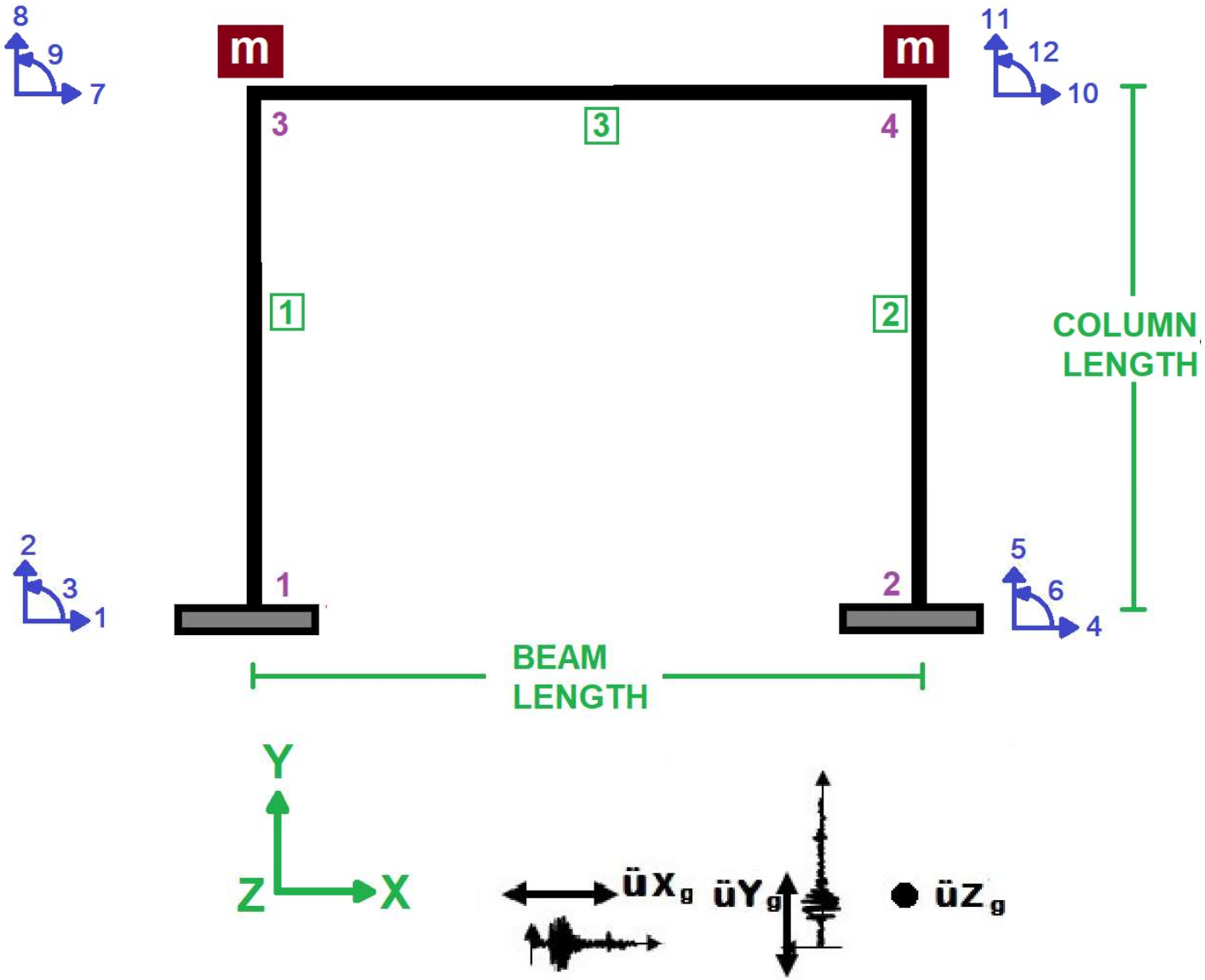
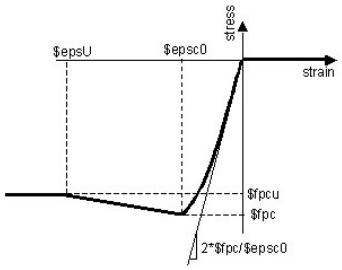
>> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<

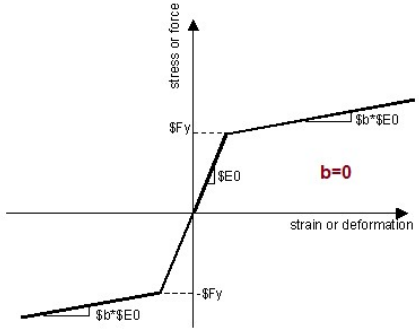
# SENSITIVITY ANALYSIS OF ELASTOC CONCRETE FRAME BY CHANGING COLUMN HEIGHT, BEAM LENGTH AND MASS USING OPENSEES

WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)

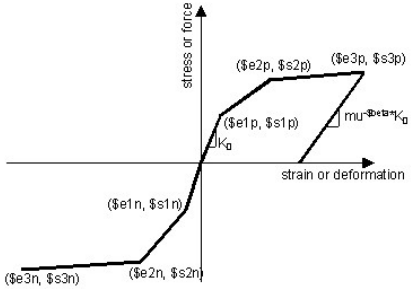

8
9
7
m
m
11
12
10
3
3
4
1
2
COLUMN
LENGTH
2
3
1
1
2
5
6
4
BEAM
LENGTH
Y
Z
X
üX$_g$
üY$_g$
üZ$_g$



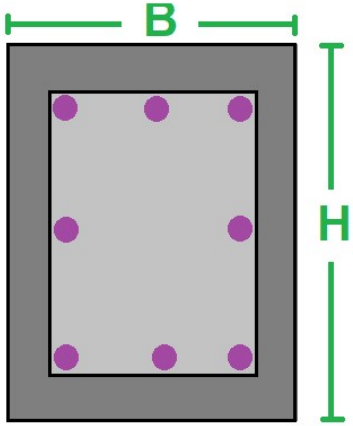

CORE AND COVER CONCRETE RELATION



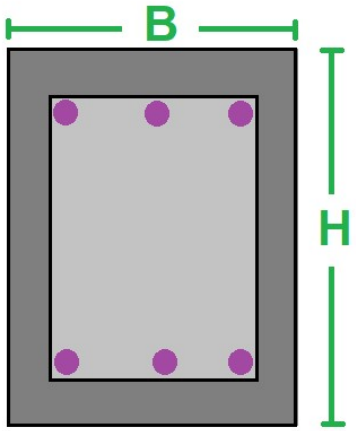

WITHOUT HARDENING AND ULTIMATE STRAIN




WITH HARDENING AND ULTIMATE STRAIN




COLUMN SECTION




BEAM SECTION

Spyder (Python 3.12)

File Edit Search Source Run Debug Consoles Projects Tools View Help

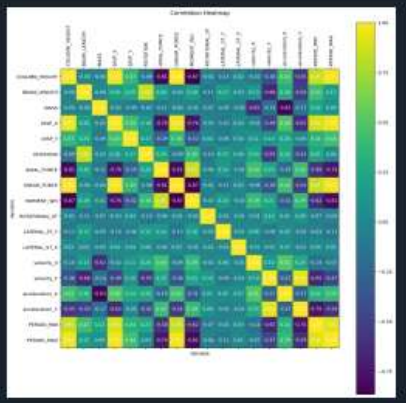
C:\Users\Dell\Desktop\OPENSEES_FILES\CONCRETE_FRA...SENSITIVITY_COLUMN_HEIGHT_&_BEAM_LENGTH_&_MASS.py

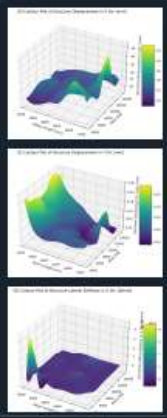
ELASTIC_CONCRETE_F...M_LENGTH__MASS.py

```
#########################################################################################################
#                          >> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<
#     SENSITIVITY ANALYSIS OF ELASTIC CONCRETE FRAME BEHAVIOR: INVESTIGATING THE IMPACT OF COLUM
#           BEAM LENGTH AND MASS ON STRUCTURAL PERIOD AND OTHER KEY PARAMETERS USING OPENSEES AN
#-------------------------------------------------------------------------------------------------------
#                              THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)
#                                       EMAIL: salar.d.ghashghaei@gmail.com
#########################################################################################################
"""
# Linear Dynamic and Sensitivity Analysis of a Concrete Frame Using OpenSees
-------------------------------------------------------------
This study performs a comprehensive linear 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. Coumn Height - Examining how different column lengths influence dynamic behavior
2. Beam length - Examining how different span lengths influence dynamic behavior
3. Structural mass - Investigating the effect of mass variation on seismic performance
-------------------------------------------------------------
## Methodology
1. Model Development
   - Create a linear finite element model of a reinforced concrete moment-resisting frame
   - Implement fiber sections with appropriate material models (Concrete02, Steel02)
   - Include geometric linearities (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
   - Linear 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
```

...EXAMPLES\SENSITIVITY_&_COLUMN_HEIGHT_&_BEAM_LENGTH_&_MASS

15 %





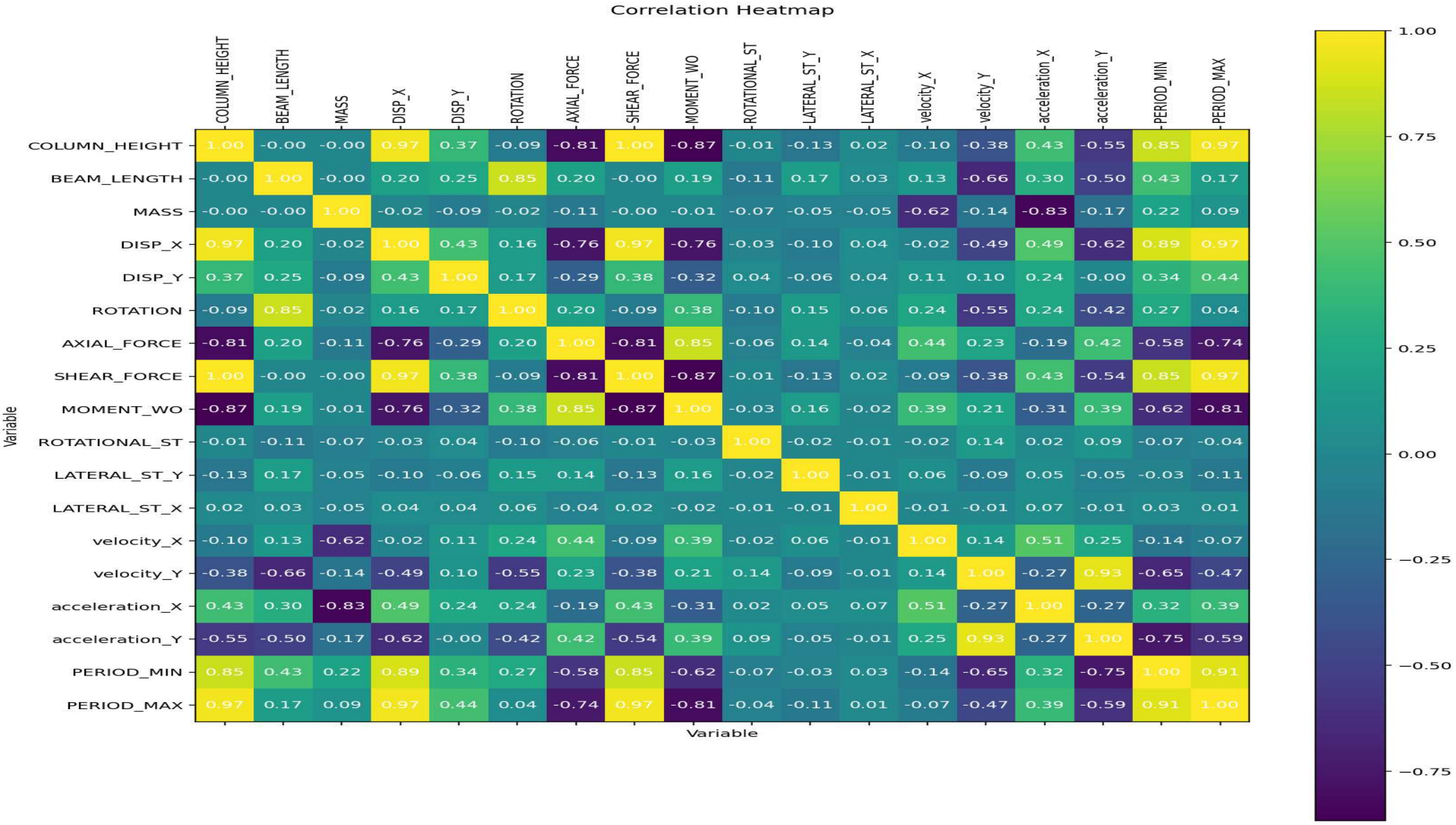
Help Variable Explorer Debugger Plots Files

