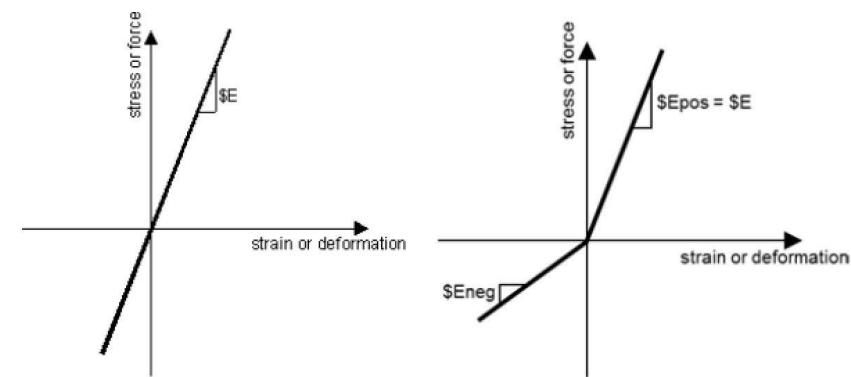
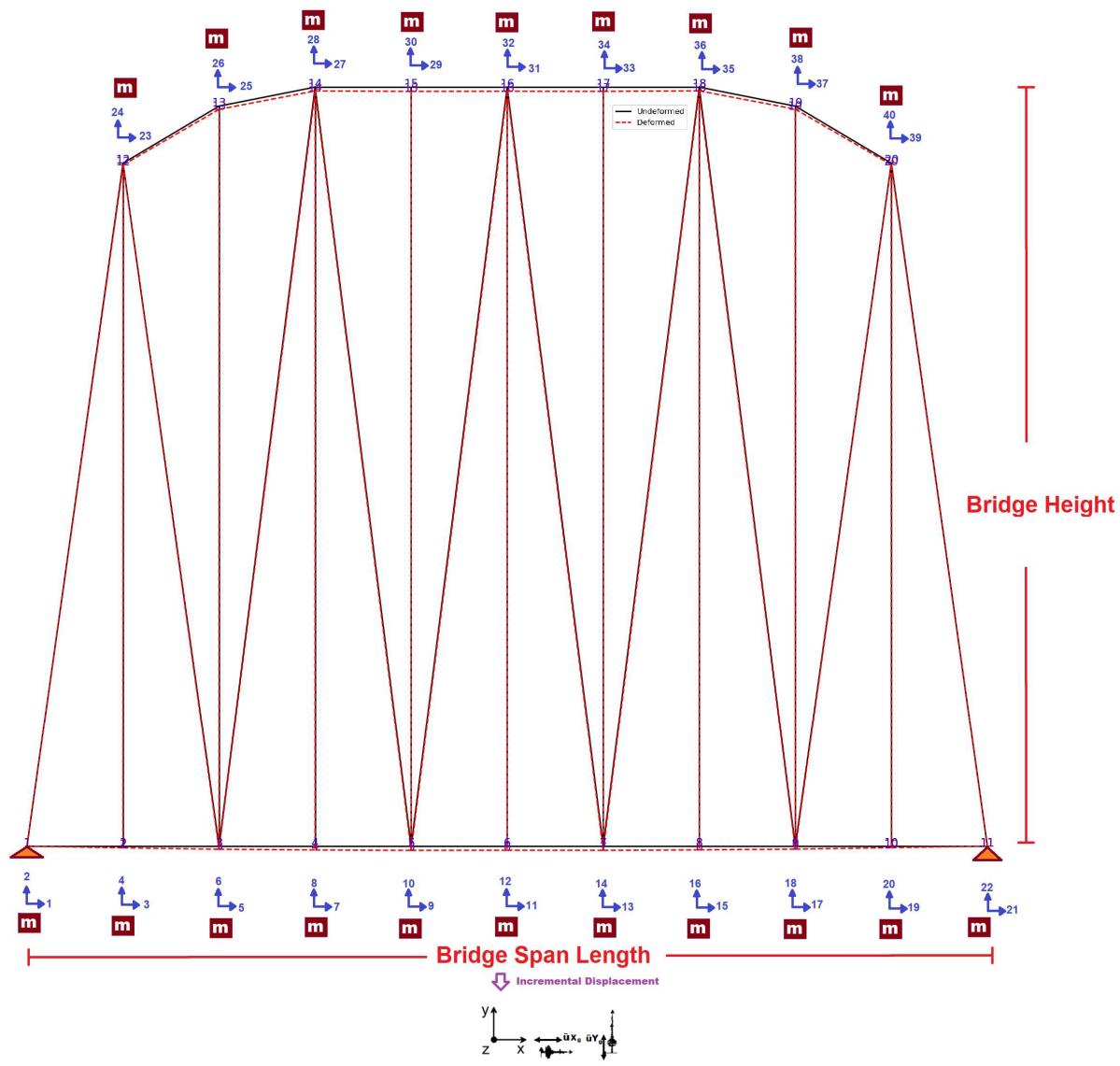


>> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<

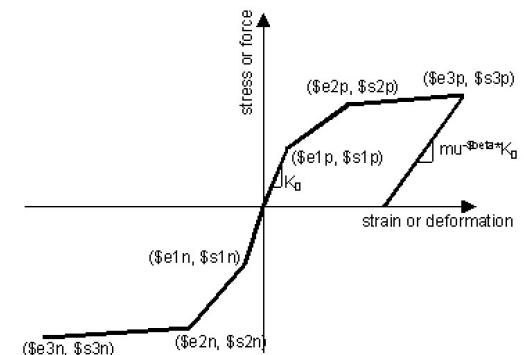
# **COMPREHENSIVE NONLINEAR SEISMIC ASSESSMENT OF STEEL TRUSS BRIDGES: AN OPENSEES FRAMEWORK FOR STATIC PUSHOVER, CYCLIC DEGRADATION, STATIC TIME-HISTORY AND DYNAMIC TIME-HISTORY ANALYSIS**

THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)





TRUSS ELEMENT ELASTIC MATERIAL



TRUSS ELEMENT INELASTIC MATERIAL

Spyder (Python 3.12)

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C:\Users\Del\Desktop\OPENSEES\_FILES\+BRIDGE\_WARREN\_TRUSS\BRIDGE\_WARREN\_TRUSS.py

BRIDGE\_WARREN\_TRUSS.py

```

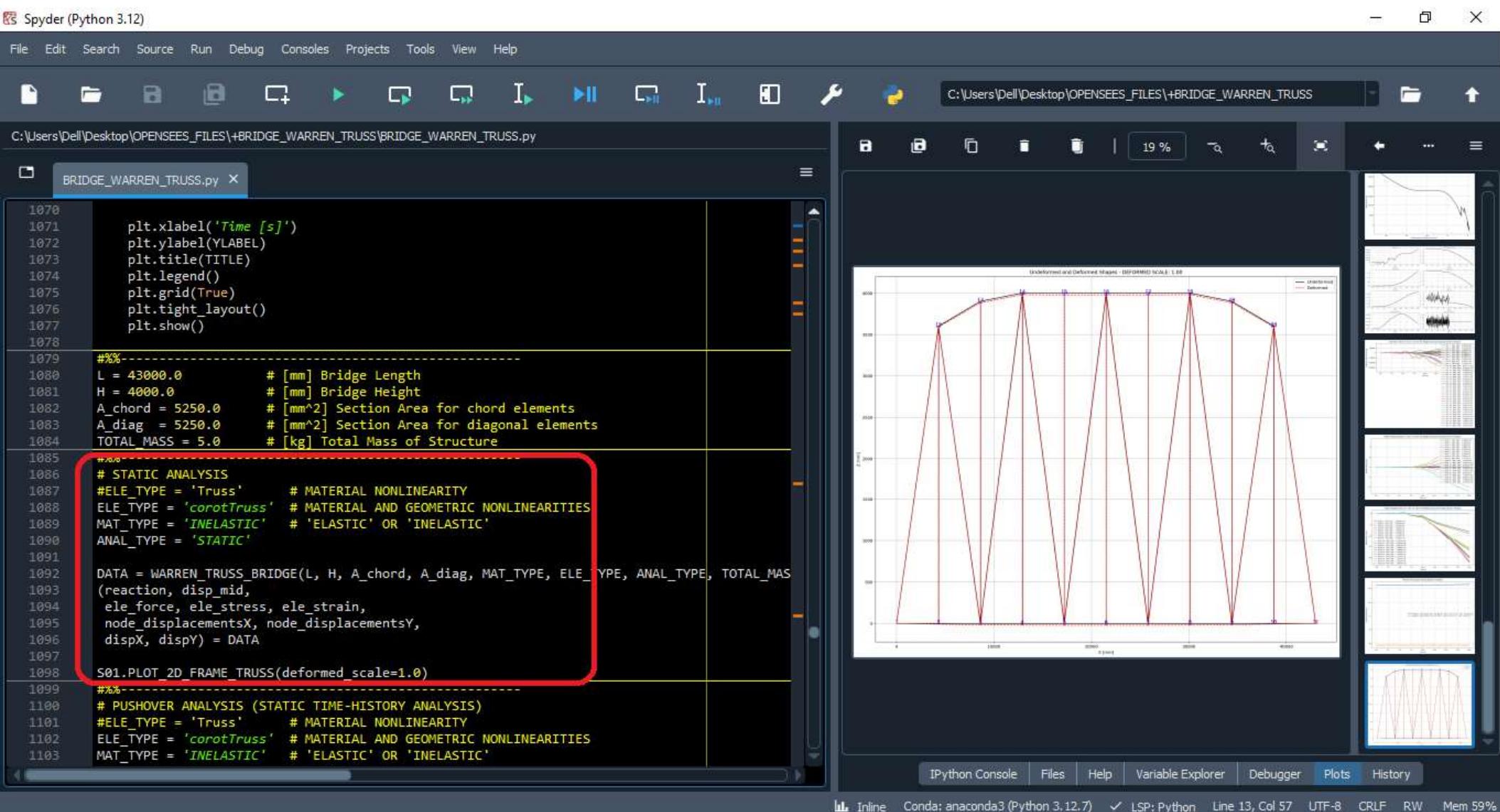
1      ##### >> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<
2      # COMPREHENSIVE NONLINEAR SEISMIC ASSESSMENT OF STEEL TRUSS BRIDGES: AN OPENSEES FRAMEWORK
3      # STATIC PUSHOVER, CYCLIC DEGRADATION, STATIC TIME-HISTORY AND DYNAMIC TIME-HISTORY
4      #
5      # THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHEI (QASHQAI)
6      # EMAIL: salar.d.ghashghei@gmail.com
