OPERATION SPECULATE ON EPOXY RESIN REINFORCEMENT OF ALUMINIUM OXIDE AND SILICON CARBIDE ON GLASS FIBER LAMINATE

V. Mallikarjuna[1], B. Ramanjaneyulu [2], C.Tirupathaiah[3] , L. Sreenivasa Rao[4]

[1]Assistant Professor, Department of Mechanical Engineering. Annamacharya Institute of Technology & Science, Rajampet, A.P. – INDIA
[2] Research scholar, Department of Mechanical Engineering. Annamacharya Institute of Technology & Science, Rajampet, A.P. – INDIA
[3]Assistant Professor, Department of Mechanical Engineering. Annamacharya Institute of Technology & Science, Rajampet, A.P. – INDIA
[4]Assistant Professor, Department of Mechanical Engineering, Joginapally BR Engineering College, Yenkapally (V), Moinabad (M), R.R(dist), Hyd-500075, India

Abstract - Fiber reinforced polymer composite have been used as more number of components such as aircrafts, satellite structure, of fiber reinforced polymer, automobile components, wind turbine blades, sports goods. Many advantages such as relatively low production, ease to fabricate and high strengthablity. Reinforcement polymer is either synthetic or natural. Synthetic fibre such as glass, carbon, Kevlar, have high specific strength but their fields of application are limited due to high production cost. In this paper, an investigation has been performed to make better utilization of Aluminium Oxide and Silicon Carbide for making value added products. The objective of the current work is to fabricate and study the mechanical behaviour of epoxy based hybrid composite with and without filler materials. Filler materials such as Aluminium Oxide and Silicon carbide which act as an epoxy modifier. Composites filled with 4%, 8%, 12% concentration of Al2O3 and SiC were fabricated by using hand layup techniques. The fabricated composites are cut into specimens according to the ASTM standards as well as superficial mechanical properties such as tensile strength, flexural strength, compression strength and hardness test of the specimens were found.

Key Words: Epoxy Resin Reinforcement, Aluminium Oxide, Silicon Carbide, Glass Fiber Laminate.

---

1. INTRODUCTION TO COMPOSITE MATERIALS

In recent years, the interest in composite materials is increasing due to its advantages as compared to monolithic metal alloys. Composites materials can be defined as engineered materials which exist as a combination of two or more materials that result in better properties than when the individual components are used alone. Composites consist of a discontinuous phase known as reinforcement and a continuous phase known as matrix. In practice, most composites consist of a bulk material (the „matrix‟), and a reinforcement of some kind, added primarily to increase the strength and stiffness of the matrix.

Matrix Phase: The matrix phase generally comprises the bulk part of a composite. Materials in fibrous form are seen to be showing good strength property and for achieving this property the fibres should be bonded by a matrix. Matrix may consist of any of the three basic material types mainly Polymer, ceramics or metals.

Reinforcement: The reinforcement is generally responsible for strengthening the composite and improves its mechanical properties. All of the different fibres used in composites have different properties and so affect the properties of the composite in different ways. It also provides stiffness to the composites.

2. FIBER REINFORCED COMPOSITES

The goals of the design of fiber-reinforced composites many times include high strength and stiffness on a weight basis. Specific strength and specific modulus are the terms that express these characteristics and correspond to the ratios of tensile strength to specific gravity and modulus of elasticity to specific gravity. For short fibers, fibers are too short to produce a significant improvement in strength. The characteristics of a fiber-reinforced composite depend not only on the properties of the fiber, but also on the degree to which an applied load is transmitted to the fibers by the matrix phase.

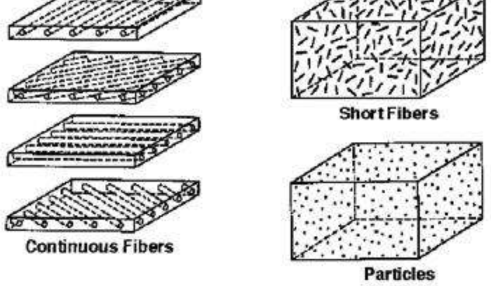


Fig 1.1: Types of fibers

The orientation of the fiber in the matrix is an indication of the strength of the composite and the strength is greatest along the longitudinal directional of fiber. This doesn't mean the longitudinal fibers can take the same quantum of load irrespective of the direction in which it is applied. Optimum performance from longitudinal fibers can be obtained if the load is applied along its direction. The slightest shift in the angle of loading may drastically reduce the strength of the composite.

