Experimental Investigation on Mechanical And Tribological Behaviour of Epoxy / Coir Fibre Hybrid Composite Application of Brake Pad

P. Gowtham[1], R.Surendran[2]
[1, 2] Dept of mechanical engineering
[1, 2] government college of technology, Coimbatore

Abstract- *The composite materials reinforced by natural fibers have improved strangely for several industrial applications such as brake pads. Composites are having low mass to strength ratio have made progress as compared to conventional materials. Hybrid polymer composites showed significant improvement in mechanical, tribological properties. Coconut Coir is one of the natural fibers to use as reinforcement with the polyester matrix. In this project, Epoxy was used as the matrix material and coir as a reinforcement and Nano SiO_2 as hybrid reinforcement. The composites fabricated by compression Moulding technique by the weight percentage in Nano SiO_2 as 1 %, 3%, and 5 %. The coconut coir fibers were randomly oriented along with the matrix. The mechanical characterises like that tensile test, impact testand tribological properties were evaluated by the ASTM standard. Based on the test results, the composite having 3 Wt % percentage of SiO_2 exhibited high tensile strength, high impact energy, and less wear.*

Keywords- Epoxy resin, Coir fibre, Compression Moulding, Wear test

I. INTRODUCTION

A hybrid composite material fabricated adding two or more fibre material adding various percentage at adding material at nano-level it is called hybrid nanocomposite. Normally adding matrix material lightweight material reinforcement material are Strength, stiffness, strong and high-density material. Adding reinforcement material depending upon required properties chosen. Epoxy resin is a matrix material form of thermoset materials that are unique properties they are good bonding strength and transparencies.

The epoxy system contains two-part. One part is resin and another is a hardener. fibre is used as reinforcing material deprive type because uniform properties obtain all over the material area so fibres are cutting in 5-10mm size.

1.2 Particle SiO_2

SiO_2 (silicon dioxide), silica is a metalloid oxide from the 14th group of the periodic table. Silicon crystal structure is quartz, boiling point 2503K. The applications for silica nanoparticles are as bonding of metal and polymer as a strengthening filler materials and construction composites, and non-hazardous platform for medical applications likes drug delivery system and radioactive material delivery system.

1.3 Problem Identification

Generally, epoxy is used corrosion resistance coating but very low wear properties.so cannot use for brake pad and wind turbine blade application but generally used epoxy wind turbine for epoxy glass fibre composites its brittle nature. So need to improve wear resistance, strength adding into epoxy some parentage nano SiO_2 and adding coconut fibre improve structural resistance. SiO_2 adding wear resistance it added various percentage level.

II. EXPERIMENTAL WORK

2.1 Material Section

Table 1. Materials Section for hybrid composite

Coconut coir fibre is used as reinforcing material deprive type 10-20mm size, Epoxy resin chemical name Diglycidal Ether of bisphenol A (DGEBA) and hardener chemical name Triethylenetetramine (TETA)is used as the matrix material and Nano SiO_2 used as a reinforcement material.

2.2 Methodology

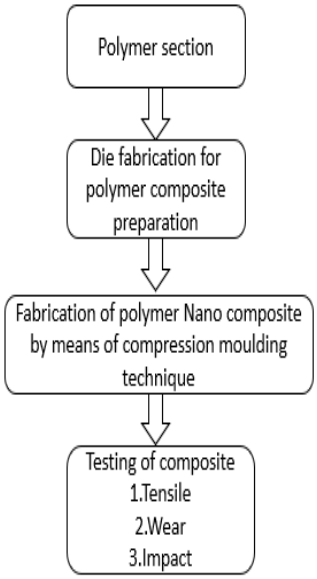

Figure 1. Methodology

2.3 Fibre And Matrix

coir is collected from local manufacture. The epoxy resin is a matrix material and the hardener hy951 was used as the hardening solution. Coconut coir was got from the regions of east and southern part of Tamil Nadu. NaOH solution and the epoxy resin were received from covai seenu chemicals company, Coimbatore. and Nano SiO_2 received metal mart.

