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Design and analysis on hybrid composite using CATIA and ANSYS

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ABSTRACT

The paper focused on tensile, compressive and hardness properties of different weight composition of hybrid composites. With chopped glass, jute and basalt fiber, hand layup method and percentage of weight is considered to prepare the hybrid composites. Tensile strength and compressive strength is validated using finite element technique. A basalt combination composite has good compressive strength and hardness as well as e-glass-jute combination has good tensile strength when compared to remaining materials. Additionally it was observed that, by changing the type of fiber combination, mechanical properties can be improved.

Keywords: Hybrid composites, strength analysis and CAE validation.

1. INTRODUCTION

The composite consists of different kind of materials to make a unique material. Composites are clustered by matrix material and reinforcement. Generally matrix materials will place the reinforcement in proper location and when the load is applied, the matrix material will help them to transfer the load applied load as a medium between matrix and reinforcement [1]. Now days, composites materials are used in various application in different industries. But the application is very limited due to the toughness. To improve the toughness of the materials, hybridization of fiber is a good option to improve the toughness as well as the mechanical

properties when compared to single reinforced composites [2]. Hybrid composites have main advantages when compared to non hybrid composites. One is, it will give new choice to the manufacturer with some good properties and another one is, cost utilization as well as it can avoid high expensive fiber materials. Using low cost reinforced materials, the strength can be improved using hybridization of composites. The strength characteristics are stiffness, ductility, wear and toughness. Due to hybridization of the composite the weight of the composites can be reduced and improve the impact resistance, fatigue life and fracture toughness when compared to single reinforced composites [4]. In automobile, defense, aerospace and sport zones; polymer reinforced synthetic fiber has huge demand because of cost effective, strength and stiffness of the structure [5]. Synthetic fibers like Kevlar, glass, nylon and carbon fibers are widely used for manufacturing of composites. But the disadvantage of these materials is they are not environmental friendly types and recently there are standards to use environment friendly fibers to reduce any further pollution [6]. So basalt fiber is used as primary reinforcement. Basalt rock is firm, dense, crystallized rock from molten magma. Basalt fiber is made by melting the basalt rock and extruded process in a single step. The basalt fibers gives same performance as that of s2 glass fiber but cost wise is in-between S2 glass fiber and e-glass fiber. Basalt fiber has high rigidity and low elongation [7]. Basalt fibers has good properties in mechanical and thermally like corrosion resistance, high tensile strength, dimensional stability, high heat and fire resistance, good thermal conductivity, durability and non toxic [8]. But the main drawback of this material is that it is costlier than e-glass fiber. So taking glass material as secondary reinforcement is a good choice and also it the glass fiber has good strength along with low cost [9].

Alexander et al [10] has done the experimental strength analysis on basalt and sisal glass fiber. Basalt glass epoxy can give good mechanical strength when compared to sisal glass fibers. This work is useful to aircraft structural analysis. So many researchers have investigated on different types of fiber materials to make hybrid composites. They are analyzed to improve the mechanical characteristics [11]. The main aim of this work is to fabricate basalt with chopped glass and jute as a hybrid composite by considering weight percentage of the individual fiber and investigation on compressive strength, tensile and hardness. Finite element analysis is performed to validate the experimental results.

2. MATERIAL AND METHODS

At first, fibers, resin and hardener are weighed and kept separately. Resin and hardener is taken in a bowl and mixed thoroughly without any bubbles. If the bubbles are present, tap it properly because, the matrix might fail in the material. Hand layup technique is used to prepare hybrid composites. The fiber material is cut into required dimension. A plain surface is taken and a plastic sheet is placed on it. On that plain surface, resin and hardener mixture is poured. And on the resin and hardener mixture, basalt, chopped glass and jute mixture is placed one by one and again resin and hardener mixture is poured on the fiber. Once it is once, a 20 kg weight is placed on it. After 24 hours, the composite is perfectly cured. It is cut in ASTMD 3009 specimen size for tensile testing.

Fig 1: hand layup technique.

Fig 2: Tensile test specimens.

3. RESULTS

The figure 3 shows the stress and strain curve representation of tensile testing for E-glass with basalt specimen. In this figure, it shows the yield, ultimate and beak point of specimen. Here yield stress is 101 M.pa, ultimate strength is 291 M.pa.

