iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** VI **Month of publication:** June 2023

DOI: https://doi.org/10.22214/ijraset.2023.54478

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

Effect of AA6061 on Mechanical Properties of Basalt Fiber Reinforced Vinyl Ester Resin by Using Hand Layup Process

Dr. A. Damodara Reddy
Assistant professor, Department of Mechanical Engineering, JNTUACEP, Pulivendula, AP, India

Abstract: ***In this research work, thermo-set polymer hybrid compound was manufactured by using vinyl ester resin. In this study, vinyl ester resin is utilized as a matrix material. Introduce to study, an AA 6061 particulate filler is added with weight ratio of (0, 5, 10, 15) and basalt fiber (330 gsm) is arranged one on other, hand layup procedure is used to prepare a composite objects. These composite materials are cut in to the test specimen's as per the ASTM standards. The mechanical properties like tensile, impact, and flexural strength are calculated according to the ASTM standards. In this work, composite with filler materials shows superior mechanical properties than the material without filler materials. The effects of AA6061 on mechanical properties of basalt fiber reinforced vinyl ester resin are studied from the experiment results. It has considerable effect on the mechanical properties of the composite material. In particular, a comprehensive SEM examination of the damaged sample surfaces has been undertaken to find out bonding between AA6061 filler, matrix and reinforcement.***
Keywords: Basalt fiber, Vinyl ester resin, ASTM standards, Aluminum Alloy (AA6061), SEM (Scanning Electron Microscope).

I. INTRODUCTION

The conservative materials are restricted to specific material properties; this circumstance leads to found composite materials. In present situation composite materials are replacing the places which are occupied by the conventional materials for several years in the manufacturing world. By adding two or more materials we can change the properties of the material. In fact the above definition is about the composite materials and an Alloy. In composite materials we can easily identify the material placement but it is not possible in the case of an alloy. The composite material has good mechanical, thermal and electrical resistance properties compared with the traditional material. The properties of the composite material are different in every direction so they are known as an anisotropic material. This materials are vitally grouped in to PMC, CMC, and MMC among them polymer matrix composite is widely used because of their easy maintenance and low cost of production.

The Polymers are classified in to thermo-set and thermoplastic polymers materials. Due to their promising strengthening system the FRP's are replacing the traditional materials like steel. Fiber reinforced polymers (FRP) has enhanced mechanical and chemical properties. It is precise that despite of high tensile and flexure strength, structures which are made with FRP can be failed in brittle manner due to their weak bonding nature between resin, fibers and filler materials. To overcome this type of situation, perfect bonding between the materials is required. For the applications which required high strength uses carbon FRP materials. . On the next hand glass fibers are classified in to E, S, C, etc. The FRP is selected according to the applications.

Basalt fibers are extracted from the basalt rock through melting process. During starting phase of production is does not hold any other additives. A basalt fiber has low water absorption, due to this it is used in construction and pipe applications. Basalt fiber has better tensile strength than the E-glass fiber. Basalt fiber can absorb more energy compared to carbon and glass fibers. It has enhanced resistance against chemical attack, impact load, and fire with less poisonous fumes.

Table1: comparative properties between basalt and other fibers

Fiber materials	Tensile strength(Mpa)	Elastic modulus(Mpa)	Elongation failure%
Basalt fiber	4100	9300	3.1
Carbon fiber	3528	-	-
Glass fiber (s- glass)	1798	-	-

The values are taken from the technical index of Lance Brown Import-Export.

II. LITERATURE REVIEW

Adeemi Adesina: gives an effect of basalt fiber on performance of cementitious composites. And tells how workability and mechanical properties can increase by adding basalt fiber to the cementitious composites.
M.T. Kim, M.H. Kim: Presents information about inter laminar fracture property of basalt/ epoxy.
D.S. Labanov: Presents information about the basalt roving with two twisted fibers impregnated with DER epoxy binder has max mechanical properties.
Osman Asi: Experimental investigation conducted to found mechanical properties of glass fiber reinforced composites filled with aluminum tri oxide.
V.R. Arun Prakash: Mechanical behavior of saline treated E-glass fiber filled with AA6061 and ss-304 reinforced epoxy resin hybrid composite.

