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Unified Design of Steel Structures | (1st Edition)

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Chapter 5, Problem 22P

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Step-by-step solution

Step 1 of 7

a)

Use Load and Resistance Factor Design (LRFD) to select a least-weight W 12 column section to carry a dead load of 95 kips and a live load of 285 kips.

Calculate the maximum required strength, P_u using load combinations.

$$P_u = \max \left\{ \begin{array}{l} 1.4P_D \\ 1.2P_D + 1.6P_L \end{array} \right\}$$

Here, P_u is the ultimate load on the section, P_D is the dead load, and P_L is the live load.

Substitute 95 kips for P_D and 285 kips for P_L .

$$\begin{aligned} P_u &= \max \left\{ (1.4 \times 95 \text{ kips}), [(1.2 \times 95 \text{ kips}) + (1.6 \times 285 \text{ kips})] \right\} \\ &= \max \left\{ 133 \text{ kips}, [(114 \text{ kips}) + (456 \text{ kips})] \right\} \\ &= \max \{ 133 \text{ kips}, 570 \text{ kips} \} \\ &= 570 \text{ kips} \end{aligned}$$

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Step 2 of 7

Determine the effective length of the column, L_{eff} .

$$L_{\text{eff}} = KL$$

Here, K is the effective length factor and L is the unconditional length of the column.

Substitute 1 for K and 16 ft for L .

$$\begin{aligned} L_{\text{eff}} &= KL \\ &= 1 \times 16 \text{ ft} \\ &= 16 \text{ ft} \end{aligned}$$

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Step 3 of 7

Select a least-weight W 12 section from Table 4-1, "Available Strength in Axial Compression, kips W-Shapes" in AISC Steel Construction Manual corresponding to an effective length (KL) of 16 ft and with allowable strength, (ϕP_n) more than 570 kips.

Select section W12×65.

$$KL = 16 \text{ ft} \rightarrow \phi P_n = 640 \text{ kips.}$$

The allowable load on section W12×65 is more than the ultimate load on the section.

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Therefore, the least-weight W12 column section that can carry a dead load of 95 kips and a live load of 285 kips is **W12×65**.

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Step 4 of 7

b)

Use Allowable Stress Design (ASD) to select a least-weight W12 column section to carry a dead load of 95 kips and a live load of 285 kips.

Calculate the maximum required strength, P_u using the load combinations.

$$P_u = \max \{ P_D, (P_D + P_L) \}$$

Here, P_u is the factored load on the column.

Substitute 95 kips for P_D , and 285 kips for P_L .

$$\begin{aligned} P_u &= \max \{ 95 \text{ kips}, (95 \text{ kips} + 285 \text{ kips}) \} \\ &= \max \{ 95 \text{ kips}, 380 \text{ kips} \} \\ &= 380 \text{ kips} \end{aligned}$$

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Step 5 of 7

Determine the effective length of the column, L_{eff} .

$$L_{\text{eff}} = KL$$

Here, K is the effective length factor and L is the unconditional length of the column.

Substitute 1 for K and 16 ft for L .

$$\begin{aligned} L_{\text{eff}} &= KL \\ &= 1 \times 16 \text{ ft} \\ &= 16 \text{ ft} \end{aligned}$$

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Step 6 of 7

Select a least-weight W12 section from Table 4-1, "Available Strength in Axial Compression, kips W-Shapes" in AISC Steel Construction Manual corresponding to an effective length (KL) of 16 ft and with allowable strength, (P_n/Ω) more than 380 kips.

Select section W12×65.

$$KL = 16 \text{ ft} \rightarrow \frac{P_n}{\Omega} = 426 \text{ kips.}$$

The allowable load on section W12×65 is more than the ultimate load on the section.

$$\begin{aligned} \frac{P_n}{\Omega} &> P_u \\ 426 \text{ kips} &> 380 \text{ kips} \end{aligned}$$

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Step 7 of 7



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