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Fabrication of composite material using Jute fiber/Glass fiber

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Abstract - *Fiber reinforced polymer composites are now considered as an important class of engineering materials. This paper depicts the processing and mechanical Properties of a new class of multi-phase composites consisting of epoxy resin reinforced with jute fiber and filled with glasses fibers particulates. The Glasses used as filler material in this Paper has been prepared from hard composite through scanning microscope processing technique. The effect of filler in modifying the physical and mechanical properties of jute-epoxy composites has been studied.*

The jute fiber is considered as an agricultural waste and it is thus interesting to explore the utilization potential of glasses fibers derived from composite making. Moreover, being cheap, inexhaustible and easily available, it would hopefully provide a cost effective solution to composite manufacturers.

With the increased use of these materials in erosive work environments, it has become extremely important to investigate their erosion characteristics intensively. In view of this, erosion trials are carried out at various test conditions. For this, an air jet type tensile test rig and Izod, Charpy tests are used. Significant control factors influencing the wear rate are identified. This paper also presents the development of a Fabrication process model for estimating strength with respect to different test for damage caused by solid particle impact on the composites. This Process of Fabrication is based upon conservation of particle kinetic energy and relates the erosion rate with some of the material properties and test Conditions.

***Key Words*: Natural Fiber, Glass/Jute, Scanning Electron Microscope etc.**

1.INTRODUCTION

Reinforcement provides strength and rigidity, helping to support structural load. The matrix or binder (organic or inorganic) maintains the position and orientation of the reinforcement. Significantly, constituents of the composites retain their individual, physical and chemical properties; yet together they produce a combination of qualities which individual constituents would be incapable of producing alone. The reinforcement may be platelets, particles or fibers and are usually added to improve mechanical properties such as stiffness, strength and toughness of the matrix material. Long fibers that are oriented in the direction of loading offer the most efficient load transfer.

This is because the stress transfer zone extends only over a small part of the fiber-matrix interface and perturbation effects at fiber ends may be neglected. In other words, the ineffective fiber length is small. Popular fibers available as continuous filaments for use in high performance composites are glass, carbon and aramid fibers.

If the fibres are derived from natural resources like plants or some other living species; they are called natural-fibres. Among all reinforcing fibres, natural fibres have gained great significance as reinforcements in polymer matrix composites.

Depending upon the source of origin, natural fibres are classified as plant, animal and mineral fibres. Recently, due to the growing global energy crisis and ecological risks, natural fibres reinforced polymer composites have attracted more research interests.

2.FIBERS AND IT'S FABRICATION

1.Fibers

A great majority of materials are stronger and stiffer in the fibrous form than as a bulk material. A high fiber aspect ratio (length-diameter ratio) permits very effective transfer of load via matrix materials to the fibers, thus taking advantage of their excellent properties. Therefore, fibers are very effective and attractive reinforcement materials. Reinforcing fibers used in advanced composites are discussed in this file.

2.Glass Fibers

Glass fibers are the most common of all the reinforcing fibers for polymer matrix composites. The principal advantages of glass fibers are the low cost and high strength. However, glass fibers have poor abrasion resistance, which reduces their usable strength.

They also exhibit poor adhesion to some polymer matrix resins, particularly in the presence of moisture. To improve adhesion, the glass fiber surface often is treated with chemicals called coupling agents. Glass fibers also have a lower modulus compared with the other advanced reinforcing fibers such as Kevlar, carbon, and boron.

3. Production of Glass Fibers

Two forms of fiberglass can be produced-continuous fiber and staple (discontinuous) fiber. Both forms are made by the same production method up to the fiber-drawing stage.

