OPEN ACCESS

International
Journal
Of Modern Engineering Research (IJMER)

Estimation of Mechanical Properties on Pineapple/Jute Hybrid Natural Fiber Composites

PhanindraVarma.D[1] Rama Krishna.T[2] Madhukiran.J[3] Lakshmi Poornima.CH[4]

[1]P.G student Sir.C.R.Reddy.Collge of Engineering Eluru West Godavari dist 534002.
[2&4]Assistant Professor Department of Mechanical Engineering Sir.C.R.Reddy College of Engineering Eluru Andhra University Eluru - 534 007, A.P, India.
[3]Assistant Professor Department of Mechanical Engineering ELURU College of Engineering &Technology Eluru West Godavari dist 534004 A.P, India..

ABSTRACT:- *The natural hybrid composites are intended for engineering applications as an alternative to synthetic fiber composites. The aim of this paper is to investigate the mechanical properties of pineapple/jute natural fiber reinforced epoxy hybrid composites. To improve the mechanical properties, pineapple fiber was hybridized with jute fiber. The hybrid combination of fibers with various weight fractions i.e. (40/0, 30/10, 20/20, 10/30 and 0/40) are incorporated into the epoxy LY556 and hardener HY951by using Hand layup technique. The tensile, flexural and impact test specimens are prepared according to ASTM standards. Mechanical properties of hybrid natural fiber composites are evaluated and compared with pure pineapple and pure jute composites. The tensile, flexural and impact strength values are higher than that of pure composites with respect weight fraction of fiber.*

Keywords:- *Jute & Pineapple fibers, Hybrid composites, Hand layup, Epoxy*

I. INTRODUCTION

Composites are used not only for their structural properties, but also for electrical, thermal, tribological and environmental applications. The interest in natural fiber - reinforced polymer composite materials is rapidly growing both in terms of their industrial applications [1-3].They are renewable, low cost, completely or partially recyclable, and biodegradable. Their abundantly availability, renewability, low density, and low price as well as satisfactory mechanical properties make them an attractive ecological alternative to glass, carbon and man-made fibers used for the manufacturing of composites. Some of plant fibers are flax, cotton, hemp, jute, sisal, Kenaf, pineapple, ramie, bamboo, banana, etc. Hybrid composites are more advanced composites as compared to conventional FRP composites. Hybrids can have more than one reinforcing phase and a single matrix phase or single reinforcing phase with multiple matrix phases. Hybrid composites have a good calorific value and cause little concern in terms of health and safety during handling. In addition they exhibit excellent mechanical properties, have low density and are inexpensive [4-10]. On the basis of above researches carried out in this field, the present research work conveys the idea of using reinforcing of natural fibers (pineapple and jute) to epoxy matrix. An attempt was made to make this composite to develop a new class of hybrid natural fiber composite. Studies related to tensile, flexural and impact was conducted and the results are analysed.

II. MATERIALS AND METHODS

II.1Jute fiber: Jute fiber is taken to cut & bundled and kept immersed in water for retting process, where the inner stem and outer, gets separated and the outer plant gets individualized, to form a fiber. Then the plant get separated and washed to remove dust from the plant.

II.2Pineapple fiber: The fibers are extracted from the leaves of the plant Ananuscosomus belonging to the Bromeliaceous family. The fiber is extracted by hand scraping after beating the leaves to break up the pulpy tissue or after a retting process (separation of fabric bundles from the cortex).The PALF is a multi-cellular fiber like other vegetable fibers.The original fiber extracted from the leaf. The excellent mechanical properties of PALF are associated with this high cellulose and low micro febrile angel.

II.3Fiber preparation: Here continuous fibers are used to fabricate the hybrid natural fiber composites; first cleaning the natural fibers in distilled water. Cleaned natural fibers are dried in the sunlight. Then the segregations are gently dispersed with hand sitting patiently. Both the fibers were combed with a cotton carding frame for several times further separate the fibers in to individual state. After that, both the fibers are measured for proper weight and length.

