Evaluation of Mechanical Properties of Basalt based Composite Structures

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Abstract

Composite materials are one of the major developments in material technology.it is necessary to find out the suitable substitute with low weight, low density, high strength, low cost of material and possess better mechanical properties. Composite materials have extensive applications such as transport industry, aerospace, automobile industry, marine applications. Our composite laminates are prepared by combination of basalt & chopped strand reinforced with epoxy resin with the help of hand lay-up technique. Basalt fiber having properties such as low density, low cost, and environmentally safe and chopped strand is a synthetic fiber having properties such as electrical and fire insulation, moisture resistance, corrosion resistance etc.,

INTRODUCTION

A composite material is defined as a material system which consists of a mixture or a combination of two or more distinctly different materials which are insoluble in each other and differ in form or chemical composition. Thus, a composite a material is labeled as any material consisting of two or more phases .many combinations of materials termed as composite materials, such as concrete. mortar, fiber, reinforced plastics, fiber reinforced metals and similar fiber impregnated materials. Basalt fiber is material made from extremely fine fibers of basalt, which is composed of the minerals plagioclase, pyroxene and olivine.

It is similar to fiberglass, having physic -mechanical properties than fiberglass, but being significantly cheaper than carbon fiber. It is used as a fireproof textile in aerospace and automotive industries and can also be used as a composite to produce products such as camera tripods.

Chopped strand materials available as a roll stock product produced in varieties of weights and widths to suitable applications.

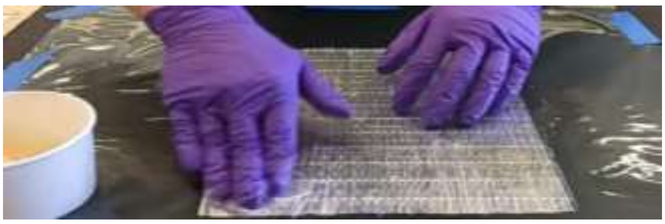
Keywords: chopped strand mat, basalt fiber, hand lay-up method

FABRICATION METHOD

Hand Lay-Up

Hand lay-up technique is the simplest method of composite processing. The infrastructural requirement for the method is also minimal. The processing steps are quite simple. First of all, a release gel is sprayed on the mold surface to avoid the sticking of polymer to the surface. Thin plastics sheet is used at the top and bottom of the mold 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 mold size and placed at the surface of mold after Perspex sheet Then thermosetting polymer in liquid form is mixed thoroughly in suitable proportion with a prescribed hardener (curing agent) and poured on to the surface on plat already placed in the mold. The polymer is uniformly spread with the help of brush. Second layer of mat is then placed on the polymer surface on a roller is moved with a mild pressure on the mat- polymer layer to remove any air trapped as well as the excess epoxy present .the process is repeated for each layer of epoxy and mat, till the required layers

Layers are stacked after placing the plastic sheet, release gel is sprayed on the inner surface of the top mold plate which is then kept on the stacked layers and the pressure is applied. After curing either at room temperature or at specific temperature, mold is opened and the developed composite part is taken out and further processed.



Hand Lay-Up Method

FABRICATION OF COMPOSITES

Basalt fiber and chopped strand reinforced composite bars are fabricated by using hand lay-up as above shows. The composite bars consist eight layers and each composite have different orientations like different positioning of layers are only basalt(8),only chopped strand(8) are two composites and changing the position of layers one by one of basalt (4) and chopped strand (4) getting remaining three composites

In the fabrication process basalt fiber, chopped strand, epoxy (LY556IN) and hardener (HY951IN) used fabricate the composite bars.

For basalt:

Weight % of fiber 47%

Weight % of matrix 52%

For chopped strand:

Weight % of fiber 32%

Weight % of matrix 67%

Epoxy and hardener are mixed continuously, now polishing cover is placed on plain surface then apply the epoxy on the polishing cover with help of brush.

- In the first composite structure one basalt layer is placed, and applying epoxy on the fiber. Similarly the second, third, fourth, fifth, sixth, seventh, and eighth basalt layers are arranged.
- In the second composite structure one chopped strand layer is placed, and applying epoxy on the fiber similarly all the eight layers are arranged.
- In the third composite structure one basalt and one chopped strand layers are placed one on the other and it is repeated for all layers.
- In this composite structure four layers of chopped strand is placed with two basalt layers on either side.
- In this composite structure four layers of basalt is placed with two chopped strand layers on either side.

