NONLINEAR PUSHOVER ANALYSIS OF A NONPRISMATIC STEEL GABLE FRAME. MODELING OF NONPRISMATIC ELEMENT WITH MULTI PRISMATIC ELEMENTS USING OPENSEES.

WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)
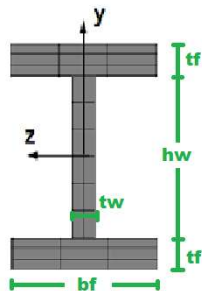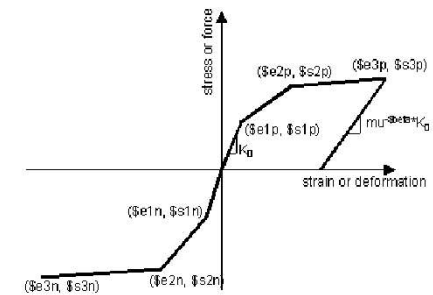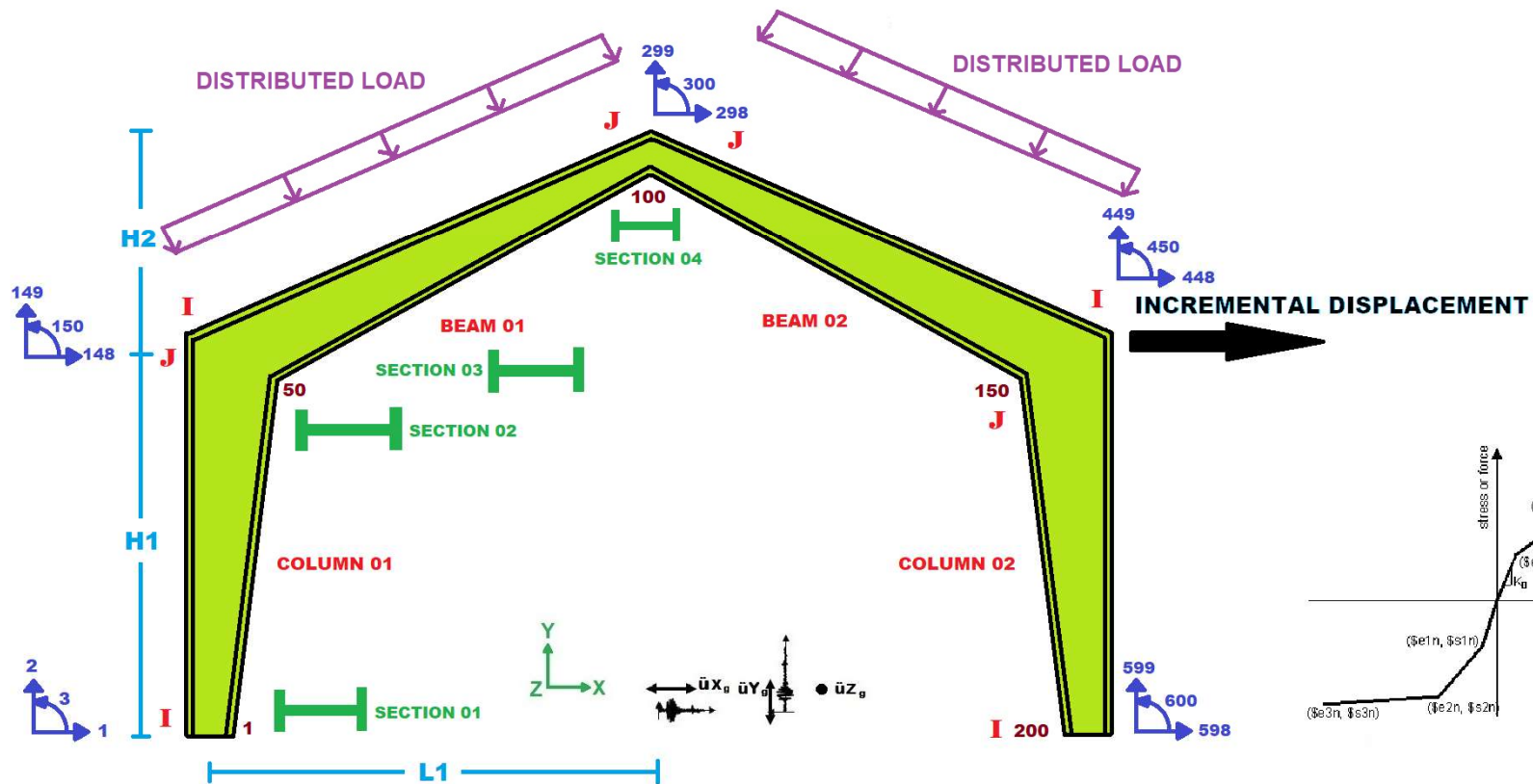
DISTRIBUTED LOAD

DISTRIBUTED LOAD

H2

H1

L1

I

J

I

J

299
300
298

449
450
448

149
150
148

2
3
1

100
SECTION 04

BEAM 01

BEAM 02

SECTION 03

50

150
J

SECTION 02

COLUMN 01

COLUMN 02

INCREMENTAL DISPLACEMENT

599
600
598

I
200

I
1

SECTION 01

Y
Z   X

üX$_g$ üY$_g$ üZ$_g$

stress or force

($e2p, $s2p)   ($e3p, $s3p)

($e1p, $s1p)

mu*$eps*K$_0$

K$_0$

strain or deformation

($e1n, $s1n)

($e3n, $s3n)   ($e2n, $s2n)

y

z

tf

hw

tw

tf

bf

NONLINEAR PUSHOVER ANALYSIS OF A NONPRISMATIC STEEL GABLE FRAME

File   Edit   Search   Source   Run   Debug   Consoles   Projects   Tools   View   Help
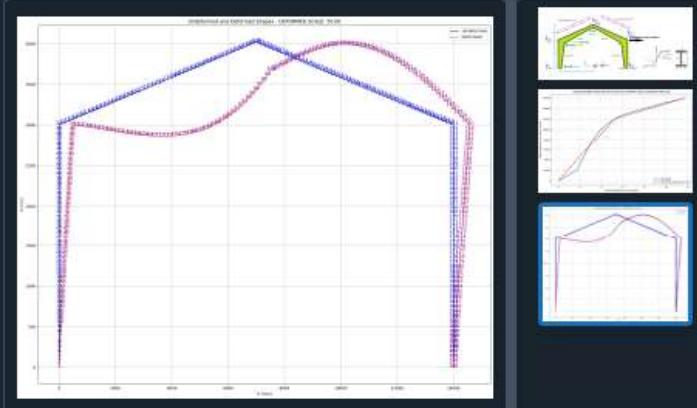
C:\Users\Dell\Desktop\OPENSEES_FILES\STEEL_GABLE_FRAME

