SENSITIVITY ANALYSIS OF CONCRETE FRAME BY CHANGING COLUMN HEIGHT, BEAM LENGTH AND MASS USING OPENSEES
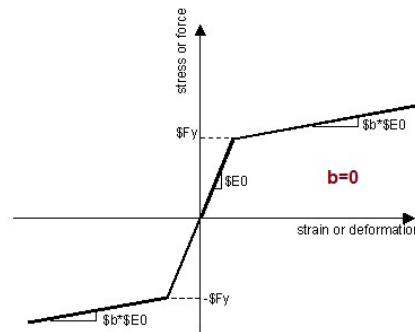
WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)
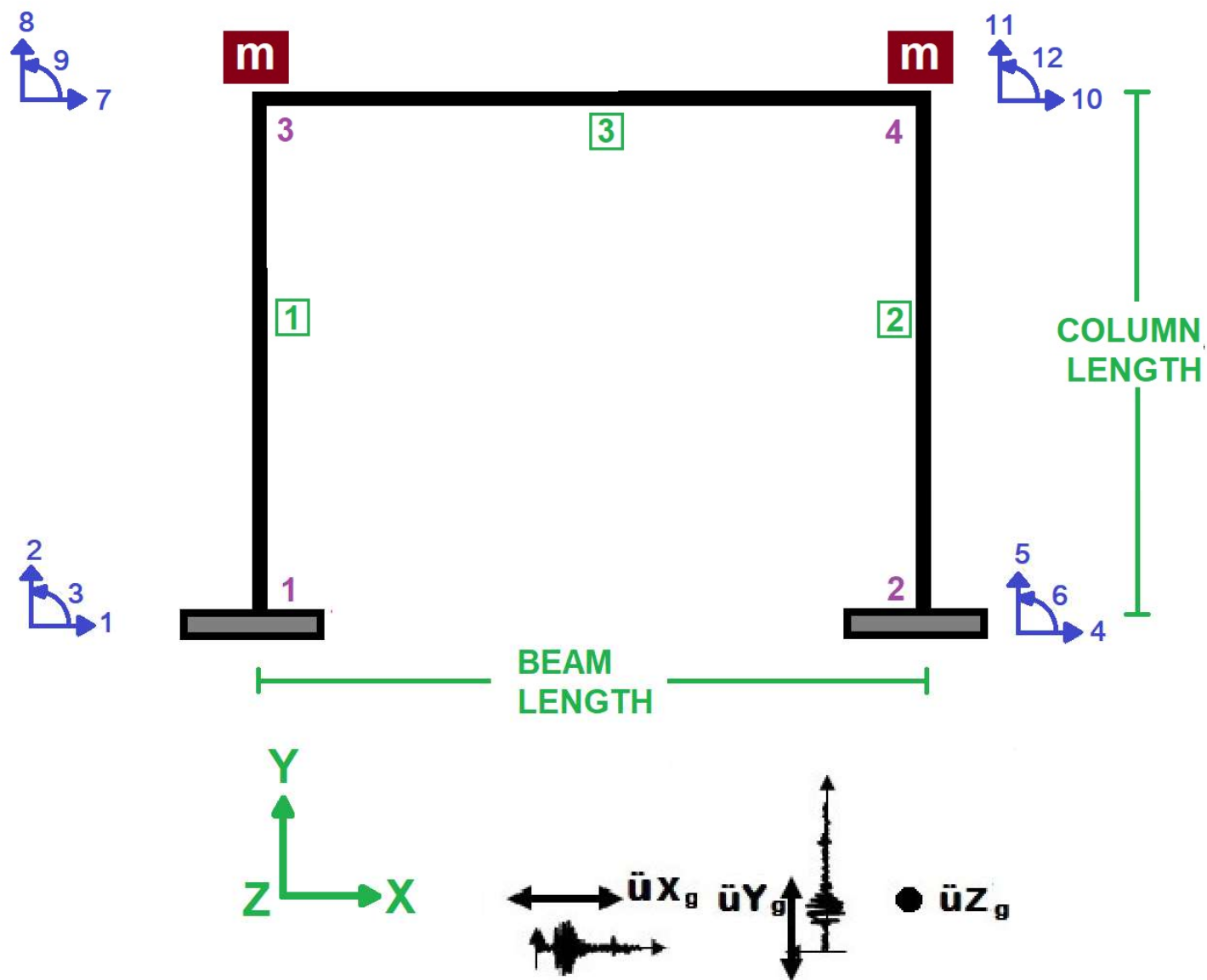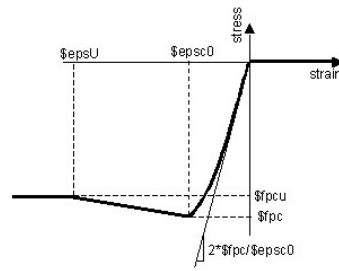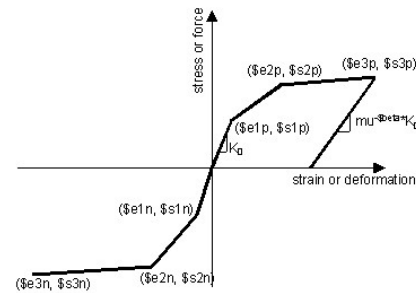
CORE AND COVER CONCRETE RELATION

Labels in figure: $stress$, $strain$, $epsU$, $epsc0$, $fpcu$, fpc, $2*fpc/epsc0$

WITHOUT HARDENING AND ULTIMATE STRAIN

Labels in figure: $stress\ or\ force$, $strain\ or\ deformation$, Fy, $-Fy$, $E0$, $b*E0$, $b=0$

WITH HARDENING AND ULTIMATE STRAIN

Labels in figure: $stress\ or\ force$, $strain\ or\ deformation$, $(e2p, s2p)$, $(e3p, s3p)$, $(e1p, s1p)$, $mu^{-beta}*K_0$, K_0, $(e1n, s1n)$, $(e3n, s3n)$, $(e2n, s2n)$

COLUMN SECTION

Labels: B, H

BEAM SECTION

Labels: B, H
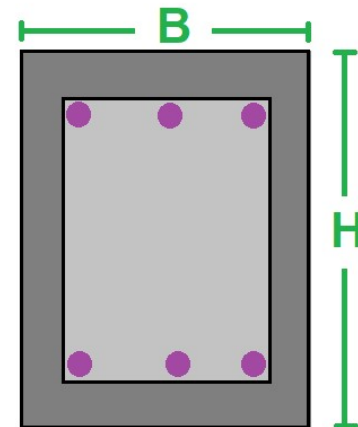
Spyder (Python 3.12)

File Edit Search Source Run Debug Consoles Projects Tools View Help

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

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

CONCRETE_FRAME_SEN...M_LENGTH__MASS.py

```
1  #################################################################################
2  #                    >> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<
3  #        SENSITIVITY ANALYSIS OF CONCRETE FRAME BEHAVIOR: INVESTIGATING THE IMPACT OF COLUMN HEIGHT AND
4  #           BEAM LENGTH AND MASS ON STRUCTURAL PERIOD AND OTHER KEY PARAMETERS USING OPENSEES AND PYTHON
5  #--------------------------------------------------------------------------------
6  #                    THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)
7  #                           EMAIL: salar.d.ghashghaei@gmail.com
8  #################################################################################
9  """
10 # Nonlinear Dynamic and Sensitivity Analysis of a Concrete Frame Using OpenSees
11 -------------------------------------------------------------
12 This study performs a comprehensive nonlinear dynamic analysis and sensitivity assessment
13  of a reinforced concrete frame structure using OpenSees.
14  The research focuses on evaluating the structural response by varying two key parameters:
15 1. Coumn Height – Examining how different column lengths influence dynamic behavior
16 2. Beam length – Examining how different span lengths influence dynamic behavior
17 3. Structural mass – Investigating the effect of mass variation on seismic performance
18 -------------------------------------------------------------
19 ## Methodology
20 1. Model Development
21    - Create a nonlinear finite element model of a reinforced concrete moment-resisting frame
22    - Implement fiber sections with appropriate material models (Concrete02, Steel02)
23    - Include geometric nonlinearities (P-Delta effects)
24
25 2. Parameter Variation
26    - Beam lengths: ±20% variation from baseline design
27    - Mass modifications: ±30% variation to represent different loading conditions
28
29 3. Analysis Procedures
30    - Nonlinear Dynamic Analysis:
31     - Apply earthquake ground motions (e.g., El Centro, Kobe records)
32     - Evaluate displacement demands, story drifts, and damage progression
33    - Sensitivity Analysis:
34     - Perform parametric studies by systematically varying beam length and mass
```

