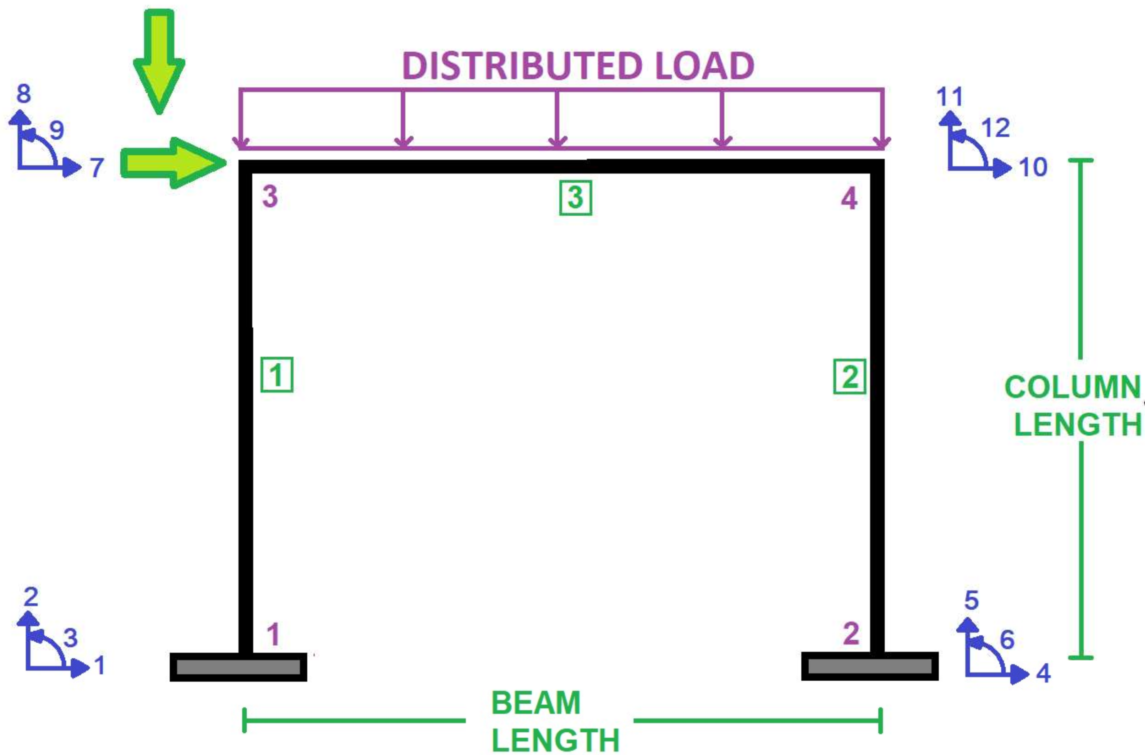
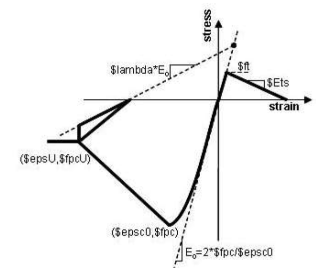
>> IN THE NAME OF ALLAH <<

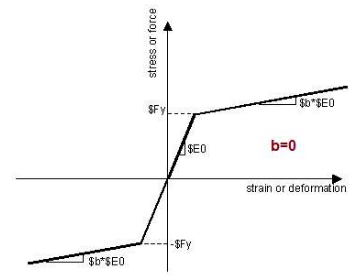
CREEP AND SHRINKAGE ANALYSIS OF CONCRETE FRAME AND EVALUATION STRUCURAL PERIOD USING OPENSEES

WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)

