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DEVELOPMENT OF COMPOSITE CHOPPED S GLASS WITH 360 GSM S-GLASS

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Abstract:

In aero application strength to weight ratio is the main factor to achieve the efficiency of an aircraft. If the structure materials are having high weight there will be some performance loss occurs, so that the researches are carried to reduce the weight of the aircrafts with the same strength. By using the composite material, it can be possible. Nowadays composite materials are used instead of aluminum, steel and other ferrous and non-ferrous materials. Because of its mechanical and physical properties are higher as compare to such ferrous and non-ferrous materials. In this paper the horizontal tail is designed by using S glass fiber with polyester and vinyl ester resin in 3:1 ratio. Tensile and compression tests are carried out over the test laminates. The test laminates are made with ASTM standards. As per the testing result, hardness, tensile and impact strengths of the composite material is higher than the alumni

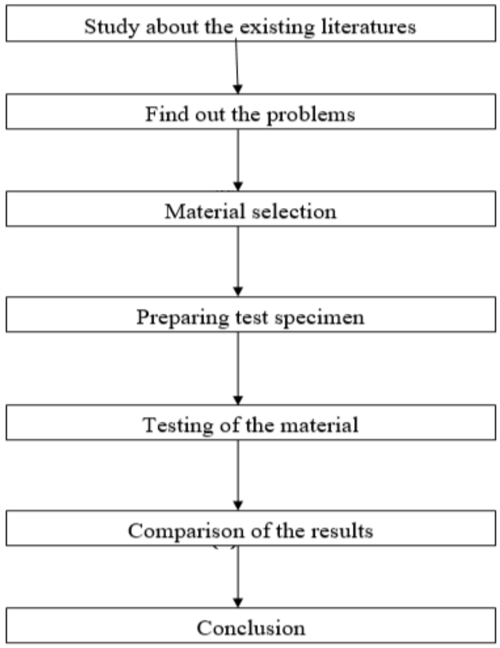
Introduction:

Nowadays fiber reinforcement polymer composites are gaining popularity and this polymer composites are finding ever increasing usage for a wide variety of industrial applications such a bearing material, cams, rollers, gears, wheels, pistons rings, mechanical seals, clutches etc. where their self-lubricating properties are exploited in order to avoid the need for any lubrication. In the past decade, many researchers made considerable efforts for better understanding the mechanical and tribological properties of polymer composites reinforced with different types of fibrous materials. In recent years, fiber Reinforced polymer composite has been the topic of interest in industries Such as aerospace and automotive industries. These polymer composites generally exhibit high levels of stiffness, high strength outstanding fatigue resistance, very impressive corrosion and wear resistance as compared to common metal/alloys, such as steel and aluminium alloys. Different parameters such as content of the reinforcement, shape, size and direction of reinforcement, type of the reinforcement and matrix, processing technique etc. can influence the properties of the polymer composites.

A composite material is a combination of two or more chemically different materials with a distinct interface between them. The constituent materials maintain their separate identities in the composite, yet their combination produces properties and characteristics that are superior to those of the constituents. One of the constituents forms a continuous phase and is called the matrix. The other major constituent is reinforcement in the form of fibers or particulates that is in general added to the matrix to enhance matrix properties. In most of the cases, reinforcement is harder, stronger and stiffer than the matrix.

The matrix material in a composite may be a polymer, a metal, or a Ceramic, depending on which composite materials are classified as polymer matrix composite (PMCs), metal matrix composite (MMCs), or ceramic matrix Composite (CMCs). Polymers are classified as thermo sets (epoxies, polyesters, phenolics, polyamide etc) and thermoplastics (polyethylene, polystyrene, polyether-ether-ketone (PEEK) etc). Examples of metal matrices are aluminium, magnesium and titanium and examples of ceramic matrices are alumina, calcium alumina silicate. Particulate reinforcements have dimensions that are approximately equal in all directions.

Methodology:



Materials Selection:

This section will give the comprehensive description of the materials that were used in our project. According to the literature survey materials and its reinforcement materials has been chosen for project. This subsequently entails the requirements and applications of different type of materials to meet this goal. The detailed description of all the materials is presented below.

Glass Fiber Reinforcement Polymer:

Fiberglass (US) or fibreglass (UK) is a common type of fiber-reinforced plastic using glass fiber. The fibers may be randomly arranged, flattened into a sheet (called a chopped strand mat), or woven into a fabric. The plastic matrix may be a thermoset polymer matrix - most often based on thermosetting polymers such as epoxy, polyester resin, or vinyl ester- or a thermoplastic. Cheaper and more flexible than carbon fiber,

It is stronger than many metals by weight, and can be molded into complex shapes. Applications include aircraft, boats, automobiles, bath tubs and enclosures, swimming pools, hot tubs, septic tanks, water tanks, roofing, pipes, cladding, casts, surfboards, and external door skins.

Fiber:

Unlike glass fibres used for insulation, for the final structure to be strong, the fiber's surfaces must be almost entirely free of defects, as these permits the gigapascal tensile strengths. If a bulk piece of glass were defect-free, it would be equally as strong as glass fibres; however, it is generally impractical to produce and maintain bulk material in a defect-free state outside of laboratory conditions.