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

Help   Variable Explorer   Debugger   Plots   Files

Console 1/A

```
Lobatto
    End 1 Forces (P V M): 1778.51 36362.3 1.9321e+08
    End 2 Forces (P V M): -1778.51 -36362.3 6.13262e+07

Element: 3 Type: ForceBeamColumn2d  Connected Nodes: 3 4
    Number of Sections: 5   Mass density: 3.75
Lobatto
    End 1 Forces (P V M): -34373.5 -17400 -6.04741e+07
    End 2 Forces (P V M): 34373.5 17400 -6.13262e+07

In [2]:
```
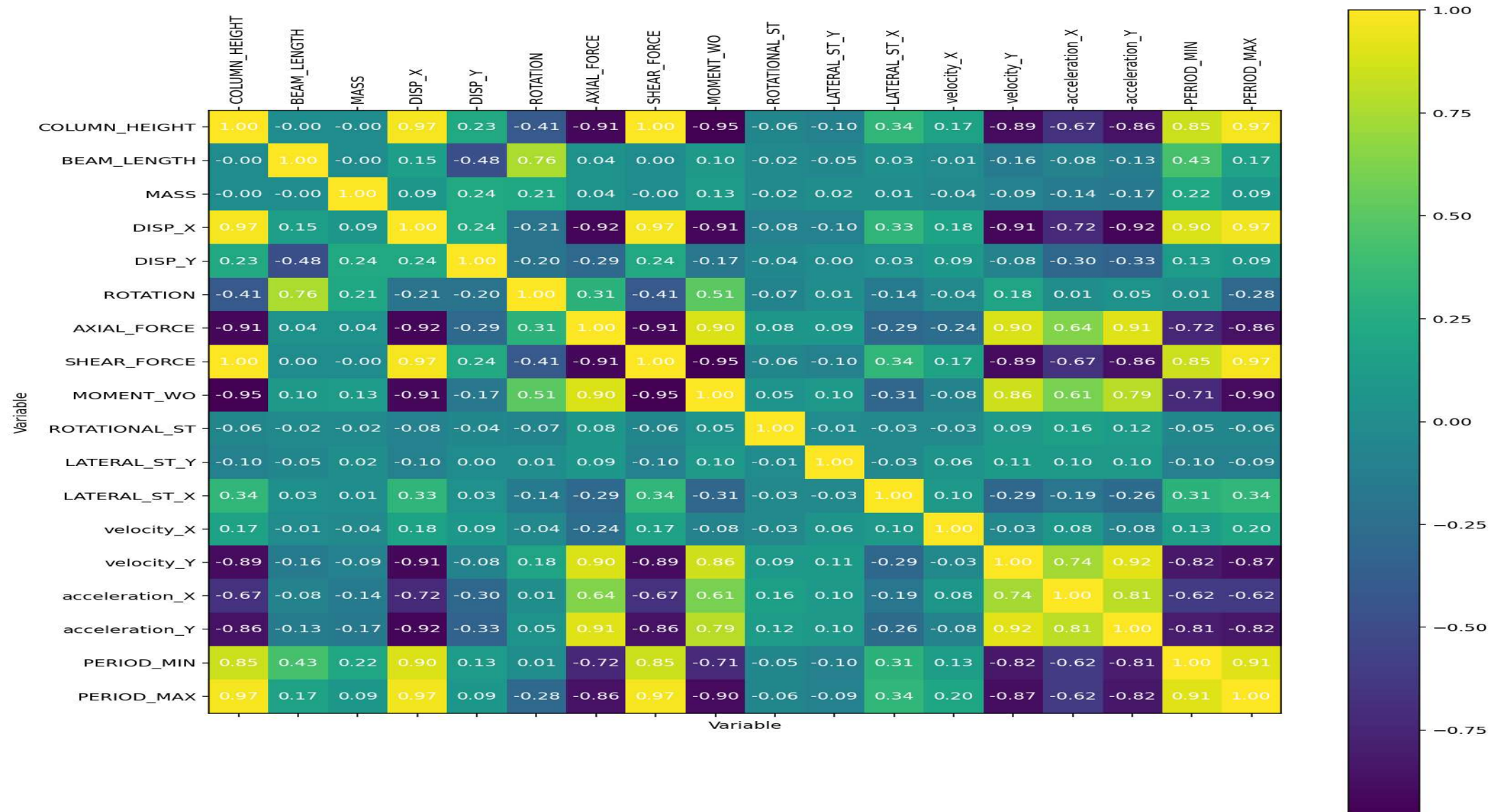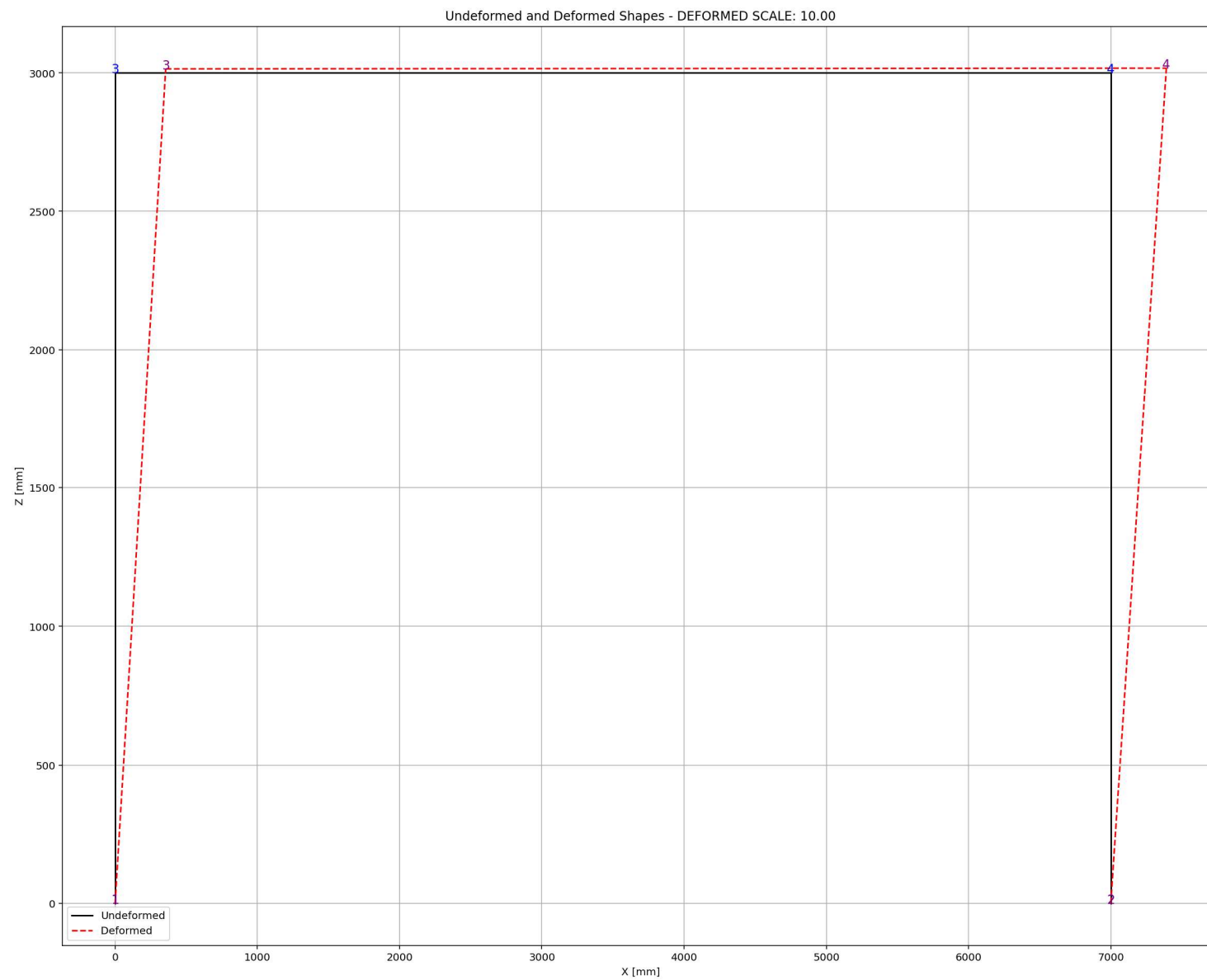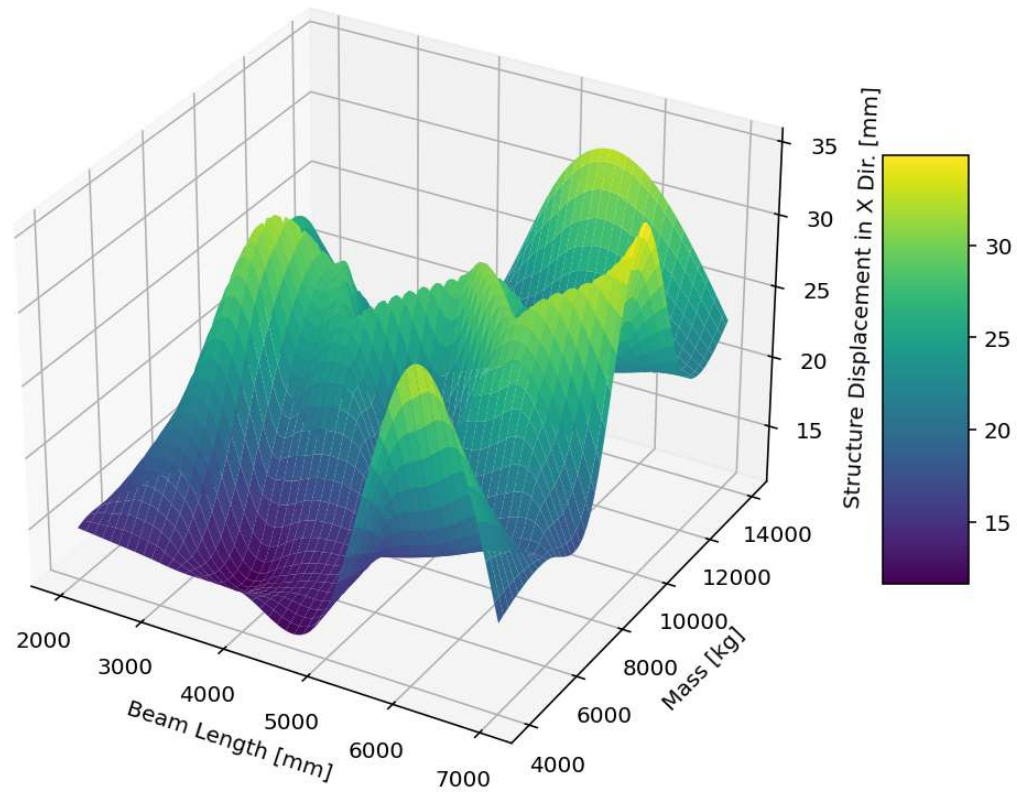
IPython Console   History

Inline   Conda: anaconda3 (Python 3.12.7)   ✓ LSP: Python   Line 559, Col 31   UTF-8   CRLF   RW   Mem 37%

Correlation Heatmap

Variable	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
COLUMN_HEIGHT	1.00	-0.00	-0.00	0.97	0.23	-0.41	-0.91	1.00	-0.95	-0.06	-0.10	0.34	0.17	-0.89	-0.67	-0.86	0.85	0.97
BEAM_LENGTH	-0.00	1.00	-0.00	0.15	-0.48	0.76	0.04	0.00	0.10	-0.02	-0.05	0.03	-0.01	-0.16	-0.08	-0.13	0.43	0.17
MASS	-0.00	-0.00	1.00	0.09	0.24	0.21	0.04	-0.00	0.13	-0.02	0.02	0.01	-0.04	-0.09	-0.14	-0.17	0.22	0.09
DISP_X	0.97	0.15	0.09	1.00	0.24	-0.21	-0.92	0.97	-0.91	-0.08	-0.10	0.33	0.18	-0.91	-0.72	-0.92	0.90	0.97
DISP_Y	0.23	-0.48	0.24	0.24	1.00	-0.20	-0.29	0.24	-0.17	-0.04	0.00	0.03	0.09	-0.08	-0.30	-0.33	0.13	0.09
ROTATION	-0.41	0.76	0.21	-0.21	-0.20	1.00	0.31	-0.41	0.51	-0.07	0.01	-0.14	-0.04	0.18	0.01	0.05	0.01	-0.28
AXIAL_FORCE	-0.91	0.04	0.04	-0.92	-0.29	0.31	1.00	-0.91	0.90	0.08	0.09	-0.29	-0.24	0.90	0.64	0.91	-0.72	-0.86
SHEAR_FORCE	1.00	0.00	-0.00	0.97	0.24	-0.41	-0.91	1.00	-0.95	-0.06	-0.10	0.34	0.17	-0.89	-0.67	-0.86	0.85	0.97
MOMENT_WO	-0.95	0.10	0.13	-0.91	-0.17	0.51	0.90	-0.95	1.00	0.05	0.10	-0.31	-0.08	0.86	0.61	0.79	-0.71	-0.90
ROTATIONAL_ST	-0.06	-0.02	-0.02	-0.08	-0.04	-0.07	0.08	-0.06	0.05	1.00	-0.01	-0.03	-0.03	0.09	0.16	0.12	-0.05	-0.06
LATERAL_ST_Y	-0.10	-0.05	0.02	-0.10	0.00	0.01	0.09	-0.10	0.10	-0.01	1.00	-0.03	0.06	0.11	0.10	0.10	-0.10	-0.09
LATERAL_ST_X	0.34	0.03	0.01	0.33	0.03	-0.14	-0.29	0.34	-0.31	-0.03	-0.03	1.00	0.10	-0.29	-0.19	-0.26	0.31	0.34
velocity_X	0.17	-0.01	-0.04	0.18	0.09	-0.04	-0.24	0.17	-0.08	-0.03	0.06	0.10	1.00	-0.03	0.08	-0.08	0.13	0.20
velocity_Y	-0.89	-0.16	-0.09	-0.91	-0.08	0.18	0.90	-0.89	0.86	0.09	0.11	-0.29	-0.03	1.00	0.74	0.92	-0.82	-0.87
acceleration_X	-0.67	-0.08	-0.14	-0.72	-0.30	0.01	0.64	-0.67	0.61	0.16	0.10	-0.19	0.08	0.74	1.00	0.81	-0.62	-0.62
acceleration_Y	-0.86	-0.13	-0.17	-0.92	-0.33	0.05	0.91	-0.86	0.79	0.12	0.10	-0.26	-0.08	0.92	0.81	1.00	-0.81	-0.82
PERIOD_MIN	0.85	0.43	0.22	0.90	0.13	0.01	-0.72	0.85	-0.71	-0.05	-0.10	0.31	0.13	-0.82	-0.62	-0.81	1.00	0.91
PERIOD_MAX	0.97	0.17	0.09	0.97	0.09	-0.28	-0.86	0.97	-0.90	-0.06	-0.09	0.34	0.20	-0.87	-0.62	-0.82	0.91	1.00

