International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 04 | April - 2022 Impact Factor: 7.185 ISSN: 2582-3930

Design and Performance Testing of Brown Grass Flower Broom Reinforced Composites

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ABSTRACT

Broom-grass is a perennial, high value, non-perishable cash crop for wide range of agro-climatic conditions. It is a multipurpose species which provides brooms, fuel, fodder, and has high soil conservation value. In this work, the natural fibre reinforced composite which consists of polymeric matrix with natural reinforcing fibres (matrix + brown grass flower plant fibre) will be fabricated using the hand layup technique. The samples are prepared using the fibres and epoxy, which are handled differently in the processing. Fibre gives reinforcement and the matrix act as a binder, so as to support and protect the fibres and provide a means of distributing load between the fibres. Mechanical properties are being determined by conducting various destructive tests on the brown grass fibre composite material specimens.

Keywords: Broom-grass, matrix, hand layup technique, epoxy, composite.

1. INTRODUCTION

1.1 COMPOSITE MATERIAL SIGNIFICANCE

Composite material signifies that two or more materials are combined on a macroscopic scale to form a useful material. Composite materials exhibit best qualities of their constituents and often some qualities that neither constituent possess. The properties that can be improved by forming a composite material include the following **(5)**:

- Strength
- Stiffness
- Corrosion resistance
- Wear resistance
- Attractiveness
- Weight
- Fatigue life

- Temperature-dependent behavior
- Thermal insulation
- Thermal conductivity
- Acoustical insulation

1.2 CLASSIFICATION OF COMPOSITE MATERIALS

Broadly, composite materials can be classified into three groups on the basis of matrix material, they are:

- Metal Matrix Composites
- Ceramic matrix Composites
- Polymer Matrix Composites

1.3 COMPOSITE PROCESSING

Composites can be made with fibres as mats and as aligned assemblies impregnated with matrix polymer.

Table 1.1 Various Fibres With Their Manufacturing Methods (6)

Plant fibre	Plant fibre% wt.	Max. total fibre % wt	Manufacturing method
Bamboo	15–35	40	Injection moulding
Bamboo	9–15	30	Compression moulding
Banana	25–37	40	Vacuum impregnation & hand-layup
Coir	30	45	Pre-preg and punch pressing
Flax	20–44	50	Hot pressing
Jute	16–33	75	Filament winding
Jute	14.5–31	30	Hand lay-up
Jute	25–27	35	Compression moulding
Oil palm	4–36	40	Vacuum impregnation
Oil palm	8–32	40	Pre-preg & Intermingled mats
Palmyra	48	48	Hand lay-up
Sisal	6–14	20	Compression moulding
Sisal	2–6	14	Hand lay-up
Sisal	4–16	20	Injection moulding after
Flax	6–31	41	Compression moulding

1.4 MATRIX

The resins that are used in fibre-reinforced composites are sometimes referred to as 'polymers'. All polymers exhibit an important common property in that they are composed of long chain-like molecules consisting of many simple repeating units. Manmade polymers are generally called 'synthetic resins' or simply 'resins'. Polymers can be classified under two types, 'thermoplastic' and 'thermosetting', according to the effect of heat on their properties.

2. BROWN GRASS FLOWER PLANT (THYSANOLAENA MAXIMA) AND FIBRE

2.1 VERNACULAR NAMES OF BROWN GRASS FOLWER PLANT

Jhadughas (Hindi), Amliso (Nepali), Taza(Nishi), Kamgang (Adi), Eppane—Nani (Apatani), Phool Jhadu (Assamese), Bouquet grass, Tiger grass (English).

