THE FAILURE MODE OF NATURAL RAMIE EPOXY TRIGGERED COMPOSITE SQUARE TUBES

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Abstract— In this study, the quasi static compression test over natural ramieepoxy triggered composite tubes has been carried out.The natural ramieepoxy composite tubes include12pliesof woven natural ramie as reinforcement and thermoset eco greenepoxy resin as matrix which both of them have excellent mechanical properties. More over the natural ramie is one of the strongest natural fibers. It exhibits even greater strength when wet.The lengths of tubes are 50, 80 and 120 mm.External trigger which includes 4 steel pieces welded on downside flat plate fixture has been used for quasi static compression test of natural ramie epoxy composite tubes.In order to make the natural ramie epoxy composite tubes, the hand lay up fabrication method has been used. Instron universal testing machine with 250 KN load capacity has been used to accomplish this research.This research investigates the failure modes of natural ramieepoxy triggered composite tubes by representative photographs which havebeen taken by a high resolution camera (16.2 Mp) during the quasi static compression test.From the photos is observed the failure modes is progressive local buckling.

Keyword— Trigger Mechanism, Natural ramie composite, Buckling.

I. INTRODUCTION

With societies development, transportation vehicles also developed and the number of them growth day by day in the societies.Within previous centuries safety and economical difficulties of them lead to intensive amount of research in this field to design and develop such structures that be able to provide more functional and economic benefits such as weight reduction, enhanced strength and lower fuel consumption [1-6].

Researchers' consideration was addressed to use of new materials rather than conventional metals including steel and aluminum. Composite material because of their special properties as well as flexibility indesign make them attractive materials, and performed researches on them showed a properly designed composite structure has been demonstrated to be safer than conventional metallic structures, such as aluminum and steel [7].

In the other hand with increasing economical consciousness in societies, strict governments'concerns about finishing of fossil fuel with this consumption rate in 5-6 forward decades open a new approach in the field of material science. In order to deal with this problem, recently different typesof fully biodegradable composites are being developed as alternative for non-biodegradablepetroleum-based plastics and even metallic structures [8].

Recently, biodegradable materials have continued attracting worldwide attentions. From 2005 to 2009, the global market for the demand of biodegradable polymers was doubled in size. In 2009, Europe had the largest growth (5–10%)in the market of biodegradable polymers as compared with 2008 and this growth has kept continuing. The prediction of the total biodegradable polymersconsumption is to grow at an average annual rate of nearly 13% from 2009 to 2014 in Europe, Asia andNorth America asmain global markets of materials consumption [8].

In coming centuries, biodegradable composites are generally known as one of the important and key materials.Their properties can be custom-made to meetrequirements of various productsfor specific applications [8].The combination of strength, stiffness and processability under environmentally friendly conditions, makes ramie attractive for tough composite materialsas a potentialreinforcing fiber [8-10].

In this work, the failure mode of natural ramie epoxy triggered composite square tubes is investigated.

II. EXPERIMENT

The quasi-static compression test for natural ramie epoxy square tubes was conducted using a fully equipped and automated INSTRON MTS 810 universal testing machine with 250 kN loading capacity. All tests were performed at a constant speed of the test crosshead at 20 mm/min.Representative photographs has been taken by a high resolution camera (16.2 Mp) during the quasi static compression test.

The square section tubes had internal dimensions of80(mm)×80(mm)×length(mm) with 5(mm) radius curvature in the corners. The tubes had different lengths of 50 mm, 80 mm, 120 mm and their thicknesses were the same (1.7 mm) consisted of 12 layers of woven ramie fabric asreinforcement and eco green epoxy resin as matrix. ramie woven fabric asreinforcement and eco green epoxy resin as matrix. The hand lay up fabrication method has been used to make the natural ramie epoxy composite tubes. A schematic sketch of tubes is shown in Figure 1.

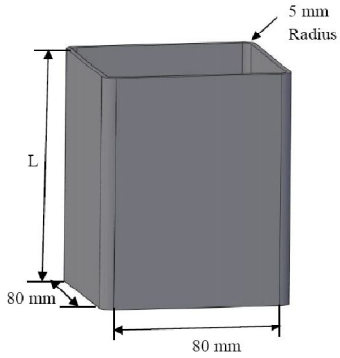


Figure 1 schematic sketch of specimen

Collapse triggering mechanism creates an area of locally concentrated stress at one end of the tube from which failure commence and then propagates[4].There are two types of triggering collapse mechanisms, namely, (i) no trigger, (ii) with triggering mechanisms.Modification of the specimenis no required in the external triggering mechanismand thus, it takes less time for modification and machinery and is re-usable.

