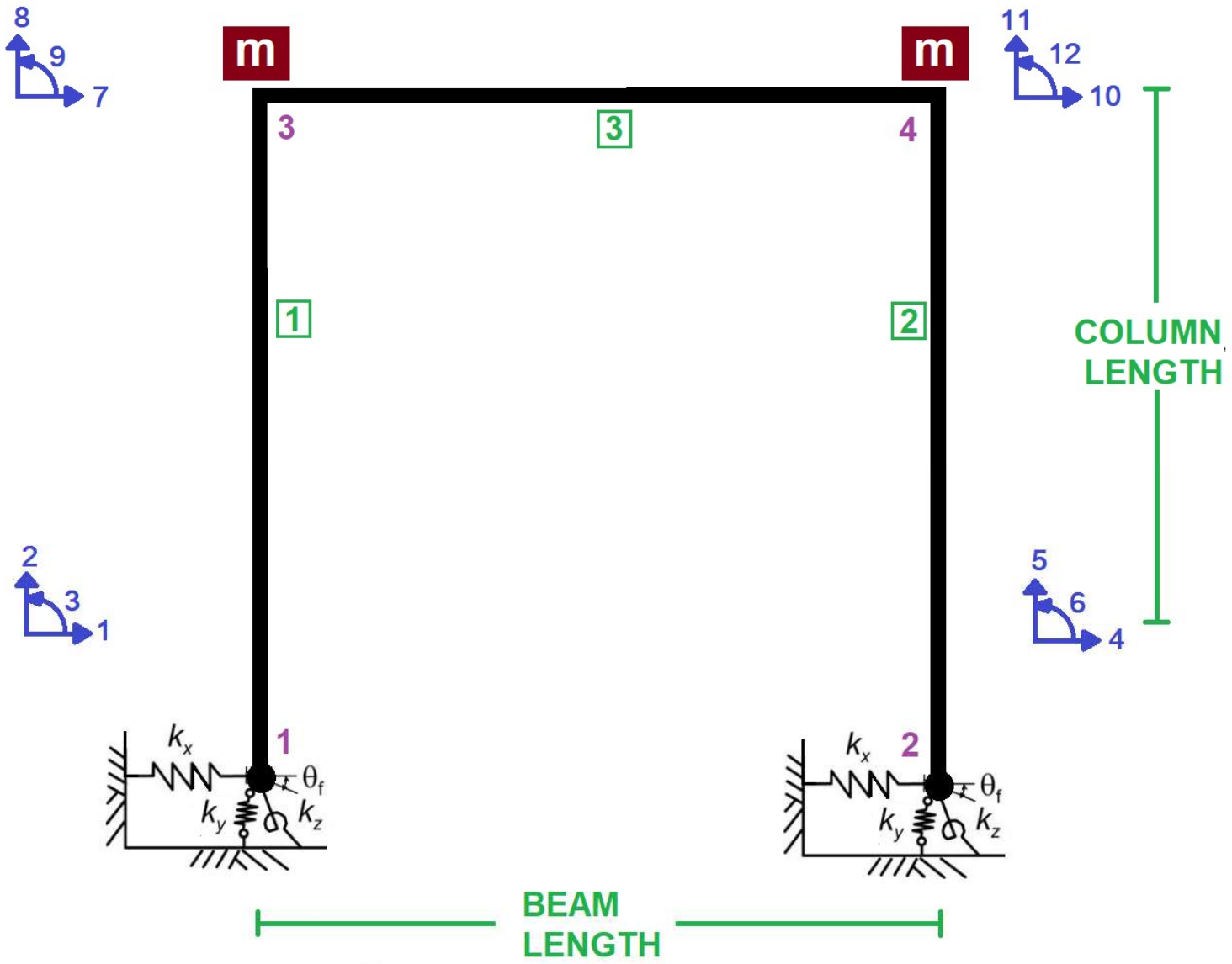
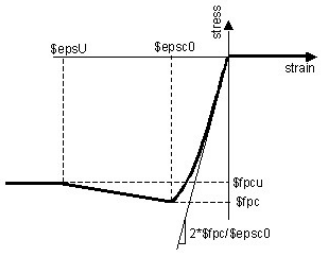
IN THE NAME OF ALLAH

ASSESSMENT OF STRUCTURAL DUCTILITY DAMAGE INDEX IN CONCRETE FRAMES CONSIDERING SOIL-FOUNDATION-STRUCTURE INTERACTION USING OPENSEES.

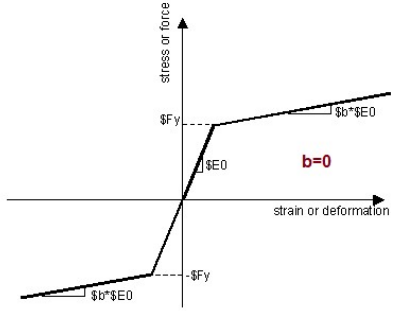
SOIL-FOUNDATION INTERACTIONS SIMULATED WITH SIMPLE SPRINGS.
SOIL SPRINGS VALUES IS NOT EXACT.

WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)

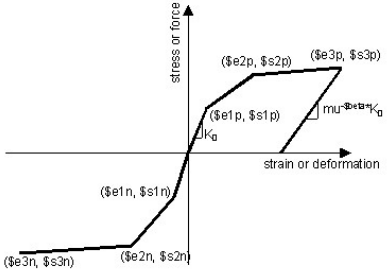

8
9
7
m
m
11
12
10
3
3
4
1
2
COLUMN
LENGTH
2
3
1
5
6
4
k_x
1
θ_f
k_y
k_z
k_x
2
θ_f
k_y
k_z
BEAM
LENGTH



