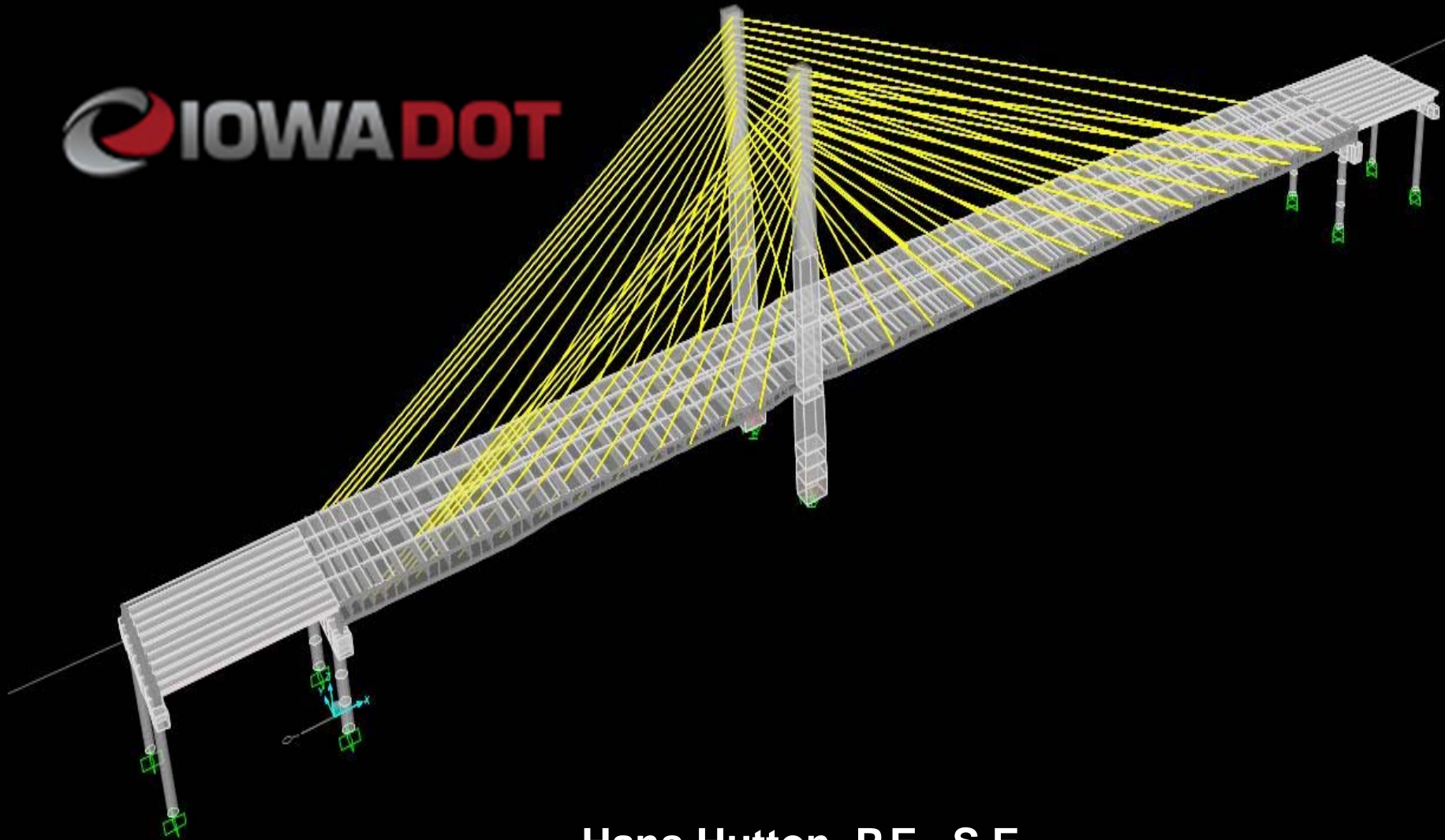


An Evolution of Analysis of Complex Structures



Hans Hutton, P.E., S.E.
Iowa DOT 3D Conference
Ames, IA

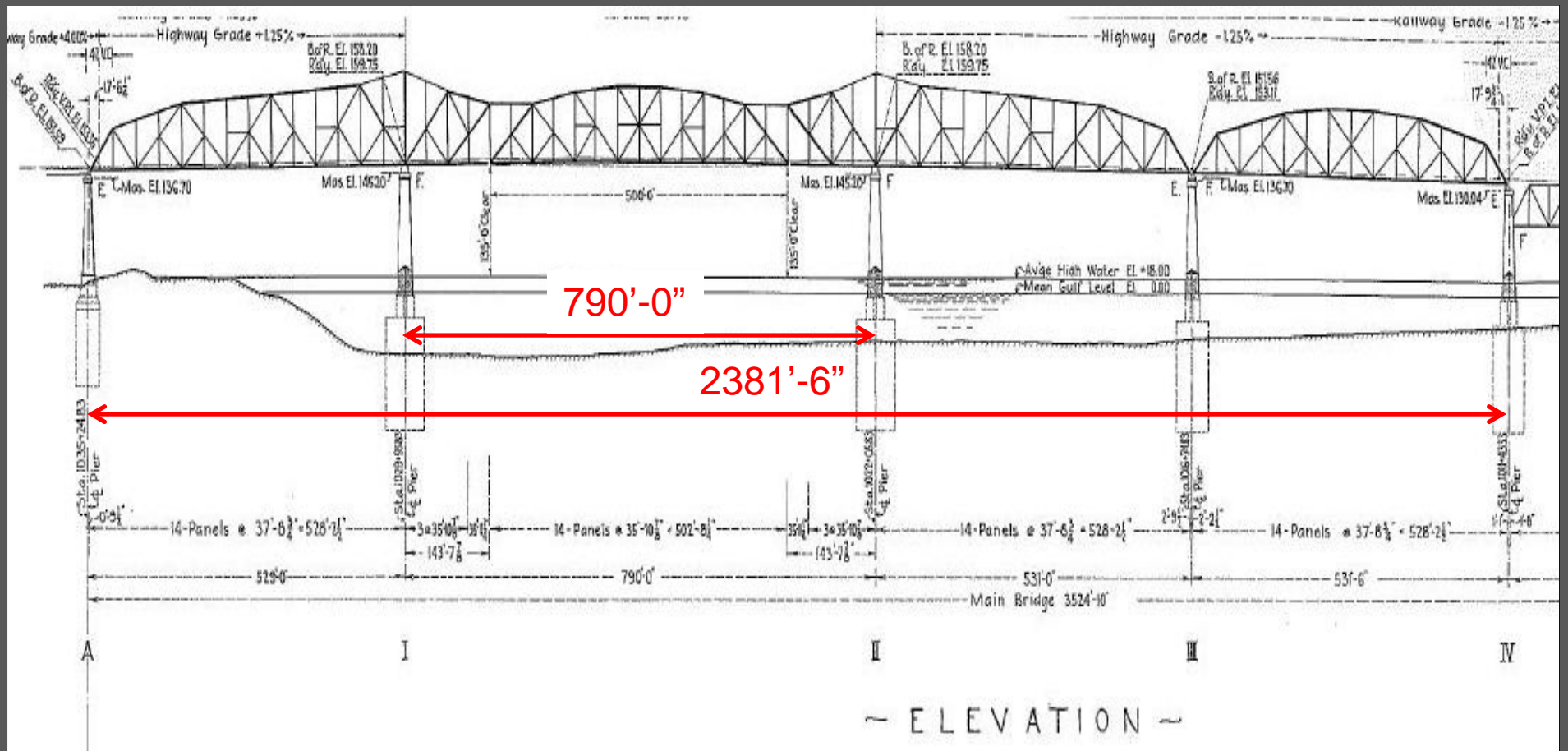




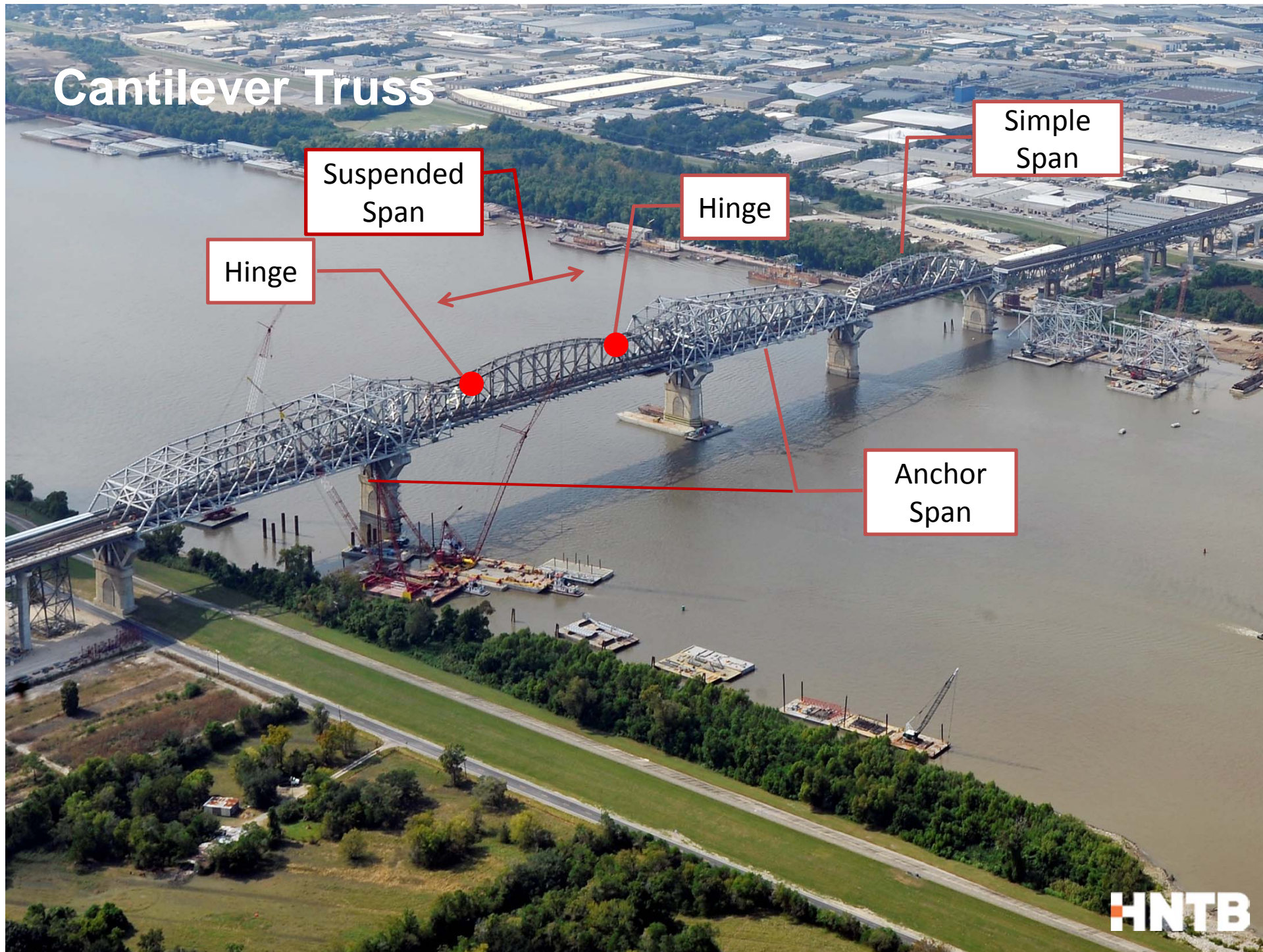
HNTB



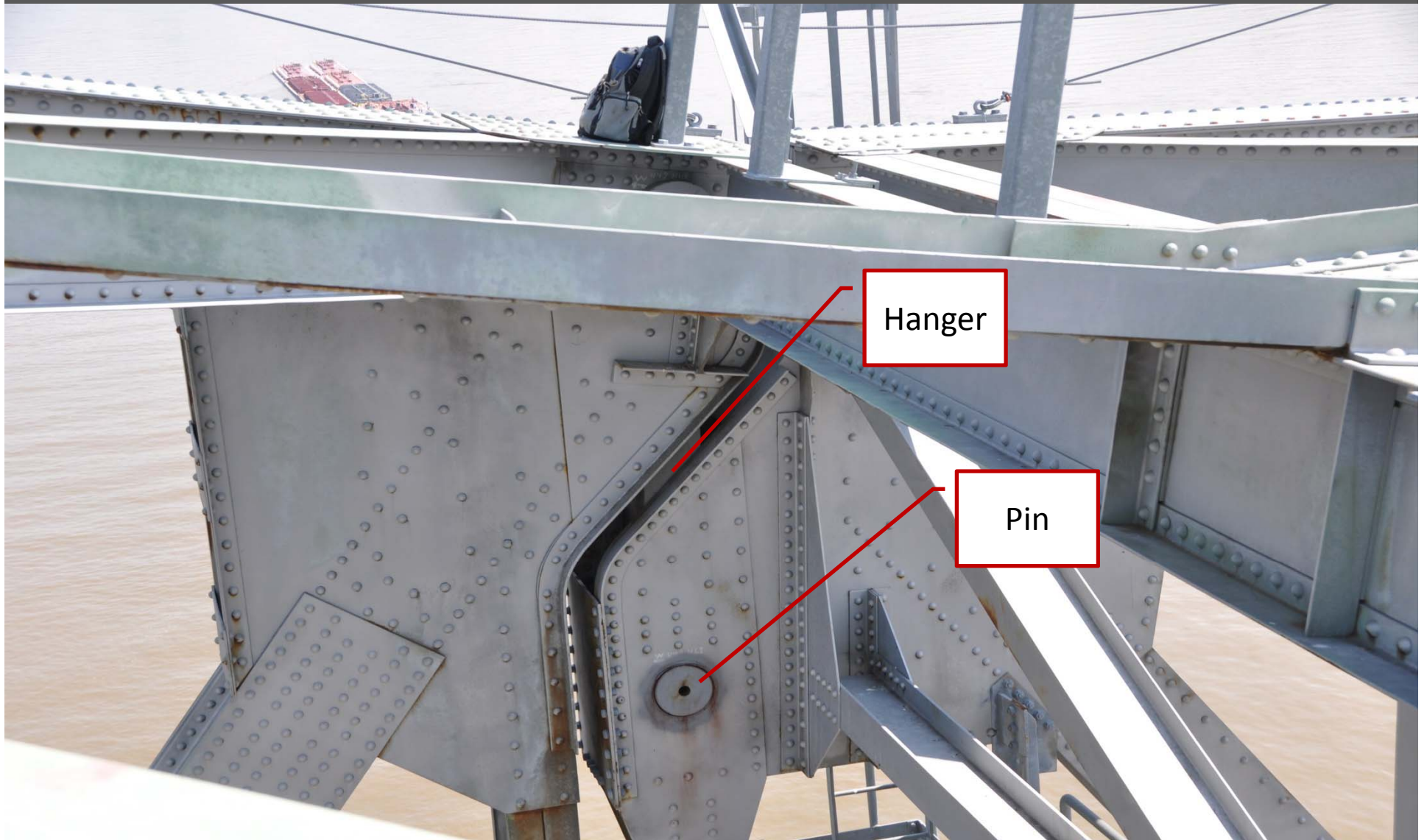
Huey P. Long Bridge over Mississippi River at New Orleans, LA - 1933



