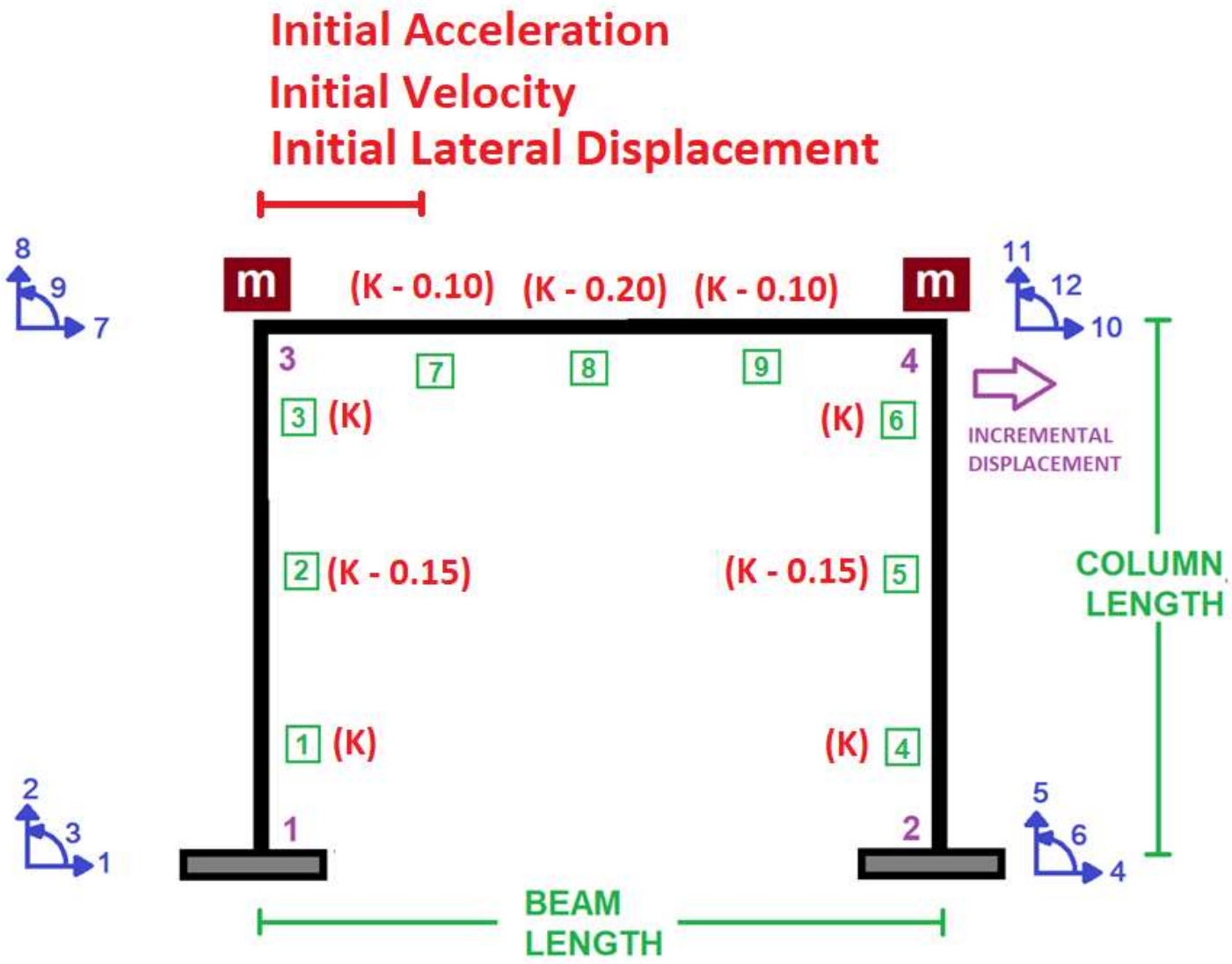
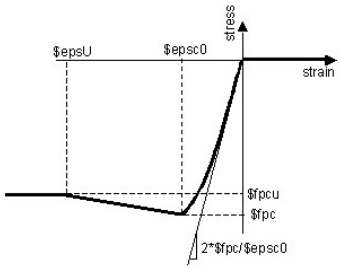
>> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<

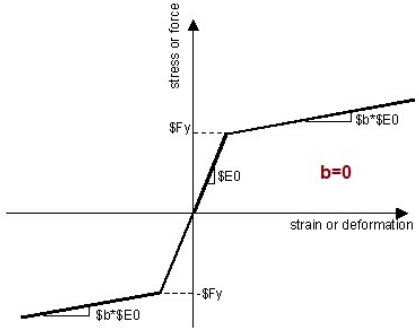
SENSITIVITY ANALYSIS OF CONCRETE FRAME BY CHANGING COLUMN REBAR DIAMETER AND SECTION DEPTH AND CONFINEMENT ENHANCEMENT RATIO. USING OPENSEES (PARALLEL COMPUTING VERSION)

WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)

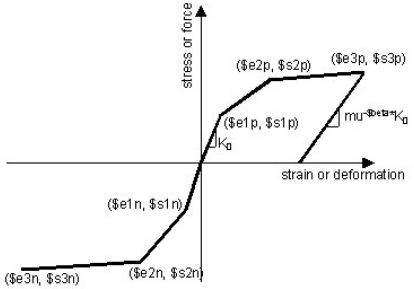

Initial Acceleration
Initial Velocity
Initial Lateral Displacement
m
m
(K - 0.10)
(K - 0.20)
(K - 0.10)
8
9
7
11
12
10
3
7
8
9
4
3 (K)
(K) 6
INCREMENTAL DISPLACEMENT
2 (K - 0.15)
(K - 0.15) 5
COLUMN LENGTH
1 (K)
(K) 4
2
3
1
1
2
5
6
4
BEAM LENGTH



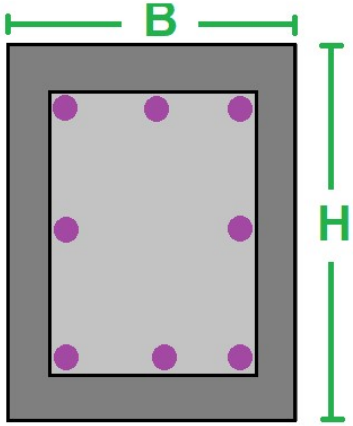
CORE AND COVER CONCRETE RELATION



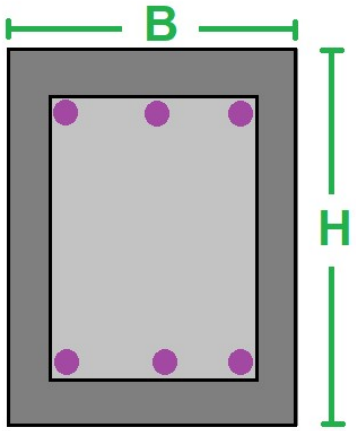
WITHOUT HARDENING AND ULTIMATE STRAIN



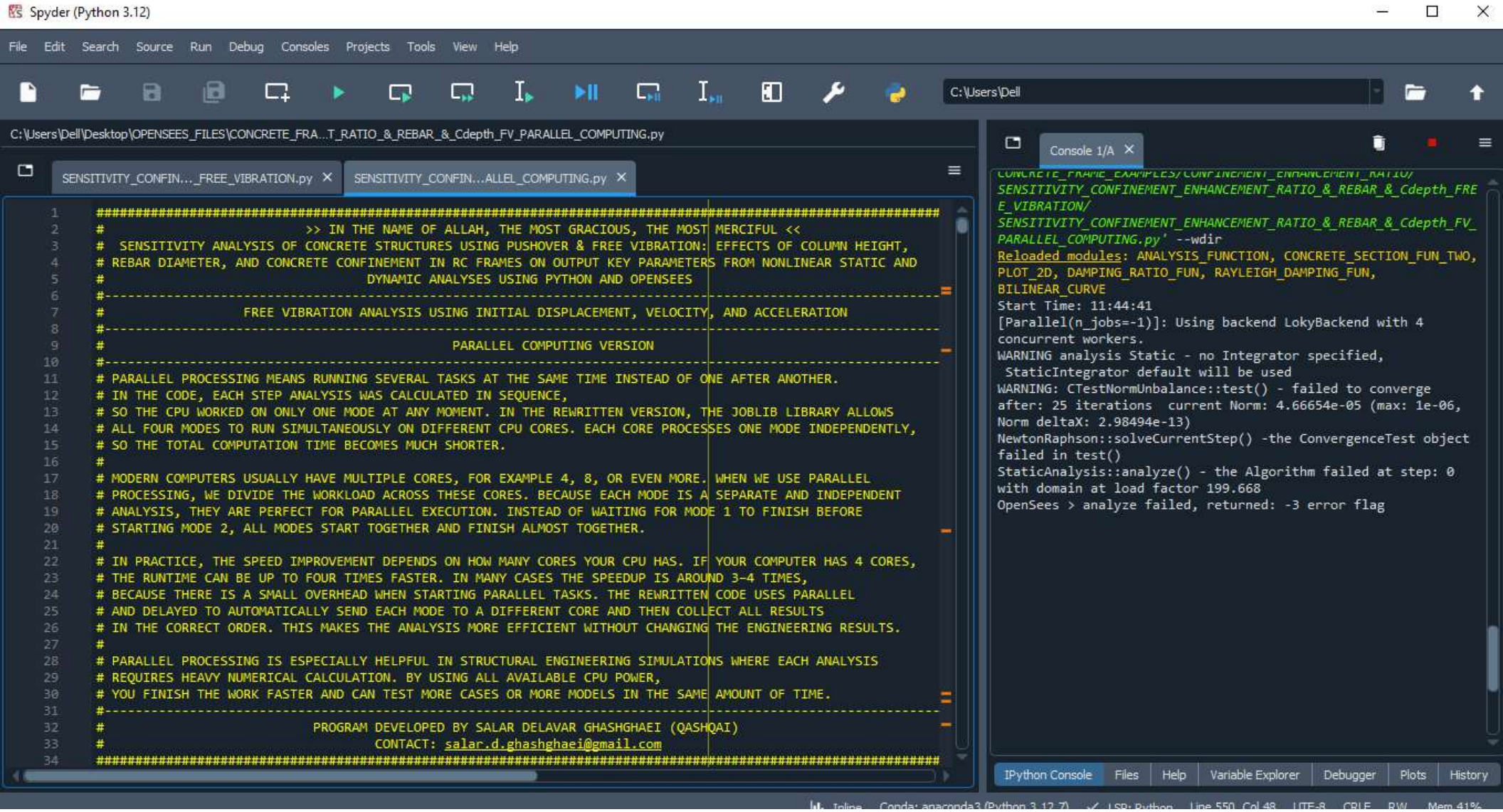
WITH HARDENING AND ULTIMATE STRAIN



COLUMN SECTION



BEAM SECTION

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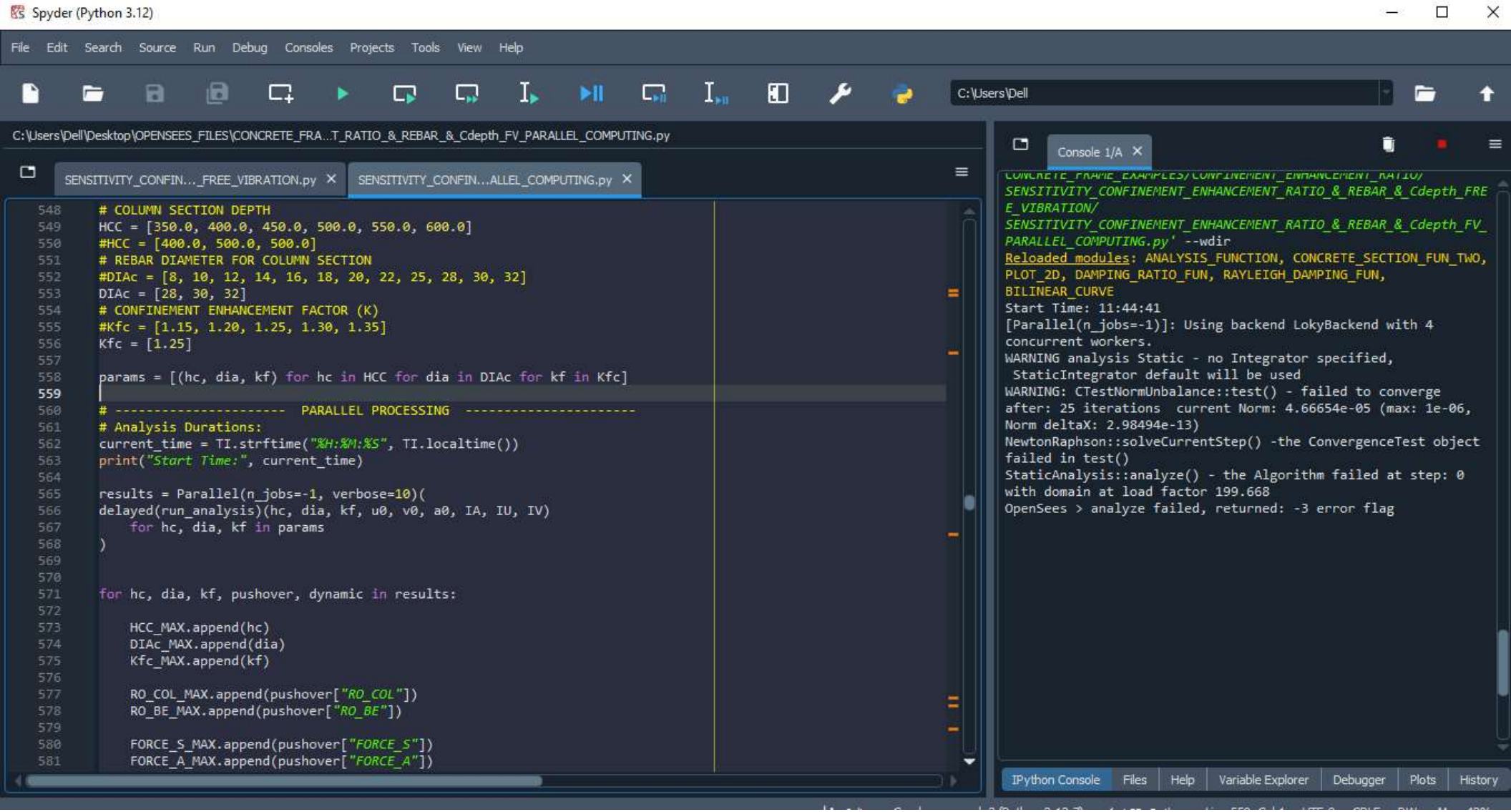
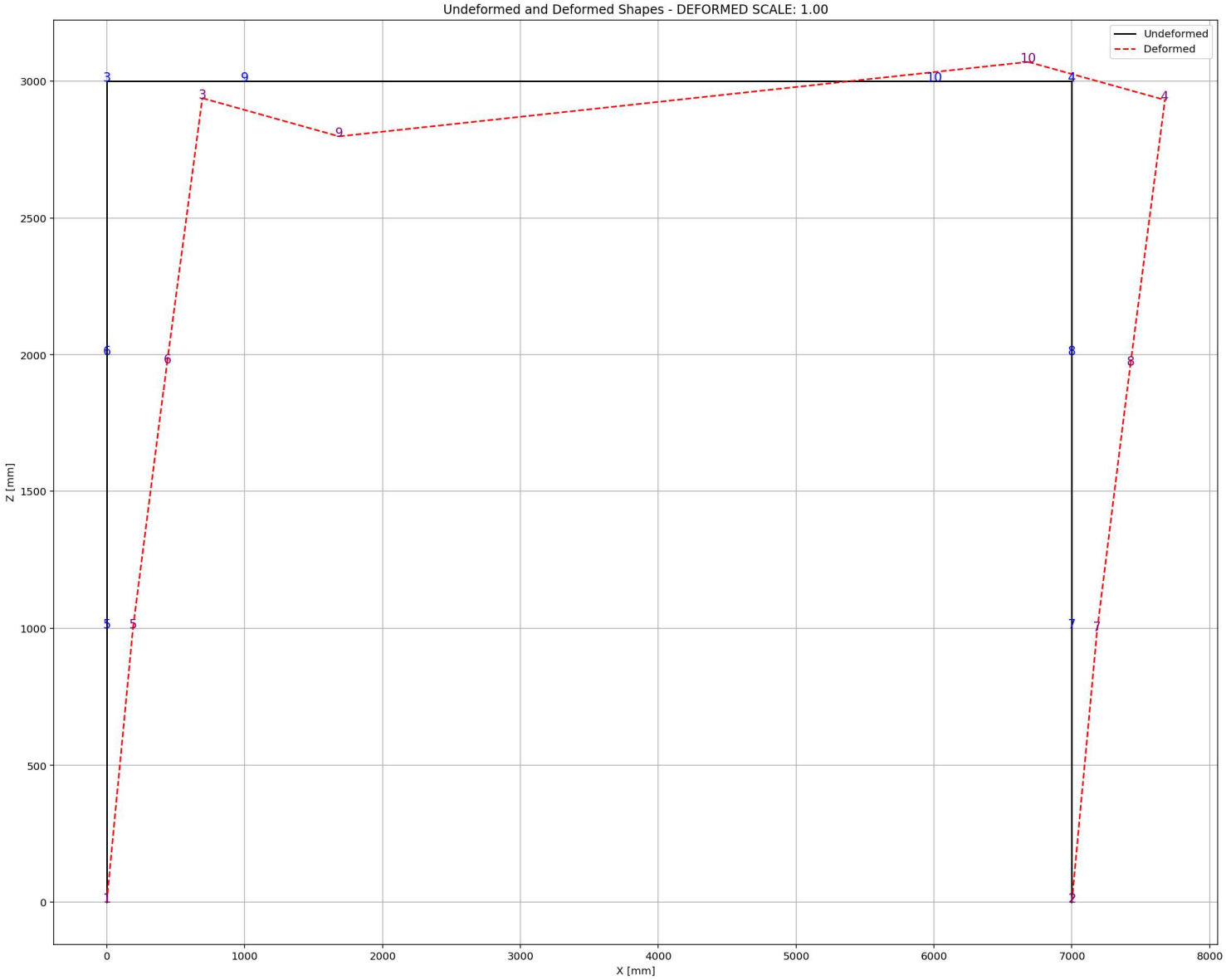
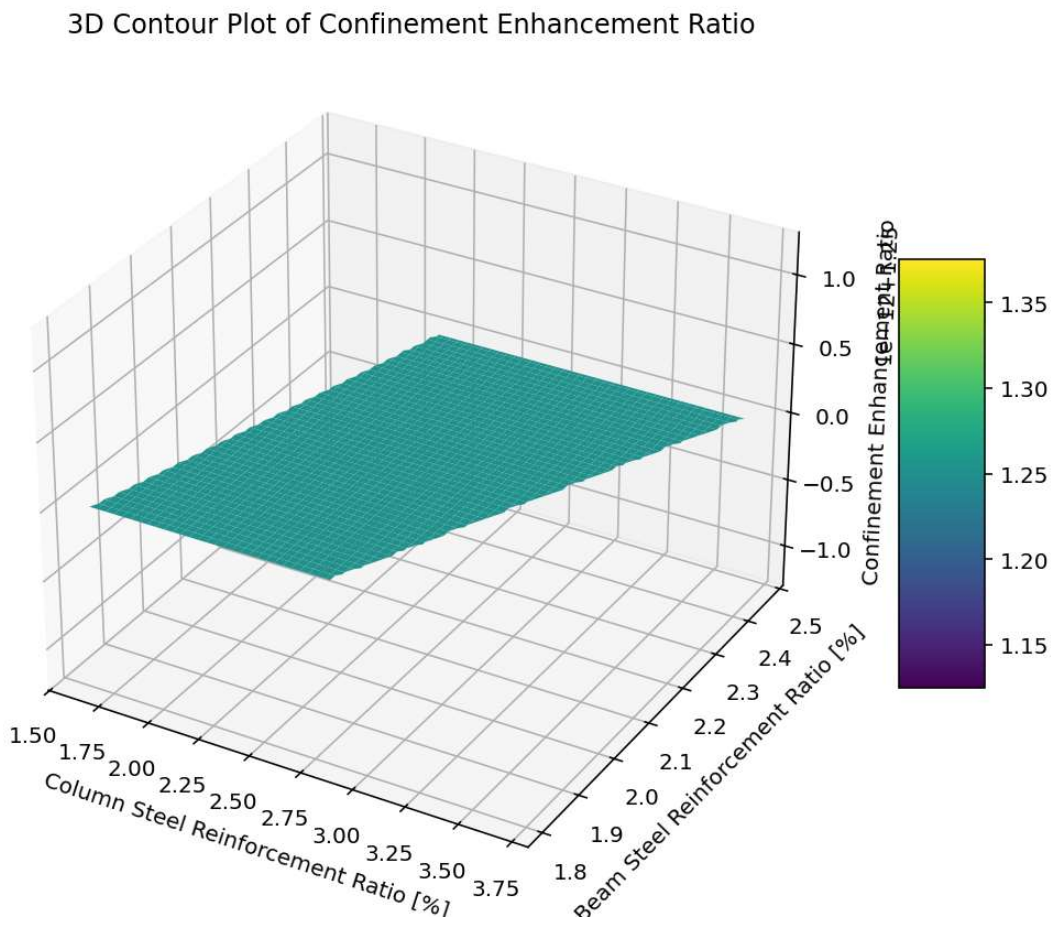
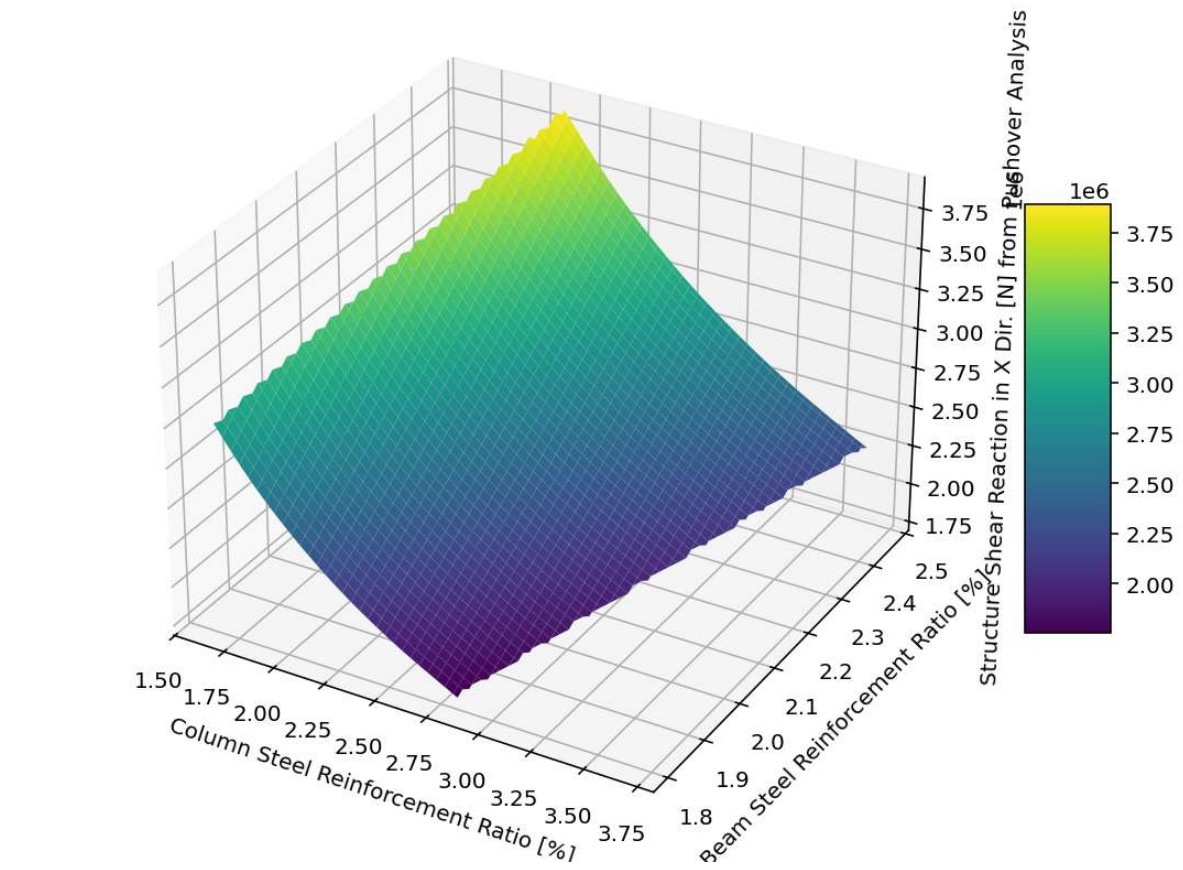
#########################################################################################################
#                          >> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<
#  SENSITIVITY ANALYSIS OF CONCRETE STRUCTURES USING PUSHOVER & FREE VIBRATION: EFFECTS OF COLUMN HEIGHT,
# REBAR DIAMETER, AND CONCRETE CONFINEMENT IN RC FRAMES ON OUTPUT KEY PARAMETERS FROM NONLINEAR STATIC AND
#                                  DYNAMIC ANALYSES USING PYTHON AND OPENSEES
#-------------------------------------------------------------------------------------------------------
#                 FREE VIBRATION ANALYSIS USING INITIAL DISPLACEMENT, VELOCITY, AND ACCELERATION
#-------------------------------------------------------------------------------------------------------
#                                        PARALLEL COMPUTING VERSION
#-------------------------------------------------------------------------------------------------------
# PARALLEL PROCESSING MEANS RUNNING SEVERAL TASKS AT THE SAME TIME INSTEAD OF ONE AFTER ANOTHER.
# IN THE CODE, EACH STEP ANALYSIS WAS CALCULATED IN SEQUENCE,
# SO THE CPU WORKED ON ONLY ONE MODE AT ANY MOMENT. IN THE REWRITTEN VERSION, THE JOBLIB LIBRARY ALLOWS
# ALL FOUR MODES TO RUN SIMULTANEOUSLY ON DIFFERENT CPU CORES. EACH CORE PROCESSES ONE MODE INDEPENDENTLY,
# SO THE TOTAL COMPUTATION TIME BECOMES MUCH SHORTER.
#
# MODERN COMPUTERS USUALLY HAVE MULTIPLE CORES, FOR EXAMPLE 4, 8, OR EVEN MORE. WHEN WE USE PARALLEL
# PROCESSING, WE DIVIDE THE WORKLOAD ACROSS THESE CORES. BECAUSE EACH MODE IS A SEPARATE AND INDEPENDENT
# ANALYSIS, THEY ARE PERFECT FOR PARALLEL EXECUTION. INSTEAD OF WAITING FOR MODE 1 TO FINISH BEFORE
# STARTING MODE 2, ALL MODES START TOGETHER AND FINISH ALMOST TOGETHER.
#
# IN PRACTICE, THE SPEED IMPROVEMENT DEPENDS ON HOW MANY CORES YOUR CPU HAS. IF YOUR COMPUTER HAS 4 CORES,
# THE RUNTIME CAN BE UP TO FOUR TIMES FASTER. IN MANY CASES THE SPEEDUP IS AROUND 3–4 TIMES,
# BECAUSE THERE IS A SMALL OVERHEAD WHEN STARTING PARALLEL TASKS. THE REWRITTEN CODE USES PARALLEL
# AND DELAYED TO AUTOMATICALLY SEND EACH MODE TO A DIFFERENT CORE AND THEN COLLECT ALL RESULTS
# IN THE CORRECT ORDER. THIS MAKES THE ANALYSIS MORE EFFICIENT WITHOUT CHANGING THE ENGINEERING RESULTS.
#
# PARALLEL PROCESSING IS ESPECIALLY HELPFUL IN STRUCTURAL ENGINEERING SIMULATIONS WHERE EACH ANALYSIS
# REQUIRES HEAVY NUMERICAL CALCULATION. BY USING ALL AVAILABLE CPU POWER,
# YOU FINISH THE WORK FASTER AND CAN TEST MORE CASES OR MORE MODELS IN THE SAME AMOUNT OF TIME.
#-------------------------------------------------------------------------------------------------------
