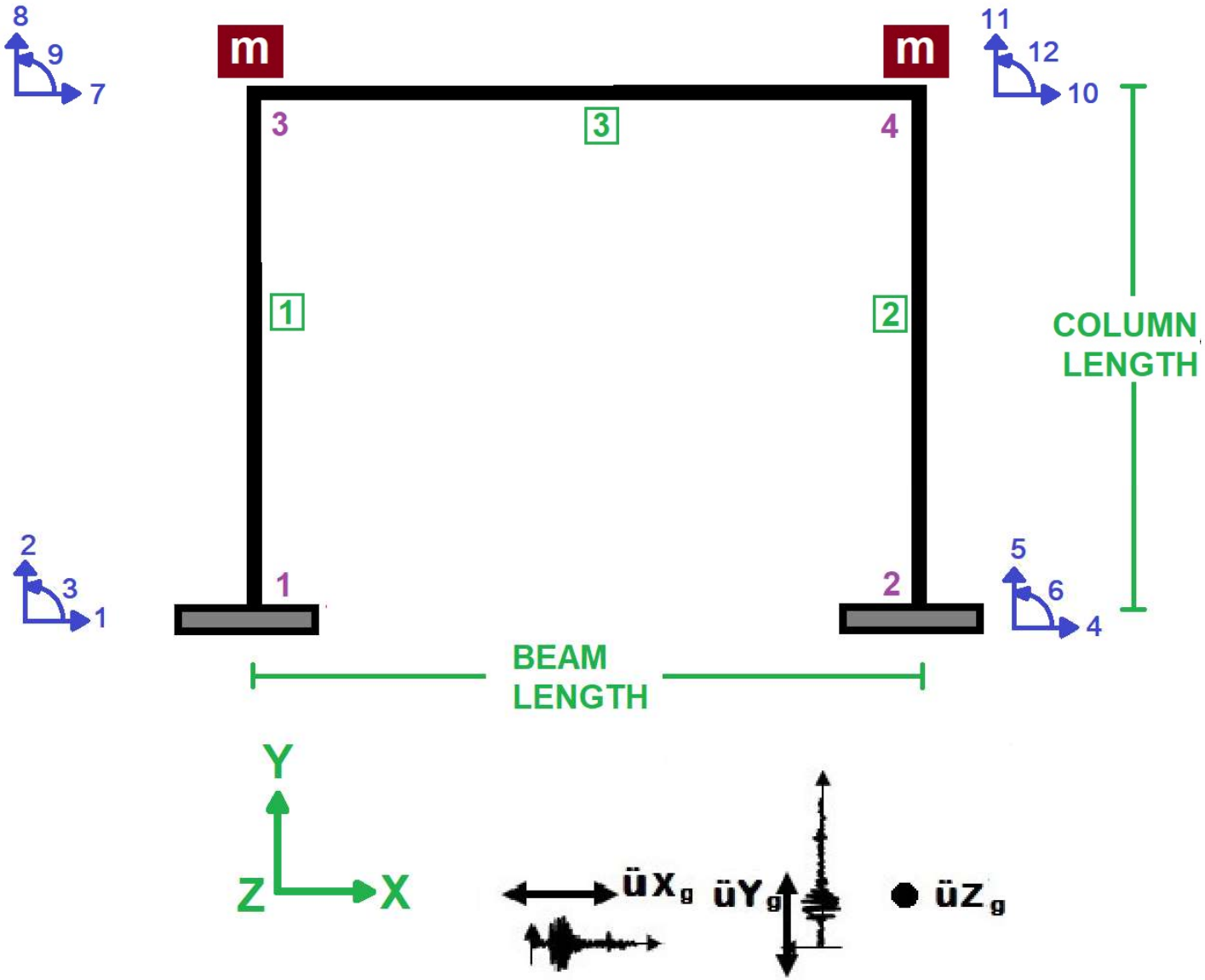
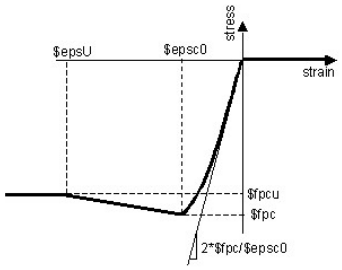
>> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<

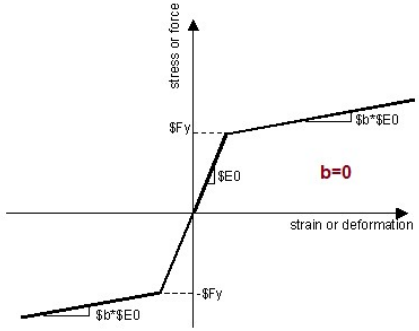
SENSITIVITY ANALYSIS OF CONCRETE FRAME BY CHANGING BEAM LENGTH AND MASS USING OPENSEES

WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)

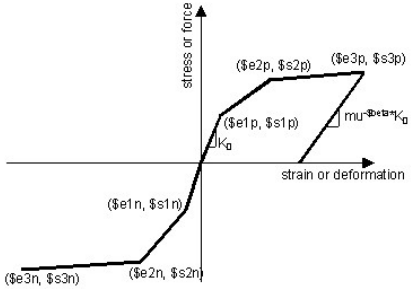

8
9
7
m
m
11
12
10
3
3
4
1
2
COLUMN
LENGTH
2
3
1
1
2
5
6
4
BEAM
LENGTH
Y
Z
X
üX$_g$
üY$_g$
üZ$_g$



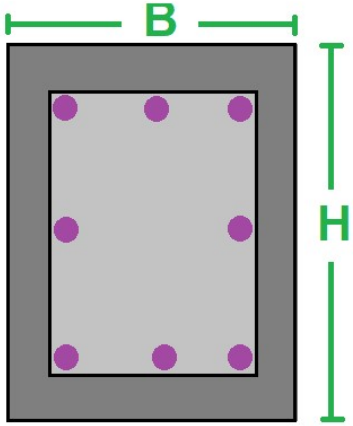
CORE AND COVER CONCRETE RELATION



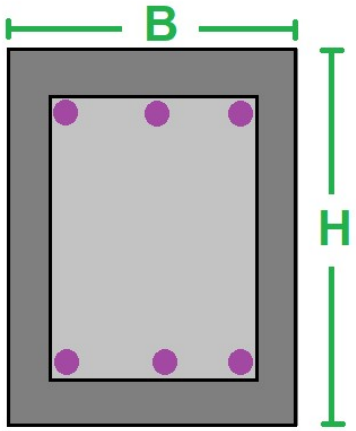
WITHOUT HARDENING AND ULTIMATE STRAIN



WITH HARDENING AND ULTIMATE STRAIN



COLUMN SECTION



BEAM SECTION

Spyder (Python 3.12)

File Edit Search Source Run Debug Consoles Projects Tools View Help

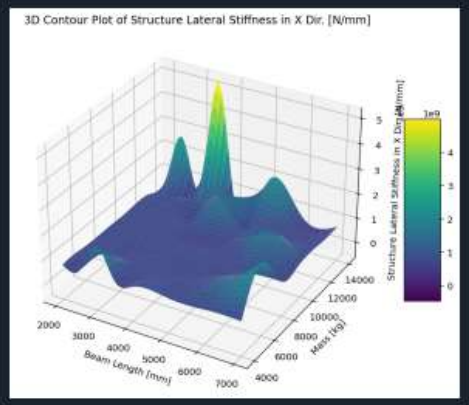
...LES\CONCRETE_FRAME_EXAMPLES\SENSITIVITY_BEAM_LENGTH_&_MASS

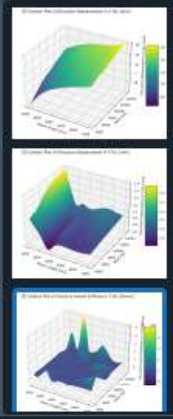
C:\Users\Dell\Desktop\OPENSEES_FILES\CONCRETE_FRA...\CONCRETE_FRAME_SENSITIVITY_BEAM_LENGTH_&_MASS.py

CONCRETE_FRAME_SEN...M_LENGTH__MASS.py

```
#######################################################################################################################
#                        >> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<
#              SENSITIVITY ANALYSIS OF CONCRETE FRAME BY CHANGING BEAM LENGTH AND MASS USING OPENSEES
#---------------------------------------------------------------------------------------------------------------------
#                                THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)
#                                        EMAIL: salar.d.ghashghaei@gmail.com
#######################################################################################################################
"""
# Nonlinear Dynamic and Sensitivity Analysis of a Concrete Frame Using OpenSees
-------------------------------------------------------------
This study performs a comprehensive nonlinear dynamic analysis and sensitivity assessment
 of a reinforced concrete frame structure using OpenSees.
 The research focuses on evaluating the structural response by varying two key parameters:
1. Beam length - Examining how different span lengths influence dynamic behavior
2. Structural mass - Investigating the effect of mass variation on seismic performance
-------------------------------------------------------------
## Methodology
1. Model Development
   - Create a nonlinear finite element model of a reinforced concrete moment-resisting frame
   - Implement fiber sections with appropriate material models (Concrete02, Steel02)
   - Include geometric nonlinearities (P-Delta effects)

2. Parameter Variation
   - Beam lengths: ±20% variation from baseline design
   - Mass modifications: ±30% variation to represent different loading conditions

3. Analysis Procedures
   - Nonlinear Dynamic Analysis:
     - Apply earthquake ground motions (e.g., El Centro, Kobe records)
     - Evaluate displacement demands, story drifts, and damage progression
   - Sensitivity Analysis:
     - Perform parametric studies by systematically varying beam length and mass
     - Quantify influence on key response parameters (peak displacements, base shear)
```

30 %





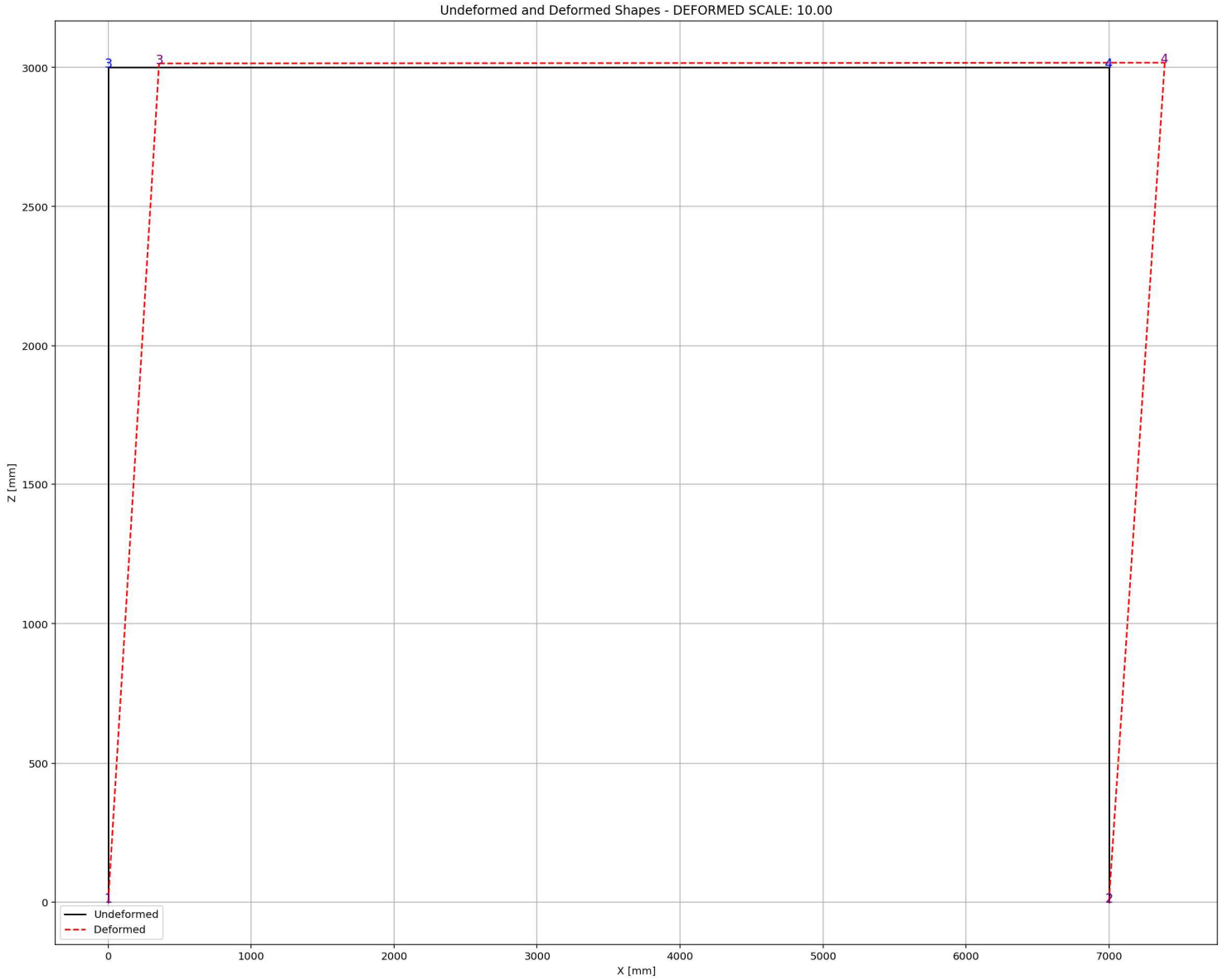
Help Variable Explorer Debugger Plots Files

