Base Slab Averaging and Inelastic Effects in Soil-Structure Interaction Behavior of Mat-Slab Founded Structures, Effects on Reduction of Seismic Demand

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Outline

Motivation

- Spatial variability of seismic motions is well documented
- Base slab averaging is used to reduce seismic demand
- Inelasticity of soil-structure interface contributes more to reduction of seismic demand then base slab averaging !

Inelastic/Nonlinear SSI Analysis

- Sophisticated inelastic SSI analysis available to engineers
  - Inelastic analysis programs
  - Fast computers

- Analysis tools for design and assessment
  `http://real-essi.us/`

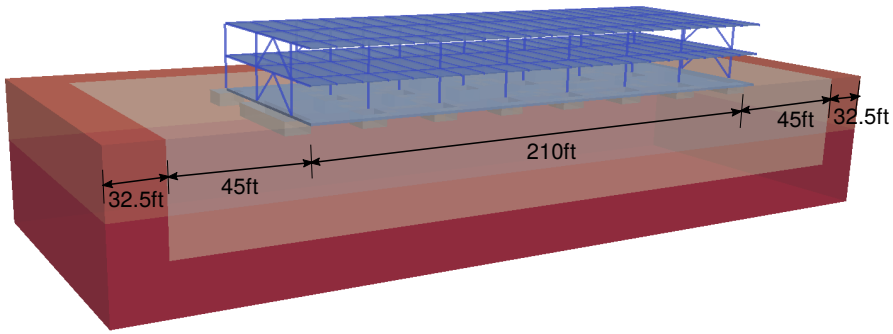
- Supplement prescriptive, generic, code requirements

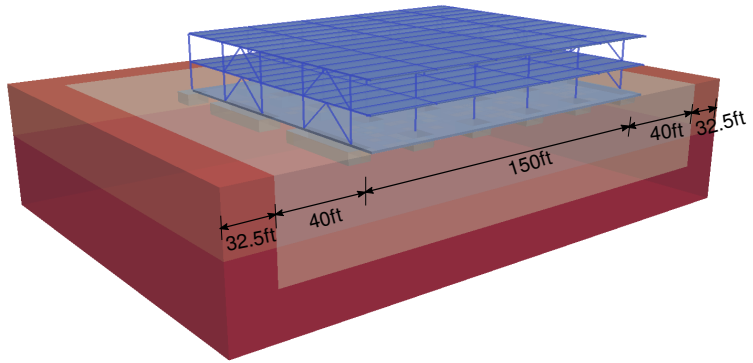
- Benefits of sophisticated inelastic SSI analysis
  infrastructure safety $\nearrow$
  infrastructure cost $\searrow$ ($CO_2 \searrow$)

Reducing Seismic Demand

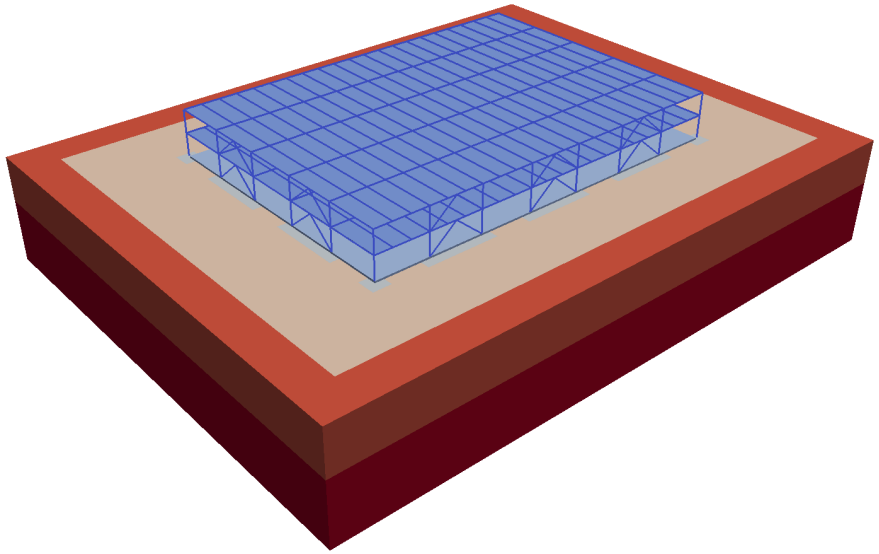
- Reduction of seismic demand due to incoherent motions
- Linear elastic material assumption
- Earthquake seismic demand reduction is mostly due to
  - Inelasticity of soil,
  - Inelasticity of soil-foundation interfaces
- Inelastic SSI analysis: demonstrate reduction in seismic demand

