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# Effect of Change Angle the Template used in Tests of Composite Materials on the Value of Modulus of Elasticity

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***Abstract***- In this paper we study the effect of change angle the template in tests of composite materials on the value of modulus of elasticity. Used two models of templates the first acute angles and the second non- acute angles and used two specimens of a composite material in experiments. Many strain gauges has been installed on the template models in the region of maximum stress is expected and the other near the edges of the template, in testing the equipment's used were equipment's tensile testing of materials. From the results has been reached that the acute angle to the edge of the template affect the results of a strain gauges which installed in the region of maximum stress and which negatively affects the value of the stress intensity. The results indicated that the value of modulus of elasticity when the template is a non-sharp angle more accurate than the results obtained when the sharp angle of the template, the reason is that some of the stress is lost near the edge of the template. The results obtained in the models we obviously in ANSYS program were identical with the results obtained from the models used in the experiments.

***Keywords-*** *composite materials, modulus of elasticity, template, strain gauge.*

## INTRODUCTION

Composites consist of two or more phases that are usually processed separately and then bonded; resulting in properties those are different from those of either of the component materials. Composites have been used throughout history, i.e., straw in bricks, metal rod-reinforced concrete, and lightweight aerospace structures. Fiber reinforced polymer matrix composite materials are being introduced in ever-increasing quantities in military systems and have become a key element in the Department of Defense's effort to lighten the force. However, polymer matrix composites have an inherent temperature limitation based on their hydrocarbon structure. The high temperature alternative to high density metals is ceramics, offering weight savings as well high temperature capability and oxidation resistance [1, 2]. Stress-strain curves are an extremely important graphical measure of a material's mechanical properties, and all students of Mechanics of Materials will encounter them often. However, they are not without some subtlety, especially in the case of ductile materials that can undergo substantial geometrical change during testing. This module will provide an introductory discussion of several points needed to interpret these curves and in doing so will also provide a preliminary overview of several aspects of a material's mechanical properties [3, 4]. Mechanical properties of the natural fiber composites depend on several factors such as the stress–strain behaviors of fiber and matrix phases, the phase volume fractions, the fiber concentration, the distribution and orientation of the fiber or fillers relative to one another. It can be seen that tensile strength and elastic module of the composites increase with an increase of the filler content. The composites demonstrate somewhat linear behavior and sharp fracture [5-7].

In this paper we study the effect of angle change the template used in tests of composite material on the value of modulus of elasticity. From the testing we found that the acute angle reduces the value of the modulus of elasticity because it reduces the value of maximum stress.

## ANSYS MODEL

Two models in ANSYS were selected first model was the corners as acute in Figure1. The second model was the angle is as non-acute in Figure 2.

