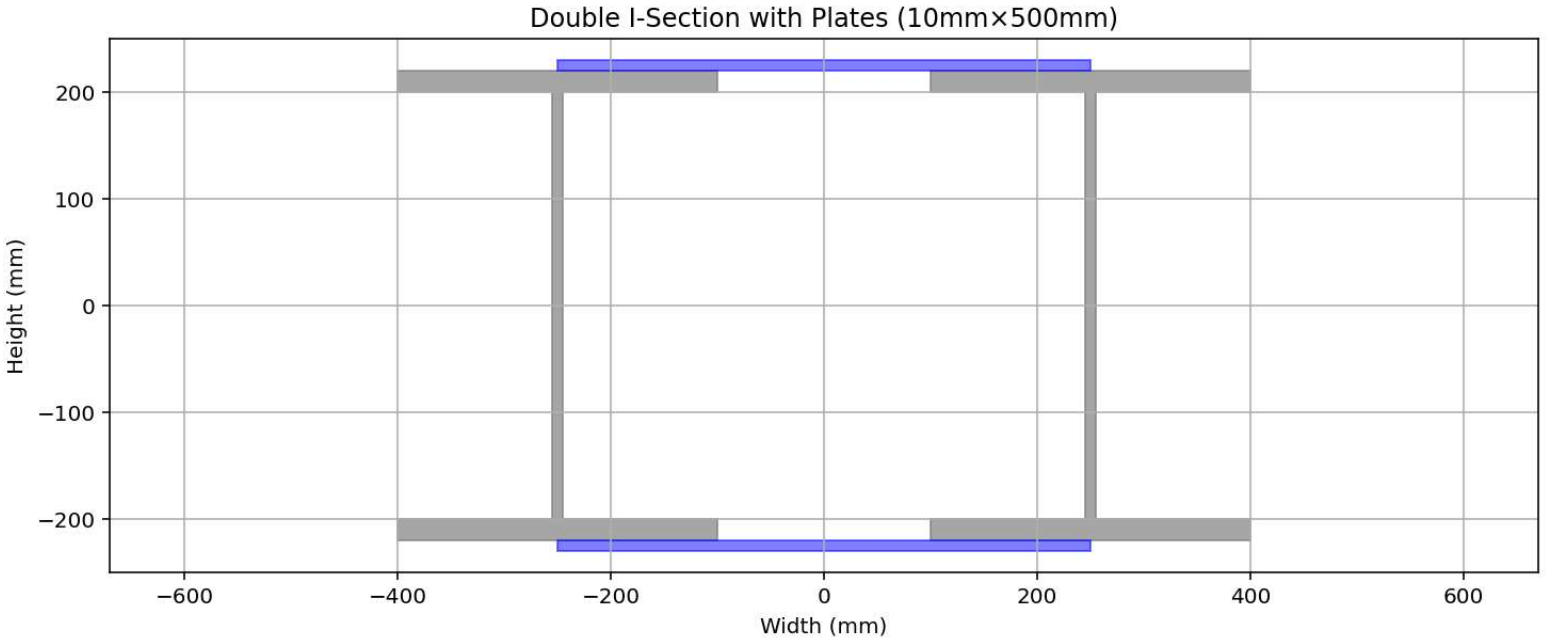
>> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<

INVESTIGATION OF MULTI-MODE POST-BUCKLING PHENOMENA IN SEMI-RIGID STEEL COLUMNS USING OPENSEES CONSIDERING THE GEOMETRIC AND MATERIAL PROPERTIES NONLINEARITY

WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)


Double I-Section with Plates (10mm×500mm)
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Width (mm)
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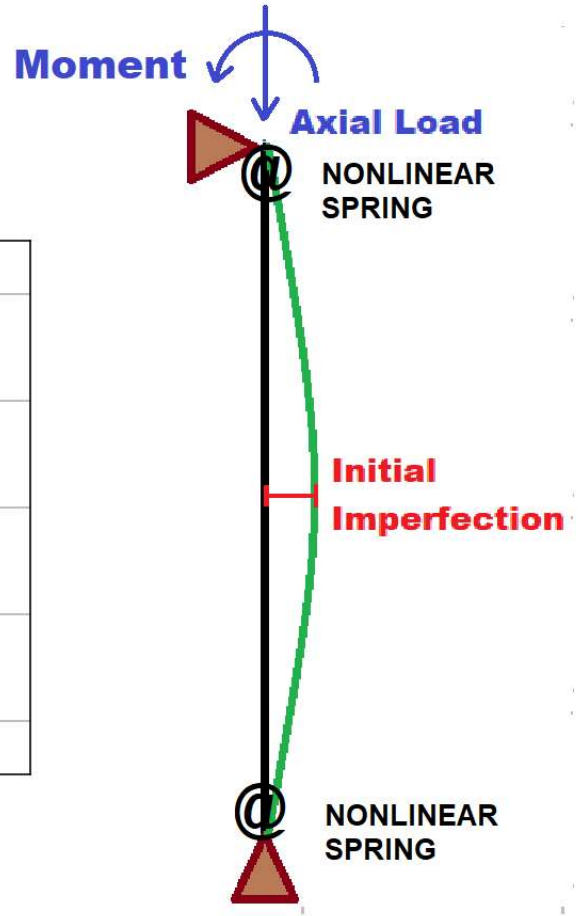
−200
0
200
400
600


