



Effect of surface crack depth on hybrid laminated composites

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ABSTRACT

Purpose: The purpose of this paper researches to effect of different surface crack depth on hibrid laminated composites under low velocity impact forces.

Design/methodology/approach: Hybrid laminated composites have 90x25 mm size and 18 layers with two different stacking sequence. Low velocity impact test of hybrid laminated composites with surface crack have been investigated with different a/t surface crack parameters and 3 m/sec velocity.

Findings: The results are presented force-time and energy-time graphs than effects of different crack parameters were observed. As a result of this study, effects of surface crack depth on hybrid composite plates were analysed.

Research limitations/implications: The research of dynamic behavior of hybrid laminated composites with surface crack can contribute to literature searches.

Practical implications: These hybrid laminated composites materials could be used for different aviation areas.

Originality/value: This paper is based on studies from Selçuk University and all the experiments and results were conducted by me.

Keywords: Materials; Low velocity impact; Surface crack; Laminated composite

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TECHNICAL PAPER

1. Introduction

Fibre composites, such as carbon fibre-glass fibre/epoxy composites, devised over a half century ago, have found common applications in the aerospace, automobile and sport industries in recent years. The mechanical behaviour of composite materials is considered as one of the most important properties [1-2]. For example, plastic behaviour and damage under low-velocity impact

can possibly rise during production, maintenance, repair, or the lifetime of composite ingredients [3]. Some factors which can seriously damage composites cover wreck and foreign object damage. Whereas damage from low velocity impact is not ocular with eyes but may affect the material's residual mechanical properties [2-5].

Elastic behaviour of matrix materials and friction between reinforcement/matrix interfaces provide damping and result in impact energy allocation. In addition to

delamination between successive plies is also able to absorb considerable amount of impact energy [6-9].

2. Material and method

The composite plates were produced from Izoreel Company and have 90 mm x 25 mm dimension and 4 mm thickness. Mechanical properties are shown in Table 1. It was manufactured at two different configurations. In the first, the carbon layer is positioned interior of composites and the second; the carbon layer is positioned out of the composites (Fig. 1).

Table 1.
Mechanical properties of fiber

	Carbon Fiber	Glass Fiber
Elasticity modulus, GPa	230	72
Tensile strength, GPa	40	2.4
Poisson's ratio	0.3	0.27

All manufactured composites have same cost, equal size and different configurations. Surface cracks with different geometries were created to composite plates with using carbon discs [7].

The produced composite laminates have been subjected to low velocity impact tests, separately. Impact tests were guided with a drop tower by varying the height of the dropped impact head. The impactor has a hemi-

spherical tip with a mass 6.35 kg and diameter of 12 mm. The testing machine and impactor reputed to be perfectly rigid. A sensor in millivolts measured the force signals. The signals were amplified by a signal conditioner and transmitted to the data acquisition card installed on a computer. The variations of interaction force between the impactor and the sample versus time were obtained using NI Signal Express software. [7] The Newton's second law of motion was used to express the velocity and displacement of impactor versus time. When the impactor first hits the material, the kinetic energy of the impactor is partly transferred to the material. The remaining kinetic energy is used to rebound which makes the impactor to rise. This process continues until the kinetic energy of the impactor is fully expanded. The testing machine has an anti-rebound system which consents us to get only one impact. So, during the test the dropping weight has been catch immediately after it hits to the test specimens and following impacts have been refrained. The test specimens were placed into a fixture produced for placing and holding the test specimens at the point of impact. The low velocity impact tests were repeated three times under impact velocity of 3 m/sec, separately.

3. Results and discussion

The low velocity impact test results are given in Figures 2-3. Figure 2 shows the impact force-time behaviour for composite laminates subjected to different surface crack geometries. Figure 3 shows that the impact force-displacement behaviour for composite laminates with different surface crack geometries.

