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Effect of Slag on Coconut Sheath Reinforced Composite

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Abstract:

This paper investigates the effect of slag on coconut sheath reinforced composites. For this purpose, the epoxy is considered as the matrix and the coconut sheath and Slag as the reinforcing material. The coconut sheets were collected from two different coconut trees and treated with NaOH solution. The specimens were prepared by using treated coconut sheaths, by keeping the weight of coconut sheath constant and varying the weight percentage of slag. The experiments have been carried out on a universal testing machine and mechanical properties such as tensile and flexural strength were evaluated. From the experimental results, it is concluded that, as the weight of Coconut Sheath constant and Slag composition increases tensile and flexural stress increases.

Keywords: **Slag; Natural fibre composites; tensile strength; flexural strength**

1. Introduction

The far reaching utilization of the fiber reinforced composites in the course of the most recent couple of years has prompted the expanded research enthusiasm in the field of fiber reinforced composites. Even though, the synthetic fibre reinforced composites have exceptional properties, Because of the high cost of synthetic fibre, the cost of processing is very high. In constrast, the utilization of natural fibres prompts reduction in weight, and cost, however the mechanical properties of natural composites are much lower as compared to synthetic fibre composites [1]. In the past, Luo and Netravali [2] presented the mechanical and thermal properties of unidirectional, degradable, environment-friendly “green” composites made from pineapple fibers and poly(hydroxybutyrate-co-valerate) (PHBV) resin. They investigated the Tensile and flexural properties of the “green” composites with different fiber contents in both longitudinal and transverse directions. They concluded that, the tensile and flexural strength are higher in longitudinal direction and lower in transverse direction. Sapuan et al. [3] presented the tensile and flexural properties of composites made from coconut shell filler particles and epoxy resin.they conducted the tensile and flexural tests by varying the filler percentages i.e., 5%, 0% and 15%. Their results reveal that the increase of filler percentage increases the tensile and flexural strength. Ramaraj and Poomalai [4] considered Poly(vinyl alcohol) (PVA) composites with 10, 20, 33, and 50 wt % of coconut shell (CCS) powder.they prepared as films and tested for physicomechanical properties such as tensile, tear, burst strengths, density, moisture content, moisture vapor transmission rate, moisture analysis; solubility resistance in water, 5% acetic acid, 50% ethanol, sunflower oil; swelling characteristics in 50% ethanol, sunflower oil; and thermal characteristics by differential scanning calorimetry.

Ramanjaneya Reddy et al. [5] studied the optimization of stacking sequence of laminated composite plates using Distance based optimal design of experiments in the design of experiments technique and artificial neural networks. They concluded that the artificial neural networks predicts accurate results with the finite element results. Olumuyiwa Agunsoye et al. [6] evaluated the morphology and mechanical properties of coconut shell polyethylene composite to establish the possibility of using as a new material for engineering applications. They prepared the composite by varying the volume fraction with 5% to 25%. Their results show that hardness of the composite increases with increase in coconut shell content, though the tensile strength, modulus of elasticity, impact energy and ductility of the composite decreases with an increase in the particle content. Vikas Dhawan et al. [7] studied the effect of rice husk, wheat husk, and coconut coir as filler on the mechanical characteristics of Glass fibre reinforced composites. They observed that the natural fillers give better results when embedded in polyester-based composites. Duroway et al.[8] developed an engineering material for industrial application using coconut shell and palm fruit particulate polyester. They evaluated the mechanical properties such as ultimate tensile strength and impact strength and hardness. They concluded that the tensile strength was 70MPa and highest impact strength was 4.6J and the highest hardness was 20.

