Wear Analysis, mechanical properties and Analysis of Variance of Jute/Glass/flax fibers and their barium sulphate as filler composites

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Abstract. Natural fibers give strength to polymer composite for making very low cost materials and are very good market now a days. Therefore the researcher’s main attention is to apply appropriate technology by utilizing these natural fibers as efficient and economically in order to produce very good quality fiber reinforced polymer composites for different engineering applications. In our research work, the experiments like tensile, flexural and impact tests were carried out for different natural fibers like, woven Jute, glass and flax hybrid-reinforced epoxy composites with filler of barium sulphate and without filler composite. Therefore the best, cheap and efficient process called hand layup technique was applied to prepare composite material. The surface morphology of the composites was examined through scanning electron microscope, due to the low density and high specific properties of glass, flax fiber composites, it offer cost savings when compared with synthetic fibers. Therefore this king of composite materials can be used in automobile industry. Fro the study, the hybrid composites with barium sulphate filler as composite was used by us to provide good and improved mechanical properties such as tensile, flexural and impact strength. And also the good reduced wear property analyzed on filler composite.

Keywords: Composite materials, reinforced composites, barium sulphate, glass, flax, Jute.

1. Introduction
The new engineering materials now a day are used as natural fiber reinforced and hence made with composite materials. The industrial applications with this composite materials are rapidly going since the natural fibers are renewable, recyclable, most cheaply occurring. Out of all the natural occurring fibers the jute fiber is one of the most widely used and very cheap. The jute and glass fiber reinforced polymer (JGFRP) was made with the help of reinforced plastic matrix, since the fiber is in light weight and also very strong in nature and hence they are extensively used in industry purpose. The best combination of composite material is obtained with the hybridization of the E-glass fiber mixed with the oil palm empty and fruit bunch (GFOPEAFB) gave the highest performance on the mechanical properties. Hence the combination of the GFOPEAFB and mixing with E-glass hybrid fiber with
reinforced with mixing with phenol formaldehyde resin gave the excellent results and also they were cost effective, hence in light weight and have never compromised in quality. The different mechanical properties of the tensile, flexural and impact properties of the composite materials with the leaf fiber made of pineapple and combined with sisal reinforced shown positive effect along with the glass fiber. The mechanical properties of the composites area unit improved because of the addition of optical fiber at the side of toddy palm fiber within the matrix and reduce the wet absorption of the composites [3]. Glass/sugar palm composites area unit found to own a rise in tensile, flexural, and impact properties with increasing fiber content and therefore the weight quantitative relation of glass/sugar palm fibers [4]. The tensile properties of the flax/glass fiber strengthened hybrid composites were improved with the increasing of optical fiber content. The interlaminar shear strength and therefore the interlaminar fracture toughness of flax/glass fiber strengthened hybrid composites were on top of those of GFRP [5]. Experimental study on untreated plain-woven jute fabric-strengthened polyester composites shows the potential of this renewable wellspring of traditional fiber for utilization in numerous consumable merchandise [6]. The market state of affairs for composite applications is dynamic because of the introduction of newer perishable polymers. Composite materials strengthened with natural fibers, like flax, hemp, kenaf and jute, area unit gaining increasing importance in automotive, aerospace, packaging and different industrial applications [7]. The aim of this study is to form use of fiber like jute fiber, that is copiously offered in Republic of India and to include with man-made fiber like optical fiber to boost the mechanical properties. during this paper, an impression of conjugation of jute/E-glass fiber strengthened epoxy composites is evaluated. The results of the tests facilitate in determining the potential applications of the jute/E-glass fiber strengthened epoxy composites.

1.1. Materials
The composite material used for our study such as Jute, glass and flax were fabricated and shown in figure 1 and figure 2. The natural fibers were collected from anakaputhur jute weaver association, Chennai, India. Matrix material selected is epoxy resin grade LY556 and hardner grade HY971 as binder for the resin, composite fabrication and testing specifications preparation was carried out at our college Bharath Institute of Higher Education and Research, Chennai, India. And the mechanical testing was carried out at Delta Inspection and testing service, Chennai, India. From the rule of mixture, it is predicated that the natural woven fiber fabric was used in out investigation was about 65% and the epoxy resin was used as 35%. The original pattern of the woven fabrics of the plain weave type and it offers high fabric integrity and the dimensional stability also.

![Figure 1. Jute and Woven Jute](image1)

![Figure 2. Glass plant and Woven glass](image2)
Figure 3. Flax plant and Woven flax

2. Composite Preparation

2.1. Preparation method-1
We 2nd hand layup method was used intended for composite grounding. The major benefit of with this procedure was that it is very effortless and easy to fabricate and simple technique. This process includes the combination of resin and fiber in dissimilar forms. In our analysis, the woven jute, glass and flax fibers were reinforced first separately by alternative layers into epoxy resin grade LY556 and the hardener grade HY971 was mixed in the ratio of 10:1. During this process of mixing resin and hardener, the correct rousing was conceded out. The mixing was continuous process to dissolve the resin and the hardener into matrix. As the 1st layer, the woven jute fiber mat measures 310mm x 310mm was kept on the epoxy resin film coating on the entire surface of the fiber mat uniformly. Once the above process was completed, woven glass fiber mat was kept as second layer with the same dimensions and the epoxy resin was applied and filled over the entire surface of the fiber mat. Then the woven flax as 3rd layer in between the each resin coatings until a thickness of 3.2 mm was obtained in the laminates. To remove the air gaps, rollers are used between the layers. Then the laminates were compressed for a curing for 24 hours. Thus the Jute, glass and flax hybrid composite laminates prepared by the hand layup technique as shown in figure 4.

