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Analysis of Mechanical Properties in Synthetic Fibre Based on Honeycomb Core Composite Material

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Abstract: Composite materials are employed to generate the special physical and mechanical property materials for various applications which are utilized to generate materials embedded with high strength and light weight. In fact, inquisitive investigators have spent a lot of sweat and blood on research for the purpose of ushering in diverse composite materials to evaluate the composite material applications. The mechanical properties of hexagonally shaped honeycomb structure is studied based on their special features such as high strength to weight ratio, excellent rigidity at minimal weight, low cost and complex applications. Square and triangular of glass fibre based honeycomb core composite structures is seldom found work. The square honeycomb core composites have been prepared using simple slotting enhanced research technique. The aim of this study is to improve the mechanical property of glass fibre reinforced epoxy honeycomb core composite material. These structures has been prepared in the range of 30, 40, 50 weight percentage of fibre by using simple slotting technique. The mechanical property of the square honeycomb core composite material has been studied experimentally.

Keywords: Glass fibre, Epoxy Resin, Honeycomb core Structure, Compression Moulding.

I. INTRODUCTION

Modern composite materials constitute a significant proportion of the engineering materials market ranging from everyday product to sophisticated applications. While composites have already proven their worth as weight- saving materials, the current challenge is to make them cost effective [1]. Orthogrid structure using three point bending tests to compare carbon fibre s and wiches with different types of core. They are aluminium-honeycomb core, aluminium plate orthogrid core and aluminium plate orthogrid core filled by aluminium honeycomb blocks[2].The Laminate composites of glass fibre/epoxy resin filled with acrylic tri-bloc copolymers which resulted in increase in both strength and impact resistance of the composite[3]. Honeycomb core made of a natural-fibre reinforce. The effective elastic properties of the core are computed via a homogenization analysis and finite element modelling which suggest that jute-reinforced cores have the potential to be an alternative to standard cores in applications that sustain compressive static loads[4].The static and impact response of aluminium sandwiches with different core types (foam and honeycomb). The static bending tests, performed at different support span distances on sandwich panels can lead to a weight reduction of the ships, providing an adequate structural strength under operating conditions [5].The honeycomb ability to withstand through thickness compression and to absorb energy by plastic deformation of the cell walls. The predicted structural response, numerically obtained using different sets of imperfections shows a good correlation with experimental results [6].High energy impact tests were carried out on E-glass phenolic impregnated sandwich structures, adopting two skin thickness values, two different impact diameters and different impact velocities. The model is validated using the results from experimental impact tests performed on different initial impact conditions [7]. An experimental method is presented for measuring the effect in plane compliance matrices of cellular structures using honeycomb cores. It is expected to advance the current state of the art through simplicity and low cost of the experiment setup, the measurement and analysis techniques, and the applicability of the method to wide range of cellular structures Such as honeycomb cores and wood species [8]. The dynamic response of end-clamped monolithic beams and sandwich beams of equal areal mass has been measured. The sandwich beams were made from carbon fibre laminate and comprised identical face sheets and a square honeycomb core. The composite beams undergo catastrophic failure at lower impulses than the steel beams of equal mass due to the lower ductility of the composite material [9]. Fatigue tests in four points bending were performed on an aramid fibre core of sandwich structure for both directions (W and L).The variation of the stiffness during the major part of the lifetime was insignificant in which the cells are in W direction While for L direction exponential model was found to be less

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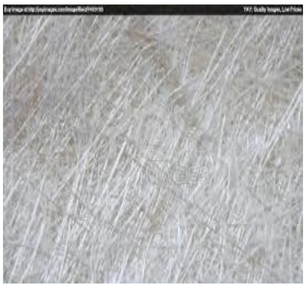
satisfactory than a third order polynomial function also noticed a subsequent shear buckling of the vertical cell walls in the core[10].The fabrication and mechanical testing of entangled sandwich beam specimens and the comparison of their results with standard sandwich specimens with honeycomb and foam as core materials. The entangled sandwich specimens have glass fibre cores and glass woven fabric as skin materials [11-19].

II. MATERIALS AND METHODOLOGY

A. Materials

The base material used in the present study is glass fibre with the mixture of epoxy resin in the structure of Honeycomb Core is shown in Fig. 1 and Fig. 2.



