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A Study on Hardness Attributes of Ban Ana and Jute Polyester Composites

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Abstract: **-- Polyester Composites have clinched utmost prominence and are implemented in various spheres of applications. The proffered research work involves evaluation of the hardness parameters of Banana and Jute Fiber reinforced Polyester Composites, assenting the precept of Shore-D Hardness Tester. Banana and Jute Fiber reinforced Polyester Composites were prepared using polyester resin and banana fibers of 10mm length, polyester resin and jute fibers of 30mm length respectively ,varying the fiber volume fraction from 5% to 25%,with an increment of 5%,to 3mm and 5mm thicknesses. The Banana fiber reinforced Polyester Composites of 5mm thickness. with fiber volume fraction of 20% exhibited higher Shore-D Hardness values. Same trend was traced by the Jute fiber reinforced Polyester Composites.**

Key words**: banana, polyester, composite, jute.**

I. INTRODUCTION

Fiber-reinforced polymer composites have acquired preeminent significance in several areas of their implementation due to pronounced phenomenal qualities, such as superior strength, durability and resistance to adverse atmospheric conditions. Composites are the materials synthesised by coalescing two or more than two substances, in a manner that they retain their individual properties and the resulting material has remarkable, distinguished characteristics in analogy with its integrants [1]. The composites, predominantly encompasses the tenacious and steady component which has load sustaining potentiality and is referred to as "Reinforcement"; the disparate fragile component which plays the role of holding the reinforcement firmly is called "Matrix"[2] .

The stiffness and strength required to sustain the structural loads is rendered by the Reinforcement. On the other hand, the matrix contributes towards retaining the placement and position of the reinforcement.

Considerably, although the integrants of the composites restrain their respective mechanical and chemical properties ,the resultant composite material possesses an array of characteristics which the constituent components cannot yield individually. The fibers performing, the role of reinforcement could be naturally obtained or artificially synthesised [3] .Synthetic fibers vastly utilised in the fabrication of Fiber reinforced Composites are carbon, glass, boron and ceramic substances. In the present scenario, composites have found wide application in the field of engineering and technology.

The reinforcement in the composites typically constitutes of fibers, flakes or particulate matter such as carbon, boron, glass, metals, silicon carbide, and ceramic materials, which play a significant role in making the composites tough and robust. Previous studies reveal that the fiber length and fiber volume fraction contribute notably to the strength acquired by the fiber reinforced composites. The matrix constitutes, primarily adopted in fabrication of composites are metals, polymers and ceramic materials.

Composite materials acquired by amalgamation of naturally accessible fibers with suitable matrix components are termed as Natural Fiber Reinforced Composites. Natural Fiber Reinforced Composites are gaining importance and are being utilised for a number of applications due to their availability in abundance, hasty accessibility and eco-friendly nature. The counterpart Synthetic fibers cause threat to the environment and also involves tedious techniques of production and is highly priced. In the case of natural fibers ,there is no urge or need of manufacturing mechanisms since they are readily, naturally available; they only need to be extracted from their respective sources and need to be processed for their usage in fabrication of composite materials. Above stated fibers are easily accessible, exhibit appreciable strength and are of course economical. The intended work portrays the formulation and the salient, competitive traits of the natural fiber reinforced composites, comprising Banana, Jute fiber and polyester resin.

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II.MATERIALS AND METHODOLOGY

2.1 Materials

The Composites retrieved from the blending of banana with polyester are Banana fiber reinforced polyester composites and those obtained from blending of jute fiber with polyester are Jute reinforced polyester composites.

Banana fiber is a ligno-cellulosic fiber excerpted from the pseudo stem of banana plant. Banana plant is a substantial perpetual herb with leaf envelopes that form pseudo stem,as shown in Figure 1. Its height ranges between 10-40 feet surrounding with 8-12 large leaves It is a bast fiber with significantly exceptional mechanical properties [4] .The chemical configuration of banana fiber consists of cellulose, hemicellulose and lignin.It is profoundly tenacious fiber with light weight and biodegradable eco-friendly fiber.Density of Banana fiber used is 1.4g/cc. It is bio- degradable and has no negative effect on environment and thus can be categorized as eco-friendly fiber.

