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Damage Tolerance of Composite Laminate Subjected to Stress - Corrosive Environment

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Abstract: This work provides an insight on very long-term degradation of polyester-fiber glass composites immersed more than 720h in saline medium under service stresses. Samples were loaded under bending conditions with stresses both in the elastic and plastic fields, with the result that characteristics in a flexural mode were able to be determined and the ensuing decrease in characteristics was fitted to an exponential model.

The degree of losses ranged from 28 to 35% for the flexural strength. The most notable losses were for specimens immersed in natural sea water under a continuous stress of some load, corresponding to the plastic behaviour of the material. Although the existence of matrix plasticization is doubtful, the osmotic effects of the diffusion on the matrix and the junction to the fibres, the presence of microcracks, and the effects of chemical ions in the medium on the surface fibre composition became evident in the strength degradation of the material.

This paper presents the recent trends in the mechanical characterization of composite systems exposed to sea water environments. First, a testing protocol for environmental effects has been developed for resin infused in-house fabricated laminates. Unidirectional ([0] and [90]) mechanical test samples were submerged in synthetic sea water at 24°C and 25°C, with the weight recorded at time intervals over the entire period.

The fatigue resistance of environmentally conditioned samples is reduced at high stress levels, but matches the un-conditioned samples at low stress levels. The flexural strength after period of time has been decreased whereas the water absorption has increased slightly.

I. INTRODUCTION

In recent times, light weight and high strength materials have been developed owing to soaring demands from industries and domestic applications. Most of the components of automobiles, aerospace, domestic appliances and packaging industries need waterproof, reasonably good strength and corrosion resistant materials to fight against environmental attack. Interior decorative materials, furnitures and fittings are also to be developed for better asthetic values. Under such circumstances, it is no doubt that polymeric composites play a very important role in such applications due to its light weight, high strength, moisture, crack and corrosion resistant properties.

Composite materials of a polymeric matrix reinforced with GFRP fiberglass permit the design of light pieces and equipment, resistant to loads. One of the most interesting qualities is that chemical resistance is achieved at an acceptable cost, and, in this respect, it proves superior to metals in many cases.

The applications related to a marine environment: sports materials, ship hulls, and naval, military, industrial, and commercial equipment are of increasing economic importance.

In exposures to aqueous and saline mediums, various effects and types of damage are presented, such as matrix plasticization, surface blistering, attack on the fiber, the matrix or the fiber–matrix interface, and internal tensions which increase the fragility of the material, as a consequence of the diffusion of sea water and the components dissolved within it.

There are few cases in which the modification of the mechanical characteristics is due to exposure to saline mediums and other types of service conditions under load. Articles dedicated to the study of exposure periods of over 720 hours are very scarce.

The main objective of our research project is to determine the effect of the prolonged exposure of GFRP materials made from polyester and glass fiber to a saline medium under bending load conditions, with regards to degradation under stress and to investigate the mechanical properties like tensile strength, compressive strength, stiffness, hardness, etc. and the age of glass fiber reinforced epoxy composites which is subjected to stress corrosive environment. The damage tolerance of the composite material is to be determined experimentally and compared with the theoretical values.

A. Motivation & History

1) Motivation

a) In recent times, light weight and high strength materials have been developed due to demands from industries and domestic application.

b) Due to high specific strength and high specific stiffness, Composites are widely used than other metal in aircraft and spacecraft structural parts (50-60)%.

c) Due to ease of availability of glass fibers at low cost, these will be used widely and manufacturing at bulk amount can be done.

d) Due to regular expose of aircraft or spacecraft or automobile on moisture content corrosive environment the age of composite material can be determined.

e) Due to high Damage tolerance and high corrosion resistance composites are used than other materials.

2) History: The use of natural composite materials has been a part of man's technology since the first ancient builder used straw to reinforce mud bricks. The 12th century Mongols made the advanced weapons of their day with archery bows that were smaller and more powerful than their rivals. These bows were composites structures made by combining cattle tendons, horn, bamboo and silk which bonded with natural pine resin. The tendons were placed on the tension side of the bow, the bamboo was used as a core and sheets of horn were laminated to the compression side of the bow. The entire structure was tightly wrapped with silk using the rosin adhesive. These 12th century weapons designers certainly understood the principles of composite design. In recent times some of these 700-year old museum pieces were strung and tested. They were about 80% as strong as modern composite bows. In the late 1800s canoe builders were experimenting with gluing together layers of kraft paper with shellac to form paper laminates. While the concept was successful, the materials did not perform well. Because the available materials were not up to the job, the idea faded. In the years between 1870 and 1890, a revolution was occurring in chemistry. The first synthetic (man-made) resins were developed which could be converted from a liquid to a solid by polymerization. These polymer resins are transformed from the liquid state to the solid state by crosslinking the molecules. Early synthetic resins included celluloid, melamine and Bakelite. Composites are no longer considered "space-age" materials utilized only for stealth bombers and space shuttles. This versatile material system has become a part of everyday life. In fact, composites are so widely used and in such varied of applications, the overall composites market had to be divided in the following major commercial segments to cover its thousands of products. The rapid development and use of composite materials started at the beginning of 1940s. When talking about history, one may conveniently speak of four generations of composites.

They are as follows:

a) The First Generation (1940s): Glass Fiber Reinforced Polymers (GFRPs): While it seems obvious that making whole components (wings, nosecones, helicopter rotors, etc.) out of these high strength materials would be the answer, this was not the solution. These materials, while strong, were also brittle. Because of this, when they failed, they did so catastrophically. The theoretical high strengths could be severely undermined by flaws in the material, such as a microcrack on the surface. Also, the stress-to-failure varied widely between what should have been identical components, because the number of flaws and their sizes were different for each manufactured piece. Since the number of flaws generally scales with the size of component, the only solution was to use short fibers of the high-strength materials to minimize the flaws in the system. But what use were short glass fibers? By themselves they seemed to be laboratory curiosities at most, with no real applications.

b) Second Generation (1960s): High Performance Composites in the post-Sputnik Era: GFRP technology spread rapidly in the 1950s. In France, a new Saint-Gobain factory in Chambery was opened in 1950 for the production of glass fibers; by 1958 they were producing composite helicopter blades for the Alouette II. Fiberglass-polyester was used to produce the sleek body of the Corvette sports car, and fiberblass-epoxy composites were used in applications ranging from printed circuit boards to Winchester shotgun barrels. However, new demands emerged for the military space programs and new fibers which prompted the search for new high modulus fibers. The conjunction of the world geopolitical situation and materials research prompted the emergence of a general notion of composites.

c) Third Generation: The Search for New Markets and for the Synergy of Properties (1970s & 1980s): Whereas space and aircraft demands had prompted the quest for new high modulus fibers in the 1960s, composites made with such expensive fibers had to find civil applications in the 1970s, when space and military demands declined. Sports and automobile industries became the more important markets. A new approach of materials design made possible by the use of computers favored the quest for a synergy of properties.

d) Fourth Generation (1990s): Hybrids and Nano composites: In the 1990s, both academic and industrial researchers started to extend the composite paradigm to smaller and smaller scales.
i) From the macroscopic scale to the molecular scale: Hybrid materials
ii) Toward the Nano scale: Nano composites

Composites had a direct impact on materials technology and indirectly reoriented materials science and engineering. Early aircraft were composite-based structures because they were built from wood, which is a composite material comprising of cellulose/lignin mixture that gives wood its excellent strength-to-weight performance and properties of resilience and damage resistance. However, wood is subjected to deterioration by moisture-induced decay and attack from fungal growths. By the 1930s, wooden aircraft structures began to be replaced by stressed-skin, monocoque aluminum alloy structures.

B. Types Of Composite Materials

In materials science, composite laminates are assemblages of layers of fibrous composite materials which can be joined to provide required engineering properties, including inplane stiffness, bending stiffness, strength, and thermal expansion. The individual layer consists of high-modulus, high-strength fibers in a polymeric, metallic, or ceramic matrix material.

Most fibers in use include graphite, glass, boron, and silicon carbide, and most of the matrix materials are epoxies, polyimides, aluminum, titanium, and alumina.

With the ongoing development of the high-tech industry, demand for advanced materials has led to the development of substitutes for traditional engineering materials (i.e., wood, aluminum, steel, concrete).

Composite materials have emerged as superior engineering materials due to attributes that are not attainable with existing engineering materials.

Due to these advantages, composite materials provide an opportunity for cost-efficient high performance in many weight-critical applications in spite of a product cost impediment compared with traditional materials.

Continuous fibers have long aspect ratios, while discontinuous fibers have short aspect ratios.

Continuous-fiber composites normally have a preferred orientation, while discontinuous fibers generally have a random orientation. Examples of continuous reinforcements include unidirectional, woven cloth, and helical winding, while examples of discontinuous reinforcements are chopped fibers and random mat. Continuous-fiber composites are often made into laminates by stacking single sheets of continuous fibers in different orientations to obtain the desired strength and stiffness properties with fiber volumes as high as 60 to70 percent.

Discontinuous-fiber composites are normally somewhat random in alignment, which dramatically reduces their strength and modulus. However, discontinuous-fiber composites are generally much less costly than continuous-fiber composites.

Therefore, continuous-fiber composites are used where higher strength and stiffness are required (but at a higher cost), and discontinuous- fiber composites are used where cost is the main driver and strength and stiffness are less important.