Amliso is a popular non-timber forest product. It is used to make sweeping brooms, leaves provide good fodder and the stems provide fuel. It has mat-like roots that bind the soil firmly, preventing soil erosion **(7).**

Figure 2.1: Out grown Thysanolaena maxima (Tiger Grass), for commercial use

Brooms are required in each house, therefore, it has sufficient demand throughout the country and marketing is not a problem. The majority of the production is from subsistence farming areas and dispersed collection from the forest, which are inaccessible to transport networks and markets. It is a high volume crop and there is glut in the market during the harvesting season which reduces the local price. Whole sale trading of brooms is a highly monopolized activity **(7).**

Figure 2.2: Tiger Grass Farming, Broom Making and Marketing

3. EXPERIMENTAL PROCEDURE

The raw material selected for the present experimental work is broom grass flower as reinforced components and (AralditeAW 106) as resin, (HV 953 IN) as hardener, releasing agent (wax and plastic sheets) **(1)**.

The present experimental work consists of two phases namely.

1. Preparation of the natural fibre (brown grass flower) reinforced composite material **(3)**

2. Tensile test testing, flexural strength testing, compressive strength testing, hardness test testing, Impact testing of the composite material **(3)**

Figure 3.1: showing of obtaining, washing, drying of brown grass flower from local broom (2)

Fibre is being obtained from locally available brown grass flower broom, properly washed, and cleaned and sundried (2). The composites were produced with broom grass flower as reinforced components and (Araldite-AW 106) as resin, (HV 953 IN) as hardener (1).

3.1 Metal moulds for sample preparation

The test specimens were prepared with different sample composites for compression test and tensile test. The GI sheet moulds of dimensions are 20x2x1 cm^3 for compression test and 30X3X1.5 cm^3 for tensile test specimen **(2).**

Fig: 3.2 GI moulds for tensile test specimens (2)

Figure: 3.3 GI moulds for compression test (2)

The GI sheet moulds of dimensions: 15X2X1 cm^3 for Flexural test and hardness test are being prepared **(1).**

Figure: 3.4 GI Moulds for Flexural and Hardness test specimen (1)

The GI sheet moulds of dimensions: 15 cm X 2 cm X 1 cm for impact test are being prepared **(3).**

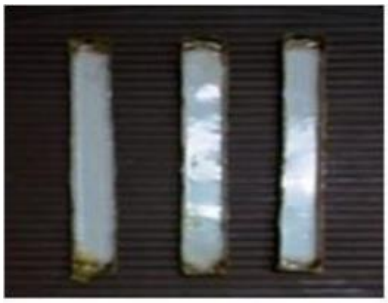

Figure: 3.5 GI Moulds for impact test specimens (3)

3.2 Steps involved in preparation of samples:

1) The mould selected for the preparation of samples is being cleaned and dried. Then release wax is being applied and being allowed to dry so that the casting can be removed easily **(2)**.

2) Formula used for deciding quantities of hardener and resin is: weight of fibre=X% of weight of Resin and hardener collectively.(WF= X% of WR+H)**(2)**

3.3 For producing tensile test and compression test specimen

- For tensile test mould size 30x3x1.5 cm& 20x2x1cm is filled with water, the volume of the water is being calculated, it's around 135cc & 40 cc **(2)**.
- Volume of water collected is being weighed it's around 170gm & 50 gm **(2)**.
- Varying % of fibre 10%, 12%, 14%, 16%, 18%, 20%, 22% is being taken for preparing various samples for tensile& compression test**(2)**.
- The manufacturer of resin specifies that these two constituents' hardener HV 953 and araldite AW106 should be taken in ratio of 100:100 by volume **(4)**.

3.4 For producing Flexural and Hardness test specimen

1) The mould selected for the preparation of samples is being cleaned and dried. Then release wax is being applied and being allowed to dry so that the casting can be removed easily **(1)**.

2) Formula used for deciding quantities of hardener and resin is: weight of fiber =X% of weight of Resin and hardener collectively.(WF= X% of WR+H) **(1)**

3) For flexural test mould size 15X2X1 cm is filled with water, the volume of the water is being calculated, it's around 30cc 4) Volume of water collected is being weighed it's around 38 gm **(1)**.

