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# Investigations of Mechanical Properties on Natural Based Composites: Carbonized rice husk (CRH), Tamarind fruit Fibers (TM) and Coco-Spathe Fibers (CS)

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**Abstract-** Now a days polymers based composites plays major role in industries. PMC have a unique properties like stiffness and fire resistance. The production of PMC is simple and better, there is no harmful chemicals and fabrication process. Natural composites are fabricated with a reinforcement like Carbonized rice husk (CRH), Tamarind fruit fibers (TM) and Coco-Spathe fibers (CS) with epoxy resin. The reinforcement are 20%, 30% and 40% by weight to epoxy matrix. The natural composites are prepared by hand layup technique. The results showed increase in the tensile strength as the fiber percentage increased however, after a certain percentage of fiber reinforcement, the tensile strength decreased. Compared to untreated fiber a significant change in tensile strength and flexural strength has been observed for surface treated fiber composites.

**Index Terms-** Coco-Spathe, Tamarind fruit fibers, tensile strength, PMC, Natural composites

## 1. INTRODUCTION

There is a growing interest in the use of woven composites for structural applications. Such applications range from bio-medical components, aircraft and space structures to automotive and other applications. In the case of aircraft structures, woven or braided composites can be used for a wide variety of cross sectional forms such as stiffeners, truss members, rotor blade and spars etc, to reduce the fabrication costs. A fabric can be made by various processes such as weaving, braiding or knitting. Woven fabric composites, in particular, are constructed by weaving two fiber tows into each other to form a layer. These layers are then impregnated with a resin or matrix material, stacked in a desired orientation, and cured to obtain a composite laminate. The interlacing of fiber bundles with matrix has several advantages such as increasing the intra and inter-laminar strength, greater damage tolerance, as well as providing a possibility to produce near net shape structural components. Such capabilities are very important for producing thick laminates. These advantages, however, come at the expense of some loss in the in-plane stiffness and strength, which depends upon the weave architecture. There is a need for sound engineering data as well as efficient analytical/design methodologies and these design methodologies must account for processing parameters and micro structural/geometrical features for accurate modeling of such composites. A synthetic fibre is also a chain of small units joined together. Natural fibers seem to be a good alternative since they are readily available in fibrous form and can be extracted from plant leaves at very low costs.

## 2. LITERATURE REVIEW

Tamarind fruit (Tf) and Sansevieria cylindrica (Sc) hybrid composites containing fiber 0:20, 5:15, 10:10, 15:5 and 20:0 of (Tf:Sc) combinations loading. Sansevieria cylindrica leaves were used in this paper for extracting fiber out of it and in the similar manner ripen Tamarind fruit was used to extract fiber. The tensile and flexural properties of the resulting 20 wt. p% loading of Tf/Sc/epoxy hybrid composites were examined [1]. Randomly oriented short Tamarind fibre reinforced Epoxy composites were prepared by hand lay-up process. To improve the surface, these fibers were treated with alkali (sodium hydroxide) and silane (3-aminopropyltriethoxy silane). The effects of alkali and silane treatment of fibers on tensile and flexural properties of the composites were investigated. Mechanical test results show that alkali and silane treatment significantly improves the tensile, flexural and impact properties of Tamarind fiber epoxy composites. Scanning electron microscopy (SEM) investigations show that surface modifications improve the fiber/matrix adhesion [2].

The need to have composite materials that are renewable has led to materials scientists researching on natural fibres. To minimize environmental pollution research into rice husk has been on for a period of time now. Cashew nut resin reinforced rice husk composite was fabricated at different particle sizes and different filler loading. The present study reveals that both filler loading and particle size can affect the tensile strength, young modulus, strain at failure, flexural strength, and impact strength [3]. The strength effect of High strength concrete of various amounts of replacement of cement viz., 0%, 5%, 10%, 15% with Rice Husk Ash of both the grades were compared with that of the high-strength concrete without Rice Husk Ash. The compressive strength at 7, 28 and 56 days have been obtained. The results of the mechanical properties of the rice husk ash at 28 days have shown quite encouraging and interesting results. The optimum replacement of rice husk ash found to be 10% in both the grades of the concrete.

## 3. FABRICATION

Coco-spathe fibers and Tamarind fruit fibers are reinforced with Epoxy matrix and composites have been developed by manual hand layup technique. These fibers were treated with NaOH (Alkali treatment) for better fiber matrix adhesion. The fiber percentages (20%, 30% and 40% by weight) were used for the preparation of hybrid composites. These natural fiber reinforced hybrid composites were then characterized by mechanical tests.

