Experimental Analysis of Luffa Composite Material

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Abstract. In recent times maximum research is based on the composite materials. In the future, many engineering developments are based on the composite material. This research is entirely based on natural composite material. In this work, Luffa material is used for making composite materials in different proportions and its mechanical properties calculated. Luffa is a natural material with less cost and easily available material. Thus the main objective of this work is determining the best composition by comparing the properties of different compositions.

Keywords. Luffa, composite, natural composite, mechanical properties.

1. Introduction
The reason for the more composite material requirement in recent time is that because of engineering development is based on the lightweight materials with less cost. Composite is defined as combining two materials or more than two materials. Recently various types of composite materials are available, which are based on the raw materials used [1]. The different categories of composite materials used now are synthetic composite, natural composite and hybrid composite. Composite materials are fabricated by various methods, but they are used to replace the ferrous materials. This research is based on natural composite. Natural fibers available are ramie, coir, luffa, hair, etc. [2].

Figure 1. Composite Material
The chemical like epoxy bonds natural composite materials. The natural composite materials have excellent strength with less cost and easily available [4]. The main advantage of natural composite material is eco-friendly with good strength. The figure shows the composite material with two layers.

2. Materials
Luffa fiber is the primary raw material used to make the luffa composite material. The bonding is made with hardener and epoxy resin. Among the different types of epoxy and hardener available, hardener HY 951 and epoxy resin LY 556 are the best bonding chemicals suitable for the luffa composite. Luffa fiber is obtained from the plant. The luffa fiber fabrication process is shown in figure 2.

![Luffa fiber](image)

**Figure 2. Luffa fiber**

3. Methodology
The cylindrical shape luffa is available in the market. The cylindrical luffa is cut at its centre rib and all seeds are removed. Then the luffa is flattened, as shown in figure 2. The scissors or sharp knife is used to cut the luffa with correct finishing and the luffa fiber is chapped into different sizes for different composites.

The plastic tray is used as a mould for the composite. PVA is applied on the plastic tray and thoroughly dried. PVA chemical is used for insulation between composite and mould. The hand lay-up is suitable for fabricating natural composite and hence in this work, this method is used to fabricate the luffa composite.

After the drying of PVA, the LY 556 and HY 951 mixing is applied on the tray over the PVA layer. The LY 556 and HY 951 are mixed in 10:1 ratio, which is obtained from previous research work. Above the chemical mixing, the luffa is placed in a vertical position. Above the luffa fiber, the chemical mixing is applied again. For a certain period, the luffa is rammed properly and the composite is dried for two or three days. The composite is cut according to the ASTM standard and the samples are prepared according to the specification. The samples are shown in figure 3.
4. Results and Discussion

4.1. Tensile strength
The main mechanical property of the luffa composite is stress and strain value as per the load. The tensile test determines the stress value of the luffa composite and a universal testing machine is used for the tensile test. The result of the three different composite values is shown in figure 4.
4.2. Bending strength
The flexural testing determines the bending strength of the luffa composite. The luffa composite is cut in the shape of a dog bone for testing [1]. The dog bone shape luffa composite material is placed in the flexural testing machine. The point load acts on the centre of composite material to find the bending strength of the luffa composite material. The values are compared in figure 5.

![Flexural strength (N/mm²)](image)

**Figure 5.** Flexural test results

4.3. Rockwell test
This Rockwell testing finds the hardness of the luffa composite material. Luffa composite is cut in the square shape and placed in the Rockwell machine. The machine has ball on the tip, which gives the load on various places. The material hardness of all the three materials are compared in figure 6.

![Hardness test results](image)

**Figure 6.** Hardness test results
4.4. Water absorption test
This test is performed by the kitchen scale machine. Luffa composite is cut into a small square, weight is measured and dumped in water for one day. After one day, the weight is determined to find the water absorption level of the luffa composite material. The water absorption results are shown in figure 7.

![Figure 7. Water absorption test results](image)

4.5. Impact test
This test helps to find the fracture value of the luffa composite as per load using the Charpy test. The luffa composite is cut in the small square shape and takes v groove in the centre. The results of all three composites are shown in figure 8.

![Figure 8. Impact results](image)

5. Conclusion
The luffa composite is prepared in three different forms of specimens using the hand lay-up method. The specimens are taken out appropriately from the mould and cut for the testing. All three specimens have
excellent mechanical properties. Here, the Rockwell hardness test, impact Charpy test, water absorption test, flexural test and bending test are performed to determine its mechanical strength. Comparing the results, it proves that specimen 2 consists of good mechanical strength compared with the other two specimens. This specimen 2 has 7.5-joule impact strength, 7 N/mm² flexural strength and 25 Mpa tensile strength. These values are high compared to the other two specimens.

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