"MECHANICAL PROPERTIES OF UNTREATED JUTE FABRIC REINFORCED POLYESTER LAMINATES WITH ALKALI TREATMENT"

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Abstract - *In recent years, the improvement of properties of natural fibre reinforced laminates over the pure polymeric matrix has been thoroughly investigated with the aim of providing a possible replacement of E-glass fibre reinforced composites for some large-volume applications. In the present study, the properties of a jute/polyester laminate are compared with those yielded by two E-glass fibre. The laminates are made by using jute fabric reinforced polyester by treated and non treated method, the mechanical tests are being carried out on the treated and non treated jute fibre composite work pieces and which have been alkali treated those resulted properties are compared with the E-glass fibre reinforced laminates properties.*

Key Words: jute fabric laminate, E-glass laminates, shear strength test and falling weight impact test.

1. INTRODUCTION

The most important types of natural fibres used in composite materials are flax, hemp, jute, kenaf, and sisal due to their properties and availability. Jute is an important bast fibre with a number of advantages. Jute has high specific properties, low density, less abrasive behaviour to the processing equipment, good dimensional stability and harmlessness. Jute textile is a low cost eco-friendly product and is abundantly available, easy to transport and has superior drapability and moisture retention capacity. It is widely being used as a natural choice for plant mulching and rural road pavement construction. The biodegradable and low priced jute products merge with the soil after using providing nourishment to the soil. Being made of cellulose, on combustion, jute does not generate toxic gases.

The natural fibres can be used to reinforce both thermosetting and thermoplastic matrices. Thermosetting resins, such as epoxy, polyester, polyurethane, phenol, etc. are commonly used today in natural fibre composites, in which composites requiring higher performance applications. They provide sufficient mechanical properties, in particular stiffness and strength, at acceptably low price levels.

Natural fibres can be considered has better than the synthetic fibres,due to its flexurl modulus and impact strength along with this natural fibres are environmentally friendly and biodegradable, easily available.Natural fibres are can be used widely because of its lowcost and high performance and which fulfils the economic needs of industries. T Berhanu P.Kumar &I singh Jute fibre reinforcement polypropelene composite.It was found that the tensil strength and flexural strength were maximum at 40% weight of jute fibre.

1.1 PMC MANUFACTURING PROCESSES

1.1.1 Wet Lay-up/Hand Lay-up Method

The hand (wet) lay-up is one of the oldest and most commonly used methods for manufacture of composite parts. Hand lay-up composites are a case of continuous fibre reinforced composites. Layers of unidirectional or woven composites are combined to result in a material exhibiting desirable properties in one or more directions. Each layer is oriented to achieve the maximum utilization of its properties. Layers of different materials (different fibres in different directions) can be combined to further enhance the overall performance of the laminated composite material. Resins are impregnated by hand into fibres, which are in the form of woven, knitted, stitched or bonded fabrics. This is usually accomplished by rollers or brushes, with an increasing use of nip-roller type impregnators for forcing resin into the fabrics by means of rotating rollers and a bath of resin. Laminates are left to cure under standard atmospheric conditions. A typical hand lay-up method is shown in Figure.

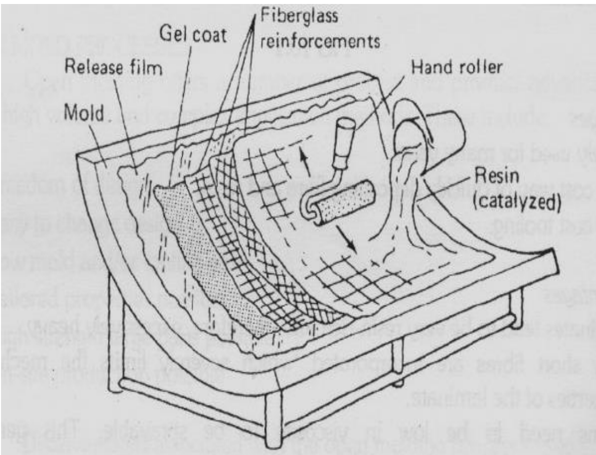

Figure 1.1: A Typical hand lay-up method

2. EXPERIMENTAL WORK

Manufacturing of jute fiber laminates

2.1 Materials and methods

This chapter describes the details of processing of the composites and the experimental procedures followed for their characterization and evaluation. The materials used in this work are:

1. JUTE Fibers.
2. Poly Vinyl Alcohol (PVA)
3. Polyester Resin.
4. Methyl ethyl ketone peroxide (MEKP)(used as catalyst) commonly called Hardener (K6).

