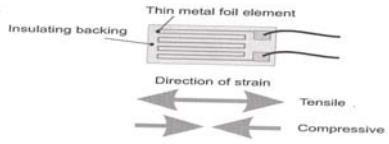
Torsion Test Procedure

Mechanics of Materials Lab, CIVL 3325
September, 29, 2011

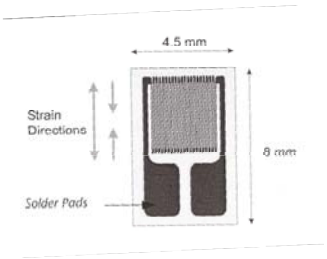
Strain Gauge

- Electrical sensor (transducer) that measures strains.
- Its electrical resistance changes when an external force stretches or compresses it
- Change in resistance is directly proportional to displacement (strain)
- Small sheet of metal foil cut in zigzag pattern, only a few micron thick
- Normally mounted on a backing sheet

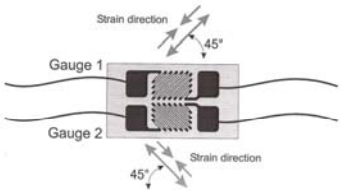


Strain Gauge

- User should:
  prepare the surface
  bond the gauge properly
  use the gauge in the right direction



for normal strains



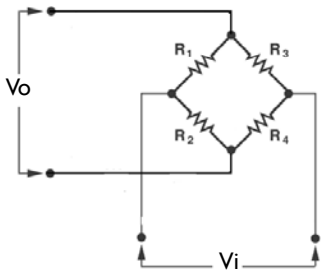
for shear strain

Strain Gauge

- Measurement is based on: *the Wheatstone Bridge*

R1 and R4:
Opposite arms

R1 and R2:
Adjacent arms

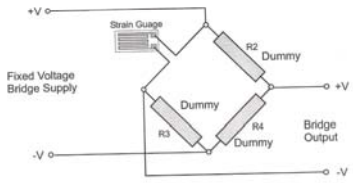


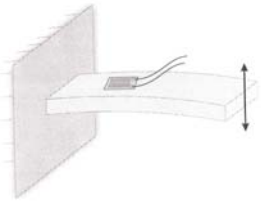
$$V_o = V_i \frac{R_3}{R_1 + R_3} - V_i \frac{R_4}{R_2 + R_4}$$

if R1, R2, R3, and R4 are all equal, then Vo = 0.0

Strain Gauge

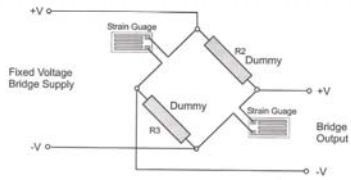
- Quarter Bridge Connection (least accurate)





Strain Gauge

- Half Bridge Connection 1 (Opposite Arms)

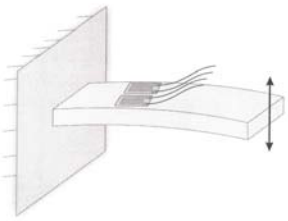


Identical strain values

With the same sign:

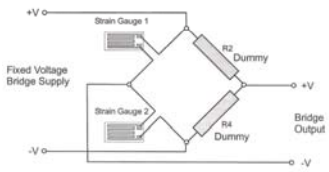
Bothe tensile

Both compression

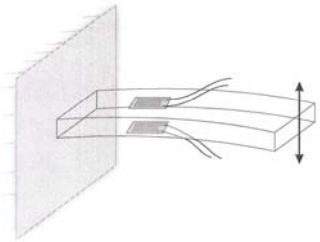


Strain Gauge

- Half Bridge Connection 2 (Adjacent Arms)

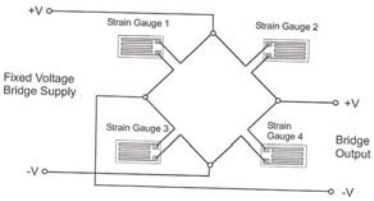


Identical strain values
With opposite sign:
One tensile and
one compression



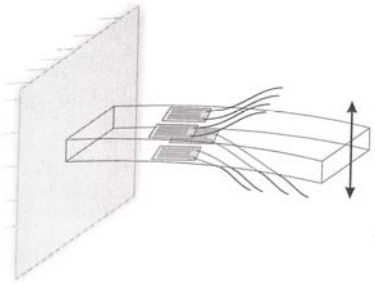
Strain Gauge

- Full Bridge Connection (most accurate)



Apposite arms have
same sign

Adjacent arms have
apposite sign



Strain Gauge

- Vi : known
- Vo : measured
- N : number of active arms (1, 2, or 4)
- GF : gauge factor (to calibrate)

$$\varepsilon = 4 \times \frac{Vo}{GF \times Vi \times N}$$

- Negative strain: compressive
- Positive strain: tensile

Strain Display Device

- Set:
  Configuration number (N), Gauge Factor;
- And, zero before loading.

