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EXPERIMENTAL TESTING OF REINFORCED SYNTHETIC FIBRES USING BASALT & E GLASS

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Abstract:- The main objective of this paper is to find the best reinforced epoxy composite. The combinations of composites were plain woven basalt epoxy composite, plain woven e-glass epoxy composite, basalt/e-glass hybrid epoxy composite, hybrid epoxy composite with Graphite power variation 3g,6g,9g and all these 6 combinations were fabricated by hand layup method. The mechanical properties of composites were calculated by tensile, flexural, impact tests. The tensile strength of basalt/e-glass reinforced epoxy composite was high around 181.6 N/mm2 when compared to remaining composites. The impact strength of basalt/e-glass reinforced epoxy composite was high around 4.32 J when compared to remaining composites. The flexural strength of basalt/e-glass with 6g of graphite reinforced epoxy composite was high around 440.34 MPa when compared to the remaining composites. Based on results basalt/e- glass hybrid epoxy composite possess a high tensile and impact strength. Basalt/e-glass hybrid epoxy composite was best composite compared to remaining composites.

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I INTRODUCTION

COMPOSITE

Composite consists of different materials with definite properties to create a superior and rare material. Composites are organized by reinforcement or by types of matrix which is shown in fig 1.10. The reinforcements are used to resist the load of the element whereas matrix material help them to keep in desired location. Fiber reinforce composites are possessing interest in various applications, but their growth is restricted due to toughness. Also, hybrid composites are weight economy, refinement of fractural toughness, reduction in notch sensitivity, good impact resistance, longer fatigue life compared to composite which are produced by single reinforcement.A "Composite" can be described as a mixture of two or more different materials. Bonding two constituent materials with different mechanical, physical, including chemical properties, will produce content with different characters as a composite material. The two members are matrix and reinforcement. The reinforcement can improve the material's strength.

1.2PHYSICAL AND CHEMICAL PROPERTIES OF COMPOSITES

- Specific stiffness and strength is high.
- Dimensional stability.
- Possess high chemical resistance.
- Relatively easy processing.
- Possess a light weight.
- High strength to weight ratio.
- Good anticorrosion properties.

The properties of composite material are exhaustion life, electrical protection, wear resistance, warm protection quality, light weight, solidness, warm conductivity, fire resistance, temperature-subordinate conduct, and warm protection. The utilization of composite materials is very long. These composite materials are renewable biodegradable. Composite materials have good fatigue resistance compared to other metals. Low radar visibility and Molding to complex forms of composites are easy compared to other materials. The wide use of composite materials in surface transportation is because of their huge size. The strength-weight ratio is higher than other materials which results in the effective use of composite materials in surface transportation. Resilience and good productivity are the basic required qualities of a good composite material.

1.3 ADVANTAGES OF COMPOSITES

Composite materials possess high strengths and abilities of different materials. Take an example of mud and straw, mud is an excellent binding material, but it cannot stand up to compression and force well. Straw is well able to withstand compression without crumbling or breaking. So, it serves to reinforce the binding action of the mud. Humans have been creating composite materials to build stronger and lighter objects for thousands of years.

1.4 APPLICATIONS OF COMPOSITE

Composite materials are used in construction, engineering and other similar applications. Composites are produced by combining two or more materials. In such way composite materials are still recognized, and not fully blended. The best of a composite material is concrete, in which cement is act as a binding material in combination with gravel as a reinforcement. In many cases, concrete uses rebar as a secondreinforcement, making it a three-phase composite, because of the three elements involved.

The properties of composites are varied continuously over wide range of values under the designer point of view. Selection of reinforcement type allows finished product characteristics to be adapted to almost any specific engineering requirement for the industrial purpose. Whereas the use of composites will be a clear choice in many cases, material selection is depends upon many factors such as working lifetime requirements, number of items to be produced, complexity shape products, to reduce the assembly costs and in experience of designer and skills of the designer in tapping the optimumpotential of composites. However, the best desired results for composites are seen along with the traditional material.

