MECHANICAL BEHAVIOR OF COIR FIBER REINFORCED HYBRID POLYMER MATRIX COMPOSITES AND OPTIMIZATION OF DESIGN PARAMETERS

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ABSTRACT

Making bio-degradable and recyclable products to avoid environmental pollution forces the researchers to develop eco-friendly and bio-degradable materials. The fibers from the natural sources (plant, animal) provide better advantages such as less cost, high specific properties, non-toxicity, strength, and minimum waste disposal problems over synthetic reinforcement materials. The aim of this work is to fabricate coir fiber-based hybrid polymer matrix composites and to study the vibration behaviors. A hybrid polymer matrix is prepared by blending natural resin (cashew nut shell liquid) with isophthalic polyester resin. The coir fiber is treated with NaOH, KMnO4 and KOH alkali solutions to improve its adhesiveness and strength before its reinforcement with matrix. The concentration of NaOH, KMnO4 and KOH in the alkali solution and duration of treatment of the fiber in the alkali solution have been varied and its effect on the vibration behaviors is studied. Using the ANOVA technique, the influence of different parameters on the Vibration test is investigated, and a regression equation will be obtained indicating the influence of parameters.

Keywords: *Bio-degradable materials, Hybrid polymer Matrix, isophthalic polyester resin, ANOVA technique*

INTRODUCTION

Coir is a natural fiber extracted from the husk of coconut and used in products such as floor mats, doormats, brushes, mattresses, etc. Coir is the fibrous material found between the hard, internal shell and the outer coat of a coconut. Other uses of brown coir (made from ripe coconut) are in upholstery padding, sacking and horticulture. White coir, harvested from unripe coconuts, is used for making finer brushes, string, rope and fishing nets Venkatachalam et al [1] have prepared coir fiber composite with cnsl resin, before treating with varying percentage of NaOH. Cnsl percentage also been varied. Flexural test is carried out. After testing increase in percentage of alkali treatment increases higher flexural strength. GU et al[3] have made Brown coir fibers treated by NaOH solution with concentrations from 2% to 10% separately. Tensile strength of the alkali-treated fibers is measured. It shows that alkali treatment will give higher fibre strength but if it increases above 10% fiber tends to deteriorate. Arrakhiz et al [4] analyzed Alfa; coir and bagasse fibers reinforced polypropylene (PP) composites. Treatment with alkali made before reinforcement.

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Addition of various amount of reinforcement fibers yielded noticeable increases in both tensile and flexural modulus as well as the torsion parameter. ROUT et al [2] prepared coir fiber with general purpose resin (polyester) with treatment of alkali, bleaching and vinyl grafting. The mechanical properties of composites like tensile,flexural and impact strength increase as a result of surface modification. ACHABY et al [7] formed high density polyethylene (HDPE) compounded with chemically treated coir fiber using a heated two roll mill. The mechanical properties of these composites are evaluated and compared against those of neat polymer and also compared with untreated fibers composites, resulting in increase in mechanical properties. YOUSIF et al [5] studied characteristics of natural fibers with synthetic resin. Single fiber pull-out test was carried for interfacial adhesion. A single fiber pull out samples are soaked in seven different solutions and the pull-out tests are then carried out. As the interfacial adhesion between coir fibers and polyester is very high, it can be used in the design and manufacture the body of liquid storage tanks. SAMIA SULTANA MIR et al [8] used coir fibre reinforced polypropylene bio composite using hot pressing technique. In order to increase the compatibility between the coir fiber and polypropylene matrix, they have treated chemically. Better interfacial bonding as well as minimization of micro-void at the fiber matrix interface occurred upon chemical treatment of the fiber resulting in better mechanical properties and lower water absorption of treated coir PP bio composites. FAIRUZ et al [6] studied the tensile properties of coir fibre reinforced with epoxy composite, with varying curing time. The result suggests that if increment in coir fibre and compression loading will increase the tensile properties of the coir fiber matrix, neglecting the effect of compression loading

EXPERIMENTAL

Coir fiber is used as a reinforcement material, whereas isophthalic polyester which is synthetic resin is blended with natural resin (CNSL) along with fiber to form a hybrid polymer which is matrix. Before experiment coir fiber is treated with 1% of NAOH, $KMnO_4$, KOH and kept for drying for 48hrs in Room Temperature to remove moisture content in fiber. After treatments the hybrid polymer matrix are prepared with 85% of isophthalic polyester and 15% of CNSL, the mold was prepared with a stainless steel of specimen size dimensions 300×30×4.