Sample	Structure
S1	B_8
S2	C_8
S3	$(BC)_8$
S4	$B_2C_4B_2$
S5	$C_2B_4C_2$

After applying the epoxy on either side of composites placing another polishing cover on the surface of composite bar and squeezers squeezing on the polishing cover for removing air bubbles from composite structure and it is solidified for 24 hours, after solidification the composites are cut in to required dimensions.

After fabrication

TESTING

- **Izod Impact Test**

IZOD impact testing machine is used to test the impact properties of five composite specimens. The impact testing machine has four working ranges of 0-2.71J, 0-5.42J, 0-10.84J and 0-21.68J with a minimum revolution on each scale. The revolutions are 0.02J, 0.05J, 0.1J and 0.2J respectively. R1, R2, R3, R4 hammers are provided on the scale for all the above working ranges

Impact Testing Machine

To test the specimen by using Izod machine, a v-notch is provided with sharp file with an included angle of 45º at the center of specimen the depth of the specimen below the notch is 10.5± 0.05 mm. Based on the composite specimen R2 hammer is selected conduct the test. The hammer was fixed to the pendulum and is contacted with the specimen on a line 22mm above the top surface of the clamping vice. The sample was fixed to the vice in a vertical cantilever beam position such that the v-notch spaces the striking edge of the hammer the pendulum hammer was released from its locking position. Th pendulum was at an angle of 150º. The energy was indicated in joules by the pointer on the scale.

Impact Strength = Energy Absorbed /Cross Sectional Area At Notch

Specimen Dimensions:-

S1 = 75× 12.5× 3.5

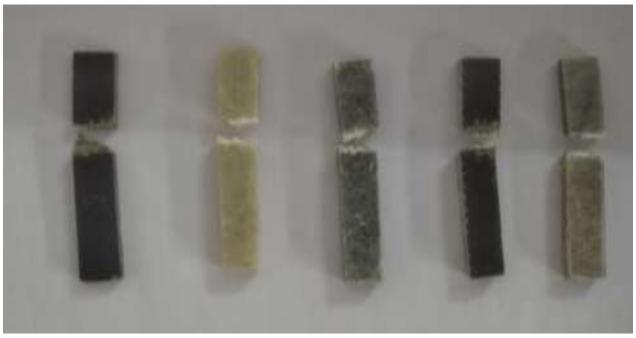
S2 = 75×12.5× 6

S3 = 75× 12.5× 6

S4 = 75× 12.5× 6

S5 = 75× 12.5× 5

Impact Testing Results

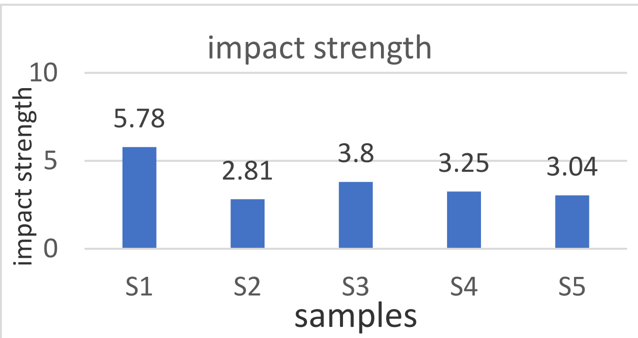


Specimens after testing

Tabular Form

Sl. No	samples	Area of cross section at notch(mm^2)	Energy absorbed (N-mm)	Impact strength (N/mm)
1	S1	3.5×(12.5-2)	4.25×0.05 ×10^3	5.78
2	S2	6× (12.5-2)	3.55×0.05 ×10^3	2.81
3	S3	6× (12.5-2)	4.85×0.05 ×10^3	3.80
4	S4	6× (12.5-2)	4.1×0.05× 10^3	3.25
5	S5	5× (12.5-2)	3.2×0.05× 10^3	3.04

Graphical Representation



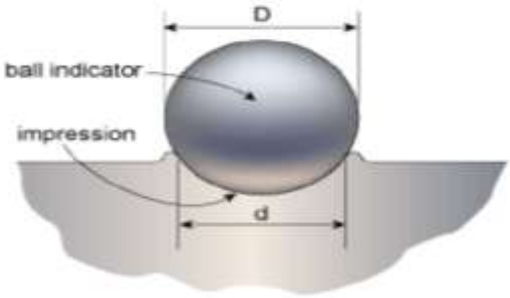
Brinell Hardness Test

Hardness is defined as the resistance of a material to permanent deformation such as indentation, wear, abrasion, scratch. Principally, the importance of hardness testing has to do with the relationship between hardness and other properties of material. For example, both the hardness test and the tensile test measure the resistance of a metal to plastic flow, and results of these tests may closely parallel each other. The hardness test is preferred because it is simple, easy, and relatively nondestructive.

