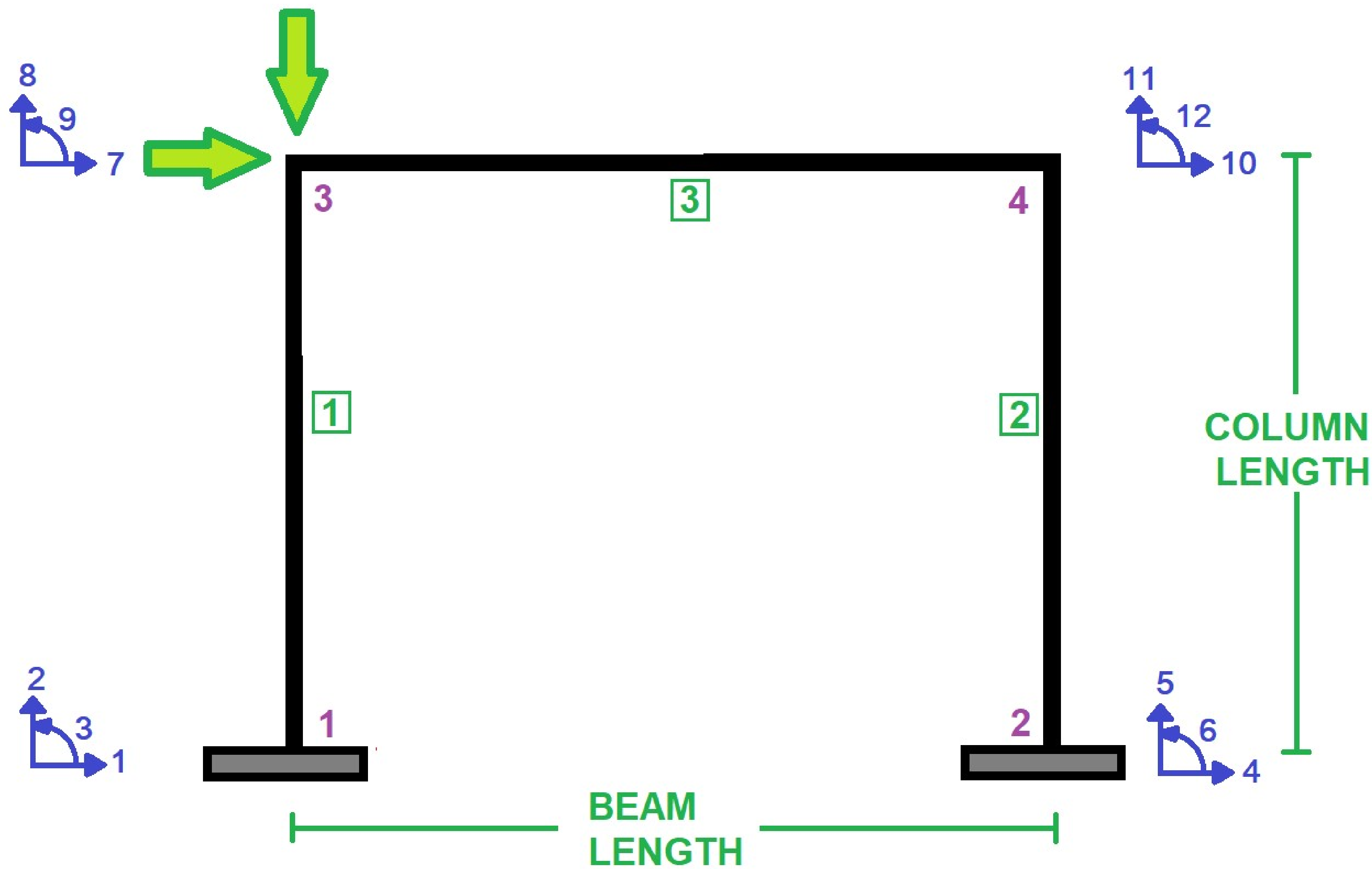
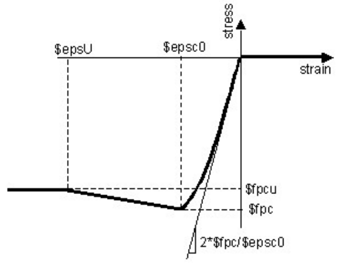
IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL

PUSHOVER ANALYSIS OF COMPOSITE SECTION FRAME AND CALCULATE STRUCTURAL BEHAVIOR COEFFICIENT USING OPENSEES

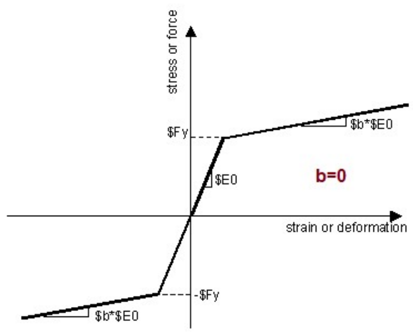
WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)



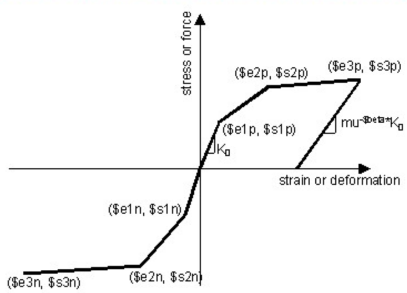
8
9
7
11
12
10
3
3
4
1
2
COLUMN
LENGTH
2
3
1
1
2
5
6
4
BEAM
LENGTH



