

Comparison of Mechanical Behaviour of E Glass Fibre and Carbon Fibre Reinforced Polymer Mixed with ARALDITE and ARADUR Using ANSYS Software and Testing Machines

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ABSTRACT This paper is concerned with experimental and Analytical investigations of the mechanical properties of bidirectional Carbon fiber reinforced polymer (CFRP) sheet and E-glass fiber reinforced polymer with LY556(ARALDITE) Epoxy resin and HY951(ARADUR) hardener under different mechanical loading using Ansys software and using tensile testing machine . The Carbon fiber and E-glass fiber composites are manufactured by hand layup processes and tested by using tensile, flexural, compression& shear loads to find out the strength of the materials.

KEYWORDS: Mechanical properties; CFRP; E-glass; epoxy; Flexure; Tensile

I. INTRODUCTION

Fibre reinforced composites materials offered a combination of strength and modulus that was either comparable to or better than that of traditional metallic materials. Because of their low specific gravities, the strength-to-weight ratios and modulus-to-weight ratios of these composite materials were markedly superior to those metallic materials.

II. LITERATURE REVIEW

Thomas Bru et al [2016]^[1] had found a complete database of an epoxy polymer reinforced carbon fibre is established. Thickness tests were performed on unidirectional laminates under normal and shear loading. And it characterise the strength, stiffness, failure features for the different loading cases. Also it characterise the fracture toughness tests were made for different loading conditions. Murugan, R. Ramesh et al [2014]^[2] had found the static and dynamic mechanical properties of epoxy based woven fabric glass/carbon hybrid composite laminates. Properties like tensile strength, flexural strength, and impact strength are evaluated as per ASTM standards .Anil Kumar Veerapaneni et al[2014]^[3] had found a mechanical properties of PAN(Poly Acrylo Nitrile) carbon fabric and epoxy resin by hand layup and match de moulding. It also gives the properties like strength, toughness, formability, joints ability, corrosion resistance, and affordability. And it characterised the physical and mechanical properties. Based on the review above shown ,by comparing the mechanical strength by using ansys software, we can differentiate the characteristics of different material without experimenting.

III. MANUFACTURING PROCESS

Hand lay up process for making carbon and E-glass epoxy composite material (3 mm thickness) by 3 layers of carbon fiber and E-glass fiber. Initially the fibre cloth is made according to the laminate plate size and number of layers needed. Then the weight of the fibre cloth is made according to the laminate plate size and number of layers needed. Then the weight of the fibre cloth is measured. Then equal weight of resin is taken and 4:1 ratio of hardener is added to the resin to increase the bonding strength of the laminate. After the curing (4 hours) the laminate plate is taken and

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the specimen will be prepared according to the ASTM standard. The above steps are repeated for E-glass fiber. Then the fiber ends are fixed with steel and reverted for holding it during mechanical testing like tensile testing machine.



Fig [1] carbon fiber- Before testing

Resin and hardener should be stirred till it mixed properly. Then one by one Carbon fibre cloth is fixed and resin hardener mixture should be applied by using a brush to make the laminate .The above steps are repeated according to the laminate plate thickness.



Fig [2] E glass fiber-Before testing

Hand roller should be rolled over every layer to avoid the air bubbles finally again glass sheet is fixed and the weight should be applied. After the curing (4 hours) the laminate plate is taken and the specimen will be prepared according to the ASTM standard. The above steps are repeated for E-glass fiber. Then the fiber ends are fixed with steel and reverted for holding it during mechanical testing like tensile testing machine.

IV. DESIGN

Ansys Procedure:

In mechanical APDL ANSYS 16.0 to perform the static analysis for different load condition. The complete procedure of analysis is done using ANSYS 16.0 ,the general process of ANSYS is divided into three main phases,

- Preprocessor.
- Solution.
- General postprocessor.

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The following are the steps to perform the analysis procedure for E-Glass and Carbon fiber epoxy.

- i. File -> clear and start new -> don't read file -> ok
- ii. File -> change job name -> composite -> ok
- iii. File -> directory -> design -> ANSYS ->ok
- iv. File -> change title -> title name -> ok
- v. Preference -> static -> ok
- vi. Preprocessor -> element type -> add -> shell -> 3D 4 node 141 -> ok -> options -> k8->all layers ->ok->close.
- vii. Material properties->material model->material->structural->linear->elastic->orthotropic->ok ->density ->ok
- viii. Section->shell->layup->add/edit->add layer->thickness 3mm->layers-6 -> ok.
- ix. Modeling->Create->Areas->Rectangle->By Dimension-> (X1,X2)=(0,165) (Y1,Y2)=(0,40).
- x. Meshing ->mesh tool-> mesh ->pick all
- xi. Plot results ->style->size and shapes->display of element ->ON->ok.
- xii. solution->analysis type->new analysis->static
- xiii. Define->loads->apply->structural->displacement->ok->force/moment->ok.
- xiv. solve->current LS->yes-> ok
- xv. General postprocessor->plot results->contour plot->nodal; solutions->all DOF soll-> displacement vector sum->ok
- xvi. Stress->XY shear stress->ok.
- xvii. Report generator->camera->ok.