Many materials are produced via the conversion of synthetic resins to solids. Important examples are bisphenol Adiglycidyl ether, which is a resin converted to epoxy glue upon the addition of a hardener. Silicones are often prepared from silicone resins via room temperature vulcanization which is shown in fig 1.25.

Figure:1 Epoxy resins

1.5 BASIC CLASSIFICATIONS OF RESINS

- Thermo sets
- Thermo plastic

THERMO SETS (Examples: Epoxies, polyesters, phenolics, polyamide) Thermo sets undergoes an irreversible chemical change when they arecured.

THERMOPLASTICS (Examples: Polyethylene, polystyrene, polyether–ether Ketone) Thermo plastics are eversibly melt when they are heated and solidify when they are cooled. By heating above lower forming temperature they can bereshaped.

1.6 TYPES OF RESINS

There are three main types of resins which are using now a days with carbon fibers, fiberglass, Aramid. These are Epoxy, vinyl ester, polyester resins. These are having a different characteristic with respective costs also.

EPOXY RESIN: Epoxy has good additive properties along with high mechanical strength, low shrinkage, chemically resistant, high diffusion density, low viscous and better electric insulation capacity. And it is easily reinforced with natural hemp, kenaf and E glass fibers. The properties of Epoxy Resin are shown in table 1.1.

Table:1.1 Properties of epoxy resin

Properties	Epoxy
Viscosity at 250µ(cP)	12000-13000
Density ρ (g.cm^{3})	1.16
Heat distortion temperature HDT (°C)	100
Modulus of elasticity E (GPa)	5
Bending strength (MPa)	60
Tensile strength (MPa)	73
Maximum elongation (%)	4

Vinyl esters: Viscosity value of vinyl esters are midway between polyesters and epoxy resins, before adding styrene. Vinyl esters shrink less on curing, which means that pre-release of a laminate from a mold is less significant. Vinyl esters are more tolerant of stretching than polyester. The properties of vinyl ester resin are shown in table 1.2.

Table :1.2 Properties of vinyl ester resin

Properties	Vinyl ester
Viscosity at 250µ(cP)	350
Density ρ (g.cm^{3})	1.09
Heat distortion temperature HDT (°C)	82
Modulus of elasticity E (GPa)	3.71
Bending strength (MPa)	55
Tensile strength (MPa)	69
Maximum elongation (%)	3

Polyester: Polyester resins are unsaturated synthetic resins formed by the reaction of dibasic organic acids and polyhydric alcohols. Maleic Anhydride is a commonly used raw material with diacid functionality. Polyester resins are used in sheet moulding compound, bulk moulding compound and the toner of laser printers. The properties of vinyl ester resin are shown in table 1.3

Table 1.3 Properties of polyester resin

Properties	Polyester
Viscosity at 250µ(cP)	250-350
Density ρ (g.cm^{3})	1.09
Heat distortion temperature HDT (°C)	54
Modulus of elasticity E (GPa)	3.3
Bending strength (MPa)	45
Tensile strength (MPa)	40
Maximum elongation (%)	1

HARDENER

Hardener was used as a binder during the fabrication. It has low viscosity, cure at room temperature, good mechanical strength, Good resistance to atmospheric and chemical degradation.

1.7 TYPES OF HARDENER

The hardeners are classified into following types

- Aliphatic and Aromatic amines,
- Anhydrides, and Polyamides.

The size of hardener molecules is much smaller than the resin molecules. Therefore, the viscosity of hardener is low compared to the resins.

