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Development and Charactrisation of Natural Hybrid Composite Using Abaca, Basalt And Glass Fibre

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Abstract
The evolution toward electric vehicle nowadays appears to be the main stream in the automotive and transportation industry. The required battery pack is a big, heavy, and expensive component to be located, managed, climatized, maintained, and protected. This paper develops some engineering analyses in material of some possible solutions that could be adopted. The possible consequences on the position of the vehicle center of gravity, which in turn could affect the vehicle drivability, lead to locate the battery housing below the passenger compartment floor. This solution is also one of the most interesting from the point of view of the battery pack protection in case of a lateral impact and for easy serviceability and maintenance. The integration of the battery pack's housing structure and the vehicle floor leads to a sort of sandwich structure that could have beneficial effects on the body's stiffness (both torsional and bending). This paper also proposes some considerations that are related to the impact protection of the battery pack, with particular reference to the side impacts against a fixed obstacle, such as a pole, We manufacture our battery cases from BASALT fiber, GLASS fiber(20% & 40%) in the form of sandwich composites material using Epoxy. The excellent properties of the fiber composite construction make the battery enclosure a supporting element of the vehicle structure.

Keywords: Abaca, Basalt, Glass Fibre, Epoxy

1. Introduction

Composite materials have played an important role throughout human history, from housing early civilizations to enabling future innovations. Composites offer many benefits; the key among them are design flexibility, durability, light weight, high strength & toughness and more. Composites have permeated our everyday lives such as products that are used in constructions, medical applications, sports, aerospace, and many more.

The developments of new materials with improved performance and functionality have paved way for newer innovations in many industrial and engineering sectors (Wang *et al.* 2012). In the present technological scenario, the materials are used in extremely challenging environments such as high temperature and low temperature applications, aggressive chemicalenvironments, high friction and wear operating conditions, highly Vacuum and radiated fields etc. (Greco *et al.* 2012). This has led to the innovation of highly performance materials which can adopt at various challenging environments. Composite materials are one such material which can operate in wide challenging environments.

2. MATERIALS:

Glass Fibre

Glass fiber-reinforced composites are commonly used around the world. These materials are suitable for the following industries: automotive—door panels, engine cover, bumpers; marine—boat construction; medical—X-ray beds; aerospace—engine cowlings, seating, cabin interior parts; as well in home applications—windows, roof sheets, tables ; and they have applications in civil engineering, The most popular E-glass fibers are characterized by the following mechanical properties: a tensile strength of 2700–3000 MPa, elastic modulus of 72–76 GPa, and a maximum application temperature of 380 °C. Much research studied composites reinforced by glass fibers .

Basalt Fibre

BASALT fibers can be a great alternative to glass fibers, as other scientists have shown . BASALT is considered as a natural material, and it is produced from volcanic rock. The major advantage of BASALT is that it is an environmentally friendly material, is non-toxic, and is non-carcinogenic. Compared to glass fibers, it has good mechanical properties, better thermal resistance, and higher chemical stability. The tensile strength of BASALT fibers is 3000–3400 MPa, and they have an elastic modulus of 86–90 GPa and a maximum application temperature of around 600 °C. The production of BASALT and glass fibers is similar; however, to produce BASALT fibers, no additives are required, as in the case of glass fibers. The disadvantage of BASALT fibers is the higher density and price.

3. Methodology

- Selection and Purchasing of Material
- Material Preparation with Layer by Layer
- Design and Fabrication of Die in PP SHEET.
- BASALT FIBER Mat, GLASS FIBRE and ABACA FIBRE reinforced EPOXY composites Processing Via WET/HAND LAY-UPMETHOD.
- Fabricate the Specimen as per ASTM standards for Tensile, Flexural and Impact.

<u>Composite Preparation</u>

Material to be Used:

BASALT FIBER Mat – Bi Directional – 200 GSM

GLASS fibre chopped (20% & 40%)

ABACA Fiber Mat - Bi Directional - 200 GSM

Resin - Epoxy Araldite – LY556 to HY951 hardener in the ratio of (10:1)

Polypropylene **MOLD** template of 200 x 200 x 6 mm size which is the size of the composite.

