Note Title 3/6/2007

Steel Compression Members (Columns)

- **Differences Between Steel Columns and Concrete Columns**

Steel is stronger and ductile

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Smaller cross-sections — { AISC Shapes (see Table 5.2) Our focus will be I-shaped sections }

(I-shaped sections: W-section from AISC or plate girder)

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Limit State = Buckling

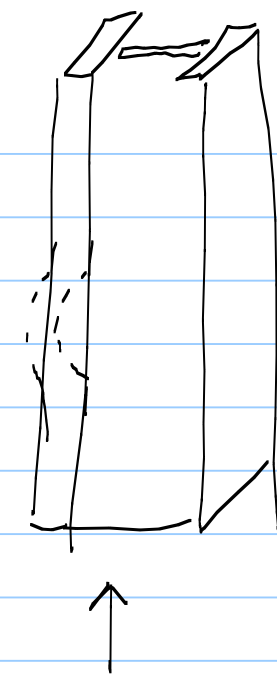
Limit States

Global Buckling

Local Buckling

↓

* Will control design



We will choose sections that local buckling will not be a concern

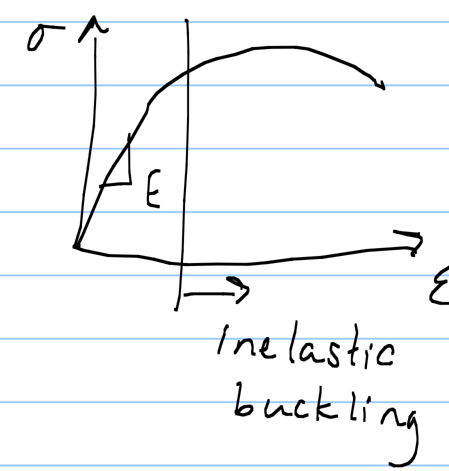
Global Buckling for Axially Loaded Columns

A. Euler Buckling Load / Elastic Buckling

$$P_e = \frac{\pi^2 EI}{L^2}$$

only works for long columns

E = modulus (stiffness)
I = moment of inertia
L = length



B. Ideal Buckling Load

$$P_i = \frac{\pi^2 E_t I}{L^2}$$

E_t = tangent modulus

Rewrite eqn. in terms of stress:

$$F_e = \frac{P_e}{A} = \frac{\pi^2 E (I/A)}{L^2} = \frac{\pi^2 E}{\underbrace{(L/r)^2}_{\text{slenderness of column}}}$$

C. Actual Buckling Load

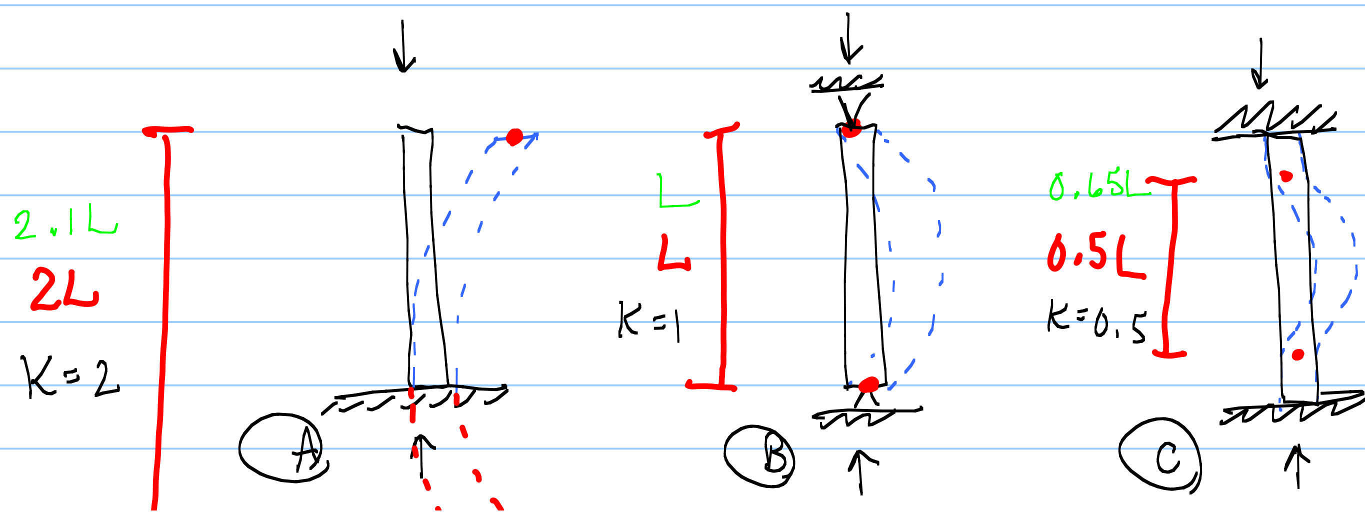
Reduction in strength:
- Residual stresses
- Geometric imperfections

