# Mechanical Properties of Makhana (Euryale Ferox Salisbury) Reinforced Composite

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*Abstract*— The natural fibre-reinforced composites are the deed of the time because of the growing concern on the environmental issues. Recently there has been a great interest in the industrial applications of composites developed from natural fibres, bio or industrial wastes. Because of their superior properties, the science is taking them as alternatives to the synthetic and non-degradable fibre composites. Visualizing the importance of polymer composites and owing to issues of environmental concerns, present work is an attempt to produce composites using a biodegradable material i.e. Makhana. Composites with 10, 20 and 30 weight % makhana particulate reinforced epoxy composites have been prepared using hand lay-up technique. Mechanical properties like tensile strength, flexural strength, and hardness have been investigated in detail.

***Key words:*** Composites, Makhana, Natural Fibre, Tensile Strength, Flexural Strength, Hardness

## I. INTRODUCTION

Now-a-days, composite materials are in demand due to their superior properties over the conventional materials. These materials are well suitable for various industrial applications which lead to the development of the society in all extents [1, 2]. Yet in the recent decade there has been growing concern and protest against the adverse effect of these materials on our environment. To cope up with this issue, a lot of research is being done to evolve on green composites in the field of engineering materials and scientists are showing their interest in the industrial applications of composites made from natural fibres [3]. Generally, a composite material is prepared by combining a binding resin (matrix) with small filaments of solid material (reinforced material). Green composite or bio-composite is a composite material which consists of one or more phase(s) of natural or biological origin [4, 5]. Natural fibres can be derived from plants and vegetables. They are economical, recyclable, renewable and biodegradable. They also have low densities, higher filling levels, and favorable mechanical and thermal properties. Because of all these advantages, today, many researchers are concentrating on the use of natural fibres as reinforcement in the polymer matrix [6-8]. Most of the research to date has concentrated on using various natural fibres or particulates to reinforce natural polymer composites, but a very little study has been done along the Makhana, also known as Gorgon nut or fox nut. It belongs to the Nympheaceae family. It grows in the countries like India, China, Japan, Bangladesh and Myanmar. However, Mithilanchal (a division of the state Bihar in India) is the main area of its present existence where it is extensively cultivated in Purnea, Madhubani, Samastipur, Dharbhanga, Muzafferpur, Saharsa districts of Bihar [9-12]. This paper presents the study of tensile strength, flexural strength, and hardness of the composite specimen.

## II. MATERIALS AND METHODS

### *A. Raw materials used in this experimental work are as follows:*

- Epoxy resin, AY 103
- Hardener, HY 951
- Makhana ((Euryale ferox Salisbury)

### *B. Composite Preparation*

Makhana powders dispersed in epoxy matrix composites have been prepared using hand lay-up technique as shown in Fig. 1. A glass mold of 200 X 200 X 03 $mm^3$ is used for this purpose. For good surface finish and easy withdrawal of prepared specimens, a white waxed Mylar sheet is employed to shield the glass mold. Firstly, the makhana was extracted from its cell and cleaned. It was placed in an oven and roasted till it became very hard and crunchy. Ball milling was used to crush the roasted makhana and powder was prepared. Meanwhile, the epoxy and the hardener were poured into a flask and mixed in a proportion of 10:1. The powder as a filler and epoxy mixture were continuously being stirred with a mechanical stirrer for homogenous mixing. Then the mixture of filler and the epoxy and hardener solution were poured slowly into the mold. After 24 hours, composites were extracted from the mold and cut with a diamond cutting tool as per the ASTM standard for different tests.

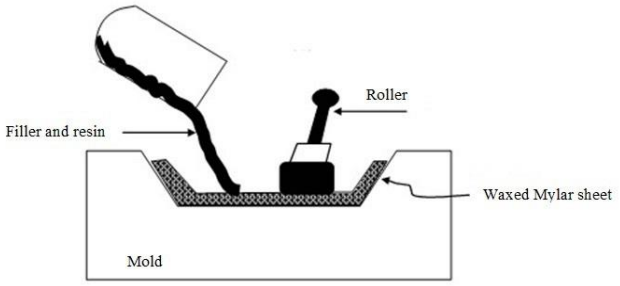


Fig. 1: Hand Lay-up Technique

## III. RESULTS AND DISCUSSION

### *A. Mechanical properties*

The mechanical properties of a composite depend upon so many factors like the type of reinforcement, amount of reinforcement, processing parameters, distribution of reinforcing material in the matrix and the type of bonding that occurs between the matrix and the reinforcement. To analyse the mechanical properties, tensile tests, flexural tests, and hardness tests are performed on the prepared composites and the following results are noted.

 

### *B. Tensile test*

The tensile test measures the capacity of a material to sustain loads before elongation. For this, the specimens were cut as per ASTM: D638-10 and the tests were performed on UTM. The results are shown in Fig. 2 with the help of bar graphs. From figure 2, it is clear that the tensile strength increases from 15 MPa of epoxy to 34, 47 and 44 in 10, 20 and 30 weight % composites respectively. Considerable increase in tensile strength is observed on the basis of better interaction between epoxy and makhana powder. At higher content, the tensile strength decreases because of accumulation and inhomogeneous distribution of the powder.