Fig 1: Banana Fiber

Jute is eminent of the substantial fibers; its primary source being corchorus olitorious.Jute predominantly consists of cellulose and lignin [5]. Jute is a long, soft, shiny vegetable fibre that can be spun into coarse, strong threads as shown in Figure 2.It is produced primarily from plants in the genus Corchorus. It falls into the bast fibre category. The fibers are off-white to brown, and 1–4 metres long. The long staple fiber has high tensile strength and low extensibility and is bio-degradable. The density of Jute fiber used is 1.3 g/cc.

Fig.2: Jute Fiber

Polyester is a thermoset polymer, whose linkage chains are strongly bonded with rigid covalent bonds after the curing process. Polyester exhibits notably increased strength, flexibility and stiffness, thus proving to be an efficient matrix component [6].Cobalt Napthanate and Methyl Ethyl Ketone peroxide are used as hardener and catalyst respectively.

2.2 Methodology

The Banana and Jute reinforced Polyester composites are fabricated, considering distinct thicknesses and fiber volume fractions. Banana and Jute Fiber reinforced Polyester Composites are cast to thicknesses of 3 mm and 5 mm, wavering the fiber volume fraction from 5 %, 10 %,15 %,20 %,25 %.

The fabrication of the various composite materials is carried out through the compression moulding technique

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Fig.3: Hot Compression Moulding Machine

Banana fibers of fiber length 30mm ,Jute fibers of fiber length 30 mm, are blended with Polyester matrix and sandwiched between the fibre glass mats and sheets at the top and bottom. Cobalt Napthanate and Methyl Ethyl Ketone peroxide are used as hardener and catalyst respectively to prepare the matrix.The catalyst, hardener and Polyester Resin are mixed in the ratio 1:1:100.The mix is stirred manually to disperse the fibers in the matrix. The compression moulding machine,(shown in figure3) is preheated to 82˚C.The fibers are distributed evenly within in the specimen mould(iron frame).The specimen moulds of thickness 3 mm and 5 mm are used for the specimen fabrication. The Fiber volume fraction of 5 %, 10 %, 15 %, 20 %, 25 % is adopted. After the even distribution of the fibers within the mould ,it is placed on the lower plate of the Compression Moulding Machine. Then the stirred mix of Polyester resin, catalyst and hardener is poured evenly on the fibers in the specimen mould and is covered with plastic sheet

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and the upper plate is lowered down to the top of the specimen mould using the jack system and locked suitably. Two fiber glass sheets one at the top and other at the bottom of the fibers and polyester matrix mix is laid. The temperature of 82˚C is maintained for about 15 minutes. Then the specimen mould is removed from the plates and the composite specimen is un-moulded.

III.RESULTS AND DISCUSSIONS

3.1 Shore-D Hardness Test

Hardness is one of the prominent mechanical traits of composite materials. Hardness could be elucidated as the resistance to any permanent indentation. Hardness traits of the cast Banana fiber reinforced Polyester Composites and Jute Fiber reinforced Polyester Composites is tested using Shore-D Hardness Tester, confirming to ASTM D2240(shown in figure 4).Shore-D Scale is used for harder materials and Shore-A scale for softer ones [10].

The hardness scale varies between 0 to 100 in the case of Shore-D Hardness Tester, higher values represent harder materials. Hardness tester quantifies the extent of indention in the material caused by a given force on a standardized presser foot. The final value of the hardness confides on the extent of penetration of the indenter after it has been imposed for 15 seconds on the material. In case that indenter permeates more into the material, the durometer reading is 0 for that scale. If it does not penetrate at all, then the durometer reading is 100 for that scale.

Fig.4: Shore-D Hardness Tester

The extent of penetration of the cone indenter in the Shore-D hardness tester relies upon the hardness of the material. The Shore-D Hardness values obtained for the 3 mm thick Banana Fiber reinforced Polyester Composites, for fiber volume fractions of 5 %, 10 %, 15 %, 20 % are 77.42 ,77.67, 78.28, 78.84 respectively, as shown in Table1. The Hardness values obtained for the 5mm thick Banana Fiber reinforced Polyester Composites, for fiber volume fractions of 5 %,10 %,15 %,20 % are 79.54, 80.90, 81.5 , 81.97 respectively as shown in Table 1.

