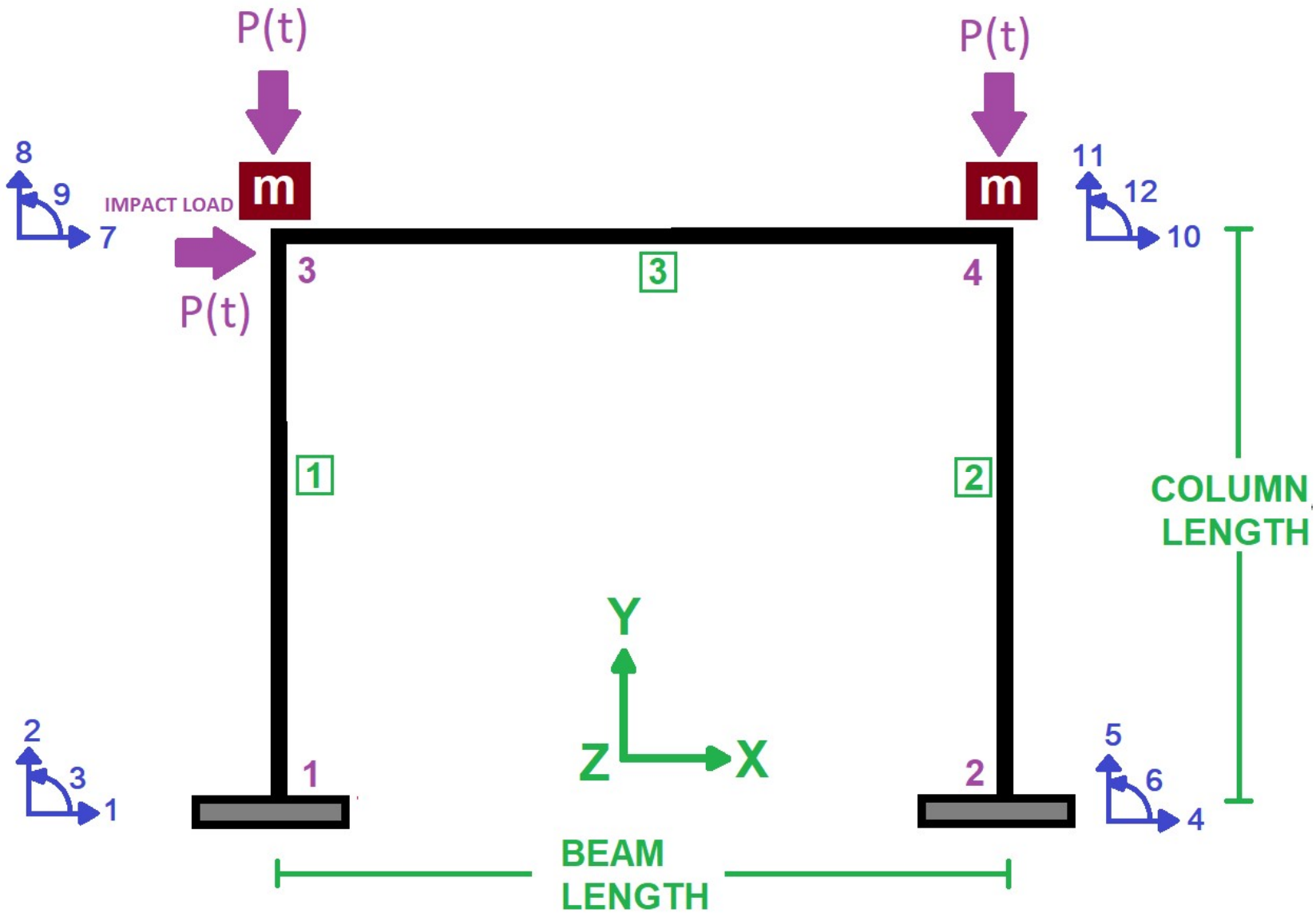
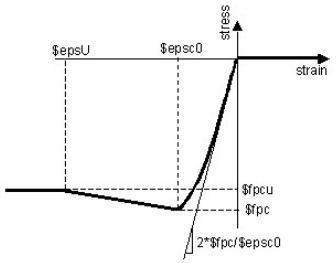
IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL

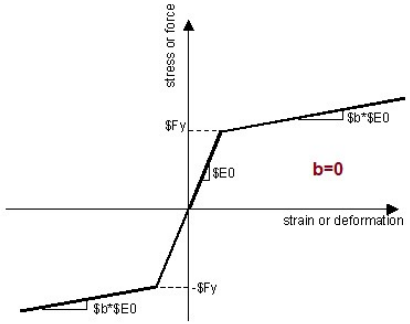
HARMONIC IMPACT LOADING ANALYSIS OF CONCRETE FRAME. EVALUATING STRAIN HARDENING AND ULTIMATE STRAIN CRITERIA USING OPENSEES

WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)

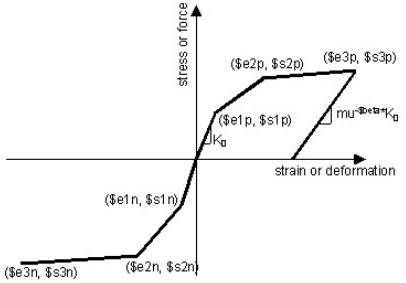

P(t)
P(t)
P(t)
m
m
IMPACT LOAD
8
9
7
11
12
10
3
3
4
1
2
COLUMN
LENGTH
Y
Z
X
2
3
1
1
2
5
6
4
BEAM
LENGTH



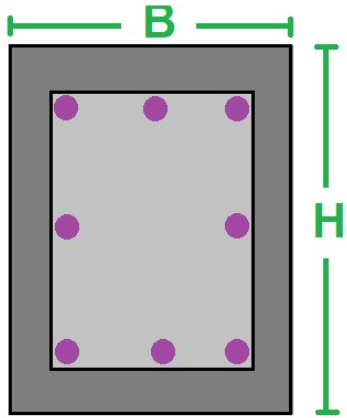
CORE AND COVER CONCRETE REALTION



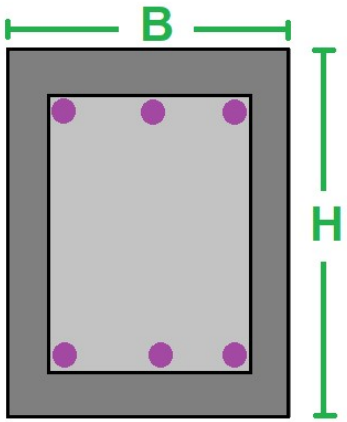
WITHOUT HARDENING AND ULTIMATE STRAIN



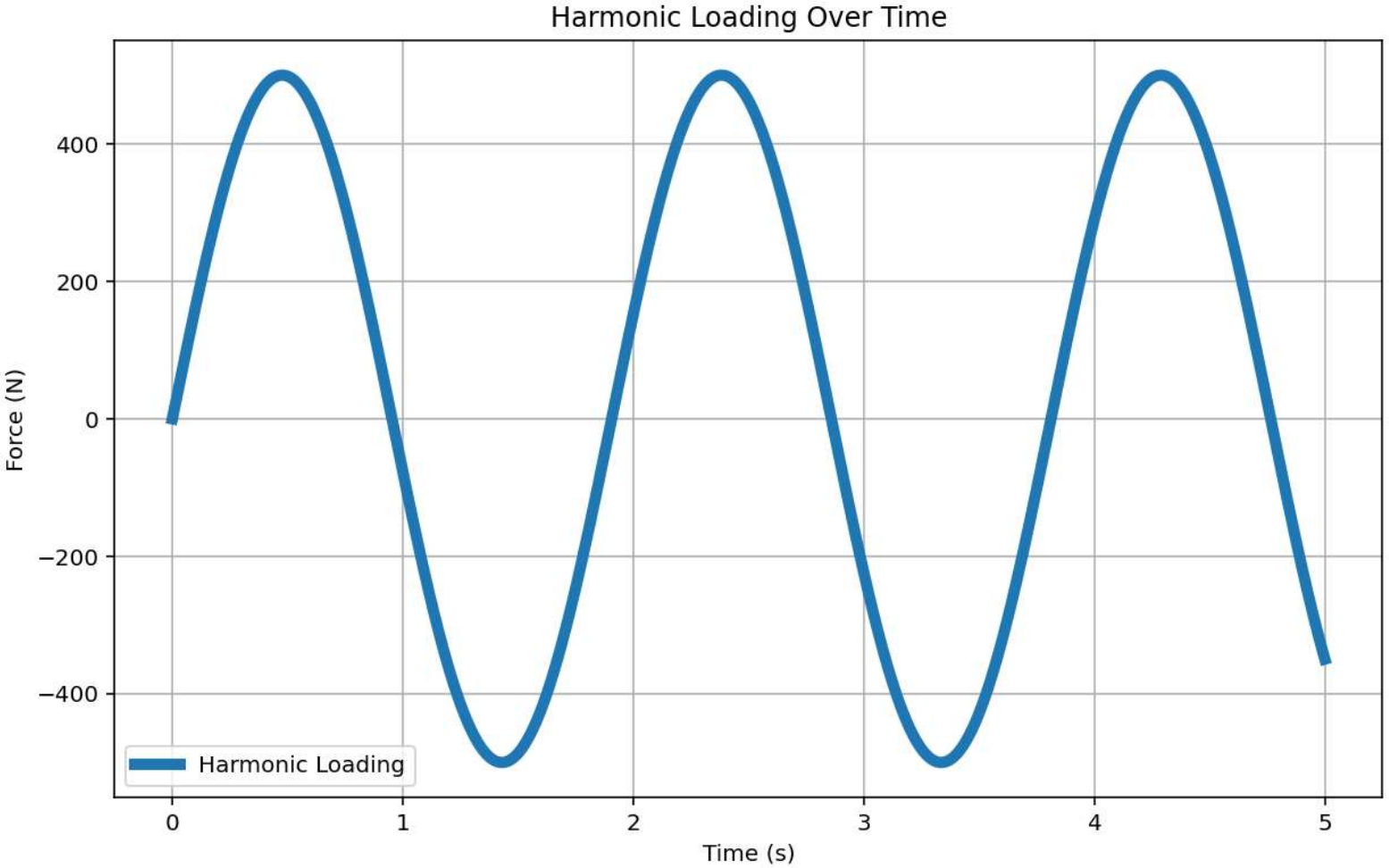
WITH HARDENING AND ULTIMATE STRAIN



COLUMN SECTION



BEAM SECTION


Harmonic Loading Over Time
Force (N)
400
200
0
−200
−400
0
1
2
3
4
5
Time (s)
Harmonic Loading

NONLINEAR DYNAMIC ANALYSIS

Spyder (Python 3.12)

