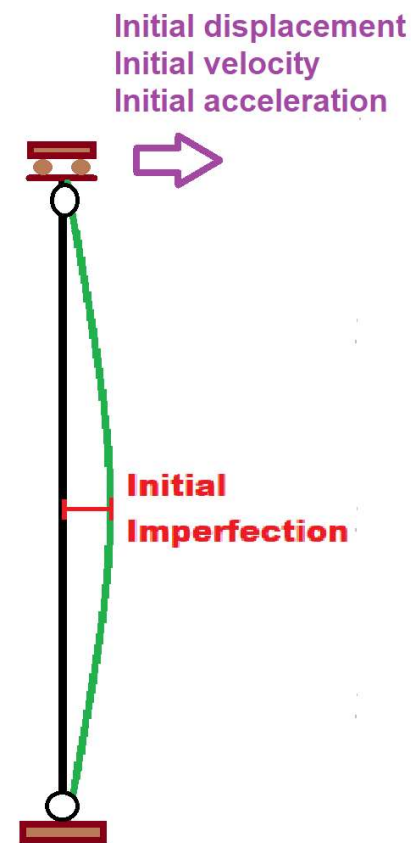
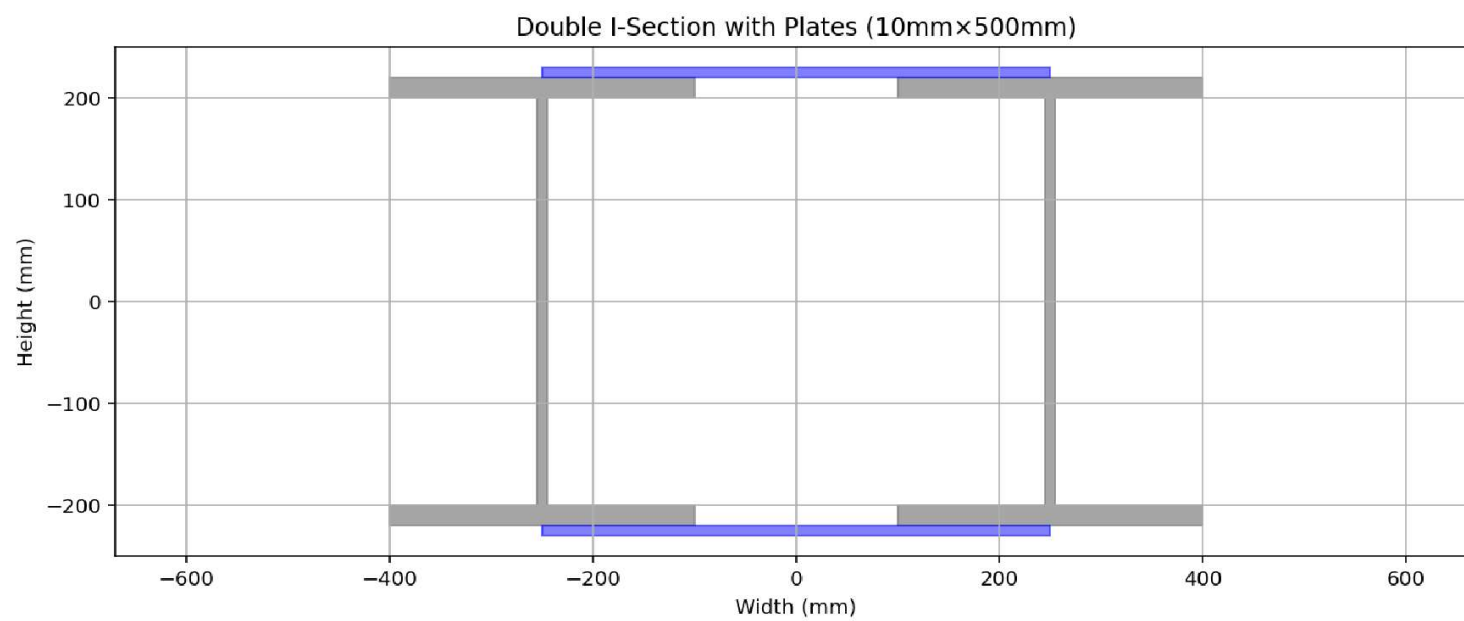


>> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<

**INVESTIGATION OF FREE-VIBRATION
ANALYSIS WITH LATERAL
DISPLACEMENT OF MULTI-MODE POST-
BUCKLING PHENOMENA STEEL
COLUMNS USING OPENSEES
CONSIDERING THE GEOMETRIC AND
MATERIAL PROPERTIES NONLINEARITY
(RELEASE MOMENT IN FIRST AND LAST ELEMENT)**

WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)

$$\left(\frac{P}{P_y}\right)^2 + \left(\frac{M}{M_y}\right)^2 \leq 1$$



Spyder (Python 3.12)

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C:\Users\Dell\Desktop\OPENSEES_FILES\MULTI-MODE-P...G_STEEL_COLUMN_NONLINEAR_FV_LATERAL_RELEASE_M3.py

MULTI-MODE-POST_BU...ERAL_RELEASE_M3.py X

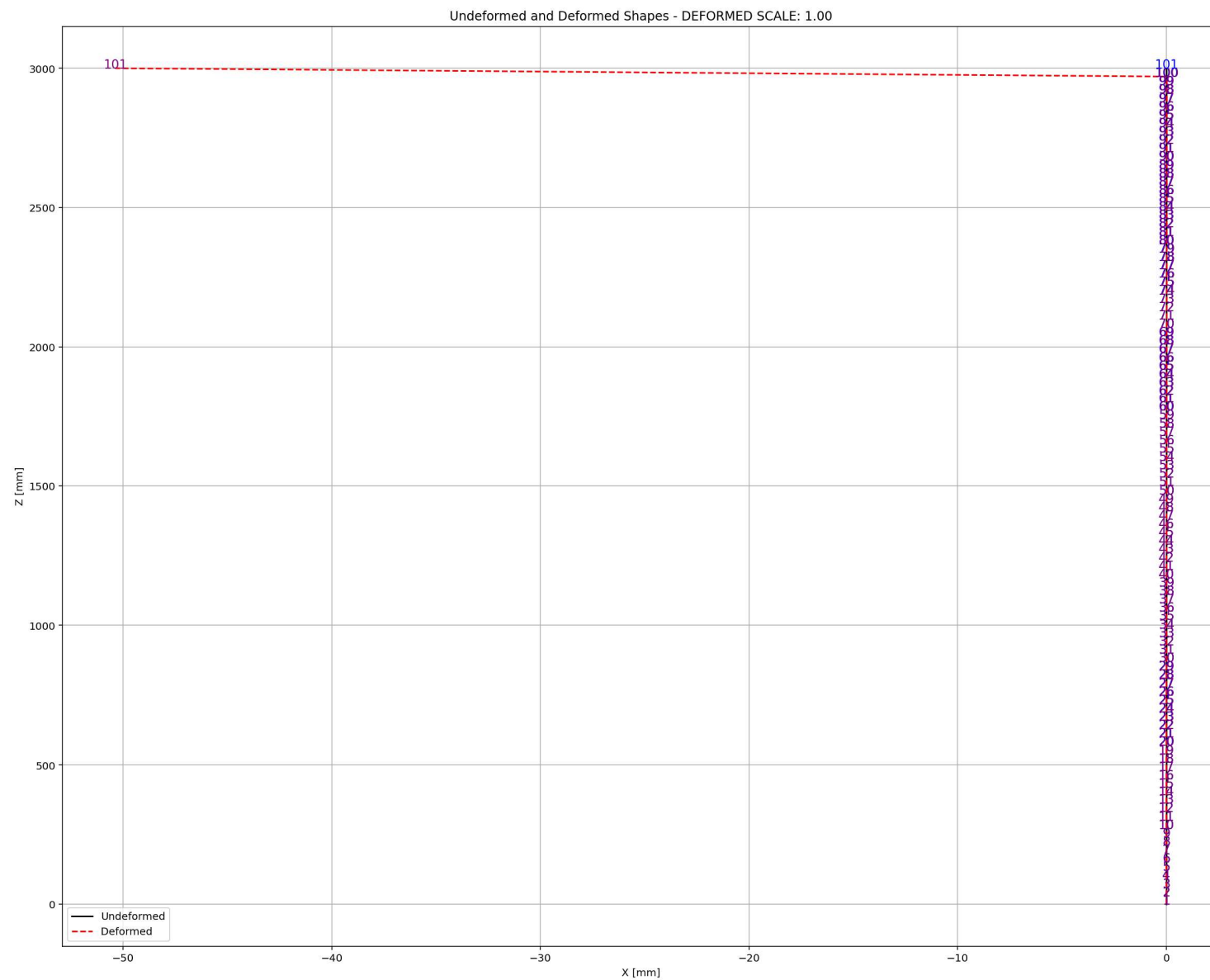
```
1 #####
2 # >> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<
3 # INVESTIGATION OF FREE-VIBRATION ANALYSIS WITH LATERAL DISPLACEMENT OF MULTI-MODE POST-
4 # PHENOMENA STEEL COLUMNS USING OPENSEES CONSIDERING THE GEOMETRIC AND MATERIAL PROPERTIES
5 # (RELEASE MOMENT IN FIRST AND LAST ELEMENT)
6 #-----
7 # IT MODELS A 2D INELASTIC BEAM-COLUMN WITH AN INITIAL IMPERFECTION (FOUR DIFFRENET SHAPES)
8 # AND APPLIES AN AXIAL COMPRESSIVE LOAD TO ANALYZE LARGE DISPLACEMENTS.
9 # 1. MODEL SETUP: A COLUMN OF LENGTH L IS DEFINED WITH N ELEMENTS, INCORPORATING A SMALL IN
10 # IMPERFECTION (HALF-SINE WAVE).
11 # 2. NODES & BOUNDARY CONDITIONS: NODES ARE CREATED, WITH THE BOTTOM FIXED IN X, Y AND THE
12 # X BUT FREE IN Y AND ROTATION.
13 # 3. ELEMENT DEFINITION: THE COLUMN IS MODELED USING ELASTIC BEAM-COLUMN ELEMENTS WITH CORO
14 # TRANSFORMATION FOR GEOMETRIC NONLINEARITY.
15 # 4. LOAD APPLICATION: A STATIC AXIAL FORCE IS APPLIED AT THE TOP NODE.
16 # 5. ANALYSIS SETUP: A DISPLACEMENTCONTROL INTEGRATOR IS USED TO INCREMENTALLY PUSH THE COL
17 # 6. NONLINEAR SOLVER: THE NEWTON METHOD IS USED WITH A NORMDISPINC R TEST FOR CONVERGENCE.
18 # 7. ANALYSIS EXECUTION: THE LOOP PERFORMS INCREMENTAL LOADING STEPS, RECORDING AXIAL DISPL
19 # LATERAL DISPLACEMENT, AND AXIAL FORCE.
20 # 8. BUCKLING BEHAVIOR CAPTURE: LATERAL DISPLACEMENTS AT THE TOP-HEIGHT NODE INDICATE POST-
21 # DEFORMATION.
22 # 9. RESULTS EXTRACTION: REACTION FORCES AT THE BASE NODE PROVIDE THE AXIAL COMPRESSIVE LOA
23 # 10. PLOTTING: THE SCRIPT VISUALIZES AXIAL FORCE VS. LATERAL DISPLACEMENT, SHOWING THE POS
24 # RESPONSE OF THE COLUMN.
25 #-----
26 # THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)
27 # EMAIL: salar.d.ghashghaei@gmail.com
28 #####
29 import openseespy.opensees as ops
30 import numpy as np
31 import matplotlib.pyplot as plt
32 import STEEL_FIBER_SECTION as S01
33 import ANALYSIS_FUNCTION as S02
34 import RAYLEIGH DAMPING FUN as S04
```