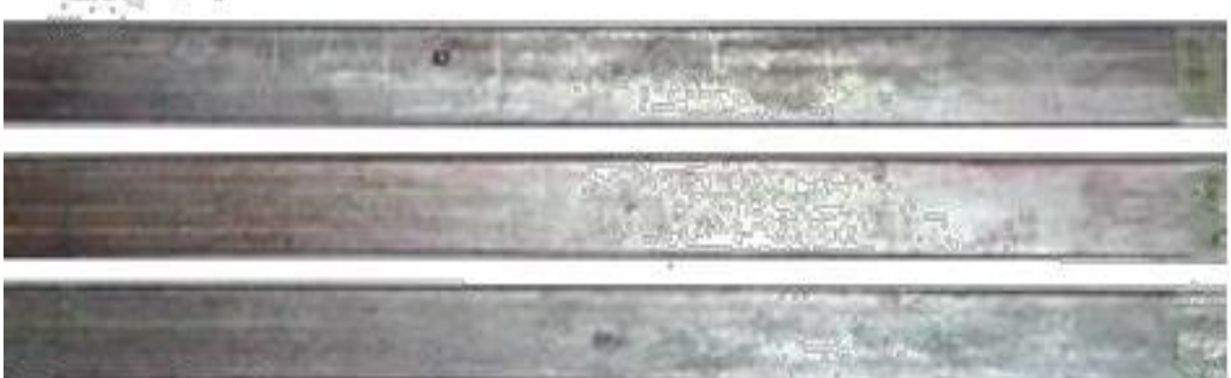

Fig.1 Specimen

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After keeping the fiber and pouring of resin, the specimens were kept in oven. Fig.1 shows the specimen prepared. Using these specimens a total of 9 samples are prepared using the table 1 by varying parameters such as fiber treatment, curing temperature and fiber volume. Table.1 below shows the TAGUCHI’S Design of Experiment.

Table.1 Test Specimen For optimization

S. No.	***Fiber Treatment***	***Curing temperature***	***Fiber volume%***
1	***NaOH***	***Room Temperature***	***5***
2	***NaOH***	***60°C***	***10***
3	***NaOH***	***90°C***	***15***
4	***KOH***	***Room Temperature***	***10***
5	***KOH***	***60°C***	***15***
6	***KOH***	***90°C***	***5***
7	$KMnO_4$	***Room Temperature***	***15***
8	$KMnO_4$	***60°C***	***5***
9	$KMnO_4$	***90°C***	***10***

After the samples prepared, vibration test was done using vibration testing machine with the help of DEWESoft version 7.11, which is shown in Fig.3. A vibration testing machine is shown below in Fig.2. Vibration test was done using the impact hammer and the corresponding frequencies of samples were noted Results and discussion. Here the boundary conditions used was both end fixed

Fig.2 Vibration Testing

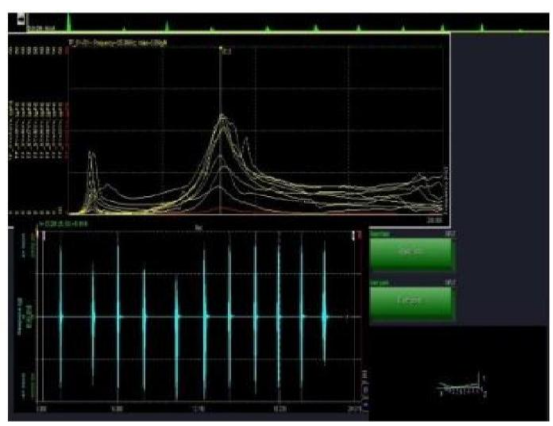

Fig.3 dewesoft image

RESULTS AND DISCUSSIONS

After the vibration testing, the natural frequencies of the corresponding fibers were noted. The Table.2 shows the natural frequencies of the respective fibers. Natural frequencies of the respective samples.

