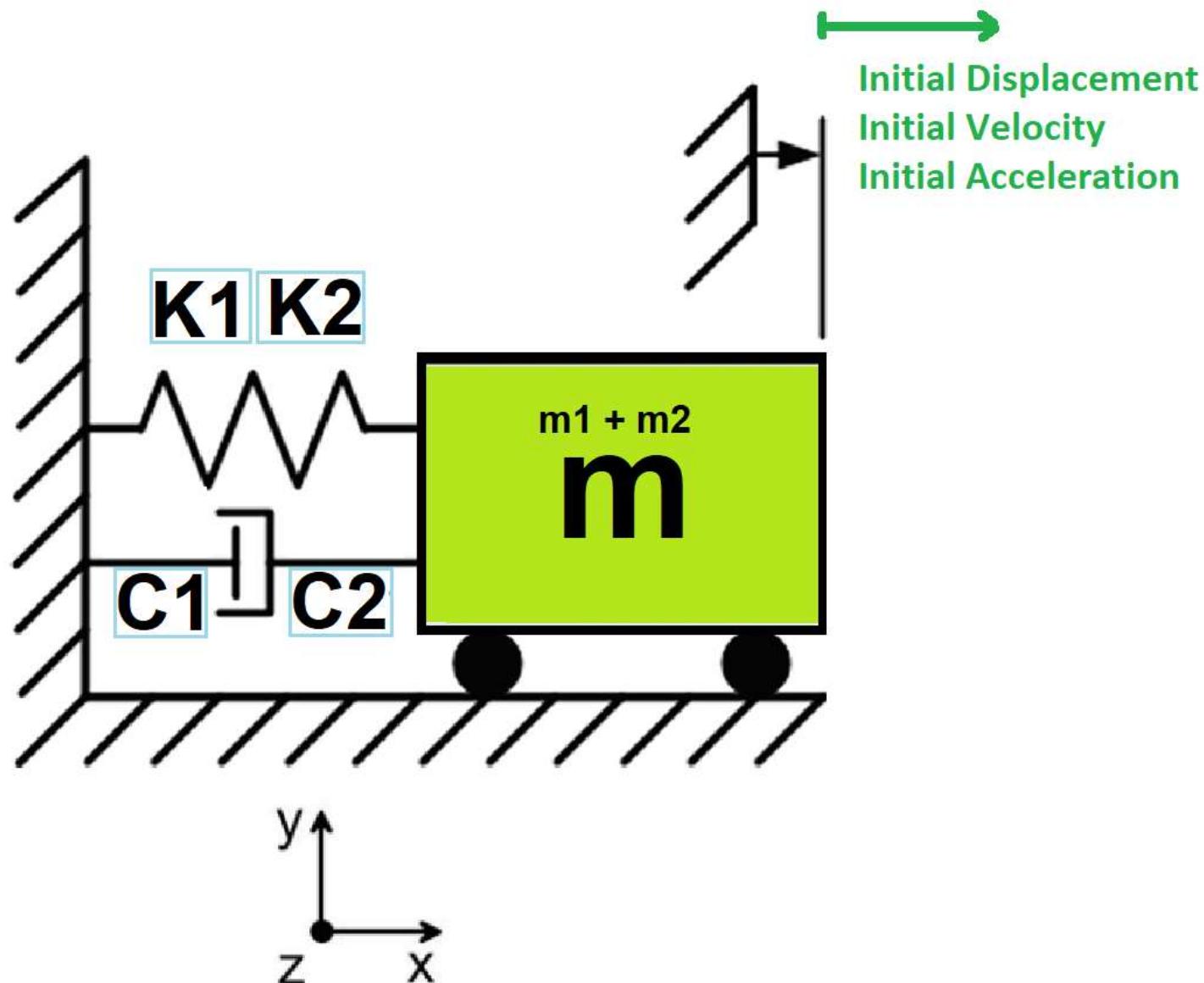
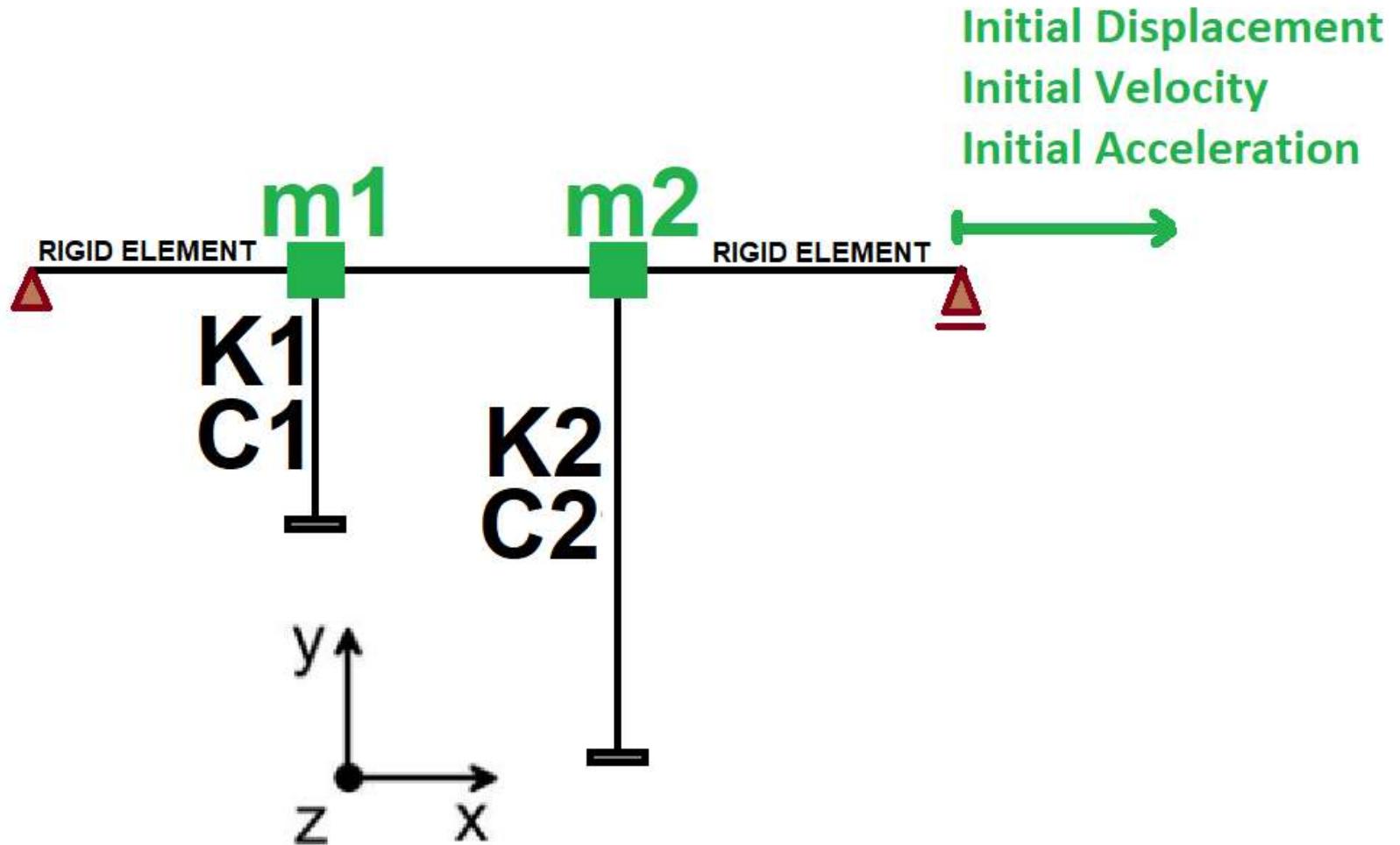


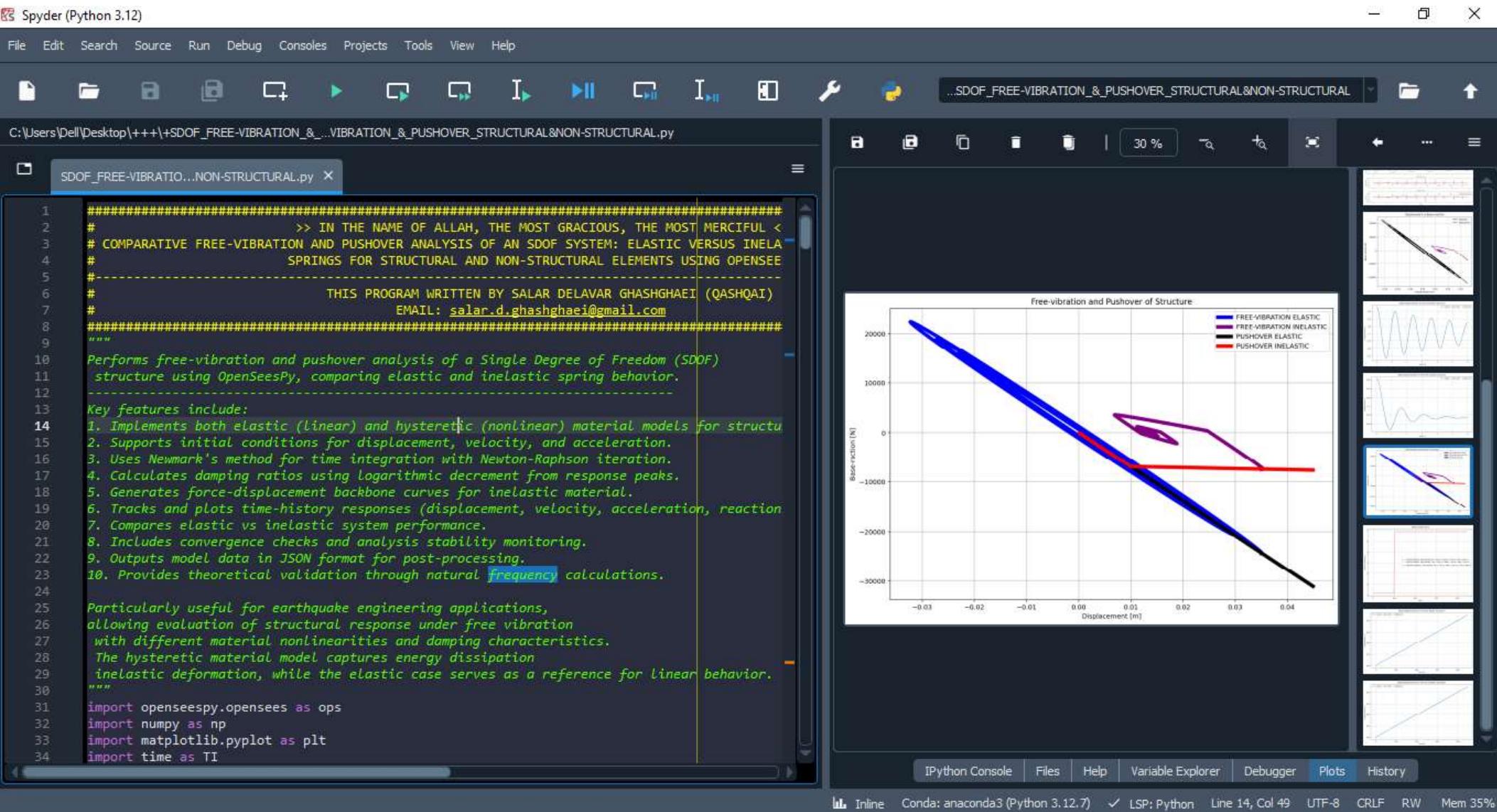
>> IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL <<

COMPARATIVE FREE-VIBRATION AND PUSHOVER ANALYSIS OF AN SDOF SYSTEM: ELASTIC VERSUS INELASTIC RESPONSE WITH PARALLEL SPRINGS FOR STRUCTURAL AND NON- STRUCTURAL ELEMENTS USING OPENSEES

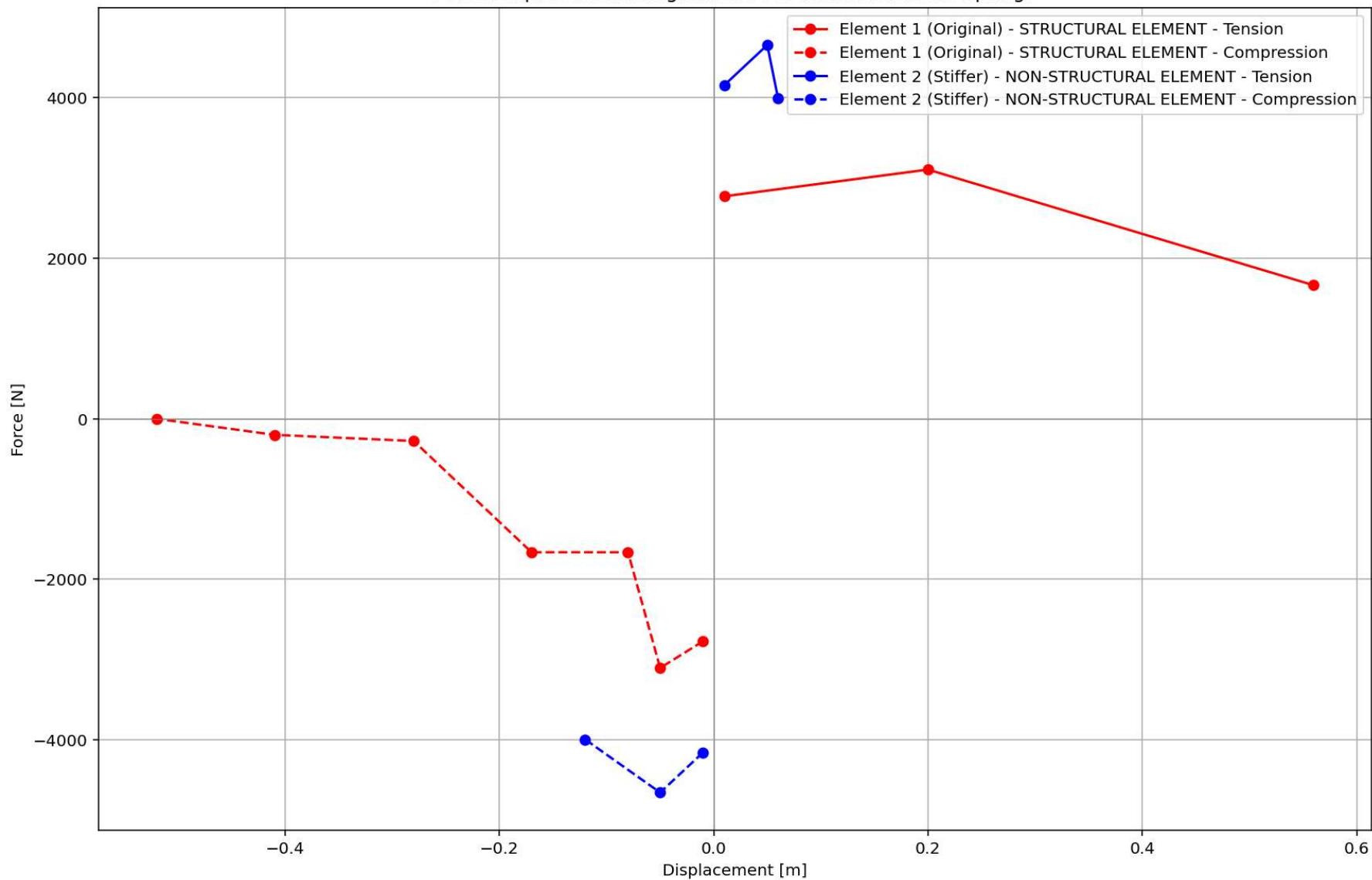
WRITTEN BY SALAR DELAVAR GHASHGHAEI (QASHQAI)

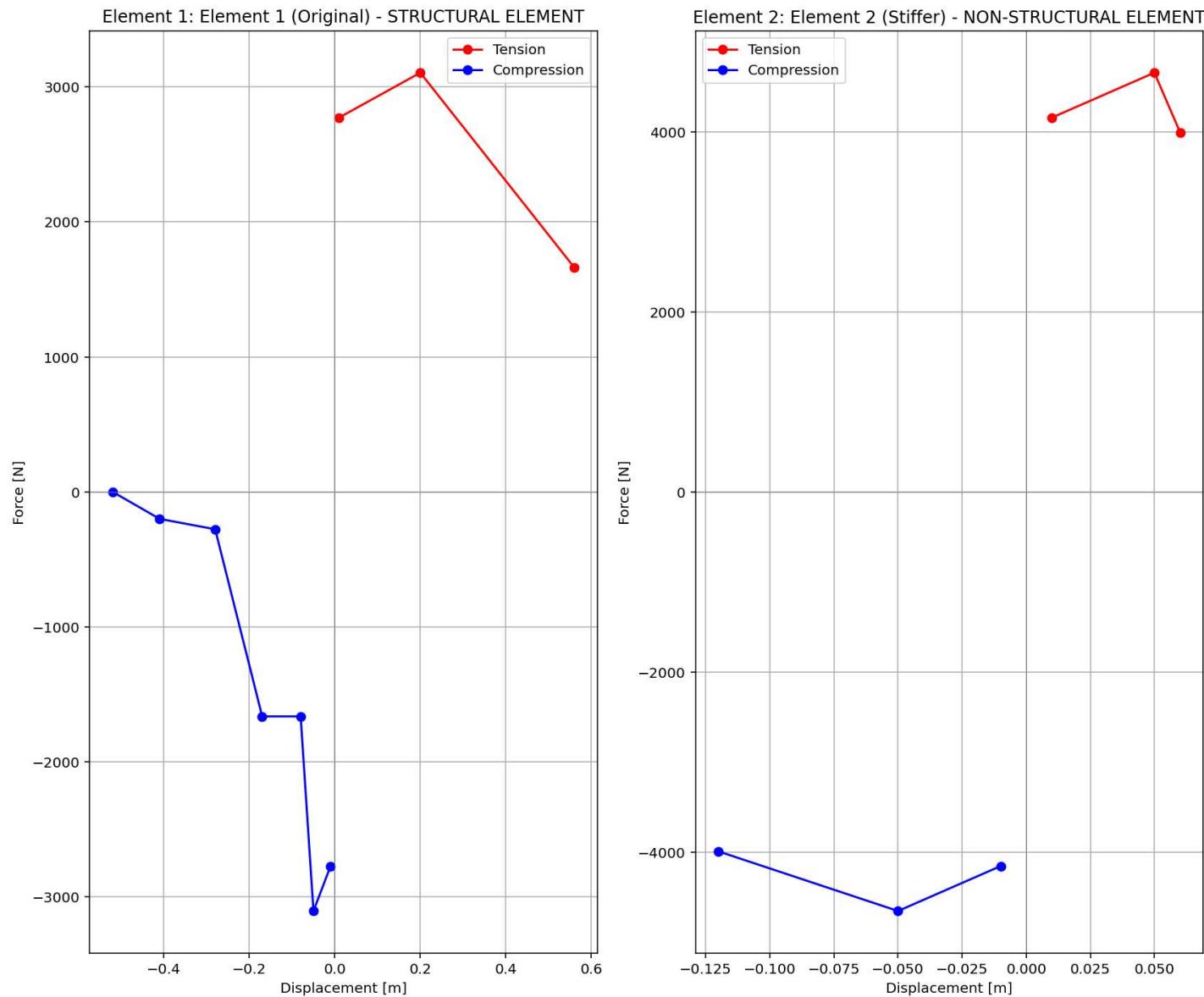






Force-Displacement Diagrams for 2 Different Inelastic Springs





FREE-VIBRATION ANALYSIS

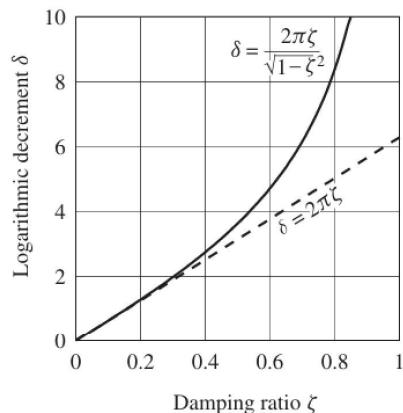
VISCOUSLY DAMPED FREE VIBRATION

$$m\ddot{u} + c\dot{u} + ku = 0$$

$$\ddot{u} + 2\xi\omega_n\dot{u} + \omega_n^2 u = 0$$

$$\omega_n = \sqrt{k/m} \quad \zeta = \frac{c}{2m\omega_n} = \frac{c}{c_{cr}} \quad \omega_D = \omega_n \sqrt{1 - \zeta^2}$$

$$u(t) = e^{-\zeta\omega_n t} \left[u(0) \cos \omega_D t + \frac{\dot{u}(0) + \zeta\omega_n u(0)}{\omega_D} \sin \omega_D t \right]$$

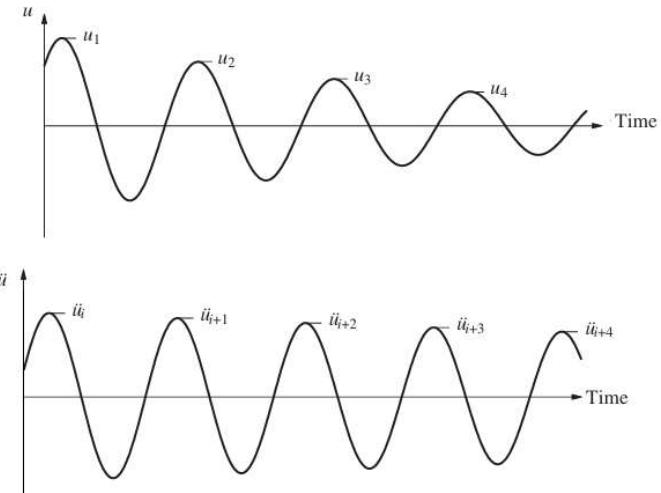


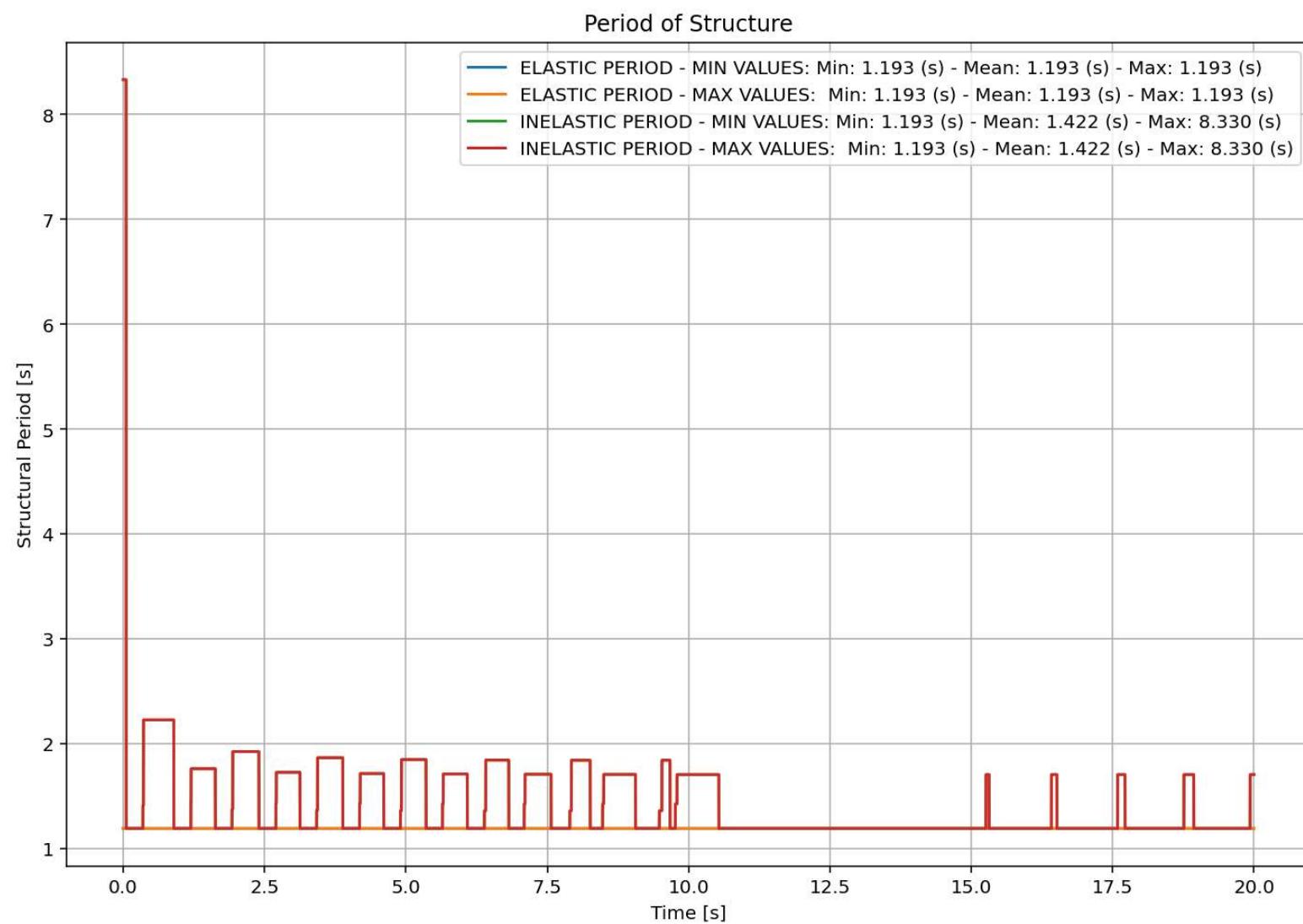
Decay of Motion

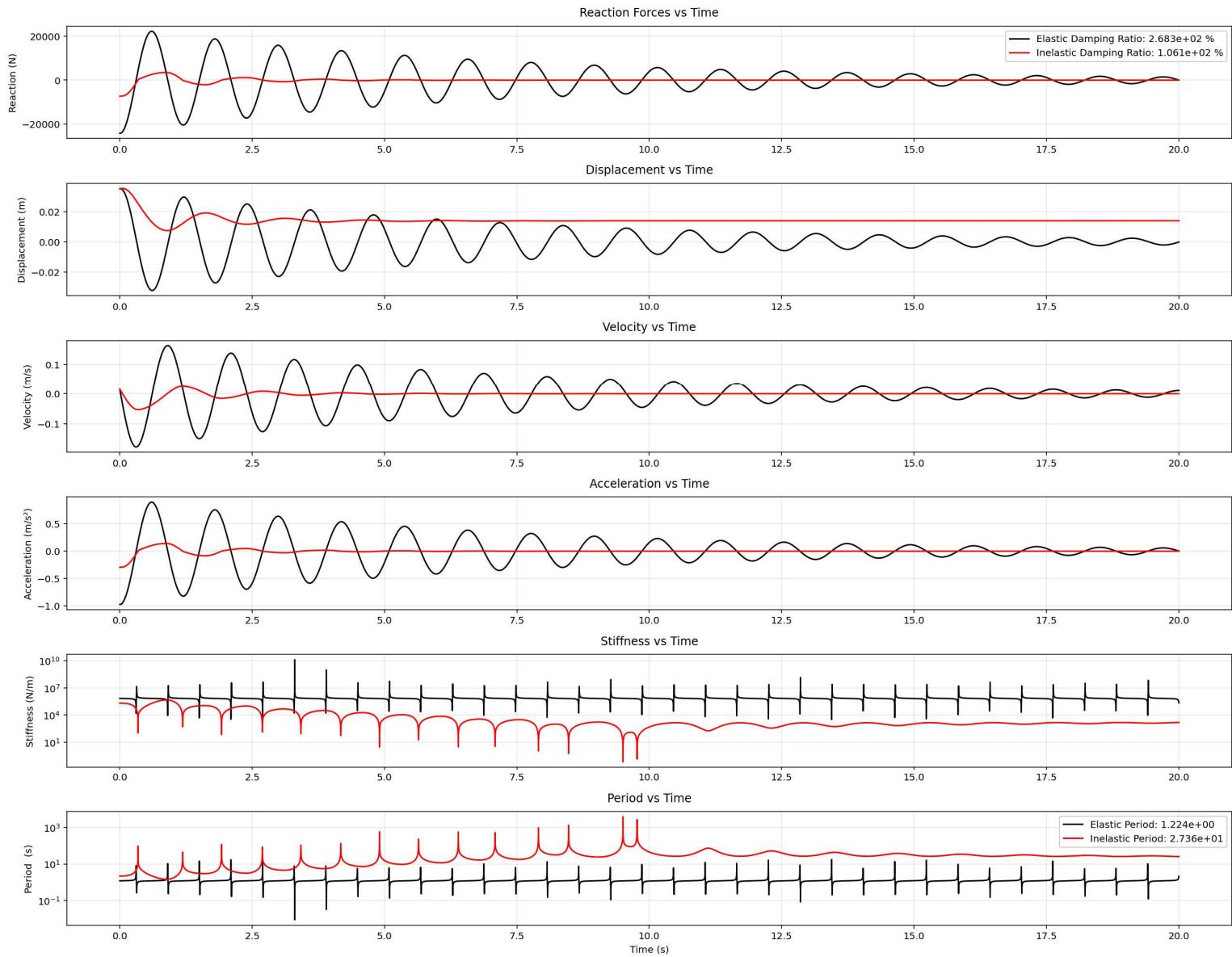
$$\delta = \ln \frac{u_i}{u_{i+1}} = 2\pi \zeta \text{ (APPROXIMATE RELATION)}$$

$$\delta = \ln \frac{u_i}{u_{i+1}} = \frac{2\pi \zeta}{\sqrt{1 - \zeta^2}} \text{ (EXACT RELATION)}$$

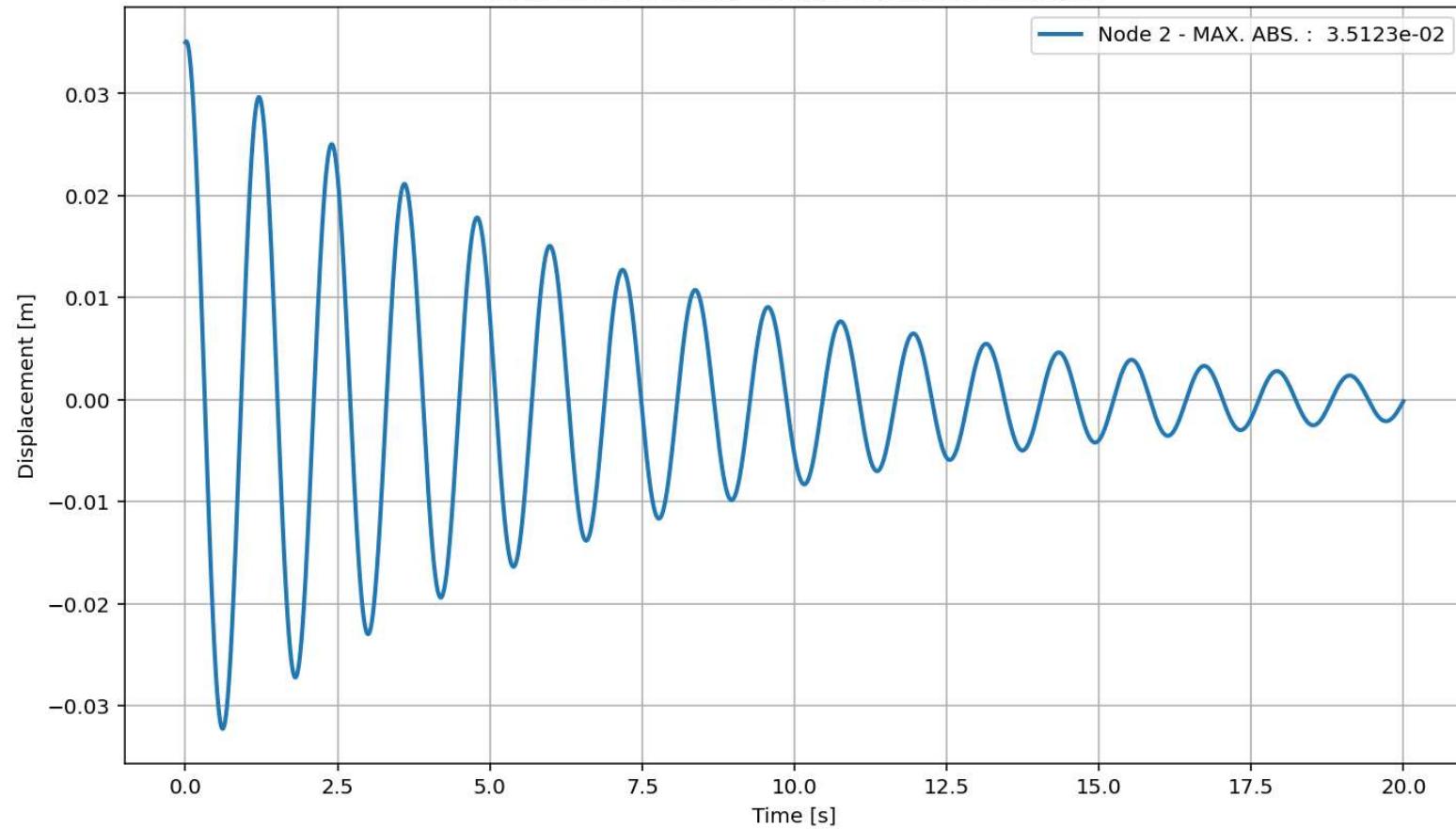
EXACT AND APPROXIMATE RELATIONS BETWEEN LOGARITHMIC DECREMENT AND DAMPING RATIO



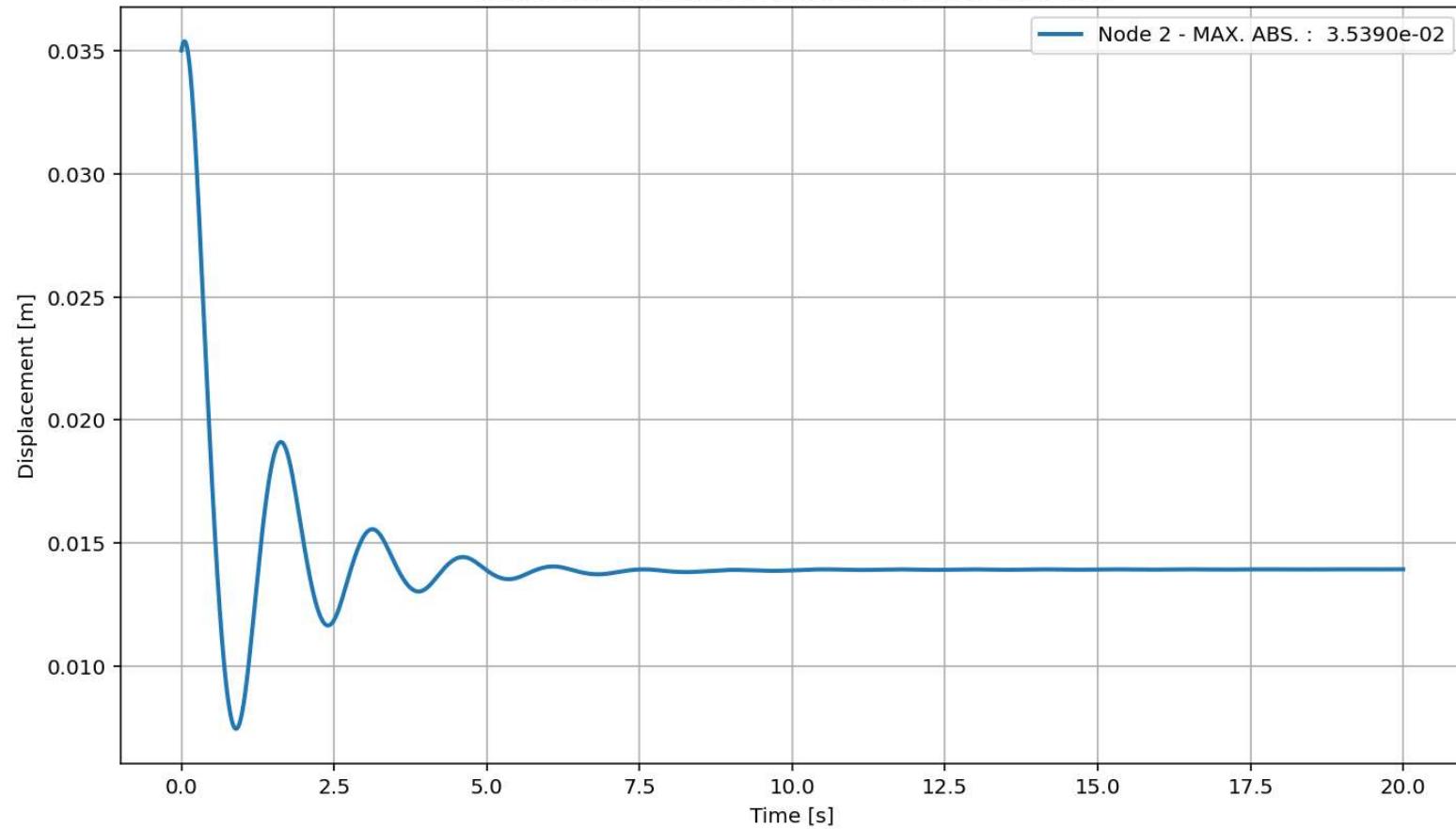


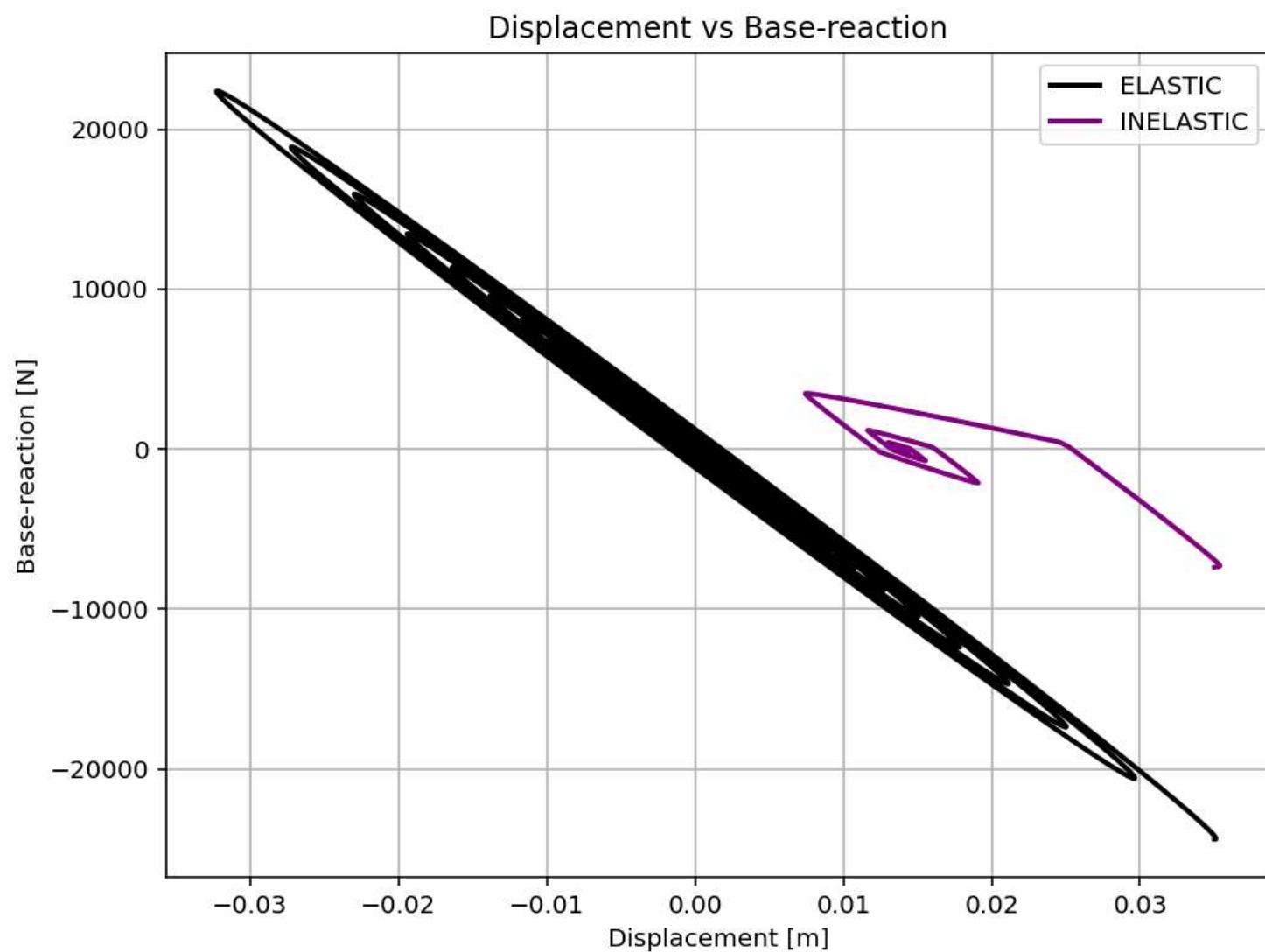


Node Displacements vs Time for Elastic Structure

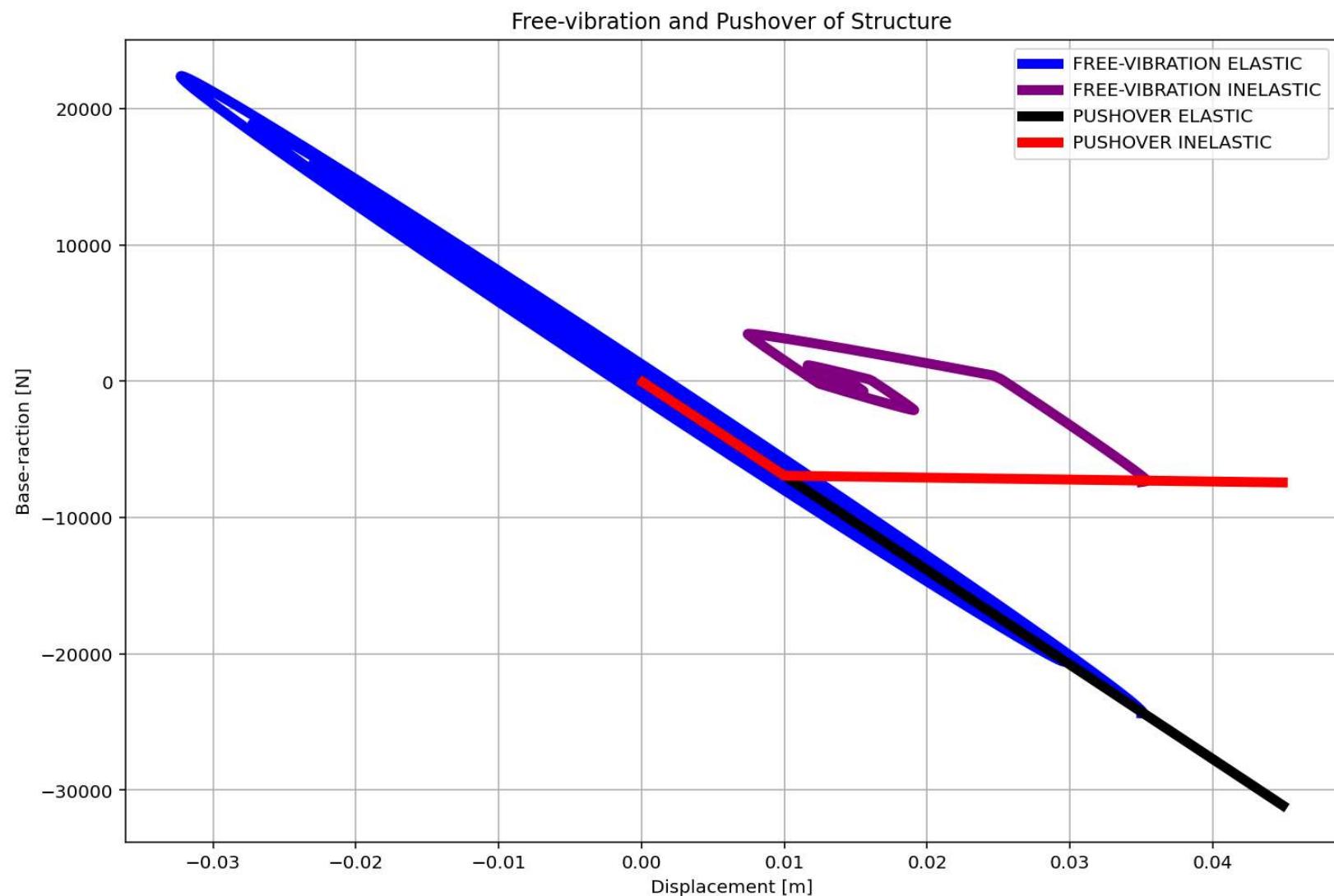


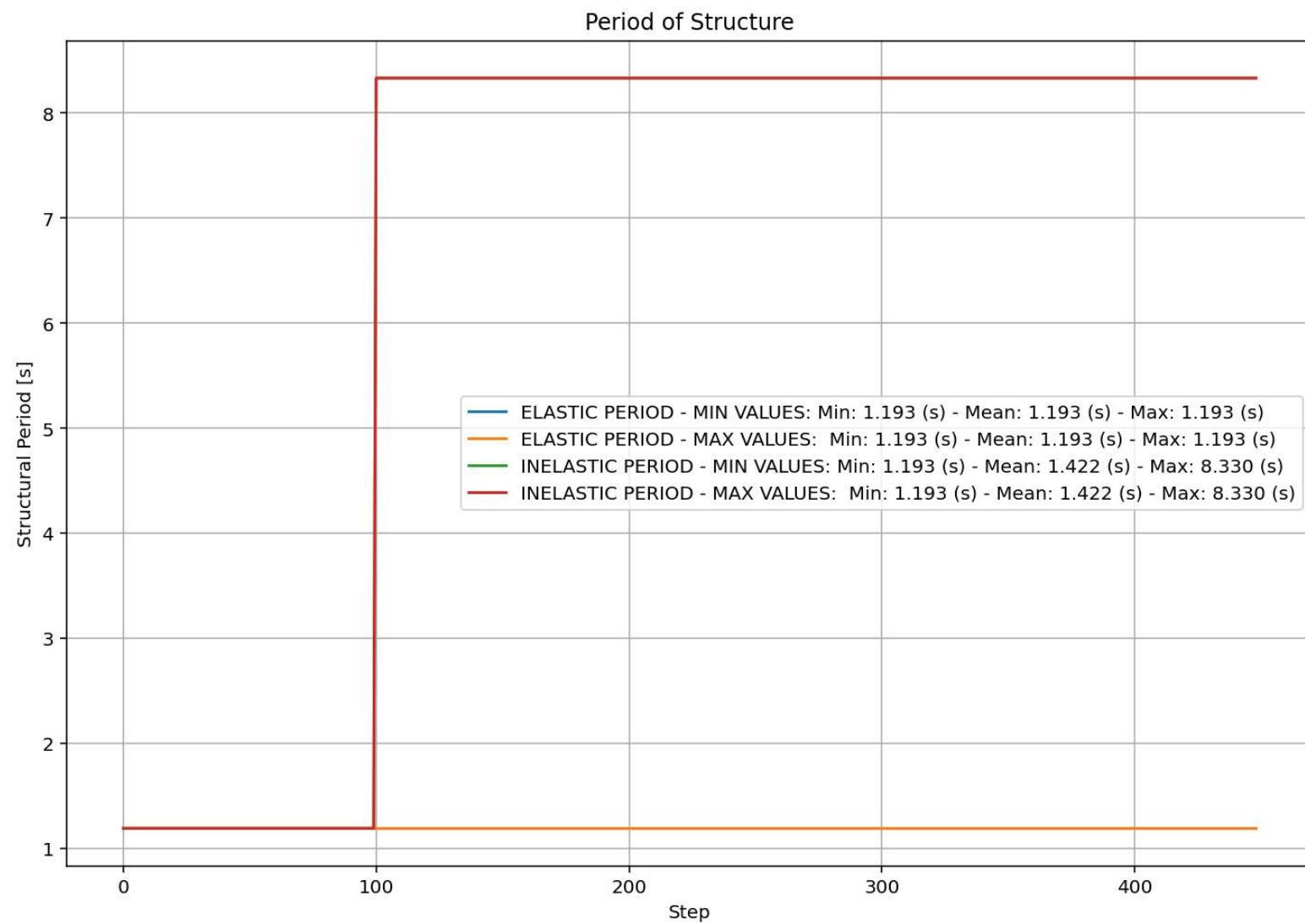
Node Displacements vs Time for Inelastic Structure



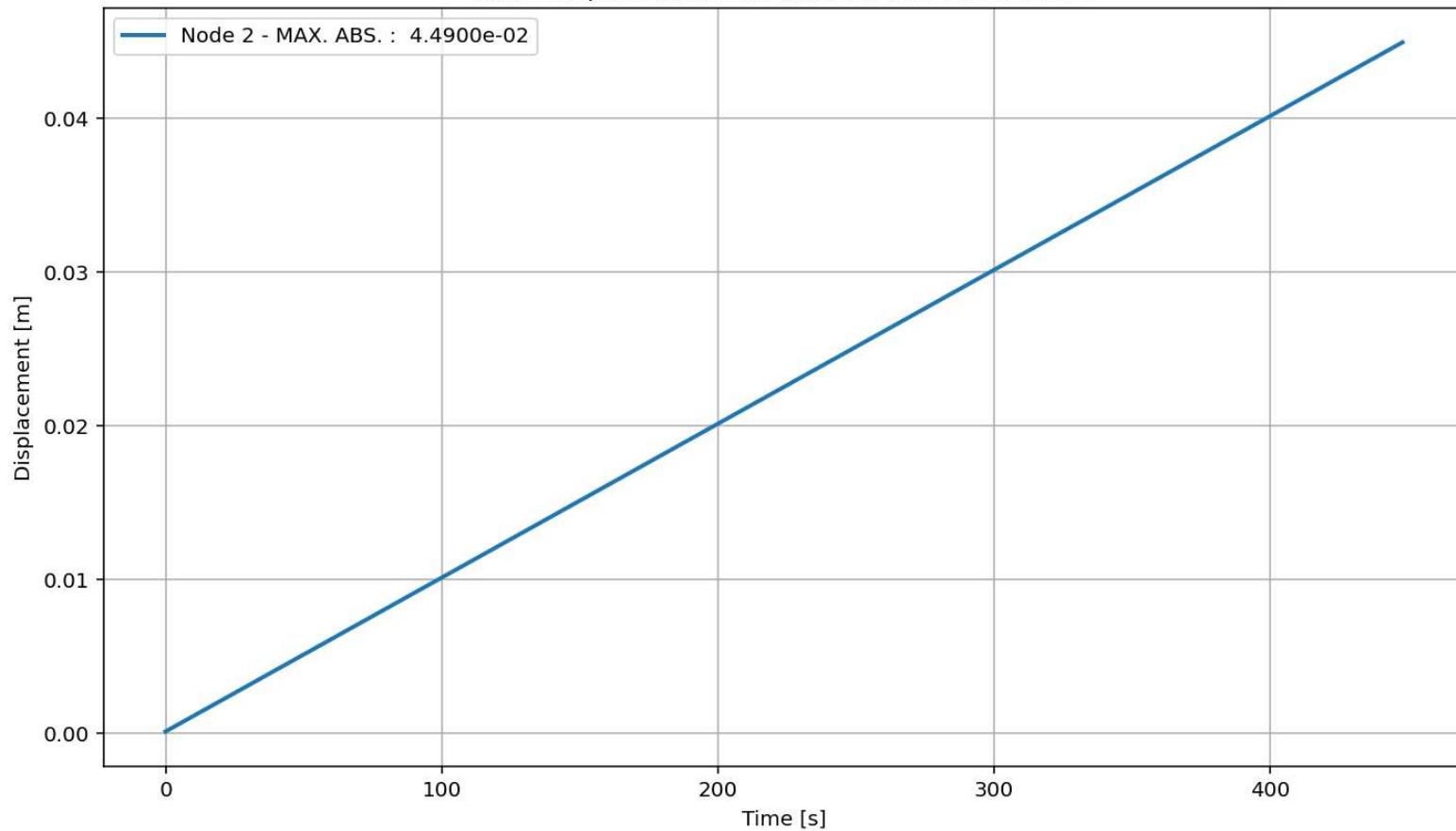


PUSHOVER ANALYSIS





Node Displacements vs Time for Elastic Structure



Node Displacements vs Time for Inelastic Structure

