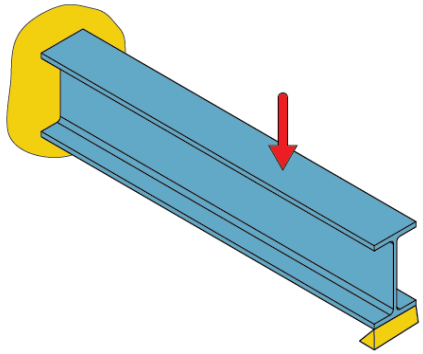
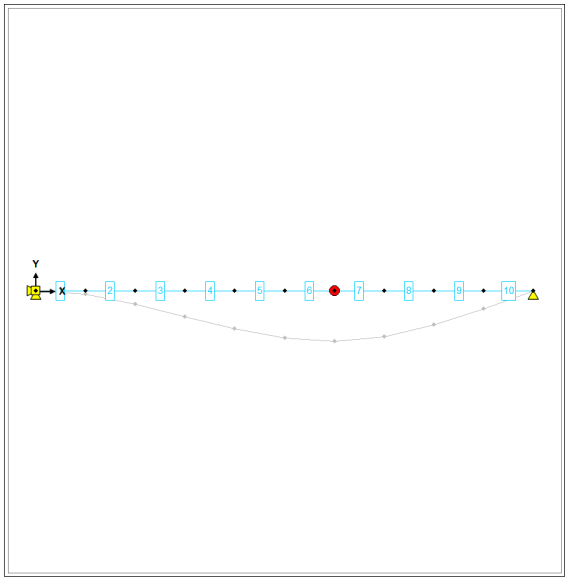
1D Elements© — Example Problems

- This document contains various types of problems that can be solved with the *1D Elements*© FEA program
- Additional examples are provided in the *1D Elements*© manual
- To download the program, visit:

  www.structuralfea.com

Simple Beam




Y
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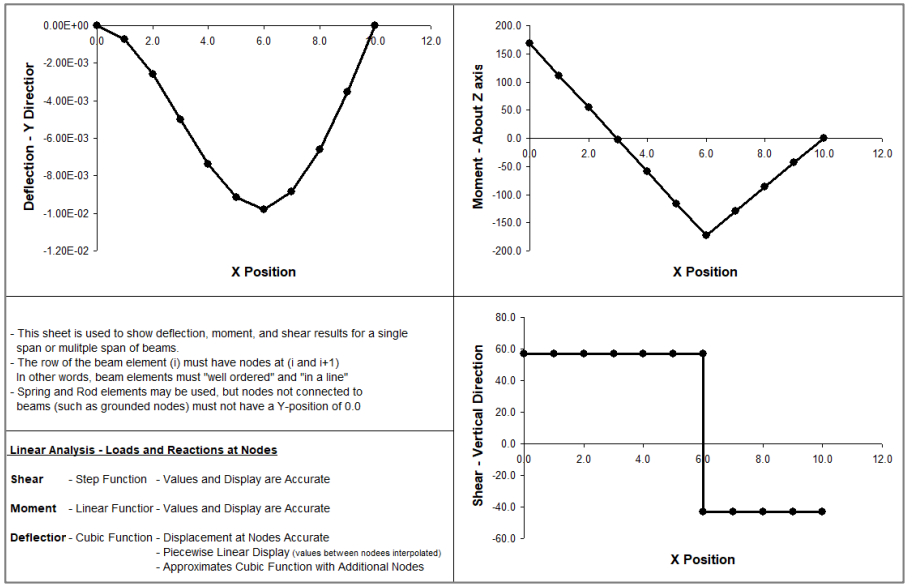
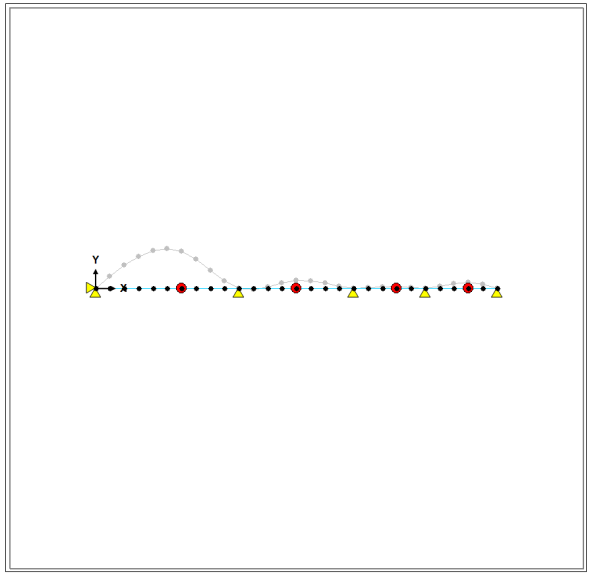
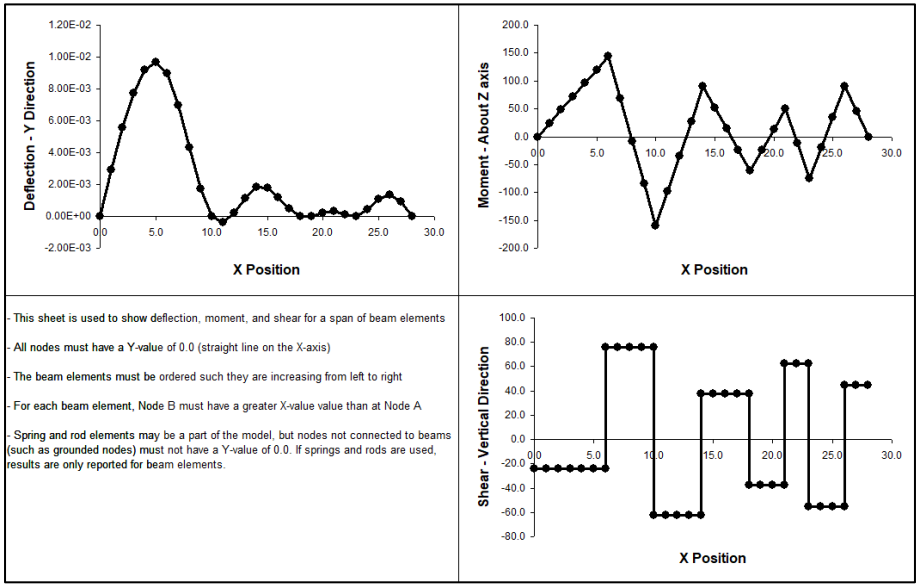

Deflection - Y Direction
0.00E+00
-2.00E-03
-4.00E-03
-6.00E-03
-8.00E-03
-1.00E-02
-1.20E-02
0.0
2.0
4.0
6.0
8.0
10.0
12.0
X Position
Moment - About Z axis
200.0
150.0
100.0
50.0
0.0
-50.0
-100.0
-150.0
-200.0
X Position
- This sheet is used to show deflection, moment, and shear results for a single span or mulitple span of beams.
- The row of the beam element (i) must have nodes at (i and i+1)
In other words, beam elements must "well ordered" and "in a line"
- Spring and Rod elements may be used, but nodes not connected to beams (such as grounded nodes) must not have a Y-position of 0.0
Linear Analysis - Loads and Reactions at Nodes
Shear - Step Function - Values and Display are Accurate
Moment - Linear Functior - Values and Display are Accurate
Deflection - Cubic Function - Displacement at Nodes Accurate
- Piecewise Linear Display (values between nodees interpolated)
- Approximates Cubic Function with Additional Nodes
Shear - Vertical Direction
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
X Position

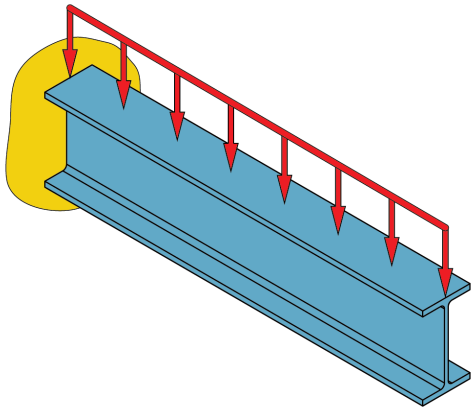
Continuous Beam

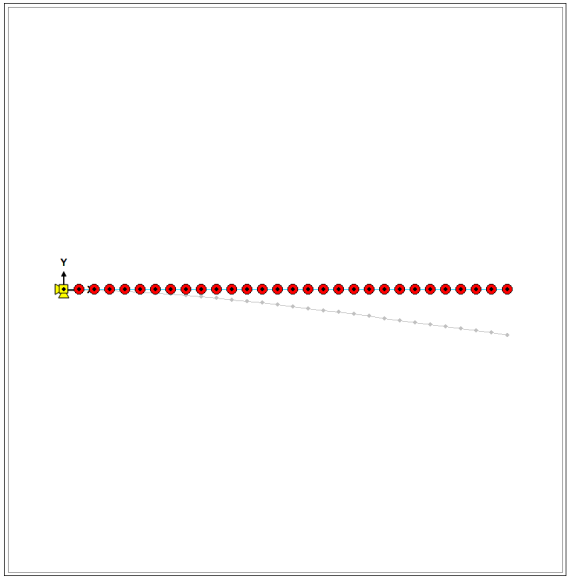
- General continuous beam on the X-axis (any combination of loads and constraints is possible)
- Beams may also have a varying cross section (i.e. tapered)