A. Objective Of The Current Work

The main purpose of the current research work is to check the effect of AA6061on composite material. To research the mechanical properties like tensile, flexural and impact by adding required proportions of AA6061 filler to the composite material.
Compared with the hybrid composites the material with filler has the better properties and can get complex shapes.

III. MATERIALS AND METHODS TO BE USED

A. Materials Used

Vinyl ester resin is collected from VRUKSHA COMPOSITES CHENNAI. It is a blend of epoxy and polyester. Vinyl ester linkages are formed by the reaction of unsaturated carboxylic acid with an epoxy resin by removing the byproduct of water. These materials are more elastic and have better mechanical properties such as good adhesion with glass fibers, excellent wet out after solidification and compared to polyester, resin low volumetric shrinkages are produced.

Figure1.2: AA6061 (Aluminum Alloy 6061) powder b) basalt fiber mat c) vinyl ester resin.

The accelerators, catalyst and promoter act as one type of curing agents .These agents are added to vinyl ester resin which helps to initiates the chemical reaction.
The basalt fiber is supplied by VRUKSHA COMPOSITES CHENNAI .These basalt reinforced material is mainly used in construction industries, due to its higher impact resistance capabilities. Basalt rebar are easily available and it has low cost compared to carbon and invar materials which are very famous for their strength. Graph of the properties like impact, electric, heat resistance of basalt fiber are in the middle of the carbon and glass fiber. This is the main reason to choose basalt fiber (330 gsm) for this project.
AA6061 (Aluminum Alloy) which is collected from VRUKSHA COMPOSITES CHENNAI. It acts as filler material in composite which provides strength to the component. AA 6061 is an alloy which has magnesium and silicon as major components in its composition. This filler material has better mechanical properties, which can support basalt fiber during heavy load apply on it. It has good thermal and electrical resistance properties. It provides good adhesion between reinforcement and matrix material to improve hardness of the laminates. The laminates which are prepared are mostly preferred in high impact resistance applications.

