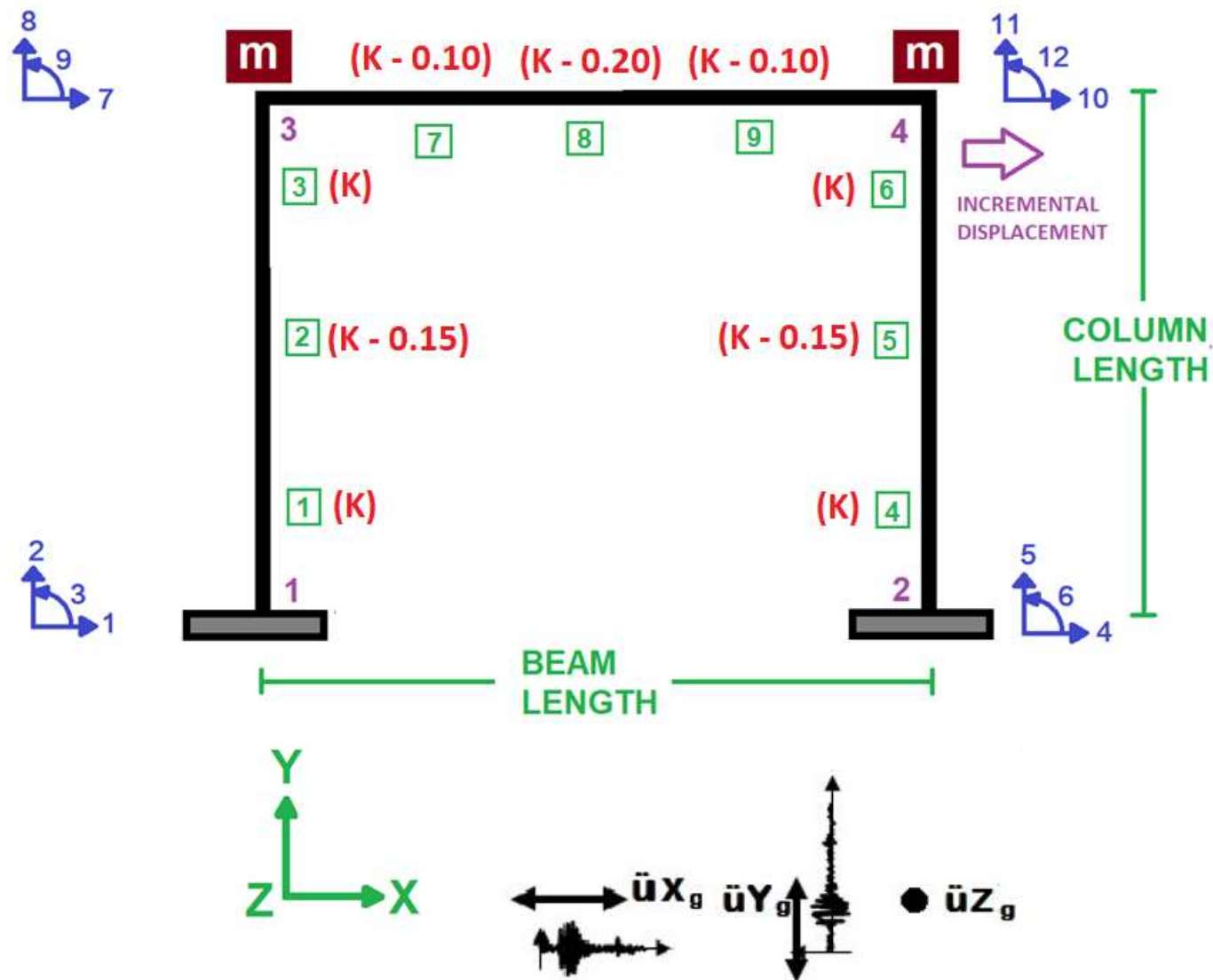
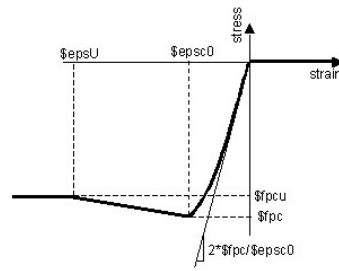


IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL

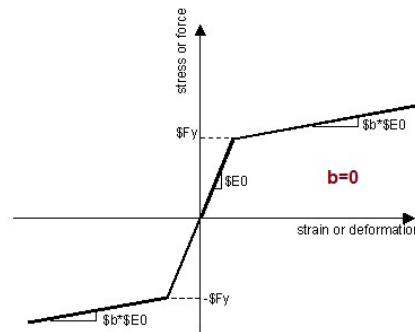
COMPARATIVE STUDY OF ELASTIC AND INELASTIC STRUCTURAL BEHAVIOR THROUGH PUSHOVER DYNAMIC ANALYSIS USING OPENSEES

WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)

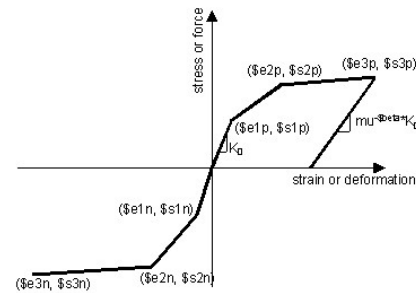




CORE AND COVER CONCRETE RELATION



WITHOUT HARDENING AND ULTIMATE STRAIN



WITH HARDENING AND ULTIMATE STRAIN



COLUMN SECTION



BEAM SECTION

1#####
2#>> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL
3# COMPARATIVE STUDY OF ELASTIC AND INELASTIC STRUCTURAL BEHAVIOR THROUGH PUSHOVER DYNAMICS
4#
5#
6# THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEE (QASHQAEI)
7# EMAIL: salar.d.ghashghaei@gmail.com
8#####
91. The script performs a comparative study of elastic and inelastic structural behavior of
102. It models a 2D reinforced concrete frame with columns (500x500mm) and beams (500x300mm).
113. Material definitions include confined/unconfined concrete ($f_c=25\text{MPa}$) and bilinear steel.
124. Two analysis types are implemented: static pushover (displacement-controlled) and dynamic.
135. Rayleigh damping is calculated based on initial modal periods and target damping ratio.
146. The pushover analysis applies incremental displacements up to 675mm, recording base shear.
157. Dynamic analysis uses Newmark integration with ground motion inputs scaled by 0.01g (1.0).
168. Key outputs include force-displacement curves, moment-rotation relationships, and stiffness degradation.
179. Eigenvalue analysis tracks period elongation due to inelasticity during dynamic events.
1810. Damage indices are computed for ductility assessment using bilinear curve fitting.
1911. Overstrength factors (Ω), ductility ratios (μ), and R-factors are quantified for seismic performance.
2012. Real-time monitoring of base shear, axial forces, and interstory drifts is implemented.
2113. The script includes advanced convergence controls (Newton-Raphson, $1e-6$ tolerance).
2214. Confinement effects are modeled with variable enhancement ratios ($K_c=1.25$ for columns).
2315. Results are exported to Excel, including displacements, forces, stiffness, and period ratios.
2416. Visualization includes deformed shapes, hysteresis loops, and cumulative response envelopes.
2517. Damping ratios are estimated from free vibration decay in dynamic analyses.
2618. Both geometric nonlinearities (P-Delta/Corotational) and material nonlinearities are considered.
2719. The code supports parametric studies by varying steel models (with/without hardening).
2820. Comprehensive plotting functions enable side-by-side comparison of elastic vs. inelastic responses.
29
30The script demonstrates professional-grade analysis combining FEMA-356 pushover methods with
31OpenSeesPy.
32import openseespy.opensees as ops
33import matplotlib.pyplot as plt
34import numpy as np

