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

Measurement is based on: the Wheatstone Bridge

$V_o = V_i \left( \frac{R_3}{R_1 + R_3} - \frac{R_4}{R_2 + R_4} \right)$

if $R_1$, $R_2$, $R_3$, and $R_4$ are all equal, then $V_o = 0.0$
Strain Gauge

- Quarter Bridge Connection (least accurate)

- Half Bridge Connection I (Opposite Arms)

Identical strain values
With the same sign:
- Both 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

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

\[
\varepsilon = 4 \times \frac{V_o}{GF \times V_i \times N}
\]

- 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

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
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<td>A. Apperson</td>
<td>Bridges</td>
<td>Overton</td>
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