II LITERATURE REVIEW

Seghini et al [1] studied the mechanical properties of basalt fiber epoxy composite analyzed by comparing the effect of commercial coupling agent thermal de-sizing treatment and the method of plasma polymerization on the interfacial strength of the Matrix fiber. Maria et al [2] measured basalt powder's effect on rigid polyurethane foams. Danuta et al [3], researched the effect of basalt dust on epoxy composite's mechanical properties and also examined the thermal stability of composite materials.Chen et al [4], testing of basalt fiber reinforced polymer by dynamic loading and impact loading were studied to determine the mechanical properties and quasi-static loads were also applied and the quasi-static and dynamic test of uni-directional basalt fiber reinforced polymer with unit weight 300g / m^2 was applied to determine the material properties of the tensile strength module and strain failure**.**

Lopresto et al [5] compared the mechanical properties of basalt fiber and E-glass reinforced plastics produced using the vacuum bag method. Dorigato et al [6] investigated the effect of fatigue resistance of laminates enhanced by basalt fibers. Brahim Benmokrane et al [7] studied glass / vinyl ester, basalt / vinyl ester and basalt / epoxy fiber reinforced polymer bar characterization and comparative durability. Sakthivel et al [8] studied the basalt / sisal reinforced polymer composite drilling study using anova and regression models. Using HSS twist drill, experimental tests were performed on basalt / sisal polymer composite material. Sabet et al [9] investigated the effect of thermal treatment on basalt fibers ' tensile properties. The effect of combined thermal and microwave healing of basalt / epoxy composites and their mechanical properties and surface hardness were studied by Alexander et al [10]. Compression moulding phase and post-curing in thermal and macro / micro wave conditions are carried out in this manufacturing process.

Rajamuragan et al [11] analyzed delamination in drilling of basalt fiber reinforced epoxy composites. In this paper the delamination of basalt fiber reinforced epoxy composites was studied through drilling operation. F.Bakare et al [12] studied the thermomechanical properties of bio-based composites made from a lactic acid thermoset resin and flax and flax/basalt fiber reinforcements. Wang et al [13] studied the low velocity impact properties of 3D woven basalt/aramid hybrid composites. Inter ply and intra ply hybrid composites has been fabricated by using Aramid (Kevlar 129), basalt fibers, and epoxy resin. Impact test has been carried out in the composite at 2 m/s and 3 m/s impact velocities along warp and weft directions. Akinci et al [14] investigated the wear behavior of basalt-filled low-density polyethylene composites. Dorigato et al [15] examined the influence of carbon / basalt fiber hybrid laminates on flexural and impact behavior. Sarasini et al [16] investigated the effect of basalt fiber hybridization on the behavior of glass / basalt woven fabric / epoxy resin composites under low impact velocity.

Dehkordi et al [17] studied the low velocity impact properties of intra-ply hybrid composites based on basalt and nylon woven fabrics. Epoxy resin was used as matrix material. Torres et al [18] manufactured green-composite sandwich structures with basalt fiber and bio epoxy resin. Khalili et al [19] investigated the mechanical behavior of basalt fiber-reinforced and basalt fiber metal laminate composites under tensile and bending loads. To study the effect of fillers in epoxy, the micro glass powder (MGP) was only added into the epoxy resin in BFRE composites at various volume fractions. Wei et al [20] investigated degradation of basalt fiber and glass fiber/epoxy resin composites in seawater with different periods of time. Chairman et al [21] investigated the mechanical and abrasive wear behavior of glass and basalt fabric-reinforced epoxy composites. Basalt fiber fabric and glass fiber fabric reinforced epoxy composites were prepared by hand layup technique.

From the literature it is found that very few authors done work on hybrid reinforced Epoxy composites. Now a day the fiber reinforced composites plays a vital role in many sectors. These composites are using in militaries, automobiles, food industries etc.., The main objective of this project is to find the best reinforced epoxy composite. The combinations of composites are plain woven basalt epoxy composite, plain woven e-glass epoxy composite, basalt/e-glass hybrid epoxy composite, hybrid epoxy composite with Graphite power variation 3g,6g,9g and all these 6 combinations are fabricated by hand layup method. Epoxy is used as matrix in the reinforced composite and investigated the mechanical properties like tensile strength**,** flexure strength, impact stength of composites. And to find the best fiber reinforced composite among the different composite by performing the 3 different tests.

