Effect of Nano Silica on the Tensile Property of Woven Banana and S-glass Fiber Reinforced Hybrid Polyester Composites

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Abstract: The paper is about the study of effect of nano silica on the tensile properties of woven banana and s-glass fiber reinforced hybrid polyester composite. Now a day's natural fibers plays an important role in field of composites because of their low cost, low density, eco-friendly and minimum waste disposal but they posses moderate strength only, where as synthetic fibers posses good strength but they are toxicity to the nature. So to overcome the strength and environmental issues a new modern hybrid composite is prepared by using the both natural and synthetic fibers. The new composite is fabricated by hand lay-up method. The reinforcing materials are in the form of layers of banana and s-glass fibers, polyester resin as matrix and nano silica as filler material. Different samples were prepared by changing the layers of fiber placed in the composite and also by changing weight of nano silica powder that is mixed into the resin. The properties like tensile strength and tensile modulus were studied. The fibers pull out, stacking of fibers and the behavior of matrix in composite are observed through scanning electron microscope to complete the morphological study. With the change of placing of fibers in composite and weight of nano silica in the matrix shows the improvement in tensile properties.

Key words: polyster composite, tensile properties, nano particles.

1. INTRODUCTION:

In present scenario, there is an increasing need for high strength to weight ratio composites with relatively eco-friendly materials. Both natural and synthetic fibers reinforced composites posse's good strength properties and a moderate eco-friendly composite. Composites have extensive applications in industries like aerospace, automotive, defense etc.

S.M. Sapun et al [1]In this study the Mechanical properties of woven banana fibre reinforced epoxy composites are determined by preparing three samples of different geometries such that the length, height, and width varies for three samples. The composite is prepared from the woven banana fibre. Tensile and flexural tests are performed on the three specimens and the values of maximum stress, elongation and deflection in x and y-directions were studied. This means that even the small differences in the geometry of the samples, givens the small differences in strain, stress, deflection, and elongation, but those differences are statistically not significant. The composite system demonstrates a very stable average mechanical behaviour.

M. Ramesh et al [2] studies the Processing and Mechanical Property Evaluation of Banana Fiber Reinforced Polymer Composites In this study, banana fiber reinforced epoxy composites are prepared. The composite samples with different fiber volume fractions such as 40%,50% and 60% of fiber were prepared by using the hand lay up process. These samples were subjected to the mechanical testing such as tensile, flexural and impact loading. The fiber mats of uniform thickness were prepared from banana fibers of particular length. The composite consists of 3 layers. The study suggested that, the 50% banana fiber and epoxy resin composite material can withstand the higher loads when compared to the other combinations and used as an alternate materials for conventional fiber reinforced polymer composites.

Bashar Dan-asabe et al [3] study about the Mechanical characterization of banana particulate reinforced composite as piping material. In this study the composite material was produced with the banana particulate as reinforcement using compression molding by varying the composition of banana particulate and polyvinyl chloride. The composite specimen having a formulation of 8%, 72% and 20% of banana stem particulates, PVC and kaolin clay respectively has better creep stability at elevated temperatures. Comparison with conventional piping materials showed the composite offered a price saving when compared with carbon steel and PVC material.

A. Alavudeen et al [4] studies about the Mechanical properties of banana/kenaf fiber-reinforced hybrid polyester composites. The study is about the effect of weaving patterns and random orientation on the mechanical properties of banana, kenaf and banana/kenaf fiber-reinforced hybrid polyester composites. Composites were prepared using the hand lay-up method with two different weaving patterns, namely, plain and twill type. Of the two weaving patterns, the plain type showed improved tensile properties compared to the twill type in all the fabricated composites. The mechanical strength of woven banana/kenaf fiber hybrid composites increases due to the hybridization of kenaf with banana fibers. Tensile, flexural and impact strengths of the woven hybrid composite of banana/kenaf fibers are superior to those of the individual fibers.

