RISA Technologies

Structural Modeling:
An essential skill for engineers

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RISA TECHNOLOGIES

Structural Modeling

Why is Structural Modeling an important part of the design process?

- Structural Model must match as-built framing configuration & loading
- Interdisciplinary models must contain relevant information

Common Pitfalls in Structural Software Modeling:

- “Black Box”
- “Garbage In – Garbage Out”

Structural Modeling

What percentage of your design work uses software?

25%

50%

75%

90%

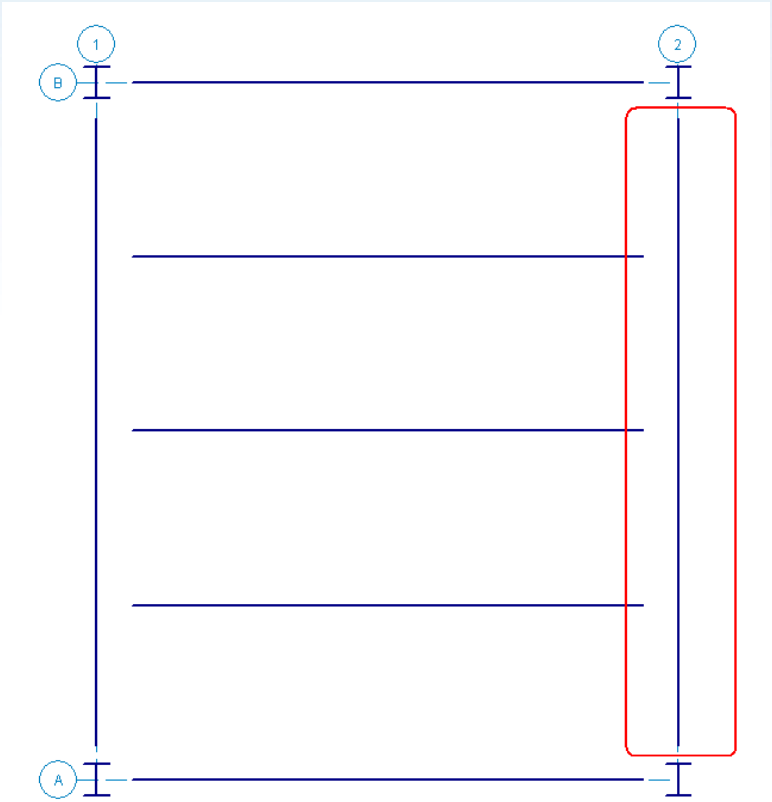
Structural Modeling

Important things to remember about Structural Modeling

- Computer programs do not have engineering judgment
- Non-experienced engineers do not have a “feel” for how the structure will behave
- Every person in your office can’t know all aspects of your software
- Establish what information you want to transfer to your partners before starting your design

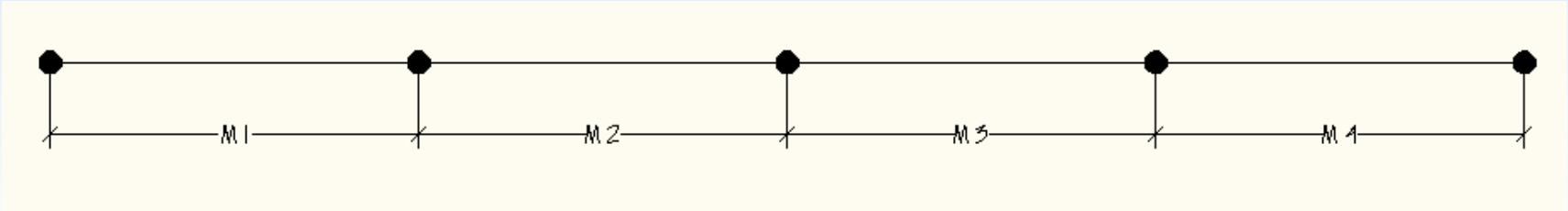
Physical Members

How do you model continuous girders, truss chords & continuous columns?

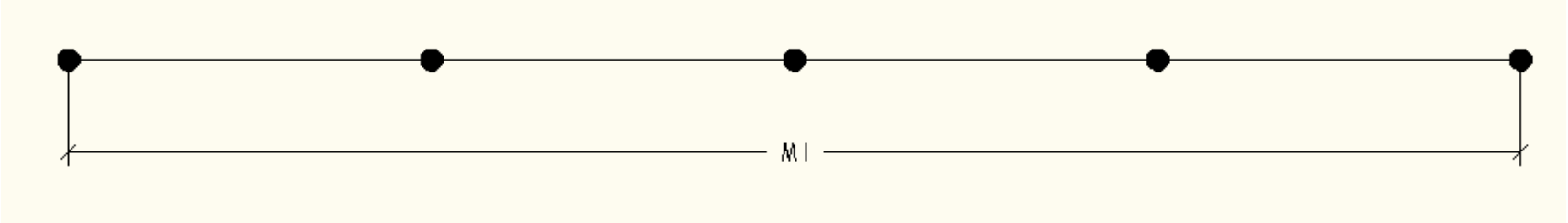


Physical Members

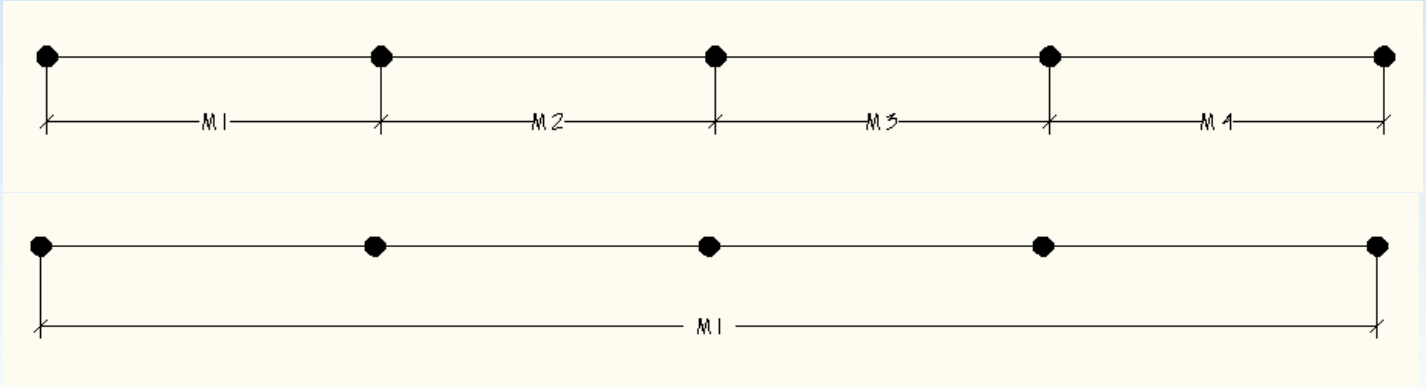
Option 1: Individual Members



Option 2: Physical Member



How do Options 1 & 2 effect your design?