Monolayer tapes consisting of continuous or discontinuous fibers can be oriented unidirectional stacked into plies containing layers of filaments also oriented in the same direction. More complicated orientations are possible too and nowadays, computers are used to make projections of such variations to suit specific needs. In short, in planar composites, strength can be changed from unidirectional fiber oriented composites that result in composites with nearly isotropic properties. Short-length fibers incorporated by the open- or close-mould process are found to be less efficient, although the input costs are considerably lower than filament winding.

Given the fact that the vast difference in length and effective diameter of the fiber are assets to a fiber composite, it follows that greater strength in the fiber can be achieved by smaller diameters due to minimization or total elimination of surface of surface defects.

After flat-thin filaments came into vogue, fibers rectangular cross sections have provided new options for applications in high strength structures. Owing to their shapes, these fibers provide perfect packing, while hollow fibers show better structural efficiency in composites that are desired for their stiffness and compressive strengths. In hollow fibers, the transverse compressive strength is lower than that of a solid fiber composite whenever the hollow portion is more than half the total fiber diameter. However, they are not easy to handle.

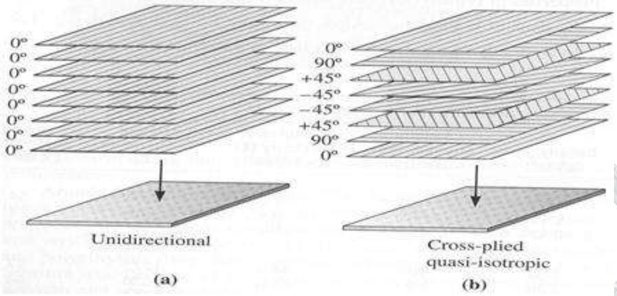


Fig 1.2: Fiber reinforced composites

Based on the length of the Fibers, Fiber reinforced composite materials are classified as shown in the figure below

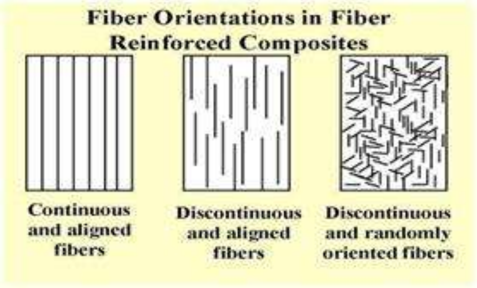


Fig 1.3: Fiber orientation

LAMINAR COMPOSITES

Laminar composites are found in as many combinations as the number of materials. They can be described as materials comprising of layers of materials bonded together. These may be of several layers of two or more metal materials occurring alternately or in a determined order more than once, and in as many numbers as required for a specific purpose.

Clad and sandwich laminates have many areas as it ought to be, although they are known to follow the rule of mixtures from the modulus and strength point of view. Other intrinsic values pertaining to metal-matrix, metal-reinforced composites are also fairly well known.

Powder metallurgical processes like roll bonding, hot pressing, diffusion bonding, brazing and so on can be employed for the fabrication of different alloys of sheet, foil, powder or sprayed materials. It is not possible to achieve high strength materials unlike the fiber version. But sheets and foils can be made isotropic in two dimensions more easily than fibers. Foils and sheets are also made to exhibit high percentages of which they are put. For instance, a strong sheet may use over 92% in laminar structure, while it is difficult to make fibers of such compositions. Fiber laminates cannot over 75% strong fibers. The main functional types of metal-metal laminates that do not posses high strength.

There are many combinations of sheet and foil which function as adhesives at low temperatures. Such materials, plastics or metals, may be clubbed together with a thirdconstituent. Pre-painted or pre-finished metal whose primary advantage is elimination of final finishing by the user is the best known metal-organic laminate. Several combinations of metal-plastic, vinyl-metal laminates, organic films and metals, account for up to 95% of metal-plastic laminates known. They are made by adhesive bonding processes.

Aircraft/military:

The use of fiber reinforced composites has become increasingly attractive alternative to the conventional metals for many aircraft components owing to its increased strength, durability, corrosion resistance, resistance to fatigue and damage tolerance characteristics. Composites also provide greater flexibility as the material can be tailored to meet the design requirements and they also offer significant weight advantages. Carefully designed individual composite parts, at present, are about 20-30% lighter than their conventional metal counterparts. Composite applications for the household and office including appliances, power tools, business equipment, etc. use of FRP in air craft applications.

Fig: 1.5: Aircraft applications

Automotive/transportation:

The potential benefits of lighter weight, durability and corrosion resistance makes advanced composite materials as choice in automotive applications. Significant changes on a broad spectrum would be required to make advanced composites attractive for widespread commercial use in cars and trucks. The principal limiting factor is the high cost.