Variable

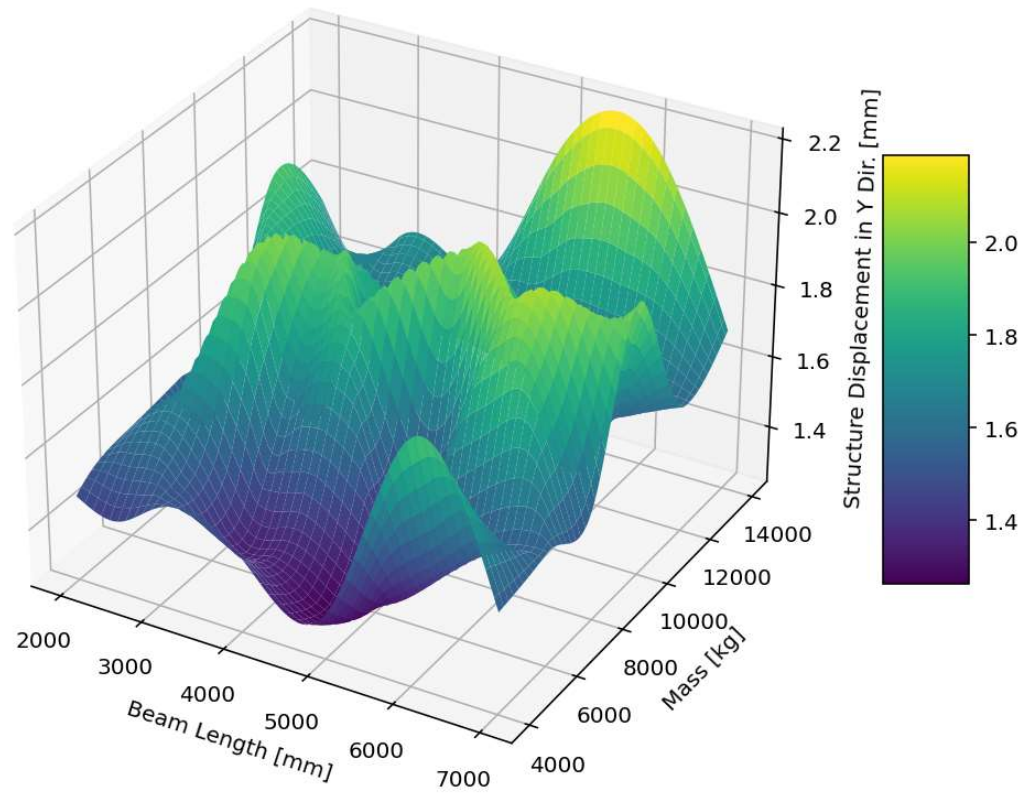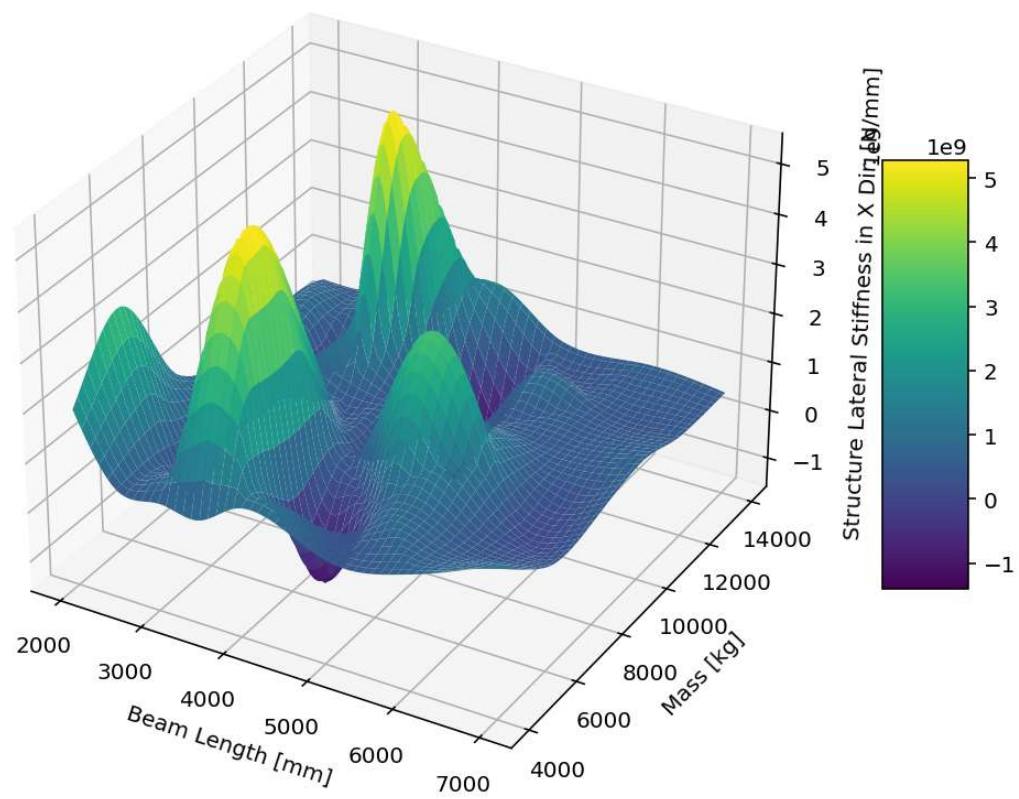Undeformed and Deformed Shapes - DEFORMED SCALE: 10.00

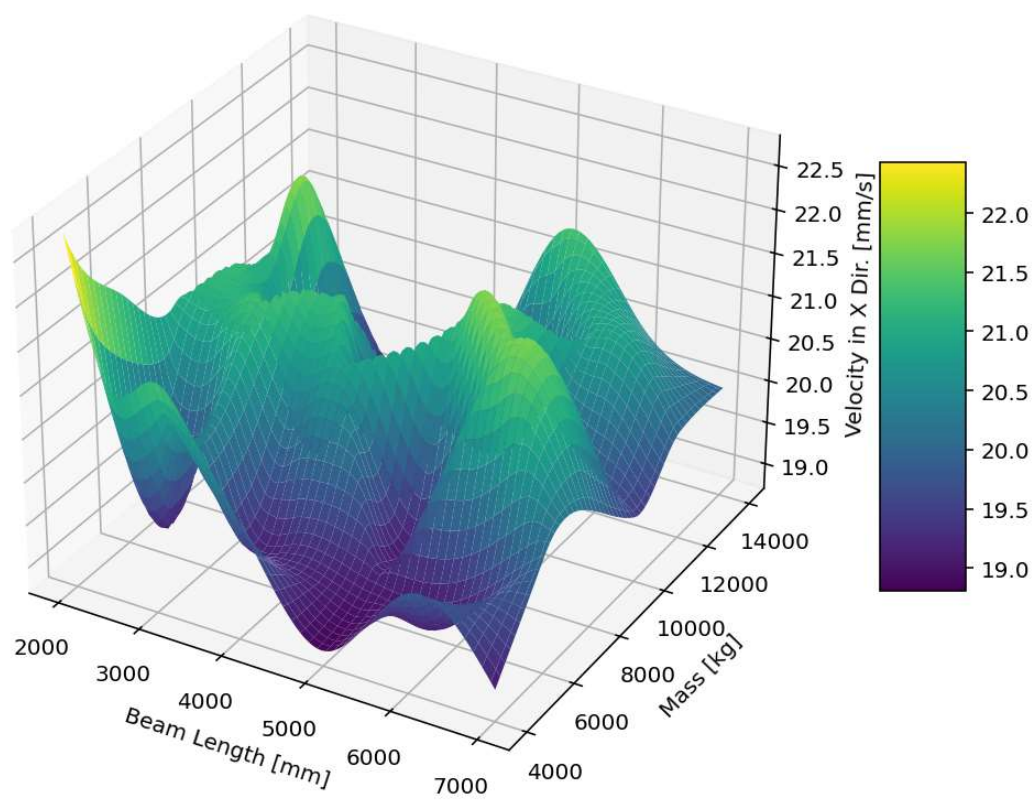3D Contour Plot of Structure Displacement in X Dir. [mm]

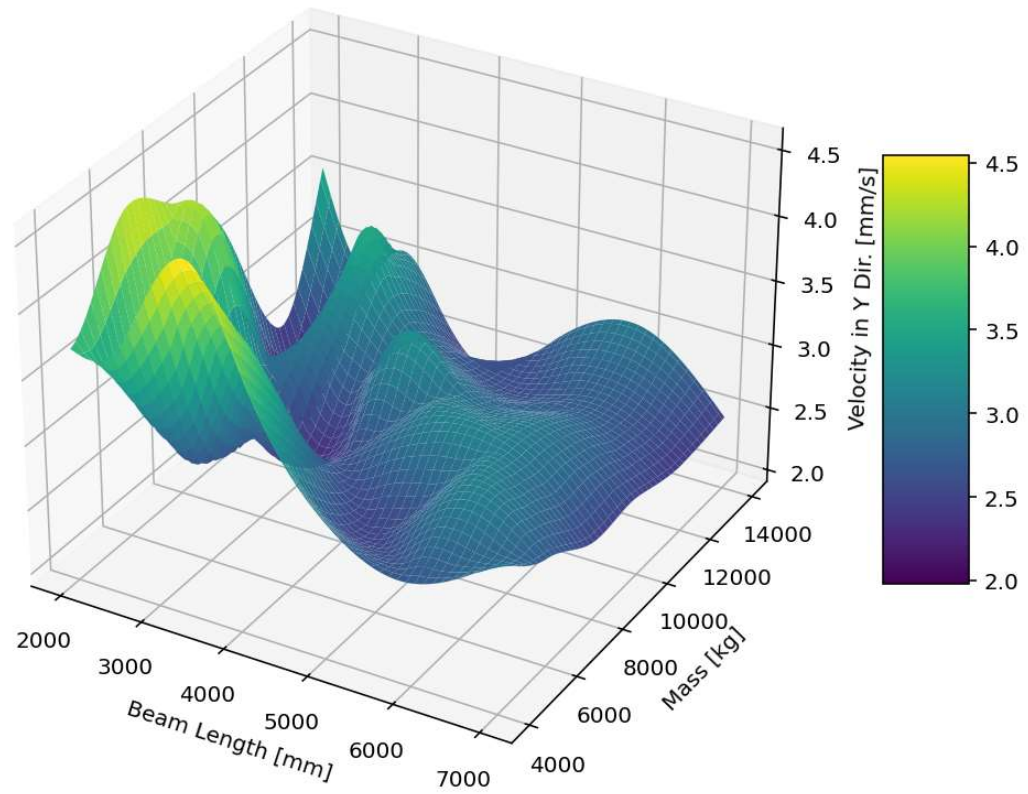3D Contour Plot of Structure Displacement in Y Dir. [mm]