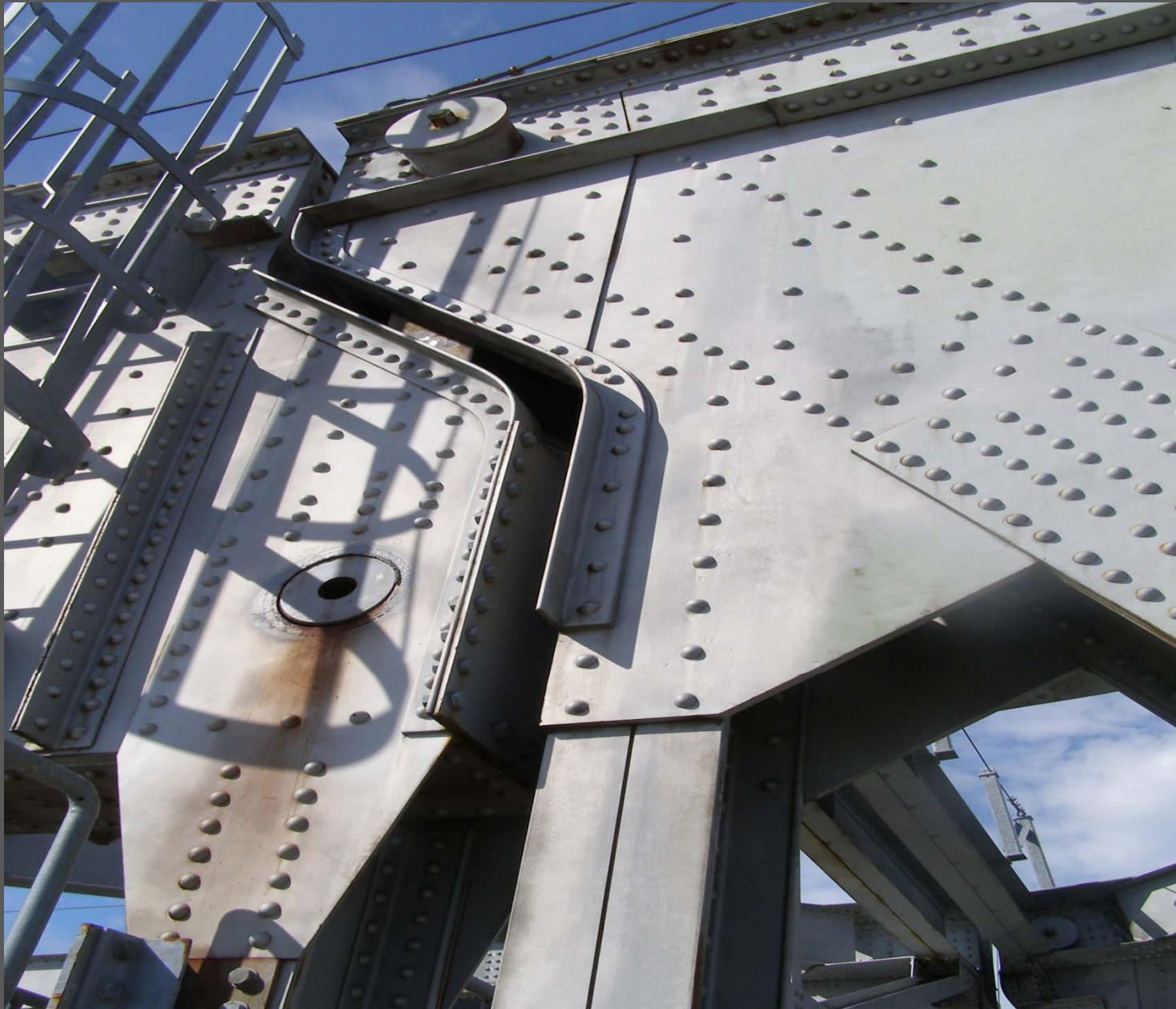
Cantilever Truss



Example of a Pin-Connected Hanger



Example of a Pin-Connected Truss



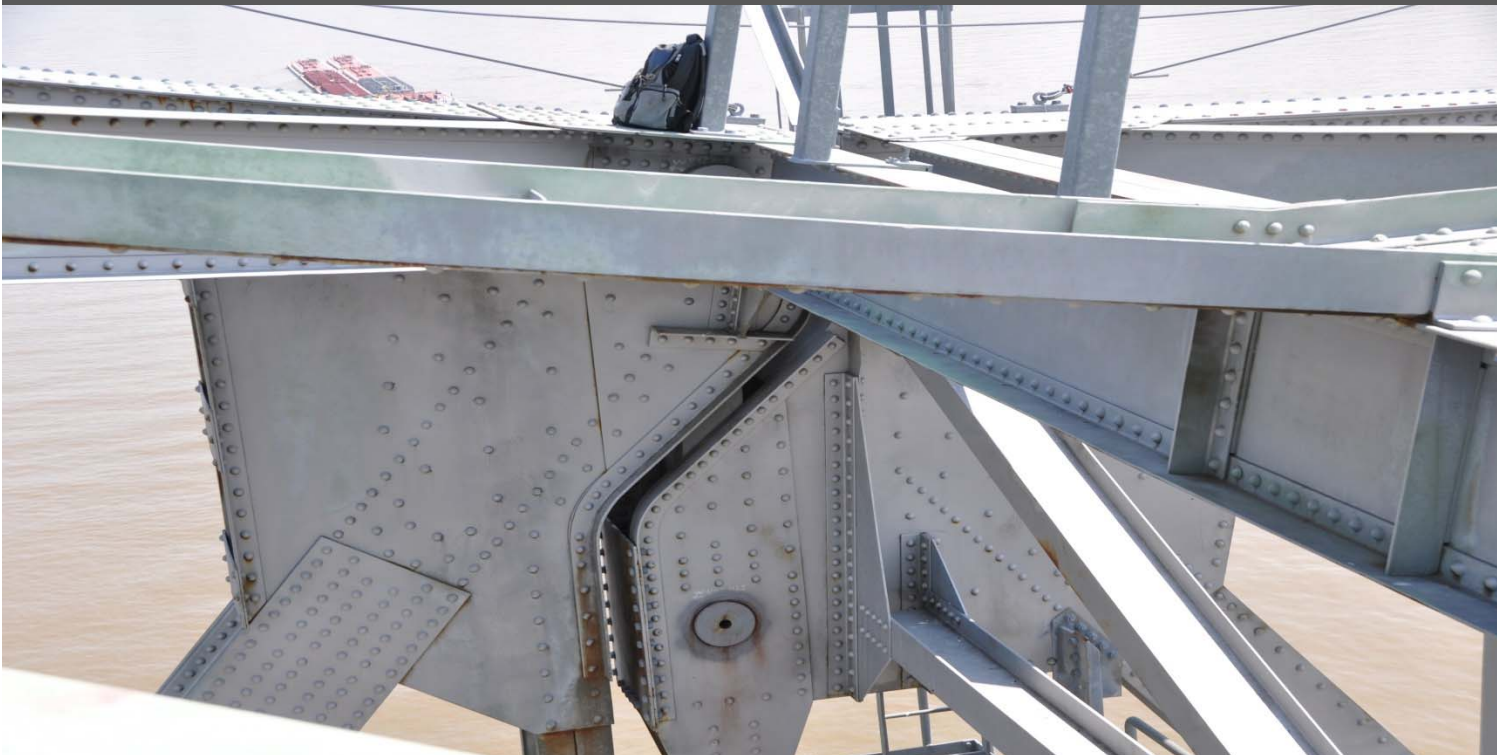
Example of a Pin-Connected Truss



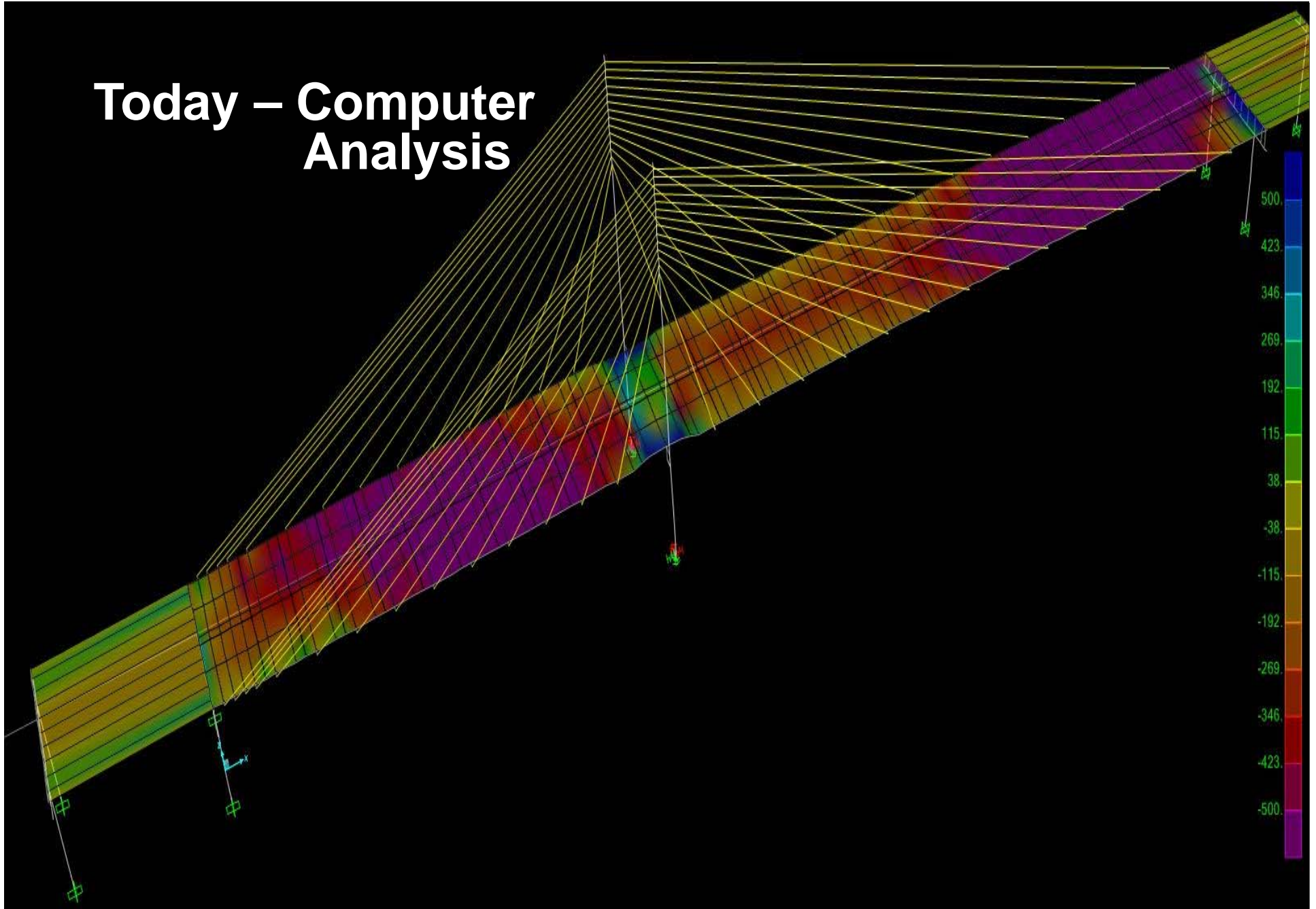
© 2012 Sherman Cahal Photography