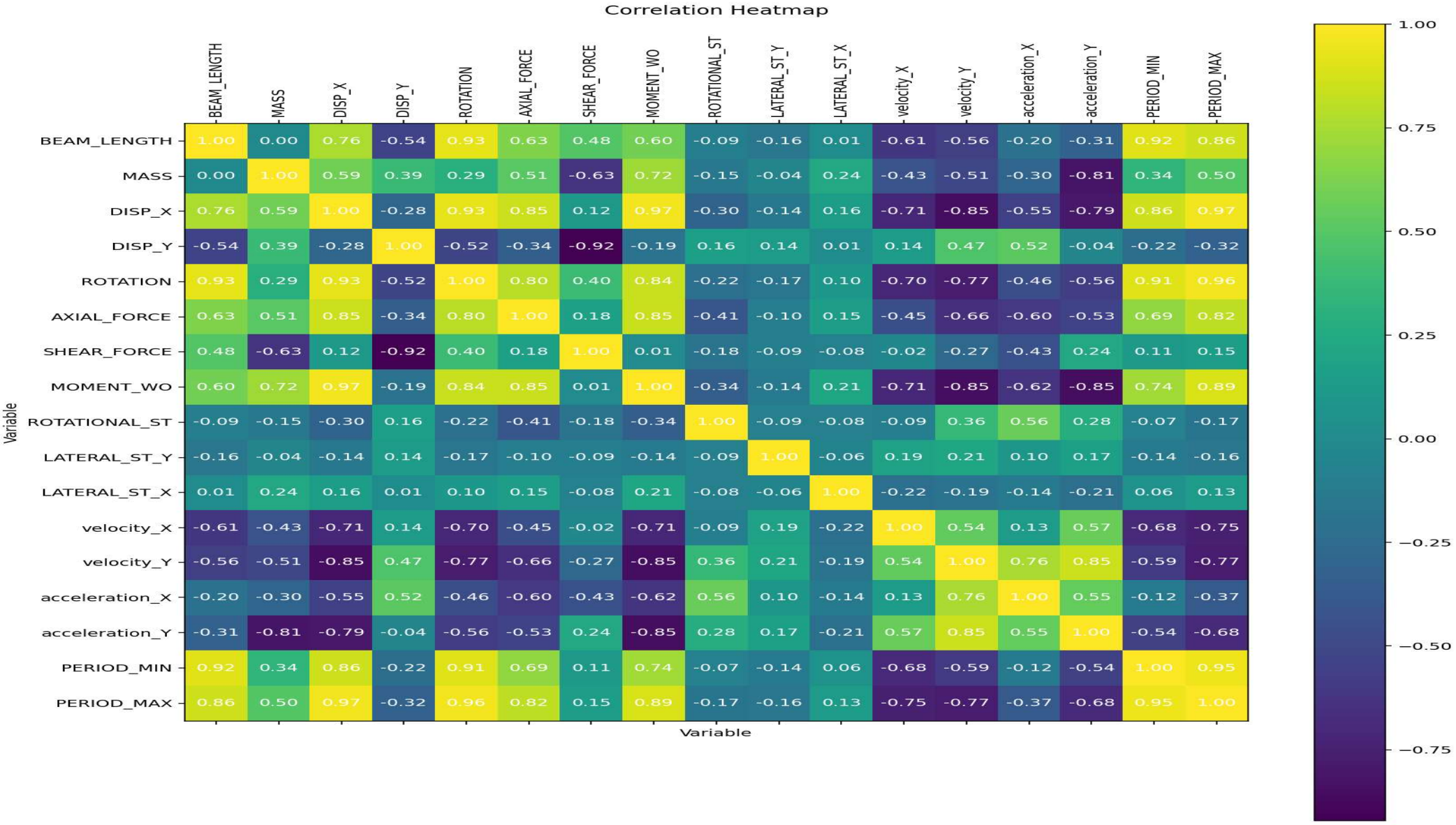
Console 1/A

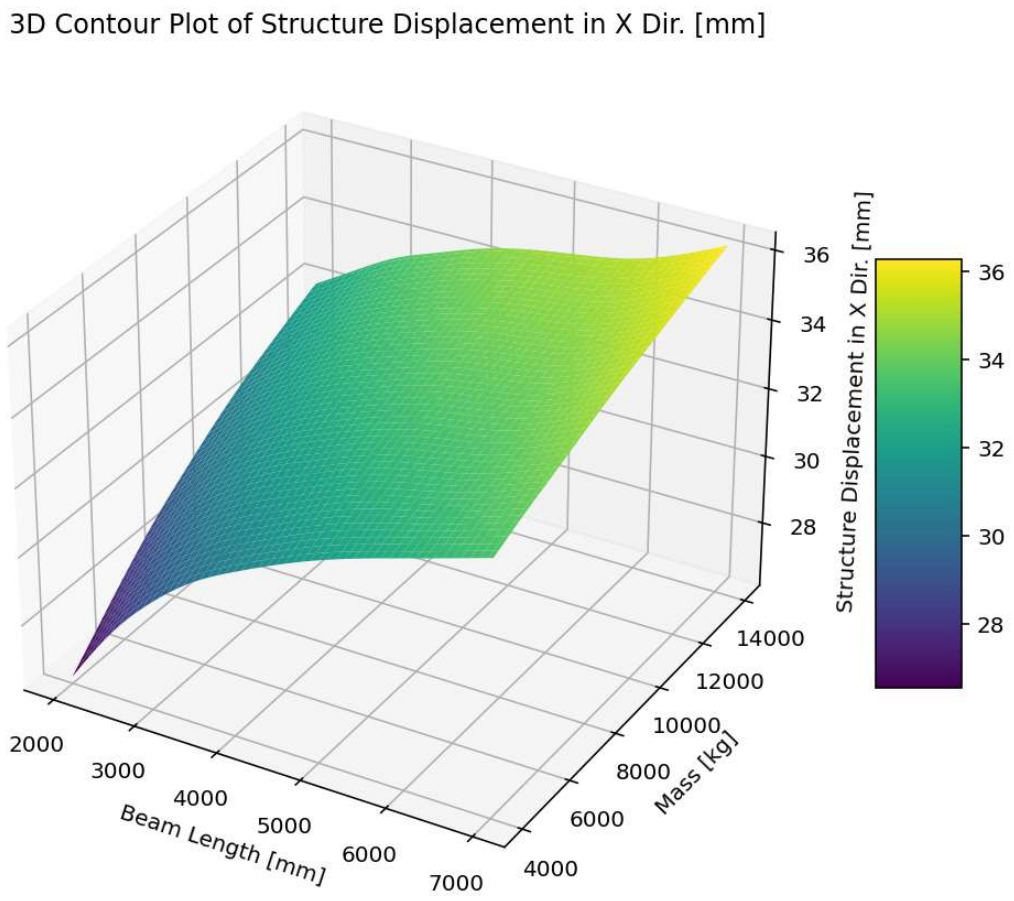
```
Lobatto
    End 1 Forces (P V M): -40019.4 190838 4.91431e+08
    End 2 Forces (P V M): 40019.4 -190838 8.10816e+07

Element: 3 Type: ForceBeamColumn2d  Connected Nodes: 3 4
    Number of Sections: 5   Mass density: 3.75
Lobatto
    End 1 Forces (P V M): -69819.3 -22848.8 -7.88635e+07
    End 2 Forces (P V M): 69819.3 22848.8 -8.1078e+07

In [11]:
```

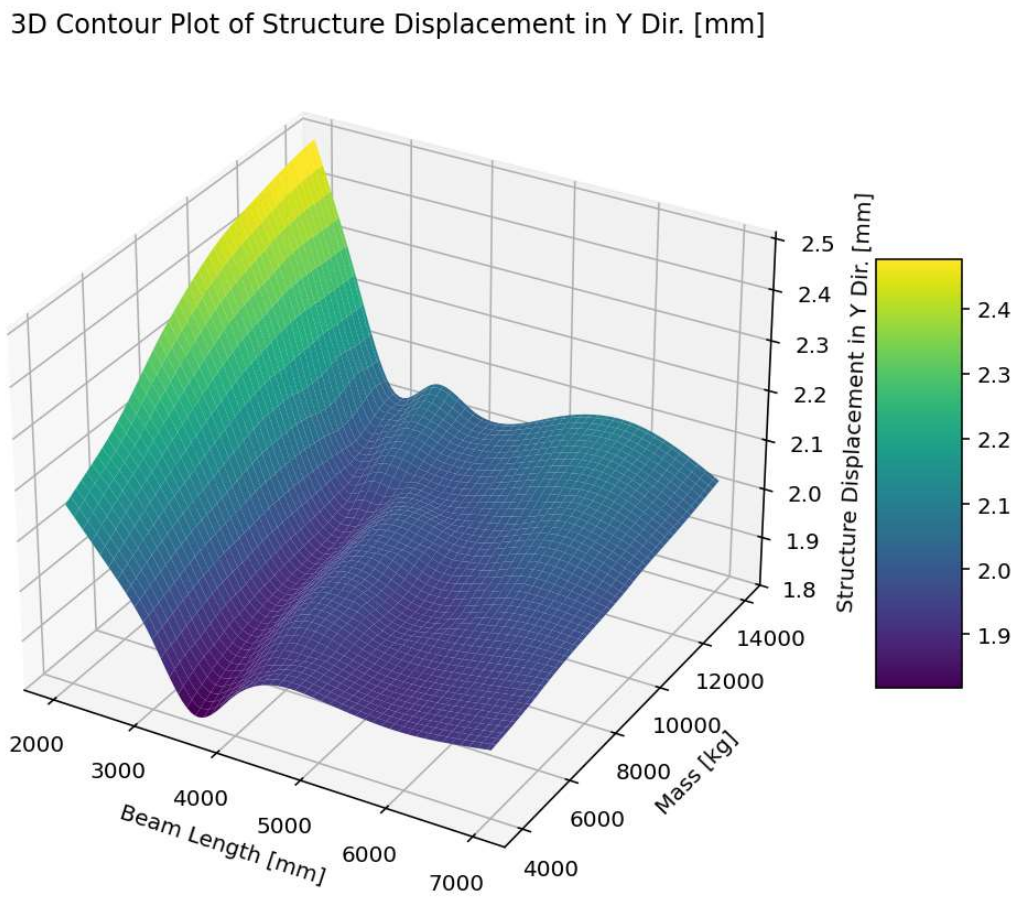
IPython Console History

Inline Conda: anaconda3 (Python 3.12.7) LSP: Python Line 600, Col 1 UTF-8 CRLF RW Mem 46%