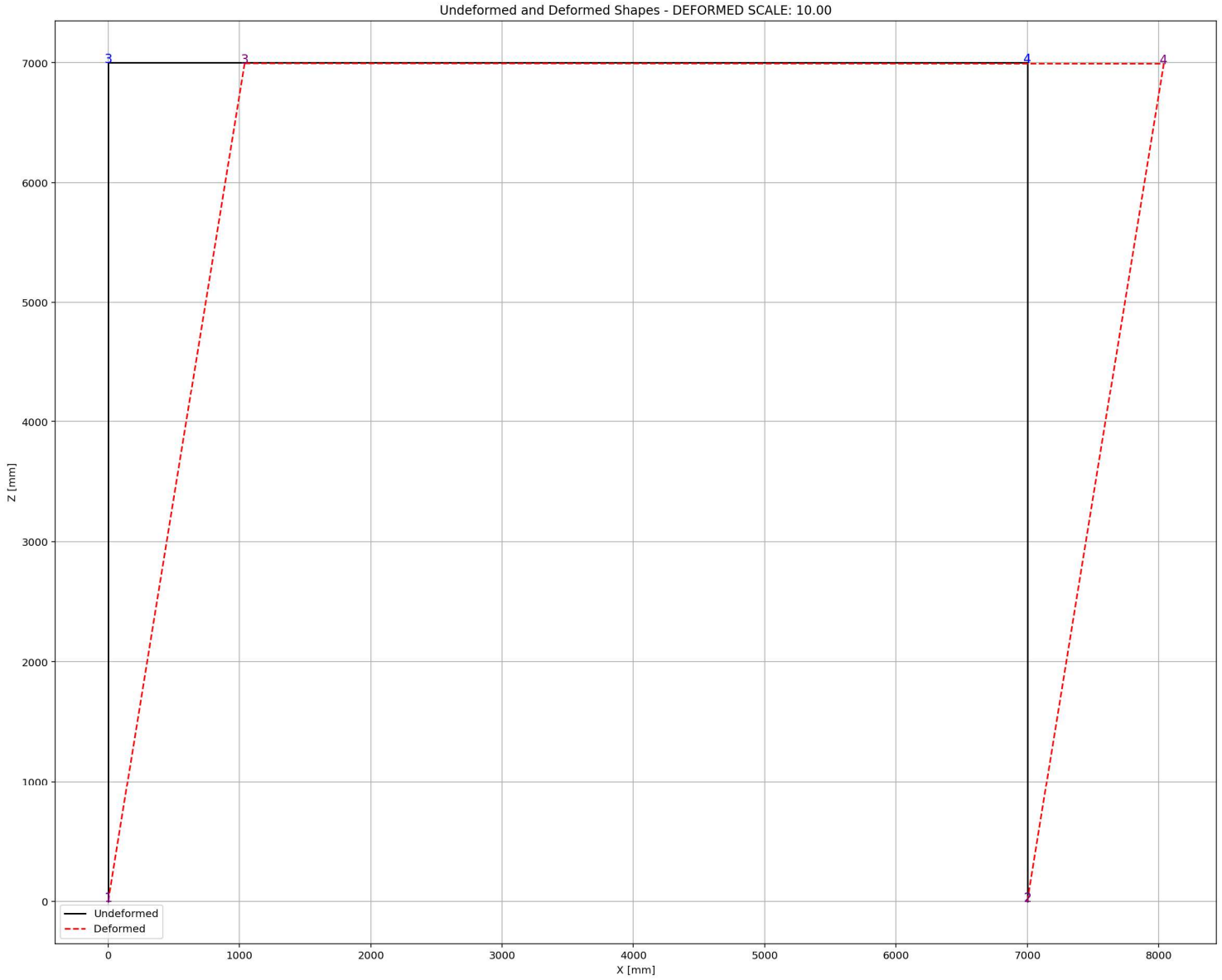
Console 1/A

```
    End 2 Forces (P V M): -74494.9 -144122 2.74076e+08

ElasticBeam2d: 3
    Connected Nodes: 3 4
    CoordTransf: 1
    mass density:  3.75, cMass: 0
    release code:  0
    End 1 Forces (P V M): -1322.64 -78306.3 -2.74068e+08
    End 2 Forces (P V M): 1322.64 78306.3 -2.74076e+08

In [4]:
```

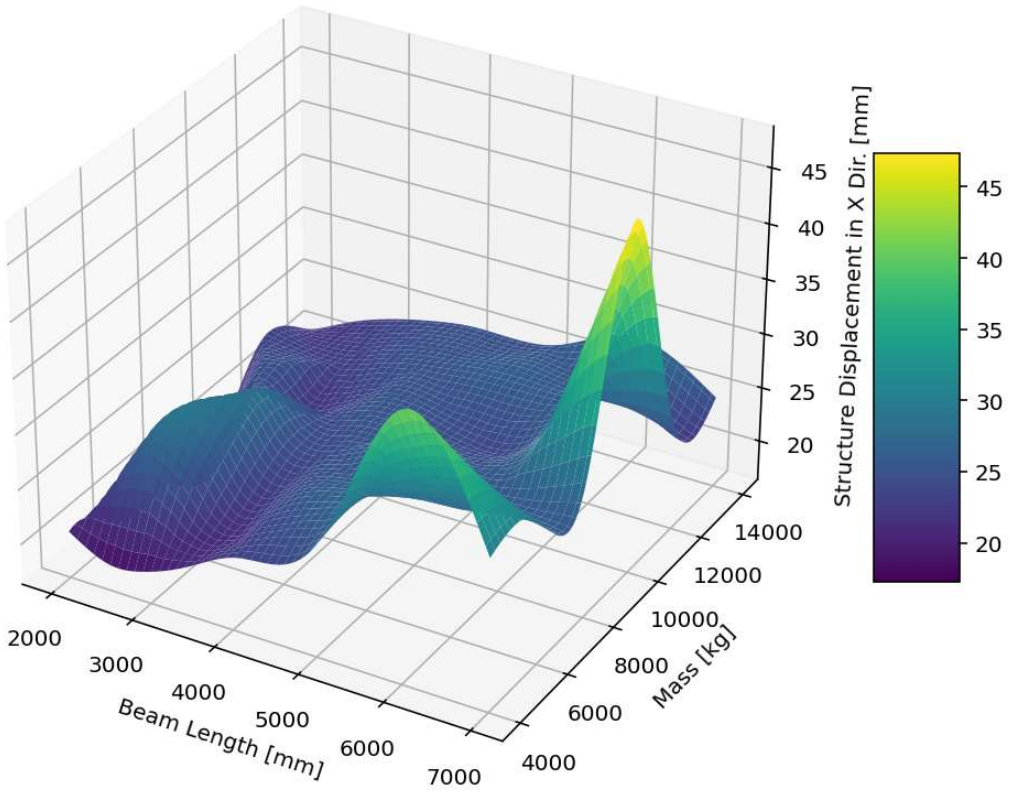
IPython Console History

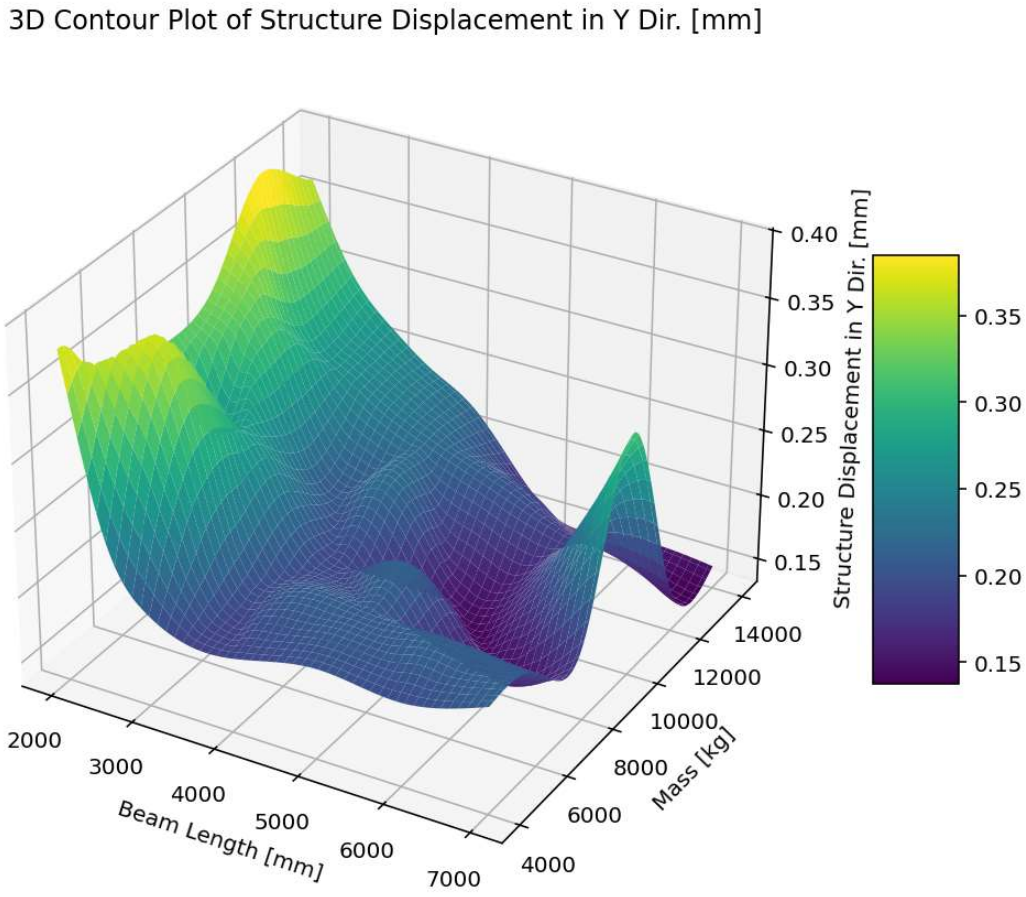
Inline Conda: anaconda3 (Python 3.12.7) LSP: Python Line 47, Col 46 UTF-8 CRLF RW Mem 34%


Correlation Heatmap
COLUMN_HEIGHT
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

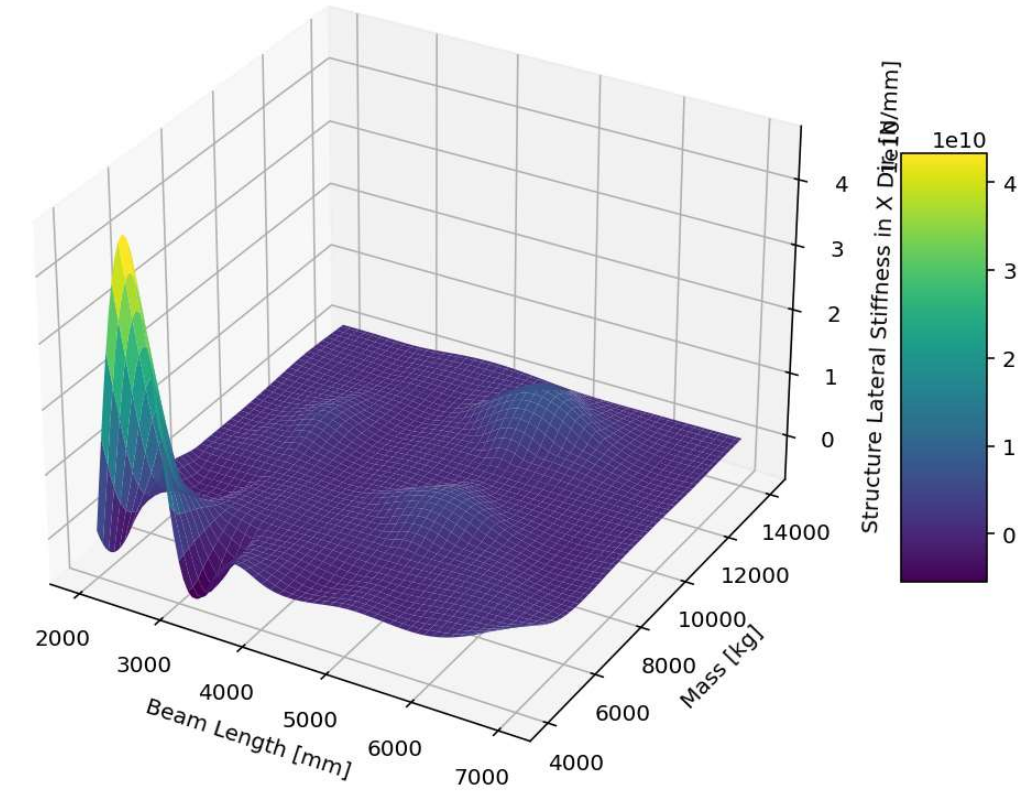

Undeformed and Deformed Shapes - DEFORMED SCALE: 10.00
Z [mm]
X [mm]
Undeformed
Deformed
0
1000
2000
3000
4000
5000
6000
7000
8000
1
2
3
4

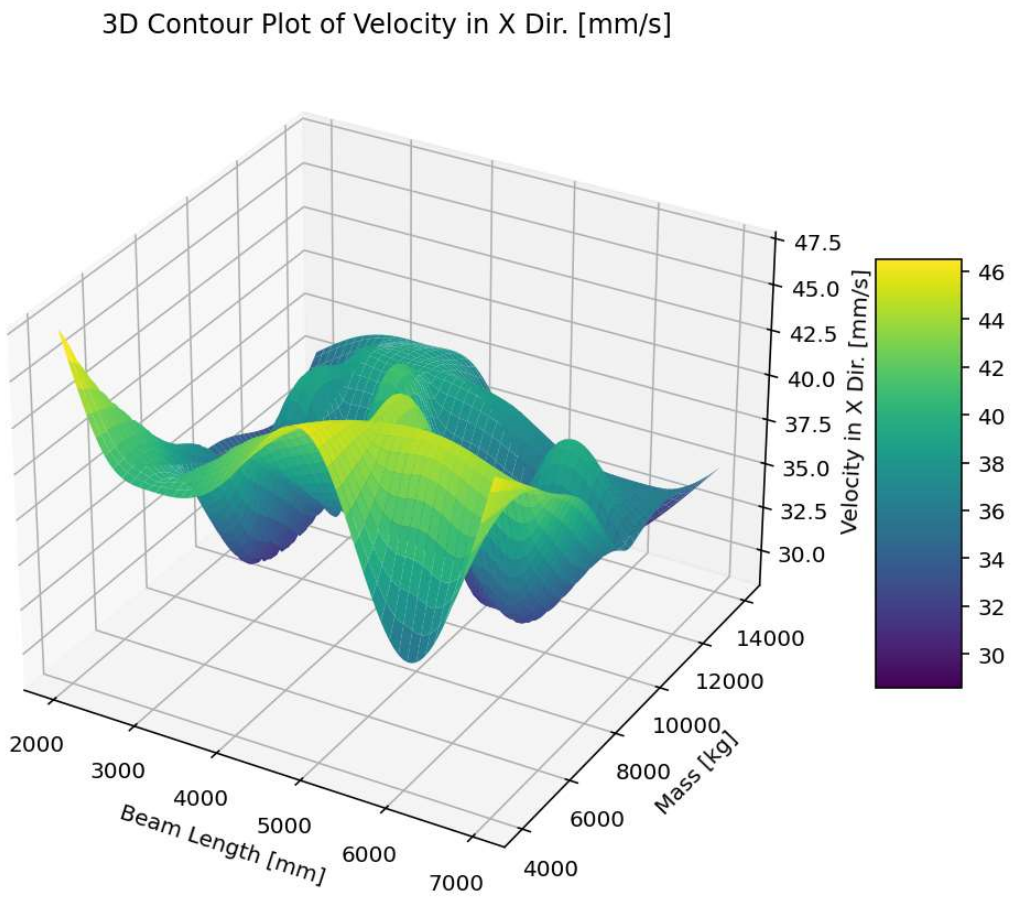
3D Contour Plot of Structure Displacement in X Dir. [mm]

