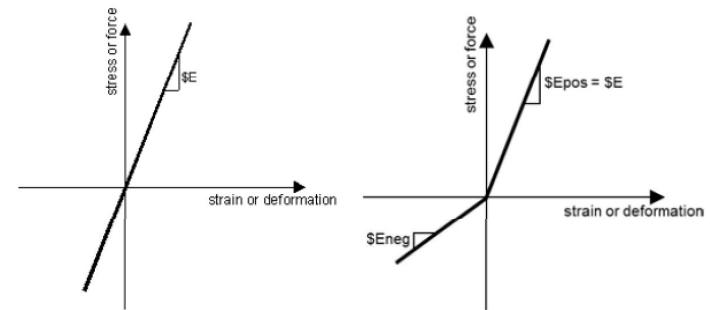
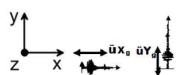
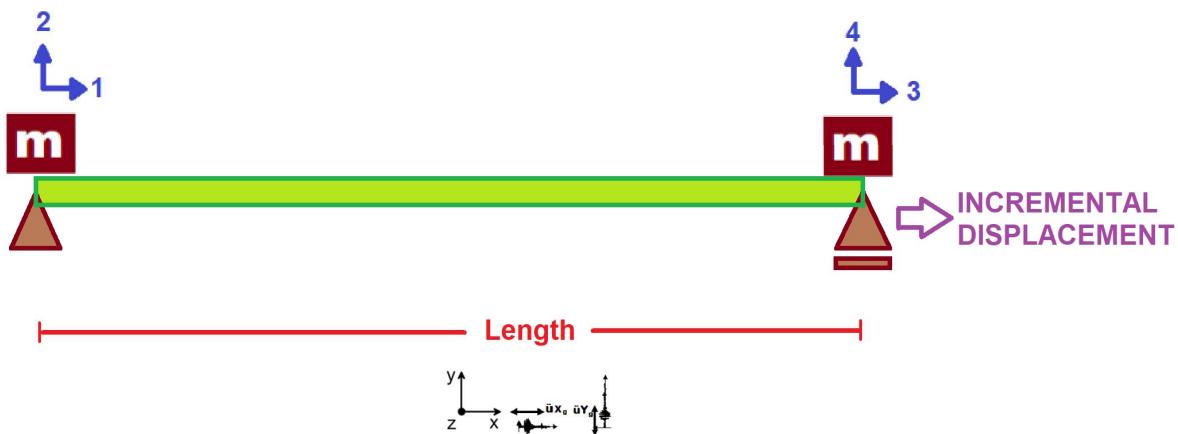


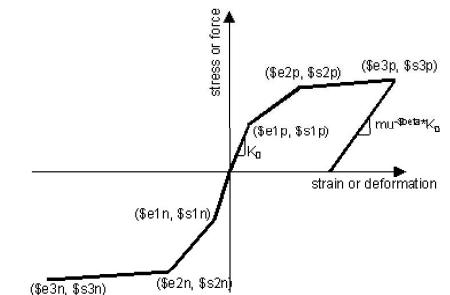
>> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<

# **COMPREHENSIVE NONLINEAR SEISMIC ASSESSMENT OF STEEL A TRUSS ELEMENT: 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)

File Edit Search Source Run Debug Consoles Projects Tools View Help

C:\Users\Dell\Desktop\OPENSEES\_FILES\+TRUSS\_ONE\_ELEMENT\TRUSS\_ONE\_ELEMENT.py

TRUSS\_ONE\_ELEMENT.py X

```

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

```

19 %

Undeformed and Deformed Shapes - DEFORMED SCALE: 1.00

IPython Console Files Help Variable Explorer Debugger Plots History

Inline Conda: anaconda3 (Python 3.12.7) ✓ LSP: Python Line 47, Col 58 UTF-8 CRLF RW Mem 44%

# **STATIC ANALYSIS**

Spyder (Python 3.12)

File Edit Search Source Run Debug Consoles Projects Tools View Help

C:\Users\Dell\Desktop\OPENSEES\_FILES\+TRUSS\_ONE\_ELEMENT

TRUSS\_ONE\_ELEMENT.py

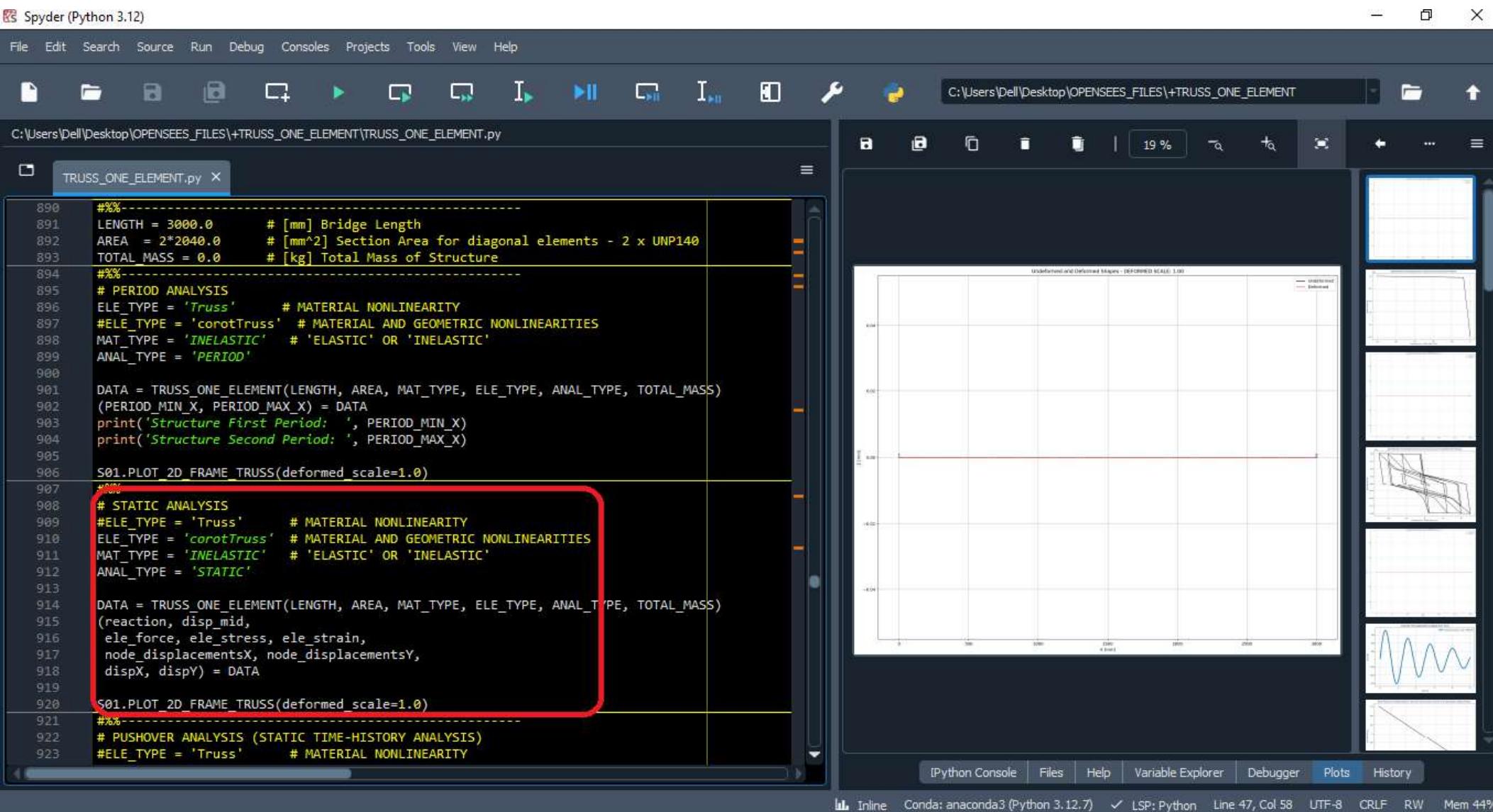
```
890 #%%-----  
891 LENGTH = 3000.0      # [mm] Bridge Length  
892 AREA = 2*2040.0     # [mm^2] Section Area for diagonal elements - 2 x UNP140  
893 TOTAL_MASS = 0.0    # [kg] Total Mass of Structure  
894 #%%-----  
895 # PERIOD ANALYSIS  
896 ELE_TYPE = 'Truss'      # MATERIAL NONLINEARITY  
897 #ELE_TYPE = 'corotTruss' # MATERIAL AND GEOMETRIC NONLINEARITIES  
898 MAT_TYPE = 'INELASTIC'   # 'ELASTIC' OR 'INELASTIC'  
899 ANAL_TYPE = 'PERIOD'  
900  
901 DATA = TRUSS_ONE_ELEMENT(LENGTH, AREA, MAT_TYPE, ELE_TYPE, ANAL_TYPE, TOTAL_MASS)  
902 (PERIOD_MIN_X, PERIOD_MAX_X) = DATA  
903 print('Structure First Period: ', PERIOD_MIN_X)  
904 print('Structure Second Period: ', PERIOD_MAX_X)  
905  
906 S01.PLOT_2D_FRAME_TRUSS(deformed_scale=1.0)  
907 #%%-----  
908 # STATIC ANALYSIS  
909 #ELE_TYPE = 'Truss'      # MATERIAL NONLINEARITY  
910 ELE_TYPE = 'corotTruss'  # MATERIAL AND GEOMETRIC NONLINEARITIES  
911 MAT_TYPE = 'INELASTIC'   # 'ELASTIC' OR 'INELASTIC'  
912 ANAL_TYPE = 'STATIC'  
913  
914 DATA = TRUSS_ONE_ELEMENT(LENGTH, AREA, MAT_TYPE, ELE_TYPE, ANAL_TYPE, TOTAL_MASS)  
915 (reaction, disp_mid,  
916 ele_force, ele_stress, ele_strain,  
917 node_displacementsX, node_displacementsY,  
918 dispX, dispY) = DATA  
919  
920 S01.PLOT_2D_FRAME_TRUSS(deformed_scale=1.0)  
921 #%%-----  
922 # PUSHOVER ANALYSIS (STATIC TIME-HISTORY ANALYSIS)  
923 #ELE_TYPE = 'Truss'      # MATERIAL NONLINEARITY
```

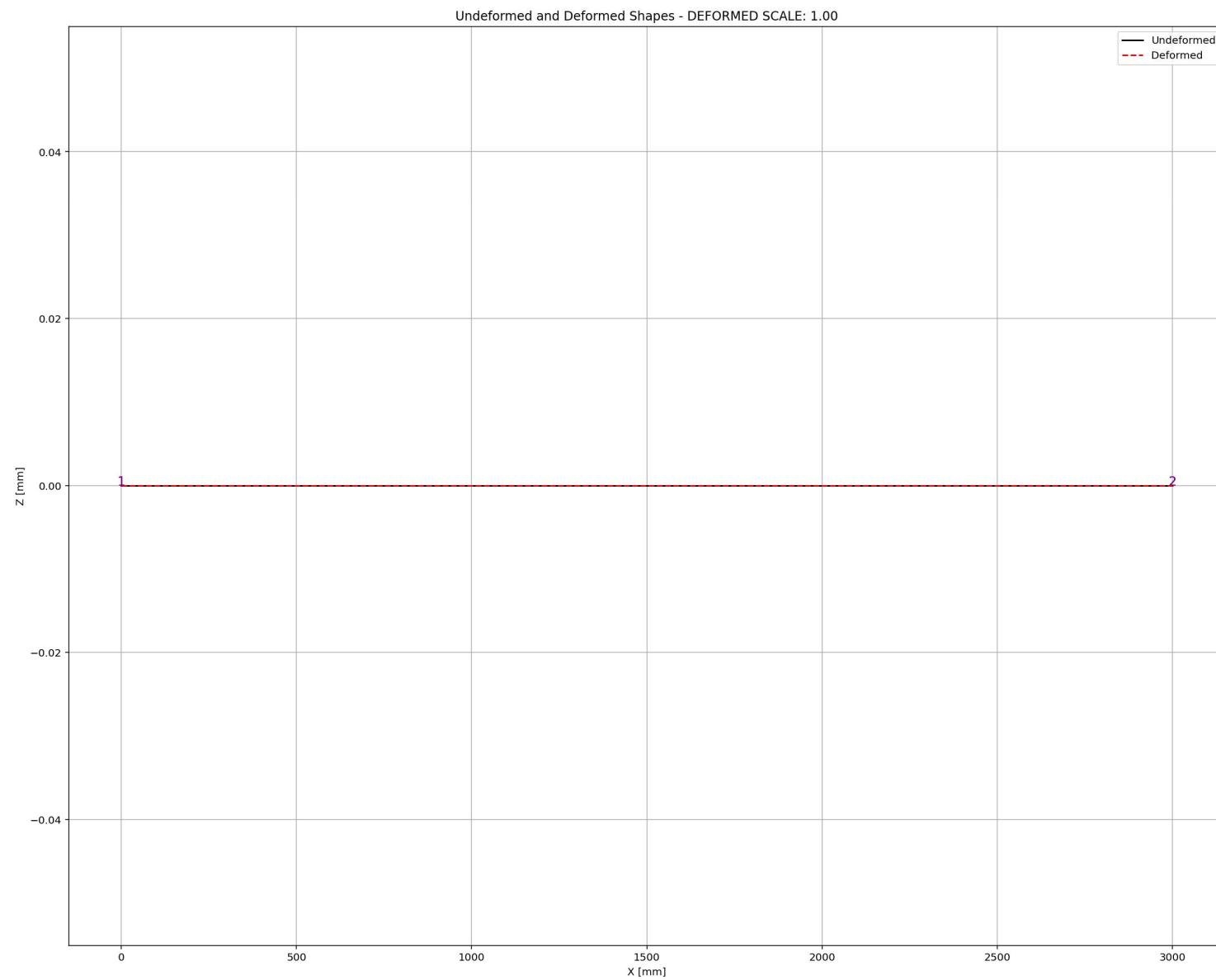
19 %

Undefined and Undefined Images (REFRESHED SCALE: 1.00)

IPython Console Files Help Variable Explorer Debugger Plots History

Inline Conda: anaconda3 (Python 3.12.7) ✓ LSP: Python Line 47, Col 58 UTF-8 CRLF RW Mem 44%





# PUSHOVER ANALYSIS

Spyder (Python 3.12)

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C:\Users\Dell\Desktop\OPENSEES\_FILES\+TRUSS\_ONE\_ELEMENT

TRUSS\_ONE\_ELEMENT.py

```
920 S01.PLOT_2D_FRAME_TRUSS(deformed scale=1.0)
921 #%%-----#
922 # PUSHOVER ANALYSIS (STATIC TIME-HISTORY ANALYSIS)
923 #ELE_TYPE = 'Truss'      # MATERIAL NONLINEARITY
924 ELE_TYPE = 'corotTruss'  # MATERIAL AND GEOMETRIC NONLINEARITIES
925 MAT_TYPE = 'INELASTIC'   # 'ELASTIC' OR 'INELASTIC'
926 ANAL_TYPE = 'PUSHOVER'
927
928 DATA = TRUSS_ONE_ELEMENT(LENGTH, AREA, MAT_TYPE, ELE_TYPE, ANAL_TYPE, TOTAL_MASS)
929 (reaction_PUSH, disp_mid_PUSH,
930  ele_force_PUSH, ele_stress_PUSH, ele_strain_PUSH,
931  node_displacementsX_PUSH, node_displacementsY_PUSH,
932  dispX_PUSH, dispY_PUSH,
933  PERIOD_MIN_PUSH, PERIOD_MAX_PUSH) = DATA
934
935
936 XDATA = disp_mid_PUSH
937 YDATA = reaction_PUSH
938 XLABEL = 'Displacement in Middle Span [mm]'
939 YLABEL = 'Base Reaction [N]'
940 TITLE = 'Base Reaction and Displacement of Structure During Pushover Analysis'
941 COLOR = 'black'
942 SEMILOGY = False
943 PLOT(XDATA, YDATA, TITLE, XLABEL, YLABEL, COLOR, SEMILOGY)
944
945 DATA = S07.BILINEAR_CURVE(np.abs(disp_mid_PUSH), np.abs(reaction_PUSH), SLOPE_NODE=10)
946 (X_PUSH, Y_PUSH, Elastic_ST, Plastic_ST, Tangent_ST, Ductility_Rito, Over_Strength_Factor)
947 """
948 # PLOT STRUCTURAL PERIOD DURING THE ANALYSIS
949 plt.figure(0, figsize=(12, 8))
950 plt.plot(disp_mid_PUSH, PERIOD_MIN_PUSH, linewidth=3)
951 plt.plot(disp_mid_PUSH, PERIOD_MAX_PUSH, linewidth=3)
952 plt.title('Period of Structure During Pushover Analysis')
953 plt.ylabel('Structural Period [s]')
```

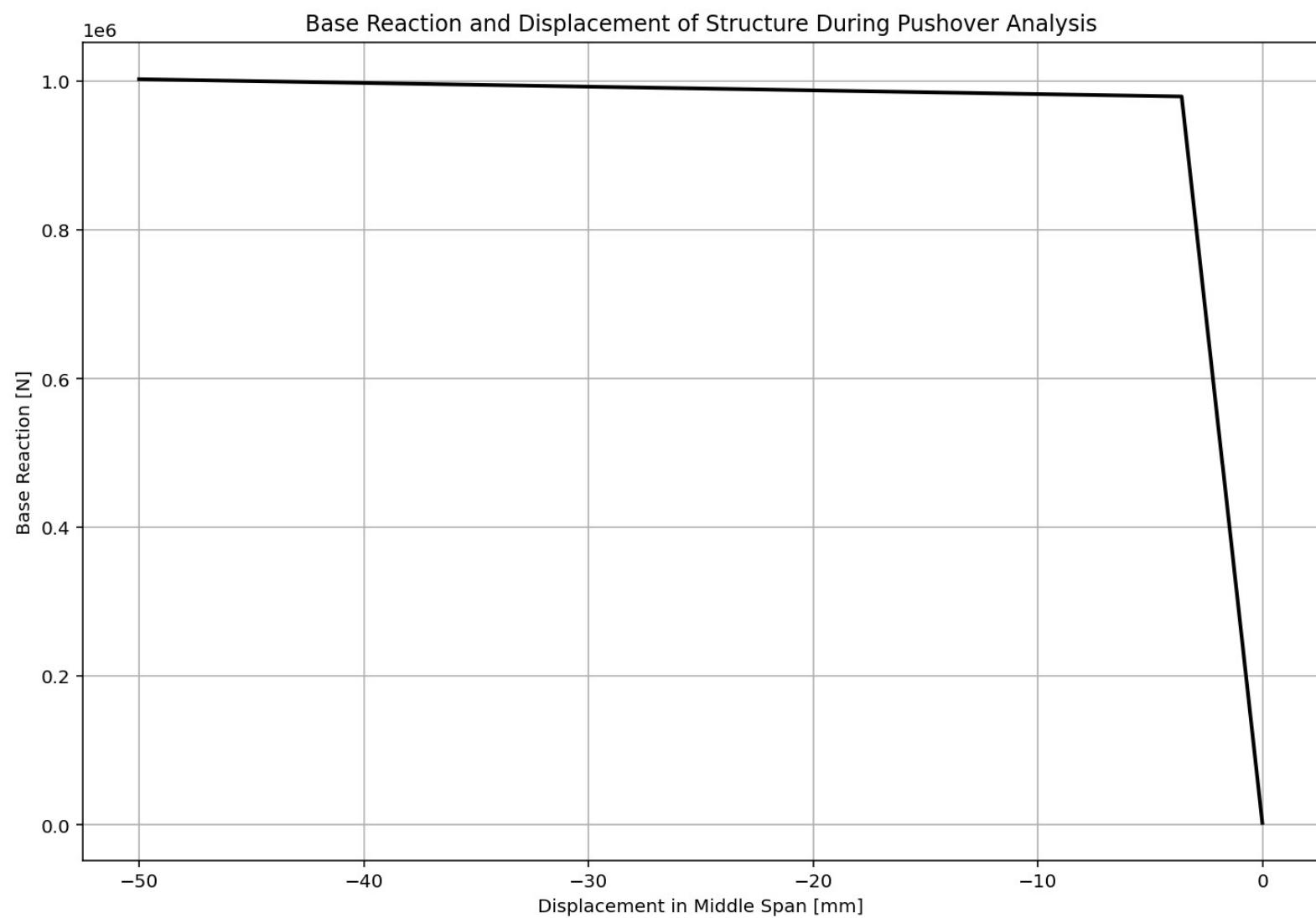
Base Reaction and Displacement of Structure During Pushover Analysis

Base Reaction [N]