Production:

The process of manufacturing fiberglass is called pultrusion. The manufacturing process for glass fibres suitable for reinforcement uses large furnaces to gradually melt the silica sand, limestone, kaolin clay, fluorspar, colemanite, dolomite and other minerals until a liquid form. It is then extruded through bushings, which are bundles of very small orifices (typically 5-25 micro meters in diameter for E-Glass, 9 micro meters for S- Glass). These filaments are then sized (coated) with a chemical solution. The individual filaments are now bundled in large numbers to provide a roving. The diameter of the filaments, and the number of filaments in the roving, determine its weight, typically expressed in one of two measurement systems:

- Yield, or yards per pound (the number of yards of fiber in one pound of material; thus, a smaller number means a heavier roving). Examples of standard yields are 225yield, 450yield, 675yield.
- Tax, or grams per km (how many grams 1 km of roving weighs, inverted from yield; thus, a smaller number means a lighter roving). Examples of standard tax are 750tex, 1100tex, 2200tex.

These rovings are then either used directly in a composite application such as pultrusion, filament winding (pipe), gun roving (where an automated gun chops the glass into short lengths and drops it into a jet of resin, projected onto the surface of a Mold), or in an intermediary step, to manufacture fabrics such as chopped strand mat (CSM) (made of randomly oriented small cut lengths of fibre all bonded together), woven fabrics, knit fabrics or unit-directional Fabri

Chopped Strand Mat:

Chopped strand mat or CSM is a form of reinforcement used in fiberglass. It consists of glass fibres laid randomly across each other and held together by a binder. It is typically processed using the hand lay-up technique, where sheets of material are placed on a Mold and brushed with resin. Because the binder dissolves in resin, the material easily conforms to different shapes when wetted out. After the resin cures, the hardened product can be taken from the Mold and finished. Using chopped strand mat gives a fiberglass with isotropic in-plane material properties.

Types of Glass Fiber:

Composition: the most common types of glass fibre used in fiberglass is E- glass, which is alumina-borosilicate glass with less than 1% w/w alkali oxides, mainly used for glass-reinforced plastics. Other types of glass used are A-glass (Alkali-lime glass with little or no boron oxide), E-CR-glass (Electrical/Chemical Resistance; alumina-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 fibres and insulation), D-glass (borosilicate glass, named for its low Dielectric constant), R-glass (alumina silicate glass without MgO and CaO with high mechanical requirements as Reinforcement), and S-glass (alumina silicate glass without Cao but with high MgO content with high tensile strength).

Applications:

Fiberglass is an immensely versatile material due to its light weight, inherent strength, weather-resistant finish and variety of surface textures. The development of fibre-reinforced plastic for commercial use was extensively researched in the 1930s. It was of particular interest to the aviation industry. A means of mass production of glass strands was accidentally discovered in 1932 when a researcher at Owens-Illinoi is directed a jet of compressed air at a stream of molten glass and produced fibres. After Owens merged with the Corning company in 1935, Owens Corning adapted the method to produce its patented "Fiberglas" (one "s"). A suitable resin for combining the "Fiberglas" with a plastic was developed in 1936 by du Pont. The first ancestor of modern polyester resins is Cyanamid's of 1942. Peroxide curing systems were used by then.

Types of Glass	Area of Application	Specifications
S-Glass	Tensile Strength	High Strength
E-Glass	Electrical	High Electrical Resistivity
C-Glass	Chemical	High Corrosion Resistance

Properties of Glass Fiber:

It has high tensile strength, elasticity and high resistant for abrasion and chemical reaction. The value of the other properties is given in table.

S.No	Properties	Values
1	Density	2.49 g/cm3
2	Tensile Strength	4.750x103Mpa
3	Young Modulus	89 Gpa
4	Poisson's Ratio	0.21

Experimental Setup:

ASTM Standards:

ASTM is an international standards and testing organization with headquarters in West Conshohocken, PA and offices in Belgium, Canada, China, Mexico and Washington, D.C. It was founded in 1898 by a group of Pennsylvania Railroad engineers and scientists, led by chemist Charles Benjamin Dudley, to address the frequent rail breaks in the fast-growing railroad industry. Originally called the "American Society for Testing and Materials", it changed its name to "ASTM International" in 2001. The association has more than 30,000 members, classified as users, producers, consumers and general interest. The latter are usually academics and consultants. ASTM develops and publishes technical standards that are arrived at through consensus and used on a voluntary basis for a wide variety of products, materials, systems and services. To date, some 12,000 ASTM standards are used around the world with 143 technical standard writing committees. The standards are developed in accordance with the guiding principles of the World Trade Organization which include "coherence, consensus, development dimensions, effectiveness, impartiality, openness, relevance and transparency." ASTM internal standards fall into six categories: Standard Specification, Standard Test Method, Standard Practice Guide, Standard Classification and Terminology Standard.

