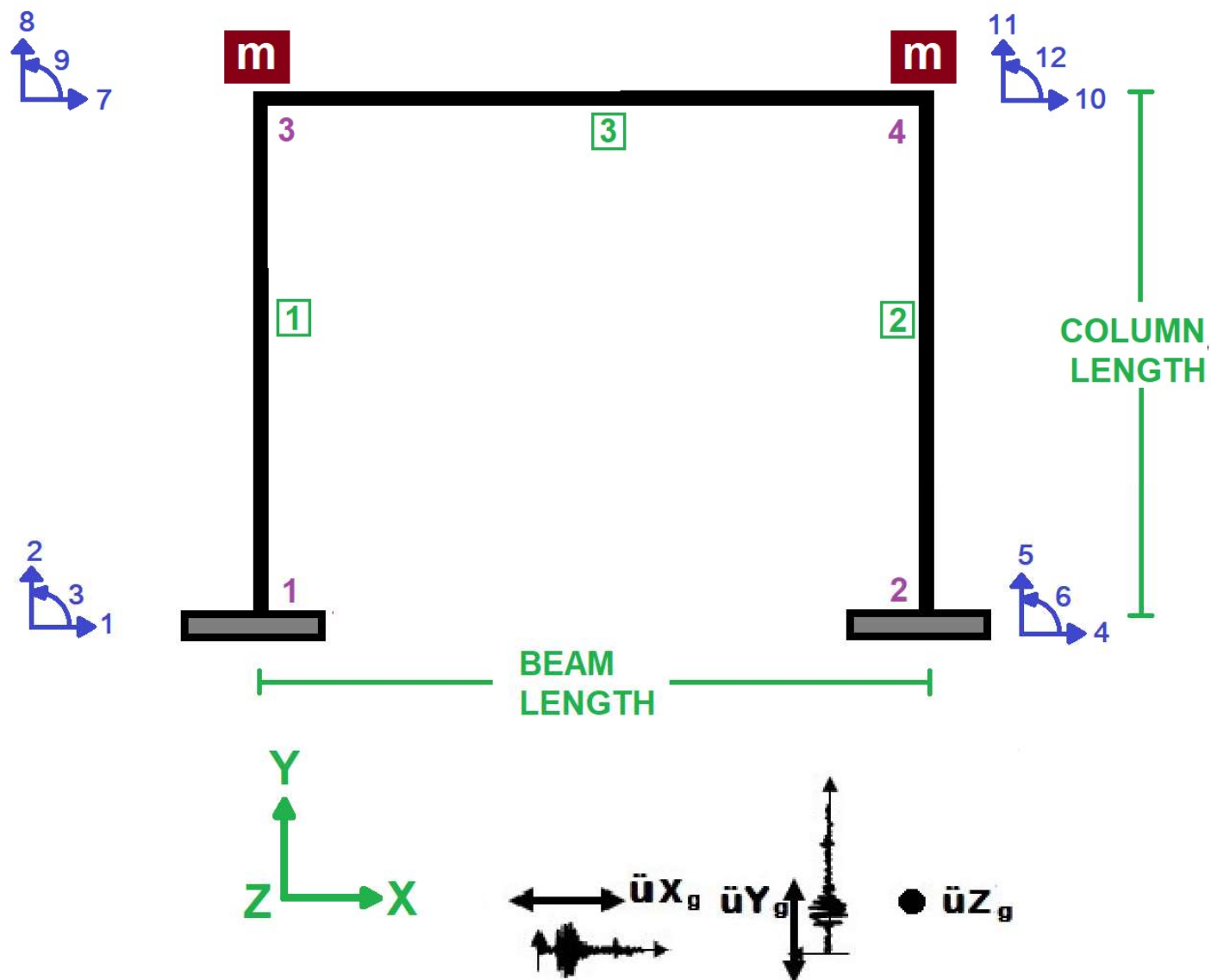IN THE NAME OF ALLAH

ASSESSMENTS OF THE STRUCTURAL DUCTILITY DAMAGE INDEX OF ULTRA-HIGH STRENGTH CONCRETE (UHSC) FRAME USING OPENSEES.

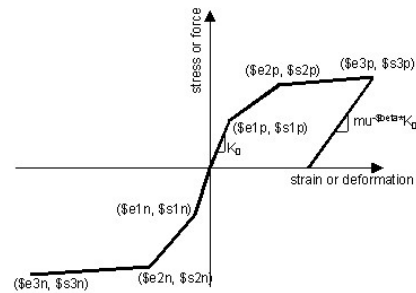WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)

CORE AND COVER CONCRETE RELATION

WITHOUT HARDENING AND ULTIMATE STRAIN

WITH HARDENING AND ULTIMATE STRAIN

COLUMN SECTION

BEAM SECTION

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

Δ_d = Lateral Displaement from Dynamic Analysis

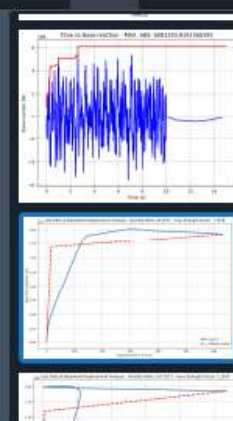Δ_y = Lateral Yield Displaement from Pushover Analysis