C:\Users\Dell\Desktop\OPENSEES_FILES\STEEL_GABLE_FRAME\STEEL_GABLE_FRAME_PUSHOVER.py

STEEL_GABLE_FRAME_DYNAMIC.py   ✕   STEEL_GABLE_FRAME_PUSHOVER.py   ✕

```python
1   # ########################################################################
2   # #                          IN THE NAME OF ALLAH                        #
3   # #      NONLINEAR PUSHOVER ANALYSIS OF A NONPRISMATIC STEEL GABLE FRAME  #
4   # #              I SECTION COLUMN WITH FINITE PRISMATIC COLUMN            #
5   # #----------------------------------------------------------------------#
6   # #    MODELING OF NONPRISMATIC ELEMENT WITH MULTI PRISMATIC ELEMENTS     #
7   # #----------------------------------------------------------------------#
8   # #              THIS PROGRAM WRITTEN BY SALAR DELAVAR QASHQAI            #
9   # #                  EMAIL: salar.d.ghashghaei@gmail.com                  #
10  # ########################################################################
11
12  #%%-----------------------------------------------------------
13  #import the os module
14  import os
15  import time as TI
16  import numpy as np
17  import openseespy.opensees as op
18  import ANALYSIS_FUNCTION as S03
19  import PLOT_2D as S04
20  import BILINEAR_CURVE as S05
21  #%%-----------------------------------------------------------
22  import matplotlib.pyplot as plt
23  import matplotlib.image as mpimg
24
25  # Load the image
26  image_path = 'STEEL_GABLE_FRAME.PNG'
27  image = mpimg.imread(image_path)
28
29  # Display the image
30  plt.figure(figsize=(30, 16))
31  plt.imshow(image)
32  plt.axis('off')  # Hide axes
33  plt.show()
34  #%%-----------------------------------------------------------
```