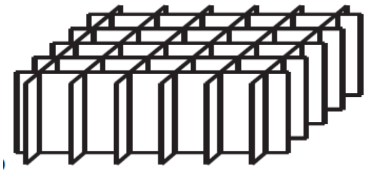


Fig. 1 Glass Fibre Fig. 2 Honeycomb Core Structure

B. Mould Preparation

The mould is prepared by using mild steel. The mould has three parts namely base plate, frame and cover plate. The base plate is of about 10 mm thick and it is attached to the frame. The cover plate is used to close the die cavity. The entire mould setup is shown in following figure 3,

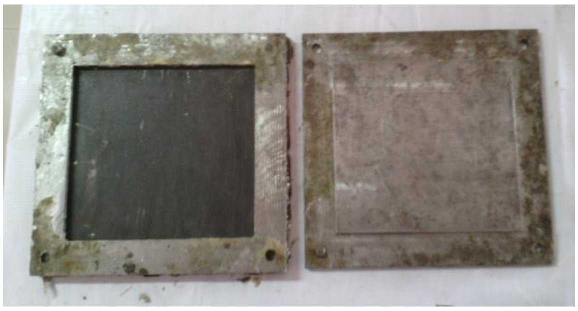


Fig. 3 Mould

C. Specimen Preparation

The compression moulding method is adopted for the fabrication of composites. The glass fibre is taken based on the cavity size as shown in Fig. 4. The epoxy resin is mixed with 10:1 ratio of hardener for curing of resin. The matrix solution is applied on the mould and fibre is spread over the resin, air bubbles are removed carefully with a roller. The mould is closed with cover plate, and hydraulic pressure is applied until complete closure. The closed mould is kept under pressure for 24 hours. The composites are fabricated in the form of a flat plate with a size of 180 X 160 X 3 mm3. Composite plates are prepared for various fibre weights % of 30, 40, and 50 is in Table 1.

Area of epoxy = 18x16 x0.3=86.4 cm^3
Weight of epoxy=86.4 cm^3 x1.1 g/cm^3=95

Then the composite plate was cut as required size to find mechanical properties. The following figure shows the specimen cut from glass fibre composite for Tensile, Impact test as per the ASTM standard

Specimens where cut as per the ASTM standards and tested

- Tensile (ASTM D638-03) = 165x13x3 mm^3
- Impact(ASTM D256) = 65x13x3 mm^3

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TABLE I COMPOSITION OF SPECIMENS

Specimen No.	Resin wt %	Fibre wt %	Fibre wt in g
1	60	40	38
2	70	30	28.5
3	50	50	47

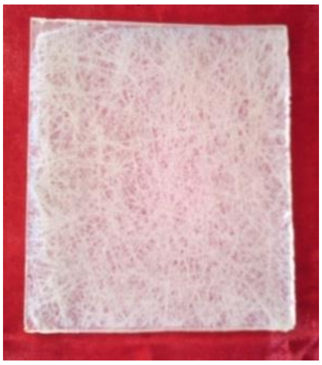

Fig. 4 Specimen

III. MECHANICAL TESTINGS

A. Tensile Test

The randomly oriented composite specimens as shown in Fig. 5 were cut as per the ASTM D638-03 to measure the tensile properties. The length, width and thickness of the specimen were 165mm long, 13mm wide and 3 mm deep, respectively. Tensile test conducted using the universal testing machine.

Fig 5 Tensile Test Specimen

B. Impact Test

Impact test specimens Fig. 6 were prepared in accordance with ASTM D256 to measure impact strength. The specimens were 65 mm long, 13 mm wide and 3 mm thickness. The test is conducted by using charpy testing machine.

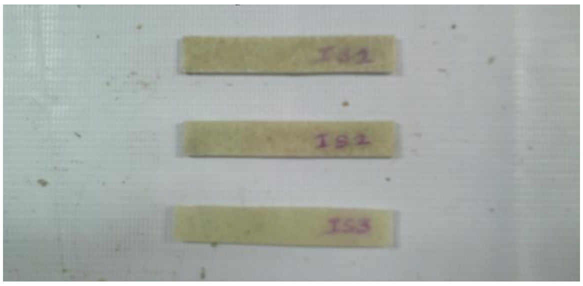

Fig 6: Impact Test Specimen

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IV. RESULTS AND DISCUSSION

A. Hardness Test

The hardness result is obtained from shore-D tester machine. Based on the result, specimen 3 having more hardness value due to the weight percentage of fibre which shown in below figure 7.