7      #
8      #
9      #
10     Nonlinear Seismic Performance Assessment of Warren Steel Truss Bridges:
11     An OpenSeesPy Framework for Material and Geometric Nonlinearity Under Static, Cyclic, and
12     Dynamic Loading
13     This OpenSeesPy script performs rigorous nonlinear static and dynamic analysis of a Warren
14     truss bridge. The model is based on a 2D frame element formulation, accounting for material non-
15     linearity (elastic-perfectly plastic or hysteretic steel with strain hardening) and geometric
16     nonlinearity (corotational truss formulation) to capture P-delta effects and large
17     displacements—essential for collapse assessment.
18
19     The bridge spans 43m with 10-panel Warren configuration, assigning distinct cross-sectional
20     areas for chords and diagonals. Eigenvalue analysis tracks period elongation throughout
21     loading, directly quantifying stiffness degradation and damage progression.
22
23     Five analysis protocols are implemented:
24     (1) [STATIC] : Gravity Load analysis establishing dead load state
25     (2) [PUSHOVER] : Displacement-controlled pushover generating full capacity curves
26     and plastic mechanism identification
27     (3) [CYCLIC_DISPLACEMENT] : Symmetric cyclic displacement protocol capturing hysteresis,
28     pinching behavior, and energy dissipation degradation
29     (4) [STATIC_EXTERNAL_TIME-DEPENDENT_LOADING] : Static Analysis of External time-dependent
30     loading
31     (5) [DYNAMIC_EXTERNAL_TIME-DEPENDENT_LOADING] : Dynamic Analysis of External time-dependent
32     loading
33     (6) [FREE-VIBRATION] : Free-vibration with initial conditions extracting damping ratios
34     via Logarithmic decrement
35     (7) [SEISMIC] : Multi-directional seismic excitation with Rayleigh damping (3% ratio)
36     and uniform acceleration patterns.

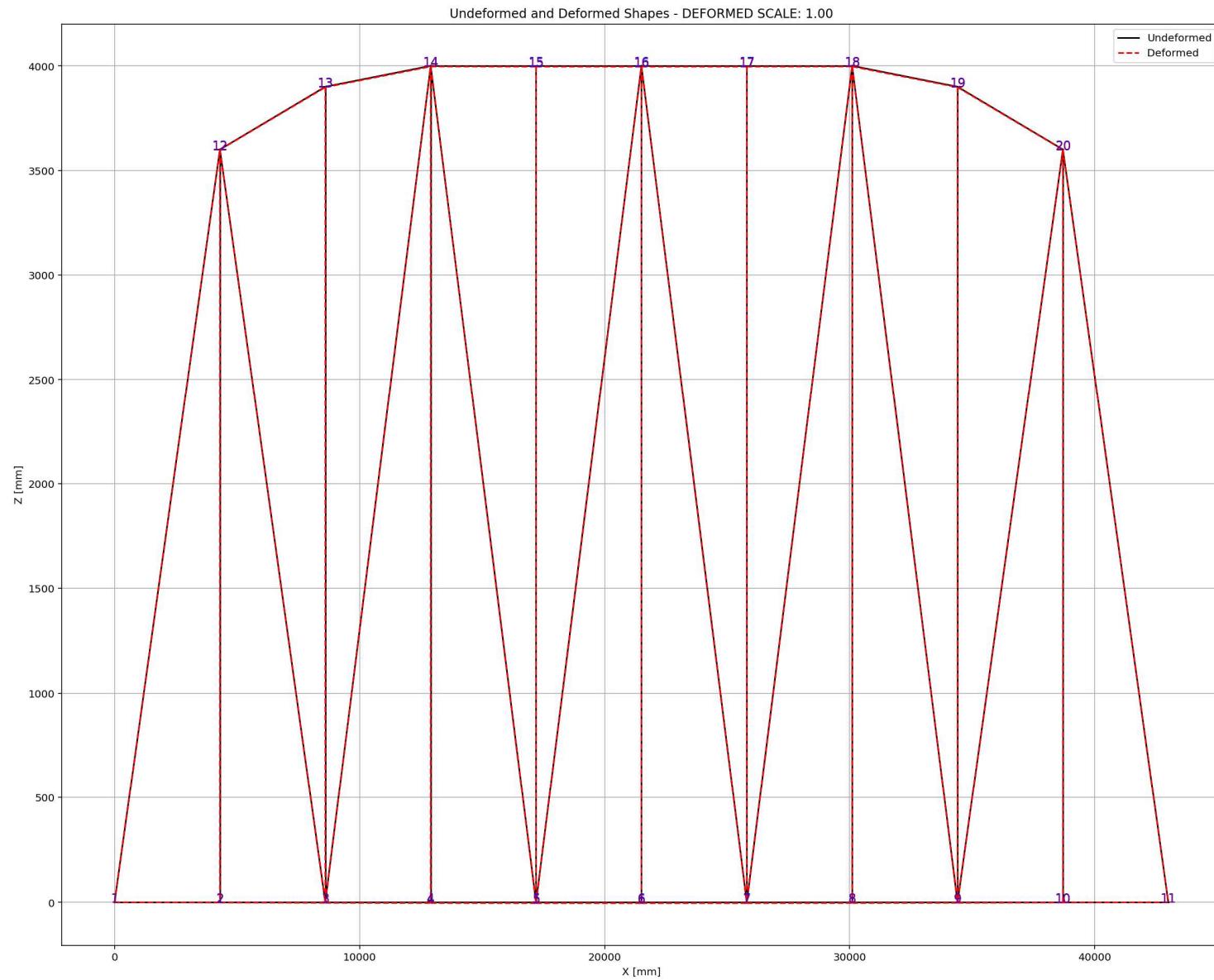
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IPython Console Files Help Variable Explorer Debugger Plots History

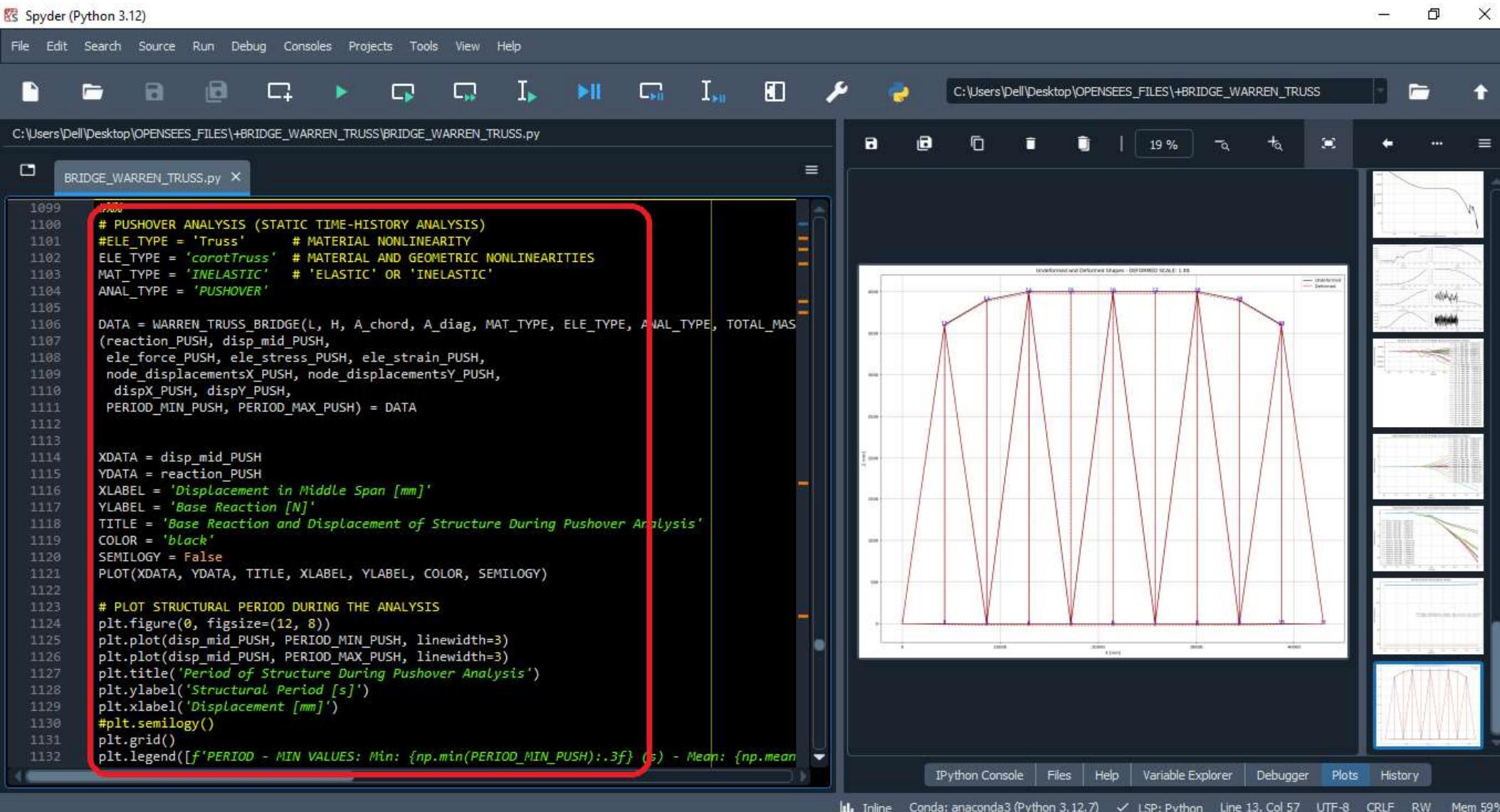
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# **STATIC ANALYSIS**

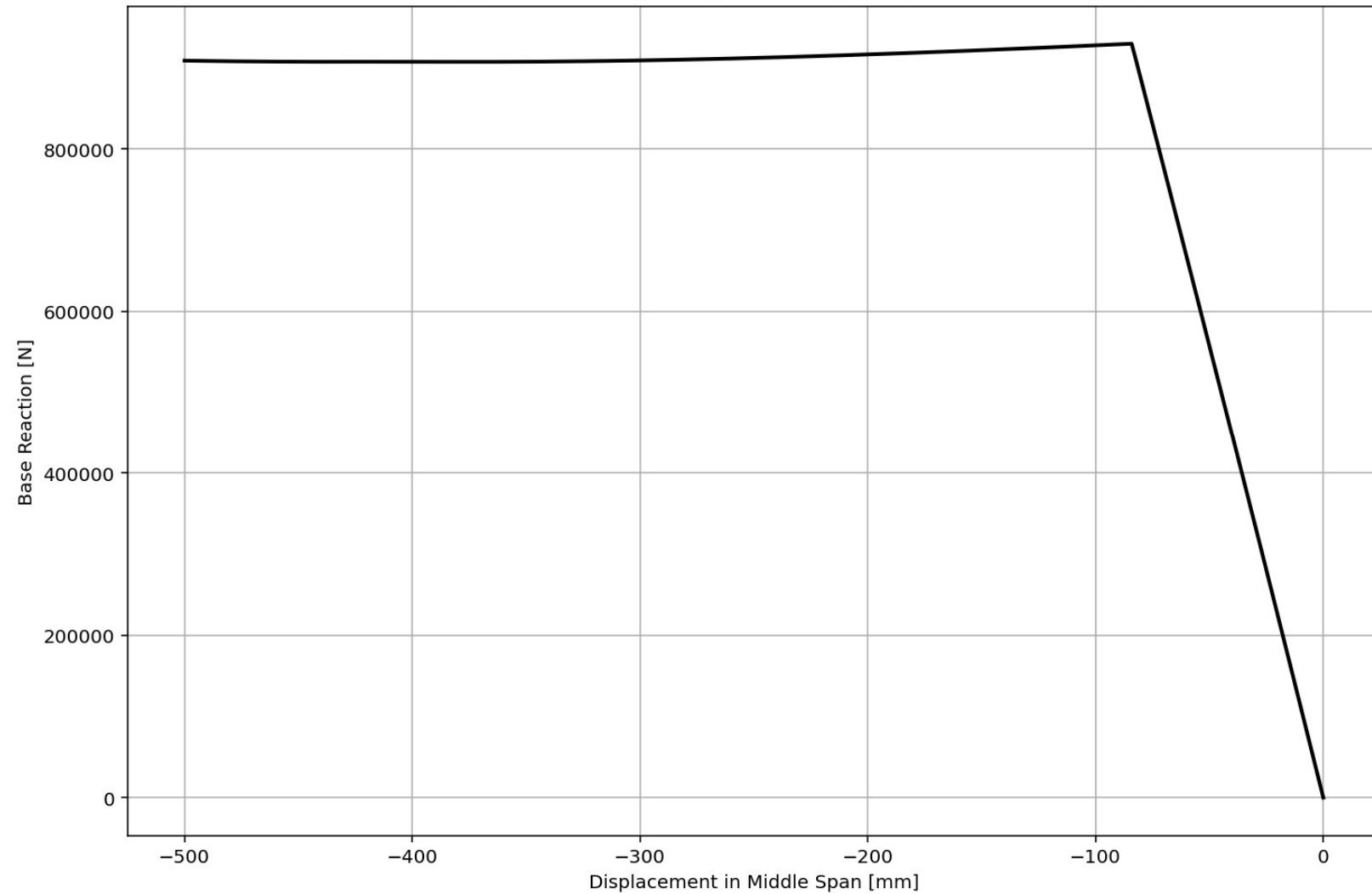




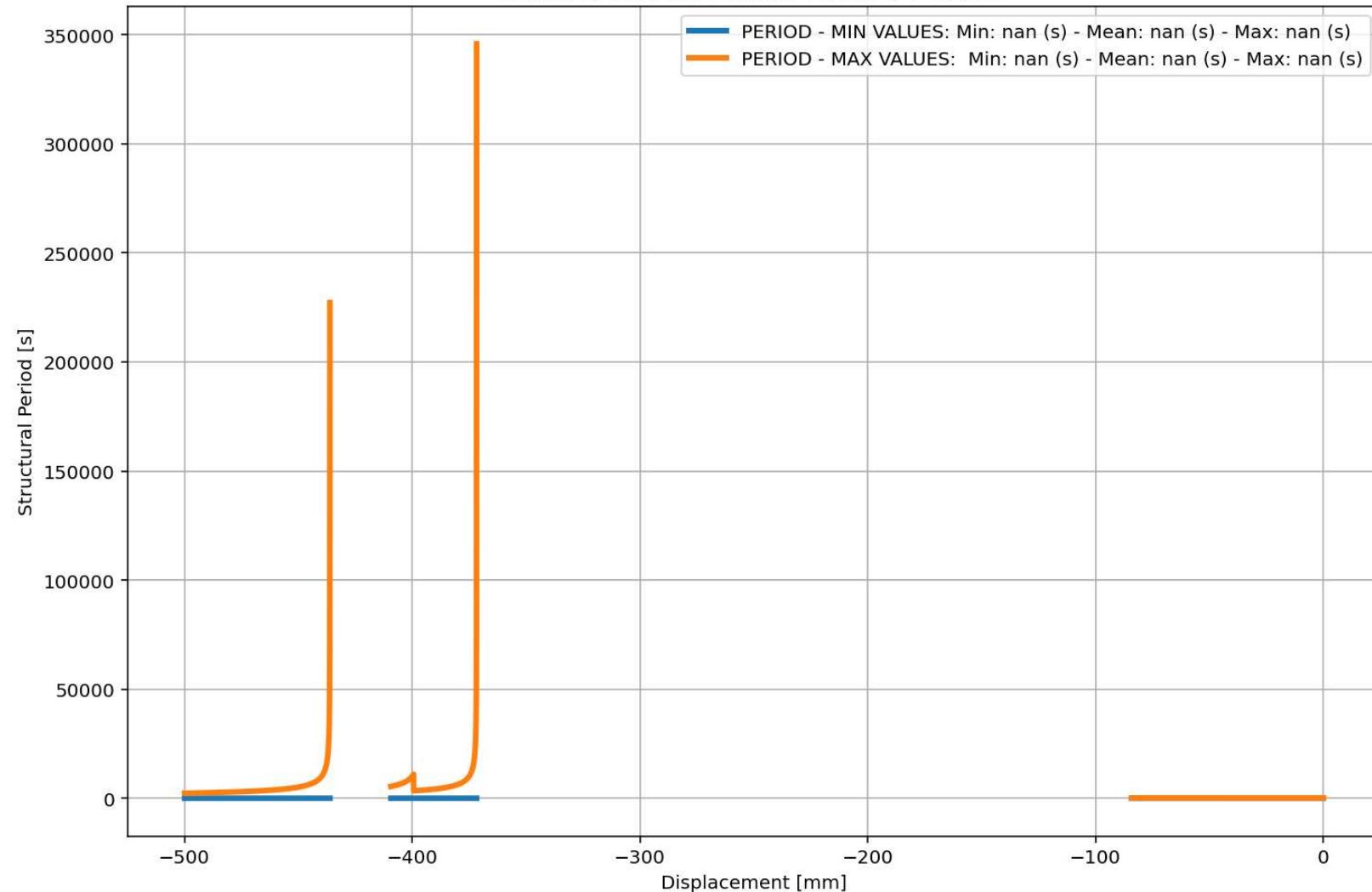
