Experimental Investigations of Mechanical Properties on Epoxy based Natural Hybrid Composites

Prof. Pradeep Kumar Ilay
Assistant Professor,
Dept. of Mech. Engg,
Navodaya Institute of Technology, Raichur,
Karnataka, INDIA

Dr. Girisha L
Associate Professor,
Dept. of Mech. Engg,
PES Intitute of Technology & Management,
Shivamogga, Karnataka, INDIA

Prof. Zeeshan Ail
Assistant Professor, Dept. of Mech. Engg,
Navodaya Institute of Technology, Raichur,
Karnataka, INDIA

***Abstract*— In present era, natural fibers are place vital role in various engineering fields. These can be used a reinforcement of composite materials. In this present work, Carbonized rice husk (CRH), Tamarind fruit fibers (TF), Coconut-spathe (CS), used as a reinforcement epoxy resin used as a matrix in preparation of composite materials. The matrix and the reinforcement are varied underweight percentage of 20%, 30% and 40%. These natural hybrid composites specimens are prepared by hand layup technique. The hybrid composites specimens are prepared according to ASTM standards. These hybrid composites specimens are carried Flexural, Impact, Hardness and water absorption test according to ASTM standards. The result shows a significant improvement in addition of this reinforcement in matrix.**

Keywords*— *Carbonized rice husk (CRH), Tamarind fruit fibres (TF), Coconut spathe (CS), Natural hybrid composites, Epoxy

I. INTRODUCTION

Natural fibers are made from plant, animals and mineral sources. They can be used as a reinforcement of composite materials. Fibers are a class of hair like materials that are continuous filament similar to pieces of thread. Thermosetting plastics have been used as a matrix in polymer composite because of its uniqueness and attractive properties. Epoxy resin is most important matrix which possesses strength to weight ratio that far exceeds any of the present materials. Tamarind fruit fibers are naturally available fibers, which are used as the reinforcement and the results shown that it gives good mechanical characteristics. Coconut spathe is an under exploited material abundantly available and having considerable potential to use as a reinforcement in composites. It is expected the short spathe fibers will enhances the strength of matrix. Rice husk is one of the waste materials in the rice growing region and is an agricultural residue. About 108 tons of rice husk are generated annually in the world. That makes rice husk one of the largest readily available and also one of the most under-utilized resources. Rice husk is particularly valuable due to its high contents of amorphous silica. Rice husk has been used as reinforcement in Polymer Matrix Composites and shown significant improvement in mechanical properties. Rice husk ash is obtained from burning of rice husk which bi-product of milling. Hybrid Composites are more advanced composites compared to fiber reinforced polymer composites. Hybrids can have more than one reinforcing phase and a single matrix phase or vice versa. They have better flexibility as compared to other fiber reinforced composites.

II. PREPARATION OF SPECIMEN

After the material was prepared and the resin to hardener weight ratio carefully mixed was 80:20, the composites with varying degrees of reinforcement percentage (i.e. 20, 30 and 40) were prepared. The resin and reinforcement was mixed via manual stirring method for five minutes and the mixture was poured into a jig box to form cylindrical pins of 30 mm long and 10 mm diameter. Load was applied upon it and was left for 24 hours to cure in the box jig at room temperature (25°C). After curing the samples were taken out from the box, finished ground to required shape, sizes and placed in a sealed envelope for test.

Table 1: Number of Specimens

Sl. No.	Epoxy Resin (%)	Composition (%)			Treatment				No. of Tests
		TF	CS	CRH	C	I	H	W	
1	80	6.6	6.6	6.6	3	3	3	3	18
2	70	10	10	10	3	3	3	3	18
3	60	13.3	13.3	13.3	3	3	3	3	18
Total no. of Specimens					9	9	9	9	54

Where, C = Compression test models, I = Impact test models, H = Hardness test models, W= Water absorption test models.

III. EXPERIMENTATION

All test specimen dimensions were according to the respective ASTM standards. All tests were performed at room temperature. Five specimens of each type were tested and five replicate values were taken as an average of tested specimens.

