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Fabrication and Determination of Mechanical Properties of Mild Steel Particle Reinforced Polyester Composite Material

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ABSTRACT:

Over the last thirty years composite materials have been dominating emerging materials. Composite material is the combination of two or more distinct faces and having bulk properties significantly different from those of any of those constituents. The volume and number of applications of composite materials have grown steadily, penetrating conquering new markets relentlessly. While composites have already proven their worth as weight saving materials, the current challenge is to add additional degree of freedom which provides potential versatility to the present composites by blending of different polymers. This project deals with fabrication and determination of mechanical properties of mild steel reinforced polymer composite material. Fabricating the composite materials with different weight percentages of reinforcement and we determine the various mechanical properties. The efficient mechanism preserved the structural integrity of the composite. The findings will support the development of a generic quasi static analytical model and numerical methods for further valuations.

1.INTRODUCTION:

Composite Materials Background The recent technological advances in engineering, material science has assumed a position of utmost importance. The interest in advanced materials is increasing rapidly, both in terms of their research and application. Whatever the field may be, the final limitation on advancement depends on materials. Composite materials in this regard represent a giant step in the ever constant endeavour of the optimization in the materials. The mechanical shortcomings of homogenous materials and the need for composites were realized in the early 1950s, with the advent of space age.

Almost all homogenous materials have their inherent shortcomings in mechanical respect. When they are stiff and sufficiently hard, they are most brittle and hardly processible, when they are ductile and well-processible, they are not stiff and hard enough. By the combination of materials, it proved possible to attain a situation in which the "whole is more than the sum of its parts". Composites were a need in the evolution of engineering materials. The simplest combination is that of only two materials, one acting as reinforcement and the other as the matrix. The composite materials have advantage over other conventional materials due to their higher specific properties such as tensile, impact and flexural strengths, stiffness and fatigue characteristics, which enable the structural design to be more versatile. Due to their many advantages, they are widely used in the aerospace industry, in a large number of commercial mechanical engineering applications, such as machine components, Internal combustion engine parts, railway coaches, flywheels, process industries, sports and leisure equipments, marine structures, and biomedical devices.

Definition The most widely used meaning is the following one, which has been stated by Jartiz "Composites are multifunctional material systems that provide characteristics not obtainable from any discrete material. They are cohesive structures made by physically combining two or more compatible materials, different in composition and characteristics and sometimes in form". The weakness of this definition resided in the fact that it allows one to classify among the composites any mixture of materials without indicating either its specificity or the laws which should given it which distinguishes it from other very banal, meaningless mixtures. Kelly very clearly stresses that the composites should not be regarded simple as a combination of two materials.

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In the broader significance; the combination has its own distinctive properties. In terms of strength to resistance to heat or some other desirable quality, it is better than either of the components alone or radically different from either of them. Beghezan defines as "The composites are compound materials which differ from alloys by the fact that the individual components retain their characteristics but are so incorporated into the composite as to take advantage only of their attributes and not of their short comings", in order to obtain improved materials. Van Suchetclan explains composite materials as heterogeneous materials consisting of two or more solid phases, which are in intimate contact with each other on a microscopic scale. They can be also considered as homogeneous materials on a microscopic scale in the sense that any portion of it will have the same physical property.

The term composite in the term composite material signifies that two or more materials are combined on a macroscopic scale to form a useful third material. A composite material is a material system combining two dissimilar materials that differ in shape and chemical composition and which are insoluble in each other.The primary functions of the matrix are to transfer stresses between the reinforcing fibres/particles and to protect them from mechanical and/or environmental damages where as the presence of fibres/particles in a composite improves its mechanical properties like tensile strength, flexural strength, impact strength, stiffness etc.

Merits of Composites :

Advantages of composites over their conventional counterparts are the ability to meet diverse design requirements with significant weight savings as well as strength-to-weight ratio. Some advantages of composite materials over conventional ones are as follows:

1.Tensile strength of composites is four to six times greater than that of steel or Aluminum (depending on the reinforcements).

2.Improved Torsional stiffness and impact properties.

3.Higher fatigue endurance limit (up to 60% of ultimate tensile strength).

4.30% - 40% lighter for example any particular aluminum structures designed to the same functional requirements.

5.Lower embedded energy compared to other structural metallic materials like steel, aluminum etc.

6.Composites are less noisy while in operation and provide lower vibration transmission than metals.

