iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 4 **Issue:** IV **Month of publication:** April 2016

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Study of Experimental Stress Analysis

Chavan Jyoti G.[1], Dixit Supriya S.[2], Pirjade Firdos I.[3]
Department of Mechanical Fabtech Technical Campus, Sangola, Maharashtra

Abstract: - This paper gives brief information about experimental stress analysis methods with the help of polariscope. Experimental stress analysis contains various methods of stress analysis which are more convenient and accurate than the analytical and numerical methods. This paper is very useful for understanding the basic concepts and basic methods of stress analysis by experimental method. For this analysis we use the preferred specimen for calibration, axially loaded circular disc with its center as a point of interest for our analysis.
First of all we make circular photo elastic model. For convenience mark the center of this circular disc as a point of interest. By observing the isoclinic's we find out the direction of principal stresses at the required point. Then by using Tardy's method we find out the fractional fringe order at the point of interest. By substituting this information in stress optic law we get stress difference. Among the various methods of stress separation such as electrical analogy, shear difference, method based on Hooke's law, oblique incidence we use the oblique incidence method. Because with the help of polariscope only this method we can use for stress separation.
Keywords: - Experimental stress analysis, casting procedure, Tardy's method, oblique incidence method.

I. INTRODUCTION

The objective of 'Experimental stress analysis' is to find stress conditions in a structural element or machine part subjected to some specified loading either by observation of physical changes brought in it or by measurement mode on model.The stress analysis could be performed by

A. Analytical Methods

These are useful to get a conceptual appreciation of the nature of stress field .The range of problems that could be solved is limited. The broad analytical methods are 'Strength of materials' and 'Mechanics of solids'. So if we have two dimensional problems to solve, we can easily solve it. However, if we look at three dimensional problems, they are very complex and difficult to solve because this has arbitrary geometry. We can't approach it from this method.

B. Numerical Methods:

These have provided scope for solving problems with arbitrary geometry at least approximately. The various methods are 'Finite difference', 'Finite elements' and 'Boundary elements'. Usually a numerical method is validated by comparing the results with an appropriate experimental technique.
The above theoretical stress analysis methods become somewhat difficult for abnormal shaped stressed models.

C. Experimental Methods:

The experimental stress analysis (ESA) plays an important role in such condition where results of above methods fail. At the same time ESA used to verify results of theoretical method. The stress analysis is accomplished by using small scale model called prototype subjected to same loading condition. The polariscope is used for the analysis.

Photo-1.Polariscope Arrangement

II. CASTING OF MODEL

A. Procedure

1) CY-230 or AY-130 along with hardener HY-951 is used for casting the sheets.
2) 100 parts of araldite mixed with 9 parts of hardener by wet or every 100 CC of araldite is mixed with 10.5 CC of hardener by volume is used for casting the sheets.
3) The araldite [resin] is heated in oven about 80^0 Cto 100^0 C for about 2 hrs to remove all air bubbles & moisture. Then it is cooled slowly to the room temp.
4) The hardener is then cooled slowly steering the mixture continuously for proper mixing.
5) The mixture should be stilled in one direction continuously for 15 min. till it is transparent and clear.
6) Now the reaction between araldite and hardener is exothermic
7) The spacer is clamped between two outer plates by using screw arrangement.
8) One side of the mould is kept open for pouring the mixture.
9) The wax applied on the outer surface of the mould to have the joints air tight and leak proof.
10) The mould is kept in vertical position for curing at room temp.
11) It has been observed that the curing time depends upon % of hardener.
12) More % of hardener, lees curing time and vice versa.
13) For easy removal of sheet from the mould the curie time of 16-18 hrs is sufficient.
14) The sheet is to be inspected in the polariscope after curing to injure that it is free from residual stresses.
15) Cut the required circular shape by machining.

III. STRESS ANALYSIS

A. Procedure for determining fractional fringe order at centre point by Tardy's method:

This method employs all the elements of circular polar scope. Before using this method, plane polariscope is used to establish isoclinic's and there by directions of principle stress at the point of interest. After this are four optical elements are rotated so that analyzer and polarizer are parallel to the direction of principle stresses. It gives dark field circular polar scope arrangement. Now the analyzer is only rotated through angle β so that either higher or lower order fringe passes through the point of interest.