Stress-Strain Relation of Element 2 Steel Rebar Top & Bottom Fibers

Console 1/A

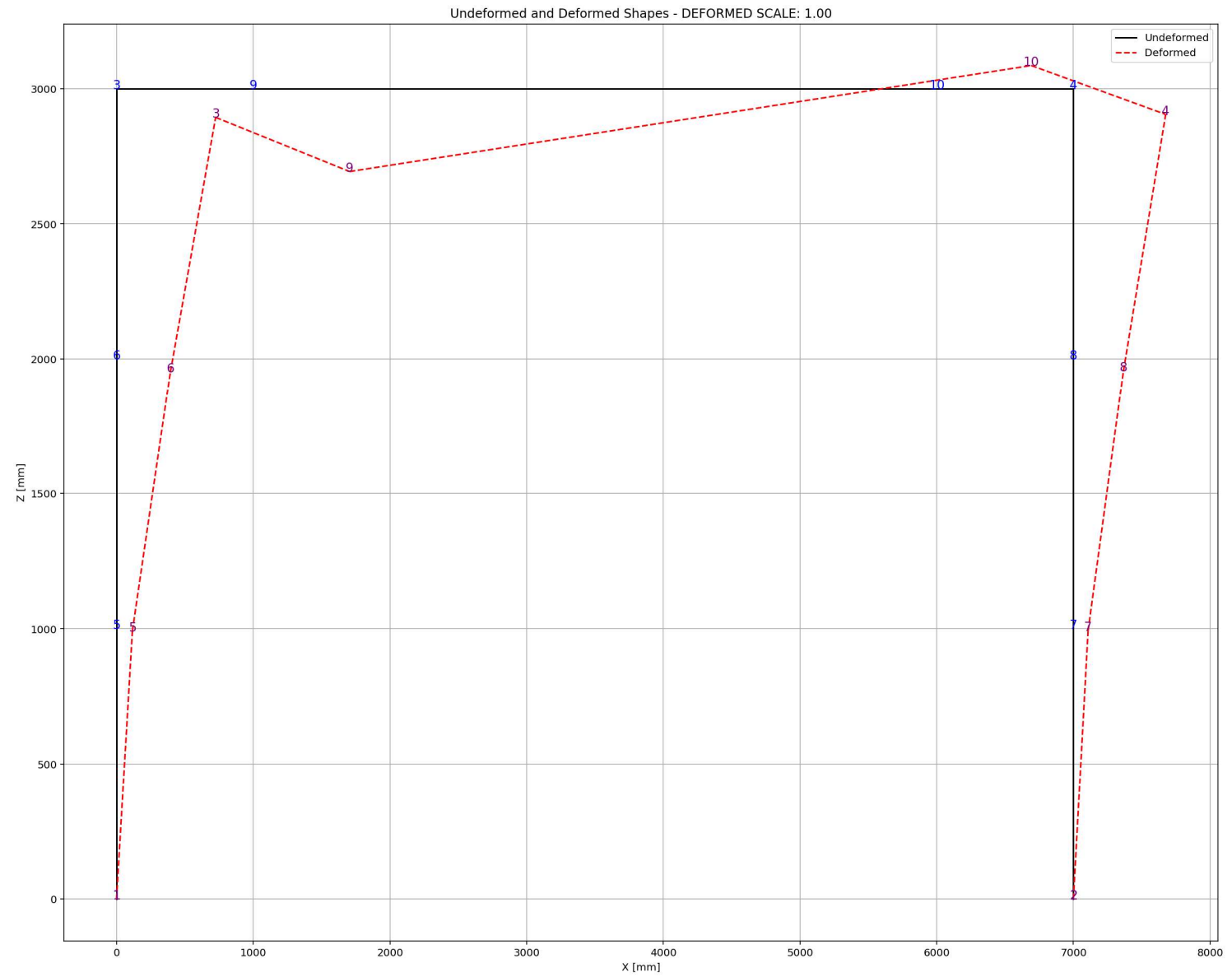
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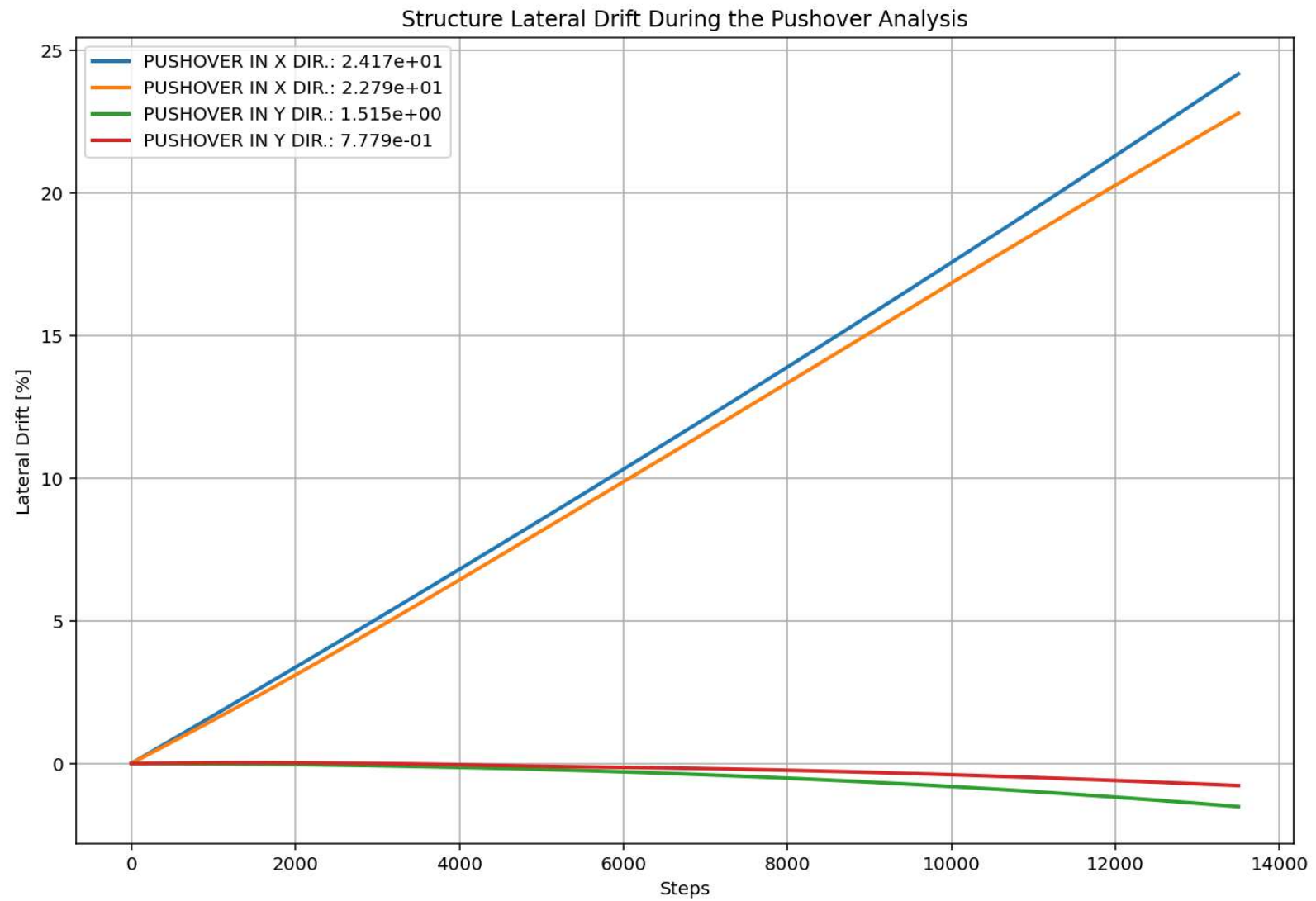
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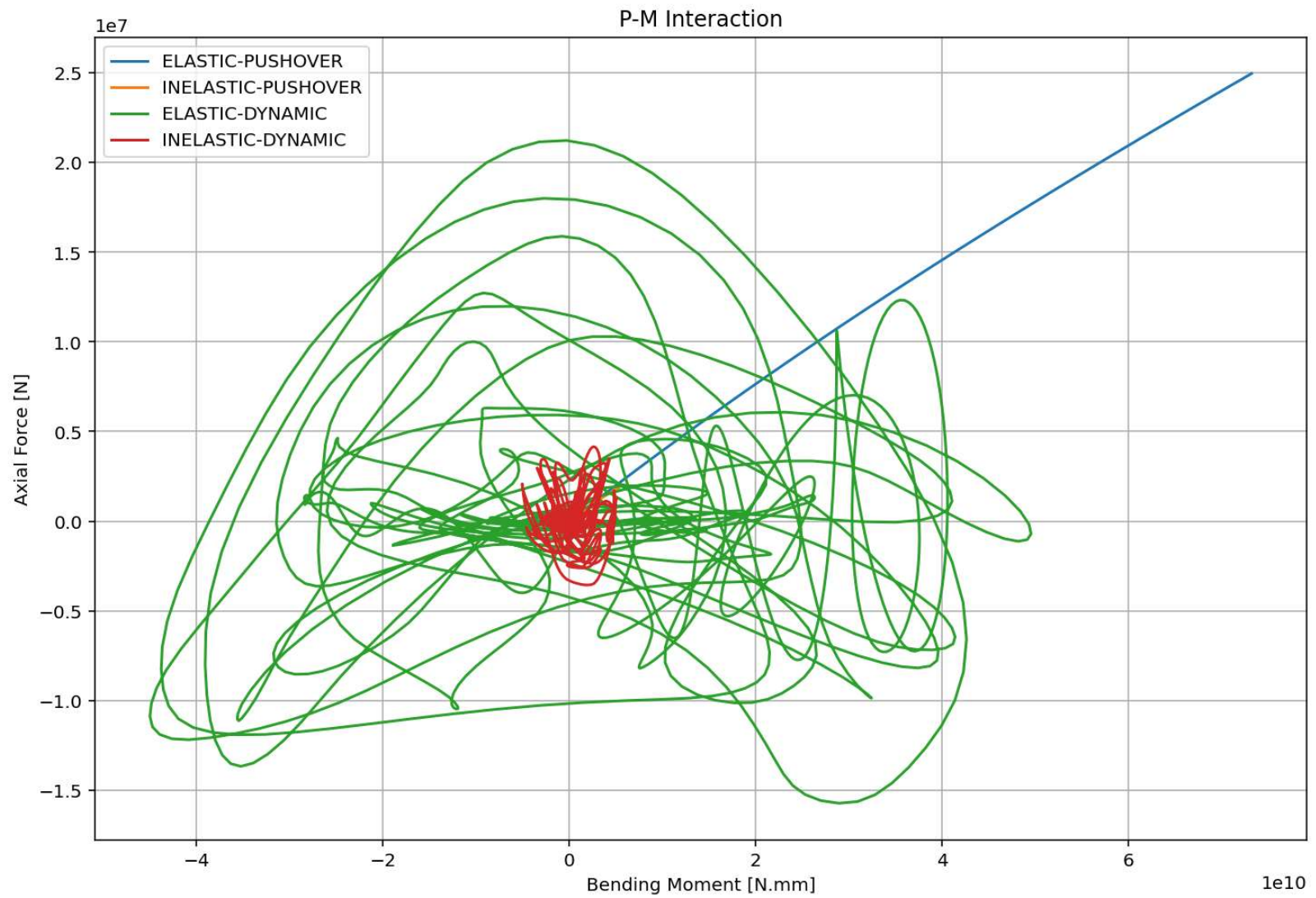
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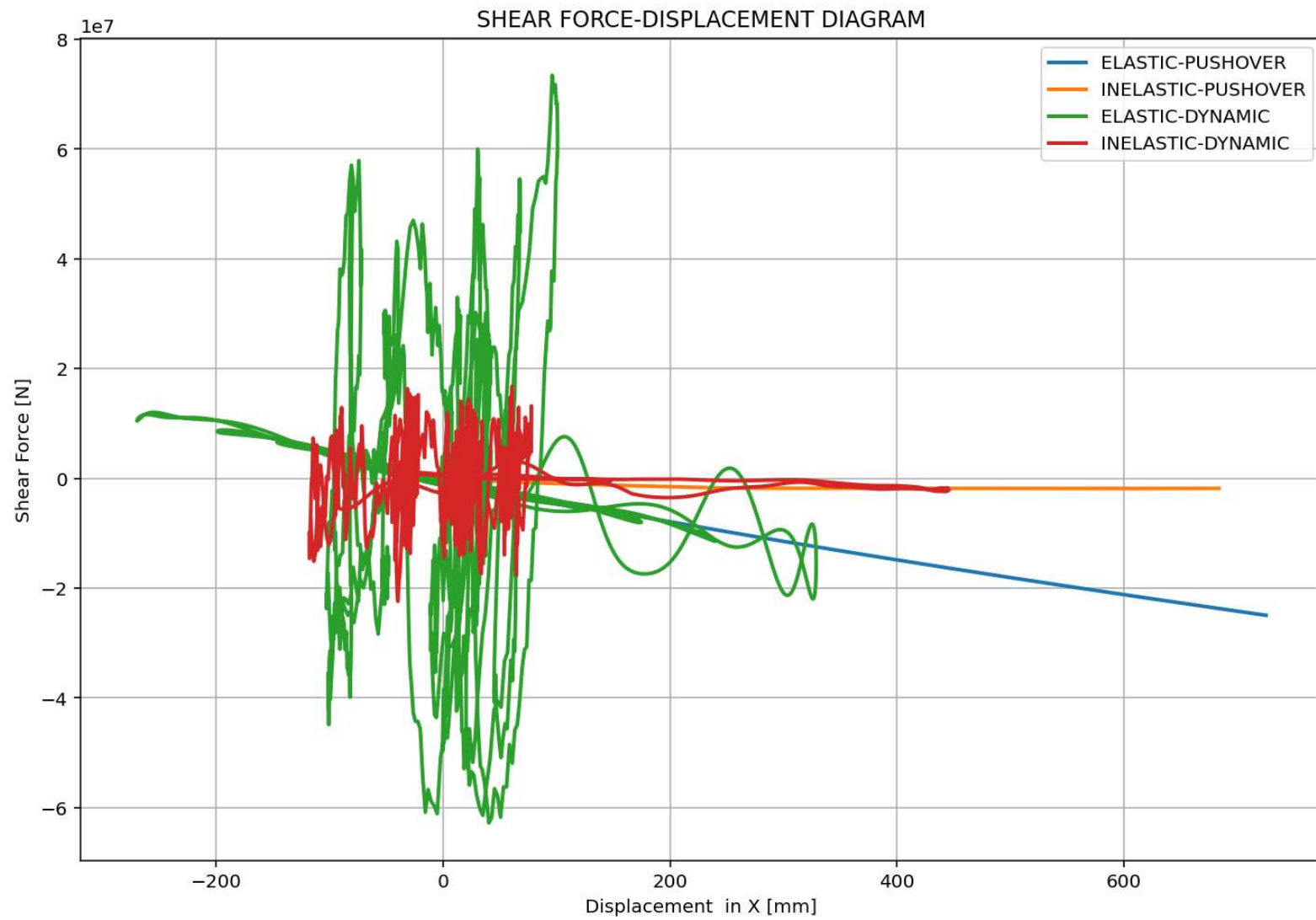
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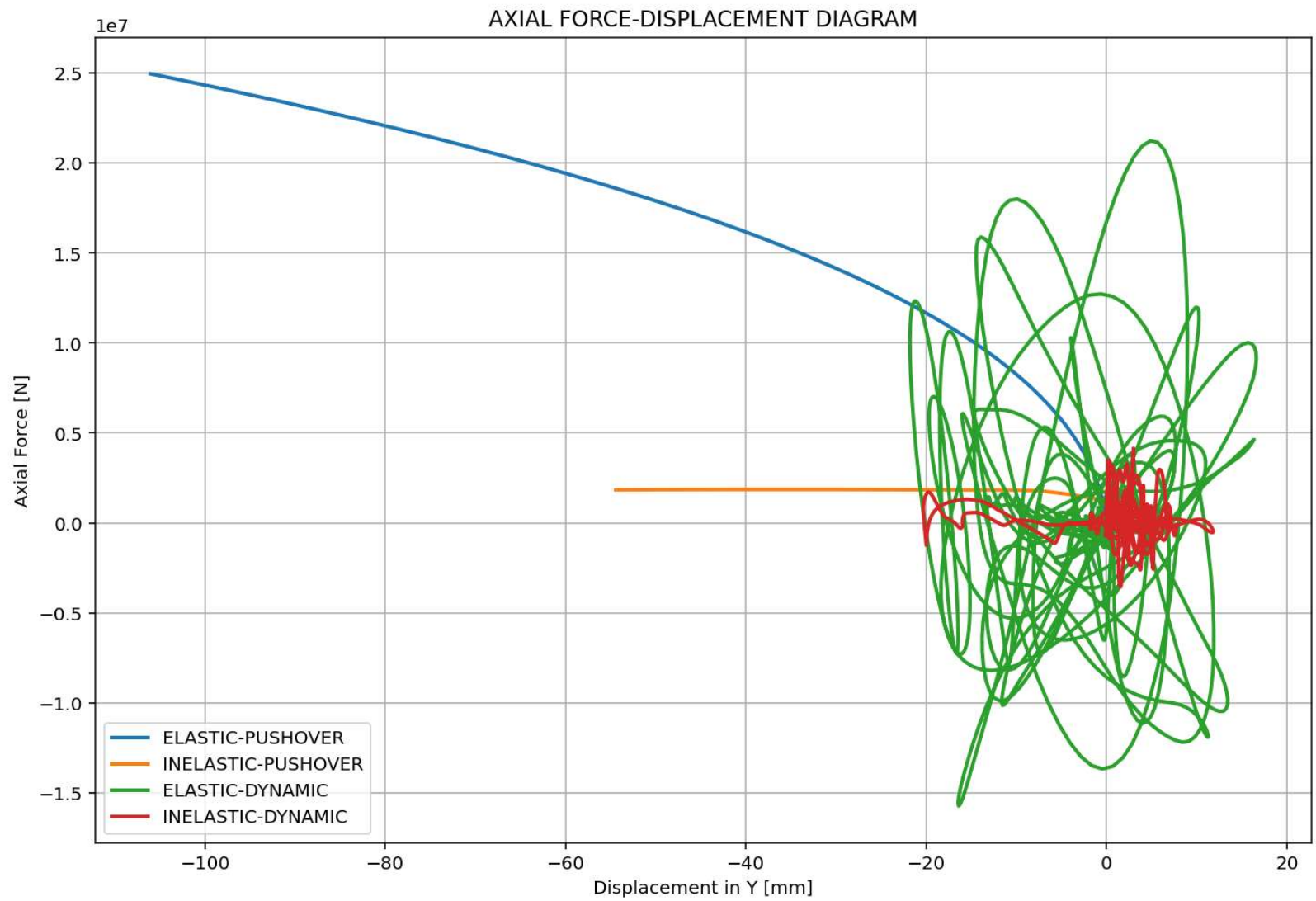
ELASTIC AND INELASTIC STATIC ANALYSIS (PUSHOVER)