S. No.	*Fiber Treatment*	*Curing temperature*	*Fiber volume(%)*	*Natural frequencies(hz)*
1	*NaOH*	*Room Temperature*	*5*	*79.108*
2	*NaOH*	*60°C*	*10*	*62.398*
3	*NaOH*	*90°C*	*15*	*50.440*
4	*KOH*	*Room Temperature*	*10*	*76.602*
5	*KOH*	*60°C*	*15*	*67.727*
6	*KOH*	*90°C*	*5*	*44.325*
7	*$KMnO_4$*	*Room Temperature*	*15*	*77.154*
8	*$KMnO_4$*	*60°C*	*5*	*48.081*
9	*$KMnO_4$*	*90°C*	*10*	*66.519*

ANOVA (Analysis Of Variance) is done to find the influence of different parameters of their responses i.e. natural frequency. MINITAB software is used in ANOVA. The impacts of different parameters on their natural frequencies are shown in fig.4. from this graph we can easily conclude that treatment with NAOH and $KMnO_4$ gives higher natural frequencies, also the curing temperature plays important part here, as curing temperature increases natural frequency decreases. Room temperature gives best results. From this it shows that room temperature with 10% fiber volume and treatment with NAOH and $KMnO_4$ gives best output.

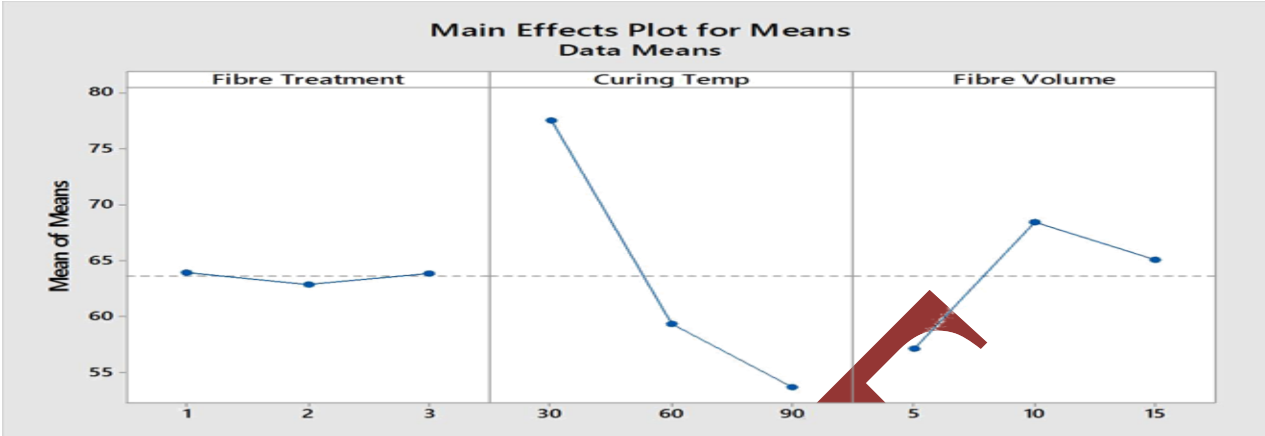

Fig.4 Effect of different parameter on natural frequency

Contour plot is also shown in fig 5, 6. It shows the interrelations between fiber volume percentage curing temperature and fiber treatments. The abscissas of fig5, 6 and 1, 2, 3, represent NAOH KOH and $KMnO_4$.

