

Experimental Stress Analysis

Assignment # 3

Transmission Photoelasticity

1. Why do you use a polarised beam of light impinge on the model in transmission photoelasticity instead of the normal light? Also reason out why normal incidence is important.
2. What do you understand by birefringence? List out the important characteristics displayed by the Calcite prism.
3. Why is relative retardation more important than absolute retardation in photoelasticity? Establish a relationship of the relative retardation introduced by a retarder in terms of its thickness and refractive indices of the ordinary and extraordinary light beams.
4. In the case of a circular polariscope, for the case of the optical arrangement in which the quarterwave plates are parallel to each other, find out trigonometrically the equations for intensity of light transmitted.

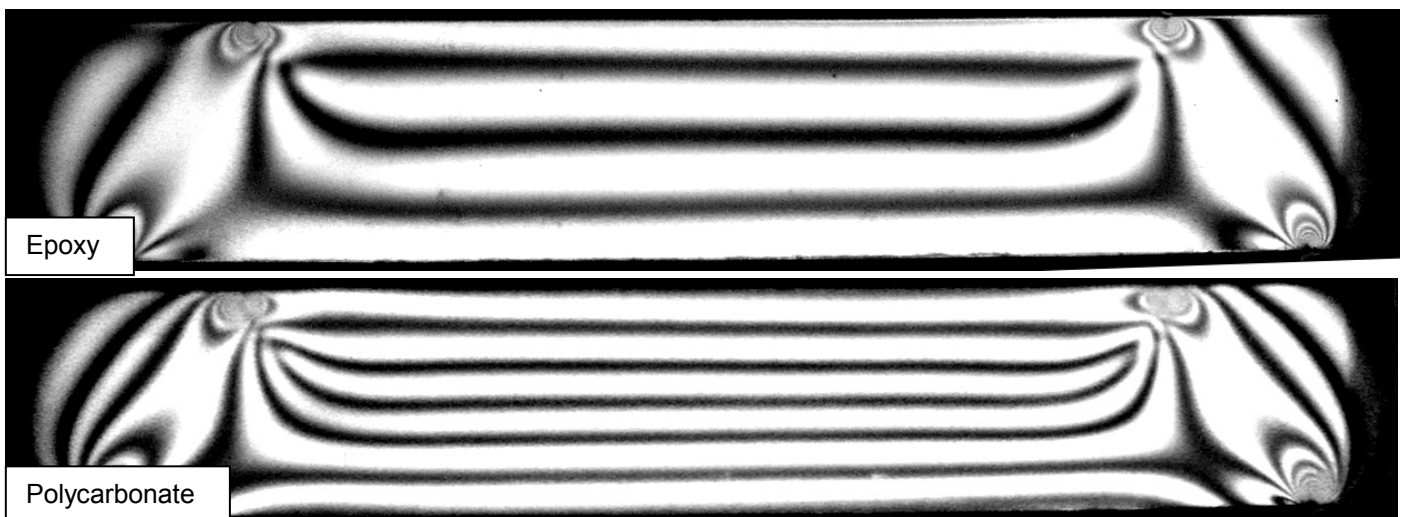


Fig.1 Beam under four point bending

5. Fringe patterns corresponding to the problem of a beam under four point bending are shown above. Both these beams are identical and are subjected to the same level of load. Mark the fringe orders in each of them. Explain why the number of fringes differs?
6. What is the Jones matrix for a retarder? How is it constructed based on rotation and retardation matrices? Derive your result. Analyze a plane polariscope using Jones calculus.

With a monochromatic light source how would you distinguish isoclinics and isochromatics in a plane polariscope? Describe at least two methods.
7. What are compensation techniques? Why are they needed? What is the general procedure to employ them?

Establish using Jones Calculus that Analyser itself can be used as a compensator.

8. Mention how to estimate stress concentration factors (SCF) from photoelastic data. Figure 2 shows the fringe pattern observed for a finite plate of dimensions (Length = 230 mm, width = 36 mm, thickness = 6 mm) with a hole of diameter 12 mm subjected to an axial tensile load of 288 N. The far-field fringe order for this load is found to be 0.86. Near the boundary of the hole, fringe order 2 was found to move and occupy the boundary of the hole when the analyzer is rotated by an angle of 63 degrees. Find the SCF. Compare the results with those available in design books and comment on your results.

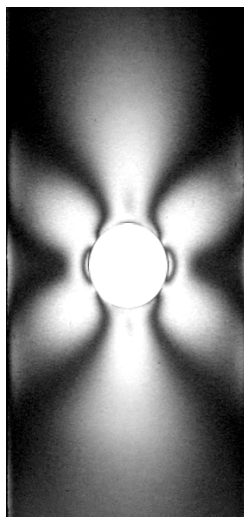


Fig. 2 Plate with single hole

9. One of the key parameters that need to be evaluated in a photoelastic test is to determine the calibration of the model material. Use of a circular disc under diametral compression is an ideal model to do that. A disc of the same material (dia 60 mm) as that of the sheet used in problems 9 and 10 was loaded in compression and the fringe order at the centre was accurately estimated by Tardy's method of compensation. The observations are tabulated as follows:

Load Applied (N)	Rotation of Analyzer (degrees)	Fringe order moved
246	145	0
328	12	1
410	60	1
554	144.5	1

It is found that the lower fringe order has moved to the centre in all the measurements.

Find the material stress fringe value.

10. The maximum shear stress at a point in a model of 5 mm thick is 10 MPa. The fringe order observed is 4.5 when observed with Sodium light (589.3 nm). It is required to find the stresses in another model made of the same material and having a thickness of 8 mm subjected to a plane state of stress. For some reasons the Sodium light is not working and the analysis has to be carried out only by another source which is a mercury light (546.1 nm). The fringe order at the point of interest observed is 6. If the maximum

principal stress at the point of interest is twice that of the minimum principal stress, find the individual magnitude of stresses at the point of interest.

11. At a point D in a photoelastic material, a fringe order of 4.25 was measured. The isoclinic parameter at the same point was 35° . The material stress fringe value of the model material is 12 N/mm/fringe. The model material's Young's Modulus is 3.275 GPa and Poisson's ratio is 0.36.

Before the application of the loads, the thickness of the model was 6 mm; and after the application of the loads, the thickness at D was measured by a lateral extensometer was 6.01 mm.

Determine the stress tensor at the point D.

12. Justify the use of a plastic in photoelastic analysis to predict the behaviour of metallic prototypes.
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