Moment
Axial Load
NONLINEAR SPRING
Initial Imperfection
NONLINEAR SPRING

Spyder (Python 3.12)

File Edit Search Source Run Debug Consoles Projects Tools View Help

...MULTI-MODE-POST_BUCKLING_STEEL_COLUMN_SEMI-RIGID_NONLINEAR

C:\Users\Dell\Desktop\OPENSEES_FILES\+++MULTI-MO...OST_BUCKLING_STEEL_COLUMN_SEMI-RIGID_NONLINEAR.py

MULTI-MODE-POST_BU...RIGID_NONLINEAR.py | STEEL_FIBER_SECTION.py

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1  ##########################################################################################################
2  #                    >> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<                    #
3  #          INVESTIGATION OF MULTI-MODE POST-BUCKLING PHENOMENA IN SEMI-RIGID STEEL COLUMNS               #
4  #           USING OPENSEES CONSIDERING THE GEOMETRIC AND MATERIAL PROPERTIES NONLINEARITY               #
5  #----------------------------------------------------------------------------------------------------------#
6  # IT MODELS A 2D INELASTIC BEAM-COLUMN WITH AN INITIAL IMPERFECTION (FOUR DIFFRENET SHAPES)              #
7  #  AND APPLIES AN AXIAL COMPRESSIVE LOAD TO ANALYZE LARGE DISPLACEMENTS.                                 #
8  # 1. MODEL SETUP: A COLUMN OF LENGTH L IS DEFINED WITH N ELEMENTS, INCORPORATING A SMALL INITIAL        #
9  # IMPERFECTION (HALF-SINE WAVE).                                                                        #
10 # 2. NODES & BOUNDARY CONDITIONS: NODES ARE CREATED, WITH THE BOTTOM FIXED IN X, Y AND THE TOP FIXED IN  #
11 # X BUT FREE IN Y AND ROTATION.                                                                         #
12 # 3. ELEMENT DEFINITION: THE COLUMN IS MODELED USING ELASTIC BEAM-COLUMN ELEMENTS WITH COROTATIONAL     #
13 # TRANSFORMATION FOR GEOMETRIC NONLINEARITY.                                                            #
14 # 4. LOAD APPLICATION: A STATIC AXIAL FORCE P IS APPLIED AT THE TOP NODE.                               #
15 # 5. ANALYSIS SETUP: A DISPLACEMENTCONTROL INTEGRATOR IS USED TO INCREMENTALLY PUSH THE COLUMN DOWNWARDS. #
16 # 6. NONLINEAR SOLVER: THE NEWTON METHOD IS USED WITH A NORMDISPINCR TEST FOR CONVERGENCE.              #
17 # 7. ANALYSIS EXECUTION: THE LOOP PERFORMS INCREMENTAL LOADING STEPS, RECORDING AXIAL DISPLACEMENT,     #
18 # LATERAL DISPLACEMENT, AND AXIAL FORCE.                                                                #
19 # 8. BUCKLING BEHAVIOR CAPTURE: LATERAL DISPLACEMENTS AT THE MID-HEIGHT NODE INDICATE POST-BUCKLING     #
20 # DEFORMATION.                                                                                          #
21 # 9. RESULTS EXTRACTION: REACTION FORCES AT THE BASE NODE PROVIDE THE AXIAL COMPRESSIVE LOAD.           #
22 # 10. PLOTTING: THE SCRIPT VISUALIZES AXIAL FORCE VS. LATERAL DISPLACEMENT, SHOWING THE POST-BUCKLING  #
23 # RESPONSE OF THE COLUMN.                                                                               #
24 #----------------------------------------------------------------------------------------------------------#
25 #                        THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)                      #
26 #                                EMAIL: salar.d.ghashghaei@gmail.com                                     #
27 ##########################################################################################################
28 import openseespy.opensees as ops
29 import numpy as np
30 import matplotlib.pyplot as plt
31 import STEEL_FIBER_SECTION as S01
32 import ANALYSIS_FUNCTION as S02
33 import time as TI
34 #%%-------------------------------------------------------------------------------------------
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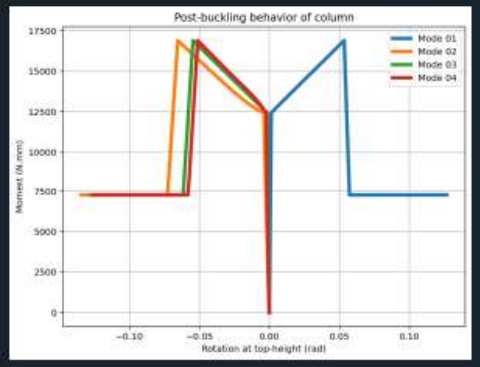

