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Mechanical Behavior of e-glass , sisal Epoxy Reinforced Natural Composite

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Abstract: -- Now-a-days, the natural fibres from renewable natural resources offer the potential to act as a reinforcing material for polymer composites alternative to the use of glass, carbon and other man-made fibres. Among various fibres, jute is most widely used natural fibre due to its advantages like easy availability, low density, low production cost and satisfactory mechanical properties. For a composite material, its mechanical behaviour depends on many factors such as fibre content, orientation, types, length etc. Attempts have been made in this research work to study the effect of fibre loading and orientation on the physical and mechanical behaviour of jute/glass fibre reinforced epoxy based hybrid composites. A hybrid composite is a combination of two or more different types of fibre in which one type of fibre balance the deficiency of another fibre. Composites of various compositions with three different fibre orientation (0°, 30° and 40°) are fabricated using simple hand lay-up technique. It has been observed that there is a significant effect of fibre loading and orientation on the performance of sisal and bamboo reinforced epoxy based composites. The developed composites undergo different kinds of tests. The result shows hybrid composites having good strength and stiffness compared to natural hybrid composites

Keywords: Renewable, Mechanical Properties, Orientation

INTRODUCTION

Mankind has been aware composite materials since several hundred years before Christ and applied innovation to improve the quality of life. Although it is not clear has to how Man understood the fact that mud bricks made sturdier houses if lined with straw, he used them to make buildings that lasted. Ancient Pharaohs made their slaves use bricks with to straw to enhance the structural integrity of their buildings, some of which testify to wisdom of the dead civilization even today. Contemporary composites results from research and innovation from past few decades have progressed from glass fibre for automobile bodies to particulate composites for aerospace and a range other applications.

Ironically, despite the growing familiarity with composite materials and ever-increasing range of applications, the term defines a clear definition. Loose terms like "materials composed of two or more distinctly identifiable constituents" are used to describe natural composites like timber, organic materials, like tissue surrounding the skeletal system, soil aggregates, minerals and rock. Composites that forms heterogeneous structures which meet the requirements of specific design and function, imbued with desired properties which limit the scope for classification. Reinforcing materials generally withstand maximum load and serve the desirable properties. Further, though composite types are often distinguishable from one another, no clear determination can be really made. The demands on matrices are many. They may need to temperature variations, be conductors or resistors of electricity, have moisture sensitivity etc. This may offer weight advantages, ease of handling and other merits which may also become applicable depending on the purpose for which matrices are chosen. Solids that accommodate stress to incorporate other constituents provide strong bonds for the reinforcing phase are potential matrix materials. A few inorganic materials, polymers and metals have found applications as matrix materials in the designing of structural composites, with commendable success. These materials remain elastic till failure occurs and show decreased failure strain, when loaded in tension and compression.

Composites cannot be made from constituents with divergent linear expansion characteristics. Choice of fabrication method depends on matrix properties and the effect of matrix on properties of reinforcements.

It is desired to produce low cost, high quality, sustainable and environmental friendly materials. It has been found from the researched study that the lower mechanical properties and poor compatibility between polymer matrix and fibers. Composite materials are one of the most favoured solutions to this problem in the field. By combining the stronger properties of traditional materials and eliminating the disadvantages they bear, fiber mats of different orientations are developed, composite materials technology is providing compromising solutions and alternatives to many engineering fields. Problems born from material limitations like heavy weight, structural strength, and thermal resistance are being solved by the composite material alternatives, and many more alternatives are being introduced to readily use engineering applications.

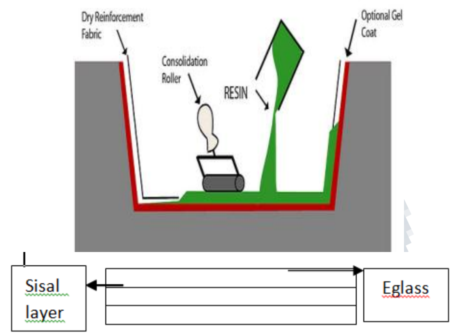
ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 5, May 2017

OBJECTIVES

1. The present study concentrates on the development of natural composite and to utilize the advantages offered by renewable sources.
2. Composites are developed by hand layup technique using sisal and eglass fiber, epoxy and hardner. Specimens are cut according to the ASTM standard.
3. The hybrid composites are developed with different reinforcements of orientations such as 0,45 & 90 degree.
4. The various tests are conducted to determine the mechanical properties.