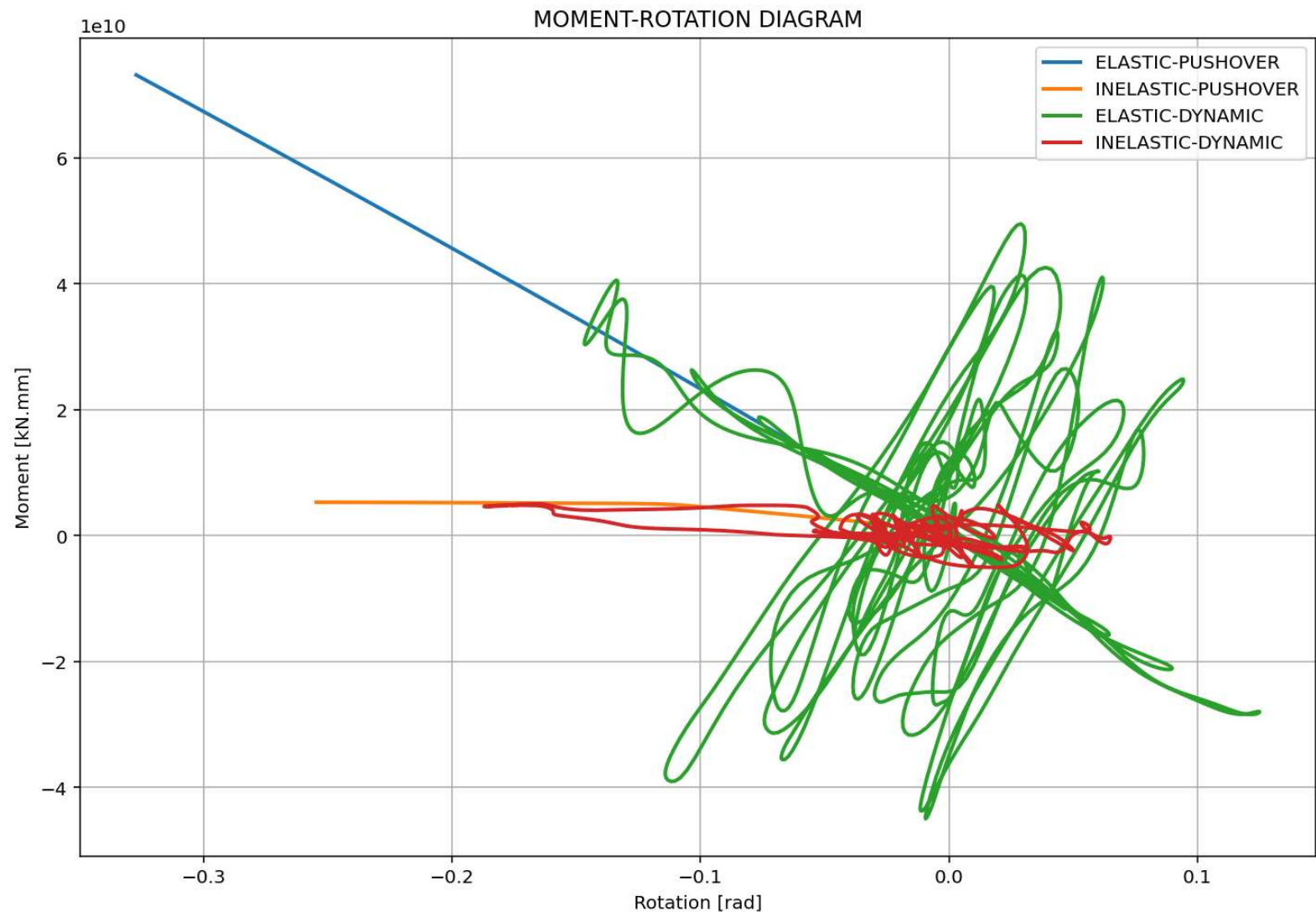




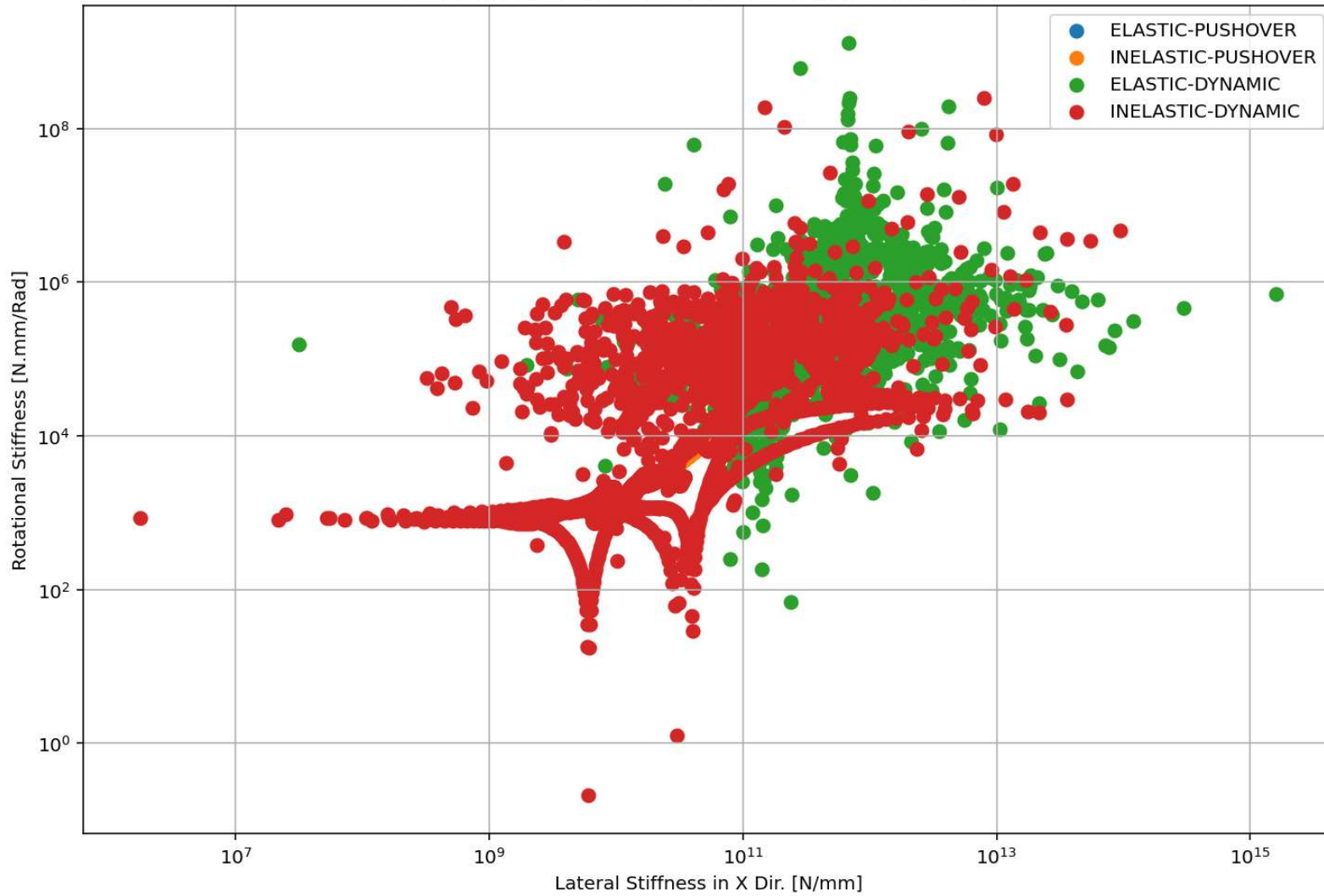




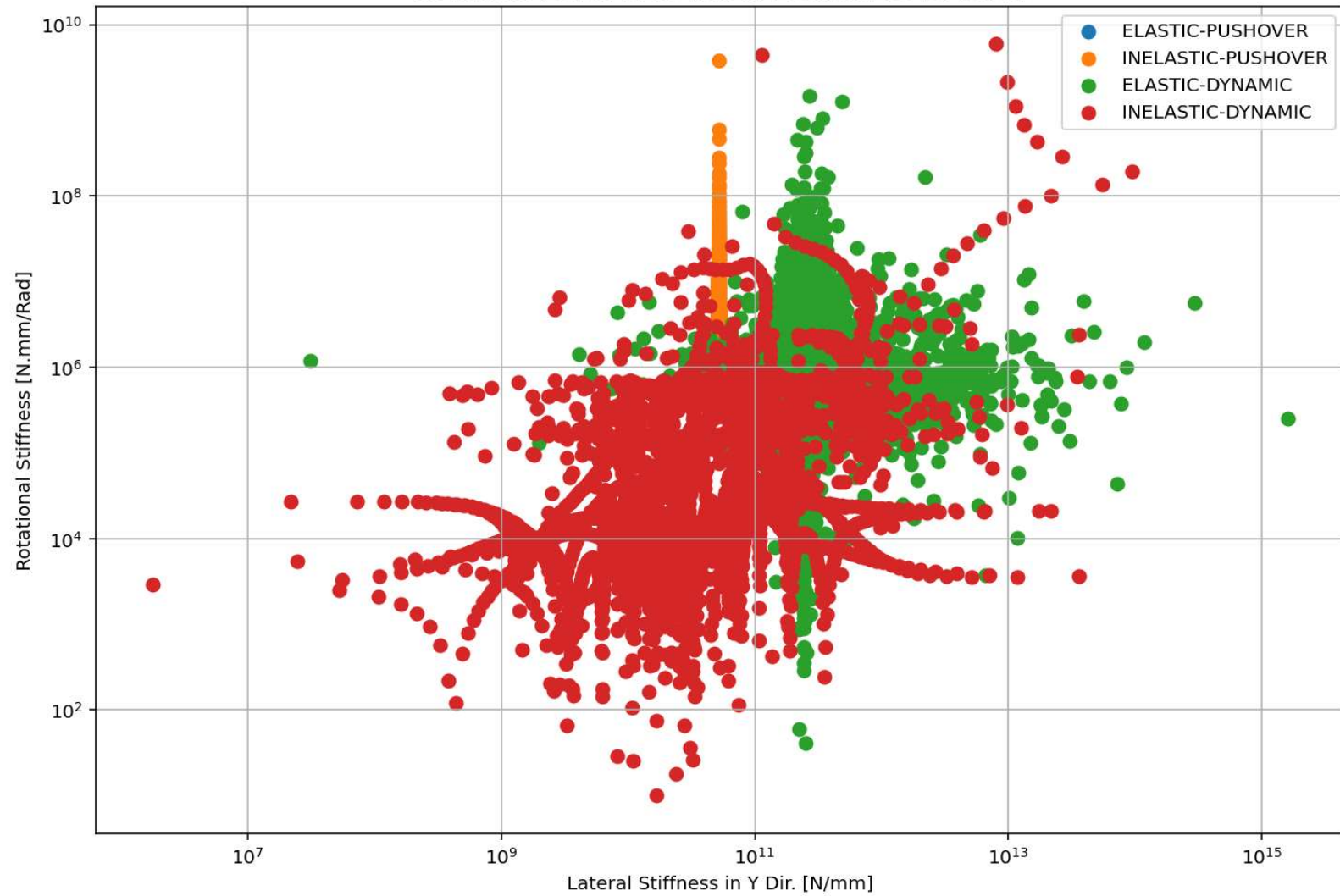


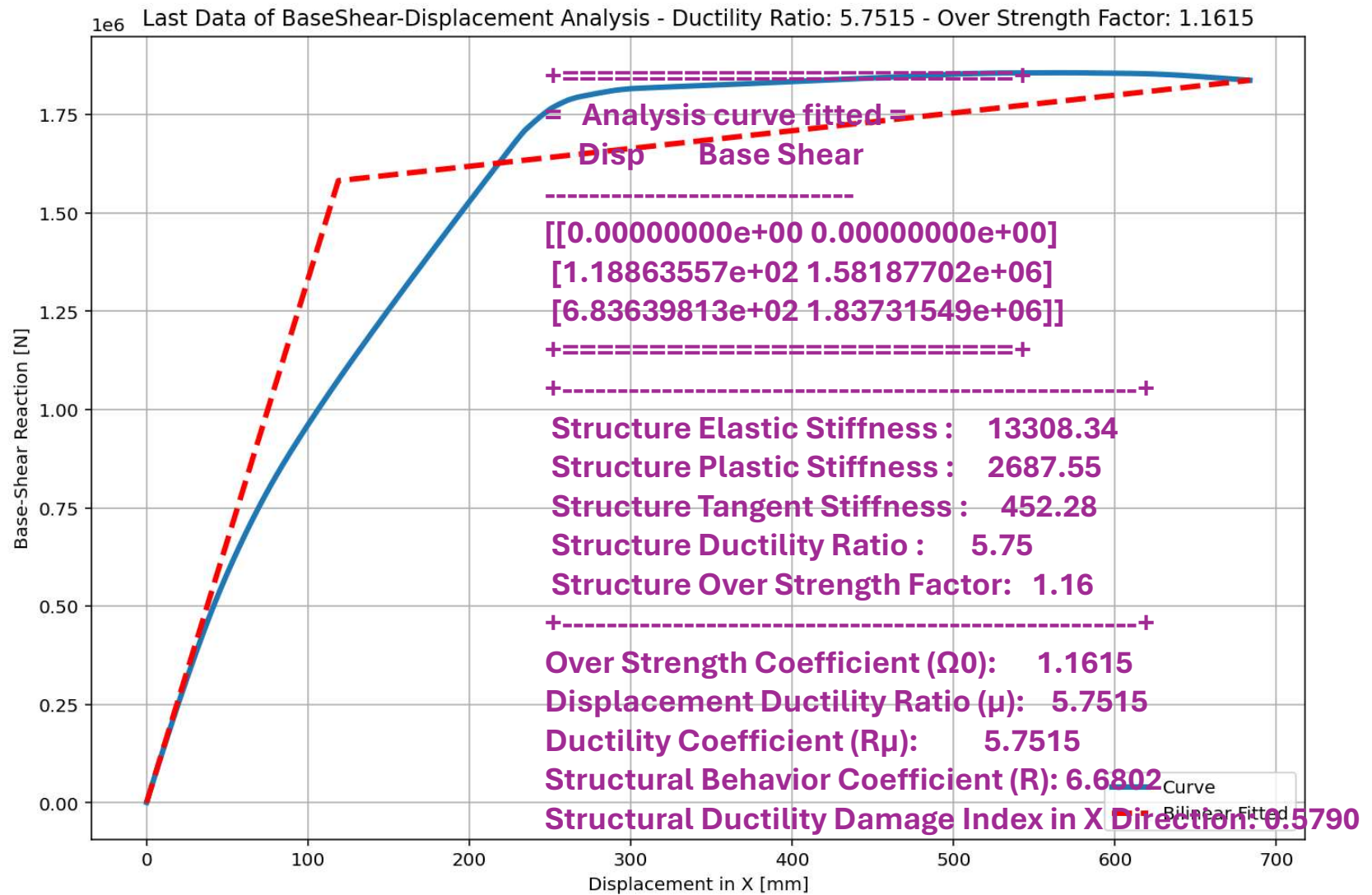