File Edit Search Source Run Debug Consoles Projects Tools View Help

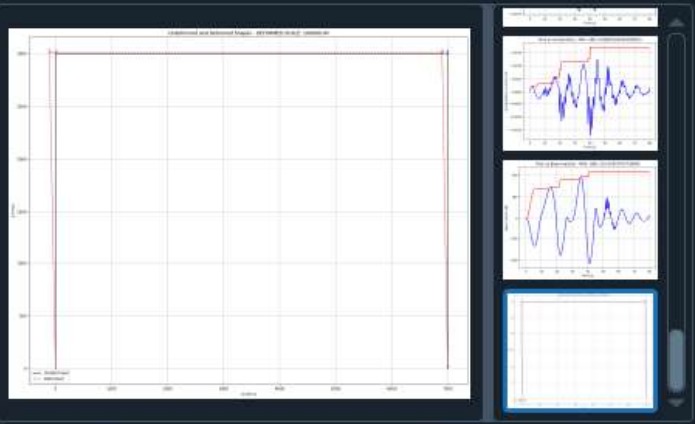
...CONCRETE_FRAME_EXAMPLES\IMPACT_LOAD\HARMONIC_IMPACT_LOAD

C:\Users\Dell\Desktop\OPENSEES_FILES\CONCRETE_FRA...MPACT_LOAD\CONCRETE_FRAME_HARMONIC_IMPACT_LOAD.py

untitled0.py | CONCRETE_FRAME_HARMONIC_IMPACT_LOAD.py

```
#############################################################################
#                              IN THE NAME OF ALLAH                         #
#               HARMONIC IMPACT LOADING ANALYSIS OF CONCRETE FRAME.         #
#      EVALUATING STRAIN HARDENING AND ULTIMATE STRAIN CRITERIA USING OPENSEES      #
#---------------------------------------------------------------------------#
#            THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)     #
#                    EMAIL: salar.d.ghashghaei@gmail.com                    #
#############################################################################
"""
-------------------------------------------------------
 Analysis of Harmonic Impact Loading on Concrete Frame
-------------------------------------------------------

A 'harmonic load' simulates the 'cyclic or oscillatory force' caused by elevator motor vibrations
 during operation. As the motor runs, it generates 'periodic dynamic forces' that can be
 approximated by sinusoidal functions (e.g., sine or cosine).
 These loads vary with time and can cause 'resonance or fatigue' in nearby structural elements
 like beams or columns. Modeling such loads helps engineers evaluate 'vibration effects' and ensure
 structural integrity, especially in high-rise buildings.
 Harmonic analysis is particularly useful when direct impact forces are not easily measurable.

This program performs a nonlinear dynamic analysis of a concrete frame subjected to harmonic impact loading usin
 The analysis evaluates two different steel material models:
1. Steel01 (without hardening and ultimate strain criteria)
2. Hysteretic (with hardening and ultimate strain criteria)

Key Features:

[1] Material Definitions
Concrete:
  - Confined core concrete (higher strength and ductility)
  - Unconfined cover concrete
Steel Reinforcement:
  - Two material models compared
```

13 %



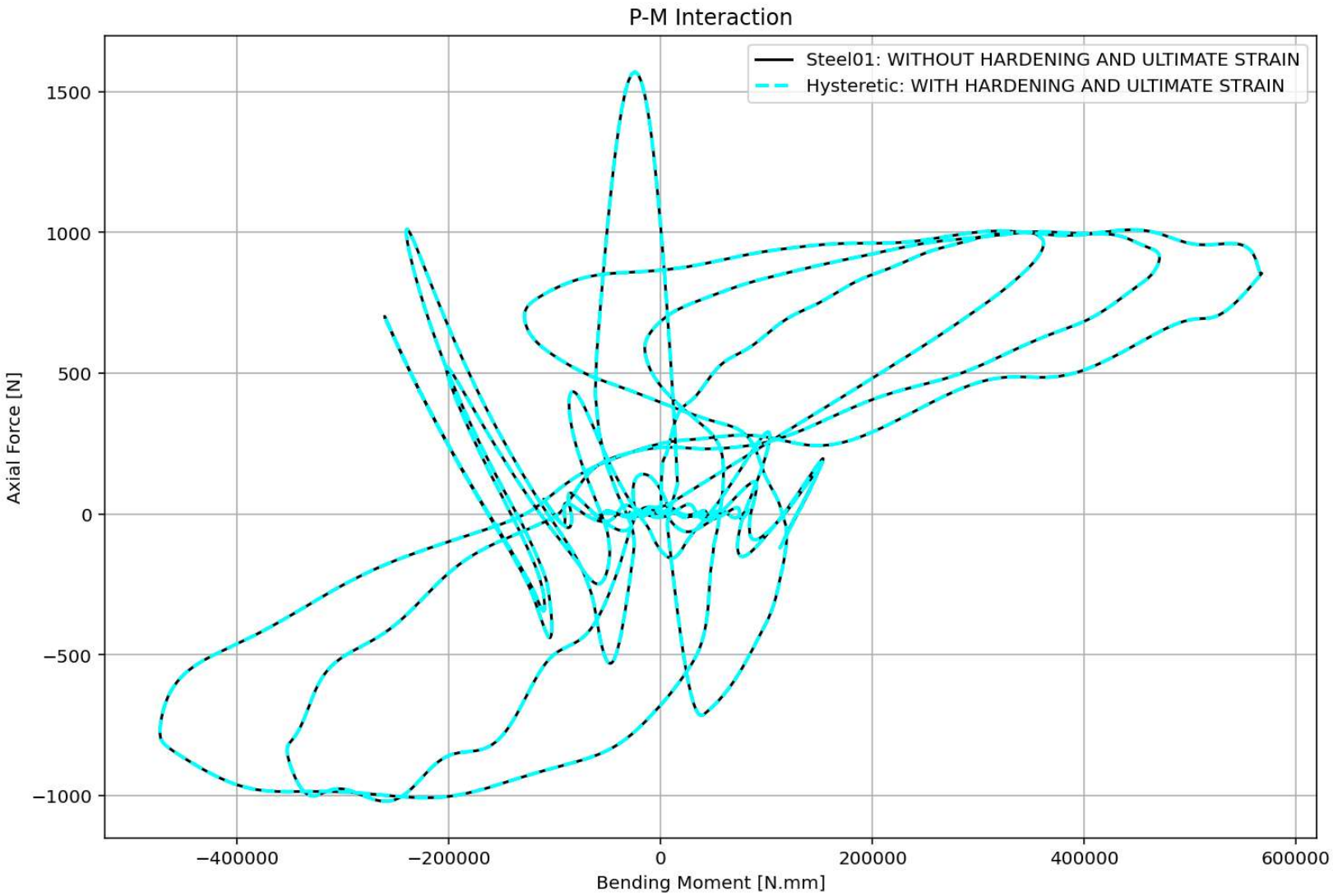
Help | Variable Explorer | Debugger | Plots | Files