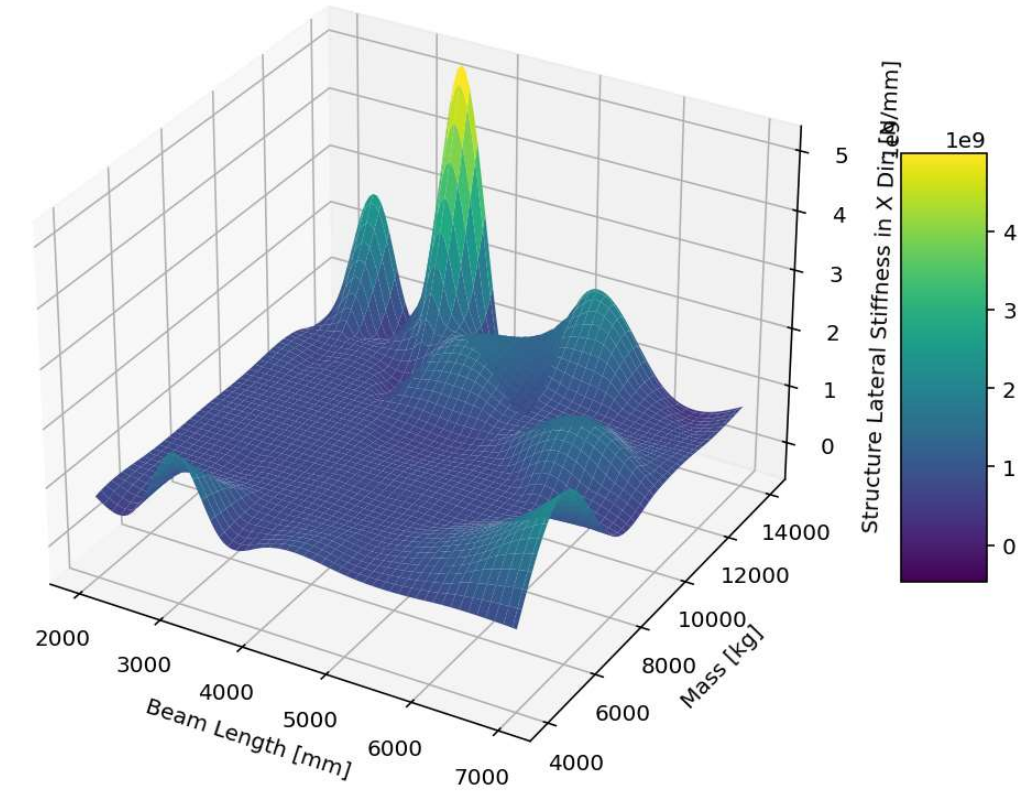

Undeformed and Deformed Shapes - DEFORMED SCALE: 10.00
Z [mm]
X [mm]
0
500
1000
1500
2000
2500
3000
0
1000
2000
3000
4000
5000
6000
7000
1
2
3
4
Undeformed
Deformed

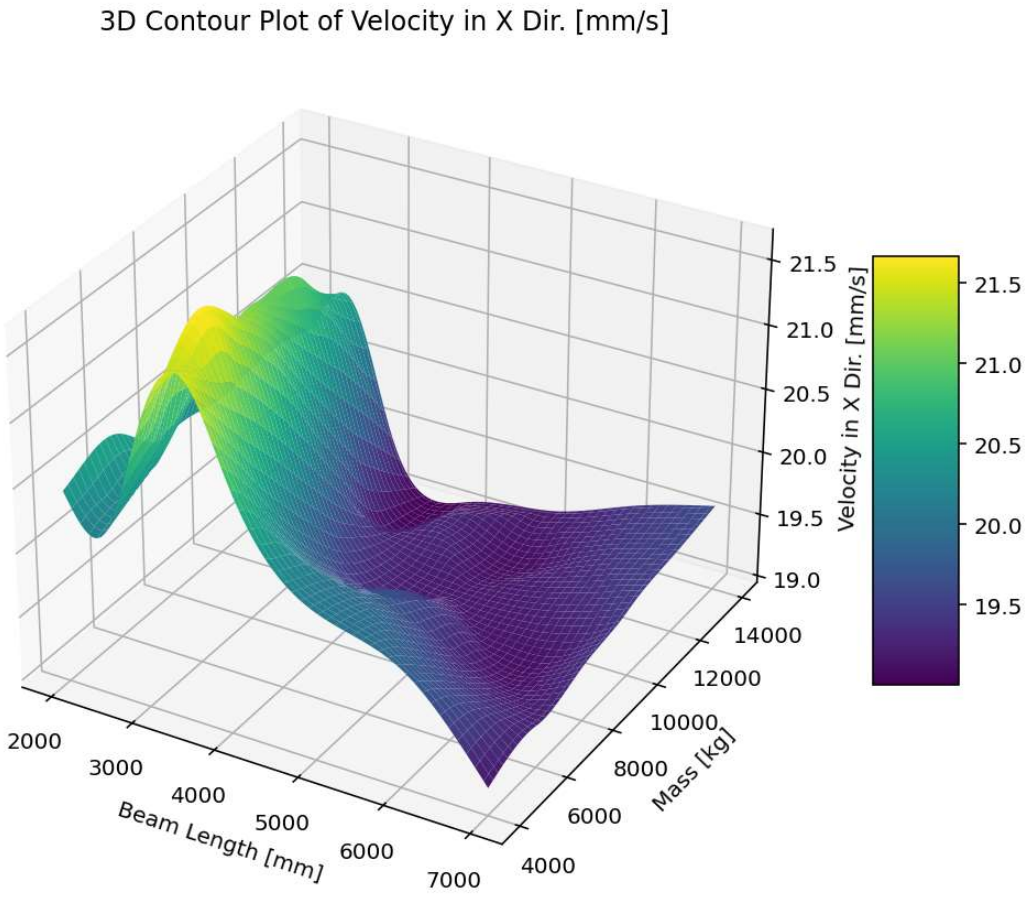

Correlation Heatmap
BEAM_LENGTH
MASS
DISP_X
DISP_Y
ROTATION
AXIAL_FORCE
SHEAR_FORCE
MOMENT_WO
ROTATIONAL_ST
LATERAL_ST_Y
LATERAL_ST_X
velocity_X
velocity_Y
acceleration_X
acceleration_Y
PERIOD_MIN
PERIOD_MAX
Variable
Variable
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75

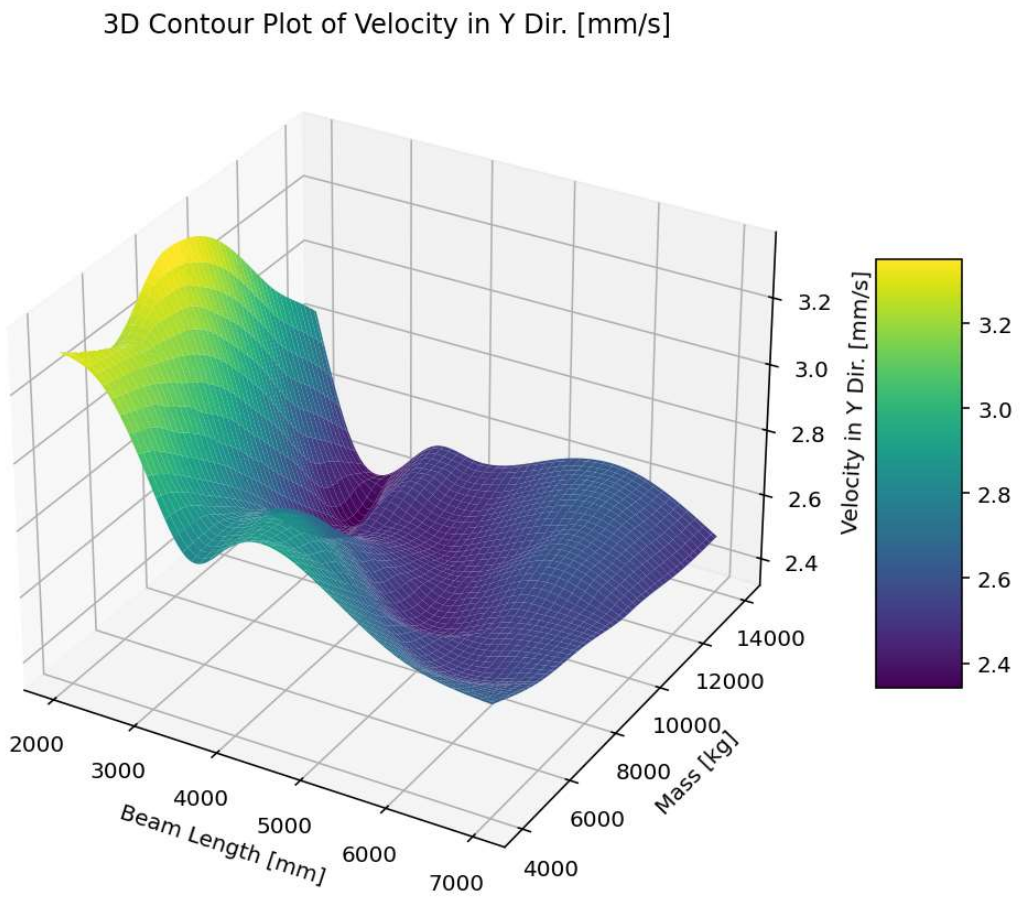

3D Contour Plot of Structure Displacement in X Dir. [mm]
Beam Length [mm]
2000
3000
4000
5000
6000
7000
Mass [kg]
4000
6000
8000
10000
12000
14000
28
30
32
34
36
Structure Displacement in X Dir. [mm]
28
30
32
34
36

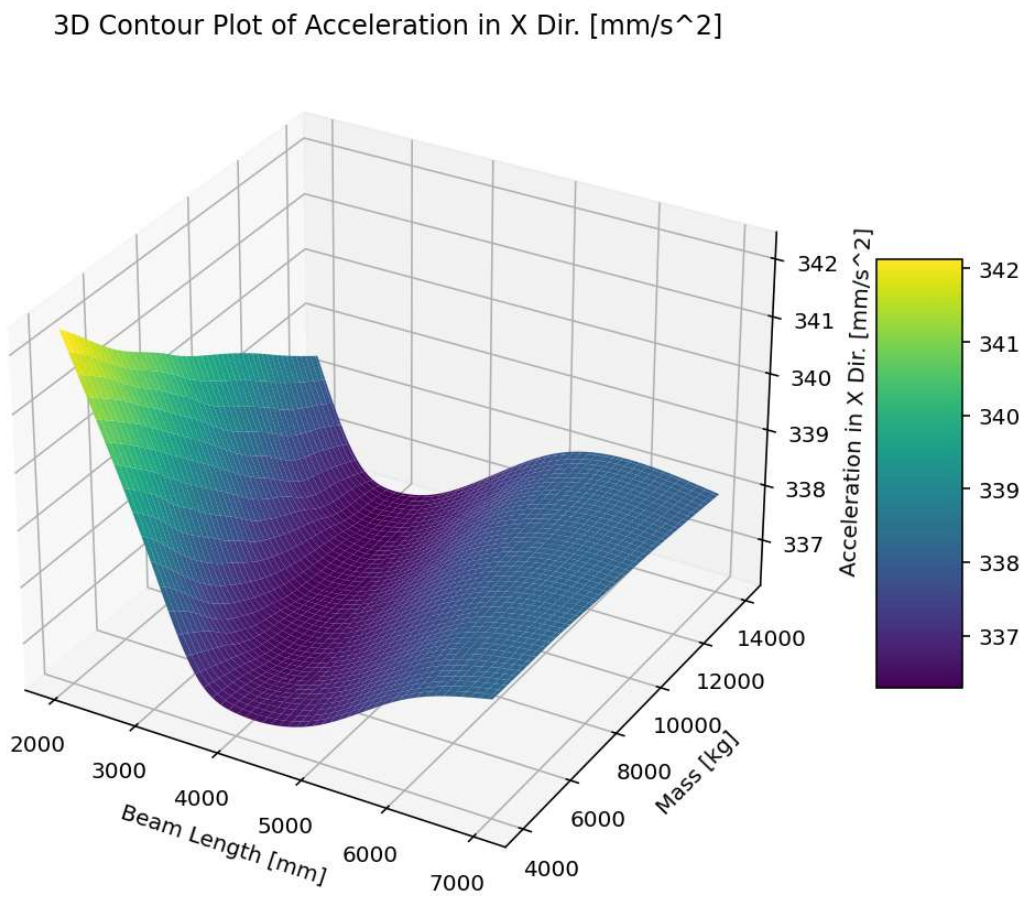

3D Contour Plot of Structure Displacement in Y Dir. [mm]
Beam Length [mm]
2000
3000
4000
5000
6000
7000
Mass [kg]
4000
6000
8000
10000
12000
14000
Structure Displacement in Y Dir. [mm]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5