<u>SAMPLE PREPERATION</u>

Layer by Layer to be added

Sample 1:	Sample 2:
BASALT MAT	BASALT MAT
Epoxy	Epoxy
GLASS fiber (20%)	GLASS fiber (40%)
Epoxy	Epoxy
ABACA Mat	ABACA Mat
Epoxy	Epoxy

Composite Preparation CALCULATION

Sample polypropylene Mold Size = 200 x 200 x 8 mm

Sample Mold Size = 200 x 100 x 6 mm

Each COMPOSITES size= 200 x 100 x 2 mm = 40000 mm^3 = 0.00004 m^3

Density of Materials

Density of EPOXY = 1100 x 0.00004 = 0.044 kg/m3 = 44 X 3 = 132 g/m3

1. Density of BASALT Fiber = 3000 x 0.00004 = 0.12 = 120 g
2. Density of GLASS FIBER = 1857 x 0.00004 = 0.074 = 74 g
3. Density of ABACA MAT = 1427 x 0.00004= 0.057 = 57 g

GLASS FIBER 20% = 74/100 X 20 = 15 g

GLASS FIBER 20% = 74/100 X 40 = 30 g

BASALT FIBER + GLASS FIBER + ABACA FIBER + EPOXY

Density of Composites (Sample 1) = 120+ 15+ 57 + 132 = 383 /4 = 81 g/m3

BASALT FIBER + GLASS FIBER + ABACA FIBER + EPOXY

Density of Composites (Sample 1) = 120+ 30 + 57 + 132 = 339 /4 = 85 g/m3

Density of Composites (Sample 1) = 120+ 30 + 57 + 132 = 339 /4 = 85 g/m3

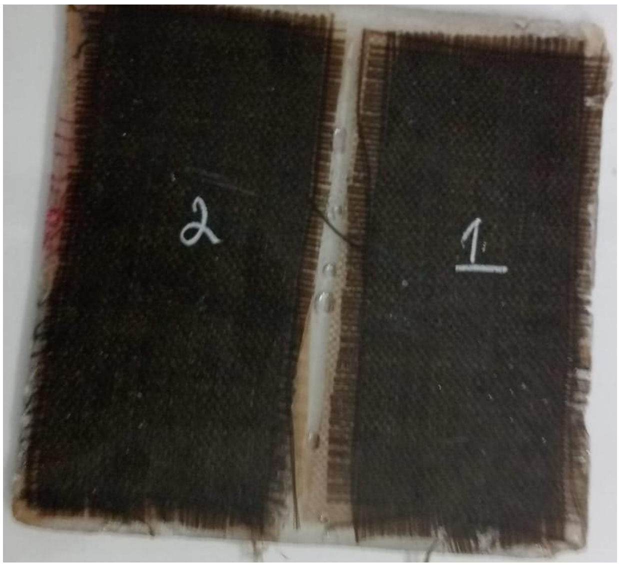

Fig 1 , sample specimen 1

Fig 2 , sample specimen 2

1. MECHANICAL TESTING:

1.1 Testing of Natural Fibers

a. Flexural Strength Test
b. Tensile Test
c. Hardness Test
d. Impact Test

4.1 (a) Flexural Strength Test:

The flexural test of composites is also carried out utilizing Universal Testing Machine Instron 1195. The findings of flexural strength should be the critical characterization of a composites material. For the testing, the cross head rate is kept as 2 mm per min and a span of 60 mm is kept up. The loading arrangement for flexural test is presented in Figure 3.5. The impact tests are carried out as per ASTM D256

Fig 3 Universal Testing Machine Instron 1195

4.1 (b) TENSILE TEST:

According to ASTM D-638 standard the tension test can be performed. This test is done by universal testing machine type (LARYEE) with cross-head speed.

The mechanical properties of composite are depending on numerous variables like fiber loading and fiber length. According to ASTM D3039-76 test models the tensile test of composites is carried out utilizing Universal Testing Machine Instron 1195. A load was connected to the both sides of composite samples for the testing. The experimental set up and specimen for tensile test is shown in Figure and respectively.

Fig 4 Universal Testing Machine

4.1 (c) Impact Test

THE DEEPAK Izod impact strength test is an ASTM D256 standard method of determining the impact resistance of materials. A pivoting arm is raised to a specific height (constant potential energy) and then released. The arm swings down hitting a notched sample, breaking the specimen. The energy absorbed by the sample is calculated from the height the arm swings to after hitting the sample. A notched sample is generally used to determine impact energy and notch sensitivity. The test is similar to the Charpy impact test but uses a different arrangement of the specimen under test.[1] The Izod impact test differs from the Charpy impact test in that the sample is held in a cantilevered beam configuration as opposed to a three-point bending configuration.

4.1(d) Hardness test

Hardness is a typical property of a material. Hardness is defined as the resistance to indentation, and it is determined by measuring the permanent depth of the indentation caused on the surface of the test material. More simply put, when using a fixed force (load) and a given indenter, the smaller the indentation, the harder the material. All the specimens are maintained at a uniform orientation of 0°.

