

# Strength of Materials

# Design

- How do engineers decide if something is a good design?
- Engineers use their understanding of forces, stress, strain and material properties to create safe designs for structures, equipment and products

# Stress

- The amount of force applied over the area of an object (computed by dividing force by area)

$$\sigma = \frac{F}{A}$$

Where  $\sigma$  (sigma lowercase) = stress

F = Force (Newtons or lbs.)

A = Cross sectional area ( $m^2$  or  $in^2$ )

# Compressive and Tensile Stresses

- Compressive
  - Stress that squeezes a material together



- Tensile
  - Stress that pulls a material apart



# Strain

- The percent amount of elongation or compression of a material

$$\varepsilon = \frac{L - L_0}{L_0}$$

Where  $\varepsilon$  (epsilon upper) = strain (percent)

$L$  = new length (mm or in)

$L_0$  = original length (mm or in)

# Elastic and Plastic Deformation

- Elastic deformation
  - Occurs when a material is strained (deformed), but returns to its original shape, like a rubber band
- Plastic deformation
  - Occurs when a material is strained (deformed) beyond its yield strength and does not return to its original shape, like silly putty

# Properties of Materials

- Engineers use their understanding of forces, stress, strain and material properties to create safe designs
- Yield strength
  - The maximum amount of stress a material can take before it deforms plastically (permanently)
- Ultimate tensile strength
  - The maximum amount of tensile stress a material can take before breaking.
- Fatigue strength
  - The maximum amount of stress a material can take one million times without breaking.

# Bridge Building