A. Flexural Strength Test

Flexural analysis was carried out at room temperature through three-point bend testing as specified in ASTM D 790, using universal testing machine. The speed of the crosshead was 5 mm/min. Three composites specimens were tested for each sample and each test was performed until failure occurred. Flexural strength was calculated from the Equation. The pictorial view of specimen is shown in figure1.

B. Charpy Impact Test

Impact test was performed on Carbonized Rice Husk, Coconut Spathe fibres and tamarind fruit fibres reinforced hybrid epoxy composite specimens as per ASTM-D256. Three samples were tested at ambient conditions and the average of impact strength was calculated. The pictorial view of specimen is shown in figure 2.

Fig. 1: Flexural test specimen.

Fig.2: Impact test specimen

C. Brinell Hardness Test

Hardness tests were conducted using hardness testing machine. In each case, three samples were tested and average value tabulated. Hardness test samples were cut as per ASTM D785 test procedure. Tests were carried out at room temperature and each test was performed until indentation will occurred. The pictorial view of specimen is shown in figure 3.

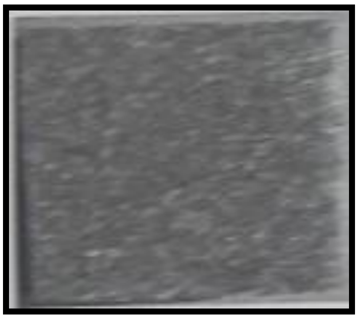

Fig. 3: Hardness test specimen

D. Water Absorption Test

The Water absorption test specimen was prepared according to ASTM5229 standard. The pictorial view of specimen is shown in figure 4.

Fig. 4: Water absorption test specimen

IV. RESULTS AND DISCUSSIONS

A. Flexural Test Of Composites

The flexural test of the prepared composite specimen tested in the UTM and the results are shown table 2. The figure 5 shows the graphical representations of flexural strength on hybrid natural composites.

Table 2: Flexural test readings.

Sl. No	Load (×0.1 kN)	Deformation for Compositions (×0.01mm)		
		80:20	70:30	60:40
1	1	35	15	30
2	2	60	35	35
3	3	-	55	60
4	4	-	73	79

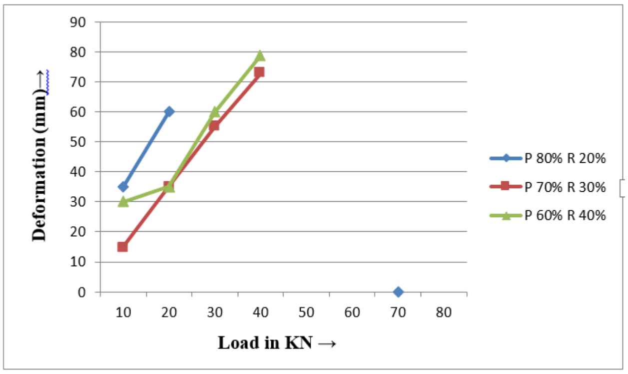

Fig. 5: Effect of flexural strength on hybrid natural composites.

The effect of flexural strength on all combination of composites is shown in figure 5. It is observed that load sustainability of specimen increases as increase in fibre proportion. The load sustainability in P60% R40% is more when compared with P70% R30% and P80% R20%. This is due to gap between the fibre and matrix can be filled by adequate amount of powder particles so that voids can be avoided and hence when the load is applied to the specimen stress can be easily transferred fibre to matrix and gives the higher flexural strength however, the flexural strength of the other two composition gives slightly lesser flexural strength. This is decrease due to poor wettability between reinforcement and matrix leading a weak interface.

B. *Impact Test Of Composites*

The Impact test of the prepared composite specimen tested in the UTM and the results are shown in table 3.

Table 3: Impact test readings.