V. EXPERIMENTAL RESULTS

E-GLASS EPOXY RESIN FIBRE:

TENSILE TESTING:

Sample type: Rectangular Bar; Area:160.000 mm²; Width:40mm; Thickness:4 mm; Gauge Length:102 mm; Final Gauge Length:112 mm

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AFTER TESTING:

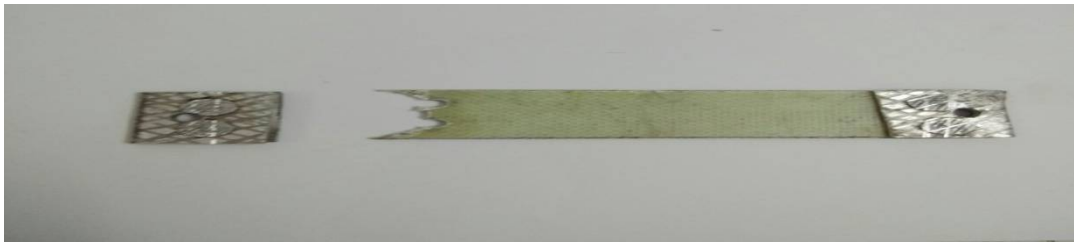


Fig.[3] E-Glass Fiber - After Testing

Sl.no	Ult./Break load	Disp.AtFMax	Max.Disp	Ult.Stress	Elongation
1.	15.620 kN	10.200 mm	11.500 mm	0.098 kN/mm2	9.804%

Tab.[1] Result of Tension Test

ANALYSIS TEST:

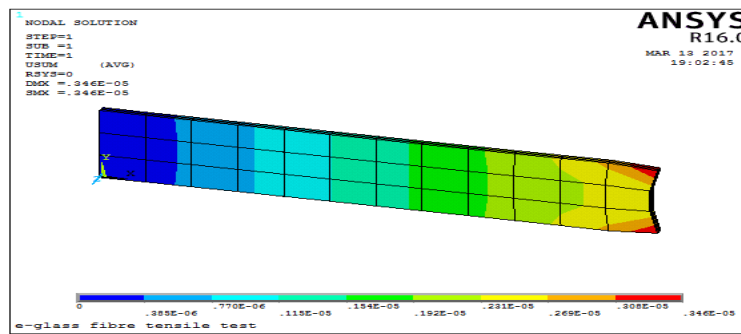


Fig.[4] Displacement Vector Sum

The above diagram shows the ansys Displacement vector sum test for our specimen

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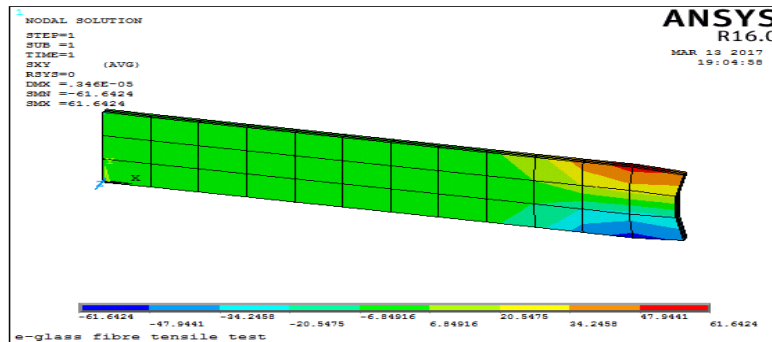


Fig.[5] XY Shear Stress

The below diagram shows the ansys XY shear stress test for our specimen.

