EVALUVATION OF COMPRESSIVE PROPERTIES OF CHOPPED STRAND MAT E- GLASS FIBER REINFORCED EPOXY COMPOSITE

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Abstract

The advantage of composite materials is strength and stiffness together with light weight. By choosing an appropriate combination of matrix material and reinforcement material, manufacturers can produce a property that exactly matches the requirements for a particular structure. The present works aims to prepare E-glass fiber reinforced composite with variation in volume fraction of glass fiber content like 1%, 2% and 3% with Bisphenol A as matrix material. Compression tests are conducted on the prepared composite. As a final point of view, the experimental results are compared with the FEA results by using analysis software like ANSYS.

Keywords: Epoxy, E-glass fiber, Composite, FEA, ANSYS, Compression test

1. Introduction

The technological development has increased on advances in the materials field.A composite material is one, which consists of at least two materials working together to produce new material with properties that are dissimilar to the properties of individual material that they possess. It contains the most important characteristic that the materials are not soluble to each other [2]. Most composites are made up by using more than one material [4]. Most of the commonly used composite materials have a large phase, which is continuous, called as the matrix, and one distributed, on-continuous phase called as the reinforcement, which is typically stronger and harder [5].

2. Methods of preparing the composite material

The raw materials used in this work are,

1) Matrix material
2) E glass fiber (chopped strand mat)
3) Hardener

The fabrication of the composites is carried out by the hand lay-up technique. Composites of three different volume fraction variations such as1%, 2% and 3% of glass fiber are made. The matrix material was weighed to the required quantity and catalyst, accelerator, hardener and glass fiber were added to the matrix material. Proper mixing was done using a mechanical stirrer. The glass fibers are randomly oriented in the matrix. The mixture was then allowed to settle for some time to reduce the air bubbles. A releasing agent was sprayed on the surface of the aluminum mould and the mixture was then poured in it. Maximum care has been taken to maintain uniformity and homogeneity of the composite. The prepared composites slabs were cured at room temperature for 24 hours before they were removed from the mould. These slabs were then post cured in the air for another 24 hours after removing out from the mould. Specimens of suitable dimensions as per the ASTM standards are cut using an electrically operated cutter for mechanical testing. Tabs of the same parent material were cut and were bound to the test specimen using the commercially available adhesive. At least three test specimens for each variant of the volume fraction (1%, 2% and 3% of glass fiber) were prepared.

3. Experimental setup and conducting the test

3.1 Compression test

Compression tests provide information about the compressive properties of plastics when employed under conditions approximating those under which the tests are made. The test specimens are prepared for compression test were cut as per ASTM D695 specification. The universal testing machine used for compression test as shown in above figure. As per ASTM D695 the specimen geometries are 12.7mm x 12.7mm x 25mm (length x width x height) as shown in fig 3.1

Fig 3.1: Specimen for compression test

The universal testing machine set-up chosen has maximum loading capacity of 100kN. The machine has two crossheads one is adjusted for the length of the specimen and the other is driven to apply the load to the test specimen. The test process involves placing the test specimen in the testing machine, Measure the width and thickness of the specimen. Measure the length of the specimen and recorded the value.

The specimen was placed between the surfaces of the compression tool; care should be taken to bring into line of its long axis with the center line of the plunger and to ensure that the ends of the specimen are parallel with the surface of the compression tool. Adjust the crosshead of the testing machine until it just contacts the top of the compression tool plunger. Calculate the compressive strength by dividing the maximum compressive load carried by the specimen during the test by the original minimum cross sectional area of the specimen.

Fig 3.2 Specimen held at Universal testing machine for compression test.

Fig 3.3: Specimen before and after the test

The load is applied gradually then specimen starts compression until the specimen breaks. During the application of loading, the compression of the specimen is recorded against the applied load. Finally the specimen decreases its length shown in the fig 3.3.