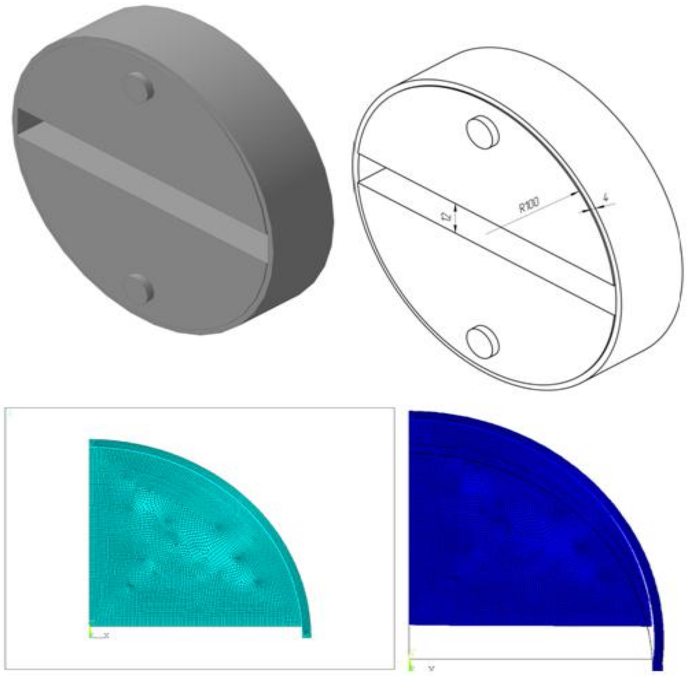

Figure 1 The first model in ANSYS shows acute angles

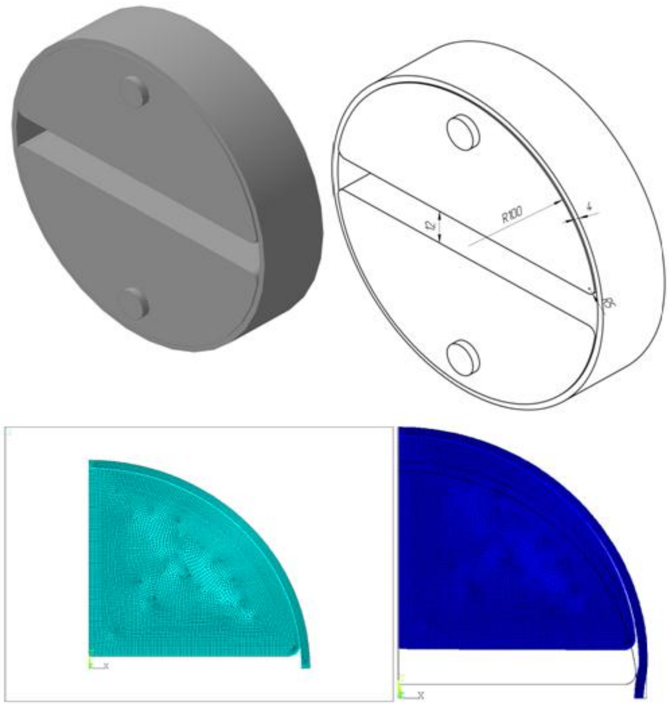

Figure 2 The second model in ANSYS shows the non-acute angles.

Figure 3Shows the comparison between the stress and strain of the results obtained from tests. From the figure shows that the values of the strain of the first model was more of the values obtained in the second Model but the values of modulus of elasticity in each case was comparable to other.

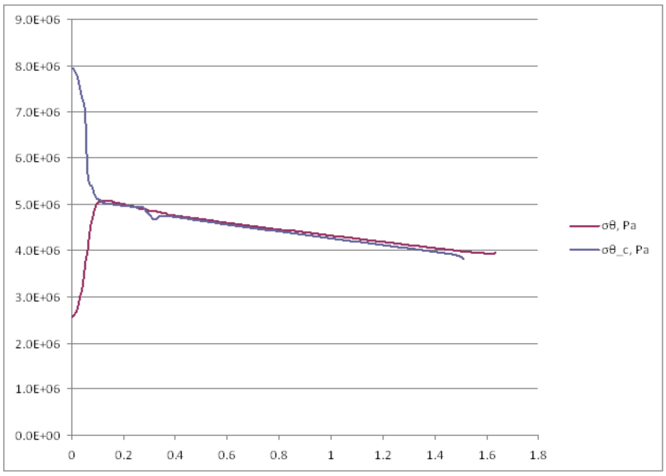


Figure 3 Shows the comparison between the stress and strain of the results

EXPERIMENT DETAILS

Two models were selected first model was the corners as acute in Figure4. The second model was the angle is as non-acute in Figure 5.

