Evaluation of Moisture Absorption Properties of Coir/Glass-Epoxy Hybrid Natural Fibre Reinforced Polymer Composite (NFRPC) under various Pretreatment Conditions of Natural Fibre.

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Abstract - *It is observed through research that Natural Fibre Reinforced Polymer Composite have high water absorption capacity. In order to make the commercial use of natural fibres, which are abundantly available at a very less cost, their water absorption is to be reduced. It was found that the chemical and physical treatment of natural fibre improves their water absorption ability. The current paper explores the different methods and treatments of natural fibre from the perspective of improving its water absorption properties.*

This work aims to prepare and test samples for their water absorption capability. Four different samples are required to be prepared in the ratio of 30:70 for fibres to matrix respectively. The samples have the natural fibres treated under different situations such as untreated, chicken fat under cold treatment, chicken fat under hot condition and NaOH treated. The experiment is to be conducted as per ASTM D570-98. The prepared samples are to be kept in the water and are to be taken out after an interval of 12 hours to check the water absorbed. This has to be continued till the saturation level. It has to be estimated if the samples follow Fick's law.

***Key Words*: Eco-sustainability, Epoxy Resin, Chicken fat, Fick's Law, NFRPC**

1.INTRODUCTION

Natural fibers are not new to the world. They gained popularity because of them being light weight, readily available, abundant in quantity, nonabrasive, combustible, nontoxic, low cost and biodegradable properties. But because of their lower strength and mechanical properties and also being moisture absorbent in nature [1], they could not stand a chance against glass fibers which possess high strength and mechanical properties and also being moisture resistant in nature. But at the end of the day , glass fiber being a plastic origin is not environment friendly and after witnessing the exploitation of plastic and its adverse effect on the environment , it is something of serious concern and cannot be neglected. but the use of glass fibres cannot be completely eradicated because of it positive properties and also complete use of only natural fibers cannot be implemented because of its drawbacks. Therefore, hybridization seems the only possible way. Even if replacing a small percentage of glass fibers with natural fibers in a material production on large scale can cause tremendous positive effect on the environment and also contribute to higher eco-sustainability. The use of gelatin as a binder for natural fibres in polymer matrix has been tried within a few works [2].

In this work, coir being used as the natural fiber, because it is easily available in the local areas and one of the most widely used in natural fibre reinforced polymer composite industry. The glass fiber of 350 GSM is to be used. According to the plan of experiments, 12 samples are to be produced using hand-layup process. In every case the natural fibres are untreated, treated with chicken fat under hot treatment, treated with chicken fat under cold condition and treated with NaOH. Three samples under each case are prepared to avoid errors. The fibre to matrix ratio would be 30:70 respectively.

2. MATERIALS

3 kg of Coir fibers bought from local vendors and 4 kg of glass fibers 350 GSM bought from a glass fiber vendor in Goregaon, Maharashtra. 1000 ml Epoxy LY556 and hardener HY951 [3] were ordered from Herenba Instruments, Chennai. Chicken fat purchased from local butcher shop and NaOH was used from the Chemical Laboratory of our Institute.

3. METHODOLOGY

Hand layup process is used in order to create the samples. The mould of 120mmx120mm was used for preparing three samples of 76.2x25.4x3.2mm.

Fig -1: Composite pressed under bending pressing to establish uniform and proper bonding.

The coir obtained from market is to be segregated so as to remove the unwanted powder from it. The coir fibres are then to be dried under sun for 24hours. The exact mass of coir fibre, natural fibre and matrix is to be calculated from its density as follows

Calculations:

Volume of mould =12x10x0.3 cm^3=36cm^3

Mass of Glass fiber =2.5x36g=90g

Mass of actual glass in composite =0. 15x90=13.5g

Mass of coir fiber =1.15x36=41.4g

Mass of actual coir fiber in the composite =0,15x41.4=6.21

Mass of epoxy resin =1x36=36g

Actual mass of epoxy =0.63x36=22.68g

Mass of hardener = 1x36=36g

Actual mass of hardener = 0.07x36=2.52g

The specimen is to be prepared by putting randomly oriented coir fibres and glass fibres layer by layer in the mould ensuring that the entrapped air is eliminated and then are pressed in the bending press for 24 hours so as to get proper bonding between the fibres and the matrix, wax is used as a separator so as to avoid the bonding of the composite with the metal sheet substrate.

The prepared specimen is then to be conditioned in an oven at 110^{0}c for one hour [4]. Similar procedure is used for preparing the samples of natural fibres treated under different conditions as mentioned below.

a) Untreated:
The natural fibre that is coir remain untreated and the composite is prepared with keeping 30% fibres to 70% matrix. Three such samples are prepared to be tested for water absorption test.

b) Chemically treated with NaOH:
For this the coir fiber sheets are now immersed in 10% NaOH solution for 1 hour. The natural fibre thus treated with NaOH is washed with water and dried.

c) Hot Treatment with Chicken Fat:
Chicken fat bought from local butcher shop, is cleaned and poured in a utensil and heated, once the fat becomes liquid the coir fibre is inserted in the utensil so that the fat gets soaked in the natural fibre. The fibres are kept in this position for an hour so that soaking becomes uniform.

d) Cold treatment with Chicken fat:
In this, the coir is treated with fat but without heating it. The fibres are rubbed by hand against the fat manually and thus making a layer of chicken fat on the surface of the fibre.