Fig: 1.6: Automotive applications

Construction:

Materials for the building of homes, offices, architectural component Products include swimming pools, bathroom fixtures, wall panels, roofing, architectural cladding because by this composites construction is been placed in anywhere like water. The composites are less cost than the equipment using for the construction.

Fig: 1.7: Construction applications

Consumer:

Products include sports and recreational equipment such as golf clubs, tennis rackets, snow mobiles, mobile campers, furniture, and microwave cookware.

Corrosion resistant equipment:

Products for chemical resistant service such as tanks, ducts and hoods, pumps, fans, grating, chemical processing, pulp and paper, oil and gas, and water/wastewater treatment markets.

Electrical:

This encompassing market includes components for both electrical and electronic applications such as pole line hardware, substation equipment, microwave antennas, printed wiring boards, etc.

Marine:

In 1880’s 20% of boats are prepared by composites whereas now a day’s maximum 90% of boat hulls are prepared by the composites, because it’s has high ductile properties and low density. And, composites have high corrosion and oxidation resistive properties.

Fig: 1.8: Marine applications

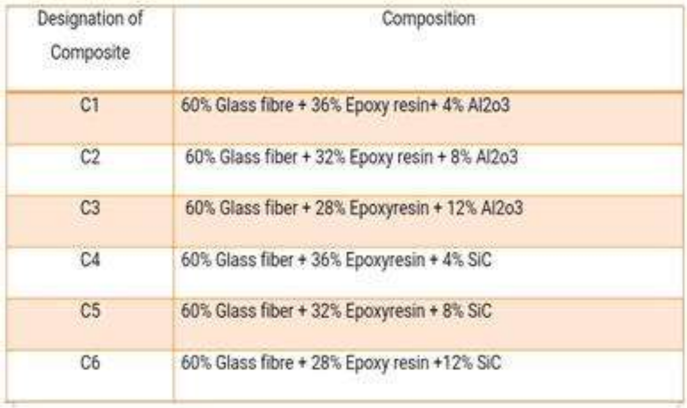
OBJECTIVE OF THE PRESENT RESEARCH WORK

Keeping in view the above mentioned knowledge gaps, the following objectiveswere chosen for the present research Paper work.

- Fabrication of SiC/ Al_2O_3 filled epoxy based hybrid composites.
- Evaluation of mechanical properties of the composites such as tensile strength, flexural, hardness and compression strength.
- To study the effect of SiC/ Al_2O_3 type on mechanical properties of composites.

Besides the above all the objective is to develop new class of composites by incorporating coal powder reinforcing phases into a polymeric resin. Also this work is expected to introduce a new class of polymer composite that might find tribological applications.

Table 2.3L Compositions



Designation of Composite	Composition
C1	60% Glass fibre + 36% Epoxy resin+ 4% Al_2o_3
C2	60% Glass fiber + 32% Epoxy resin + 8% Al_2o_3
C3	60% Glass fiber + 28% Epoxyresin + 12% Al_2o_3
C4	60% Glass fiber + 36% Epoxyresin + 4% SiC
C5	60% Glass fiber + 32% Epoxyresin + 8% SiC
C6	60% Glass fibre + 28% Epoxy resin +12% SiC

MATERIALS AND METHODS

The following section will elaborate in detail the experimental procedure carried outduring the course of our project work. The steps involved are:

3.1 SPECIMEN FABRICATION

Raw materials:

Raw materials used in this experimental work are:

Glass fibre
Epoxy resin
Hardener

Filler materials
SiC
Al_2O_3

Glass fiber (E-glass): E- Glass fiber (‘E’ stands for Electric) is made up of alumino borosilicate glass with less than 1wt% alkali oxide. Some other elements may also be present at low impurity levels. A typical nominal chemical composition of E-glass fiber is Sio_2 54wt%, Al_2O_3 14wt%, CaO + MgO 22wt%, B_2O_3 10wt% and Na_2O + K_2O less than 2wt%.

Fig 3.1: Glass fiber

Weight of E- Glass fiber per unit area is given by: **$1m^2$=320gms**

- ➢ It has relatively low density.

- Low cost and High production rate.
- Chemically resistant.
- Non- Flammable and heat resistant.
- Relatively insensitive to moisture.
- It has able to maintain strength properties over a wide range of conditions.

2.Epoxy resin:

Epoxy resin (Araldite GY 257) made by HUNTSMAN CORPORATION. It is a low viscous epoxy resin based on Bisphenol-A modified with an aromatic glycidyl ether.

Araldite GY 257 is the most suitable epoxy resin in formulating solvent free systems yielding, due to the low viscosity and full crystallisation resistance.