Δ_u = Lateral Ultimate Displaement from Pushover Analysis

File Edit Search Source Run Debug Consoles Projects Tools View Help

...ILES\CONCRETE_FRAME_EXAMPLES\ULTRA_HIGH_STRENGTH_CONCRETE

C:\Users\Dell\Desktop\OPENSEES_FILES\CONCRETE_FRA...TE\CONCRETE_FRAME_ULTRA_HIGH_STRENGTH_CONCRETE.py

T_BUCKLING.py ×   CONCRETE_FRAME_INC...ISTRIBUTED_LOAD.py ×   CONCRETE_FRAME_ULT...RENGTH_CONCRETE.py* ×

```python
1   ##############################################################################
2   #                    >> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<
3   #    ASSESSMENTS OF THE STRUCTURAL DUCTILITY DAMAGE INDEX OF ULTRA-HIGH STRENGTH CONCRETE (UHSC) FRAME
4   #------------------------------------------------------------------------------
5   #              THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)
6   #                       EMAIL: salar.d.ghashghaei@gmail.com
7   ##############################################################################
8   """
9   # Ultra-High Strength Concrete (UHSC) is concrete with compressive strength over 100 MPa.
10  # It is used in advanced structures like tall buildings, bridges, tunnels, and military facilities.
11
12  # Main Properties of UHSC:
13  # -------------------------------
14  # - Compressive strength: >100 MPa (often up to 150 MPa or more)
