# CE 415: Design of Steel Structures

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# Compression Member :
# Column Design Problem

**Select the lightest W section of A992 ($F_y$ = 50 ksi) steel to serve as a pinned-end main member column 16 ft long to carry an axial compression load of 115 kips dead load and 125 kips live load in a braced structure, as shown in Fig. Use ASD approach.**

**SOLUTION:**

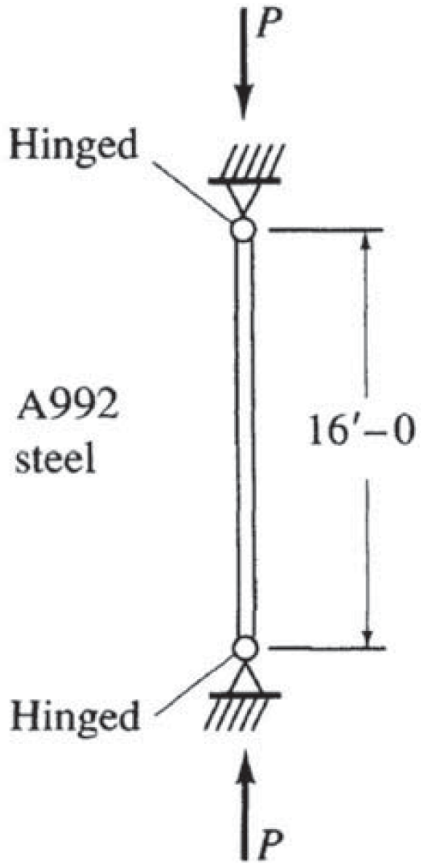
**$P$= 115+125= 240 kip, $L$ = 16' = 192"**
**Both ends hinged, therefore $K$ = 1.0**

**Nominal strength $P_n = F_{cr} A_g$**

**1.** $$F_{cr} = \left[0.658^{\frac{F_y}{F_e}}\right] F_y \quad \text{For } \frac{KL}{r} \le 4.71\sqrt{\frac{E}{F_y}} \quad \text{or} \quad F_e \ge 0.44F_y \qquad \textbf{(6.7.7)}$$

**2.** $$F_{cr} = 0.877F_e \qquad \text{For } \frac{KL}{r} > 4.71\sqrt{\frac{E}{F_y}} \quad \text{or} \quad F_e < 0.44F_y \qquad \textbf{(6.7.8)}$$

$$F_e = F_{cr} = \frac{\pi^2 E}{\left(\frac{KL}{r}\right)^2}$$




**$4.71\sqrt{(E/F_y)}$ = 4.71 $\sqrt{(29000/50)}$ = 113.4**

**TRIAL-1**

Assume $KL/r = 90$, $\therefore r = KL/90 = 192/90 = 2.133$ in.

$F_e = \pi^2 E/(KL/r)^2 = 3.14^2 \times 29000/(90)^2 = 35.33$ ksi.

$$F_{cr} = \left[0.658^{\frac{F_y}{F_e}}\right] F_y = [0.658^{(50/35.33)}]50 = 27.65 \text{ ksi} \quad \text{For } \frac{KL}{r} \le 4.71\sqrt{\frac{E}{F_y}}$$

Nominal strength $P_n = \Omega P = 1.67 \times 240 = 400.8$ kip

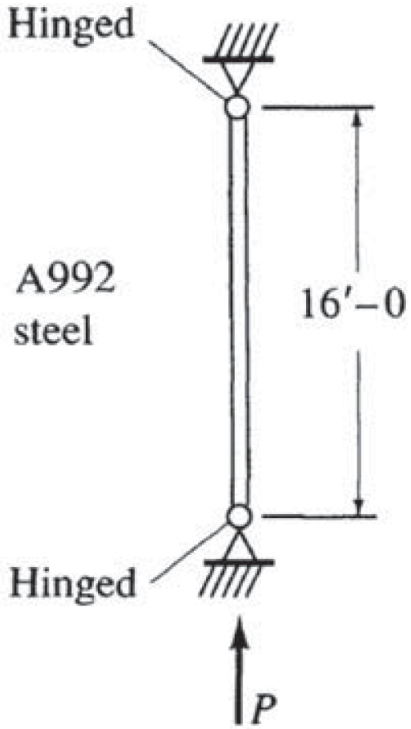
But $P_n = F_{cr} A_g$

$\therefore A_g = P_n/F_{cr} = 400.8/27.63 = 14.5$ in$^2$.

Now go to W section charts of AISC Manual and find a section having $r \ge 2.133$ and $A_g \ge 14.5$.

From AISC Manual Chart on Pages 1-24 and 1-25,

Select W12x53 with $A$=15.6 in$^2$ and $r$ = 2.48 in




**TRIAL-2**

Assume $KL/r = 80$, $\therefore r = KL/80 = 192/80 = 2.4$ in.

$F_e = \pi^2 E/(KL/r)^2 = 3.14^2 \times 29000/(80)^2 = 44.72$ ksi.

$$F_{cr} = \left[0.658^{\frac{F_y}{F_e}}\right] F_y = [0.658^{(50/44.72)}]50 = 31.31 \text{ ksi}$$

But $P_n = F_{cr} A_g$ $\therefore A_g = P_n/F_{cr} = 400.8/31.31 = 12.8$ in$^2$.

From AISC Manual Chart on Pages 1-24 and 1-25,

Select W10x49 with $A$=14.4 in$^2$ and $r$ = 2.54

**TRIAL-3**

**Assume $KL/r = 70$, $\therefore r = KL/70 = 192/70 = 2.743$ in.**

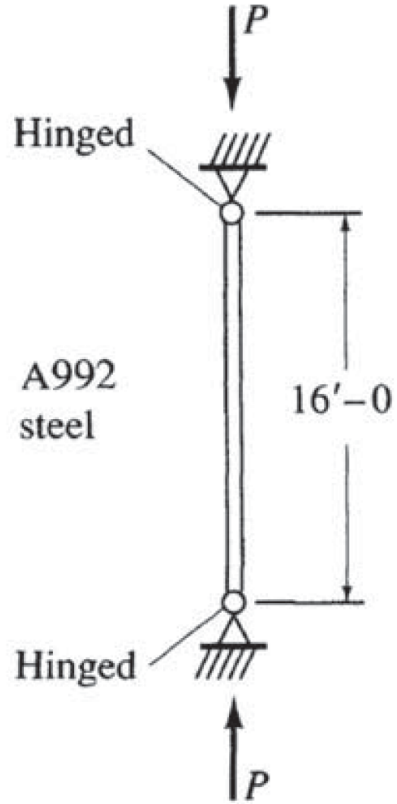
**$F_e = \pi^2 E/(KL/r)^2 = 3.14^2 \times 29000/(70)^2 = 58.35$ ksi. ( > $F_y$ Note)**

$$F_{cr} = \left[0.658^{\frac{F_y}{F_e}}\right] F_y = [0.658^{(50/58.35)}]50 = 34.93 \text{ ksi}$$

**But $P_n = F_{cr} A_g$ $\therefore A_g = P_n/F_{cr} = 400.8/34.93 = 11.45$ in$^2$.**

**Now go to W section charts of AISC Manual and find a section having $r \geq 2.743$ and $A_g \geq 11.45$**

**From AISC Manual Chart on Pages 1-22 and 1-23, Select W12x65 with $A$=19.1 in$^2$ and $r$ = 3.02**




**Based on above three trials, the finally chosen section is W10x49**