II.4 Mould Preparation: Mould used in this work is made of well-seasoned teak wood of 200 mm X 200 mm X 3 mm dimension with five beadings. The fabrication of the composite material was carried out through the hand lay-up technique. The top, bottom surfaces of the mould and the walls are coated with remover and allowed to dry.The functions of top and bottom plates are to cover, compress the fiber after the epoxy is applied, and also to avoid the debris from entering into the composite parts during the curing time.

Fig: 1 Raw pineapple fiber

Fig: 2 Raw jute fiber

Fig: 3 Fabrication of composite

Fig: 4 Epoxy and Hardener

II.5 Composite fabrication: Here Hand layup technique is used for fabrication of the hybrid natural fiber composites. The base plate is fixed inside the frame to fabricate the natural fiber composites of 60% resin, hardener mixture and remaining 40% of natural fibers are used. The mixed resin and hardener is filled in the pattern. The prepared natural fibers are randomly poured in the resin hardener mixture without any gap. The roller is rolled in the mould. Again the mould is filled in pattern by next layer and fibers poured randomly. This process is continued till the mould is completely filled. The weights are placed on the top of the frame to distribute the load evenly on the mould. The setup is allowed to dry for 24 hours. After drying the specimens are removed from the die.All the specimens (40/0) pure pineapple. (30/10) pineapple/jute. (20/20) pineapple/jute. (10/30) pineapple/jute (0/40) pure jute is fabricated under similar processing conditions [11-12].

III. METHOD OF TESTING

III.1Tensile Test: The hybrid composite specimens are prepared according to ASTM D638 standard for tensile test [13]. The tensile test is performed on the Universal Testing Machine (UTM) FIE make. There are five different kinds of specimens are prepared according to the fibers used. The fractured specimen after tensile test is presented in Fig: 7.for each case 3 samples are tested and the average values are reported.

III.2Flexural Test: The flexural specimens are prepared as per the ASTM D790 standards [14]. A3-point flexure test is used in the present investigation. Specimen deflection is measured by the crosshead position. Test results include flexural strength and displacement. The testing process involves placing the test specimen in the universal testing machine and applying force on it until it fractures and breaks. The specimen used for conducting the flexural test is presented in Fig: 8

III.3Impact Test: The impact testing specimens are prepared according to ASTMD 256 standards the apparatus involved was Cantilever Beam and Izod type test procedure is adopted in the present study [15].

IV. RESULTS AND DISCUSSIONS

IV.1. Tensile strength:

Table1. Tensile Properties of Different Composite Samples.

Composites	% Weight fraction	Tensile Strength (MPa)	Tensile Modulus (MPa)
Pure pineapple	40/0	22.52	364.23
Pineapple/Jute	30/10	33.25	510.17
Pineapple/Jute	20/20	36.3	576.10
Pineapple/Jute	10/30	40.21	599.54
Pure Jute	0/40	29.63	440.33

The loads with respect to the displacement for five different combinations of composite specimens are presented in Fig.5.The results indicated that (10/30) (pineapple/jute) composite shows better tensile strength (40.21 MPa) then the other types of composites. The ultimate tensile strength of the pure pineapple and pure jute composites are 22.5 MPa and 29.6 MPa respectively. Hybrid combination of fibers pineapple/jute (30/10) and (20/20) composite values were observed to be high as compared to pure composites. This behaviour can be attributed to hybridization effect as both fibers contributed higher tensile strength to the composite. It is evident that when fiber content increases, strength of the composite also increases to certain extent.