4 Experimental Results

Specimens	1%	2%	3%
Load (kN)	**12.91**	**15.3**	**16.04**
Deformation (mm)	**2.06**	**2.42**	**3.06**

4.1 Deformation v/s Load

1. Compression test results

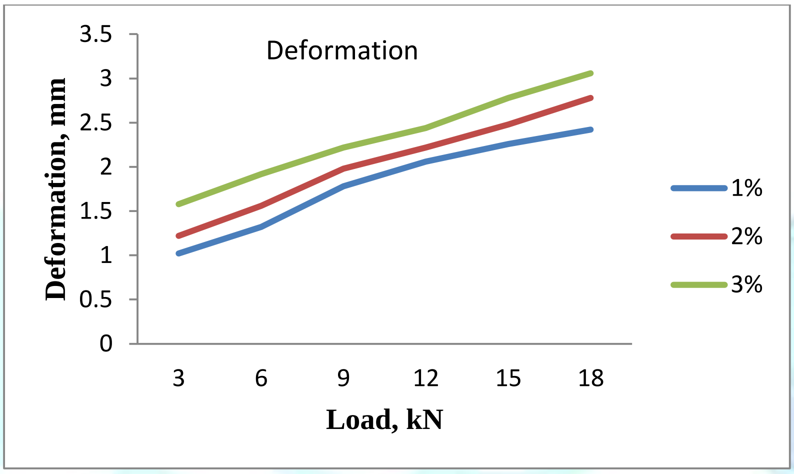


Fig 4.1 Mean deformation for compression test for 1%, 2%, 3%

Figure 4.1 clearly shows that with increasing the % of glass fiber content, the deformation also goes on increasing. From fig 6.9 to fig 6.11 shows that the deformations for different % variations of glass fiber content. Fig 6.12 shows that comparison of deformation in different % variations of glass fiber, it results that the maximum deformation occurs at 3% of glass fiber contents which increases the load bearing capacity. An experimental result indicates that, when load increases the deformation also increases and also whenever the percentage (%) of glass fiber content increases, the load and deformation also increasing.

4.2 Parameters chose as input to FEA

In ANSYS 14.5 software chose following input parameters for analysis purpose and also selects static structure and advanced composite tools.

1. Analysis type: ANSYS 14.5
2. Engineering data sources: Composite materials

3. Contents of composite materials: a) Epoxy E-glass UD
   b) Resin Epoxy PR500/1250
4. Stiffness behavior: Flexible
5. Material properties:
   a) Young's modulus: 80Gpa
   b) Poisons ratio: 0.35
   c) Density (gms/cc): 2.58

These above mentioned engineering data and materials properties are required to analyze the prepared composite specimens so we can created one model and meshed it.

Finite element Analysis is a numerical method of a complex system into very small pieces called elements. The software uses equations that generate the behavior of these elements and solves them all. The results can be presented in tabulated as above.

4.2.1 Compressive Test Results

Compressive analysis is done by using one end is fixed and other one is applying a compression as shown below

