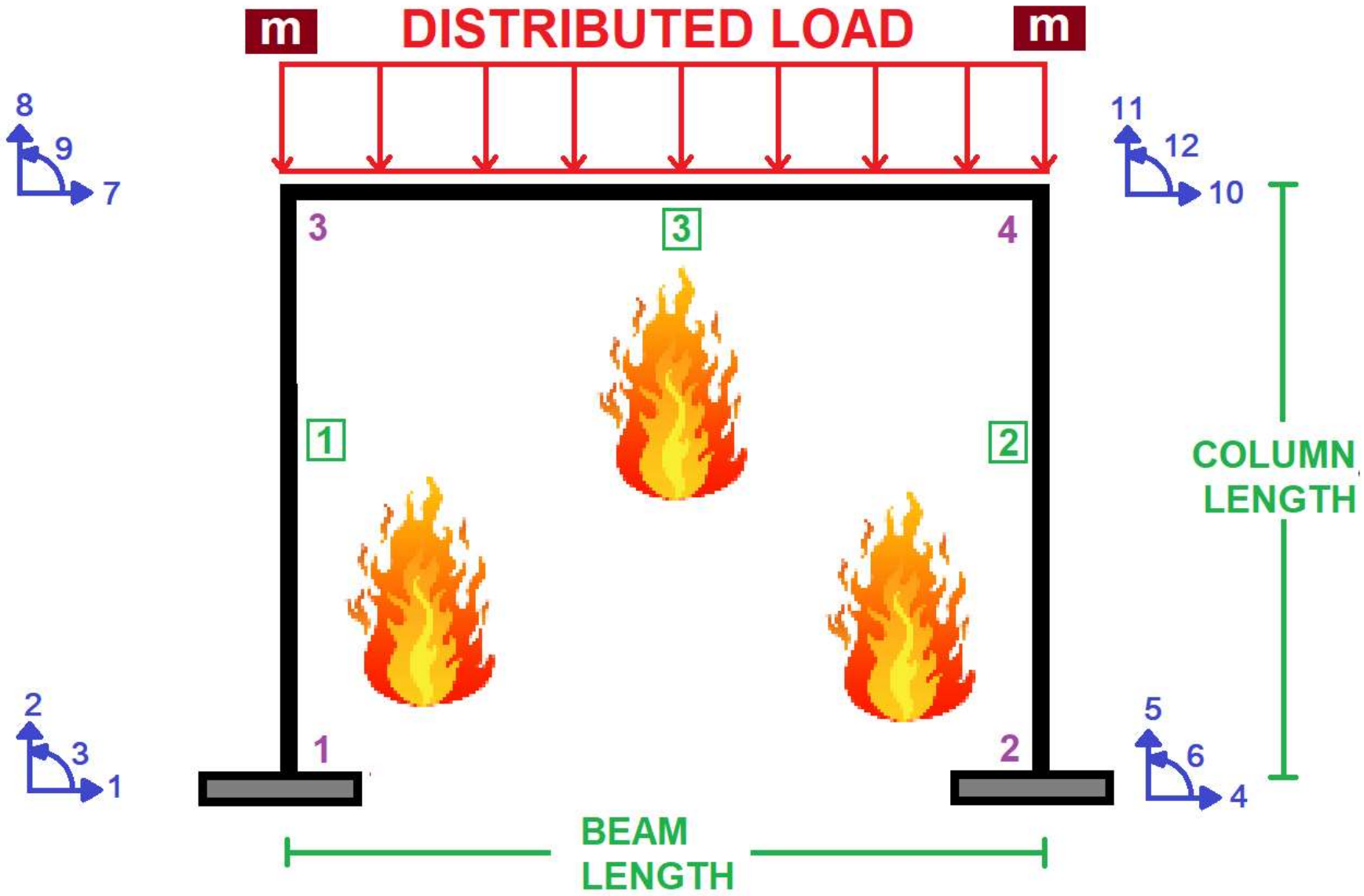
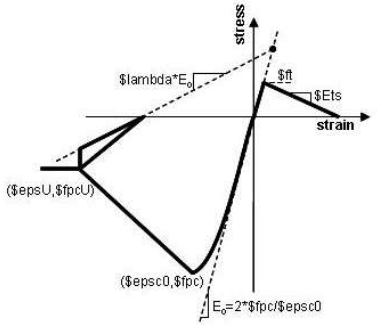
IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL

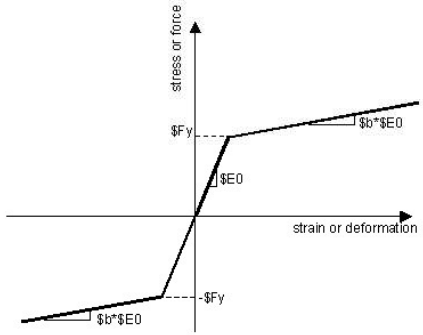
THERMAL ANALYSIS OF CONCRETE FRAME USING OPENSEES. EVALUATION OF THE STRUCTURAL PERIOD DURING THERMAL LOAD APPLIED TO ALL ELEMENTS

WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)

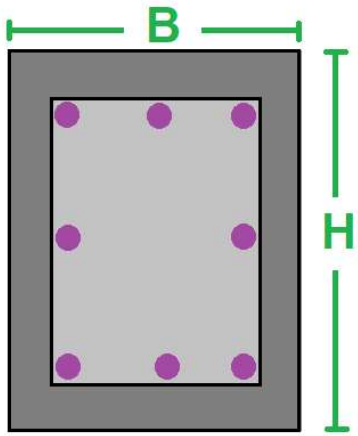

m
DISTRIBUTED LOAD
m
8
9
7
11
12
10
3
3
4
1
2
COLUMN LENGTH
2
3
1
5
6
4
1
2
BEAM LENGTH



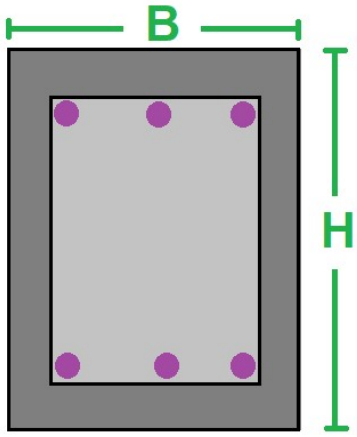
Concrete02 Thermal Material - Linear Tension Softening



Steel01 Thermal Material



COLUMN SECTION



BEAM SECTION

Spyder (Python 3.12)

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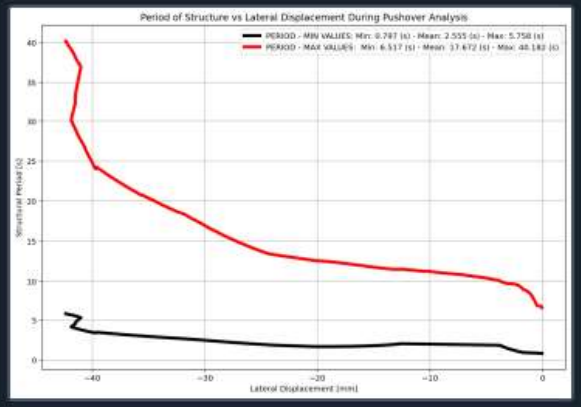
C:\Users\Dell\Desktop\OPENSEES_FILES\CONCRETE_FRA...EMENTS_PERIOD\THERMAL_LOAD_ALL_ELEMENTS_PERIOD.py

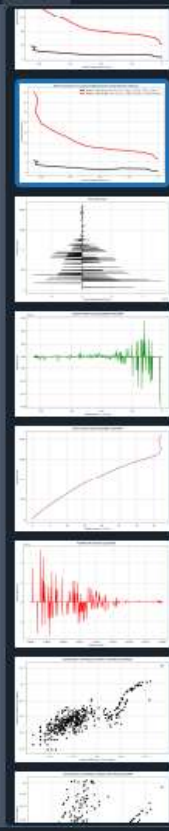
THERMAL_LOAD_ALL_ELEMENTS_PERIOD.py

```
1  ##########################################################################################################
2  #                                          IN THE NAME OF ALLAH
3  #                                  THERMAL ANALYSIS OF CONCRETE FRAME USING OPENSEES
4  #                EVALUATION OF THE STRUCTURAL PERIOD DURING THERMAL LOAD APPLIED TO ALL ELEMENTS
5  #--------------------------------------------------------------------------------------------------------
6  #                                THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)
7  #                                          EMAIL: salar.d.ghashghaei@gmail.com
8  ##########################################################################################################
9
10 """
11 Models and Analyzes a 2D Concrete Frame subjected to Thermal and Distributed Loads using OpenSees.
12 Key points:
13 [1] Model Definition: The 2D frame has specified node coordinates for stories and bays, with fixed sup
14  Material properties for concrete (with thermal effects) and concrete rectangular section geometries a
15 [2] Element and Load Setup: Beam-column elements with corotational geometric transformation and Lobatt
16  are created. Distributed loads are applied to beams, and a thermal gradient is applied to the first s
17 [3] Analysis Setup: The analysis uses static load control with thermal increments, and the Newton-Raph
18  Convergence tolerances and maximum iterations are defined.
19 [4] Output and Post-processing: Displacements, reactions, and deformations are recorded during the ana
20  Data is extracted from output files for plotting base reactions (axial, shear, moment) and node displ
21  against temperature or applied load.
22 [5] Visualization: The frame's undeformed and deformed shapes are plotted, and results like temperatur
23  relationships and base reactions are visualized.
24 """
25 import openseespy.opensees as ops
26 import matplotlib.pyplot as plt
27 import numpy as np
28 import time as TI
29 import ANALYSIS_FUNCTION as S02
30 import CONCRETE_THERMAL_SECTION_FUN as S03
31 #import CONCRETE_FIBERTHERMAL_SECTION as S03
32 import PLOT_2D as S04
33 import EIGENVALUE_ANALYSIS_FUN as S05
34 #%%------------------------------------------------------------------------
```