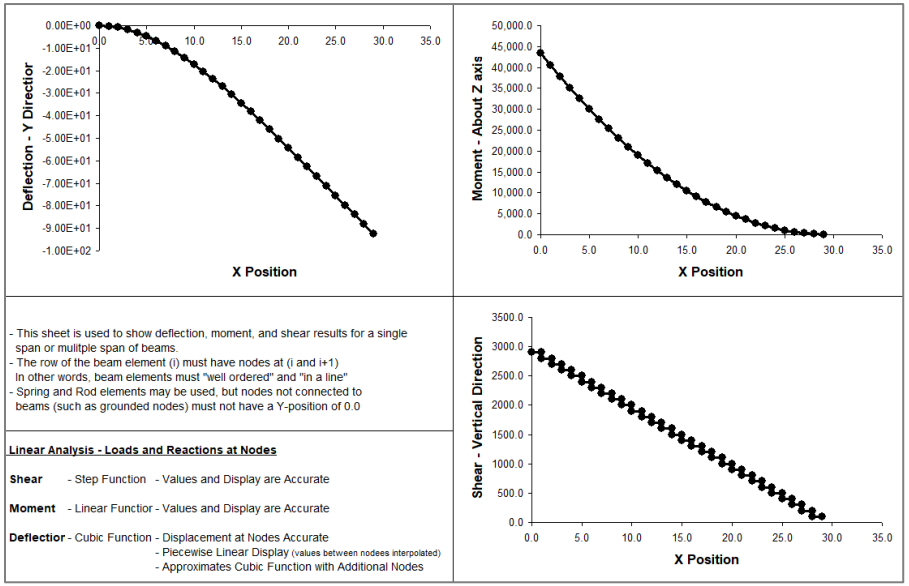




Distributed Load

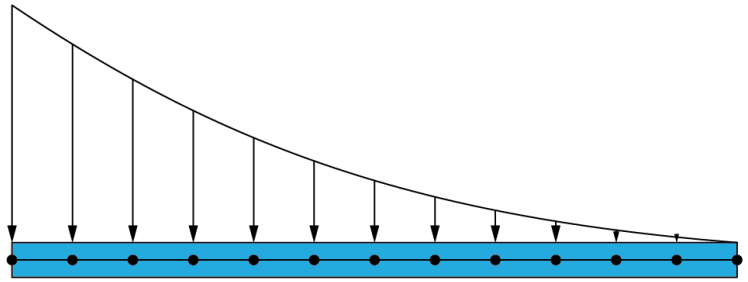


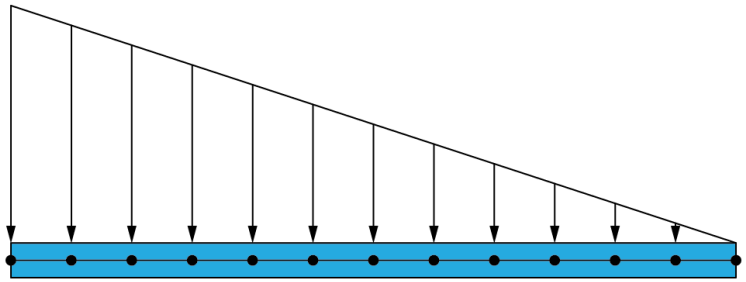




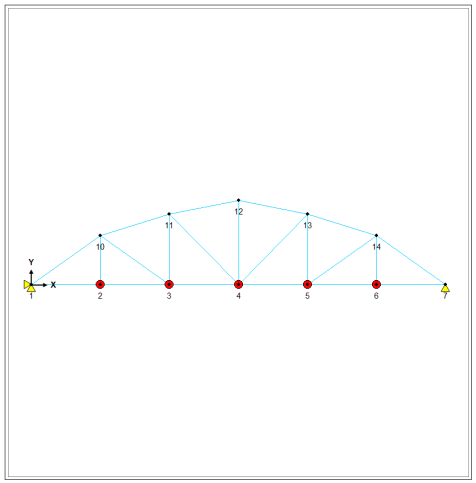
Arbitrary Loading

- Via discretization (several beam elements to represent the beam), any type of loading is possible)





Bridges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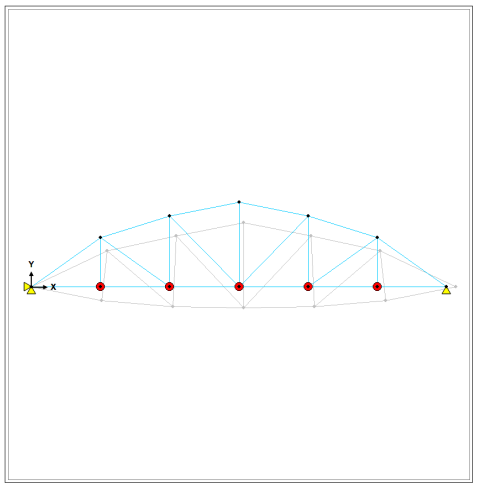
