EXPERIMENTAL STUDY OF POLYMER MATRIX COMPOSITES REINFORCED WITH ARACHIS HYPOGAEA SHELL POWDER

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ABSTRACT

Natural fiber reinforced polymer composites are cost-productive and also emerging as a potential environmentally friendly alternative to the synthetic fiber reinforced composites. In recent times, synthetic fibers are replaced by natural fibers for polymer composite due to their several benefits regarding environmental aspects. The attractive features of Groundnut Shell powder are low cost, renewability, and biodegradability. The experimental study aims at learning the tensile, impact and flexural behavior of the natural fiber reinforced polymer composite. The study has been carried out in the view of highlighting advantages of bio-waste over synthetic fibers. Different percentage of the polyester resin is used as a Matrix and Groundnut shell powder is used as a reinforcing material. Tensile, Flexural, and Charpy impact test are performed on the specimen and the specimen with groundnut shell with 55% composition have highest tensile, transverse and impact strength when compared with others.

Key Words: Polyester, Arachis Hypogaea shell (Groundnut shell), Methyl ethyl ketone peroxide, cobalt oxide, Natural Material

INTRODUCTION

A composite is a combination of two or more materials in which one of the material is called as reinforcing phase in which the form of sheets or particles are used and the other is known as matrix phase. The reinforcing material and the matrix material can be of ceramic, metal, or polymer. Composites have the distinctive qualities of a fiber or particle phase that is stiffer and stronger than the continuous matrix phase which acts as the principal load carrying members in the composite. The matrix acts as a load transfer medium mostly and in less ideal cases where the loads are complex, the matrix may even have to bear the loads transverse to the fiber axis. Most commonly used matrix materials are polymers. Generally, the mechanical properties of the polymers are inadequate for many structural purposes. In particular, their strength and stiffness are low when compared to metals and ceramics but they are nonbiodegradable and low weight. These difficulties can be overcome by reinforcing other materials with polymers [1]. Secondly, the processing of polymer matrix composite need not require high pressure and high temperatures. Also, equipment required for manufacturing polymer matrix composites are simpler [2, 8, 7]. For this reason, polymer matrix composites developed rapidly and soon became popular for structural applications. In its most fundamental form, a composite material is fabricated of at least two elements that work together to produce the properties that are different to the properties of those elements originally are [3]. In practice, most of the composites consist of a bulk material and a reinforcement of some kind, added primarily to increase strength and stiffness of the matrix [4, 9].The polymer-reinforced composite is made with bio-waste materials as matrix material [1]. Arachis hypogaea (Groundnut) are cultivated at a rate of 7249.167 thousand tons in an area of 6783 thousand hectares average yearly in India. In Andhra Pradesh, it is cultivated at an average rate of 1639 thousand tons in an area of 1841 thousand hectares at an average [6]. The groundnut shell which is used is taken from Kadapa district. The groundnut shell is peeled from the groundnut using the peeler machine and then they are cleaned by using distilled water and then dried in sunlight. Then the groundnut shells are ground into fine granules by using flour grinding machine and then after by using sew shaker the grain size is classified. The natural material has become alternative reinforcement for synthetic fibers in polymer composites, due to their advantages like low density, fewer tool wears during processing, low cost, non-toxic, easy to process, environmentally friendly, and biodegradability.

Figure-1 Groundnut shell powder

FABRICATION

For the preparation of the polymer reinforced composite, the measurement of the samples should be accurate and the mixture should be very uniform. By calculating the amount of mixture required we take the accurate amount of polymer and 10% of its hardener (MEKP). The polyester and hardener (Methyl ethyl ketone peroxide (MEKP)) were mixed by using glass rod in a bowl based on volume and then 5ml of the catalyst. Then this mixture is stirred thoroughly till it becomes a bit warm. Hardener should be taken in the minute because the little extra amount of hardener can spoil the composite. Care was taken to avoid the formation of bubbles. Because the air bubbles were trapped in the matrix may result in failure in the material. The subsequent fabrication process consists of putting a releasing film on the mold surface. It was left for 8 hrs to allow sufficient time for curing and subsequent hardening. The catalyst used over here is cobalt oxide. The fibers were converted to small particulates form from the Groundnut shell powder.

Hand lay-up is one of the simple and oldest methods used for open molding of the composite fabrication. It is low volume, labor intensive method suited for large components, such as boat hulls. Glass or other reinforcing mat or woven fabric or roving is placed manually in the open mold, and the resin is poured or sprayed over and into the glass plies. Trapped air is removed manually with the help of rollers to complete the laminated structure of the composite. At the Room temperature in matrix resins, the curing polyesters. Curing is initiated by a catalyst in the resin, which then hardens the fiber reinforced resin composite without the requirement of external heat. For a quality part surface, a pigmented gel coat is first applied to the mold surface.