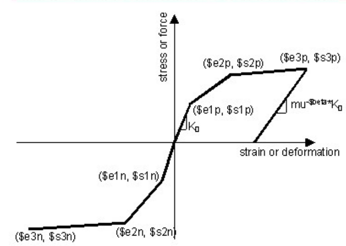




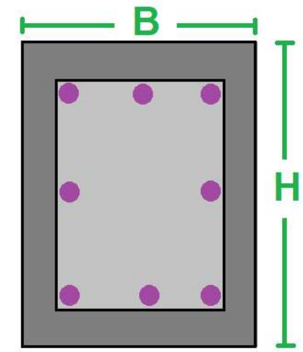
CORE AND COVER CONCRETE REALTION



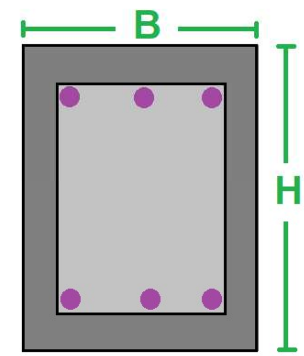
WITHOUT HARDENING AND ULTIMATE STRAIN



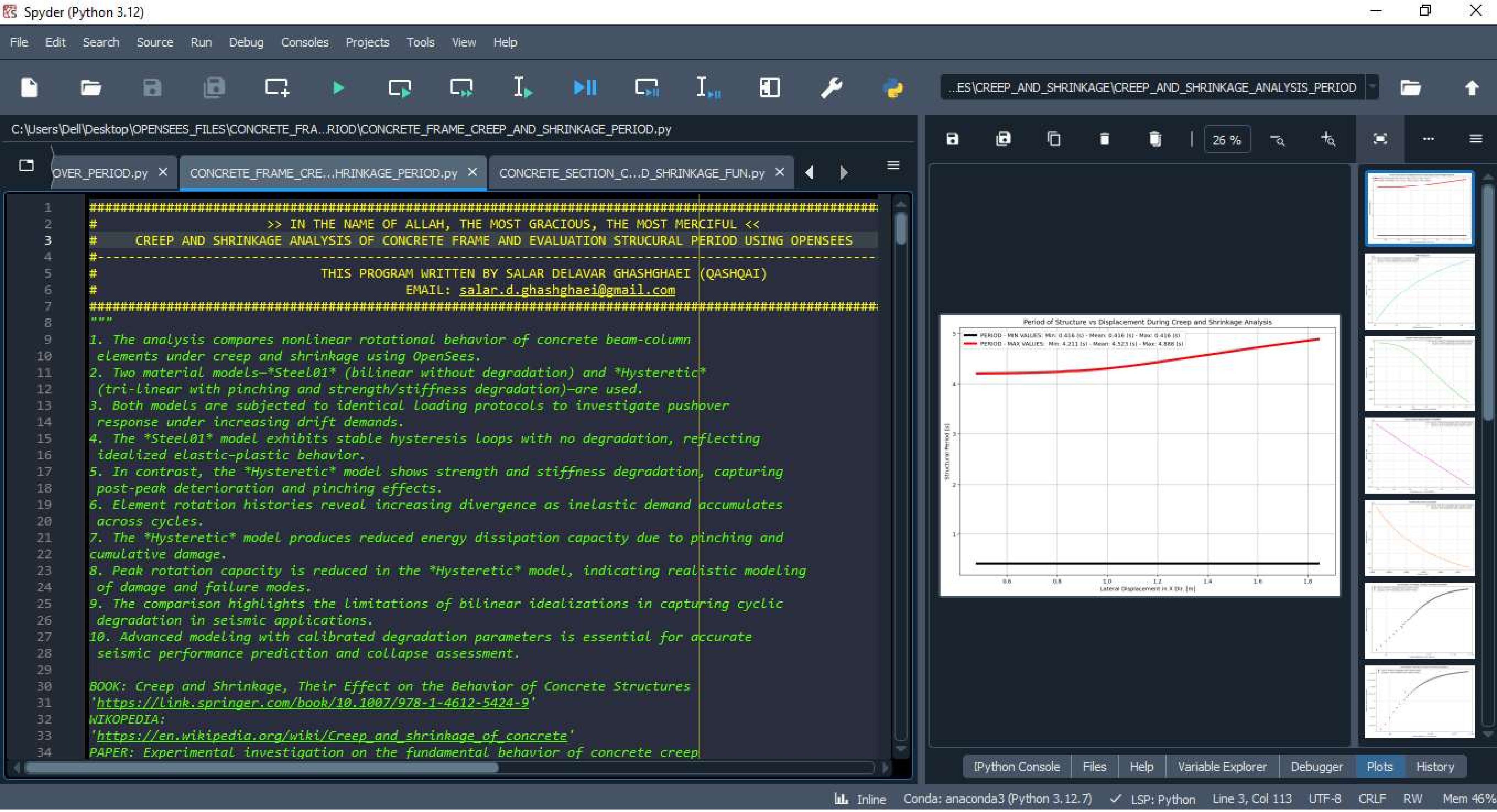
WITH HARDENING AND ULTIMATE STRAIN



COLUMN SECTION



BEAM SECTION


Spyder (Python 3.12)
File Edit Search Source Run Debug Consoles Projects Tools View Help
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OVER_PERIOD.py
CONCRETE_FRAME_CRE...HRINKAGE_PERIOD.py
CONCRETE_SECTION_C...D_SHRINKAGE_FUN.py
##
>> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<
CREEP AND SHRINKAGE ANALYSIS OF CONCRETE FRAME AND EVALUATION STRUCURAL PERIOD USING OPENSEES
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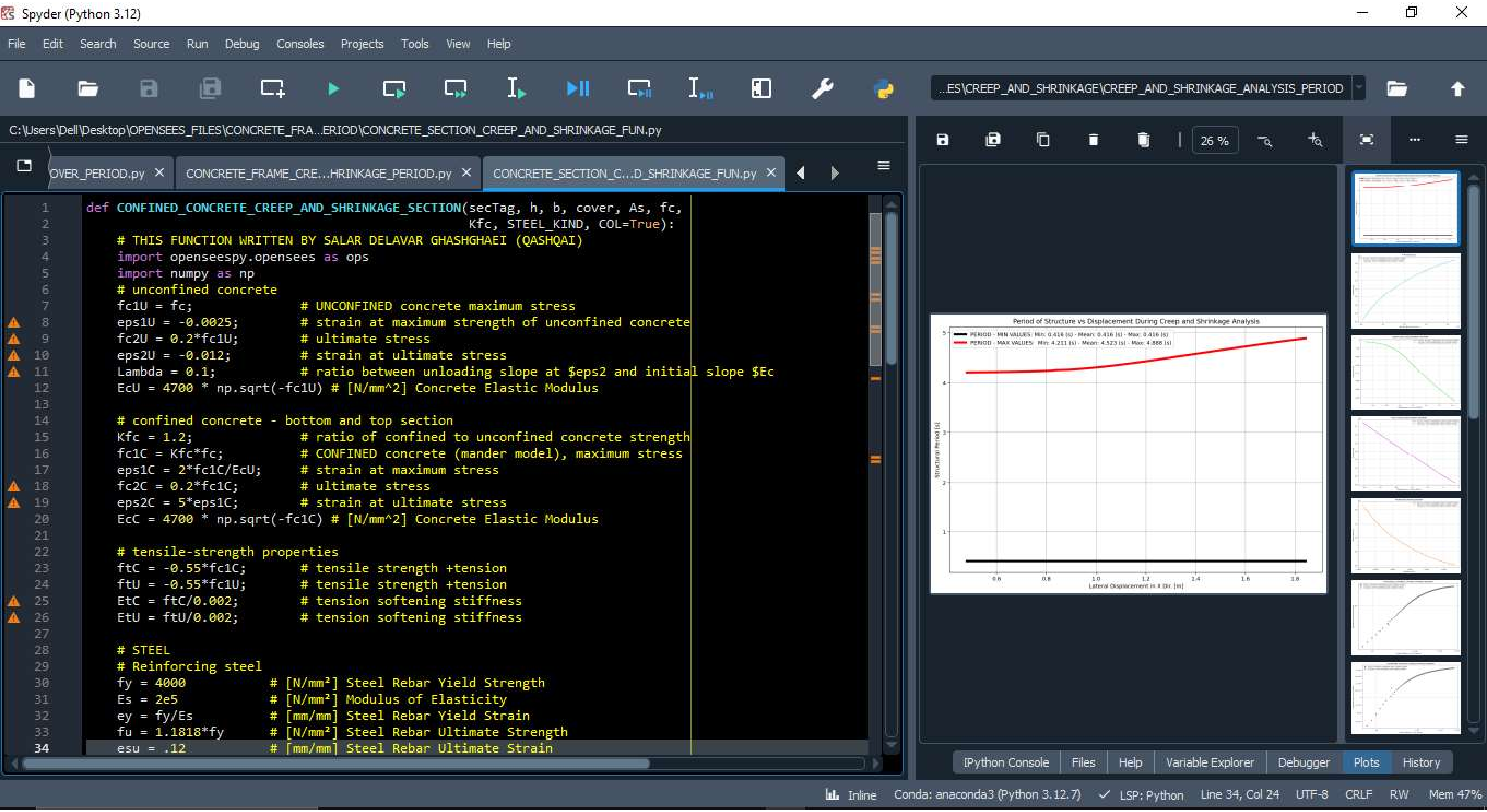
THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)
EMAIL: salar.d.ghashghaei@gmail.com
##
"""
1. The analysis compares nonlinear rotational behavior of concrete beam-column
 elements under creep and shrinkage using OpenSees.
2. Two material models—*Steel01* (bilinear without degradation) and *Hysteretic*
 (tri-linear with pinching and strength/stiffness degradation)—are used.
3. Both models are subjected to identical loading protocols to investigate pushover
 response under increasing drift demands.
4. The *Steel01* model exhibits stable hysteresis loops with no degradation, reflecting
 idealized elastic-plastic behavior.
5. In contrast, the *Hysteretic* model shows strength and stiffness degradation, capturing
 post-peak deterioration and pinching effects.
6. Element rotation histories reveal increasing divergence as inelastic demand accumulates
 across cycles.
7. The *Hysteretic* model produces reduced energy dissipation capacity due to pinching and
cumulative damage.
8. Peak rotation capacity is reduced in the *Hysteretic* model, indicating realistic modeling
 of damage and failure modes.
9. The comparison highlights the limitations of bilinear idealizations in capturing cyclic
 degradation in seismic applications.
10. Advanced modeling with calibrated degradation parameters is essential for accurate
 seismic performance prediction and collapse assessment.

BOOK: Creep and Shrinkage, Their Effect on the Behavior of Concrete Structures
'https://link.springer.com/book/10.1007/978-1-4612-5424-9'
WIKOPEDIA:
'https://en.wikipedia.org/wiki/Creep_and_shrinkage_of_concrete'
PAPER: Experimental investigation on the fundamental behavior of concrete creep
Period of Structure vs Displacement During Creep and Shrinkage Analysis
IPython Console Files Help Variable Explorer Debugger Plots History
Inline Conda: anaconda3 (Python 3.12.7) LSP: Python Line 3, Col 113 UTF-8 CRLF RW Mem 46%


Spyder (Python 3.12)
File Edit Search Source Run Debug Consoles Projects Tools View Help
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C:\Users\Dell\Desktop\OPENSEES_FILES\CONCRETE_FRA...ERIOD\CONCRETE_SECTION_CREEP_AND_SHRINKAGE_FUN.py
OVER_PERIOD.py
CONCRETE_FRAME_CRE...HRINKAGE_PERIOD.py
CONCRETE_SECTION_C...D_SHRINKAGE_FUN.py
def CONFINED_CONCRETE_CREEP_AND_SHRINKAGE_SECTION(secTag, h, b, cover, As, fc,
                                                  Kfc, STEEL_KIND, COL=True):
    # THIS FUNCTION WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)
    import openseespy.opensees as ops
    import numpy as np
    # unconfined concrete
    fc1U = fc;   # UNCONFINED concrete maximum stress
    eps1U = -0.0025;   # strain at maximum strength of unconfined concrete
    fc2U = 0.2*fc1U;   # ultimate stress
    eps2U = -0.012;   # strain at ultimate stress
    Lambda = 0.1;   # ratio between unloading slope at $eps2 and initial slope $Ec
    EcU = 4700 * np.sqrt(-fc1U) # [N/mm^2] Concrete Elastic Modulus

    # confined concrete - bottom and top section
    Kfc = 1.2;   # ratio of confined to unconfined concrete strength
    fc1C = Kfc*fc;   # CONFINED concrete (mander model), maximum stress
    eps1C = 2*fc1C/EcU;   # strain at maximum stress
    fc2C = 0.2*fc1C;   # ultimate stress
    eps2C = 5*eps1C;   # strain at ultimate stress
    EcC = 4700 * np.sqrt(-fc1C) # [N/mm^2] Concrete Elastic Modulus

    # tensile-strength properties
    ftC = -0.55*fc1C;   # tensile strength +tension
    ftU = -0.55*fc1U;   # tensile strength +tension
    EtC = ftC/0.002;   # tension softening stiffness
    EtU = ftU/0.002;   # tension softening stiffness

