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TENSILE TEST ANALYSIS OF NATURAL FIBER REINFORCED COMPOSITE

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Abstract: This project mainly deals with analysis of tensile properties of Palmyra fiber Reinforced Epoxy Composite that is suitable for automobile application. First, the property of material was obtained on the basis of some assumptions (i.e., Rule of Mixture) and was modeled with reference to ASTM D638. Here the simulation was carried out on specimen under different fiber volume fraction and fiber length. The present work includes the Analysis of Palmyra Fiber Reinforced Epoxy Composites using FEA with various fiber volume fractions and these results were validated with the experimental result. The tensile property of Palmyra fiber composite material can be obtained by using tensometer. During the tensile load, the maximum strain, stress and displacement were obtained and, then this experimental result was compared with the analytical results and the error percentage of these results were calculated.

Keyword: Palmyra natural fiber, Epoxy resin, Tensile strength, Ansys solving

1. METHODOLOGY

The Palmyra natural fiber and epoxy resin are select for this project and fabricate the tensile test specimens according to the ASTM standard (D638). As per the dimension the Palmyra natural fiber and epoxy composite is manufacturing different volume fraction of fiber and resin. The prepared D638 specimens were tested by using tensometer and list the results. The analytical result has is get from ansys software as per the composite analytical procedure. Compare the experimental and analytical values. In such a comparison helps to known the tensile strength of the any natural fiber composite materials.

2. FIBRE EXTRACTION PROCES

The Palmyra fibers available from Palmyra tree. Palmyra fruits were cut and tied in to the bundles and retted in the water for a week. The retted fruits were washed in running water. Then the fruits are beaten with a thick round mallet until the fleshy matter is dusted off. The fibers were cleaned and dried in sunlight.



Fig2.1 Palmyra fiber

3. CHEMICAL TREATMENT

Fiber were treated with 5% aq. NaOH solution and washed in distilled water. Then these fibers were washed with very dilute acid (HCL) to remove any particles of alkali. Then the fibers were washed with in water. Finally these fibers were washed with distilled water until the fibers were alkali free. Then the washed fibers were dried in shadow.



Fig3.1. Palmyra treated fiber

4. FIBRE PREPARATION

Both treated and untreated fibers were chopped uniformly at a length of 3mm and 5mm. these fibers were mixed thoroughly with the ratio of based on the rule of mixture.

5. SELECTION OF RESIN

In this present work epoxy LY556, mixed with hardner HY951 was used as matrix material. The weight ratio of mixing epoxy and hardener was 1:4.

6. COMPOSITE FABRICATION

Composite plates are prepared with mixer of epoxy and Palmyra fiber. The weighted amounts of treated and untreated fiber were taken, and cleaned the dust from fiber. The fiber cut for different length, 3mm, and 5mm.

The epoxy resin act as a bonding material of the composite plate. Based on The rule of mixture the fiber and resin were mixed. Previously defined the best volume fraction 0.4 to 0.6 is mainly suites for composite material. The selected volume fraction of fiber and resin were mixing together based on rule of mixer. As like the, same procedure was followed for treated and untreated fibers for different length and volume fraction offiber. The combination of fiber and resin made a composite plate.

The fiber and resin mixer pour in to the prepared die with respect to the height of composite plate. The short hammer used for rammung the fiber and resin mixer in the die. The upper plate was placed on the die plate were used applied pressure on the mould. While fabrication of the composite plate high pressure applied on the upper plate After 24 hours, the composite plate was removed from die set.



Fig6.1 composite plate fabrication

7. CUTTING THE ASTM D638 MODEL SPECIMEN

1. The prepared composite plate were cut ASTM specimen dimension shown in fig below D638 tensile test specimen.

2. The burrs were removed with smooth emery cloth and the specimens were cleaned.



Fig7.1ASTM D638 specimen

8. EXPERIMENTAL PROCEDUR

The procedure for conducting the tensile test in a tensometer as follows.