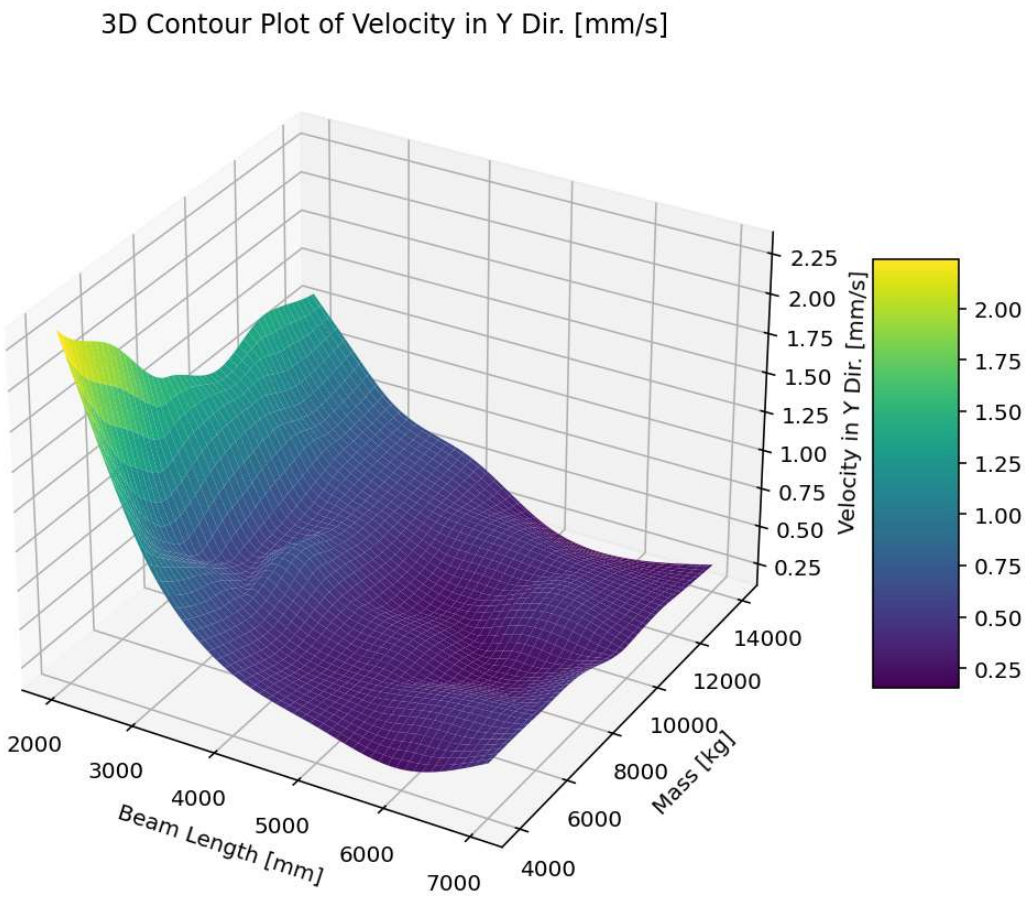


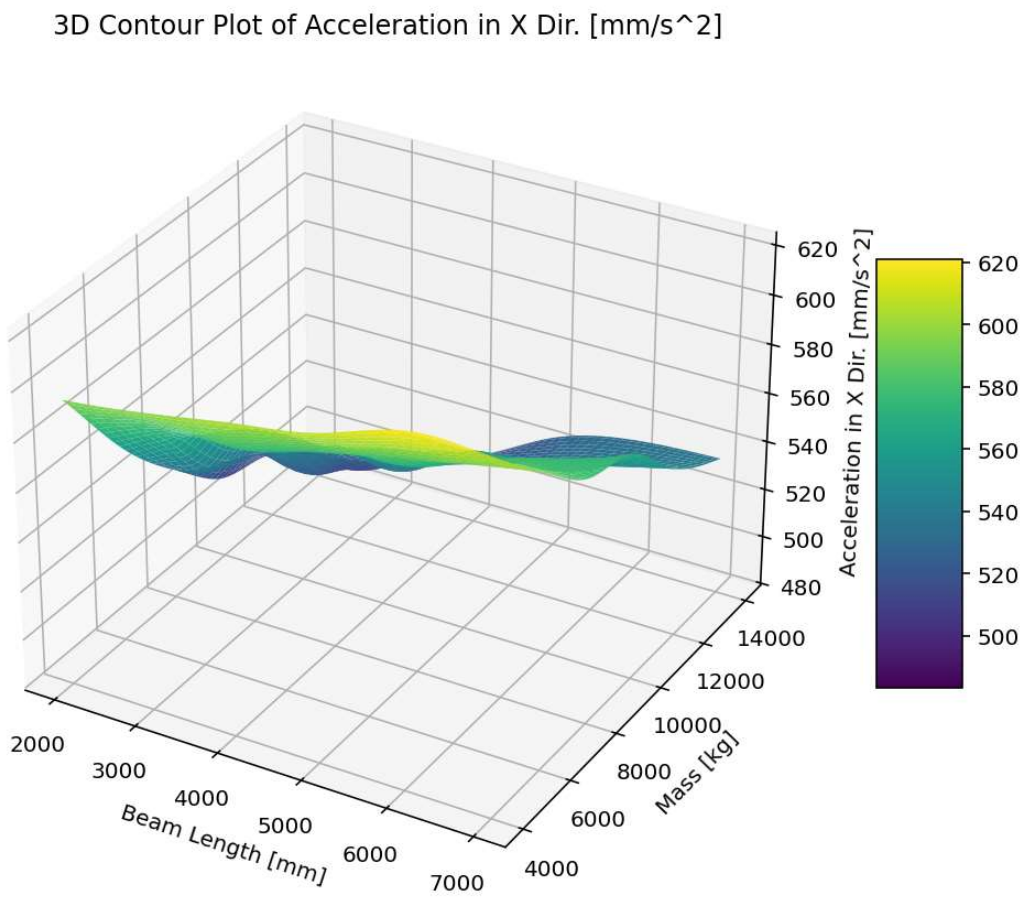

3D Contour Plot of Structure Displacement in Y Dir. [mm]
Beam Length [mm]
2000
3000
4000
5000
6000
7000
Mass [kg]
4000
6000
8000
10000
12000
14000
0.15
0.20
0.25
0.30
0.35
0.40
Structure Displacement in Y Dir. [mm]
0.15
0.20
0.25
0.30
0.35

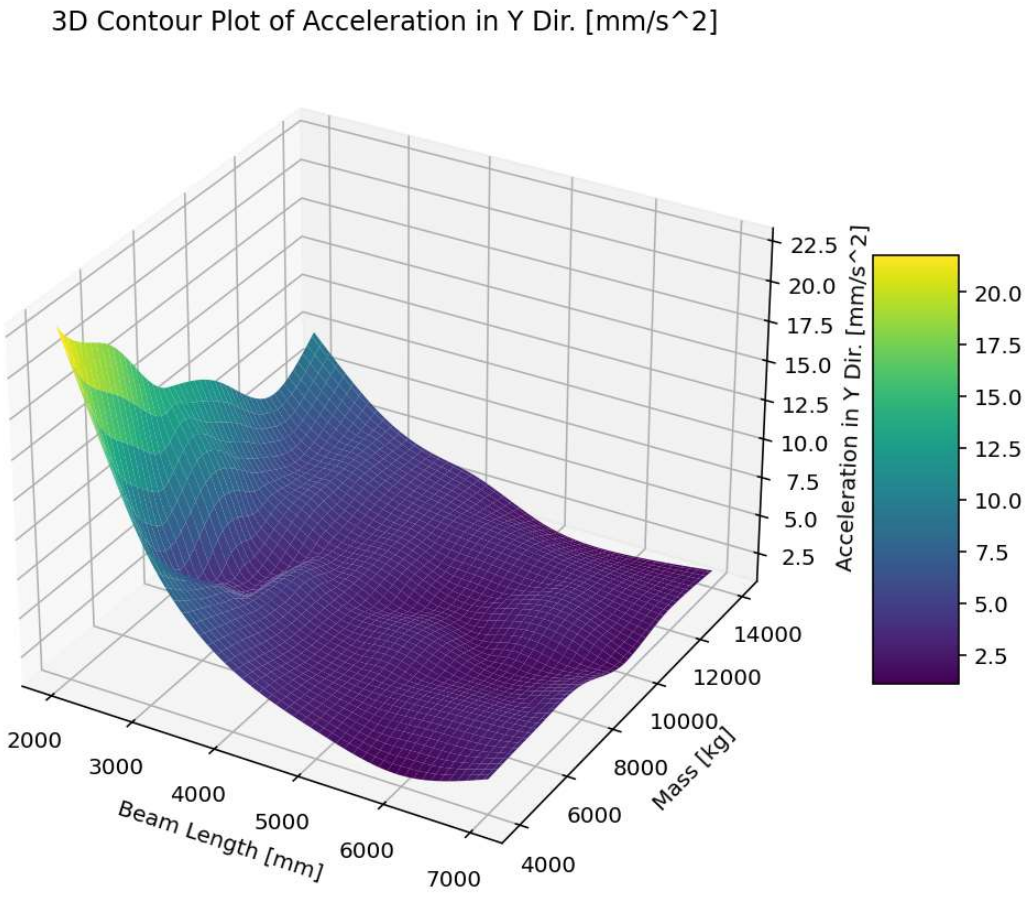
3D Contour Plot of Structure Lateral Stiffness in X Dir. [N/mm]

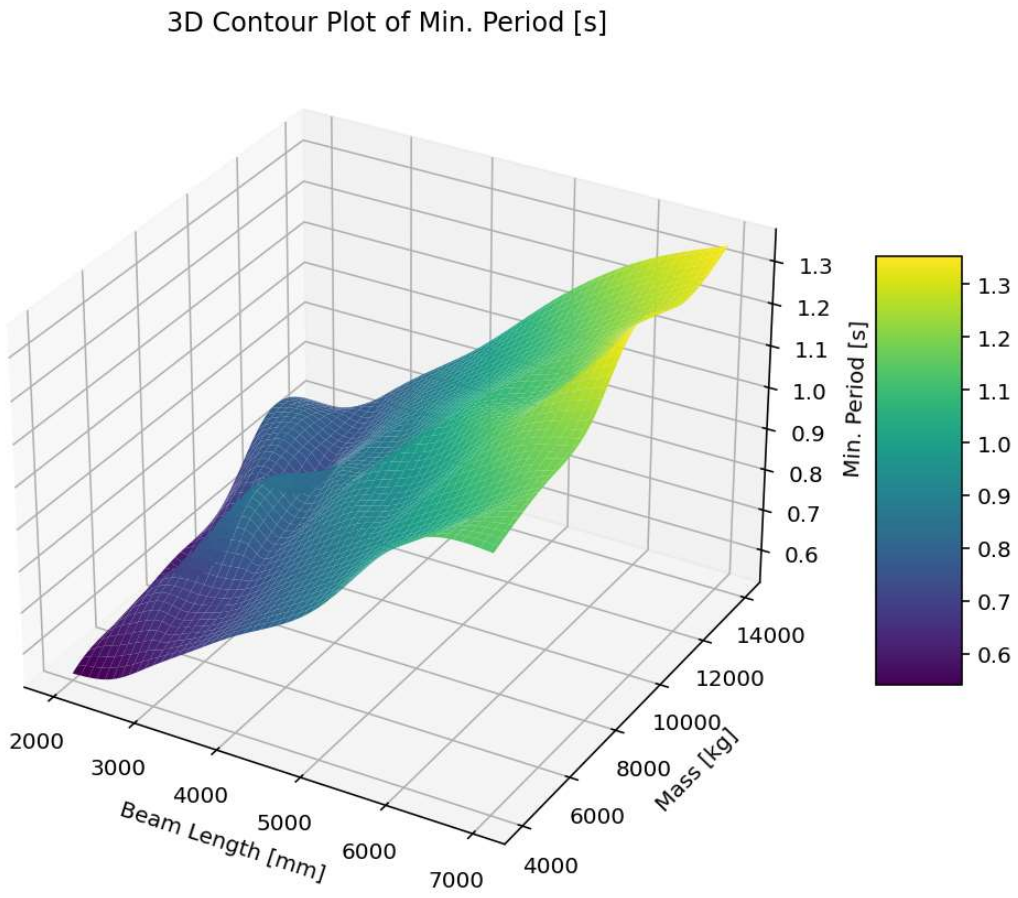


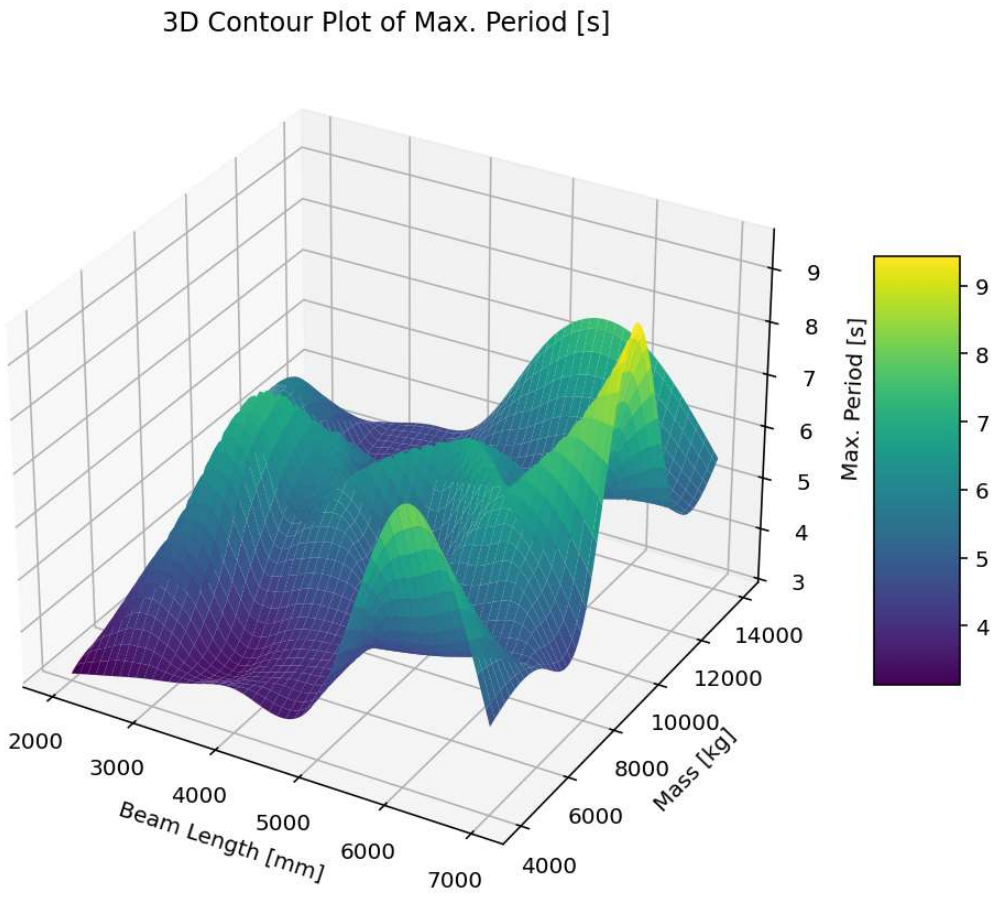

3D Contour Plot of Velocity in X Dir. [mm/s]
47.5
45.0
42.5
40.0
37.5
35.0
32.5
30.0
Velocity in X Dir. [mm/s]
46
44
42
40
38
36
34
32
30
14000
12000
10000
8000
6000
4000
Mass [kg]
2000
3000
4000
5000
6000
7000
Beam Length [mm]

