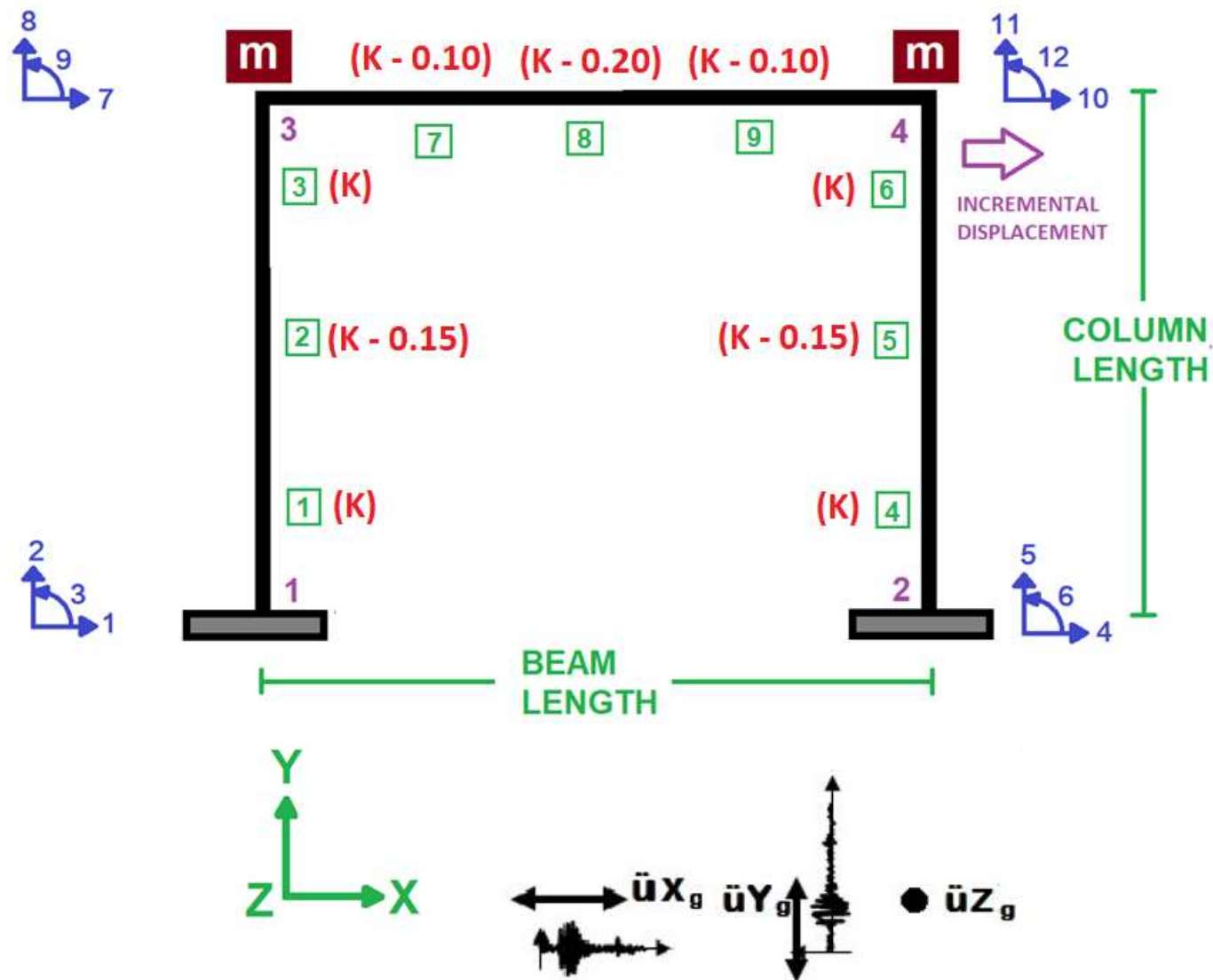
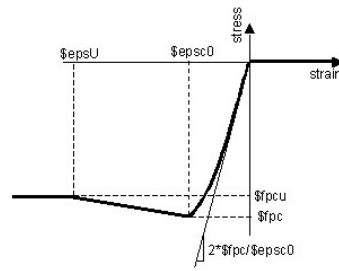


IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL

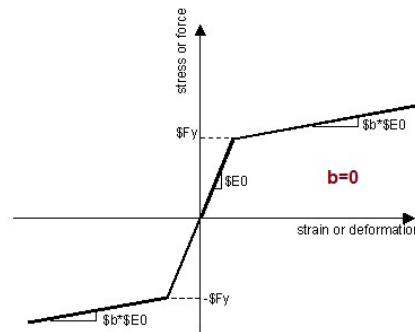
ASSESSMENTS OF THE STRUCTURAL DUCTILITY DAMAGE INDEX WITH DIFFERENT CONFINEMENT ENHANCEMENT RATIO OF CONCRETE FRAME WITH RIGID ROOF USING OPENSEES

WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)