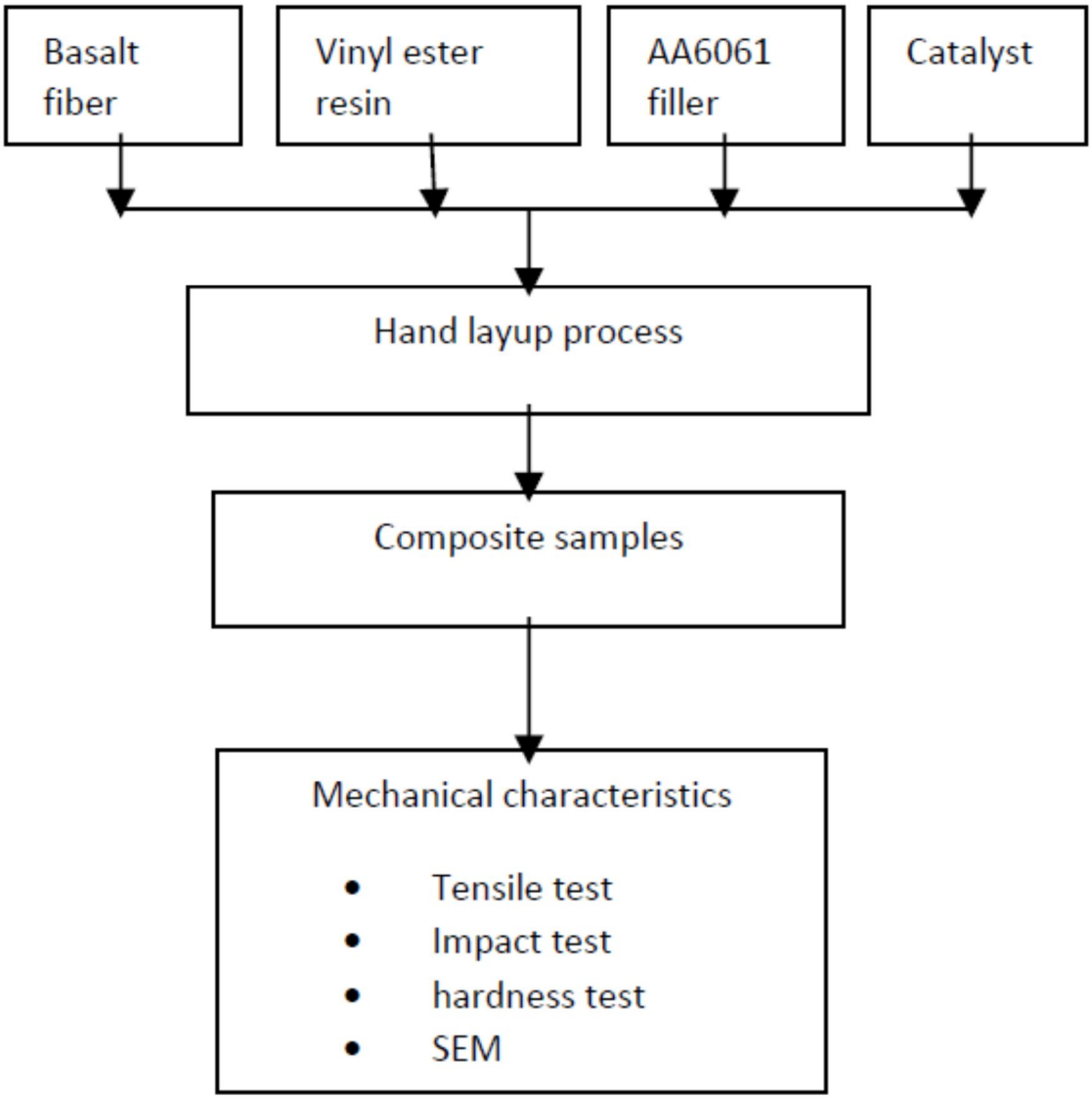


Figure1.3: Tree diagram of the process

B. Methods

Various processing techniques are used to fabricate the polymer matrix composite and the selection process is mainly depends on the processing cost required properties and curing time. Main processing techniques are:

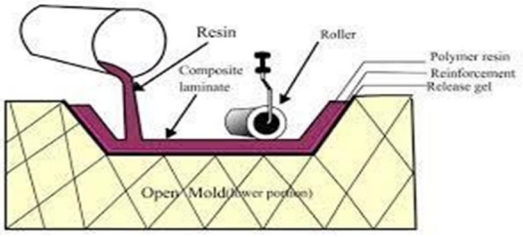
1) Hand Layup Practice.
2) Spray up Practice.
3) Compression Molding: Load with raw material press in to shape.
4) Vacuum Bag: Prepare layup with the help of bag.
5) Resin Transfer Molding: Fibers places in mould where resin injected at low pressure.
6) Injection Molding: Mould is injected under high pressure.

IV. METHODOLOGY

A. Hand Layup Practice

It is one of the open molding practices. In this method, large parts in little quantities are produced. This method is so simple and cost effective. Workforce need skills to produce good surface finish of the products. Product excellence is totally depending up on the worker knack and the material which have chosen to produce the part.

In this method, the underpinning material is placed on each other in a mould in order to form a required thickness of the material. Each layer is treated with reinforcement material (resin) by using brushes, and rollers are used to achieve consistent thickness.



1) Composition of Samples:

Table2: Composition of each sample

DISIGNATION OF SAMPLES	COMPOSITONS
C1	60% BASALT FIBER+35%VINYL ESTER+2%MEKP+2%ACE+1%PROMOTER+0%FILLER MATERIAL
C2	60% BASALT FIBER+30% VINYL ESTER+2%MEKP+2%ACE+1%PROMOTER+5% FILLER MATERIALS
C3	60%BASALT FIBER+25%VINYL ESTER+2%MEKP+2%ACE+1%PROMPTER+10% FILLER MATERIALS
C4	60%BASALT FIBER+20%VINYL ESTER+2%MEKP+2%ACE+1%PROMOTER+15% FILLER MATERIALS

2) Preparation of Samples by using Hand Layup Process

It is one of the open molding practices. In this method, large parts in little quantities are produced. This method is so simple and cost effective. Workforce need skills to produce good surface of the glass mould for easy removal of the part after solidification without scratches. The basalt fiber (330) GSM mats are cut in to dimensions of 20X15cm till the required thickness is obtained. The matrix material as a vinyl ester resin is weighted in beaker of 500gms and mixed with catalyst, accelerator and promoter in required proportions; these are used to speed up the chemical reaction, in this 2% of MEKP & 2% of promoter are used. AA6061 filler material of different percentages (0, 5%, 10%, 15%) is added to vinyl ester and then mixed by using stirrer.