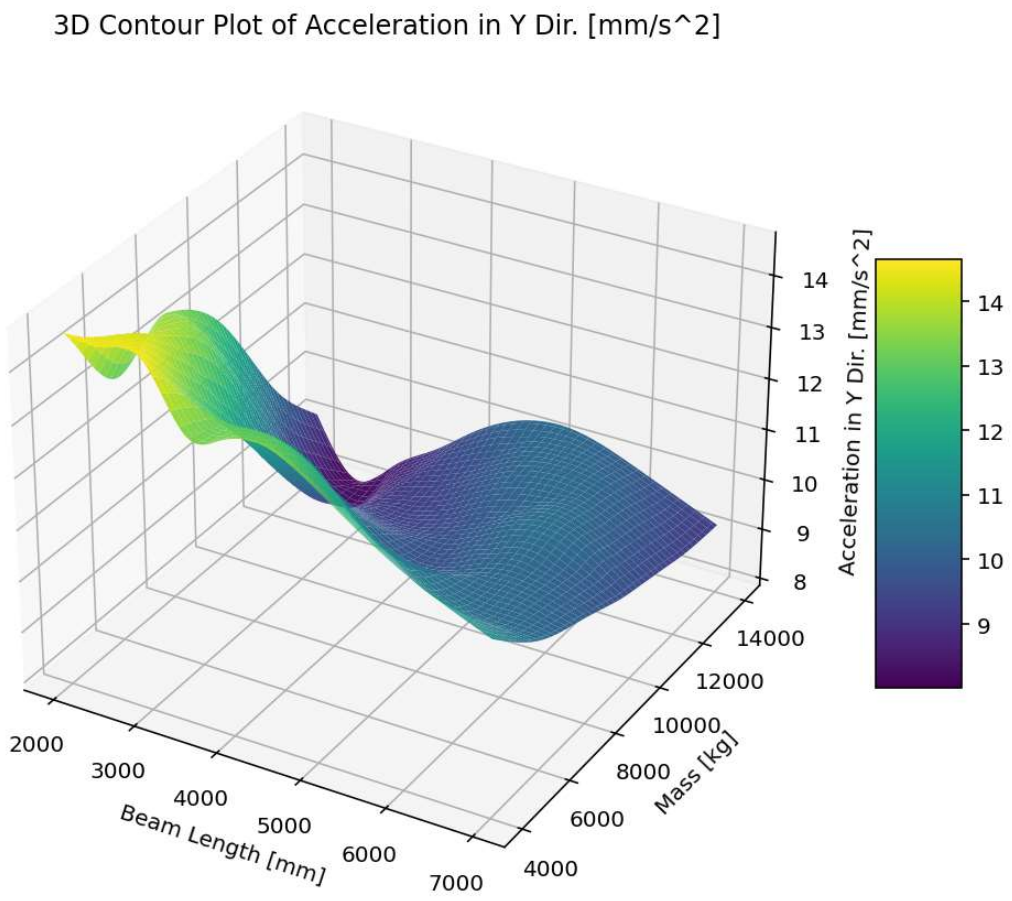
3D Contour Plot of Structure Lateral Stiffness in X Dir. [N/mm]

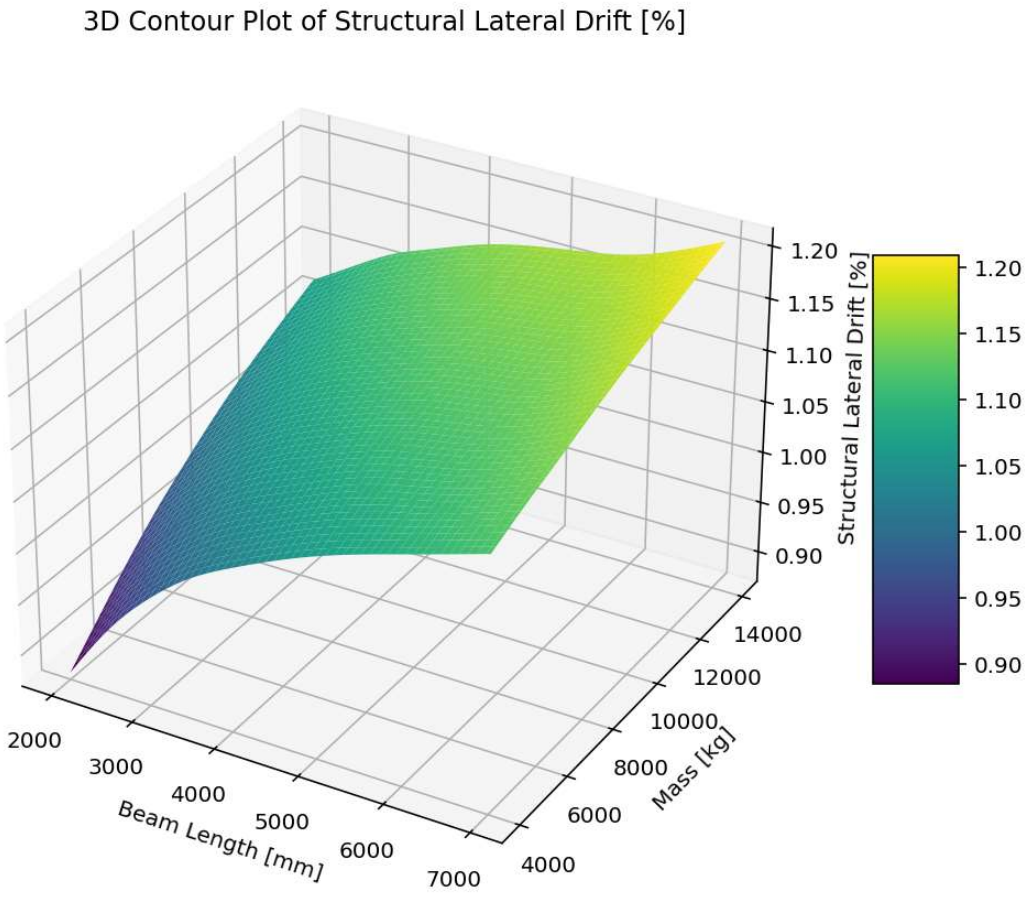


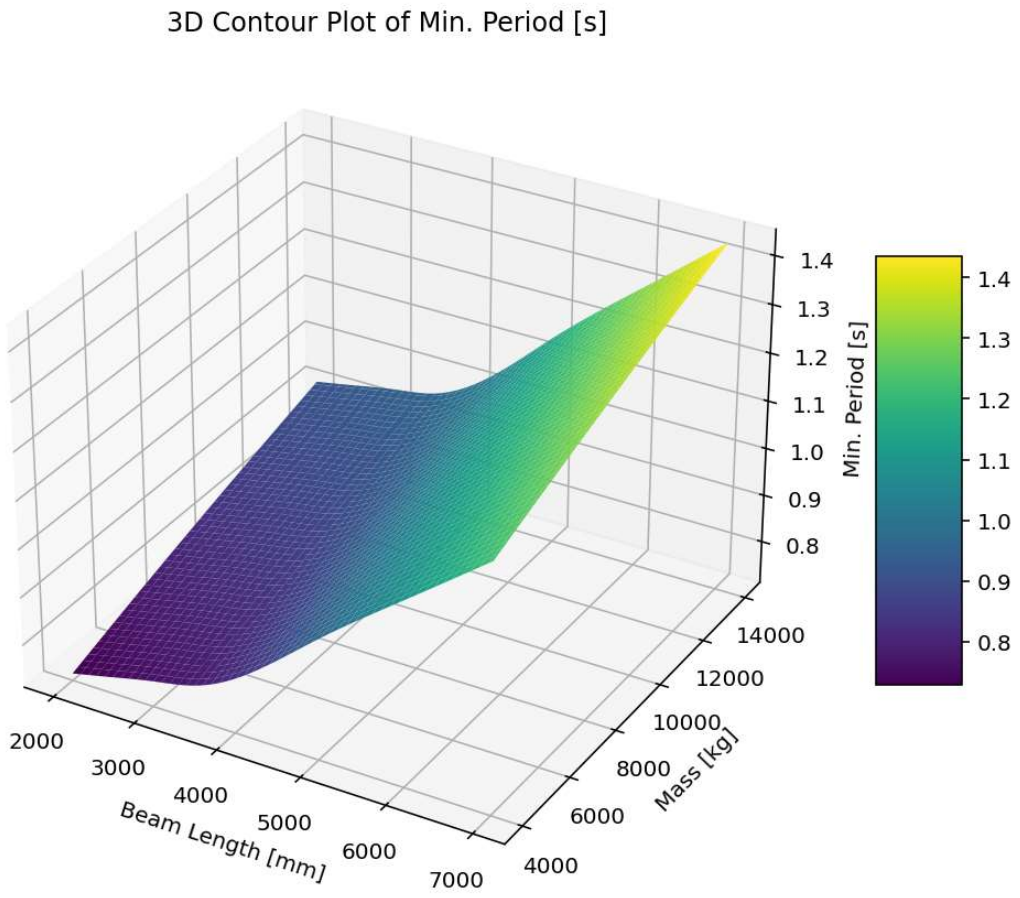

3D Contour Plot of Velocity in X Dir. [mm/s]
Beam Length [mm]
2000
3000
4000
5000
6000
7000
Mass [kg]
4000
6000
8000
10000
12000
14000
Velocity in X Dir. [mm/s]
19.0
19.5
20.0
20.5
21.0
21.5

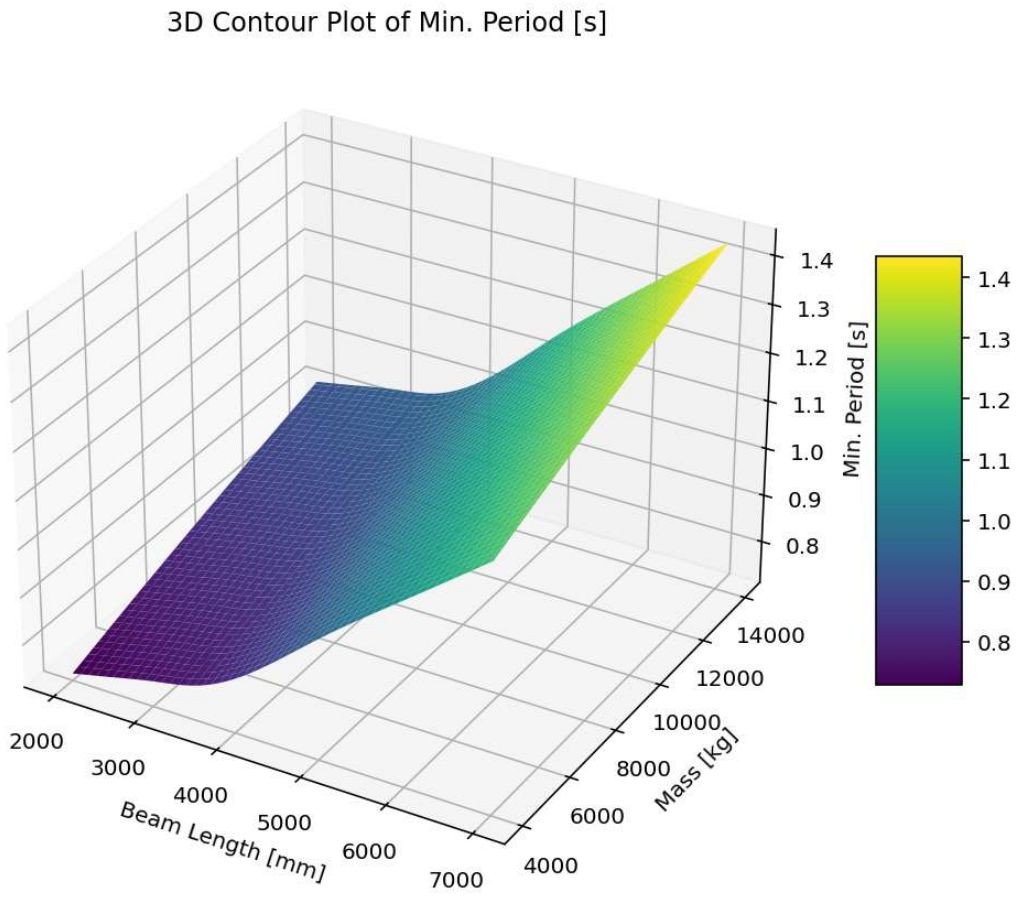

3D Contour Plot of Velocity in Y Dir. [mm/s]
Beam Length [mm]
2000
3000
4000
5000
6000
7000
Mass [kg]
4000
6000
8000
10000
12000
14000
2.4
2.6
2.8
3.0
3.2
Velocity in Y Dir. [mm/s]
2.4
2.6
2.8
3.0
3.2