Python Console | Files | Help | Variable Explorer | Debugger | Plots

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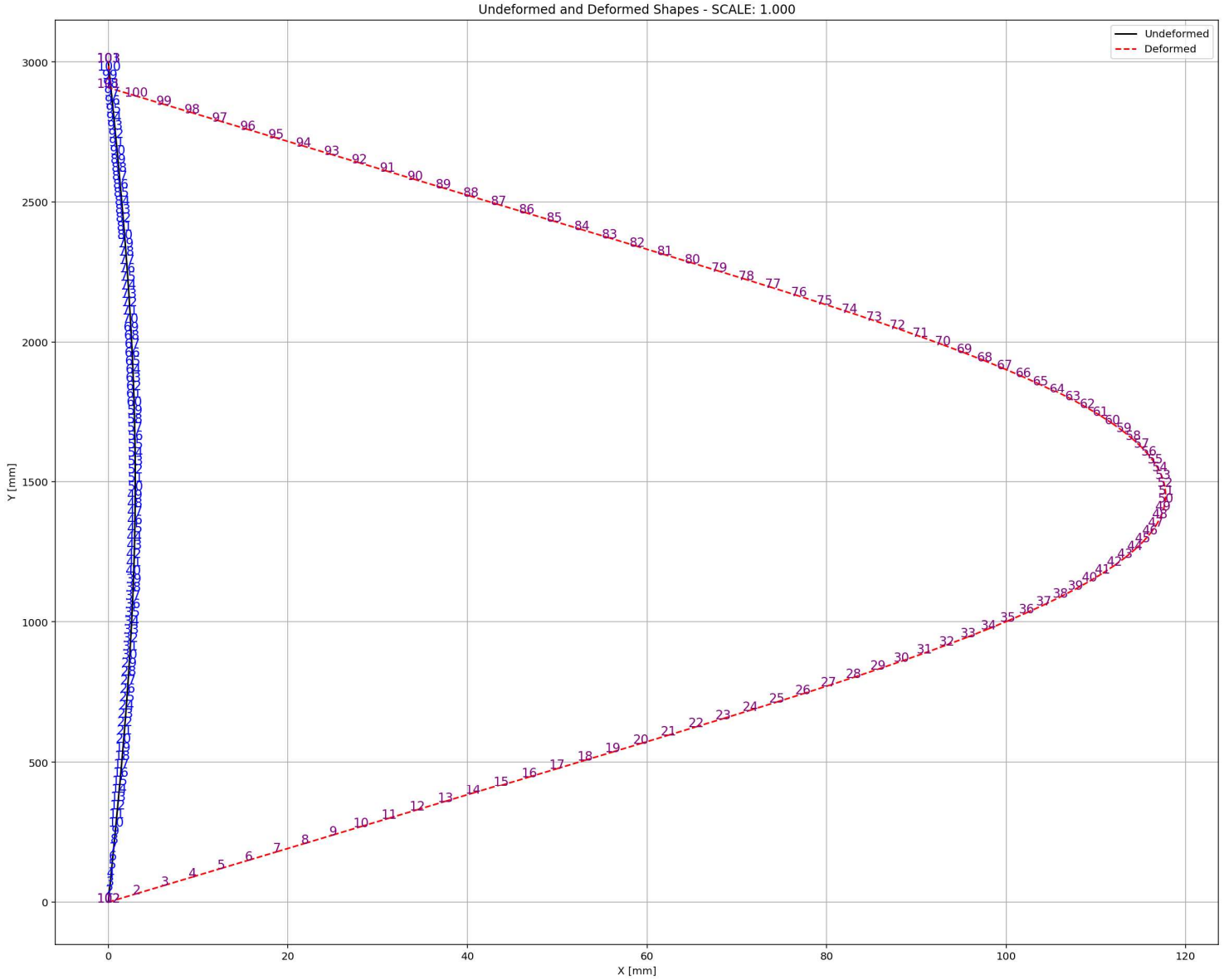
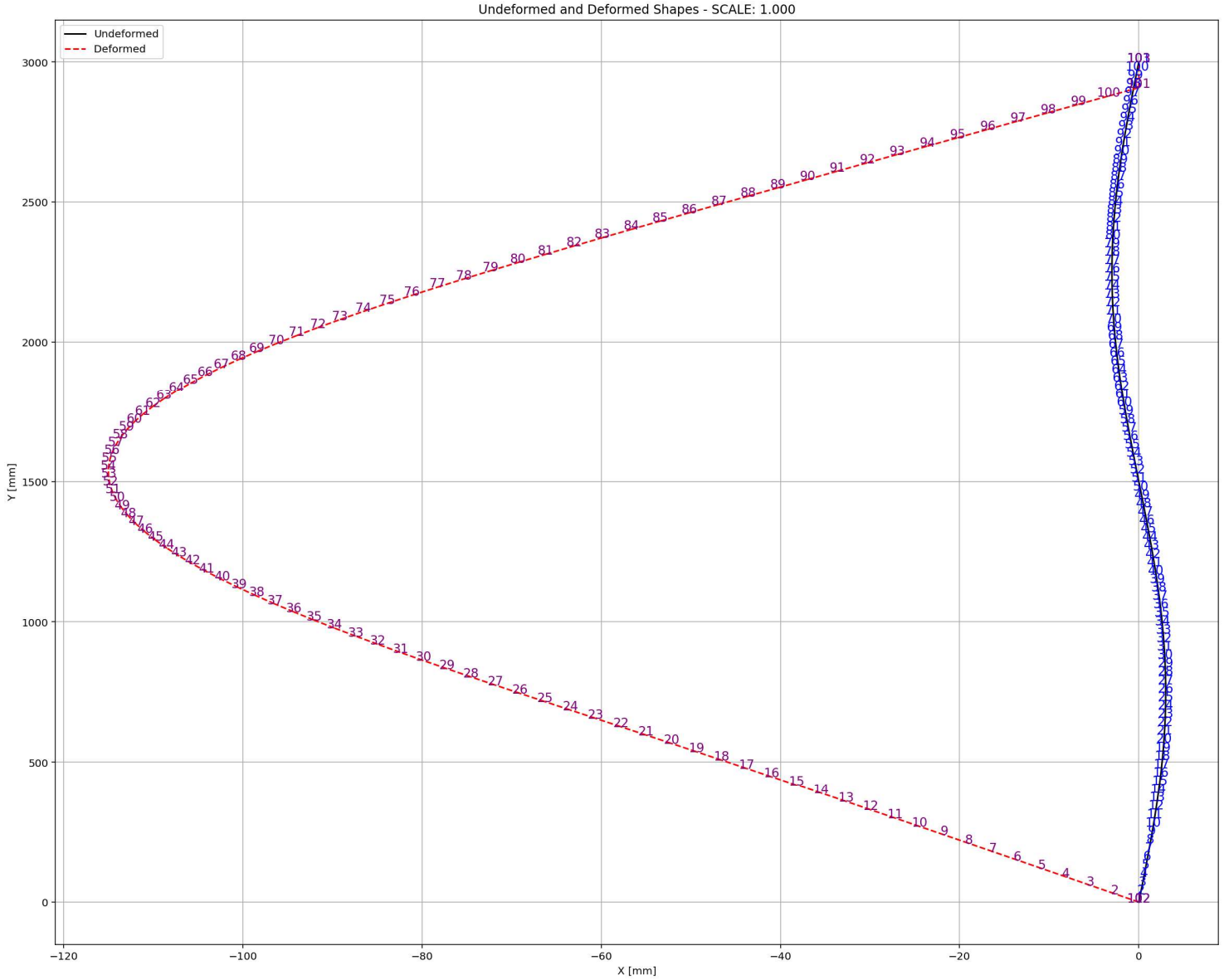