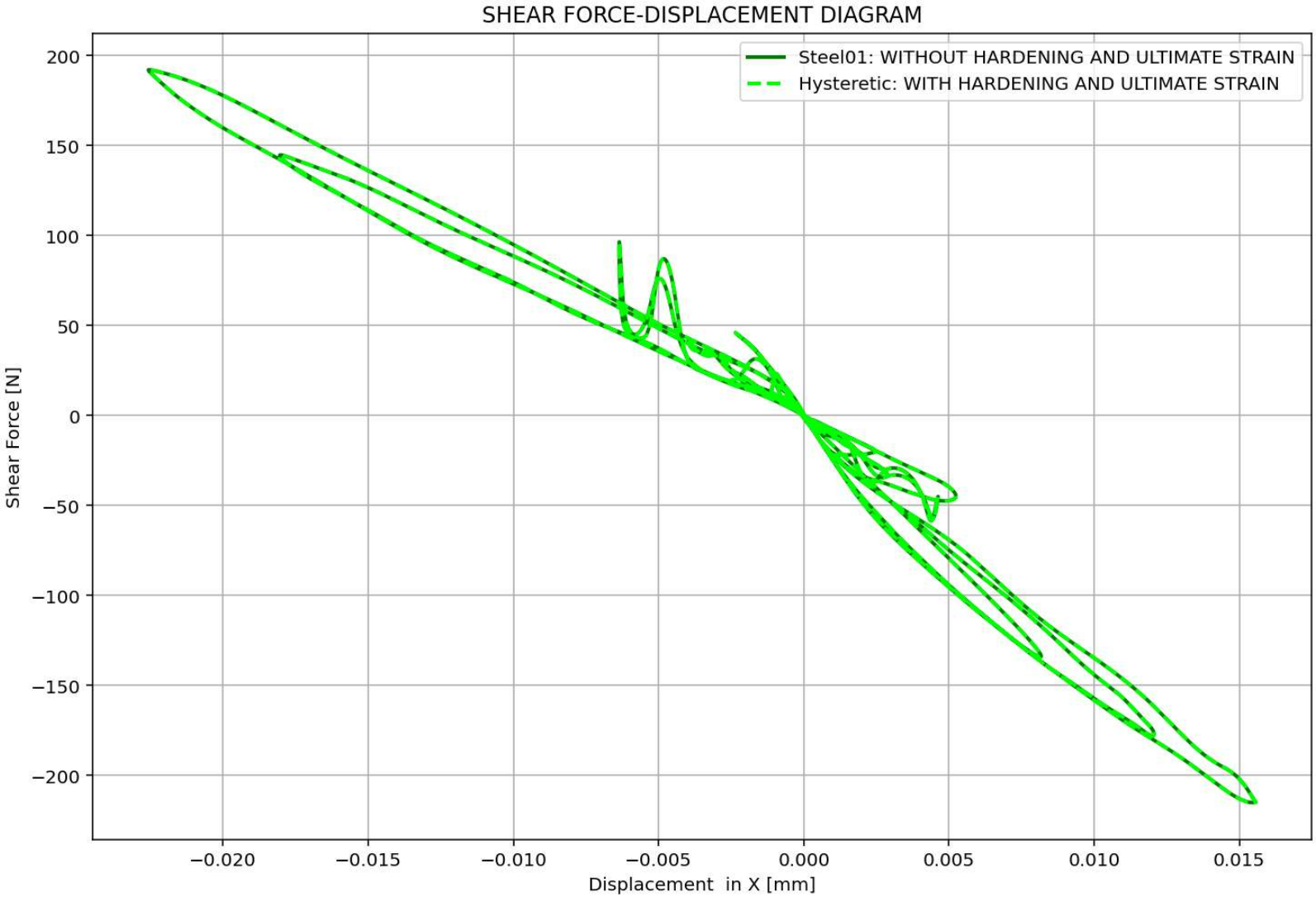
Console 1/A

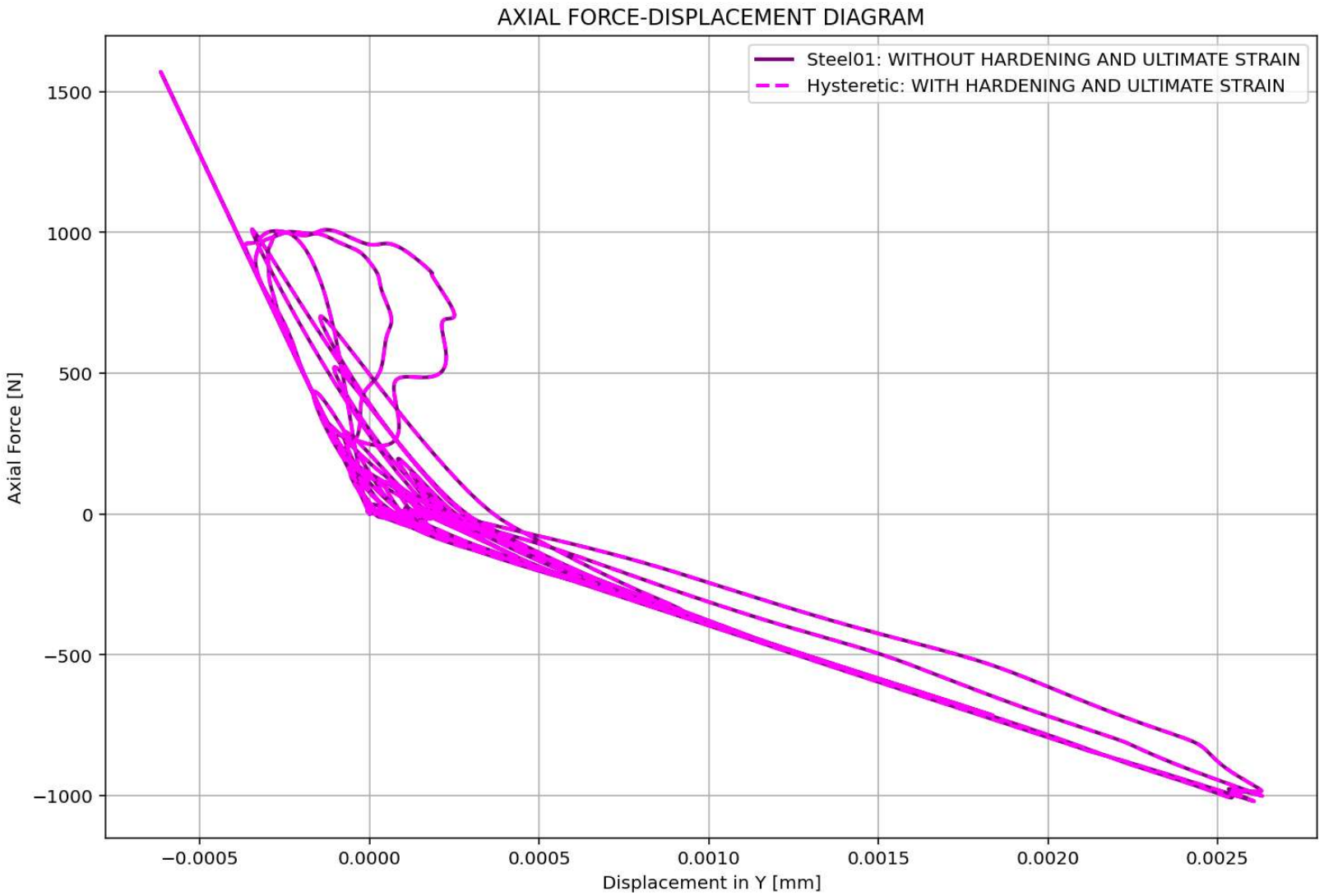
```
80.00000000000402 -0.0011013827607377757 11.340301289636898
WITHOUT HARDENING AND ULTIMATE STRAIN:
 Period 01: 8.2477e-01  - Period 02: 5.8217e+00
WITH HARDENING AND ULTIMATE STRAIN:
 Period 01: 8.2477e-01  - Period 02: 5.8217e+00

Total time (s): 6.8125


Exact Damping Ratio: 3.47856272e-02
C:
```

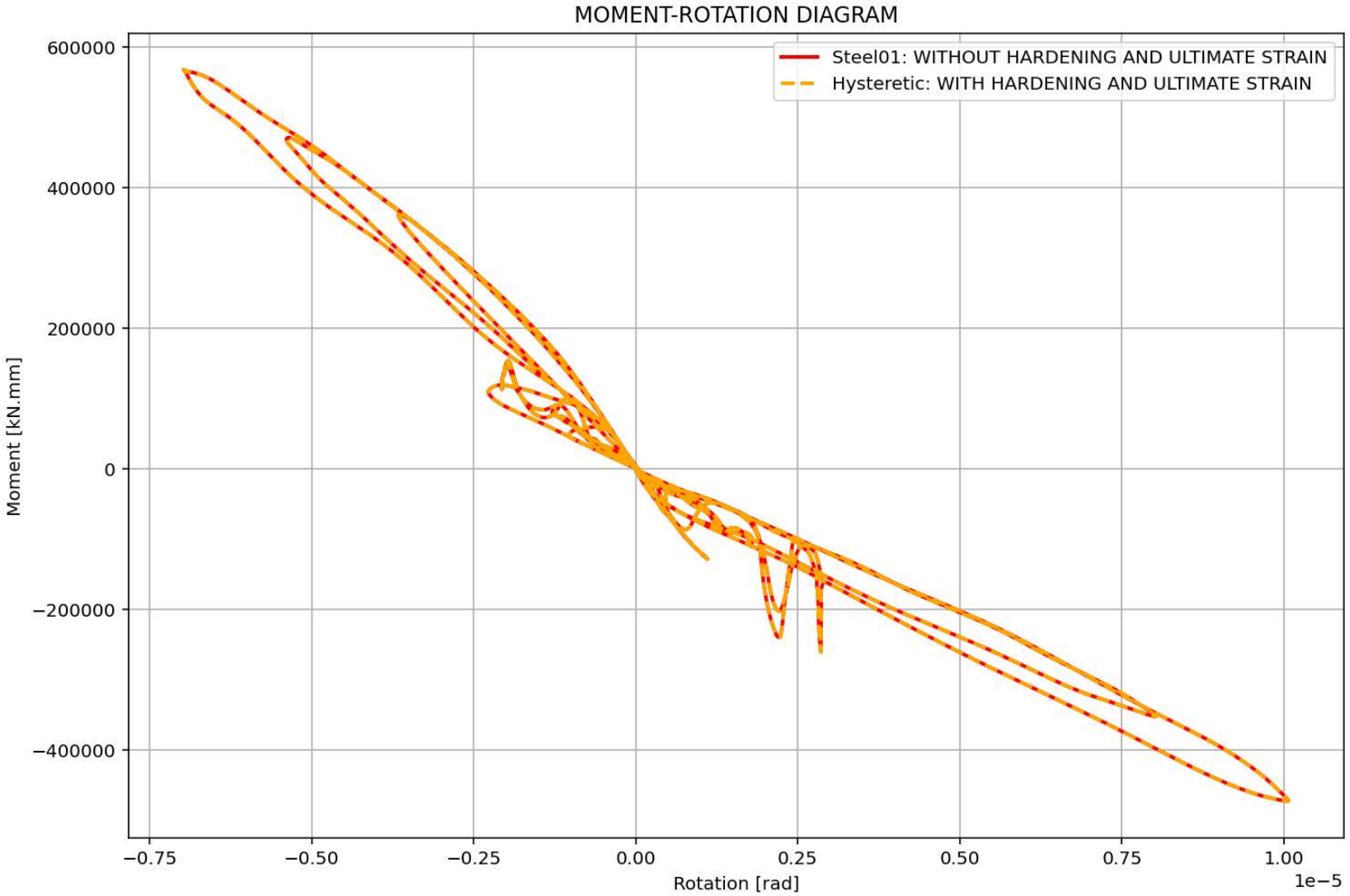
IPython Console | History

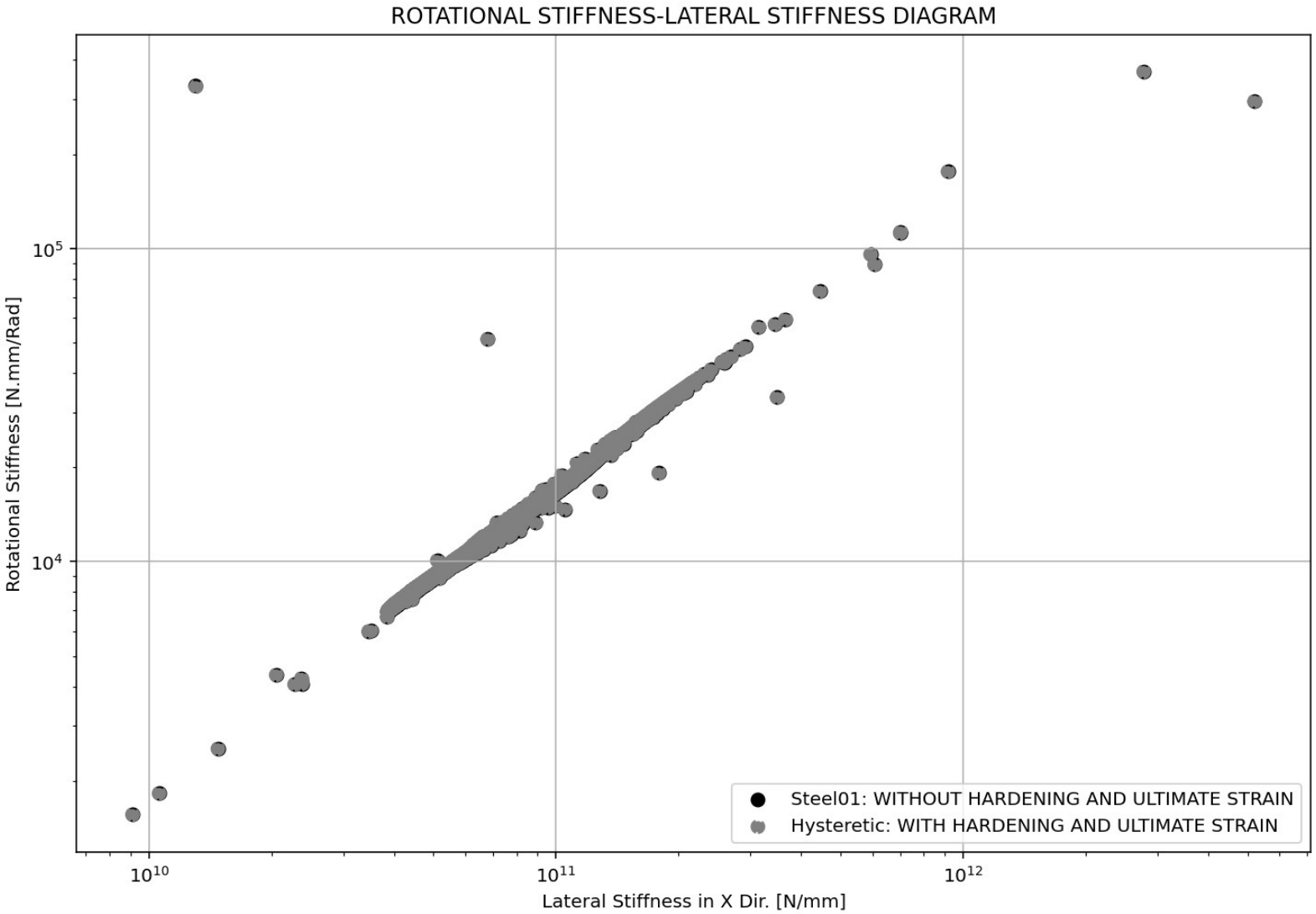
Inline Conda: anaconda3 (Python 3.12.7) LSP: Python Line 12, Col 48 UTF-8 CRLF RW Mem 38%