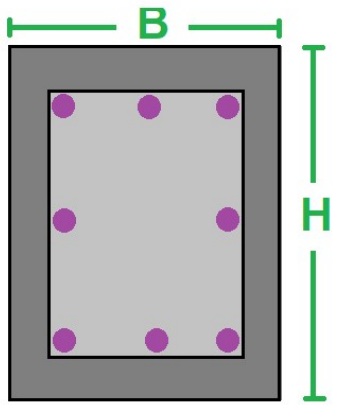
CORE AND COVER CONCRETE REALTION



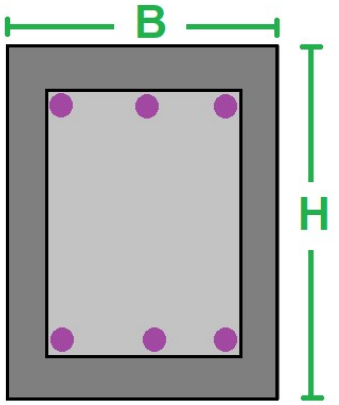
WITHOUT HARDENING AND ULTIMATE STRAIN



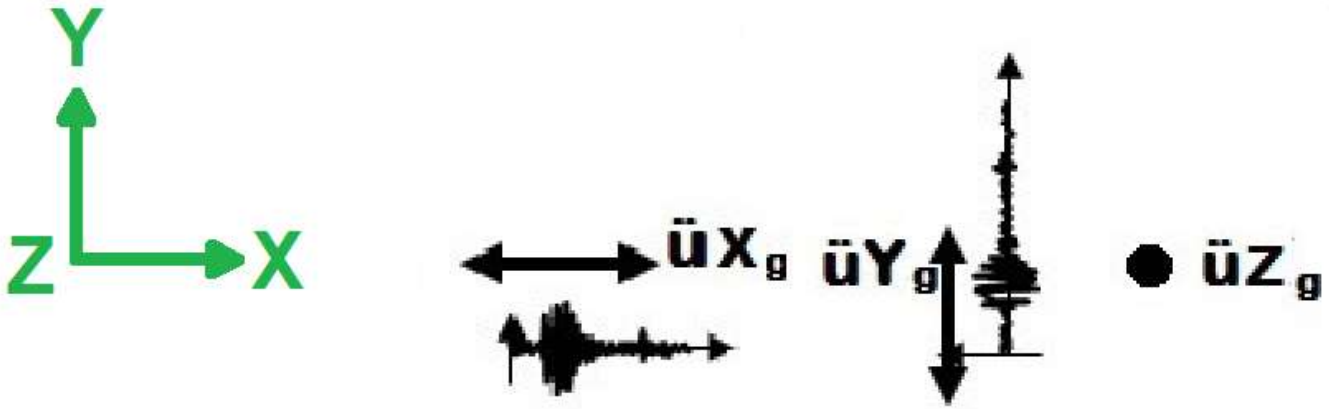
WITH HARDENING AND ULTIMATE STRAIN



COLUMN SECTION



BEAM SECTION

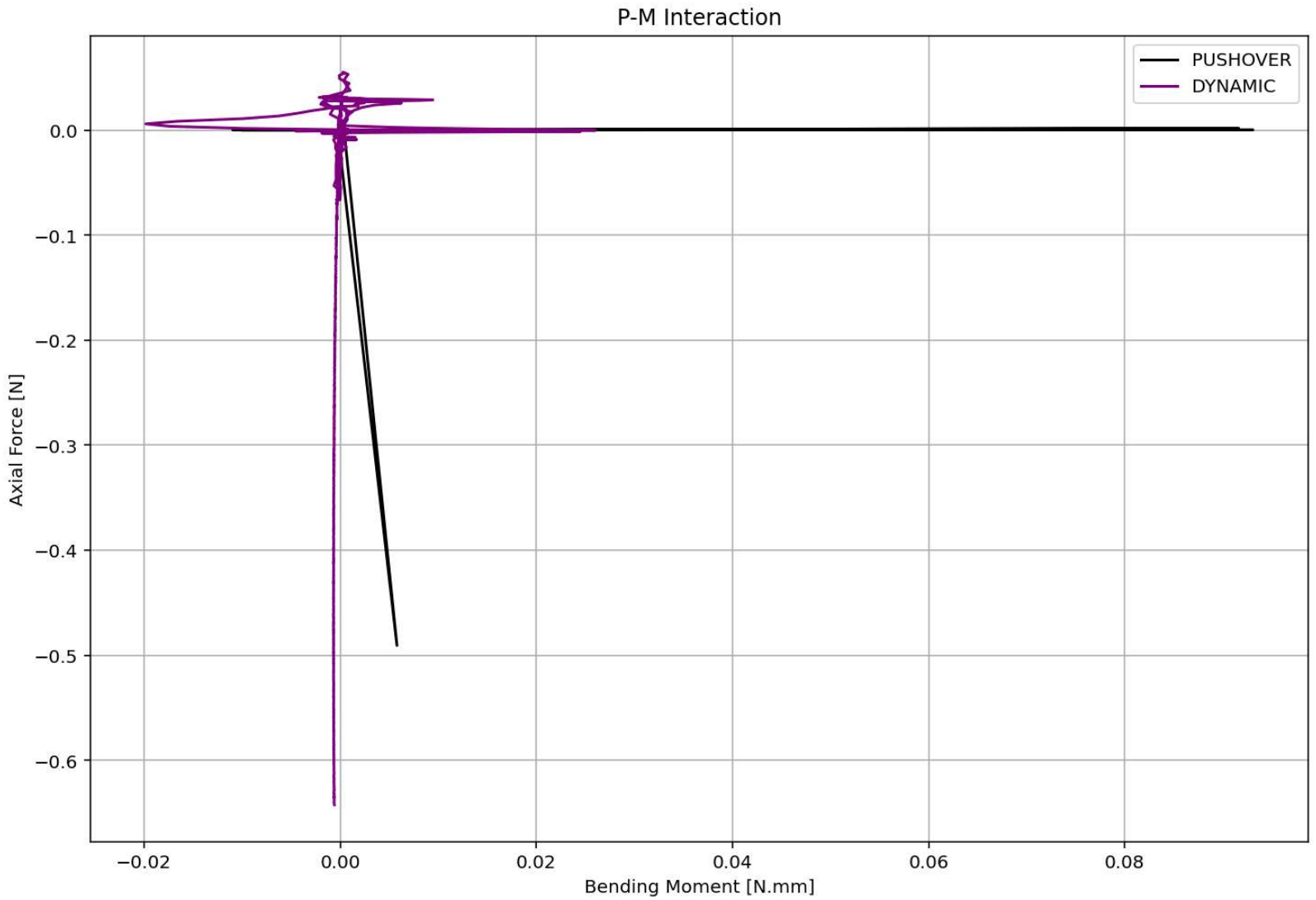


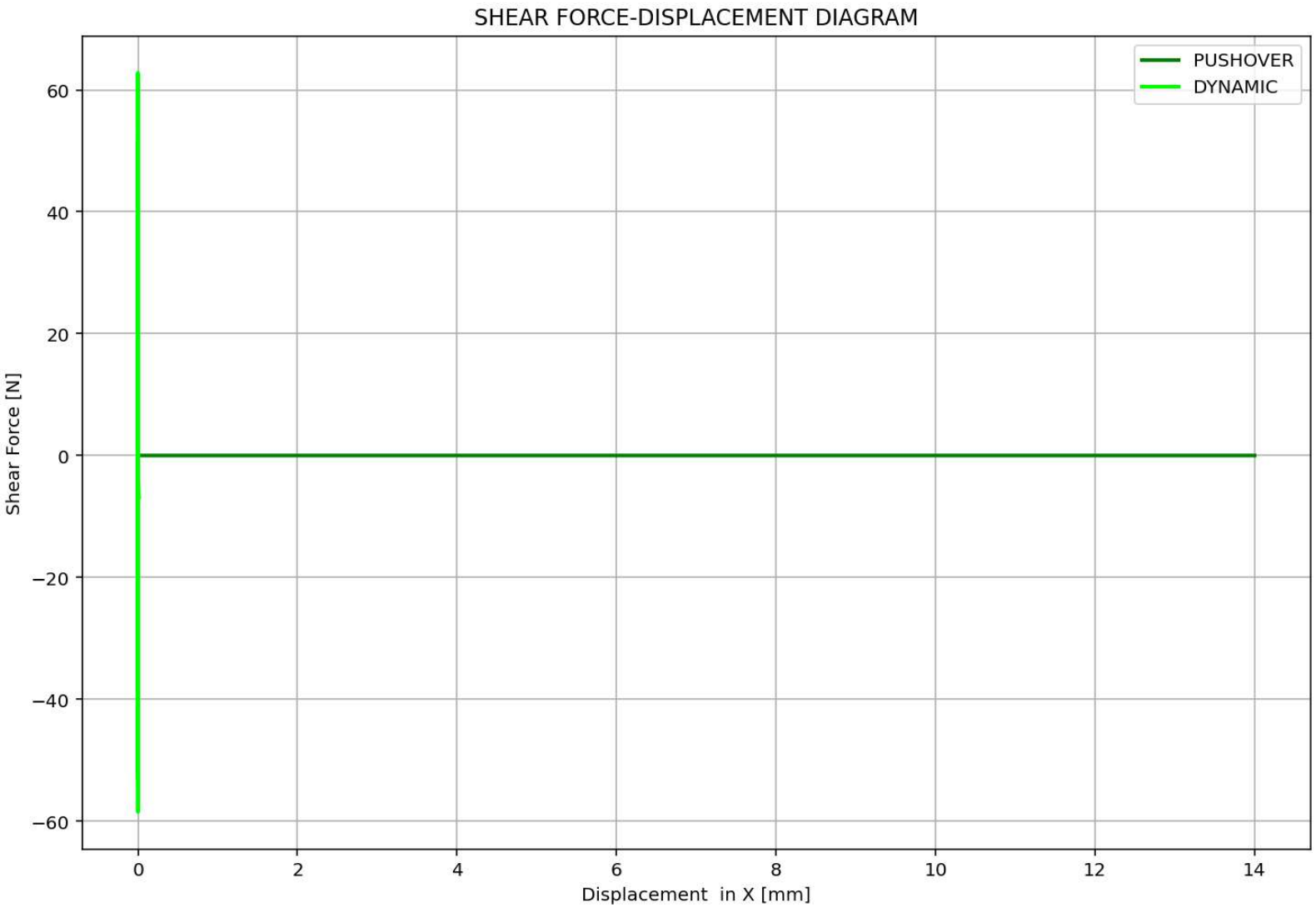
$$Structure\ Ductility\ Damage\ Index = \frac{\Delta_d - \Delta_y}{\Delta_u - \Delta_y}$$

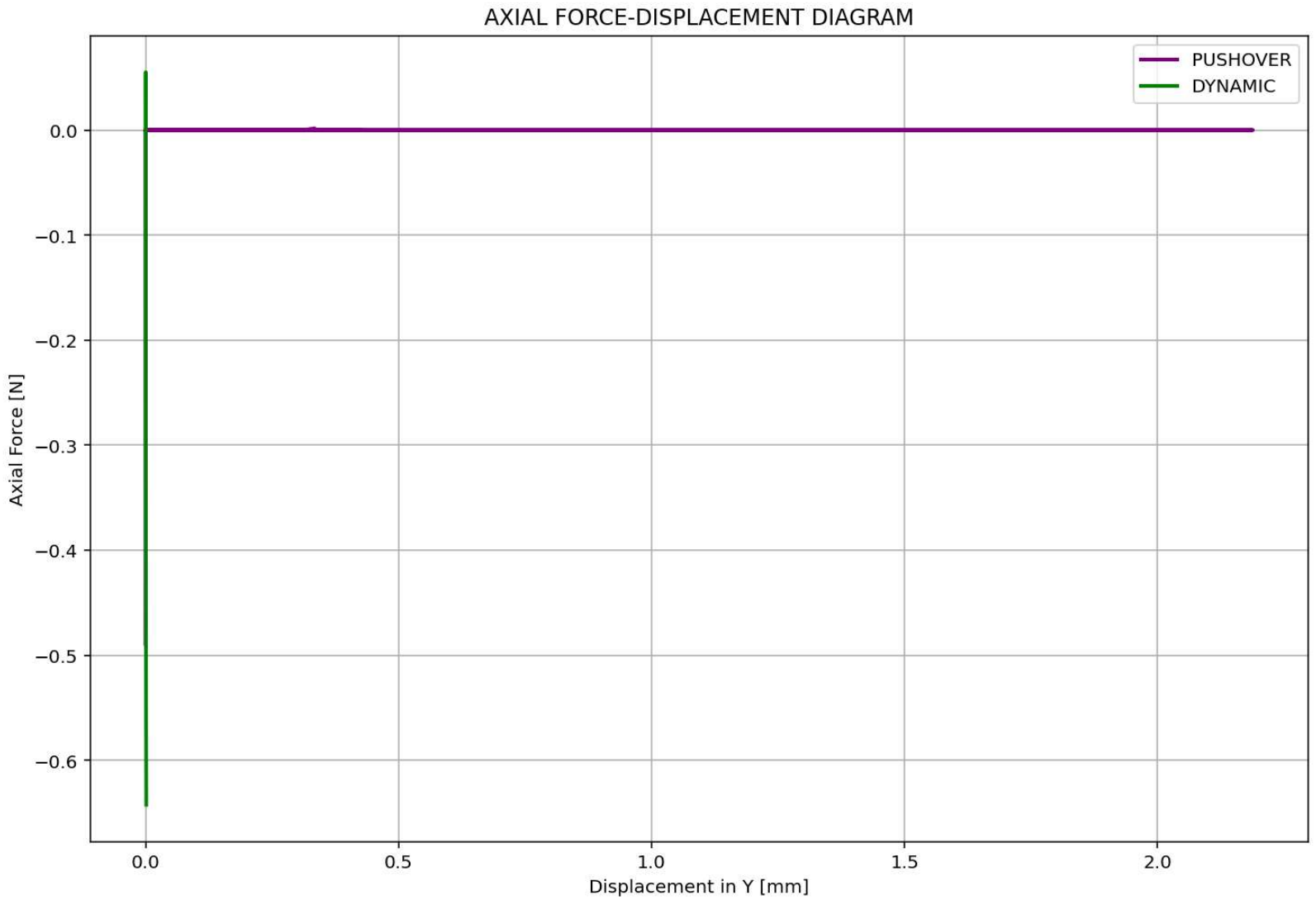
$$\Delta_d = Lateral\ Displaement\ from\ Dynamic\ Analysis$$