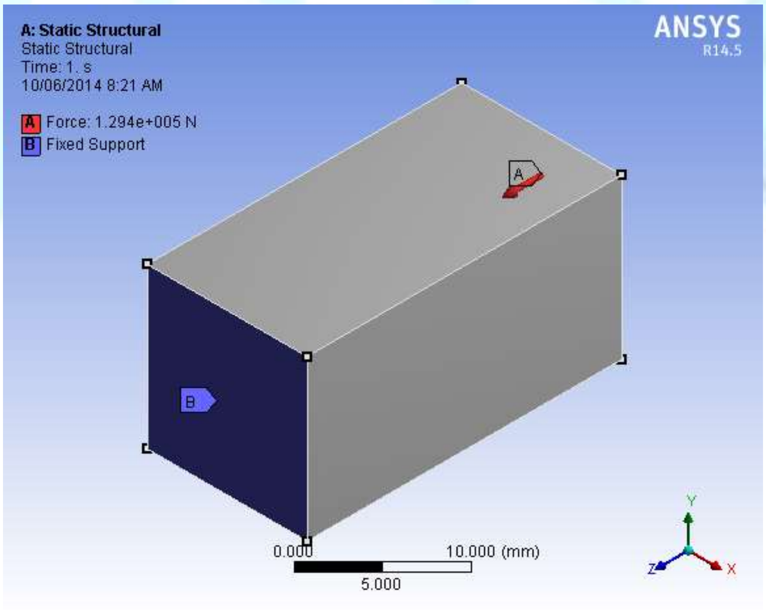
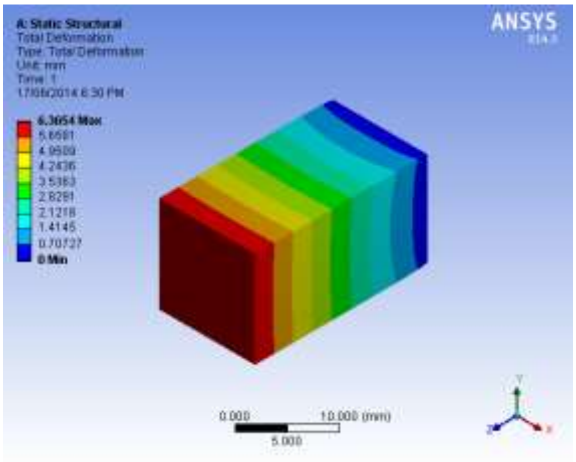


Fig 4.1 One end fixed and one end load applied



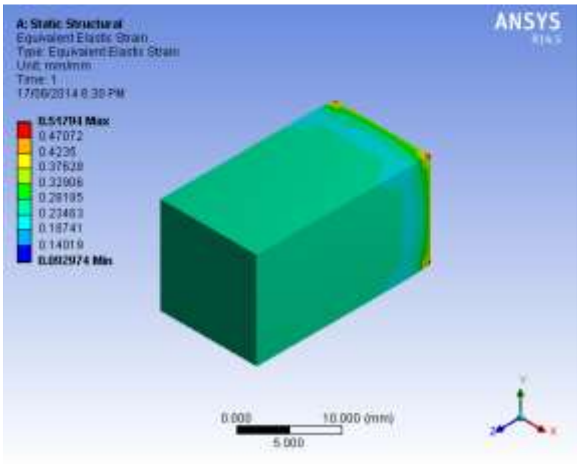


Fig 4.2 Total Deformation for pure epoxy Fig 4.3 Elastic strain for pure epoxy

Above fig 4.2shows the Total Deformation for pure epoxy under the 12.2e4 kN load. The Total deformation for pure epoxy, max is 6.365 mm. Above fig 4.3 shows the Elastic strain for pure epoxy under the 12.2e4 kN load. The elastic strain for pure epoxy, max is 0.5179 and min is 0.0929.