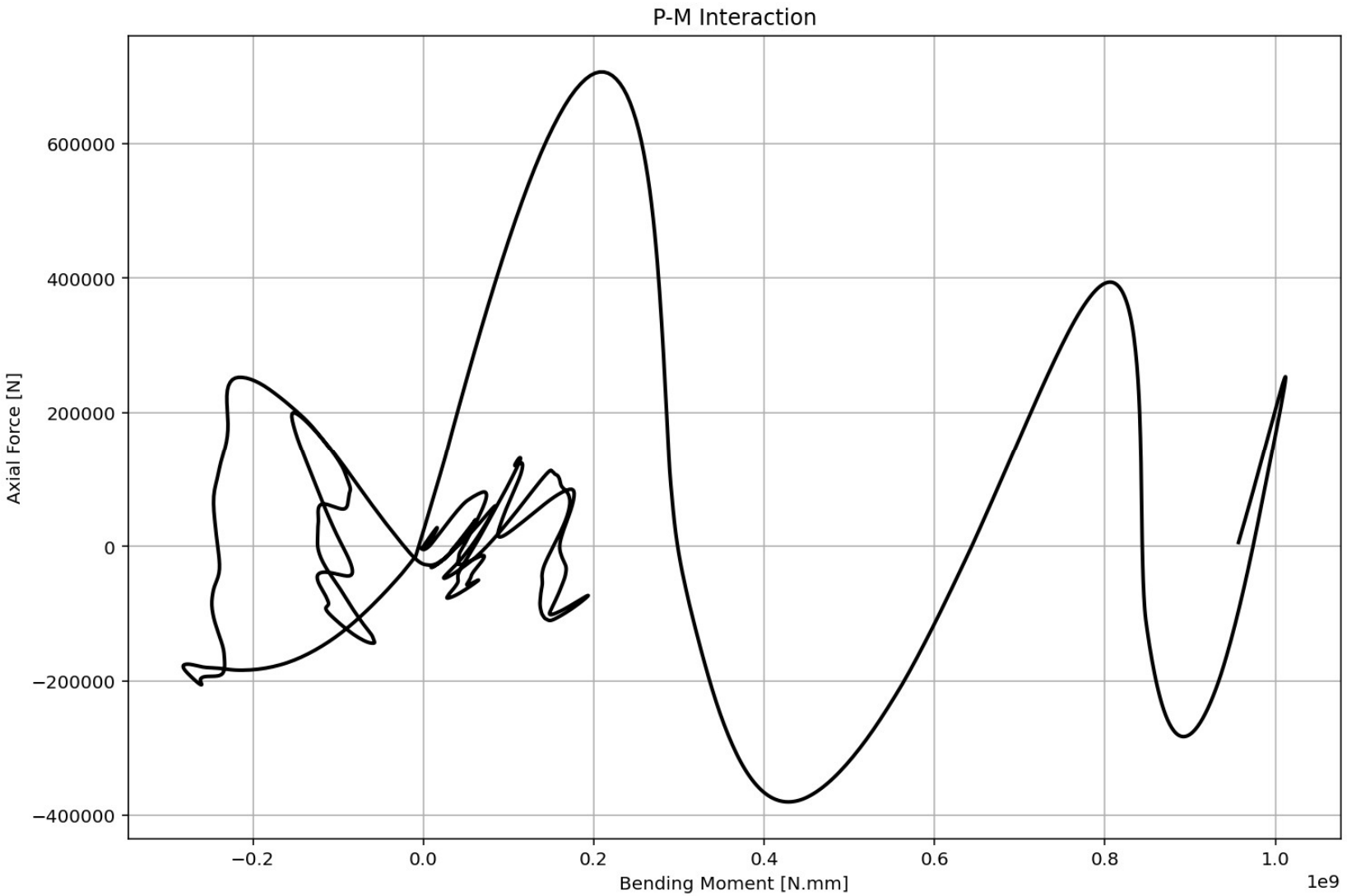

3D Contour Plot of Acceleration in X Dir. [mm/s^2]
Beam Length [mm]
2000
3000
4000
5000
6000
7000
Mass [kg]
4000
6000
8000
10000
12000
14000
342
341
340
339
338
337
Acceleration in X Dir. [mm/s^2]
342
341
340
339
338
337

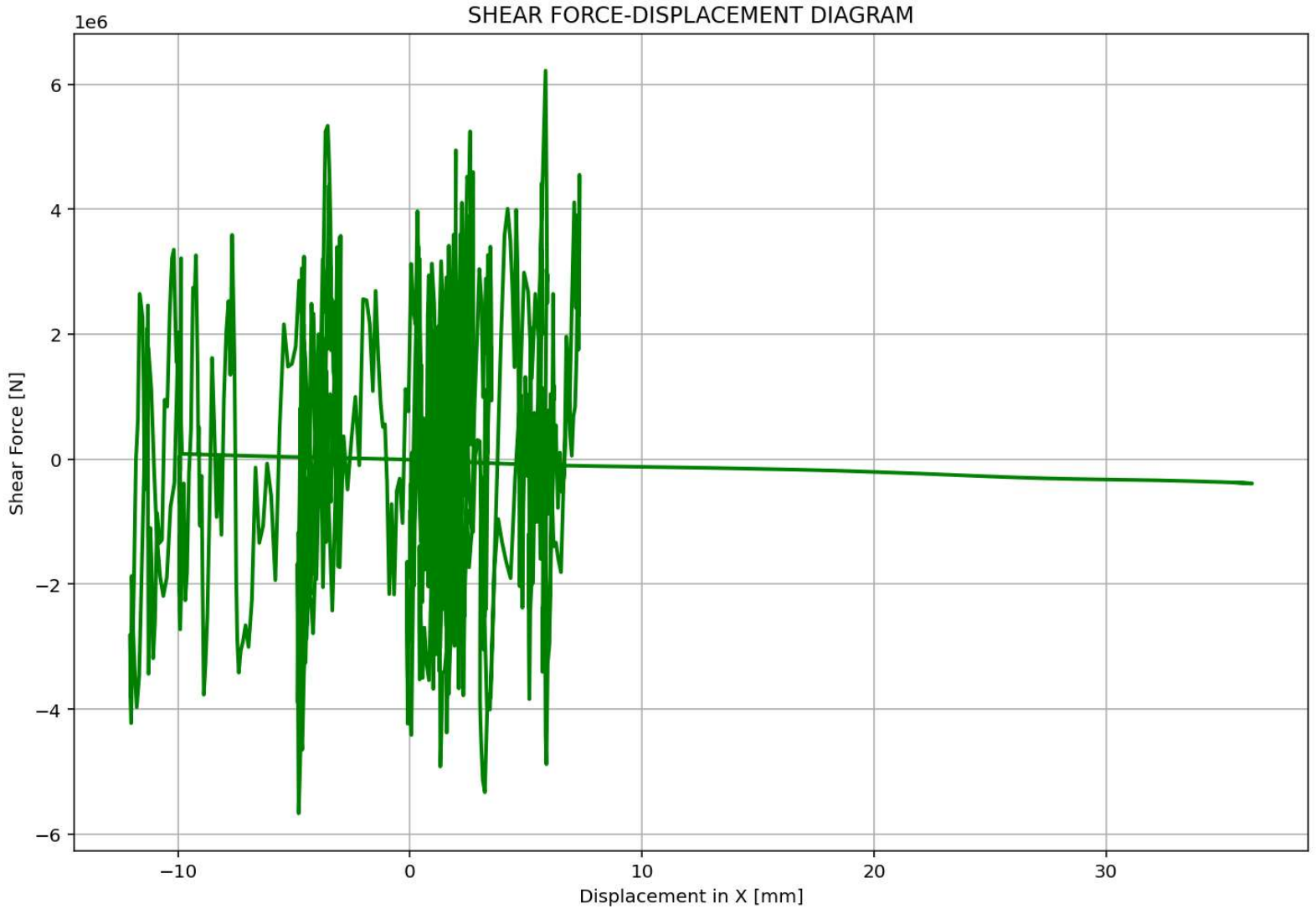

3D Contour Plot of Acceleration in Y Dir. [mm/s^2]
Beam Length [mm]
2000
3000
4000
5000
6000
7000
Mass [kg]
4000
6000
8000
10000
12000
14000
8
9
10
11
12
13
14
Acceleration in Y Dir. [mm/s^2]
9
10
11
12
13
14

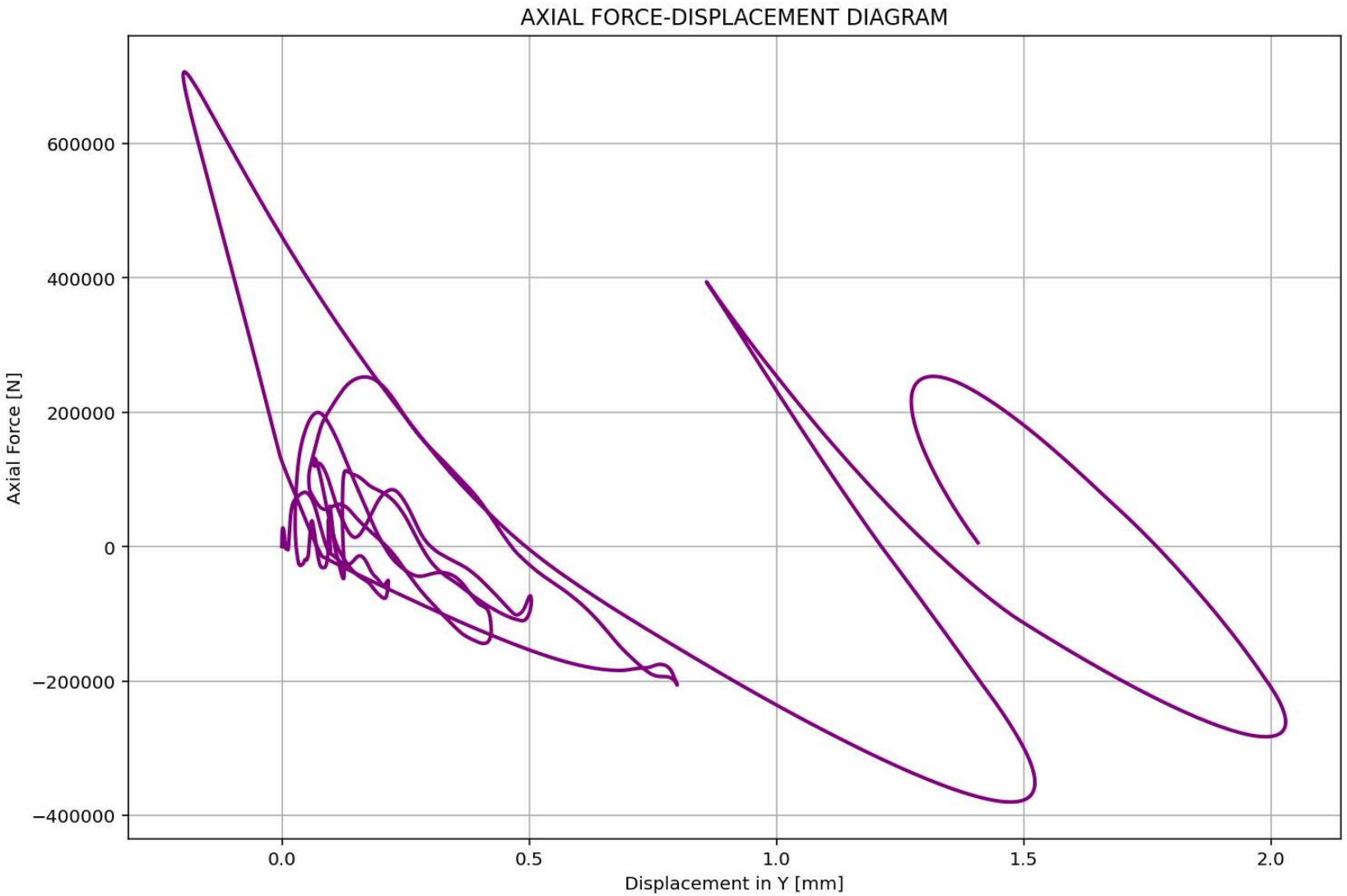

3D Contour Plot of Structural Lateral Drift [%]
Beam Length [mm]
2000
3000
4000
5000
6000
7000
Mass [kg]
4000
6000
8000
10000
12000
14000
Structural Lateral Drift [%]
0.90
0.95
1.00
1.05
1.10
1.15
1.20