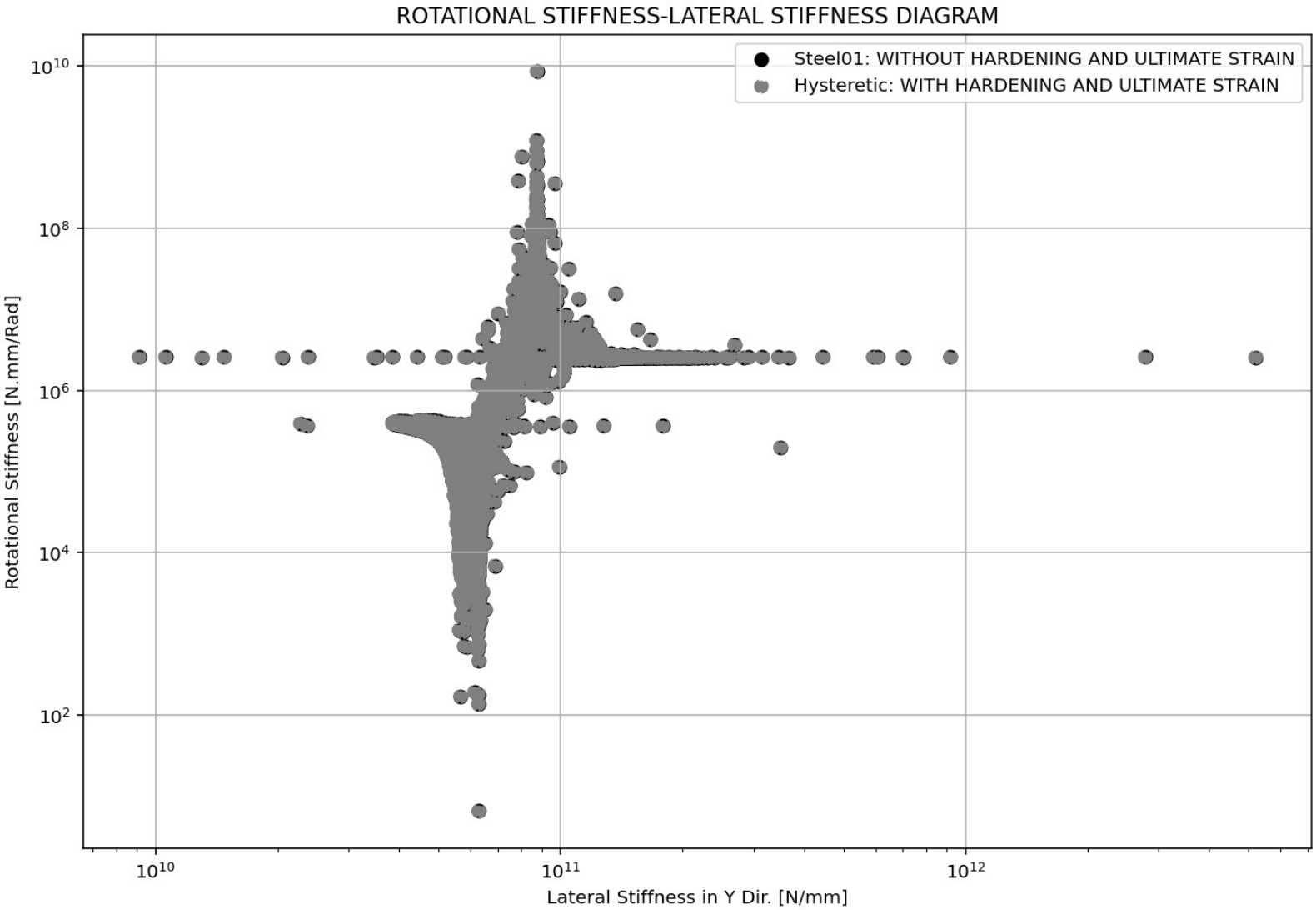

P-M Interaction
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
Axial Force [N]
1500
1000
500
0
−500
−1000
−400000
−200000
0
200000
400000
600000
Bending Moment [N.mm]

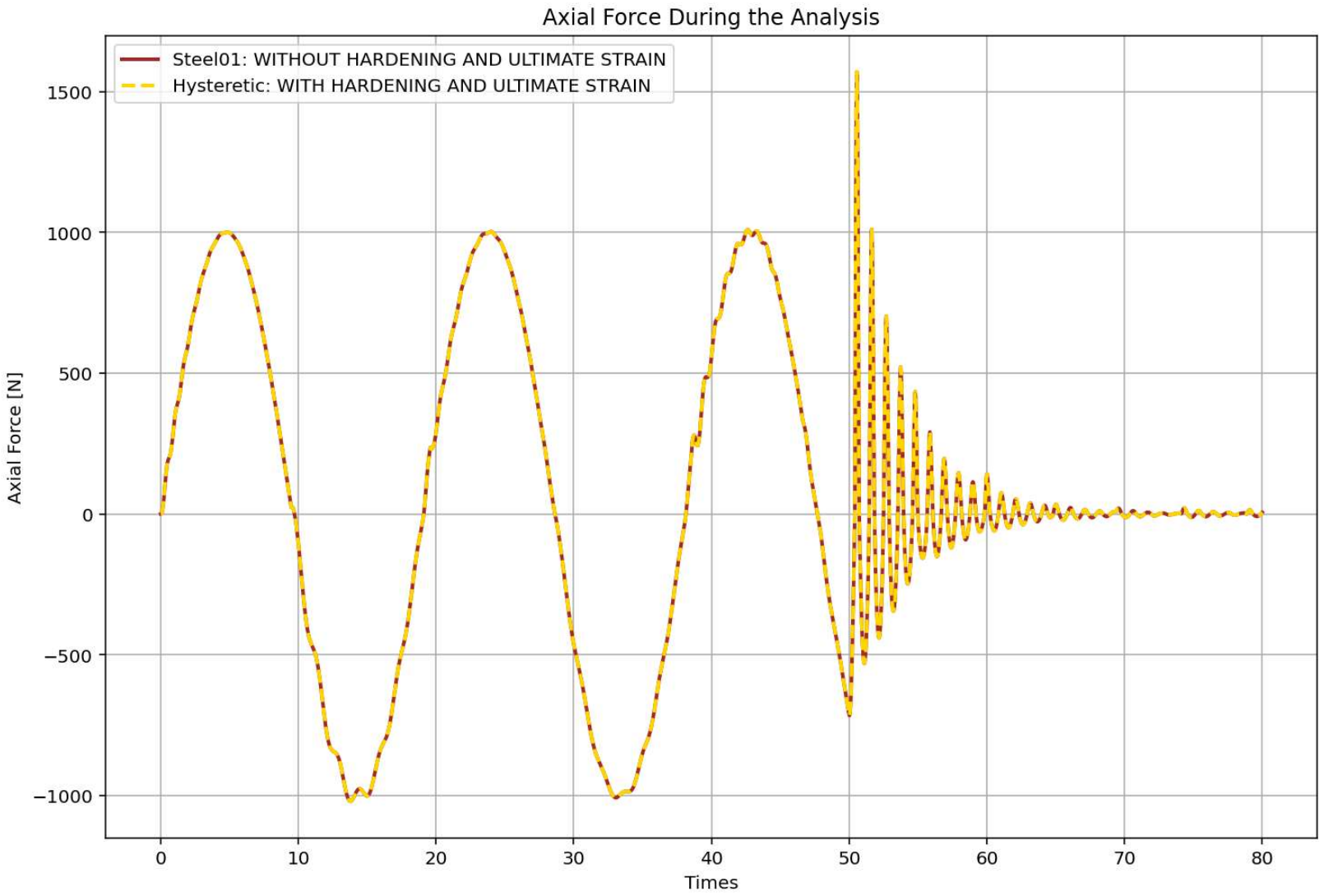

SHEAR FORCE-DISPLACEMENT DIAGRAM
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
Shear Force [N]
200
150
100
50
0
−50
−100
−150
−200
−0.020
−0.015
−0.010
−0.005
0.000
0.005
0.010
0.015
Displacement in X [mm]

