Note Title 3/15/2007

HW #6 (6.6 and 6.10) due Tues
Midterm next Thurs.

Design Charts for Column Design

- Variable F_y (or $F_y \neq 50$ ksi)

  Tables are for $F_y = 50$ ksi

  For elastic buckling, $\phi P_{n-36} = \left(\frac{36}{50}\right) \underbrace{\phi P_{n-50}}_{\text{table value}}$

  For inelastic buckling, $F_{cr} = \left(0.658^{\lambda_c^2}\right) F_y$

$$\lambda_c = f(F_y)$$

$\therefore$ Not linear relationship between F_y and ϕP_n

$\therefore$ Tables are not reliable for A36

Strong Axis Buckling w/ Design Charts

- Tables assume weak axis buckling
- Data must be converted for strong axis buckling
- Recall: Compare $\left(\frac{KL}{r}\right)_y$ and $\left(\frac{KL}{r}\right)_x$ → larger ratio controls

$\left(\frac{KL}{r}\right)_x > \left(\frac{KL}{r}\right)_y$ → strong axis buckling controls

$$\frac{(KL)_x}{(KL)_y} > \frac{r_x}{r_y} \rightarrow \text{strong axis buckling controls}$$

Table: $\frac{KL}{r_y}$ Need: $\boxed{KL} \frac{}{r_x}\left(\frac{1}{r_y/r_x}\right) = \frac{KL}{r_y}$

* If strong axis buckling: Use KL_{eff} for strong axis

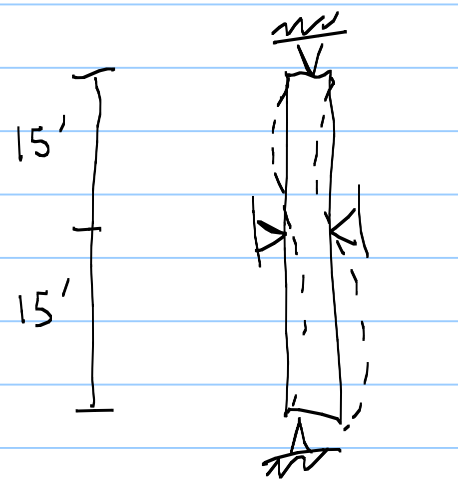
$$KL_{eff} = \frac{(KL)_x}{r_y/r_x}$$

r_y/r_x given at bottom of tables for each section.

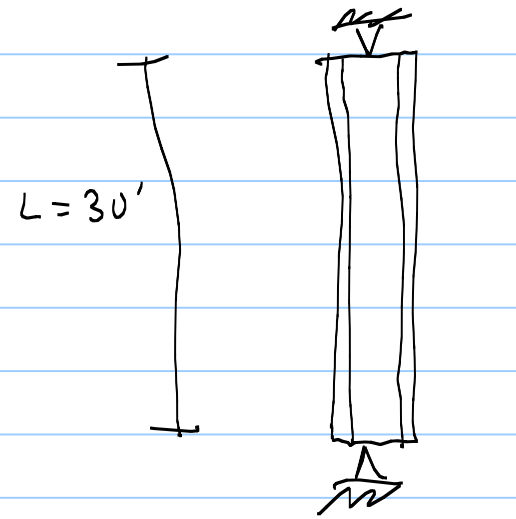
Example 1. Select lightest W section (from column design tables) to resist a factored axial compression $P_u = 420$ kips. Member is Grade 50. Member length = 30'.

Weak axis bracing @ mid-height (pinned support).

Column is pinned @ top and bottom.



Weak Axis



Strong Axis

- Weak Axis Design : $(1)(15') = 15' = (KL)_y$

  $P_u = 420\ k$

Possible Sections ; W14×61 $r_x/r_y = 2.44$

W12×53 $r_x/r_y = 2.11$

W10x49 $(r_y/r_x)^{-1} = 1.71$

- Check Weak Axis Designs for strong axis buckling:

  $(KL)_x = (1)(30)' = 30'$

  - **W14x61**:

    $KL_{eff} = \frac{30'}{2.44} = 12.3' < 15'$

    $\phi P_n > 566 > 420k = P_u \therefore OK$

  - **W12x53**: $KL_{eff} = \frac{30'}{2.11} = 14.2' < 15' \therefore OK$

  - W10x49: $KL_{eff} = \frac{30'}{1.71} = 17.5' > 15'$

    $\phi P_n \approx 372$ kips < 420 kips $\Rightarrow$ ⊗ No good.

