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Mechanical Properties Hemp and Sisal Fiber Reinforced Hybrid Cashew Nut Shell Liquid and Epoxy Matrix Polymer Composites

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MECHANICAL PROPERTIES HEMP AND SISAL FIBER REINFORCED HYBRID CASHEW NUT SHELL LIQUID AND EPOXY MATRIX POLYMER COMPOSITES

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Abstract– Adaptability to sustainable development on different environmental conditions and this indicates to introduce an eco-friendlier composite. Natural fibre is replacing the artificial fibre due to its superior mechanical properties and characteristics as high specific strength, small weight produces a more strength and relative usage of makes the hybrid composite material as a reliable compensate to conventional composite materials. In this study of sisal fibre and hemp fibre as reinforcements in cashew nut shell liquid and epoxy polymer matrix composites. The both nature and artificial resin as used to make a composite, the ratio of resin as prepared a sample (0%,25%,50%,75%,100%) of a material. The results prohibited the hybrid composite is more strength characteristics and properties compared artificial fibre reinforced composite. The composite product would test the ASTM standard of testing like water absorption test, hardness, tensile strength, flexural etc. The composite material is suitable field to applied a product to usable things such as engineering technology and transportation industry.

Keywords: Hemp fiber, jute fiber Epoxy resin, Cashew nut shell liquid.

1.Introduction

The developing environmental global energy crisis and natural based resin and fibres reinforced polymer matrix composites has more research works in their potential of serving as compensates for synthetics fibre material composites. The previous prepared studies on the fabrication of composites material and properties of thermoplastic and thermosetting composites occupies with the natural based fibres such as hemp and sisal fibre used in the polymer composites material. The artificial fibres were compared between the natural based fibre such as glass fibres and carbon fibres, natural based fibres have more advantages like high mechanical properties, reusable, cost effect low and less amount of weight, eco-friendly etc.

Natural based fibres also consist a composite material prepared of cellulose fibre (fibres) mixed to binding in matrix (resin). They also consider a low quantity of extra components involved a smaller number of molecular weights. When the organic components & inorganic content products. With often small quantity, extractives of big interface to consider on properties and characteristics such as colour and odour in the composite material.

The fibre is considered to absorbs low quantity of moisture because the its cellulose content in the journal to consist of studying the causes of hemp and sisal fibre has a source of natural based material for matrix epoxy and cashew nut shell liquid in their mechanical properties. The conventional of hemp and sisal fibre has also produce in section of various applications and treatment, The usage of polymer matrix composites has more very rare. The present research paper is under to study the material matrix composites, characteristics of hemp and sisal fibre reinforced epoxy and cashew nut shell liquid composites.

Thermoplastic materials currently used in fiber matrices, the most known thermoplastics material used for benefits polypropylene, and poly vinyl chloride, and then thermosetting matrix material include Cashew Nut Shell Liquid (CNSL) and epoxy resins.

The research studies and development of inorganic and organic fiber composites materials is used huge applications in the sustainable product increased in recent research because their benefits of compare natural based fibers, such as cost effective, electrical resistance to produce electricity also, and non-flammability to employee developers and scientists. Glass, carbon, metal, silica, carbide, and ceramic. There are used in the aerospace, construction, packaging, and automobile industries.

These inorganic materials used as a compensated of natural based fibre composite material because of its strength. In dual things of the developments in more field applied the both thermoplastic and thermosetting in inorganic materials. The inorganic material is used in the composites material to perform the maximum amount in the fabrication of natural based composites material is produced from the sustainable product in this study.

1.1 Components of composites

The composite material must require the two elements:

- Reinforcement
- Matrix

1.1.1 Reinforcement

The reinforcement is present to considered the quality and quantity to produce the composite material. The usage of the reinforced in a composite material is based on composite of throughout the mechanical condition and characteristics to produce a composite material. The most popular applications of the fibres (hemp and sisal) are used to produce a composites material. In many ways of assemble fibres into the sheets require material size and shape and then the orientation fibre is used to the reinforced to fabricated the composites materials.

1.1.2 Matrix

The matrix is the must component used in the composites materials to produced it. Materials used in the form of raw material and for produce these properties of the fibres used to bind by a matrix as used in the composite's material.

Matrix Composites are classified the composite material;

1.1.2.1 Metal Matrix Composites

They are used the numerous amounts of advantages compared monolithic metals, that consider to higher specific rate and specific strength also increased the properties and characteristics at maximum temperatures, and then a decrease the coefficient of thermal expansion. Metal matrix composites are considered a huge range of applications, and then the considered the field combustion chamber nozzles, heat exchanger and organic components.