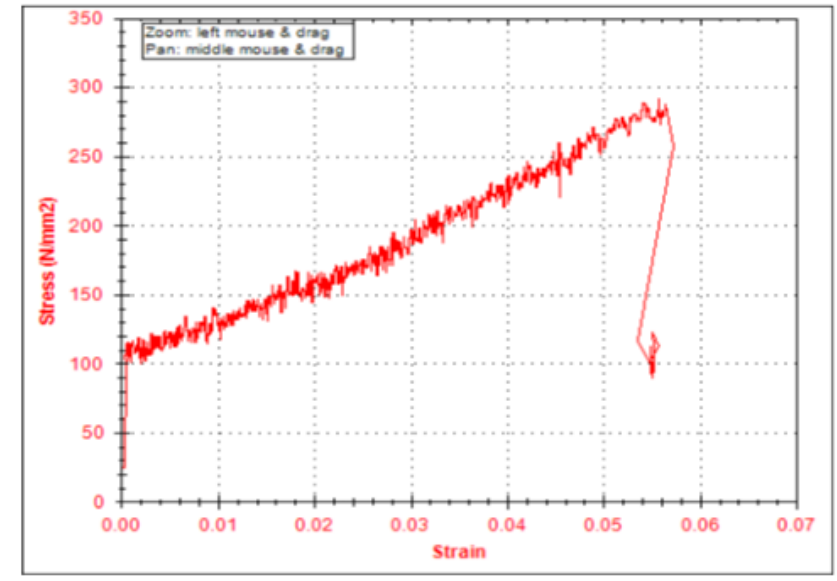

Figure 3: Stress –Strain curve for chopped E glass with basalt specimen.

AS well as experimental test was conducted on remaining specimens, results are noted as chopped E-glass with flash jute specimen is having yield stress 103.9 M.Pa, ultimate strength is 226 M.Pa. Basalt Specimen is having yield stress 95.3 M.Pa and ultimate strength is 276.4 M.Pa. Chopped E-glass is having the yield stress 95 M.Pa, ultimate strength is 283.5 M.Pa.

Finite Element Method is an alternative method to find out the mechanical strength of the materials. In this paper, simulation software, ANSYS 19.0 is used. Tensile and compressive strength analysis is performed in explicit dynamical analysis and Eigen buckling analysis. Initially geometric model is prepared as same as experimental model. A tetrahedron element shape is used in this analysis. One and half specimen is fixed and axial displacement is applied at another end of the specimen. The analysis is carried out till the specimen is damaged.

The figure 4 shows stress on tensile specimen when applied displacement at one end of specimen. In this the blue indicates for minimum stress and red indicates for maximum stress. The stress is 275 Pa at 5e-5 sec time. After applied the random loading at one end of specimen, work piece is getting yield stress and failure.