..ME_EXAMPLES\THERMAL_LOAD\THERMAL_LOAD_ALL_ELEMENTS_PERIOD

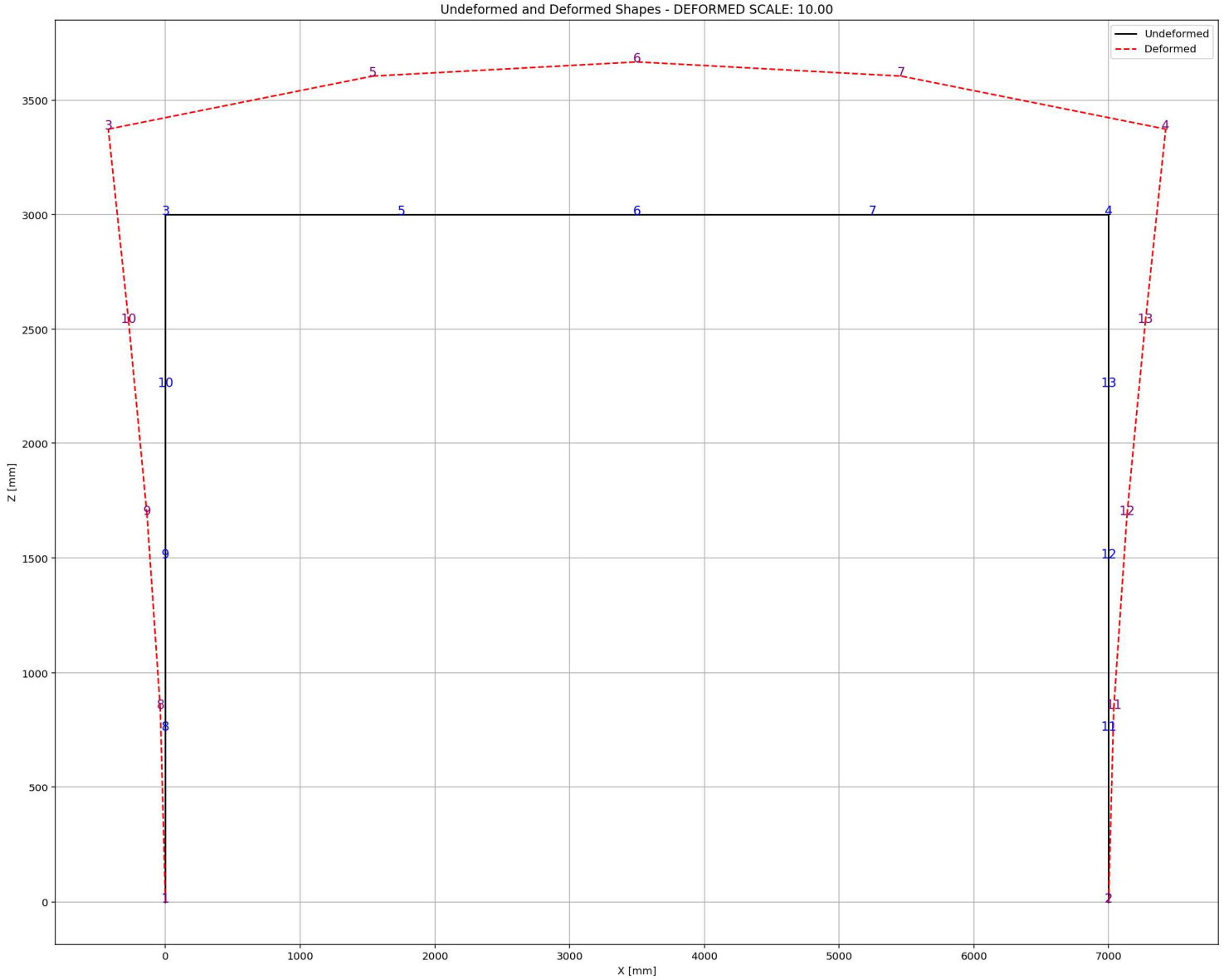
26 %

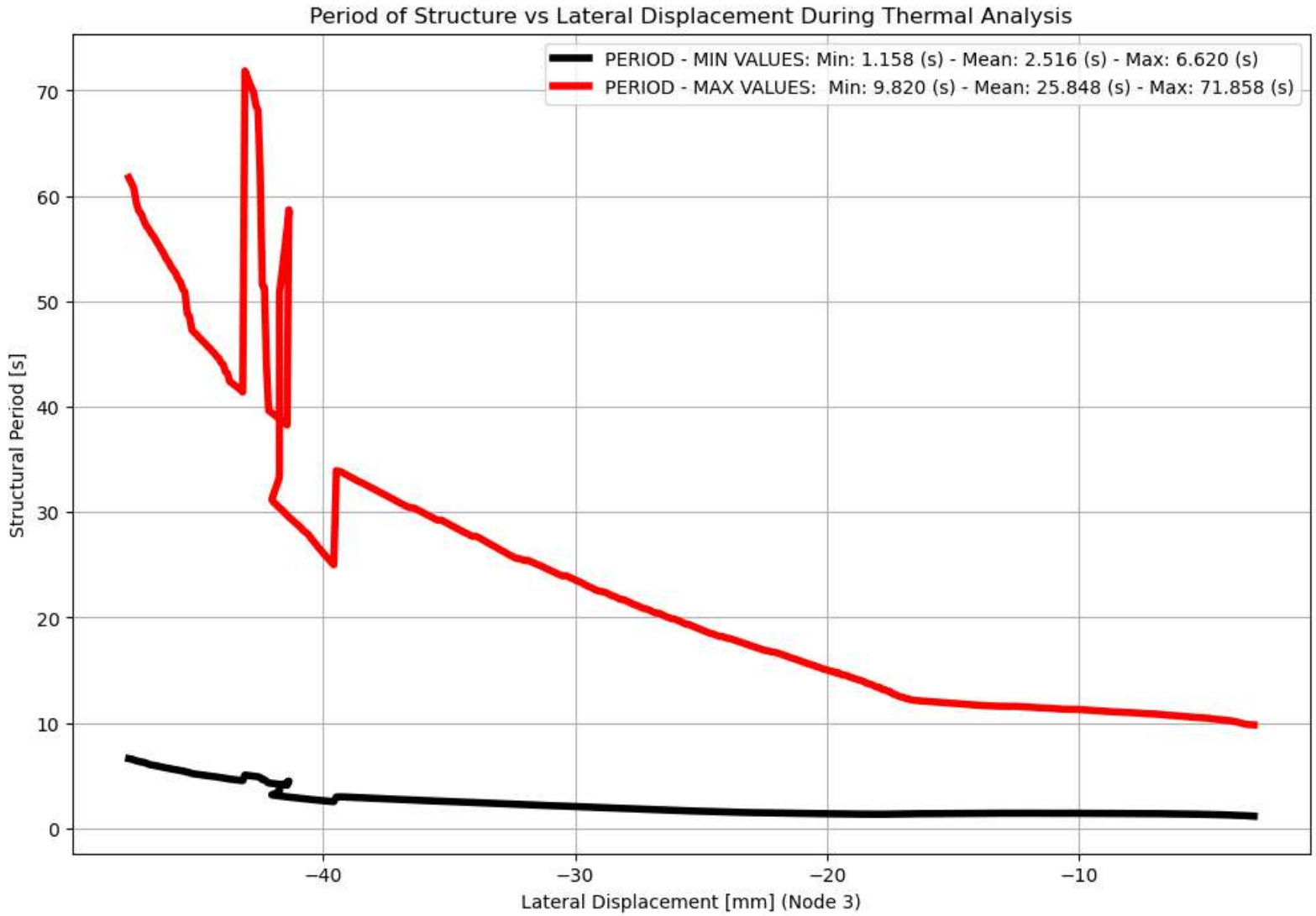


