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1. Project reference number: 46S_BE_2111

2. Title of the project: "EXPERIMENTAL INVESTIGATION ON MECHANICAL BEHAVIOR OF JUTE AND E-GLASS FIBER REINFORCED EPOXY COMPOSITE FILLED WITH FLY ASH AS FILLER MATERIAL"

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5. Keywords: Fly ash, woven jute fiber, hybrid composite,

6. Introduction

A composite material can be defined as a combination of two or more constituent materials with different physical or chemical properties. And which remain separate and distinct on microscopic or macroscopic level within the finished structure. In other words, the constituents do not dissolve or merge into each other, although they act together to form a single material.

The engineering importance of a composite material is that to or more distinctly different materials combine together to form a composite that is either superior or important in some other manner to the properties of the individual components. Most composites have been created to improve combinations of mechanical characteristics such as stiffness, toughness, ambient and high temperature strengths, wear resistance and also aesthetic properties.

Most composites are made up of just two materials. Representing as matrix and reinforcement. The matrix surrounds and binds together a cluster of fibers, particles, or fragments of a much stronger material called the reinforcement. The following examples illustrate the matrix and the reinforcement phase, and how their combination results in better properties.

Composites are now extensively being used for rehabilitation strengthening of pre-existing structures that have to be retrofitted to make them seismic resistant, or to repair damage caused by seismic activity. Unlike conventional materials (e.g., steel), the properties of the composite material can be designed considering the structural aspects.

7. Objectives

- The main aim of the project work is to fabricate the hybrid composites and to study the different strength of the prepared composite materials
- To fabricate the hybrid composite materials using hand layup method
- To prepare the specimens according to ASTM standards
- To determine the ultimate, impact, hardness and flexural strengths of the hybrid composite materials
- To study the failure patterns