If lower order fringe passes from the point of interest then exact fringe order is given by,

$$N = n + \beta/\pi$$

Volume 4 Issue IV, April 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Where, n = lower order fringe

If higher order fringe passes from the point of interest then exact fringe order is given by,

$$N = n` - \beta`/\pi$$

Where, n`= higher order fringe

B. Procedure for determining material fringe value

Determination of material fringe value means calibration of model material Consider, circular disc of diameter 'D' and thickness 'h' subjected to vertical diametric compression load 'P'. The material fringe value i.e. fσ at centre of disc i.e. at point of interest is given by the formula:

$$f\sigma = \frac{8P}{\pi DN}$$

C. Observations:

1) Diameter of disc = 6cm

2) Horizontal distance = 51.3cm

3) Vertical distance = 21.28cm

Observation Table 01

Sr.No.	Load on Disc: $P=\frac{WY}{X}$ (N)	Fringe order		Mean (N1+N2)/2	fσ =8P/π DN	Mean (f σ)
		N_1(Lower)	N_2(Higher)			
1	1.66	0.56	0.54	0.55	1.2809	1.5615
2	3.3216	0.86	0.875	0.865	1.6297	
3	4.152	1.1	1.1	1.1	1.6019	
4	6.2221	1.55	**1.5**	1.525	1.7335	

D. Sample Calculations

Exact fringe order

$N_1 = n + \frac{\beta}{\pi} = 0+0.56 = 0.56$

$N_2 = n' - \frac{\beta'}{\pi} = 1-0.46 = 0.54$

Therefore, average exact fractional fringe order

$N = (N1+N2)/2 = (0.56+0.54)/2 = 0.55$

Material fringe value is given by,

$f\sigma = \frac{8P}{\pi DN} = \frac{8X1.66}{\pi X6X0.55} = 1.2809$ N/Cm

E. Separation of stresses

The stress optic law,

$$\sigma_1 - \sigma_2 = \frac{Nf\sigma}{h}$$

From this equation, value of σ_1-σ_2 can be obtained. However, for the separation of σ_1 & σ_2 following methods are used:

1) Method based on hooks law

Volume 4 Issue IV, April 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

2) Electrical analogy method
3) Shear difference method
4) Oblique incidence method

Among the various methods of stress separation such as electrical analogy, shear difference, method based on Hooke's law, oblique incidence we use the oblique incidence method. Because with the help of polar scope only this method we can use for stress separation.

IV. OBLIQUE INCIDENCE METHOD

For this method extra attachment is done for the obliquely incidence of light ray on model. Then by combining the equation for normal and oblique incidence

$$\sigma_1 = \frac{f6 - \cos\phi}{h\ \sin^2\phi\,[N' - N\cos\phi]}$$

$$\sigma_2 = \frac{f6}{h\ \sin^2\phi\ [N'\cos\phi - N]}$$

Where,
N' = Fringe pattern associated with oblique incidence
N = fringe pattern associated with normal incidence
h = Model thickness
Φ = Angle of light incidence

