EXPERIMENTAL ANALYSIS OF COMPOSITE MATERIALS

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Abstract: Composite materials are replacing traditional materials because of their high tensile strength, low thermal expansion, and high strength to weight ratio. The development of new materials is on the anvil and is growing. Therefore, we choose some of them to study their mechanical and physical properties under various conditions. So summarize which is best and why. In this project, we selected three composite materials to study their different properties to get the perfect composite. In this project, we chose Bakelite, Glass epoxy and Delrin to study their different properties under various conditions. Also in this project, we will study their microstructural behavior and mechanical properties under various conditions. This is a design choice for aerospace, biomedical and other applications because of its attractive combination of low density, high strength, ductility, high corrosion resistance and biocompatibility

***Index Terms* - Glass Epoxy, Derlin, Bakelite, Tensile Test, Hardness Teat.**

I. INTRODUCTION

The world is beginning to look for material seminar materials that may have an impact, or at least reduce the lethal effects of bullets and shells. The problem is that traditional steel plates are too heavy and inefficient. But developers must search for a long time to get the perfect impact-resistant plastic ingredients and technology. "Composite is defined as a combination of two or more materials having completely different properties that provide more desirable and unique properties than the materials alone. As a result, it can also be noted that the combinations of materials do not dissolve or mix with each other, and The theory behind composite construction comes from the need to produce strong, hard and lightweight materials such as glass, carbon and Kevlar that have extremely high tensile and compressive strengths, but in solid form, in these materials Many random surface defects, which cause them to break and fail under stresses that are theoretically much lower. Fiber-reinforced composites are continuing to replace the first grade due to their excellent mechanical properties, such as the high strength weight stiffness-to-weight ratio. Traditional metals in secondary aerospace and aircraft structural components.

Composites or composites are available in nature or are designed to fuse two or more materials with significantly different chemical and physical properties that remain different at the micro or macro level within the finished structure. The constituent materials are basically classified into two types: a reinforcing material and a matrix which are supported to enhance resistance to mechanical and environmental damage by surrounding and maintaining their relative positions, and the reinforcing material imparts physical properties and special mechanical properties such as dielectric, strength, rigidity and the like.
Basically, the composite materials can be divided into three groups based on the matrix material.

II. LITERATURE REVIEW

P.W. Manders proposed that, From the review of the papers it can be concluded that: A reinforced composite shows more tensile and wear strength than unreinforced epoxy. The value of young modulus of elasticity also increased with increase in weight fraction of material, which signifies increased strength and reduced strain. Fibers normal oriented to the friction surface transferring loads deep into matrix material caused higher deformation of the matrix. The performance of these composites in longer durations is vital to employ them for critical areas such as marine structures, in which they are constantly exposed to moisture. The moisture diffusion through polymer composites and the resulting property degradation revealed that moisture diffusion and hence the degradation is accelerated by temperature and humidity levels.
Gu, Y., Indrakanti he proposed that, the main objective in this paper is to review the mechanical and chemical properties of glass/epoxy composite with asbestos as filler material with different percentages. The composite is manufactured by hand-layup process. Specimens were cut and tested according to ASTM standards. The mechanical properties were studied like tensile strength, bending strength and hardness of the material. The chemical properties were studied by keeping the material into sea water/salt solution (NaOH) and results were compared for different percentage of materials.