1.1.2.2 Ceramic matrix composites

Composites materials are used to ceramic matrix raising the hardness of ceramic matrix composites. Where the ceramic matrix components materials are producing a better material matrix composite, that ceramic matrix composites are increase strength and hardness of the materials.

1.1.2.3 Polymer Matrix Composites

Polymer matrix metal is used to produce a material is mechanical characteristics are low to use in the application in many fields. In over the both metals and ceramics, their strength and hardness are less amount. Composites material are involved in the matrix composites. Composites material as a more modulus than polymers but low brittle than ceramics.

2. EXPERIMENTAL

2.1 MATERIAL REQUIREMENT

The materials required to fabricate a composites material are:

1.Natural fibres
- Hemp fibre
- Sisal fibre

2. Polymer material
- Epoxy Resin
- Cashew Nut Shell Liquid (CNSL)
- Hardener (MEKP)

3. Alkali Treatment
- Sodium Hydroxide (NaOH)

2.2 Material

In this research work to use to fabricated to produce a composites material used hemp fiber and sisal fibre. The hemp fiber, sisal fibre, epoxy resin), and hardener is Methyl Ethyl ketone Peroxide (MEKP), cashew nut shell liquid (CNSL)is got from a resin in kadampullyur.

2.2.1 Hemp Fiber.

The hemp plant is the prepared a hemp fiber. It can easy to grow a height of 4 m. "Cannabis Sativa" is its botanical name of the hemp fibers and has a cellulose concentration of about 60% and a lignin content of 7-9%, making to long and length, tough. The diameter of the fibers from 17 to 55 microns. Hemp fiber is a natural based anti-bacterial material there as a transfer's heat, colors, take a UV light, and is heat resistance. Lignin range are high in short core fibers. Hemp fibers is one of the most resplendence and tough of all natural based fibers.

2.2.2 Sisal fibre

The Sisal fibres is use in the fabricated the composites material. Sisal fibre have a more specific strength and easy to usable in application, low cost, reusable. The fibres are got to dried in sunlight. After dry, the fibres are used for knotting. Sisal fibres can be used in high strength ropes.

2.2.3 Epoxy resin.

Epoxy resins is another name is Poly-epoxides. The epoxy is a used to make composite material to a solid material, then polymer molecules are to bind the fibre to a material in solidification.

Properties

- High strength in the produce glass fiber reinforced composite material.
- Density of the Epoxy resin (1.7 – 2.0 g/cm).

2.2.4 CNSL resin

Cashew Nut Shell Liquid (CNSL**)** is the product of the Cashew Nut shells. It consists the 71% of anacardic acid, 17% cardol, and 6% cardanol,the remain can be make another phenols and low polar substances and it's to be produced by a heating process which is used to produce a anacardia acid to get Cardanol and the proposition of CNSL resin is 54% of cardanol,12% cardol, 26% polymeric substance material, with the remaining can be make an other substances.

Properties:

- Low-cost of the Phenol in CNSL form.
- Possibilities for developed of high-performance ratio of polymers
- Properties of advantage compare phenolics in particular application as impact resistance, faster heat dissipation.
- Automobile brake colling system used a Liquid Resin
- Cashew Friction Dust is produced from Cashew nut shell after get cardol (CFD)

2.2.5 Alkali Treatment

Alkali treatment is used in the method of chemical treatment in natural based fibres. Its treatment is producing a lignin substance, waxes, dirties in fibre surface that is increasing the mechanical properties and characteristics. Alkali treatment effects the fibre properties:
1. It exhibit the surface of fibre is higher through resin
can improve a surface roughness of fibre.
2. It give out the cellulose from a fibre surface and wax cover, that as raise the number of reactions in the chemical reaction.

In this research fibres are washed in distilled water 2 to 4 times and then dried in sunlight for three continuous days. After dried the fibre is soaked in 5% NaOH solution for 10 hours at 23 degrees Celsius. Then the fibres are removed from alkali solution and treatment in the dilute hydrochloric acid to remove an excess amount of NaOH.

2.2 Preparation of hybrid fibre composition

1. To extract hemp and sisal fiber, follow the methods below.

2. The bast plants, which is 4 to 5 mm length, is trimmed. The leaves are then cut into garbage.

3. After, the bast plants fibre are immersed in distilled 4ewwater. The stem is removing a water and completely clean after 2 to 3 days.

