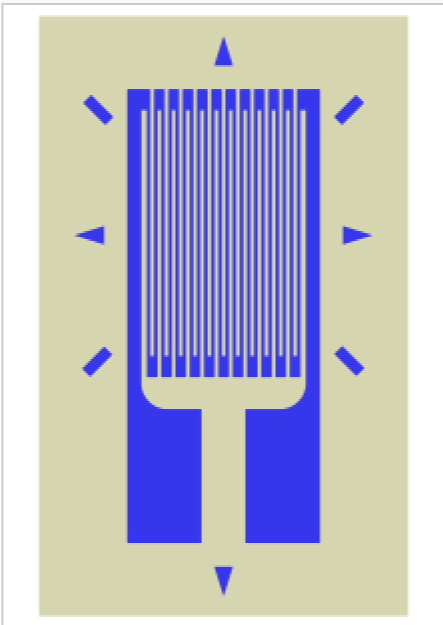
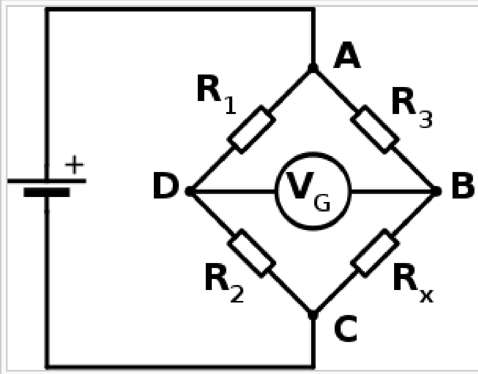
Strain gauge

From Wikipedia, the free encyclopedia

A **strain gauge** is a device used to measure the strain of an object. Invented by Edward E. Simmons and Arthur C. Ruge in 1938, the most common type of strain gauge consists of an insulating flexible backing which supports a metallic foil pattern. The gauge is attached to the object by a suitable adhesive, such as cyanoacrylate.[1] As the object is deformed, the foil is deformed, causing its electrical resistance to change. This resistance change, usually measured using a Wheatstone bridge, is related to the strain by the quantity known as the *gauge factor*.



Typical foil strain gauge. The gauge is far more sensitive to strain in the vertical direction than in the horizontal direction. The markings outside the active area help to align the gauge during installation.



Wheatstone's bridge circuit diagram.

Wheatstone bridge

From Wikipedia, the free encyclopedia

A **Wheatstone bridge** is an electrical circuit invented by Samuel Hunter Christie in 1833 and improved and popularized by Sir Charles Wheatstone in 1843. [1] It is used to measure an unknown electrical resistance by balancing two legs of a bridge circuit, one leg of which includes the unknown component. Its operation is similar to the *original* potentiometer.

Tension Test

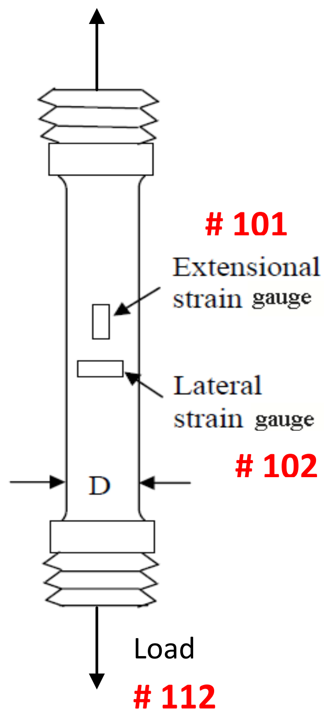


Figure 1. Tension test specimen

V_{in} = Voltage input (Excitation Voltage) = 5 V

GF = gauge factor = 1.778

Record the unstrained voltage for each gauge before loading.

Extensional strain gauge: $(V_{out})_{unstrained}$ =

Lateral strain gauge: $(V_{out})_{unstrained}$ =

Load gauge: $(V_{out})_{unstrained}$ =

Note: P_s (Load cell sensitivity) = 1 kN/Volt

Diameter of the sample is 0.5 inch. (Do not forget to converge every parameter to S.I. unit).

- The strain is related to voltage as follows:

$$\varepsilon = \frac{-4V_r}{GF(1+2V_r)}(1+R_l/R_g) \approx \frac{-4V_r}{GF(1+2V_r)} \quad ; \quad \text{Since } R_g >> R_l$$

Here $V_r = (V_{out}/V_{in})_{strained} - (V_{out}/V_{in})_{unstrained}$

(Unstrained voltage is voltage at time t=0, when the strain gage is not under any load. Therefore the initial voltage is actually the unstrained voltage).

V_{out} = Voltage recorded
V_{in} = Voltage input (Excitation voltage) = 5 V
ε =Strain
GF= Gage factor = 1.778
R_g =Gage resistance
R_l = Line resistance

- Load is related to voltage as

$F=V*P_s$ F: Load (kN), V=[$V_{Strained}$-$V_{unstrained}$] (V),
P_s(Load cell sensitivity)= 1 kN/Volt

Torsion Test

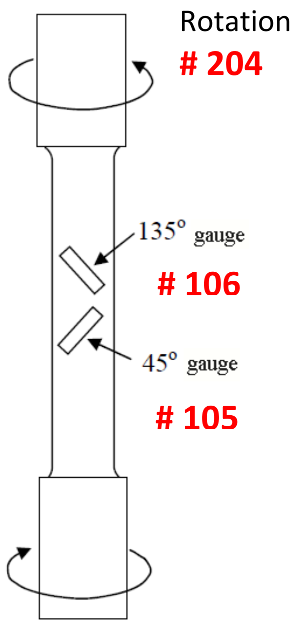


Figure 2. Torsion test specimen

V_{in} = Voltage input (Excitation Voltage) = 5 V

GF = gauge factor = 2.055

Record the unstrained voltage for each gauge before loading.

135° strain gauge: $(V_{out})_{unstrained}$ =

45° strain gauge: $(V_{out})_{unstrained}$ =

Torque gauge: $(V_{out})_{unstrained}$ =

Note: Q_s (Torque cell sensitivity) = 0.2 kN*cm/Volt

Diameter of the sample is 0.5 inch. (Do not forget to

converge every parameter to S.I. unit).

- The strain is related to voltage as follows:

$$\varepsilon = \frac{-4V_r}{GF(1+2V_r)}(1+R_l/R_g) \approx \frac{-4V_r}{GF(1+2V_r)} \quad ; \quad \text{Since } R_g >> R_l$$

Here $V_r = (V_{out}/V_{in})_{strained} - (V_{out}/V_{in})_{unstrained}$

(Unstrained voltage is voltage at time t=0, when the strain gage is not under any load. Therefore the initial voltage is actually the unstrained voltage).

V_{out} = Voltage recorded
V_{in} = Voltage input (Excitation voltage) = 5 V
ε =Strain
GF= Gage factor = 2.055
R_g =Gage resistance
R_l = Line resistance

- Torque is related to voltage as

$T = V*Q_s$ T: Torque (kN*cm), V =[$V_{Strained}$-$V_{unstrained}$] (V),
Q_s :Torque sensor sensitivity =0.2 kN*cm/Volt