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PRODUCTION OF PAPER FROM GROUNDNUT SHELL BY CHEMICAL METHOD

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ABSTRACT :

Paper creation through compound pulping has been recognized as one of the best roads of investigating the purposes of groundnut shells as they are wealthy in cellulose. The ideal application for cellulose would be the production of fibers that could be incorporated into useful paper products. In this review, synthetic pulping was the picked cycle for freeing the filaments as it is compelling in dissolving lignin implanted inside the cellulose. Additionally, when compared to mechanical pulping, the produced fibers possess superior physical properties. To ensure that energy and chemical consumption are kept to a minimum, it is essential to determine the ideal conditions for the chemical treatment process. This large number of measures are pointed toward lessening creation expenses and making synthetic pulping financially practical, when contrasted with the mechanical pulping process which is less exorbitant. The effect of three independent variables cooking time, temperature, and sulphidityon pulp yield and kappa number was examined using response surface methodology (RSM). These boundaries are basic in the substance pulping process and the ideal circumstances acquired were 180 min, 100 C and 23.6 wt.%, individually. The pulp yield was 64.39 wt% with a kappa value of 19.5 at the optimal cinders. The outcomes showed that all boundaries examined, had a measurably tremendous impact on the development of mash. The increased cooking time was effective in ensuring that the groundnut shells were completely impregnated with chemicals prior to pulping and that the dissolution of lignin was not selective, preventing dead spots from compromising the pulp's quality. On the other hand, lower temperatures restricted the stripping impact because of hydrolysis of starches which expanded mash yield because of a higher cellulose maintenance. As a result, this helped produce pulp that is well cooked, uses less bleach, and is of higher quality.

1.INTRODUCTION :

1.1. PAPER

Paper is a flexible material with many purposes. It is mostly made by drying wood-derived cellulose pulp into flexible sheets and preparing it. Writing and printing are the most common applications; it is likewise broadly utilized as a bundling material and, surprisingly, as a food fixing - - especially in Asian societies. China is where the ancient process of making paper and pulp for paper was developed. Groundnuts are also useful as a crop for rotation. Due to the presence of atmospheric nitrogen fixing bacteria in its root nodules, it improves soil nutrients as a plant. As a result, the groundnut plant's various parts are all useful. The shell of a groundnut has a lot of potential for use in business. Groundnut shell is utilized as a fuel, filler in dairy cattle feed, hard particleboard, enacted carbon, and so forth. The groundnut shell filaments have great actual strength properties. The higher pentosan content along with gums of certain types of groundnut plant might be a reasonable hotspot for delivering paper.

The process of pressing and drying moist fibers, typically cellulose pulp derived from wood, rags, or grasses, into flexible sheets yields the thin material known as paper. Paper is a material that can be used for many things. While the most well-known is for composing and printing upon, it is likewise generally utilized as a bundling material, in many cleaning items, in various modern and development cycles, and, surprisingly, as a food fixing - - especially in Asian societies.

The Han court eunuch Cai Lun is said to have invented paper and the pulp papermaking process in China in the early 2nd century AD, possibly as early as 105 A.D., though China has the earliest archaeological paper fragments from the 2nd century BC. From that point on paper is utilized as the significant wellspring of correspondence through composing letters, tracking important data like books, engaging individuals as books and spreading data about the day to day happenings as new s papers, which is the significant upheaval in correspondence that consistently occurred throughout the entire existence of humankind. With different advances accessible for creation of paper, made itself utilize full in bunches of utilizations.

It plays part in correspondence as well as to huge degree in pressing materials (poor quality paper), which is justification behind determination of this undertaking. As a result, numerous attempts to produce paper from agricultural waste have been made in recent years. This undertaking includes the development of paper as well as the fundamental unrefined substance for paper creation that is mash from groundnut shells (bounteously accessible on the planet). Groundnut shells were chosen as the raw material because the shells would be wasted once the nuts were removed. Lots of groundnut shells are discarded every year.

1.2. GROUNDNUT

Groundnuts (Arachis hypogaea), also known as peanuts. Mention their widespread cultivation and consumption globally. Botanical Characteristics:

Description of the plant's appearance, including its growth habits, leaves, flowers, and fruiting structures. Explanation of its unique reproductive process of pegging, where the flowers are self-pollinating and develop into pods underground. Environmental requirements: soil type, temperature, rainfall, and sunlight. Planting techniques, including seed selection, spacing, and planting depth. Irrigation, fertilization, pest, and disease control. Harvesting methods and post-harvest handling. Analysis of groundnuts' nutritional content, including macronutrients (carbohydrates, proteins, fats), vitamins (especially B vitamins), minerals (such as magnesium, phosphorus, and potassium), and phytochemicals. Emphasis on their high protein and healthy fat content, making them a valuable dietary source. Global production and trade statistics. Importance in agriculture for smallholder farmers and as a cash crop in various regions.

