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A Study on Mechanical Behavior of Jute and Hair Fiber Composites

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Abstract: *This project inspects the mechanical properties of jute, hair fortified epoxy composites. These materials combined to produce a material with characteristics differ from the individual components. The components such as jute fiber, hair fiber, and hardener and epoxy resin combined to produce the new fiber material.*

1. INTRODUCTION

Natural fiber reinforced composites have a good potential as a substitute for wood-based material in many applications. The development of environment friendly green materials is because of natural fiber's biodegradability, light weight, low cost, high specific strength compared to glass and carbon, recycling and renewing natural sources. Composites, the wonder material with light- weight, high strength-to-weight ratio and stiffness properties have come a long way in replacing the conventional materials like metals, wood. The materials scientists all over the world focused their attention on natural composites reinforced with jute, sisal, coir, pineapple etc. Primarily to cut down the cost of raw materials. The jute fiber is an important best fiber and composites bundled ultimate cells each containing spirally oriented micro-fiber bound together from the point of view of wood substitute, jute composite based on renewable resources is poised to penetrate the market. Indigenous wood supply for plywood industry having been stopped virtually and with increasing landed cost of important plywood veneers, the jute composite board's offer very good value for the customers without any compromise in properties. The jute-coir boards proving superior over application plywood boards find potential in railways coaches for sleeper berth backing, for sleeper berth backing, for building Combination with polymer film potentially offers a rapid and simple means of manufacturing composites through film stacking, heating and press- consolidation. The most important types of natural fibers used in composite materials are flax, hemp, jute and sisal due to their properties and availability. Using jute fiber for composites has many advantages. Firstly it has wood like characteristics as it is a best fiber. Jute has high specific properties, low density, less abrasives behavior to the processing equipment, good dimensional stability and harmlessness.

2. COMPOSITE MATERIALS

A composite is structural materials which consist of combining two or more constituents are companied at a macroscopic level and are not soluble in each other. One constitute is called the reinforcing phase and the one in which it is embedded is called the matrix. The reinforcement phase material is generally continuous. The main difference between composite and an alloy are in composites constituent's materials are insoluble in each other and the individual constituents retain those properties.Where as in alloys constituents materials are soluble in each other and from a new material which has different properties from their constituents. The stress and strain characteristics of fiber-reinforced plastics are different from most metals and plastics. Short term testing gives a linear stress strain curve. Both the fibers and the matrix retain those physical and chemical identities, but produce a combination of properties that cannot be achieved with either of the constituents acting alone. In general, fibers are the principle load carrying members, while the surrounding matrix keeps them in the desired location and orientation, acts as a load transfer medium between them and protects them from environmentaldamages due to elevated temperature and humidity. Properties of composites are strongly influenced by the properties of their constituent materials, their distribution and the interaction between them. Like conventional materials, composites are not homogeneous and isotropic. Composites are generally completely elastic up to failure exhibit no yield point or a region of plasticity.

2.1Past: After making and controlling fire and inventing the wheel, spinning of continuous yarns is probably the most important development of mankind enabling him to survive outside the tropical climate zones and spread across the surface of the Earth. Flexible fabrics made of locally grown and spun fibers as cotton flax and jute were a big step forward compared to animal skins. More and more natural resources were used resulting in the first composites straw reinforced walls and bows and chariots made of glued layers of wood, bone and harm. More durable materials as wood and metal soon replaced these antique composites.

2.2Present: Originating from early agricultural societies and being almost forgotten after centuries, a true revival started of using lightweight composite structures for many technical solutions during the second half of the 20th century. After being solely used for their electromagnetic properties using composites to improve the structural performance of spacecraft and military aircraft became popular in the last two decades of the previous century. First at any costs with development of improved materials with increasing costs, nowadays cost reduction during manufacturing and operation are the main technology drivers. Latest development is the use of composites to protect man against fire and impact and a tendency to a more environmental friendly design, leading to the reintroduction of natural fibers in the composite technology. friendly design, leading to the reintroduction of natural fibers in the composite technology.

2.3Future: In future, composites will be manufactured even more according to an integrated design process resulting in the optimum construction according to parameters such as shape, mass, strength, stiffness, durability, costs etc. Newly developed design tools must be able to instantaneously show customers the influence of a design change on each one of these parameters.