Undeformed and Deformed Shapes - SCALE: 1.000
Undeformed
Deformed
Y [mm]
X [mm]
0
500
1000
1500
2000
2500
3000
0
20
40
60
80
100
120


Undeformed and Deformed Shapes - SCALE: 1.000
Undeformed
Deformed
Y [mm]
X [mm]
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2500
2000
1500
1000
500
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−100
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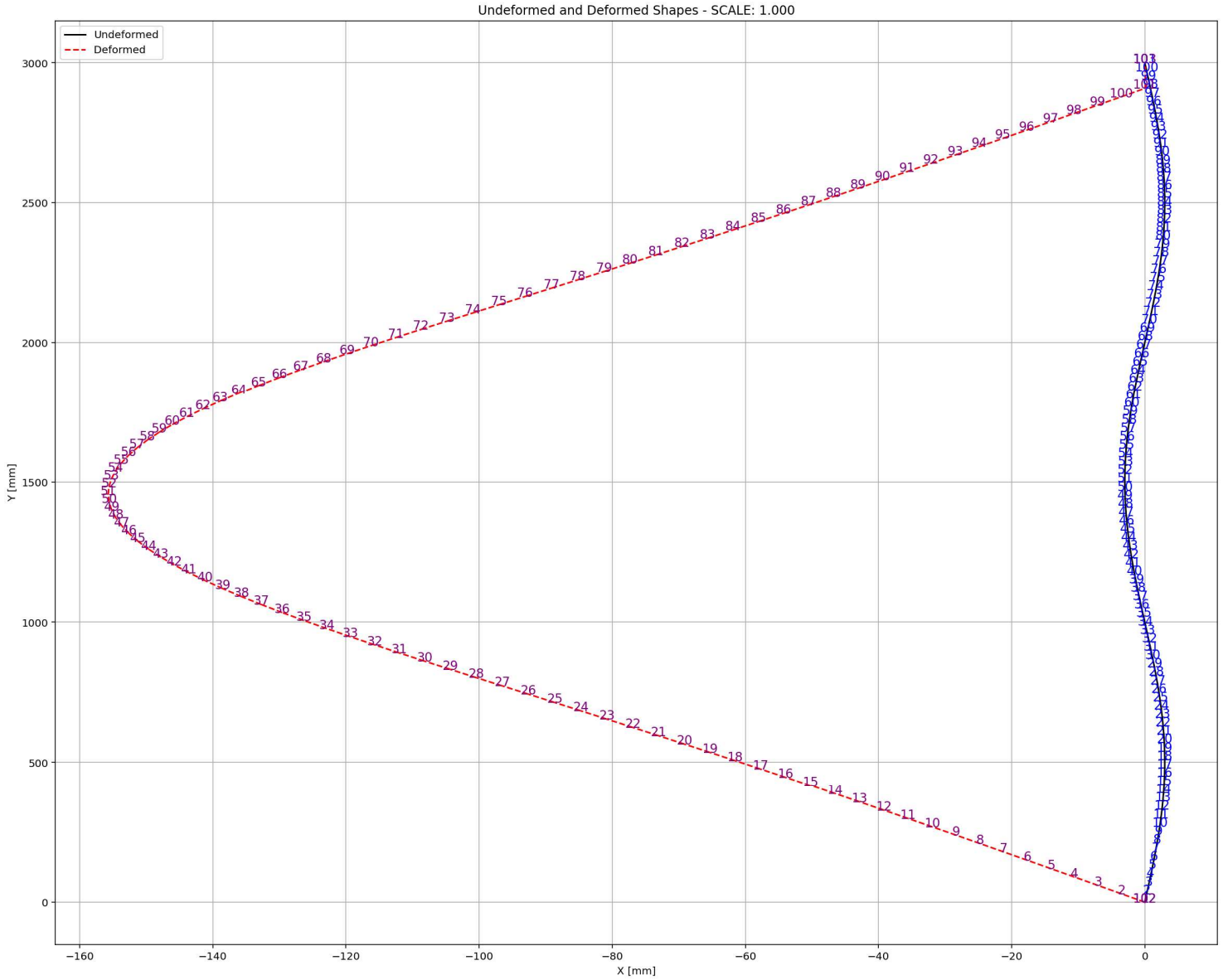
0


