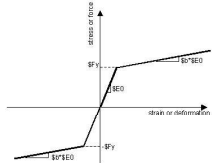
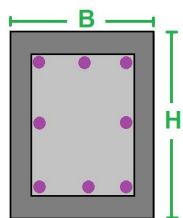


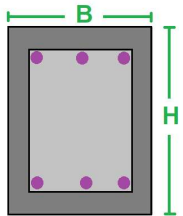
Concrete02 Thermal Material - Linear Tension Softening



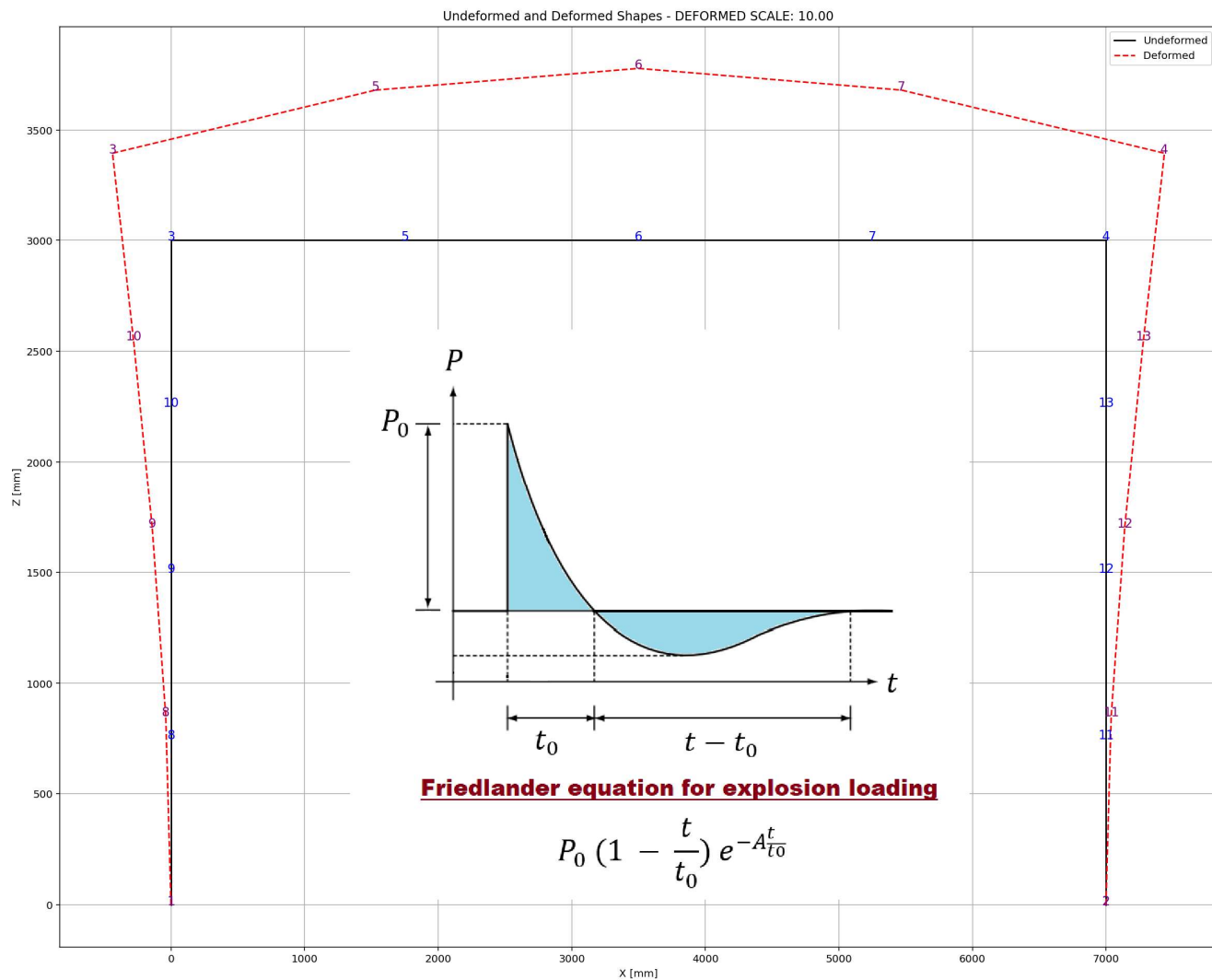
Steel01 Thermal Material



COLUMN SECTION



BEAM SECTION



IN THE NAME OF ALLAH

**SEQUENTIAL EXPLOSION IMPACT AND THERMAL LOAD ANALYSIS
OF A CONCRETE FRAME USING OPENSEES.
THERMAL LOAD APPLIED THERMAL LOAD ON ALL ELEMENTS**

WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)

C:\Users\Dell\Desktop\OPENSEES_FILES\CONCRETE_FRAME_EXAMPLES\EXPLOSION_IMPACT_LOAD-THERMAL_LOAD-THERMAL_LOAD.py

CONCRETE_FRAME_EXP...AD-THERMAL_LOAD.py X

```

1 #####
2 #                               IN THE NAME OF ALLAH
3 #   SEQUENTIAL EXPLOSION IMPACT AND THERMAL LOAD ANALYSIS OF A CONCRETE FRAME USING OPENSEES.
4 #   THERMAL LOAD APPLIED THERMAL LOAD ON ALL ELEMENTS
5 #-----
6 #   THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEE (QASHQAI)
7 #   EMAIL: salar.d.ghashghaei@gmail.com
8 #####
9
10 """
11 Explosion Impact and Thermo-Mechanical Analysis of Reinforced Concrete Frames Using OpenSees
12
13 This computational framework performs coupled nonlinear analyses of 2D RC frames subjected to:
14 - Transient explosion loading (Friedlander wave equation)
15 - Steady-state thermal gradients
16 - Distributed mechanical loads
17
18 Key Analysis Components:
19
20 [1] Material Modeling:
21 - Concrete02Thermal material for temperature-dependent concrete behavior (Eurocode 2 compliant)
22 - Steel01Thermal for reinforcing steel with thermal effects
23 - Distinct confined/unconfined concrete material models
24 - Fiber section discretization for nonlinear section response
25
26 [2] Structural Configuration:
27 - Multi-element 2D frame with refined mesh (quarter-point nodes)
28 - Corotational geometric transformation for large displacements
29 - Lobatto integration for accurate section response
30 - Fixed base boundary conditions
31
32 [3] Loading Protocols:
33 - Dynamic explosion loading via Friedlander equation (P0, t0, A parameters)
34 - Thermal gradients across section depth (beam/column specific)

