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Study of Glass Fiber Reinforced Plastic in Aluminum Square Tube for Bus Frame

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ABSTRACT:

Due to its superior mechanical qualities, including high strength, low weight, and exceptional corrosion resistance, aluminum square is a frequently used material in engineering applications. The focus of this research is to determine the effect of glass fiber reinforcement plastic in an aluminum sheet. During their in-service life, these composite materials can expose to different working condition as well as to different environments, where Moisture can be introduced to the materials; in such working condition the properties of such materials need to be well understood for appropriate design and use.

KEY WORDS: - Glass fiber reinforced plastic (GFRP), Aluminum, compression and tensile stress.

INTRODUCTION:

Glass fiber reinforced plastic (GFRP) and aluminum square tube are two materials that can be used in the construction of a bus frame. GFRP is a composite material that is made up of glass fibers and a polymer resin. It is lightweight, strong, and has good resistance to corrosion, making it a popular choice for many applications, including transportation. Glass Fiber Reinforced Plastic (GFRP) is a composite material made of a polymer matrix reinforced with glass fibers. It has become a popular material for various applications due to its high strength-to-weight ratio, corrosion resistance, and durability. One area where GFRP has been extensively used is in the construction of structural components for buildings, bridges, and other infrastructure.

Aluminum square tube, on the other hand, is a metal that is also lightweight and strong, with good resistance to corrosion. It is commonly used in the construction of frames for vehicles and other structures. Aluminum square is a commonly used material in engineering applications due to its excellent mechanical properties, Due to its superior mechanical qualities, including high strength, low weight, and exceptional corrosion resistance, aluminium square is a frequently used material in engineering applications.. However, it can still benefit from further improvements in its mechanical properties and durability. One way to achieve this is by incorporating GFRP into the aluminum square, forming a composite material with superior mechanical properties.

When these two materials are combined in the construction of a bus frame, the resulting structure can benefit from the advantages of both materials. The GFRP can provide strength and stiffness, while the aluminum square tube can provide additional rigidity and support.

One potential drawback of using GFRP is that it can be more expensive than other materials. However, the durability and resistance to corrosion may make it a cost-effective choice in the long run.

Overall, the use of GFRP and aluminum square tube in the construction of a bus frame can result in a strong, lightweight, and corrosion-resistant structure that is well-suited for the demands of transportation.

The study of GFRP in aluminum square involves evaluating the mechanical properties of the composite material, such as tensile strength, compressive strength, and fatigue resistance. The properties of the composite material are influenced by various factors, such as the type and orientation of the fibers, the matrix material, and the manufacturing process.

Researchers have conducted numerous studies to investigate the effects of different parameters on the mechanical properties of GFRP-reinforced aluminum square. These studies have led to the development of improved manufacturing techniques and design guidelines for composite materials.

The frame of a bus is an essential part of its body structure, providing the necessary support and rigidity for the bus body and the various components that make up the vehicle. Here are some details about the frame structure of a typical bus:

Material: Bus frames are typically made of high-strength steel, which provides the necessary stiffness and strength to support the bus body. In some cases, aluminum or composite materials may be used to reduce weight and improve fuel efficiency.

Frame rails: The main structural members of a bus frame are the frame rails, which run longitudinally along the length of the vehicle. These rails are typically welded together to form a rigid, box-like structure that can support the weight of the bus and its cargo.

Cross members: In addition to the frame rails, a bus frame also includes a series of cross members that connect the two frame rails and provide additional support. These cross members may be spaced at regular intervals or placed strategically to support specific components of the bus body.

LITERATURE REVIEW: -

The research focuses on the fabrication and evaluation of Glass Fibber Reinforced Aluminium (GLARE) laminates. For the construction of GLARE laminates, aluminium 2024 (T3) sheets, e-glass fibre and epoxy resin were used. The laminates ranged in thickness from 0.2 mm to 3.5 mm. Aluminium sheets and epoxy/E-glass fibre laminates are joined using the hand layup technique in a variety of configurations. The test specimens were made in accordance with ASTM guidelines, and the common three-point bending test was used to assess various bending characteristics. Increases in aluminium sheet thickness from 0.2 mm to 0.35 mm resulted in a 60% increase in load-bearing capacity(1).