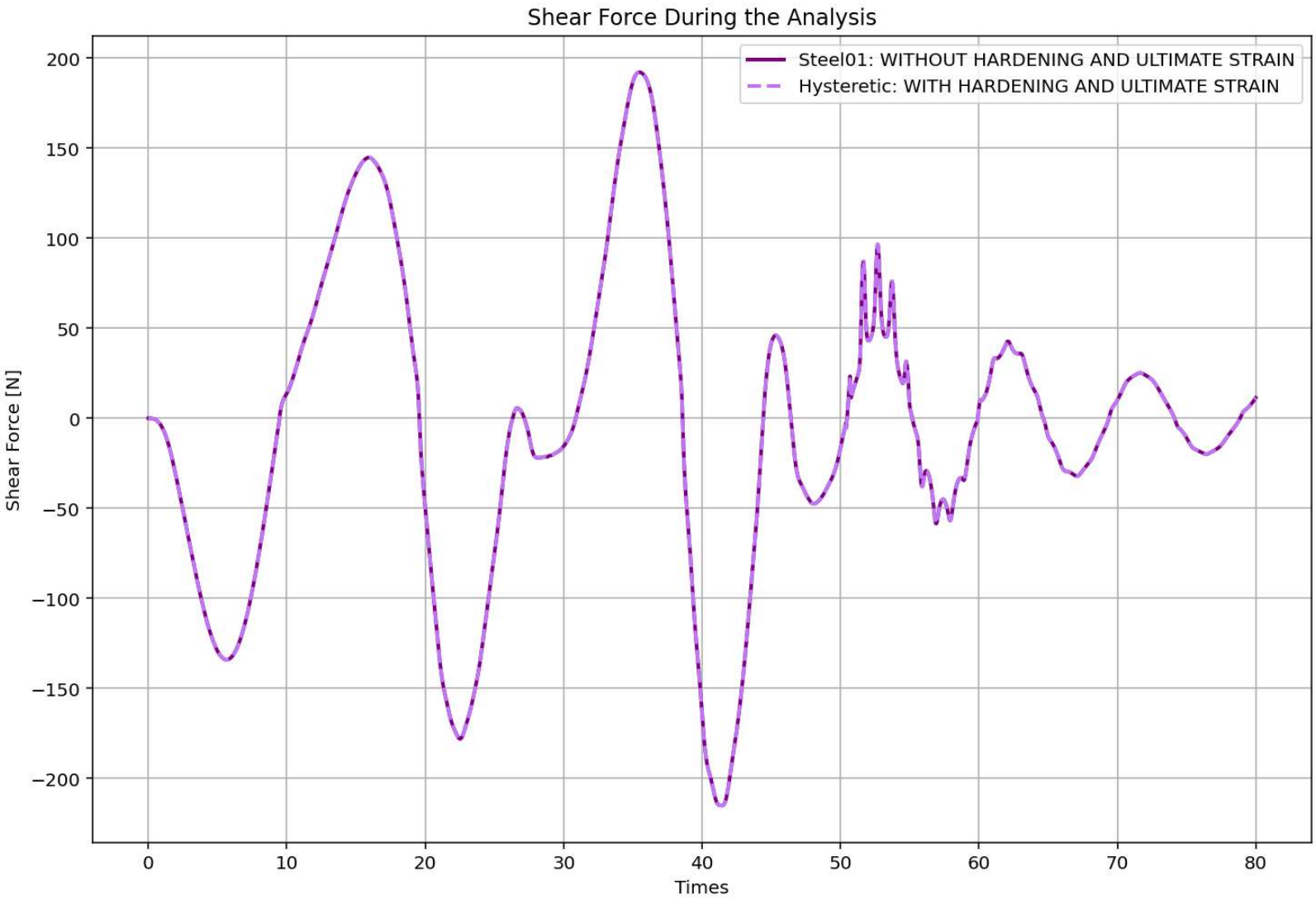

AXIAL FORCE-DISPLACEMENT DIAGRAM
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
Axial Force [N]
1500
1000
500
0
−500
−1000
−0.0005
0.0000
0.0005
0.0010
0.0015
0.0020
0.0025
Displacement in Y [mm]

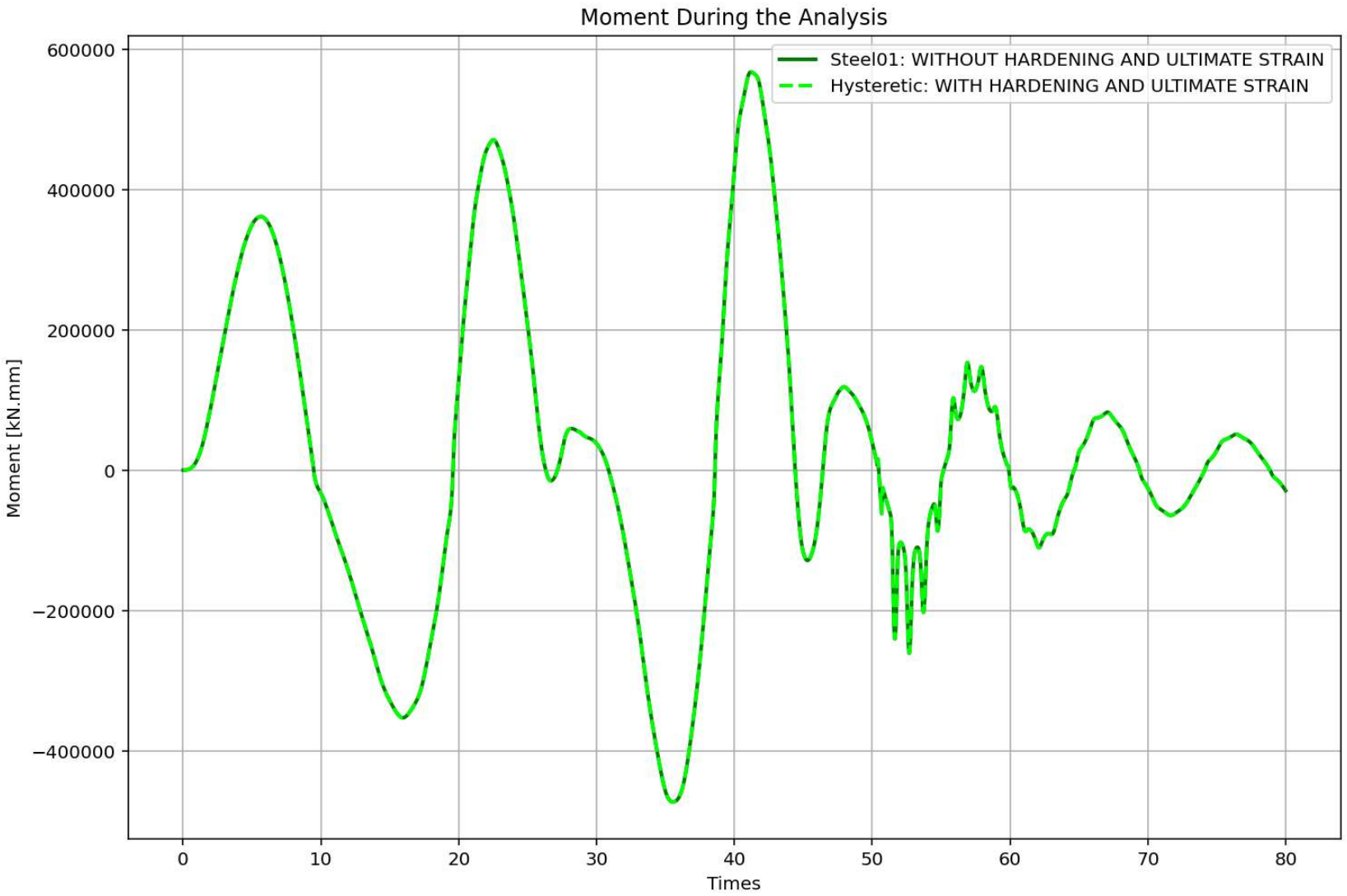

MOMENT-ROTATION DIAGRAM
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
600000
400000
200000
0
−200000
−400000
Moment [kN.mm]
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
1e−5
Rotation [rad]

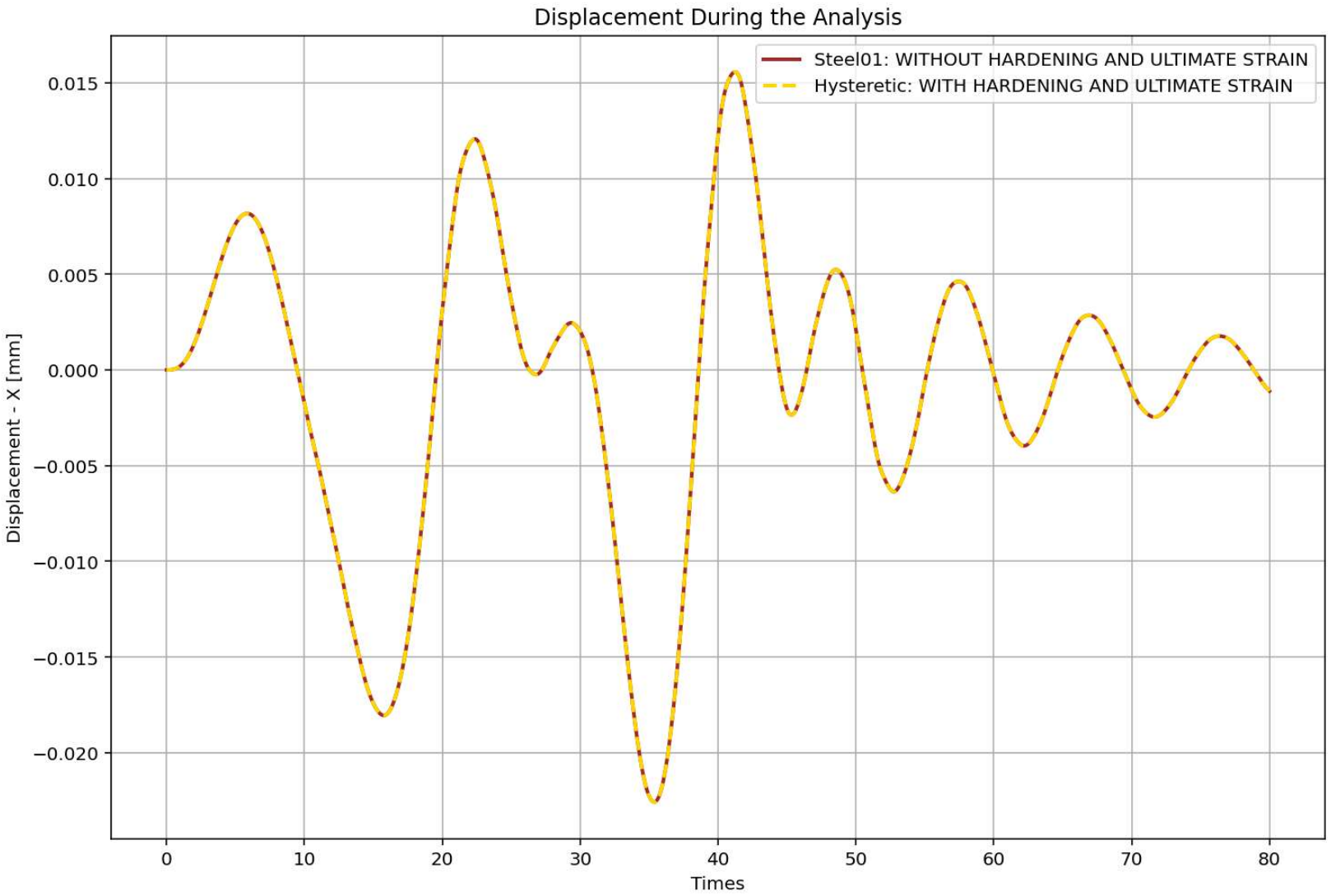

ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM
Rotational Stiffness [N.mm/Rad]
10^5
10^4
10^{10}
10^{11}
10^{12}
Lateral Stiffness in X Dir. [N/mm]
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN

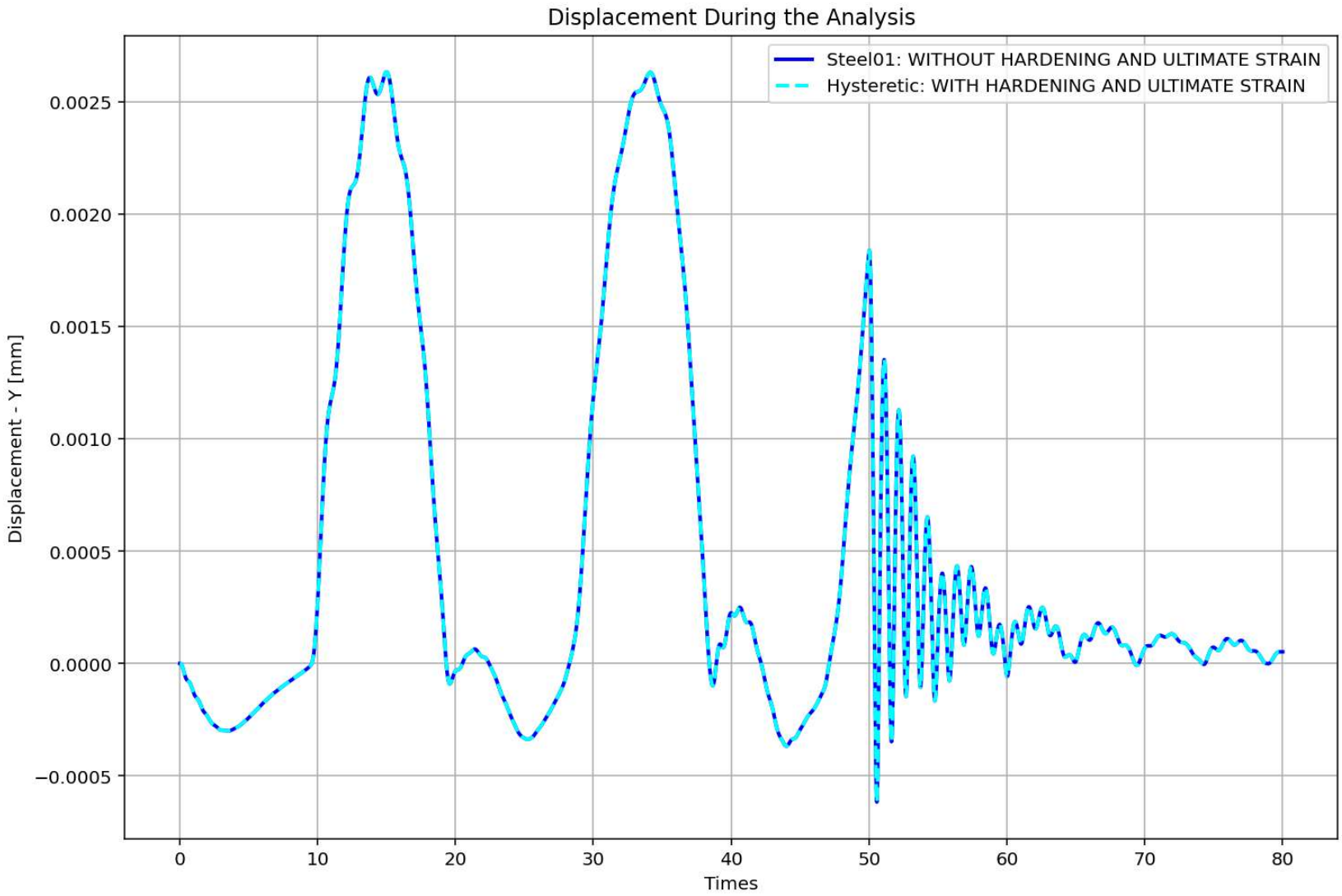

ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
Rotational Stiffness [N.mm/Rad]
10^{10}
10^{8}
10^{6}
10^{4}
10^{2}
10^{10}
10^{11}
10^{12}
Lateral Stiffness in Y Dir. [N/mm]

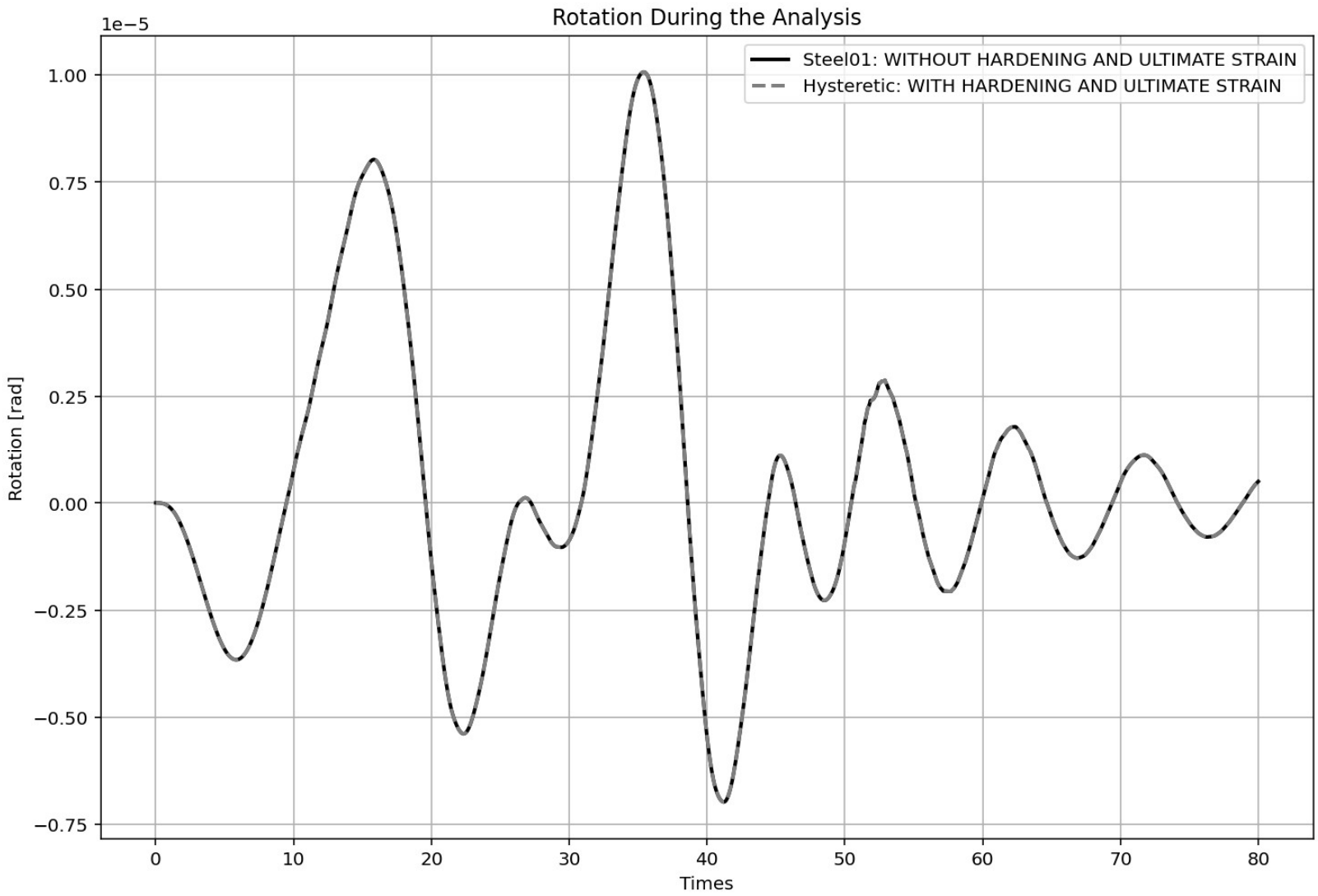

Axial Force During the Analysis
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
Axial Force [N]
1500
1000
500
0
−500
−1000
0
10
20
30
40
50
60
70
80
Times

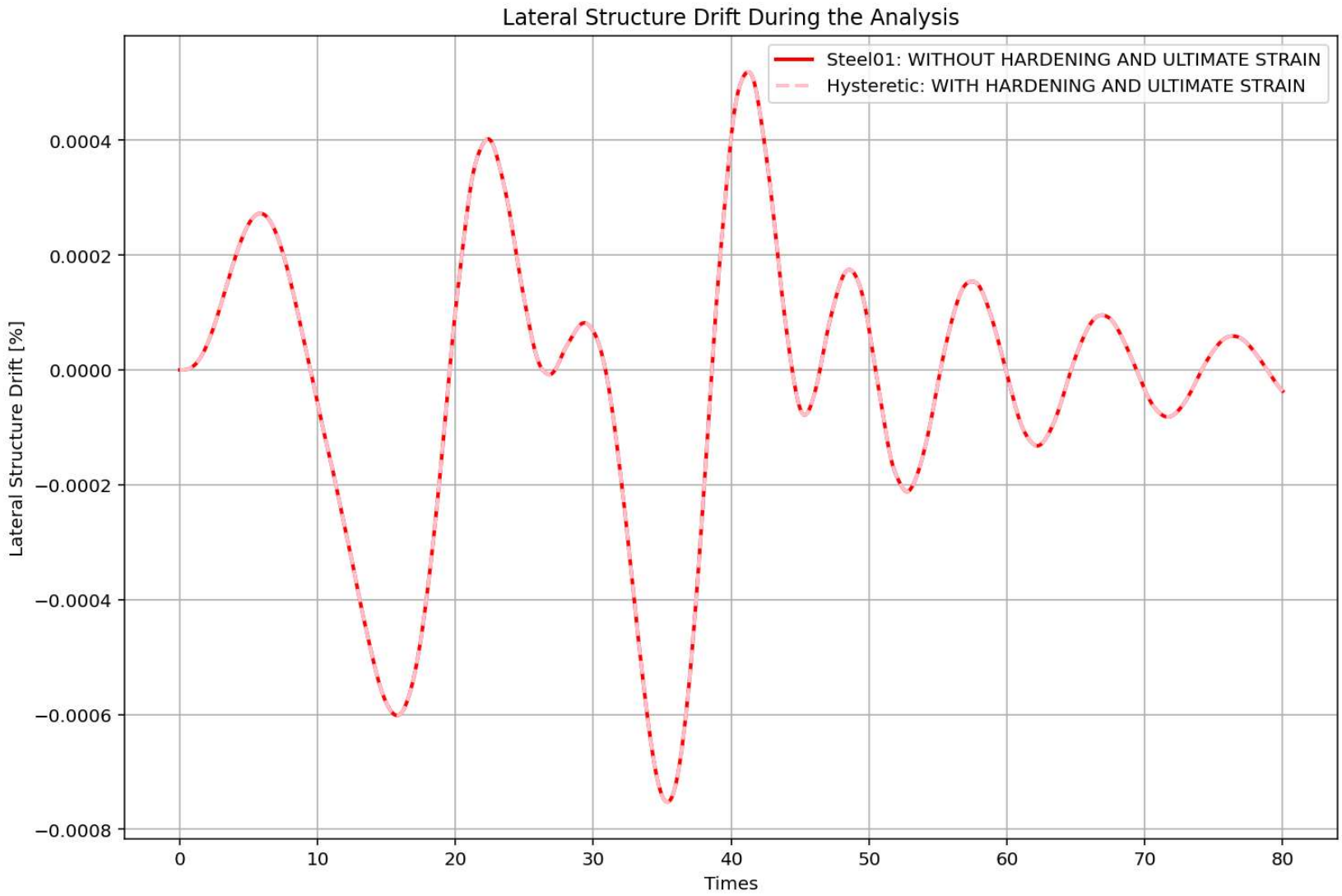

Shear Force During the Analysis
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
Shear Force [N]
Times
200
150
100
50
0
−50
−100
−150
−200
0
10
20
30
40
50
60
70
80