Figure1.4: Mould with fixtures.

After placing basalt fiber mats one by one on mould the each layer is coated with the vinyl ester resin with the help of brushes. Hand roller is used to obtain uniform thickness and to remove air bubbles.

The samples are solidified at room temperature. After curing, the samples are cut in to the required dimensions. Samples are cut according to the ASTM standards. Samples are allowed to conduct mechanical testing's like tensile, flexural, and impact on them according to the ASTM (3039-79) standards. Mechanical testing conducted on samples according to their filler percentage.

V. MECHANICAL TESTING'S OF THE COMPOSITES

Figure1.5: Universal Tensile Machine

Model: UTM Instron 3369

The above model universal tensile machine is used to find mechanical properties of composites.

UTM is commonly used in the aviation, marine, chemical industry for petroleum, machinery, metal materials and goods, electric wire and cable etc., Testing for all types of materials and the physical properties of the products, the select and purchase all kinds of different furniture can do tensile and compressive. Tests Conducted on UTM are tensile and flexural by replacing the required grips of UTM.

Features:

1) Acceptance of high precision data acquisition circuit capability to feel the tensile strength value of materials.
2) Extensively used in plastic hardware, rubber, wires, cables, leather and other physical strength materials.
3) Test for physical strength: tensile, tearing, peeling, compression, bending, etc.
4) Function: maximum lock take save, random calculation elongation, print around automatic capture of the entire car translation
5) Connect to requirements for ISO, ASTM, DIN and other specifications.

Specifications of UTM Instron 3369:

Table3: Specifications of Universal Testing Machine.

S.No	Parameters	Specifications
1	Maximum load	50KN
2	Maximum speed	500mm/min
3	Minimum speed	0.005mm/min
4	Maximum at full speed	25KN
5	Total cross head travel	1122mm
6	Max power required	700VA
7	Return speed	500mm/min

A. Tensile Test

It is the ability of the material that can withstand while being stretched or pulled over. Tensile nature of the body tells us about how much maximum stress it can observe without getting deform. It is one of the most important mechanical property of the body to be measure, before it is being used in the applications. Tensile test is carried out on the bodies which are used on the structural applications. UTM Instron 3369 is being used to find the tensile strength of the composite. The samples which are being tested are cut according to the ASTM 3140/695 to be fitted in the grips of UTM.

Specifications of Tensile test:

Specimen size: 150mm X 15mm X 3.5mm

Cross head speed: 10mm/min

The samples of required filler percentages are cut in to above specifications. UTM Instorn 3369 is used to found tensile strength of the sample. The samples which are being tested are shown below.

Figure1.6: Samples according to their filler percentage.

B. Flexural Test

Flexural strength is also known as modulus of rupture. Flexural strength is a mechanical property of material. Flexural strength gives the information about highest stress experienced within the material at its moment of yield. Flexural strength would be same for homogeneous materials. Composites are anisotropic material; flexural strength is different at each and every point.

Flexural strength of the composite samples is measured with UTM Instron 3369. The samples are cut according to the ASTM (3036-79) test standards.

Specifications of Flexural Test:

Specimen size: 150mm X 15mm X 3.5mm.

Cross head speed: 10mm/min.

Temperature: 25^0C & Humidity: 50%.

C. Impact Test

Impact test gives information about the amount of energy observed by the material during fracture.

This energy is a measure of given material toughness. In this impact strength of the composites are measured by using izod test.

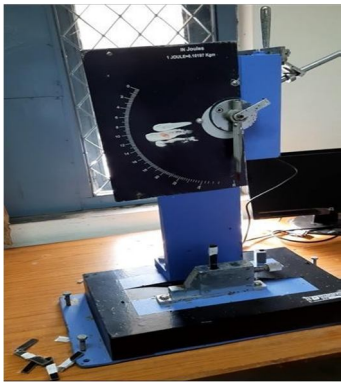


Figure1.7: Impact Testing Equipment.

Specification of Impact Test:

Sample size: 120mm X 13mm X 3.5mm.