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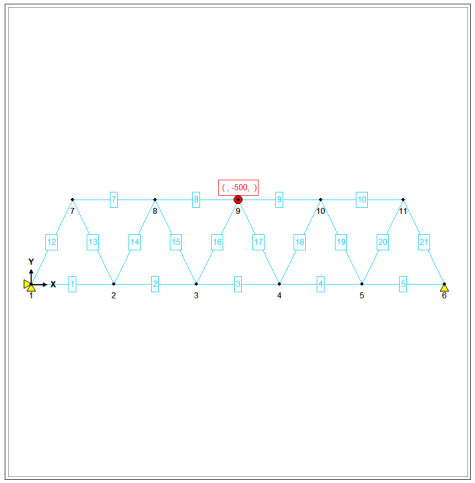
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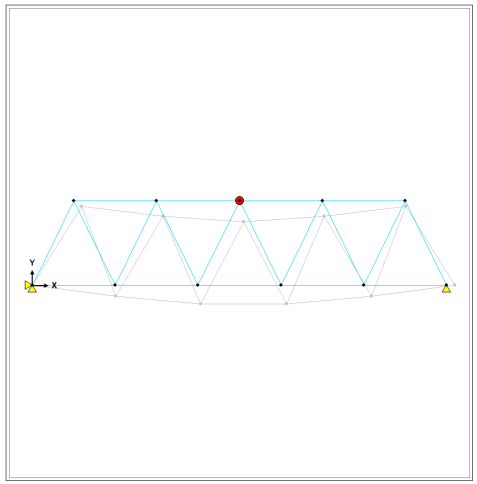
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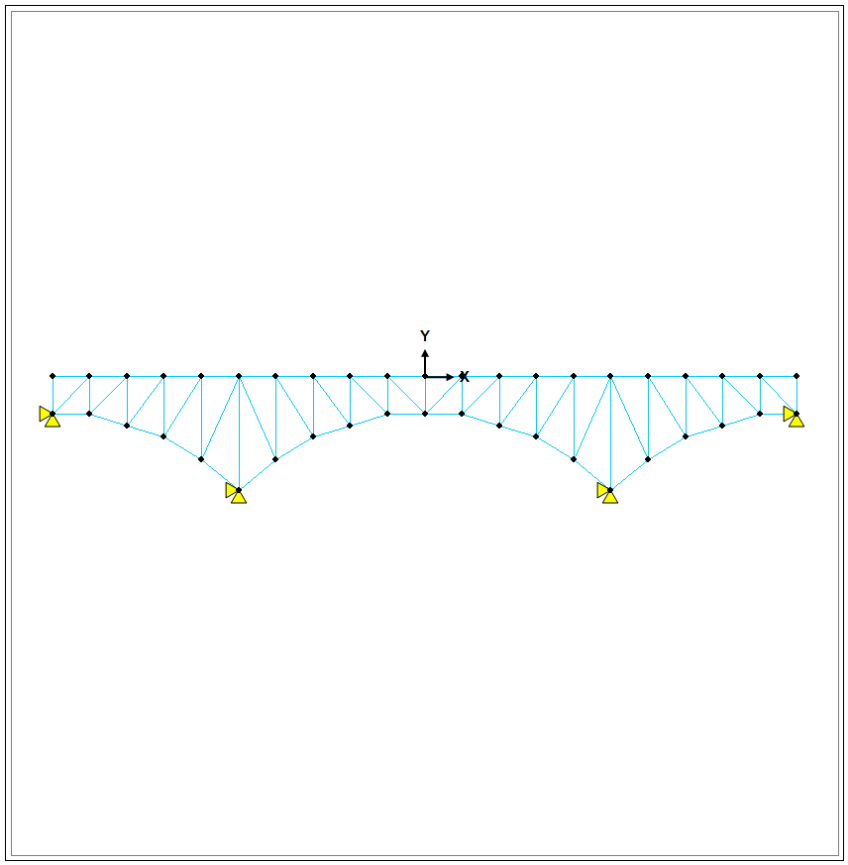
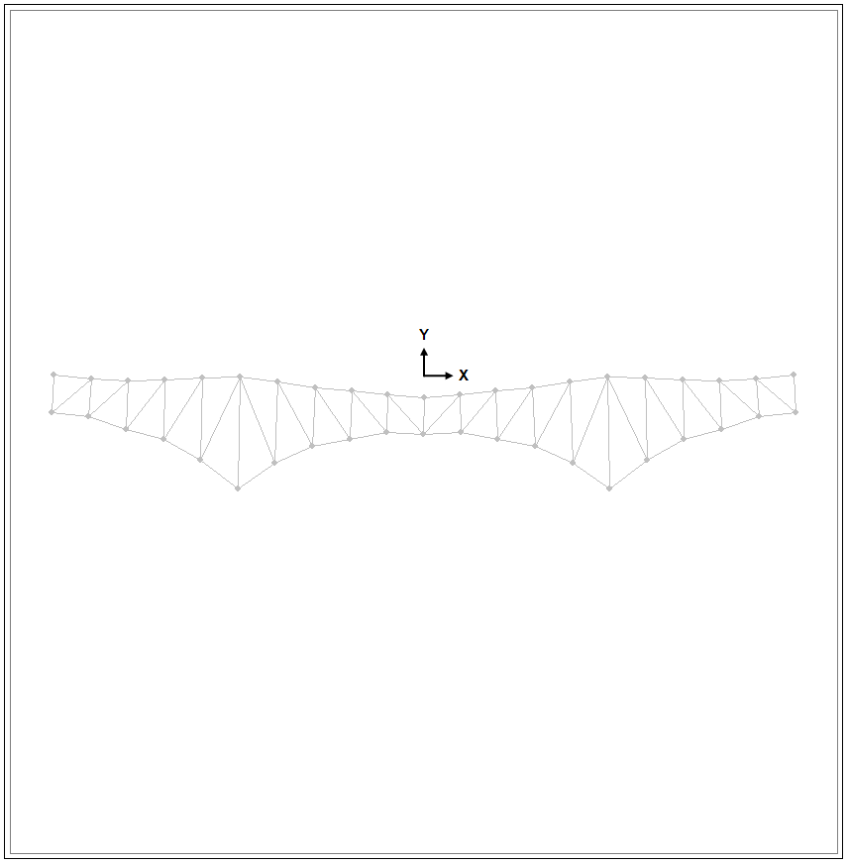
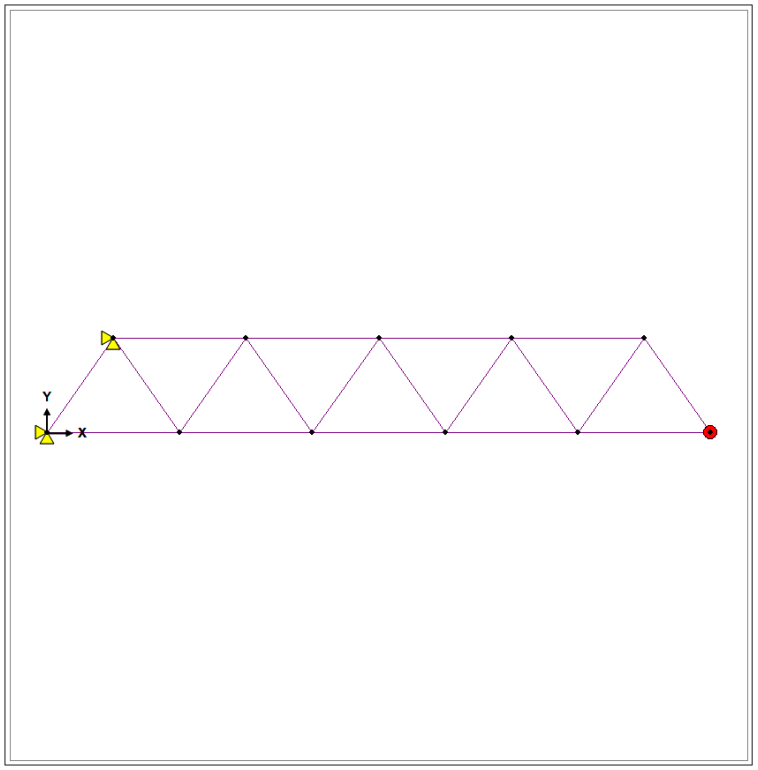
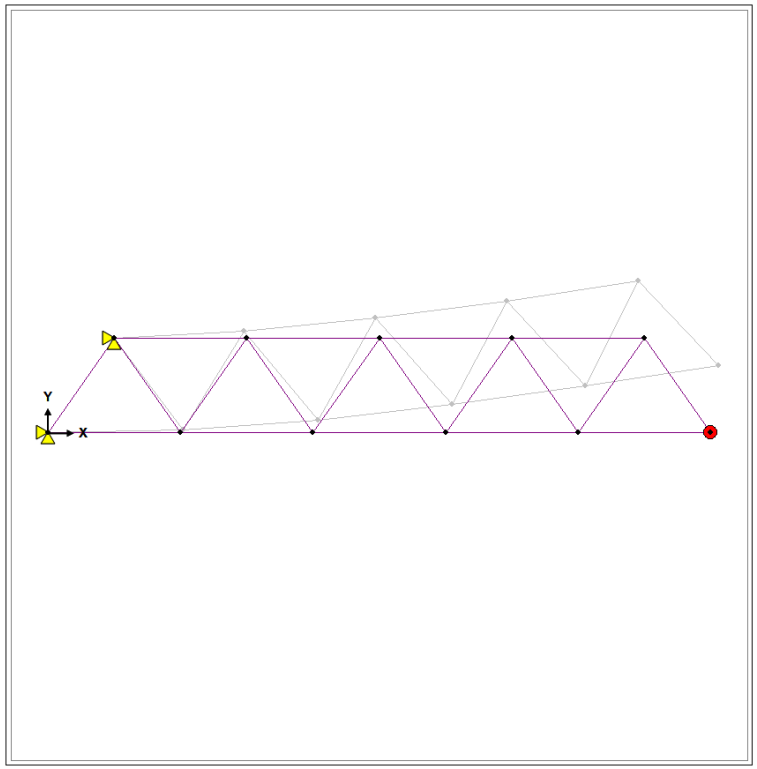
Arch Bridge