Methods of Dealing with Rigidity in Riveted Joints

1. Camber
2. Style of Truss (e.g. Warren vs. Baltimore)
3. Narrow Cross Sections
4. Estimate and Include Secondary Stresses



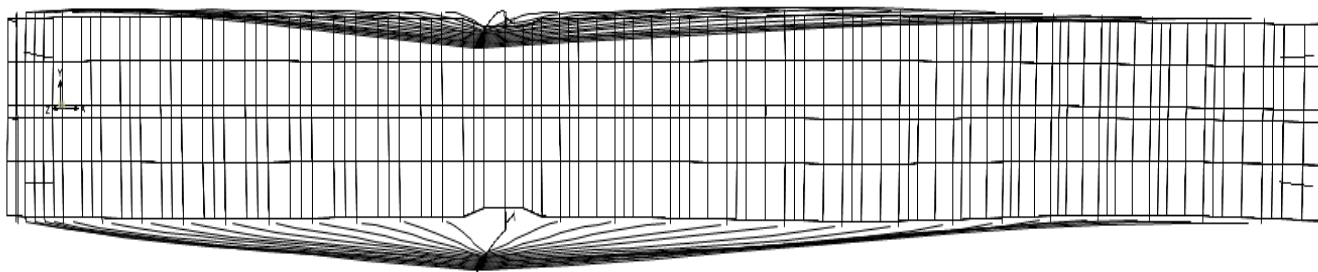
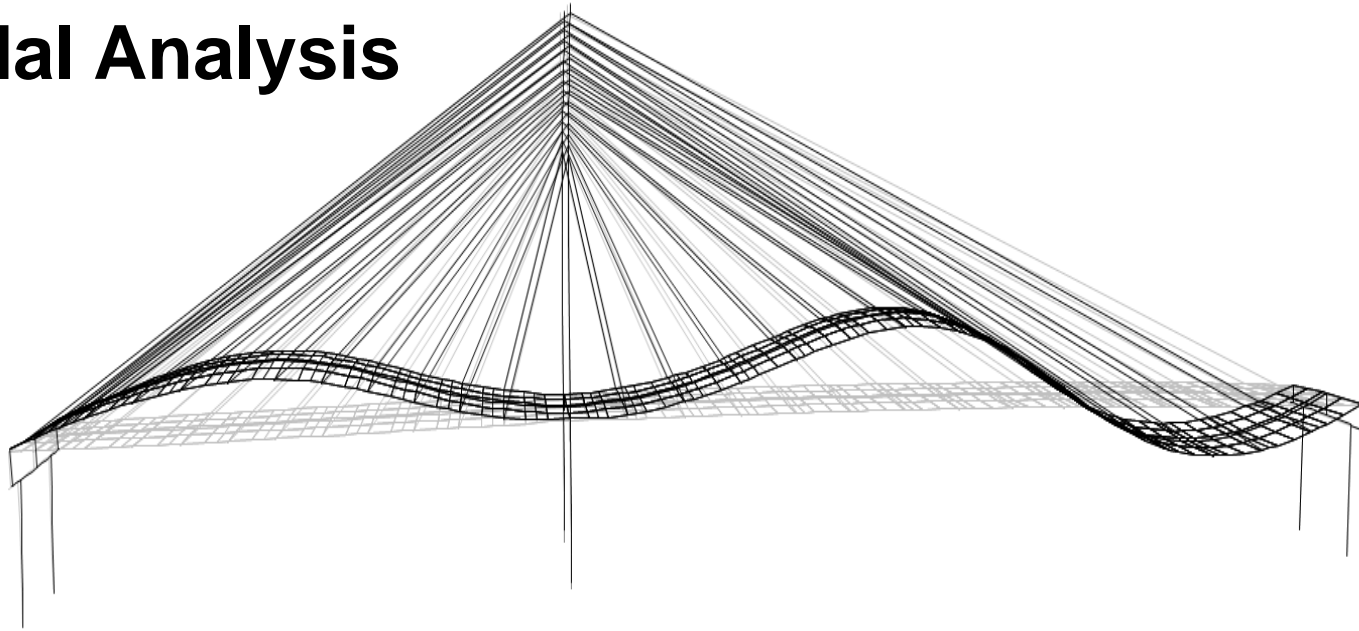
Today – Computer Analysis