    # STEEL
    # Reinforcing steel
    fy = 4000   # [N/mm²] Steel Rebar Yield Strength
    Es = 2e5   # [N/mm²] Modulus of Elasticity
    ey = fy/Es   # [mm/mm] Steel Rebar Yield Strain
    fu = 1.1818*fy   # [N/mm²] Steel Rebar Ultimate Strength
    esu = .12   # [mm/mm] Steel Rebar Ultimate Strain
26 %
Period of Structure vs Displacement During Creep and Shrinkage Analysis
IPython Console
Files
Help
Variable Explorer
Debugger
Plots
History
Inline
Conda: anaconda3 (Python 3.12.7)
LSP: Python
Line 34, Col 24
UTF-8
CRLF
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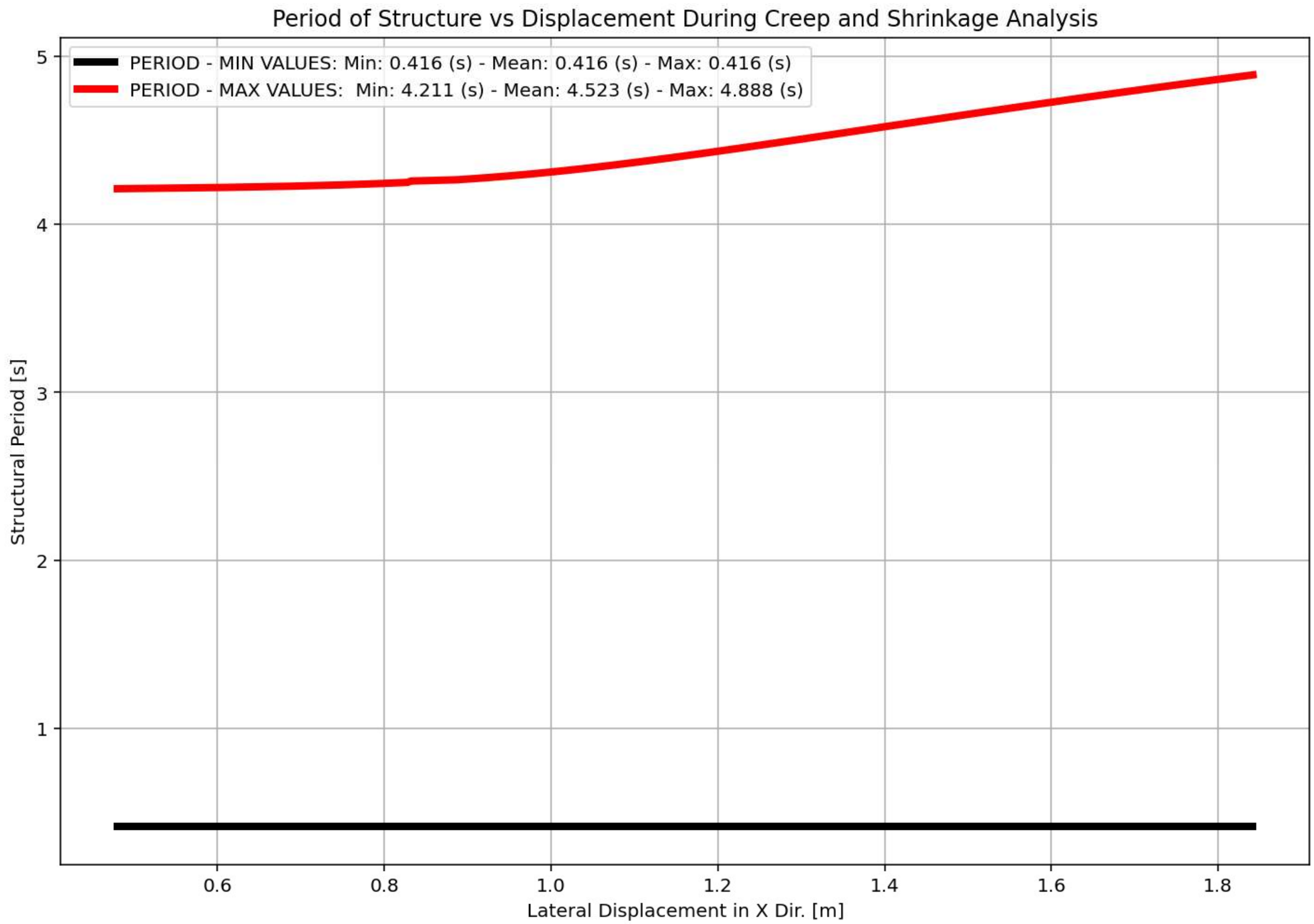
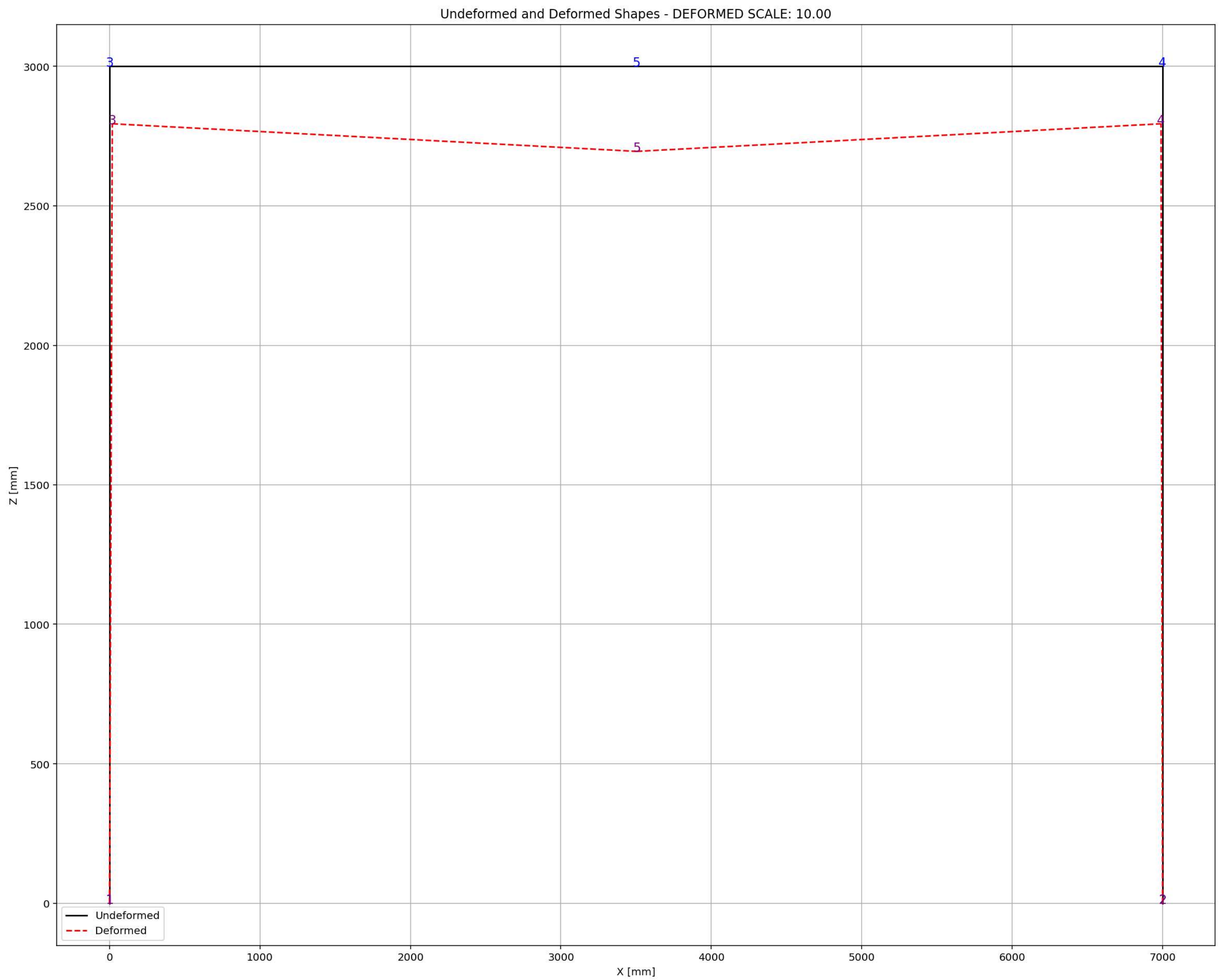
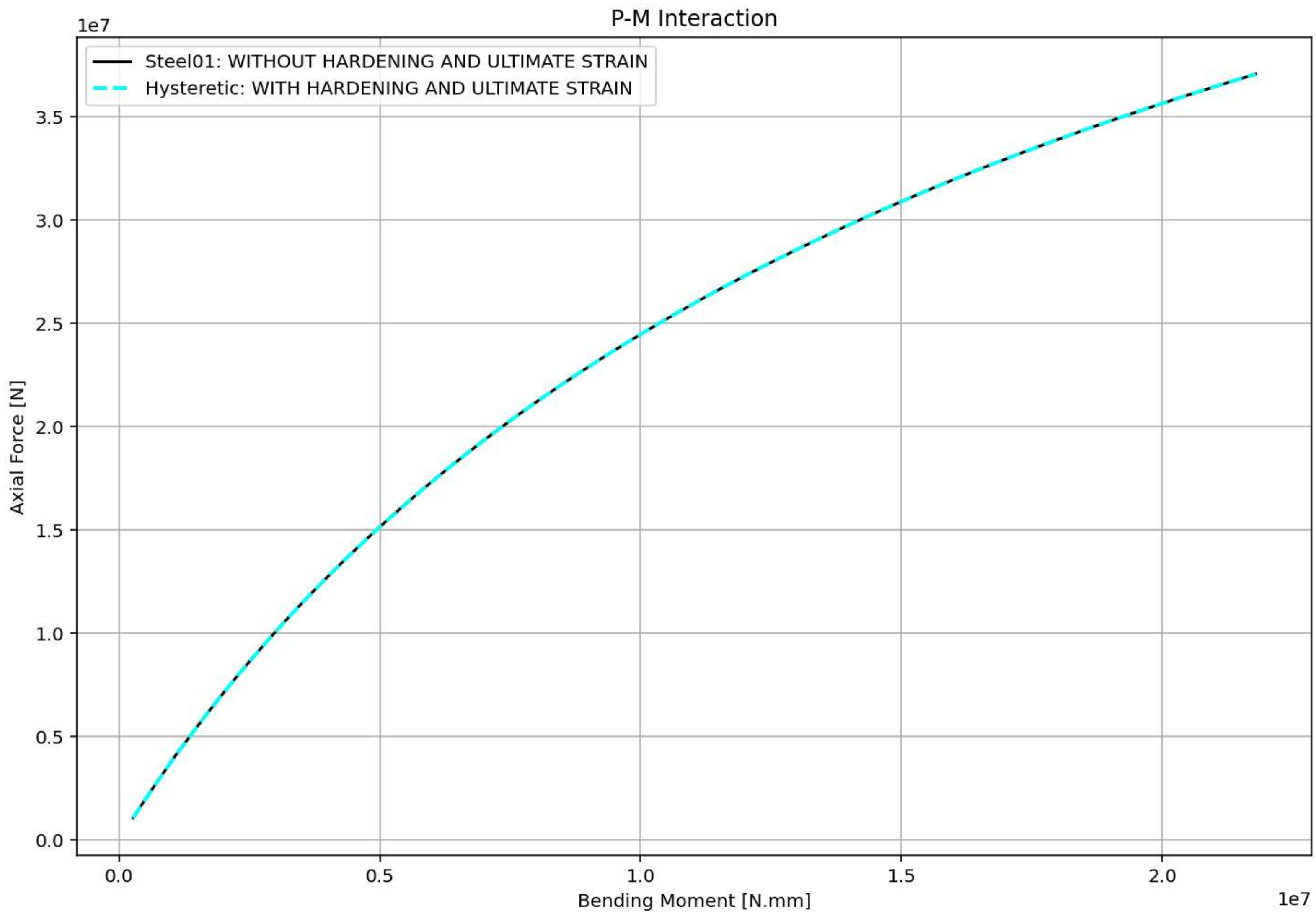
Mem 47%

