The Effect of TiO2 in Glass Fiber Reinforced Polymer

R. Ganesh, V. Balaji,

***Abstract*: Composite materials serve as an alternative to the conventional metals. These materials used in various applications like automotive, aerospace, marine industries, etc. so, there is a requirement for detailed base of structural design. Air craft industries use composite material in their major structural works instead of the metals as composites have low weight density. The major key area of these structural work is fabricating the joint of composites. The data base for these joint strengths is more important.**

In this research work, the effect of Titanium Di Oxide filler materials in the GFRP and on the lap joint Bidirectional ply Glass Fiber Reinforced Polymer is fabricated for changing the performance characteristics of composite. Tensile and flexural test has been carried for the above specimen. Investigation of the effect of the lap joint specimens has been carried experimentally. The results of the specimens are compared.

Keywords* : *Titanium Di Oxide, GFRP, Lap joint, Tensile strength, Flexural strength.

I. INTRODUCTION

The composites are the alternate of the engineering metals. Composites are made of fiber reinforcement in matrix with addition of fillers. The fiber reinforcement enhances the mechanical characteristics such as tensile strength, compression strength, flexural strength, impact strength, etc.

Because of its high specific strength and stiffness, these glass fiber reinforced polymers are used in aerospace industries. And also, it has good thermal and electrical resistant properties. The factors affecting characteristics of composites are types of reinforcement, matrix, fillers used.

Composite materials are also fabricated inclusion of filler material for reducing cost, for improving the physical, mechanicals performance characteristics. Sometimes many combinations of filler materials are added to improve the functional performance.

Several techniques have been used for fabricating composite materials such as hand layup method, vacuum bag moulding, filament winding etc. Hand layup tech is easiest and cost-effective manufacturing method for fabricating composites,

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In air craft industries, for fabricating structural part, one of the key process called joining process. Joint structure has to have good mechanical properties to prevent failure. In particular the strength of joint must be good enough. The joint strength can also be tested through universal testing machine.

The properties of materials and joints has to be investigated and to be recorded for database for the materials. possible.

II. SELECTION OF MATERIALS

A.Epoxy resin Matrix

Epoxy resins have at least two epoxide groups is termed as oxirane group. Variable chain length causes high pure polymer during polymerization.

Fig. 1. Epoxy Resin. (*8912 VBR*)

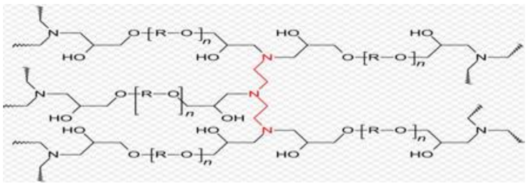

Fig. 2. Polymer cross chain link of Epoxy

B.Properties of epoxy

. Because of its high strength in polymer groups, it has been used in many applications widely. It has been uses in many electrical and electronics application due to its high electrical resistance property. And also it is chemically inert. These materials also have good adhesive properties and it can be used to adhere dissimilar metals.

C. E-glass fiber

High strength and high stiffness of glass fiber causes this fiber has been used in variety of applications. By melt spinning technique, these fibers are fabricated. Drawing a molten glass through a platinum nozzle is producing these fibers.

Fig. 3. E- Glass fiber

D. Properties of E glass fiber

These E glass fibers having simple manufacturing technique and raw materials are abundantly available. Due to this reason, it is available in low cost.

Due to its high strength and high stiffness it has the capability to use in composite materials. it is chemically inert and has good heat resistance. It serves as good electrical insulation.

E. Titanium dioxide

Titanium dioxide is used as a pigment, it is also known as titanium white.

Fig. 4. Titanium Di Oxide

. The table 1 shows the physical properties of these nanoparticles.

Table- I: Physical properties

Properties	Metric
Density	4.3 g/cm^3
Molar value	79.9438 g/mol

III. MANUFACTURING PROCESS

A. Abbreviations and Acronyms

Hand lay up techniques is used to prepare the thermosetting polymer matrix composite in the mould which has the similar shape of product.

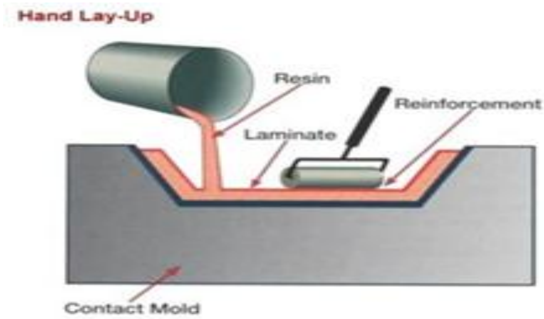

Fig. 5. Hand Layup process

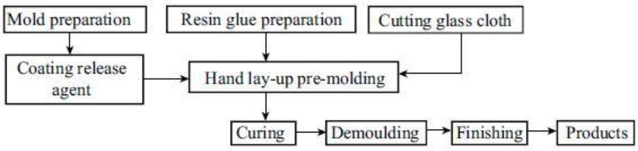

Fig. 6. Process Flow in Hand Layup Technique

IV. EXPERIMENTAL WORK

A. Preparation of specimen for tensile strength

Tensile strength is the property of material to resist breaking of material under tensional force.