15  # - High tensile and flexural strength (due to steel or polymer fibers)
16  # - High density: 2400-2600 kg/m³
17  # - Very low permeability (resistant to water, chloride, and sulfate)
18  # - High elastic modulus (low deformation under load)
19  # - Excellent durability
20
21  # Main Components:
22  # -------------------------------
23  # 1. High-quality Portland cement
24  # 2. Silica fume (to reduce pores and improve strength)
25  # 3. Steel or polypropylene fibers (for crack control and toughness)
26  # 4. Superplasticizer (to reduce water/cement ratio, typically W/C ≤ 0.25)
27  # 5. Well-graded sand and aggregates
28  # 6. Mineral powders (e.g., quartz powder in some mixes)
29
30  # Advantages:
31  # -------------------------------
32  # - High strength in compression, tension, and bending
33  # - Very durable in harsh environments (marine, chemical, etc.)
34  # - Allows smaller sections and lighter structures
```

Help   Variable Explorer   Debugger   Plots   Files
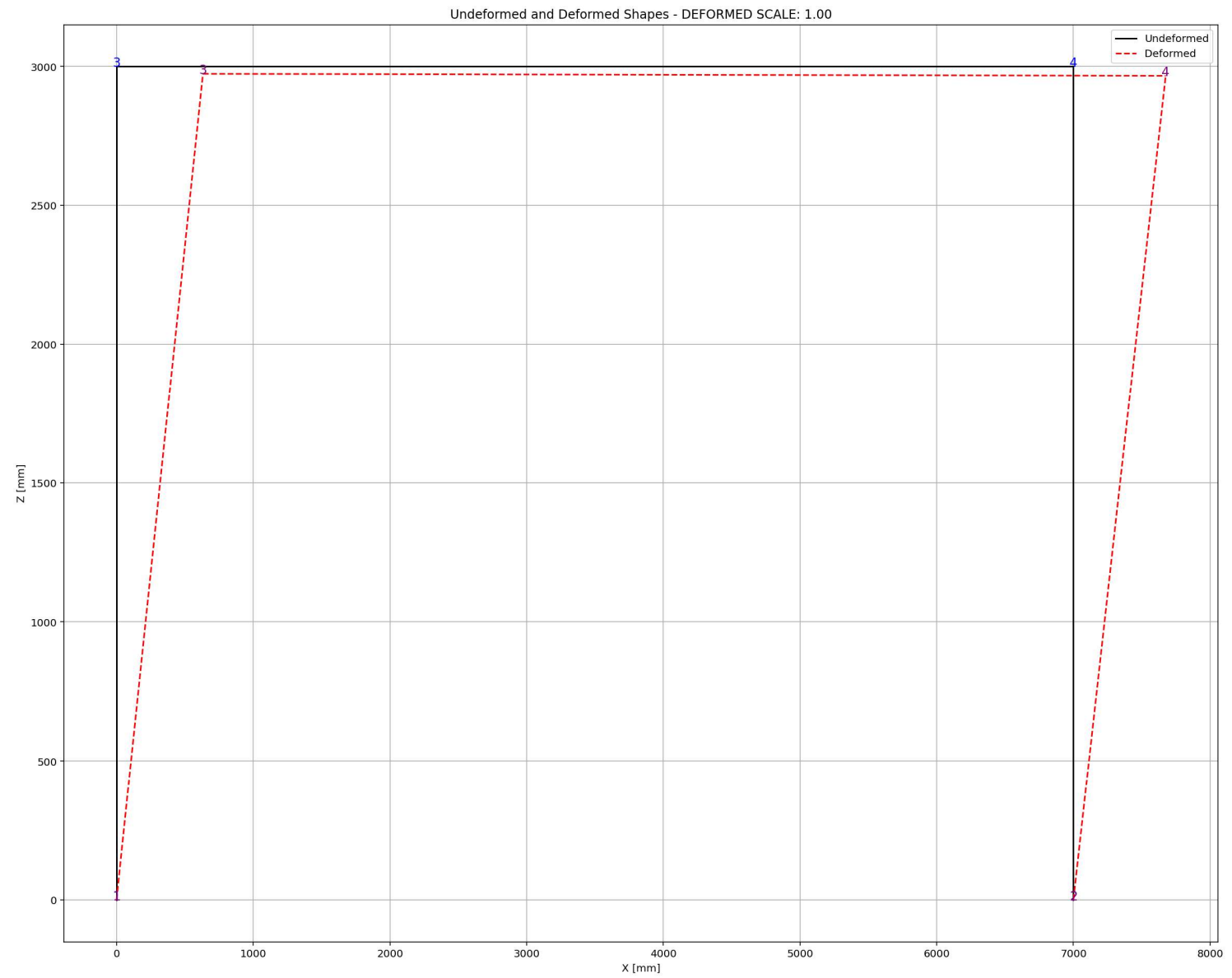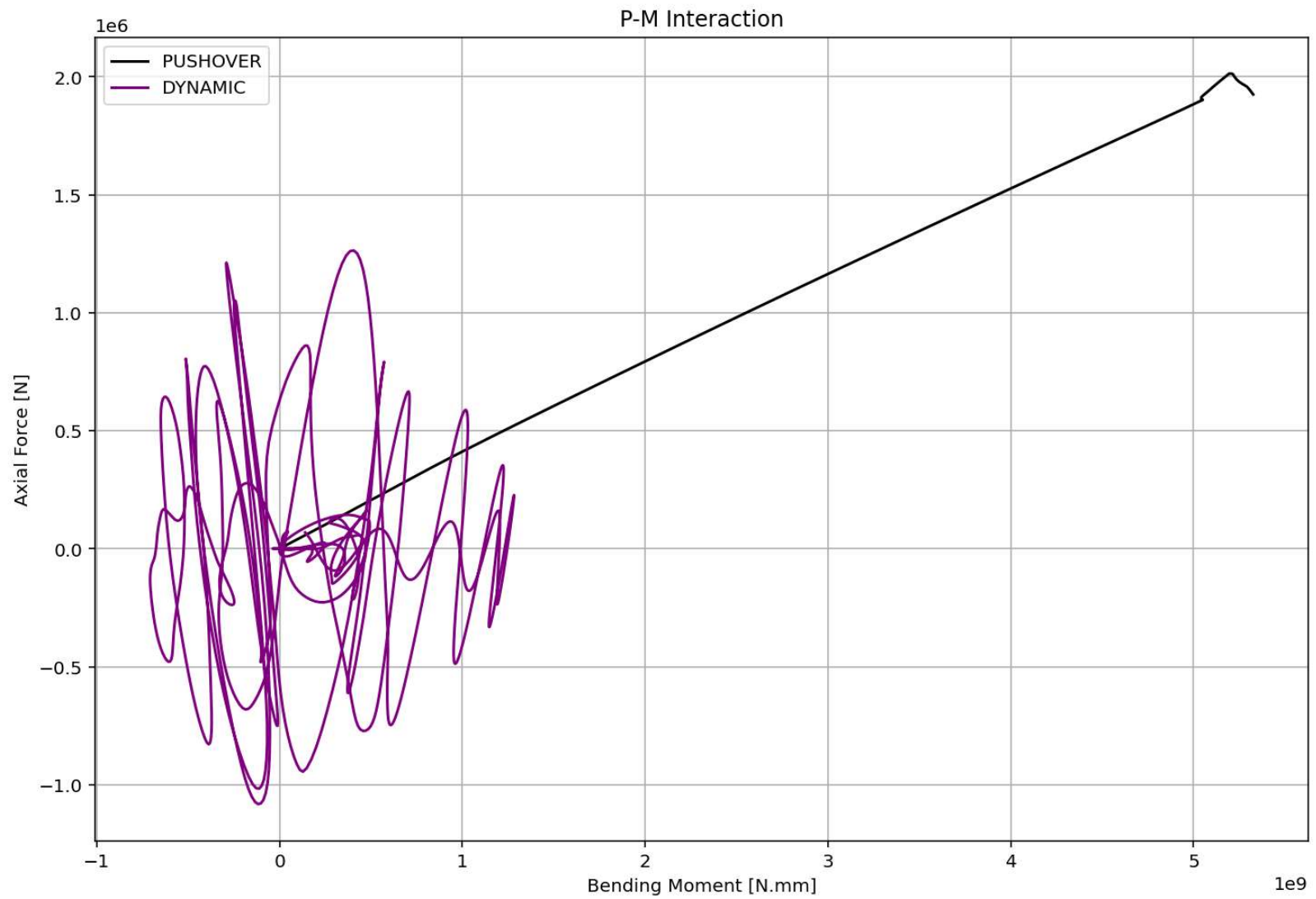
Console 1/A ×

```
12000 0 0
0 12000 0
0 0 0

    Rayleigh Factor: alphaM: 0.110163
    Rayleigh Forces: 13661.9 781.391 0
    Eigenvectors:
0.00380693 -0.00380693
5.98074e-06 -2.01903e-20
-1.67136e-06 1.81917e-06
```