METHODOLOGY USED

Hand lay-up technique is the simplest method of composite processing. The infrastructural requirement for this method is also minimal. The processing steps are quite simple. First of all, a release gel is sprayed on the mold surface to avoid the sticking of polymer to the surface. Thin plastic sheets are used at the top and bottom of the mold plate to get good surface finish of the product. Reinforcement in the form of woven mats or chopped strand mats are cut as per the mold size and placed at the surface of mold after perspex sheet. Then thermosetting polymer in liquid form is mixed thoroughly in suitable proportion with a prescribed hardner (curing agent) and poured onto the surface of mat already placed in the mold. The polymer is uniformly spread with the help of brush. Second layer of mat is then placed on the polymer surface and a roller is moved with a mild pressure on the mat-polymer layer to remove any air trapped as well as the excess polymer present. The process is repeated for each layer of polymer and mat, till the required layers are stacked. After placing the plastic sheet, release gel is sprayed on the inner surface of the top mold plate which is then kept on the stacked layers and the pressure is applied. After curing either at room temperature or at some specific temperature, mold is opened and the developed composite part is taken out and further processed. The schematic of hand lay-up is shown in figure 1. The time of curing depends on type of polymer used for composite processing. For example, for epoxy based system, normal curing time at room temperatur is 24-48 hours. This method is mainly suitable for thermosetting polymer based composites. Capital and infrastructural reuirement is less as compared to other methods. Production rate is less and high volume fraction of reinforcement is difficult to achieve in the processed composites. Hand lay-up method finds application in many areas like aircraft components, automotive parts, boat hulls, diase board, deck etc



LITERATURE REVIEW

The main concept of a composite is that it contains matrix materials. Typically, composite material is formed by reinforcing fibers in a matrix resin. The reinforcements can be fibers, particulates, or whiskers, and the matrix materials can be metals, plastics, or ceramics. The reinforcements can be made from polymers, ceramics, and metals. The fibers can be continuous, long, or short. Composites made with a polymer matrix have become more common and are widely used in various industries.

M. Davallo et.al:[1] Flexural properties of continuous random glass-polyester composites formed by resin transfer moulding and hand-layup moulding have been studied to determine the effects of glass content, composite thickness, reinforcement geometry and type of fabrication on damage developed during flexure tests. Strain values both at maximum-load and failure were determined. The failure strains of the two sets of composite series were relatively constant. Hence, both types of composite series appeared to fail at a critical strain value. The damage developed during the test was monitored on the side of each polished beam using an optical microscope.

Slavisa Putic et.al:[2] This paper outlines the experimental investigation of inter laminar shear strength as the critical mechanical property of composite constructions of structure elements Placed between two thin glass mat layers where a layer is placed on the glass fabric of the same structure but of different density, with different polyester resin matrices. The significance of the shear strength lies in the fact that for all types of

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Vol 2, Issue 5, May 2017

composites it is strongly influenced by factors weakening the interface binds.

EGLASS FIBRE

Glass fiber (or **glass fibre**) is a material consisting of numerous extremely fine fibers of glass Glass fiber has roughly comparable mechanical properties to other fibers such as polymers and carbon fiber. Although not as strong or as rigid as carbon fiber, it is much cheaper and significantly less brittle when used in composites. Glass fibers are therefore used as a reinforcing agent for many polymer products he most common types of glass fiber used in fiberglass is E-glass, which is alumino-borosilicate glass with less than 1% w/w alkali oxides, mainly used for glass-reinforced plastics. Other types of glass used are A-glass (**A**lkali-lime glass with little or no boron oxide), E-CR-glass (**E**lectrical/**C**hemical **R**esistance; alumino-lime silicate with less than 1% w/w alkali oxides, with high acid resistance), C-glass (alkali-lime glass with high boron oxide content, used for glass staple fibers and insulation), D-glass (borosilicate glass, named for its low **D**ielectric constant), R-glass (alumino silicate glass without MgO and CaO with high mechanical requirements as **r**einforcement), and S-glass (alumino silicate glass without CaO but with high MgO content with high tensile strength)

SISAL FIBER

Sisal Fiber is one of the most widely used **natural fiber** and is very easily cultivated. It is obtain from sisal plant. The plant, known formally as Agave sisalana. These plants produce rosettes of sword-shaped leaves which start out toothed, and gradually lose their teeth with maturity. Each leaf contains a number of long, straight fibers which can be removed in a process known as decortication. During decortication, the leaves are beaten to remove the pulp and plant material, leaving the tough fibers behind. The fibers can be spun into thread for twine and textile production, or pulped to make paper products.