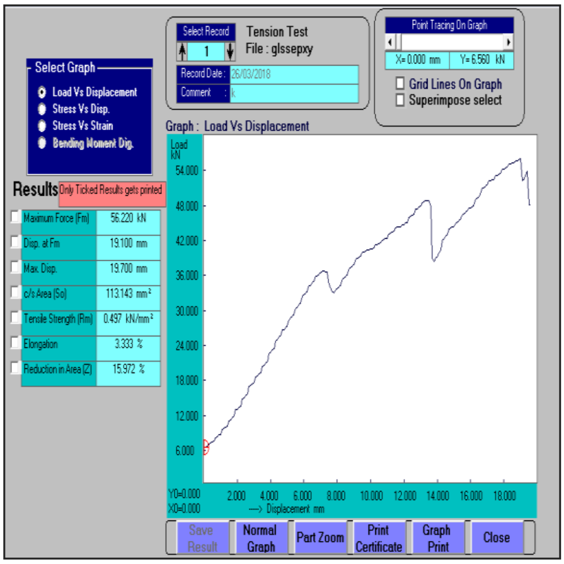
III. DESIGN METHODOLOGY

3.1 Tensile Testing

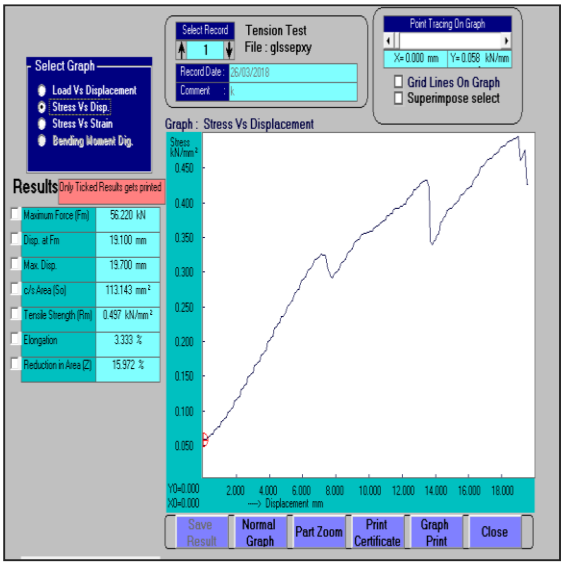
The main purpose of the test machine is to create a stress-strain diagram. Tensile testing determines the strength of the material subjected to a simple stretching operation. All three rods are approximately 300 mm long and each material is 12 mm in diameter. Testing was performed using a 40 Ton universal test machine using the following parameters, Test speed: 500 mm / minute, Grips: Pneumatic grips, Load cell: 2.5 KN, Pre-load: 0.5 N, Extensometer: Longitudinal extensometer with gauge length L0 = 60 mm, Temperature Chamber: Temperature set to 27°C using LN2, Electric supply: 400-440 v, Capacity: 1000 kV. Working: Mount the sample on a universal testing machine (UTM) and test it. Record the load and extension of the stress-strain curve configuration for each test sample. Young's modulus, yield strength, ultimate tensile strength, strain at break, % elongation and % area reduction for each sample were calculated and recorded on the tables provided. Analyze the fracture surface of the fractured specimen using a stereoscope and plot and describe the results.

3.1.1 Glass Epoxy

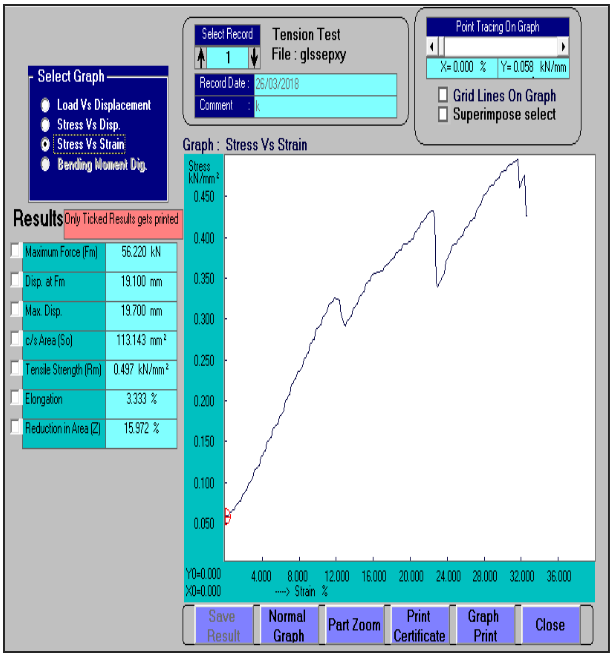
The tensile test graphs are as follows:



Graph 3.1.1: Load vs Displacement of glass epoxy.



Graph 3.1.2: Stress vs Displacement of glass epoxy.



Graph 3.1.3: Stress vs Strain of glass epoxy.