Strain Display Device

- Wire plugs, connects the gauges to active arms
- Dummy plugs, for inactive arms

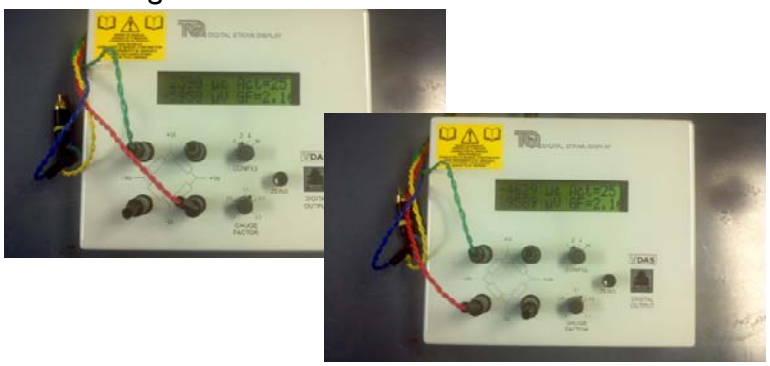
Strain Display Device

- Quarter bridge:

- Fit inactive arms with dummy plugs
- Config. = 1

Strain Display Device

- Half bridge:



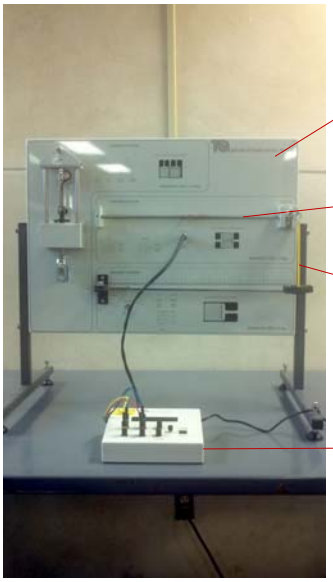
- Fit inactive arms with dummy plugs
- Config. = 2

Strain Display Device

- Full bridge:

- Config. = 4

Torsion Test Device



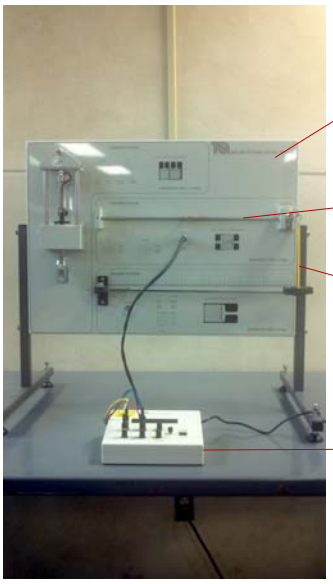
Main frame

Torsion test specimen (bar) with installed strain gauges

Loading arm, hanger and weights

Strain display

Torsion Test Device



Main frame

Torsion test specimen (bar) with installed strain gauges

Loading arm, hanger and weights

Strain display

Torsion Test Device

The load distance is constant 15 cm

Test Procedure

- Using vernier caliper, measure the diameter of the specimen
- Calculate J (torsional stiffness)
- Using a same weight, find the colors (gauges) with same sign (which two are copressive and which two are tensile)
- Setup the full bridge connection
- Try 100g, 300g, 400g, 500g, and 750g weights, read the strain from strain display and calculate the stress for each one
- Plot the five points and compute the shear modulus, G, using a best-fit straight line

Group 4	Group 3	Group 2	Group 1
Morgan	Beal	Malmi	Cody Baker
A. Apperson	Bridges	Overton	Clint Baker
Elzey	McAnally	Thomas	Luttman
Brasher	Gafferd	Syverson	Owens
Zenelaku	Mariano	Ford	Parrish
	DePriest	Ellis	W. Apperson