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Evaluation of Mechanical Properties of Epoxy Matrix Composites for various Fiber Loading

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Abstract: ***Due to excellent properties and cost effective the polymer composites are widely used for various engineering applications.The polymer composites having high durability, good abrasion resistance, high strength-to-weight ratio.This study explains the variations of tensileand flexural properties of epoxy matrix composite materials with respect to the addition of coconut and palm fiber content. Three different composite samples such as PC-2.5, PC-5, PC-7.5 were prepared using hand layup techniques and the mechanical characters were analyzed. The results prove the improvement of tensile strength and flexural properties of composites by the addition of fiber content in the composites up to a certain level.***

Keywords: The Polymer Composites Having High Durability, Good Abrasion Resistance, High Strength-To-Weight Ratio.

I. INTRODUCTION

The FRP Composites havingextensive range of uses in various industries like in aerospace manufacturing ,automobile manufacturing and aircraft production industries due to better mechanical and thermal properties like good strength, less weight, unique modulus of elasticity, better damping capacity, ability to withstand corrosion, good fatigue resistance and low coefficient of thermal conductivity[1–4].Polymershave been playing a dynamic rolein the manufacturing of FRPC. Increasing price of the man-made fiberstrengthened polymer matrix composite (PMCs) has known as for the use of smaller amount of usages and efficient methods [5]Natural fiberslike pineapple leaves, jute, hemp, banana, sisal, palm etc., are used as strengthening elements of polymers and they have been improving the mechanical characters of the polymer composites with low cost [6].To increase the strength of polymer compositesthe fillers are widely used as additives along with the composition. Thesize of fillers used as reinforcing agents are playing major role for affecting properties of composites[7].Smaller fillers have more surface area which increases the interfacial bonds between the polymer andfiller [8, 9].Natural fillers such as coconut shell, palm kernel shell, rice husk, fish born, and battle nut are small amount of water content in nature as they invent from lignin and cellulosewhich have strongly polarizedOH group.

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These natural fillers are not suitablewith water repellingepoxieslike polypropylene taking to very low interfacial bondingamong the fibresand matrix. It is lead (poor wetting) to low adhesion between fibres and matrix when fillers mix with matrix. The bonding of such fibre-matrix mismatch and very low wetting it is lead to create poor mechanical strength of the natural fibre strengthenedcomposites. Numbers of approaches have been developed in order to overcome thisundesirable situation of fiber-matrix mismatch and very lowbonding. The approaches includethe surfacemodifications of fibers are chemical treatment, mixing of atoms, the use of coupling agents andpolymers onto the fibre surface modification. The chemicals such as NaOH, KOH, KCl are used for surface treatment [8,9].The used coconut shell, palm shell and epoxywerereviewed to be a waste which their improper dumping it is lead toaffecting the environmental. However, this study is aimed at maximally the properties of the epoxy.

II. MATERIALS AND METHODOLOGY

In this study shell particles of palm and coconut were used as fillerwithepoxy resin matrix phase.HY951 hardener was mixed in the ratio of 10:1.

2.1 Preparation of Coconut and Palm Shell Fillers

Coconut and Palm shells are collected from the daily household wastes and palm farm. These shells are first involved to dry by using sun light after that it is involved in pulverizing by using iron hammer after this process shells are changed to small pieces. At the next phase these small pieces are exposed to crushing machine that machine is used to change the small pieces to required filler form. At this stage coconut shell filler (CSF) and palm shell filler (PSF) derived. The sieve analyser is used to isolate the required size. This sieve analysis followed by the pulverizing and crushing process. This process is made by our college laboratory, after this process the fillers rage is detached in 75 to 150 microns size. These fillers are exposed to the surface modificationprocess and has experienced for 12 hours at room temperature with 5% of NaOH concentrated distilled water. Afterwards the fillers were filtered from the water and exposed to sunlight for 24hours to remove the moisture. The dried fillers were heated at a temperature of 120°C for 3 hours.. This heat treatment procedure is used to improve the strength of the fillers.