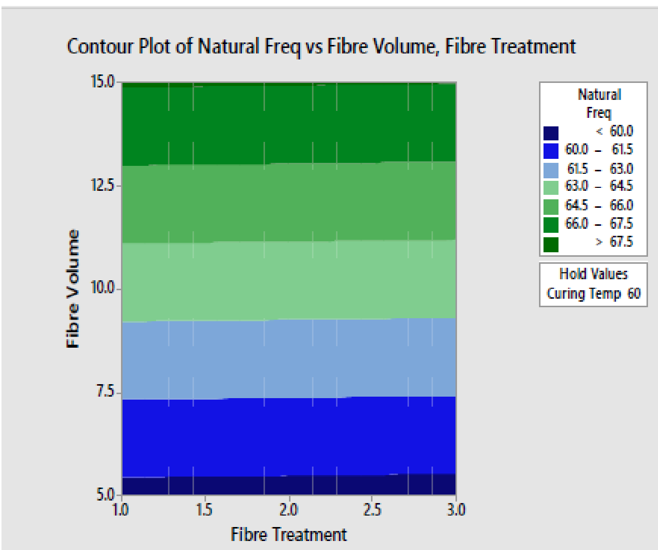

Fig.5 Fiber treatment VS fiber volume

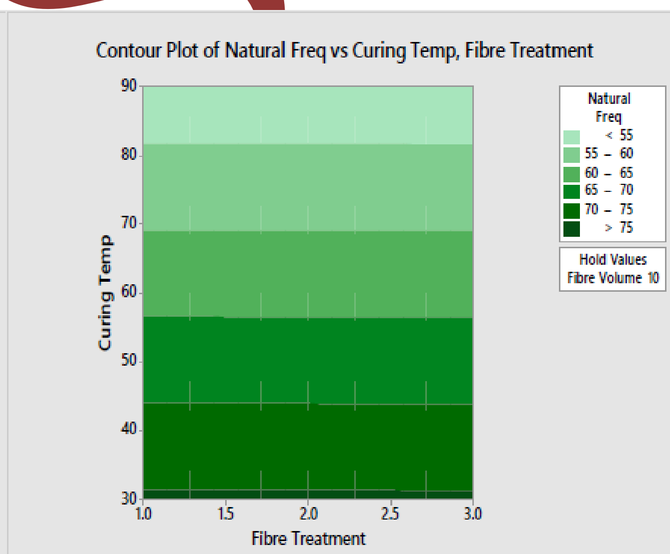

Fig.6 Fiber treatment VS curing temperature

From fig.5 it is evident that fiber treatments with Fiber volume 15% provide best results. Also in Fig.6 it shows that curing temperature decreases with moderate fiber treatment gives best results, as increase in curing temperature decreases the natural frequency.

CONCLUSION

From this based on the present work, it is concluded that fiber treatment influences the surface and stiffness properties. And out of these all treatment with NAOH and $KMnO_4$ provides good results. Also curing temperature plays important part on stiffness properties; increase in curing temperature reduces stiffness of hybrid polymer composite. Moderate Increase in volume percentage increases dynamic load carrying capability of hybrid composite and stiffness also increases. As per the study, NAOH and $KMnO_4$ with curing temperature of 30°C and 10% of fiber volumes gives higher frequency.

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REFERENCES

I. G. Venkatachalam, Ankit Gupta, and A. Gautham Shankar, 2015, Flexural Analysis of Coir Fiber-reinforced Hybrid Polymer Matrix Composites, Composites: Mechanics, Computations, and Applications. An International Journal 6(2), 105–112.

J. J. Rout, M. Misra , S.S. Tripathy , S.K. Nayak and A.K. Mohanty ,2001, The influence of fibre treatment on the performance of coir-polyester composites, Composites science and Technology,1303-1310.

II. Huang Gu,2009, Tensile behaviours of the coir fibre and related composites after NaOH treatment, Materials and Design 30,3931–3934.

JJ. F.Z. Arrakhiz, M. Malha, R. Bouhfid, K. Benmoussa and A. Qaiss, 2013, Tensile, flexural and torsional properties of chemically treated alfa, coir and bagasse reinforced polypropylene, Composites: Part B 47, 35–41.

[5] B.F. Yousif and H. Ku, 2012, Suitability of using coir fiber/polymeric composite for the design of liquid storage tanks, Materials and Design 36, 847–853.

[6] Fairuz I. Romlia,*, Ahmad Nizam Aliasb, Azmin Shakrine Mohd Rafiec, Dayang Laila Abang Abdul Majidd, 2012, Factorial Study on the Tensile Strength of a Coir Fiber-Reinforced Epoxy Composite AASRI Procedia 3,242 – 247.

[7] F.Z. Arrakhiz, M. El Achaby, A.C. Kakou, S. Vaudreuil, K. Benmoussa,R. Bouhfid,O. Fassi-Fehri and A. Qaiss,2012, Mechanical properties of high density polyethylene reinforced with chemically modified coir fibers: Impact of chemical treatments,Materials and Design 37,379-383.

[8] Samia Sultana Mir, Nazia Nafsin, Mahbub Hasan, Najib Hasan, and Azman Hassan, 2013 Improvement of physico-mechanical properties of coir-polypropylene biocomposites by fiber chemical treatment: Material and Design 52, 251-257.