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

(Table 5.2)

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**Strength Factors**

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

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

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

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

2. obtain \( F' \)
   - compute \( F_{cE} = \frac{K_{cE}E}{(L/d)^2} \)
     - \( K_{cE} = 0.3 \) sawn
     - \( K_{cE} = 0.418 \) glu-lam

3. compute \( F_c^* \approx F_cC_D \)

4. calculate \( F_{cE}/F_c^* \) and get \( C_p \) (chart)

5. calculate \( F_c' = F_c^*C_p \)

Procedure for Design

1. guess a size (pick a section)

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

3. obtain \( F' \)
   - compute \( F_{cE} = \frac{K_{cE}E}{(L/d)^2} \)
     - \( K_{cE} = 0.3 \) sawn
     - \( K_{cE} = 0.418 \) glu-lam

4. compute \( F_c^* \approx F_cC_D \)

5. calculate \( F_{cE}/F_c^* \) and get \( C_p \) (chart)
Procedure for Design (cont’d)

6. calculate \( F'_{c} = F_{c} C_{p} \)

7. compute \( P_{\text{allowable}} = F'_{c} A \)
   • or find \( f_{\text{actual}} = P/A \)

8. is \( P \leq P_{\text{allowable}} \)? (or \( f_{\text{actual}} \leq F'_{c} \)?)
   • yes: OK
   • no: pick a bigger section and go back to step 2.

Specific Column Charts

<table>
<thead>
<tr>
<th>Column Section</th>
<th>Unbored Length (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Area (in.)</td>
<td>6</td>
</tr>
<tr>
<td>4 x 4</td>
<td>12.25</td>
</tr>
<tr>
<td>4 x 6</td>
<td>19.25</td>
</tr>
<tr>
<td>4 x 8</td>
<td>25.35</td>
</tr>
<tr>
<td>6 x 6</td>
<td>30.25</td>
</tr>
<tr>
<td>6 x 8</td>
<td>41.25</td>
</tr>
<tr>
<td>8 x 8</td>
<td>52.25</td>
</tr>
<tr>
<td>8 x 10</td>
<td>62.50</td>
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<tr>
<td>8 x 10</td>
<td>71.25</td>
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<tr>
<td>8 x 12</td>
<td>86.25</td>
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<tr>
<td>10 x 10</td>
<td>90.25</td>
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<tr>
<td>10 x 12</td>
<td>109.25</td>
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<tr>
<td>10 x 14</td>
<td>126.25</td>
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<tr>
<td>12 x 12</td>
<td>132.25</td>
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<tr>
<td>14 x 14</td>
<td>162.25</td>
</tr>
<tr>
<td>16 x 16</td>
<td>190.25</td>
</tr>
</tbody>
</table>

*Load capacity in kips for solid-sawn sections of No. 1 grade Douglas fir-larch with no adjustment for moisture or load duration conditions.

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

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

() 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