Developmentof hybrid Composites An approach for Cenosphere filled with Jute, E-glass fibre and comparison with 0 & 5 wt% Cenosphere

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Abstract

Composites plays predominant role in the Engineering materials and wide verities of applications in the Universe. The development of new generation of the composites have been undertakento satisfy with equivalent material properties including Physical and Mechanical behaviour. Advanced composites requires different properties like, good appearance, Light in weight, Stronger than conventional metals and economics. In the present work,Cenosphere is being used with Jute, E-glass fibres and forms a composite. This composite have been developed and tested with comparative studies based on the weight. This studies found that the effect of cenosphere as a particulate filler of mechanical behaviour of woven jute-glass hybrid composites. The hybrid consists of jute and glass fibre as reinforcement and epoxy matrix. The conventional hand lay-up technique is used to prepare composite specimens. Cenosphere of different weight percentage (0 to 5 wt %) have been added to the hybrid composite. The samples were tested as per ASTM standard for their mechanical behaviour's and also compared the effect of filler material. The morphologies of the composites have been studied by using electron microscope. The morphologies results and test results felt found that 10% improved mechanical behaviour in tensile and compression strength.

Key words
Cenosphere, E-Glass fibre, Jute fibre, Epoxy Resign and composite material, UTM

1.0 Introduction:

Composites are one of the fastest growing in Industries and continue to dominate a significance impact in the material world, hence, the usage & application of composites increases day by day. The advanced composites [1], find huge applications in Industries, Automotive, Aircraft, Structural and Superconductive, construction applications. The two main constituents of composite materials are reinforcement and matrix. Composites are direct impact on materials technology and indirectly reoriented materials science and Technology.

1.1Hybrid composites [2]:

Composite materials incorporated with two or more different types of fillers especially fibres in a single matrix are commonly known as Hybrid composites.Hybridization is commonly used for improving the properties and for lowering the cost of conventional composites. The manufacturing of Hybrid composite is being done by combining two or more fibres in a single matrix. The process of Hybridization is to increase a resistance against the inter laminar toughness that cannot be obtained with only conventional composite material. The fibres can be arranged in various orientations during preparation of composite. However other factors such as cost, weight, post-failure behaviour lead the designer to use hybridization in order to tailor the material to exact needs under design. Epoxy resin is used in these hybrid composites because it provides a unique balance of chemical and mechanical properties combined with extreme processing versatility. In all cases, thermoset resins may be tailored to some degree to satisfy particular requirement.

1.2 Jute fibre [3&4]:

Jute is an annual plant in the genus corchorus and having properties of renewable, versatile, nonabrasive, porous, hygroscopic, viscoelastic, biodegradable, combustible, computable and reactive. Major types grown are generally known as white jute and tosa jute. Jute, grown mainly in India and Bangladesh, is harvested at 2to 3 months of growth, at which time it is 3-5 meters tall. Jute has a pithy cover known as jute stick and the blast fibres grow length wise around this core. Jute blast fiber is separated from pith in a process known as retting. Retting is accomplished by placing cut jute stalks in ponds for several weeks. Microbial action in the pond softens the Jute fiber and weakness the bonds between individual fiber and pith. The fiber stands are then mainly stripped from the jute stick and hung on track to dry. The fiber is treated with various conditioners to increase flexibility; the retted jute fiber stands are suitable for manufacturing textiles. The structure of jute fiber is influenced by the climatic conditions, age and fermentation process, which also influences the chemical composition [20].

Figure 1. Woven Jute fiber

1.3 Glass Fiber [2]:

Glass Fibers are Silica based glass compounds that include some metal oxides, which can be used to produce different types of glass. A Variety of different chemical compounds is commercially available. Common glass fibres are silica based (50-60% SiO_2) and contains a host of other oxides of Calcium, Boron, Sodium, Aluminium and Iron. The limitations of glass fibers are comparatively low modulus of Elasticity, low inter laminar shear strength and compressive properties in relation to tensile strength. Poor abrasive resistance causing reduced strength and poor adhesion to specific polymer matrix materials in humid environments.

Figure (02): Glass fiber

1.4 Cenosphere [2]:

A cenosphere is a light weight inert, hollow sphere made largely of silica and alumina and filled with air or inert gas. It is typically produced as a by-product of coal combustion at thermal power plants.Cenosphere produce a free flowing white or grey white powder. The chemical composition of Cenosphere consists of SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, K_2O, Na_2O and SO_3. The Density of the Cenosphere is about 0.4 -0.8 g/cm^3, which gives them great buoyancy. A typical cenosphere are as shown in figure.