3. CONCEPT OF COMPOSITE

Fibers or particles embedded in matrix of another material are the best example of modern-day composite materials, which are mostly structural. Laminates are composite material where different layers of materials give them the specific character of a composite material having a specific function to perform. Fabrics have no matrix to fall back on, but in them, fibers of different compositions combine to give them a specific character. Reinforcing materials generally withstand maximum load and serve the desirable properties.In matrix-based structural composites, the matrix serves two paramount purposes binding the reinforcement phases in place and deforming to distribute the stresses among the constituent reinforcement materials under an applied force. The demands on matrices are many. They may need to temperature variations be conductors or resistors of electricity, have moisture sensitivity. 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

4. FIBER INTRODUCTION

The fiber polymers are capable of being drawn into long filaments having at least a 100:1 length-to-diameter ratio. Fibers may be subjected to a variety of mechanical deformations-stretching, twisting, sharing and abrasion. They must have a high tensile strength and a high modulus of elasticity as well as abrasion resistance. These properties are governed by the chemistry of polymer chains and also by the fiber drawing process. The molecular weight of fiber materials should be relatively high. Since the tensile strength increases with degree of crystalline, structure and configuration of the chain should allow the production of a highly crystalline polymer that translates into a requirement for linear and branched chains that are symmetrical and have regularly repeating per units.

4.1Types of Fibers:

- Natural fibers
- Artificial fibers

4.2 Natural fiber: Natural fiber reinforced composites have a good potential as a substitute for wood-based material in many applications. The development of environment friendly green materials is because of natural fiber's bio-degradability, light weight low cost, high specific strength compared to glass and carbon, recycling and renewing natural sources. Composites the wonder material with light- weight, high strength-to-weight ratio and stiffness properties have come a longway in replacing the conventional materials like metals, woods etc. The material scientists all over the world focused their attention on natural composites reinforced with jute, sisal coir, pineapple etc. primarily to cut down the cost of raw materials Artificial fiber These refer to those fiber that are not naturally present in nature and are made artificially man. Man-made fibers have high strength, strong when wet low moisture absorption characteristics. Examples of man-made fibers are viscose rayon, acetate rayon,etc

4.3Composite: The jure and hair fiber is an important best fiber and comprises bundled ultimate cells, each containing spirally oriented micro- fibrils bound together. Jute composite materials consist of jute and hair fibers of high strength and modulus embedded in or bonded to a matrix with distinct interfaces between them. In this form, both fibers and matrix retain their physical and chemical identities, yet they produce a combination of properties that cannot be achieved with either of the constituents acting alone. la general jute and hair fibers are the principle load carrying member, while the surrounding matrix keeps them in the desired location and orientation. It acts as a load transfer medium between them, and protects them from environmental damages due to elevated temperature and humidity.

4.4Jute fiber: Jute is multi-celled in structure; the cell wall of a fiber is made up of a number of layers the primary wall and the secondary wall, which again is made up of the three layers. As in all lingo cellulosic fibers, these layers mainly contain cellulose, hemicellulose and lignin in varying amounts. The individual fibers are bonded together by a lignin-rich region known as the middle lamella Cellulose attains highest concentration in the layer and lignin is most concentrated in the middle lamella which, in principle, is free of cellulose. The layer is usually by far the thickest layer and dominates the properties of the fibers.

FIGURE 1. Jute fiber

The long chains of cellulose are linked together in bundles called micro fibrils. Hemicelluloses are also found in all plant fibers. Hemicelluloses are polysaccharides bonded together in relatively short, branching chains. They are intimately associated with the cellulose micro fibrils, embedding the cellulose in a matrix. The most important types of natural fibers used in composite materials are flax, hemp, jute, kenaf, and sisal due to their properties and availability. Using jute fiber for composites has many advantages. Firstly, it has wood like characteristics as it in a best fiber. Jute has high specific properties, low density, less abrasive behavior to the processing equipment, good dimensional stability and harmlessness. Jute is renewable, an abrasive, pours, hydroscopic, viscous-elastic, biodegradable and reactive, the fiber has a high aspect ratio, high strength to weight ratio, and has good insulation properties. Jute textile is a low-cost eco-friendly product and easy to transport. The biodegradable and low-priced jute products merge with the soil after using providing nourishment to the soil, being made of cellulose on combustion jute does not generate tonic gases. Some might consider part of these properties as disadvantages, such as biodegradable and combustible, but these features provide a means of predictable and programmable disposal not easily achieved with other resources.

