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Evaluation of Bending Strength of Natural Jute Fiber Reinforced Hybrid Composite Subjected to SENB Specimens

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Abstract:- Nowadays, hybrid composites are new class of developing materials due to their unique properties such as light weight, good mechanical properties and low cost compared to other synthetic fiber composites. In this investigation, an attempt is made to study the bending strength of natural jute fiber reinforced hybrid composite subjected to SENB specimens as per ASTM standard. Jute/glass fibers are used as reinforcing materials and epoxy used as matrix with coconut shell powder and egg shell powder as secondary filler materials. The total volume fraction of fibers is 60% with remaining 40% of epoxy resin including hardener. The fabrication of composite was carried out using hand lay-up technique. It was observed that the bending strength of the hybrid composite specimen is greater in equal volume fraction of Jute and Glass fiber. The bending strength is maximum for equal percentage of jute and glass fiber in case of notch along width and notch along both thickness and width.

***Keywords*:-** Secondary Fillers, Hand layup, Hybrid composite, Bending strength.

I. INTRODUCTION

Now a days in every aircraft and automobile industries natural fiber along with glass fiber are used to adapt in various situations. plastic usage is unavoidable in these days. Science synthetic fibers are not environment friendly it creates environmental pollution so researchers are more concentrated on natural fibers, they are, economical, environment friendly, higher filling levels, lower densities and environment friendly **[1, 2].** Natural fibers used are jute, hemp, banana **[3, 4],** Natural fibers have good mechanical properties such as stiffness and modulus compared to glass fibers. Glass fiber reinforced composites are attractive due to their high specific strength in automobile, aerospace, marine, railway, civil structures, sports, goods, which are weight sensitive. The commonly used polymer matrix with reinforcing fiber in advanced composite is epoxy resin. They are used as matrix to hold fibers with composites. In polymer composites natural fibers are gaining more and more interest among the available reinforcing fiber. A bunch of work has been done by various researchers to meet the challenges like degradation of strength due to moisture absorption, little processing temperature, greater impact strength variations in property and quality, by adopting technique like proper selection of resin and additives, hybridization of natural fiber with more durable glass fiber. The project mainly focuses on fabrication of advanced hybrid composites from glass woven fibers with jute woven fiber along with epoxy matrix (Lapox L-12) and secondary fillers (coconut shell powder CSP, egg shell powder ESP) using hand lay-up technique. And also studied the effect of secondary filler and durability in sea water, along with notch orientation. **Ashik K P et al. [5]** have evaluated the flexural, impact and flexural strength of glass and natural fiber reinforce hybrid composites as per ASTM standard. The composites were fabricated using hand lay-up technique. The experiment was conducted for four different volume fractions. The laminate 1 consists of 100% jute fiber and laminate 2 consists of 100% glass fiber, laminate 3 consists of 60% jute and 40% glass fiber and laminate 4 consists of 60% glass and 40% jute fiber. He used woven fiber reinforcement since these fibers give good strength compared to unidirectional and chopped fiber. He concludes that jute and glass hybrid composites improve mechanical properties and 100% glass fiber gives high bending strength compared to other laminate. Experimental and FEM results are approximately validated. **Anin Memon et al. [6]** have conducted experimentation to evaluate the mechanical properties of jute spun yarn unidirectional composites using compression moulding. Parallel yarn winded on metallic frame then placed in heated mold to produce unidirectional specimen with different moulding temperature. Initially solid matrix become soft then matrix in liquid form soaked and during cooling stage the matrix turned into solid and he concluded that mechanical properties are affected by moulding temperature. As mould temperature increases impregnation quality increases, hence property of composite is affected by mould temperature. **Md. Rashnal Hossain et al. [7]** have evaluated tensile behaviour of jute epoxy laminated composites. jute fibre is very interested in composite because of the high specific strength compared to synthetic fibre like Kevlar, asbestos and glass. The prepared composite specimen was subjected to 3-point bending and tensile test, and the theoretical and experimental results were matched. Then the specimen was observed in scanning electron microscopy. Jute fibre perform stacking sequence are 0/0/0/0, 0/+45°/-45°/0, 0/90°/90°/0. Longitudinal tensile strength is higher than transverse direction in case of 0/+45°/-45°/0 and 0/0/0/0. And concludes that tensile strength is higher in 0-0 laminate in case of longitudinal direction compared to 0-45 or 0-90. Tensile and bending strength is lower in 0-0 laminate compared to 0-90 and 0-45 in case of transverse direction **B Sutharsonet et al. [8]** conducted experimentation and have evaluated the effect of fibre treatment and stacking sequences of alkali treated jute fibre and glass fibre and untreated composite by conducting