4. To eliminate the skin, sodium hydroxide is used in the alkali method. Sodium hydroxide is combines to the water and mixed. The skin layer of the plant is immersed in a sodium hydroxide prepared solution.

5. The skin is removed from the sodium hydroxide solution and clean completely in the water after 4 to 5 days. The fibers are removed in the hydrogen peroxide solution and completely clean in water after 4 to 5 days.

6. Hemp fiber is obtained after dried process and that is used to make a composite material.

2.2.1 Hand lay-up process

- The method of Open Moulding process to make composite material.
- Hand lay-up process is another name is Wet lay-up process.

- Hand lay-up is used to produce an any dimensions in the small area to produce a composite material.
- The method is limit to the fabricate the parts with a normal shape that as require dimension and size to produce it.
- Remove from composite material after use a wax is remove from the mould. The cost is required for hand lay-up in open mould process is less over the closed mould process.

3. Fabrication

Moulds with dimensions of 15 x 30 cm are make and used in composite manufacturing. A removing agent is used in the mould to remove mould sheets, allow to the composite material to be remove after curing the composite material.

The composite material samples are making a particular composition that vary the percentage of Epoxy and cashew nut shell liquid content in the composite materials, such as 0%, 25%, 50%, 75%.,100%. The Epoxy Resin and its hardener were first mixed at a 10:1 ratio.

The layer of hemp fibre and CNSL & Epoxy resin is placed on mould sheet and then sisal fibres is placed on the mould and another layer of mixture is placed on hemp fibres and using rollers to remove the air entrapped between fibres and another layer of fibres are mixed the CNSL and Epoxy resin in several percentage in the mixtures on hand lay-up process and roll with rollers another time and last layer of resin mixture is applied over the mould sheet and finally the manufacture the composite material and pressed under the load a 15 kg at room temperature for 24 hours. The composites material removes from the mould sheet after two days.

Table 1: Composition of resin and fibre

SAMPLE.	HEMP & SISAL FIBRE in (grm)	CNSL RESIN in (grm)	EPOXY RESIN in (grm)	HARDENR
1	120	280	0	Methyl ethyl ketone peroxide
2	120	210	70	Methyl ethyl ketone peroxide
3	120	140	140	Methyl ethyl ketone peroxide
4	120	70	210	Methyl ethyl ketone peroxide
5	120	0	280	Methyl ethyl ketone peroxide

Figure 1: Sample 1

Figure 2: Sample 2

Figure 3: Sample 3

Figure 4: Sample 4

Figure 5: Sample 5

3.1 Sample cutting

The composite material fabricated to from mould sheet and clean the dirty and dust from the composite material. The all the samples of the composite material are cut into the ASTM standard of the Mechanical test.

Mechanical Testing

The composite material is cut an ASTM standard of the required test in the mechanical properties to attained the composite material.
a) Tensile test of mechanical test.
b) Flexural test (Bending test)
c) Impact test (Izod test)
d) Hardness test (Rockwell hardness test)
e) Water Absorption test (Distilled, Sea, Ordinary water)

4. Mechanical properties of composites material.

4.1 Tensile test.

The composite material is tested under the tensile load where specimens are cut the ASTM standards and procedures. The tensile test hybrid composites material, two specimens from each sample. The test is using a universal testing machine and the specimen is loaded desired it fail under the tensile load. This test is tested the all the sample of composites material and the note the value of the tensile load to break a sample of composite material. Tensile test specimens of hemp fibres, sisal fiber and reinforced epoxy and cashew nut shell liquid composites before and after breakage.