7.Composites are more versatile than metals and can be tailored to meet performance needs and complex design requirements.

8.Long life offer excellent fatigue, impact, environmental resistance and reduce maintenance.

9.Composites enjoy reduced life cycle cost compared to metals.

10.Composites exhibit excellent corrosion resistance and fire retardancy.

11.Improved appearance with smooth surfaces and readily incorporable integral decorative melamine are other characteristics of composites.

12.Composite parts can eliminate joints / fasteners, providing part simplification and integrated design compared to conventional metallic parts.

Classification of Composite Materials :

Composites can be classified according to different criteria. Figure 1 shows the classification of composites based on geometry and physical structure of matrix and reinforcement.

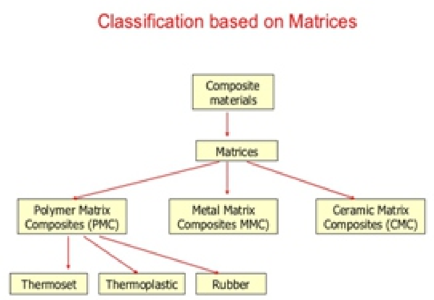

Figure.1 Classification of composites based on geometry and physical structure of matrix and reinforcement.

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According to the type of matrix materials, composite materials are classified into three categories (as shown in Figure 2), such as metal matrix composites (MMCs), ceramic matrix composites (CMCs) and polymer matrix composites (PMCs). Each type of composites is suitable for different applications.

Metal Matrix Composites:

When the matrix material is taken as metal like aluminium, copper, it is called as metal matrix composite. These are having high ductility and strength, good fracture toughness, inter-laminar shear strength and transverse tensile strength and also having superior electrical and thermal conductivity. These materials are high dimensional stable due to low thermal expansion coefficient of matrix and withstand to a high temperature. Due to high elastic modulus of reinforcements they have very high stiffness.

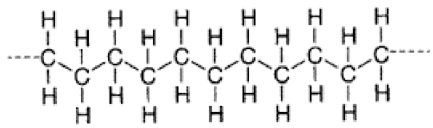
Ceramic Matrix Composites:

When the matrix material is taken as ceramic it is called as ceramic matrix composite. Ceramic material include a wide verity of inorganicmaterials like bricks, pottery, titles also include oxide, nitrides and carbides of silicon, aluminium, zirconium etc. They are normally non metallic and processed very often at high temperature. The main objective in producing ceramic matrix composites is to enhance the toughness, high strength and hardness, high temperature properties, wear resistance etc.

Polymer Matrix Composites:

Polymer matrix composites consist of a polymer resin as the matrix material which filled with a variety of reinforcements. This kind of composite is used in the greatest diversity of composite applications due to its advantages such as low density, good thermal and electrical insulator, ease of fabrication, and low cost. The properties of polymer matrix composites are mainly determined by three constitutive elements such as the types of reinforcements (particles and fibres), the type of polymer, and the interface between them. 1.5 Polymers Many common classes of polymers are composed of hydrocarbons. These polymers are specifically made of small units bonded into long chains.

Carbon makes up the backbone of the molecule and hydrogen atoms are bonded along the backbone. Below is a diagram of polyethylene, the simplest polymer structure.



Polymers are containing only carbon and hydrogen Polypropylene, Polybutylene, Polystyrene and polymethylpentene are examples of these. Even though the basic makeup of many polymers is carbon and hydrogen, other elements can also be involved. Oxygen, chlorine, fluorine, nitrogen, silicon, phosphorous, and sulfur are other elements that are found in the molecular makeup of polymers. Polyvinyl chloride (PVC) contains chlorine. Nylon contains nitrogen and oxygen. Teflon contains fluorine. Polyester and polycarbonates contain oxygen. Vulcanized rubber and Thiokol contain sulfur. There are also some polymers that, instead of having a carbon backbone, have a silicon or silicon-oxygen backbone. These are considered inorganic polymers.