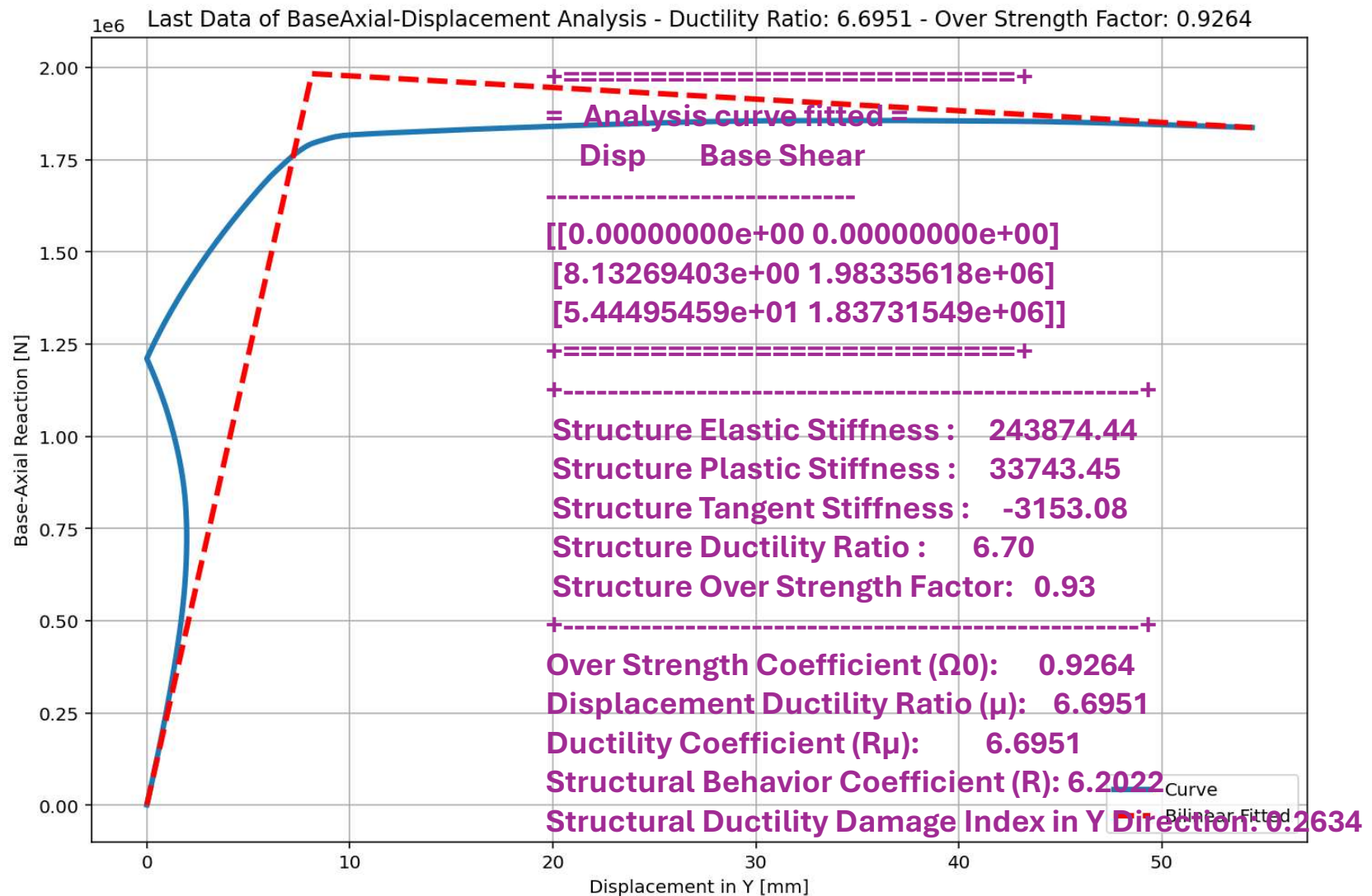
ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM



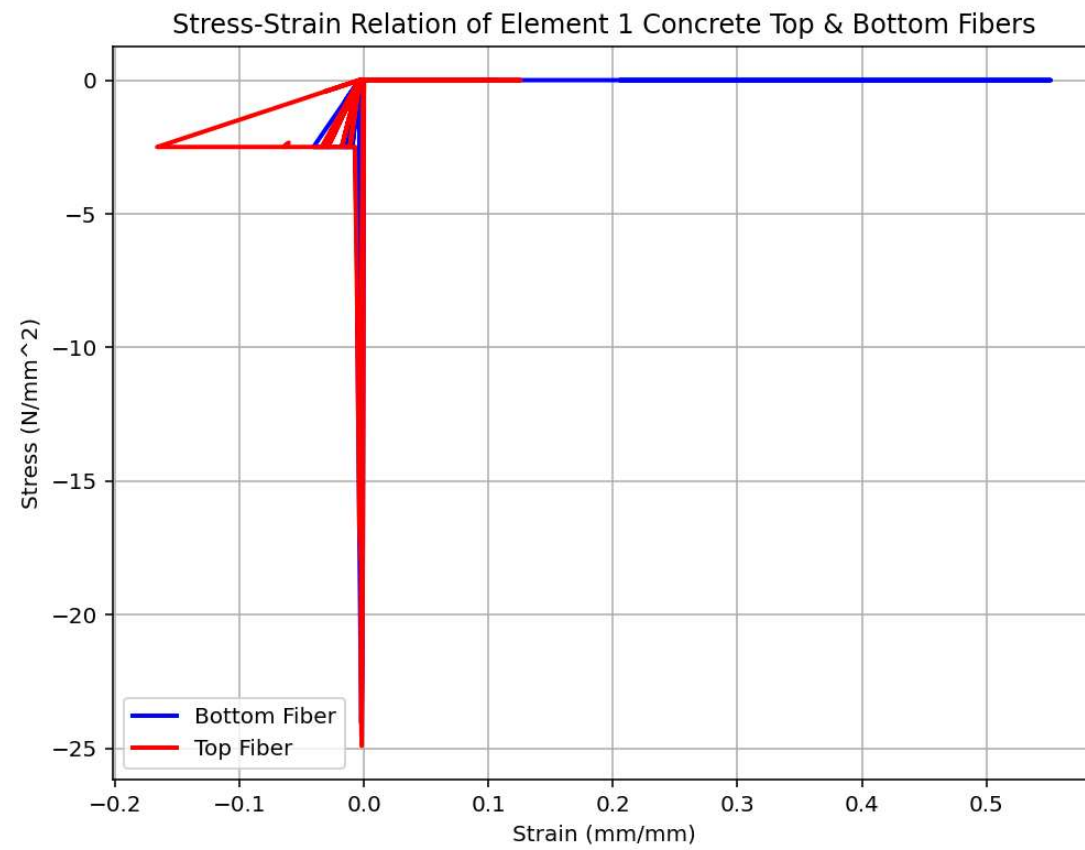
ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM



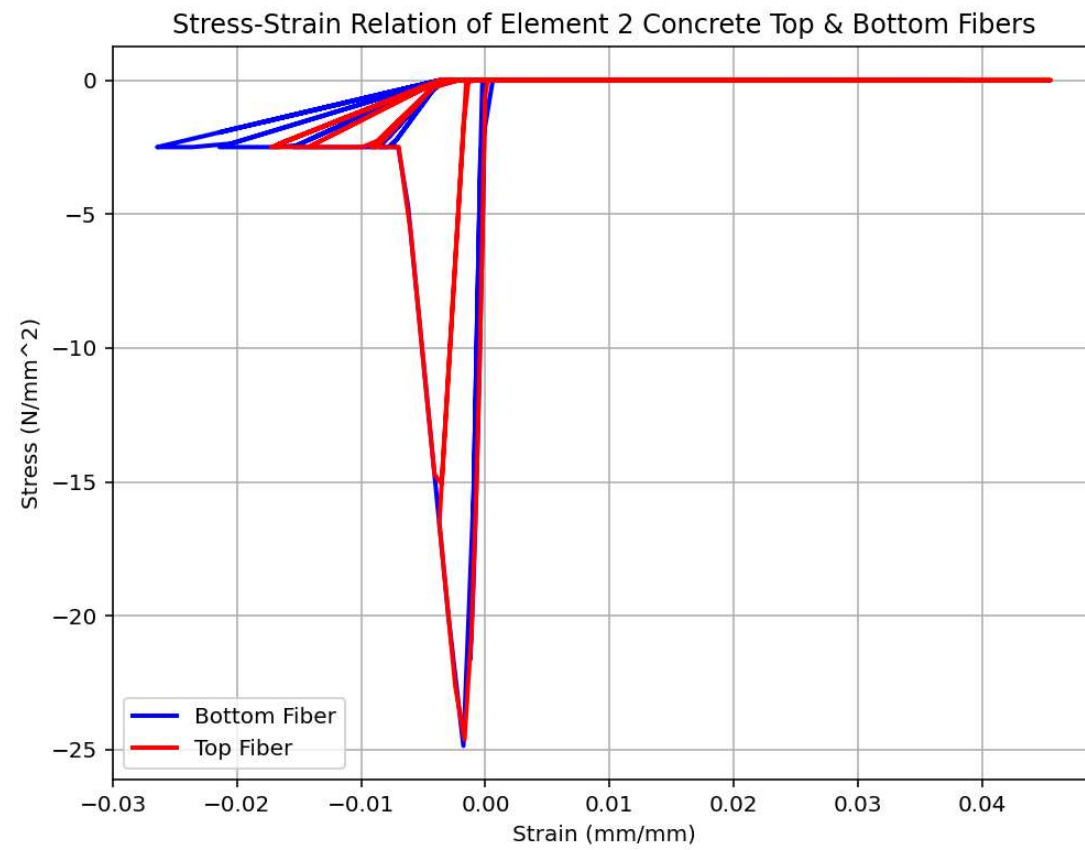




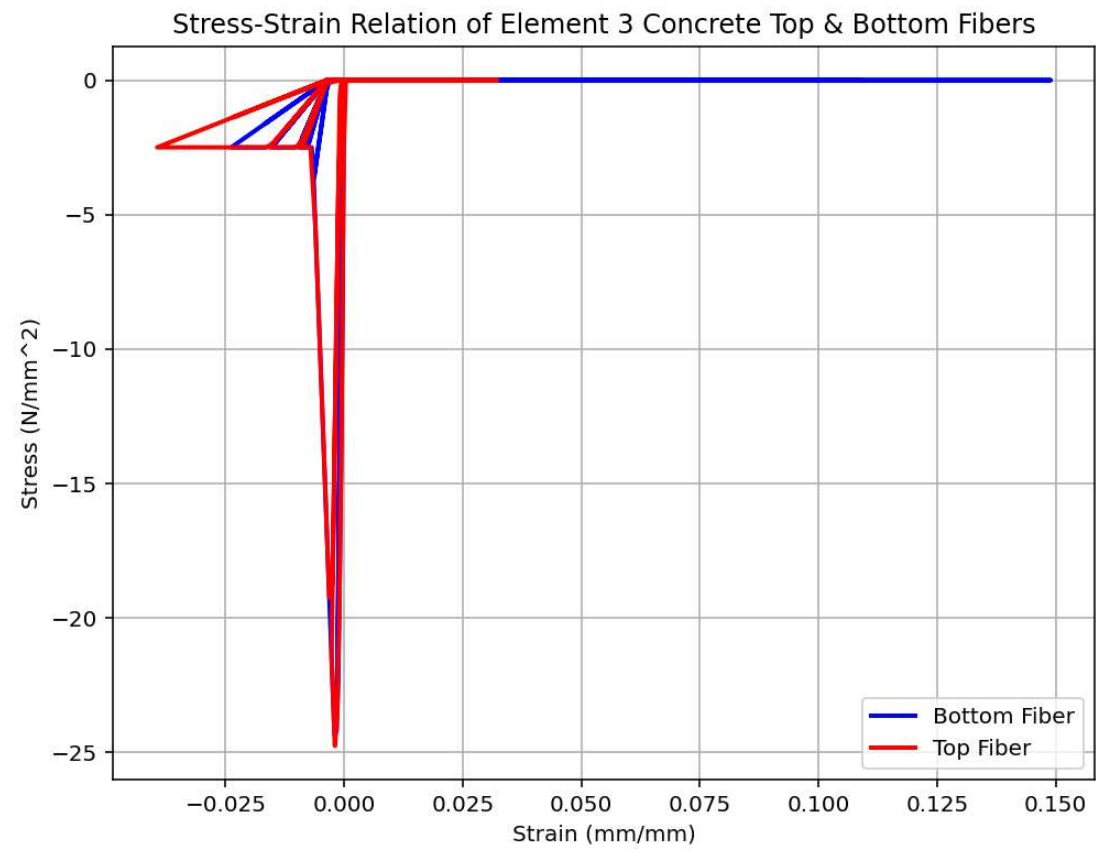
ELASTIC AND INELASTIC DYNAMIC ANALYSIS



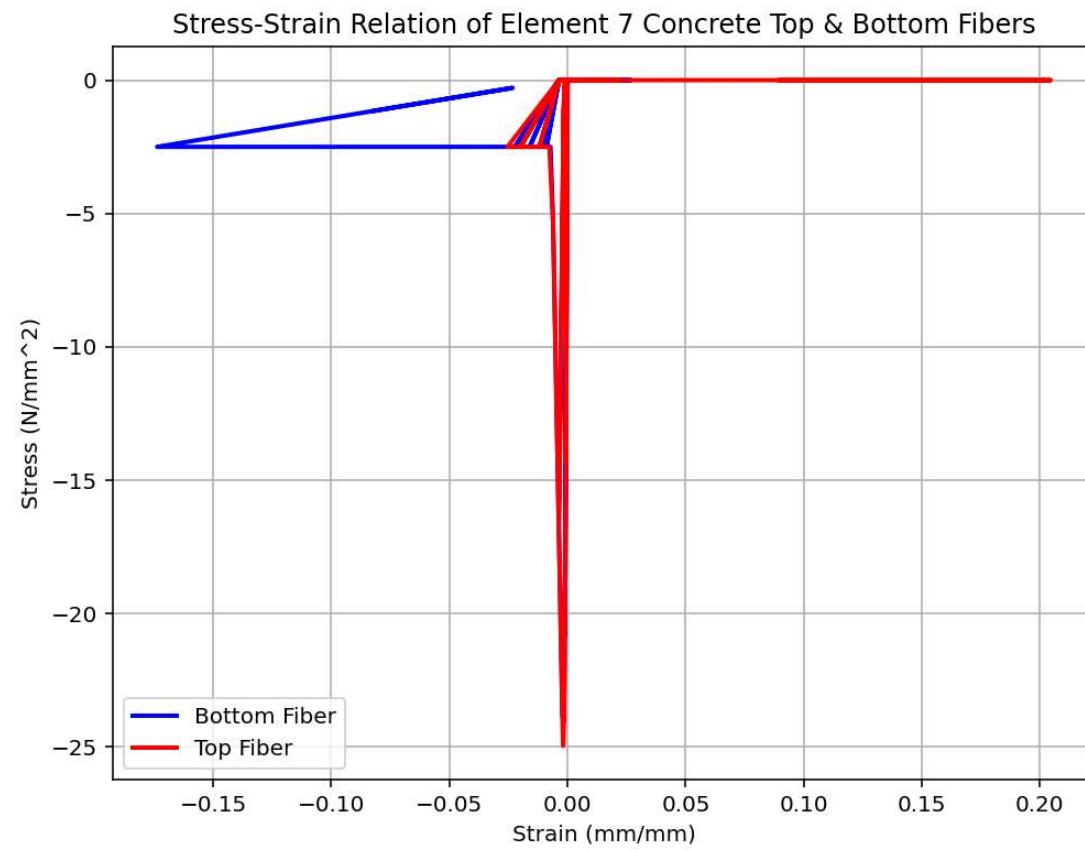


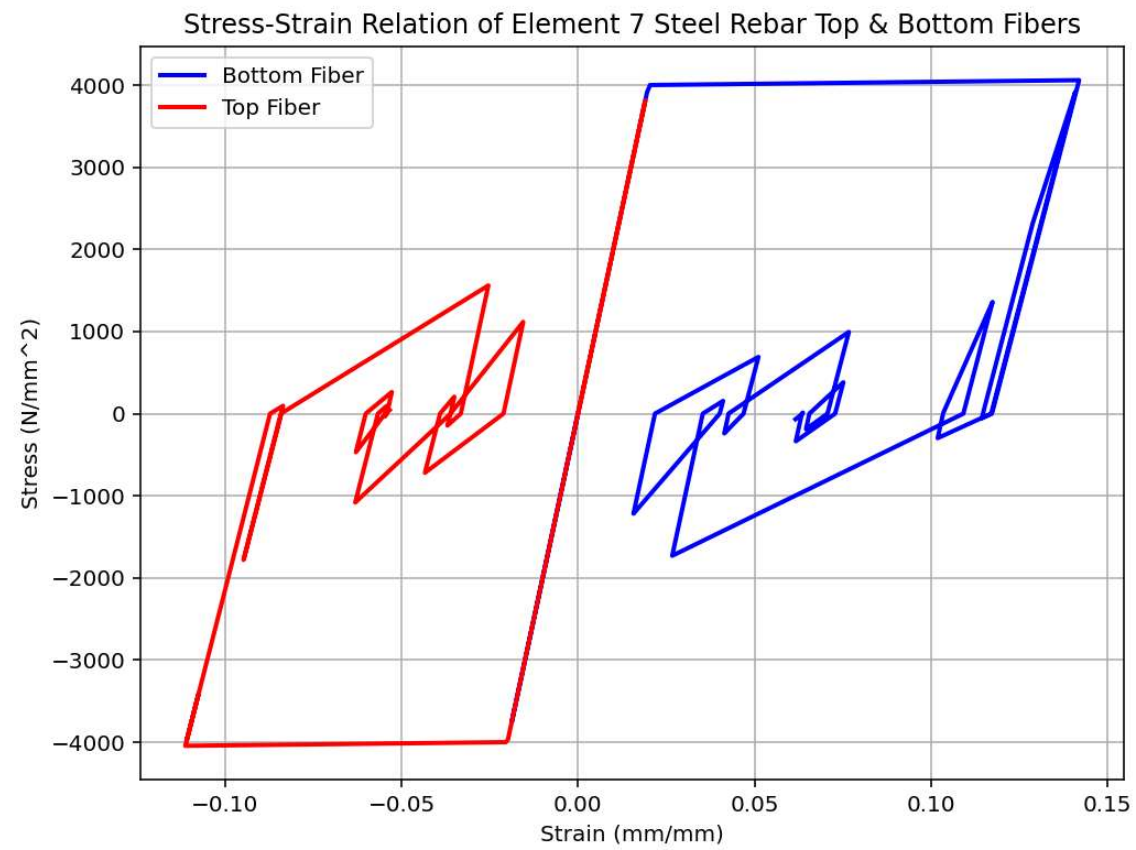


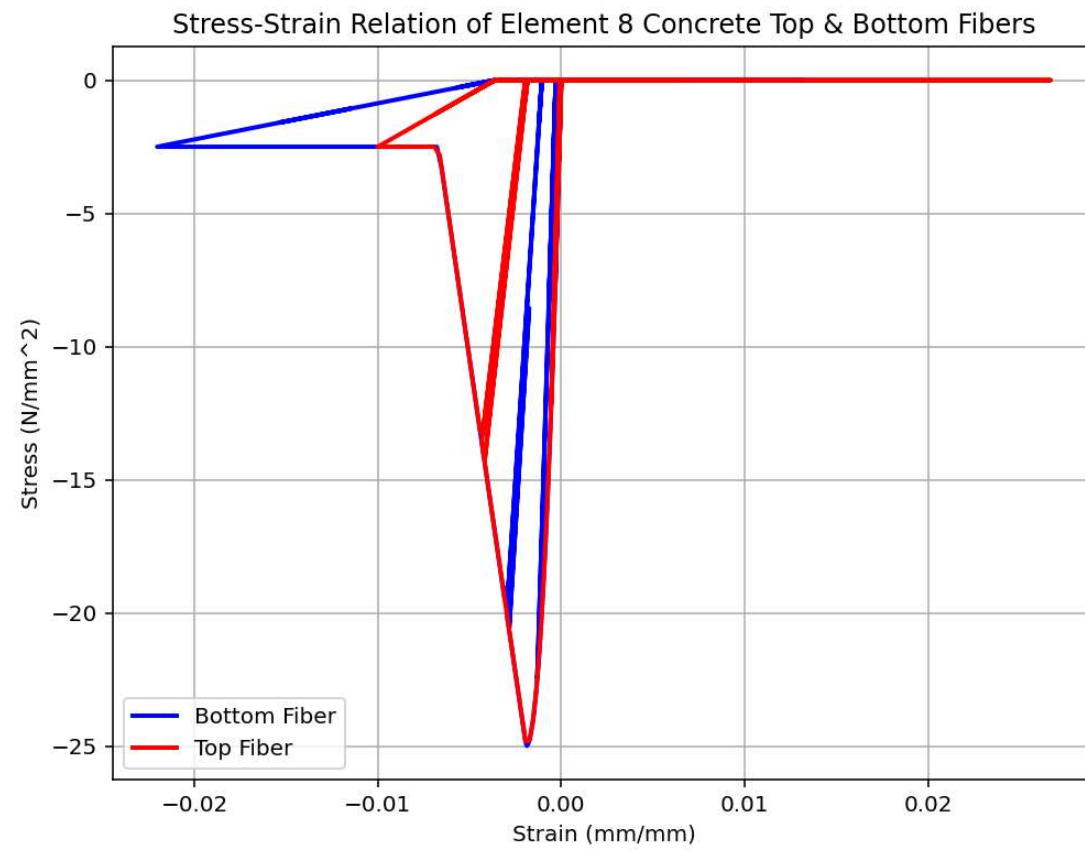




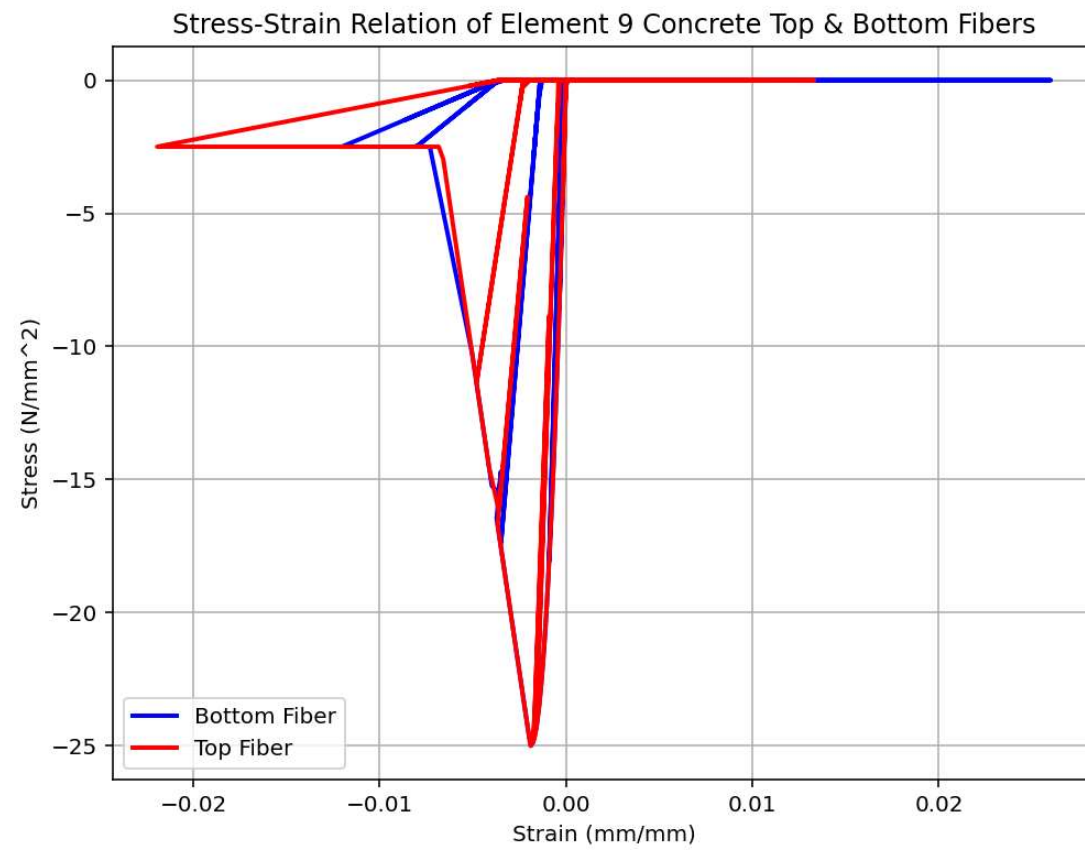