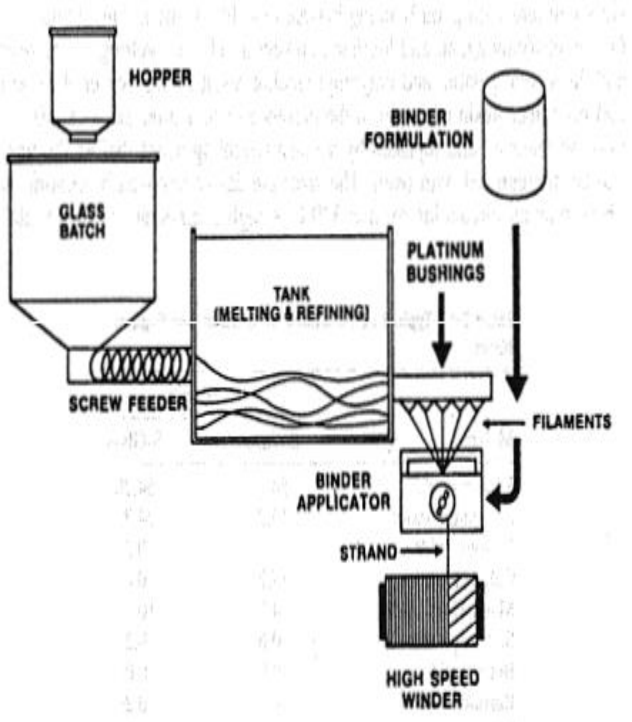


Fig1. Glass fiber production setup

Staple fibers are produced by passing a jet of air across the orifices in the base of the bushing, thus pulling individual filaments 20-40 cm long from the molten glass exiting from each orifice. These fibers are collected on a rotating vacuum drum, sprayed with a binder, and gathered as a "sliver" that can be drawn and twisted into yams.

4. Glass Composition and Properties

Glass fibers are amorphous solids. Chemically, glass is composed primarily of a silica (SiO_2) backbone in the form of ($-SiO_4-$)n tetrahedra. Modifier ions are added for their contribution to glass properties and manufacturing capability.

For structural composites, the two commonly used types of glass fiber are E-glass and S-glass. For structural composites, the two commonly used types of glass fiber are E-glass and S-glass.

5. Surface Treatment of Fibers

The chemical treatments applied during the forming of glass fibers are called sizes. These are of two general types: temporary sizes and compatible sizes.
Sizes of this type must be removed and replaced by a finish (coupling agent) before the fibers can be impregnated with resin. The sizes are easily removed by heating the fibers in an air-circulating oven at 340°C or higher temperatures for 15-20 h.
The compatible sizes are applied to help improve initial adhesion of resin to glass and to reduce the destructive effects of water and other environmental forces on this bond.

Material	% Weight	
	E- Glass	S-Glass
Silicon oxide	54.3	64.20
Aluminum oxide	15.2	24.80
Ferrous oxide	-	0.21
Calcium oxide	17.2	0.01
Magnesium oxide	4.7	10.27
Sodium oxide	0.6	0.27
Boron oxide	8.0	0.01
Barium oxide	-	0.20
Miscellaneous	-	0.03

Table 1. Typical composition of E-glass and S-glass fibers

Property, Units	E-Glass	S-Glass
Density(g/cm^3)	2.54	2.49
Tensile strength(MPa)	3448	4585
Tensile modulus(GPa)	72.4	84.5

Table 2. Properties of E-Glass and S-Glass Fibers

6. Forms of Glass Fiber

Glass fibers are commercially available in various forms suitable for different applications. Some of them are described below.

1) Fiberglass roving - Fiberglass roving is a collection of parallel continuous ends of filaments. Conventional rovings are produced by winding together the number of single strands necessary to achieve the desired yield (number of meters of roving per kilogram of weight). Generally, rovings are made with fibers of diameter 9 or 13 µm. Roving yields vary from about 3600 to 450 m/kg and typically have 20 strands. Rovings are used directly in pultrusion, filament winding, and prepreg manufacture.

Fig 2.Fiberglass roving

2) Woven roving - Rovings may be woven into a heavy, Coarse-weave fabric for applications that require rapid thickness build up over large areas. This characteristic is especially useful in the manufacture of fiber glass boats, various marine products, and many types of tooling. Woven rovings are available in different widths and weights.