```



Help Variable Explorer Debugger Plots Files

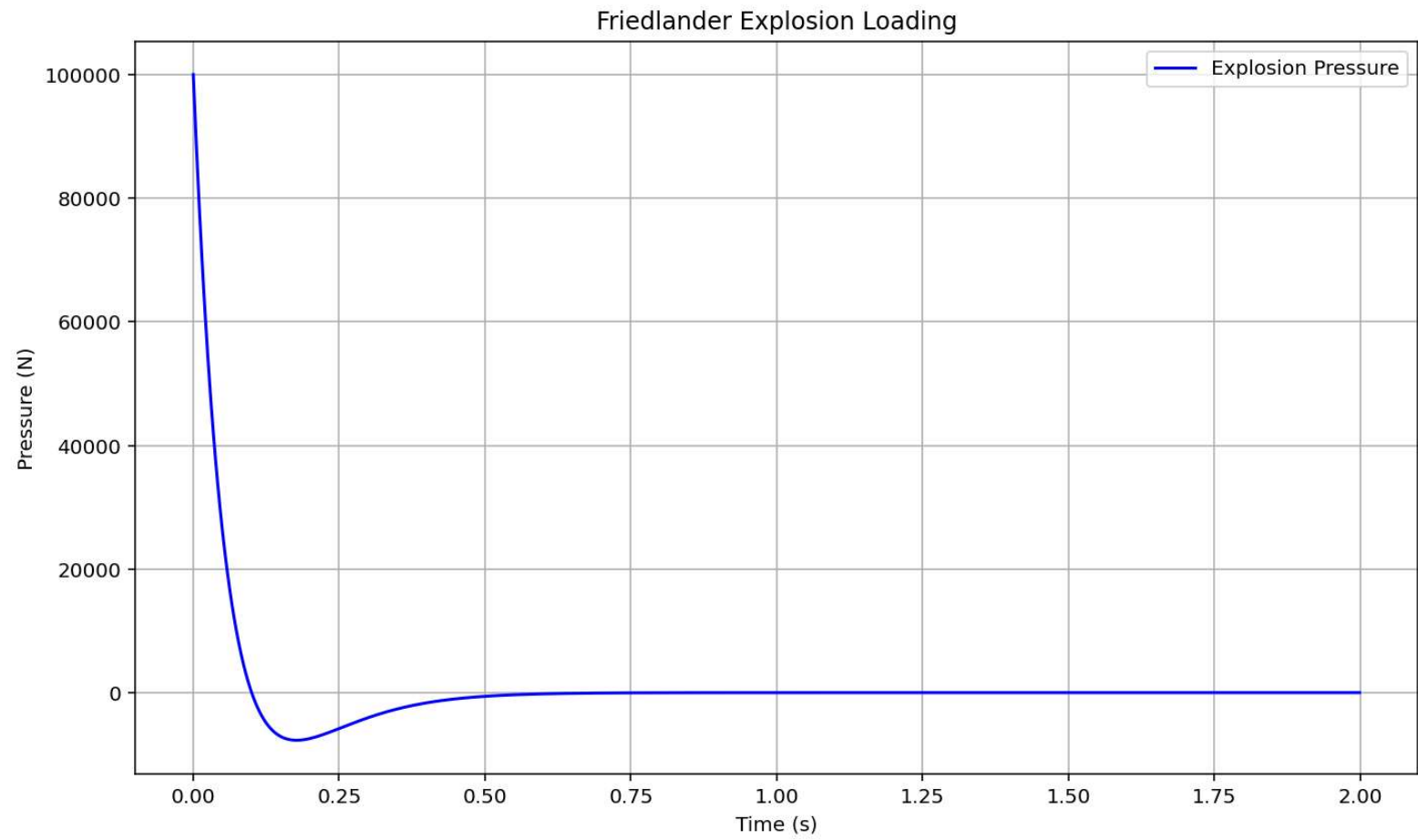
Console 1/A X

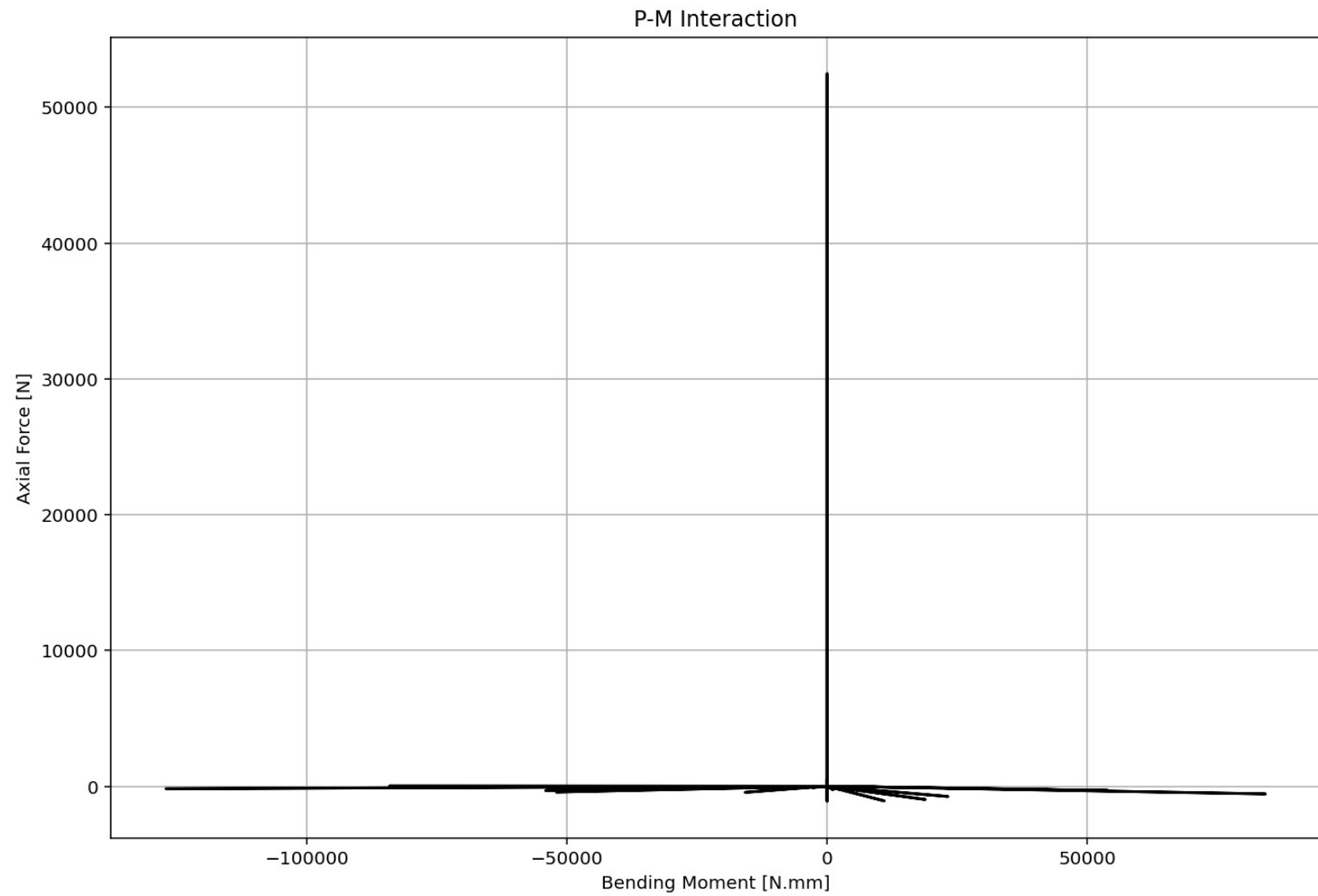
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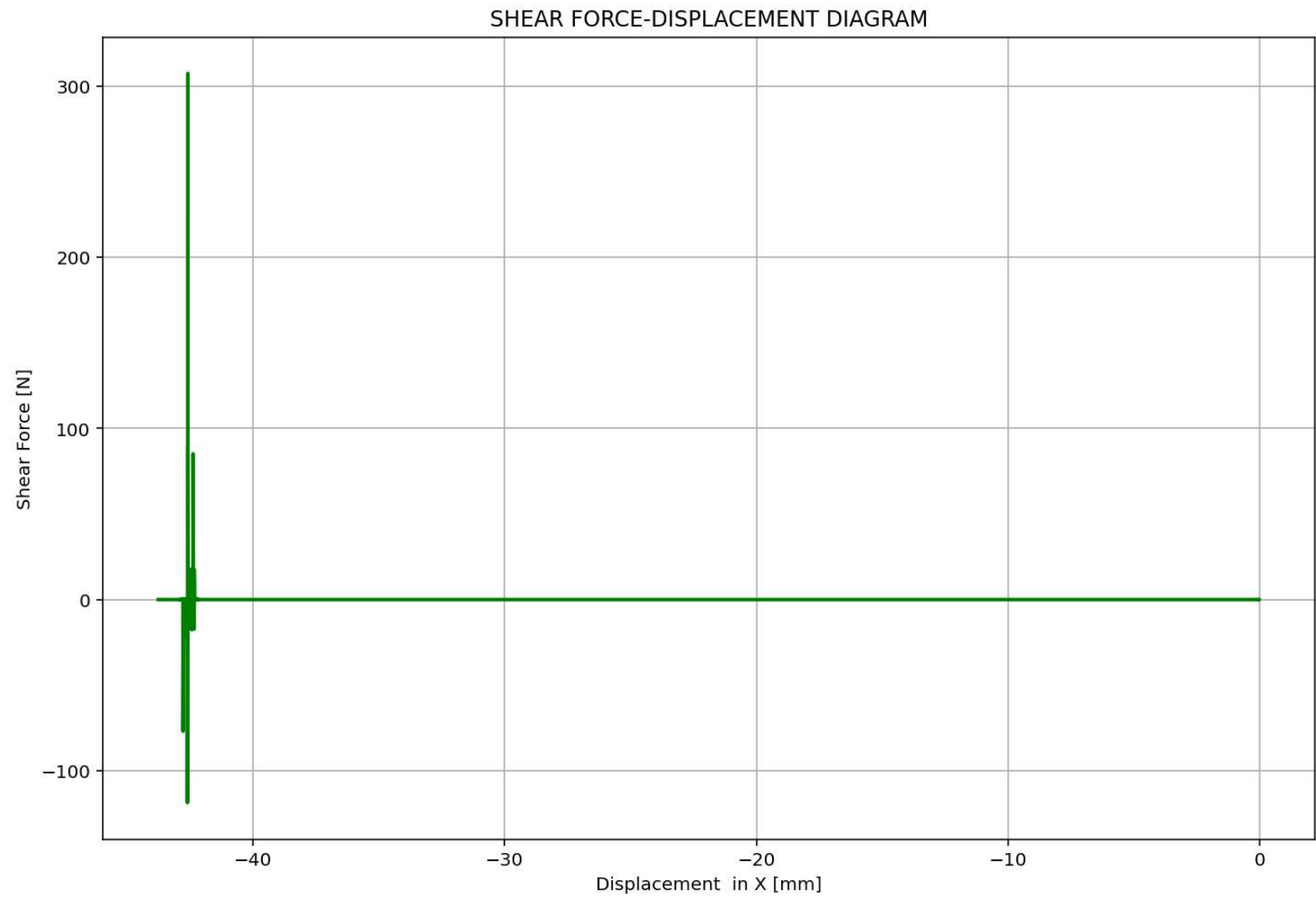
improvement from the last ten iterations.
solution = fsolve(EQUATION, x0, args=(delta))
C:
\Users\Dell\Desktop\OPENSEES_FILES\CONCRETE_FRAME_EXAMPLES\EXPLOSION_IMPACT_LOAD-THERMAL_LOAD\EXPLOSION_IMPACT_LOAD-THERMAL_LOAD\
PLOT_2D.py:43: UserWarning: Legend does not support handles for Text instances.
See: https://matplotlib.org/stable/tutorials/intermediate/legend_guide.html#implementing-a-custom-legend-handler
ax.legend()

