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Load Combinations Worksheet Answers

Show your work as you use the following load combinations to solve the problem.

Load Combinations

1. **Ultimate load = dead load + live load + snow load**
2. **Ultimate load = dead load + live load + wind load (or earthquake load)**
3. **Ultimate load = dead load + live load + wind load + (snow load ÷ 2)**
4. **Ultimate load = dead load + live load + snow load + (wind load ÷ 2)**
5. **Ultimate load = dead load + live load + snow load + earthquake load**

Calculate the five ultimate loads resulting from each combination for the following loads:

Dead load = 100,000 lbs
Live load = 30,500 lbs
Wind load = 5,020 lbs
Snow load = 400 lbs
Earthquake load = 5,000 lbs

Answer
Load combination 1: = 100,000 + 30,500 + 400 = 130,900 lbs
Load combination 2: = 100,000 + 30,500 + 5020 (or 5000) = 135,520 lbs with wind load
OR = 135,500 lbs with earthquake load
Load combination 3: = 100,000 + 30,500 + 5020 + (400 ÷ 2) = 135,720 lbs
Load combination 4: = 100,000 + 30,500 + 400 + (5020 ÷ 2) = 133,410 lbs
Load combination 5: = 100,000 + 30,500 + 400 + 5000 = 135,900 lbs

From the five ultimate loads calculated above, for which ultimate load amount must the structure be designed?

The structure must be designed for 135,900 lbs which is obtained with load combination 5.

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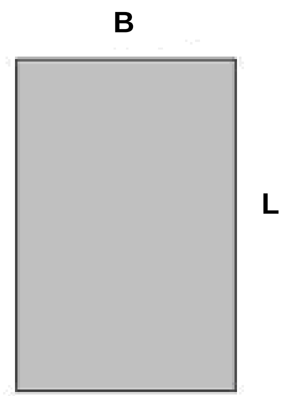
Problem 1: Using the highest load calculated from the first page, calculate the required area of a rectangular shape made of concrete if it is a pier or a column with a compression force acting on it. If L = 10 inches, what must B be equal to?

The maximum compressive strength of this concrete is 4,000 lbs/in^2. Use the following equations to complete the problem. Show all work and calculations.

Highest ultimate load = (max. compressive strength) x (cross-sectional area)
Cross-sectional area = (B) x (L)



Problem 1 cross-sectional area.

Answer
Highest ultimate load = 135,900 lbs

Cross-sectional area = highest ultimate load ÷ max. compressive strength
Cross-sectional area = 135,900 lbs ÷ 4,000 lbs/in^2
Cross-sectional area = 33.975 in^2

If L = 10 inches,
B = cross-sectional area ÷ L
B = 33.975 in^2 ÷ 10 inches
B = 3.3975 inches

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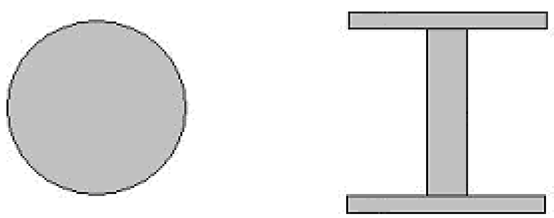
Problem 2A: Using the highest load calculated from the first page, calculate the required area of the circular shape made of concrete if it is a pier or a column with a compression force acting on it. What is the radius of this circle? The maximum compressive strength of this concrete is 5,000 lbs/in^2.

Problem 2B: Using the highest load calculated from the first page, calculate the required cross sectional area of the I-shape made of steel if it is a pier or a column with a tension force acting on it. The maximum tensile strength of this steel is 50,000 lbs/in^2.

Use the following equations to complete the problem. Show all work and calculations.

Highest ultimate load = (max. compressive strength) x (cross-sectional area)
Cross-sectional area of circle = π x (radius)^2 $\pi = 3.14$
Highest ultimate load = (max. compressive strength) x (cross-sectional area)



Problem 2 cross-sectional areas.

Answer
Highest ultimate load = 135,900 lbs

For the circular shape:
Cross-sectional area = highest ultimate load ÷ max. compressive strength
Cross-sectional area = 135,900 lbs ÷ 5,000 lbs/in^2
Cross-sectional area = 27.18 in^2
Radius of circle = square root of (cross-sectional area of circle ÷ π)
Radius of circle = square root of (27.18 in^2 ÷ 3.14)
Radius of circle = 2.942 inches

For the I-shape:
Cross-sectional area = highest ultimate load ÷ max. tensile strength
Cross-sectional area = 135,900 lbs ÷ 50,000 lb/in^2
Cross-sectional area = 2.718 in^2

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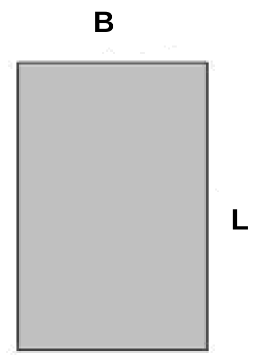
Problem 3A: Using the highest load calculated from the first page, calculate the required Z_x of the rectangular shape made of steel if it is a beam or a girder with a length equal to 20 feet (or 240 inches). F_y of steel is equal to 50,000 lbs/in^2.

Problem 3B: What if the same beam was made of concrete with F_y equal to 4,000 lbs/in^2.

Use the following equations to complete the problem. Show all work and calculations.

Z_x = (force x length) ÷ (F_y x 4)



Problem 3 cross-sectional area.

Answer
Highest Ultimate Load = 135,900 lbs

If made of steel:
Z_x = (force x length) ÷ (F_y x 4)
Z_x = (135,900 lbs x 240 inches) ÷ (4 x 50,000 lbs/in^2)
Z_x = 163.08 in^3

If made of concrete:
Z_x = (135,900 lbs x 240 inches) ÷ (4 x 4,000 lbs/in^2)
Z_x = 2038.5 in^3