#                           PROGRAM DEVELOPED BY SALAR DELAVAR GHASHGHAEI (QASHQAI)
#                                   CONTACT: salar.d.ghashghaei@gmail.com
#########################################################################################################
```

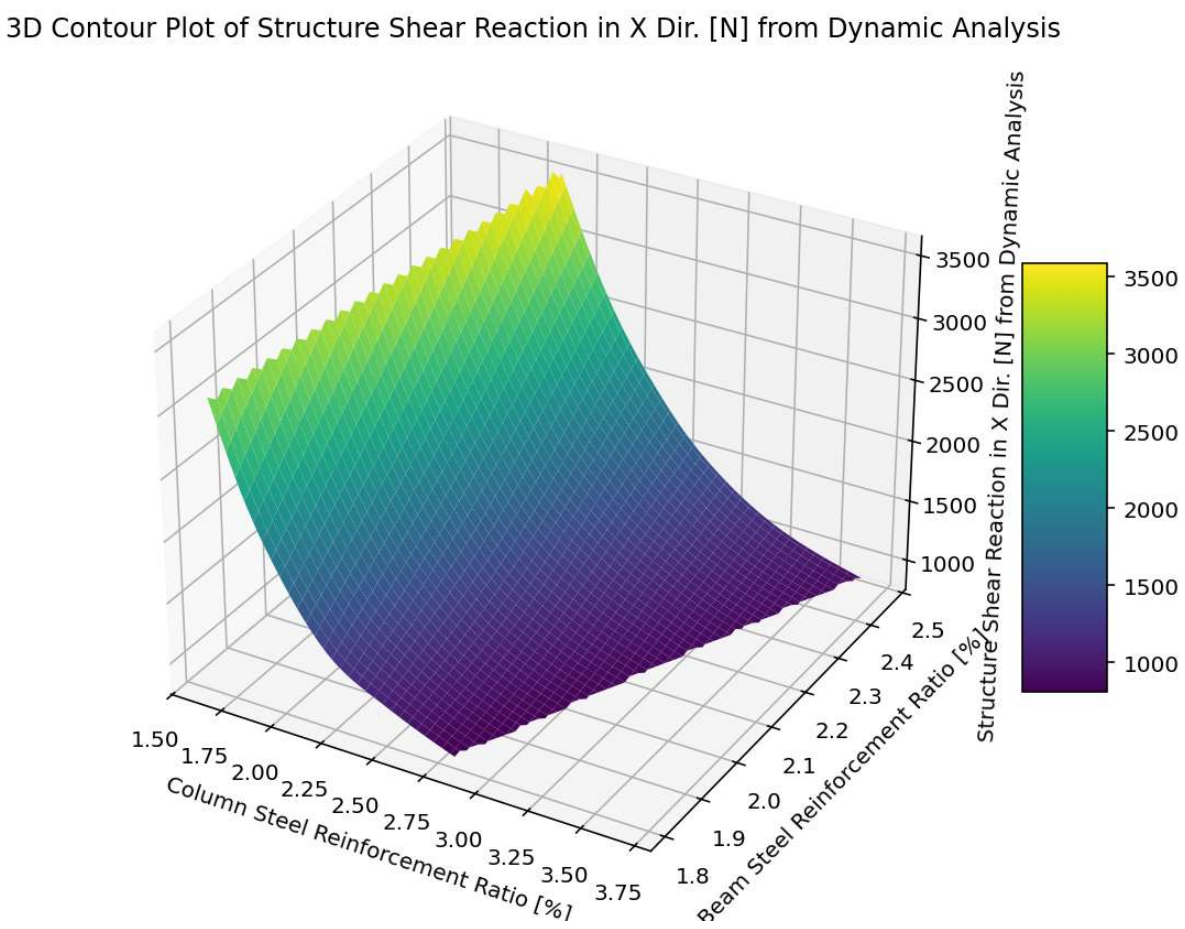
```
CONCRETE_FRAME_EXAMPLES/CONFINEMENT_ENHANCEMENT_RATIO/
SENSITIVITY_CONFINEMENT_ENHANCEMENT_RATIO_&_REBAR_&_Cdepth_FRE
E_VIBRATION/
SENSITIVITY_CONFINEMENT_ENHANCEMENT_RATIO_&_REBAR_&_Cdepth_FV_
PARALLEL_COMPUTING.py' --wdir
Reloaded modules: ANALYSIS_FUNCTION, CONCRETE_SECTION_FUN_TWO,
PLOT_2D, DAMPING_RATIO_FUN, RAYLEIGH_DAMPING_FUN,
BILINEAR_CURVE
Start Time: 11:44:41
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 4
concurrent workers.
WARNING analysis Static - no Integrator specified,
 StaticIntegrator default will be used
WARNING: CTestNormUnbalance::test() - failed to converge
after: 25 iterations  current Norm: 4.66654e-05 (max: 1e-06,
Norm deltaX: 2.98494e-13)
NewtonRaphson::solveCurrentStep() -the ConvergenceTest object
failed in test()
StaticAnalysis::analyze() - the Algorithm failed at step: 0
with domain at load factor 199.668
OpenSees > analyze failed, returned: -3 error flag
```

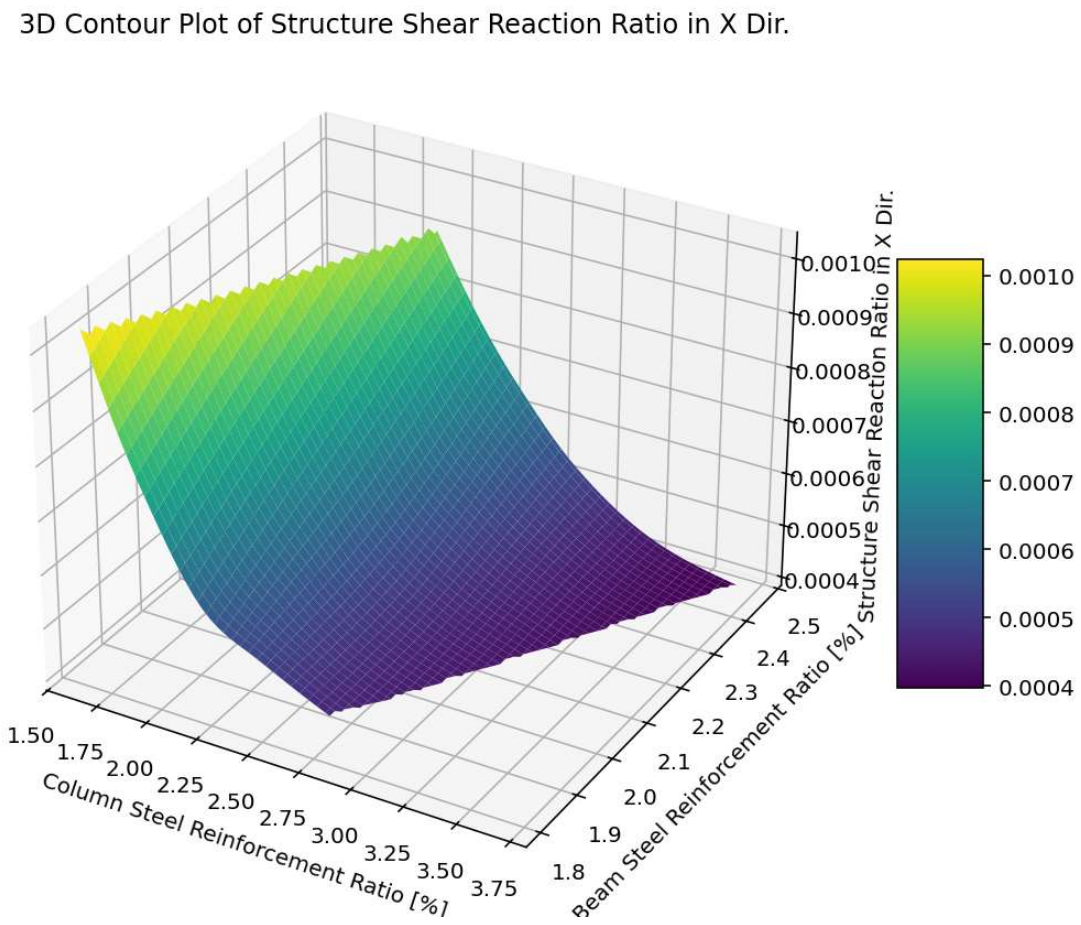

Spyder (Python 3.12)
File Edit Search Source Run Debug Consoles Projects Tools View Help
C:\Users\Dell
C:\Users\Dell\Desktop\OPENSEES_FILES\CONCRETE_FRA...T_RATIO_&_REBAR_&_Cdepth_FV_PARALLEL_COMPUTING.py
SENSITIVITY_CONFIN..._FREE_VIBRATION.py
SENSITIVITY_CONFIN...ALLEL_COMPUTING.py
548 # COLUMN SECTION DEPTH
549 HCC = [350.0, 400.0, 450.0, 500.0, 550.0, 600.0]
550 #HCC = [400.0, 500.0, 500.0]
551 # REBAR DIAMETER FOR COLUMN SECTION
552 #DIAc = [8, 10, 12, 14, 16, 18, 20, 22, 25, 28, 30, 32]
553 DIAc = [28, 30, 32]
554 # CONFINEMENT ENHANCEMENT FACTOR (K)
555 #Kfc = [1.15, 1.20, 1.25, 1.30, 1.35]
556 Kfc = [1.25]
557
558 params = [(hc, dia, kf) for hc in HCC for dia in DIAc for kf in Kfc]
559
560 # ---------------------- PARALLEL PROCESSING ----------------------
561 # Analysis Durations:
562 current_time = TI.strftime("%H:%M:%S", TI.localtime())
563 print("Start Time:", current_time)
564
565 results = Parallel(n_jobs=-1, verbose=10)(
566 delayed(run_analysis)(hc, dia, kf, u0, v0, a0, IA, IU, IV)
567   for hc, dia, kf in params
568)
569
570
571 for hc, dia, kf, pushover, dynamic in results:
572
573   HCC_MAX.append(hc)
574   DIAc_MAX.append(dia)
575   Kfc_MAX.append(kf)
576
577   RO_COL_MAX.append(pushover["RO_COL"])
578   RO_BE_MAX.append(pushover["RO_BE"])
579
580   FORCE_S_MAX.append(pushover["FORCE_S"])
581   FORCE_A_MAX.append(pushover["FORCE_A"])
Console 1/A
SENSITIVITY_CONFINEMENT_ENHANCEMENT_RATIO_&_REBAR_&_Cdepth_FREE_VIBRATION/
SENSITIVITY_CONFINEMENT_ENHANCEMENT_RATIO_&_REBAR_&_Cdepth_FV_PARALLEL_COMPUTING.py' --wdir
Reloaded modules: ANALYSIS_FUNCTION, CONCRETE_SECTION_FUN_TWO, PLOT_2D, DAMPING_RATIO_FUN, RAYLEIGH_DAMPING_FUN, BILINEAR_CURVE
Start Time: 11:44:41
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 4 concurrent workers.