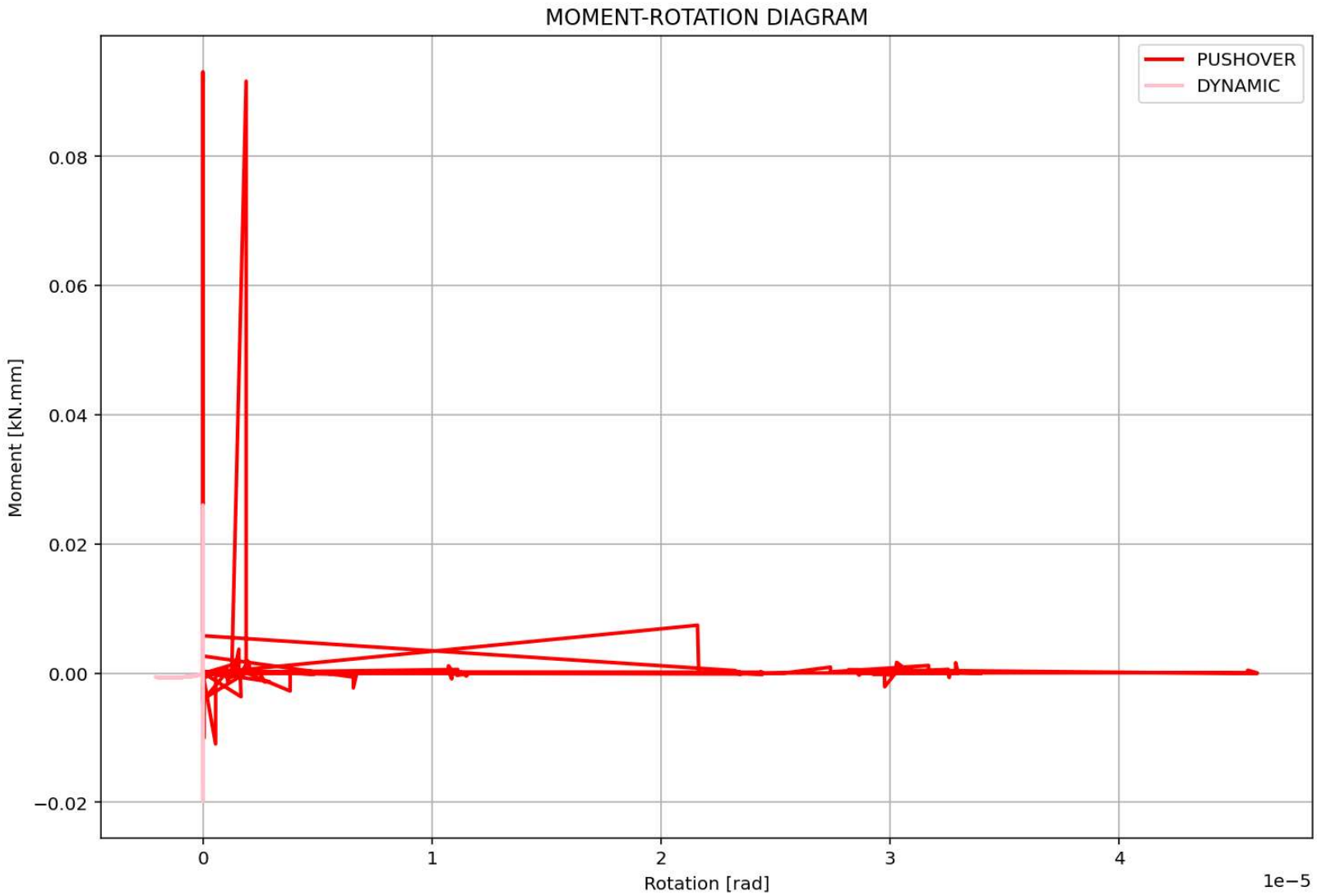
$$\Delta_y = Lateral\ Yield\ Displaement\ from\ Pushover\ Analysis$$

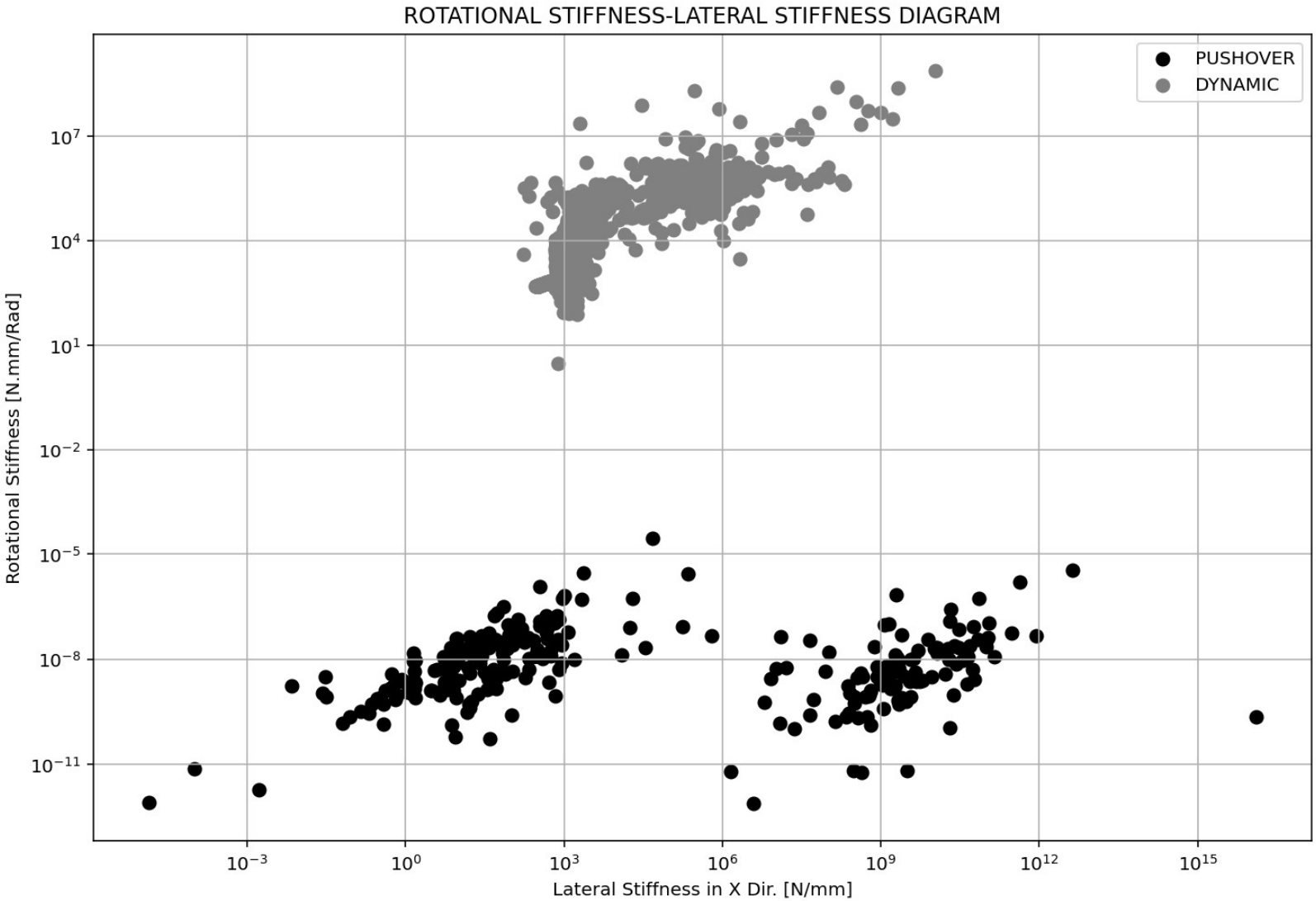
$$\Delta_u = Lateral\ Ultimate\ Displaement\ from\ Pushover\ Analysis$$

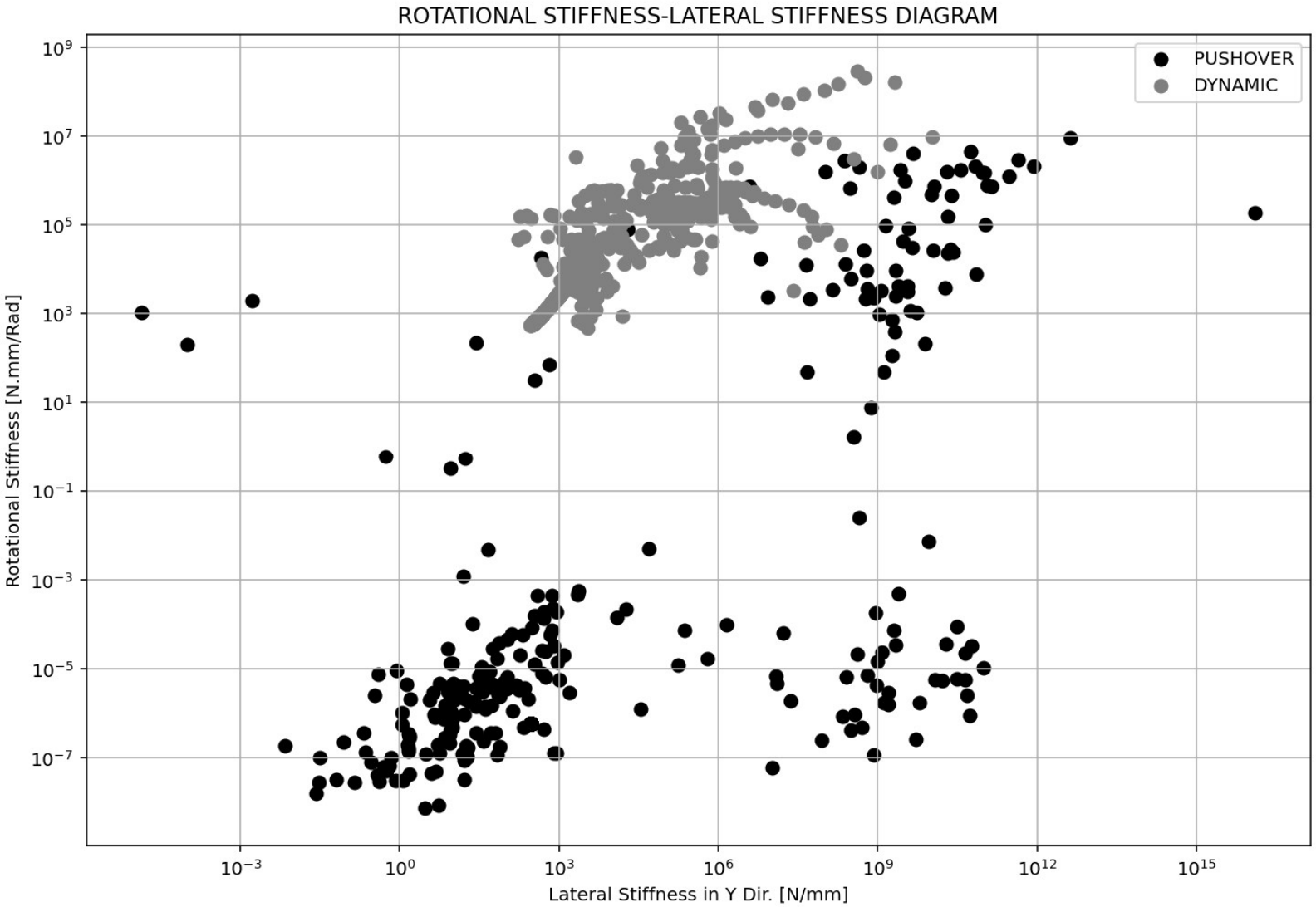

P-M Interaction
PUSHOVER
DYNAMIC
Axial Force [N]
0.0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
−0.02
0.00
0.02
0.04
0.06
0.08
Bending Moment [N.mm]