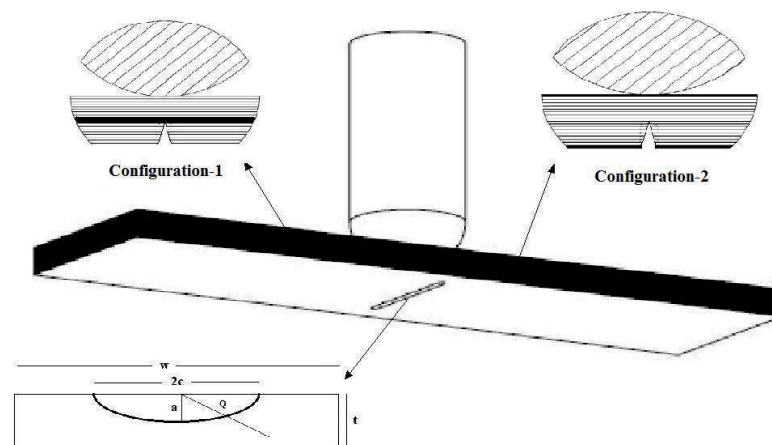


Fig. 1. Surface crack geometry

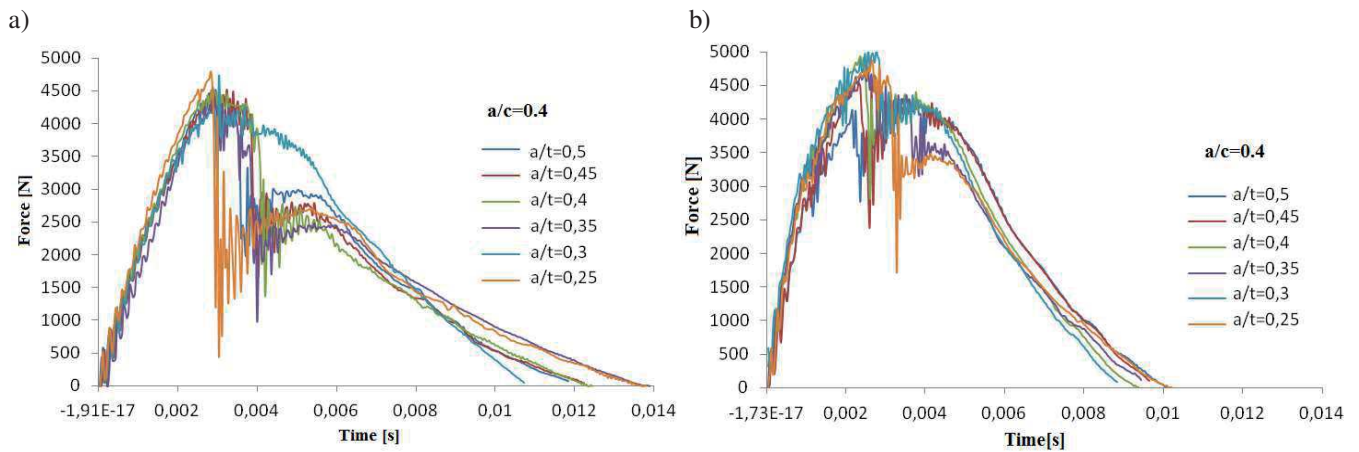


Fig. 2. Variation of contact force versus time for different surface geometry a) configuration-1, b) configuration-2

