Flexural Behavieral Study of Coir and Wool Hybrid Natural Fibre Epoxy Resin

Shivayogi B H[1], Akhilesh Angadi[2], Chetan Sharma C K[3], Manjunath S Angadi[4], Veerabhadrayya Hiremath[5]
Department of Mechanical Engineering,
Jain Institute of Technology, Davangere, India[1,2,3,4,5]

Abstract: **Natural fiber reinforced polymer composites are employed in a variety of applications ranging from fundamental research to engineering. They are less expensive and may be easily recycled. Due to the quick renewability and availability of basic components, these composites have a low density and low cost, as well as good mechanical qualities. This is because every component of the fibre crop, both upstream and downstream, has the potential to generate classic and unique products for a wide range of applications in textiles, packaging, constructions, automotive, marine, electronic, and home use.**
Following are the conclusions obtained from the result and discussions
When compared to other composites CWRA-1, CWRA-3, and other CWRL-1, CWRL-2, and CWRL-3, the composite CWRA exhibits the largest bearing load in bending, with CWRA-2 (coir 15%, wool 10%, and araldite 75%) having the maximum bearing load of 6120N.

Keywords:- Natural fiber, polymer composites,fibre crop, bearing load

1. INTRODUCTION

Composite materials can be used in a variety of ways, and so me have even found new markets. Modern composites materials are made of a wide range of materials that are employed in both common and high-tech application. While composites have previously demonstrated their value as lightweight materials, the present challenge is to make them robust enough to replace traditional materials while remaining cost effective. As results, a number of cutting edge approaches that are now in use in the industry have been developed. Several industrial applications, particularly in transportation, have begun to be recognised by the composites industry. New polymer resin matrix materials, as well as high-performance glass, carbon, and armid fibres, have recently been introduced, resulting in an increase in the use and volume of composites. There has been a significant cost decrease as a result of this expansion. Existing structures are routinely reinforced using composite materials to make them more seismically resistant are to repair earthquake damage.

➢ NATURAL FIBER

Natural fibres are type of fibres that occurs natural in great numbers. It outperforms synthetics due to its expensive cost, low density, stiffness, outstanding mechanical capabilities, high specific strength, and nonabrasive properties, and eco-friendly biodegradability.

There is a considerable source of high-tensile-strength coconut coir fibre in our country. As the world's population rises, natural resources are being heavily mined as an alternative to artificial products. As a result, natural fibre composite reinforcement is becoming more popular. Natural fibres have several notable advantages over manufactured fibres. Mineral-based, plant-based, and animal-based natural fibres are separated into three categories based on their origin. Plant-based natural fibres like cellulose, hemicelluloses, and lignin contain cellulose, hemicelluloses, and lignin, but animal-based natural fibres like silk and wool contain proteins. Natural fibre- reinforced polymer composites have piqued the interest of researchers because they have potential to replace synthetic fibre composites such as glass or carbon fibre composites.

Natural fibres are classified into three groups. Fibres come in three different types: plant, animal, and mineral.

i) Animal fibres: Proteins are commonly found in animal fibres. Wool, silk, and avian fibre is examples of fibres that can be obtained from an animal's body. Sheep's wool, goat's hair, horse's hair, feathers, and feather fibres, among other materials, can be used to make it.
ii) Mineral fibres: Mineral fibres are divided into the following categories, based on whether they are naturally occurring or significantly modified fibres made from minerals. Asbestos is a collection of minerals that naturally occur as bundles of fibres in the environment. These fibres are resistant to heat and fire, as well as being poor electrical conductors. Asbestos is a silicate mineral with the chemical structure of silicon and oxygen. Serpentine asbestos and amphibole asbestos are the two main types of asbestos rocks. Ex-asbestos, ceramic, and metal fibre is the three types of asbestos.
iii) Plant fibre: Cellulose is the most common component of plant fibres. This fibre can be divided into the following categories.
   a) Seed fibre: Cotton and kapok fibres were extracted from the seed and seed casing.
   b) Lea fibre: Fibres can be collected readily from the leaves of plants such as sisal and agave.
   c) Skin fibre: Fibres are harvested from the skin or from the bast that surrounds the stem of the plant.