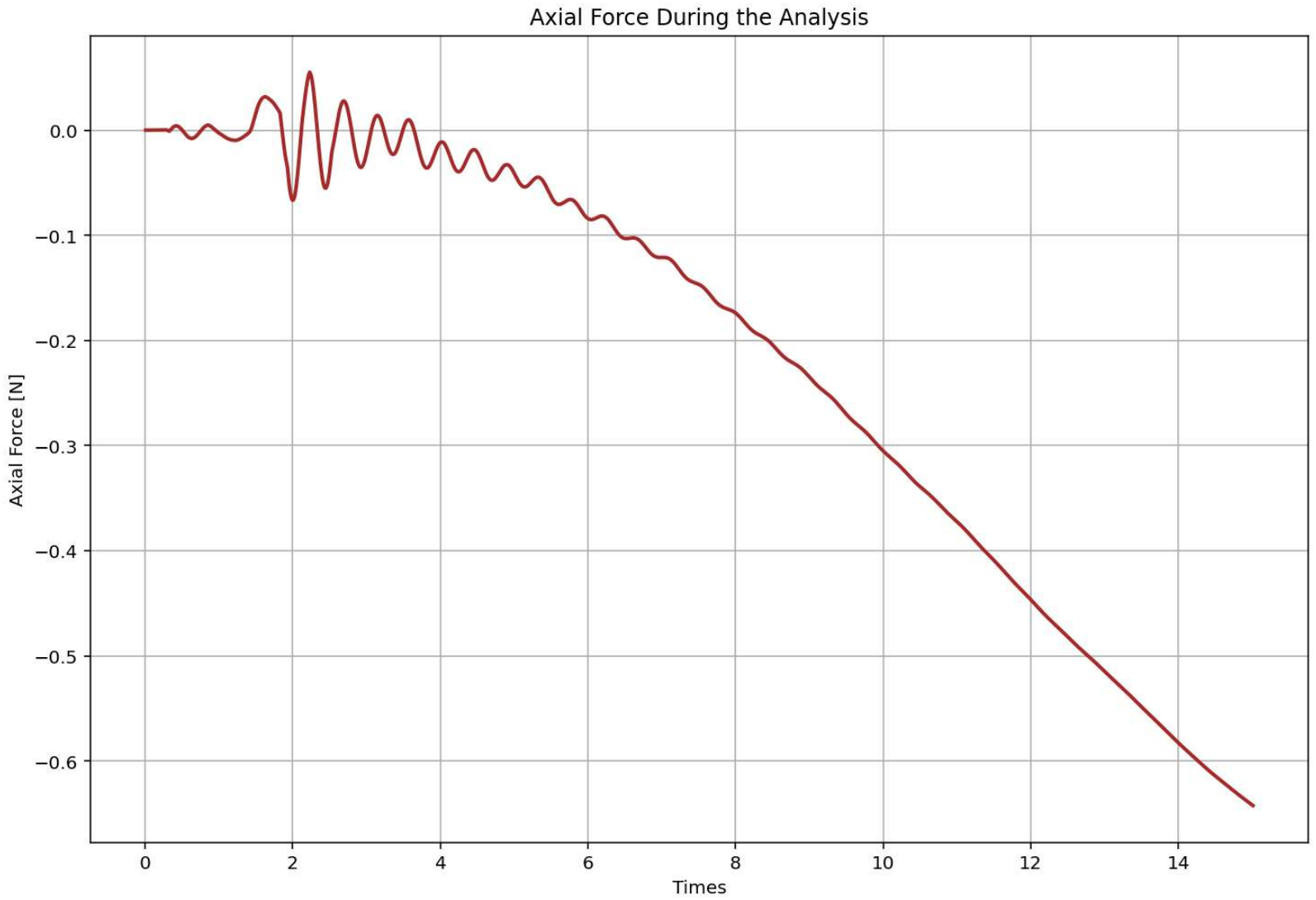

SHEAR FORCE-DISPLACEMENT DIAGRAM
PUSHOVER
DYNAMIC
Shear Force [N]
60
40
20
0
−20
−40
−60
0
2
4
6
8
10
12
14
Displacement in X [mm]

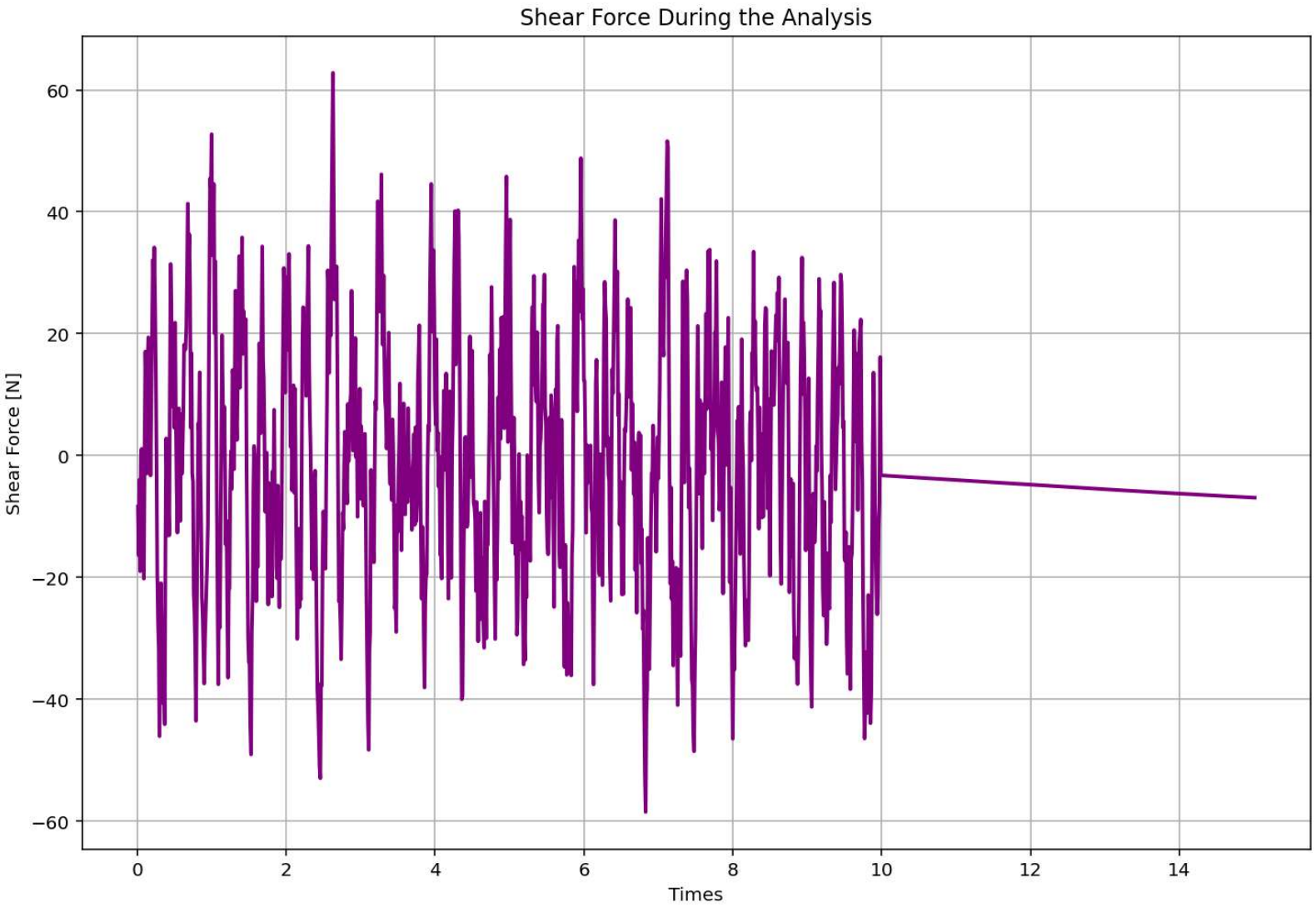

AXIAL FORCE-DISPLACEMENT DIAGRAM
PUSHOVER
DYNAMIC
0.0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
Axial Force [N]
0.0
0.5
1.0
1.5
2.0
Displacement in Y [mm]