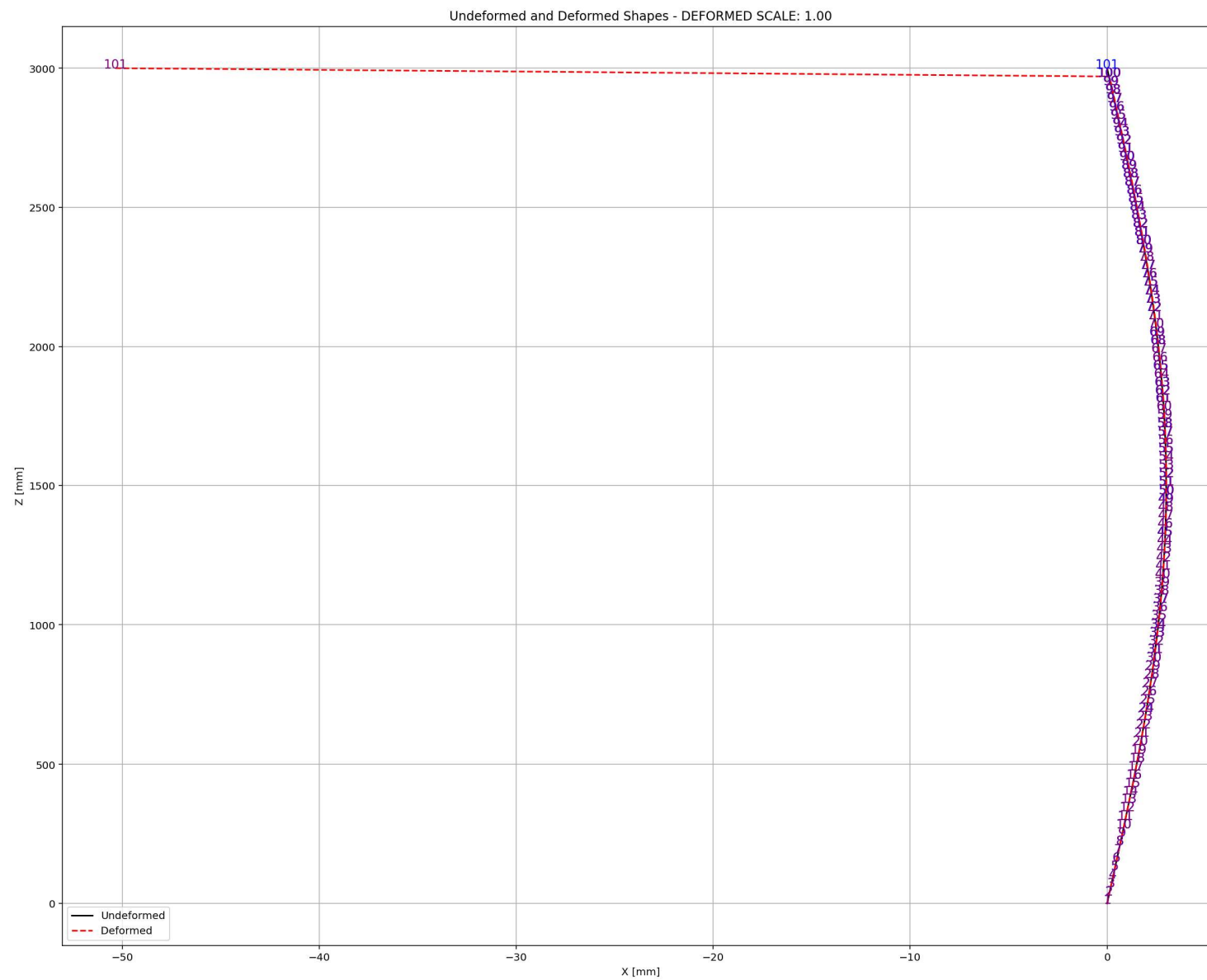
Post-buckling behavior of column - Axial-Disp. Curve

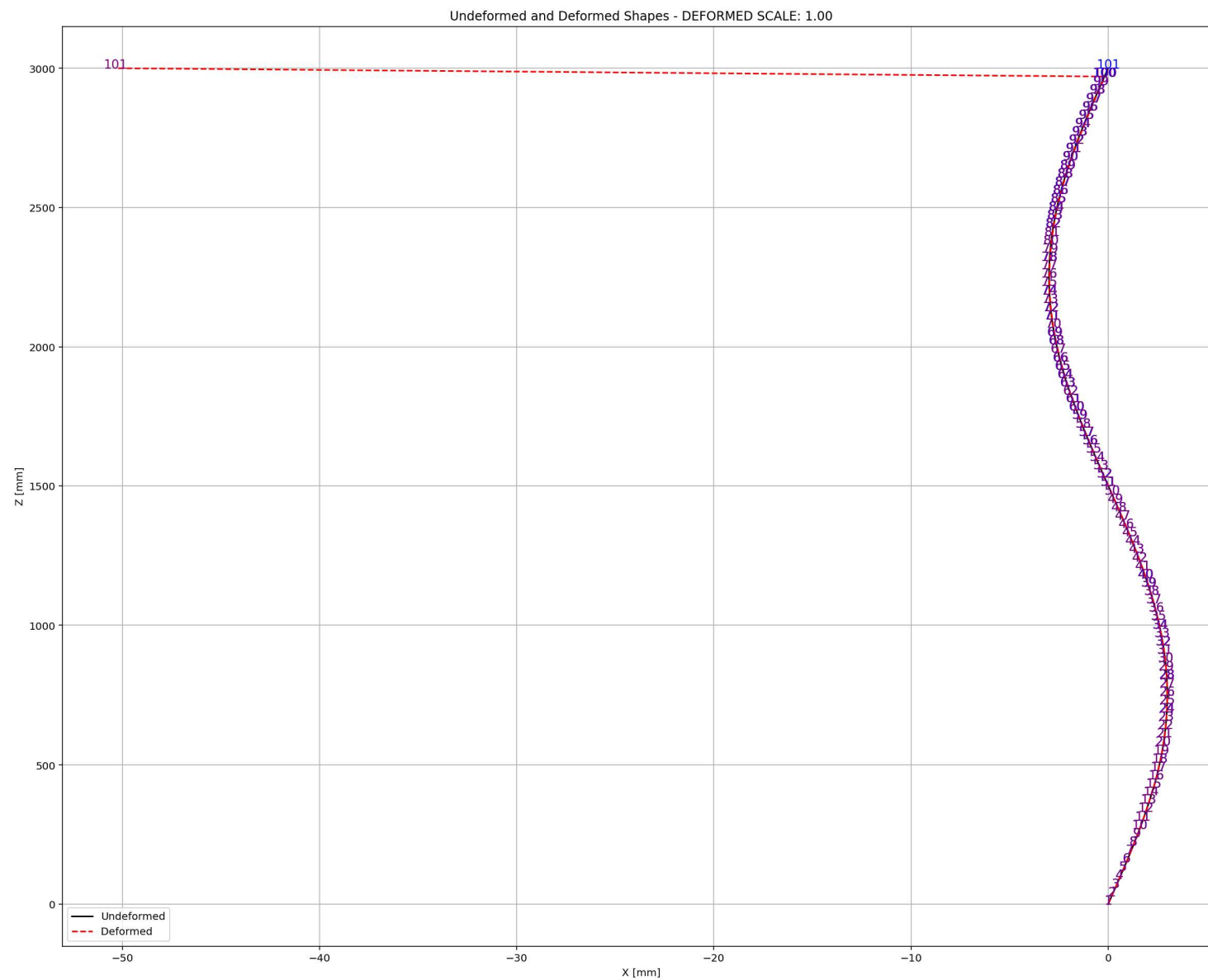
Mode	Post Buckling Load
Mode 00	5.759
Mode 01	6.177
Mode 02	27.009
Mode 03	5.988
Mode 04	16.287