Industrial uses: food processing, culinary applications, oil extraction, and animal feed. Discussion of the potential health benefits associated with groundnut consumption, such as heart health due to their monounsaturated fat content, protein content aiding muscle repair and growth, and rich source of antioxidants like resveratrol. Mention of studies linking groundnuts to reduced risk of chronic diseases like diabetes and certain cancers. Cultural and Culinary. Exploration of groundnuts' role in various cuisines around the world, from savory dishes to confectionery.

Cultural traditions and rituals associated with groundnuts in different societies. Recap of the importance of groundnuts as a versatile crop with significant nutritional and economic value. Potential for further research into their health benefits and sustainable cultivation practices. The following are this herb's taxonomic details:

Kingdom: Plantae
Division: Magnoliophyte
Class : Magnoliopsida
Order : Fabales
Family : Fabaceae
Genus : Arachis
Species : Arachis hypogaea

1.2.1Bio-active Compounds Present in Groundnut Shell

The groundnut shell contains several bioactive components, one of which is phenolic compounds. Phenolic compounds are known for their antioxidant properties and potential health benefits. These compounds include flavonoids, phenolic acids, and tannins. Additionally, groundnut shells contain other bioactive compounds such as lignin, which may have various biological activities including antimicrobial and anticancer properties.

2. METHODOLOGY

TYPES OF COMPOSITES

Broadly the composite materials in use in the industry today are classified into the three main categories as

a) Metal Matrix Composites (MMCs)
b) Ceramic Matrix Composites (CMCs)
c) Polymer Matrix Composites (PMCs)

2.2 POLYMER MATRIX COMPOSITES

In the modern perfume industry, this method of extracting aromatics is the most popular and economically significant. The desired aromatic compounds are dissolved in a solvent that is submerged in the raw ingredients. Woody aromatic compounds and fibrous plant materials, as well as all aromatics from animal sources, are frequently acquired in this way. Additionally, odorants that are too volatile for distillation or quickly denatured by heat can be extracted using this method. Hexane and dimethyl ether are common solvents used for solvent extraction and maceration. A "concrete" is what this technique produces.Natural fibres are grouped into different categories, based on their origin, derivations of plant, animal and mineral types.These sustainable and eco-efficient fibres have been applied as substitutions for glass and other synthetic fibres in diverse engineering applications. With the consideration of environmental consciousness, natural fibres are biodegradable and hence, they can alleviate the problem of massive solid wastes, and relieve the pressure of landfills, if they are used for replacing other non-degradable materials for product development. Besides, according to their inherent properties, natural fibres are flexible for processing, due to their being less susceptible to machine tool damage and health hazards during manufacture.

2.3 COMPONENTS DETAILS

Materials Required
Polymer component :E-Poxy polymer
Natural component : Groundnut Shell Powder
For Compression Molding :290 X 290mm MOLD

2.4.MATERIALS, EQUIPMENT AND EXPERIMENTAL PROCEDURES

Materials The materials used for this research work were all sourced locally. These include:

i. Groundnut shell
ii. Epoxy resin (Bisphenol-A-Co-Epichlorohydrin)
iii. Tetraethylenepentamine (Hardener)
iv. Sodium hydroxide solution (NaOH)
v. Distilled water
vi. Wax 2.2 Equipment

The major items of equipment used for this work are as follows:

i. Impact Testing Machine 100kg (Norwood)
ii. Monsanto Tensometer serials No. 9875, UK (200KN)
iii. Universal Material Testing Machine (100KN)
iv. Thermal conductivity testing machine (Norwood)
v. Metallic sieve of size 0.5mm, 1mm and 1.5mm.
vi. Mixing Sterilizer
vii. Metal Mould

2.5 PROPERTIES OF EPOXY RESINS

Epoxy resins are defined as a family of monomeric or oligomeric materials that can be further reacted to form thermoset polymers possessing a high degree of chemical and solvent resistance, outstanding adhesion to a broad range of substrates, a low order of shrinkage on cure, impact resistance, flexibility, and good electrical properties. When selecting an epoxy resin, the resin, modifiers, and cross-linking agent can be custom-selected to create specific characteristics for a particular application. This allows epoxy resins to be used in a wide variety of applications.