2.1.1 Preparation of Mould

For making the composite laminate, a mould was prepared with mild steel with 300 mm×300 mm and 10mm thickness of the base plate and 10 mm mould cavity.

2.1.2 Alkali Treatment of Jute Fabrics

- The jute fabrics were cut to 300*300 mm and were soaked in a 750 ml of NaOH solution.
- The fabrics were kept immersed in the alkali solution for 8 h.
- Then the fibres were dried at room temperature for 48h.

2.1.3 Preparation of Composite

- By hand laying technique:
- A 7 mm thick plate was made from the polyester mixed with the cobalt naphtha ate and hardener taken in the proportion of 1000 and 20 parts by weight respectively
- The mixture of polyester resin with the given %s of hardener and cobalt naphtha ate were applied in between treated jute fabric pieces to get alternate layers of resin matrix and jute fabric reinforcement.
- The laminate prepared was subjected to a load of25 -30kgs.
- Then it was left under the load for8-12hrs so that uniform distribution of resin mixture was ensured.
- The specimens were then cut from the composite for flexural tests and tensile test with the help of hacksaw or cutting machine.

Fig 2.1Preparation of the Composite

Then a compression pressure of 0.05MPa was applied on the mould and the composite specimens were cured for 24 h. After curing, the jute fiber laminate was removed from the mould it was cut into samples for tensile test with dimensions of. 300 mm x 30 mm x7(±.5) mm are cut as per specifications of the ASTM D 3039. Samples for the flexural test from the laminate are also cut in the dimension of 200 mm x 40mm x7(±.5) mm.

Figure 2.2: Preparation of specimen

3. RESULTS AND DISCUSSIONS

Testing of jute fiber laminates

The prepared laminates are then cut into the required dimensions and then tests are conducted on the specimen. Multiple specimens are prepared to cancel out any human error to be observed.

3.1 TESTING OF SPECIMENS

3.1.1 Tensile test

The tensile test is performed in the universal testing machine (UTM) 1195 and results are analyzed to calculate the tensile strength of composite samples. The tensile test is generally performed on flat specimens. During the test a uni-axial load is applied through both the ends of the specimen. The ASTM standard test method for tensile properties of fiber resin composites has the designation D 3039-76. The length of the test section is 120 mm approximately. The test specimen was cut into 300 mm x 30 mm x7(±.5) mm specifications for all three types of jute fiber laminates.

- The tensile strength (σ) is given by σ = F/ b h
- Where,
- F: load
- b: width of the sample
- h: thickness of the sample.

3.1.2 Flexural Test

The short beam shear (SBS) tests are performed on the composite samples at room temperature to evaluate the value of flexural strength (FS). It is a 3-point bend test, which generally promotes failure by inter-laminar shear. The SBS test is conducted as per ASTM standard (D2344- 84) using the same UTM. Span length of 150 mm was maintained. The flexural strength (F.S.) of any composite specimen is determined using the following equation.

The equation to calculate flexural strength is

$$F.S = 3PL/2bt^2$$

Where,

P is the load applied

L is the span length

b is the width and

t is the thickness of the specimen.

RESULTS

Composite laminates have been prepared with the same volume fraction of the fiber for all the laminates and have been tested by cutting them into required dimensions to perform tests. All the tests have been performed on the specimens and results obtained from the experiments have been tabulated and It is clearly observed that the NaOH treatment improves the tensile strength and Energy to Break Point. An improvement in the tensile strength of the 5 layer fibre composites was observed with increasing from 285.59 MPa in the case of untreated fibre and fibre treatment by NaOH , 8hours. This can be understood that the removal of the hemicellulose and a part of the lignin by alkali treatment can increase the interfacial adhesion between the matrix and NaOH treated fibre.

