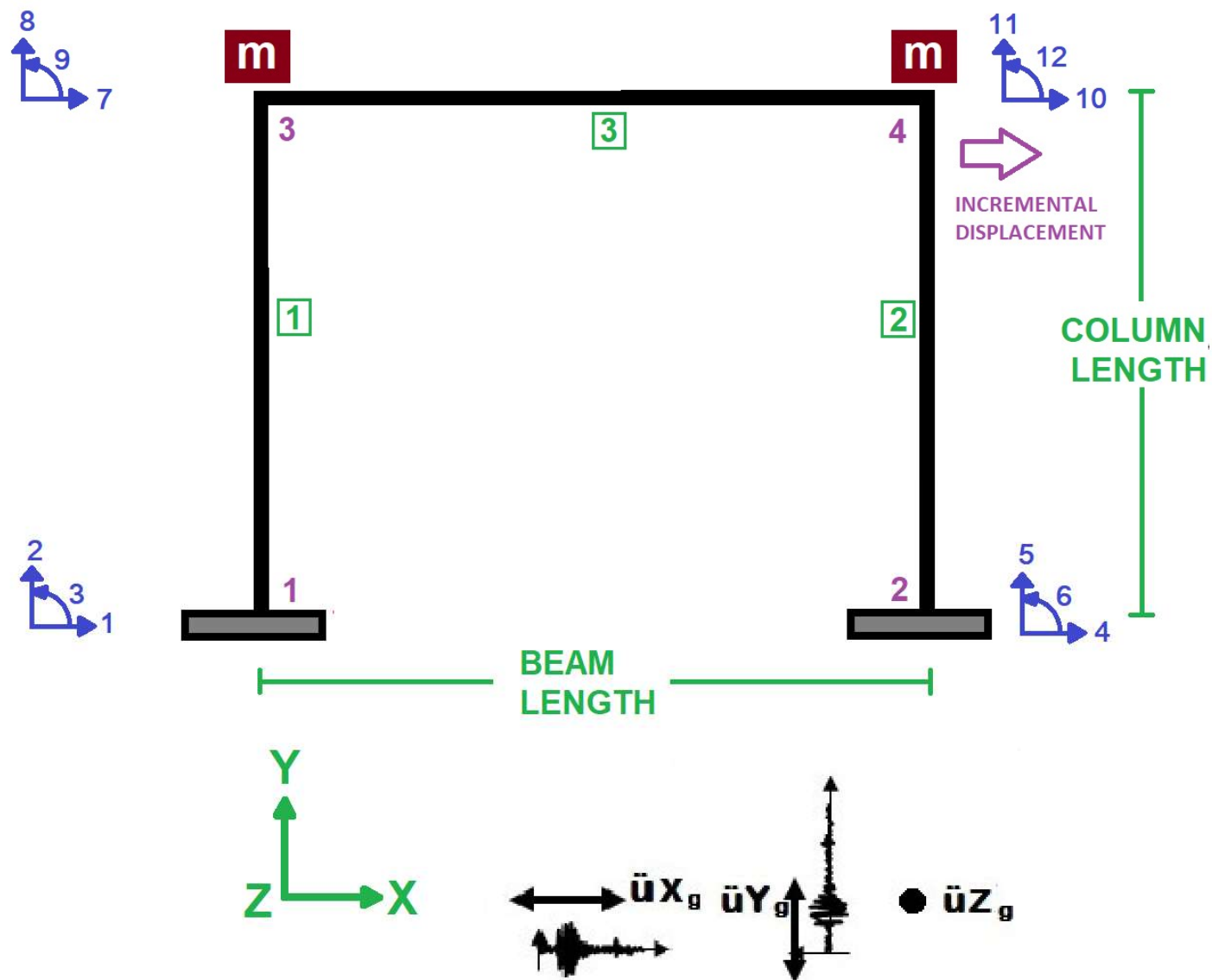


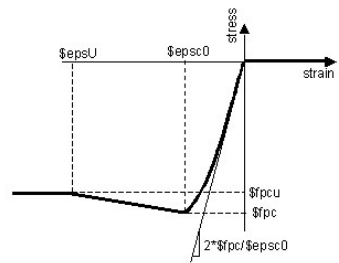
IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL

CONCRETE COLUMN SECTION REBAR OPTIMIZATION BASED ON DEMAND BASE-SHEAR REACTION.