2.5.1 EPOXY RESINS CHARACTERISTICS

Epoxy resins are known for high performance. They are the building blocks for adhesives, coatings, reinforced plastics, and composite materials such as fiberglass and carbon fiber, which remain intact under intense conditions. When properly cured, epoxy resins offer a number of desirable characteristics, including:

* Resistance to chemicals, particularly alkaline environments

- Heat resistance
- Adhesion to a variety of substrates
- High tensile, compression, and bend strengths
- Low shrinkage during curing
- High electrical insulation and retention properties
- Corrosion resistance
- Cures under a wide range of temperatures

2.5.2 EPOXY RESINS APPLICATIONS

*****Construction: Laminated wood, walls, roofs, flooring, and more.
*Paints and coatings: Outdoor coatings, sealers, heavy-duty protective coatings, industrial and automotive paints, primers, and sealers.
*Industrial tooling and composites: Molds, master models, laminates, castings, fixtures, and other industrial production aids, as well as carbon-fiber-reinforced and composite parts.
*Turbine technology: Wind turbine blades.
*****Electrical systems and electronics: Motors, generators, transformers, gear switches, bushings, insulators, printed wiring boards (PWBs), potting, and semiconductor encapsulants.
*Consumer and marine: You can pick up epoxies in most hardware and marine stores in packs that facilitate the mixing of resin and hardener before use. These kits are useful in many home and boat repair applications.
*Aerospace: In the aerospace industry, among others, epoxy is used as a structural glue that is reinforced with glass, Kevlar, boron, or carbon fiber. This option is particularly used in the aerospace industry because of epoxy resins high-performance mechanical properties and resistance to environmental deterioration.
*Biology: Durcopan is a water-soluble epoxy used for embedding electron microscope samples in plastic for sectioning and imaging.

2.5.3. SELECTING EPOXY RESINS

Since epoxy resins perform well under extreme conditions, when they are combined with carbon or other fibers, they produce composite materials with the properties that are beneficial in many applications. Their unique, high-performance characteristics make them well-suited to work in many environments that offer extreme conditions. The resin, modifier, and cross-linking agent can be switched up to create a custom epoxy that performs under very specific conditions.
Reactive diluents free matrix system with a very long pot life. The reactivity can be adjusted by varying the accelerator content. The system has very good high temperature performance after post cure and exhibits good mechanical and dynamic properties.

2.5.4 EPOXY RESIN 556

Properties of Epoxy resin LY-556: 1. Visual aspect -Clear, pale-yellow liquid 2. Viscosity at 250 C -10000-12000 MPa s 3. Density at 250 C -1.15-1.20 gm/cm3 4. Flash point -1950 C 3.1.2.

3.COMPOSITION OF GROUNDNUT SHELL

Peanut shells, an abundant agricultural waste, have emerged as a valuable source for producing various derivatives with potential applications in polymer composites. These derivatives offer advantageous properties that can contribute to the development of high-performance materials. In this subsection, we provide a comprehensive overview of the key derivatives obtained from peanut shells, highlighting their properties and potential applications in polymer composites.
Cellulose, hemicellulose, lignin, protein, and ash are all components of the chemical structure of peanut shells. The primary structural element of plant cell walls is cellulose. Cellulose is a glucose molecule with beta (14) linked chain. Hemicellulose, a complex carbohydrate, gives plant cell walls

strength and stability. Plant cell walls are made of lignin, an intricate organic polymer that gives them stiffness and strength. Ash is an inorganic substance that is still present after organic material has been burned. Protein is an energy-rich organic molecule that provides a source of fuel for plant.

3.1 PHYSICAL PROPERTIES OF FIBERS:

Groundnut shell having the following physical properties:
Chemical composition
Groundnut shells are made of cellulose, hemicellulose, and lignin. They also contain silica, iron oxides, alumina, and calcium oxide.
Density
The solid density of groundnut shells is between 0.27–0.30 g cm−3, and their average bulk density is between 0.066–0.077 g cm−3.
Porosity
Groundnut shells are highly porous and can absorb around 198% of water in 72 hours.
Microstructure
Groundnut shells are made of microfibers with highly porous borders.