1) *Isotropic, Anisotropic, and Orthotropic Materials:* Materials can be classified as either isotropic or anisotropic. Isotropic materials have the same material properties in all directions, and normal loads create only normal strains. By comparison, anisotropic materials have different material properties in all directions at a point in the body. There are no material planes of symmetry, and normal loads create both normal strains and shear strains. A material is isotropic if the properties are independent of direction within the material. Bulk materials, such as metals and polymers, are normally treated as isotropic materials, while composites are treated as anisotropic. However, even bulk materials such as metals can become anisotropic—for example, if they are highly cold worked to produce grain alignment in a certain direction. Composites are a subclass of anisotropic materials that are classified as orthotropic. Orthotropic materials have properties that are different in three mutually perpendicular directions. They have three mutually perpendicular axes of symmetry, and a load applied parallel to these axes produces only normal strains. However, loads that are not applied parallel to these axes produce both normal and shear strains. Therefore, orthotropic mechanical properties are a function of orientation. Thus, when the fibers are aligned parallel (0°) or perpendicular (90°) to the direction of applied stress, the lamina is known as a *specially orthotropic lamina* ($\theta = 0°$ or 90°). A lamina that is not aligned parallel or perpendicular to the direction of applied stress is called a *general orthotropic lamina* ($\theta \neq 0°$ or 90°).

2) *Laminates:* When there is a single ply or a lay-up in which all of the layers or plies are stacked in the same orientation, the lay-up is called a *lamina*. When the plies are stacked at various angles, the lay-up is called a *laminate*. Continuous-fiber composites are normally laminated materials in which the individual layers, plies, or laminate are oriented in directions that will enhance the strength in the primary load direction. Unidirectional (0°) laminate are extremely strong and stiff in the 0° direction. However, they are very weak in the 90° direction because the load must be carried by the much weaker polymeric matrix. While a high-strength fiber can have a tensile strength of 500 ksi (3500 MPa) or more, a typical polymeric matrix normally has a tensile strength of only 5 to 10 ksi (35 to 70 MPa) . The longitudinal tension and compression loads are carried by the fibers, while the matrix distributes the loads between the fibers in tension and stabilizes the fibers and prevents them from buckling in compression. The matrix is also the primary load carrier for inter-laminar shear (i.e., shear between the layers) and transverse (90°) tension. Because the fiber orientation directly impacts mechanical properties, it seems logical to orient as many of the layers as possible in the main load-carrying direction. While this approach may work for some structures, it is usually necessary to balance the load-carrying capability in a number of different directions, such as the 0°, +45°, -45°, and 90° directions. A balanced laminate having equal numbers of plies in the 0°, +45°, –45°, and 90° degrees directions is called a *quasi-isotropic laminate*, because it carries equal loads in all four directions.
3) *Composites versus Metallics:* As previously discussed, the physical characteristics of composites and metals are significantly different. Because composites are highly anisotropic, their in-plane strength and stiffness are usually high and directionally variable, depending on the orientation of the reinforcing fibers. Properties that do not benefit from this reinforcement (at least for polymer matrix composites) are comparatively low in strength and stiffness. Metals typically have reasonable ductility, continuing to elongate or compress considerably when they reach a certain load (through yielding) without picking up more load and without failure. Two important benefits of this ductile yielding are that (1) it provides for local load relief by distributing excess load to an adjacent material or structure; therefore, ductile metals have a great capacity to provide relief from stress concentrations when statically loaded; and (2) it provides great energy-absorbing capability (indicated by the area under a stress-strain curve). As a result, when impacted, a metal structure typically deforms but does not actually fracture. In contrast, composites are relatively brittle. The brittleness of the composite is reflected in its poor ability to tolerate stress concentrations. The characteristically brittle composite material has poor ability to resist impact damage without extensive internal matrix fracturing. The response of damaged composites to cyclic loading is also significantly different from that of metals. The ability of composites to withstand cyclic loading is far superior to that of metals, in contrast to the poor composite static strength when it has damage or defects.

C. Advantages And Disadvantages

1) Advantages

a) A higher performance for a given weight leads to fuel savings. Excellent strength-to weight and stiffness-to-weight ratios can be achieved by composite materials. This is usually expressed as strength divided by density and stiffness (modulus) divided by density. These are so-called "specific" strength and "specific" modulus characteristics.
b) Laminate patterns and ply buildup in a part can be tailored to give the required mechanical properties in various directions
c) It is easier to achieve smooth aerodynamic profiles for drag reduction. Complex double-curvature parts with a smooth surface finish can be made in one manufacturing operation. 4. Part count is reduced.
d) Production cost is reduced. Composites may be made by a wide range of processes.
e) Composites offer excellent resistance to corrosion, chemical attack, and outdoor weathering; however, some chemicals are damaging to composites (e.g., paint stripper),and new types of paint and stripper are being developed to deal with this. Some thermoplastics are not very resistant to some solvents.

2) Disadvantages

a) Composites are more brittle than wrought metals and thus are more easily damaged. Cast metals also tend to be brittle.
b) Repair introduces new problems, for the following reasons: Materials require refrigerated transport and storage and have limited shelf lives. . Hot curing is necessary in many cases, requiring special equipment. Curing either hot or cold takes time. The job is not finished when the last rivet has been installed.
c) If rivets have been used and must be removed, this presents problems of removal without causing further damage.
d) Repair at the original cure temperature requires tooling and pressure.
e) Composites must be thoroughly cleaned of all contamination before repair.
f) Composites must be dried before repair because all resin matrices and some fibers absorb moisture.

II. LITERATURE SURVEY

A. *Performance of Composite Materials Subjected to Salt- Water Environment*

Author: *David Miller, John F. Mandell, Daniel D. Samborsky, Bernadette A. Hernandez-Sanchez and D. Todd Griffith*

This paper presents the recent trends in the mechanical characterization of composite systems under consideration for Marine Hydro Kinetic (MHK) applications exposed to salt water environments. Tensile fatigue resistance was also measured at room temperature for the 0° samples. These results show trends of reduced tensile and compressive strength with increasing moisture and temperature in the 0° (longitudinal) direction.

1) *Weight Gain for Conditioned Samples:* The weight gain for epoxy samples conditioned at 40°C, and indicates that the samples are approaching an equilibrium moisture content at 1000 hours. However, the thicker samples, have lower moisture absorption and have not reached saturation. Initial testing protocol was to remove sample after 1000 hrs at 40°C and store in synthetic sea water at 20°C until testing. These mechanical results are presented later as complete and partial saturation. This study was performed on a variety of neat material and fiber layup orientations.
2) *Effects of Conditioning on Material Strength and Fatigue Life:* The samples were tested in both the fully saturated and partially saturated conditions. Due to the long times required for full saturation to occur in the thicker samples, full saturation data is not yet available for the 6-ply samples. However, testing of saturated samples has been completed both statically and cyclically for thinner samples. The ultimate tensile strength for samples is a function of test temperature and moisture content. These results show trends of reduced tensile strength with increasing moisture and temperature in the 0degree direction. These results show that as the applied stress decreases, the influence of the moisture uptake is diminished. This result implies that the fatigue life of a saturated composite is only affected at areas of high stress. Samples tested in tension and compression show that the tensile strength is little affected by temperature or moisture, but the compressive strength is reduced by both. Samples conditioned in the Salt Water chamber showed little uptake in moisture and little drop in material properties. The thinner samples had a 0.31% mass increase while the thicker samples had a 0.24% mass increase.
3) *Microstructural and Chemical Inspection:* SEM and EDS mapping was performed to determine the extent of NaCl water diffusion into the uncoated coupons during salt water exposure. Four sample types were analyzed and included: (a) an untreated coupon for baseline measurements, (b) 2 mm miscellaneous samples , (c) 6 mm miscellaneous samples, and (d) an epoxy resin. Cross-sections were removed from the middle and end locations and the EDS mapping areas. The configurations of the fiberglass were embedded within the epoxy resins. Flecks of NaCl crystals could be found on the exposed side and surface of the coupons. For our mapping analysis, the spectra obtained from these areas were compared and normalized to identify if significant NaCl diffusion was occurring during exposure. The EDS baseline measurements from the unexposed coupon and from the epoxy resin both revealed the presence of Na and Cl. The exposed side has a stronger signal than the epoxy resin. Trace amounts are expected since epoxy polymerization often uses chlorinated precursors and NaOH to catalyze the reaction in the presence of amine-based cross linkers. The thickness of each sample was measured to get an estimate of diffusion depth for the Na and Cl. Upon examining all the different regions from coupons, it was found that the epoxy naturally contains some presence of Na and Cl. Analysis on both the end and middle sections does not indicate an increase in the Na or Cl content within the unexposed regions of the samples. However, this analysis would only see crystals on exposed edges. Based on our test, the exposure conditions did not allow for any significant NaCl diffusion within the sample as verified by the EDS analysis.

B. *Effects of Alkaline and acid Solutions on glass/epoxy Composites*

Author: *A.M. Amaro, P.N.B. Reis, M.A. Neto, C. Louro*

This work studied the flexural and low velocity impact response of a glass fibre/epoxy composite after immersion in hydrochloric acid (HCl) and sodium hydroxide (NaOH). It was concluded that the corrosive environmental affects significantly the flexural strength and flexural modulus. The exposure time was determinant on the mechanical properties degradation.

The alkaline solution shows to be more aggressive than the acid solution, promoting the lowest flexural properties. Complementary tests were carried and the ultramicroindentation shows a decrease of the matrix mechanical properties. The roughness increases with the exposure time and is higher for the samples immersed in NaOH solutions. In terms of impact it was concluded that the resistance of the laminates to repeated low velocity impacts is very dependent of the corrosive environment and the exposure time. The alkaline solution shows to be more aggressive than the acid solution, promoting the lowest impact resistance. The maximum load decreases with the impact numbers, however, the contact time and displacement presents the inverse tendency. The elastic energy decreases also with the impact numbers and, consequently, the damaged area increases. The impact bending stiffness showed to be an important property to assess the damage resistance of composites.