Figure 6: Tensile test specimen after test

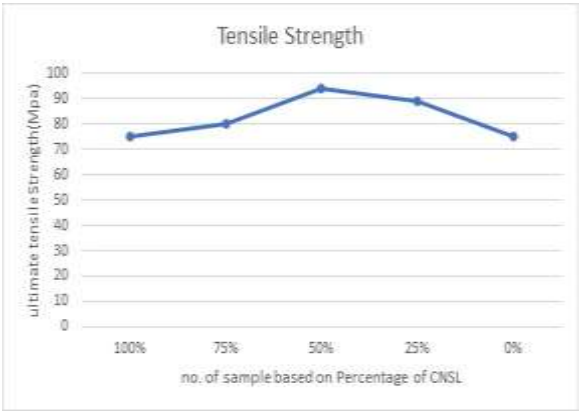

Figure 7: Comparison of Tensile strength of Samples

The tensile test of all the composite material sample as obtained a tensile strength under a tensile force. Sample 1 (100% of CNSL resin) as attain a tensile strength is 72.21 Mpa, the sample 2 (75% of CNSL & 25% of Epoxy resin) as exhibit the 83.32 Mpa, sample 3 (50% of CNSL & 50% OF Epoxy resin) as attain a 90.32 Mpa, sample 4 (25% of CNSL & 75% OF Epoxy resin) as exbibit an 87 Mpa, and final sample as attain a tensile strength is 76.55 Mpa.

3.2 Flexural test

The flexural test is test to find out the flexural strength of the composite. The flexural test of the all the composite sample material under the flexural (bending) load to find the flexural strength of the hybrid composite material. The specimen of the all the composite material is placed on the support span and load is applied perpendicular at the centre of the specimen, that cause sample of the specimen is produce a 3-intend bending at a specified rate.

The tests are tested the specimen of the all the composites material.
The flexural strength is determined by the following formula:
$F = 3PL/bt2$
, where F= flexural strength of specimen of the composite material
P= load applied under bending test
L= gauge length of composite material
b= width of specimen of the composite material
t= thickness of specimen of the composite material

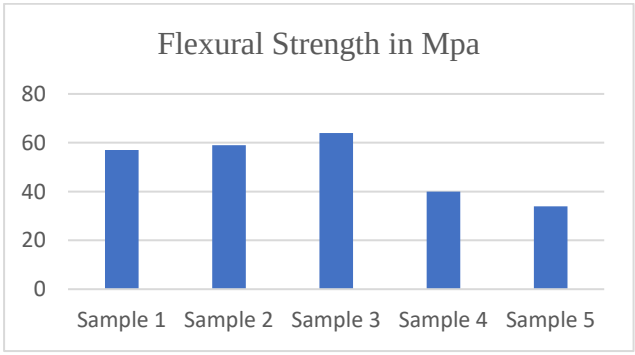

Figure 8: Wt % of resin vs Flexural Strength

The Flexural test of all the composite material sample as obtained a flexural strength under a perpendicular compressive force. Sample 1 (100% of CNSL resin) as attain a flexural strength is 56.23 Mpa, the sample 2 (75% of CNSL & 25% of Epoxy resin) as exhibit the 58.34 Mpa, sample 3 (50% of CNSL & 50% OF Epoxy resin) as attain a 64.54 Mpa, sample 4 (25% of CNSL & 75% OF Epoxy resin) as exbibit a 40.34 Mpa, and final sample as attain a tensile strength is 38.44Mpa.

Hence the flexural strength is maximum attain a sample 3 (50% of CNSL & Epoxy). the best sample is a both nature and artificial resin as partially to use composite material.

3.3 Impact test

The impact test is to test sudden force to the specimen to break a material to find out the impact strength of the composite material of the specimen. In this test a sample of the specimen is create a notched specimen is placed in the anvil in impact test machine which the notch facing the swinging hammer. The hammer is taken to a certain height and suddenly to attack the notched specimen and break the specimen at the composite material. The energy absorbed rate is noted and to calculate the mean value of impact strength.

Figure 9: Impact test specimen after impact test

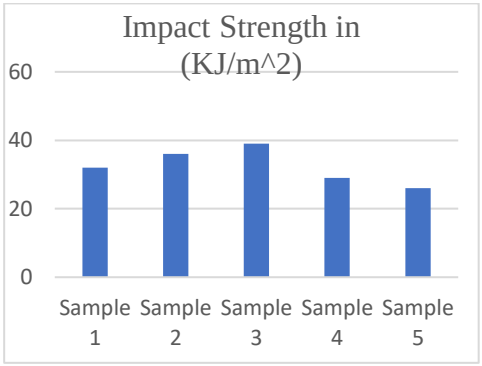

Figure 10: Wt % of resin vs Impact Strength

The impact test of all the composite material sample as obtained an impact strength under a longitudinal force. Sample 1 (100% of CNSL resin) as attain a tensile strength is 32 KJ/m^2, the sample 2 (75% of CNSL & 25% of Epoxy resin) as exhibit the 36 KJ/m^2, sample 3 (50% of CNSL & 50% OF Epoxy resin) as attain a 39 KJ/m^2, sample 4 (25% of CNSL & 75% OF Epoxy resin) as exbibit a 29 KJ/m^2, and final sample as attain a tensile strength is 26 KJ/m^2.