Undeformed and Deformed Shapes - SCALE: 1.000
Undeformed
Deformed
Y [mm]
X [mm]
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2000
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1000
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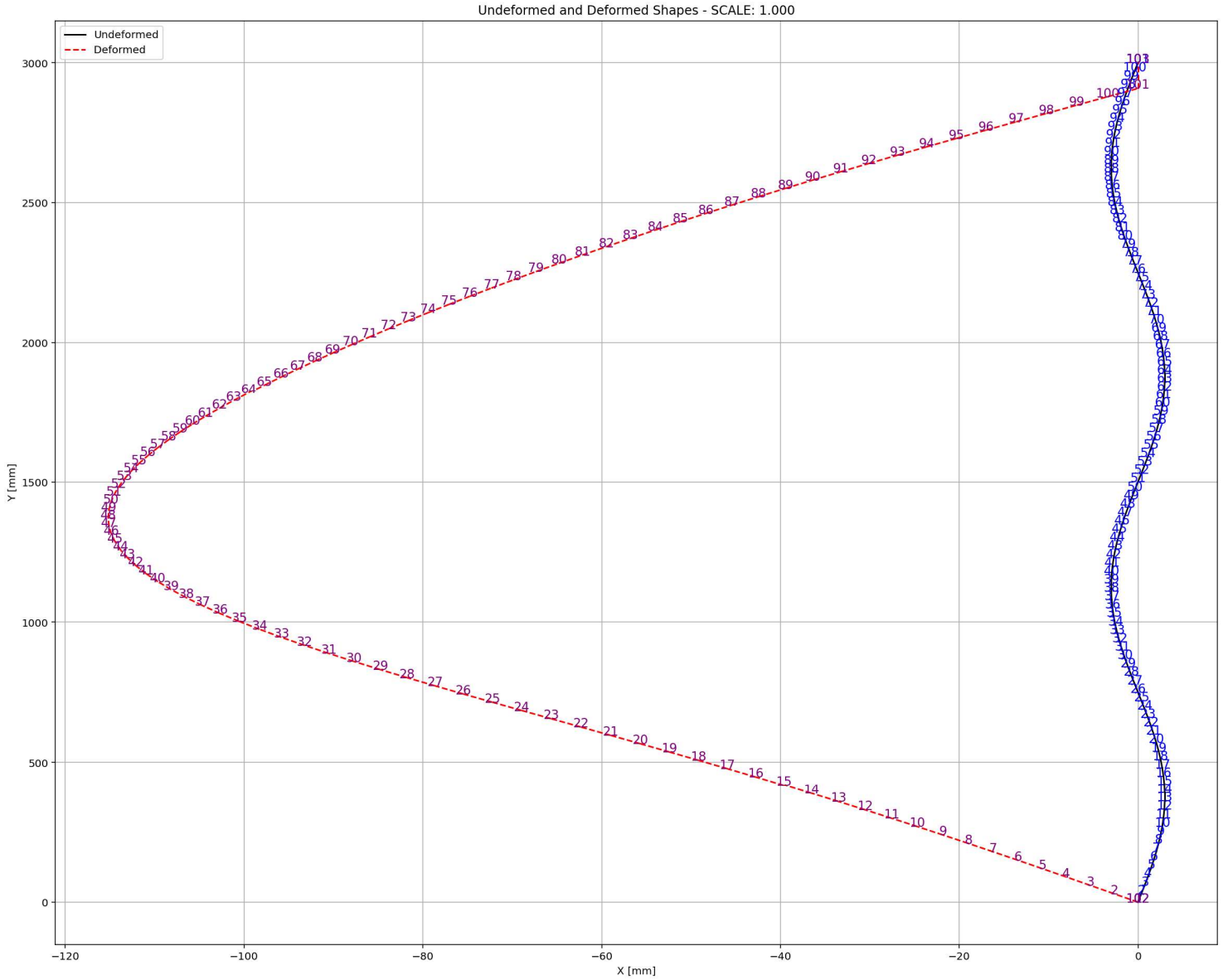