It has the following properties:

- Very good processing properties.
- Good mechanical performance.
- Good surface penetration.
- Good chemical resistant to acids but less resistant to solvents.
- Density at 25^0C is 1.15gms/cm^3.
- Viscosity at 25^0C is 500-700MPa.

SILICON CARBIDE

Silicon Carbide is the only chemical compound of carbon and silicon. It was originally produced by a high temperature electro-chemical reaction of sand and carbon, silicon carbide is an excellent abrasive and has been produced and made into grinding wheels and there, abrasive products for over one hundred years. Today the material has been developed into a high quality technical grade ceramic with very good mechanical properties. It is used in abrasives, refractories, ceramics, and numerous high-performance applications. The material can also be made an electrical conductor and has applications in resistance heating. flame igniters and electronic components Structural and wear applications are constantly developing. Key Silicon Carbide Properties

- Low density
- High strength
- Low thermal expansion
- High thermal conductivity
- High hardness
- High elastic modulus

SELECTION OF MANUFACTURING PROCESS

Selection of manufacturing process depends upon the cost estimation, properties required form the specimen and curing time taken for the specimens to set.

TYPES OF MANUFACTURING PROCESS

Open Mold Process:

- Spray lay-up - Chopped roving and resin sprayed simultaneously, rolled
- Hand lay-up - Lay-up of fibers or woven cloth, impregnate, no heat or pressure
- Filament winding.
- Sheet molding compound.
- Expansion tool & contact molding

Closed Mold Process

- Compression molding – Load with raw material, press into shape.
- Vacuum bag, pressure bag, autoclave - Prepreg laid up, bagged, cured.
- Injection molding – Mold injected under pressure.
- Resin Transfer – Fibers in place, resin injected at low temperature.

Filament winding Method

Filament winding is a very high rate production process, due to which a continuous fiber band wetted with accelerated and catalyzed Thermoset resign is placed on a rotating mandrel and left for curing. The mandrel is removed after curing of the filament wound product. 50–200Kg/h production is very generally obtained. It is also highly repeatable process that can fabricate large and thick-walled structures. Filament winding is a well established process, which is in continuous use since the mid 1940s. It can be used to fabricate almost anybody of revolution, such as cylinders, shafts, spheres, and cones. Filament winding can also fabricate a large range of part sizes; parts smaller than 25mm in diameter (e.g., golf club shafts) and as large as 6 meter in diameter have been wound. The major restriction on geometry is that concave contours cannot be wound, because the fibers are under tension and will bridge across the cavity. Typical applications for filament winding are cylinders, pressure vessels, and rocket motor cases. End fittings are often wound into the structure producing strong and efficient joints. The selection of manufacturing process for the component to be made with polymer matrix composite depends on various factors such as batch quantity, quality level, the constraint of achieving repeatable quality and so on.

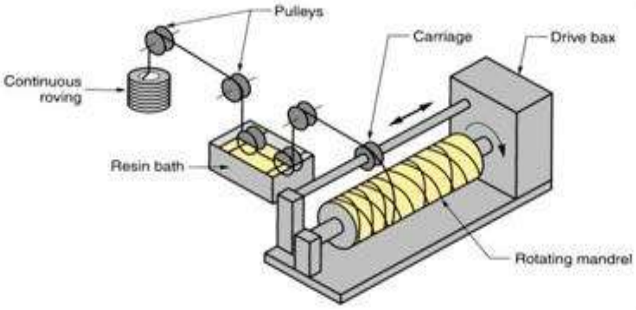


Fig 3.8: Schematic diagram of filament winding machine

FABRICATION

Fabrication of composite with filler material

A mould of size 180×180×5 mm^3 is prepared. Inside the mould is coated with Mansion Wax Polish was coated which acts as a releasing agent. Resin and Hardener were mixed and stirred mechanically in the ratio of 10:1 by weight. With the help of a brush a mixture of epoxy resin and hardener are applied inside the mould surface. One layer of E-Glass fibre of size 180×180 mm² is placed in the mould. E-glass sheet is coated with the resin and mild steel roller is used to remove the entrapped air bubbles and to get uniform distribution of resin and another layer of E-glass fibre is placed on it and the process is continued up to eighth layer and it is cured at room temperature for 24hrs.

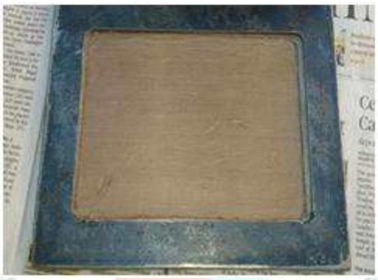


Fig 3.9: Mould

SPECIMEN PREPARATION

From the moulds the fabricated E-glass reinforced particulate filled epoxy based hybrid composite were taken out and as per ASTM standards they are cut into specimens of perfect dimensions from the composite slabs for mechanical characterization (i.e, Tensile test, Flexural test, compression test and hardness test) by using hacksaw and various tools in the engineering workshop, various specimens of shapes and sizes are shown.