# PUSHOVER ANALYSIS

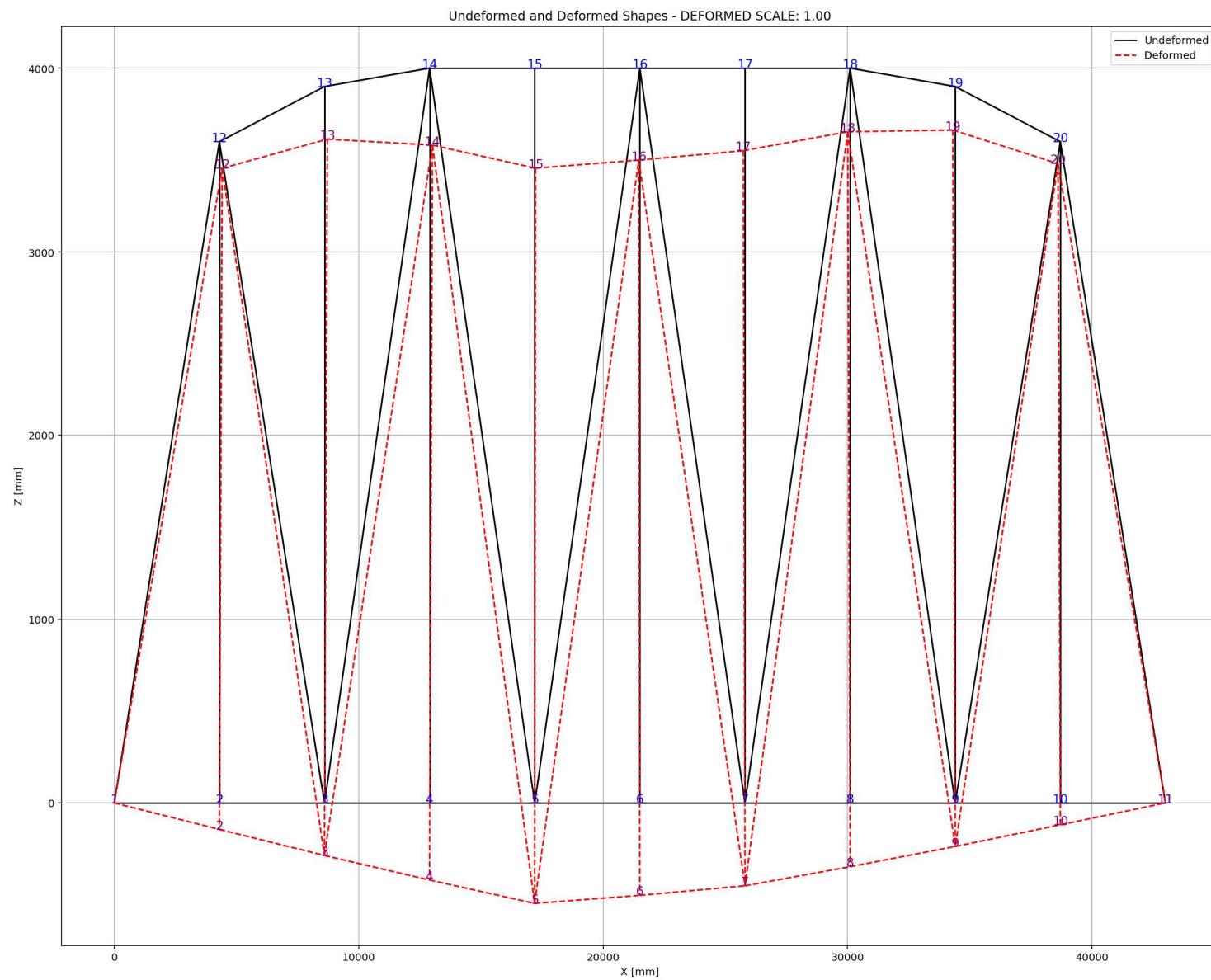


Base Reaction and Displacement of Structure During Pushover Analysis

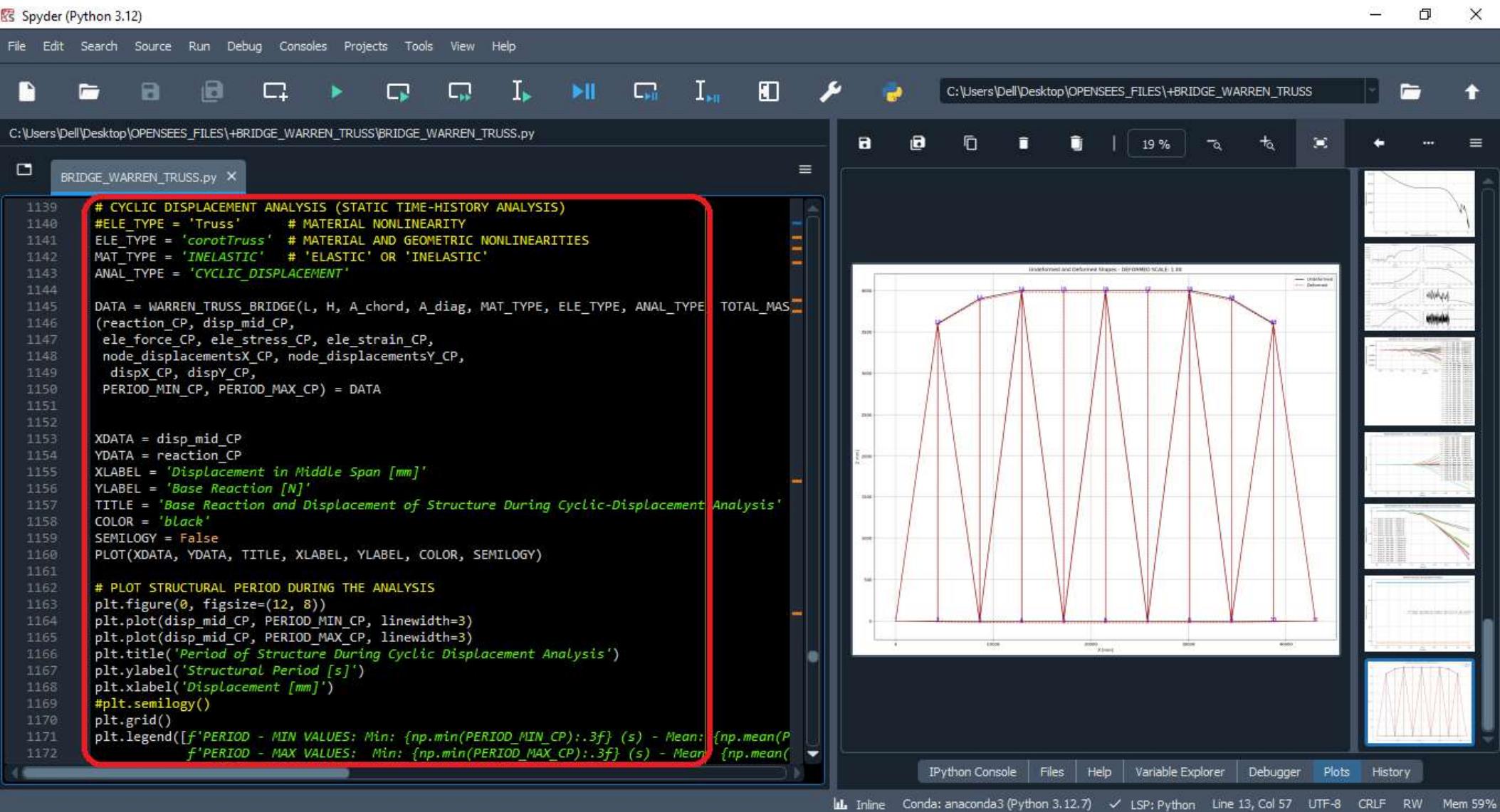


### Period of Structure During Pushover Analysis



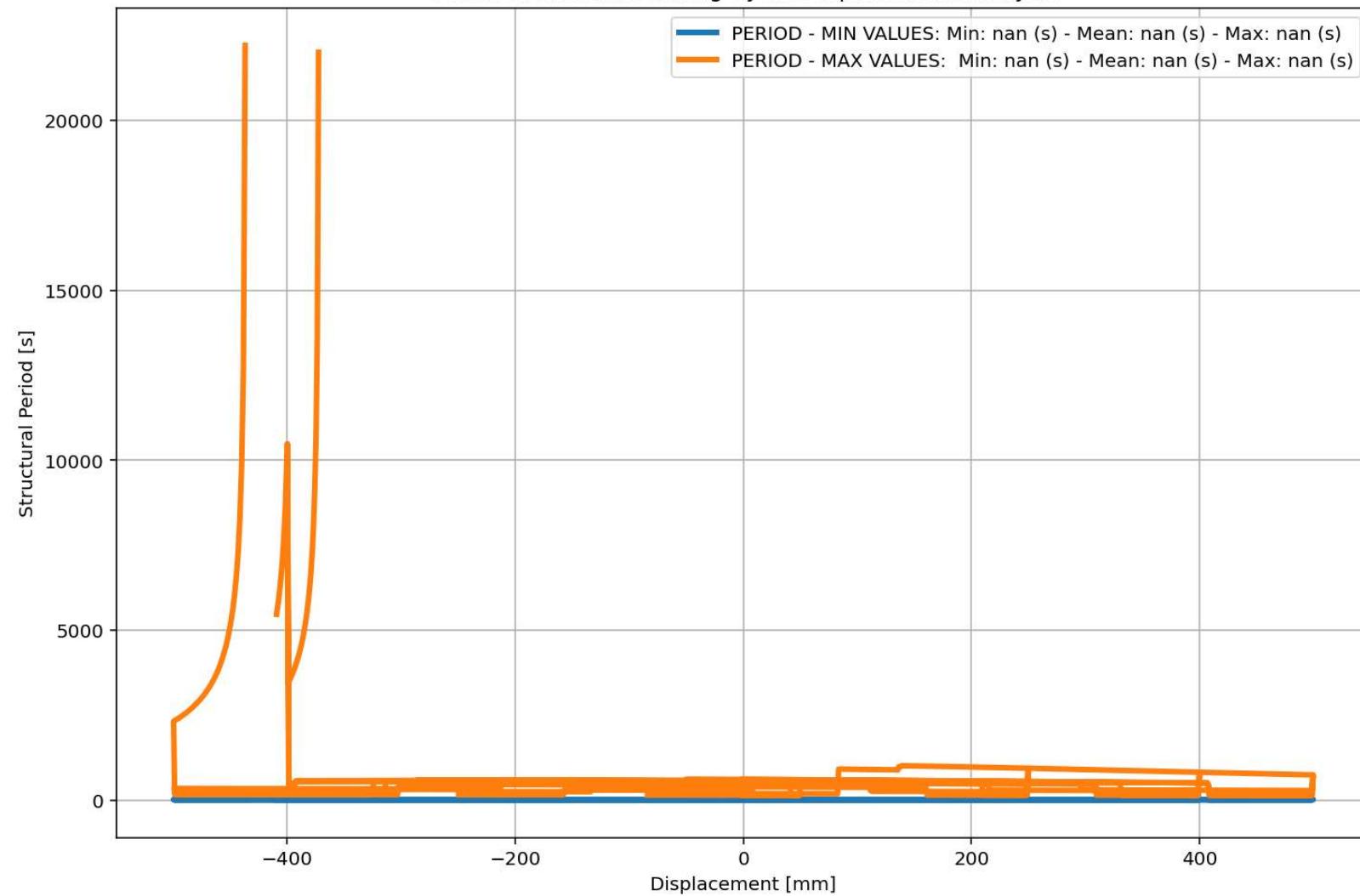


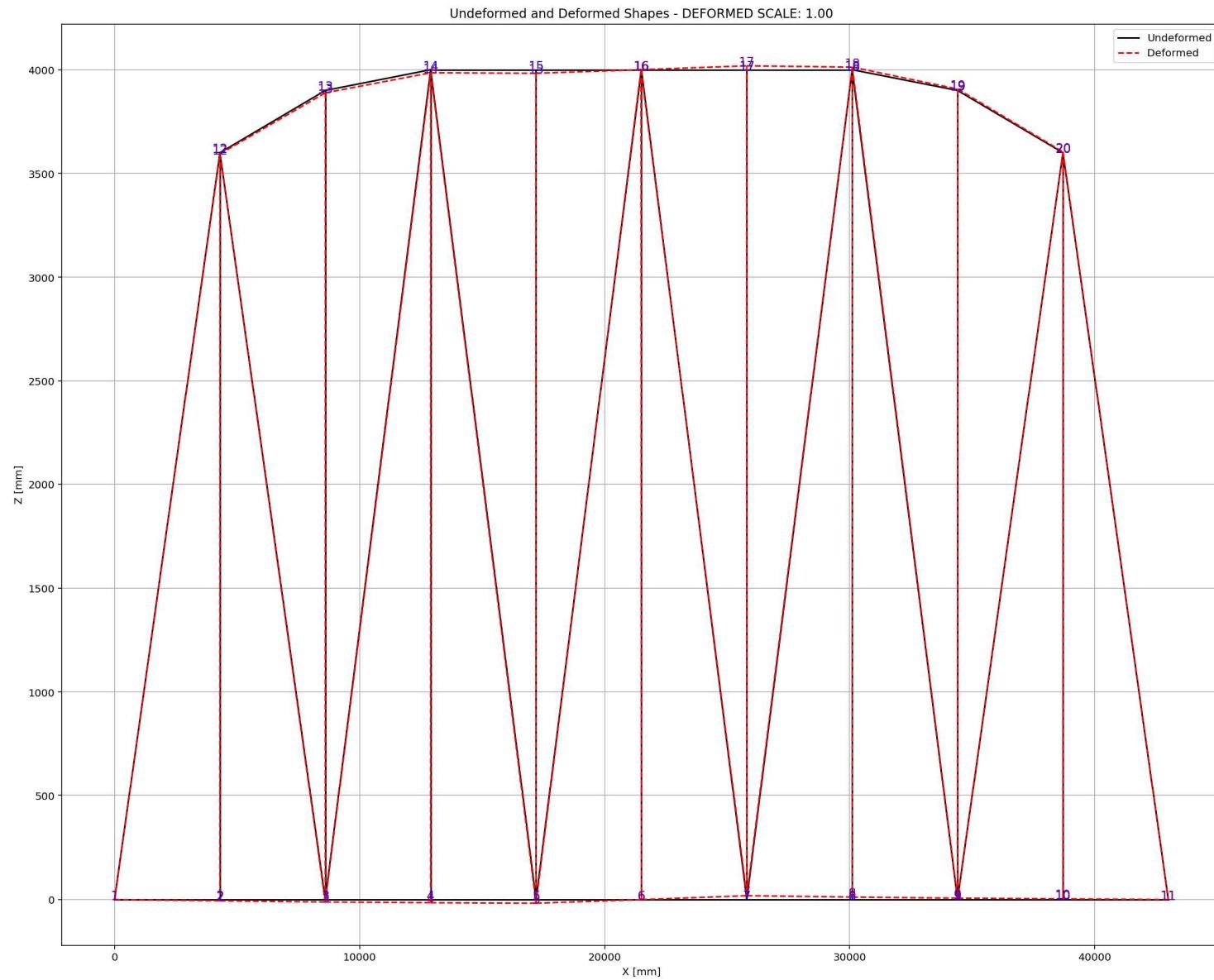
# CYCLIC DISPLACEMENT ANALYSIS



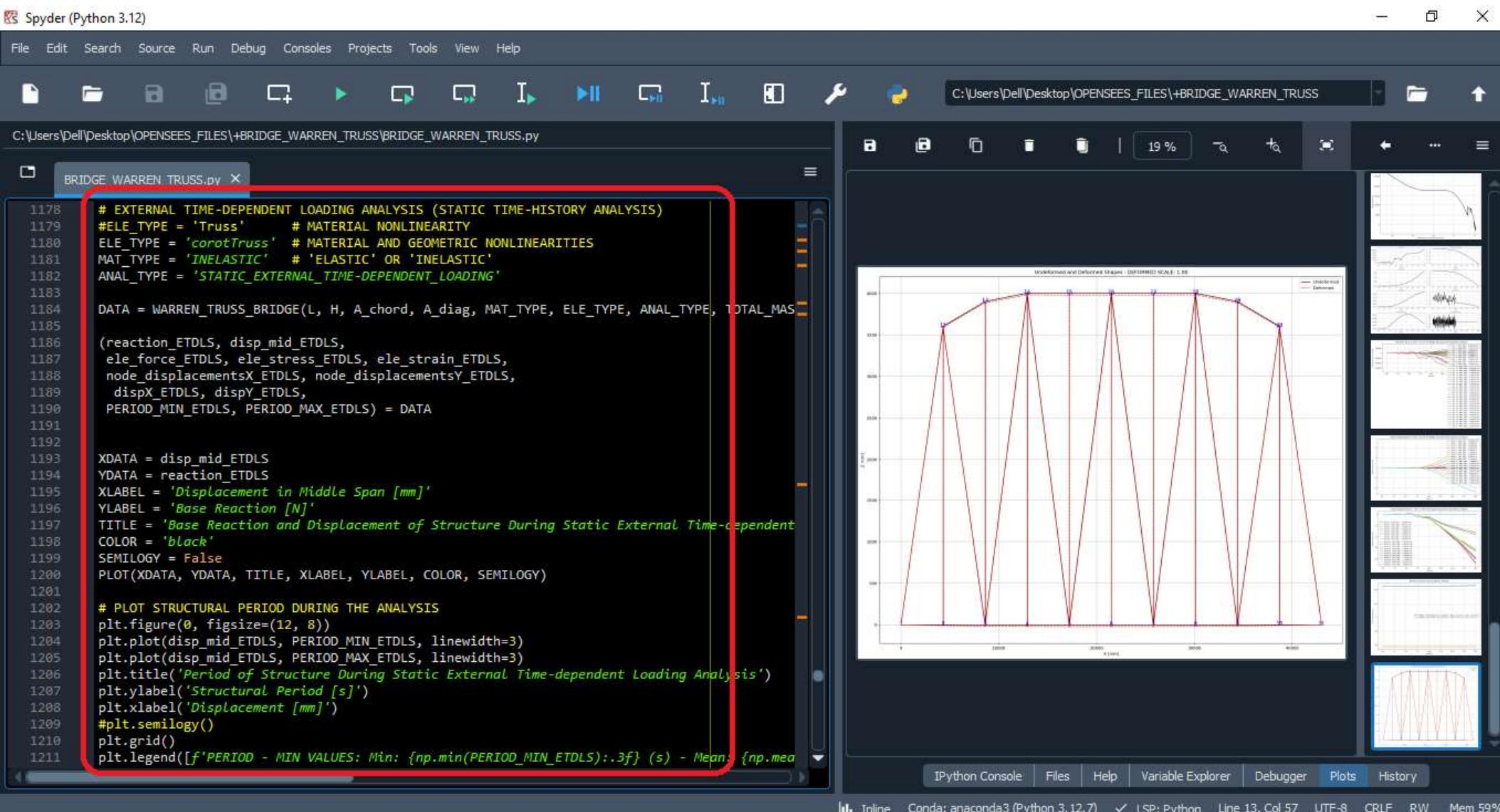


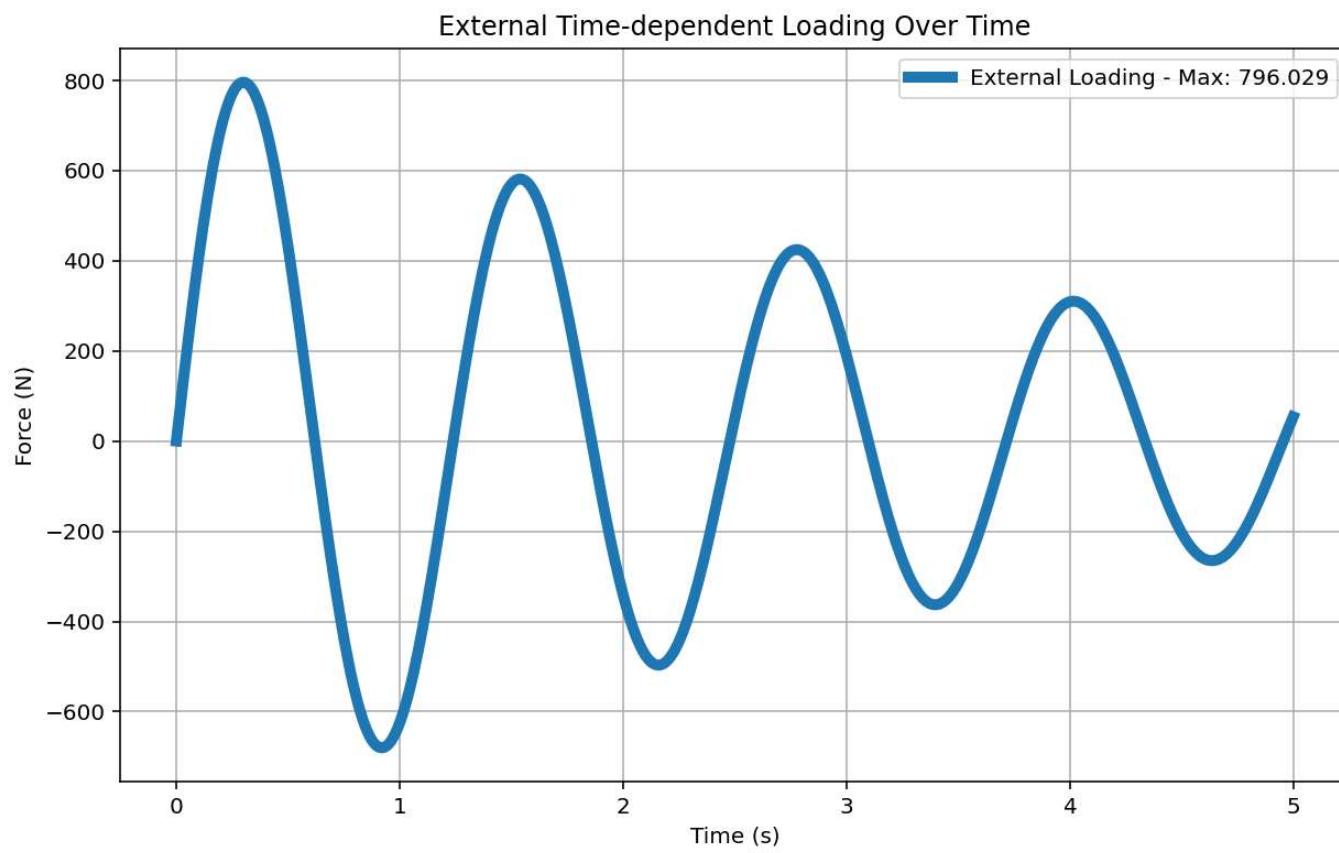
Period of Structure During Cyclic Displacement Analysis



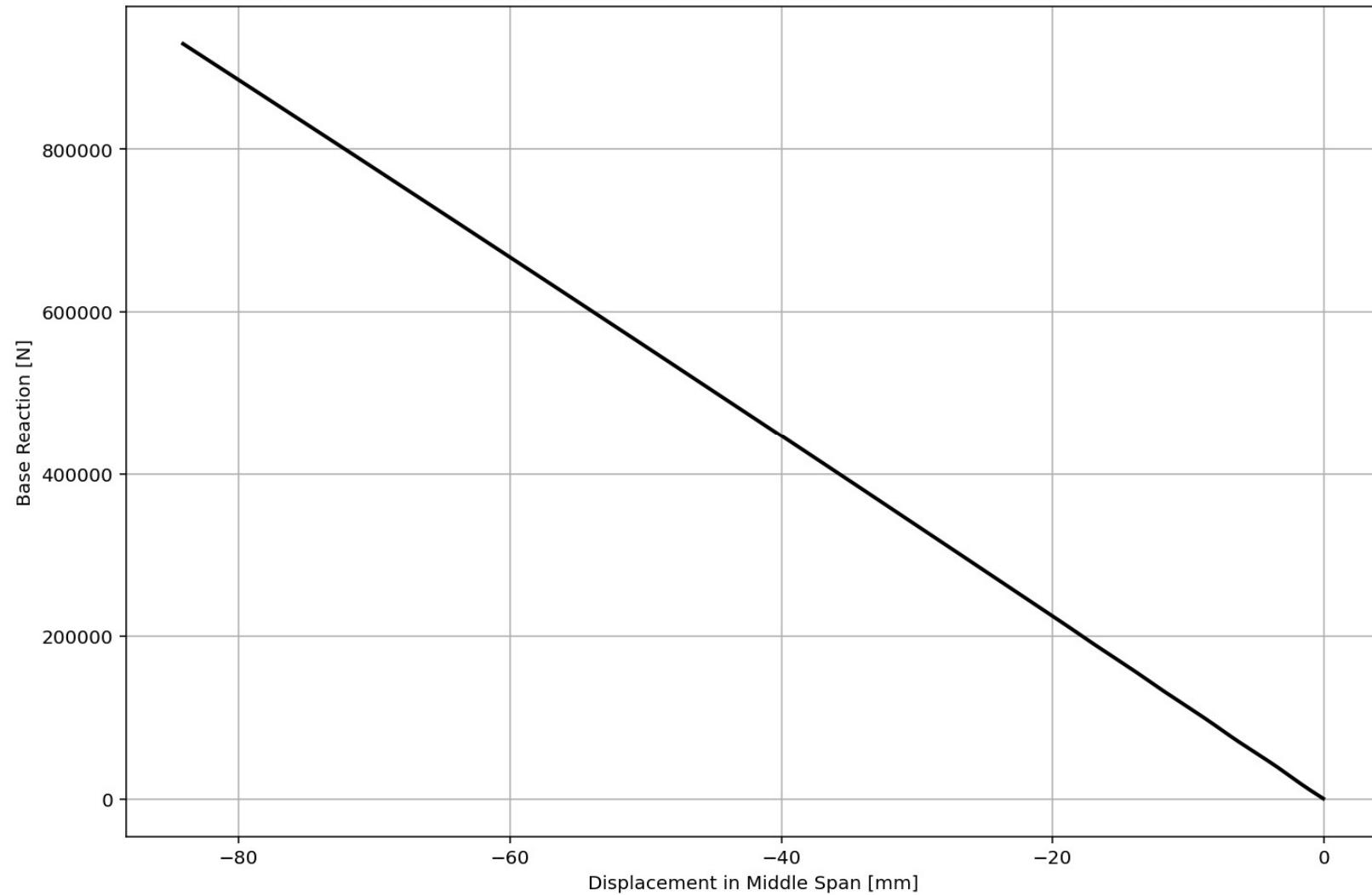


# **STATIC TIME-HISTORY WITH EXTERNAL TIME- DEPENDENT LOADING ANALYSIS**

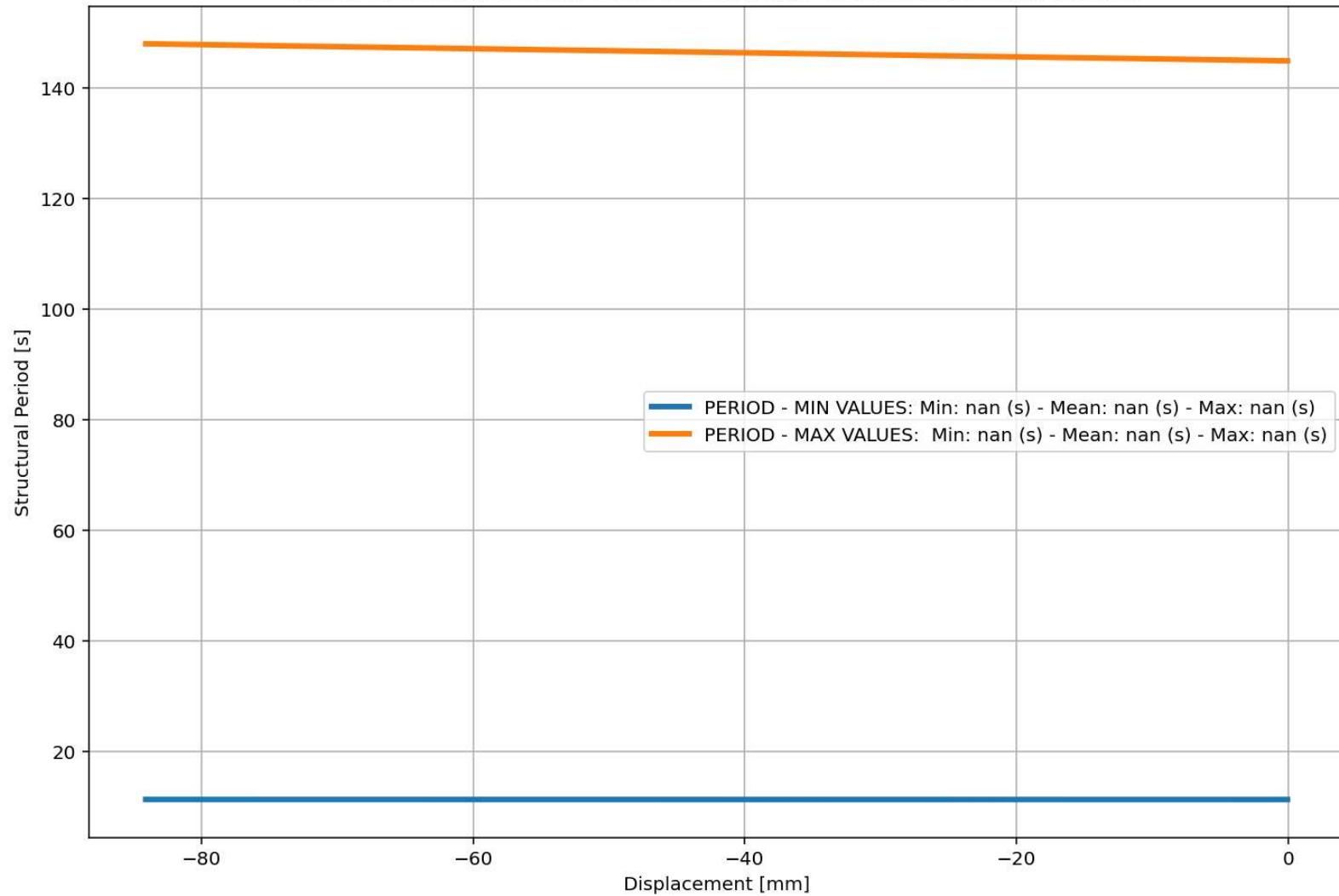




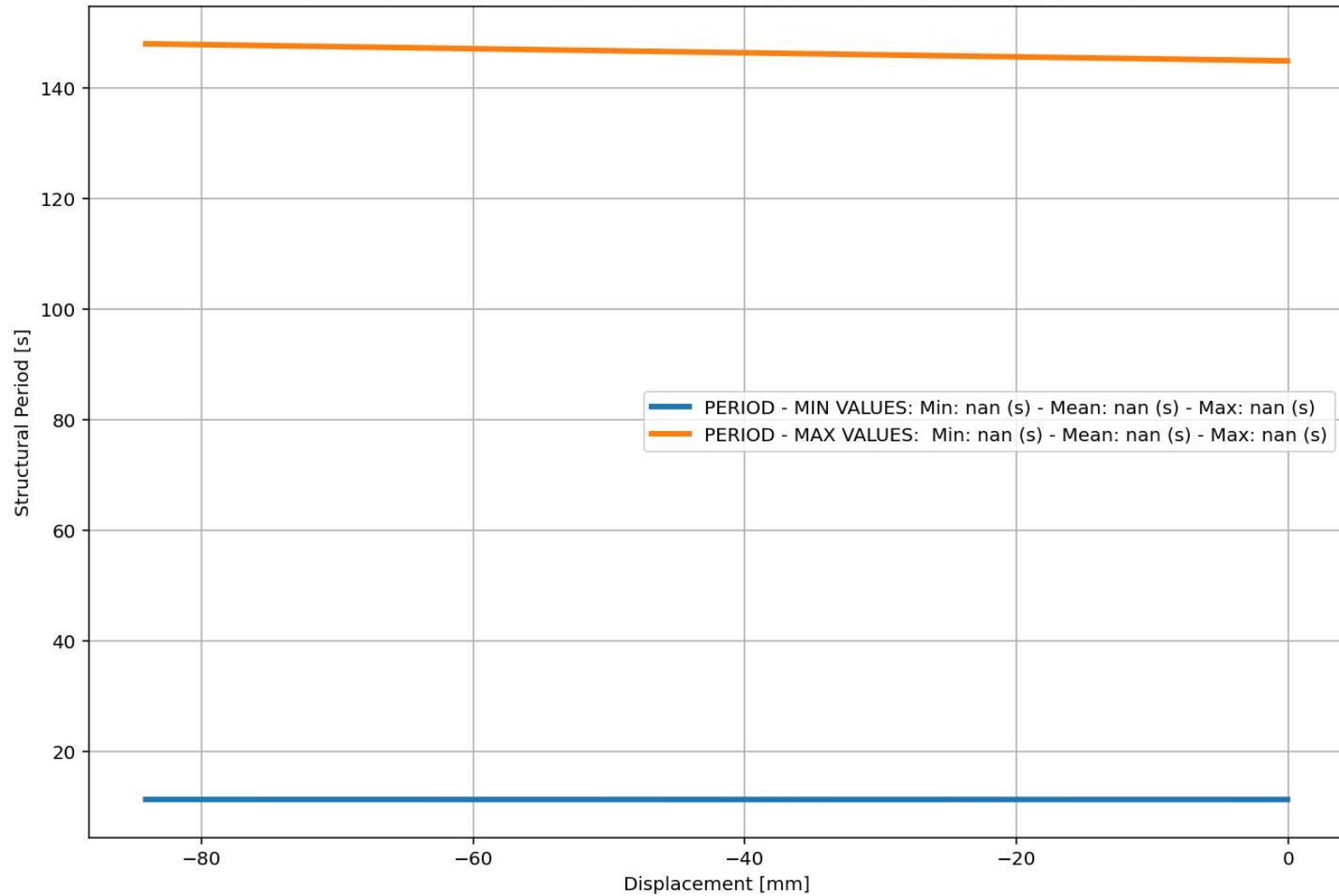
Base Reaction and Displacement of Structure During Static External Time-dependent Loading Analysis

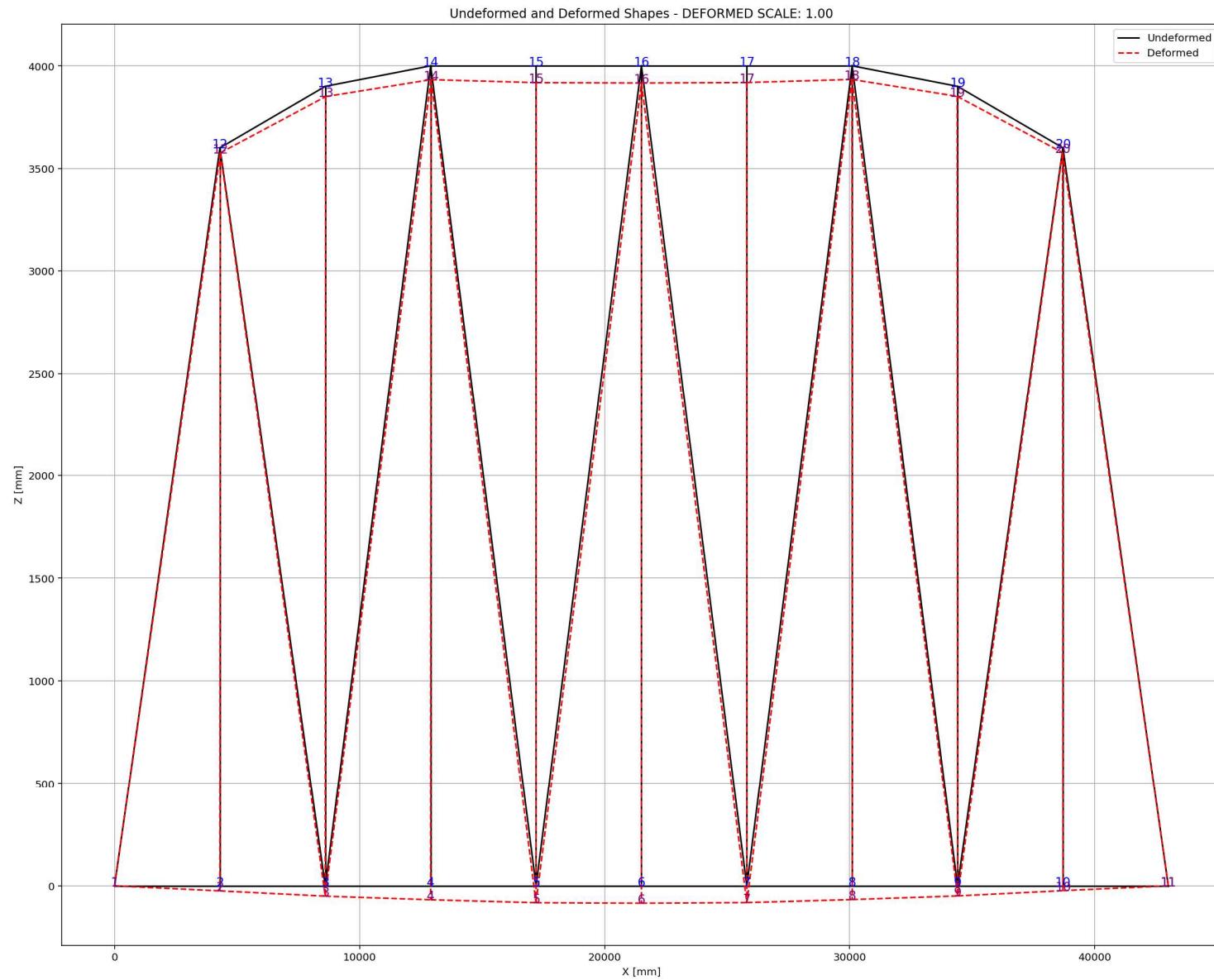


### Period of Structure During Static External Time-dependent Loading Analysis



### Period of Structure During Static External Time-dependent Loading Analysis





# DYNAMIC TIME-HISTORY WITH EXTERNAL TIME- DEPENDENT LOADING ANALYSIS

Spyder (Python 3.12)