C. Effects of Long-term Exposure on E-glass Composite Material Subjected To Stress Corrosion In A Saline Medium

Author: *F. Segovia, M.D. Salvador, O. Sahuquillo and A. Vicente*

This work provides an insight on very long-term degradation of polyester-fiber glass composites immersed more than 30,000 h in saline medium under service stresses. Samples were loaded under bending conditions with stresses both in the elastic and plastic fields, with the result that characteristics in a flexural mode were able to be determined and the ensuing decrease in characteristics was fitted to an exponential model. The degree of losses ranged from 25 to 31% for the bending modulus, from 28 to 35% for the flexural strength, and from 40 to 51% for the specific fracture energy. The most notable losses were for specimens immersed in artificial sea water under a continuous stress of 140 MPa, corresponding to the plastic behavior of the material. Although the existence of matrix plasticization is doubtful, the osmotic effects of the diffusion on the matrix and the junction to the fibers, the presence of microcracks, and the effects of chemical ions in the medium on the surface fiber composition became evident in the strength degradation of the material.

Prolonged exposure to saline media which imitates sea water produces significant deteriorations in the mechanical properties of the composite materials of polyester and fiberglass. These losses increase in the elastic modulus order by 25%, in flexural strength by 28%, and with regard to specific fracture energy by 40%. All this indicates that the reduction in the properties is mainly due to the degradation of the matrix–fiber bonding. This is helped by the existence of internal tensions in this area, by the osmotic effect which produces the presence of water which is mainly distributed by hydrolytic attack on the matrix–fiber bonding, primarily on the fiber. This process is stimulated by the presence of microcracks in the matrix. The degradation mechanism such as hydrolysis of the acid groups in the polyester and chemical attack to the fiber occur and it is also very important.

III. FABRICATION AND MACHINING

A. Materials Used

1) *C-Channel:* These are the devices used to apply service stress (load) to the samples. Mild steel contains approximately 0.05–0.25% carbon making it malleable and ductile. Mild steel has a relatively low tensile strength, but it is cheap and easy to form; surface hardness can be increased through carburizing. It is often used when large quantities of steel are needed, for example as structural steel. For ASTM 790D-86, the test is stopped when the specimen reaches 5% deflection or the specimen breaks before 5%. For ISO 178, the test is stopped when the specimen breaks. Of the specimen does not break, the test is continued as far a possible and the stress at 3.5% (conventional deflection) is reported.
2) *Composite Laminate:* E-glass was chosen because the E-glass fibre is known to be highly susceptible to stress-corrosion cracking when exposed to acids. Epoxy used is LY556 and hardener HY951. Steel roller were used to consolidate the laminate and to remove the entrapped air. Dead weights (20kg) was used for loading.
3) *E-Glass Fibre*

a) *Background:* E-Glass or electrical grade glass was originally developed for stand off insulators for electrical wiring. It was later found to have excellent fibre forming capabilities and is now used almost exclusively as the reinforcing phase in the material commonly known as fibreglass.

b) *Fibre Manufacture:* Glass fibres are generally produced using melt spinning techniques. These involve melting the glass composition into a platinum crown which has small holes for the molten glass to flow. Continuous fibres can be drawn out through the holes and wound onto spindles, while short fibres may be produced by spinning the crown, which forces molten glass out through the holes centrifugally. Fibres are cut to length using mechanical means or air jets. Fibre dimension and to some extent properties can be controlled by the process variables such as melt temperature (hence viscosity) and drawing/spinning rate. The temperature window that can be used to produce a melt of suitable viscosity is quite large, making this composition suitable for fibre forming.As fibres are being produced, they are normally treated with sizing and coupling agents. These reduce the effects of fibre-fibre abrasion which can significantly degrade the mechanical strength of the individual fibres. Other treatments may also be used to promote wetting and adherence of the matrix material to the fibre.

c) *Composition:* E-Glass is a low alkali glass with a typical nominal composition of SiO_2 54wt%, Al_2O_3 14wt%, CaO+MgO 22wt%, B_2O_3 10wt% and Na_2O+K_2O less then 2wt%. Some other materials may also be present at impurity levels.

d) *Key Properties:* Properties that have made E-glass so popular in fibreglass and other glass fibre reinforced composite include:

- Low cost
- High production rates
- High strength,

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- High stiffness
- Relatively low density
- Non-flammable
- Resistant to heat
- Good chemical resistance
- Relatively insensitive to moisture
- Able to maintain strength properties over a wide range of conditions
- Good electrical insulation

4) *EPOXY LY556:* Araldite LY556 is an epoxy resin based on Bisphenol -A suitable for high performance composite FRP applications. Its has good fibre impregnation properties excellent mechanical, dynamic and thermal properties.

Fig. No.3.1 EPOXY LY556

5) *Hardener HY951:* Hardener HY 951 used is a two component, low viscosity, unfilled epoxy casting resin system. It is generally used for curing at room temperature. It has following features:-

a) Good mechanical strength
b) Good resistance to atmospheric to atmospheric and chemical degradation
c) Excellent electrical properties

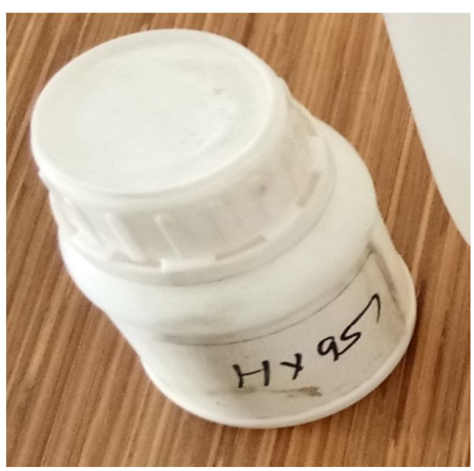

FIG. No.3.2 HARDENER HY951

6) *Wax:* Waxes are a diverse class of organic compounds that are hydrophobic,, malleable solids near ambient temperatures. They include higher alkanes and lipids typically with melting points above about 40 °C (104 °F), melting to give low viscosity liquids. Waxes are insoluble in water but soluble in organic, nonpolar solvents. Natural waxes of different types are produced by plants and animals and occur in petroleum.

FIG. No.3.3 WAX

7) *Steel Roller:* A steel roller is a roller that is defined by having a track made of steel. Steel have earned immense popularity in the past 50 years throughout the world.Tthe steel roller can provide a taller, smoother, and faster ride with more inversions than a traditional wooden roller.

Fig. No.3.4 Steel Roller

8) *Acetone:* Acetone (systematically named propanone) is the organic compound with the formula$(CH_3)_2CO$.[12] It is a colorless, volatile, flammable liquid, and is the simplest ketone. Acetone is miscible with water and serves as an important solvent in its own right, typically for cleaning purposes in the laboratory. About 6.7 million tonnes were produced worldwide in 2010, mainly for use as a solvent and production of methyl methacrylate and bisphenol It is a common building block in organic chemistry. Familiar household uses of acetone are as the active ingredient in nail polish remover, and as paint thinner.

FIG.No.3.5 ACETONE

9) *Mylar Sheet:* Mylar is often used to generically refer to polyester film or plastic sheet. However, it is a registered trademark owned by Dupont Tejjin Films for a specific family of plastic sheet products made from the resin Polyethylene Terephthalate (PET). The true generic term for this material is Polyester Film or Plastic Sheet.

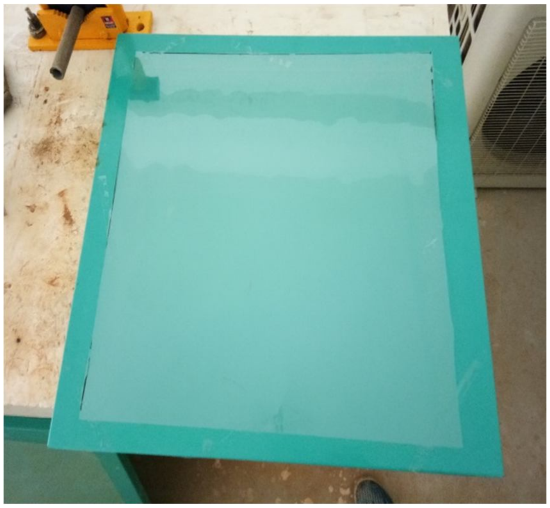

Fig. No.3.6 mylar sheet

10) *Sea Water:* Seawater pH is typically limited to a range between 7.5 and 8.4. Seawater in the world's oceans has a salinity of approximately 3.5%.

Fig. No.3.7 Sea Water

B. Fabrication

1) Overview

a) Hand moulding technique is applied to manufacture the composite laminates. Hand layup is an open moulding method suitable for making a wide variety of composites products from very small to very large.
b) Mylar sheet is first applied to the mould for a high quality surface.
c) Wax polish is used to ensure that the Mylar sheet gets separated easily from the fabricated composite.
d) Epoxy resin is applied on the fibres thoroughly by brushing.
e) Fiberglass reinforcement is manually placed on the mould.
f) Steel rollers are used to consolidate the laminate, thoroughly wetting the reinforcement and removing entrapped air.
g) Certain load (20kg) is applied on the fabricated material.
h) Then the Mylar sheets were detached and the composite laminates were removed.

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2) *C-Channel:* These are the devices used to apply service stress (load) to the samples. The test specimens were cut according to the ASTM 790D-86, with a length of 145mm, a width of 24.5mm, and with 3.2mm of thickness. The length between supports was fixed at 113.0mm and the testing velocity at 5.0mm/min.
3) *Detailed Design / Fabrication Of Model Name*
a) Hand layup technique was applied to manufacturing of the composite laminates.