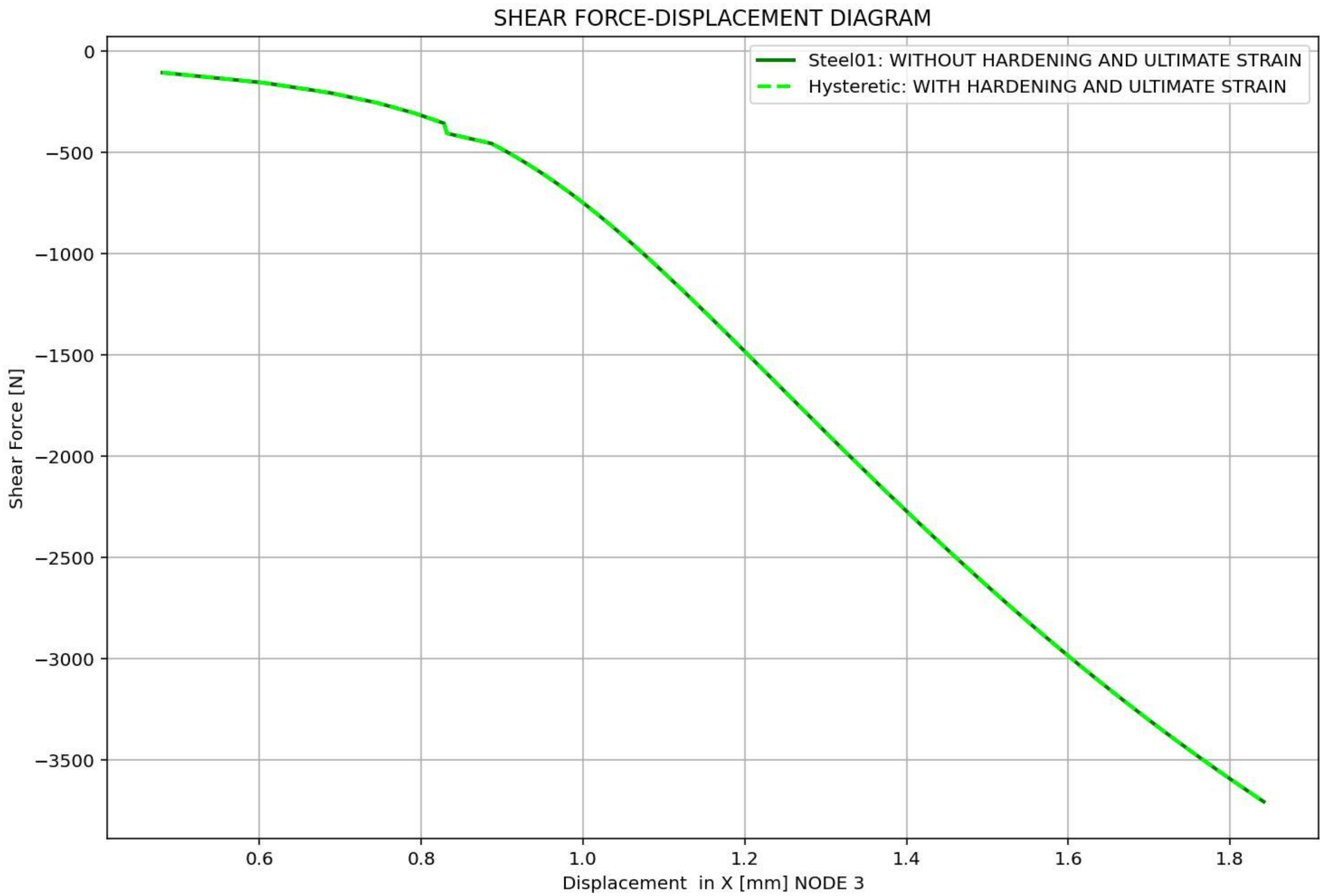


Period of Structure vs Displacement During Creep and Shrinkage Analysis
PERIOD - MIN VALUES: Min: 0.416 (s) - Mean: 0.416 (s) - Max: 0.416 (s)
PERIOD - MAX VALUES: Min: 4.211 (s) - Mean: 4.523 (s) - Max: 4.888 (s)
Structural Period [s]
Lateral Displacement in X Dir. [m]
1
2
3
4
5
0.6
0.8
1.0
1.2
1.4
1.6
1.8

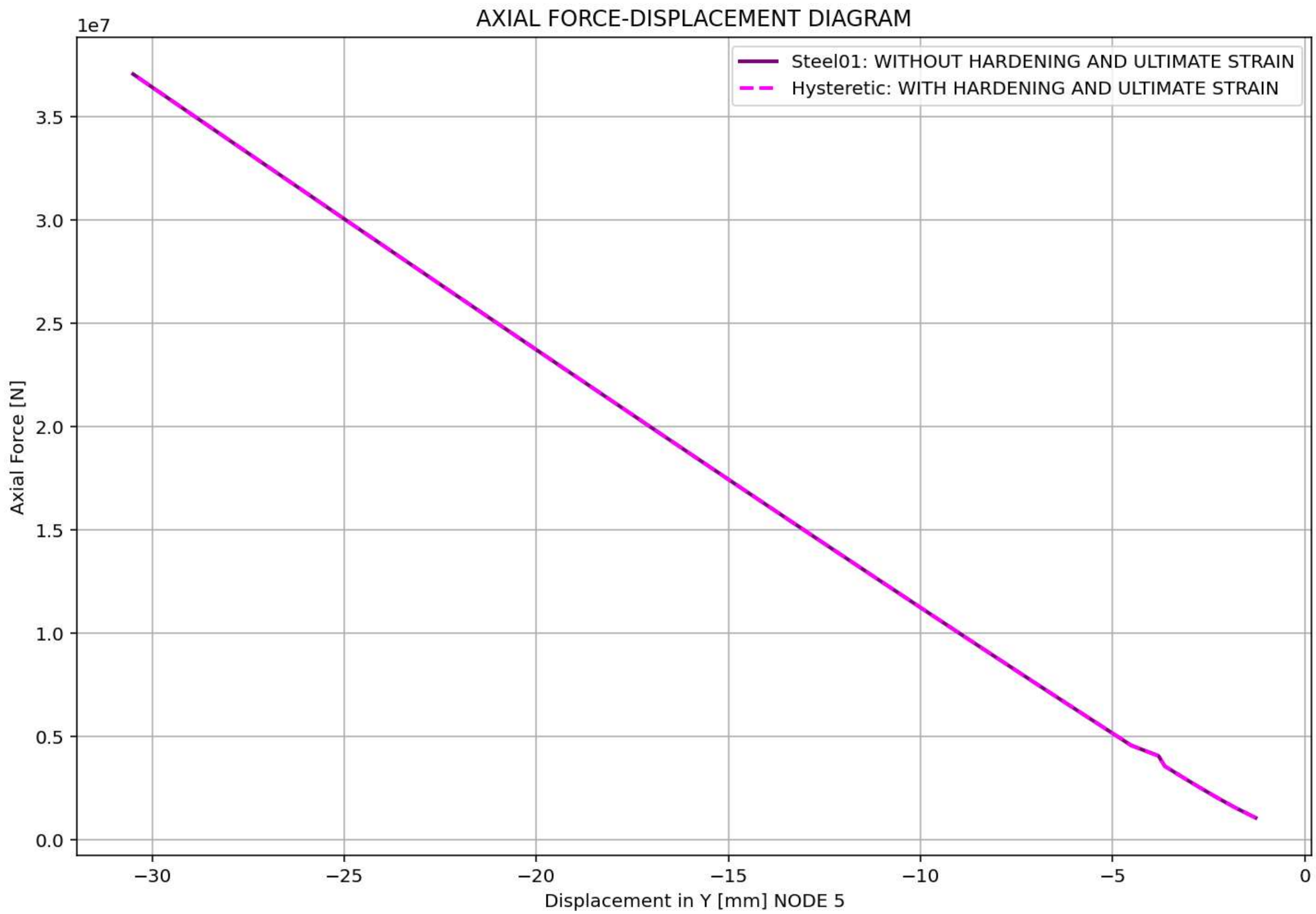


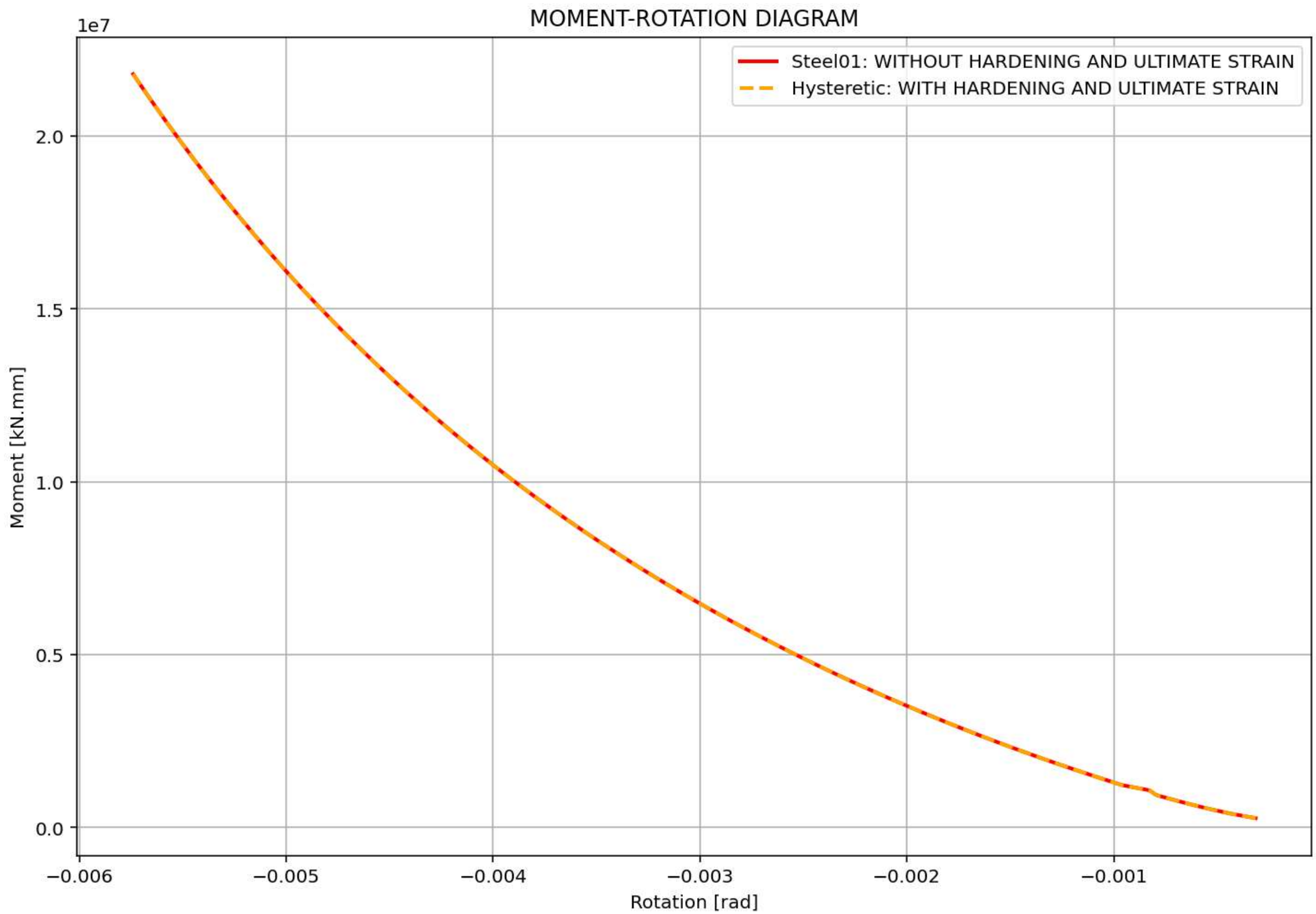
Undeformed and Deformed Shapes - DEFORMED SCALE: 10.00
3
5
4
3
5
4
1
2
Undeformed
Deformed
Z [mm]
X [mm]
0
500
1000
1500
2000
2500
3000
0
1000
2000
3000
4000
5000
6000
7000


