

# Experimental method of Elastic mechanics

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## **1.Reasons for analysing stress in the experiment**

## **2.Stress analysis method in the experiment**

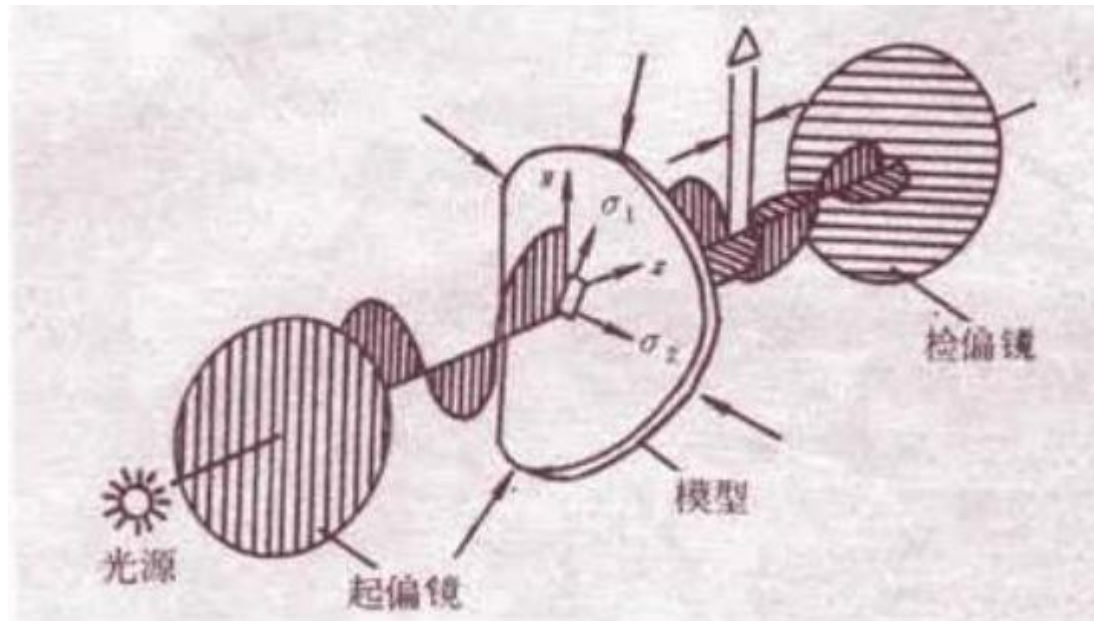
- Photometry
- Electrical measurement
- Coating method
- X-ray method
- Analog method
- Holographic method

# **1.Reasons for analysing stress in the experiment**

- a.Theoretical formulas are experiments, hypotheses, and pushes through geometric and physical equilibrium relationships.
- b.The derived theoretical formula is verified by practice
- c.For some (force, structure, shape) complex components, the conditions of the theoretical formula are not satisfied, and it is difficult to analyze and derive
- d.New theories, new formulas, and new materials must be experimentally verified.

## 2. Stress analysis method in the experiment

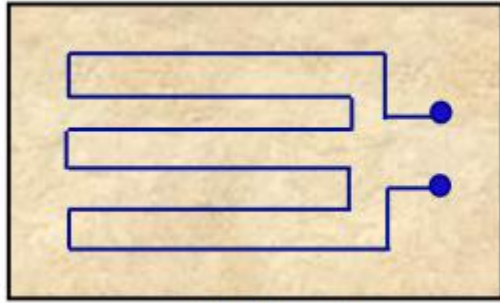
### -Photometry



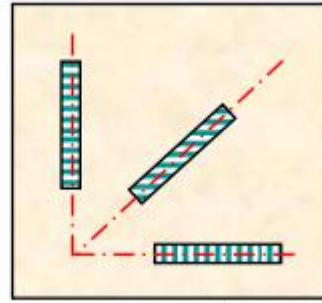
### Principle of photoelastic method

Birefringence effect produced by polarized light incident on a photoelastic model under stress