WARNING analysis Static - no Integrator specified,
 StaticIntegrator default will be used
WARNING: CTestNormUnbalance::test() - failed to converge after: 25 iterations current Norm: 4.66654e-05 (max: 1e-06, Norm deltaX: 2.98494e-13)
NewtonRaphson::solveCurrentStep() -the ConvergenceTest object failed in test()
StaticAnalysis::analyze() - the Algorithm failed at step: 0 with domain at load factor 199.668
OpenSees > analyze failed, returned: -3 error flag
IPython Console Files Help Variable Explorer Debugger Plots History

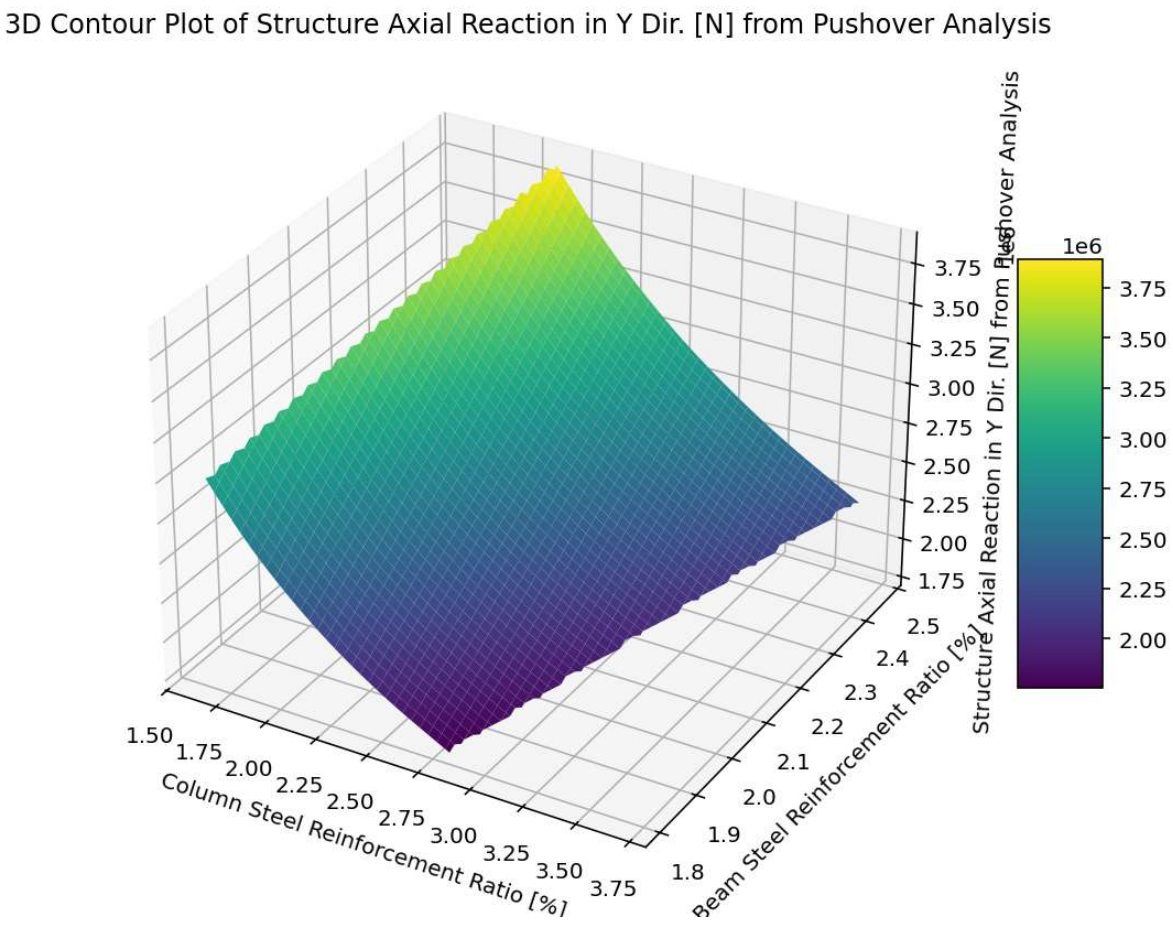

Undeformed and Deformed Shapes - DEFORMED SCALE: 1.00
Undeformed
Deformed
Z [mm]
X [mm]
0
500
1000
1500
2000
2500
3000
0
1000
2000
3000
4000
5000
6000
7000
8000

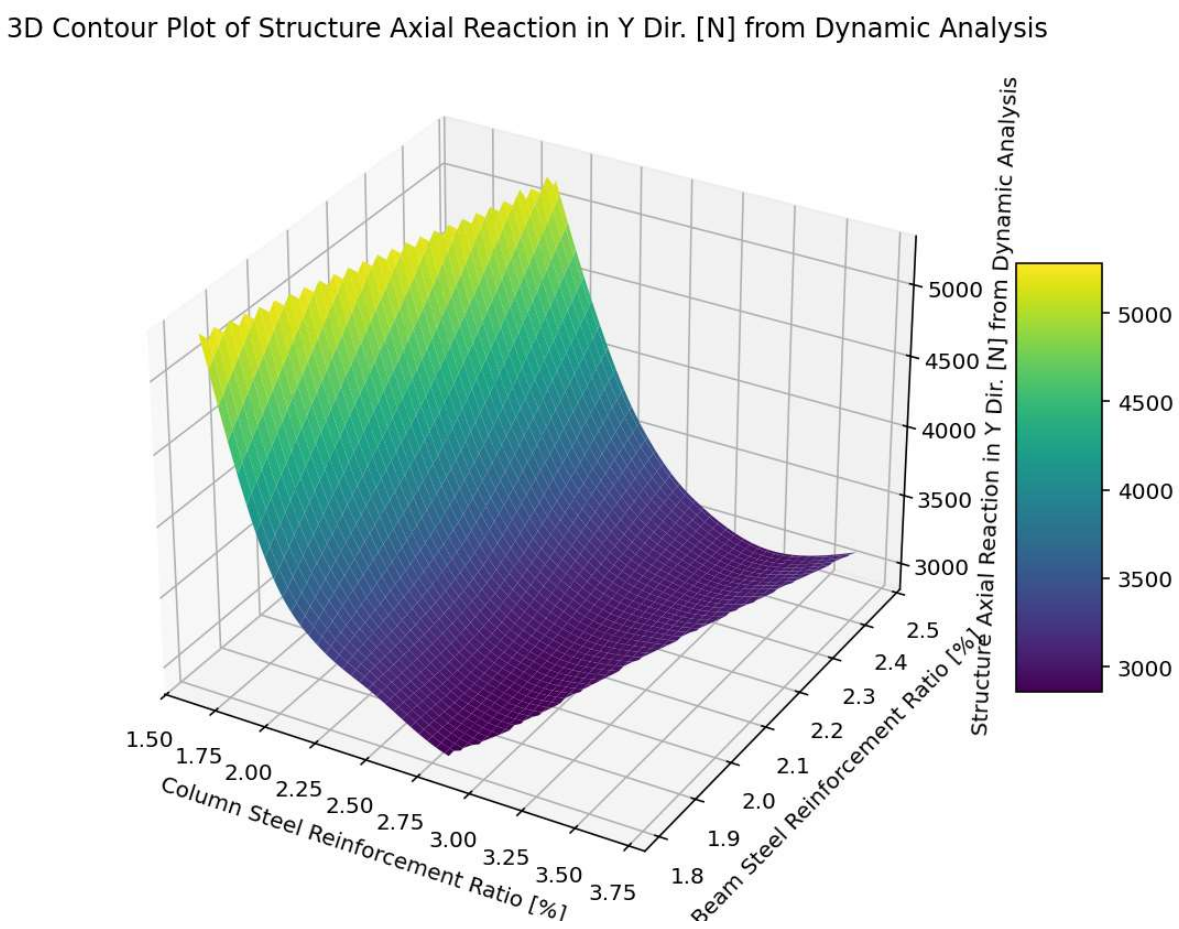

3D Contour Plot of Confinement Enhancement Ratio
Confinement Enhancement Ratio
1.35
1.30
1.25
1.20
1.15
1.0
0.5
0.0
−0.5
−1.0
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Column Steel Reinforcement Ratio [%]
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
Beam Steel Reinforcement Ratio [%]

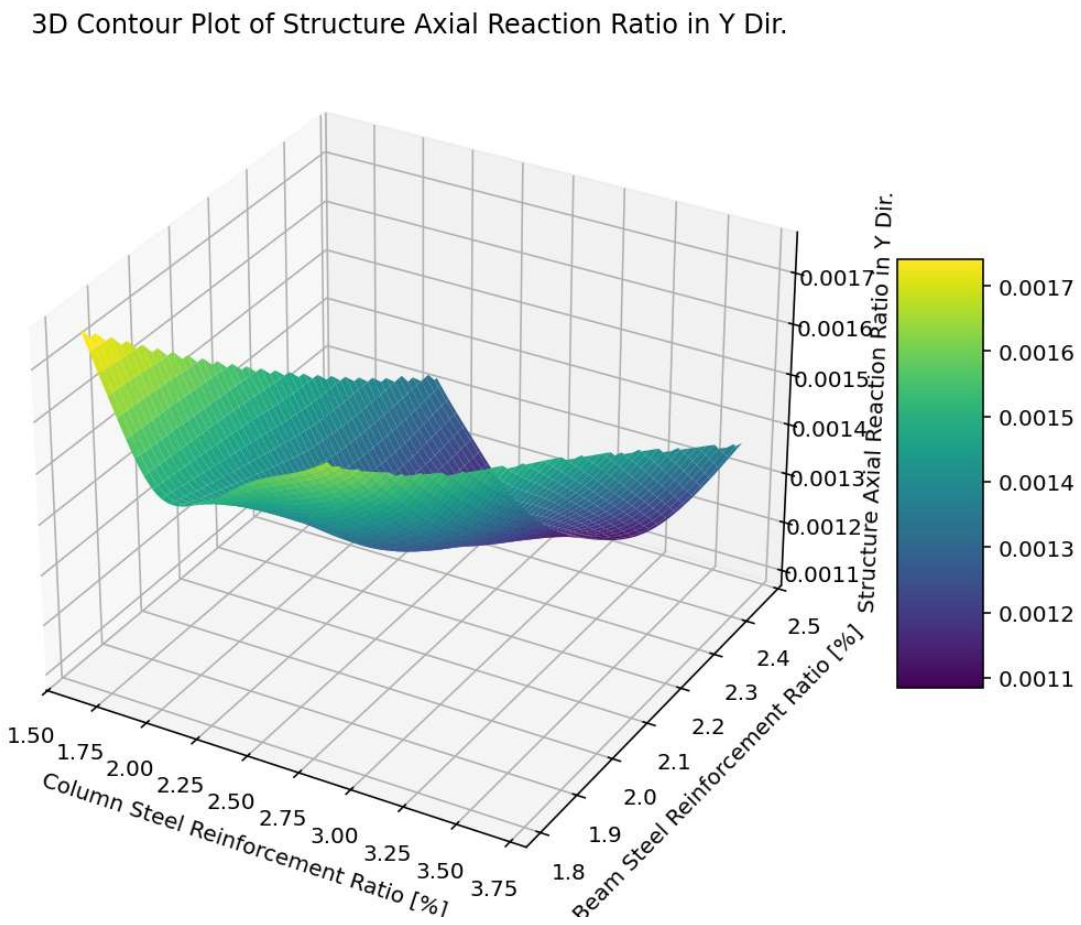

3D Contour Plot of Structure Shear Reaction in X Dir. [N] from Pushover Analysis
Column Steel Reinforcement Ratio [%]
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Beam Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Structure Shear Reaction in X Dir. [N] from Pushover Analysis
1e6
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
1e6
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75

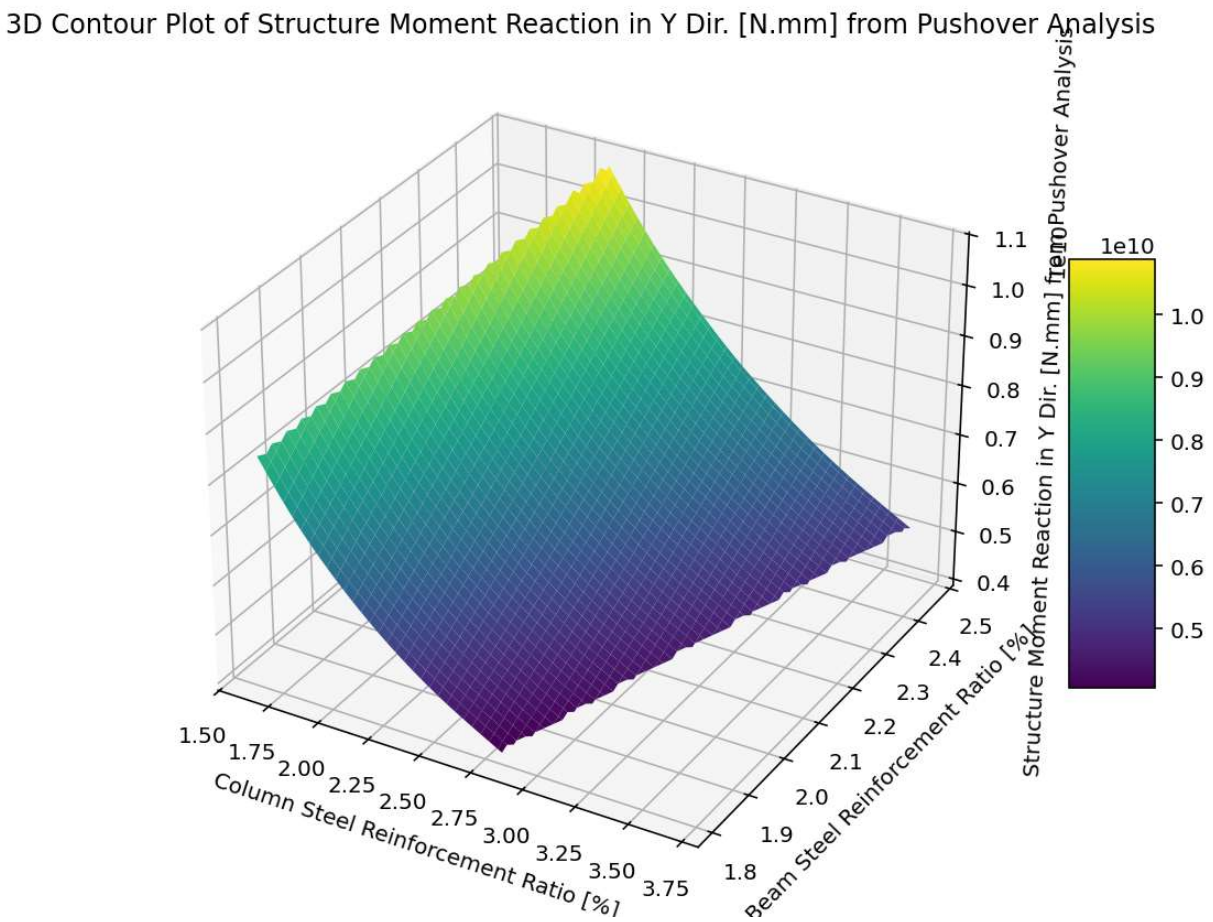

3D Contour Plot of Structure Shear Reaction in X Dir. [N] from Dynamic Analysis
Structure Shear Reaction in X Dir. [N] from Dynamic Analysis
3500
3000
2500
2000
1500
1000
Column Steel Reinforcement Ratio [%]
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Beam Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5

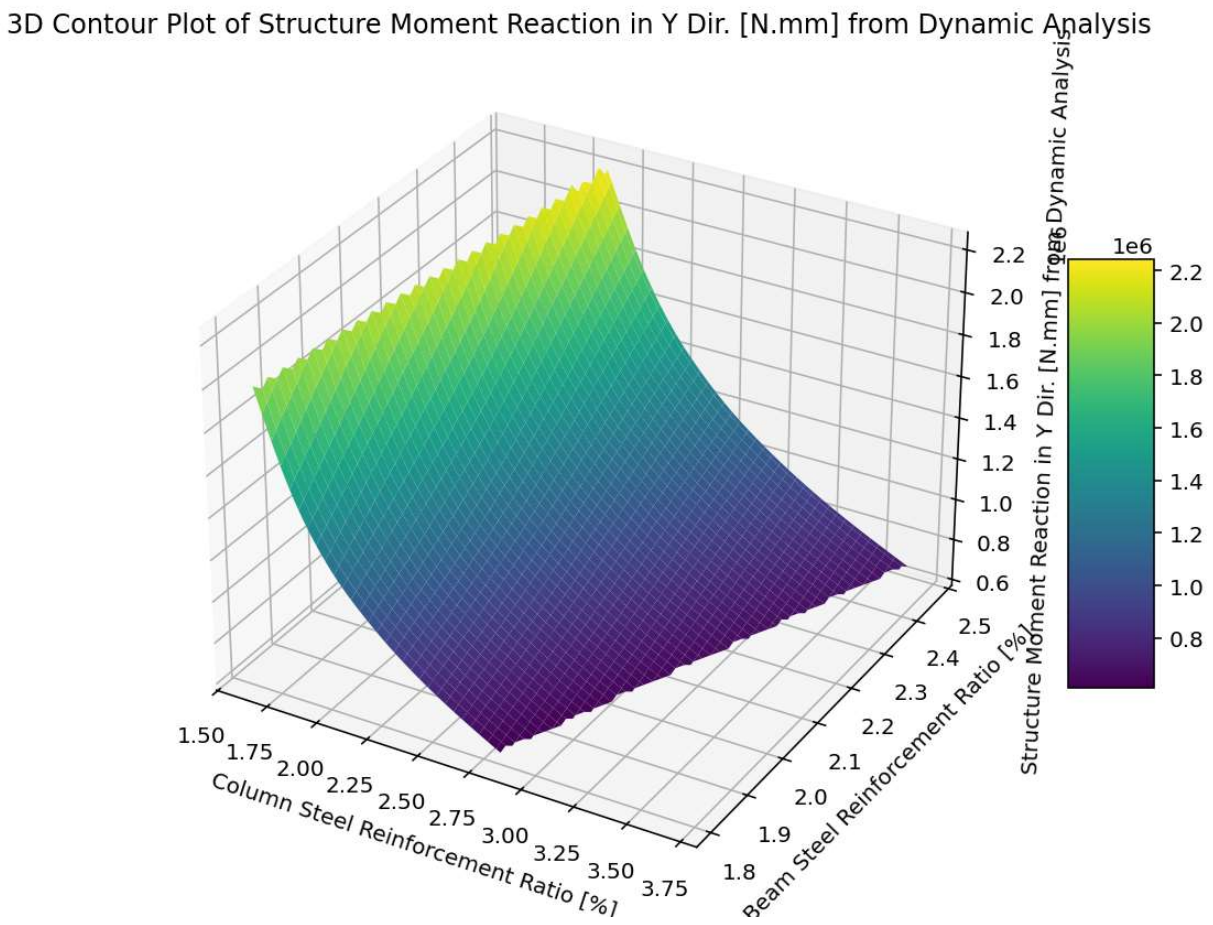

3D Contour Plot of Structure Shear Reaction Ratio in X Dir.