Figure 2.1 sieve analyser

Figure 2.2 Muffle furnace

2.2 Preparation of Composites

The sheet metal tray used for casting the composite fabrication. The size of mold is 300 mm × 210 mm × 6 mm. In the first stage prepared CSF and PSF were mixed (1:1) with each other pre-defined correct proportion. In next stage the mixed fillers and resin (epoxy:hardener 10:1) was stirred properly by using mechanical stirrer. Themixed fillers and resin solution poured over the sheet metal tray.Mansion polish wax was applied on the surface of tray to avoid the sticking of composite with tray. Curing was done in room temperature for 6 hours. The designation of samples is given in Table 1. After curing, the specimens were taken out from the cavity and cut into required size as per the ASTM standards for mechanical testing.

Table-1 Different PRP Sample ID's

Sample Id	**Filler** (Coconut + Palm) **(wt %)**	**Epoxy (wt %)**
PC- 2.5	2.5	97.5
PC -5	5	95
PC -7.5	7.5	92.5

Figure 2.3 Mould plate

III. EXPERIMENTATION

3.1 Tensile Testing

Generally, tensile test performed on flat composite sample in Instron UTM testing machine. The cross head speed of the machine tor tensile testing is 2mm/min.

Figure 3.1. Tensile testing machine

3.2 Flexural Testing

Flexural test wasaccomplishedby three point bending method. The cross head speed of machine was 2 mm/min.

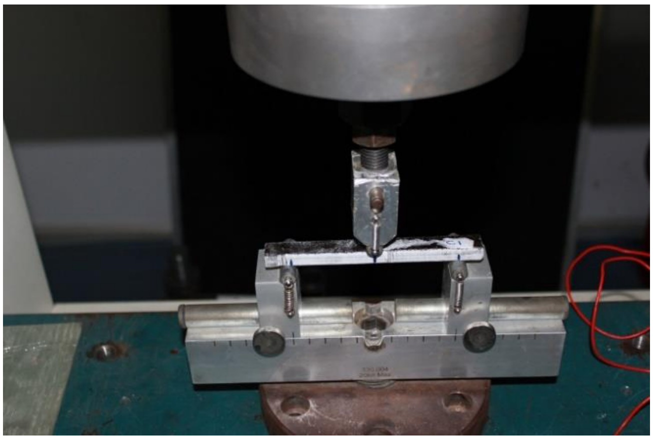

Figure-7 Three point bending arrangement

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IV. RESULT AND DISCUSSION

4.1 Effect of Fiber Contents on Flexural Strength of Epoxy Composites

The effect of addition of coconut and palm fibers on epoxy polymercomposite is shown in Figures. From the graph we found that the flexural strength of coconut and palm strengthened epoxy composites increases with increase in fiber loding up to 2.5 weight%, The addition of fiber content more than 2.5% in composite leads to reduce flexural strength. The 5% addition of fiber content (PC-5 sample) reduce the flexural strength of 33% than PC-2.5 sample. Same as the 7.5% of fiber content i.e., PC-7.5 sample having 45% reduced flexural strength than PC-2.5 sample. The higher content of fiber in epoxy matrix composites leads the drop of flexural strength because of the poor dispersionof fiber content in epoxy matrix, void formation, and weak fiber-to-fiber adhesion, and poormatrix-fiber interaction. However, the addition of fiber content 2.5% improves the flexural strength of composites than neat resin sample.

