

Soil-Pipe Interaction Phenomena on Slopes under Asynchronous Earthquake Excitation

Athanasios A. MARKOU¹, Amir M. KAYNIA², Anastasios SEXTOS³,
George D. MANOLIS⁴

¹ *Aalto University, Espoo, Finland, athanasios.markou@aalto.fi*

² *NGI, Oslo, Norway, amir.m.kaynia@ngi.no*

³ *Bristol University, Bristol, UK, a.sextos@bristol.ac.uk*

⁴ *Aristotle University, Thessaloniki, Greece, gdm@civil.auth.gr*

Overview

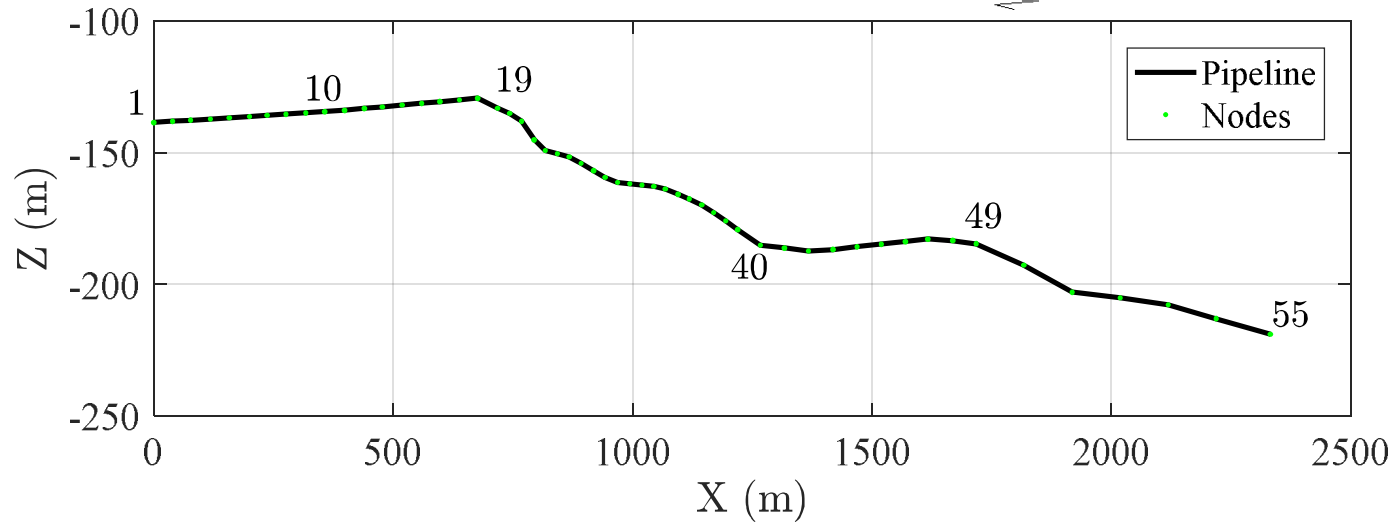
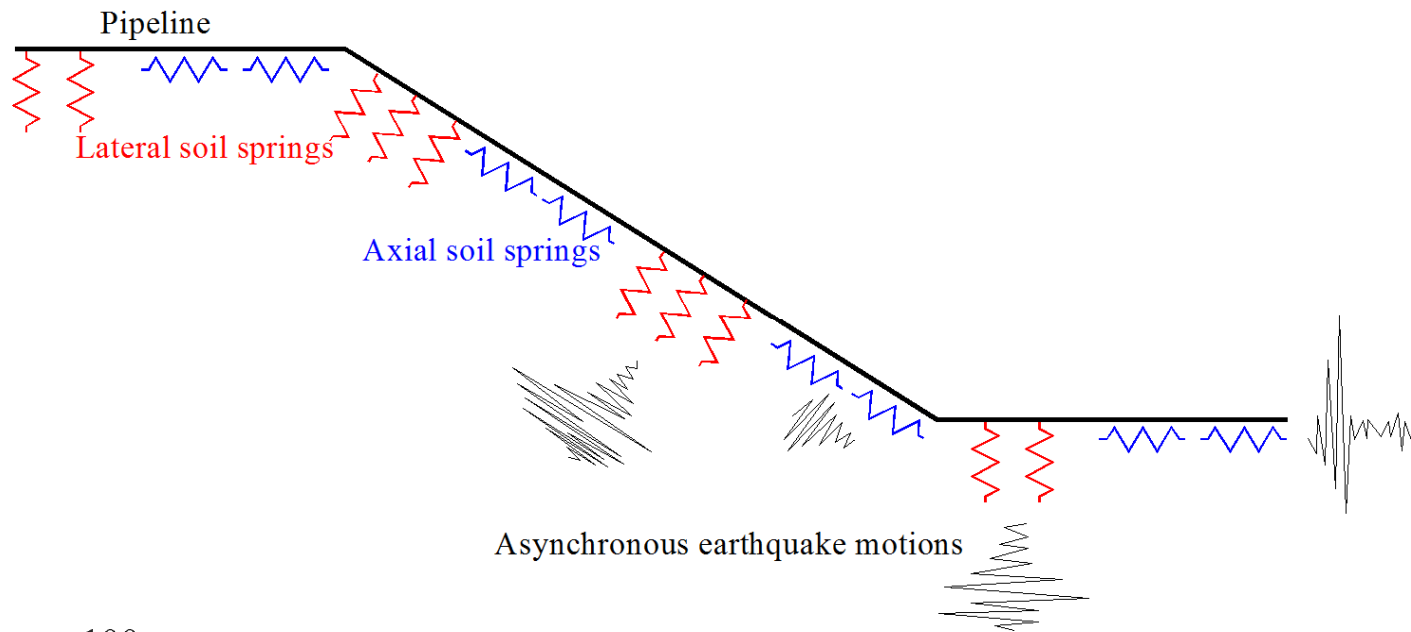
The current work is focused on the response of offshore pipelines traversing slopes under asynchronous acceleration time histories. The pipeline itself is modelled as a **generalized beam element**. Two **generalized nonlinear models** are used to account for the soil behavior:

- Two **elastoplastic elements** with a **trilinear elastic spring** in parallel
- Three **elastoplastic elements** in parallel

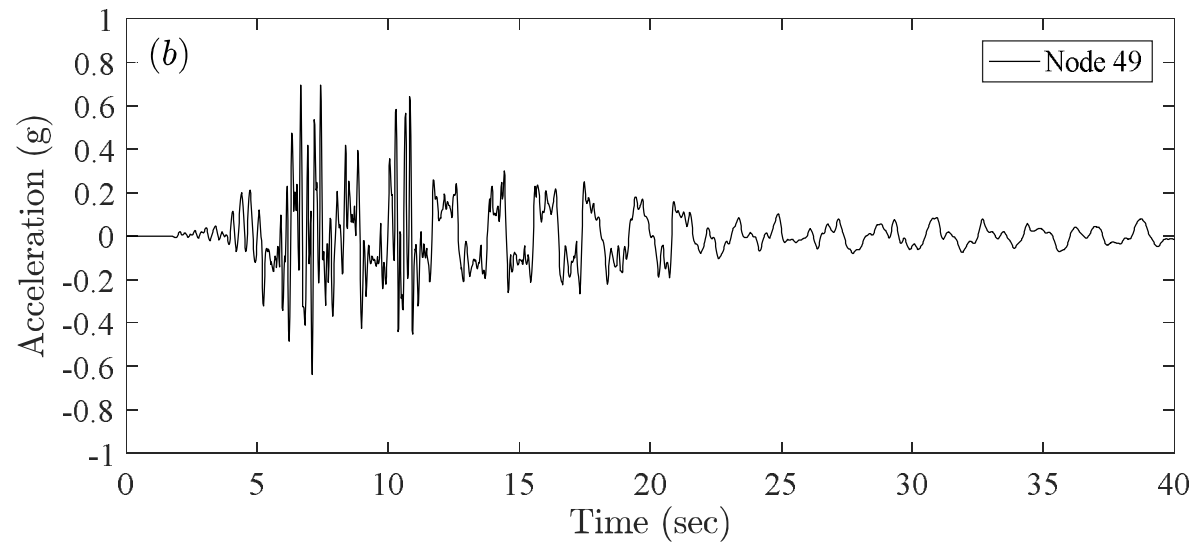
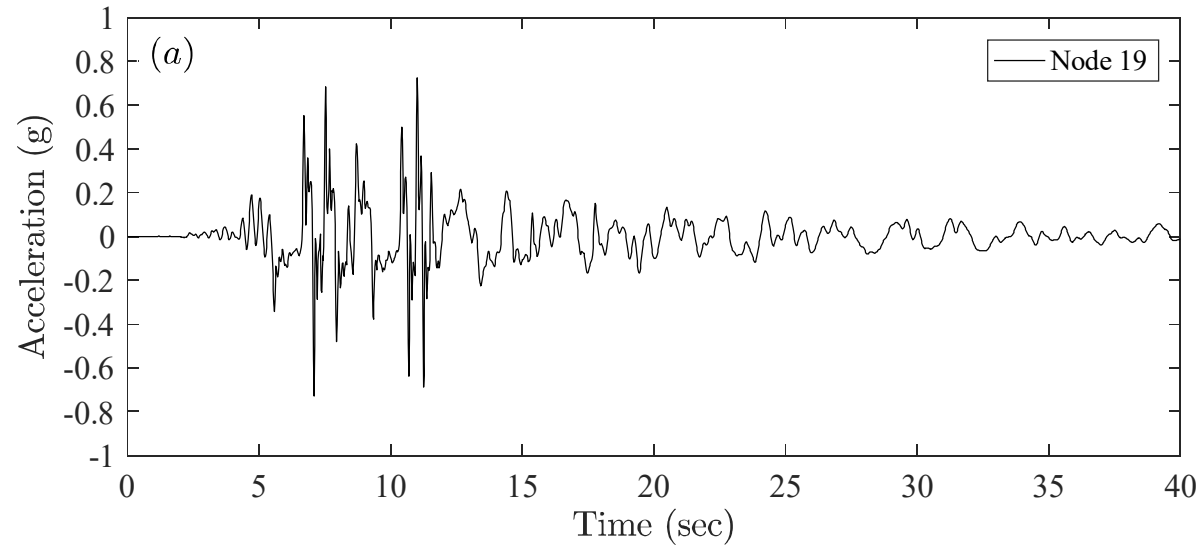
Purpose:

- Introduce nonlinear mechanical models to account for **smooth transition between elastic and plastic phase** and to **control the soil damping**
- Investigate the **effect of soil strength and soil damping** on axial force

Numerical Simulation



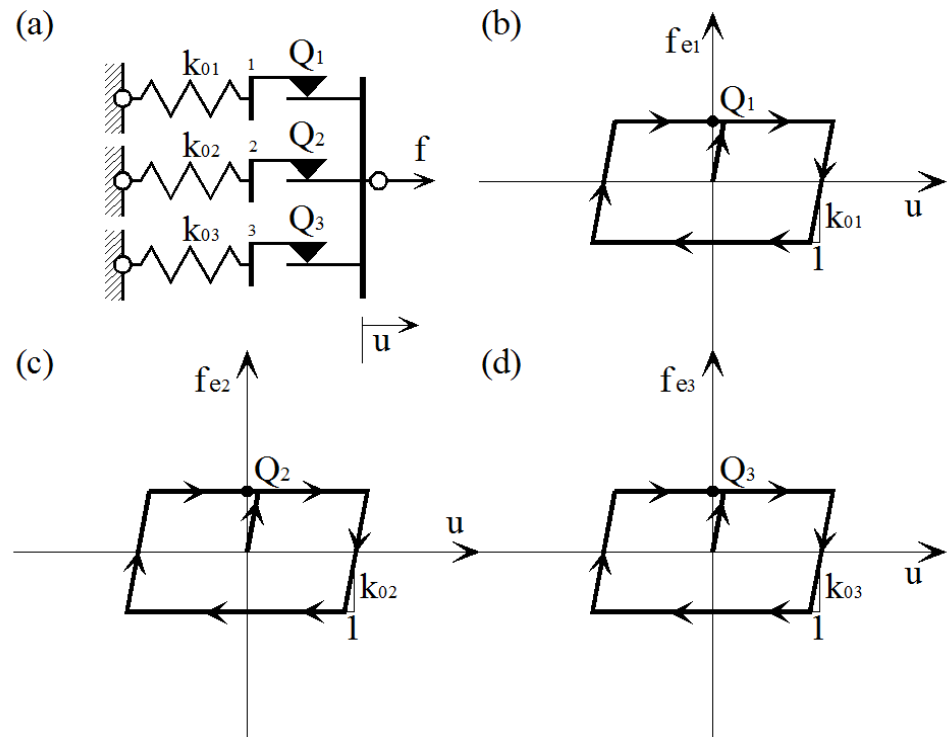
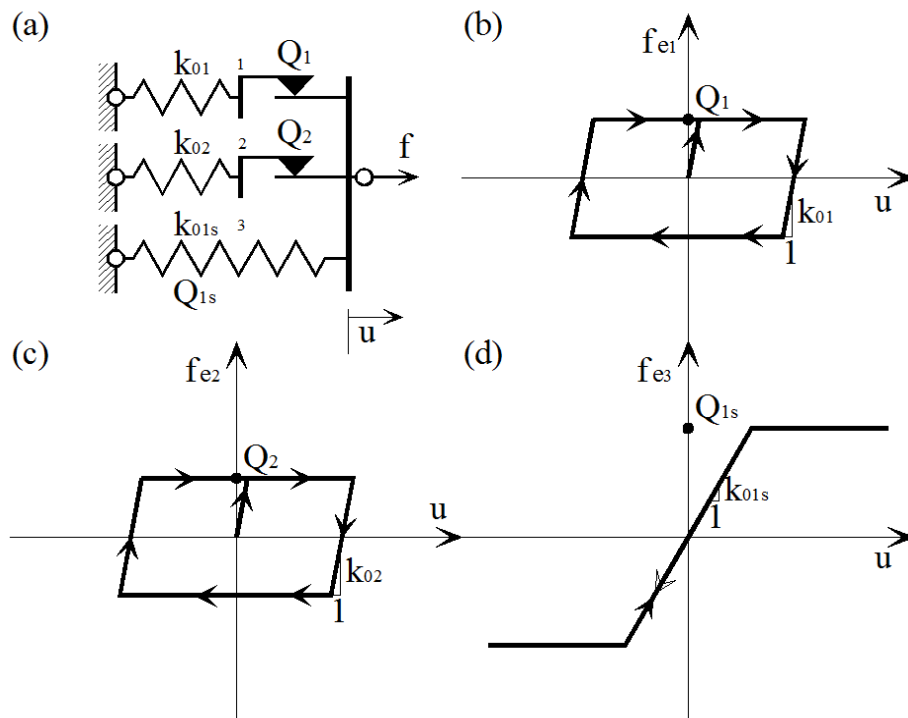
Asynchronous earthquake motions