Tensile strength (σst): Area of rod, $A0 = \pi / 4 \times (d^2) = \pi / 4 \times (12^2) = 113.143$ mm2

Now, σst = max / $A0$ = 56209 / 113.143 = 497 MPa

Fracture Strength ($\boldsymbol{\sigma}$f): $\boldsymbol{\sigma}$f = Pf / $A0$ = 48405 / 113.143 = 428 MPa

Young Modulus (E): E = σst / e= 497 / 0.012 = 41416.66 MPa

Percent Elongation (% EL): % $Elongation = (Lf - L0)100 / L0$ = (309.99 – 300) x 100 / 300 = 3.33 %

Percent Reduction in Area (%RA): = $(A0-Af)$ 100 / $A0$ = (113.143 – 95.03) 100 / 113.143 = 15.972 %.

Ansys Report

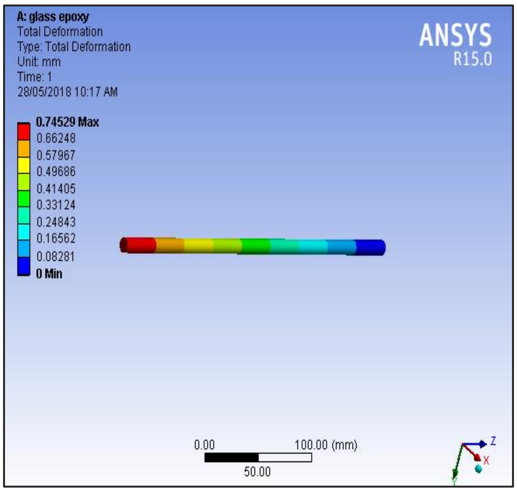
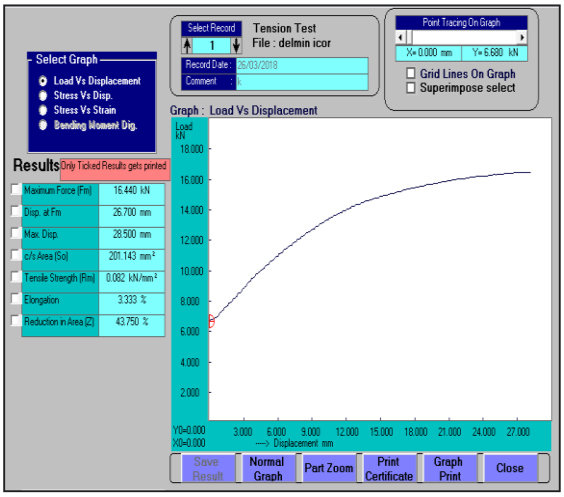


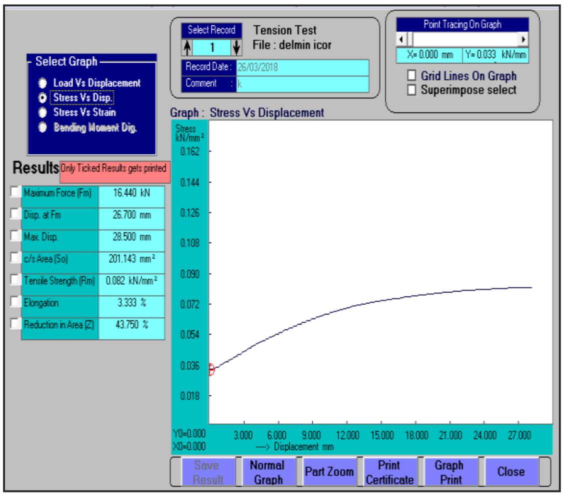
Figure 3.1.1.1: Ansys report of glass epoxy