K factors

- RISA can automatically calculate this factor for you.

  Calculated K values are based on the on the member's sway condition and end release configuration.

AISC Chapter C Table C-C2.2

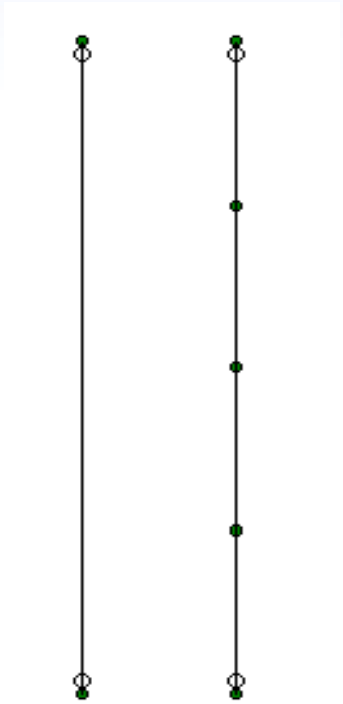
Table Case	End Conditions	Sidesway?	K-Value
(a)	Fixed-Fixed	No	.65
(b)	Fixed-Pinned	No	.80
(c)	Fixed-Fixed	Yes	1.2
(d)	Pinned-Pinned	No	1.0
(e)	Fixed-Free	Yes	2.1
(f)	Pinned-Fixed	Yes	2.0

How do Options 1 & 2 effect your design?

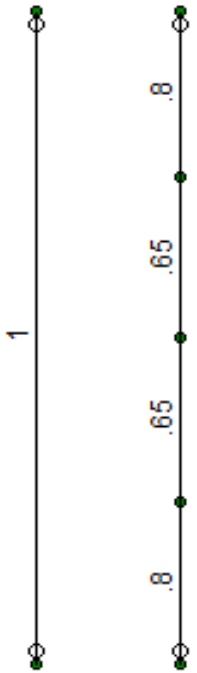
K factors

What are the end conditions for each segment vs. the entire member?

Both Columns
Pinned- Pinned



K-Factors



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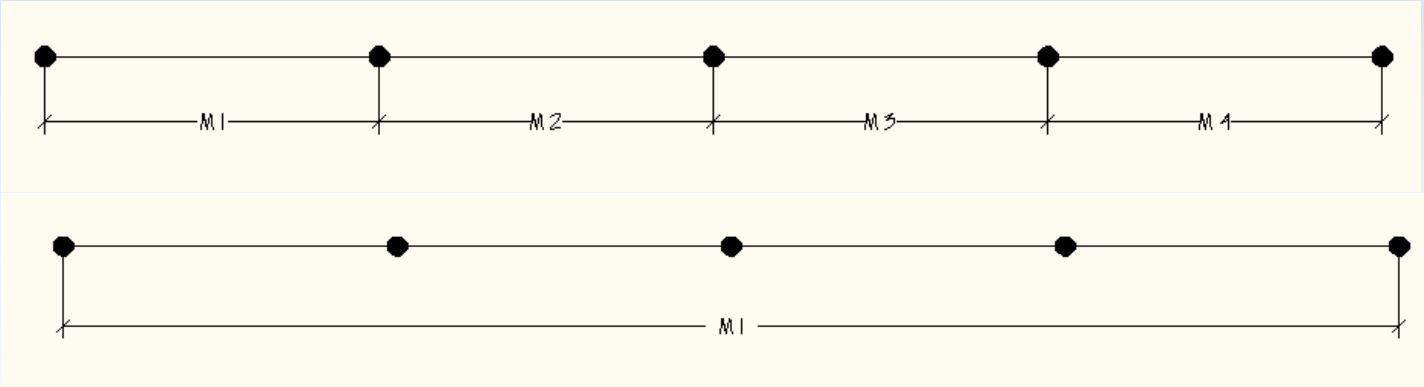


Unbraced Length

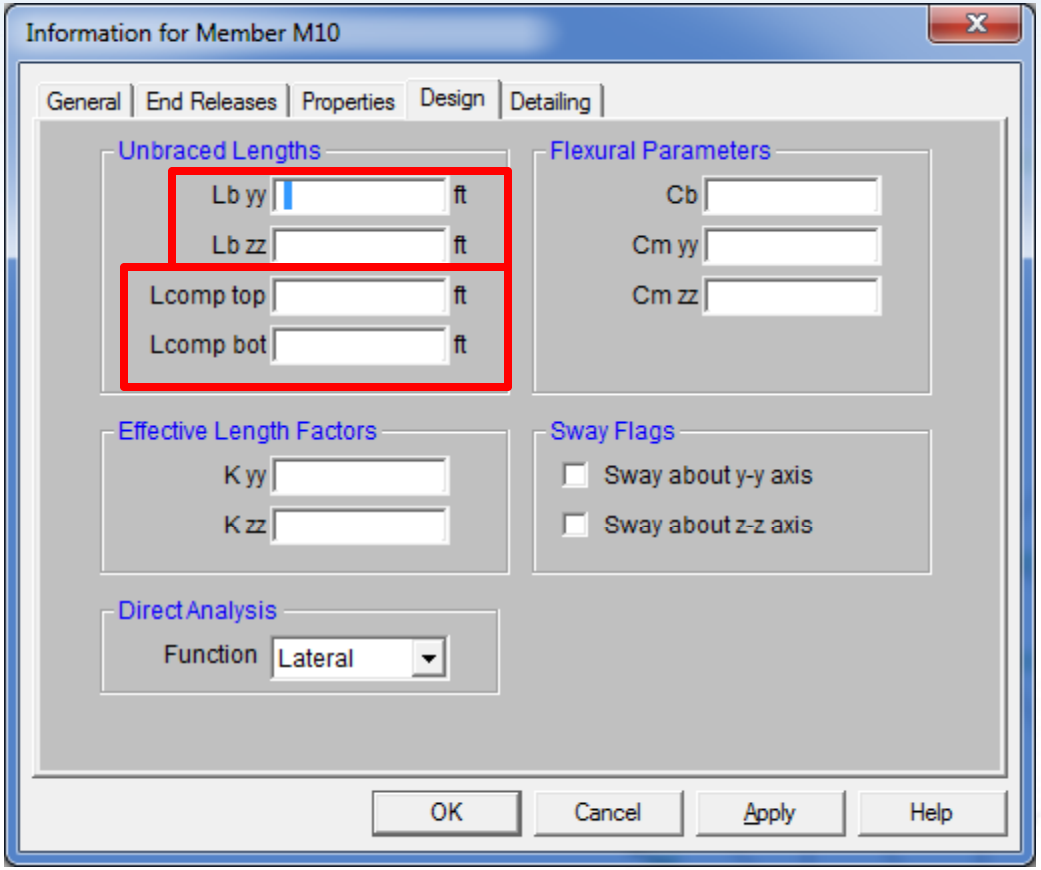
- The default member length is the full length of the member.
- RISA can automatically calculate the brace points- “Segment”
- Or manually enter your unbraced length