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hardness, impact and tensile tests. He concludes that, Hardness and impact strength is affected by stacking sequence. High impact strength can be obtained by increasing NAOH percentage and treatment time period (hour). In case of same weight percentage of jute, there is an effect of stacking sequence on tensile properties. Combination of glass and jute fibre improves the impact properties. **K Sabeel ahmed et al. [9]** have investigated to evaluate the properties of jute and glass reinforced hybrid composite. The impact of hole size and hybridization on woven jute fibre composites are investigated both experimentally and analytically. They have concluded that, as glass fibre increases poison's ratio decreases, Jute composite processes high transverse strain and longitudinal strain compared to jute-glass hybrid composite. In order to predict modulus of composite with different orientation classical laminate theory were used. Notch sensitivity is higher in case of jute composite compared to hybrid composite. In order to find elastic properties of jute and glass fibre reinforced hybrid composite rule of hybrid mixture is used.

II. MATERIALS AND EXPERIMENTATION

A. Materials

Materials used in the experimental work are, jute as natural fiber and glass as synthetic fiber with Epoxy resin (Lepox-12) Hardner (k-6). The Secondary filler in the form of coconut shell powder and egg shell powder was used in fabrication of specimens. The investigation of bending strength of composite was carried out as per ASTM standard.

- **Jute:** Jute is soft, long and strong plant fibre extracted from skin of the plant and spun into coarse, strong threads. Jute fibres consist of cellulose fibre and lignin. It is the cheapest natural fiber next to cotton. It can be expressed as a lingo-cellulose fibre which is partially wood fiber, and partially textile.
- **Glass:** In polymer Matrix composites, glass is widely used since, it introduces high insulating properties, low cost, chemical resistance and high strength. The disadvantage of glass fibre includes poor elastic modulus, less adhesion to polymer, poor fatigue strength, specific gravity is high and sensitive to abrasion. Glass fiber processes high stiffness and strength and easy to manufacture. The available form of glass fibres are mat, cloth, tape chopped and continuous.
- **Epoxy**: Lapox is in liquid form, and it is unmodified epoxy resin with medium viscosity.Lapox is used with different hardeners to make fibre reinforced composites. Hardeners are selected on the basis of properties of cured composites and processing method. The matrix material, which is most commonly, used thermosetting resin. Polymer Matrix give many physical and Mechanical properties liquid resin become solid by chemical linking which make tight bound in 3D network to hold and protect the reinforcement material..
- **Hardener k-6:** In hand lay-up techniques K6 hardeners are widely used. K-6 hardener is generally employed for hand lay-up applications being non-reactive. Hardener is used to increase the resilience of the mixture. In other mixtures a hardener is used as a curing component.
- **Egg shell powder(ESP):** Egg shell is a fertilized shell which is surrounded by albumen. egg shell is made up of a calcium carbonate and is dissolved in different acids. In our layup we used 200 microns of powder. While dissolving, the calcium carbonate in an eggshell reacts with the acid to form carbon dioxide.
- **Coconut shell powder(CSP):** Coconut shell is the non-food part of coconut which are lingo-cellulose agricultural co-product. CSP is low cost compared to mine mineral fibres and it is four advantage like bio-degradable less abrasion to machine and ecofriendly. In the experiment 200 microns powder is used for the fabrication of composites.