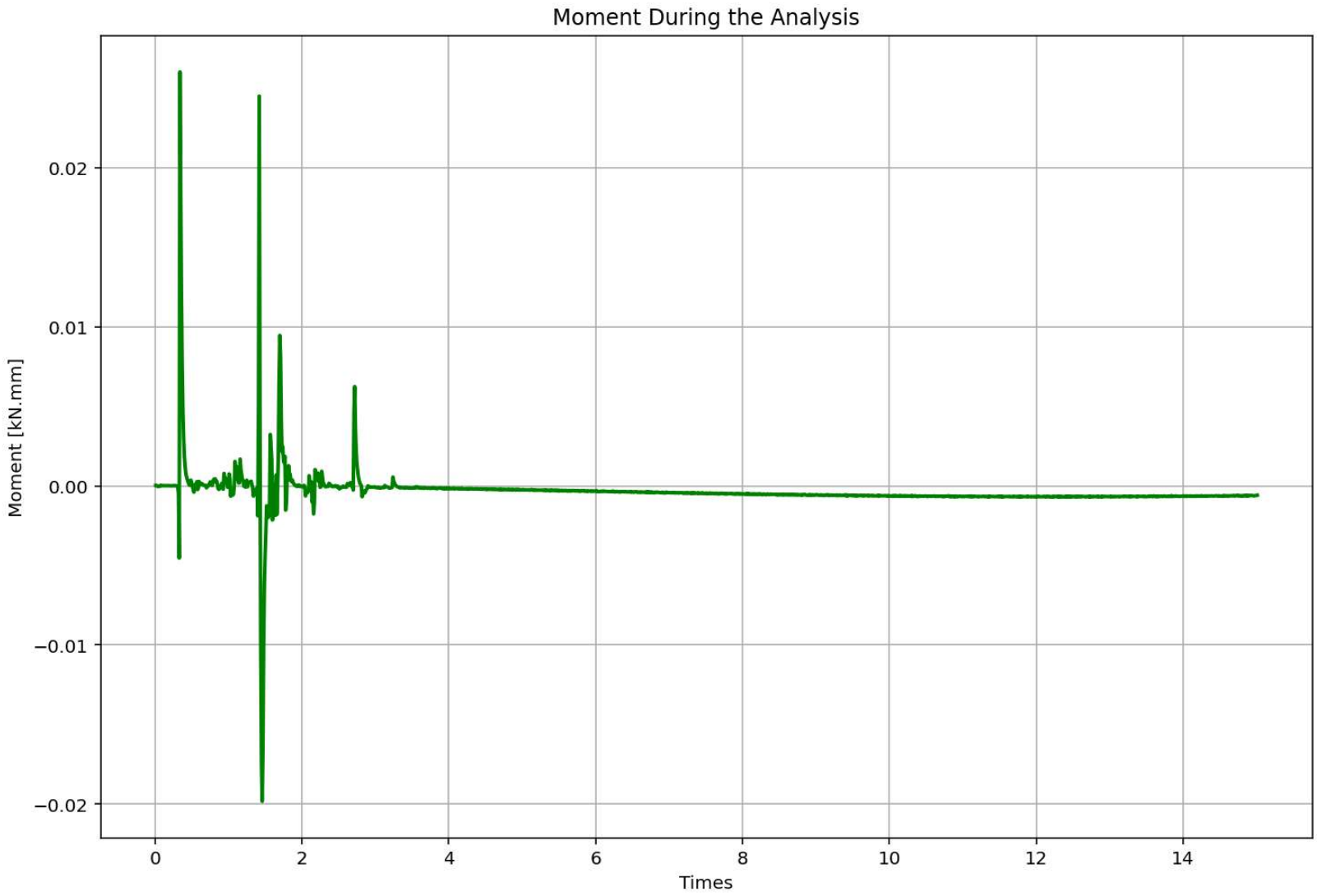

MOMENT-ROTATION DIAGRAM
PUSHOVER
DYNAMIC
Moment [kN.mm]
0.08
0.06
0.04
0.02
0.00
−0.02
0
1
2
3
4
Rotation [rad]
1e−5

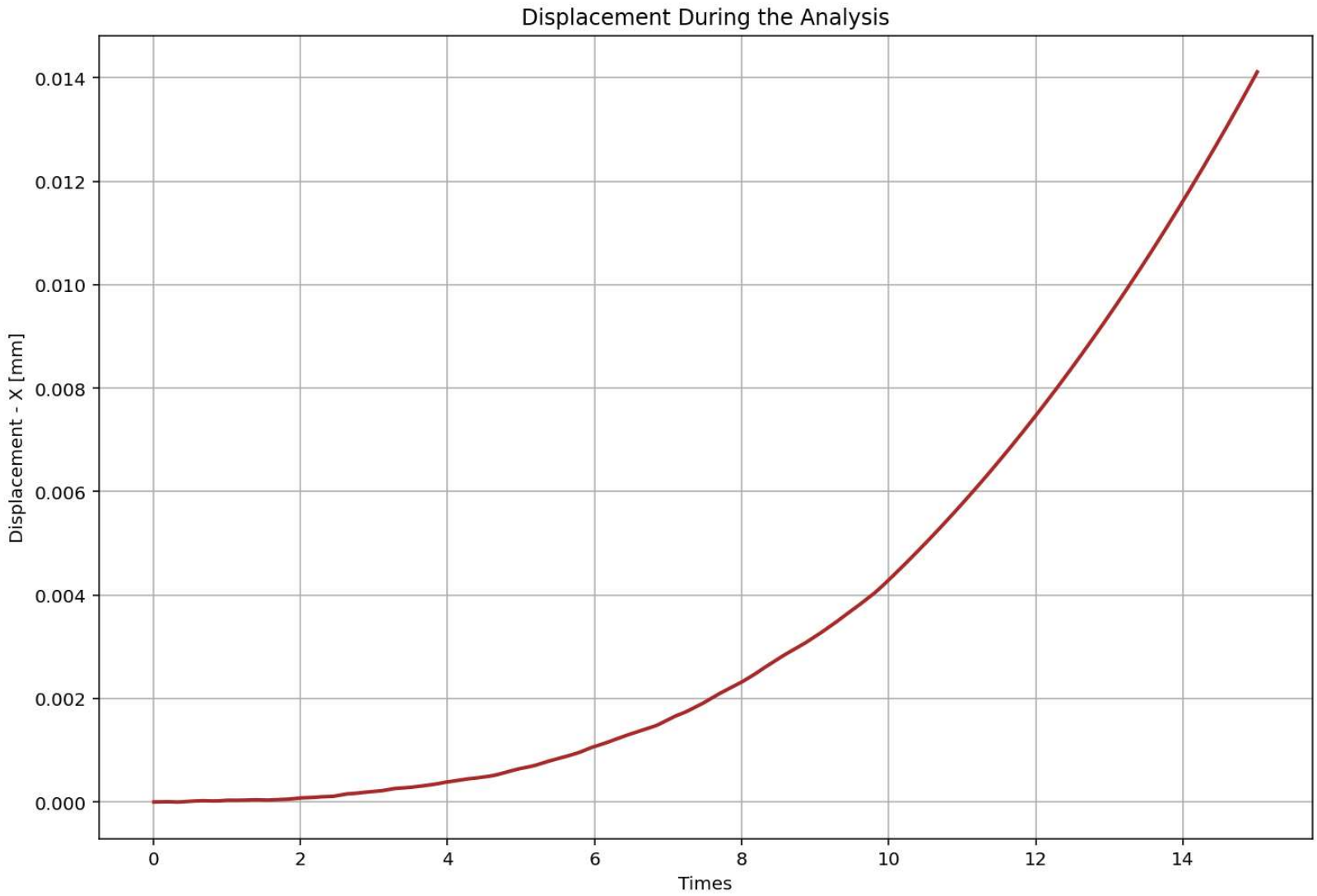

ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM
PUSHOVER
DYNAMIC
Rotational Stiffness [N.mm/Rad]
10^{7}
10^{4}
10^{1}
10^{-2}
10^{-5}
10^{-8}
10^{-11}
10^{-3}
10^{0}
10^{3}
10^{6}
10^{9}
10^{12}
10^{15}
Lateral Stiffness in X Dir. [N/mm]

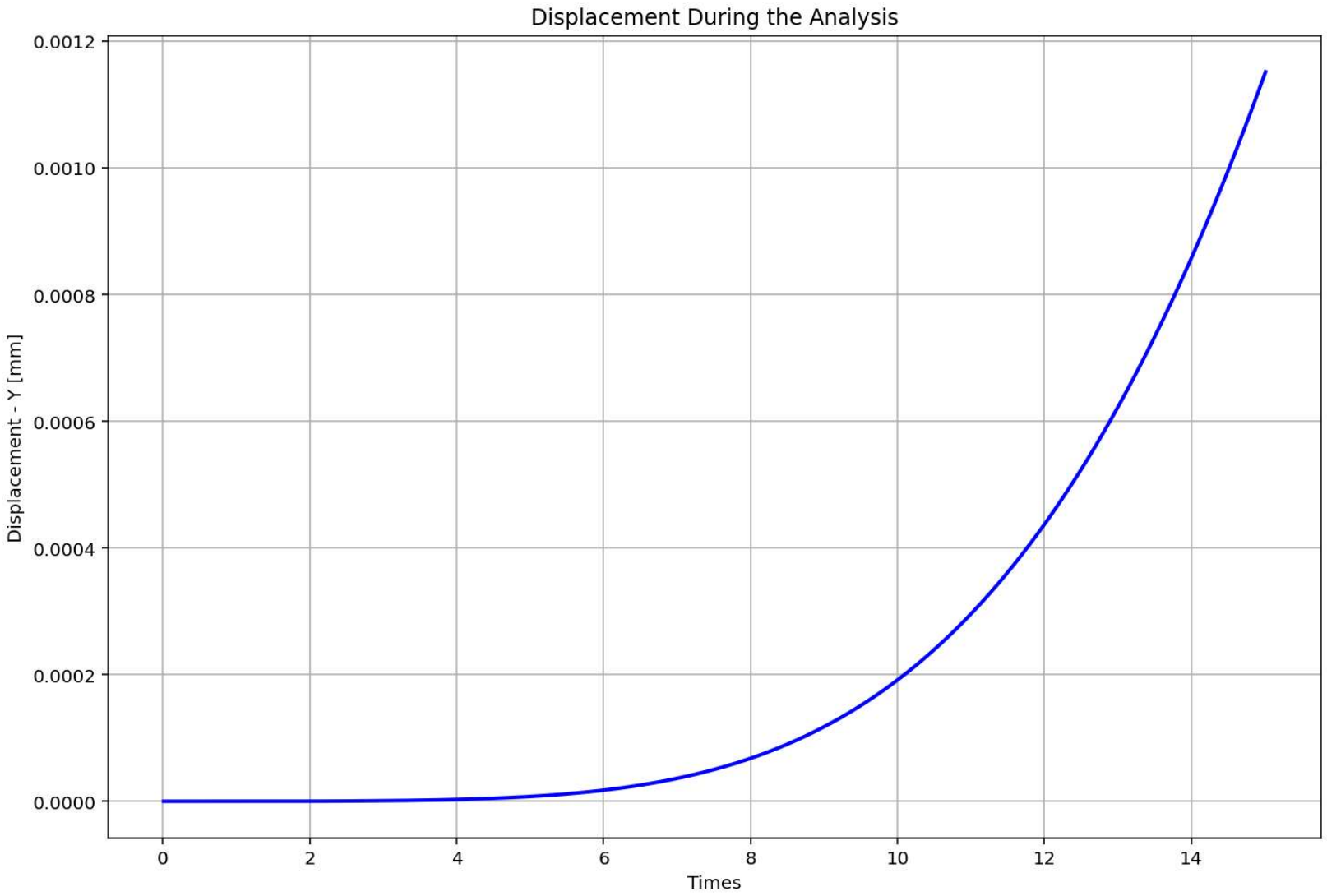

ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM
PUSHOVER
DYNAMIC
Rotational Stiffness [N.mm/Rad]
Lateral Stiffness in Y Dir. [N/mm]
10^{9}
10^{7}
10^{5}
10^{3}
10^{1}
10^{-1}
10^{-3}
10^{-5}
10^{-7}
10^{-3}
10^{0}
10^{3}
10^{6}
10^{9}
10^{12}
10^{15}