Vinod kumar et al.[9] investigated the effect of coconut fibre and glass fibre on the mechanical properties like tensile strength, impact strength and hardness. They concluded that, the addition of coconut fibre (coconut fibre/glass fibre) gives the better impact strength and no improvement in tensile strength and hardness. Murthy Chavali et al. [10] made composite with matrix as high-density polyethylene (HDPE) and filler as the coconut shell powder. Coconut shell powder was mixed with HDPE via compounding of coconut shell powder and HDPE of HDPE and Coconut shell powder.They investigated their mechanical properties and compared with the conventional composite made from the coconut shell powder used as reinforcement and high-density polyethylene (HDPE) which was used as a matrix. They concluded that the resulting material can be used in the applications of Aerospace and Automobile etc.

The present work is concerned with the study of the effect of slag on coconut sheath reinforced composites. For this purpose, the epoxy is considered as the matrix and the coconut sheath and Slag as the reinforcing material. Specimens were prepared by using treated coconut sheaths of different trees with NaOH. The specimens were prepared by keeping the weight of coconut sheath constant and varying the weight of slag. Mechanical properties like Tensile and Flexural were evaluated.

2. Materials

Coconut sheath is a long, soft fiber it is in the form of mat, strong threads. It is naturally woven type fibers that can be found in the branches of the coconut tree. Coconut Sheath fiber is one of the most affordable natural fibers and variety of uses of fibers. Coconut sheath fiber is the second most important fiber after cotton due to its versatility. Fig 1. Shows the coconut sheath collected from the coconut tree.

Fig 1: coconut sheath.

3. Chemical Treatment of fibre with NaOH

In the present work, the fibers were treated with NaOH to increase the wet-ability and to remove impurities present in the fiber. The fibers were then treated with 5% NaOH per one litre of water solution for 5 hours. The fibers are then washed thoroughly with distilled water. Fibers are then dried in atmosphere for 24 hours to remove any traces of moisture. Fig 2. Shows the chemical treatment of coconut sheath.

Fig 2. Shows the chemical treatment of coconut sheath.

4. Fabrication of composite with Hand layup technique

Hand Layup Method is used for fabricating the natural fiber composites. The base plate is fixed inside the frame to fabricate the resin, hardener mixture and remaining natural fibers used. The mixed resin and hardener is filled in the pattern. The prepared natural fibers are randomly poured in the resin, hardener mixture without any gap. The roller is rolled in the mould. Again the mould is filled in pattern by next layer and fibre are placed in the mould. This process is simultaneously done till the height of 3mm and the Slag is to be uniformly distributed. The plane plastic paper is placed on the top of the frame to distribute the load evenly on the mould. Then plastic sheet is placed on the mould again rolling is done. Then it is kept for 24 hours, after that specimen is taken off from the mould. This process is repeated for different weight percentages of Slag as 5%, 10%, 15%, 20%, 25% and Coconut Sheath fibre weight is constant i.e 3gms some mould releasing agent like wax is used for easy removal of specimen from the mould. Fig 3. Shows the specimens used for tensile and flexural tests.

Fig 3. Prepared specimens for tensile and flexural tests

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5. Mechanical Characterization

The fabricated samples are cut to suitable dimensions as per ASTM standard for mechanical characterization. On the prepared specimens the following tests were performed. The fabricated samples were prepared on weight percentage of fiber shown in Table 1.

Table 1:Weight percentage of fibre

Slag weight Percentage	4	8	12	16	20
Coconut sheath weight percentage	3	3	3	3	3
Epoxy weight percentage	73	69	65	61	57

5.1 Tensile test

The tensile strength of a material is the maximum amount of longitudinal stress that it can take before failure. The commonly used specimen for tensile test is prepared as per ASTM D638 standard of specimen dimension. The testing process involves placing the test specimen in the testing machine and applying tension to it until it fractures. The tensile force is recorded as a function of the increase in gauge length. During the application of tension, the elongation of the gauge section is recorded against the applied force. The tensile test is performed in universal testing machine (UTM). The tensile strength is a measure of strength and ductility of the material. Ultimate tensile strength is the force required to fracture a material. The tensile strength can be experimentally determined by the given formula. The Tensile test is performed on flat specimens following ASTM test standard in the universal testing machine. In each case five samples are taken and average values are reported in Table 2 and 3. Fig 4. Shows the machine used for tensile test. Fig 5 and 6 shows the tensile test specimen before test and after testing of the specimen.

