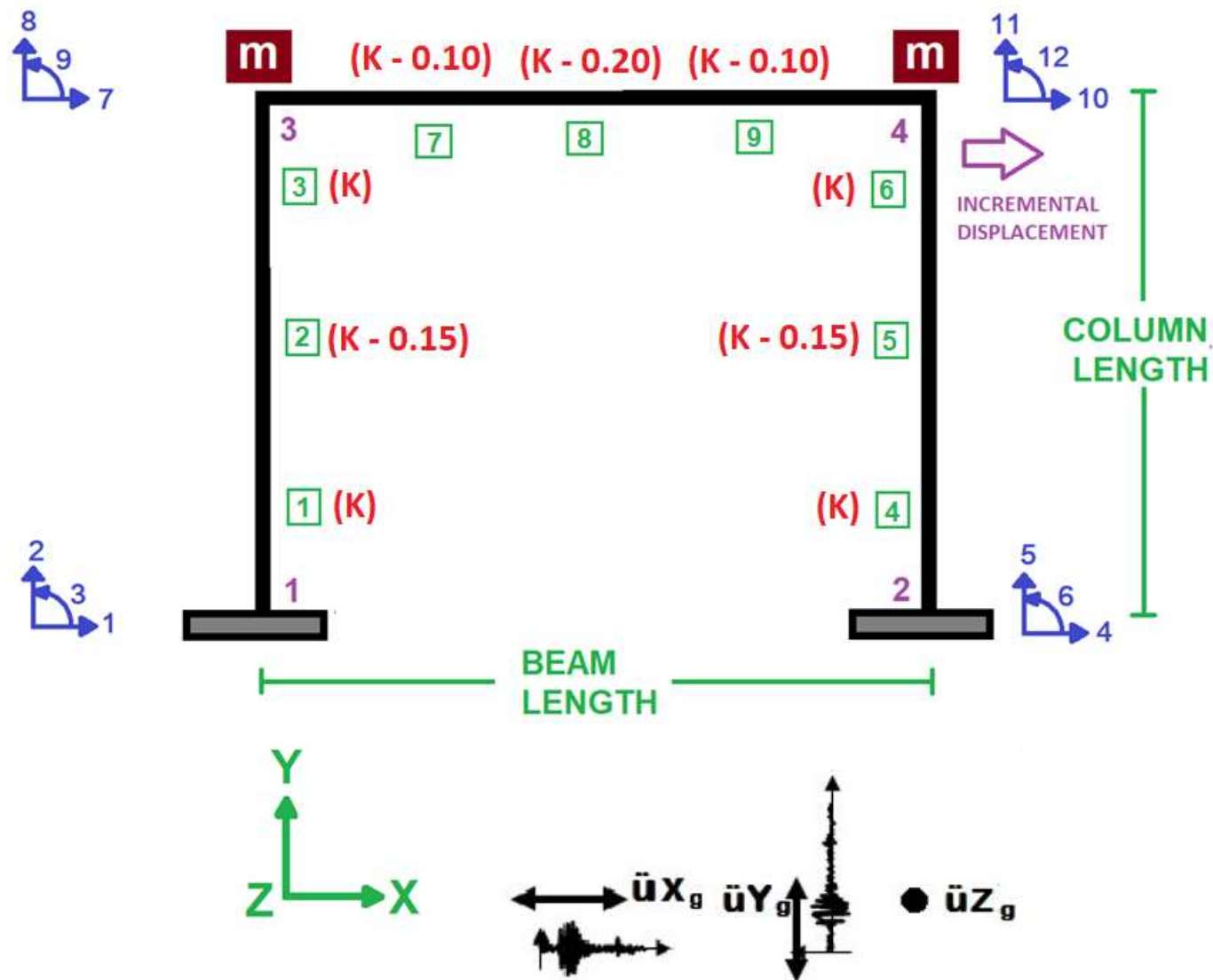


IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL

COMPARATIVE STUDY OF ELASTIC AND INELASTIC STRUCTURAL BEHAVIOR THROUGH PUSHOVER DYNAMIC ANALYSIS USING OPENSEES

WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)

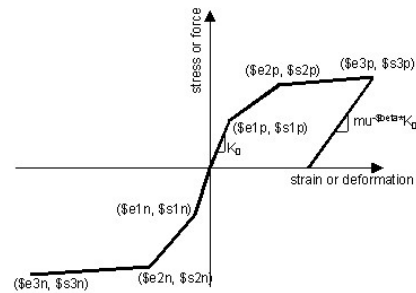




CORE AND COVER CONCRETE RELATION



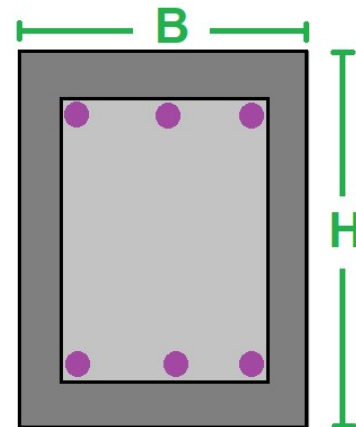
WITHOUT HARDENING AND ULTIMATE STRAIN



WITH HARDENING AND ULTIMATE STRAIN



COLUMN SECTION



BEAM SECTION

FileEditSearchSourceRunDebugConsolesProjectsToolsViewHelp

C:\Users\Del\l\Desktop\OPENSEES_FILES\CONCRETE_FRA...INEMENT_NONCONSTANT_ELASTIC_OR_INELASTIC_FRAME.py

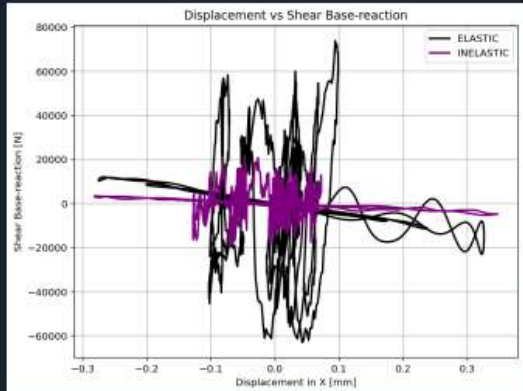
CONFINEMENT_NONCON...INELASTIC_FRAME.py X

```
1 #####
2 # >> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<
3 # COMPARATIVE STUDY OF ELASTIC AND INELASTIC STRUCTURAL BEHAVIOR THROUGH PUSHOVER DYNAMIC ANALY
4 #-----
5 # THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)
6 # EMAIL: salar.d.ghashghaei@gmail.com
7 #####
8 """
9 1. The script performs a comparative study of elastic and inelastic structural behavior using pu
10 2. It models a 2D reinforced concrete frame with columns (500x500mm) and beams (500x300mm) using
11 3. Material definitions include confined/unconfined concrete (fc=25MPa) and bilinear steel reinf
12 4. Two analysis types are implemented: static pushover (displacement-controlled) and dynamic tim
13 5. Rayleigh damping is calculated based on initial modal periods and target damping ratios (5%).
14 6. The pushover analysis applies incremental displacements up to 675mm, recording base reactions
15 7. Dynamic analysis uses Newmark integration with ground motion inputs scaled by 0.01g (El Centr
16 8. Key outputs include force-displacement curves, moment-rotation relationships, and stiffness d
17 9. Eigenvalue analysis tracks period elongation due to inelasticity during dynamic events.
18 10. Damage indices are computed for ductility assessment using bilinear curve fitting.
19 11. Overstrength factors (Ω), ductility ratios (μ), and R-factors are quantified for seismic per
20 12. Real-time monitoring of base shear, axial forces, and interstory drifts is implemented.
21 13. The script includes advanced convergence controls (Newton-Raphson, 1e-6 tolerance).
22 14. Confinement effects are modeled with variable enhancement ratios (Kc=1.25 for columns).
23 15. Results are exported to Excel, including displacements, forces, stiffness, and period data.
24 16. Visualization includes deformed shapes, hysteresis loops, and cumulative response envelopes.
25 17. Damping ratios are estimated from free vibration decay in dynamic analyses.
26 18. Both geometric nonlinearities (P-Delta/Corotational) and material nonlinearities are conside
27 19. The code supports parametric studies by varying steel models (with/without hardening) and el
28 20. Comprehensive plotting functions enable side-by-side comparison of elastic vs. inelastic res,
29
30 The script demonstrates professional-grade analysis combining FEMA-356 pushover methods with ASC
31 """
32 import openseespy.opensees as ops
33 import matplotlib.pyplot as plt
34 import numpy as np
```

..._INDEX\CONFINEMENT_NONCONSTANT_ELASTIC_OR_INELASTIC_FRAME

32 %

Displacement vs Shear Base-reaction



HelpVariable ExplorerDebuggerPlotsFiles

Console 1/A X

Structure Over Strength Factor: 0.93

+-----+

Over Strength Coefficient (Ω): 0.9264

Displacement Ductility Ratio (μ): 6.6951

Ductility Coefficient (Rμ): 6.6951

Structural Behavior Coefficient (R): 6.2022

Structural Ductility Damage Index in Y Direction: -0.1750

Node: 3

Coordinates : 0 3000

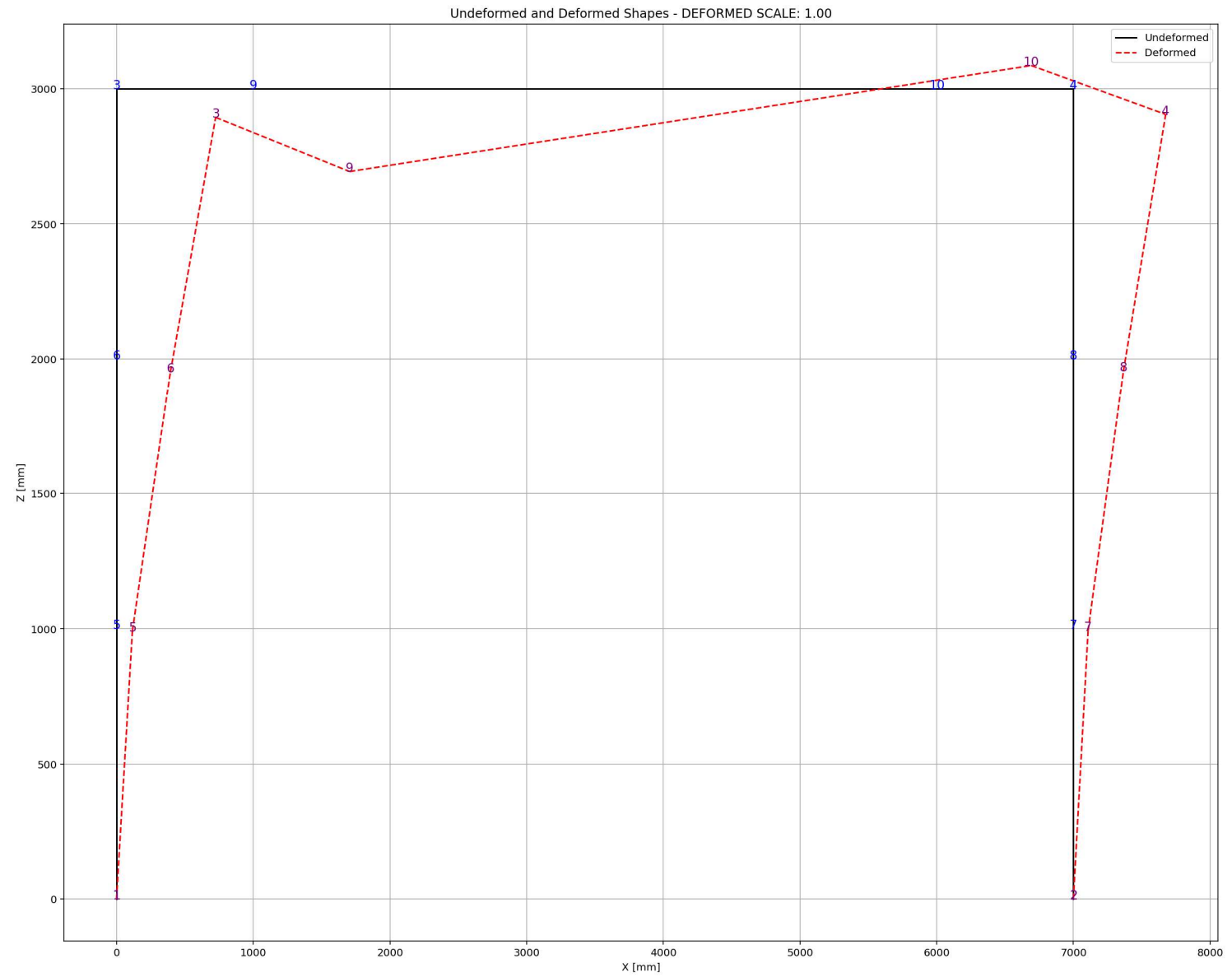
Disps: -0.080493 0.0050033 3.61619e-05

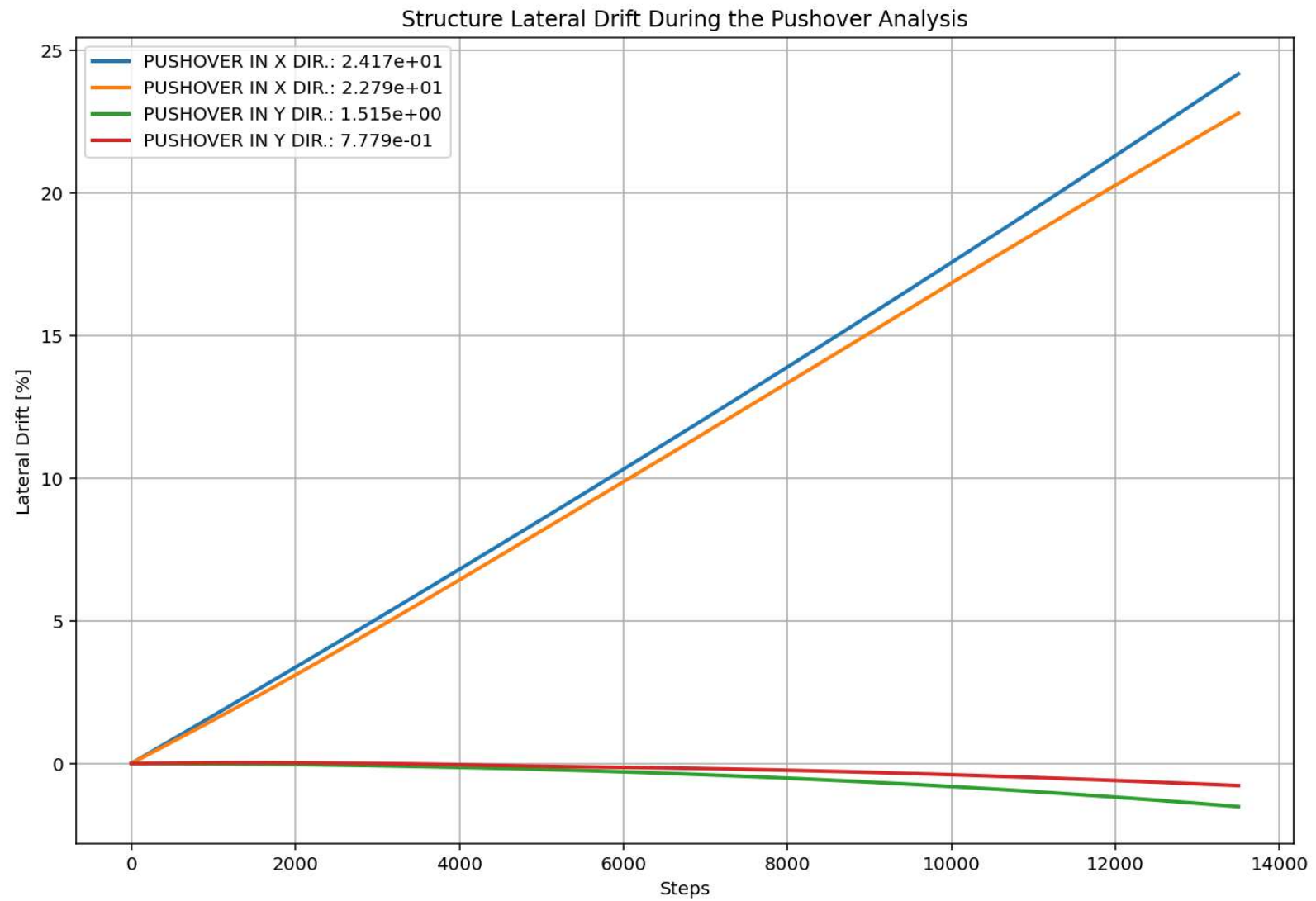
Velocities : -0.00740551 0.00258162 1.36492e-06