### 3.1 *Fiber Surface Treatment*

Washed and dried Tamarind fruit fibers and Coco-Spathe fibers were taken in separate trays, to these trays 10% NaOH solution was added, and the fibers were soaked in the solution for 10 hours. The fibers were then washed thoroughly with water to remove the excess of NaOH sticking to the fibers. The fibers were chopped into short fiber length of 3 mm for molding the composites. Final washing was carried out with distilled water and the fibers were then dried in sunlight for 10hrs. The below Figure 1 and Figure 2 shows before and after treatment of fibers.

Fig.1.Before treatment of tamarind fibers

Fig.2.Before treatment of tamarind fibers

### *3.2 Preparation of Composites Specimen*

After the material was prepared and the resin to hardener weight ratio carefully mixed was 80:20, the composites with varying degrees of reinforcement percentage (i.e. 20, 30 and 40) were prepared. The resin and reinforcement was mixed via manual stirring method for five minutes and the mixture was poured into a jig box to form cylindrical pins of 30 mm long and 10 mm diameter. Load was applied upon it and was left for 24 hours to cure in the box jig at room temperature (25°C). After curing the samples were taken out from the box, finished ground to required shape, sizes and placed in a sealed envelope for test.

Table 1: Number of Specimens

| Sl. No. | Epoxy Resin (%) | Composition (%) | | | Treatment | |
|---|---|---|---|---|---|---|
| | | TF | CS | CRH | Tensile Test | Compression Test |
| 1 | 80 | 6.6 | 6.6 | 6.6 | 3 | 3 |
| 2 | 70 | 10 | 10 | 10 | 3 | 3 |
| 3 | 60 | 13.3 | 13.3 | 13.3 | 3 | 3 |
| Total no. of Specimens | | | | | 9 | 9 |

## 4. EXPERIMENTATION

All experimentation were performed according to ASTM standards. These standards are taken into account of individual test performance.

### *4.1 Tensile Test*

Tensile tests were conducted using universal testing machine with across head speed of 5mm/min. In each case, three specimens were tested and average value tabulated. Tensile test specimen were cut as per ASTM D3039 test procedure. Tests were carried out at room temperature and each test was performed until tensile failure occurred. The pictorial view of specimen is shown in Fig.3.

Fig.3 Tensile test specimen

### *4.2 Compression Test*

Compression tests were conducted using compression testing machine. In each case, three samples were tested and average value tabulated. Compression test samples were cut as per ASTM D695 test procedure. Tests were carried out at room temperature and each test was performed until compressive failure occurred. The pictorial view of specimen is shown in Figure. 4.

Fig.4: Compression test specimen.

## 5. RESULT AND DISCUSSIONS

Analysis of the mechanical behaviour and moisture absorption of composites are the most important aspects. Performance testing of mechanical behaviour of composites depends on the nature of matrix material, distribution and orientation of the reinforcing fibres, nature of the fibres-matrix interfaces. Even small changes in the physical nature of the reinforcement for a given matrix may result in prominent changes in overall mechanical behaviour of the composites.

### *5.1 Tensile Test of Composites Specimens*

The tensile test of the prepared composite specimen tested in the UTM and the results are shown Table 2.

Table 2: Tensile test deformations readings.

| Sl No | Load (×0.1 KN) | Deformation for Compositions (×0.01mm) | | |
|---|---|---|---|---|
| | | 80:20 | 70:30 | 60:40 |
| 1 | 1 | 0 | 2 | 3 |
| 2 | 2 | 10 | 23 | 37 |
| 3 | 3 | 29 | 42 | 58 |
| 4 | 4 | 45 | 60 | 90 |
| 5 | 5 | 61 | 85 | 115 |
| 6 | 6 | 80 | 110 | 135 |
| 7 | 7 | 95 | 122 | 145 |
| 8 | 8 | 110 | 130 | - |

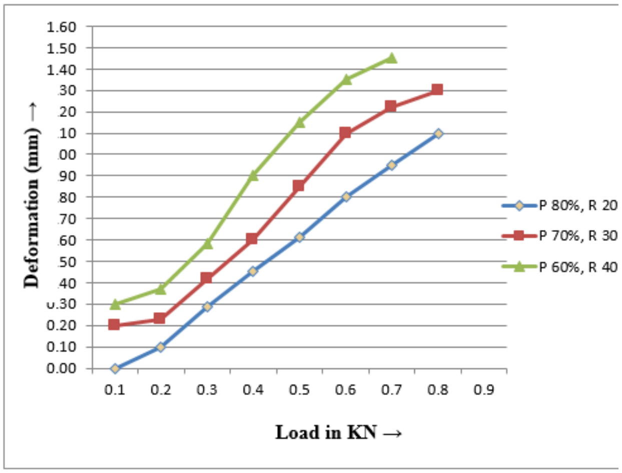


Fig. 5: Effect of tensile strength on natural composites.