Notch angle: 45° and the above samples are cut according to the ASTM (256-88) test standards.

VI. RESULTS AND DISCUSSIONS

A. Results of Tensile Test

Effect of Filler AA6061 on Mechanical property of the Composite:

In this study, we addressed the AA6061 powder percentage on the basalt fiber/vinyl ester composites mechanical properties. The composites with different filler percentages are prepared by using hand layup process.

Table4: Tensile strength with varying filler percentages

S.No	Filler percentages	Tensile strength(Mp a)	Tensile modulus (Mp a)	Max load(N)
1	0%	376.26	4994.76	16931
2	5%	329.96	5155.70	14848
3	10%	381.78	11375.42	11453
4	15%	376.55	13234.89	11296

Tensile strength of each composite is determined by using UTM Instron 3369. In this study the effect of AA6061 powder on tensile strength of each sample is observed.

The maximum tensile strength is observed at 10% filler percentage. The tensile strength is getting increased up to 10% later tensile strength is getting decreased by adding more amounts of filler. The excess amount of filler creates less bonding between the filler, matrix and reinforcement.

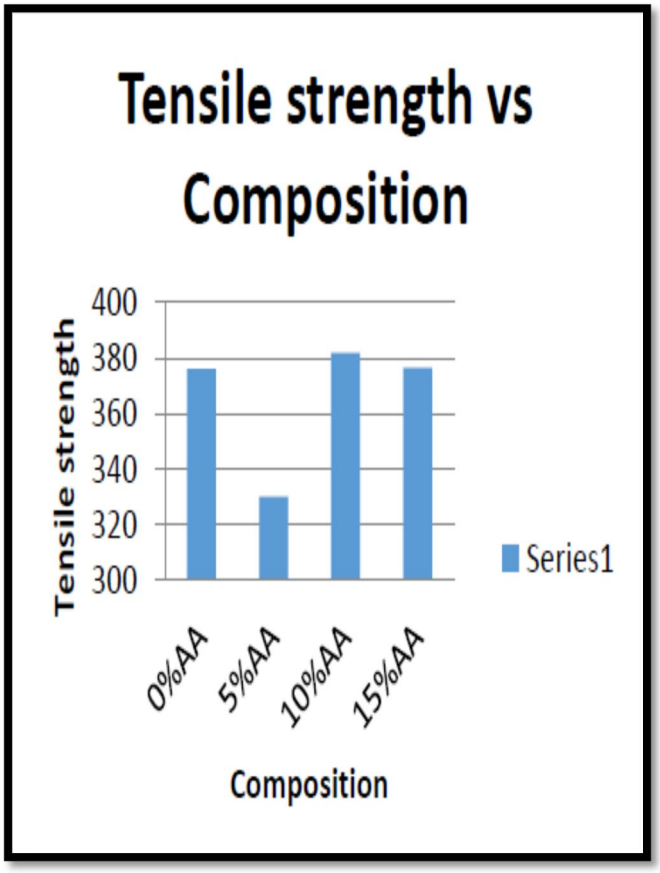


Figure1.8: Effect of AA6061 powder on Tensile Strength

The samples which are being tested are cut according to the ASTM 3140/695.

B. Results of Flexural Test

Effect of Filler AA6061 on Mechanical Property of the Composite:

S.No	Filler percentages %	Max stress(MPa)	Flex modulus(MPa)	Max load(KN)
1	0	378.84	35941.62	0.68
2	5	355.89	27212.95	0.64
3	10	528.24	49806	0.95
4	15	473.72	41113.95	0.85

Table5: Flexural strength with varying Filler Percentages

Flexural strength of the sample has increased by increasing filler percentages. Maximum Flexural strength is observed at 10% filler. The excess amount of filler creates less bonding between the filler and reinforcement.