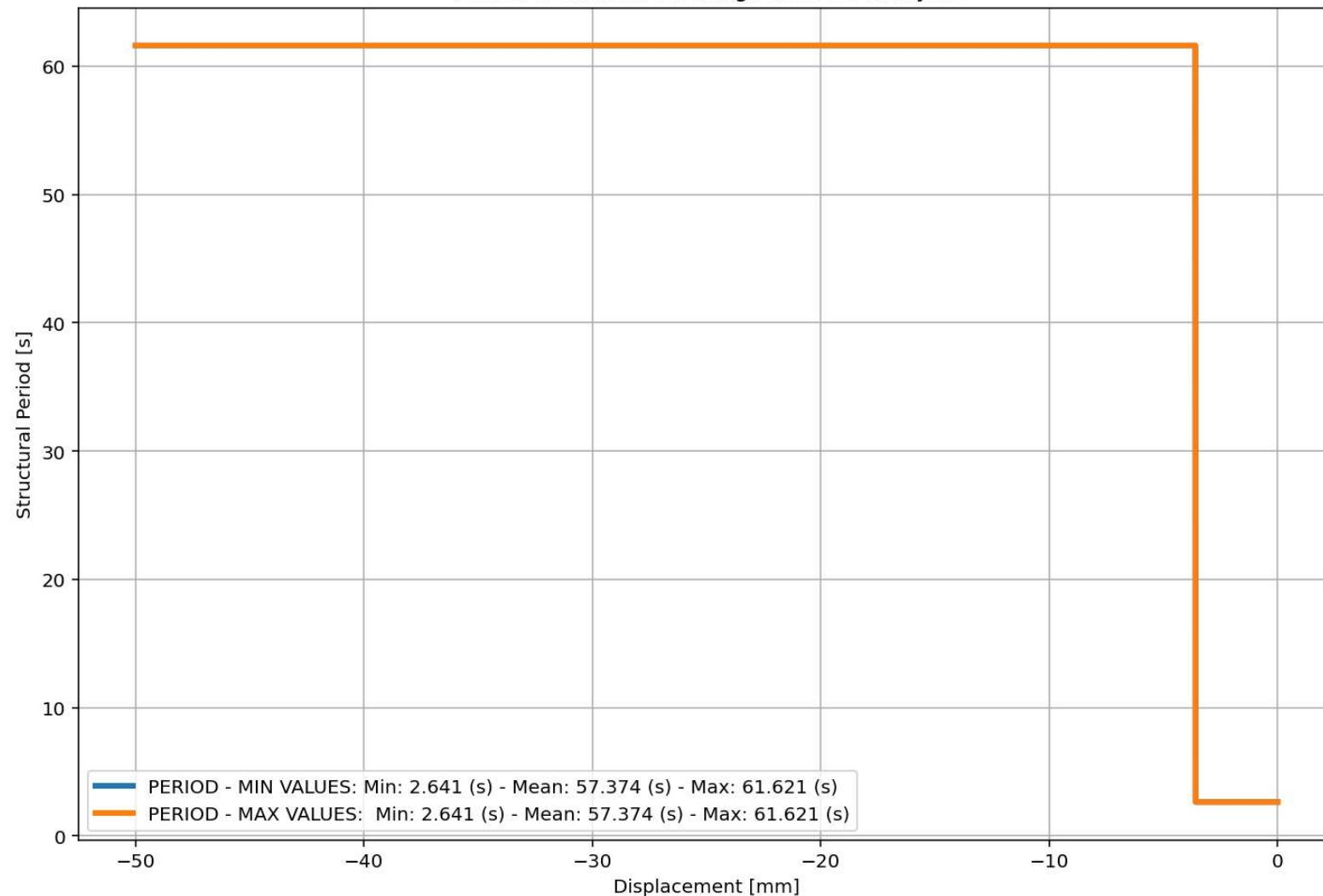
Displacement in Middle Span [mm]

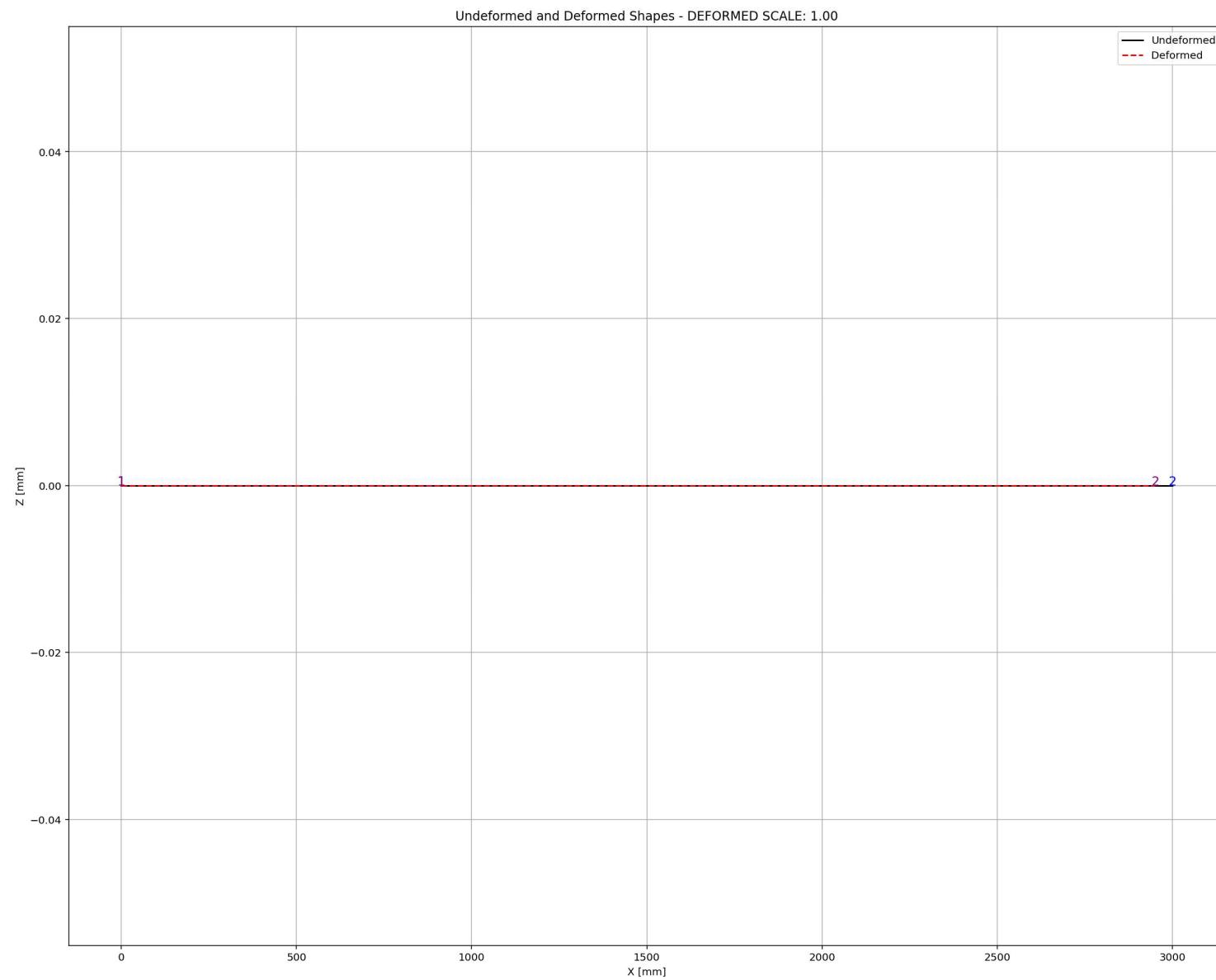
IPython Console Files Help Variable Explorer Debugger Plots History

Inline Conda: anaconda3 (Python 3.12.7) ✓ LSP: Python Line 47, Col 58 UTF-8 CRLF RW Mem 47%



### Period of Structure During Pushover Analysis





# CYCLIC DISPLACEMENT ANALYSIS

Spyder (Python 3.12)

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C:\Users\Dell\Desktop\OPENSEES\_FILES\+TRUSS\_ONE\_ELEMENT

TRUSS\_ONE\_ELEMENT.py

```
964 # CYCLIC DISPLACEMENT ANALYSIS (STATIC TIME-HISTORY ANALYSIS)
965 #ELE_TYPE = 'Truss'      # MATERIAL NONLINEARITY
966 ELE_TYPE = 'corotTruss'  # MATERIAL AND GEOMETRIC NONLINEARITIES
967 MAT_TYPE = 'INELASTIC'   # 'ELASTIC' OR 'INELASTIC'
968 ANAL_TYPE = 'CYCLIC_DISPLACEMENT'
969
970 DATA = TRUSS_ONE_ELEMENT(LENGTH, AREA, MAT_TYPE, ELE_TYPE, ANAL_TYPE, TOTAL_MASS)
971 (reaction_CP, disp_mid_CP,
972  ele_force_CP, ele_stress_CP, ele_strain_CP,
973  node_displacementsX_CP, node_displacementsY_CP,
974  dispX_CP, dispY_CP,
975  PERIOD_MIN_CP, PERIOD_MAX_CP) = DATA
976
977
978 XDATA = disp_mid_CP
979 YDATA = reaction_CP
980 XLABEL = 'Displacement in Middle Span [mm]'
981 YLABEL = 'Base Reaction [N]'
982 TITLE = 'Base Reaction and Displacement of Structure During Cyclic-Displacement Analysis'
983 COLOR = 'black'
984 SEMILOGY = False
985 PLOT(XDATA, YDATA, TITLE, XLABEL, YLABEL, COLOR, SEMILOGY)
986 """
987 # PLOT STRUCTURAL PERIOD DURING THE ANALYSIS
988 plt.figure(0, figsize=(12, 8))
989 plt.plot(disp_mid_CP, PERIOD_MIN_CP, linewidth=3)
990 plt.plot(disp_mid_CP, PERIOD_MAX_CP, linewidth=3)
991 plt.title('Period of Structure During Cyclic Displacement Analysis')
992 plt.ylabel('Structural Period [s]')
993 plt.xlabel('Displacement [mm]')
994 #plt.semilogy()
995 plt.grid()
996 plt.legend([f'PERIOD - MIN VALUES: Min: {np.min(PERIOD_MIN_CP):.3f} (s) - Mean: {np.mean(PERIOD_MIN_CP):.3f} (s)', f'PERIOD - MAX VALUES: Min: {np.min(PERIOD_MAX_CP):.3f} (s) - Mean: {np.mean(PERIOD_MAX_CP):.3f} (s)'])
997
```

Base Reaction and Displacement of Structure During Cyclic-Displacement Analysis

Base Reaction [N]

Displacement in Middle Span [mm]

1e6

1.00

0.50

0.00

-0.50

-1.00

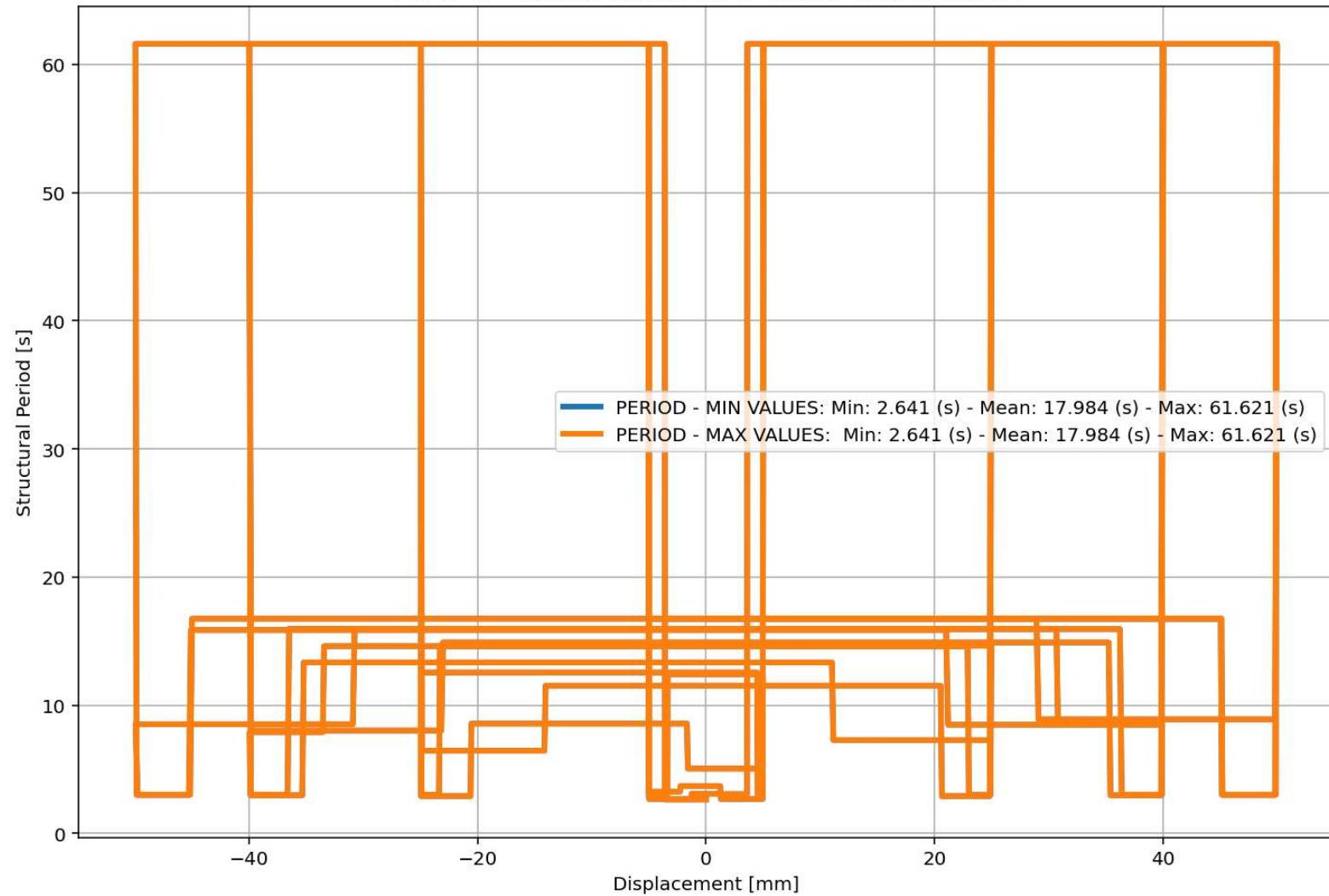
-40 -20 0 20 40

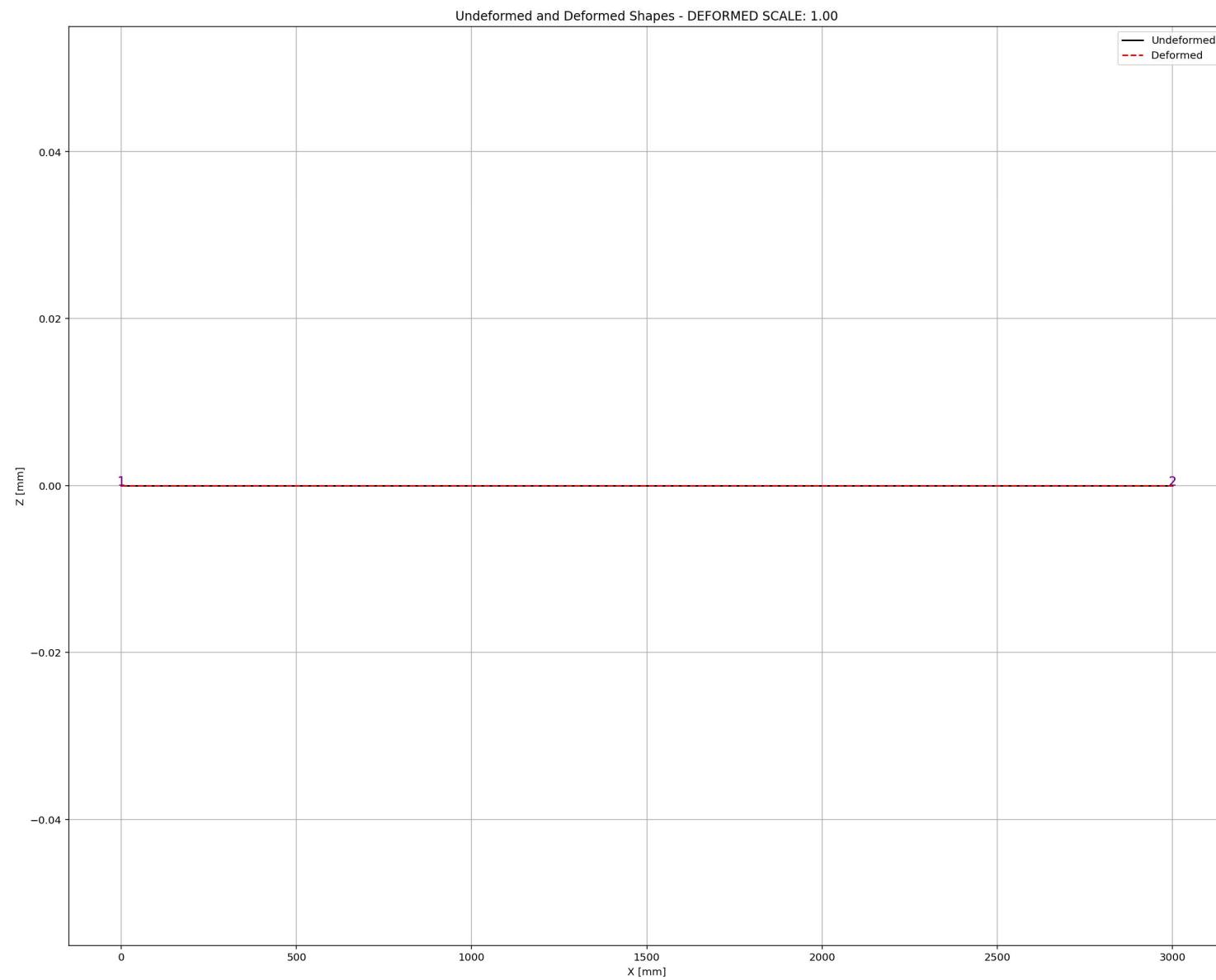
IPython Console Files Help Variable Explorer Debugger Plots History

Inline Conda: anaconda3 (Python 3.12.7) ✓ LSP: Python Line 47, Col 58 UTF-8 CRLF RW Mem 47%



Period of Structure During Cyclic Displacement Analysis





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

Spyder (Python 3.12)

File Edit Search Source Run Debug Consoles Projects Tools View Help

C:\Users\Dell\Desktop\OPENSEES\_FILES\+TRUSS\_ONE\_ELEMENT

TRUSS\_ONE\_ELEMENT.py

```
1003 # EXTERNAL TIME-DEPENDENT LOADING ANALYSIS (STATIC TIME-HISTORY ANALYSIS)
1004 #ELE_TYPE = 'Truss'      # MATERIAL NONLINEARITY
1005 ELE_TYPE = 'corotTruss' # MATERIAL AND GEOMETRIC NONLINEARITIES
1006 MAT_TYPE = 'INELASTIC'  # 'ELASTIC' OR 'INELASTIC'
1007 ANAL_TYPE = 'STATIC_EXTERNAL_TIME-DEPENDENT_LOADING'
1008
1009 DATA = TRUSS_ONE_ELEMENT(LENGTH, AREA, MAT_TYPE, ELE_TYPE, ANAL_TYPE, TOTAL_MASS)
1010
1011 (reaction_ETDLS, disp_mid_ETDLS,
1012  ele_stress_ETDLS, ele_strain_ETDLS,
1013  node_displacementsX_ETDLS, node_displacementsY_ETDLS,
1014  dispX_ETDLS, dispY_ETDLS,
1015  PERIOD_MIN_ETDLS, PERIOD_MAX_ETDLS) = DATA
1016
1017
1018 XDATA = disp_mid_ETDLS
1019 YDATA = reaction_ETDLS
1020 XLABEL = 'Displacement in Middle Span [mm]'
1021 YLABEL = 'Base Reaction [N]'
1022 TITLE = 'Base Reaction and Displacement of Structure During Static External Time-dependent Loading Analysis'
1023 COLOR = 'black'
1024 SEMILOGY = False
1025 PLOT(XDATA, YDATA, TITLE, XLABEL, YLABEL, COLOR, SEMILOGY)
1026
1027 # PLOT STRUCTURAL PERIOD DURING THE ANALYSIS
1028 plt.figure(0, figsize=(12, 8))
1029 plt.plot(disp_mid_ETDLS, PERIOD_MIN_ETDLS, linewidth=3)
1030 plt.plot(disp_mid_ETDLS, PERIOD_MAX_ETDLS, linewidth=3)
1031 plt.title('Period of Structure During Static External Time-dependent Loading Analysis')
1032 plt.ylabel('Structural Period [s]')
1033 plt.xlabel('Displacement [mm]')
1034 #plt.semilogy()
1035 plt.grid()
1036 plt.legend([f'PERIOD - MIN VALUES: Min: {np.min(PERIOD_MIN_ETDLS):.3f} (s) - Mean: {np.mean(PERIOD_MIN_ETDLS):.3f} (s)'])
```