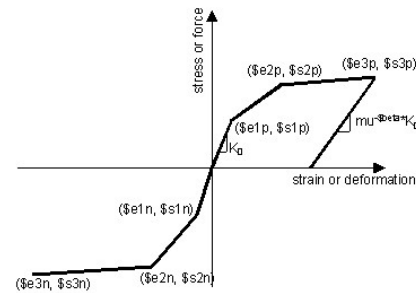




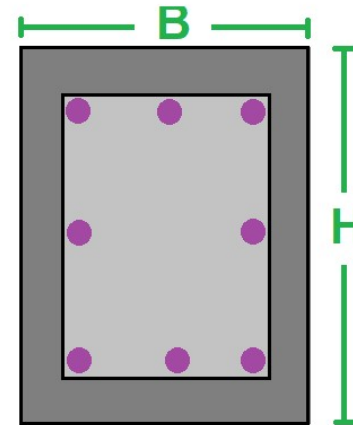
CORE AND COVER CONCRETE RELATION



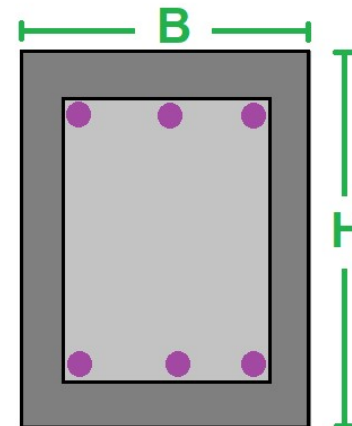
WITHOUT HARDENING AND ULTIMATE STRAIN



WITH HARDENING AND ULTIMATE STRAIN



COLUMN SECTION



BEAM SECTION

12345678910111213141516171819202122232425262728293031323334

```
#####
#                               >> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<
#                               ASSESSMENTS OF THE STRUCTURAL DUCTILITY DAMAGE INDEX WITH DIFFERENT
#                               CONFINEMENT ENHANCEMENT RATIO OF CONCRETE FRAME WITH RIGID ROOF USING OPENS
#                               -----
#                               THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)
#                               EMAIL: salar.d.ghashghaei@gmail.com
#####
'''
[1] Nonlinear Frame Modeling: 2D RC frame with distributed plasticity (fiber sections) using `no.
[2] Material Laws:
    - Concrete: `Concrete01` with confined (core) and unconfined (cover) properties.
    - Steel: `Hysteretic` model with pinching, hardening, and cyclic degradation.
[3] Seismic Loads:
    - Pushover: Displacement-controlled lateral loading to failure.
    - Dynamic: Uniform excitation with user-defined ground motions (X/Y components).
[4] Damping: Rayleigh damping (a0, a1) calibrated via eigenvalue analysis (modes 1-2).
[5] Performance Metrics:
    - Ductility Ratio (μ): Derived from bilinearized pushover curves.
    - Overstrength (Qo): Yield vs. ultimate capacity.
    - Damage Index (DI): Normalized displacement demand/capacity.
[6] Advanced Solver: HHT-α integrator (unconditionally stable) with Newton-Raphson iterations.
[7] Outputs:
    - Hysteretic responses (P-M, V-Δ, M-θ).
    - Time-history plots (displacement, base shear).
    - Stiffness degradation tracking.
[8] Validation: Logarithmic decrement method for damping ratio verification.
[9] Ductility Damage Index (DDI) Implementation:
    DDI quantifies structural damage via normalized displacement demand.
    # After bilinear fit (X[1] = Δy, X[2] = Δu):
    Dd = max(abs(DISPL_Xd)) # Max dynamic displacement demand
    DI = (Dd - Dy) / (Du - Dy) # Ductility Damage Index (X-dir)
    DI ≈ 0: Elastic response (no damage).
    DI ≥ 1: Collapse (demand ≥ ultimate capacity).
```

File Edit Search Source Run Debug Consoles Projects Tools View Help

32 %

Time vs Displacement - MAX. ABS: 24.133253591970615 | ξ (Calculated): 0.00000e+00 %

Help Variable Explorer Debugger Plots Files

Console 1/A

Lobatto
End 1 Forces (P V M): -13803 24877.5 1.17319e+07
End 2 Forces (P V M): 13803 -24877.5 1.31456e+07

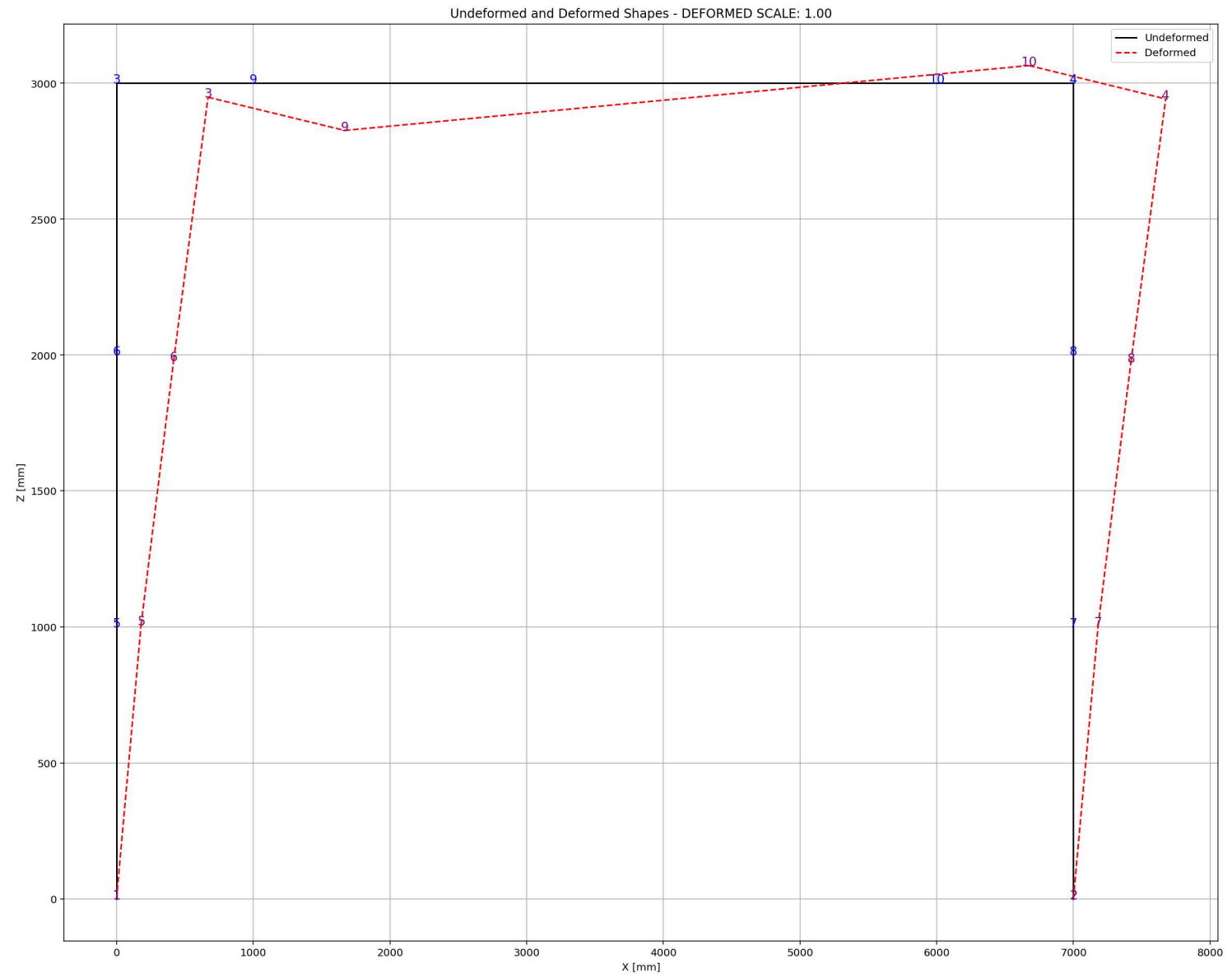
Element: 3 Type: ForceBeamColumn2d Connected Nodes: 6 3
Number of Sections: 10 Mass density: 6.25
Lobatto
End 1 Forces (P V M): -12629.2 22844.1 -1.31448e+07
End 2 Forces (P V M): 12629.2 -22844.1 3.59889e+07