Structure Shear Reaction Ratio in X Dir.
0.0010
0.0009
0.0008
0.0007
0.0006
0.0005
0.0004
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Column Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Beam Steel Reinforcement Ratio [%]


3D Contour Plot of Structure Axial Reaction in Y Dir. [N] from Pushover Analysis
Column Steel Reinforcement Ratio [%]
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Beam Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Structure Axial Reaction in Y Dir. [N] from Pushover Analysis
1e6
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75

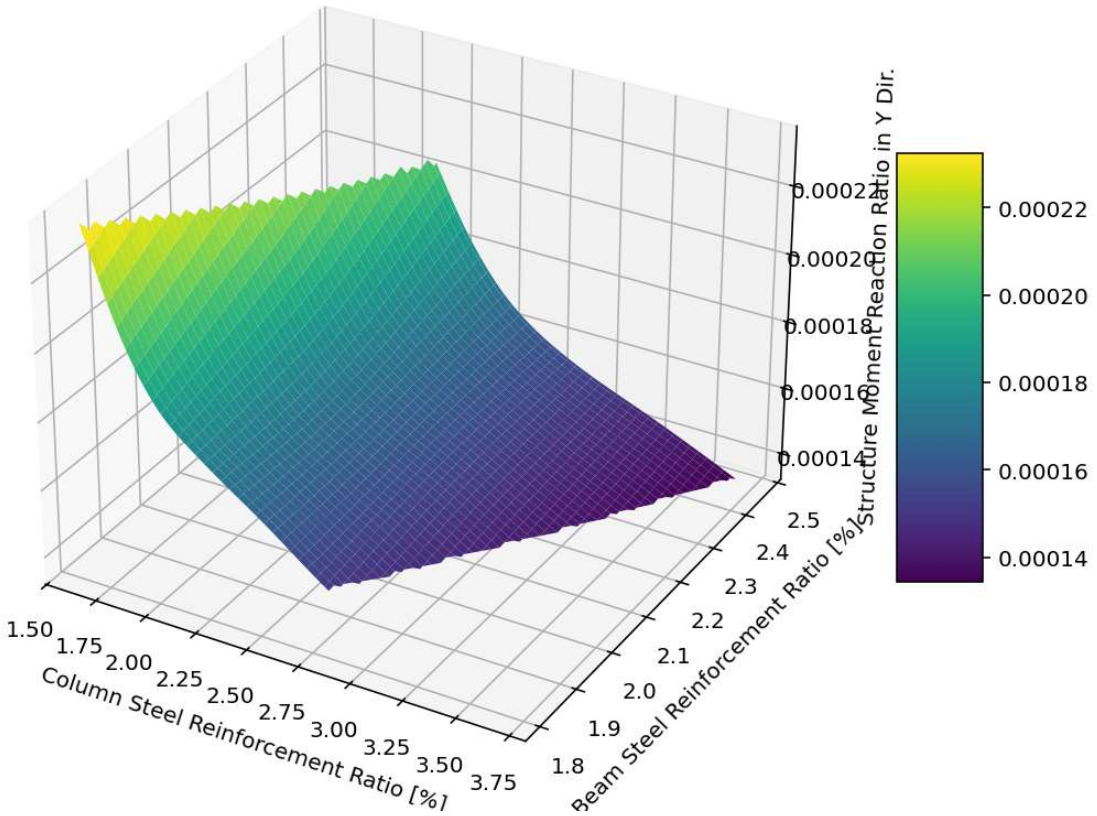

3D Contour Plot of Structure Axial Reaction in Y Dir. [N] from Dynamic Analysis
Column Steel Reinforcement Ratio [%]
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Beam Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Structure Axial Reaction in Y Dir. [N] from Dynamic Analysis
3000
3500
4000
4500
5000

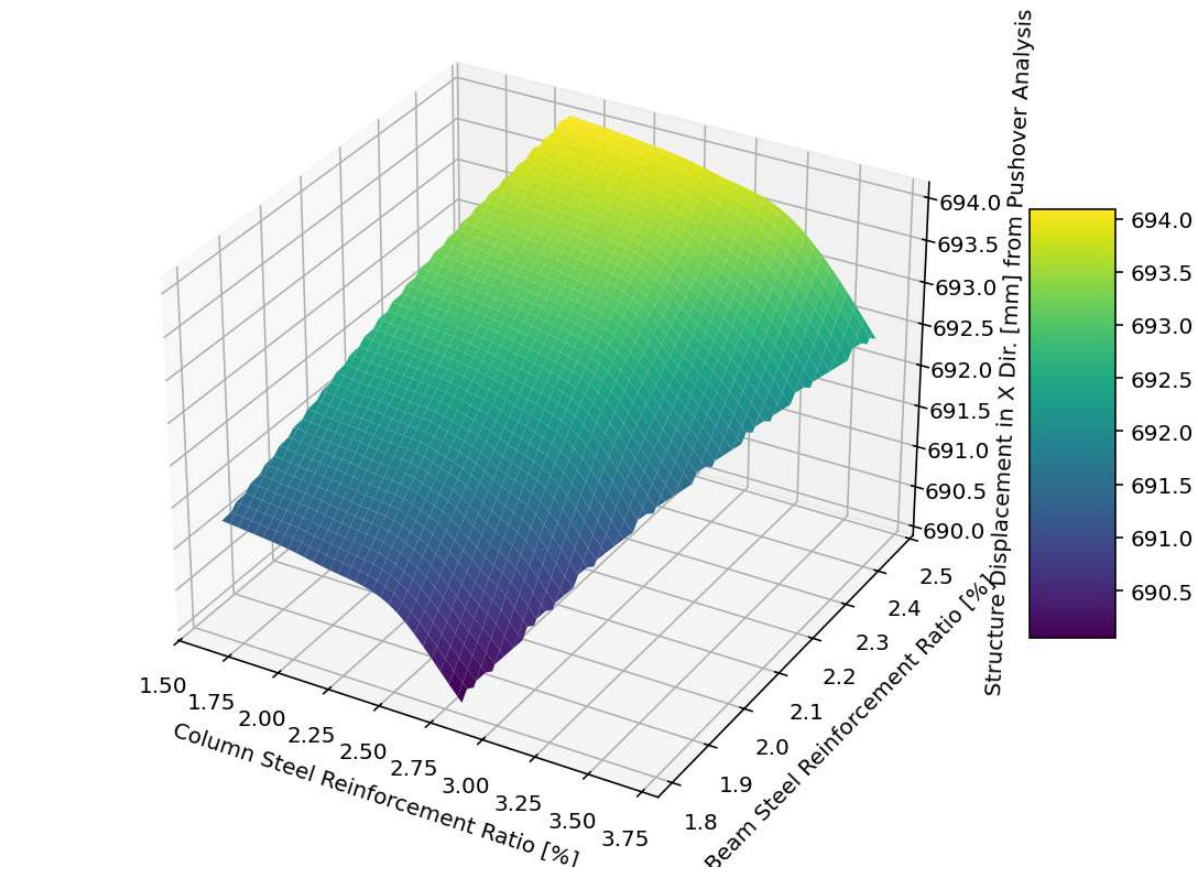

3D Contour Plot of Structure Axial Reaction Ratio in Y Dir.
Structure Axial Reaction Ratio in Y Dir.
0.0017
0.0016
0.0015
0.0014
0.0013
0.0012
0.0011
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Column Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Beam Steel Reinforcement Ratio [%]

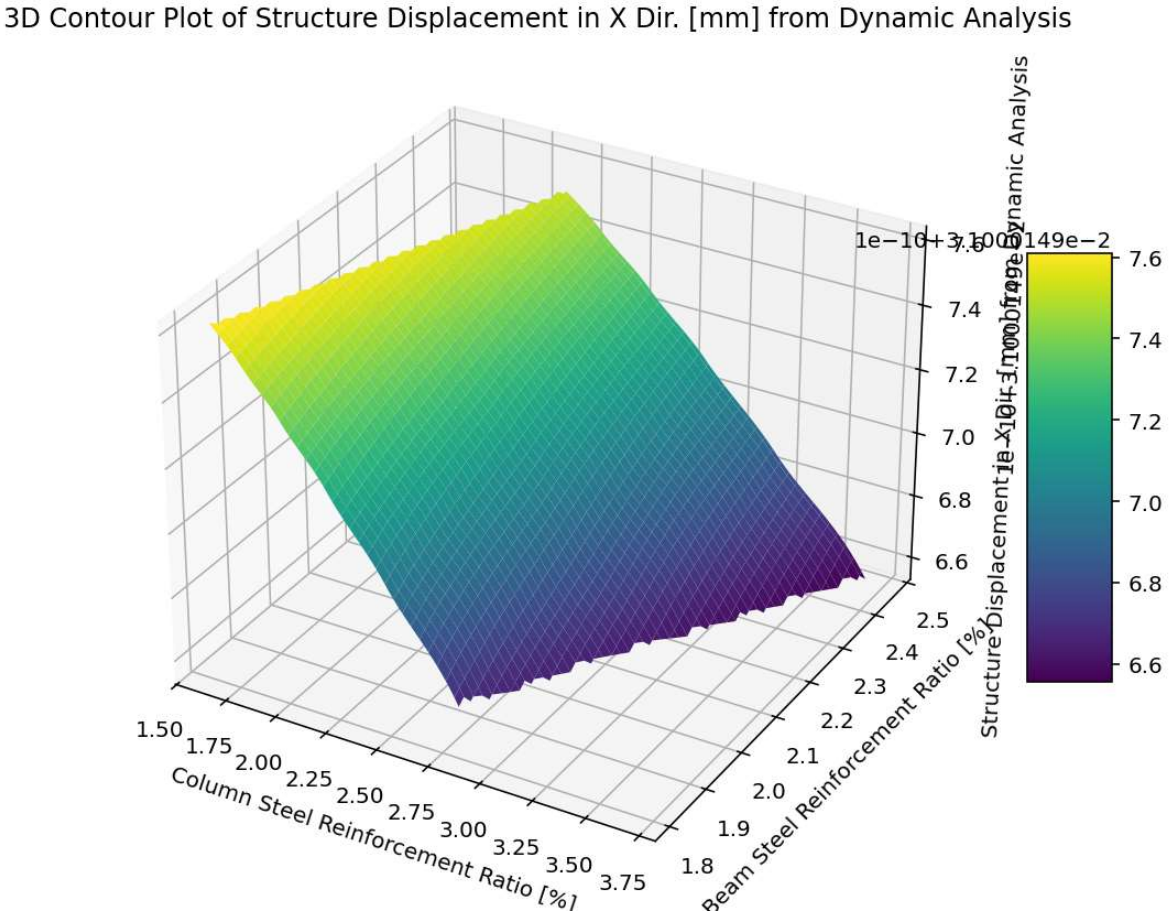

3D Contour Plot of Structure Moment Reaction in Y Dir. [N.mm] from Pushover Analysis
Column Steel Reinforcement Ratio [%]
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Beam Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Structure Moment Reaction in Y Dir. [N.mm] from Pushover Analysis
1e10
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
1e10
1.0
0.9
0.8
0.7
0.6
0.5

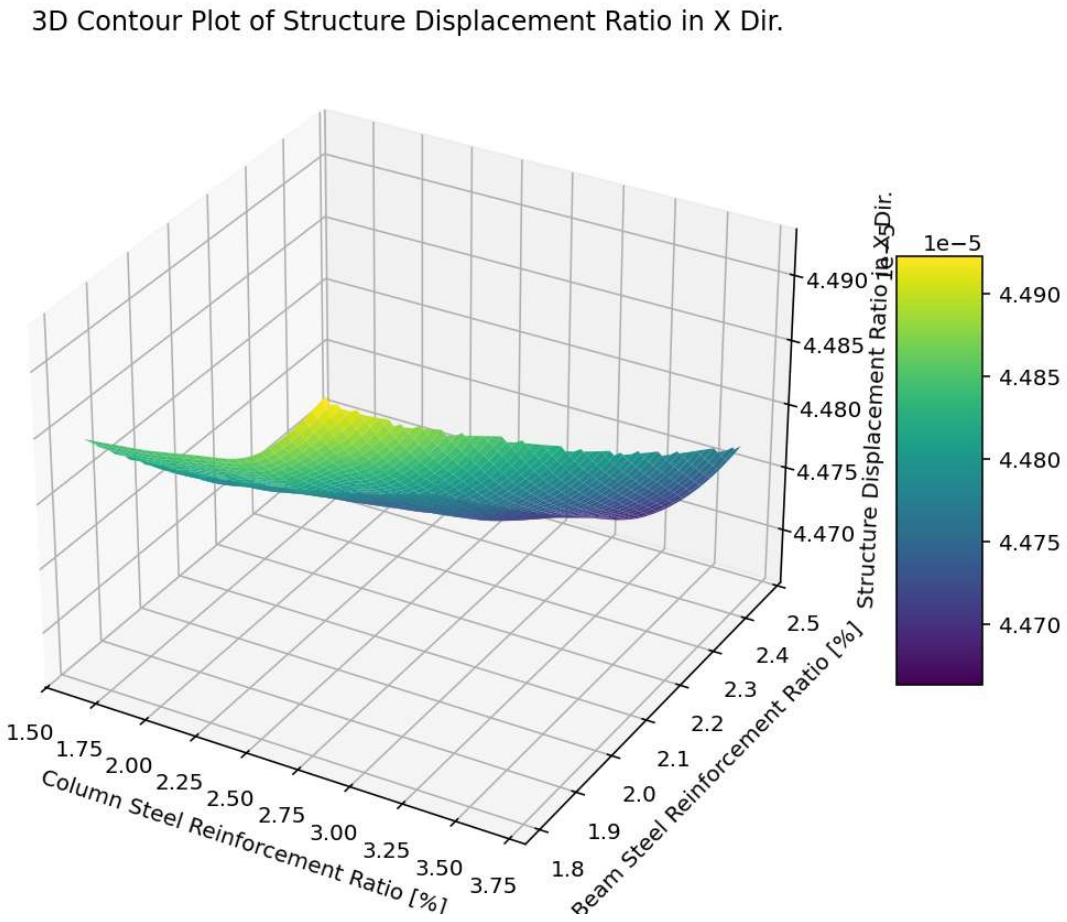

3D Contour Plot of Structure Moment Reaction in Y Dir. [N.mm] from Dynamic Analysis
Column Steel Reinforcement Ratio [%]
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Beam Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Structure Moment Reaction in Y Dir. [N.mm] from Dynamic Analysis
1e6
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
1e6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2

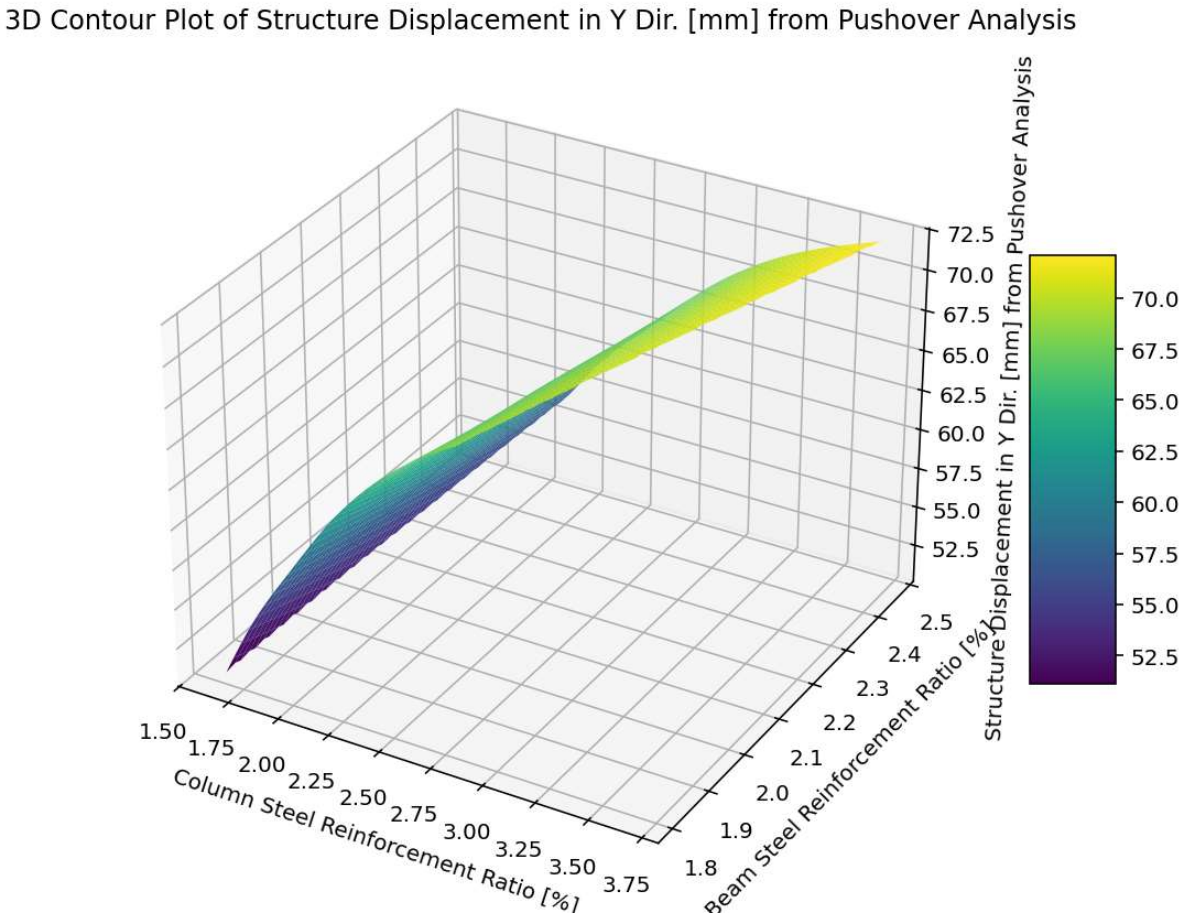
3D Contour Plot of Structure Moment Reaction Ratio in Y Dir.