2.4 Sonication

sonication is the process of performing sound energy used to vibrated particles in a liquid sample, for mixing application. When directly adding nano SiO_2 to forms bulbous structures. So need to sonication uniformly mix nano SiO_2 with epoxy resin with help sonication.

2.5 Compression Moulding Technique

Inthis technique moulding polymer is squeezed. At pressure applied to the cope direction only. This method is frequently used for moulding thermosetting polymer resins, some thermoplastic parts are produced by Compression Moulding but mostly thermoplastic parts are produced by injection moulding technique both the method uses a divided die. Die is mounted in a hydraulic press

procedure:

- A weighed amount of a polymer mixed with nano sio_2 reinforcement materials and coir fibers placed into the bottom part of the die.
- The top half of the die moves down, pressing on the polymer forcing in to fill the mould cavity without any void and then after wait for curing time 7 hours.
- The mould is opened and the composite is removed from it using the releasing agent.

2.6 Fabrication Of Hybrid Composites

The beginning starts with the cutting of the coconut coir in 10-20mm size. In general, the coconut coir has the property of change in dimensions when it is soaked in the distilled water. So, the extra dimensions are cut along with the actual dimensions to remove the shrinkage of the coconut coir. Then it is washed with the distilled water to remove the unwanted materials. Generally, there will be more fibre materials that will be soaked with the coir because of the sticky characteristic of the fibre material. So, the foreign materials are only removed by the cleaning of the fibre material with the distilled water. After the foreign materials are being removed then the fibre is soaked in the NaOH solution. The initial testing is taken with the 5% concentration of the solution. This concentration is made by taking 100ml distilled water in the beaker solution. The 5% concentration includes the 5mg of the NaOH solution and a stirrer is used to stir the NaOH to form a white solution.

Nano SiO2 mixed with epoxy under sonication process. And the frequency set a minimum range for 15 minutes. Then adding coconut coir fibre (10-20mm size) is followed by mechanical stirring of the mix using a stirrer with help of a small motor.so that a uniform dispersion takes place. Once the mixture reaches a certain temperature, the hardener is mixed in the ratio of 10:1 The epoxy, fibre and the hardener are stirred for a long period to get a heat generated. Then pouring into die. The condition should be maintained in room temperature under compression moulding machine. Before pouring into die apply releasing agent. After 10 to 12 hours, the mould is removed and the composite is obtained.

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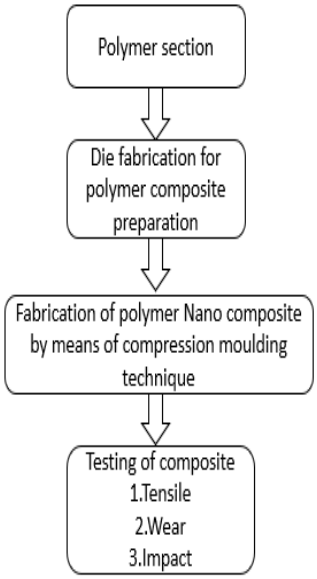

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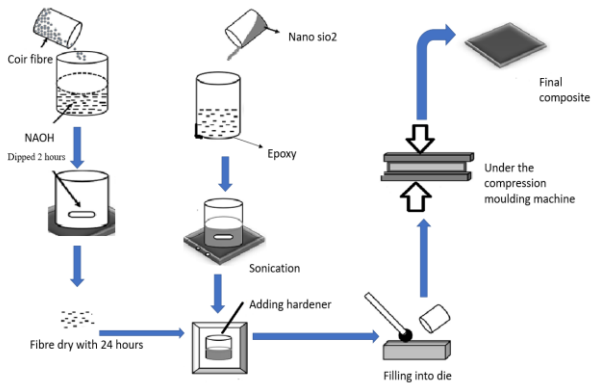