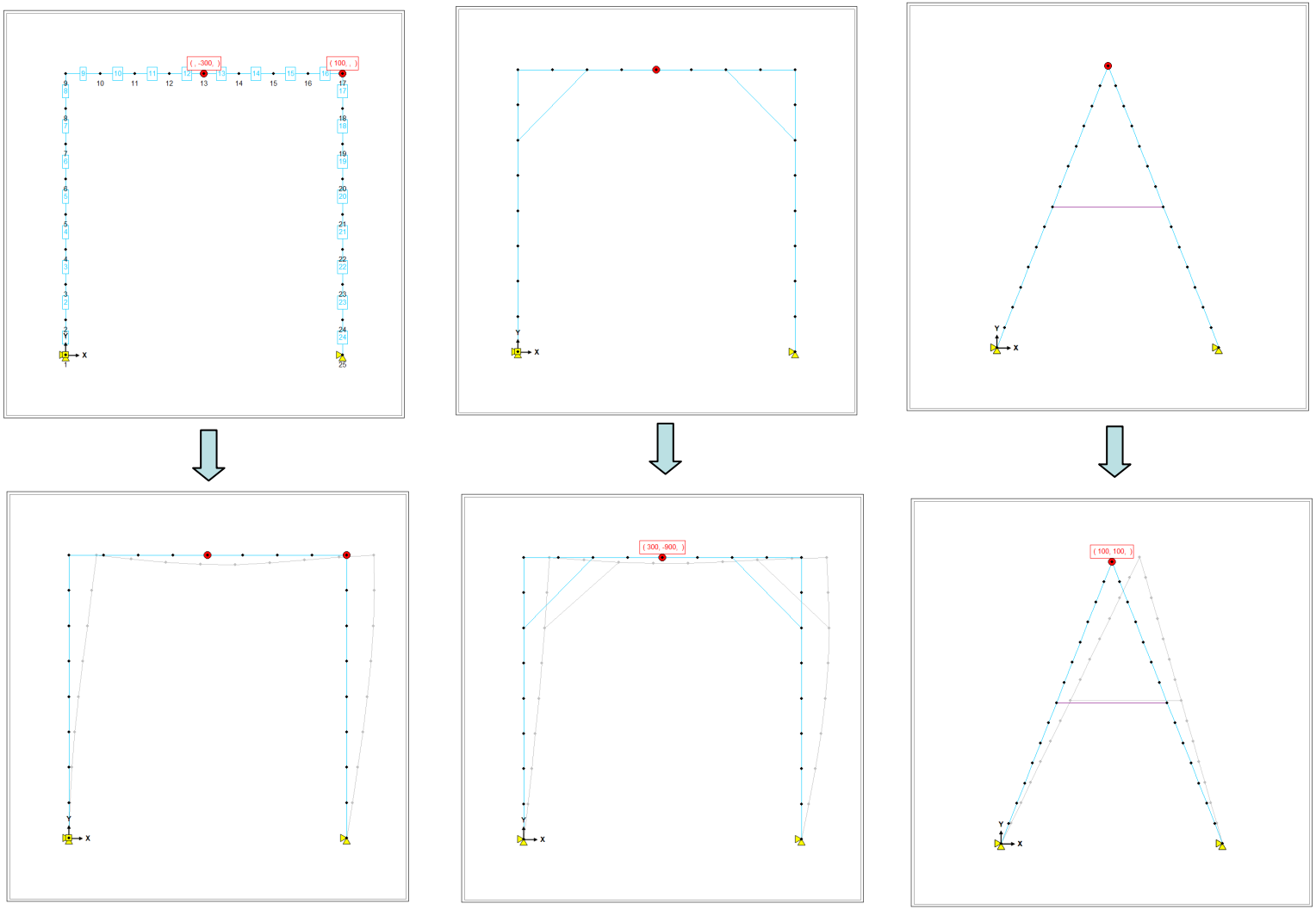


Truss

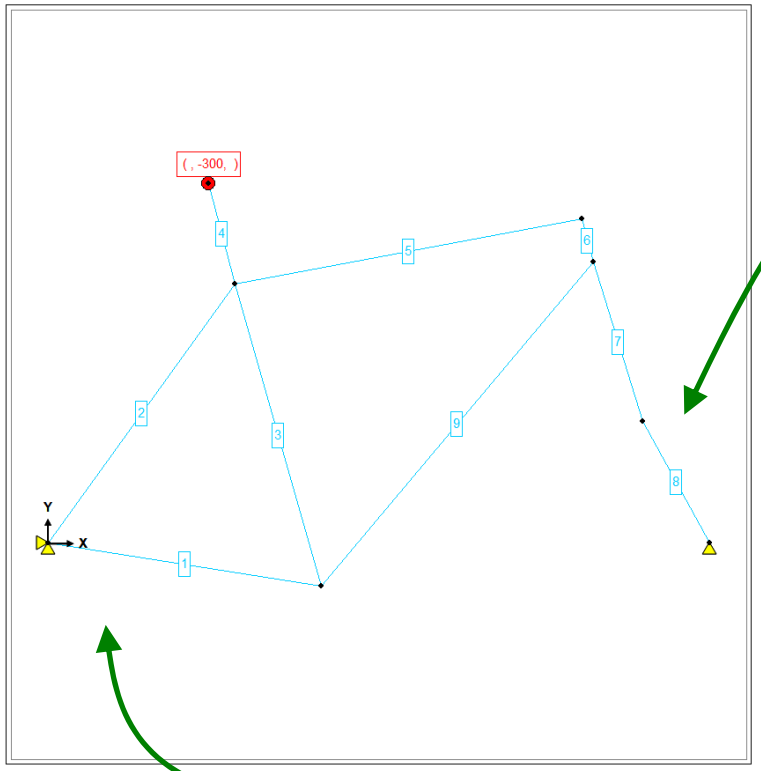




Structural Frames



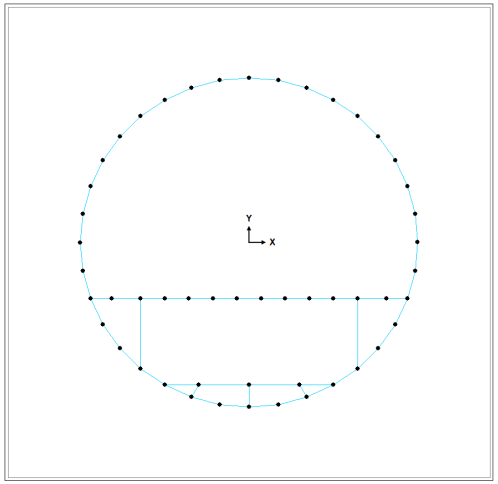
Bike Frame

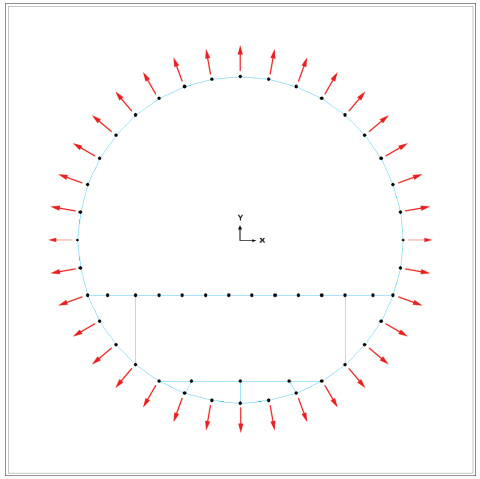


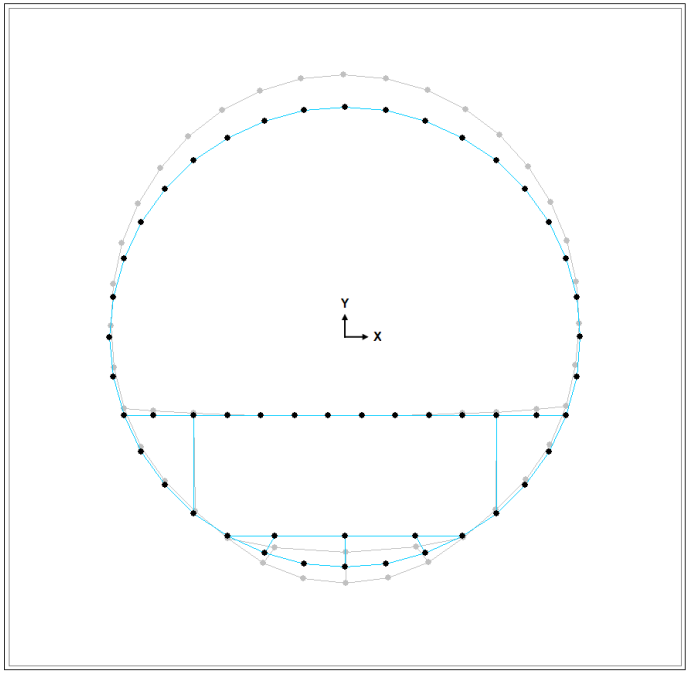
two front members can be lumped together in 2D space

two rear members can be lumped together in 2D space

Fuselage Frame



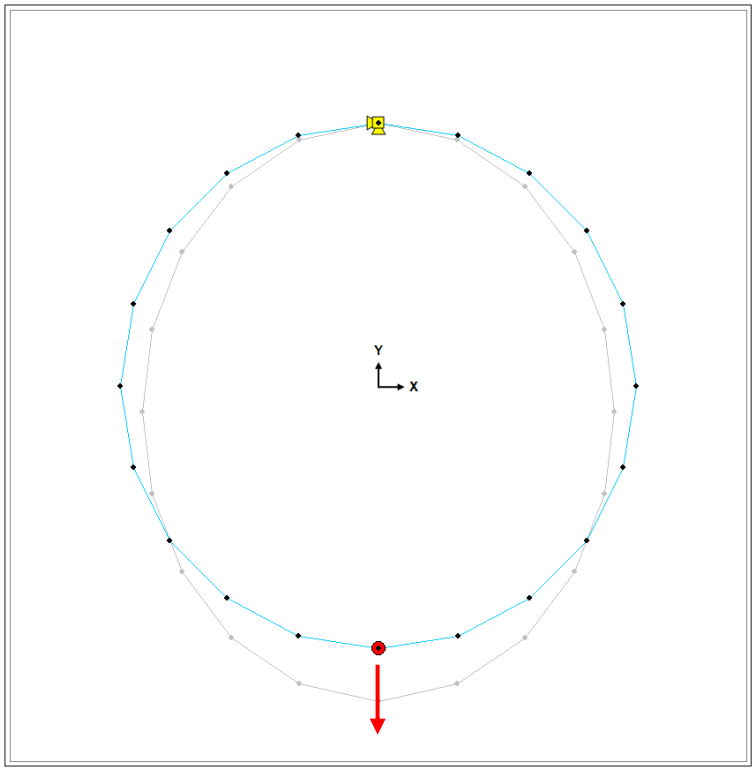




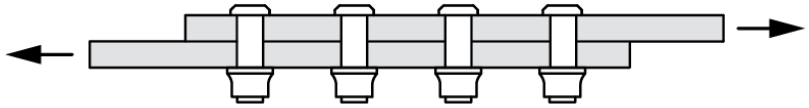
fuselage frame, floor beam and struts, cargo floor

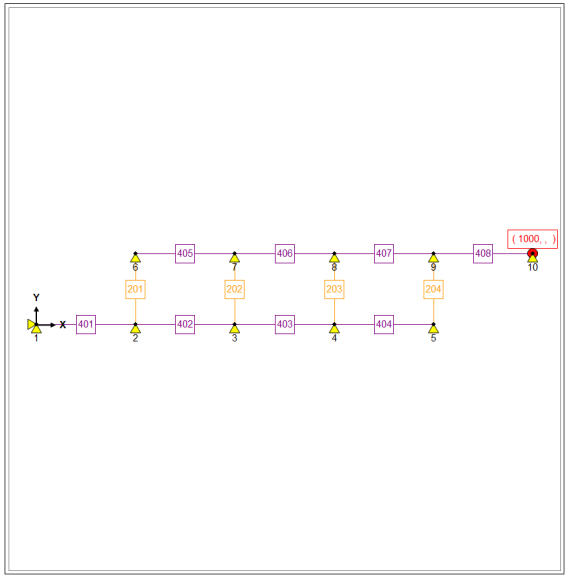
(internal pressure loading condition)

Ring



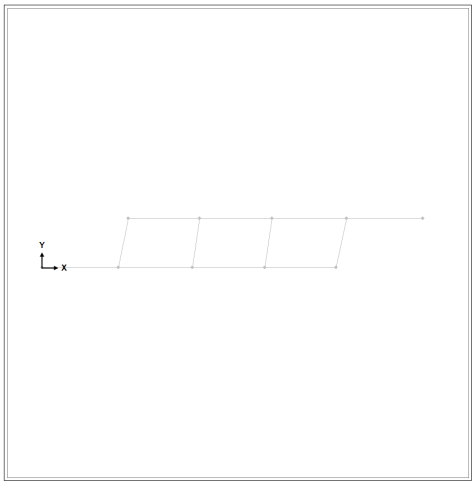
Joint (4 Fastener Row Example)