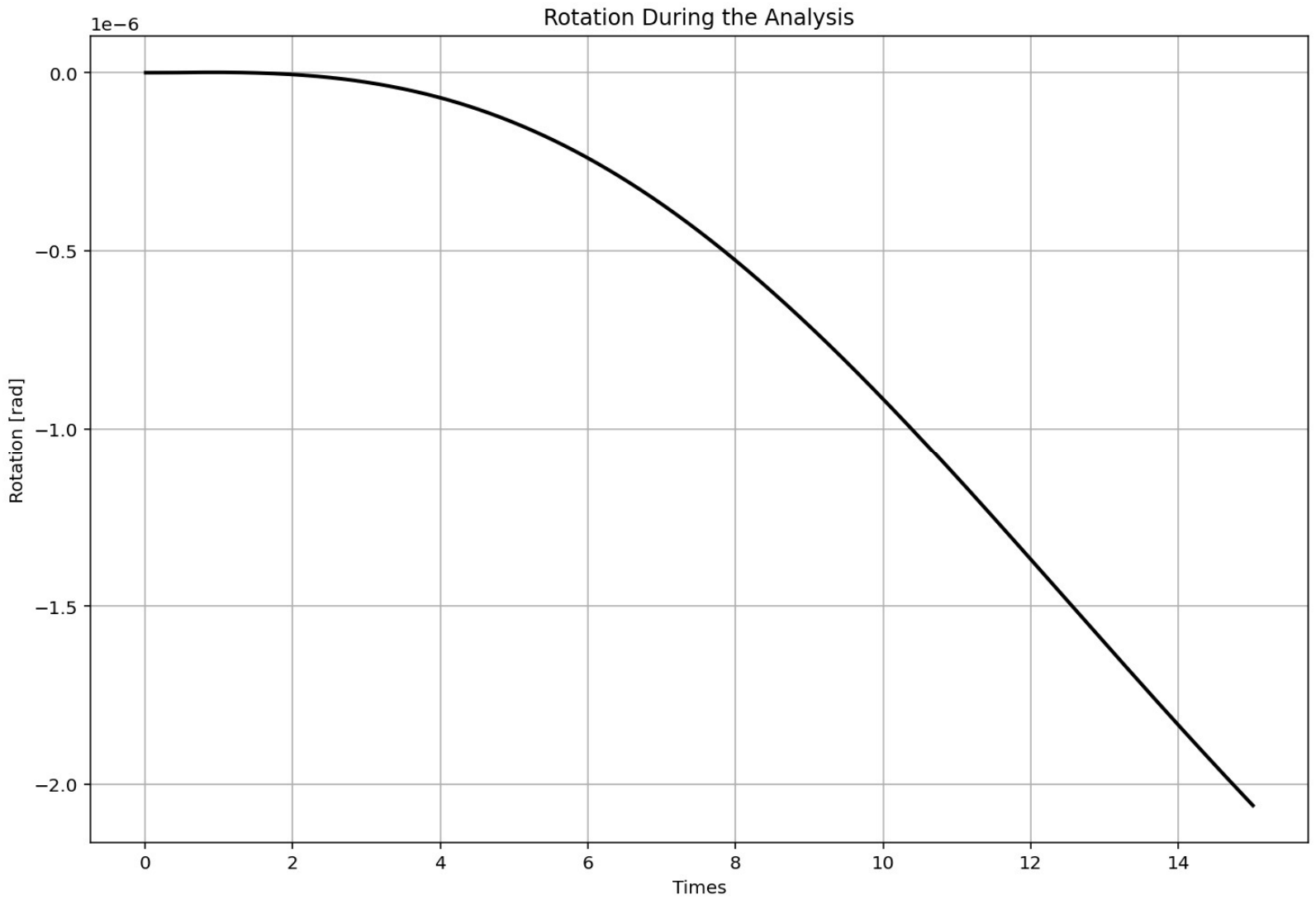

Axial Force During the Analysis
Axial Force [N]
0.0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
0
2
4
6
8
10
12
14
Times

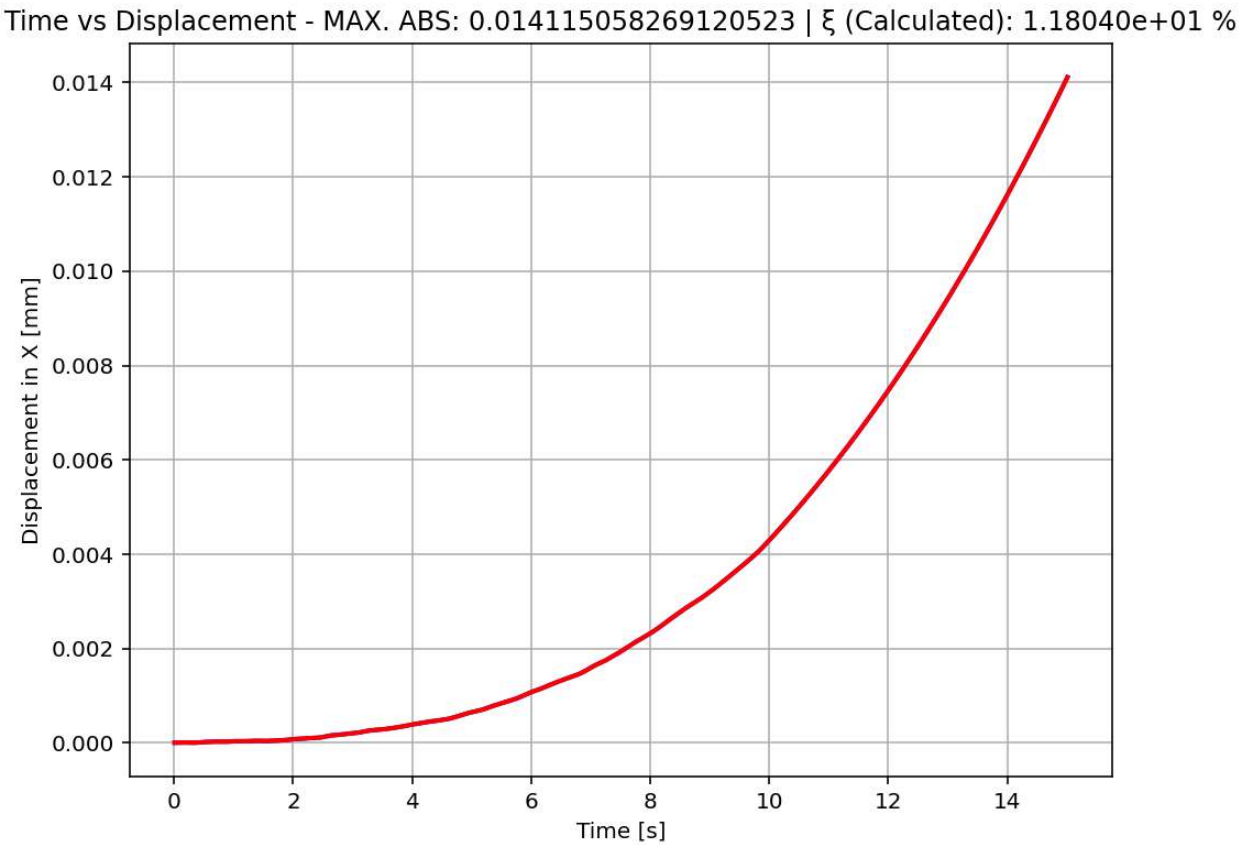

Shear Force During the Analysis
Shear Force [N]
60
40
20
0
−20
−40
−60
0
2
4
6
8
10
12
14
Times

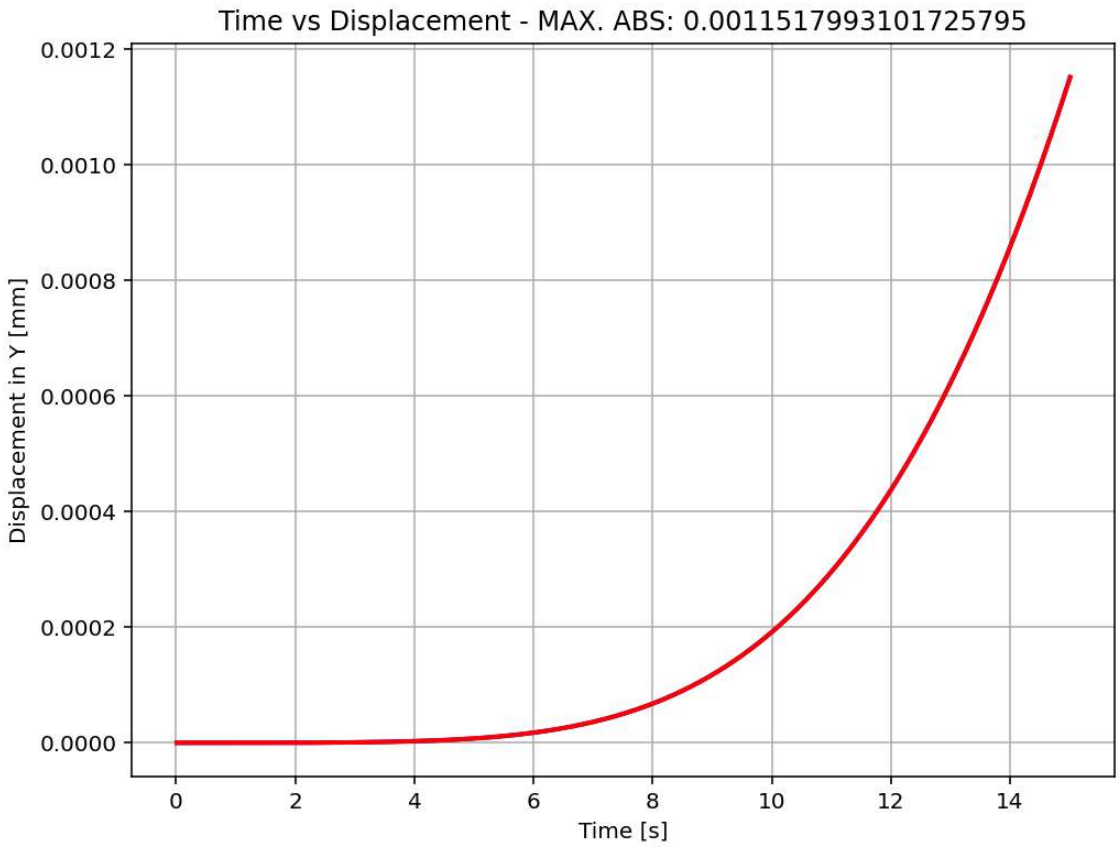

Moment During the Analysis
Moment [kN.mm]
0.02
0.01
0.00
−0.01
−0.02
0
2
4
6
8
10
12
14
Times