8. Methodology

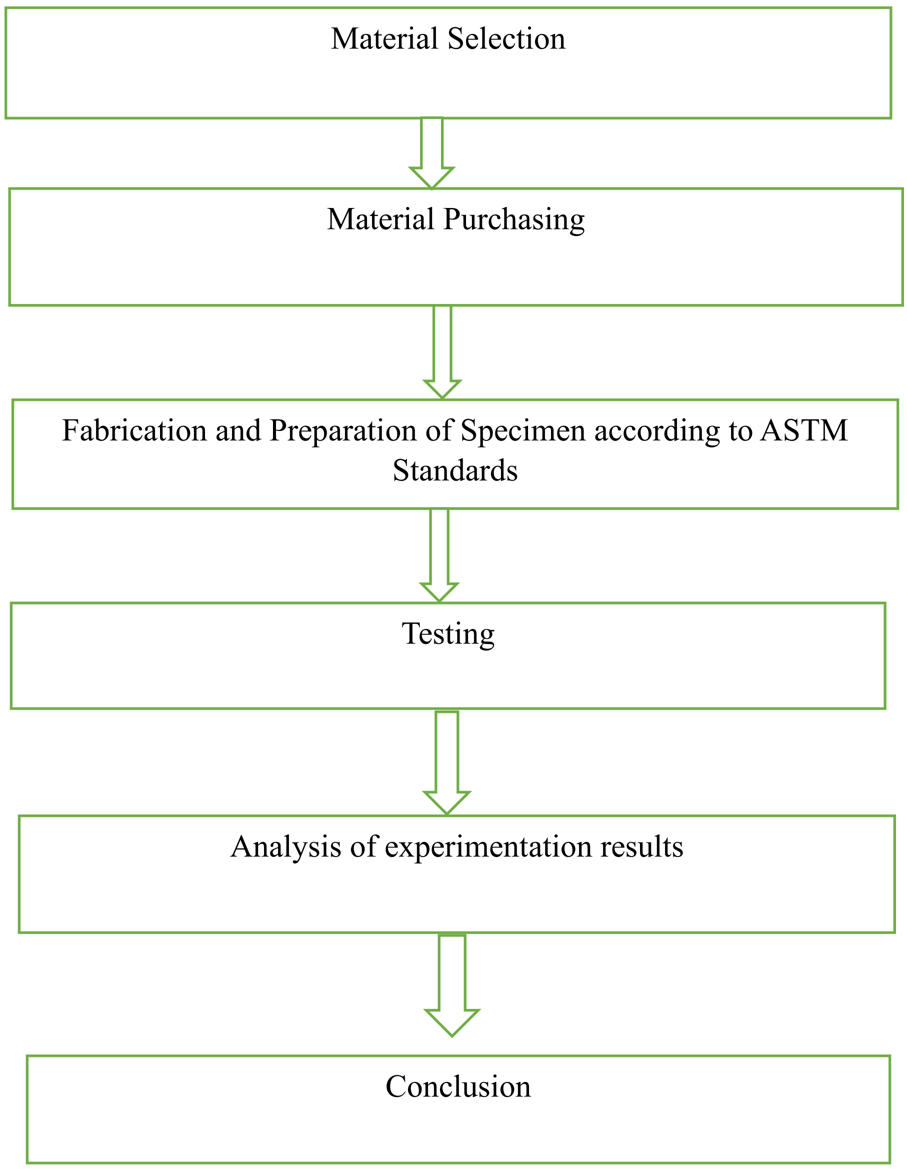

Figure 1: Flow Chart of methodology

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

MATERIALS USED

1. Jute fiber

2. E Glass

3. Epoxy resin (L12)

4. Hardener (K6)

5. Fly ash

Hand lay-up technique

Hand lay-up technique is the simplest method of composite processing. The infrastructural requirement for this method is also minimal. The processing steps are quite simple. First of all, a release gel is sprayed on the mould surface to avoid the sticking of polymer to the surface. Thin plastic sheets are used at the top and bottom of the mould plate to get good surface finish of the product. Reinforcement in the form of woven mats or chopped strand mats are cut as per the mould size and placed at the surface of mould after Perspex sheet. Then thermosetting polymer in liquid form is mixed thoroughly in suitable proportion with a prescribed hardener (curing agent) and poured onto the surface of mat already placed in the mould.

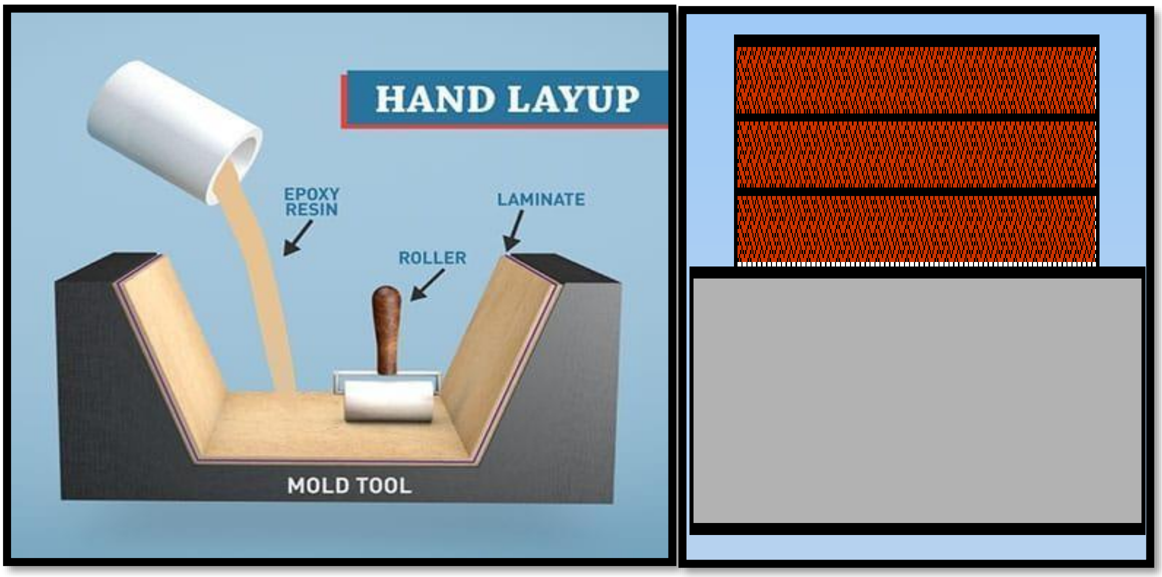

Figure 2: Schematic Diagram of hand lay-up process

The polymer is uniformly spread with the help of brush. Second layer of mat is then placed on the polymer surface and a roller is moved with a mild pressure on the mat-polymer layer to remove any air trapped as well as the excess polymer present. The process is repeated for each layer of polymer and mat, till the required layers are stacked. After placing the plastic sheet, release gel is sprayed on the inner surface of the top mould plate which is then kept on the stacked layers and the pressure is applied