III FABRICATIONS AND EXPERIMENTAL SETUPS

In our country India, there are far reaching particular blended packs of regenerative plants and trees with some fiber content. In them, some are created from the times and some are wild plants, creepers, and trees that create in woodlands and woods.

It is a known fact that any material which is in stringy structure is more grounded than in the mass structure. Thus, these strong filaments are used. Pineapple and Agave Americana are energetically open in our country that has been used as a piece of their therapeutic structure.

Figure:3 Epoxy Resin LY556 Hardener

In any case, same business identified with this fiber is all that abundantly obliged when stood out from various filaments. This examination incorporates to explore the possible usage of filaments in making of new blended sack of composites for weight passing on structures. The propose of trademark filaments is to extend the quality. A vast bit of the ordinary composites is less costly than the produced fiber composites.These typical fibers have a key part in long time past days. These individuals, in light of these fibers they make them for their private uses like range homes cruising strength etc. The examination has exhibited that, these built fiber advancements are offered by an impelled development, then again, these investigates are to upgrade the application, quality and effectiveness of customary fibers. These standard fiber composites have various inclinations of being strong, unassuming, and light, eco-friendlier and safer. Regardless, by using of these trademark fibers there are a couple of requests raised up that how such sort of materials is to be striven for sturdiness and quality. More works ought to be required before these regular fiber composites are used as a piece of asking for conditions. From these trademark fiber sustained plastics, Daimler Benz have used gateway sheets for their Mercedes G class cars besides they have courses of action to construct the material containing normal fiber fortified plastics for various portions. Once after developed, the advancement would be a dynamic making of a broad number of Eco-friendly things.

Materials

On among different types of resins and hardener. Epoxy LY556 and hardener HY951 are chosen. The materials taken to fabricate the specimens are Basalt, E-glass and Graphite powder. These are taken in the different ratios and different combinations. The six different composites are investigated the impact strength, tensile strength, flexural strength.

EPOXY

In this work epoxy LY556 is used as matrix material shown in figure.3.1 to fabricate hybrid fiber epoxy composites. Epoxy LY556 is chosen because it is a one such matrix which is mostly used because it possesses low shrinkage, higher mechanical properties, easy to fabricate, possess excellent chemical and moisture resistance and good wet ability. For thermoset plastic composite epoxy resins are most commonly used in polymer matrix composite. Epoxy resins are a family of thermoset plastic materials which do not release any reaction products when they cure. They also have good adhesion to other materials, good chemical and environmental resistance and good insulating properties.

Hardener used for present investigation for initiating gel formation is hardener HY951 which is shown in figure.3.2. The combination of epoxy LY556 and hardener which cures at room temperature, excellent adhesive strength, good mechanical and electrical properties.

The ratio of the epoxy and hardener are taken 10:1 that is 10 grams of epoxy and 1 gram of hardener.

Figure:4 Hardener HY 951

Basalt fiber

Basalt fibers are most commonly used in natural fiber and extensively used in various fields of engineering. A lot of research activities has been carried out to study the material properties of basalt by reinforced it with polymer matrix materials. Basalt fiber is mineral fiber a type of natural fiber shown in figure.3.3 with mechanical properties near or above glass fiber and possesses low cost when compared to carbon fibers.

Basalt fiber is a material made from extremely fine fiber of basalt which is also called as golden fiber. The basalt looks like a golden brown which is consists of minerals plagioclase, pyroxene, and olivine. It is a natural fiber because it produced from the basalt rock which is an extrusive igneous rock which is formed by rapid cooling of basaltic lava which is exposed near the surface of the earth. Basalt is fine-grained, hard rock forms when a bit of lava shoots out of volcanoes.

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Figure:5 Basalt fiber

Basalt possesses a similar chemical composition as a glass fiber. Most of the glass fibers have a highly resistant to alkaline, acidic and salt attack making it a good candidate for concrete, bridge and shoreline structures.