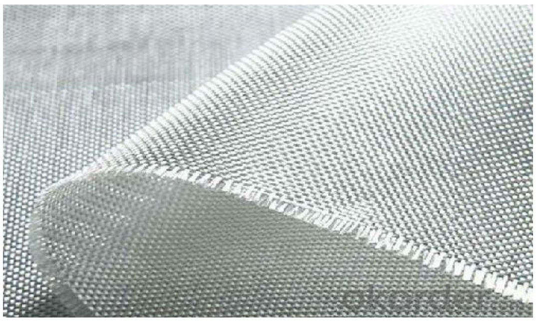


Fig 3.Woven Glass Fiber

3) Chopped-Strand Mat and Other Mats - There are three basic forms of fiber glass mats: chopped-strand mat, continuous-strand mat, and surfacing mat or veil.

Chopped-strand mat is a nonwoven material in which the fiber glass strands from roving are chopped into 25-50-mm lengths, evenly distributed at random onto a horizontal plane, and bound together with an appropriate chemical binder. These mats are available in widths of from 5 cm to 2 m and weigh 0.25-0.92 kg/m^2.

Continuous-strand mat consists of unchopped continuous strands of fiber glass deposited and interlocked in a spiral fashion. This mat is open and springy but, as a result of mechanical interlocking, does not require much binder for adequate handling strength.

Surfacing mat or veil is a very thin mat of single continuous filaments often used as a surface reinforcing layer in hand lay-up or molding process to minimize telegraphing the primary reinforcement through to the finished surface of a component, thus providing a smoother surface.

4) Textile fiberglass yarn - A yarn is a combination of strands that can be woven suitably into textile materials. The continuous, individual strand as it comes from the bushing represents the simplest form of textile fiberglass yarn and is referred to as a single yarn. In order for this yarn to be used properly and efficiently in a weaving operation, additional strand integrity is introduced by twisting it slightly, usually less than 40 turns per meter.

However, many woven fabrics require yarns that are heavier than can be conveniently drawn from a bushing. These can be produced by combining single strands via twisting and plying operations. Typically, this involves twisting two or more strands together and subsequently plying (i.e., twisting two or more of the twisted strands together).

5) Fiberglass fabric - Fiberglass yam is woven into fabric by standard textile operations. The properties and contribution to product performance of fiberglass fabric depend on the fabric construction, that is, the number of yams per inch in each direction, weave pattern, and yarn type.

6) Chopped-strand milled fibers - Continuous fiberglass strands can be chopped to specific lengths or hammer-milled into very short fiber lengths (generally 0.4-6.5 mm). The actual lengths are determined by the diameter of the screen openings through which the fibers pass during the milling. Milled fibers are used as reinforcements and fillers for thermoplastic and thermosetting resins.

7. Jute Fiber

Jute is a long coarse soft fibrous material obtained from plant Corchorus olitorius. It has good tensile strength and a good thermal and electrical Insulator.

Cultivation of Jute Fibers

To grow jute, farmers scatter the seeds on cultivated soil. When the plants are about 15-20 cm tall, they are thinned out. About four months after planting harvesting begins. The plants are usually harvested after they flower, before the flowers go to seed.

The stalks are cut off close to the ground. The stalks are cut off close to the ground. The stalks are tied into bundles and soaked in water for about 20 days. This process softens the tissues and breaks the hard pectin bond between the bast and Jute hurd (inner woody fiber stick) and the process permits the fibers to be separated.

The fibers are then stripped from the stalks in long stands and washed in clear, running water. Then they are hung up or spread on thatched roofs to dry. After 2-3 days of drying, the fibers are tied into bundles.

The suitable climate for growing jute is a warm and wet climate, which is offered by the monsoon climate during the fall season, immediately followed by summer. Temperatures ranging from 70-100 ^{0}F and relative humidity of 70%-80% are favourable for successful cultivation. Jute requires 2-3 inches of rainfall weekly with extra needed during the sowing period.