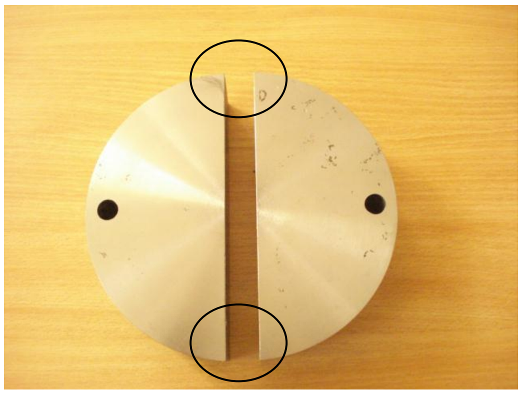

Figure 4 The first model shows acute angles

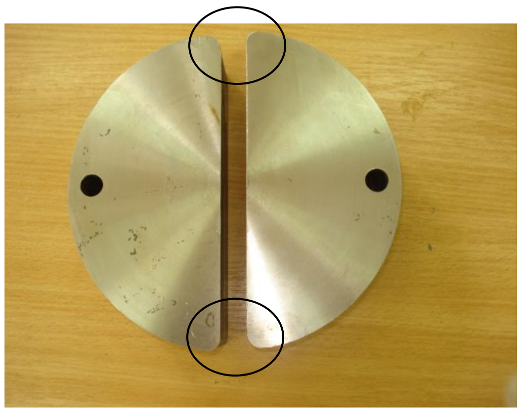

Figure 5 The second model shows the non-acute angles.

Filament wound composite materials are used in commercial industries such as fuel tank, portable oxygen storage, and natural gas. The fibers used were semicircular bars. The bars typically 196 mm inner diameter, 200 mm outer diameter, 4 mm thickness, 48.3 mm width shown in figure 6 (a, b).

Figure 6 (a, b) Shown the bars, strain gauges and instruments were used in experiment.

Figure 7, 8.Shown the analysis forces and moments in the model 1 and model 2. The stresses calculate from there equation

$$\sigma_{\theta} = \frac{P}{2A} \pm \frac{M.C}{I}$$

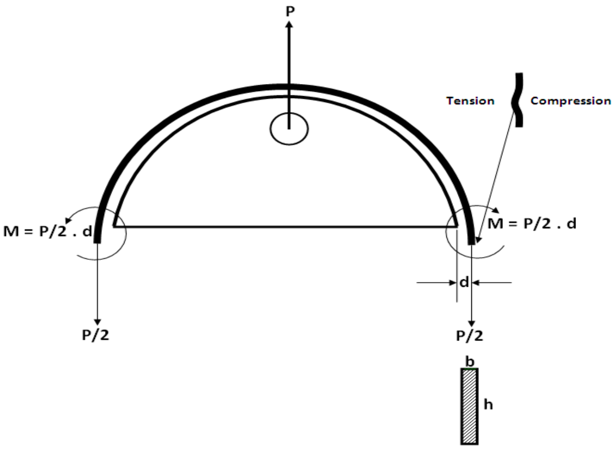


Figure 7 Shown the analysis forces in model 1.

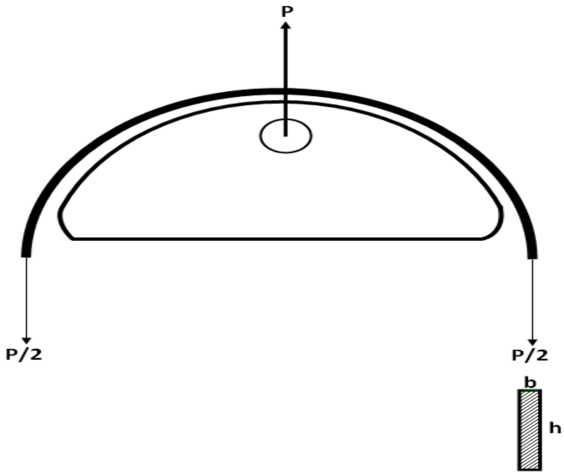


Figure 8 Shown the analysis forces in model 2.