Compared to carbon and aramid fiber, basalt fiber has a features of wider application temperature range -452° F to 1,200° F (-269° C to +650° C), higher oxidation resistance, higher radiation resistance, higher compression strength, and higher shear strength. The Basalt in the form of 300 GSM sheets was chosen. One 300 GSM basalt produces the 0.5mm thickness.

E-Glass Fiber

E-glass fiber is a one of the glass fibers so, it is also called as Glass Fiber. Generally, glass fiber consists of alkali oxide components such as aluminum oxide, less than 1% or less than 0.8%. So, it contains very little alkali. It is the most widely used glass fiber formula in the world. Although the glass fibers are used in many electronic applications and also, they are used in many areas today. The glass fiber is combined with thermoset resins in order to produce the glass reinforced plastic production. In most of the industrial are using these glasses reinforced plastic panels and sheets in modern life. These fibers are using in many sectors now a days. These fibers possess a high mechanical impact and mechanical effects. They don't melt in heat, but they're soft. These fibers are as shown in figure 3.4

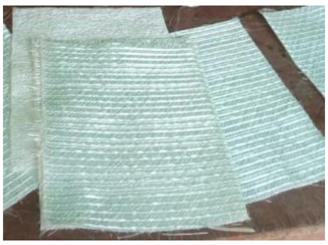

Figure: 6 E-Glass fiber

E-Glass is a low alkali glass with a typical nominal composition of SiO_2 54wt%, Al_2O_3 14%, CaO + MgO 22%, B_2O_3 10% and Na_2O + K_2O less than 2%. Some other materials may also be present at impurity levels. The 300 GSM E-glass fiber is chosen. One 300GSM sheet produces the 0.5mm thickness.

Material	Density (g/cm³)	Tensile Strength (GPa)	Specific strength	Elastic Modulus (GPa)	Specific modulus
Basalt fiber	2.65	2.9-3.1	1.09-1.17	85-89	32.1-32.8
E-Glass	2.60	2.5	0.962	76	29.2

Table:3.1 Properties of basalt and e-glass fiber

IV FABRICATION OF COMPOSITE SPECIMENS

Hand lay-up technique is the simple and cheapest method of composite processing. The infrastructural need for this technique is also minimal. The standard test procedure for Mechanical properties of fiber-resin composites; ASTM-D790M-86 is utilized to according to the measurements. The mold is prepared on smooth clear film with 2-way tape to the required measurement. At that surface mold is prepared keeping the 2-way tape on the clear film. The reinforcement in the form of long fiber are cut as per the mold size and placed on the surface of thin plastic sheet. Then the thermosetting polymer in liquid form is assorted thoroughly in appropriate proportion with a recommended hardener (curing agent) and poured on the surface of clear. The polymer is uniformly spread with the help of brush. Then second layer of fiber is placed on the polymer surface and another layer of polymer is applied after this is closed with another thin plastic sheet after squeezer is moved with a gentle pressure on the thin plastic sheet to remove air. The consequential mold is cured for 24 hours at room temperature.

Figure:7 3g,6g,9g of graphite powder

Graphite powder is mixed with epoxy resin which is shown in fig 3.5 and stirred uniformly half an hour and same process is follow to produce Graphite powder After fabrication specimens are cut form sheets according to the ASTM statndards165mm long, 12.5mm in width and 4mm in thick are fabricated for tensile testing. 100mm long, 25mm width and 4mm in thick are fabricated for flexural testing. 63.5mm long, 12.36mm width and 6mm thick are fabricated for impact testing.

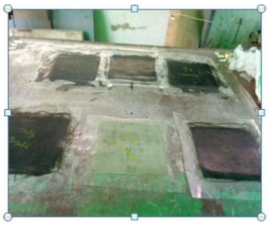

Figure:8 Before cutting the specimen

Steps Involved In The Fabrication Of Specimen:

The E-Glass fibre reinforced Epoxy Composite specimen was fabricated by hand layup technique. In this process 8 sheets of 300GSM E-glass fibre (230/300mm) and 10 grams of hardener (HY951) is mixed with 100 grams of Epoxy (LY556) which is used as matrix in the composite. The thickness of the specimen is 4mm for tensile test and flexural test which is shown in figure 3.7. Thickness of the specimen that obtained by 2 sheets of 300GSM of E-glass fibre is around 1mm. For obtain 4mm thickness eight sheet of E-glass are used. And the thickness of specimen for impact test is 6mm for obtain these 12 sheets of E-glass areused which is shown in fig 3.7.