3.2 CHEMICAL PROPERTIES OF FIBERS:

Groundnut shell powder is a lignocellulosic material that is made up of cellulose (44.8%), hemicellulose (5.6%), and lignin (36.1%), and also contains proteins (5.4%), minerals, pectin, and tannins. The surface of groundnut shell powder contains several polar functional groups, including hydroxyl, methoxy, and carboxyl groups.
Groundnut shells are also high in the following minerals:
Sodium (42.00 mg/100 g)
Potassium (705.11 mg/100 g)
Magnesium (3.98.00 mg/100 g)
Calcium (2.28 mg/100 g)
Iron (6.97 mg/100 g)
Zinc (3.20 mg/100 g)
Phosphorus (10.55 mg/100 g)

3.3 MECHANICAL PROPERTIES OF FIBERS:

Groundnut shell powder (GSP) has mechanical properties such as tensile strength, impact strength, and flexural property. The mechanical properties of GSP can be improved by treating it with alkali or acetylation. For example, alkaline treatment of GSP can improve the mechanical properties of recycled high density polyethylene composites. Acetylation treatment can enhance the physicochemical and mechanical properties of groundnut shell fiber, making it suitable for composite processing.
GSP is a lignocellulosic material made up of cellulose (44.8%), hemicellulose (5.6%), and lignin (36.1%). It can be used in automobiles, railway coach, and military applications.
Other mechanical properties of GSP include Density, Microhardness, and Inter-laminar shear strength (ILSS).
GSP can also be used as a source of fuel for cooking, heating, and electricity generation. It can also be used as a component of animal feed, especially for ruminants like cattle and sheep.

4. EXPERIMENTAL SET UP:

Groundnut shell preparation A sample of groundnut shells was washed with distilled water for 5 min to remove any material attached to the shells. Thereafter, the groundnut shells were ground in a blender to reduce their size and increase the surface area for increased contact with the chemicals during the cooking process. The groundnut shells were then dried with air for 24 h and placed in an oven for 1 h at 100 C for further drying.
Cooking liquor preparation A solution of NaOH and Na2S was prepared using distilled water by mixing the two to form a white liquor. The active alkali (NaOH þ Na2S) was 20% the weight of the groundnut shells.
Cooking temperature The effect of temperature on the pulping of groundnut shells was evaluated with the objective of maximizing the rate of delignification and reducing the energy requirements. The temperature ranges for chemical pulping are usually in the range 140180 C, but also depends on the raw material being used for pulping, considerably lower temperatures were investigated in this research, a temperature range of 84100 C was used to reduce energy requirements.
Sulphidity Addition of sodium sulphide to sodium hydroxide increases the rate of delignification whereas sulphidity represents the amount of sodium sulphide added as a percentage. To ensure that the process is economically, and environmentally sustainable minimal chemical consumption is desirable.

4.1 SPECIMEN PREPARATION:

The strength of the composite largely depends on the preparation of the shell. The groundnut shells were collected and sun dried. The dried groundnut shells were washed with water to take away the sand and other impurities.

The washed shells were later treated with 10% sodium-hydroxide (NaOH) solution for two (2) hours and then washed with distilled water until the sodium hydroxide (NaOH) in the groundnut was eliminated. Subsequently, the shells were solar dried and hammer milled to reduce its size to smaller ones and then grinded in a machine and particles were sieved through 0.5mm, 1mm and 1.5mm BS sieves to obtain fine uniform shapes and get different sizes of groundnut shell particles.

The three (3) different fine sieved particles were used as reinforcement material in the polymer matrix. The low temperature curing epoxy resin (Bisphenol-A-Co-Epichlorohydrine) was dissolved in acetone and then mixed with tetraethylenepentamine in ratio of 10:1 by weight as recommended .

A prototype of a gerrad roofing sheet was used to design a metallic mould for the production process. The mould made of Aluminum was constructed for producing sample roofing sheets. Aluminum material was chosen due to its availability, relatively low cost and resistance to corrosion.

4.2 PRODUCTION TECHNIQUE:

Each composite consists of 30% groundnut particles and 70% epoxy resin (weight ratio 30:70). The designations of these composites are given in Table 1 below. A layer of wax was applied to the mould so that the specimen can be easily taken out of the mold. Measured quantities of groundnut shell particles and resin were taken in a plastic container and stirred thoroughly to get homogenous mixture. After adding a suitable quantity of hardener, the mixture was again stirred for ten minutes. The prepared composite was placed in the mould and compressed uniformly. Compression is done carefully to avoid buildup of air gap within the sample, the set up was allowed to cure for 8 hours at room temperature and then the sample roofing sheet was taken out from the mould, it was taken to an electric oven for 48 hours at 380C for further curing. This procedure was repeated for each of the three specimens.