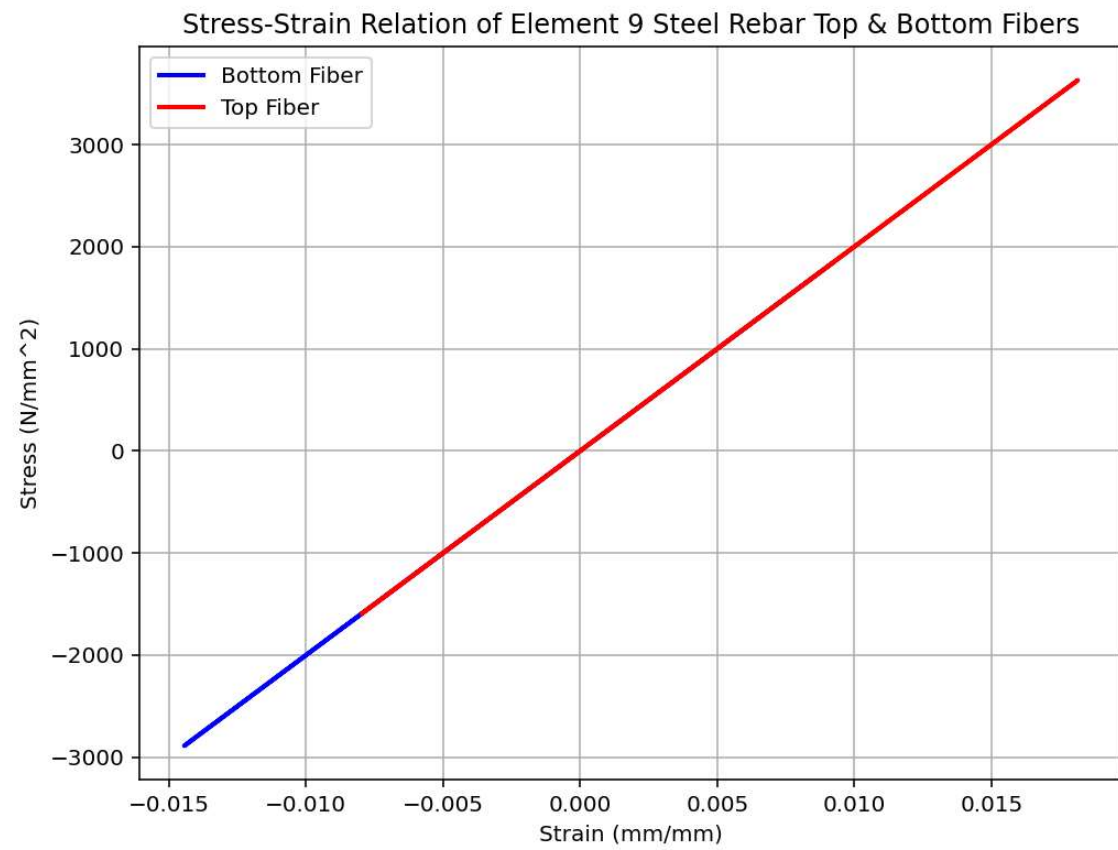


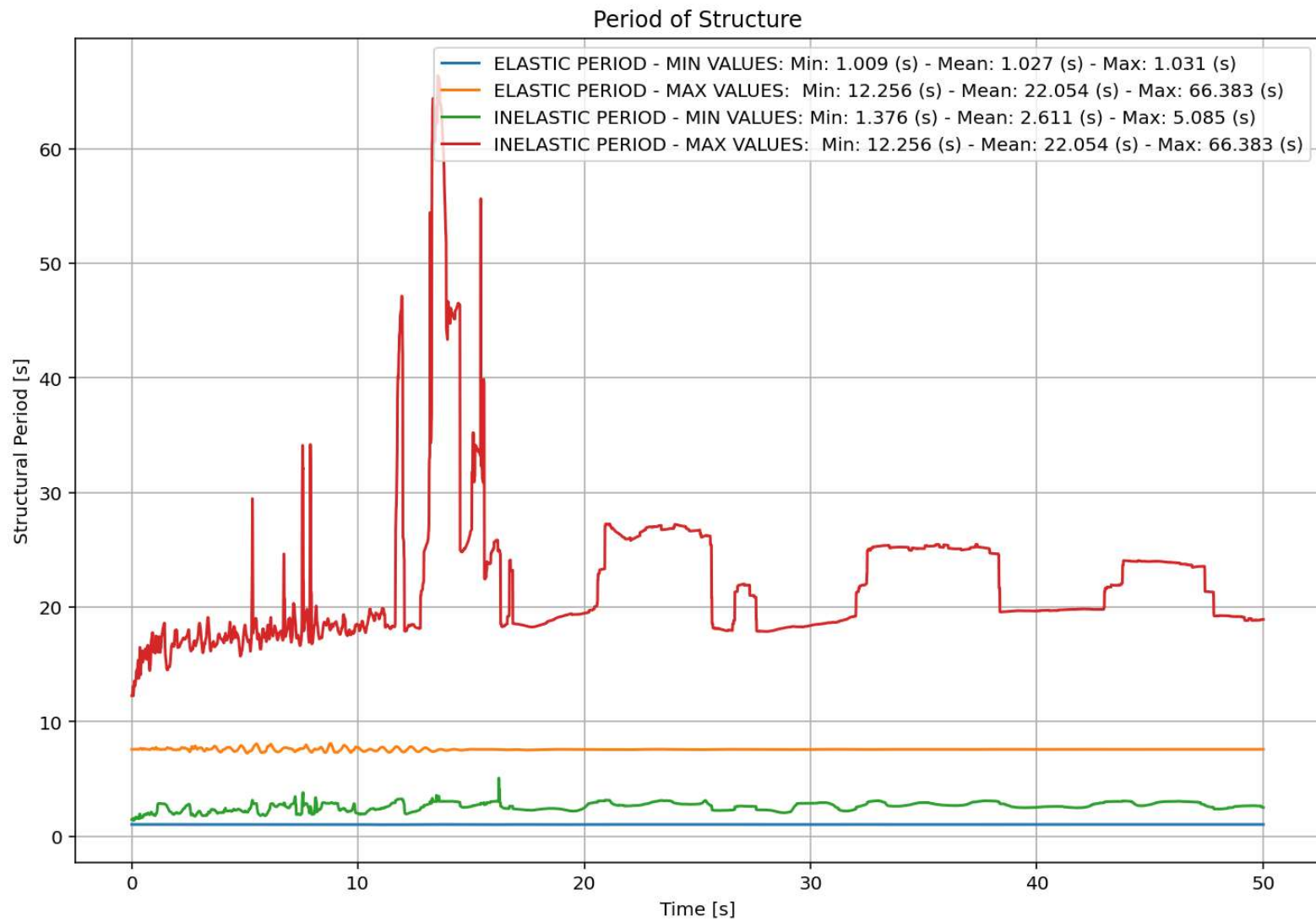


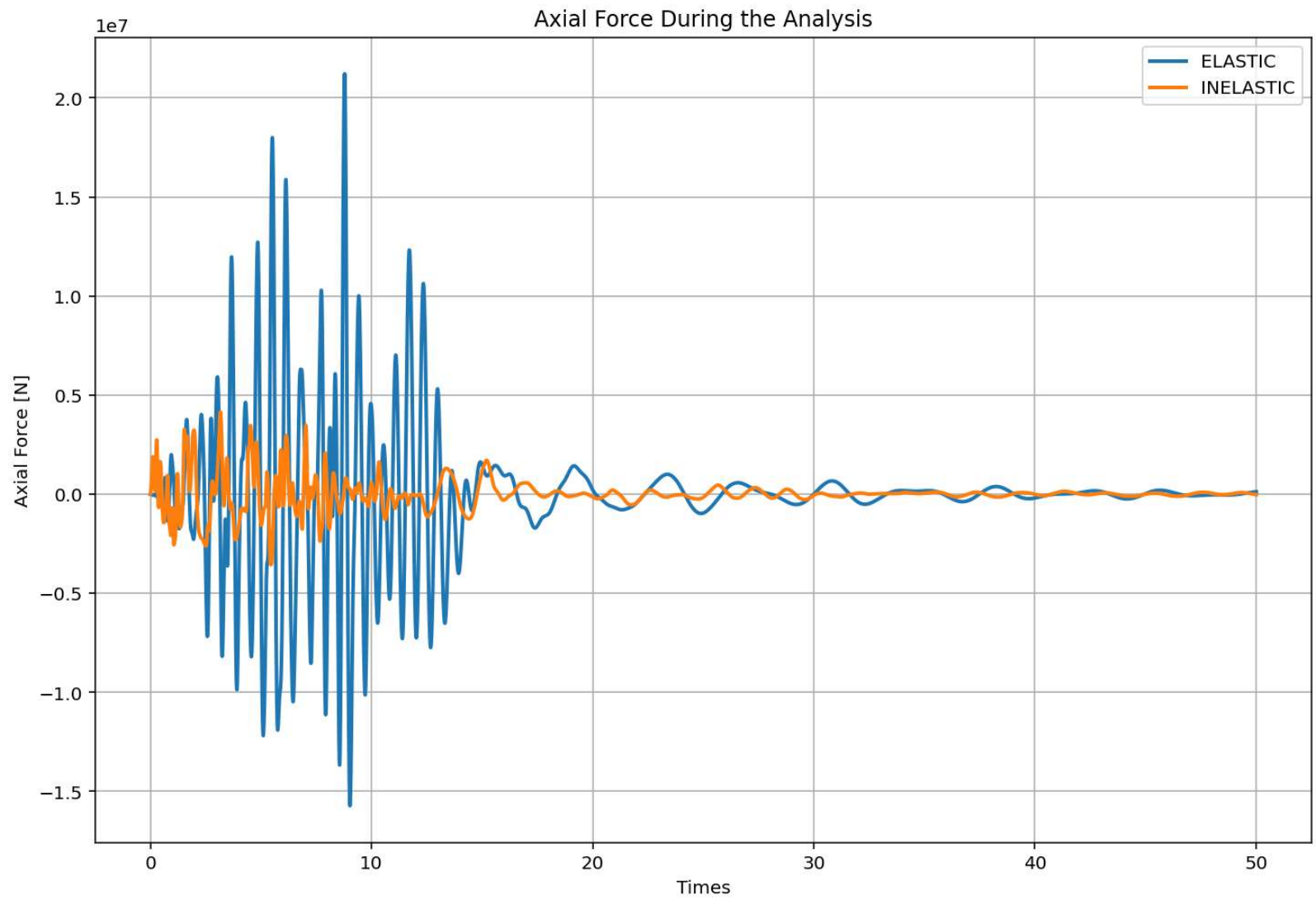


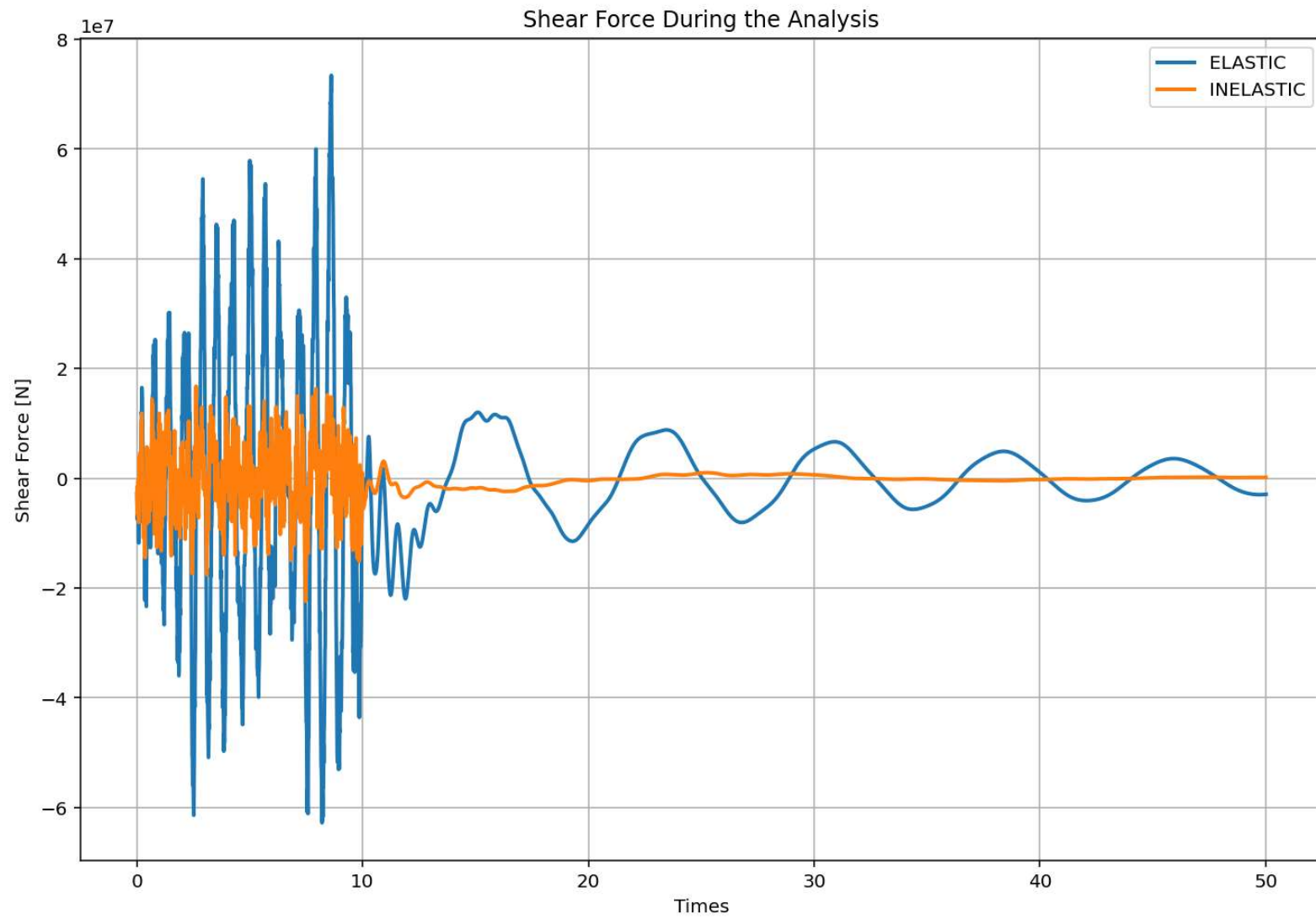


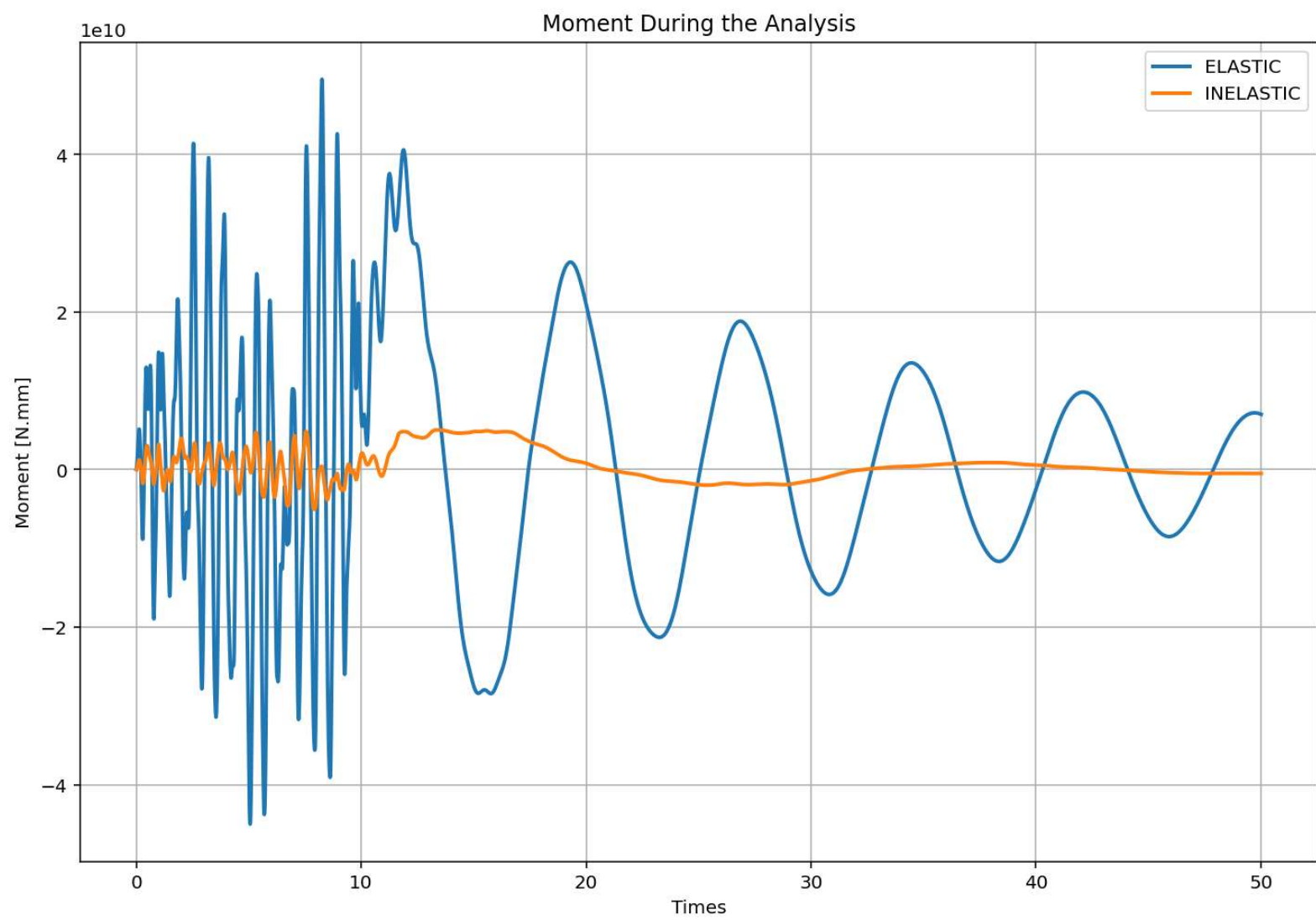


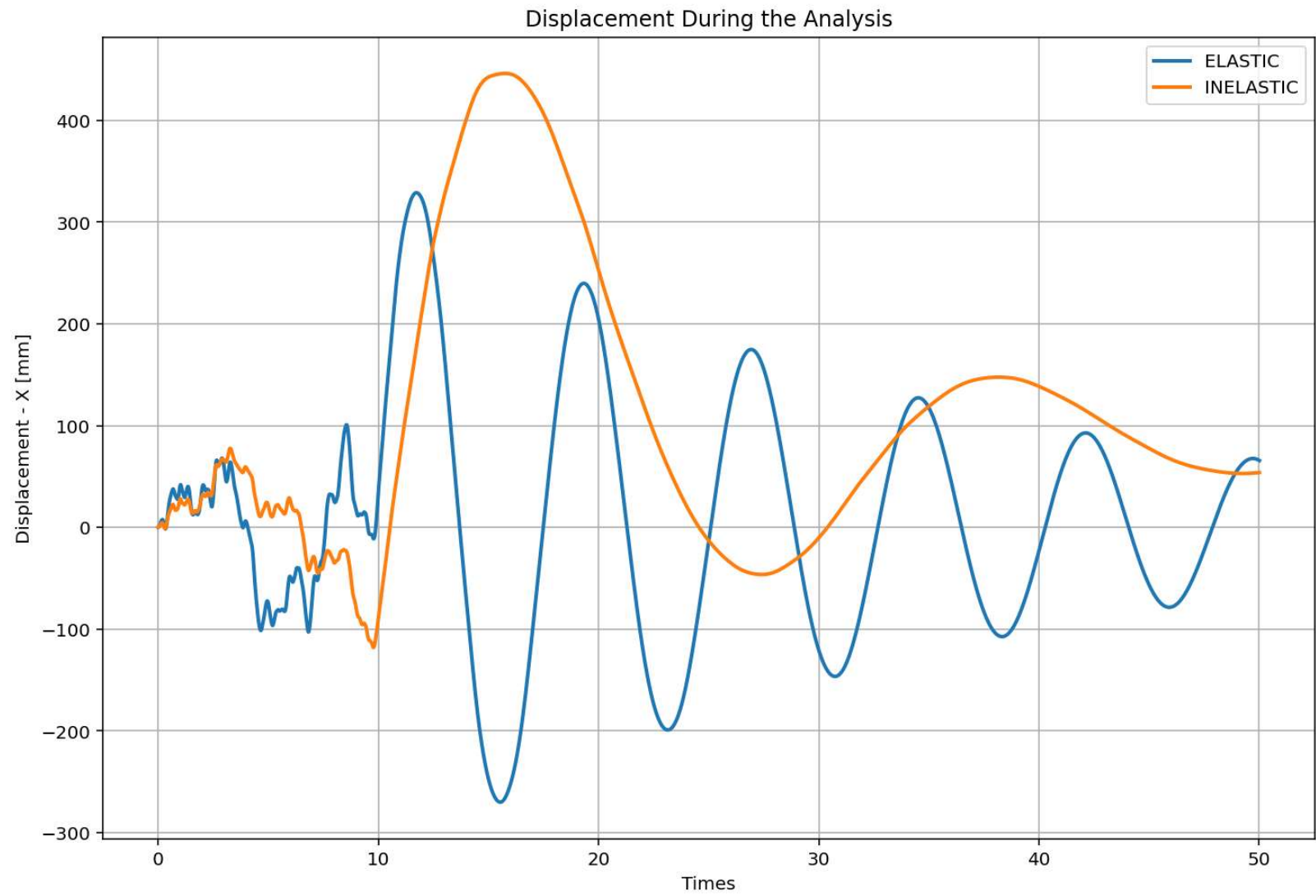