B. Specimen preparation

The simplest method to produce fibre reinforced hybrid composite is by using hand layup techniques as shown in figure 1. In order to make a composite an appropriate number of fiber plies were taken according to the different volume fraction. The mould was applied with gel coat. The on the mould as shown in figure 1. The mixture of resin, hardeners, fillers is applied by brushing. Then rollers are used to remove entrapped air in order to avoid air entrapment as it causes failure of the material. Finally, the lay-up is covered with thin polythene sheet and tiles are placed over it. Then a weight of 400N is placed over the composite lay-up. In order to cure the composite, it was left for 24 hours. The moulds in the hand lay-up process are generally made of wax, clay or wood and the gel coat is applied for easy removal of the product from the mould. Applications of this method include boat hulls, tanks, housings, chairs etc.different orientation of notches as shown in figure 2 (a) without notch along width (b) notch along width (c) notch along thickness (d) notch along both thickness and width.

Fig. 1: Hand lay-up technique.

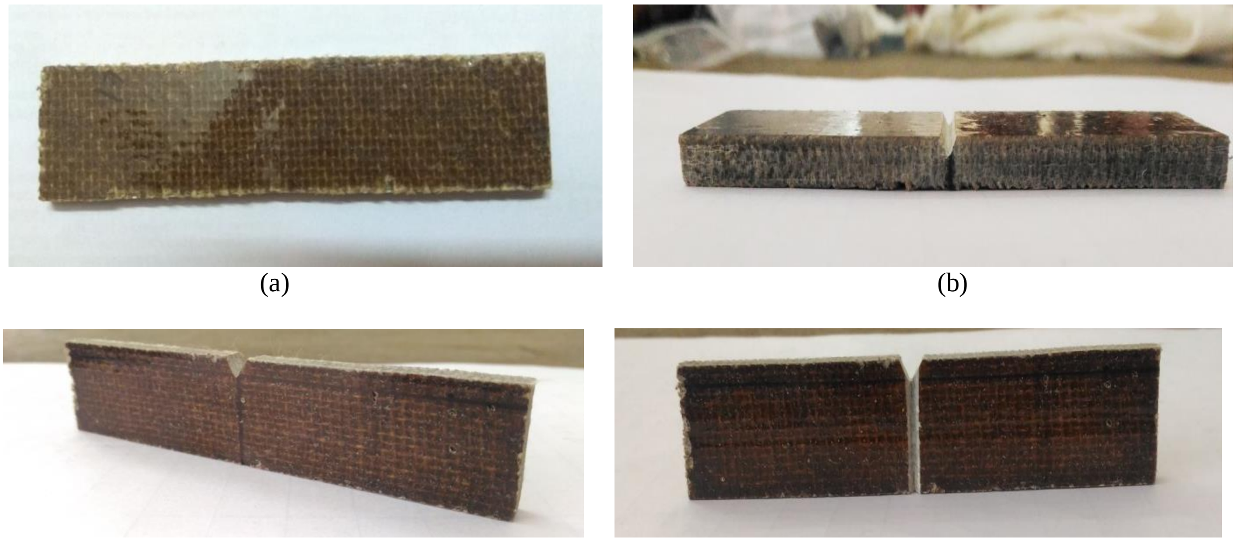

Fig. 2: Different orientation of notches (a) without notch along width (b) notch along width (c) notch along thickness (d) notch along both thickness and width

C. Experimentation

Fig. 3 Point Bending Setup

D. Bending strength:

The test ready specimens as per ASTM D790 standard are subjected to bending test in universal testing machine (UTM) of 60 tonne capacity under room temperature for various volume fraction of jute, glass fiber and secondary filler and the peak bending load was recorded to evaluate the bending strength, 3 point bending setup as shown in figure 3.

III. RESULTS AND DISCUSSION

A. Effect of volume fraction and different notches on bending strength in case of 3% secondary filler

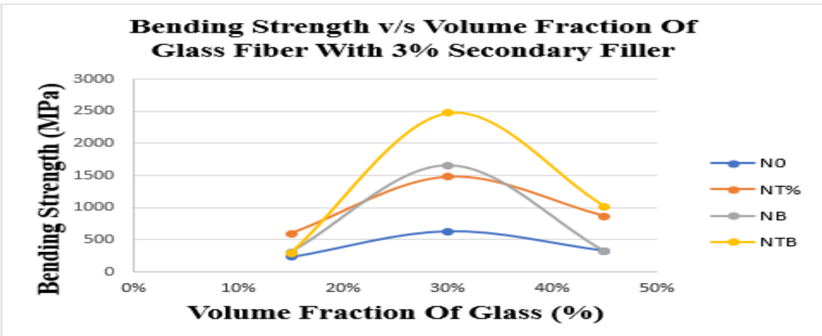

Fig. 4: Effect of percentage of glass fiber and different notches on bending strength, for 3% secondary filler.