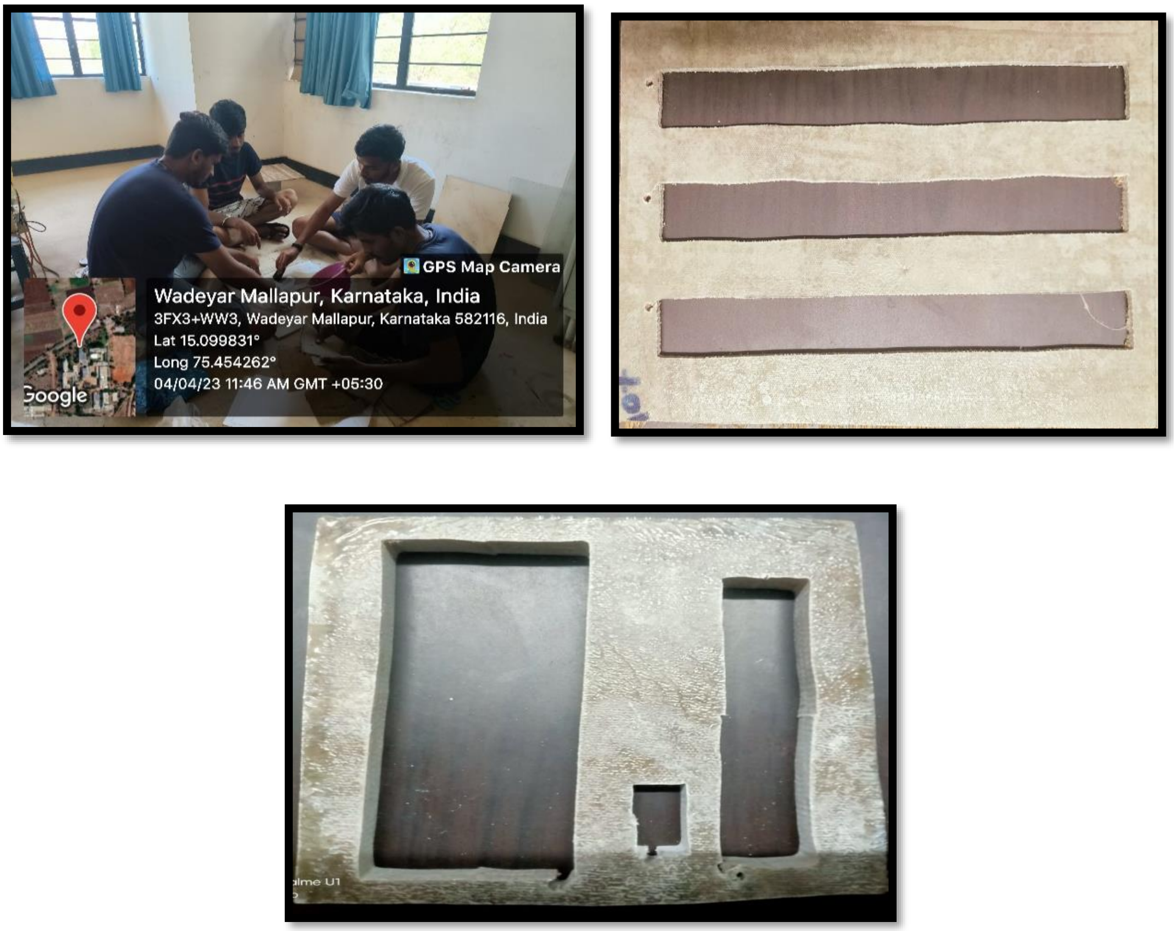

Figure 3: Sample Preparation by hand lay-up process

Figure 4: Tested Specimens

Designation of Composites

Material Designation	Fibres % (Jute + E-Glass)	Epoxy (%Volume)	Filler Materials (%Volume)
GJE	50	50	NIL
$GJEF_1$	50	45	5 (Fly ash)
$GJEF_2$	50	40	10 (Fly ash)