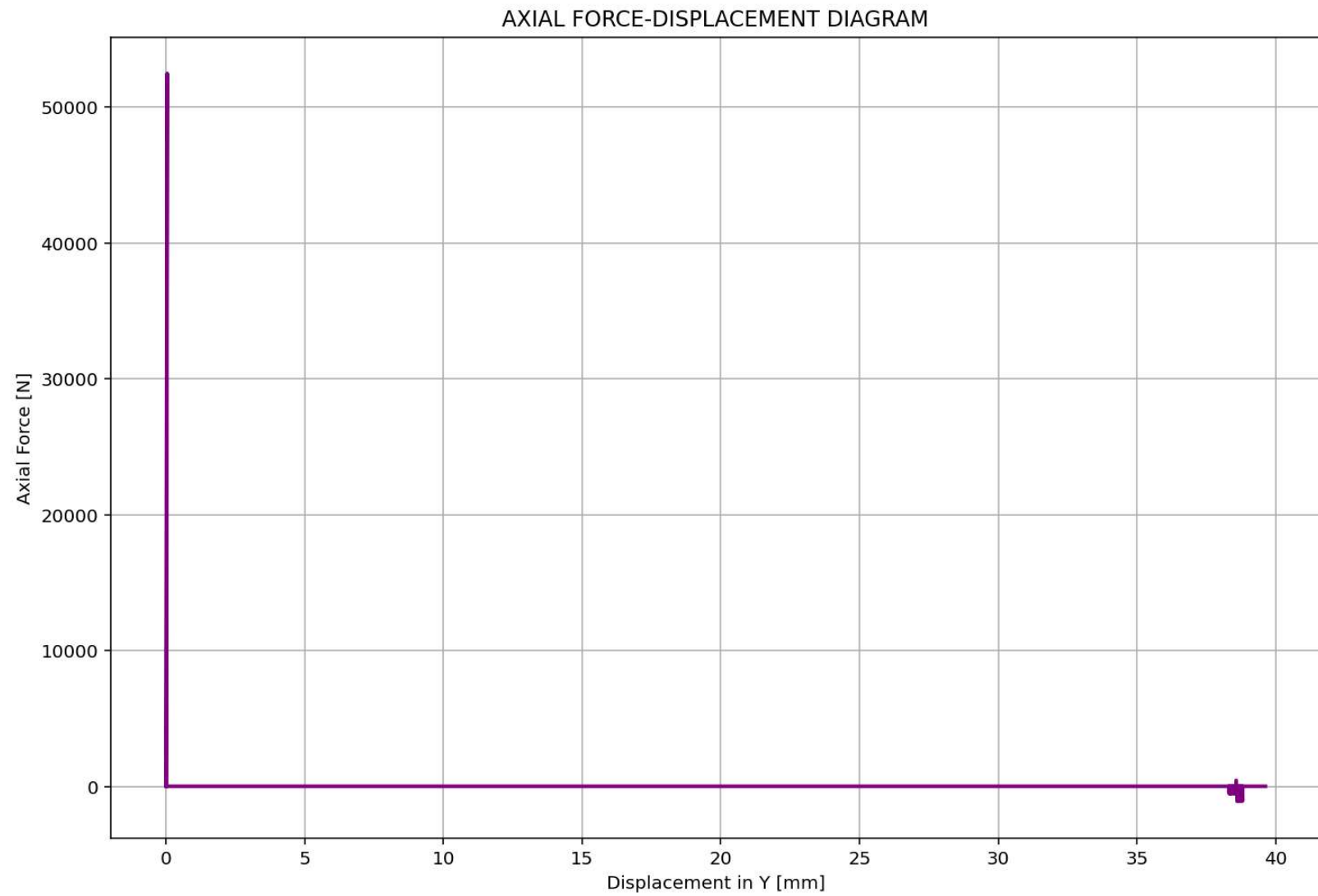
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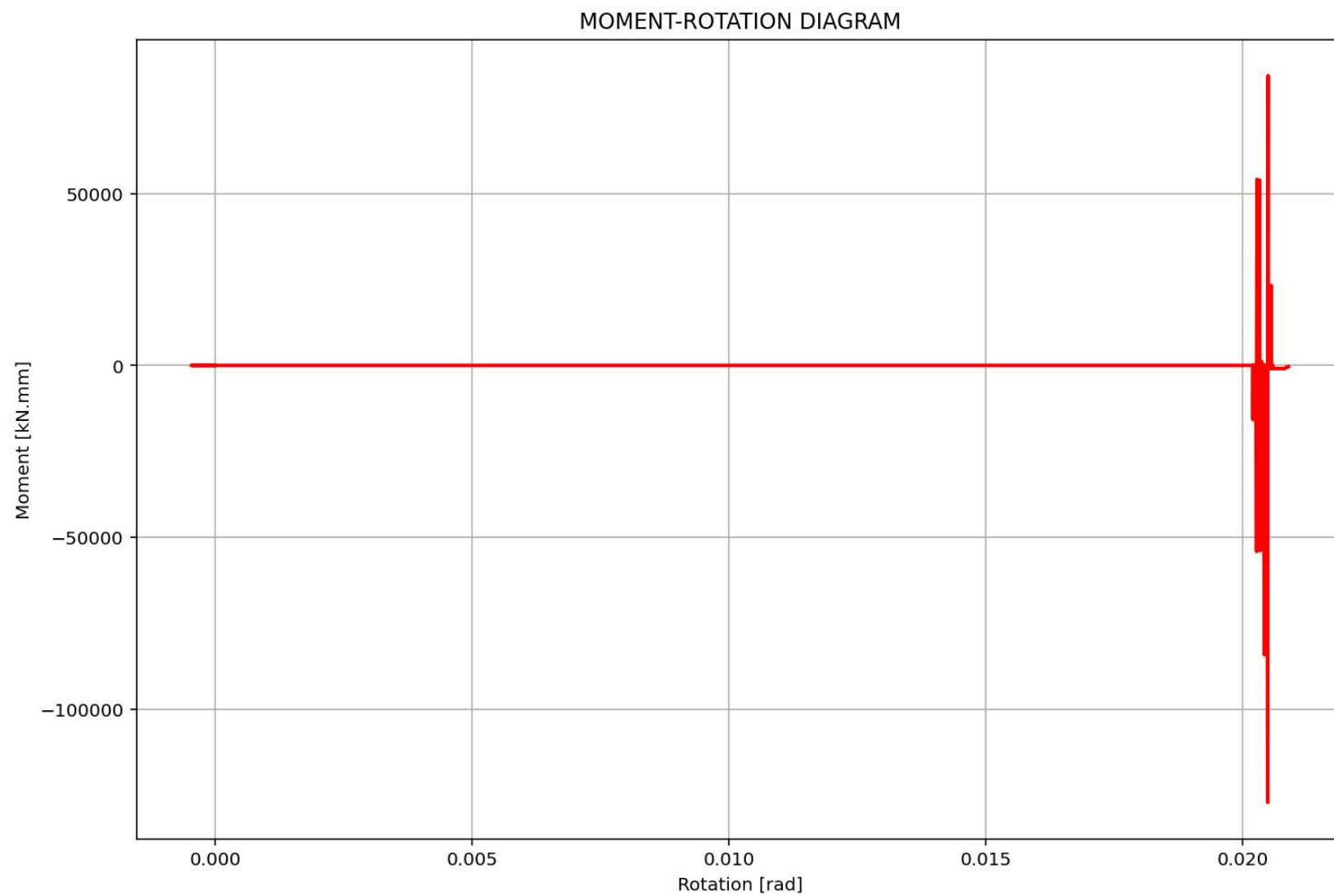
IPython Console History