N. Amir et al [5] studies the Effects of Fibre Configuration on Mechanical Properties of Banana Fibre/PP/MAPP Natural Fibre Reinforced Polymer Composite. The banana fibre is varied by three different configurations such as raw banana fibre, banana fibre yarn, and banana fibre mat. Mechanical properties of the composite samples were assessed using tensile and flexural testings. Banana yarn composite gave the highest improvement of tensile strength and as well as flexural strength. The findings showed that banana yarn configuration is the best when compared to the other two configurations. This was because the yarn fibre is continuous in the composite and commingled by its configuration.

N. Venkateshwaran et al [6] studies Mechanical and water absorption behaviour of banana/sisal reinforced hybrid composites. In this paper Banana and banana/sisal hybrid composites are prepared and the mechanical properties like tensile, flexural, impact and water absorption tests were carried out. These composites are prepared by varying the Fibers of different lengths and weight percentages. To improve the mechanical properties, banana fiber was hybridized with sisal fiber. The optimum fiber length and weight percentage of banana/epoxy composite are 15 mm and 16% respectively provides optimal tensile, flexural and impact strength. The addition of sisal fiber in the composite, results in 16% increase in tensile strength, 4% increase in flexural strength and 35% increase in impact strength. Hybridization of natural fiber composite by another natural fiber does not yield superior mechanical properties as hybridization by glass fiber and carbon fiber and hence this kind of hybrid composite are suitable for low cost applications.

A .Baharin et al [7] studies the Production of Laminated Natural Fibre Board from Banana Tree Wastes. In this paper Laminated boards were produced by laminating banana stem fibre boards with banana leaf tapes. Various laminated boards were created by changing the number of layers of leaf tapes used. The first type are boards with the banana leaf tapes fibre in different layers aligned in the parallel direction and the second type with banana leaf tapes fibre in different layers aligned in the perpendicular directionThe tensile strength, elongation, flexural modulus and impact strength of the laminated boards increased with increasing number of layers of the leaf tapes. The orientation of fibre in the leaf tapes has little effect on impact strength but other properties studied showed that the properties measured along the parellel fibre orientation were higher than that in the perpendicular direction.

N. Venkateshwaran et al [8] studies the Prediction of tensile properties of hybrid-natural fiber composites. In this paper Hybrid composites were prepared using banana/sisal fibes. The fiber volume fraction of banana and sisal fibers was varied from 0 to 100%. The tensile strength and modulus of short, randomly oriented hybrid-natural fiber composite was found out experimentally. The tensile strength of the hybrid composite along longitudinal and transverse direction, whose maximum values are obtained for 50:50 ratio. Maximum tensile modulus of the composite along longitudinal and transverse direction is obtained for 50:50 ratio.

In the present study, we have investigated the tensile behavior of banana and s-glass fibers reinforced hybrid composite. The mixture of nano silica and polyester resin has been used as matrix. Prior to fabrication of composite, the fibers have been taken in the woven form and placing of layers of fibers are varied. The tensile properties of the hybrid composite laminates have been compared with one another.

2. EXPERIMENTAL PROCEDURE:

2.1 Materials used:

The woven banana and s-glass fibers were purchased from local manufacturers. These fibers used as the reinforcement of the composite. The mixture of polyester resin and nanosilica powder, which was used as matrix material, was purchased from Go green products, India. The materials used in this study are shown in fig 2.1.1 and fig 2.1.2.