Sisal fiber is fully biodegradable, green composites were fabricated with soy protein resin modified with gelatin. Sisal fiber, modified soy protein resins, and composites were characterized for their mechanical and thermal properties. It is highly renewable resource of energy. Sisal fibre is exceptionally durable and a low maintenance with minimal wear and tear. Its fibre is too tough for textiles and fabrics. It is not suitable for a smooth wall finish and also not recommended for wet areas.

The fine texture of Sisal takes dyes easily and offers the largest range of dyed colours of all natural fibres. Zero pesticides or chemical fertilisers used in sisal agriculture. It is a stiff fiber traditionally used in making twine, rope and also dartboards Sisal fiber is manufactured from the vascular tissue from the sisal plant (Agavesisalana). It is used in automotive friction parts (brakes, clutches), where it imparts green strength to performs, and for enhancing texture in coatings application.

PROPERTIES OF SISAL FIBRE

1. Sisal Fiber is exceptionally durable with a low maintenance with minimal wear and tear.
2. It is Recyclable.
3. Sisal fibers are obtained from the outer leaf skin, removing the inner pulp.
4. It is available as plaid, herringbone and twill.
5. Sisal fibers are Anti static, does not attract or trap dust particles and does not absorb moisture or water easily.
6. The fine texture takes dyes easily and offers the largest range of dyed colours of all natural fibers.
7. It exhibits good sound and impact absorbing properties.
8. Its leaves can be treated with natural borax for fire resistance properties

THEORETICAL STUDY

3.1 Tensile Test

Tensile testing, also known as tension testing, is a fundamental materials science test in which a sample is subjected to a controlled tension until failure. The results from the test are commonly used to select a material for an application, for quality control, and to predict how a material will react under other types of forces. Properties that are directly measured via a tensile test are ultimate tensile strength, maximum elongation and reduction in area. From these measurements the following properties can also be determined: Young's modulus, Poisson's ratio,

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Vol 2, Issue 5, May 2017

yield strength, and strain-hardening characteristics. Uniaxial tensile testing is the most commonly used for obtaining the mechanical characteristics of isotropic materials. For anisotropic materials, such as composite materials and textiles, biaxial tensile testing is required.
A tensile specimen is a standardized sample cross-section as shown in fig 3.1. It has two shoulders and a gauge in between. The shoulders are large so they can be readily gripped, whereas the gauge section has a smaller cross-section so that the deformation and failure can occur in this area.

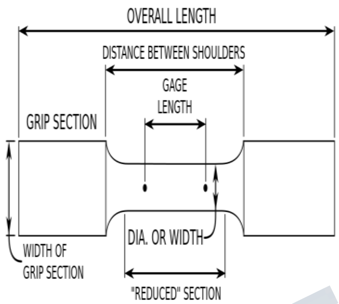

Fig.3.1 Shows Test Specimen Nomenclature

The shoulders of the test specimen can be manufactured in various ways to mate to various grips in the testing machine. Each system has advantages and disadvantages; for example, shoulders designed for serrated grips are easy and cheap to manufacture, but the alignment of the specimen is dependent on the skill of the technician.
On the other hand, a pinned grip assures good alignment. Threaded shoulders and grips also assure good alignment, but the technician must know to thread each shoulder into the grip at least one diameter's length, otherwise the threads can strip before the specimen fractures.
In large castings and forgings it is common to add extra material, which is designed to be removed from the casting so that test specimens can be made from it. These specimens may not be exact representation of the whole workpiece because the grain structure may be different throughout. In smaller workpieces or when critical parts of the casting must be tested, a workpiece may be sacrificed to make the test specimens. For workpieces that are machined from bar stock, the test specimen can be made from the same piece as the bar stock.

