Experimental method of Elastic mechanics

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1.Reasons for analysisising 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 analysisising stress in the experiment

a.Theoretical formulas are experiments, hypotheses, and pushes through geometric and physical equilibrium relationships.

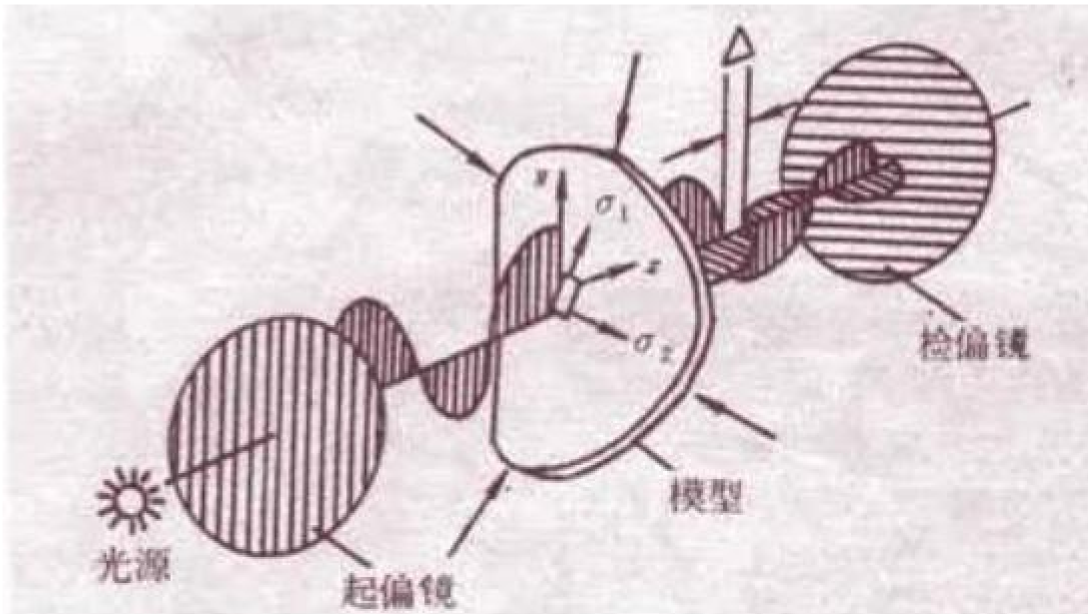
b.The derived theoretical formula is verified by practice