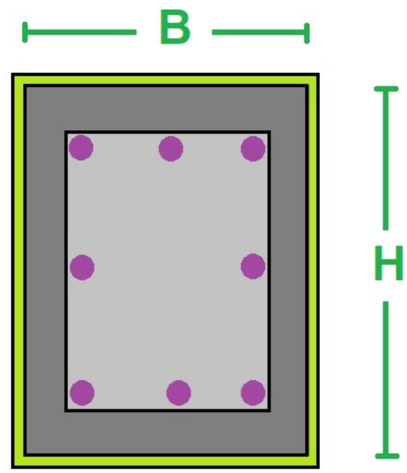
CORE AND COVER CONCRETE REALTION



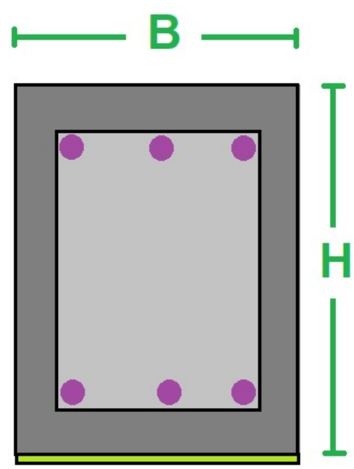
WITHOUT HARDENING AND ULTIMATE STRAIN



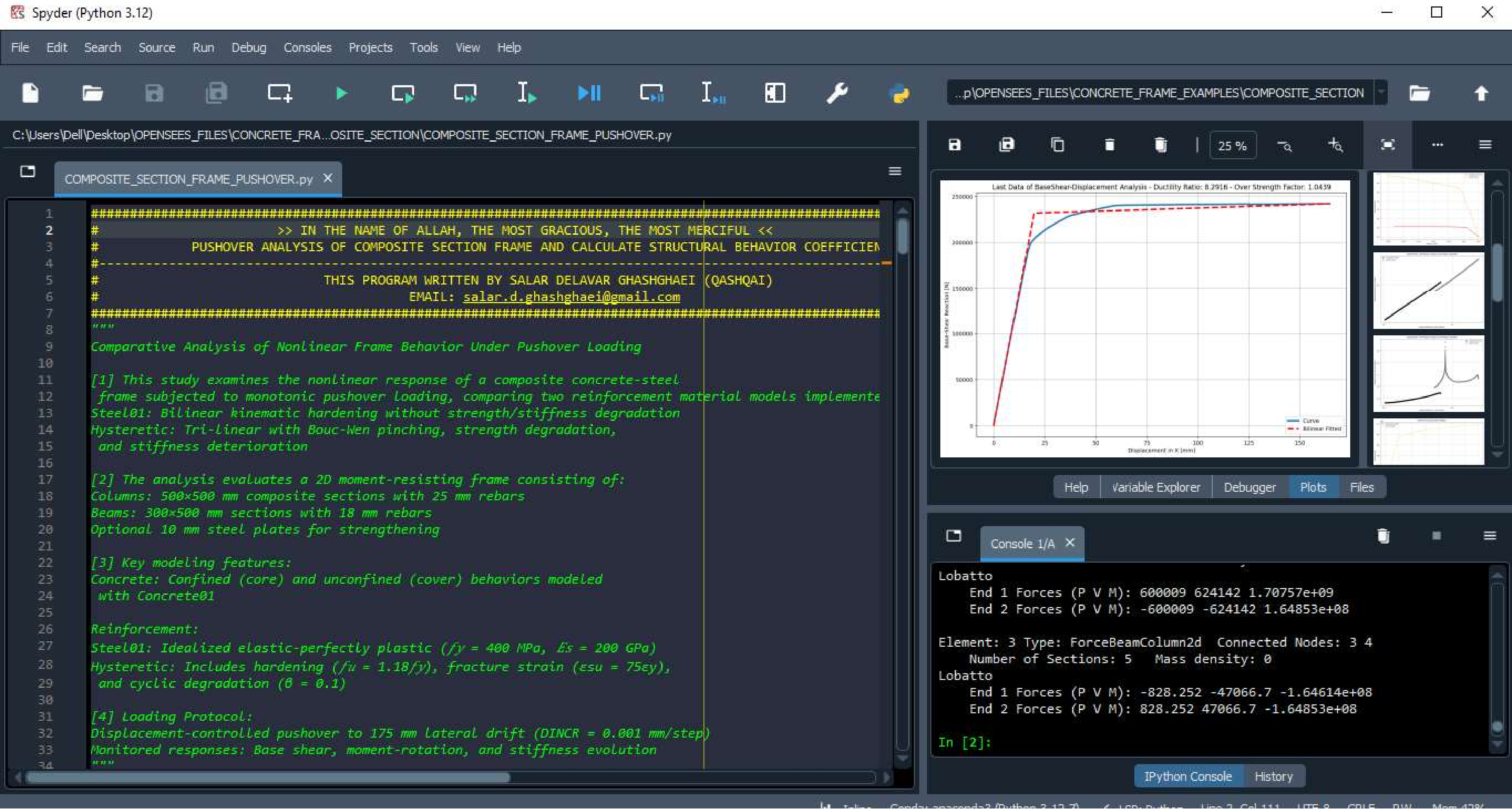
WITH HARDENING AND ULTIMATE STRAIN

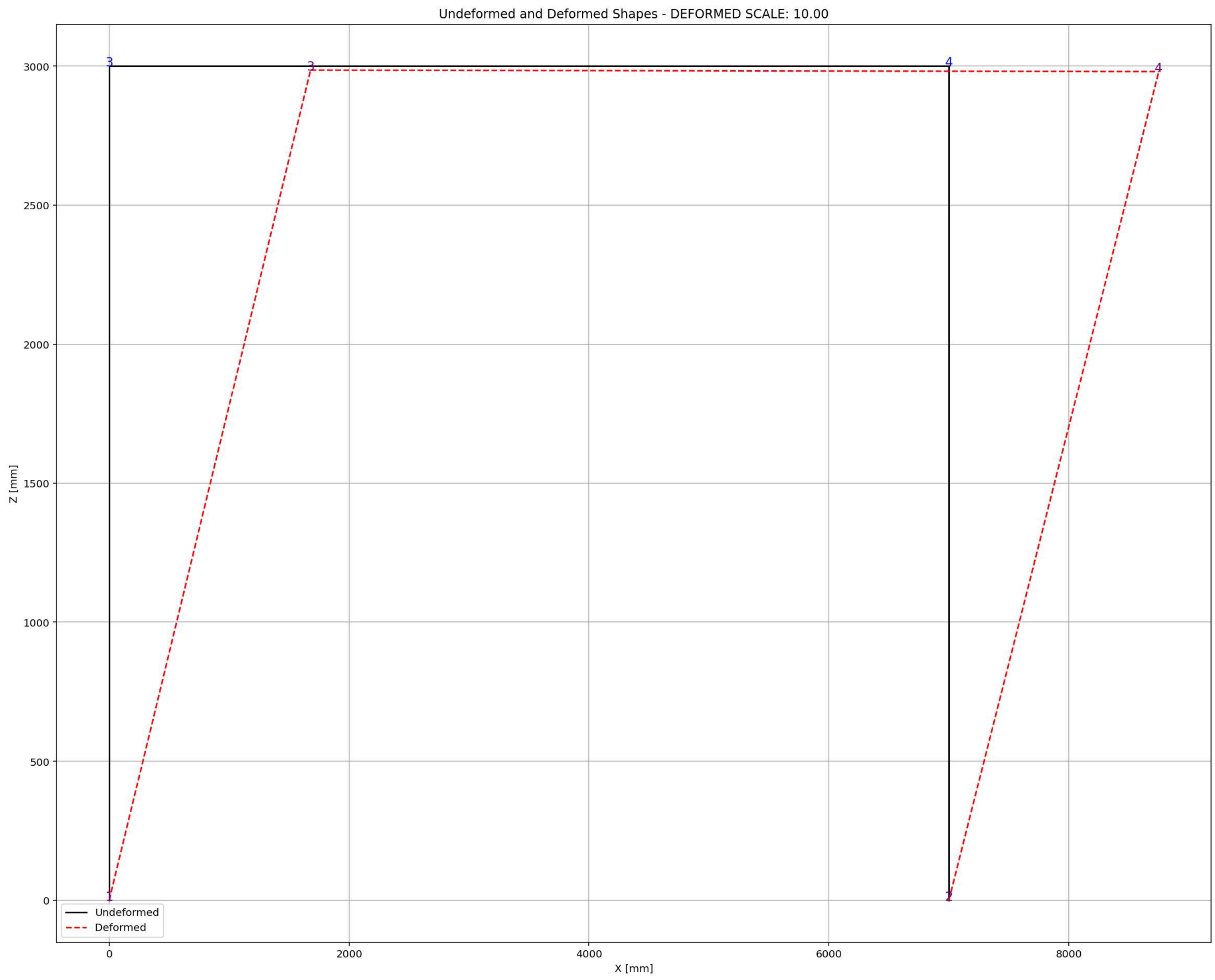


COLUMN SECTION

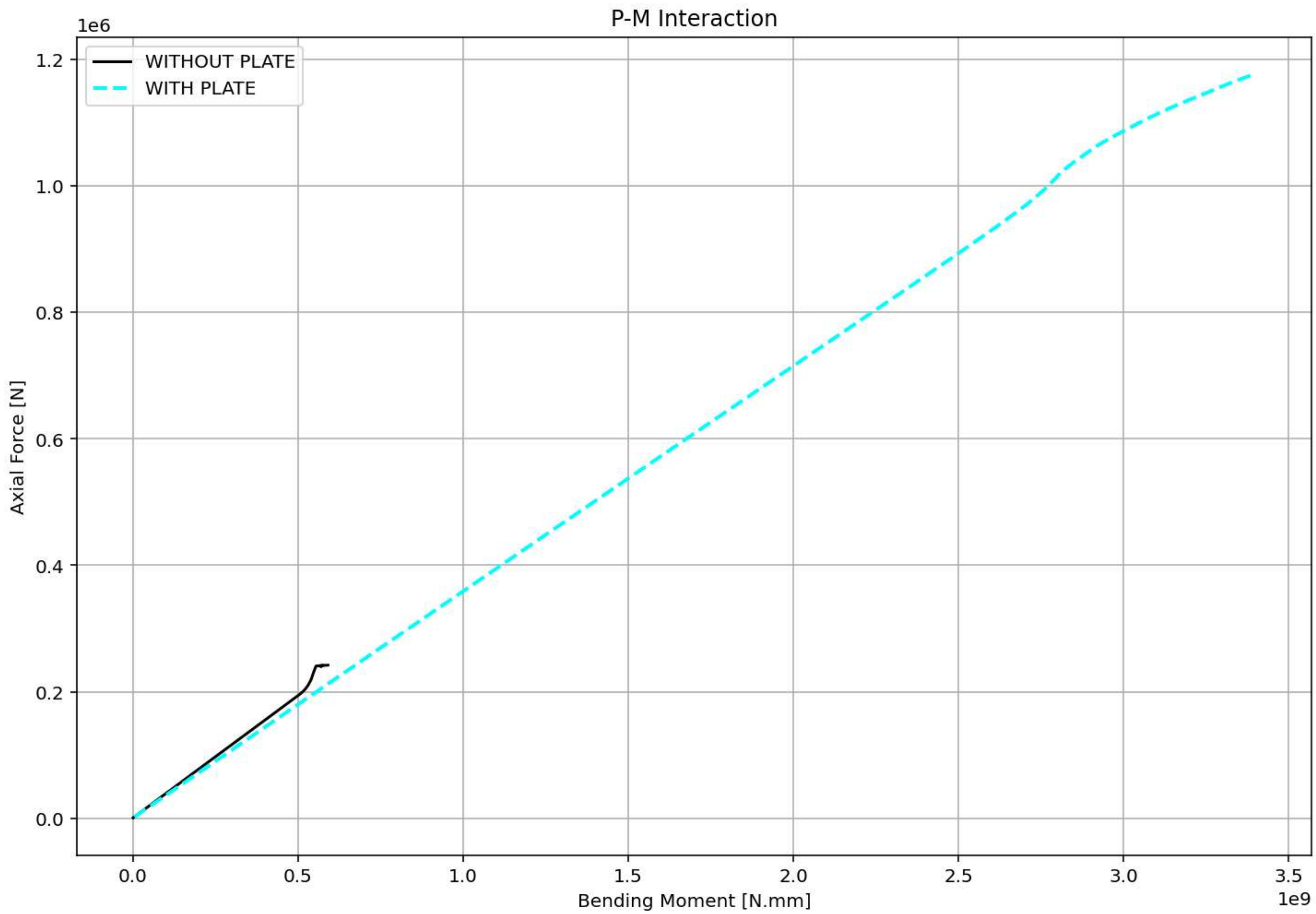


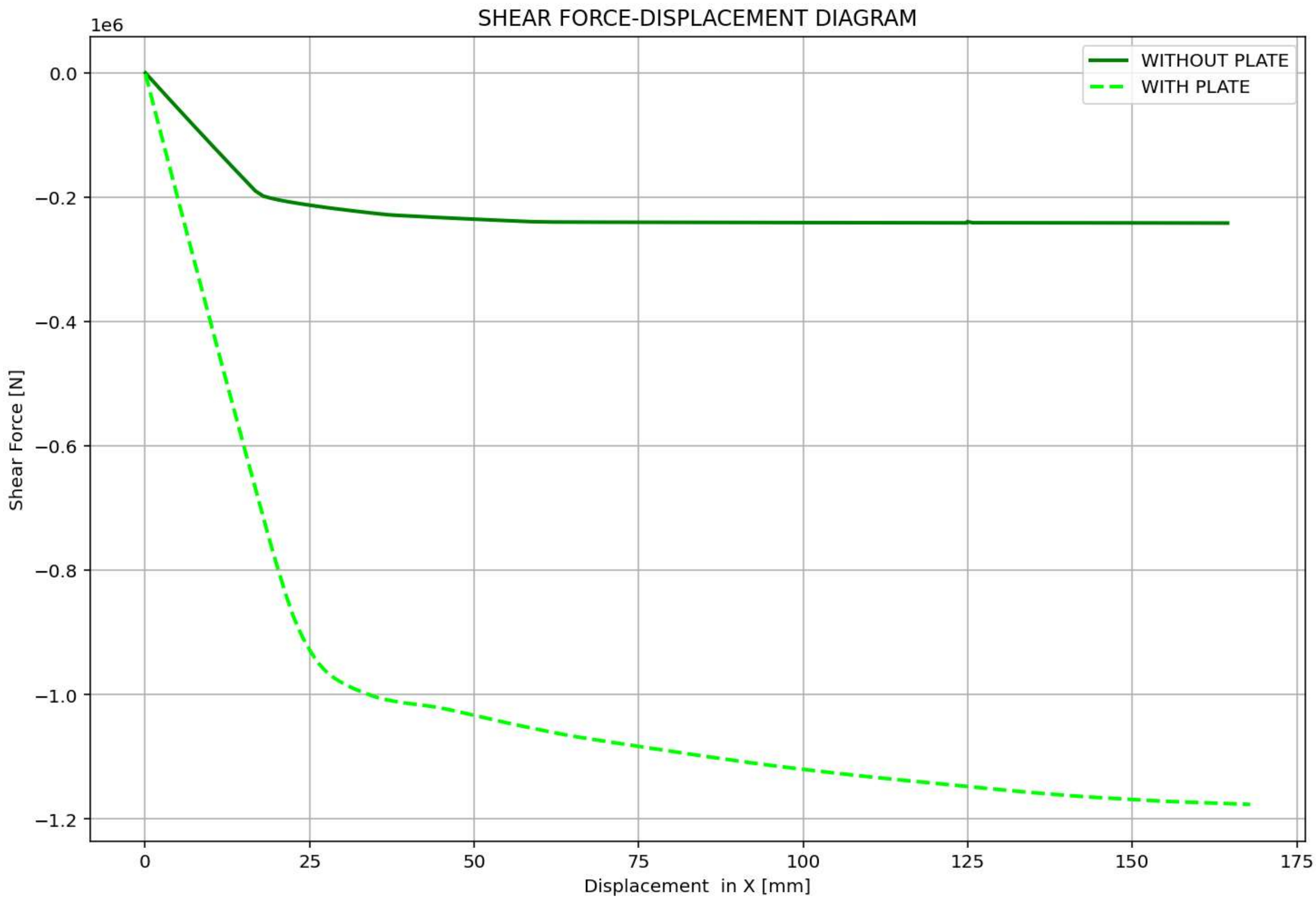
BEAM SECTION

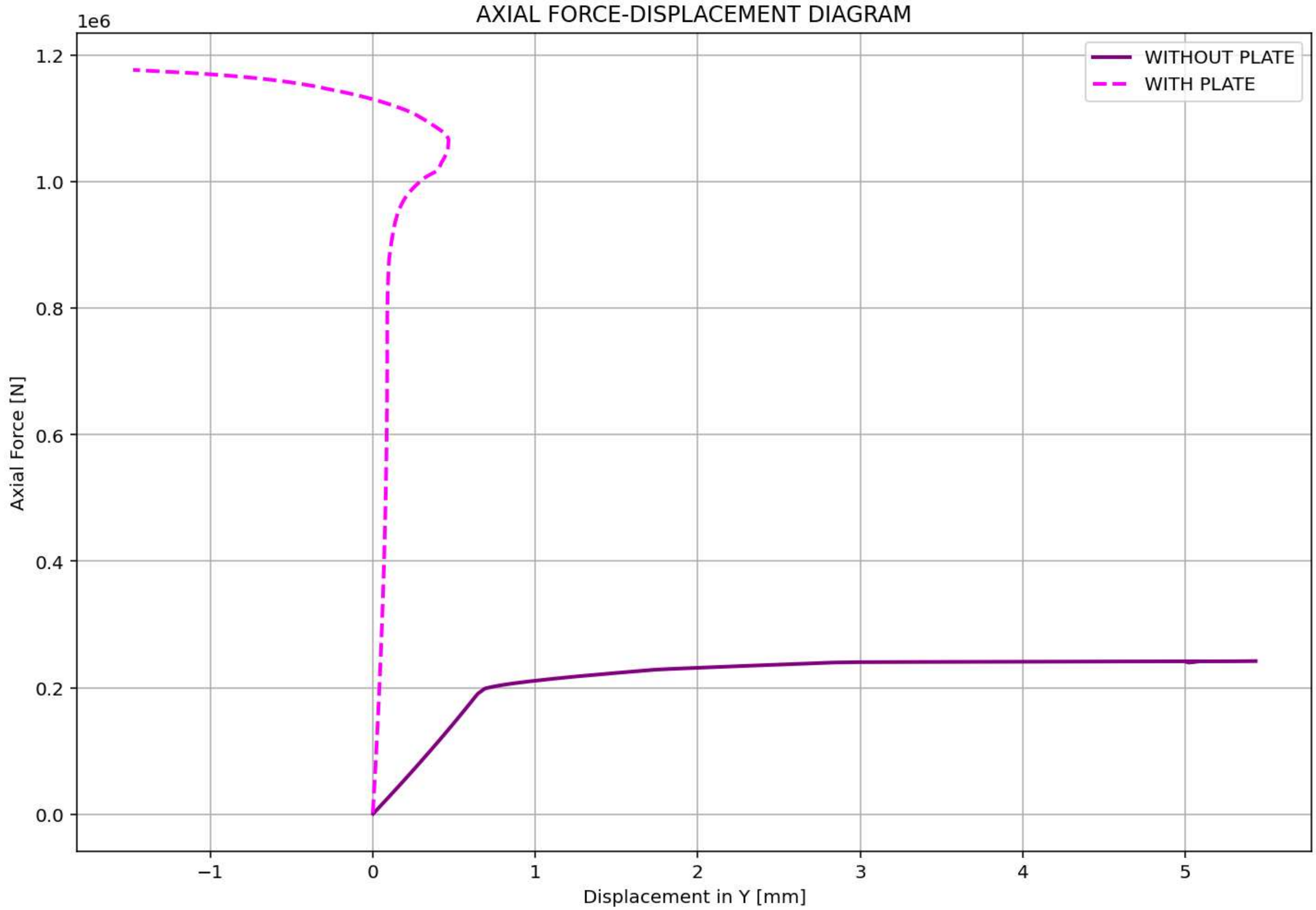

Spyder (Python 3.12)
File Edit Search Source Run Debug Consoles Projects Tools View Help
...p\OPENSEES_FILES\CONCRETE_FRAME_EXAMPLES\COMPOSITE_SECTION
C:\Users\Dell\Desktop\OPENSEES_FILES\CONCRETE_FRA...OSITE_SECTION\COMPOSITE_SECTION_FRAME_PUSHOVER.py
COMPOSITE_SECTION_FRAME_PUSHOVER.py
>> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<
PUSHOVER ANALYSIS OF COMPOSITE SECTION FRAME AND CALCULATE STRUCTURAL BEHAVIOR COEFFICIEN
THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)
EMAIL: salar.d.ghashghaei@gmail.com
"""
Comparative Analysis of Nonlinear Frame Behavior Under Pushover Loading
[1] This study examines the nonlinear response of a composite concrete-steel
frame subjected to monotonic pushover loading, comparing two reinforcement material models implemente
Steel01: Bilinear kinematic hardening without strength/stiffness degradation