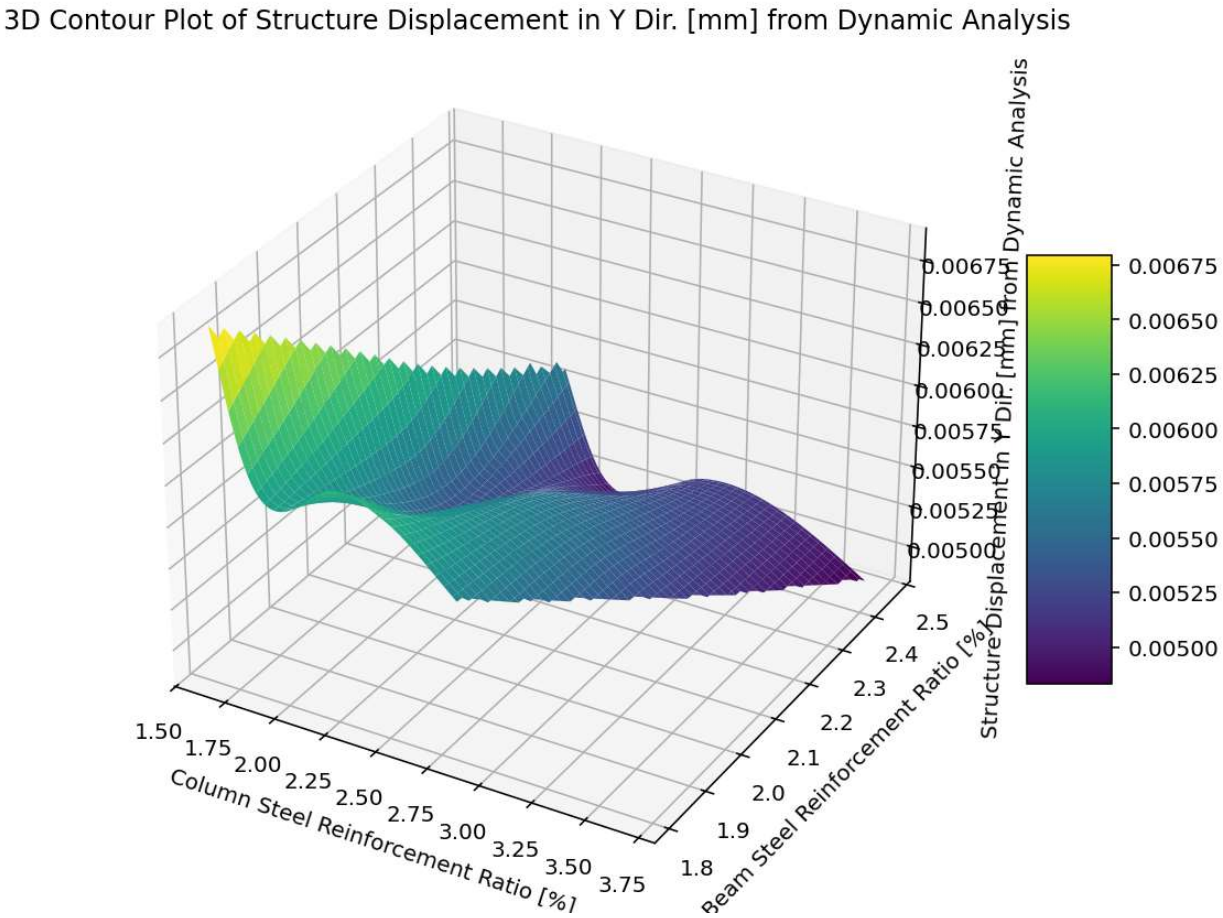


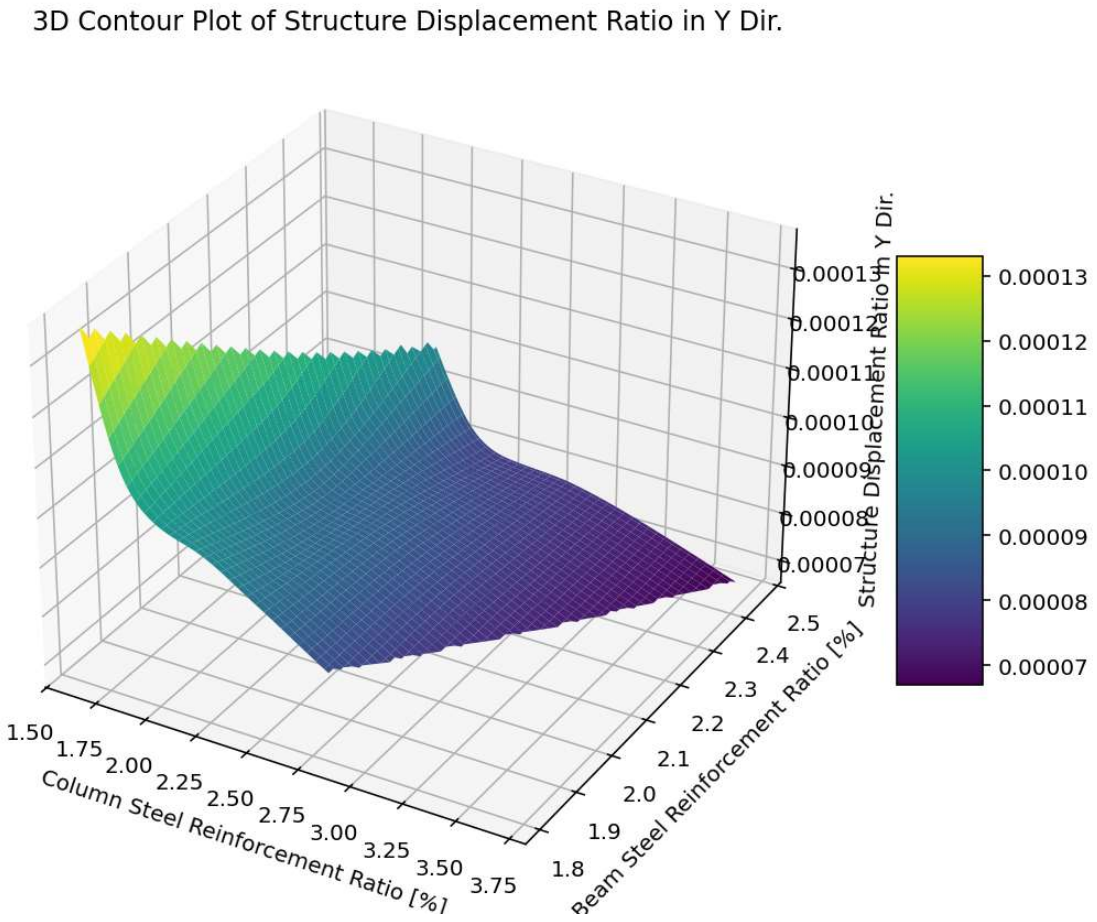

3D Contour Plot of Structure Displacement in X Dir. [mm] from Pushover Analysis
Column Steel Reinforcement Ratio [%]
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Beam Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Structure Displacement in X Dir. [mm] from Pushover Analysis
690.0
690.5
691.0
691.5
692.0
692.5
693.0
693.5
694.0

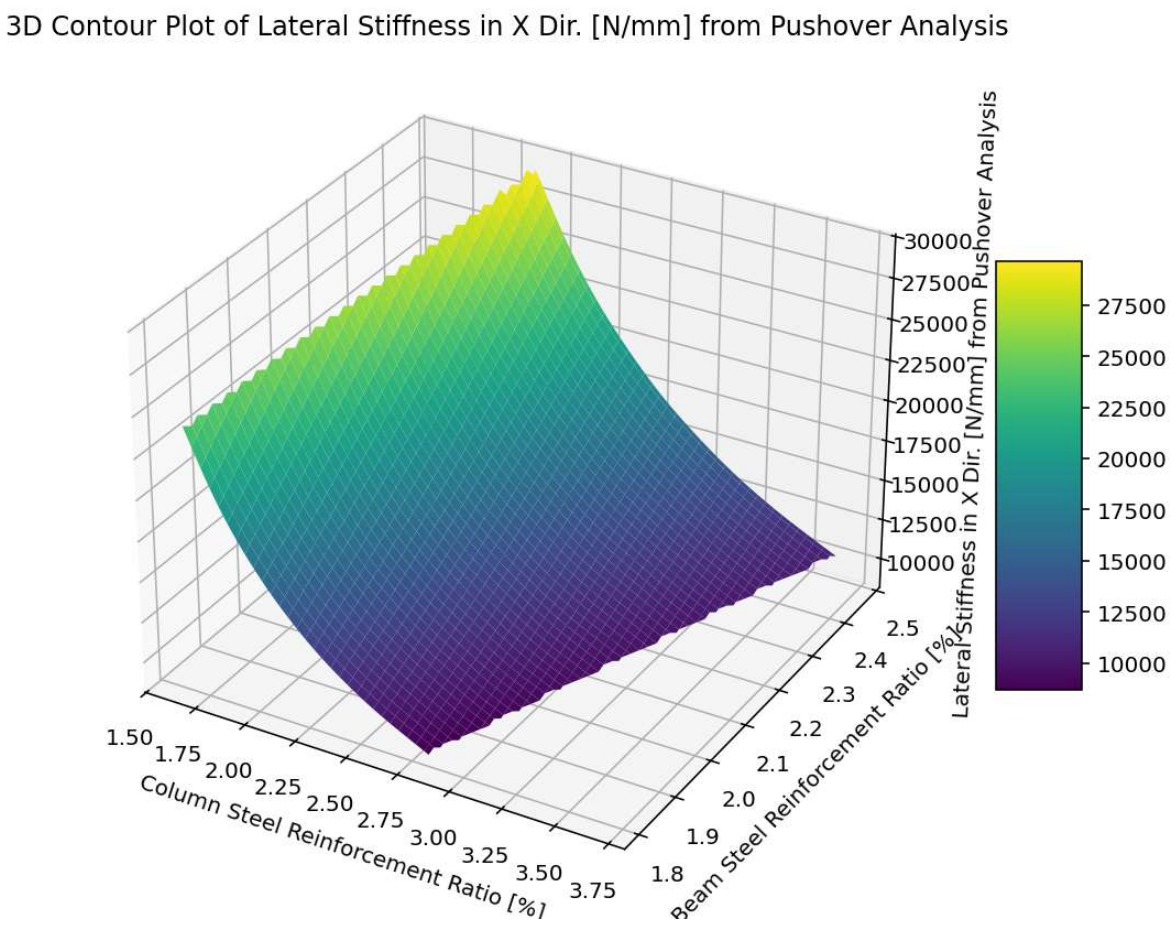

3D Contour Plot of Structure Displacement in X Dir. [mm] from Dynamic Analysis
1e−10+3.1000149e−2
7.6
7.4
7.2
7.0
6.8
6.6
Structure Displacement in X Dir. [mm] from Dynamic Analysis
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Column Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Beam Steel Reinforcement Ratio [%]


3D Contour Plot of Structure Displacement Ratio in X Dir.
Structure Displacement Ratio in X Dir.
1e−5
4.490
4.485
4.480
4.475
4.470
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Column Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Beam Steel Reinforcement Ratio [%]

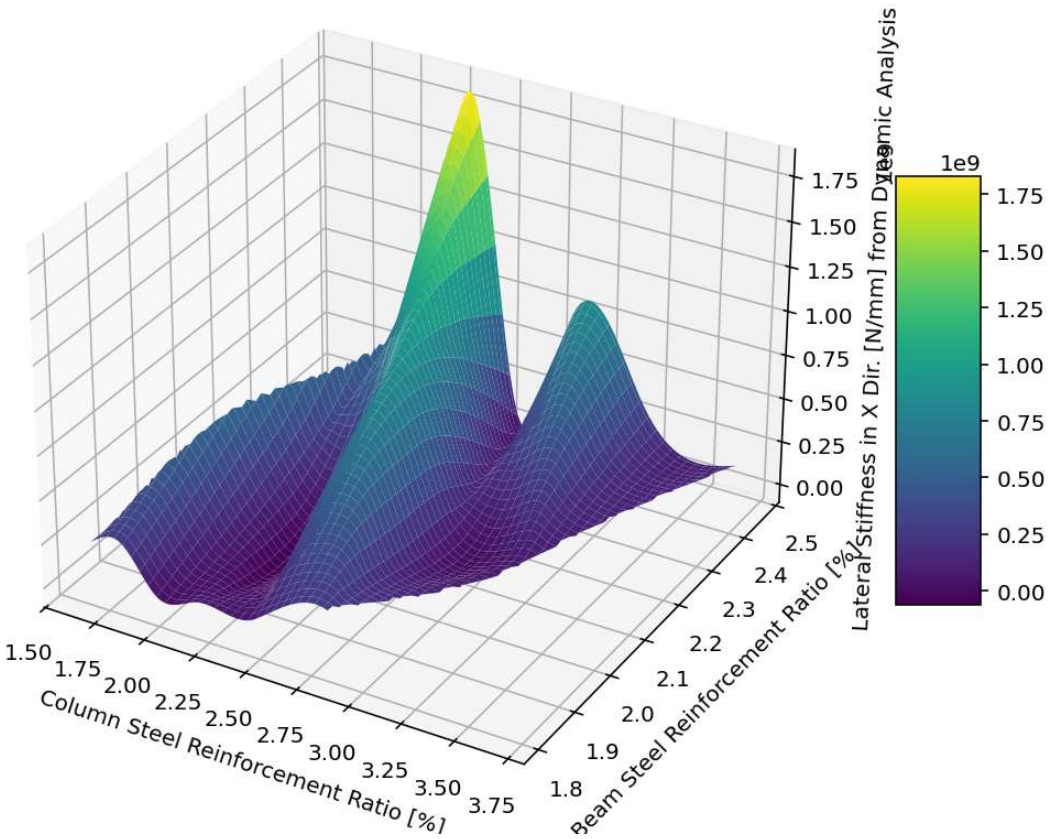

3D Contour Plot of Structure Displacement in Y Dir. [mm] from Pushover Analysis
72.5
70.0
67.5
65.0
62.5
60.0
57.5
55.0
52.5
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Column Steel Reinforcement Ratio [%]
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
Beam Steel Reinforcement Ratio [%]
Structure Displacement in Y Dir. [mm] from Pushover Analysis
70.0
67.5
65.0
62.5
60.0
57.5
55.0
52.5

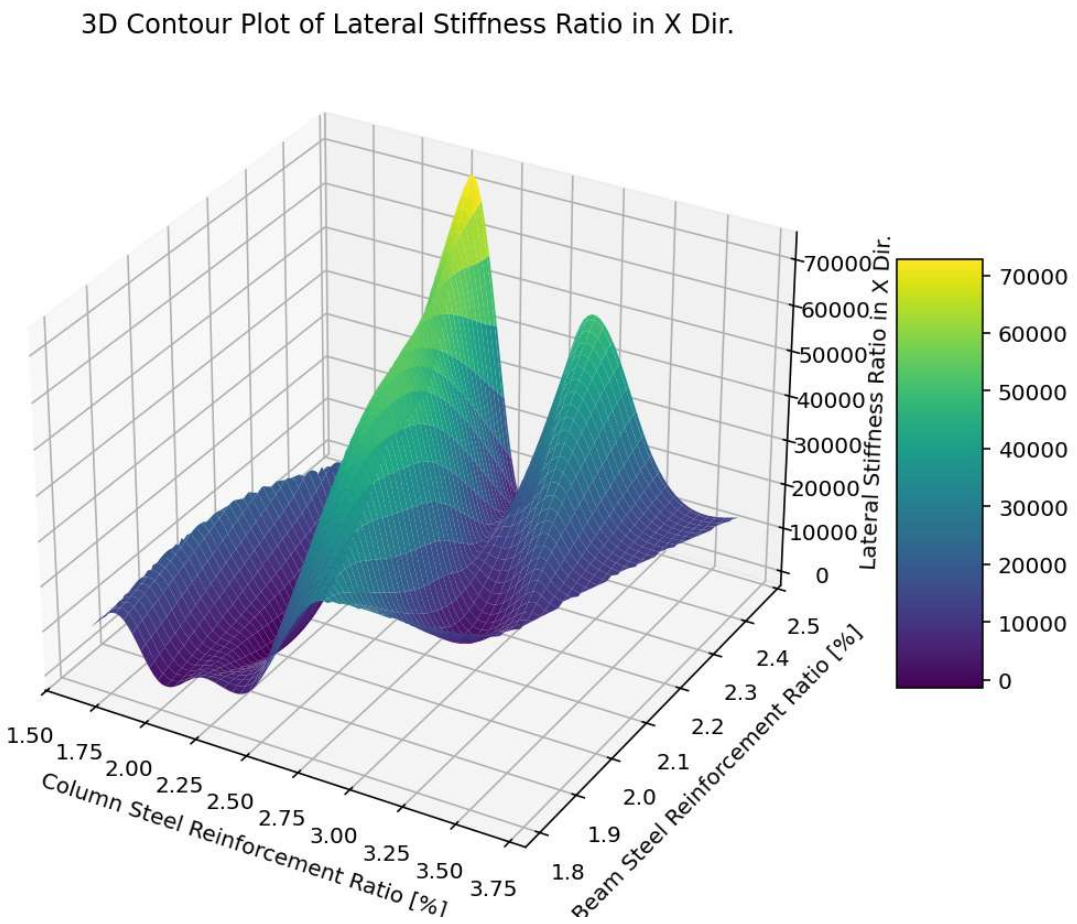

3D Contour Plot of Structure Displacement in Y Dir. [mm] from Dynamic Analysis
Column Steel Reinforcement Ratio [%]
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Beam Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Structure Displacement in Y Dir. [mm] from Dynamic Analysis
0.00675
0.00650
0.00625
0.00600
0.00575
0.00550
0.00525
0.00500


3D Contour Plot of Structure Displacement Ratio in Y Dir.
Structure Displacement Ratio in Y Dir.