Help   Variable Explorer   Debugger   Plots   Files
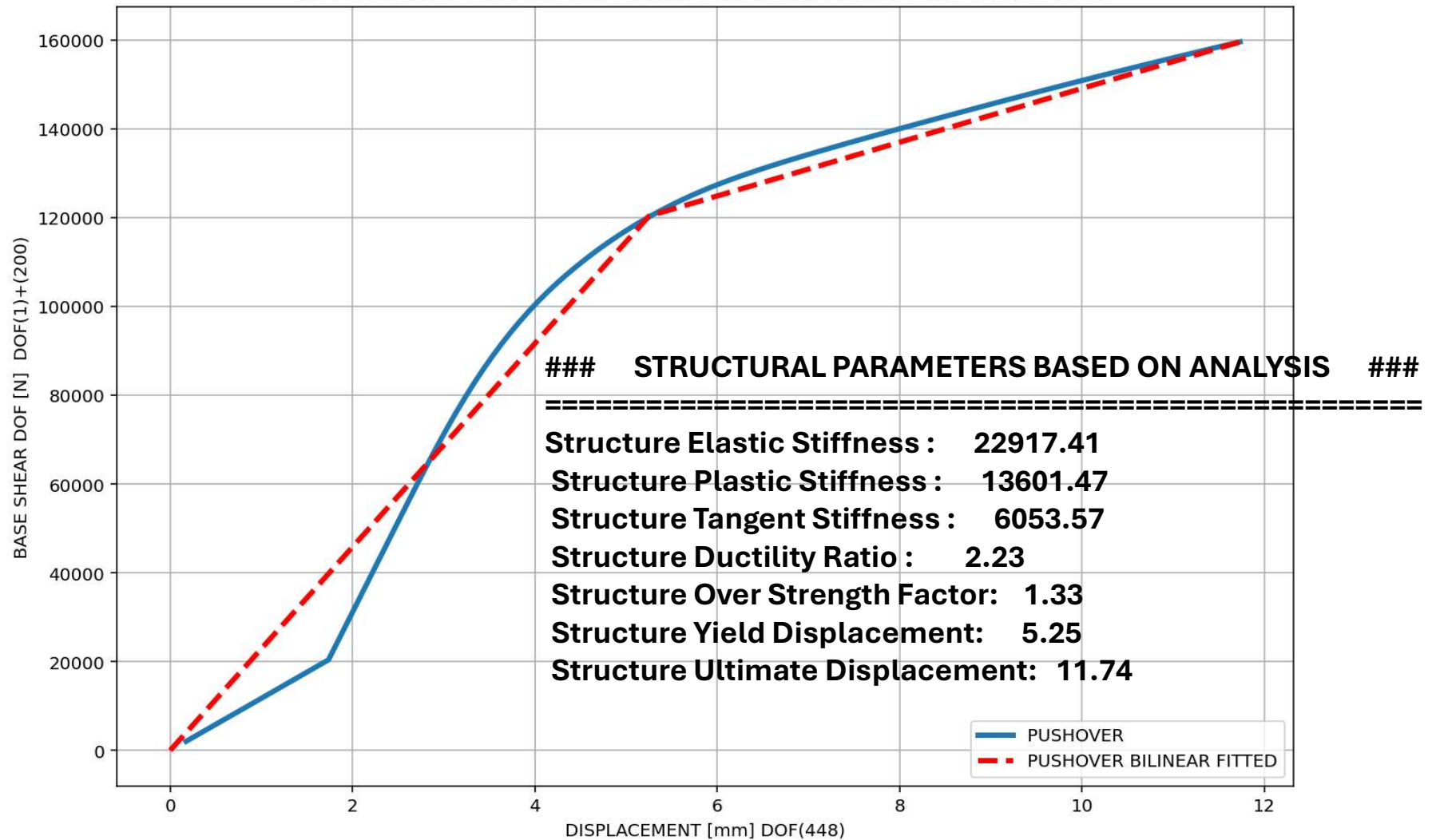
Console 1/A   ✕

```
Structure Yield Displacement:        5.25
Structure Ultimate Displacement:     11.74
C:
\Users\Dell\Desktop\OPENSEES_FILES\STEEL_GABLE_FRAME\PLOT_2D.
py:43: UserWarning: Legend does not support handles for Text
instances.
See: https://matplotlib.org/stable/tutorials/intermediate/
legend_guide.html#implementing-a-custom-legend-handler
  ax.legend()

In [3]:
```
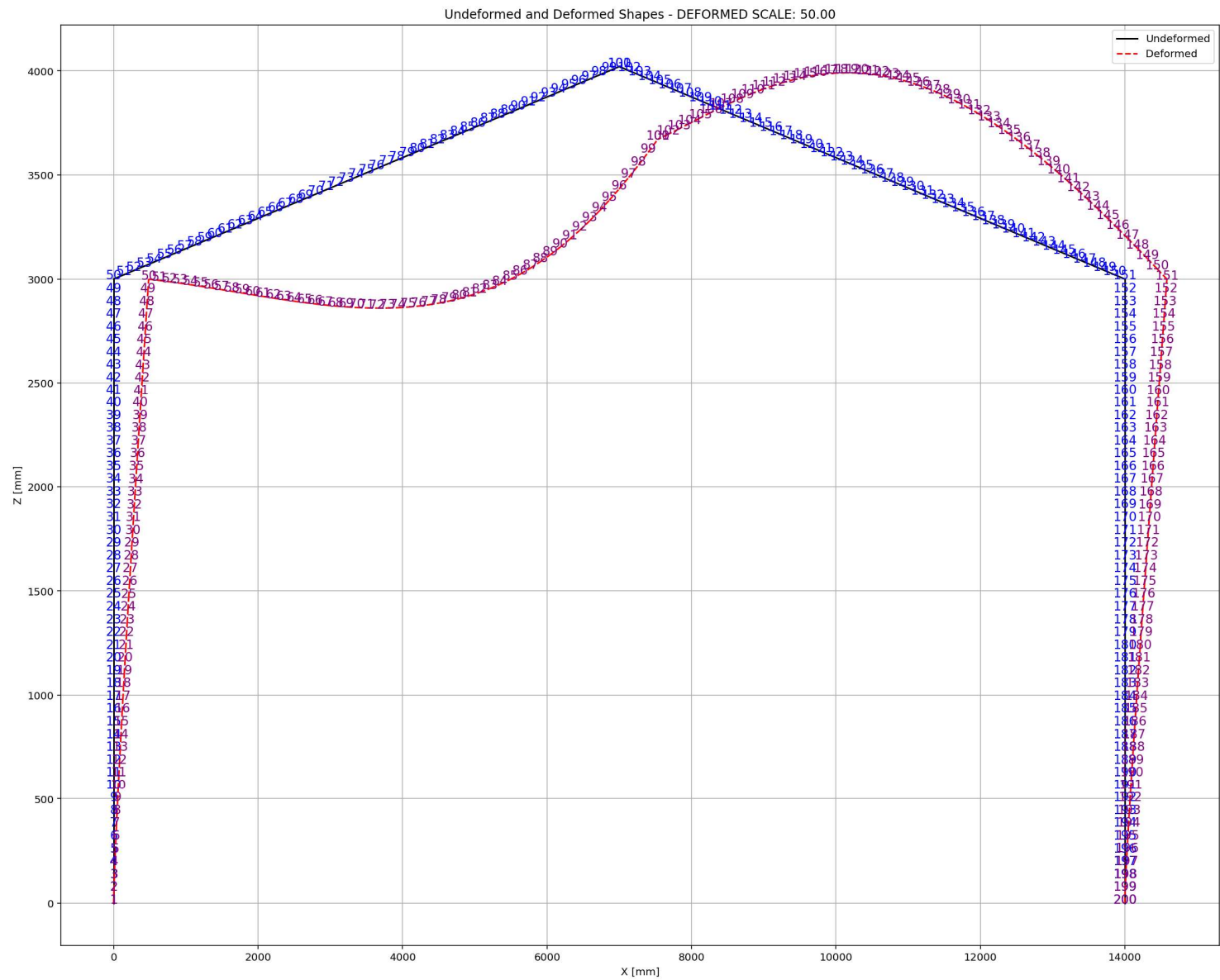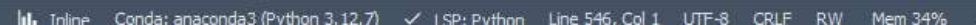
IPython Console   History