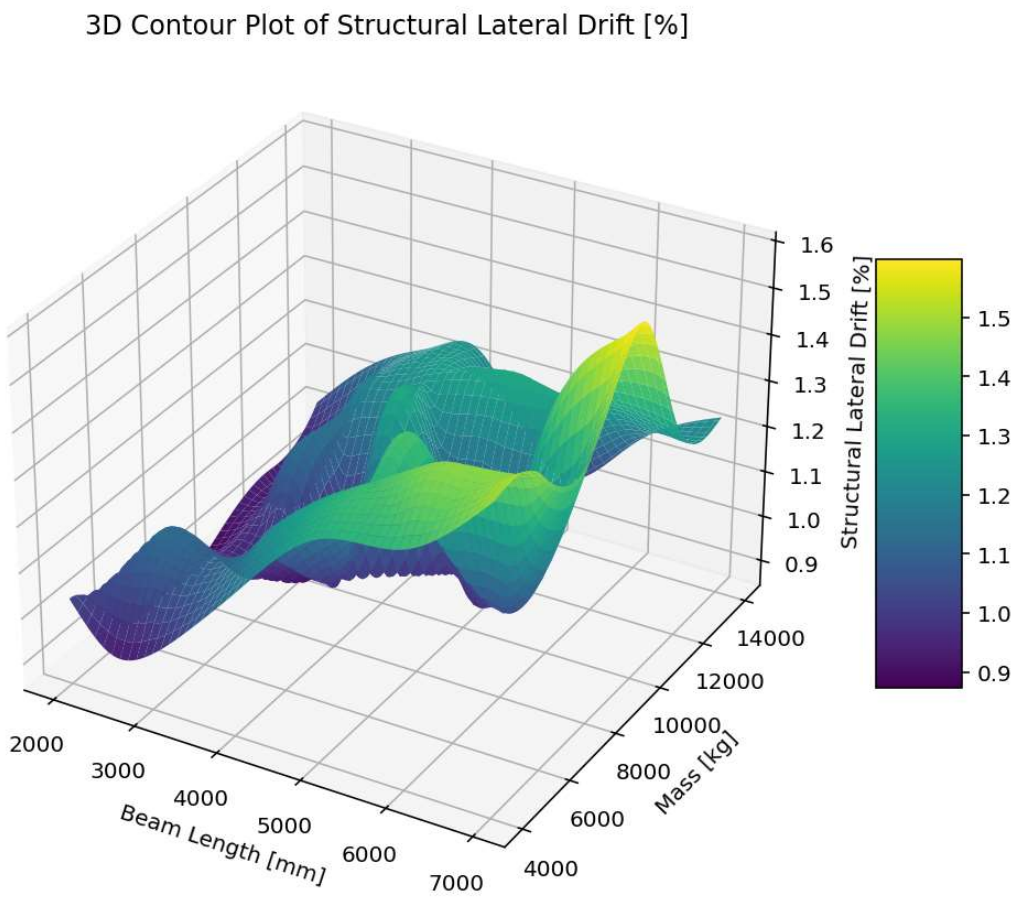

3D Contour Plot of Velocity in Y Dir. [mm/s]
Velocity in Y Dir. [mm/s]
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
Beam Length [mm]
2000
3000
4000
5000
6000
7000
Mass [kg]
4000
6000
8000
10000
12000
14000

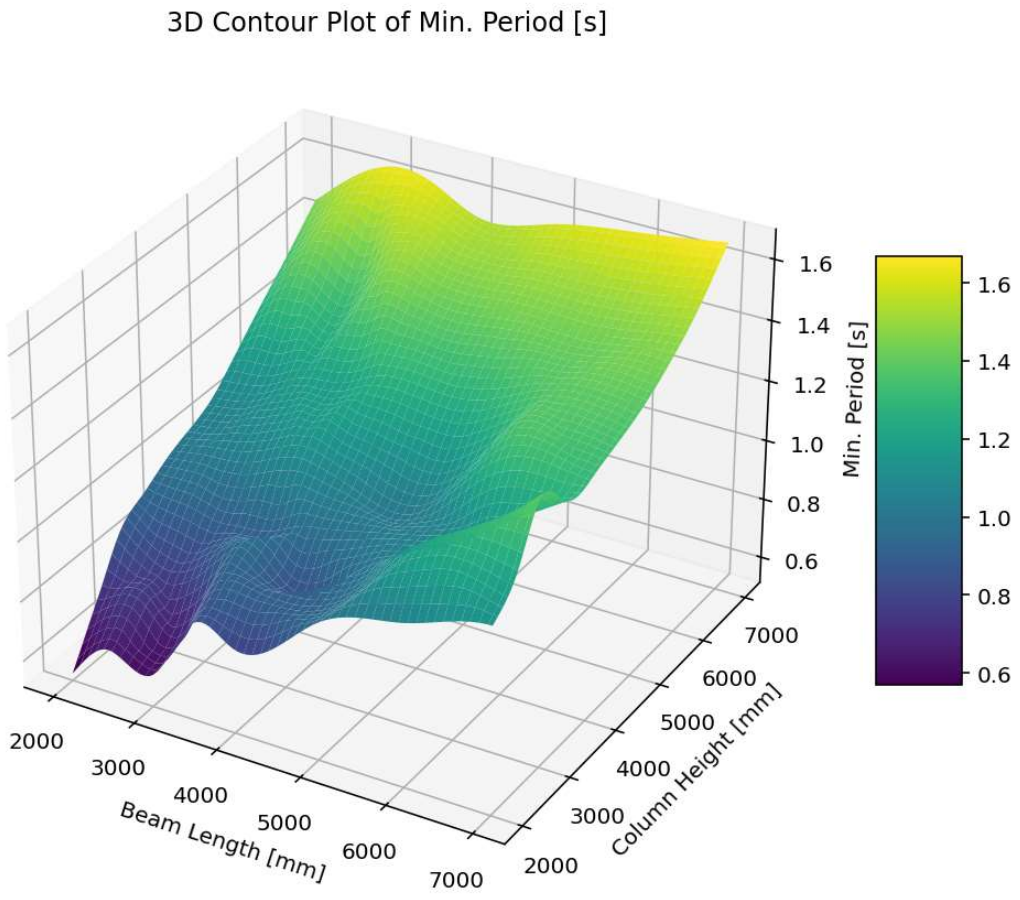

3D Contour Plot of Acceleration in X Dir. [mm/s^2]
Beam Length [mm]
2000
3000
4000
5000
6000
7000
Mass [kg]
4000
6000
8000
10000
12000
14000
480
500
520
540
560
580
600
620
Acceleration in X Dir. [mm/s^2]
500
520
540
560
580
600
620

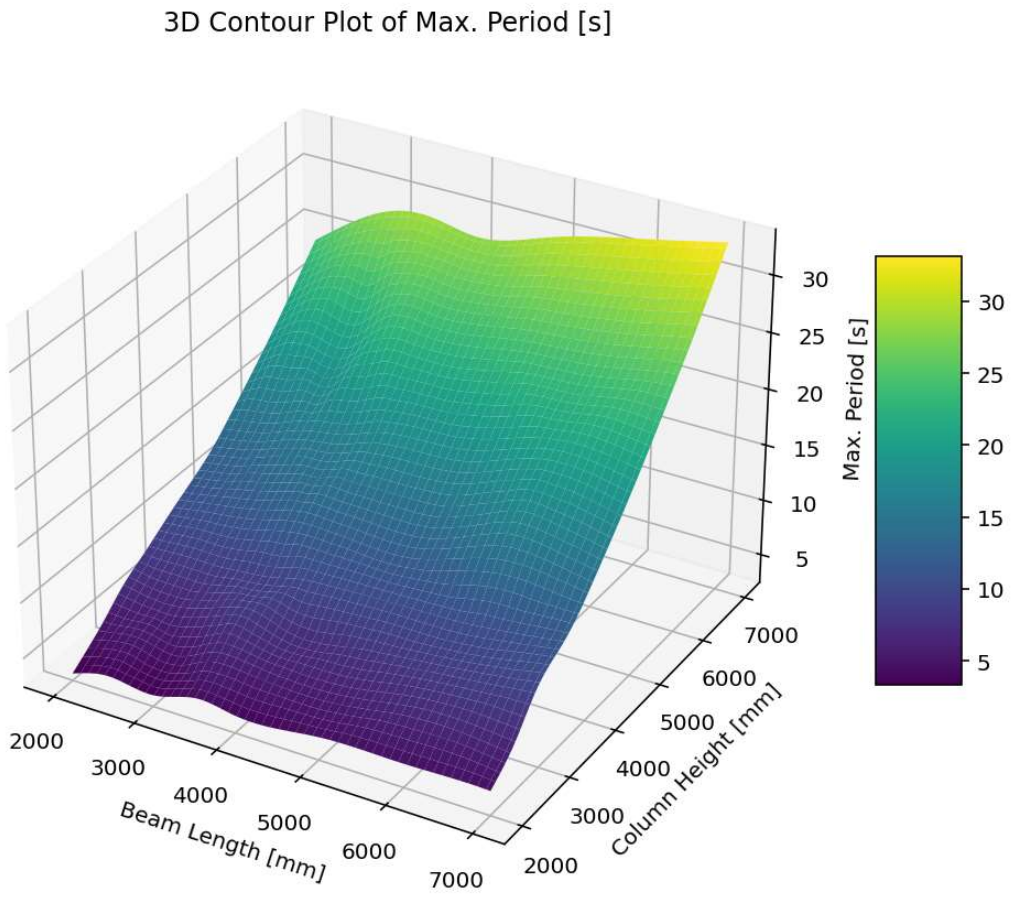

3D Contour Plot of Acceleration in Y Dir. [mm/s^2]
Beam Length [mm]
2000
3000
4000
5000
6000
7000
Mass [kg]
4000
6000
8000
10000
12000
14000
Acceleration in Y Dir. [mm/s^2]
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5

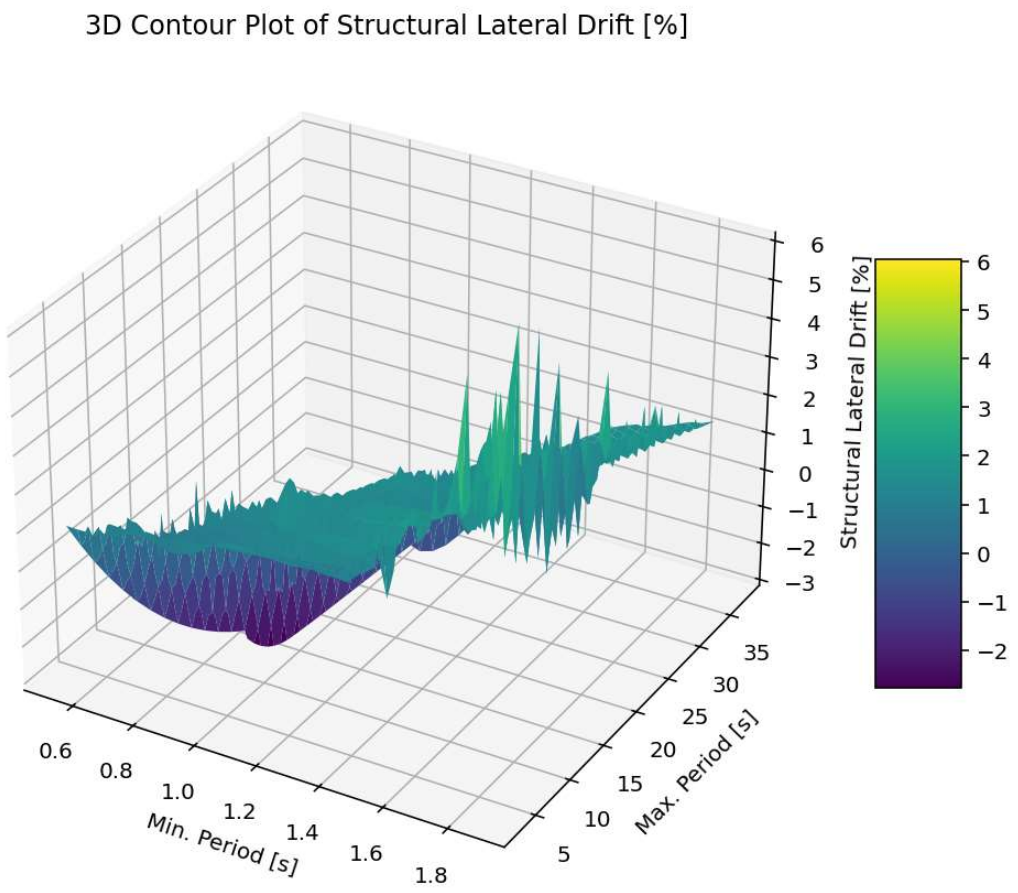

3D Contour Plot of Min. Period [s]
Beam Length [mm]
2000
3000
4000
5000
6000
7000
Mass [kg]
4000
6000
8000
10000
12000
14000
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
Min. Period [s]
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3


