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Experimental Stress Analysis of Composite Circular Disc

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Abstract: *Now a day's composites play very important role in many industrial mechanical applications due to their strength to low weight ratio. Many simulation studies are being studied on composites using commercially available software's to determine the strength of the structure made up of composites. Predicting stresses in the composite structure may not be sufficient in applications such as aerospace, ships, high-precision machines etc. In this paper we attempted to determine stresses developed in composites experimentally as well as analytically. For the investigation of stresses developed we used circular disc made up of Araldite (CY230).Compression test on circular disc conducted and the results are compared with the results obtained from analytical and stimulation studies. In this paper, analysis and measurement of stress along composite disc is carried out using the carrier fringe method in photo-elasticity.*
Keywords: *Polariscope, Photo-elasticity, Compression Stress, Araldite (CY230)*

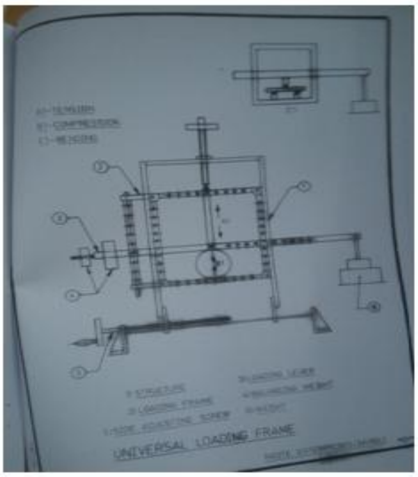
I. Introduction

Many researchers used photo-elasticity as one of the major experimental techniques for analyzing stress or strain distributions in loaded ductile members. Photo depicts the use of optical methods and elasticity depicts interpretation of experimental data utilizing the theory of elasticity. Fang Li [ref.1] experimentally determined the stress contours on various shapes of objectives having optical properties. The task of determining stresses in composite material is very difficult due to the number of laminates in the orientation in the metal matrix. Gilbert [ref.2] tried the determination of stresses developed in glass epoxy composites with a mix of optical material with the technique of photo-elasticity. The formation of the fringe pattern in composites is discontinuous due to which the prediction of exact stress values is very difficult. In this paper we attempted to make use of the light property of polarization instead of interference fringes. This attempt largely reduces the discontinuity of stress contours that are developed in the composites.

This paper is organized in the following manner: Sec2. Describes the experimental setup of polariscope and the principle involved for the formation of continues colored fringes when light is polarized due to deformation of the object.Sec3 covers the experimentation and discussion on the results obtained from the experiment. To validate experiment stress results simulation studies also made and they are given in the Sec4. finally, conclusions are drawn in Sec5.

II. Description Of Experimental Setup

The experimental setup of photo-elasticity with polariscope consists of (a) light source b) polarizer c) analyzer and d) load frame
The schematic diagram of the setup is shown in fig 2.1.



A plane polariscope is an optical instrument that can produce a plane-polarized light and can measure the resulting phase difference when the polarized light passes through a stressed photo-elastic model. The plane polariscope consists of a light source and two linear polarizers. The linear or plane polarizer is an optical element, which can resolve a light vector into two orthogonal components: one is transmitted and the other is absorbed. The axis parallel with the transmitted component is called the axis of polarization. The plane polarizer near the light source is called the polarizer and its axis of polarization is called the axis of polarizer. The other one is known as the analyzer and its axis of polarization is called the axis of the analyzer. Since the two axes are perpendicular to each other, no light will be transmitted through the analyzer when the transparent model is stress-free, and dark field will result. The terminology connected to polariscope is shown in the fig2.2

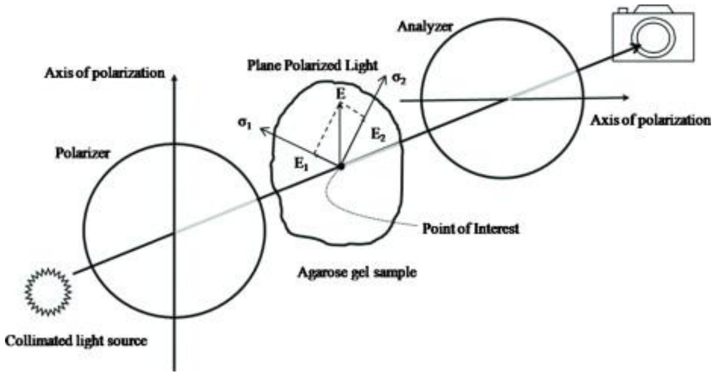


Fig2.2 Elements of Polariscope.

