Experimental Investigation of Tensile Property of Rice Husk Reinforced Polymer Composites

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ABSTRACT

The proposed research work is dedicated in the development of rice husk reinforced polymer composites. Here chemically treated and untreated fibers are mixed separately with matrix material (polyester, vinyl ester & epoxy) and by using hand lay-up technique, these reinforced composite material is moulded in to box shape. The specimens are prepared in different volume percentage of rice husk particulates and by using three different polymer resins (polyester, epoxy and vinyl ester). With this study we come to know the compatibility of rice husk particulates with various polymer resins and significance of reinforcement & matrix in the mechanical property of the composite.

Key Words: *Rice husk, ANOVA, Design of Experiments, Response surface methodology*

1. INTRODUCTION

Several researchers have carried out extensive experimental investigations on various properties of composites such as hardness, tensile, flexural, compression and density of natural fiber reinforced composites. As reinforcing natural fibers provide positive environmental benefits with respect to ultimate disposability and raw material utilization. It possesses better electrical resistance, low density, and environmental friendly. It was reported that combination of natural fiber and polymer resin has great synergy. The volume fraction of reinforcement has also a significant effect on hardness of natural fiber composites.

The current proposed work relates to the preparation of composites with rice husk as a reinforcement and polymer resins (polyester, vinyl-ester & epoxy) as a matrix material aiming at investigating the tensile property by varying the parameters such as resin type, % NaOH, % filler weight, and keeping particle size as constant (1mm).

2. SPECIMEN PREPARATION

Specimens were prepared by using rice husk particles and polymer resins (polyester, vinyl ester and epoxy) by hand lay-up technique in a wooden mould box of dimensions 100mmX100mmX10mm thickness at room temperature. First the rice husk particles were washed with water, and then treated with NaOH solution followed by washing with distilled water. Subsequently, the rice husk particles were dried at room temperature, the required particle sizes are maintained as per the experimental requirements. The prepared rice husk particles are grinded into 1mm grain size and is thoroughly spread with the matrix material (polyester, vinyl ester and epoxy) to which curing additives are added in the proportion and pressed with load and allowed to cure for 2 hours, to achieve uniform thickness.

3. INVESTIGATION STUDY

The current proposed work relates to the preparation of bio-composites with rice husk particles as a reinforcement and various polymer resins (polyester, vinyl ester and epoxy) as a matrix material aiming at investigating the mechanical properties by varying the parameters such as rein type, % NaOH and % filler weight using response surface methodology (RSM). Later, the properties are compared with wood. 3 levels are defined for each of the factors identified and are summarized as shown in Table 1.

Table 1: Levels and parameters

PARAMETERS	LEVELS		
	I	II	III
Resin Type	Epoxy	Vinyl ester	Polyester
% NaOH	0	5	10
% Filler weight	10	20	30

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4. TENSILE TEST

According to ASTM D638-10, composite specimen was prepared for test as shown in figure 1.

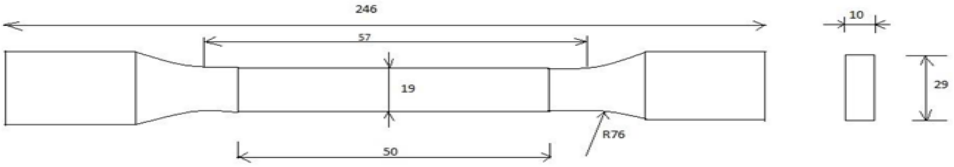

Figure 1: Specimen dimensions according to the ASTM D638-10 standard

Procedure: The test specimen was placed between the two holders of the machine. The constant rate of loading of 100 mm/min is applied on the specimen. The specimen of 50mm gauge length, 29mm wide and 10mm thickness is used. The specimen is fixed in the tensile testing machine jaws and initial adjustments are made. The experiments are conducted on the prepared specimen. The values of load and corresponding deflection are noted down. The results are obtained from the UTM machine connected to a computer.

