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Experimental Investigations of Corn Husk Fibre Reinforced Polymer Composite

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Abstract: **- This work's objective is to utilise the dissipated corn husk from agricultural background, reinforce it in polymer matrix and study its tensile characters. The intention of this work is to reduce the problems produced by the agricultural residues rewardingly. The composite is prepared by drying the corn husk under the sunlight and treat it chemically to make it compatible with the polymer matrix. They are then chopped to reinforce it into the polymer matrix using hand layup process. The polymer composites are prepared according to ASTM standards. The prepared composites are cured and tested, based on the conclusion the favourable outcomes are chosen for optimum results.**

1. INTRODUCTION

The leafy outer cover or the external shell or the coating on a seed is call husk (or hull) in terms of botany. It includes the protective layer around a seed, vegetable or fruit. It is not edible but is used in cooking to steam vegetable, meat and other dishes. Generally fibres are used as a material to strengthen to the material to which it is added. The husks are generally disposed as wastes. In this work, the disposable corn husks are used as reinforcement. The husk is also recyclable and can be used in automobile applications, manufacturing of fibre boards, etc. as they possess more strength and are light in weight. Ibrahim Et Al inquired the acoustic absorption behaviour of corn husk, it was inferred that the increase in the number of layer of husk does not improve the absorption. It was also concluded that corn husk is appropriate to reduce noise and is not effective at low frequencies.

1.1 Material:

The corn husks of average size, 240 – 245 mm length and 110–135 mm width are used. The procedure of collecting was done with the intention of maintaining the consistency of the CHFs selected.

1.2 Fibre Bundle Extraction:

To undergo the process of microbacterial poverty, corn husks are soaked under water for a course of 16 days. It is then washed thoroughly using fresh water along with a brush made of plastic which removes the residual particles from the surface of the fibre.

Fibres accumulate forming the inner layer that could be extracted for further use. The CHFs that are uncooked are cleaned and dried by exposing them to the atmospheric air.

1.3 COMPOSITE

The material which is produced when two or more materials of different chemical or physical characteristics are combined, that possesses characteristics which differ from their parent materials are called composite materials.

1.4 Matrices (Resins)

The composite material different l polymer-based includes different combinations with various compositions. Polyester resin is appropriate for many plot projects and produces different color tints. It has certain weaknesses – it responses to UV rays and tends to degrade over time. The polyester resin is frequently used to manufacture surfboards and for other marine applications. Its hardener is light, MEKP (methyl ethyl ketene peroxide) is often used. When the resin and the peroxide are mixed, they decompose together to generate free radicals. These hardeners are generally called catalysts, but they do not re-appear at the end, which violates the basic definition of a catalyst.

2 EXPERIMENTAL METHODS

The corn husks are gathered and analyzed effectively with the help of various tests. The husks are processed chemically and the hardness is increased using various techniques. This investigation uses effective methods. The method of preparation of husk and the techniques associated with it are analyzed in this work.

2.1 Corn husk collection:

The domestic wastes generate a lot of corn husks. The corn husk is supposed to be free from dust and other foreign particles. If in case dust particles are present it should be cleaned or washed. After washing, the husks should be dried under the sun and treated chemically. The collected corn husks are shown in Figure 1.

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Figure :1 Raw corn husk

2.2 Corn Husk Preparation and Fibre Extraction:

To remove the moisture content from the corn husk, it is washed and dried under the sun. To enhance various characteristics of the fibre, it is then chemically treated. The ability of getting wet of the fibres is low, to increase its wetting ability it is treated with satiric acid or NaOH solution. The treated husk is shown in Figure 2.

Figure :2 Processed and chemical treated corn husk

2.4 Composite Preparation as Per ASTM Standards:

The ASTM standard ASTM D3039-79 was followed for the creation of the compound and it was then fabricated using hand layup process. The fibre was covered with a release gel so that the pattern does not stick or merge with the template. The resin was then coated all over the material and then the reinforcement was stretched over the matrix. Until the required form of the material is attained the process is repeated. The required form of the material is shown in Figure 3.

Figure :3 Prepared composite through hand layup process

2.4 Tensile test:

The specimen in the shape of a dog's bone is prepared for tensile test. The shape and the dimension of the specimens are shown in Figure 4. The tests were conducted in accordance to the ASTM D3039-76 standard in universal testing machine (UTM, H10KS, Tinius Olsen, UK) at 23°C. The speed of the cross head is assigned as 5mm/min at the constant strain rate of 5 mm/min.