Molecular Arrangement of Polymers:

Polymers can be arranged if they are amorphous. An amorphous arrangement of molecules has no long-range order or form in which the polymer chains arrange themselves. Amorphous polymers are generally transparent. This is an important characteristic for many applications such as food wrap, Plexiglas, headlights, and contact lenses. Controlling and quenching the polymerization process can result in amorphous organization. Obviously, not all polymers are transparent. The polymer chains in objects that are translucent and opaque are in a more crystalline arrangement. By definition a crystalline arrangement has atoms, ions, or in this case, molecules in a distinct pattern. You generally think of crystalline structures in salt and gemstones, but not in plastics. Just as quenching can produce amorphous arrangements, processing can control the degree of crystallinity. The higher the degree of crystallinity, the less light can pass through the polymer. Therefore, the degree of translucence or opaqueness of the polymer is directly affected by its crystallinity. Engineers are always producing better materials by manipulating the molecular structure that affects the final polymer produced.

Manufacturers and processors introduce various fillers, reinforcements, and additives into the base polymers to expand product possibilities.

1.5.2 Characteristics of Polymers:

Polymers are divided into two distinct groups: thermoplastics and thermosets. The majority of polymers are thermoplastic, meaning that once the polymer is formed it can be heated and reformed over and over again. This property allows for easy processing and recycling. The other group, the thermosets, cannot be remelted. Once these polymers are formed, reheating will cause the material to scorch.

Thermoplastics:

Thermoplastic are in general, ductile and tougher than thermosetting materials. They are reversible and can be reshaped by application of heat and pressure. Thermoplastic molecules do not cross-link and therefore they are flexible and reformable. Generally, thermoplastics show poor creep resistance, especially at elevated temperatures, as compared to thermosetting materials. Their lower stiffness and strength values require the use of fillers and reinforcements for structural applications. The most common materials used in thermoplastic composites are nylon, polyether ketone, Acetal, polyphenylene sulfide, polycarbonate, Teflon, polyethylene etc.

Thermosetting Resin:

Thermosetting materials undergo a curing process through part fabrication and once cured cannot be re-melted or reformed. Thermosetting materials are brittle in nature and offer greater dimensional stability, better rigidity, and higher chemical, electrical, and solvent resistance.

The most common materials used in thermosetting resin composites are epoxy, unsaturated polyester, phenolics, vinyl ester, and polyimides. Based on the types of reinforcement, polymer composites can be classified as particulate reinforced polymer composite and fibre reinforced polymer composites. Every polymer has very distinct characteristics, but most polymers have the following general attributes:

1. Polymers can be very resistant to chemicals. Consider all the cleaning fluids in your home that are packaged in plastic. Reading the warning labels that describe what happens when the chemical comes in contact with skin or eyes or is ingested will emphasize the chemical resistance of these materials.

2. Polymers can be both thermal and electrical insulators. A walk through your house will reinforce this concept, as you consider all the appliances, cords, electrical outlets, and wiring that are made or covered with polymeric materials. Thermal resistance is evident in the kitchen with pot and pan handles made of polymers, the coffee pot handle, the foam core of refrigerators and freezers, insulated cups, coolers, and microwave cookware. The thermal underwear that many skiers wear is made of polypropylene and the fiberfill in winter jackets is acrylic.

3. Generally, polymers are very light in mass with varying degrees of strength. Consider the range of applications, from dime store toys to the frame structure of space stations, or from delicate nylon fiber in pantyhose to Kevlar, which is used in bulletproof vests.

Polymers can be processed in various ways to produce thin fibres or very intricate parts. Plastics can be molded into bottles or the body of a car or be mixed with solvents to become an adhesive or paint. Elastomers and some plastics stretch and are very flexible. Other polymers can be foamed like polystyrene (Styrofoam) and urethane, to name just two examples. Polymers are materials with a seemingly limitless range of characteristics and colors. Polymers have many inherent properties that can be further enhanced by a wide range of additives to broaden their uses and applications. Particle reinforced composites also called particulate composites consisting of reinforcing material that is in the form of particle. The shape of reinforcing particle may either spherical, a platelet, cubic, tetragonal, or of other regular or irregular geometry. The arrangement of the particles in the composites may be either random or preferred orientation. Generally, particles are used in composites to modify the thermal and electrical conductivities, improve performance at elevated temperatures, reduce friction, increase wear and abrasion resistance, improve machinability, increase surface hardness and reduce shrinkage.