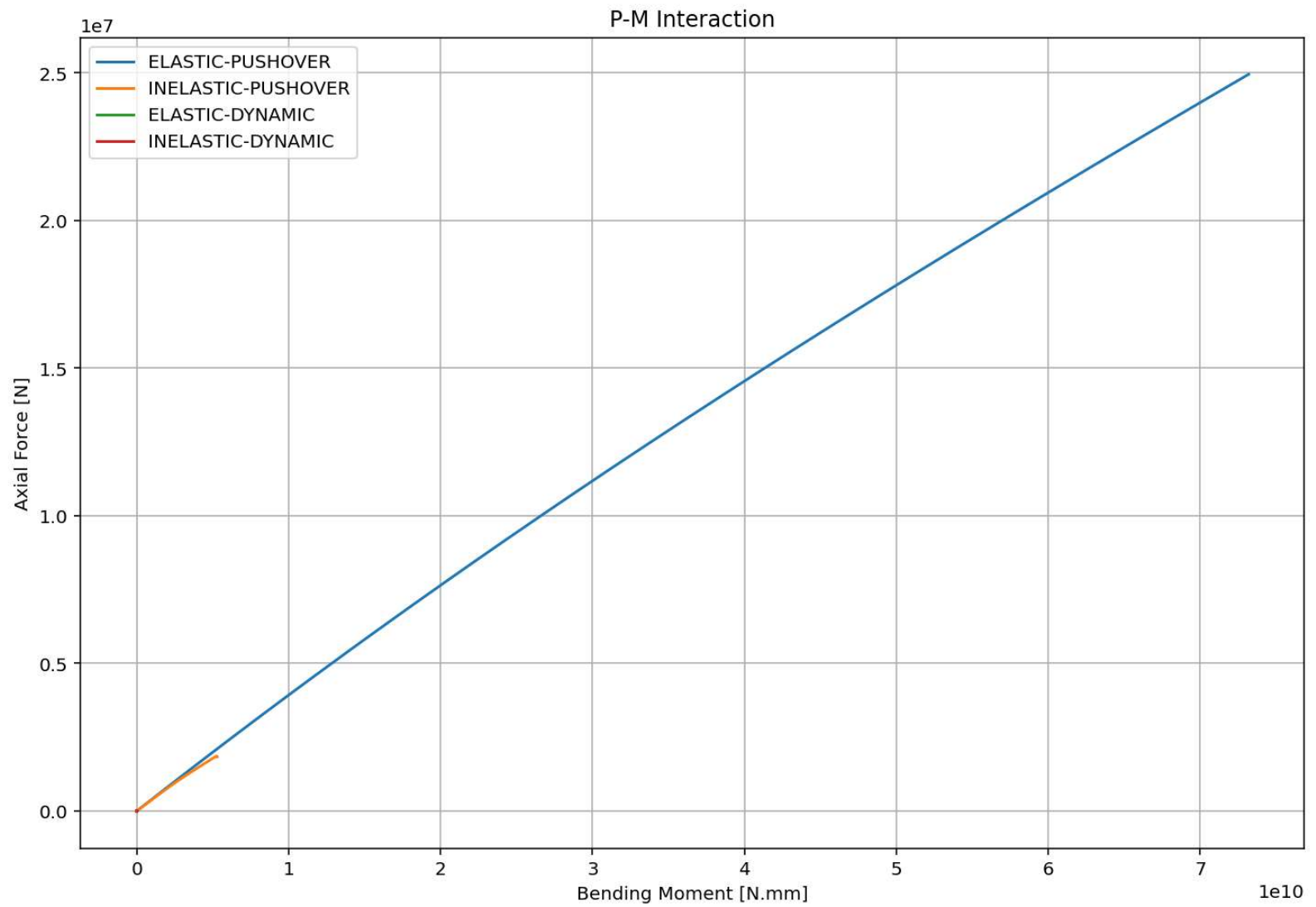
IPython ConsoleHistory

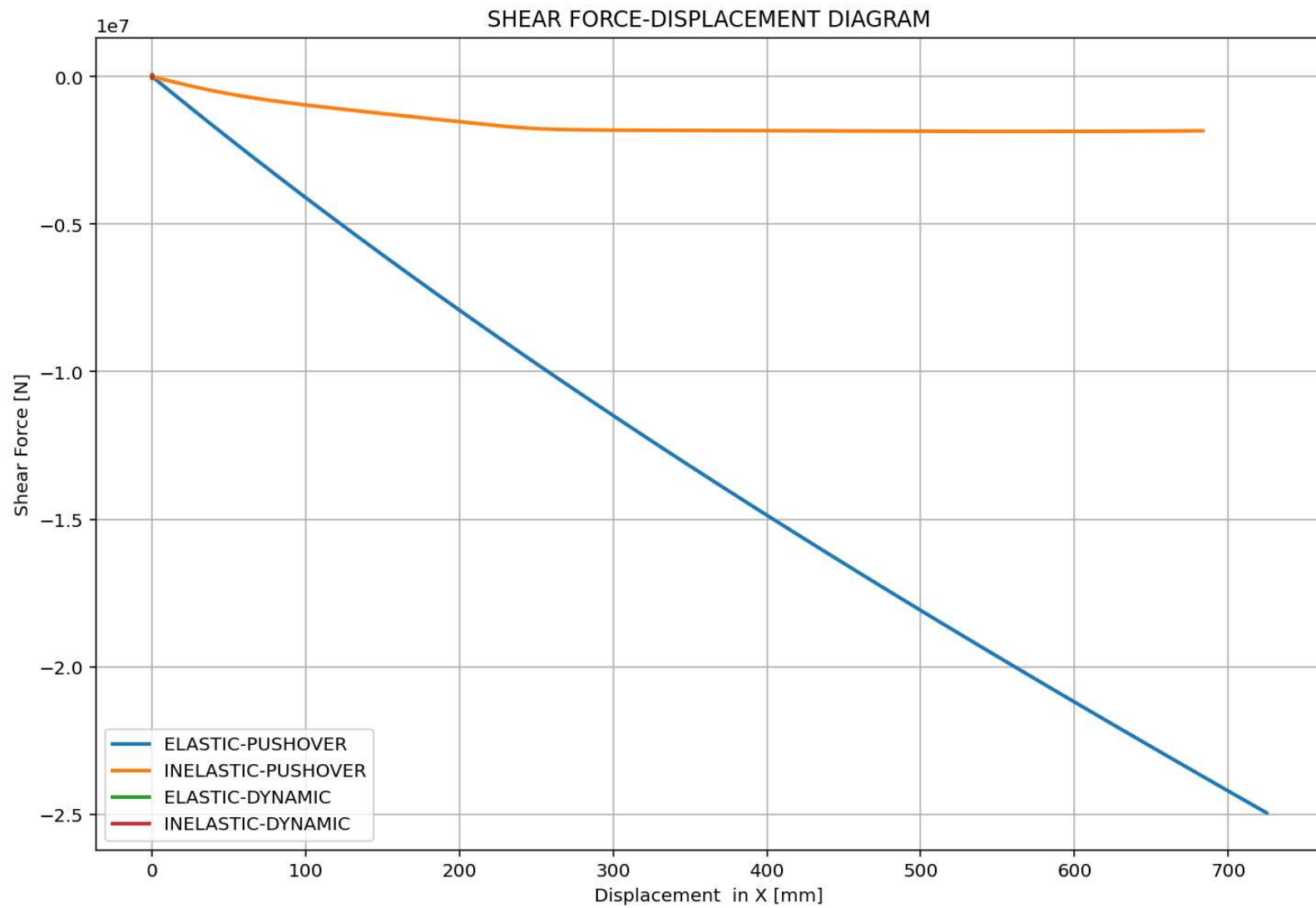
InlineConda: anaconda3 (Python 3.12.7) ✓ LSP: PythonLine 8, Col 4UTF-8CRLF RWMem 37%

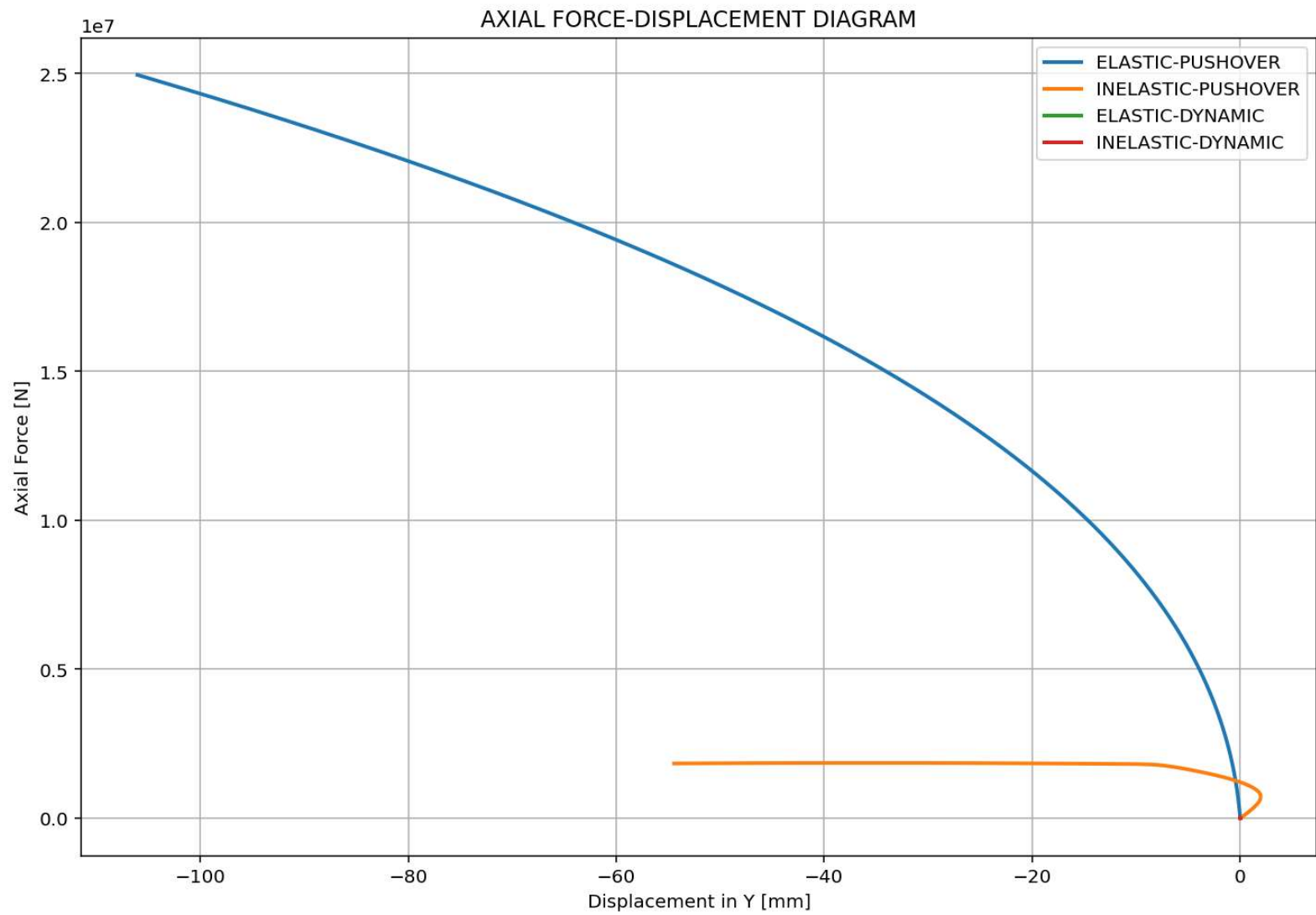
ELASTIC AND INELASTIC STATIC ANALYSIS (PUSHOVER)