5) Varying % of fibre 10%, 12%, 14%, 16%, 18%, 20%, 22% is being taken for preparing various samples for tensile & compression test. 6) The manufacturer of resin specifies that these two constituents' hardener HV 953 and araldite AW106 should be taken in ratio of 100:100 by volume **(1)**

3.5 For producing Flexural and Hardness test specimen

1) The mould selected for the preparation of samples is being cleaned and dried **(3)**.
2) Then release wax is being applied and being allowed to dry so that the casting can be removed easily**(3)**.
3) Formula used for deciding quantities of hardener and resin is: weight of fibre=X% of weight of Resin and hardener collectively. [WF= X% of W(R+H)] **(3)**.
4) For impact test mould size 15 cm X 2 cm X 1 cm is filled with water, the volume of the water is being calculated, it's around 30 cc, Volume of water collected is being weighed it's around 38 gm **(3)**.
5) Varying % of fibre 10%, 12%, 14%, 16%, 18%, 20%, 22% is being taken for preparing various samples for impact test **(3)**.

NOTE: ALL SAMPLES PREPARED FOR ALL THE ABOVE TESTS WERE SENDED TO CIPET RAIPUR, FOR STANDARD TESTING

4. RESULTS AND DISCUSSION

4.1 Variation of tensile strength with respect to fibre %

It can be seen from the graph on Fig. 4.1 that as the fiber weight fraction increased to 10%, the tensile strength shows remarkable increase. Then as the fiber weight fraction continually increased, the tensile strength of the composites slightly started showing decreasing variations**(2)**.

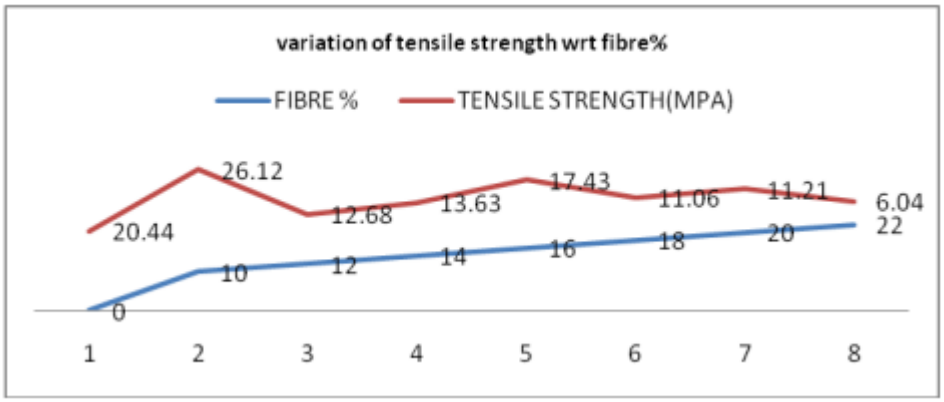

Figure 4.1: Showing variation of tensile strength with respect to fibre %(2).

It is clear that tensile strength of the composites increased with increasing in percentage of fiber weight fraction upto 10% compared to pure resin sample, and presented the highest average value of 26.12MPa at fiber weight fraction 10%, and the lowest of 6.04MPa at fiber weight fraction 22%**(2).**

4.2 Variation of compressive properties with respect to fibre %:

This test is conducted to determine the compressive properties of the material particularly composites.
The result for various combinations is shown graphically in Fig.4.2 **(2).**