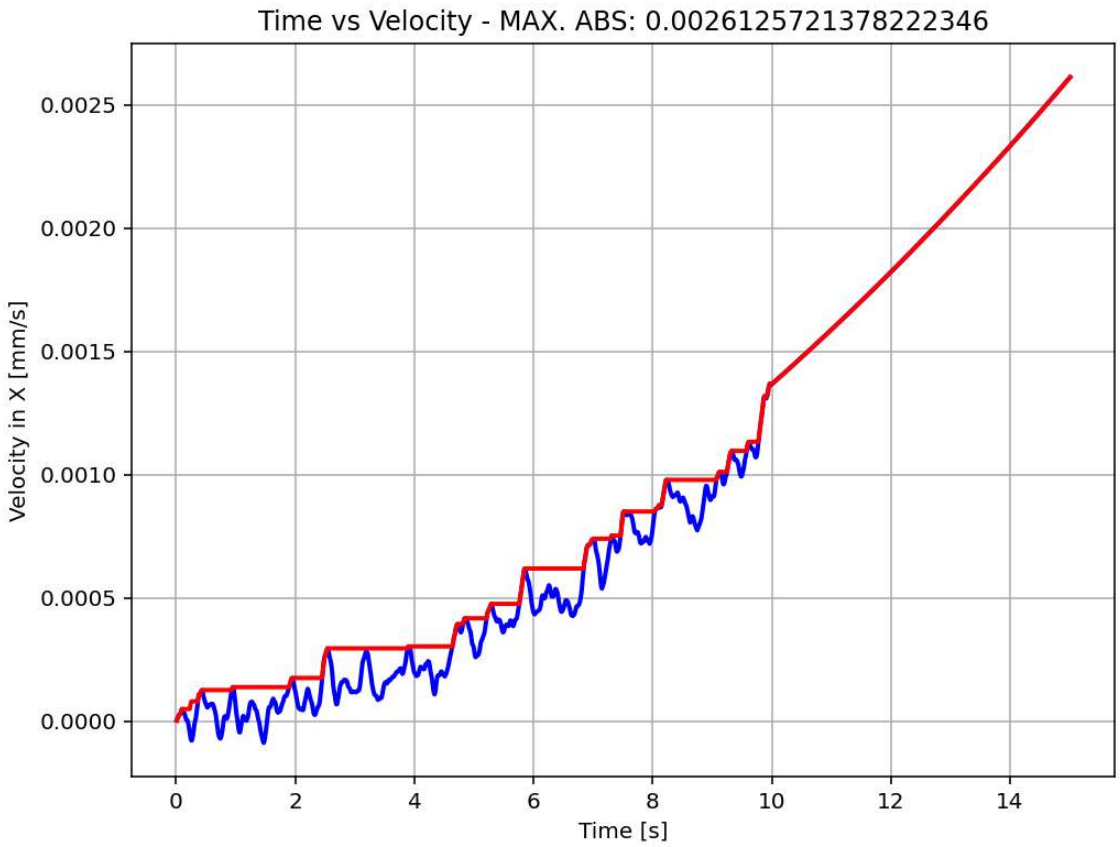

Displacement During the Analysis
Displacement - X [mm]
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
0
2
4
6
8
10
12
14
Times

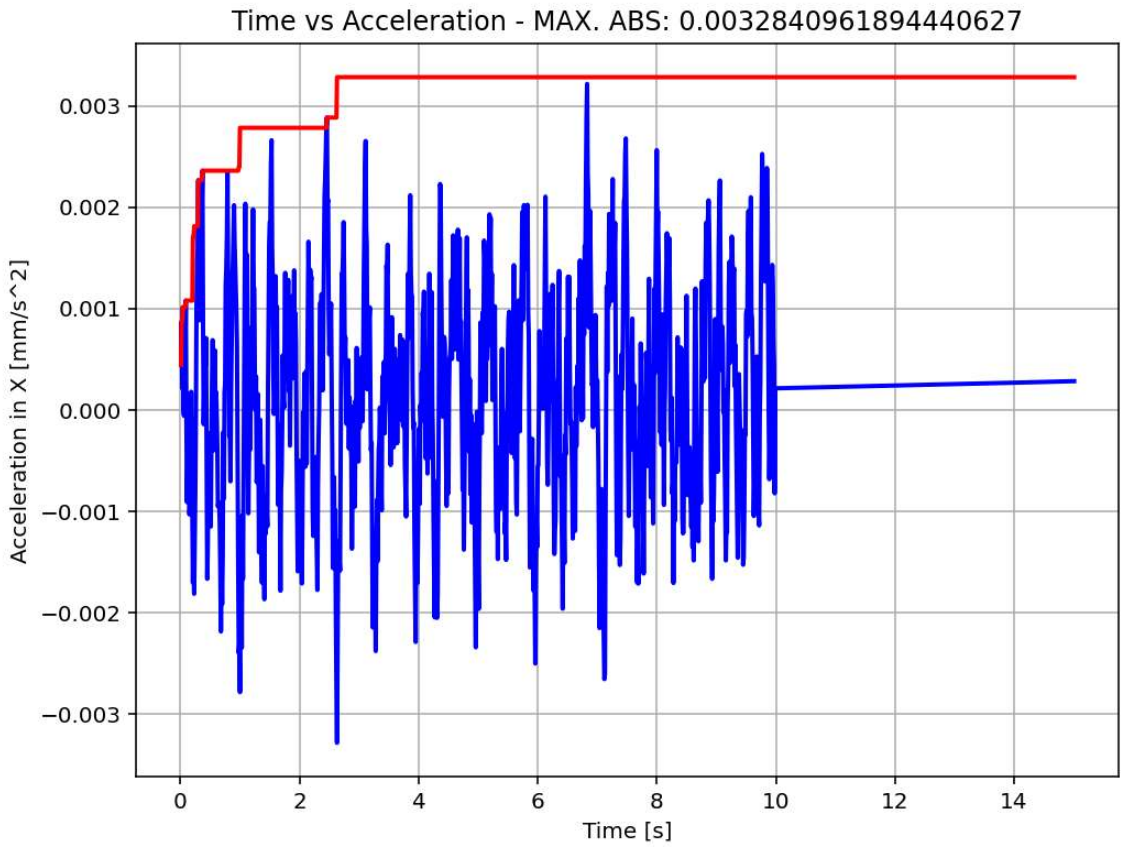

Displacement During the Analysis
Displacement - Y [mm]
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
0
2
4
6
8
10
12
14
Times

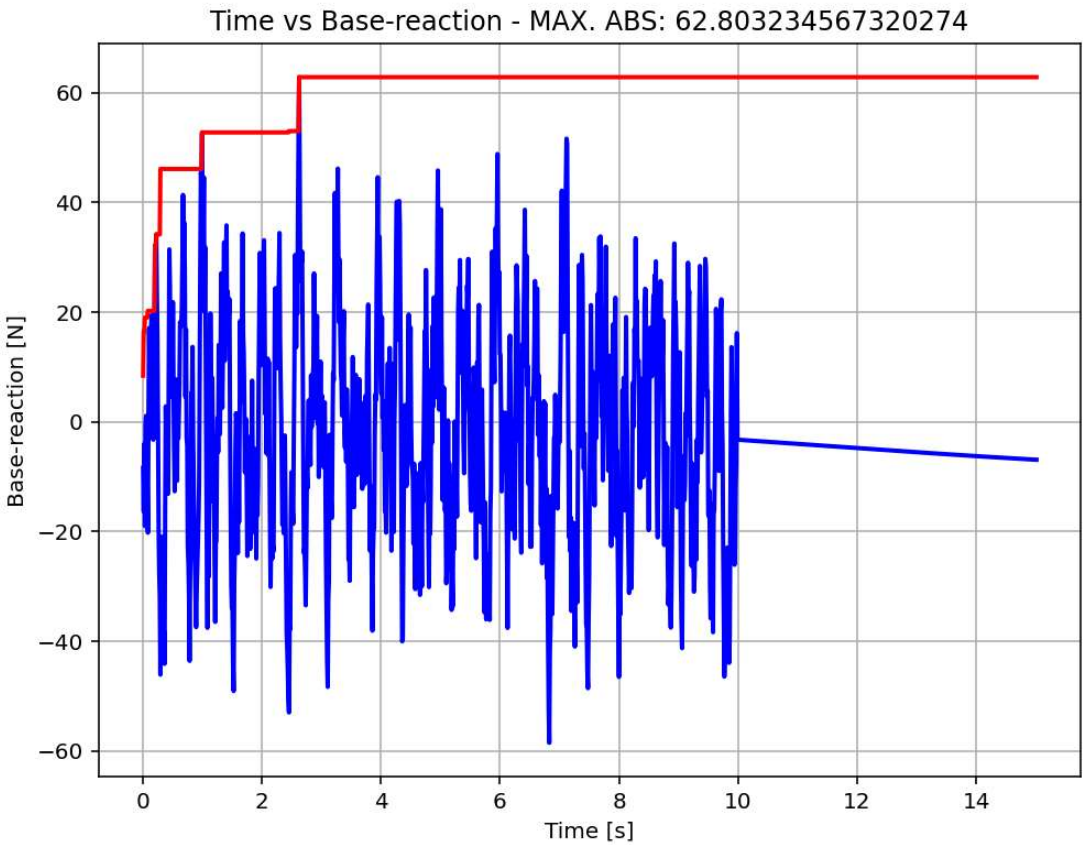

Rotation During the Analysis
1e−6
0.0
−0.5
−1.0
−1.5
−2.0
Rotation [rad]
0
2
4
6
8
10
12
14
Times

