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Biochar Composite

Sanchu Varghese[1], Sijo Saji[2], V Ramkumar[3], V Manikandan[4]
B E Students[1,2], Professor[3], Principal[4]
Department of Mechanical & Automation Engineering, PSN College of Engineering & Technology, Tirunelveli, Tamil Nadu, India

ABSTRACT

Polymer composite has been used in a variety of application because of their many advantages such as relatively low cost of production, easy to fabricate and superior strength compared to neat polymer resin. Reinforcement in polymer is either syntenic or natural. The objective of the project work is to steady the physical and mechanical behaviour of biochar nano material based on epoxy matrix composite. The project focuses on the effect of differences in weight percentage of the nano material on the mechanical properties of the fabricated composites.

The specimen is prepared with biochar obtained from rice husk and epoxy resin as a matrix in the polymer composite. The weight percentages were change and the moulding is done in a closed mould. The specimens were subjected to tensile strength, flexural strength and impact strength test and the failure of the composite was examined.

Keywords : Biochar, Composite, Epoxy Resin, Mould

I. INTRODUCTION

1.1 Composite:

A composite material (also called a composition material or shortened to composite, which is the common name) is a material which is produced from two or more constituent materials. These constituent materials have notably dissimilar chemical or physical properties and are merged to create a material with properties unlike the individual elements. Within the finished structure, the individual elements remain separate and distinct, distinguishing composites from mixtures and solid solutions. There are various reasons where new material can be favored. Typical examples include materials which are less expensive, lighter or stronger when related to common materials. More recently researchers have also begun to actively include sensing, actuation, computation and communication into composites, which are known as Robotic Materials.

Composite materials are generally used for building used for buildings, bridges and structures such as boat hulls, swimming pool panels, racing car bodies, shower stalls, bathtubs, storage tanks, imitation granite and cultured marble sinks and countertops.

Concrete is the most common artificial composite material of all and typically consists of loose stones (aggregate) held with a matrix of cement. Concrete is an inexpensive material, and will not compress or shatter even under quite a large compressive force.

1.1.1 Nano Material Composite:

Nanocomposite is a multiphase solid material where one of the phases has one, two or three dimensions of less than 100 nanometers (nm) or structures having nano-scale repeat distances between the different phases that make up the material.

The idea behind Nanocomposite is to use building blocks with dimensions in nanometer range to design and create new materials with unprecedented flexibility and improvement in their physical properties.

In the broadest sense this definition can include porous media, colloids, gels and copolymers, but is more usually taken to mean the solid combination of a bulk matrix and nano-dimensional phase(s) differing in properties due to dissimilarities in structure and chemistry. The mechanical, electrical, thermal, optical, electrochemical, catalytic properties of the nanocomposite will differ markedly from that of the component materials. Size limits for these effects have been proposed:

1. <5 nm for catalytic activity.
2. <20 nm for making a hard magnetic material soft.
3. <50 nm for refractive index changes.
4. <100 nm for achieving superparamagnetic, mechanical strengthening or restricting matrix dislocation movement.

1.2 Polymer Resin:

Polymer resin is like the industrial counterpart of naturally-occurring plant resins. Much like plant resins, polymer resin starts out as a thick and sticky fluid that hardens permanently when left out in the open air for a certain period of time. They are usually produced by soaping organic compounds like thermosetting plastics. Companies that manufacture thermoplastics can make use of substances like methyl methacrylate, which behaves like a casting sort of resin in its liquid state. Once the methyl methacrylate goes through a polymerization process, it then sets into a hard, solid form. The finished product is sometimes used as a kind of acrylic glass.

Given that polymer resin is produced via the compounding of plastic substances, PolyVisions, Inc. typically supplies this sort of raw material to be used in many manufacturing processes. The average person actually encounters this sort of material every day in a variety of finished products, such as the following:

1.) In cars or automobiles. Car factories as well as manufacturing plants that produce spare parts and components for vehicles use polymer resin a lot. The material is crucial to the production of several automobile-related components such as seat belts and carpets. These polymers are also used in the injection moulding processes for cars or automobiles and are responsible for the durability of the said components and finished products. PolyVisions, Inc. is usually tapped by companies looking for polymers that are sure to withstand a great deal of force and strain to help keep customers riding the vehicles and automobiles safe and secure.

2.) In construction. There are a wide variety of uses for this material in construction. They can be used to produce sturdy window or door frames, durable but aesthetically-pleasing floor tiles, the bases of countertops, and so on. Apart from its durability, polymer resins are prized in the field of construction for its versatility since the liquid form can be poured into moulds to produce the desired shape.