- The ASTM D638 composite tensile test specimen was checked for dimension.
- The specimens were clamped in the fixture of the tensometer.
- The machine was switched ON and the stepper motor in the tensometer gradually applied the tensile load on the specimen.
- The strain gage which is connected in the tensometer, measured the displacement value.
- The specimen was cut in two piece, after critical load applied on the specimen. Shown in fig.
- The stress and strain value were noted from the computer which is coupled with the tensometer.



Fig8.1braked specimen with machine

Fibre length (treated fiber)	Load N	Strain	Stress (N/sq. mm)	Displacement (mm)
3 mm	1618.2	0.129	20.9	6.485

	1667.2	0.126	20.64	6.341
5 mm	1618.16	0.436	20.34	7.181
	1882.94	0.152	23.84	7.606
	2059.47	0.159	26.24	7.962

Table 8.1 result for treated fiber

Fibre length (untreated fiber)	Load N	Strain	Stress (N/sq. mm)	Displacement (mm)
3 mm	1304.33	0.151	16.5	7.552
	1529.89	0.144	19.23	7.198
5 mm	1500.47	0.159	19.11	7.954
	1765.26	0.142	22.16	7.113
	1500.47	0.113	18.69	6.680

Table 8.2 result for untreated fiber

9. TENSILE TEST RESULT FOR ANSYS

The tensile test is generally performed on ASTM specimens. The commonly used specimens for tensile test are the dog-bone type and the straight side type with end tabs. During the test a uni-axial load is applied through both the ends of the specimen. The ASTM standard test method for tensile properties of fiber resin composites has the designation D638. The length of the test section should be 203.2 mm. The tensile test results SUCH AS Stress, Strain and Displacement are analyzed.

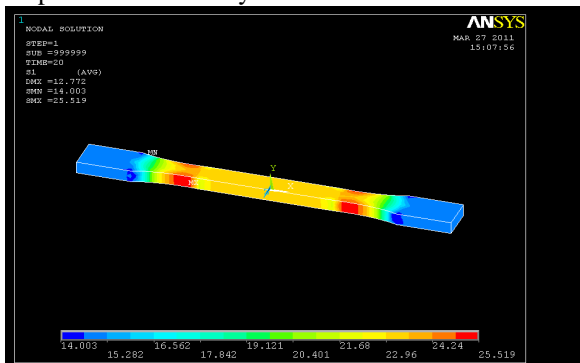


Fig.9.1 Stress Distributions on Composite Plate

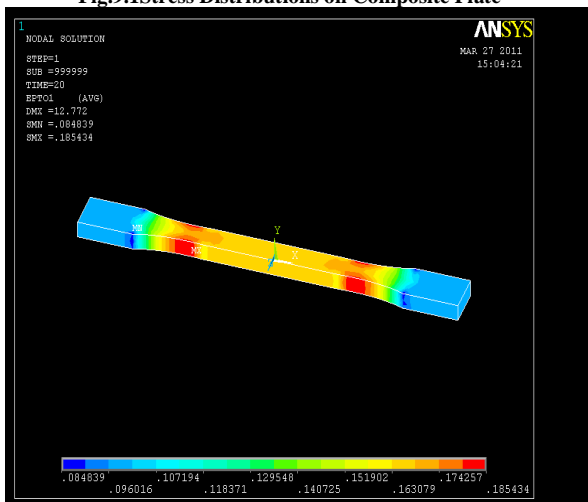


Fig. 9.2 Strain Distributions on Composite Plate

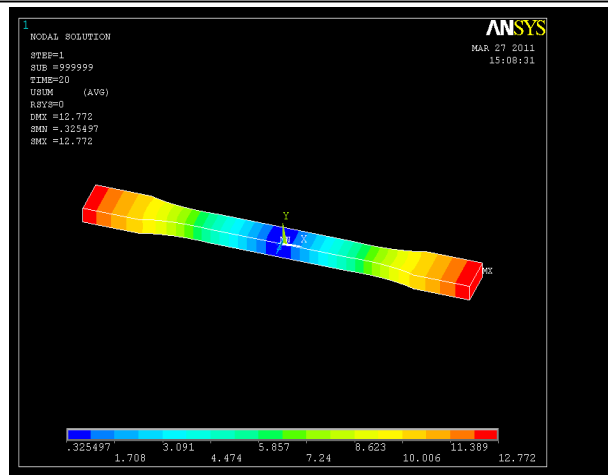


Fig.9.3 Displacement on Composite Plate

10. STRESS VS STRAIN CURVE

The stress vs strain curve was plotted by using experimental results. The X-axis indicates stress value and Y-axis indicate strain value.