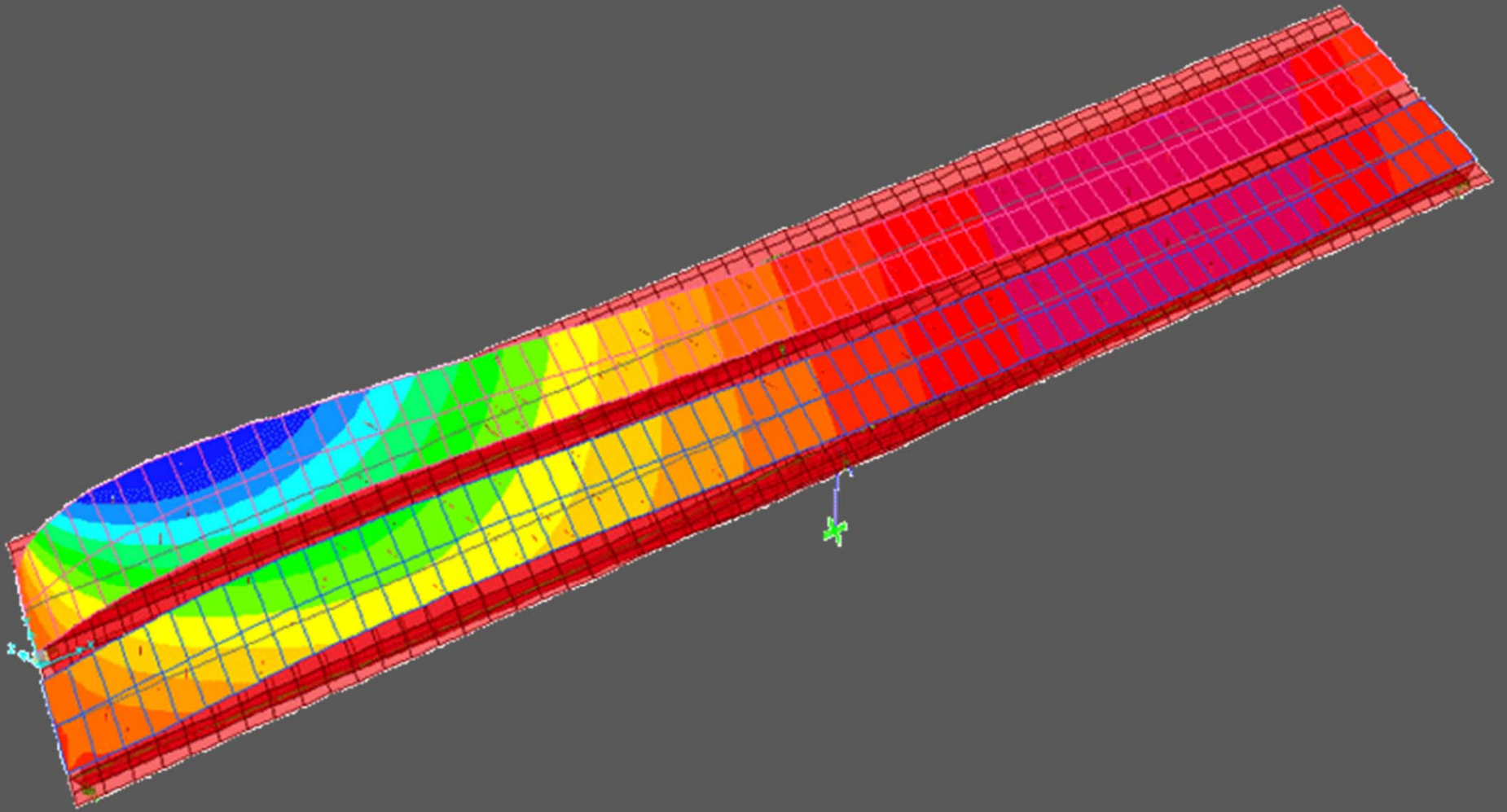
Some Benefits of Computer Analysis

1. Statically Indeterminate Structures
2. Influence Surface for Live Load Analysis
3. Geometric Nonlinearity
4. Material Nonlinearity
5. Time Dependent Effects (e.g. Creep & Shrinkage)
6. Effective Width of Deck
7. Step-by-Step Time History Analysis
8. Erection Analysis
9. High Order Finite Elements – Complex Geometry

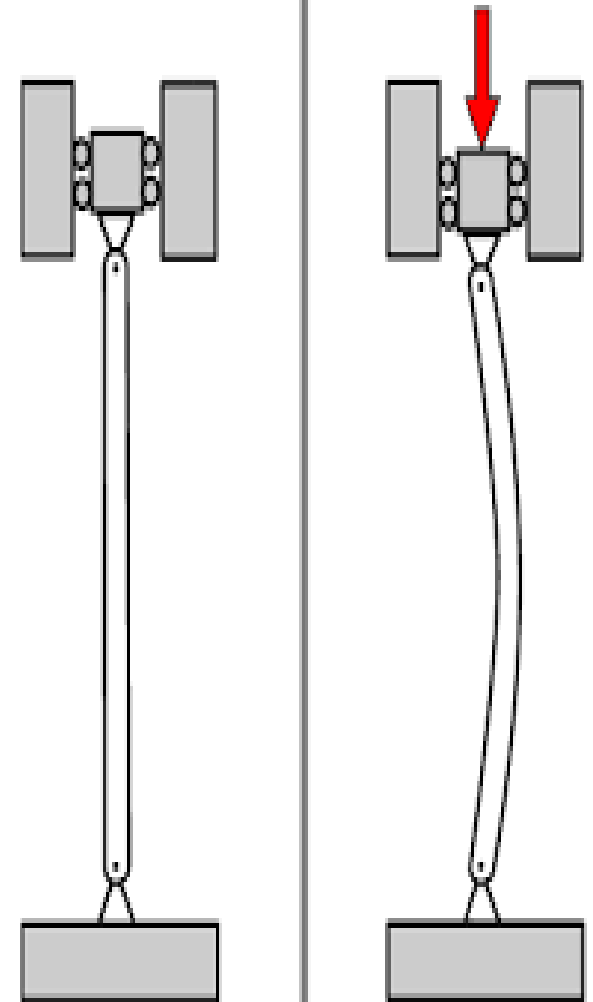
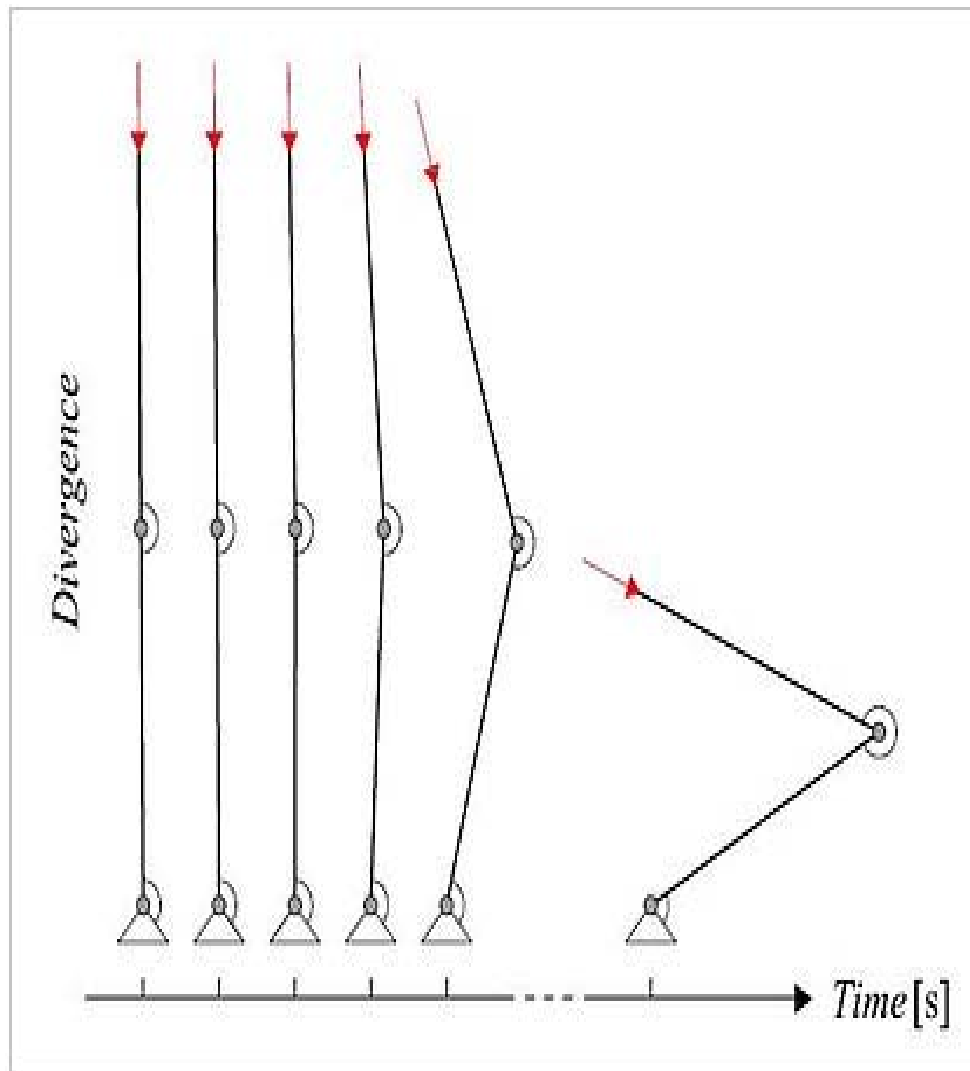
Modal Analysis