One flat plate is used as crosshead of the press at the top and another plate which fourrectangular shape as external metallic trigger are welded on it is employed as down side fixture. Figure 2 shows the trigger configurations.



Figure 2 a) fixture used at the top and b) metallic external trigger plate used at the bottom

III. RESULTS

The quasi static compression test photos of 50, 80 and 120 mm triggered woven natural ramie epoxy composite tube have been shownin the Figures 3, 4 and 5 respectively.

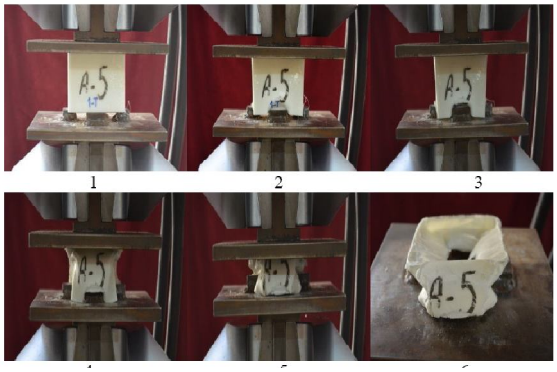


Figure 3 quasi static axial compression test of ramie/epoxy tube with 50mm length

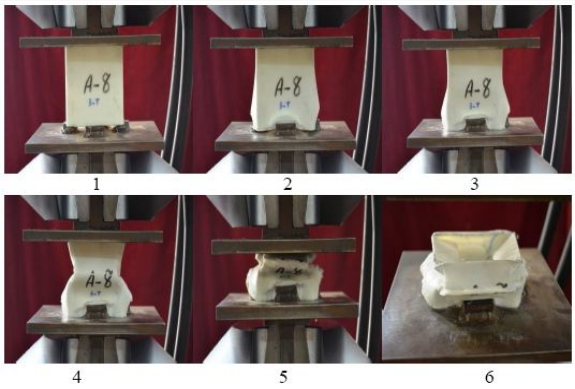


Figure 4 quasi static axial compression test of ramie/epoxy tube with 80mm length

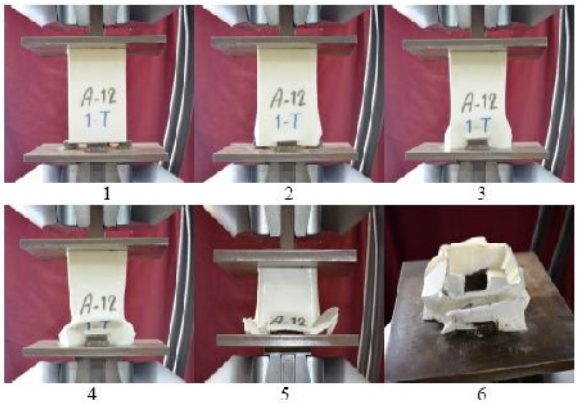


Figure 5 Quasi static axial compression test of ramie/epoxy tube with 120mm length

It has been observed from figures 3-5 that the failure start from the intersection location of tubeswith triggers. When the trigger indented completely inside the tube wall and tube meet the down side plate, the progressive local buckling failure began. As the failure of tube proceeds due to the concentration of stress at the corners, rapture is observed especially at the down side of tubesas another phenomenon.

IV. DISCUSSION

Mamalis et al. [2] reported in composite structures based on epoxy resin three mode of failure was observed including: local buckling and mid length buckling progressive end-crushing. However according to the Hull classification [3] there are two other failure modes; Euler overall column buckling and progressive folding with hinge formation.

One of the main problems that need to be solved before widely use of the natural fibres as reinforcement in energy absorbing systems is the understanding of how they behave as load-carriers [3]. In woven natural ramie epoxy composite tubes the progressive local buckling failure was observed.

CONCLUSION

In woven natural ramie epoxy composite tubes progressive end-crushing failure and Euler overall

buckling were not observed. The failure mode of woven natural ramie epoxy composite tubes was progressive local buckling. Triggered woven natural ramie epoxy composite tubes in contrary to brittle composite tubes deform in a plastic mode like metallic tubes and shown ductile failure.

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