0.00013
0.00012
0.00011
0.00010
0.00009
0.00008
0.00007
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Column Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Beam Steel Reinforcement Ratio [%]

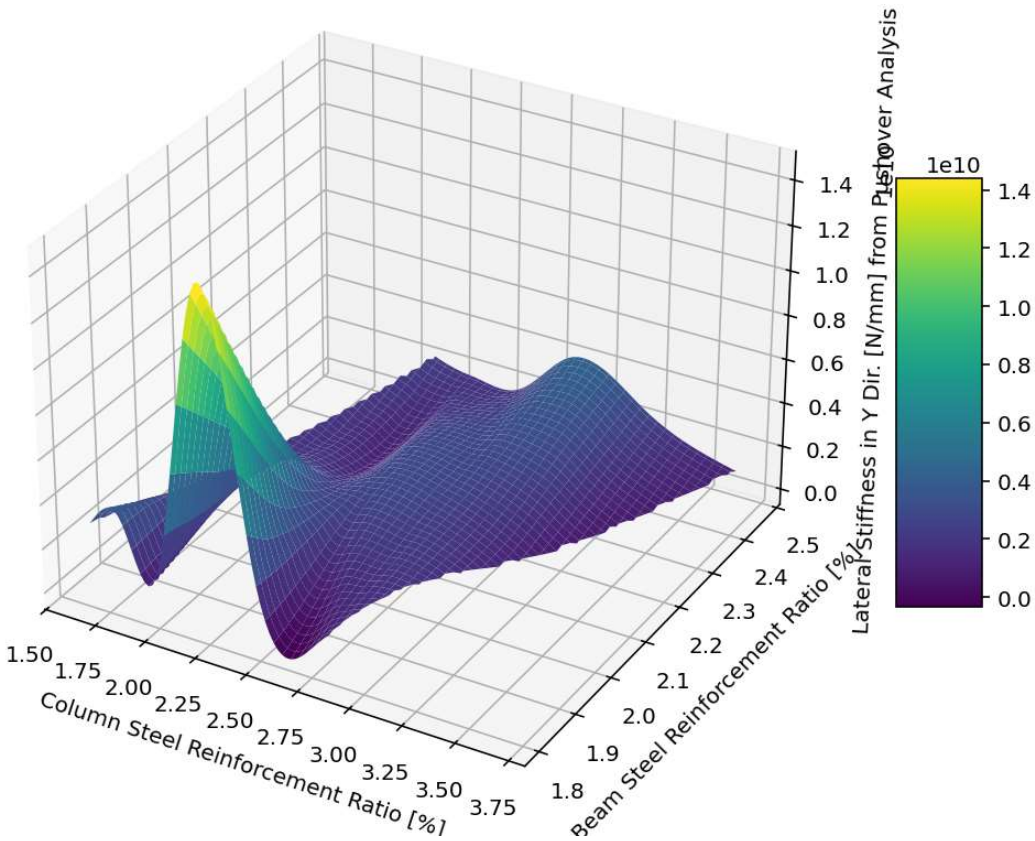

3D Contour Plot of Lateral Stiffness in X Dir. [N/mm] from Pushover Analysis
Lateral Stiffness in X Dir. [N/mm] from Pushover Analysis
30000
27500
25000
22500
20000
17500
15000
12500
10000
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Column Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Beam Steel Reinforcement Ratio [%]

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

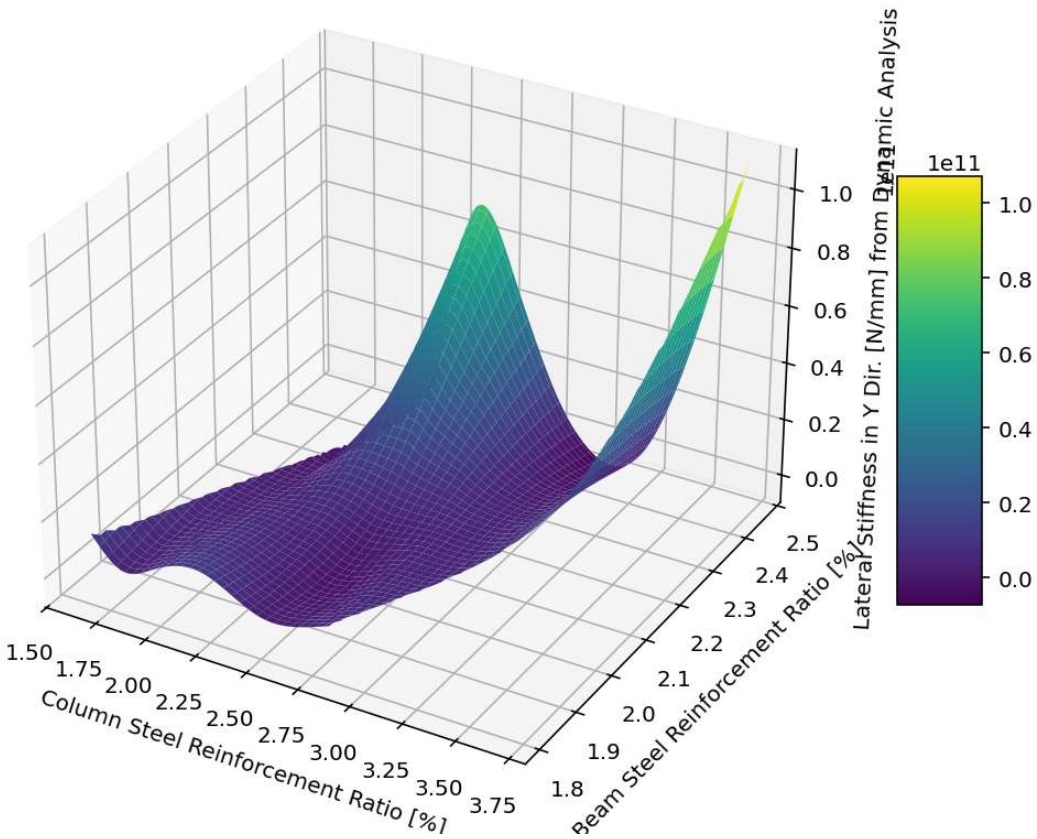


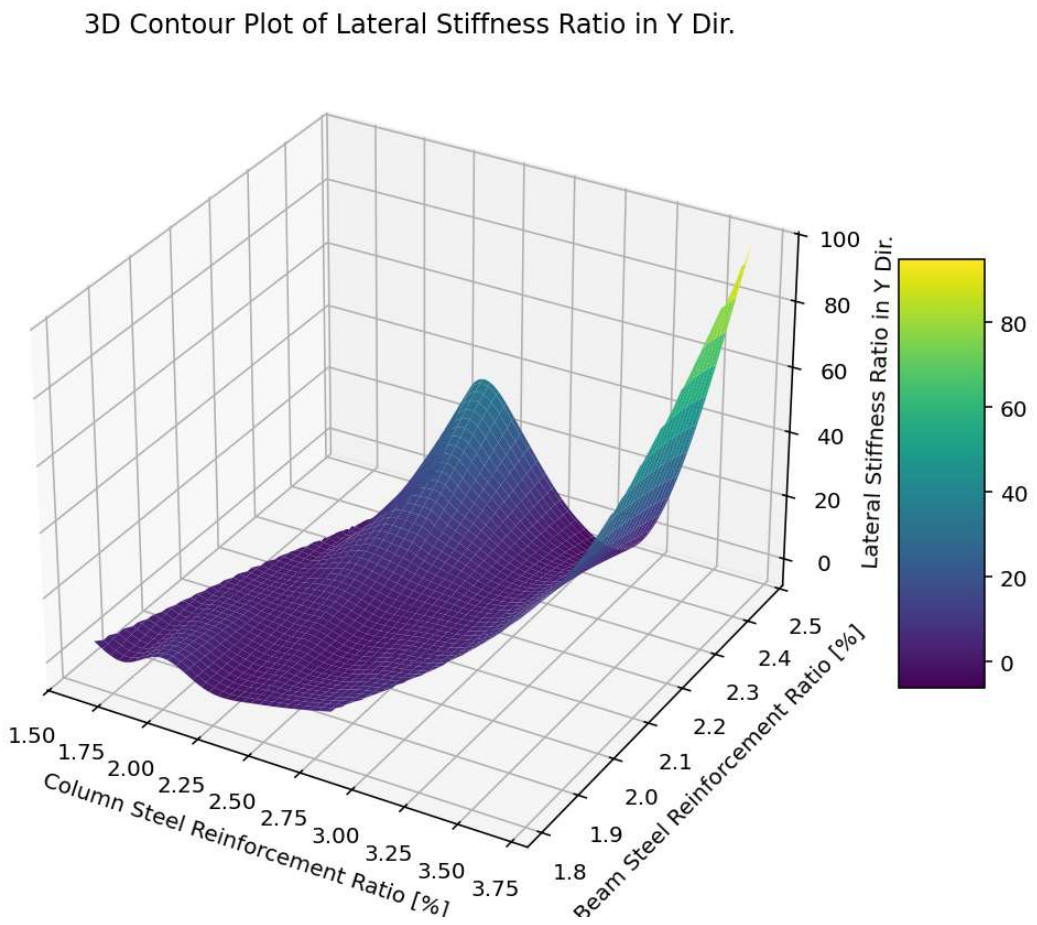

3D Contour Plot of Lateral Stiffness Ratio in X Dir.
Lateral Stiffness Ratio in X Dir.
70000
60000
50000
40000
30000
20000
10000
0
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Column Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Beam Steel Reinforcement Ratio [%]

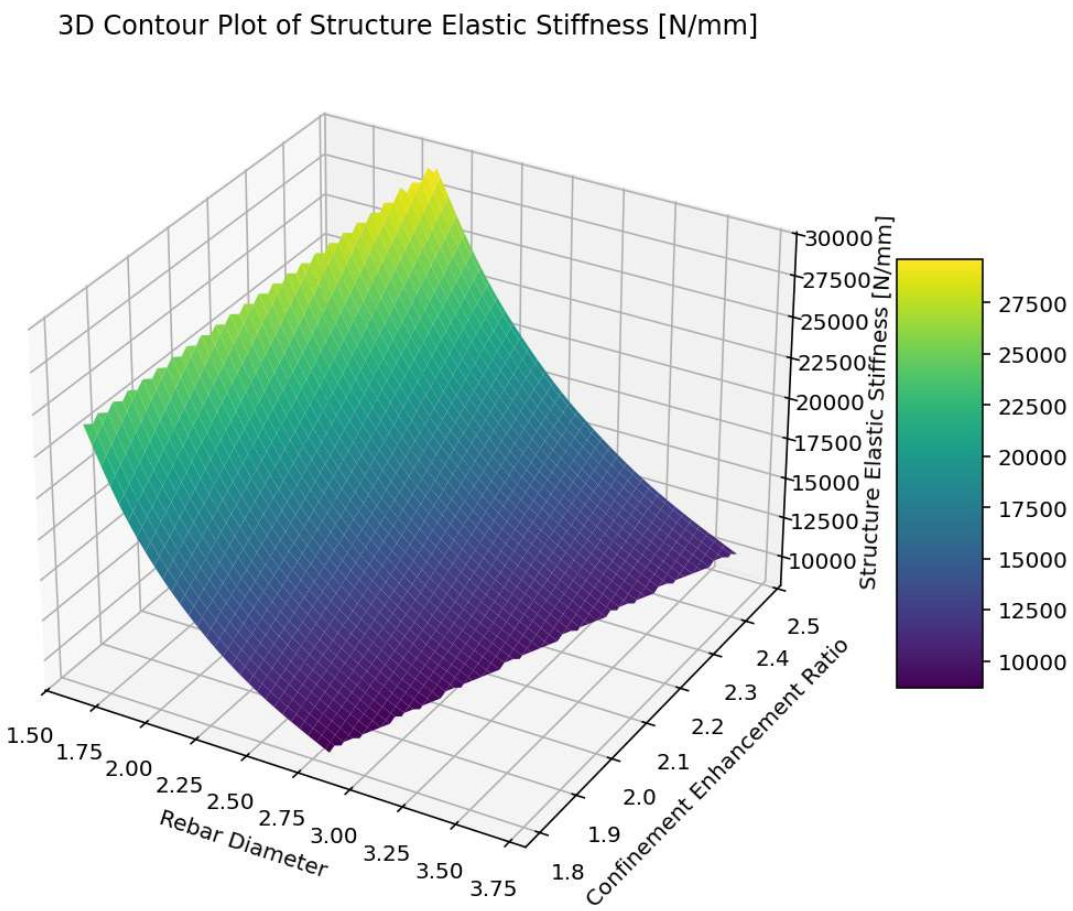
3D Contour Plot of Lateral Stiffness in Y Dir. [N/mm] from Pushover Analysis

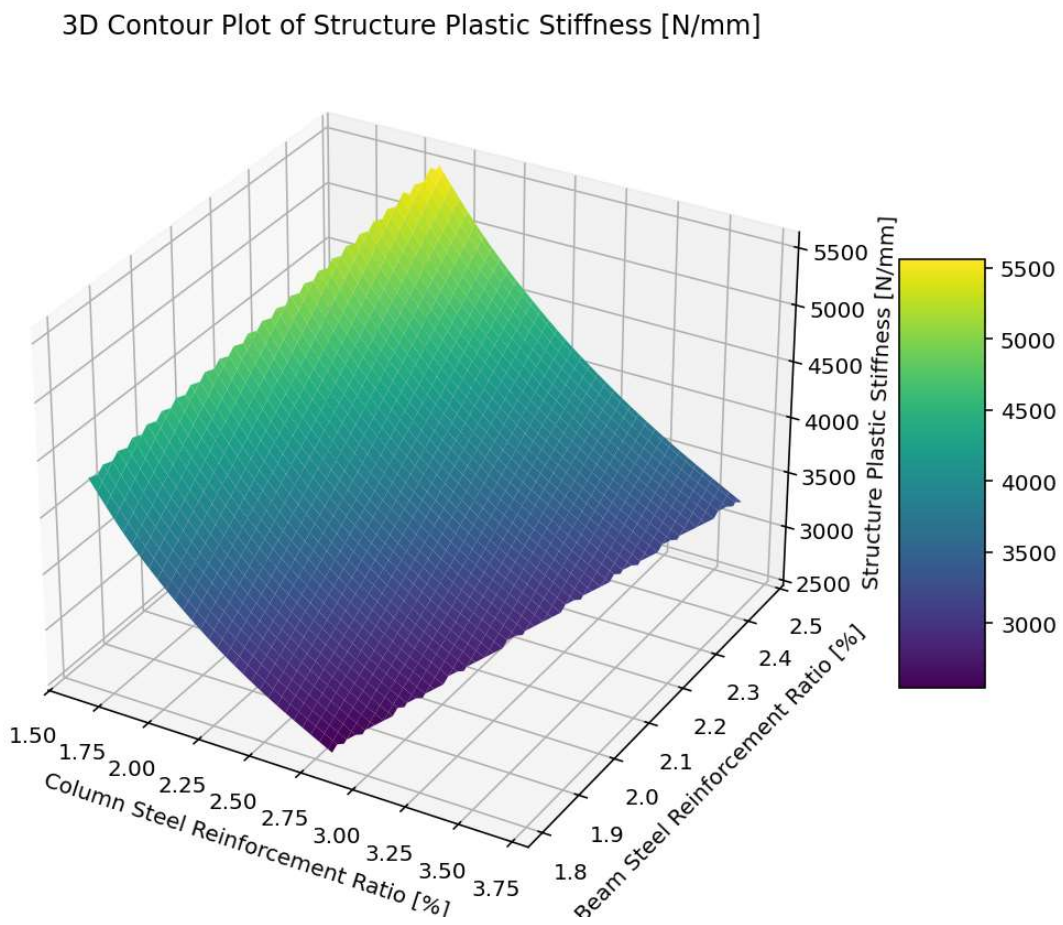


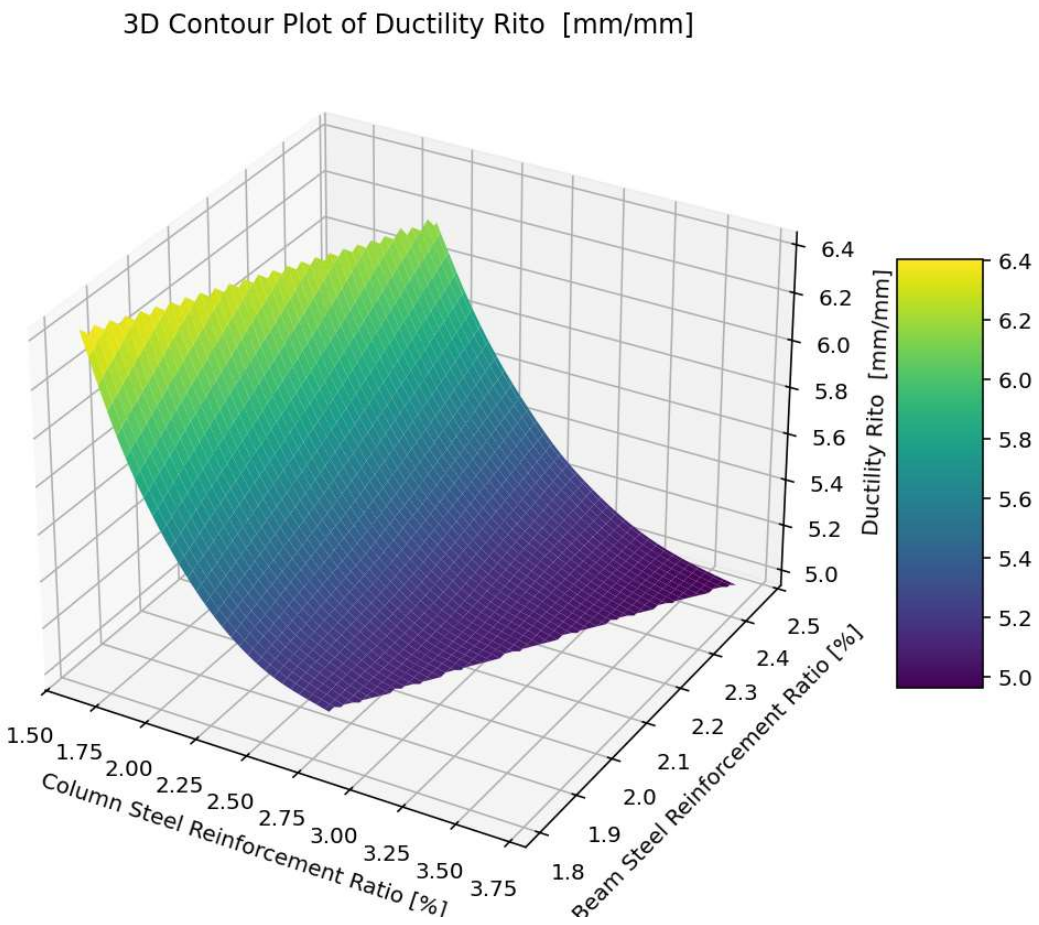
3D Contour Plot of Lateral Stiffness in Y Dir. [N/mm] from Dynamic Analysis

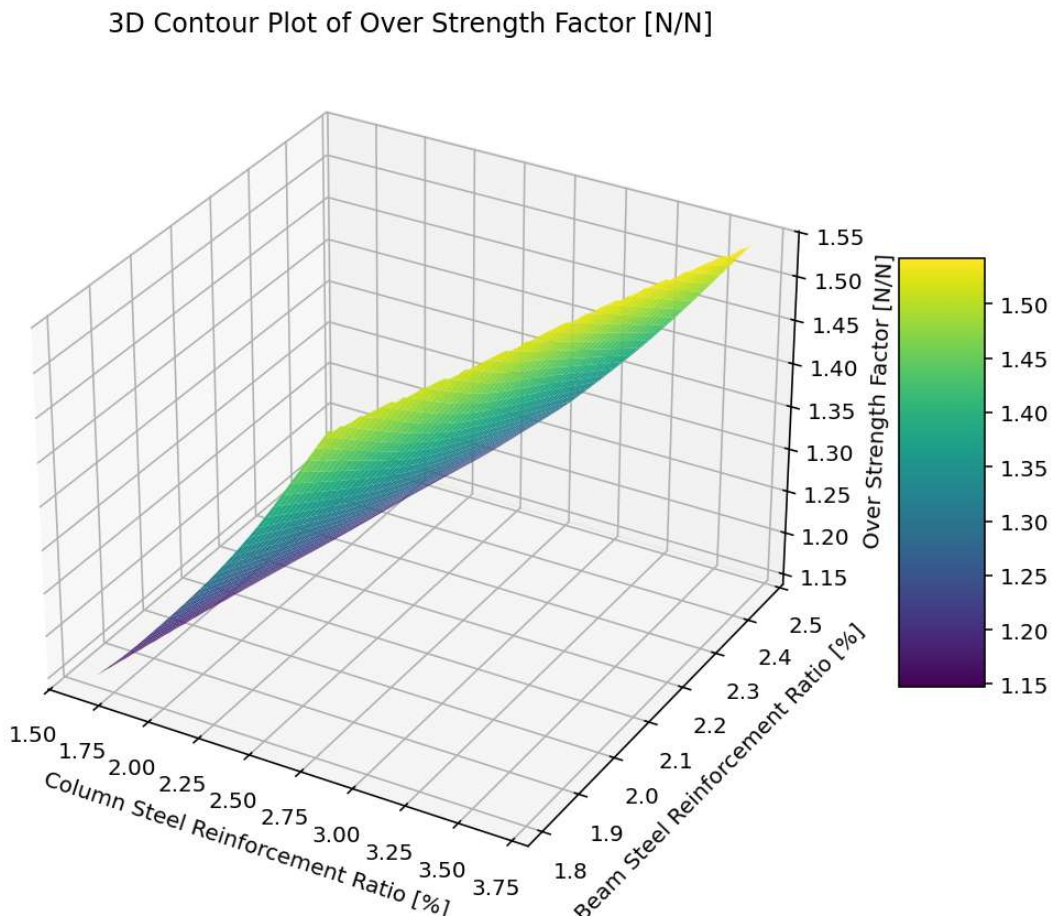


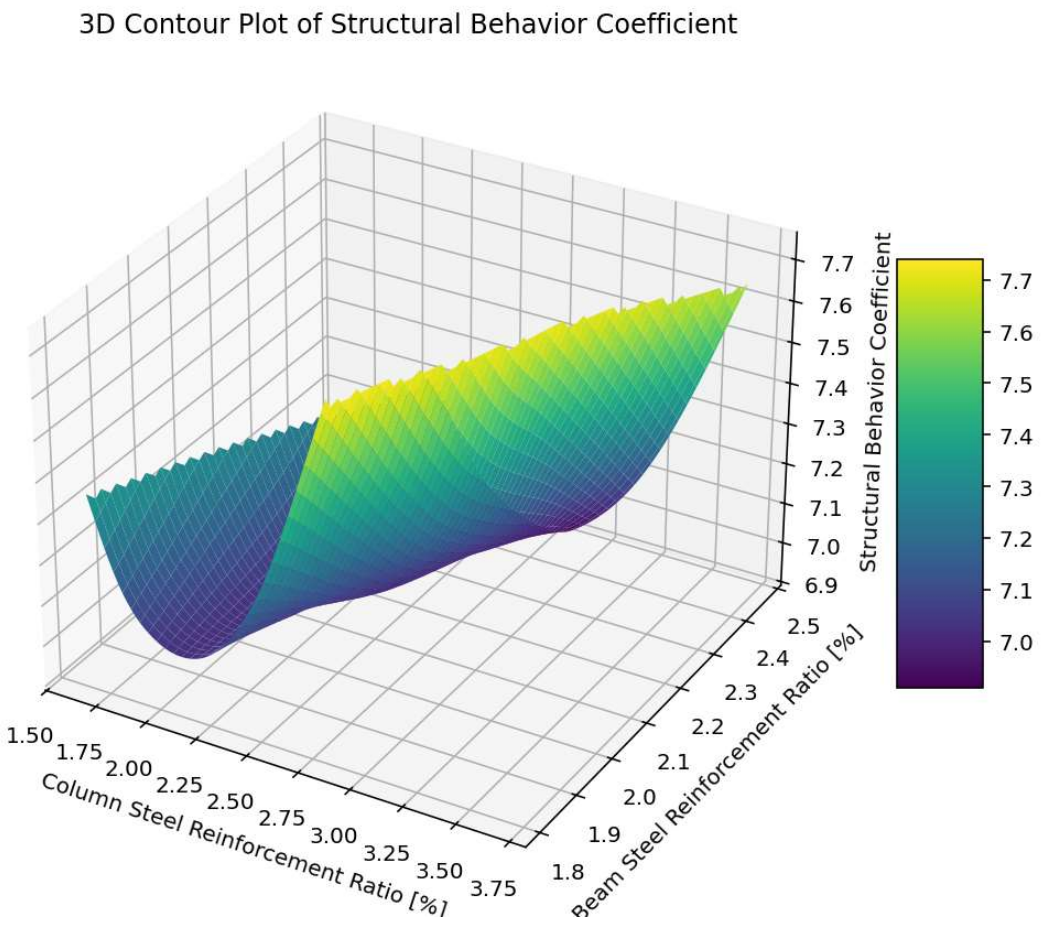

3D Contour Plot of Lateral Stiffness Ratio in Y Dir.