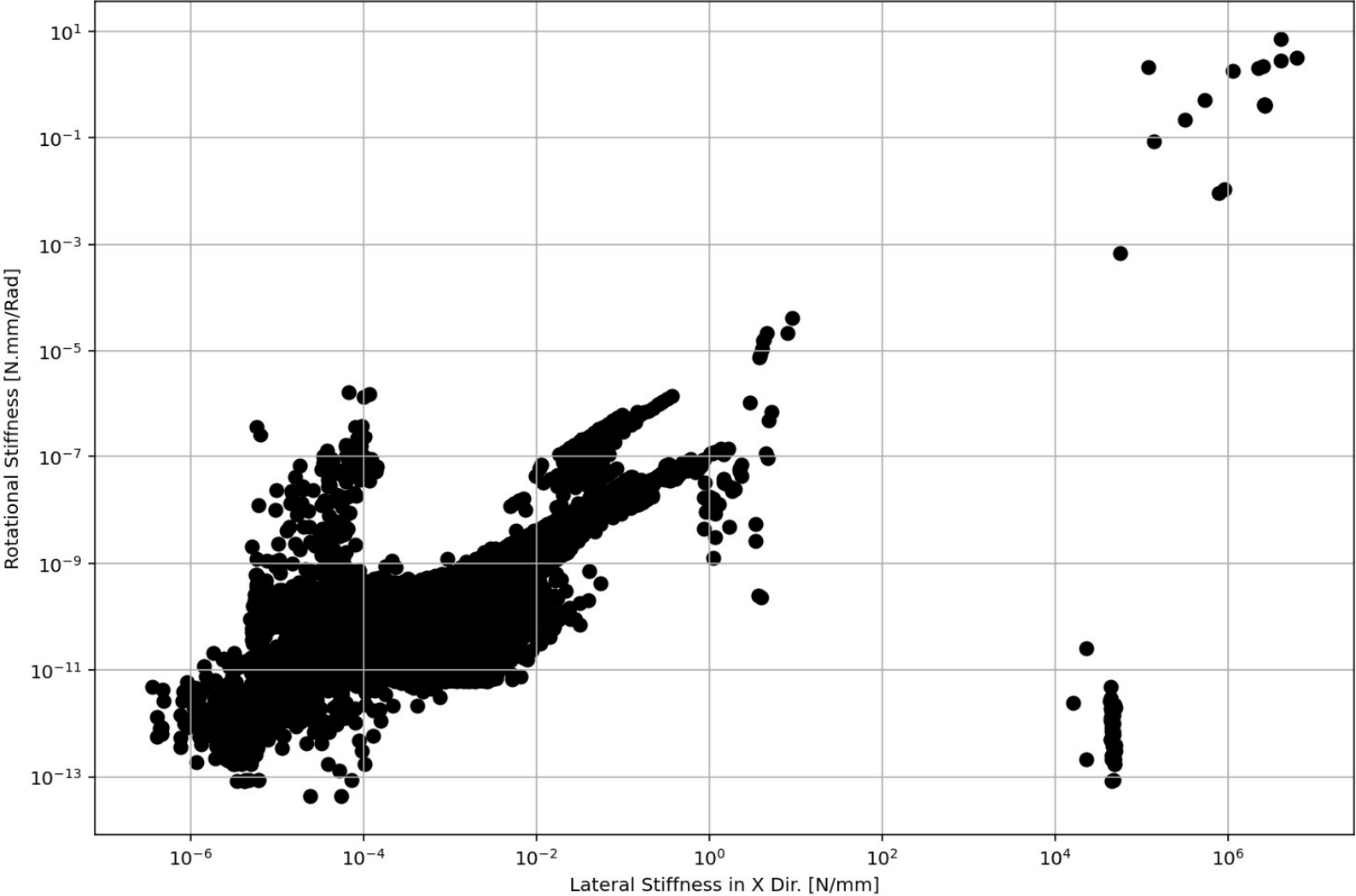




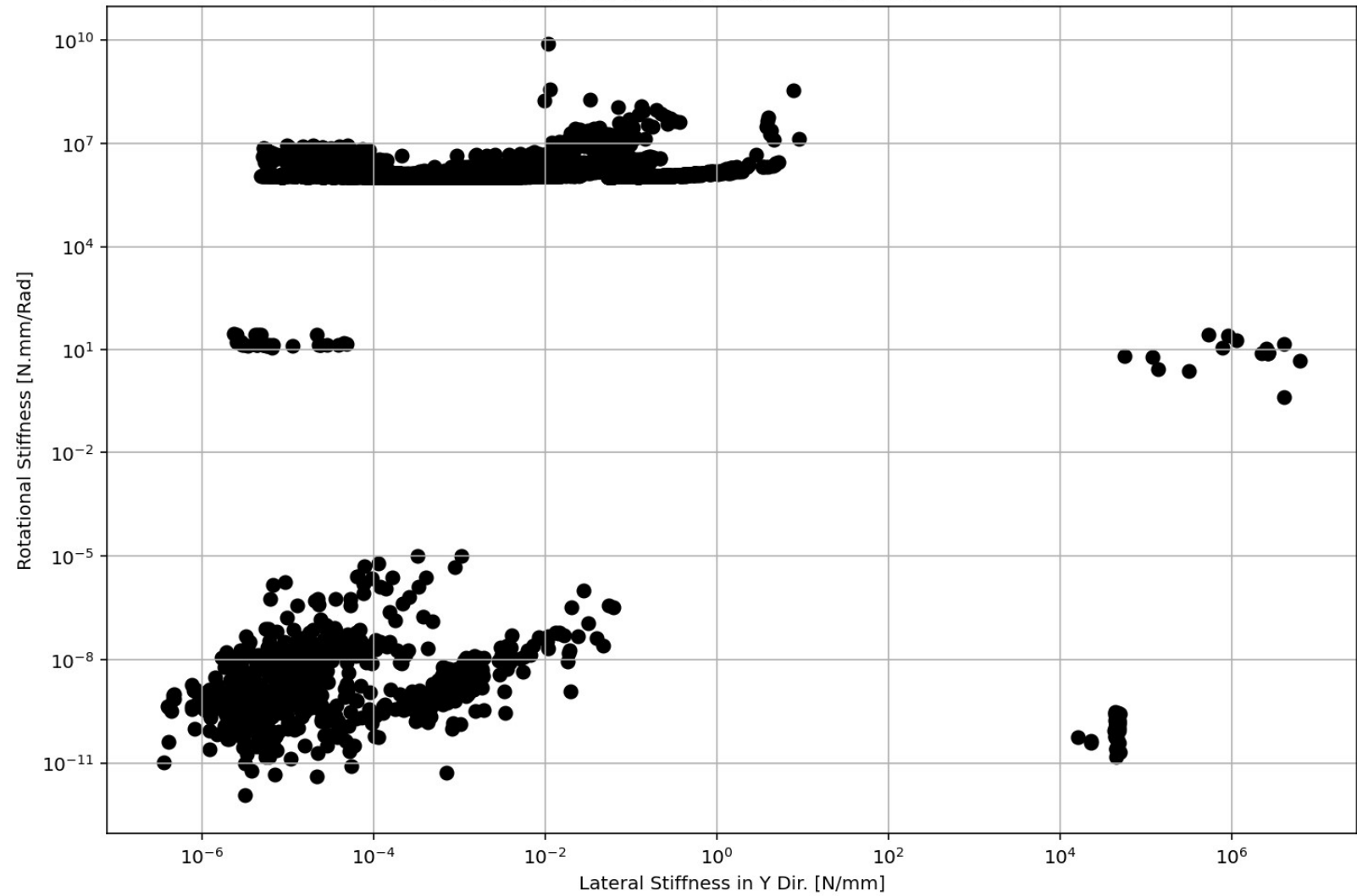




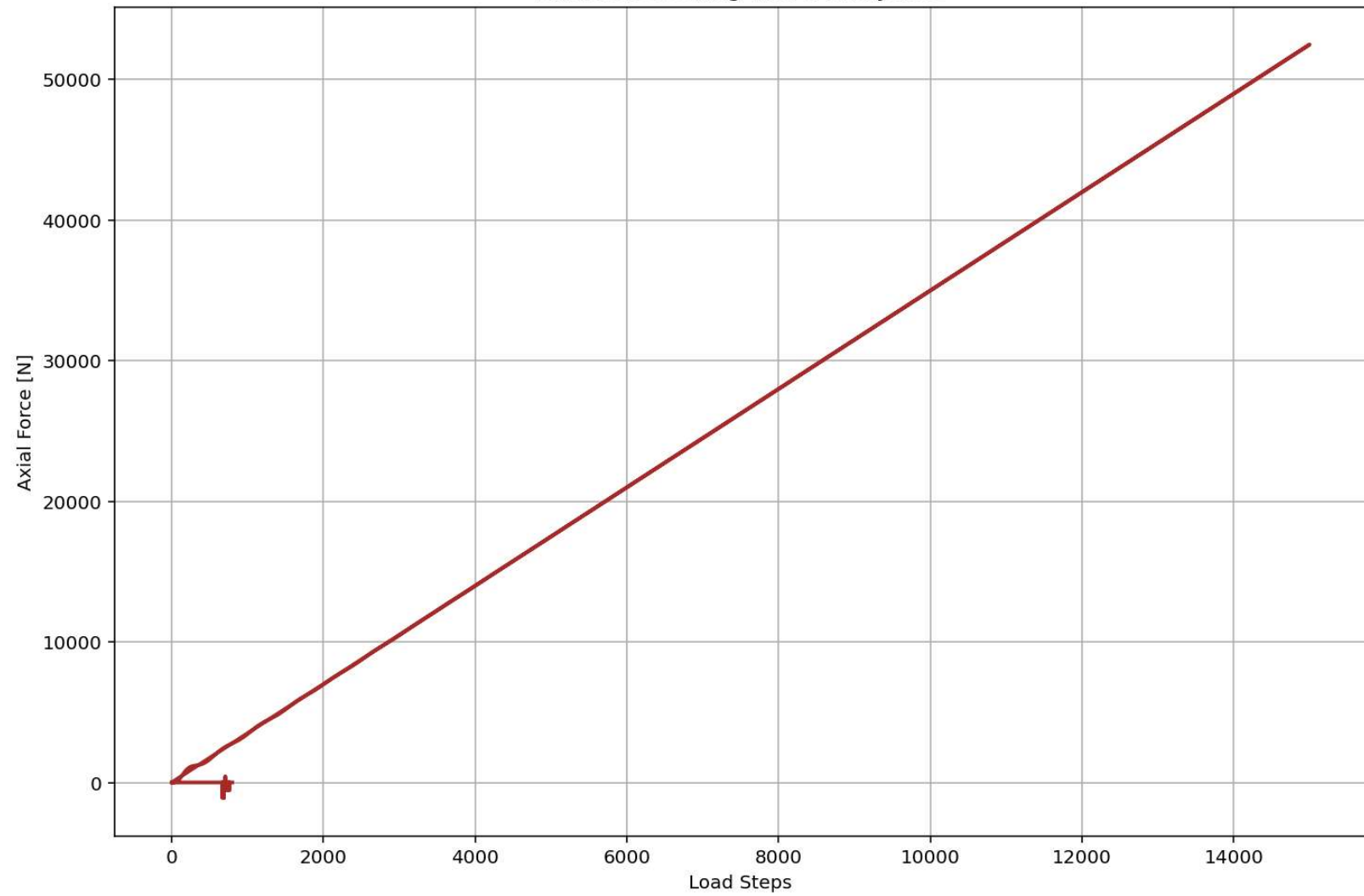
ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM

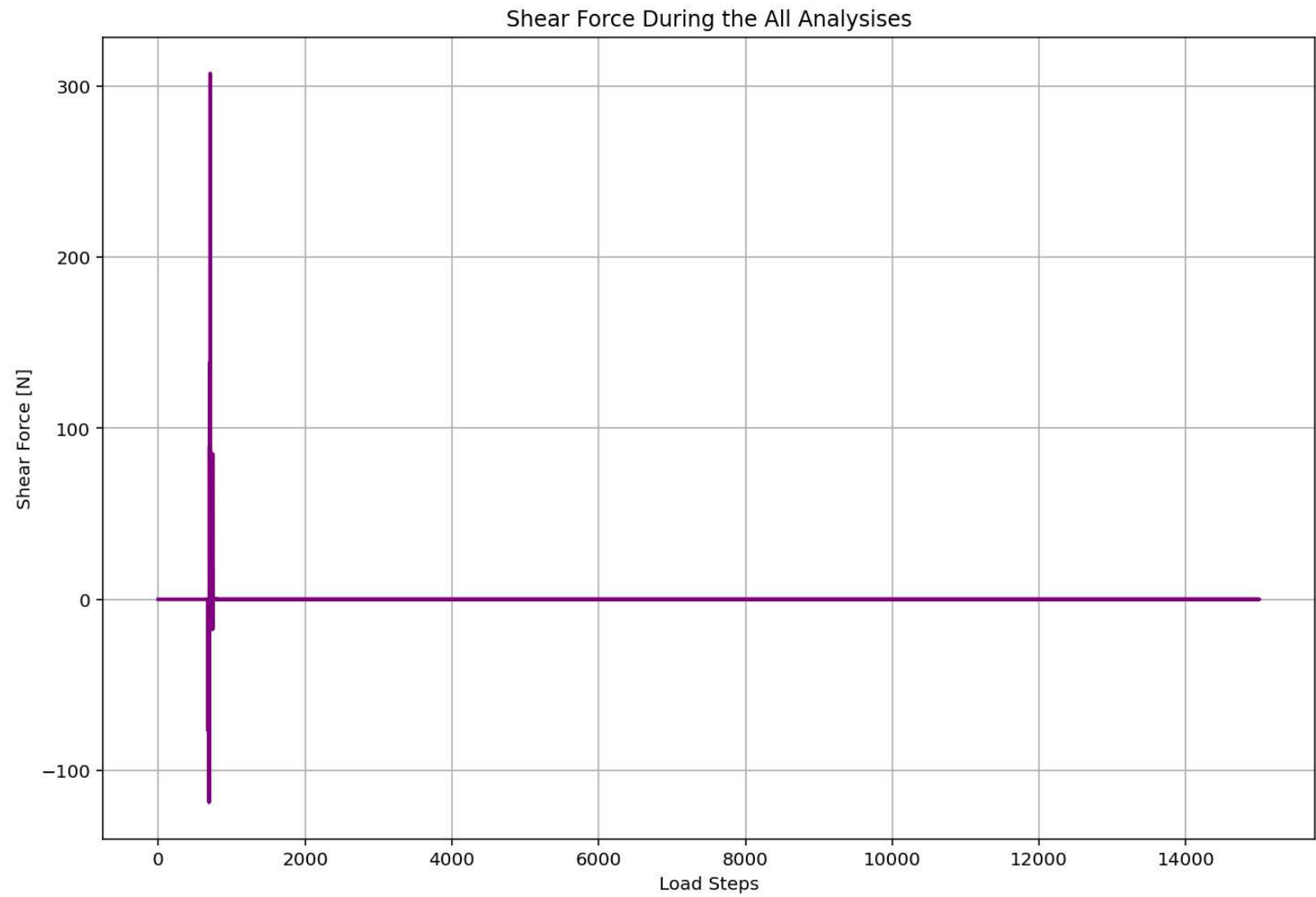


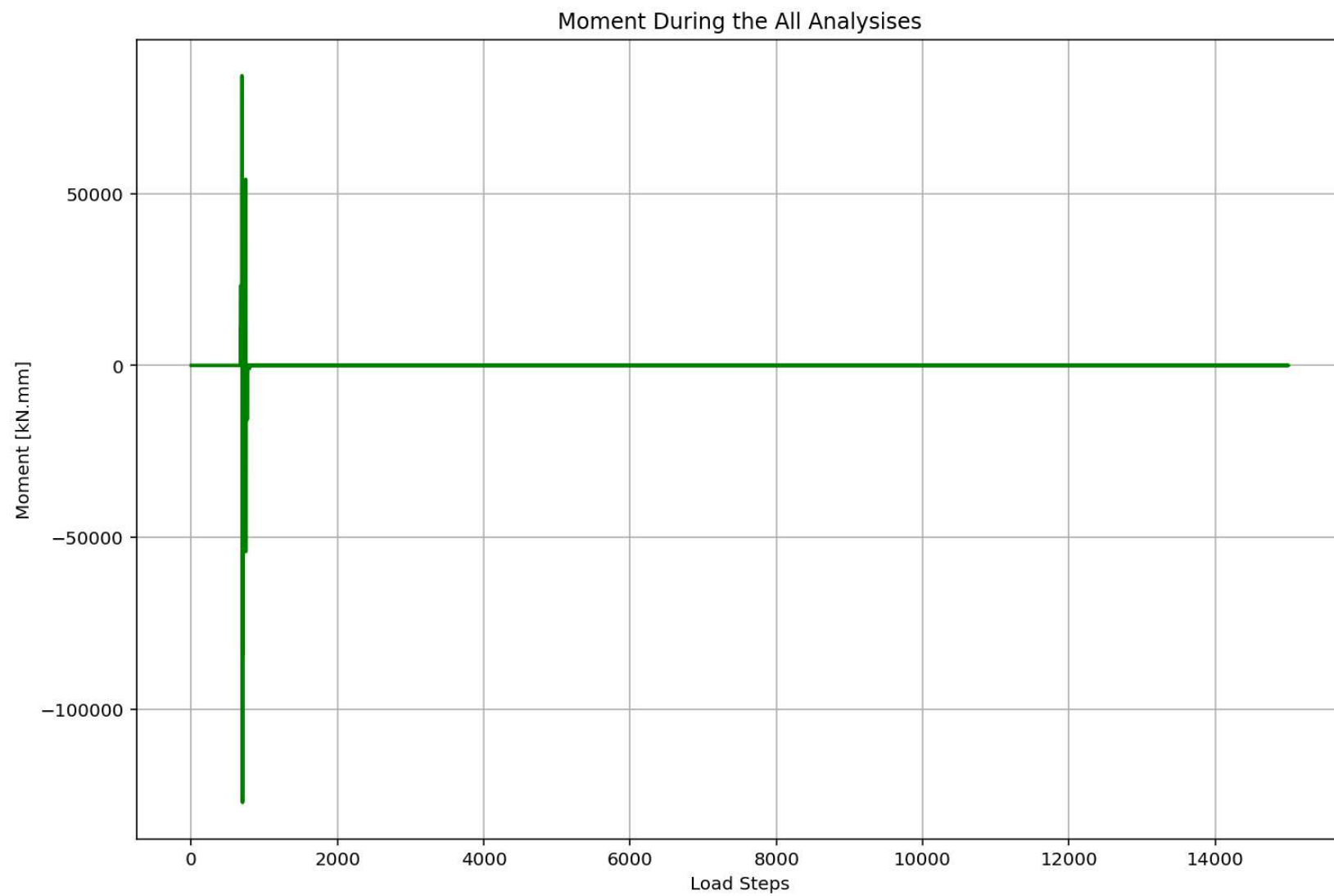
ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM

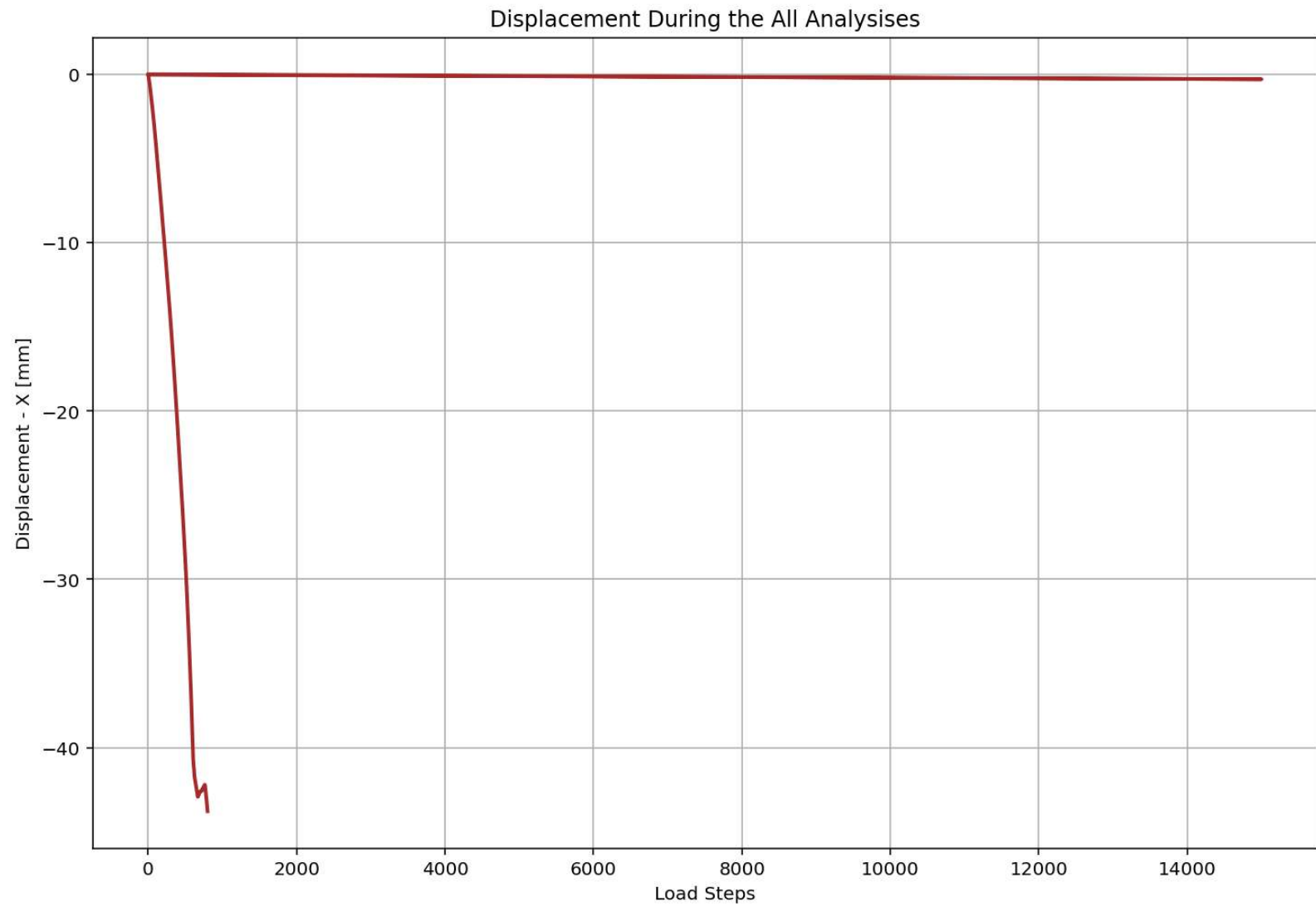


Axial Force During the All Analyses

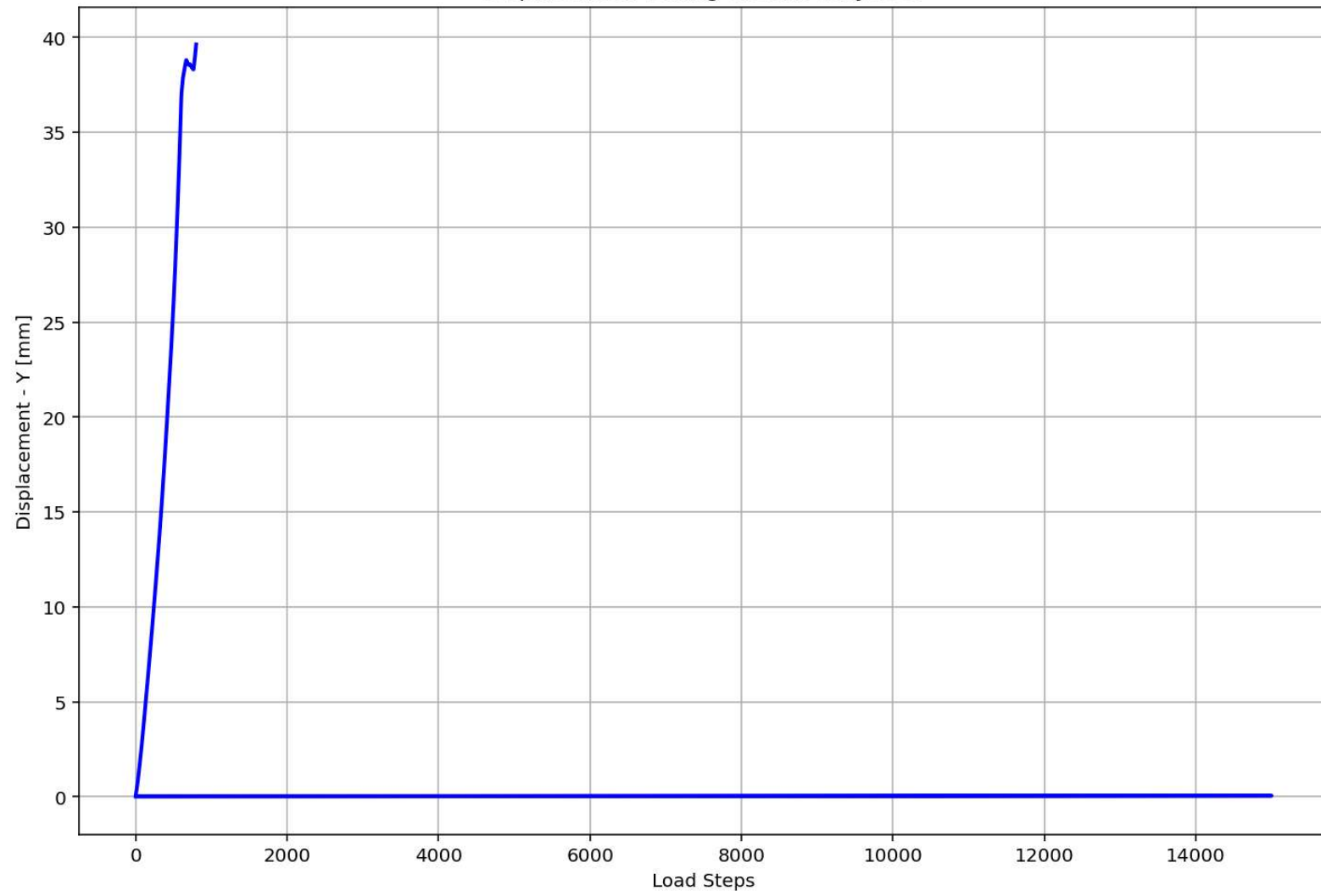


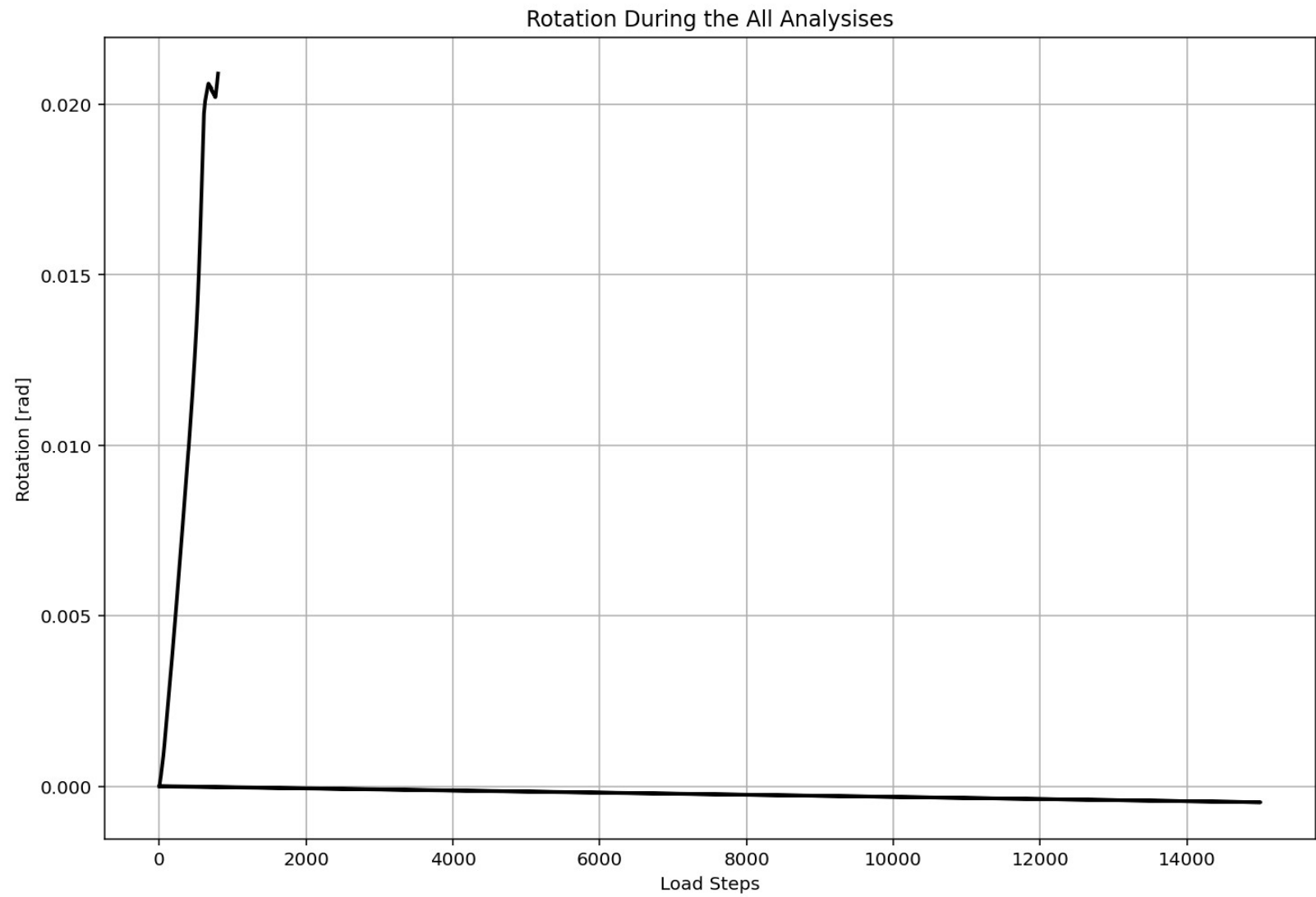




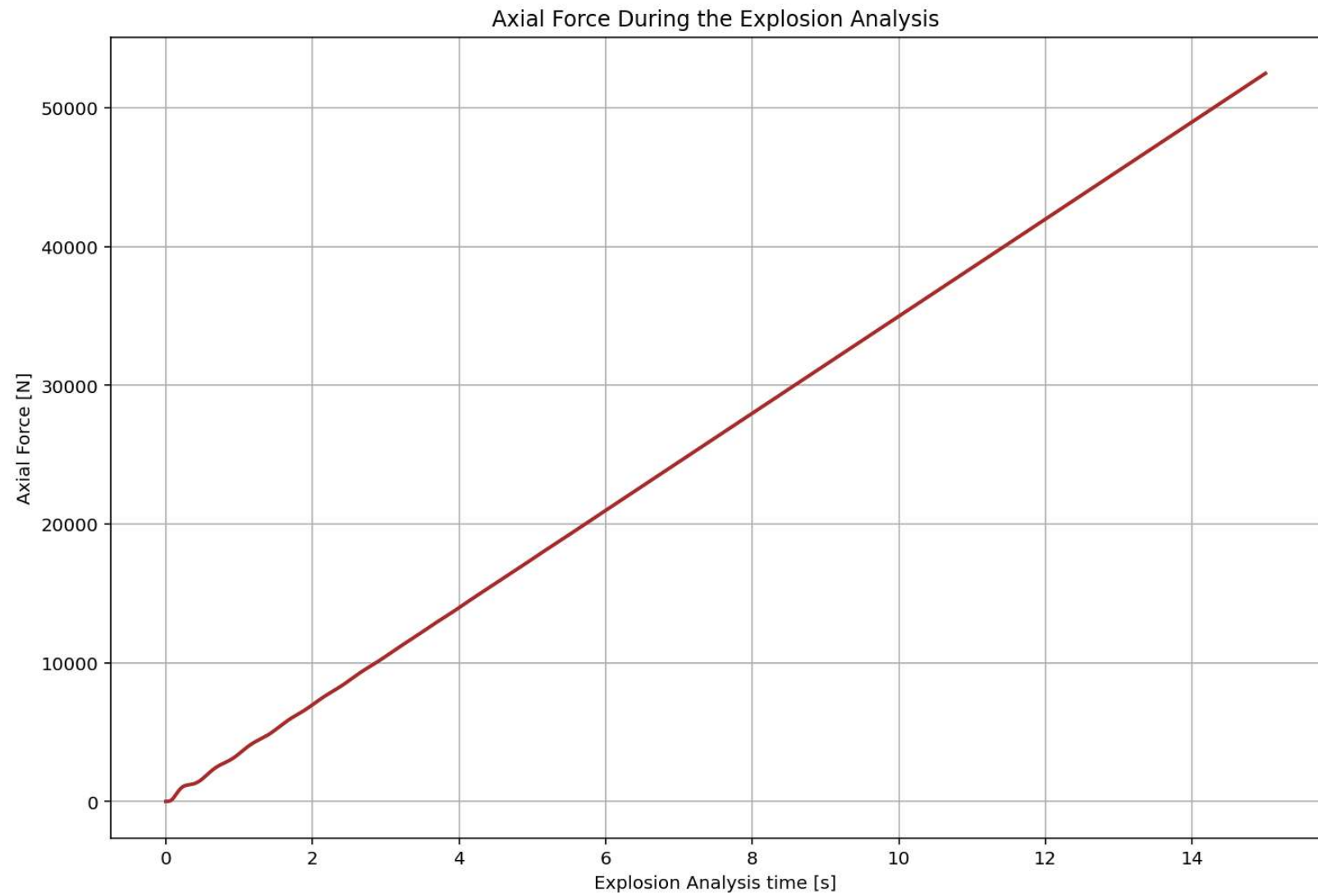


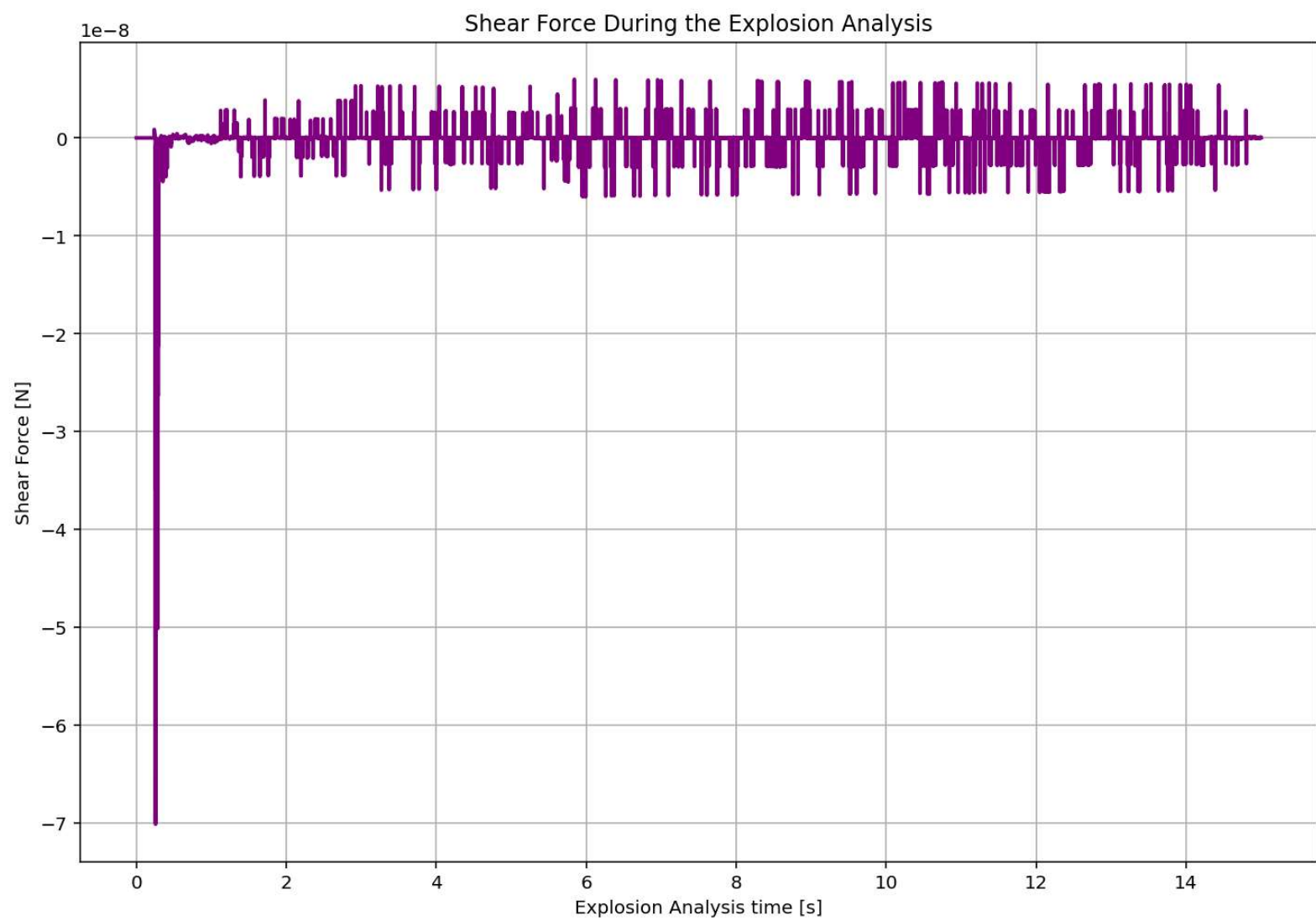