3.1.3 Delrin

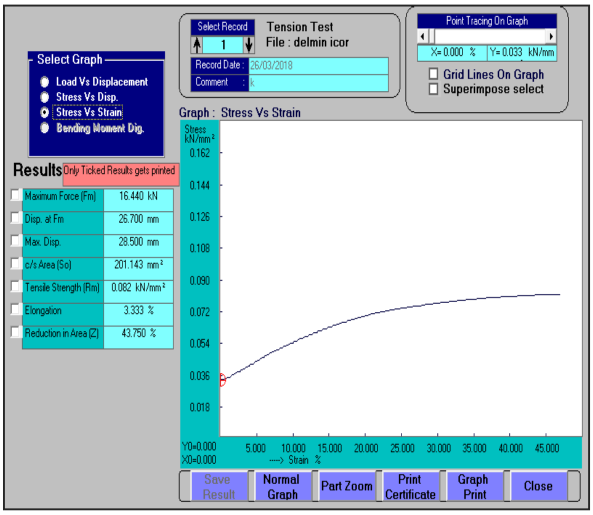
The tensile test graphs are as follows:



Graph 3.1.3.1: Load vs Displacement of delrin.



Graph 3.1.3.2: Stress vs Displacement of delrin.



Graph 3.1.3.3: Stress vs Strain of delrin.

Calculation

Tensile strength (σst): where area of rod is, $A0$ = π / 4 x (d^2) = π / 4 x (16^2) = 201.143 mm2

Now, σst = max / $A0$ = 16440 / 201.143 = 81.73 MPa

Fracture Strength ($\boldsymbol{\sigma}$f): = Pf / $A0$ = 16050 / 201.143 = 79.79 MPa

Young Modulus (E): = σst / e = 81.73 / 0.0333 = 2454.35 MPa

Percent Elongation (% EL): $(Lf-L0)$100 / $L0$ = (309.99 – 300) x 100 / 300 = 3.33 %

Percent Reduction in Area (%RA): = ($A0-Af$) 100 / $A0$ = (201.143 – 113.143) 100 / 113.143 = 43.75 %

Ansys Report

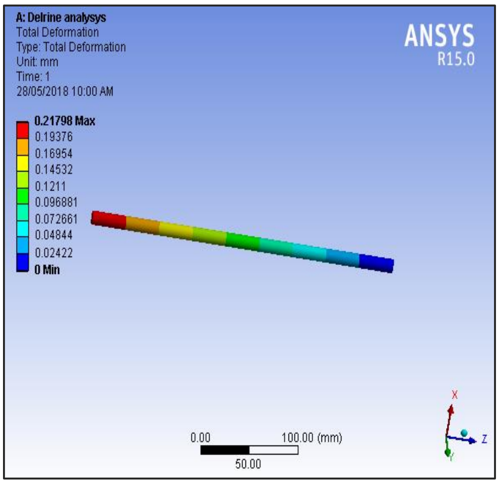


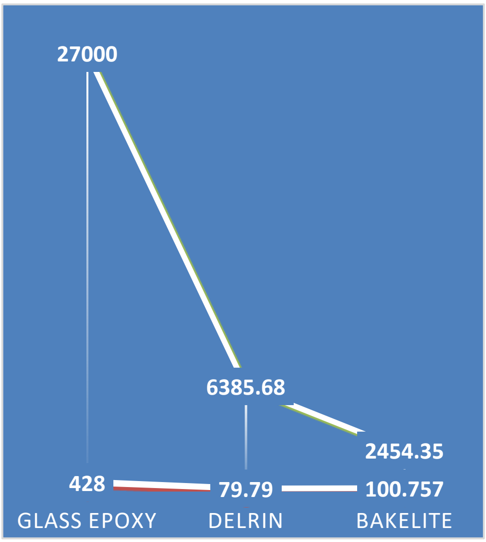
Figure 3.1.3.1: Ansys report of Delrin.