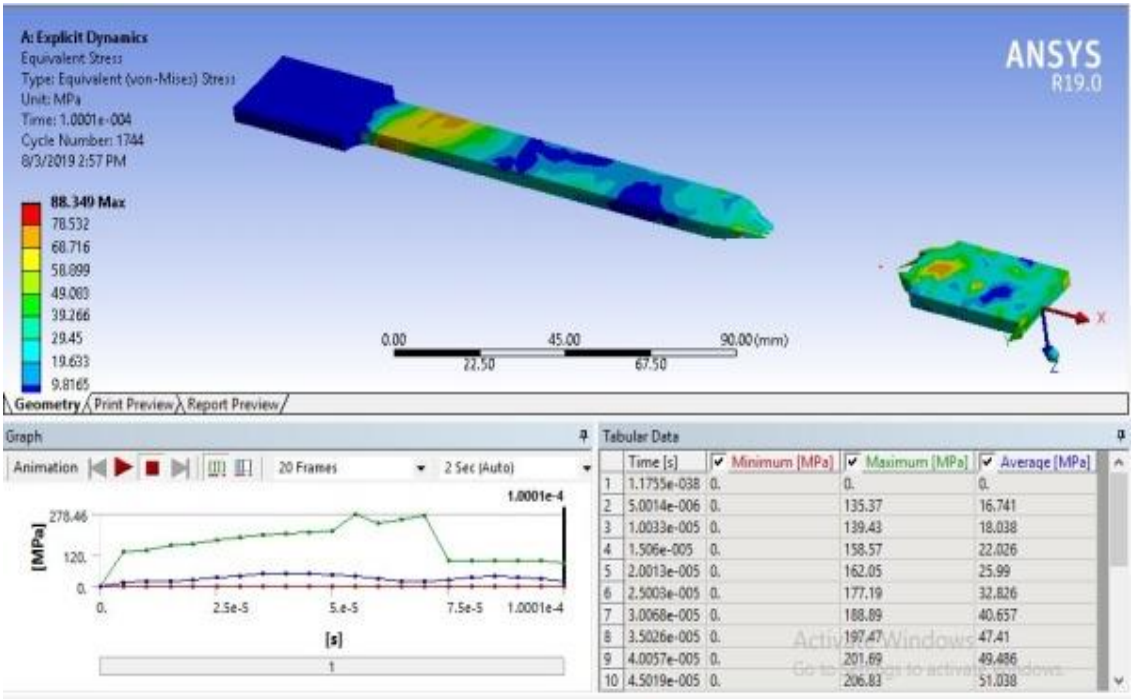

Fig 4: Stress on specimen.

In this paper, have mainly concentrated on six type of specimen such as jute, chopped E-glass, basalt, jute with basalt, jute with chopped E-glass and chopped E-glass with basalt. Tensile, hardness, compressive test is conducted on above specimen. Results are plotted in figure 5.

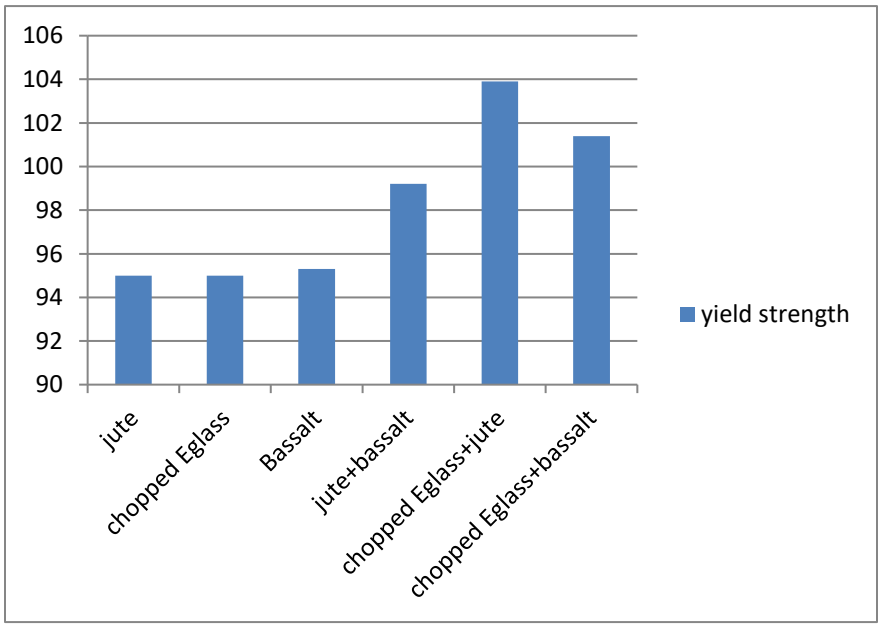

Fig 5: yield strength comparison graph.

The image 5 shows the yield strength of different specimen. Here chopped E-glass with jute specimen are having maximum yield strength and jute specimen is having minimum yield strength as compared to remaining materials. Maximum yield strength 103M.Pa for E-glass with jute specimen and minimum yield strength is 95 M.Pa for jute specimen.