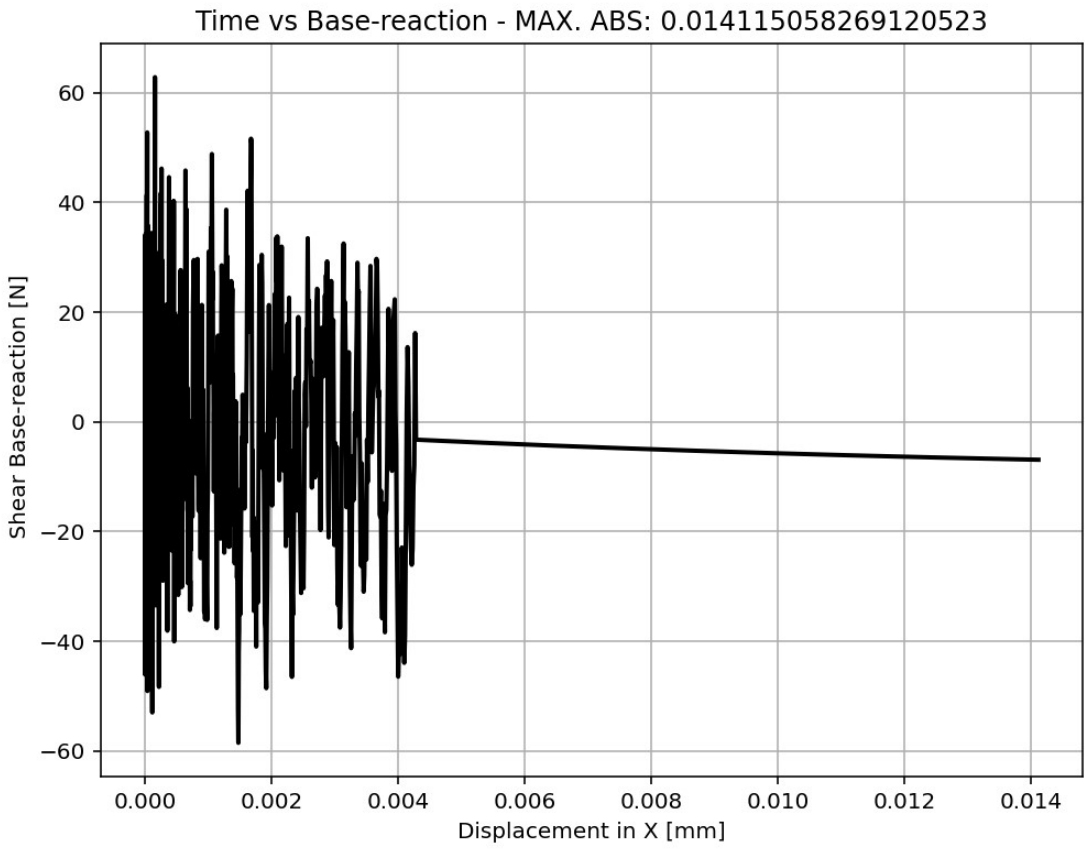

Time vs Displacement - MAX. ABS: 0.014115058269120523 | ξ (Calculated): 1.18040e+01 %
Displacement in X [mm]
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
0
2
4
6
8
10
12
14
Time [s]

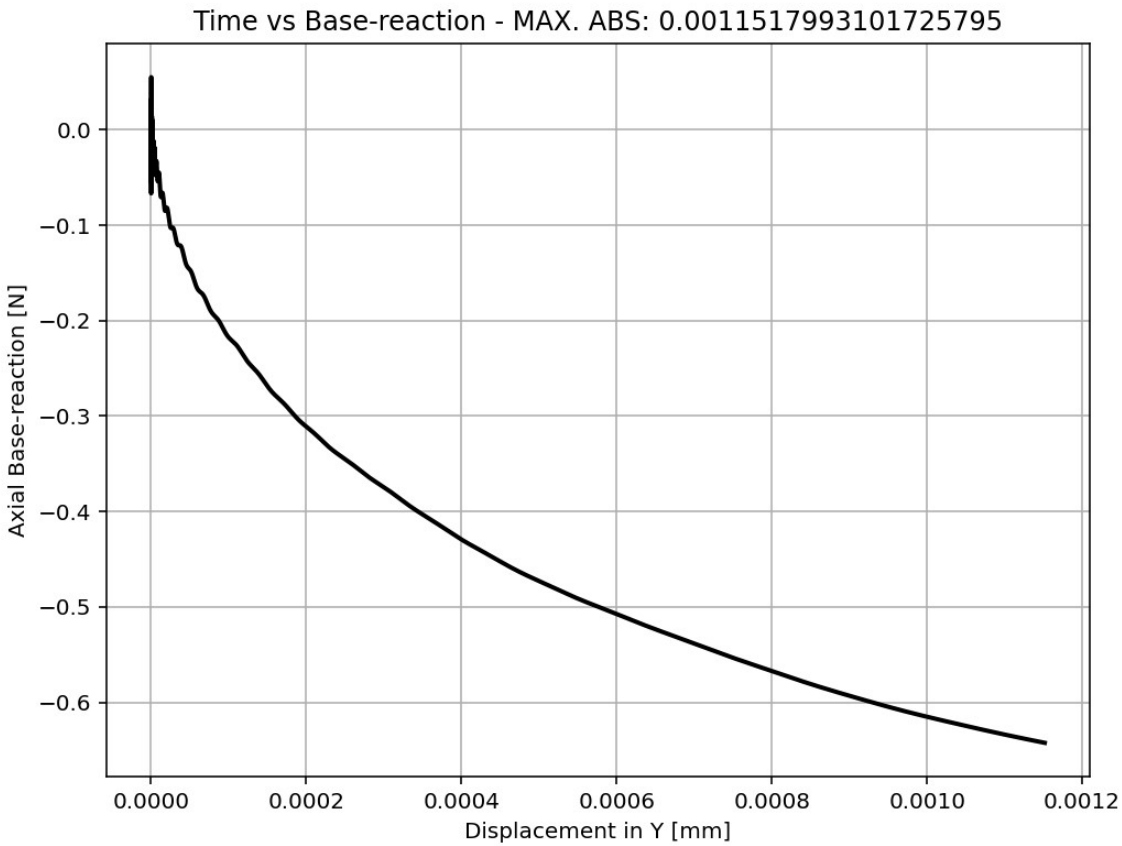

Time vs Displacement - MAX. ABS: 0.0011517993101725795
Displacement in Y [mm]
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
0
2
4
6
8
10
12
14
Time [s]

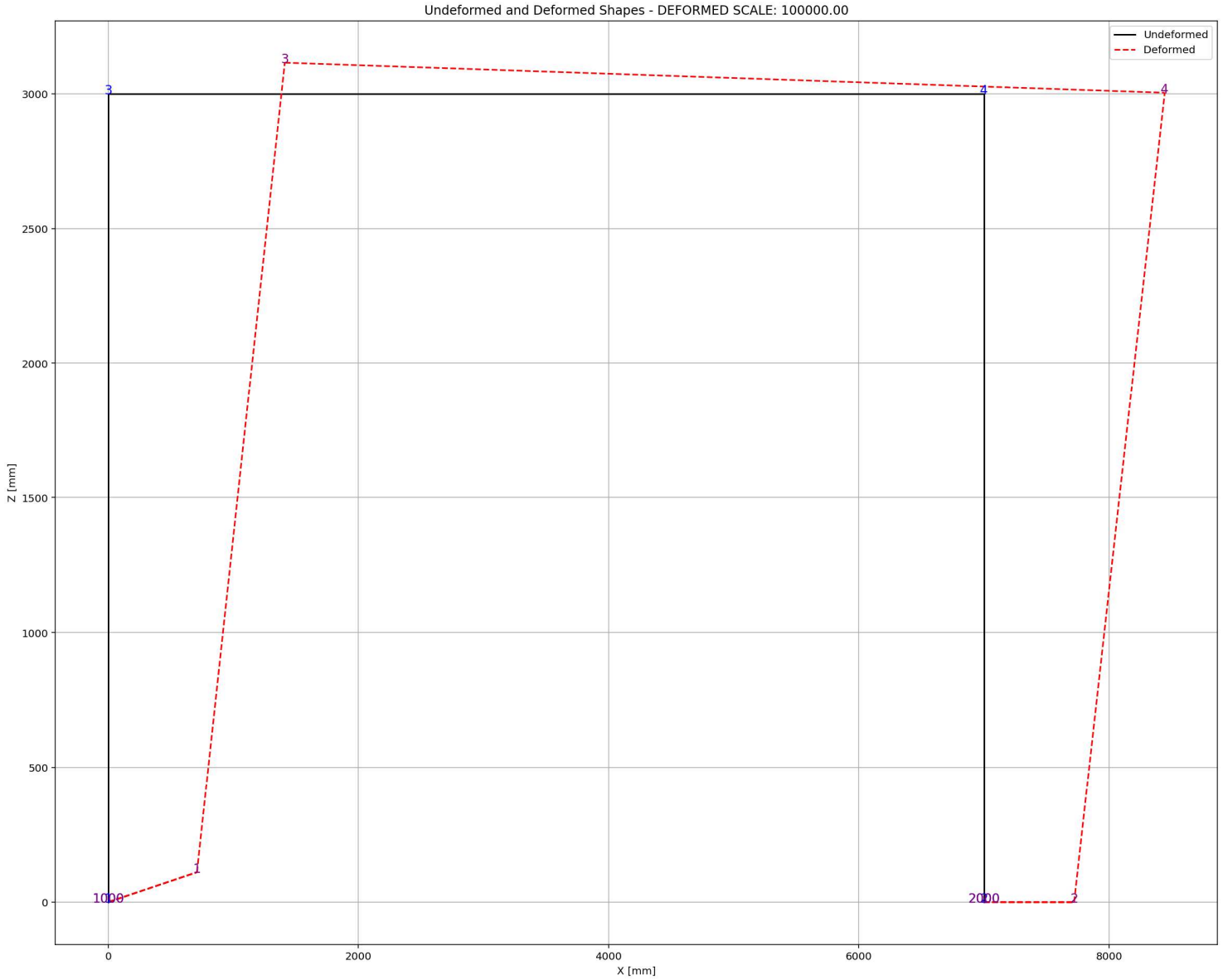

Time vs Velocity - MAX. ABS: 0.0026125721378222346
Velocity in X [mm/s]
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
0
2
4
6
8
10
12
14
Time [s]


Time vs Acceleration - MAX. ABS: 0.0032840961894440627
Acceleration in X [mm/s^2]
0.003
0.002
0.001
0.000
−0.001
−0.002
−0.003
0
2
4
6
8
10
12
14
Time [s]


Time vs Base-reaction - MAX. ABS: 62.803234567320274
Base-reaction [N]
Time [s]
60
40
20
0
−20
−40
−60
0
2
4
6
8
10
12
14


Time vs Base-reaction - MAX. ABS: 0.014115058269120523
Shear Base-reaction [N]
60
40
20
0
−20
−40
−60
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
Displacement in X [mm]


Time vs Base-reaction - MAX. ABS: 0.0011517993101725795
Axial Base-reaction [N]
0.0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
0.0000
0.0002
0.0004
0.0006
0.0008
0.0010
0.0012
Displacement in Y [mm]


Undeformed and Deformed Shapes - DEFORMED SCALE: 100000.00
Undeformed
Deformed
Z [mm]
X [mm]
0
500
1000
1500
2000
2500
3000
0
2000
4000
6000
8000
3
4
1
2