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# Mechanical Characterisation of Basalt Based Composite Materials

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***ABSTRACT:*** *The very fast developments in technology of composite materials have led to newer and wider applications of such promising materials. Composite materials offer a number of potential advantages in the aerospace field, particularly in safety-critical structures such as primary and secondary aircraft components. Here Basalt Fiber as a reinforcement and Epoxy (Di-Ethylene Glycidel Ether BisPhenol-A) as a matrix for making a Composite Material have been chosen. Basalt provides high strength than the commercial Glass fiber. It provides high heat resistance. Since this material is having a great Scope in Space application it has been choosen for determining Mechanical characterisation of this materials. Tensile Test , Bending Test have been carried out for this purpose. Specimens have been preferred with and without addition of Aluminium with Epoxy. The results are compared and it has been studied that Aluminium increases the strength of the specimens in the above mentioned tests.*

***Key Words****: Basalt Fiber, Epoxy, Tensile Test, Bending Test*

## I. INTRODUCTION

In a fast developing country the Engineering place an important role for wealth and development. This Engineering includes Designing, Manufacturing, maintenance and control. For a Successful implementation of a particular task the primary decision is important. So in designing and Manufacturing Engineers important role is material selection. Before selecting the material they must consider the following requirement as mentioned below.

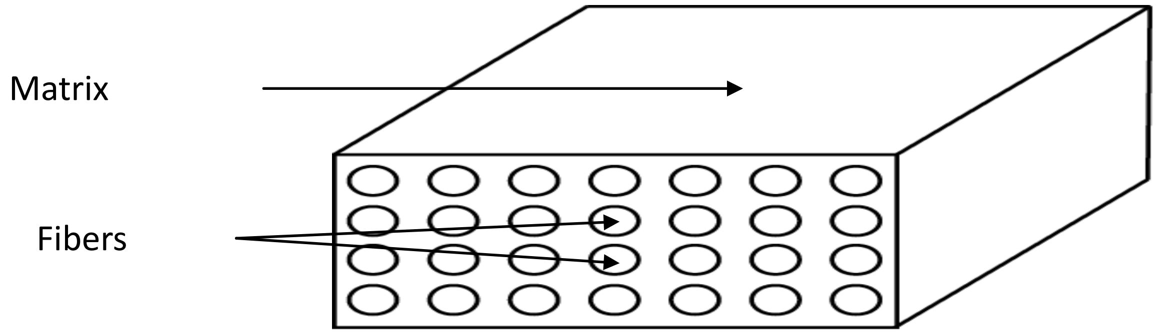
| | |
|---|---|
| **Mechanical & Thermal:**<br>High strength<br>High elastic elongation<br>High shear strength<br>High modulus<br>High toughness/impact strength<br>High heat distortion temp.<br>Low creep at use temp.<br>Thermal expansion near fiber<br>Resistance to thermal degradation<br>Low thermal conductivity | **Processing Characteristics:**<br>Low enough melt or solution viscosity and surface tension to permit thorough fiber wet-out<br>Good flow characteristics<br>Rapid cure or solidification<br>Suitable for precoated reinforcement<br>Cure temp. not greatly above use temp.<br>Low shrinkage during and after molding<br>Long shelf life and pot life |
| **Chemical Properties:**<br>Good bond to fiber (directly or with coupling agent)<br>Resistance to solvents & chemicals<br>Low moisture absorption | **Other Factors:**<br>Low cost<br>Low density<br>Low dielectric constant |

## II. LITERATURE SURVEY

Prof. Jiří Militký and Martin Černý(2006) focused on unidirectionally reinforced basalt fibre composites with a matrix derived by partial pyrolysis at 650 –750°C from commercially available polysiloxane precursors. The composite pyrolysed at 650 °C revealed the best room temperature properties. Van de Velde K.,Kiekens.P(2008) Used basalt as a reinforcement of Composite Material. They mainly used Basalt(as crushed rock) in construction, industrial and high way engineering. One can also melt basalt (1300-1700°C) and spin it into fine fibres. When used as (continuous) fibres, basalt can reinforce a new range of (plastic and concrete matrix) composites.Professor G. L. Sheldon describes work carried out to produce commercially useful fibre from the basalt which occurs as an enormous outcrop in Idaho, Oregon and Washington in the United States of America.

