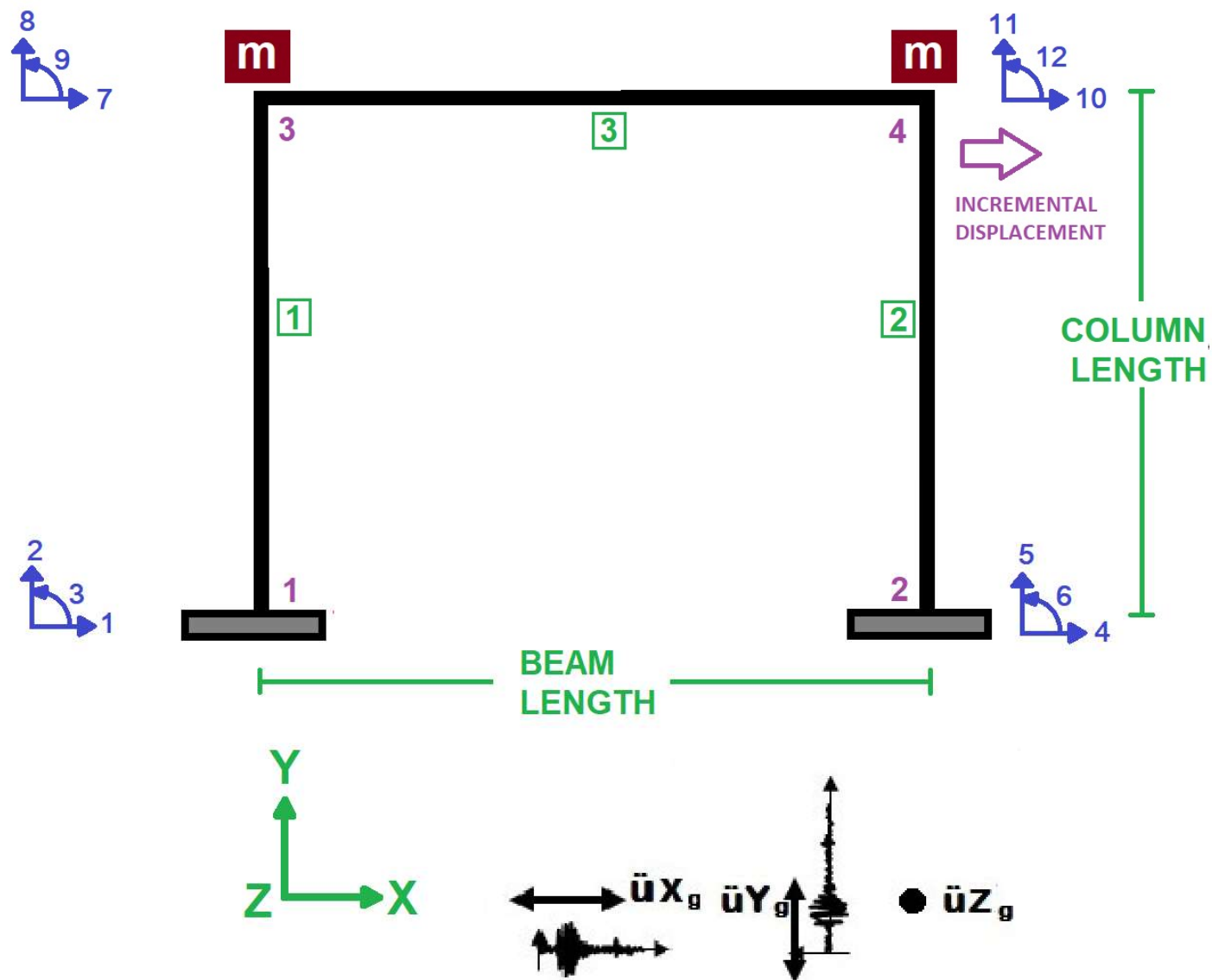
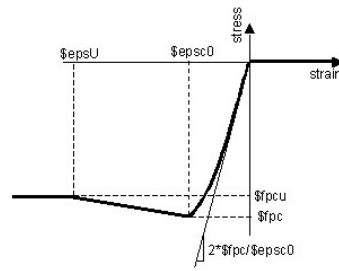


IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL

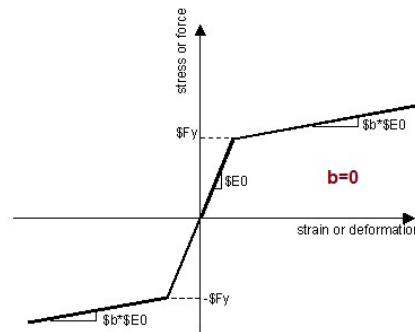
**CONCRETE SECTION CONFINEMENT
ENHANCEMENT RATIO OPTIMIZATION WITH
PUSHOVER ANALYSIS USING OPENSEES. FIND
BEST CONCRETE COLUMN SECTION
CONFINEMENT ENHANCEMENT RATIO WITH
DEFINED STRUCTURAL DUCTILITY RATIO.
OPTIMIZATION ALGORITHM: NEWTON-
RAPHSON METHOD**

WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)

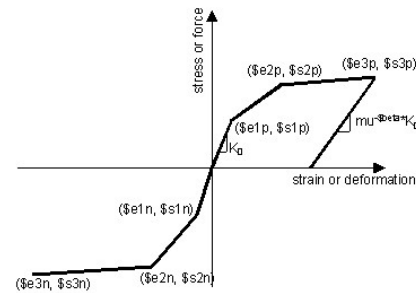




CORE AND COVER CONCRETE RELATION



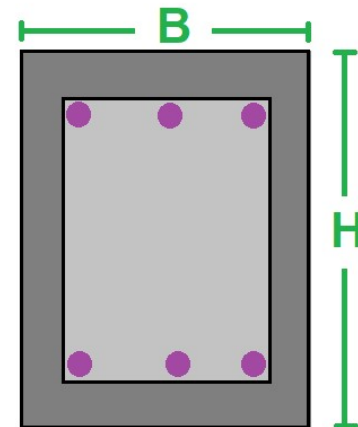
WITHOUT HARDENING AND ULTIMATE STRAIN



WITH HARDENING AND ULTIMATE STRAIN



COLUMN SECTION



BEAM SECTION

Spyder (Python 3.12)

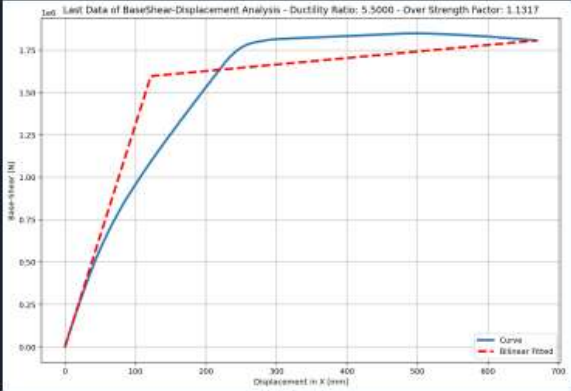
File Edit Search Source Run Debug Consoles Projects Tools View Help

C:\Users\Dell\Desktop\OPENSEES_FILES\CONCRETE_FRAME_OPTIMIZATION_CONFINEMENT_ENHANCEMENT_RATIO.py

CONCRETE_FRAME_OPT...HANCEMENT_RATIO.py x CONCRETE_SECTION_FUN_TWO.py x

```
1 #####
2 # >> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<
3 # CONCRETE SECTION CONFINEMENT ENHANCEMENT RATIO OPTIMIZATION WITH PUSHOVER ANALYSIS
4 # -----
5 # FIND BEST CONCRETE COLUMN SECTION CONFINEMENT ENHANCEMENT RATIO WITH DEFINED STRUCTU
6 # OPTIMIZATION ALGORITHM: NEWTON-RAPHSON METHOD
7 # -----
8 # THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)
9 # EMAIL: salar.d.ghashghaei@gmail.com
10 #####
11 """
12 [1] Objective: The code optimizes the confinement enhancement ratio (Kc) of reinforced
13 achieve a target structural ductility ratio ( $\mu$ ) using OpenSees.
14 [2] Methodology: It employs the Newton-Raphson optimization algorithm coupled with non
15 analysis to iteratively refine Kc.
16 [3] Modeling: A 2D frame with confined/unconfined concrete sections (fibers) and bilin
17 accounting for geometric nonlinearity (P-Delta/Corotational).
18 [4] Key Outputs: Computes ductility ratio ( $\mu$ ), overstrength factor ( $\Omega_0$ ), and structura
19 per seismic design principles.
20 [5] Analysis: Pushover analysis generates force-displacement curves, later fitted to a
21 yield and ultimate states.
22 [6] Dynamic Capability: Includes Rayleigh damping and eigenvalue analysis for dynamic
23 focus is static pushover.
24 [7] Validation: Checks convergence via residual tolerance and finite difference deriva
25 [8] Visualization: Plots P-M interaction, shear-displacement, stiffness degradation, a
26 performance assessment.
27 [9] Applications: Ideal for performance-based seismic design, retrofitting, and code c
28 [10] Efficiency: Tracks computational time and exports results (Excel/JSON) for post-p
29 The code bridges theoretical mechanics and practical design, emphasizing ductility-dri
30 """
31
32 import openseespy.opensees as ops
33 import matplotlib.pyplot as plt
34 import numpy as np
```

1st: Load Data of BaseShear-Displacement Analysis - Ductility Ratio: 5.5000 - Over Strength Factor: 1.1317



Help Variable Explorer Debugger Plots Files

Consoles x/y

```
DI: -0.4136423401430501
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: 2.311566998773391e-08
IT: 4 - RESIDUAL: 2.311566998773391e-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