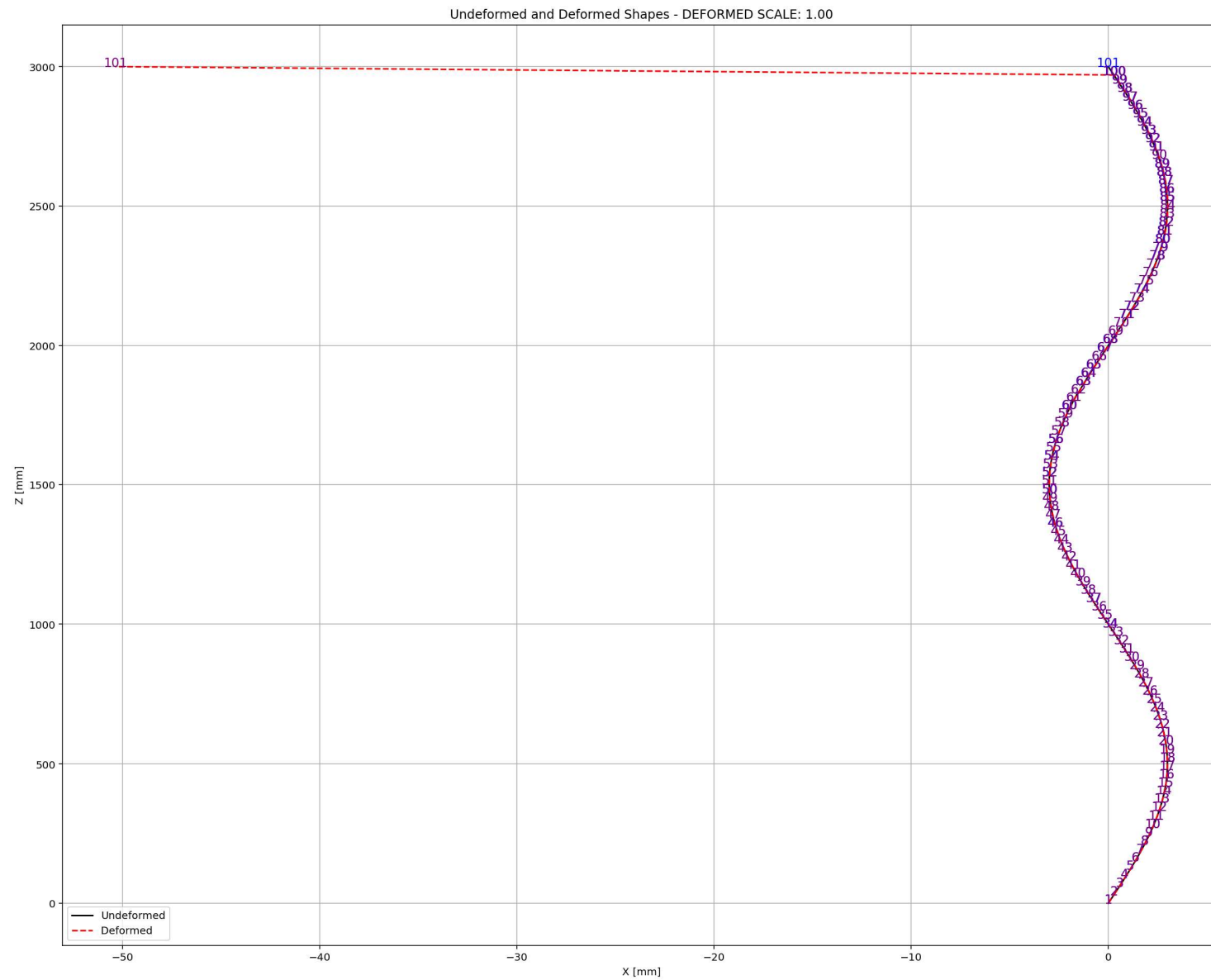
IPython Console Files Help Variable Explorer Debugger Plots History

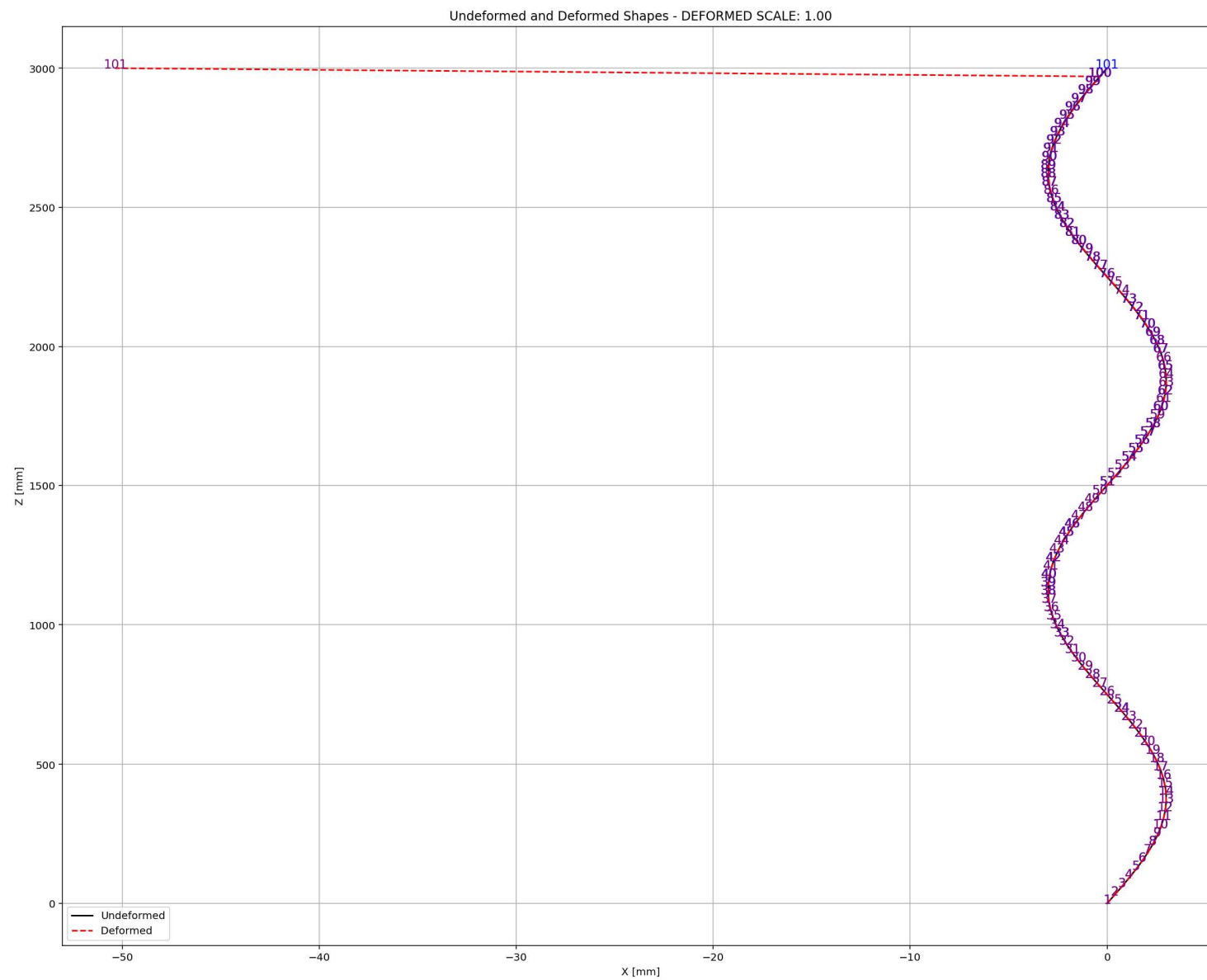
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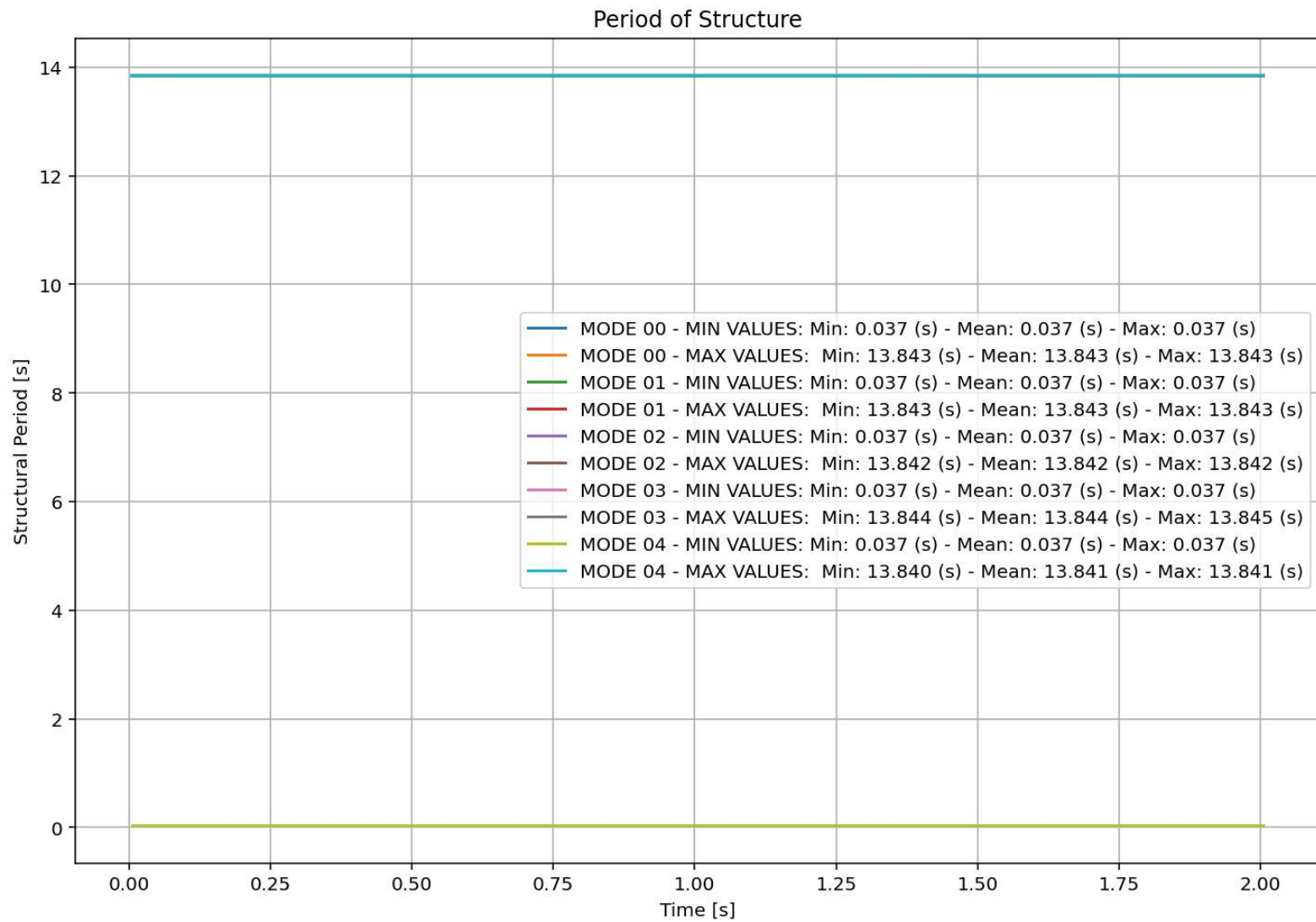