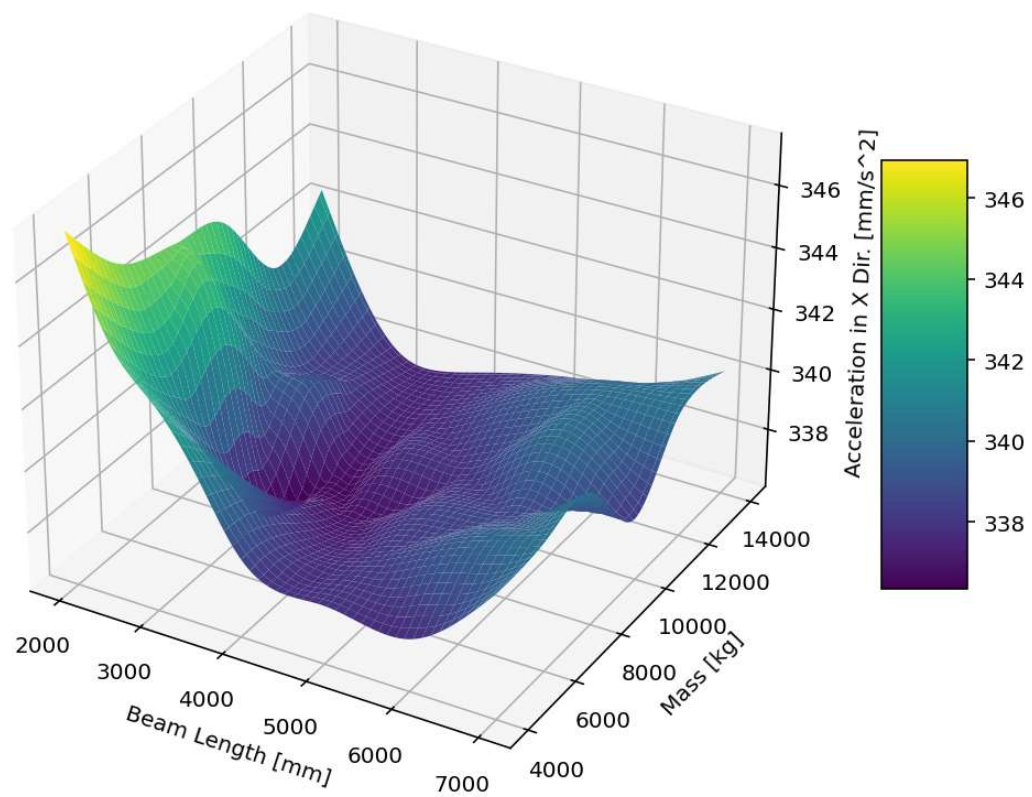3D Contour Plot of Structure Lateral Stiffness in X Dir. [N/mm]
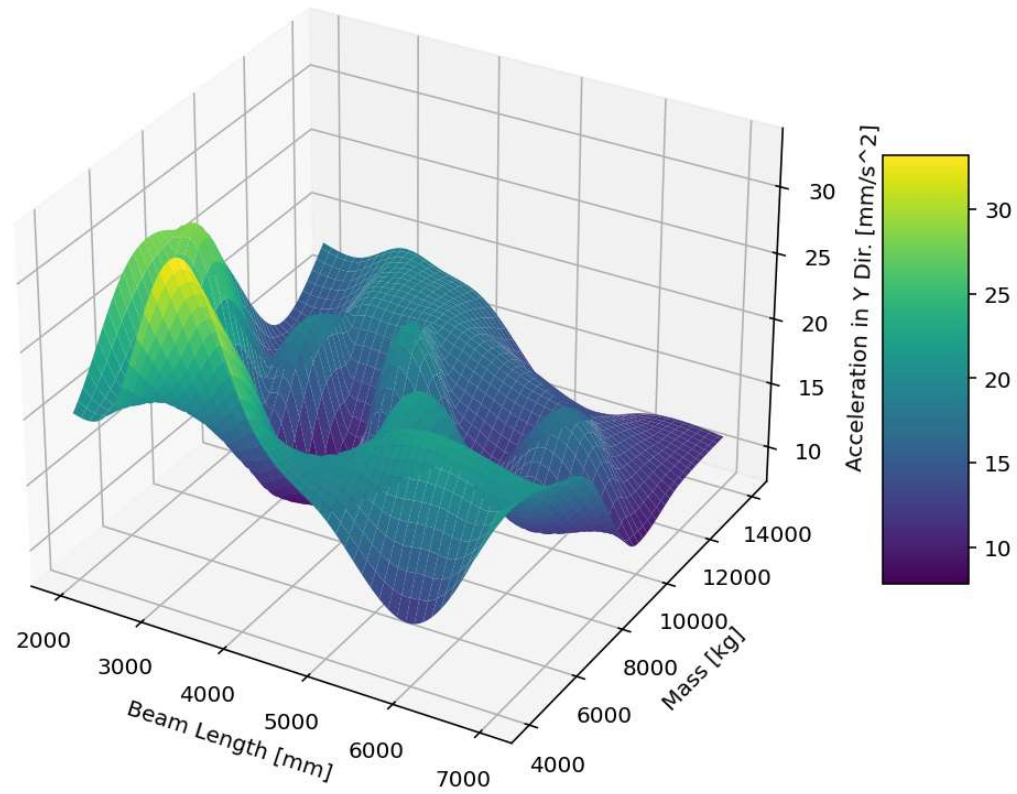
3D Contour Plot of Velocity in X Dir. [mm/s]