Figure 4. Woven Jute/glass/flax

2.2. Preparation method-2
The same procedure was applied for Jute, glass and flax with barium sulphate as a filler composite laminate, the prepared sample with barium sulphate (JGF+B.S.) composites is shown in figure 5 below.

Figure 5. Woven Jute/glass/flax with barium sulphate
2.3. Specimen preparation

From the prepared above specimens the size are striking with the facilitate of the pattern made according to ASTM D638 standard for tensile testing. And ASTM D790 for flexural testing and ASTM D256 customary for impact testing, using cutter specimen in all hybrid composites laminates were prepared. The edge of the specimen was smoothened using a file and emery sheet to get smooth surface. The prepared specimens from the JGF and JGF+B.S hybrid composite laminates that undergo mechanical testing. The different tested specimens were shown in figure 6 to figure 9 below.

![Figure 6(a): Tensile(before)](image)
![Figure 6(b): Tensile(after)](image)

![Figure 7(a): Flexural(before)](image)
![Figure 7(b): Flexural(after)](image)

![Figure 8(a): Impact(before)](image)
![Figure 8(b): Impact(after)](image)

![Figure 9(a): Hardnes(before)](image)
![Figure 9(b): Hardnes(after)](image)

![Figure 10(a): Compression(before)](image)
![Figure 10(b): Compression(after)](image)
From the above tested specimens the results were tabulated below and shown in figure 11.

### Table 1. Mechanical properties of tested components

| Sl No | Test parameters             | Sample 1 JGF | Sample 2 JGF+B.S |
|-------|----------------------------|--------------|------------------|
| 1     | Tensile Strength, N/mm²     | 45           | 50               |
| 2     | Flexural Strength in N/mm²  | 156          | 176              |
| 3     | Impact Energy in J/mm²      | 35           | 35               |
| 4     | Hardness, HRR               | 55           | 58               |
| 5     | Compressive Strength in N/mm²| 355          | 453              |

![Test results graph](image)

**Figure 11. Comparison of 2 specimens test results**

### 3. Water Absorption Test

The fabricated sample was tested for water absorption for about 24 hours. The sample was soaked in curing tank; the weight had been checked before and after the test. First the specimen’s weight was taken in dry condition and is immersed in water which was maintained at normal temperature. The water absorption of the composites was calculated by the weight increased with respect to the dry weight condition. Finally the weight percentage of samples was calculated with the help of the following formula.

\[
\text{% of water absorbed} = \left[ \frac{(M_i - M_s)}{M_s} \right] \times 100
\]

\[M_i = 110\text{grams}, M_s = 103\text{grams}\]

\[
\text{% of water absorbed} = 6.36\%
\]

Since the percentage of water absorbed is 6.36% which was very low. Hence the tested specimen can be used in wet condition applications.

### 4. SEM Analysis

The scanning electron microscopy (SEM) microscopic detail of the prepared specimens were tested in optical microscope and further SEM examination since the information was not sufficient from the optical microscope. The different SEM pictures were taken during the test analysis from SUPRA 55 FESEM, which contain the resolution of 0.8nm and the enlargement factor which varies from 100X till 1000KX. The SEM Images for JGF and JGF+B.S are shown in following figure 12 to figure 13.
Figure 12. SEM Image of JGF

Figure 13. SEM Image of JGF+B.S

Table 2. Wear test results

| Sl No | Wear test                     | Sample 1 JGF | Sample 2 JGF+B.S |
|-------|-------------------------------|--------------|------------------|
| 1     | Applied Load (kN)             | 0.02         | 0.02             |
| 2     | Sliding distance (meter)      | 1000         | 1000             |
| 3     | Weight Loss (gm)              | 1.3149       | 1.8846           |
| 4     | Wear Volume Loss (mm³)        | 487          | 698              |
| 5     | Wear Volume Loss (cm³) 0.078  | 0.487        | 0.698            |
| 6     | Wear rate(cm³/Nm)             | 0.02435      | 0.0233           |
| 7     | Wear rate(m²/N)               | 2.435E-08    | 2.827E-08        |
5. Conclusions
In this study woven Jute, Glass, flax with barium sulphate as an filler and its without filler epoxy composites, tensile, flexural and impact, hardness, interdelamina strength were determined using universal testing machine and impact tester, hardness. Based on the results the following conclusions are drawn:

- A new natural fiber Jute in woven form is experimented in this study.
- The Jute, glass and flax with barium sulphate sample gives better tensile strength of 50N/mm$^2$ during its tensile test.
- During flexural test the Aleovera, glass, flax with barium sulphate composite shoes the better flexural property of 173 N/mm$^2$
- From that result better impact property is observed on both the composites
- It is clearly observed that woven A/H/F With baso4 gives the maximum hardness number
- The compressive strength is also maximum for A/H/F with BASO4
- The results indicated that woven jute glass, flax with baso4 epoxy hybrid composite possess good tensile, flexural and impact, hardness, compressive strength. So that the filler effect is more on composite
- From the investigation the water absorption property is high for the woven aleovera/glass/flax composite
- The Thermogravity analysis is observe red more in the woven aleovera/glass/flax with baso4 filler composites the filler composites can with stand high temperature.
- Enhancement of mechanical properties may be attained by using the treated fibres and correct method of fabrication.
- The wear rate is observed Jute, glass and flax with barium sulphate. The natural fibre slowly replaces the synthetic fibres from its environmental impact, marching towards to make a revolution in engineering materials.

6. References
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