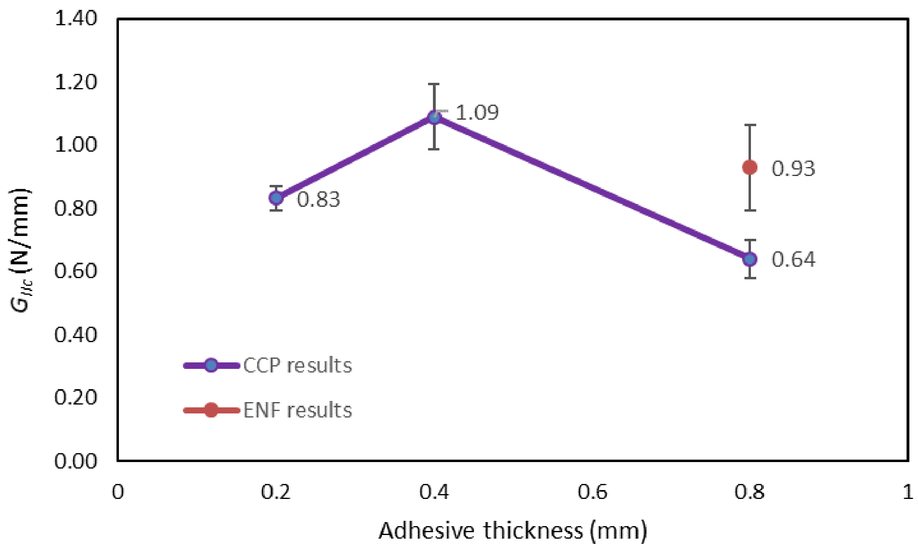


Figure 5 – Shear fracture energy, Effect of specimen type and adhesive thickness

Conclusions

Both the CCP and ENF specimens were evaluated to measure the shear fracture energy of a brittle adhesives. Although, for brittle adhesives the fracture occurs in a single step and the initiation fracture energy and propagation fracture energy are the same but using a CCP method it is possible to reach a more stable crack propagation for brittle adhesives.

Reference

[1] M.R. Ayatollahi, A. Ajdani, A. Akhavan-Safar, L. F. M. da Silva, “Effect of Notch Length and Pre-Crack Size on Mode II Fracture Energy of Brittle Adhesives”, International Journal of Adhesion and Adhesives, 87: 12-21, 2018.