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C:\Users\Dell\Desktop\OPENSEES\_FILES\+BRIDGE\_WARREN\_TRUSS

BRIDGE\_WARREN\_TRUSS.py

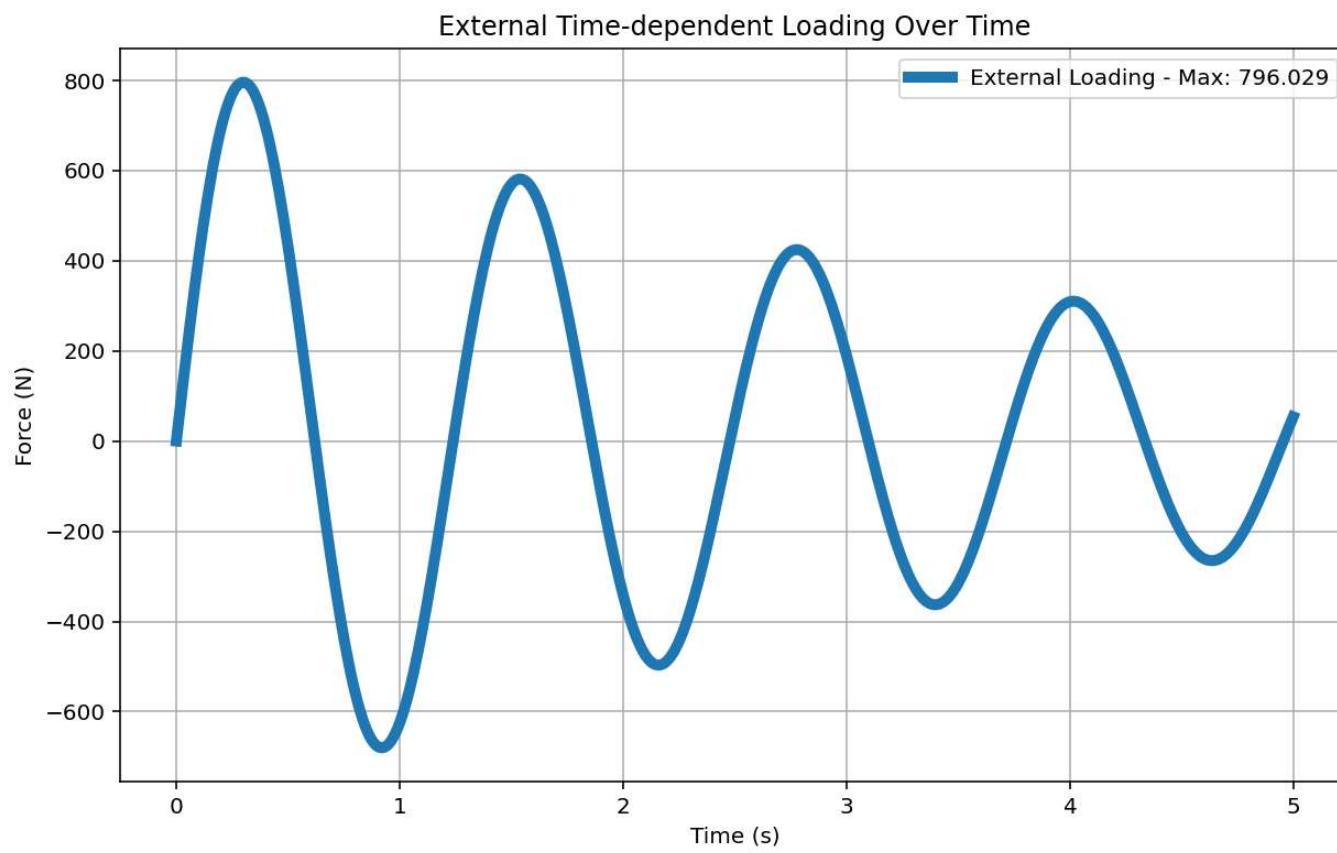
```
1218 # EXTERNAL TIME-DEPENDENT LOADING ANALYSIS (DYNAMIC TIME-HISTORY ANALYSIS)
1219 #ELE_TYPE = 'Truss'          # MATERIAL NONLINEARITY
1220 ELE_TYPE = 'corotTruss'    # MATERIAL AND GEOMETRIC NONLINEARITIES
1221 MAT_TYPE = 'INELASTIC'     # 'ELASTIC' OR 'INELASTIC'
1222 ANAL_TYPE = 'DYNAMIC_EXTERNAL_TIME-DEPENDENT_LOADING'
1223
1224 DATA = WARREN_TRUSS_BRIDGE(L, H, A_chord, A_diag, MAT_TYPE, ELE_TYPE, ANAL_TYPE, TOTAL_MAS)
1225
1226 (time_ETDLD, reaction_ETDLD, disp_mid_ETDLD,
1227 ele_force_ETDLD, ele_stress_ETDLD, ele_strain_ETDLD,
1228 node_displacementsX_ETDLD, node_displacementsY_ETDLD,
1229 dispX_ETDLD, dispY_ETDLD,
1230 veloX_ETDLD, veloY_ETDLD,
1231 accX_ETDLD, accY_ETDLD,
1232 stiffness_ETDLD, PERIOD_ETDLD, damping_ratio_ETDLD,
1233 PERIOD_MIN_ETDLD, PERIOD_MAX_ETDLD) = DATA
1234
1235
1236 XDATA = disp_mid_ETDLD
1237 YDATA = reaction_ETDLD
1238 XLABEL = 'Displacement in Middle Span [mm]'