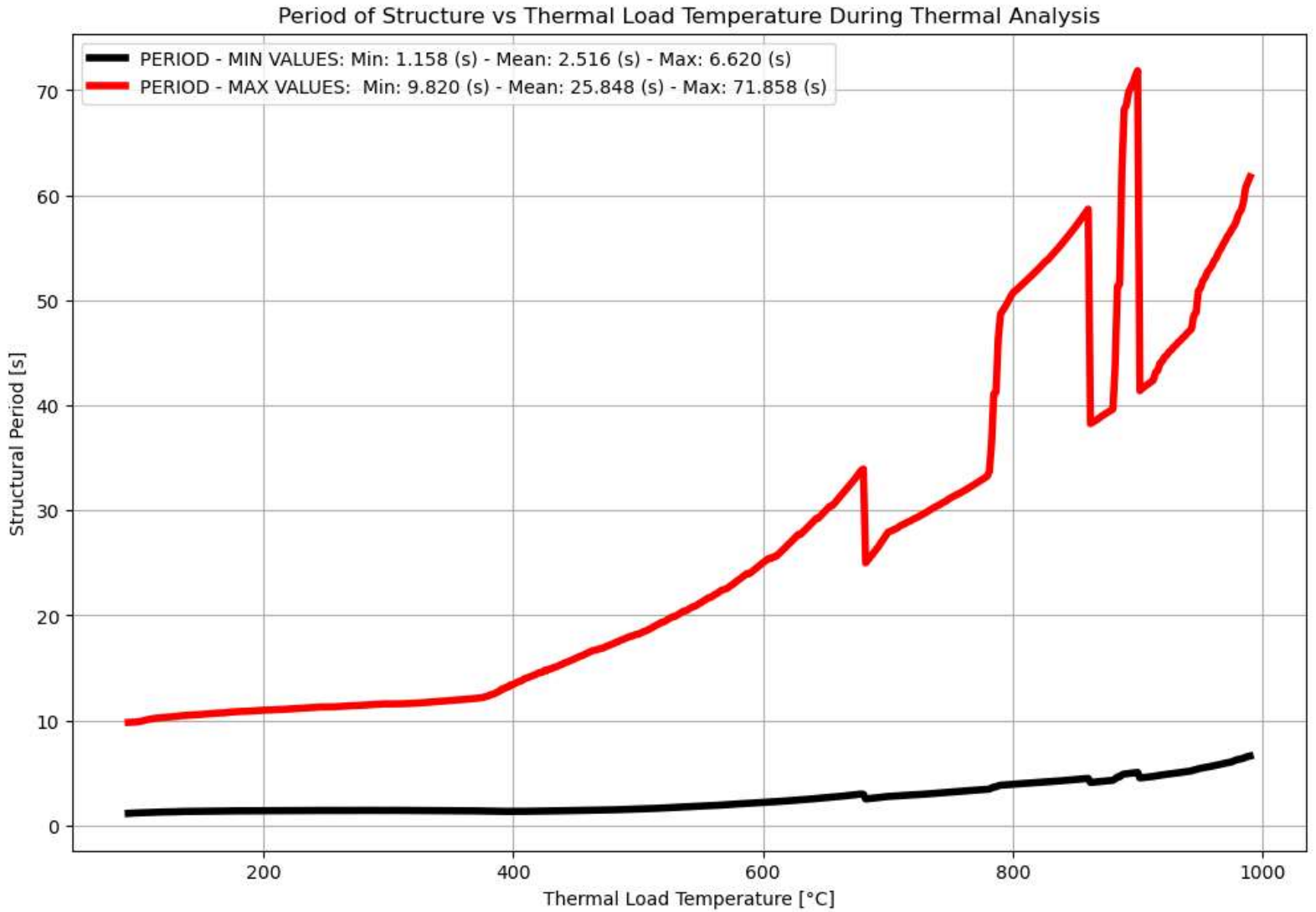


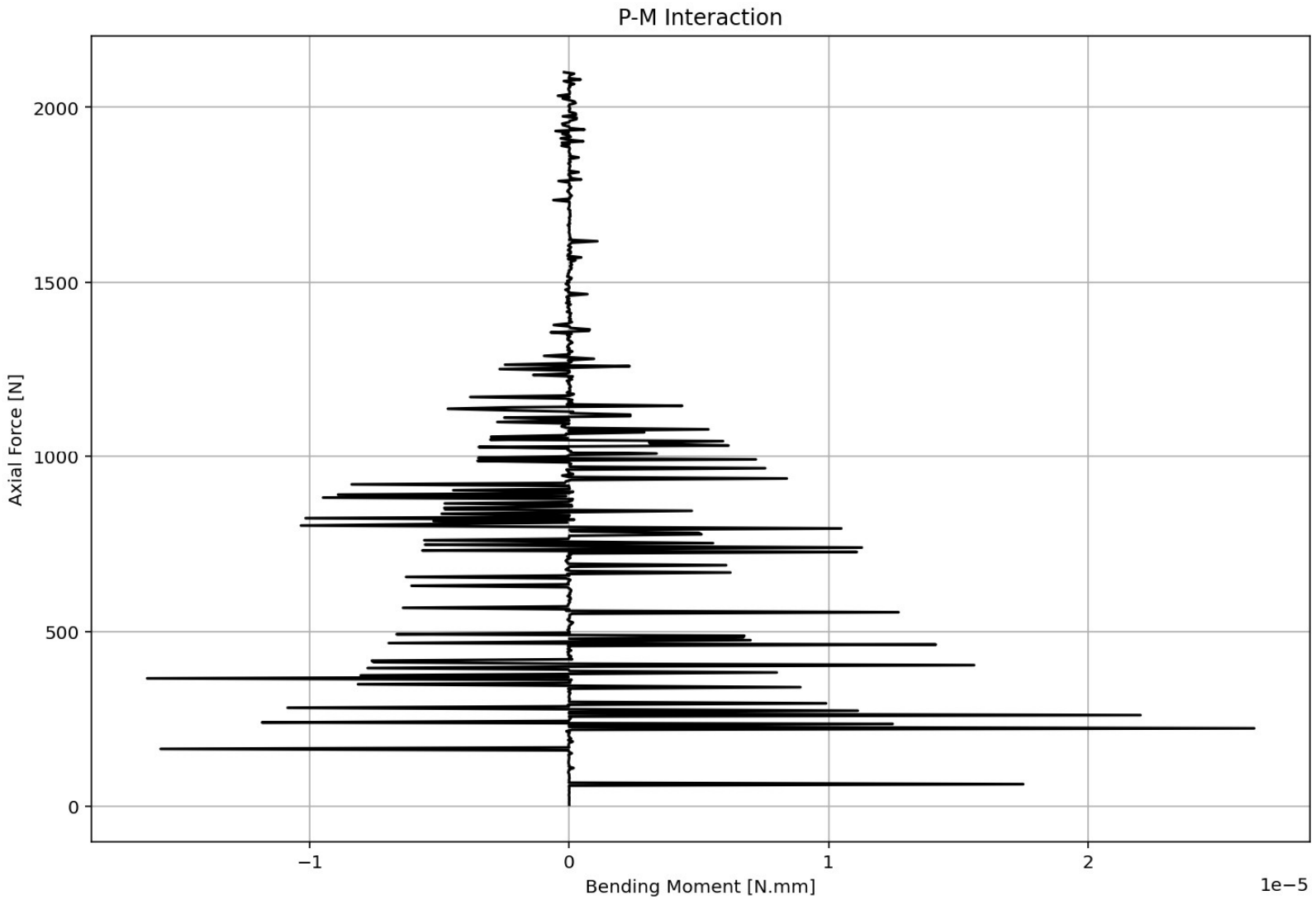
IPython Console | Files | Help | Variable Explorer | Debugger | Plots | History