- **Tensile test-** sample was cut into dog bone shape as per ASTM D3039 (TENSILE).
- **Flexural test-** sample was cut into flat shape as per ASTM D790 (FLEXURAL).
- **Compression Test-** sample was cut into flat shape with notch at the centre as perASTM D790.
- **Hardness Test** –sample was cut into flat shape as per ASTM D 2240

Fig 3.10: Tensile test Specimen

Fig 3.11: Flexural test specimens

Fig 3.12: Compression test specimens

3.5 TENSILE TEST

Tensile Testing is a way of determining how something will react when it is pulled apart. When a force is applied it in tension. It is one of the simplest and most widely used mechanical test by measuring the force required to elongate a specimen to breaking point, Material properties can be determined that will allow designers and quality mangers to predict how material and product will behave in their intended applications.

The tensile test is carried out by applying longitudinal or axial load at a specific extension rate to a standard tensile specimen with known dimensions until failure. The applied tensile load and extensions are recorded during the test for the calculation of tensile strength. Test was performed on Universal Testing Machine (UTM). The dimensions of the specimen is as per ASTM D638 having length of 250mm, width of 25mm, thickness of 2.5mm. The specimen is loaded between to manually adjustable grips of 20tons computerised UTM. Test was repeated twice and average value is taken to calculate the tensile strength of the prepared composites. The result is expressed in Mpa.

$$\text{Tensile strength} = \frac{\text{Load taken to break the wire in Newtons}}{\text{Cross-sectional area in mm}^2}$$

Fig 3.13: Universal Testing Machine

FLEXURAL TEST

Flexural test is generally used to determine the flexural strength of the material. The material is laid horizontally over two points of contact(lower support span) and then a force is applied to the top of the material through either one or two points of contact(upper loading span) until the sample fails. The maximum recorded force is the flexural strength of that particular sample. This test is done as per ASTM D790 on a three-point bend test using UTM of 40T capacity.

Flexural strength= $3PL/(2bd^2)$
Where, P= Applied central load,
NL= Test span of sample,
mmB= width of the specimen,
mmD= thickness of the specimen , mm

Fig 3.14: Flexural testing machine

COMPRESSION TEST

Compressive load was applied on the composite using UTM Machine and the following parameters were determined. The mechanical properties such as ultimate breaking load, displacement at maximum force and ultimate stress were determined.

The compression specimen is prepared as per the ASTM D790 standard. A compression test involves mounting the specimen in a machine and subjecting it to the compression. The compression process involves placing the test specimen in the testing machine and applying load to compress it until it fractures. The compress force is recorded as a function of displacement. During the application of compression, the elongation of the gauge section is recorded against the applied force.

Fig 3.15: Compression Testing machine

HARDNESS TEST

Hardness is a property of the material that enables it to resist plastic deformation, usually by penetration. However, the term hardness may also refer to resistance to bending, scratching, abrasion (or) cutting. Hardness test was conducted on the specimen using a shore hardness tester. The specimen is first placed on a hard flat surface. The indenter for the instrument is then pressed into the specimen making sure that it is parallel to the surface. The hardness is read within one second of firm contact with the specimen. The hardness was measured at three different locations of the specimen and the avg. value was calculated.

Fig 3.16: Hardness testing instrument

SPECIMENS AFTER TESTING

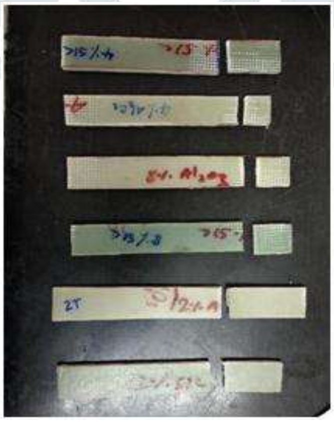


Fig 3.17: After Tensile Test

Fig 3.18: After Flexural test

Fig 3.19: After Compression test

TESTING REPORTS

TENSILE TEST REPORT

TEST DETAILS			
Initial & Final parameters		Observed data	
Specimen type	Flat	Ultimate load(KN)	13.66
Initial width(mm)	22.56	Ultimate Tensile Strength(N/mm^2)	128.566
Initial thickness(mm)	4.71	%EL	0.6
Cross sectional area(mm^2)	106.26	Yield Load(KN)	2.68
Initial Gauge Length(mm)	153.25	Yield stress(N/mm^2)	25.222
Final Gauge Length(mm)	154.15		