Empirical Eqn. to account for this

Eqns above are for :

Effective Length

- Accounts for different types of supports (other than pinned - pinned)



A is weakest
C is strongest

K = effective length factor

See Table 5.1

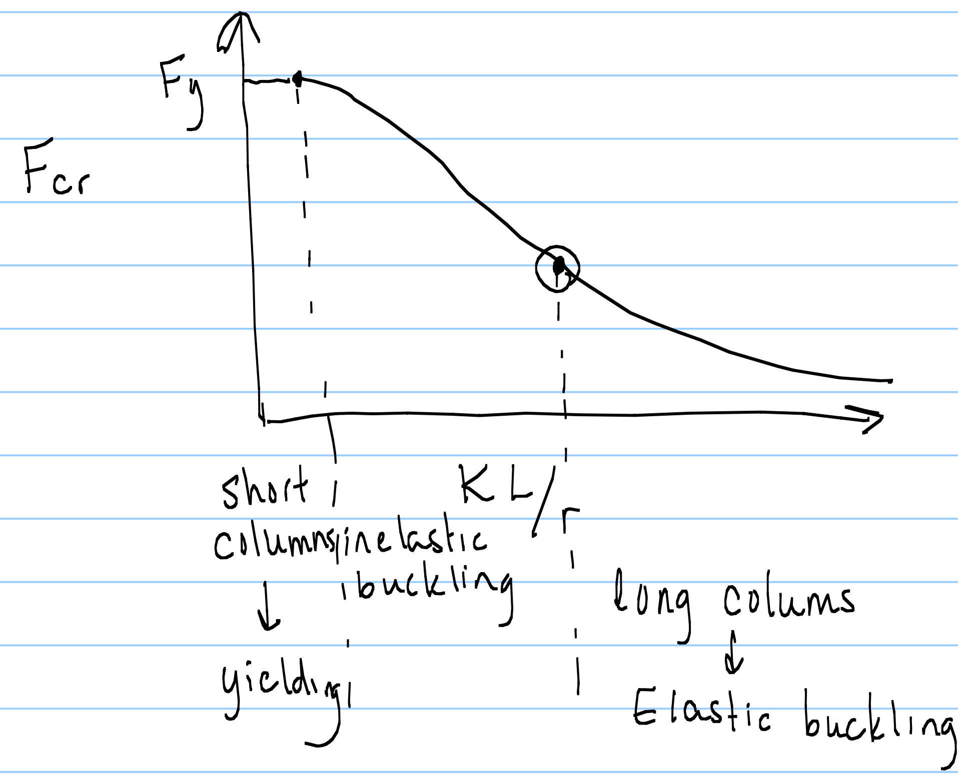
Buckling Strength of Axially Loaded Columns

Based on Euler Buckling : $F_e = \dfrac{\pi^2 E}{\left(\frac{KL}{r}\right)^2}$ for any type of supports

Need to modify to account for :

1. Inelastic buckling
2. Residual stresses
3. Geometric Imperfections

AISC gives empirical eqns based on test data and these factors.



Slenderness for columns

$$\lambda_c = \frac{KL}{r\pi}\sqrt{\frac{F_y}{E}}$$

$\lambda_c \le 1.5 \rightarrow$ intermediate column $\rightarrow$ (1) $F_{cr} = \left(0.658^{\lambda_c^2}\right) F_y$

$\hookrightarrow$ 100% – 39% F_y

$\lambda_c > 1.5 \rightarrow$ long columns $\rightarrow$ (2) $F_{cr} = \dfrac{0.877}{\lambda_c^2} F_y \; (= 0.877 F_e)$

Buckling Load, $\phi P_n = \phi F_{cr} A_g$

F_{cr} = critical stress, buckling stress from (1) or (2)

A_g = gross area

$\phi = 0.85$

Steel Tension	Concrete Columns
0.9 for yielding	0.70 spiral } crushing
0.75 for fracture	0.65 tied } crushing

→ Do not need to check yielding

→ Also need to check that local buckling will not occur.