3.1.1 Equipment

Fig.3.2 Shows A universal testing machine (Hegewald & Peschke)

The most common testing machine used in tensile testing is the universal testing machine as shown in fig 3.2. This type of machine has two crossheads; one is adjusted for the length of the specimen and the other is driven to apply tension to the test specimen. There are two types: hydraulic powered and electromagnetically powered machines.
The machine must have the proper capabilities for the test specimen being tested. There are four main parameters: force capacity, speed, and precision and accuracy. Force capacity refers to the fact that the machine must be able to generate enough force to fracture the specimen. The machine must be able to apply the force quickly or slowly enough to properly mimic the actual application. Finally, the machine must be able to accurately and precisely measure the gauge length and forces applied; for instance, a large machine that is designed to measure long elongations may not work with a brittle material that experiences short elongations prior to fracturing.

3.2 Properties

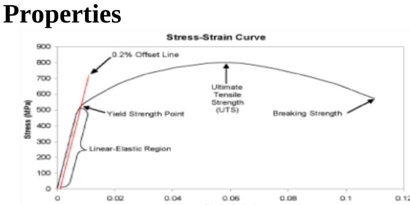

Fig. 3.3 Shows Stress Strain curve

As can be seen in the fig. 3.3, the stress and strain initially increase with a linear relationship. This is the linear-elastic portion of the curve and it indicates that no plastic deformation has occurred. In this region of the curve, when the stress is reduced, the material will return to its original shape. In this linear region, the line obeys the

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Vol 2, Issue 5, May 2017

relationship defined as Hooke's Law strain is where the ratio of stress to a constant.

1. Modulus of elasticity or young's modulus
2. Poisson's ratio
3. Yield point
4. Ultimate tensile strength

3.2.1 Modulus of Elasticity or Young's Modulus

The slope of the line in this region where stress is proportional to strain is called the modulus of elasticity or Young's modulus. The modulus of elasticity (E) defines the properties of a material as it undergoes stress, deforms, and then returns to its original shape after the stress is removed. It is a measure of the stiffness of a given material. To compute the modulus of elastic, simply divide the stress by the strain in the material. Since strain is unitless, the modulus will have the same units as the stress, such as kpa or MPa. The modulus of elasticity applies specifically to the situation of a component being stretched with a tensile force. This modulus is of interest when it is necessary to compute how much a rod or wire stretches under a tensile load.

There are several different kinds of moduli depending on the way the material is being stretched, bent, or otherwise distorted. When a component is subjected to pure shear, for instance, a cylindrical bar under torsion, the shear modulus describes the linear-elastic stress strain relationship.

3.2.2 Poisson's Ratio

Poisson's ratio is defined as the negative of the ratio of the lateral strain to the axial strain for a uniaxial stress state.

$$\nu = -\frac{\varepsilon_{lateral}}{\varepsilon_{axial}}$$

Poisson's ratio is sometimes also defined as the ratio of the absolute values of lateral and axial strain. This ratio, like strain is unitless since both strains are unitless. For stresses within the elastic range, this ratio is approximately constant. For a perfectly isotropic elastic material, Poisson's Ratio is 0.25, but for most materials the value lies in the range of 0.28 to 0.33. Generally for steels, Poisson's ratio will have a value of approximately 0.3. This means that if there is one inch per inch of deformation in the direction that stress is applied, there will be 0.3 inches per inch of deformation perpendicular to the direction that force is applied. Only two of the elastic constants are independent so if two constants are known, the third can be calculated using the following formula:

E = 2 (1 + n) G.

Where: E = modulus of elasticity (Young's modulus)

N = Poisson's ratio

G = modulus of rigidity (shear modulus).

A couple of additional elastic constants that may be encountered include the bulk modulus (K), and Lame's constants (m and l). The bulk modulus is used describe the situation where a piece of material is subjected to a pressure increase on all sides. The relationship between the change in pressure and the resulting strain produced is the bulk modulus. Lame's constants are derived from modulus of elasticity and Poisson's ratio.

3.2.3 Yield Point

In ductile materials, at some point, the stress-strain curve deviates from the straight line relationship and Law no longer applies as the strain increases faster than the stress. From this point on in the tensile test, some permanent deformation occurs in the specimen and the material is said to react plastically to any further increase in load or stress. The material will not return to its original, unstressed condition when the load is removed. In brittle materials, little or no plastic deformation occurs and the material fractures near the end of the linear elastic portion of the curve.