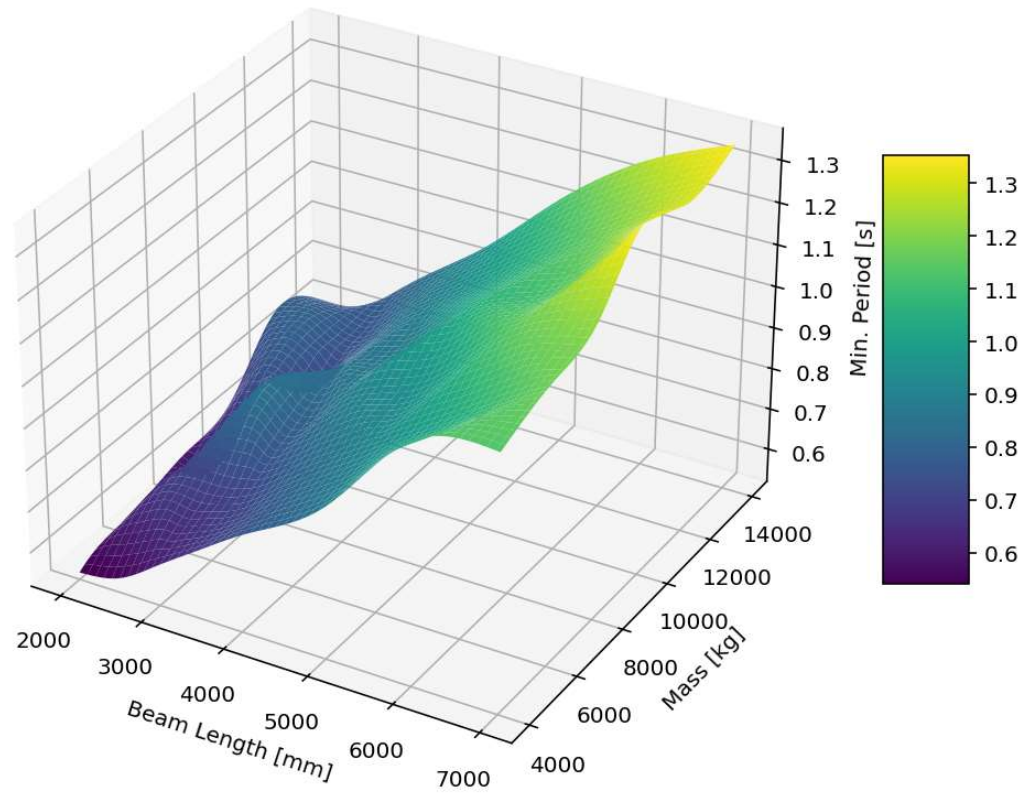3D Contour Plot of Velocity in Y Dir. [mm/s]
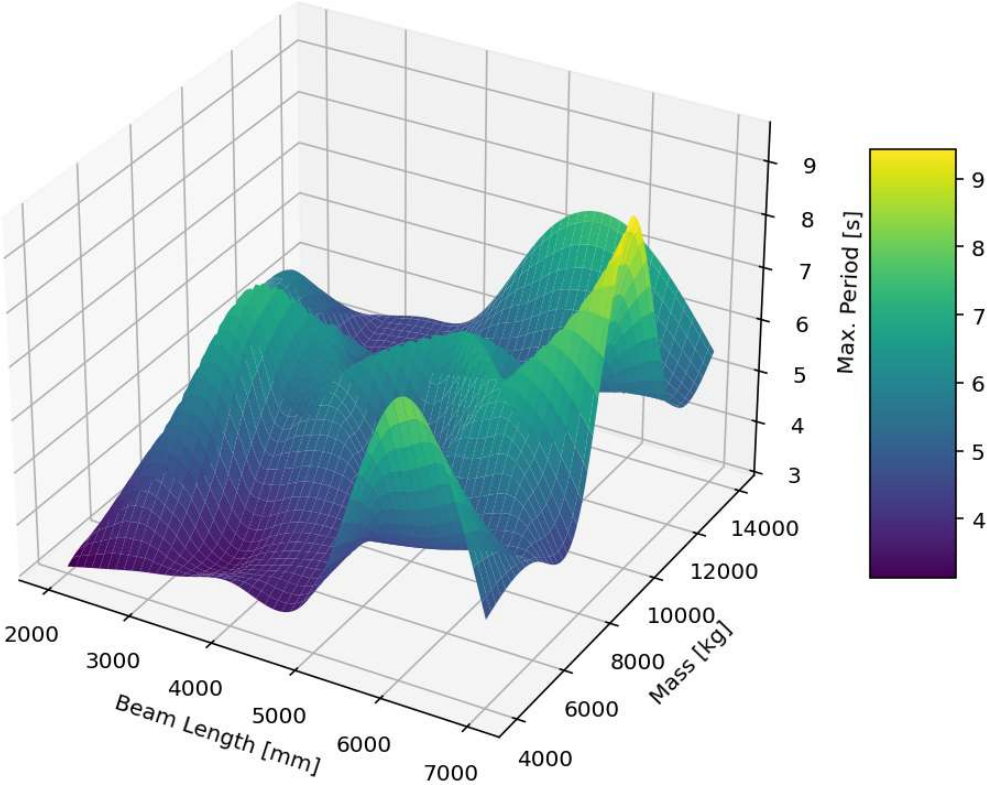
3D Contour Plot of Acceleration in X Dir. [mm/s^2]
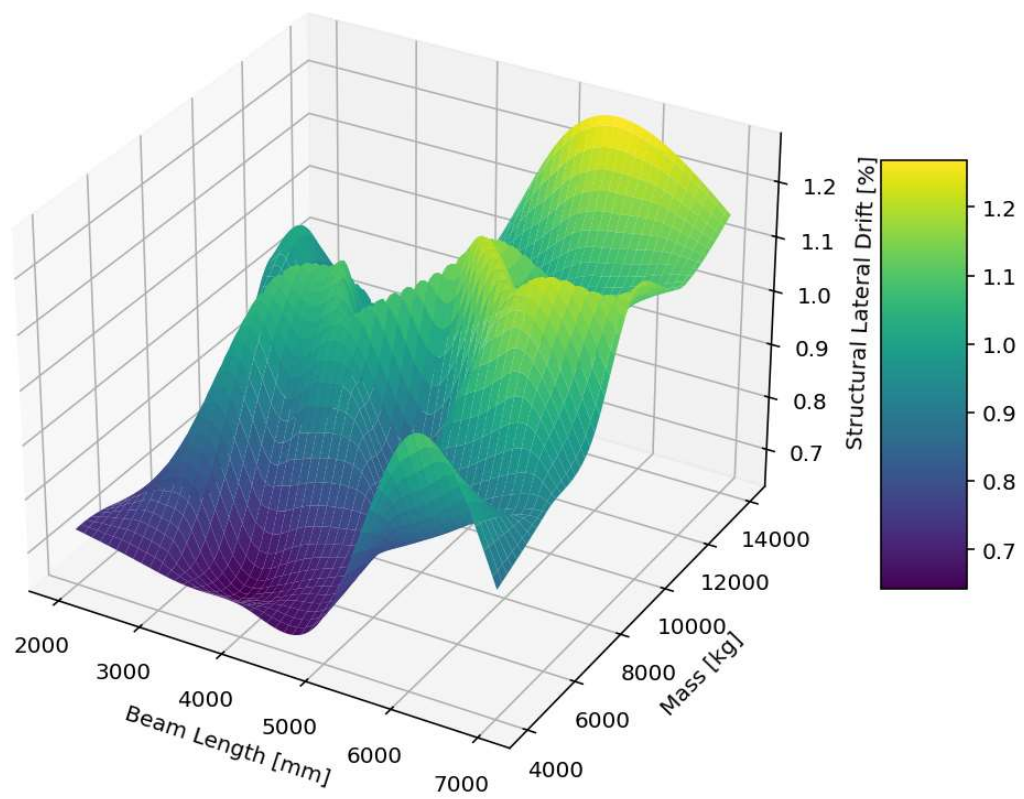
3D Contour Plot of Acceleration in Y Dir. [mm/s^2]
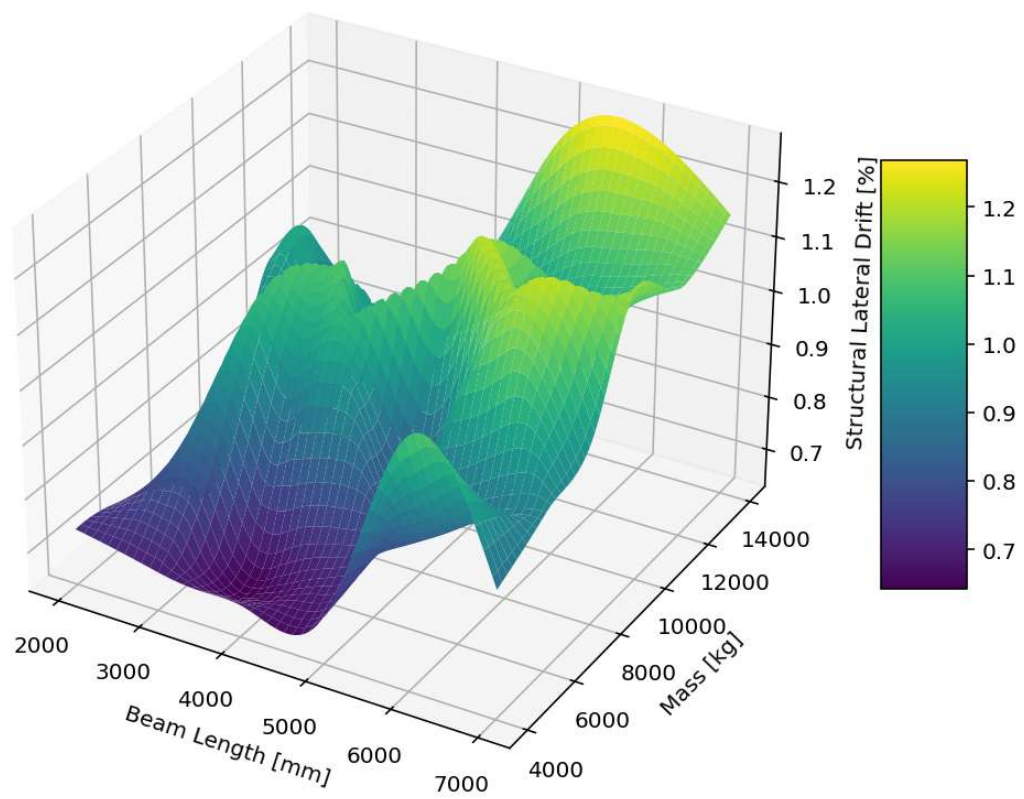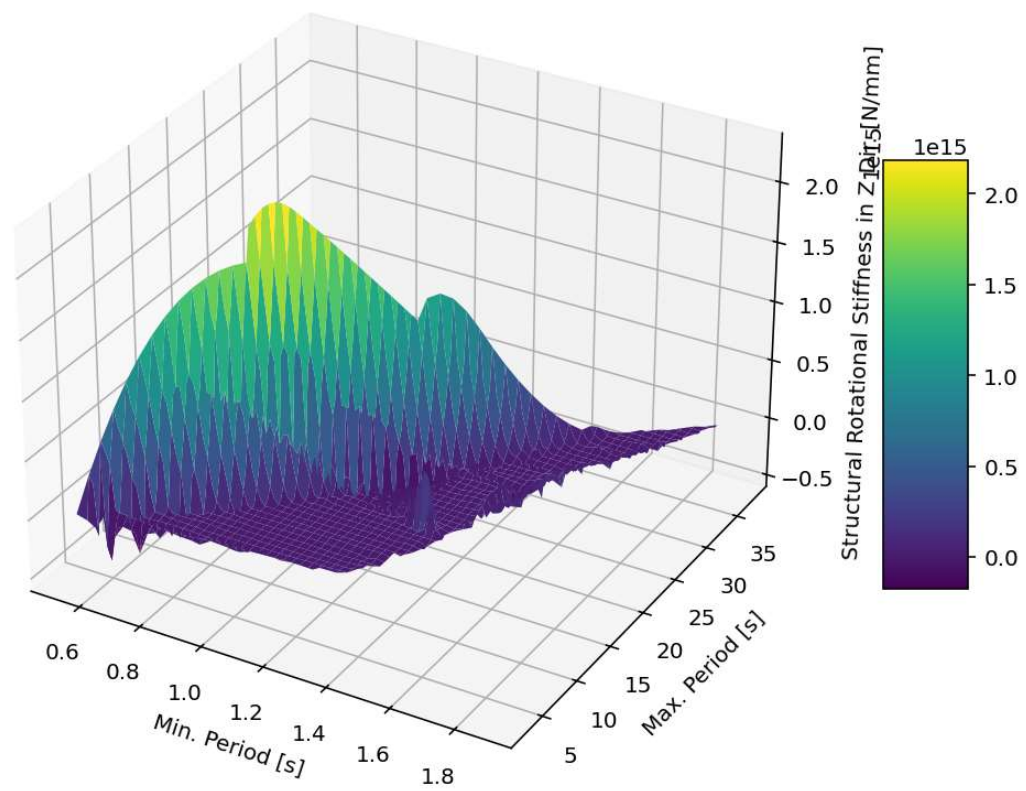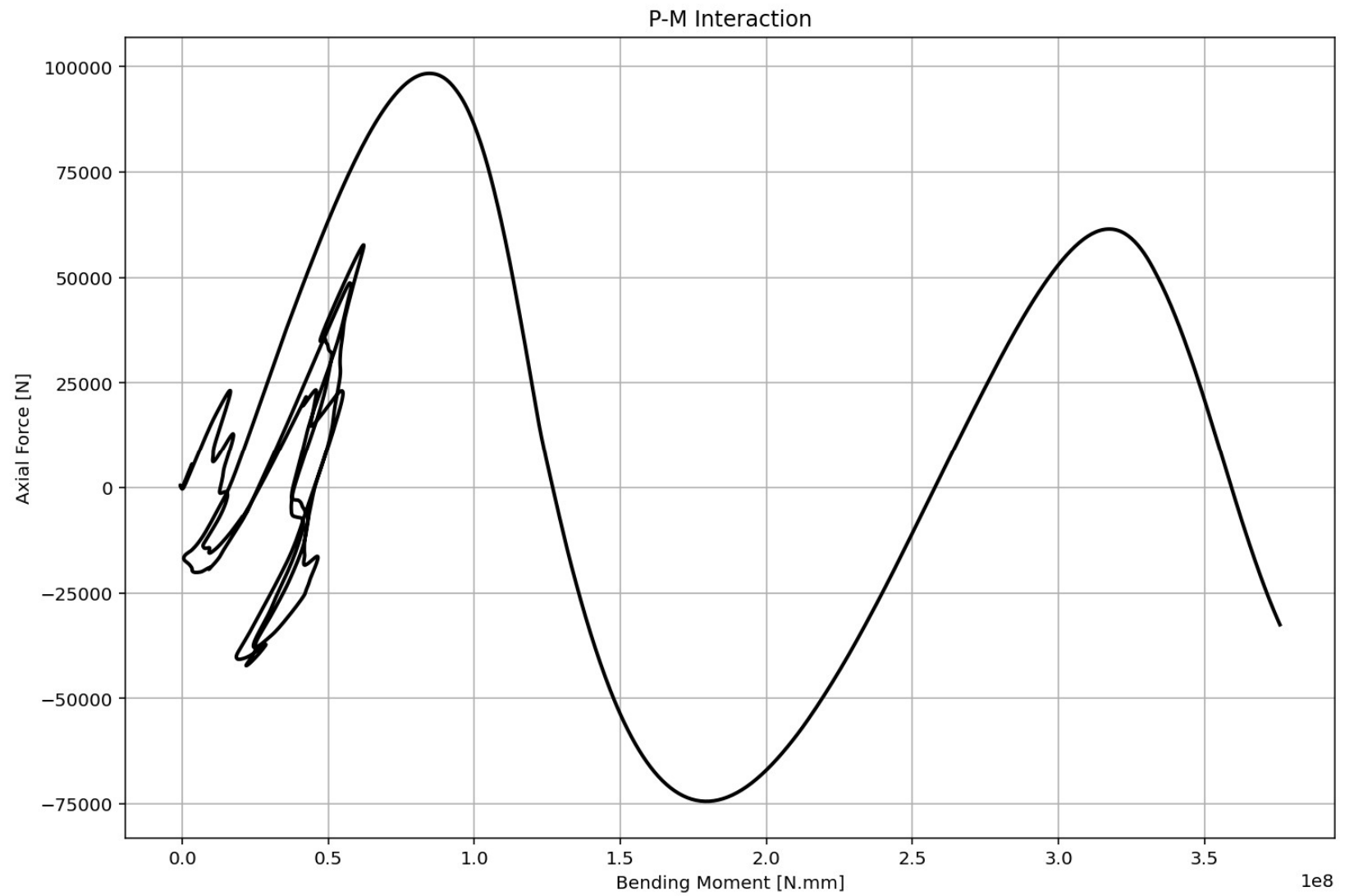
3D Contour Plot of Min. Period [s]