3.1 Experimental Results for Tensile strength of Untreated and treated specimens.

Specimen	Ultimate tensile strength of untreated specimen(MPa)	Ultimate tensile strength of treated specimen(MPa)
I	109.28	196.71
II	112.4	371.57
III	113.65	288.51
Average	111.7	285.59

However, at higher alkali treatment time (6hr, 8hr), the tensile strength of the composites was observed to level off. It is possible that the fibres became rigid and somewhat brittle afterwards owing to the development of crystallinity causing high strength and low extensibility. On application of stress, these fibres suffered breakage due to increased brittleness and could not take part in effective stress transfer at the interface, thus lowering the strength of the composites. Therefore, the treatment condition of NaOH, 8 hours was found to be the optimal for the treatment. The ILSS of the composites after alkali treatment was 285.59 MPa in contrast to 111.77MPa for the composites with E-glass fibres. An improvement of 173.82 MPa was measured.

3.2 Experimental Results for Flexural strength of Untreated and treated specimens.

Specimen	Flexural strength of untreated specimen(MPa)	Flexural strength of treated specimen(MPa)
I	33.78	50.67
II	22.52	67.56
III	33.78	56.307
Average	58.18	91.931

Loss in weight was observed after the alkali treatment of the fibres, due to heavy dissolution of the hemicellulose content. This had resulted in the drop of linear density of the fibres when treated for 8 hours due to the creation of voids in the fibre structure, the strands became well separated and dispersed. The crystallinity of the fibres was observed to have increased only after 8 h treatment. It was imperative that the fibres became stiff and brittle on account of its high strength and low extensibility

The NaOH treatment of jute fibres leads to changes in shrinkage or mechanical properties like tensile modulus and tensile strength (under isometric conditions) dependent on the NaOH concentration. NaOH concentration and allowed shrinkage during the alkali treatment are the most significant treatment parameters, as far as mechanical fibre properties are concerned. Other treatment parameters with comparatively smaller effects are temperature and time, if treatments are carried out for more than approximately 5 min. The mechanical properties of composites prepared from Fibres treated with alkali NaOH Solution are included.

The composites prepared with fibres treated for 8 h showed maximum improvements. The ILSS of the composites after alkali treatment was 91.931 MPa in contrast to 58.18 MPa for the composites with untreated fibres. An improvement of 33.751 MPa was measured.

3.3 Comparison for Tensile strength and flexural strength of treated jute and E-Glass.

TEST	JUTE	E-GLASS
TENSILE TEST	196.711	102.72
	371.56	130.345
	288.51	140.085
FLEXURAL TEST	50.67	101.311
	67.56	90.055
	56.307	84.426

The tension test performed on the specimens from the laminates prepared revealed that the Jute fiber can withstand higher loads in tension when compared to E-Glass. The ILSS of the composites after alkali treatment was 285.59 MPa in contrast to 124.388 MPa for the composites with E-glass fibres. An improvement of 161.202 MPa was measured. The bending test revealed that the specimens made from Jute fiber Lower loads when compared to E-Glass fiber.The ILSS of the composites after alkali treatment was 58.18MPa in contrast to 91.9311MPa for the composites with E-glass fibers. A degradation of 33.75 MPa was measured.

4. CONCLUSIONS

- The Idea of preparing laminates of composite materials has been achieved.
- The observations that was made was the exothermic reaction that takes place between the hardener, catalyst and the resin which gives out heat while preparing the laminate which in turn raises the temperature of the mold.
- The tension test performed on the specimens from the laminates prepared revealed that the Jute fiber can withstand higher loads in tension when compared to untreated jute fiber.
- The bending test revealed that the specimens made from Jute fiber Higher loads when compared to untreated jute fiber.
- The tension test performed on the specimens from the laminates prepared revealed that the Jute fiber can withstand higher loads in tension when compared to E-Glass.
- The bending test revealed that the specimens made from Jute fiber Lower loads when compared to E-Glass fiber.
- We see some of the values as scattered which can be accounted for by the manufacturing process used (Hand Lay up) due to which human errors could have crept in.
- As per the values arrived at by the experimentation the application of the laminates can be decided.

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