Hysteretic: Tri-linear with Bouc-Wen pinching, strength degradation,
and stiffness deterioration
[2] The analysis evaluates a 2D moment-resisting frame consisting of:
Columns: 500×500 mm composite sections with 25 mm rebars
Beams: 300×500 mm sections with 18 mm rebars
Optional 10 mm steel plates for strengthening
[3] Key modeling features:
Concrete: Confined (core) and unconfined (cover) behaviors modeled
with Concrete01
Reinforcement:
Steel01: Idealized elastic-perfectly plastic (fy = 400 MPa, Es = 200 GPa)
Hysteretic: Includes hardening (fu = 1.18fy), fracture strain (εsu = 75εy),
and cyclic degradation (β = 0.1)
[4] Loading Protocol:
Displacement-controlled pushover to 175 mm lateral drift (DINCR = 0.001 mm/step)
Monitored responses: Base shear, moment-rotation, and stiffness evolution
"""
25 %
Last Data of BaseShear-Displacement Analysis - Ductility Ratio: 8.2916 - Over Strength Factor: 1.0439
Curve
Bilinear Fitted
Displacement in X [mm]
Help Variable Explorer Debugger Plots Files
Console 1/A
Lobatto
End 1 Forces (P V M): 600009 624142 1.70757e+09
End 2 Forces (P V M): -600009 -624142 1.64853e+08
Element: 3 Type: ForceBeamColumn2d Connected Nodes: 3 4
Number of Sections: 5 Mass density: 0
Lobatto
End 1 Forces (P V M): -828.252 -47066.7 -1.64614e+08
End 2 Forces (P V M): 828.252 47066.7 -1.64853e+08
In [2]:
IPython Console History