Table 1:

Specimen	Composition
A (Particles length 0.5mm)	70% Wt Epoxy + 30% Wt shell particles
B (Particles length 1mm)	70% Wt Epoxy +30 %Wt shell particles
C (Particles length 1.5mm)	70%Wt Epoxy + 30%Wt shell particles

4.3 MOULDINGS:

Compression molding is the process of molding in which a preheated polymer is placed into an open, heated mold cavity. The mold is then closed with a top plug and compressed in order to have the material contact all areas of the mold. This process is able to produce parts with a wide array of lengths, thicknesses, and complexities. The objects it produces are also high in strength, making it an attractive process for a number of different combinations.

Compression molding is a method of molding in which the molding material, generally preheated, is first placed in an open, heated mold cavity. The mold is closed with a top force or plug member, pressure is applied to force the material into contact with all mold areas, while heat and pressure are maintained until the molding material has cured**.**

The process employs thermosetting resins in a partially cured stage, either in the form of granules, putty-like masses, or preforms. Compression molding is a high-volume, high-pressure method suitable for molding complex, high strength fiberglass reinforcements.

Advanced composite thermoplastics can also be compression moulded with unidirectional tapes, woven fabrics, randomly oriented fiber mat or chopped strand. The advantage of compression moulding is its ability to mold large, fairly intricate parts. Also, it is one of the lowest cost molding methods compared with other methods such as transfer molding and injection molding; moreover it wastes relatively little material, giving it an advantage when working with expensive compounds.

4.4 MOULD PREPARATION:

Epoxy LY556 of density 1.151.20 g/cm3, mixed with hardener HY951 of density 0.970.99 g/cm3 is used to prepare the composite plate. The weight ratio of mixing epoxy and hardener is 10:1. This has a viscosity of 10-20 poise at 2500°C. Hardeners include anhydrides (acids), amines, polyamides, dicyandiamide etc. Mould used in this work is made of well-seasoned teak wood of 290 mm X 290 mm X 3 mm dimension with five beadings. The fabrication of the composite material was carried out through the hand lay-up technique.

The top, bottom surfaces of the mould and the walls are coated with remover and allowed to dry. The functions of top and bottom plates are to cover, compress the fiber after the epoxy is applied, and also to avoid the debris from entering into the composite parts during the curing time. Epoxy is both the basic component and the cured end product of epoxy resins, as well as a colloquial name for the epoxide functional group. Epoxy resins, also known as poly epoxides are a class of reactive pre polymers and polymers which contain epoxide groups.

4.5 FABRICATION PROCEDURE:

The top, bottom surfaces of the mould and the walls are coated with remover and allowed to dry. The functions of top and bottom plates are to cover, compress the fiber after the epoxy is applied, and also to avoid the debris from entering into the composite parts during the curing time.

The moulds are cleaned and dried before applying epoxy. The fibers were laid uniformly over the mould before applying any releasing agent or epoxy. After arranging the fibers uniformly, the epoxy resin was applied over the fibers and then they were compressed for a few hours in the mould. Then the compressed form of fiber (groundnut shell) is removed from the mould.

4.6 MOULDING RATIO:

MATERIAL	POLYMER	FIBER 1
100%	70%	15%
100%	65%	15%
100%	65%	20%

After Moulding 290mm length 290mm width and 10mm height.

4.7 CUTTING OF SAMPLES:

We prepared total 4 samples for testing, all 3 samples are reinforcement added samples in different ratios.
We are having one pure samples
Composition of the materials are given in previous slide.
All the samples are 120 x 20 mm (l and b) size with 20mm thickness.
After Moulding the reinforced materials we are going to take 5 tests to check the flexural, tensile, compression, impact and water absorbtion test.

4.8 TEST TAKEN:

*Water absorptivity test
*Flexural strength
*Tensile Strength
*Impact strength.

5.MATERIAL TESTING:

5.1 TENSILE TEST:

Specimen for tensile testing has been cut from all samples according to the ASTM D638 standard. This test is used to find the Ultimate Tensile Strength of materials. Tensile testing utilizes the classical coupon test geometry as shown below and consists of two regions: a central region called the gauge length, within which failure is expected to occur, and the two end regions which are clamped into a grip mechanism connected to a test machine.
The samples for tensile test are shown in the below fig.6. The samples are prepared under the specification of ASTM-D638.