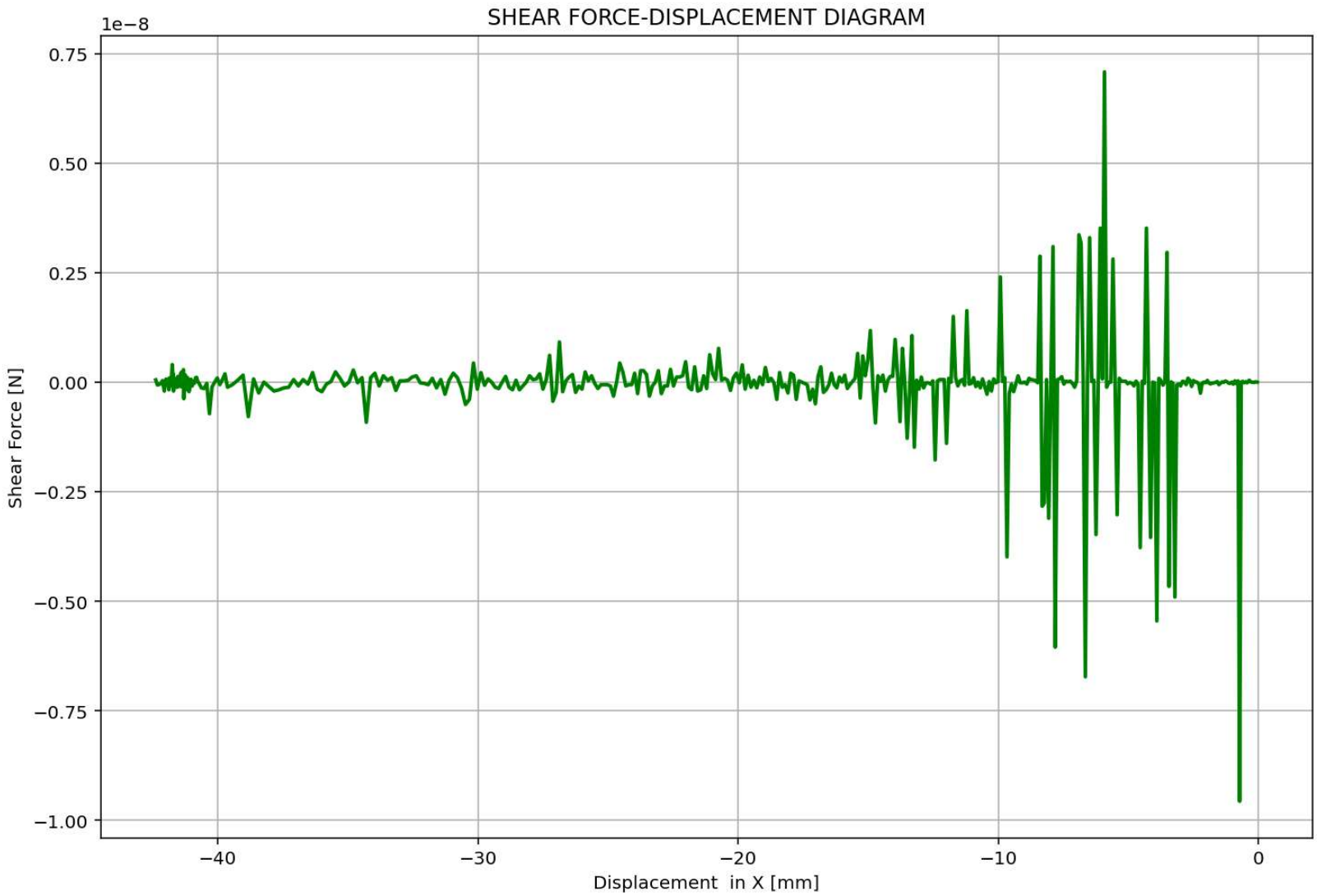
Inline Conda: anaconda3 (Python 3.12.7) LSP: Python Line 4, Col 17 UTF-8 CRLF RW Mem 40%

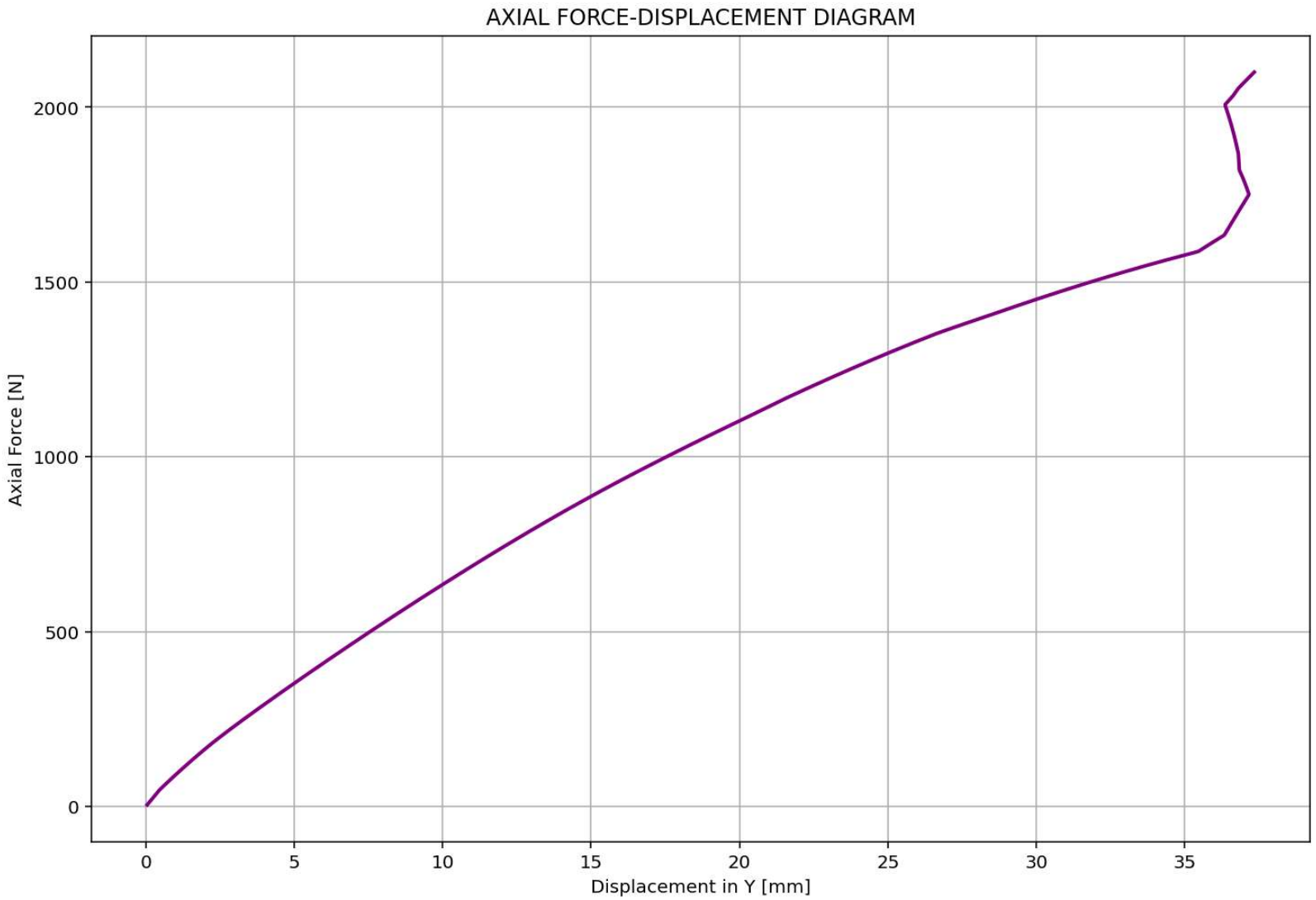

Undeformed and Deformed Shapes - DEFORMED SCALE: 10.00
Undeformed
Deformed
Z [mm]
X [mm]
0
500
1000
1500
2000
2500
3000
3500
0
1000
2000
3000
4000
5000
6000
7000
1
2
3
4
5
6
7
8
9
10
11
12
13

