Activity 6.5 Material Testing Formulas

Material Testing Unit

Principles of Engineering™

Name:___________________________

School:__________________________

Date:____________________________

Definitions and units of measurement

Δ = the change in
δ = total deformation (inches)
σ = stress (force per unit area, psi)
ε = strain (inches per inch)
E = modulus of elasticity, Young's modulus (psi)
P = axial force (pounds)
A = cross section area (inches^2)
L = Length (inches)
R = Radius (inches)
D = Diameter (inches)

Formulas

$\sigma = P/A$
$\varepsilon = \delta/L$
$\delta = PL/AE$
$E = \sigma / \in$
$A = \Pi R^2$
$A = .7854D^2$

Statistical Process Controls
Material:_______________

Attach a printout of the measurements taken on the tensile specimen.

Proportional Limit Stress

Proportional Limit: The greatest stress a material is capable of withstanding without deviation from straight line proportionality between the stress and strain. If the force applied to a material is released, the material will return to its original size and shape.

Calculations:

$$\sigma = P/A$$

Yield Point Stress

Yield Point: The point at which a sudden elongation takes place, while the load on the sample remains the same or actually drops. If the force applied to the material is released, the material will not return to its original shape.

Calculations:

$$\sigma = P/A$$

Ultimate/Tensile Stress

Ultimate Strength: The point at which a maximum load for a sample is achieved. Beyond this point elongation of the sample continues, but the force exerted decreases.

Calculations:

$$\sigma = P/A$$

Breaking/Rupture Point

Proportional Limit: The maximum amount of stress that can be applied before rupture occurs. The specimen fractures in the necking region where the material reduces in diameter as it elongates.

Calculations:

$$\sigma = P/A$$

Modulus of Elasticity

Modulus of Elasticity: A measure of a material's ability to regain its original dimensions after the removal of a load or force. The modulus is the slope of the straight line portion of the stress-strain diagram up to the proportional limit.

Calculations:

$$E = (P_1 - P_2)L_0/(\delta_1 - \delta_2)A$$

Modulus of Resilience

Modulus of Resilience: A measure of a material's ability to absorb energy up to the elastic limit. This modulus is represented by the area under the stress vs. strain curve from 0-force to the elastic limit.

Calculations:

$$U_r = \tfrac{1}{2}(\sigma_{yp})(\varepsilon_{yp})$$

Modulus of Toughness

Modulus of Toughness: A measure of a material's ability to plastically deform without fracturing. Work is performed by the material absorbing energy by the blow or deformation. This measurement is equal to the area under the stress vs. strain curve from its origin through the rupture point.

Calculations:

$$U_t = 1/3\,(\varepsilon_{br})(\sigma_{yp} + 2\,\sigma_{ult})$$

Calculation Page

Total Strain/Deformation: The total amount of elongation of a sample to rupture normalized (divided by) by the initial length.

Calculation:

$\varepsilon_{total} = \delta_{total}/L_0$

ε_{total} =

ε_{total} =

Ductility: The ability of a material to be deformed plastically without rupture.

Calculations:

% of Elongation = ε_{total} **(100)**

% of Elongation =
Elongation =

Reduction in area = ($A_{original}$ – A_{final})/$A_{original}$*100

Reduction in area =