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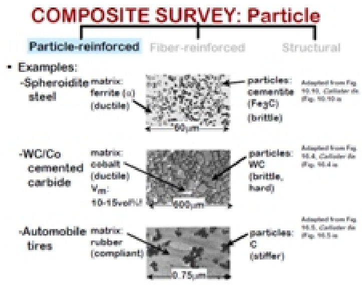
Fibre reinforced polymer composites also called fibrous composites consisting of fibres as the reinforcement. Now-a-days, these composites have found applications in various areas such as automotive, marine, aerospace etc. due to their high specific stiffness and strength. Generally, fibres are the most important class of reinforcements in composite materials, as they satisfy the desired conditions and transfer strength to the matrix constituent, influencing and enhancing their desired properties. A fibre is characterized by its length being much greater as compared to its cross-sectional dimensions. The properties of matrix, fibre and its interface have greatly influencing the properties of composite materials.

Characteristics of the Composites:

A composite material consists of two phases. It consists of one or more discontinuous phases embedded in a continuous phase. The discontinuous phase is usually harder and stronger than the continuous phase and is called the „reinforcement or „reinforcing material, whereas the continuous phase is termed as the matrix. The matrix is usually more ductile and less hard. It holds the dispersed phase and shares a load with it. Matrix is composed of any of the three basic material type i.e. polymers, metals or ceramics. The matrix forms the bulk form or the part or product. The secondary phase embedded in the matrix is a discontinuous phase. It is usually harder and stronger than the continuous phase. It servers to strengthen the composites and improves the overall mechanical properties of the matrix. Properties of composites are strongly dependent on the properties of their constituent materials, their distribution and the interaction among them. The composite properties may be the volume fraction sum of the properties of the constituents or the constituents may interact in a synergistic way resulting in improved or better properties. Apart from the nature of the constituent materials, the geometry of the reinforcement (shape, size and size distribution) influences the properties of the composite to a great extent. The concentration distribution and orientation of the reinforcement also affect the properties. The shape of the discontinuous phase (which may by spherical, cylindrical, or rectangular cross-sectioned prisms or platelets), the size and size distribution (which controls the texture of the material) and volume fraction determine the interfacial area, which plays an important role in determining the extent of the interaction between the reinforcement and the matrix.

Concentration, usually measured as volume or weight fraction, determines the contribution of a single constituent to the overall properties of the composites. It is not only the single most important parameter influencing the properties of the composites, but also an easily controllable manufacturing variable used to alter its properties.



2.LITERATURE SURWAY:

Literature Review on the analysis–methodology of composite materials is presented here, under five basic headings. These are important in understanding the analysis technique including experimental and analytical ways.Stress-Analysis appears to the satisfactory in many causes for the identification of the location in composites structures, at which delamination is likely to commence. Load transfer between adjacent layers in a composite material takes place by means of inter-lamina stresses. The stress field was calculated by Mikata and Jaya by use of a four concentric circular cylindrical model. The target material was Ni or silicon-Carbide coated graphite fiber/6061 aluminum composite. Ni-coating is found to be advantageous over SiC coating from the crack resistance view point. Critical test intensity factor and strain energy release rate data were studied from stress analysis point of view. The quadratic interaction or mixed mode behavior was compared with the experimental data.

Quasi state thermal stress response and failure behavior of graphite /Epoxy laminated plates under combined intense thermal and mechanical loading were investigated by Chen sun and Chang. The analytical predictions were compared with experimental data. An analytical model was developed to assess the compressive strength critically of inter-laminar in laminated composites by Chai and Babcock. The Delaminated region was elliptic in shape .The parameters controlling the growth or asset of the delamination damage were identified as the fracture energy, disband depth and elastic properties of materials from both sides of delamination inter face.

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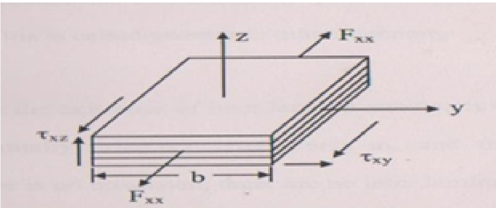
By varying the degree of material anisotropy relative to the loading axis, arrange in growth behavior was found. Wanget.al. studied compressive stability of delaminated fiber composites. A mechanistic model was introduced for the problem. Both buckling stability and crack stability were investigated. Two analytical methods were developed for these studies. Load transfer between adjacent layer in a fiber-reinforced laminate takes place by means of inter-lamina stresses,viz,σxx,τxz and τyz. To visualize the mechanism of load transfer, a symmetric [, laminate under uniaxial tensile load Fxx is considered.