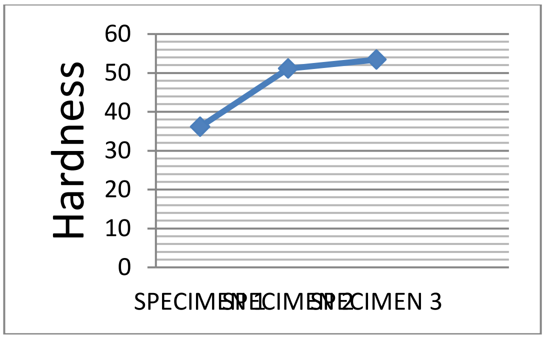

Fig. 7 Hardness Test

B. Impact Test

The impact test is the energy absorbing capacity of specimen during sudden loading condition. The test is conducted by using impact testing machine the impact result of the various specimen is shown in figure 8 where Specimen 3 has more strength based on fibre percentage.

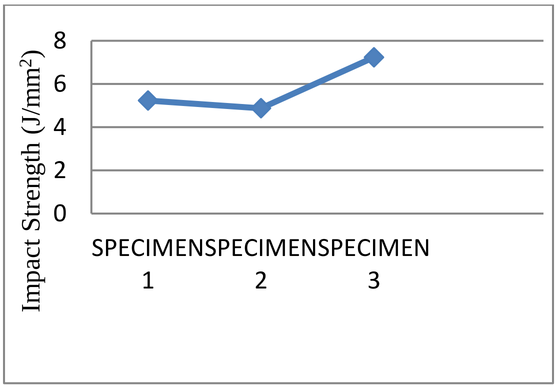

Fig. 8 Impact Test

C. Flexural Test

The flexural result is obtained from the tests. Based on the result, specimen 3 having more value due to the weight percentage of fibre which shown in below figure 9.

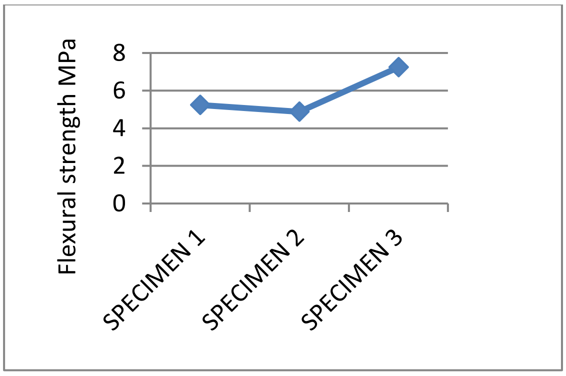

Fig. 9 Flexural Test

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V. CONCLUSION

The glass fibre and epoxy have been selected as the reinforcement and matrix material respectively as they find vast applications in automotive, aviation, defence and construction industries. Glass fibre reinforced epoxy composite slabs have been prepared at various weight percentages by compression moulding technique. The slabs are cut into required dimensions and the square honeycomb core structure is fabricated. Mechanical properties of square honeycomb structure are evaluated, based on the various mechanical properties testing conducted.

REFERENCES

[1]. M.Y.M.Zhuri, Z.W.guan, W.J.cantwell (2014) "The mechanical properties of honeycomb core composite materials" composites, Vol: part B 58, pp.1-9

[2]. ShanshanShi, ZhiSun, XiaozhiHu, HaoranChen (2014) "Flexural strength and energy absorption of carbon-fibre–aluminium-honeycomb composite sandwich reinforced by aluminium grid" Thin-Walled Structures, Vol:74,pp.416–42

[3]. Ariel Stocchi, Lucas Colabella, Adrián Cisilino, Vera Álvarez (2014) "Manufacturing and testing of a sandwich panel honeycomb core reinforced with natural-fibre fabrics" Materials and Design, Vol: 55,pp.394–403

[4]. Alp Karako, Jouni Freund (2014) "Experimental studies on mechanical properties of cellular structures using Nomex honeycomb cores" Composite Structures, Vol: 94, pp.2017–2024