1239 YLABEL = 'Base Reaction [N]'
1240 TITLE = 'Base Reaction and Displacement of Structure During Dynamic External Time-dependent Loading'
1241 COLOR = 'black'
1242 SEMILOGY = False
1243 PLOT(XDATA, YDATA, TITLE, XLABEL, YLABEL, COLOR, SEMILOGY)
1244
1245 PLOT_TIME_HISTORY(time_ETDLD, reaction_ETDLD, disp_mid_ETDLD,
1246                     dispX_ETDLD, dispY_ETDLD,
1247                     veloX_ETDLD, veloY_ETDLD,
1248                     accX_ETDLD, accY_ETDLD)
1249
1250 # PLOT ELEMENTS AXIAL FORCE
1251 YLABEL = 'Element Axial Force [N]'
```

19 %

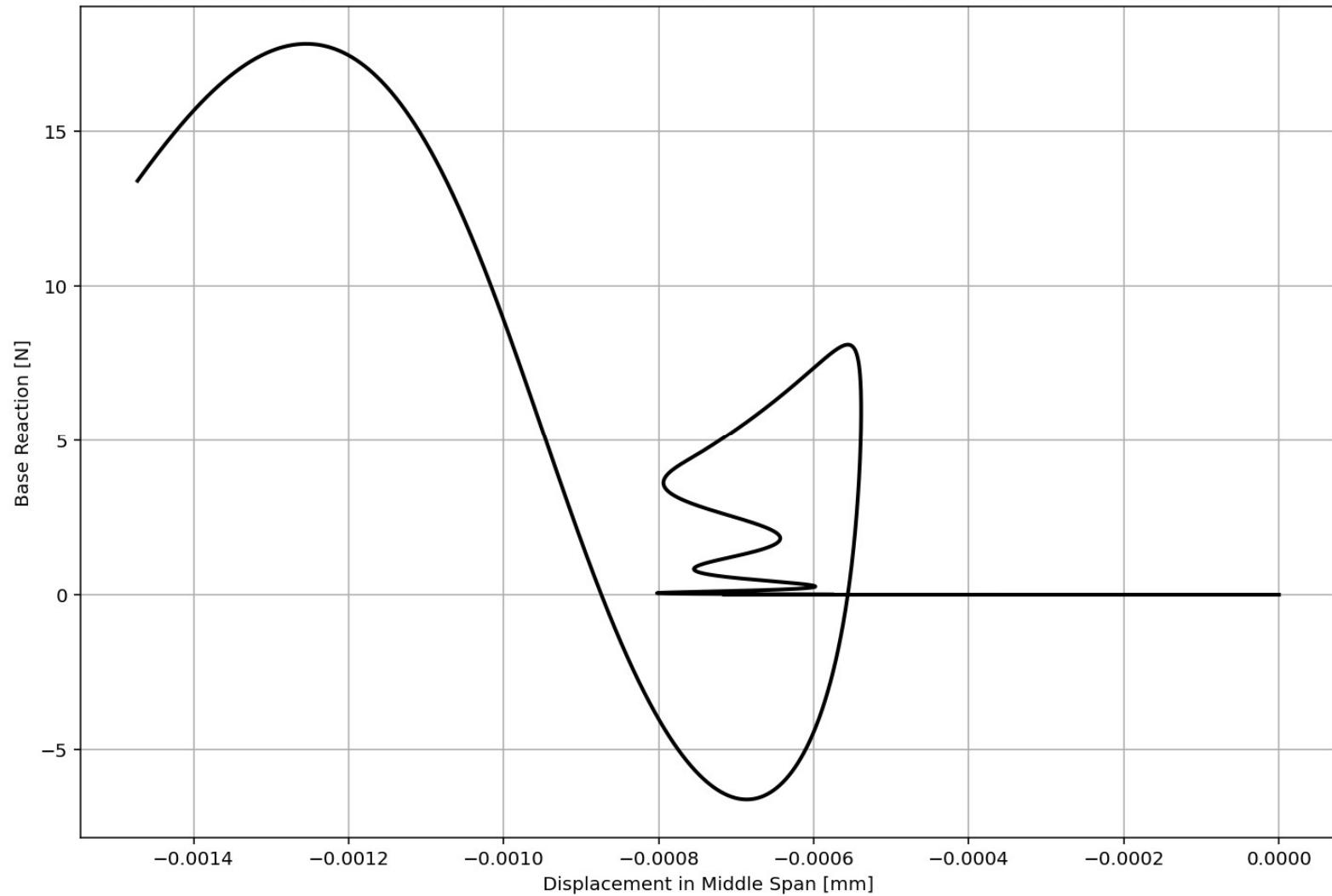
Undeformed and Deformed Models - DEFORMED SCALE 1:60

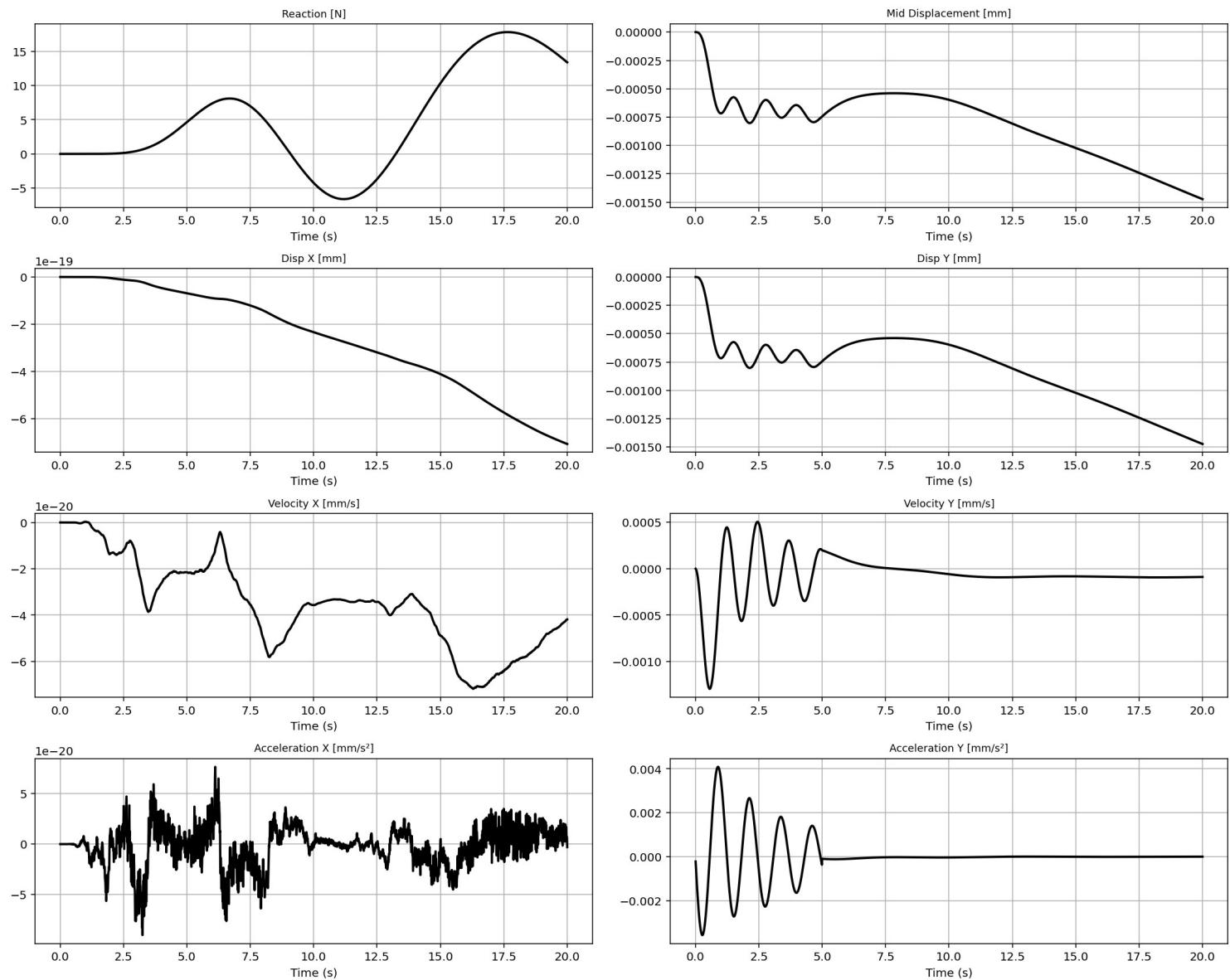
IPython Console Files Help Variable Explorer Debugger Plots History

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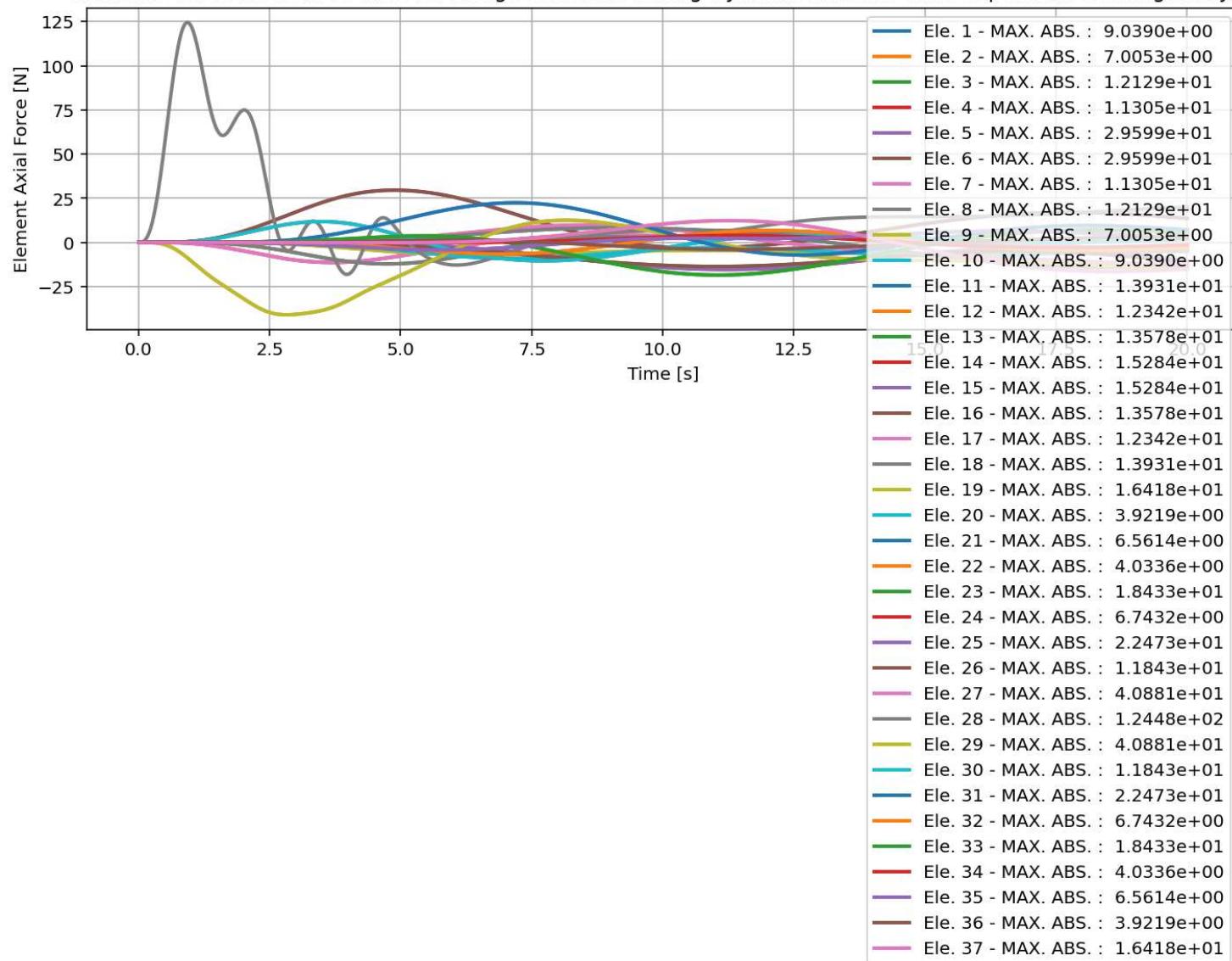


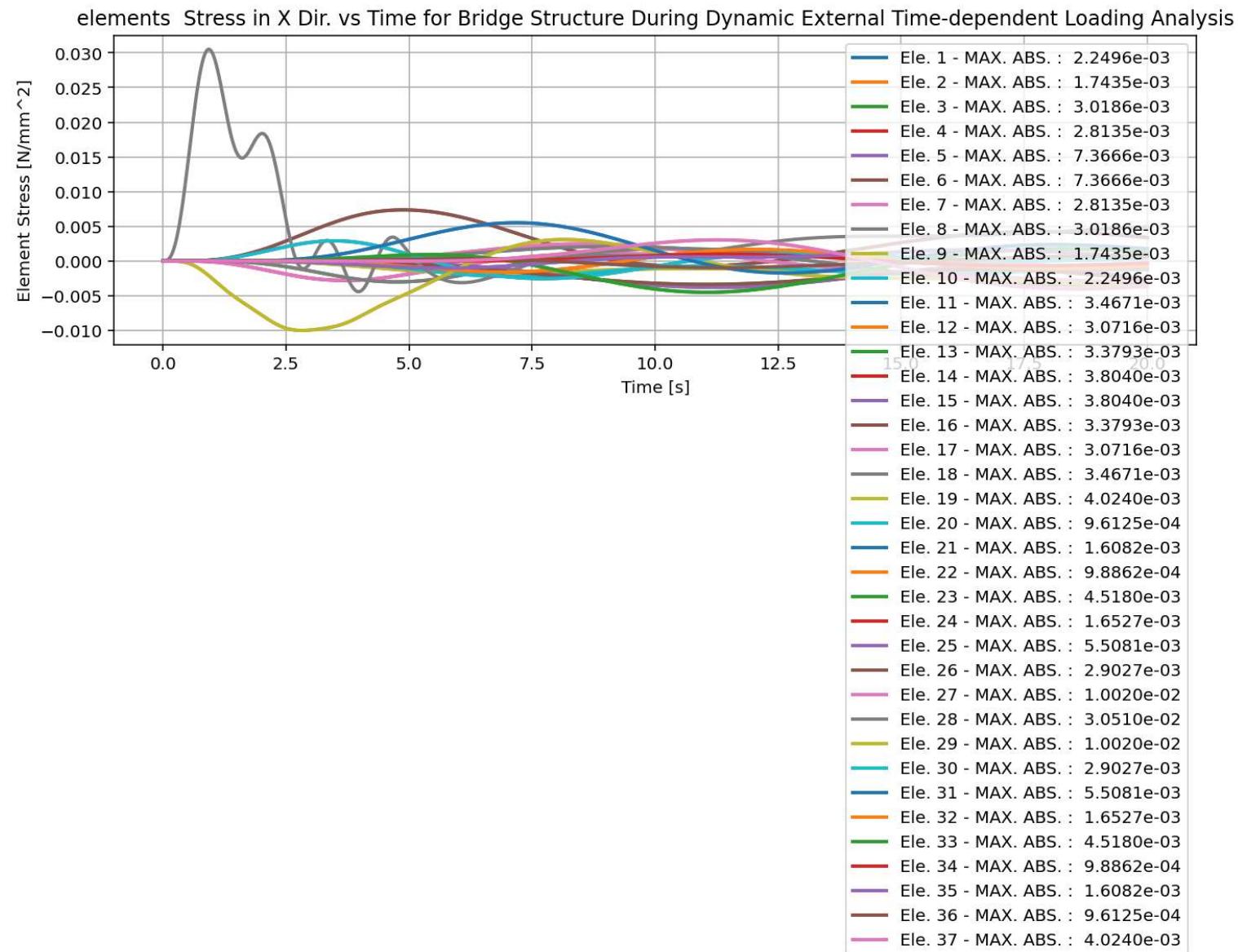
Base Reaction and Displacement of Structure During Dynamic External Time-dependent Loading Analysis



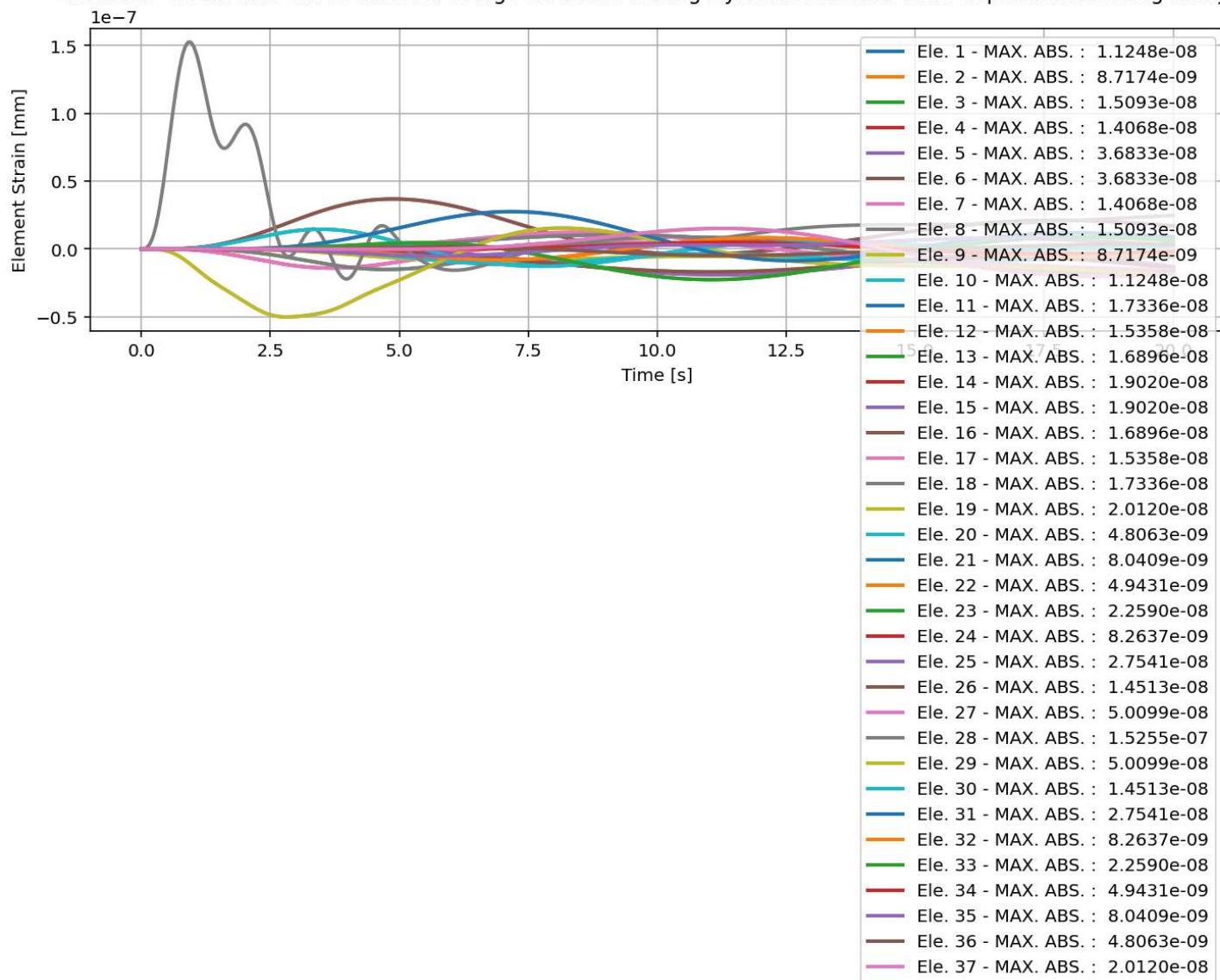


elements force in X Dir. vs Time for Bridge Structure During Dynamic External Time-dependent Loading Analysis