The basalt fibre reinforced Epoxy Composite specimen was fabricated by hand layup technique. In this process 8 sheets of 300GSM basalt fibre (230/300mm) and 10 grams of hardener (HY951) is mixed with 100 grams of Epoxy (LY556) which is used as matrix in the composite. The thickness of the specimen is 4mm for tensile test and flexural test which is shown in figure 3.8.

Thickness of the specimen that obtained by 2 sheets of 300GSM of basalt fibre is around 1mm. For obtain 4mm thickness eight sheet of basalt are used. And the thickness of specimen for impact test is 6mm for obtain these 12 sheets of basalt are used.

Hybridifi

Figure: 9 Basalt Fiber Reinforced Epoxy

COMPOSITE

The Hybrid basalt/E-glass reinforced Epoxy Composite specimen was fabricated by using hand layup technique. In this process 4 sheets of 300GSM E-glass fibre (230/300 mm) and4 sheets of 300GSM basalt fibre are used to obtain the 4mm thickness. And 10 grams of hardener (HY951) is mixed with 100 grams of Epoxy (LY556) which is used as matrix in the composite.

The thickness of the specimen for tensile test and flexural test is 4mm which is shown in figure 3.9. The thickness of specimen for impact test is 6mm to obtained this thickness 6 sheets of 300GSM basalt fibre and 6 sheets of 300GSM E-glass fibre are used.

Figure:10 Hybridization of basalt with E-glass fiber reinforced Epoxy Composite

The Hybrid basalt/E-glass fiber reinforced Epoxy Composite specimens are fabricated by hand layup method. For this hybrid composite 3g of graphite powder is added to the epoxy and hardener. In this process 4 sheets of 300GSM E-glass fibre (230/300 mm) and 4 sheets of 300GSM basalt fibre are used to obtain the 4mm thickness. And 10 grams of hardener (HY951) is mixed with 100 grams of Epoxy (LY556) and 3g of graphite powder which is used as matrix in the composite.

The thickness of the specimen for tensile test and flexural test is 4mm which is shown in figure 3.10. The thickness of specimen for impact test is 6mm to obtained this thickness 6 sheets of 300GSM basalt fibre and 6 sheets of 300GSM E-glass fibre are used.

Figure 11 hydrization of basalt/E-glass fiber with 3g of graphite powder reinforced Epoxy Composite

The Hybrid basalt/E-glass fiber reinforced Epoxy Composite specimens are fabricated by hand layup method. For this hybrid composite 6g of graphite powder is added to the epoxy and hardener. In this process 4 sheets of 300GSM E-glass fibre (230/300 mm) and 4 sheets of 300GSM basalt fibre are used to obtained the 4mm thickness. And 10 grams of hardener (HY951) is mixed with 100 grams of Epoxy (LY556) and 6g of graphite powder which is used as matrix in the composite.

The thickness of the specimen for tensile test and flexural test is 4mm which is shown in figure 3.11. The thickness of specimen for impact test is 6mm to obtained this thickness 6 sheets of 300GSM basalt fibre and 6 sheets of 300GSM E-glass fibre are used.

e11

Figure12 hydrization of basalt/E-glass fiber with 6g of graphite powder reinforced Epoxy Composite

The Hybrid basalt/E-glass fiber reinforced Epoxy Composite specimens are fabricated by hand layup method. For this hybrid composite 9g of graphite powder is added to the epoxy and hardener. In this process 4 sheets of 300GSM E-glass fibre (230/300 mm) and 4 sheets of 300GSM basalt fibre are used to obtained the 4mm thickness. And 10 grams of hardener (HY951) is mixed with 100 grams of Epoxy (LY556) and 9g of graphite powder which is used as matrix in the composite.