Unbraced Length

Double-click on the member to get the Design tab information

Column type buckling **about** the member local axis

Flange buckling due to flexure relative to the top & bottom of the member



Unbraced Length

How does Unbraced Length effect your results?

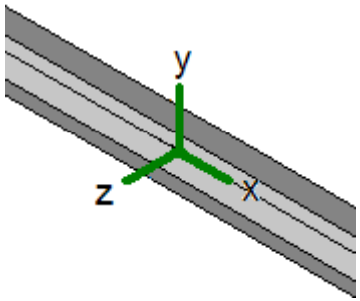
- Axial Design Results

  $\frac{KL}{r}$

- Bending Design Results
  - Is the top or bottom of the member braced for bending?

  - How do you tell the “top” from the “bottom” of the member?

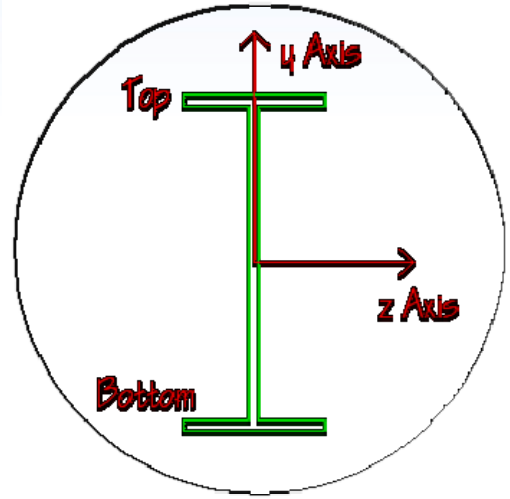
    The “top” of the member is in the direction of the positive y axis



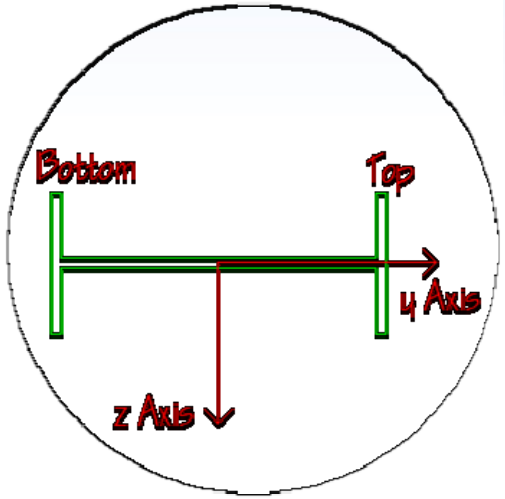
Unbraced Length

How do local axes affect the Unbraced length?

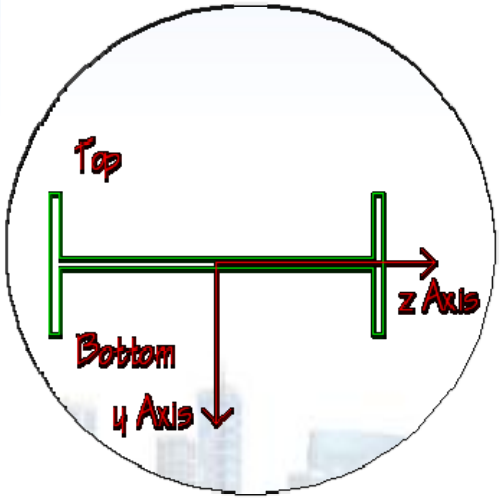
- How is the “top” and “bottom” of the member determined?
- How are the weak and the strong axis related to the local coordinates?
- When you rotate the member how does this affect the results?