3.) In packaging. This material is godsend for those producing all sorts of packaging materials. The liquid form of this material is helpful for producing uniquely-shaped yet durable kinds of packaging for products that have an irregular shape. Some components of packaging materials, such as screws or bolts, can also be hewn from this material. Polymer resins can also be used to fashion solid and sleek cases for expensive powders and cosmetics, along with sturdy bottles and containers for substances that need to kept in airtight containers (e.g., nail polish, etc.).

4.) In textiles. While polymer resins aren't really a component of the common kinds of fabrics being used in the textile industry, they are used to produce other clothing components. Buttons and zippers with polymer resin parts, for example, are widely used in the production processes of companies involved in the textile industry.

5.) In other technical applications. Goods like paper machine clothing, mechanical rubber products, and industrial, technical fabrics also involve quantities of polymer resin in their respective production processes.

1.2.1 Epoxy Resin:

Epoxy Resin is used for the matrix of the composite. Epoxy resin is a low temperature curing resin. It consists of mainly two parts, the resin and the hardener. They are mixed at 2:1 weight ratio to obtain the optimum hardness once it is cured. The epoxy resin is clear resin and cures within 24 to 48 hours. Once the resin and hardener are mixed, an approximate time of 30 to 40 minutes is available for working before the resin starts curing. To prevent the resin from sticking on the mould, wax or plastic or certain chemicals have to be used. Thin plastic sheets are effective for this purpose and hence they are used.

Epoxy resins may be reacted (cross-linked) either with themselves through catalytic homopolymerisation, or with a wide range of co-reactants including polyfunctional amines, acids (and acid anhydrides), phenols, alcohols and thiols (usually called mercaptans). These co-reactants are often referred to as hardeners or curatives, and the cross-linking reaction is commonly referred to as curing.

The applications for epoxy-based materials are extensive and include coatings, adhesives and composite materials such as those using carbon fibre and fiberglass reinforcements (although polyester, vinyl ester, and other thermosetting resins are also used for glass-reinforced plastic). The chemistry of epoxies and the range of commercially available variations allows cure polymers to be produced with a very broad range of properties. In general, epoxies are known for their excellent adhesion, chemical and heat resistance, good-to-excellent mechanical properties and very good electrical insulating properties.

Fig 1.1 Epoxy Resin and Hardener

1.3 Nano Materials:

The rice plant is one of the most common food crops cultivated in many countries. As a result, over 150 million tons of rice hulls are produced around the world as unavoidable agricultural waste material when the rice is separated from the paddy. The term paddy is used to refer to rice still containing hull and is derived from the Malay word paddy, meaning "rice plant". Effective utilization of rice hulls is important for both solving the problem of agricultural waste and creating sustainable agriculture.

Fig 1.2 Rice Husk

Rice husk biochar (RHB) is produced by low temperature pyrolysis of these rice hulls and has been traditionally used in Japan as a soil ameliorant. Pyrolysis of biomass is a thermal degradation process in the absence of oxygen and produces gas, tar, and char. The product distribution depends on pyrolysis conditions which range from heating rate and peak temperature to particle size. RHB had been thought to increase crop productivity by amending soil structure and improving nutrient adsorption. These effects had been explained only through physical and chemical properties.

Fig 1.3 Biochar

Muffle Furnace

Muffle furnace refers to a type of jacketed enclosure that is used to heat a material to significantly high temperatures while keeping it contained and fully isolated from external contaminants, chemicals or substances.

Both of the above-mentioned furnaces are usually heated to desired temperatures by conduction, convection, or blackbody radiation from electrical resistance heater elements. Therefore, there is (usually) no combustion involved in the temperature control of the system, which allows for much greater control of temperature uniformity and assures isolation of the material being heated from the by-products of fuel combustion.

Fig 1.4 Muffle Furnace

• Ball Mill

A ball mill is a type of grinder used to grind or blend materials for use in mineral dressing processes, paints, pyrotechnics, ceramics, and selective laser sintering. It works on the principle of impact and attrition: size reduction is done by impact as the balls drop from near the top of the shell.

A ball mill consists of a hollow cylindrical shell rotating about its axis. The axis of the shell may be either horizontal or at a small angle to the horizontal. It is partially filled with balls. The grinding media are the balls, which may be made of steel (chrome steel), stainless steel, ceramic, or rubber. The inner surface of the cylindrical shell is usually lined with an abrasion-resistant material such as manganese steel or rubber lining. Less wear takes place in rubber lined mills. The length of the mill is approximately equal to its diameter.