Table 2: ANOVA for tensile strength property of composites

Source	DOF	SS	Variance	F_{Cal}	F_{Table}
A (Resin Type)	2	37.04	18.52	4.9204	2.59
B (% NaOH)	2	27.84	13.92	3.6982	2.59
C (% Filler Weight)	2	39.45	19.725	5.2405	2.59
Error	10	86.57	3.7639	*****	*****
Total	16	190.9	*****	*****	*****

SS- Sum of Squares, DOF-Degree of Freedom

All the factors are significant since F value which is calculated is higher than value obtained from the F table.

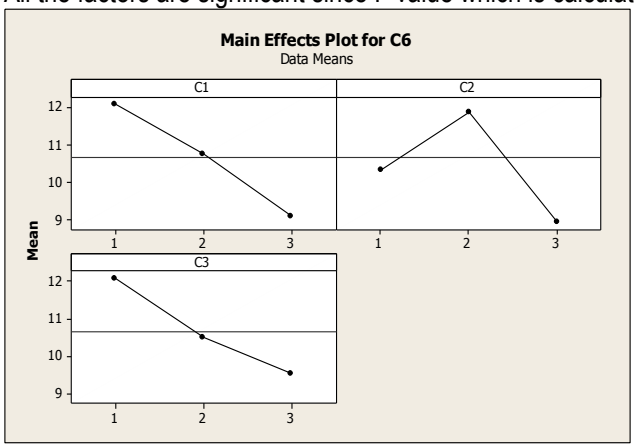

Figure 2: Main effects plot for mean for Tensile

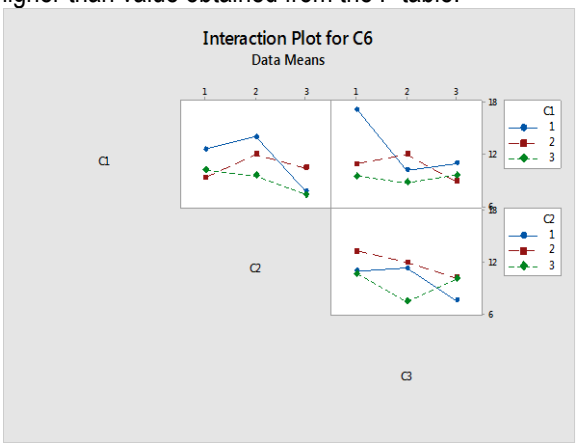

Figure 3: Interaction effect plot for mean for Tensile

Main effect plot significance: From the above plot we find that for obtaining the higher tensile strength, we need to place factor 1 at level 1 i.e. epoxy resin, factor 2 at level i.e.5% NaOH and factor 3 at level 1 i.e. 10% weight.

Interaction effect plot Significance: The above plot shows the tensile strength considering interaction effects (i.e. Resin Type (C1), % NaOH (C2), % Filler weight (C3).

The interaction effect for C1 and C2: Epoxy resin has highest Tensile corresponding to 5% NaOH; Vinyl ester resin gives high tensile strength corresponding to 5% NaOH & Polyester resin gives high tensile strength corresponding to 0% NaOH.

The interaction effect for C1 and C3: Epoxy resin has highest Tensile corresponding to 10% filler weight; Vinyl ester resin gives high tensile strength corresponding to 20% filler weight & Polyester resin gives high tensile strength corresponding to 30% filler weight.

The interaction effect for C2 and C3: 0% NaOH has highest Tensile corresponding to 10% filler weight, 5% NaOH gives high tensile strength corresponding to 20% filler weight & 10% NaOH gives high tensile strength corresponding to 10% filler weight.

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5. CONCLUSION: The current investigation highlights the preparation and characterization of new set of natural fiber based polymer composites consisting of rice husk as reinforcement and polymer resins (polyester, vinyl-ester and epoxy) as matrix. The developed composites are characterized with respect to tensile property. The experiments have been planned to study the effects of resin type, NaOH and filler weight, on mechanical behavior of polymer composites under tension. The analysis of variance (ANOVA) has been performed to check the significance of the above-mentioned factors. The main effects on tensile property is shown in the graphical form. From the subsequent analysis of the results, the following conclusions are drawn within the ranges of the process parameters selected.

- It has been observed that NaOH treatment of filler particles increases the tensile strength of the composites. This is due to the increase in adhesion property of particles.
- It has been observed that specimen 8 (epoxy resin, 10% filler weight, 5% NaOH treatment) has the highest tensile strength.

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