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Evaluation of Mechanical Properties of Cordia Dichotoma Based Natural Fibre/Epoxy Composite

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Abstract: **These days, plastics and synthetic fiber composites are growing remarkably due to their wide range of domestic applications. However, it is more evident that the environment is considerably stressed and damaged due to their non degradable plastic and synthetic essence. In recent years, natural fibre composites have gathered much research attention as reinforcing components owing to their affluent mechanical properties. So far, various natural fibres like sisal, bamboo, banana, flax, kenaf and coir were used as reinforcements and more such natural fibers with outstanding properties can be a considerable breakthrough. One such fibre with proven bio-medical properties is Cordia dichotoma where in this work; its fibers were used as reinforcement to fabricate the composite. Hand-layup technique has been used for preparing the specimens with an increasing fiber weight of 5, 10, 15, and 20 gms respectively. They were cut as per the ASTM standards. Further they were tested for Tensile and flexural strengths using Instran Testing Machine (UTM). They depicted a regular trend of an increase in properties with fiber weight of 20grams.Tensile and flexural tests revealed 23.41MPa and 103.48 Mpa of tensile and flexural strengths respectively. Morphology of tensile and flexural specimens was carried out to observe the interfacial bonding using scanning electron microscope (SEM).**

Index terms— **Composites, Epoxy, Natural fibers, Mechanical Properties, UTM.**

I. INTRODUCTION

FRP (fiber reinforced polymer) is a composite material having a polymer matrix secured with high strength fibers such as synthetic fibers [1].Natural fibers are among the most commonly investigated materials by researchers due to their remarkable utilization in polymer composites as reinforcements. In addition polymer composites are eco-friendly and sustainable materials [2]. They have received much attention in the recent decades as an alternative to synthetic fibers. Many factors such as hydrophilic nature of fiber, its content and amount of filler affect the performance of natural FRP's. [2]. It was observed that increase in fiber loading drastically increases its tensile properties [3]. Most of the plant fibers which are being considered as reinforcements for polymeric materials are obtained from the outer cell layers of the stems of various plants [4, 11]. Sizing treatment of glass fiber has shown to effectively enhance fiber-matrix interfacial adhesion whereas only few studies were reported on the sizing treatment of natural fibers[5].few researchers have investigated its several phytochemical and pharmacological studies. Its leaves have also shown antibacterial activity [6-7]. Lohithasu Duppala et al. worked on film forming potential of the Boraginacease[8].it has been found by some of the researchers that cardia dichotoma has shown the presence of flavonoids and saponins,which show an anthelmintic activity[9,10].In this work, Cardia dichotoma fabrics were considered for investigation because of their availability in most of the country regions. The as mentioned fiber was collected locally in Dorigallu village, Ananthapuramu district of Andhra Pradesh, India

Experimental Details

Cordia Dichotoma fiber reinforced natural composites were fabricated using Hand-layup method and its different mechanical properties were analyzed. Present work aims at; manual hand layup method is used for preparing composite specimens.

1.1 Fiber used

Cordia Dichotoma (Boriginaceae family) natural fibers were extracted from bark of the tree. These fibers were collected from local areas of dorigallu, Andhra Pradesh state. They were immersed in water up to one week, to remove the dirt and other foreign materials. They were also washed thoroughly with water, and dried in the sun for a week. This is to remove the moisture content in them.

1.2 Matrix

LY556 epoxy resin and HY951 hardener are used as they yield best binding results under standard conditions. An Optimum mixing ratio of 10:1 (resin & hardener), usually recommended is considered here in synthesizing the specimens.

1.3 Fabrication procedure

At first, fibers were dried under direct sunlight in order to remove the moisture content innate in it. Later a release gel (wax) is spread over the mold surface to avoid the sticking of polymer to it. There upon the epoxy resin and hardener were mixed in a separate beaker. It was then poured on to the surface of the mold and further, compressed natural fibers were uniformly laid upon the epoxy-hardner coating and thereafter remaining mixture was applied over the natural fiber layer. A roller was used to uniformly spread the epoxy-hardener mixture according to the required dimension. A uniform 25 kg wt was placed over the mold undisturbed for 24 h. later the mould was kept in an oven for 30 minutes, such that the releasing agent gets melted and removal of the composite material from the glass mould is made easier. Further the specimens were kept in oven again for one hour in order to cure them. In this manner different specimens were prepared by changing the weights of the fiber with 5, 10, 15 and 20 grams. Specimens were now cut according to the ASTM Standards.