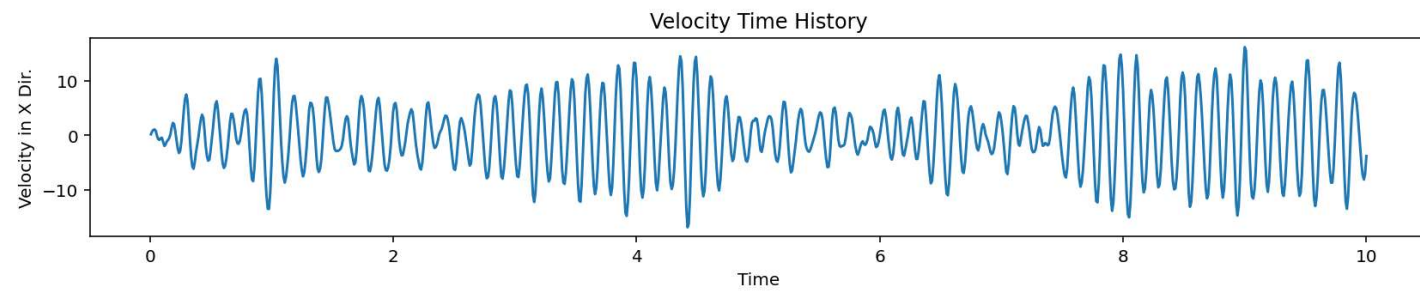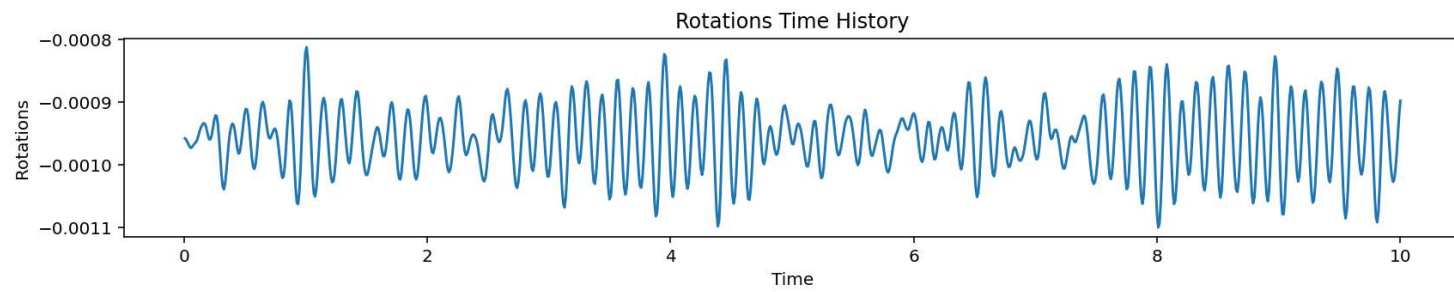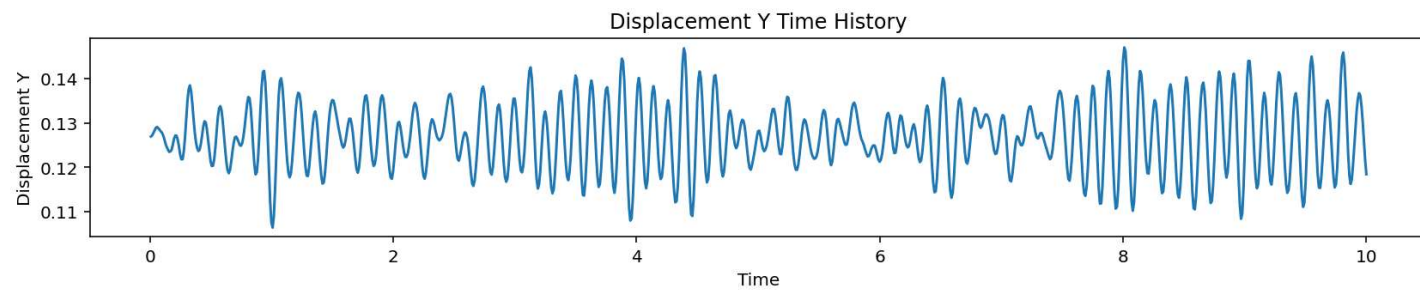Inline   Conda: anaconda3 (Python 3.12.7)   ✓ LSP: Python   Line 1, Col 1   UTF-8   CRLF   RW   Mem 35%

DISPLACEMENT BASE-SHEAR CURVE FOR DYNAMIC AND PUSHOVER ANALYSIS

STRUCTURAL PARAMETERS BASED ON ANALYSIS
==

Structure Elastic Stiffness :   **22917.41**
Structure Plastic Stiffness :   **13601.47**
Structure Tangent Stiffness :   **6053.57**
Structure Ductility Ratio :   **2.23**
Structure Over Strength Factor: 1.33
Structure Yield Displacement: 5.25
Structure Ultimate Displacement: 11.74

PUSHOVER
PUSHOVER BILINEAR FITTED

BASE SHEAR DOF [N] DOF(1)+(200)

DISPLACEMENT [mm] DOF(448)

Undeformed and Deformed Shapes - DEFORMED SCALE: 50.00

NONLINEAR DYNAMIC ANALYSIS OF A NONPRISMATIC STEEL GABLE FRAME

Spyder (Python 3.12)

File   Edit   Search   Source   Run   Debug   Consoles   Projects   Tools   View   Help

C:\Users\Dell\Desktop\OPENSEES_FILES\STEEL_GABLE_FRAME

C:\Users\Dell\Desktop\OPENSEES_FILES\STEEL_GABLE_FRAME\STEEL_GABLE_FRAME_DYNAMIC.py

STEEL_GABLE_FRAME_DYNAMIC.py   STEEL_GABLE_FRAME_PUSHOVER.py

```
 1    # ############################################################
 2    # #                                                          #
 3    # #        IN THE NAME OF ALLAH                              #
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 6    # #----------------------------------------------------------#
 7    # #    MODELING OF NONPRISMATIC ELEMENT WITH MULTI PRISMATIC ELEMENTS  #
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11    # ############################################################
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13    #%%-----------------------------------------------------------
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15    import os
16    import time as TI
17    import numpy as np
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19    import ANALYSIS_FUNCTION as S03
20    import PLOT_2D as S04
21    #%%-----------------------------------------------------------
22    import matplotlib.pyplot as plt
23    import matplotlib.image as mpimg
24
25    # Load the image
26    image_path = 'STEEL_GABLE_FRAME.PNG'
27    image = mpimg.imread(image_path)
28
29    # Display the image
30    plt.figure(figsize=(30, 16))
31    plt.imshow(image)
32    plt.axis('off')  # Hide axes
33    plt.show()
34    #%%-----------------------------------------------------------
35    # Create a directory at specified path with name 'directory path'
```

13 %

Help   Variable Explorer   Debugger   Plots   Files

Console 1/A

C:
\Users\Dell\Desktop\OPENSEES_FILES\STEEL_GABLE_FRAME\PLOT_2D.
py:43: UserWarning: Legend does not support handles for Text
instances.
See: https://matplotlib.org/stable/tutorials/intermediate/
legend_guide.html#implementing-a-custom-legend-handler
  ax.legend()

In [2]:

IPython Console   History

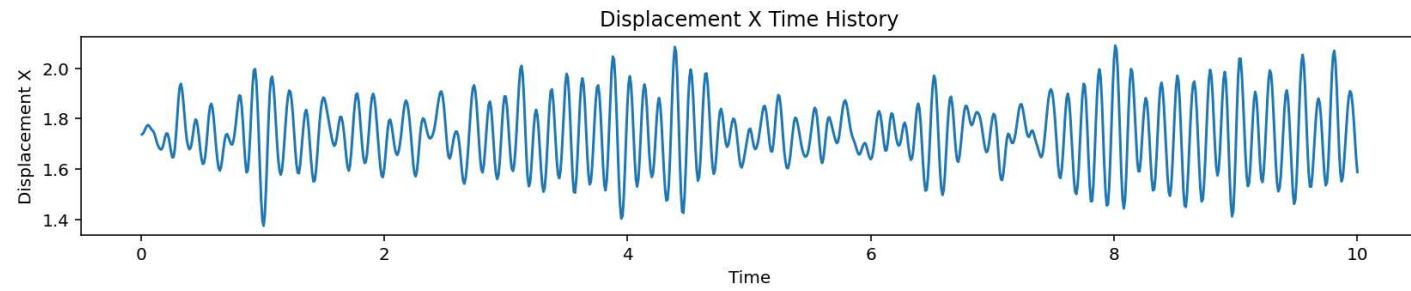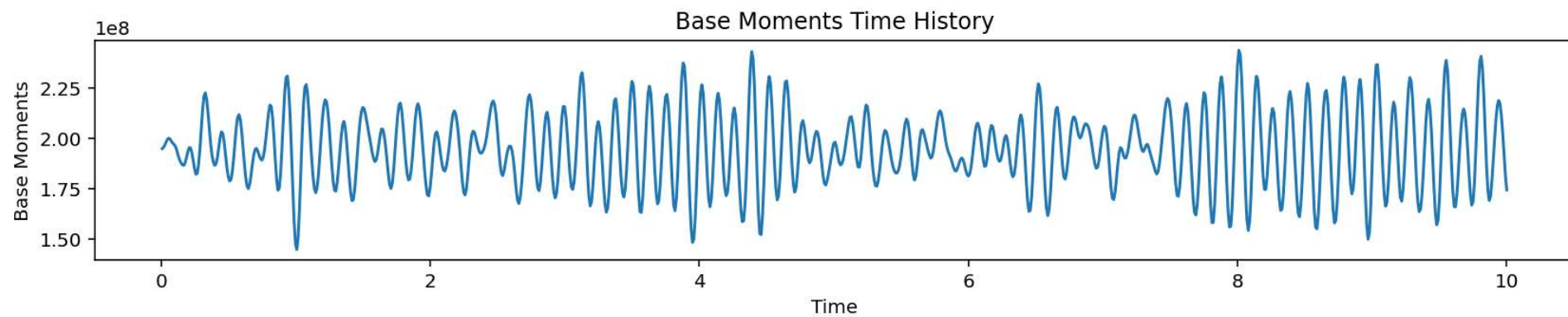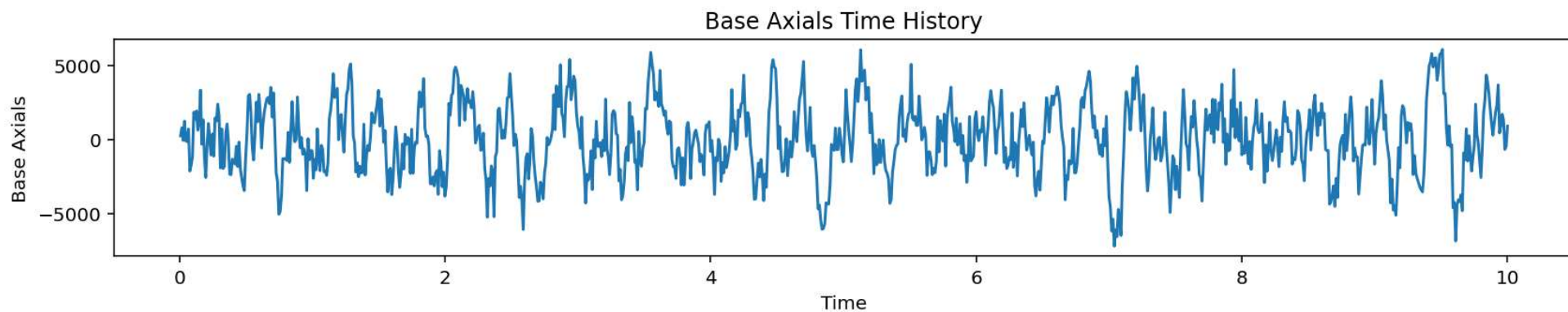