Lateral Stiffness Ratio in Y Dir.
100
80
60
40
20
0
80
60
40
20
0
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Column Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Beam Steel Reinforcement Ratio [%]

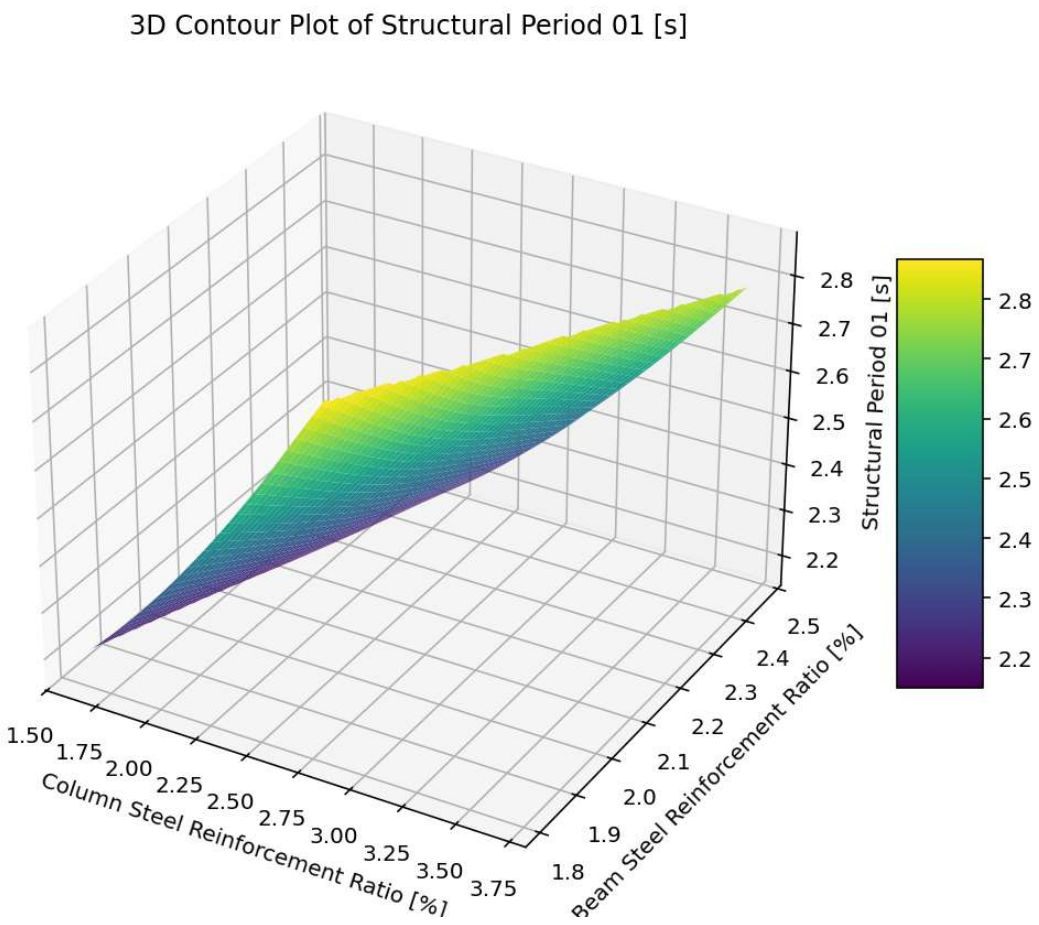

3D Contour Plot of Structure Elastic Stiffness [N/mm]
Structure Elastic Stiffness [N/mm]
30000
27500
25000
22500
20000
17500
15000
12500
10000
Rebar Diameter
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Confinement Enhancement Ratio
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5

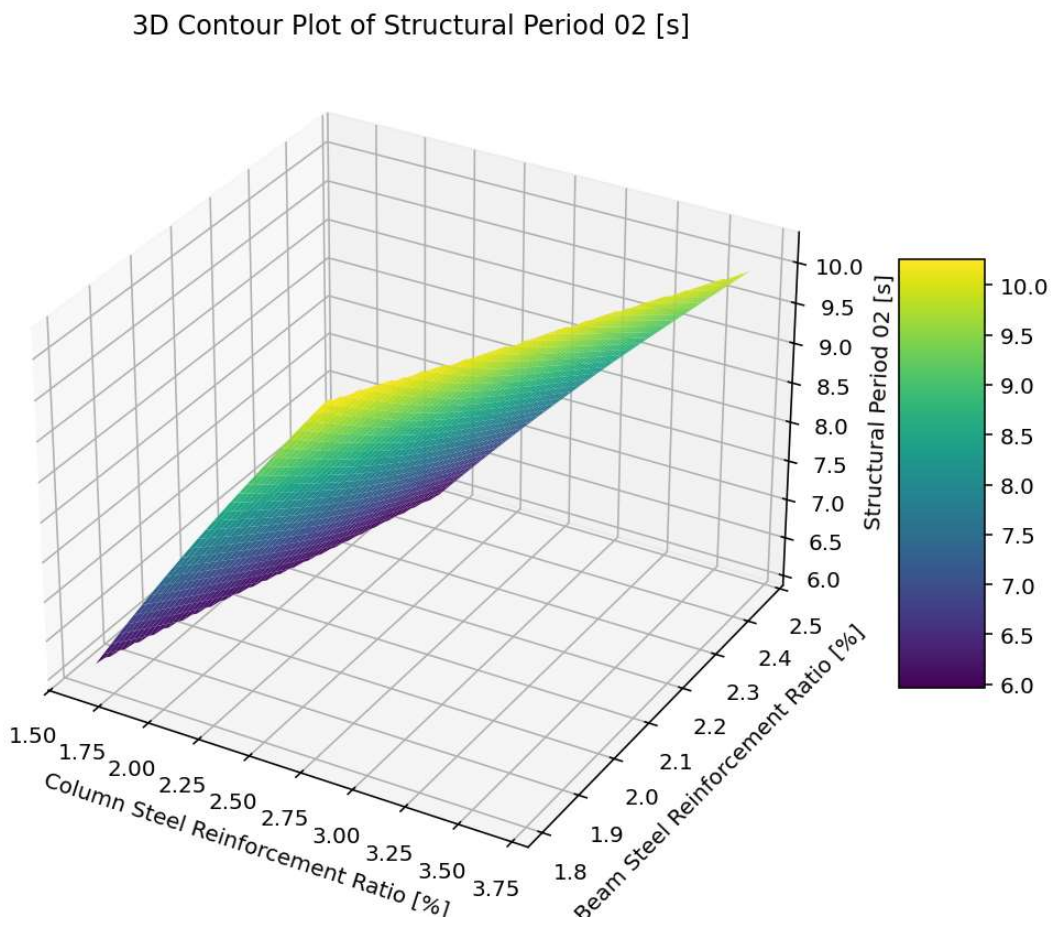

3D Contour Plot of Structure Plastic Stiffness [N/mm]
Structure Plastic Stiffness [N/mm]
5500
5000
4500
4000
3500
3000
2500
Column Steel Reinforcement Ratio [%]
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Beam Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5

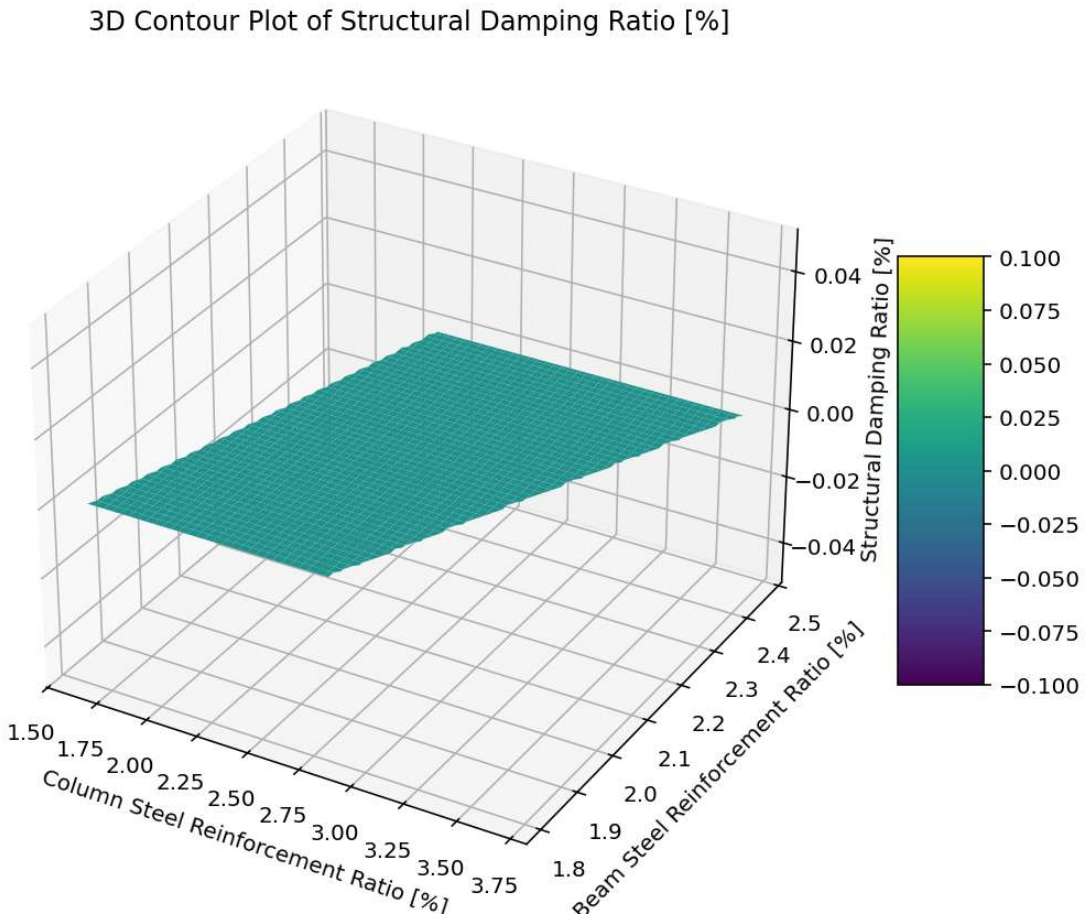

3D Contour Plot of Ductility Rito [mm/mm]
Ductility Rito [mm/mm]
6.4
6.2
6.0
5.8
5.6
5.4
5.2
5.0
Column Steel Reinforcement Ratio [%]
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Beam Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5

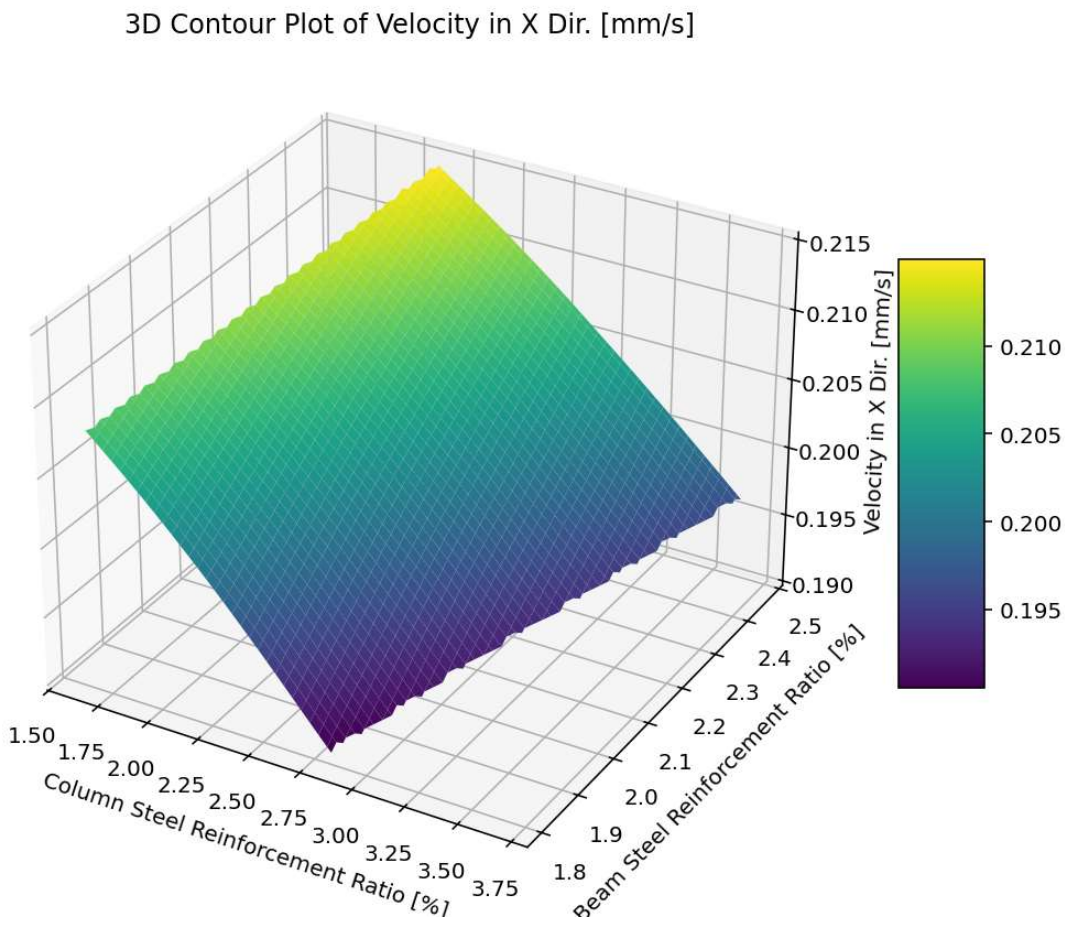

3D Contour Plot of Over Strength Factor [N/N]
Column Steel Reinforcement Ratio [%]
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Beam Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Over Strength Factor [N/N]
1.15
1.20
1.25
1.30
1.35
1.40
1.45
1.50
1.55

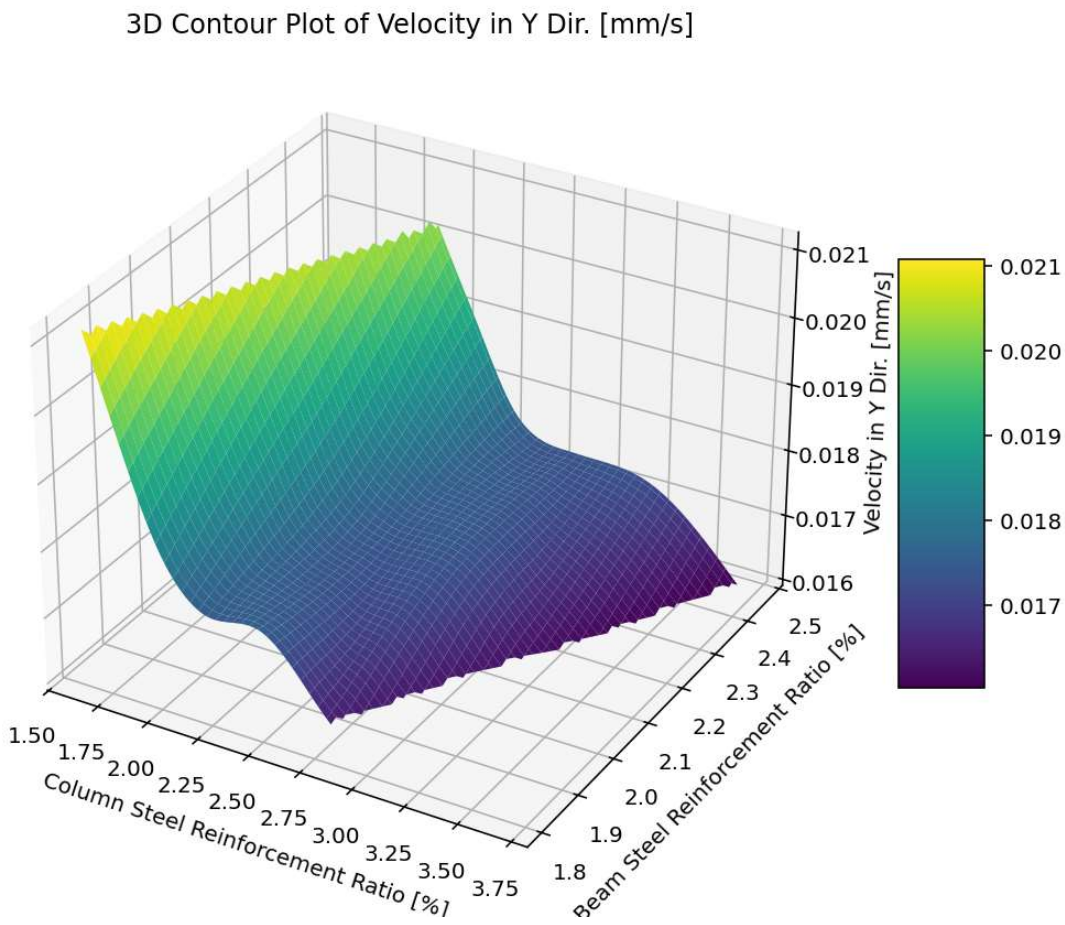

3D Contour Plot of Structural Behavior Coefficient
Structural Behavior Coefficient
7.7
7.6
7.5
7.4
7.3
7.2
7.1
7.0
6.9
Column Steel Reinforcement Ratio [%]
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Beam Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5

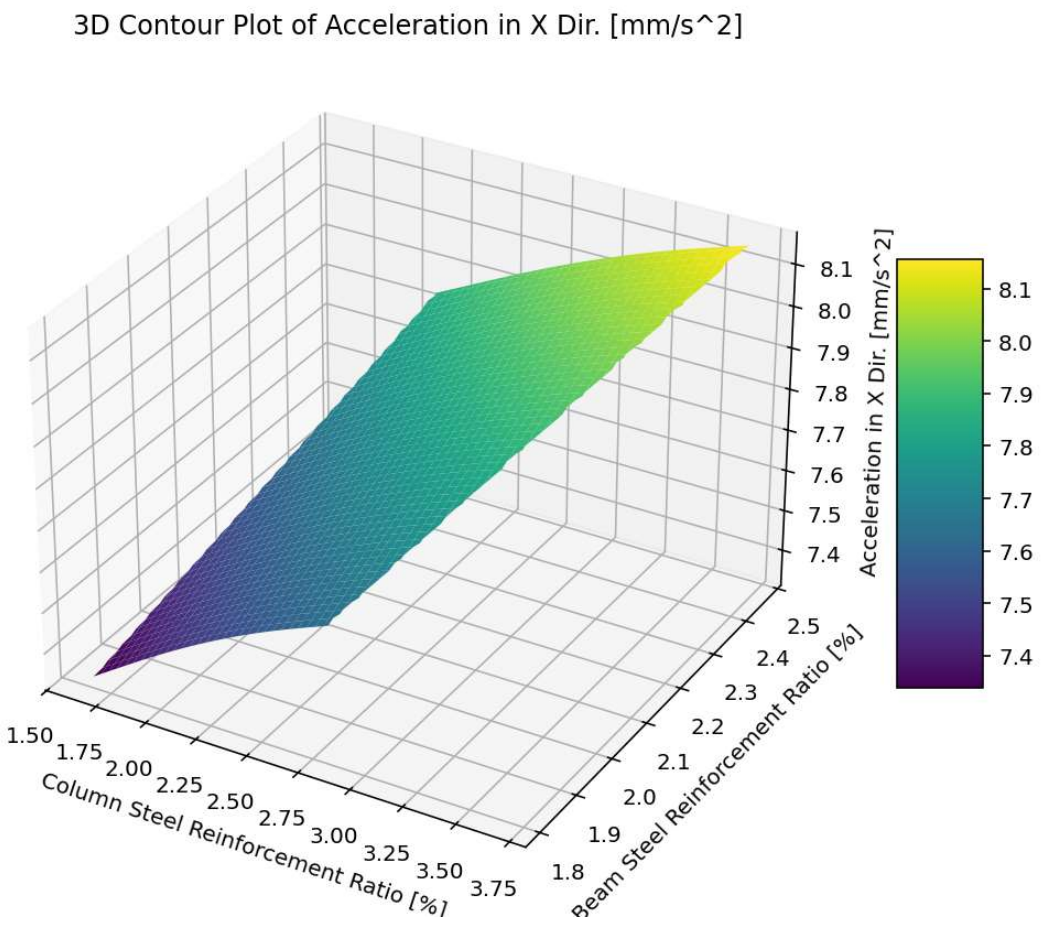

3D Contour Plot of Structural Period 01 [s]
Column Steel Reinforcement Ratio [%]
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Beam Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Structural Period 01 [s]
2.2
2.3
2.4
2.5
2.6
2.7
2.8

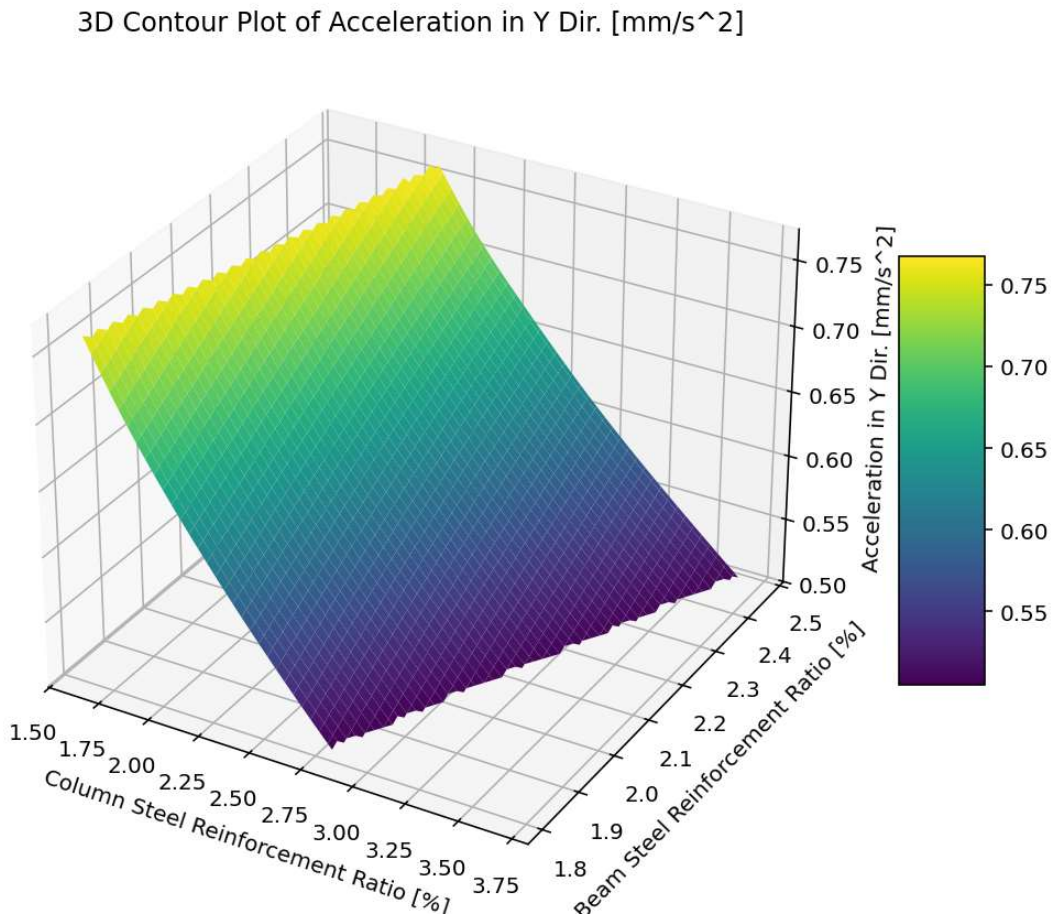

3D Contour Plot of Structural Period 02 [s]
Structural Period 02 [s]
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Column Steel Reinforcement Ratio [%]
