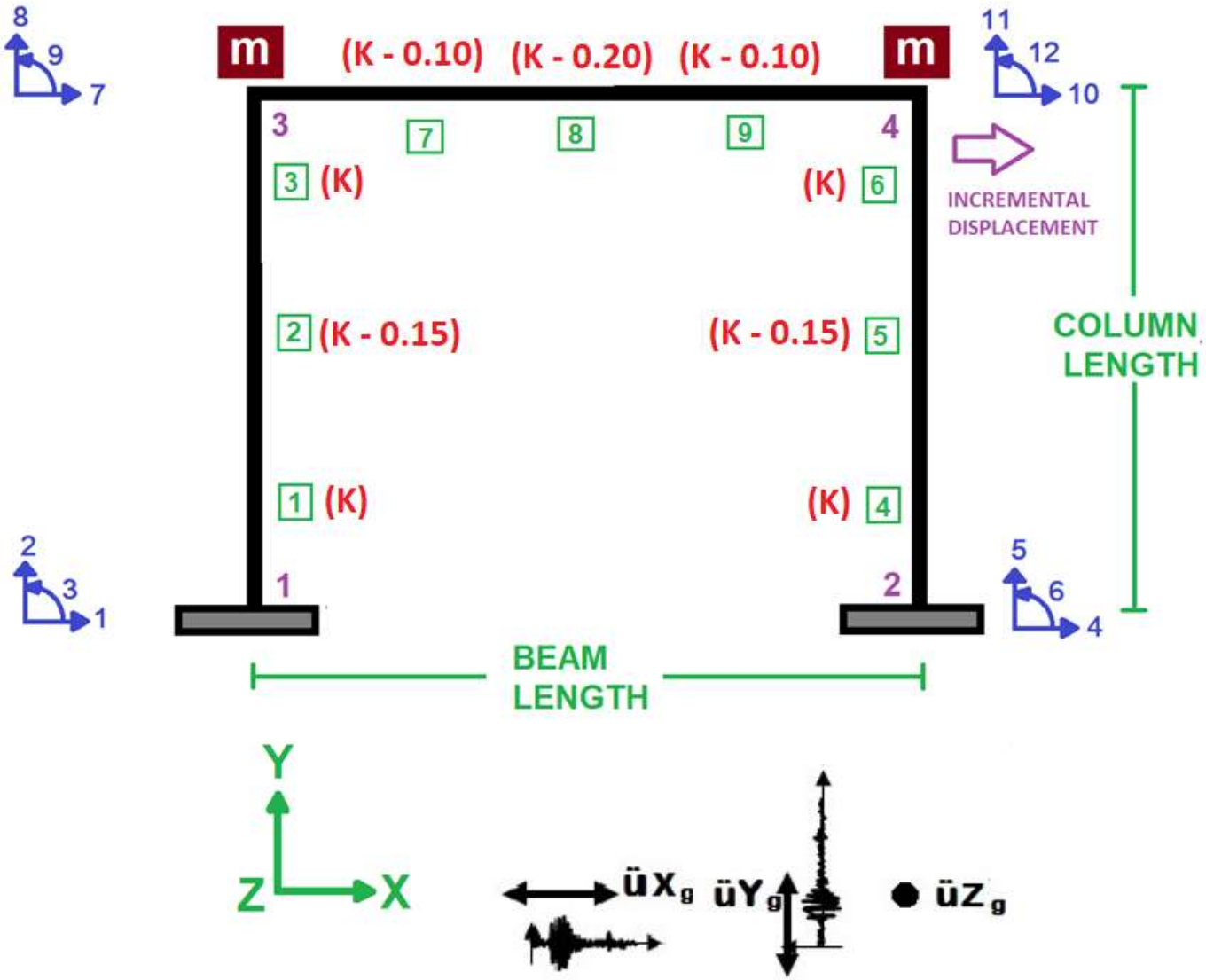
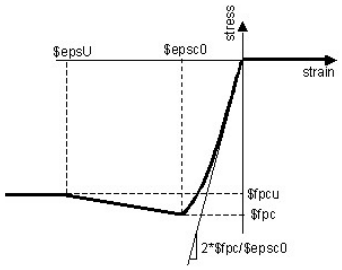
IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL

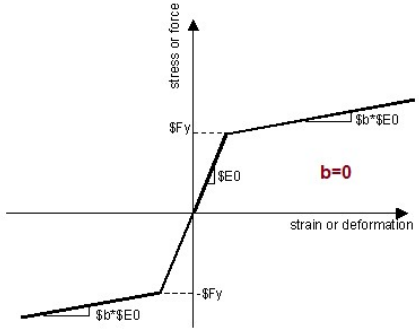
CONCRETE SECTION CONFINEMENT ENHANCEMENT RATIO OPTIMIZATION WITH PUSHOVER ANALYSIS USING OPENSEES. FIND BEST CONCRETE COLUMN SECTION CONFINEMENT ENHANCEMENT RATIO WITH DEFINED STRUCTURAL DUCTILITY RATIO. OPTIMIZATION ALGORITHM: NEWTON-RAPHSON METHOD

WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)

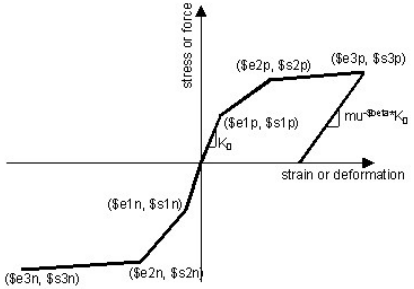

8
9
7
m
(K - 0.10)
(K - 0.20)
(K - 0.10)
m
11
12
10
3
7
8
9
4
3
(K)
(K)
6
INCREMENTAL
DISPLACEMENT
2
(K - 0.15)
(K - 0.15)
5
COLUMN
LENGTH
1
(K)
(K)
4
2
3
1
1
2
5
6
4
BEAM
LENGTH
Y
Z
X
üX g
üY g
üZ g



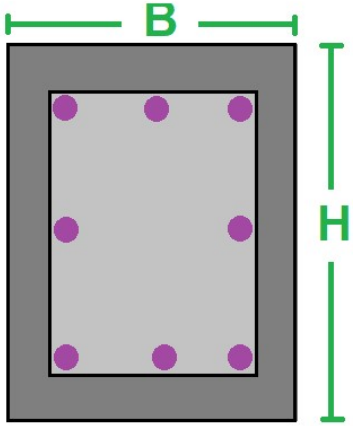
CORE AND COVER CONCRETE RELATION



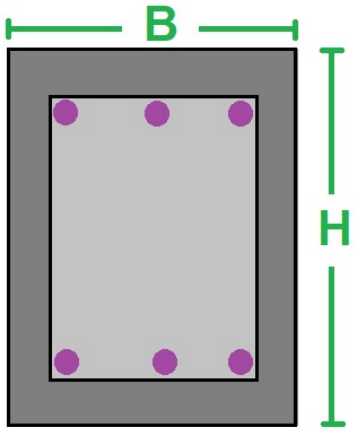
WITHOUT HARDENING AND ULTIMATE STRAIN



WITH HARDENING AND ULTIMATE STRAIN



COLUMN SECTION



BEAM SECTION

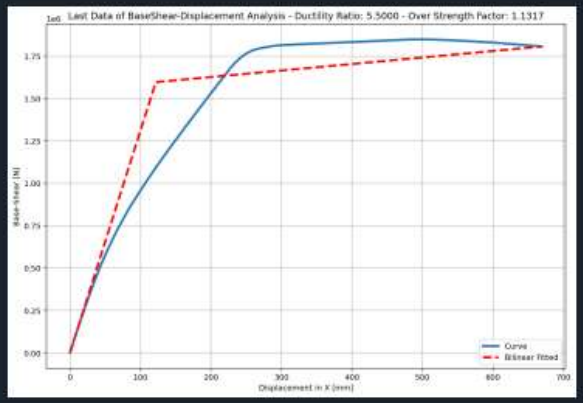
Spyder (Python 3.12)