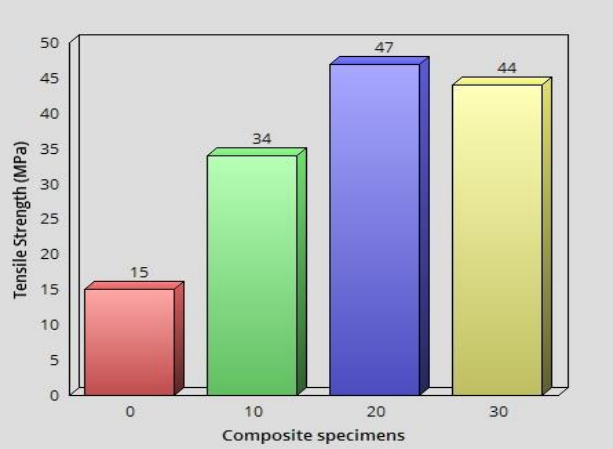


Fig. 2: Tensile strength of Composite specimens

### *C. Flexural Test*

The flexural text measures the behavior of materials subjected to simple beam loading. It plays a very important role in structural application purposes. To determine the flexural strength of composites a three-point bending test was carried out. For this, the specimens were cut as per ASTM D2344-84 and the tests were performed on UTM. The results are shown in Fig. 3 with the help of bar graphs. From figure 3, it is clear that the flexural strength increases from 37 MPa of epoxy to 64, 76 and 70 in 10, 20 and 30 weight % composites respectively. Considerable increase in tensile strength is observed on the basis of better interaction between epoxy and makhana powder. At higher content, the tensile strength decreases because of accumulation and inhomogeneous distribution of the powder.

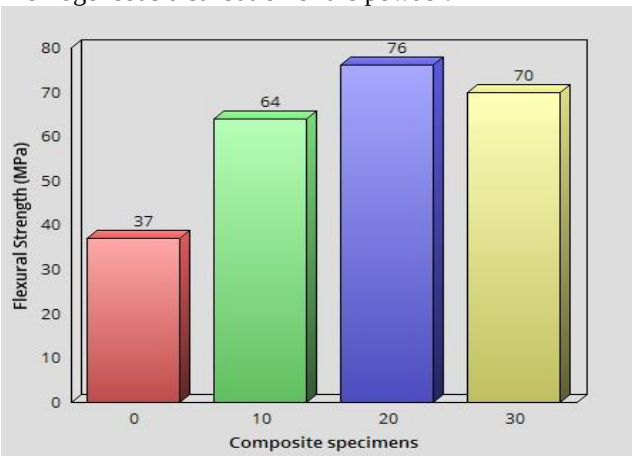


Fig. 3: Flexural strength of Composite specimens

### *D. Hardness test*

The hardness test measures the capacity of a material to resist penetration or wear and tear. The hardness test was carried out on a Leitz Micro-hardness tester in accordance with ASTM E384 to measure the hardness of the composite specimens. The results are shown in Fig. 4 with the help of bar graphs. From figure 4, it is clear that the hardness increases from 12 HV of epoxy to 18, 26 and 36 in 10, 20 and 30 weight % composites respectively. It is apparent from the figure that hardness increases with the increase in filler content in composites.

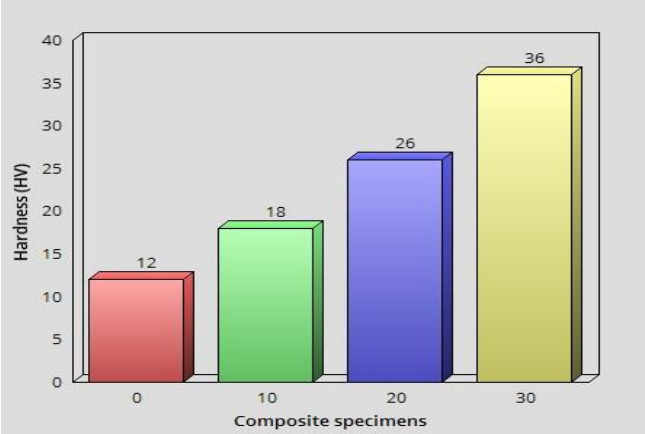


Fig. 4: Hardness of Composite specimens

## IV. CONCLUSION

The present work deals with the preparation of new biodegradable composites where makhana is used as a filler material. A study has been accomplished to investigate the mechanical properties of the prepared composites and the following conclusions are made:

1) With the successful production of novel grade of epoxy based composites reinforced with makhana powder using hand lay-up technique.
2) The prepared composite exhibits superior mechanical properties than epoxy.
3) The tensile strength of the composite is utmost for the 20 % weight percentage of the makhana powder.
4) The flexural strength of the composite is maximum with 20% weight percent of makhana powder.
5) With the increase of the filler content in the polymer matrix the mechanical properties are improved up to a certain extent, beyond that, they start deteriorating because of poor adhesion between matrix and filler.
6) The hardness value of the composite increases with the addition of the filler content which indicates a better resistance to abrasion and wear.

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