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Beam Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5

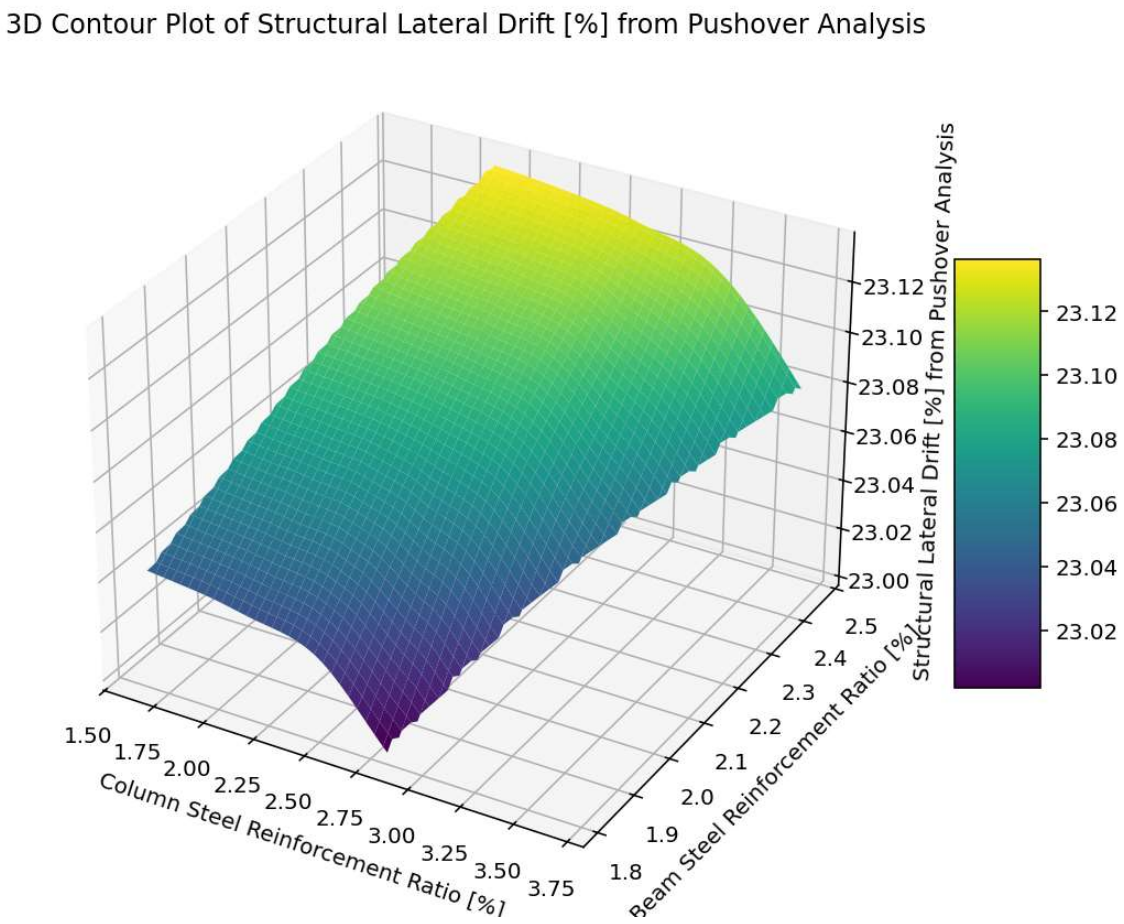

3D Contour Plot of Structural Damping Ratio [%]
Structural Damping Ratio [%]
0.04
0.02
0.00
−0.02
−0.04
0.100
0.075
0.050
0.025
0.000
−0.025
−0.050
−0.075
−0.100
Column Steel Reinforcement Ratio [%]
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Beam Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5


3D Contour Plot of Velocity in X Dir. [mm/s]
Velocity in X Dir. [mm/s]
0.215
0.210
0.205
0.200
0.195
0.190
0.210
0.205
0.200
0.195
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Column Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Beam Steel Reinforcement Ratio [%]

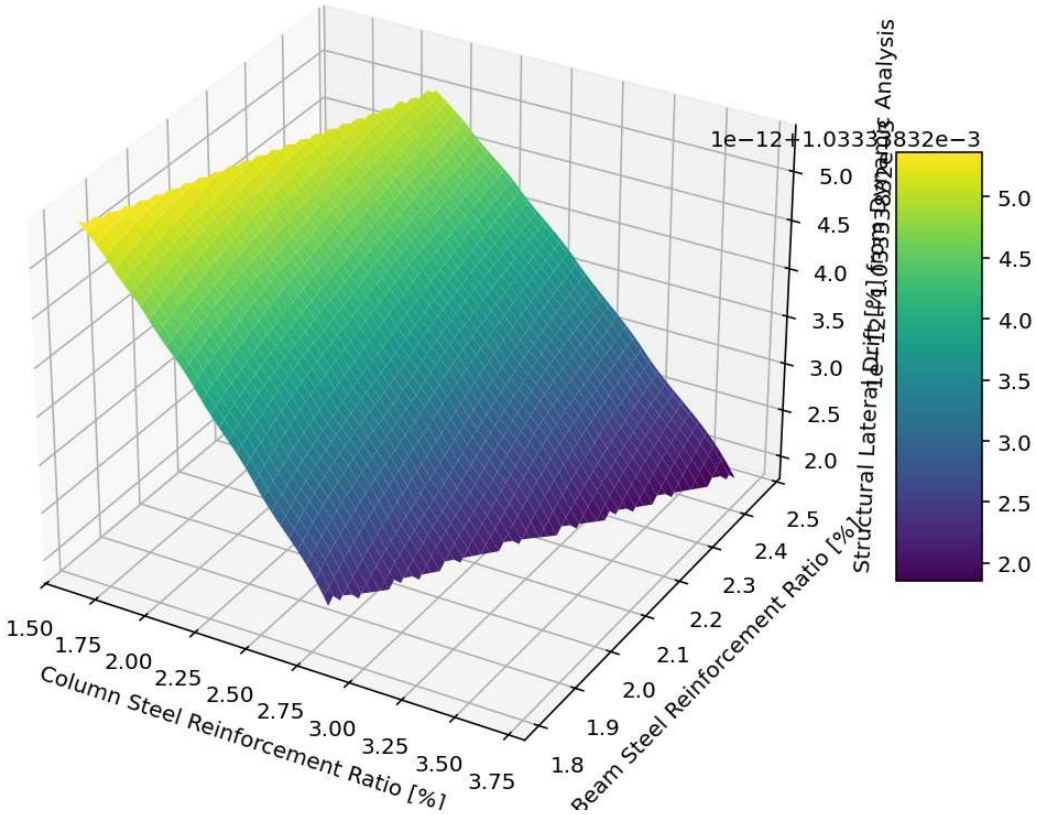

3D Contour Plot of Velocity in Y Dir. [mm/s]
Velocity in Y Dir. [mm/s]
0.021
0.020
0.019
0.018
0.017
0.016
Column Steel Reinforcement Ratio [%]
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Beam Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5

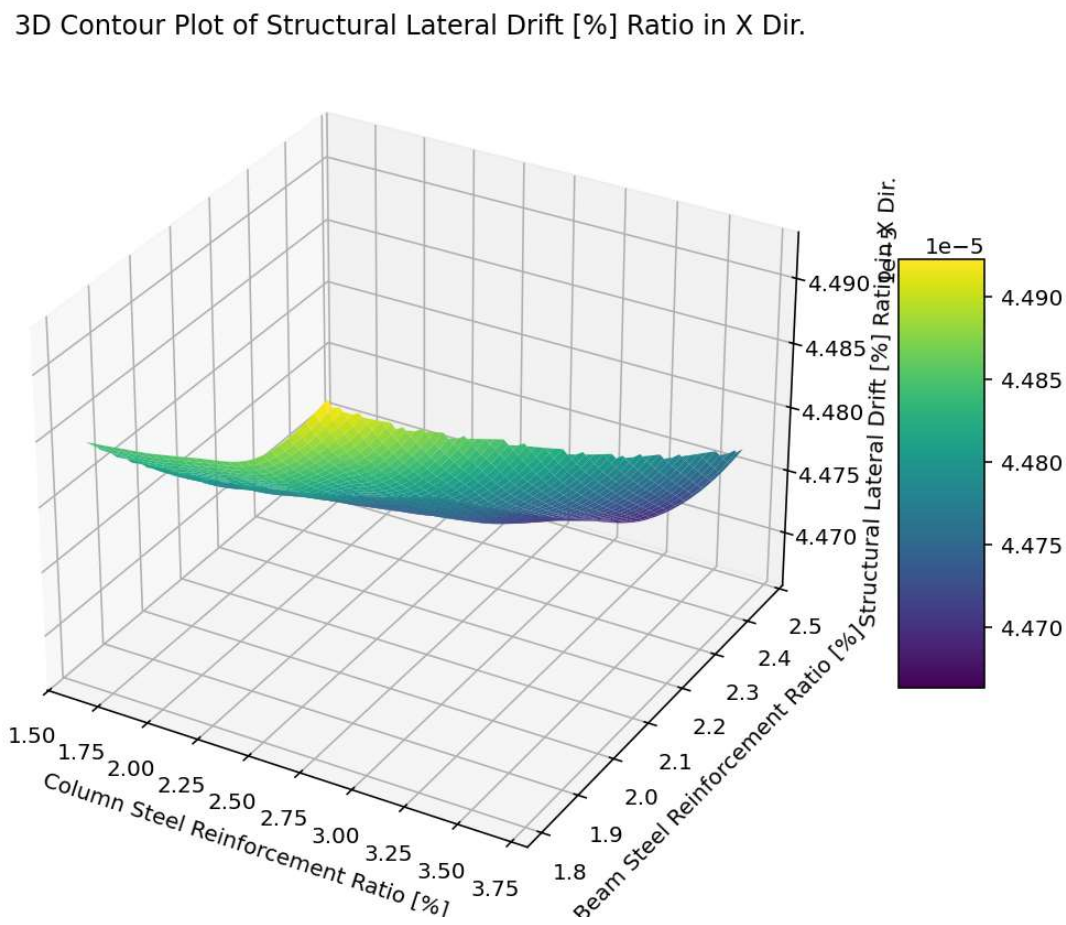

3D Contour Plot of Acceleration in X Dir. [mm/s^2]
Column Steel Reinforcement Ratio [%]
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Beam Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Acceleration in X Dir. [mm/s^2]
7.4
7.5
7.6
7.7
7.8
7.9
8.0
8.1


3D Contour Plot of Acceleration in Y Dir. [mm/s^2]
Acceleration in Y Dir. [mm/s^2]
0.75
0.70
0.65
0.60
0.55
0.50
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Column Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Beam Steel Reinforcement Ratio [%]


3D Contour Plot of Structural Lateral Drift [%] from Pushover Analysis
Column Steel Reinforcement Ratio [%]
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Beam Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Structural Lateral Drift [%] from Pushover Analysis
23.00
23.02
23.04
23.06
23.08
23.10
23.12

3D Contour Plot of Structural Lateral Drift [%] from Dynamic Analysis




3D Contour Plot of Structural Lateral Drift [%] Ratio in X Dir.
Structural Lateral Drift [%] Ratio in X Dir.
1e−5
4.490
4.485
4.480
4.475
4.470
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
Column Steel Reinforcement Ratio [%]
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Beam Steel Reinforcement Ratio [%]