4.5Hair fiber: Biological fibers have been already used some 3000 years ago in composite systems in the ancient Egypt, where straw and clay were mixed together to build the walls. In the last few years, biological fibers have become an attractive reinforcement for polymeric composites from economic and ecological point of view. Here is an increase in the environmental awareness in the world which has aroused an interest in the research and the development of biodegradable materials. Biological/Natural fibers can be obtained from natural resources such as plants, animals or minerals. With the increase of global energy crisis and ecology risk, the unique advantages of biological fibers such as its abundance quantity, non-toxic, non- irritation of the skin, eyes, or respiratory system, noncorrosive property, biological fiber reinforced polymer composites have attracted much interest owing to their potential of serving as alternatives reinforcement to the synthetic ones. Here lower weight and higher volume of the biological fibers as compared to the synthetic fibers improve the fuel efficiency and reduced emission in auto applications.Hair is a protein filament that grows from follicles found in the dermis or skin. It is one of the defining characteristics of mammals. Be human body, apart from areas of glabrous skin, is covered in follicles which produce thick terminal and fine vellus hair. Most common interest in hair is focused on hair growth, hair types and hair care, but hair is also an important biomaterial primarily composed of protein, notably keratin. Keratins are proteins, long chains (polymers) of amino acids. In terms of raw elements, on an average, hair is composed of 50.65% carbon, 20.85% oxygen, 17.14% nitrogen, 6.36% hydrogen, and 5.0% Sulphur. Amino acid present in hair contain cytosine, serine, glutamine, threonine, glycine, leucine, valine and arginine

5. CHEMICAL COMPOSITION OF FIBER

Jute fiber

TABLE1. Chemical composition of jute fiber

CONSITITUTES	PERCENT AGE (%)
Cellulose	60-62
Hemi cellulose	22-24
Lignin	12-14
Others	1-2

Hair fiber

TABLE2. Chemical composition of hair fiber

CONSITITUENTS	PERCENTAGE (%)
Cellulose	43-88
Hemi cellulose	10-15
Lignin	4-20
Others	10-22

6. EPOXY RESININTRODUCTION

Epoxy resin was discovered in 1938 by Pierre Castan, a chemist in Switzerland. As of 1989, 137,000 tons of epoxy resin had been produced in Japan and epoxy resin has been used in a wide range of fields, such as paints, electricity, civil engineering and bonds. This is because epoxy resin has excellent bonding property, and also after curing, it has excellent properties on mechanical strength, chemical resistance, and electrical insulation. In addition, epoxy resin is able o have various different properties as it is combined and cured together with various curing agents. This issue describes the types of curing agents for epoxy resin and their characteristics comparing to Three Bond products.

Definition: Epoxy resin is defined as a molecule containing more than one epoxide groups. The epoxide group also termed as oxidant or ethoxy line group which is also known as poly epoxides. Epoxy resins are also known as poly epoxides, are a class of reactive polymers which contain epoxide groups. It is a polymer formed a reaction of epoxide resin with curing agent.

They have the following characteristics

- Good thermal and electric property
- Excellent mechanical property & cohesiveness to variety of substrates
- Chemical and corrosion resistance
- Good Process ability & electrical conductivity
- High mechanical properties and large cohesive force

6.1Curing of Epoxy Resins: Epoxy resins are cured by means of a curing agent, often referred as catalysts, hardeners or activators. Often amines are used as curing agents. In amine curing agents, each hydrogen on amine nitrogen is reactive and can open one epoxide ring to form a covalent bond

7. APPLICATION OF EPOXY RESINS

7.1 Adhesives: Epoxy adhesives are a major area of the class of adhesives called structural adhesives or engineering adhesives. These high-performance adhesives are utilized in the construction of aircraft, automobiles, bicycles, boats, golf clubs, skis, snowboards and other applications where high strength bonds are needed. They may be used as adhesives for wood, metal, glass, stone and some plastics. They could be made flexible or rigid, transparent. Such epoxies are commonly utilized in optics, fiber optics and optoelectronics.