File Edit Search Source Run Debug Consoles Projects Tools View Help

C:\Users\Dell\Desktop\OPENSEES_FILES\CONCRETE_FRA...AME_OPTIMIZATION_CONFINEMENT_ENHANCEMENT_RATIO.py

CONCRETE_FRAME_OPT...HANCEMENT_RATIO.py | CONCRETE_SECTION_FUN_TWO.py

```
##########################################################################################
#                    >> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<
#     CONCRETE SECTION CONFINEMENT ENHANCEMENT RATIO OPTIMIZATION WITH PUSHOVER ANALYS
#----------------------------------------------------------------------------------------
# FIND BEST CONCRETE COLUMN SECTION CONFINEMENT ENHANCEMENT RATIO WITH DEFINED STRUCTU
#                          OPTIMIZATION ALGORITHM: NEWTON-RAPHSON METHOD
#----------------------------------------------------------------------------------------
#                       THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)
#                              EMAIL: salar.d.ghashghaei@gmail.com
##########################################################################################
"""
[1] Objective: The code optimizes the confinement enhancement ratio (Kc) of reinforcea
 achieve a target structural ductility ratio (μ) using OpenSees.
[2] Methodology: It employs the Newton-Raphson optimization algorithm coupled with non
 analysis to iteratively refine Kc.
[3] Modeling: A 2D frame with confined/unconfined concrete sections (fibers) and bilin
 accounting for geometric nonlinearity (P-Delta/Corotational).
[4] Key Outputs: Computes ductility ratio (μ), overstrength factor (Ω₀), and structura
 per seismic design principles.
[5] Analysis: Pushover analysis generates force-displacement curves, later fitted to a
 yield and ultimate states.
[6] Dynamic Capability: Includes Rayleigh damping and eigenvalue analysis for dynamic
 focus is static pushover.
[7] Validation: Checks convergence via residual tolerance and finite difference deriva
[8] Visualization: Plots P-M interaction, shear-displacement, stiffness degradation, a
 performance assessment.
[9] Applications: Ideal for performance-based seismic design, retrofitting, and code c
[10] Efficiency: Tracks computational time and exports results (Excel/JSON) for post-p
The code bridges theoretical mechanics and practical design, emphasizing ductility-dri
"""

import openseespy.opensees as ops
import matplotlib.pyplot as plt
import numpy as np
```