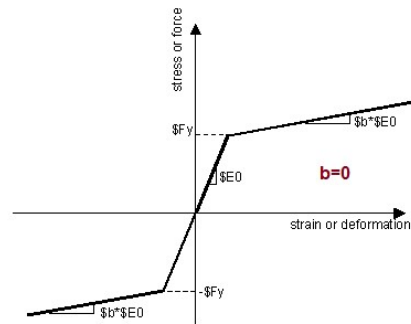
**UTILIZING PARALLEL PROCESSING PROCEDURES
FOR THE SIMULTANEOUS EXECUTION OF
NONLINEAR STATIC AND DYNAMIC CONCRETE
STRUCTURAL ANALYSIS, USING OPENSEES**

WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)

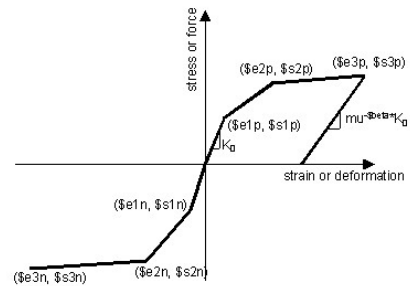




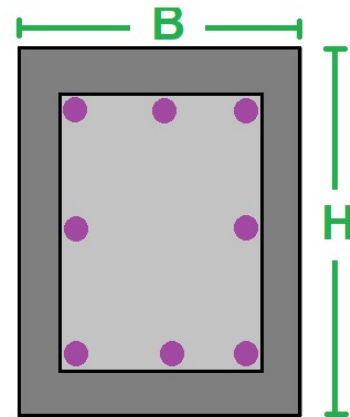
CORE AND COVER CONCRETE REALTION



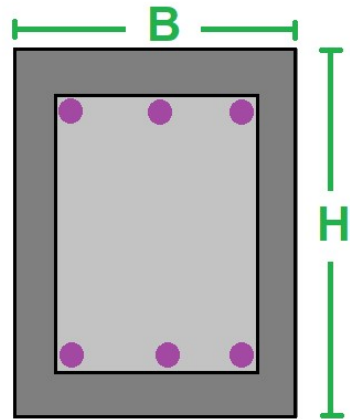
WITHOUT HARDENING AND ULTIMATE STRAIN



WITH HARDENING AND ULTIMATE STRAIN



COLUMN SECTION



BEAM SECTION

Spyder (Python 3.12)

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C:\Users\Dell\Desktop\OPENSEES_FILES\CONCRETE_FRAME_PARALLEL_COMPUTING_&_OPTIMIZATION.py

CONCRETE_FRAME_PAR..._OPTIMIZATION.py

```
1 #####
2 #           IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL
3 #           CONCRETE COLUMN SECTION REBAR OPTIMIZATION BASED ON DEMAND BASE-SHEAR REACTION.
4 # UTILIZING PARALLEL PROCESSING PROCEDURES FOR THE SIMULTANEOUS EXECUTION OF NONLINEAR STATIC AND DYN
5 #           STRUCTURAL ANALYSIS, USING OPENSEES.
6 #
7 #           OPTIMIZATION ALOGORITHM: NEWTON-RAPHSON METHOD PARALLEL COMPUTING
8 #
9 # PARALLEL COMPUTING IS A METHOD OF PERFORMING MULTIPLE CALCULATIONS OR PROCESSES SIMULTANEOUSLY BY DI
10 # INTO SMALLER SUB-TASKS. THESE SUB-TASKS RUN CONCURRENTLY ON MULTIPLE PROCESSORS OR CORES TO SPEED UP
11 # IT'S COMMONLY USED IN HIGH-PERFORMANCE TASKS LIKE SIMULATIONS, DATA ANALYSIS, AND MACHINE LEARNING.
12 #
13 #           THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)
14 #           EMAIL: salar.d.ghashghaei@gmail.com
15 #####
16 """
17 [1] Nonlinear Frame Modeling: 2D RC frame with distributed plasticity (fiber sections) using `nonline
18 [2] Material Laws:
19     - *Concrete*: `Concrete01` with confined (core) and unconfined (cover) properties.
20     - *Steel*: `Hysteretic` model with pinching, hardening, and cyclic degradation.
21 [3] Seismic Loads:
22     - Pushover: Displacement-controlled lateral loading to failure.
23     - Dynamic: Uniform excitation with user-defined ground motions (X/Y components).
24 [4] Damping: Rayleigh damping (a0, a1) calibrated via eigenvalue analysis (modes 1-2).
25 [5] Performance Metrics:
26     - Ductility Ratio (μ): Derived from bilinearized pushover curves.
27     - Overstrength (Qo): Yield vs. ultimate capacity.
28 [6] Advanced Solver: HHT-α integrator (unconditionally stable) with Newton-Raphson iterations.
29 [7] Outputs:
30     - Hysteretic responses (P-M, V-Δ, M-θ).
31     - Time-history plots (displacement, base shear).
32     - Stiffness degradation tracking.
33 [8] Validation: Logarithmic decrement method for damping ratio verification.
34
```