11. LOAD VS DISPLACEMENT CURVE

The load vs displacement curve was plotted by using experimental results. The X-axis indicates displacement value and Y-axis indicate load value.

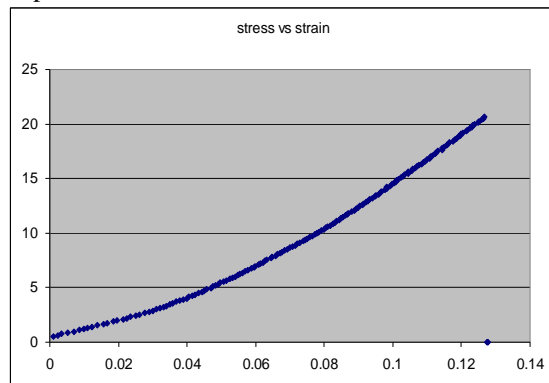


Fig11.1 Stress Vs Strain curve

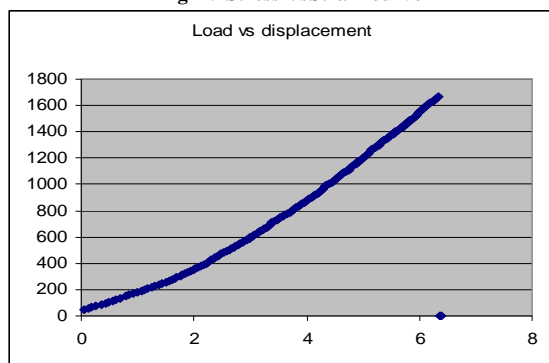


Fig11.2 load vs displacement curve

12. PERCENTAGE OF ERROR CALCULATION

The percentage of error can be calculated based on the comparison of experimental and

analytical results. The results were shown in the tables. The analytical values from ansys were obtained by applying the maximum load at failure and the results were compared with the experimental results. The error percentage between these two was illustrated in the table.

Fibre length (untreated fiber)	Experimental strain	Analytical strain	% of error
3 mm	0.151	0.162	6.790
	0.144	0.163	11.65
5 mm	0.159	0.193	17.61
	0.142	0.174	18.39
	0.113	0.133	15.037

Table 12.1 error percentage of strain (untreated fiber)

Fibre length (untreated fiber)	Experimental stress	Analytical stress	% of error
3 mm	16.5	18.961	24.86
	19.13	23.450	24.8
5 mm	19.23	23.31	14.6
	22.16	22.29	5.84
	18.69	23.31	19.09

Table 12.2 error percentage of stress (untreated fiber)

Fibre length (treated fiber)	Experimental strain	Analytical strain	% of error
3 mm	0.129	0.135	4.44
	0.126	0.130	3.07
5 mm	0.436	0.417	4.35
	0.152	0.169	10.05
	0.159	0.182	12.63

Table 12.3 error percentage of strain (treated fiber)

Fibre length (treated fiber)	Experimental stress	Analytical stress	% of error
3 mm	20.9	23.519	11.13
	20.64	25.982	20.5
5 mm	20.34	23.247	12.50
	23.84	26.921	11.44
	26.24	25.943	1.131

Table 12.4 error percentage of stress (treated fiber)

13. GRAPH COMPARISON

The following graph were plotted to compare and visualize the analytical and experimental results.