[45/-45/-45/45] laminate

Kim and Soni tested a large number laminates prone to delamination under uniaxial loading. The onset of delamination was determined on the basis of acoustic emission data. The experimental and analytical studies were found to be in good agreement. Ericson,et.al. Studied the prediction of the initiation of delamination in a composite laminate by means of two approaches. In the first approach singular finite elements at edge of the hole was employed. Fracture mechanics always was employed in the second approach.Lee characterized delamination and transverse cracking failure modes of composites by means of width tapered double cantilever beam test and double torsion test respectively. The fracture toughness values obtained from the two tests were found to be quite materials.

This indicated that two failures modes have similar failure mechanisms.Wan-Lee-Yun studied the effects of laminated structure on delamination. The energy release rate at the crack tip were evaluated o determine the stability characteristics of delamination growth-Lee Studied failure mechanics of edge delamination of composites and found to be strongly dependent on the resin matrix. for the same resin matrix their properties varied with the fiber studied. This suggested a fiber /matrix interface controlled mechanism. The critical role of fiber/matrix adhesion on edge delamination was demonstrated.

Composite materials can be characterized as a material composed of two or more phases and tha tphases influence each other synergistically. Those materials have become indispensable in many industrial areas, from the aviation to the agriculture where composite materials replace the conventionally used materials such as steel. However, the composite systems find their application in the field of joining dissimilar materials, in the renovation of machine parts etc. This paper describes the mechanical properties of composite systems consisting of two phases – epoxy resin and wood floor. One of the benefits of polymer matrix based on epoxy resins is its excellent resistance to the various degradation environments which are in the contact with composite materials in crop and livestock production. Different mechanical and physical properties of individual phases define the properties of the resulting composite. Adding wood flour into the polymer materials can affect the mentioned properties and the resulting price.

It is also a good way for the material recycling that complements conventional ways of recycling wood waste. It is inexpensive and sensitive to the environment. The experiment describes the mechanical properties of polymer composite materials with epoxy matrix such as: hardness, impact strength, tensile strength and resistance to abrasive wear. The resulting composite systems may find their application in the field of agriculture – especially during joining and sealing materials of larger units where high quality connections are not required. The experimental results confirm the hypothesis that the interaction between the epoxy matrix and inorganic filler (wood flour) creates a qualitatively new composite system for usage in agriculture.

3.MATERIALS AND METHODOLOGY:

This chapter details the materials and methodologies adopted during fabrication, sample preparation, mechanical testing and characterization of composites. The raw materials used are :

1.Polyester resin

2.Catalyst (methyl and ethyl ketone peroxide)

3.Accelerator (cobalt naphthenate)

4.Mild steel particles (as reinforcement)

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Matrix material:

Polyester is a category of polymers which contain the ester functional group in their main chain. The term unsaturated polyester resin is generally referred to unsaturated formed by the reaction of dibasic organic acids and polyhydric alcohols. Polyester resin is also known as thermosetting plastic which can be formed at high temperatures. Polyester resin can attach things together to itself, creating a strong bond. Moreover, as it is a plastic it put against all elements as long as it has been produced to a high standards without any problems of it falling apart. Polyester resins are the most economical and widely used resin systems, especially in the marine industry. Nearly one half million tons of this material is used annually in the united states in composite application. Polyester resins can be formulated to be obtained a wide range of properties ranging from soft and ductile to hard and brittle. Their advantages include low viscosity, low cost and fast cure time. In addition polyester resins have long been considered least toxic.

Unsaturated polyester resin grade of ECMALON 4413 supplied by ECMAS resins pvt limited,Hyderabad is a matrix material in the present investigation ECAMALON 4413 is an unsaturated polyester resin of orthophathalic acid grade with clear colorless are pale yellow color. It is s viscosity is 500 to 600 cps (brokfield viscometer) and Sp.gravity is 1.13. Acid number is 22 and manometer content is methyl ethyl keton peroxide as catalyst and cobalt naphthanate as accelerator are added for curing the resin at room condition. The quantity of each of these materials, added is 2% of the W/V of the resin. The gel time is found to be about 5-7 mins. The accelerator is mixed thoroughly with the resin and the catalyst is added later to avoid the explosion.

Matrix material

Reinforcement materials :

Mild steel particles:

Mild steel rod of definite size is taken and places it in the chuck of lathe and then switch on machine make the plane turning operation during this, place file on the surface of the M.S rod due to contact with the rough surface of file there will be a removal of material in the of form of particles and these particles are of different sizes.