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III. Experimental Results

The experiments are conducted on a circular disc having following particulars:
Diameter of the disc: 6.8
Thickness of the disc: 0.42
Material of the disc: Araldite CY230
Young's modulus of the disc: 15.05
Poisons ratio: 0.3
The circular disc is placed in the load frame and compressed with the loads ranging from 20N to 100N.
In each loading of circular disc, the fringe patterns are examined and they are shown in the fig.3.1

Fig. 3.1.Fringe patterns observed on disc due to loads 20N,40N,80N,100N

By observing the fringe pattern on circular disc, calculations to determine stresses is made with the following expression:

$f\sigma = 8p/\pi DN$

Where; $f\sigma$ = compressive stress

p= load on model in kg.

D= diameter of disc in cm.

N= fractional fringe order at the centre.

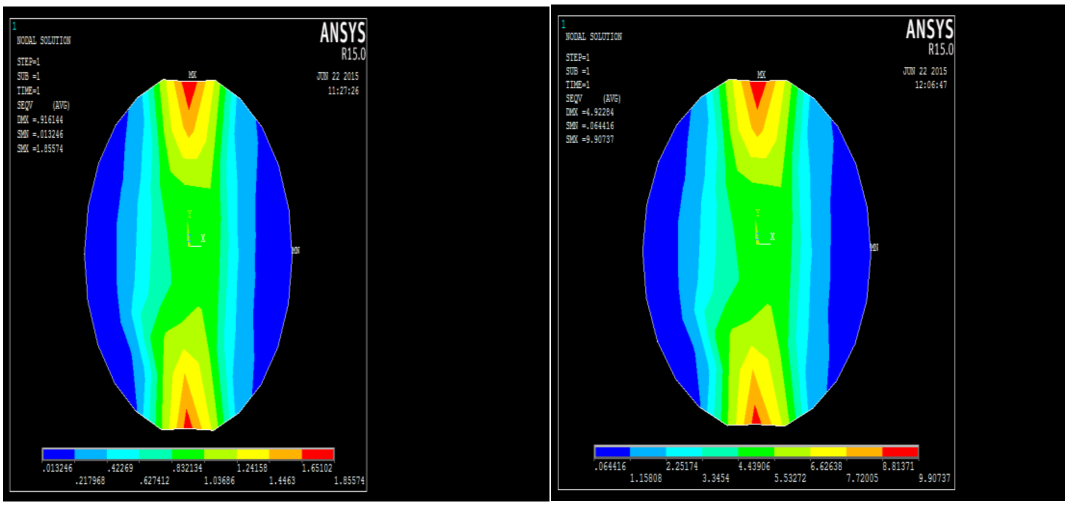
The calculated stress value from the above formula for different loading is shown in the table3.1

Table 3.1 Experimental stress values on circular disc

S.NO	Load	Stress(MPa)
1	20N	3.1957
2	40N	6.390
3	80N	12.782
4	100N	24.3212

IV. Valudation Of Experimental Stresses With Simulation Results

The circular disc is modeled in ANSYS software with the dimension as described in section 3. The material properties of circular disc also considered in the ANSYS analysis. In F.E modeling we have considered shell element with appropriate real constants. The supporting point of the disc and load acting point are being taken on the diagonal points of the disc. The simulation study on the disc is carried out for the loads 20N,40N,80N,100N as that of the loads taken in experiment. After careful handling of preprocessing stage of the model, the solution is sort to know the stresses and deflections on circular composite disc. The stress contours obtained due to four varieties of loads are shown in fig 4.1.