External Time-dependent Loading Over Time

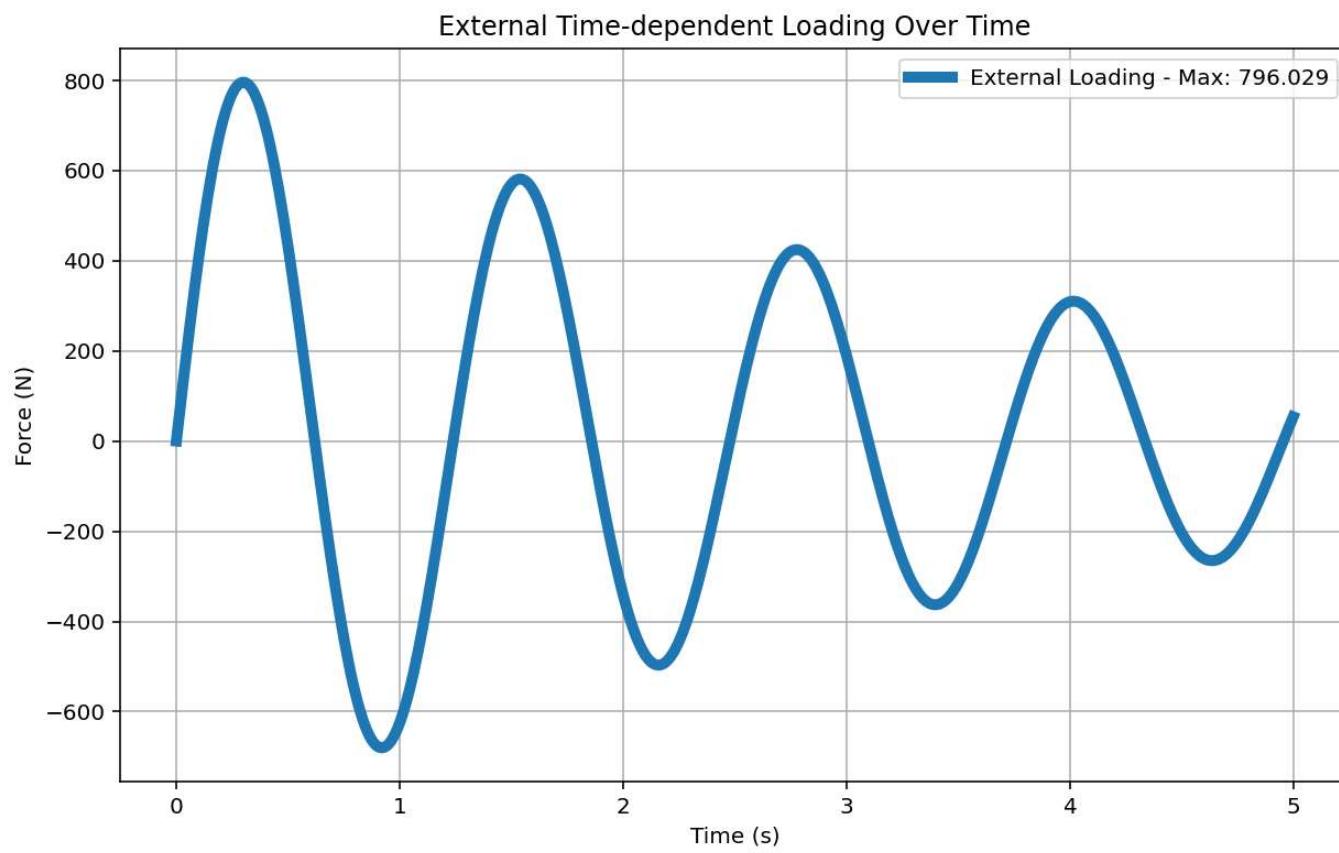
External Loading - Max: 888.590

Force (N)

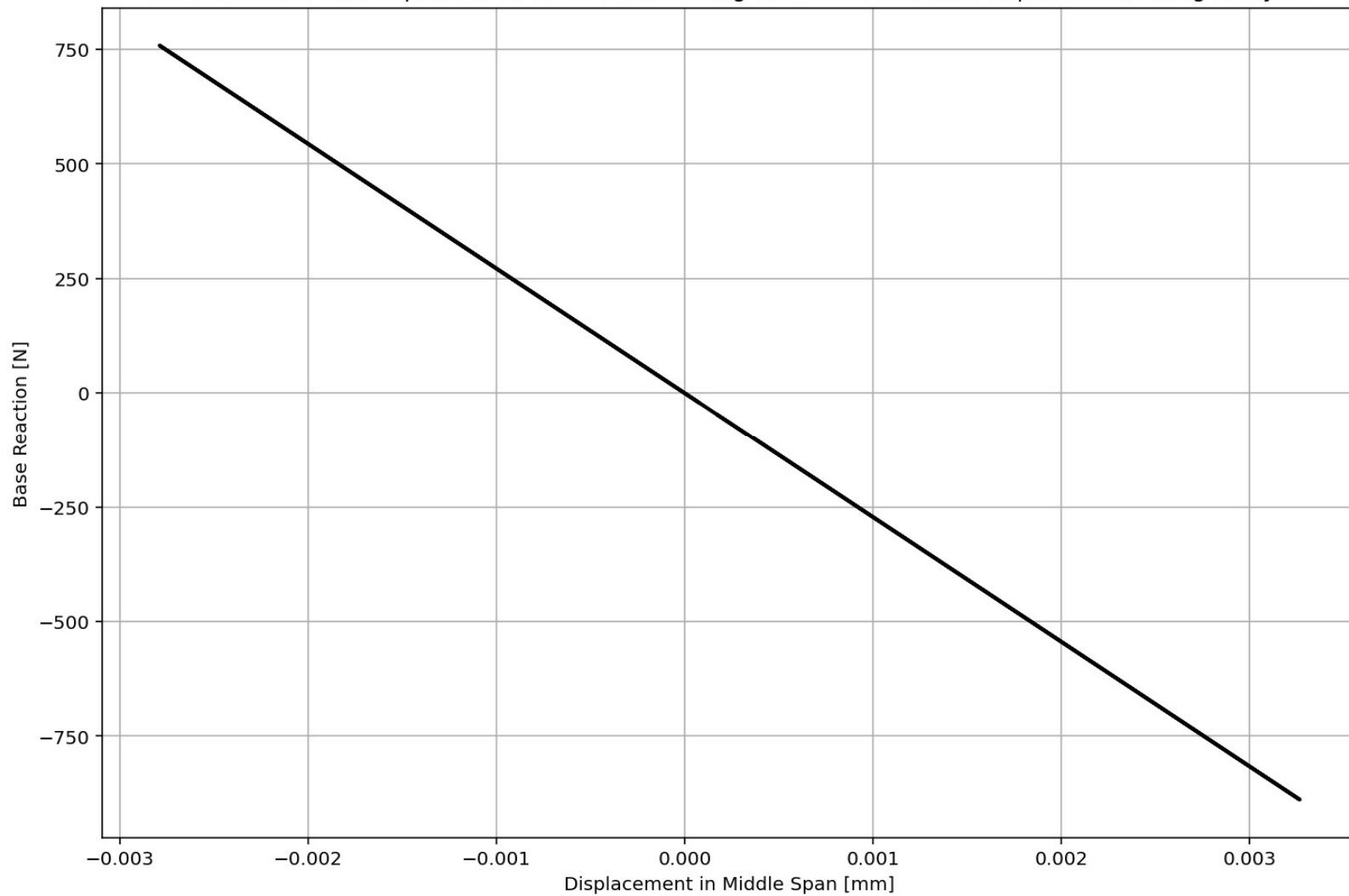
Time (s)

IPython Console Files Help Variable Explorer Debugger Plots History

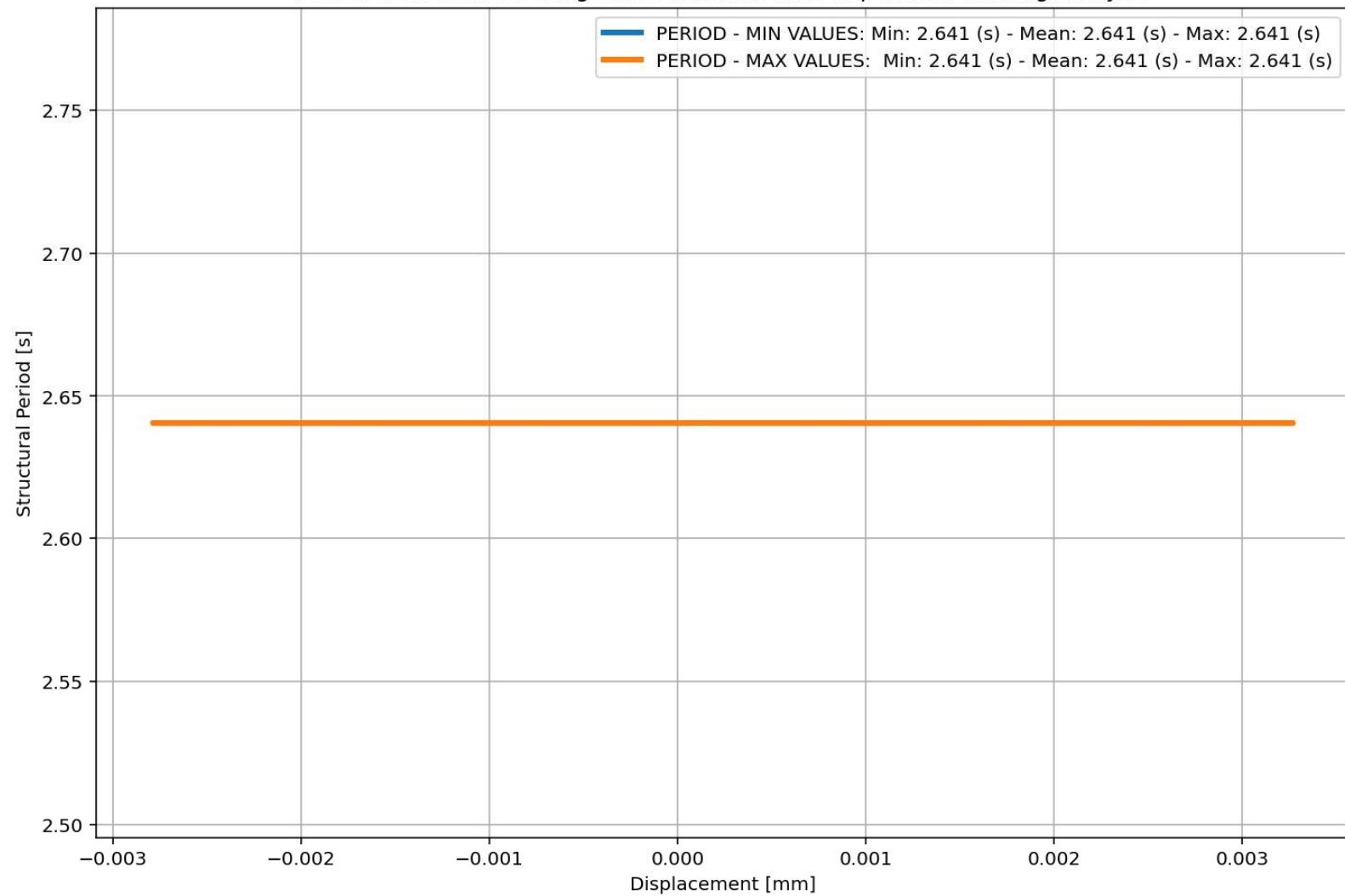
Inline Conda: anaconda3 (Python 3.12.7) ✓ LSP: Python Line 47, Col 58 UTF-8 CRLF RW Mem 49%

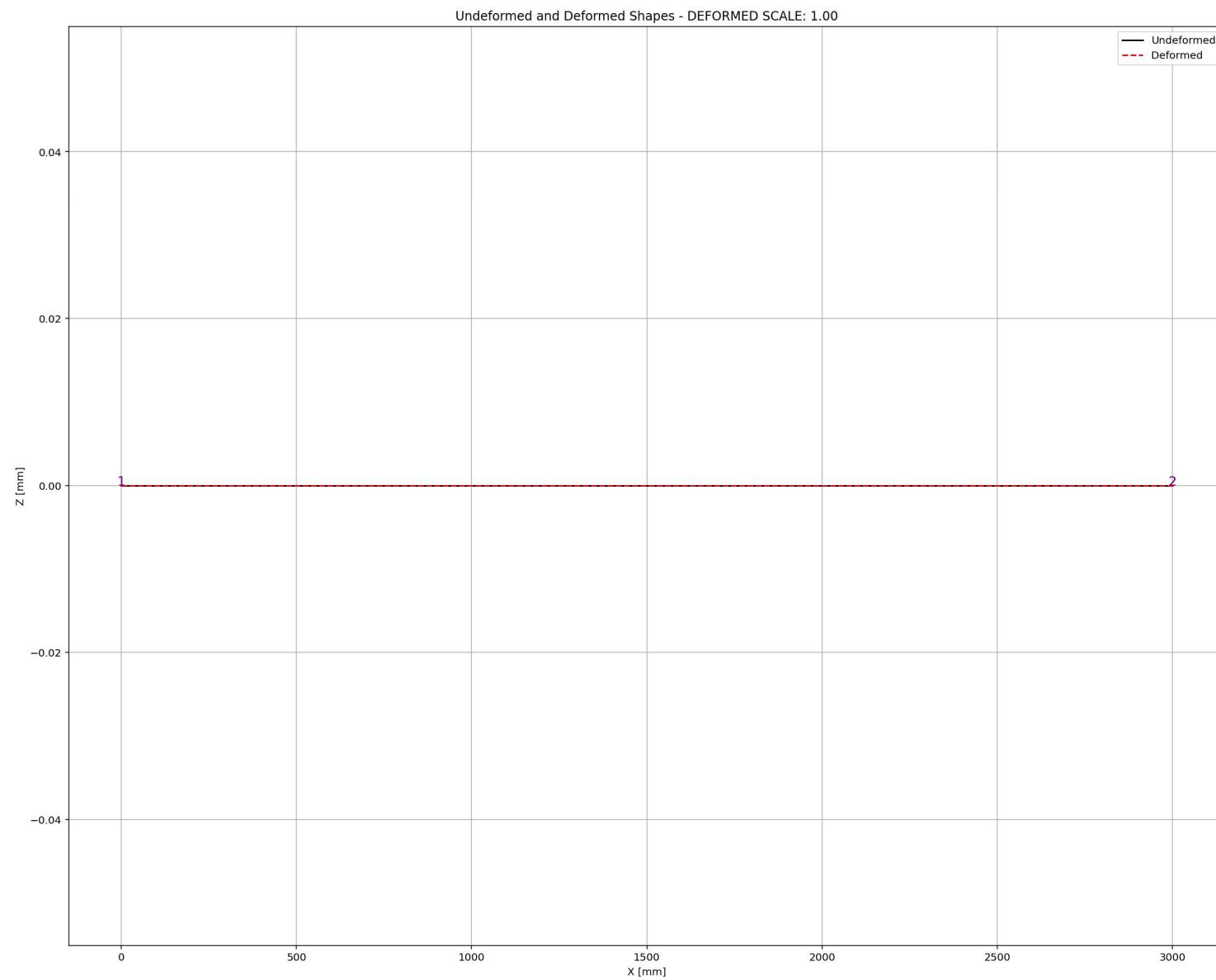


Base Reaction and Displacement of Structure During Static External Time-dependent Loading Analysis



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





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

Spyder (Python 3.12)

File Edit Search Source Run Debug Consoles Projects Tools View Help

C:\Users\Dell\Desktop\OPENSEES\_FILES\+TRUSS\_ONE\_ELEMENT\TRUSS\_ONE\_ELEMENT.py

TRUSS\_ONE\_ELEMENT.py X

```
1043 # EXTERNAL TIME-DEPENDENT LOADING ANALYSIS (DYNAMIC TIME-HISTORY ANALYSIS)
1044 #ELE_TYPE = 'Truss'      # MATERIAL NONLINEARITY
1045 ELE_TYPE = 'corotTruss' # MATERIAL AND GEOMETRIC NONLINEARITIES
1046 MAT_TYPE = 'INELASTIC'  # 'ELASTIC' OR 'INELASTIC'
1047 ANAL_TYPE = 'DYNAMIC_EXTERNAL_TIME-DEPENDENT_LOADING'
1048
1049 DATA = TRUSS_ONE_ELEMENT(LENGTH, AREA, MAT_TYPE, ELE_TYPE, ANAL_TYPE, TOTAL_MASS)
1050
1051 (time_ETDLD, reaction_ETDLD, disp_mid_ETDLD,
1052 ele_force_ETDLD, ele_stress_ETDLD, ele_strain_ETDLD,
1053 node_displacementsX_ETDLD, node_displacementsY_ETDLD,
1054 dispX_ETDLD, dispY_ETDLD,
1055 veloX_ETDLD, veloY_ETDLD,
1056 accX_ETDLD, accY_ETDLD,
1057 stiffness_ETDLD, PERIOD_ETDLD, damping_ratio_ETDLD,
1058 PERIOD_MIN_ETDLD, PERIOD_MAX_ETDLD) = DATA
1059
1060
1061 XDATA = disp_mid_ETDLD
1062 YDATA = reaction_ETDLD
1063 XLABEL = 'Displacement in Middle Span [mm]'
1064 YLABEL = 'Base Reaction [N]'
1065 TITLE = 'Base Reaction and Displacement of Structure During Dynamic External Time-dependent Loading'
1066 COLOR = 'black'
1067 SEMILOGY = False
1068 PLOT(XDATA, YDATA, TITLE, XLABEL, YLABEL, COLOR, SEMILOGY)
1069
1070 PLOT_TIME_HISTORY(time_ETDLD, reaction_ETDLD, disp_mid_ETDLD,
1071                      dispX_ETDLD, dispY_ETDLD,
1072                      veloX_ETDLD, veloY_ETDLD,
1073                      accX_ETDLD, accY_ETDLD)
1074
1075 # PLOT ELEMENTS AXIAL FORCE
1076 YLABEL = 'Element Axial Force [N]'
```

C:\Users\Dell\Desktop\OPENSEES\_FILES\+TRUSS\_ONE\_ELEMENT

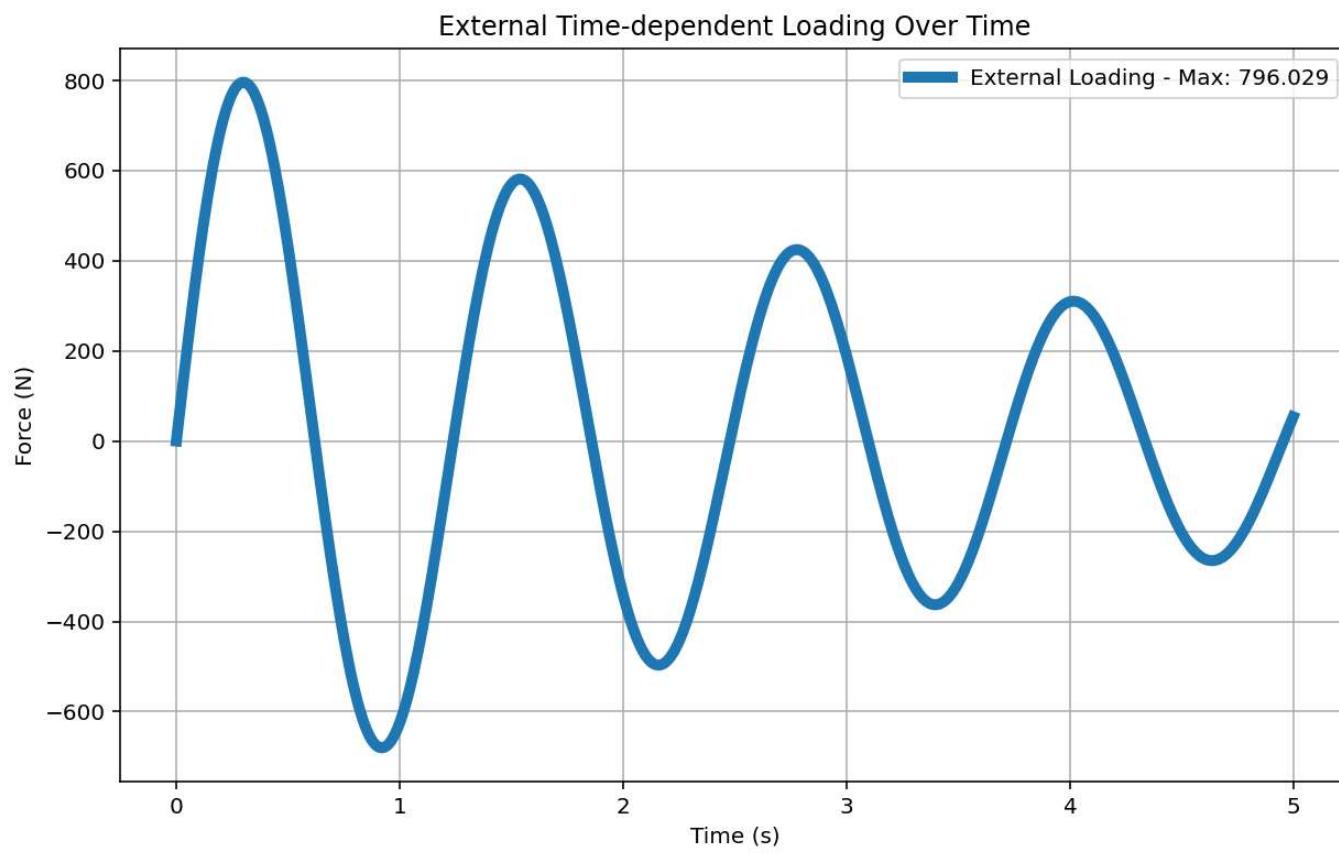
External Time-dependent Loading Over Time

Force (N)