9. RESULTS

ULTIMATE TENSILE STRENGTH TESTING

Composite materials	Sample 1 (KN)	Sample 2 (KN)	Average in (KN)
GJE	18.78	16.50	17.64
$GJEF_1$	16.38	16.74	16.56
$GJEF_2$	15.60	15.36	15.48

Table 1. Experimental results for Ultimate Tensile Strength

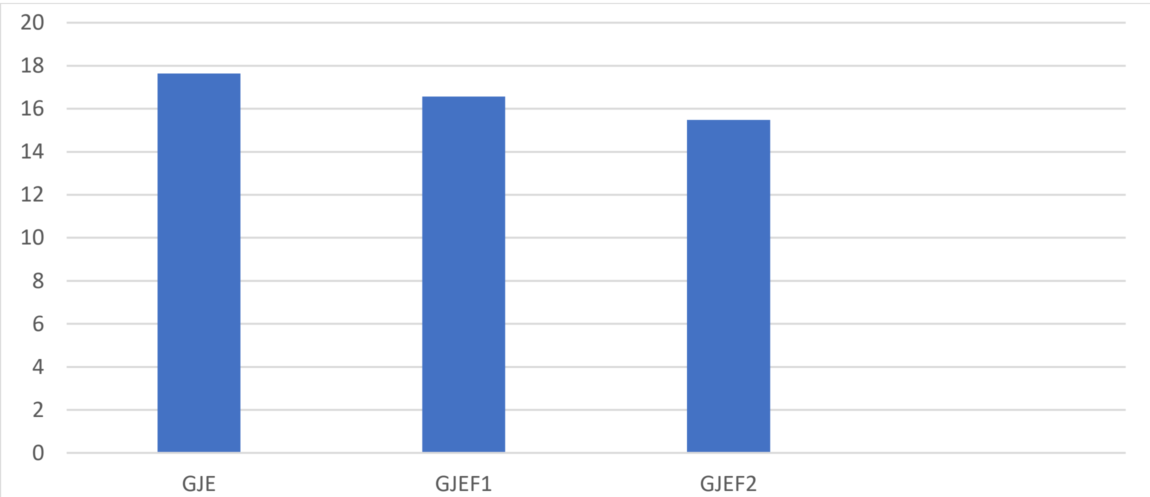

Figure 5: Composite material vs Ultimate Tensile Strength (KN)

The result of the tensile test conducted on the fabricated composite specimen are displayed in the graph shown in the Figure 5. The results reveals that decrease in Ultimate tensile strength upon increasing the filler content may be due to the voids that may have been created by the air entrapment by the nano sized fly ash. This phenomenon makes this composite unsuitable for structural applications.

CHARPY IMPACT TEST

Composite materials	Sample 1	Sample 2	Sample 3	Average
GJE	20	12	20	17.5
$GJEF_1$	28	18	24	24
$GJEF_2$	26	28	32	28.66