Sieve analysis :

Sieve by hand shacking each sieve in the order for a period of not less than two minute. The shacking is done with a varied motion that is back word and fore word, left to right, circular clock wise and anti clock wise keeping the material moving over the sieve in frequently changing the direction.

MAKING OF M.S. PARTICLES ON LATHE

SIEVE ANALYSIS

Samples preparation :

Hand layup method is adopted to fill the prepared mould. First we have to take the required quantity of resin, catalyst and accelerator and other fiber materials. First resin is poured into the mixing beaker and then catalyst is added to the resin and then mixed thoroughly with stir rod. Then added accelerator to the above mixture and after mixing thoroughly and before solidification if is then poured in the aluminum mould.

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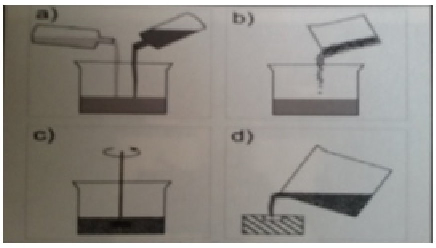
After 24 hours remove specimens slowly, and then repeat the procedure by changing the percentage of reinforcement as 0% i.e, 0 layer of the matrix.In order to prepare the composites with reinforcement

1.First the matrix material was poured slowly into the mouldto avoid trapping of air. The mixture was left for 2 min. until it become little tacky.
2.After completion of making the 0% specimen then repeat the same procedure with adding the particles of 2%,4%, 6% and 8%.
3.The remove the specimens form the aluminum mould and keep them undisturbed for 24 hrs.

HAND LAY- UP:

Hand lay-up is an open molding method suitable for making a wide variety of composites products including: boats, tanks bathware, housings, truck/auto components, architectural products and many other products ranging from very small to very large. Production volume per mold is low; however, it is feasible to produce substantial production quantities using multiple molds. Moulds can range from very small to very large and are low cost in the spectrum of soft composites moulds. Gel coat is first applied to the mold using a spray gun for high quality surface. When the gel coat has cured sufficiently, roll stock fiber glass reinforcement is manually placed on the mold, the lamination resin is applied by pouring, brushing, spraying, of using a paint roller. FRP rollers, paint rollers, or squeegees are used to consolidate the laminate, thoroughly wetting the reinforcement, and removing entrapped air. Subsequent layers of fiberglass reinforcement are added to build laminate thickness. Simplest method offering low-cost tooling, simple processing and wide range of part sizes are the major advantages of this process. Design changes are readily made. There is a minimum investment in equipment. With skilled operators, good production rates consistent quality is obtainable.



MIXING PROCESS

Fabrication of composite specimen for tensile test:

A special code for the tensile testing of polymer matrix composite materials ASTM D638 tensile testing is used to measure the force required to break a polymer composite specimen and the extent to which the specimen stretches or elongates to that breaking point. Tensile tests produce a stress- strain diagram, which is used to determine tensile modulus. The data is often used to specify a material, to design parts to withstand application force and a quality control check of material.

Test specimen	Composition
TS 1	POLYESTER RESIN + 0% REINFORCEMENT
TS 2	POLYESTER RESIN + 2% REINFORCEMENT
TS 3	POLYESTER RESIN + 4% REINFORCEMENT
TS 4	POLYESTER RESIN + 6% REINFORCEMENT
TS 5	POLYESTER RESIN + 8% REINFORCEMENT

UNIVERSAL TESTING MACHINE

SPECIMEN UNDER TESTING

Hardness test:

This test was conducted on Rockwell and Brinell hardness tester. It is an indentation hardness lest using a verified machine to force a diamond sphere conical indenter or hard steel ball indenter under specified condition in to the surface of material.

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under test in to operations and to measure difference in depth of measuring the hardness is as follows: The operating lever is kept in horizontal position. Then specimen is placed on the test table. Then hand wheel is turned in clock wise direction such that the specimen touches of the ball/diamond indenter. Initially 3kg load is applied on specimen. Then the load is applied gradually over the indenter by moving the lever from the horizontal position. After indentation, for Brinell hardness test,the diameter of the indentation can be calculated by using a Microscope with a graduated scale in it.Calculated the BHN by using the given formulae.Brinell Hardness Number (BHN)is calculated by using following relation:=2P/RD(2-2) Rockwell hardness Number (HRC)=10*BHN (approximately) where, P=Load applied inKgf=100Kgf D=Diameter of indenter =6mm d=Diameter of indentation in mm.