5.2 IMPACT TEST:

Before looking at impact testing let us first define what is meant by 'toughness' since the impact test is only one method by which this material property is measured. Toughness is, broadly. A measure of the amount of energy required to cause an item - a test piece or a bridge or a pressure vessel - to fracture and fail. The more energy that is required then the sougher the material.
The area beneath a stress/strain curve produced from a tensile test is a measure of the toughness of the test piece under slow loading conditions. However, in the context of an impact test we are looking at notch toughness, a measure of the metal's resistance to brittle or fast fracture in the presence of a flaw or notch and fast loading conditions.
The samples for impact test are shown in the below fig.7. The samples are prepared under the specification of ASTM-D256-90.

5.3 FLEXURAL STRENGTH TEST:

ASTM D790 is used to determine the flexural strength of plastics and composites. Flexural strength is the measure of a material's ability to resist cracking or breaking under bending stress. When designing a product that needs to withstand loading or containing pressure, it is important to know which material or combination of materials will do the best job.
Flexural analysis was carried out at room temperature through three-point bend testing as specified in ASTM D 790, using universal testing machine. The speed of the crosshead was 5 mm/min. five composites specimens were tested for each sample and each test was performed until failure occurred.
Flexural strength was calculated from the Equation.
(f = (3PL) / (2bd2)
Where,
P = Load at a given point on the load deflection curve in Newton (Peak load)
L = support span in mm
b = width of the samples in mm

d = thickness of the samples in mm.

The samples for flexural strength test are shown in the below fig.8. The samples are prepared under the specification of ASTM D 790.

5.4 WATER ABOSORBVITY TEST:

The test quantifies the water absorptivity of the sample roofing sheets, this test is pertinent to measure its response to water leakage from the roof after or during down pour (rainfall). This test was carried out in accordance with international method for determination of water absorptivity test ASTMD 570 for all composite.

Three samples were cut from each mass fraction, weighted and socked in water, cleaned, dried and reweighted. The obtained data were recorded against each mass fraction and the mean value obtained. The percentage water absorptivity was calculated and recorded against each mass fraction. The percentage increase in weight during immersion was calculated using the following equation. $m = w - w0\ w0 \times 100\%$ Where m, w, w0 are the moisture absorption content, weight of dried and wet composite material respectively.

EPOXY- GROUNDNUT SHELL POWDER

RATE OF WATER ABSORPTIVITY

Specimen	Dry pieces weight (gm)	Weight of the water content (gm)	Average % of the water absorption
A	3.0	3.25	8.3
B	5.6	6.8	21.43
C	5.6	6.9	23.21

6. TESTING OUTPUT RESULTS:

6.1 TENSILE TEST:

This test was carried out in accordance with the international method for determination of tensile test ASTM D638 [22], on sample roofing sheets due to direct loads (gradually applied). A point load was applied along the center of the span of the corrugation. The maximum load at the point was noted, which gives the splitting load for the corrugated specimen. Ultimate tensile strength for sample 2 and sample 3 are 8.37N/mm2 and 7.85 N/mm2 respectively but for sample 1 is 4.78 N/mm2 . From these results it is found that the ultimate tensile strength and peak load of sample 3 is higher than the sample 1 and sample 2.

Because of high proportion of fiber gives better load carrying capacity to the sample 3 from among the sample 1 and sample 2.

EPOXY- GROUNDNUT SHELL POWDER TENSILE STRENGTH

Specimen A (0.5mm)	Width (mm)	Thickness	Cross area (mm2)	Load(N)	Tensile strength (N/mm2)
A1	11.4	4.1	46.74	400	8.56
A2	10.6	10.6	112.36	350	3.11
A3	10.6	10.6	112.36	300	2.67
Average	10.867	8.433	90.487	350	4.78

Specimen B (1.0mm)	Width (mm)	Thickness	Cross area (mm2)	Load(N)	Tensile strength (N/mm2)
B1	10.3	2.5	26.1	165	6.2
B2	10.5	6.2	63	685	10.86
B3	10.2	5.2	54.4	409	7.86
Average	10.333	4.633	47.833	419.667	8.307

Specimen C (1.5mm)	Width (mm)	Thickness	Cross area (mm2)	Load (N)	Tensile strength (N/mm2)
C1	10	2.7	27	276	10.22
C2	10.2	3.8	39.14	360	9.2
C3	10.2	5.5	55	228	4.15
Average	10.0677	4.000	40.380	288.00	7.857

6.2 IMPACT TEST:

Impact test result shows that sample 3 which contains 35% fiber and 65% resin having more impact value than the sample 1 and sample 2. Because of high proportion of fiber gives good bonding strength to the sample 3 from among the sample 1 and sample 2.