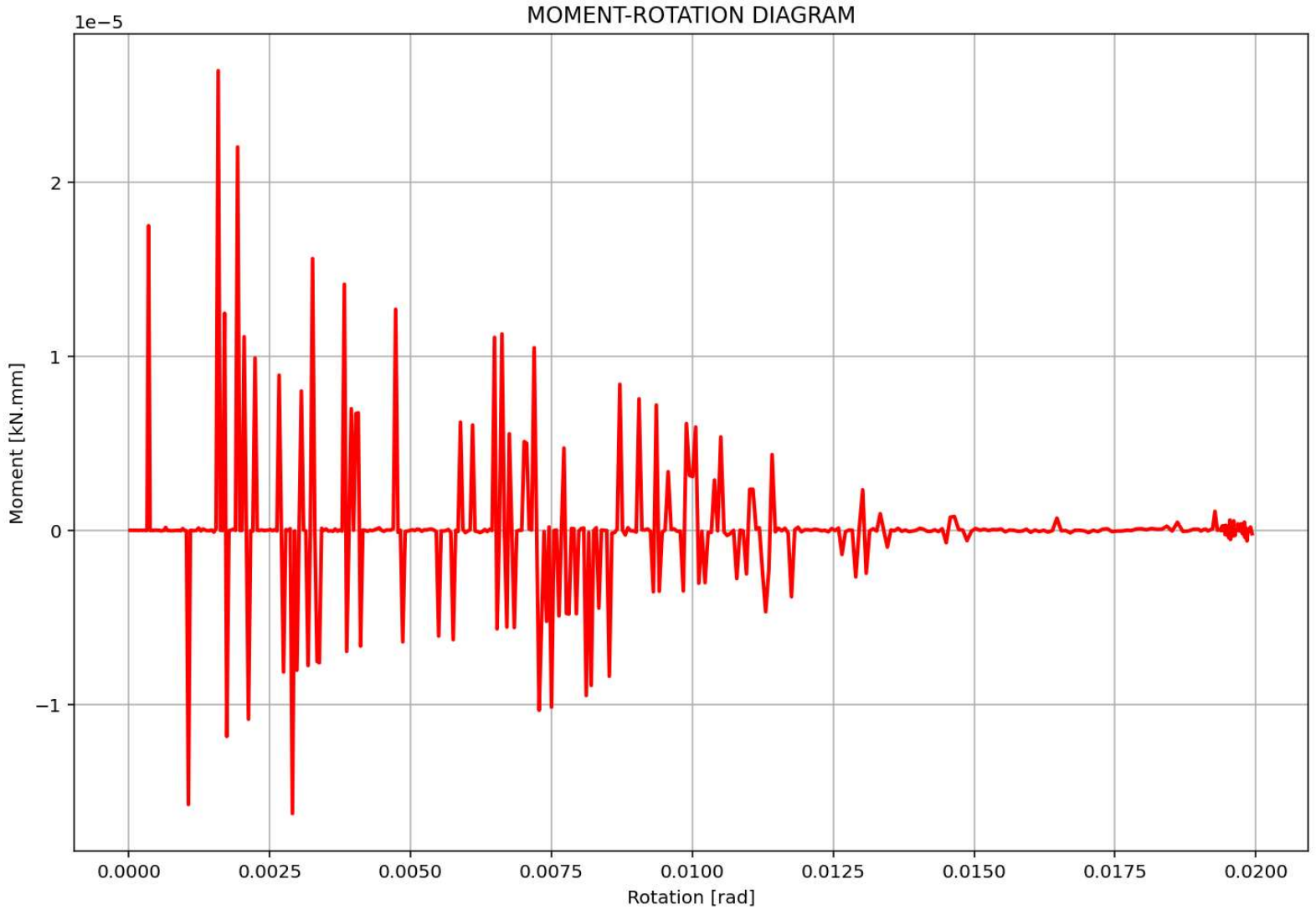

Period of Structure vs Lateral Displacement During Thermal Analysis
PERIOD - MIN VALUES: Min: 1.158 (s) - Mean: 2.516 (s) - Max: 6.620 (s)
PERIOD - MAX VALUES: Min: 9.820 (s) - Mean: 25.848 (s) - Max: 71.858 (s)
Structural Period [s]
0
10
20
30
40
50
60
70
−40
−30
−20
−10
Lateral Displacement [mm] (Node 3)

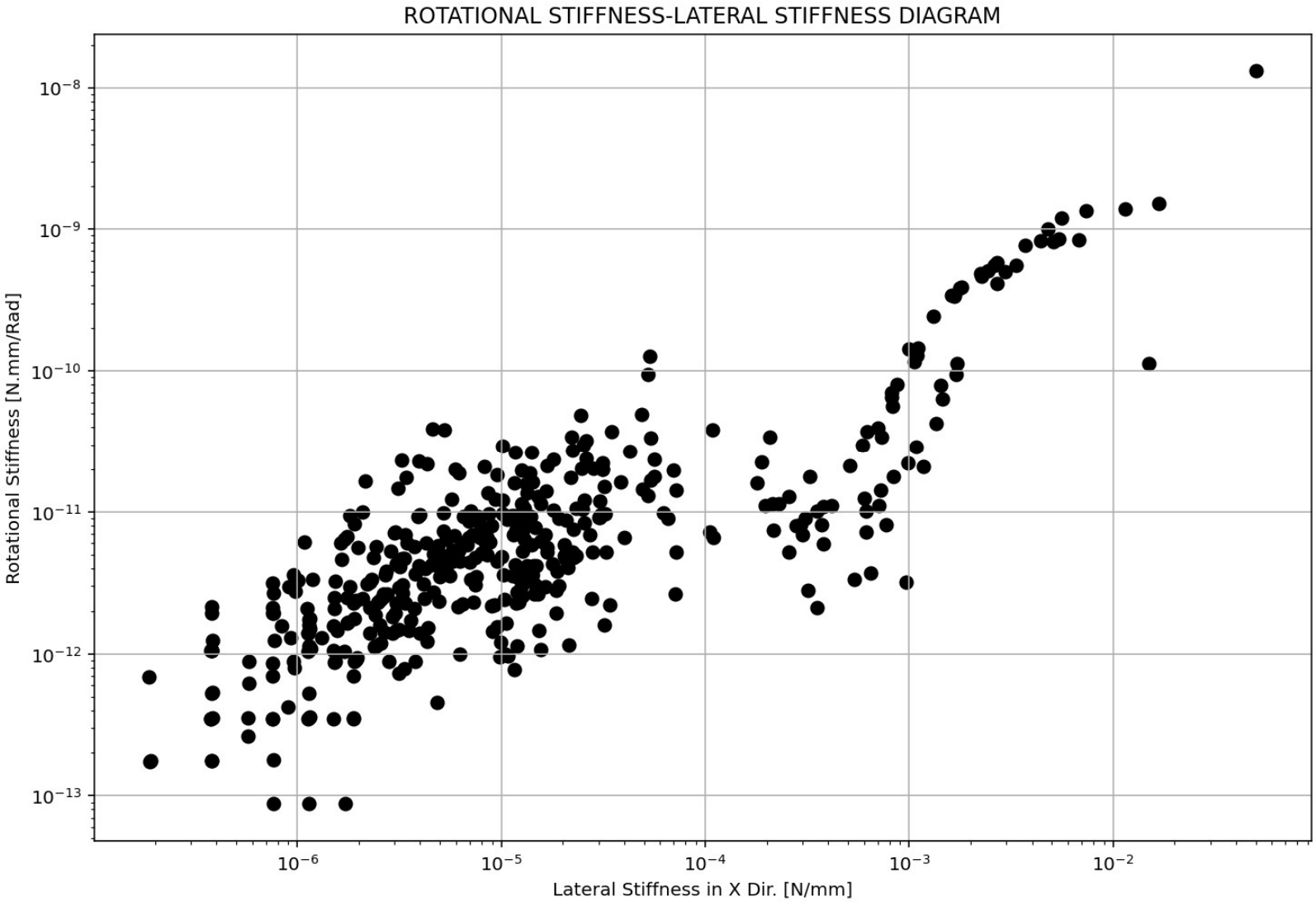

Period of Structure vs Thermal Load Temperature During Thermal Analysis
PERIOD - MIN VALUES: Min: 1.158 (s) - Mean: 2.516 (s) - Max: 6.620 (s)
PERIOD - MAX VALUES: Min: 9.820 (s) - Mean: 25.848 (s) - Max: 71.858 (s)
Structural Period [s]
0
10
20
30
40
50
60
70
200
400
600
800
1000
Thermal Load Temperature [°C]