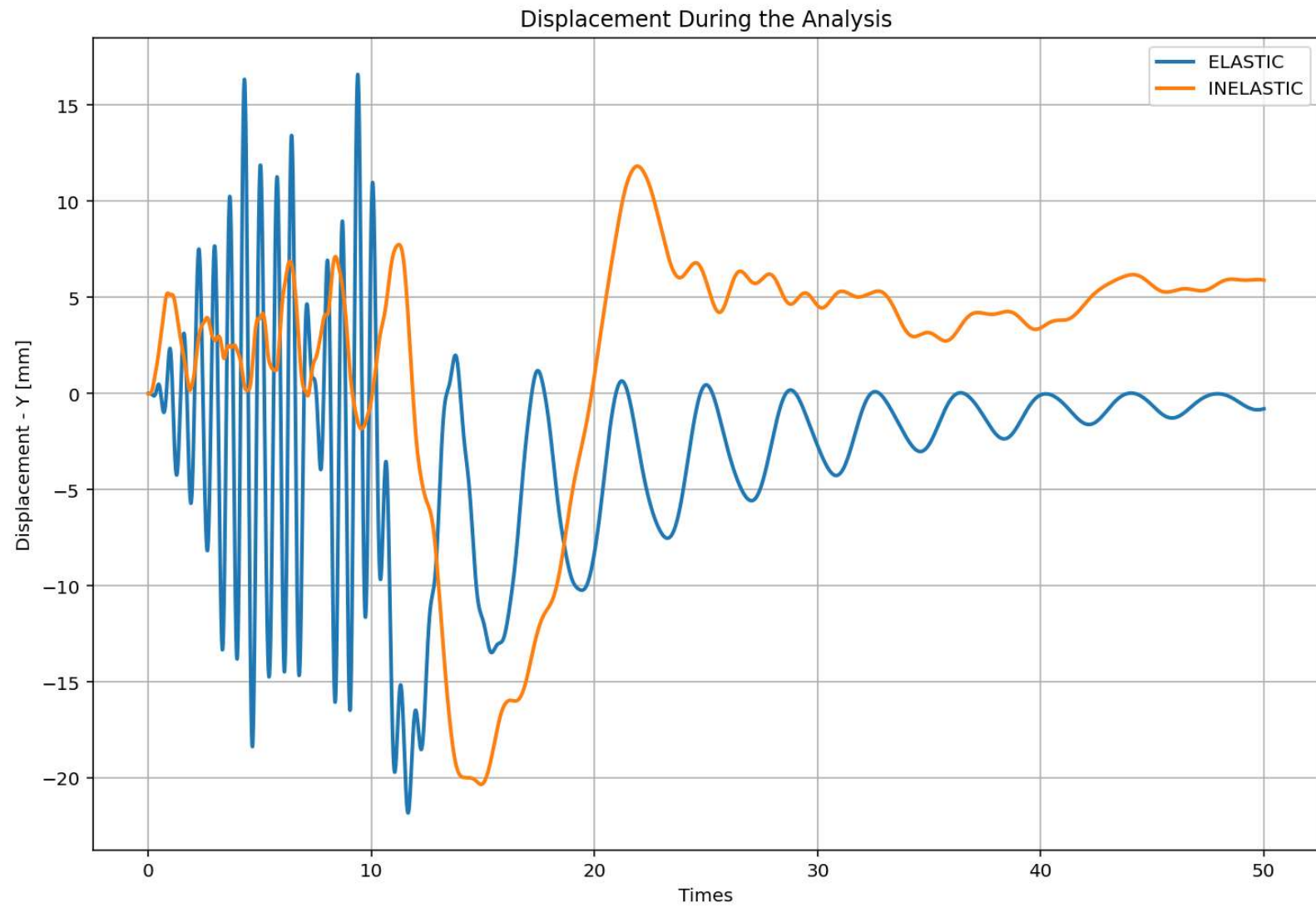


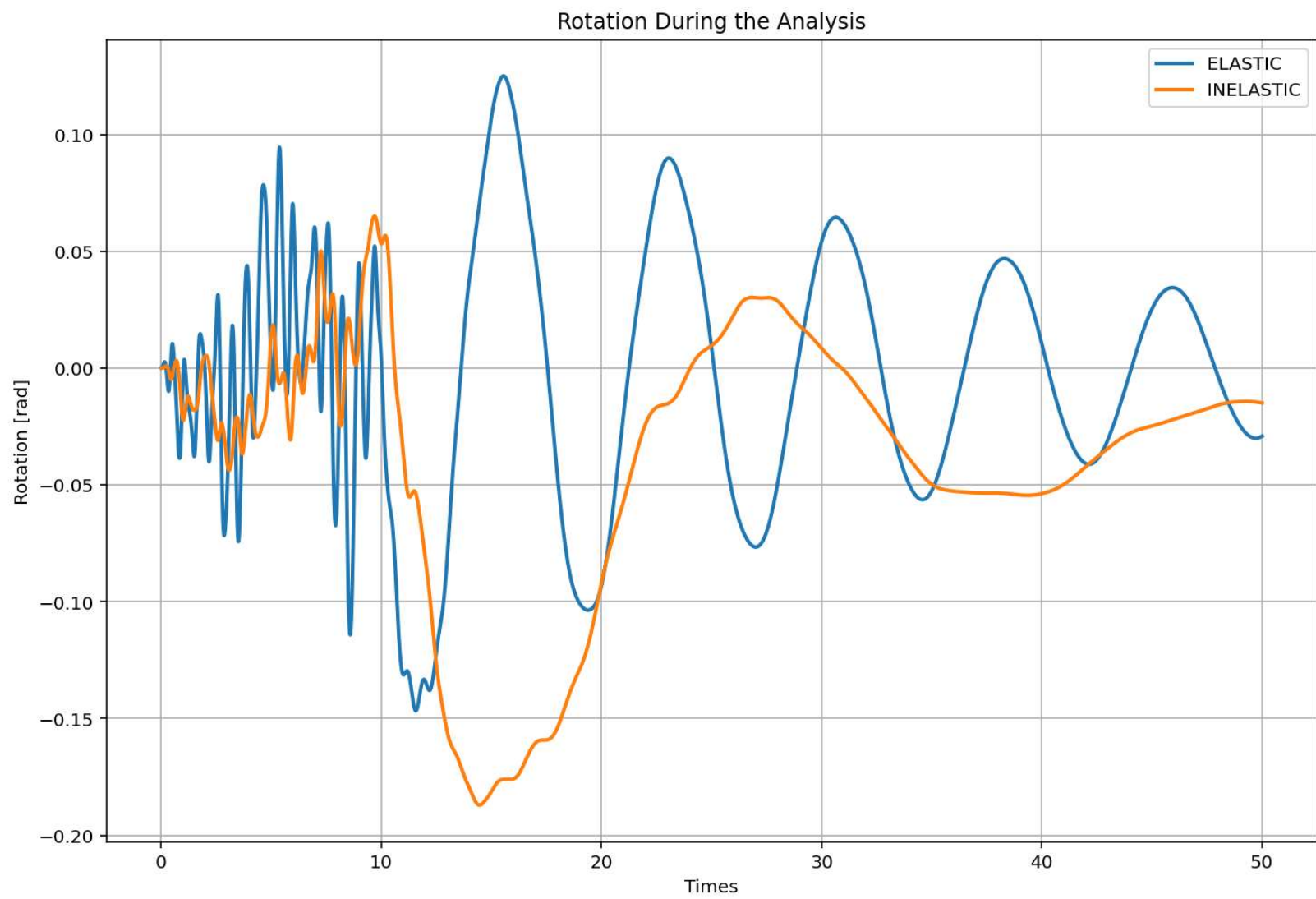


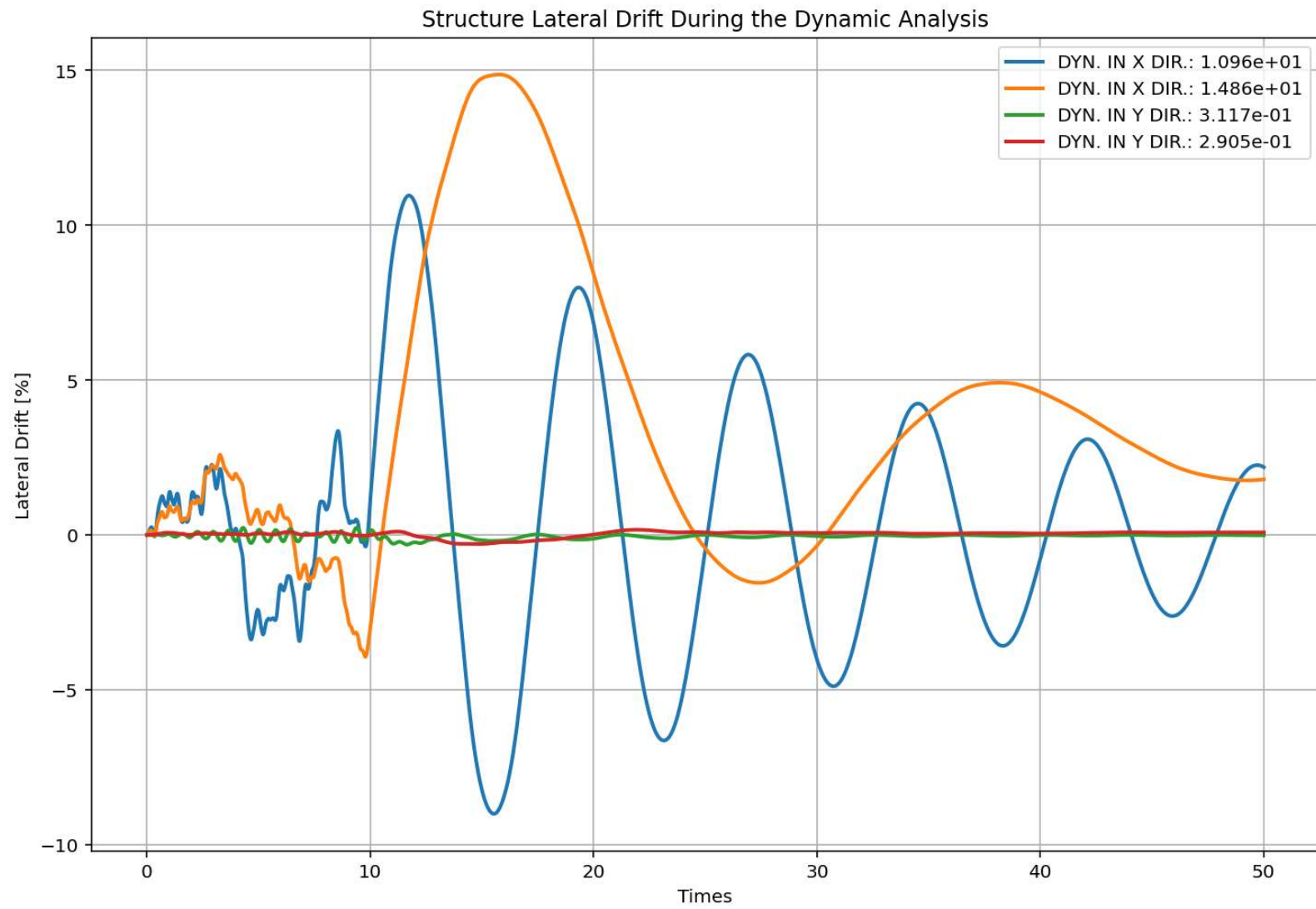




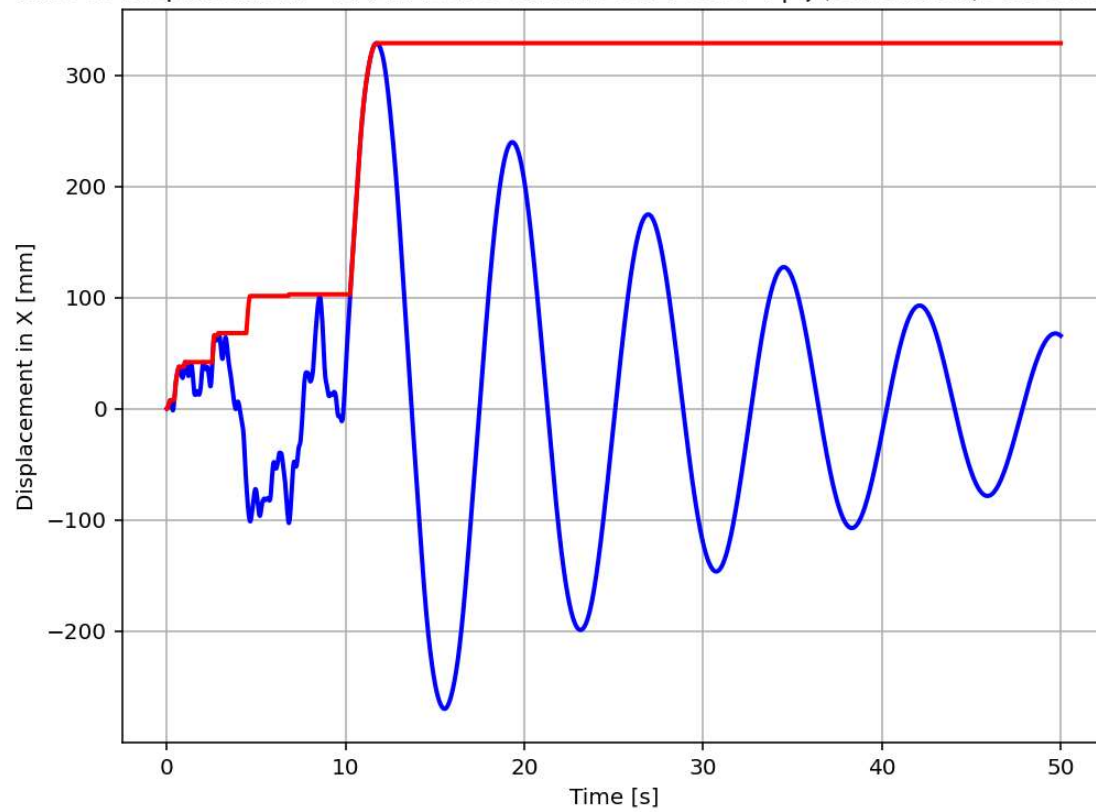




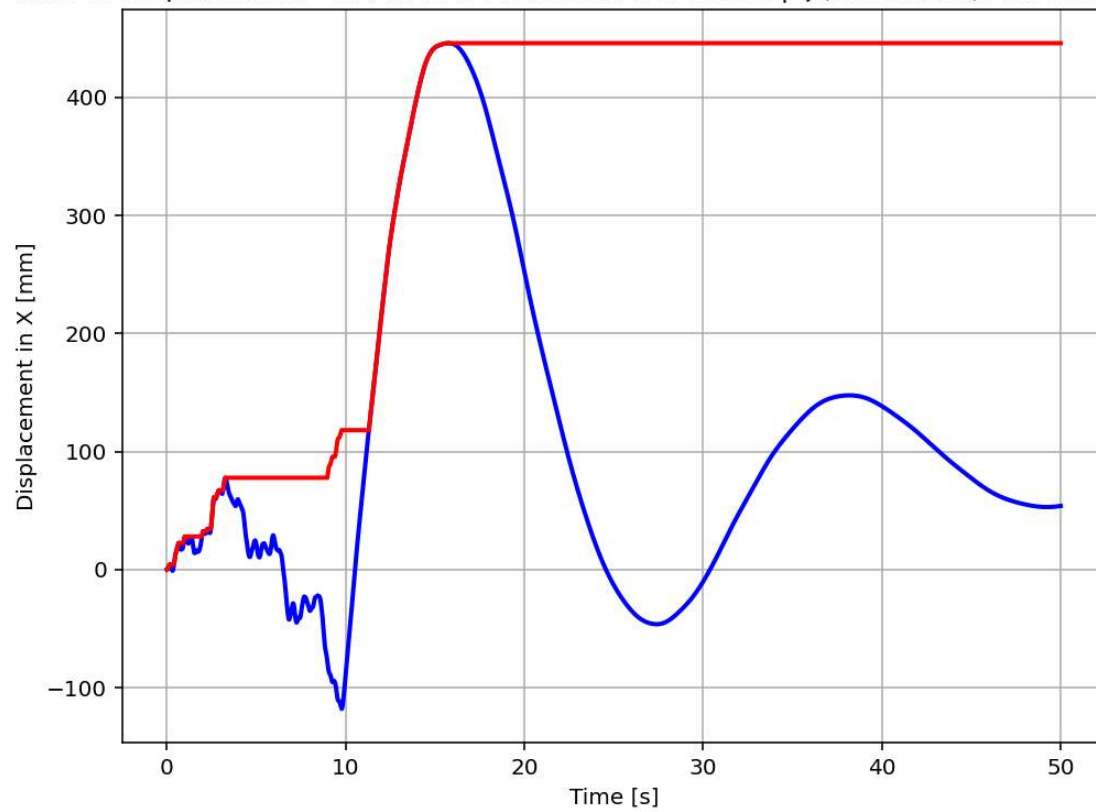




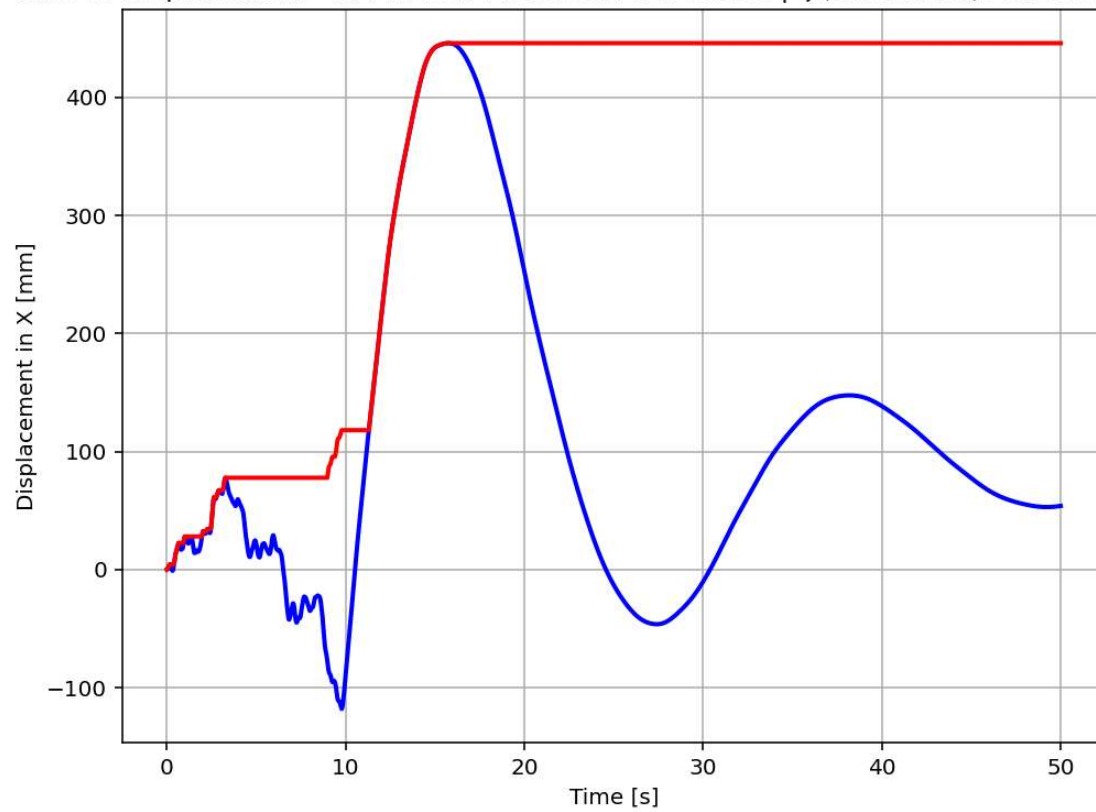
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