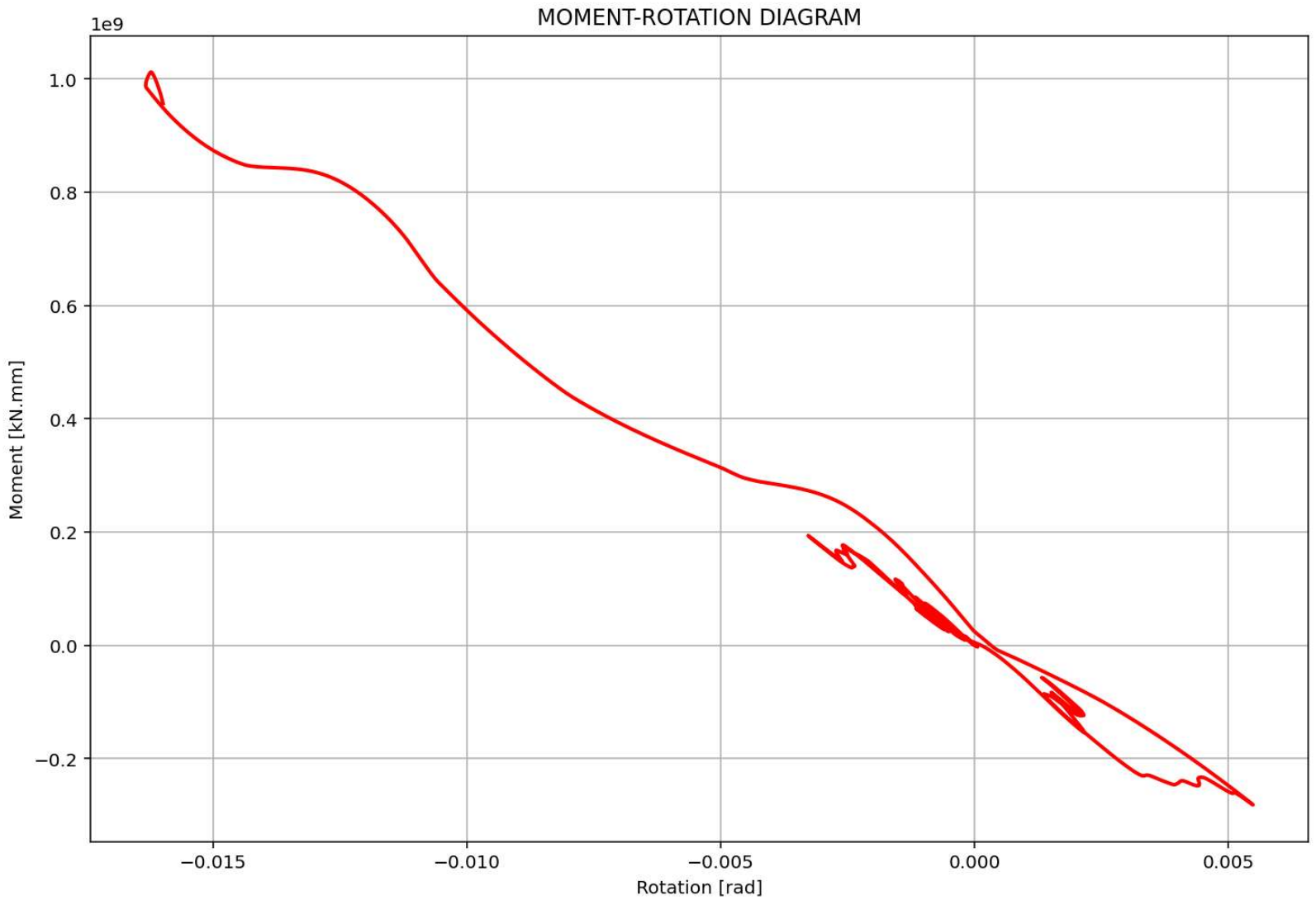

3D Contour Plot of Min. Period [s]
Beam Length [mm]
2000
3000
4000
5000
6000
7000
Mass [kg]
4000
6000
8000
10000
12000
14000
Min. Period [s]
0.8
0.9
1.0
1.1
1.2
1.3
1.4

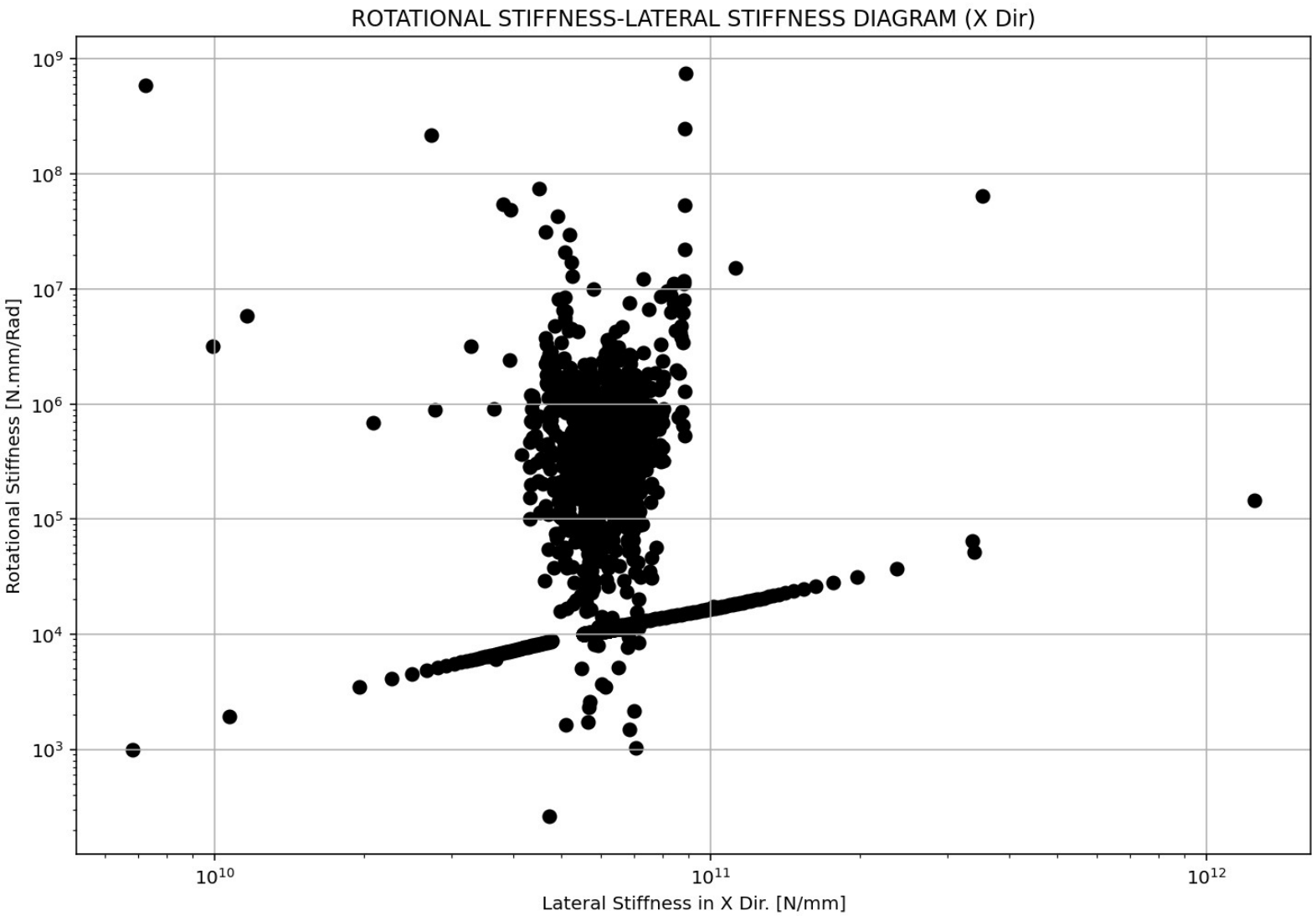

3D Contour Plot of Min. Period [s]
Beam Length [mm]
2000
3000
4000
5000
6000
7000
Mass [kg]
4000
6000
8000
10000
12000
14000
Min. Period [s]
0.8
0.9
1.0
1.1
1.2
1.3
1.4

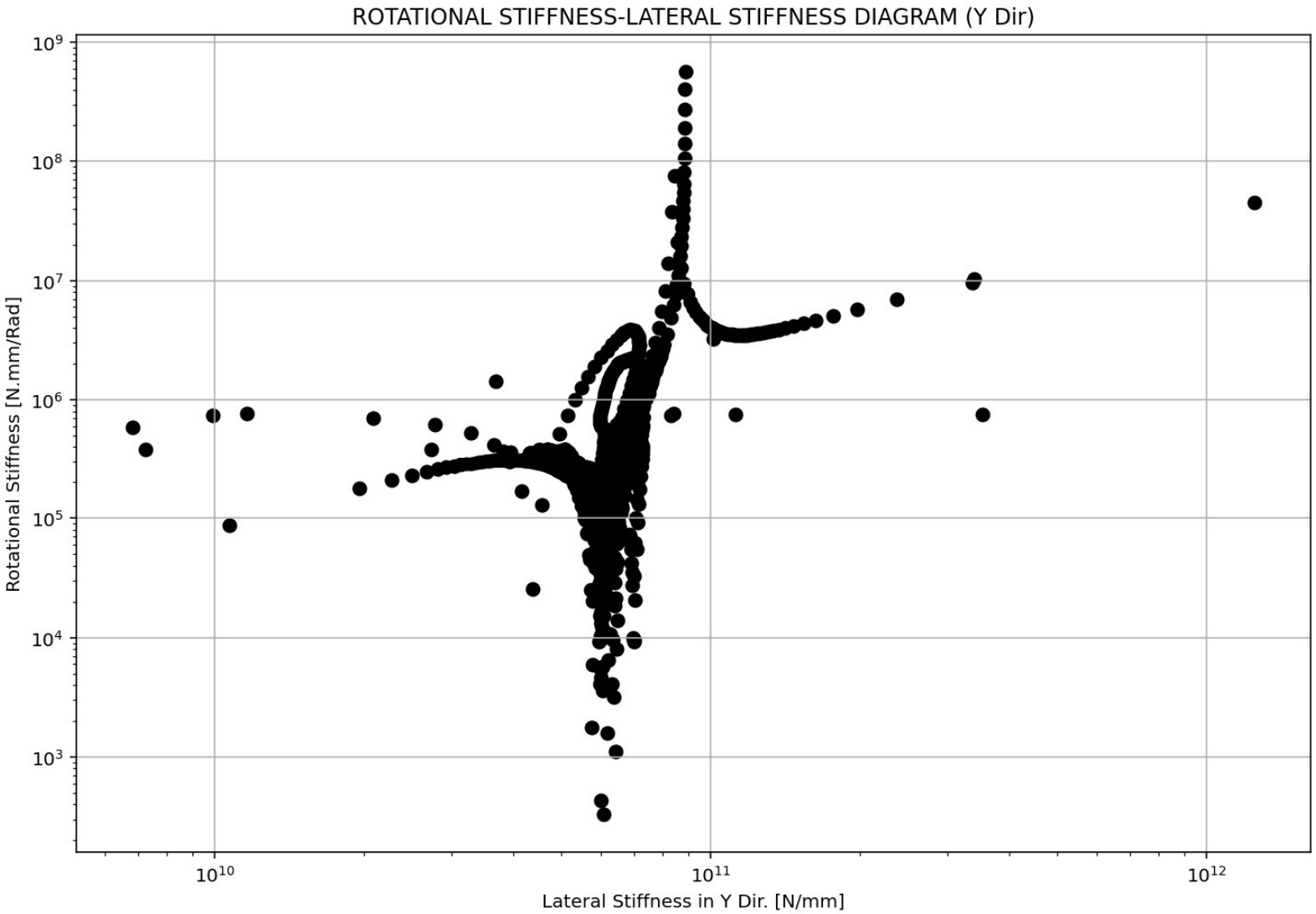

P-M Interaction
600000
400000
200000
0
−200000
−400000
Axial Force [N]
−0.2
0.0
0.2
0.4
0.6
0.8
1.0
Bending Moment [N.mm]
1e9