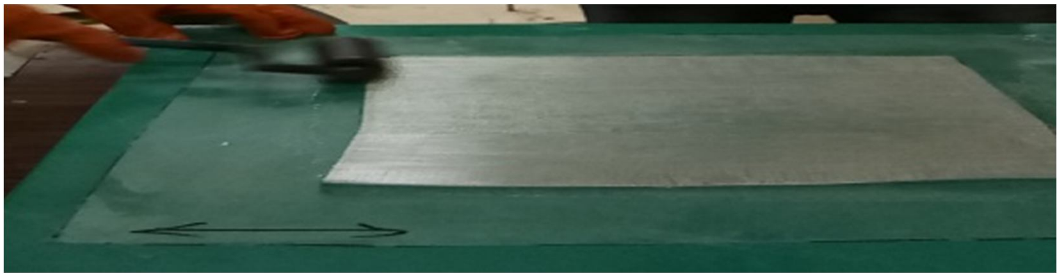

Fig. No.3.8 hand layup technique

b) Epoxy LY556 and Hardner-HY951 were mixed in a ratio of 10:1 and was used for the matrix.

Fig. No.3.9 epoxy ly556 and hardener-hy951 preparation

c) Unidirectional plain weave E-glass of 0.25mm thickness was selected for glass reinforcements having orthonormal orientation (0/90 degree).

Fig. No.3.10 unidirectional plain weave

d) Mylar sheets were used as a mould-releasing agent.

Fig. No.3.11 mylar sheets as mould releasing agent

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e) Wax polish was applied on the Mylar sheet. The Mylar sheets were completely wetted by epoxy resin.

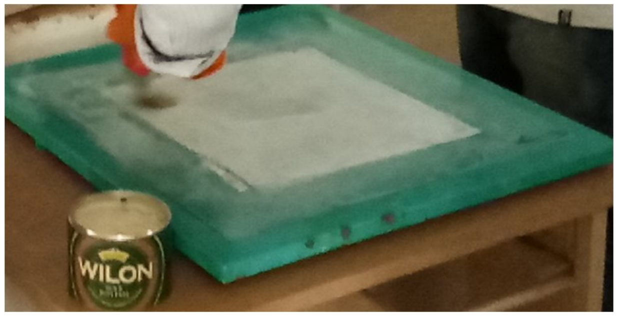

Fig. No.3.12 application of wax

f) The glass fibres mat (300*300mm) of 12 layers with appropriate epoxy resin in between each layer was placed on the sheet.

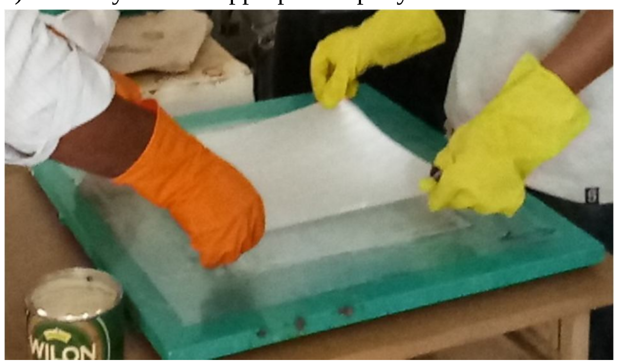

Fig.No.3.13 Placing Of Glass Fabric Over Myler Sheet

g) By using rollers, rolling was done on the glass fibres and the Mylar sheets to remove voids.

Fig. No.3.14 use of rollers

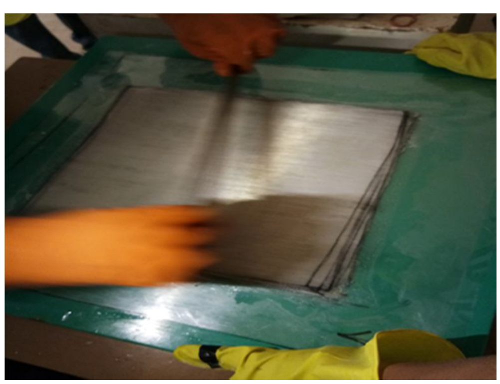

Fig.no. 3.15 use of steel scale to remove air bubbles

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h) The composite laminate was kept for 15-24 hours for curing at room temperature under application of pressure by dead weights (20 Kg).

i) Then the Mylar sheets were detached and the composite laminates were removed.

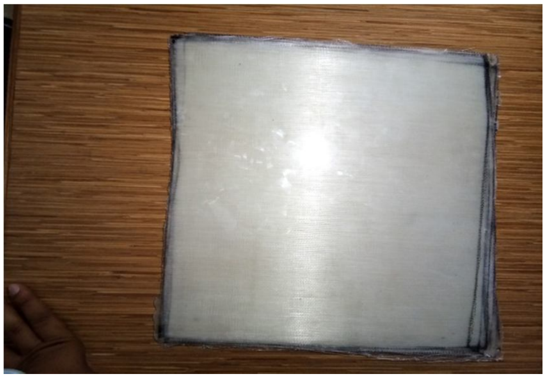

Fig. No.3.16 specimen after dead weight is removed

j) Then the specimen was prepared according to the dimension by water jet cutting.

Fig. No.3.17 specimen after water jet cutting

C. Machining

1) *Water Jet Cutting:* A water jet cutter, also known as a water jet or waterjet, is an industrial tool capable of cutting a wide variety of materials using a very high-pressure jet of water, or a mixture of water and an abrasive substance. The term abrasive jet refers specifically to the use of a mixture of water and abrasive to cut hard materials such as metal or granite, while the terms pure waterjet and water-only cutting refer to waterjet cutting without the use of added abrasives, often used for softer materials such as wood or rubber. Waterjet cutting is often used during fabrication of machine parts. It is the preferred method when the materials being cut are sensitive to the high temperatures generated by other methods. Waterjet cutting is used in various industries, including mining and aerospace, for cutting, shaping, and reaming.

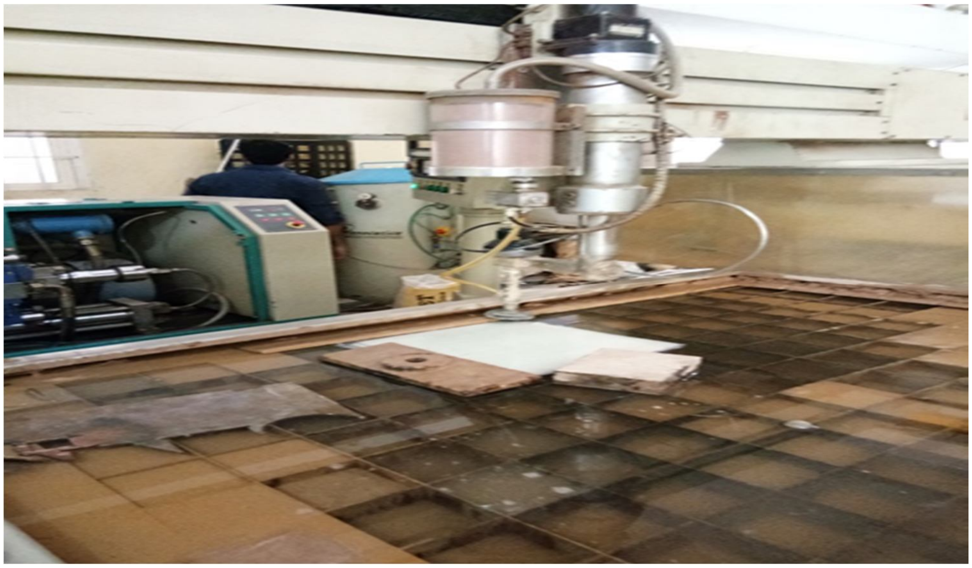

Fig. No.3.18 water jet cutting

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a) *Operation:* All waterjets follow the same principle of using high pressure water focused into a beam by a nozzle. Most machines accomplish this by first running the water through a high pressure pump. There are two types of pumps used to create this high pressure; an intensifier pump and a direct drive or crankshaft pump. A direct drive pump works much like a car engine, forcing water through high pressure tubing using plungers attached to a crankshaft. An intensifier pump creates pressure by using hydraulic oil to move a piston forcing the water through a tiny hole.The water then travels along the high pressure tubing to the nozzle of the waterjet. In the nozzle, the water is focused into a thin beam by a jewel orifice. This beam of water is ejected from the nozzle, cutting through the material by spraying it with the jet of high-speed water. The process is the same for abrasive waterjets until the water reaches the nozzle. Here abrasives such as garnet and aluminium oxide, are fed into the nozzle via an abrasive inlet. The abrasive then mixes with the water in a mixing tube and is forced out the end at high pressure.
b) *Benefits:* An important benefit of the water jet is the ability to cut material without interfering with its inherent structure, as there is no heat-affected zone (HAZ). Minimizing the effects of heat allows metals to be cut without harming or changing intrinsic properties. Water jet cutters are also capable of producing intricate cuts in material. With specialized software and 3-D machining heads, complex shapes can be produced. Due to its relatively narrow kerf, water jet cutting can reduce the amount of scrap material produced, by allowing uncut parts to be nested more closely together than traditional cutting methods.
2) *Welding:* Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing fusion, which is distinct from lower temperature metal-joining techniques such as brazing and soldering, which do not melt the base metal. In addition to melting the base metal, a filler material is typically added to the joint to form a pool of molten material (the weld pool) that cools to form a joint that is usually stronger than the base material. Pressure may also be used in conjunction with heat, or by itself, to produce a weld.
3) *Fabricated Model*
a) +C-Channel fabrication

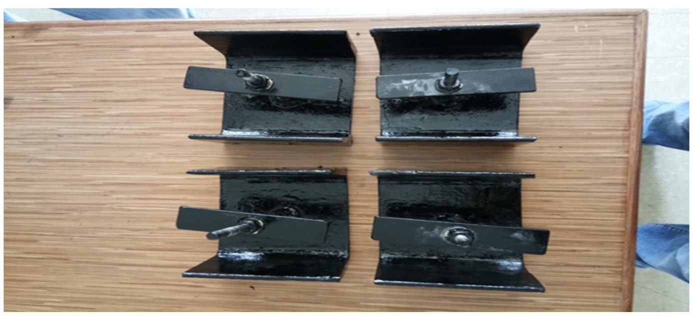

Fig. No.3.19 c-channel fabrication

IV. METHODOLOGY

A. *C-Channel Prepration*

C-Section is made with C-channel Beam of 5inch ie.113mm apart and according to required dimension Cutting has been done at WorkShop. After that a nut and bolt set has been welded at centre of C-Channel. Finally a thick plate with point load has been inserted at the top of nut-bolt assembly and allow to press specimen with its point edges as shown in figure.Full C-channel assembly has been coated by water resistance coating inorder to prevent C-channel from rust formation or corrosion.