Need **W10x60** for strong axis buckling.

⇒ **Use W12×53.** $A_g = 15.6\ in^2$ $r_x = 5.23"$ $r_y = 2.48"$

$$\lambda_{cx} = \frac{KL}{r\pi}\sqrt{\frac{F_y}{E}} = \frac{(1)(30')(12\ in/ft)}{\pi(5.23)}\sqrt{\frac{50}{29000}} = 0.910$$

$$\lambda_{cy} = \frac{(1)(15')(12\ in/ft)}{\pi(2.48)}\sqrt{\frac{50}{29000}} = 0.959$$

$\lambda_{cy} > \lambda_{cx}$ ∴ weak axis controls

$$F_{cr} = \left(0.658^{\lambda_c^2}\right)F_y = \left[0.658^{(0.959)^2}\right](50\ ksi) = 34.0\ ksi$$

$$\phi P_n = \phi F_{cr} A_g = 0.85(34.0\ ksi)(15.6\ in^2) = 451\ kips > 420k$$

Check web and flange slenderness → ok

Example 2. (6-11)

Given: Choose lightest W section to support axial compression of

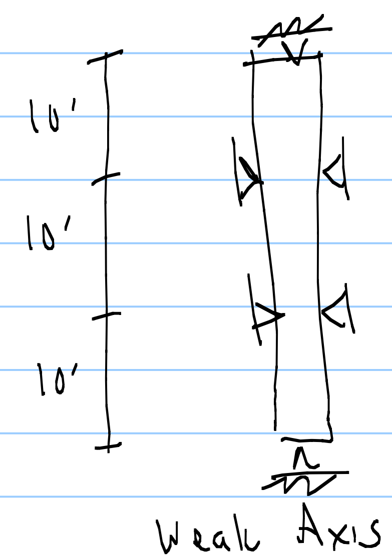
$P_u = 1600\ k$

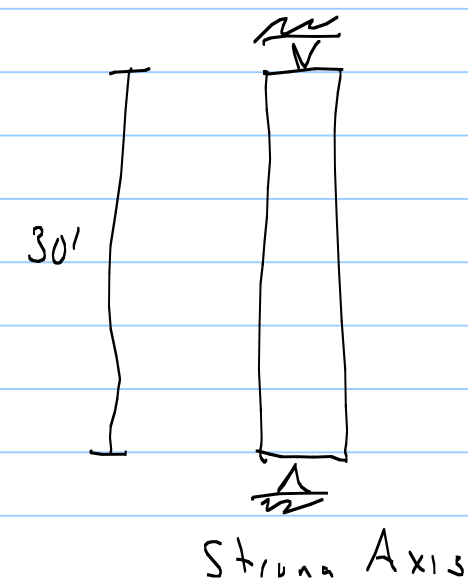
Grade 50

Column is 30' long

Pinned @ top and bottom

Braced in weak axis @ 10' from each end. (pinned supports)





- Weak Axis Design: $(KL)_y = (1)(10') = 10'$

  Possible: W14 x 145 $\quad r_x/r_y = 1.59$

  W12 x 152 $\quad r_x/r_y = 1.77$

  No W10 available

- Check possible sections for strong axis buckling. $(KL)_x = (1)(30) = 30'$

  - W14 x 145 : $KL_{eff} = \dfrac{30'}{1.59} = 18.87 \Rightarrow$ won't work

    Try W14 x 176 instead.

  - W12 x 152 : $KL_{eff} = \dfrac{30'}{1.77} = 16.95 \Rightarrow$ won't work

    Try W12 x 190 instead.

- Check W14x176.

  - Strong axis : $KL_{eff} = \frac{30'}{1.60} = 18.75'$

    $$\phi P_n = \underbrace{1740 + (1780 - 1740)(0.75)}_{\text{interpolation}} = 1770 \text{ kips} > 1600$$

    $\therefore$ OK

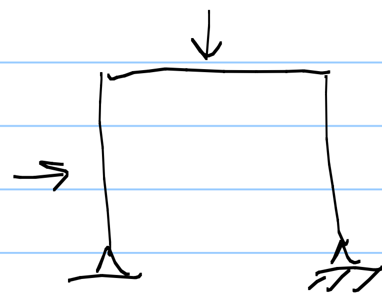
  - Weak Axis : $KL = 10' <$ strong axis

    Strong axis controls.

    $\phi P_n = 1770$ kips

Use W14x176.

- "Axially - Loaded Columns"
  - Loaded in compression only



  - Most real columns have compression and moment
    - → Beam - Columns