HARDNESS TESTING MACHINE

Impact test:

The impact test designed to give information on how a specimen material will respond to stress applied suddenly, e.g., shock. The test ascertains whether the material is tough or brittle. A notched test piece is normally employed and the two methods in general use are the Izod and the Charpy test. The result is usually reported as the energy in ft.ibs. or KJ required to fracture the test piece. Molded-in stresses, polymer orientation, weak spots (e.g., weld lines or gate areas),and part geometry will affect impact performance .impact properties also changes by reinforcements. Charpy v-notch test ,is a standardized high-strain-rate test, which determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of the toughness of a given material and acts as a tool to study temperature-dependent brittle-ductile transitions. It is applied widely in industry, because it is easy to prepare and conduct, and because the result can be quickly and cheaply. However, a major disadvantage is that all result only comparative. The test specimen size was prepared as per the standard IS867.

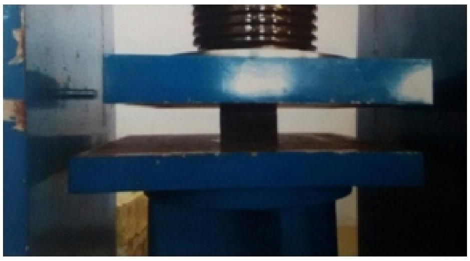
IMPACT TESTING MACHINE:

SPECIMEN UNDER TESTING:

Preparation of compression cube specimen:

Preparation a specimen sizes of 5cm×5cm×5cm by using G.Isheetmoulds

COMPRESSION TESING MACHINE



SPECIMEN UNDER TESTING

4.RESULTS AND DISCUSSION:

This chapter deals with the mechanical behavior of polyester based mild steel particle reinforced composites.

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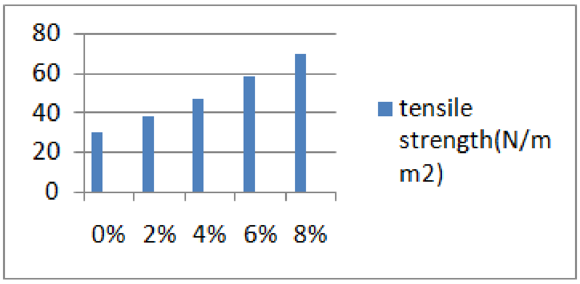
EFFECT OF REINFORCEMENT ON TENSILE PROPERTIES OF THE COMPOSITE:

The effect of particle dispersion on tensile strength is analyzed for polyester. From the experimental result it is clear that tensile strength is significantly affected by particle reinforcement. Tensile strength of composite are superior for particle reinforced composite compared to other composites. That is attributed to the clean reason that, in case of 0% reinforcement the applied load is equally distributed on the entire specimen. Where as in case of other reinforcements, the tensile load is not evenly distributed and had a significant effect on the tensile properties of the composite and by increasing the reinforcement as 2%,4%,6% and 8%, the strength of the specimen increases. As the reinforcements increases the voids was increasing and which further effecting the properties, both in planar shear and tensile forces are act on the specimen. The coupling between in planar shear and tension resulting off axis pulling of fiber and causing earlier failure of the specimen before ultimate strength is reached. The tensile strength of different composites were show on the graphs We can observe the variations of the different tensile properties with different reinforcements.

Percentage of reinforcement	Tensile strength(N/mm2)
0%	30
2%	38
4%	47
6%	59
8%	70

Specimens under Tensile Testing



GRAPF FOR TENSILE TEST:

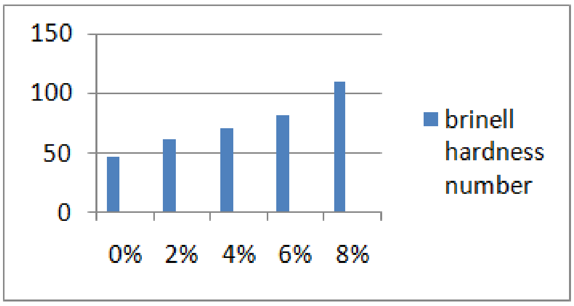
On x-axis we are taken the percentage of reinforcement and On y-axis tensile strength (N/mm2). This graph indicates that the maximum tensile load was bared i.e, 70 N/mm2 by the specimen which is reinforced with 8%of M.S particles.