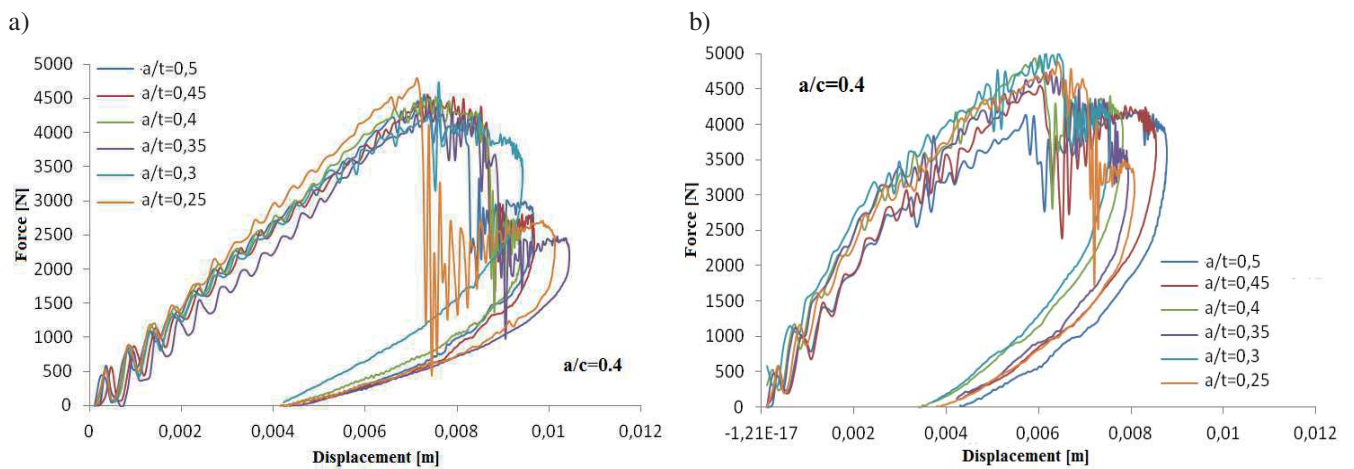


Fig. 3. Variation of contact force versus vertical displacement for different surface geometry a) configuration-1, b) configuration-2

At the loading phase, force increases linearly with displacement and achieves to its maximum rate. After this point the unloading phases starts with representing nonlinear behaviour. The slope of the loading phase of force–displacement curve is described as bending stiffness under loading. In the instance of delamination, bending stiffness decreases substantially and shows itself as depress in slope of force–displacement line. A fibre breakage generally results in decrease in stiffness associated with decrease in contact force [1,7].

Acknowledgements

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References

- [1] T.L. Anderson, Fracture mechanics: Fundamentals and applications, CRC Press, 1995.

- [2] Y. Tang, L. Ye, Z. Zhang, K. Friedrich, Interlaminar fracture toughness and CAI strength of fibre-reinforced composites with nanoparticles-A review, *Composite Science and Technology* 86 (2013) 26-37.
- [3] M.A. Hassan, S. Naderi, A.R. Bushroa, Low velocity impact damage of woven fabric composites: Finite element simulation and experimental verification, *Materials and Design* 53 (2014) 706-718.
- [4] F. Aymerich, P. Priolo, Characterization of fracture modes in stitched and unstitched cross-ply laminates subjected to low-velocity impact and compression after impact loading, *International Journal of Impact Engineering* 35 (2008) 591-608.
- [5] G. Belingardi, R. Vadori, Low velocity impact tests of laminate glass-fiber-epoxy matrix composite material plates, *International Journal of Impact Engineering* 27 (2002) 213-229.
- [6] M.D. Kulkardi, R. Goel, N.K. Naik, Effect of back pressure on impact and compression-after-impact characteristics of composites, *Composite Structures* 93 (2011) 944-951.
- [7] A. Gunes, Investigation of dynamic behaviours of hybrid stacked composite laminates with surface crack, Ms Thesis, Selçuk University, Department of Mechanical Engineering, 2013.
- [8] W. Trabelsi, L. Michel, R. Othomene, Effects of stitching on delamination of satin weave carbon-epoxy laminates under mode I, mode II and mixed-mode I/II loadings, *Applied Composite Materials* 17 (2010) 575-595.
- [9] D.D.L. Chung, Structural composite materials tailored for damping, *Journal of Alloys and Compounds* 355 (2003) 216-223.