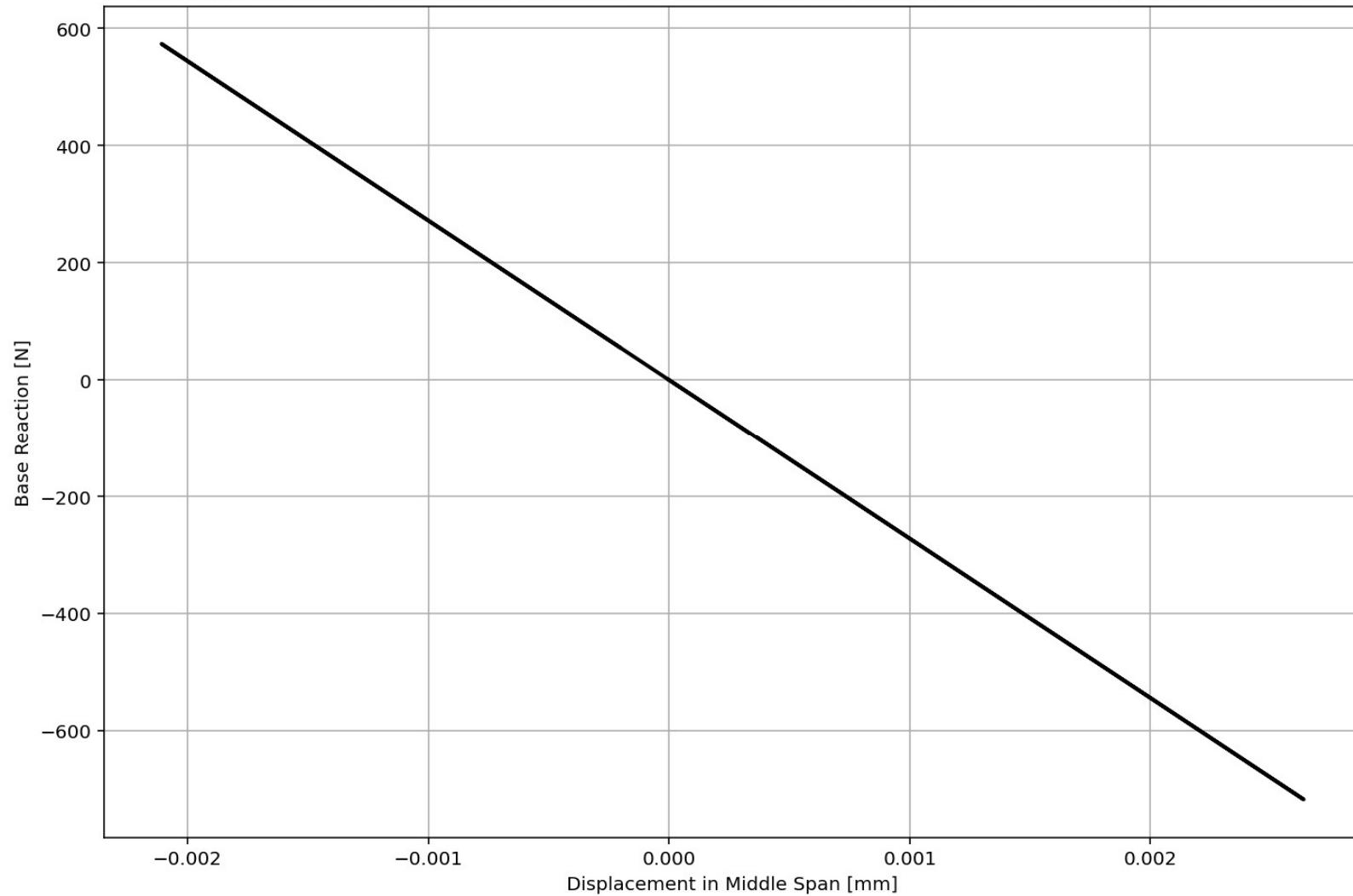
Time (s)

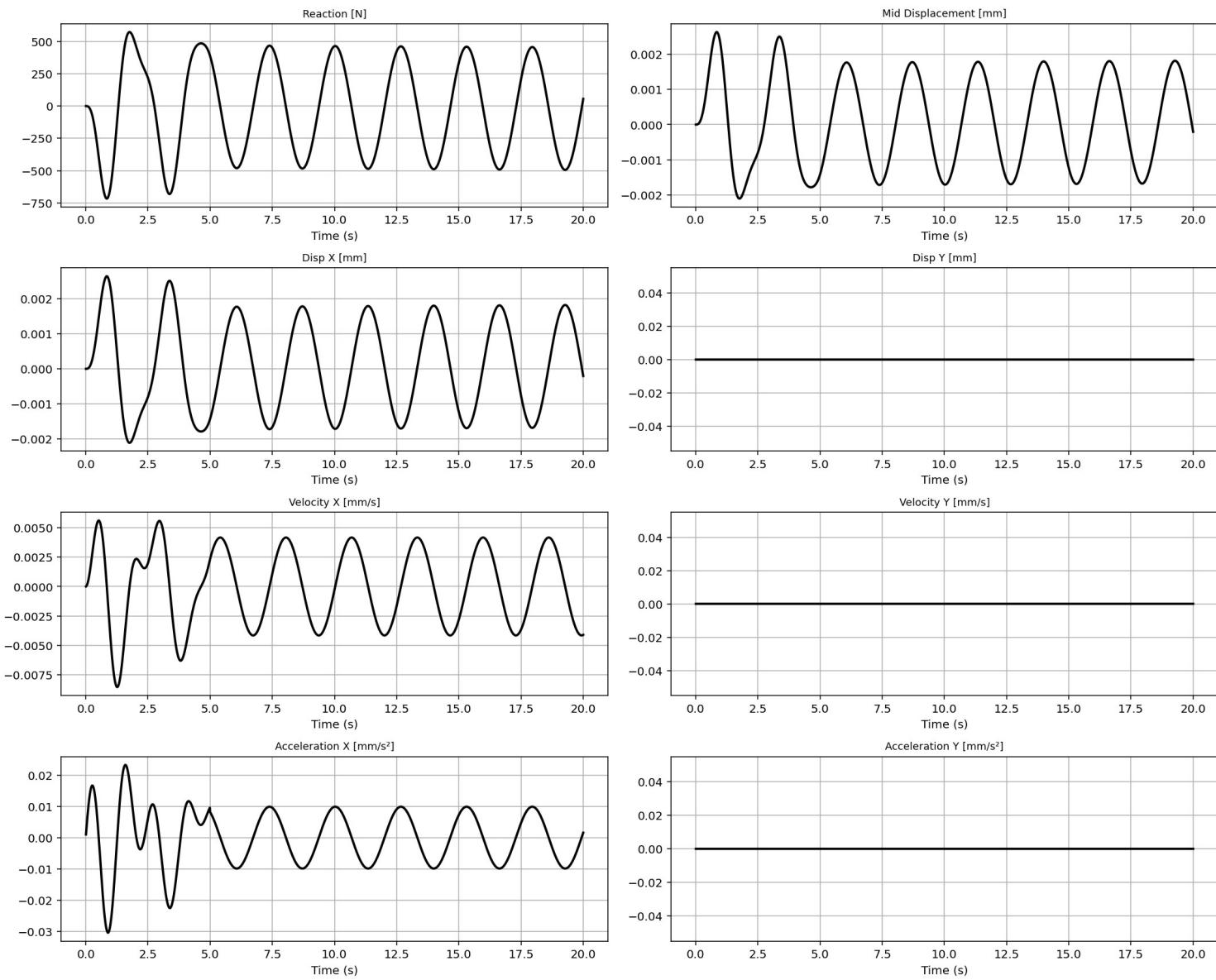
IPython Console Files Help Variable Explorer Debugger Plots History

Inline Conda: anaconda3 (Python 3.12.7) ✓ LSP: Python Line 47, Col 58 UTF-8 CRLF RW Mem 48%

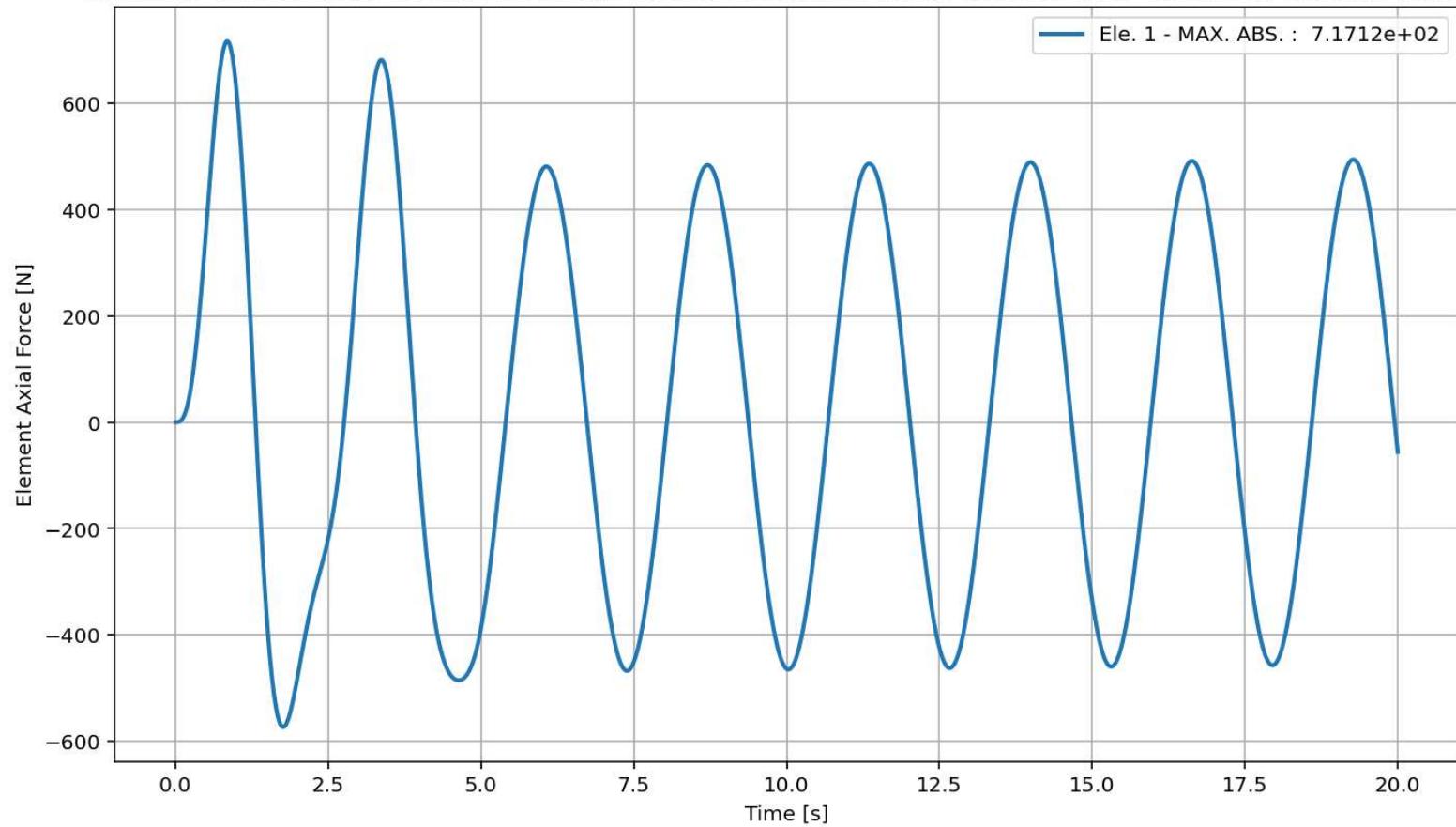


Base Reaction and Displacement of Structure During Dynamic External Time-dependent Loading Analysis

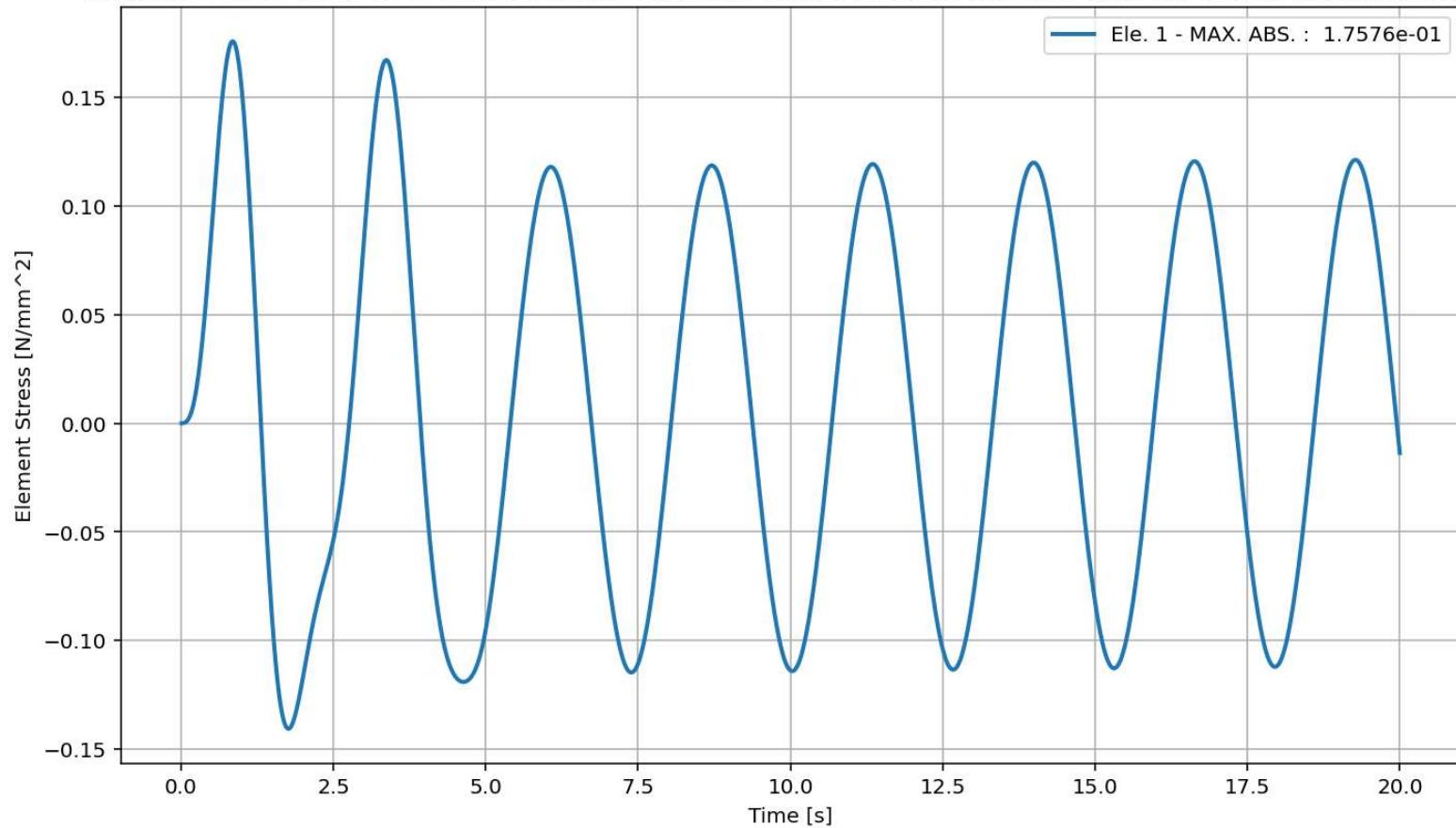




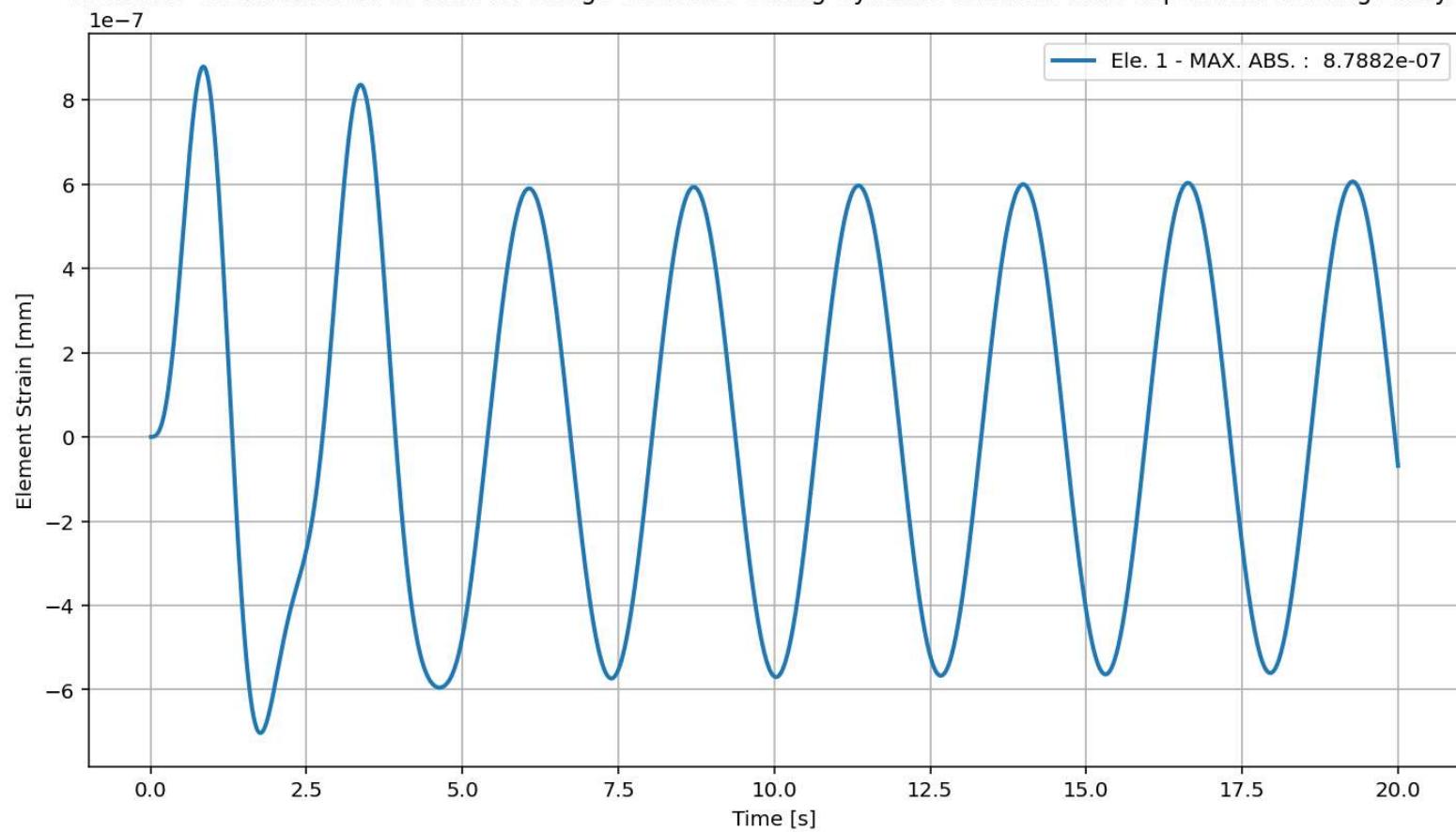
elements force in X Dir. vs Time for Bridge Structure During Dynamic External Time-dependent Loading Analysis



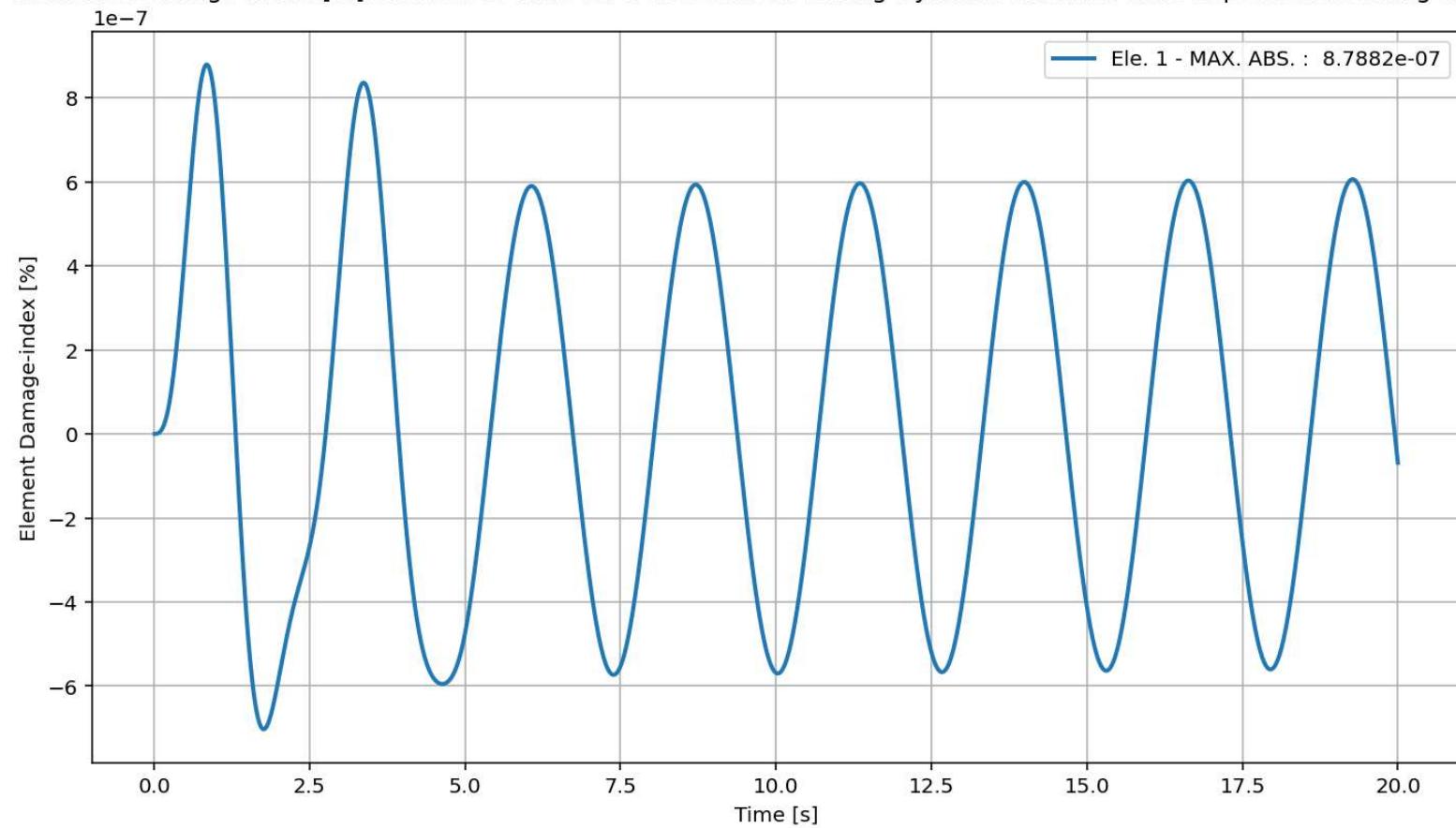
elements Stress in X Dir. vs Time for Bridge Structure During Dynamic External Time-dependent Loading Analysis