Rotate: 0º



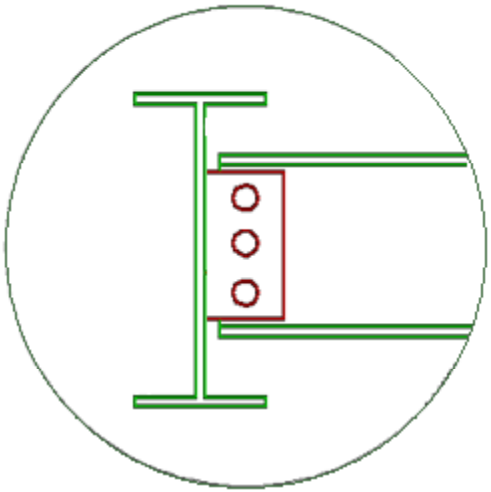
RISA-3D:
Rotate: 90º



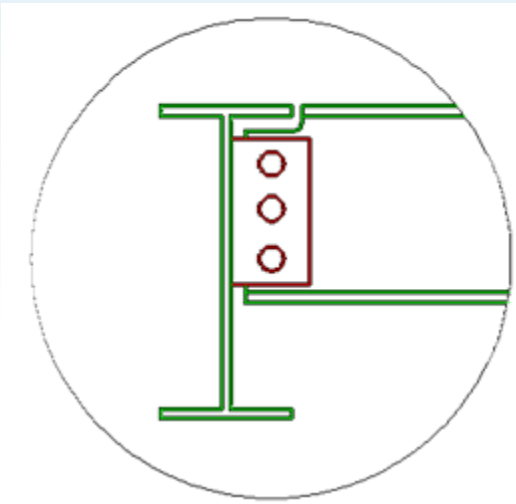
Other Software:
Rotate: 90º

Unbraced Length

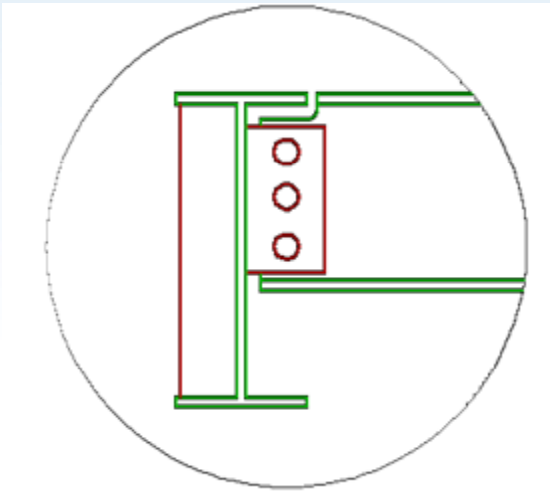
How do connection types effect unbraced lengths?



Top Flange: No
Bottom Flange: No
Weak Axis: Yes
Strong Axis: No



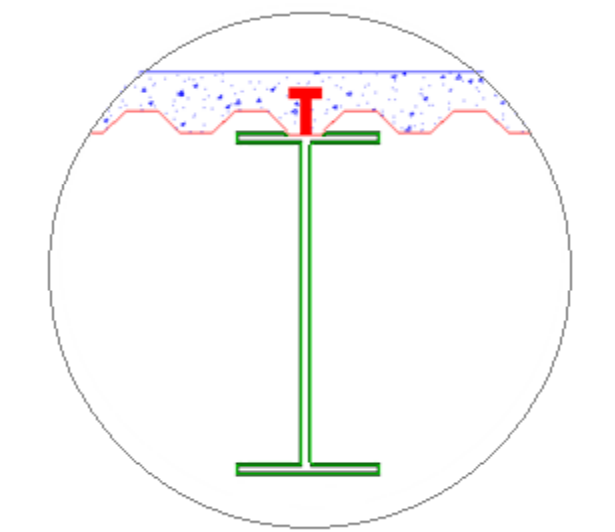
Top Flange: Yes
Bottom Flange: No
Weak Axis: Yes
Strong Axis: No



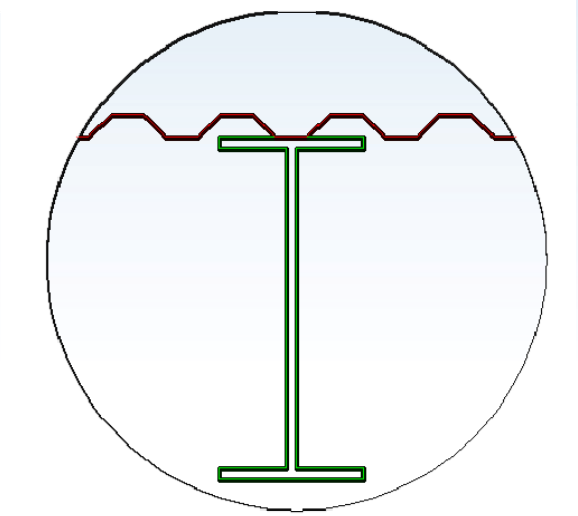
Top Flange: Yes
Bottom Flange: Yes
Weak Axis: Yes
Strong Axis: No

Unbraced Length

How does construction type effect Unbraced length?

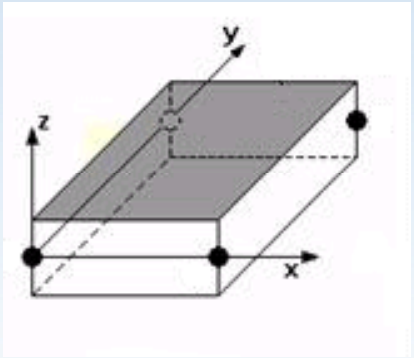


Top Flange: Yes
Bottom Flange: No
Weak Axis: Yes?
Strong Axis: No



Top Flange: Yes/No
Bottom Flange: No
Weak Axis: No
Strong Axis: No

Plate Modeling



What are the Rules of Thumb for plate modeling?

<u>Rule 1: Plate Size</u>

Quadrilateral Elements

length: width < 9

thickness : length < 3

Triangular Elements

length: width < 9

Θ< 135º
(90 º + 45 º)

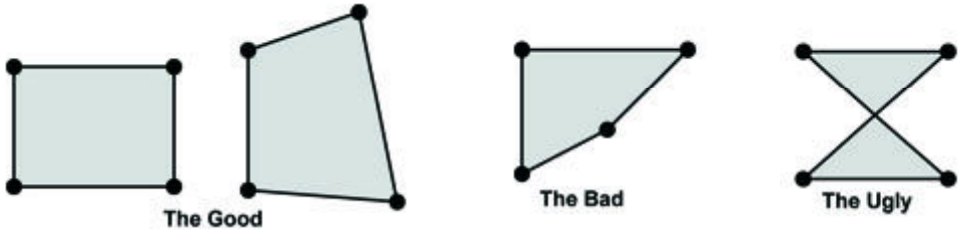
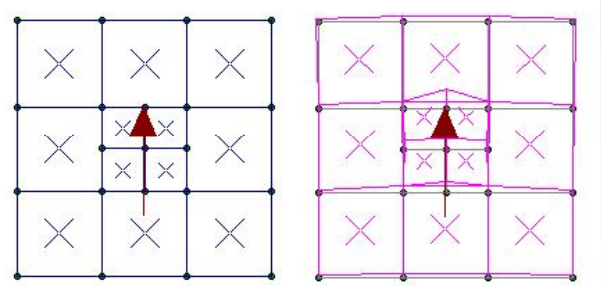


