Compression Members (revisited)

- designed for strength & stresses
- designed for serviceability & deflection
- need to design for stability
  - ability to support a specified load without sudden or unacceptable deformations

Effect of Length (revisited)

- long & slender
- short & stubby

Critical Stresses (revisited)

- when a column gets stubby, crushing will limit the load
- real world has loads with eccentricity
**Bracing (revisited)**

- bracing affects shape of buckle in one direction
- both should be checked!

**Wood Columns**

- slenderness ratio = \( L/d_{\text{min}} = L/d_1 \)
  - \( d_1 \) = smaller dimension
  - \( l/e/d \leq 50 \) (max)

\[
f_c = \frac{P}{A} \leq F'_c
\]

- where \( F'_c \) is the allowable compressive strength parallel to the grain
- bracing common

**Allowable Wood Stress**

\[
F'_c = F_c \left( C_D \right) \left( C_M \right) \left( C_t \right) \left( C_F \right) \left( C_p \right)
\]

- where:
  - \( F_c \) = compressive strength parallel to grain
  - \( C_D \) = load duration factor
  - \( C_M \) = wet service factor (1.0 dry)
  - \( C_t \) = temperature factor
  - \( C_F \) = size factor
  - \( C_p \) = column stability factor

\[
= f \left( \frac{F_c E}{F_c^s} \right)
\]

**Strength Factors**

- wood properties and load duration, \( C_D \)
  - short duration
    - higher loads
  - normal duration
    - > 10 years

- stability, \( C_p \)
  - combination curve - tables

\[
F'_c = F_c^s C_p = \left( F_c C_D \right) C_p
\]
 Procedure for Analysis

1. calculate \( L_e/d_{\min} \)
   - KL/d each axis, choose largest

2. obtain \( F'_c \)
   - compute \( F_{cE} = \frac{0.822E'_{\min}}{(L_e/d)^2} \)
     - where \( E'_{\min} = E_{\min}(C_M)(C_I)(C_T)(C_i) \)

3. compute \( F'_c \approx F_cC_D \)

4. calculate \( F_{cE}/F'_c \) and get \( C_p \) (chart)

5. calculate \( F'_c = F'_cC_p \)

Procedure for Design

1. guess a size (pick a section)

2. calculate \( L_e/d_{\min} \)
   - KL/d each axis, choose largest

3. obtain \( F'_c \)
   - compute \( F_{cE} = \frac{0.822E'_{\min}}{(L_e/d)^2} \)
     - where \( E'_{\min} = E_{\min}(C_M)(C_I)(C_T)(C_i) \)

4. calculate \( F_{cE}/F'_c \) and get \( C_p \) (chart)
Procedure for Design (cont’d)

6. calculate $F' = F_c C_p$

7. compute

$$P_{allowable} = F_c A$$

• or find $f_{actual} = P/A$

8. is $P \leq P_{allowable}$? (or $f_{actual} \leq F' c$?)

• yes: OK
• no: pick a bigger section and go back to step 2.

Specific Column Charts

<table>
<thead>
<tr>
<th>Nominal Area (in.²)</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
<th>22</th>
<th>24</th>
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<td>20.5</td>
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<td>212</td>
<td>208</td>
<td>200</td>
<td>190</td>
<td>179</td>
</tr>
</tbody>
</table>

Specific Column Charts Table 5.1 Safe Loads for Wood Columns

Timber Construction by Code

- light-frame
  - light loads
  - 2x’s
  - floor joists – 2x6, 2x8, 2x10, 2x12 typical at spacings of 12”, 16”, 24”
  - normal spans of 20-25 ft or 6-7.5 m
  - plywood spans between joists
  - stud or load-bearing masonry walls
  - limited to around 3 stories – fire safety

Design of Columns with Bending

- satisfy
  - strength
  - stability
- pick
  - section
Design

• Wood

\[
\left( \frac{f_c}{F_c'} \right)^2 + \frac{f_{bx}}{F_{bx}'} \left( 1 - \frac{f_c}{F_{cEx}} \right) \leq 1.0
\]

(\text{term}) – magnification factor for \( P-\Delta \)

\( F'_{bx} \) – allowable bending strength

Design Steps Knowing Loads

1. assume limiting stress
   • buckling, axial stress, combined stress
2. solve for \( r, A \) or \( S \)
3. pick trial section
4. analyze stresses
5. section ok?
6. stop when section is ok