2. PROPERTIES OF COMPOSITES

Composites are multiphase materials made up of one or more discrete phases embedded in a continuous phase that have superior properties that none of the constituent elements can accomplish on its own. These constituents are still bound together, but their identities and attributes are preserved. The continuous phase that is more prevalent in composites is referred to as "matrix". "The discrete phase, often known as "reinforcement" or "reinforcing material," is generally harder and stronger than the continuous phase. One of the most important factors in determining the efficiency of reinforcement is the geometry of the reinforced phase. Composites are employed in both modern and ancient applications because they can increase strength, stiffness, facture toughness, and toughness without adding weight.

3. LITERATURESURVEY

[1] KN Bharath, BA Nizamuddin, Mudasar Pasha1, and Mudasar Pasha2. Tensile, bending, water absorption, chemical absorption, and biodegradable tests of woven sheep fibre reinforced with 40 percent and 50 percent epoxy composites were evaluated under various operating circumstances using destructive methods. When woven sheep fibre composites of composition (50–50) are compared to woven sheep fibre composites of composition (60–40), tensile and bending tests reveal high strength and maximum bending. The composition (50–50) absorbs more moisture than the composition (60–40), but the (60–40) absorbs more chemicals. The compositions (50–50) and (60–40) grew roughly the same amount of weight after a few days in a biodegradable test. A scanning electron microscope was used to inspect corroded s urfaces.

[2] Abdul Nazeer examines the mechanical properties of coconut coir fibres reinforced with epoxy resin of various lengths (5mm, 10mm, 15mm) and coir fibres treated with NaOH at a fraction of 5% in this research. All specimens were manufactured in line ASTM D3039, and all samples were hand crafted. In accordance with the ASTM D3039 standard, the samples were tested using ASTM D3039 universal testing equipment (UTM). The researchers discovered that treating the composite with NaOH increased its tensile characteristics, ductility, and hardness even more. The tensile strength of fibres was shown to rise as the length of the strands increased. Coir fibres with a length of 15 mm had the highest tensile strength.

[3] Edith Ishidi, Chizoba Obele1 For feasible manufacturing, several loadings of coir fiber/ epoxy resin composites has been created. The fibre in flexure was tested using universal testing equipment. There was also a tensile and impact test performed. At 30% weight percent, the tensile strength of coir fibre/epoxy resin composites are was discovered to the highest.

The impact strength of the charpy notch was likewise at its peak, at 30wt percent (26.43KJ/m2). The tensile modulus of coir/epoxy resin composites increased with increasing filler loading as follows: 10wt percent (900.00N/mm2), 20wt percent (977.80N/mm2), 30wt percent (1000.00N/mm2), 40wt percent (1066.67 N/mm2), and 50wt percent (1733.3 N/mm2).

4. OBJECTIVES

- Hybrid natural fibre reinforced Polymer matrix composite is made using a hand layup method.
- To create specimens with various compositions (20-80, 25-75, 30-70), as well as to evaluate the qualities of such hybridised composites with various compositions.
- To investigate the mechanical properties of various resin materials used as the composite's matrix.
- Experiment of bending test, as well as determining the mechanical properties of all compositions.
- To compare the results and understand the impact of natural fibre hybridization in composites by plotting the graph.

5. METHODOLOGY

- Define the work's objectives and formulate the problem.
- Matrix material and reinforcement should be chosen carefully.
- Obtaining the raw ingredients required for composite production.
- Using the hand layup process, construct the composites.
- Preparation of specimens for testing in accordance with ASTM standards.
- Obtaining results for specimens that have been tested and analyzing the data.

6. SELECTION OF MATRIX MATERIAL AND REINFORCEMENT

- Epoxy resin and hardener (Matrix)

Epoxy resins are a form of thermoset material that is commonly used in structural composites because they offer a unique set of properties not seen in other thermoset resins. Because of their great strength and mechanical adhesiveness, epoxy resin is frequently employed in industrial applications. These resins are excellent solvents and chemically resistant.