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2. LAB REPORTS

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TEST REPORT

Customer : Mr. P. LOHITH BABU, Mr. M. PRUDHVI, Mr. V. CHENCHAIAH, Mr. N. KARTHIKMr, Mr. S. HARISH		
	Report No/ Date	ML/37135A/1/23-24 Dt- 28 Feb 2024
	Your ref./ Date	Letter Dt: 20 Feb 2024
	Our ref./ Date	TOCR :37135A/23-24 Dt: 20 Feb 2024
	Date of testing	20 Feb 2024 – 28 Feb 2024
	Sample Drawn By	Customer
	Sample Description	Sample-1 Basalt Fiber Mat + Glass Fiber Chopped (20%) + Abaca Fiber Mat + Epoxy

Test Observation :

S.No	Test Parameter	Test Obervation
1	Tensile Strength	29 Mpa
2	Flexural Strength	23.9 Mpa
3	Izod Imapct Strength	10.34 Joules
4	Rockwell Hardness (HRR)	108

Verified by:Govindarajilu
End of the test report
For MICROLAB
B. Sudharsan Head - Technical
Authorized Signatory

Format No. ML / QMS / TR / 03

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TEST REPORT

Customer : Mr. P. LOHITH BABU, Mr. M. PRUDHVI, Mr. V. CHENCHAIAH, Mr. N. KARTHIKMr, Mr. S. HARISH		
	Report No/ Date	ML/37135A/2/23-24 Dt- 28 Feb 2024
	Your ref./ Date	Letter Dt: 20 Feb 2024
	Our ref./ Date	TOCR :37135A/23-24 Dt: 20 Feb 2024
	Date of testing	20 Feb 2024 – 28 Feb 2024
	Sample Drawn By	Customer
	Sample Description	Sample-2 Basalt Fiber Mat + Glass Fiber Chopped (40%) + Abaca Fiber Mat

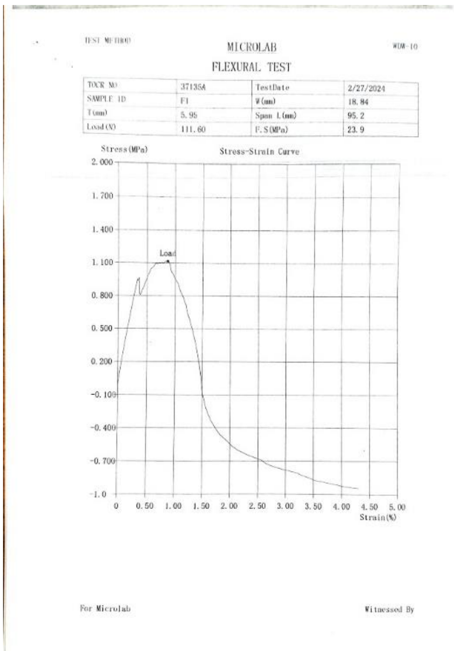
Test Observation :

S.No	Test Parameter	Test Obervation
1	Tensile Strength	21 Mpa
2	Flexural Strength	43.3 Mpa
3	Izod Imapct Strength	1.780 Joules
4	Rockwell Hardness (HRR)	105

Verified by:Govindarajilu
End of the test report
For MICROLAB
B. Sudharsan Head - Technical
Authorized Signatory

Format No. ML / QMS / TR / 03

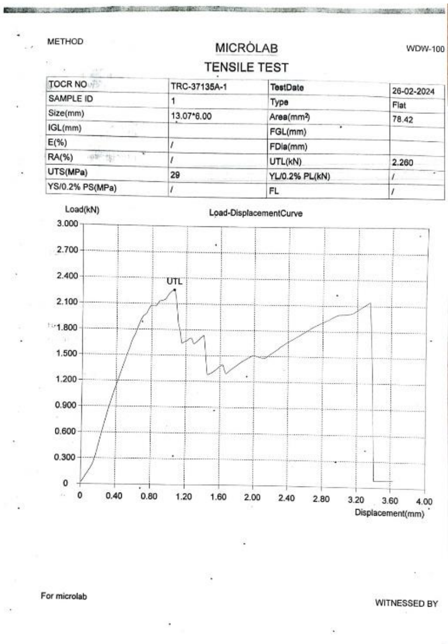
Lab Report 1 Lab Report 2



TEST METHOD
MICROLAB
FLEXURAL TEST
WDW-10

TOCR NO	37135A	TestDate	2/27/2024
SAMPLE ID	F1	W(mm)	18.84
T(mm)	5.95	Span L(mm)	95.2
Load(N)	111.60	F.S(MPa)	23.9