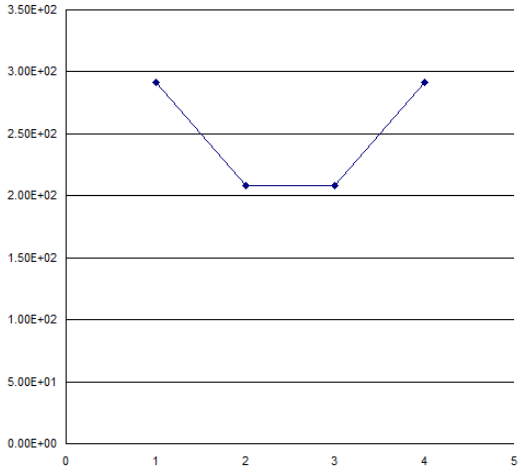


rods (violet) are the structural the members

spring elements (orange) are the fasteners



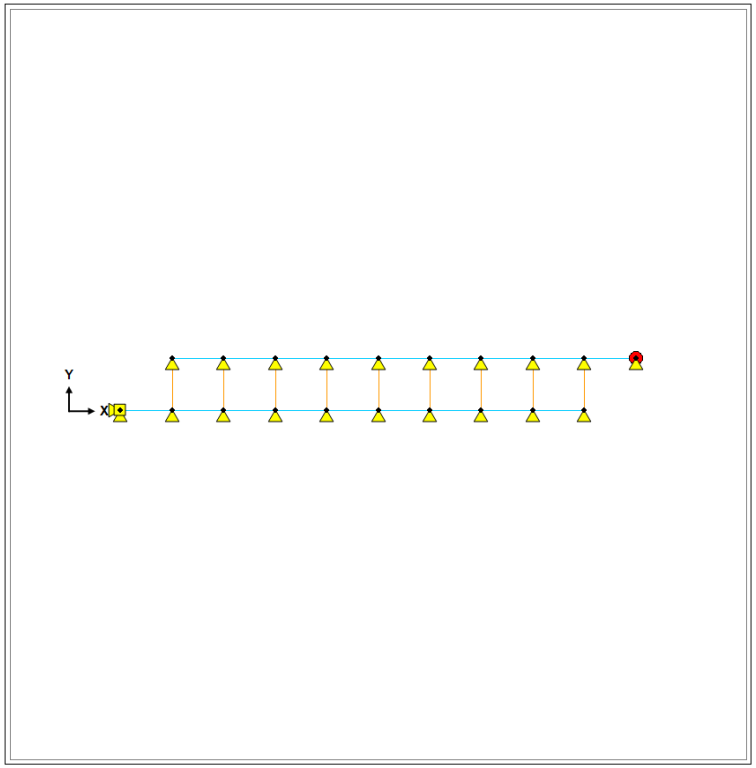
displaced shape



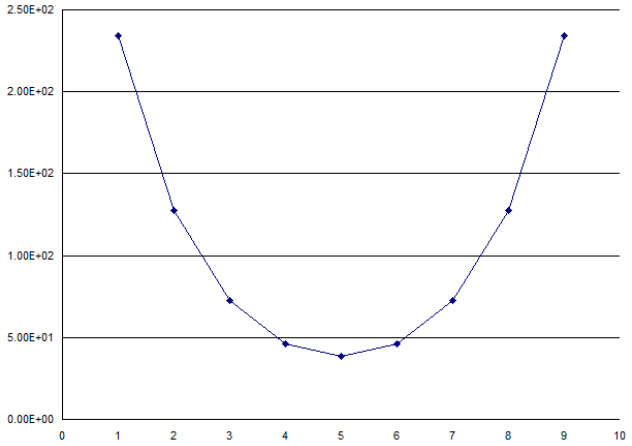
fastener loads

(spring forces)

Joint (9 Fastener Rows)

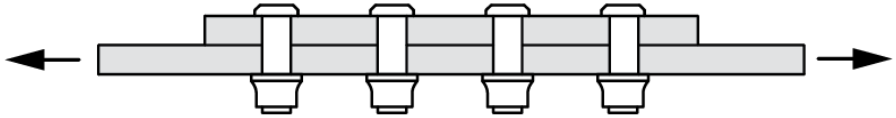


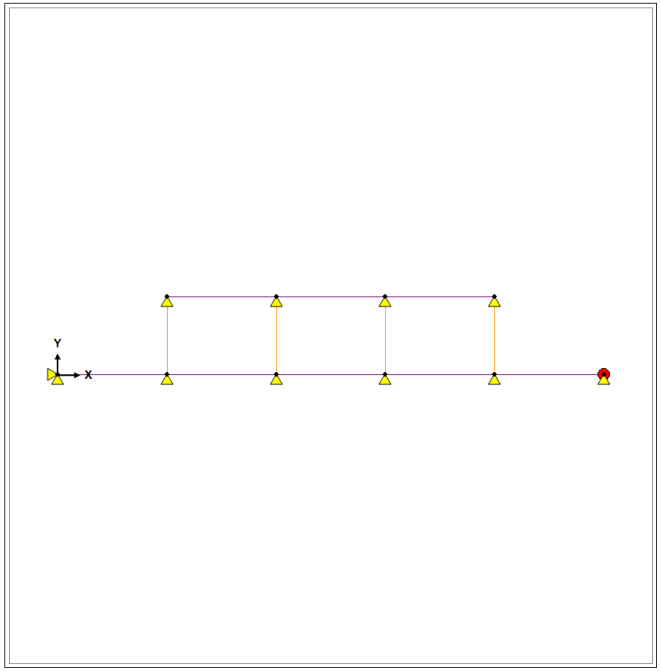
parametric and sensitivity
studies are easily performed

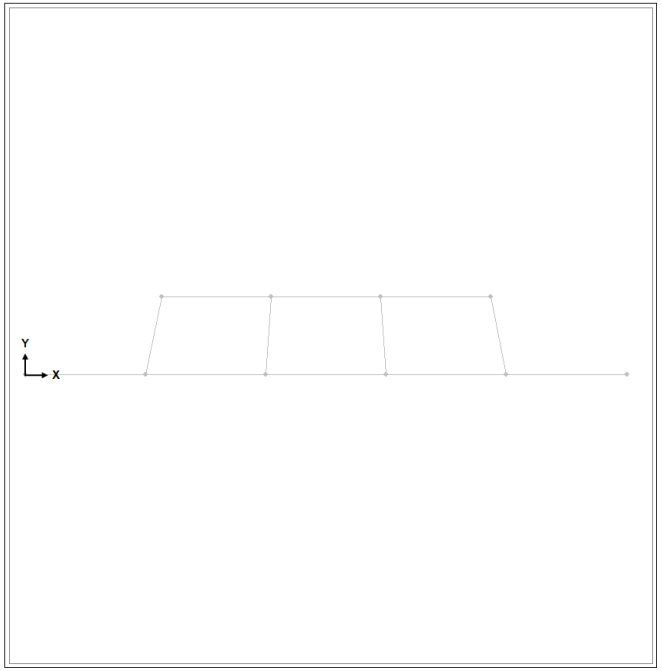


fastener load distribution
typical “U-shape”

Hard Point

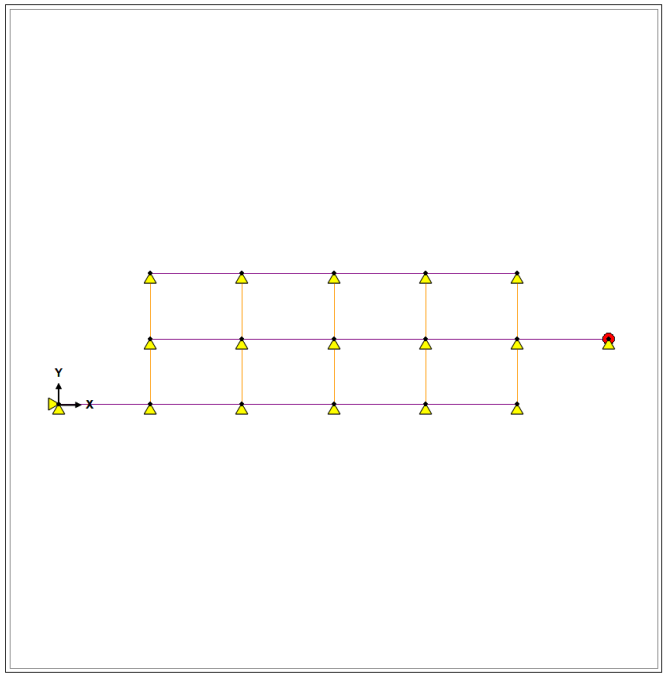


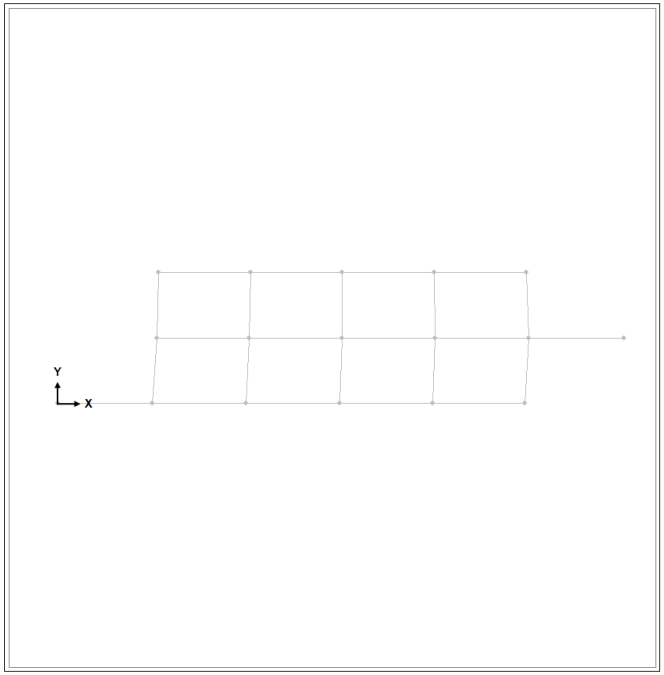




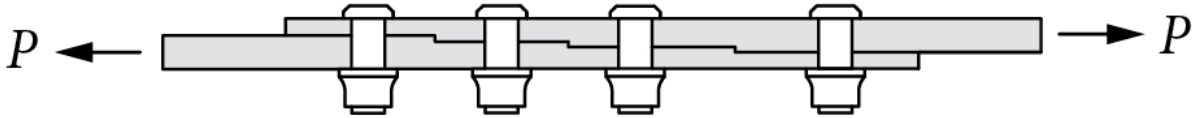
Joint (Multi-Layer)