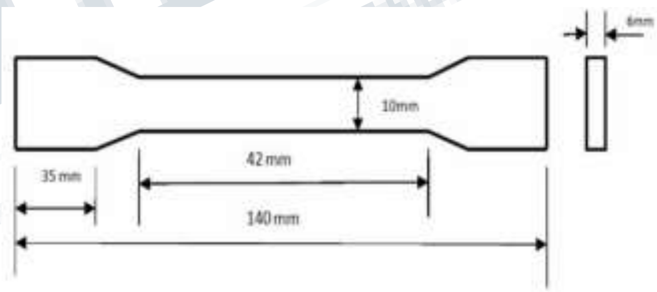

Figure :4 Specimen for tensile test

The specimens of the same size with various compositions are arranged. Totally, 9 specimens were prepared for the investigation. The prepared specimens are shown in figure 5.

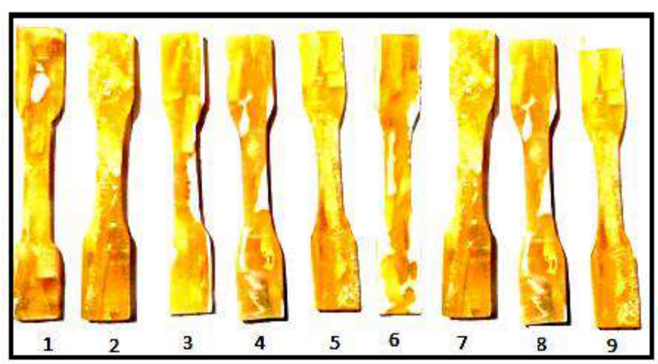

Figure :5 Composite prepared as per ASTM standards

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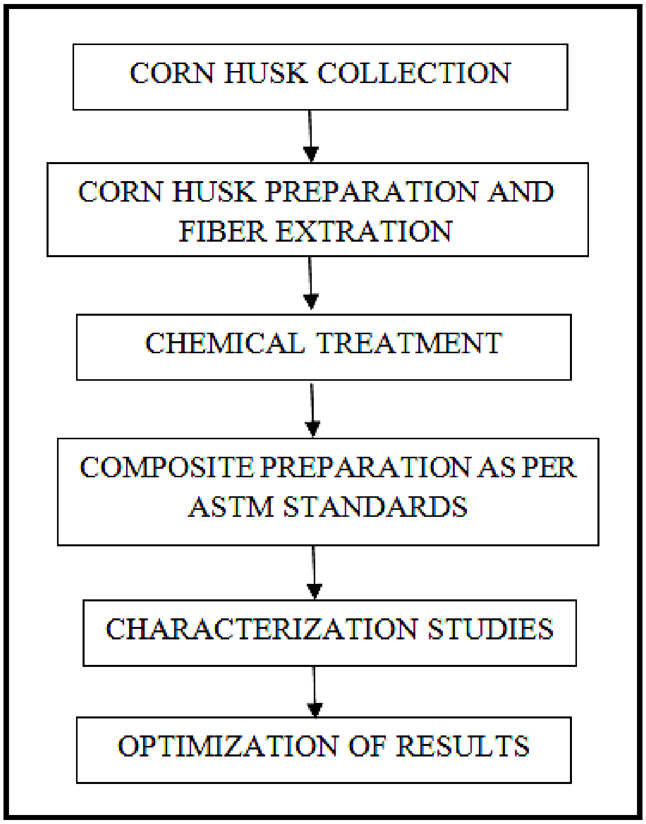
Methodology

There are six major steps carried out in the process of this work. The methods are displayed below, in figure 6.



2.6 Taguchi method:

The difficulty and the complications of traditional experimental designs are high. When the parameters in the experiment increases, the experiments in the methodology also increases. Taguchi experimental design method is adopted as it minimizes the number of experimental tests and makes the task easier. It also acts as a powerful tool for high-quality designing. A design of orthogonal arrays are used to reduce the number of experiments for all the parameters.

2.7 Design of Experiments:

The aim of this research is to optimize the tensile properties of the banana pistil composite and evaluate it. Variations of parameters like different chemical treatments, percentage of hardener and percentage of the hardener used are the most influential. These parameters vary at three stages. The process parameters along with their levels in the study are provided in table 1. The three levels of orthogonal array L9 along with nine experimental runs were selected for the presentation work. The result values for the nine trial conditions are tabulated in table 2.

Table 2 :Process parameters and their levels

Sl. No	Parameters	Unit	Levels		
			1	2	3
1	% of fiber loading(A)	%	10	20	30
2	Chemical treatment(B)	-	No treatment	NaoH treatment	Stearic acid
3	Percentage of hardener	-	30	40	50

The ANOVA L9 orthogonal array experimental work carried out the output responses in Table 3. the total combination of tensile strength is minimum achieved in trail no1 and hioghest tensile strength is achieved in trail no 9.