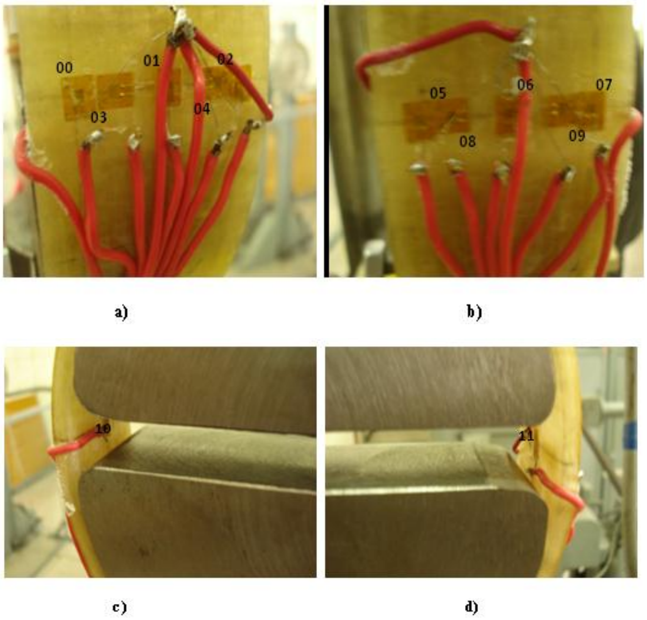


Figure 9 (a, b, c, d) Shows how to link the strain gauges on the models.

## RESULTS AND DISCUSSION

Method has a number of experiments using two templates the first has acute angle and second non- acute angle shown in Figures (4, 5). Readings were taken in the strain gauges (00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 10,11) and start the process of conducting experiments to register readings when the load is equal to zero and then added 100 kg each time to end pregnancy 2000 kg readings are recorded every time.

Results were analyzed by using the Excel program to convert the readings in results in strain gauge to strains (ε) and then find the values of the modulus of elasticity by using Hooke's law of elasticity. The medium value of modulus of elasticity equal ($4.46*10^4$ MPa) .Obtained the desired results of the modulus of elasticity are shown in figures 8, 9, 10, 11.

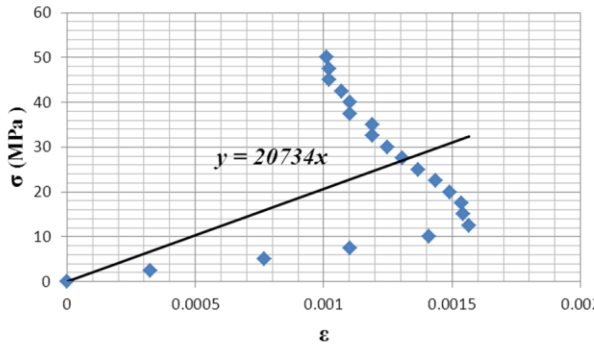


Figure 8 Shown results of modulus of elasticity when first test for model 1.

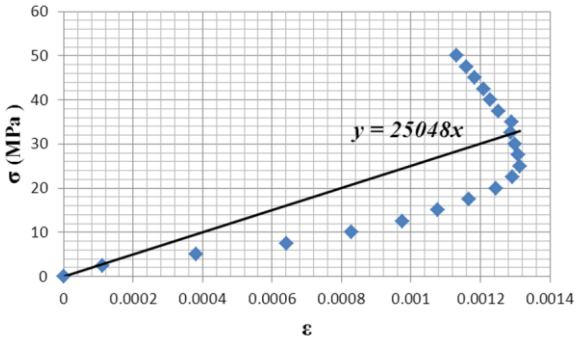


Figure 9 Shown results of modulus of elasticity when second test for model 1.

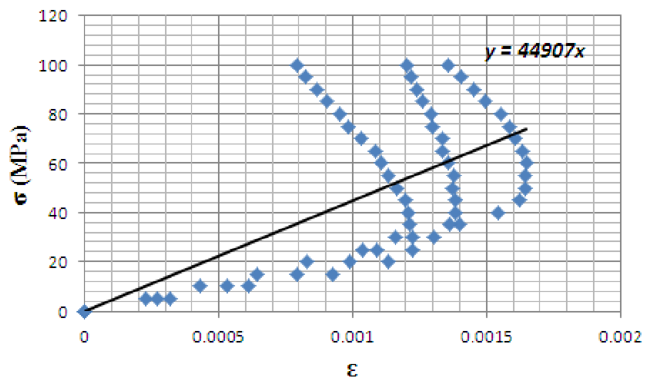


Figure 10 Shown results of modulus of elasticity when first test for model 2.