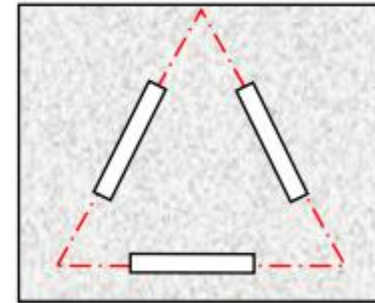
## -Electrical measurement



Strain gauges



45° strain flower



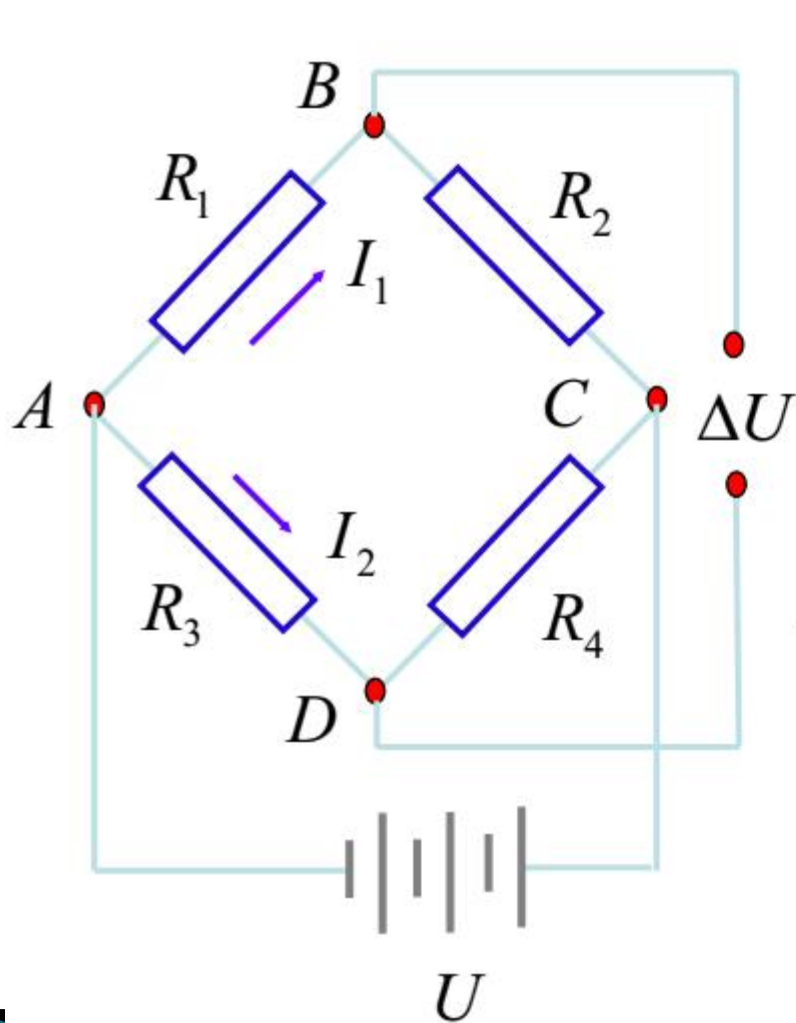
60° strain flower

Raw resistance value: 120Ω, 350Ω; 1000Ω

After strain:  $R + \Delta R$

$$k\varepsilon = \frac{\Delta R}{R}$$

K-Sensitivity coefficient



$$I_1 = \frac{U}{R_1 + R_2}$$

$$U_{AB} = \frac{R_1 U}{R_1 + R_2}$$

$$U_{CD} = \frac{R_3 U}{R_3 + R_4}$$

$$\begin{aligned} \Delta U &= U_{AB} - U_{CD} = \frac{R_1 U}{R_1 + R_2} - \frac{R_3 U}{R_3 + R_4} \\ &= \frac{R_1 R_4 - R_2 R_3}{(R_1 + R_2)(R_3 + R_4)} U \end{aligned}$$

$$\Delta U = U_{AB} - U_{CD} = \frac{R_1 U}{R_1 + R_2} - \frac{R_3 U}{R_3 + R_4}$$

$$= \frac{R_1 R_4 - R_2 R_3}{(R_1 + R_2)(R_3 + R_4)} U$$

When the bridge is balanced:  $\Delta U = 0$

$$R_1 R_4 - R_2 R_3 = 0$$

Actual measurement

$$\Delta U = \frac{(R_1 + \Delta R_1)(R_4 + \Delta R_4) - (R_2 + \Delta R_2)(R_3 + \Delta R_3)}{(R_1 + \Delta R_1 + R_2 + \Delta R_2)(R_3 + \Delta R_3 + R_4 + \Delta R_4)} U$$

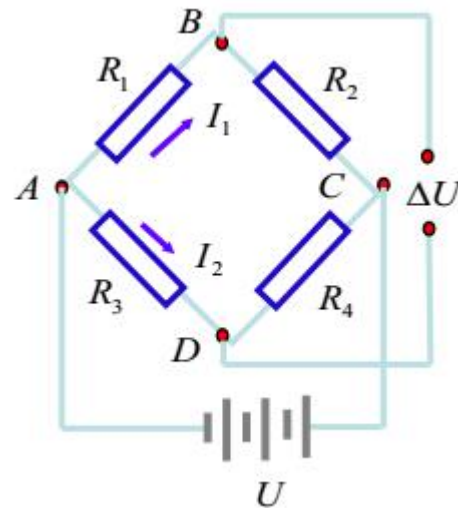
Omit high-order trace

$$\Delta U = U \frac{R_1 R_2}{(R_1 + R_2)^2} \left( \frac{\Delta R_1}{R_1} - \frac{\Delta R_2}{R_2} - \frac{\Delta R_3}{R_3} + \frac{\Delta R_4}{R_4} \right)$$

When the strain gauges connected are the same

$$\Delta U = U \frac{R_1 R_2}{(R_1 + R_2)^2} \left( \frac{\Delta R_1}{R_1} - \frac{\Delta R_2}{R_2} - \frac{\Delta R_3}{R_3} + \frac{\Delta R_4}{R_4} \right)$$

$$\begin{aligned} \Delta U &= \frac{U}{4} \left( \frac{\Delta R_1}{R} - \frac{\Delta R_2}{R} - \frac{\Delta R_3}{R} + \frac{\Delta R_4}{R} \right) \\ &= \frac{kU}{4} (\varepsilon_1 - \varepsilon_2 - \varepsilon_3 + \varepsilon_4) \end{aligned}$$



The opposite arms have the same symbol,

The opposite arm has the opposite sign,



## Experimental connection

1.Full bridge

2.Half bridge

3.1/4 bridge (Temperature compensation)

-stress eccentric tensile test in the plane