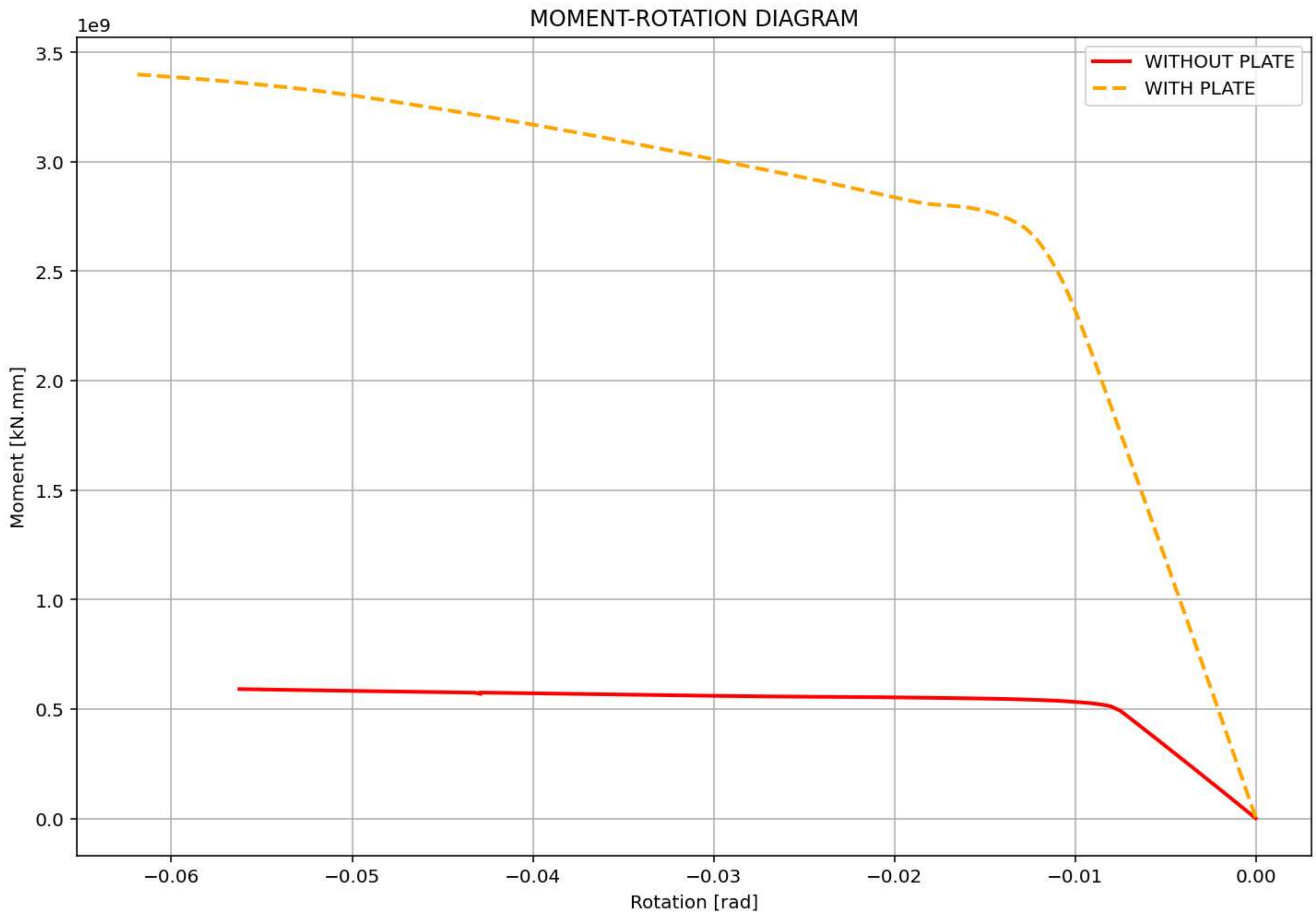


Undeformed and Deformed Shapes - DEFORMED SCALE: 10.00
3
4
1
2
3000
2500
2000
1500
1000
500
0
Z [mm]
0
2000
4000
6000
8000
X [mm]
Undeformed
Deformed

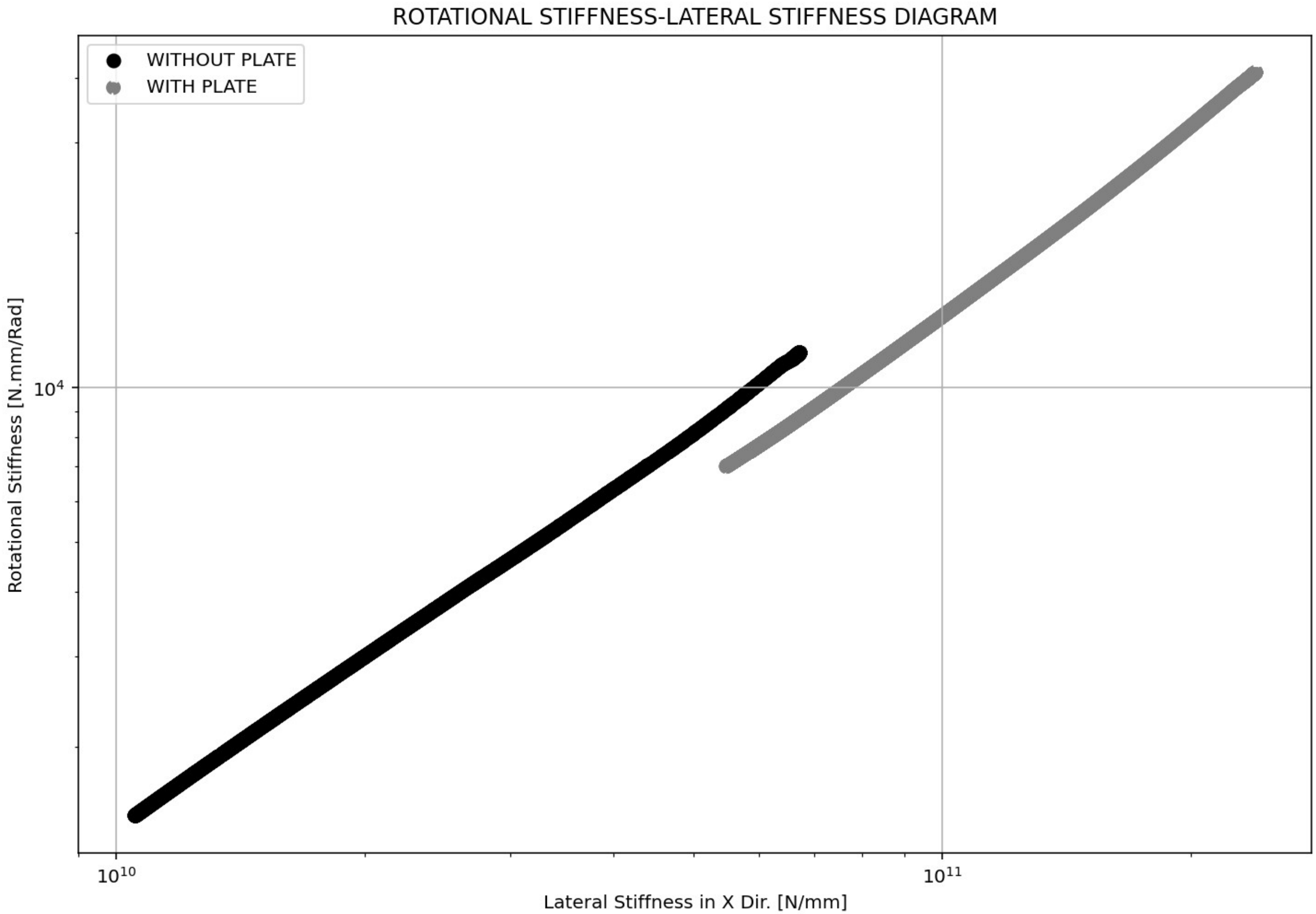

P-M Interaction
1e6
WITHOUT PLATE
WITH PLATE
Axial Force [N]
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
1e9
Bending Moment [N.mm]

