Local Buckling

Global Buckling

Limit States

Limit State = Buckling

Reinforced Concrete

Steel

Steel Columns

Steel Compression Members (Columns)

Steel Shear Stiffness

Column and Concrete

Steel Columns

Small Cross-Sections

Large Shapes (sec. Table 5.2)

W-section from AISC or plate

I-section from AISC or plate

Steel is stronger and stiffer

Differences Between Steel Columns and Concrete Columns

Girders

Reinforcement

Reinforcement

Reinforcement

Reinforcement
not be a concern that local buckling will. We will choose sections control design.
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

\[ E = \text{modulus (stiffness)} \]
\[ I = \text{moment of inertia} \]
\[ L = \text{length} \]

B. Ideal Buckling Load

\[ P_i = \frac{\pi^2 E_t I}{L^2} \]  
inelastic buckling
Empirical Eqn. to account for frs:

Geometric Imperfections
- Residual Stress
- Reduction in Section

C. Actual Buckling Load

Strain Energy of Column

\[ \frac{(C/E)}{l} = \frac{L^2}{2EC} \]

\[ \frac{Ae}{Pe} = \frac{Ae}{2Ec} \]

Requisite Eqn. in terms of Stress:

\[ E \cdot \text{Tangent Modulus} \]
Accounts for different types of supports (other than ground planed).

Effective Length

Legs above arc force
3. Geometric Imperfections
2. Axial loads
1. Inelastic buckling

Need to modify to account for:

Suppose for any type of:

Based on Euler buckling: $P_e = \frac{\pi^2 E}{L_c^2}$ for any length of:

Buckling Strength of Axially Loaded Columns

See Table 5.1

$K_e = \text{Effective Length Factor}$

$C$ is strongest
$A$ is weakest
AISC gives empiricaluards based on test data and these factors.
Slenderness for columns

\[ \lambda_c = \frac{KL}{r_{eq} \sqrt{\frac{F_y}{E}}} \]

\[ \lambda_c \leq 1.5 \rightarrow \text{intermediate column} \rightarrow F_{cr} = (0.658 \frac{\lambda_c^2}{100\% - 39\% F_y}) F_y \]

\[ \lambda_c > 1.5 \rightarrow \text{long columns} \rightarrow F_{cr} = \frac{0.877}{\lambda_c^2} F_y (= 0.877 F_e) \]
Also need to check that local buckling will not occur.

- Do not need to check yielding

<table>
<thead>
<tr>
<th>Concrete Columns</th>
<th>Steel Tension</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.65 for Fracture</td>
<td>0.75 for Fracture</td>
</tr>
<tr>
<td>0.70 for Spalling</td>
<td>0.9 for Yielding</td>
</tr>
</tbody>
</table>

\[
\phi = 0.85
\]

\[
A_g = \text{gross area}
\]

\(
F_c = \text{critical stress, buckling stress from Buckling Load}
\)

\[
P_{cr} = \phi F_c A_g
\]