

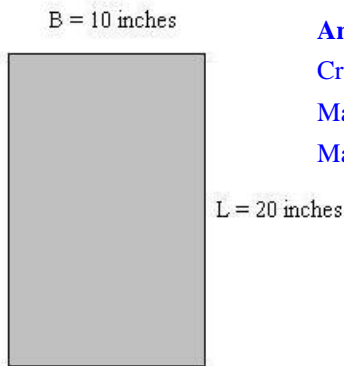
Strength of Materials Math Worksheet **Answers**

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/in² (pounds per inches squared). The maximum compressive strength is 5,000 lb/in². 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 in²

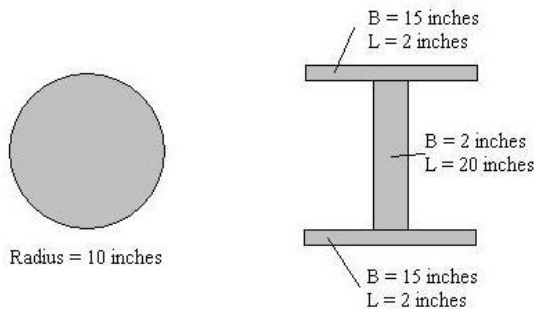
Maximum tensile force = (500 lb/in²) x (200 in²) = 100,000 lb

Maximum compressive force = (5,000 lb/in²) x (200 in²) = 1,000,000 lbs

Figure 1: Cross-sectional area.

2. 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/in². The maximum compressive strength is 4,850 lb/in². Use the following equations along with those in #2 to complete the problem. Show your work and calculations.

cross-sectional area = $\pi \times (\text{radius})^2$ $\pi = 3.14$



Answer: Figure 2: Cross-sectional areas.

Cross-sectional area of circle = 3.14 x (10 inches)² = 314 in²

Cross-sectional area of I-beam = (15 inches) x (2 inches) + (15 inches) x (2 inches) + (2 inches) x (20 inches) = 100 in²

Maximum tensile force of circle = (3,750 lb/in²) * (314 in²) = 1,177,500 lb

Maximum compressive force of circle = (4,850 lb/in²) * (314 in²) = 1,522,900 lb

Maximum tensile force of I-beam = (3,750 lb/in²) x (100 in²) = 375,000 lb

Maximum compressive force of I-beam = (4,850 lb/in²) x (100 in²) = 485,000 lb

3. **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/in². 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.

$$\sigma = E * \varepsilon$$

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

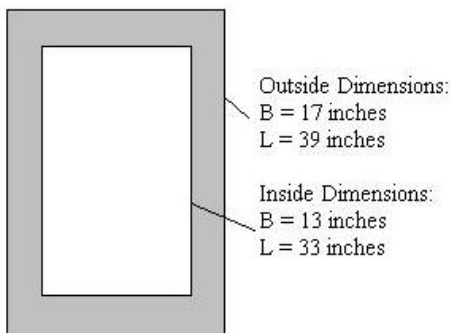


Figure 3: Cross-sectional area.

Part 1 Answer:

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

Taking the absolute value, change in length = 1 inch

$\varepsilon = 1 \text{ inch} / 100 \text{ inches} = 0.01$

$\sigma = (10,000 \text{ lb/in}^2) \times (0.01) = 100 \text{ lb/in}^2$

Cross-sectional area = (17 inches) x (39 inches) – (13 inches) x (33 inches) = 234 in²

Force = (100 lb/in²) x (234 in²) = 23,400 lb

Part 2 Answer:

Change in length = 103 - 100 inches = 3 inches

$\varepsilon = 3 \text{ inches} / 100 \text{ inches} = 0.03$

$\sigma = (10,000 \text{ lb/in}^2) \times (0.03) = 300 \text{ lb/in}^2$

Cross-sectional area = (17 inches) x (39 inches) – (13 inches) x (33 inches) = 234 in²

Force = (300 lb/in²) x (234 in²) = 70,200 lb