Table 2: Sheath1

Sl. No.	Slag (grams)	Maximum Load (N)	Tensile stress (MPa)	Tensile strain
1	4	470.32	9.01	0.01117
2	8	329.13	10.92	0.00333
3	12	485.14	16.17	0.00684
4	16	782.92	26.10	0.00617
5	20	817.38	27.25	0.00600

Table 3: Sheath2

Sl. No.	Slag (grams)	Maximum Load (N)	Tensile stress (MPa)	Tensile strain
1	4	504.39	9.01	0.00400
2	8	185.35	10.92	0.00233
3	12	172.01	16.17	0.00283
4	16	643.80	26.10	0.00450
5	20	327.65	27.25	0.00200


Fig 4: Tensile test Machine


Fig 5: tensile test specimen before test


Fig 6. Tensile test specimen after test

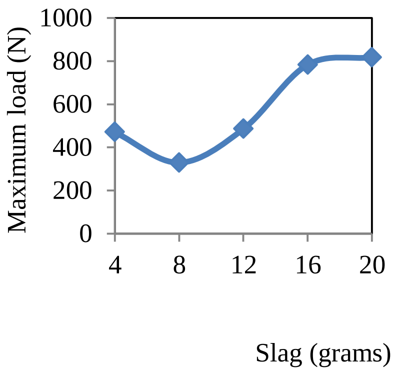

Fig 7: Variation of Maximum load against slag for sheath 1.

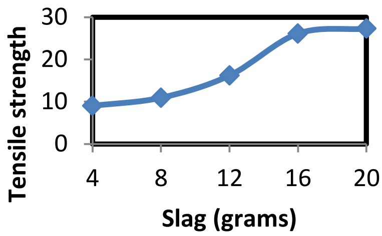

Fig 8: Variation of Tensile strength against slag for sheath 1.

From Fig 7 and 8 it is observed that As the weight of Coconut Sheath constant and Slag composition increases, increases the load and tensile strength.

5.2.Flexural test

Flexural characteristics represent the flexibility of the materials and good flexural strength indicates the materials have brittle properties and high hardness. Flexural strength behaved with a similar trend to tensile strength behaviour; fiber content has the highest stress to resist deformation under flexural condition.Table 4 and 5 shows the variation of flexural modulus with the slag in sheath 1 and sheath 2.

Table 4. Sheath 1

Sl. No	Slag (gms)	Maximum Load	Maximum Stress	Flex Modulus
1	4	0.06	34.42	3716.26
2	8	0.08	46.66	4007.13
3	12	0.10	53.42	6213.72
4	16	0.12	64.28	9986.80
5	20	0.13	71.58	10098.6

Table 5: sheath 2

Sl. No	Slag (gms)	Maximum Load	Maximum Stress	Flex Modulus
1	4	0.05	34.42	5046.86
2	8	0.09	46.66	6294.30
3	12	0.07	53.42	4422.94
4	16	0.07	64.28	6291.12
5	20	0.08	71.58	4725.09

From Table 4 and 5, it is observed that the Flexural stress increases with increase of slag. The variation of flexural modulus are also presented in Table 4 and 5.

6. Conclusions

The following conclusions are drawn from experimental observation:

- Hand Layup technique has been successfully implemented to process the Coconut Sheath Fiber Reinforced Epoxy Composites.
- The tensile strength of the Coconut Sheath fiber reinforced epoxy composites increases gradually with increase in weight percentage of Slag.
- The maximum strength of the Coconut Sheath Fiber Reinforced Epoxy composites is observed at 20gms of Slag weight in sheath-1
- From the experimental observation, it is concluded that tensile strength is inversely proportional to elongation.

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