IPython Console   History

Inline   Conda: anaconda3 (Python 3.12.7)   ✓ LSP: Python   Line 392, Col 32   UTF-8   CRLF   RW   Mem 37%

NONLINEAR STATIC ANALYSIS (PUSHOVER)

Undeformed and Deformed Shapes - DEFORMED SCALE: 1.00

P-M Interaction

SHEAR FORCE-DISPLACEMENT DIAGRAM

AXIAL FORCE-DISPLACEMENT DIAGRAM
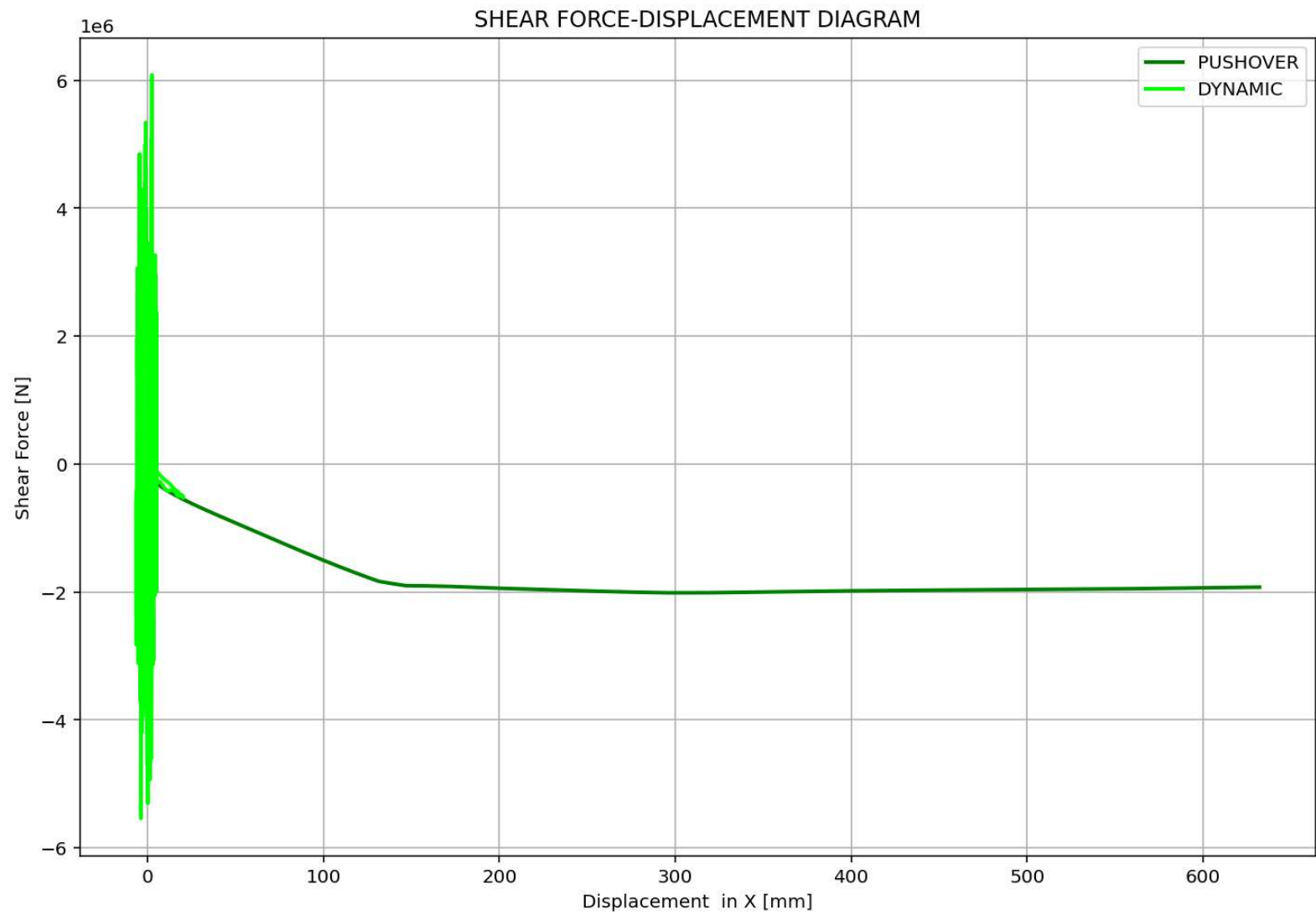
ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM
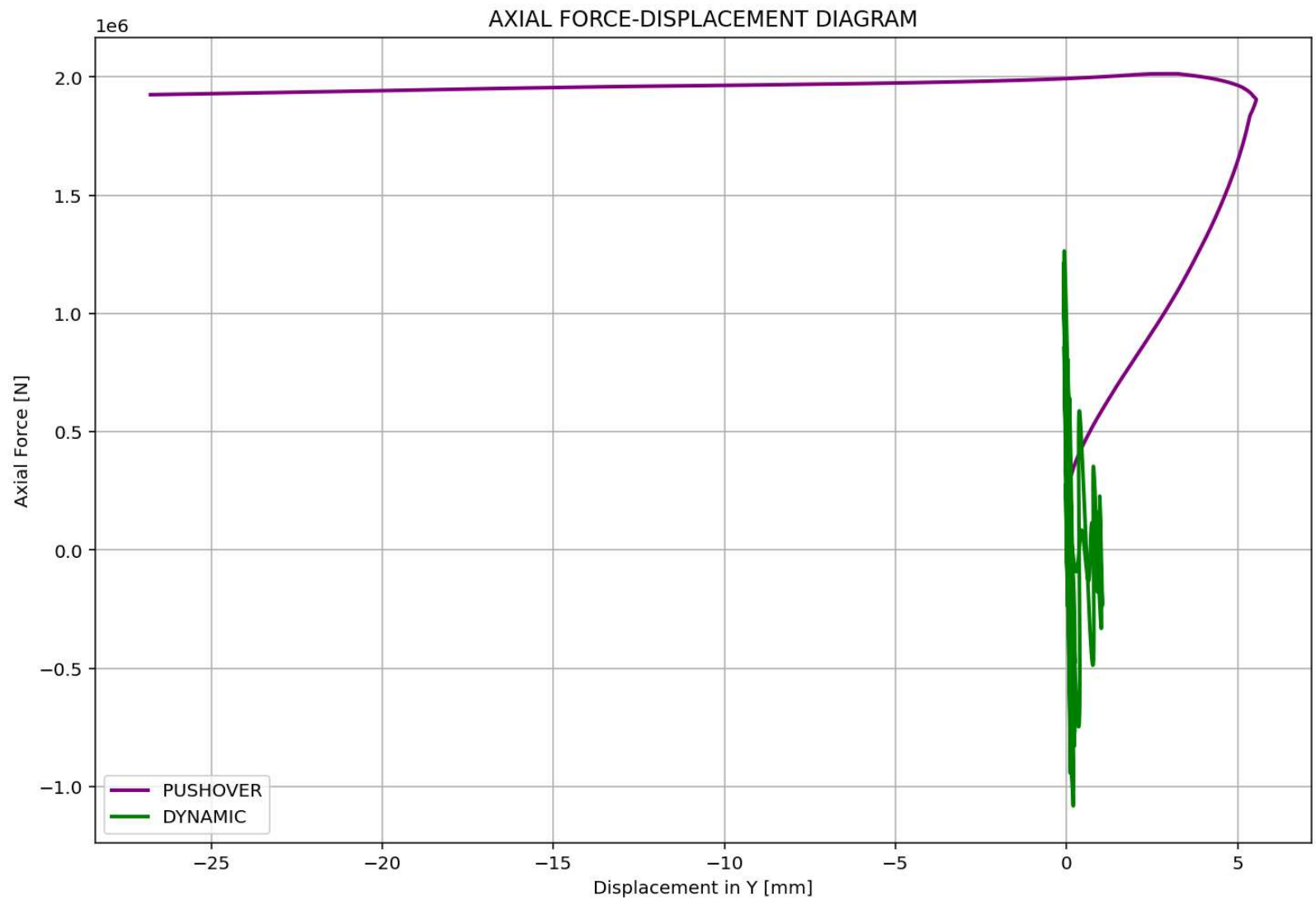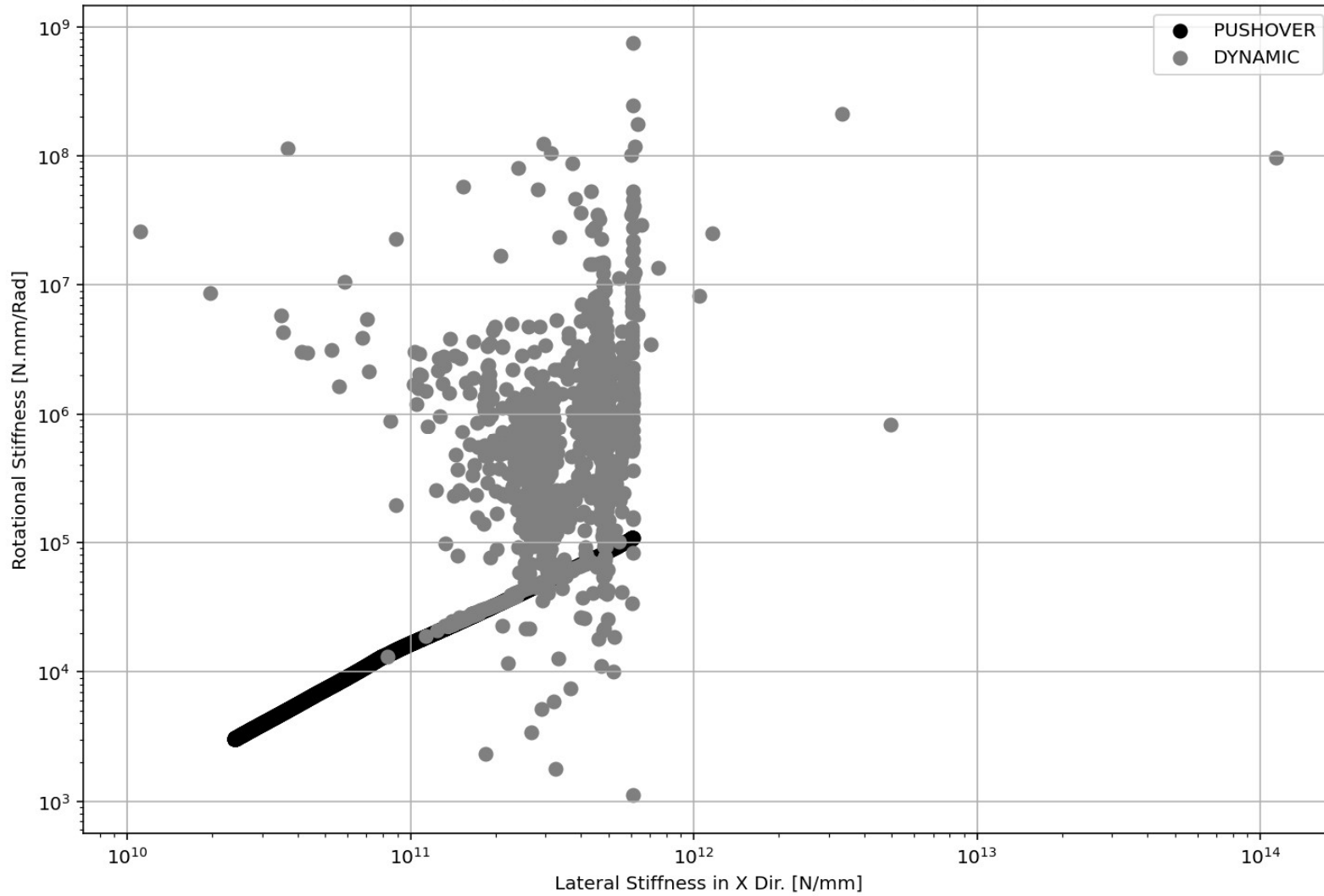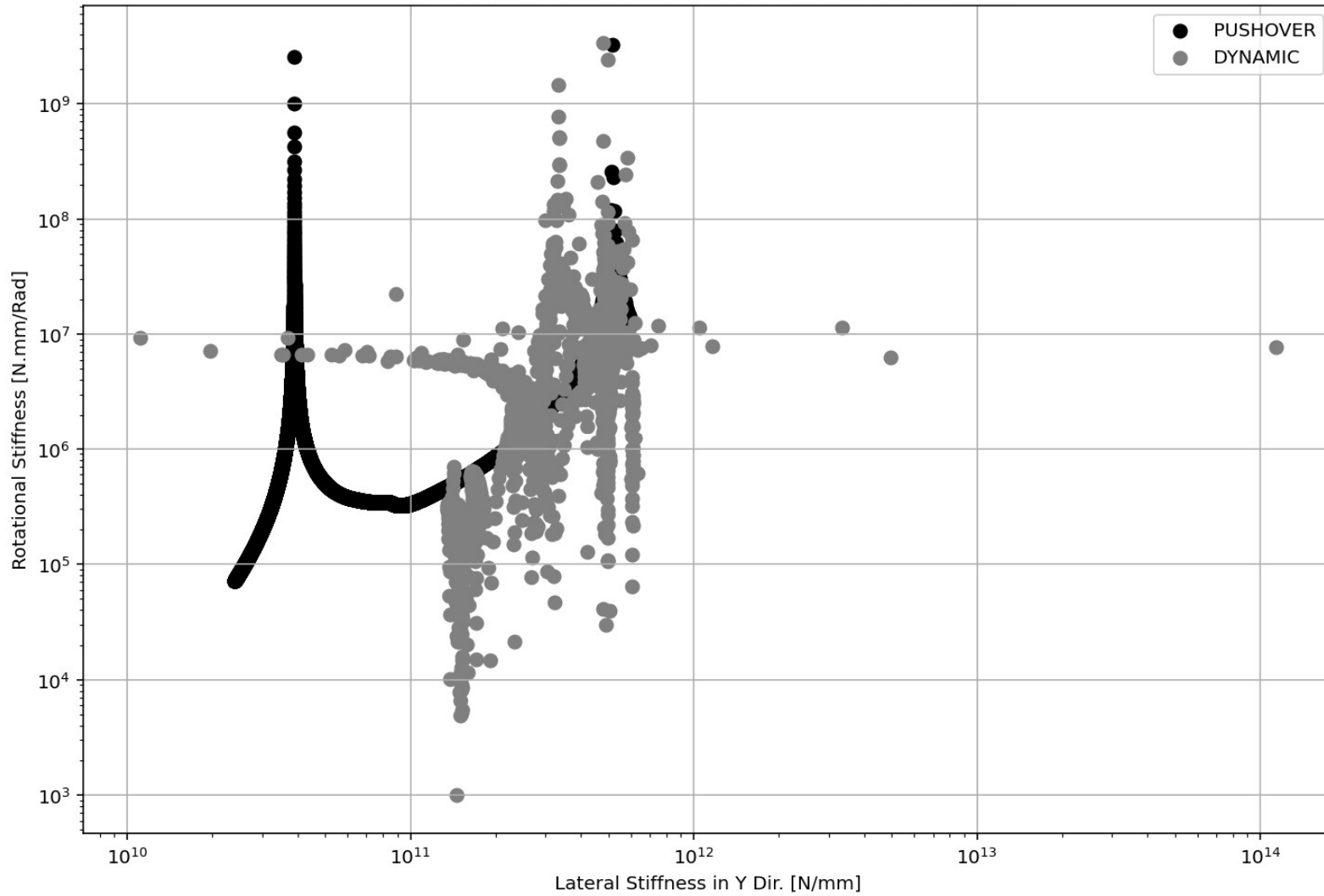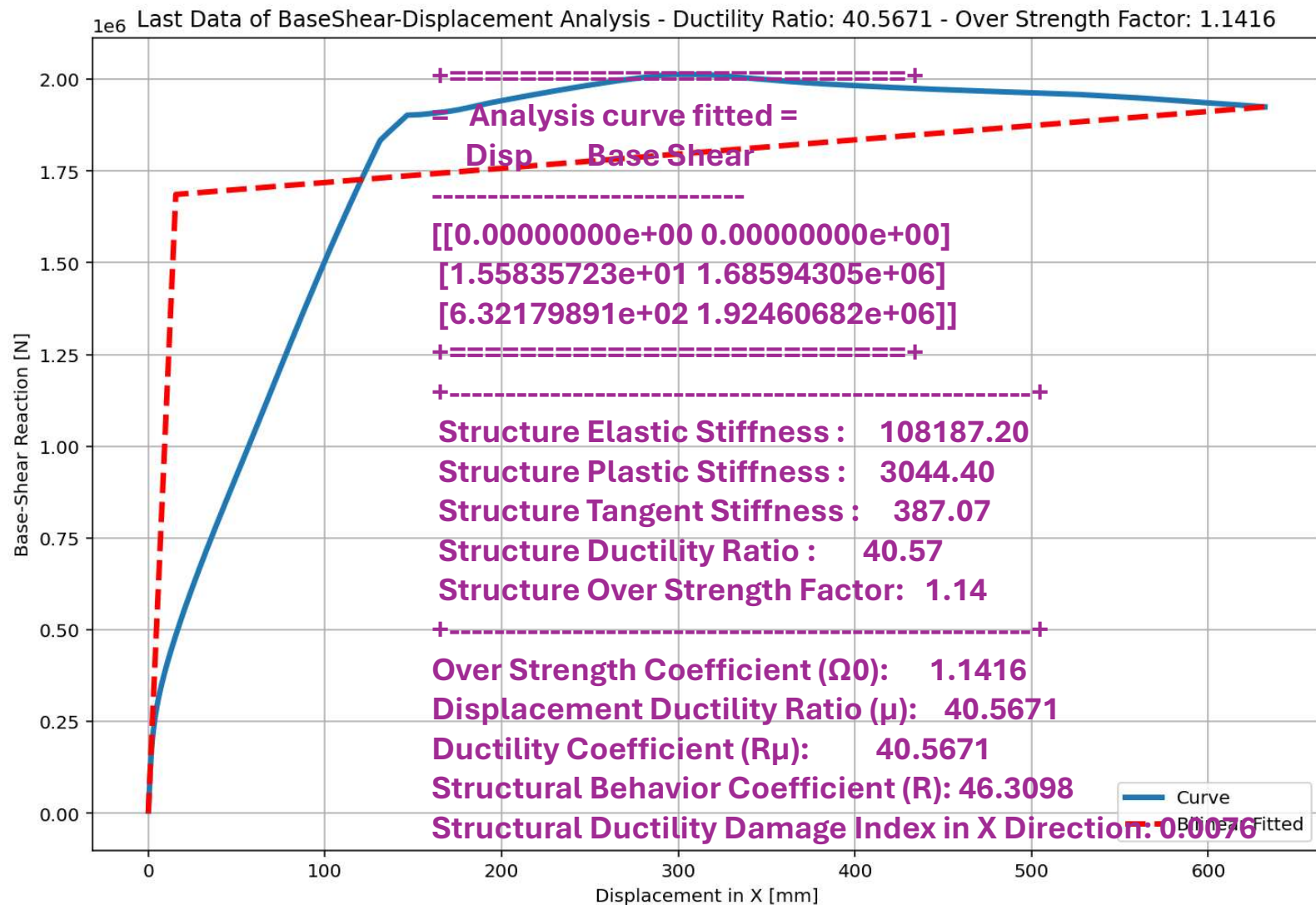
ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM

Last Data of BaseShear-Displacement Analysis - Ductility Ratio: 40.5671 - Over Strength Factor: 1.1416

+=============================+
= Analysis curve fitted =
Disp   Base Shear

[[0.00000000e+00 0.00000000e+00]
[1.55835723e+01 1.68594305e+06]
[6.32179891e+02 1.92460682e+06]]
+=============================+
+---+
Structure Elastic Stiffness :   108187.20
Structure Plastic Stiffness :   3044.40
Structure Tangent Stiffness :   387.07
Structure Ductility Ratio :   40.57
Structure Over Strength Factor: 1.14
+---+
Over Strength Coefficient (Ω0):   1.1416
Displacement Ductility Ratio (μ):   40.5671
Ductility Coefficient (Rμ):   40.5671
Structural Behavior Coefficient (R): 46.3098
Structural Ductility Damage Index in X Direction: 0.0076

Last Data of BaseAxial-Displacement Analysis - Ductility Ratio: 207.0227 - Over Strength Factor: 1.2073

+==============================+
=   Analysis curve fitted =
Disp   Base Shear

[[0.00000000e+00 0.00000000e+00]
 [1.29320525e-01 1.59412277e+06]
 [2.67722849e+01 1.92460682e+06]]
+==============================+
+--+
  Structure Elastic Stiffness :   12326912.32
  Structure Plastic Stiffness :   71888.03
  Structure Tangent Stiffness :   12404.18
  Structure Ductility Ratio :   207.02
  Structure Over Strength Factor: 1.21
+--+
Over Strength Coefficient (Ω0):   1.2073
Displacement Ductility Ratio (μ):   207.0227
Ductility Coefficient (Rμ):   207.0227
Structural Behavior Coefficient (R): 249.9414
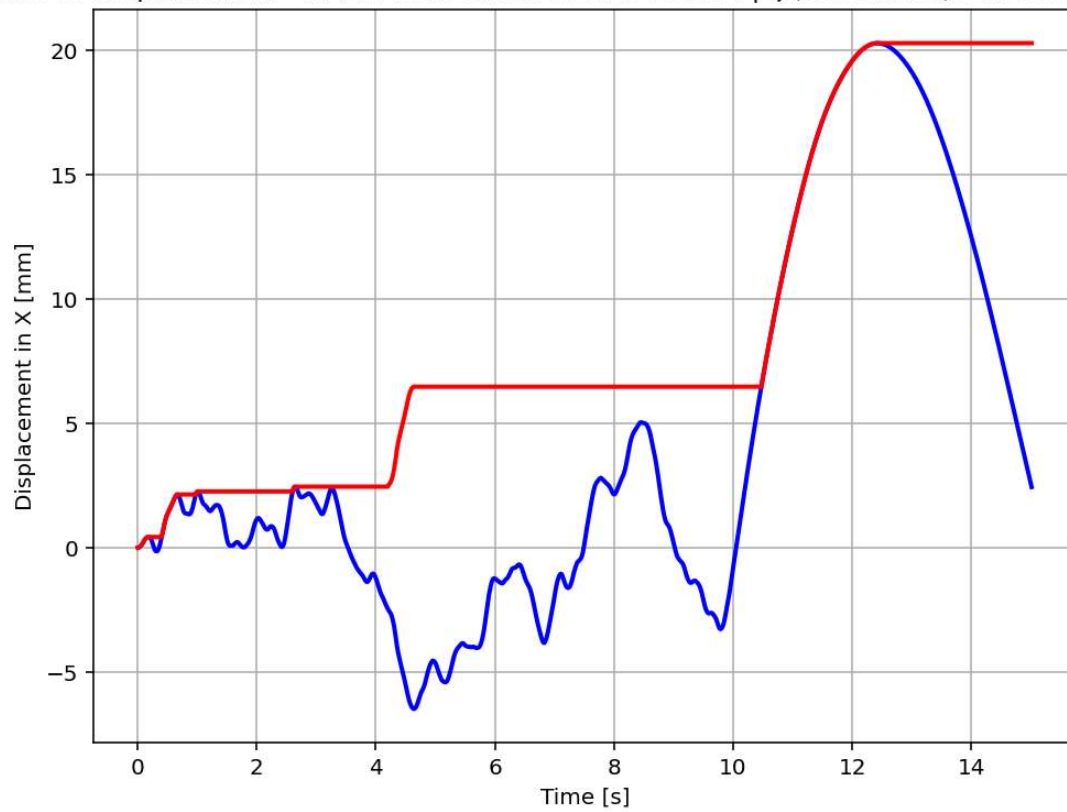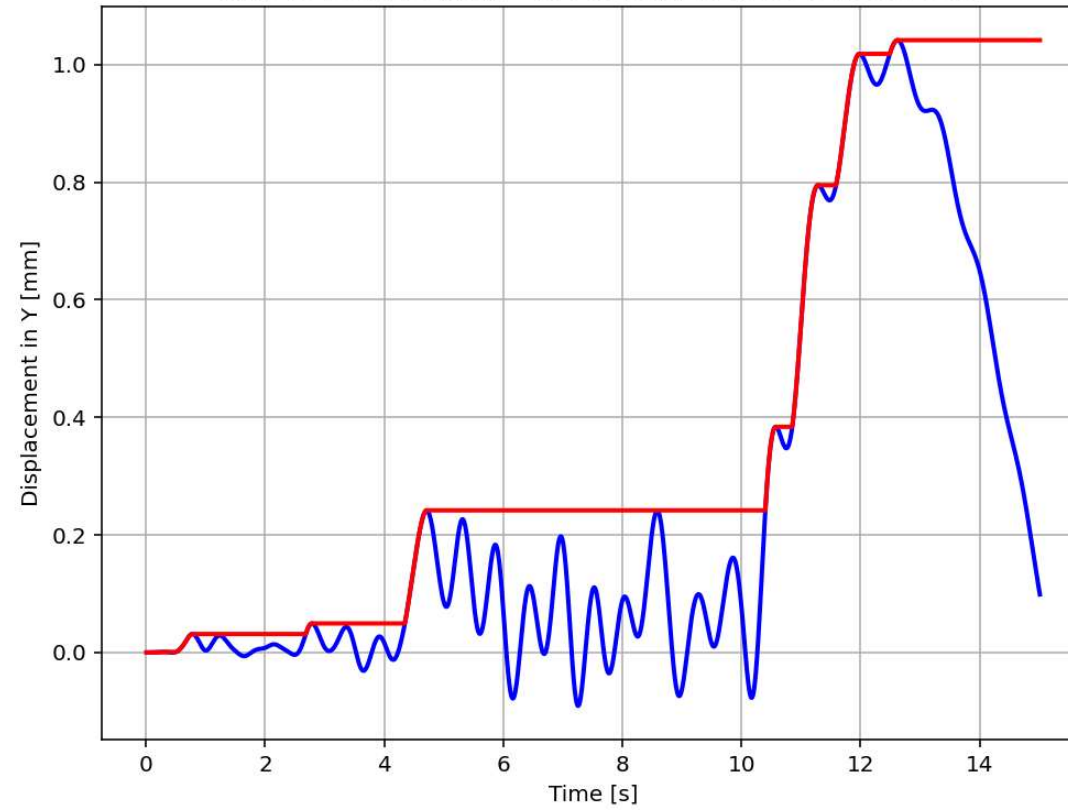Structural Ductility Damage Index in Y Direction: 0.0342