TEST DETAILS			
Initial & Final parameters		Observed data	
Specimen type	Flat	Ultimate load(KN)	13.84
Initial width(mm)	25.47	Ultimate tensile strength(N/mm^2)	141.876
Initial thickness(mm)	3.83	%EL	0.7
Cross sectional area(mm^2)	97.55	Yield load(KN)	2.44
Initial gauge length(mm)	153	Yield stress(N/mm^2)	25.013
Final gauge length(mm)	154.12		

TEST DETAILS			
Initial & Final parameters		Observed data	
Specimen type	Flat	Ultimate load(KN)	11.7
Initial width(mm)	23.81	Ultimate tensile strength (N/mm^2)	120.088
Initial thickness(mm)	3.96	%EL	2.1
Cross sectional area(mm^2)	94.29	Yield load(KN)	2.12
Initial gauge length(mm)	50.09	Yield stress(N/mm^2)	22.484
Final gauge length(mm)	51.12		
Specimen type	Flat	Ultimate load(KN)	17.16
Initial width(mm)	24.51	Ultimate tensile strength(N/mm^2)	133.103
Initial thickness(mm)	5.26	%EL	0.64
Cross sectional area(mm^2)	128.92	Yield load(KN)	3.32
Initial gauge length(mm)	155	Yield stress(N/mm^2)	25.752
Final gauge length(mm)	156		

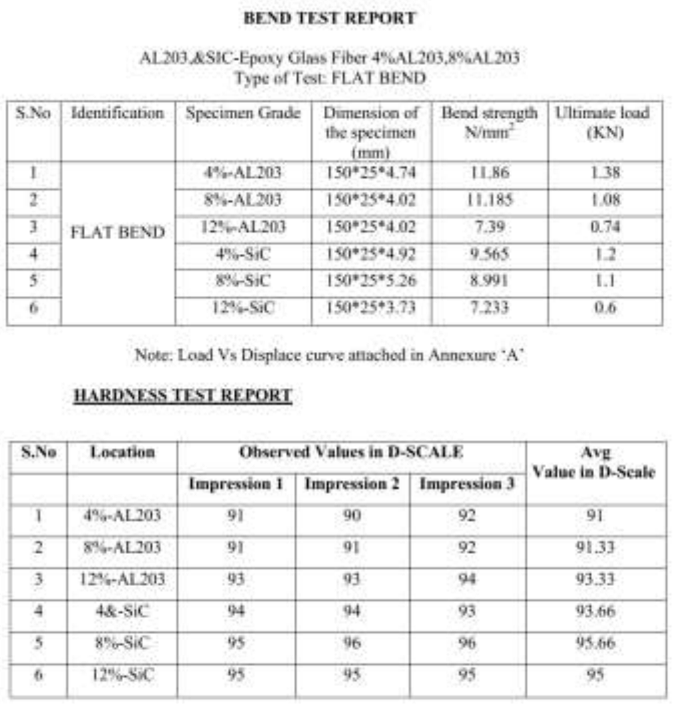
TEST DETAILS			
Initial & Final parameters		Observed data	
Specimen type	Flat	Ultimate load(KN)	10.34
Initial width(mm)	23.45	Ultimate tensile strength(N/mm^2)	92.634
Initial thickness(mm)	4.76	%EL	0.7
Cross sectional area(mm^2)	111.62	Yield load(KN)	2.94
Initial gauge length(mm)	144	Yield stress(N/mm^2)	26.339
Final gauge length(mm)	145		

TEST DETAILS			
Initial & Final parameters		Observed data	
Specimen type	Flat	Ultimate load(KN)	11.96
Initial width(mm)	23.67	Ultimate tensile strength(N/mm^2)	127.60
Initial thickness(mm)	3.96	%EL	0.5
Cross sectional area(mm^2)	93.73	Yield load(KN)	3.25
Initial gauge length(mm)	50.00	Yield stress(N/mm^2)	28.25
Final gauge length(mm)	50.25		

COMPRESSION TEST REPORT

AL203,&SIC-Epoxy Glass Fiber
4%AL203,8%AL203,12%AL203,4%SiC,8SiC
Type of test: COMPRESSION

S.No	Specimen Grade	Specimen Dimension in mm (W*T)	Ultimate load (KN)	Compression Strength(N/mm^2)
1	4%AL203	10*4.59	29.52	643.57
2	8%AL203	10*3.84	18.78	489.063
3	12%AL203	10*3.83	30.86	805.774
4	4%SiC	10*5.18	26.6	513.514
5	8%SiC	10*4.76	34.98	734.97
6	12%SiC	10*3.82	27.14	710.471



