Topic CLASS 6.1: COMP. MEMBERS - MORE ON K

Date 10-1-19

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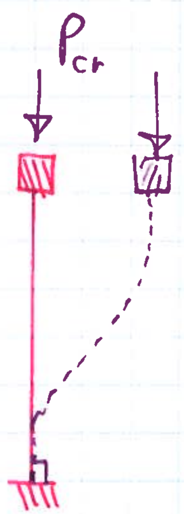
MORE ON EFFECTIVE LENGTH

$L_c = KL$ = eff. length

f (end conditions, brace points, braced length)

$$\phi_c P_n = f\left(\frac{KL}{r}\right)_{max}$$

must calc. $\left(\frac{KL}{r}\right)$ for all buckling axes

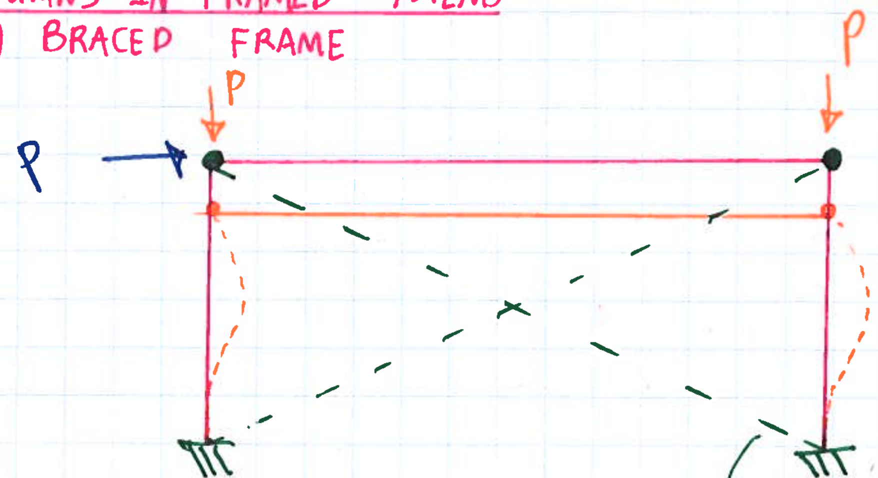


$\Rightarrow$ K, Table C-A-7.1

* Segui, Pg 135, study examples

COLUMNS IN FRAMED SYSTEMS

1) BRACED FRAME

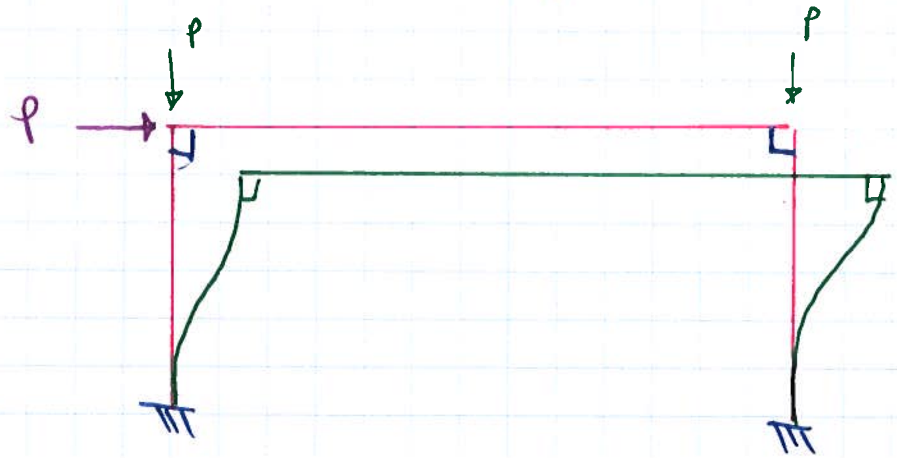


