EFFECT OF LAYER STACKING NUMBER ON CRASHWORTHINESS CHARACTERISTICS OF WOVEN NATURAL RAMIE EPOXY COMPOSITE TUBES

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Abstract— This research concentrates on the evaluation of crashworthiness characteristics of natural ramie epoxy composite square tubes energy-absorbers. Composite laminate specimens were subjected to static axial compression load and experimental evaluation of the energy absorption capability of ramie epoxy composite. Specimens were in the form of square cross-sections with the dimension of 80 mm × 80 mm and a radius curvature of 5 mm. The variables in the experiment were the thicknesses of the walls, consisting of laminates of ramie epoxy of 12, 24 and 30 plies for 50 mm length ramie epoxy composite tubes. The parameters measured werethe total absorbed energy (E_{total}), peak load (P_{max}) and the specific energy absorption (SEA).

Keywords— Fibres; Natural ramie Composite ; Energy Absorption.

I. INTRODUCTION

The crashworthiness of transportation structures as a parameter for evaluating the safety of a structure has become an important issue with the development of societies and the increment in daily transportation vehicle usage in the last century [1]. Crashworthiness is defined as the capability of a structure to protect its occupants in a survivable collision [2]. Two main parameters should be considered for evaluating the crashworthiness of a structure. These two parameters are specific energy absorption and maximum load transferred to the structure during the collision [3]. Both metallic and composite structures have been subjected to abundant studies for the evaluation of the crashworthiness of different structures [4-8]. A properly designed composite structure has been demonstrated to be safer than conventional metallic structures, such as steel and aluminium[9,10]. Furthermore, the functional benefits of composite structures, such as light weight effects and the reduction of fuel consumption, make them excellent substitutes for conventional metals, such as steel and aluminium[3].

Composite structure crashworthiness has become an essential requirement in the design of automobiles, airplanes, helicopters,spacecrafts, and rail cars [5]. However, the reinforcement of composite materials in a crashworthy structure can possibly come from synthetic or natural materials. More attention has recently been given to the influence of the production of factories on the environment because of the global warming crisis. Thus, research in the field of composites, like in other fields of science and engineering, are inclined to discovering materials that are more adoptable for the environment [11]. Abundant, renewable, low density, low cost, and high tensile strength are some of the properties of natural fibre that make it an excellent alternative to synthetic composite materials [12].

Natural ramie has been used in the textile industry since the ancient times up to the present. Natural ramie currently attracts the attention of researchers because of its novel mechanical properties, environment friendly characteristics, and greater moisture resistance than other natural fibres [13]. The behaviour of any new material in different conditions should be completely analysed prior to its use in structures.

In this work, the crashworthiness characteristics of natural ramie epoxy triggered composite tubes are investigated.

II. EXPERIMENT

The compression tests of the square tubes were in quasi-static conditions at constant cross head speed of 20 mm/min. Specimens were compressed in INSTRON MTS 810 universal testing machines utilised with 250 kN load capacity.

The square section tubes had internal dimensions of 80 mm × 80 mm with 5 mm radius curvature in the corners. The tubes had lengths of 50 mm with different thicknesses of12, 24 and 30 layers of woven ramie fabric and 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.

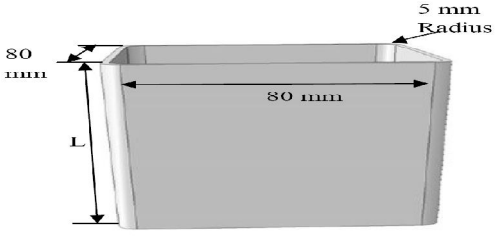


Figure 1 schematic sketch of specimen

Load-displacement curves obtained from quasi static compression test for ramieepoxy square

tubes are presented in the following sections. Results are divided into three groups according to their number of ramieepoxy layers (12, 24 and 30 layers).

III. RESULTS

In the Figures2, 3 and 4 the crash load/energy absorption characteristics of the tested composite square tubes namely total absorbed energy (E_{total}), peak load (P_{max}) and the specific energy absorption (SEA) of 12, 24 and 30 layers triggered woven natural ramie epoxy composite tube are presented.

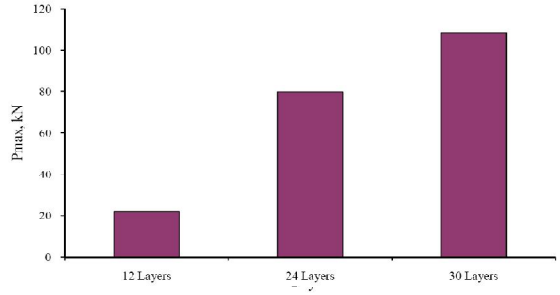


Figure 2. Peak load characteristics for composite square tubes with different layers

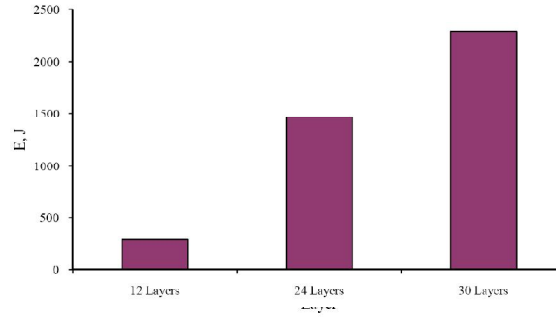


Figure 3. Energy absorption characteristics for composite square tubes with different layers

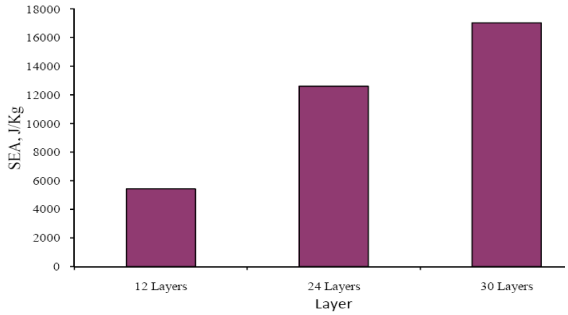


Figure 4Specific energy absorption characteristics for composite square tubes with different layers

In figures 2-4 it has been observed thatthere is a significant higher value of crashworthiness characteristicsin tubes with 30 plies of ramie epoxy laminates compare with 24 plies of ramie/epoxy laminates and this difference persists in value of crashworthiness characteristics in tubes with 24 plies compare with 12 plies of ramie epoxy laminates.

IV. DISCUSSION

Increase crashworthiness characteristics **(**total absorbed energy (E_{total}), peak load (P_{max}) and the specific energy absorption (SEA)) associated with rising number of composite laminates in **Error! Reference source not found.**, 4.3 and 4.4 clearly indicated that, number of composite plies in the tube wall of the tested specimens influence significantly on crashworthiness characteristicsvalue.

As sum up, results showed specimens with higher numbers of plies performed more resistance in compression test with performing higher value of crashworthiness characteristics. It is proved by previous researches, mentioned that crashworthiness characteristicsare depend on the geometric and material characteristics of the tested specimen [12].

CONCLUSION

Crashworthiness characteristics of woven natural ramie epoxy composite tubes increased as the layer stacking number increased. This increment is with a greater ration than the increment ration of layer stacking number.

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