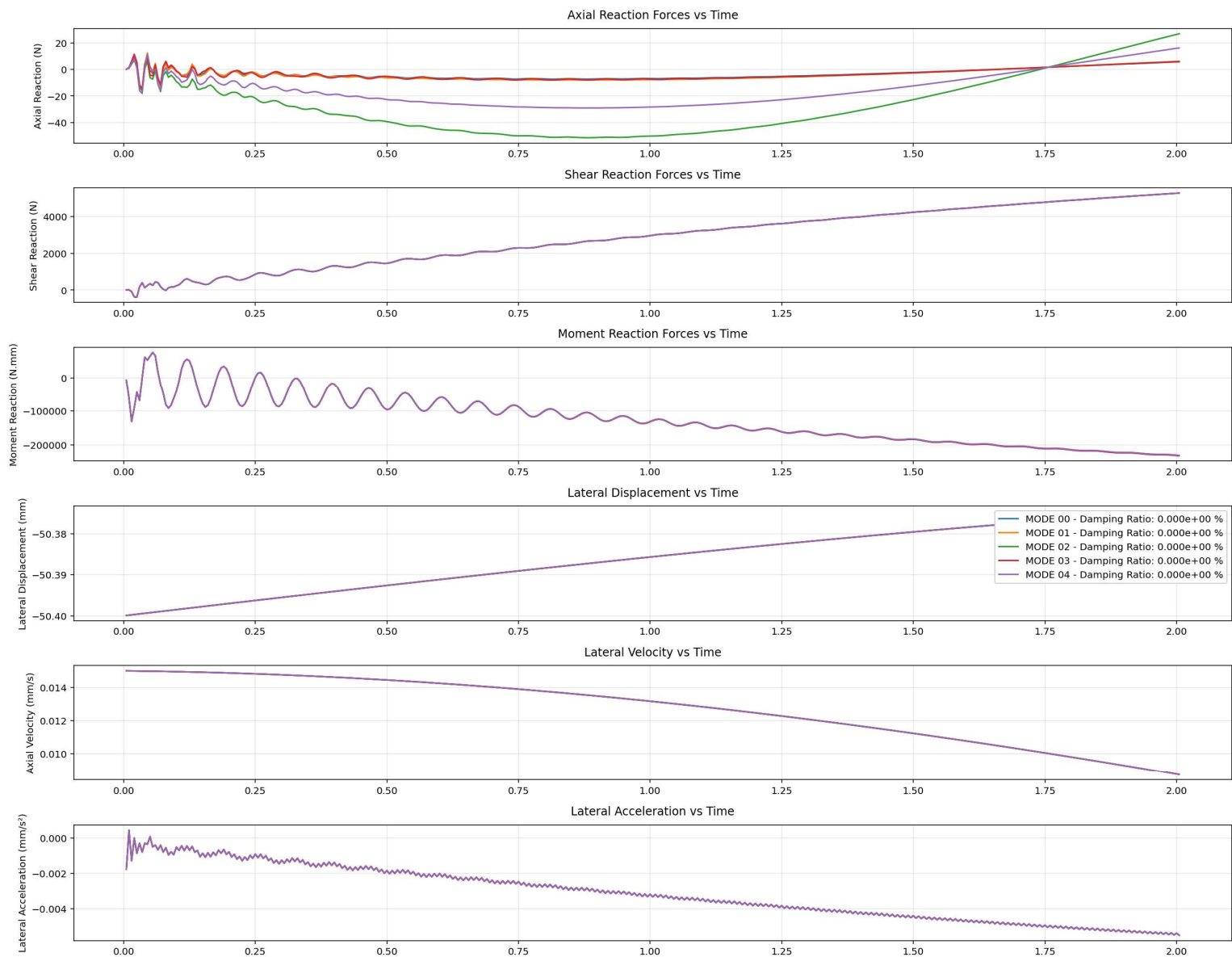


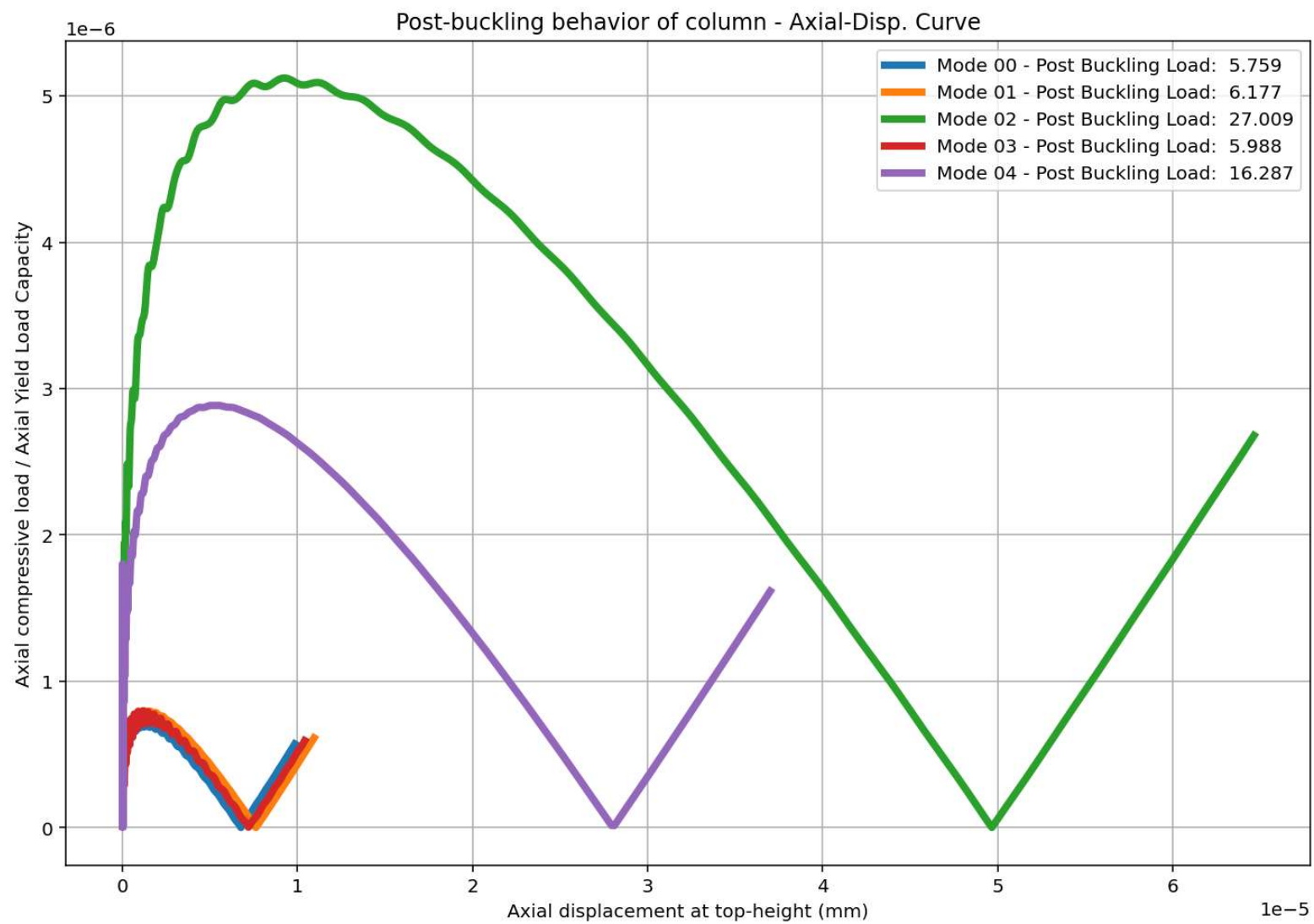


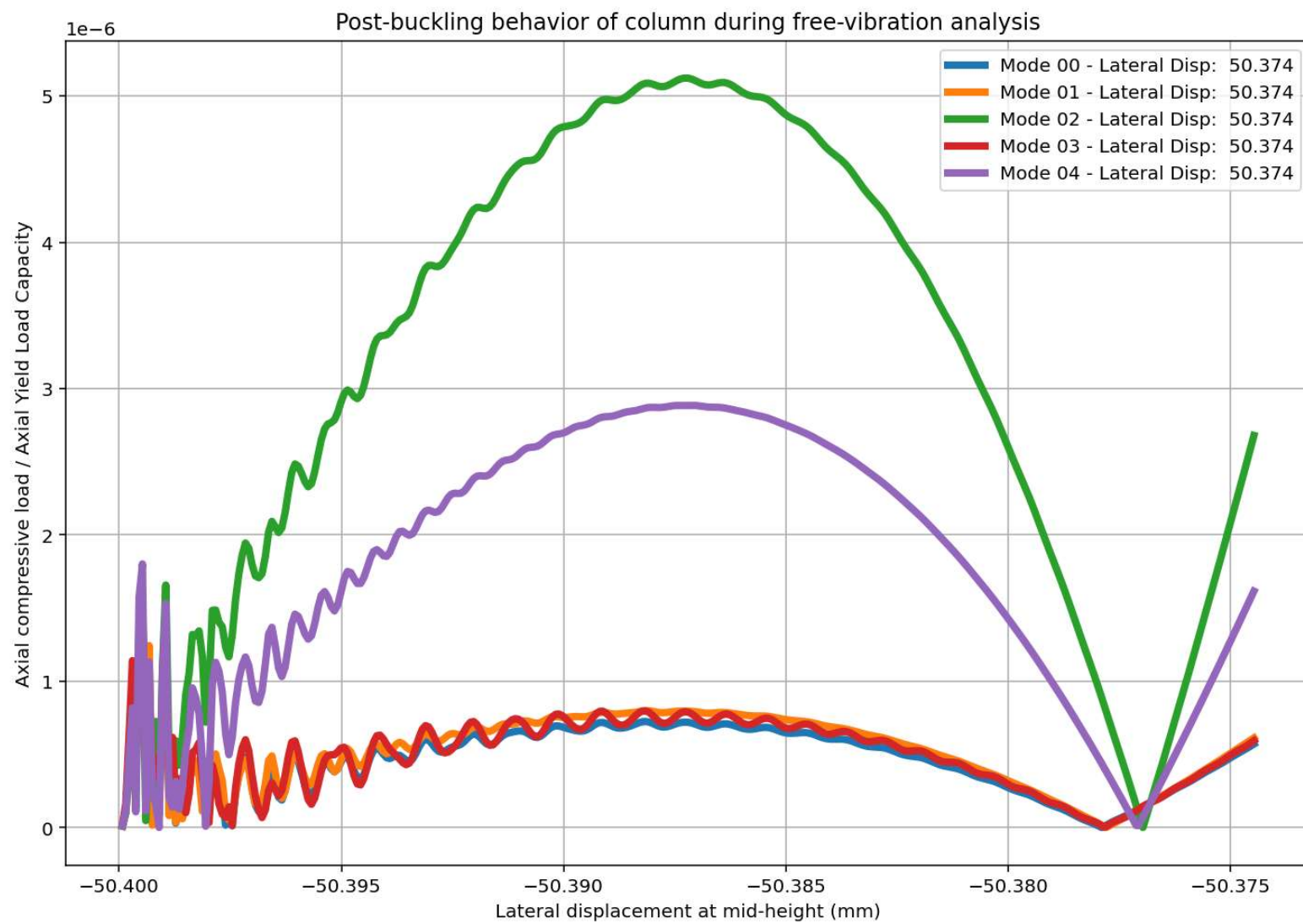