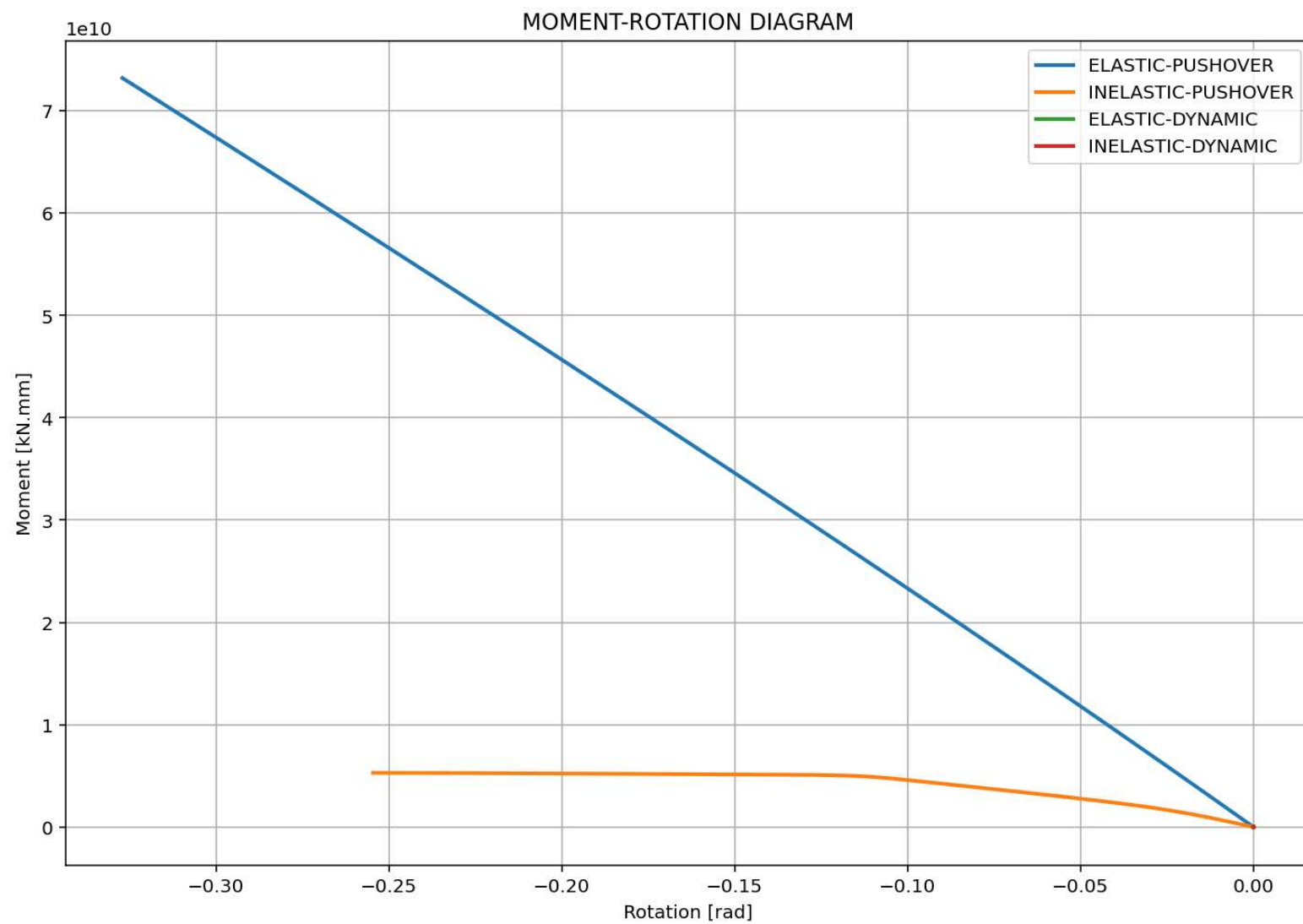




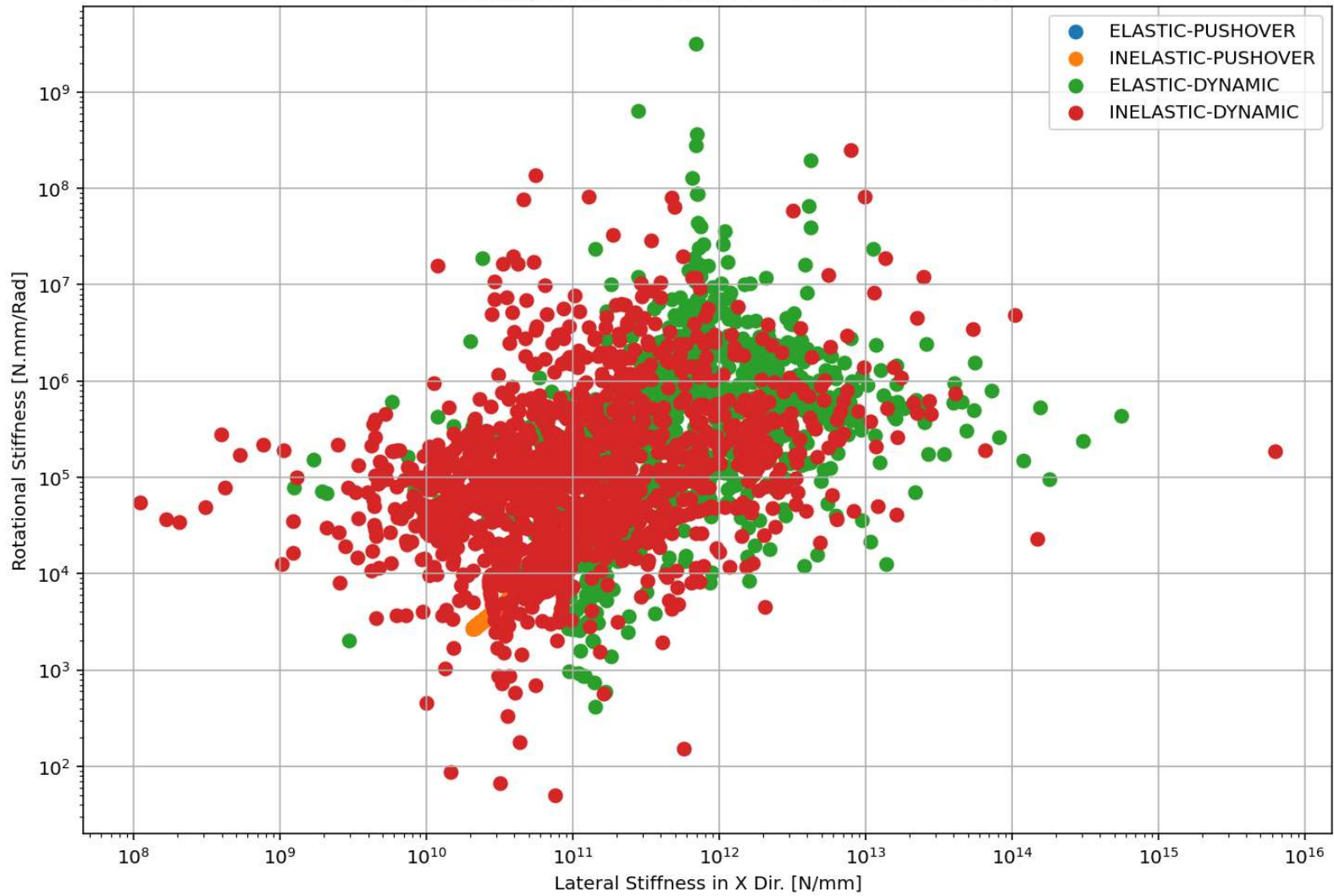




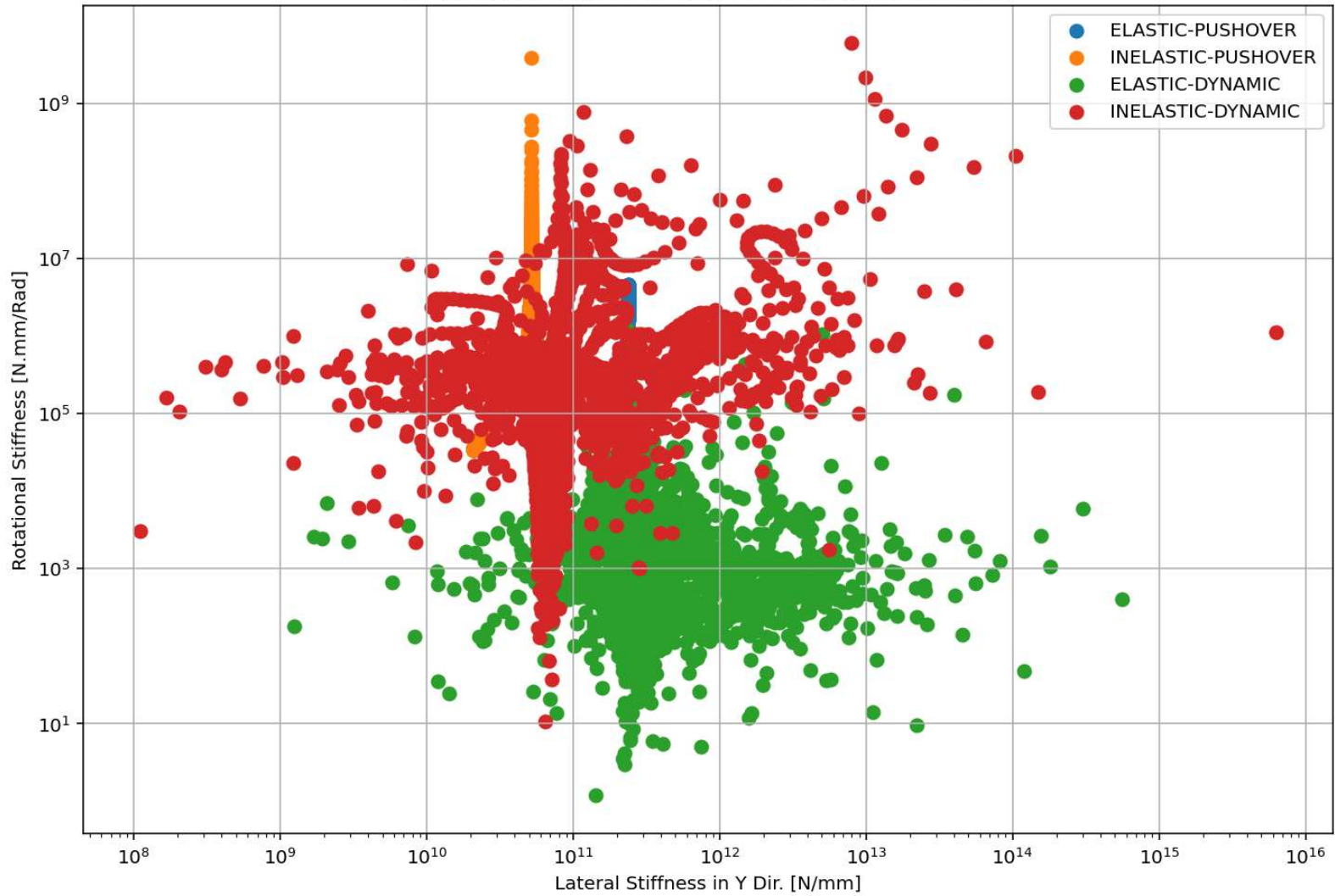


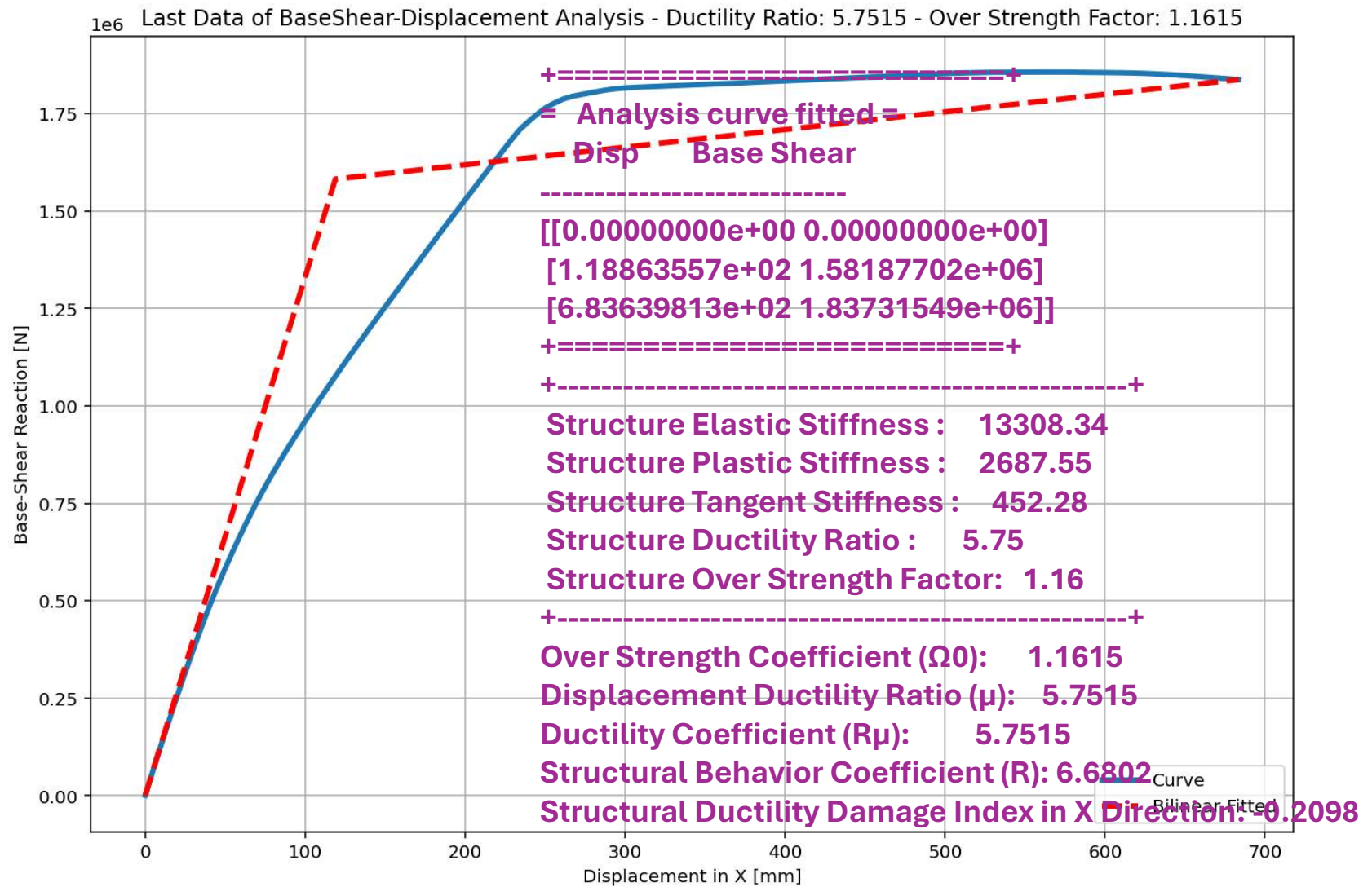


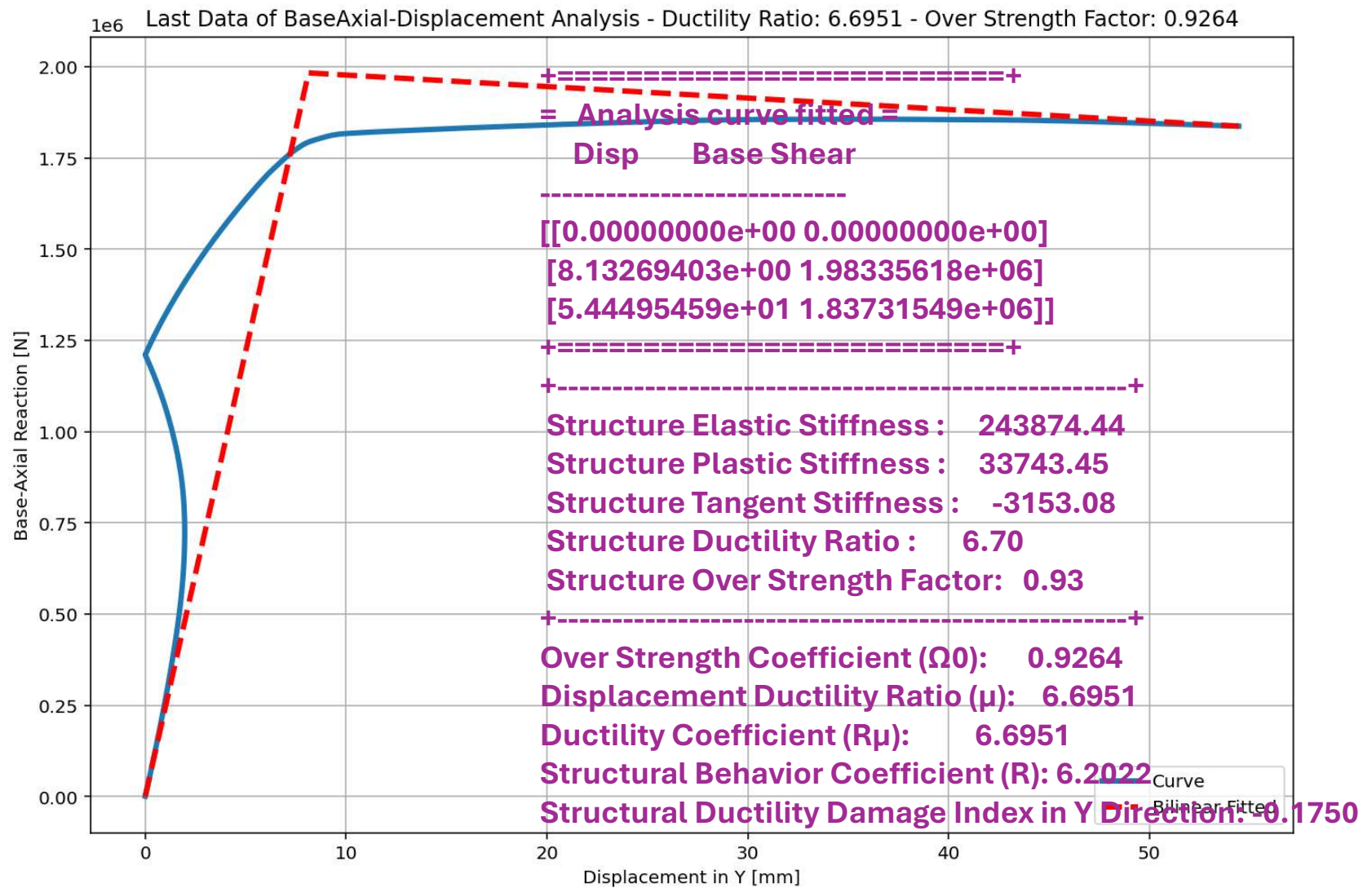
ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM



ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM

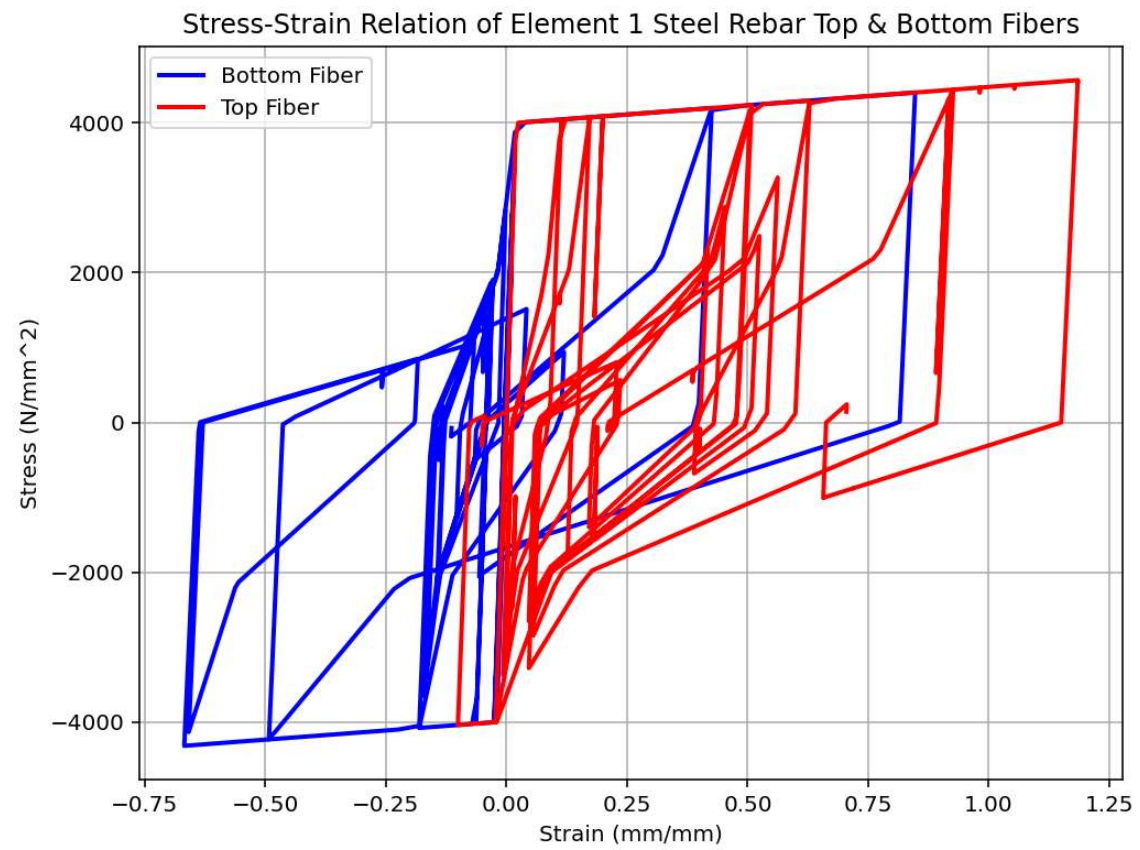


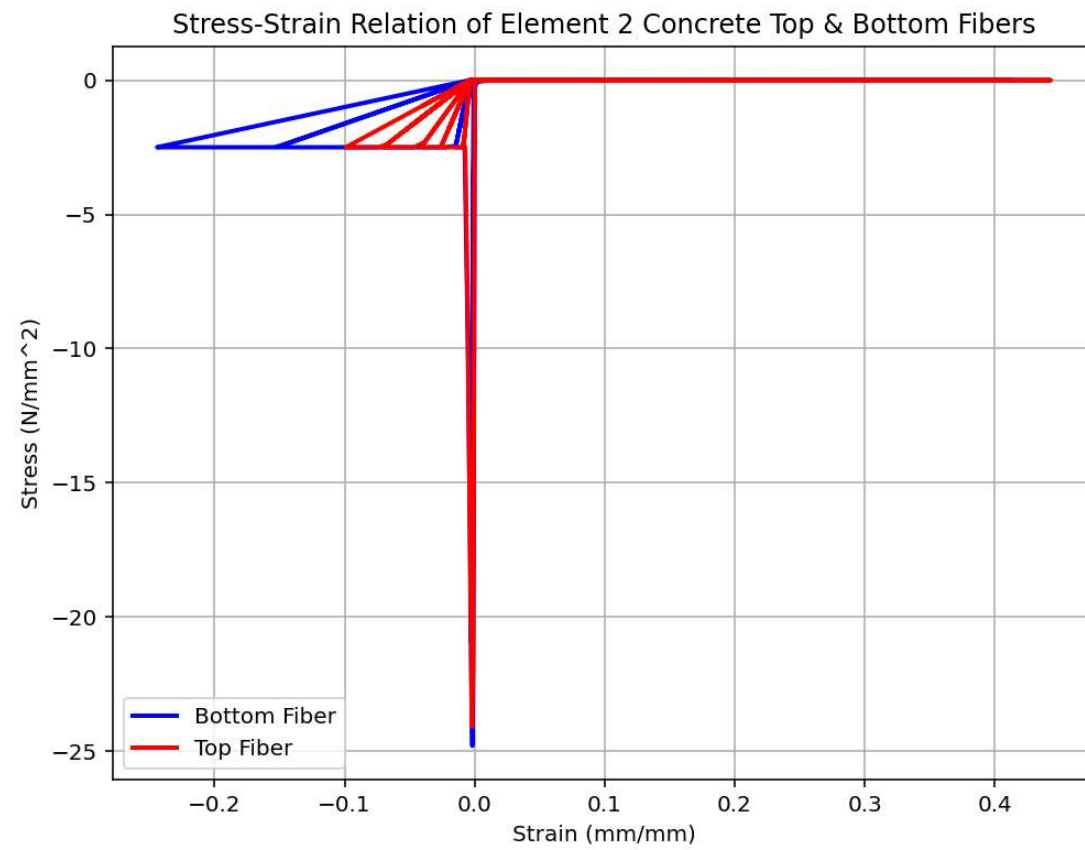


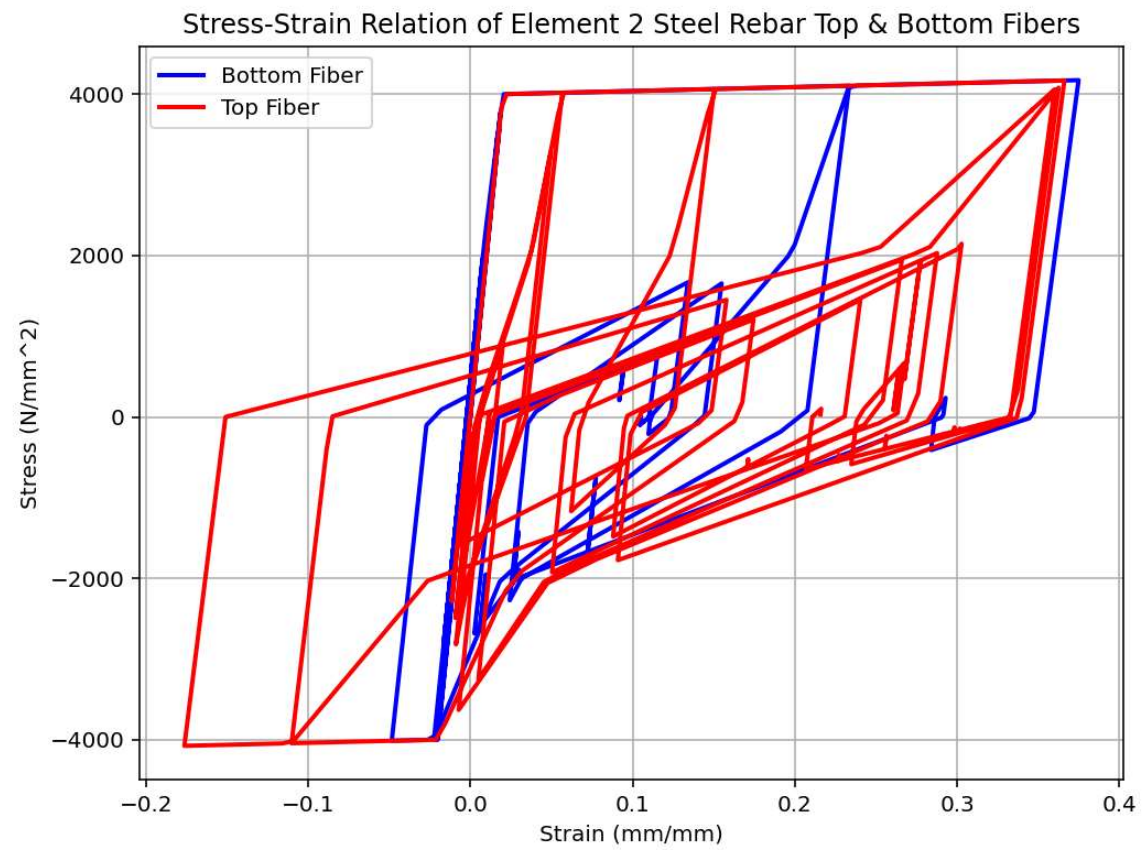


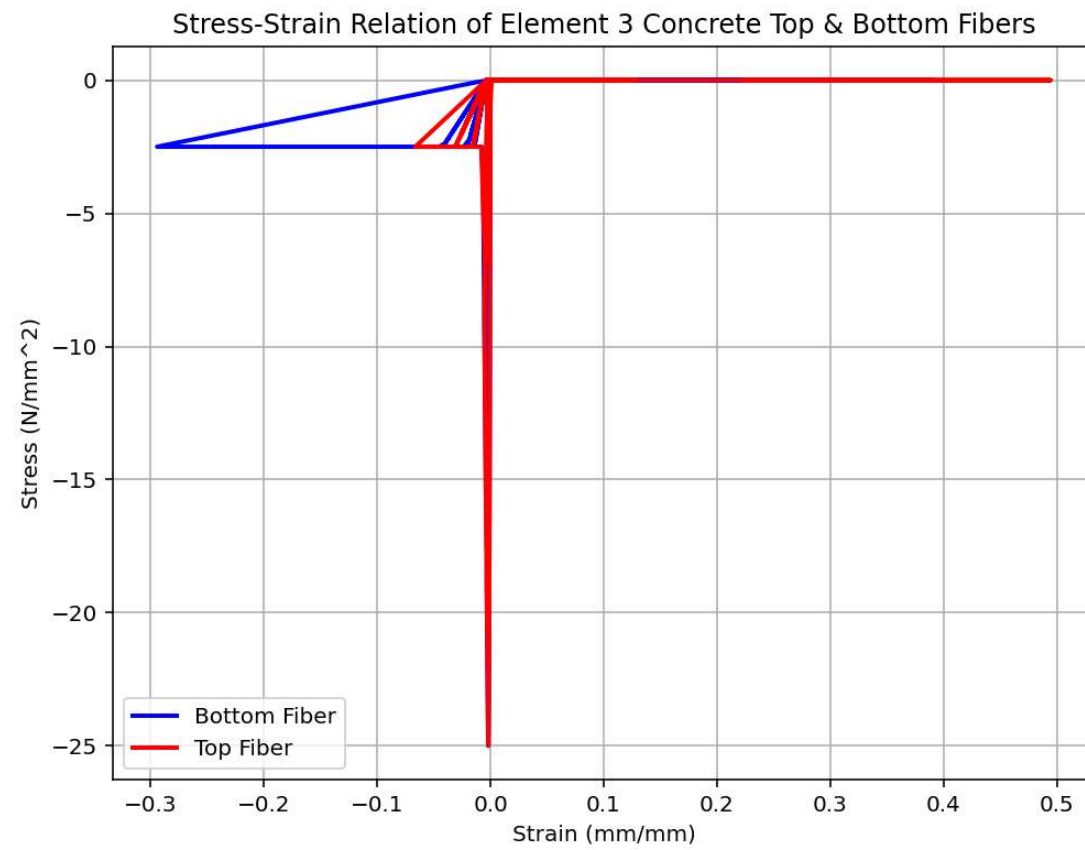
ELASTIC AND INELASTIC DYNAMIC ANALYSIS



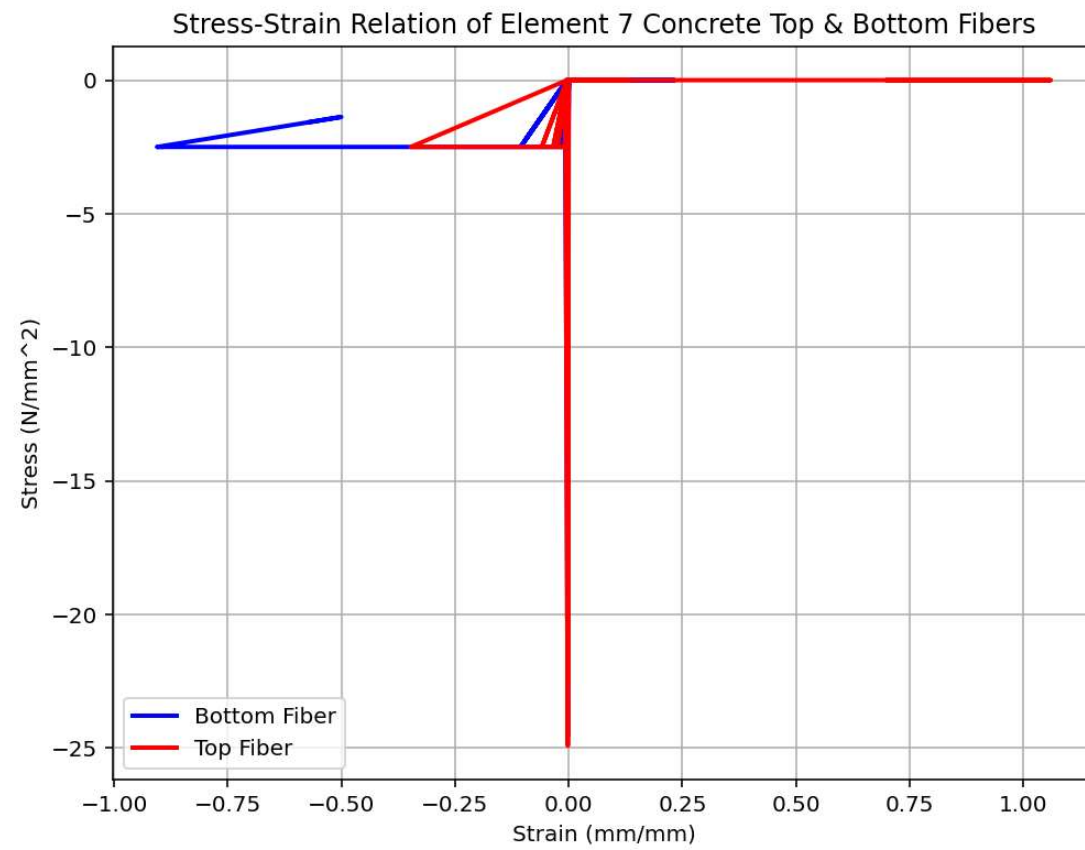