K=0.8

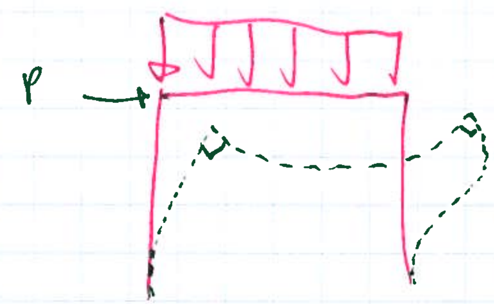
* Sidesway Inhibited

Bracing → Tension Members ; Shear Wall

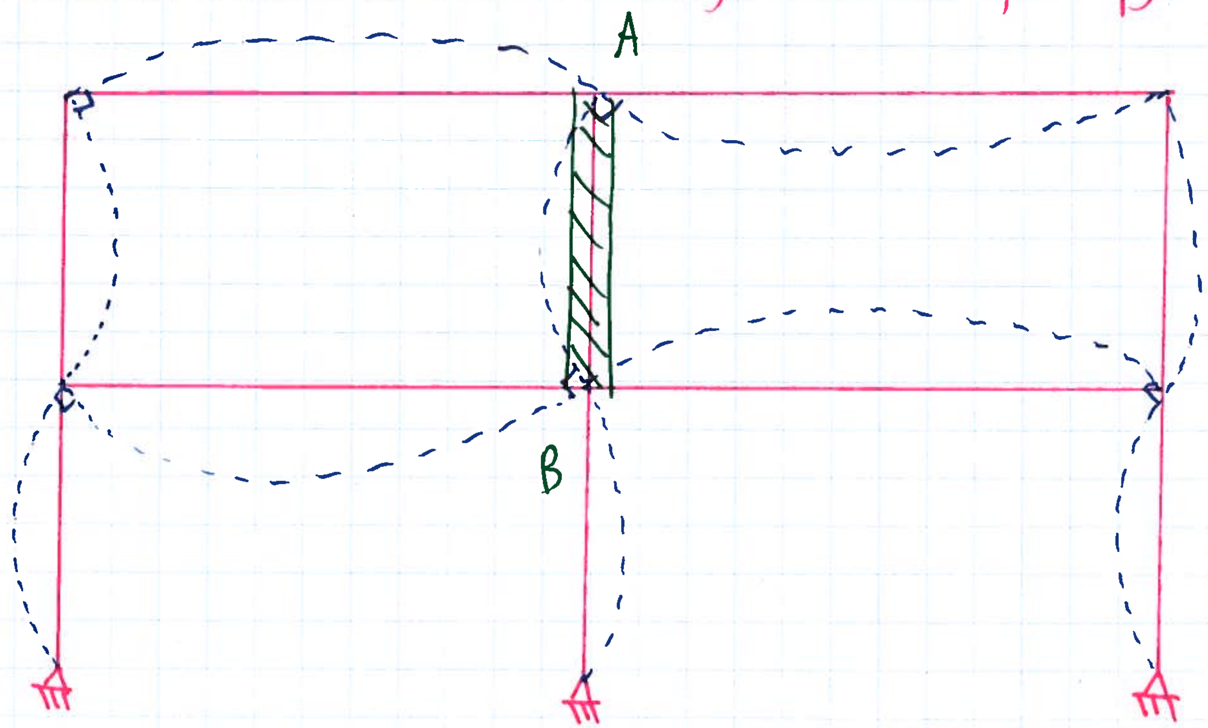
2) MOMENT FRAME → Sidesway Uninhibited (unbraced frame)

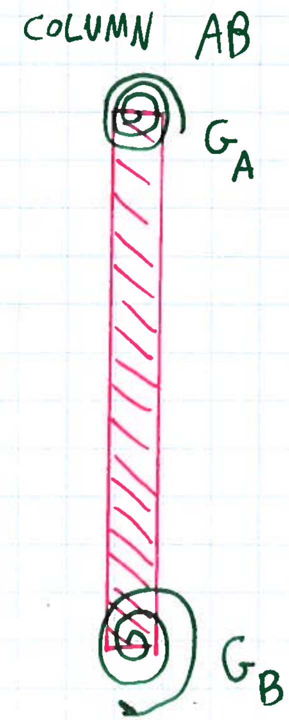


$K \geq 1.0$



"Real" Frames we use column alignment charts, pg 16.1 - 569 - 574, to determine k





$(G_A, G_B) = f$ (relative stiffness of column AB to the member connected at each end)

$$G = \frac{\sum \left(\frac{\cancel{E}I}{L}\right)_{column}}{\sum' \left(\frac{\cancel{E}I}{L}\right)_{girder}}$$