NONLINEAR DYNAMIC ANALYSIS

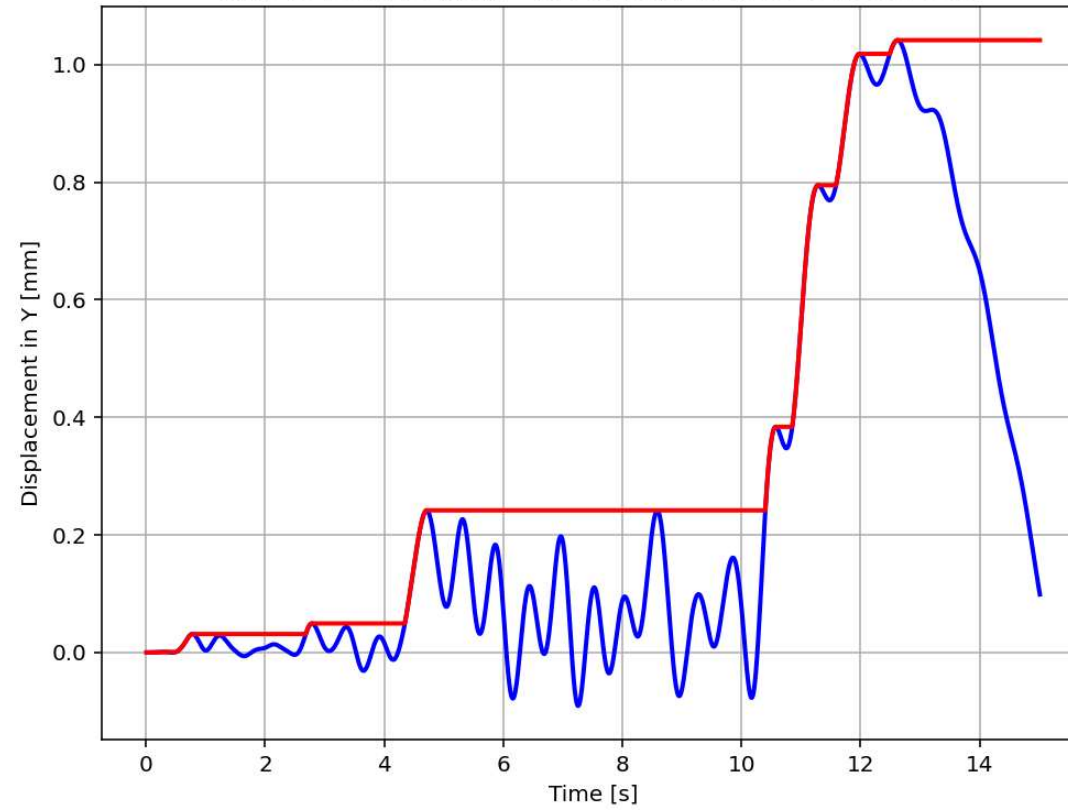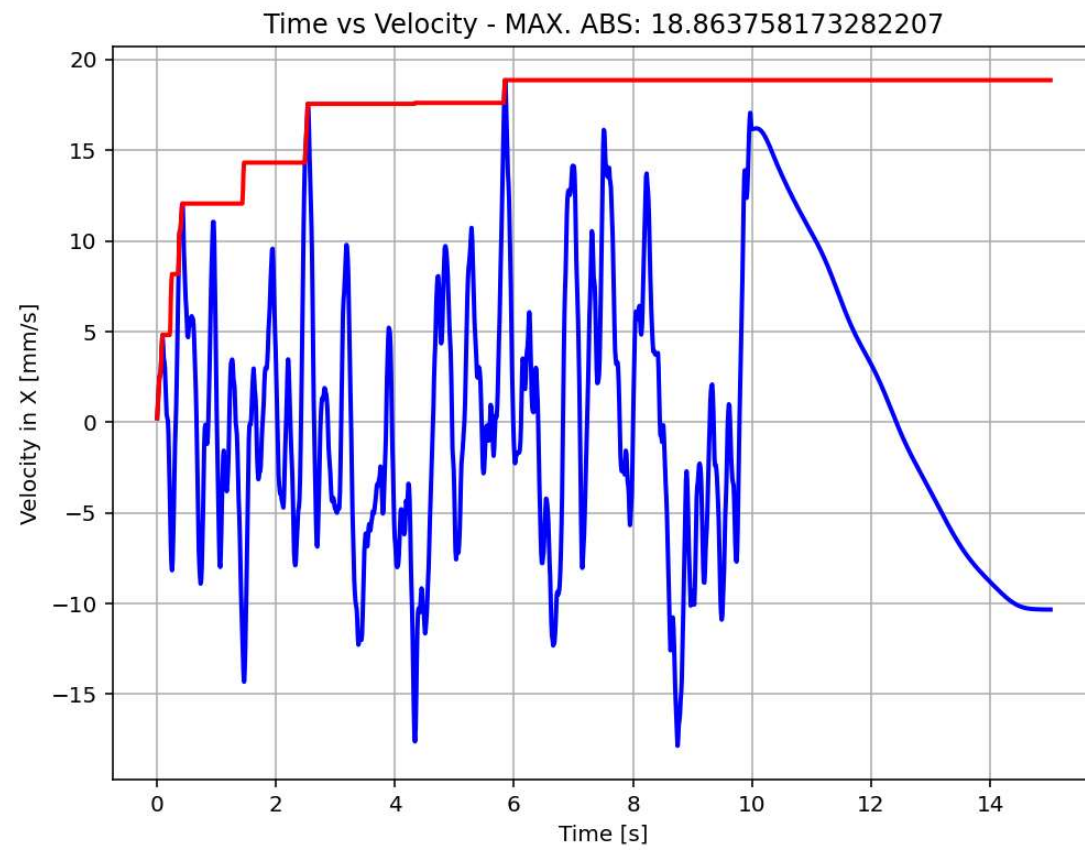Time vs Displacement - MAX. ABS: 20.281462425066504 | ξ (Calculated): 1.00000e+02 %

Time vs Displacement - MAX. ABS: 1.0415597243087915

Time vs Displacement - MAX. ABS: 1.0415597243087915

Time vs Velocity - MAX. ABS: 18.863758173282207

Time vs Acceleration - MAX. ABS: 339.4645712802474

Time vs Base-reaction - MAX. ABS: 6083293.8191568395