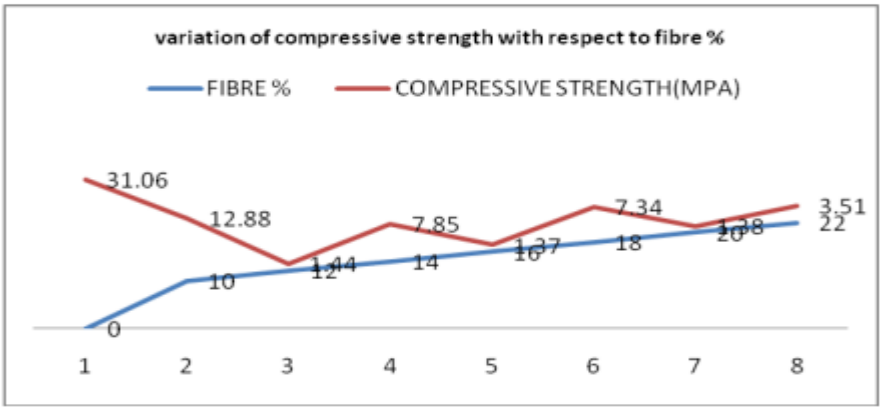

Figure 4.2: Showing variation of compressive strength with respect to fibre %(2).

It can be seen from the graph on Fig. 4.2, that as the fiber weight fraction increased to 10%, the compressive strength shows remarkable increase. Then as the fiber weight fraction continually increased, the compressive strength of the composites slightly started showing decreasing variations. It is clear that compressive strength of the composites increased with increasing in percentage of fiber weight fraction upto 10% compared to pure resin sample, and presented the highest average value of 12.88MPa at fiber weight fraction 10%, and the lower of 1.37MPa at fiber weight fraction 16%**(2).**.

4.3 Variation of flexural strength with respect to fibre %:

It can be seen from the graph on Fig4.3 that as the fiber weight fraction increased to 10%, the flexural strength shows remarkable increase. Then as the fiber weight fraction continually increased, the flexural strength of the composites slightly started showing decreasing variations. It is clear that flexural strength of the composites increased with increasing in percentage of fiber weight fraction upto 10% compared to pure resin sample, and presented the highest average value of 149.56MPa at fiber weight fraction 10%, and the lowest of 30.1MPa at fiber weight fraction 16%**(1).**

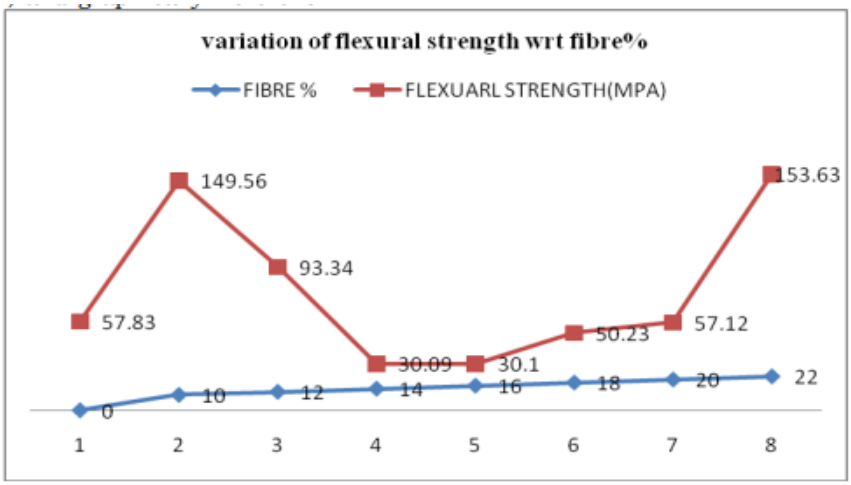

Figure 4.3: Showing Variation of flexural strength with respect to fibre %(1)

4.4 Variation of hardness with respect to fibre %:

The Rockwell hardness test is a measurement based on the net increase in depth of impression as a load is applied. In the Rockwell method of hardness testing, the depth of penetration of an indenter following application of a minor load and a major load is measured. Here flexural test result for brown grass flower broom fiber composites with variation of fiber weight fractions were presented in Fig.4.4 ,**(1).**