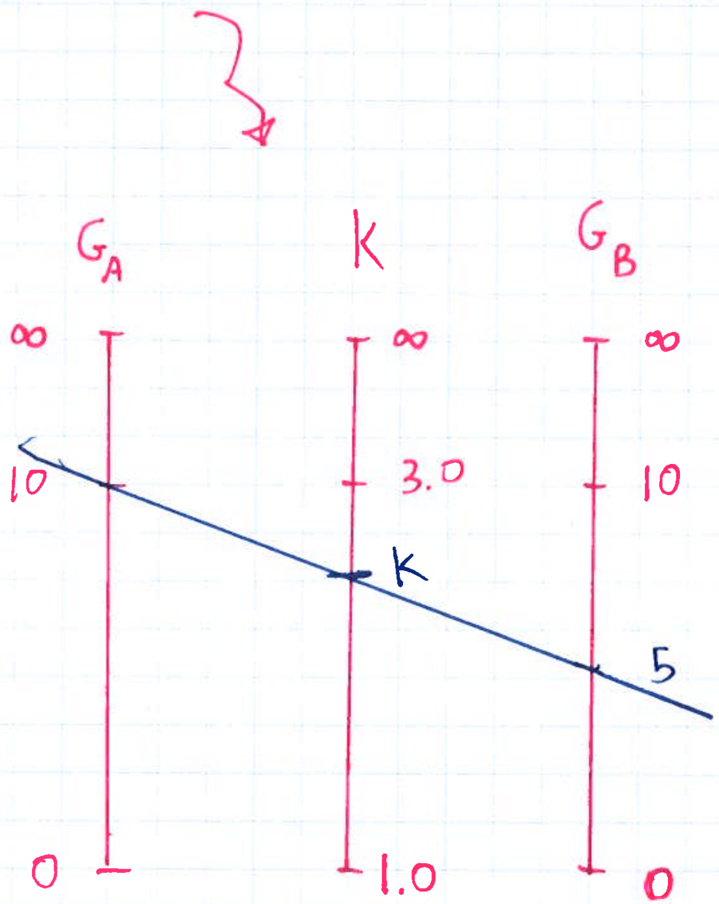
column ↩ vert. members

girder ↩ Horiz. members

E is constant $\Rightarrow$ $E_{col} = E_{gird}$

For Braced Frames: $0.5 \le K \le 1.0$

For Moment Frames: $1.0 \le K < \infty$



K should never exceed 3.0

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Note: Pin → G = 10.0

fixed → G = 1.0

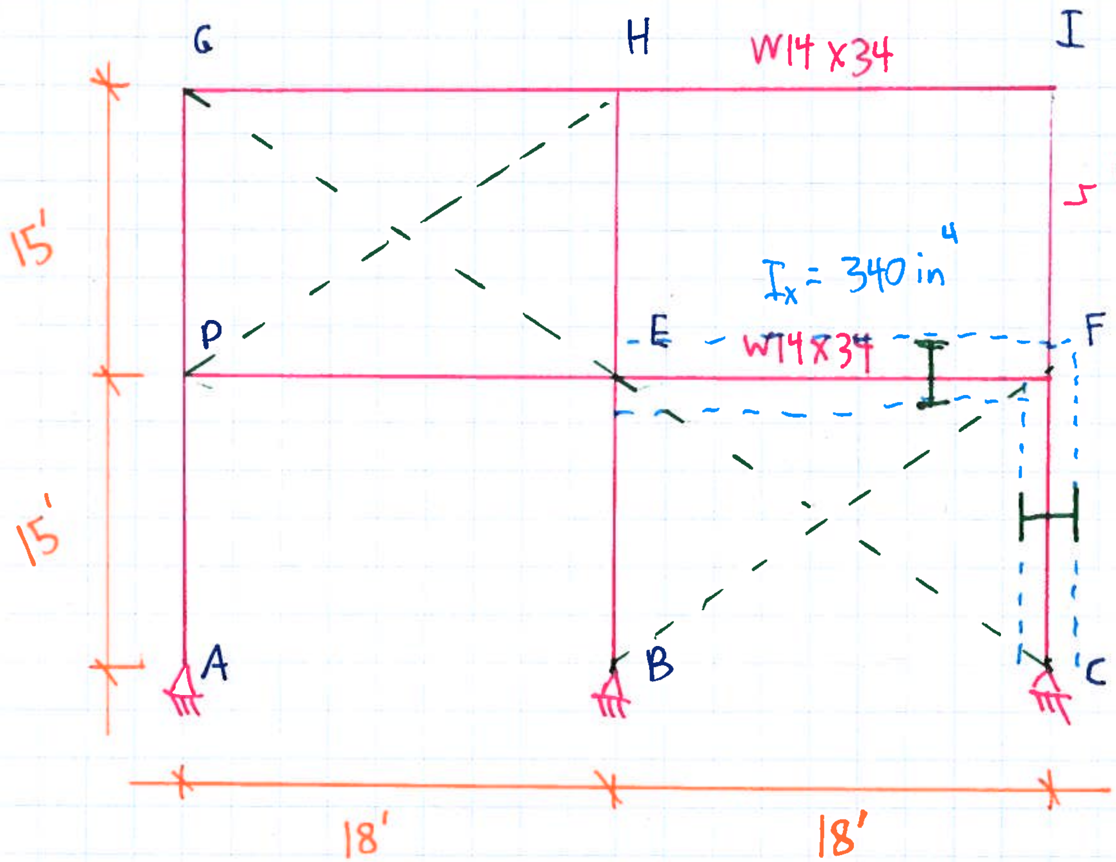
} 1st para. pg 16.1-573

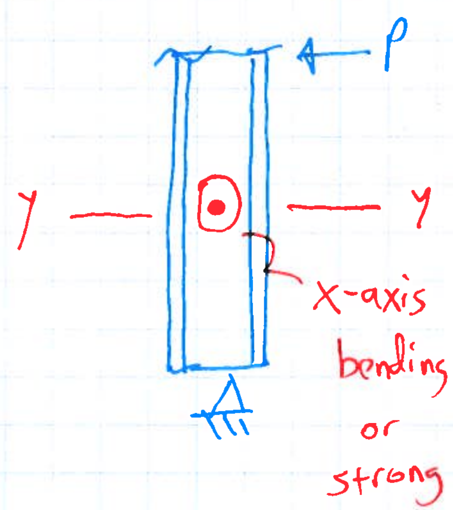
** p16.1-570 assumptions; In general, neglecting these assumptions results in a conservative design (ie column is larger than needed)

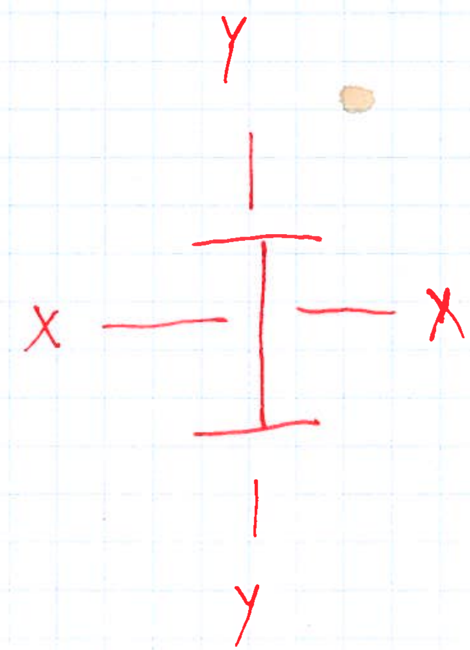
EXAMPLE

GIVEN: The frame shown is constrained w/ A992 steel. Column FC is to carry the load (factored) of 500^k

Braced / sidesway inhibited







$K_y = 0$

REQD: Select the lightest W12X__ to carry the load. Assume column FC is fully-braced out-of plane, so that only in-plane buckling need be considered.

Braced Frame → $K = 1.0$ (max possible for braced frame)