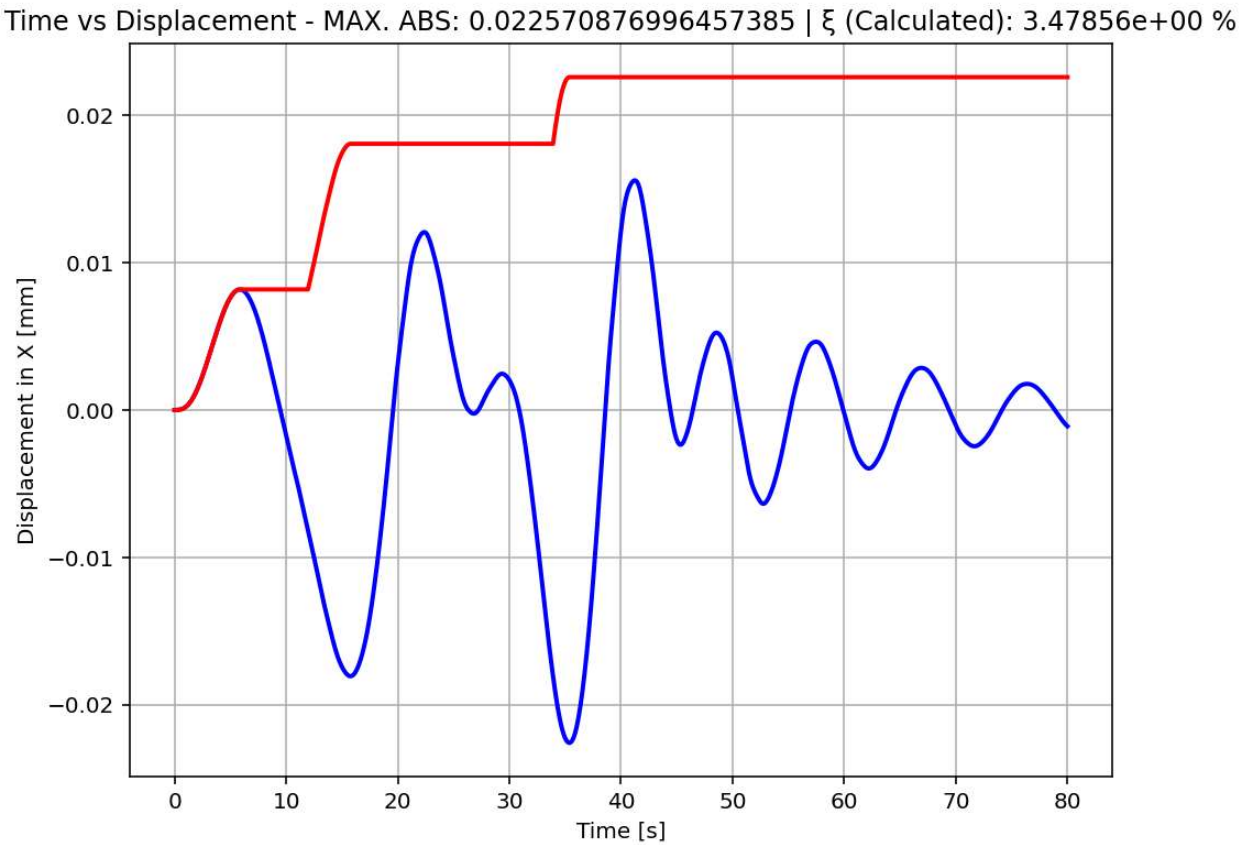

Moment During the Analysis
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
Moment [kN.mm]
600000
400000
200000
0
−200000
−400000
0
10
20
30
40
50
60
70
80
Times

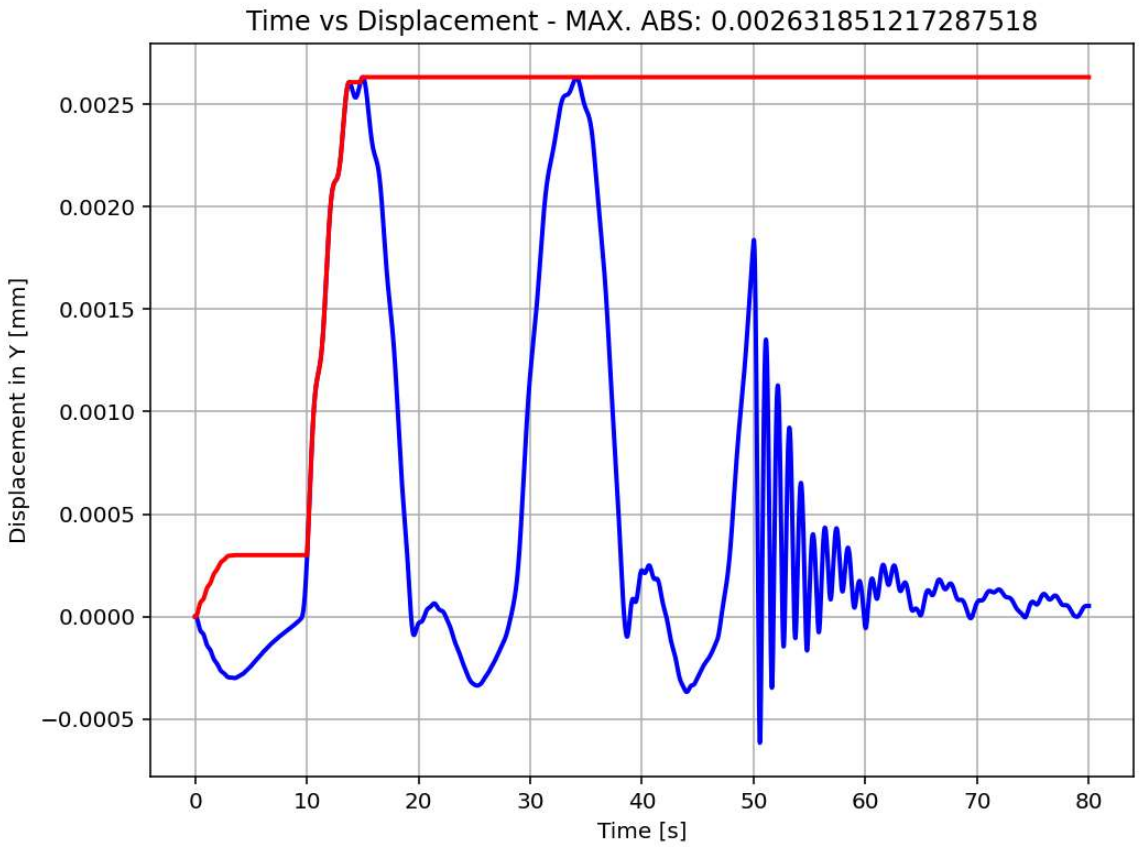

Displacement During the Analysis
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
Displacement - X [mm]
0.015
0.010
0.005
0.000
−0.005
−0.010
−0.015
−0.020
0
10
20
30
40
50
60
70
80
Times

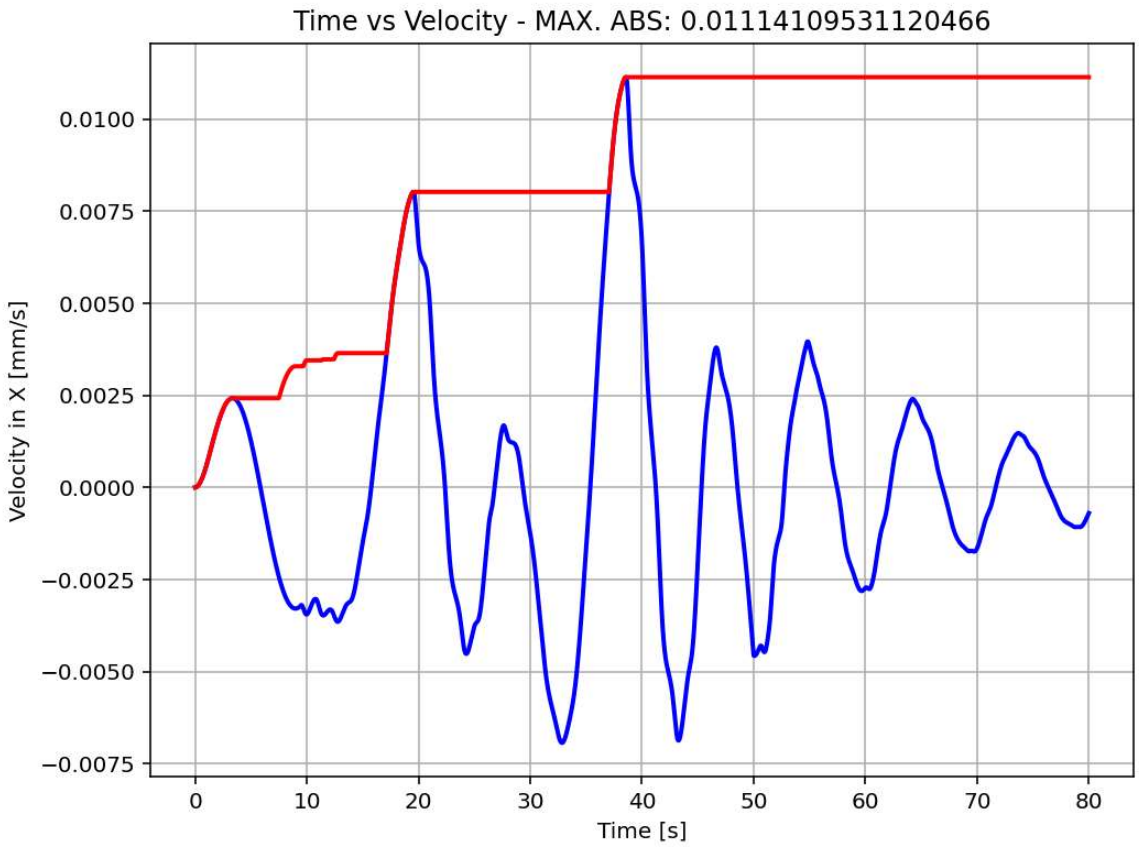

Displacement During the Analysis
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
Displacement - Y [mm]
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
−0.0005
0
10
20
30
40
50
60
70
80
Times

