Analysis of Stress using Photoelasticity technique -A Review

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ABSTRACT

Photoelasticity is a non-destructive experimental method which is widely utilized for analysis of stress and strain value of complicated geometry of model and loading conditions. This experimental approach is based on birefringence effect of material. This method is very sensible as compared to the analytical methods considering mathematical steps which is a time-consuming method and unbalanced for examination. This method is widely used in various areas such as automotive, dentistry, civil and electrical field also. This review paper gives the information related to extent the photoelasticity technique has been explored in various fields of the various research and science. After reading and analyzing past work of photoelasticity experiment the effect of the increase of temperature due to different reasons based on a different kind of loading on the model has been neglected by the earlier researches paper. Also try to make, an elective polariscope is developed by using economical types of equipment for industrial purpose, for examination of stress field on the model or prototype.

Keyword: *Photoelasticity, Plexiglass, Structural analysis, Principle stress, Fringes.*

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1. INTRODUCTION

Photoelasticity is an experimental method is used for the analysis of stress and strain value of complicated members and loading conditions which is completely based on the property of material called double refraction or birefringence effect. This effect is the result of refraction of the polarized light come from monochromatic or white light source by internal deformations due to stresses occurred in the model. By proper analysis of these fringes pattern it provides all stress distribution and allows the measurement of their direction and magnitude in any model points. The development in the rapid proto-typing and different methods for fringe pattern in the field of photoelasticity from finite element results, that technique is ideally suited for hybrid analysis of complex problems. Experiment based on photoelasticity technique by utilizing a polariscope that is an optical system. Birefringent phenomena of a photoelastic sample in the polariscope make fringe patterns that depend on external load applied to the specimen. The fringes pattern are obtained by this technique is due to the property of material called as birefringence, since the refractive index of sample changes by the application of external load applied on the sample.

2. EXPERIMENTAL SETUP

A polariscope consists of various elements given such as polarizer, analyzer, and wave plates. These three optical elements along with light source form the assembly of polariscope. In which the polarizer, wave plates, sample and analyzer are placed at specified distance to each other. The light source can either emit monochromatic light or white light depending upon the test. To begin with, the light is passed through the primary polarizer which changes over the light into plane polarized light. The device is set up in such a way that the plane polarized light passes through the stressed object. This light then follows, at each point of the object, the direction of principal stress at that point. The light is at that point made to pass through the analyzer and we get the fringe pattern on the specimen. Fringe patterns obtained in the polariscope consist of broad fringe bands with different width and they have limited fringe orders. The fringe patterns are analyzed to obtain information about stress of the specimen. The fringe pattern is combination of isoclinics and isochromatics.

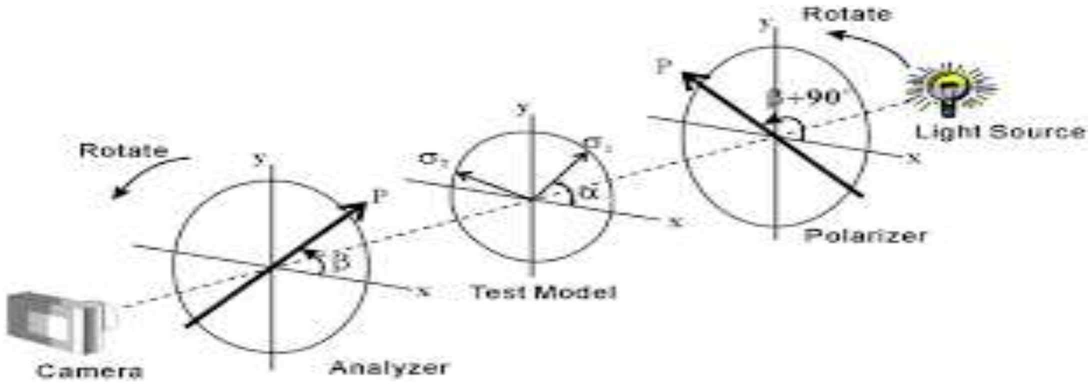

Fig.1 Arrangment for Plane polariscope

(Source: Improvement of digital photoelasticity based on camera response function Shih-Hsin Chang and Hsien-Huang P. Wu)

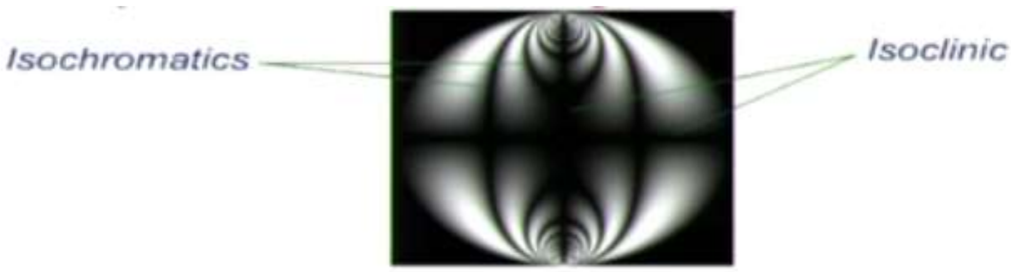

Fig.2 Isocilics and Isochromatics Frienge pattern

3. ANALYTICAL METHOD

In the photoelastic stress analysis, first of all calibration of the test material is done to calculate the fringe constant (F_σ) of the material. To determine the fringe constant it is required to find the fringe order (N).

$$N1,2 \ = n \pm \frac{\beta}{180}$$

Where n = intermediate fringe order and sign is chosen according to the lower or higher fringe order and
β = angle of rotation of analyzer plate
Now calculate the average of N_1 and N_2,

$$N \ = \frac{(N1 + N2)}{2}$$

The next step is to find the material fringe constant (F_σ),

$$(F\sigma) \ = \frac{8P}{\pi DN}$$

Where P = load applied on specimen
D = Diameter of specimen
h = Thickness of specimen
Now,
The difference in the principle stresses ($\sigma_1 - \sigma_2$),

$$(\sigma 1 - \sigma 2) \ = \frac{NF\sigma}{h}$$

4. CONCLUSION

In the past research work, the experiments has been carried-out on Transmission Photoelasticity on different circular disc of acrylic material using circular polariscope and subsequent calculation has been carried-out with Tardy’s compensation technique. This technique is employed for the determination of fractional fringe order at an arbitrary point within the specimen.
The following conclusions are drawn from various research papers and articles as follow
(a) This experimental technique is capable of evaluate stresses-strain effectively with complicated geometry as well as complicated loadings condition.
(b) The method is adaptable for both static and dynamic investigation.

(c) With the help of digital photoelasticity it is quiet easier and very less time consuming to capture and process the image of the fringe pattern.
(d) This technique provides reliable full-field values of the difference between the principle normal stresses in the plane of the model.

5. REFERANCES

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