Paints and coatings Coatings Application

Technologies includes below

- Low Solids Solvent borne Coatings
- High Solids Solvent borne Coatings
- Solvent-Free Coatings
- Waterborne Coatings
- Powder Coatings
- Radiation-Curable Coatings

Two-part epoxy coatings were developed for high quality service on substrates use less energy than heat-cured powder coatings. These systems use of a 4:1 by volume mixing ratio, dry quickly provides a hardcore, protective coating with excellent hardness.Their low volatility and water cleanup makes them helpful for factory cast iron, cast steel, cast aluminums applications reduces exposure and flammability issues associated with solvent-become coatings. They are usually utilized in industrial automotive applications being that they are more heat resistant than Jutes-based alkyd-based paints. Epoxy paints often deteriorate called as a result of UV exposure. Polyester epoxies are employed as powder coatings for washers, driers and other white goods.

7.2Composites: Epoxies may also be used in producing fiber-reinforced or composite parts, they are more costly than polyester resins and vinyl ester resins, but usually produces stronger more temperature-resistant composite parts. Epoxy resins are suitable as a fiber reinforcing material since they exhibit excellent adhesion to reinforcement, cure with low shrinkage and provide good mechanical, electrical and thermal, chemical, fatigue and moisture-resistant properties.The processes for making composites encompass the whole range of epoxy resin technology. i.e. laminating. filament winding, pultrusion, casting and molding. For their excellent adhesion, good mechanical properties, resistance to humidity chemicals, epoxy resins are employed in combination with glass, graphite, boron Kevlar fibers. The orientation of the fibers is important in establishing the properties of the laminate. In the manufacture of tools, epoxy casting resins are utilized as prototype and master models for product design, drilling, welding jigs, checking fixtures, vacuum forming and injection molding. Aerospace Applications in the aerospace industry, epoxy is employed as a structural matrix material which can be then reinforced by fiber. Typical fiber reinforcements include glass, carbon and Kevlar boron. Epoxies may also be used as structural glue. Materials like wood and others which low-tech are glued with epoxy resin. Electrical Systems & Electronics Epoxy resin formulations are essential in the electronics industry are employed in motors, generators, transformers, switchgear, bushings, insulators. They are excellent electrical insulators also protect from dust and moisture. In the electronics industry epoxy resins are the principal resin used in over molding integrated circuits, transistor hybrid circuits, making printed circuit boards. Epoxy resins are a costumed to bond copper foil to circuit board substrates, really are component of the solder mask on many circuit boards.

7.3Consumer & Marine Applications: Epoxies can be purchased in hardware stores typically as a bunch containing separate resin and hardener, which must be mixed immediately before use. They are also sold in boat shops as repair resins for marine applications. Epoxies typically are not used in the outer layer of a boat because they deteriorate by experience of UV light.

8. MANUFACTURING PROCESS

8.1Die Set Process: The word die is a generic term used to describe the tooling used to produce stamped parts. A die set assembly consisting of a male and female component is the actual tool that produces the shaped stamping. The male and female components work in opposition to both form and punch holes in the stock. The upper half of the die set, which may be either the male or female, is mounted on the press ram and delivers the stroke action. The lower half is attached to an intermediate bolster plate which in turn is secured to the press bed. Guide pins are used to insure alignment between the upper and lower halves of the die set.

8.2Sheet Metal Stamping: Stamping presses and stamping dies are tools used to produce high volume sheet metal parts. The press provides the force to close the stamping dies where they shape and cut the sheet metal into finished parts.

8.3Die Lubrication: The resistance of the sheet metal stock to the forces exerted by the moving dies creates friction. For this reason, lubrication is vital for successful sheet metal forming. Lubrication's function is to minimize contact between the tooling and the work piece. This results in reduced tonnage requirements, conger tooling life, and improved product quality. Lubricants range from light mineral oils to high viscosity drawing compounds. They may be oil base, water soluble, synthetic materials. These lubricants may be applied in a variety of ways including are

- Manually by roller or brush
- Drip

- Machine roller
- Spraying
- Flooding

8.4Grinding Machine: Grinding Machines are also regarded as machine tools. A distinguishing feature of grinding machines is the rotating abrasive tool. Grinding machine is employed to obtain high accuracy along with very high class of surface finish on the work piece.However, advent of new generation of grinding wheels and grinding machines are characterized by their rigidity, power and speed enables one. Conventional grinding machines can be broadly classified as

- Surface grinding machine
- Cylindrical grinding machine
- Internal grinding machine
- Tool and cutter grinding machine