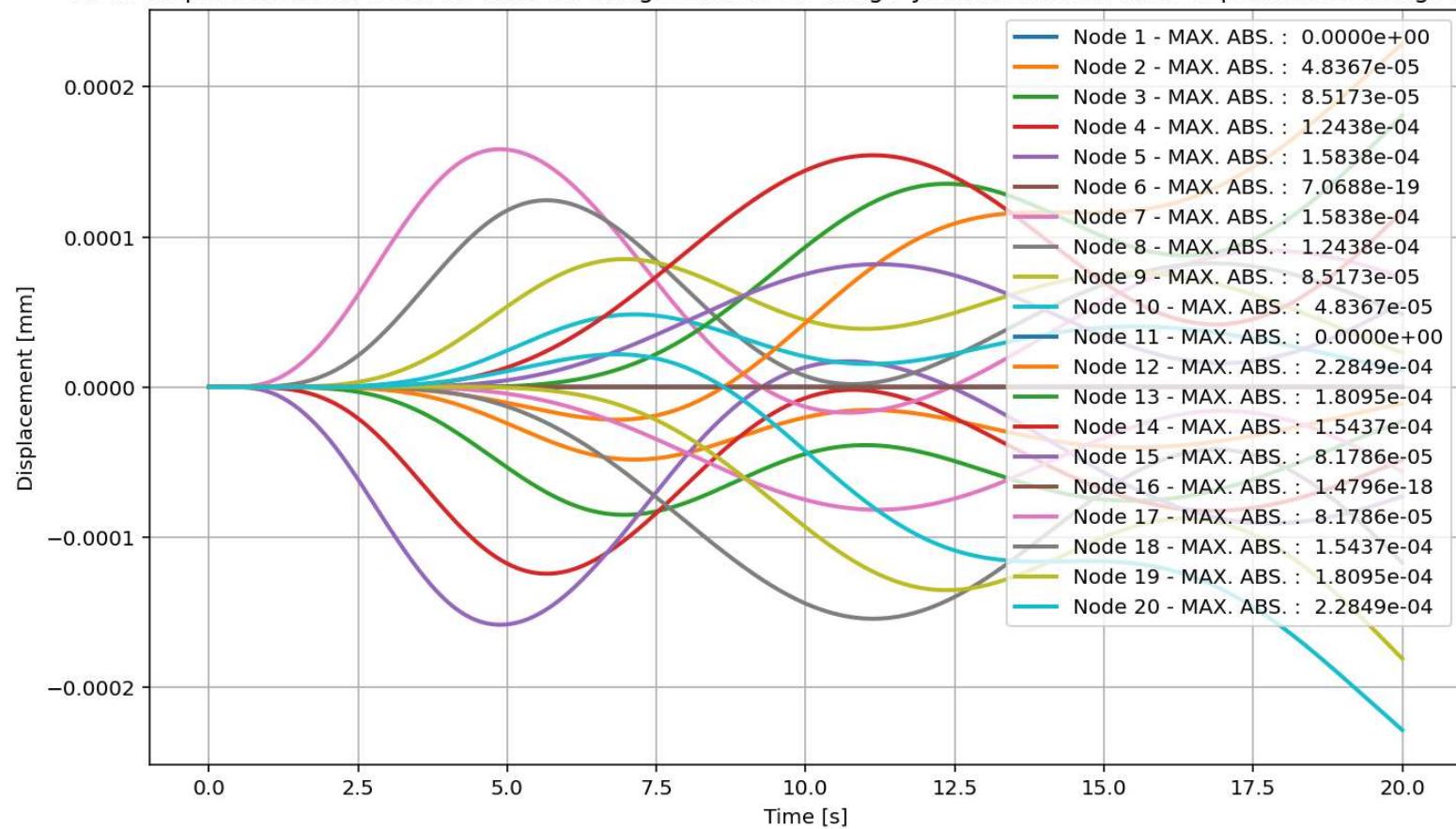


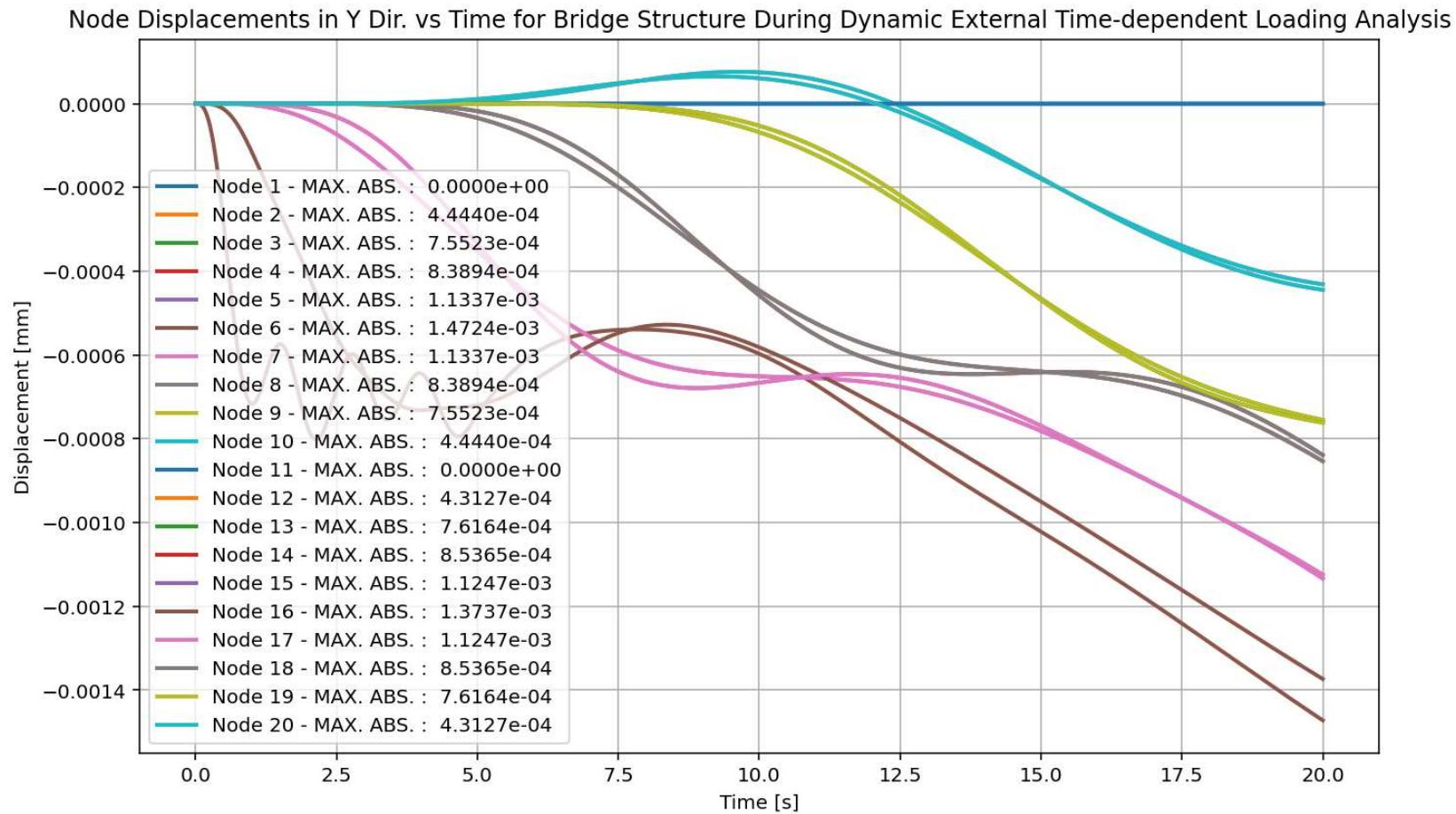


### elements Strain in X Dir. vs Time for Bridge Structure During Dynamic External Time-dependent Loading Analysis

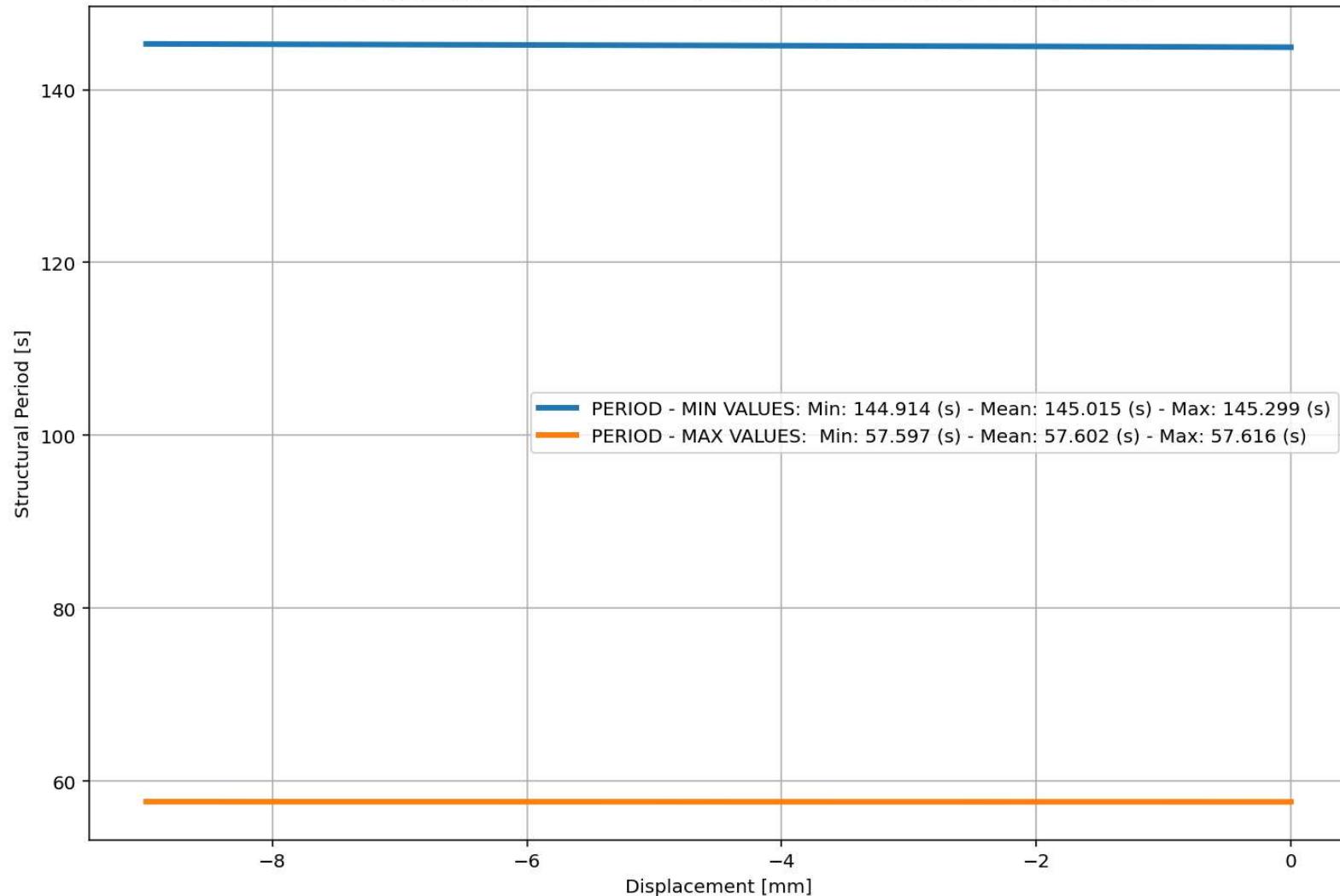


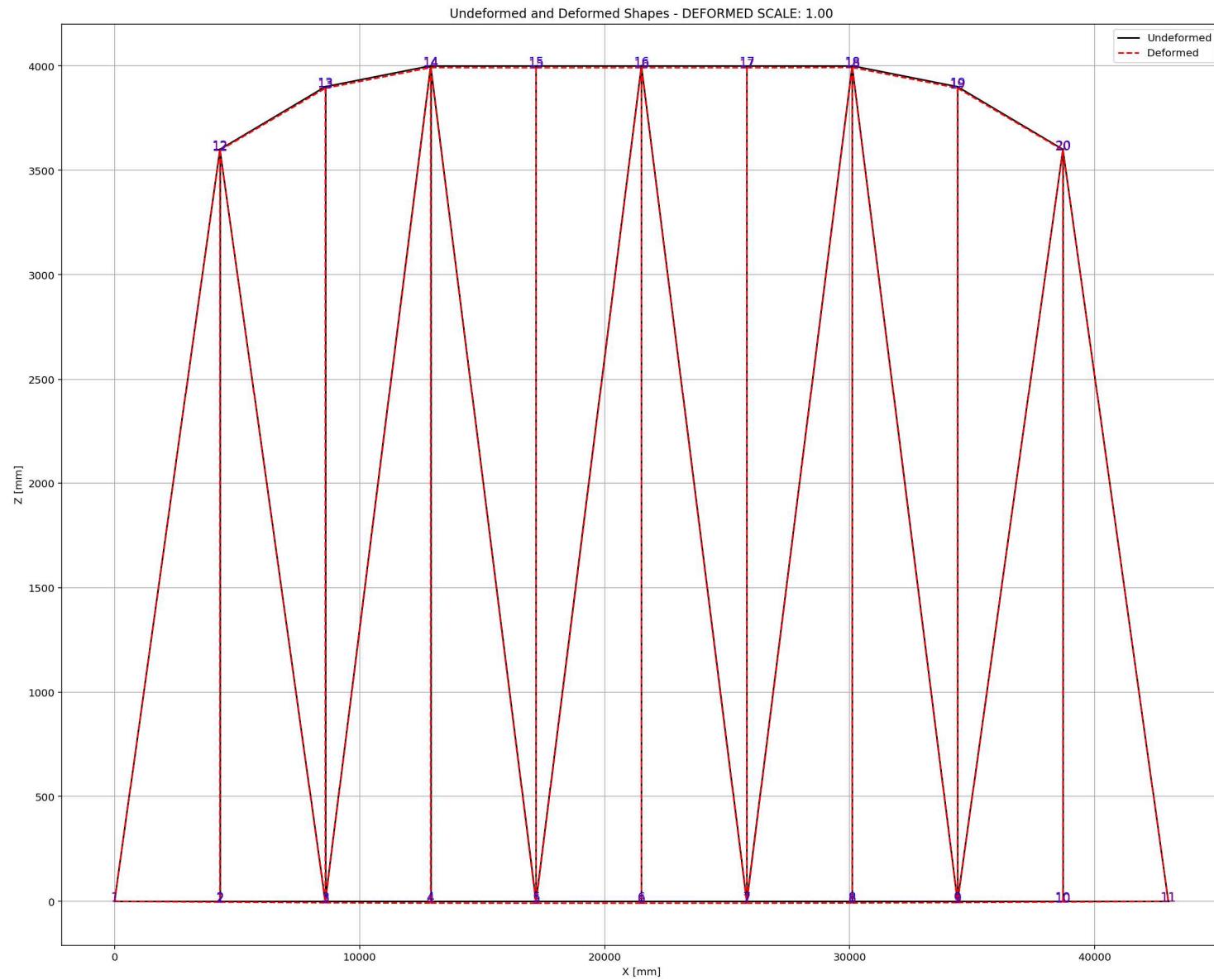
Node Displacements in X Dir. vs Time for Bridge Structure During Dynamic External Time-dependent Loading Analysis



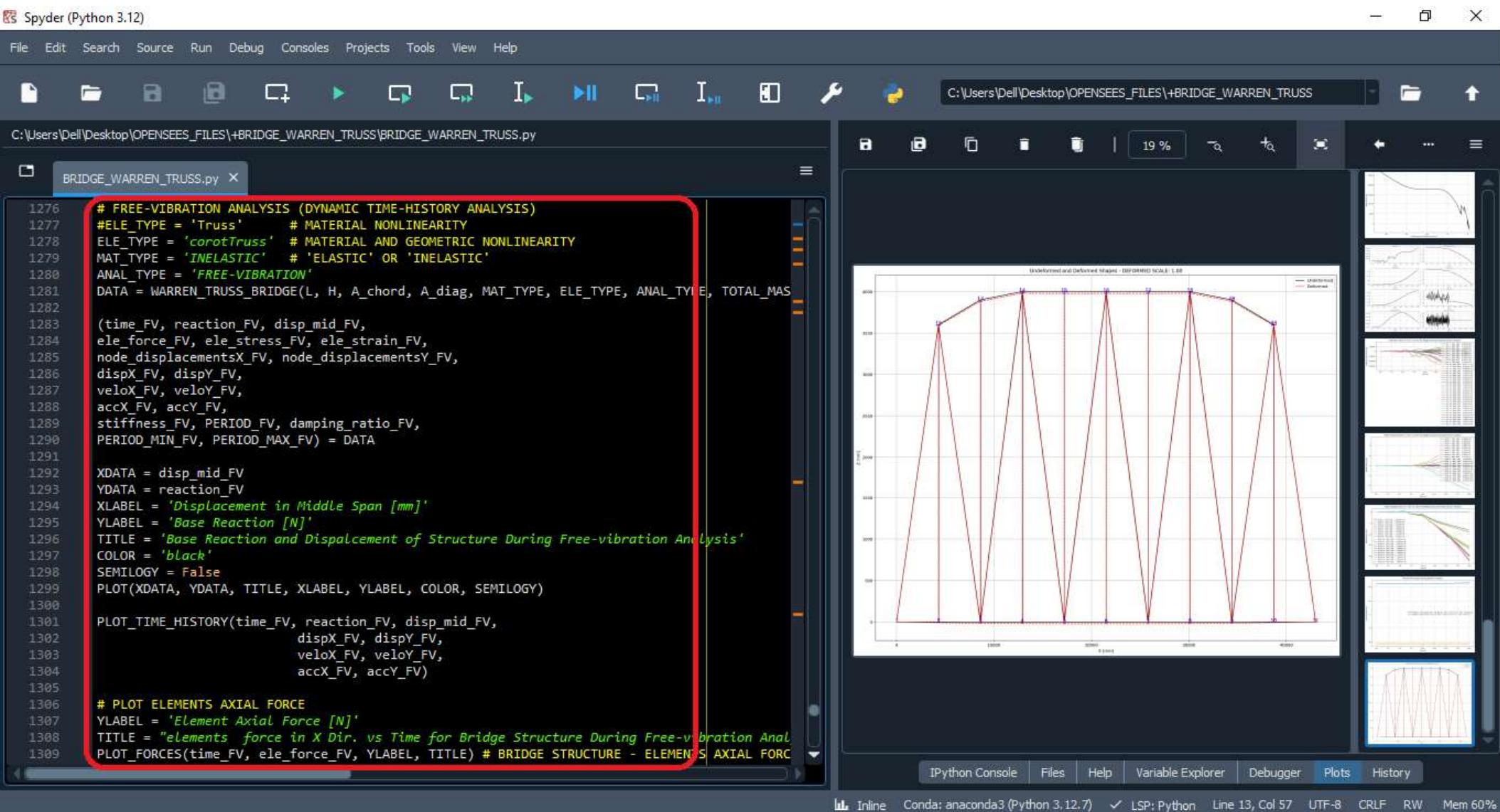


### Period of Structure During Dynamic External Time-dependent Loading Analysis

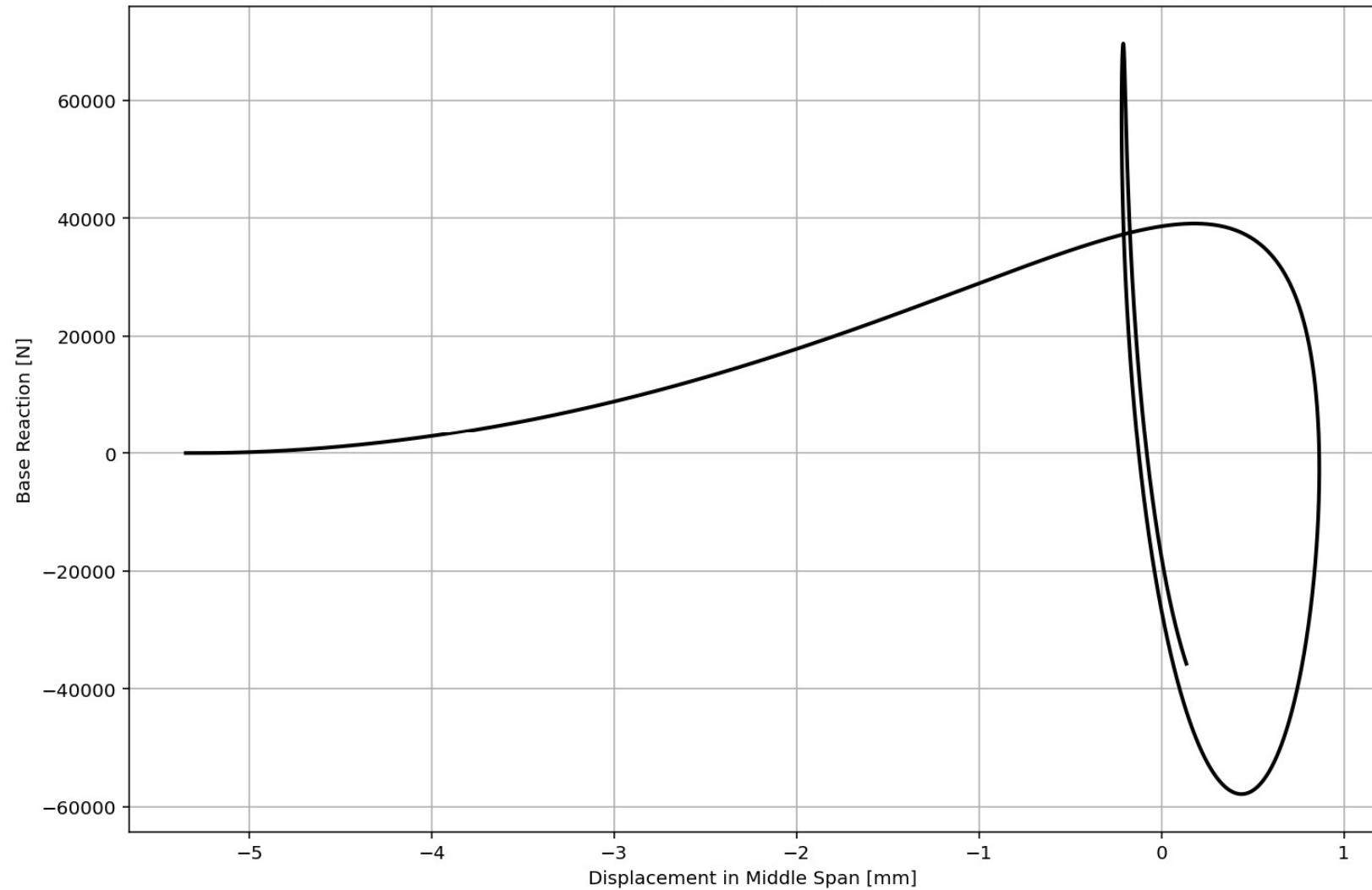


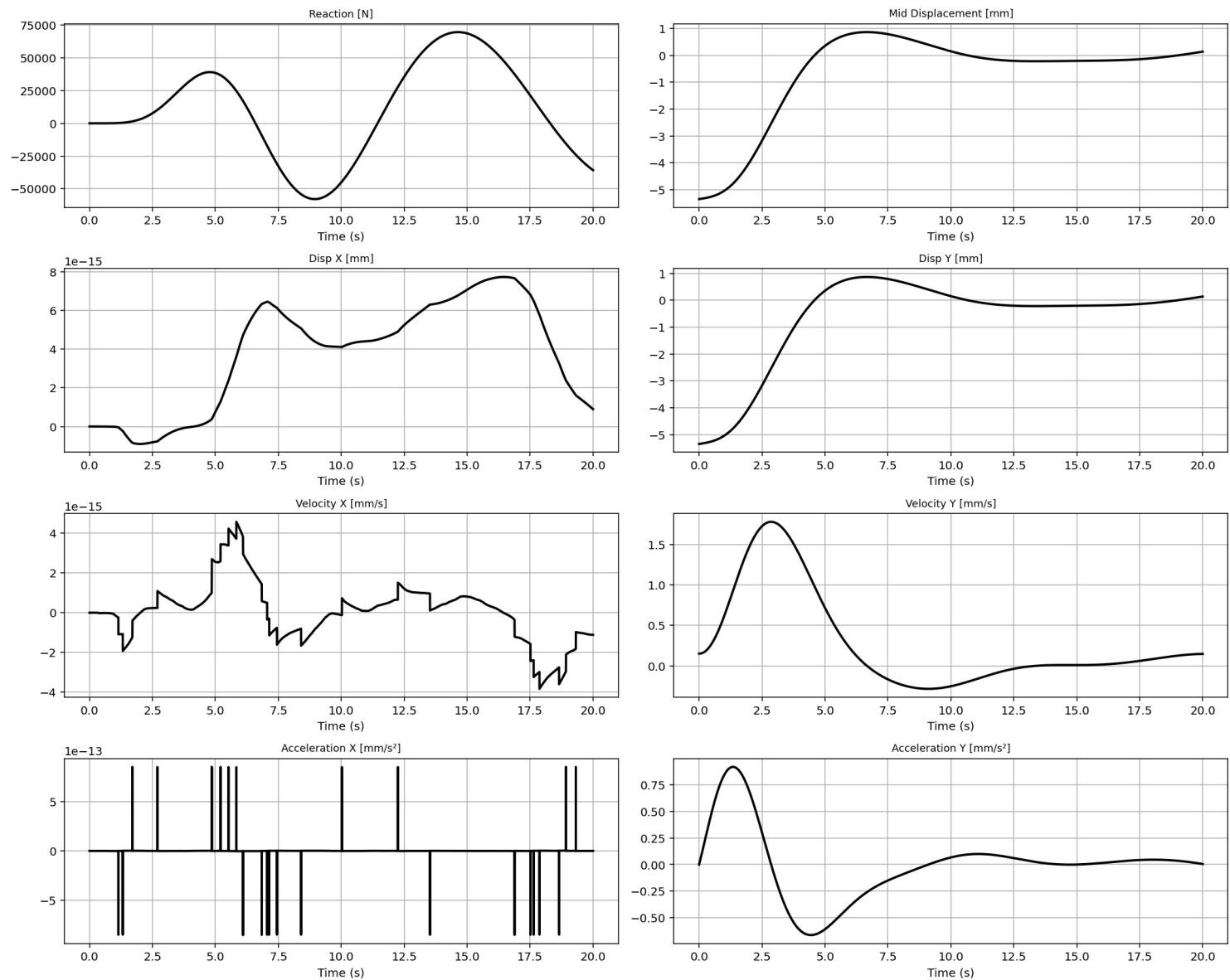


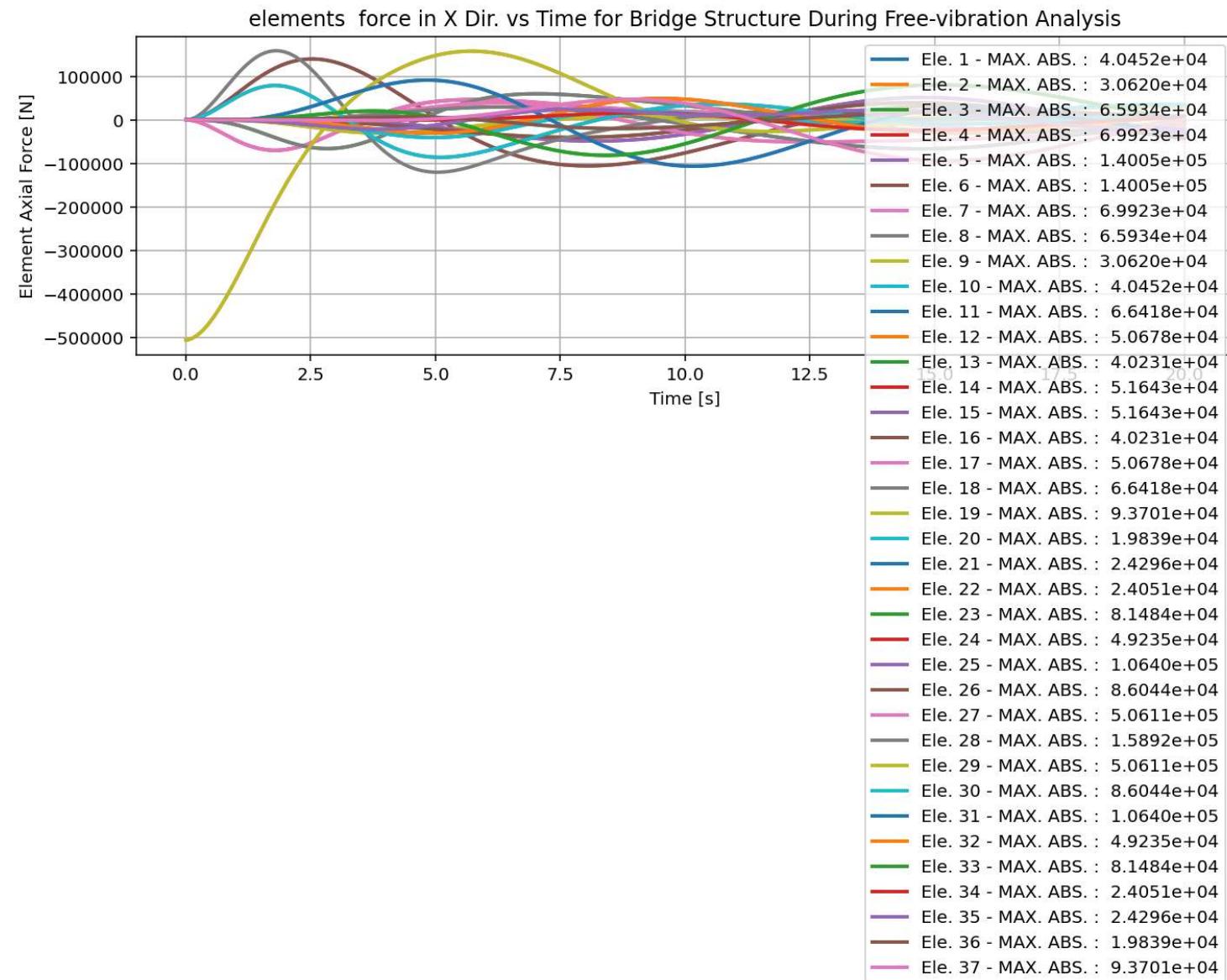
# FREE-VIBRATION ANALYSIS



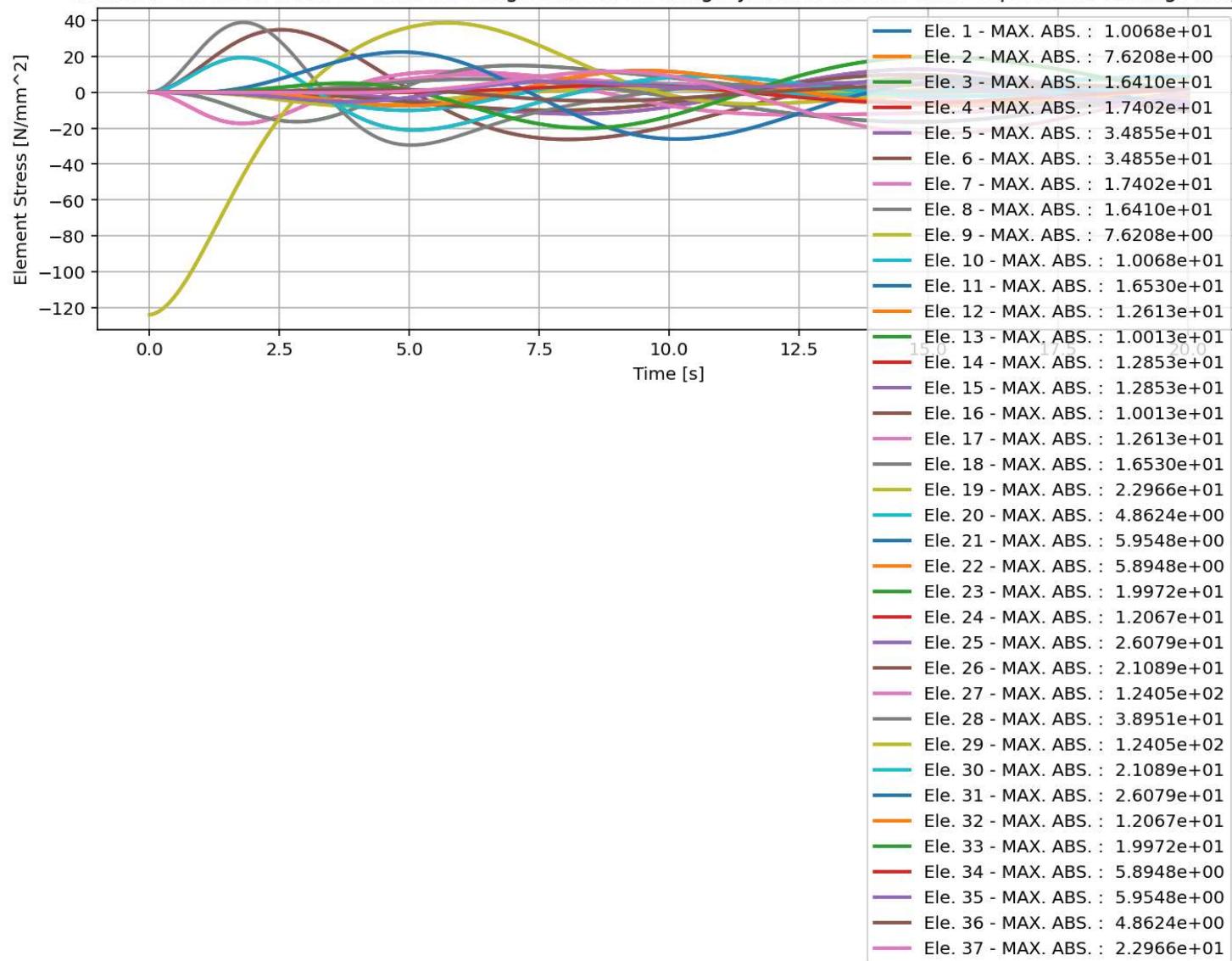
Base Reaction and Displacement of Structure During Free-vibration Analysis



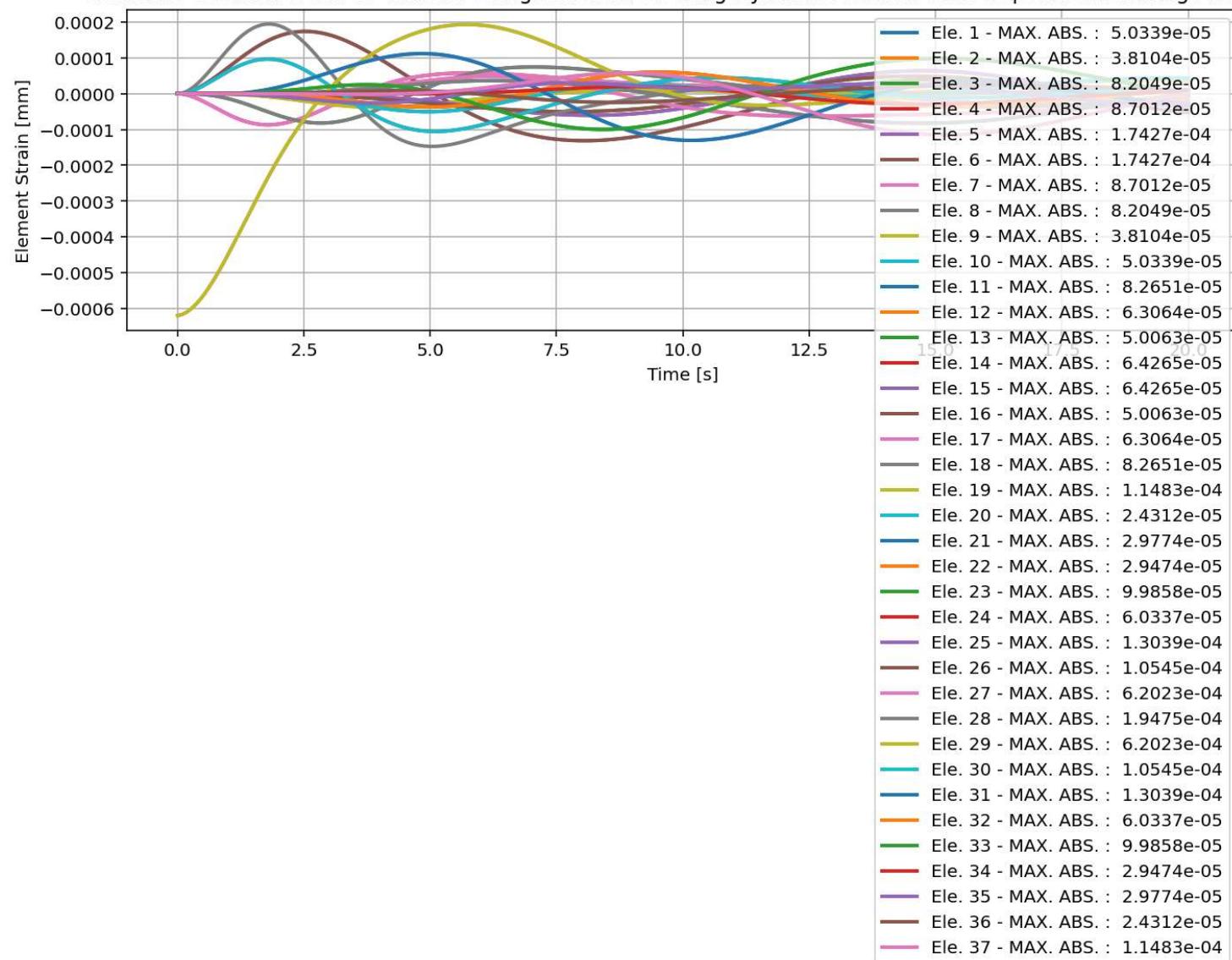


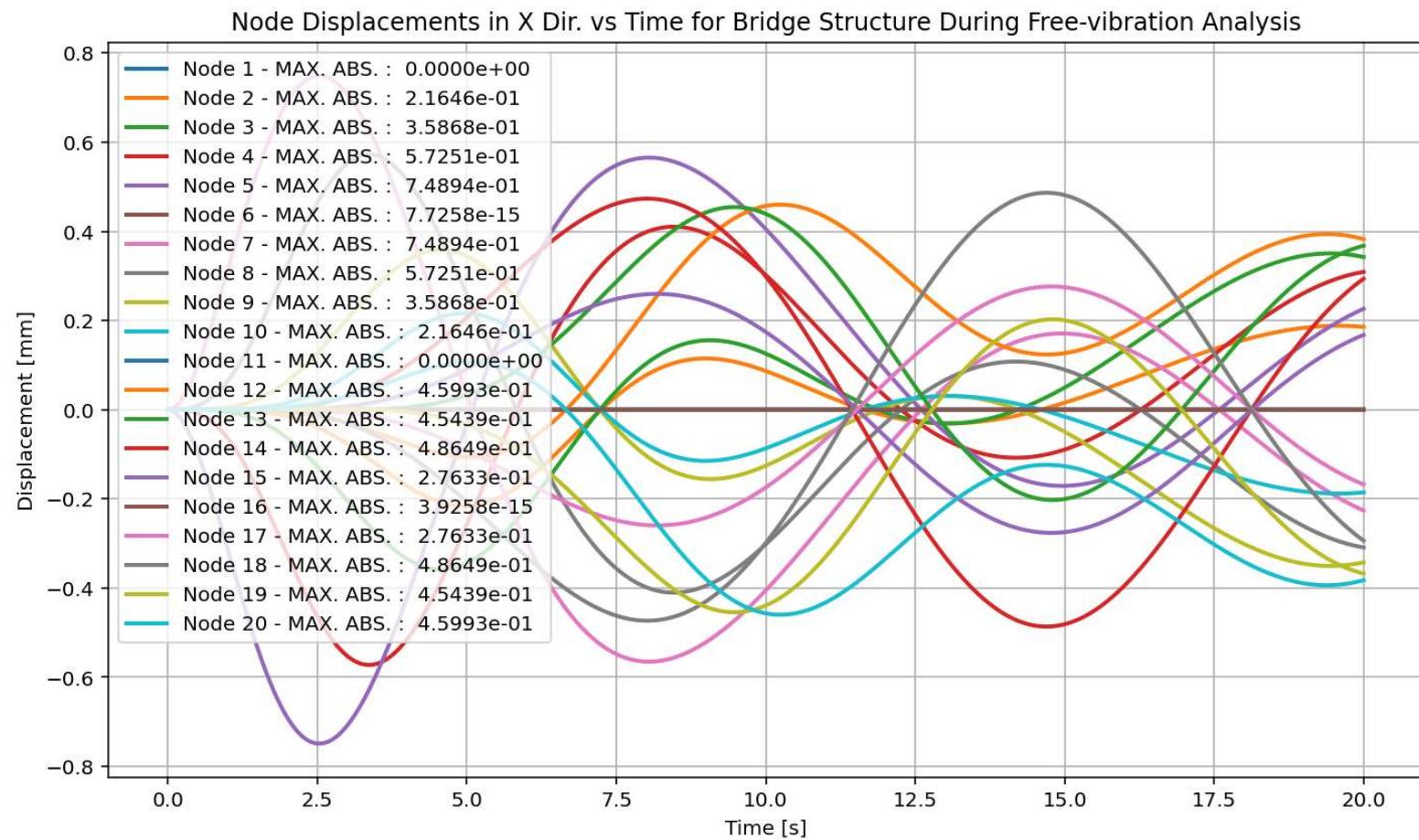


### elements Stress in X Dir. vs Time for Bridge Structure During Dynamic External Time-dependent Loading Analysis

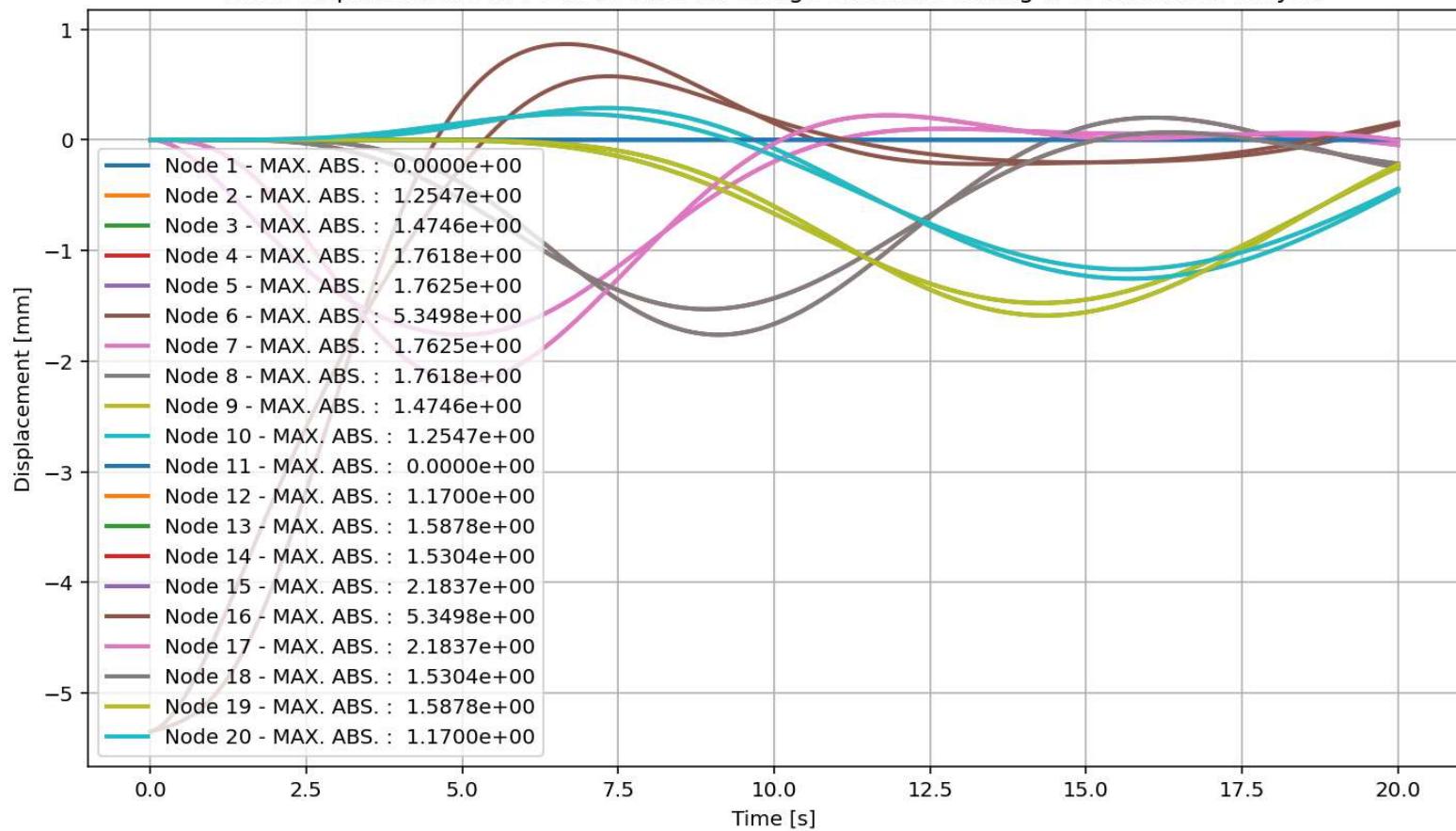