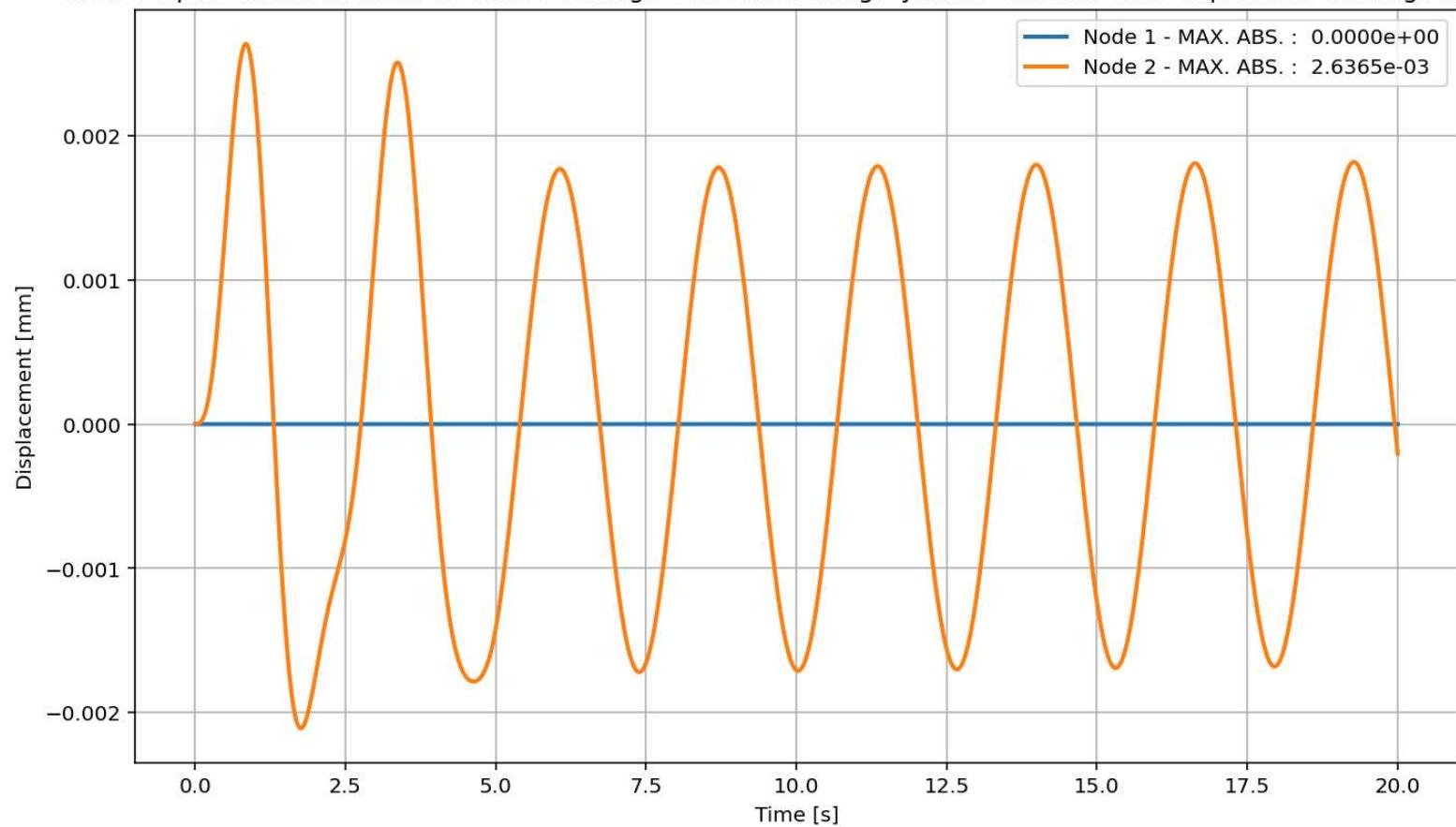
elements Strain in X Dir. vs Time for Bridge Structure During Dynamic External Time-dependent Loading Analysis



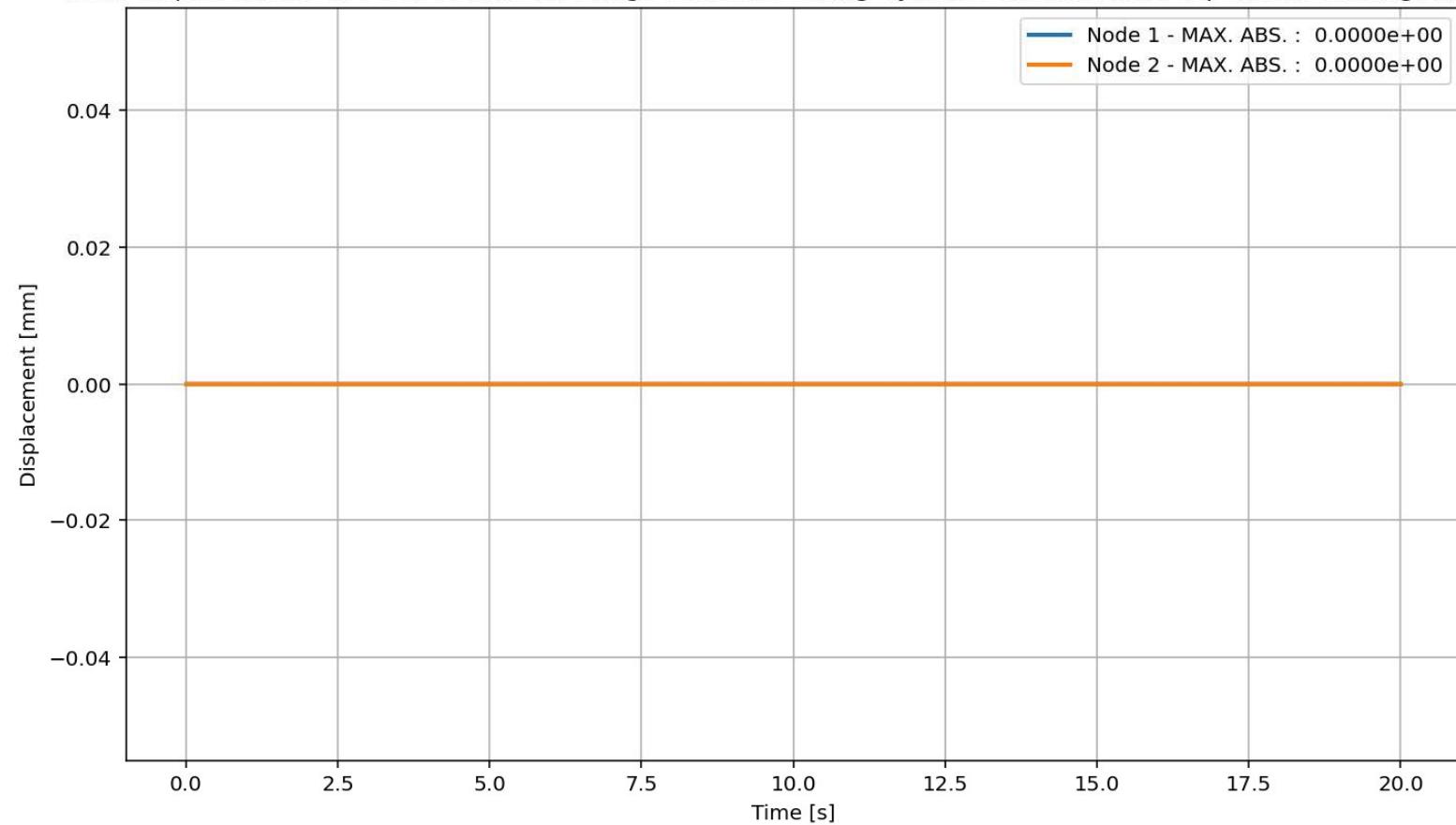
elements Damage-index [%] in X Dir. vs Time for Truss Element During Dynamic External Time-dependent Loading Analysis



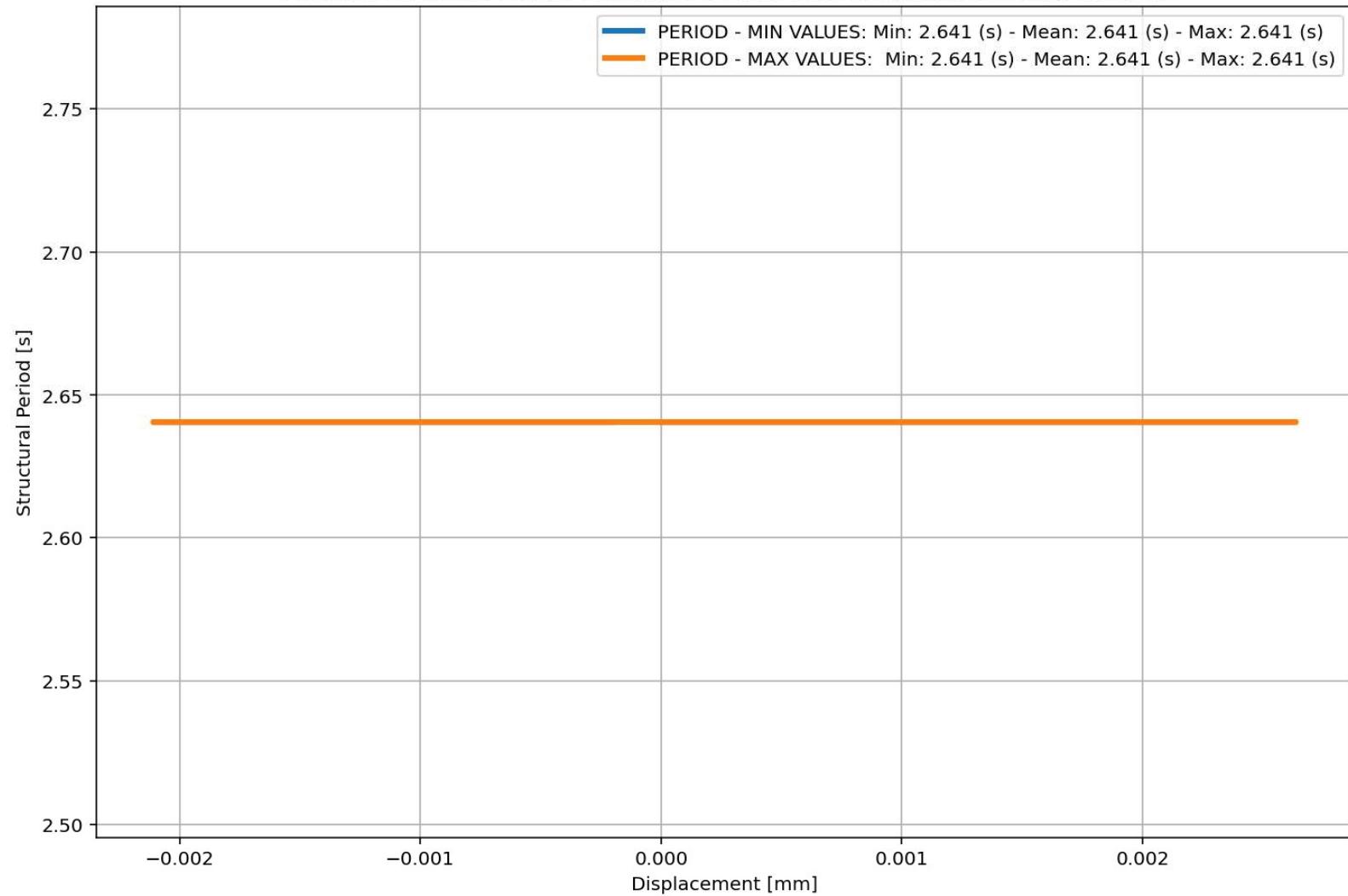
Node Displacements in X Dir. vs Time for Bridge Structure During Dynamic External Time-dependent Loading Analysis

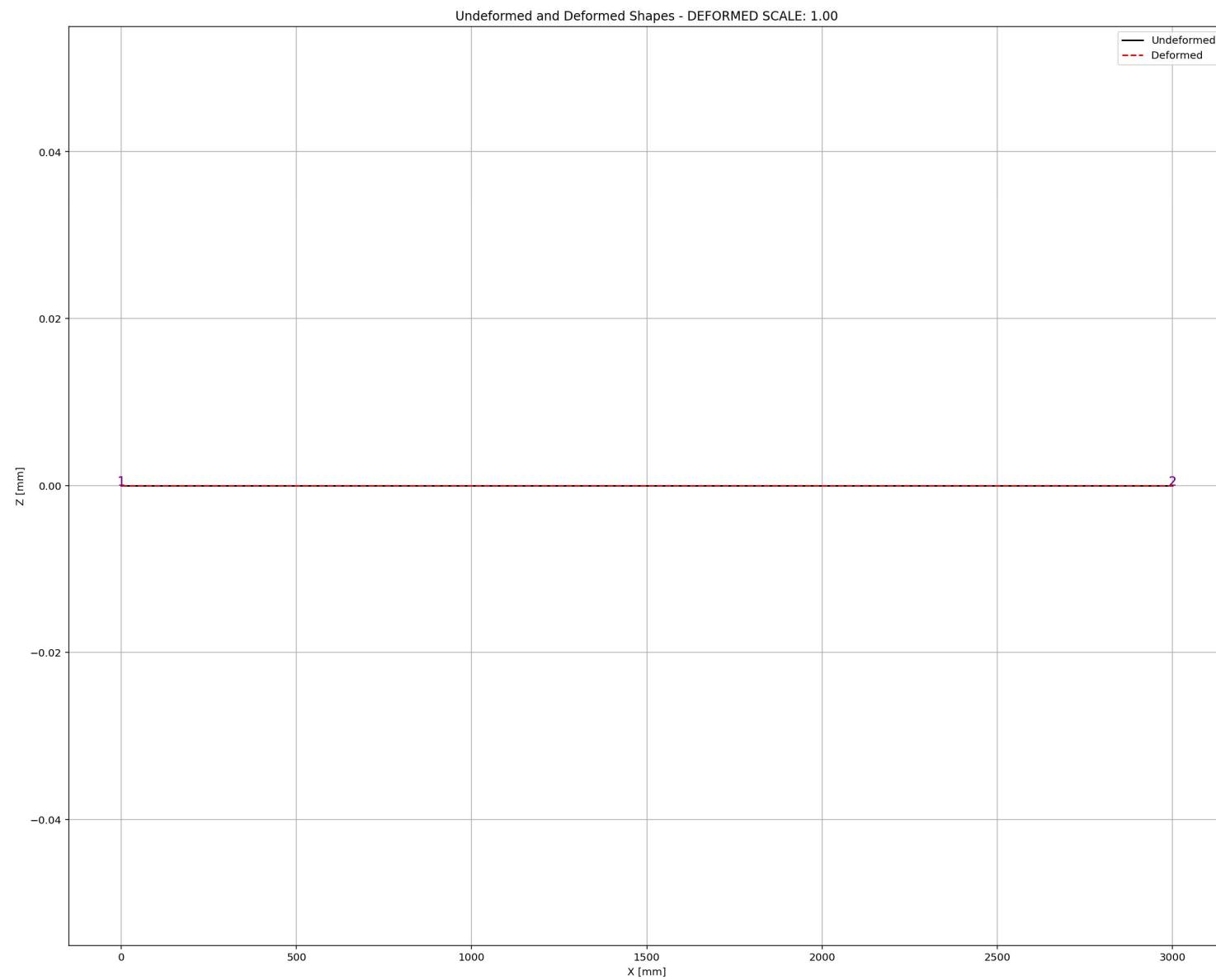


Node Displacements in Y Dir. vs Time for Bridge Structure During Dynamic External Time-dependent Loading Analysis



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





# **FREE-VIBRATION ANALYSIS**

Spyder (Python 3.12)

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C:\Users\Dell\Desktop\OPENSEES\_FILES\+TRUSS\_ONE\_ELEMENT\TRUSS\_ONE\_ELEMENT.py

TRUSS\_ONE\_ELEMENT.py X

```
1109 # FREE-VIBRATION ANALYSIS (DYNAMIC TIME-HISTORY ANALYSIS)
1110 #ELE_TYPE = 'Truss'      # MATERIAL NONLINEARITY
1111 ELE_TYPE = 'corotTruss' # MATERIAL AND GEOMETRIC NONLINEARITY
1112 MAT_TYPE = 'INELASTIC'  # 'ELASTIC' OR 'INELASTIC'
1113 ANAL_TYPE = 'FREE-VIBRATION'
1114 DATA = TRUSS_ONE_ELEMENT(LENGTH, AREA, MAT_TYPE, ELE_TYPE, ANAL_TYPE, TOTAL_MASS)
1115
1116 (time_FV, reaction_FV, disp_mid_FV,
1117 ele_force_FV, ele_stress_FV, ele_strain_FV,
1118 node_displacementsX_FV, node_displacementsY_FV,
1119 dispX_FV, dispY_FV,
1120 veloX_FV, veloY_FV,
1121 accX_FV, accY_FV,
1122 stiffness_FV, PERIOD_FV, damping_ratio_FV,
1123 PERIOD_MIN_FV, PERIOD_MAX_FV) = DATA
1124
1125 XDATA = disp_mid_FV
1126 YDATA = reaction_FV
1127 XLABEL = 'Displacement in Middle Span [mm]'
1128 YLABEL = 'Base Reaction [N]'
1129 TITLE = 'Base Reaction and Displacement of Structure During Free-vibration Analysis'
1130 COLOR = 'black'
1131 SEMILOGY = False
1132 PLOT(XDATA, YDATA, TITLE, XLABEL, YLABEL, COLOR, SEMILOGY)
1133
1134 PLOT_TIME_HISTORY(time_FV, reaction_FV, disp_mid_FV,
1135                 dispX_FV, dispY_FV,
1136                 veloX_FV, veloY_FV,
1137                 accX_FV, accY_FV)
1138
1139 # PLOT ELEMENTS AXIAL FORCE
1140 YLABEL = 'Element Axial Force [N]'
1141 TITLE = "elements force in X Dir. vs Time for Bridge Structure During Free-vibration Anal"
1142 PLOT_FORCES(time_FV, ele_force_FV, YLABEL, TITLE) # BRIDGE STRUCTURE - ELEMENTS AXIAL FORC
```

30 %

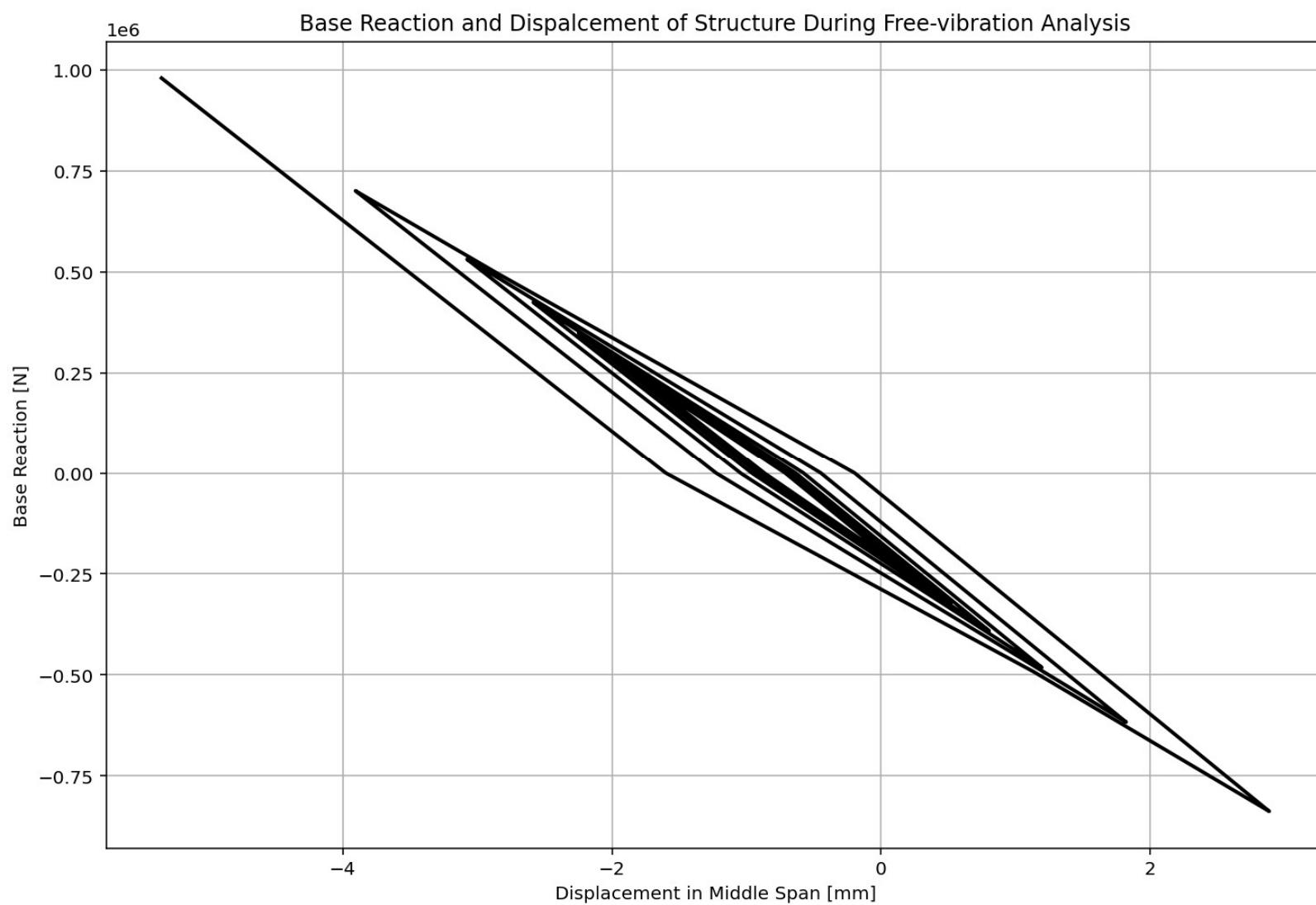
Base Reaction and Displacement of Structure During Free-vibration Analysis