To determine the yield strength using this offset, the point is found on the strain axis (x-axis) of 0.002, and then a line parallel to the stress-strain line is drawn. This line will intersect the stress-strain line slightly after it begins to curve, and that intersection is defined as the yield strength with a 0.2% offset. A good way of looking at offset yield strength is that after a specimen has been loaded to its 0.2 percent offset yield strength and then unloaded it will be 0.2 percent longer than before the test. Even though the yield strength is meant to represent the exact point at which the material becomes permanently deformed, 0.2% elongation is considered to be a tolerable amount of sacrifice for the ease it creates in defining the yield strength.

3.3 Tensile Test Procedure

Specimens as shown in the fig.4.3, are placed in the grips of a Universal Test Machine at a specified grip separation and pulled until failure. For ASTM D-638 the test speed can be determined by the material specification or time to

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International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 5, May 2017

failure (1 to 10 minutes). A test speed for standard test specimens is 5 mm/min. An extensometer or strain gauge is used to determine elongation and tensile modulus. Depending upon the reinforcement and type, testing in more than one orientation may be necessary.

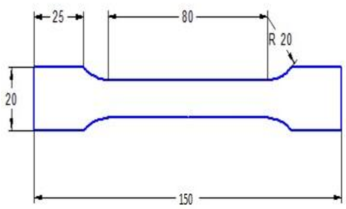

Fig. 3.4 Shows Dimensions of Tensile test specimen (All dimensions are in mm)

3.4 Hardness Test

Hardness is the resistance of a material to localized deformation. The term can apply to deformation from indentation, scratching, cutting or bending. In metals, ceramics and most polymers, the deformation considered is plastic deformation of the surface. For elastomers and some polymers, hardness is defined at the resistance to elastic deformation of the surface. The lack of a fundamental definition indicates that hardness is not be a basic property of a material, but rather a composite one with contributions from the yield strength, work hardening, true tensile strength, modulus, and others factors. Hardness measurements are widely used for the quality control of materials because they are quick and considered to be non-destructive tests when the marks or indentations produced by the test are in low stress areas. There are a large variety of methods used for determining the hardness of a substance.

3.4.1 Operation

The determination of the Rockwell hardness of a material involves the application of a minor load followed by a major load. The minor load establishes the zero position. The major load is applied, then removed while still maintaining the minor load. The depth of penetration from the zero datum is measured from a dial, on which a harder material gives a higher number. That is, the penetration depth and hardness are inversely proportional. The chief advantage of Rockwell hardness is its ability to display hardness values directly, thus obviating tedious calculations involved in other hardness measurement techniques.

Fig.3.5 Shows A digital Rockwell tester

It is typically used in engineering and metallurgy. Its commercial popularity arises from its speed, reliability, robustness, resolution and small area of indentation.
In order to get a reliable reading the thickness of the test-piece should be at least 10 times the depth of the indentation. Also, readings should be taken from a flat perpendicular surface, because convex surfaces give lower readings. A correction factor can be used if the hardness of a convex surface is to be measured.

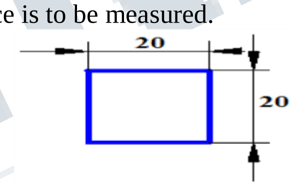

Fig. 3.6 Shows Hardness test specimen (All dimensions are in mm)

3.5 Compression test

A compression test is any test in which a material experiences opposing forces that push inward upon the specimen from opposite sides or is otherwise compressed, “squashed”, crushed, or flattened. The test sample is generally placed in between two plates that distribute the applied load across the entire surface area of two opposite faces of the test sample and then the plates are pushed together by a universal test machine causing the sample to flatten. A compressed sample is usually shortened in the direction of the applied forces and expands in the direction perpendicular to the force. A compression test is essentially the opposite of the more common tension test

TYPES OF COMPRESSION TESTS:

In general a compression test for a material involves at least two opposing forces directed towards each other applied to opposite face of the test sample so that the sample is compressed. However, there are many different

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International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 5, May 2017

variations to this basic test setup that involve any combination of different variables. The more common compression tests involve forces applied to more than one axis of the specimen as well as the testing of the sample at elevated and lowered temperatures. Uniaxial, biaxial, triaxial, cold temperature, elevated temperature, fatigue and creep are all examples of different compression tests that may be performed upon a material.