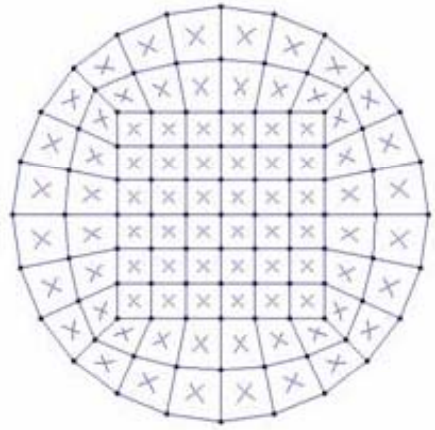
Plate Modeling

Rule 2: Plate Connectivity

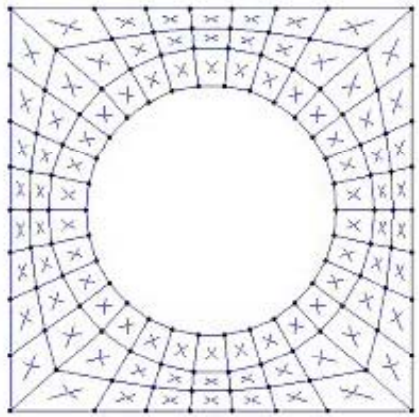
- Plates can only transfer forces at their corner nodes



- Transition meshing is important for proper load transfer



Square to Round



Round to Square

Plate Modeling

Rule 3: Mesh Size

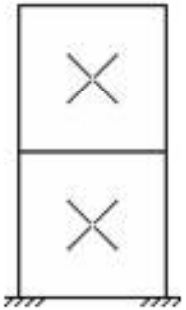
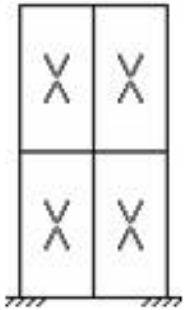
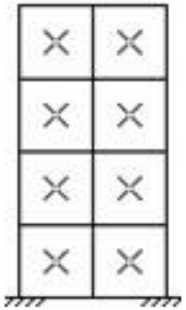
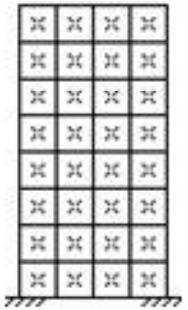
- Decreased mesh size needs to be uniform

Original Mesh Size	New Mesh Size
1 x 2	2 x 4
2 x 2	4 x 4
1 x 3	2 x 6
2 x 3	4 x 6

- Rule of 10%

  There should be less than 10% difference between results for each mesh iteration.

Plate Modeling

					
Element Mesh	1x1	1x2	2x2	2x4	4x8
Deflection (in.)	4.54	8.07	8.26	10.43	11.29
Error	62%	33%	31%	13%	6%
Stiffness K (kips/in)	3304.0	1858.7	1816.0	1438.2	1328.6