No plots to show

Run plot-generating code in the Editor or IPython console to see your figures appear here. This pane only supports static images, so it can't display interactive plots like Bokeh, Plotly or Altair.

Help Variable Explorer Debugger Plots Files

Console 1/A

```
SUPPLY: 214811.76988
18827.638671151362
IT: 4 - RESIDUAL: 2.669230e-09 - COLUMN SECTION REBAR DIAMETER
2.267750e+01
    Optimum Section Rebar Diameter:    22.6775
    Iteration Counts:                  4
    Convergence Residual:              2.6692301703e-09
Finish time (HH:MM:SS): 10:55:33
```

IPython Console History

Inline Conda: anaconda3 (Python 3.12.7) ✓ LSP: Python Line 1, Col 1 UTF-8 C I F RW Mem 42%

NONLINEAR STATIC ANALYSIS (PUSHOVER)

Start time (HH:MM:SS): 15:06:41

SUPPLY: 214817.69064

NormDispIncr KrylovNewton 0

Nonlinear Static Analysis Done.

SUPPLY: 214811.76988

18827.638671151362

IT: 4 - RESIDUAL: 2.669230e-09 - COLUMN SECTION REBAR DIAMETER 2.267750e+01

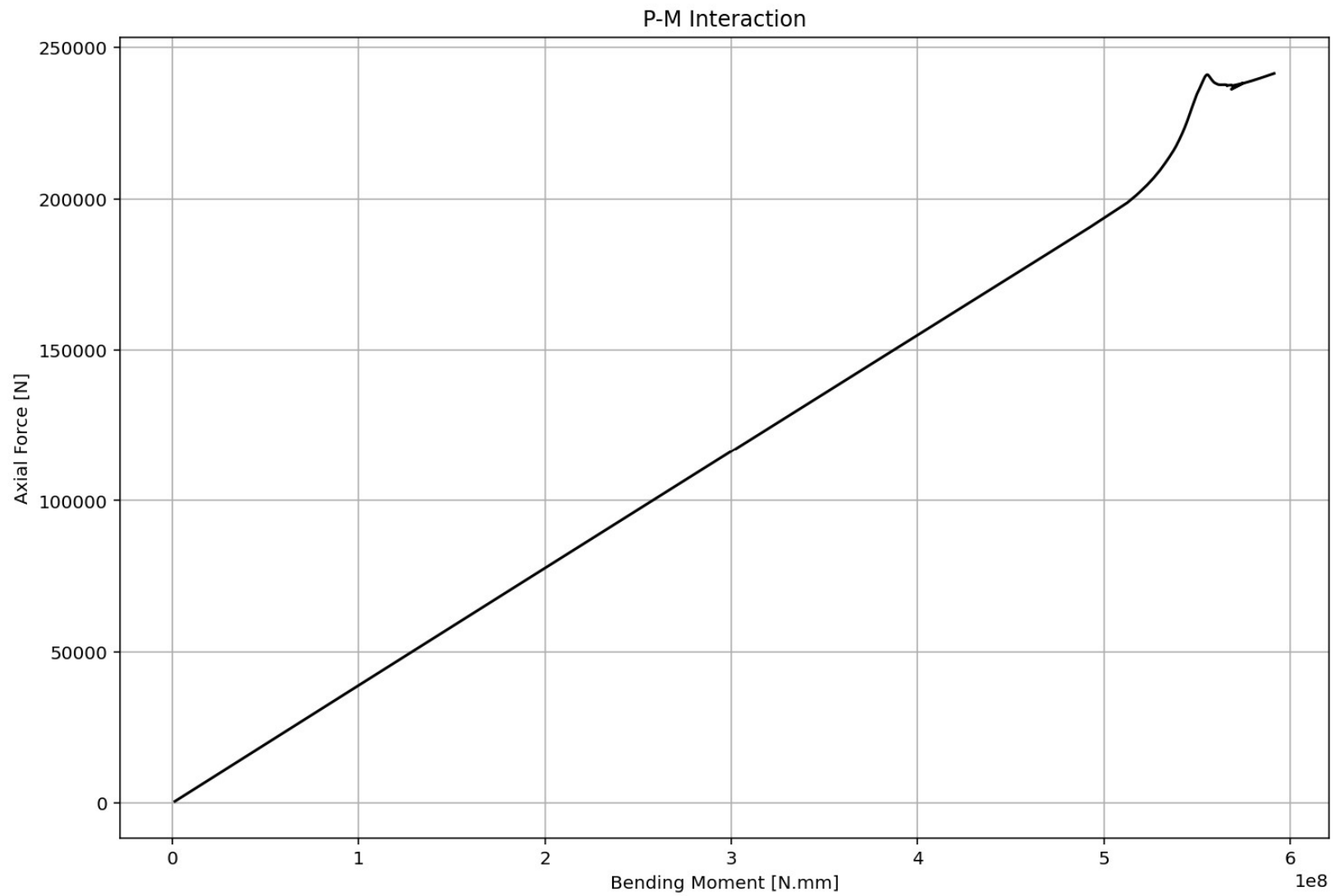
Optimum Section Rebar Diameter: 22.6775