Fig. No.4.1 c-channel preparation

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B. Submurging Specimen In Water

Composite specimen or sample of required dimension is made by fabrication of composite laminate by Hand-Lay Up process and followed by Water jet Cutting Machining process.

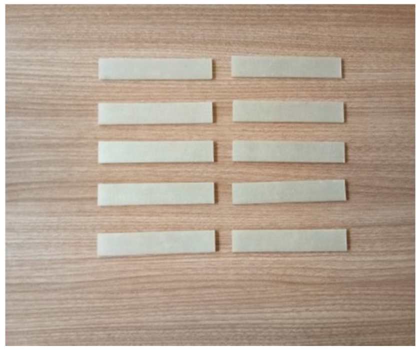

Fig. No.4.2 specimen completed

Deflection test is done in Structure lab applying load by point load as shown in figure.Dial gauge shows reading of deflection where as Load Cell indicate load in Kgs.The setup is arranged in such away that load is applied on middle of specimen.

Fig. No.4.3 dial gauge and deflection test

Table No.4.1:LOAD VS DEFLECTION TEST

S.N.	Load(kgs)	Deflection(mm)
1	0.5	0.37
2	2.5	0.97
3	4.5	1.48
4	6.5	1.96
6	10.5	2.82
7	12.5	3.26
8	14.5	3.63
9	16.5	4.12
10	18.5	4.57

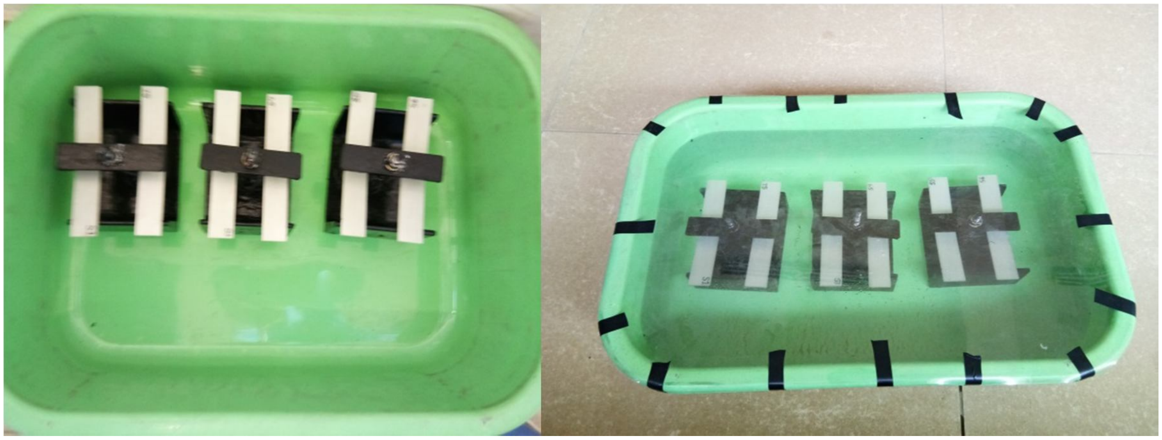

Fig. No.4.4 specimen submerged in sea water

After fixing constand load to every specimen by applying same deflection in all batches by help of dial gauge and avobe tabulation. Fix 4.57mm deflection and 18.5 kgs point load in all specimen.After that put all batches of C-channel inside Sea Water and covered by Myler sheet as shown in figure below.Myler sheet covering protects dust to enter inside water.

Take out one batch 2 specimen from water after 10 days,20 days and 30 days and then go to Metallurfgical lab for testing.Take Standard specimen for testing to compare with other days specimen result and Finally analyse it from result output.

V. TESTING & REPORTS

A. Digital Universal Testing Machine

Fig. No.5.1 digital ultimate testing machine

Digital Universal Testing Machines Capacity 100 kN - 2000 kN Mechanical, Electronic & Computerized versions available Capable of tensile, compression bend & shear tests. It is used to test the tensile strength ,flexular strength and compressive strength of materials The "universal" part of the name reflects that it can perform many standard tensile and compression tests on materials, components, and structures (in other words, that it is versatile).

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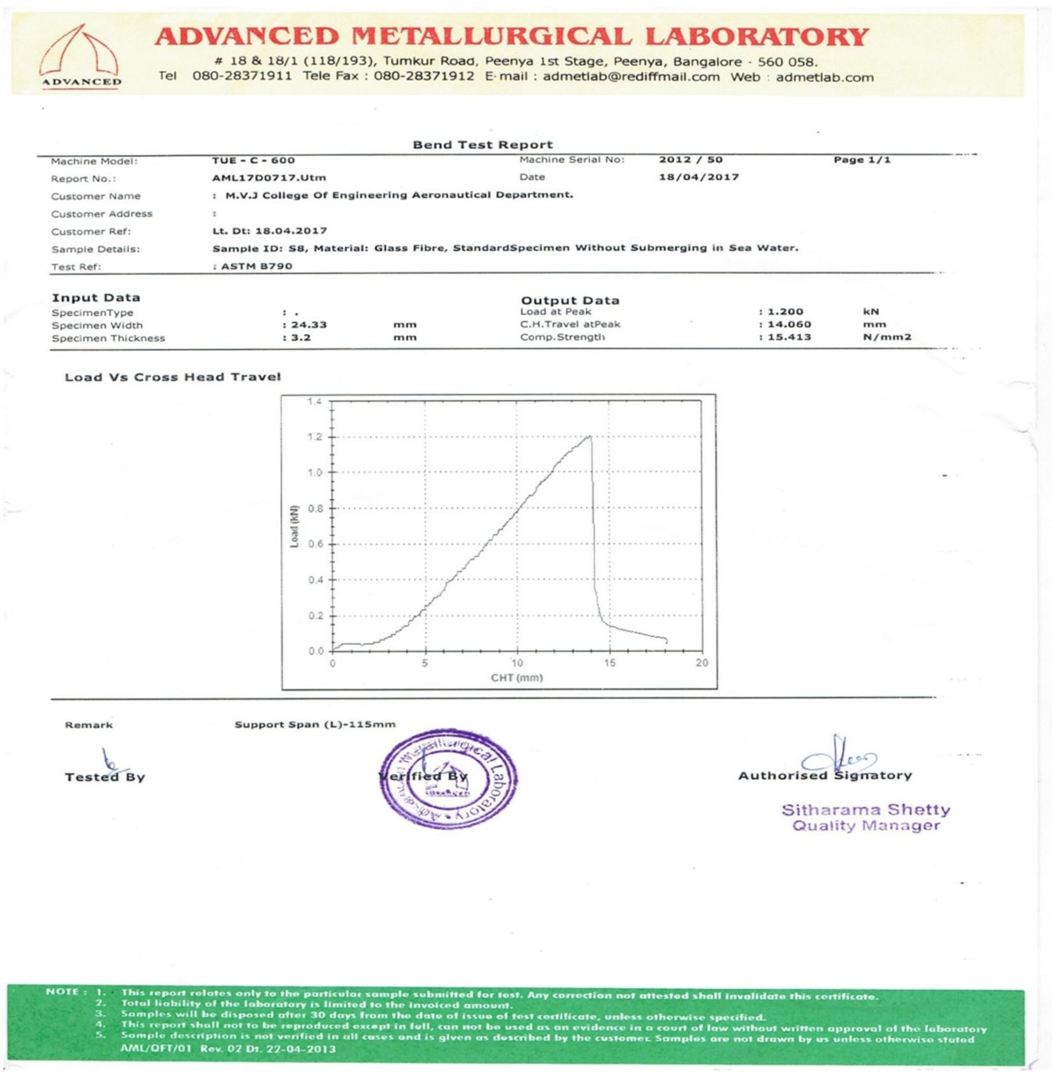
1) *Salient Features*
a) Windows Based Click and Go Software Package.
b) Supports Tensile, Compression, Bending and many more Tests.
c) Confirms BIS 1825 - 1991 and ISO - 7500 – 1986
d) Standard / Customer defined reports
e) Compensated for main screw clearances and frame stiffness.
f) Extensive Database support.

B. Lab Reports

Lab Reports are collected from ADVANCE METALLURGICAL LABORATORY which is situated at Tumkur Main Road, Peenya Bangalore. It is a reknown laboratory for material testing where testing of composites, metals, ceramics are done. Different test like Tensile, Compressive, Flexular tests are being carried out over there. Here following are the lab reports of flexular testing by 3-ponit testing method has been done.