1 → 2 → 3

Plate Modeling

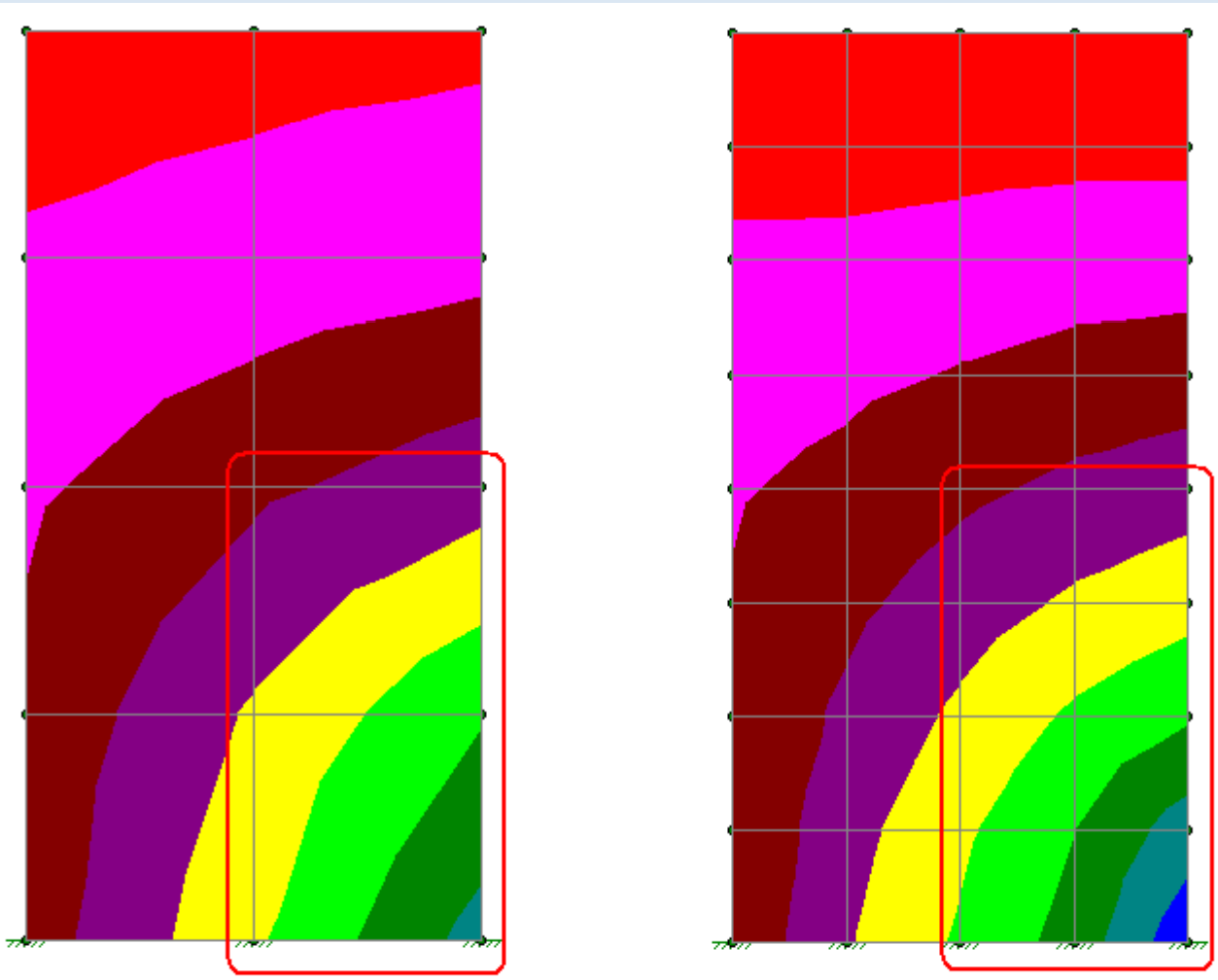
Rule 3: Mesh Size

- Plate Force Contours

  There should be 3 or fewer contour changes

  in each plate

Plate Modeling



4 Contours per Plate

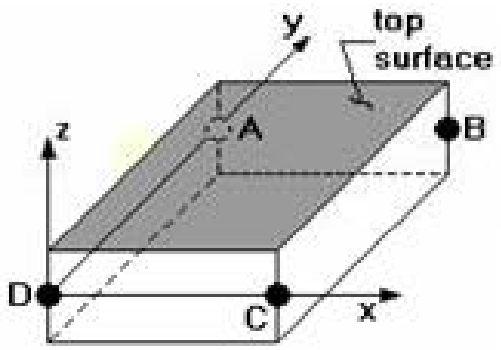
2-3 Contours per Plate

Plate Results

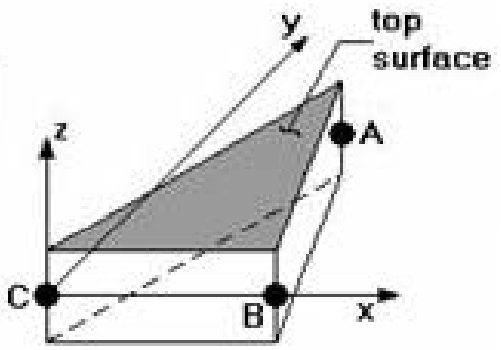
What are the Rules of Thumb for reviewing plate results?

Rule 1: Know the Plate Local Axes

- Are the forces displayed in the Plate Local Axes or the Global Axes?



4 Node Quad
Local Axes



3 Node Triangle
Local Axes

Plate Results

Rule 2: Know how the Forces are displayed

- On a per unit length basis?
- Total forces on the plate?

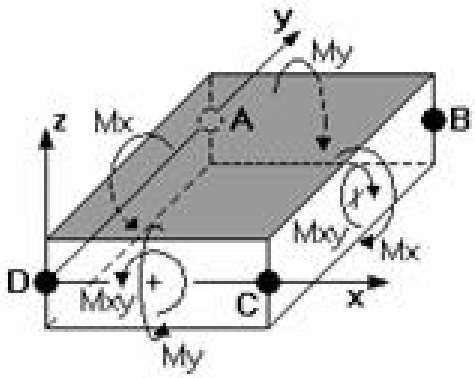
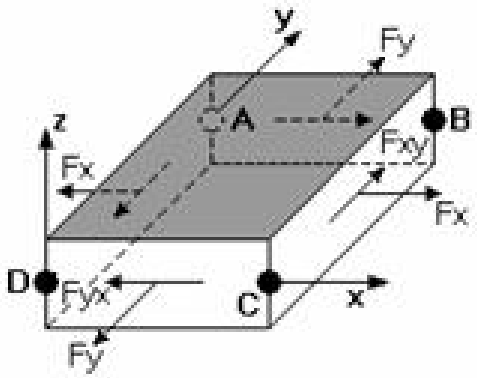


Plate Moments

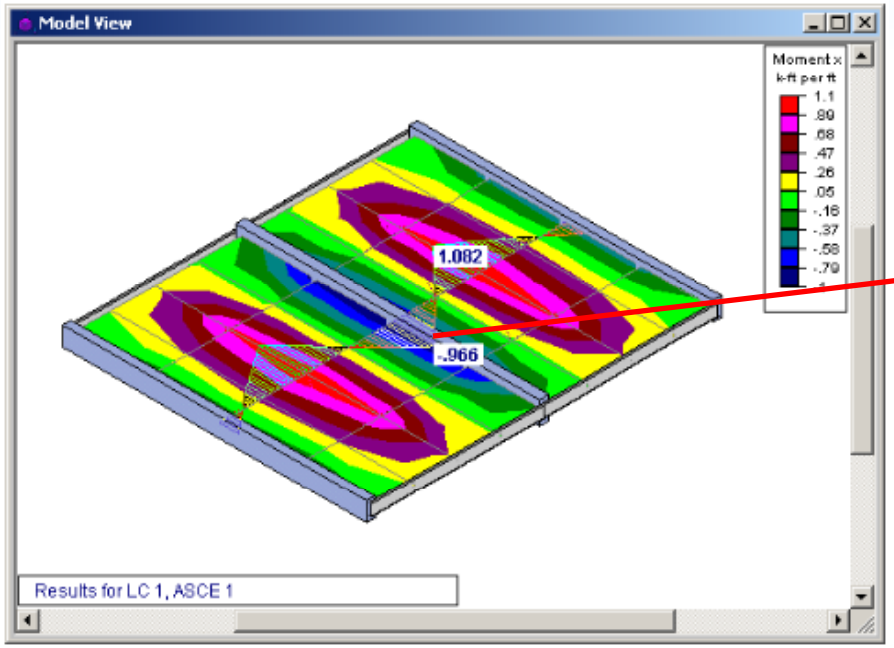


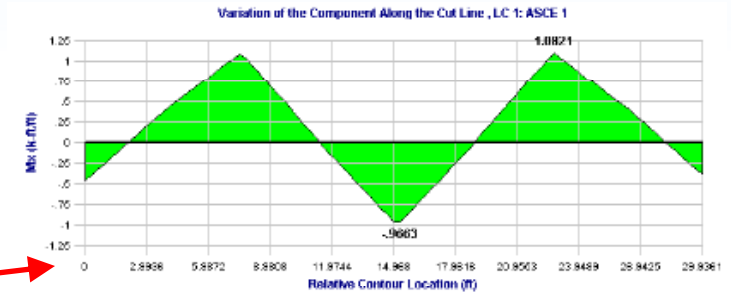
Plane Stress Forces

Plate Results

Rule 3: Know what tools are available to simplify reading Plate results

- Automatic meshing
- Force and/or design strips
- Display forces along a user defined line