Table.2 Experimental results for Charpy Impact Test

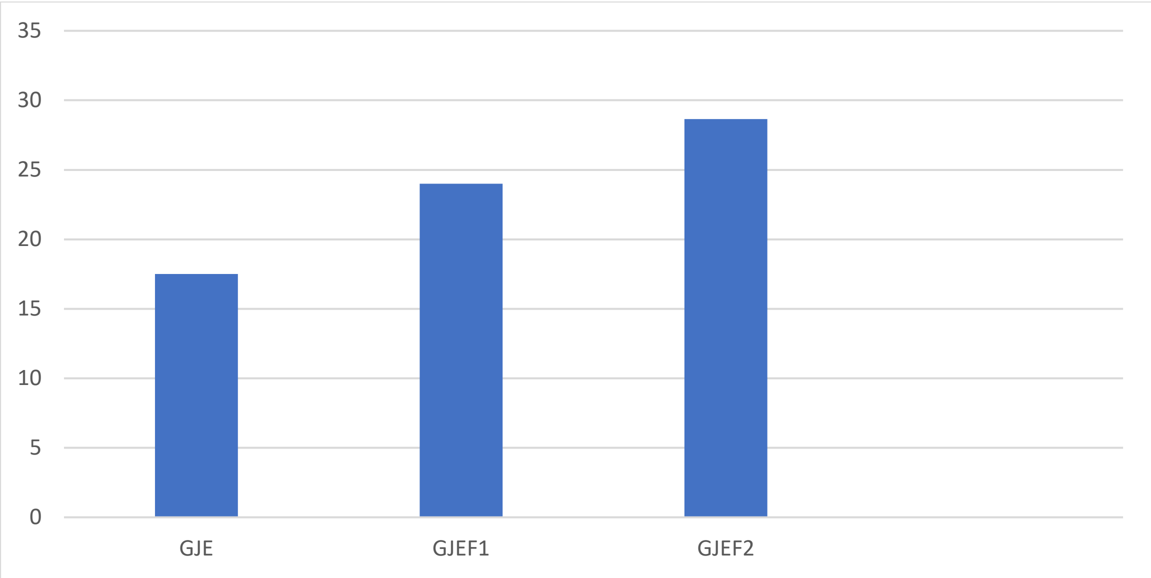

Figure 6: Composite material vs Impact Resistance Strength

From figure 6. it is observed that impact strength increases with increase in addition of filler content in the composites. This may be due to the good compatibility of filler and epoxy resin. The maximum impact strength was observed when composite filled by 10% vol. of Fly ash ($GJEF_2$) .This is due to that good bonding strength between filler, matrix, fiber and flexibility of the interface molecular chain resulting in absorbs and disperses the more energy,

FLEXURAL TESTING

Composite materials	Sample 1 (KN)	Sample 2 (KN)	Average in (KN)
GJE	9.78	8.94	9.36
$GJEF_1$	9.96	11.16	10.56
$GJEF_2$	11.04	12.36	11.7

Table.3 Experimental results Flexural Testing

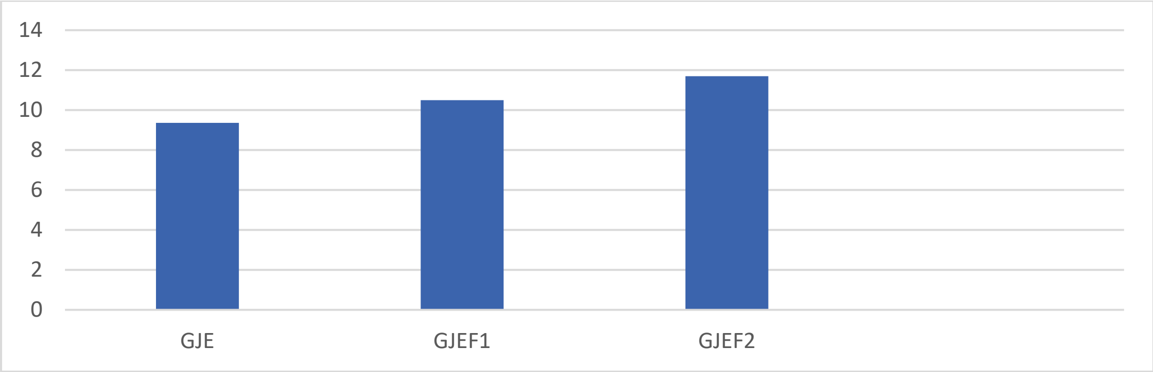

Figure 7.Composite material vs Ultimate Flexural Strength (KN)

The variation of flexural strength of composite materials is shown in Figure 7.It is interesting to note that flexural strength increases with increase in addition of filler content. This may be due to the good compatibility of filler and epoxy resin. Remarkable improvement in flexural strength was observed in $GJEF_1$ and $GJEF_2$.