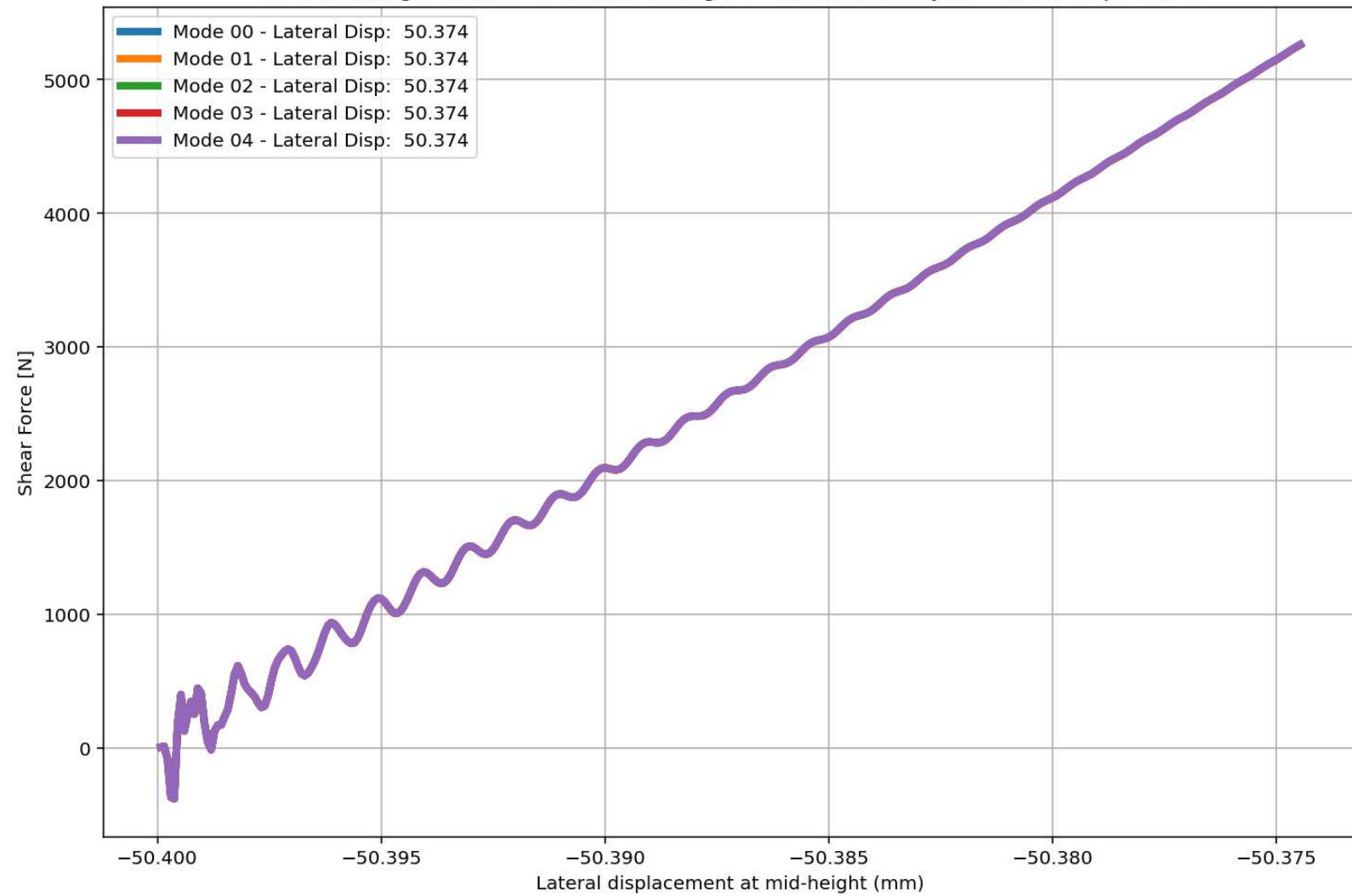




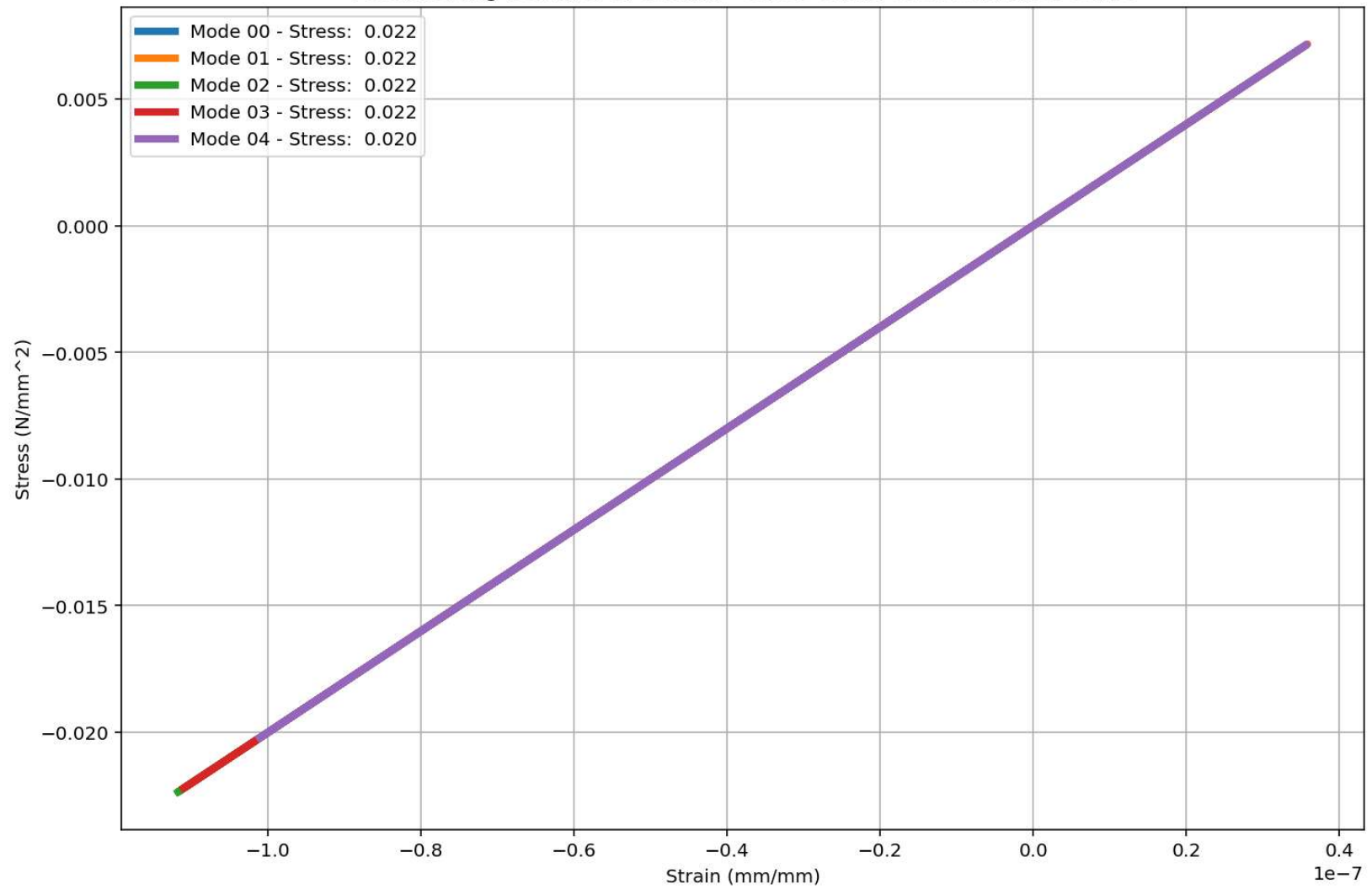


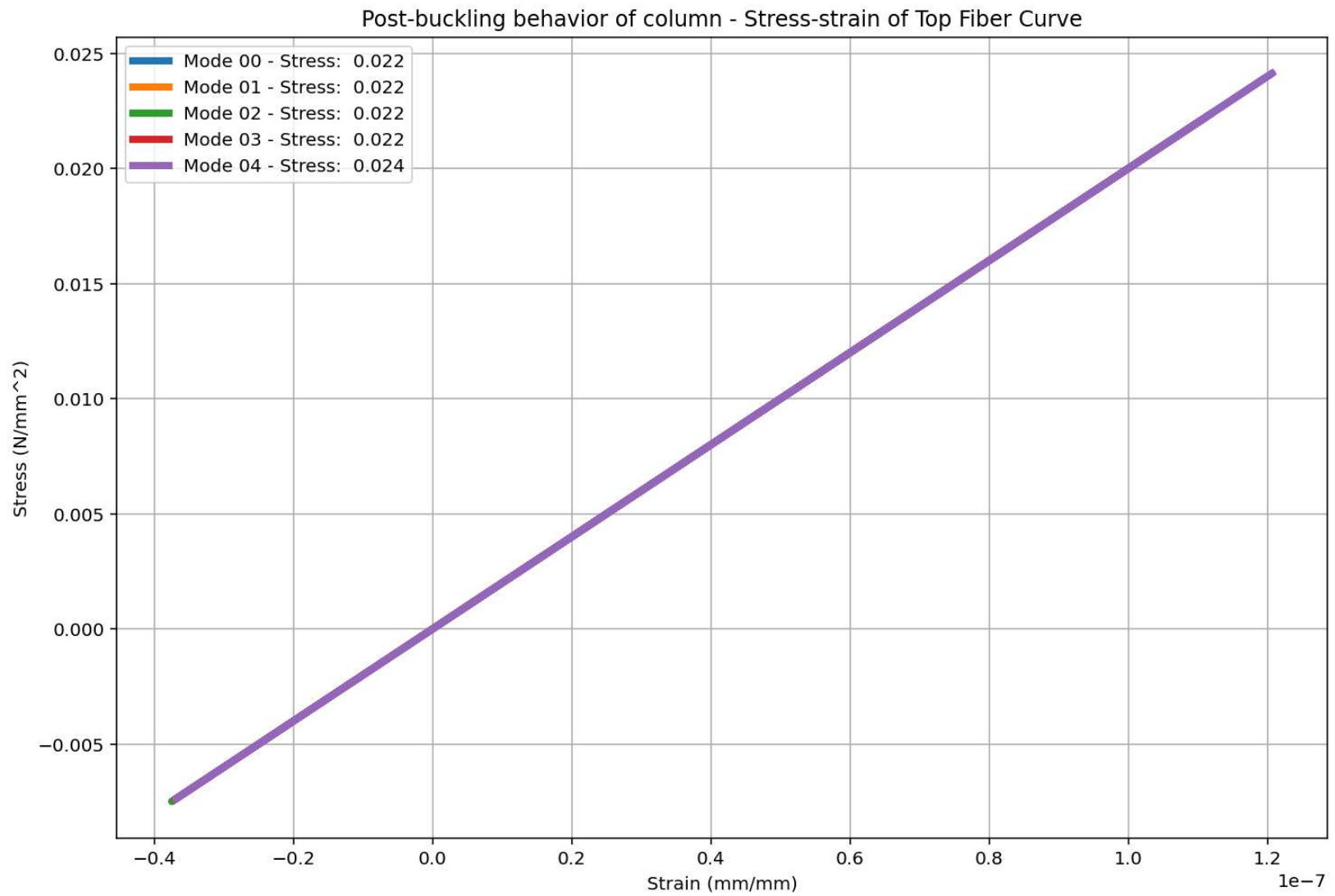


