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Study of Mechanical Properties of Polypropylene Natural Fiber Composite

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Abstract: ***The current research deals with manufacturing of composite using a heated press machine. Four values of loading were selected. The jute and fibers of coir were used in eual quantity to make the composite. Tensile strength, flexural strength, impact strength and hardness tests were performed to quantify the performance of the composite developed. The results concluded that tensile strength of the composite shows a decreasing trend with increase in the fiber component of the composite. During flexural strength, impact strength and hardness test, it was concluded that they follow an increasing trend when the fiber loading is increased. A fiber loading of 20% was found to have optimum results for the manufactured composite.***
Keywords: Fiber Composite, Tensile Strength, Impact Strength, Hardness

I. INTRODUCTION

In the present scenario, the hybrid composites have achieved great attention in the industries as it possess properties desired to manufacture products that are impossible to achieve by one-type of fiber matrix It has also yielded a more economical utilization of costly fibers by replacing them partially with low cost fibers. Hybrid composites yield the potential of acquiring a balanced level of stiffness, strength and ductility. Moreover, bending and mechanical properties with less weight, low notch sensitivity, enhanced fracture toughness; larger fatigue life and tremendous impact resistance is achieved [1].

In order to be environmental friendly, a non toxic and eco friendly structure is suitable. Natural fiber reinforced composites are not costly and can reduce environmental issues as they are bio-degradable [2]. Moreover, the lingo-cellulosic fibers are of minimum weight, easily available, easily processed, low density, non abrasive, possess low wear and are renewable and can be recycled [1,2]. The lingo-cellulosic fibers with thermosetting or thermoplastic polymer are used to make composites Brittle composite is formed when thermosetting polymer is used. Thermoplastic polymer composites offer high resistance to the impact loading. It also possess shape change at high temperature and can be recycles\d or repaired. [3].

Glass fiber materials possess enhanced resistance towards environmental aspects and fatigue with the advantages of having higher stiffness to weight and strength to weight ratio when compared with different synthetic fibers [5].

Research showed that water resistant and saline water damage resistant composites are manufactured by using coir fibers. It can comparatively absorb more moisture than other natural fibers. They can be recycled and renewed and resistant to CO_2 [8]. Coir fibers possess less abrasive property. When considering jute fiber, it posses low density but better strength. [4].

Natural fibers are super alternatives for synthetic fiber as reinforcements for polymeric composites due to their high flexural modulus and impact strength. Furthermore, natural fibers are environmental friendly, biodegradable, abundant, renewable with less density and low cost. Natural fibers are biodegradable and thus are not harmful to the environment. They are cheap and thus economic for the industries for application [6]. Generally used natural fibers are leaves of pineapple, palm, sisal, kapok, bamboo, etc [7]. Among all the plant fibers, jute shows to be the most utilized, and low cost fiber, that can be moulded to different structures [6].

II. EXPERIMENT AND METHODOLOGY

The machine used to prepare samples is hot hydraulic press machine. The machine setup is shown in figure 1. The materials used are jute fibre, polypropylene and coir. Die for preparing the specimen of composite was made of aluminium. A hydraulic machine having maximum load of 35kN and maximum temperature of 300°C was used. The fiber loading was diverse at 5, 10,15, and 20 wt% with jute to coir ratio of 1:1. The polypropylene and fiber were weighed and then placed in oven for drying before specimens are prepared. Heating results in better adhesion of the polypropylene granules with fiber.

The temperature was initially raised to 160°C and hold there for around 12-15 minutes. After that the temperature was raised upto 180°C depending upon the thickness. Later the die was made to cool down and after releasing the pressure, the specimen was withdrawn.

Table I: Designation Of Composites

S. No.	Composite	Composition
1	PPJCF-1	PP (90 wt%) +Jute (5 wt%) + Coir (5 wt%)
2	PPJCF-2	PP (80 wt%) +Jute (10 wt%) +Coir (10 wt%)
3	PPJCF-3	PP (70 wt%) +Jute (15 wt%) + Coir (15 wt%)
4	PPJCF-4	PP (60 wt%) +Jute (20 wt%) + Coir (20 wt%)

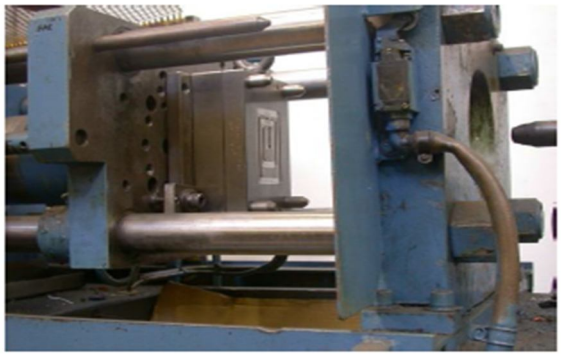

Fig. 1 Hot hydraulic press machine

The responses selected are tensile strength, flexural strength, impact strength and hardness.
The main objectives of current research work are to fabricate short jute, coconut fiber based polypropylene composites, evaluate the mechanical properties and studying their influence of fiber loading on mechanical properties of composite
The following table II shows the mechanical properties of composites.