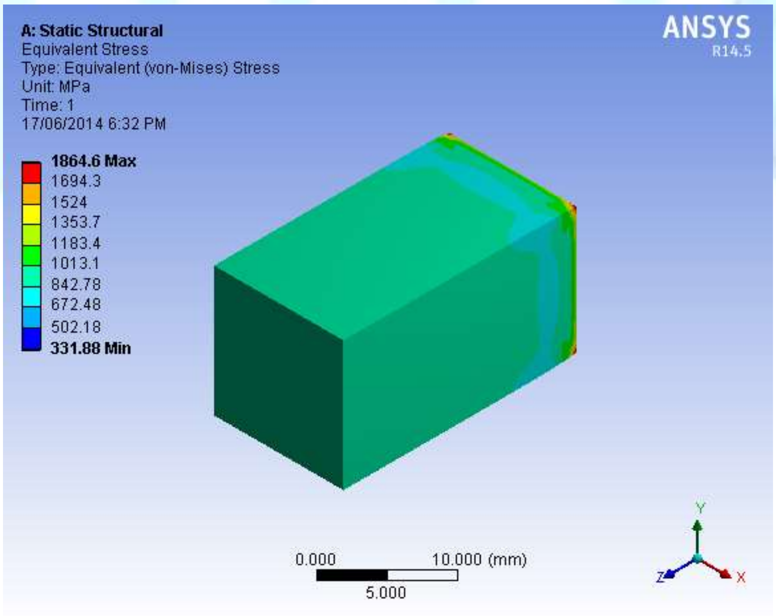


Fig 4.4 von misses stress for pure epoxy

Above fig4.4 shows the von-misses stress for epoxy under the 12.2e4 kN load. The von0mises stress for pure epoxy, max is 1864.6 mpa and min is 331.88 mpa

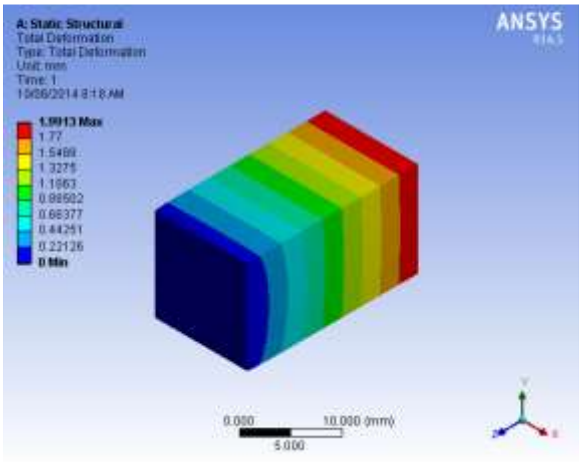


Fig 4.5 Total Deformation for1%

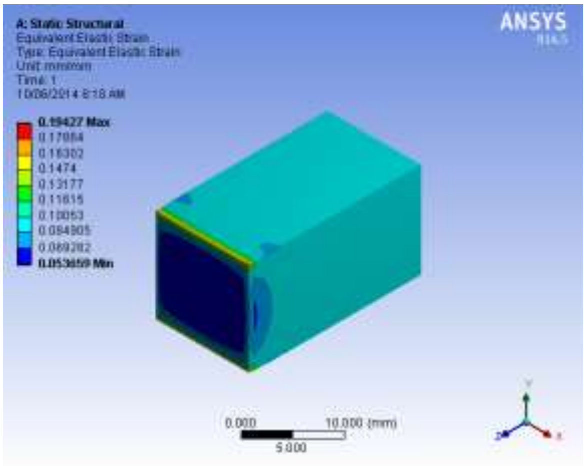


Fig 4.6 Elastic Strain for 1%

Above fig 4.5 shows the Total Deformation for 1%of glass fiber under the 12.91e4 kN load. The Total deformation for 1% of glass fiber, max is 1.9913mm. Above fig 4.6 shows the Elastic strain for 1%of glass fiber under the 12.91e4 kN load. The elastic strain for 1% of glass fiber, max is 0.1942 and min is 0.05365