Fig. 2.1.1 Woven Banana fiber

Fig. 2.1.2 Woven S-glass fiber

2.2 Fabrication of composite specimens:

There are so many fabrication techniques were available in manufacturing of composites. They are pultruding, compression moulding, resin transfer moulding, and vacuum moulding are some examples. The hand layup fabrication technique is one of the simplest, easiest and reducing manufacturing method for manufacturing composites. The main advantage of the hand layup fabrication technique is ease of fabrication of large and complex materials with less strain and low manufacturing time. In Addition to these benefits it requires simple equipment and tooling that are less expensive. Different steps to be taken while fabricating the composites are collection of fibers and resin, preparing of mould, making and extraction of composite from the mould. The dimensions of the mould is restricted to 200mm*170mm*3mm. At the starting stage of fabrication the base plate and mould is cleaned by thinner solution. Now the surfaces of mould and base plate is allowed to dry after cleaning it with a thinner and the wax has to be applied to the base plate and mould sheet for the easy removal of the specimen. After that the fibers are cut down to the mould dimensions and then take the polyester resin which is mixed with the nano silica. The weight percentage of nano silica is varied in 1wt%. 2wt%, 3wt%. Now the polyester resin, catalyst, accelerator are mixed in the proportion of 100:1.5:1.5 and place the fibers in mould sheet and apply resin. This process is continuing up to four layers of fiber. After preparing the different laminates by changing the layer sequence of fibers a weight is placed on the laminates. After 24 hours the weight is removed and the cured specimens are removed, cleaned & inspected. The layering sequence of fibers is presented in table 1.

Table 1. layering sequence and weight percentage of fiber and resin in the composite

layering sequence	Wt.% of fibers		Fiber weight fraction(%) in composite	Polyester resin weight fraction(%) in composite
	Banana	S-glass		
BGGB	50	50	26	74
GBBG	50	50	26	74
GBGB	50	50	26	74

G= Woven S-glass fiber and B= Woven Banana fiber.

3. TENSILE PROPERTIES:

For a new class of composites, the tensile strength evaluation is very much essential in order to characterize the composites. In the present study, a set of data has been provided that are obtained from tension test conducted under controlled laboratory conditions in order to evaluate the tensile property of these composites.

The tensile test specimens were prepared according to the ASTM D638M-89 and the length and width of the specimen are 160mm and 3mm respectively. The test is conducted on the Tensometer, by applying load on the specimen until specimen gets failure and the results are observed. The test is performed on the Five samples of each composite to get the mean values. The same procedure is applied for all the different tensile test specimens to observe the mean load and elongation values. From these mean load and elongation values the tensile strength and tensile modulus values were calculated respectively. The tensile specimens before and after the fracture are shown in fig. 3 and fig. 4.

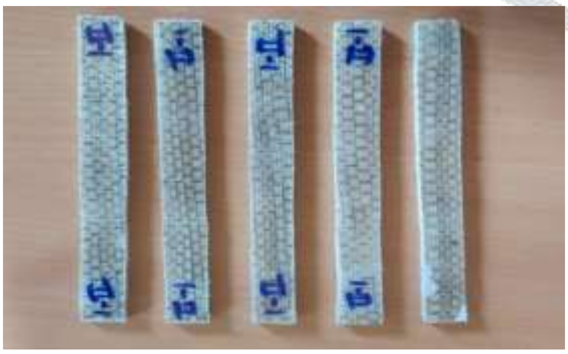

Fig. 3.1 tensile test specimens before fracture

Fig. 3.2 Tensile test specimens after fracture

4. RESULTS AND DISCUSSIONS:

In the above procedure total 45 tensile specimens i.e., 5 samples from 9 laminates were prepared and tested. The results are observed and the mean tensile strength and tensile modulus values were calculated. The mean tensile strength and tensile modulus values are tabulated in the table 2.

Table. 2 Tensile Properties of hybrid composite with addition of nano silica

Composite Sample	Tensile Strength (MPa)	Tensile Modulus (GPa)
Polyester	19.76	0.23
BGGB+1wt.% nano silica	91.2	4.43
BGGB+2wt.% nano silica	101.44	4.16
BGGB+3wt.% nano silica	112.64	3.36
GBBG+1wt.% nano silica	93.97	3.31
GBBG+2wt.% nano silica	96.64	3.5
GBBG+3wt.% nano silica	100.1	4.6
GBGB+1wt.% nano silica	98.93	3.21
GBGB+2wt.% nano silica	102.99	3.31
GBGB+3wt.% nano silica	101.49	4.8

G= Woven S-glass fiber and B= Woven Banana fiber.

For the obtained Tensile strength and tensile modulus values the corresponding graphs are plotted. The graph of BGGB hybrid composite for the tensile strength and tensile modulus are shown in fig. 4.1 and fig. 4.2 respectively. From the graphs the tensile strength is maximum at 3wt. % nano silica and is minimum at 1wt. % nano silica. Simillarly The tensile modulus value is maximum at 1wt. % nano silica and minimum at 3wt. % nano silica.