1) Standard Sample Reports (Unsubmerged)
2) 10 days submerged report
3) 20 days submerged report
4) 30 days submerged report

These reports are given below:



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Tel 080-28371911 Tele Fax : 080-28371912 E-mail : admetlab@rediffmail.com Web : admetlab.com

Bend Test Report

Machine Model:	TUE - C - 600	Machine Serial No:	2012 / 50	Page 1/1
Report No.:	AML17D0717.Utm	Date	18/04/2017	
Customer Name	: M.V.J College Of Engineering Aeronautical Department.			
Customer Address	:			
Customer Ref:	Lt. Dt: 18.04.2017			
Sample Details:	Sample ID: S8, Material: Glass Fibre, StandardSpecimen Without Submerging in Sea Water.			
Test Ref:	: ASTM B790			

Input Data			Output Data		
SpecimenType	: .		Load at Peak	: 1.200	kN
Specimen Width	: 24.33	mm	C.H.Travel atPeak	: 14.060	mm
Specimen Thickness	: 3.2	mm	Comp.Strength	: 15.413	N/mm2

Load Vs Cross Head Travel

Remark Support Span (L)-115mm

Tested By Verified By Authorised Signatory

Sitharama Shetty
Quality Manager

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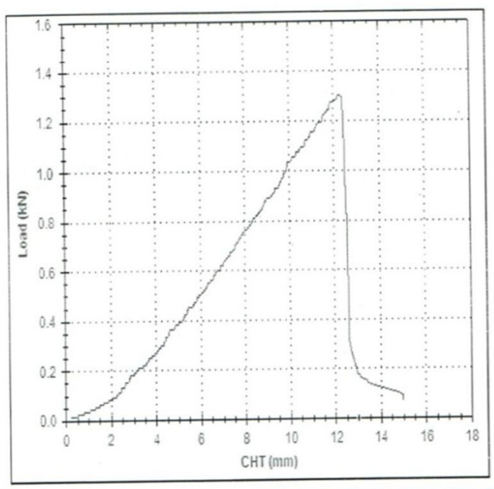
Bend Test Report

Machine Model:	TUE - C - 600	Machine Serial No:	2012 / 50	Page 1/1
Report No.:	AML17D0718.Utm	Date	18/04/2017	
Customer Name	: M.V.J College Of Engineering Aeronautical Department.			
Customer Address	:			
Customer Ref:	Lt. Dt: 18.04.2017			
Sample Details:	Sample ID: S9, Material: Glass Fibre, StandardSpecimen Without Submerging in Sea Water.			
Test Ref:	: ASTM B790			

Input Data			Output Data		
SpecimenType	: .		Load at Peak	: 1.300	kN
Specimen Width	: 24.36	mm	C.H.Travel atPeak	: 12.340	mm
Specimen Thickness	: 3.3	mm	Comp.Strength	: 16.172	N/mm2

Load Vs Cross Head Travel



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Quality Manager

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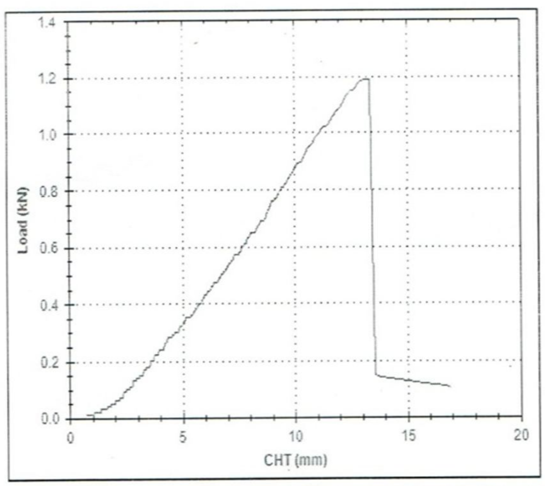
Machine Model:	TUE - C - 600	Machine Serial No:	2012 / 50	Page 1/1
Report No.:	AML17D0719.Utm	Date	18/04/2017	
Customer Name	: M.V.J College Of Engineering Aeronautical Department.			
Customer Address	:			
Customer Ref:	Lt. Dt: 18.04.2017			
Sample Details:	Sample ID: S1, Material: Glass Fibre, After 10 Days Submerged in Sea Water.			
Test Ref:	: ASTM B790			

Input Data			Output Data		
SpecimenType	: .		Load at Peak	: 1.190	kN
Specimen Width	: 24.1	mm	C.H.Travel atPeak	: 13.470	mm
Specimen Thickness	: 3.05	mm	Comp.Strength	: 16.189	N/mm2

Load Vs Cross Head Travel



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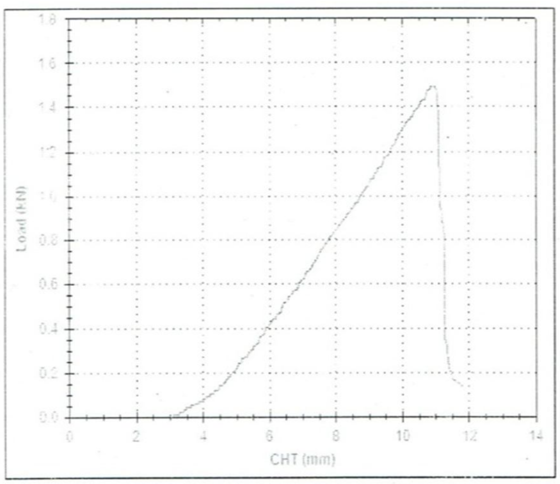
Bend Test Report

Machine Model:	TUE - C - 600	Machine Serial No:	2012 / 50	Page 1/1
Report No.:	AML17D1286.Utm	Date	03/05/2017	
Customer Name	: M.V.J College Of Engineering Aeronautical Department.			
Customer Address	:			
Customer Ref:	Lt. Dt: 25.04.2017			
Sample Details:	Sample ID: S3, Material: Glass Fibre, Material Submerging in Sea Water For 20 Days.			
Test Ref:	: ASTM D790			

Input Data			Output Data		
SpecimenType	: .		Load at Peak	: 1.490	kN
Specimen Width	: 24.5	mm	C.H.Travel atPeak	: 11.040	mm
Specimen Thickness	: 3.3	mm	Comp.Strength	: 18.429	N/mm2

Load Vs Cross Head Travel



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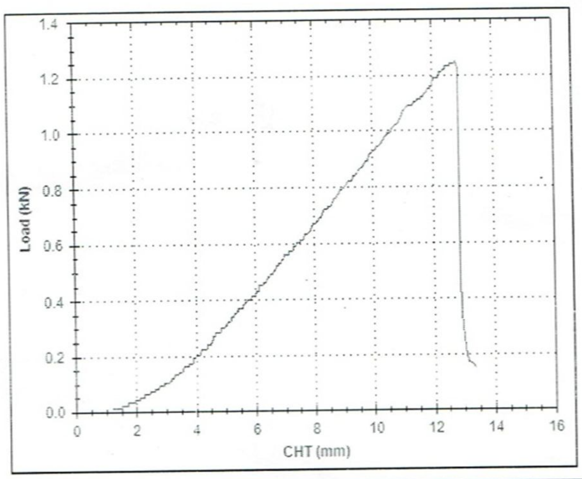
Machine Model:	TUE - C - 600	Machine Serial No:	2012 / 50	Page 1/1
Report No.:	AML17D0720.Utm	Date	18/04/2017	
Customer Name	: M.V.J College Of Engineering Aeronautical Department.			
Customer Address	:			
Customer Ref:	Lt. Dt: 18.04.2017			
Sample Details:	Sample ID: S2, Material: Glass Fibre, After 10 Days Submerged in Sea Water.			
Test Ref:	: ASTM B790			

Input Data			Output Data		
SpecimenType	: .		Load at Peak	: 1.250	kN
Specimen Width	: 24.3	mm	C.H.Travel atPeak	: 12.840	mm
Specimen Thickness	: 3.23	mm	Comp.Strength	: 15.926	N/mm2

Load Vs Cross Head Travel



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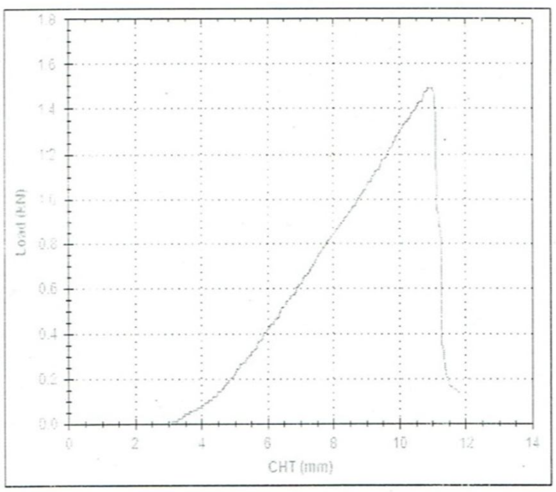
Bend Test Report

Machine Model:	TUE - C - 600	Machine Serial No:	2012 / 50	Page 1/1
Report No.:	AML17D1286.Utm	Date	03/05/2017	
Customer Name	: M.V.J College Of Engineering Aeronautical Department.			
Customer Address	:			
Customer Ref:	Lt. Dt: 25.04.2017			
Sample Details:	Sample ID: S3, Material: Glass Fibre, Material Submerging in Sea Water For 20 Days.			
Test Ref:	: ASTM D790			

Input Data			Output Data		
SpecimenType	: .		Load at Peak	: 1.490	kN
Specimen Width	: 24.5	mm	C.H.Travel atPeak	: 11.040	mm
Specimen Thickness	: 3.3	mm	Comp.Strength	: 18.429	N/mm2

