Iowa State University
Aerospace Engineering

AER E 322 Lab 2
Stress Concentration

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February 10, 2023

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Aerospace Structures Laboratory Summary
Lab 2 Stress Concentration
Section 4 Group 2
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AER E 322 February 10, 2023 **Spring 2023**

1.   Introduction

This lab will demonstrate how internal stresses change due to stress concentrators using a special material with photoelastic properties. To view the stresses, we will use a special tool called a light-field circular polariscope (Figure 1). The light-field circular polariscope utilizes two polarized sheets that visualize the internal stresses, specifically the difference between the principal stresses, $\sigma_{p1} - \sigma_{p2}$. To examine the effects of different types of stress concentrators, we will test three different samples: a notched sample, an arched sample, and a sample with a hole.
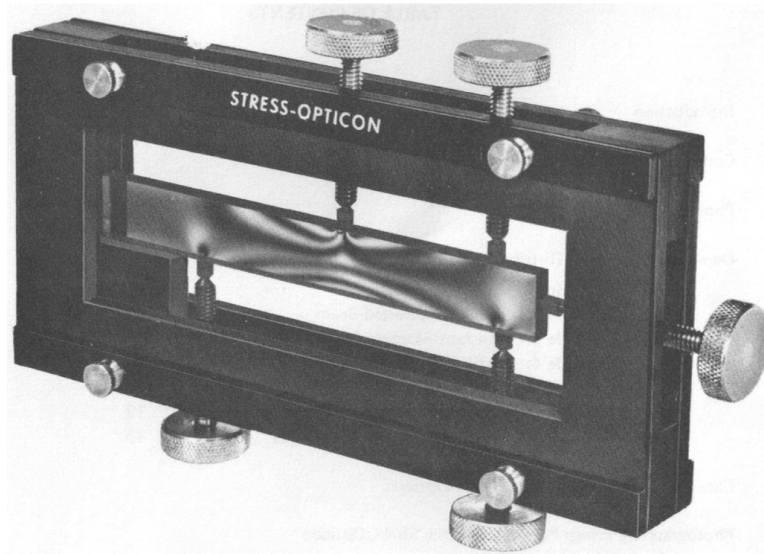

Figure 1: The light-field circular polariscope. Image from the Lecture 2 Notes. Copyright 2023 by Thomas Chiou.

Using MATLAB, we will analyze the stress equations for a sample with a hole in it. Our MATLAB scripts will reveal the maxima and minima for the three different types of internal stresses: σ_r, σ_θ, and $\sigma_{r\theta}$. Additionally, we will plot the different stress distributions and the difference between the principal stresses. We will compare the theoretical plot of the principal stress difference with the pictures gathered from the experiment.

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2.   Objectives

To observe how internal stress changes due to stress discontinuities, also known as stress concentrators, and to analyze theoretical internal stresses due to stress concentrators using MATLAB. An example of stress concentrators is shown in Figure 2.
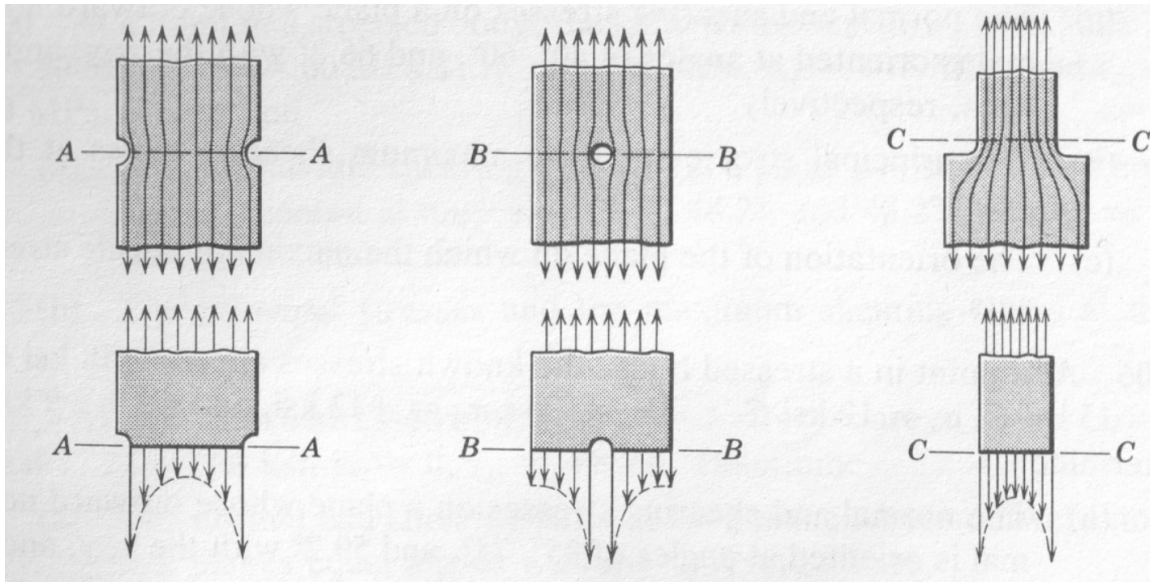

Figure 2: An example of stress discontinuities or concentrators. Image from A. Higdon et al., *Mechanics of Materials*, 4th ed, 1985.

3.   Hypothesis

Due to the photoelastic nature of the material and the polarized sheets, we will be able to clearly photograph the internal stress patterns around the stress concentrators. The difference between the principal stresses will be higher closer to the edges of the discontinuities.

4.   Work Assignments

Refer to Table 1 for the distribution of work during this lab.

Table 1: Work assignments for AER E 322 Lab 2.

Task	Matthew	Peter	Natsuki
Lab Work			
Date Recording	X	X	X
Exp. Setup	X	X	X
Exp. Work	X	X	X
Exp. Clean-Up	X	X	X
Post Lab			
Question 1	X		
Question 2	X	X	
Question 3	X	X	X
Report			
Introduction		X	
Objectives		X	
Hypothesis		X	
Materials		X	
Apparatus			X
Procedures			X
Data	X	X	X
Analysis	X	X	X
Conclusion	X	X	
Revisions	X	X	
Editing	X		

5. Materials

6. Apparatus

7. Procedures

8. Data

9. Analysis

10. Conclusion