Nonlinear mechanical models

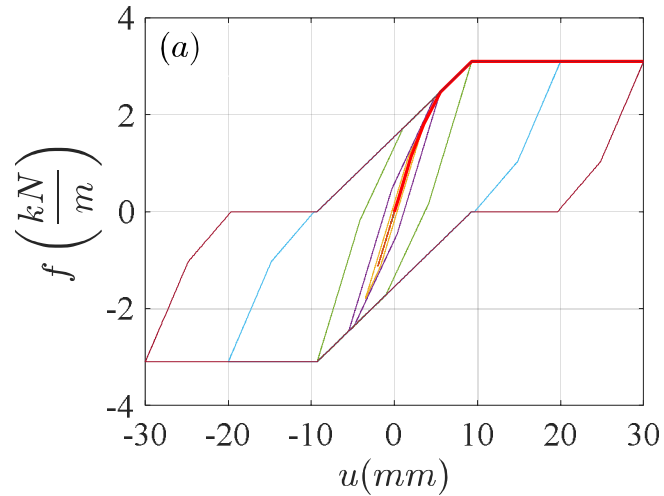
Models 1, 3

Models 2, 4

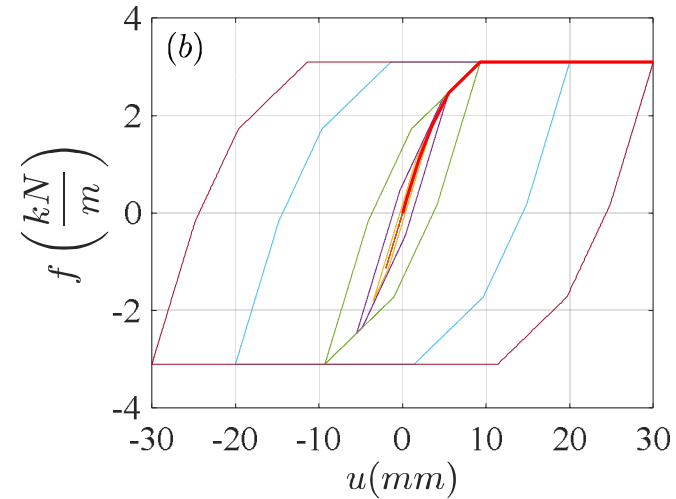


Force-displacement behaviour

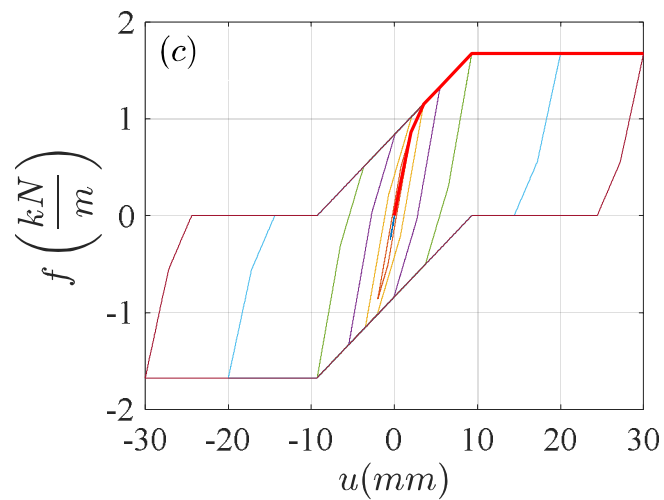
Model 1 (HSLD)



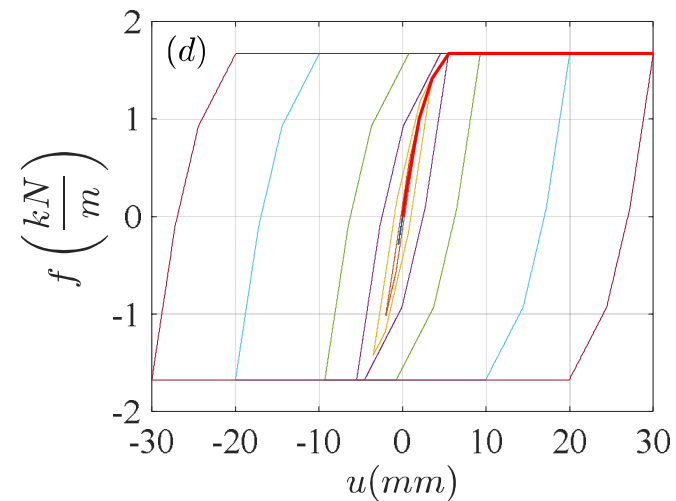
Model 2 (HSHD)



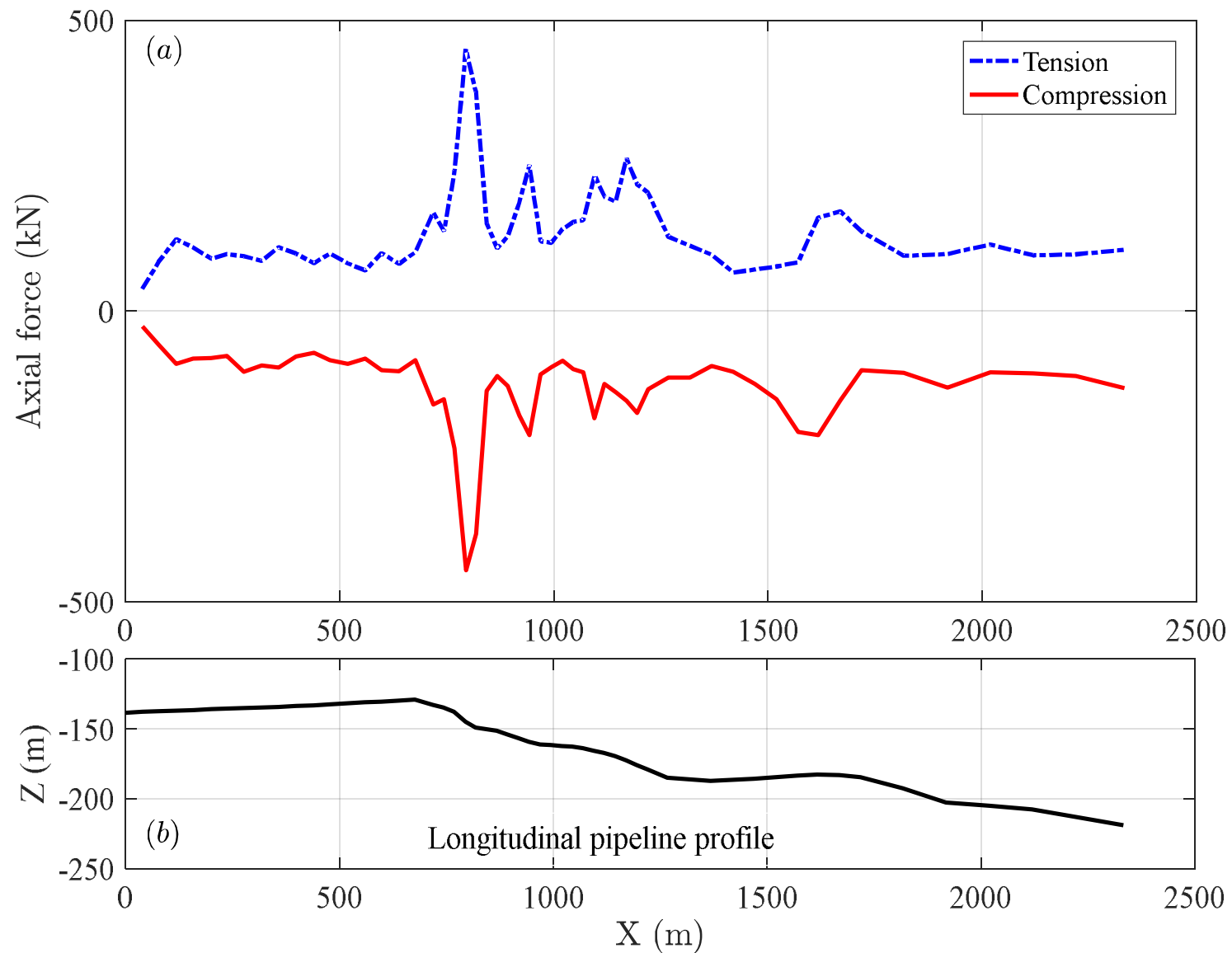
Model 3 (LSLD)



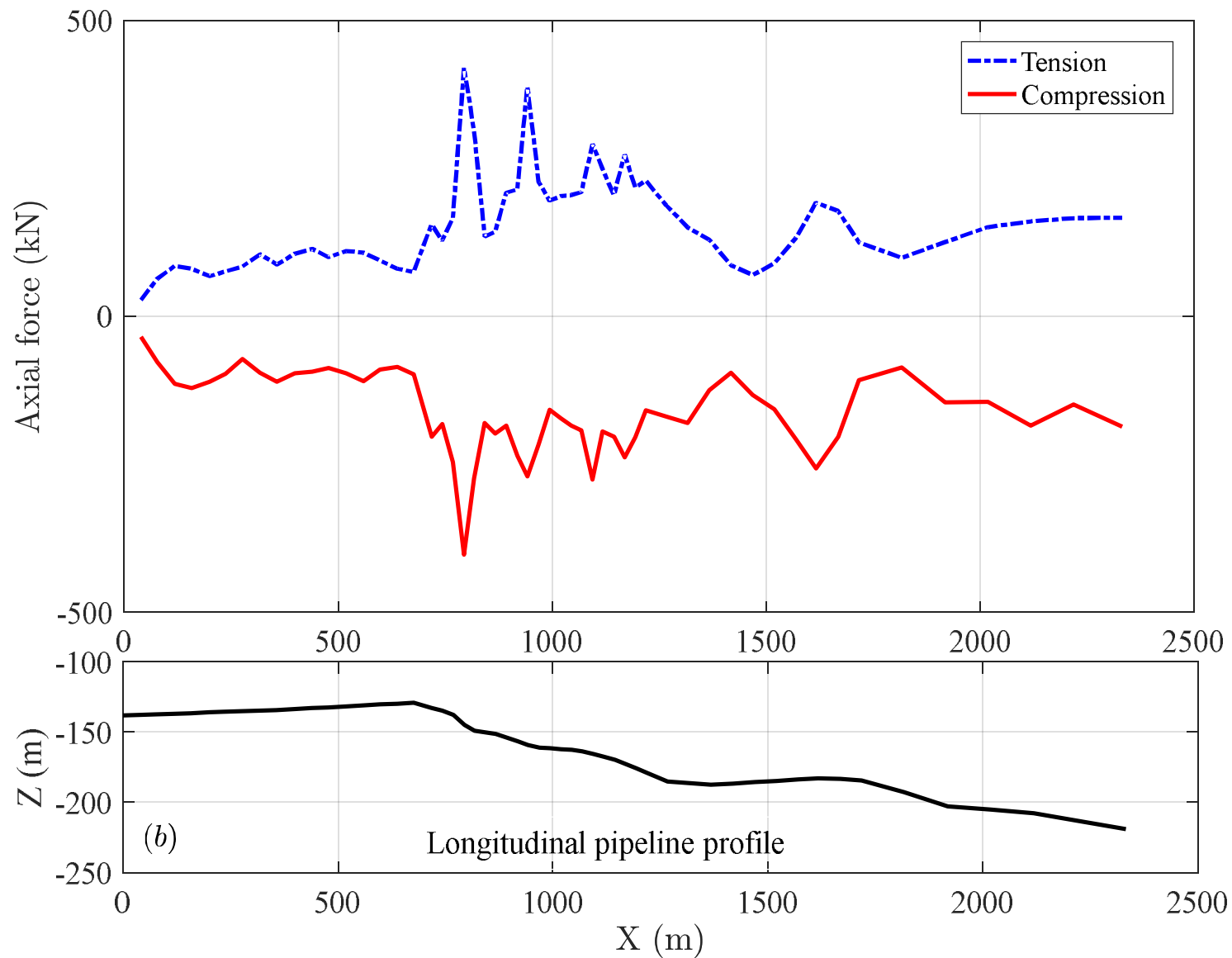
Model 4 (LSHD)



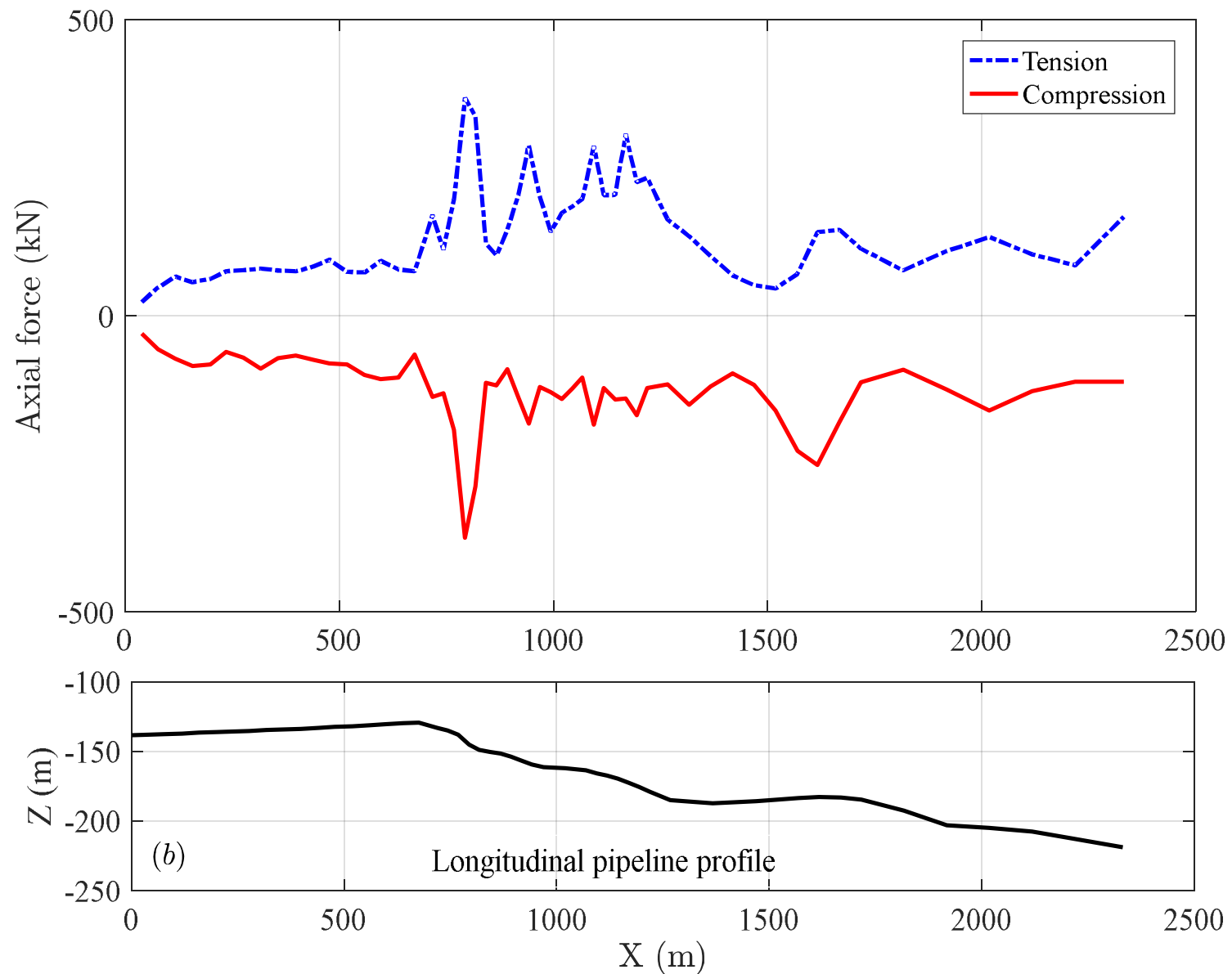
Axial force for models 1 (HSLD), 2 (HSHD)



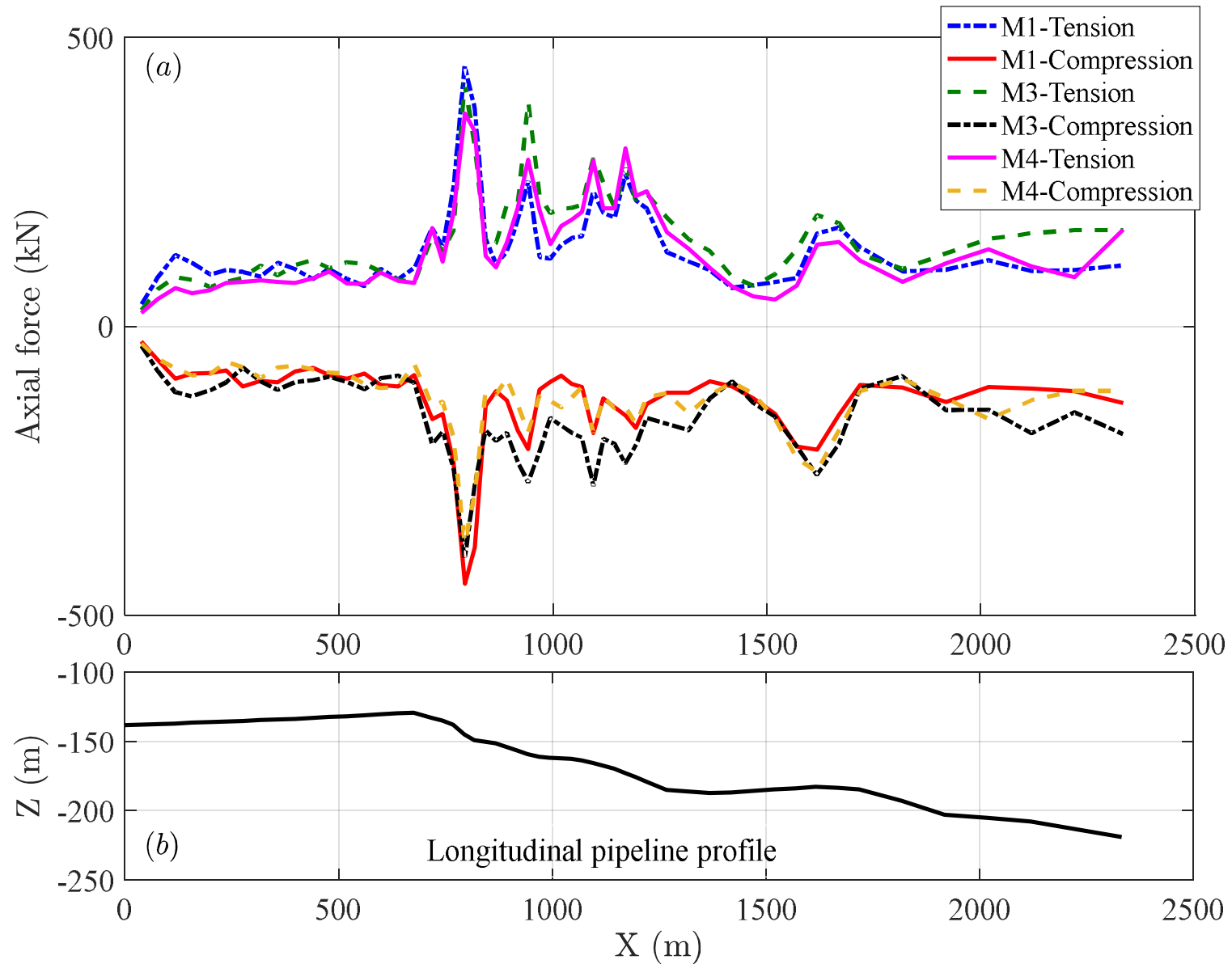
Axial force for model 3 (LSLD)