[5]. R. Matadi Boumbimba, C.Froustey, P.Viot, J.M.Olive, F.Léonardi, P.Gerard, R. Inoubli (2013) "Preparation and mechanical characterization of laminate composites made of glass fibre/epoxy resin filled with tri bloc copolymers" Composite Structures, Vol: 116, pp.414–422

[6]. V.Crupi, G.Epasto, E.Guglielmino (2013) "Comparison of aluminium sandwiches for lightweight ship structures: Honeycomb vs. foam'"Marine Structures, Vol: 30,pp.74–96

[7]. Domenico Asprone, Ferdinando Auricchio, Costantino Menna, Simone Morganti, Andrea Prota, Alessandro Reali (2013) "Statistical finite element analysis of the buckling behavior of honeycomb structures"Composite Structures, Vol: 105, pp.240–255

[8]. Costantino Menna, Alberto Zinno, Domenico Asprone, Andrea Prota (2013) "Numerical assessment of the impact behavior of honeycomb sandwich structures" Composite Structures, Vol: 106,pp.326–339

[9]. B.P. Russell, T. Liu, N.A. Fleck, V.S. Deshpande (2012) "The soft impact of composite sandwich beams with a square-honeycomb core" International Journal of Impact Engineering, Vol: 48, pp.65e8

[10]. A.Abbadi, Z.Azari, S.Belouettar, J.Gilgert, P.Freres (2010) "Modelling the fatigue behavior of composites honeycomb materials (aluminium/aramide fibre core) using four-point bending tests"International Journal of Fatigue, Vol: 32,pp.1739–1747

[11]. Amir Shahdin, Laurent Mezeix, Christophe Bouvet, Joseph Morlier , Yves Gourinat (2009) "Fabrication and mechanical testing of glass fibre entangled sandwich beams A comparison with honeycomb and foam sandwich beams" Composite Structures, Vol: 90, pp.404–412

[12]. Extraction and Characterization of Agricultural Discarded Sesbania Aculeata Stem Waste as Potential Alternate for Synthetic Fibers in Polymer Composites. G. Venkatesh, V. Vignesh, K. Vinayagar. Journal of Natural Fibers, Taylor and Francis, 2021, https://doi.org/10.1080/15440478.2021.2002756

[13]. Enhancing performance of cell formation problem using hybrid efficient swarm optimization, G Nagaraj, M Arunachalam, K Vinayagar, S Parama samy, Soft Computing, A Fusion of Foundations, Methodologies and Applications, Springer. 2020, DOI 10.1007/s00500-020-05059-4

[14]. Mechanical, Structural and Optical Properties of the Silicon Nanowire Arrays. Ramuvel M, Manimaran A, Vinayagar K, DE GRUYTER Z. Phys. Chem. aop, 1 – 13, 2020; https://doi.org/10.1515/zpch-2019-1588

[15]. Parametric Optimization of Effect of ZnO Nano Particle on the Mechanical Properties of Randomly Oriented Chicken Feather Fiber-Reinforced Vinyl Ester Composite. R. SRIDHAR, A. ATHIJAYAMANI, K.VINAYAGAR, Journal of the Balkan Tribological Association, 2019, 3 (3), 767-778

[16]. Review on Crashworthiness Studies of Foam Filled Thin Walled Structures, K. Vinayagar, Muthusamy, Nagaraj, Sridhar, International Advanced Research Journal in Science, Engineering and Technology, 2020, Vol. 7, Issue 6.

[17]. VinayagarK, Kumar A S.Crashworthiness analysis of double section bi-tubular thin-walled structure. Thin-Walled Structure, 2017, 112:184–193

[18]. K. Vinayagar and A. Senthil Kumar Multi-response optimization of crashworthiness parameters of bi-tubular structures. Steel and Composite Structures, 2017, Vol. 23, No. 1; 31-40.

[19]. K Vinayagar, AS Kumar, MV Vignesh, K Gokulan, Experimental and Theoretical Investigation of Interaction Effect on Energy Absorption of Bi-tubular Structures under Quasi-static Axial Crushing Springer, Singapore Proceedings of ICDMC 2019, 2020, 491-503.