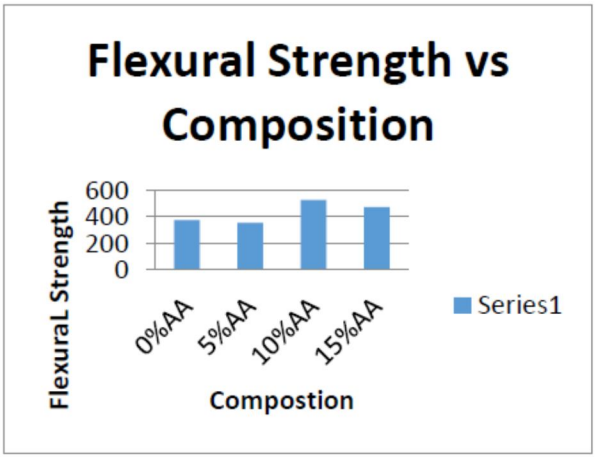


Figure1.9: Effect of AA606 powder on Flexural Strength

C. Results of Impact Test

Effect of Filler AA6061 on Mechanical Property of the Composites:

S.No	Filler percentage %	Impact load(joules)
1	0	11
2	5	5.8
3	10	8
4	15	5

Table 6: Impact load with varying filler percentages

From the above table impact strength of the sample with 0% filler observe more energy than the samples with filler. The bonding between filler AA6061 and underpinning is not that good comparing with the samples without filler.

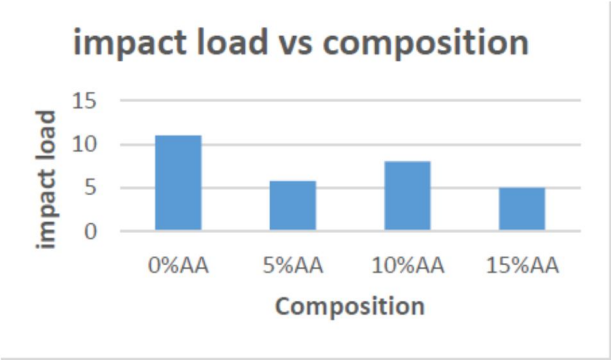


Figure2.1: Impact load with filler percentages

VII. SEM ANALYSIS

It is used to examine the morphology of the fractured surfaces and the bonding between filler, matrix and reinforcement. Samples are stick to carbon to the carbon tape.