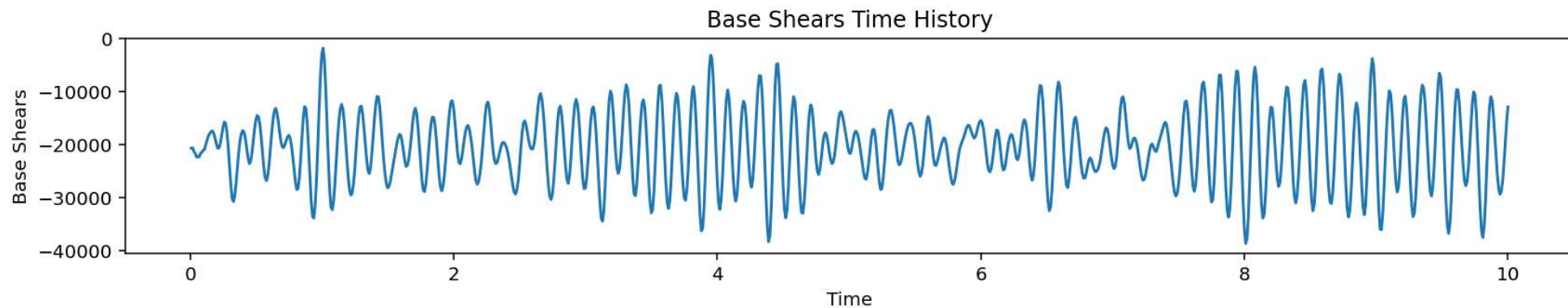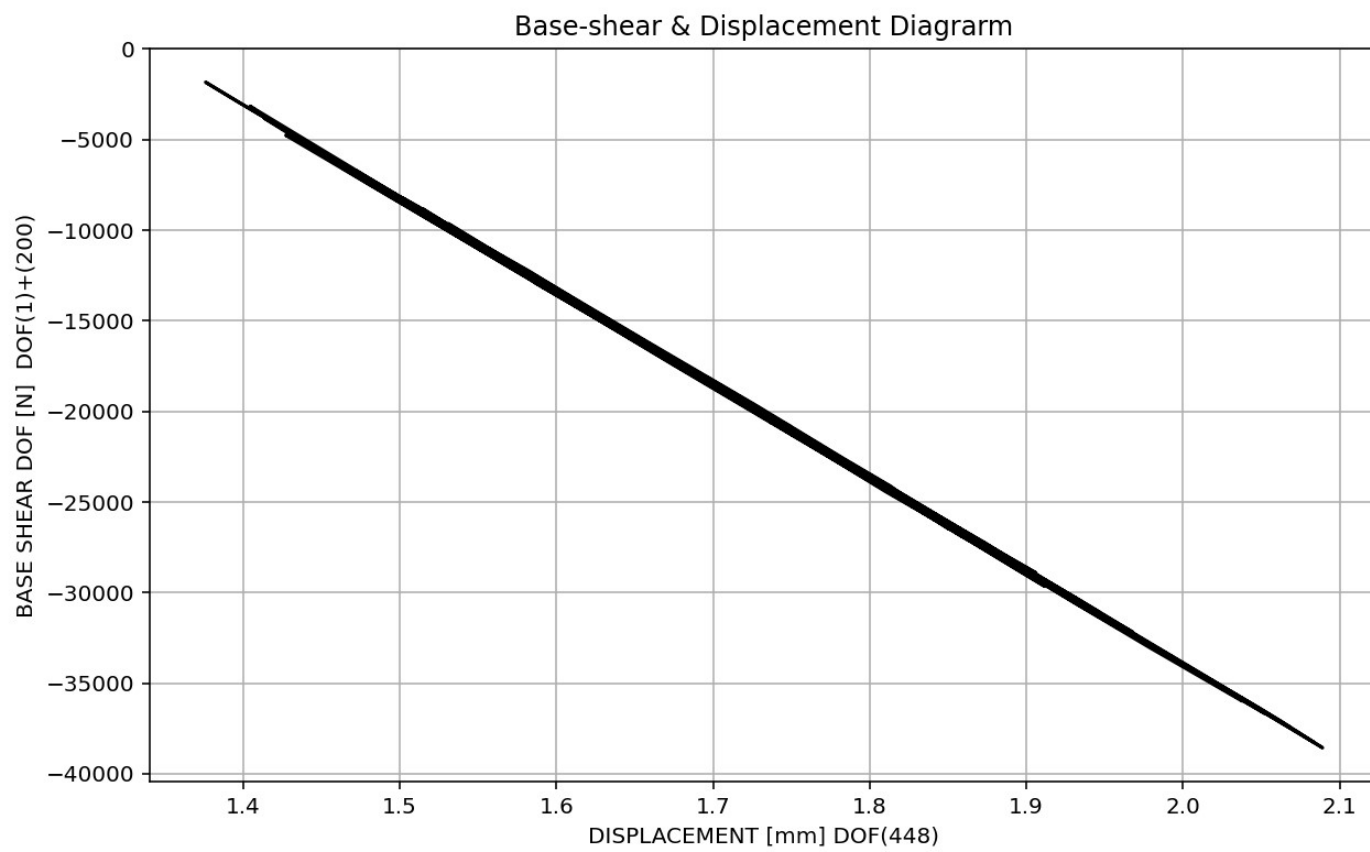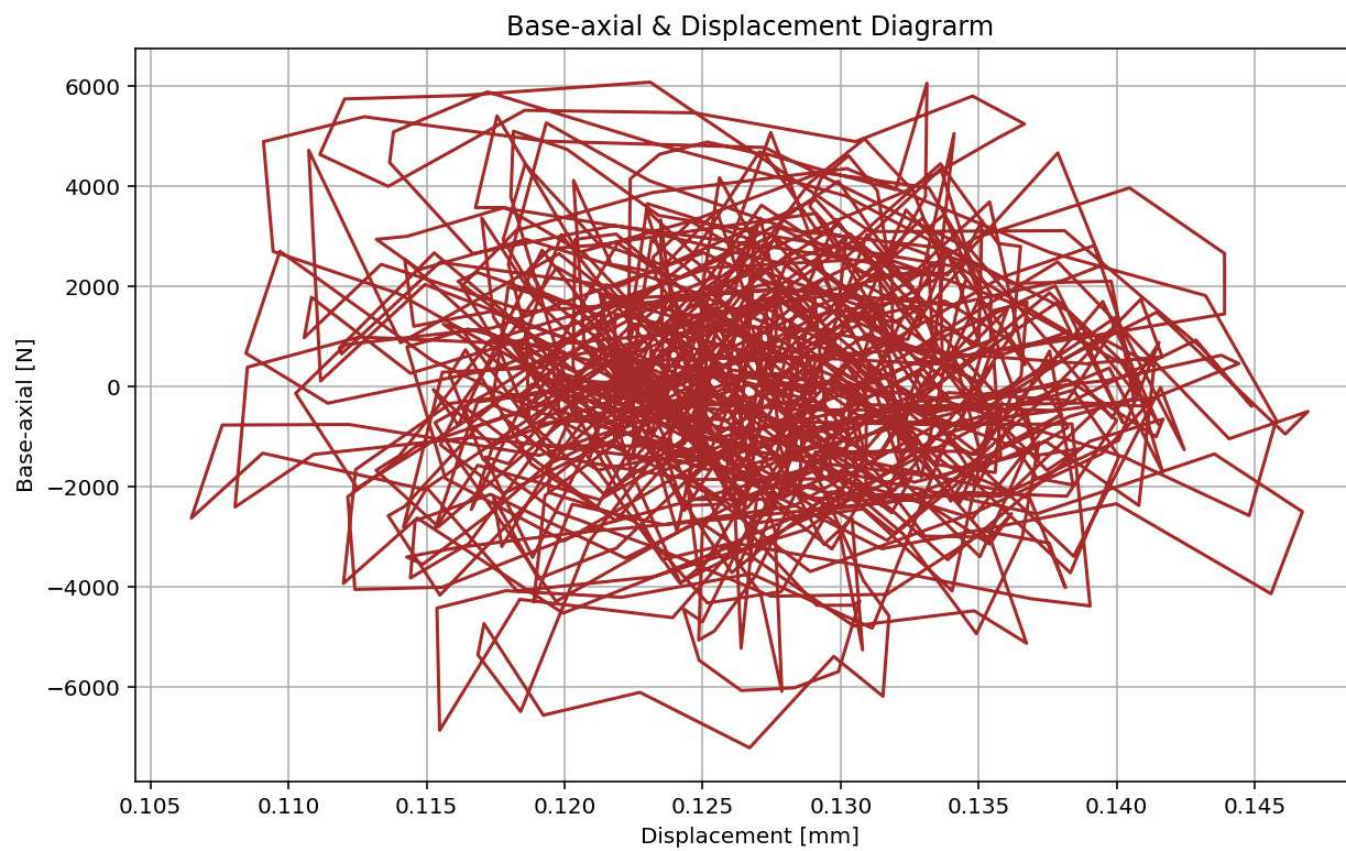