Hardener is an epoxy or fibre glass curing agent. To begin curing, epoxy resin requires a hardener, also known as a catalyst. When the adhesive is mixed with resin, the hardener, also known as a catalyst, hardens it. The final qualities and application of the epoxy coating for a specific environment are influenced by the correct selection and combination of epoxy and hardener components.

- Coconut Coir Fibre (Reinforcement)

Coir fibre and pith, which is a corky tissue, make up the husk. Water, fibres, and a few soluble chemicals make up this material. Coir is more durable than other natural fibres due to its high lignin concentration. Natural fibres, such as coir based composites, are increasingly being used in automobiles, railway coaches, and public transit buses as the emphasis on fuel efficiency grows.

- Sheep wool:

Wool is a soft, ling-lasting, and environmentally beneficial textile fibre. Wool is a durable fibre that can resist a lot of abuse. Wrinkle resistance, shape preservation, and flame resistance are just a few of the benefits of wool. Wool is a non-sticky fibre with excellent elongation and elastic rebound. Wool is a durable fabric with a low abrasion resistance. The hygroscopicity of these fibres is the highest of any fibre. They have a high resilience level.

7. FABRICATION

Hand Layup is the most common type of Open Moulding. The hand layup is a labour-intensive, manual process that entails the following steps:

- A release anti-adhesive chemical is applied to the mould, preventing the moulded component of the surface from sticking.

- Gel coating is used to generate the part's main surface layer.
- Epoxy resin and hardener are combined to make the gel coating, which is then left without filler.
- The structure is reinforced with a layer of fine fibre reinforcing tissue.
- You can use a brush or a roll to apply the resin mixture.
- The part can be cured for up to 24 hours.
- The portion is taken out of the mold’s surface.
- Low concentration of reinforcing phase and low densif ication of composites are two disadvantages of Hand L ayup procedures.

8. SPECIMEN PREPARATION

The composites were first prepared, and then marked according to industry standards before being cut with a cutting machine.
Below is a list of test specimens, as well as specimen dimension s and test standards.

➢ Flexural test specimen

The ASTM criteria were followed when preparing the flexural test specimen. As seen in the illustration, the specimen utilized is a rectangular bar with dimensions of 150x25x10mm.

Fig. 1: ASTM-recommended flexural test specimen

9. CHARCTERSTICS OF COMPOSITES

➢ Flexural strength:

The most common method of flexural strength testing is to use universal testing equipment.

Flexural strength testing is an integral part of any structural material’s characterization. It is a material's ability to withstand bending before it reaches its breaking point. A three point bend test is commonly used to determine this material attribute, and the composites in this study were also submitted to this test in a testing machine. Samples were gathered from each test throughout a 150mm period, and the findings were averaged. In UTM, the flexural test is carried on. All three samples were subjected to a flexural test in accordance with ASTM D 953 test guidelines. In basic beam loading or transverse beam tests, flexural tests examine the behaviour of materials. At the midpoint of the specimens, a compressive force is applied, and the maximum fibre stress and strain are calculated.

After testing, specimens that failed

Fig. 2: Failured specimen in bending test

10. RESULTS AND DISSCUSSION

The mechanical properties of reinforced polymer matrix composites are influenced by the matrix material, the distribution and orientation of reinforcing fibres, and the structure of fiber-matrix interactions. Even little changes in a matrix's reinforcement's physical composition can have a significant impact on the composites' overall mechanical performance.

Mechanical properties of composites,

➢ Flexural Test:

For various Hybridized Natural Fibers Reinforced Polymer Composite compositions, the table displays the maximum bearing load in bending.

Table 1. Maximum Bearing Load In Bending

Sl.no	Composition	Maximus bearing lo in N
1	CWRL-1	420
2	CWRL-2	360
3	CWRL-3	320
4	CWRA-1	560
5	CWRA-2	780
6	CWRA-3	500

The graph below compares the maximum bearing load in bending for various hybridised coir and sheep wool fibre reinforcement compositions using lapox as the matrix material.