Bench type grinding machine

Grinding flat or plane surfaces is known as surfaces grinding. Two general types of machines have been developed for this purpose those of the planer type with a reciprocating table and those having a rotating worktable. Each machine has the possible variation of a horizontal or vertical positioned grinding wheel spindle This machine may be similar to a milling machine used mainly to grind flat surface. However, some types of surface grinders are also capable of producing contour surface with formed grinding wheel. Basically, there are four different press of surface grinding machines characterized by the movement of their tables and the orientation of grinding wheel spindles as follows

- Horizontal spindle and reciprocating table
- Vertical spindle and reciprocating table
- Horizontal spindle and rotary table
- Vertical spindle and rotary table

The wheel is generally made from a matrix of coarse panicles pressed and bonded together to form a solid, circular shape, various profiles and cross sections are available depending on the intended usage for the wheel. They may also be made from a solid steel or aluminum disc with particles bonded to the surface.

9. CHARPY IMPACT TEST

9.1Impact Testing: The purpose of impact testing is to measure a material ability to resist high rate reading impact often is one the determining factor in the service life of the material. Impact testing commonly consists of Charpy and Izod specimen configuration.

FIGURE 2. Impact test machine

The impact test also known as the 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 given materials toughness and acts as a tool to study temperature - dependent brittle- ductile transition. It is widely applied in industry. It is easy to prepare and conduct und result can be obtained quickly and cheaply. But major disadvantage is that all results are only comparative.The apparatus consists of a pendulum hammer swinging at a notched sample of material. The energy transferred to the material can be inferred by comparing the difference to the height of the hammer before and after a big fracture The notch in the sample affects the results of the impact test. Thus it is necessary the notch to be of a regular dimension determine the material in plane stain, difference can greatly affect conclusions made.

9.2Impact Energy: Impact energy is a measure of the work done to fracture a test specimen. When the striker impacts the specimen, the specimen will absorb energy until it yields. At this unit, the specimen will begin to undergo plastic deformation at the notch. The test specimen continues to absorb energy and work hardness at the plastic zone at the notice. When the specimen can absorb no more energy and fracture occurs.

9.3Charpy Impact Test: The Charpy impact test, also known as the Charpy V- notch test is a standardized high strain- rate test which determines the amount of energy absorbed by a material during fracture.

9.4Izod Impact Test: Izod impact testing is an ASTM (American Standard Testing Materials) standard method of determining the impact resistance of materials.

9.5Dimensions of Specimens:

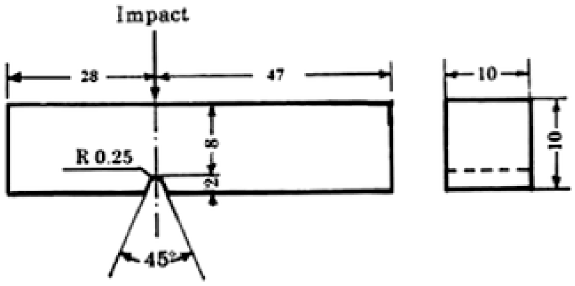

FIGURE3. Izod dimensions of specimens

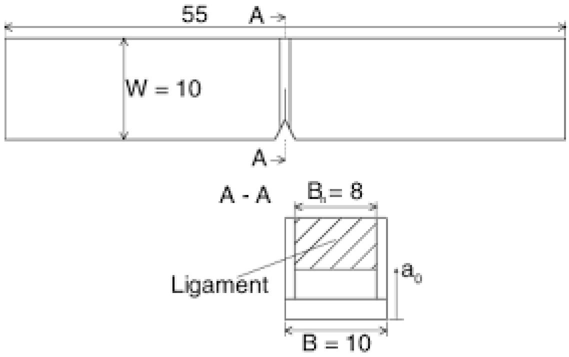

FIGURE4. Charpy dimensions of specimens

The dimension or size of the specimen used in the Charpy Test is 55mm x 10mm x 10mm. On the other hand, the dimension of the specimen used is 75mm x 10mm x 10mm in Izod Test.

9.6Factors Affecting Impact Test: Factors that affect the Charpy and izod impact energy of a specimen include.Yield strength and ductilityNotches rapture and stain rateFracture mechanism

9.7Quantitative Results: The quantitative results of the impact test can be used to determine the ductility of material. If the material breaks on a flat plane, the fracture was brittle and if the material breaks with jagged edges or shea lips. Then the fracture was ductile. Usually a material does not break in just one way or the other and thus comparing the jagged to flat surface areas of the facture will give an estimate of the percentage of ductile and brittle fracture.