Table :4 Input and Output Responses by Using L9 Orthogonal Array

Trial No	Designation	Tensile strength in Mpa
1	A1B1C1	61.3
2	A1B2C2	62.2
3	A1B3C3	63.56
4	A2B1C2	65.21
5	A2B2C3	66.45
6	A2B3C1	68.1
7	A3B1C3	68
8	A3B2C1	68.8
9	A3B3C2	70.48

3 RESULTS AND DISCUSSION

3.1 Regression analysis

A first order polynomial regression equation is derived for tensile strength along with significant parameters with R-Sq value of 98.1%, to predict the tensile strength values within th specified level. The regression equation is

TENSILE STRENGTH = 56.9 + 0.337
PERCENTAGE OF FIBER + 1.27
CHEMICAL TREATMENT - 0.0032

3.2 ANOVA:

For the analysis of variations in S/N ratios of the tensile strength of the material which is tabulated in Table4, a

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statistical method is used. It is computed, considering the R-Sq value to be 98.1% and the percentage of fibre is spotted as a significant parameter with 95% contribution. The consequences of the chemical treatment and the percentage of hardener in the experiment was identified to be trivial on the tensile strength of the material with very low percentage of contributions.

Table 4: ANOVA for S/N ratio of Tensile strength

Source	DF	Seq SS	Adj SS	Adj MS	F	P
% of Fibre	2	1.34783	1.34783	0.67392	49.23	0.02
Chemical treatment	2	0.02097	0.02097	0.01049	0.77	0.566
percentage of hardener	2	0.04787	0.04787	0.02394	1.75	0.364
Residual Error	2	0.02738	0.02738	0.01369		
Total	8	1.44406				

The main effect plot is shown in figure 7. It gives the necessary conditions of the process parameters to obtain the maximum tensile strength. The optimal conditions are a fibre percentage of 30% and treating it chemically with satiric acid and 30% of addition of hardener. It was also observed that the percentage of fibre has a major effect on the tensile strength.

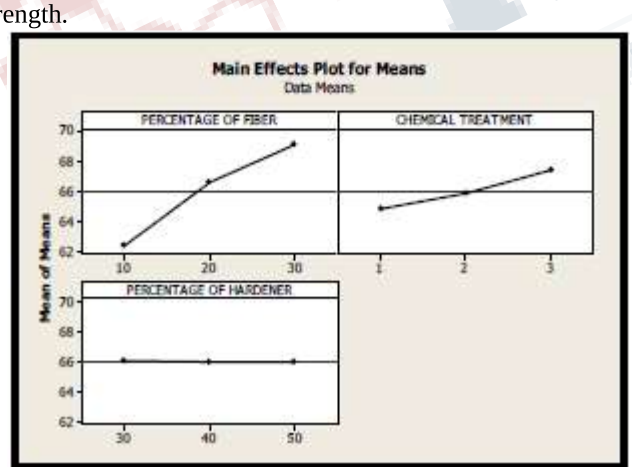

Figure 7 : Main Effect Plot for tensile strength

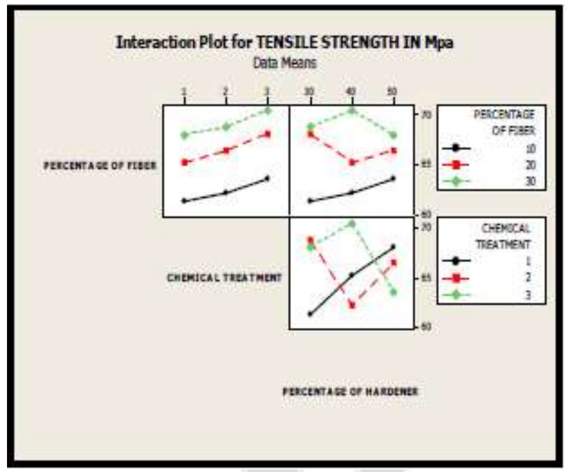

Figure 8 : Interaction Plot for tensile strength

The plot for the interaction of tensile strength between chemical treatment, percentage of hardener and percentage of fibre is shown in Figure 8. In the interaction graph, the non-parallel lines depict the presence and the parallel lines depict the absence and of the effect due to the interaction of the factors. This interaction plot insists that, percentage of hardener and the chemical treatment interacts with each other. The percentage of hardener, chemical treatment and the percentage of fibre does not have any interaction effect between them.

4. VALIDATION TEST

Based on the level of permutation of each parameter (i.e. A3B3C1) a validation test was performed, to establish the main effect on the plot of tensile strength. Considering the predicted and the experimental value, a minor error of 1.98% is observed that presents a good relation as observed in Table 5.

Table 5: Validation of Predicted with Experimental result

	Optimal Control Parameters		Error (%)
	Predicted	Experimental	
Level	A3B3C1	A3B3C1	
Tensile strength in Mpa	62.5	61.26	1.98

5 CONCLUSION

The analysis of the tensile strength has been done using Taguchi method in accordance to the various consolidations of the process parameters. The utmost result on tensile strength of the material is determined using the ANOVA.

The results reveal that the amount of fibre present is the influential factor for the effect on its tensile strength. The optimal levels for the controllable factors are 30% of hardener addition, 30% of fibre addition and stearic acid chemical treatment.

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