Fig 2. Processes Involved In The Preparation Of Composite Laminate

2.7 Experimental Setup Used For Dry Sliding Wear Test

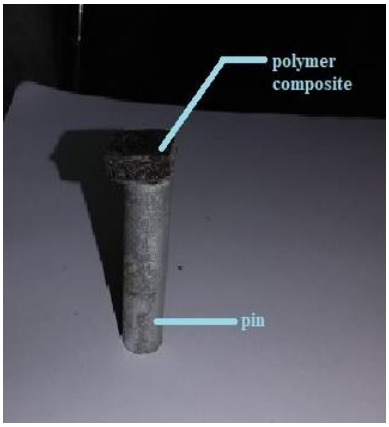

Figure 3. Composite sample with pin assembly and the steel countersurface on which sliding takes place

III. RESULTS AND DISCUSSION

The hybrid nanocomposite is fabricated various weight % of reinforcement under the compression moulding technique. Various reinforcement percentage is shown in table 3

Table 2 Sampleand Its Composition Fabricated By Compression Moulding Machine

S NO	SAMPLES	
1	Sample A	79%Epoxy+1%SiO_2+20%Coir fibre
2	Sample B	77%Epoxy+3%SiO_2 +20%Coir fibre
3	Sample C	75%Epoxy+5%SiO_2 +20%Coir fibre

3.1 Tensile Test

As per ASTM- D368 the tensile test was conducted by UTM. Then the test sample was taken dimensions of 100 x 25 x 5 mm. The crosshead travel speed was at a span of 3 mm/min. The testing methodology used for the process is the same for all the process and the results that were obtained also viewed a slight change in their properties as the concentrations had a slight change. The materials were cut into the required dimensions and the dimensions of the specimen also remained the same for all the testing conditions. The temperature considered for the testing method is the room temperature as the composite was prepared only under the room temperature. The UTM results give to tensile strength, modulus of elasticity, elongation to break, etc. The tensile test on the UTM machine, at the government college of technology, Coimbatore. The testing of the sample is shown in figure 5

Table 3 Tensile Test of the Composites

Test parameters	Observed Values		
Tensile strength(N/mm²orMpa)	1%	3%	5%
	12.5	37.56	45.37

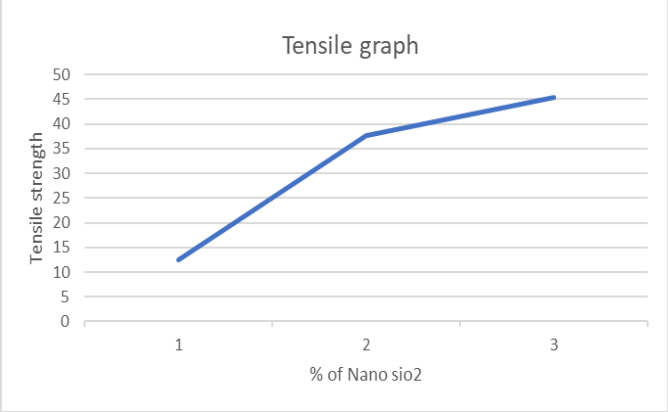

Figure 6. Tensile Result

3.2 Impact Test

Impact test specimen prepared by ASTM – D256 standard.The test specimen of cut followed dimension 65x 15 x 5 for 1, 3, and 5% were prepared by an un-notched specimen. A notch is prepared by using a triangular file of 3 mm. The specimen was fitted into the impact test machine the vice. Then the pendulum was restricted with the help of the operating lever, pendulum released the energy absorbed and then impact strength at notch was calculated.

Impact test used to calculate the energy absorption capability of the material when an applied sudden load is applied. Izod and Charpy test machine give to impact strength of the material. Impact testing of the polymer specimen was done on Izod and Charpy Impact Tester, strength material lab in government college of technology, Coimbatore.

Izod test result gives an increase in impact strength till 3 wt.% of SiO2 nanoparticles. up to 3 wt.% of SiO2 was proper banding between the matrix and reinforcement of nano-silica particles. And also, it was giving to no change in the impact strength of epoxy increase wt% loading of nano SiO2. But an additional increase in the percentage of nano SiO_2 may increase brittle character.