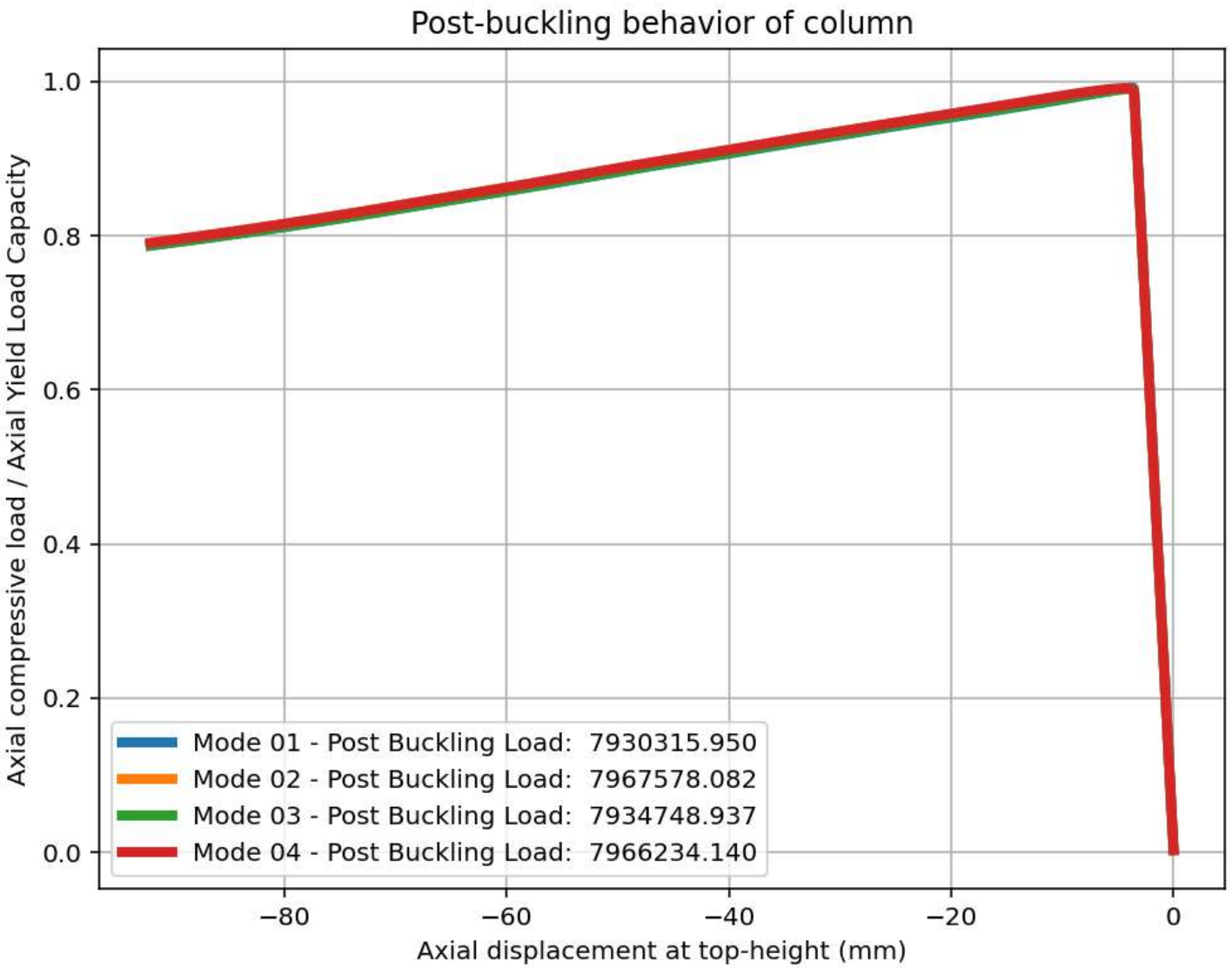
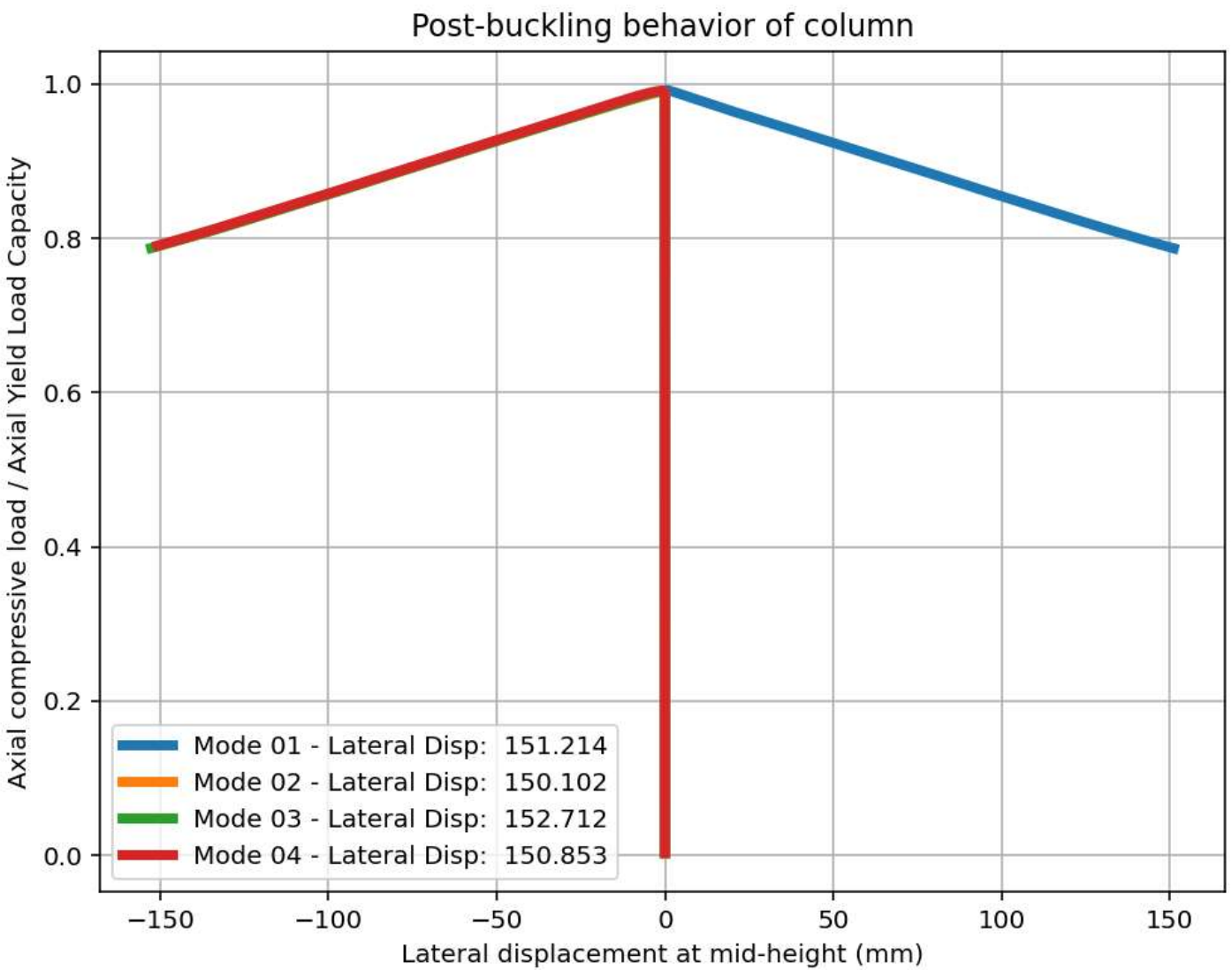
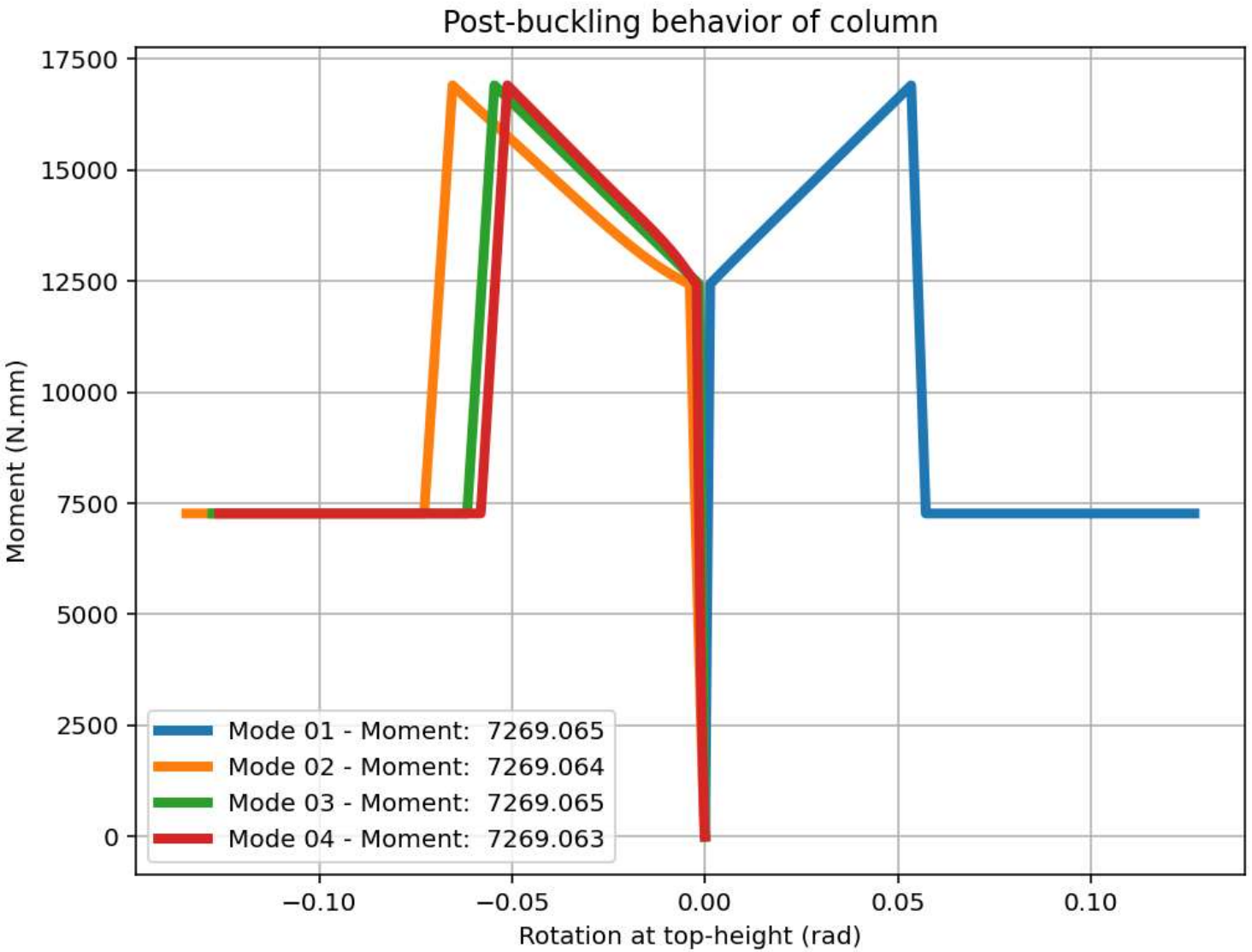
−100
−80
−60
−40
−20
0