As per ASTM –D-638-III, the specimen has been prepared for tensile test. MCS 60 UTE-60 universal testing machine has been used to perform the test.

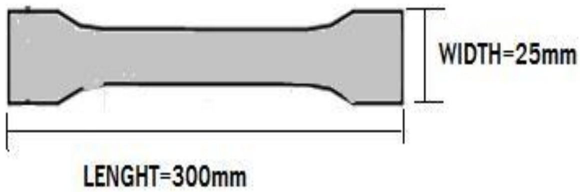

Fig. 7. Tensile strength single plate specimen

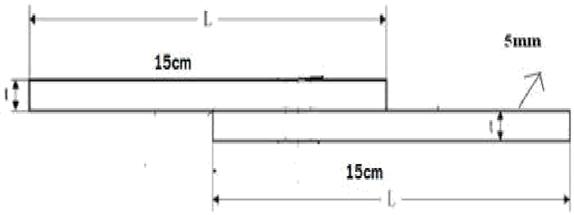

Fig. 8. Tensile strength Lap joint composite specimen

B. Preparation of specimen for flexural strength

Flexural strength is a material property the stress in a material just before it yielding.

By using three point bend test on universal testing machine UTE-60T for the specimen of size as per ASTM D-790-2003 has been prepared.

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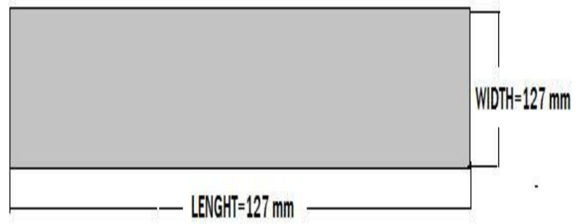

Fig. 9. Flexural strength single plate composite specimen

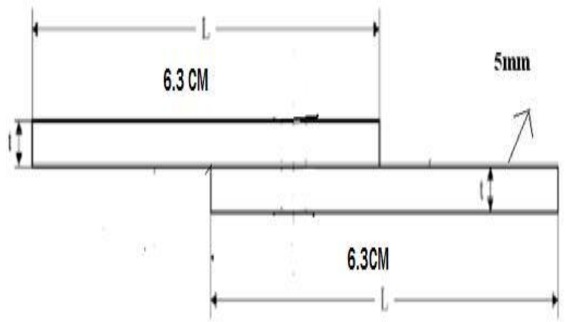

Fig. 10. Flexural strength Lap joint composite specimen

V.RESULT AND DISCUSSION

A.Results of specimen for Tensile strength and Maximum flexural load

The Table - II shows the various compositions of fillers in GFRP single plate and its tensile strengths and flexural loads are compared.

Table- II: Tensile strength and Flexural Load values of Single plate specimen

Percentage of filler mixed with matrix	Tensile strength in MPa	Maximum flexural load in KN
TiO2 (0%)	68.31	0.32
TiO2 (5%)	85.77	0.42
TiO2 (10%)	50.88	0.17

The Table - III shows the various compositions of fillers in GFRP lap joint plate and its tensile strengths and flexural loads are compared.

Table- III: Tensile strength and Flexural Load values of Lap joint specimen

Percentage of filler mixed with matrix	Tensile strength in MPa	Maximum flexural load in KN
TiO2 (0%)	7.77	0.74
TiO2 (5%)	13.48	0.41
TiO2 (10%)	14.24	0.76