Figure-2 Ground nut shell 45% Mould

Table-1 Combination of powders for preparation of composite materials

Type of material	Combination of material	Specimen-1 (%combination)	Specimen-2 (%combination)	Specimen-3 (%combination)
Ground nut shell powder	Ground nut shell powder + polyester	45%+55%	50%+50%	55%+45%

Experiment

To cut each laminate into smaller pieces a wire hacksaw blade was used, for various experiments the following standards were followed:

Tensile test- Sample is cut into dog bone shape 165x30x3 mm (ASTM D638-3).

Flexural test specimen was cut into 125*12.7*3.2 (ASTM D 790)

Impact test specimen was cut into 64*12.7*5(ASTM E 23)

Tensile Test

The tensile strength of a material is the maximum amount of stress it can withstand before reaching its failure. The specimen used for the tensile test is dog bone type. In this test, a uniaxial load is applied through both the ends of the specimen. The dimension of the specimen used is (165x30x3) mm. The important factors that are too considered when testing a material are mostly ultimate tensile strength (UTS) which represents a point just beyond the onset of permanent deformation or fracture point where the specimen breaks into pieces. The tensile test is performed on the universal testing machine (UTM) model: TUE-CN 200 Make: FSA Pvt Ltd.

Figure-3 Tensile test specimen

Flexural Test

The flexure test is used to measure the behavior of material subjected to a simple beam loading. It is also called a transverse beam test for materials. The specimen is kept on a support span and the load is applied to the center by the loading nose producing three points bending at a constant rate. In this method, the crosshead travel at peak (C.H. Travel) is measured. The parameters for this test are the support span, the maximum deflection, and the speed of the loading for the test. The test was carried out as per the ASTM standard D790 procedure. The flexural test is performed on the universal testing machine (UTM) model: TUE-CN 200 Make : FSA Pvt Ltd.

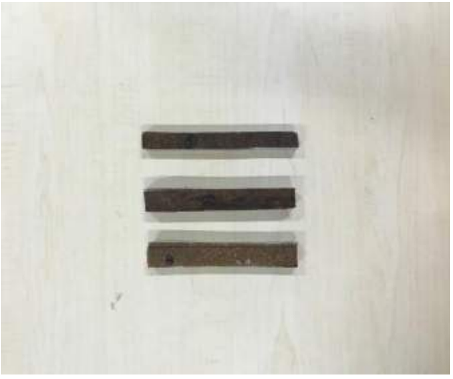


Figure-4 Flexural test specimen

Charpy Impact

The Charpy impact test is conducted to determine the amount of energy absorbed by the material or specimen during fracture. The absorbed energy is a measure of the given material's toughness. The apparatus contains a pendulum of known mass and length that is dropped from a known height to impact a notched specimen. The energy absorbed by the material can be known by comparing the difference in the height of the hammer before and after the fracture, it is known as energy absorbed by the fracture event. Machine model used for testing is AIT 300N Make: FASE Pvt Ltd.

Figure-5 Charpy test specimen

Table-2 TENSILE TEST DIMENSIONS FOR GROUNDNUT SHELL POWDER

GROUDNUT SHELL POWDER %	LENGTH (mm)	WIDTH (mm)	THICKNESS (mm)
SPECIMEN 1(45%)	71	10.06	9.8
SPECIMEN 2(50%)	69	15.4	10.9
SPECIMEN 3(55%)	59	17.8	10.7

Table-3 FLEUXRAL TEST DIMENSIONS FOR GROUNDNUT SHELL POWDER

GROUNDNUT SHELL POWDER %	LENGTH (mm)	WIDTH (mm)	THICKNESS (mm)
SPECIMEN 1(45%)	75	17.3	10.5
SPECIMEN 2(50%)	75	16.1	12.7
SPECIMEN 3(55%)	75	12.6	10.31

Table-4 CHARPY TEST DIMENSIONS FOR GROUNDNUT SHELL POWDER

GROUNDNUT SHELL POWDER %	LENGTH (mm)	WIDTH (mm)	THICKNESS (mm)
SPECIMEN 1(45%)	69	14.3	9.4
SPECIMEN 2(50%)	69	18.9	14.2
SPECIMEN 3(55%)	69	12.7	11.34

RESULT AND DISCUSSION

Tensile Test

Table-5 SPECIMEN DIMENSIONS AFTER TENSILE TEST

GROUNDNUT SHELL POWDER %	GAUGE LENGTH(mm)	WIDTH(mm)	THICKNESS (mm)
SPECIMEN 1(45%)	74	16.4	9.3
SPECIMEN 2(50%)	60	13.4	11.09
SPECIMEN 3(55%)	69	18	11.7