The general idea behind the ball mill is an ancient one, but it was not until the industrial revolution and the invention of steam power that an effective ball milling machine could be built. It is reported to have been used for grinding flint for pottery in 1870.

• Size: The smaller the media particles, the smaller the particle size of the final product. The grinding media particles should be substantially larger than the largest pieces of material to be ground.

• Density: The media should be denser than the material being ground. It becomes a problem if the grinding media floats on top of the material to be ground.

• Hardness: The grinding media needs to be durable enough to grind the material, but, where possible, not so tough that it also wears down the tumbler.

• Composition: Various grinding applications have special requirements. Some of these requirements are based on some of the grinding media being in the finished product, while others are based on how the media will react with the material being ground.

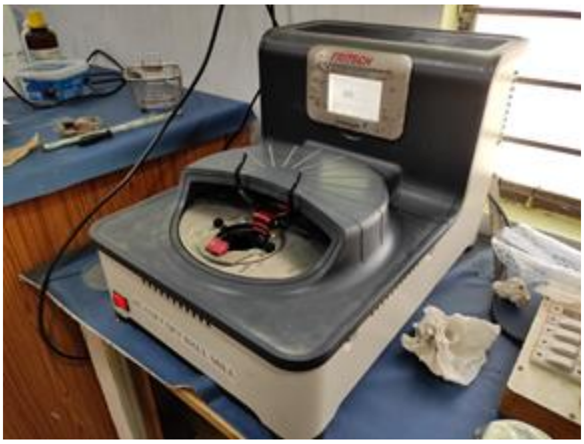

Fig 1.5 Ball Mill

II. EXPERIMENTS & TESTING

2.1 Tensile strength

Tensile strength is a measurement of the force required to pull something such as rope, wire, or a structural beam to the point where it breaks. Tensile strength of an can be measured by testing it with an Universal Testing Machine (or UTM). It is a versatile machine that can be used to measure tensile and compression tests on materials, components, and structures. Hence the part "universal" is attached to this machine.

A universal testing machine (UTM), also known as a universal tester, materials testing machine or materials test frame, is used to test the tensile strength and compressive strength of materials. An earlier name for a tensile testing machine is a tensometer. The "universal" part of the name reflects that it can perform many standard tensile and compression tests on materials, components, and structures (in other words, that it is versatile).

Fig 2.1 Tensile test on UTM

A material can withstand the maximum stress while being stretched or pulled before necking. This test was done with universal testing machine (UTM) according to ASTM standards(D638). The fabricated composite slabs were cut according to the above-mentioned standard. i.e., 200mm x 20 mm x 3mm.

Fig 2.2 Cutting the slabs to the dimension

Fig 2.3 Specimen for tensile test

2.2 Flexural Strength:

The flexure test method measures behavior of materials subjected to simple beam loading. The 3-point bending test is used to find the flexural modulus, flexural strength and strain at break of the Basalt fibre reinforced polymer composites. Flexural test is conducted on Universal Testing machine with cross head speed of 2 mm/min according to ASTM D790-98. The sample dimensions are 127 mm×13 mm×3 mm. The span length of 100 mm is maintained

2.3 Impact Strength

Bend testing (also flex or flexural testing) is commonly performed to measure the flexural strength and modulus of all types of materials and products. This test is performed on a universal testing machine (tensile testing machine or tensile tester) with a 3 point or 4 point bend fixture.

The key analysis when performing bend testing are:

Flexural Modulus – This measures the slope of a stress / strain curve and is an indication of a material's stiffness

Flexural Strength – This measures the maximum force that a material with withstand before it breaks or yields. Yield is where you have pushed a material past its recoverable deformation and it will no longer go back to the shape it once was.

Yield Point – The yield point is the point where the material essentially "gives up" or the point where if you were to continue to bend the product, the force will not continue to increase and will then start to decrease or break

Impact test is used to determine the amount of impact energy that was required to break the specimen. An un-notched Izod Impact test is conducted to study the impact energy according to ASTM D256. The un-notched specimens are kept in a cantilever position, and a pendulum has swung around to break the specimen. The impact energy (J) is calculated using a dial gauge that is fitted on the machine. Five samples were taken for each test, and the results are averaged.