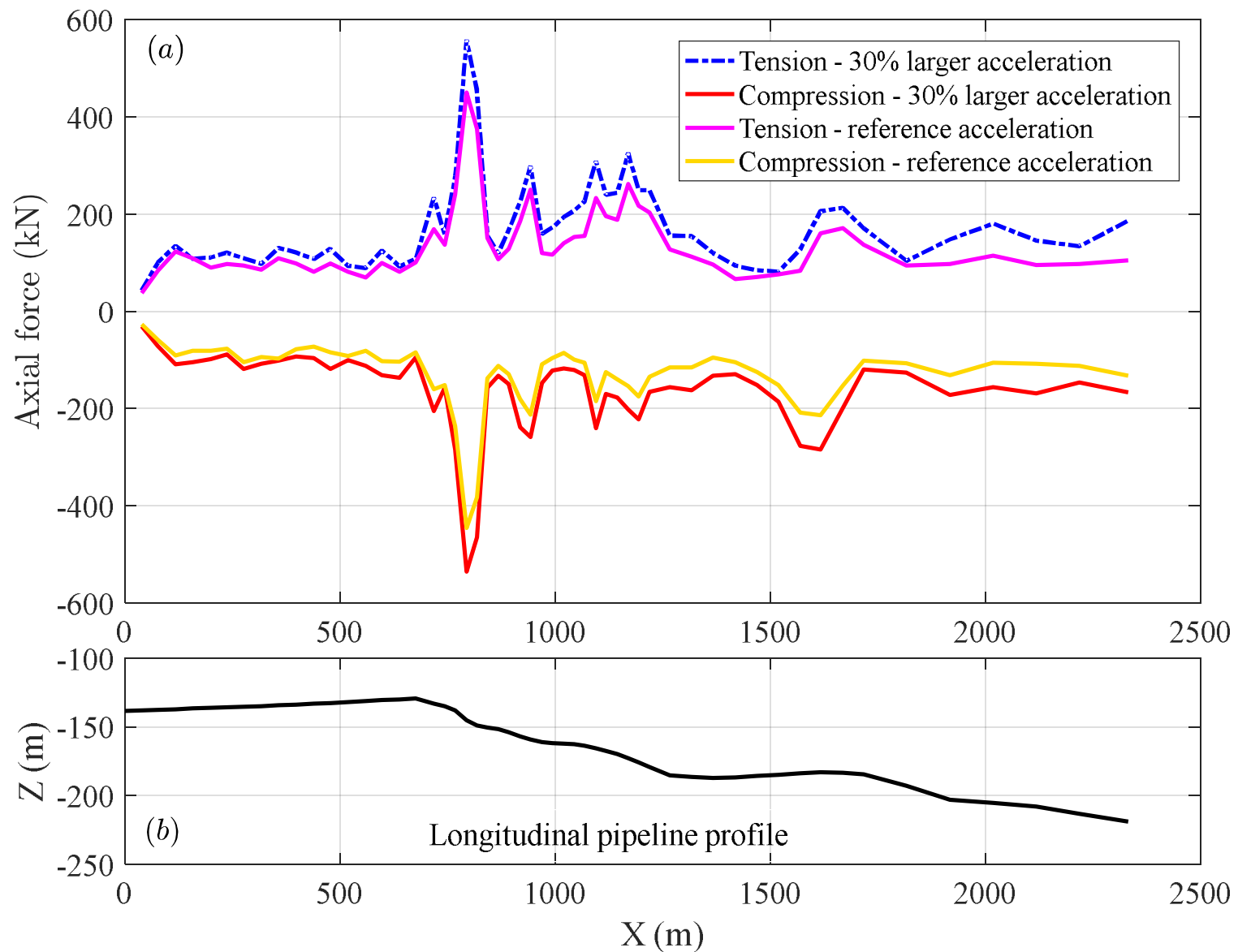
Axial force for model 4 (LSHD)



Comparison of four models



Increase of acceleration for model 1 (HSLD)



Conclusions

- The results of the sensitivity analysis indicated that **reduction in the soil strength and damping ratio of the order of 50%** produced a **significant variation in the maximum axial force** developed under asynchronous earthquake excitation.
- Both **tension and compression forces** play a **significant** role in the **design of the pipelines**.
- To this end, **the parameters of the SPI system**, namely **soil strength and damping ratio**, should be chosen carefully in order to produce a **successful design** in terms of safety and performance.

Thank you very much for your attention!