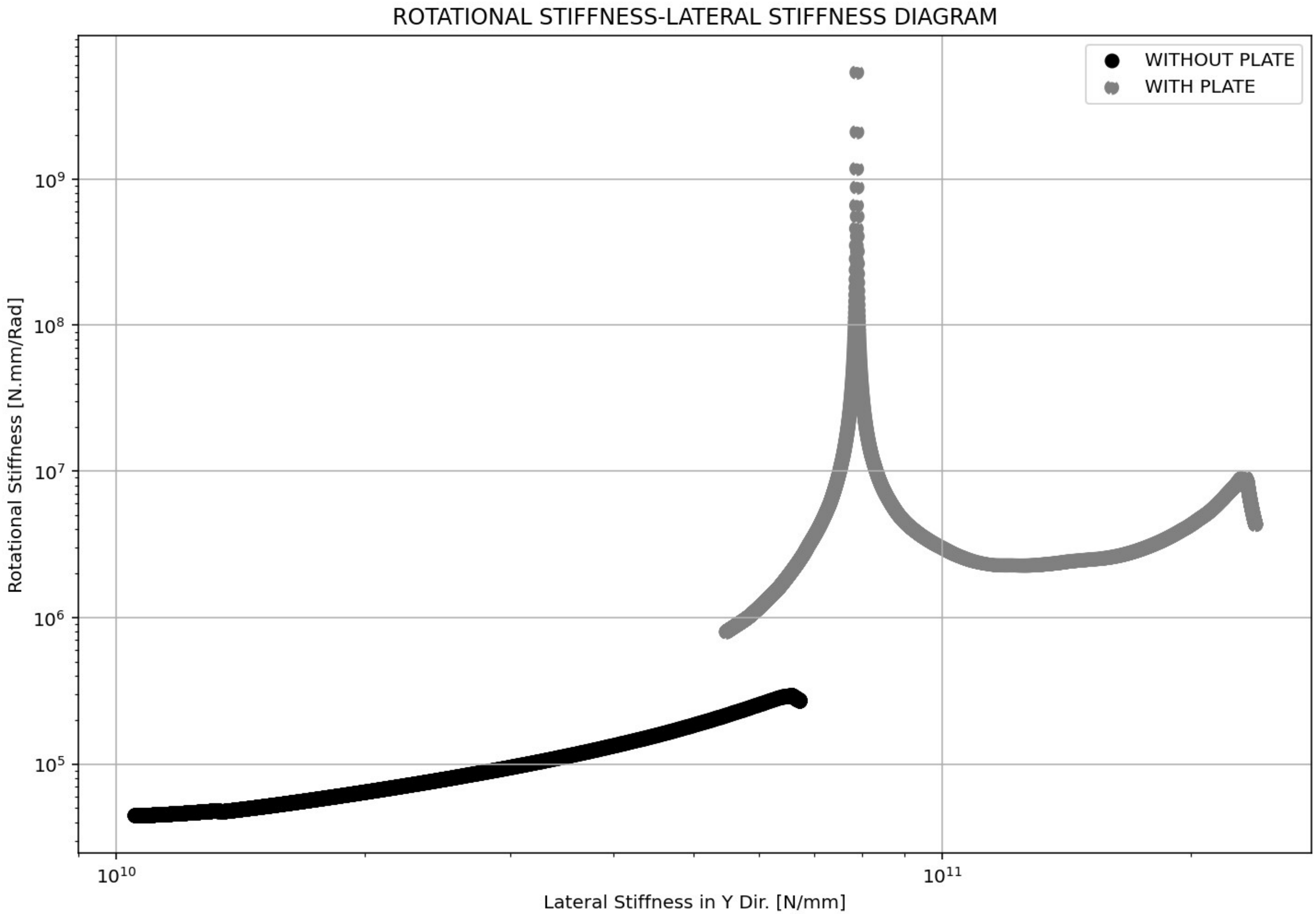

SHEAR FORCE-DISPLACEMENT DIAGRAM
1e6
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
Shear Force [N]
0
25
50
75
100
125
150
175
Displacement in X [mm]
WITHOUT PLATE
WITH PLATE

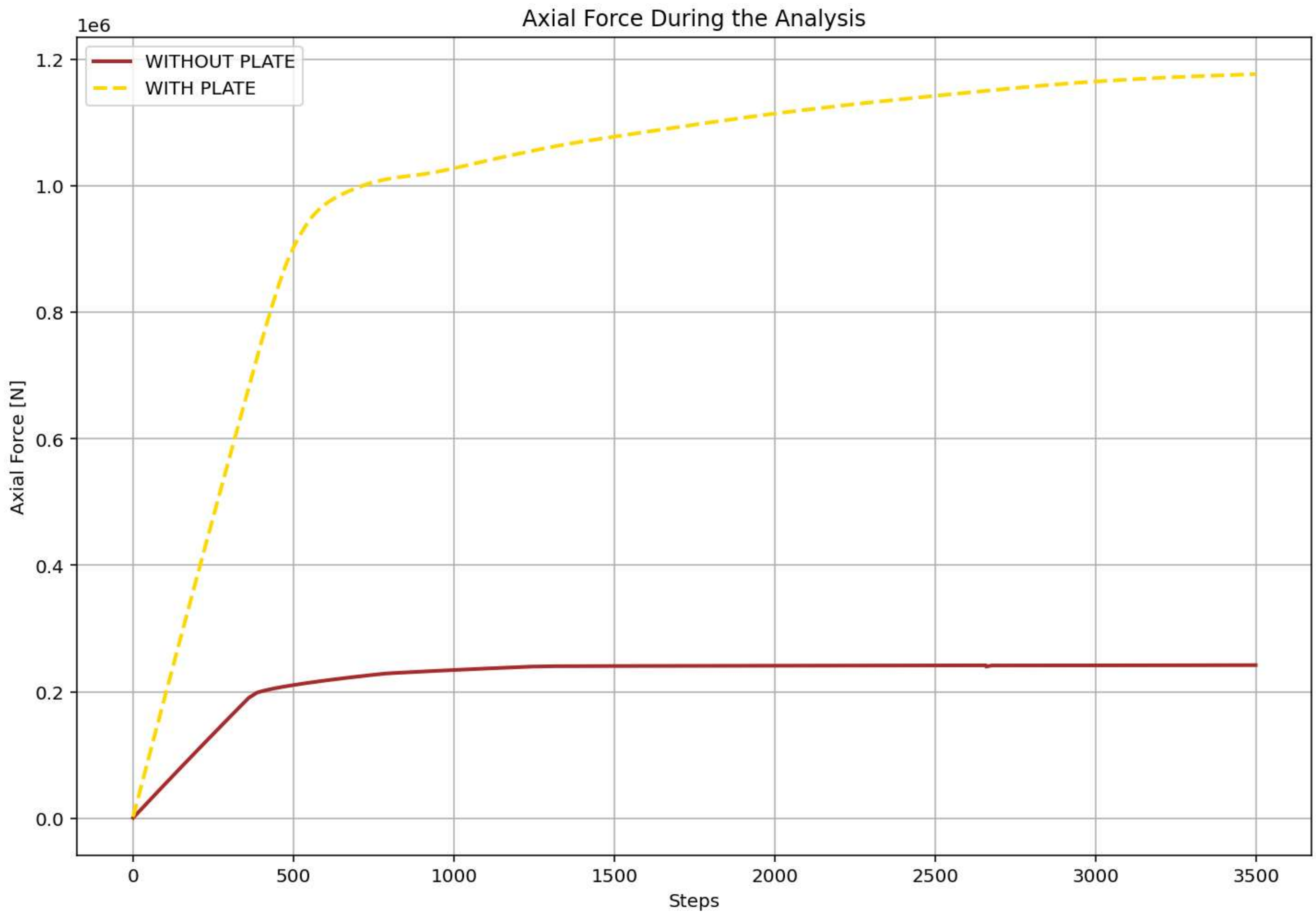

AXIAL FORCE-DISPLACEMENT DIAGRAM
1e6
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Axial Force [N]
−1
0
1
2
3
4
5
Displacement in Y [mm]
WITHOUT PLATE
WITH PLATE