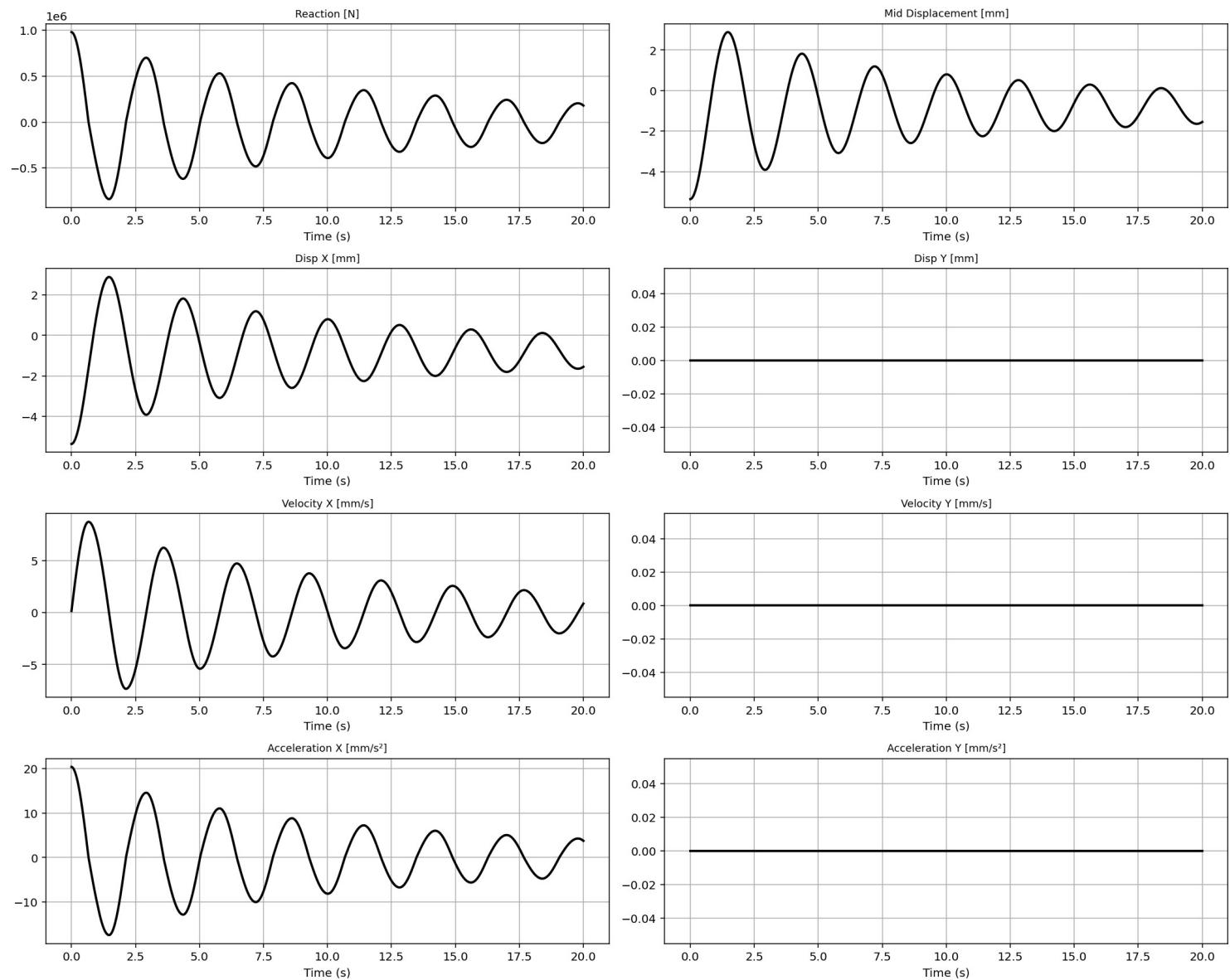
Base Reaction [N]

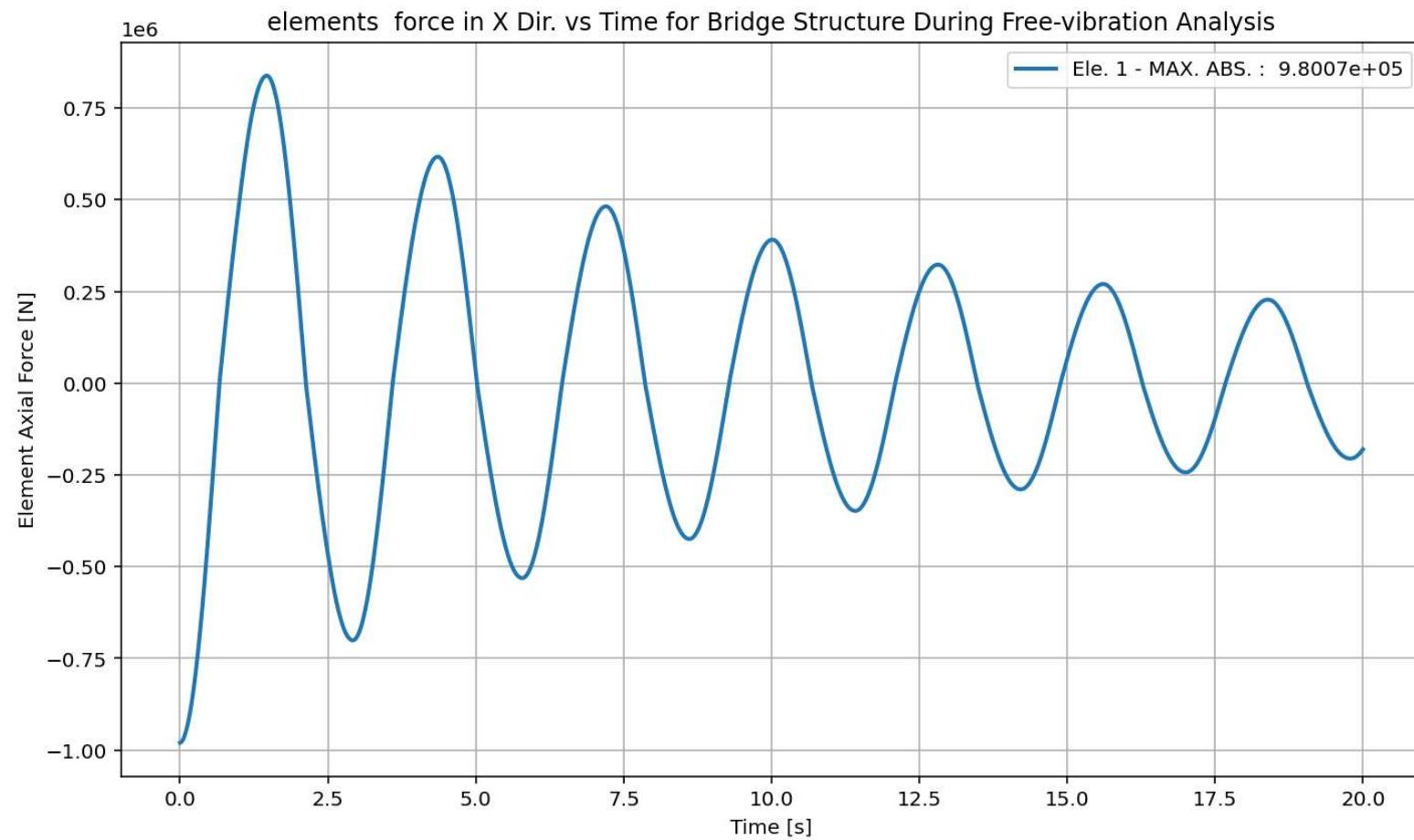
Displacement in Middle Span [mm]

IPython Console Files Help Variable Explorer Debugger Plots History

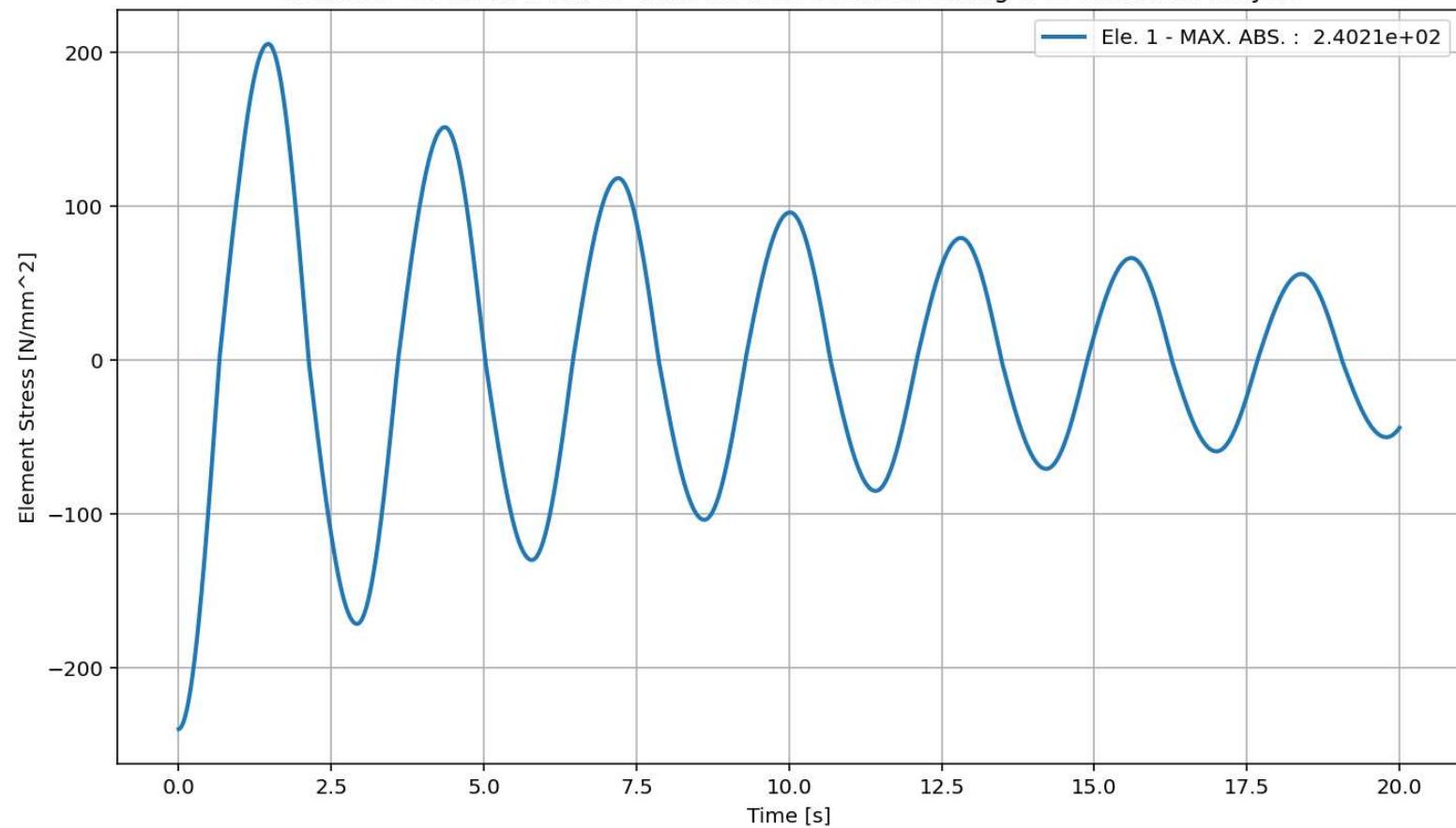
Inline Conda: anaconda3 (Python 3.12.7) ✓ LSP: Python Line 47, Col 58 UTF-8 CRLF RW Mem 48%



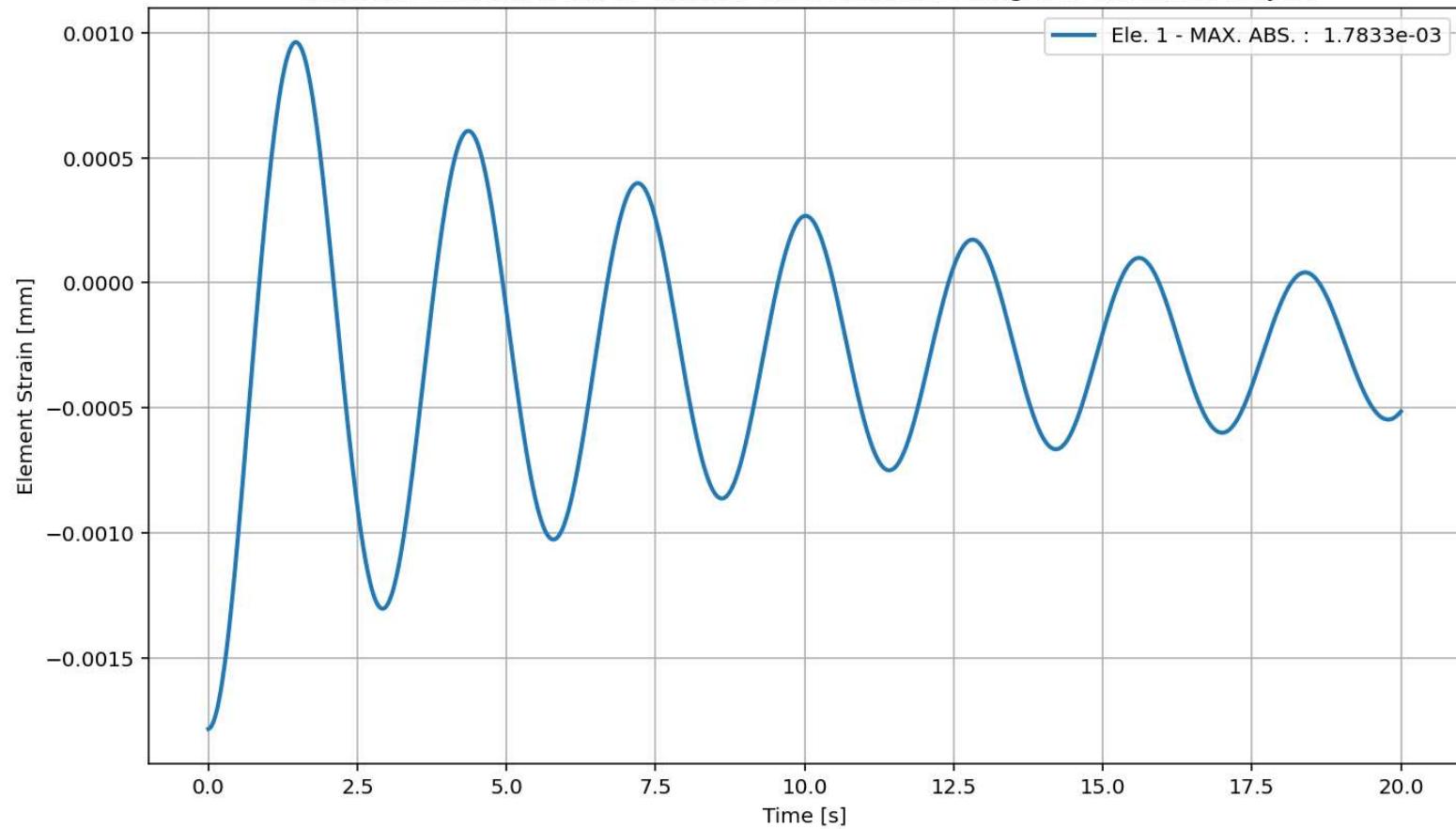




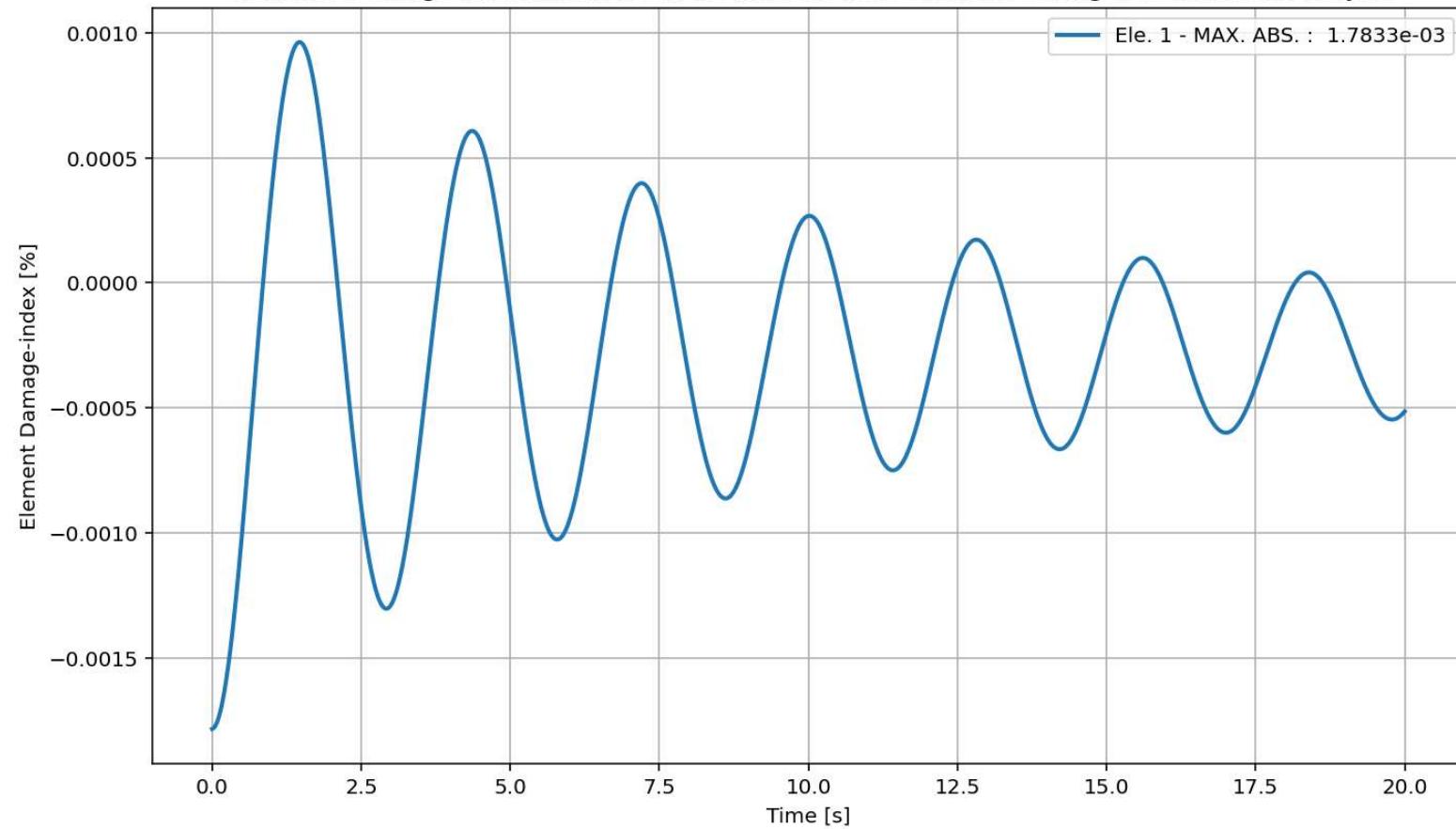
elements Stress in X Dir. vs Time for Truss Element During Free-vibration Analysis