EPOXY -GROUNDNUT SHELL POWDER IMPACT TEST

Specimen A(0.5mm)	LOAD(KJ)	Cross area(mm2)	Impact value (KJ/m2)
A1	220	0.4674	10.28
A2	350	0.11236	39.33
A3	350	0.11236	39.33
Average	306.667	0.231	29.64666667

Specimen B(1.0mm)	LOAD(KJ)	Cross area(mm2)	Impact value (KJ/m2)
B1	300	0.00257	7.73
B2	350	0.063	22.05
B3	450	0.05304	23.87
Average	366.667	0.047	17.883

Specimen C(1.5mm)	LOAD(mm)	Cross area(mm2)	Impact value (KJ/m2)
C1	200	0.027	5.4
C2	220	0.03914	8.61
C3	250.0	0.55	17.75
Average	223.333	0.040	10.587

6.3 FLEXURAL STRENGTH TEST:

Flexural Strength test results show that the flexural strength and peak load for the sample 3 is higher than the sample 1 and sample 2. Among this result sample 2 is highly better than the other two samples. Because of high proportion of fibers gives better flexural strength from among the sample 1 and sample 2. Among this result sample 3 is highly better than the other two samples.

EPOXY -GROUNDNUT SHELL POWDER FLEXURAL TEST

Specimen B(1.0mm)	Width(mm)	Thickness	Load(N)	Deflection (mm)
B1	54.8	4	90	2.18
B2	53.4	4.4	130	2.63
B3	53	4.7	130	3.34

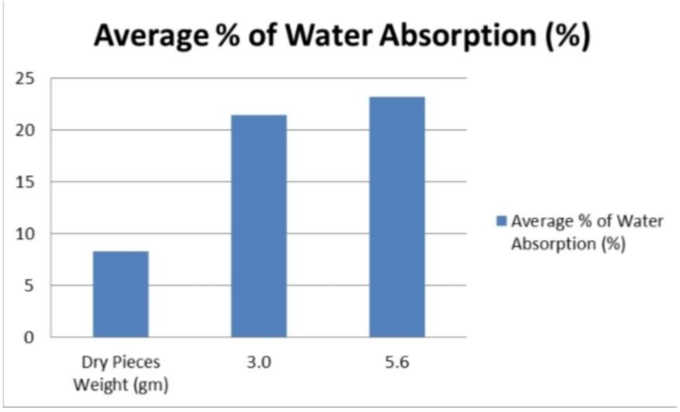
Specimen A(0.5mm)	Width(mm)	Thickness	Load(N)	Deflection (mm)
A1	52	5.5	130	1.95
A2	50.6	4.4	140	2.019
A3	53.6	4.9	160	2.192
Average	52.067	4.933	143.3333	2.05366667
Average	53.733	4.367	116.667	2.717v

Specimen C(1.5mm)	Width(mm)	Thickness	Load(N)	Deflection (mm)
C1	52.0	3.7	80	1.748
C2	52	4.5	130	1.591
C3	53.4	3.6	130	2.387
Average	52.467	3.933	113.333	1.909

7.RESULT:

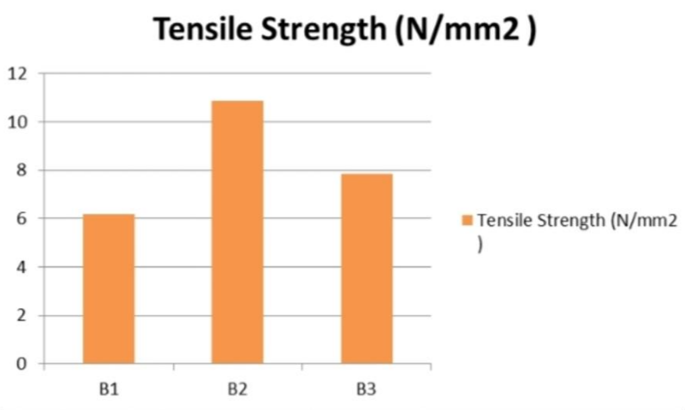
7.1 WATER ABSORPTIVITY TEST:

The purpose of water absorptivity test is to determine the amount of water that the roofing sheet can absorb during raining season or down fall in relation to its weight. The percentage of water absorbed was computed to be 8.3% for specimen A with 0.5mm particle length, while specimen B and C with 1mm and 1.5mm particle length had 21.43% and 23.21% respectively, when soaked for 17hours. Figure 1 below depicts the results graphically, from the result obtained, specimen A with 0.5mm particle length had the lowest percentage mean water absorptivity with a value of 8.3% followed by sample B with 1mm particle length had a value of 21.43%. Then sample C with 1.5mm particles length had a value of 23.27% respectively. The smaller the grain size, the better the bond, the lower is the water absorptivity ratio.