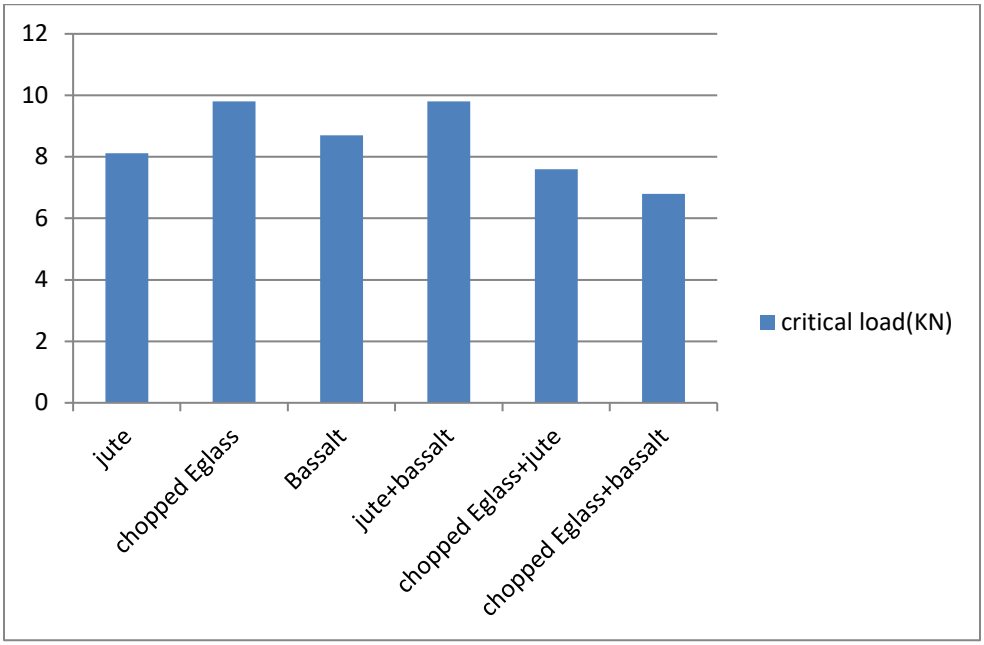

Fig 6: critical load comparison graph.

The image 6 shows the critical load of different specimen. Here chopped E-glass specimen are having maximum critical load and chopped E-glass with basalt specimen is having minimum critical load as compared to remaining materials. Maximum critical load is 102 KN for basalt specimen and Minimum critical load 6.8KN for chopped E-glass with basalt specimen.

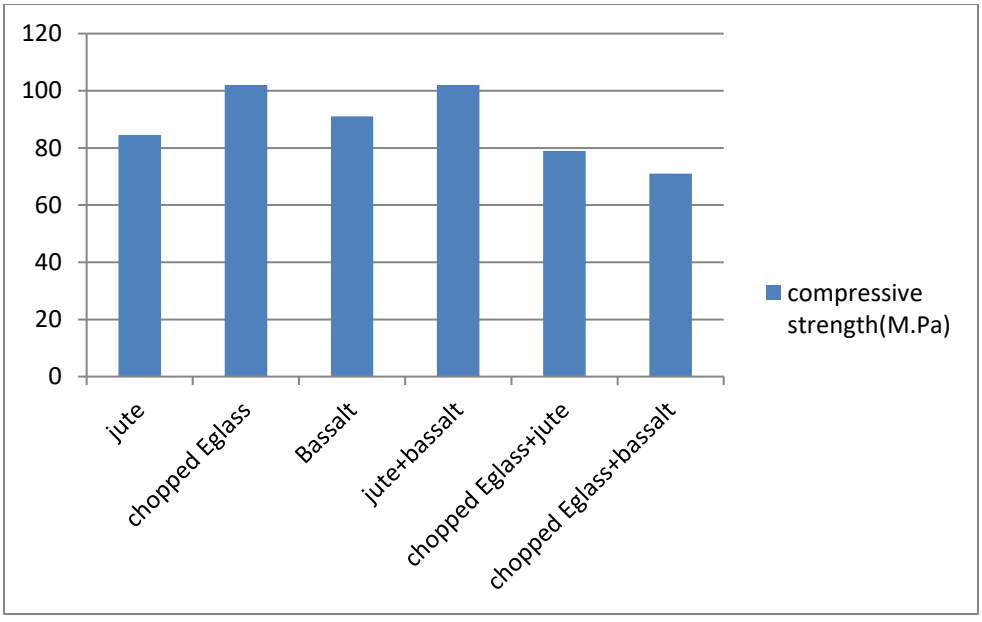

Fig 7: compressive strength comparison graph.

The image 7 shows the compressive strength of different specimen. Here chopped E-glass specimen is having maximum compressive strength and chopped E-glass with basalt specimen is having minimum hardness as compared to remaining materials. Maximum compressive strength is 102 M.Pa for basalt specimen and Minimum compressive strength is 71 M.Pa for chopped E-glass with basalt specimen.

The image 8 shows the Hardness of different specimen. Here basalt specimen is having maximum hardness and jute specimen is having minimum hardness as compared to remaining materials. Maximum hardness is 94 for basalt specimen and minimum hardness is 55 for jute specimen.