P-M Interaction
1e7
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Axial Force [N]
0.0
0.5
1.0
1.5
2.0
1e7
Bending Moment [N.mm]

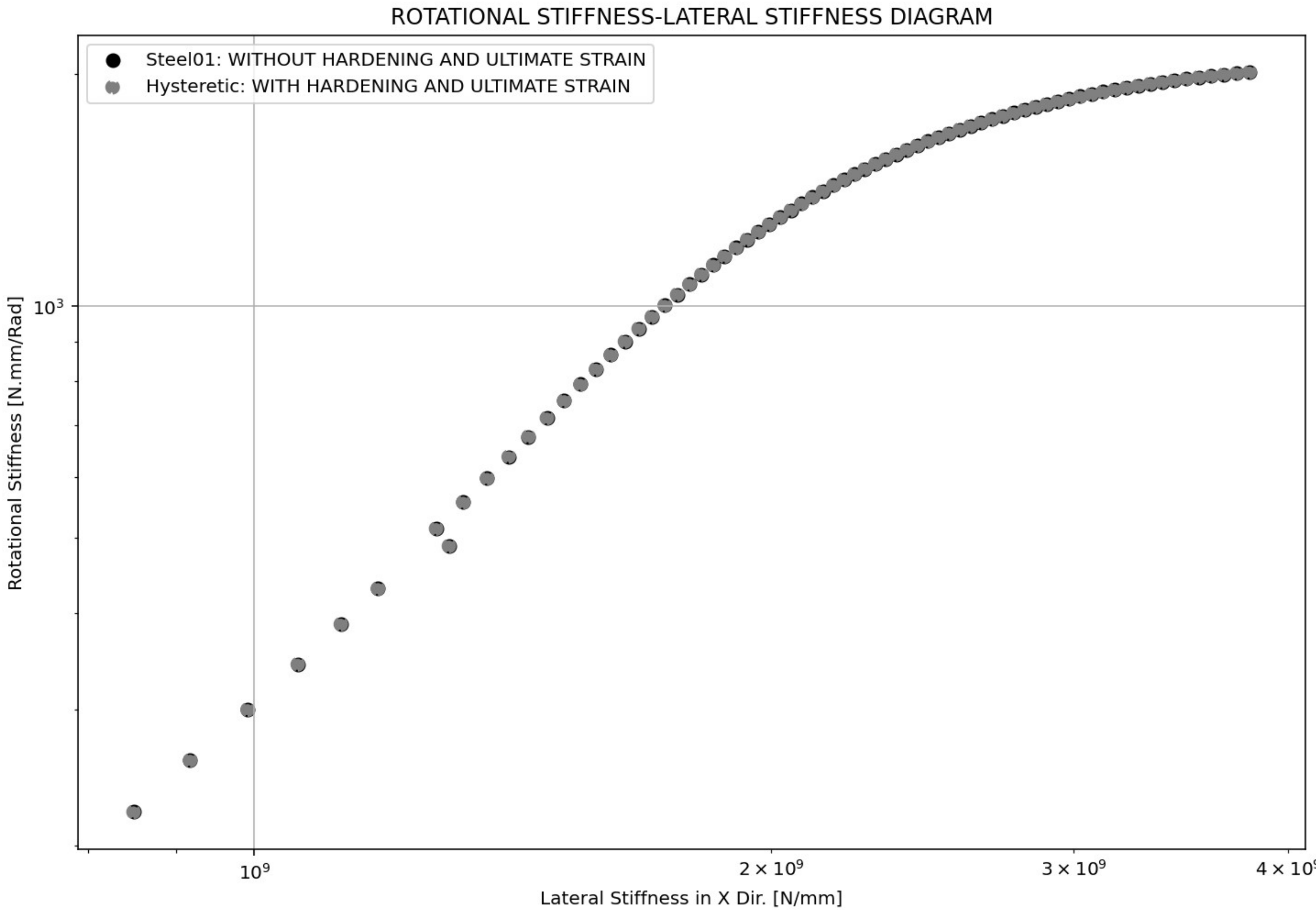


SHEAR FORCE-DISPLACEMENT DIAGRAM
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
Shear Force [N]
0
−500
−1000
−1500
−2000
−2500
−3000
−3500
0.6
0.8
1.0
1.2
1.4
1.6
1.8
Displacement in X [mm] NODE 3

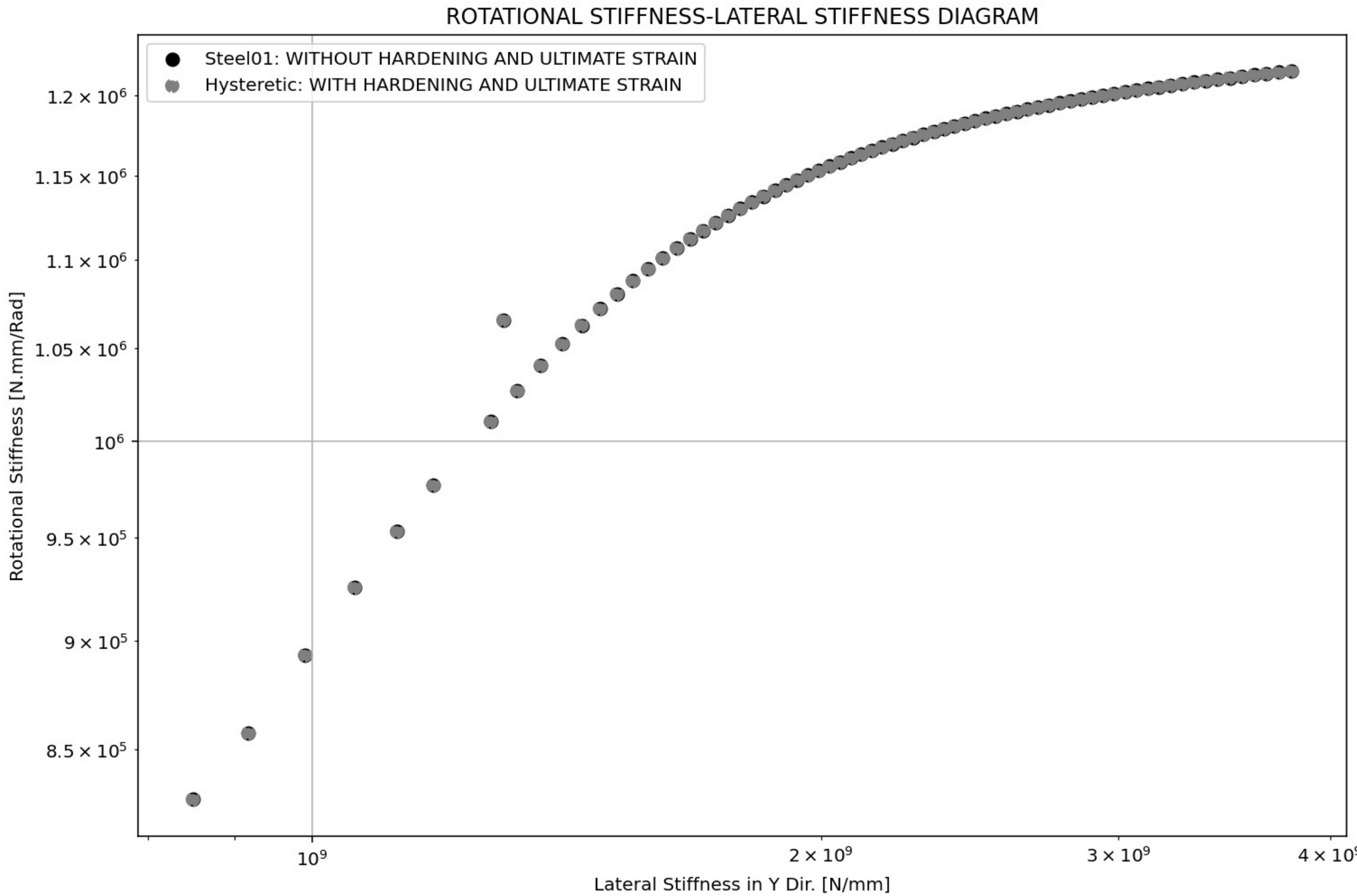

AXIAL FORCE-DISPLACEMENT DIAGRAM
1e7
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
Axial Force [N]
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−30
−25
−20
−15
−10
−5
0
Displacement in Y [mm] NODE 5