Table 4 Impact Test of the Composites

Test parameters	Observed Values		
Impact strength(kj/cm^2)	1%	3%	5%
	283.66	343.57	333.24

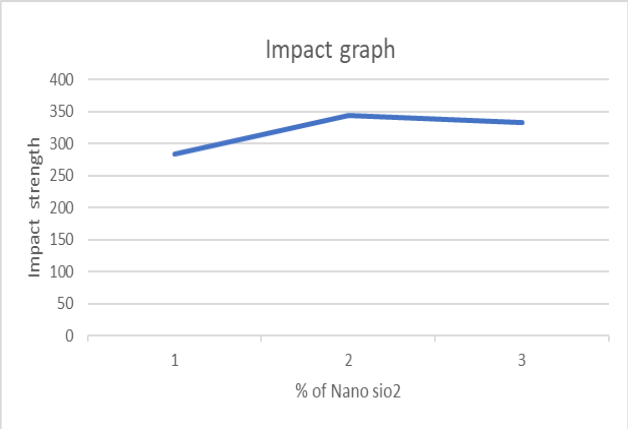

Figure 7. Impact Result

3.3 Wear Test

wear test has been carried out in the pin-on-disc machine as per according to the ASTM G99 standard. The polymeric samples at fixed pin holder. The polymer sample is held tightly in the help of a pin holder and various load is applied lever attachment. Parameters are like that time; the speed of rotation and track diameter have to be fixed manually every experiment. Here, the load is added depending upon our application. Wear test parameters are constant.

Speed 500rpm, Track diameter 80mm, Time 5mins. Wear test result show that wears rate increases normally up to 3% then decreases after then increase. low wear rate 3% of SiO2.

Figure 8. Wear test machine

Table 5 Wear Test Parameters

Sno	Sample	Speed (rpm)	Time (min)	Load (KN)	Track distance(mm)	Wear rate (Micronmeter)	Frictional Force(n)	Coefficient frictio n
1	1%	500	5	20	80	326	8.8	0.44
2	2%	500	5	20	80	179	10.8	0.51
3	3%	500	5	20	80	275	12.9	0.65

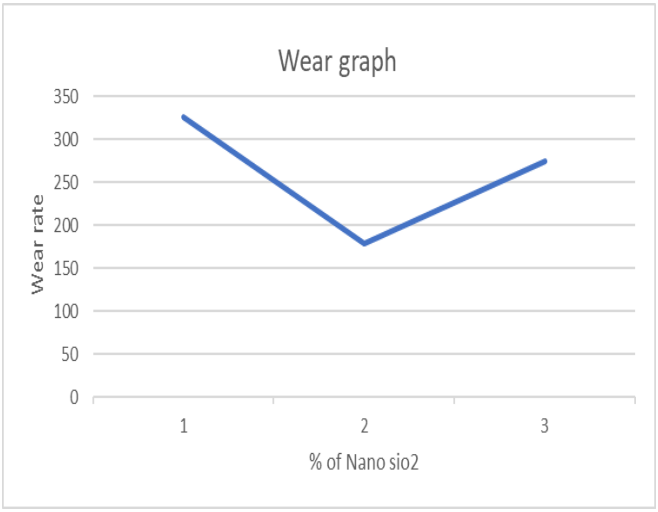

Figure 9. Wear rate in micrometer

3.4 Summary Of Results

The test on the three specimens was done on the testing machine and the results were observed. That is found adding nano SiO2 an increase in the strength of the composite. Impact test results given an increase in impact strength value up to 3Wt% of SiO_2 nanoparticles, this shows that there is a proper bonding between the matrix and reinforcement of nano-silica particles. Then further increase the impact of the nanoparticles strength value a little bit varied, so best 3wt% of nano SiO_2. Dry sliding wear test results gives that an increase in the wear rate up to 3Wt% of nano SiO2 in this 3% SiO2 have low wear rate then further addition SiO2 wear rate also increased. The best result shows 3Wt% of nano SiO2 have a low wear rate

IV. CONCLUSION

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