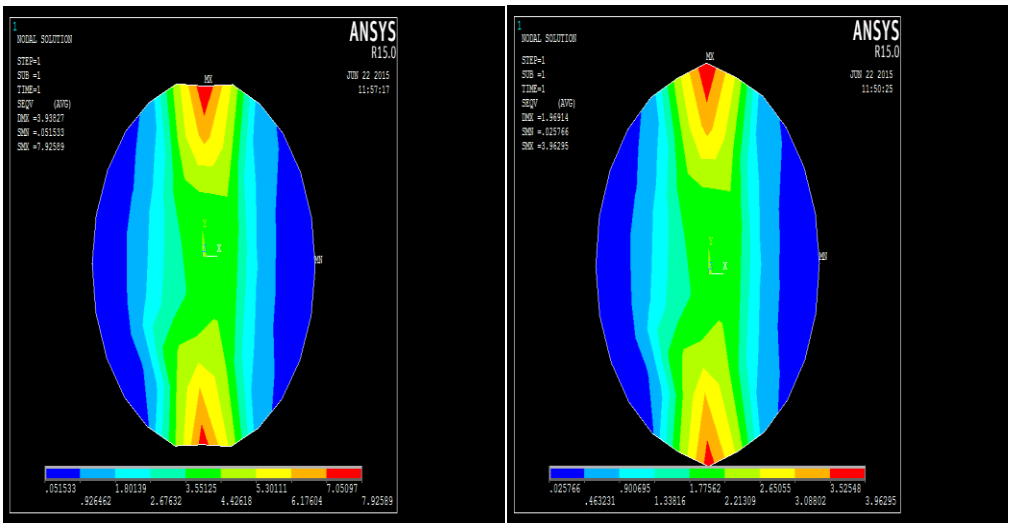


Fig. 4.1 . Stress contours on circular disc obtained through ANSYS.

The values of stresses and deflection due to loads 20,40,80,100N are shown in the table 4.1

Table 4.1. Stress and Deflection values of disc through ANSYS

S.NO	Loads	Deflection of numerical (ANSYS)	Stresses (ANSYS)
1	20	0.9161	1.855
2	40	1.9691	3.963
3	80	3.938	7.925
4	100	4.923	9.907

The stress values in a circular disc obtained from ANSYS are compared with the stress values obtained from the experiment and they are shown in the table 4.2

Table 4.2 Comparison of stress values obtained through experiment and ANSYS

S.NO	Loads(N)	Stresses experimental	Stresses (ANSYS)
1	20	3.1957	1.855
2	40	6.390	3.963
3	80	12.782	7.925
4	100	24.3212	9.907

The comparison of stress values in circular disc obtained from experiment and ANSYS software also shown in the fig.4.2

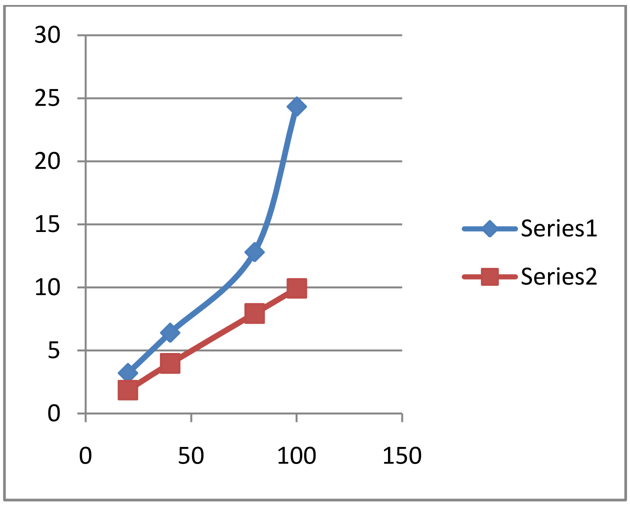


Fig.4.2. Stress values of experiment and ANSYS.

It is observed that the experimental stress values are tuning the stress values of disc obtained through the ANSYS software. The variation in stress values of both methods is due to the modeling error which includes the proper selection of element and the correct values of material properties of disc.

V. Conclusion

The composite disc considered in this paper is a composite material of Araldite CY230 which has low density and high compression strength. A compression test is conducted on the disc with the help of photo-elastic principles and polariscope experimental setup to evaluate compressive stresses. The experimental stress values are compared with the simulation results that are obtained from the ANSYS software. From the work carried out in this paper we can conclude the photo-elastic stress analysis is the simplest experimental stress analysis in composite materials. The stress contours also examined in the disc specimen to understand the stress variations in composite circular disc.

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References

[1]. FANG LI "Study of stress measurement using polariscope thesis, august 2010"
[2]. John A. Gilbert "Experimental techniques in solid mechanics, 2013"