Table-6 GROUND NUT SHELL POWDER

GROUND NUT SHELL POWDER %	LOAD AT YIELD (KN)	ELONGATION AT YIELD(mm)	YIELD STRESS (N/m m^2)	LOAD AT PEAK (KN)	TENSILE STRENGTH(N/mm^2)
Specimen 1(45%)	1.5	2.48	9.52	1.88	11.94
Specimen 2(50%)	1.1	2.3	6.55	1.38	8.22
Specimen 3(55%)	1.84	2.68	9.66	2.32	12.18

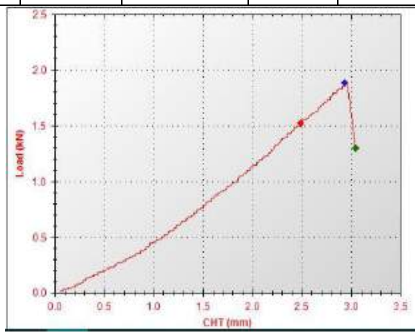


Fig-6 Polymer + GN (45%)

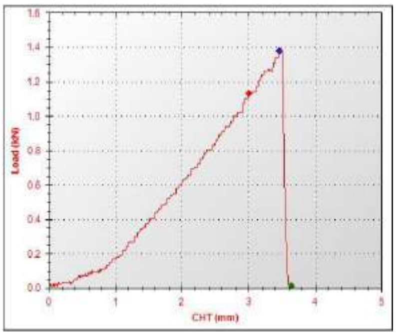


Fig-7 polymer + GN (50%)

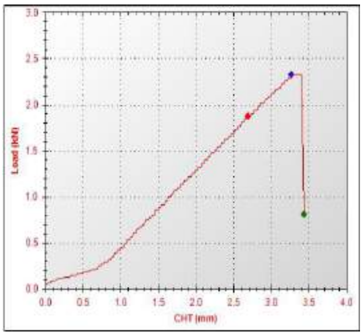


Fig-8 Polymer + GN (55%)

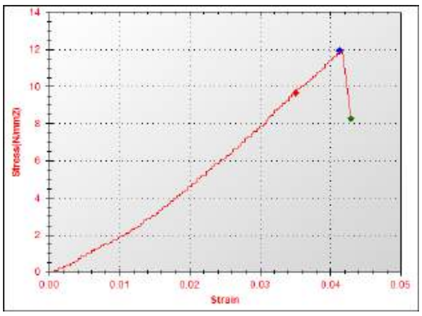


Fig-9 Polymer + GN (45%)

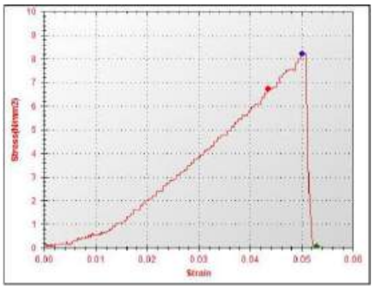


Fig-10 polymer + GN (50%)

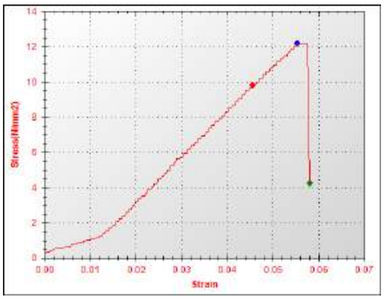
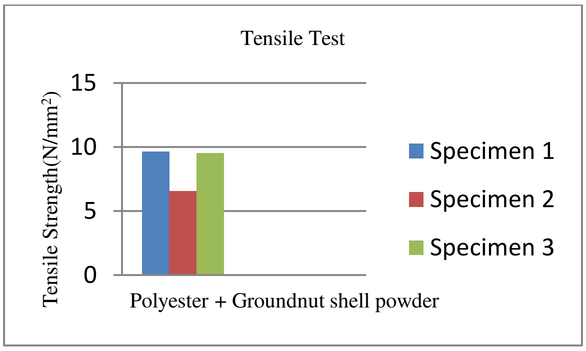


Fig-11 Polymer + GN (55%)

The specimen with groundnut shell powder 55% has highest tensile strength when compared with the specimen with groundnut shell powder with 45% and 50%.