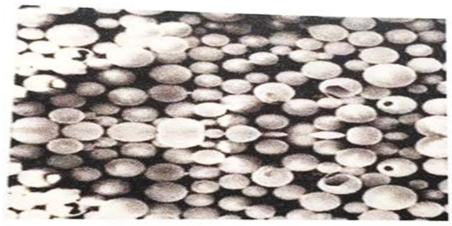


Figure [03]Cenosphere

1.5 Epoxy Resin(LY-556)

Epoxy Resins are relatively low molecular weight pre-polymers capable of being processed under a variety of conditions. Advantages over polyester resins are they can be partially cured and stored in that state and they can exhibit low shrinkage during cure. The viscosity of conventional epoxy resin is relatively higher and they are more expensive as compared to polyester resign. The type of epoxy resin used in the present investigation is Araldite LY – 556, which chemically belongs to epoxide family. Epoxy resin are characterized by the presence of a three membered ring containing two carbons and an oxygen.

1.6 Hardener (HY-951)

Hardener is a curing agent for epoxy or fiberglass. Epoxy resin requires a hardener to initiate curing. It is also called as catalyst, the substance that hardness the adhesive when mixed with resin. It is the specific selection and combination of the epoxy and hardener components that determines the final characteristics and suitability of the epoxy coating for the given environment. The hardener with IUPAC name NNO-bis (2amino ethyl ethane-1, 2 diamin) have been used with the epoxy designated as HY 951, having viscosity of (10-20) MPa at 25^0C. Both the epoxy and hardener were supplied by Coai and Ceenu. Pvt. Ltd.

2.0 Method for preparing Hybrid composite

In the present work, open moulding method, Hand lay-up Technique have been used. Production volume per mould is low: however, it is feasible to produce substantial production quantities using multiple moulds. Simple single cavity moulds of fiberglass composites construction have been adopt. 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 mould using a spry gun for a high quality surface. When the gel coat cured sufficiently, roll stock fiberglass reinforcement is manually placed on the mould. The lamination resin is applied by pouring, brushing, spraying or using a paint roller. Fiber reinforced plastic rollers, paint roller or squeegees have been used to consolidate the laminate, thoroughly wetting the reinforcement and removing entrapped air. Subsequent layer of fiber glass reinforcement are added to build laminate thickness.. Advantages of this process is low-cost tooling, simple process etc.

There are two types of composite manufacturing process, namely open moulding and closed moulding. In open moulding methods the coat and laminate exposed to atmosphere during the process. In a closed moulding method the composite is processed in a two-part mould set or within a vacuum bag.

2.1 Open moulding method:

Hand Lay-up Technique: The figure[5] showsHand lay-up technique. Gel coat is first applied to the mould using a spry gun for obtaining high quality surfaces. When the gel coat is cured sufficiently, roll stock fiberglass reinforcement is manually placed on the mould. The lamination resign is applied by pouring, brushing, spraying or using paint roller. Fiber reinforced plastic rollers, paint rollers, or squeegees are used to consolidate the laminate, thoroughly wet the reinforcement, and remove the entrapped air. Subsequent layers of fiber glass reinforcement are added to build the laminate thickness as shown in figure [5]. This technique is a low-cost technique & does not requiredany high skilled labourer.

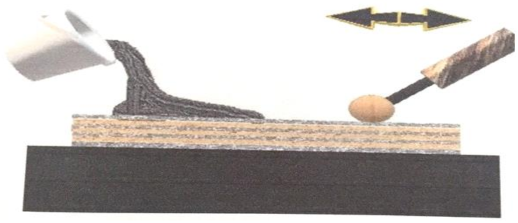


Figure [5]: Hand Lay-Up Process.

Hybrid Laminates of jute and glass composites are prepared by usual hand lay-Up technique. Place the layout of glass fiber& jute fiberwith orientation of 90 degree. An Iron mould of 600x600x5 mm has been used for composite fabrication. For quick and easy removal of composite, a mould release sheet is placed on the top and bottom of the mould. The mould release spry is also applied to the inner surface of the mould wall to facilitate easy removal of the composite specimen. A calculated amount of epoxy resin and hardener of 10:1 by weight thoroughly mixed with mechanical starrier. After 5 min stirring, the mixture is poured into the mould uniformly, and the jute fibers are placed and required amount of epoxy resin poured over it. Continue this process for four layers of jute-glass composites and then put in a mould. Roll the roller over the fiber to remove air bubbles present. Place the dead weights on the mould for 24 hours and remove the composite block from the mould. The same procedure repeated with different percentage of Cenosphere to obtain different composite slabs and care must be taken for maintain 5mm thickness of the slab. The final form of the laminate is shown in figure [6].