Influence Surface

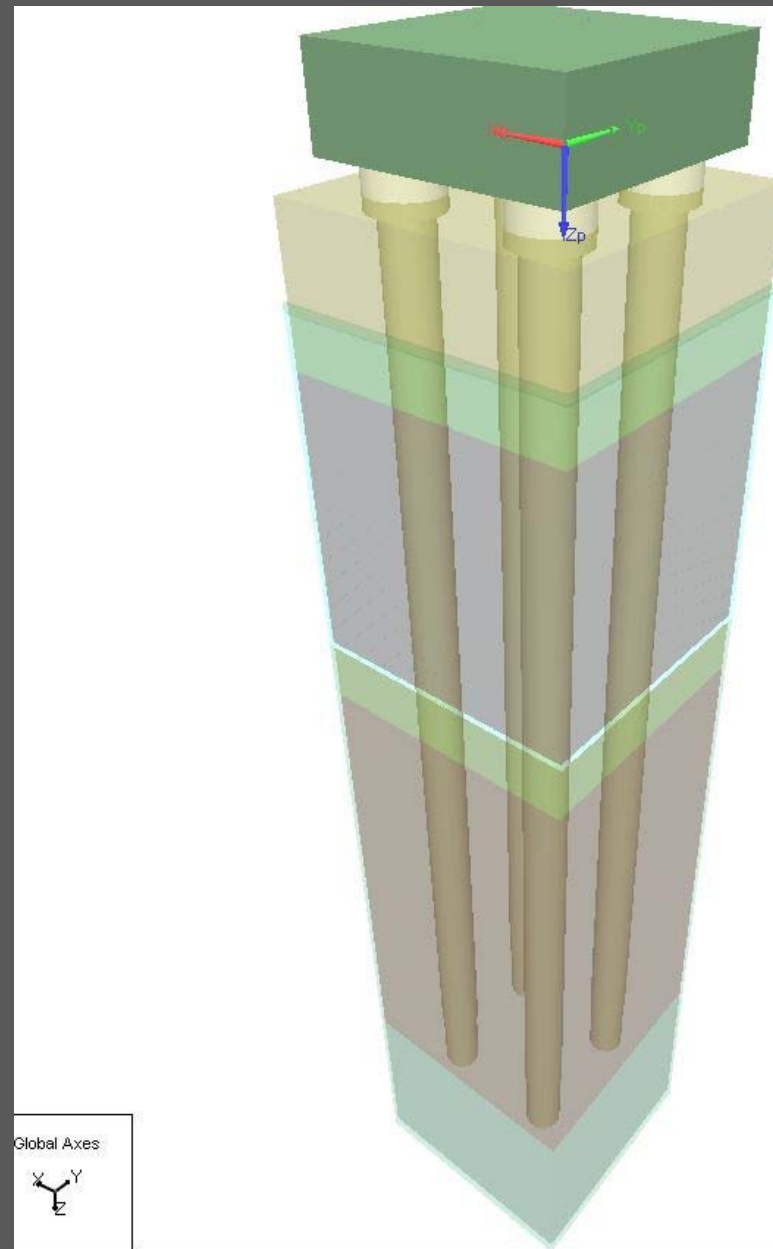
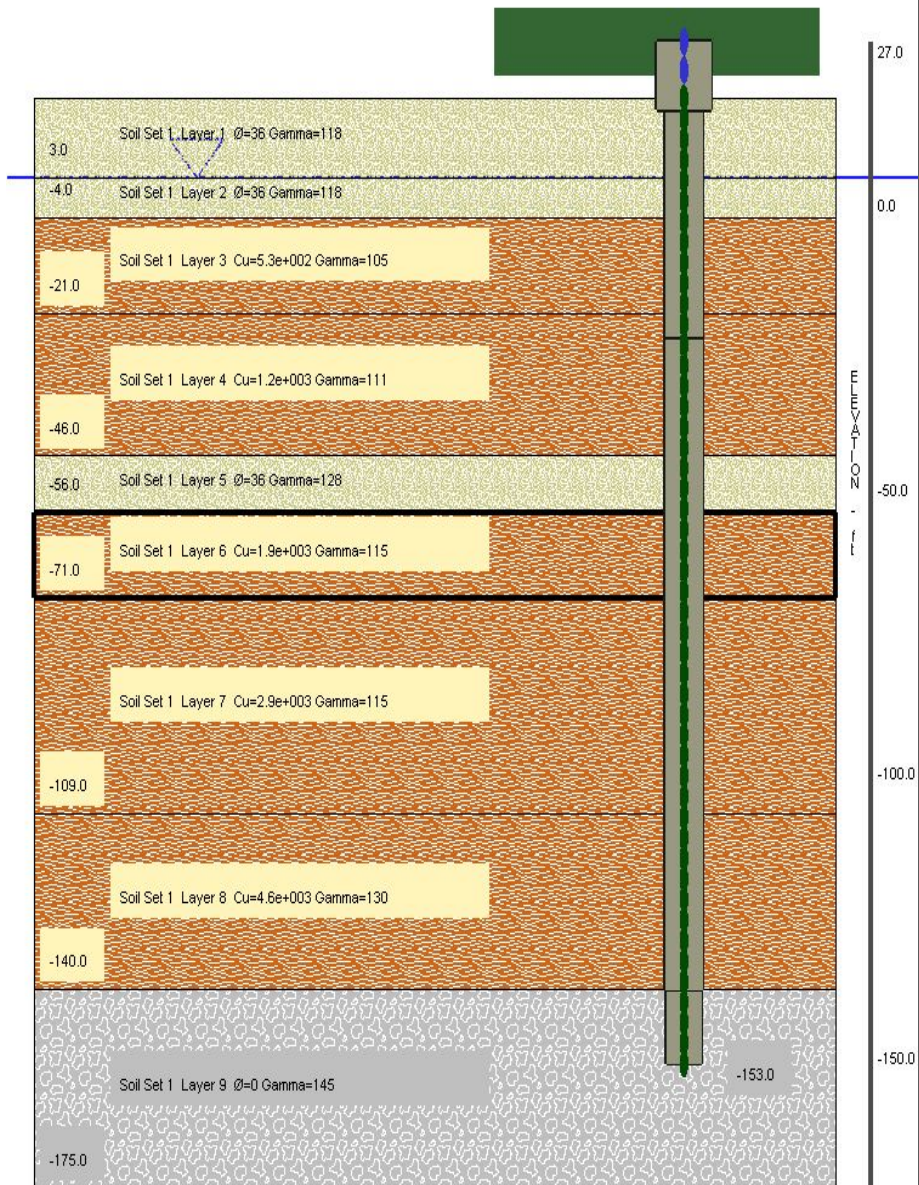