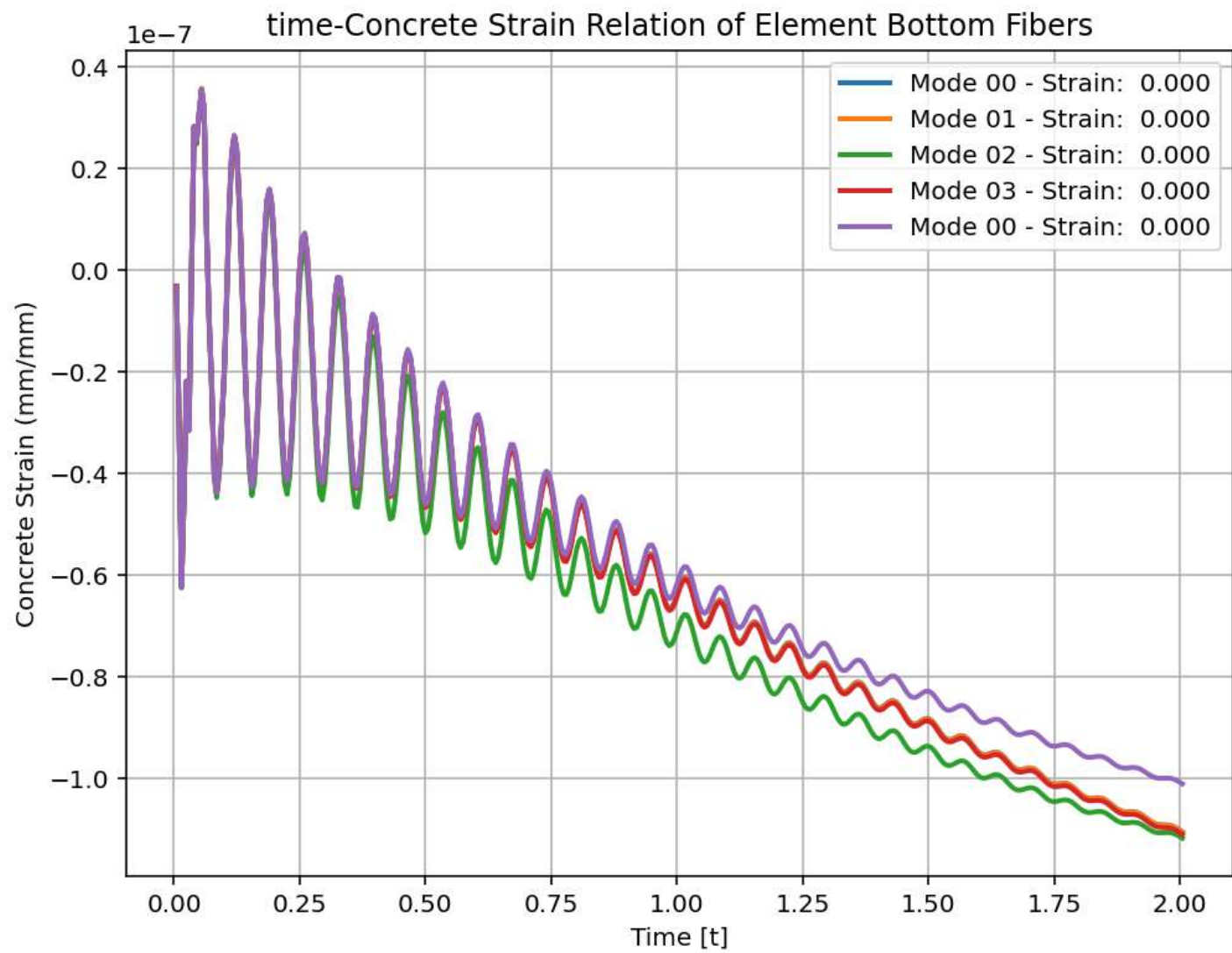
Post-buckling behavior of column during free-vibration analysis - Shear-Disp. Curve