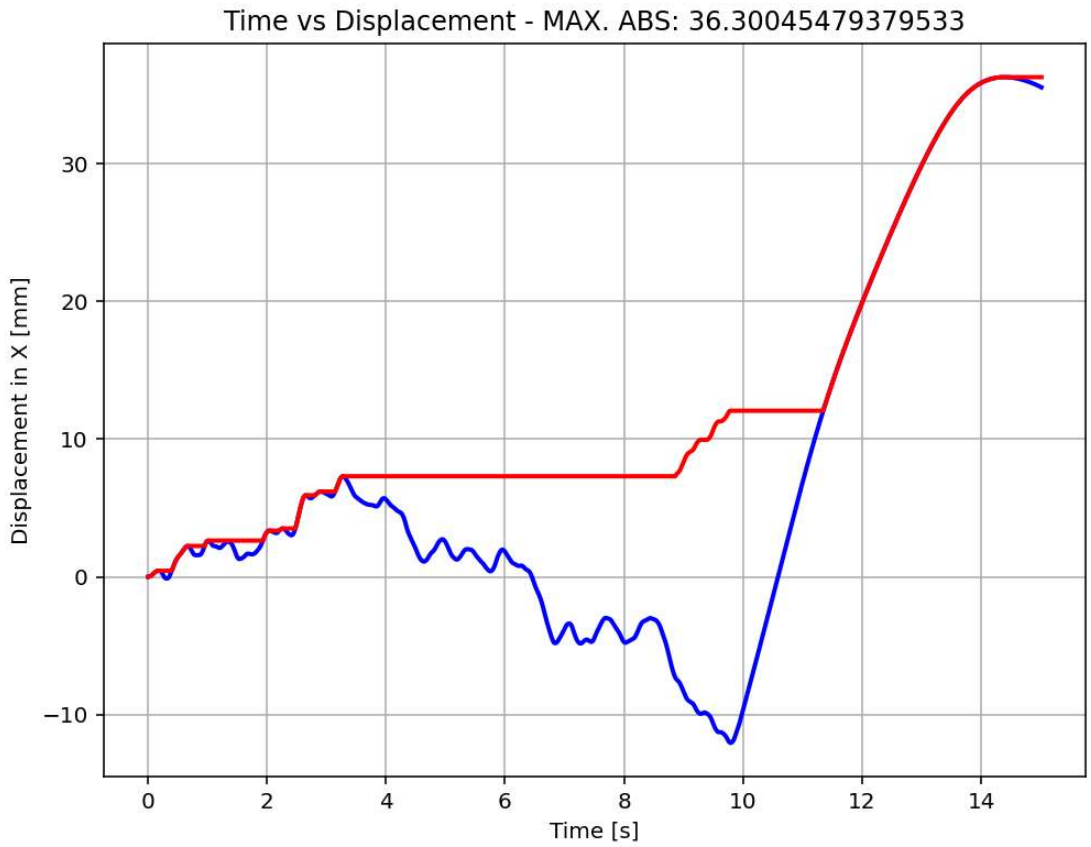

SHEAR FORCE-DISPLACEMENT DIAGRAM
1e6
6
4
2
0
−2
−4
−6
Shear Force [N]
−10
0
10
20
30
Displacement in X [mm]

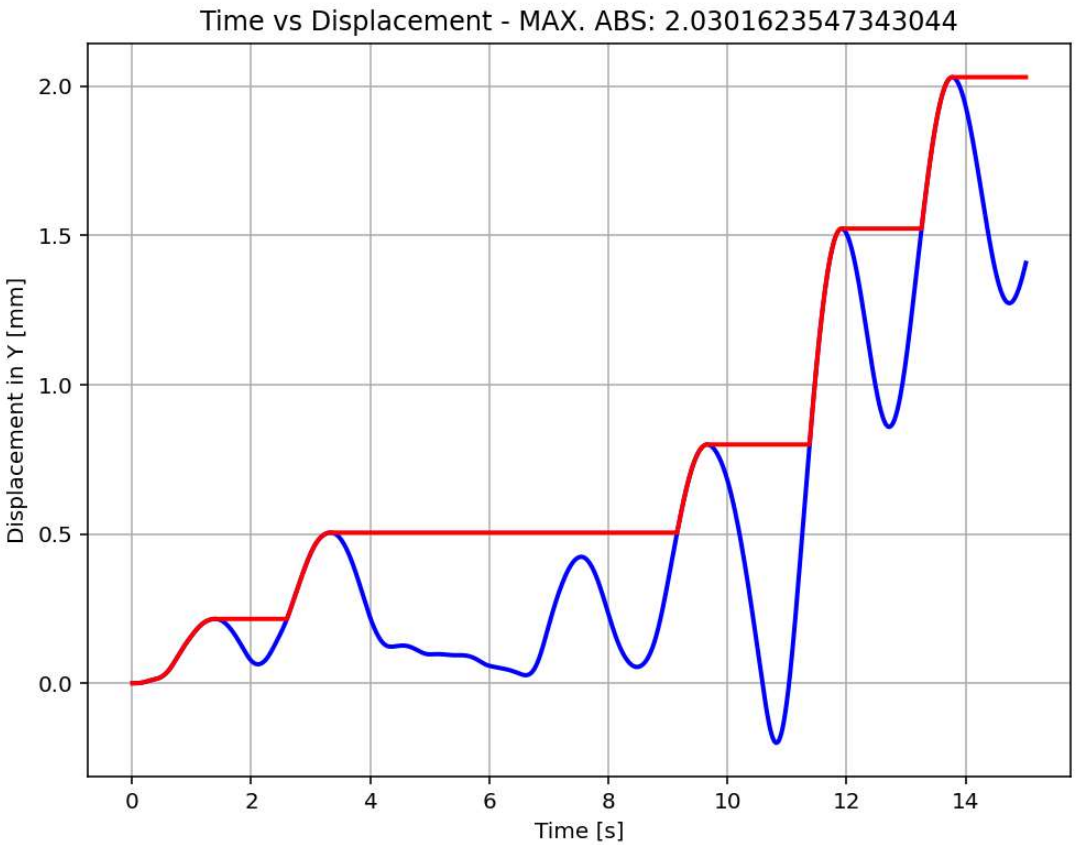

AXIAL FORCE-DISPLACEMENT DIAGRAM
600000
400000
200000
0
−200000
−400000
Axial Force [N]
0.0
0.5
1.0
1.5
2.0
Displacement in Y [mm]

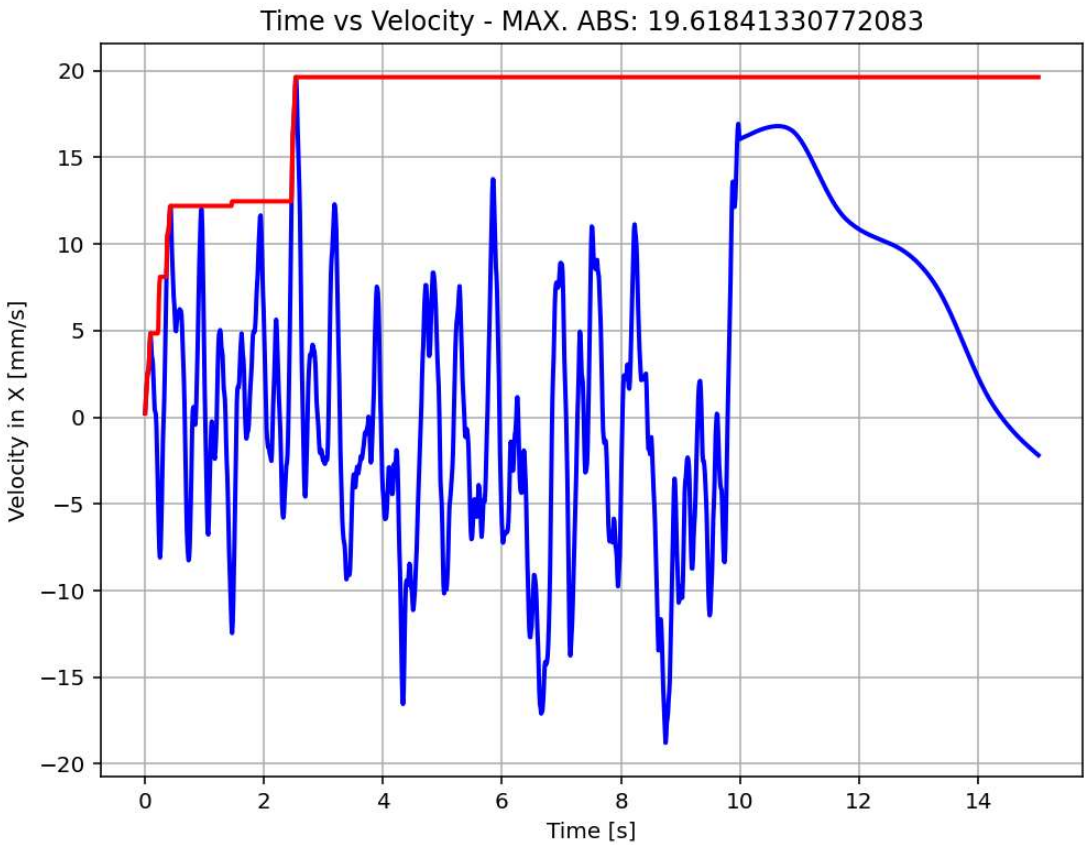

MOMENT-ROTATION DIAGRAM
1e9
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
Moment [kN.mm]
−0.015
−0.010
−0.005
0.000
0.005
Rotation [rad]

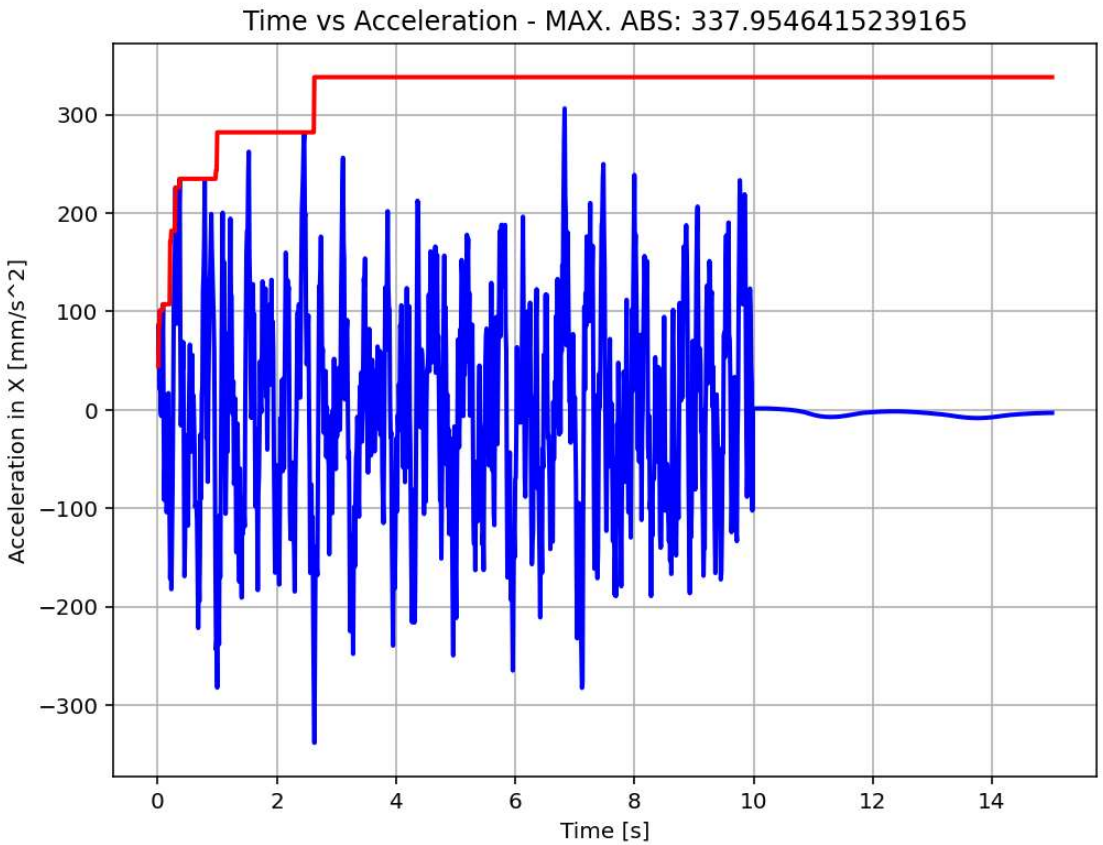

ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM (X Dir)
Rotational Stiffness [N.mm/Rad]
Lateral Stiffness in X Dir. [N/mm]
10^{9}
10^{8}
10^{7}
10^{6}
10^{5}
10^{4}
10^{3}
10^{10}
10^{11}
10^{12}