Geometric Nonlinearity

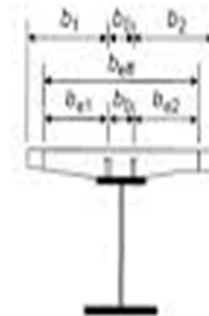
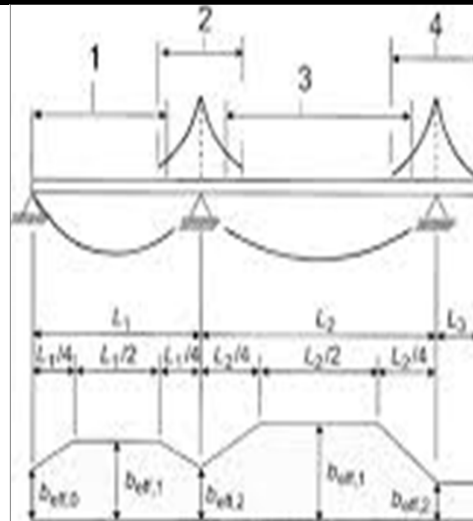
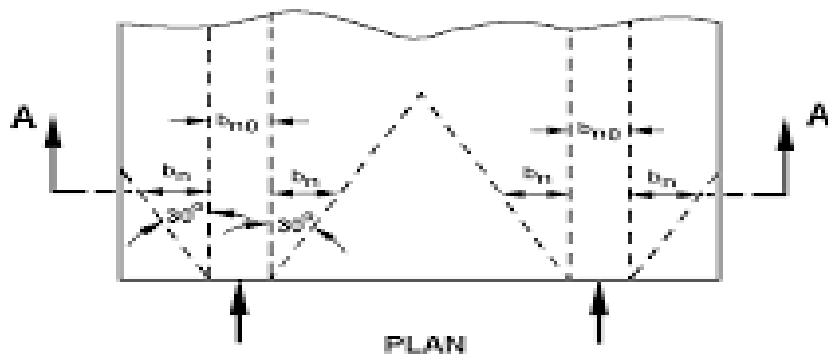
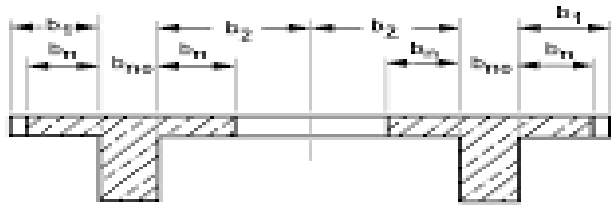
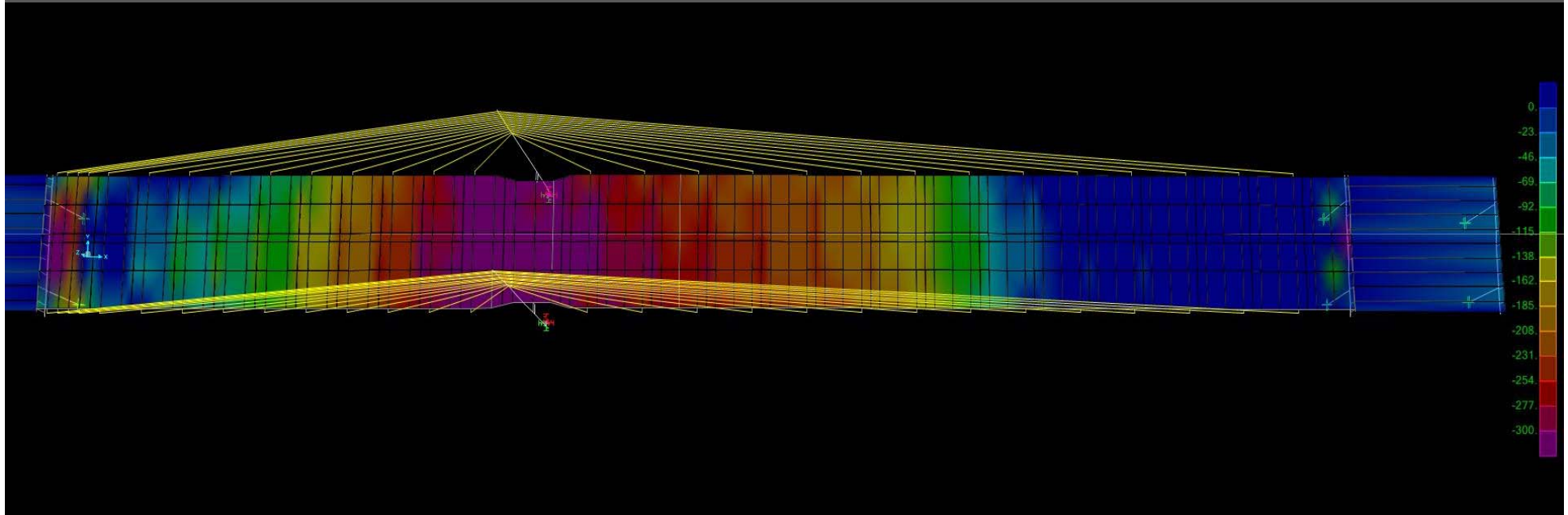


Material Nonlinearity

Pile 1, Pile Type 1



Effective Width of Deck

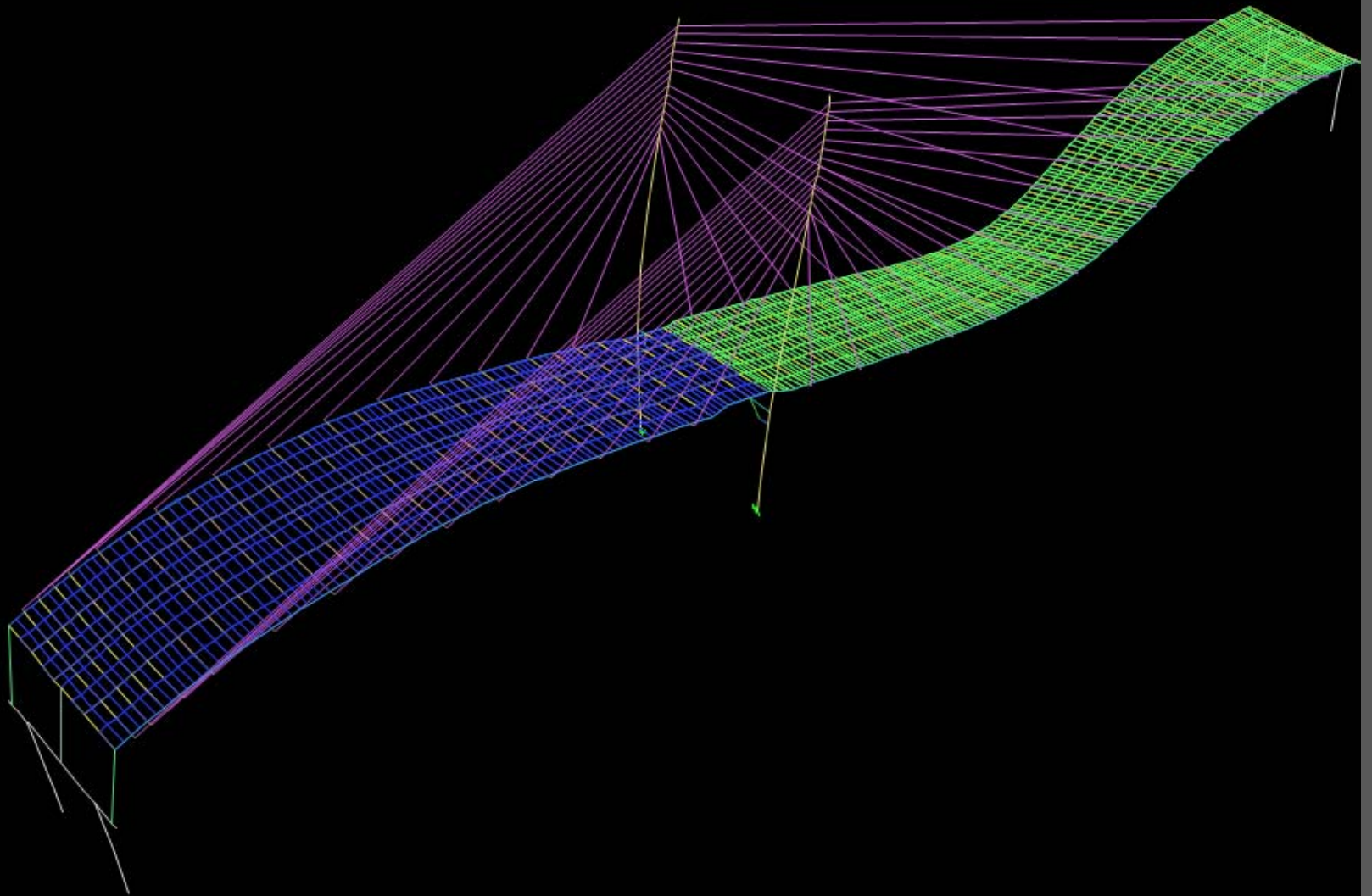


Key:

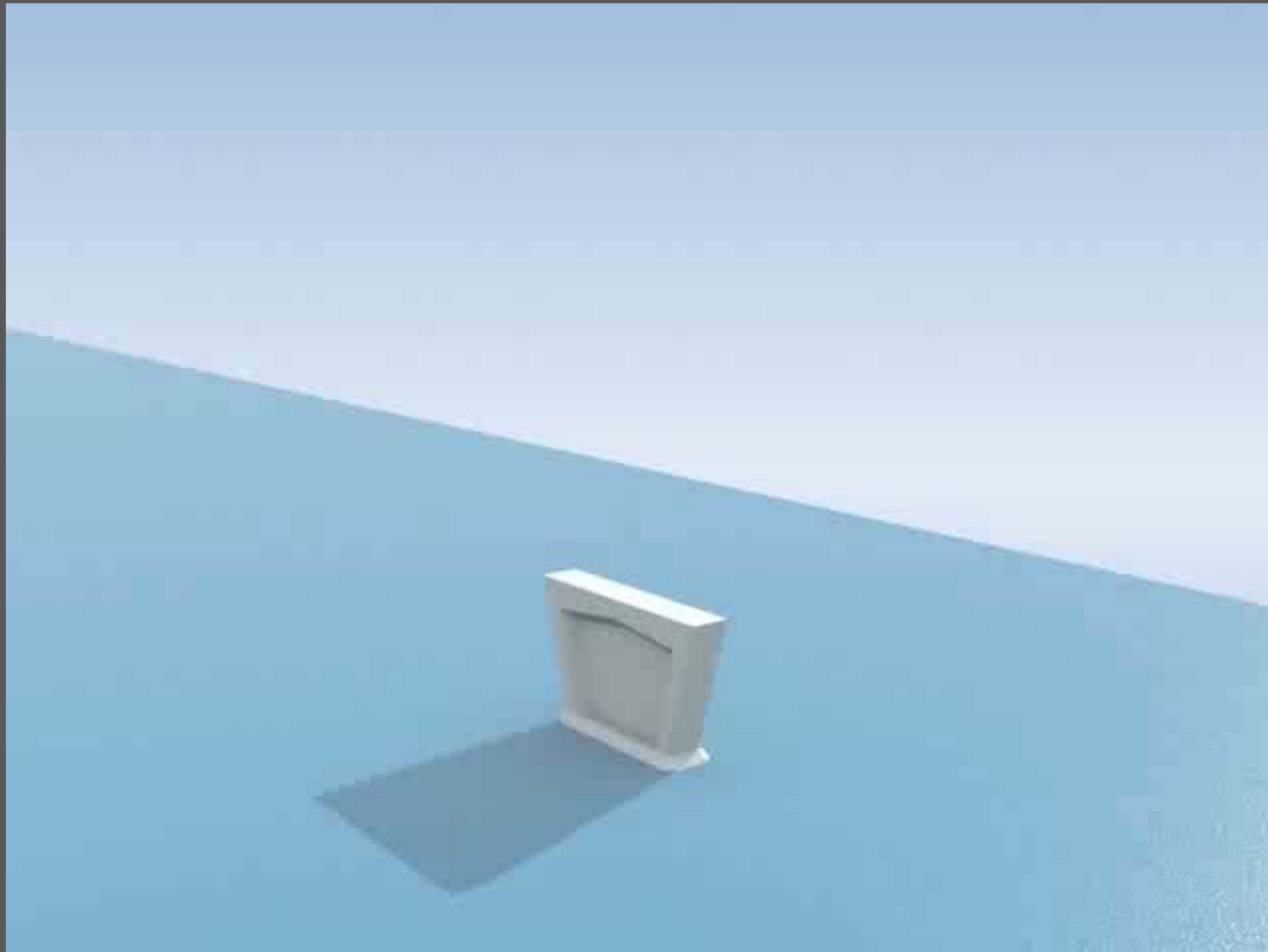
- 1 $L_e = 0,85 L_1$ for $b_{eff,1}$
- 2 $L_e = 0,25(L_1 + L_2)$ for $b_{eff,2}$
- 3 $L_e = 0,70 L_2$ for $b_{eff,3}$
- 4 $L_e = 2 L_3$ for $b_{eff,4}$