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

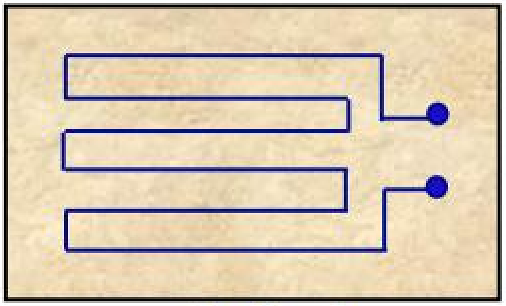
-Photometry



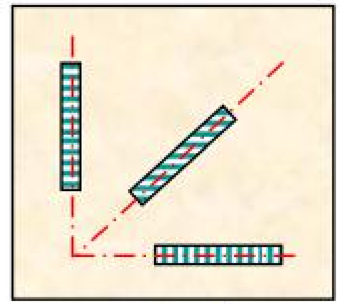
Principle of photoelastic method

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

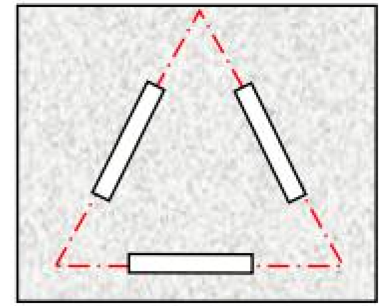
-Electrical measurement



Strain gauges



45° strain flower



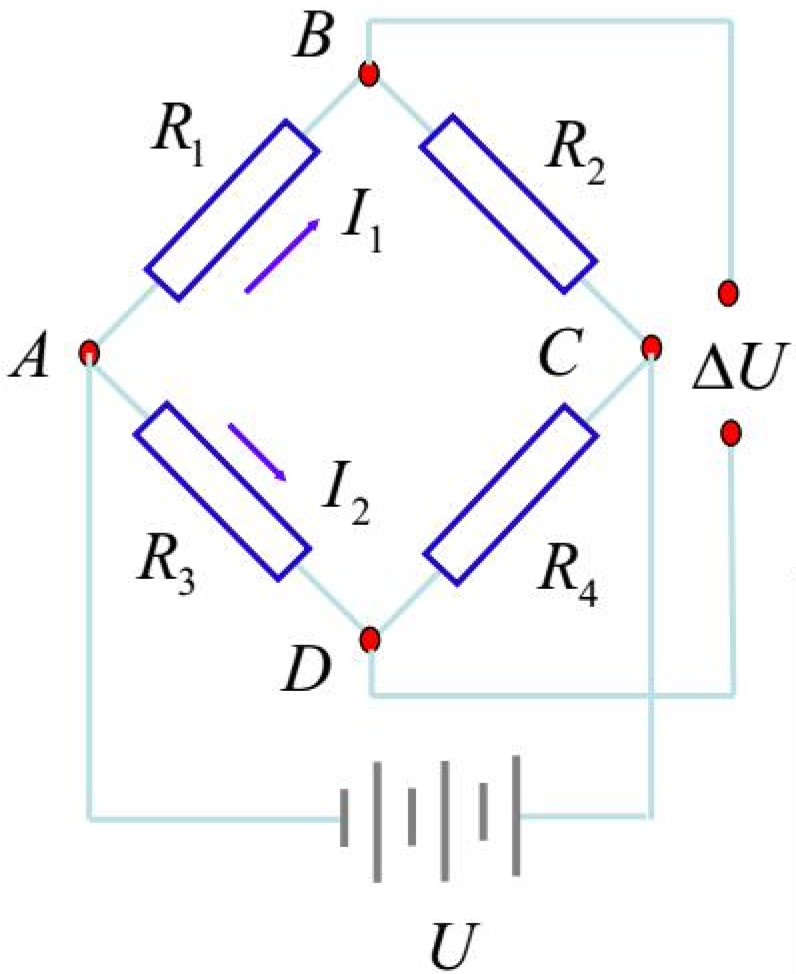
60° strain flower

Raw resistance value：120Ω，350Ω；1000Ω

After strain: $R+_{\Delta}R$

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

K-Sensitivity coefficient



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

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

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

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

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

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

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

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

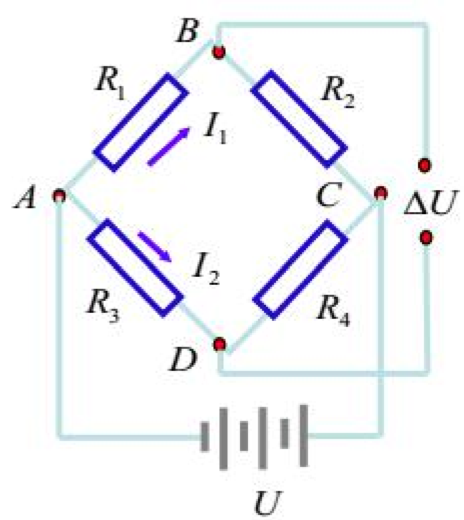
$$\Delta U = U \frac{R_1 R_2}{(R_1 + R_2)^2} \left(\frac{\Delta R_1}{R_1} - \frac{\Delta R_2}{R_2} - \frac{\Delta R_3}{R_3} + \frac{\Delta R_4}{R_4} \right)$$

When the strain gauges connected are the same

$$\Delta U = U\frac{R_1R_2}{(R_1+R_2)^2}\left(\frac{\Delta R_1}{R_1}-\frac{\Delta R_2}{R_2}-\frac{\Delta R_3}{R_3}+\frac{\Delta R_4}{R_4}\right)$$

$$\Delta U = \frac{U}{4}\left(\frac{\Delta R_1}{R}-\frac{\Delta R_2}{R}-\frac{\Delta R_3}{R}+\frac{\Delta R_4}{R}\right)$$

$$= \frac{kU}{4}(\varepsilon_1-\varepsilon_2-\varepsilon_3+\varepsilon_4)$$



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