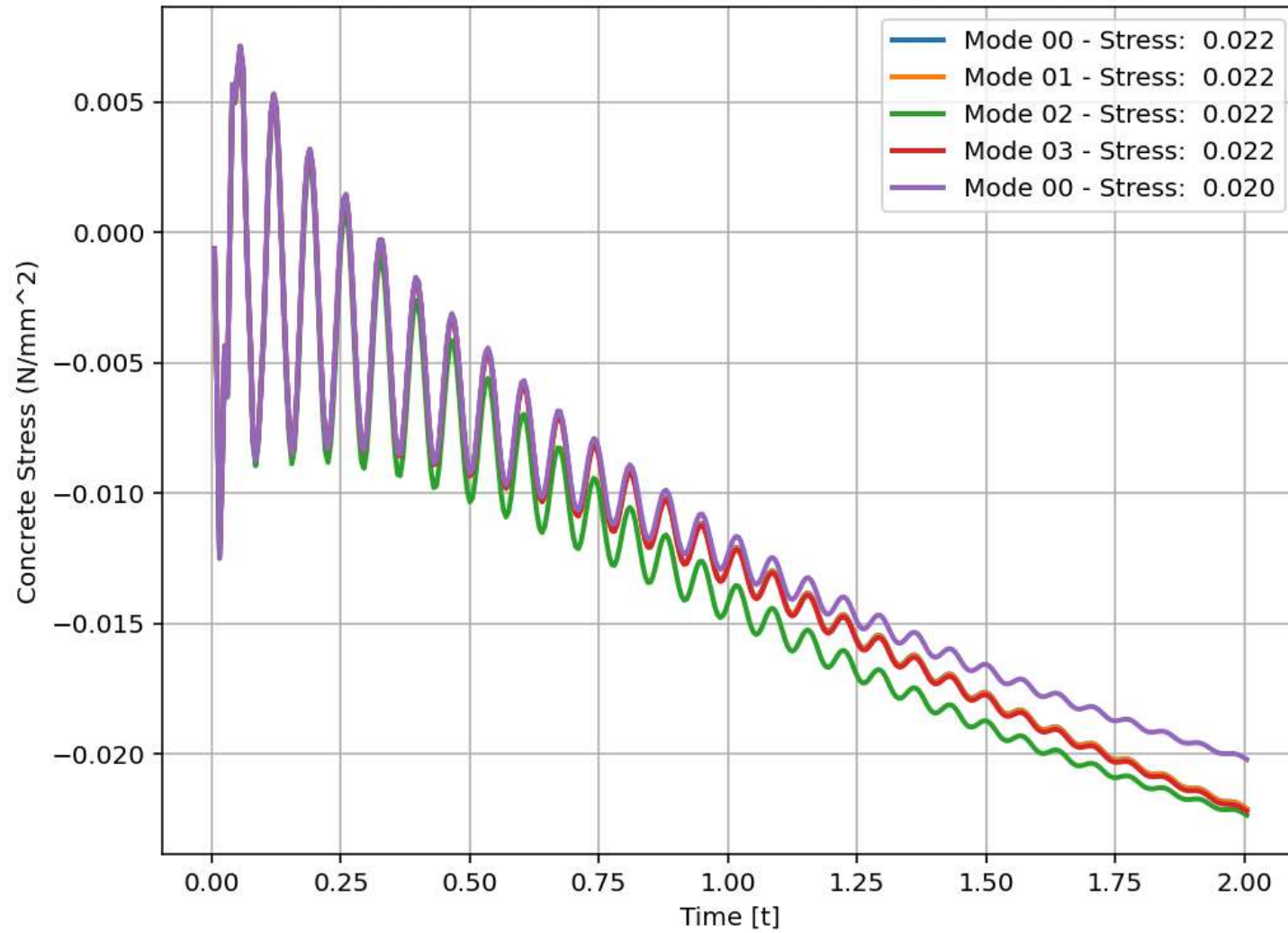
Post-buckling behavior of column - Stress-strain of Bottom Fiber Curve