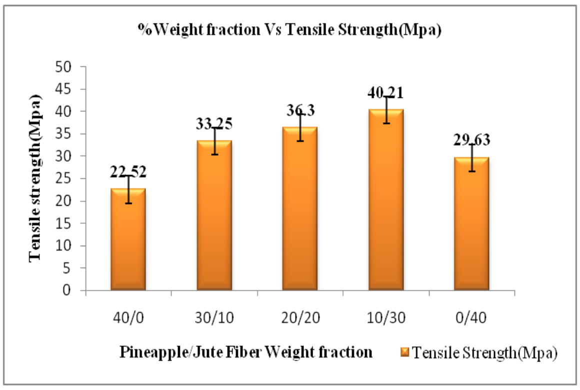

Fig: 5 Tensile Strength Vs % Weight fraction

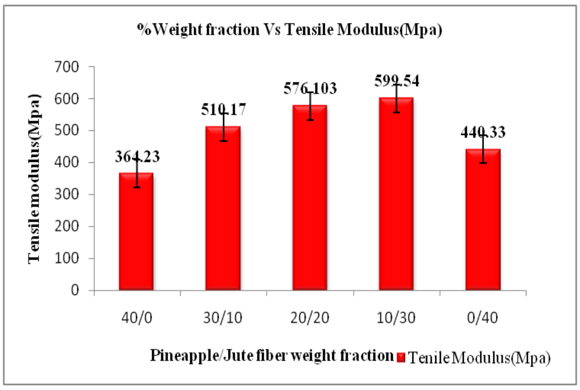

Fig: 6 Tensile Modulus Vs % Weight fraction

Fig: 6showsthe tensile modulus of pineapple/jute fiber hybrid composites values presented in table 1. The results indicated that the (pineapple/jute) (10/30) hybrid composite exhibits higher tensile modulus, than the other fiber reinforced composites. The pineapple/jute hybrid composite tensile modulus values i.e.w/f (20/20) and (30/10) are 576.103MPa and 510.17MPa respectively. But it is higher than the pure composites**.** This can be attributed to strong interfacial bonding between fiber and matrix.

Fig: 7 Tensile test specimens after fracture.

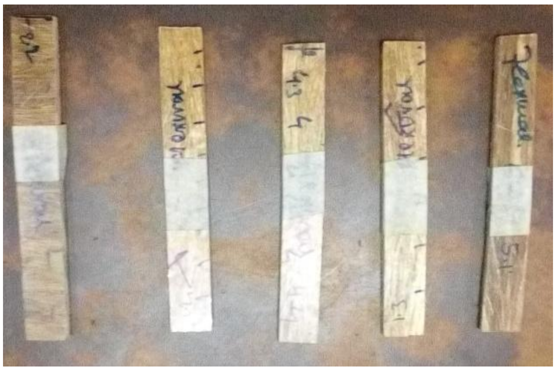

Fig: 8 Flexural test specimens after fracture.

IV.2Flexural strength:

Table 2.Flexural Properties of Different Composite Samples.

Composites	% Weight fraction	Flexural strength (MPa)	Flexural modulus (MPa)
Pure pineapple	40/0	107.77	4310.8
Pineapple/jute	30/10	127.23	4961.97
Pineapple/jute	20/20	155.09	5783.24
Pineapple/jute	10/30	147.63	5314.68
Pure jute	0/40	114.24	4569.6

Fig: 9 shows that pineapple/jute (20/20) hybrid composite exhibits better flexural results as compared to the others. The hybrid composites of jute/pineapple (10/30) and (30/10) values are also higher as compared to the pure composites. It has been observed that pure pineapple and pure jute composite values are 107.77MPa and 114.24MPa, these values are compared to low as compared to hybrid composites.