Hardness testing machine

Specimen is placed on the anvil. When the hand wheel is rotated an anvil is moving up and down so the specimen is also moved based on anvil moment and contact with the indenter with a 5mm diameter. Made up of hardened steel or carbide ball subjected to a load of 150 kg. The diameter of the indentation left in the test material is measured with a Brinell microscope. The Brinell harness number is calculated by dividing the load applied by the surface area of the indentation. When the indenter is retracted three diameters of the impression, d1, d2, and d3 are measured using a microscope with a calibrated graticule and then averaged.

Hardness = load / Spherical area of indentation



$$BHN = \frac{P}{\frac{\pi D}{2}\left[D - \sqrt{D^2 - d^2}\right]}$$

Where,

P is the test load in kg

D is the diameter of ball in mm

d is the average impression diameter of indentation

Specimen Dimensions:-

S1 = 50×50 ×3.5

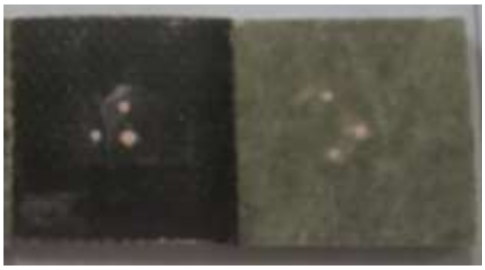
S2 = 50×50 × 6

S3 = 50×50 ×6

S4 = 50×50 × 6

S5 = 50×50 × 5

Hardness Testing Results

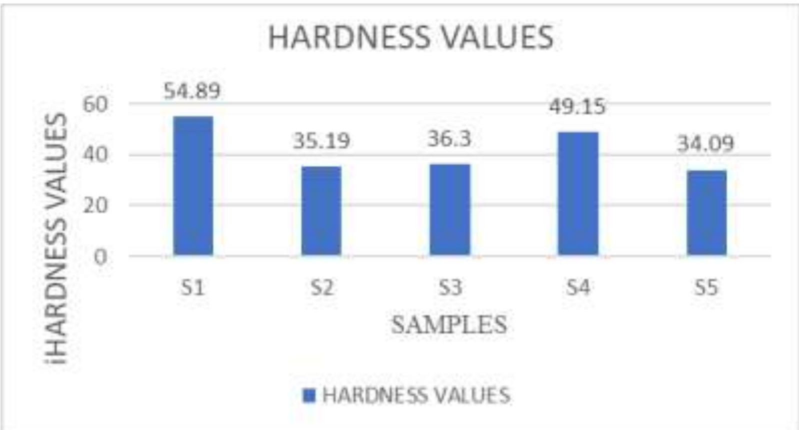


specimens After testing

Tabular Form

Sl. no	Samples	Indenter diameter (mm)	Diameter of impression(mm)				load in kg	BHV value
			Trail 1	Trail 2	Trail 3	Average Diameter		
1	S1	5	1.7	1.8	2	1.833	150	54.89
2	S2	5	2.3	2.1	2.4	2.266	150	35.19
3	S3	5	2.1	2.3	2.3	2.233	150	36.30
4	S4	5	2	1.8	2	1.933	150	49.15
5	S5	5	2.2	2.3	2.4	2.3	150	34.09

Graphical Representation



RESULTS DISCUSSIONS

From the experiment of chopped strand and basalt fiber with epoxy resin component it has been that specific mechanical property as its own strength. The results confirmed that sheet formed by basalt fiber are reinforced with epoxy resin is basically superior to find out the values of each test.

- Impact test has found that the composite of basalt fiber material obtained a value 5.78 n/mm.
- In hardness test has found that the composite of basalt fiber material obtained value. Average value of hardness number is 54.89 .

CONCLUSIONS

Composite materials are most ideal materials for structural applications were high strength and stiffness are required. Therefore this study focused on various mechanical properties of basalt and chopped strand at different arrangement of layers.

From this study it was concluded that the basalt fiber alone has the highest impact strength and hardness even at very low thickness. The chopped strand incorporation into the basalt fiber shows the moderate improvement impact strength and hardness values. The optimum values of properties of both chopped strand and basalt fiber occurred in sample3.

Pure chopped strand exhibits lower mechanical properties than remaining composites.

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