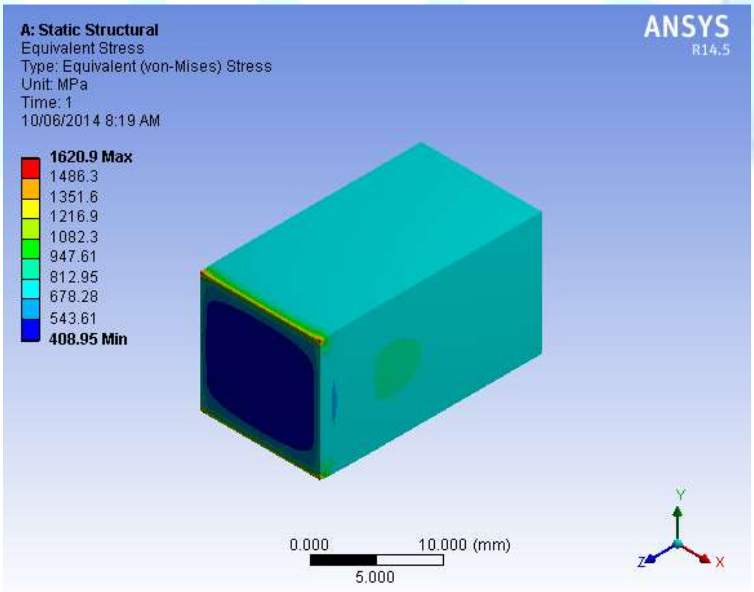


Fig 4.7 Von-misses Stress for 1%

Above fig 4.7 shows the von- mises for 1%of glass fiber under the 12.91e4kN load. The von-mises stress for 1% of glass fiber, max is 1620.9 mpa and min is 408.95mpa.

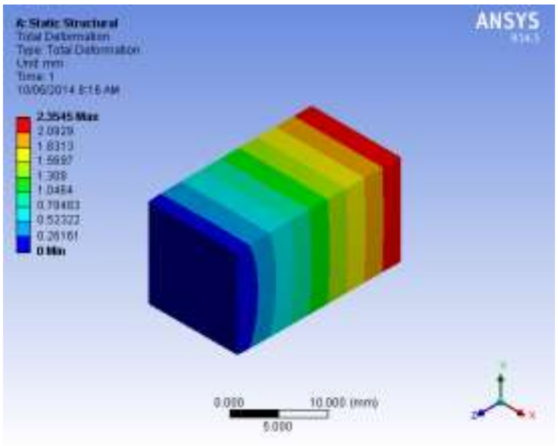


Fig 4.8 Total Deformation for 2%

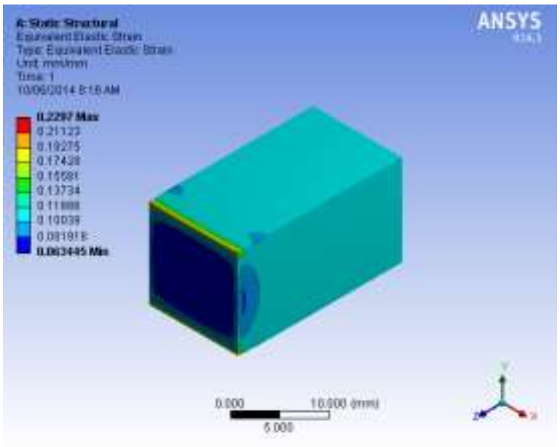


Fig4.9 Elastic Strain for 2%

Above fig 4.8 shows the Total Deformation for 2%of glass fiber under the 15.3e4 kN load. The Total deformation for 2% of glass fiber, max is 2.3545 mm. Above fig 4.9 shows the Elastic strain for 2%of glass fiber under the 15.3e4 kN load. The elastic strain for 2% of glass fiber, max is 0.2297 and min is 0.06344.