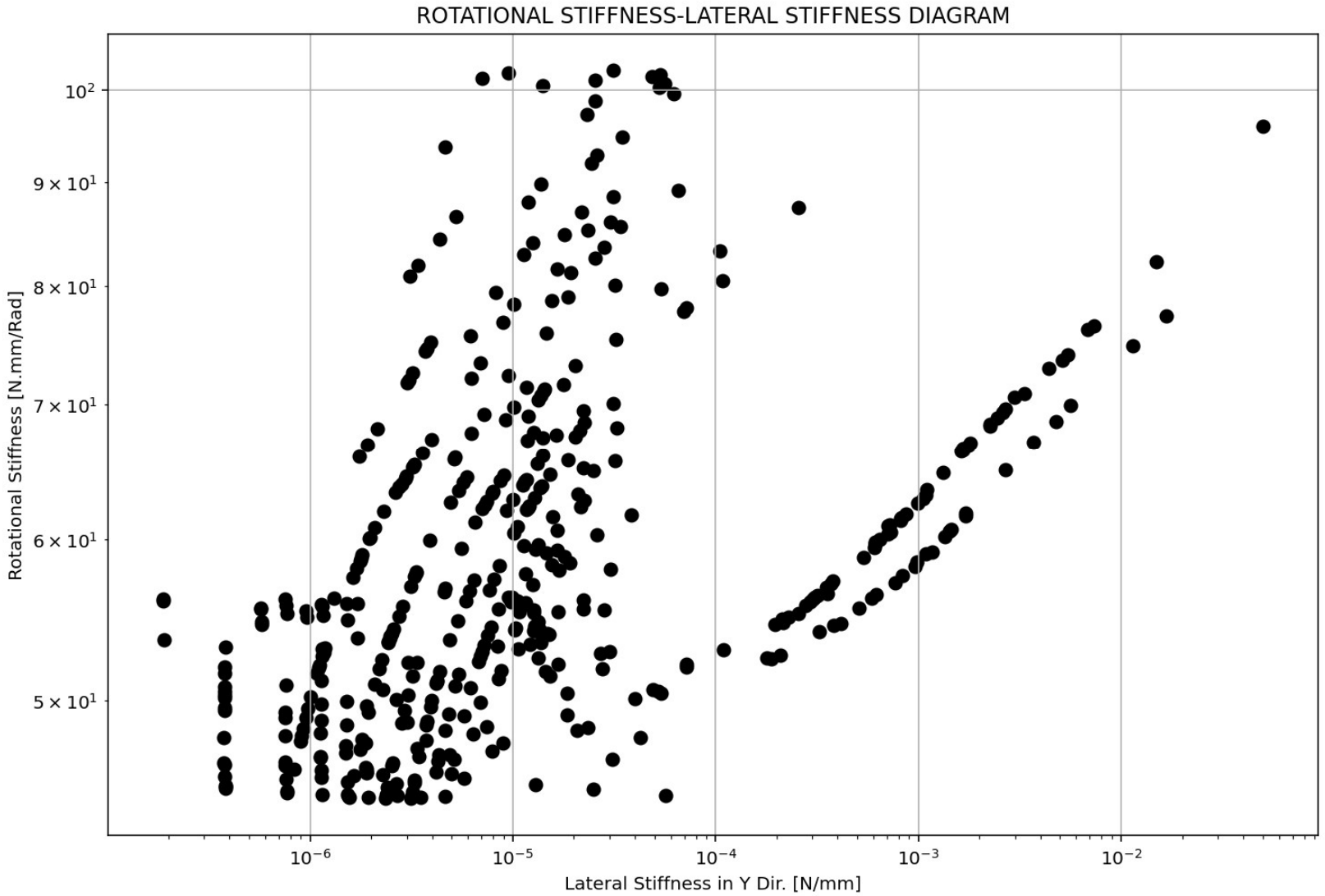

P-M Interaction
Axial Force [N]
2000
1500
1000
500
0
−1
0
1
2
Bending Moment [N.mm]
1e−5

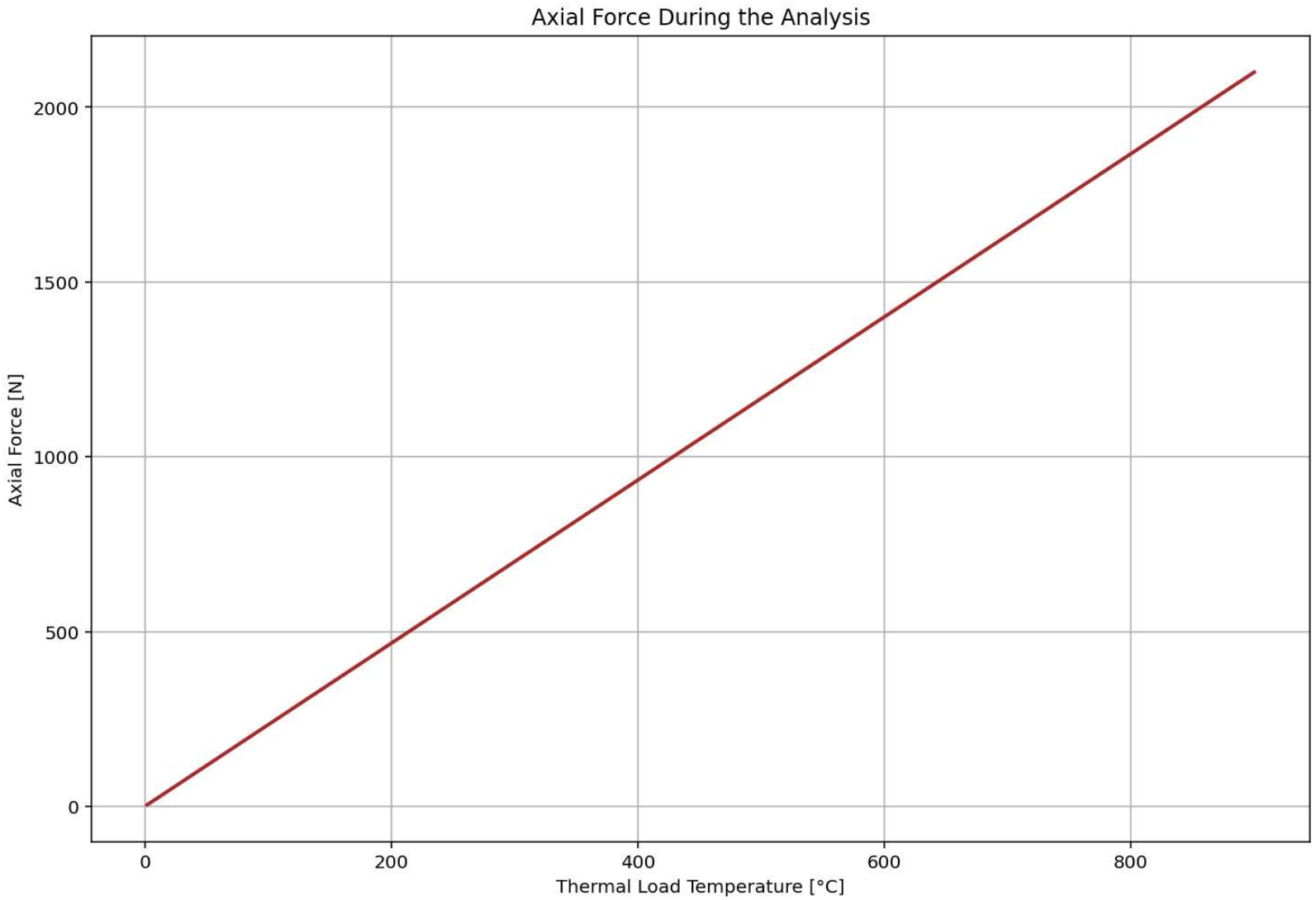

SHEAR FORCE-DISPLACEMENT DIAGRAM
1e−8
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
Shear Force [N]
−40
−30
−20
−10
0
Displacement in X [mm]

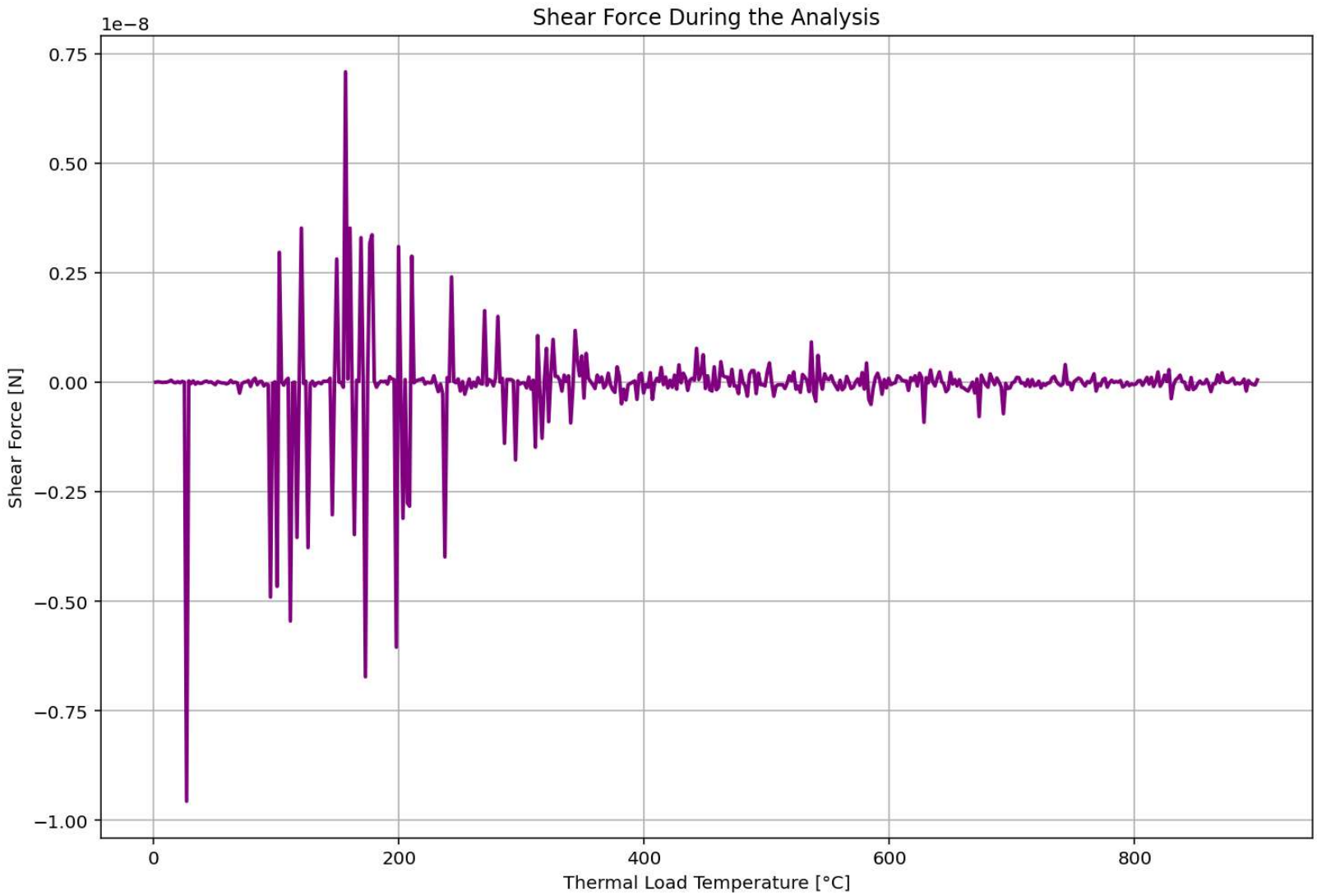

AXIAL FORCE-DISPLACEMENT DIAGRAM
Axial Force [N]
2000
1500
1000
500
0
0
5
10
15
20
25
30
35
Displacement in Y [mm]