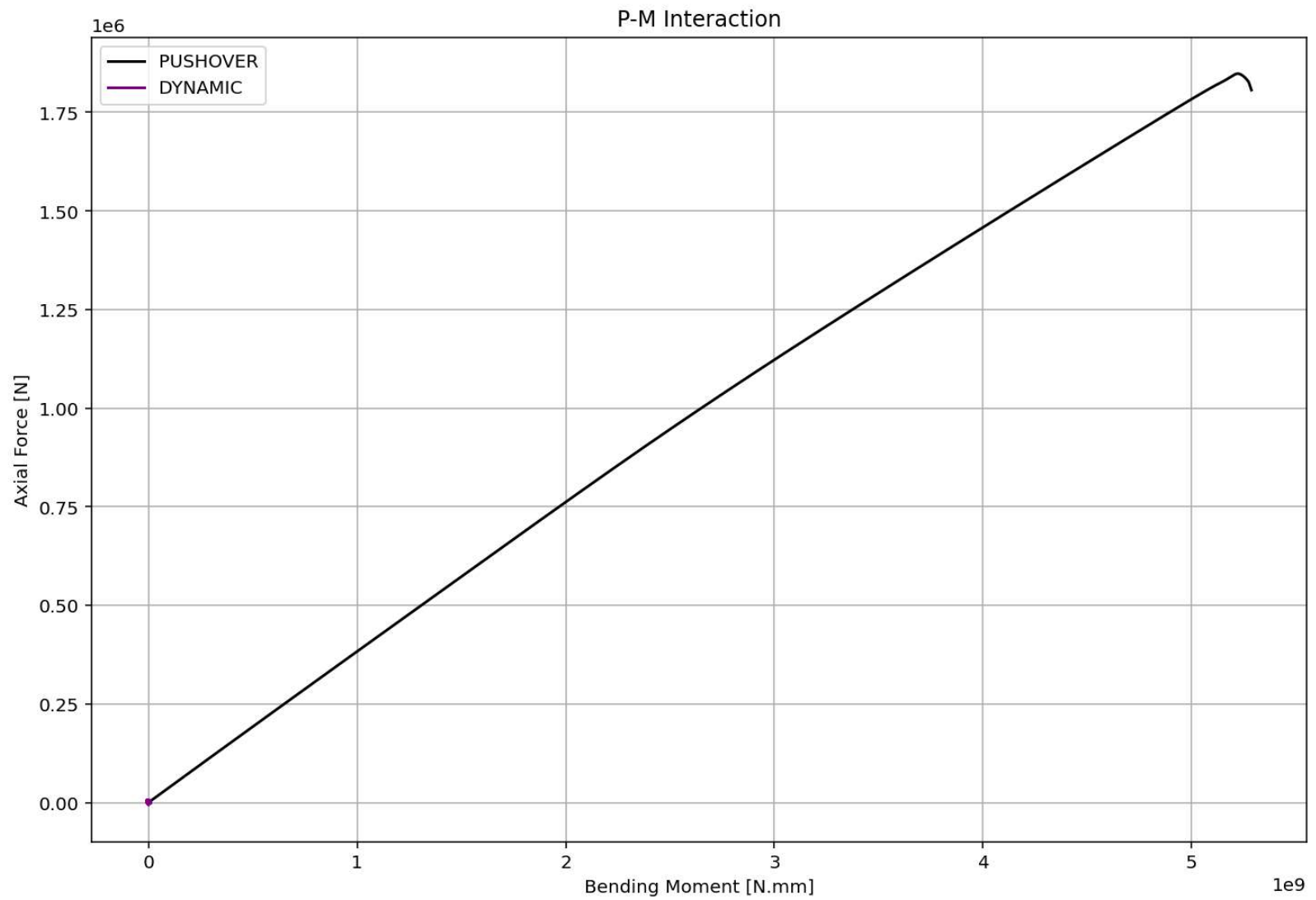
In [2]:

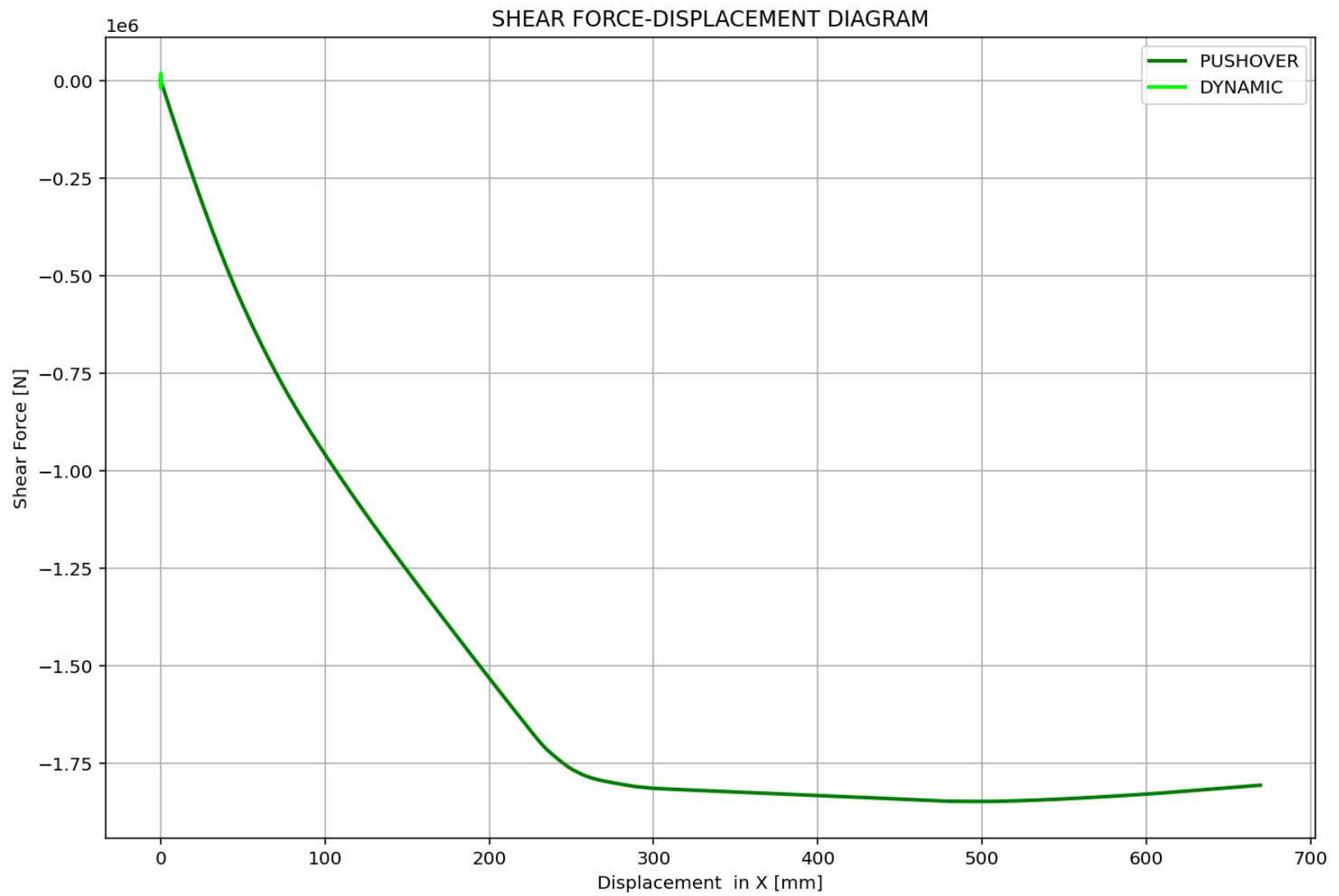
IPython Console History

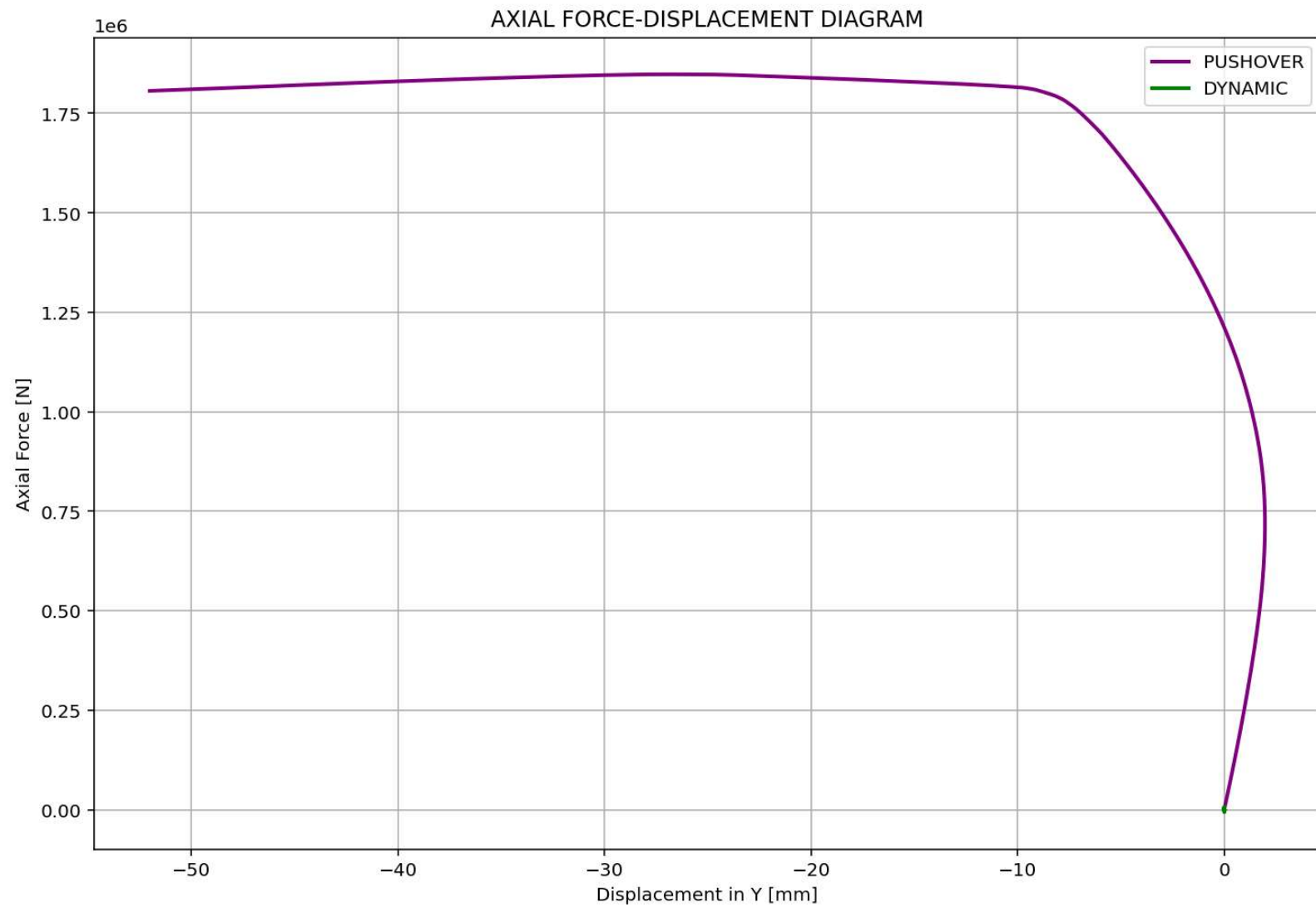
Inline Conda: anaconda3 (Python 3.12.7) LSP: Python Line 4, Col 117 UTF-8 CRLF RW Mem 32%