Undeformed and Deformed Shapes - SCALE: 1.000
Undeformed
Deformed
Y [mm]
X [mm]
3000
2500
2000
1500
1000
500
0
−120
−100
−80
−60
−40
−20
0


Post-buckling behavior of column
Axial compressive load / Axial Yield Load Capacity
1.0
0.8
0.6
0.4
0.2
0.0
−80
−60
−40
−20
0
Axial displacement at top-height (mm)
Mode 01 - Post Buckling Load: 7930315.950
Mode 02 - Post Buckling Load: 7967578.082
Mode 03 - Post Buckling Load: 7934748.937
Mode 04 - Post Buckling Load: 7966234.140


Post-buckling behavior of column
Axial compressive load / Axial Yield Load Capacity
1.0
0.8
0.6
0.4
0.2
0.0
−150
−100
−50
0
50
100
150
Lateral displacement at mid-height (mm)
Mode 01 - Lateral Disp: 151.214
Mode 02 - Lateral Disp: 150.102
Mode 03 - Lateral Disp: 152.712
Mode 04 - Lateral Disp: 150.853


Post-buckling behavior of column
17500
15000
12500
10000
7500
5000
2500
0
Moment (N.mm)
−0.10
−0.05
0.00
0.05
0.10
Rotation at top-height (rad)
Mode 01 - Moment: 7269.065
Mode 02 - Moment: 7269.064
Mode 03 - Moment: 7269.065
Mode 04 - Moment: 7269.063