B.Stress strain curve for the single plate specimens tested

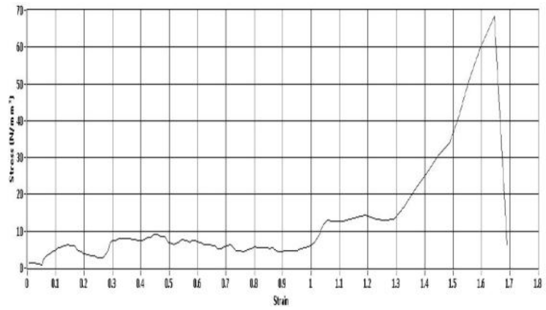

Fig. 11. Tensile stress strain curve of specimen with out TiO2

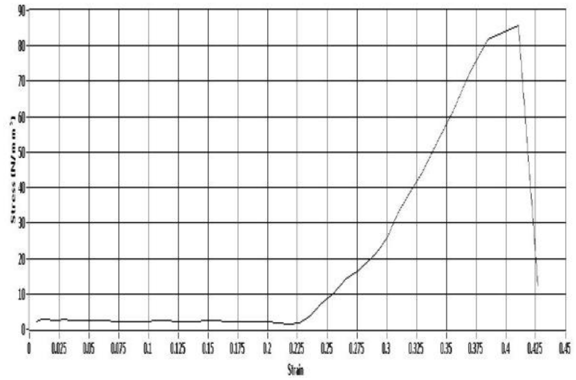

Fig. 12. Tensile stress strain curve of specimen with 5% TiO2

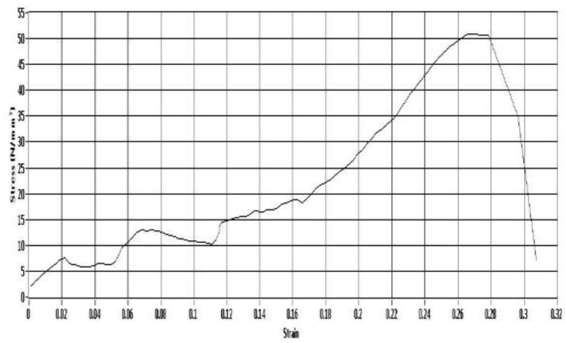

Fig. 13. Tensile stress strain curve of specimen with 10% TiO2

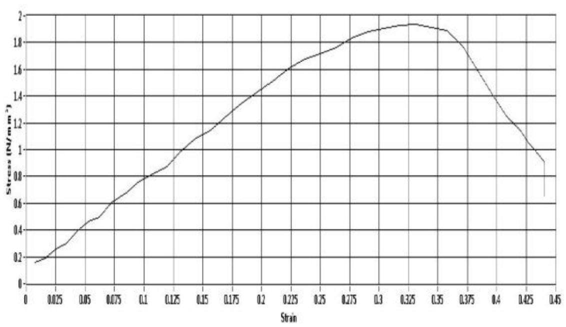

Fig. 14. Flexural stress strain curve of specimen with out TiO2

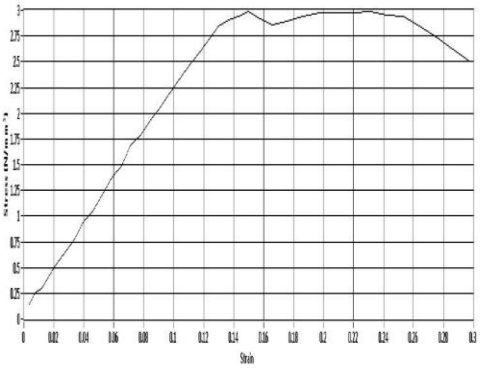

Fig. 15. Flexural stress strain curve of specimen with 5% TiO2

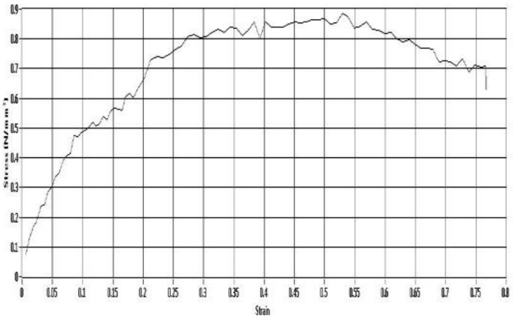

Fig. 16. Flexural stress strain curve of specimen with 10% TiO2

C.Stress strain curve for the Lap joint specimens tested

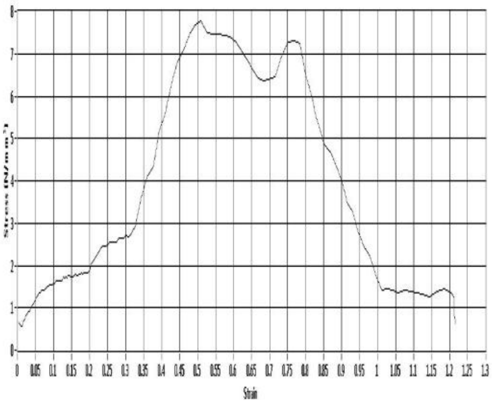

Fig. 17. Tensile stress strain curve of specimen with out TiO2

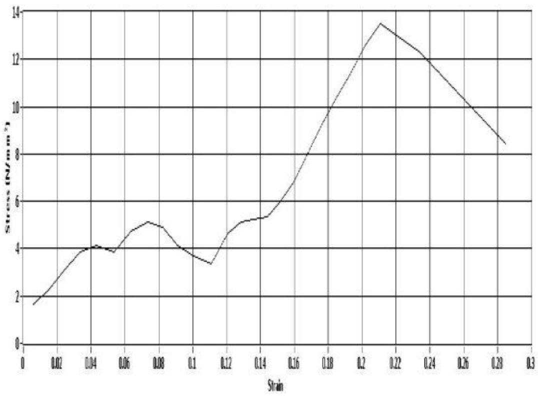

Fig. 18. Tensile stress strain curve of specimen with 5% TiO2

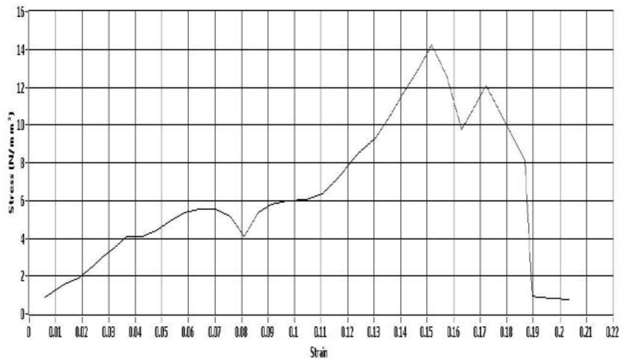

Fig. 19. Tensile stress strain curve of specimen with 10% TiO2

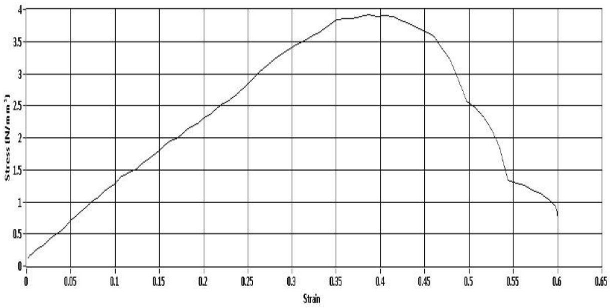

Fig. 20. Flexural stress strain curve of specimen with out TiO2