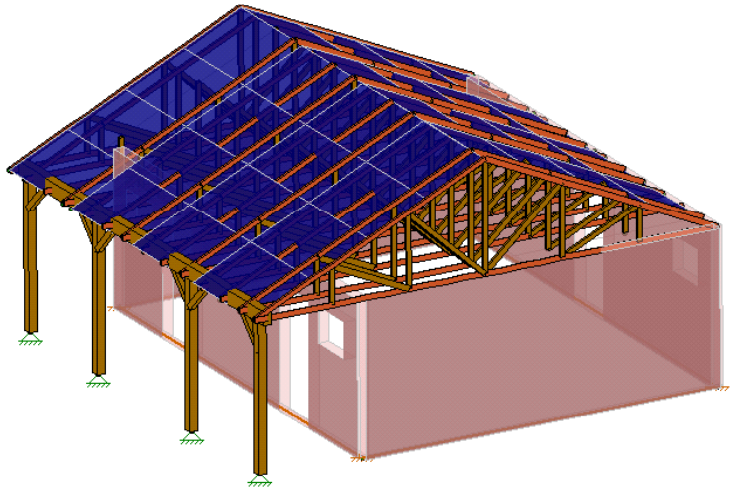


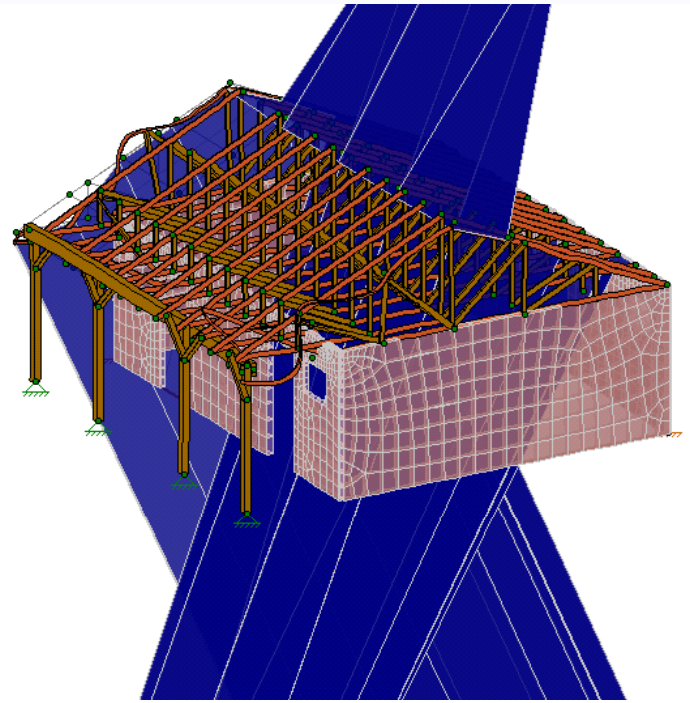


Understand your Results

Make sure your results make “Sense”

- Check your Deflected Shape
- Check your Joint Reactions – Total Loads = Total Reactions
- Understand the Code Check





Integration

What other software will you need to integrate with?

- BIM
- CAD
- Steel Detailing
- Plant Design Systems

What format will you be using to integrate?

- Direct links via an API
- DXF
- CIS/2
- IFC

Integration

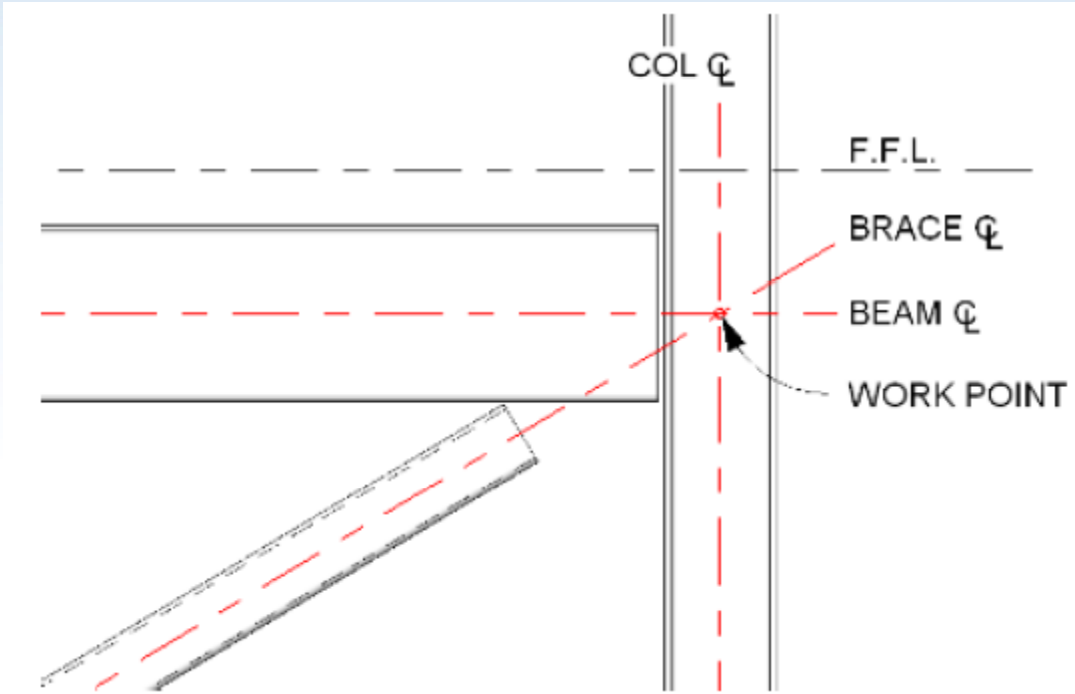
What information does your software transfer?

- Geometry
- Sizes
- Materials
- Loads
- End Reactions

What information is vital to correctly transfer information?

