Name: Date: Class:

# 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

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?**

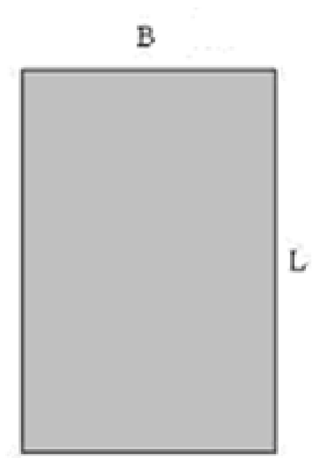
The structure must be designed for 135,900 lbs which is obtained with load combination 5.

**Name:** **Date:** **Class:**

**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.**

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

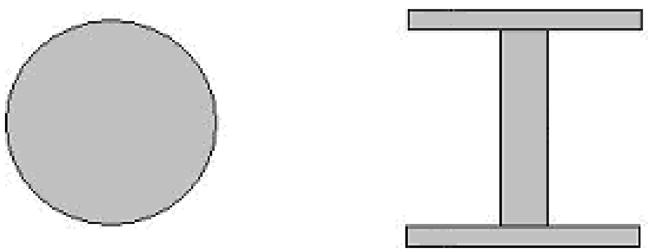
Name: Date: Class:

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



**Problem 2 cross-sectional areas.**

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$^2$

TeachEngineering Engineering UNIVERSITY OF COLORADO BOULDER

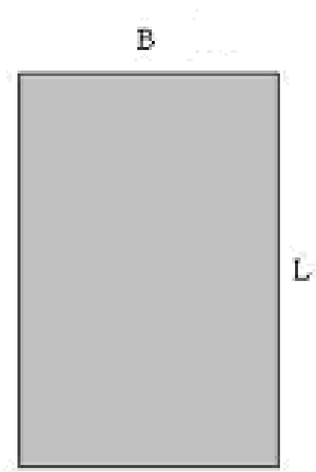
Name: Date: Class:

**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.**

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$^3$