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Investigation on Properties of Sugarcane Bagasse with Waste Plastic powder Reinforced Polymer Composites

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Abstract:

In modern days natural fibers and synthetic fibers are used in many engineering fields. Natural fibers are preferred to synthetic fibers because they are naturally available and they are bio degradable. In this paper the sugarcane bagasse fiber is selected because it is collected from waste, after it can be utilized. Polymer composites are carried out with epoxy resins and poly amide hardener. Many papers are made with sugarcane bagasse and came out with various results but we additionally added the waste plastic powder. Waste plastic (thermoplastic) powder is taken because it can be reused and to control environmental pollution. The sample is made by hand lay process by adding correct proportion of plastic powder, epoxy resins and hardener. Finally the prepared sample will undergone various testing to prove the strength and it will be useful in day to day life at low cost. From this waste can be recycled to avoid various pollution norms and to provide good quantity product at lowerrates.

Keywords — **Sugarcanebagasse fiber, plastic powder, Hand lay-up method, Chemical treatment**.

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I. INTRODUCTION

Environmental awareness is increased regarding the safeguard of naturally available things. The pollution is main reason for the destroying the environmental. In this the naturally available products can be used to create useful things to be used in day to day life. So that there are many fields are doing a research in creating a product that will be used for various purpose in this world. Many products are developed for fibers like natural and synthetic fibers. Synthetic fibers are artificially produced and it will be used to form many products. They are non-biodegradable and can cause pollution. Natural fibers are used for making products with proper reinforcement and they are tested to prove the better strength and their capacity in various field. Natural fibers are naturally available and they are easily available. Many natural fibers are used to create useful products .Natural fibers are bio-degradable and they do not cause any pollution if they are thrown freely in land. Nowadays products are made by additive manufacturing. These products find an application in engineering and medical field. The hand lay process is used to create a product. The sugarcane bagasse, epoxy resins and hardener is used in making a sample. Sugarcane bagasse is selected because they are recovered from waste that are produced in large scale while compared to other natural fibers like coir, luffa fibers etc. Composites are made by mixing of two or more insoluble and chemically various phase. Different materials are added to improve the strength to get better results at final. Proportions are must because they provide better results. Reinforcement such as fibers are added to create fine products and they can find application in various field. The reinforcement can be added in continuous and discontinuous phase toprovide

better outcomes. The materials we have selected are sugarcane bagasse, plastic powder and epoxy resin. The reason behind the selection of sugarcane bagasse is a fibrous residue from sugarcane and it past they are used only for burning fuel but now at current engineers chooses the bagasse as valuable products for the production of polymer matrix composites, the main reason behind is that 100% compostable and bio-degradable, reusable andrecyclable.

Cao Y [1] and alkali treated fibers were preferred to untreated fibers. Before using natural fibers in composites it is treated with 1% of NaOH solution for improvement of tension strength, impact strength and hardness. Addition of NaOH can cause several property changes in results. Good improvement in tensile strength, impact strength and hardness. The alkali treated fibers gives better results than untreated fibers. The impurities removed from fibers by alkali treatment for certain hours to get pure fibers and then treat with water.

Sulawan kaewkuk [2] and other two foreign authors from Bangkok, Thailand discussed about the physical properties of the sisal fiber and its fiber content and the interfacial modifications of the fiber. They keep on testing about the mechanical, morphological, thermal and the water absorption characters of the Sisal fiber. They characterized the fiber based on fiber content into the 10, 20, 30 weight percentage. With improving the fiber content, modulus and tensile strength, water absorption qualities get improved and the impact strength and elongation getsdecreased.

Hari Om Mayura [3] and other two authors who belongs to Mothilal Nehru Institute of Technology, Allahabad on 2015 had done their research work on the short sisal fiber with the epoxy resin and they done detailed study about the mechanical properties of the Sisal fiber. Their main motto is to use the natural fiber for their fabulous feature such as low density, low cost and special mechanical features. The fibers gets classified based upon the fiber length such as 5, 10,15and20mmbut30percentconstantfiber content. The result obtained by them is that the tensile strength was not improved but the flexural strength gets improved.

Siddharth Vikram Singh [4] and natural fibers employed in mixing with plastics in recent times. For low cost, low density and certain properties natural fibers are used as reinforcement. To avoid certain environmental issues like avoiding pollutions the natural fibers is preferred to synthetic fibers. Increase in fibers increases the hardness, tensile strength and impact strength. For various composition of sugarcane bagasse the sample were tested. At high percentage of sugarcane bagasse the high strength areobtained.