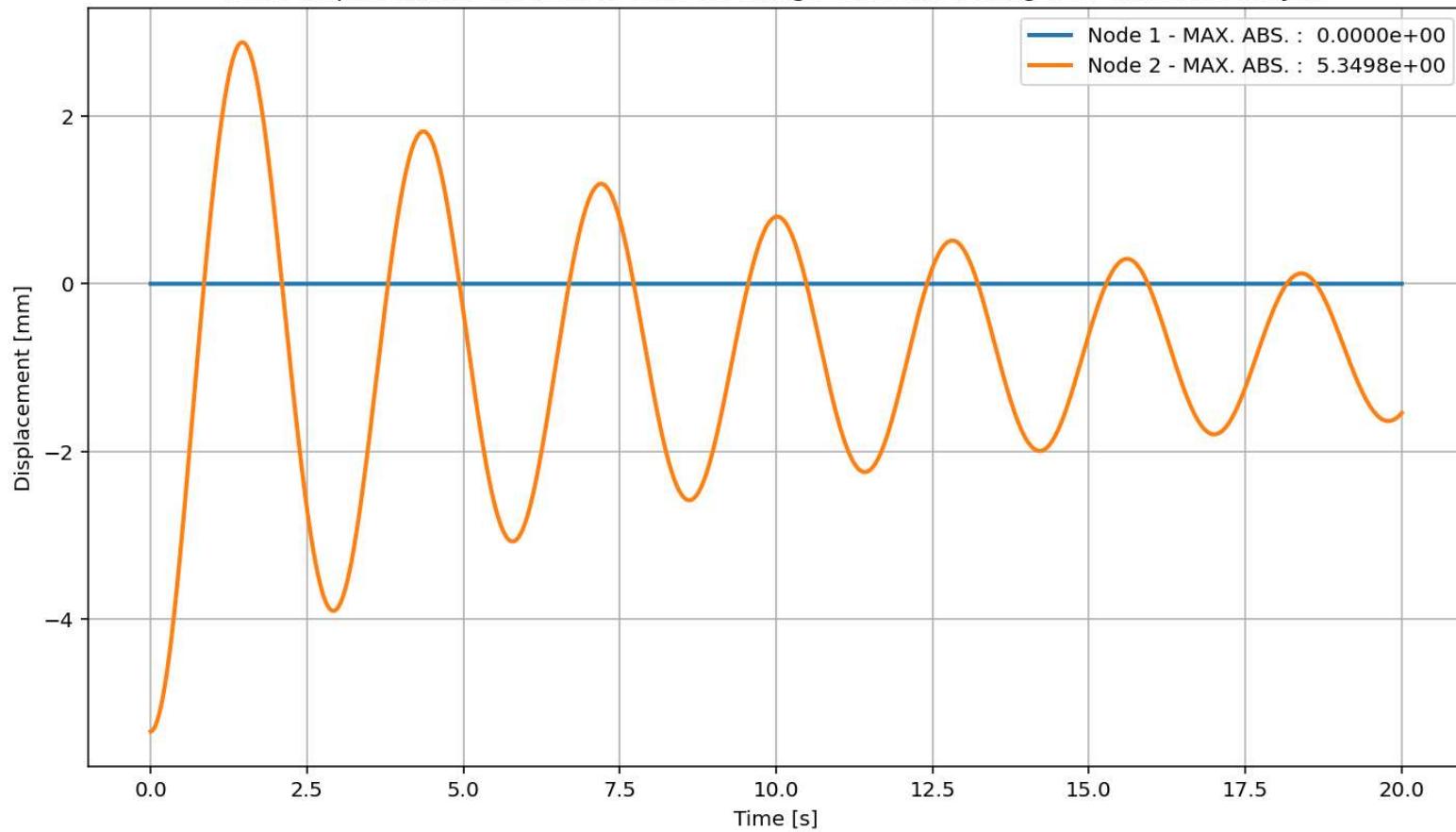
elements Strain in X Dir. vs Time for Truss Element During Free-vibration Analysis



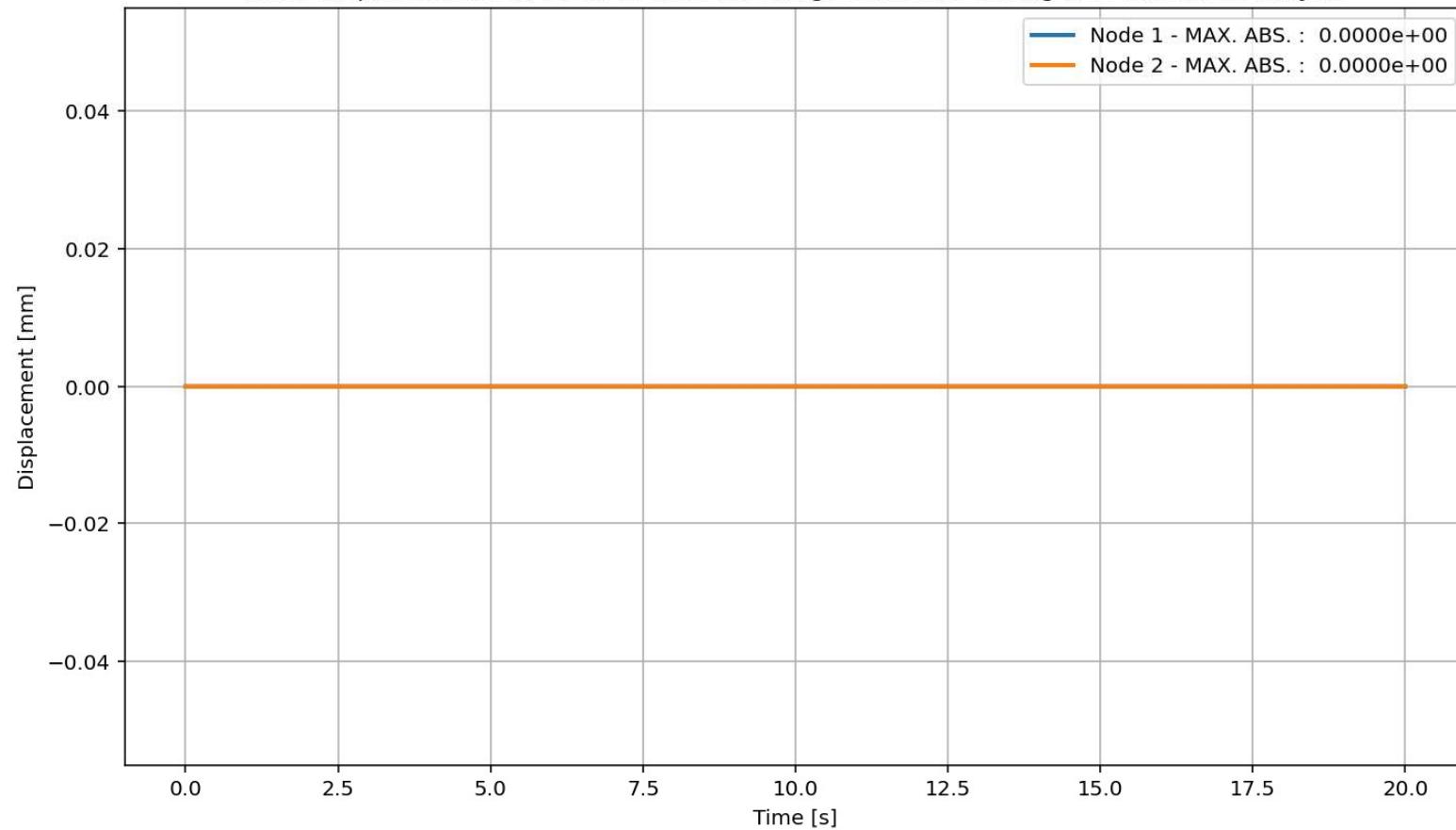
elements Damage-index [%] in X Dir. vs Time for Truss Element During Free-vibration Analysis



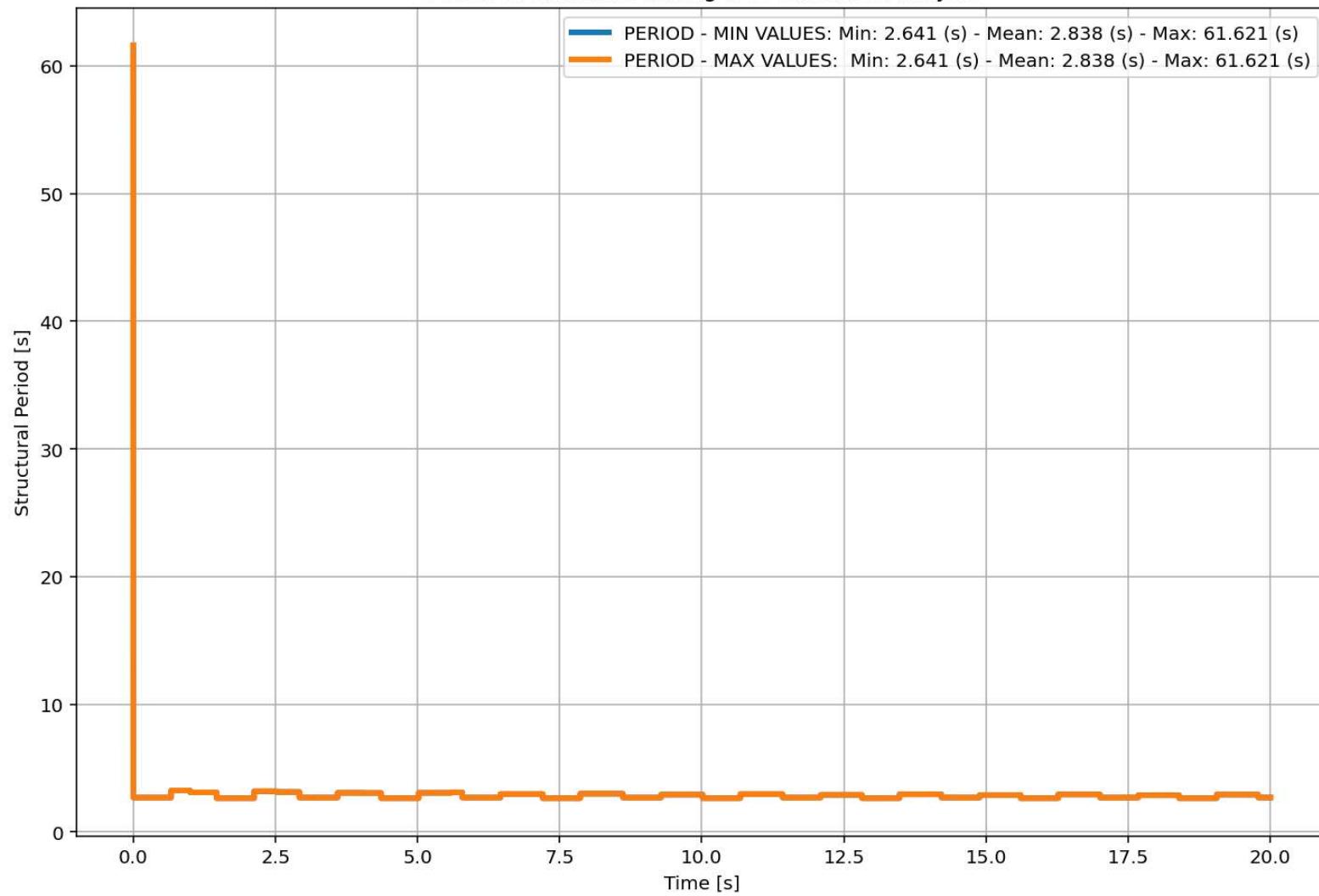
Node Displacements in X Dir. vs Time for Bridge Structure During Free-vibration Analysis

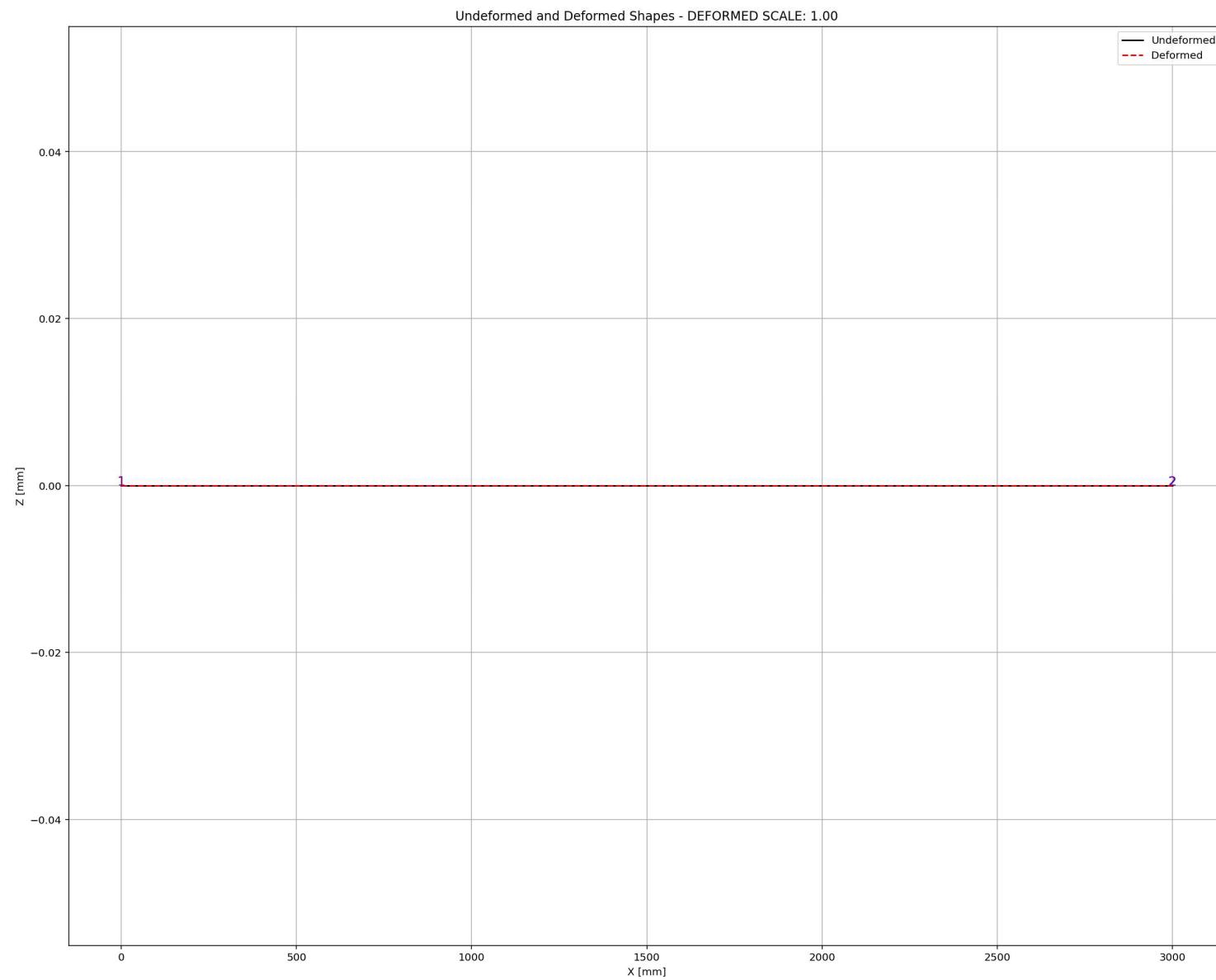


Node Displacements in Y Dir. vs Time for Bridge Structure During Free-vibration Analysis



### Period of Structure During Free-vibration Analysis





# **SEISMIC ANALYSIS**

Spyder (Python 3.12)

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C:\Users\Dell\Desktop\OPENSEES\_FILES\+TRUSS\_ONE\_ELEMENT

TRUSS\_ONE\_ELEMENT.py

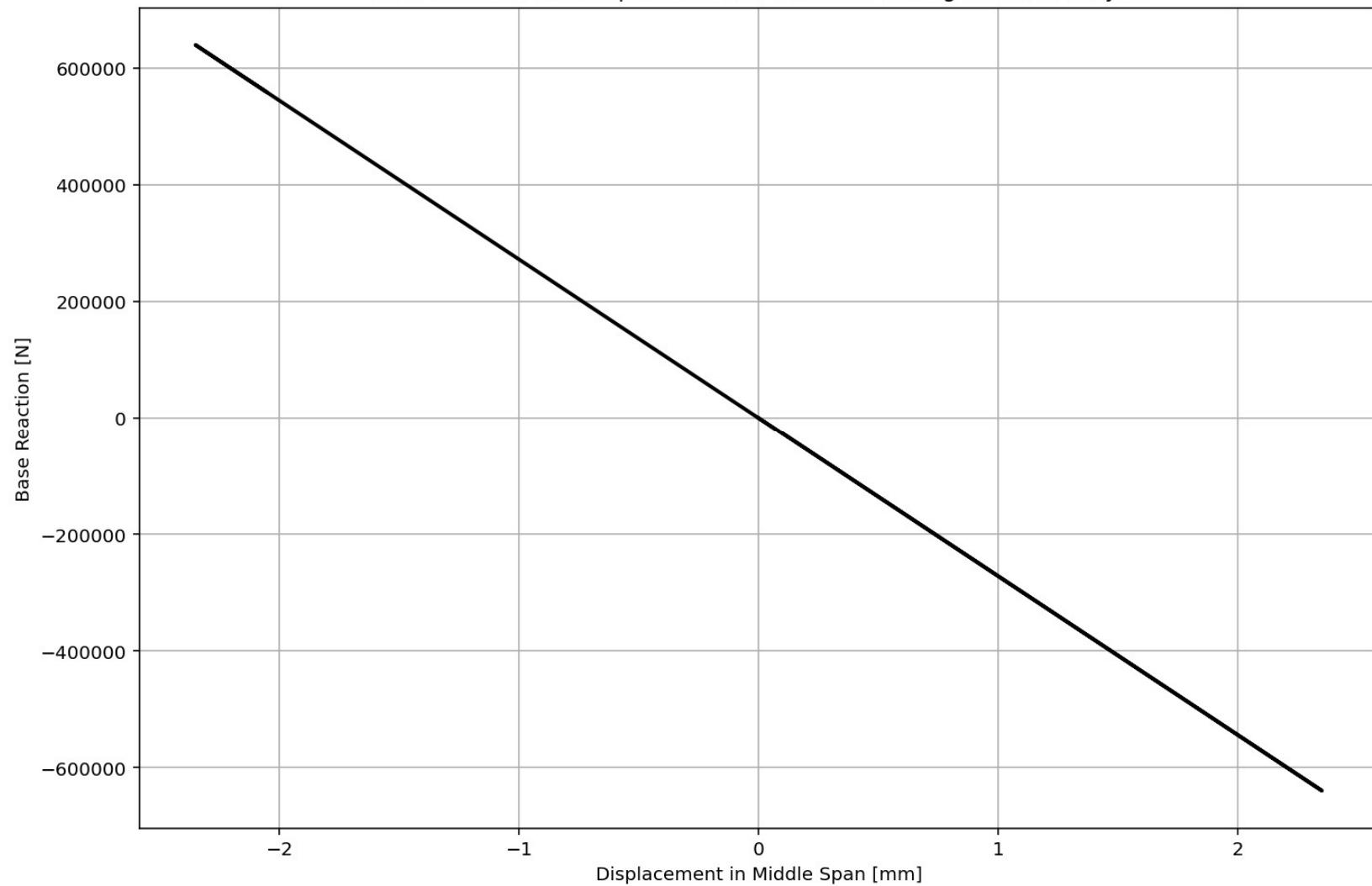
```
1172 # SEISMIC ANALYSIS (DYNAMIC TIME-HISTORY ANALYSIS)
1173 #ELE_TYPE = 'Truss'      # MATERIAL NONLINEARITY
1174 ELE_TYPE = 'corotTruss'  # MATERIAL AND GEOMETRIC NONLINEARITY
1175 MAT_TYPE = 'INELASTIC'   # 'ELASTIC' OR 'INELASTIC'
1176 ANAL_TYPE = 'SEISMIC'
1177
1178 DATA = TRUSS_ONE_ELEMENT(LENGTH, AREA, MAT_TYPE, ELE_TYPE, ANAL_TYPE, TOTAL_MASS)
1179
1180 (time_SEI, reaction_SEI, disp_mid_SEI,
1181 ele_axialforce_SEI, ele_stress_SEI, ele_strain_SEI,
1182 node_displacementsX_SEI, node_displacementsY_SEI,
1183 dispX_SEI, dispY_SEI,
1184 veloX_SEI, veloY_SEI,
1185 accX_SEI, accY_SEI,
1186 stiffness_SEI, PERIOD_SEI, damping_ratio_SEI,
1187 PERIOD_MIN_SEI, PERIOD_MAX_SEI) = DATA
1188
1189
1190 XDATA = disp_mid_SEI
1191 YDATA = reaction_SEI
1192 XLABEL = 'Displacement in Middle Span [mm]'
1193 YLABEL = 'Base Reaction [N]'
1194 TITLE = 'Base Reaction and Displacement of Structure During Seismic Analysis'
1195 COLOR = 'black'
1196 SEMILOGY = False
1197 PLOT(XDATA, YDATA, TITLE, XLABEL, YLABEL, COLOR, SEMILOGY)
1198
1199 PLOT_TIME_HISTORY(time_SEI, reaction_SEI, disp_mid_SEI,
1200                     dispX_SEI, dispY_SEI,
1201                     veloX_SEI, veloY_SEI,
1202                     accX_SEI, accY_SEI)
1203
1204 # PLOT ELEMENTS AXIAL FORCE
1205 YLABEL = 'Element Axial Force [N']
```