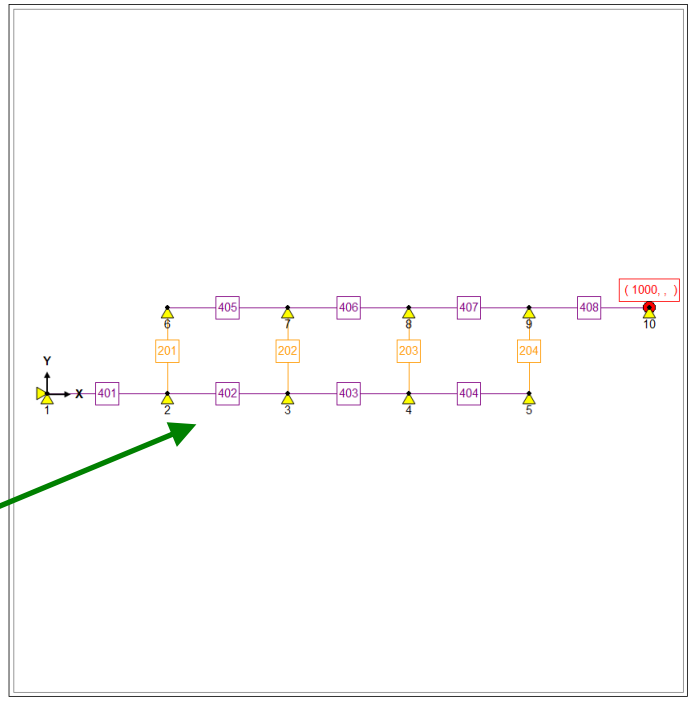
- Load transfer joint with a hard point
- General multi-layer joints are easily created





Stepped Joint

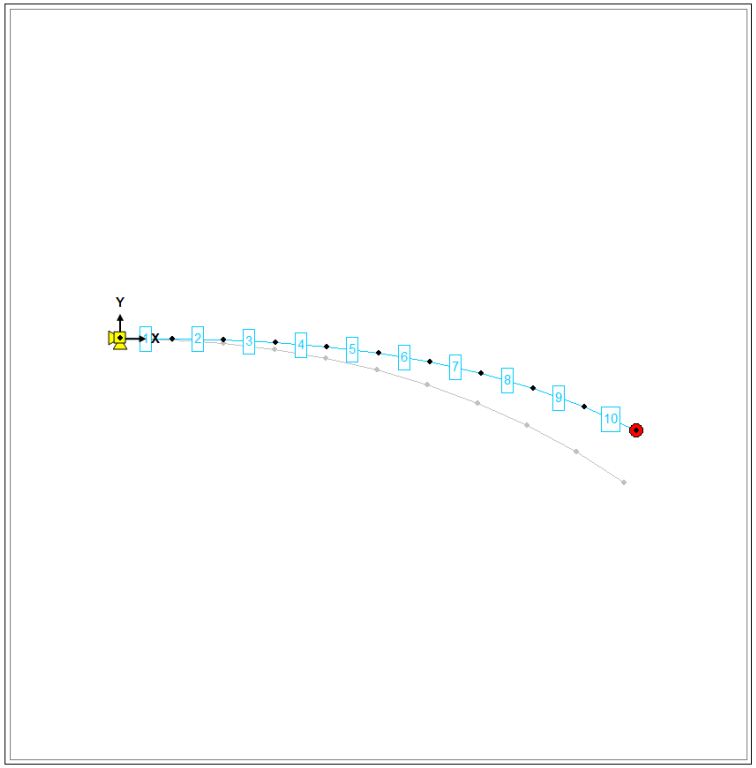




each element has the appropriate thickness

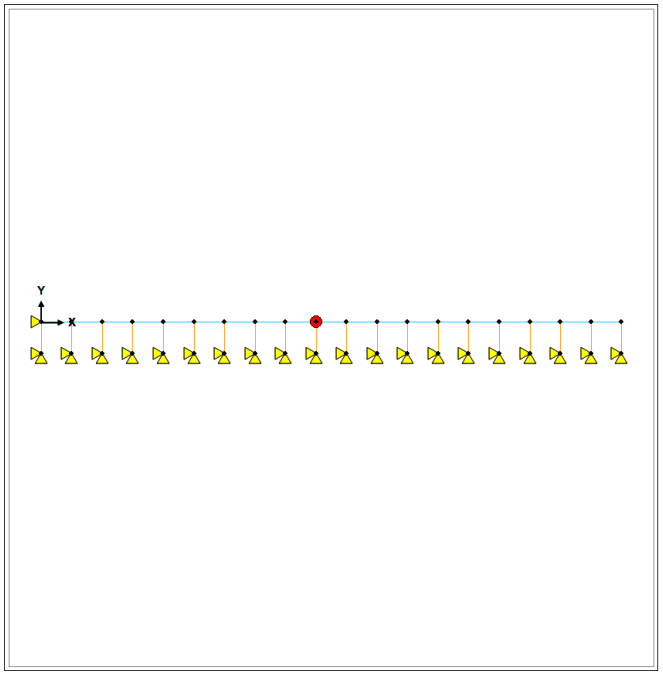
rod elements 401-408

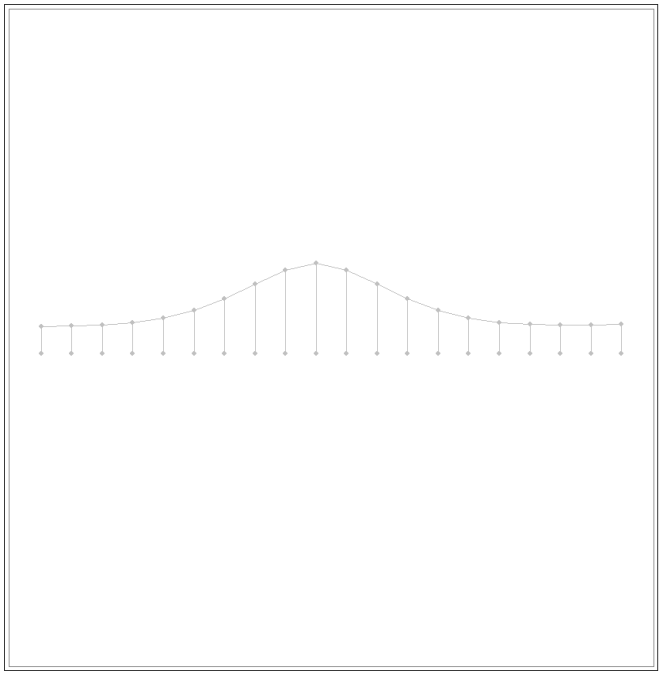
Curved Beams



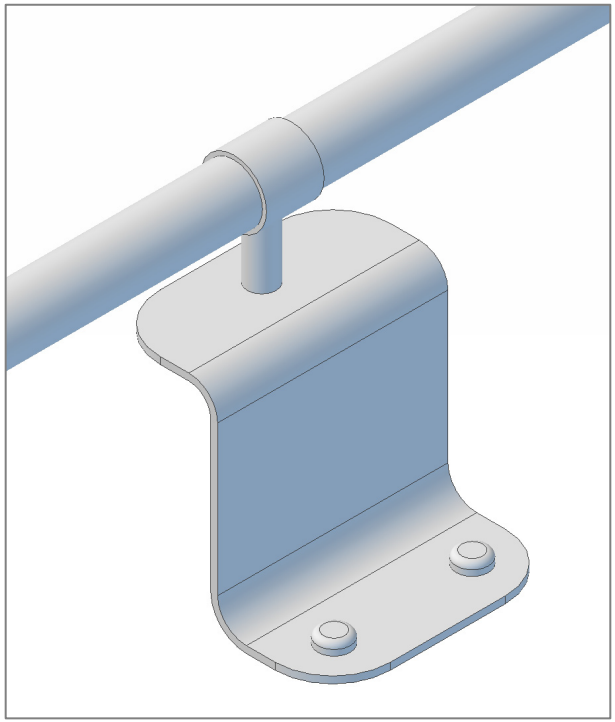
Elastic Foundation

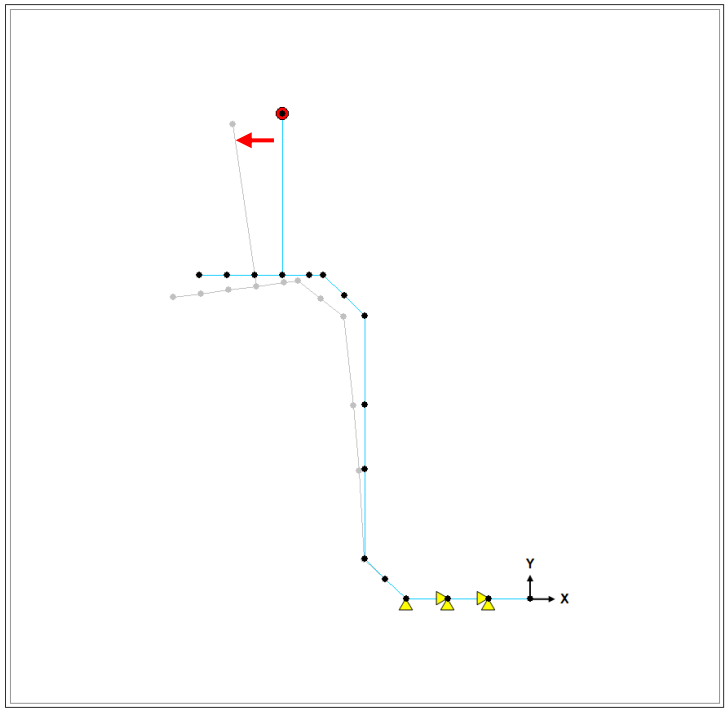
- Beam (light blue elements) on an elastic foundation (orange spring elements)