Time History Analysis

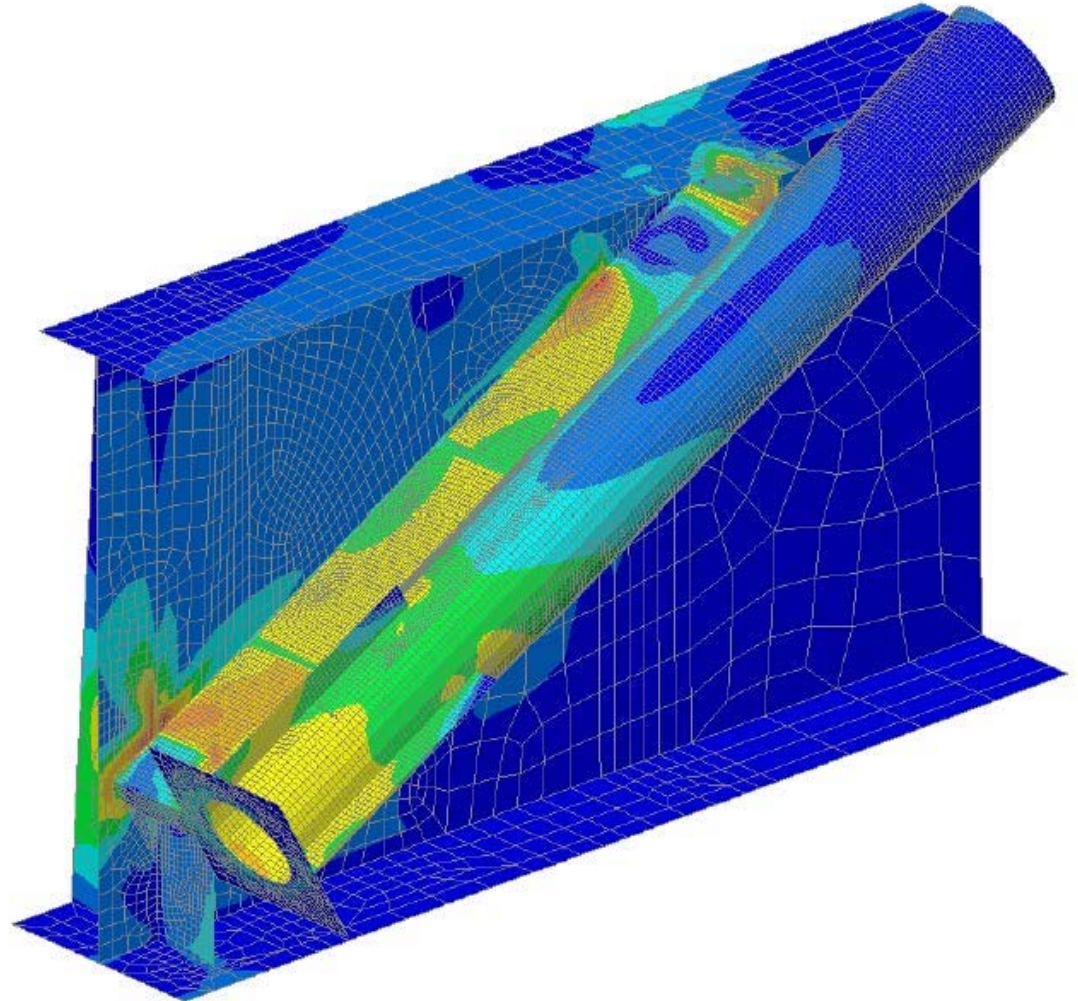
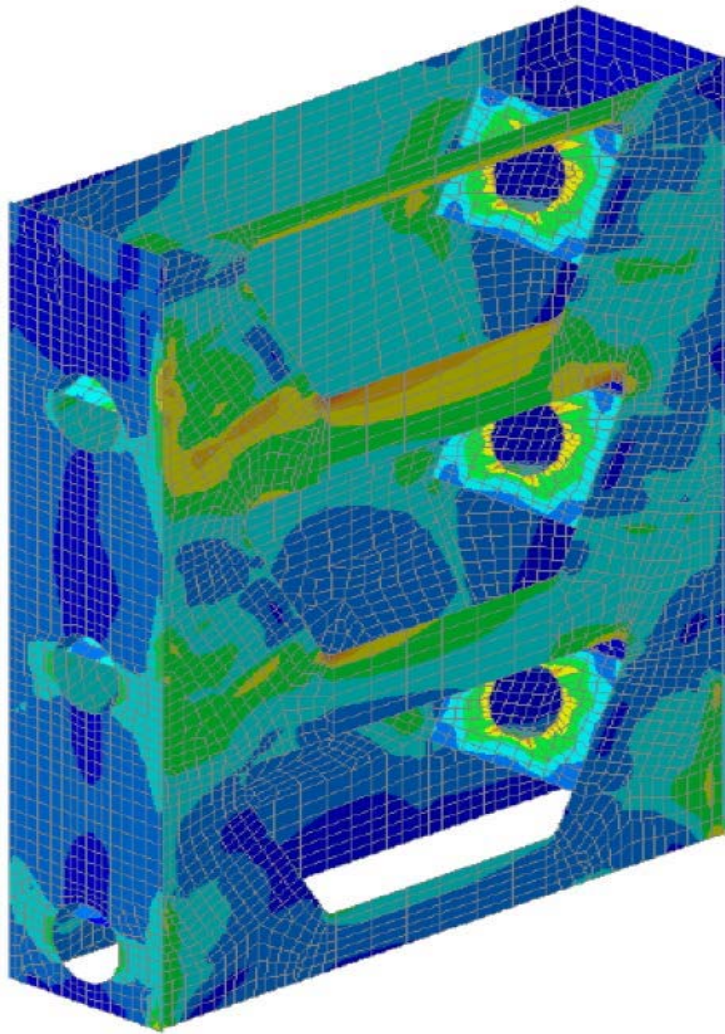
CSiBridge 2014 Filename: K-BridgeModel_EB_CableLoss_Dynamic.bdb Case: DYN_EG_2070_Max Time 0.



Erection Analysis & Time Dependent Effects



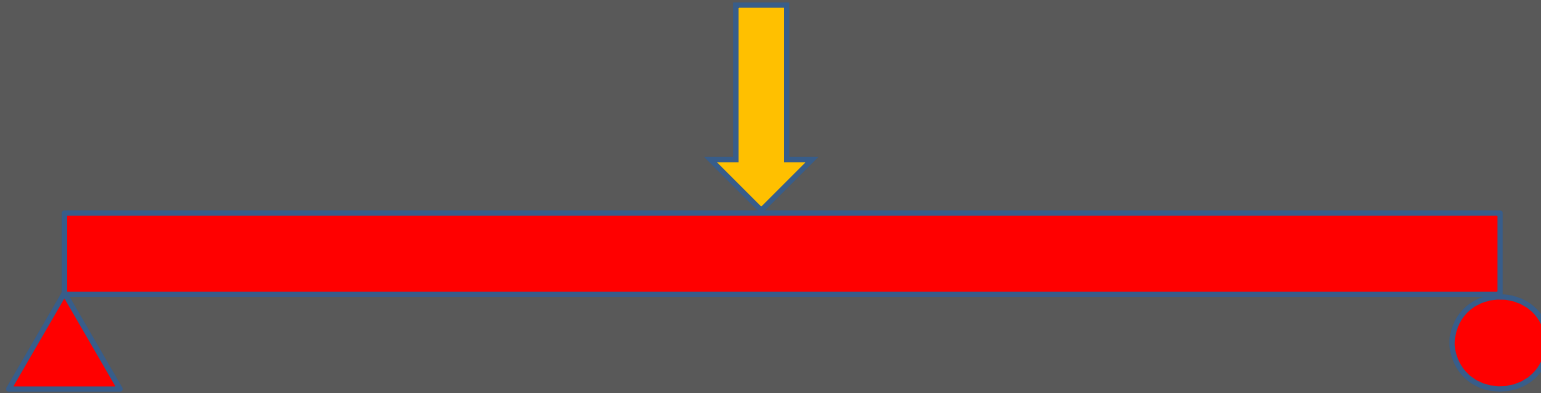
High-Order Finite Elements – Complex Geometry



Wrong Answer?