Sr. No.	Treatment of natural Fibre	Number of samples
1	Untreated	03
2	Treated with NaOH	03
3	Hot treatment with chicken fat	03
4	Cold treatment with chicken fat	03

4. TESTS

Moisture absorption test in accordance with ASTM D 570 [5] is to be conducted. The percentage of moisture absorbed is calculated as per the following equation

$$\text{Increase in weight, \%} = \frac{\text{wet weight - conditioned weight}}{\text{Conditioned weight}} \times 100$$

The specimen as per the category mentioned are to be immersed in distill water solution and are to be weighed after an interval of 12 hours. The weight of the specimen after conditioning is also required to be measured through an electronic weight balance.

A graph of Increase in weight Vs square root of time is to be prepared based on which it can be found if the behavior of water absorption follows Ficker's rule or not.

5. RESULTS

DAY	HOT TREATMENT		UNTREATED		DURATION
	wt.1 (gms)	wt.2 (gms)	wt.1 (gms)	wt.2 (gms)	hours
1	27.478	29.840	28.035	30.125	12
2	30.435	31.600	31.645	31.843	12
3	31.659	31.722	31.960	32.104	12
4	31.745	31.760	32.190	32.225	12
5	31.770	31.775	32.346	32.410	12

Figure 5.1: Weights of samples after successive immersion

DAY	NaOH		COLD TREATMENT		DURATION
	wt.1 (gms)	wt.2 (gms)	wt.1 (gms)	wt.2 (gms)	hours
1	60.648	66.840	29.230	36.190	12
2	68.170	68.785	37.640	38.375	12
3	68.952	69.156	38.419	38.470	12
4	69.266	69.390	38.553	38.684	12
5	69.420	69.470	38.424	38.740	12