Analysis Model

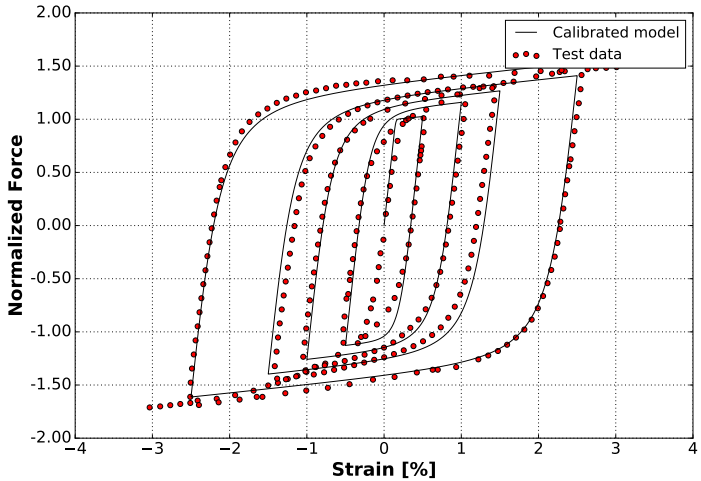




Steel Frame with BRBs

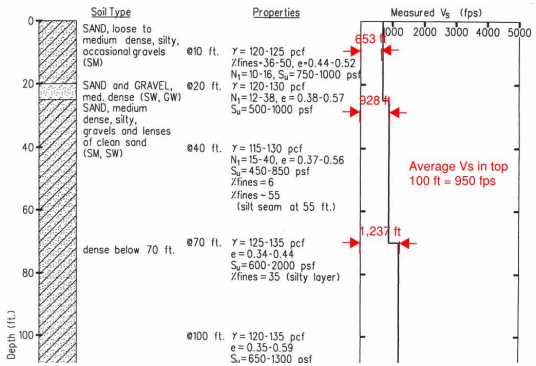


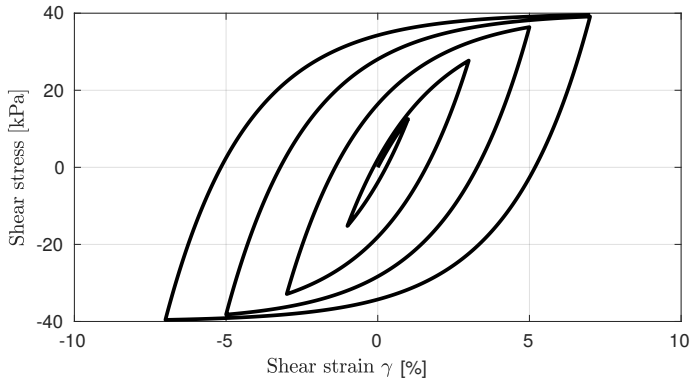
Inelastic Frame

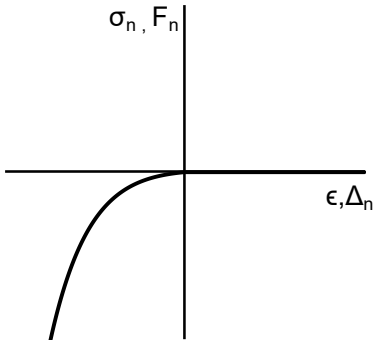