## III. COMPOSITES

Composites are combinations of two materials in which one of the material is called the reinforcing phase, is in the form of fibers, sheets, or particles, and is embedded in the other material called the matrix phase. Typically, reinforcing materials are strong with low densities while the matrix is usually a ductile or tough material. If the composite is designed and fabricated correctly, it combines the strength of the reinforcement with the toughness of the matrix to achieve a combination of desirable properties not available in any single conventional material.




### 3.1 Basalt Fiber as a Reinforcement

Basalt is well known as a rock found in virtually every country round the world. Basalt Rock fibres have no toxic reaction with air or water, are non-combustible and explosion proof. Basalt base composites can replace steel and known reinforced plastics. Basalt Fibre is a material which is made from the extremely fine fibres of the Basalt, which composed of Pyroxene, minerals plagioclase and Olivine. This is very much similar to the Carbon Fibre and the Fibre Glass, which is having better Physicomechanical properties than the fibreglass, but which is being significantly cheaper that the Carbon Fiber. Basalt rock (Deccan Trap) an area of about 500,000square KM cover largepart of the Maharastra,Kutch, Saurashtra,Gujarat,Decan,Central India, Maharastra etc,


Fig 3: Basalt Conversion Process

Table 1. Chemical Composition of Basalt Fiber

| **Chemical compound** | **% weight of basalt** |
|---|---|
| $SiO_2$ | 49,58 |
| $TiO_2$ | 2,08 |
| $Al_2O_3$ | 14,48 |
| $Fe_2O_3$ | 4,42 |
| FeO | 9,43 |
| $Na_2O$ | 1,89 |
| MgO | 5,10 |
| CaO | 8,50 |
| MnO | 0,17 |

**3.2 Matrix**

Matrix are used to bind the fibers and provide sufficient strength. Normally matrix includes resin and Hardener. **Polyester resin** tends to have yellowish tint, and is suitable for most backyard projects. Its weaknesses are that it is UV sensitive and can tend to degrade over time, and thus generally is also coated to help preserve it. It is often used in the making of surfboards and for marine applications. Its hardener is a MEKP, and is mixed at 14 drops per oz. **Vinylester resin** tends to have a purplish to bluish to greenish tint. This resin has lower viscosity than polyester resin, and is more transparent. This resin is often billed as being fuel resistant, but will melt in contact with gasoline. **Epoxy resin** is almost totally transparent when cured. In the aerospace industry, epoxy is used as a structural matrix material or as a structural glue. **Di Glecedyl Ether Bis Phenol-A** has been chosen for manufacturing a composite material. The Chemical structure of the Resin is given below

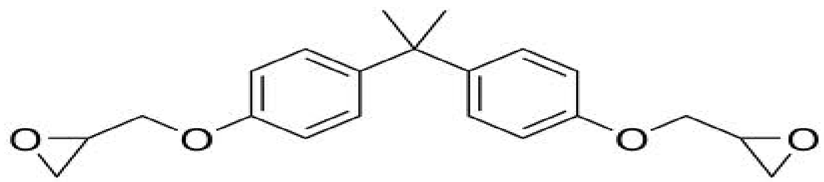


Fig 4 : Atom Structure of DGEBA

## IV. SAMPLE PREPARATION

The sample should be prepared as per the ASTM's standard so that it is easy to compare the result with the result which is already used. The following Samples are to be prepared as per our requirement,

a) Tensile test Specimen with Aluminium
b) Tensile Test Specimen without Aluminium
c) Bending Test Specimen With Aluminium
d) Bending Test Specimen without Aluminium
e) Fig 5: Tensile Test Specimen