elements Strain in X Dir. vs Time for Bridge Structure During Dynamic External Time-dependent Loading Analysis

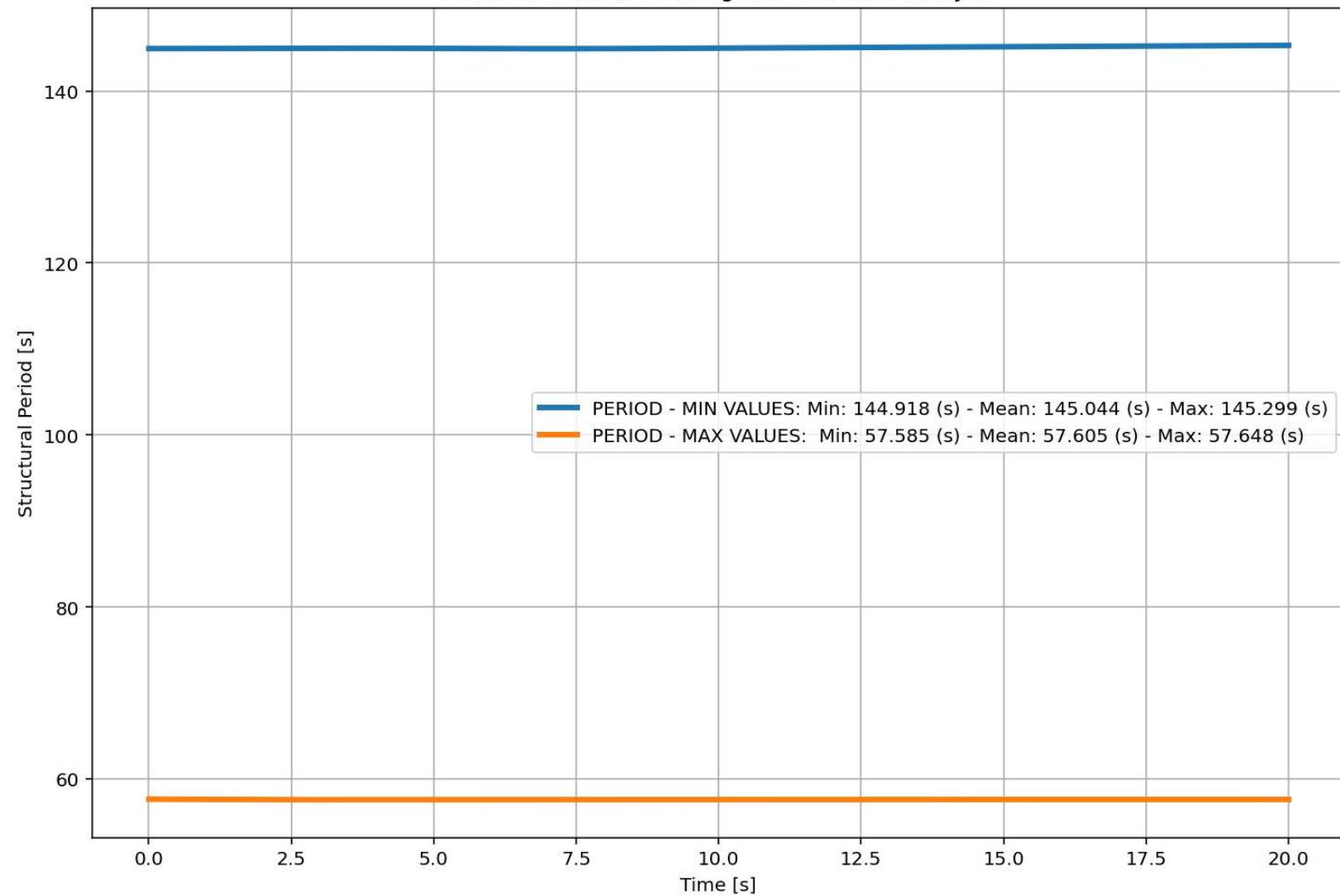


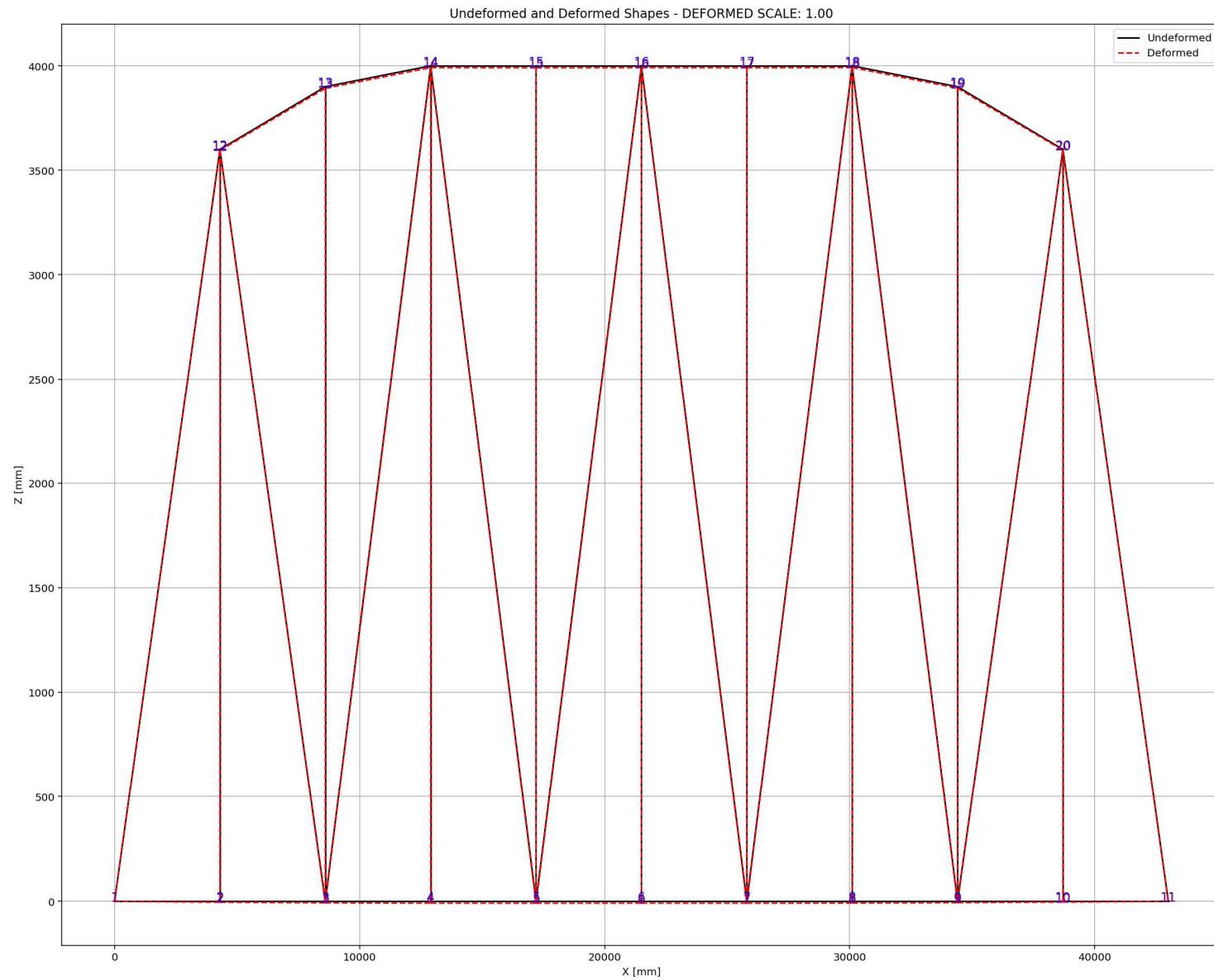


Node Displacements in Y Dir. vs Time for Bridge Structure During Free-vibration Analysis

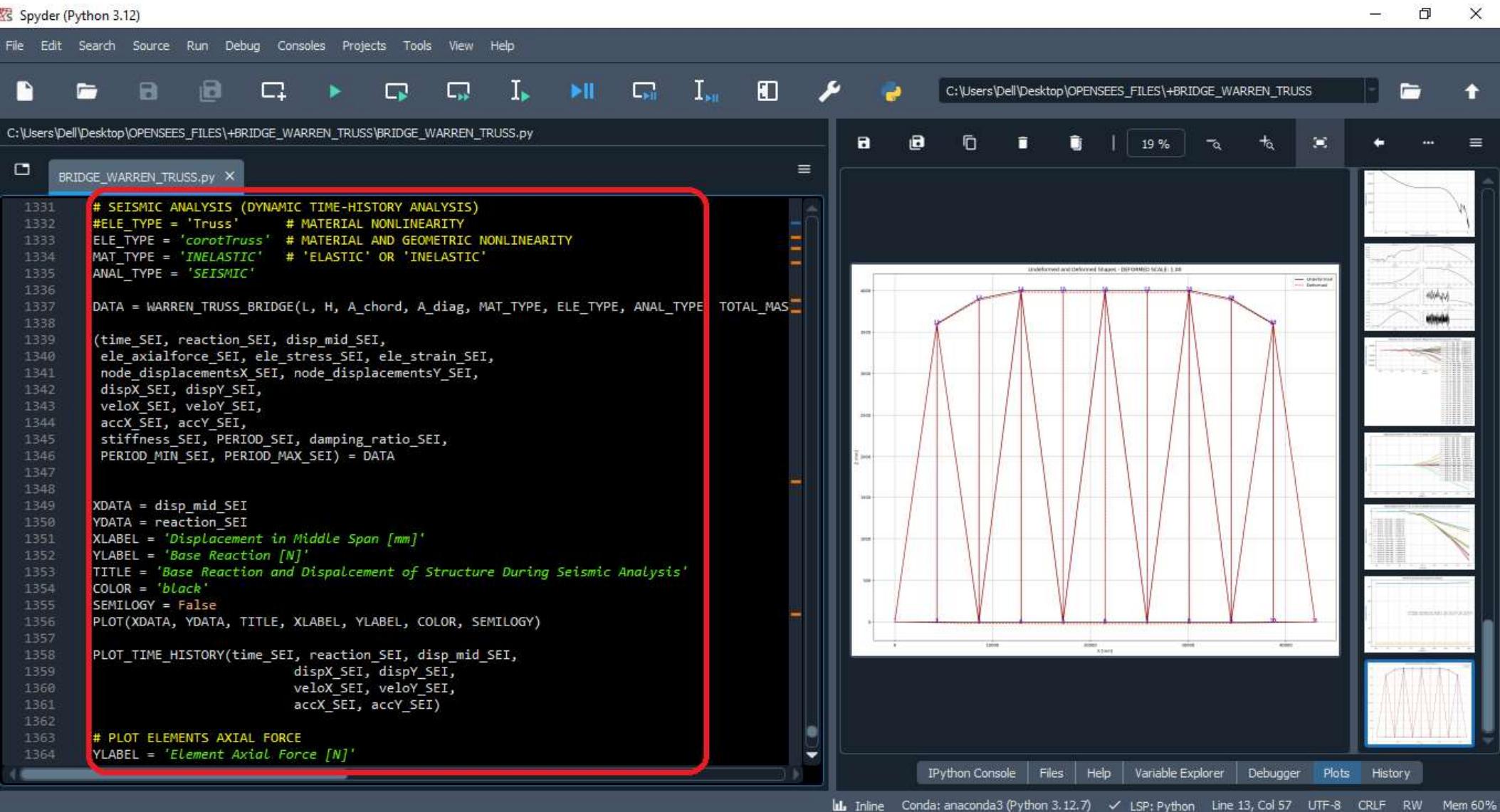


### Period of Structure During Free-vibration Analysis

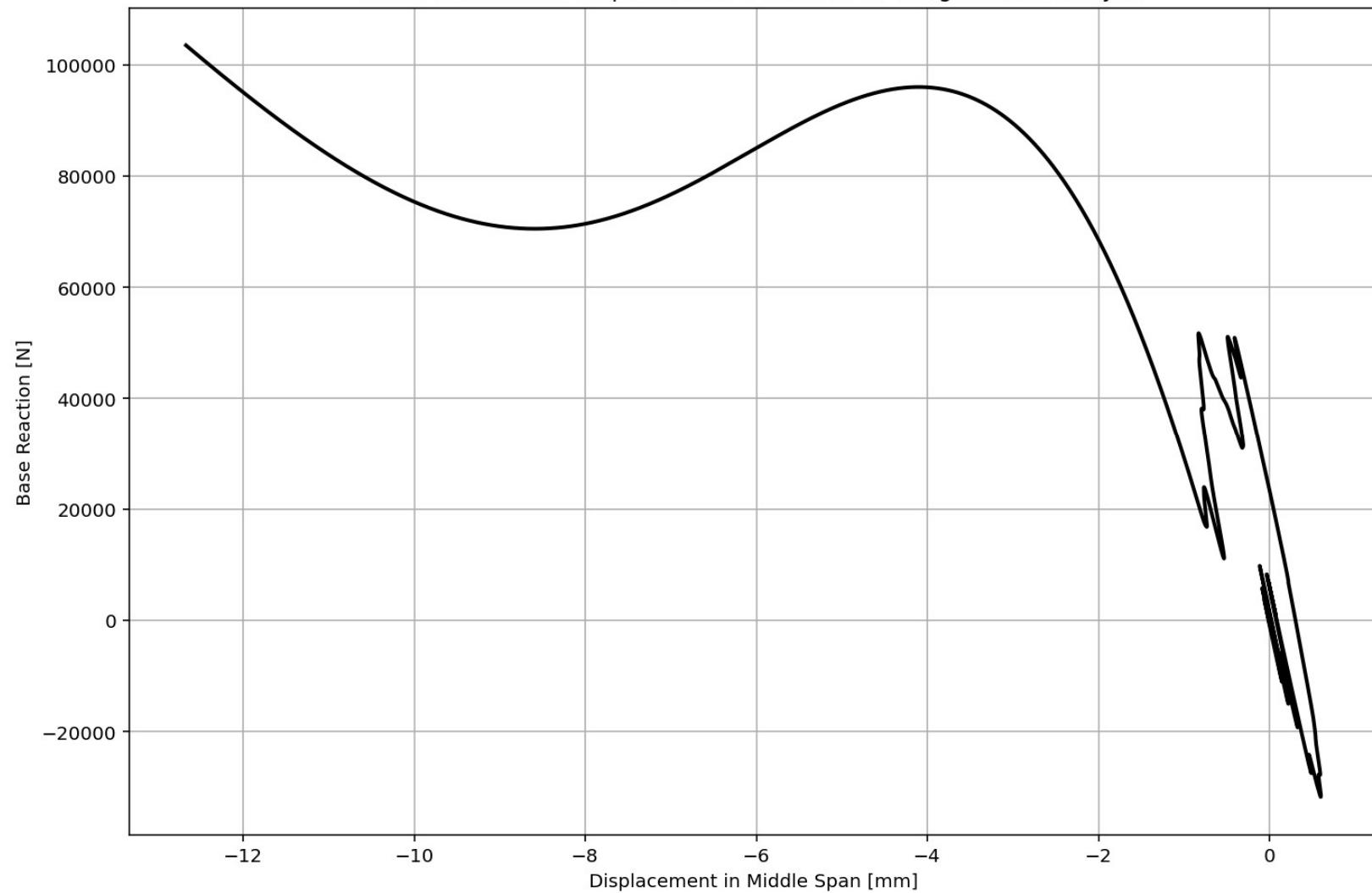


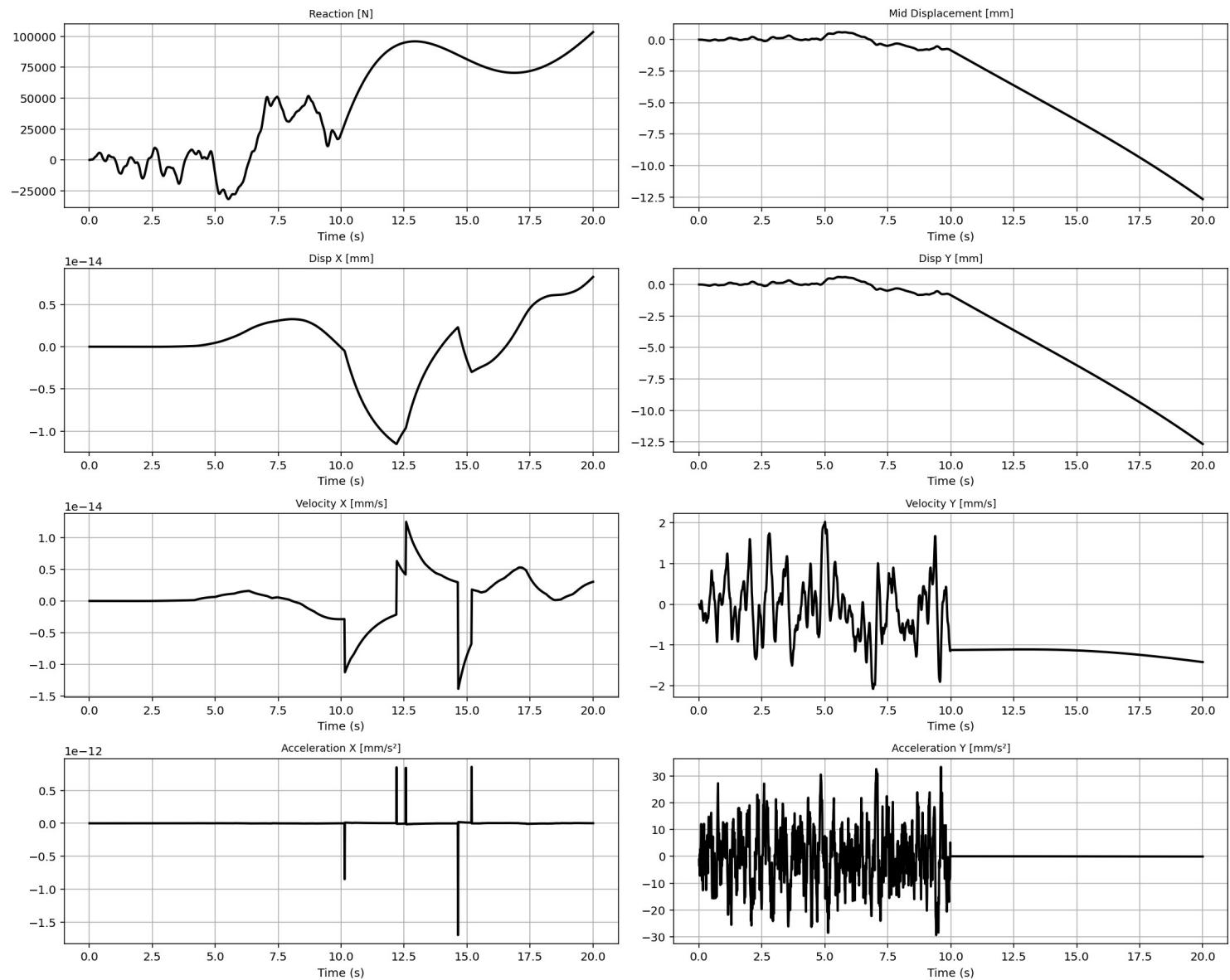


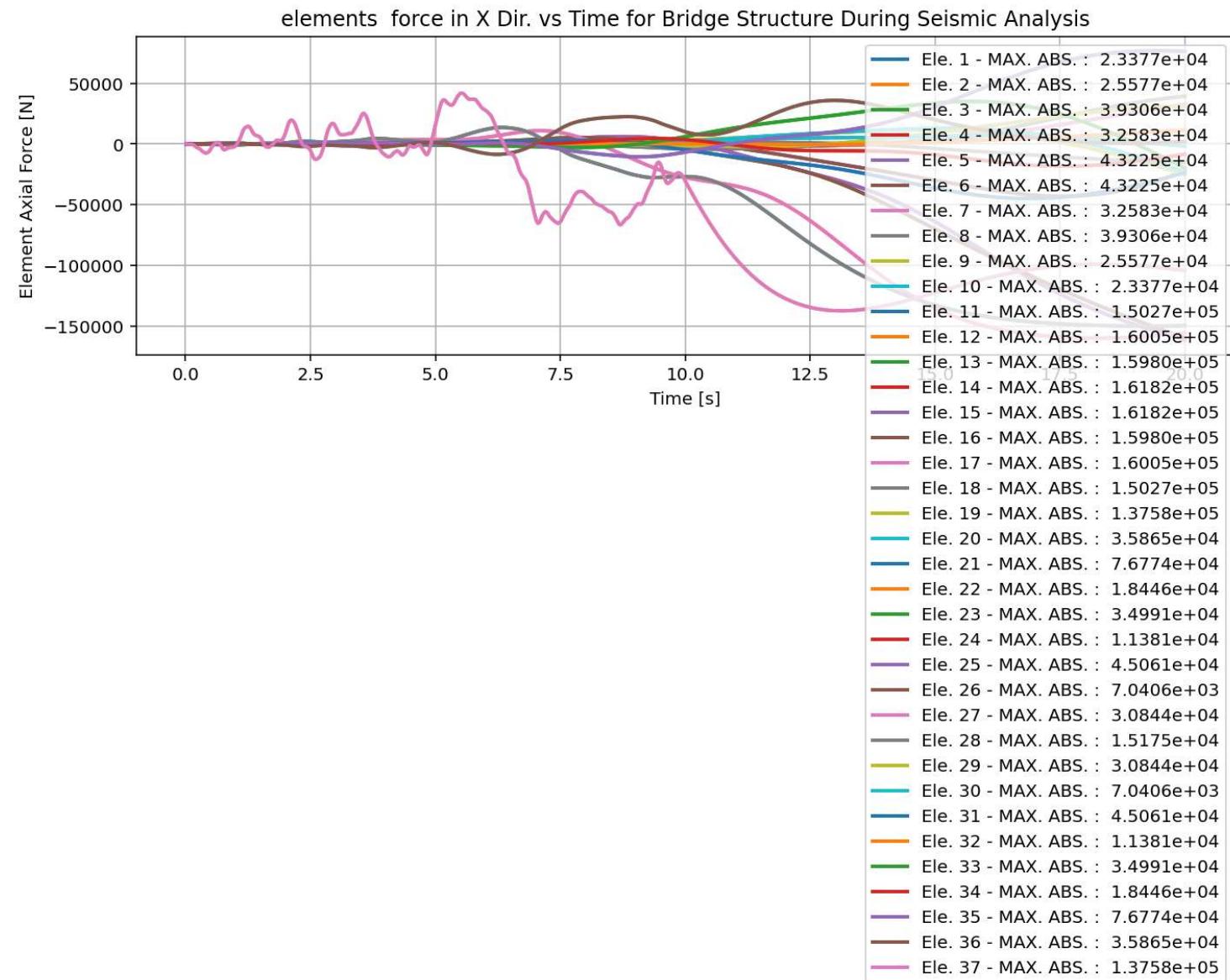
# **SEISMIC ANALYSIS**

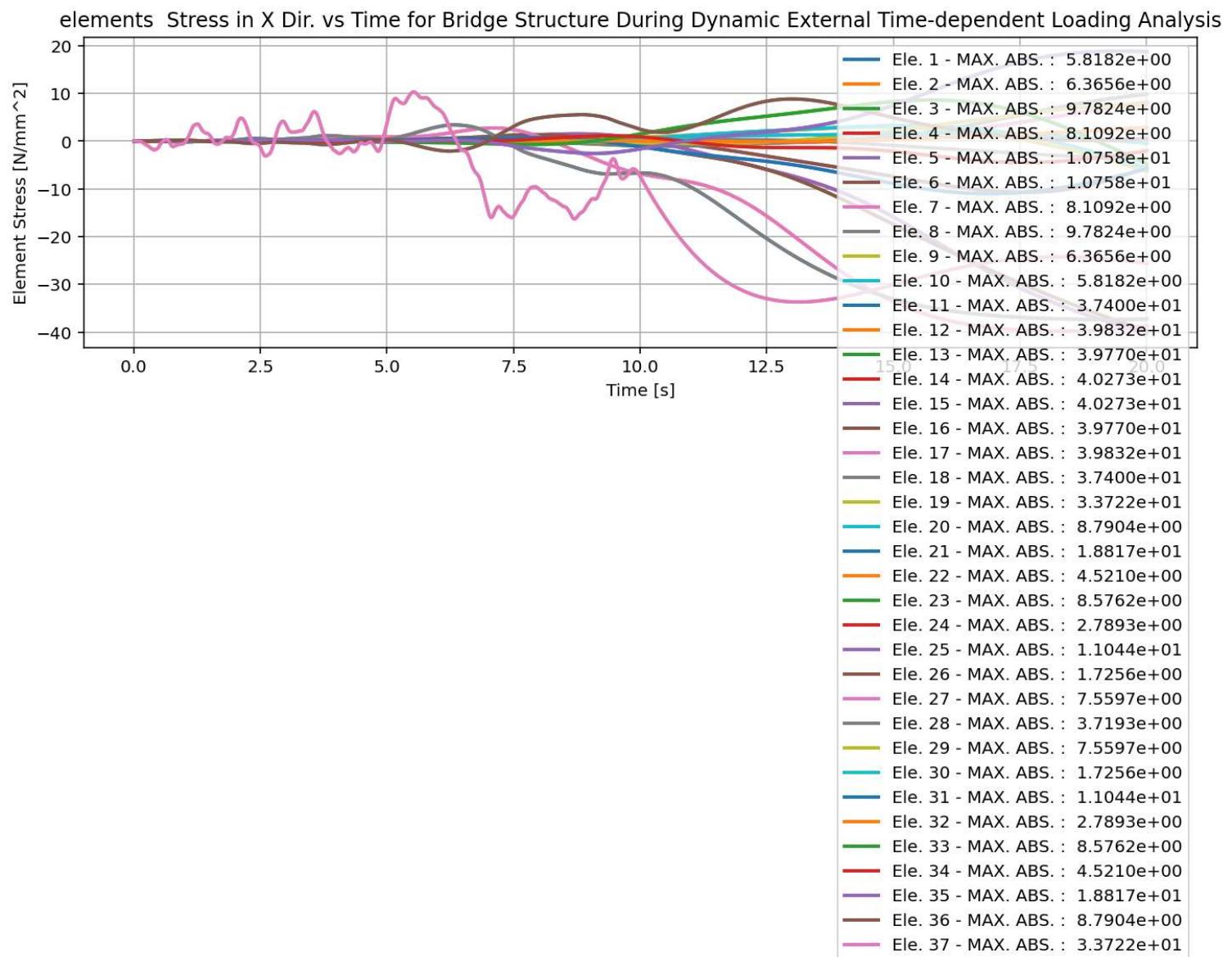


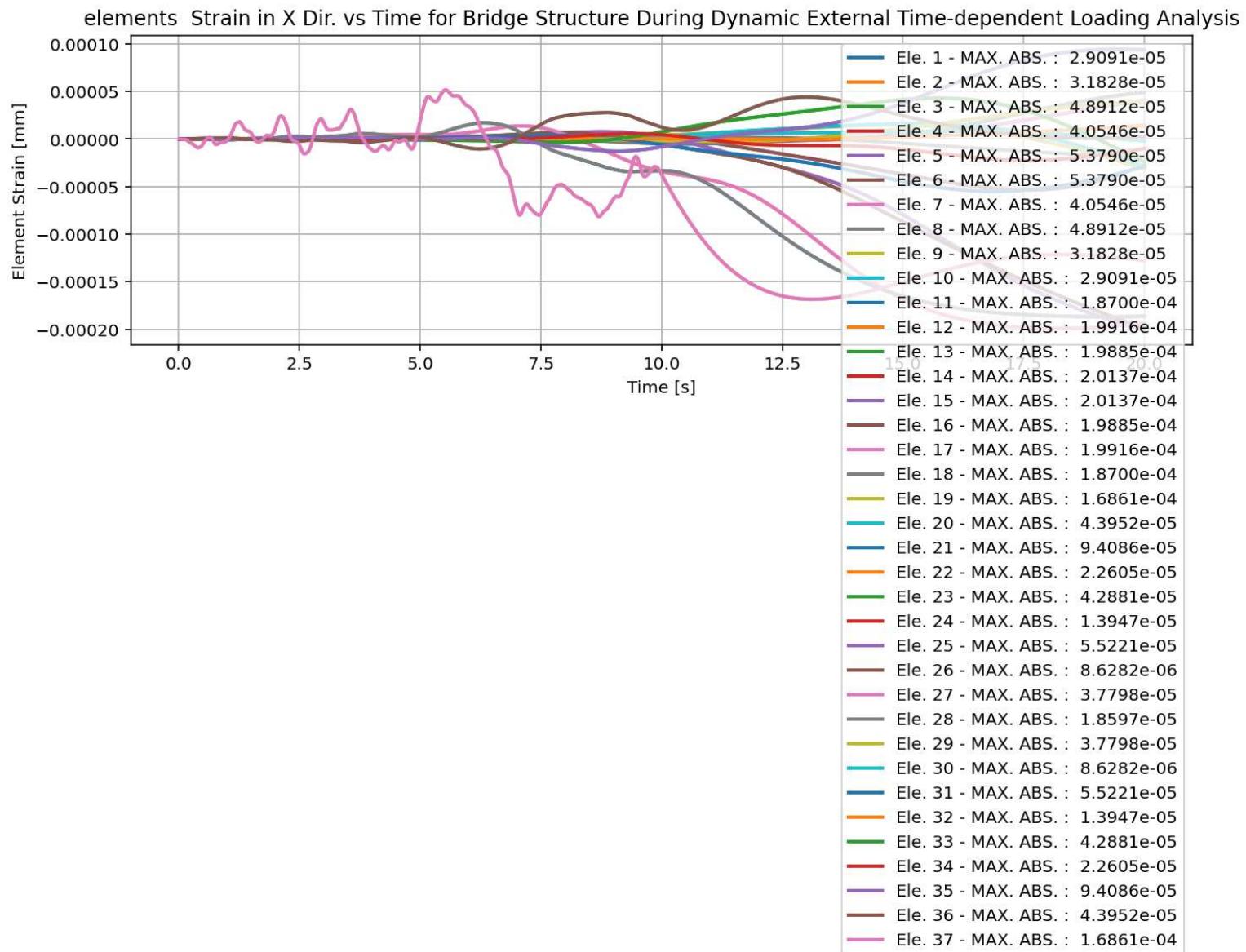
Base Reaction and Displacement of Structure During Seismic Analysis



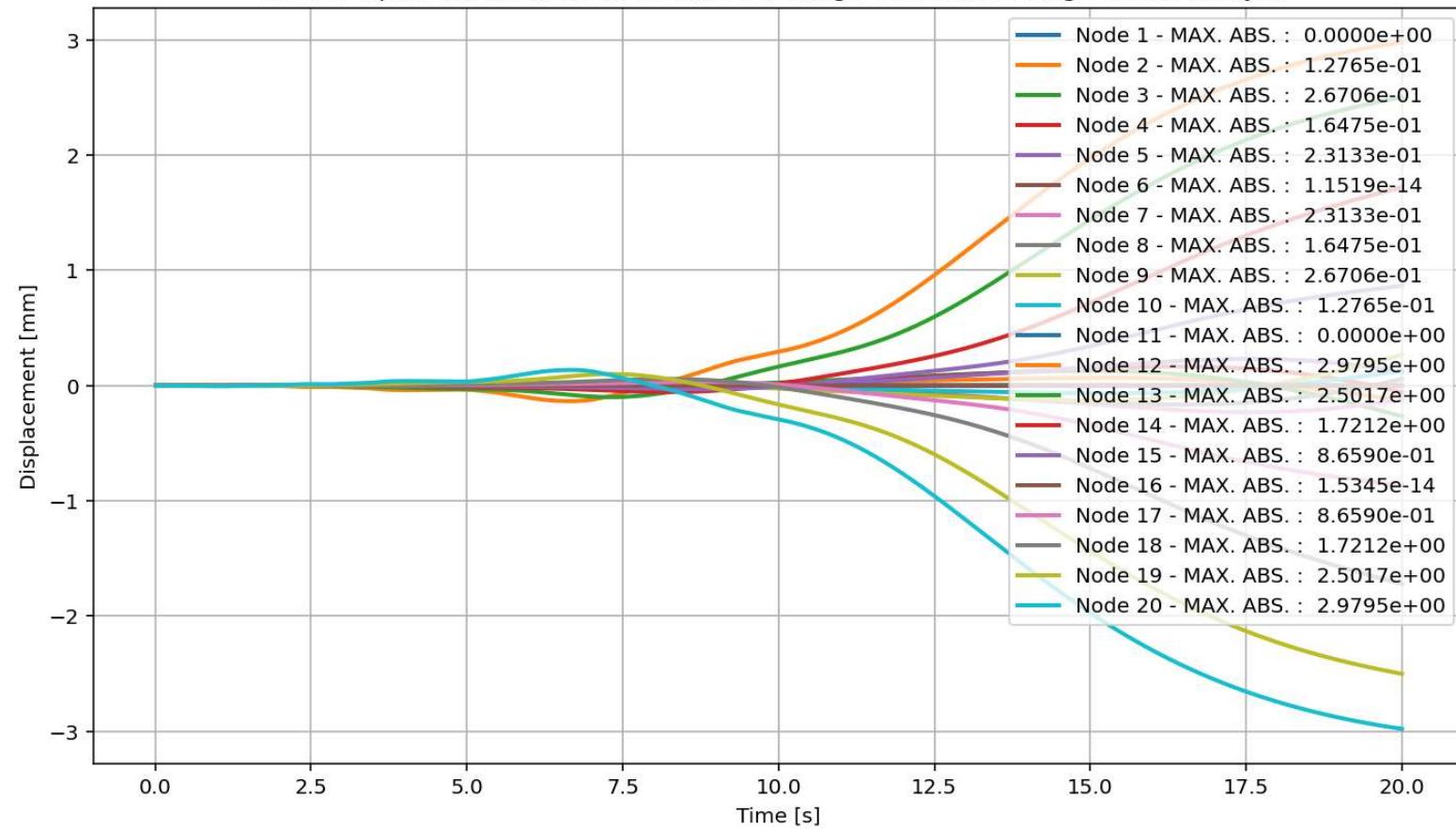




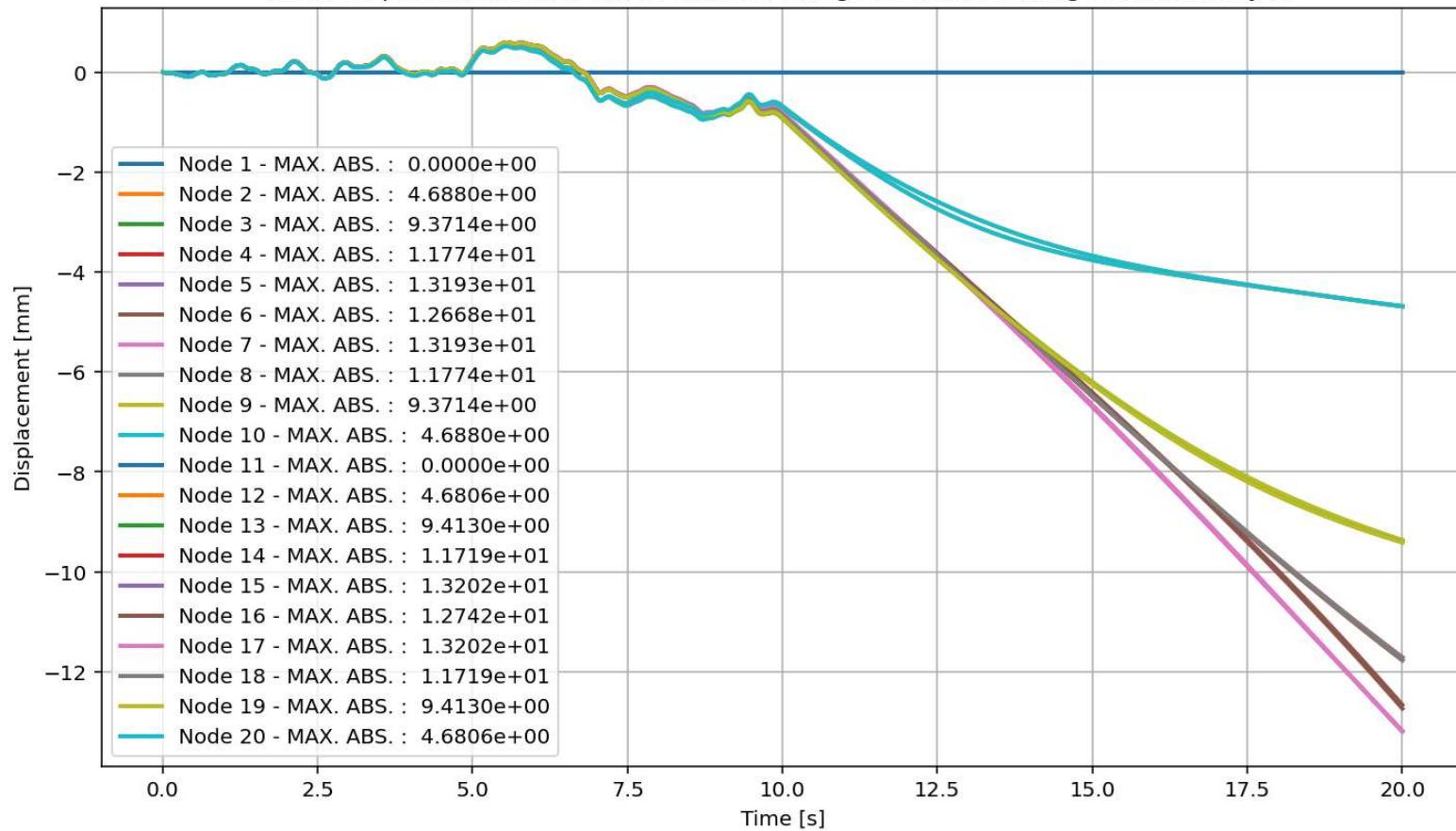




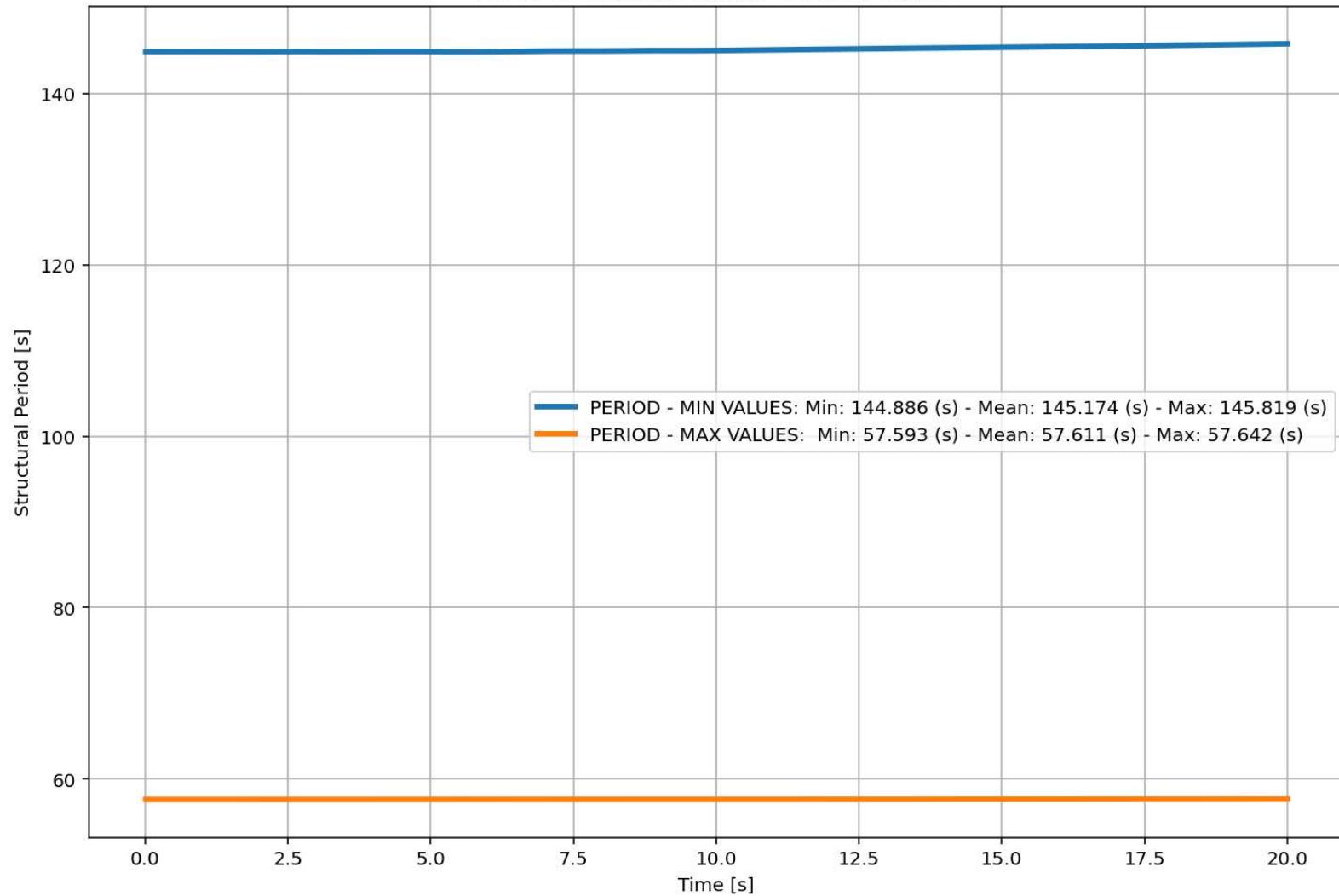
Node Displacements in X Dir. vs Time for Bridge Structure During Seismic Analysis



Node Displacements in Y Dir. vs Time for Bridge Structure During Seismic Analysis



### Period of Structure During Seismic Analysis



Last Data of BaseShear-Displacement Analysis - Ductility Ratio: 5.7564 - Over Strength Factor: 0.9949