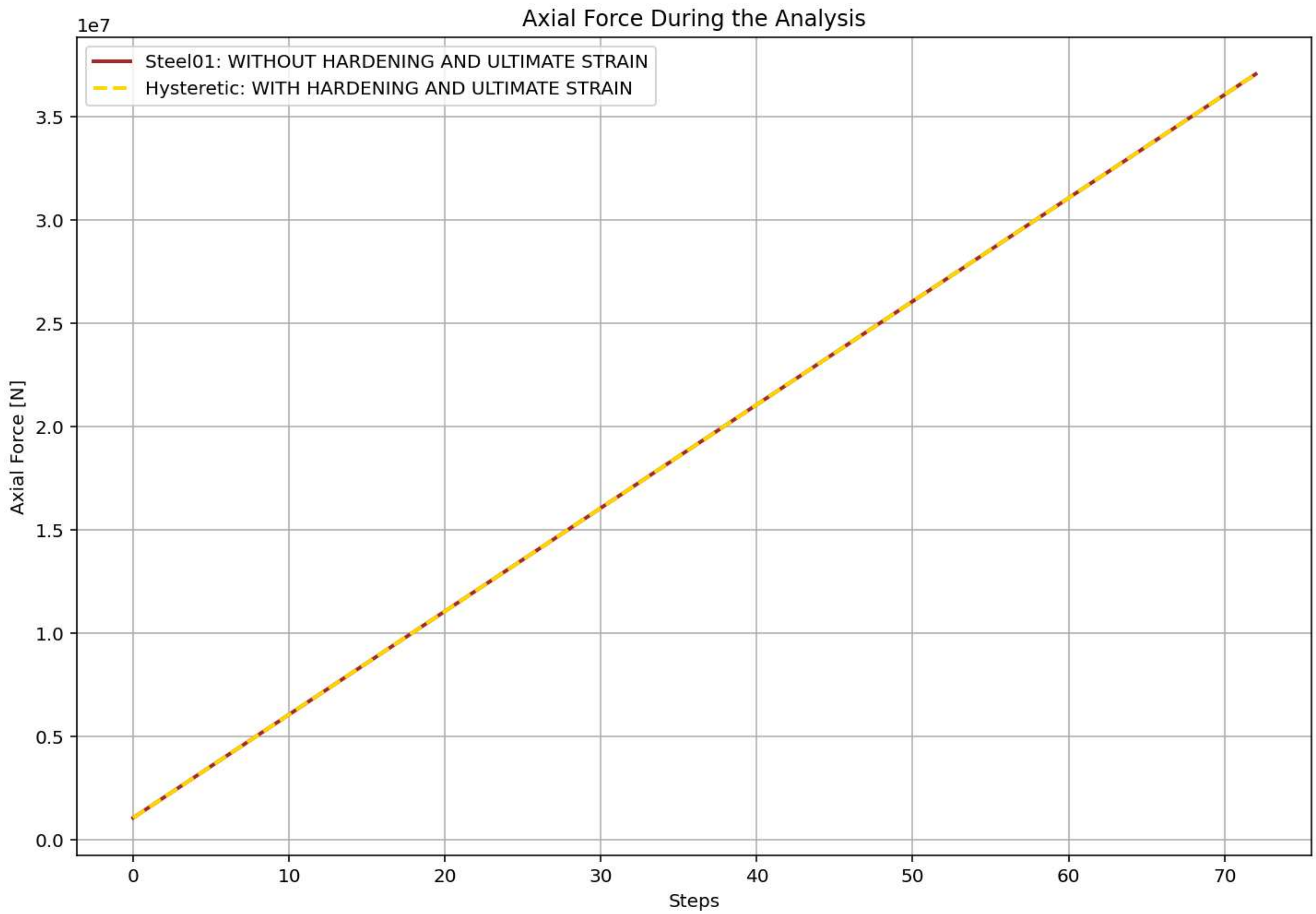
MOMENT-ROTATION DIAGRAM
1e7
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
2.0
1.5
1.0
0.5
0.0
Moment [kN.mm]
−0.006
−0.005
−0.004
−0.003
−0.002
−0.001
Rotation [rad]



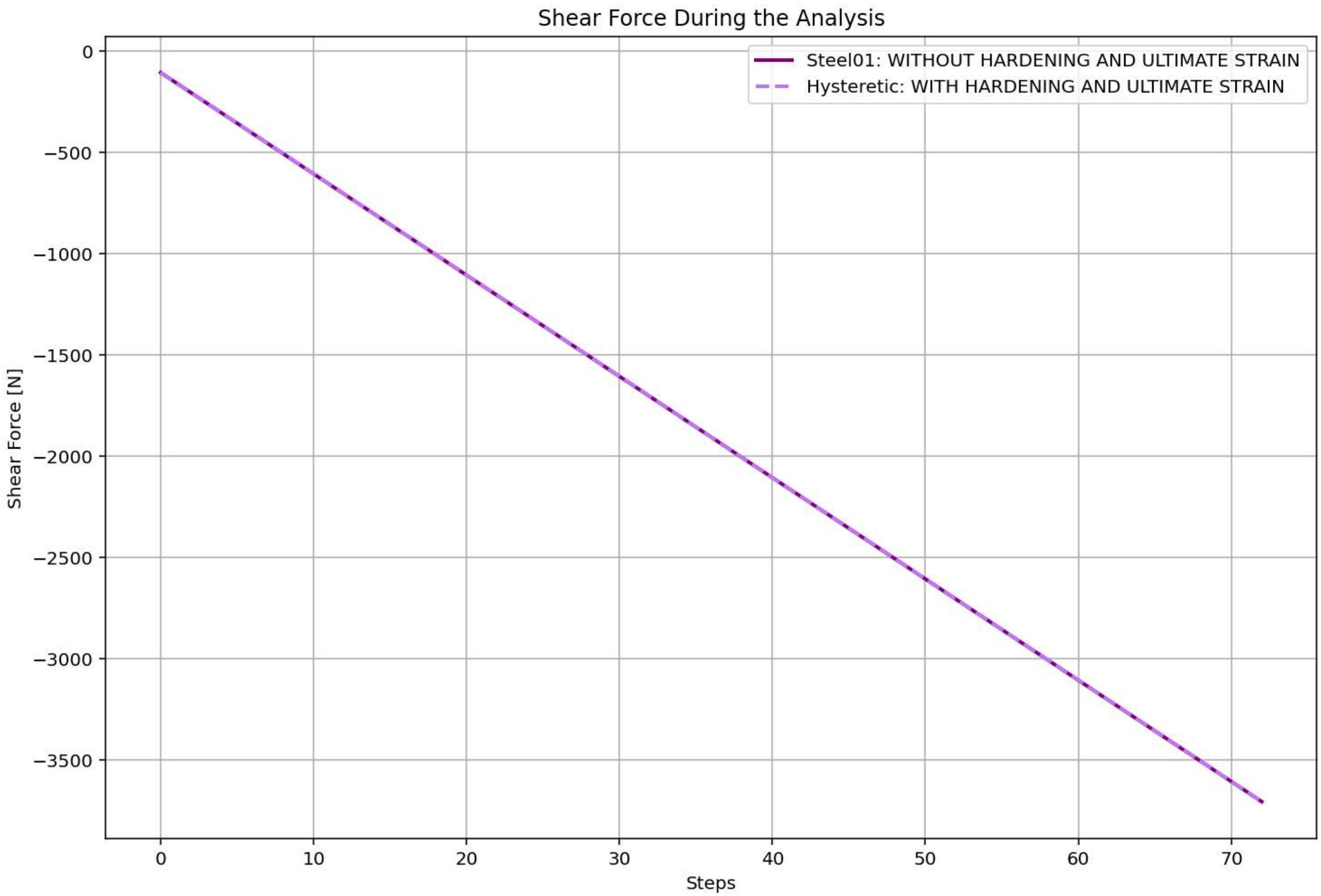
ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
Rotational Stiffness [N.mm/Rad]
10^3
10^9
2×10^9
3×10^9
4×10^9
Lateral Stiffness in X Dir. [N/mm]