3D Contour Plot of Max. Period [s]
Beam Length [mm]
2000
3000
4000
5000
6000
7000
Mass [kg]
4000
6000
8000
10000
12000
14000
3
4
5
6
7
8
9
Max. Period [s]
4
5
6
7
8
9

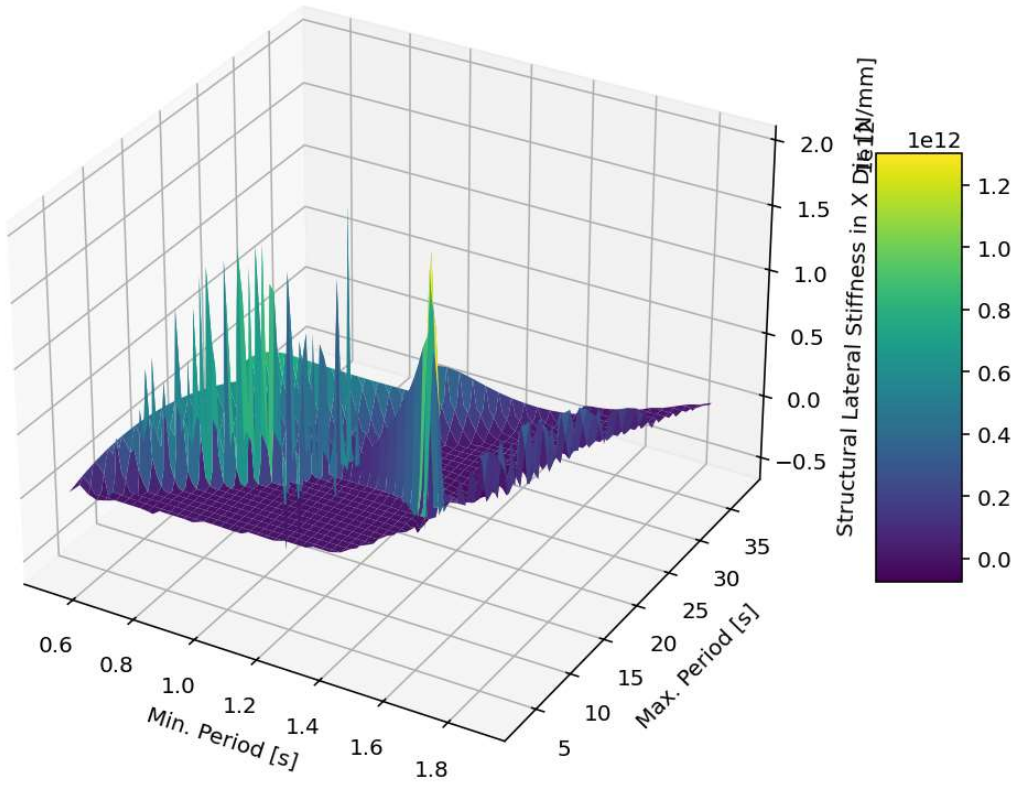

3D Contour Plot of Structural Lateral Drift [%]
Beam Length [mm]
2000
3000
4000
5000
6000
7000
Mass [kg]
4000
6000
8000
10000
12000
14000
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
Structural Lateral Drift [%]
1.5
1.4
1.3
1.2
1.1
1.0
0.9


3D Contour Plot of Min. Period [s]
Beam Length [mm]
2000
3000
4000
5000
6000
7000
Column Height [mm]
2000
3000
4000
5000
6000
7000
Min. Period [s]
0.6
0.8
1.0
1.2
1.4
1.6

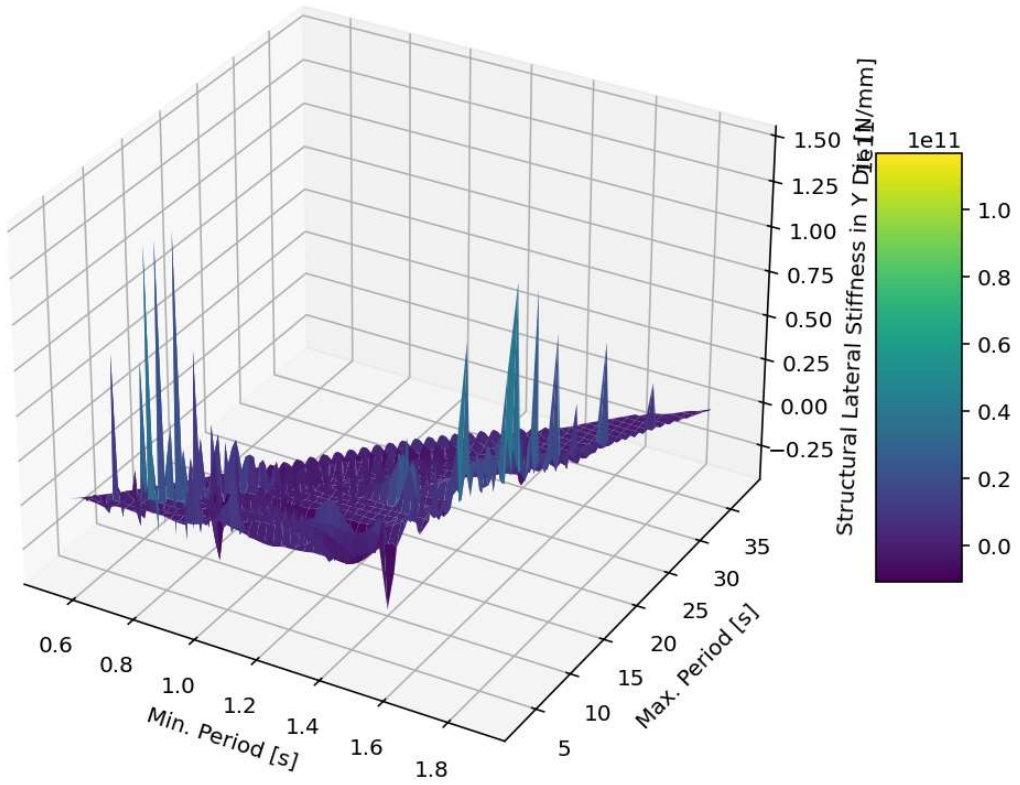

3D Contour Plot of Max. Period [s]
Beam Length [mm]
2000
3000
4000
5000
6000
7000
Column Height [mm]
2000
3000
4000
5000
6000
7000
Max. Period [s]
5
10
15
20
25
30


3D Contour Plot of Structural Lateral Drift [%]
Min. Period [s]
0.6
0.8
1.0
1.2
1.4
1.6
1.8
Max. Period [s]
5
10
15
20
25
30
35
Structural Lateral Drift [%]
6
5
4
3
2
1
0
−1
−2
−3

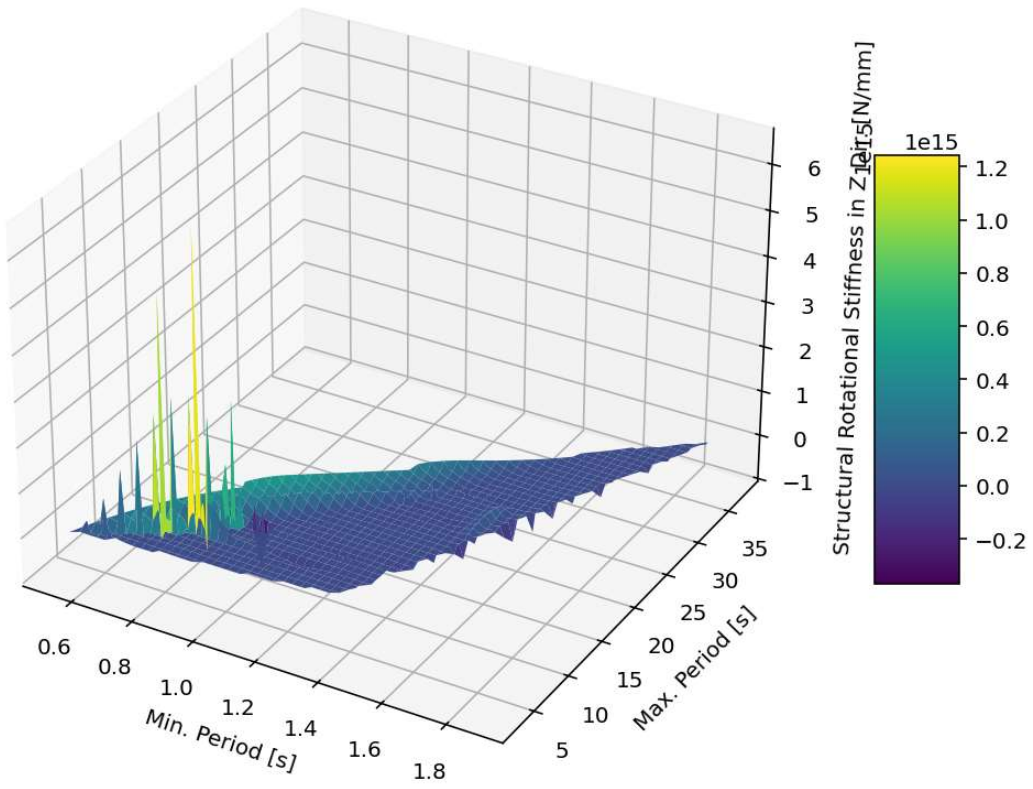
3D Contour Plot of Structural Lateral Stiffness in X Dir. [N/mm]

