Lucerne Road Bridge Analysis

Ariel Foundation Park Pratt Truss Bridge

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- HTTP://HISTORICBRIDGES.ORG/BRIDGES/BROWSER/?BRIDGEBROWSER=OHIO/ARIELFOUNDATIONPARK_LUCERNE/#PHOTOSVIDEOS

Project Goal

Determine the maximum strength of the bridge to confirm the claim that the bridge can hold 6 tons.

Approach

Using ANSYS, create and analyze a truss system model of the Lucerne road bridge and a beam deflection model of the supporting I-beams to see how they react under different magnitudes of force.

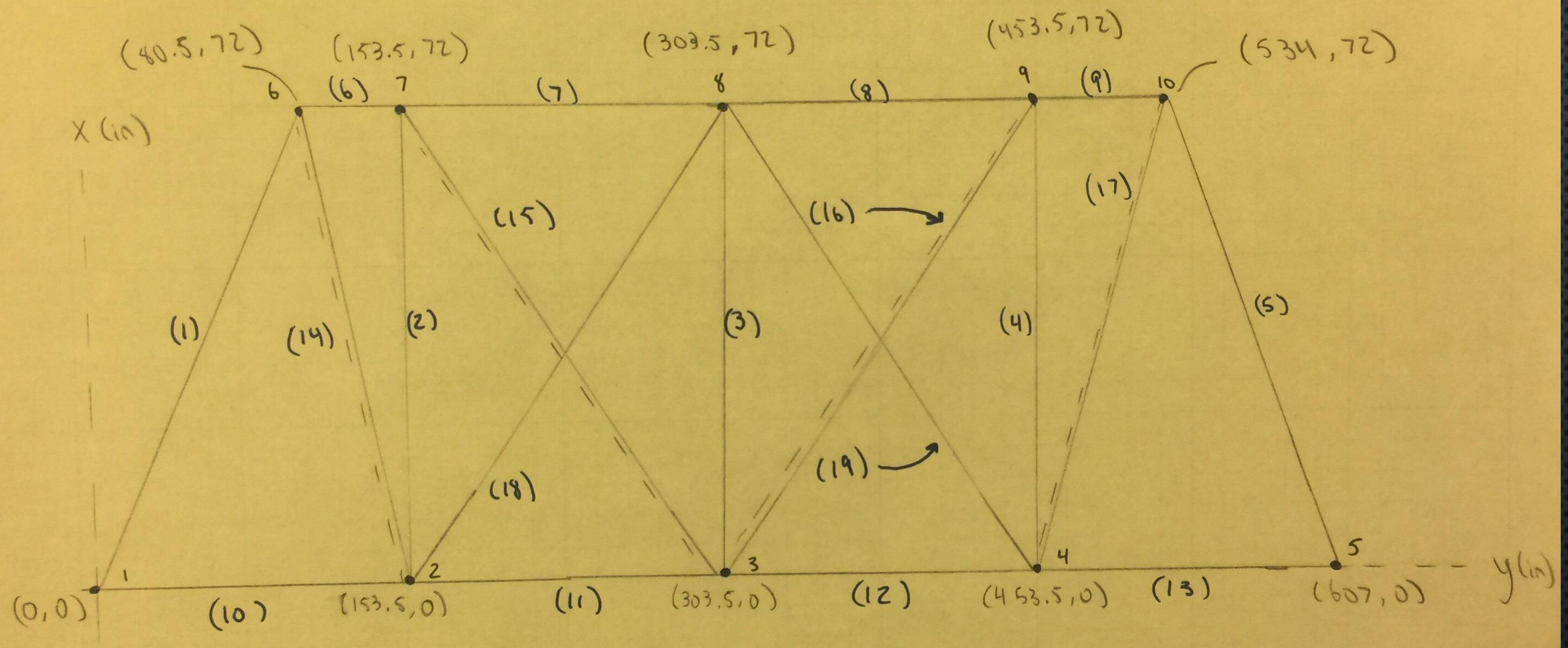
Data Collection

- Went to Lucerne Road Bridge and using a tape measure and Vernier caliper collected the bridge dimensions.
- The bridge is made up of multiple types of beams, such as:
  - I-beams
  - C-beams
  - Rods
  - Rectangular beams
  - Square beams
- We measured each type of beam and its dimensions and cross-sectional areas.

Node numbers

(Element numbers)

= double beamed, so thickness is doubled and considered as one beam



Real Constant 1 (Elements 10, 11, 12, 13)

Real Constant 2 (Elements 1, 5, 6, 7, 8, 9)

Real Constant 3 (Elements 2, 3, 4)

Real constant 4 (14, 17)

Real constant 5 (15, 16)

Real constant 6 (18, 19)

ANSYS

- Material Properties (Structural A-36 Steel)
  - Modulus of Elasticity (E)= 29.0 (10^6) psi
  - Poisson's Ratio= 0.32
  - Link180
- Constraints
  - At node 1& 5: All directions

Load Distribution

Scenario 1

- Forces applied at nodes 2, 3, and 4.

Scenario 2

Forces applied at nodes 1, 2, and 3.

Load Distribution

-In most extreme case, force would be acting at 3 nodes. (A distance around 25 ft.)

Bridge Truss

- Only analyzing one side of the bridge so the 6 tons is divided by two

Force applied per node:

F=2000 lbs.

Bridge I-beam

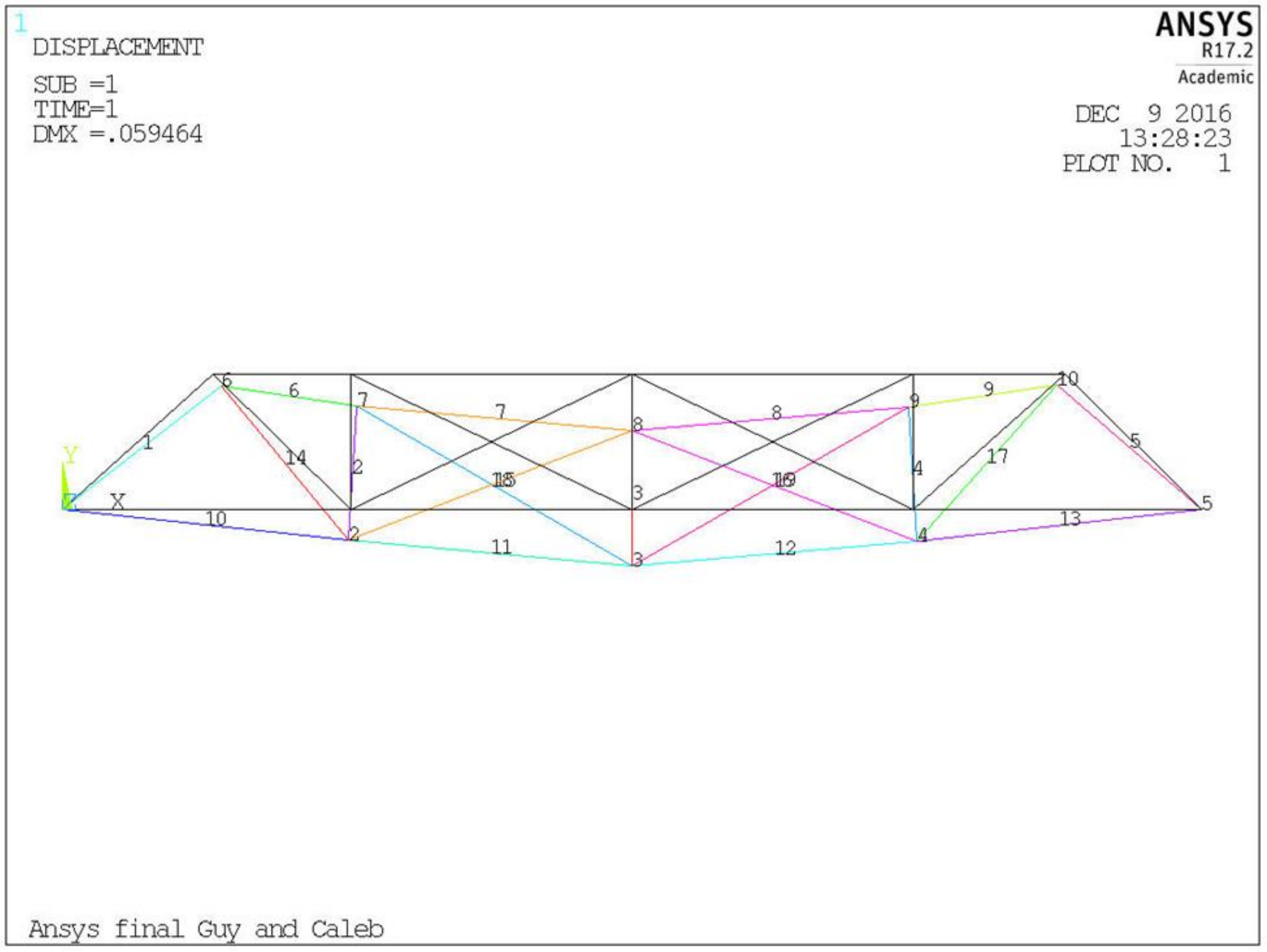
- There are seven I-beams under the bridge supporting it so the 6 tons is divided by seven.

Force applied per node:

F=571.43 lbs.



ANALYSIS AND OUTPUT DATA – TRUSS MODEL

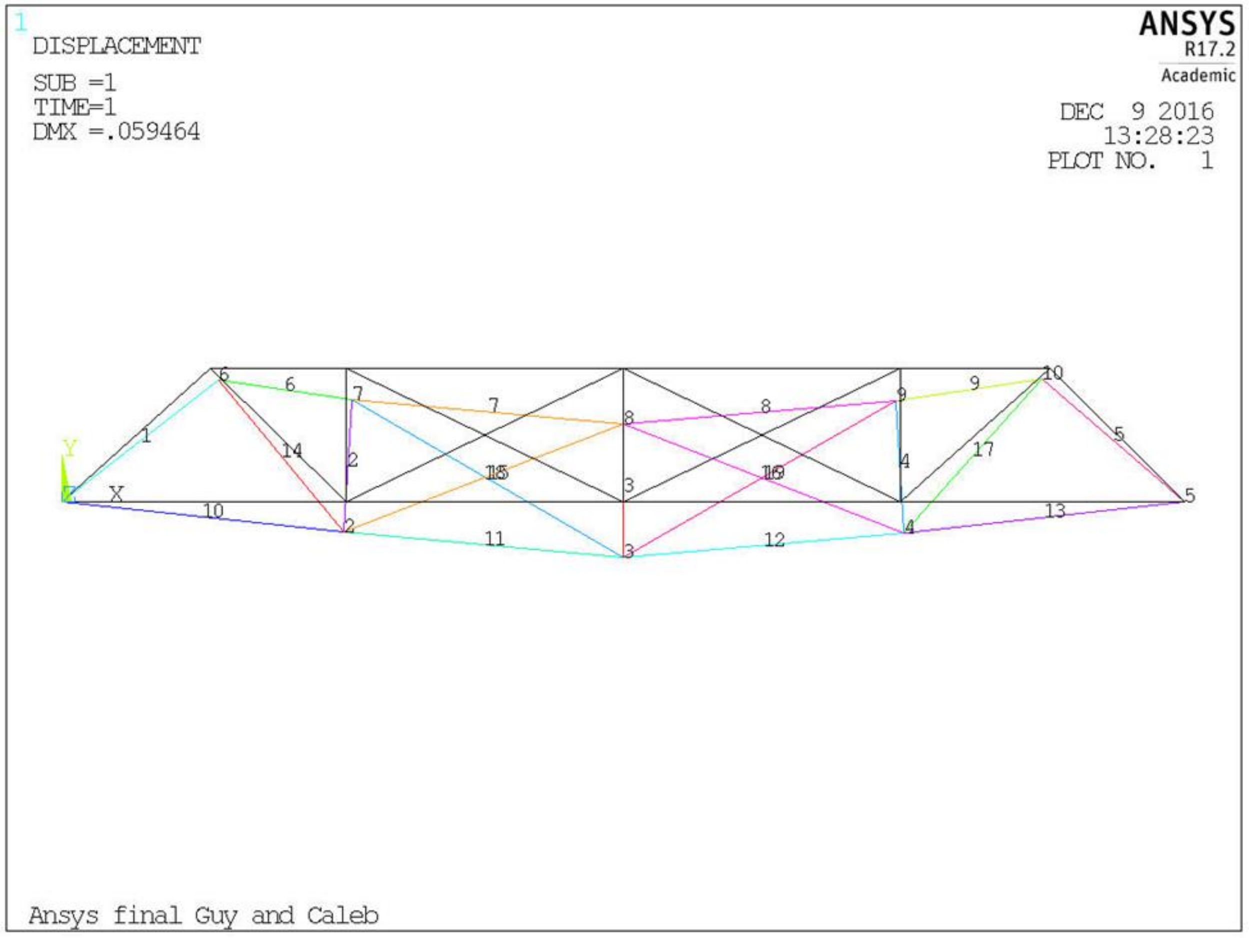


Scenario 1

NODE	UX	UY
1	0.0000	0.0000
2	- 0.23916E-02	-0.32874E-01
3	0.21650E-03	-0.59463E-01
4	0.28246E-02	-0.33514E-01
5	0.0000	0.0000
6	0.84382E-02	-0.13005E-01
7	0.61513E-02	-0.33390E-01
8	0.37011E-03	-0.59035E-01
9	-0.54111E-02	-0.34030E-01
10	-0.79330E-02	-0.11099E-01

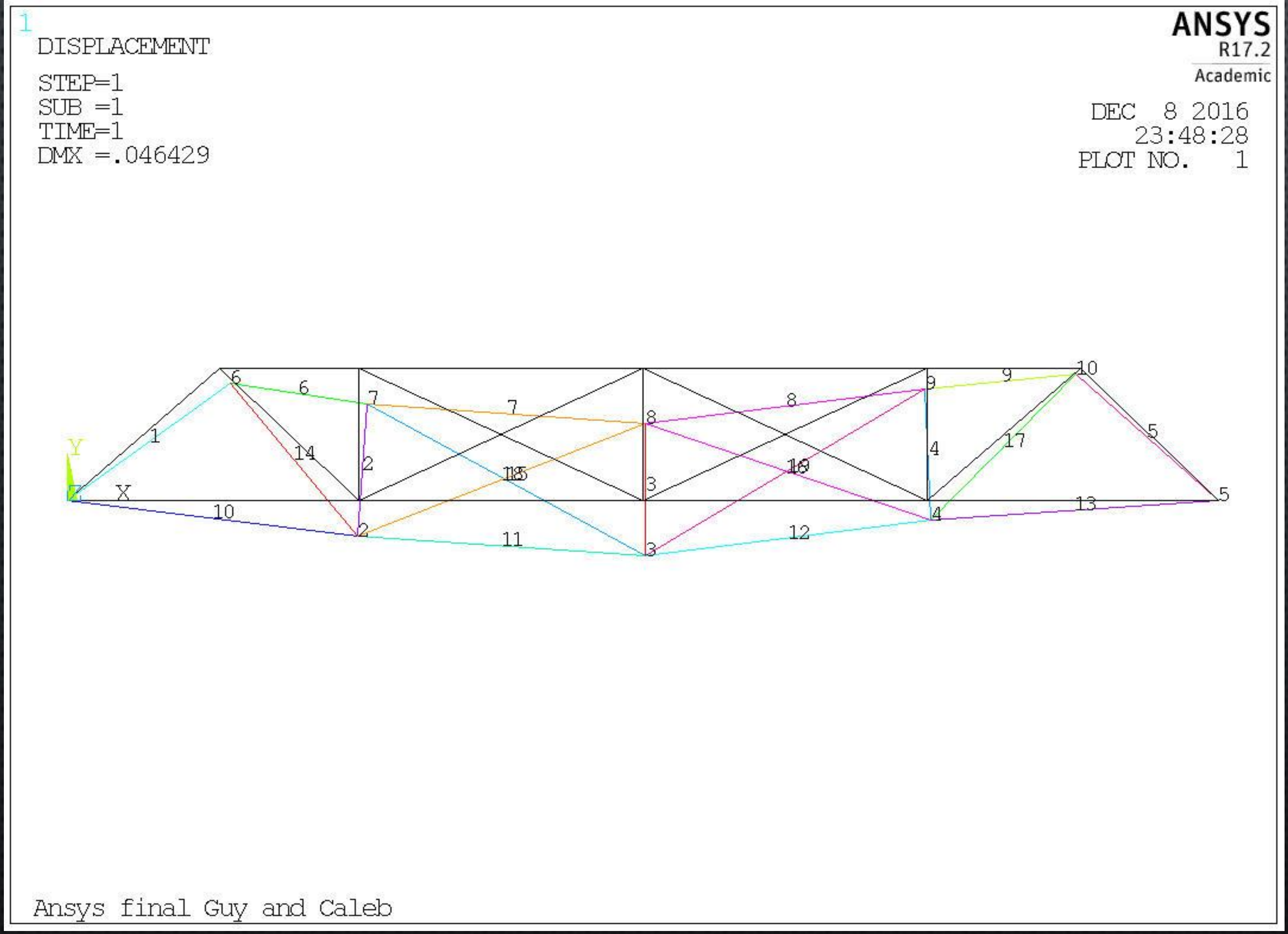
ANALYSIS AND OUTPUT DATA – TRUSS MODEL

Scenerio 1



Element	Stress	Element	Stress
1	-639.21	10	-451.84
2	-207.92	11	504.24
3	172.39	12	504.24
4	-207.92	13	-533.65
5	-606.85	14	1765.4
6	-908.50	15	1034.0
7	-1117.7	16	1034.0
8	-1117.7	**17**	**1859.5**
9	-908.50	**18**	**-1539.2**
		19	**-1539.2**

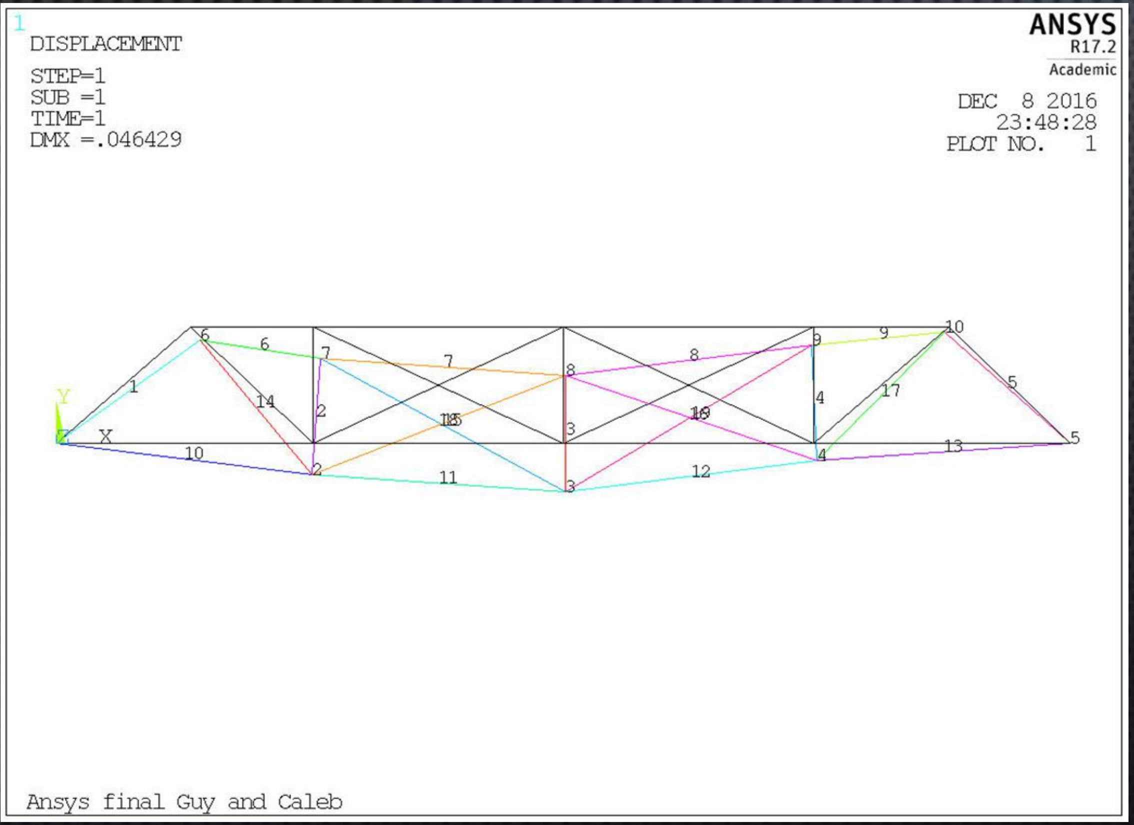
ANALYSIS AND OUTPUT DATA – TRUSS MODEL



Scenario 2

NODE	UX	UY
1	0.0000	0.0000
2	-0.961E-03	-0.295E-01
3	0.1925E-02	-0.463E-01
4	0.270E-02	-0.164E-01
5	0.0000	0.0000
6	0.852E-02	-0.125E-01
7	0.662E-02	-0.297E-01
8	0.218E-02	-0.459E-01
9	-0.185E-02	-0.172E-01
10	-0.312E-02	-0.469E-02

ANALYSIS AND OUTPUT DATA – TRUSS MODEL

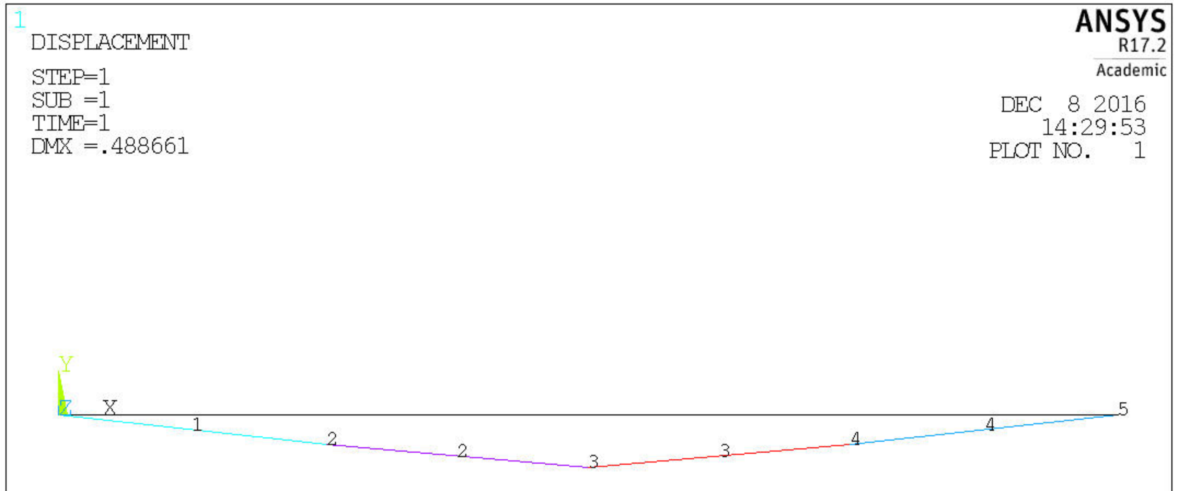


Scenario 2

Element	Stress	Element	Stress
1	-531.45	10	-181.59
2	-103.45	11	558.13
3	162.09	12	151.6
4	-322.69	13	-511.96
5	-304.59	14	1457.8
6	-755.34	15	514.46
7	-859.43	**16**	**1604.7**
8	-780.67	17	933.34
9	-456	18	-748.36
		19	**-2146**

ANALYSIS AND OUTPUT DATA – I BEAM MODEL

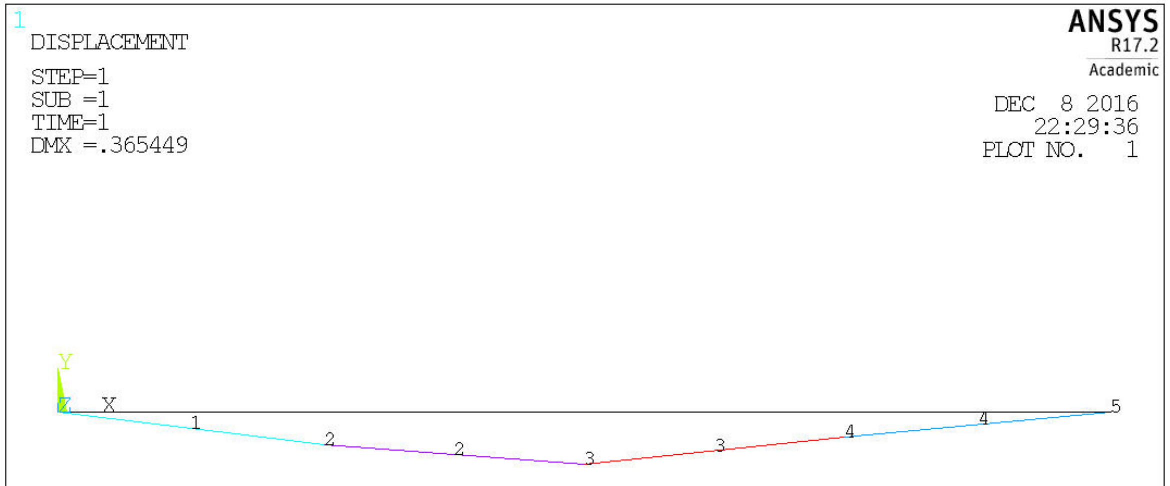
Deflection and Displacement scenario 1



Displacement Vectors

NODE	UX	UY
1	0.0000	0.0000
2	0.0000	-0.27909
3	0.0000	-0.48866
4	0.0000	-0.27909
5	0.0000	0.0000

Deflection and Displacement Scenario 2



Displacement Vectors

NODE	UX	UY
1	0.0000	0.0000
2	0.0000	-0.22802
3	0.0000	-0.36545
4	0.0000	-0.17428
5	0.0000	0.0000

Analysis and Output Data – I Beam Model

- Stress on Scenario 1

Element	бmax/min (Psi)
1	± 5586
2	± 3362.1
3	± 3362.1
4	± 5586

- Stress on scenario 2

Element	бmax/min
1	± 4735.2
2	± 2793.1
3	± 2793.1
4	± 3074.9

Results and Interpretation

- Structural A-36 Steel
  - Yield Strength: 36,000 psi
  - Ultimate Strength: 58,000 psi