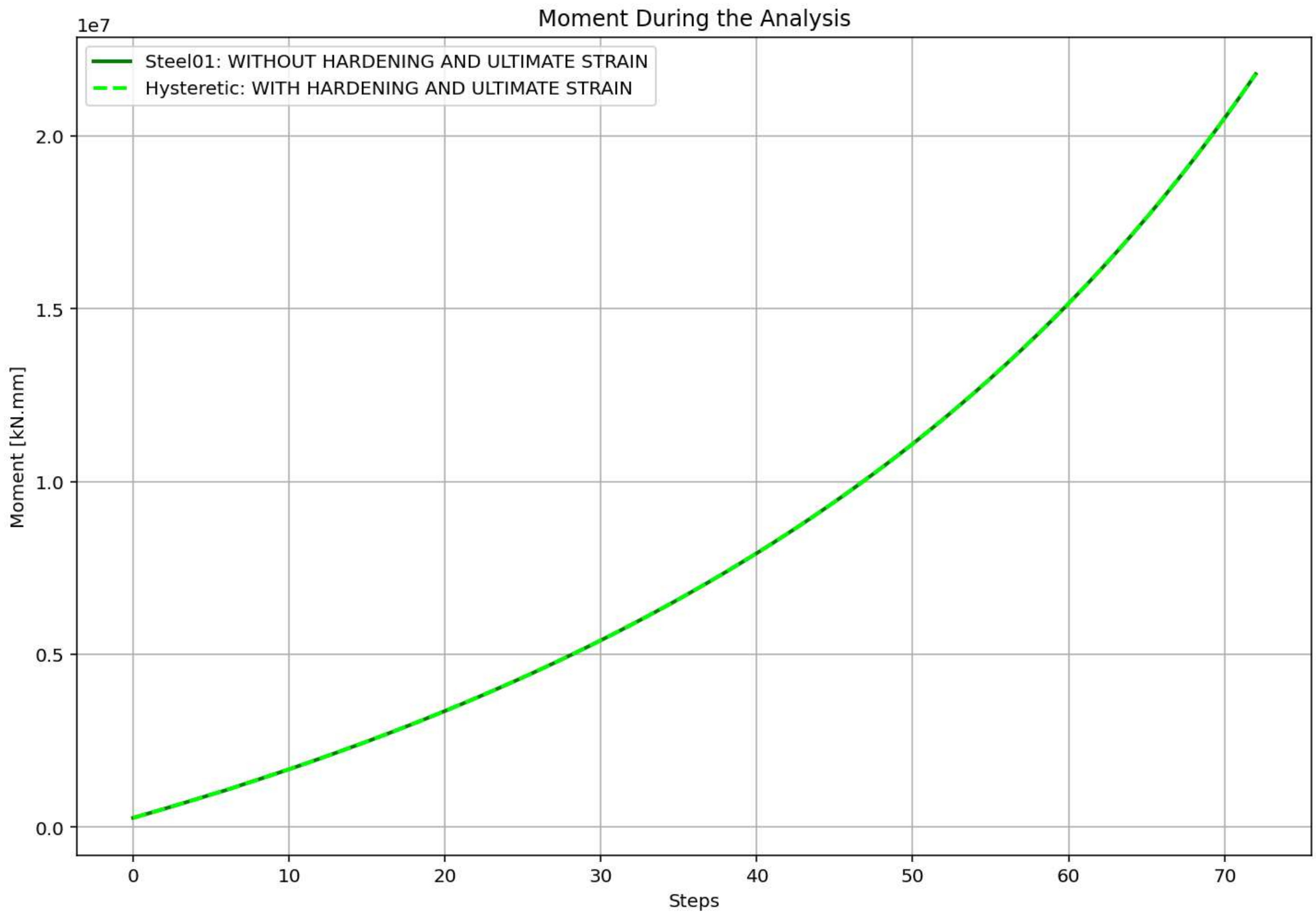


ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
Rotational Stiffness [N.mm/Rad]
1.2 × 10^6
1.15 × 10^6
1.1 × 10^6
1.05 × 10^6
10^6
9.5 × 10^5
9 × 10^5
8.5 × 10^5
10^9
2 × 10^9
3 × 10^9
4 × 10^9
Lateral Stiffness in Y Dir. [N/mm]

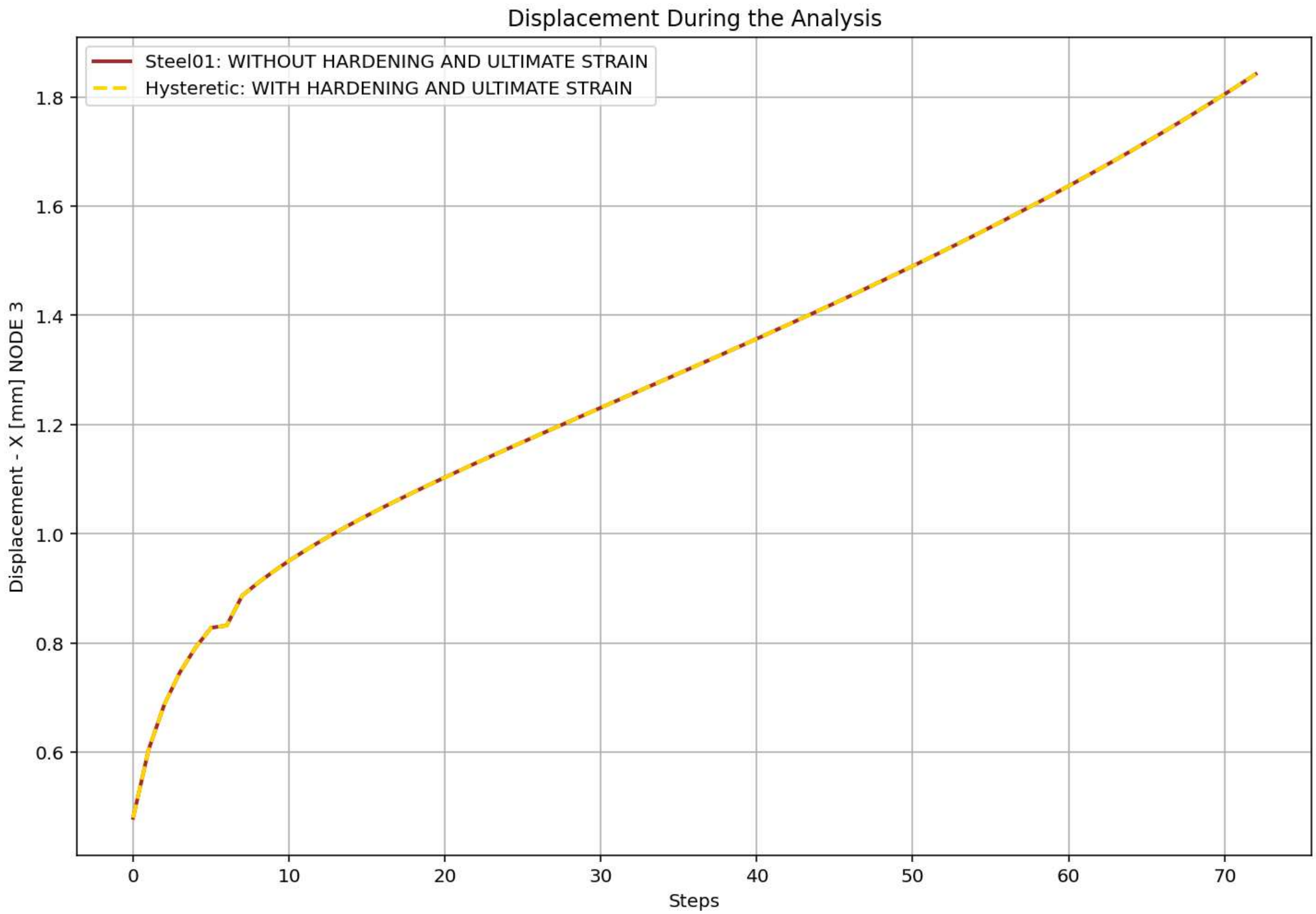


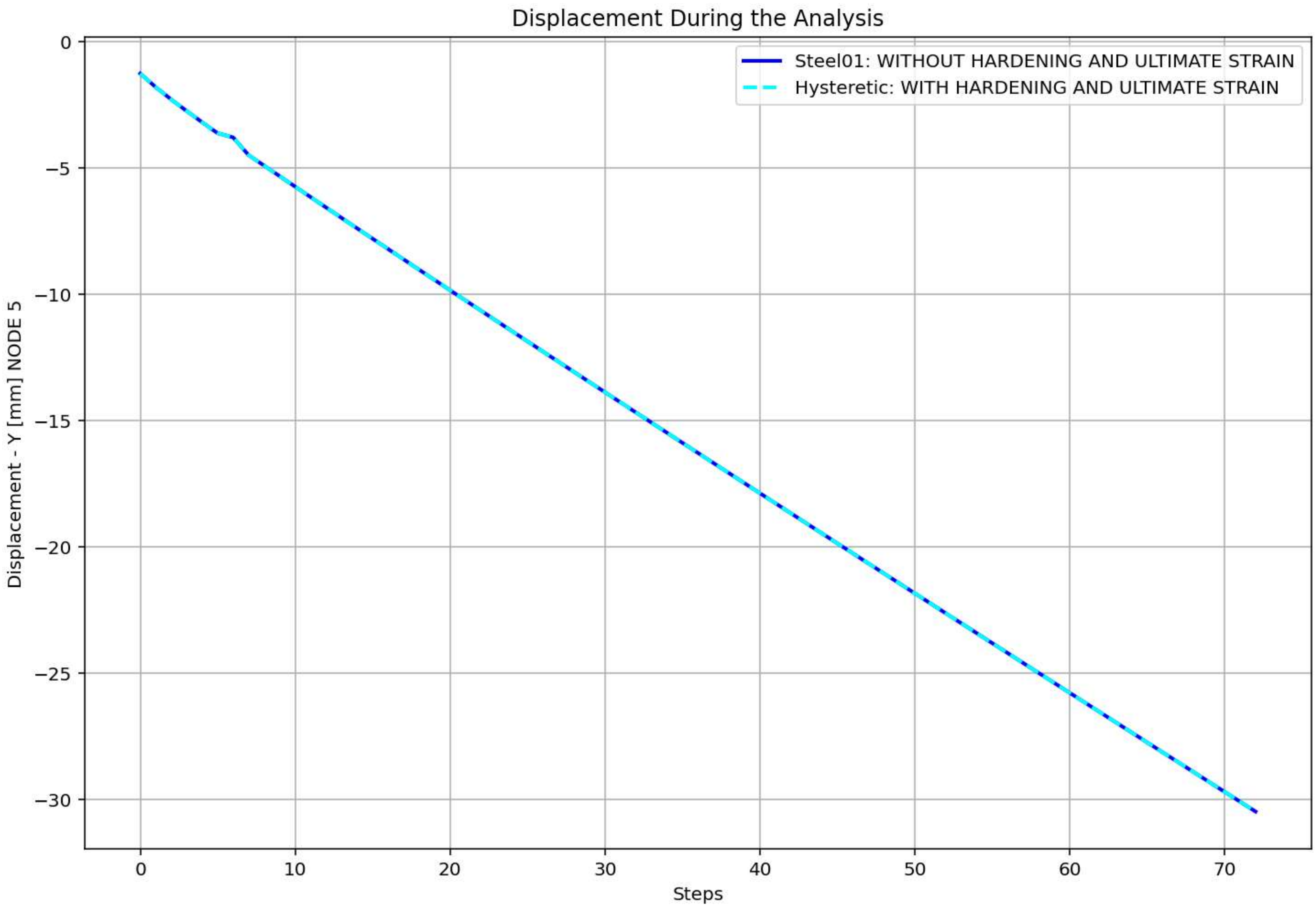
Axial Force During the Analysis
1e7
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Axial Force [N]
0
10
20
30
40
50
60
70
Steps