Fig 2.4 Specimen for impact test

Fig 2.5 IZOD Impact testing machine

III. RESULTS

Fig 3.1 Typical specimen after tensile test

Fig 3.2 Typical specimen after flexural test

Fig 3.3 Typical specimen after impact test

3.1 Tensile strength

6% Carbon biochar Composite

Load (KN)	Extension (mm)
0	0
0.32	0.6
0.26	0.7
0.57	0.85
0.8	0.95
0.73	2
0.55	2.2

Table 3.1 Tensile test Tabular column for 6% carbon composite

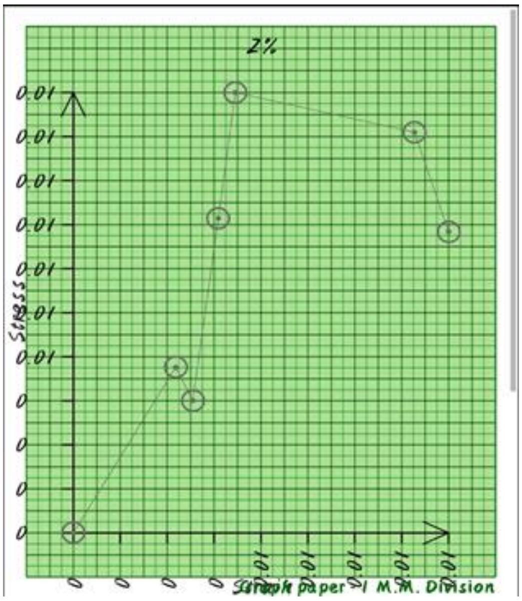

Fig 3.4 Stress-strain Curve of 6% carbon composite

4% Carbon biochar Composite

Load (KN)	Extension (mm)
0	0
0.35	0.71
0.31	0.8
0.64	0.89
0.85	0.97
0.77	2.1
0.59	2.3

Table 3.2 Tensile test Tabular column for 4% carbon composite

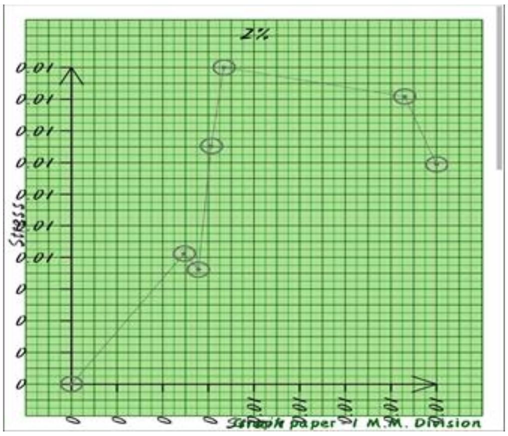

Fig 3.5 Stress-strain Curve of 4% carbon composite

2% Carbon biochar Composite

Load (KN)	Extension (mm)
0	0
0.39	0.79
0.37	0.91
0.71	0.97
0.93	1.34
0.84	2.7
0.67	2.9

Table 3.3 Tensile test Tabular column for 2% carbon composite

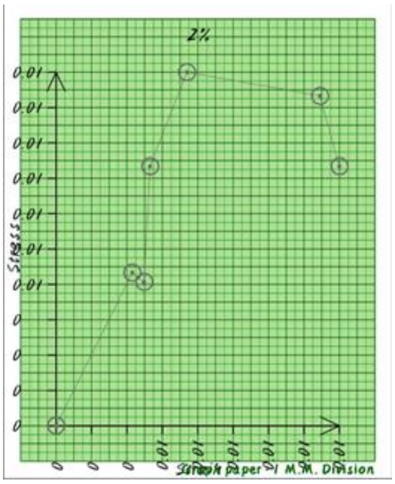

Fig 3.6 Stress-strain Curve of 2% carbon composite

From the figure it is clear that the 6% carbon composite has an improved tensile strength. The 6% carbon composite has a higher strength and the composite with 2% & 4% have less strength.

In the composite, the higher percentage of carbon results in higher tensile strength.