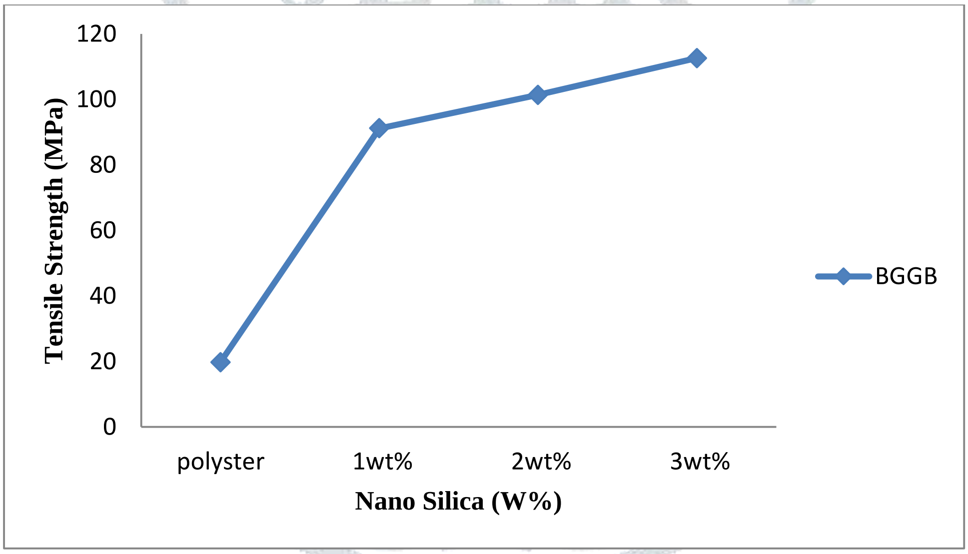

Fig. 4.1 Change in Tensile Strength for Different wt. % of Nano Silica.

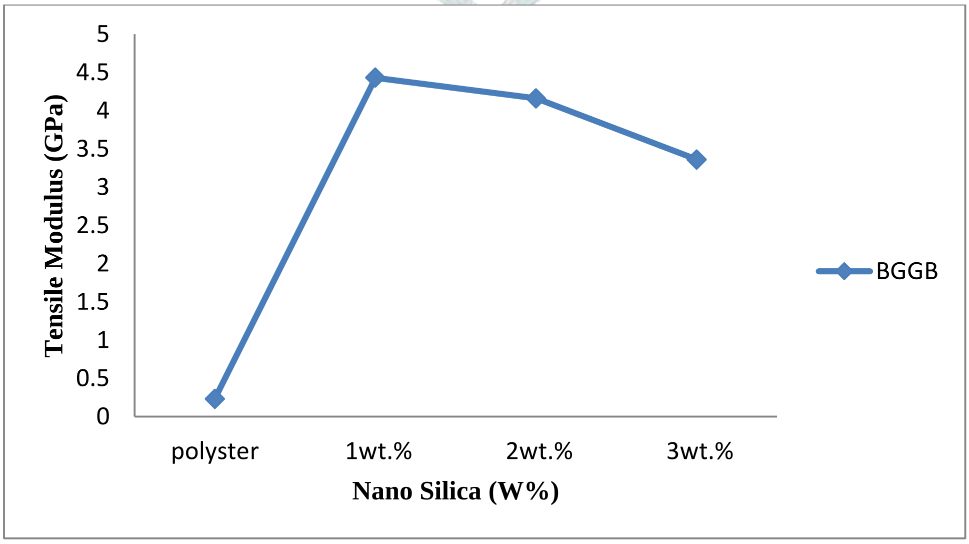

Fig. 4.2. Change in Tensile Modulus for Different wt. % of Nano Silica.

Now the graphs of GBBG hybrid composite laminate for the tensile strength and tensile modulus are shown in fig. 4.3 and fig. 4.4 respectively. From the graph the tensile strength is maximum at 3wt. % nano silica and is minimum at 1wt. % nano silica. The tensile modulus is maximum at 3wt. % nano silica and minimum at 1wt. % nano silica.