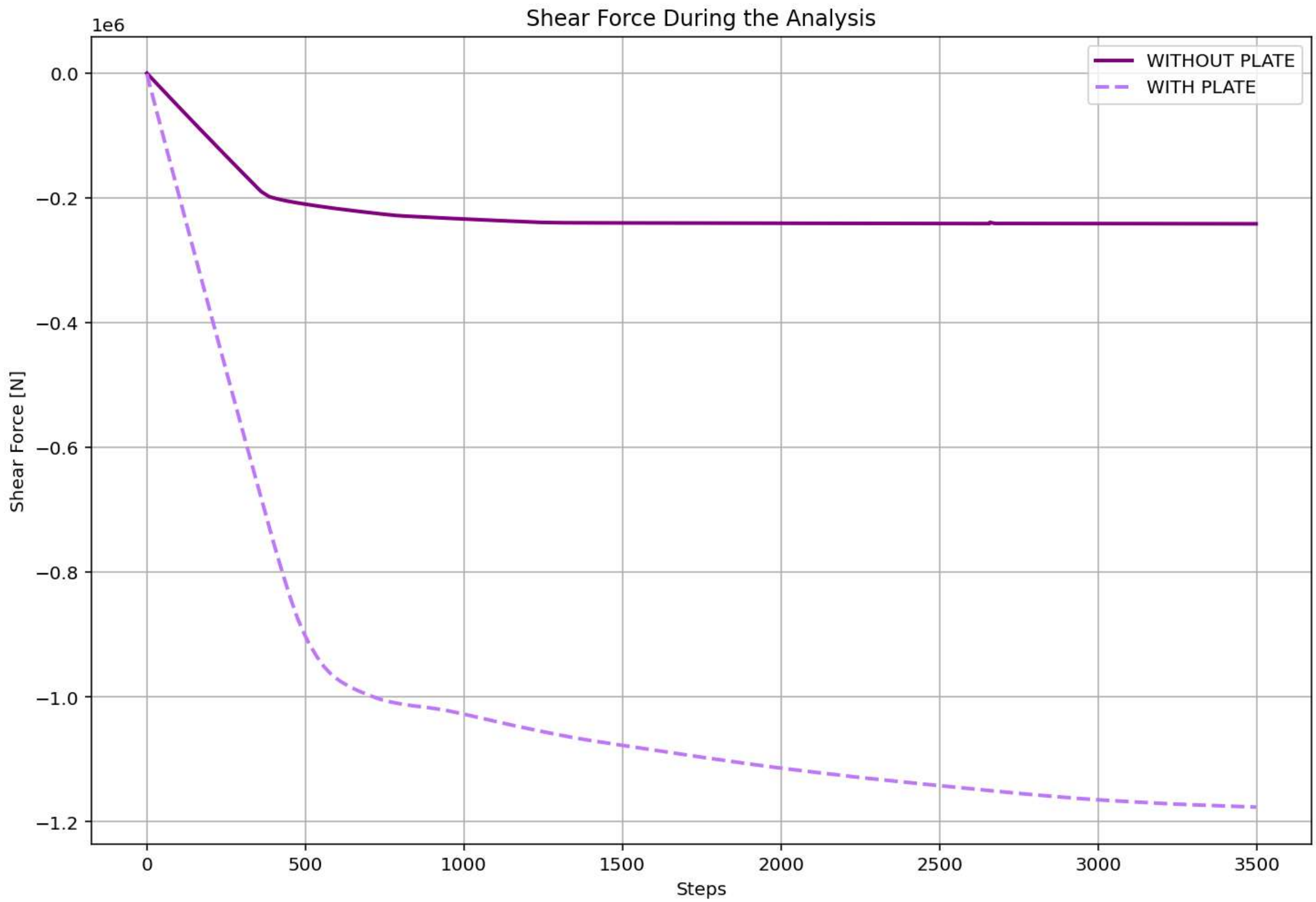
MOMENT-ROTATION DIAGRAM
1e9
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Moment [kN.mm]
−0.06
−0.05
−0.04
−0.03
−0.02
−0.01
0.00
Rotation [rad]
WITHOUT PLATE
WITH PLATE

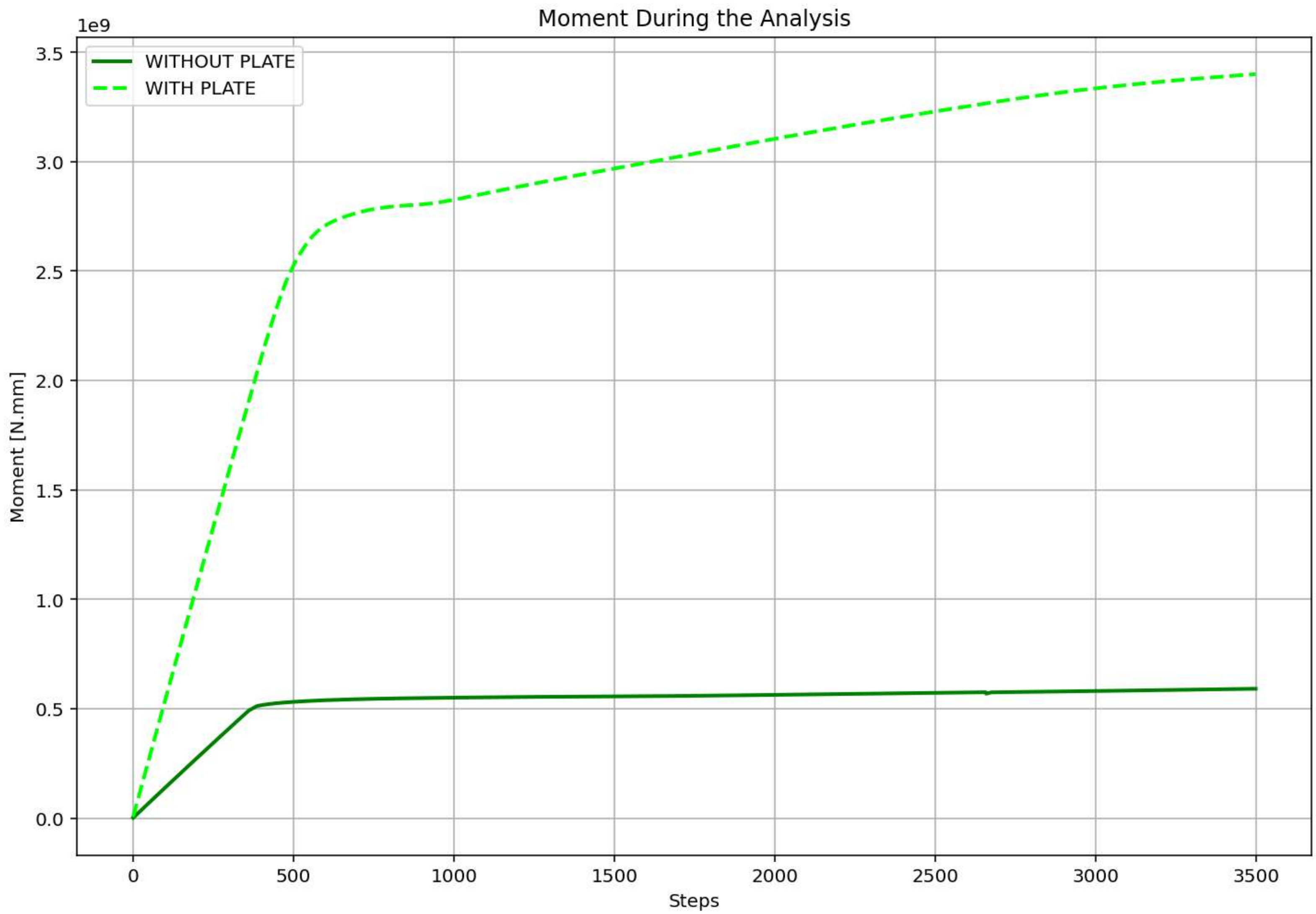

ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM
WITHOUT PLATE
WITH PLATE
Rotational Stiffness [N.mm/Rad]
10^4
10^{10}
10^{11}
Lateral Stiffness in X Dir. [N/mm]

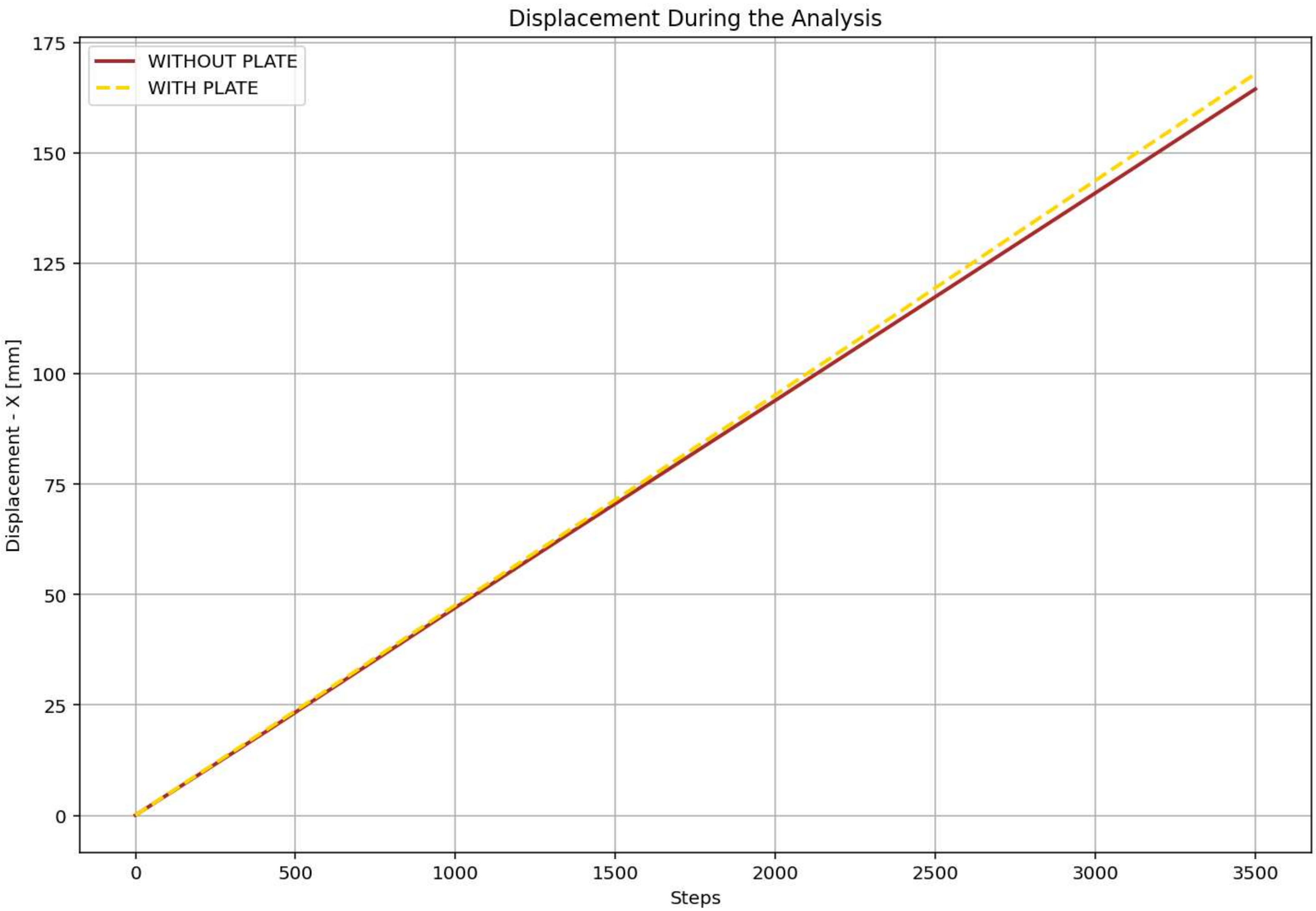

ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM
WITHOUT PLATE
WITH PLATE
Rotational Stiffness [N.mm/Rad]
10^9
10^8
10^7
10^6
10^5
10^{10}
10^{11}
Lateral Stiffness in Y Dir. [N/mm]