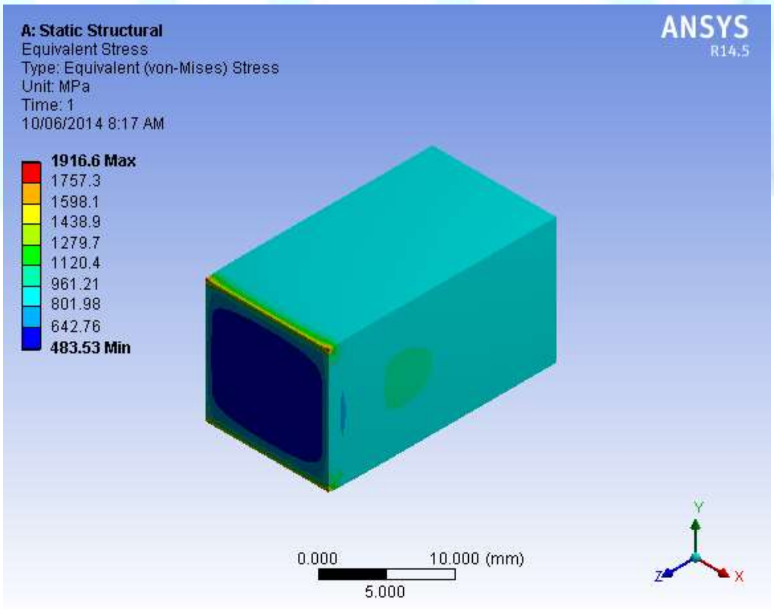


Fig 4.10 Von-misses Stress for 2%

Above fig 4.10 shows the von-mises for 2%of glass fiber under the 15.3e4 kN load. The von-mises for 2% of glass fiber, max is 1916.60 mpa and 483.53mpa.

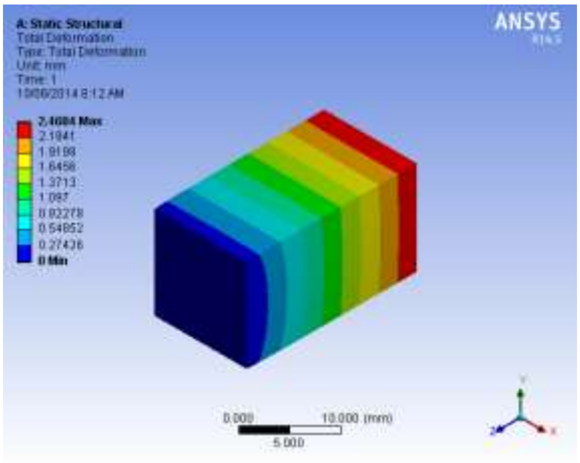


Fig 4.11 Total Deformation for 3%

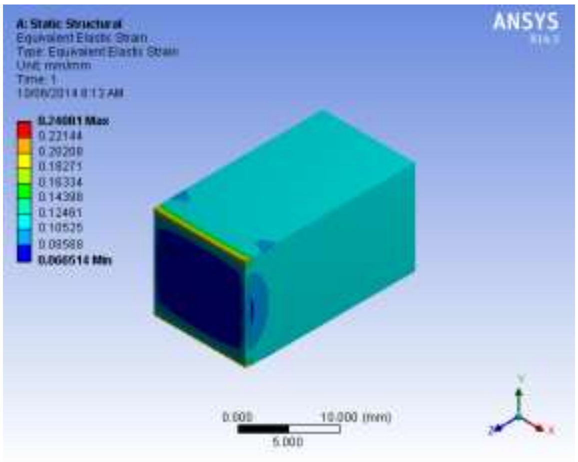


Fig 4.12 Elastic Strain for 3%

Above fig 4.11 shows the Total Deformation for 3%of glass fiber under the 16.04e4 kN load. The Total deformation for 3% of glass fiber, max is 2.4684 mm. Above fig 4.12 shows the Elastic strain for 3%of glass fiber under the 16.04e4 kN load. The elastic strain for 3% of glass fiber, max is 0.2408 and min is 1.06651