The effect of tensile strength on all combination of composites is shown in Figure 5. It is observed that load sustainability of specimen increases as increase in fibre proportion. The load sustainability in P60% R40% is more when compared with P70% R30% and P80% R20%. This is due to gap between the fibre and matrix can be filled by adequate amount of powder particles so that voids can be avoided and hence when the load is applied to the specimen stress can be easily transferred fibre to matrix and gives the higher tensile strength however, the tensile strength of the other two composition gives slightly lesser tensile strength. This is decrease due to poor wettability between reinforcement and matrix leading a weak interface.

### 5.2 COMPRESIVE TEST OF COMPONENT

The compressive test of the prepared composite specimen tested in the UTM and the results are shown Table 6.

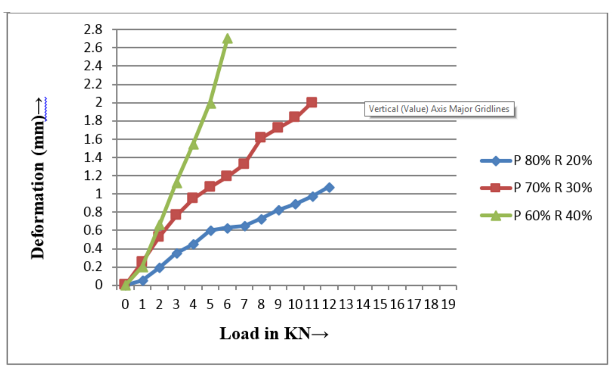


Fig. 6: Effect of compression strength on natural composites.

Table 6: Compressive test deformation readings

| Sl. No | Load (×0.1 KN) | Deformation for Compositions (×0.01mm) | | |
|---|---|---|---|---|
| | | 80:20 | 70:30 | 60:40 |
| 1 | 5 | 0 | 10 | 0 |
| 2 | 10 | 5 | 25 | 20 |
| 3 | 15 | 12 | 40 | 46 |
| 4 | 20 | 19 | 53 | 66 |
| 5 | 25 | 27 | 65 | 93 |
| 6 | 30 | 35 | 76 | 112 |
| 7 | 35 | 41 | 85 | 133 |
| 8 | 40 | 45 | 95 | 155 |
| 9 | 45 | 53 | 102 | 180 |
| 10 | 50 | 60 | 107 | 200 |
| 11 | 55 | 65 | 119 | 222 |
| 12 | 60 | 73 | 132 | 270 |
| 13 | 65 | 82 | 144 | - |
| 14 | 70 | 89 | 161 | - |
| 15 | 75 | 97 | 172 | - |
| 16 | 80 | 108 | 183 | - |
| 17 | 90 | 117 | 200 | - |

The effect of compression strength on all combination of composites is shown in Figure 6. It is observed that load sustainability of specimen increases as increase in fibre proportion. The load sustainability in P60% R40% is more when compared with P70% R30% and P80% R20%. This is due to gap between the fibre and matrix can be filled by adequate amount of powder particles so that voids can be avoided and hence when the load is applied to the specimen stress can be easily transferred fibre to matrix and gives the higher compression strength however, the compression strength of the other two composition gives slightly lesser compression strength. This is decrease due to poor wettability between reinforcement and matrix leading a weak interface.

### 6. CONCLUSION

Based on the results of the experimental investigation, Carbonized rice husk (CRH), tamarind fruit fibre(TM) and Coconut-Spathe(CS) these are the agricultural wastes generate from paddy, tamarind tree and coconut tree respectively are used as reinforcement of materials to produce polymer matrix composites (PMCs) in epoxy resin thus the use of these material for the production of composites can turn waste into industrial wealth and inevitably solved problem of storage and disposal of those wastes. There is a good dispensability of reinforcement particles in epoxy resin which improves hardness of matrix materials and also mechanical behaviour of the composite. The result of this increase in interfacial area between matrix material and reinforcement particles leading to increase in strength appreciably. It was found that tensile strength, compression strength, increases with increase in reinforcements. Finally it is concluded that composite specimens P60%, R40% exhibits better mechanical properties.

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