II. TESTING OF COMPOSITES

The mechanical properties were carried out by Instran Universal Testing Machine (UTM) for the fabricated composites.

2.1. Tensile test

Tensile tests were performed according to ASTM D3039-76 standards. For this a universal testing machine having a maximum load rating of 400 kN was used. In each case, five samples were tested and its average was calculated. The specimen was held in the grip and the load was applied till its breakage. This was followed by noting its Ultimate tensile strengths. The sample specimens were depicted in Fig.1

Fig.1. Tensile test specimens

2.2 Flexural test

The flexural strength, flexural modulus and break load were measured with Instron Universal Testing Machine incorporated with 3-point flexural setup, according to ASTM D5943-96. The sample size of specimen was 150 mm x 15 mm x 3 mm. The crosshead speed was 1.5 mm/min and the span length was 50 mm. the sample specimens were represented in Fig.2

Fig.2.Flexural test specimens

III. RESULTS AND DISCUSSION

3.1 Tensile properties

The composite specimens S1, S2, S3 and S4 were tested for tensile properties in universal testing machine and results were tabulated in Table 1. The fiber's weight against tensile strength for four samples is typified in Fig. 3.From this test, it is clear that specimen 4 has higher tensile strength than that of the remaining ones.

Table 1 Tensile property of composites.

Sample	Fiber wt (gms)	Break load(N)	Tensile stress (MPa)	Modulus (MPa)
S1	5	409.72	13.66	1705.44
S2	10	511.28	17.19	2310.77
S3	15	646.32	22.70	2610.60
S4	20	702.32	23.41	3415.04

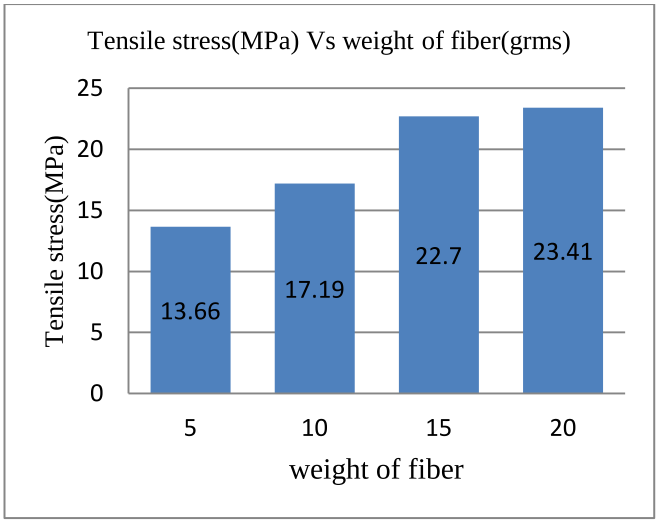


Fig.3.Tensile stress (Mpa) VS Weight of fiber

3.2 Flexural properties

The flexural properties, which include flexural break load, flexural stress and ultimate flexural strength of the composites S1, S2, S3 and S4 are tabulated in Table 2.the fiber's weight against Flexural stress is shown clearly in Fig.4. From this it can be seen that specimen 4 has flexural strength than remaining composite specimens.