Help | Variable Explorer | Debugger | Plots | Files

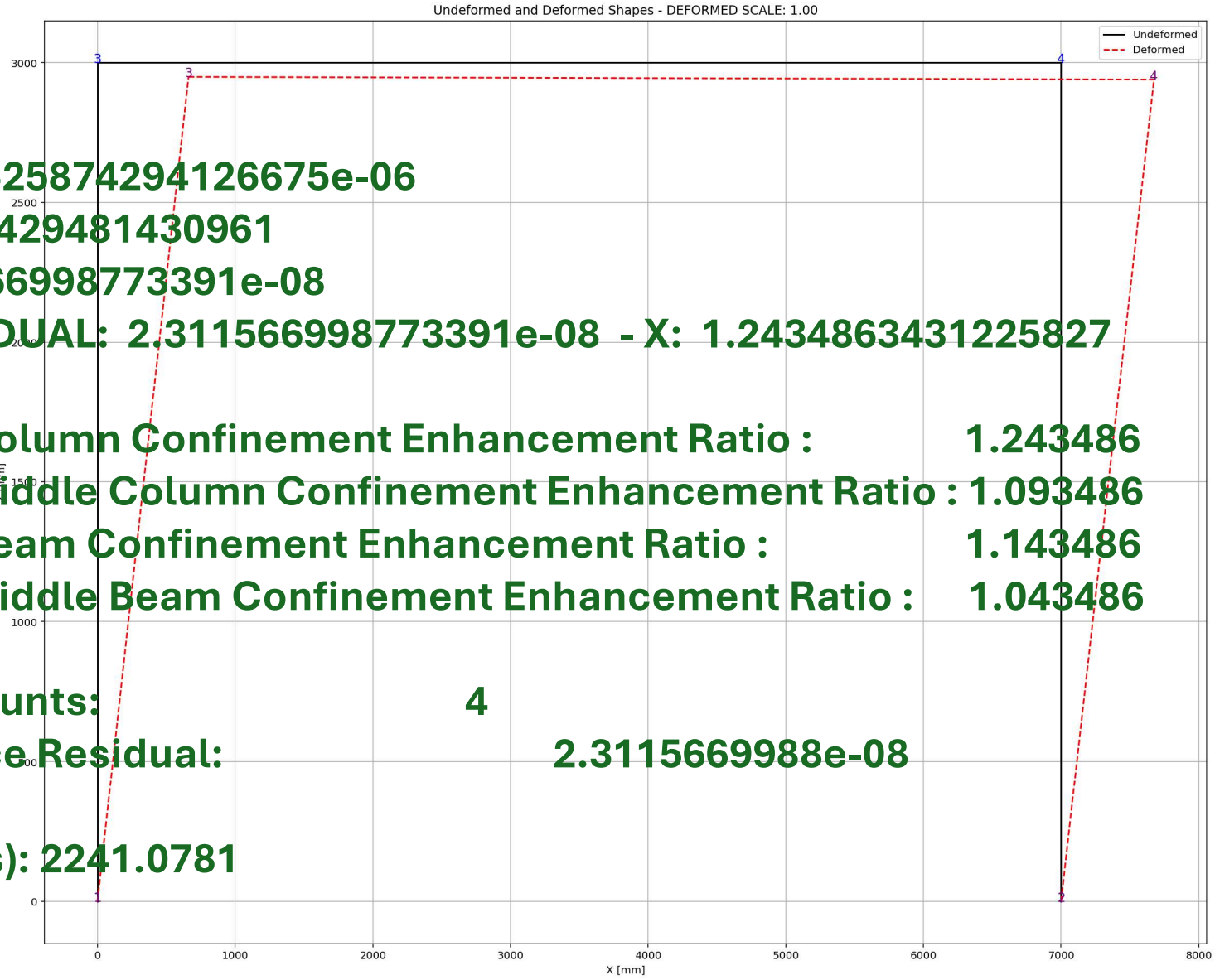
```
DX:  2.311566998773391e-08
IT:  4  - RESIDUAL:  2.311566998773391e-08  - X:  1.2434863431225827

        Optimum Column Confinement Enhancement Ratio :          1.243486
        Optimum Beam Confinement Enhancement Ratio :            1.143486
        Iteration Counts:                                       4
        Convergence Residual:                                   2.3115669988e-08

Total time (s): 2241.0781
```

37 MINUTES

IPython Console | History

Inline | Conda: anaconda3 (Python 3.12.7) | LSP: Python | Line 9, Col 68 | UTF-8 | CRLF | RW | Mem 47%

NONLINEAR STATIC ANALYSIS (PUSHOVER)