4.2Effect of particle loading on Hardness of Composites:

Surface hardness of the composites is considered as one the most important factors that govern the wear resistance of the composites.

Percentage of reinforcement	Brinel hardness number
0%	47.74
2%	62.40
4%	71.58
6%	82.45
8%	111.35

Specimen under Hardness Test



GRAPF FOR HARDNESS TEST:

On x-axis we have taken the percentage of reinforcement and on y-axis we have taken the brinell hardness number. The hardness of the composite rarely by reinforcement as the reinforcement is particle which have a micro effect on the surface property of the material as it was totally covered by the matrix material so the particle reinforcement plays a major role in the hardness of the composite but the particle shows different hardness characteristics. So the results shows that the pure polyester has less harder than the particle reinforced composite.

Effect of particle reinforcement on Impact Strength of Composites :

Graph 4.3a shows the variation of the impact strength of particle and polyester composites with and without reinforcement. It is found that the impact strength of composites linearly increased as the reinforcement is increased. This is due to excellent dispersion of reinforcement and effective stress transfer between the particles and the matrix.

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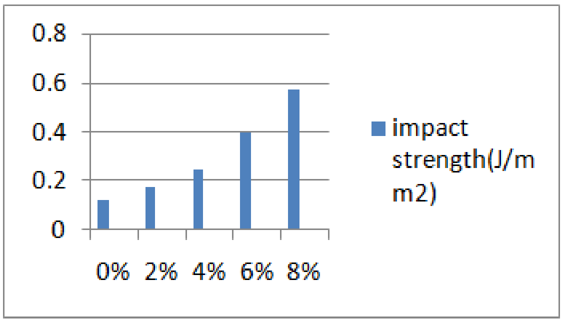
Percentage of reinforcement	Impact strength (J/mm2)
0%	0.125
2%	0.175
4%	0.250
6%	0.40
8%	0.575

Specimen Under impact Test

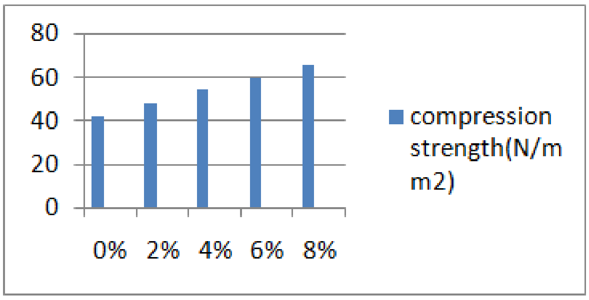


GRAPF FOR IMPACT TEST :

Effect of particle reinforcement on compression test Compression test are used to determine how a product or material reacts when it is compressed, squashed, crushed or flattened by fundamental parameters that determine the specimen behavior under a compressive load. These include the clastic limit, approximately equal to the proportional limit, and also known as yield strength, young's Modulus and compressive strength. Take specimen of size 5cm×5cm×5cm. place the specimen in the machine in such manner that the load shall be applied to the opposite sides of the tube. Clean the bearing surface of the machine. Rotate the movable portion gently by hand so that it touches the top surface of the specimen. Apply the load gradually until the specimen fails. Record the maximum load and note any unusual features in the type of failure.

Percentage of reinforcement	Compression strength (N/mm^2)
0%	42
2%	48
4%	55
6%	60
8%	66

Specimen under compression testing machine



GRAPF FOR COMPRESSION TEST

5.CONCLUSION:

The fabrication and determination of mechanical properties of polyester based particle reinforced composite leads to following conclusions:

The successful fabrication of a new class of polyester based composites reinforced with M.A particles have been done. The present investigation revealed that reinforcement significantly influences different properties of composites. The maximum tensile load 19.83KN is obtained for composite polyester resin +8% particle reinforcement.

The maximum hardness 111.35 BHN is obtained for composites with +8% reinforcement.

The maximum impact strength .575 joules is obtained for composites with +8% reinforcement.

The maximum compressive strength 66 N⁄mm^2 is obtained for +8% reinforcement.

Possible use of these composites such as particle reinforced transparent green house coverings for gardens, laminates for marine applications etc. These particle reinforced composites can be used at the applications where the flexibility of the material is required. Specially from the study +8% of particle reinforcement composites have great mechanical properties for the applications in the automobile sectors. However, this study can be further extended in future to manufacture new types of composites using other potential and the resulting experimental findings can be similarly analyzed.

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