9.8Toughness Properties Of Composites:D ue to the layered structure of composites and their intrinsic ability to deflect cracks it is very difficult in many GRP (Glass Reinforced Plastic) to propagate a crack perpendicular to the plane of lamination instead crack growth have concentrated on the inter laminar delaminating fracture toughness values are invariably higher for continues unidirectional GRP materials then for ERP. The higher strain energy release rates for GRPS can be attributed to poor fiber matrix interfacial bonding that occurs with these materials giving an increased crack surface energy and fiber bridging for mode GRP specimens which contributes significantly to crack growth resistance. GRP laminates are rate dependent, increasing strain rate, whereas strain energy release rate for remain relatively constant with changes in strain rate.

10. CHAPTER 8 HARDNESS TEST

Introduction: The hardness test is a mechanical test for material properties which are used in engineering design, analysis of structures, and materials development. The principal purpose of the hardness test is to determine the suitability of a material for a given application, or the particular treatment to which the material has been subjected. The ease with which the hardness test can be made has made it the most common method of inspection for metals and alloys.The importance of hardness testing has to do with the relationship between hardness and other properties of material. For example, both the hardness test and the tensile test measure the resistance of a metal to plastic flow and results of these tests may closely parallel each other. The hardness test is preferred because it is simple, easy and relatively nondestructive. There are many hardness tests currently in use. The necessity for all these different hardness tests is due to the need for categorizing the great range of hardness from soft rubber to hard ceramics.

10.1Rockwell Hardness Test: Hugh M. Rockwell (1890-1957) and Stanley P. Rockwell (1886-1940) from Connecticut in the United States co-invented the "Rockwell hardness tester", a differential-depth machine; they applied for patent on July 15, 1914. They requirements for this tester were to quickly determine the effect of heat treatment on steel bearing races. The application was subsequently approved on February 11, 1919, and holds U.S. patent 1,294,171. At the time of invention, both Hugh and Stanley Rockwell worked for the new departure manufacturing Co. of Bristol CT. The Rockwell hardness test method is defined as in ASTM E-18, is the most commonly used hardness test method. You should obtain a copy of this standard read and understand the standard completely before a attempting a Rockwell test. The Rockwell hardness test is generally easier to perform and more accurate than her types of hardness testing method. The Rockwell test method is used on all metals, expect in condition where the test metal structure of surface conditions would introduce to much variation where the indentation would be too large, he c application the sample size or sample shape prohibits its uses.The Rockwell hardness test method consists of indenting the test material with a diamond cone or hardened steel ball indenter. The indenter is forced into the test material under a preliminary minor load usually 10 kgf. When equilibrium has m reached, an indicating device, which follows the movements of the indenter ad responds to changes in depth of penetration of the indenter is set to a datum position. While the preliminary minor load is still applied anAdditional major load is applied with resulting increase in penetration. When equilibrium has again been reach the additional major load is removed but the preliminary minor load is still maintained. Removal of the additional major load allows a partial recovery, so reducing the depth of penetration. The permanent increase in depth of penetration, resulting from the application and removal of the additional major load is used to calculate the Rockwell hardness number. We press a diamond cone into the material. The angle of this cone is 120. We can use a steel ball instead of the cone. The level of hardness is the size of the plastic deformation. We do this test on a Rockwell hardness tester.

FIGURE 6. Rockwell Hardness Testing machine

11. CALCULATION

11. Specifications of Impact Test

Pendulum weight =21.350 kg Angle of pendulum =140

Breadth =10mm

Width=10mm

Length (Charpy) =55mm

Length (Izod) =75mm

Formula Used

Energy observed =Initial reading -final reading

Impact strength = Energy observed /cross sectional area

Cross sectional area =Width×breadth

Calculation

Cross sectional area =10×10=100mm2

Charpy impact test

Energy observed =300-42=258J

Impact strength =258-100=2.58J/mm2

Izod impact test

Energy observed =300-50=250J

Impact strength =250-100=2.50J/mm2

12. CONCLUSION

With this project we came to an understanding of the behavior of our composite materials. Many composite materials are produced and each of them serves unique purpose with their respective properties. So, with our work we conclude that composite material (jute fiber) we made in a successful one and it has the strength properties as mentioned in the comparison table. This can serve in material selection that is; whoever needs the strength or properties of the composite material. We made can choose our material for the manufacturing process.

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