Hence the impact strength is maximum attain a sample 3 (50% of CNSL & Epoxy). the best sample is a both nature and artificial resin as partially to use composite material.

3.4 Hardness test

The hardness test is the find out the hardness of the composite material. The composite material is surface hardness is determined and capacity of the indentation on its surface. The hardness test is used to find the hardness of the material and surface quality to check. The specimen is placed in turn table and load is applied to the surface of specimen is to resist to indentation is find out by hardness test

Figure 10: Hardness test specimen

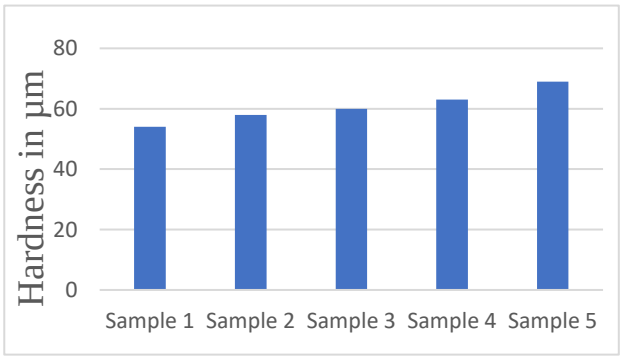

Figure 11: Hardness value of the sample

The hardness test of all the composite material sample as obtained a surface strength under a force. Sample 1 (100% of CNSL resin) as attain a hardness strength is 56.7µm, the sample 2 (75% of CNSL & 25% of Epoxy resin) as exhibit the 58.3 µm, sample 3 (50% of CNSL & 50% OF Epoxy

resin) as attain a 61.3 µm, sample 4 (25% of CNSL & 75% OF Epoxy resin) as exbibit a 64.4 µm, and final sample as attain a 70.2 µm.

The maximum number of hardness strength exhibit the sample 5, that has 100% of Epoxy resin. The synthetic resin is used material is more hardness compare the other material. The 5 th sample attain a maximum hardness value.

3.5 Water absorption test

The water absorption test is the treatment to find out water absorption rate of sample of the composite material. This water absorption test is to find out water absorbed under specific conditions in sea water, normal water, and distilled water when increasing the sample percentages, the water absorption rate is determining the hybrid natural composite.
The samples are taken the from the water and dried completely in the sunlight for 10-12 hours to remove moisture. After is weighed immediate to the specimen of the sample of composite materials.

Figure 12: water absorption specimen

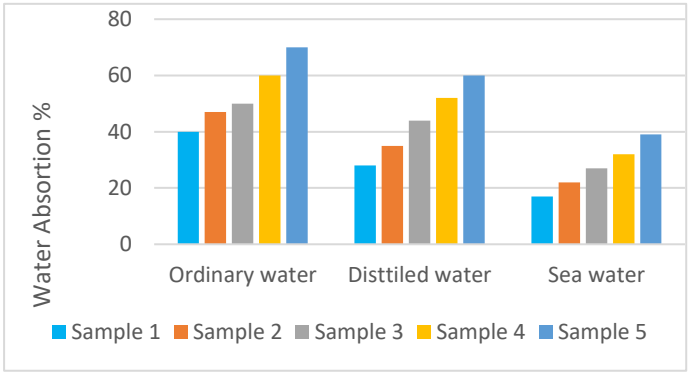

Figure 13: Water absorption rate

In 50% of fibre content has maximum range of CNSL resin, its resistance of the absorption of water in the water particles. The Hybrid Composite materials has less value of water absorption rate in sea water test were checked to other ordinary water and distilled water in the absorption tests.

5. Conclusion

The mechanical properties of hybrid composite material are investigated in this research. The characteristics of alkali treatment of fibre reinforced (CNSL) composites are more than the of composite reinforced with hybrid fibres. Alkali treatment is increasing the bind properties between fibre and CNSL resins of the composite materials. The results are got from the investigation that the highest tensile and flexural strengths were get from a sample 3 (50 % 0f CNSL & 50 % epoxy) content. The results find from the water absorption at sea water check to ordinary water and distilled water absorption rate in the water absorption test. The water resistance at Sample 1(100 % of CNSL) content composite, however of good water resistance of CNSL resin materials. Hence, it can be concluded that the maximum strength properties and characteristics can be invested at sample 3 content.

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