Table II: Mechanical Properties of Composites

Composite	Tensile Strength (MPa)	Flexural Strength (MPa)	Impact Strength (J/m)	Hardness
PPJCF-1	25.7	25.1	450	93
PPJCF-2	25.2	28.3	700	95
PPJCF-3	21.8	30.2	800	98
PPJCF-4	21.3	32.1	1100	99

III.RESULTS AND DISCUSSION

A. Tensile Strength

The tensile strength of each specimen was estimated at different fiber composition i.e. 5, 10, 15 and 20 weight % by using stress strain curve. Figure 2 shows the tensile strength of the specimens at various levels of loading of fiber. It is elucidated that the tensile strength of the composite get reduced as the fiber loading is enhanced. This is due to the fact that when the fiber loading is increased, it increases the interfacial spacing in the composite matrix that weakens the bond and reduces the tensile strength of the composite. This consequently decreases the tensile strength of the composite.

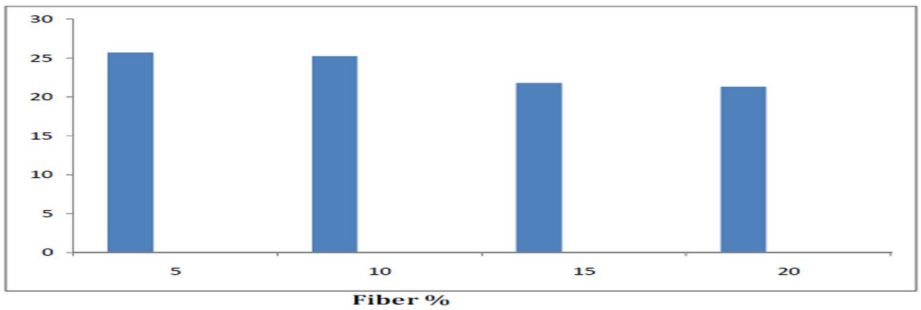

Fig. 2 Tensile strength of composite at different levels of fibre loading

Figure 3 represents the plot for young modulus of composite at various level of loading of fiber. It is elucidated that the young's modulus increases with increase in value of fiber loading. The reason for occurrence is due to increased brittleness of composite that is caused due to increase in fiber composition. Weak bond of interfacial results in micro-spacing which propogates stress within the composite.

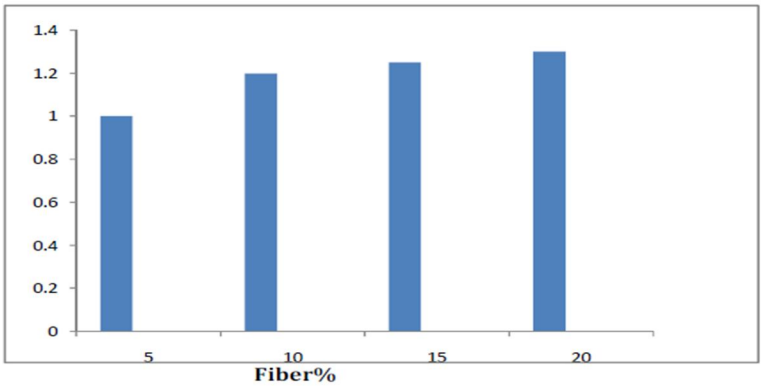

Fig. 3 Variation of Young's modulus at different levels of fiber content

B. Flexural Properties

Figure 4 depicts the plot between flexural strength of the composite specimens prepared and different levels of loading of fiber. The plot elucidates that the flexural strength get increased with increase in the value of loading of fiber. This complies to the earlier findings of researchers. This occurs due to entangled polymer chain with the fiber which imparts increased content and better adhesiveness.