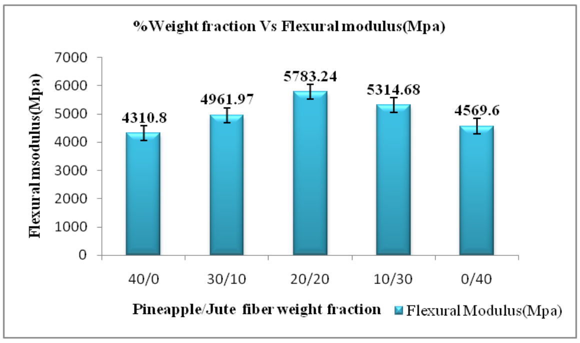

Fig: 9 Flexural Strength Vs % Weight fraction

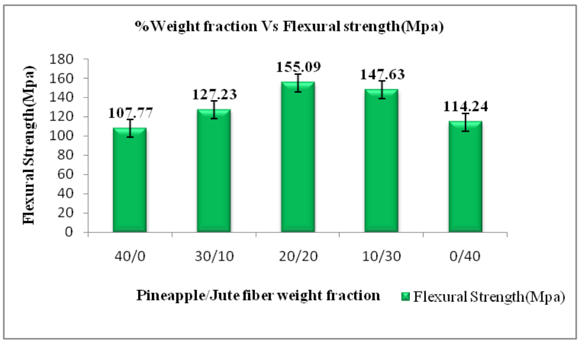

Fig: 10 Flexural Modulus Vs % Weight fraction

Fig: 10 shows pineapple/jute hybrid composites has considerable increase of flexural modulus. As the percentage of jute fiber increases a maximum value of (20/20) 5783.24MPa is obtained. The flexural modulus was observed pure pineapple and pure jute values are 4310.8MPa and 4569.6MPa respectively. The hybrid combination of jute/pineapple (10/30) and (30/10) flexural modulus values are high, when compared to pure composites. The flexural properties not only depend on the hybrid composition but also an arrangement of the fiber piles. The flexural modulus of the hybrid composites shows the similar trends as the flexural strength.

IV.3 Impact strength and elongation:

Table 3. Impact and Elongation Properties of Different Composite Samples:

Compositions	Impact strength(J)	Elongation (%)
40/0	6.4	3.08
30/10	8.5	3.91
20/20	10.25	4.23
30/10	12.37	5.16
0/40	7.3	3.54

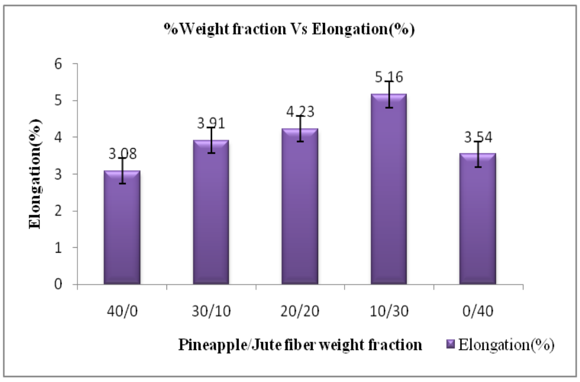

Fig: 11 Elongation Vs %Weight fraction

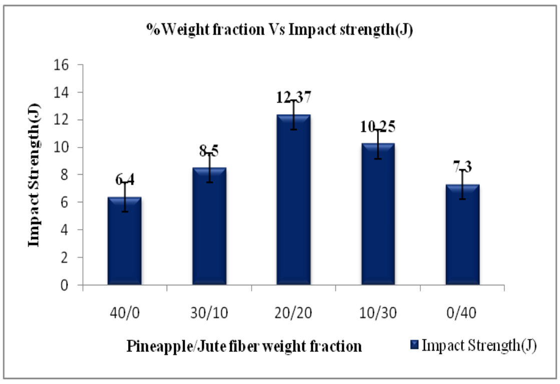

Fig: 12 Impact strength Vs % Weight fraction

Fig: 11 shows the results indicated that elongation of pineapple/jute hybrid composite (10/30) value is 5.16. It is evident that the highest tensile strength and highest elongation was found. This can be attributed to hybridization effect as both fibers contributed higher strength and elongation of the hybrid composite.

Fig: 12the Impact strength of the hybrid composite is having a ratio of pineapple and jute fiber of 20/20 at 40% fiber by weight with different compositions as shown table 3. It can be seen that impact strength of pineapple/jute 20/20, 10/30 and 30/10 hybrid composite values are found to be12.37, 10.25, and 8.5 respectively. The pure composite sample shows very low impact strength compared to hybrid reinforced polymer matrix composites. It is clear that fiber play an important role in the impact resistance of the composite as they interact with the crack formation with in matrix and acts as stress transferring medium.