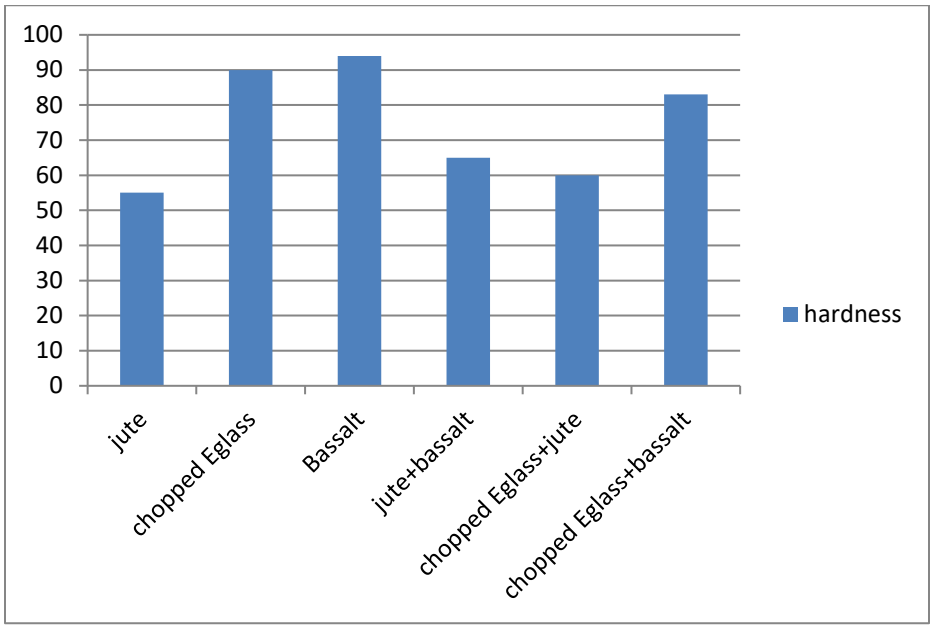

Figure 8: Hardness comparison Graph

4. CONCLUSION

Tensile test conducted on UTM at vignan college, Rockwell hardness test conducted on hardness tester and compressive strength conducted on compressive test machine. The respective tests are successfully completed on above specified equipment's. The addition of chopped E-glass on above specified jute and basalt materials tensile strength is increases continuously. As well as if add the basalt and jute material yield strength is increased. The addition of chopped E-glass on above specified jute and basalt materials compressive is decreases. As well as if we add the basalt and jute material compressive strength is increased. The addition of chopped E-glass on above specified jute and basalt materials hardness is decreases. As well as if add the basalt and jute material hardness is increased.

Tensile and compressive stress and strain curve data is validated with finite element software ANSYS. Between these two, it was observed that both results have good agreement with less deviation. Finally, it was concluded that chopped E-glass on jute and basalt materials having more tensile strength and minimum hardness, compressive strength.

Conflict of interests

There is no conflict of interest among the authors.

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Peer-review

External peer-review was done through double-blind method.

Data and materials availability

All data associated with this study are present in the paper.

REFERENCE

1. Singh S, (2013), "An experimental and numerical investigation of mechanical properties of glass fiber reinforced epoxy composites". Adv. Mat. Lett, 4(7), pp:567-572.
2. Gorbatikh L et al,(2014). "Fibre hybridisation in polymer composites: a review". Composites Part A: Applied Science and Manufacturing, 67, pp:181-200.
3. Mingchao W et al, (2009). "The hybrid model and mechanical properties of hybrid composites reinforced with

different diameter fibers". Journal of Reinforced Plastics and Composites, 28(3), pp:257-264.

4. Shahzad, A, (2011)."Impact and fatigue properties of hemp–glass fiber hybrid biocomposites". Journal of Reinforced Plastics and Composites, 30(16), pp:1389- 1398.
5. Kumar A, (2015). "Analysis of mechanical properties and cost of glass/jute fiberreinforced hybrid polyester composites". Part L: Journal of Materials: Design and Applications, 229(3), pp:202-208.
6. Zhang Z. et al, (2013). "Development of flax/carbon fibre hybrid composites for enhanced properties". Carbohydrate polymers, 96(1), pp:1-8.
7. Singha K, (2012). "A short review on basalt fiber". International Journal of Textile Science, 1(4), pp:19-28.
8. Cao H et al (2011). "Degradation of basalt fibre and glass fibre/epoxy resin composites in seawater". Corrosion Science, 53(1), pp: 426-431.
9. Amico, S. C, Amado, (2013). "Hybridization effect on the mechanical properties of curaua/glass fiber composites". Composites Part B: Engineering, 55, pp:492-497.
10. Churchill S. E, Alexander J, (2017, May). "Mechanical Characterization of Baslat Based Natural Hybrid Composites for Aerospace Applications". Materials Science and Engineering (Vol. 197, No. 1, p. 012008).
11. Sachan Y, Bandaru, A. K, (2016). "Mechanical behavior of Kevlar/basalt reinforced polypropylene composites". Applied Science and Manufacturing, 90, pp:642-652.