TYPES OF COMPRESSION TESTING MATERIALS:

Typically materials subjected to compression testing have a compressive strength generally accepted to be high and a tensile strength (e.g tensile test) that is considered to be of a lower value. Almost all materials can experience compressive forces in one way or another depending upon their application, but the most common materials are composites, concretes, wood, stone, brick, mortars, grouts, polymers, plastics, foam and metals among many others.

Selected Test Standards

- ASTM D575 Compression Test of Rubber
- ASTM D6641 Compression Testing for Polymer Matrix Composite Laminates
- ASTM D695 Compression Testing for Rigid Plastics
- ASTM D7137 Compressive Residual Strength Test Equipment for Damaged Polymer Matrix Composite Plates
- ASTM D905 Wood Adhesive Bonds in Shear by Compression Loading
- ASTM E9 Compression Testing of Metallic Materials at Room Temperature
- ISO 14126 Compression Fiber-Reinforced Plastic Composites Test Machine
- ISO 1856 Flexible Cellular Polymeric Materials Compression EN
- ISO 604 Compressive Plastics Testing Equipment
- ISO 844 Compressive Strength of Rigid Cellular Plastics

TYPES OF COMPRESSION TESTING

Types of compression testing include:

Flexure/Bend, Spring Testing,Top-load/Crush

BENEFITS OF COMPRESSION TESTING

Compression testing provides data on the integrity and safety of materials, components and products, helping manufacturers ensure that their finished products are fit-for-purpose and manufactured to the highest quality.
The data produced in a compression test can be used in many ways including:

- To determine batch quality
- To determine consistency in manufacture
- To aid in the design process
- To reduce material costs and achieve lean manufacturing goals
- To ensure compliance with international and industry standards

MATERIALS UNDER COMPRESSION

Certain materials subjected to a compressive force show initially a linear relationship between stress and strain. This is the physical manifestation of Hooke's Law, which states:
E = Stress (s) / Strain (e)
where E is known as Young's Modulus for compression. This value represents how much the material will deform under applied compressive loading before plastic deformation occurs. A material's ability to return to its original shape after deformation has occurred is referred to as its elasticity. Vulcanized rubber, for instance, is said to be very elastic, as it will revert back to its original shape after considerable compressive force has been applied.

APPLICATIONS OF COMPRESSION TESTING

Compression testing is used to guarantee the quality of components, materials and finished products within a wide range industries. Typical applications of compression testing are highlighted in the following sections on:

- Aerospace and Automotive Industry
- Construction Industry
- Cosmetics Industry
- Electrical and Electronic Industry
- Medical Device Industry
- Packaging Industry
- Paper and Board Industry
- Plastics, Rubber and Elastomers Industry
- Safety, Health, Fitness and Leisure Industry

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ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 5, May 2017

Aerospace and Automotive Industry
Applications of compression testing in the aerospace and automotive industry include:

- Actuation tests on pedals, switches and solenoids`
- Spring testing

Construction Industry
Applications of compression testing in the construction industry include:

- Measuring the flexural strength of sheet construction materials, insulation boards and roofing panels
- Penetration tests on plasterboard, pipes and shotcrete

Cosmetics Industry
Applications of compression testing in the cosmetics industry include:

- Actuation force testing of sprays and dispensing pumps
- Break strength testing of lipsticks, lip balms, lip and eye liners
- Compaction strength of powder compacts and eye shadows
- Testing the force to dispense creams and lotions from containers and sachets

Electrical and Electronic Industry
Applications of compression testing in the electrical and electronic industry include:

- Actuation force testing of push buttons and switches
- Compression testing of LCD screens and keypads

Medical Device Industry
Applications of compression testing in the medical device industry include:

- 3-point bend testing of needles
- Actuation force testing of metered dose inhalers and pen injectors
- Sharpness, insertion and penetration force testing of needles and scalpel blades
- Syringe plunger actuation and "travel" force assessment

Packaging Industry
Applications of compression testing in the packaging industry include:

- Compressive strength testing of cardboard packaging
- Dispensing pump actuation force
- Top-load testing of:
  - Bevcans
  - Cardboard and plastic containers
  - PET bottles