V. CONCLUSIONS

After determining the material properties of natural fiber reinforced epoxy hybrid composites with five different weight fractions of the materials, the following conclusions can be made.

1. Successful fabrication of the hybrid composite using pineapple/jute fiber reinforced epoxy has been done by the hand layup technique.
2. It can be observed that pineapple/jute (10/30) weight fraction hybrid composite samples possess good tensile strength and can with stand the strength up to 40.21 MPa.
3. The pineapple/jute (20/20) weight fraction hybrid composite samples maximum flexural strength 155.09 MPa.
4. From the above experimental results indicate that the hybrid fiber reinforced epoxy composite will have better mechanical properties by increasing the percentage of hybrid fiber.
5. This work also demonstrates the potential of the hybrid natural fiber composites can be regarded as a useful material in light weight applications.

REFERENCES

[1]. N. Venkateshwaran, A. ElayaPerumal, A. Alavudeen, M. Thiruchitrambalam"Mechanical and water absorption behavior of banana/sisal reinforcedhybrid composites" Materials and Design 32 (2011) 4017–4021.

[2]. Sreekalaa MS, George Jayamol, Kumaran MG, Thomas Sabu. The mechanical performance of hybrid phenol–formaldehyde-based composites reinforced with glass and oil palm fibers. Composite Science and Technology 2002;62:339–53.

[3]. Jarukumjorn Kasama, Suppakarn Nitinat. Effect of glass fiber hybridization on properties of sisal fiber–polypropylene composites. Composites Part B 2009:623–7.

[4]. M. Boopalan, M. Niranjanaa, M.J. Umapathy "Study on the mechanical properties and thermal properties of juteand banana fiber reinforced epoxy hybrid composites"Composites: Part B 51 (2013) 54–57.

[5]. Mishra S, Mohanty AK, Drzal LT, Misra M, Parijac S, Nayak SK, et al. "Studies on mechanical performance of bio fiber/glass reinforced polyester hybrid composites". Composites Science and Technology 2003; 63(10):1377–85.

[6]. Jacob Maya, Thomas Sabu, Varghese KT. "Mechanical properties of sisal/oil palm hybrid fiber reinforced natural rubber composites". Composites Science and Technology 2004; 64(7– 8):955–65.

[7]. Esfandiari Amirhossein. "Mechanical properties of PP/Jute Glass fiber composites – a statistical investigation". Journal of Applied Sciences 2007; 7(24):3943–50.

[8]. Velmurugan R, Manikandan V. "Mechanical properties of palmyra/glass fiber hybrid composites". Composites Part a 2007; 38(10):2216–26.

[9]. Thiruchitrambalam M, Alavudeen A, Athijayamani A, Venkateshwaran N, Elayaperumal A. " Improving mechanical properties of banana/kenaf polyester hybrid composites using sodium lauryl sulfate treatment" Materials Physics and Mechanics 8 (2009) 165-173

[10]. M. Jawaid, H.P.S. Abdul Khalil, A. Abu Bakar "Mechanical performance of oil palm empty fruit bunches/jute fibres reinforcedepoxy hybrid composites".Materials Science and Engineering A 527 (2010) 7944–7949.

[11]. KotreshSardar, Dr. T. Rangaswamy, Shivakumar"Fabrication and Investigation of Bending Test on Hybrid (Sisal and Banana) Fiber Reinforced Polyester Composite" International Journal of Recent Development in Engineering and Technology-Volume 3, Issue 6, December 2014.

[12]. Sudhir.A, Madhukiran.J, Dr. S. Srinivasa Rao, Dr.S.Madhusudan"Tensile and Flexural Properties of Sisal/Jute Hybrid Natural Fiber Composites"IJMER Vol. 4 Iss.7 July.2014 29.

[13]. ASTM D638-03.Standard test method for testing tensile properties of plastics.

[14]. ASTM D790-07. Standard tests method for testing flexural properties of unreinforced and reinforced plastics and electrical insulating material.

[15]. ASTM D256-06a.Standard test method for determining Izod pendulum impact resistance of pla tics.