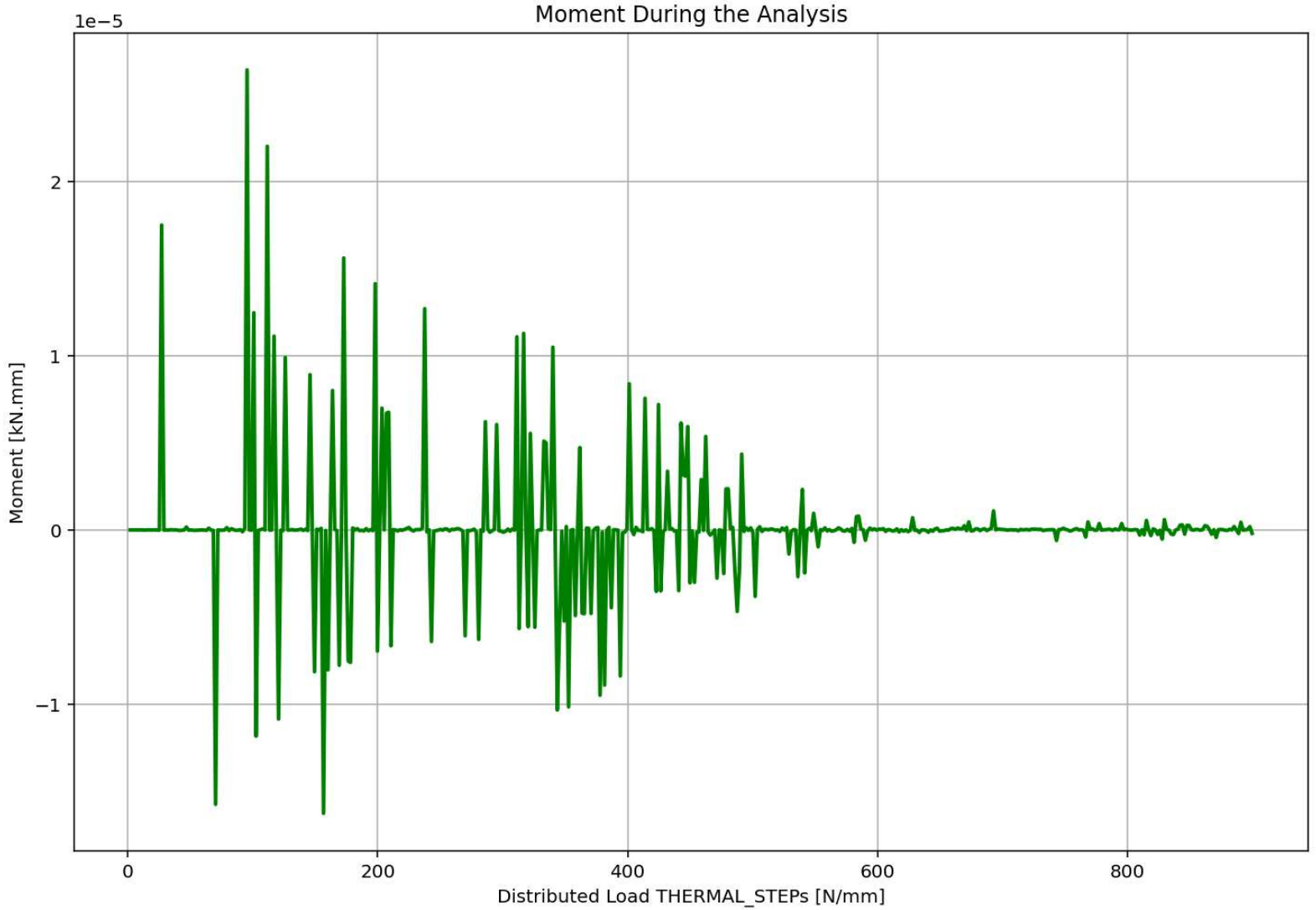

MOMENT-ROTATION DIAGRAM
1e−5
2
1
0
−1
Moment [kN.mm]
0.0000
0.0025
0.0050
0.0075
0.0100
0.0125
0.0150
0.0175
0.0200
Rotation [rad]

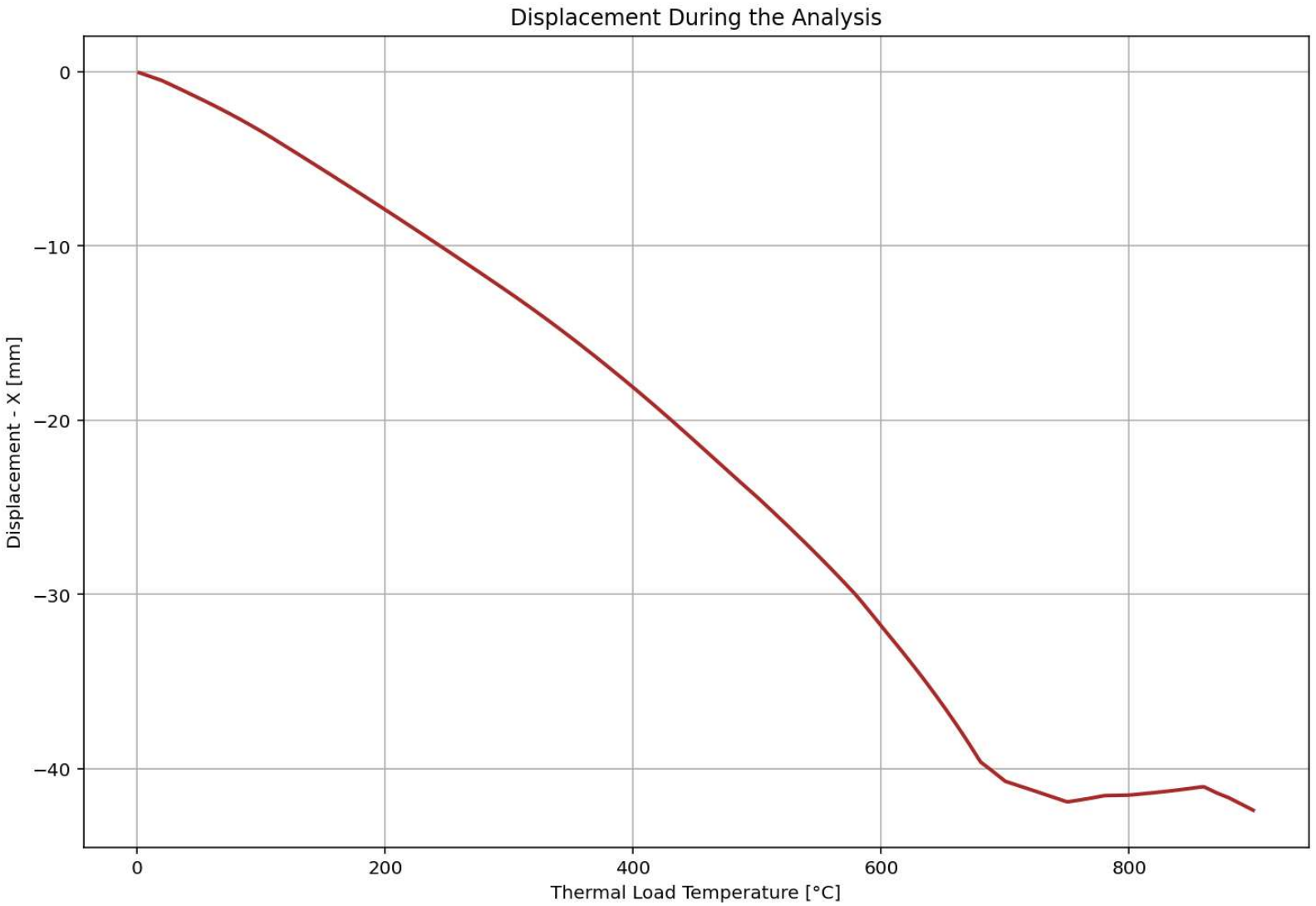

ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM
Rotational Stiffness [N.mm/Rad]
Lateral Stiffness in X Dir. [N/mm]
10^{-8}
10^{-9}
10^{-10}
10^{-11}
10^{-12}
10^{-13}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}