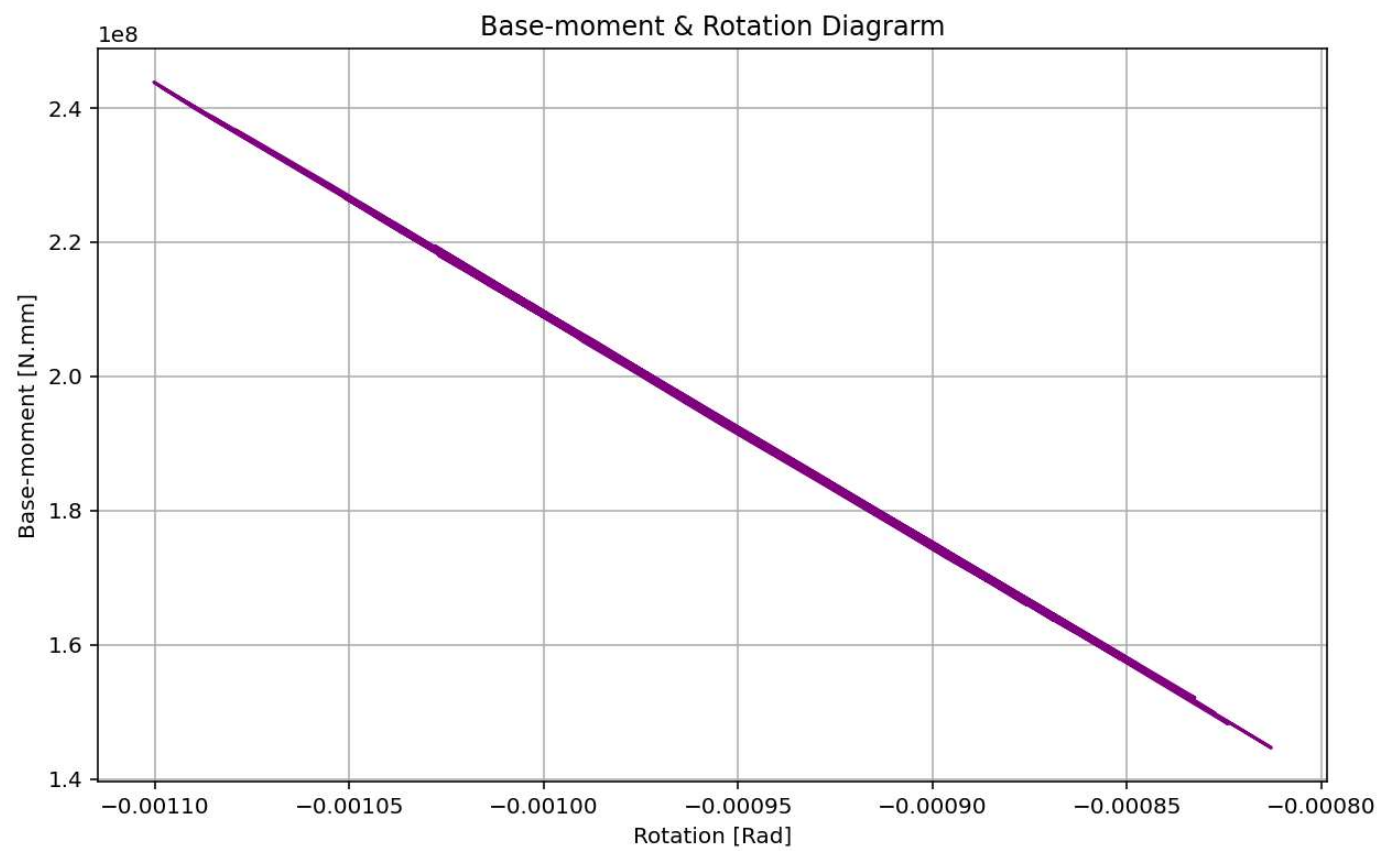Inline   Conda: anaconda3 (Python 3.12.7)   LSP: Python   Line 546, Col 1   UTF-8   CRLF   RW   Mem 34%