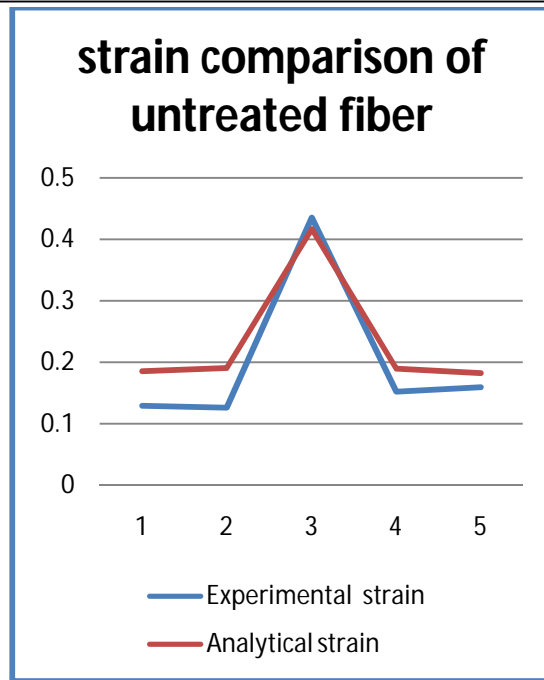


Fig 13.1 strain comparison of untreated fiber

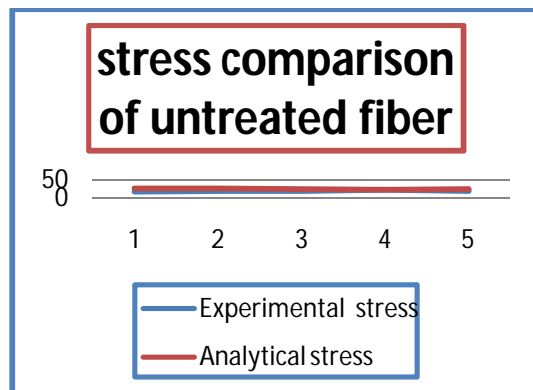


Fig 13.2 stress comparison of untreated fiber

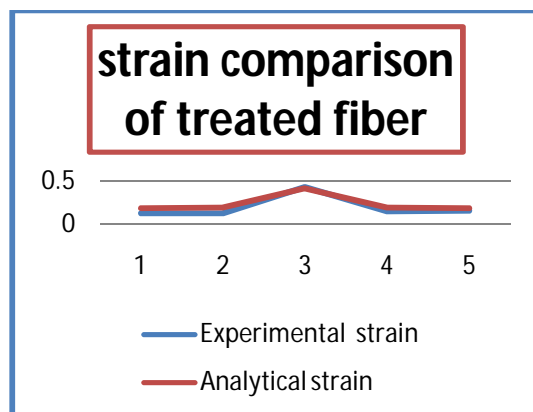


Fig 13.3 strain comparison of treated fiber

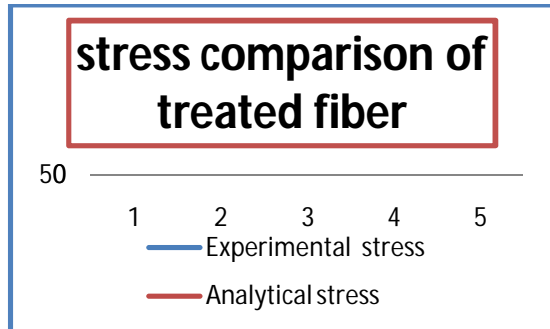


Fig 13.4 stress comparison of treated fiber

14. CONCLUSION

The exploration of mechanical properties of natural fiber reinforced composite was done by using analytical method and experimental method. The analytical software, ansys12 was used to solve the analytical method. Palmyra fibers and resin were mixed, based on the rule of mixture. The epoxy resin and Palmyra fiber were mixing together to make the composite plate.

This project mainly focuses on tensile strength of Palmyra nature fiber composite. The ASTM (D638) specimens were used to done the tensile test. Tensometer machine was used to determine the experimental result. The experimental results were compared with the analytical result and error percentage was determined. From the comparison tables it was proved that the tensile test for the composite ASTM can be done with the guide of ansys software itself with less error percentage. The costly procedure of making the plates and conducting real time destructive experiments may be varied. This project work facility the research for doing their tensile test analysis for various fiber and resin with the help of procedure derived in this project work.



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