BEND TEST REPORT

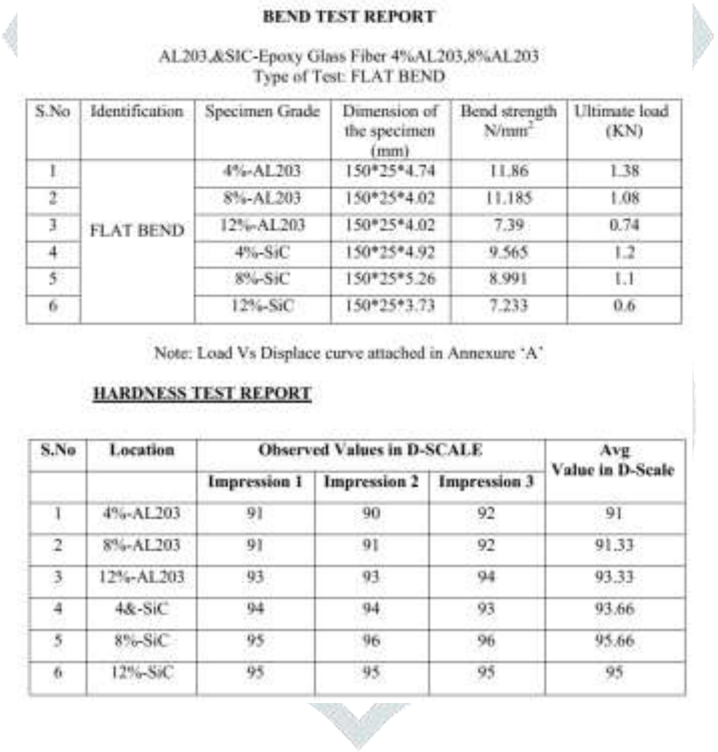
AL203,&SIC-Epoxy Glass Fiber 4%AL203,8%AL203
Type of Test: FLAT BEND

S.No	Identification	Specimen Grade	Dimension of the specimen (mm)	Bend strength N/mm^2	Ultimate load (KN)
1	FLAT BEND	4%-AL203	150*25*4.74	11.86	1.38
2		8%-AL203	150*25*4.02	11.185	1.08
3		12%-AL203	150*25*4.02	7.39	0.74
4		4%-SiC	150*25*4.92	9.565	1.2
5		8%-SiC	150*25*5.26	8.991	1.1
6		12%-SiC	150*25*3.73	7.233	0.6

Note: Load Vs Displace curve attached in Annexure 'A'

HARDNESS TEST REPORT

S.No	Location	Observed Values in D-SCALE			Avg Value in D-Scale
		Impression 1	Impression 2	Impression 3	
1	4%-AL203	91	90	92	91
2	8%-AL203	91	91	92	91.33
3	12%-AL203	93	93	94	93.33
4	4&-SiC	94	94	93	93.66
5	8%-SiC	95	96	96	95.66
6	12%-SiC	95	95	95	95



BEND TEST REPORT

AL203,&SIC-Epoxy Glass Fiber 4%AL203,8%AL203
Type of Test: FLAT BEND

S.No	Identification	Specimen Grade	Dimension of the specimen (mm)	Bend strength N/mm^2	Ultimate load (KN)
1	FLAT BEND	4%-AL203	150*25*4.74	11.86	1.38
2		8%-AL203	150*25*4.02	11.185	1.08
3		12%-AL203	150*25*4.02	7.39	0.74
4		4%-SiC	150*25*4.92	9.565	1.2
5		8%-SiC	150*25*5.26	8.991	1.1
6		12%-SiC	150*25*3.73	7.233	0.6

Note: Load Vs Displace curve attached in Annexure 'A'

HARDNESS TEST REPORT

S.No	Location	Observed Values in D-SCALE			Avg Value in D-Scale
		Impression 1	Impression 2	Impression 3	
1	4%-AL203	91	90	92	91
2	8%-AL203	91	91	92	91.33
3	12%-AL203	93	93	94	93.33
4	4&-SiC	94	94	93	93.66
5	8%-SiC	95	96	96	95.66
6	12%-SiC	95	95	95	95

RESULTS AND DISCUSSIONS:

This chapter presents the mechanical properties of the glass fibre reinforced Epoxy modified hybrid composite with and without filled materials (sic/al2o3) prepared for this present investigation. Details of processing of these composites and the tests conducted of them have been described in the previous chapter. The results of various characterization tests are reported here. This includes evaluation of tensile strength, Flexural strength, compression strength and hardness test has been studied and discussed. The interpretation of the results and the comparison among various composites samples are also presented.