Figure 5.2: Weights of samples after successive immersion

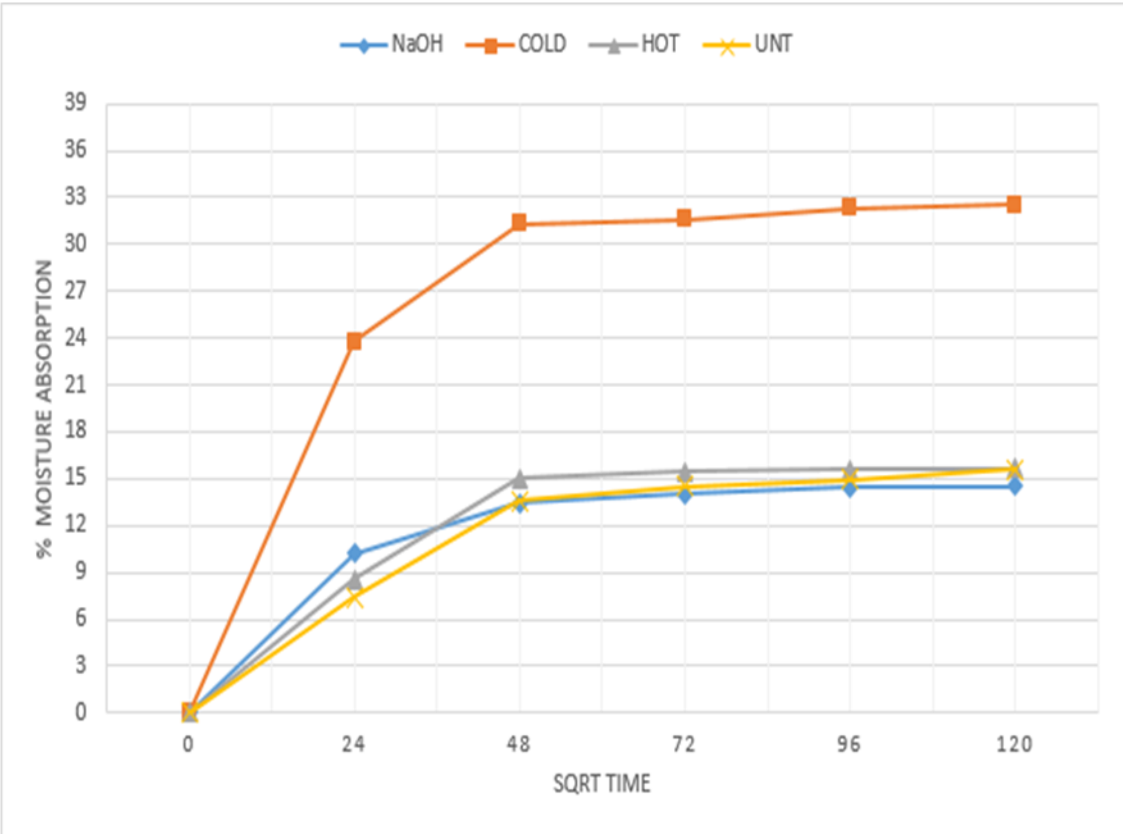

Figure 5.3: Plot of %age moisture absorption Vs Sq. Root of time

DAY	HOT TRT.	UNTREATED
	(%)	(%)
1	8.59	7.44
2	15	13.583
3	15.44	14.512
4	15.558	14.945
5	15.637	15.605

Figure 5.4: Percentage weight of moisture absorbed

DAY	NaOH	COLD TRT.
	(%)	(%)
1	10.209	23.81
2	13.41	31.28
3	14.028	31.61
4	14.414	32.34
5	14.546	32.535

Figure 5.5: Percentage weight of moisture absorbed

DAY	HOT TREATMENT		UNTREATED		DURATION
	wt.1 (gms)	wt.2 (gms)	wt.1 (gms)	wt.2 (gms)	hours
1	29.478	31.350	30.564	32.125	12
2	32.456	32.956	33.645	33.943	12
3	33.259	33.452	34.260	34.404	12
4	33.685	33.756	34.605	34.885	12
5	33.863	33.956	34.995	35.103	12

Figure 5.6: Weights of samples after successive immersion

DAY	NaOH		COLD TREATMENT		DURATION
	wt.1 (gms)	wt.2 (gms)	wt.1 (gms)	wt.2 (gms)	hours
1	58.200	60.540	27.430	28.390	12
2	61.170	61.785	29.640	30.385	12
3	61.952	62.156	30.919	31.670	12
4	62.560	63.706	31.968	32.232	12
5	63.920	64.170	32.424	32.536	12

Figure 5.8: Weights of samples after successive immersion

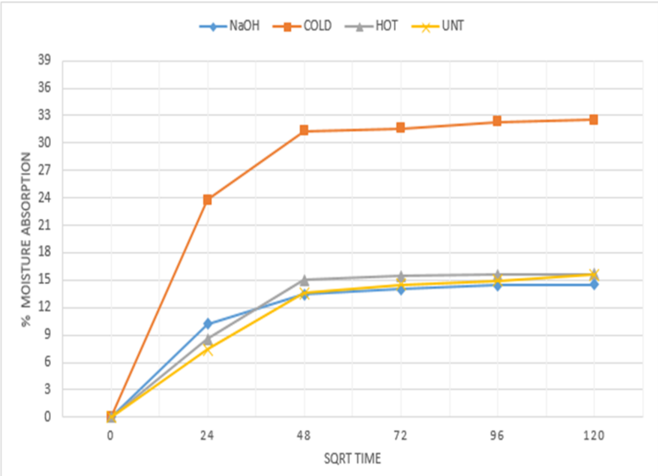

Figure 5.9: Plot of %age moisture absorption Vs Sq. Root of time

DAY	HOT TRT.	UNTREATED
	(%)	(%)
1	6.350	5.107
2	11.798	11.055
3	13.481	12.563
4	14.512	14.135
5	15.190	14.850

Figure 5.10: Percentage weight of moisture absorbed

DAY	NaOH	COLD TRT.
	(%)	(%)
1	4.310	3.499
2	6.15	10.772
3	6.797	15.457
4	9.460	17.506
5	10.257	18.687

Figure 5.11: Percentage weight of moisture absorbed

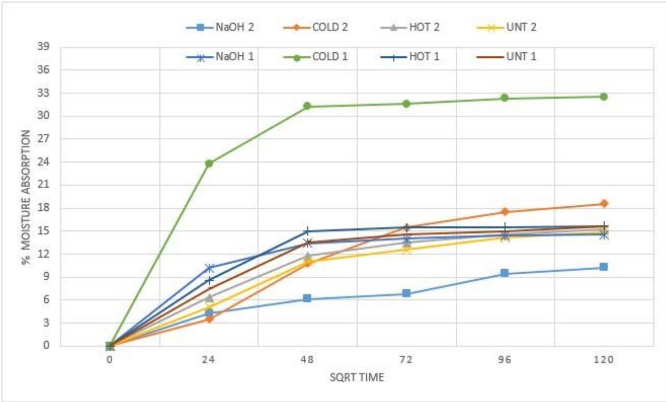

Figure 5.12: Plot of %age moisture absorption Vs Sq. Root of time

Figure 5.13: Samples immersed in water

Figure 5.14: Samples before immersion in water

6. CONCLUSION

From different pretreatment processes performed and the obtained results it can be concluded that there is not much significant effect of the pretreatment processes as expected. But the percentage of water absorbed by different samples is exponential after successive immersions and weighing it can be noted that the samples reach saturation point and further water absorption doesnt takes place and hence following fickian's behaviour. It can be also noted that NaOH treatment show lesser water absorption as compared to the other treatments

The SEM images of fibres treated under all the three criteria and untreated are to be made so as to know about the bonding between the natural fibre and the bonding agents. The case which has less water absorption should be considered for exploring the further potential of these NFRP.

7. FUTURE SCOPE

The samples such prepared should be subjected to testing for mechanical properties such as tensile strength, Flexural strength, elongation, and impact strength. Also, the fractured surface can be tested for analyzing the defects between fibre and matrix.

8. REFERENCES

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