Figure [6] Final form of Laminate

3.0 TESTING AND RESULTS DISCUSSIONS:

In the present work, experimentshave been conducted on tensile and compressive test; these tests are very suitable for flat specimen prepared in the present work. The Universal testing machine as shown in figure [7].

Figure [7]: Universal testing Machine

Tensile Test: The most commonly used geometries are the dog-bone shape & straight sided specimen with end tabs. The standard test method used as per ASTM D 3039. The length of the specimen is 250mm. The tensile test has been conducted on UTM INSTRON H10KS. The test conducted with a cross head speed of 10mm/min. The tensile stress calculated by dividing total load exerted on specimen by actual cross sectional area through which force is applied. The tensile young's modulus (E) shall be calculated using following equation.

Young's modulus (E): Stress(σ)/ strain (ϵ)

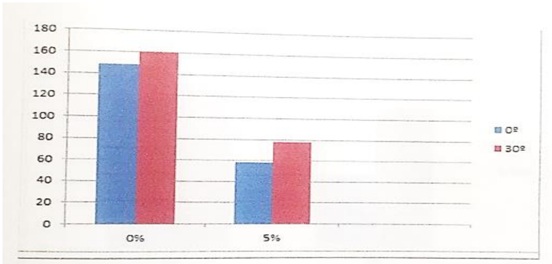
The different percentage of Cenosphere, specimens shown in figure [8] have been tested and results are tabulated as shown Table [1].

Figure [8]: Specimens

Table [1]

Sl No	Test	0% Cenosphere		5% Cenosphere	
		0^0	30^0	0^0	30^0
01	Ultimate Tensile Strength	148.10 N/mm^2	58.57 N/mm^2	160.68 N/mm^2	77.94 N/mm^2

Bar chart for tensile test:



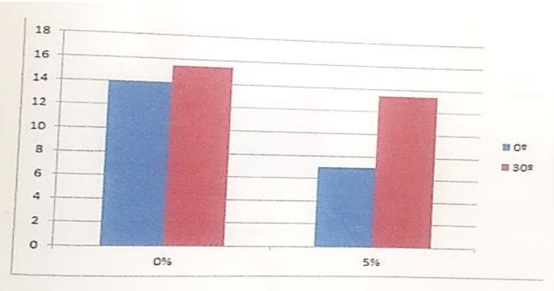
4.0 Compression test:

Compression test have been conducted as per ASTM E9 standard. The experiments have been conducted in UTM in a four column tool at room temperature and readings are tabulated and corresponding Bar chart are drawn as shown in the figure. Total four specimens are prepared with variation of Cenosphere 0 to 5 weight ratio and conducted the test, failure of specimen are shown in figure [8] and results are tabulated as shown in table [2].

Table [2]: Compression test results

SL No	Test	0% Cenosphere		5% Cenosphere	
		0^0	30^0	0^0	30^0
01	Ultimate Compression stress	13.964 N/mm^2	7.046 N/mm^2	15.407 N/mm^2	13.417 N/mm^2

Bar chart for compression test:



5.0 Results discussions:

From the table [1] and its bar chart shows that the Hybrid composite increases in tensile strength from 148.106 to 168.683N/mm^{2}for 0 degree, and from 58.5N/mm^2 to 77.946 N/mm^{2}for 30 degree orientation, it is felt found that when Cenosphereadded 0-5 weight percentage to the composite material, increases in tensile strength.

From the table [2] and corresponding bar chart shows that hybrid composite increases its compressive strength from 50 to 60 N/mm^2 for 0 degree and from 50 to 60N/mm^2 30 degree orientation, when cenosphere added 0-5 weight percentage to the composite material. From the results it is felt found that increase in compressive strength.

5.0 Conclusion:

Jute of bidirectional orientation and glass fibre of unidirectional orientation can successfully fabricated to form a Hybrid composite by suitably bonding with a resign. Effect of stacking sequence on tensile and compressive strength results indicates that the properties of Jute composites considerably improved by incorporation of glass fibre. There is a good dispensability of cenosphere filler on matrix, which improves the strength and work fracture of the composite. Inclusion of cenosphere to the hybrid composites felt found that improved in mechanical properties. Both layered and cenosphere filled hybrid jute-glass composites shows semi ductile response to solid particle erosion.

7.0 Recommendations:

In the present work combination of jute and glass fibre have been used to prepare the hybrid composite. The present methodo can be recommended to prepare hybrid composite by using other natural fibres like Bamboo, Sisal, etc and also can be recommended to use in engineering works like automobile bodies, construction etc.

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