Shear Force During the Analysis
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
Shear Force [N]
0
−500
−1000
−1500
−2000
−2500
−3000
−3500
0
10
20
30
40
50
60
70
Steps

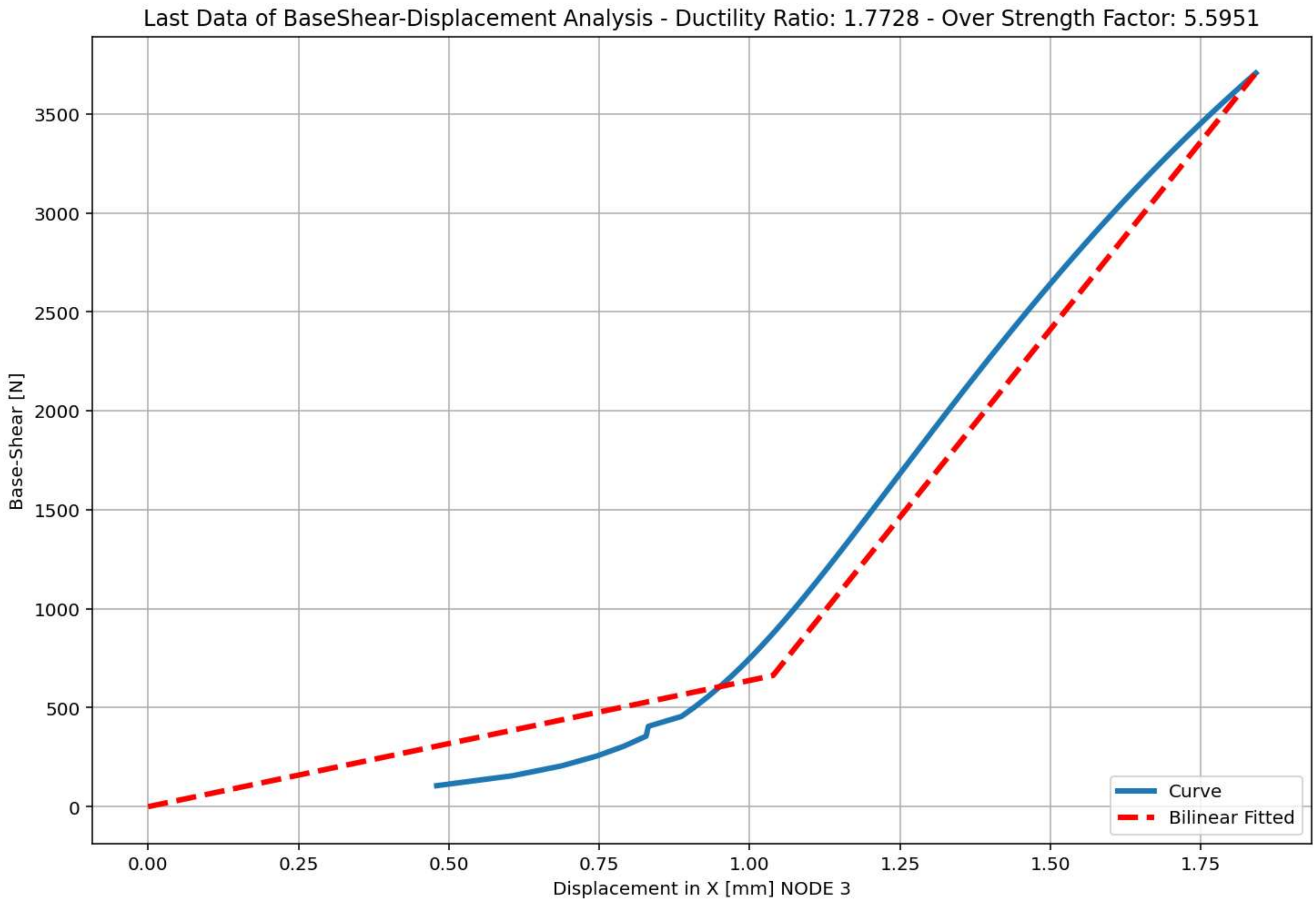


Moment During the Analysis
1e7
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
2.0
1.5
1.0
0.5
0.0
Moment [kN.mm]
0
10
20
30
40
50
60
70
Steps

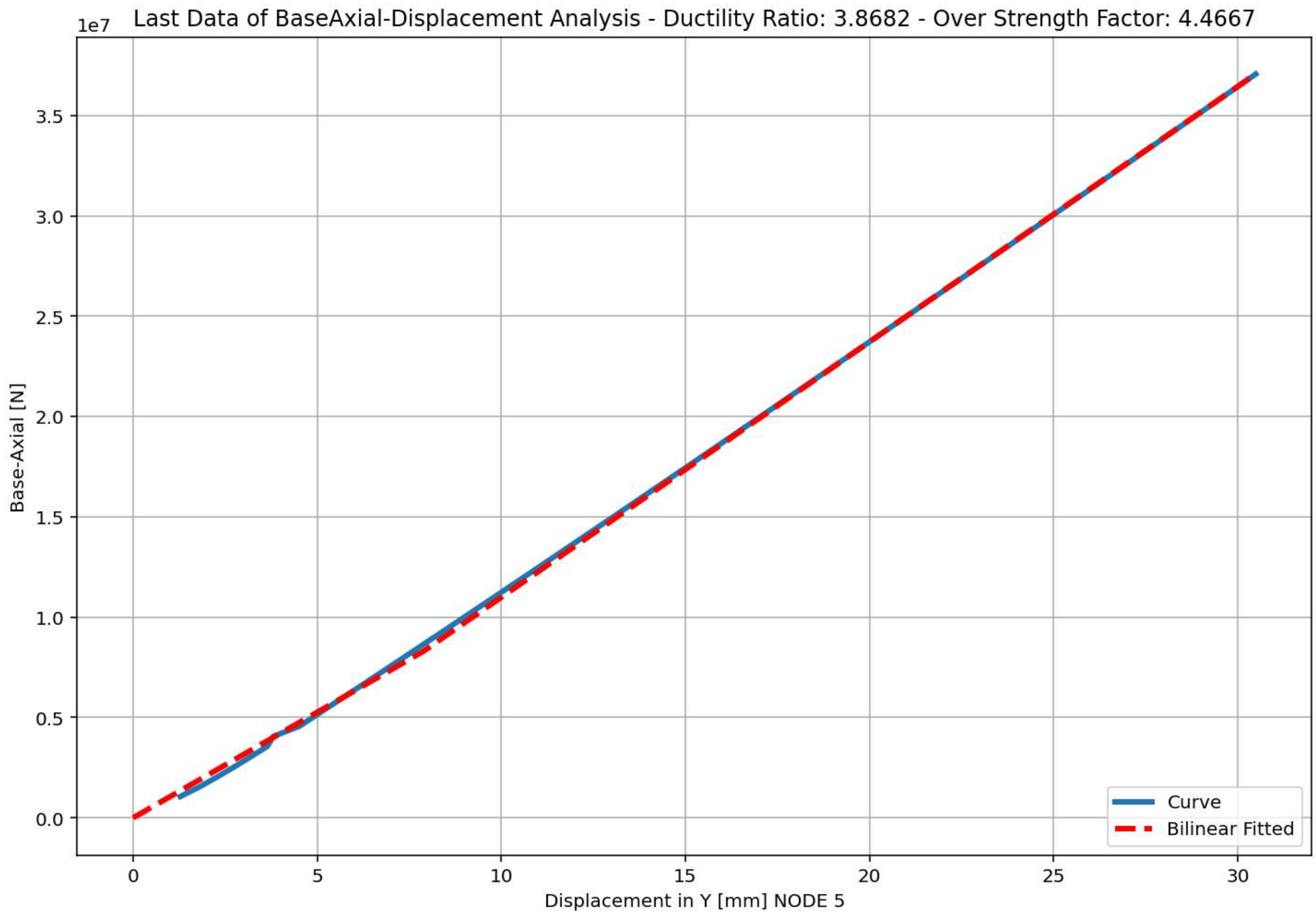

Displacement During the Analysis
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
Displacement - X [mm] NODE 3
Steps
0.6
0.8
1.0
1.2
1.4
1.6
1.8
0
10
20
30
40
50
60
70



Displacement During the Analysis
Steel01: WITHOUT HARDENING AND ULTIMATE STRAIN
Hysteretic: WITH HARDENING AND ULTIMATE STRAIN
Displacement - Y [mm] NODE 5
Steps
0
−5
−10
−15
−20
−25
−30
0
10
20
30
40
50
60
70



Last Data of BaseShear-Displacement Analysis - Ductility Ratio: 1.7728 - Over Strength Factor: 5.5951
Base-Shear [N]
3500
3000
2500
2000
1500
1000
500
0
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
Displacement in X [mm] NODE 3
Curve
Bilinear Fitted



Last Data of BaseAxial-Displacement Analysis - Ductility Ratio: 3.8682 - Over Strength Factor: 4.4667
1e7
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Base-Axial [N]
0
5
10
15
20
25
30
Displacement in Y [mm] NODE 5
Curve
Bilinear Fitted