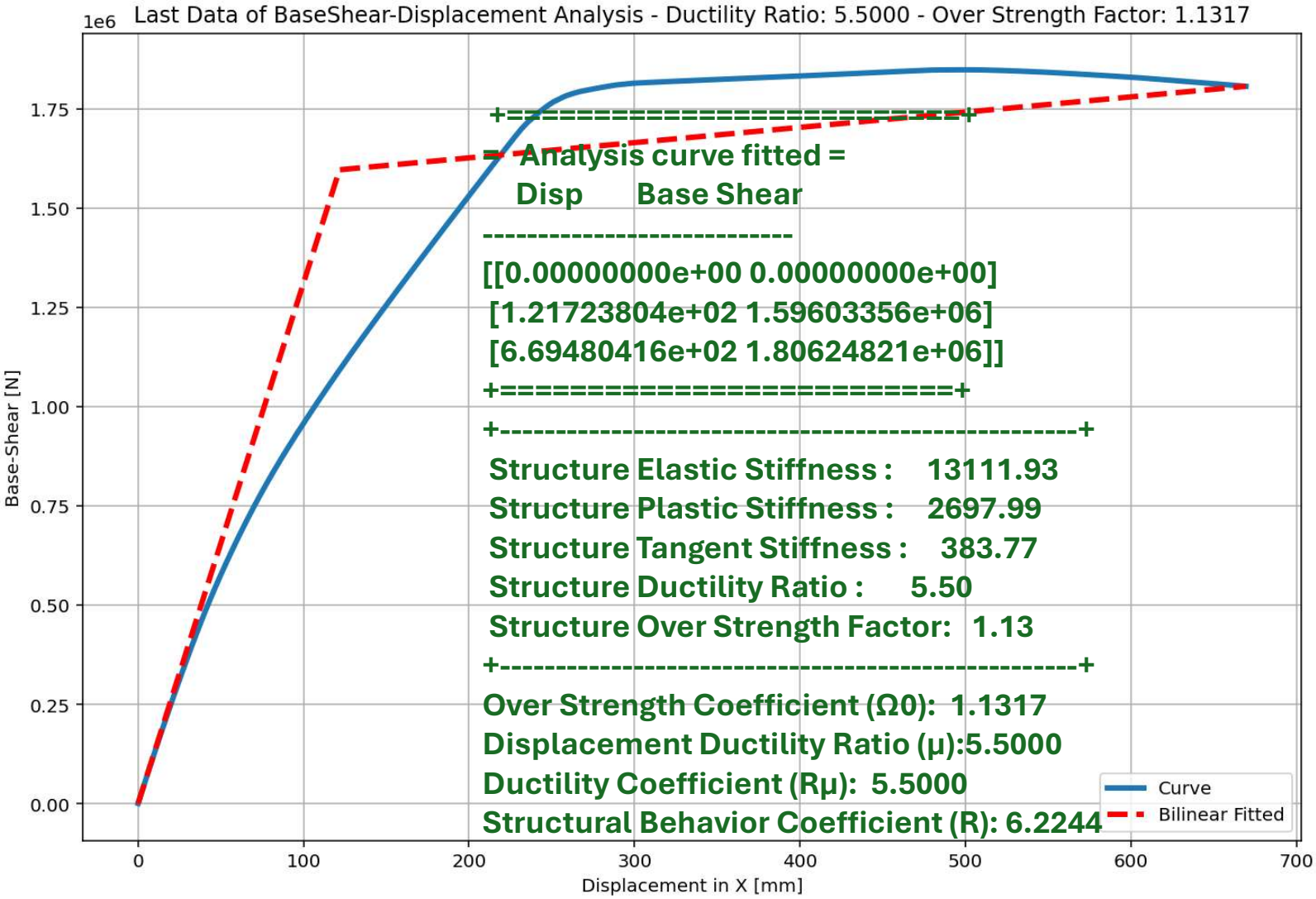


Fmax: -4.1625874294126675e-06
DF: -0.4150429481430961
DX: 2.3115669987733 91e-08
IT: 4 - RESIDUAL: 2.3115669987733 91e-08 - X: 1.2434863431225827

Optimum Column Confinement Enhancement Ratio : 1.243486
Optimum Middle Column Confinement Enhancement Ratio : 1.093486
Optimum Beam Confinement Enhancement Ratio : 1.143486
Optimum Middle Beam Confinement Enhancement Ratio : 1.043486

Iteration Counts: 4
Convergence Residual: 2.3115669988e-08

Total time (s): 2241.0781


Last Data of BaseShear-Displacement Analysis - Ductility Ratio: 5.5000 - Over Strength Factor: 1.1317
1e6
Base-Shear [N]
Displacement in X [mm]
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
0
100
200
300
400
500
600
700
+============================+
= Analysis curve fitted =
Disp Base Shear

[[0.00000000e+00 0.00000000e+00]
[1.21723804e+02 1.59603356e+06]
[6.69480416e+02 1.80624821e+06]]
+============================+
+----------+
Structure Elastic Stiffness : 13111.93
Structure Plastic Stiffness : 2697.99
Structure Tangent Stiffness : 383.77
Structure Ductility Ratio : 5.50
Structure Over Strength Factor: 1.13
+----------+
Over Strength Coefficient (Ω0): 1.1317
Displacement Ductility Ratio (μ):5.5000
Ductility Coefficient (Rμ): 5.5000
Structural Behavior Coefficient (R): 6.2244
Curve
Bilinear Fitted