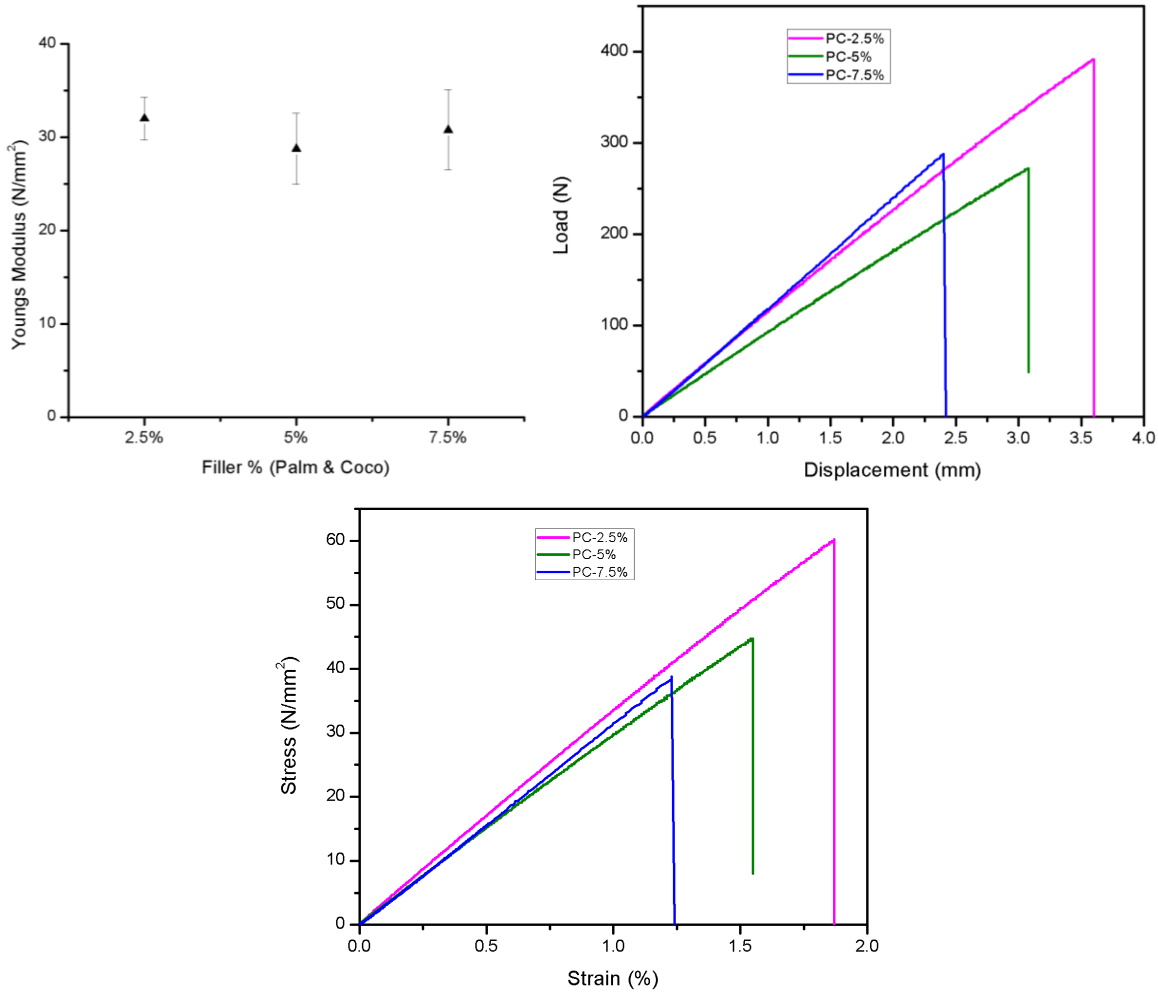

Figure 4.1. Flexural Properties of Coconut + Palm reinforced Epoxy Composites

4.2 Effect of Fiber Contents On Tensile Strength Of Epoxy Composites

The effect of addition of coconut and palm fibers on the tensile properties ofepoxy composites is shown in Figures. From the graph we found that the tensile strength of coconut and palm reinforced epoxy composites increases with increase in fiber content up to 5weight %, The addition of fiber content more than 5 % in composite leads to reduce tensile strength. The 7.5% addition of fiber content (PC-7.5 sample) reduce the tensile strength of 45% than PC-5 sample. Sample PC-2.5 having 2.5% fiber content and it has the lower tensile strength about 36% than PC-5 sample. It is found that the optimum level of addition of fiber to improve the tensile strength of the composite is 5. The higher content of fiber in epoxy matrix composites leads the reduction of tensilestrength due to the poor dispersion of fiber content in epoxy matrix, void formation, and weak fiber-to-fiber adhesion, and poormatrix-fiber interaction. Lower content also reduces the tensile strength due to insufficient strengthening of matrix by fiber.However, the addition of fiber content 5% improves the flexural strength of composites than neat resin sample.