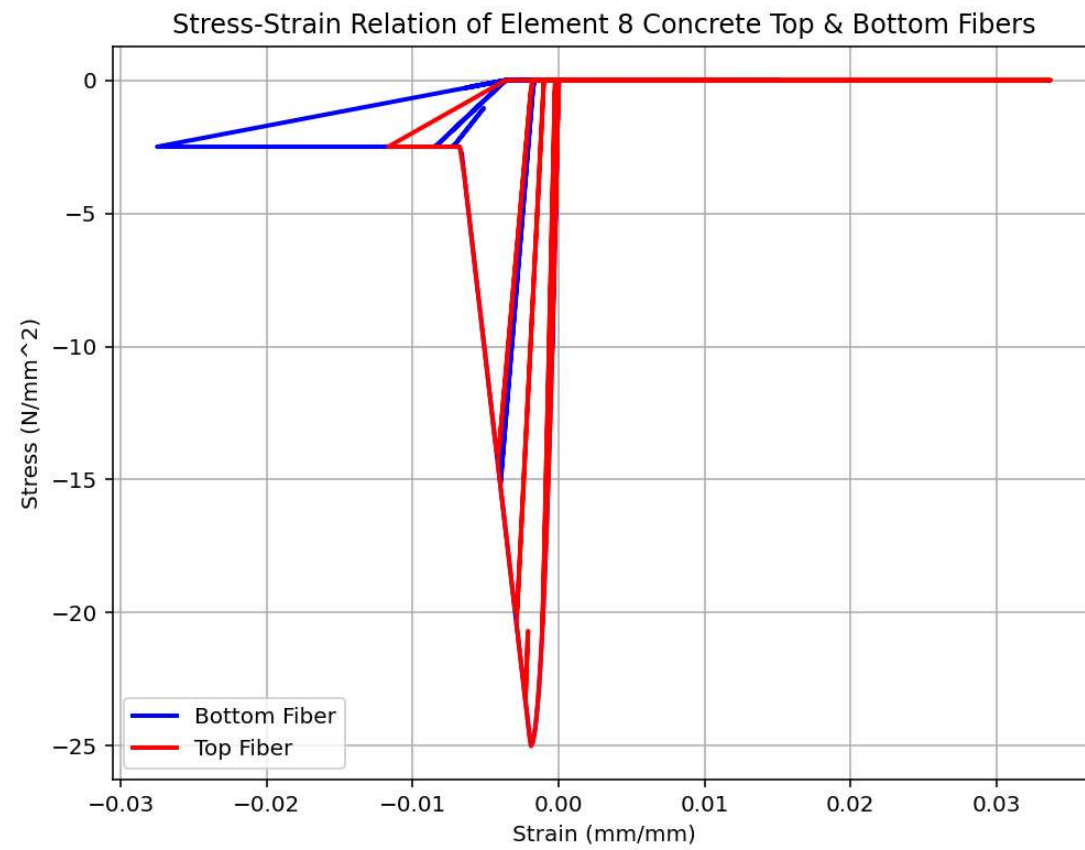


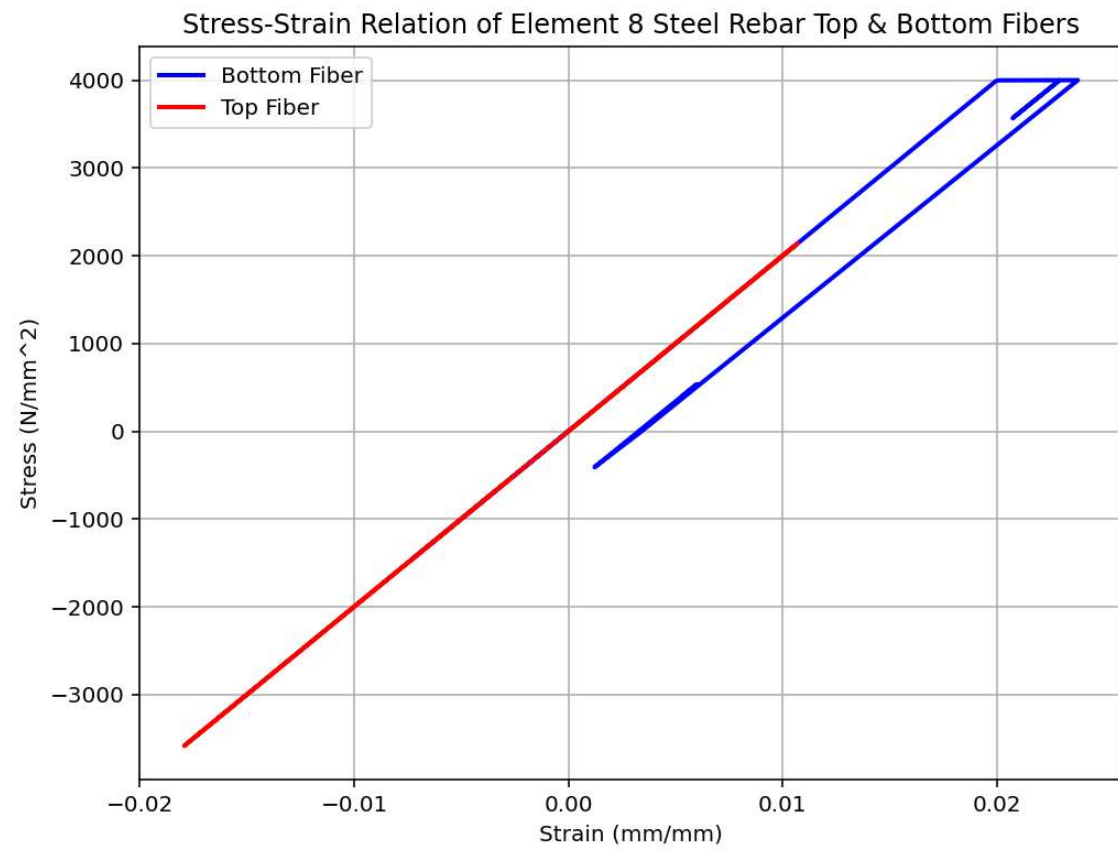




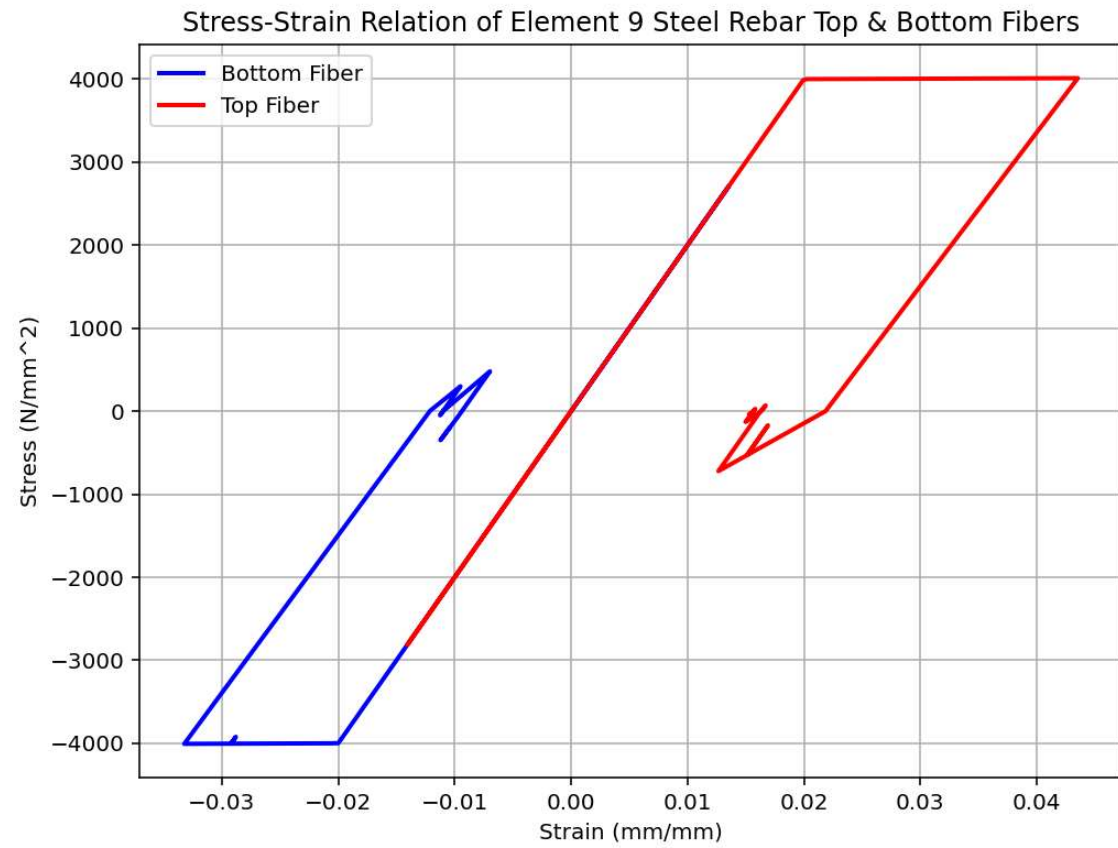


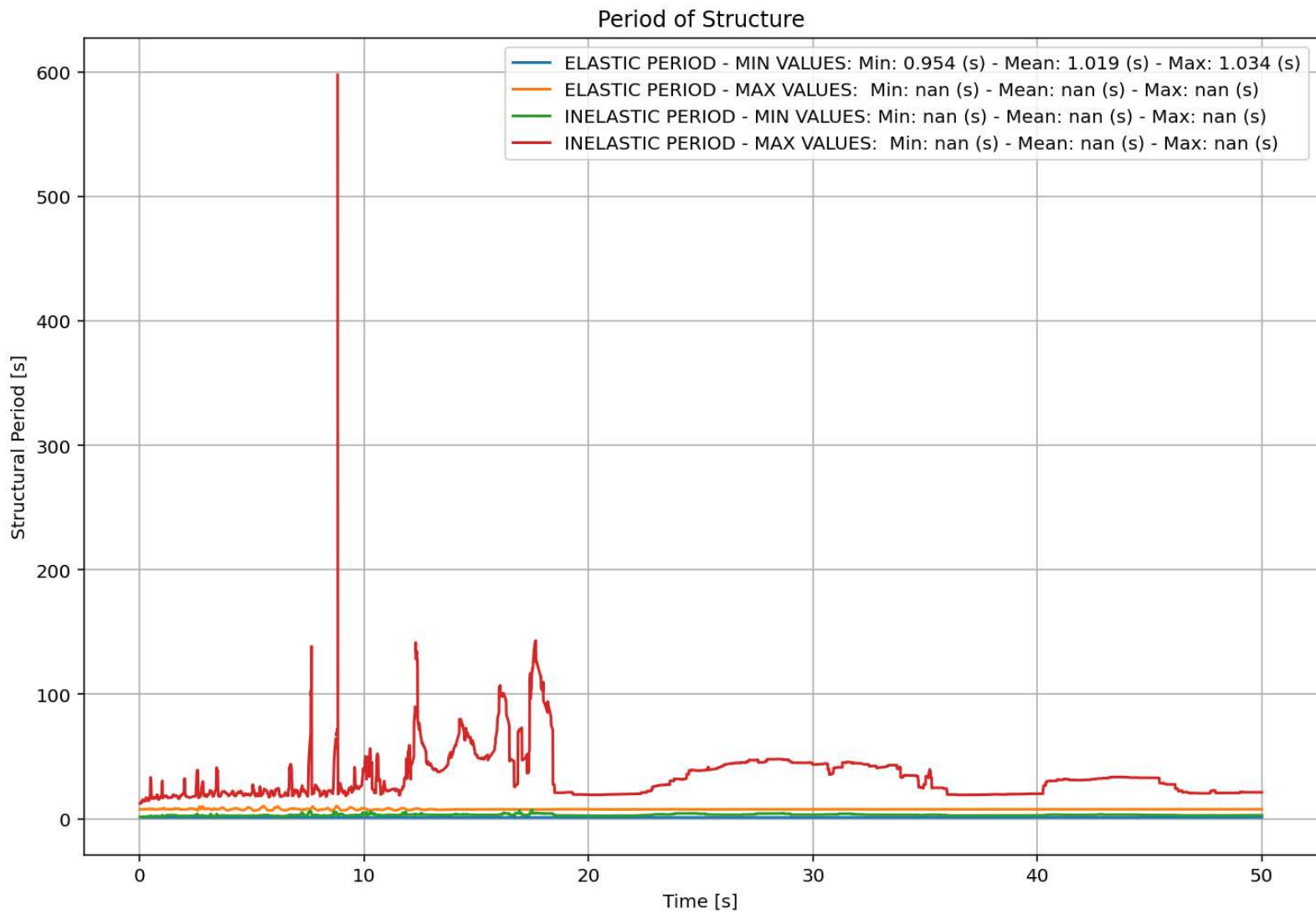




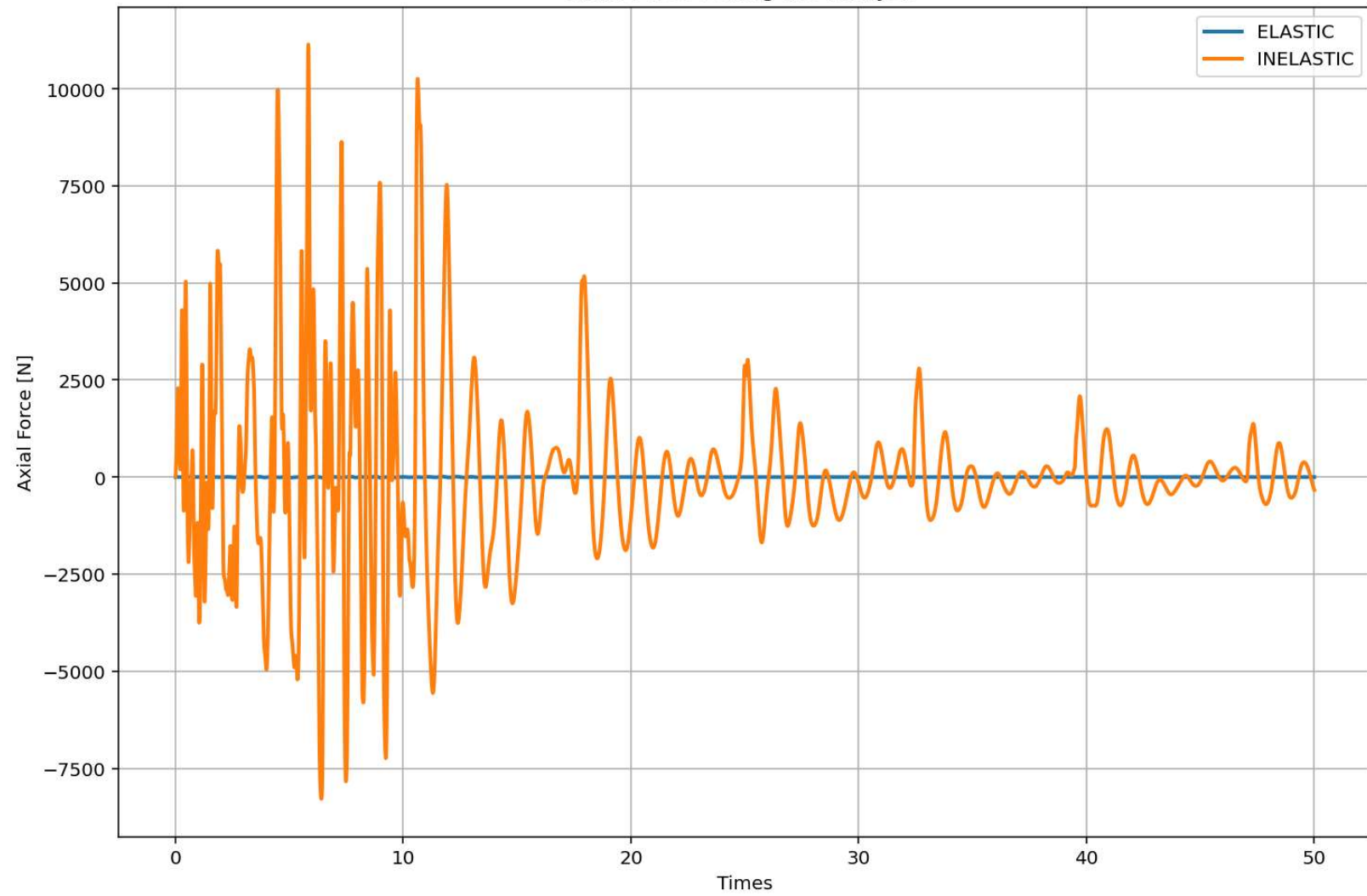


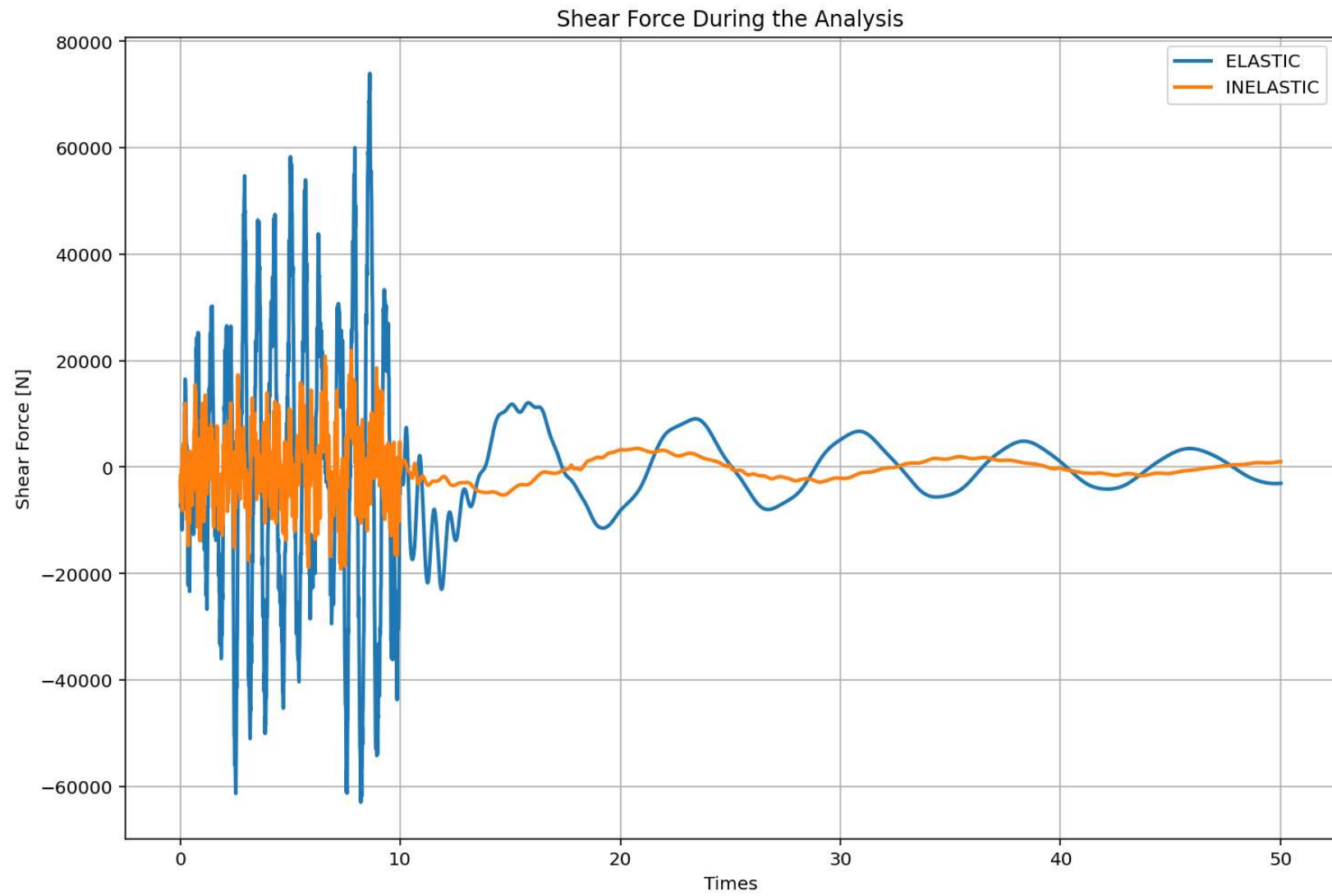


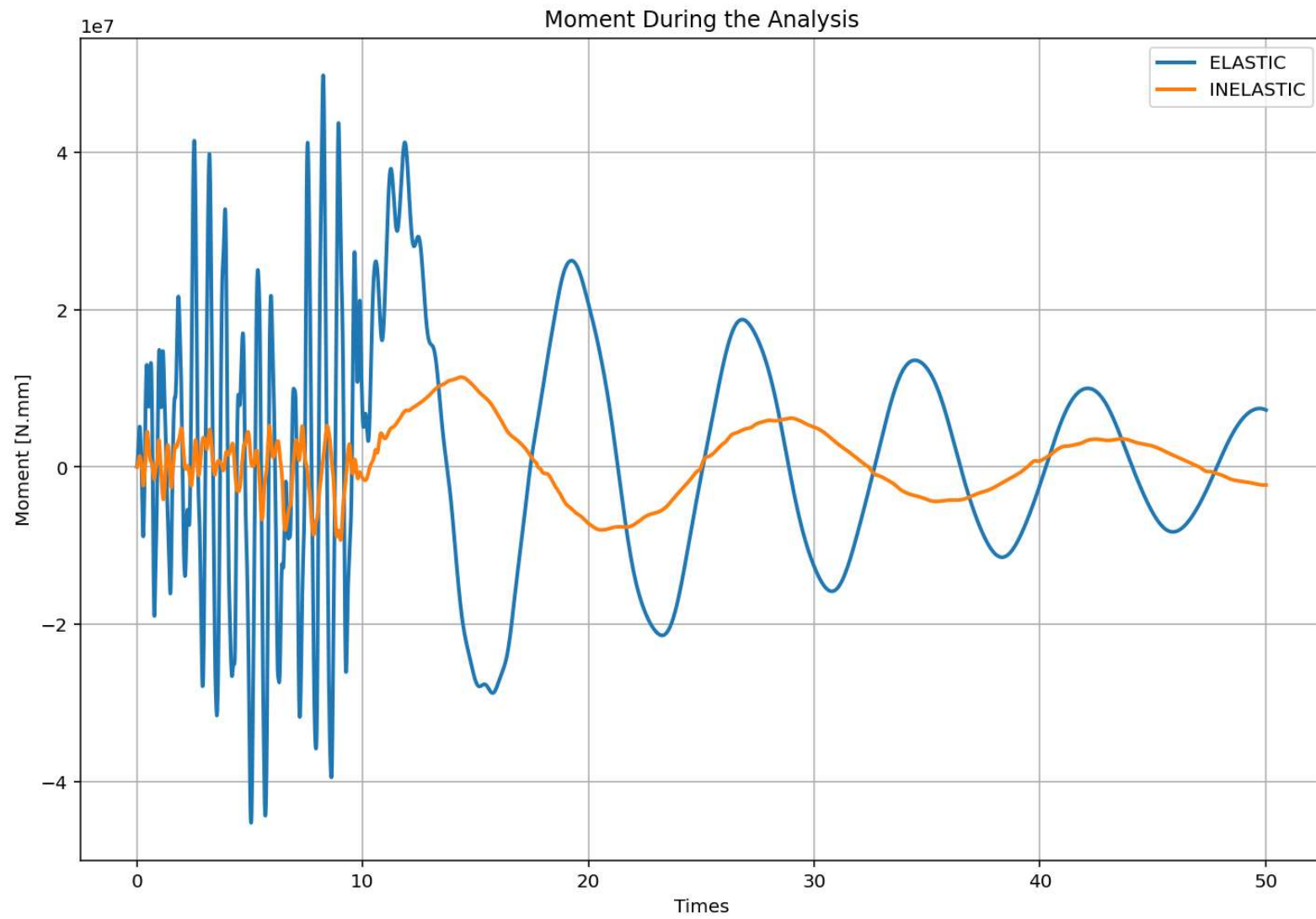