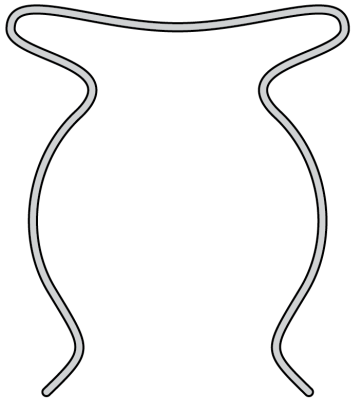
Brackets

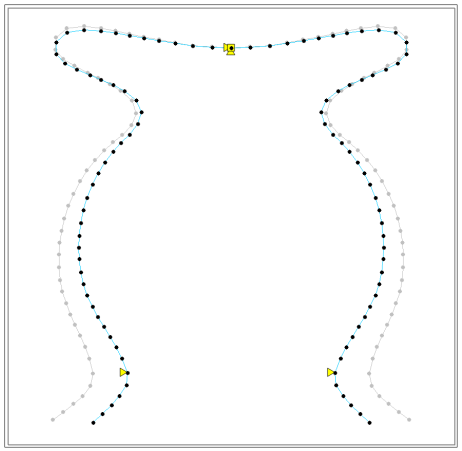


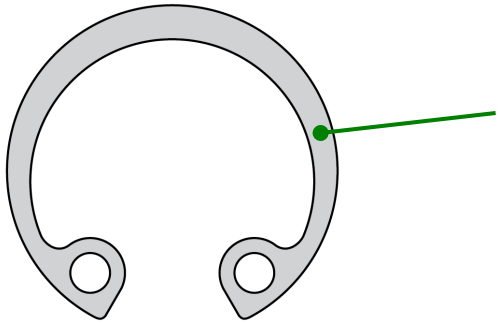


Clips

- Enforced displacement (required open position of the clip)
- Associated bending moments and shear forces are the results (as well as stresses)

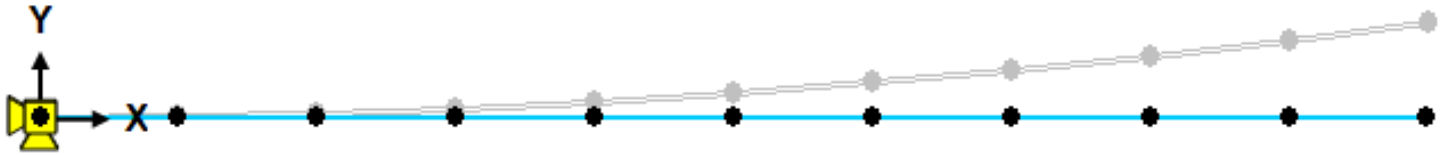






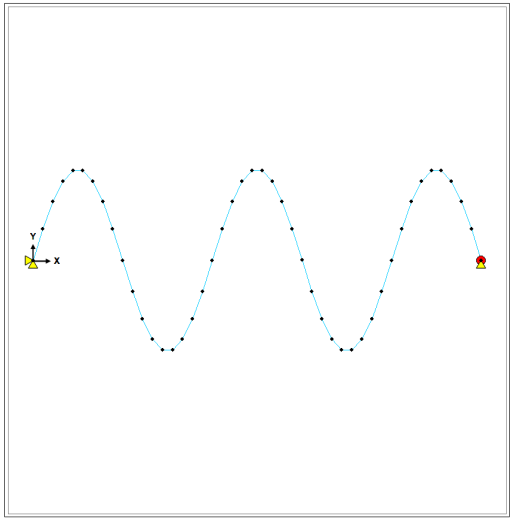
Bimetallic Strip

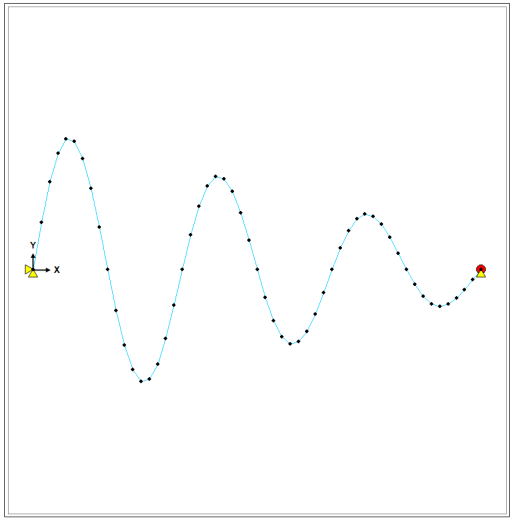
- Two “strips” offset by the distance between the N.A. of each strips (and connected by beams)
- Thermal load applied to determine the curvature

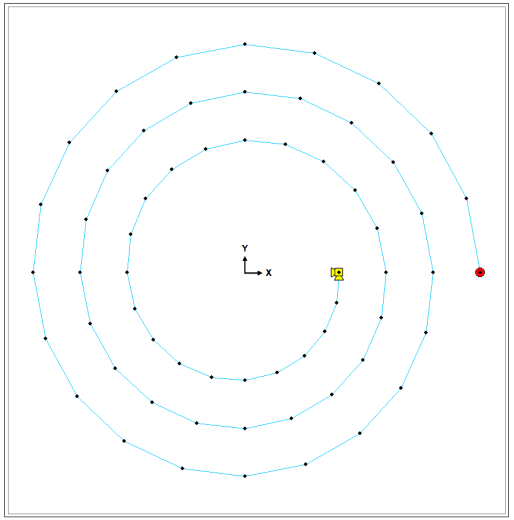


Mathematically Generated Shapes

- Mathematically generated shapes are easily incorporated

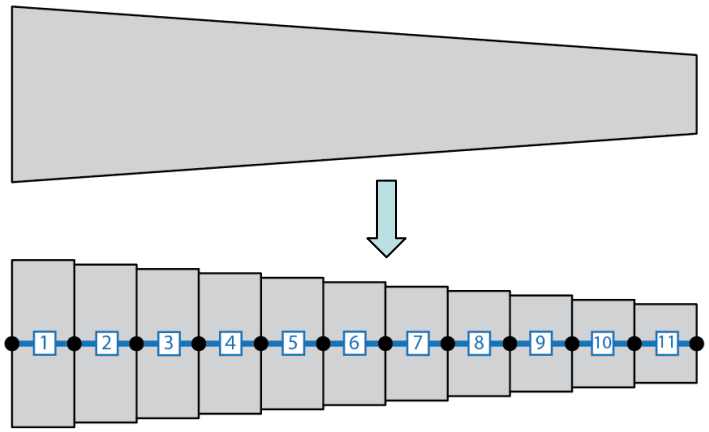




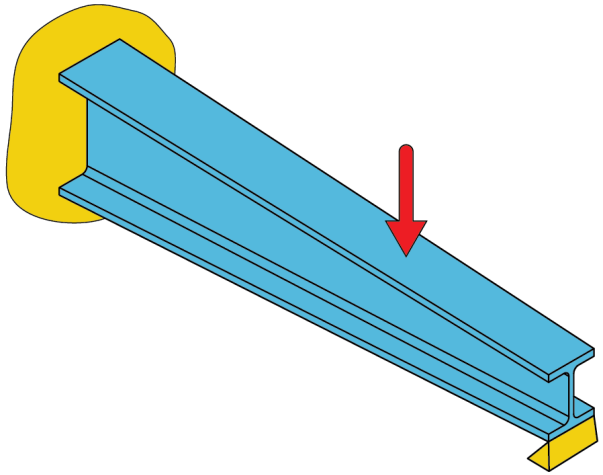


Variable Sections

tapered section

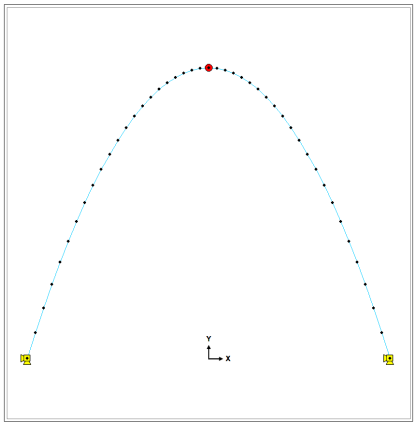


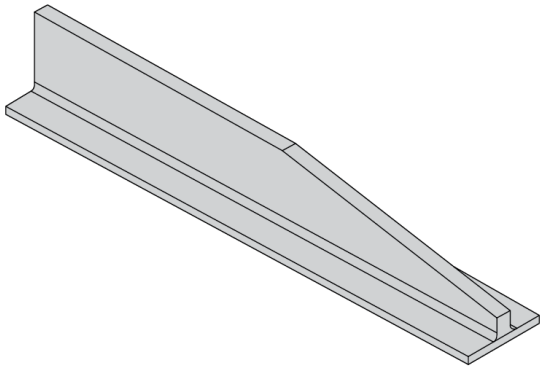
modeled as a series of
beam elements with
varying properties



beam can be tapered
in 2 directions

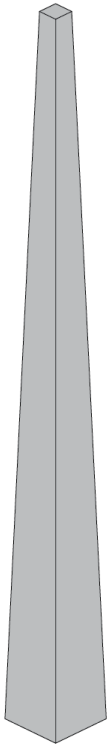
Variable Sections (cont.)





stringer runout can be modeled

(varying cross section)