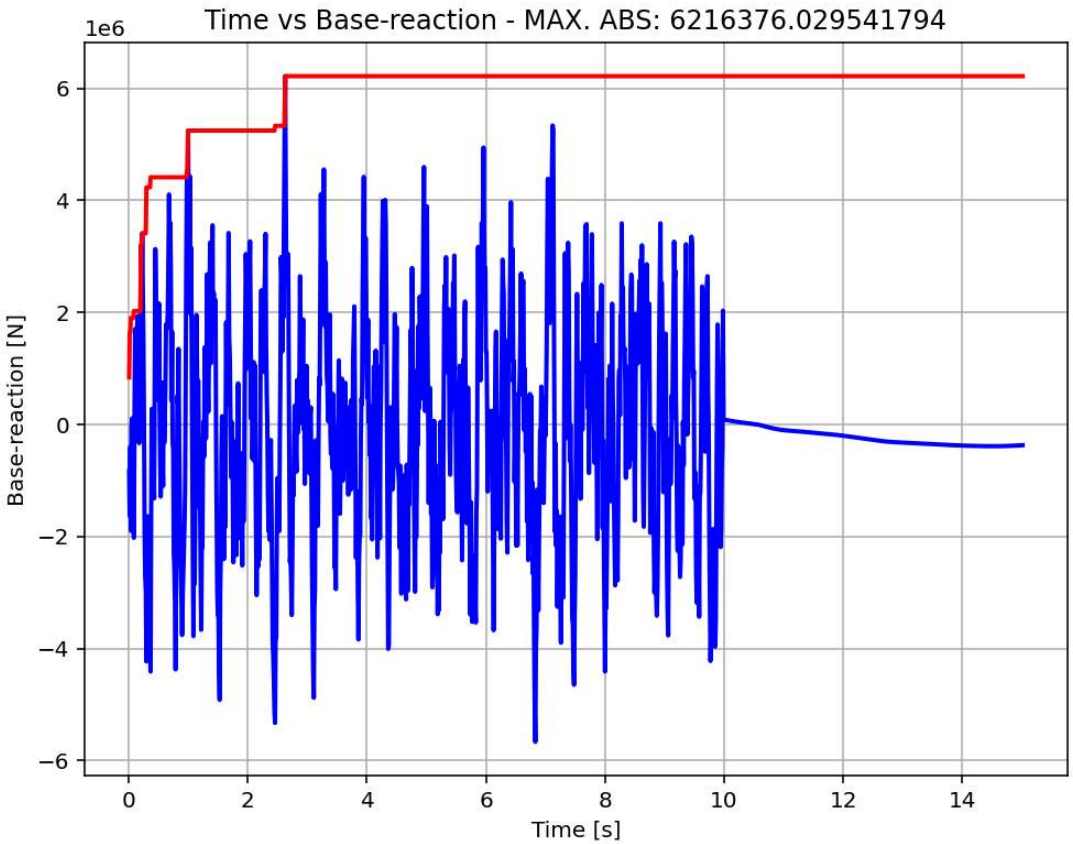

ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM (Y Dir)
Rotational Stiffness [N.mm/Rad]
Lateral Stiffness in Y Dir. [N/mm]
10^{9}
10^{8}
10^{7}
10^{6}
10^{5}
10^{4}
10^{3}
10^{10}
10^{11}
10^{12}

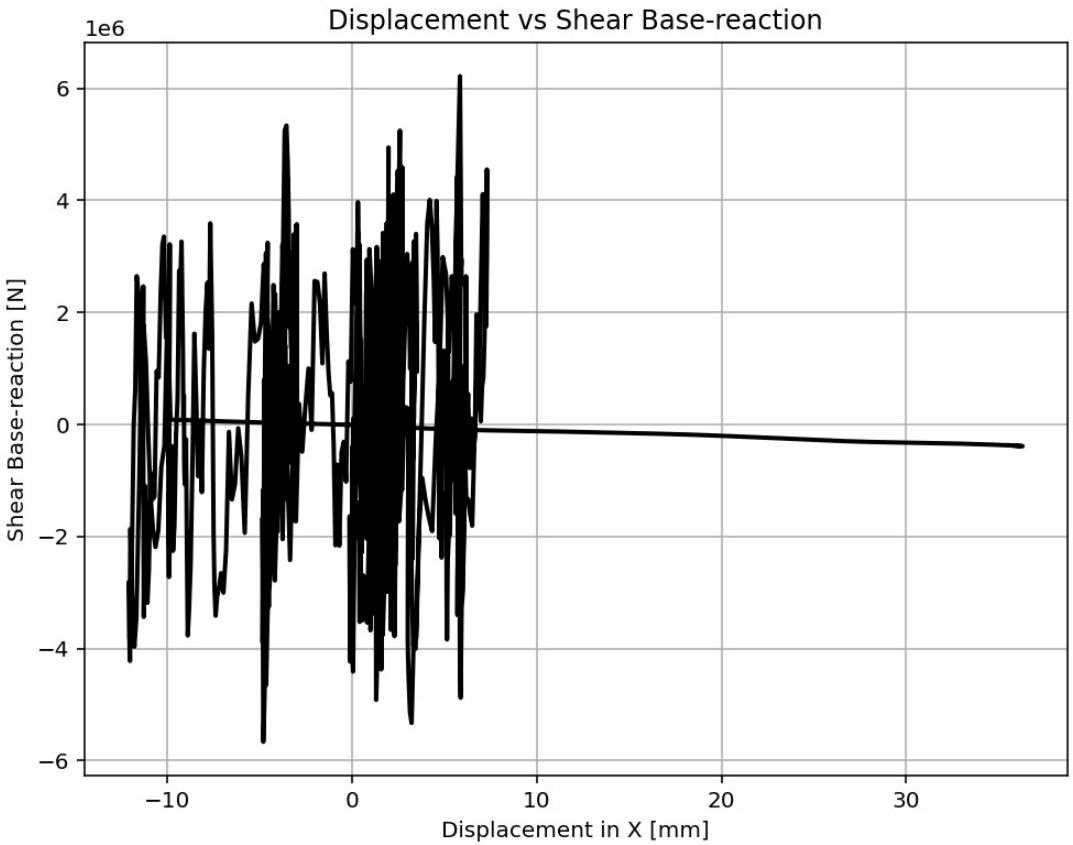

Time vs Displacement - MAX. ABS: 36.30045479379533
Displacement in X [mm]
Time [s]
30
20
10
0
−10
0
2
4
6
8
10
12
14

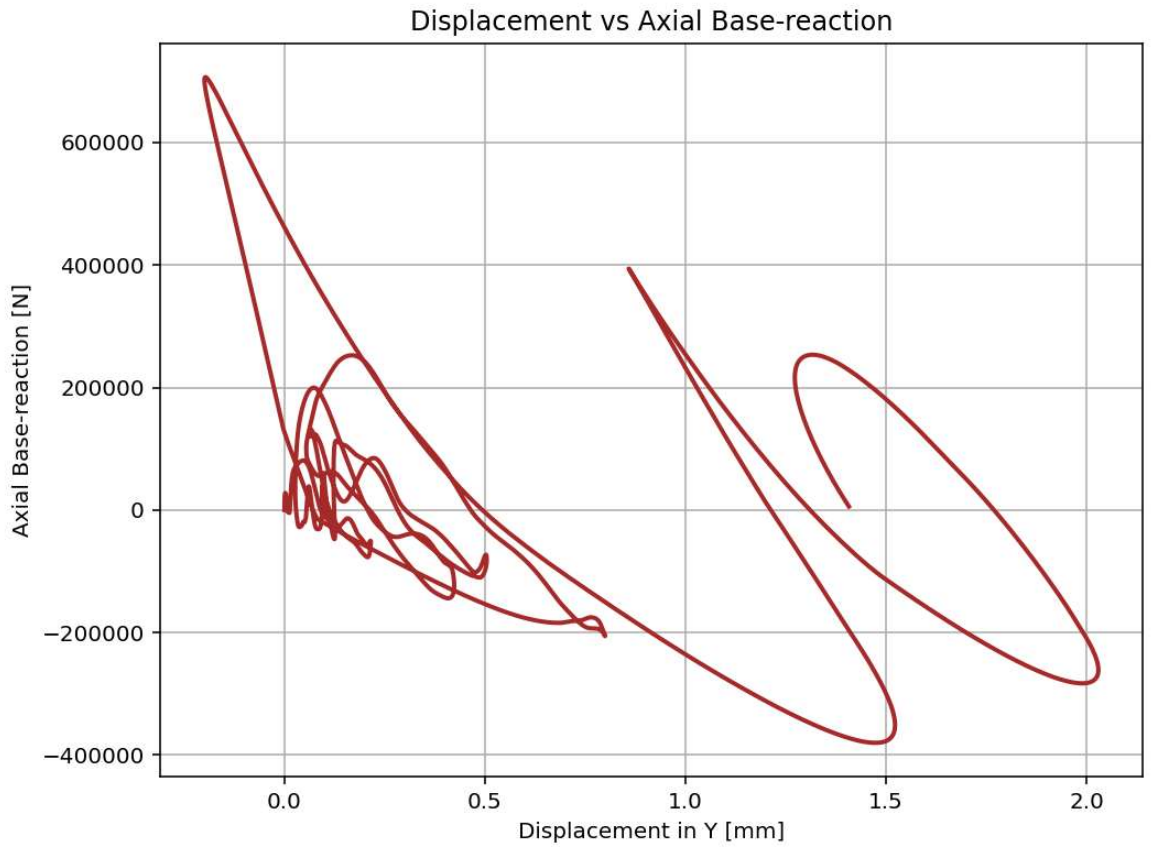

Time vs Displacement - MAX. ABS: 2.0301623547343044
Displacement in Y [mm]
Time [s]
2.0
1.5
1.0
0.5
0.0
0
2
4
6
8
10
12
14


Time vs Velocity - MAX. ABS: 19.61841330772083
Velocity in X [mm/s]
Time [s]
20
15
10
5
0
−5
−10
−15
−20
0
2
4
6
8
10
12
14


Time vs Acceleration - MAX. ABS: 337.9546415239165
Acceleration in X [mm/s^2]
Time [s]
300
200
100
0
−100
−200
−300
0
2
4
6
8
10
12
14


Time vs Base-reaction - MAX. ABS: 6216376.029541794
1e6
6
4
2
0
−2
−4
−6
Base-reaction [N]
0
2
4
6
8
10
12
14
Time [s]


Displacement vs Shear Base-reaction
1e6
6
4
2
0
−2
−4
−6
Shear Base-reaction [N]
−10
0
10
20
30
Displacement in X [mm]


Displacement vs Axial Base-reaction
600000
400000
200000
0
−200000
−400000
Axial Base-reaction [N]
0.0
0.5
1.0
1.5
2.0
Displacement in Y [mm]