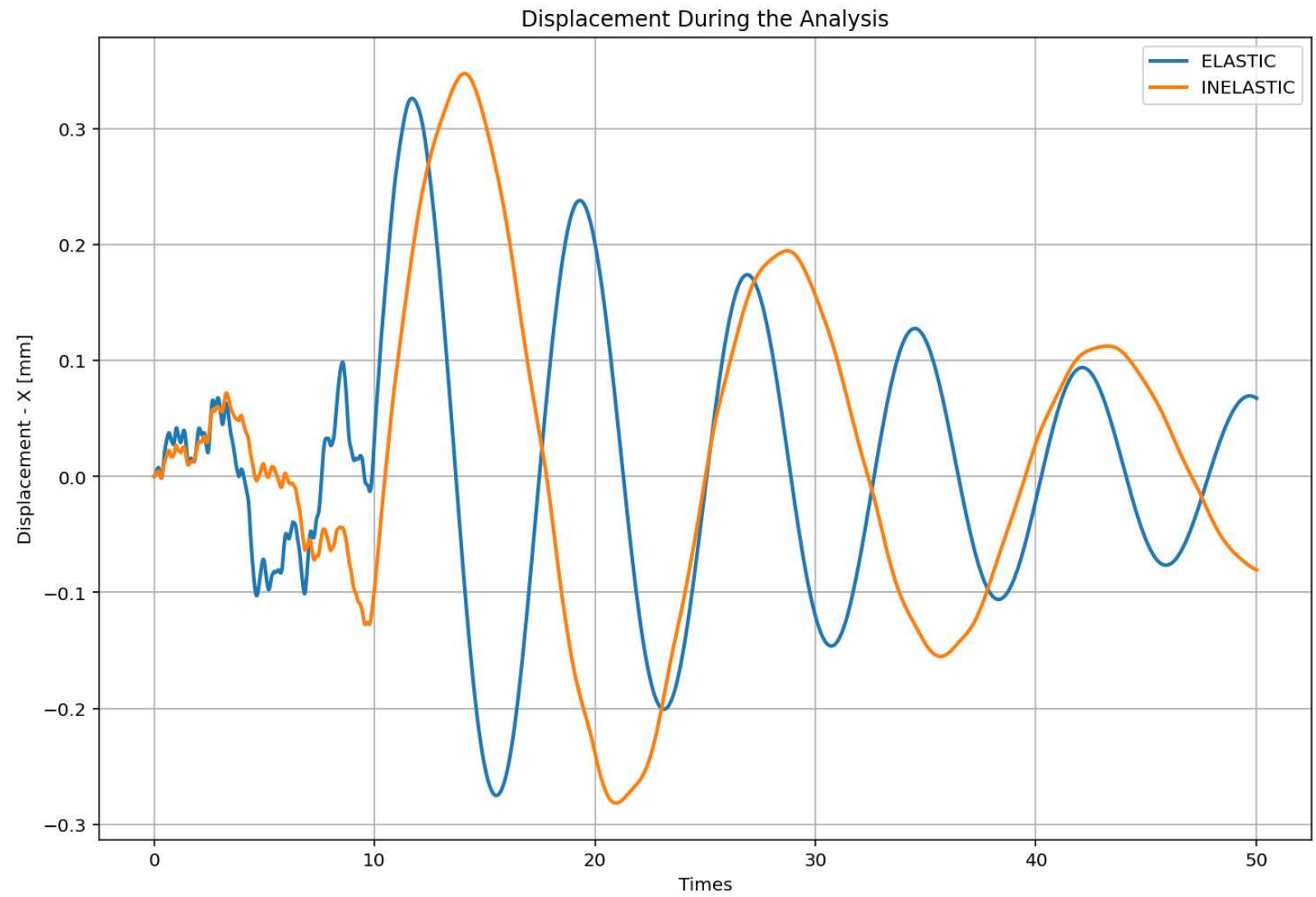


Axial Force During the Analysis

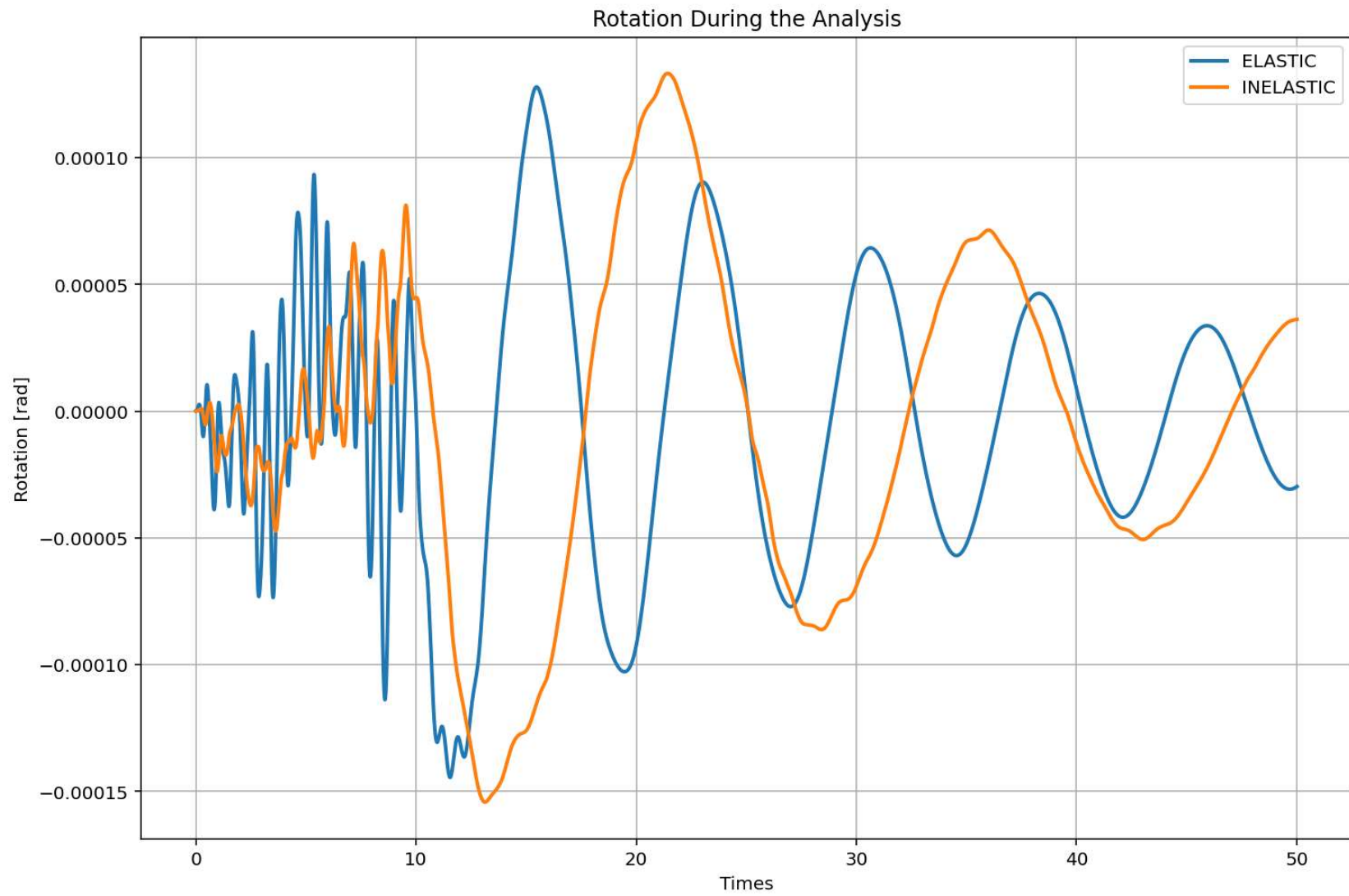




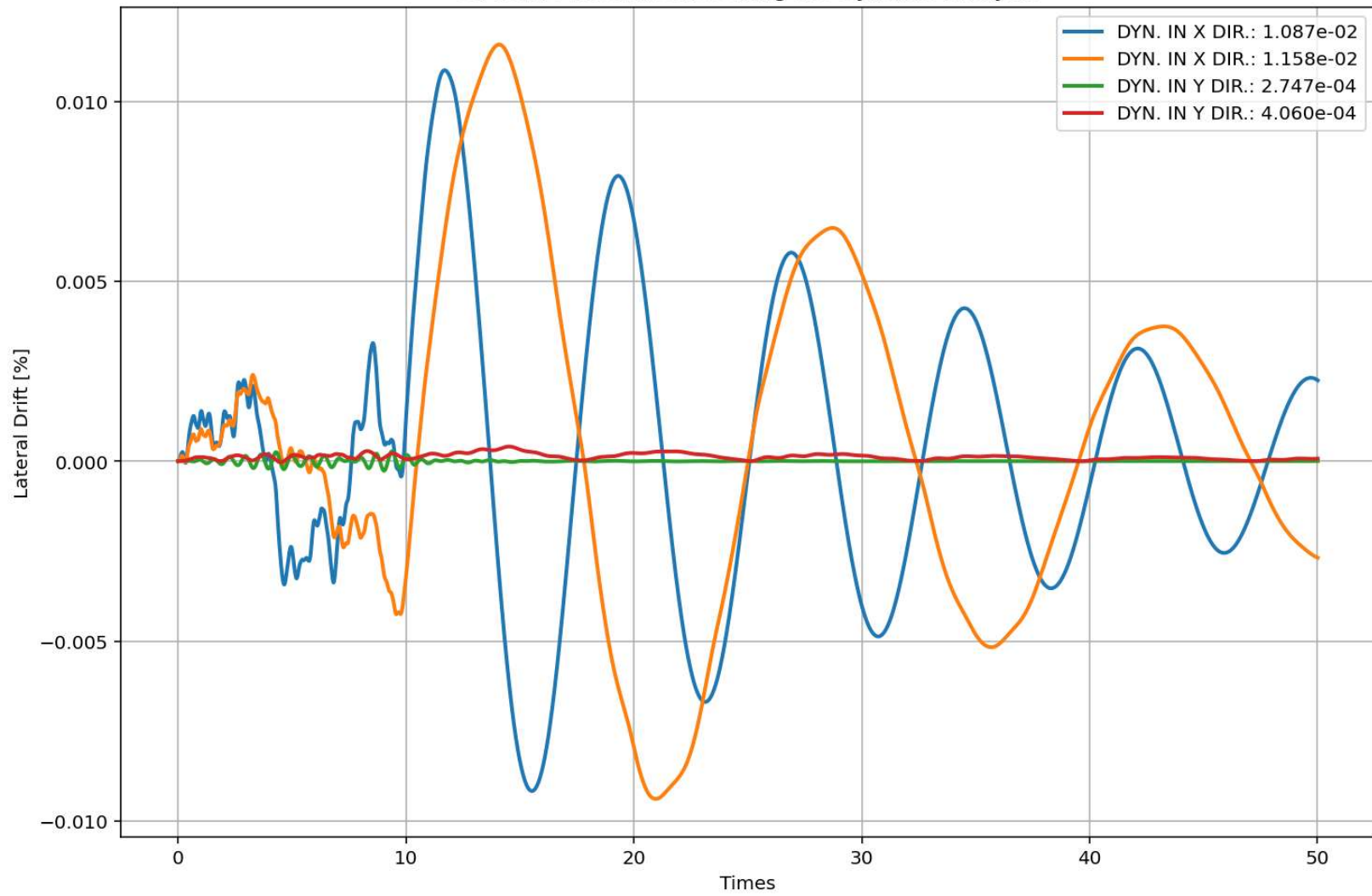




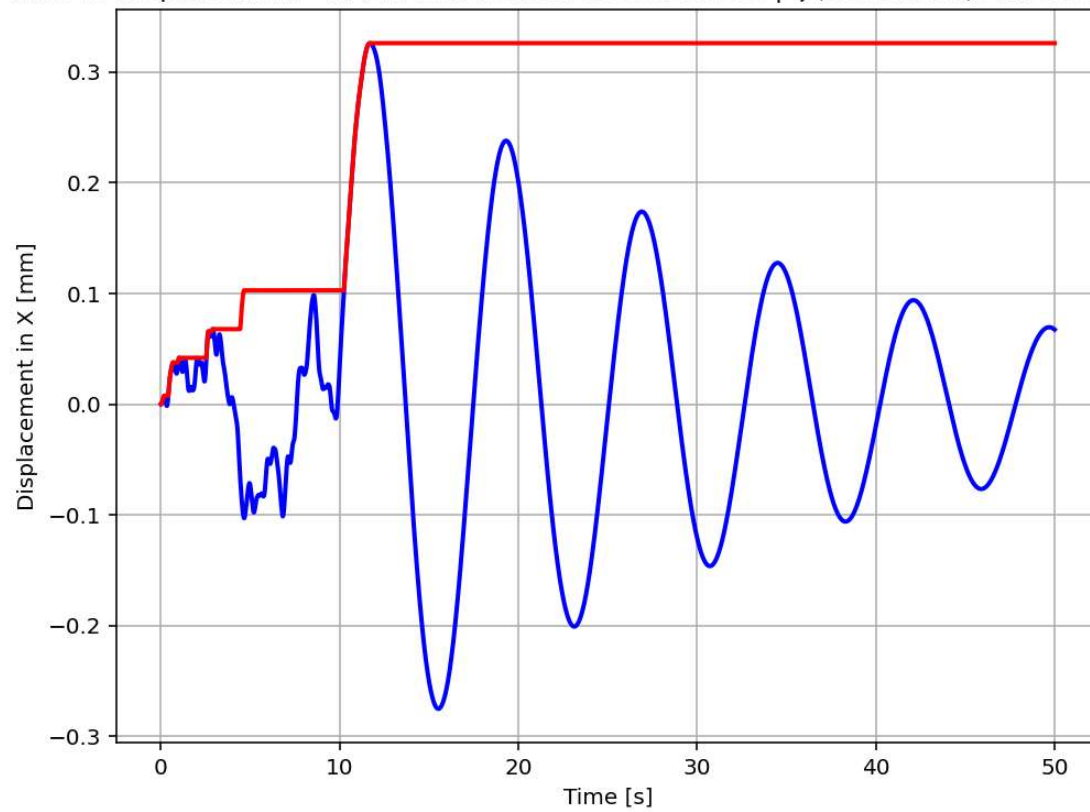




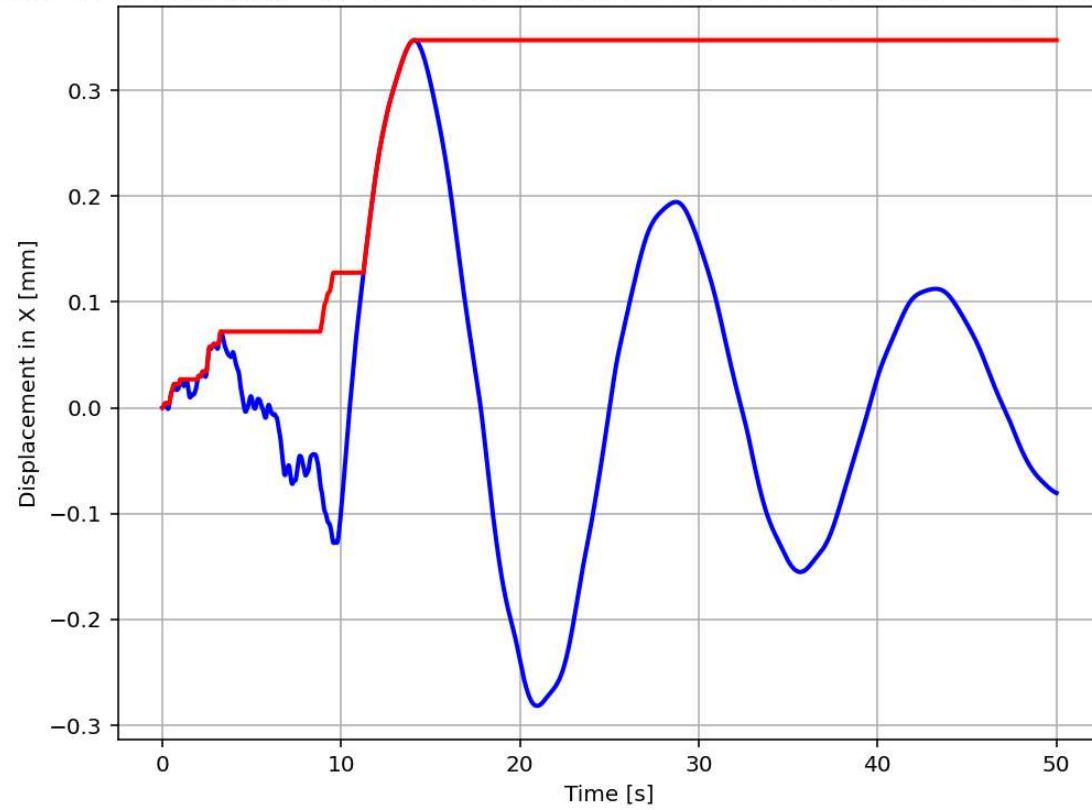
Structure Lateral Drift During the Dynamic Analysis