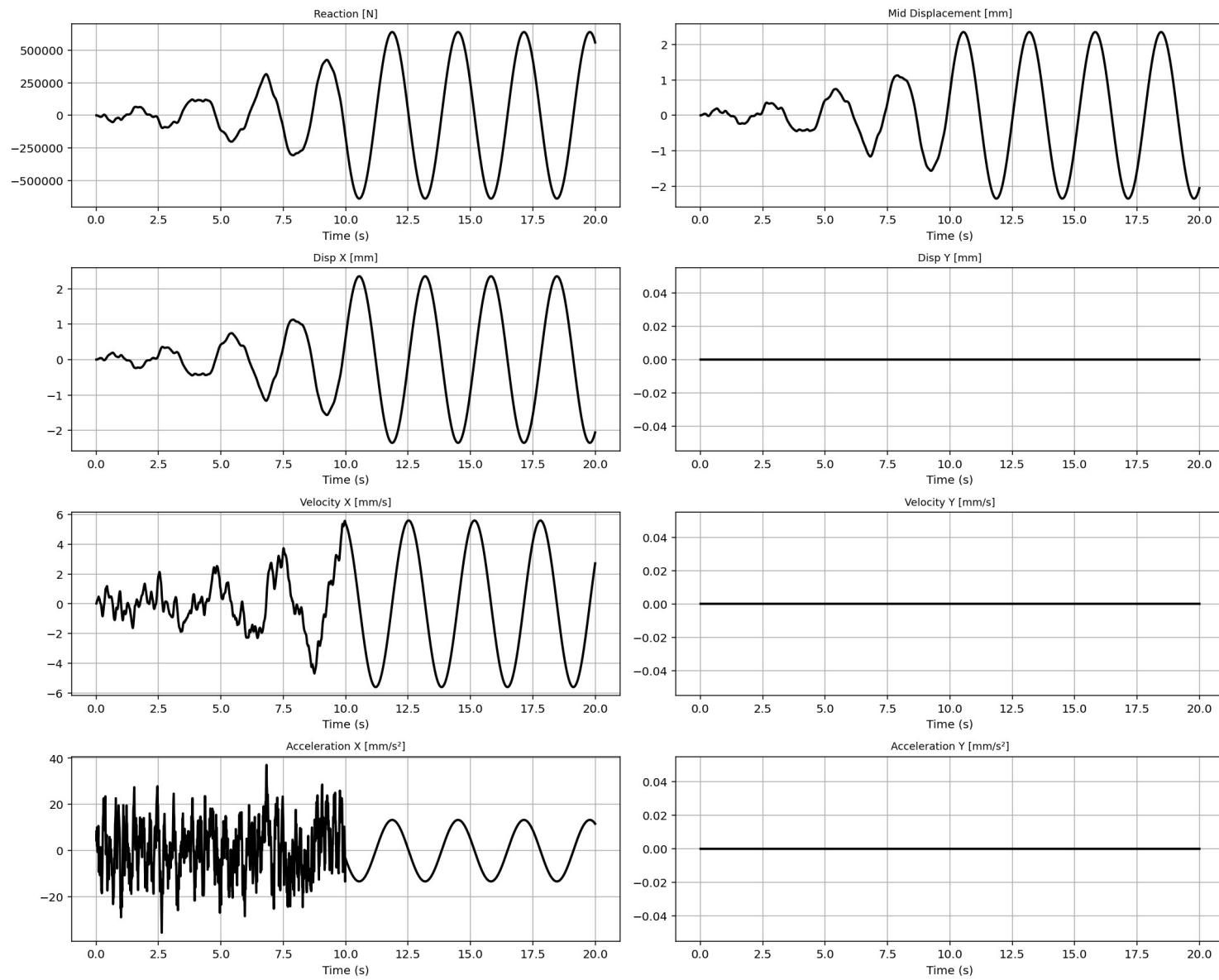
Undeformed and Deformed Shapes - DEFORMED SCALE: 1.00

IPython Console Files Help Variable Explorer Debugger Plots History

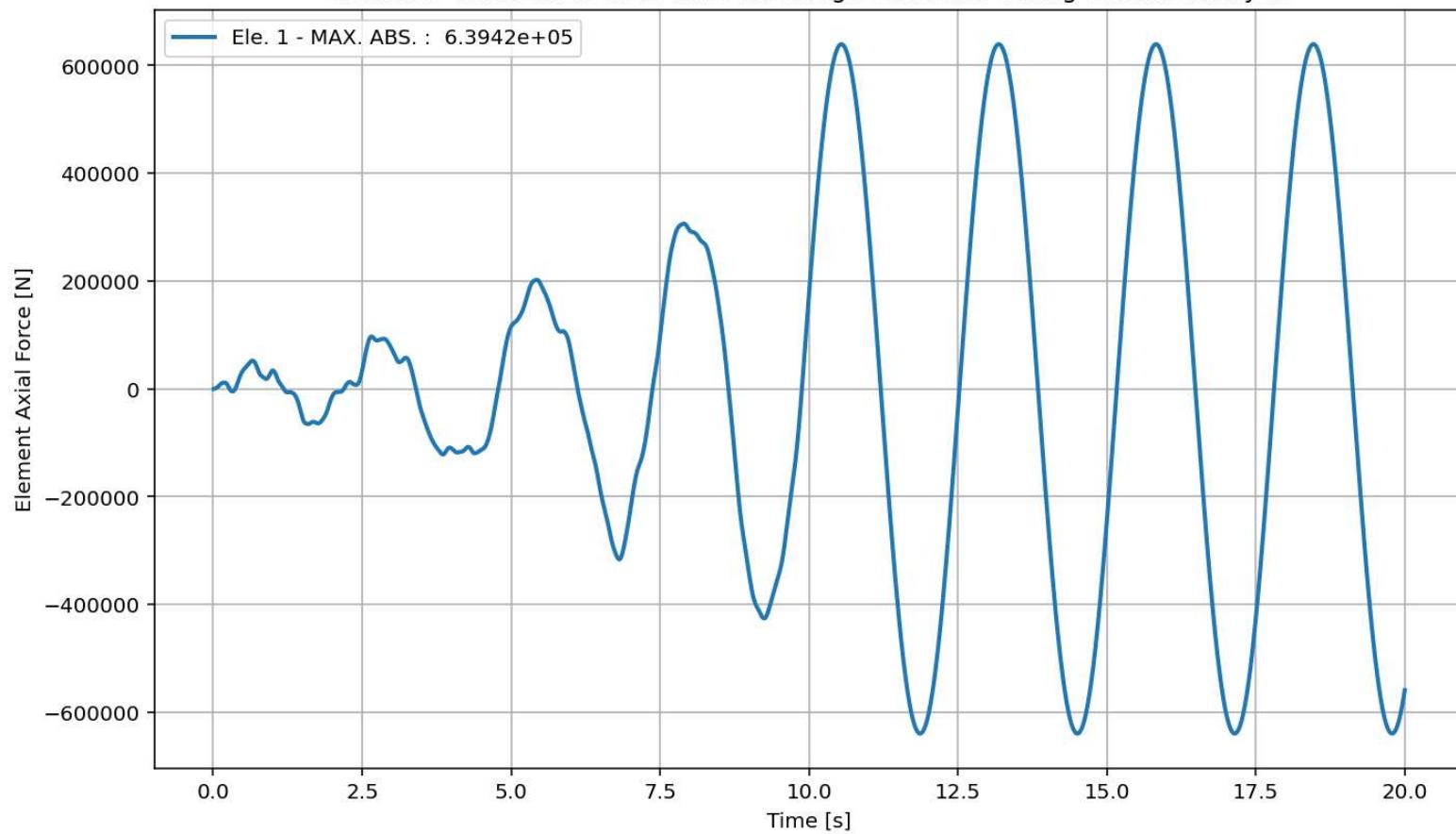
Inline Conda: anaconda3 (Python 3.12.7) ✓ LSP: Python Line 47, Col 58 UTF-8 CRLF RW Mem 43%

Base Reaction and Displacement of Structure During Seismic Analysis

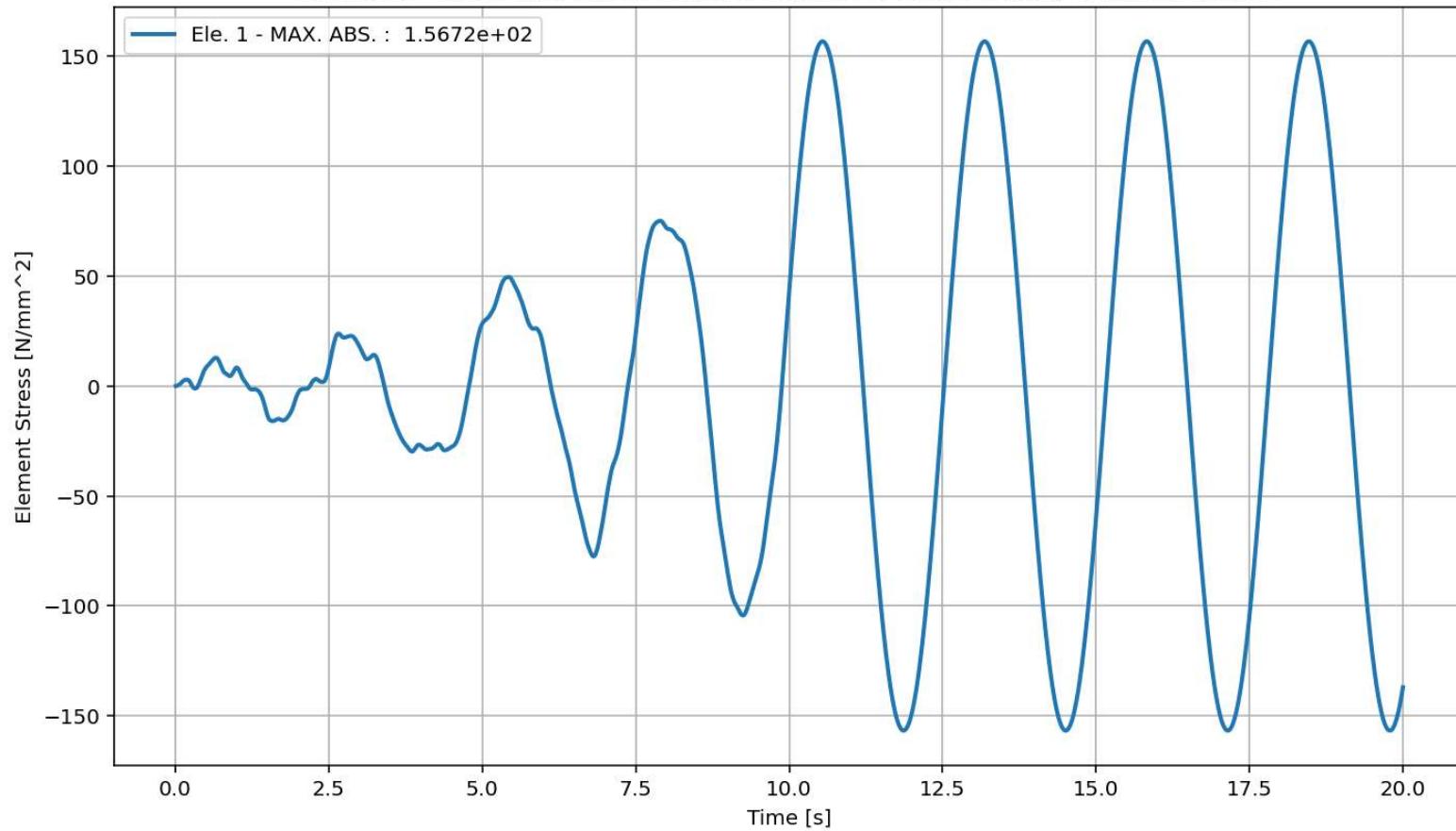


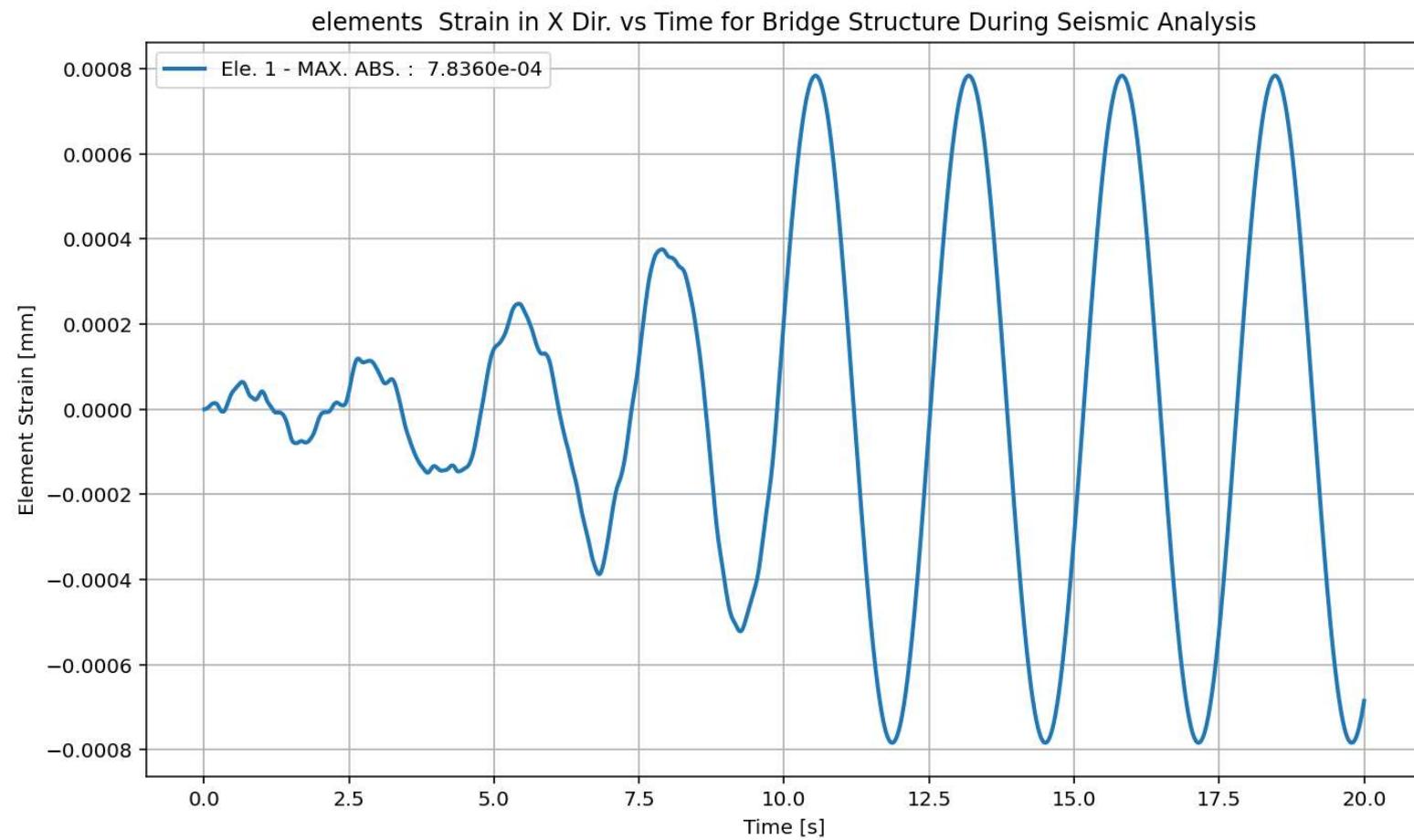


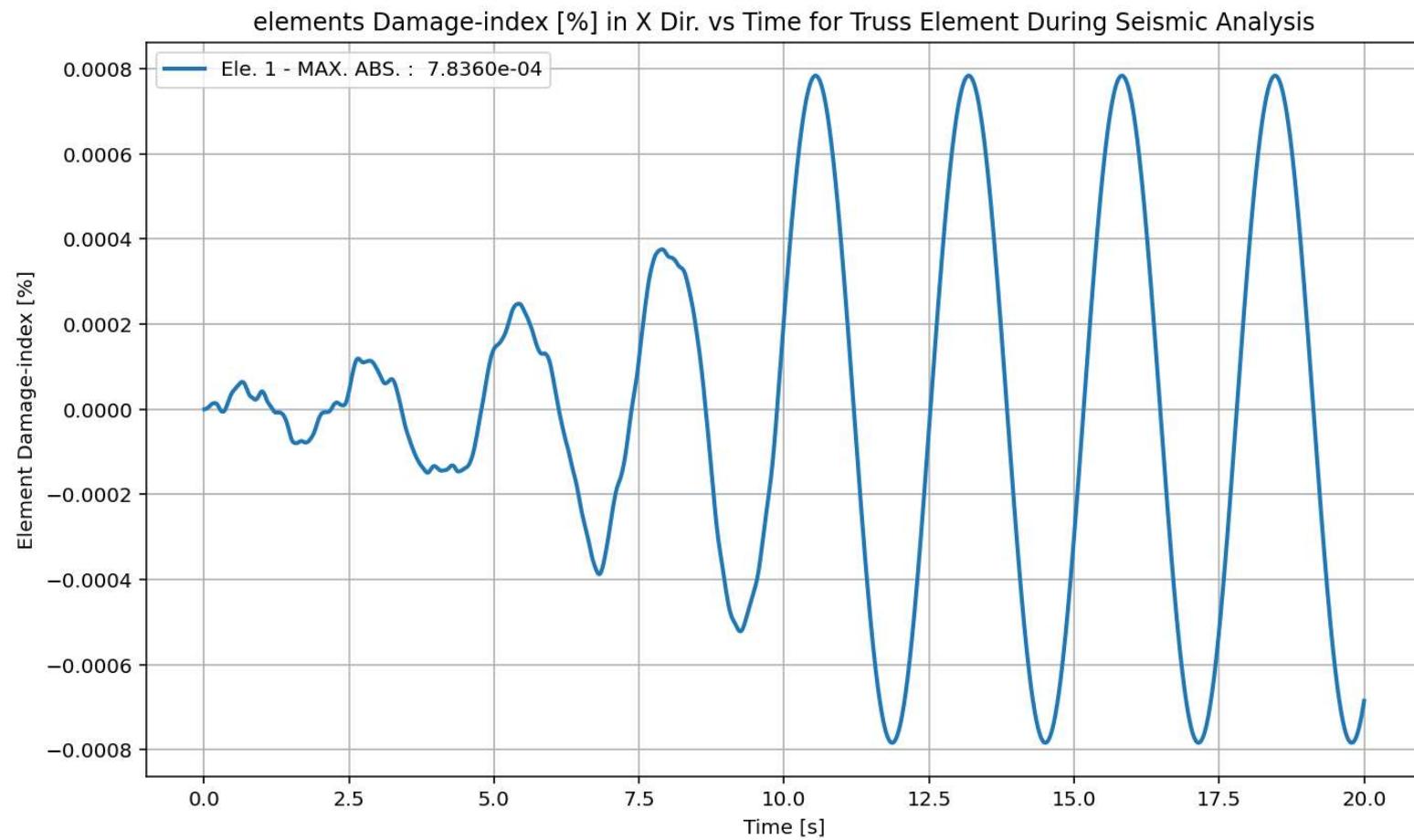
elements force in X Dir. vs Time for Bridge Structure During Seismic Analysis



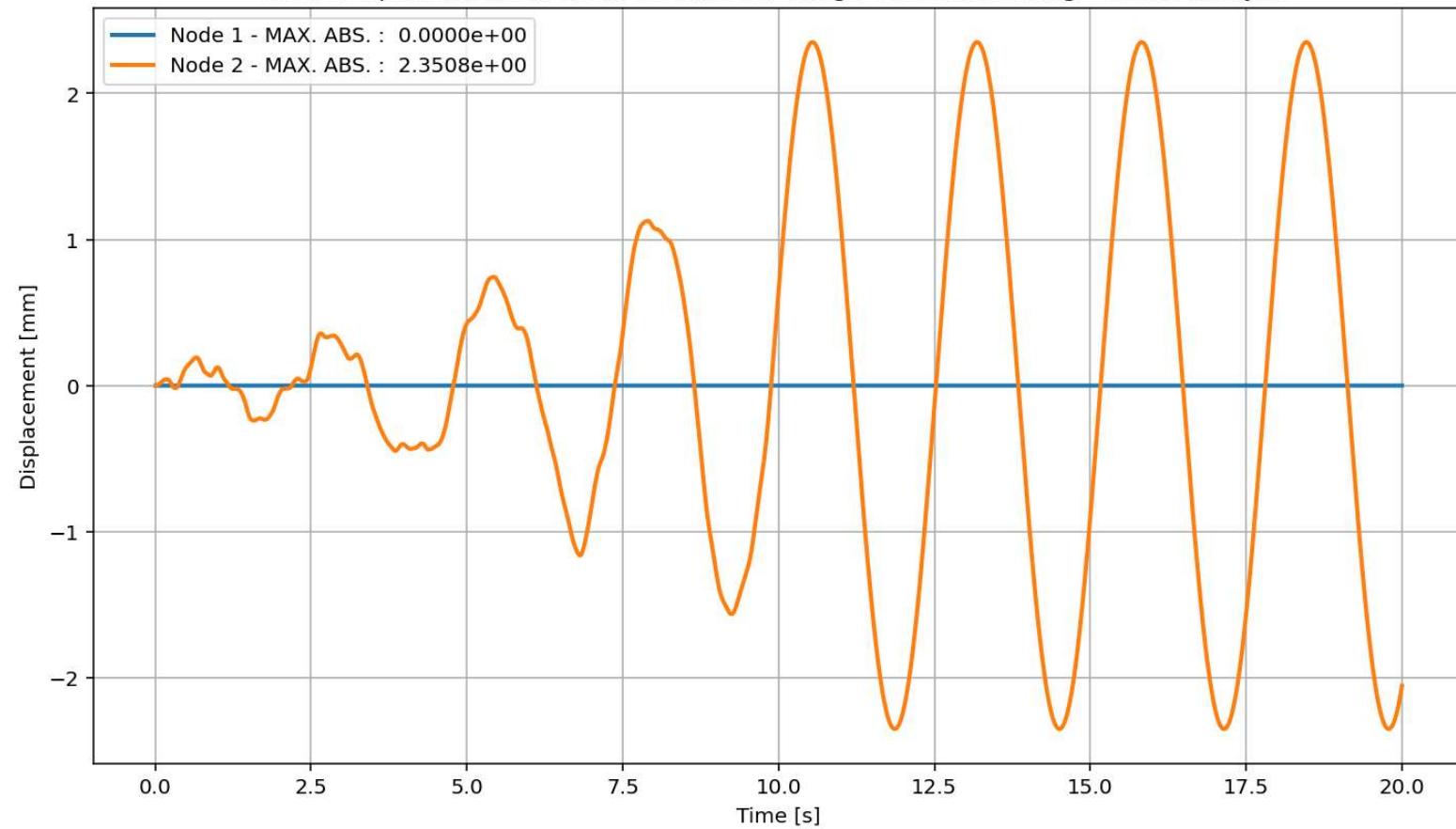
elements Stress in X Dir. vs Time for Bridge Structure During Seismic Analysis







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