For Microlab
Witnessed By

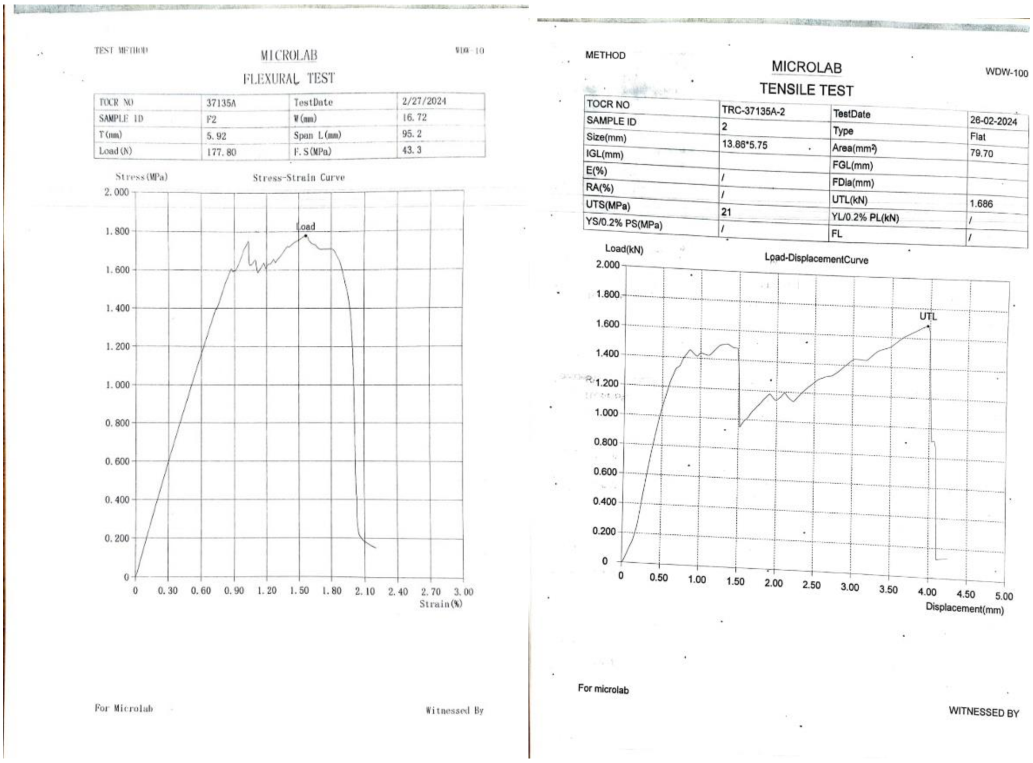


METHOD
MICROLAB
TENSILE TEST
WDW-100

TOCR NO	TRC-37135A-1	TestDate	26-02-2024
SAMPLE ID	1	Type	Flat
Size(mm)	13.07*6.00	Area(mm²)	78.42
IGL(mm)		FGL(mm)	
E(%)	/	FDia(mm)	
RA(%)	/	UTL(kN)	2.260
UTS(MPa)	29	YL/0.2% PL(kN)	/
YS/0.2% PS(MPa)	/	FL	/

For microlab
WITNESSED BY

Flexural and Tensile Test for Specimen 1



TEST METHOD MICROLAB WDW-10

FLEXURAL TEST

TOCR NO	37135A	TestDate	2/27/2024
SAMPLE ID	F2	W(mm)	16.72
T(mm)	5.92	Span L(mm)	95.2
Load(N)	177.80	F.S(MPa)	43.3

METHOD MICROLAB WDW-100

TENSILE TEST

TOCR NO	TRC-37135A-2	TestDate	26-02-2024
SAMPLE ID	2	Type	Flat
Size(mm)	13.86*5.75	Area(mm²)	79.70
IGL(mm)		FGL(mm)	
E(%)	/	FDia(mm)	
RA(%)	/	UTL(kN)	1.686
UTS(MPa)	21	YL/0.2% PL(kN)	/
YS/0.2% PS(MPa)	/	FL	/

Flexural and Tensile Test for Specimen 2

3. CONCLUSIONS

The mechanical behaviour of glass fibre and BASALT fibre reinforced epoxy composites was studied. From the results it is observed that the BASALT fibre & resin of epoxy showed better Mechanical properties. The conclusions are made from the experimental investigation of tensile test; flexural test & Hardness test on laminated polymer composite materials.

The manufacturing methodologies, properties (mechanical, vibrational, environmental, tribological and thermal), advantages, limitations and main applications of BFRP composites have been reviewed. The important application of these composites has been highlighted along with their failure modes. Multiple development technologies were utilized for developing the BFRP composites, with several climatic requirements. Flexural strength and ultimate tensile strength of the BFRP composites were enhanced with an improvement in the BF and GF content of fiber weight portions.

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