Unified Design of Steel Structures | (1st Edition)

Chapter 5, Problem 22P | Bookmark | Show all steps: ON

Step-by-step solution

Step 1 of 7

a)

Use Load and Resistance Factor Design (LRFD) 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 load combinations.

$$P_u = \max\begin{Bmatrix}1.4P_D \\ 1.2P_D + 1.6P_L\end{Bmatrix}$$

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.

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

Comment

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*.

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

Comment

Step 3 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, (ϕP_n) more than 570 kips.

Select section $W12\times 65$.

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

The allowable load on section $W12\times 65$ is more than the ultimate load on the section.

Therefore, the least-weight $W12$ column section that can carry a dead load of 95 kips and a live load of 285 kips is $\boxed{W12\times65}$.

Comment

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_a using the load combinations.

$$P_a = \max\left\{P_D,\left(P_D + P_L\right)\right\}$$

Here, P_a is the factored load on the column.

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

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

Comment

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*.

$$\begin{aligned} L_{\text{Eff}} &= KL \\ &= 1\times16\,\text{ft} \\ &= 16\,\text{ft} \end{aligned}$$

Comment

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, $\left(P_n/\Omega\right)$ more than 380 kips.

Select section $W12\times65$.

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

The allowable load on section $W12\times65$ is more than the ultimate load on the section.

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

Comment

Step 7 of 7

Comment

Was this solution helpful? 0 0

Recommended solutions for you in Chapter 1

Chapter 1, Solution 5P

7185-1-7P AID: 1825 | 24/08/2013 The two types of lateral bracing systems commonly used in high-rise buildings are as follows:...

See solution

Chapter 1, Solution 10P

7185-1-12P AID: 1825 | 24/08/2013 Examples for three strength limit states are .

See solution

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