Specimen Preparation:

Description of Resin Transfer Method:

Matrixes/Resins are impregnated by hand into fibers which are in the form of chopped strand mat woven, knitted, stitched or bonded fabrics. This is usually accomplished by rollers or brushes, with an increasing use of nip-roller type impregnators for forcing resin into the fabrics by means of rotating rollers and a bath of resin. Laminates are left to cure under standard atmospheric conditions.

Materials Options:

Resins: Epoxy, polyester, vinyl ester, phenolic and any other resin.

Fibers: Glass, Carbon, Aramid and any other reinforcement, although heavy aramid fabrics can be difficult to wet-out by hand.

Advantages:

- Low capital Investment.
- Simple principles to fabricate the part.
- Low-cost tooling, if room-temperature cure resins are used.
- Wide choice of suppliers and material types.

Initially Mold for the test specimens is prepared. By this Mold mixed fibres and resins were filled and cured for some time. After curing the specimen did some machining process like cutting and grinding for achieve desired size for testing standards.

Introduction of Testing:

Metals testing is very important to show the various properties of metals and the defects which may found in it during production or during its service.

Classification of Metals Testing:

- Destructive Tests.
- Non-Destructive Tests.
- Technological Tests.
- Chemical Tests.
- Electrochemical Test (Corrosion Test).
- Metallographic Tests.

In the following the different classes of material tests will be discussed briefly.

Destructive Tests:

Destructive material tests are the kind of tests where the test specimen destroys after the test and could not be used. The test specimens for destructive tests can be a sample taken out from

- A piece of a semi-product (sheet, rod, section).
- A sample of the final products (bolts, shafts), or any simple structure.

Destructive Tests Are:

- Tensile Test
- Compression Test
- Bending Test
- Impact Test
- Creep Test, and Stress Relaxation Test.
- Fatigue Test

Tensile Test:

The ability to resist breaking under tensile stress is one of the most important and widely measured properties of materials used in structural applications. The force per unit area (MPa or psi) required to break a material in such a manner is the ultimate tensile strength or tensile strength at break. Tensile properties indicate how the material will react to forces being applied in tension. A tensile test is a fundamental mechanical test where a carefully prepared specimen is loaded in a very controlled manner while measuring the applied load and the elongation of the specimen over some distance. Tensile tests are used to determine the modulus of elasticity, elastic limit, elongation, proportional limit, and reduction in area, tensile strength, yield point, yield strength and other tensile properties. For the tensile test of GFRP composite is taken by universal testing machine FIE-UTN 40 with ASTM D3039- 76 standard. A 250mm x 25mm x 4mm specimen is used for a tensile test. Maximum operating load of the machine is 400KN.Figure represent the UTM.

Universal Testing Machines

The composite material GFRP where tested and results are tabulated.

S.No	Material	Tensile Strength (Mpa)	% of Elongation
1	GFRP	45	1.2

Impact Test:

An impact test is used to observe the mechanics that a material will exhibit when it experiences a shock loading that causes the specimen to immediately deform, fracture or rupture completely. To perform this test the sample is placed into a holding fixture with the geometry and orientation determined by the type of test that is used and then a known weight generally but not always in the shape of a pendulum is released from a known height so that it collides with the specimen with a sudden force. This collision between the weight and specimen generally results in the destruction of the specimen but the transfer of energy between the two is used to determine the fracture mechanics of the material That is called as impact test machine there is two types of impact testing machines widely used one is Izod and another one is Charpy

Impact Test Machine:

In this test, the impact behaviour of different GFRP composites is presented. The Impact test was carried out on Izod Impact testing machine, as per the ASTM standards. The test specimens are prepared as per ASTM D256. All specimens were subjected to Impact test and their values were reported. Above picture illustrates the specimen for Izod impact test with ASTM Standards dimensions.

The impact load for the material GFRP combinations was done and the results were tabulated.

S.No	Material	Impact Strength (Mpa)	Impact Energy (J/mm2)
1	GFRP	240	7.25

Hardness Test:

According to ASTM D 2583 standards for composites, the specimens were prepared for Rockwell-B hardness test, the specimen is of 25mmX25mmx10mm. Configuration and volume fraction are two important factors that affect the properties of the composite. In this test, the configuration is limited to unidirectional and continuous equal to the length of the specimen. For the harness test of Glass fibre composite had done using hardness testing machine.

Rockwell hardness testing Machin

Generally, fibres that increase the module of composites increase the hardness of the composite. This is because hardness is a function of the relative fibre volume and modulus.

S.No	Composition	Load (Kgf)	Rockwell Hardness Number (HRB)
1	GFRP	100	69

Conclusion:

The following conclusions are drawn based on the fabrication and testing of horizontal tail using S glass fiber along with polyester and vinylene resin. By replacing the aluminium with S-glass fiber, we can reduce the weight. Even though the cost of manufacturing is higher for fiber, by comparing the long-term results achieved by reduction in fuel consumption and increase in fuel efficiency, we can compensate or decrease the maintenance costs. According to the final result, composite material (S glass fiber) has high tensile and compressive strength than the aluminium. So, composite is better than the aluminium.

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