The thickness of the specimen for tensile test and flexural test is 4mm which is shown in figure 3.12. The thickness of specimen for impact test is 6mm to obtained this thickness 6 sheets of 300GSM basalt fibre and 6 sheets of 300GSM E-glass fibre are used.

Figure13 Hybridization of basalt/E-glass fiber with 9g of graphite powder reinforced Epoxy Composite

IV TENSILE TESTING OF COMPOSITES

A 2-ton limits electronic tensometer which is shown in figure, METM 2000 ER-1 model (Plate II-18), supplied by M/S microtech Pune, is used to determine the elasticity of composites. Its capability can be changed by burden cells of 20 kg, 200 kg and 2 ton. A burden cell of 2 ton is used for testing composite specimens. Self-adjusted brisk grasp throw is used to hold composite specimens. A computerized micrometer is used to measure the required thickness and width of composite specimens. The gauge length, width and thickness are measured with 0.001 mm minimal tally computerized micrometer. This electronic tensometer is fixed with burden and augmentation pointers, which has a minimal tally of 0.01 kg and 0.01mm individually. An electronic tensometer is fitted with an altered self-adjusted snappy grasp toss and other versatile self-adjusted fast hold toss to hold 165 mm long, 12.5 mm wide and 4 mm thick specimens. Specimens are placed in the grips of a tensometer at a specific grip separation and subjected to load until failure. The force applied is varied on to quantify the heap and expansion of specimen. The flexible throw is further moved such that the heap pointer just begins giving evidence stacking on the specimen.

Flexural testing of composites

Three point bowing test are carried out as per ASTM-D790M-86 which is shown in fig 3.13, the specimens are 100 mm long, 25 mm wide and 4 mm thick .In three point bowing test, the external rollers are 70 mm separated and specimens are subjected at a strain rate of 0.2 mm/min. Flexural strength are determined by the following relations

Figure:14 Electronic tensometer for tensile & flexural testing

IMPACT TESTING OF COMPOSITES

Impact test is also known as Charpy v notch, Impact tester was way analyzer supplied by M/S International Equipments, Mumbai, was used to test the impact properties of fiber Reinforced composite specimen which is shown in fig 3.14. The Impact tester has four working abilities of effect quality i.e. 0-2.71 J.0-5.42 J,0-10.84 J and 0-21.68 J, with a base determination on every size of 0.02J, 0.05 J, 0.1 J and 0.2 J individually .Four scales and comparing mallets (R1,R2,R3,R4) are presented in equipment.

FIGURE:15 IMPACT MACHINE FOR IMPACT TESTING

AFTER TESTING:

FIGURE 16 AFTER TESTING SPECIMENS

V RESULTS AND DISCUSSION

Mechanical characteristics of composites

The properties of the E-glass & Basalt fibers reinforced epoxy composites are investigated are presented in below Table 4.1. The fabrication processing of composites and the tests conducted on them have been described in the previous chapter. The mechanical properties of the reinforced composites are described in strength, chemical composition, type of fiber used and also atmospheric condition while fabricating the specimens.

The results of various characterization tests are reported here. This includes evaluation of tensile strength, flexural strength; impact strength has been studied and discussed. Based on the tabulated results, various graphs are plotted and presented in figures for composites.

S.NO	Composite	Flexural Load in N	Elongation in mm	Flexural strength in MPa
1	Basalt+E-glass	1165	7.175	305.81
2	Basalt+E-glass+6g graphite	1677.5	7.37	440.34
3	E-glass	1580	6.82	414.75
4	Basalt+E-glass+9g graphite	1217.5	6.07	319.59
5	Basalt	1015	5.95	266.43
6	Basalt+E-glass+3g	1192.5	5.9	313.03

Table: 17 Flexural testing results for 6 composites

The table 4.4 shows Flexural testing results for 6 composites, the composites are Basalt, E-glass and various propositions of graphite like 3g,6g,9g. In this flexural load ranges in between 1015-1677.5, difference in elongation and flexural strength ranges of these composites were 266.43 to440.34.