The effect of percentage of glass fiber on bending strength for 3% secondary filler as shown in figure 4.. From the graph it is observed that maximum bending strength is at 30% glass fiber in case of notch along both thickness and width. The minimum bending strength is at 15% glass fiber in case of without notch specimens.

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B. Effect of volume fraction and different notches on bending strength in case of 6% secondary filler.

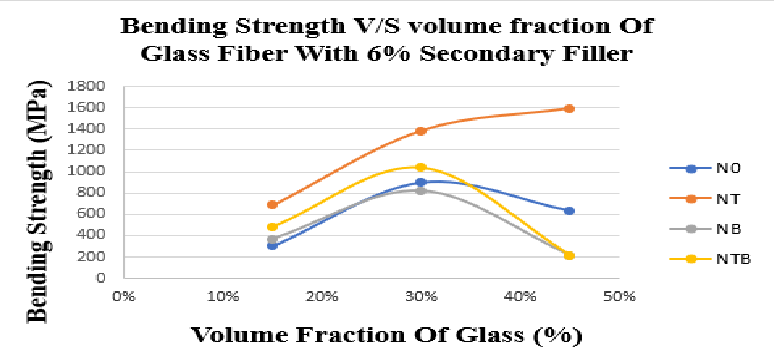

Fig. 5: Effect of percentage of glass fiber and different notches on bending strength, for 6% secondary filler.

The effect of percentage of glass fiber on bending strength for 6% secondary filler as shown in figure 5. From the figure it is observed that the bending strength is maximum in case of 45% percentage glass fiber subjected to notch along both thickness and width specimens. The bending strength increases with decrease in glass fiber percentage in case of notch along thickness specimen. From the graph it is observed that maximum bending strength is at 45% glass fiber in case of notch along thickness. The minimum bending strength is at 15% glass fiber in case of without notch specimens.

C. Effect of volume fraction and different notches on bending strength in case of 9% secondary filler.

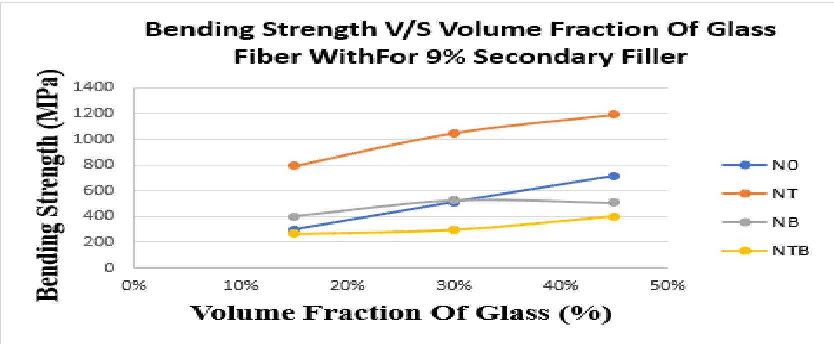

Fig. 6: Effect of percentage of glass fiber and different notches on bending strength, for 9% secondary filler.

The effect of percentage of glass fiber on bending strength for 9% secondary filler as shown in figure 6. The bending strength increases with increase in glass fiber percentage in case of without notch and notch along thickness specimen. From the graph it is observed that maximum bending strength is at 45% glass fiber in case of notch along thickness. The minimum bending strength is at 15% glass fiber in case of notch along both thickness and width specimens.