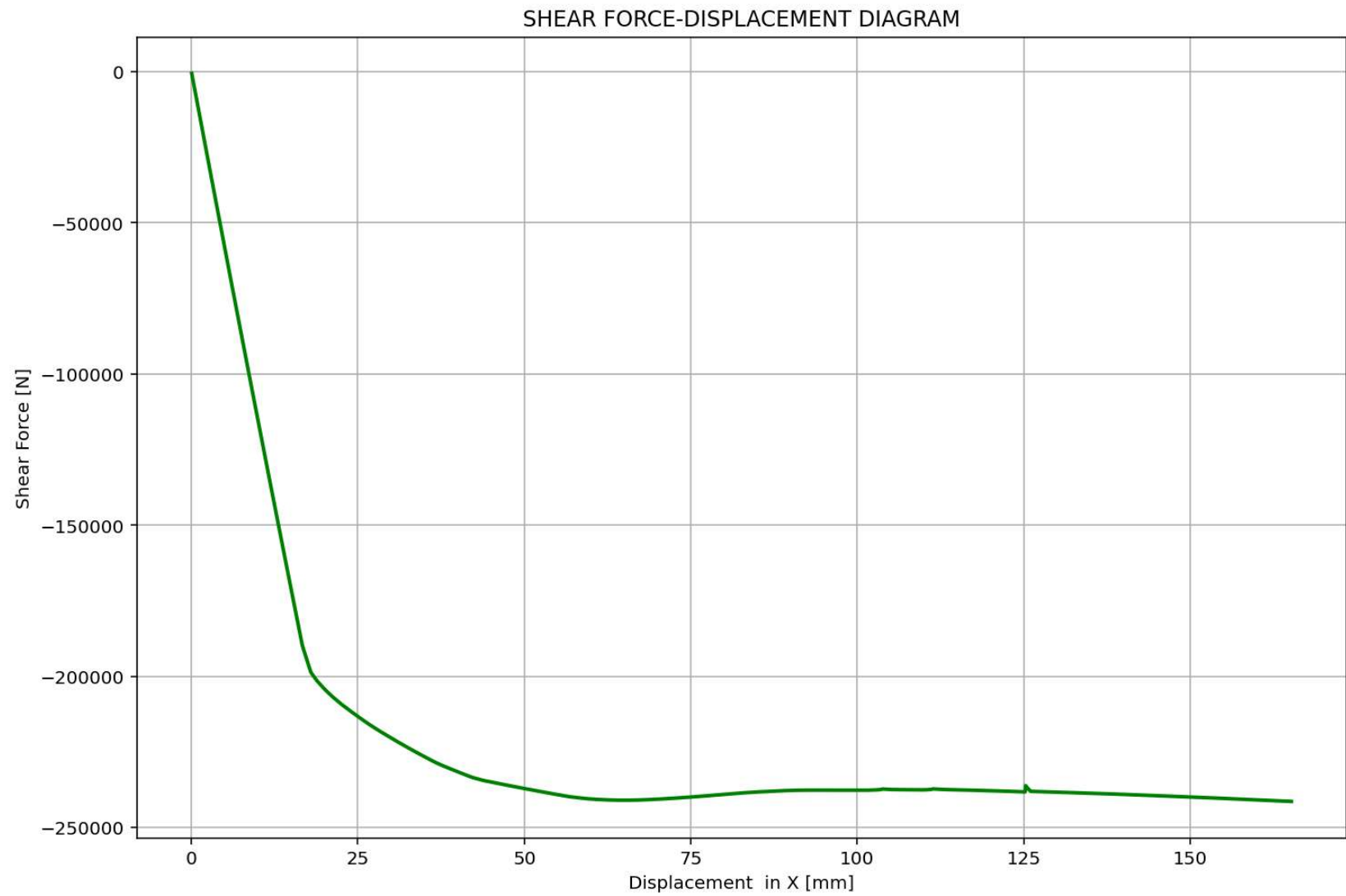
Iteration Counts: 4

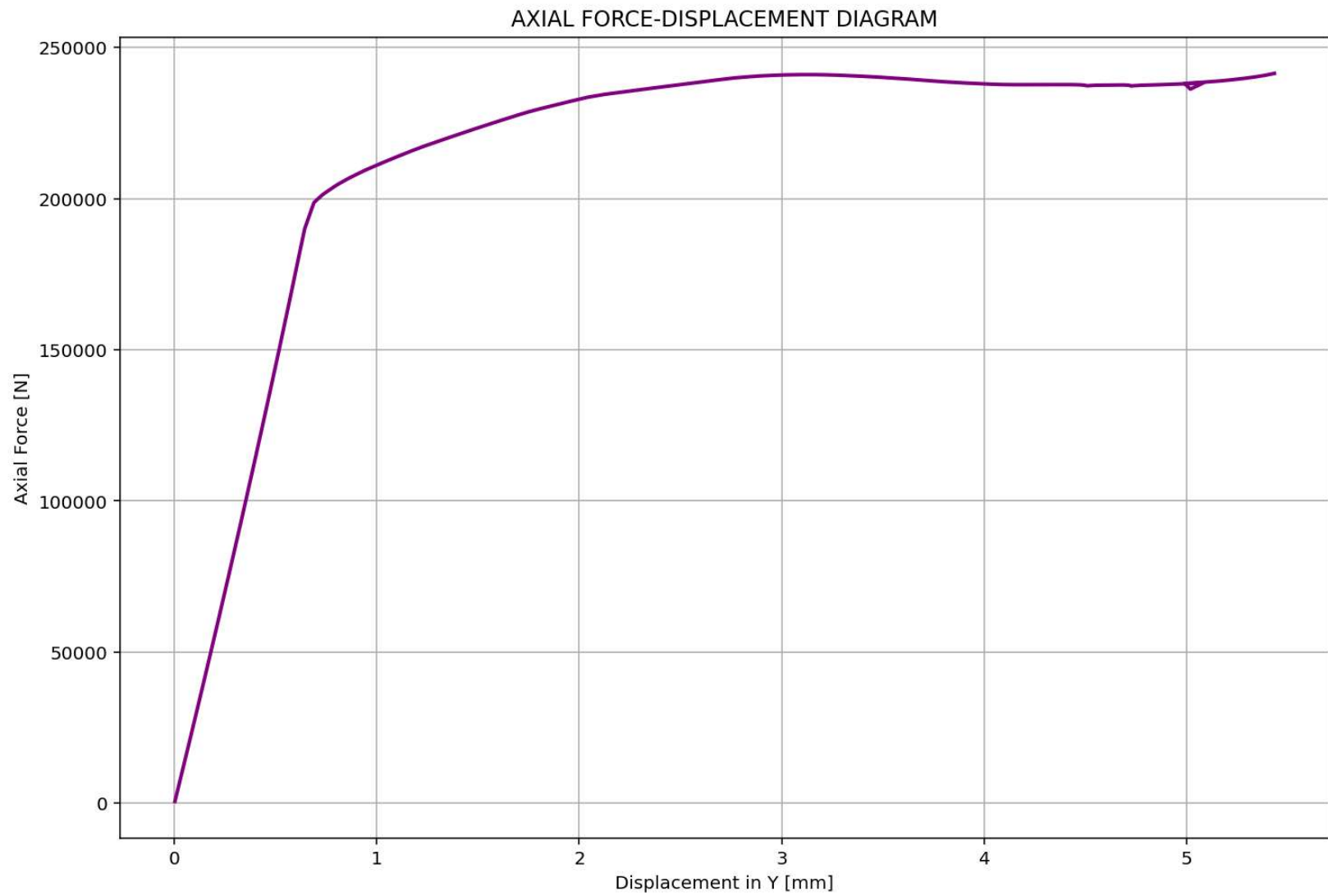
Convergence Residual: 2.6692301703e-09

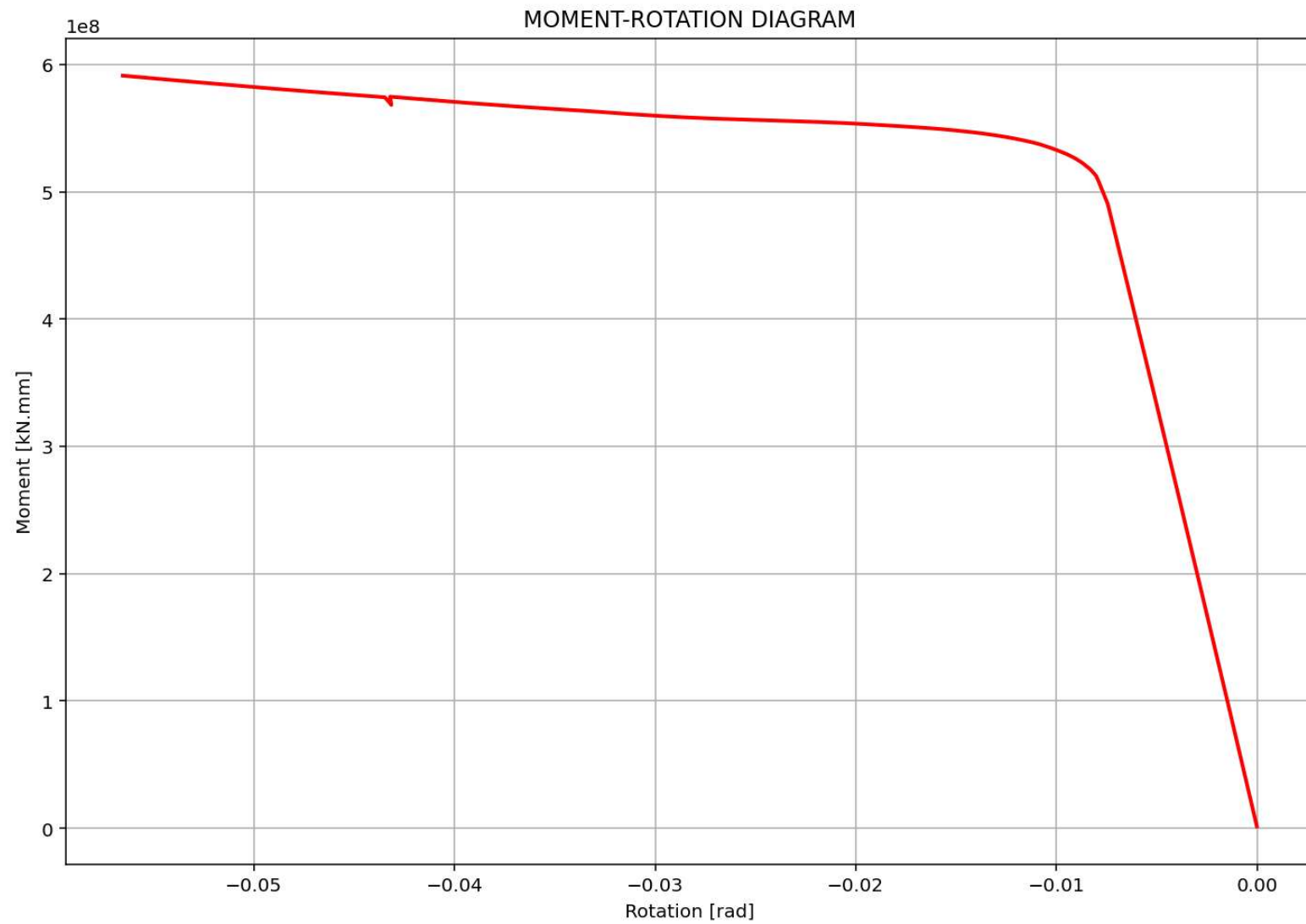
Finish time (HH:MM:SS): 15:08:44

**OPTIMIZATION ANALYSIS DURATION IS 2 MINUTES WITH
4 ITERATIONS**









ROTATIONAL STIFFNESS-LATERAL STIFFNESS DIAGRAM