40-ft Simple Span with 1000-kip Force Midspan



Beam Properties:

- Web is $\frac{1}{2}$ " x 60"
- Flanges are 1" x 24"

Shear in Beam = 500-kip

Shear Stress in Beam = $500\text{-kip} / (0.5" \times 60") = 16.67\text{-ksi}$

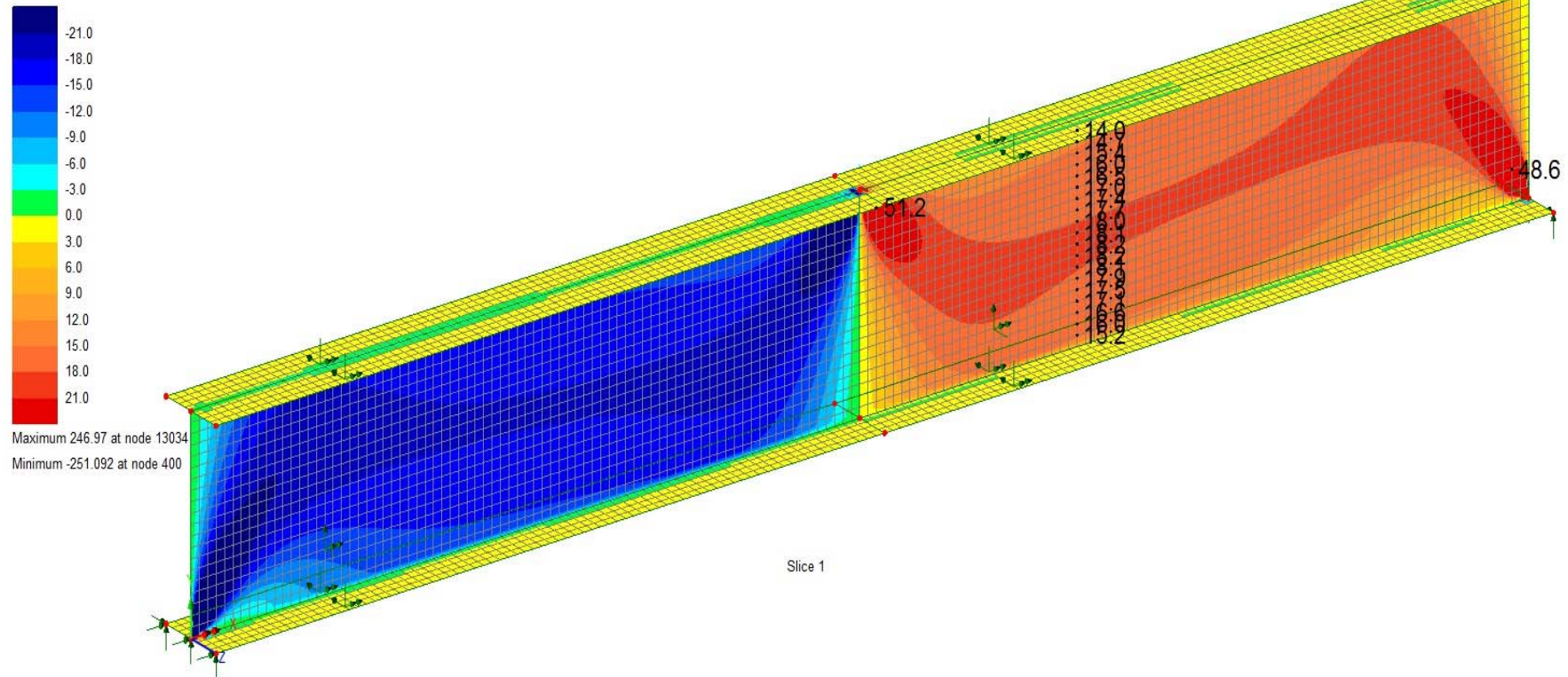
Finite Element Analysis Results

Loadcase: 1:Loadcase 1

Results file: Beam2.mys

Entity: Stress (middle) - Thin Shell

Component: SXY



Finite Element Analysis Results

Results file: Beam2.mys

Component: SXY



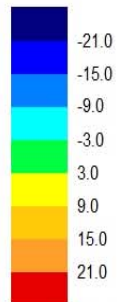
Finite Element Analysis Results

Loadcase: 1:Loadcase 1

Results file: Beam2.mys

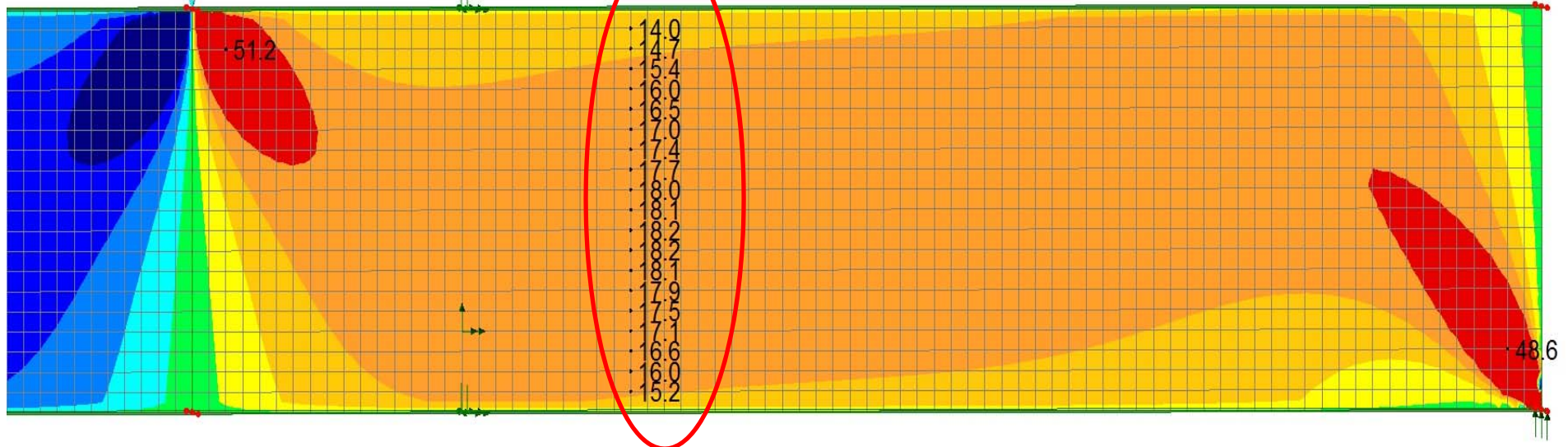
Entity: Stress (middle) - Thin Shell

Component: SXY



Maximum 246.97 at node 13034

Minimum -251.092 at node 400



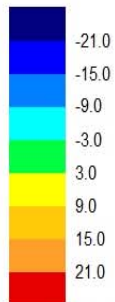
Finite Element Analysis Results

Loadcase: 1:Loadcase 1

Results file: Beam2.mys

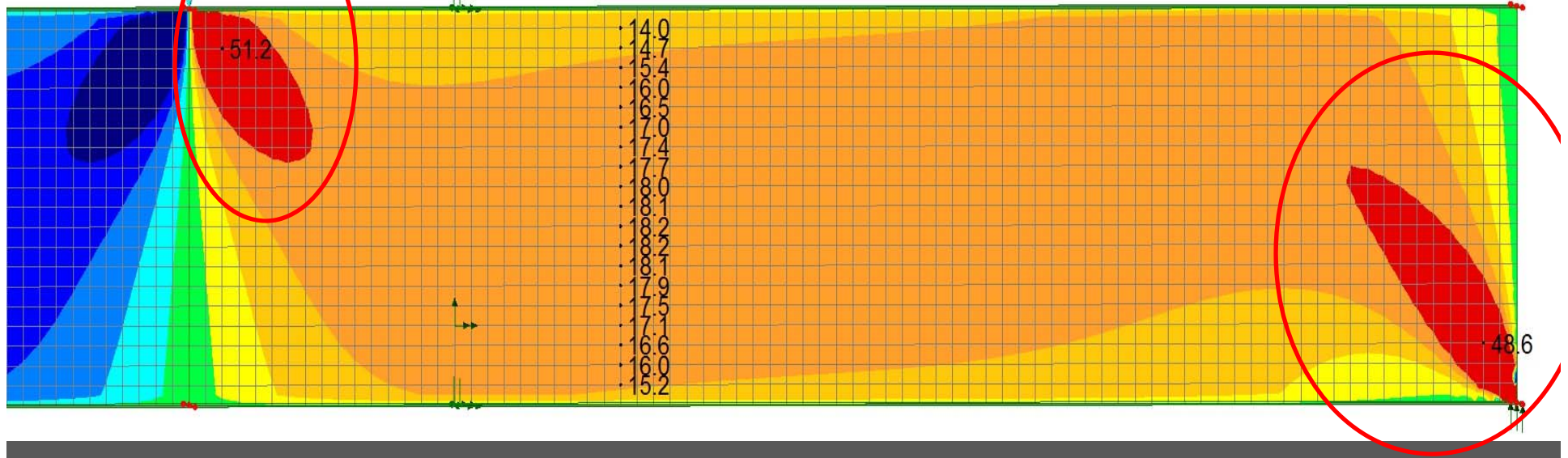
Entity: Stress (middle) - Thin Shell

Component: SXY



Maximum 246.97 at node 10034

Minimum -251.092 at node 400



Questions