$$(KL)_x = 1.0(15') = 15^{ft}$$

$$P_u = 500^k$$

estimate $r_x/r_y \approx 2.64$ p4-21 → W12X40

$$(KL)_{eqv} = \frac{(KL)_x}{r_x/r_y} = \frac{15^{ft}}{2.64} = 5.7'$$

Try W12X45: @ $KL = 6'$ $\phi_c P_n = 534^k \geq P_u = 500^k$

$A_g = 13.1\ in^2$

$I_x = 348\ in^4$ ←

$r_y = 1.95''$; $r_x = 1.95(2.64) = 5.15$ in

p4-21

$$G_F = \frac{\sum\left(\frac{I}{L}\right)_{vert.}}{\sum\left(\frac{I}{L}\right)_{Horz}} = \frac{\frac{204\ in^4}{15'} + \frac{348\ in^4}{15'}}{\frac{340\ in^4}{18'}} = 2.13$$

ratio; units don't matter

$G_{pin} = 10$

$K_x \approx 0.91$ fig. CA7.1

VERIFY CAPACITY

$$\left(\frac{kL}{r}\right)_x = \frac{0.91(15')(12)}{5.15\text{ in}} = 31.8 \leq 200 \checkmark$$

$$f_e = \frac{\pi^2 E}{\left(\frac{kL}{r}\right)^2} = 283^{ksi} > 22^{ksi} \therefore \text{Inelastic Buckling}$$

* No notation ∴ no local buckling

$$f_{cr} = \left(0.658^{f_y/f_e}\right) f_y = 46.44 \text{ ksi}$$

$$\phi_c P_n = \phi_c f_{cr} A_s = 547.5^{k} \geq P_u = 500 \checkmark$$