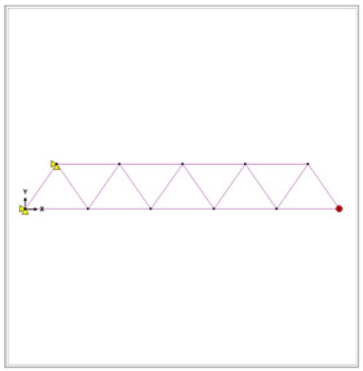
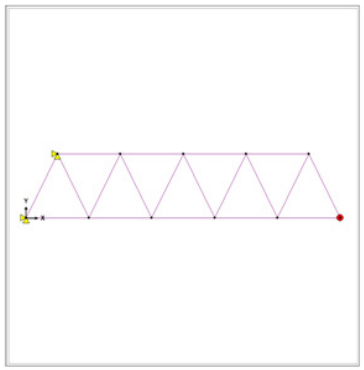
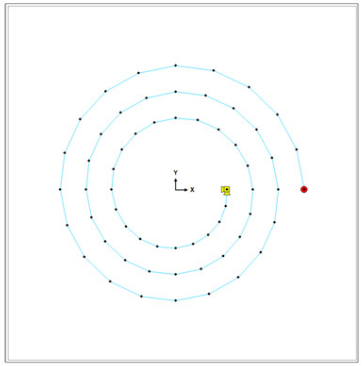
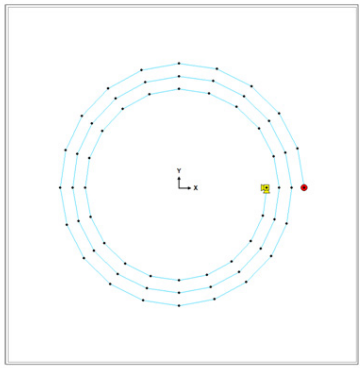
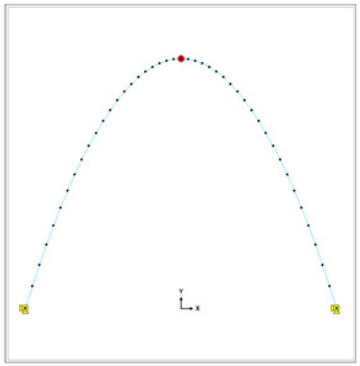
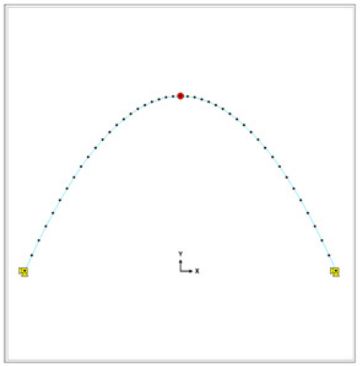


tapered column

(buckling)

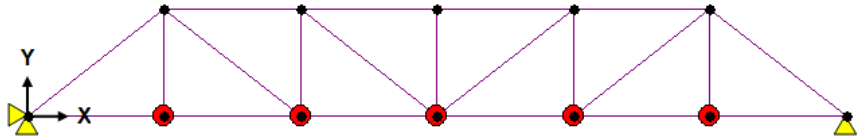
Parametric Models

- Models can set up to be changed via parameters
- For the shown 3 examples, the model is changed by a single variable

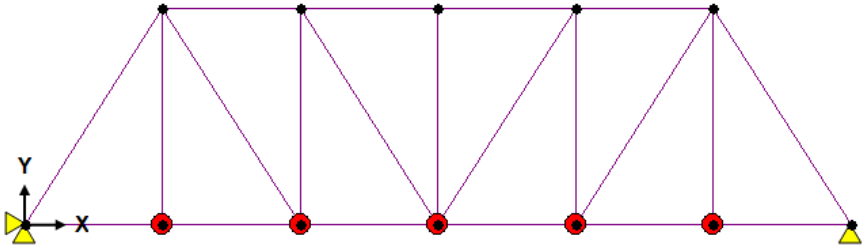







Optimization

- *1D Elements* has multiple features that can be used for optimization



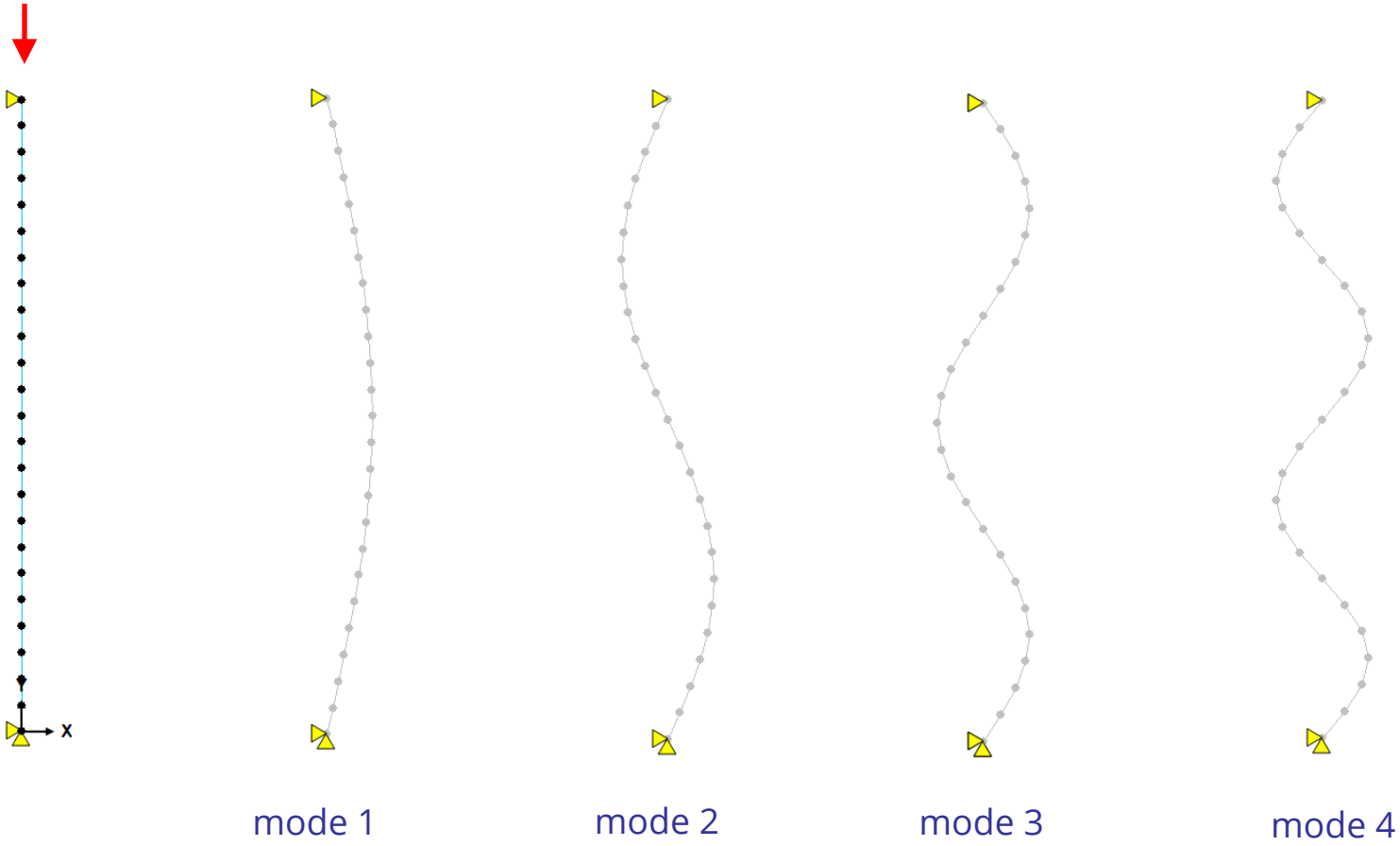
before optimization



after optimization

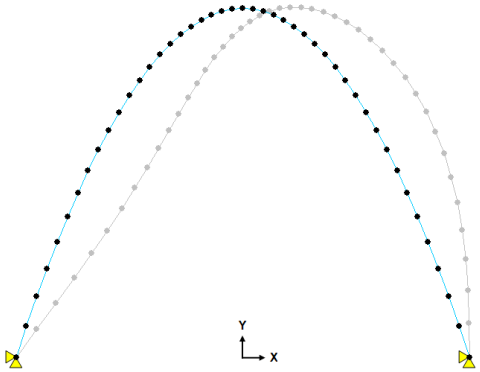
Eigen Solution Buckling

- Simple column example (simply supported on both ends)

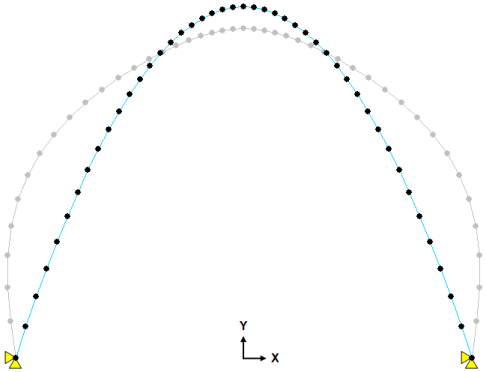


Natural Frequency

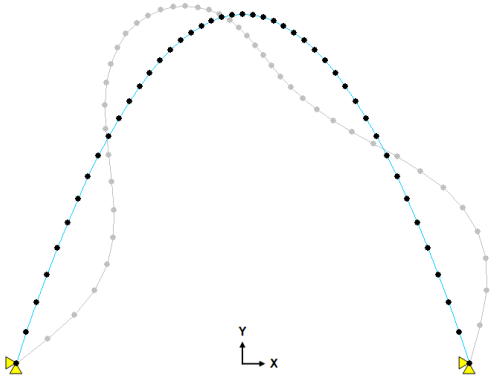
- Arch example



mode 1



mode 2



mode 3

Geometric Nonlinearity (NASTRAN Sol 106)

- Nonlinear buckling
- Beam-column analysis
- Stress stiffening