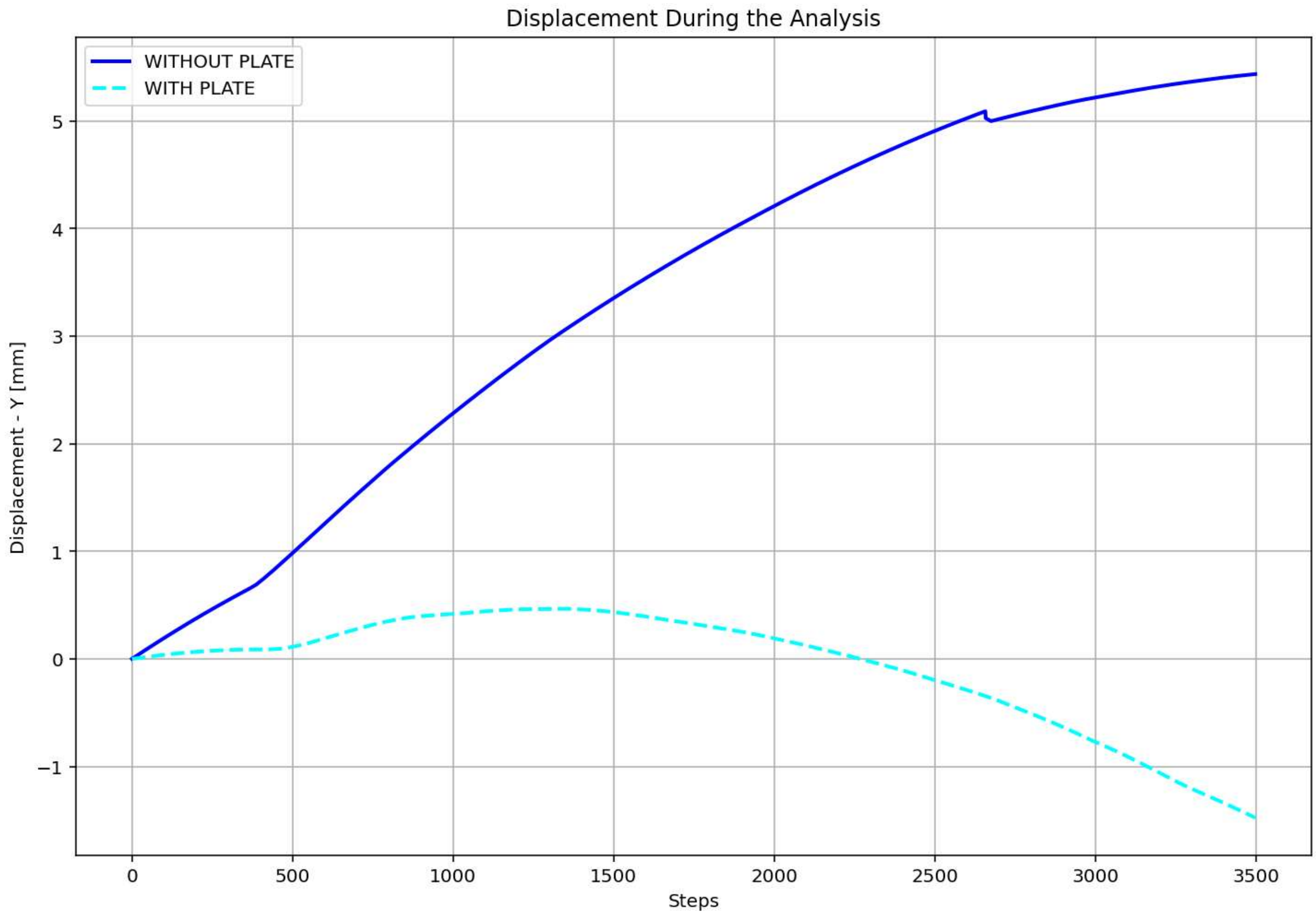
Axial Force During the Analysis
1e6
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Axial Force [N]
WITHOUT PLATE
WITH PLATE
0
500
1000
1500
2000
2500
3000
3500
Steps


Shear Force During the Analysis
1e6
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
Shear Force [N]
0
500
1000
1500
2000
2500
3000
3500
Steps
WITHOUT PLATE
WITH PLATE

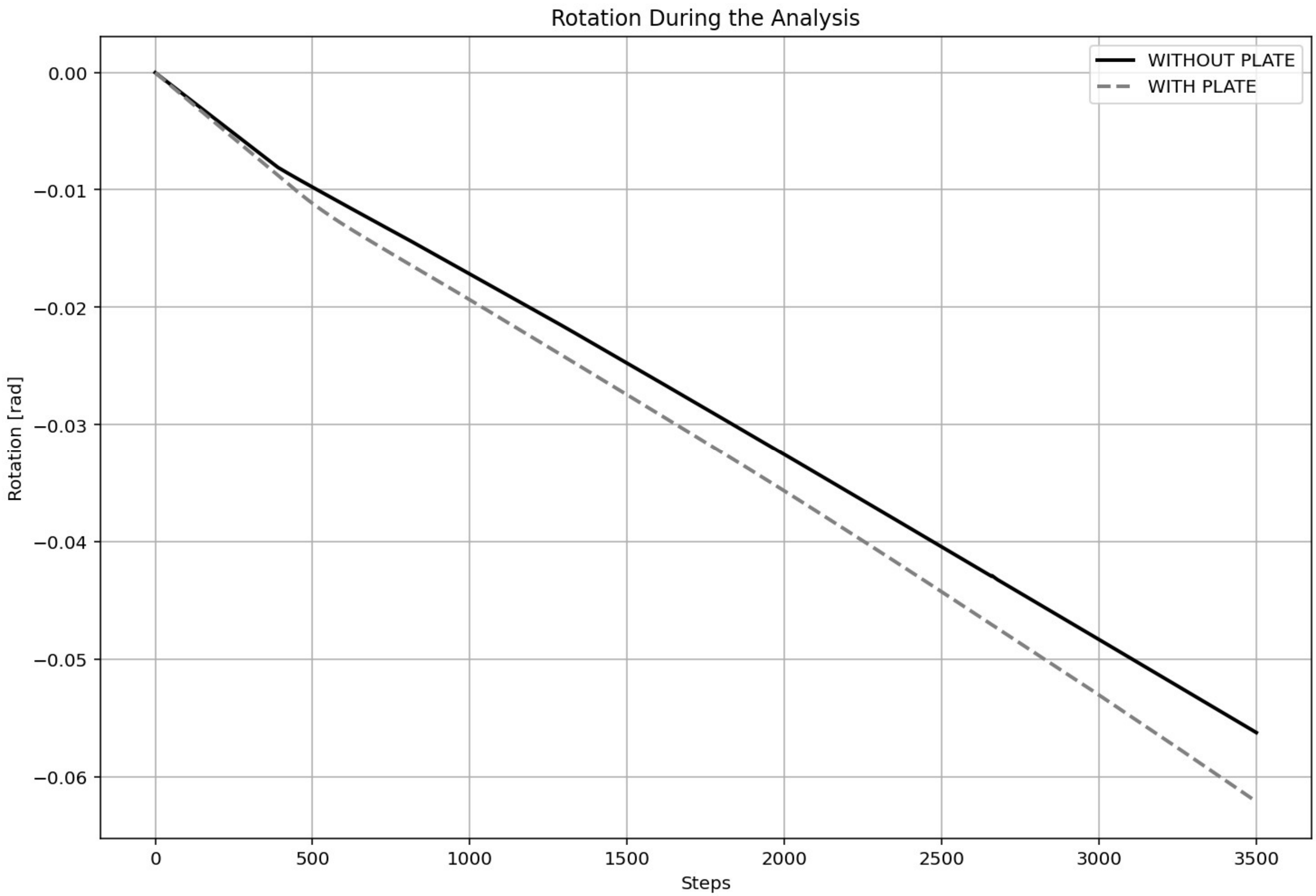

Moment During the Analysis
1e9
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Moment [N.mm]
0
500
1000
1500
2000
2500
3000
3500
Steps
WITHOUT PLATE
WITH PLATE