Table 1: Shore-D Hardness Values of Banana Polyester Composites.

Fiber volume fraction(%)	Shore-D Hardness Numbers For Banana Polyester Composites	
	3mm thick	5mm thick
5	77.42	79.54
10	77.67	80.90
15	78.28	81.50
20	78.84	81.97

Table 2: Shore-D Hardness Values of Jute Polyester Composites.

Fiber volume Fraction (%)	Shore-D Hardness Numbers For Jute Polyester Composites	
	3mm thick	5mm thick
5	80.85	82.36
10	81.62	82.94
15	81.94	84.64
20	83.93	84.95

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The Shore-D Hardness test was conducted on 3mm and 5mm thick Jute Fiber reinforced Polyester Composites. The Hardness values obtained for 3 mm thick Jute Fiber reinforced Polyester Composites for fiber volume fractions of 5 %, 10 %, 15 %, 20 % are 80.85, 81.62, 81.94, and 83.93 respectively as shown in Table 2. The Hardness values obtained for 5mm thick Jute Fiber reinforced Polyester Composites for fiber volume fractions of 5 %, 10 %, 15 %, 20 % are 82.36, 82.94, 84.64, 84.95 respectively as shown in Table2. The Young's Modulus of Elasticity values were obtained for the Banana and Jute Polyester Composites of 3 mm and 5 mm thicknesses, with fiber volume fraction of 5 %, 10 %, 15 %, 20 % from the Shore-D Hardness values available from the Shore-D Hardness Durometer. The Young's Modulus of Elasticity values obtained for the Banana Polyester Composites from the Shore-D Hardness Values are tabulated in Table 3, which exhibit an ascending trend with the increase in fiber volume fractions.

Table 3: Young's Modulii of Elasticity of Banana Polyester Composites

Fiber volume fraction(%)	Young's Modulus of Elasticity For Banana Polyester Composites(MPa)	
	3mm thick	5mm thick
5	225.98	253.45
10	229.06	272.80
15	236.74	281.81
20	244.03	289.06

Table 4: Young's Modulii of Elasticity of Jute Polyester Composites.

Fiber volume fraction (%)	Young's Modulus of Elasticity For Jute Polyester Composites(MPa)	
	3mm thick	5mm thick
5	272.07	299.57
10	283.64	304.64
15	288.60	334.00
20	327.02	339.64

The Young's Modulus of Elasticity values obtained for the Jute Polyester Composites from the Shore-D HardnessValues are tabulated in Table 4, which exhibit an ascending trend with the increase in fiber volume fraction

IV. CONCLUSIONS

Shore-D Hardness Test was conducted on Banana and Jute Polyester Composites of 3 mm and 5mm thicknesses, with fiber volume fraction 5 %, 10 %, 15 % & 20%.

In the case of Banana reinforced Polyester Composites maximum Hardness Values of 78.84 and 81.97 were obtained corresponding to fiber volume fraction of 20 % for 3 mm and 5 mm thick composite panels respectively. For Jute fiber reinforced polyester composites, maximum hardness value of 84.25 and 84.95 was obtained corresponding to fiber volume fraction of 20 % for 3 mm and 5 mm thick composite panels respectively. The Young's Modulus Of Elasticity corresponding to the Maximum Hardness values are 244.03 MPa and 289.06 MPa for 3 mm and 5 mm thick Banana Polyester Composites. The Young's Modulus Of Elasticity corresponding to the Maximum Hardness values are 327.02 MPa and 339.64 MPa for 3 mm and 5 mm thick Jute Polyester Composites. Thus we observe that the Shore-D Hardness values and Young's Modulus of Elasticity values of Banana Polyester Composites and Jute Polyester Composites increase with the increase in fiber volume fraction and thickness of the composite panels.

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