Paper and Board Industry
Application of compression testing in the paper and board industry include:

- Compressive strength testing of cardboard

Pharmaceuticals Industry
Applications of compression testing in the pharmaceuticals industry include:

- Gel strength and gel rupture testing
- "Press-out" force of blister packs
- Compression testing of tablets and capsules to measure characteristics:
  - Breaking
  - Coating strength
  - Crumbling
  - Hardness
  - Powdering

Plastics, Rubber and Elastomers Industry
Application of compression testing in the plastics, rubber and elastomers industry include:

- 3-point bend testing to identify flexural properties of plastics

Safety, Health, Fitness and Leisure Industry
Applications of compression testing in the safety, health, fitness and leisure industry include:

- Assess the performance of cricket, golf and tennis balls
- Compression tests on car seat safety harnesses

3.6 BENDING TEST

Bend tests deform the test material at the midpoint causing a concave surface or a bend to form without the occurrence of fracture and are typically performed to determine the ductility or resistance to fracture of that material. Unlike in a flexure test the goal is not to load the material until failure but rather to deform the sample into a specific shape. The test sample is loaded in a way that creates a concave surface at the midpoint with a specified radius of curvature according to the standard in relation to which the test is performed. Bending tests are as popular as tensile test, compression test, and fatigue tests.

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Vol 2, Issue 5, May 2017

PURPOSE OF BEND TESTING:

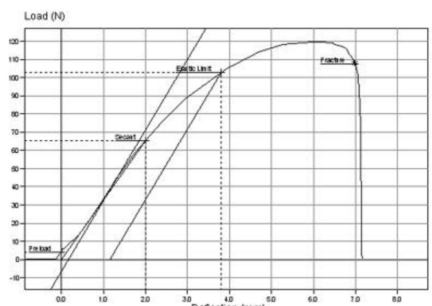
Bend testing a material allows for the determination of that materials ductility, bend strength, fracture strength and resistance to fracture. These characteristics can be used to determine whether a material will fail under pressure and are especially important in any construction process involving ductile materials loaded with bending forces. If a material begins to fracture or completely fractures during a three or four point bend test it is valid to assume that the material will fail under a similar in any application, which may lead to catastrophic failure.

TYPES OF MATERIALS USED IN BENDING APPLICATIONS:

Generally a bending test is performed on metals or metallic materials but can also be applied to any substance that can experience plastic deformation, such as polymers and plastics. These materials can take any feasible shape but when used in a bend test most commonly appear in sheets, strips, bars, shells, and pipes. Bend test machines are normally used on materials that have an acceptably high ductility.

Generally, there are two types of bending tests: 3-point bend and 4-point bend. The materials that are tested using the flex test method vary from metal, plastic, wood, laminates, particle board, dry wall, ceramic tile to glass. Bending tests vary greatly based on the product being tested.

Typical graph showing 3-point bend strength test:



We provide force measurement instruments and materials testing machines for bending tests such as 3-point and 4-point bend.

3.7 Fabrication of Composite

3.5.1 Materials

The fabrication of composite requires reinforcement of E-glass and Jute (here), resin (Epoxy and polyester), hardener. A thin protective film was laid to prevent final composite from mechanical abrasion. A roller was used to have a uniform distribution of the resin system throughout the film. A roller was used to allow proper binding between the resin mix and the reinforce materials. The various materials involved are

1. Woven roved E glass fiber mat
2. Jute fiber
3. Epoxy resin
4. Hardener

3.5.4 Epoxy Resin

Epoxy resins are available in liquid and solid forms and are cured into the finished plastics by a catalyst. They are cured at room temperatures as well as elevated temperatures of about 275ºC. The resin of grade Lapox L-12 has the following outstanding properties has been used as the matrix material.

1. Excellent adhesion to different materials.
2. High resistance to chemical and atmospheric attack.
3. High dimensional stability.
4. Free from internal stresses.
5. Excellent mechanical and electrical properties.
6. Odourless, tasteless and completely nontoxic.
7. Negligible shrinkage

3.6 Development of Composite

There are many composite manufacturing techniques available in industry. Compression moulding, vacuum moulding, pultruding, and resin transfer moulding are few options.