3D Contour Plot of Max. Period [s]

3D Contour Plot of Structural Lateral Drift [%]

3D Contour Plot of Structural Lateral Drift [%]

3D Contour Plot of Max. Period [s]
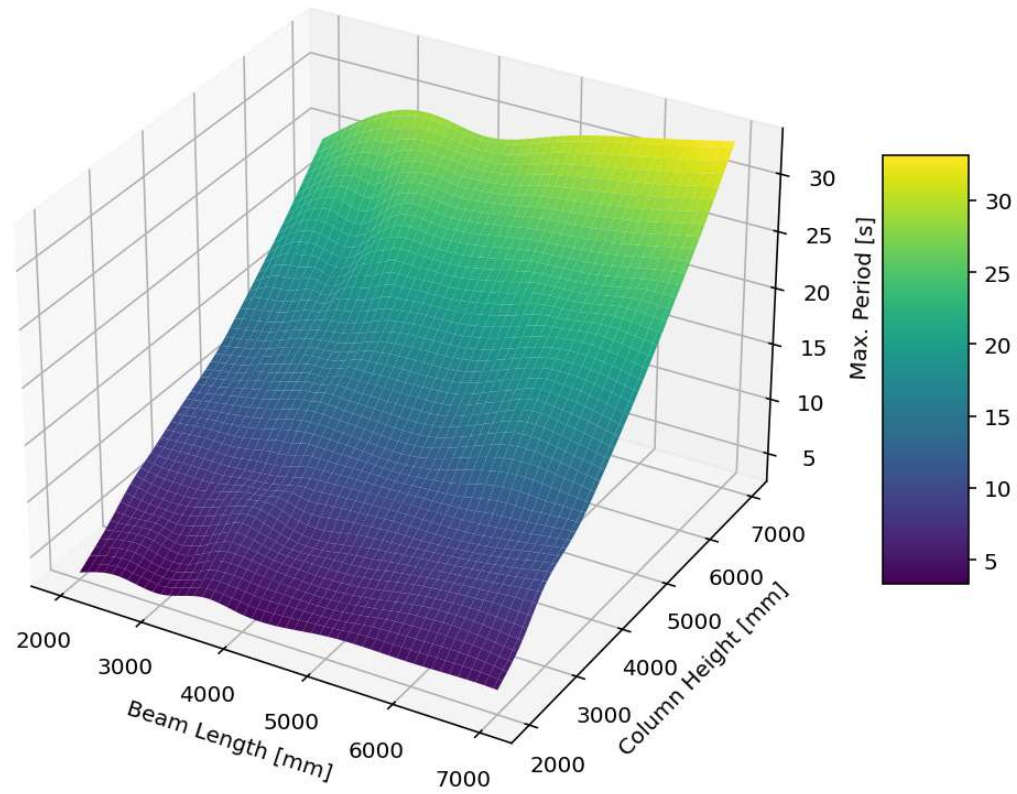
3D Contour Plot of Structural Lateral Drift [%]
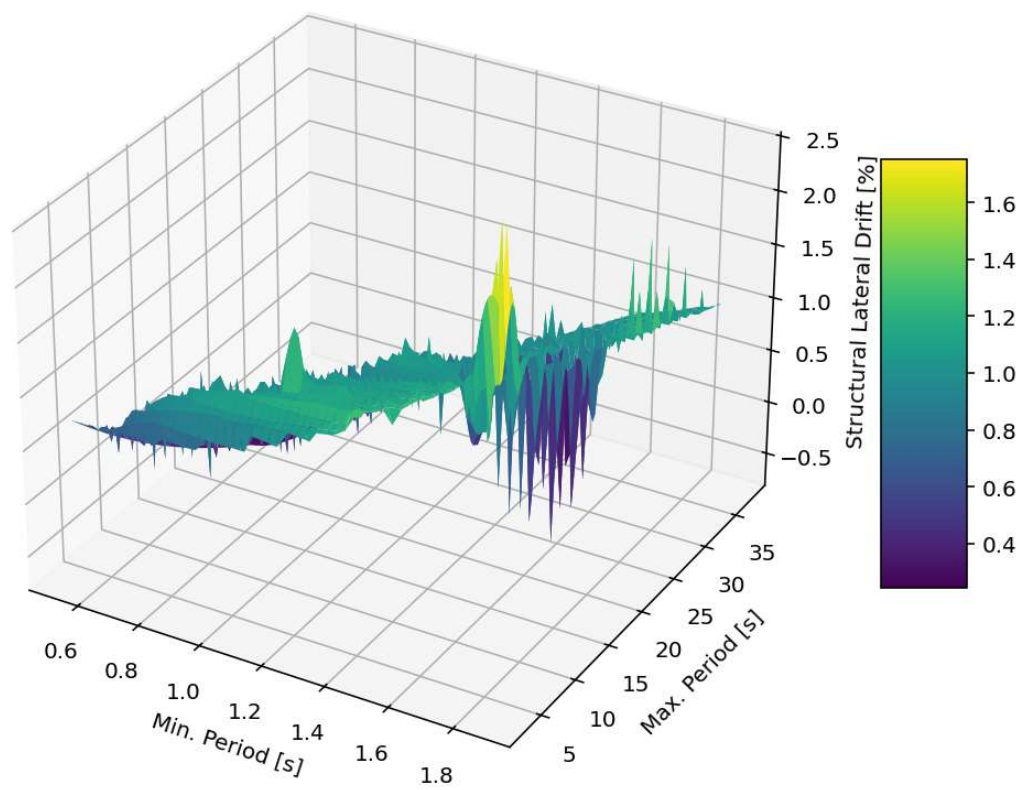