HARDNESS TEST RESULTS

Three trials were conducted on different locations of the sample and the average values are tabulated. The average Rockwell hardness test results are tabulated as shown in Consistent hardness test results can be obtained by testing at least three samples of the same composition.

ROCKWELL HARDNESS NUMBER

Composite materials	Trail 1	Trail 2	Trail 3	Average
GJE	15.2	9.3	11.1	11.86
$GJEF_1$	30.2	30.4	21.2	27.26
$GJEF_2$	74.2	83.2	84.1	80.5

Table 4 Experimental results Hardness test

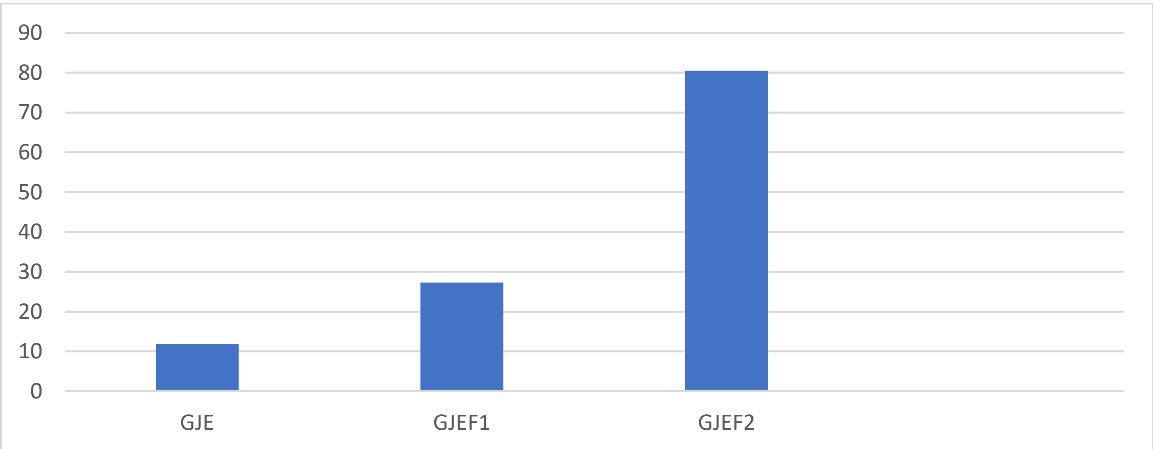

Figure 8. Composite material vs Rockwell Hardness Number

The experimental results show that composite filled by 10 % vol. of Fly ash exhibits the maximum hardness number when compared with the other filled composites this due to uniform dispersion of filler particles and good bonding strength between fiber and matrix. It is noted that hardness of the composites increases with increase in addition of Fly ash filler Content because decrease in inter particle distance and with increasing particle loading in the matrix results in increase of resistance to indentation.

CONCLUSION

1. The results reveals that decrease in Ultimate tensile strength upon increasing the filler content may be due to the voids that may have been created by the air entrapment by the nano sized fly ash.
2. The hardness of the composite filled by 10 % vol. of Fly ash exhibits the maximum hardness number when compared with the other filled composites. This is because of the carbon content present in the fly ash. Also the particle size plays a vital role to increase the material density, which improves the hardness of the material.
3. From the experimental results it was observed that flexural strength increases with increase in the addition of filler content. Composite with 10%vol. Fly ash filled ($GJEF_2$) composite shows the better flexural strength.
4. The impact strength of composite material increases with increase in addition of filler materials. Composite with 10%vol. Fly ash filled ($GJEF_2$) shows the maximum impact strength.
5. The results of this research points out that, fly ash an industrial waste can be used effectively to produce light weight composites with good mechanical Hence, the newly fabricated composite material can be used as an alternative material in automobile, electronics, machine tool, Construction, Aircraft and sports Industries.

10. Future scope

1.To develop and characterise a new combination of composites to suit wide range of applications.

2. To investigate the mechanical, thermal and fire resistance behaviour of new class of composites.

3. To study the effect of filler materials on the mechanical, thermal and fire

resistance properties of composites