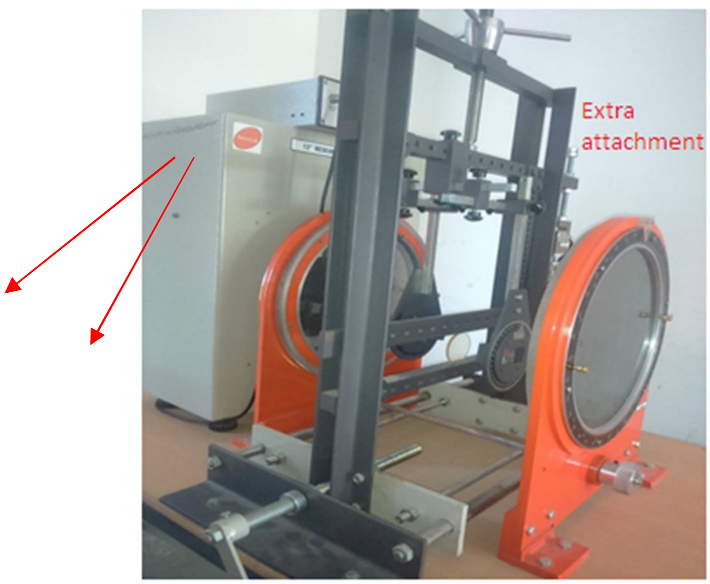


Photo 2 - Oblique Incident Attachment

A. Procedure

First of all isoclinic are determined and direction of principle stress at a point of interest are established. Now the exact fringe (N) established in normal incidences at the point of interest. Now attach the extra attachment for oblique incidence of light. Determine the fringe order N' at the point of interest in oblique incidence, then use two equations mentioned above for calculating principle stresses σ_1& σ_2.

B. Observations

1) Diameter of disc = 6cm
2) Thickness of disc = 0.5cm

Observation Table-02

Sr. No.	Load on Disc: $P=\frac{WY}{X}$ (N)	Normal incidence (N)	Oblique incidence (N')
01.	1.660	0.55	0.57
02.	3.3216	0.865	0.89
03.	4.1520	1.1	1.2
04	6.2221	1.525	1.56

C. *Sample Calculations*

For Example-1.660N and N = 0.55 , N'= 0.57

σ_1 = f6-cosϕ/h $\sin^2$ϕ [N' – Ncosϕ]

= 1.2816-cos45/0.5$\sin^2$45[0.57-0.55cos45]

σ_1 = 0.4161N/cm^2

σ_2 = f6/h $\sin^2$ϕ [N'cosϕ-N]

= 1.2816/$\sin^2$45[0.57cos45-0.55]

σ_2 = -0.7533N/cm^2

τ_{max} = (σ_1-σ_2)/2

τ_{max} = 0.5847N/cm^2

V. ADVANTAGES AND DISADVANTAGES

A. *Advantages*

1) It has wide range of use
2) It has higher reliability
3) It has unique safety
4) It enhances the efficiency of product
5) Determination of stresses in model is simple

B. *Disadvantages*

1) Two or more persons are required for handling.
2) More skill require for attachment.

VI. CONCLUSION

In above analysis we find out the stresses at our point of interest (i.e. centre of circular disc) in circular disc with the help of polariscope. By finding out the stresses at the point of interest we can easily find out the strains also at this point. We use here very basic and conventional method of experimental stress analysis. For that purpose we study here all the processes such as casting procedure of photoelastic model, finding of required isoclinic's and isochromatic, Tardy's method and oblique incidence method . It is observed that experimental stress analysis contains very easy, economical, fast and accurate methods of stress analysis than the theoretically stress analysis methods.

The results obtained from above analysis are as follows:

A. Direction of principal stresses :- 45
B. Fringe order at required point:- 0.55
C. Stress difference:-1.1694N/cm^2
D. Separate stresses at the point of interest:-
   1) 0.4161N/cm^2
   2) -0.7533N/cm^2

E. Maximum shear stress at the point of interest:- 0.5847N/cm^2

F. Material fringe value = 1.2816N/cm

VII. FUTURE SCOPE

For this study we use the preferred specimen for calibration, axially loaded circular disc with its center as a point of interest for our analysis. We can choose other shapes such as tensile specimen, circular disc with centre hole, Crane Hooke or any other required shape. We choose here the centre point of the disc as a point of interest one can also choose the point other than the centre point with the same circular shape for the analysis.