D. Effect of volume fraction and different notches on deflection in case of 3% secondary filler.

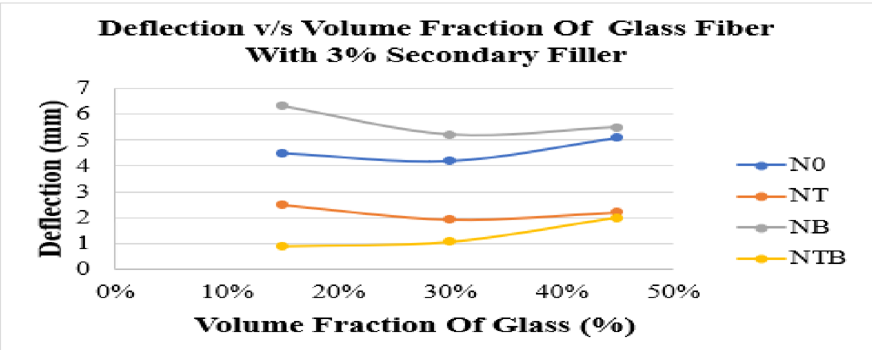

Fig. 7: Effect of percentage of glass fiber and different notches on deflection, for 3% secondary filler.

The effect of percentage of glass fiber on deflection for 3% secondary filler as shown in figure 7. From the graph it is observed that maximum deflection is at 15% glass fiber in case of notch along width. The minimum deflection is at 15% glass fiber in case of notch along both thickness and width specimens.

E. Effect of volume fraction and different notches on deflection in case of 6% secondary filler.

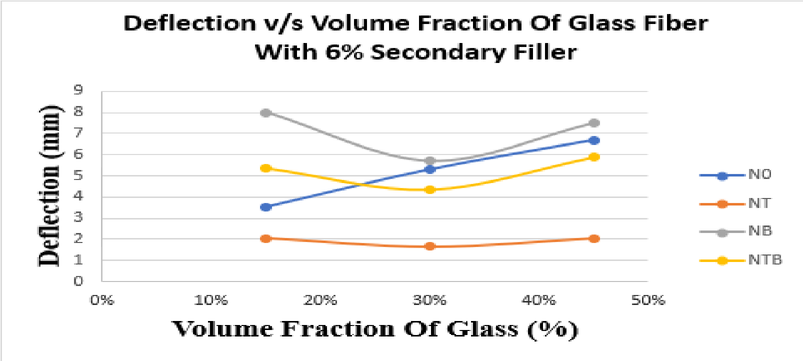

Fig. 8**:** Effect of percentage of glass fiber and different notches on deflection, for 6% secondary filler.

The effect of percentage of glass fiber on deflection for 6% secondary filler as shown in figure 8. From the figure it is observed that the deflection is minimum in case of equal percentage of jute and glass fiber subjected to notch along thickness. From the graph it is observed that maximum deflection is at 15% glass fiber in case of notch along width specimens. The minimum deflection is at 30% glass fiber in case of notch along thickness specimens.

F. Effect of volume fraction and different notches on deflection in case of 9% secondary filler.

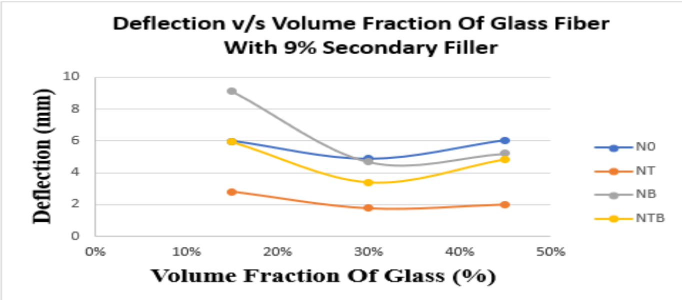

Fig. 9: Effect of percentage of glass fiber and different notches on deflection, for 9% secondary filler.

The effect of percentage of glass fiber on deflection for 9% secondary filler as shown in figure 9. From the figure it is observed that the deflection is minimum in case of equal percentage of jute and glass fiber subjected to notch along both thicknesses. From the graph it is observed that maximum deflection is at 15% glass fiber in case of notch along width specimens. The minimum deflection is at 30% glass fiber in case of notch along thickness specimens.

IV. CONCLUSION

Based on the investigation following conclusions are drawn

- The bending strength is maximum in case of 3% secondary filler for 30% percentage of glass fiber in case of notch along both thickness and width.
- The bending strength is minimum in case of 6% secondary filler for 45% percentage of glass fiber in case of notch along both thickness and width.
- The deflection is maximum in case of 9% secondary filler for 15% percentage of glass fiber in case of notch along width.
- The deflection is minimum in case of 3% secondary filler for 15% percentage of glass fiber in case of notch along both thickness and width.

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