MECHANICAL CHARACTERISTICS OF COMPOSITE MATERIALS

The characterization of the composites reveals that the filler materials(sic/al2o3) have a significant effect on mechanical properties of composites.

CONCLUSIONS

The experimental study on the effect of fibre loading and filler content on mechanical behaviour of glass fibre reinforced epoxy modified hybrid composites leads to following conclusions

- Increase in filler content leads to improving hardness in both Al2O3 and Sic epoxy/glass fiber composites.
- Increase in percentage of SiC filler content in epoxy resin composite leads to deducing tensile strength.
- In addition of Al2O3 in epoxy/Glass fiber composite, the tensile strength and bendability was determined to be more to certain limit (8%) and lower at (12%).

- Selected samples, 8% of Al2O3 have very high tensile strength (141.876 MPa) and 4% of Al2O3 having more bendabiity of (11.86 MPa).
- 12% of Al2O3 with there parent material having excellent compression strength of (805.77MPa).
- Al2O3 composite materials have superficial mechanical properties than SiC composite materials.

Scope for future work

Continuation of this project work will utilizing to explore for variety of aspects of such composites and also varying the compositions for development of hybrid composites and evaluate their physical, chemical, dielectric, wear behaviour and resulting experimental findings would be investigated.

References

[1] Wambua P, Ivens J and Verpoest I, “Natural fibers: Can they replace glass in fibre reinforced plastics?”, Composites Science and Technology, 63, 2003, pp.1259-1264.
[2] Tserki V, Zafeiropoulos N. E, Simon F and Panayiotou C, “A study of the effect of acetylation and propionylation surface treatment on natural fibres”, Composites Part A: Applied Science and Manufacturing, 36, 2005, pp. 1110-1118.
[3] American Society for Testing and Materials (ASTM) 2000. ASTM D 638–99-2000 and 790–99-2000. ASTM Committee on Standards.
[4] Magudu IA, Abdulwahab M, Aigbodion VS. Effect of iron fillings on the properties and microstructure of cast fiber-polyester/iron filings particulate composite. J Alloys Compounds 2009:476;807–811.
[5] Casaurang M, Herrera P, Gonzalez I, Aguilar VM. Physical and mechanical properties of henequen fibers’’. J Appl Polym Sci 1991;43:749–56.
[6] Satyanarayana KG, Sukumaran K, Kulkarni AG, Pillai SGK, Rohatgi PK. Fabrication and properties of natural fiber-reinforced polyester composites. J Compos 1986:17(4);329–333.
[7] Pothan LA, Thomas S, Neelakantan. Short banana fiber reinforced polyester composites: mechanical, failure and aging characteristics’’. J Reinf Plast Compos 1997;16(8):744–65.
[8] D.Hull, T.W. Clyne, An introduction to composite materials, Cambridge university press, 1996.
[9] R.M. Wang, S.R. Zheng, Y.G. Zheng, Polymer matrix composites and technology, Elsevier, 2011.
[10] N. Mohan, C.R. Mahesha, R. Raja, Tribo-mechanical behaviour of SiC filled glass-epoxy composites at elevated temperatures, International Journal of Engineering, Science and Technology. 6 (2014) 44-56.
[11] B. Shivamurthy, M.S. Prabhuswamy, Influence of SiO2 fillers on sliding wear resistance and mechanical properties of compression moulded glass epoxy composites, Journal of Minerals and Materials Characterization and Engineering. 8 (2009) 513-530.
[12] A. Nadia et al., Effect of Al2O3 and SiO2 nanoparticle on wear, hardness and impact behavior of epoxy composites, Chemistry and Materials Research. 7 (2015) 34-39.
[13] D. Lingaraju et al., Mechanical and tribological studies of polymer hybrid nanocomposites with nano reinforcements, Bull. Mater. Sci. 34(4) (2001) 705-712.
[14] B.R. Raju et al., Investigations on mechanical and tribological behaviour of particulate filled glass fabric reinforced epoxy composites, Journal of Minerals and Materials Characterization and Engineering. 4 (2013) 160-167.
[15] O. Asi, An experimental study on the bearing strength behavior of Al2O3 particle filled glass fiber reinforced epoxy composites pinned joints, Compos. Struct. 92(2) (2010) 354-363.
[16] K. Devendra, T. Rangaswamy, Determination of mechanical properties of Al2O3, Mg(OH)2 and SiC filled E-glass/epoxy composites, International Journal of Engineering Research and Applications. 2 (2012) 2028-2033.