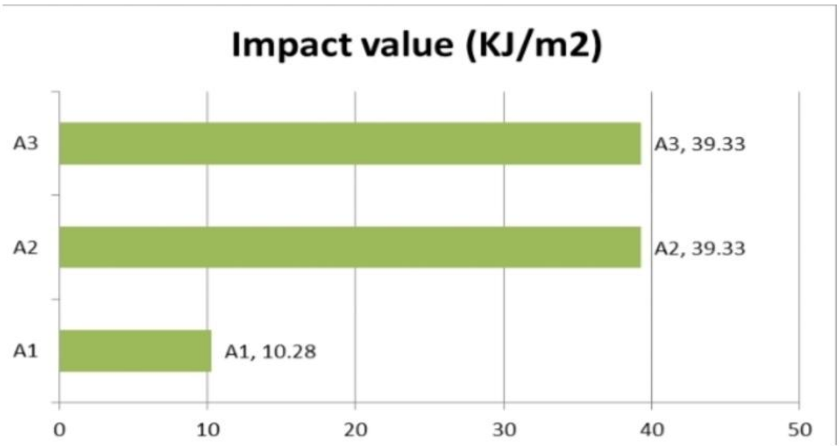
7.2 TENSILE STRENGTH TEST:

The Below Figure depicts the tensile test result graphically. Specimen B with 1mm particle length followed by specimen C with 1.5mm particle length had the highest strength of 8.25 N/mm2 and 7.86 N/mm2 respectively. While specimen A with 0.5mm particle length had 4.78 N/mm2 strength value, therefore the strength increases with grain size up to maximum of 1.00mm beyond which the strength decreases.



7.3 IMPACT TEST:

The Below Figure depicts the result of impact strength graphically. The impact energy absorbed by specimens A with 0.5mm particle length had a value of 29.65 KJ/m2 followed by sample B with 1.0mm particle length which had a value of 17.88 KJ/m2 while sample C with 1.5mm particle length had a value of 10.58 KJ/m2 . Thus these indicate that sample A with 0.5mm particle length had the highest impact strength while sample C with 1.5mm particle length had the lowest impact strength.



7.4 FLEXURAL TEST (DEFLECTION):

The Figure below shows the mid-span deflection and toughness of each of the specimen. The specimen (B) with 1mm particles length showed the greatest deflection with value of 2.356mm signifying that it possessed the highest ductility followed by the specimen (A) with 0.5mm particle length with value of 2.05mm, specimen C with 1.5mm particle length had the lowest value of 1.907mm showing that it had a poor ductility and hence, most brittle of all the specimens. Therefore, ductility increases with grain size up to a maximum of 1mm beyond which it reduces.

8. CONCLUSION:

The aim of this work is to develop roofing sheet material from groundnut shell polymer matrix composite. Three different grades of sample roofing sheets were produced, the samples differ from one another by varying the composition, epoxy resin proportion and particle sizes during production. Based on the experimental investigation carried out on the produced sample roofing sheets, the results and analysis of the data obtained shows that:

i. Sample A with 8.3% water absorption rate had the best and lowest rate of water absorption followed by sample B with 21.43% While C had the highest of 23.21% respectively.
ii. Sample A with 140N had the highest strength before bending occurred while sample A and C fracture at the lowest values of 117N and 113N respectively.
iii. Likewise sample B had the highest ductility value of 2.717mm followed by sample A with 2.05mm value, while sample C is the lowest with value of 1.909mm.
iv. Sample B also had the highest tensile strength of 8.307 N/mm2 followed by sample C and A with 7.857 N/mm2 and 4.78 N/mm2 respectively.
v. Sample A had the highest impact value of 29.646 KJ/m2 followed by sample B and C with 17.883 KJ/m2 and 10.587 KJ/m2 respectively.

Sample A and B have the best possible proportion to be taken into consideration for the production of commercial roofing sheets. Sample A was adopted in this work because of its excellence performance properties. The results revealed that Groundnut shell particles can be used as reinforcement for polymer matrix for the production of roofing sheets.

9. REFERENCE:

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