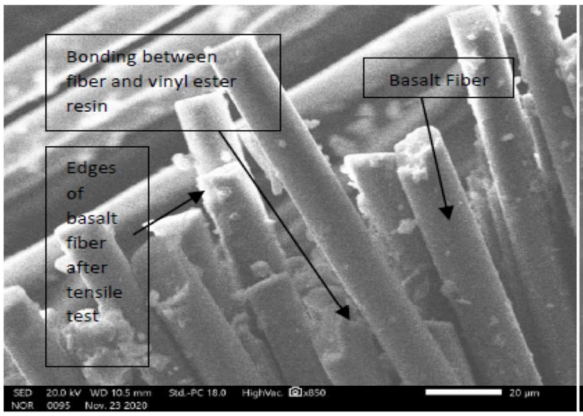


Figure2.1: Photomicrograph of sample with 0% AA6061 filler

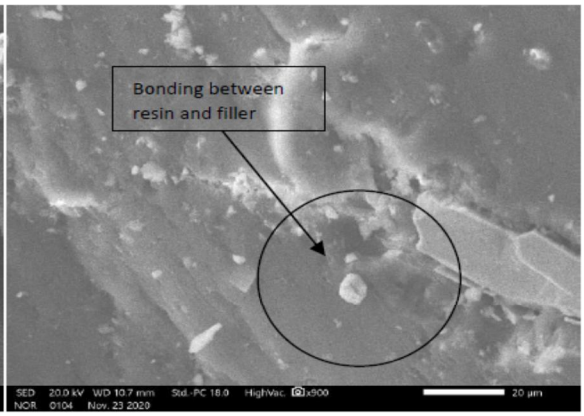


Figure2.2: Photomicrograph of sample with 5% AA6061 Filler

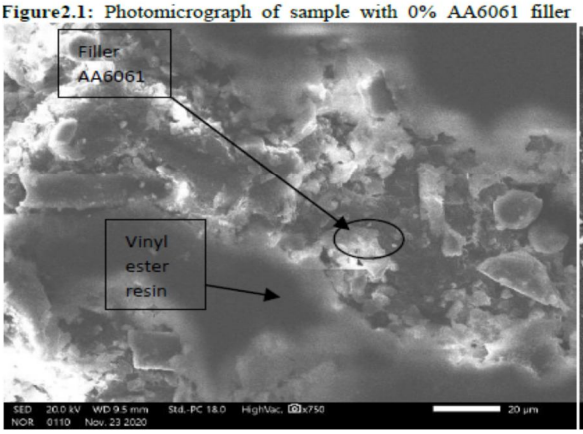


Figure2.3: Photomicrograph of sample with 10% AA6061 Filler

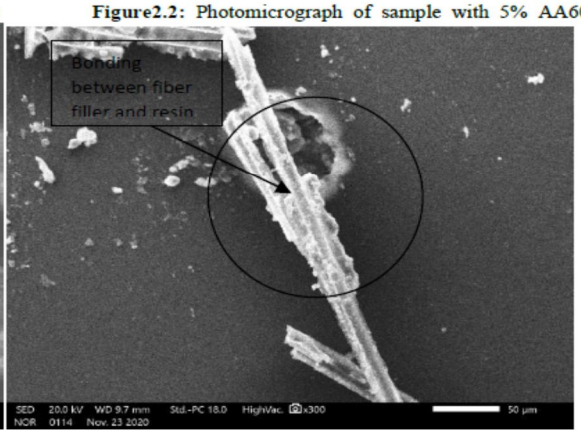


Figure2.4: photomicrograph of sample with 15% AA6061 Filler

Above shown sample with 0% filler has more impact strength compared to other samples, this is due to weak bonding between filler and matrix and reinforcement. Sample with 10% AA6061 has more tensile and flexural strength compared with other samples. Micrographs with 15% filler shows the weak bonding between the compositions, increasing filler percentage in this combination can create more voids which can cause failure of the structural material when load applied on it. Sample with weak adhesion of compounds can bare less inter laminar forces compared with other samples with good adhesion. The above figure shows the surface of the specimen demonstrated that the vinyl esters between basalt woven layers are entirely separated from one side to other side, when load has applied on it. Adhesion between filler and resin was improved that can decrease from the failure of the material.