Retting

Retting is the process of extracting fibers from the long lasting life stem or bast of the bast fiber plants. The available retting processes are: mechanical retting (hammering), chemical retting (boiling & applying chemicals), steam/vapor/dew retting, and water or microbial retting. Among them, the water or microbial retting is a century old but the most popular process in extracting fine bast fibers. However, selection of these retting processes depends on the availability of water and the cost of retting process.
To extract fine fibers from jute plant, a small stalk is harvested for pre-retting. Usually, this small stalk is brought before 2 weeks of harvesting time. If the fiber can easily be removed from the Jute hurd or core, then the crop is ready for harvesting.

After harvesting, the jute stalks are tied into bundles and submerged in soft running water. The stalk stays submerged in water for 20 days. However, the retting process may require less time if the quality of the jute is better. In most cases, the fiber extraction process of bast fibers in water retting is done by the farmers while standing under water.
When the jute stalk is well retted, the stalk is grabbed in bundles and hit with a long wooden hammer to make the fiber loose from the jute hurd or core. After losing the fiber, the fiber is washed with water and squeezed for dehydration. The extracted fibers is further washed with fresh water and allowed to dry on bamboo poles. Finally, they are tied into small bundles to be sold into the primary market.

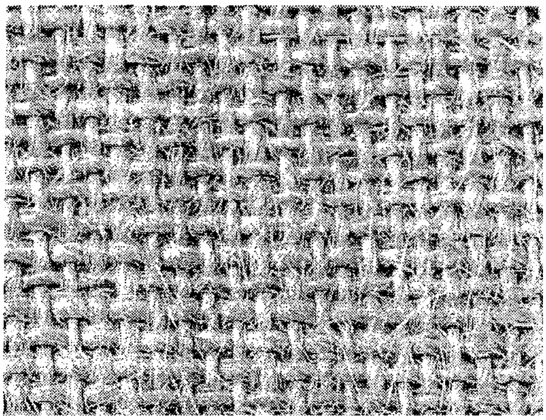
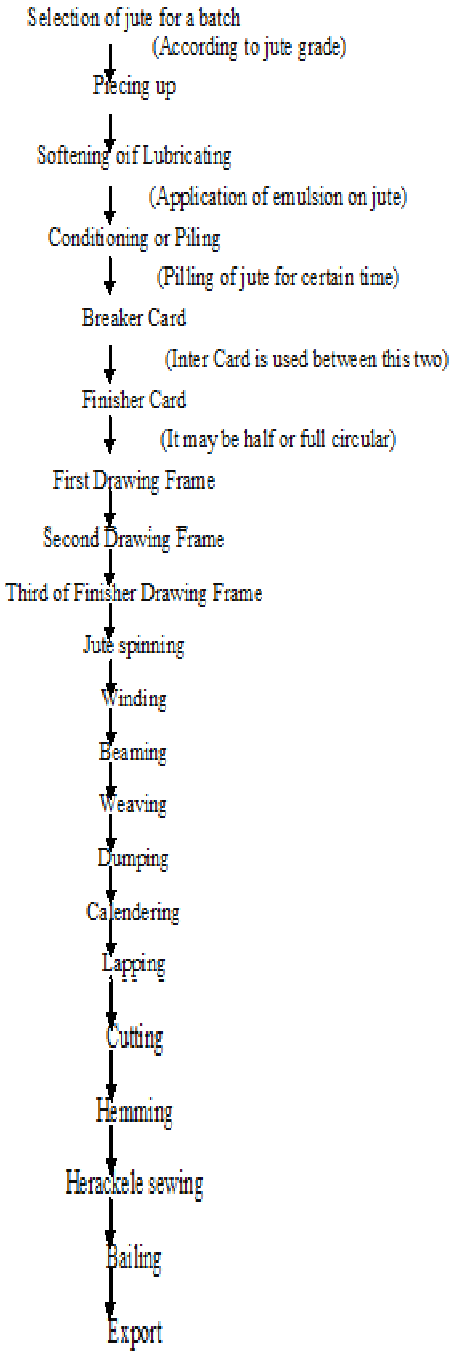
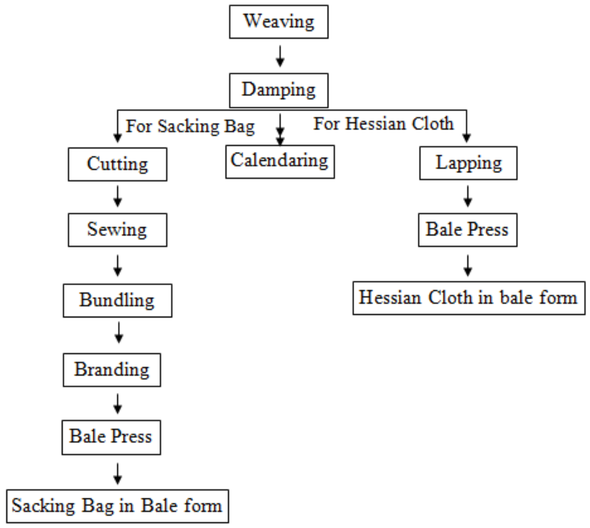