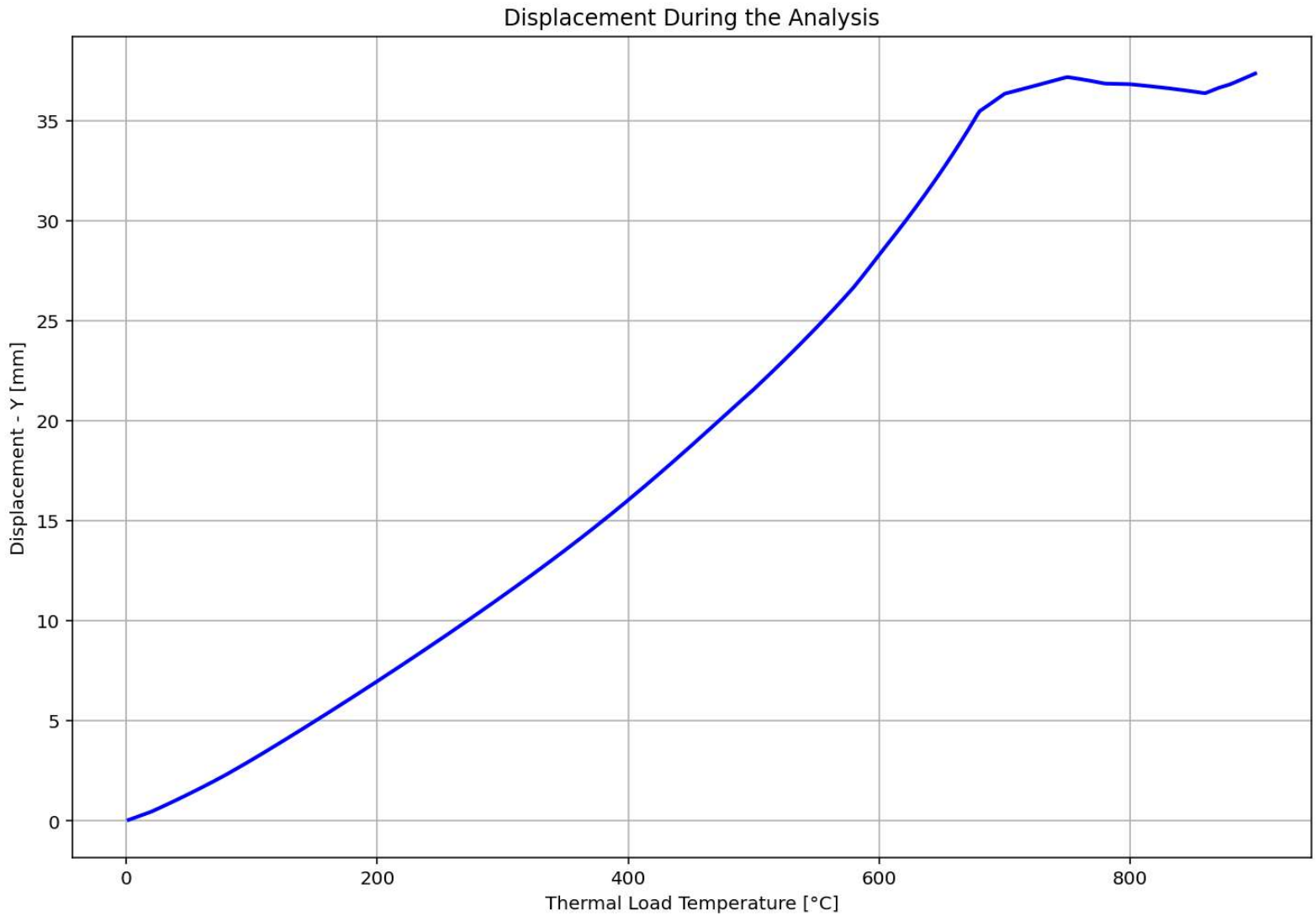

ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM
Rotational Stiffness [N.mm/Rad]
10^2
9×10^1
8×10^1
7×10^1
6×10^1
5×10^1
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
Lateral Stiffness in Y Dir. [N/mm]

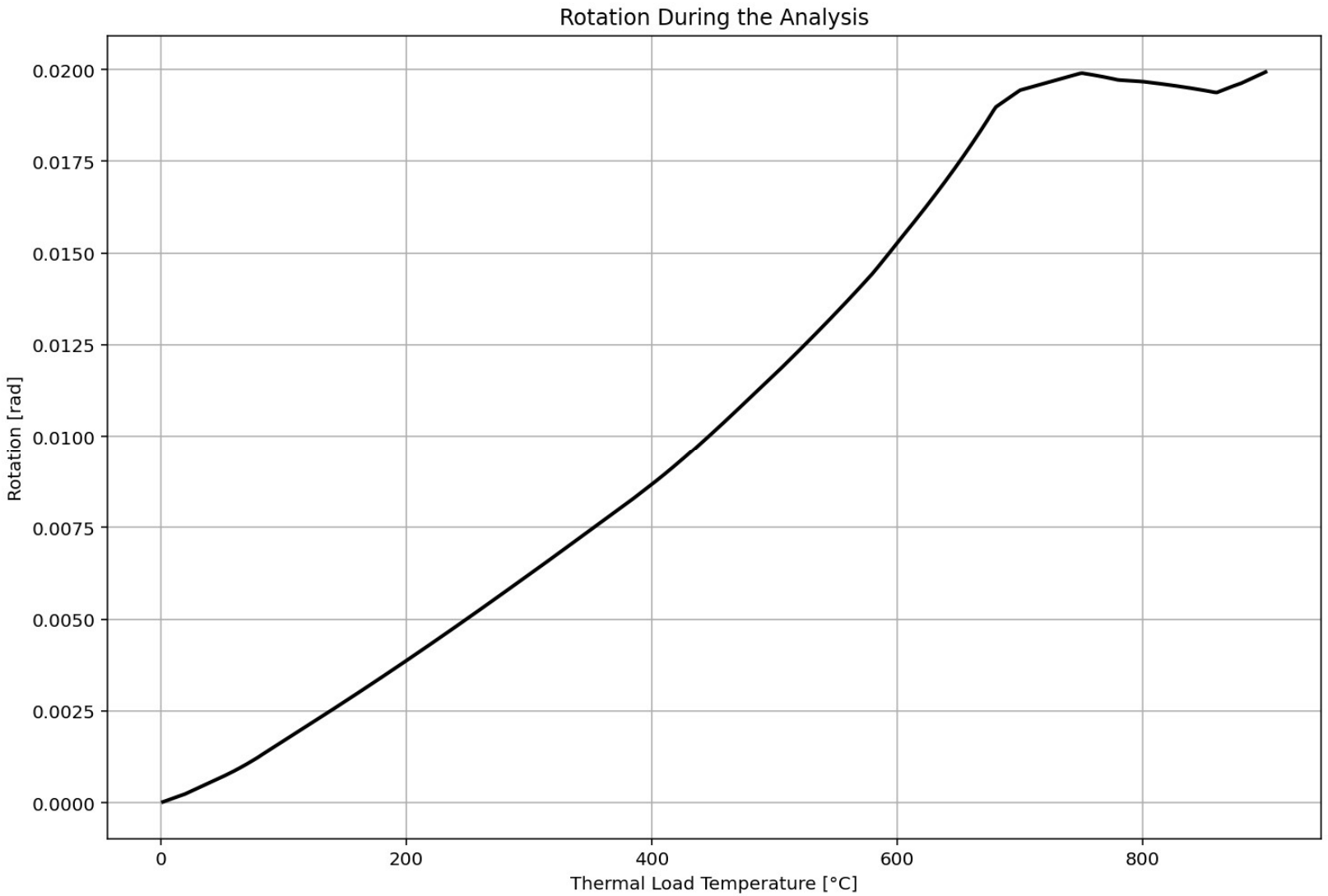

Axial Force During the Analysis
Axial Force [N]
2000
1500
1000
500
0
0
200
400
600
800
Thermal Load Temperature [°C]


Shear Force During the Analysis
1e−8
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
Shear Force [N]
0
200
400
600
800
Thermal Load Temperature [°C]


Moment During the Analysis
1e−5
2
1
0
−1
Moment [kN.mm]
0
200
400
600
800
Distributed Load THERMAL_STEPs [N/mm]


Displacement During the Analysis
0
−10
−20
−30
−40
Displacement - X [mm]
0
200
400
600
800
Thermal Load Temperature [°C]


Displacement During the Analysis
Displacement - Y [mm]
0
5
10
15
20
25
30
35
0
200
400
600
800
Thermal Load Temperature [°C]


Rotation During the Analysis
Rotation [rad]
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
0
200
400
600
800
Thermal Load Temperature [°C]