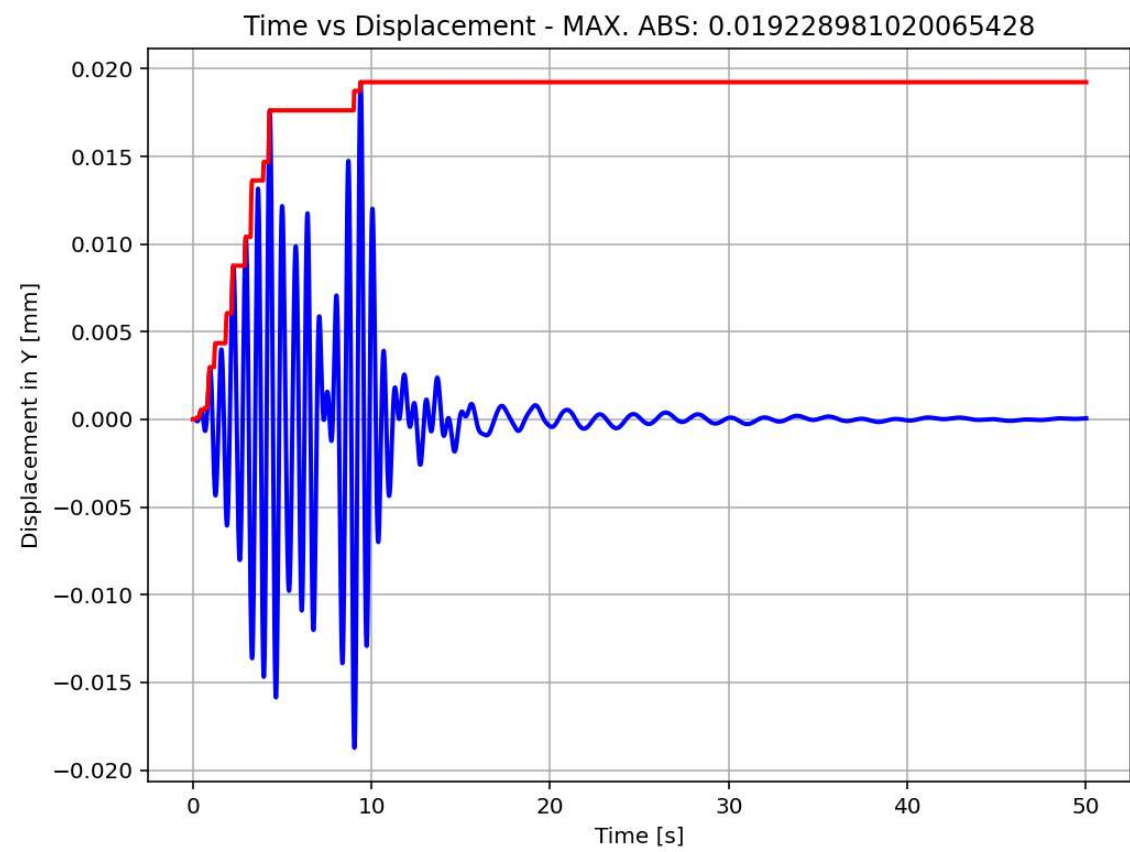


Time vs Displacement - MAX. ABS: 0.3260728353159758 | ξ (Calculated): 0.00000e+00 %

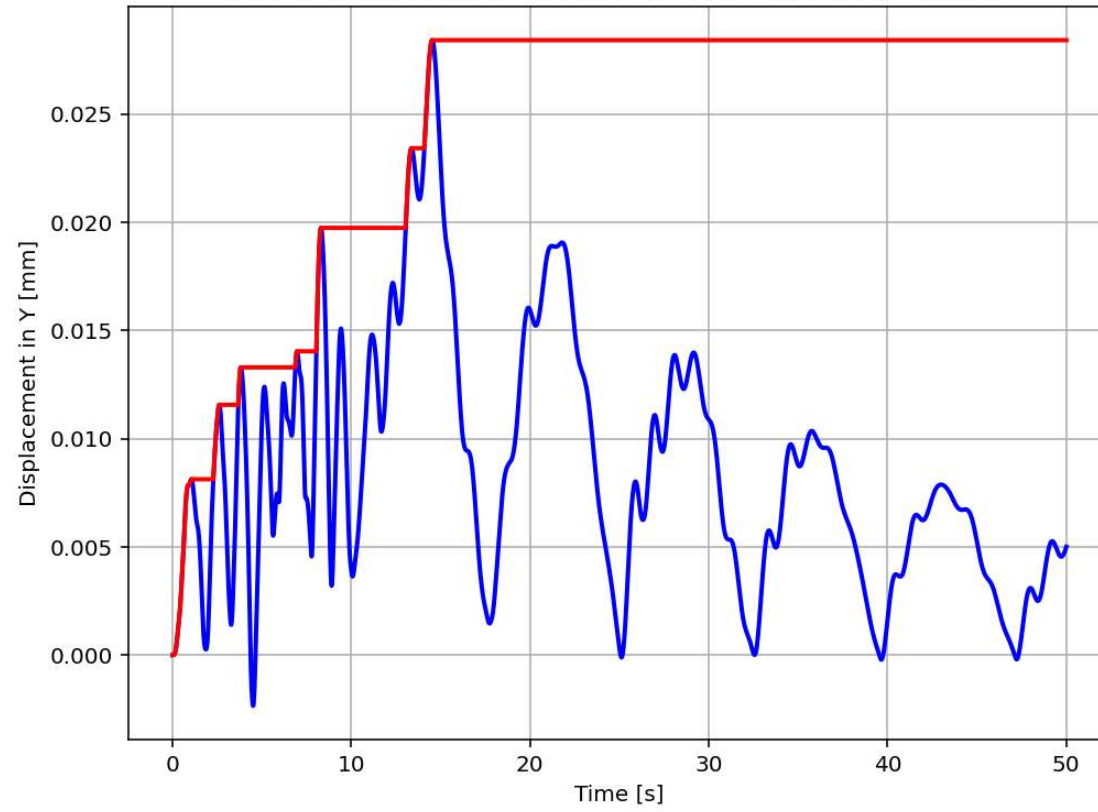


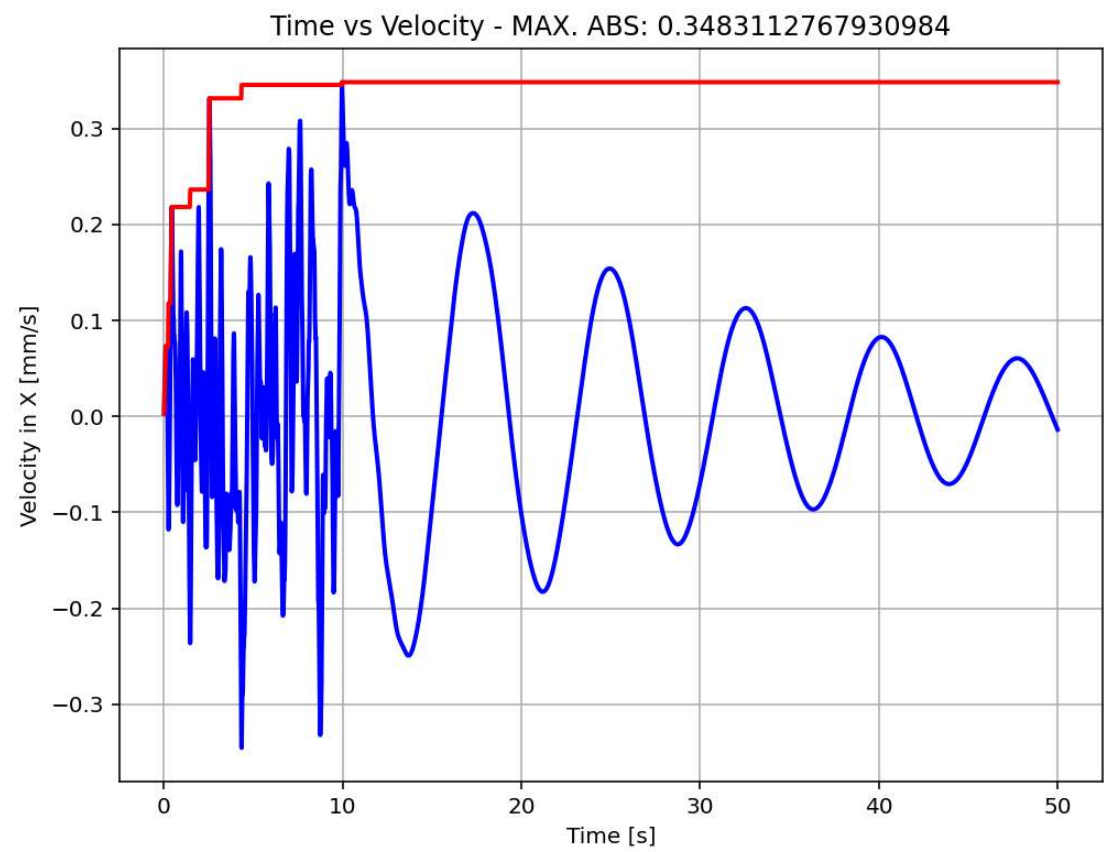
Time vs Displacement - MAX. ABS: 0.34745151281860015 | ξ (Calculated): 0.00000e+00 %