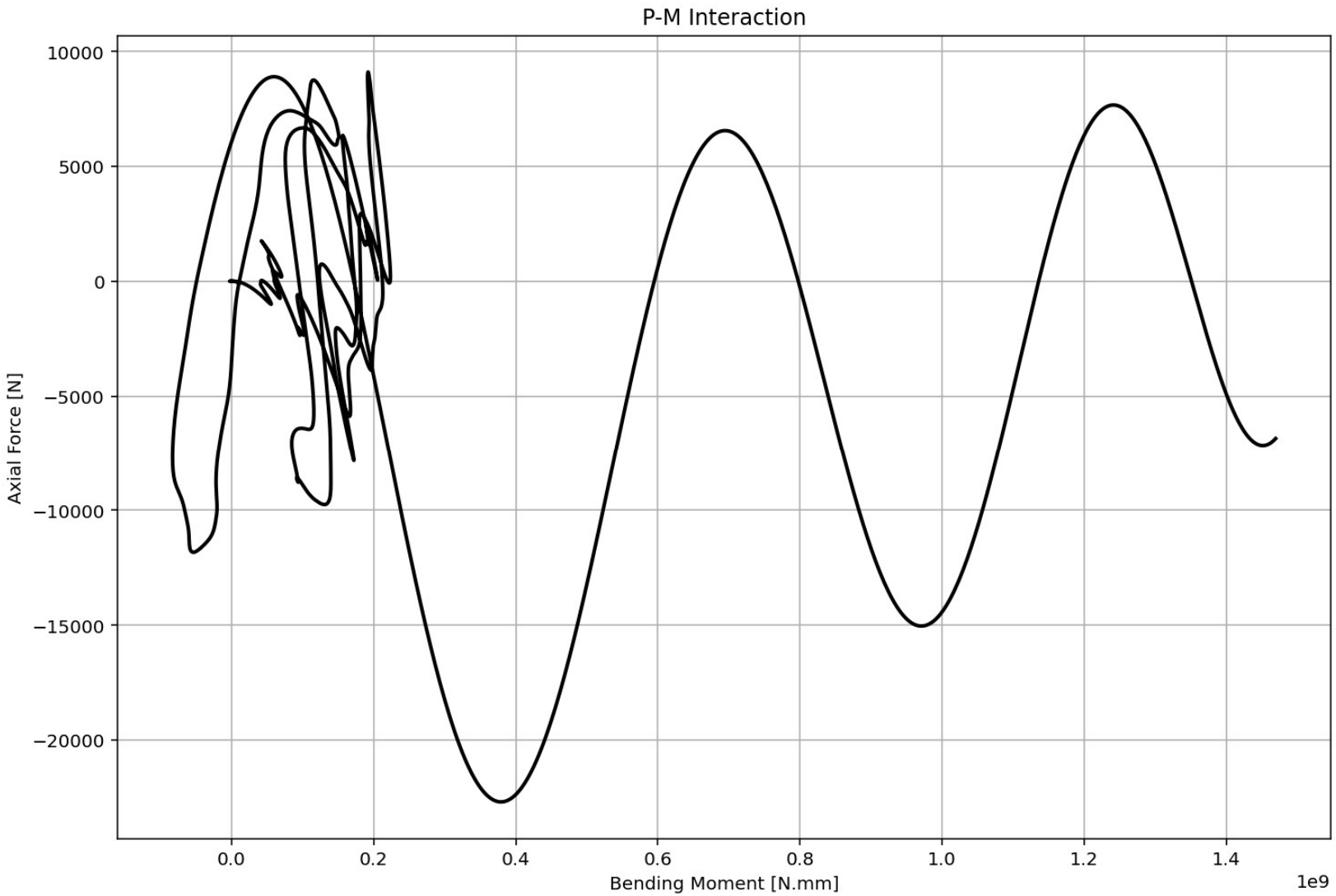


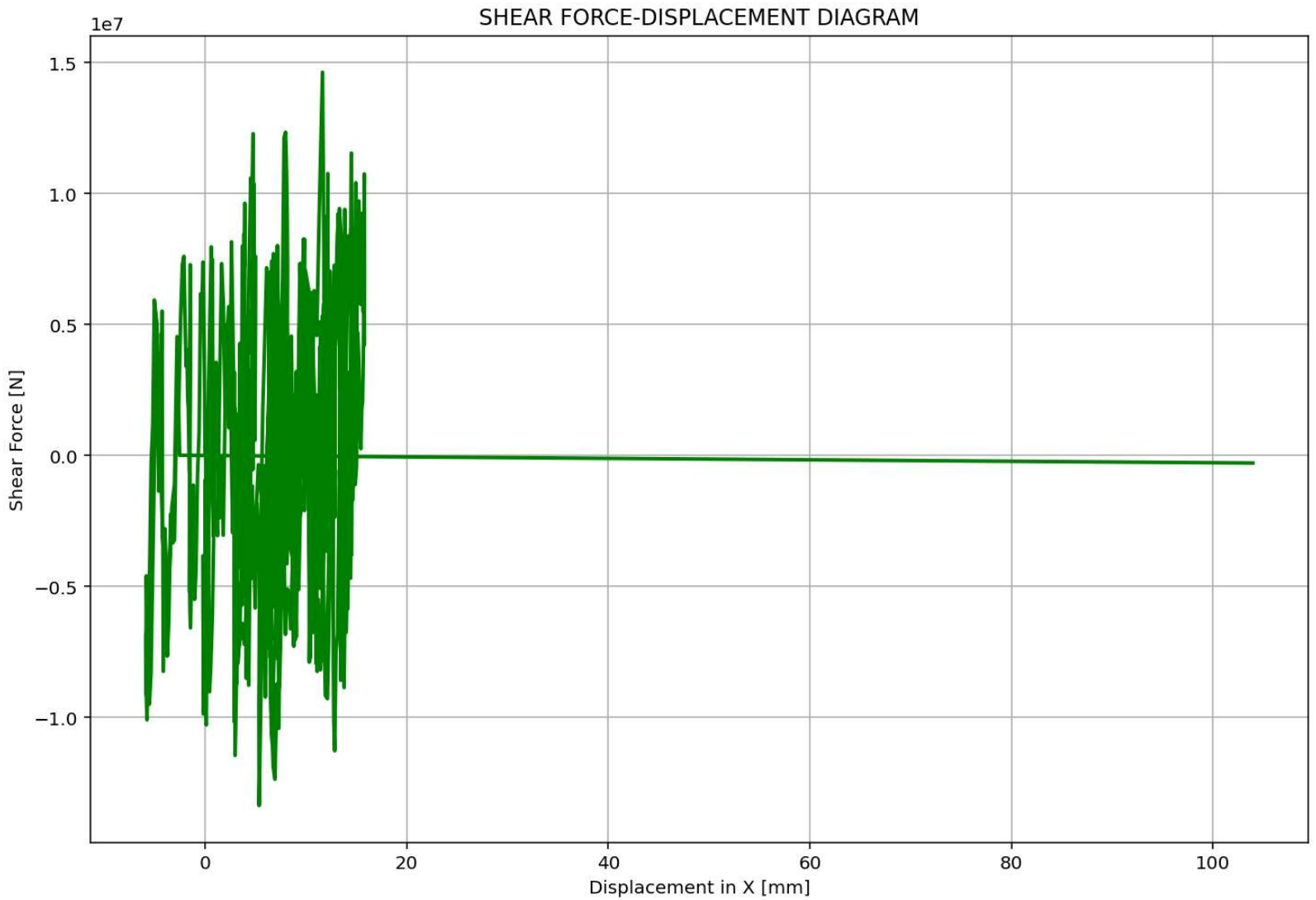
3D Contour Plot of Structural Lateral Stiffness in Y Dir. [N/mm]

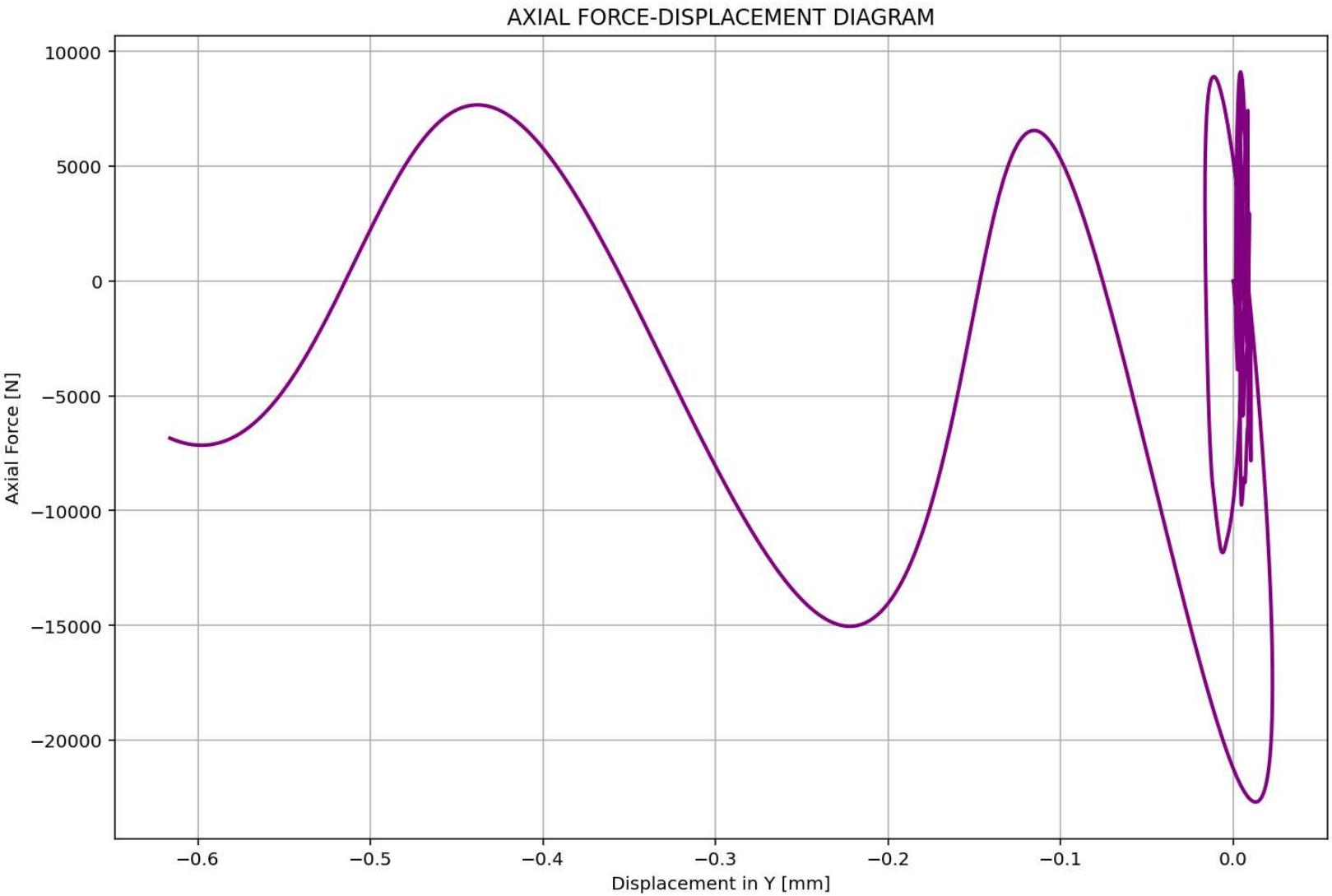


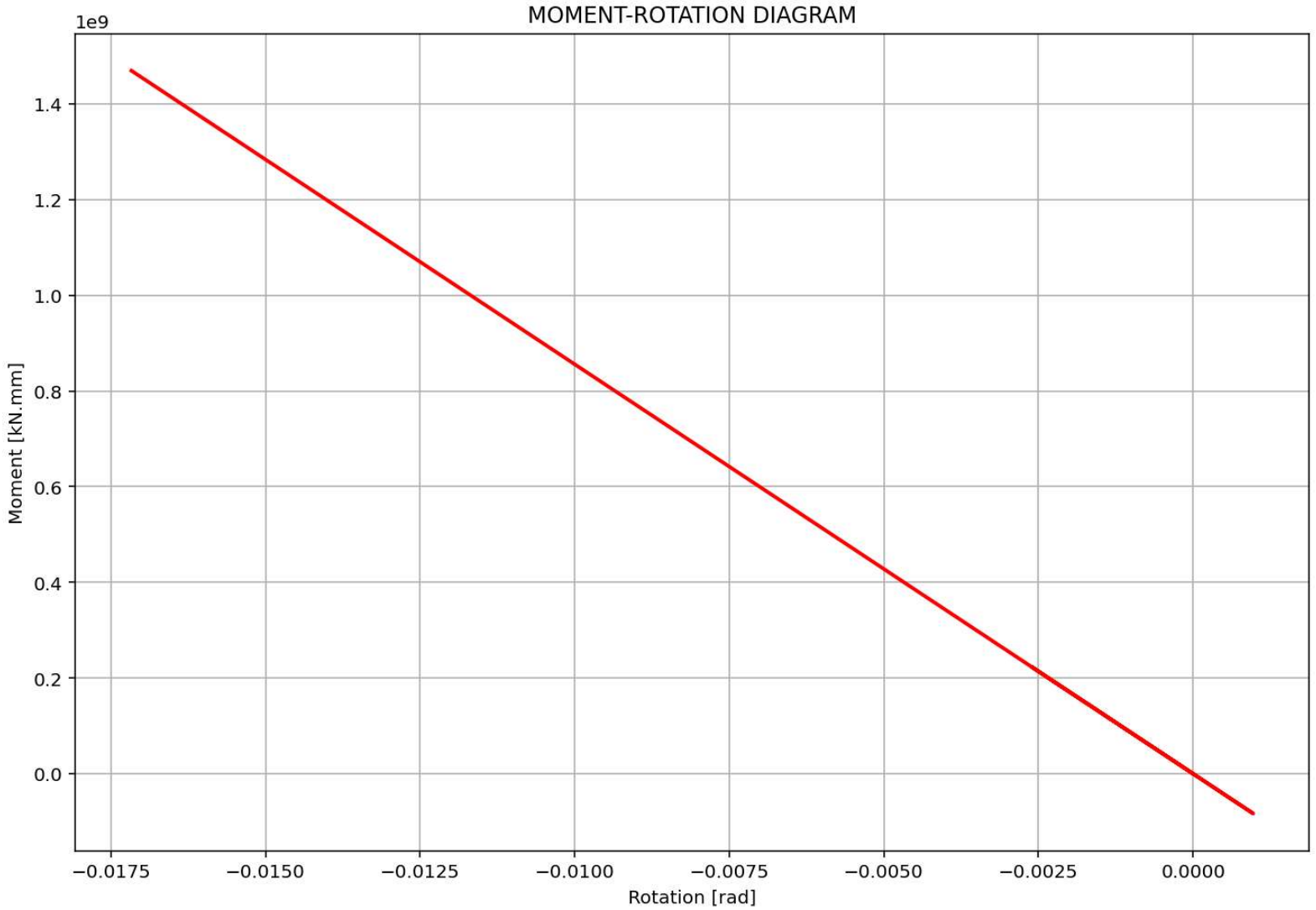
3D Contour Plot of Structural Rotational Stiffness in Z Dir. [N/mm]