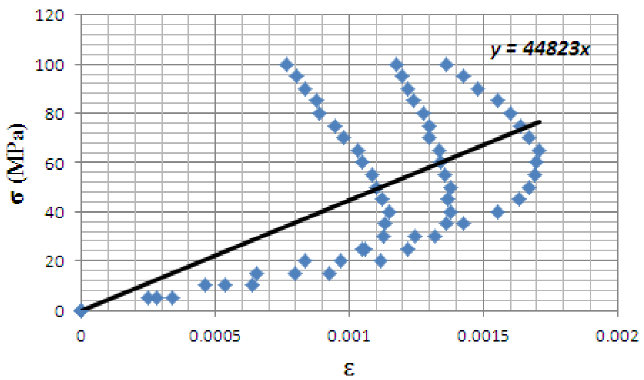


Figure 11 Shown results of modulus of elasticity when second test for model 2.

Figure 12.Shows the comparison between the stress and strain of the results obtained from tests. From the figure shows that the values of the strain of the first model was more of the values obtained in the second Model but the values of modulus of elasticity in each case was comparable to other.

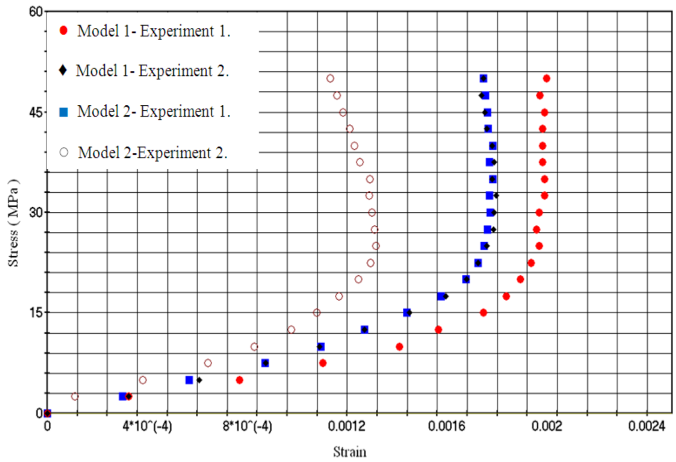


Figure 12 Show the comparison between the stress and strain of the results

Table (1) shows the results obtained from the analysis of readings in the strain gauges by using the Excel program and the Method of finding the slop between two points on the line. From the results in the first model the value of modulus of elasticity ($E_1$) was greater than the value of the modulus of elasticity ($E_2$) by equal ($0.163*10^4$ MPa), while in second model the value of modulus of elasticity ($E_1$) was greater than the value of the modulus of elasticity ($E_2$) by equal ($0.1886*10^4$ MPa) where the rate difference between two experiment equal ($0.1758*10^4$ MPa).

TABLE 1 Shown the results of the modulus of elasticity.

| Tests | Modulus of elasticity $E_1$ for model 1 Mpa | Modulus of elasticity $E_2$ for model 2 Mpa | Deference between $E_1$ & $E_2$ Mpa |
|---|---|---|---|
| 1 | $2.0734*10^4$ | $4.473*10^4$ | $0.2481*10^4$ |
| 2 | $2.0039*10^4$ | $4.467*10^4$ | $0.1885*10^4$ |
| Average | $2.03865*10^4$ | $4.470*10^4$ | $0.2183*10^4$ |

## CONCLUSION

The results indicated that the value of modulus of elasticity in the second model (when the template is a non-sharp angle) more accurate than the results obtained in the first model (when the sharp angle of the template), the reason for this, please be stress near the edge of the model to be high when the sharp corner.

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