Displacement During the All Analyses

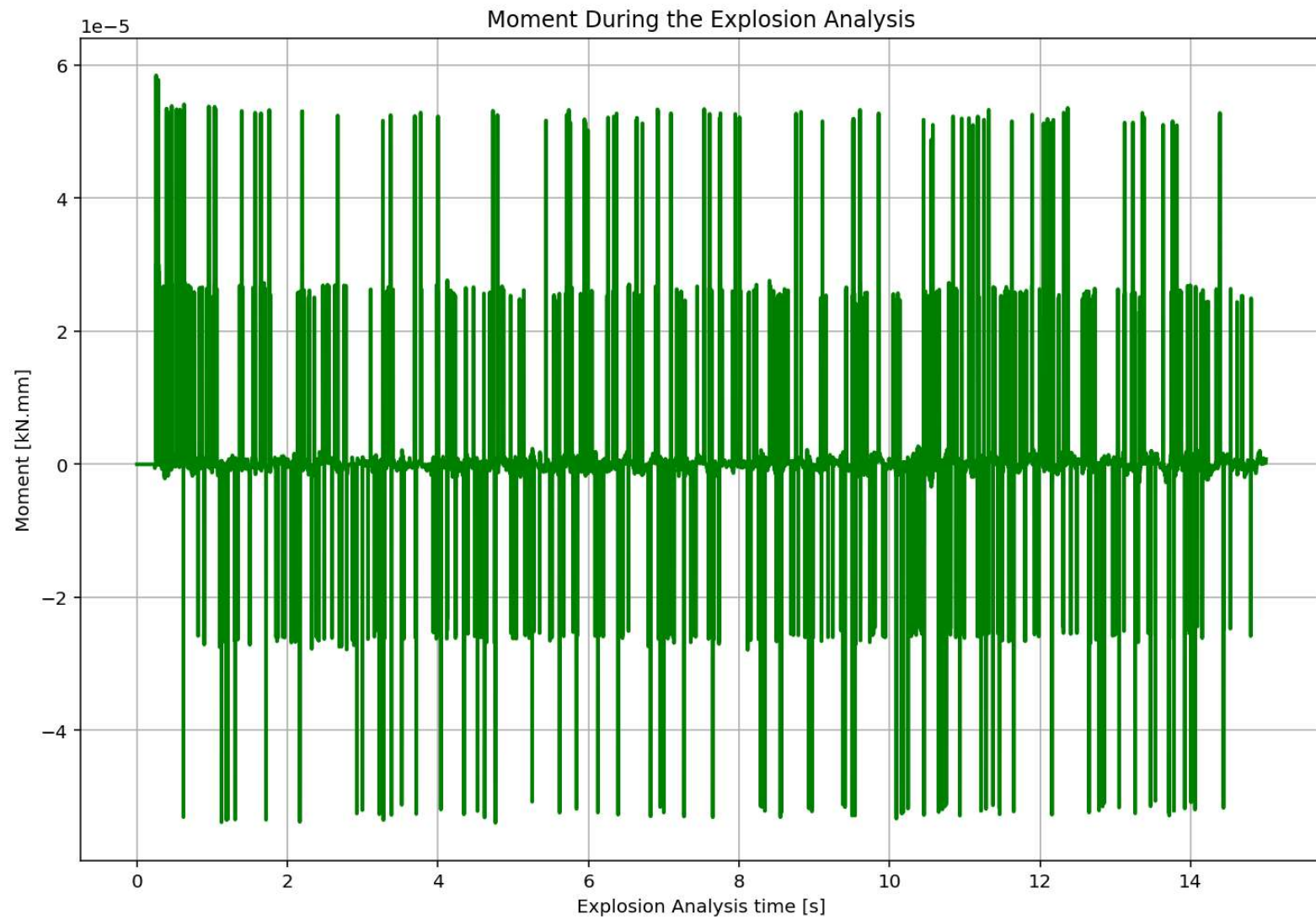


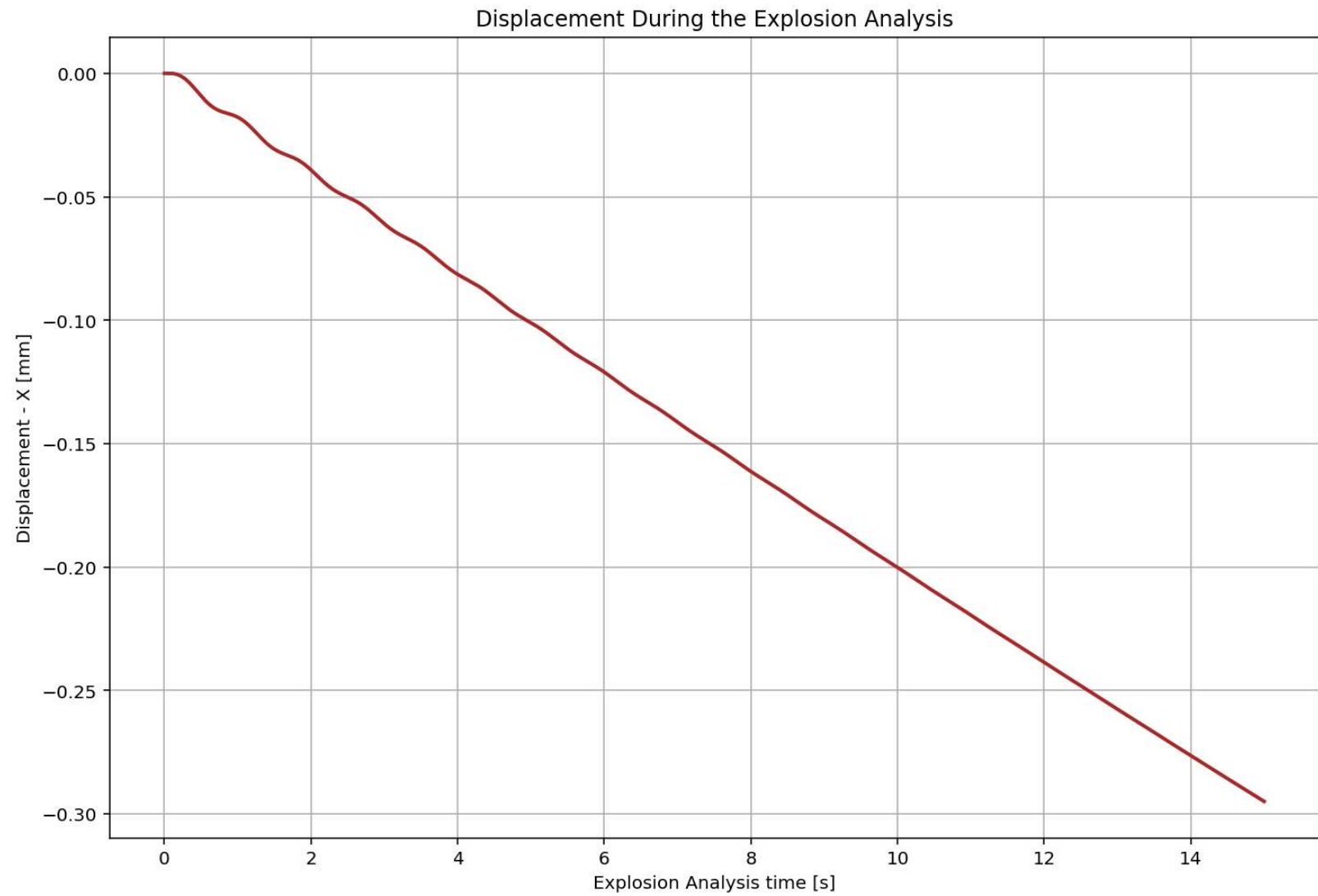


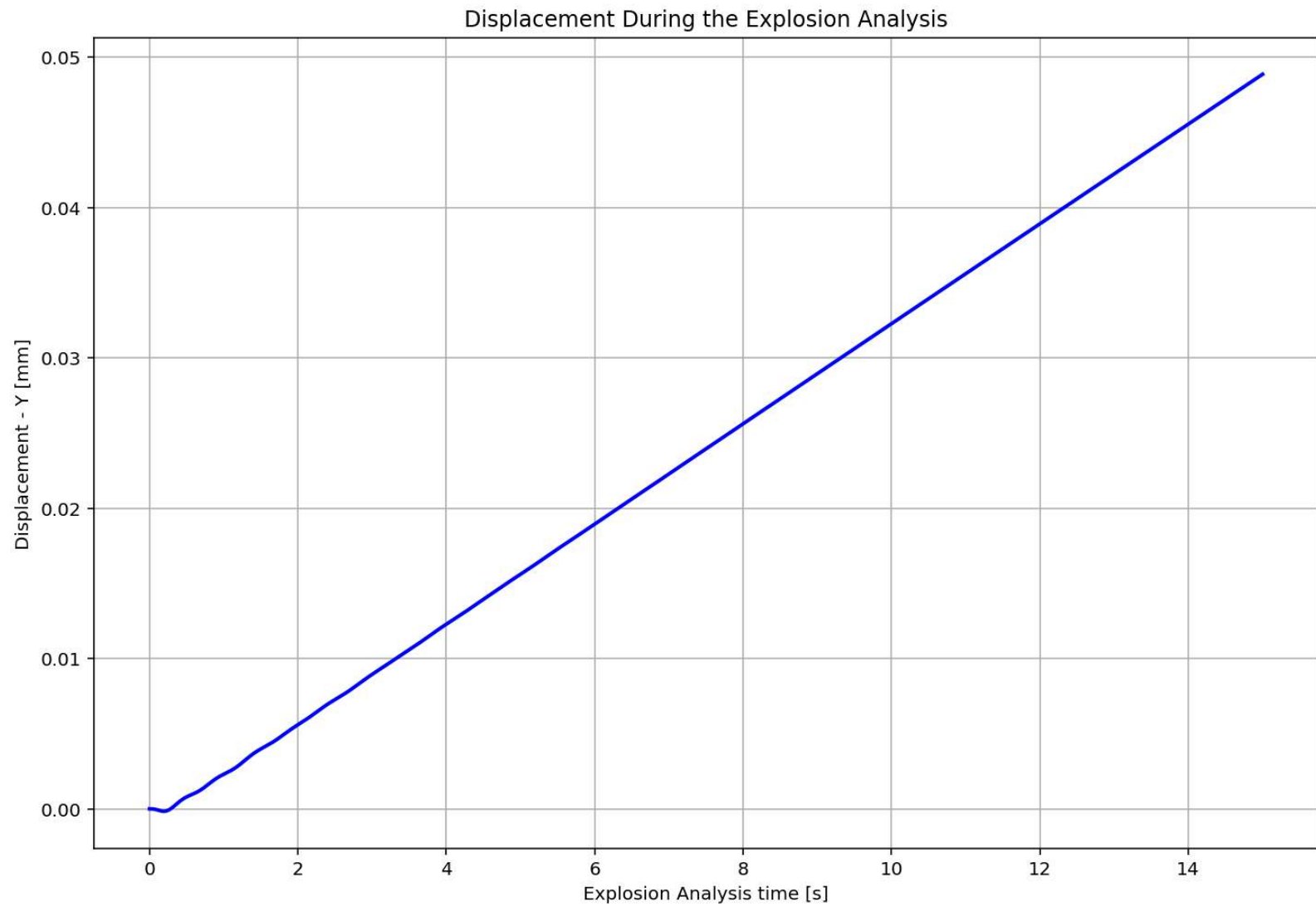
EXPLOSION IMPACT ANALYSIS RESULTS

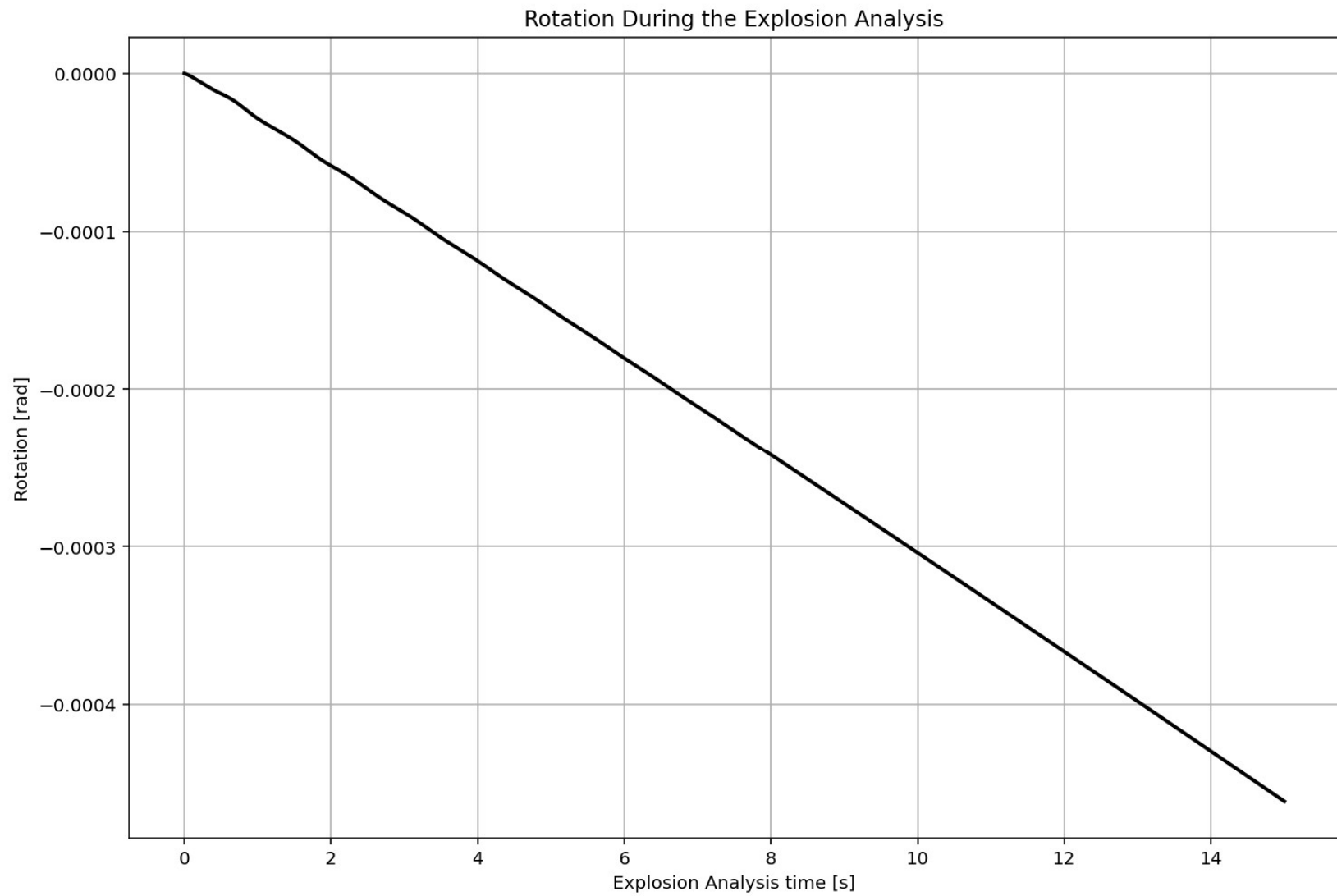






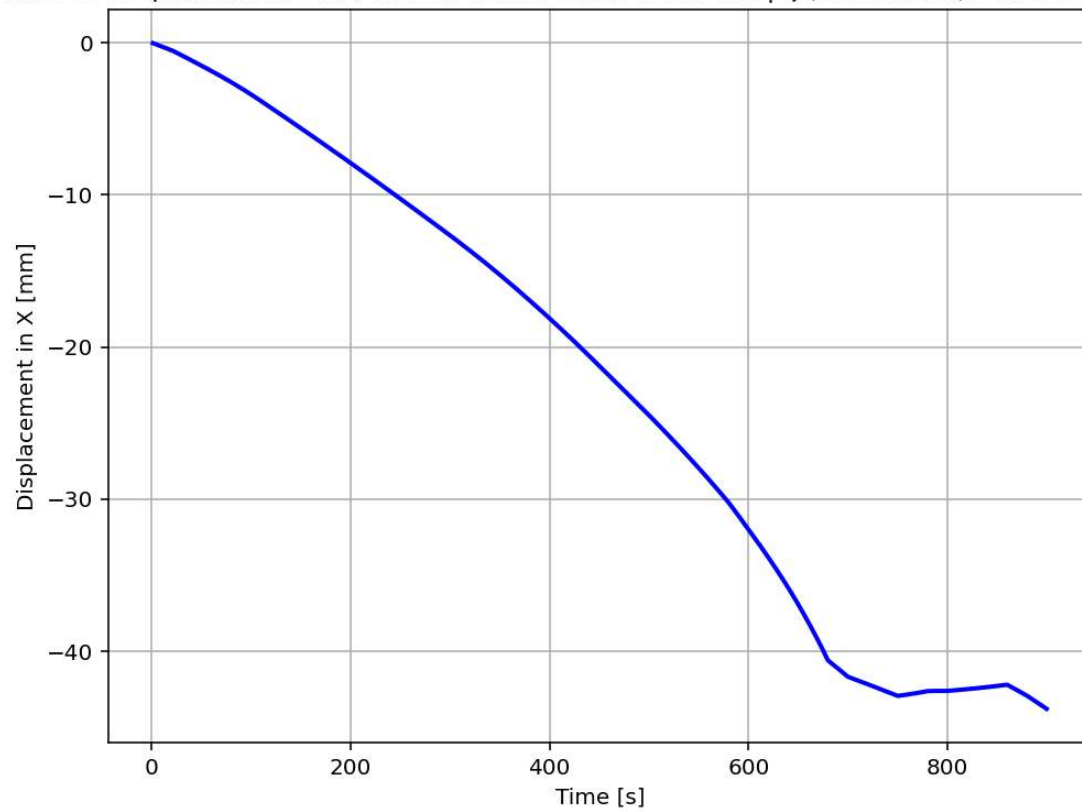