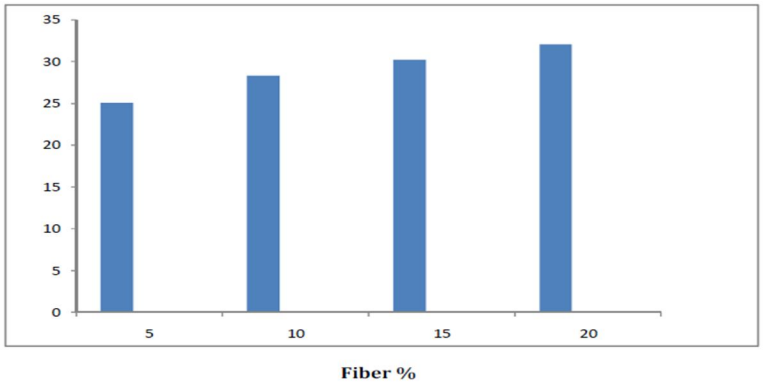

Fig. 4 Variation of flexural strength at various fiber content

Figure 5 depicts the histogram between the composite and the various levels of loading of fiber. It elucidates that the flexural modulus is increased when the level of fiber loading is increased. As we know that coir and jute both posses higher modulus, therefore a better fiber concentration demands better stress for the similar deformation.

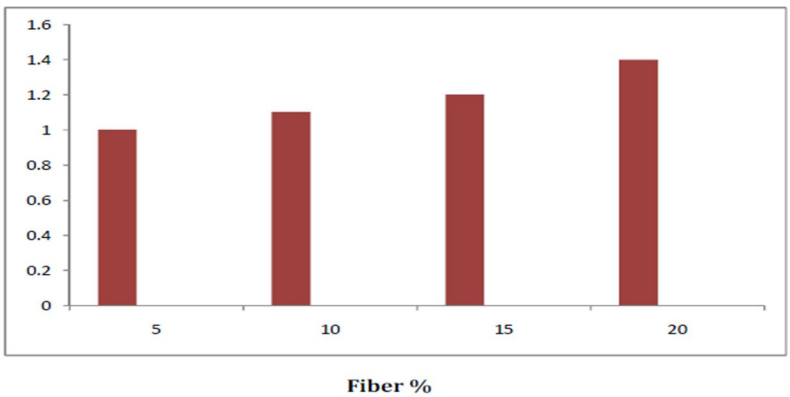

Fig. 5 Variation of flexural modulus at various level of fiber content

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C. Impact Strength

The figure 6 shows the relation between the impact strength of composite with various fiber contents. It elucidates that the impact strength increases when the fiber loading is increased. It is clear that the impact strength of the composite rely upon the type of bonding between the polymer and the fiber.

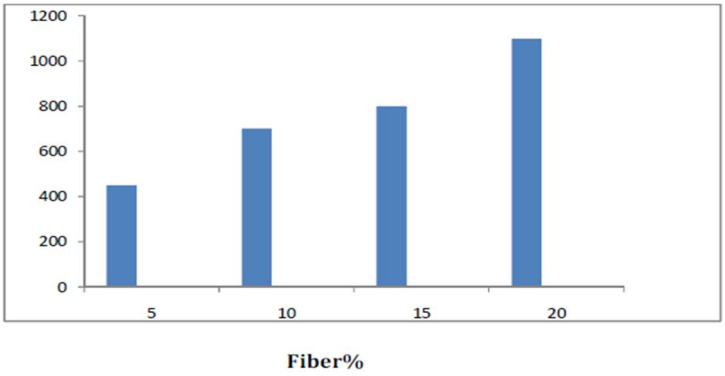

Fig. 6 Variation of various fiber content

D. Hardness Test

Generally low hardness is possessed by the composite when flexible matrix is present in the composite. The figure 7 shows the plot, a rigid composite is achieved when fiber are mixed in polymer reducing its flexibility. When the stiffness of the composite is increased, hardness increases with fiber content. For better hardness, improved dispersion of fiber in polymer matrix must be done to remove the voids.

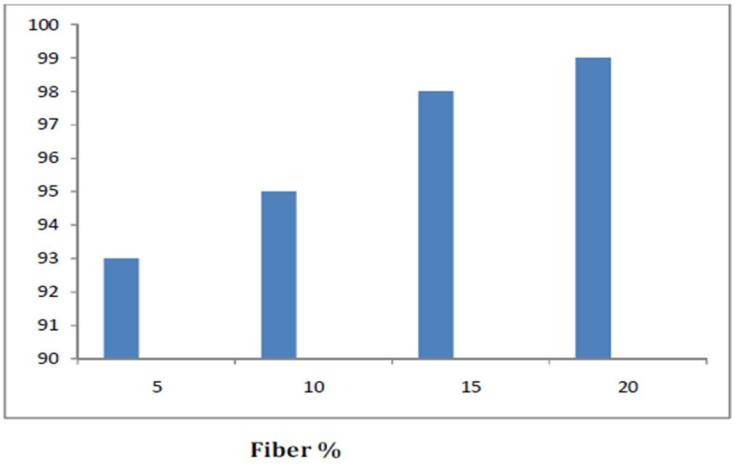

Fig. 7 Variation of Hardness at various levels of fibre content

IV. CONCLUSIONS

The present study on hybrid jute and coir fiber with polypropylene composite at various levels of loading of fiber i.e. 5, 10, 15 and 20 weight % and equal composition of jute and coir was performed. Following conclusions were drawn from the study:

A. The tensile strength of the composites decreased with an increase in fiber loading. The Young's modulus shows an increasing trend with loading of fiber. The fact behind this is that the brittleness of composite increases with increase in fiber content.
B. It is also found that he flexural strength of the composite increases when the loading of fiber is increased. It is also concluded that the flexural modulus also increases with loading of fiber.
C. As coir and jute posses better young modulus, thus better fiber concentration requires better stress for the similar deformation.
D. The impact strength of the prepared composite shows increasing trend with loading of fiber. This is because the fiber can absorb energy due to entangled fiber and polymer matrix.
E. The hardness values increase with an increase in fiber loading. Thus it is concluded that 20 weight % of fiber content posses better strength and hardness.

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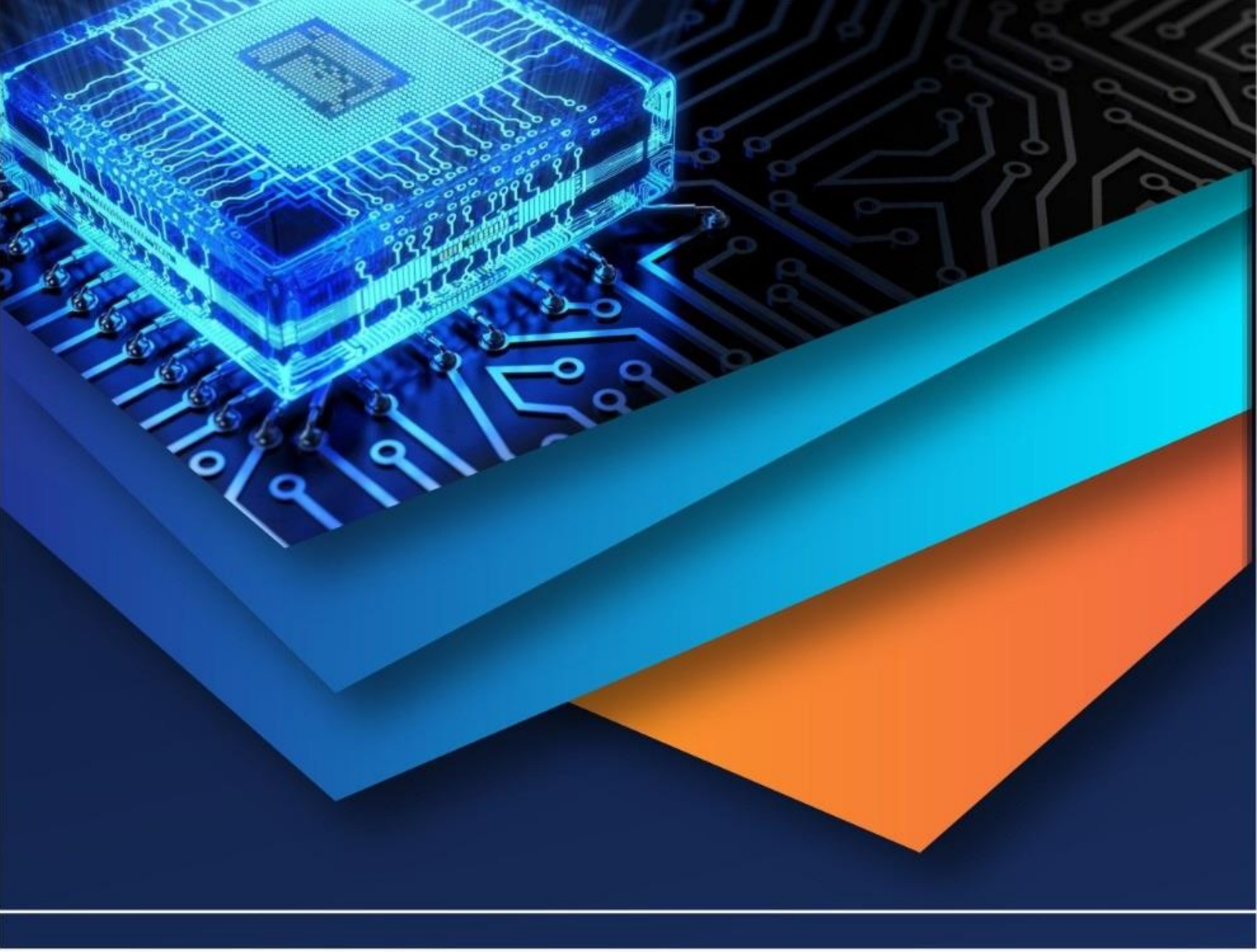

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