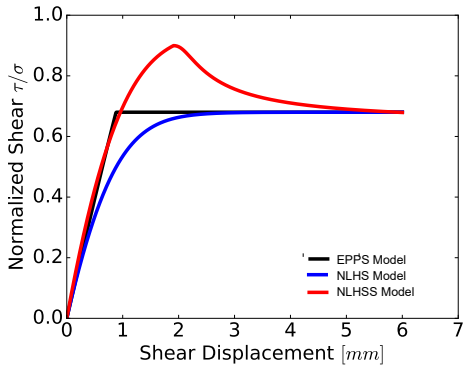
BRBs

Soil and Interfaces Behavior





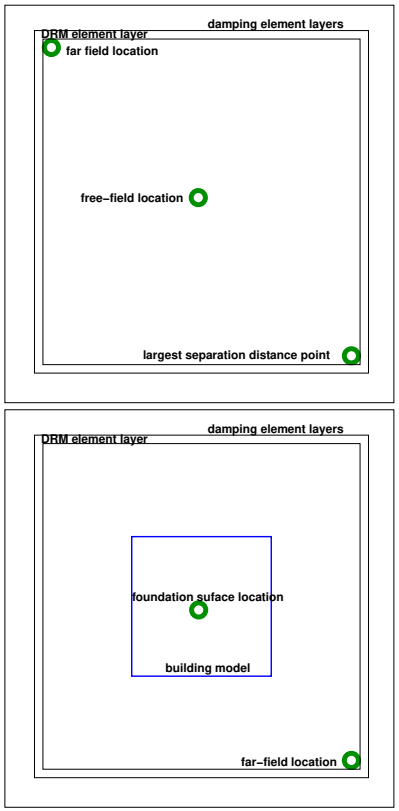


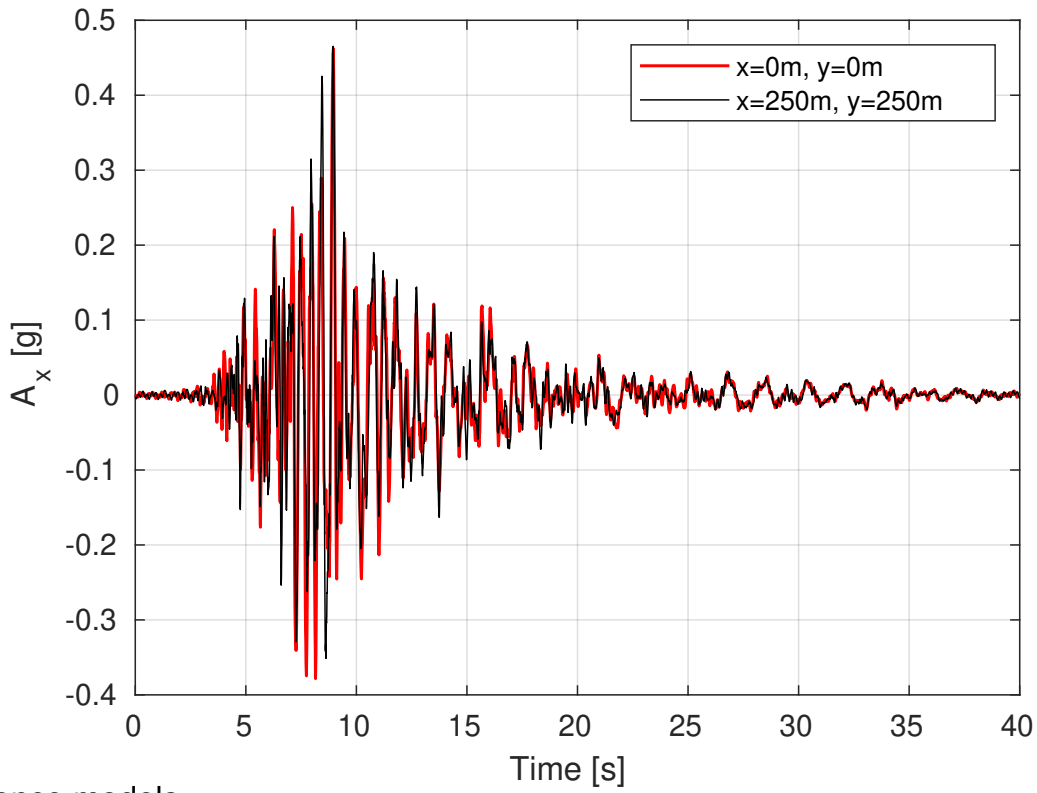


Axial

Shear

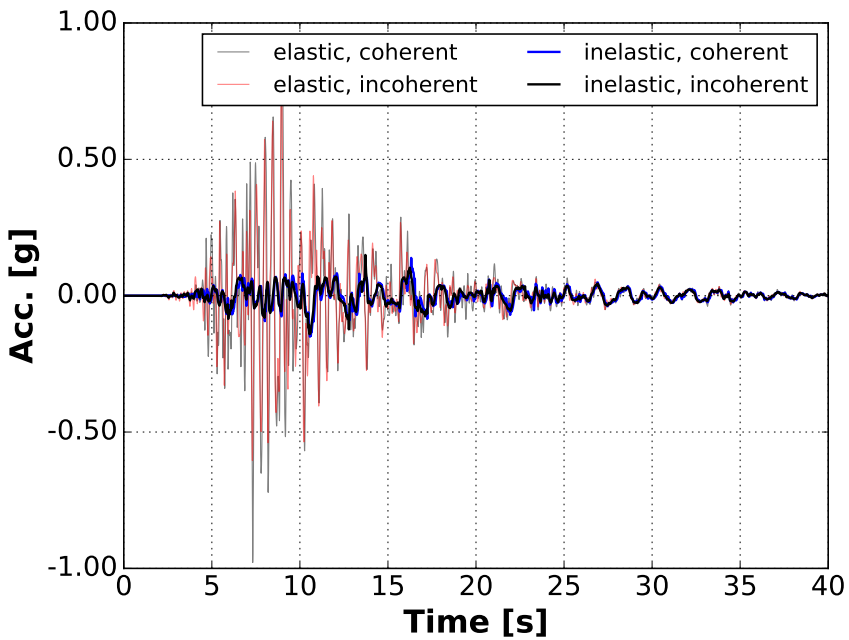