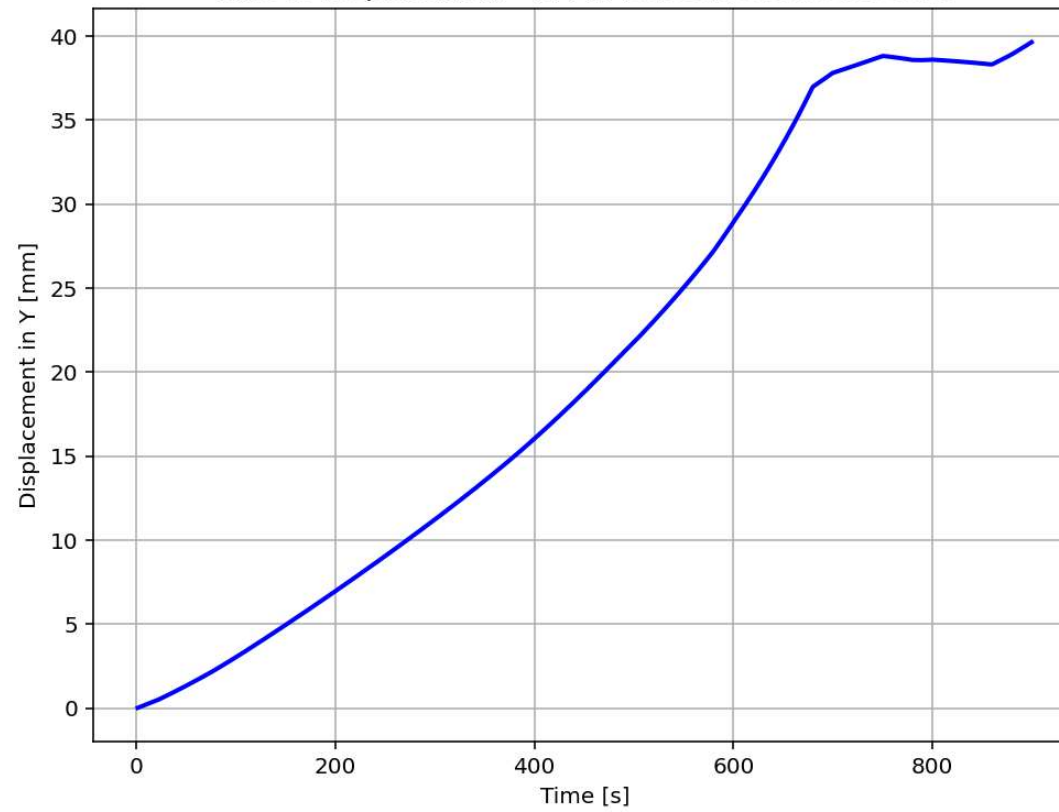


THERMAL ANALYSIS RESULTS

Time vs Displacement - MAX. ABS: 43.777821729882426 | ξ (Calculated): 1.00000e+02 %



Time vs Displacement - MAX. ABS: 39.63120038596678



Time vs Base-reaction - MAX. ABS: 307.3855022700882