From all of the above discussions made bythe scientists we have planned to use sugarcane bagasse gets reinforced with the epoxy polymer composites. Here we use sugarcane bagasse reinforcement as a matrix and epoxy as a resin. Hand lay-up method is used for our work because we use the hybrid fibers. We analyze the mechanical properties such as tensile test, impact test and toughness test and compared with the previous work with the scientists and the result will bedeclared.

II. EXPERIMENTALPROCEDURE

This chapter explains the process underwent during the fibre extraction, chemical treatment, testing and fabrication of specimen.

A. Fiber Extraction Process

Polyurethane with sugarcane bagasse is used in this paper. The resins and hardener are taken. The polyamide is used as hardener and polyurethane is used as resin. The ratio of resin and hardener are in 2:1 that is for two part of resin one part of hardener is added and they are stirred properly. To avoid sticky surface the mansion polish is used. Pretreatment of fiber is most important step to be carried out at first. That is cleaning the fiber with water and then they are treated with alkali treatment. For soaking the fiber which was cleaned with fresh water then with NaOH of 5% concentration for 8-10hours.

Then removing the sticky of NaOH on fiber they are washed with water and then before using in the reinforcement neutralization done with the help of acetic acid and then wash with water. Finally allow them to dry at room temperature for 8-10hours.

Fig.1. Sugarcane bagasse fiber

Fig.2. Extraction of sugarcane bagasse

III. FABRICATION OFCOMPOSITE:

B. DieMaking:

The primary step involved is the fabrication of the die. The tooling process required in this molding process is quite similar to that of stamping dies. The stamping dies needs external force but molding does not need any is the key difference between them. In plastic molding, two necessary components units are carefully designed in a way that, when the two units are brought together, they make up a system of closed cavities linked to a central orifice. Liquid plastic is fed through the orifice or into the cavities, or molds, depending upon the shape of the mold. Then the plastic is allowed to solidify, then the molds are opened and the finished parts are ejected from themold.

C. Materialpreparation:

Here, there are two separate containers they are part A and part B. Part A is nothing but polyurethane resin and part B is poly amide hardener. Polyurethane resin has high viscosity and slightly amber. For improving cost less product and performance they may be filled with mineral fillers. Resins must be stirred properly before adding hardener because resins can settle down at bottom. On continuous contact with resins they can cause skin irritation, so they must be used carefully. Similarly, in part B, polyamide hardener is used. They are also settled down so that they must be stirred thoroughly. They must be tightly sealed and when used in equipment like meter mix dispense, it is better to use air drier type like desiccating on vent. For application purpose the static mixing data sheet is very important so that final product to be worth for the use. Viscosity difference must be small. Cartridges used are thin walled and thick walled. To avoid lag effect thick walled cartridges must be used. So that ratio of part A and part B changes are also avoided. To meet a successful result the factors like cartridges size and type, viscosity, ratio, flow rate, temperature etc., are very important. Lag effect must be avoided by using thick walled containers. They must check that any changes made can't affect the static mixture of components used in the process. First thing is to be noted in surface preparation is adhesive. Adhesive is nothing but creating surface do not stick to base surface of die or mold. The oil and dirt are the major problems in adhesive. That dirt also sticks to sample which provide bad results. For getting bond quality the surface is to be painted well. So that it provides oxygen rich surface environment. Therefore, sample can't stick to the surface of mold or die. At first add the part A that is resin by proper weighting to the vessel. Then using similar weighted environment part B that is hardener is poured and then mixer is stirred by stir stick for 3-5 minutes. Then further proceedings are to be carried out so that the mixer can deposit at fiber properly. To avoid the effects of voids and bubbles the mixer of resin and hardener must be vacuumed before used in process. After that mixer of both rein and hardener are poured into mold. Vacuum is done by enclosing the mix vessel into vacuum chamber and pulling minimum 28" Hg vacuum or above 28". For vacuum degassing at least 4 times volume of liquid should be mixed. For degas the mixture, one-gallon bucket is required for one quart of liquidproduct.

D. Hand layup process:

Hand layup method is one of the simple PMC processing technique. The hand (wet) lay-up is one of the oldest and most commonly used methods for manufacture of composite parts. Hand lay-up composites are a case of continuous fiber reinforced composites. The process involves the combination of multiple layers of unidirectional or woven composite materials to produce an advanced material which is capable of exhibiting desirable properties in one or more directions. The layup process is generally proceeded out using the help of hand held rollers or brushes. Polyurethane resin and polyamide hardener are mixed together. The powder is applied with resin and hardener mixture. Then sugarcane bagasse fiber of proportion 45% is added. Fiber is applied constantly throughout the mold for keeping the length constantly. Fiber can be placed as continuous or discontinuous for required application. Releasing agent must be applied very first. So that samples are removed easily without any damages. At curing temperature of 30oc the air bubbles are removed by constant load of 50kg, after that sample is taken for further mechanical testing. For easy removal of the composite material after the curing process a releasing agent is used on the mold. The entrapped air bubbles are removed carefully with a sliding roller. Curing process is carried out at a temperature of 30^{o} C for 24 hours at a constant load of 50kg and the mold is closed. When the curing process is completed the specimen of suitable dimension is cut using a diamond cutter as per the ASTM standards for investigating its mechanicalbehavior.