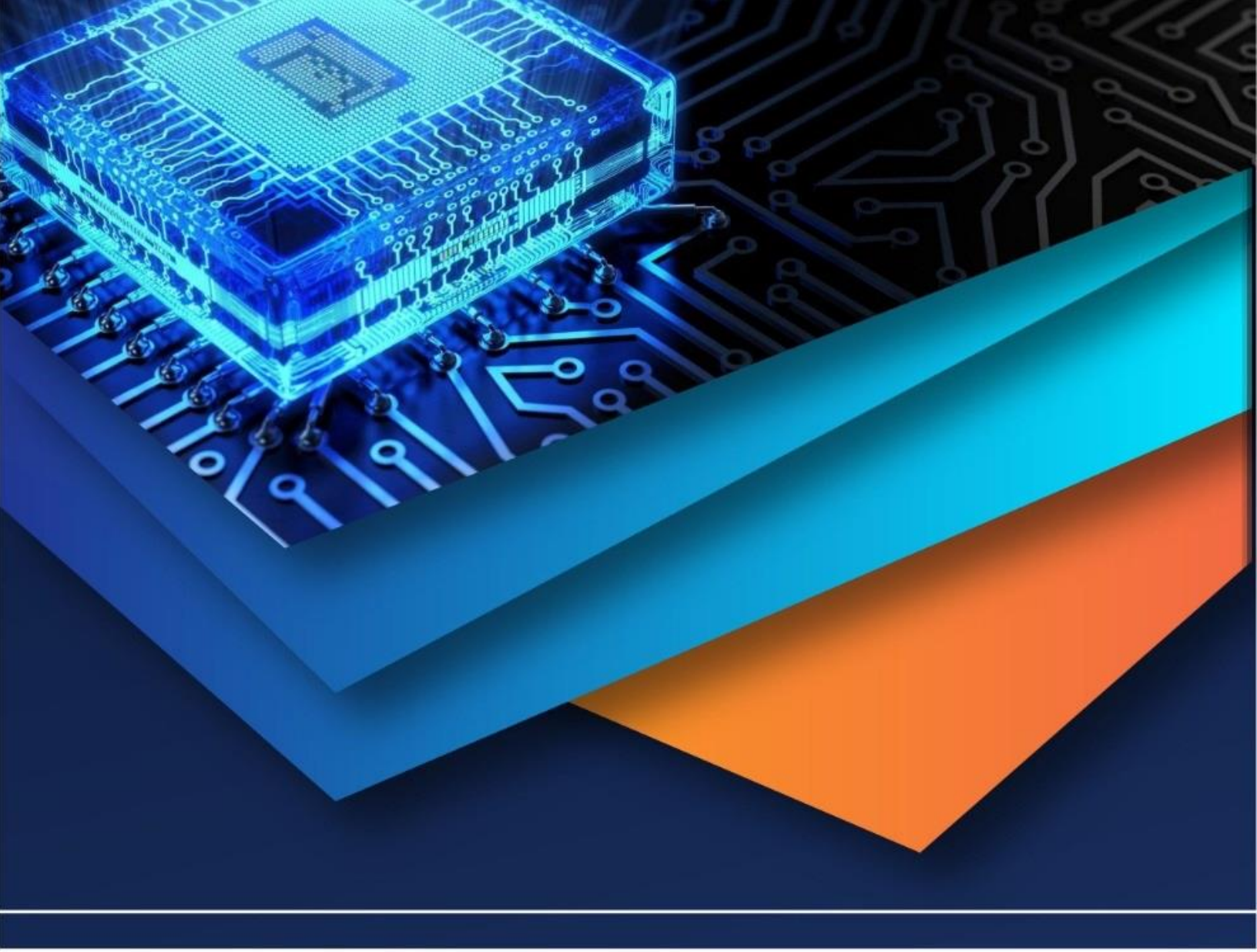
VIII. CONCLUSION

In this research work, I probed how varying percentages of AA6061 filler affects the mechanical assets of basalt fiber reinforced vinyl ester resin composites. Following conclusions are made from this study.

1) Impact strength of basalt fiber reinforced composites is getting decreased by increasing the filler percentages.
2) Increasing filler in the composite can reduce the bonding between the compounds.
3) Highest tensile and flexural strength is obtained at 10% addition of filler to the composite.
4) Inter laminar toughness is getting increased by increasing filler percentage to the composite.

REFERENCES

[1] Adeyemi Adesina, "performance of cementitious composites reinforced with chopped basalt fibers", "construction and building materials", Vol 266, 120970, (2021).
[2] M.T. Kim, M.H. Kim, K.Y. Rhee, S.J. Park, "study on an oxygen plasma treatment of a basalt fiber and its effect on a inter laminar fracture property of basalt/epoxy woven composites", composites: part B" Vol 42, 499-504, (2011).
[3] D.S. Lobanov and S. V. Slovikov," mechanical properties of a unidirectional basalt- fiber reinforced plastic under a loading simulating operation conditions mechanics of composite materials", Vol. 52, No.6, January, 201
[4] Irena Zivkovix, Cristino Fragassa, "AnaPavlovic, Tommaso Brugo, Influence of moisture absorption on the impact properties of flax", "composites: part B", (2016
[5] Antara Bhatta Charjee &B.K Nanda, "effect of silicon carbide on the mechanical and damping properties of glass fiber/epoxy composites", "international conference on composites", 2017,(468-471)
[6] Samit kumar, Atul Kumari Tiwari, "development and analysis of hybrid polymer composite from bagasse and coconut coir ", "(IJSR)", 2027, (106-113).
[7] Kareem AA& Hassan JM, "effect of silicon carbide particle on dielectrically properties of epoxy reinforced bidirectional glass fiber" "journal of material science", 4:168, 2015.
[8] Ganesh. B & keerthi Kumari and vithal Rao Chavan, "effect of cerium oxide as filler material on the e-glass fiber/epox reinforced polymer composites", "IJDR", April (7425-7428, 2016.
[9] Sreenivasulu. S, Vija kumar reddy. K, Varadarajulu. A and Ramachandra reddy .G,Chemical, "Resistance and tensile Properties of polycarbonate Toughened Epoxy-bambo fiber composites", "bulletin of pure and applied science", 25C(2):137- 142,2006.
[10] V. R. Arun Prakash, S.Julyes Jaisingh "mechanical strength behavior of silane treated E-Glass fiber/AI6061& SS-304 Wire mesh reinforced epoxy resin hybrid composite", "springer", (2017).



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY