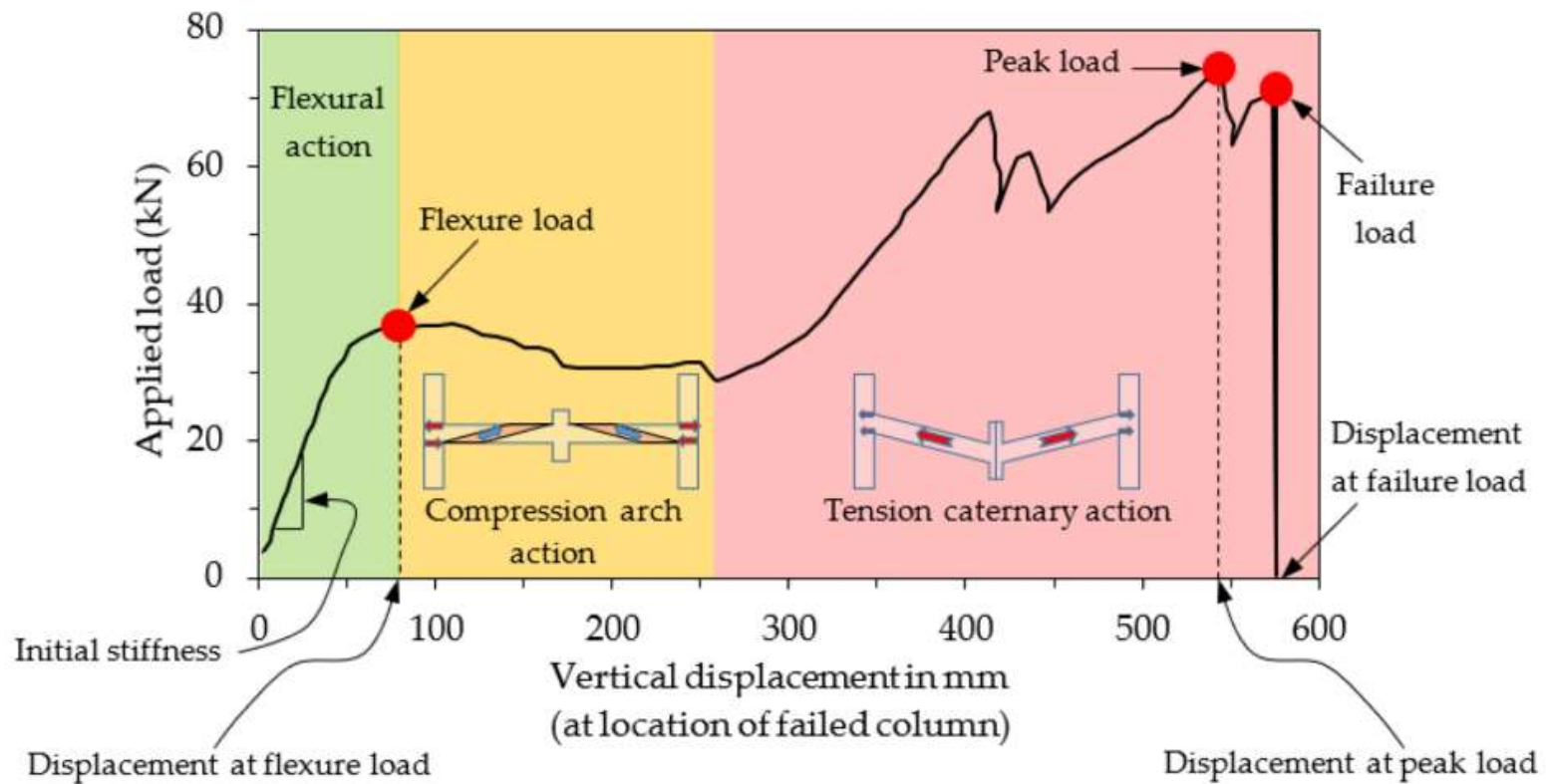


>> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<

PROGRESSIVE COLLAPSE ANALYSIS OF CONCRETE FRAME. EVALUATING STRAIN HARDENING AND ULTIMATE STRAIN CRITERIA USING OPENSEES. DISPLACEMENT CONTROL

WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)





Spyder (Python 3.12)

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C:\Users\Dell\Desktop\OPENSEES_FILES\PROGRESSIVE_COLLAPSE\PROGRESSIVE_COLLAPSE_CONCRETE_2STORY.py

PROGRESSIVE_COLLAPSE_CONCRETE_2STORY.py

```
1 #####
2 # >> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL << #
3 # PROGRESSIVE COLLAPSE ANALYSIS OF CONCRETE 2-STORY FRAME WITH DISPLACEMENT CONTROL #
4 #-----#
5 # THIS PROGRAM WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI) #
6 # EMAIL: salar.d.ghashghaei@gmail.com #
7 #####
8
9 Progressive collapse of reinforced concrete frames occurs when a local failure—due to accidental
10 actions such as impact, explosion or fire—triggers a chain reaction of element removals, leading
11 to partial or total structural loss. Advanced assessment hinges on capturing nonlinear material
12 behavior, geometric effects, and load-redistribution mechanisms that dictate whether alternative
13 load paths can sustain the imposed demands.
14
15 [1] Modeling Philosophy:
16 - Fiber based sections discretize concrete and steel across the cross-section, enabling accurate
17 stress-strain representation under combined axial, bending and shear demands. Cover, core concrete
18 and rebar layouts are modeled with uniaxial constitutive laws that include confinement, cracking,
19 strain hardening and ultimate strain limits.
20 - Nonlinear beam-column elements employ Gauss integration points along member length, paired with
21 corotational kinematics to account for large displacements and P-Δ effects in a fully consistent
22 manner.
23
24 [2] Analysis Strategy:
25 - Alternate Load-path method: deliberately remove one or more columns (or beams) after applying
26 gravity loads, then trace the static response under incremental displacement control at a critical
27 location. The structural response captures bending yielding, shear failure, catenary action and
28 eventual loss of load-bearing capacity.
29 - Pushover framework: displacement control at a predefined “attack” node (e.g., mid-height of a
30 column) simulates the increasing drift demands after element removal. Reaction forces at the base yield
31 a capacity curve relating force vs. displacement, from which reserve strength and ductility can
32 be assessed.
33
34 [3] Key Response Mechanisms:
35 - Flexural yielding and plastic hinge formation in adjacent beams and columns allow moment redistribution.
36 Hinge rotation capacity depends on reinforcement ratio, concrete confinement and strain-hardening.
```

Applied load (kN)

Vertical displacement in mm (at location of failed column)

Flexural action

Flexure load

Compression arch action

Tension catenary action

Peak load

Failure load

Displacement at failure load

Displacement at flexure load

Displacement at peak load

Help Variable Explorer Debugger Plots Files

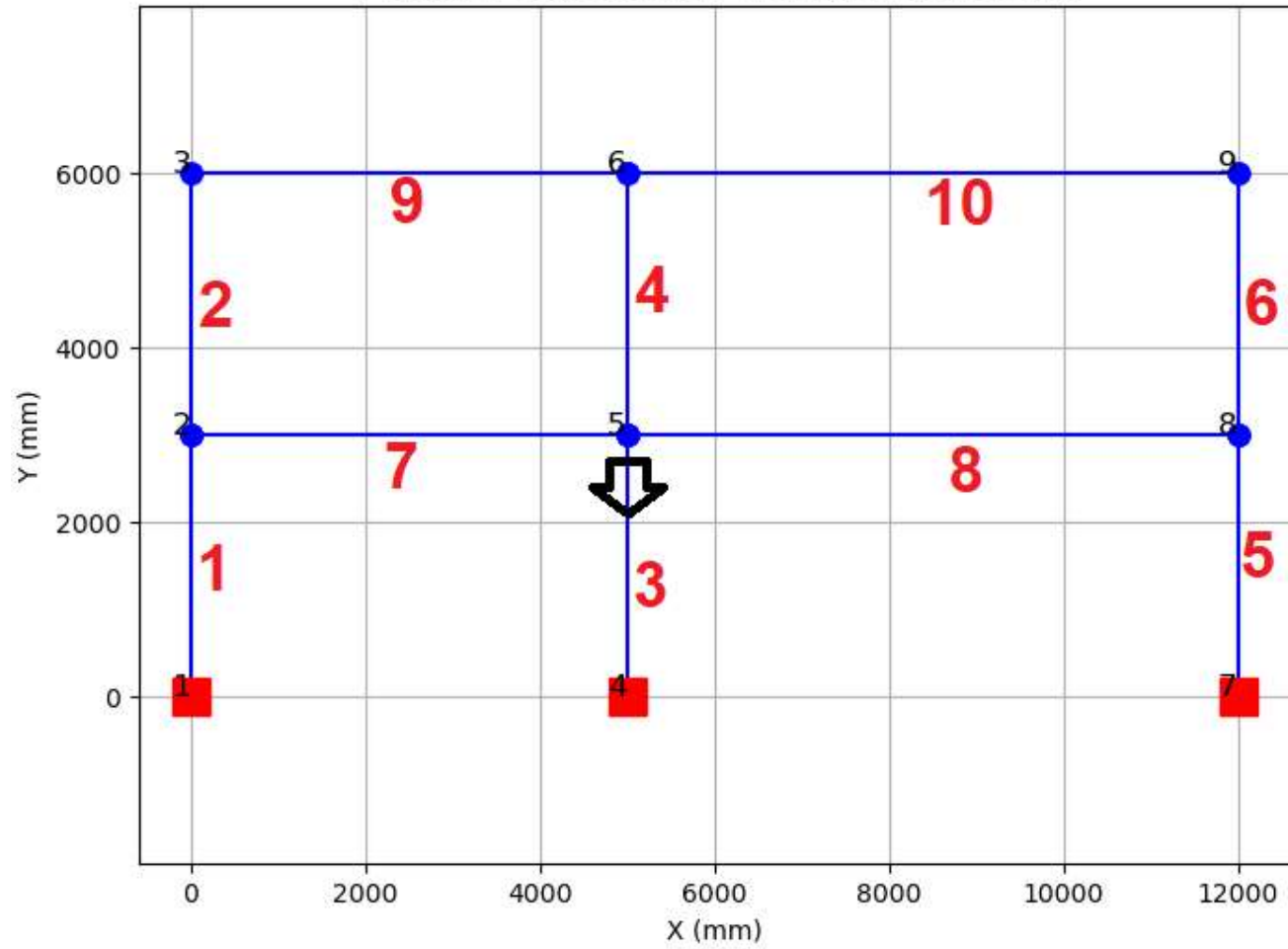
Console 1/A

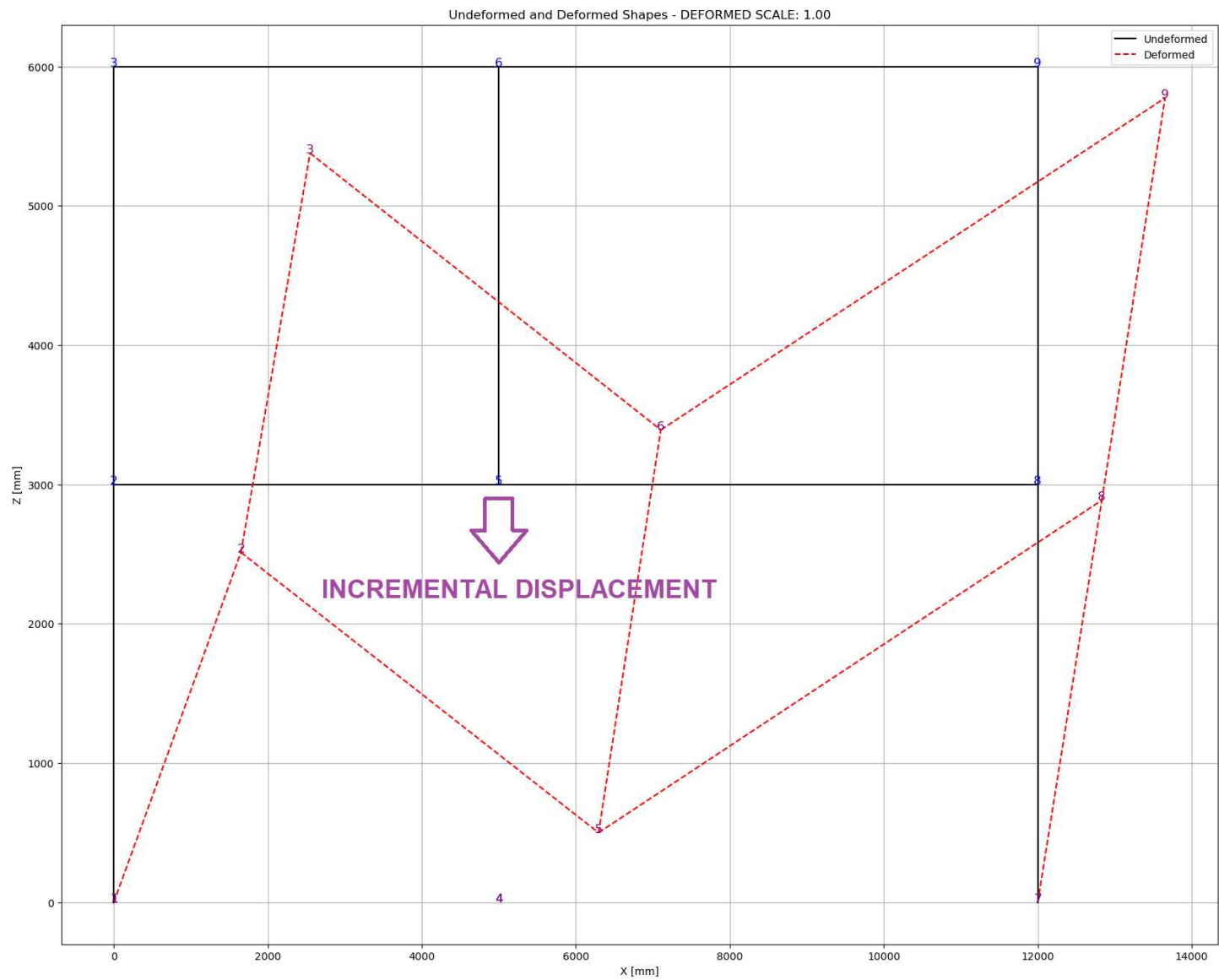
```
forces & deformations for element: 3(dw: << 832.551)
Domain::update - domain failed in update
DisplacementControl::newStep - model failed to update for new dU
StaticAnalysis::analyze() - the Integrator failed at step: 0 with domain at
load factor 1286.67
OpenSees > analyze failed, returned: -2 error flag
NormUnbalance RaphsonNewton -2
NormUnbalance PeriodicNewton -2
NormUnbalance BFGS -2
NormUnbalance Broyden -2
```

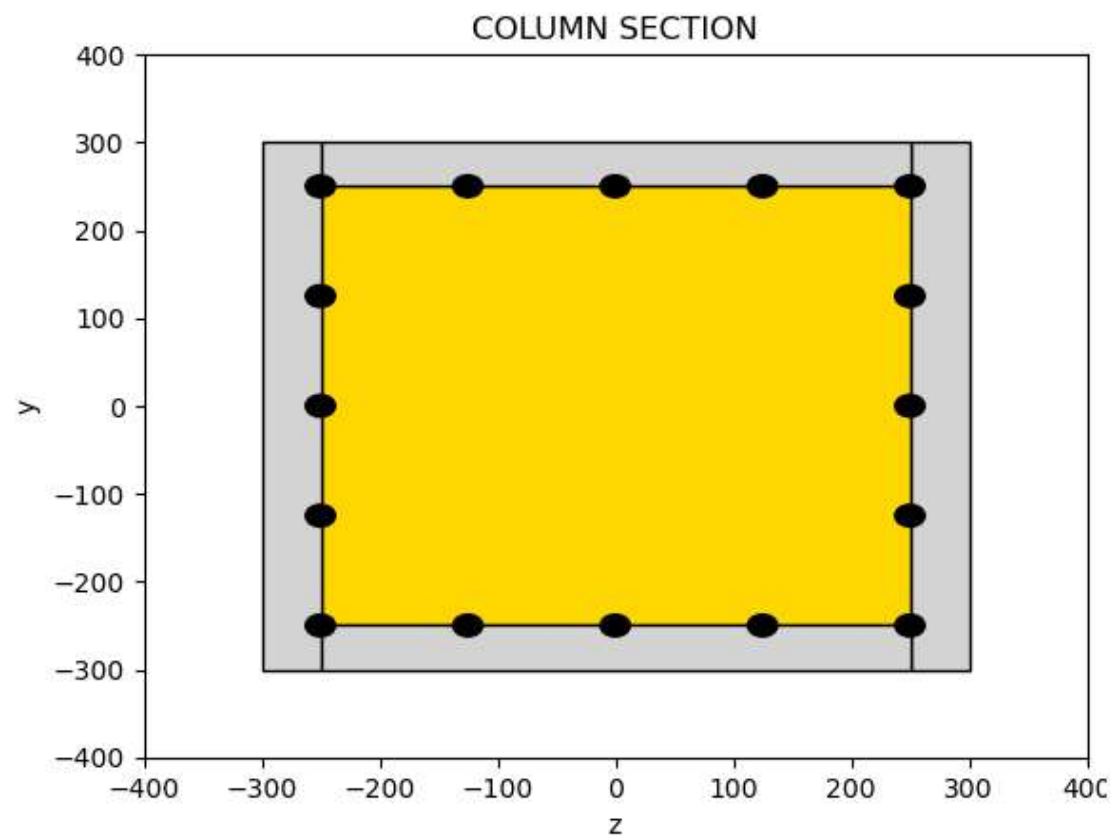
IPython Console History

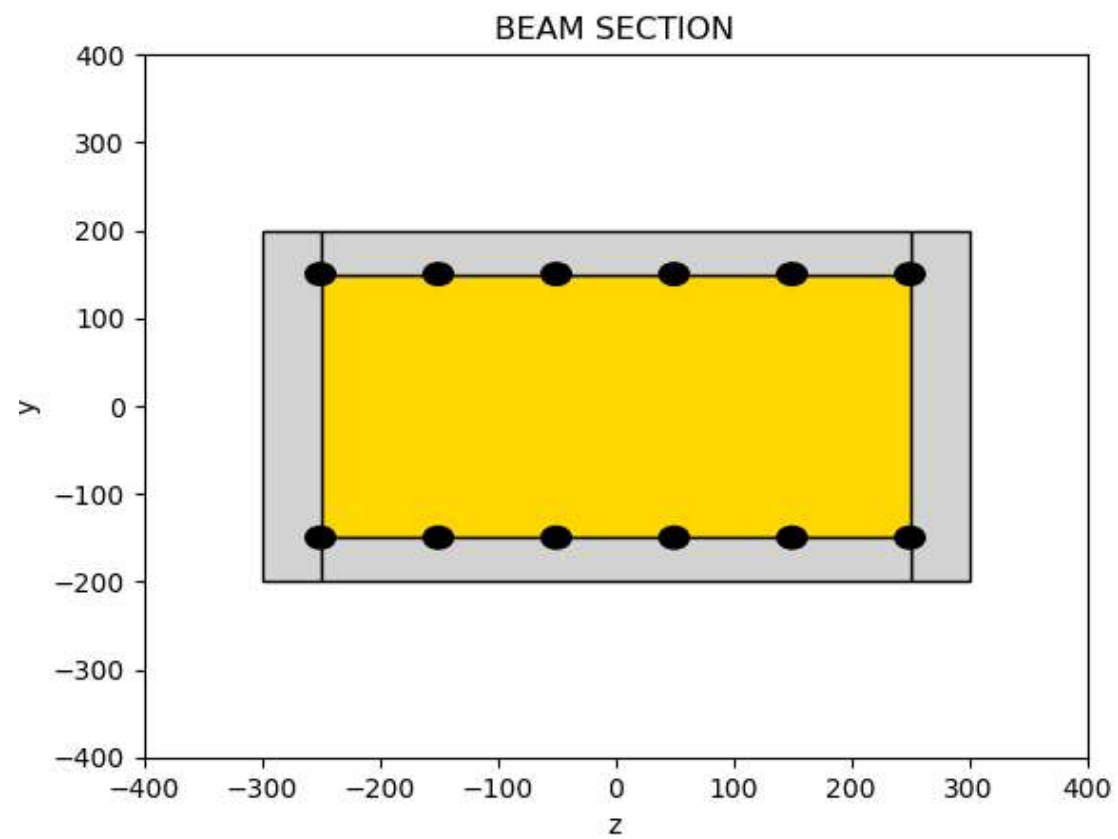
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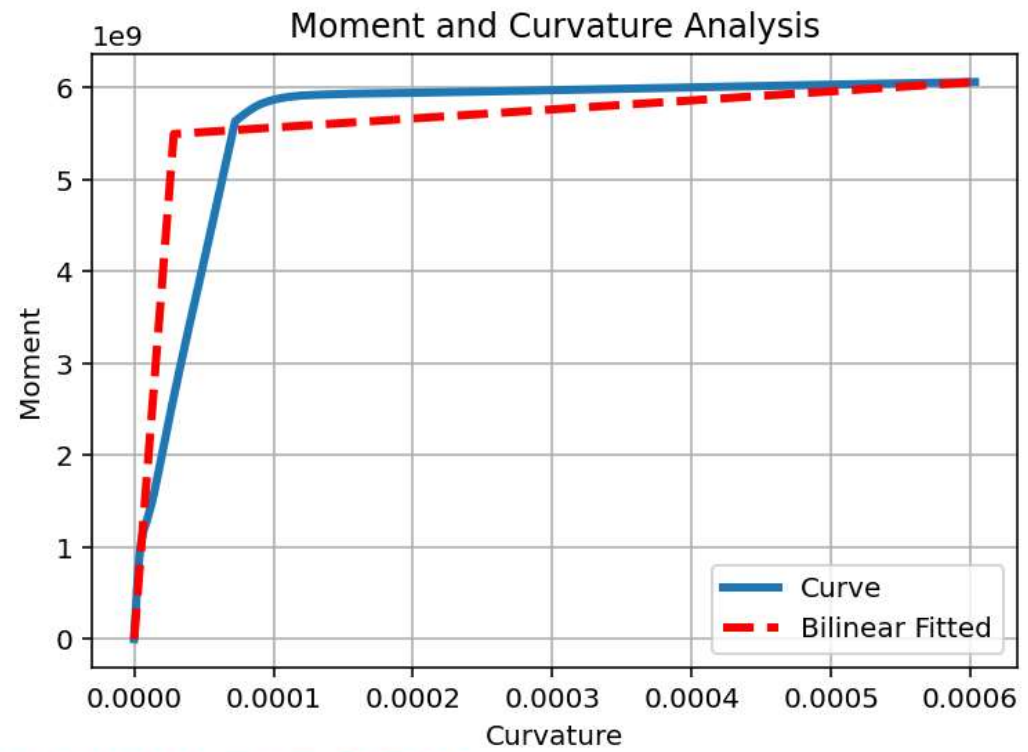
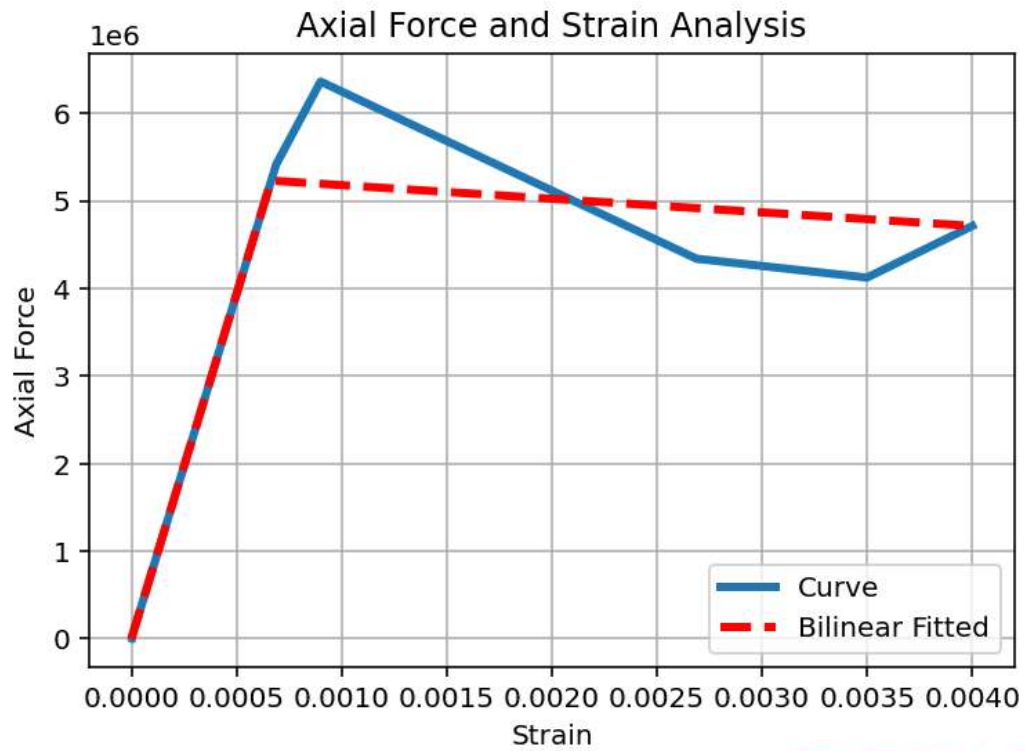
2-Story, 2-Bay Structure with Fixed Constraints



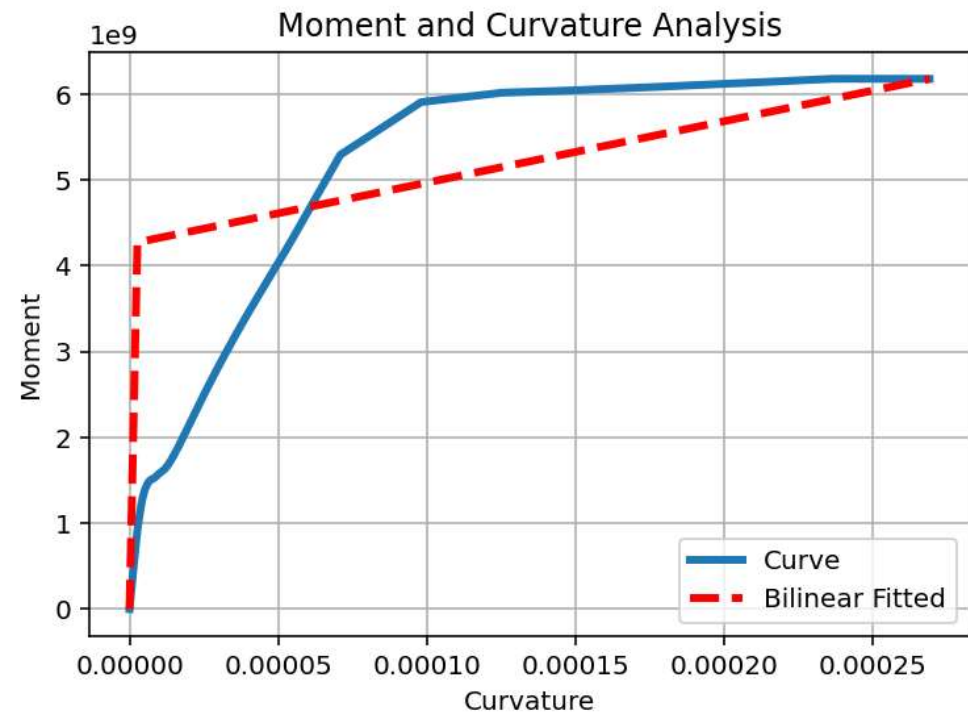
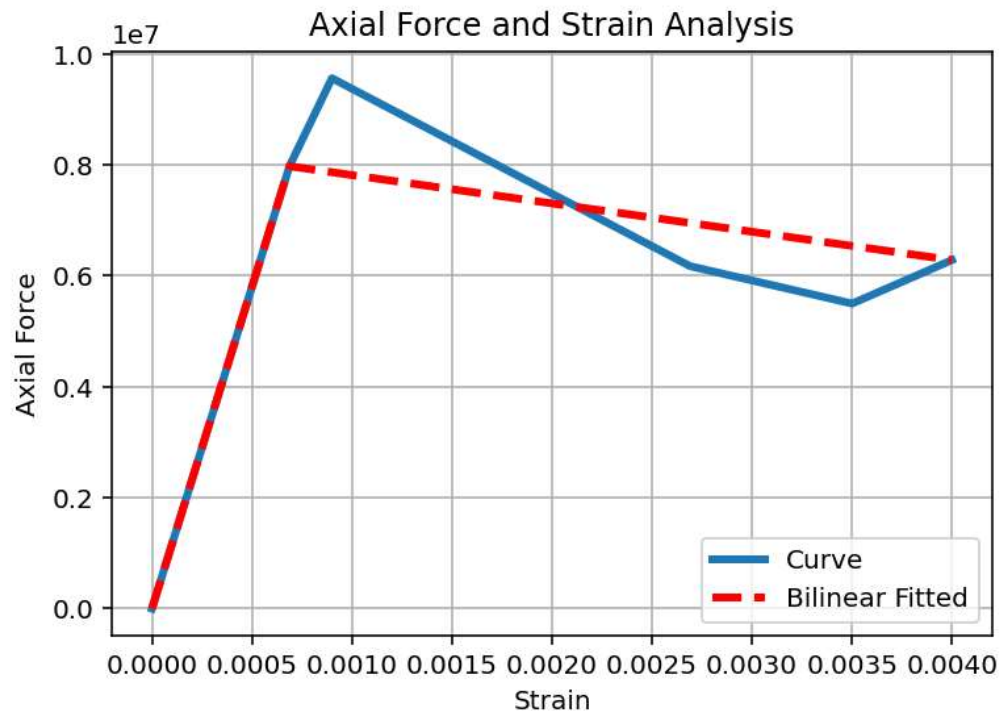




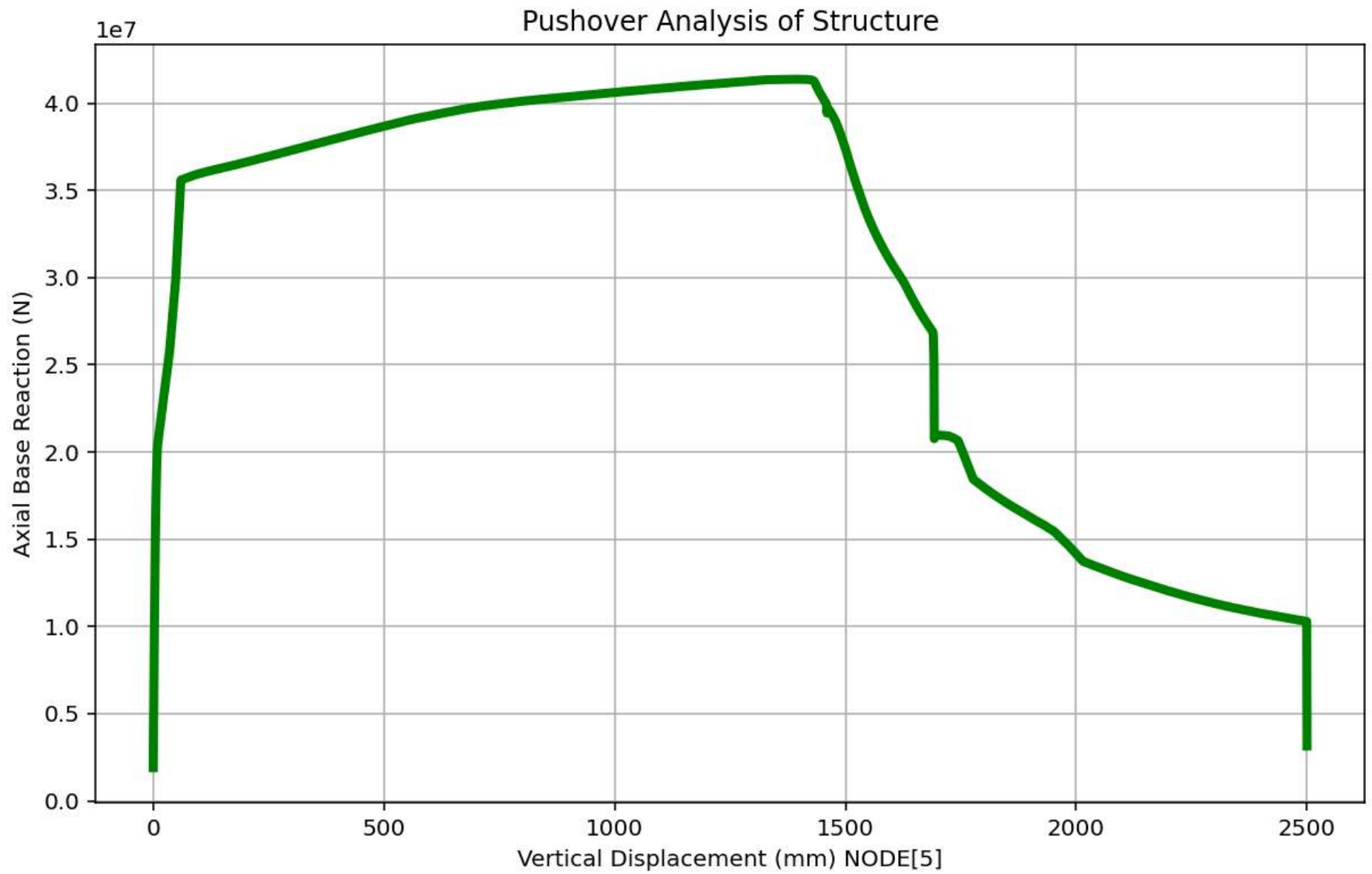


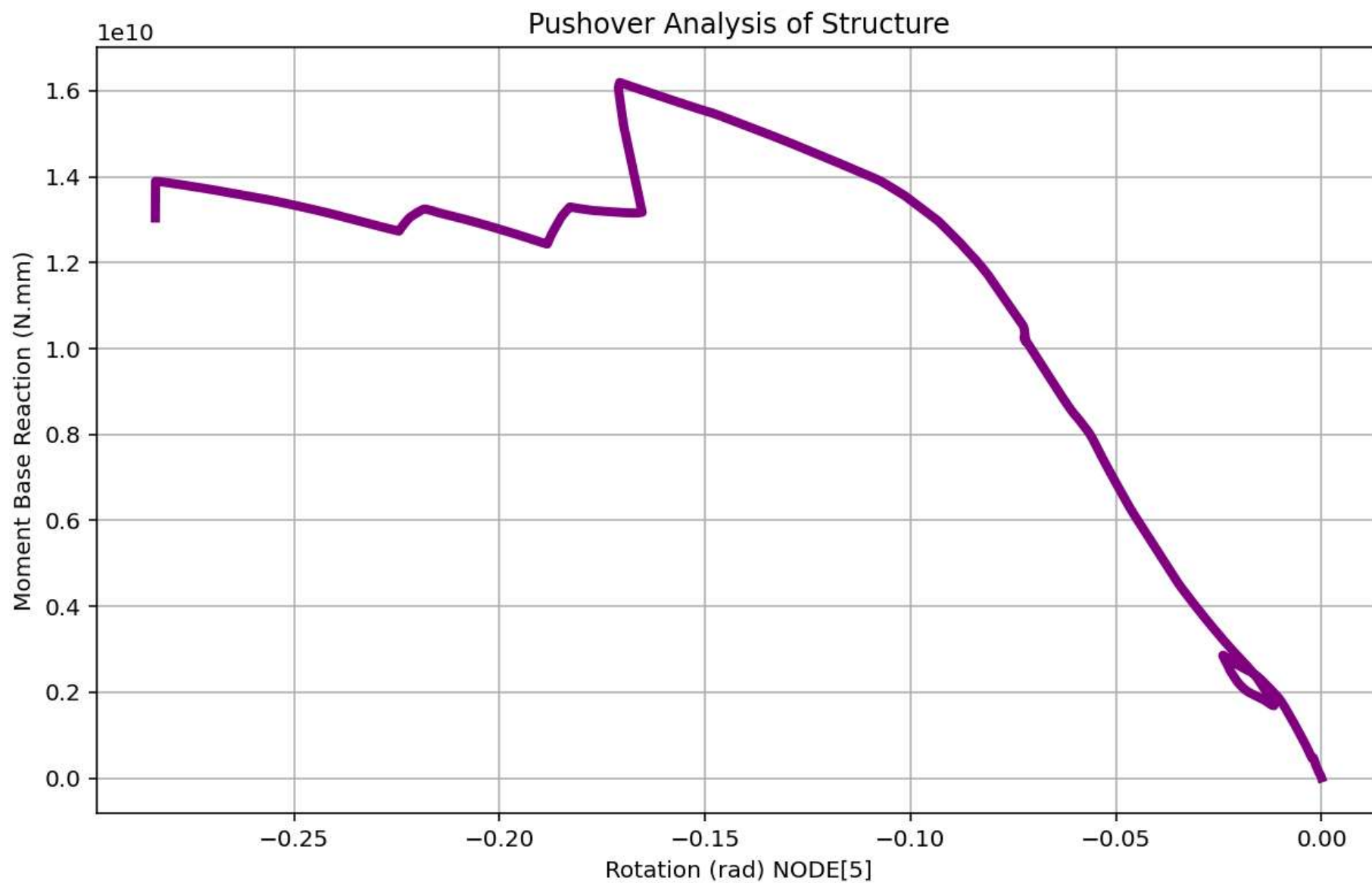


SECTION ANALYSIS FOR BEAM

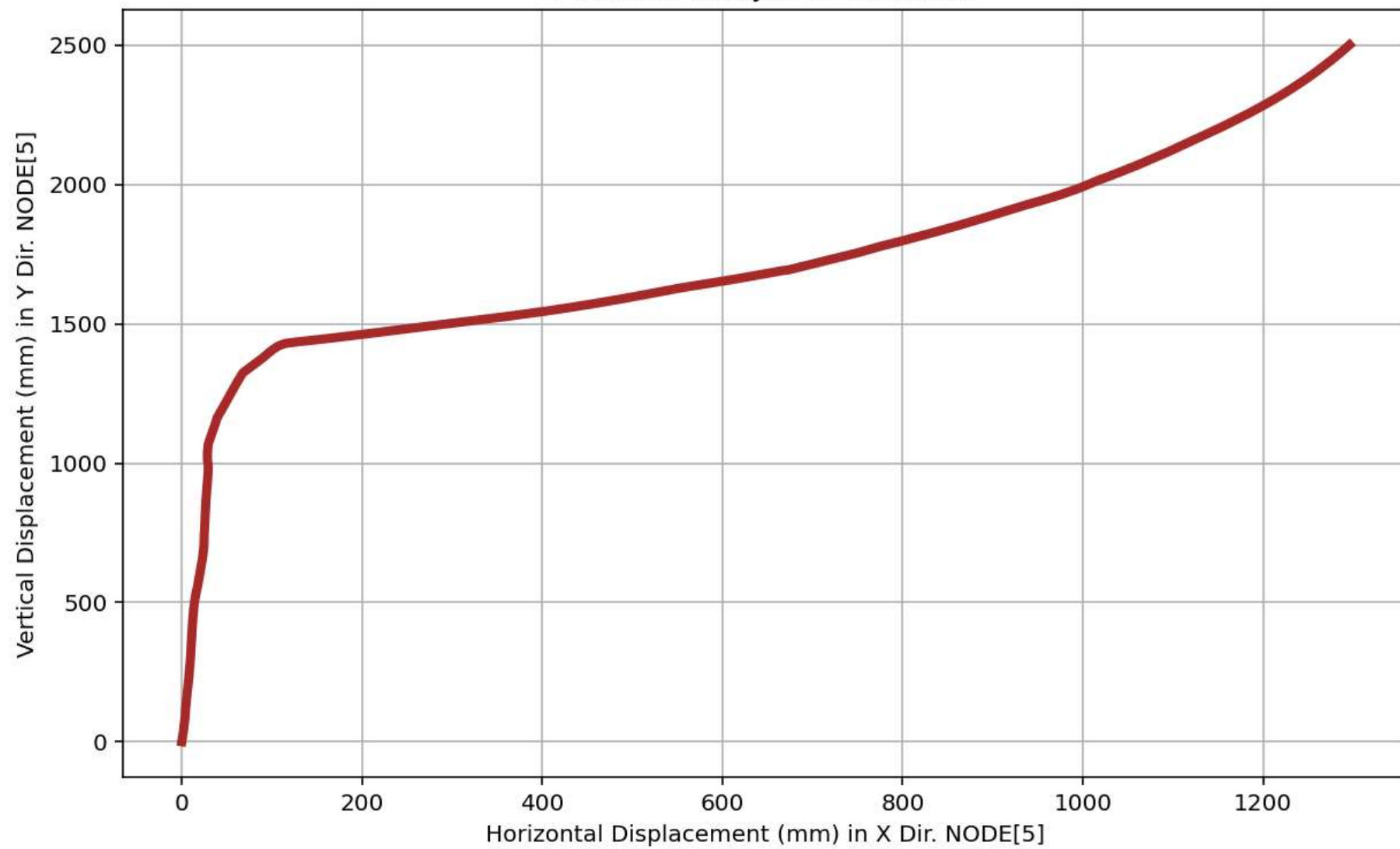


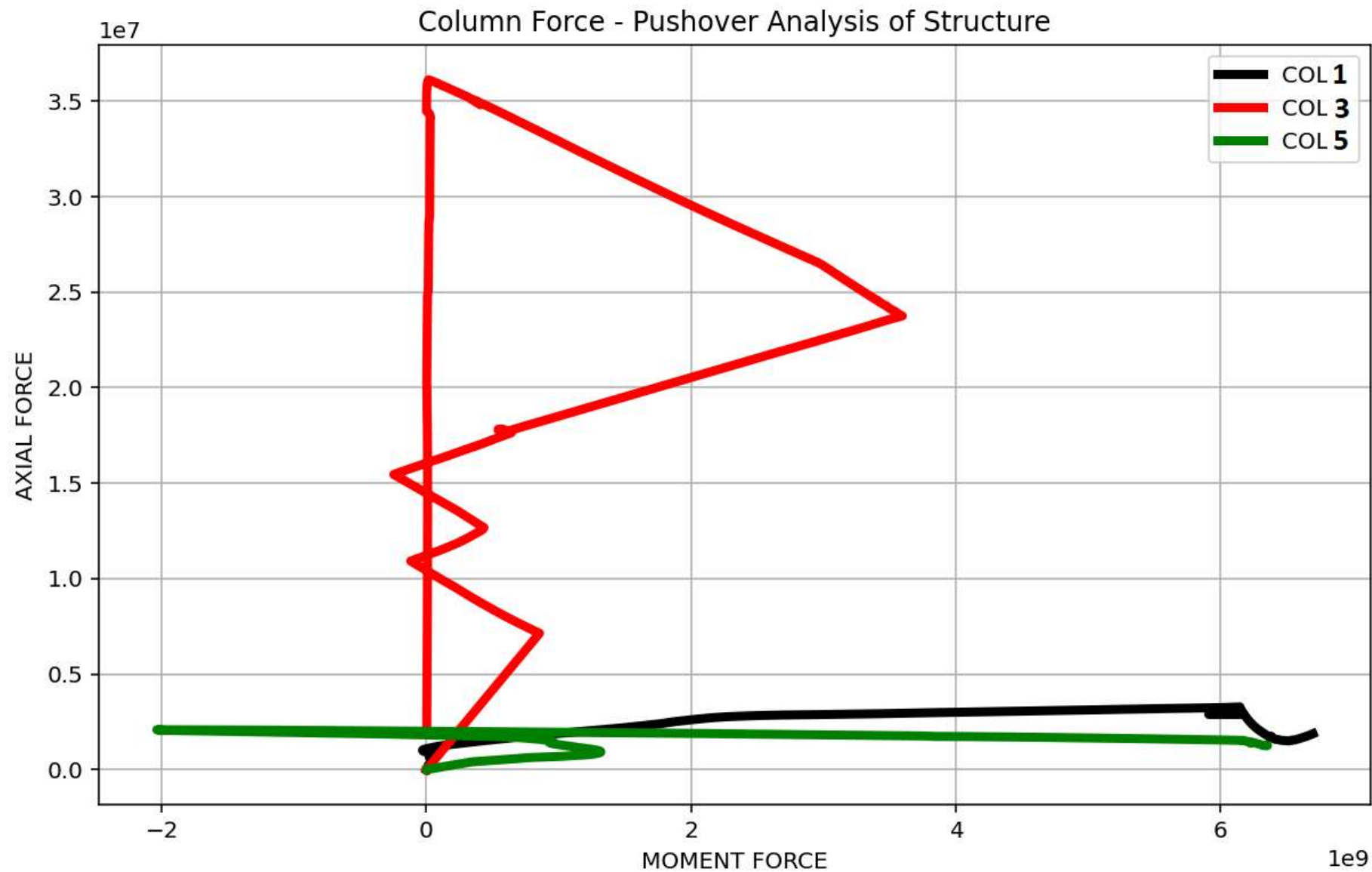
SECTION ANALYSIS FOR COLUMN

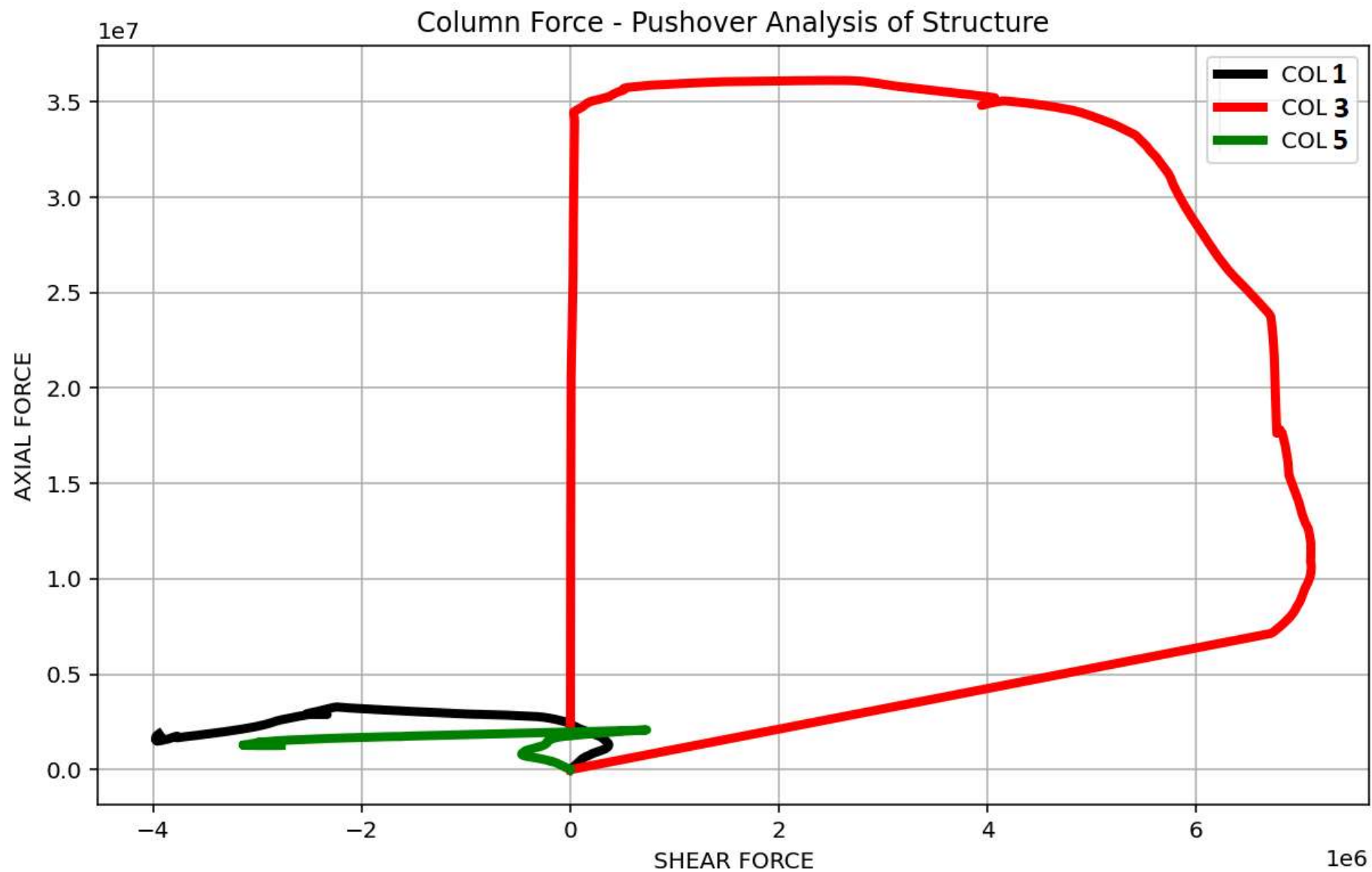


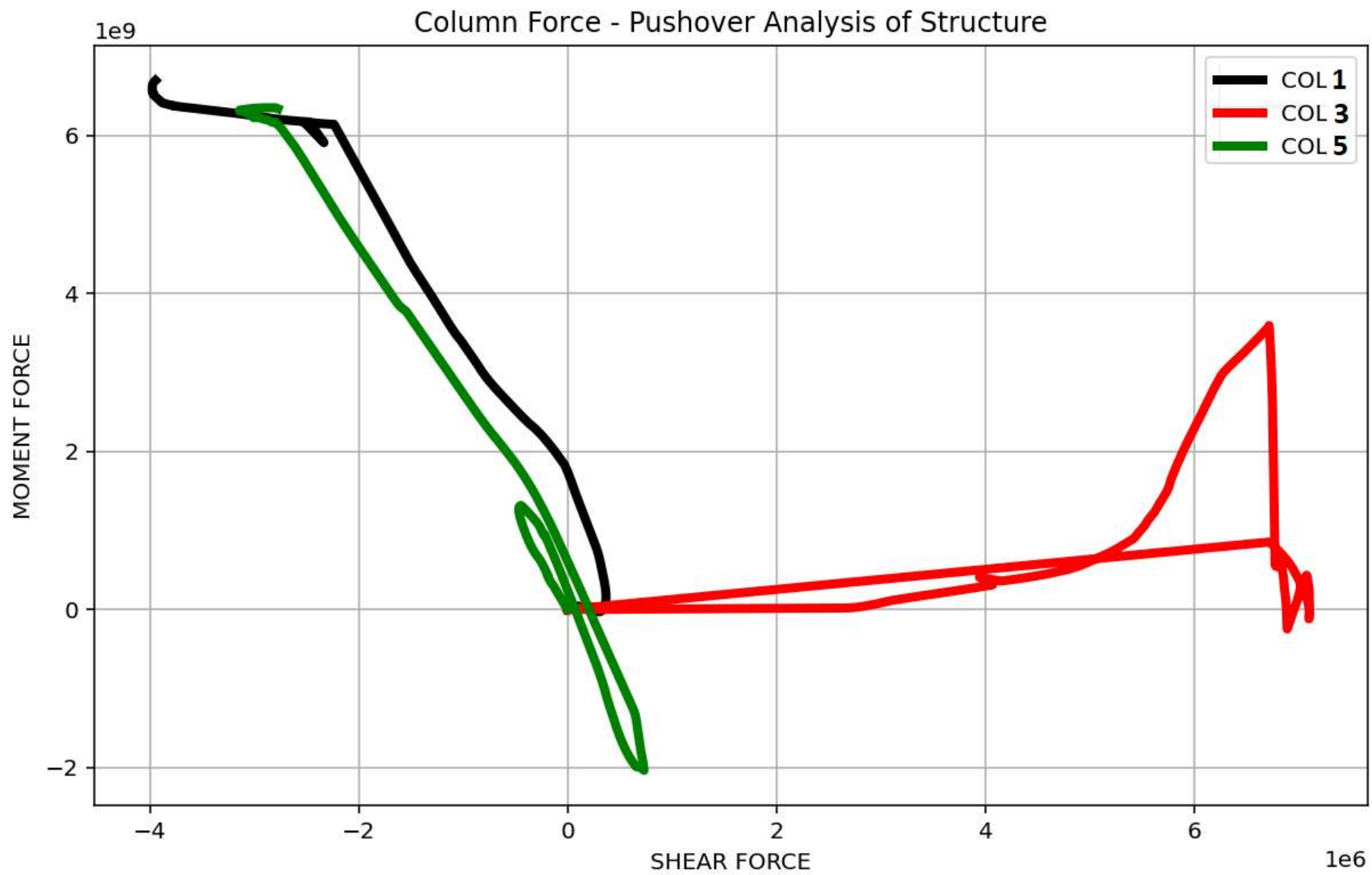


Pushover Analysis of Structure

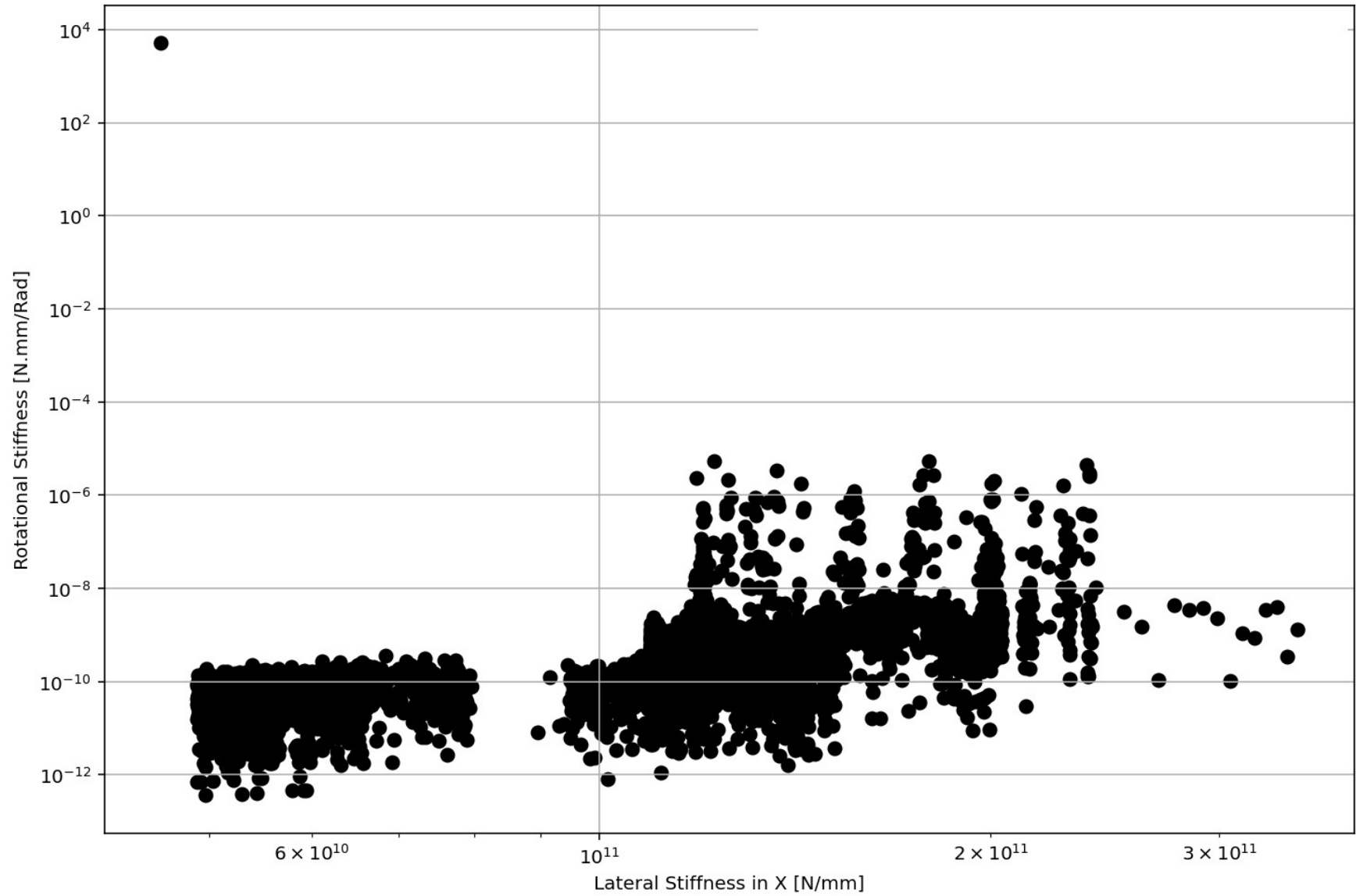








ROTATIONAL STIFFNESS-LATERAL STIFFNESS IN X DIR. FOR STORY-1 DIAGRAM



ROTATIONAL STIFFNESS-LATERAL STIFFNESS IN Y DIR. FOR STORY-1 DIAGRAM