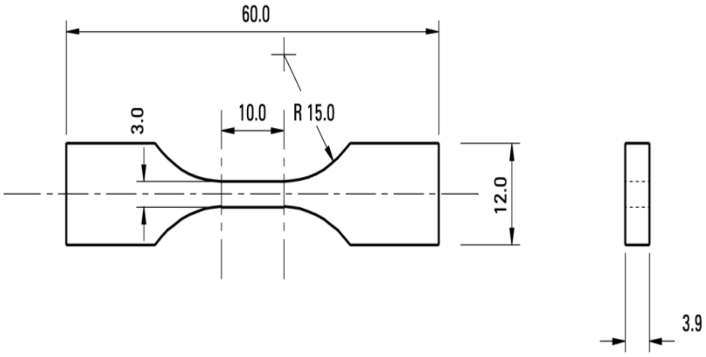



Fig 5: Tensile Test Specimen

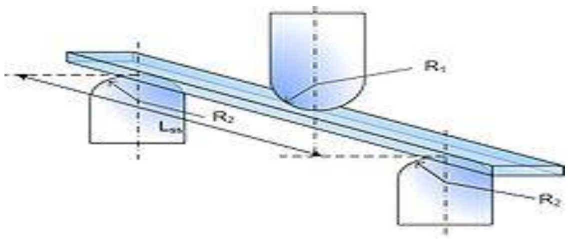



Fig 6: Bending Test Specimen

## V. TESTINGS

- Materials are tested /inspected for one more of the following purposes.
- To assess numerically the fundamentals mechanical properties of the materials e.g. Ductility, Malleability, hardness, toughness, brittleness etc.

- To determine data that is stress values (deformation force) which break the specimen upon which engineer can base his design.
- To determine suitability of material/products for a particular application.

For the above reason the following tests are to be carried out ,

a) Tensile Test
b) Bending Test

**5.1 Tensile Test:**

Tensile tests are normally carried out in Universal Testing Machine. The Parameters to be found out during Tensile tests are Young's Modulus, Ultimate Stress, Peak Load, Stress-Strain Plot and Yield Strength. Many materials display linear elastic behavior, defined by a linear stress-strain relationship.

**5.1.1 Test Results**

Gauge length : 25 mm
Rate : 5 mm/min
Area : 77.256 sq-m
Peak Stress :59.364 Mpa
Peak load : 3.727 kN
Yield Strain : 0.72
Modulous : 9.825 GPa

Gauge length : 25 mm
Rate : 5 mm/min
Area : 78.256 sq-mm
Peak Stress :46.362 Mpa
Peak load : 3.497 kN
Yield Strain :1.22
Modulous : 8.192 GPa

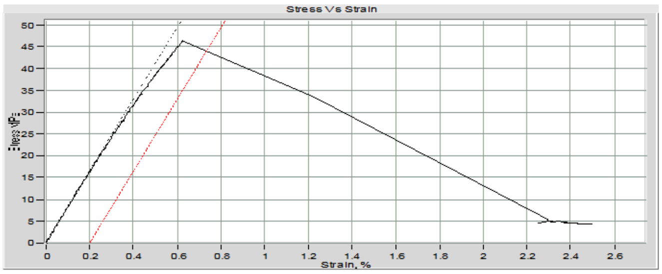


Fig 7: Universal Testing Machine

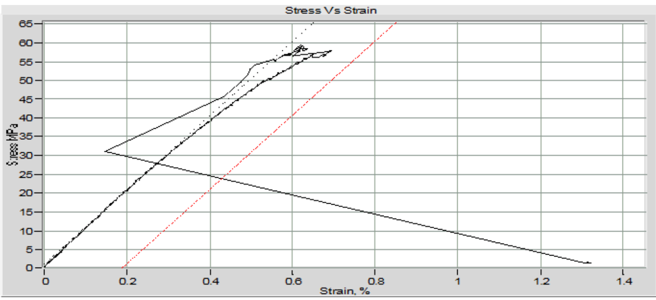


Fig 8: Tensile Test With Aluminium

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Fig 9: Tensile Test Without Aluminium