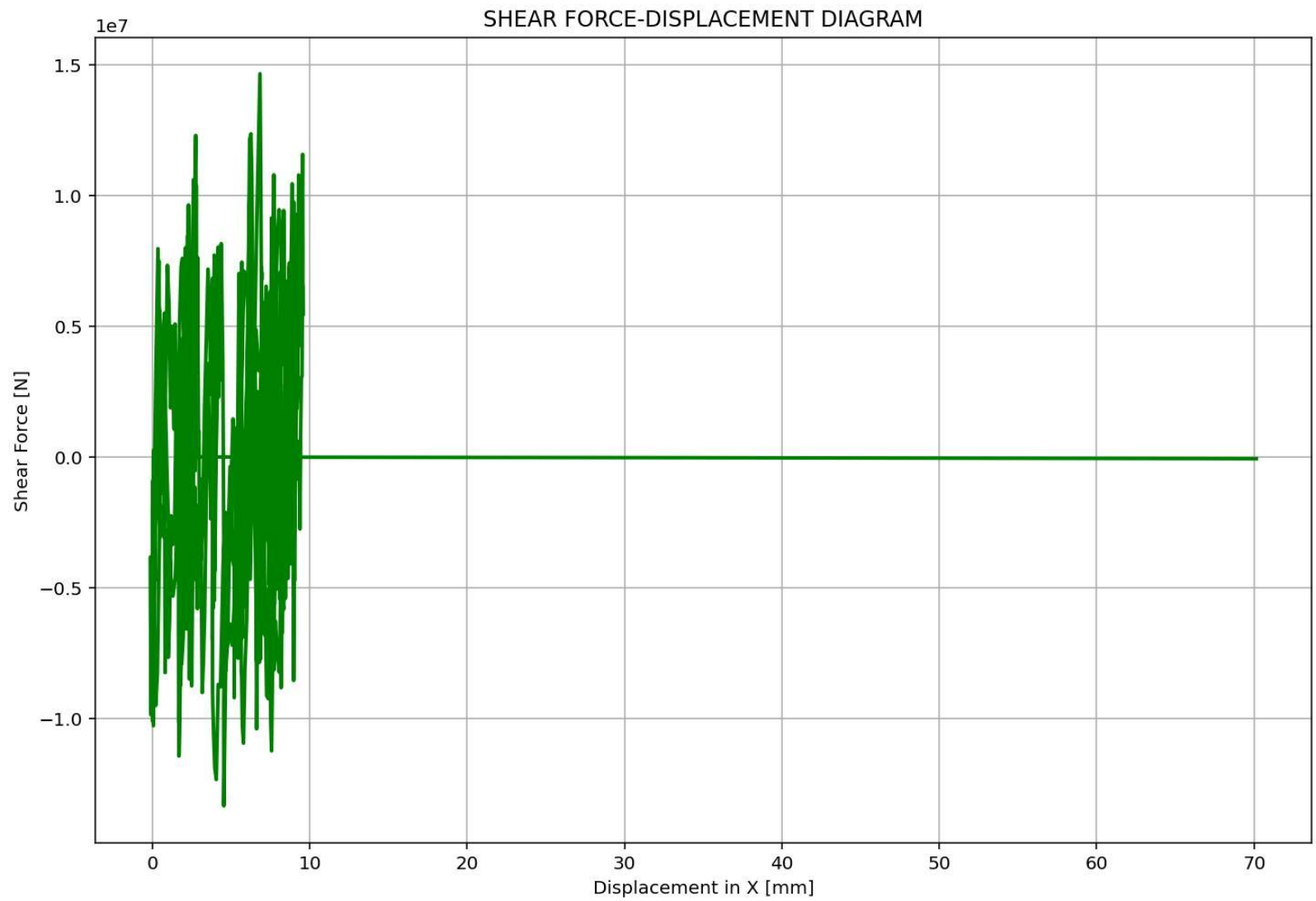3D Contour Plot of Structural Lateral Stiffness in X Dir. [N/mm]
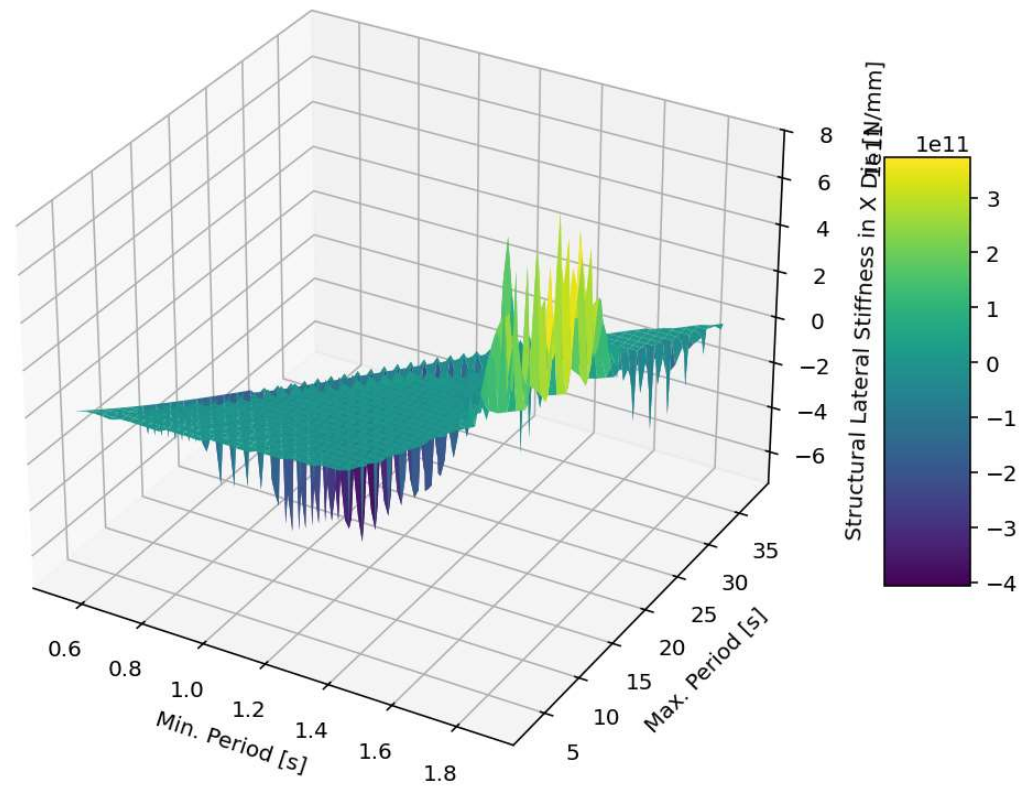
3D Contour Plot of Structural Lateral Stiffness in Y Dir. [N/mm]
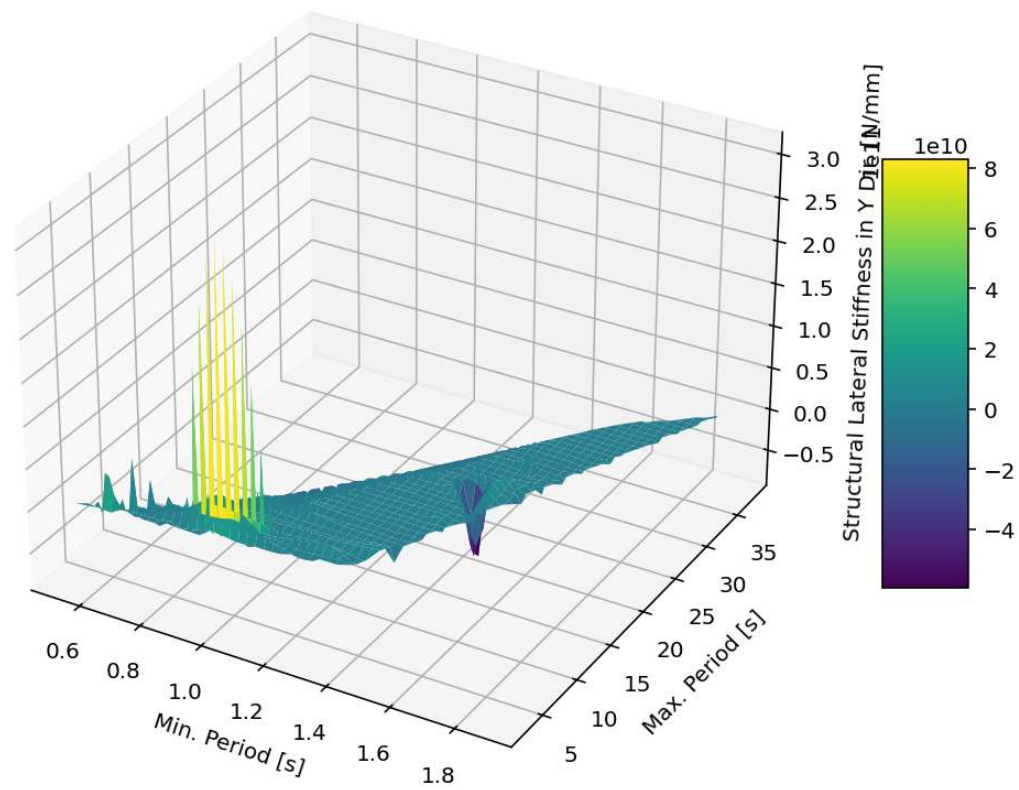
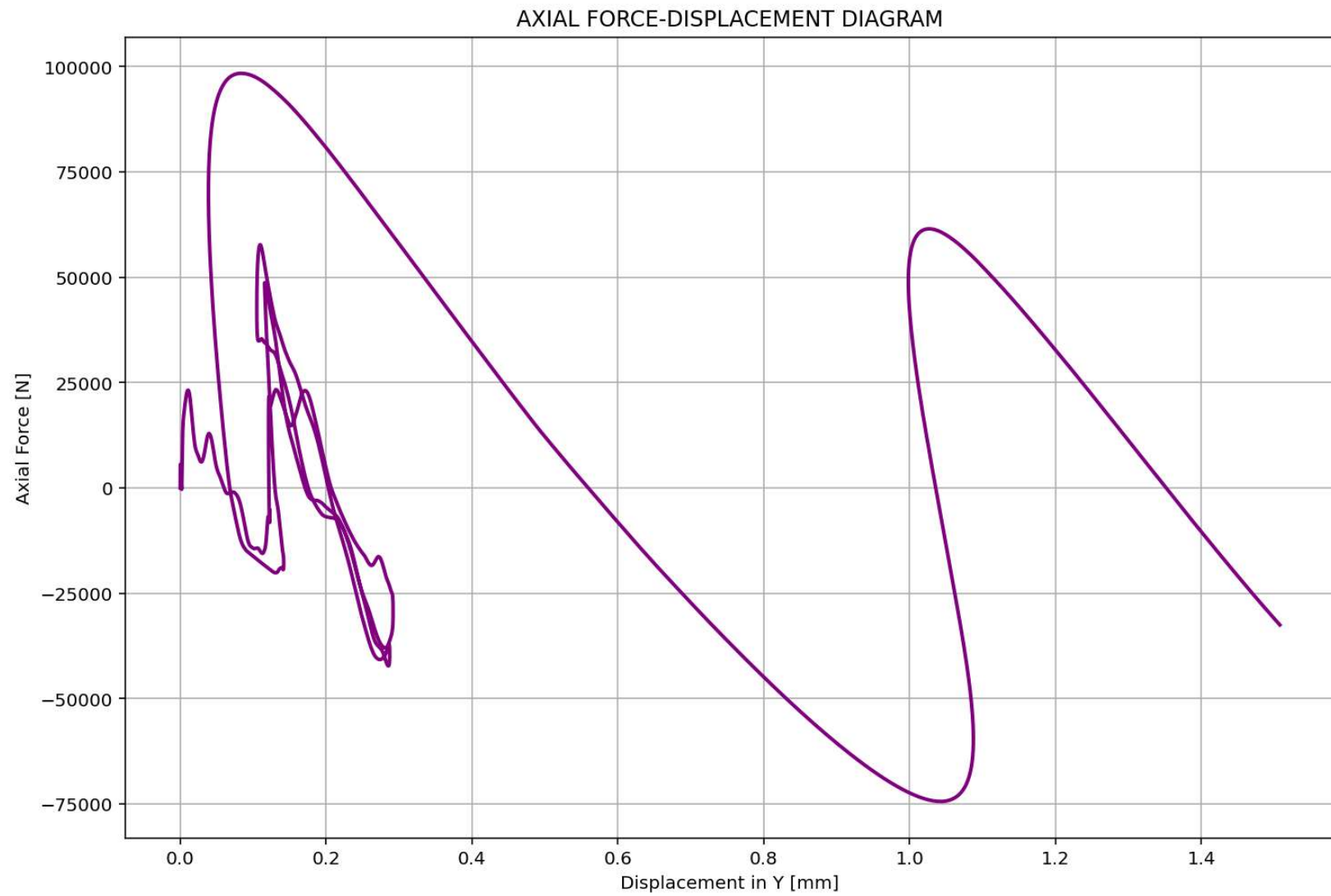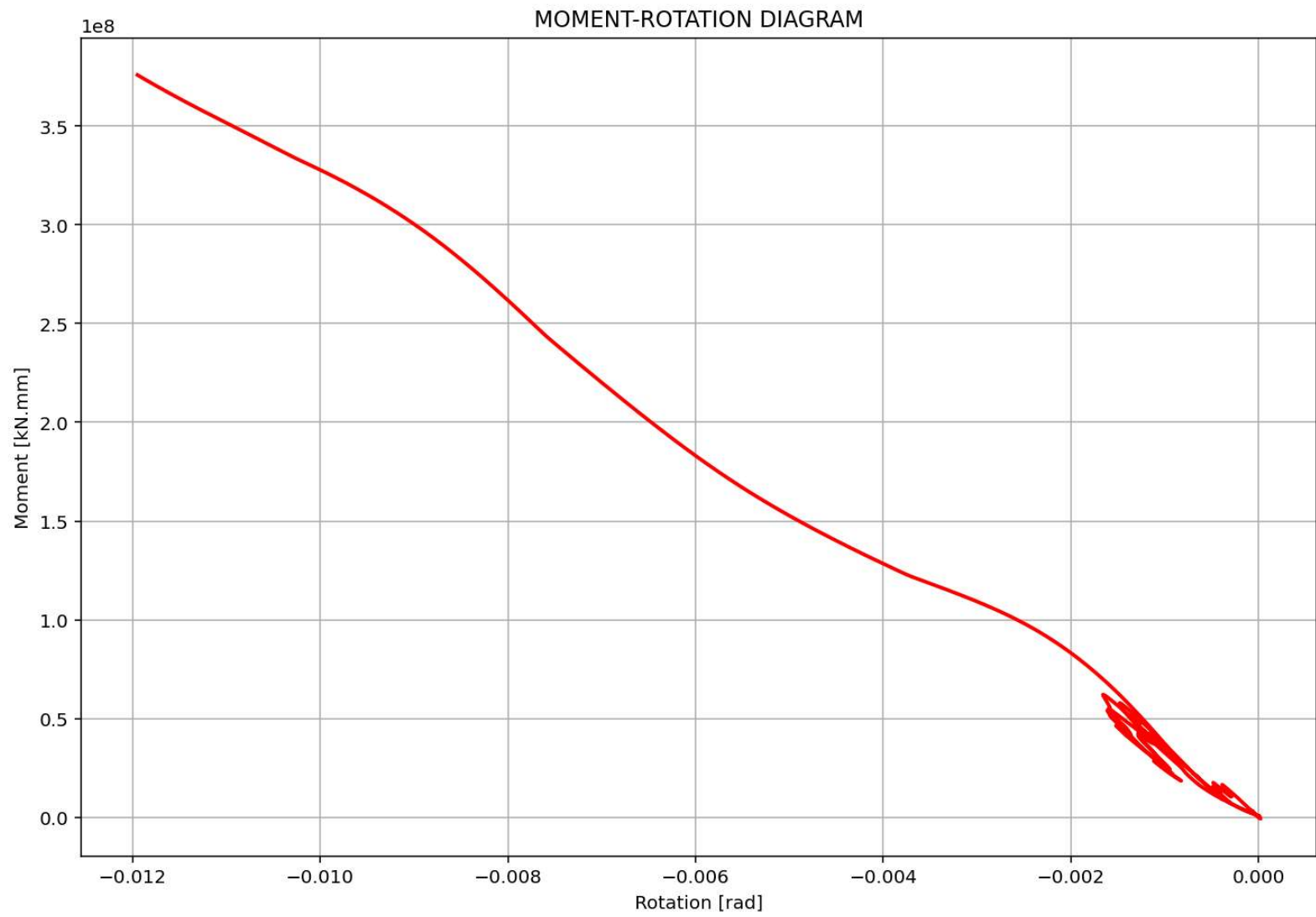3D Contour Plot of Structural Rotational Stiffness in Z Dir. [N/mm]