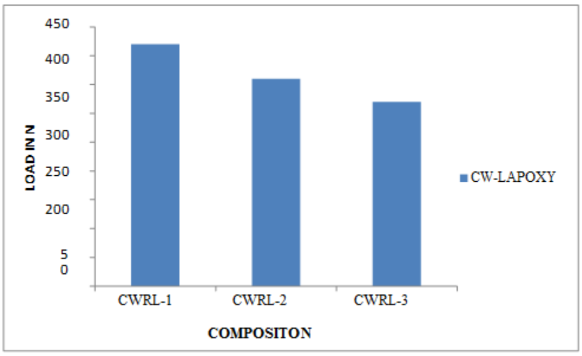

Fig 3: Maximum bending bearing load for different compositions utilizing lapox as the resin.

When comparing the CWRL-1 composition (coir 15%, sheep 10%, and Lapox 80%) to the other compositions CWRL-2 and CWRL-3, we can find that the CWRL-1 composition (coir 15%, sheep 10%, and Lapox 80%) has a maximum bearing load of 420N.

With araldite as the matrix material, the graph below compares the maximum bearing load in bending for various hybridised coir and sheep wool fibre reinforcement compositions

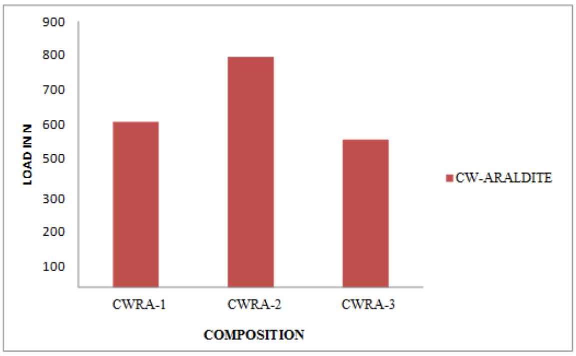

Fig. 4: Maximum bearing load in bending for various compositions using araldite as the resin

When compared to the other compositions CWRA-1 and CWRA-3, we can estimate from the graph that the composition CWRA-2 (coir 15%, sheep wool 10%, and araldite 75%) has a maximum bearing load of 780 N.

In the graph below, the maximum bearing load in bending is compared for different hybridised coir and sheep wool fibre reinforcement compositions using lapox and araldite as the matrix material.

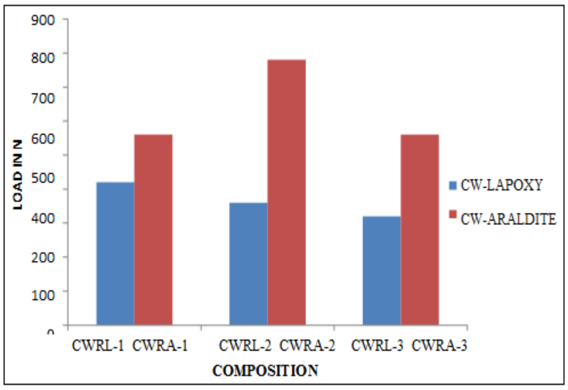

Fig. 5: Maximum bearing load in bending for various lapox and araldite resin compositions

According to the graph, when compared to the composite CWRA has the composite CWRA has the highest bearing load in bending, with CWRA-2 (coir 15%, wool 10%, and araldite 75%) having the maximum bearing load of 780 N when compared to the other compositions CWRL-1, CWRL-2, and CWRL-3.

11. CONCLUSION

This study uses bending tests to investigate the maximum bearing load on failure load of hybridised untreated coir and wool fibre reinforced polymer matrix composites. Two variables were investigated during the analysis.

- The composition is varied as coir-10%, wool-10% and matrix material-80%,coir-15% wool-10% and matrix material-75%, coir-20%,wool-10% and matrix material-70%.
- The two different matrix materials are used such as lapox and araldite.

Following are the conclusions obtained from the result and discussions

- Since the resin araldite is more compatible for the hybridized coir and wool fiber compared to the resin lapox. So we observed that the maximum bearing load of the composite CWRA is greater than CWRL in both tensile and bending as well.
- When compared to other composites CWRA-1, CWRA-3, and other CWRL-1, CWRL-2, and CWRL-3, the composite CWRA exhibits the maximum bearing load in bending, with CWRA-2 (coir-15 percent, wool-10 percent, and araldite-75 percent) having the maximum bearing load of 6120N.

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