In the research, various test is done in polymer composite with different volume fraction of glass fibre and polyester resin and conclude that the COMBO MAT 910 is superior to all other laminates(2).

In the research, under uniaxial loading the stress distribution of the hybrid laminated composites at each layer is determined by using ANSYS software as well as theoretical and compared(3).

In this research, to increase the fuel efficiency, the car front hood is made up metal laminate and as well as the effect of the water absorption test is done(4).

In this research, two varies density of GFRP are used, with ten different composition where tensile modulus, tensile test and impact strength with two different standards (ASTM D3039 and ASTM D6110). The impact test results of the laminated structure reinforced with glass fibres illustrate a significant increase in the impact strength owing to adding the glass fibres compared to the control specimens(5).

In this research, interlaminar fracture toughness of the aluminium laminated specimen were tested at end notched position and this were compared theoretically and analytically(6).

In this research, the bonding between CFRP and the concrete were tested using 3 point bending test using universal testing machine (UTM) with 5 different sheet thickness (200 GSM, 300GSM, 400GSM, 600GSM ,1.4 mm laminate). This result that, 300 GSM has high bonding strength (7).

In this research, the main objective of this research is to reduce the weigh and improved damage tolerance characteristics of the aircraft. This results that the moisture absorption of FML composites is slower than the polymer composite and can be used in parts of aircrafts when it is necessary the use of highly compression resistant material (8).

MATERIALS & METHODS

COMPOSITION OF FIBER REINFORCED

Composites are made up of fiber and matrix. Where reinforcement is fibers, and the strength of the composites is increased by the fiber togetherness with the help of 'glues or resin.' This helps the material to increase the transfer of stresses between the reinforcing fibers. To get smooth manufacturing process, fillers or modifiers are also added which increases the material special properties, and/or reduces the initial cost.

ALUMINIUM PROPERTIES

TABLE:1 PROPERTIES

MECHANICAL PROPERTIES	Al 6061
DENSITY	2700g/mm3
YOUNGUS MODULUS	68.9 Gpa
TENSILE STRENGTH	198 Mpa
POISSION RATIO	0.33
THERMAL CONDUCTIVITY	168W/(m.K)

COMPOSITION OF MATRIX:

The basic function of the matrix is to transfer stresses along the reinforcing fiber and to prevent mechanical/environmental damage. The basic requirement of the matrix is to increase the breaking stress of the fibers it holds. To get wide variation, mostly resin is used as matrix like resin matrix, Epoxy, phenolic, polyester, vinyl Ester, Etc. The most effectively used resin is Epoxies because of its higher adhesion and less shrinkage, but Epoxies has higher cost than Polyester.

GLASS FIBER-REINFORCED PLASTIC (GFRP):

The fig:1 which is a Glass, aramid, carbon is the most widely used as synthetic fibers to reinforce plastic materials. Since the cost of the glass is less, it is used most widely in industries. To improve the aluminum square hollow tube the GFRP is used with aluminum square hollow tube.

TABLE:2 GSM 200 PROPERTIES

PROPERTIES	MAXIMUM VALUE
ATOMIC VOLUME	0.009 m3/kmol
DENSITY	2.6 Mg/m3
BULK MODIULUS	50 Gpa
COMPRESSIVE STRENGTH	5000 Mpa
ELASTIC LIMIT	2875 Mpa
ENDURANCE LIMIT	3110 Mpa
HARDNESS	6000 Mpa
POISSION RATIO	0.23
TENSILE STRENGTH	2050 Mpa
YOUNGS MODULUS	85 Gpa

SPECIMEN IMAGE

FIG:1 SPECIMEN IMAGE

MACHINE IMAGE

FIG:2 UNIVERSAL TESTING MACHINE

Fig:2 Universal Testing Machine (UTM) is a piece of equipment used in materials testing to determine mechanical characteristics of different materials, including their tensile, compressive, bending, and shear strengths.

A typical UTM consists of a frame that houses the testing components, including the load cell, grips or fixtures, and the testing software. The load cell is responsible for measuring the force applied to the material being tested, while the grips or fixtures hold the material in place during testing.

During a test, the material is pulled, compressed, or bent using the grips or fixtures while the load cell measures the force being applied. The testing software records the data, which can be used to determine the material's properties, such as its elasticity, plasticity, and toughness.