**5.2 Flexure/ Bending Test**

Flexure/bend testing is also known as transverse testing, modulus of rupture testing, 3-point bend testing and 4-point bend testing. It is a way of determining the flexural strength of how something will react when it is being bent, and we do this by supporting the specimen by two bearing surfaces and applying an axial compressive load at its centre by either a third bearing load, or a further two bearing load points.

**5.2.1 Results**

| | |
|---|---|
| Scan Rate | : 5.536069 Hz |
| Stroke | : 35 mm |
| Load | : 25.09 kN |
| Strain | : 5.3253 mm |
| Set point | : 35 mm |

| | |
|---|---|
| Scan Rate | : 5.536069 Hz |
| Stroke | : 35 mm |
| Load | : 25.09 kN |
| Strain | : 5.3253 mm |
| Set point | : 35 mm |

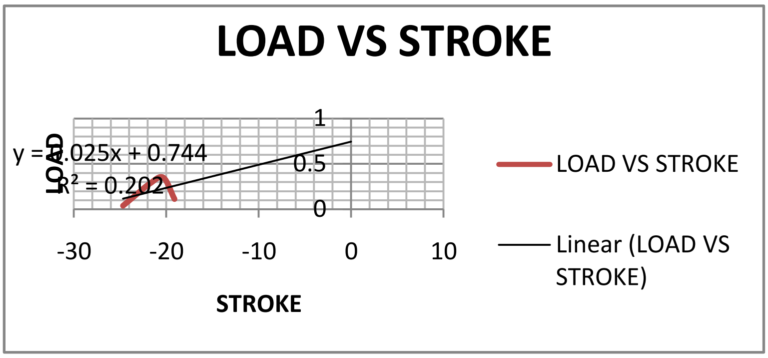


**Fig 9 : Force-Deflection Curve with Aluminium**

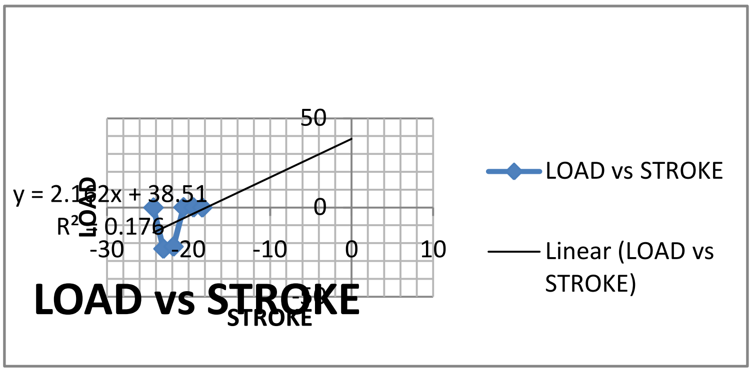


**Fig 10 : Force-Deflection Curve without Aluminium**

## VI. RESULTS AND DISCUSSIONS

From the Tensile test the following results have been obtained,

With Aluminium

**Average Peak Stress = 49.03 Mpa**

**Average Youngs modulus = 10.3 GPa**

Without Aluminium

**Average Peak Stress = 43.22 Mpa**

**Average Youngs modulus = 8.5 GPa**

By Comparing the Above two results we conclude that Peak Stress increases by adding 5% Aluminium as filler material.

Similarly from the Bending test the following results have been obtained. Average load which the material can carry during the load is given by,

**Specimen with Aluminium as filler : 0.33 kN**

**Specimen without Aluminium : 0.22 kN.**

The Radius of Curvature during Bending also Increases in the Specimen with Aluminium as filler. So We Concluded that the Bending Stress increases by adding Aluminium.

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