Incoherent Seismic Motions, 1D/1C



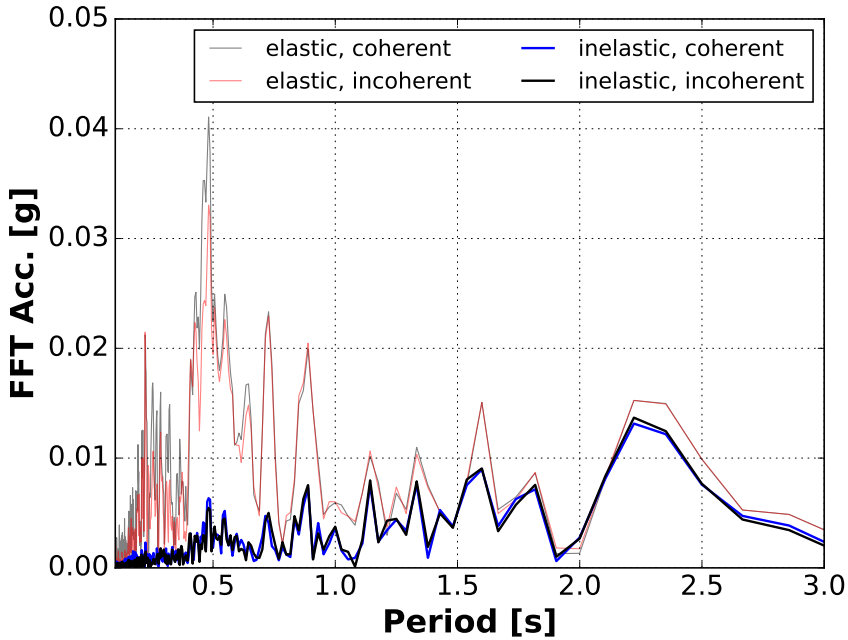


Abrahamson and Ancheta incoherence models

Foundation: Elastic/Inelastic vs Coherent/Incoherent

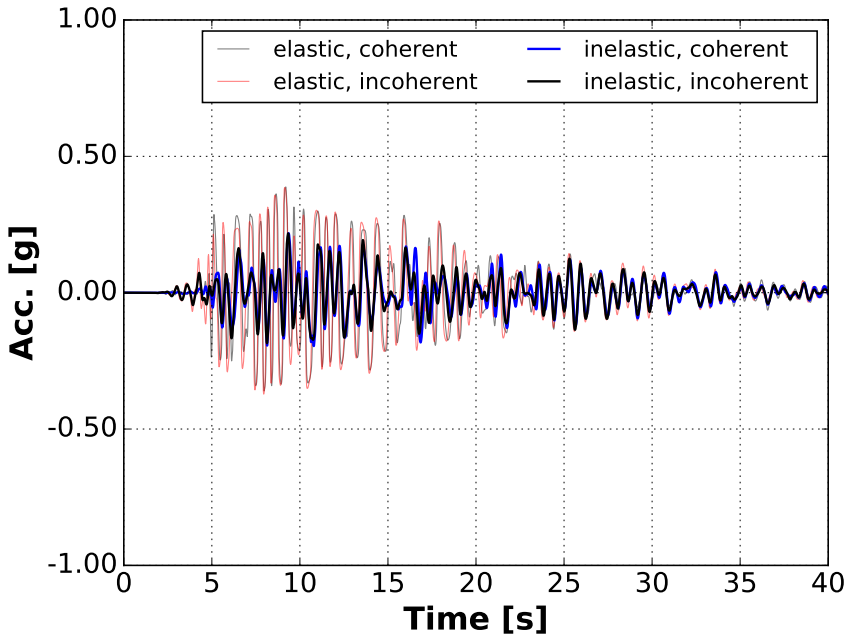


(a) Acc.