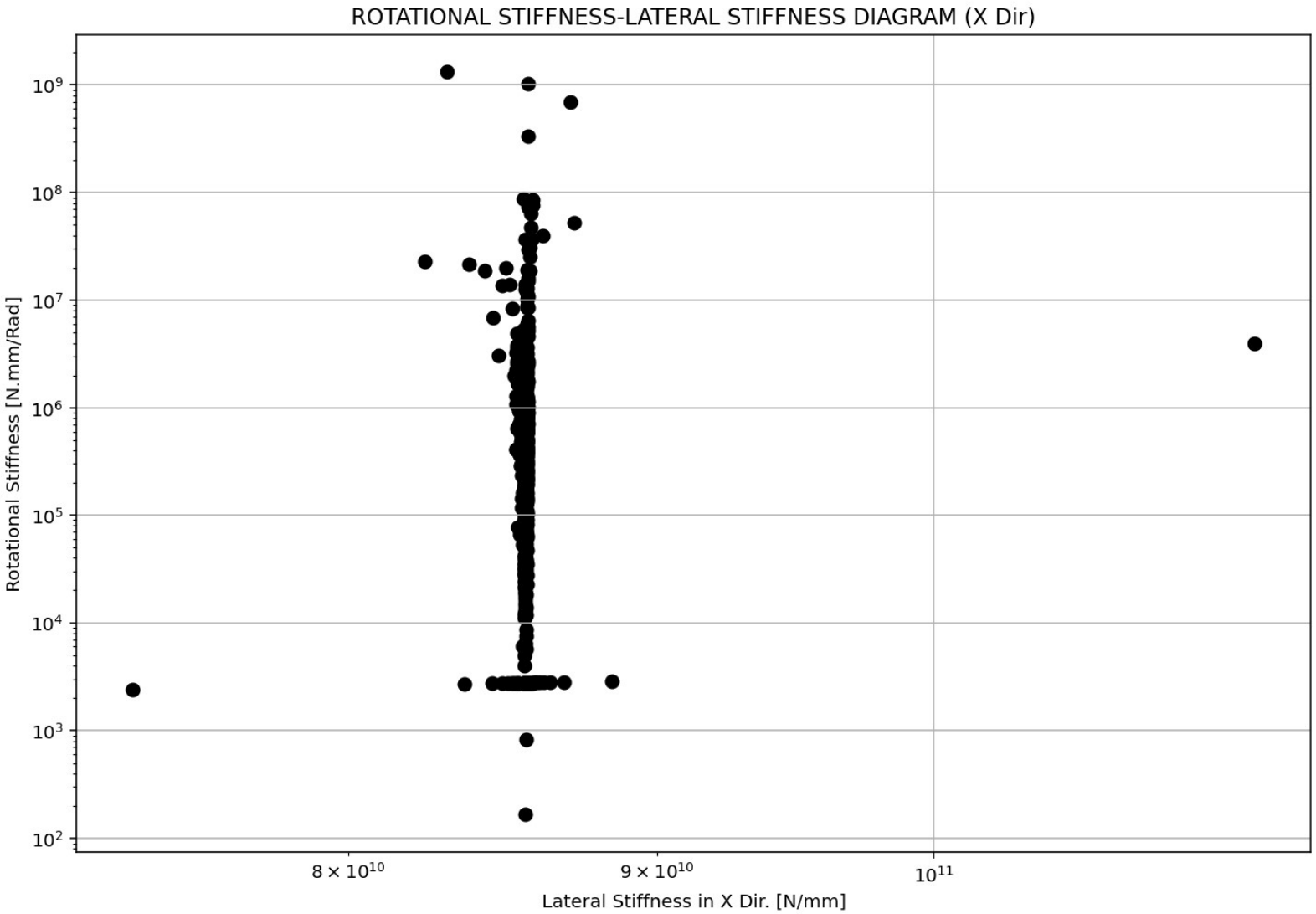


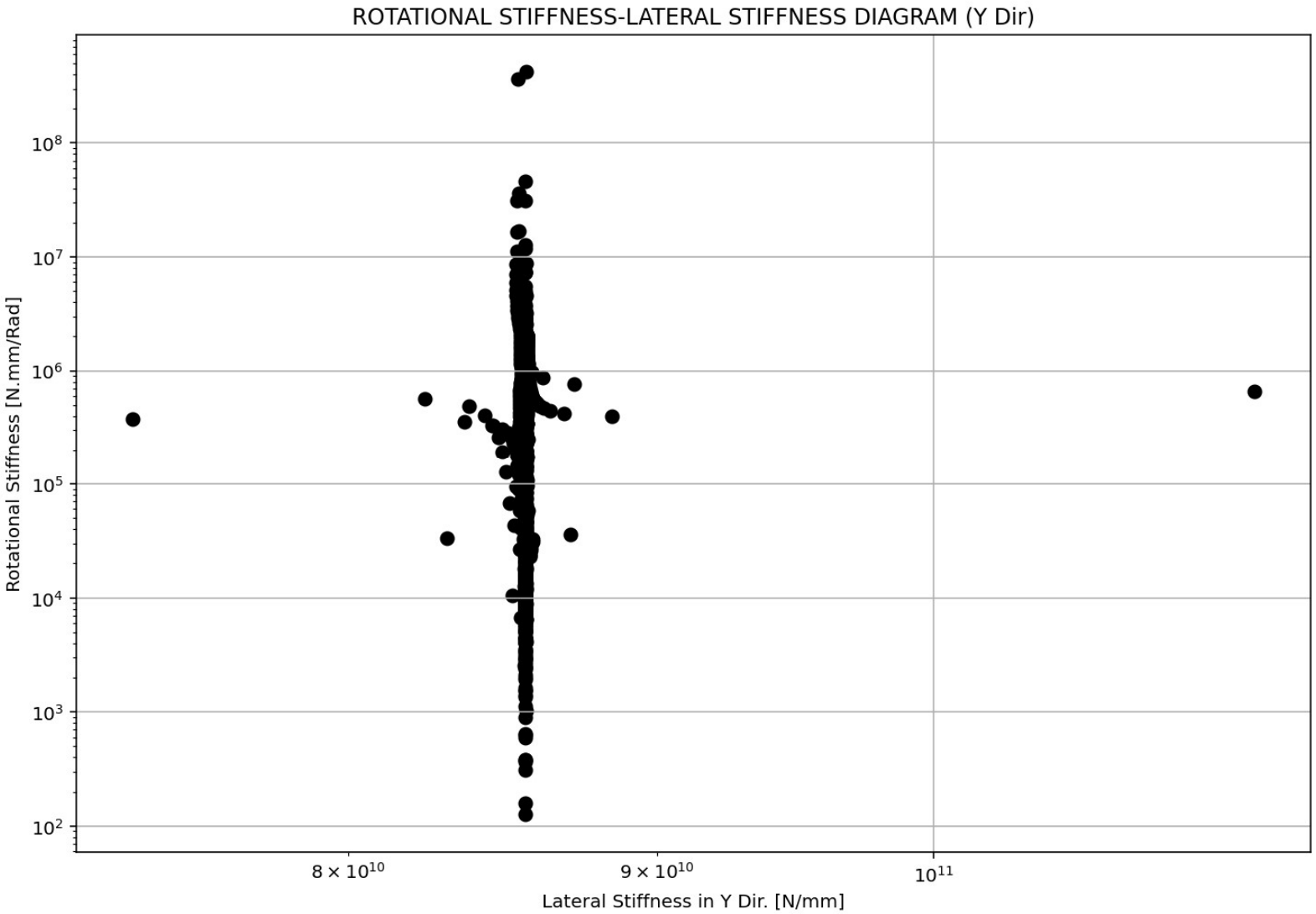

P-M Interaction
10000
5000
0
−5000
−10000
−15000
−20000
Axial Force [N]
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Bending Moment [N.mm]
1e9

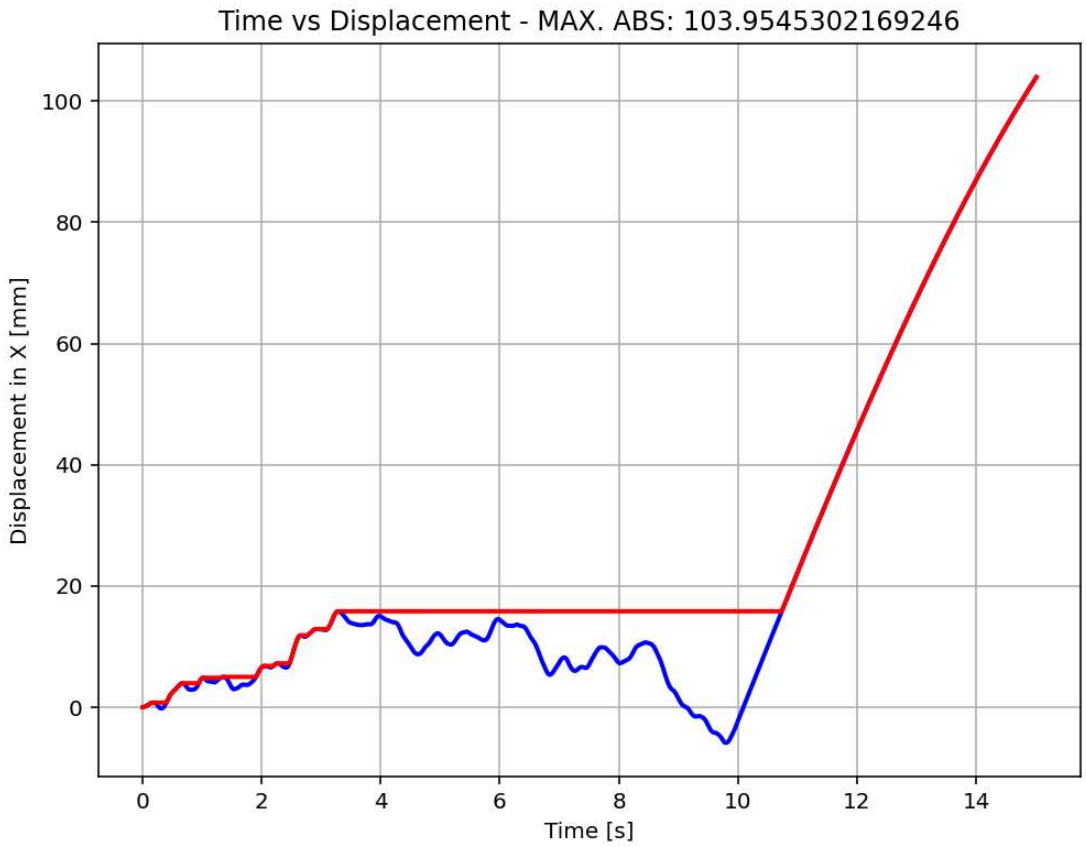

SHEAR FORCE-DISPLACEMENT DIAGRAM
1e7
1.5
1.0
0.5
0.0
−0.5
−1.0
Shear Force [N]
0
20
40
60
80
100
Displacement in X [mm]

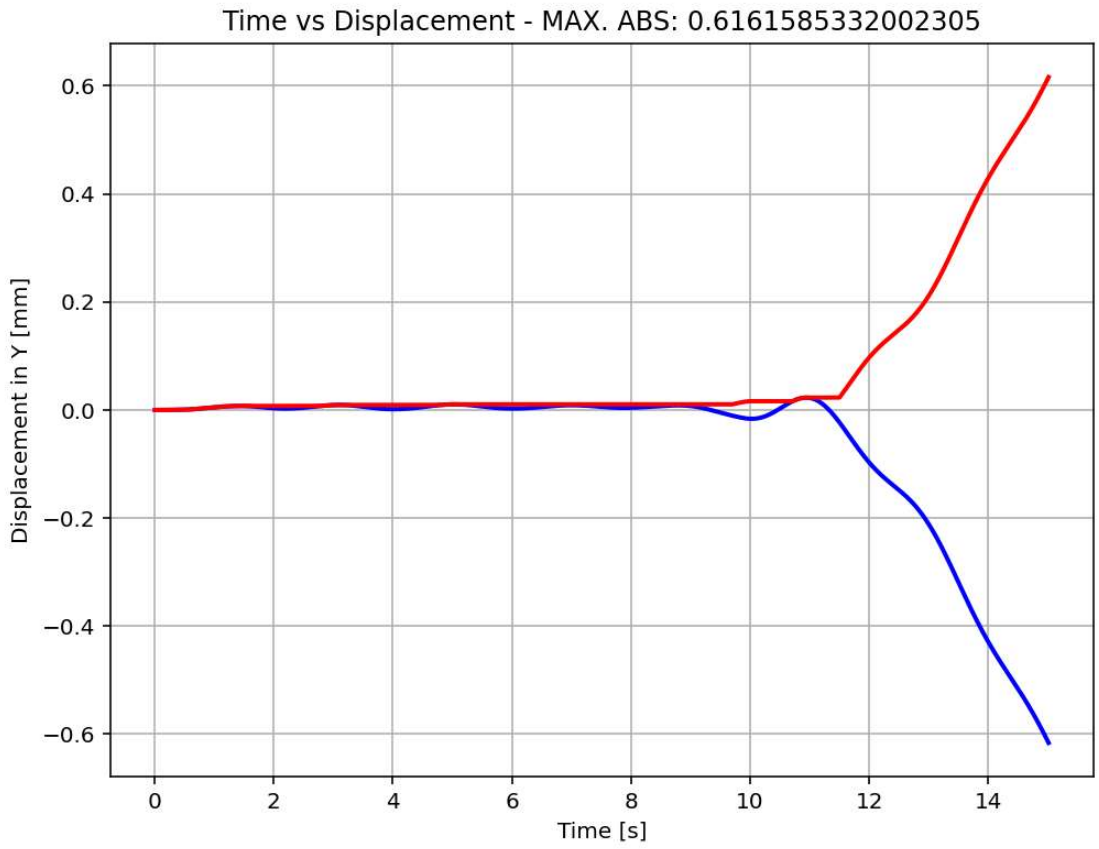

AXIAL FORCE-DISPLACEMENT DIAGRAM
Axial Force [N]
10000
5000
0
−5000
−10000
−15000
−20000
−0.6
−0.5
−0.4
−0.3
−0.2
−0.1
0.0
Displacement in Y [mm]

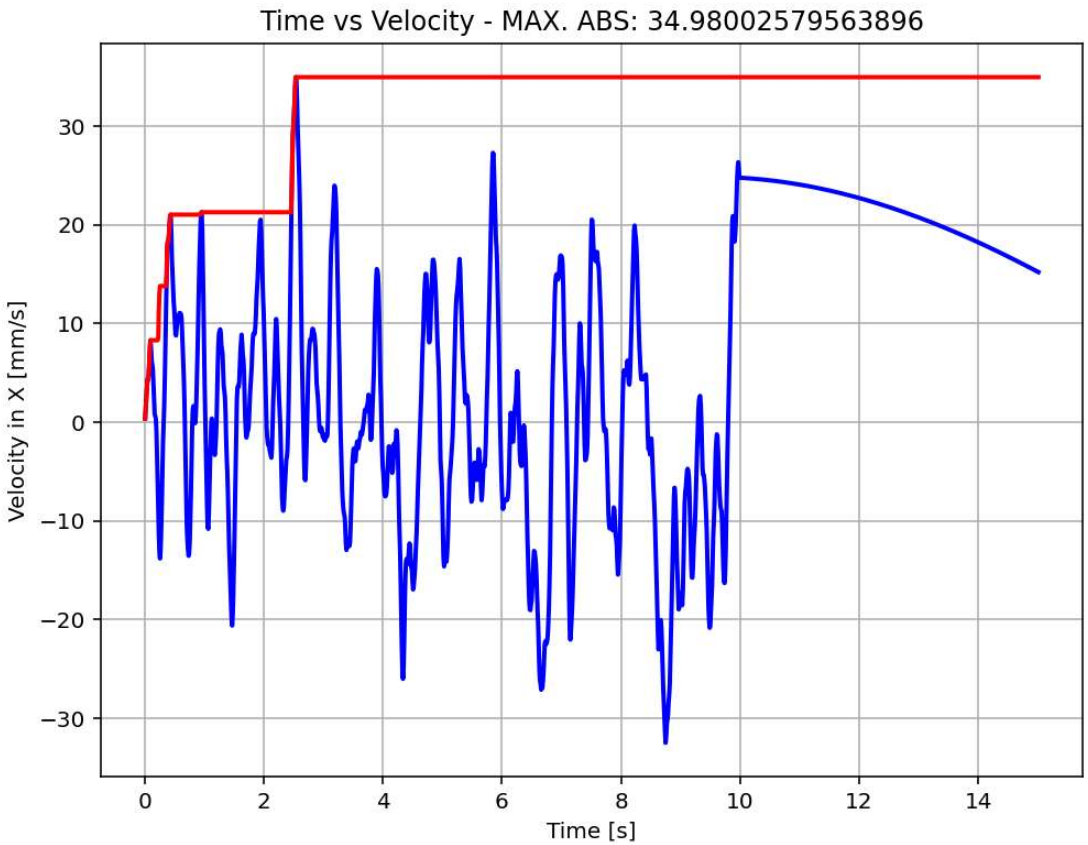

MOMENT-ROTATION DIAGRAM
1e9
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Moment [kN.mm]
−0.0175
−0.0150
−0.0125
−0.0100
−0.0075
−0.0050
−0.0025
0.0000
Rotation [rad]