UTMs are commonly used in industries such as construction, manufacturing, and aerospace to test the strength and durability of materials used in their products. They are also used in research and development to study the behavior of new materials and to develop new testing methodologies.

COMPRESSIOIN LOAD

Load test in universal testing machine (UTM) with ASTM A370:21 test method. Which result the huge difference between the normal aluminum and aluminum with GFRP. That conclude that the aluminum rod with GFRP is used where load subjected on the body is high.

TABLE:3 COMPRESSION RESULT

PARAMETERS	OBSERVED VALUES IN KN
Compression load	0.18

HARDNESS

There are several methods to perform hardness testing on glass fiber materials, but the most common technique is the Rockwell hardness test. The Brittle hardness test is a widely used method for measuring the hardness of materials, including glass fibers.

It is important to note that the Brittle hardness test may not be suitable for all types of glass fibers, and the test results may vary depending on the specific conditions of the test. Therefore, it is recommended to consult with a materials testing expert to determine the most appropriate hardness testing method for your particular glass fiber material.

MACHINE IMAGE

FIG:3 BRITTLE HARDNESS MACHINE

The brittle hardness test is a measure of the ability of a material to resist cracking or breaking under an applied load. This test can be performed on glass fiber materials to assess their hardness.

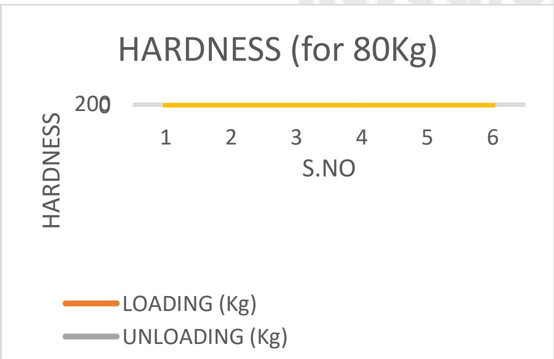
Brittle hardness test may not provide a precise measure of the hardness of glass fiber materials, as they are often composed of multiple layers and have complex microstructures that can affect their fracture behavior. Therefore, it is recommended to perform multiple tests and consult with a materials testing expert to obtain a more accurate measure of the glass fiber's hardness.

1/16 INCH STEEL BALL INDENTER

A 1/16 inch steel ball indenter is a small steel ball that is used in certain types of hardness testing, such as Rockwell hardness testing. The indenter is pressed into the surface of the material being tested with a specific force, and the depth of the resulting indentation is measured. This indentation depth is used to calculate the material's hardness.

The 1/16 inch steel ball is one of several sizes of indenters that can be used in Rockwell hardness testing, and the choice of indenter size depends on the type of material being tested and the hardness range of interest. The 1/16 inch size is typically used for softer materials, such as plastics and non-ferrous metals

TABLE:4 HARDNESS



S.NO	LOADING (Kg)	UNLOADING (Kg)	HARDNESS (UNLOADING-LOADING) (Kg)
1	80	132	52
2	80	151	71
3	80	149	69
4	80	174	94
5	80	162	82
6	80	164	84

Fig:4 HARDNESS (for 80Kg) GRAPH

CONCLUSION:

This research paper concluded that using 200 GSM with aluminum hollow square tube have increases the compression load of the aluminum. We suggest that by increasing the thickness and the layers of GSM, the hardness and compression load are increased , increase the strength and durability of the bus frame by using this material.

COMPRESSION LOAD : 0.18 KN

HARDNESS TEST : 753.3 N

REFERENCE:

1. Harish Kumar M, Dr. N. Rajesh Mathivanan , Satish Kumar - experimental investigations of effect of laminate thickness of flexural properties of GLARE and GFRP laminates.
2. A. Gnanavelbabu, P.Saravanan , K.Rajkumar P.Sabarinathan S.Karthikeyan - Mechanical strengthening effect by various forms and orientation of glass fibre reinforced isopthalic polyester polymer composite
3. Yogesh Giri Goswami, Rakesh Saxena - Stress and failure analysis of inter-ply hybrid laminated composite using finite element method
4. Noordiana Mohd Ishak, Sivakumar Dhar Malingam, Muhd Ridzuan Mansor, Nadlene Razali, Zaleha Mustafa and Ahmad Fuad Ab Ghani - Investigation of natural fibre metal laminate as car front hood
5. M. E. Golmakani, T. Wiczenbach, M. Malikan, E. Z. Karimi, M. Masoumi and V. A. Eremeyev2,4 - Experimental and numerical study on mechanical characteristics of aluminium/glass fibre composite laminates
6. Konrad Dadej , Jarosław Bienia´s and Paolo Sebastiano Valvo -Experimental testing and analytical modeling of asymmetric end-notched flexure tests on glass-fibre metal laminates
7. Vijay Savant, Vidula Sohoni, Dinesh Khedkar, Dipali Yerudkar - Influence of thickness of carbon fibre sheet on bond strength between CFRP and concrete.
8. Bino prince raja d, Ramanan G, ishwara gowda v.patil, suganthi.P -Static structural analysis and testing of aircraft wing spar using composite material
9. Yadav Khagendra Kumar, Dr. Dalbir Singh Lohchab - Influence of Aviation Fuel on Mechanical properties of Glass Fiber-Reinforced Plastic Composite.
10. Fatma Rebaïne*, Mohamed Bouazara, Ahmed Rahem, Lyne St-Georges -Static and Vibration Analysis of an Aluminium and Steel Bus Frame.
11. Patil, M., Thakare, R. and Bam, A. (2015) Analysis of a Tanker Truck Chassis. International Journal on Mechanical Engineering and Robotics, 3, 20-24.
12. Udhay Kiran, S. and Mahesh Kumar, M. (2016) Linear Static Analysis of Truck Chassis. International Journal of Innovative Research in Science Engineering and Technology, 5, 15713-15719.
13. Bajwa, M.S., Pundir, S. and Joshi, A. (2013) Static Load Analysis of Tata Super Ace Chassis and Stress Optimisation using Standard Techniques. International Journal of Mechanical and Production Engineering, 1, 50-54.
14. Fui, T.H. and Rahman, R.A. (2007) Statics and Dynamics Structural Analysis of a 4.5-Ton Truck Chassis. Jurnal Mekanikal, No. 24, 56-67.
15. Rahman, R.A., Tamin, M.N. and Kurdi, O. (2008) Stress Analysis of Heavy Duty Truck Chassis as a Preliminary Data for Its Fatigue Life Prediction using FEM. Jurnal Mekanikal, No. 26, 76-85.
16. Patel, V.V. and Patel, R.I. (2012) Structural Analysis of a Ladder Chassis Frame World Journal of Science and Technology, 2, 5-8.
17. Khannukar, K., Kallannavar, V. and Manjunath, B.S. (2015) Dynamic Analysis of Automotive Chassis Using FEA. International Research Journal of Engineering and Technology, 2, 2165-2170.
18. Ravi Chandra, M., Sreenivasulu, S. and Altaf Hussain, S. (2012) Modeling and Structural Analysis of Heavy Vehicle Chassis Made of Polymeric Composite Material by Three Different Cross Sections. International Journal of Modern Engineering Research, 2, 2594-2600.
19. Jain, A. and Seshagiri Rao, G.V.R. (2016) Stress and Weight Analysis of Ladder Frame of Light Duty Truck. International Journal of Engineering Sciences & Management, 6, 118-128.
20. Patel Vijaykumar, V. and Patel, R.I. (2012) Structural Analysis of Automotive Chassis Frame and Design Modification for Weight Reduction. International Journal of Engineering Research & Technology, 1, 1-6.
21. Swami, K.I. and Tuljapure, S.B. (2014) Analysis of Ladder Chassis of Eicher 20.16 using FEM. Journal of Applied Geology and Geophysics, 2, 6-13.
22. Godse, S. and Patel, D.A. (2013) Static Load Analysis of Tata Ace Ex Chassis and Stress Optimisation Using Reinforcement Technique. International Journal of Engineering Trends and Technology, 4, 3037-3039.
23. Patil, H.B., Kachave, S.D. and Deore, E.R. (2013) Stress Analysis of Automotive Chassis with Various Thicknesses. Journal of Mechanical and Civil Engineering, 6,44-49. https://doi.org/10.9790/1684-0614449.