Load Vs Cross Head Travel



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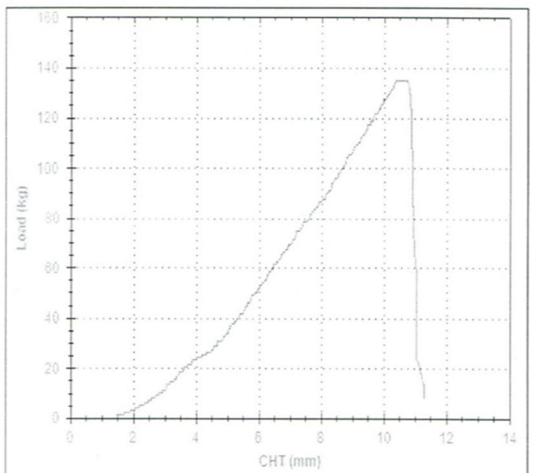
Machine Model:	TUE - C - 600	Machine Serial No:	2012 / 50	Page 1/1
Report No.:	AML17E0471.Utm	Date	10/05/2017	
Customer Name	: M.V.J College Of Engineering Aeronautical Department.			
Customer Address	:			
Customer Ref:	Lt. Dt: 09.05.2017			
Sample Details:	Sample ID: S7, Material: Glass Fibre, After 30 Days Submerged in Sea Water.			
Test Ref:	: ASTM D790			

Input Data			Output Data		
SpecimenType	: .		Load at Peak	: 134.608	kg
Specimen Width	: 24.35	mm	C.H.Travel atPeak	: 10.770	mm
Specimen Thickness	: 3.25	mm	Comp.Strength	: 1.701	kg/mm2

Load Vs Cross Head Travel



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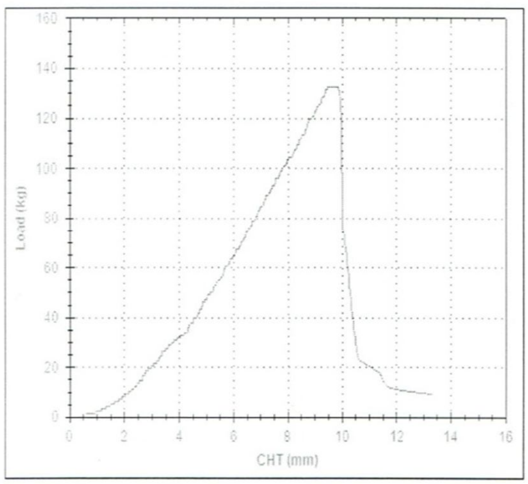
Report No.:	AML17E0470.Utm	Date	10/05/2017	
Customer Name	: M.V.J College Of Engineering Aeronautical Department.			
Customer Address	:			
Customer Ref:	Lt. Dt: 09.05.2017			
Sample Details:	Sample ID: S6, Material: Glass Fibre, After 30 Days Submerged in Sea Water.			
Test Ref:	: ASTM D790			

Input Data			Output Data		
SpecimenType	: .		Load at Peak	: 132.569	kg
Specimen Width	: 24.32	mm	C.H.Travel atPeak	: 9.890	mm
Specimen Thickness	: 3.36	mm	Comp.Strength	: 1.622	kg/mm2

Load Vs Cross Head Travel



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VI. RESULTS & DISCUSSION

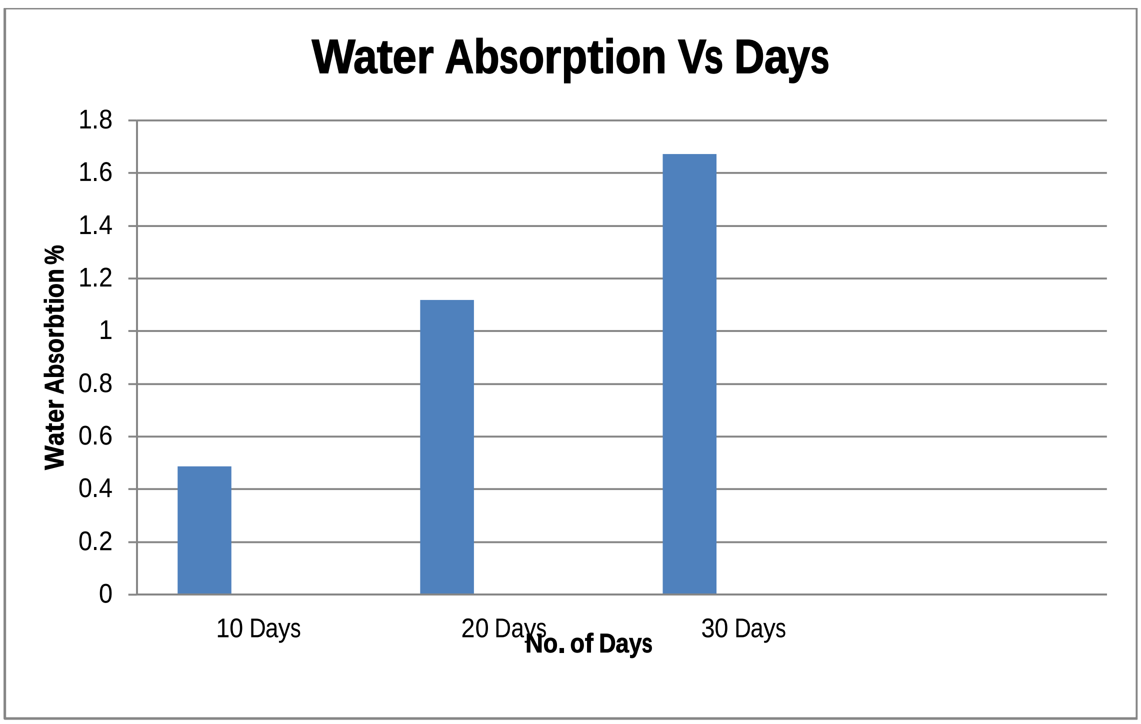
A. Water Absorption

Table No.6.1 WATER ABSORPTION DATA:

Sample Nos.	Categories (Days)	Weight of samples	Average Weight	Increased Weight	Water Abbsorption (%)
S8	Unsubmerged (standard)	18.572	18.568	…………	……………….
S9	Unsubmerged (standard)	18.565		…………	………………..
S1	Submerged (10 Days)	18.650	18.6615	0.093	0.488
S2	Submerged (10 Days)	18.673			
S3	Submerged (20 Days)	18.774	18.778	0.21	1.118
S4	Submerged (20 Days)	18.783			
S6	Submerged (30 Days)	18.874	18.884	0.316	1.673
S7	Submerged (30 Days)	18.895			

Water absorption has been increased in different interval of time but at very minimum rate.Only 0.5 % has been incread in 10 days and1.12% at 20days and 1.67% at 30 days.

Bar Chart No.6.1 WATER ABSORPTION VS DAYS



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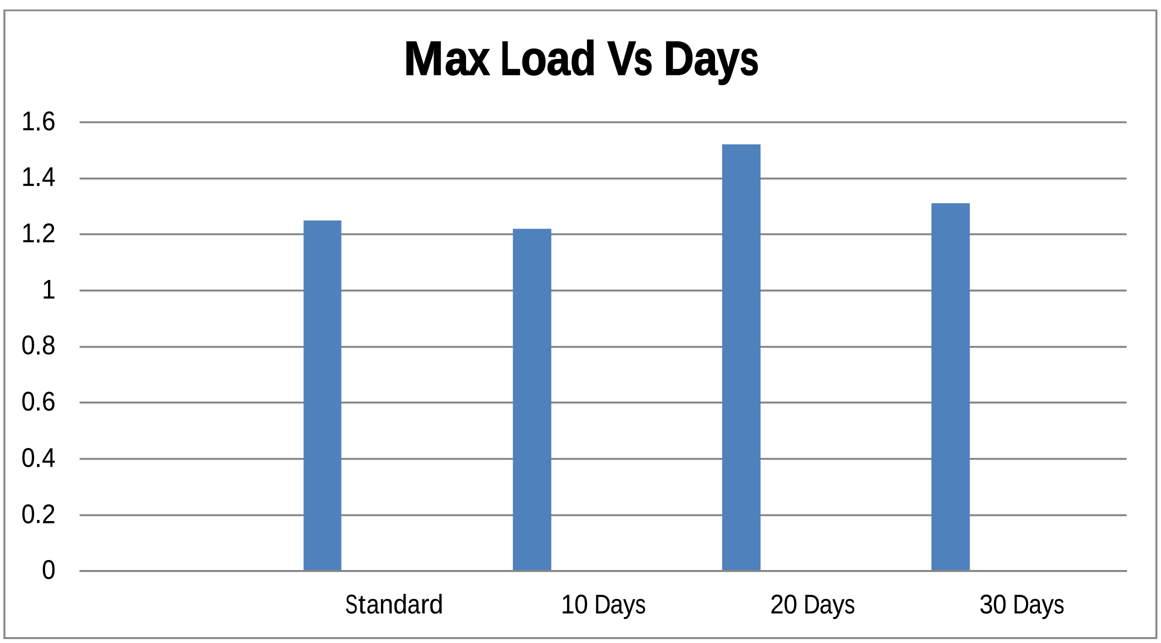
B. Samples Data

Table No.6.2 SAMPLES DATA OF FLEXULAR TEST

Sample Nos.	Categories (Days)	Width(b) (mm)	Thickness(t) (mm)	Maximum load (kN)	Average Maximum load (kN)	Maximum deflectionl(mm)	Average CrossHead Travel(mm)
S8	Unsubmerged (standard)	24.33	3.2	1.2	1.25	14.06	13.2
S9	Unsubmerged (standard)	24.36	3.3	1.3		12.34	
S1	Submerged (10 Days)	24.1	3.05	1.19	1.22	13.47	13.15
S2	Submerged (10 Days)	24.3	3.23	1.25		12.84	
S3	Submerged (20 Days)	24.5	3.3	1.49	1.52	11.04	10.85
S4	Submerged (20 Days)	24.5	3.3	1.55		10.67	
S6	Submerged (30 Days)	24.32	3.36	1.3	1.31	9.89	10.33
S7	Submerged (30 Days)	24.35	3.25	1.32		10.77	

Table 5.1 explains result obtained from lab testing of samples Including their specification such as width and thickness. Maximum Load of each samples at different days were tested on lab and average is taken from two samples readings.Different width and thickness are measured in lab for different samples and accordingly tests are done.