3.6.1 Hand Lay-Up Technique

The hand lay-up manufacturing process is one of the common techniques to combine resin and fabric components. This process allows manual insertion of fiber reinforcement into a single-sided mould, where resin is then forced through fiber mats using hand rollers. A primary advantage to the hand lay-up technique is its ability to fabricate very large, complex parts with reduced manufacturing times. Additional benefits of hand lay-up process are simple equipment and tooling that are relatively less expensive than other manufacturing processes. All composite specimens were manufactured using hand lay-up process.

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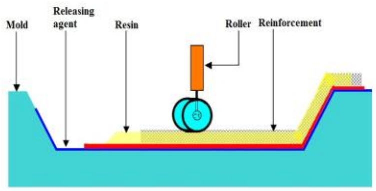

Fig. 3.9 Shows Hand Lay-Up technique

The fig.3.9 shows typical hand lay-up technique the mould is treated with a release agent to prevent sticking, the thermosetting resin is mixed with a curing agent or hardener, and applied with brush or roller on the release agent, put the reinforcement (woven rovings), again resin is applied with brush or roller on the reinforcement, with the desired layers of reinforcements to get minimum thickness of about 4mm and that is closed using release film to get good surface finish and to release easily, curing at room temperature for 24 hour.

3.6.2 Steps for Development of Composite

1. Wash the flat surface/slab (granite slab) carefully with warm water and soft soap to remove any dust, grease, finger marks, etc.
2. Dry the mould thoroughly.
3. Apply the acetone solution carefully with a piece of sponge or foam rubber, the solution must be allowed to dry completely.
4. The slab is treated with a release agent to prevent sticking. Epoxy or polyester is weighed out and the correct quantity of 10% hardener for epoxy and stirred in. Brush is the most suitable.
5. The E-glass fabric/mat and sisal fabric required for the lay-up should have been previously cut to the desired shape and size by means of templates, paper patterns or by approximate measurements taken.
6. The weight of fabrics is determined, in accordance with the quantity of resin to be used and is decided in such a way that the final plate is made up of 45% resin and 55% reinforcement by weight.
7. The first resin coat is applied on the release film as per the size of the fabric with the help of brush.
8. The first layer of fabric is placed over the resin coat in and Care must be taken to ensure an even coverage of resin, free from air bubbles.
9. Immediately after the first layer of fabric has been applied a compression roller is used to compress the mat and squeeze air bubbles and excess resin from the laminate. This technique appreciably improves the strength of the moulding by increasing its density and reducing its porosity on the inside surface, so it is important that the roller are used firmly and evenly across the entire surface.
10. Successive layers of laminate are now applied to the mould until the lay-up is complete. Each layer is compression rolled as described above. The number of layers required will depend on the type of moulding and the structural stresses it will need to withstand in use.
11. After the final resin coat is applied, the lay- up is covered by another release film. The mould is closed by placing the weight/ top slab.
12. the fabricated models are given for hydraulic press in order to compress . weights around 100-150 kg will be provided .

RESULTS AND DISCUSSION

After test results are obtained need to tabulate and compare the models and show which model holds better

CONCLUSION

The hybrid composite was developed by using hand layup technique. The hybrid composite, using E-glass, sisal fiber and epoxy resin was developed for 0^0, 30^0 and 45^0 fiber orientations. The effects of combination of the fibers were investigated. The experiments are carried out to understand tensile compression bending and hardness tests were conducted for different orientations.. The tensile strength is more at ___ orientations of hybrid composites. Elongation is more at ___ orientations compared to __^{0} and __^{0} orientations. The hardness was more in __° orientation while compared to the other. The finite element analysis result is agreeable with experimental results.

REFERENCES

[1] M. Davallo, H. Pasdar, Comparison of Mechanical Properties of Glass- Polyester Composites Formed by Resin Transfer Moulding and Hand Lay-Up Technique, International Journal of ChemTech Research CODEN(USA): IJCRGG ISSN : 0974-4290 Vol.1, No.3 , July-Sept 2009, pp 470-475.

[2] Slavisa Putic, Branislav Bajceta, Dragana Vitkovic, Marina Stamenovic, Vladimir Pavicevic, The Inter laminar Strength Of The Glass Fiber Polyester Composite, Chemical Industry & Chemical Engineering Quarterly 15 (1), 2009, pp. 45-48.