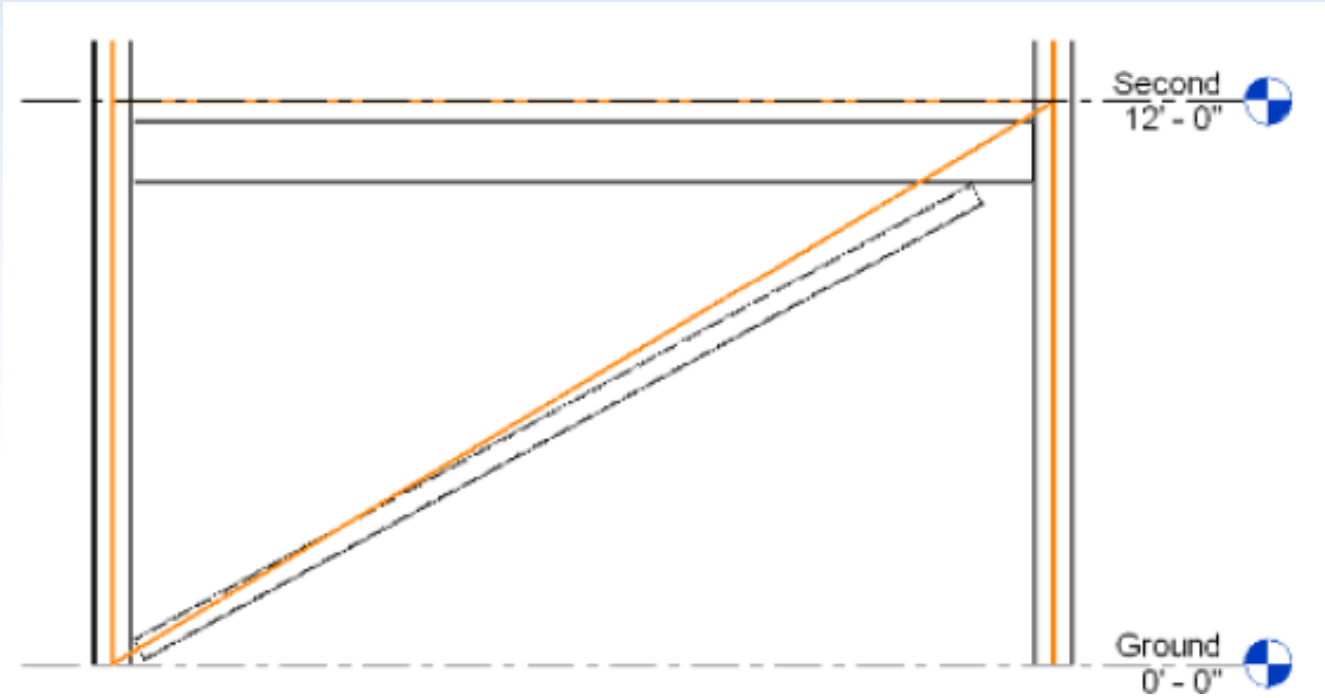
- Member Offsets: Top of Steel or Centerline?
- Brace Points: Model vs Construction
- Modeling Simplifications

Integration



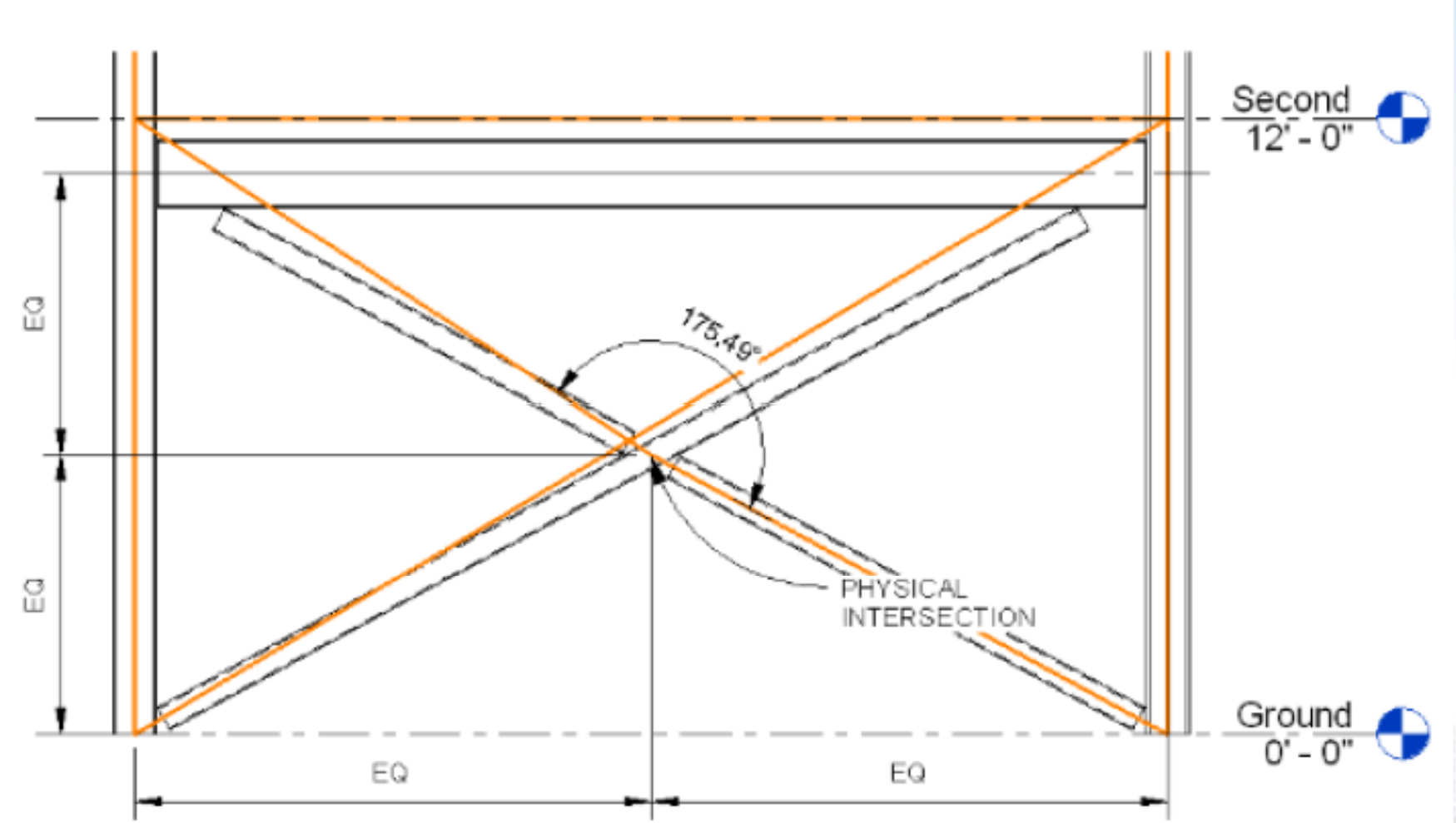
Analytical Assumption

Integration



Modeling Assumption

Integration



Integration

Who needs to know about these modeling assumptions?

- Detailer?
- Fabricator?
- Contractor?

Communication is VITAL to the design process!

- When transferring electronic files you MUST communicate with your partners about your modeling assumptions

Structural Modeling

How can you apply these theories to your office?

- Assign a “champion” for each software program you use
- Attend training specifically for your software
- Create a list of “modeling rules” for your office
- Establish what information you’d like to transfer to your partners
- Utilize your software support with questions about modeling

Structural Modeling

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 to our website: www.risatech.com
- For further information, contact us at: info@risatech.com