IV. TESTINGSTANDARDS

E. TensileTesting

Tensile testing is otherwise known as the tension testing. The tensile test is used in the field of fundamental materials science and engineering test in which a product sample is subjected to a controlled tension until failure of the sample occurs. Universal testing machine (UTM) otherwise known as universal tester is used to investigate the tensile and compressive properties of the given test specimen by applying tensile, compressive or transverse stresses. This test method is used to determine yield strength, ultimate tensile strength, ductility, strain-hardening characteristics, Young's modulus and Poisson's ratio. The Standard testing method is ASTM D 3039/D 3039M: for Tensile Properties of Polymer Matrix Composite Materials. The dimensions of the test sample are 175 mm in gauge length, 25 mm in width and having 8 mm thickness. FIE Make Universal Testing Machine, UNITEK-9450 is used for performing the tensile test and the results of the Tension Test are tabulated.

Fig.3. Tensile sample

TABLE I
TENSILE TEST

Sample	Elongation %	Tensile Strength (MPa)	Tensile Modulus (GPa)
1	3.2	181	4.1
2	4.3	173	3.9
3	2.7	187	6.4

F. Hardnesstest

Hardness test is carried out to find the hardness of the test sample. Hardness is defined as the resistance of the material to indentation and it is measured by determining the permanent depth of indentation. It is seen that hardness is an empirical test rather than being a material property. For finding the hardness of our test specimen, the Micro-hardness test is carried out in the ASTM standard E92-2016, which is achieved with the Vickers hardness test. Composite materials varying in the volume fraction between sugarcane bagasse fiber and other natural fibers are tested to study its hardness.

Fig.4. Hardness test sample

TABLE II
HARDNESS TEST

Sample	Hardness value (HV)		
	Trial 1	Trial 2	Average
1	120	116	118
2	106	106	106
3	86	92	89

G. Impacttest

We mainly focused on the three main mechanical properties, one of the most important test is the Impact test. Impact test is used to analyze the dynamic tear of the work tool when the load gets applied.

Charpy impact Test is otherwise known as V-notch Charpy Test. This test is carried out to find the amount of brittle fracture absorbed by a material while testing. This test is also used as an indicator to determine the several suitable temperatures. The Charpy test is similar to the impact test. The specimen used for charpy test has the dimensions of 55mm*10mm*10mm. The specimen consists of V-notch of about 45 degrees at the room temperature of 25^0 C. To perform the test, the pendulum set at the preferred height is allowed to hit on the test sample and the notched sample is thrown away. As from the results, we find out the fracture of thematerial.

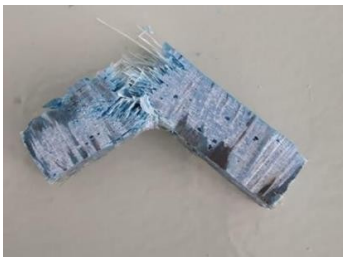

Fig.5. Charpy test sample

TABLE III
IMPACT TEST

Trial no.	Room temperature (^{0}C)	Charpy Impact value(J)		
		Sample 1	Sample 2	Average
1	25	104	114	109
2	25	110	106	108
3	25	112	106	109

V. CONCLUSION

Many researches are going on different fibers in recent times. Many of them use synthetic fibers for creating a product. Synthetic fiber is not easily available and can cause environment pollution. So we shifted our work to natural fiber. Natural fibers are easily available, low cost and good mechanical properties. We selectedsugarcanebagassefiberforoursample creation. Many natural fibers are available but they are cut down after get damaged or purposely cut down. But in sugarcane bagasse wastages are created more. Rather than other paper we used recycled plastic powder which is new, because recycling is very important to avoid environmental pollution. Our aim is to create useful product at low cost by using high percentage of waste materials as raw materials. Hand lay method is used rather than new technologies. With composition of epoxy resin and hardener, then reinforcement of sugarcane bagasse gives significant results which were not previously by researcher. As a result, mechanical properties such as impact toughness, tensile strength and hardness of sugarcane bagasse with waste plastic powder are noted.

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