Percentage of composition	Energy Consumed in J/mm^2
80% Epoxy, 20% Reinforcement	0.006
70% Epoxy, 30% Reinforcement	0.008
60% Epoxy, 40% Reinforcement	0.011

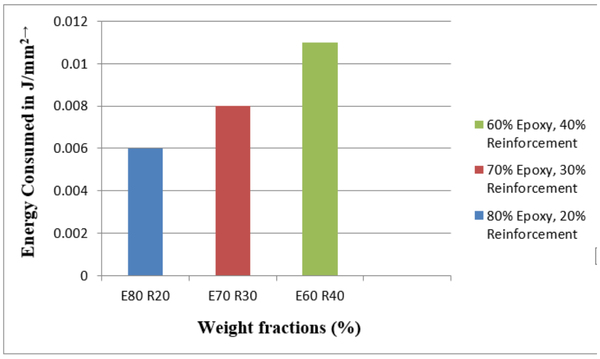

Fig. 6: Variation in impact strength of three different combinations of composites.

The effect of impact strength on all combination of composites is shown in figure 6. It is observed that load sustainability of specimen increases as increase in fiber proportion. The load sustainability in P60% R40% is more when compared with P70% R30% and P80% R20%. The composites having higher epoxy resin have least impact strength as compared with other two composites.

C. *Hardness of Composites*

The hardness test of the prepared composite specimen tested in the Brinell hardness testing machine with ball indenter and the results are shown table 4.

Table 4: Hardness values of composites.

Composition	Load (kg)	BHN
80% Epoxy, 20% Reinforcement`	100	73
70% Epoxy, 30% Reinforcement	100	61.55
60% Epoxy, 40% Reinforcement	100	58

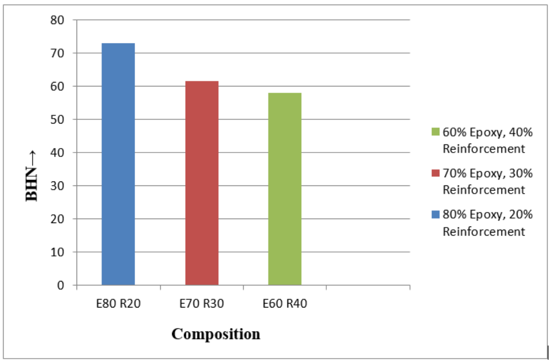

Fig.7: BHN of Hybrid composites

From the figure 7 it can be observed that the hardness value increase with increase in reinforcement in the composites. In this the specimen of composition 80% Epoxy, 20% Reinforcement composition exhibits the higher hardness value. This is due to high filler content present in the composites that makes matrix harder which leads to reduction in elasticity of composites. The 40% fiber content composite as shown a lower trend in hardness. This is due to the fact that the fiber becomes the predominant than the base material and has the percentage of fiber increases. The interaction between the fibers inside the composites increases that is there will be higher fiber to fiber contact which leads to poor interfacial bonding between the fiber and the matrix. Due to this poor interfacial bonding effective. Load transfer may not takes place and leads to quick failure.

D. *Water Absorption Test*

The water absorption test of the prepared composites specimen tested and the results are shown table 5.

Table 5: Water absorption by composition

No. of soaking days	Absorptions of water by compositions		
	80% Epoxy, 20% Reinforcement(gms)	70% Epoxy, 30% Reinforcement(gms)	60% Epoxy, 40% Reinforcement(gms)
1	10.392	10.041	10.012
2	13.483	13.507	13.614
3	14.024	14.159	14.253
4	14.782	15.023	15.657
5	15.125	15.357	15.826
6	15.201	15.386	15.833
7	15.201	15.392	15.833
8	15.224	15.391	-
9	15.224	15.91	-

Figure.8 shows moisture absorption test results for water. From the plotted graphs it can be observed that the amount of moisture in the composite increases with time and later levelled off at some period, which is an indication of saturation. It is observed that composites of 80% Epoxy, 20% Reinforcement composite absorbs less water as compared to other two composites.