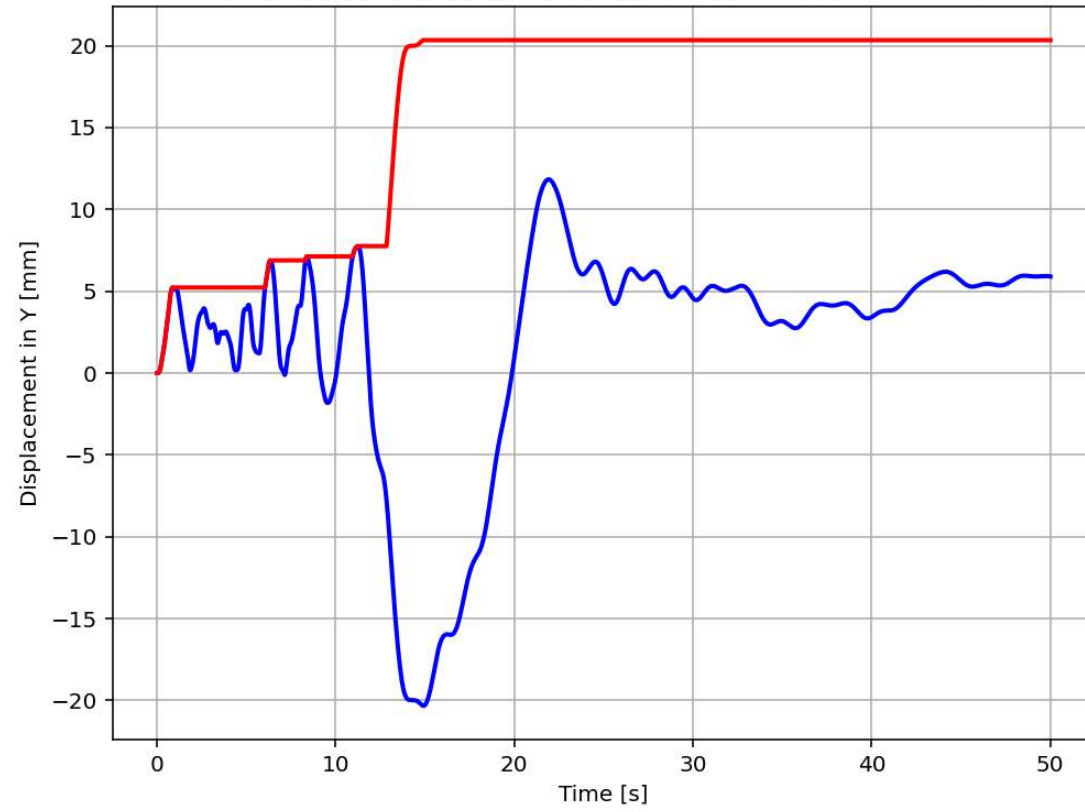
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Time vs Displacement - MAX. ABS: 445.88220200211356 | ξ (Calculated): 0.00000e+00 %



Time vs Displacement - MAX. ABS: 20.332477733093214



Time vs Velocity - MAX. ABS: 351.09246333850416