Fig 4.Woven Jute Fiber

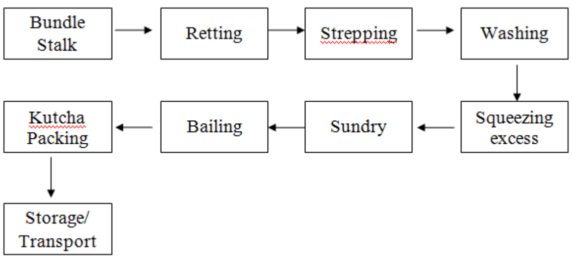
Flow Chart of Jute Spinning: Due to its worldwide demand different country manufacture jute goods. Jute goods produce by a line of sequence. Its manufacturing process is completely different from cotton. By the following way jute goods are produced



Fibre Fabrication Procedure



Process of Fiber Extraction



BAGGING SYSTEM

A typical bagging system used for a pre impregnated lay-up system consists of the following steps:

1) Cover the layup with a perforated parting film or a separator cloth and then a layer or layers of bleeder material. The combination should be such as to ensure adequate bleeding of air and excess resin out of the part so that the curved part will have the desired content.
2) Place a strip of jute just beyond the edge of the lay-up and put bag sealing compound 10 cm beyond the edge of the layup.
3) Cover the lay-up jute , sealing compound with a flexible film diaphragm and seal the diaphragm to the mold with the sealing compound.
4) Connect the vacuum lines slowly apply the vacuum pressure whle working the wrinkles and excess air out of the lay-up, bleeder material, and vacuum bag. Keep the part under vacuum while it is being cured in the avon or autoclave.

A bagging system for a wet laid up part must be as free as possible of entrapped air. The working life of this type of resin system is important because the bagging and rub-out procedure must be accomplished before the resin advances too far and becomes semi gelled.

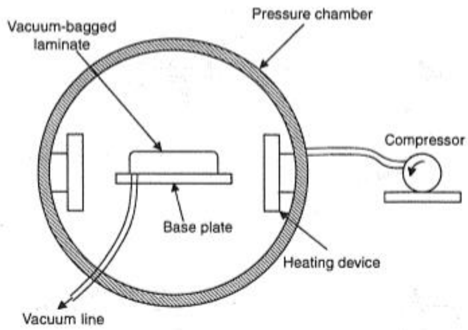


Fig 5.Bagging Setup

As soon as the part is laid-up, it should be bagged. In this case to prevent the air in the jute bleeder material is placed about 2.5 cm away from the edge of the wet lay-up, which allows for a 2.5 cm resin seal.

3. CONCLUSIONS

1. The mechanical properties of jute and glass fiber is increased by incorporating the epoxy resin and increasing their tensile and impact strength.
2. The GGGG laminate composite shows pure brittleness and having highest tensile strength of all hybrid composites.
3. From Stress strain curve of both JGGJ & GJJG composite laminate the GJJG laminate is more ductile than JGGJ laminate composite.
4. The GJJG laminate composite having the highest impact strength and therefore it can be used in structural applications in medium load without affecting the surrounding environment
5. Hardness of GGGG composite laminate is highest among all composites.

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