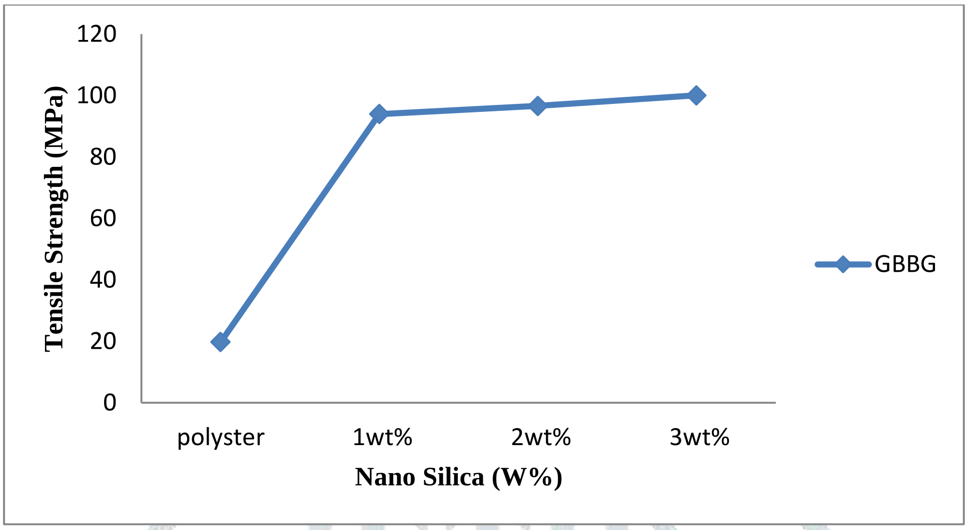

Fig. 4.3. Change in Tensile Strength for Different wt. % of Nano Silica.

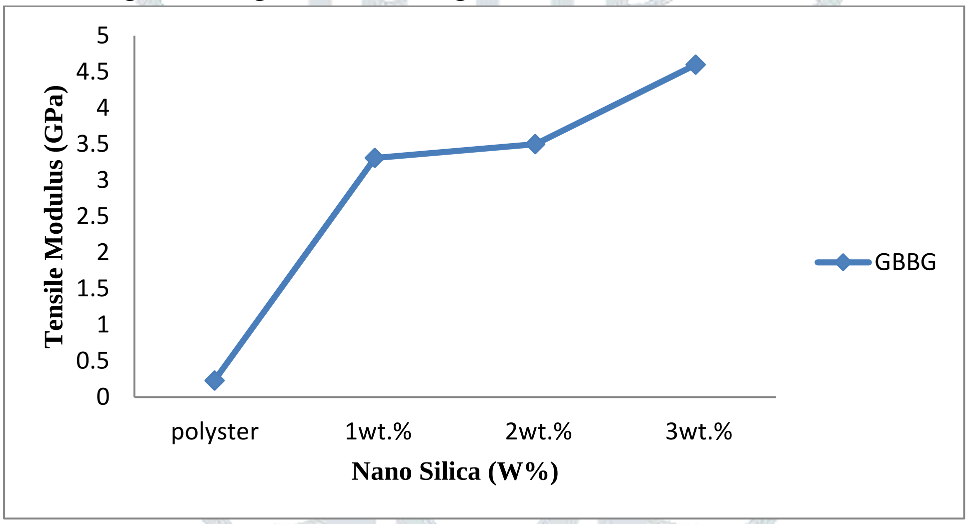

Fig. 4.4 Change in Tensile Modulus for Different wt. % of Nano Silica.

Now the graph of GBGB hybrid composite for the tensile strength and tensile modulus are shown in fig. 4.5 and fig. 4.6 respectively. From the graph the tensile strength is maximum at 2wt. % nano silica and is minimum at 3wt. % nano silica. The tensile modulus is maximum at 3wt. % nano silica and minimum at 1wt. % nano silica.