Table.2 Flexural property of composite

S.No	Fiber wt (grms)	Maximum Load(KN)	Flexural Stress(MPa)	Flexural Modulus(MPa)
S1	5	0.9	47.23	3914.96
S2	10	0.09	52.59	3942.27
S3	15	0.19	102.88	8327.52
S4	20	0.19	103.48	9466.64

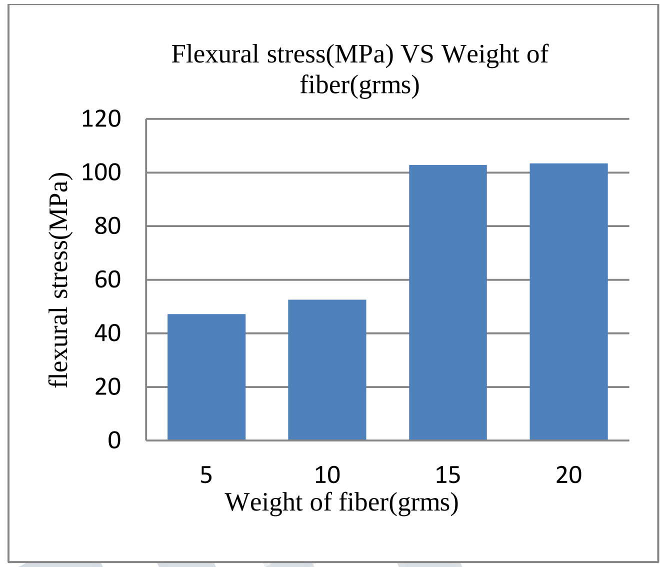


Fig.4. Flexural stress (MPa) VS Weight of fiber (grms)

3.3 Microstructure analysis using SEM

The specimens were analyzed for their microstructure using TESCAN Scanning Electron Microscope available at CeNS, Bangalore. A separate specimen from each test namely tensile and flexural was taken for carrying the analysis. The specimen is gold coated with a thickness of 15– 20 nm using an ion-sputter device attached to microscope. The SEM images show details like failure morphology, defects, and adhesions between resin and the fibres in the specimen. The Fig. 5(a) depicts clearly the image of tensile tested cardia dichotoma fibre. It can be observed that in between the fibre and resin there is a proper bonding prior to the application of tensile stress, where later it was observed that the fiber brakes prior to the resin The Fig. 5(b) pinpoints the SEM analysis details of the flexural tested specimen. In which a uniform load was applied on the middle of the specimen, where a tensile stress develops on its convex side and a compressive stress was clearly observed on the specimen's concave side. The image shown in figure.

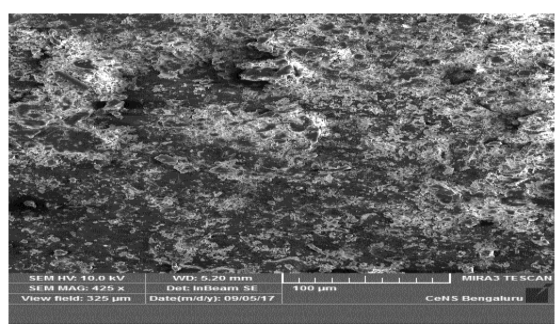
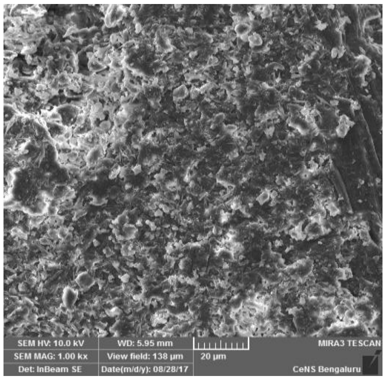


Fig.5 (a & b) SEM images of fiber under tensile and flexural test specimen.



IV. CONCLUSION

In conclusion, our work makes an attempt on fabrication of composites using Cordia Dichotoma fiber and Eopxy resin through hand layup method. The evidence from the study intimates its significant mechanical properties and we suggest that

1. The ultimate tensile strength of the composite S4 is 23.41MPa which is higher than that of the composite S3 with 22.70 MPa, Composites with 17.19 MPa and composite S1 with a value of 13.66 MPa.

2. From the Flexural test it is clear that composite S4 has a higher flexure stress of 103.48 MPa than composite 3, 2 and 1 with values of 102.88 MPa , 52.59 MPa and 47.23 MPa respectively. Hence, composite 4 have good flexural properties.

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