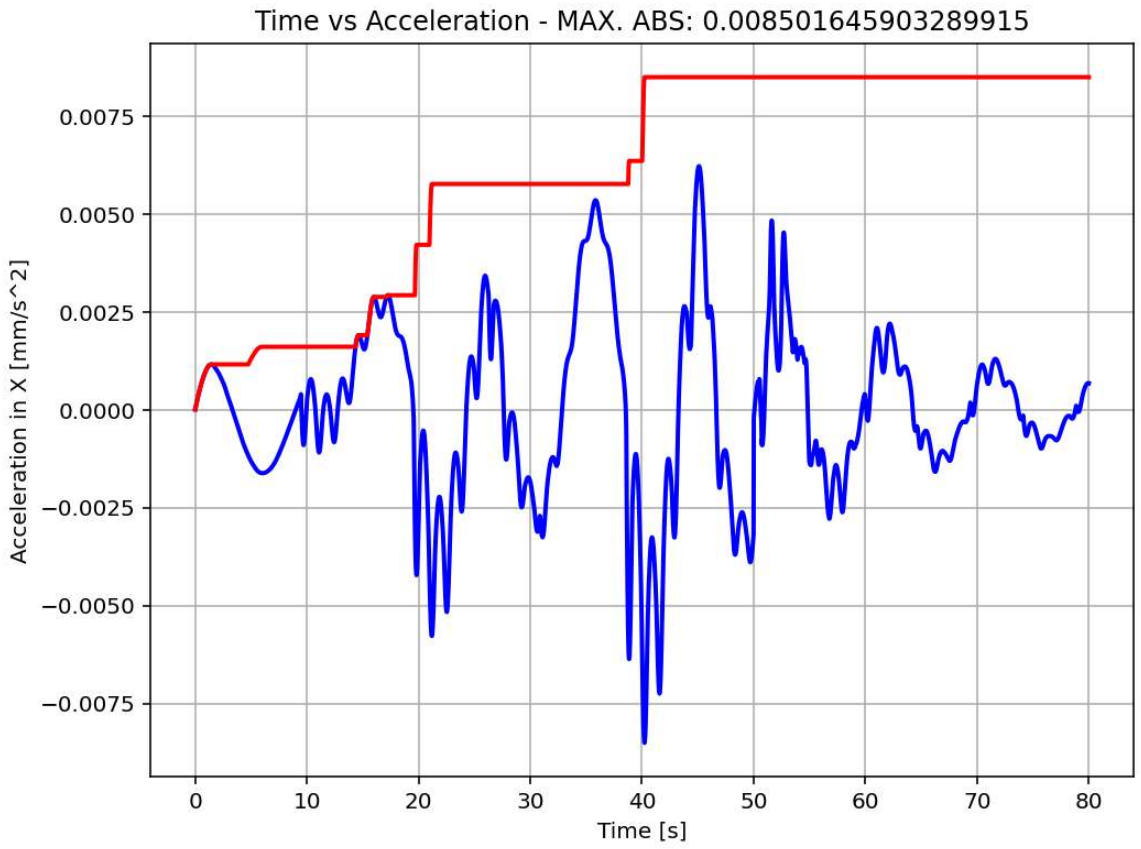

Rotation During the Analysis
1e−5
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
Rotation [rad]
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
0
10
20
30
40
50
60
70
80
Times

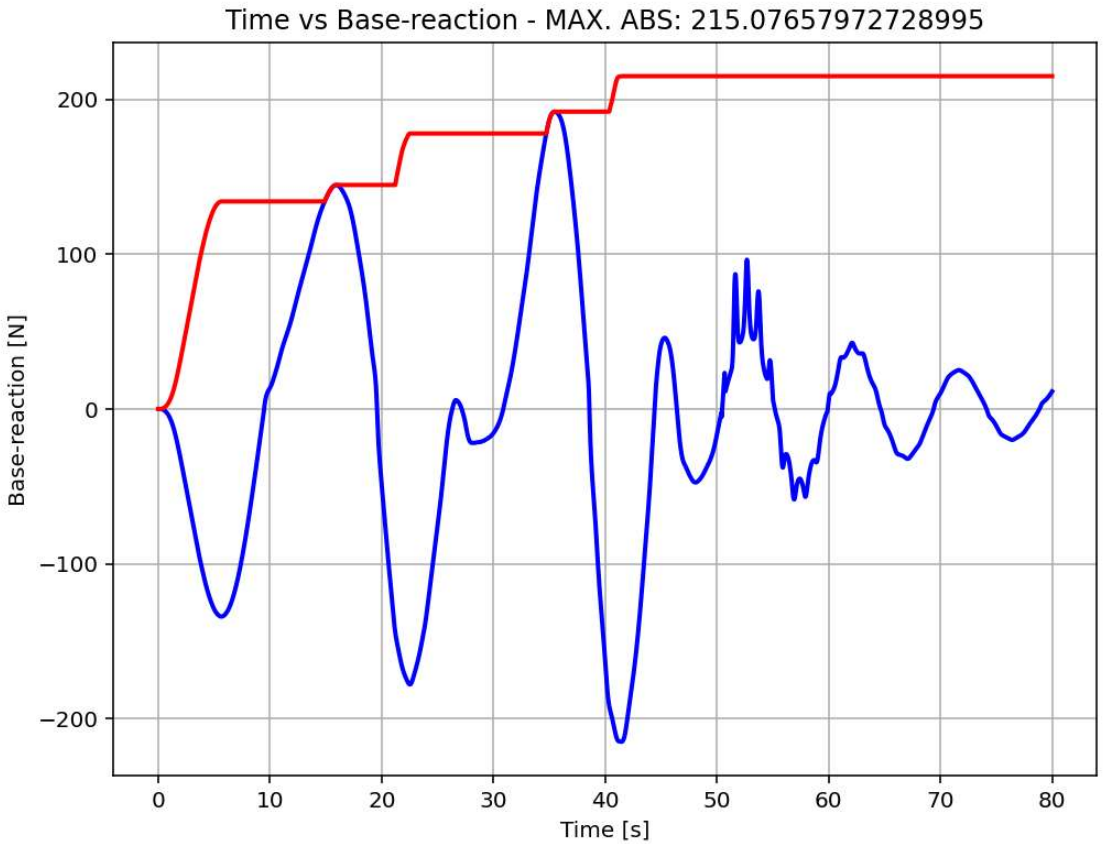

Lateral Structure Drift During the Analysis
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
Lateral Structure Drift [%]
0.0004
0.0002
0.0000
−0.0002
−0.0004
−0.0006
−0.0008
0
10
20
30
40
50
60
70
80
Times

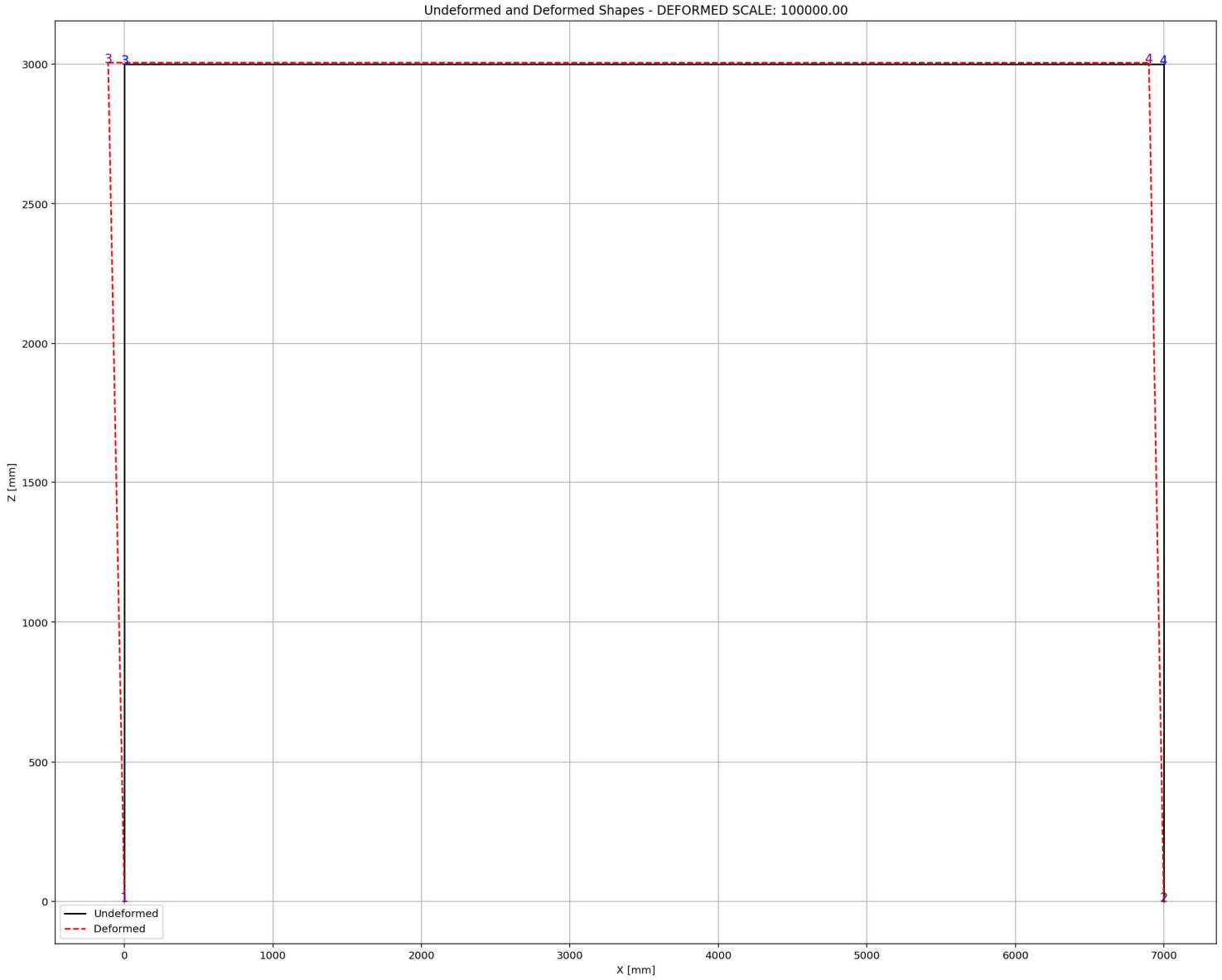

Time vs Displacement - MAX. ABS: 0.022570876996457385 | ξ (Calculated): 3.47856e+00 %
Displacement in X [mm]
0.02
0.01
0.00
−0.01
−0.02
0
10
20
30
40
50
60
70
80
Time [s]


Time vs Displacement - MAX. ABS: 0.002631851217287518
Displacement in Y [mm]
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
−0.0005
0
10
20
30
40
50
60
70
80
Time [s]


Time vs Velocity - MAX. ABS: 0.011141095311204 66
Velocity in X [mm/s]
0.0100
0.0075
0.0050
0.0025
0.0000
−0.0025
−0.0050
−0.0075
0
10
20
30
40
50
60
70
80
Time [s]


Time vs Acceleration - MAX. ABS: 0.008501645903289915
Acceleration in X [mm/s^2]
0.0075
0.0050
0.0025
0.0000
−0.0025
−0.0050
−0.0075
0
10
20
30
40
50
60
70
80
Time [s]


Time vs Base-reaction - MAX. ABS: 215.07657972728995
Base-reaction [N]
Time [s]
200
100
0
−100
−200
0
10
20
30
40
50
60
70
80


Undeformed and Deformed Shapes - DEFORMED SCALE: 100000.00
Z [mm]
X [mm]
0
500
1000
1500
2000
2500
3000
0
1000
2000
3000
4000
5000
6000
7000
1
2
3
3
4
4
Undeformed
Deformed