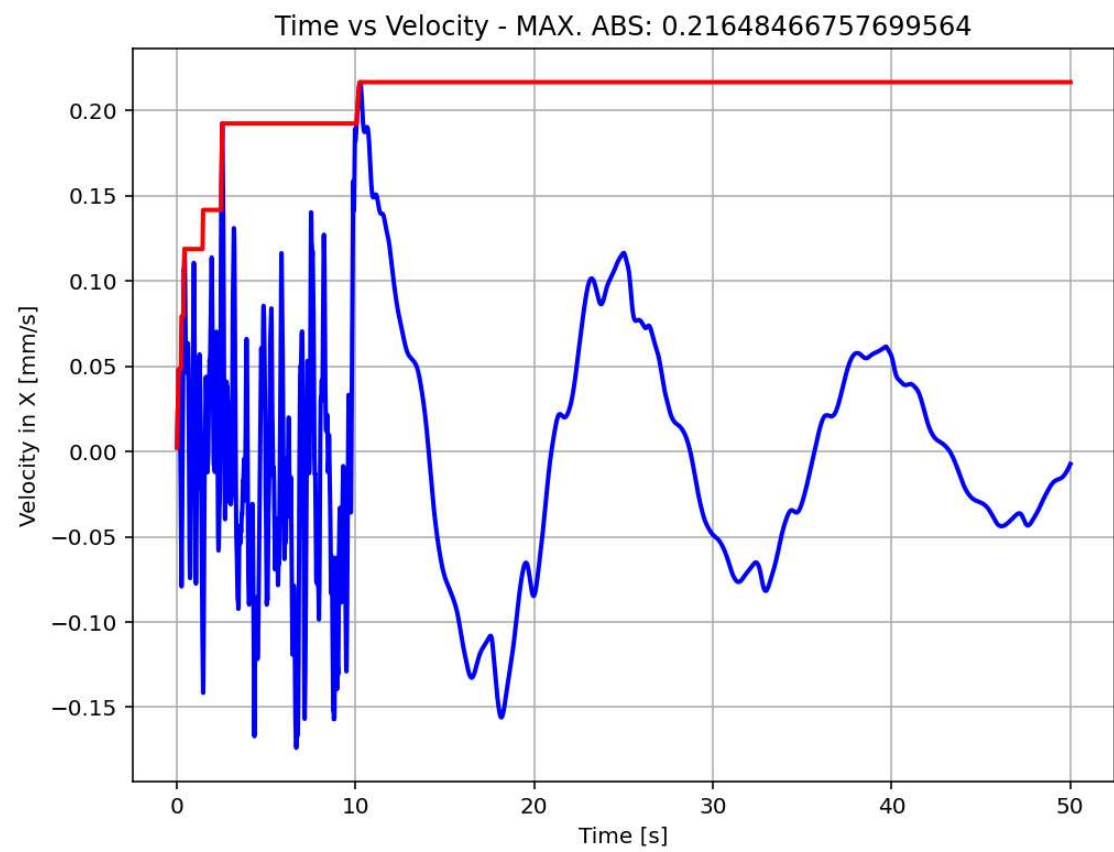


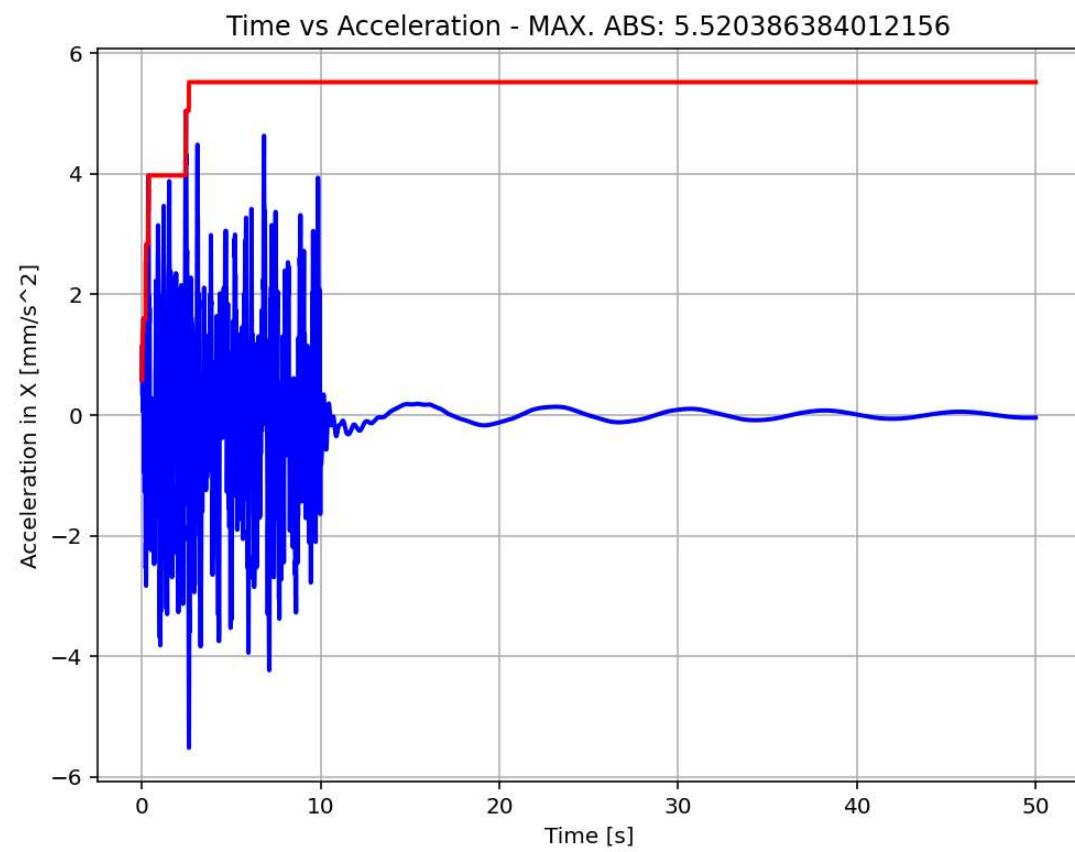


Time vs Displacement - MAX. ABS: 0.028418960202766155

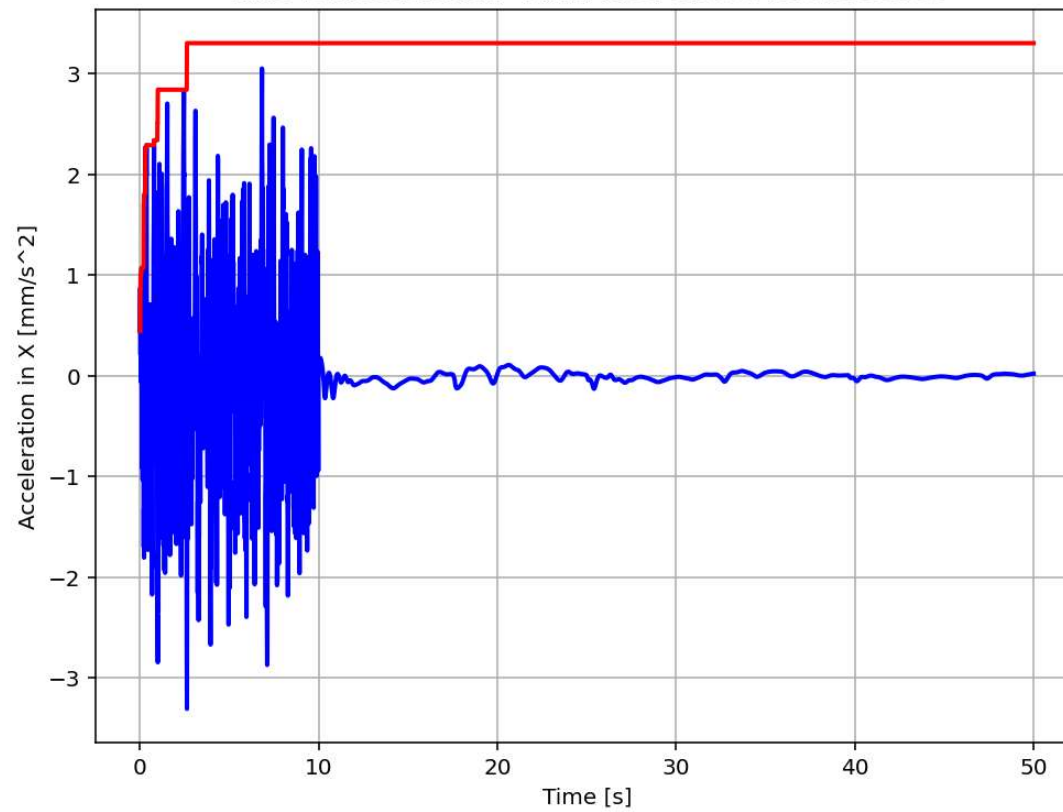


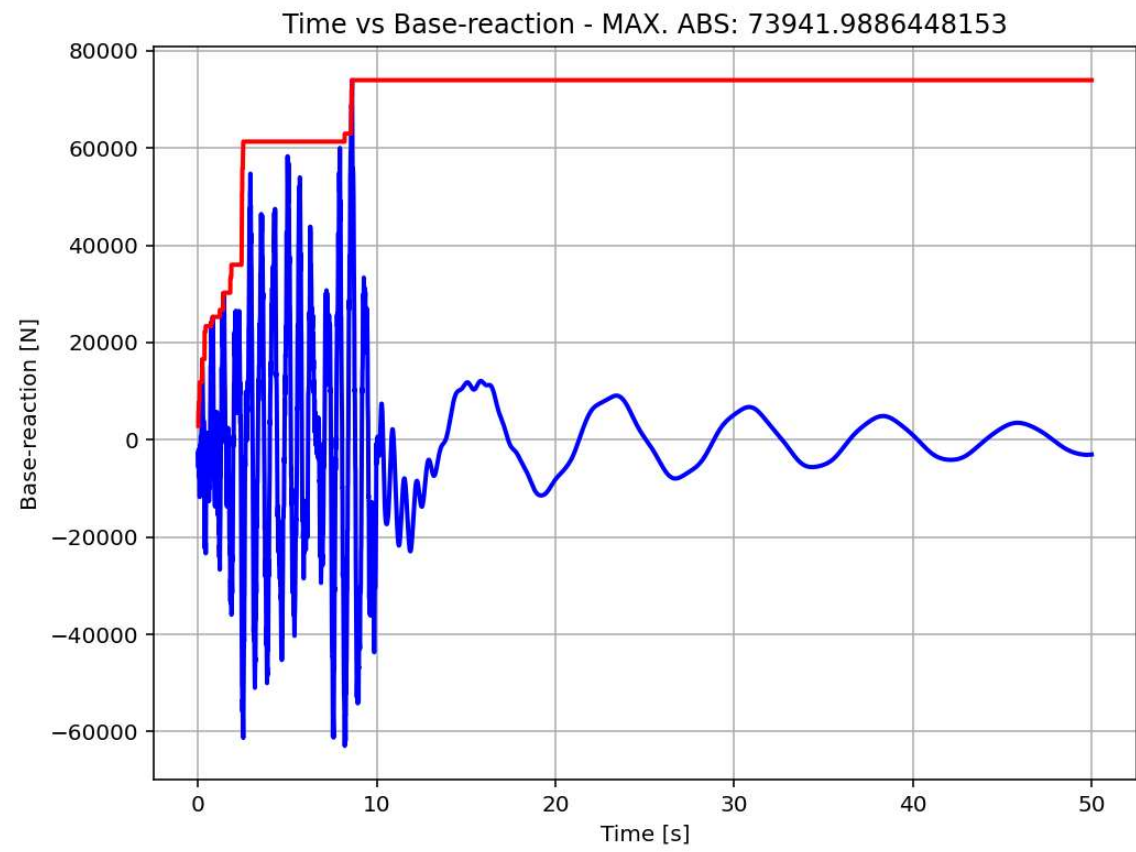


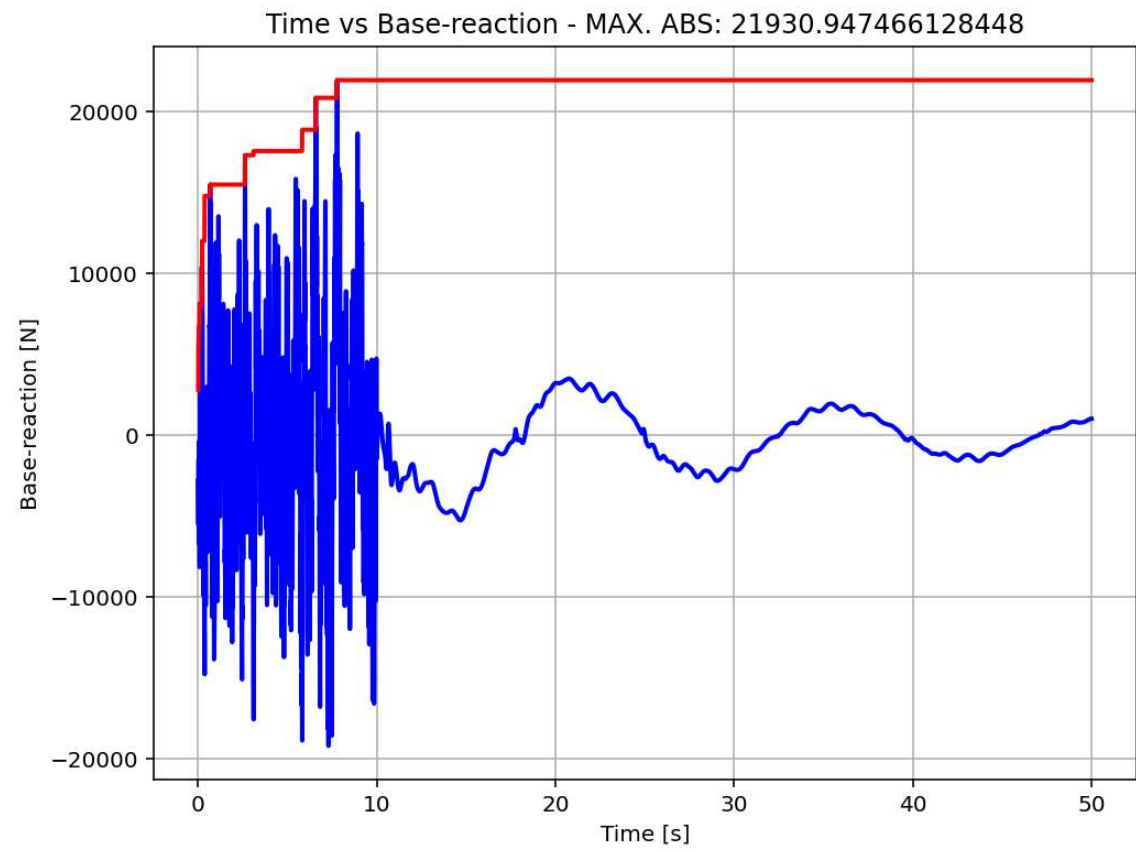


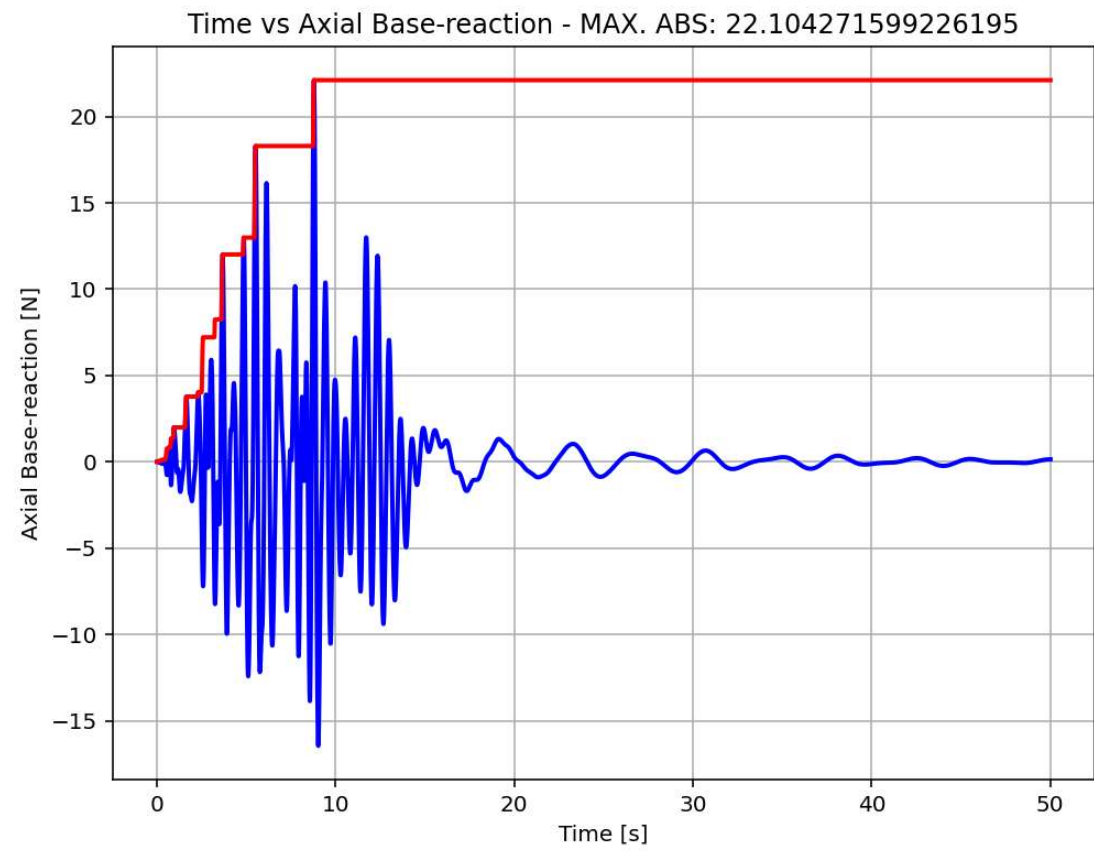


Time vs Acceleration - MAX. ABS: 3.305373228288009









Time vs Axial Base-reaction - MAX. ABS: 11139.52226294204