IV. Result & discussion

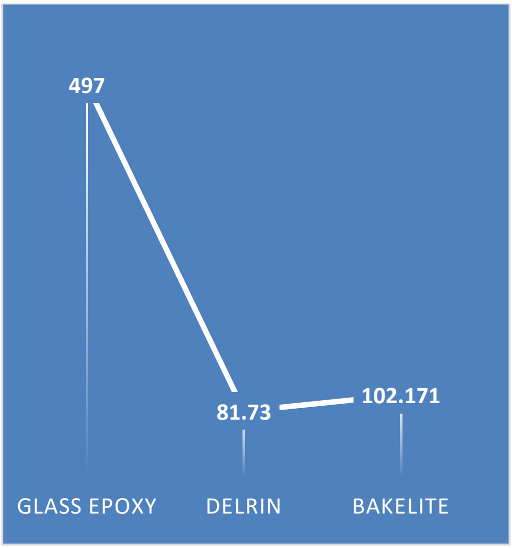
Table 4.1 Tensile Test Results

Sr. No.	Material	Glass Epoxy	Delrin	Bakelite
1	tensile strength(σst)	497	81.73	102.171
2	fracture strength($\boldsymbol{\sigma}$f)	428	79.79	100.757
3	young modulus (e)	27000	6385.68	2454.35
4	percent elongation (% el)	3.33	3.33	1.667
5	percent reduction area(%RA)	15.972	43.75	15.972

Graphs



Graph 4.1: comparison of young modulus



Graph 4.2: comparison of tensile strength

V. Conclusion

When we performed different tests, it was observed that glass epoxy resin is the best composite material compared to Delrin and Bakelite. These three materials are widely used in industry. If we have to choose any of these three materials, then we choose glass epoxy for product manufacturing. These three composite materials have a wide range of applications in the automotive industry. Glass epoxy resins are attractive, such as relatively high compressive strength, good flexibility in making thick composite casings, low weight, low density and corrosion resistance.

VI. FUTURE SCOPE

These three composite materials have a wide range of applications in the automotive industry. Composite materials have great potential for application in structures that are primarily subjected to compressive loads. Composite materials are attractive, such as relatively high compressive strength, good flexibility in making thick composite shells, low weight, low density and corrosion resistance. Composite materials have good mechanical, electrical and chemical properties, so we can use composite materials in many different industries. Due to good performance, the automotive and aerospace components are made of composite materials.

REFERENCE

[1] T D Jagannatha, G Harish. “Mechanical properties of carbon/glass fibre reinforced epoxy hybrid polymer composites", International Journal of Mechanical Engineering and Robotics 2015.

[2] P.W. Manders, M.G.Bader, “The strength of hybrid glass/carbon fibre composite ", Journal of Material Science 1981, 2233-2245.

[3] Nesterenko, V.F., Indrakanti, S.S., Brar, S. and Gu, Y. (2000). Ballistic Performance of Hot Isostatically Pressed (HIPed) Ti-based Alloys, Key Engng. Mater., 177–180: 243–248.

[4] Goldsmith, W. (2001). Impact: The Theory and Physical Behaviour of Colliding Solids, Dover Publications, Inc., Mineola, New York.

[5] Gu, Y., Indrakanti, S.S. and Nesterenko, V.F. (2002). Ballistic Testing and High-strain-rate Properties of Hot Isostatically Pressed Ti–6Al–4V, Shock Compression of Condensed Matter, AIP Conference Proceedings, 620(1): 1294–1297.

[6] Chaos.org.uk, (2015). Mechanical properties of materials. [online] Available at: http://www.chaos.org.uk/~eddy/project/space/materials.html [Accessed 3 Jun. 2015].

[7] Vikas Verma, Rajendra Patel, Sweena Kashyap and Aakanksha Suryawanshi “EXPERIMENTAL ANALYSIS OF COMPOSITE MATERIAL” International Journal of Engineering Technology, Management and Applied Sciences, February 2015, Volume 3 Issue 2, ISSN 2349-4476.

[8] Karthick Saravanan.S, Vetrivel .R. “Experimental Analysis of Carbon/Glass Fiber Reinforced Epoxy Hybrid Composites With Different Carbon/Glass Fiber Ratios” International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 5, May 2016

[9] Anil Kumar, Arshad Mehmood “Experimental Analysis of Mechanical Properties of Composite Material Reinforced By Aluminum-Fibers” International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 11 | Nov – 2017.

[10] M.S.Yadav and L. B. Raut “Experimental Analysis of Different Composition in Hybrid Composite Material for Propeller Shaft : A Review” International Journal of Current Engineering and Technology, Vol.7, No.3 (June 2017).