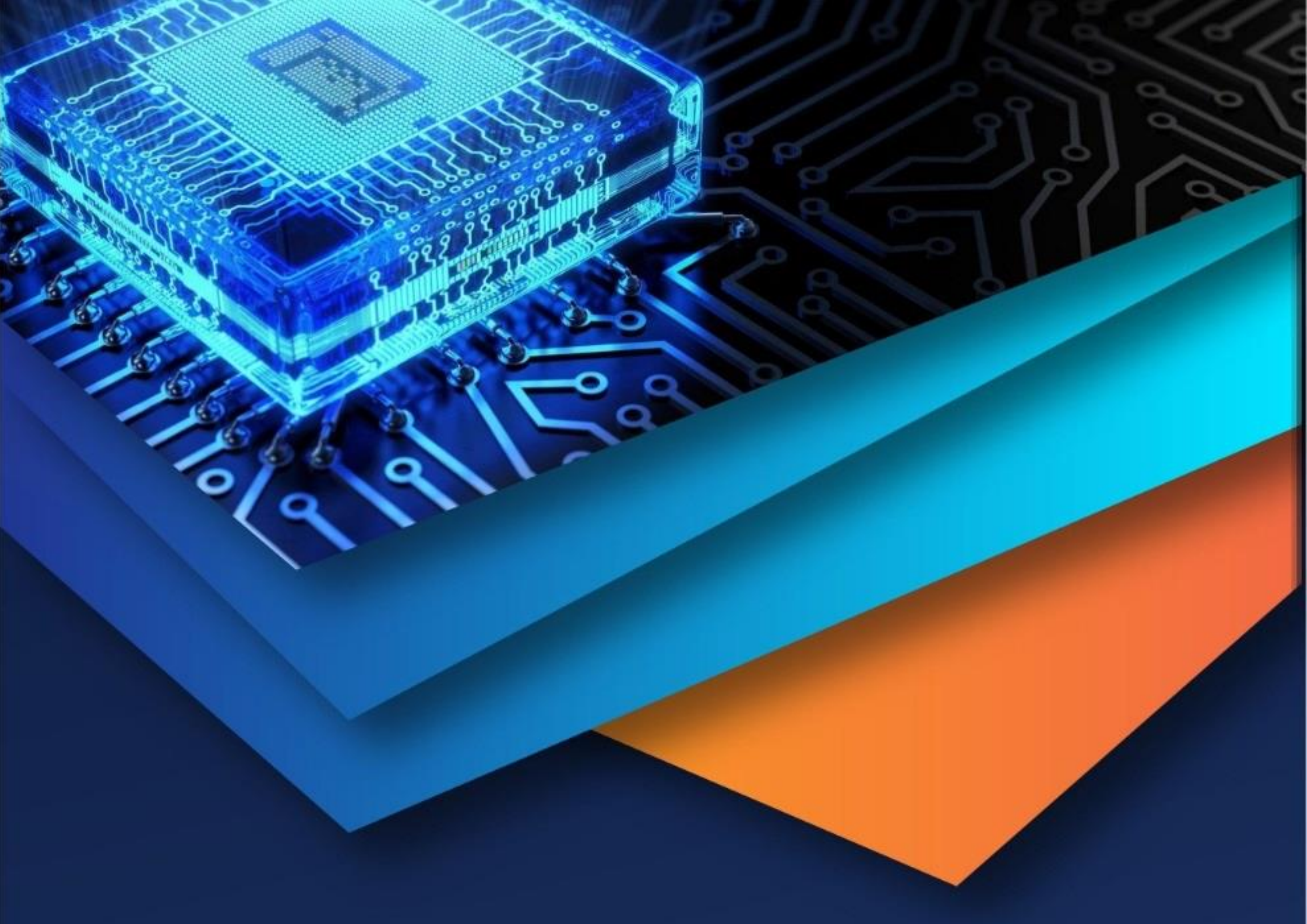
Also other methods of stress separation such as electrical analogy method, shear difference method and methods based on Hooke's law may be used.

REFERANCES

[1] Dr. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, 4th Edition, (2014).

[2] James W. Dally & William F. Riley, "Experimental Stress Analysis", McGraw-Hill Publication, 3rd Edition, (1991).

[3] Rashmi Uddanwadiker, "Stress Analysis of Crane Hook and Validation by Photo-Elasticity" *Engineering;* 2011; vol.3; pp. 935-941



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY