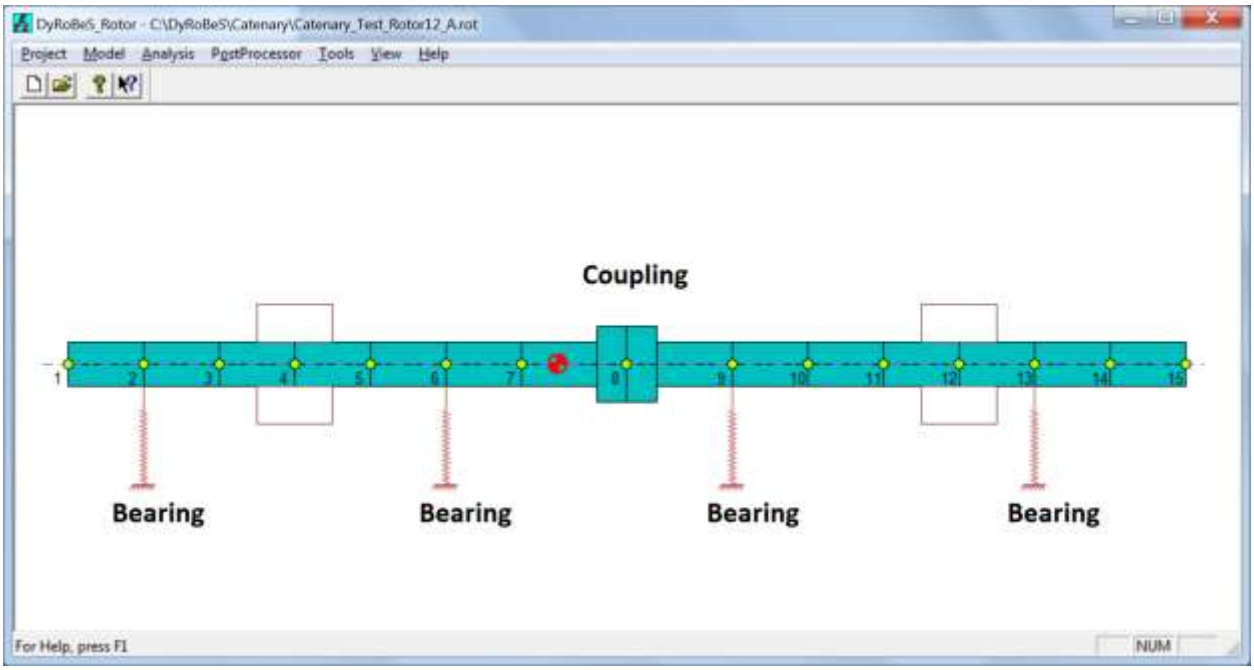
Catenary Analysis

The objective is to raise the bearing elevations (misalignments) such that the moment and force at couplings are minimized due to rotor weight at static condition.

1. Why called it Catenary curve ?
2. Does it have to be like catenary ?
3. Are there any other requirements beside the moment and force cross the couplings ?

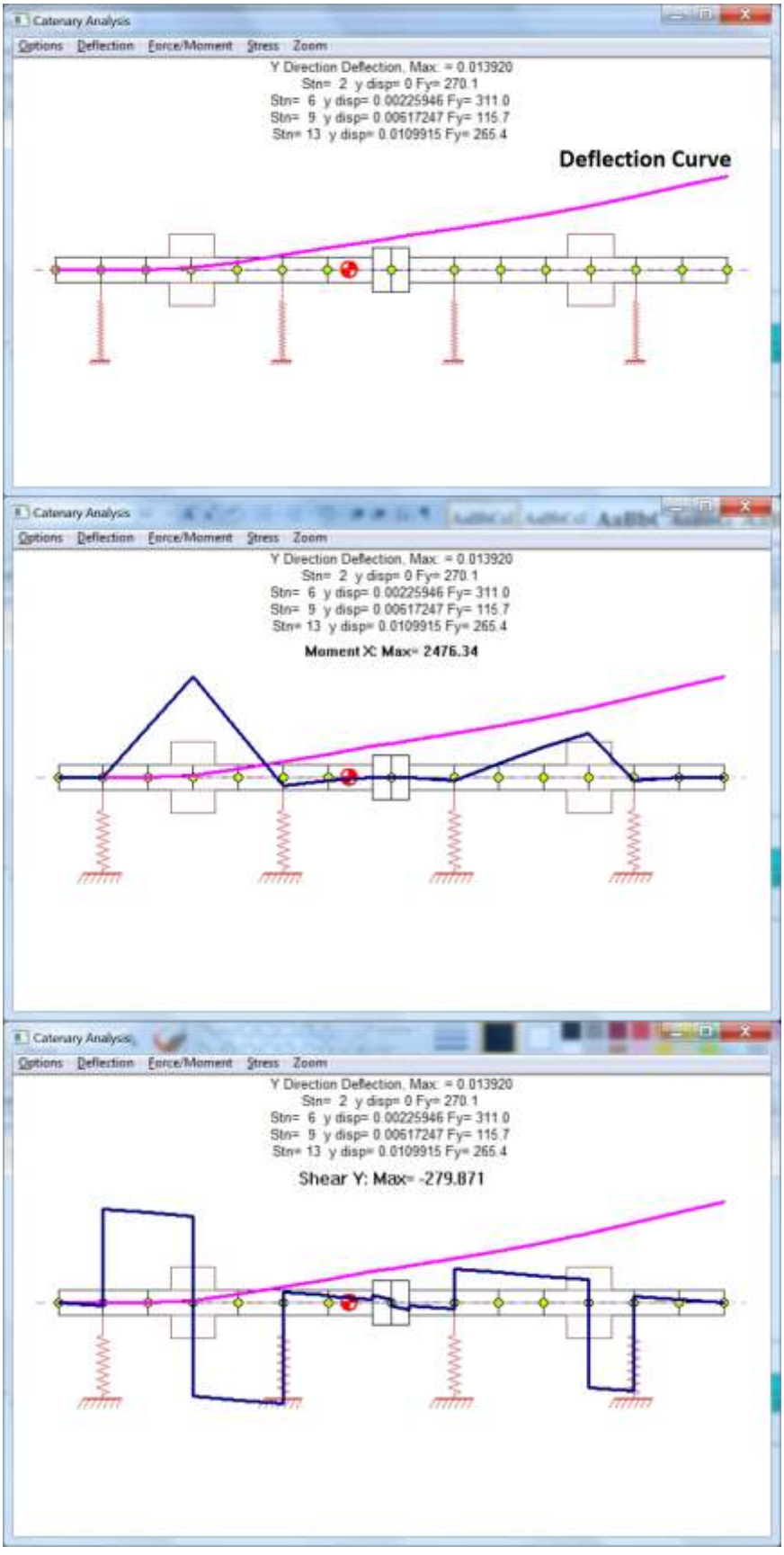
Problem 1



Two rotors connected at station 8 coupling.
Bearings at stations 2, 6, 9, and 13 stations.

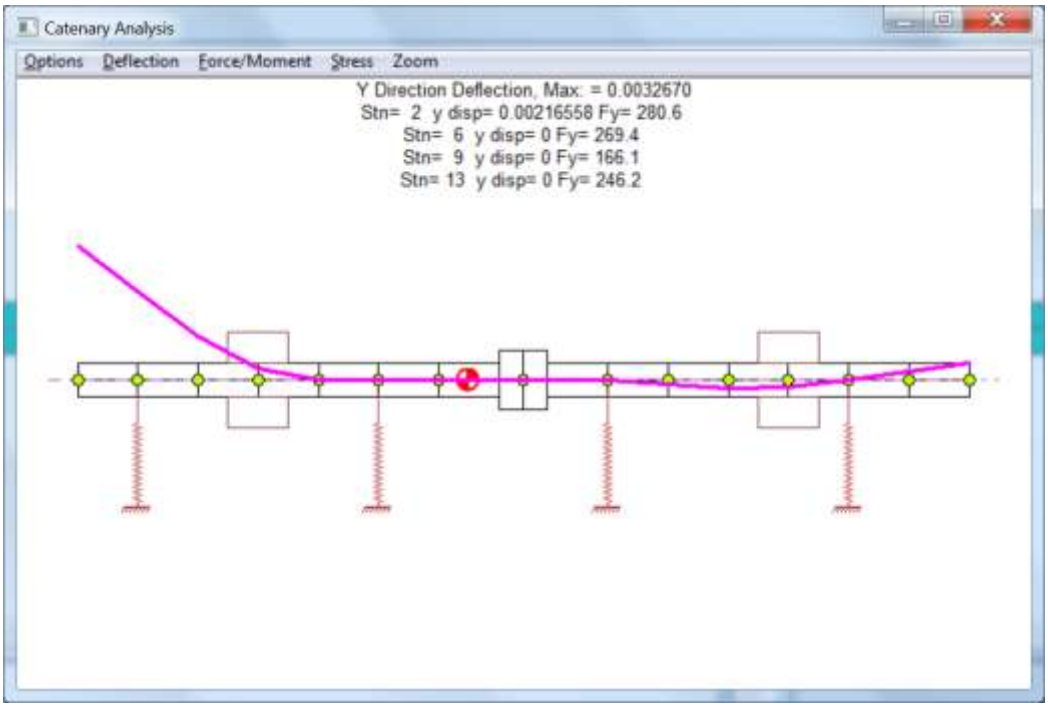
Goal 1: To minimize the moment and force at coupling

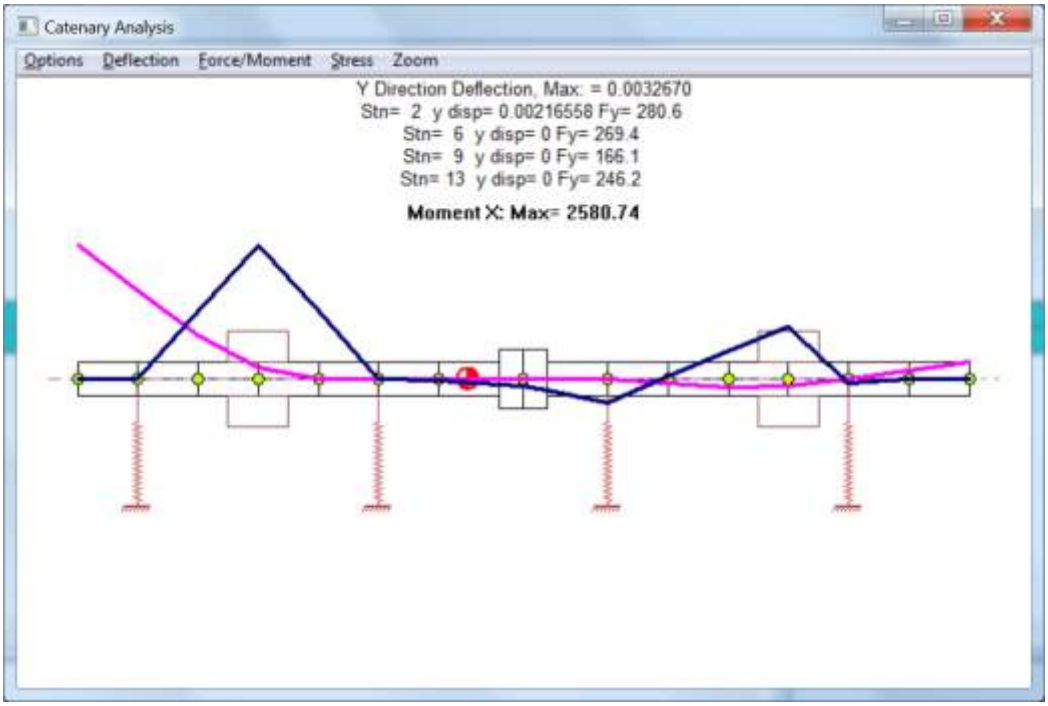
The converged bearing elevations and deflection curve as shown below. Although the curve does not look like catenary, but the moment and shear force at coupling station (station 8) are ZERO. THREE bearing locations must be raised and the maximum elevation at station 13 is 0.01 inches.

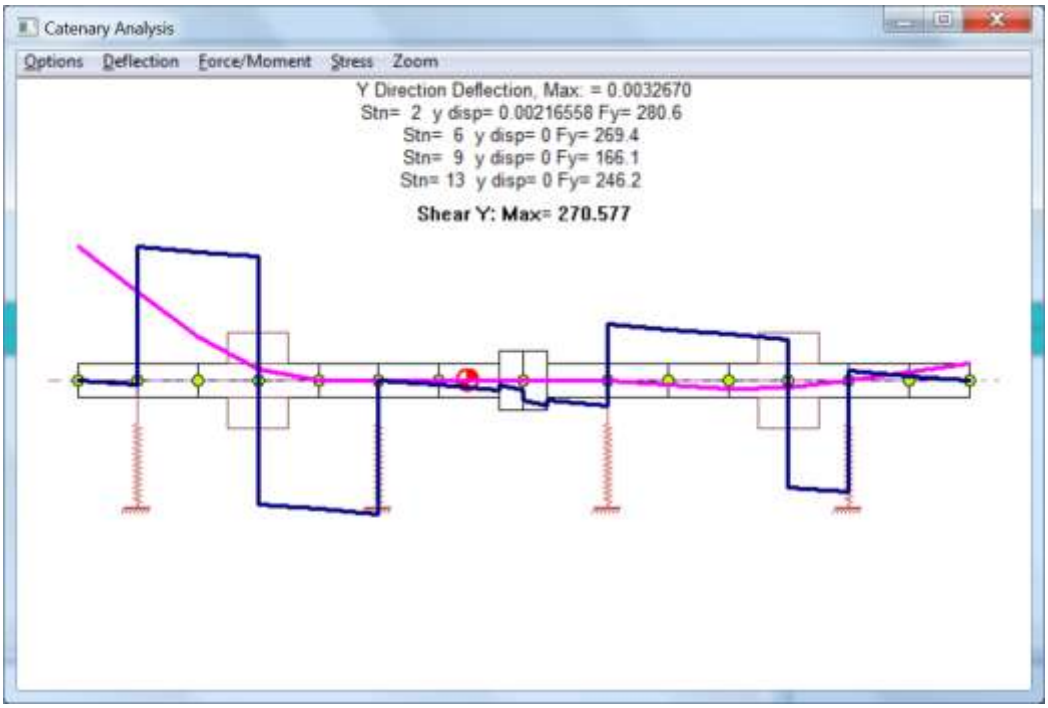

Catenary Analysis
Options Deflection Force/Moment Stress Zoom
Y Direction Deflection, Max. = 0.013920
Stn= 2 y disp= 0 Fy= 270.1
Stn= 6 y disp= 0.00225946 Fy= 311.0
Stn= 9 y disp= 0.00617247 Fy= 115.7
Stn= 13 y disp= 0.0109915 Fy= 265.4
Deflection Curve
Catenary Analysis
Options Deflection Force/Moment Stress Zoom
Y Direction Deflection, Max. = 0.013920
Stn= 2 y disp= 0 Fy= 270.1
Stn= 6 y disp= 0.00225946 Fy= 311.0
Stn= 9 y disp= 0.00617247 Fy= 115.7
Stn= 13 y disp= 0.0109915 Fy= 265.4
Moment X: Max= 2476.34
Catenary Analysis
Options Deflection Force/Moment Stress Zoom
Y Direction Deflection, Max. = 0.013920
Stn= 2 y disp= 0 Fy= 270.1
Stn= 6 y disp= 0.00225946 Fy= 311.0
Stn= 9 y disp= 0.00617247 Fy= 115.7
Stn= 13 y disp= 0.0109915 Fy= 265.4
Shear Y: Max= -279.871

Goal 2: Minimize the slope at coupling stations

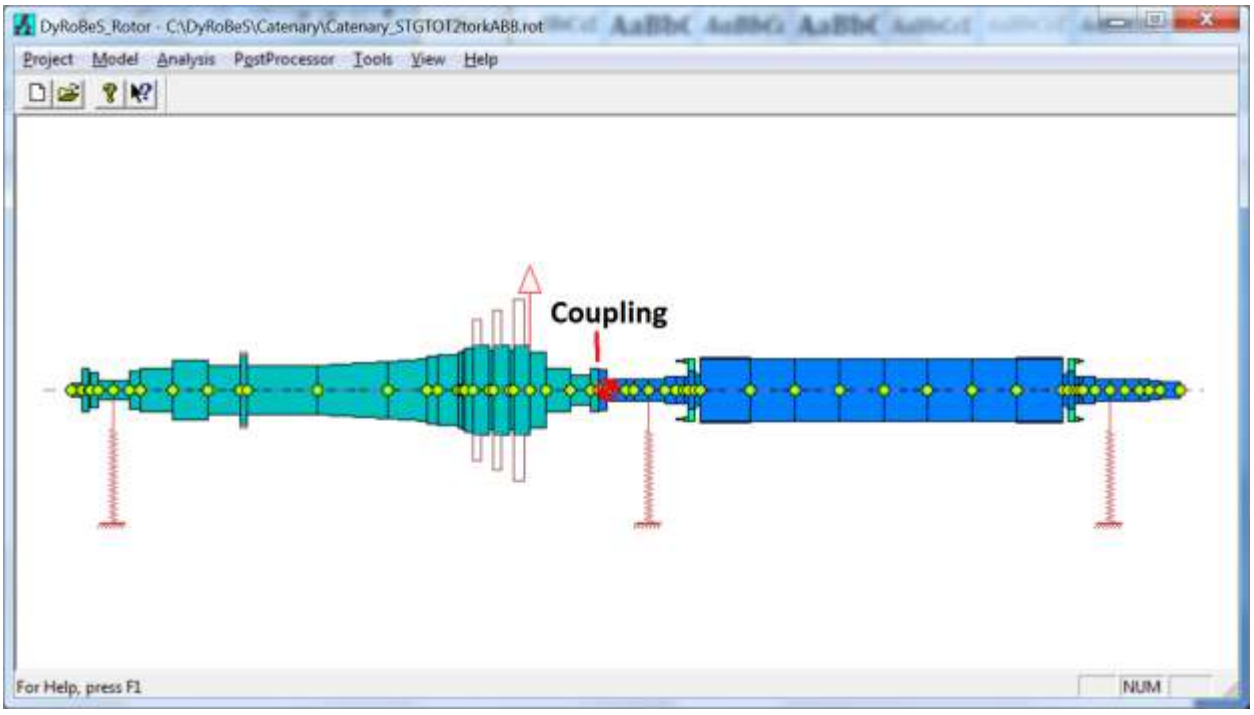
Now, change the design goal. The goal now is to minimize the slope at coupling station. The converged data is shown below. It does not look like catenary curve either. Now, only the first bearing station must be raised to 0.002 inches and the rest of 3 bearings remain unchanged. The slope at coupling station is ZERO, however, there are small moment and force transmitted through coupling.







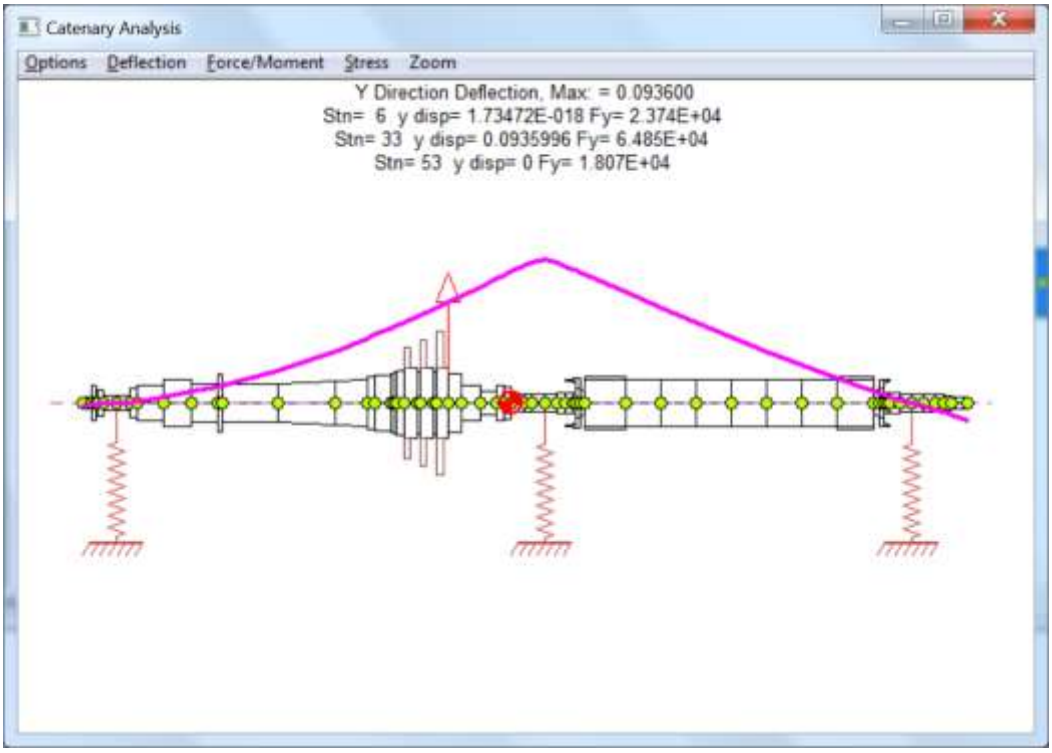
Problem 2

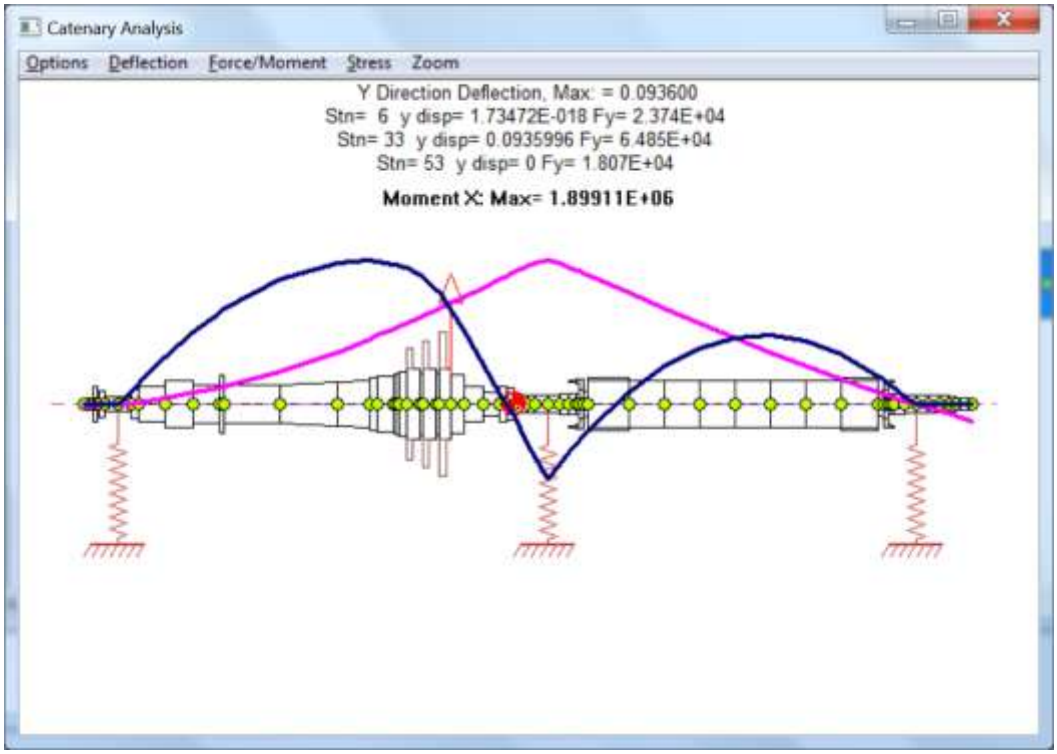


Bearing stations: 6, 33, and 53
Coupling station 29

Goal 1: To minimize the moment and force at coupling.

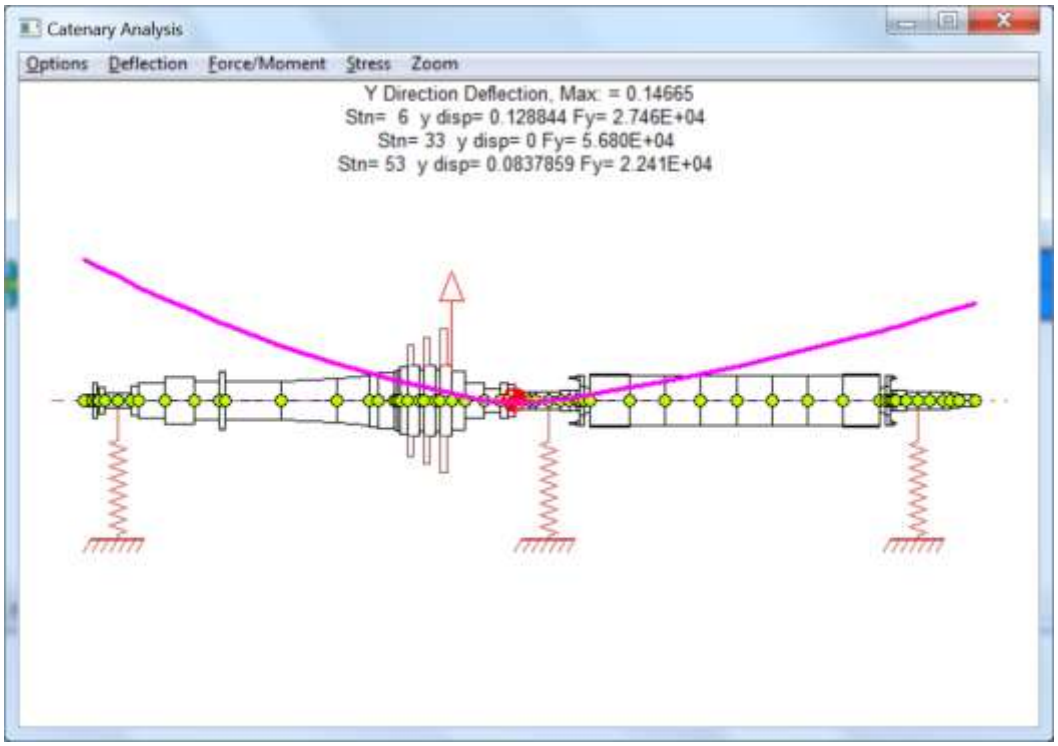
The converged curve as shown below. It looks even stranger than catenary. However, it does produce ZERO moment cross the coupling.

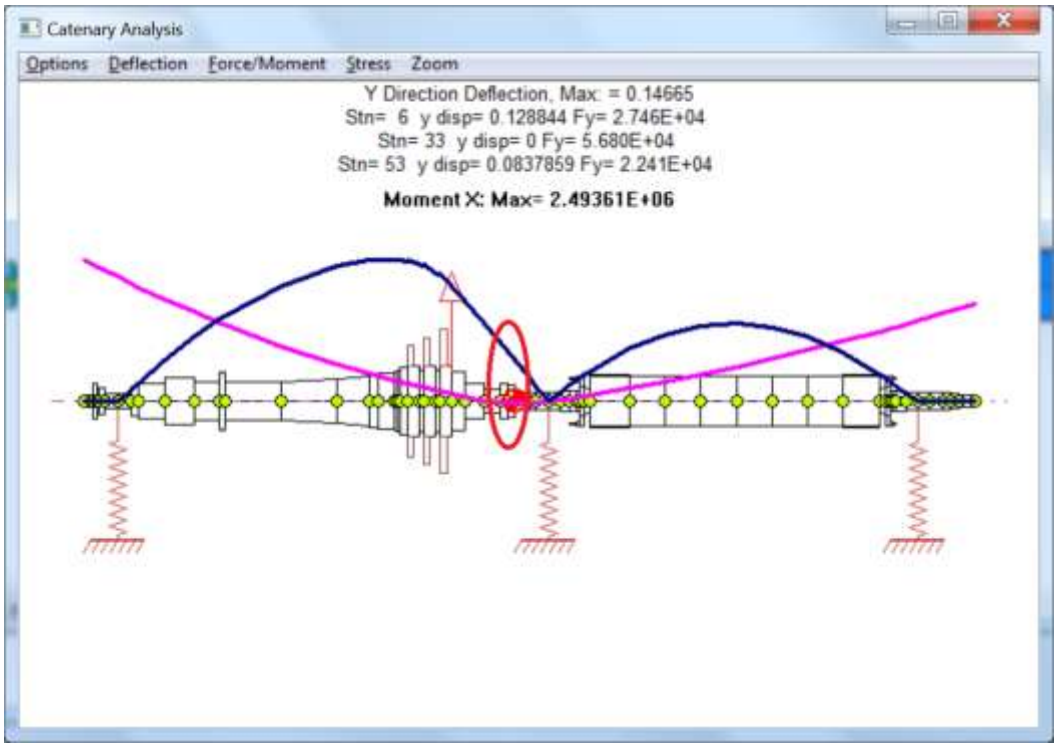




Goal 2: To minimize the moment and force at 2nd bearing station

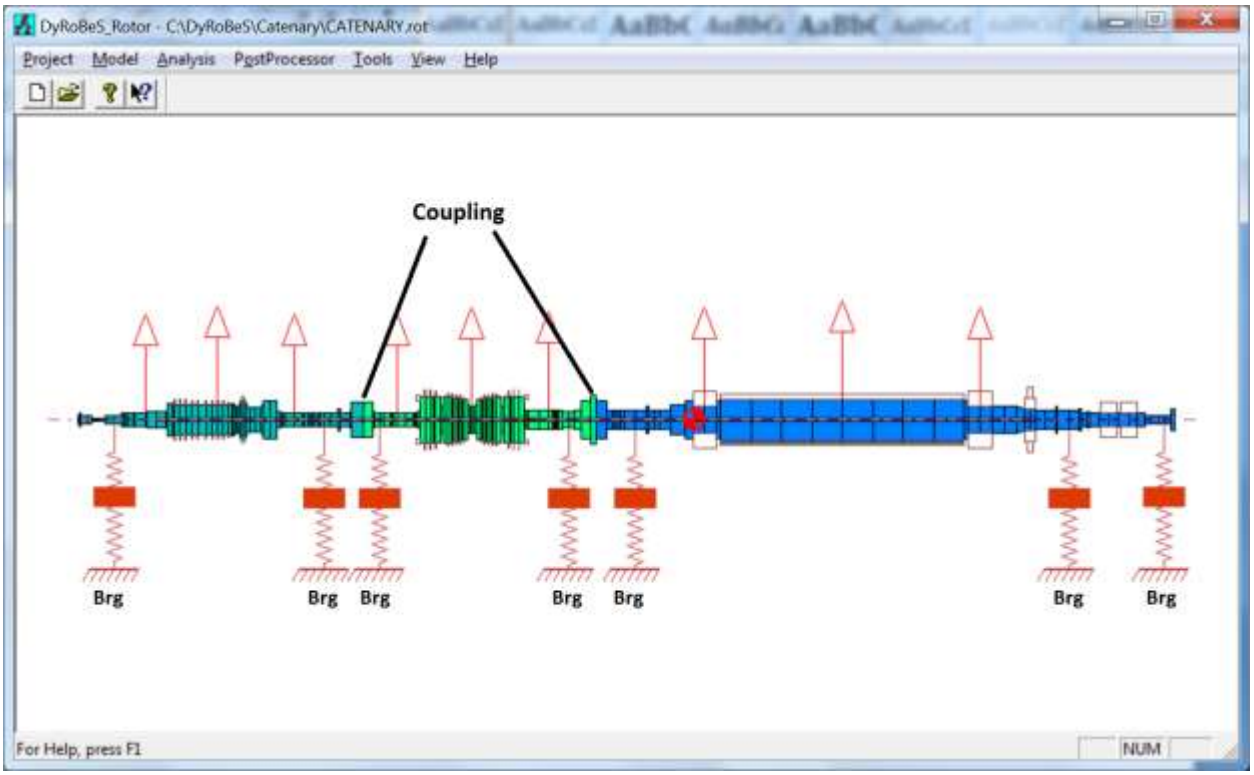
Now, the converged curve more looks like catenary as show below, but, the moment cross the coupling is NOT zero.





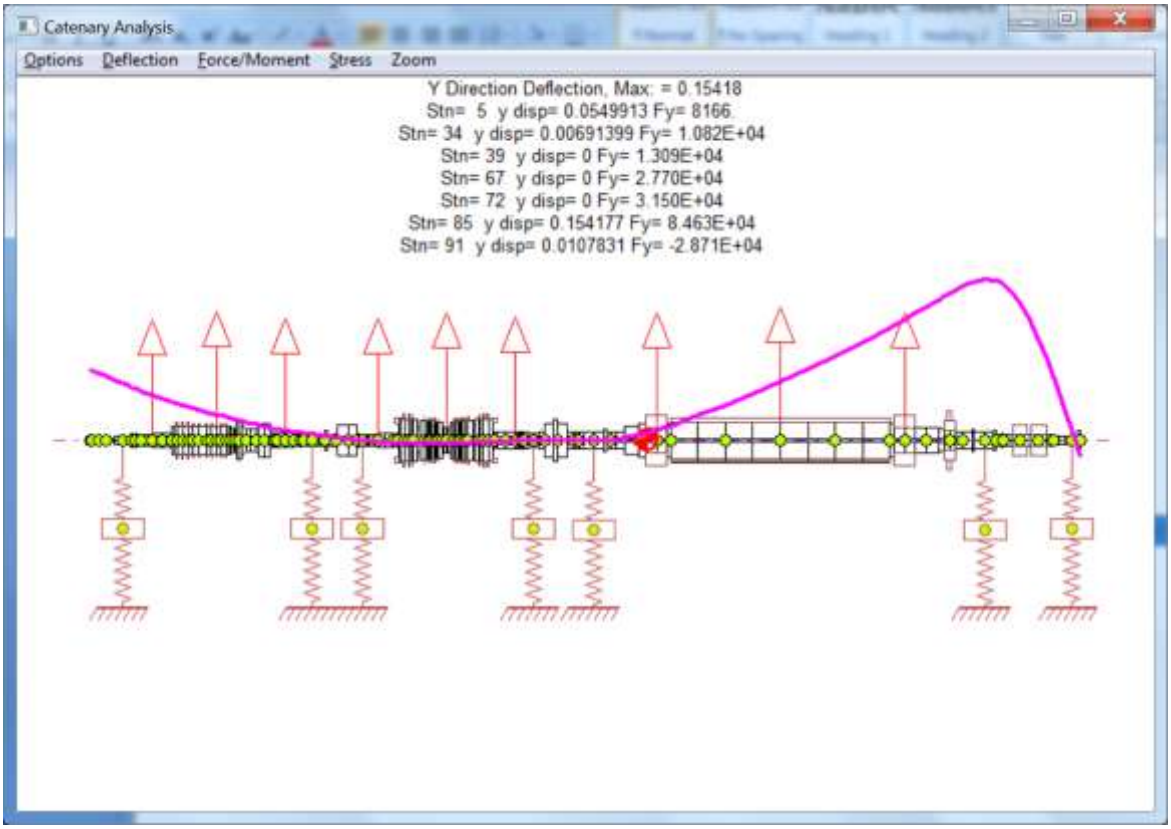
Now, I am puzzled, what is the purpose of catenary curve ? Minimize the moment and force cross the coupling ?