NONLINEAR STATIC ANALYSIS (PUSHOVER)

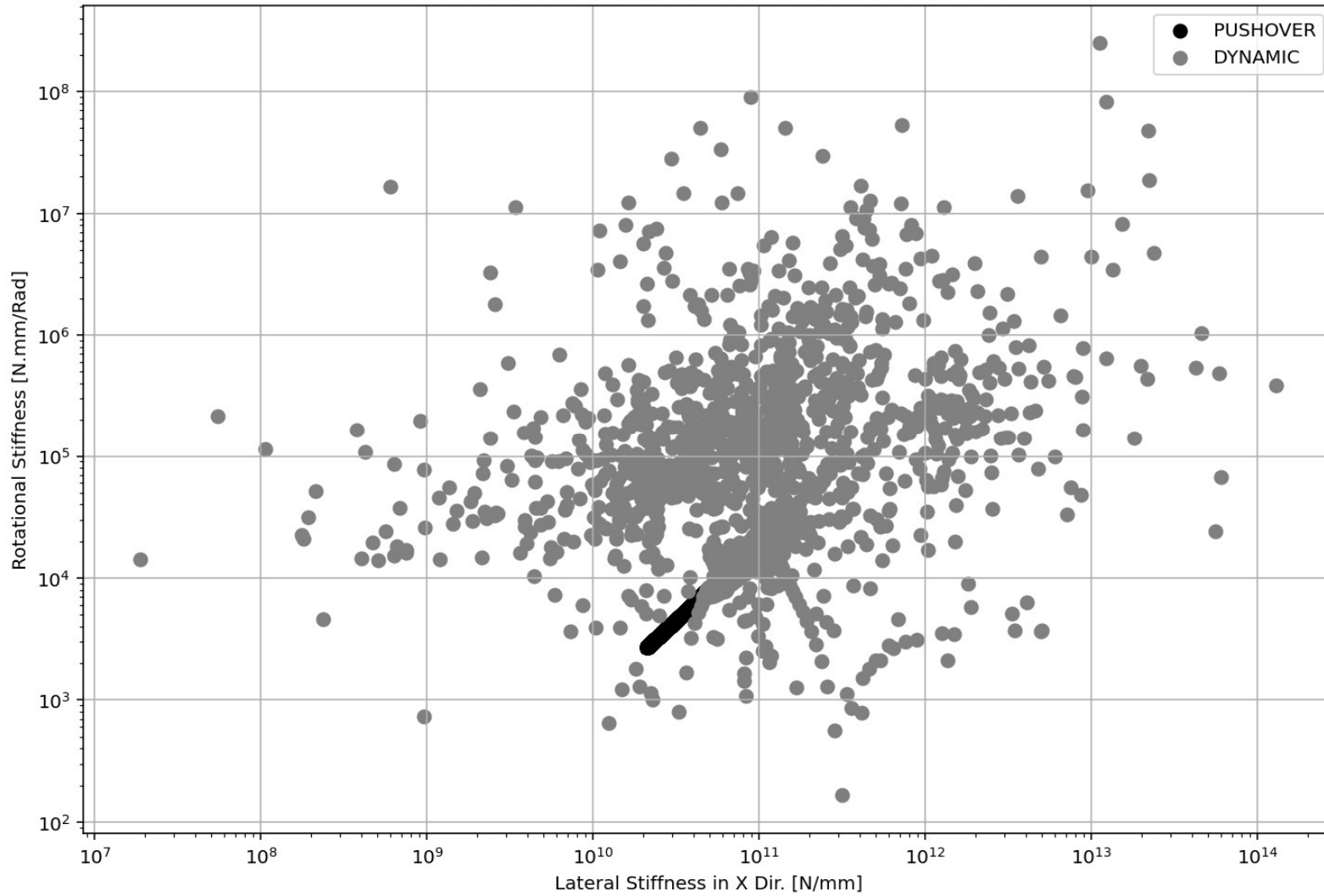