FLEXURE TEST:

ANALYSIS TEST:

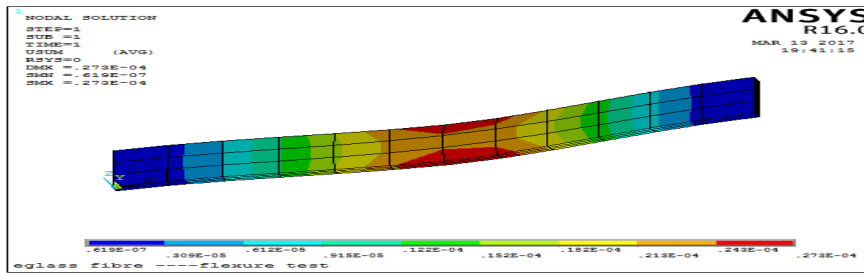


Fig.[6] Flexure Test- Displacement Vector Sum

The below diagram shows the ansys Displacement vector sum test for our specimen

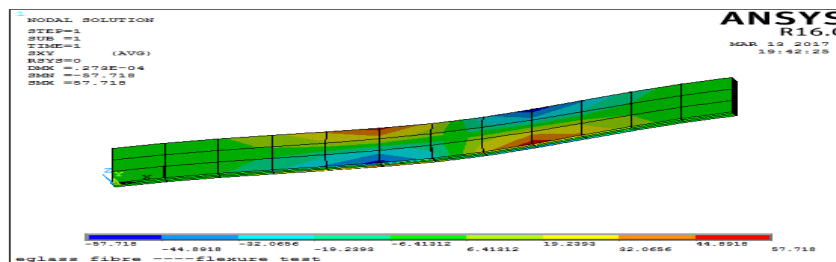


Fig.[7] Flexure Test - XY Shear Stress

The below diagram shows the ansys XY shear stress test for our specimen.

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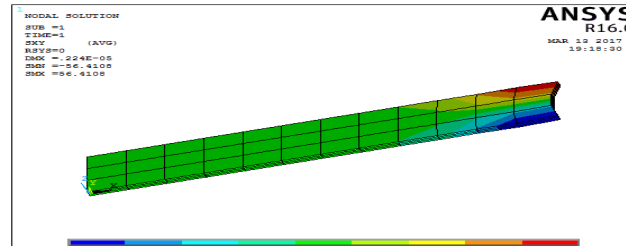


Fig [11] Carbon Fiber - XY Shear Stress

FLEXURE TEST:

ANALYSIS TEST : The below diagram shows the ansys Displacement vector sum test for our specimen.

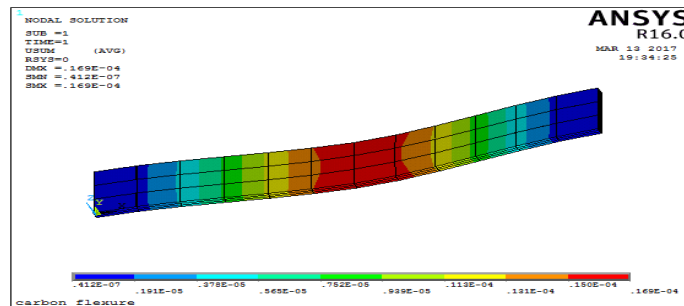


Fig [12] Flexure Test - Displacement Vector Sum

COMPRESSION TEST:

ANALYSIS TEST: The below diagram shows the ansys compressive test for our specimen.

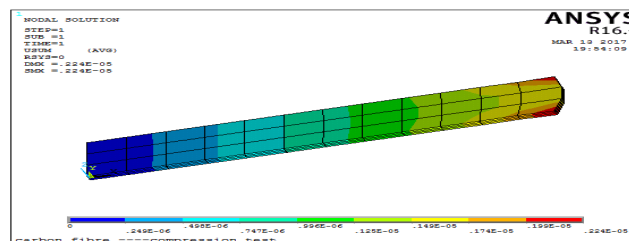


Fig [13] Compression test - Displacement Vector Sum

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COMPARSION TEST ON ANALYSIS :

SPECIMEN	TENSION		FLEXURE		COMPRESSION	
	DISP	SHEAR	DISP	SHEAR	DISP	SHEAR
E-GLASS	.346e-5	61.6424	0.273e-4	57.718	0.34e-5	61.601
CARBON	.224e-05	56.41	.169e-04	19.2561	.224e-05	56.4108

COMPARSION TEST ON EXPERIMENTAL:

SPECIMEN	BREAK LOAD	DISP	MAX DISP	ULT. SRESS	ELONGATION
E-GLASS	22.480kN	6.4 mm	6.6 mm	0.141 kN/mm ²	3.922%
CARBON	15.620kN	10.2 mm	11.5 mm	0.098 kN/mm ²	9.804%

VI. CONCLUSION

From the detailed study, analysis and experimental verification we conclude that carbon fiber has more strength than E-Glass fiber. In each case of the testing and analyzing the carbon fiber has some prior value than the E-glass fiber thus we conclude that the carbon fiber has more strength when compared with E-Glass fiber.

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