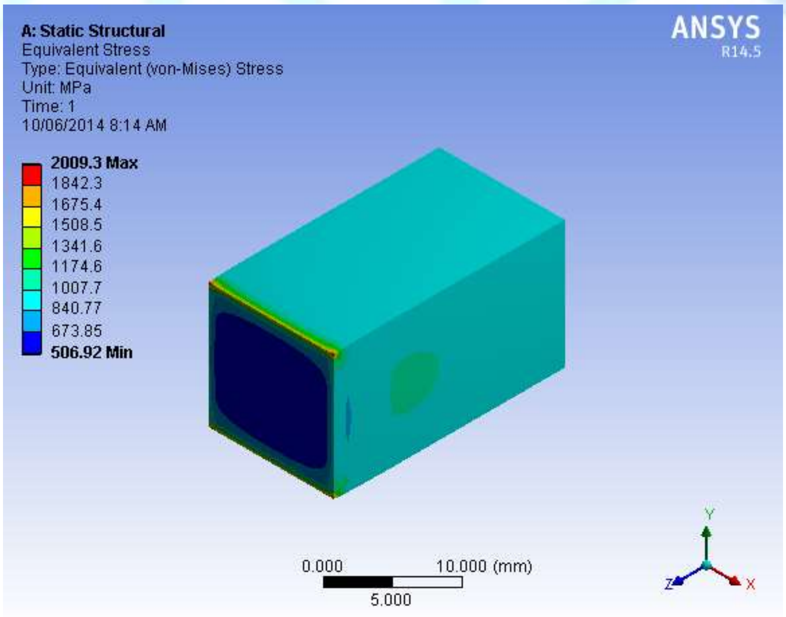


Fig 4.13 Von-misses stress for 3%

Above fig 4.13shows the von-mises stress for 3%of glass fiber under the 16.04e4 kN load. The von-mises for 3% of glass fiber, max is 2009.3 mpa and min is 506.92 mpa.

5 Validation of Experimental and ANSYS Results

5.1 Compression test

% of glass fiber	Load (kN)	Deflection from Experimental, mm	Deflection from FEA (ANSYS), mm	Error between Experimental and FEA in mm
1%	12.91	2.06	1.991	0.07
2%	15.3	2.42	2.354	0.06
3%	16.04	3.06	2.468	0.6

Table 5.1 Comparison of FEA and experimental deformation for Compressive test

Table 5.1 shows that the experimental deformation is more than the FEA deformation because this difference can be observe that due to the presence of inhomogenities such as air bubbles are present in the specimens and also improper mixture of reinforcement and matrix.

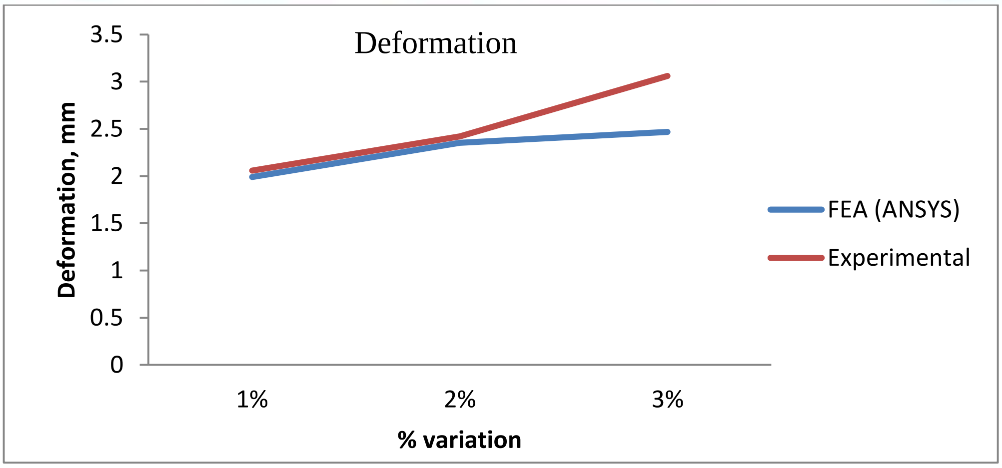


Fig 5.2 Comparison of FEA and experimental deformation for compressive test

Figure 5.2 shows that the experimental deformation is more than the FEA deformation because this difference can be observe that due to the presence of inhomogenities such as air bubbles are present in the specimens and also improper mixture of reinforcement and matrix.

CONCLUSION

The present work concludes the successful preparation of composite materials by using the E glass fiber reinforced epoxy composite testing of new class of epoxy composites reinforced with using the glass fiber and the bisphenol A as a matrix material is done. This work deals with the testing and evaluation of compressive properties of the E glass fiber reinforced epoxy composites.

The compressive properties are analyzed by using compression test. From this test we conclude that compressive modulus for 2% is more than the 1% and 3% of glass fiber content from the FEA (ANSYS) analysis. The result from the FEA and experimental values matches nearly. The experimental values are more than the FEA values.

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