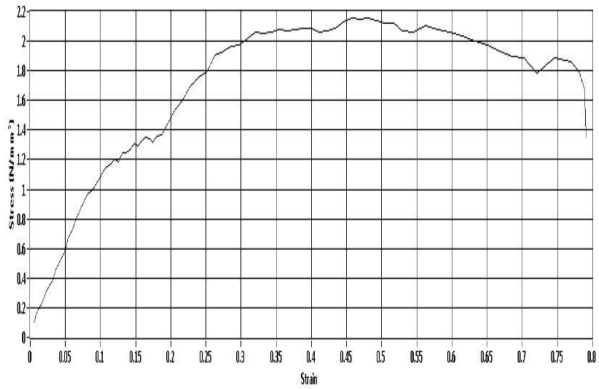

Fig. 21. Flexural stress strain curve of specimen with 5% TiO2

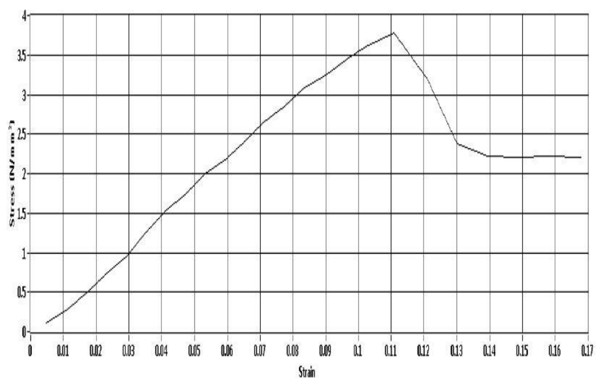

Fig. 22. Flexural stress strain curve of specimen with 10% TiO2

VI. CONCLUSION

In this work, GFRP were fabricated and the materials were machined according to ASTM standard to prepare specimens of single plate and lap joint. The tensile strength test and Flexural strength test were carried on the specimens of single plate and lap joint of different composition of TiO2 fillers. The Experimental l results for GFRP with different composition of TiO2 (0%, 5%, 10%) are obtained.

From this work, the tensile strength and flexural load are maximum of 85.77MPa and 0.42KN respectively for the 5% of TiO2 GFRP when compared with other compositions (TiO2 (0%, 10%)) results were obtained.

Then the tensile strength of the for 10% of TiO2 GFRP lap joint is maximum of 14.24MPa with other compositions. And the flexural strength of TiO2(10%) GFRP is maximum of 0.76 KN.

According to the results of tensile and flexural, 5%&10% TiO2 GFRP is suitable for Aircraft and Automobile application than 0%TiO2 GHRP.

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