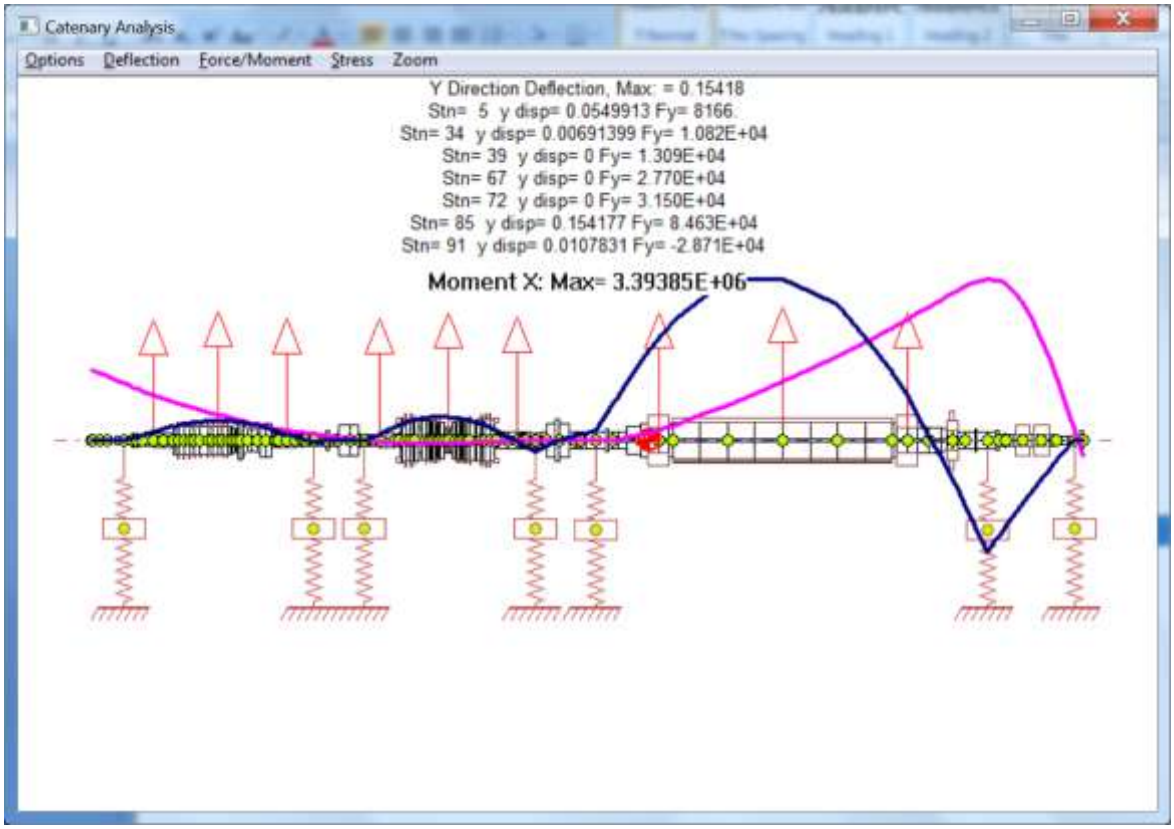
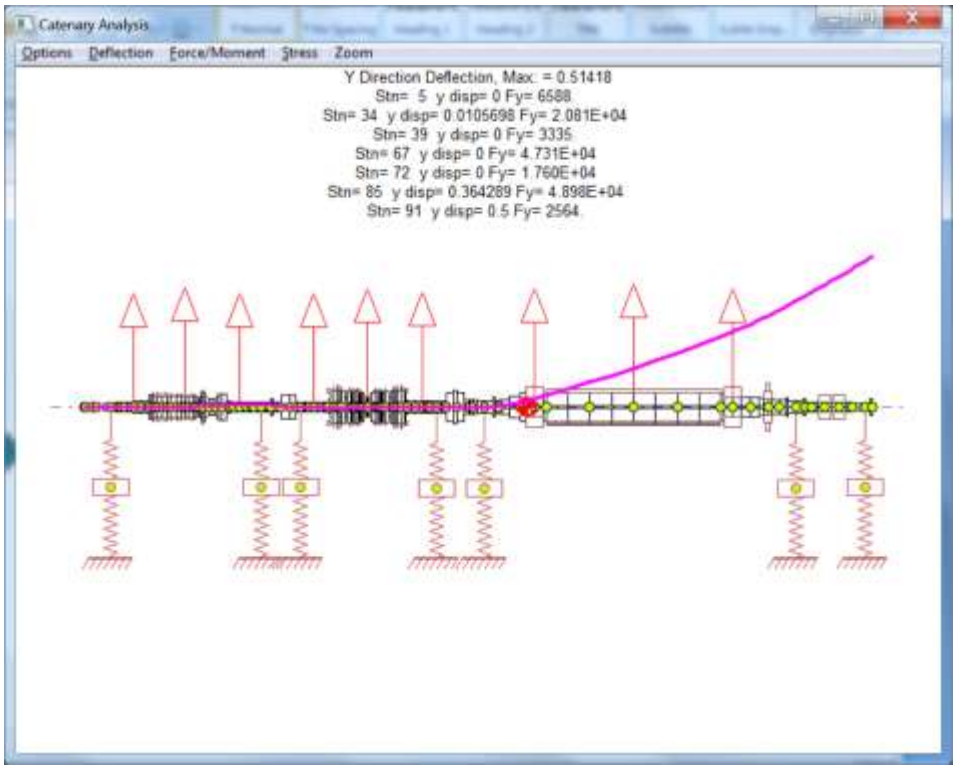
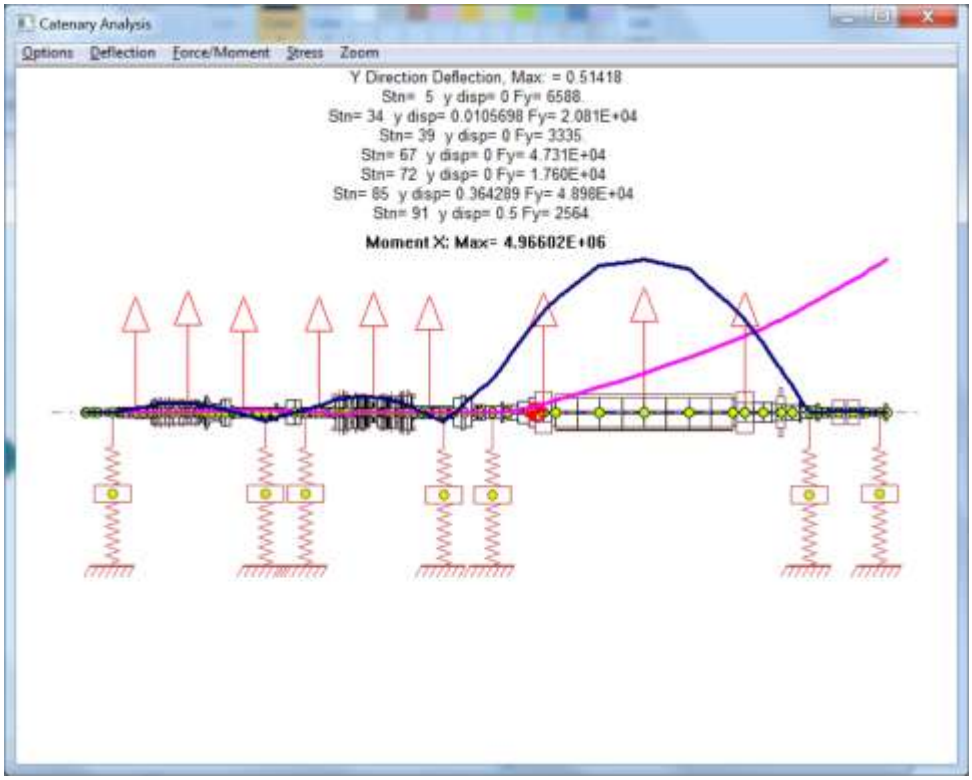
Problem 3



Goal 1: To minimize the moment and force at couplings (stations 37, 69)

The results are shown below. It is a curve which will produce the minimize moment and force cross 2 couplings. But large moment at beating 6.


Catenary Analysis
Options Deflection Force/Moment Stress Zoom
Y Direction Deflection, Max: = 0.15418
Stn= 5 y disp= 0.0549913 Fy= 8166.
Stn= 34 y disp= 0.00691399 Fy= 1.082E+04
Stn= 39 y disp= 0 Fy= 1.309E+04
Stn= 67 y disp= 0 Fy= 2.770E+04
Stn= 72 y disp= 0 Fy= 3.150E+04
Stn= 85 y disp= 0.154177 Fy= 8.463E+04
Stn= 91 y disp= 0.0107831 Fy= -2.871E+04


Catenary Analysis
Options Deflection Force/Moment Stress Zoom
Y Direction Deflection, Max: = 0.15418
Stn= 5 y disp= 0.0549913 Fy= 8166.
Stn= 34 y disp= 0.00691399 Fy= 1.082E+04
Stn= 39 y disp= 0 Fy= 1.309E+04
Stn= 67 y disp= 0 Fy= 2.770E+04
Stn= 72 y disp= 0 Fy= 3.150E+04
Stn= 85 y disp= 0.154177 Fy= 8.463E+04
Stn= 91 y disp= 0.0107831 Fy= -2.871E+04
Moment X: Max= 3.39385E+06

Goal 1: To minimize the moment and force at couplings (stations 37, 69) and bearing #6 location