Acceleration Time History

Velocity Time History

Acceleration Time History

Base-shear & Displacement Diagrarm

Base-axial & Displacement Diagrarm

Base-moment & Rotation Diagrarm

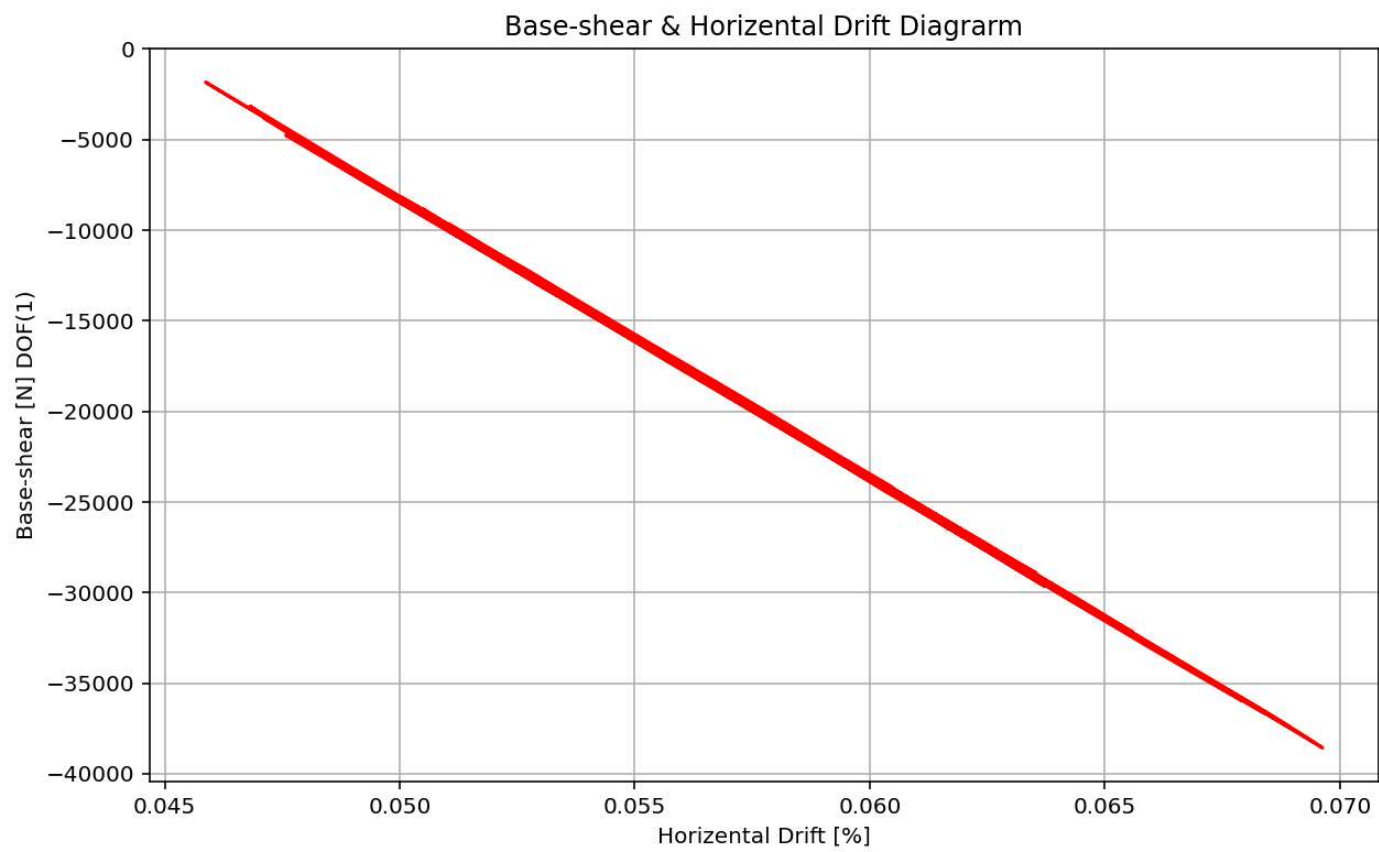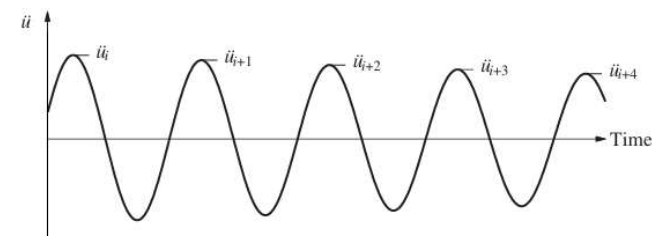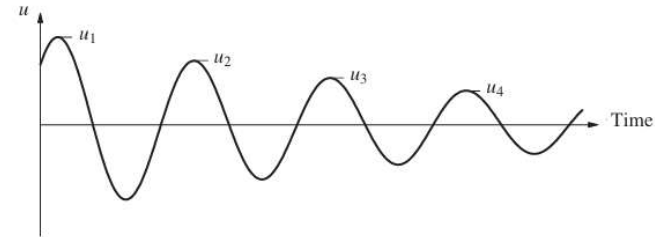Base-shear & Horizental Drift Diagrarm

VISCOUSLY DAMPED FREE VIBRATION
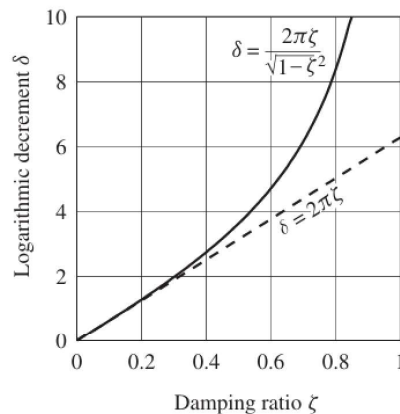
$$m\ddot{u} + c\dot{u} + ku = 0$$

$$\ddot{u} + 2\zeta\omega_n\dot{u} + \omega_n^2 u = 0$$

$$\omega_n = \sqrt{k/m} \quad \zeta = \frac{c}{2m\omega_n} = \frac{c}{c_{cr}} \quad \omega_D = \omega_n\sqrt{1 - \zeta^2}$$

$$u(t) = e^{-\zeta\omega_n t}\left[u(0)\cos\omega_D t + \frac{\dot{u}(0) + \zeta\omega_n u(0)}{\omega_D}\sin\omega_D t\right]$$

Exact Damping Ratio: 1.50494054e-04

Decay of Motion

$$\delta = \ln\frac{u_i}{u_{i+1}} = 2\pi\zeta \quad \text{(APPROXIMATE RELATION)}$$

$$\delta = \ln\frac{u_i}{u_{i+1}} = \frac{2\pi\zeta}{\sqrt{1 - \zeta^2}} \quad \text{(EXACT RELATION)}$$

EXACT AND APPROXIMATE RELATIONS BETWEEN LOGARITHMIC DECREMENT AND DAMPING RATIO

Undeformed and Deformed Shapes - DEFORMED SCALE: 100.00