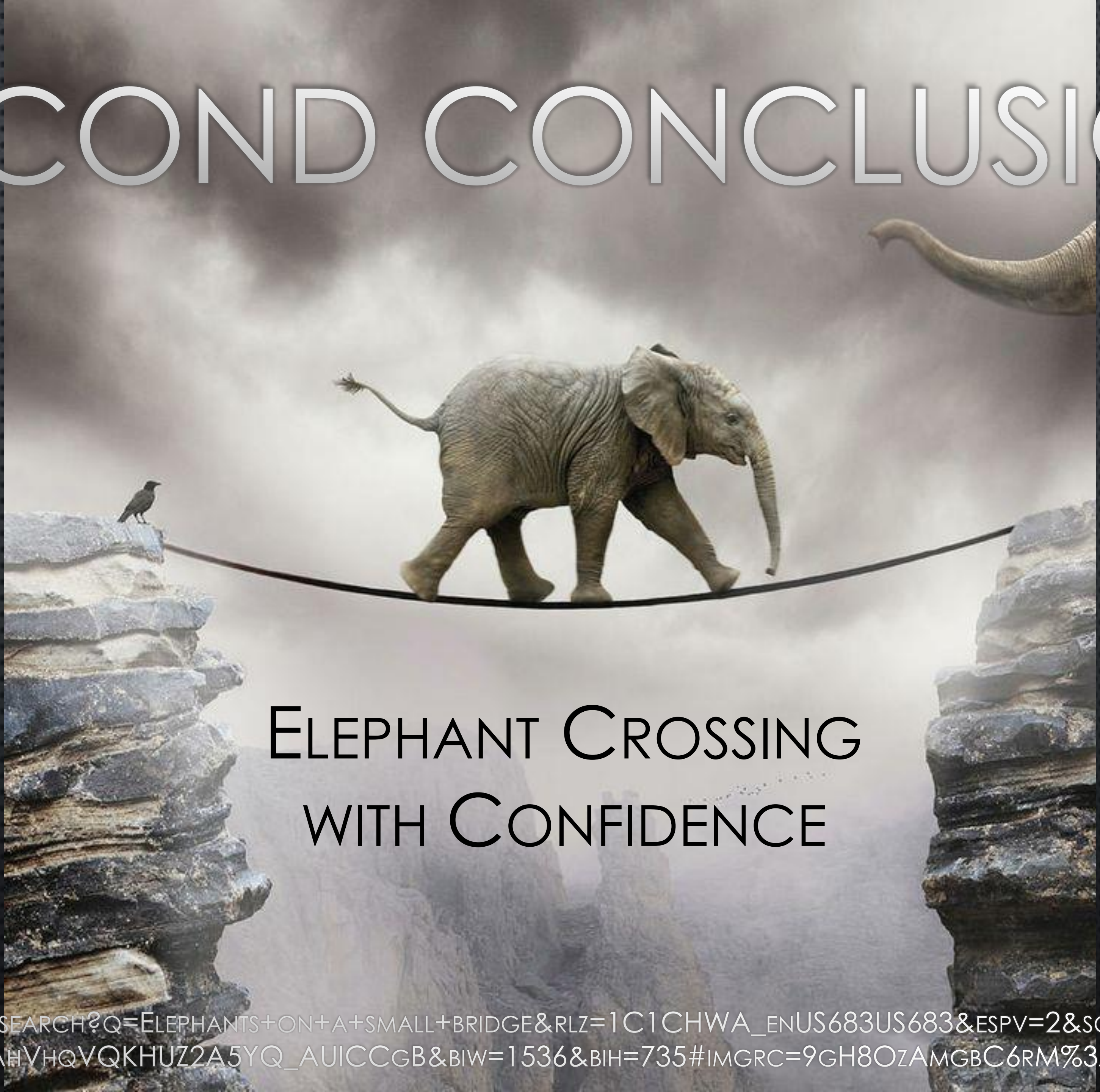
- Safety Factor for Structural steelwork in bridges
  - 5-7
- Max Stress in Truss
  - 2146 psi in compression
  - 1859.5 psi in tension
- Max Stress in I-beam
  - 5586 psi

*Stress is between 1/6 and 1/7 of the yield strength

Conclusion

- Our goal was to determine the maximum strength of the bridge to confirm the claim that the bridge can hold 6 tons. We have successfully done so using ANSYS to analyze the elements that make up the bridge. We can confidently state that the Lucerne Road Bridge can hold 6 tons.

SECOND CONCLUSION



Elephant Crossing with Confidence

- https://www.google.com/search?q=Elephants+on+a+small+bridge&rlz=1C1CHWA_enUS683US683&espv=2&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjBucmw4OfQAhVhqVQKHUZ2A5YQ_AUICCgB&biw=1536&bih=735#imgrc=9gH8OzAmgbC6rM%3A