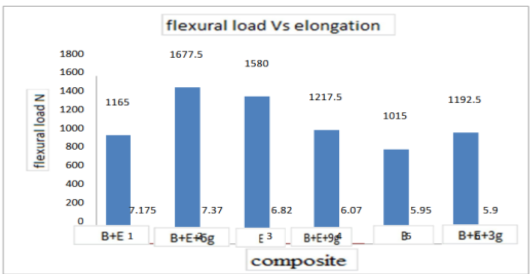

Figure: 18 flexural load Vs elongation diagram

Based on the flexural strength finally concluded that Basalt+Eglass+6g of graphite hybrid epoxy composite possess high flexural strength compared to remaining composite as shown in figure 4.7. And E-Glass having a second highest flexural strength compared to remaining composite.

Impact strength

Fabrication and testing are successfully completed in this project. The impact strength of plain-woven basalt, plain woven E-Glass fiber and basalt/E-glass, basalt/E- glass with Graphite power variation 3%,6%,9%, are tested which are fabricated by using hand lay-up method.

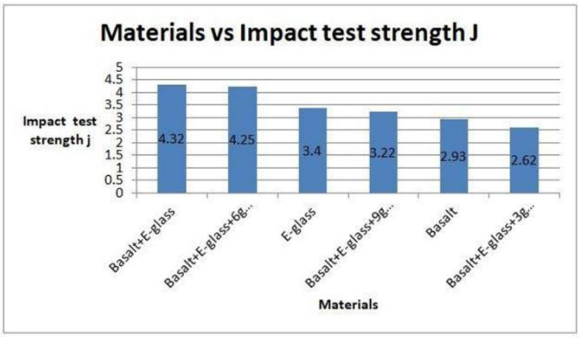

Figure: 19 Impact strength result graph

. From the impact strength finally concluded the Basalt + E-glass hybrid material possesses high impact strength compared to the remaining compositions which are shown in figure 4.8. Basalt/E-glass with 6g of graphite powder is also poses a second highest impact strength.

VI CONCLUSION& FUTURE SCOPE

The mechanical properties of composites are calculated by tensile, flexural, impact tests. The conclusions of the present study are:

- Tensile strength of plain-woven basalt epoxy composite is 125.8 N/mm^2, flexural strength is 266.43MPa, impact strength is 2.93J
- Tensile strength of plain-woven e-glass epoxy composite is 161.75 N/mm^2, flexural strength is 414.75MPa, impact strength is 3.4J
- Tensile strength of basalt/e-glass hybrid epoxy composite is 181.6 N/mm^2, flexural strength is 305.81MPa, impact strength is 4.32J
- Tensile strength of hybrid epoxy composite with 3g Graphite power is 92.55 N/mm^2, flexural strength is 313.03MPa, impact strength is 2.62 J
- Tensile strength of hybrid epoxy composite with 6g Graphite power is 176.35 N/mm^2, flexural strength is 440.34MPa, impact strength is 4.25 J
- Tensile strength of hybrid epoxy composite with 9g Graphite power is 157.9 N/mm^2, flexural strength is 319.59MPa, impact strength is 3.22 J

Based on tests basalt/E-Glass hybrid reinforced epoxy compositeshows a best result in the tensile strength and as well as impact strength.The flexural strength is high in the

Basalt+Eglass+6g of graphite hybrid material possess high flexural strength compared to remaining composite. So, it is concluded that basalt/e-glass hybrid epoxy composite is the best result which satisfying the two mechanical properties.

Future scope

1) The extension of this thesis work can be done by considering the following points:
2) The fiber can also take in the form of powder to fabricate the specimen which may increases the strength.
3) Different type reins can be used to find the mechanical properties like strength, wear resistance
4) By considering different process parameter and different composites which improves the properties of composites.

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