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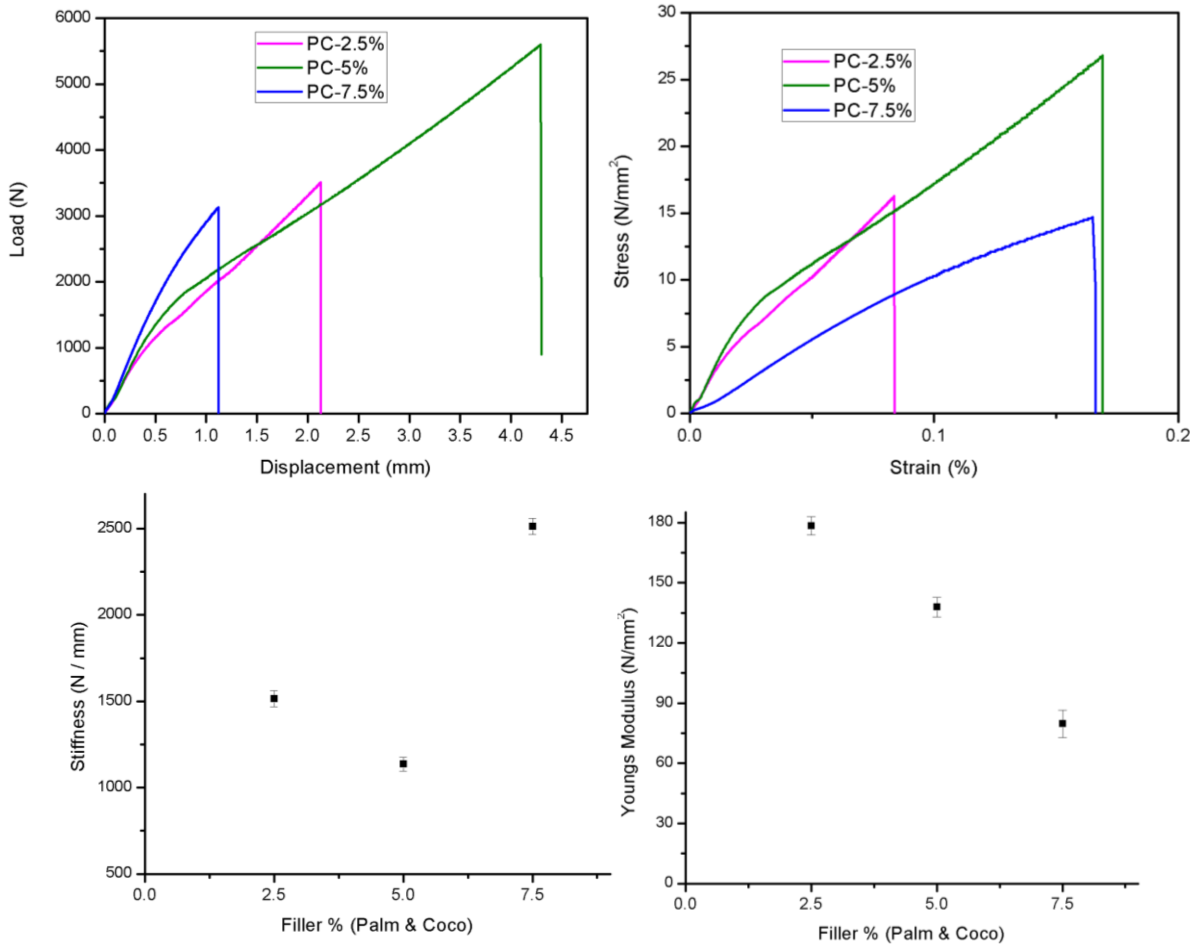

Figure 4.1. Flexural Properties of Coconut + Palm reinforced Epoxy Composites

V. CONCLUSION

The coconut and palm reinforced epoxy composites were prepared using hand layup method. The flexural and tensile strength increases with respect to the addition of coconut and palm fiber content with the polymer composites. It is found that the optimum fiber loading for getting the good flexural strength is 2.5% and the tensile strength is 5% Increase of fiber content more than the optimum level leads the reduction of tensile and flexural strength of epoxy composites.

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