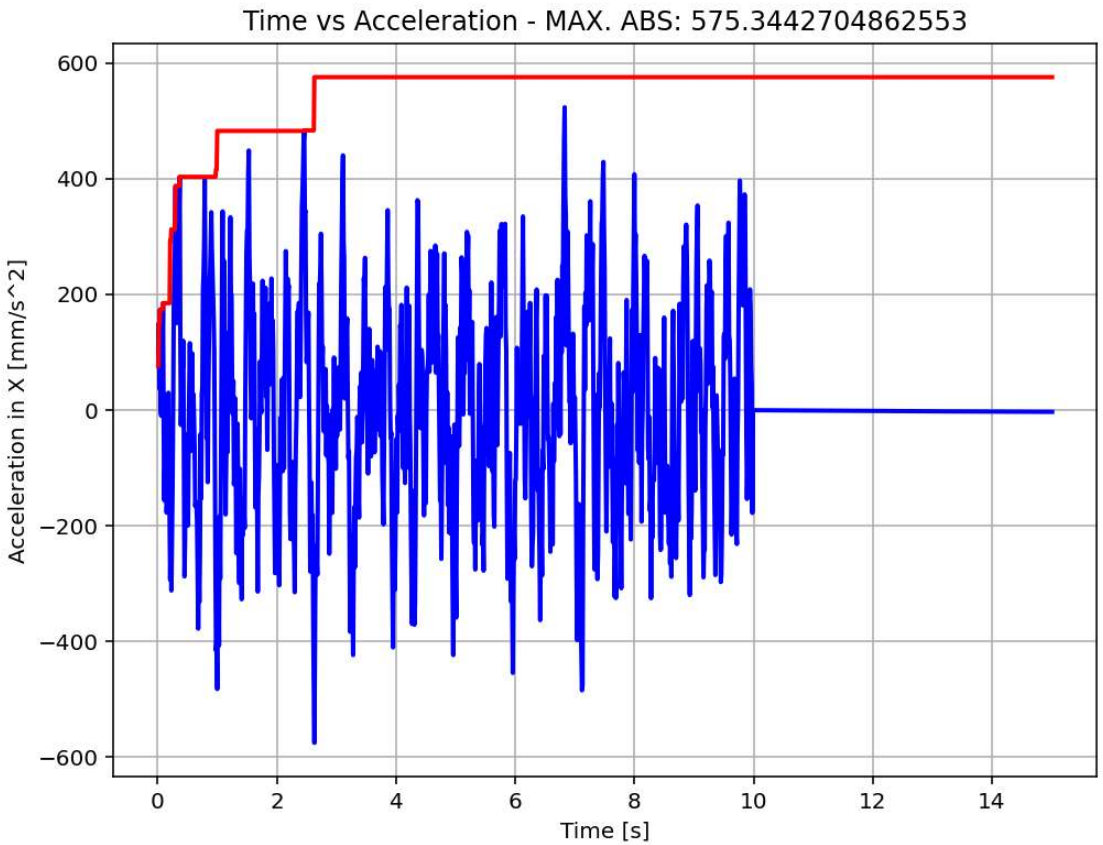

ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM (X Dir)
Rotational Stiffness [N.mm/Rad]
$10^9$
$10^8$
$10^7$
$10^6$
$10^5$
$10^4$
$10^3$
$10^2$
$8 \times 10^{10}$
$9 \times 10^{10}$
$10^{11}$
Lateral Stiffness in X Dir. [N/mm]

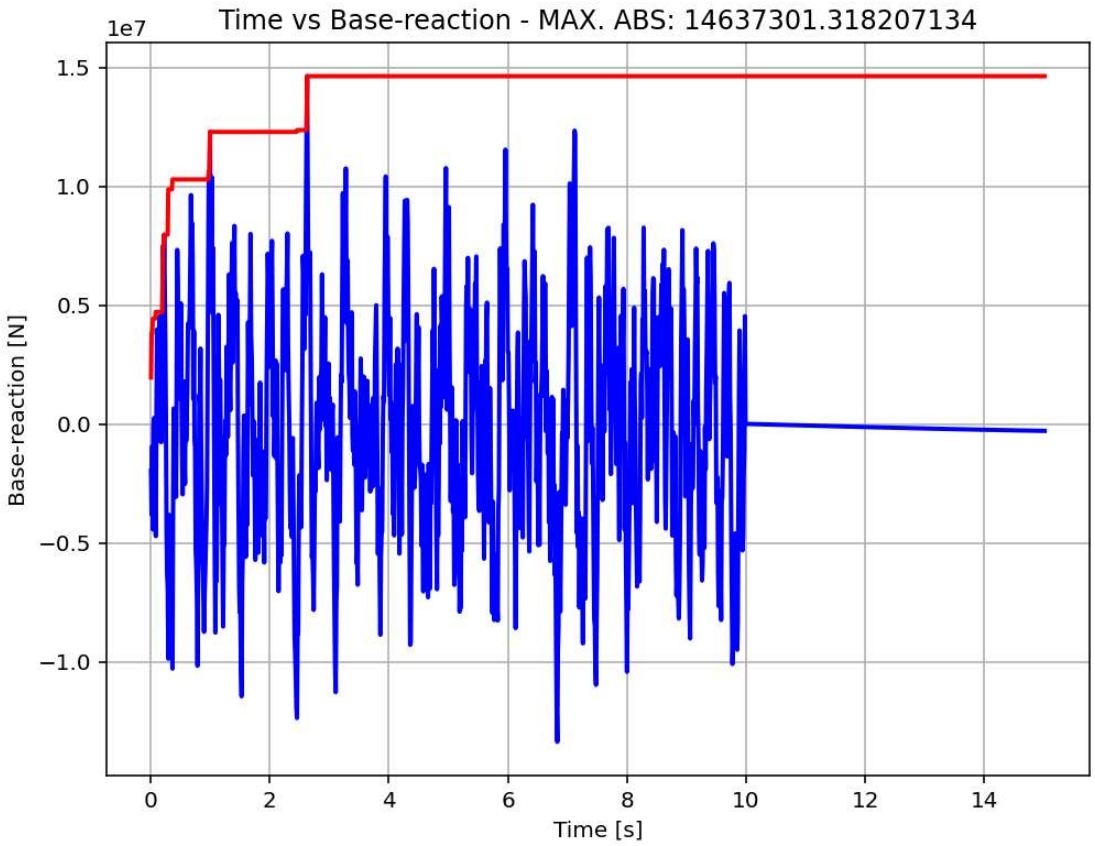

ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM (Y Dir)
Rotational Stiffness [N.mm/Rad]
$10^8$
$10^7$
$10^6$
$10^5$
$10^4$
$10^3$
$10^2$
$8 \times 10^{10}$
$9 \times 10^{10}$
$10^{11}$
Lateral Stiffness in Y Dir. [N/mm]

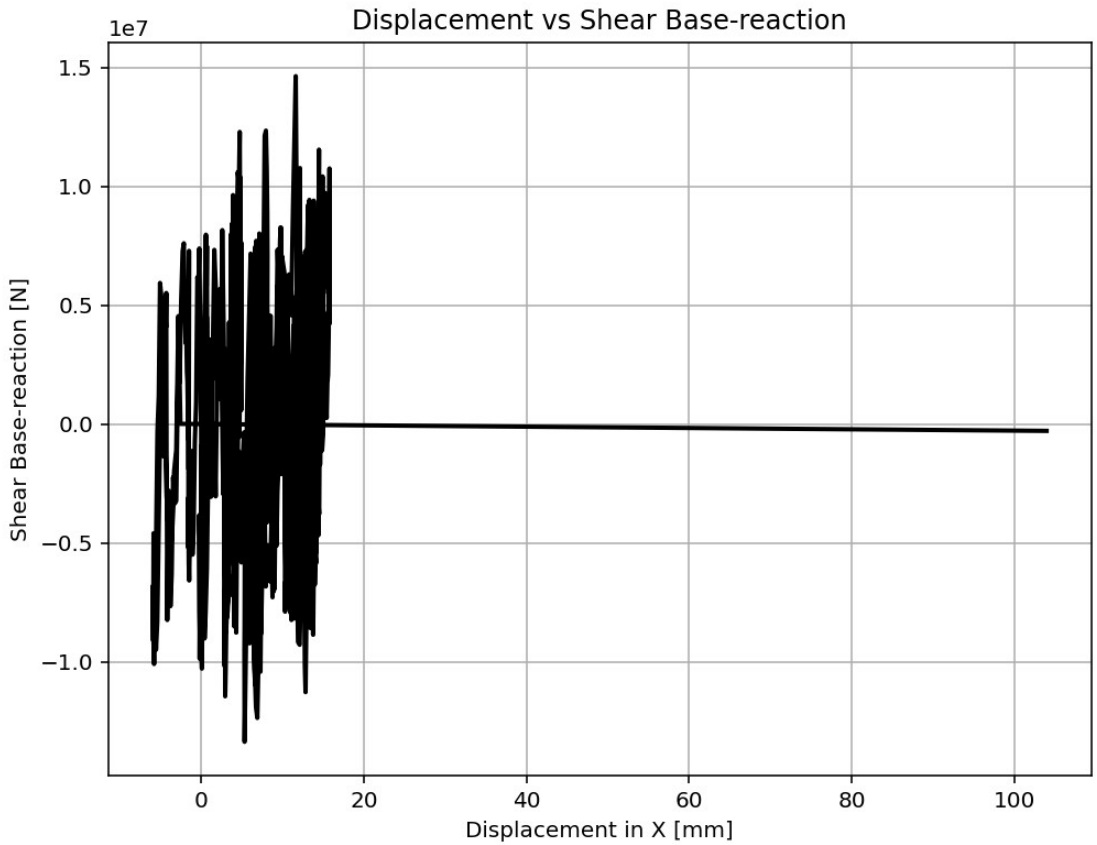

Time vs Displacement - MAX. ABS: 103.9545302169246
Displacement in X [mm]
Time [s]
100
80
60
40
20
0
0
2
4
6
8
10
12
14

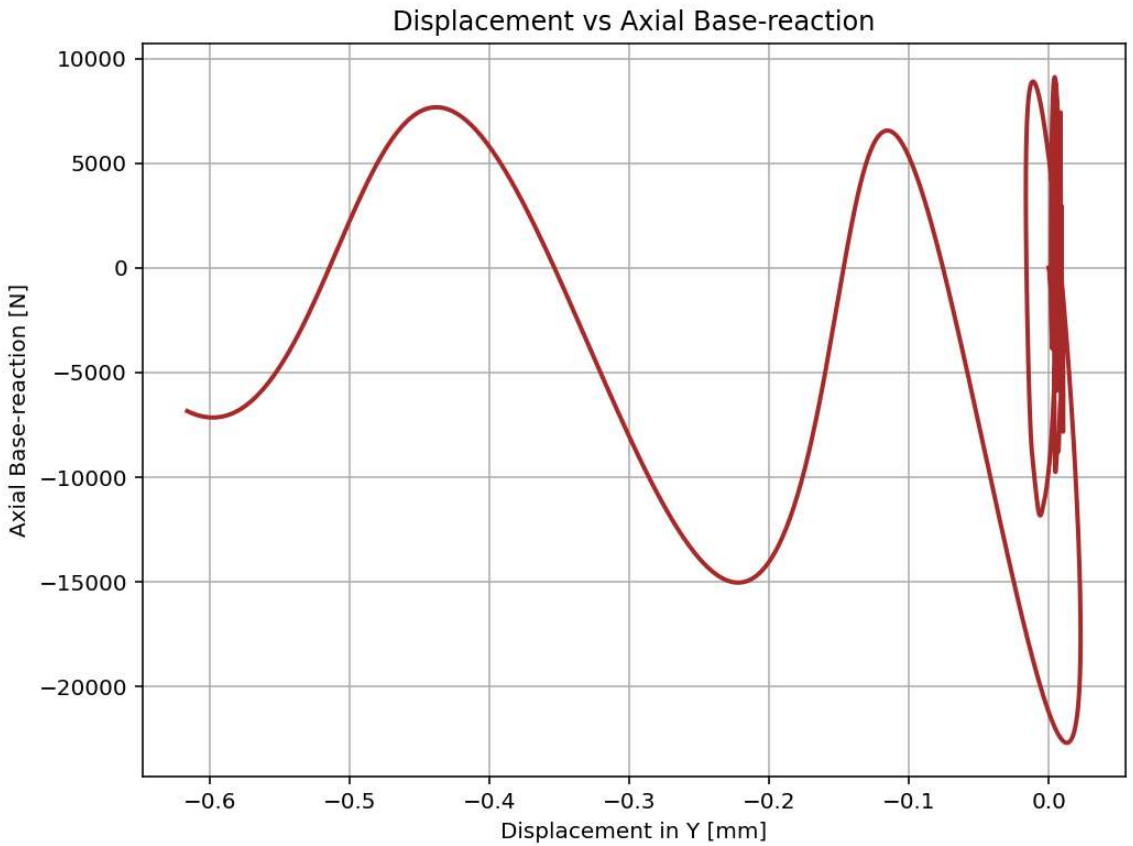

Time vs Displacement - MAX. ABS: 0.6161585332002305
Displacement in Y [mm]
Time [s]
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
0
2
4
6
8
10
12
14


Time vs Velocity - MAX. ABS: 34.98002579563896
Velocity in X [mm/s]
Time [s]
30
20
10
0
−10
−20
−30
0
2
4
6
8
10
12
14


Time vs Acceleration - MAX. ABS: 575.3442704862553
Acceleration in X [mm/s^2]
Time [s]
600
400
200
0
−200
−400
−600
0
2
4
6
8
10
12
14


Time vs Base-reaction - MAX. ABS: 14637301.318207134
1e7
1.5
1.0
0.5
0.0
−0.5
−1.0
Base-reaction [N]
0
2
4
6
8
10
12
14
Time [s]


Displacement vs Shear Base-reaction
1e7
1.5
1.0
0.5
0.0
−0.5
−1.0
Shear Base-reaction [N]
0
20
40
60
80
100
Displacement in X [mm]


Displacement vs Axial Base-reaction
Axial Base-reaction [N]
10000
5000
0
−5000
−10000
−15000
−20000
−0.6
−0.5
−0.4
−0.3
−0.2
−0.1
0.0
Displacement in Y [mm]