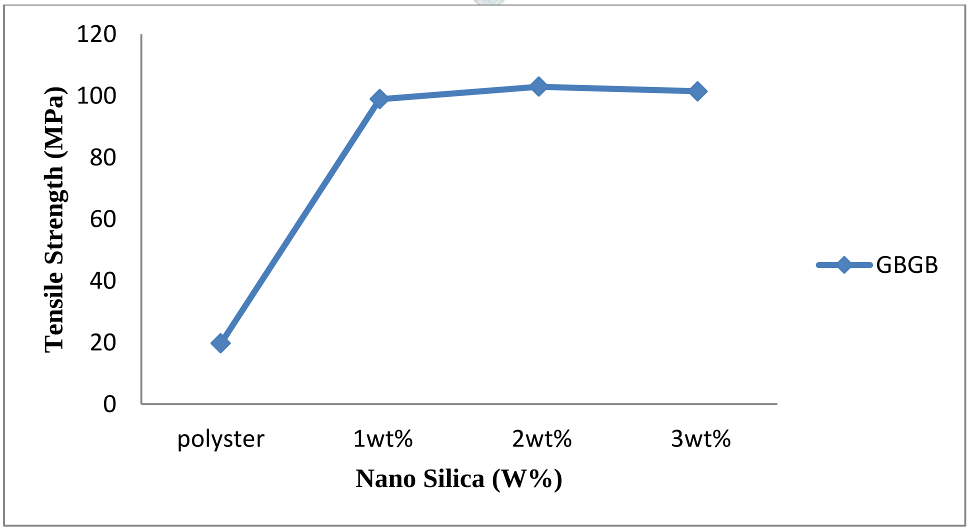

Fig. 4.5 Change in Tensile Strength for Different wt. % of Nano Silica.

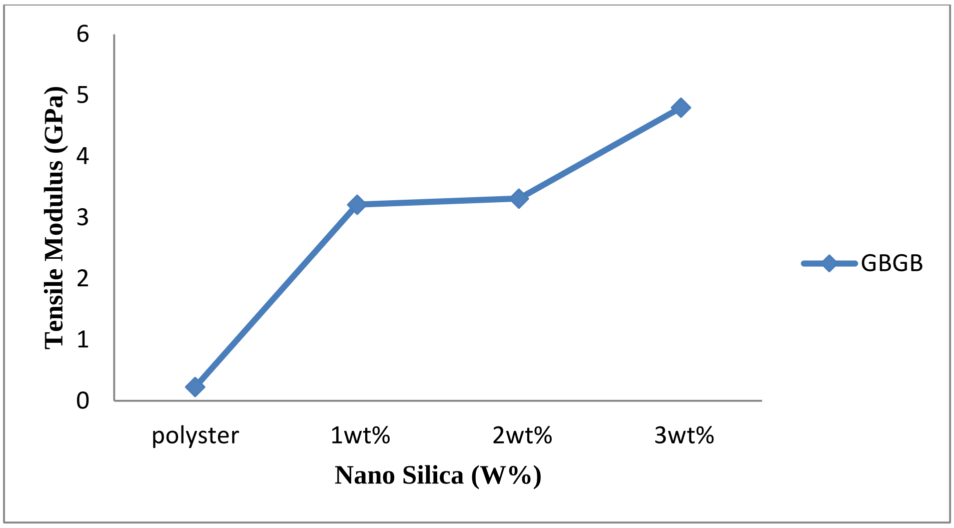

Fig. 4.6 Change in Tensile Modulus for Different wt. % of Nano Silica

5. CONCLUSION:

In this study, the hybrid composite is fabricated with low toxicity and good tensile property. The tensile properties of the hybrid composite with different layering sequence of fibers are observed and the following observations were made.

The tensile strength for different hybrid composites exhibits that layeringing sequence of BGGB hybrid composite with 3 wt.%. of nano silica has 112.64 MPa as higher tensile strength than other hybrid composites. This is due placing of s-glass fibers in between the fibers of banana. This forms a stronger layer in that composite. There is also an increase in the tensile strength upon increasing the weight percentage of nano-powder.

6. REFERENCES:

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