3.2 Flexural Strength

6% Carbon biochar Composite

Load (KN)	Deflection (mm)
0.05	9
0.1	15
0.15	21
0.2	29

Table 3.4 Flexural test tabular column for 6% Carbon composite

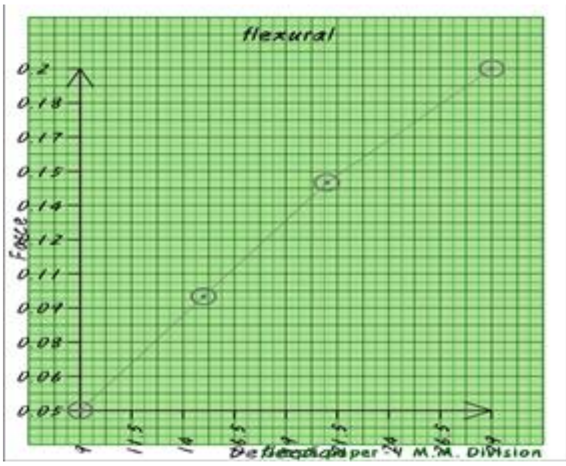

Fig 3.7 Force to deflection of 6% carbon composite

4% Carbon biochar Composite

Load (KN)	Deflection (mm)
0.05	11
0.1	17
0.15	23
0.2	32

Table 3.5 Flexural test tabular column for 4% Carbon composite

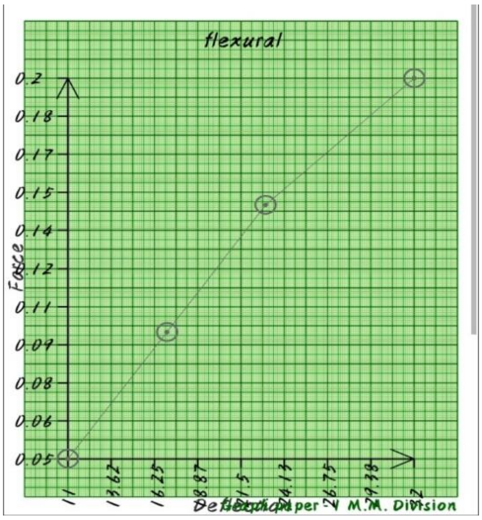

Fig 3.8 Force to deflection of 4% carbon composite

2% Carbon biochar Composite

Load (KN)	Deflection (mm)
0.05	13
0.1	19
0.15	25
0.2	34

Table 3.6 Flexural test tabular column for 2% Carbon composite

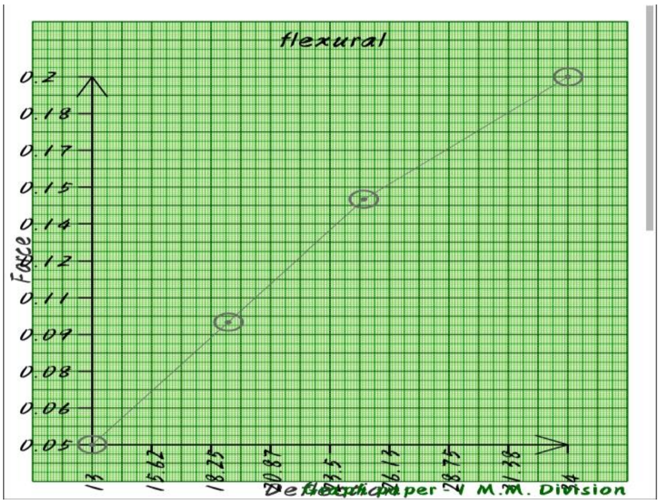

Fig 3.9 Force to deflection of 2% carbon composite

The flexural strength was found to remain constant up to a certain limit and then vary. The highest flexural strength was observed in 6% carbon composite. The higher amount of carbon nano particles results in the higher flexural strength in the 6% carbon composite.

IV. CONCLUSION

The biochar composite has been investigated with various weight percentage of Carbon and the following conclusion was drawn. The characterization of the composite reveals that the variation in the amount of carbon nano material has a significant effect on the mechanical properties of the composite. From the investigation we have found out that the tested mechanical properties are higher in the specimen having 6% carbon nano particle. The specimen with 2% and 4% carbon have relatively lower values in the tested mechanical properties.

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VI. REFERENCES

[1]. Tiesong Lin, Dechang Jia, Meirong Wang, Peigang He, Defu Liang // Bull. Mater. Sci. 32 (1) (2009)77.

[2]. Shao-Yun Fu, Bernd Lauke // Composites Science and Technology 56 (1996) 1179.

[3]. G. Zak, M. Haberer, C.B. Park, B. Benhabib // Composites Science and Technology 60 (2000) 1763.

[4]. Junzhi Zhang, Huating Liu, Yandong Zhu, Zhaoqi Fu, Jing Zhao // Advanced Materials Research 261-263 (2011) 407

[5]. Weimin Li, Jinyu Xu // Materials Science and Engineering 505 (1-2) (2009) 178.

[6]. J.L. Thomason, M.A. Vlug // Composites Part A: Applied Science and Manufacturing 28 (1997) 277.

[7]. Xinrui Zhang, Xianqiang Pei, Qihua Wang // Journal of Applied Polymer Science 111 (2009) 2980.

[8]. M. Botev, H. Betchev, D. Bikiaris, C. Panayiotou // Journal of Applied Polymer Science 74 (1999) 523.