P-M Interaction

SHEAR FORCE-DISPLACEMENT DIAGRAM

AXIAL FORCE-DISPLACEMENT DIAGRAM

MOMENT-ROTATION DIAGRAM

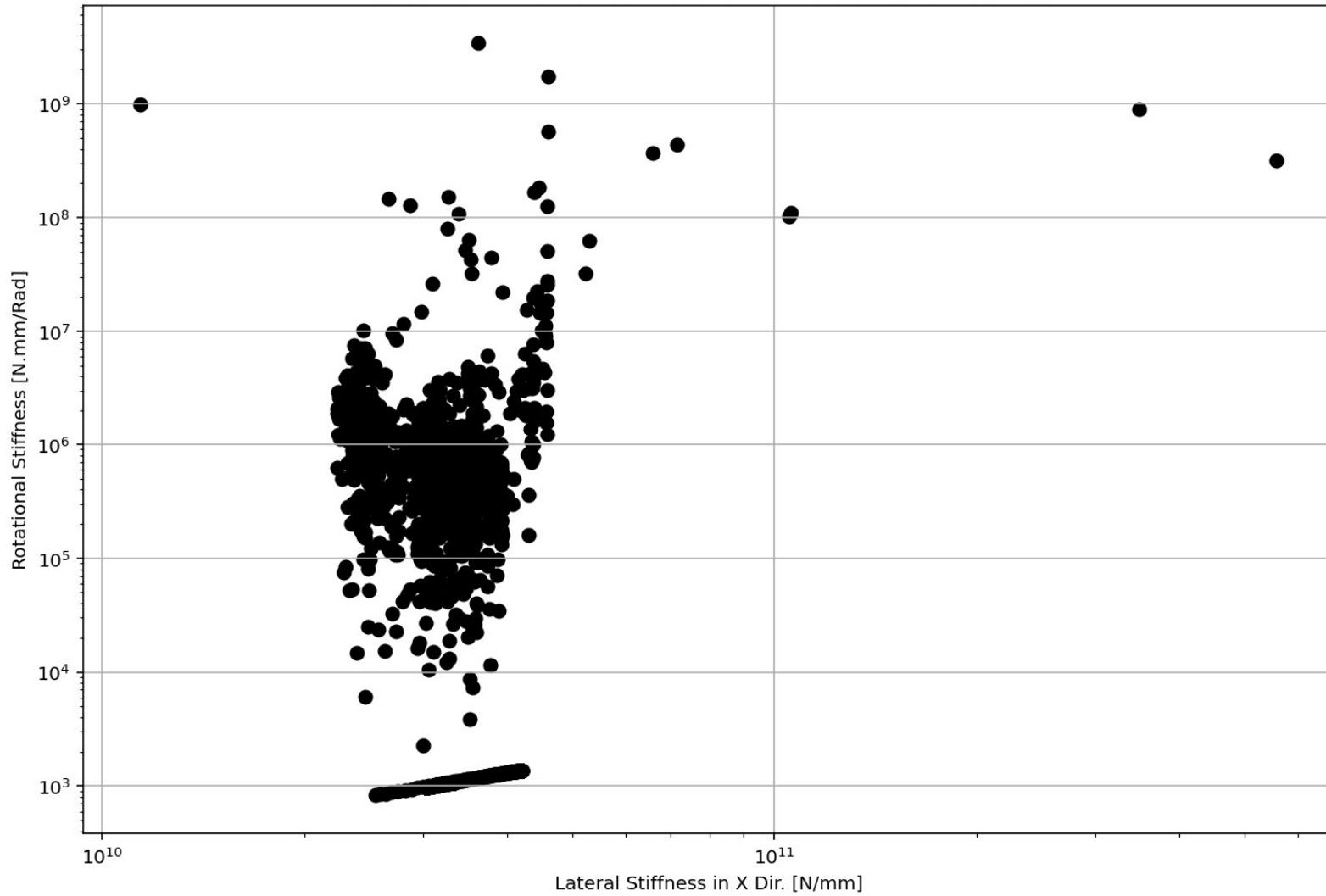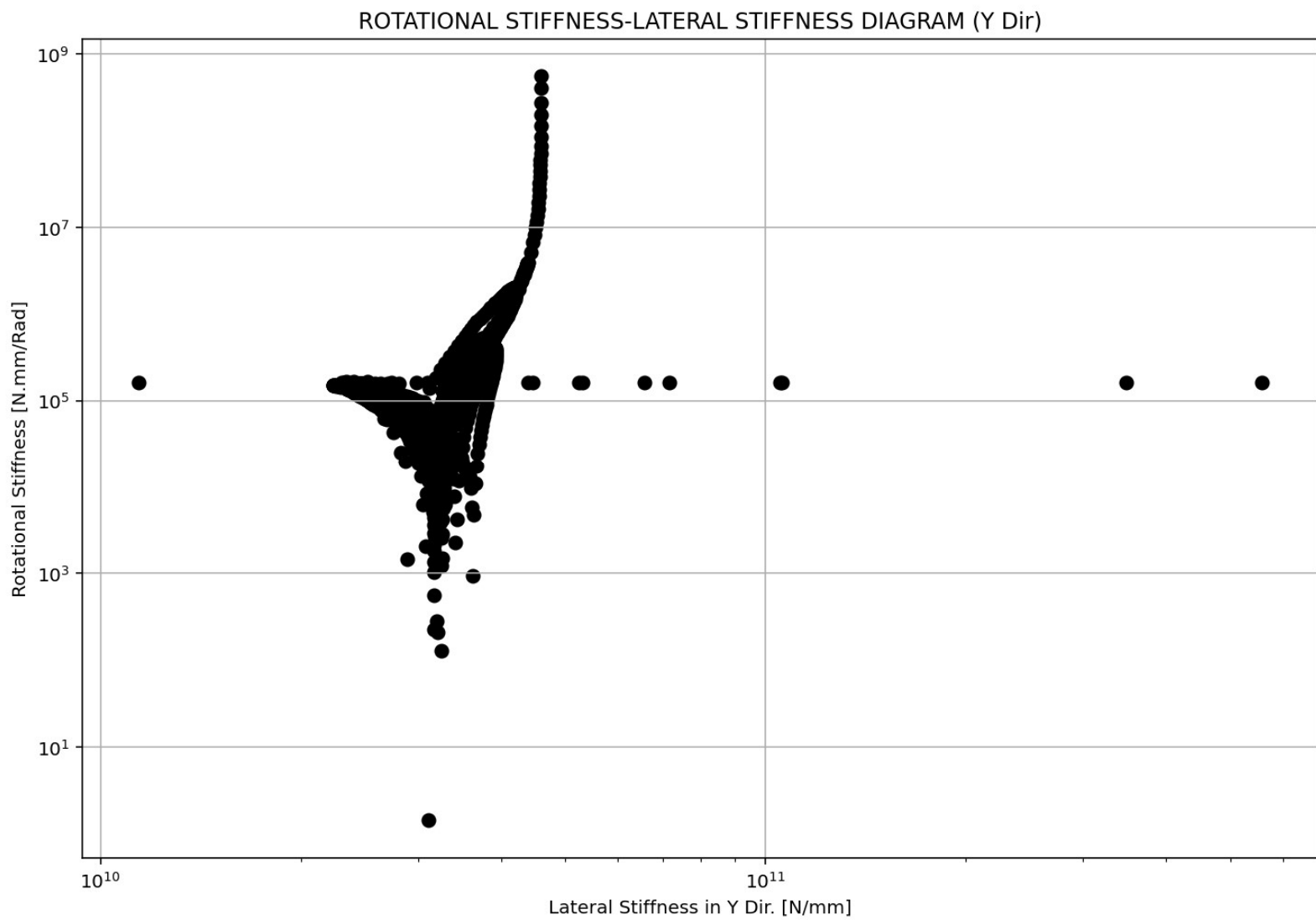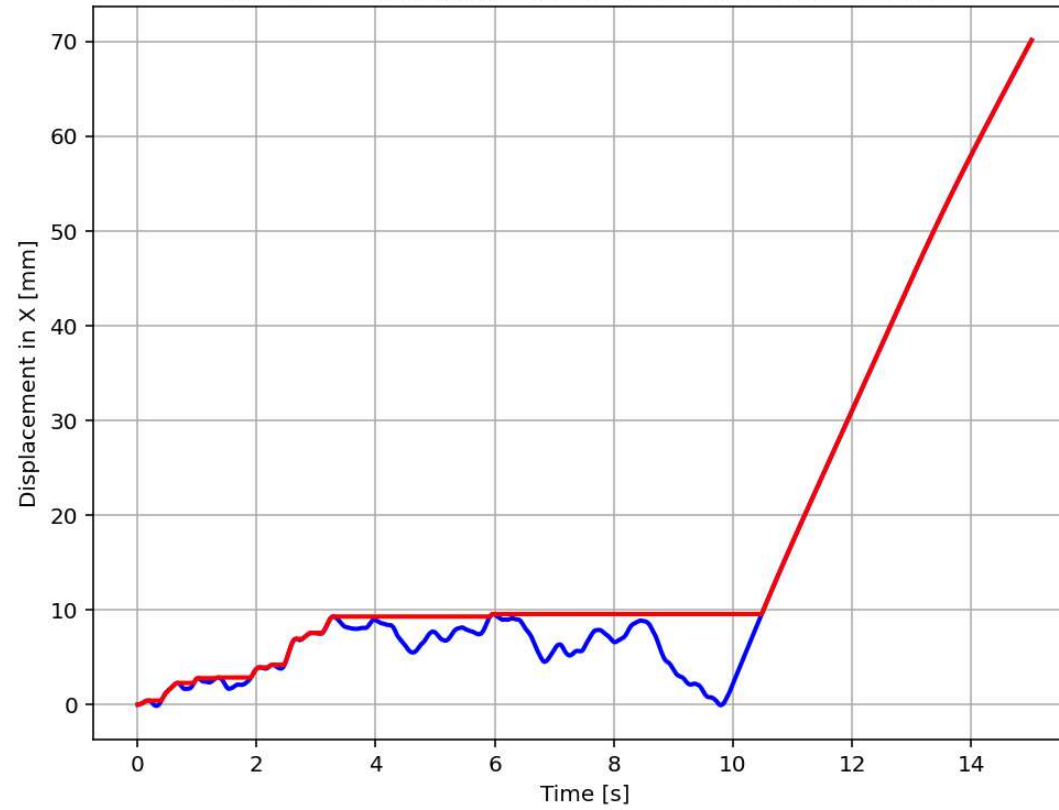ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM (X Dir)

ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM (Y Dir)

Time vs Displacement - MAX. ABS: 70.14219458735194

Time vs Displacement - MAX. ABS: 1.507676809926989

Time vs Velocity - MAX. ABS: 20.52917724497818

Time vs Acceleration - MAX. ABS: 335.84039776327506

Time vs Base-reaction - MAX. ABS: 14661545.135733385

Displacement vs Shear Base-reaction

Displacement vs Axial Base-reaction