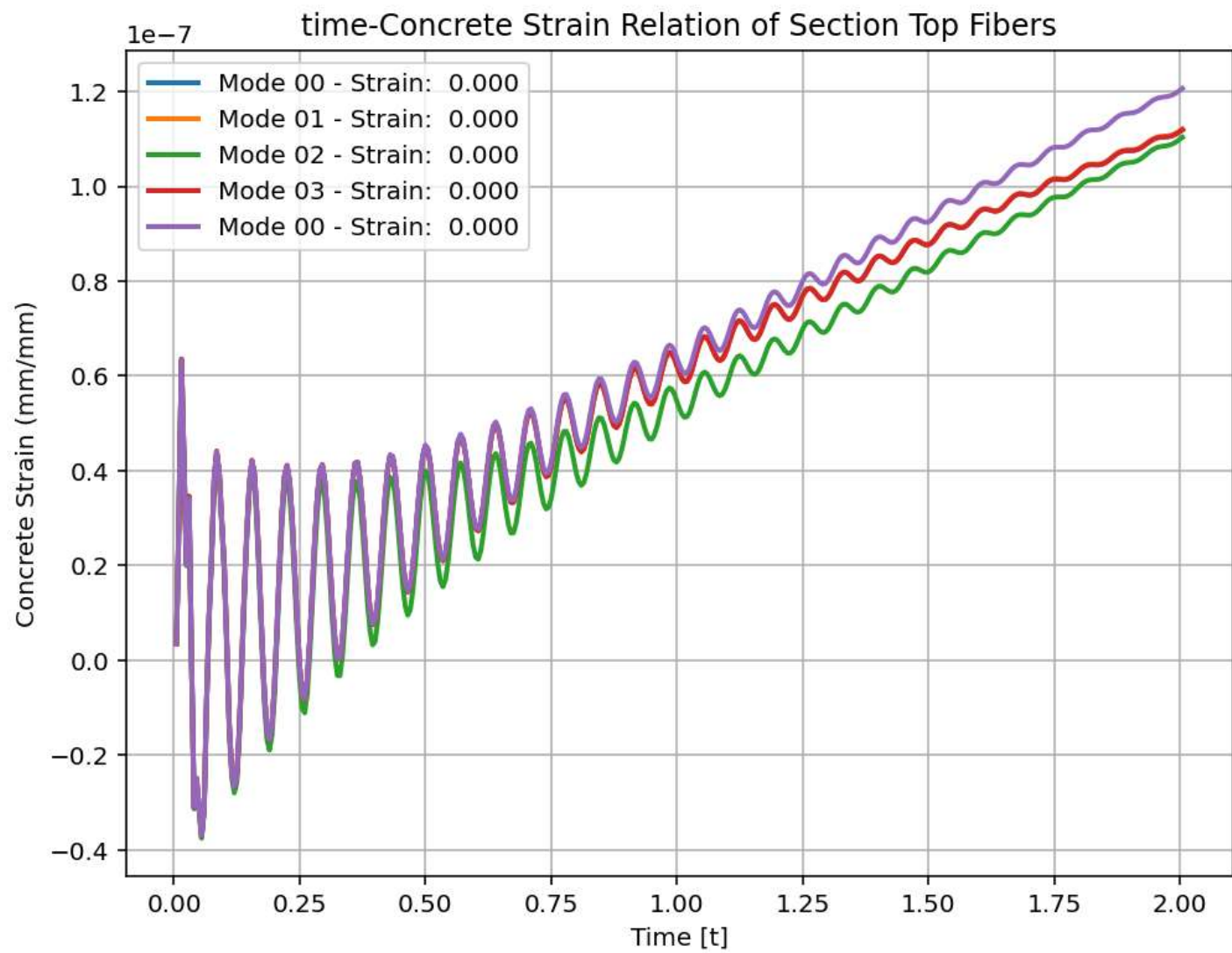




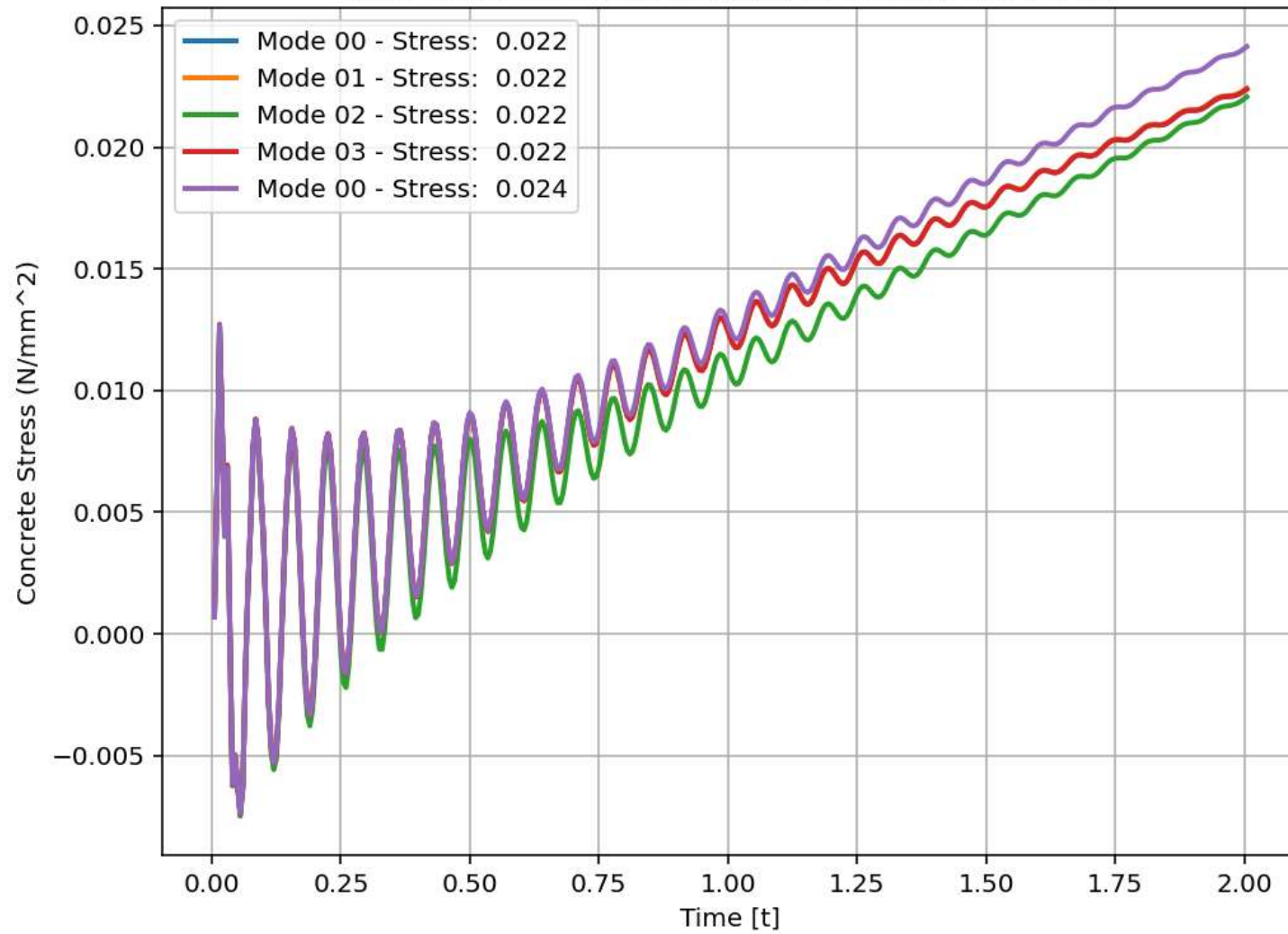


time-Concrete Strain Relation of Element Bottom Fibers

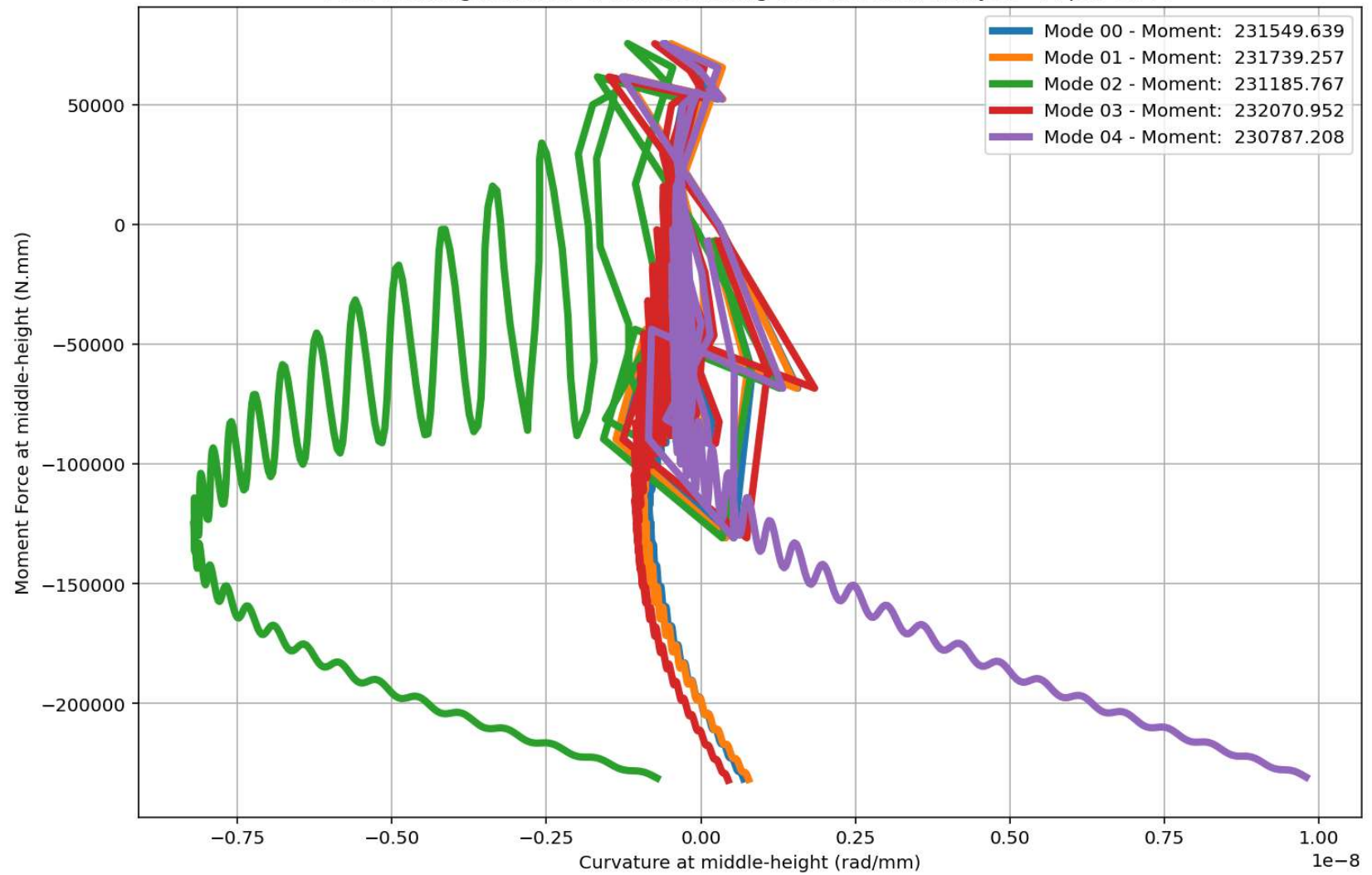




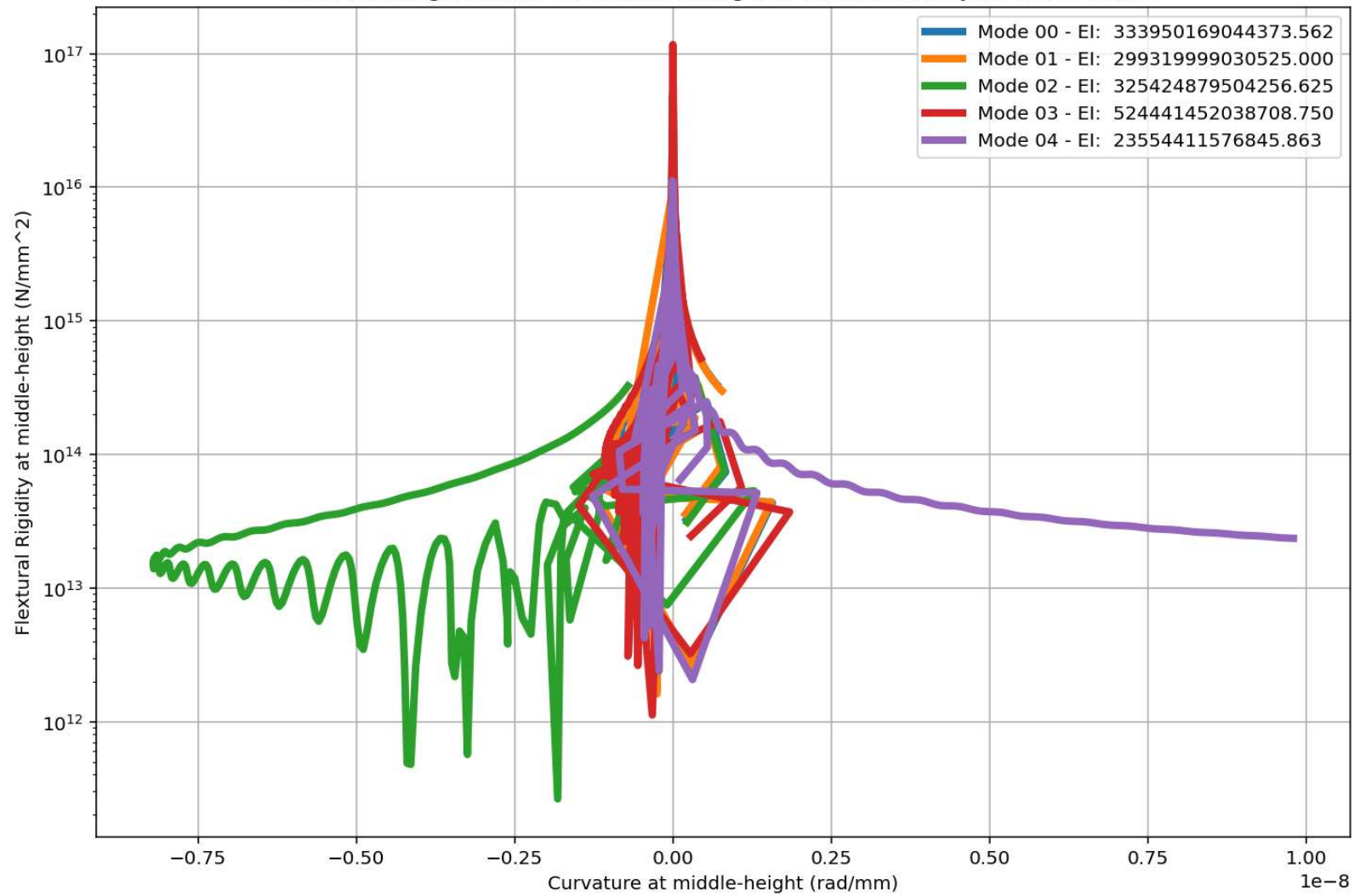
time-Concrete Strain Relation of Section Top Fibers



Post-buckling behavior of column during free-vibration analysis - M-phi Curve



Post-buckling behavior of column during free-vibration analysis- Phi-EI Curve



Post-buckling behavior of column during free-vibration analysis - Moment-Rotation Curve