Graph-1

Flexural Test

Table-7 SPECIMEN DIMENSION AFTER FLEXURAL TEST

GROUNDNUT SHELL POWDER %	**Length(mm)**	**Transverse strength(N/mm^2)**
Specimen 1(45%)	75	32.9
Specimen 2(50%)	75	24.03
Specimen 3(55%)	75	37.79

Table-8 GROUND NUT SHELL POWDER

GROUNDNUT SHELL POWDER %	**LOAD AT PEAK(KN)**	**C.H.TRAVEL AT PEAK(mm)**	**TRANSVERSE STRENGTH (N/mm^2)**
SPECIMEN 1(45%)	0.560	3.230	32.916
SPECIMEN 2(50%)	0.560	2.220	24.003
SPECIMEN 3(55%)	0.450	3.060	37.779

Figure-12 Flexural after test specimen

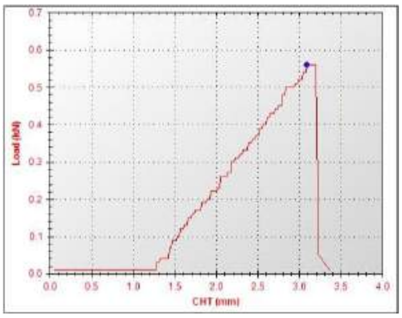


Fig-13 Polymer + GN (45%)

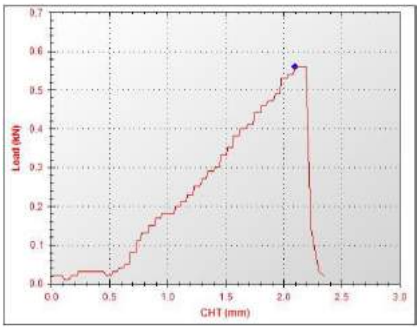


Fig-14 polymer + GN (50%)

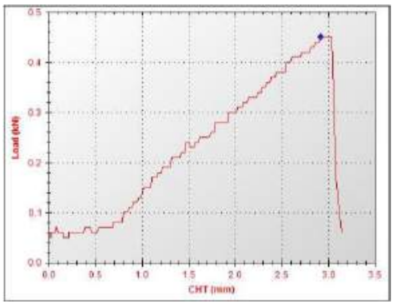
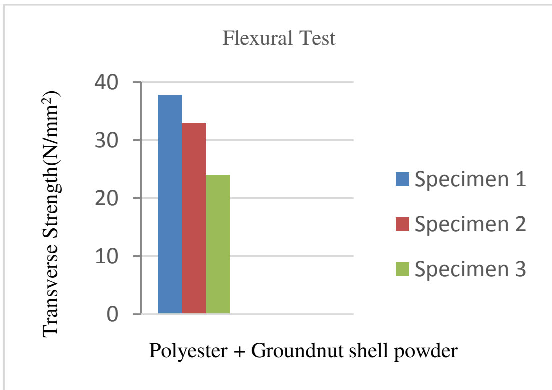


Fig-15 Polymer + GN (55%)



Graph-2

The specimen with groundnut shell powder 55% has highest transverse strength when compared with the specimen with groundnut shell powder with 45% and 50%.

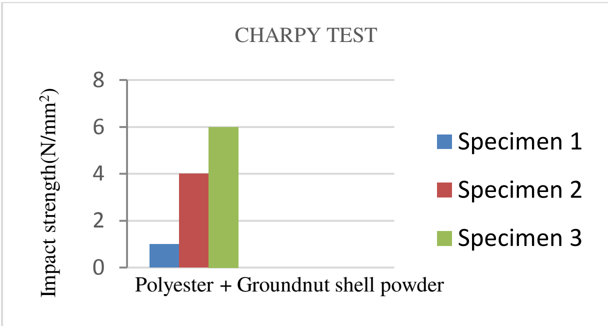
Charpy impact test result

Table-9 SPECIMEN IMPACT STRENGTH

GROUNDNUT SHELL POWDER %	IMPACT STRENGTH (J)
Specimen 1(45%)	1
Specimen 2(50%)	4
Specimen 3(55%)	6

Figure-16 Charpy after Test specimen

The specimen with groundnut shell powder 55% has highest impact strength when compared with the specimen with groundnut shell powder with 45% and 50%.



Graph-3

CONCLUSION

Based on experimental results the following major conclusions are made:

1. The peak value of Tensile strength is recorded as 12.18N/mm^2 for Groundnut shell powder 55% as shown in Figure-16.
2. The peak value of Transverse strength is recorded as 37.77N/mm^2 for Groundnut shell powder 55% as shown in Figure-17.
3. The peak value of Impact strength is recorded as 6J for Groundnut shell powder 55% as shown in Figure-23.
4. Although it is not a big saving, it is available abundantly in the nature. So by doing some research we can make use of it and make the work as consumable as in the market.
5. And also it is an eco-friendly product as it is degradable in the earth.
6. The output of the work can also be used as roof toppings and bathroom fixtures.

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