Bar Chart No.6.2 MAX.LOAD VS DAYS



The Maximum Load withstand capacity has decreased initially at 10 days and slightly increased and again decreased due to unequal pressure distribution in specimen during hand layup process and due to improper application of load on the specimen.

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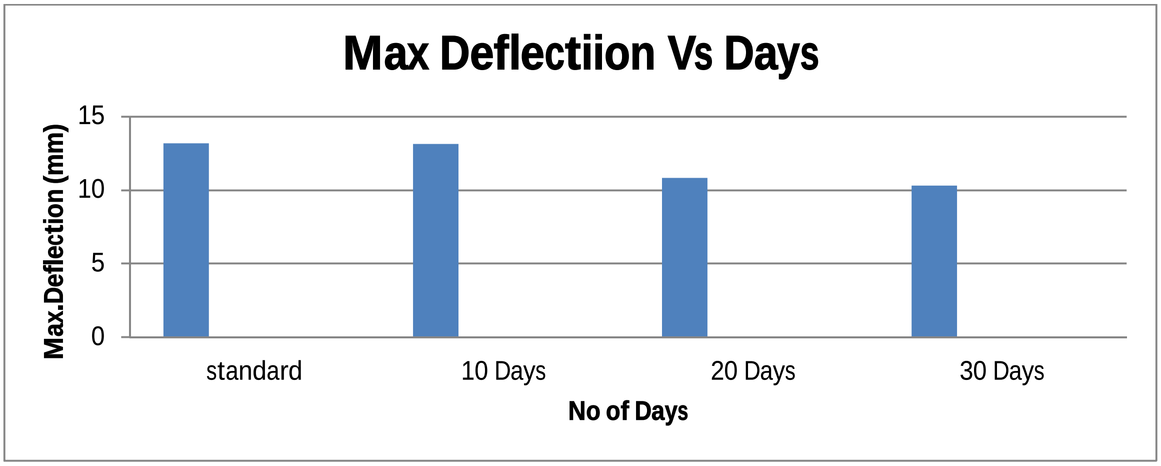
Bar Chart No.6.3 MAX.DEFLECTION VS DAYS



The deflection is decreasing as the number of days is increasing which indicates that the material gets stronger and stiffer as the composite is exposed for a longer period of time. Therefore after certain time it the corrosive environment does not affect the strength of composite material.

VII. CONCLUSION

A. Conclusion

The Maximum Load withstand capacity has decreased initially at 10 days and slightly increased and again decreased due to unequal pressure distribution in specimen during hand layup process and due to improper application of load on the specimen

Prolonged exposure to saline media which imitates sea water produces significant deteriorations in the mechanical properties of the composite materials of polyester and fiberglass. The exposure to this medium together with continuous working stress contributes to the increase in the losses within the different mechanical properties with regards to flexure. The difference with no-loaded samples is minimal in the case of flexural characteristics corresponding to the elastic period, with regard to these working stresses. Whereas the diffusion of water reaches values near saturation point relatively quickly in prolonged exposures and with a low level of working load, the penetration of the marine medium on the material is continuous when high working tensions operate and does not reach saturation even after such an extended period as 720h. All this indicates that the reduction in the properties is mainly due to the degradation of the matrix–fiber bonding. This is helped by the existence of internal tensions in this area, by the osmotic effect which produces the presence of water which is mainly distributed by hydrolytic attack on the matrix–fibre bonding, primarily on the fibre.

Hence due to negligible moisture absorption capacity, these composites can be used in Amphibian Sail Plane, Navy ship, Submarine etc. Based on analysis on the result, it can be well predicted that the E-glass fibre composite underwent reduction for a small period of time initially and then oxidation. These changes inferred from results suggested that these composites may be fully suitable for use in marine environment. The future scope of this project will make suitable for the same period of time or prolonged periods.

B. Applications

Composites have made possible new craft called tiltrotors—airplanes with a swiveling propeller at the end of each wing that can hover or take off vertically like a helicopter. Made from traditional materials such as aluminum, craft of this sort would have been simply too heavy to carry their cargo. Space rockets and satellites are also benefiting from composites, and in some unusual ways. Instead of having fuel tanks that must be jettisoned part way through a mission, the next generation of spacecraft may have tanks made from composites that can themselves be burned up as fuel.

Composites are so versatile that they are now being used even to build large-scale structures. Bridges made from composites are about a fifth as heavy as equivalent metal bridges and don't suffer problems such as corrosion and metal fatigue. The strength and lightness of composites has made them equally popular in the design of sports equipment. Tennis rackets are made from graphite or graphite-based composites, and improved composites based on fiberglass, Kevlar (aramid fibers), titanium, and ceramics. The latest composite hockey sticks made from aerospace-grade carbon fibers in a nylon polymer matrix are twice as tough and six times stronger than sticks made from ordinary composites. The same material is used to make wheels for mountain bicycles, but more advanced Kevlar composites are used to make the light, super-strong, solid wheels used in Olympic-style cycles.

1) *Major areas of Applications*
a) Thermal insulation
b) Marine Application: Submarine
c) Electrical insulation,
d) sound insulation,
e) corrosion-resistantance
f) translucent roofing panels
g) Automobile bodies,
h) Sports: Hockeysticks
i) Navy Ships
j) Amphibian Planes: Sail planes Landing Skits
k) FRP tanks and vessels,

C. Future Scope

Composites are not just useful in making things fly. Cars of the future must be safer, more economical, and more environmentally friendly, and composites could help achieve all three. Although composites such as GRP have been used in the manufacture of automobile parts since the 1950s. Engineers believe carefully designed composites could cut the weight of a typical steel car by as much as 40 percent, increasing fuel economy by as much as a quarter, yet maintaining body strength and crash-resistance. High-temperature ceramic-matrix composites are also making possible cleaner-burning, more fuel-efficient engines for both cars and trucks.

Composites are increasingly used in place of metals in machine tools. Apart from being lighter and stronger, they can offer better performance than metals at high temperatures and do not develop potentially dangerous weaknesses such as fractures and fatigue.

Investigations can be extended on different types of fibers and matrix materials such as:-

1) Fatigue and Impact tests can be carried to evaluate the fatigue life and impact strength of the laminated composites.
2) Vibration and modal analysis can be carried to evaluate vibration strength of the laminates.
3) Acoustic studies can be carried on the laminates.
4) U-V radiation tests and chemical degradation test can be performed to analyze the resistance of the laminates for the environmental conditions.

D. Cost Estimation

It was estimated to reach expenses value in total 9000INR but it came to 11000INR.All materials were bought at reasonable price. Water jet cutting operation was quiet expensive. Lab Test of 8 specimen were done at Student discount rate.Travel expenses also increased as we have to travel far for lab and also several times.

REFERENCES

[1] Performance of Composite Materials Subjected to Salt- Water Environment Author: David Miller, John F. Mandell, Daniel D. Samborsky, Bernadette A. Hernandez-Sanchez and D. Todd Griffith
[2] Effects of alkaline and acid solutions on glass/epoxy composites Author: A.M. Amaro, P.N.B. Reis, M.A. Neto, C. Louro
[3] Effects of Long-term Exposure on E-glass Composite Material Subjected To Stress Corrosion In A Saline Medium Author: F. Segovia, M.D. Salvador, O. Sahuquillo and A. Vicente
[4] Reis PNB, Ferreira JAM, Antunes FV, Richardson MOW. Effect of interlayerdelamination on mechanical behavior of carbon/epoxy laminates. J ComposMater 2009;43:2609e21
[5] Effects of alkaline and acid solutions on glass/epoxy composites (PDF Download Available). Available from: https://www.researchgate.net/publication/236625867_Effects_of_alkaline_and_acid_solutions_on_glassepoxy_composites [accessed May 30, 2017].
[6] Influence of the specimenthickness on low velocity impact behavior of composites. Amaro AM, Reis PNB, de Moura MFSF, Santos JB, J Polym Eng 2012;32:53e
[7] An experimental study of damageaccumulation in balanced CFRP laminates due to repeated impact. David-West OS, Nash DH, Banks WM. ComposStruct 2008;83:247e58
[8] The influence of servicesolutions on the longitudinal and circumferential tensile properties of glass-polyester composite pipes. Stamenovic M, Putic S, Drmanic S, Rakin M, Medjo B. Mater Sci 2011;47:61e9
[9] An assessment of the properties and degradation behaviourof glass-fibre-reinforced polyester polymer concrete. Griffiths R, A. Ball Compos Sci Technol2000;60:2747e53
[10] Equivalent crack basedmode II fracture characterization of wood. de Moura MFSF, Silva MAL, Morais AB, Morais JJL. Eng Fract Mech 2006;73:978e93