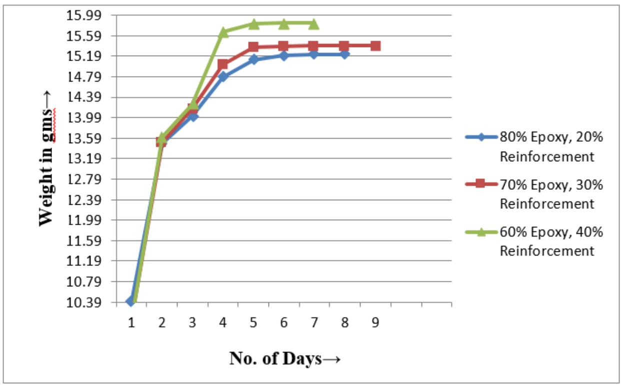

Fig. 8: Comparison of water absorption property of composites in water.

V. CONCLUSION

Based on the results of the experimental investigation, Carbonized rice husk, tamarind fruit fiber and Coconut Spathe these are the agricultural wastes generate from paddy, tamarind tree and coconut tree respectively are used as reinforcement of materials to produce polymer matrix composites (PMCs) in epoxy resin thus the use of these material for the production of composites can turn waste into industrial wealth and inevitably solved problem of storage and disposal of those wastes. There is a good dispensability of reinforcement particles in epoxy resin which improves hardness of matrix materials and also mechanical behavior of the composite. The result of this increase in interfacial area between matrix material and reinforcement particles leading to increase in strength appreciably. The E60%, R40% composite exhibits higher water absorption as compare to other two composites. But E80%, R20% composites gives better hardness as compare to other two composites because of higher matrix material. Whereas the composition P80%, R20% & P70%, R30% have greater hardness as compared with P60%, R40%.

REFERENCES

[1] G Ramachandra Reddy, Mala Ashok kumar, Jarugal Jayaramudu, “Biodegradable Sansevieria cylindrical leaves fiber/ Tamarind fruit fiber based Polymer Hybrid composite on characterisation”, International letters of chemistry, physics and Astronomy, 20(2) 2014,PP 116-128.

[2] C Uma maheswari, K Obi Reddy, E Muzenda and M Shukla, “Biodegradable Sansevieria cylindrical leaves fiber/ Tamarind fruit fiber based Polymer Hybrid composite on characterisation”, International Conference on innovation in Chemical Engg. And Medical Sciences(ICICEMS2012), December 26-27,2012, PP 16-19.

[3] S M Sapuan, M N M Zan, E S Zainudin and Prithvi Raj, “Tensile and Flexural strengths of coconut spathe-fibre reinforced epoxy composites”, Arora Journal of Tropical Agriculture 43(1-2)2005,PP 63-65.

[4] Girisha C, Sanjeevamurthy, Gunti Rangasrinivas, “Tensile Properties of Natural Fibre- Reinforced Epoxy- Hybrid Composites”, International Journal of Modern Engineering Research(IJMER), Vol 2, Issue 2, 2012, PP 471-474.

[5] Michael Ikpi Ofem, Muneer Umar and Friday Aje Ovat, “Mechanical properties of Rice husk Filed Cashew Nut shell Liquid Resin Composites”, Journal of Mterial Science Research, Vol 1, No. 4,2012, PP 89-97.

[6] Ravande Kishore, V. Bhikshma and P Jeevana Prakash, “Study on strength Characteristics of High strength rice husk ash concrete”, The twelfth East Asia – Pacific Conference on Structural Engineering and Constructions, Procedia Engineering 14(2011), PP 2666-2672.

[7] Francis Uchenna OZIOKO, Leonardo “Effect of Carbonization Temperature on Wear rate Behaviour of Rice Husk ash Reinforced Epoxy Composites”, Electronic Journal of Practices and Technologies,2011, PP 172-182.

[8] Girisha C, Sanjeevamurthy, Gunti Rangasrinivas, Manu S, “Mechanical Performance of Natural Fibre – Reinforced Epoxy – Hybrid Composites”, International journal of Engineering Research and Applications, 2012, PP 615-619.

[9] P Nowshoba, M Gunasekhar Reddy, Dr. G Hainath Gowd, “Synthesis and Characterisation of Hardwickia Binata fiber with Epoxy”, International Journal of Emerging Technology and Advanced Engineering,2013, PP 370-374.