It can be seen from the graph on Fig. 4 that as the fiber weight fraction increased to 10%, the hardness strength shows remarkable increase. Then as the fiber weight fraction continually increased, the hardness strength of the composites slightly started showing decreasing variations and as soon as on 20% & 22% variation there is slight increase in hardnessstrength. It is clear that hardness strength of the composites increased with increasing in percentage of fiber

weight fraction up to 10% but less than compared to pure resin sample, and presented the highest average value of R58.45 at fiber weight fraction 10%**(1).**

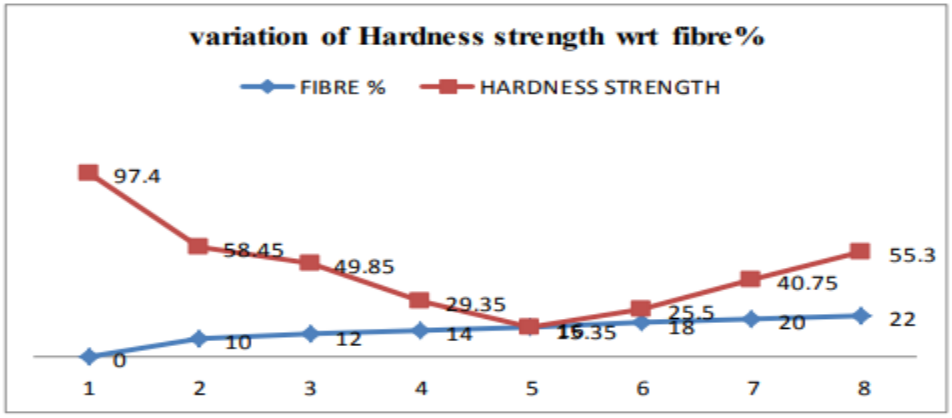

Figure 4.4: Showing Variation of hardness strength with respect to fibre %(1)

4.5 Variation of hardness with respect to fibre %:

IZOD IMPACT TEST RESULTS: Fibre concentration, in which we can observe maximum value of impact strength is at 10%, 14%, 16%, 18%, 20% in which 18% has got highest value, on other percentage scale 0%, 12%, 22% has lowest value**(3)**.

CHARPY IMPACT TEST RESULT: Fibre concentration, in which we can observe maximum value of impact strength is at 12%, 14%, 18%, 20% in which 20% has got highest value, on other percentage scale 0%, 10%, 16%, 22% has lowest value**(3)**..

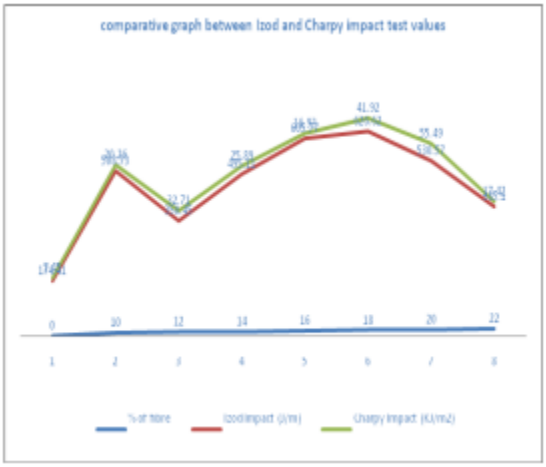

Figure 4.5: Showing Variation of hardness strength with respect to fibre % (3).

5. CONCLUSIONS AND SCOPE FOR FUTURE STUDIES

This study leaves wide scope for future investigations. It can be extended to newer composites using other reinforcing phases and the resulting experimental findings can be similarly analyzed. Tribological evaluation of brown grass flower broom fibre reinforced epoxy resin composite has been a much less studied area. There is a very wide scope for future scholars to explore this area of research.

(a) New method of manufacturing employing spraying technique, compression moulding or other effective way may be developed; where the percentage of fibre use is increased by maintaining homogenous distribution of resin in our principal fibre.

(b) The strength can be increased by surface treatment of fibre.

(c) The hybrid composite can be manufactured.

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