RISA Webinar

Understanding and Optimizing Hot Rolled Steel Design in RISA

Presenter: Matt Brown, P.E.
INTEGRATED PROGRAMS

RISAFloor 5.1

RISA-3D 9.1
• AISC 360-05 (13th Edition Steel Construction Manual)
• AISC Design Guide #9 (Torsion)
• AISC Design Guide #11 (Vibration)

Images courtesy of AISC.org
Today’s Topics

• Direct Analysis Method
• Warping Torsion
• Single Angles
• Floor Vibrations
• Steel Joists
AISC Specification Chapter C

Stability Analysis and Design

AISC Specification Appendix 7

Direct Analysis Method
Direct Analysis Requirements

1. Second Order Analysis ($P-\Delta$, $P-\delta$)
2. Stiffness Reduction ($EI^*$, $EA^*$)
3. Notional Loads
Cantilever Column

- W12x45
- 200k Gravity Load
- 10k Lateral Load
- 12’-0” Tall
Initial Shear: 10k

Initial Moment: \((10k) \times (12 \text{ ft}) = 120 \text{ ft-k}\)

Initial Deflection: \(\frac{PL^3}{3EI} = 0.981''\)
Bending Deflection: \( \frac{PL^3}{3EI} = 0.981" \)

Shear Deflection: \( \frac{cPL}{AwG} = 0.035" \)
Final Shear: 11.6k
Final Moment: 139 ft-k
Final Deflection: 1.182”

16% Increase over First-Order
Final Shear: 12.5 k
Final Moment: 140 ft-k
Final Deflection: 1.216”
Direct Analysis Requirements

1. Second Order Analysis ($P-\Delta$, $P-\delta$)
2. Stiffness Reduction ($EI^*$, $EA^*$)
3. Notional Loads
Flexural Stiffness

\[ EI^* = 0.8 \tau_b EI \]

Axial Stiffness

\[ EA^* = 0.8EA \]

\[ \tau_b = f \left( \frac{P_u}{P_n} \right) \]
Direct Analysis Requirements

1. Second Order Analysis ($P-\Delta$, $P-\delta$)

2. Stiffness Reduction ($EI^*$, $EA^*$)

3. Notional Loads
Per AISC Code of Standard Practice

Erection Tolerance for Columns
(out of plumb) = \( \frac{H}{500} \)

Notional Load (\( N \)) = \( \frac{P}{500} \)
Direct Analysis Requirements

1. Second Order Analysis \((P – \Delta, P – \delta)\)
2. Stiffness Reduction \((EI^*, EA^*)\)
3. Notional Loads

\[ K = 1.0 \]
<table>
<thead>
<tr>
<th>Traditional Design</th>
<th>Direct Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M = 120\text{ k-ft}$</td>
<td>$M = 152\text{ k-ft}$</td>
</tr>
<tr>
<td>$K = 2.1$</td>
<td>$K = 1.0$</td>
</tr>
<tr>
<td>Req’d Shape:</td>
<td>Req’d Shape:</td>
</tr>
<tr>
<td>W12x40</td>
<td>W12x45</td>
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</tbody>
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**COMPARISON**
Warping Torsion affects Wide Flange and Channel Shapes
Idealize as two WT sections, each in minor axis bending
Geometric Bending  Principal Bending

SINGLE ANGLES
Floor Vibration Procedure:

1. Determine damping weight
2. Determine beam natural frequency
3. Calculate expected acceleration
Damping Weight

Beam Self Weight

+ Slab Weight

+ Realistic Superimposed Load (11 psf?)
Allowable Acceleration

• Based on 65 lb excitation force (footfall)
• 0.5% g for Offices, Residences, Churches
• 1.5% g for Shopping Malls
STEEL JOISTS

Actual Load

Equivalent Uniform Load

W

P

w’
Additional Resources

- AISC Publications
- RISA-3D Help File / Manual
- www.risanews.com

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Questions?

Please let us know if you have questions.

We will answer as many questions as time permits during the webinar.

Once the webinar is closed, we will post all Q&A’s, as well as the Quick Reference Guide, to our website: www.risa.com

For further information, contact us at: info@risatech.com

Thank you for Attending!