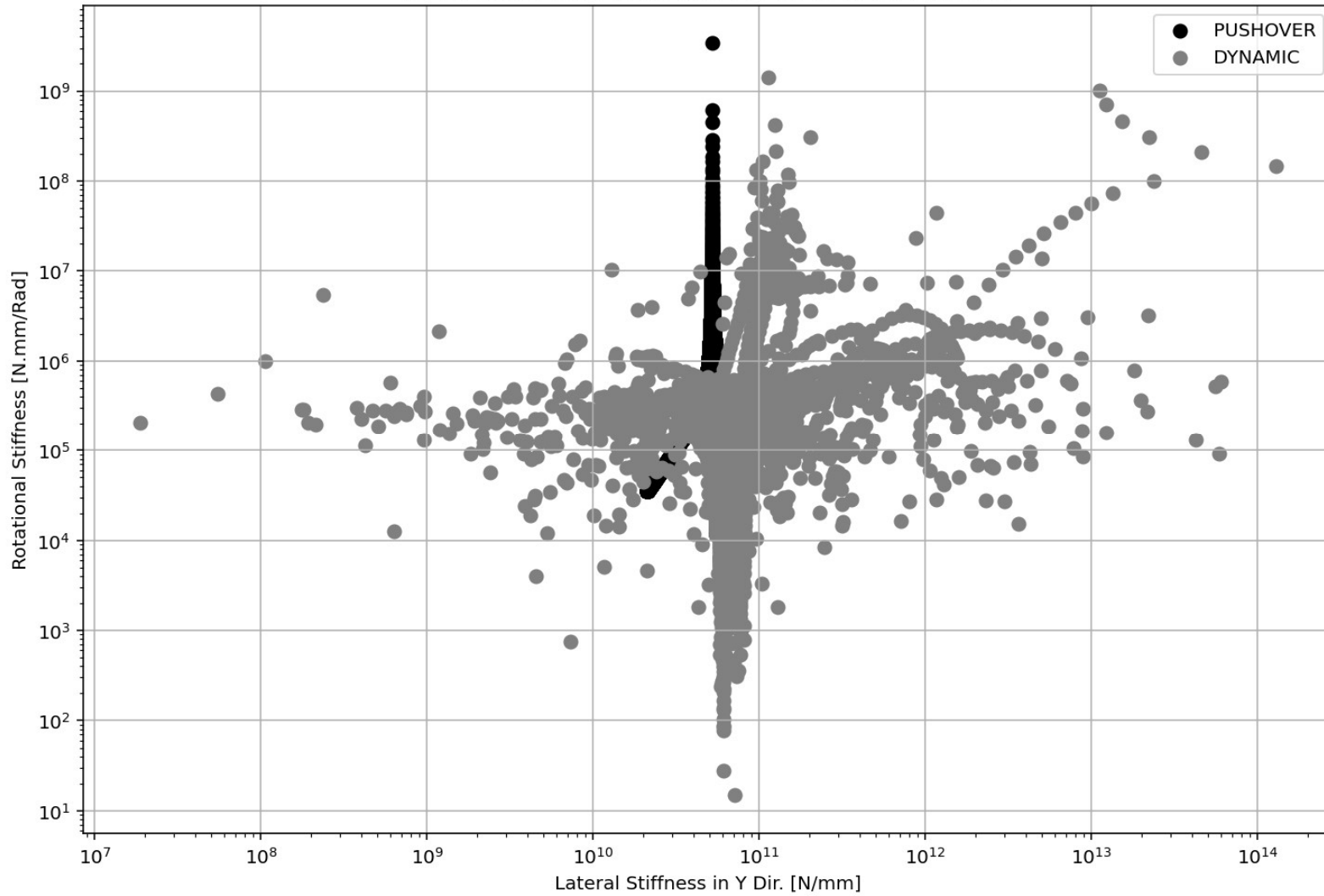


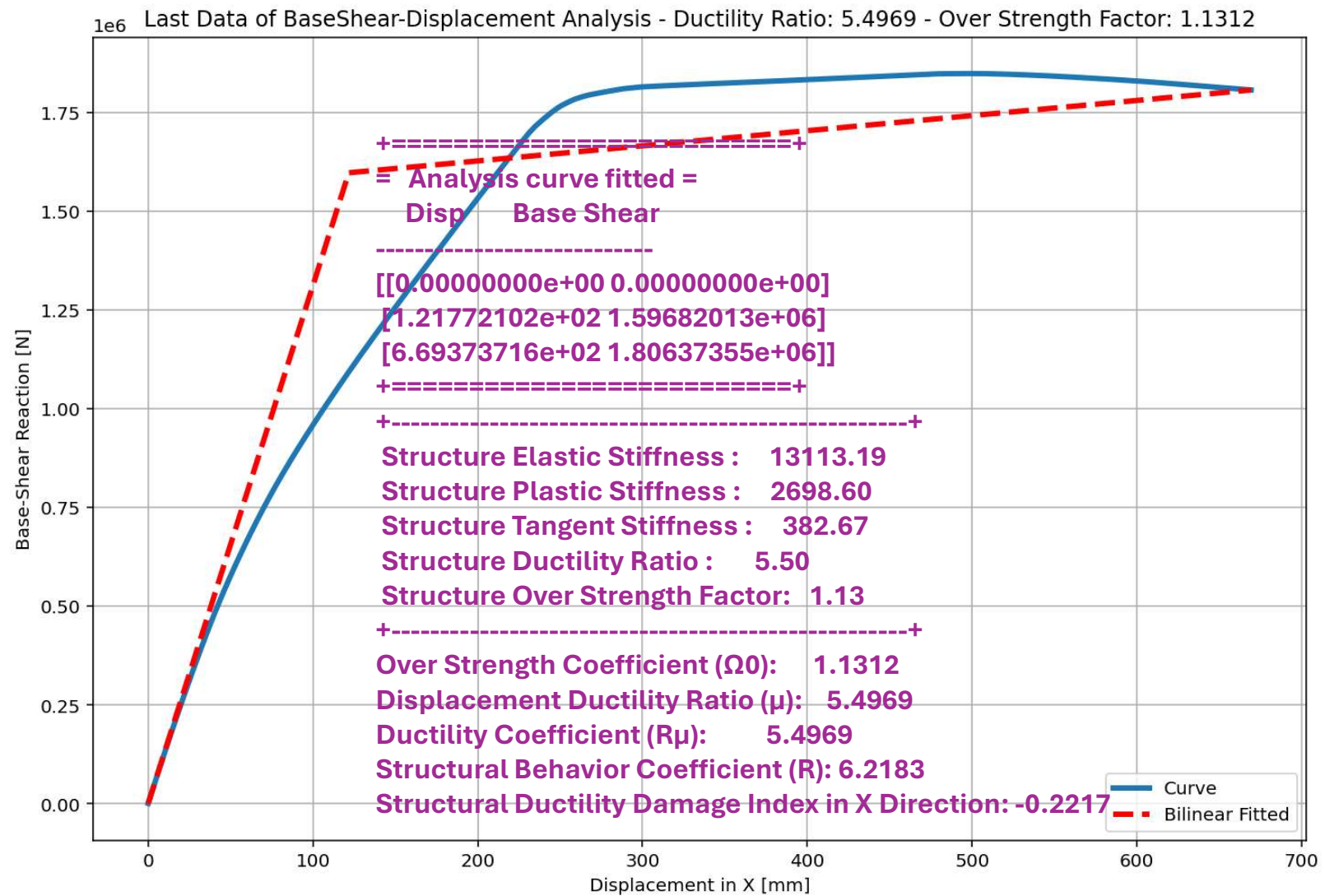