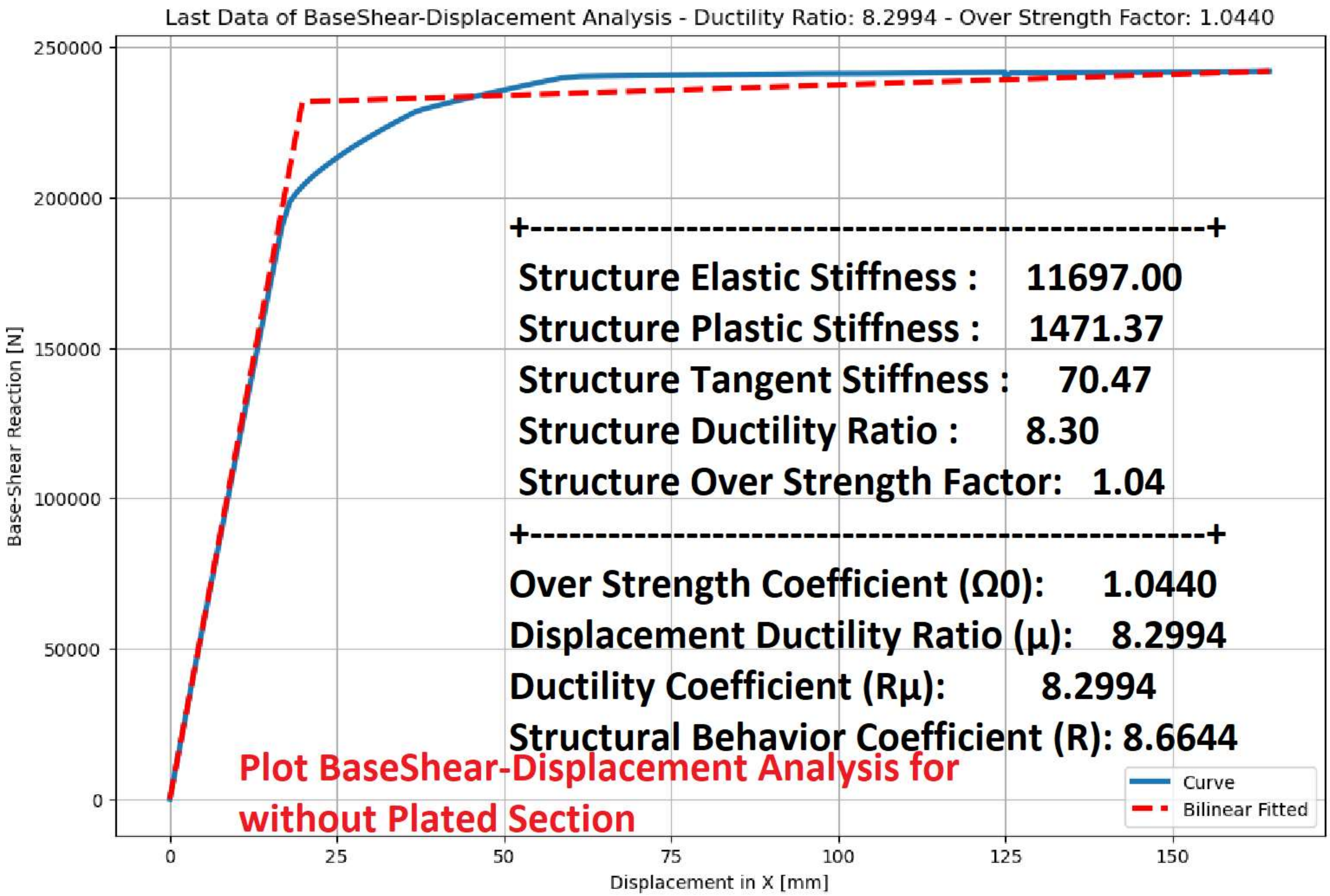


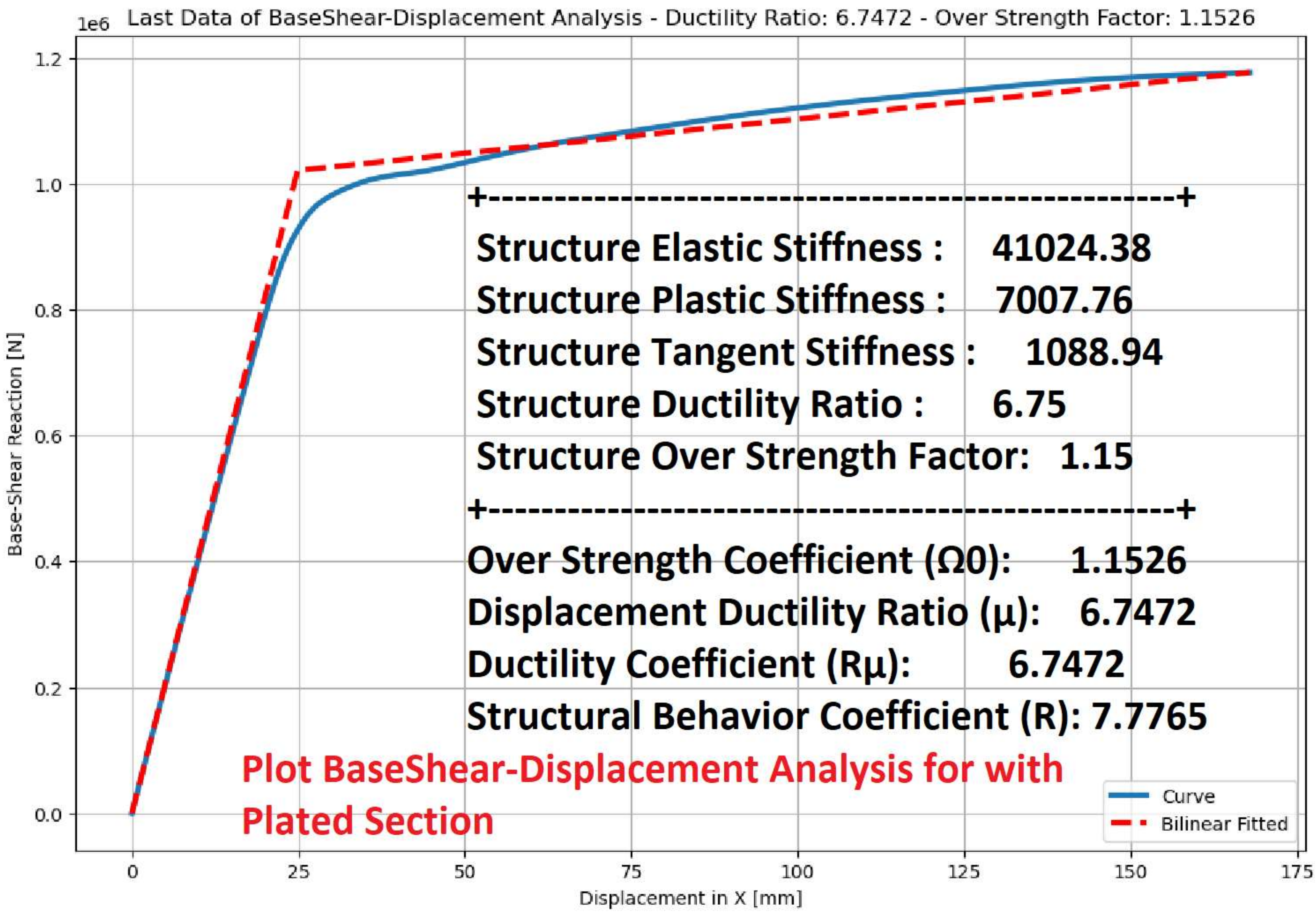
Displacement During the Analysis
WITHOUT PLATE
WITH PLATE
Displacement - X [mm]
0
25
50
75
100
125
150
175
0
500
1000
1500
2000
2500
3000
3500
Steps



Displacement During the Analysis
WITHOUT PLATE
WITH PLATE
Displacement - Y [mm]
Steps
0
500
1000
1500
2000
2500
3000
3500
−1
0
1
2
3
4
5


Rotation During the Analysis
WITHOUT PLATE
WITH PLATE
Rotation [rad]
0.00
−0.01
−0.02
−0.03
−0.04
−0.05
−0.06
0
500
1000
1500
2000
2500
3000
3500
Steps


Last Data of BaseShear-Displacement Analysis - Ductility Ratio: 8.2994 - Over Strength Factor: 1.0440
Base-Shear Reaction [N]
250000
200000
150000
100000
50000
0
Displacement in X [mm]
0
25
50
75
100
125
150
+--+
Structure Elastic Stiffness : 11697.00
Structure Plastic Stiffness : 1471.37
Structure Tangent Stiffness : 70.47
Structure Ductility Ratio : 8.30
Structure Over Strength Factor: 1.04
+--+
Over Strength Coefficient (Ω0): 1.0440
Displacement Ductility Ratio (μ): 8.2994
Ductility Coefficient (Rμ): 8.2994
Structural Behavior Coefficient (R): 8.6644
Curve
Bilinear Fitted
Plot BaseShear-Displacement Analysis for
without Plated Section



Plot BaseShear-Displacement Analysis for with Plated Section