**Strength of Materials Math Worksheet Answers**

1. **Calculate the maximum tensile and compressive forces allowed for the cross-sectional area shown in Figure 1. The maximum tensile strength is 500 lb/**$in^{2}$ **(pounds per inches squared). The maximum compressive strength is 5,000 lb/**$in^{2}$**. Use the following equations to complete the problem. Show your work and calculations.**

cross-sectional area = (B) x (L)

maximum tensile force = (maximum tensile strength) x (cross-sectional area)

maximum compressive force = (maximum compressive strength) x (cross-sectional area)

**Answer**:

Cross-sectional area = (10 inches) x (20 inches) = 200 $in^{2}$

Maximum tensile force = (500 lb/$in^{2}$) x (200 $in^{2}$) = 100,000 lb

Maximum compressive force = (5,000 lb/$in^{2}$) x (200 $in^{2}$) = 1,000,000 lbs

**Figure 1: Cross-sectional area.**

1. **Calculate the maximum tensile and compressive forces allowed for the following two cross-sectional areas shown in Figure 2. The maximum tensile strength is 3,750 lb/**$in^{2}$**. The maximum compressive strength is 4,850 lb/**$in^{2}$**. Use the following equations along with those in #2 to complete the problem. Show your work and calculations.**

cross-sectional area = $π x (radius)^{2}$ $π = 3.14$



**Answer**:

Cross-sectional area of circle = 3.14 x $(10 in)^{2}$ = 314 $in^{2}$

Cross-sectional area of I-beam = (15 inches) x (2 inches) + (15 inches) x (2 inches) + (2 inches) x (20 inches) = 100 $in^{2}$

Maximum tensile force of circle = (3,750 lb/$in^{2}$) \* (314 $in^{2}$) = 1,177,500 lb

Maximum compressive force of circle = (4,850 lb/$in^{2}$) \* (314 $in^{2}$) = 1,522,900 lb

**Figure 2: Cross-sectional areas.** Maximum tensile force of I-beam = (3,750 lb/$in^{2}$) x (100 $in^{2}$) = 375,000 lb

 Maximum compressive force of I-beam = (4,850 lb/$in^{2}$) x (100 $in^{2}$) = 485,000 lb

1. **Part 1: Calculate the compressive force for the cross-sectional area shown in Figure 3. The original length of the member was 100-in long. After applying the compressive force, the member was 99-in long. The modulus of elasticity for the material used in the cross section is 10,000 lb/**$in^{2}$**. Use the following equations along with those in #2 and #3 to complete the problem. Show your work and calculations.**

**Part 2: Calculate the tension force for the cross-sectional area shown in Figure 3. The original length of the member was 100-in long. After applying the tensile force, the member was 103-in long. The modulus of elasticity for the material used in the cross section is the same as in #2 above. Use the following equations along with those in #2 and #3 to complete the problem. Show your work and calculations.**

$σ$ = E \* $ε$ $σ$ = stress

$ε$ = change in length / original length $ε$ = strain

E = modulus of elasticity

change in length = (length after force applied) – (original length)

If the change in length is negative, take the absolute value to get a positive number

force = $σ$ \* cross-sectional area



**Part 1 Answer:**

Change in length = 99 inches - 100 inches = -1 inch

Taking the absolute value, change in length = 1 inch

$ε$ = 1 inch / 100 inches = 0.01

$σ$ = (10,000 lb/$in^{2}$) x (0.01) = 100 lb/$in^{2}$

Cross-sectional area = (17 inches) x (39 inches) – (13 inches) x (33 inches) = 234 $in^{2}$

Force = (100 lb/$in^{2}$) x (234 $in^{2}$) = 23,400 lb

**Part 2 Answer:**

Change in length = 103 - 100 inches = 3 inches

$ε$ = 3 inches / 100 inches = 0.03

$σ$ = (10,000 lb/$in^{2}$) x (0.03) = 300 lb/$in^{2}$

**Figure 3: Cross-sectional area.** Cross-sectional area = (17 inches) x (39 inches) – (13

inches) x (33 inches) = 234 $in^{2}$

 Force = (300 lb/$in^{2}$) x (234 $in^{2}$) = 70,200 lb