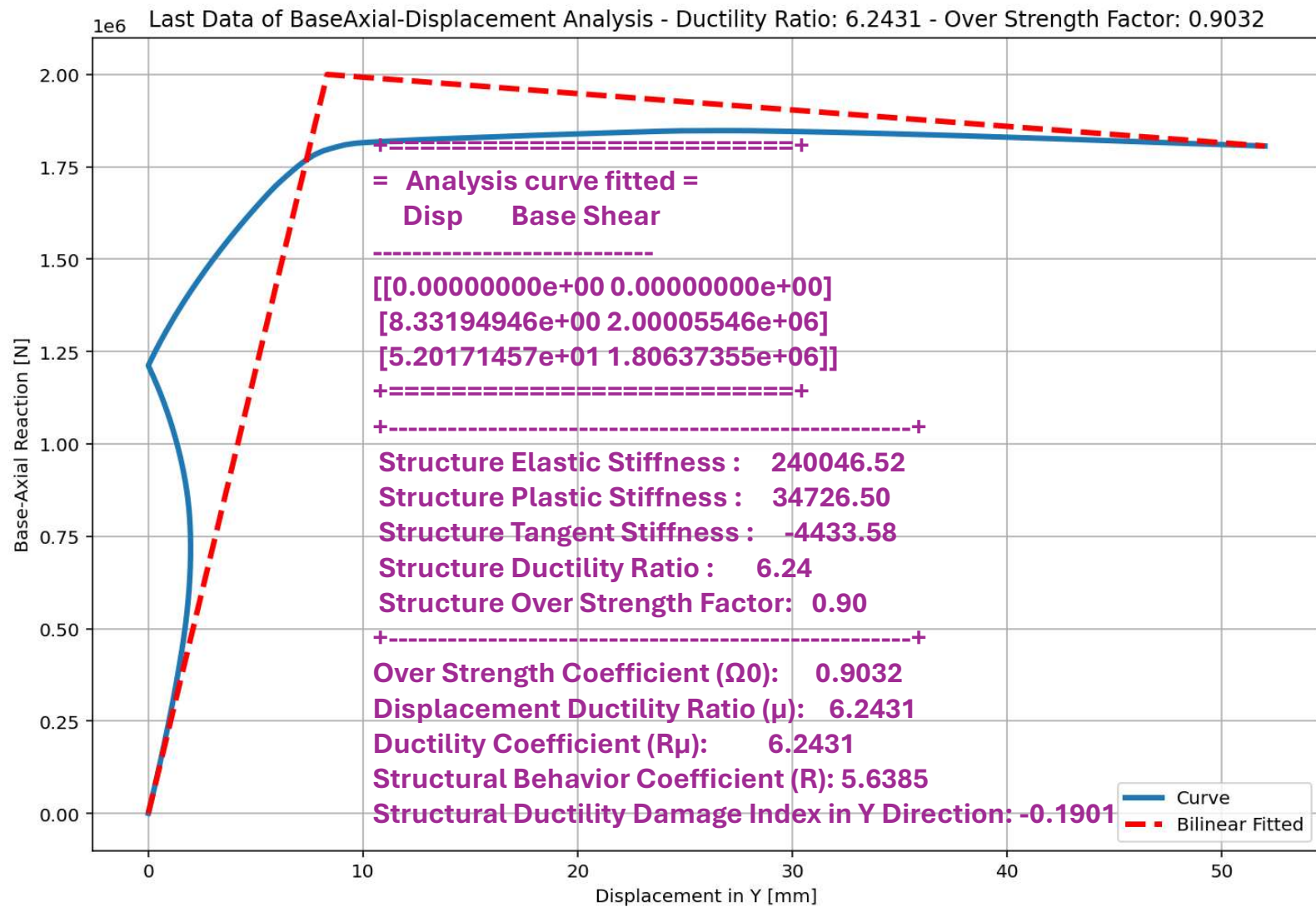
ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM



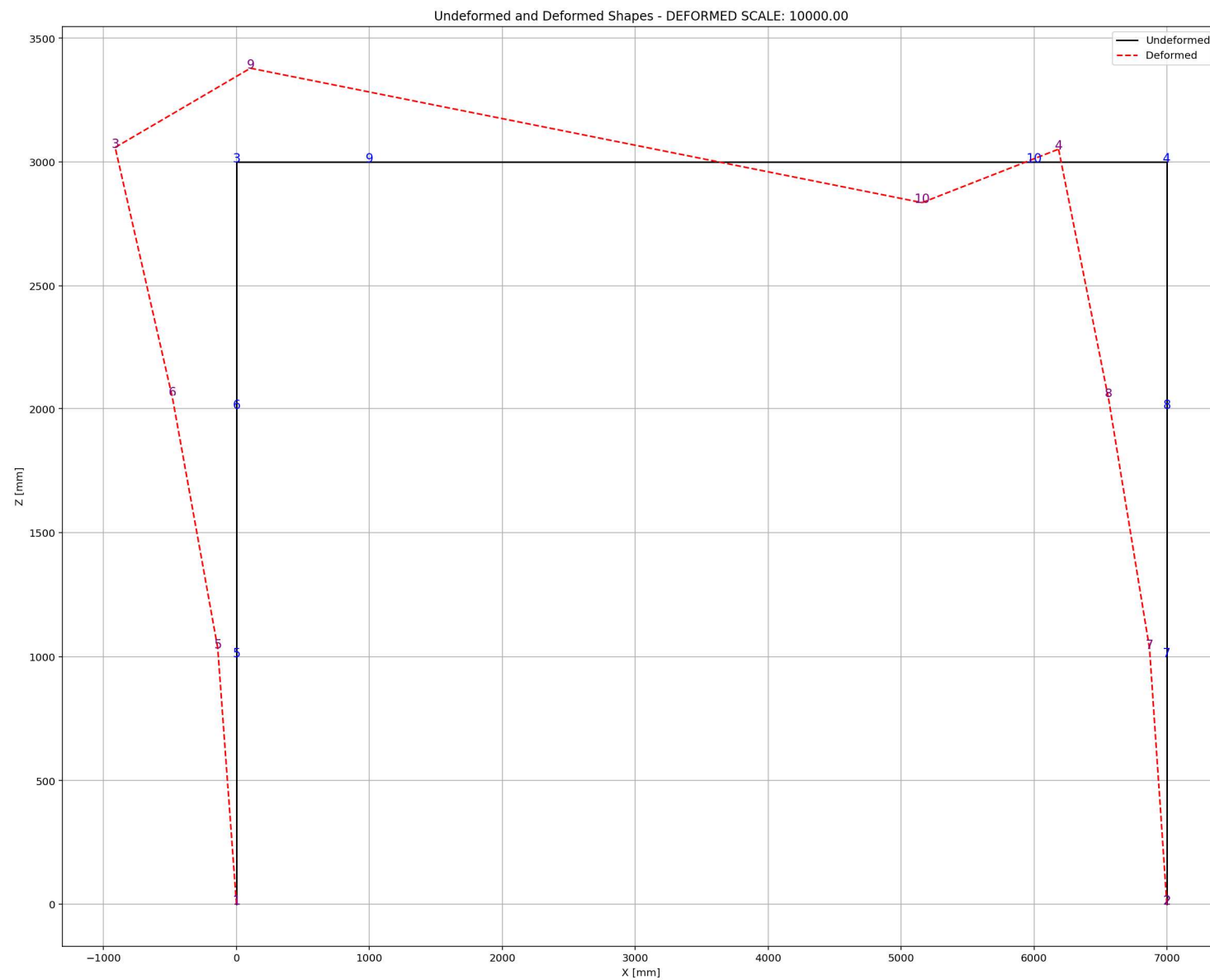
ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM



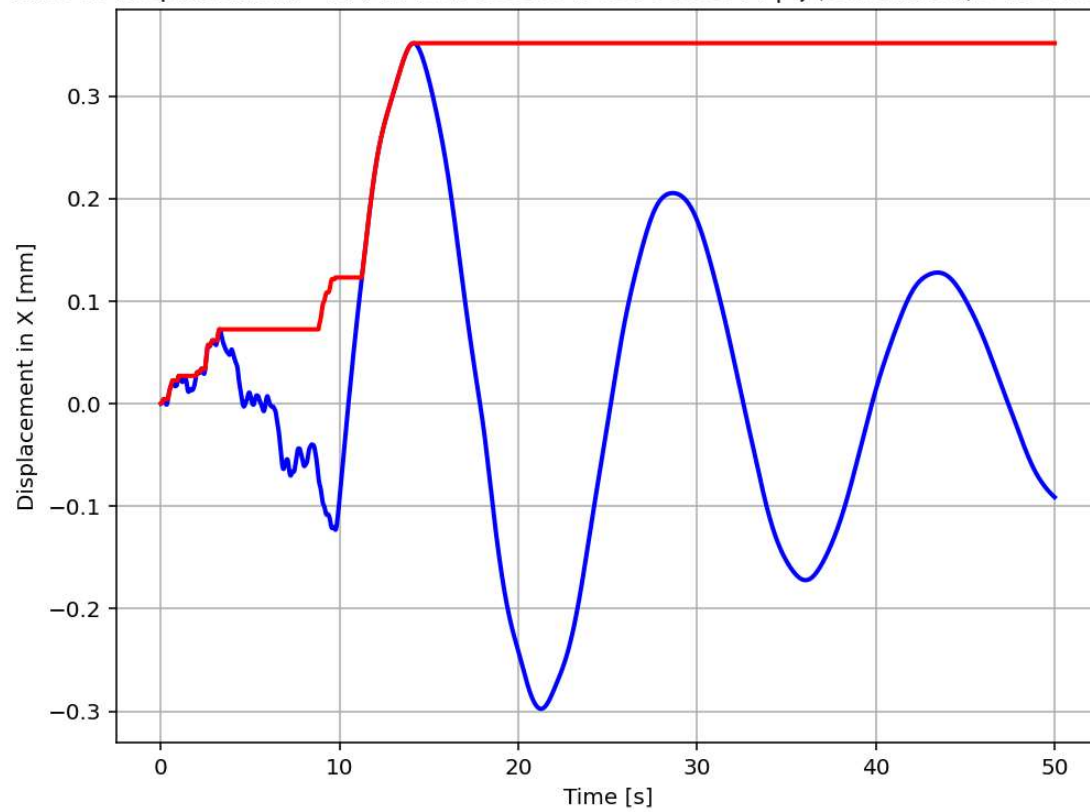




NONLINEAR DYNAMIC ANALYSIS



Time vs Displacement - MAX. ABS: 0.3516474868005344 | ξ (Calculated): 1.00000e+02 %



Time vs Displacement - MAX. ABS: 0.025528740750356632