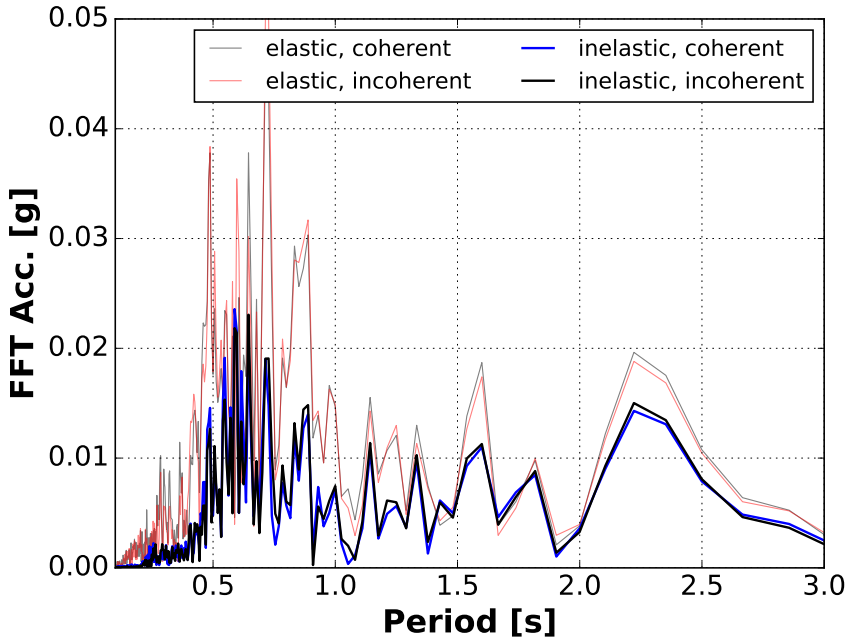


(b) FFT Acc.

Top Floor: Elastic/Inelastic vs Coherent/Incoherent

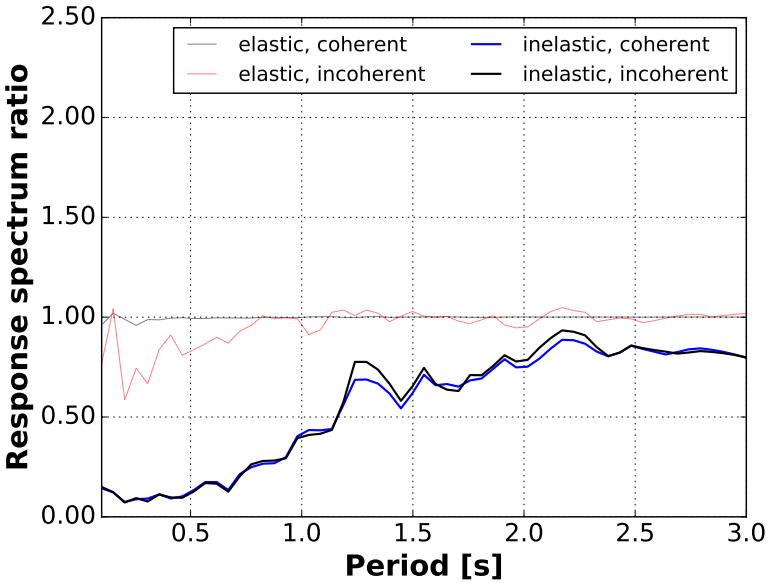


(c) Acc

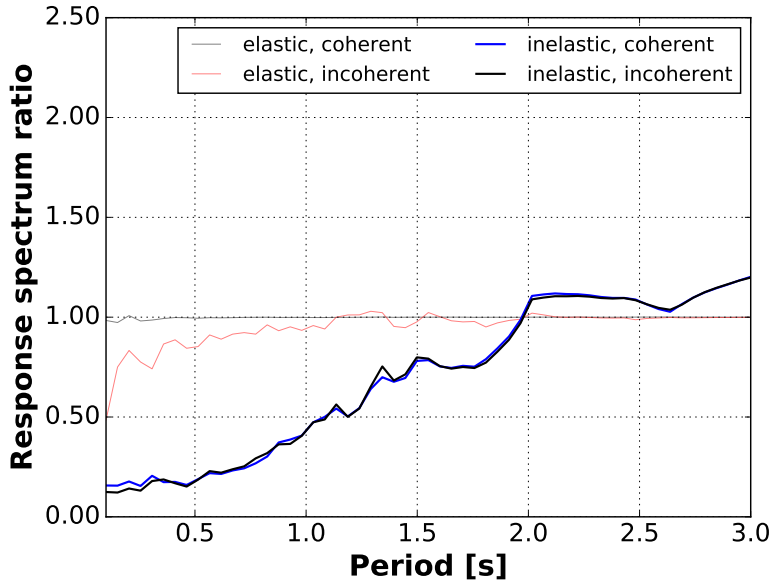


(d) FFT Acc.

Ratio of Response Spectra, Free-Field vs Foundation

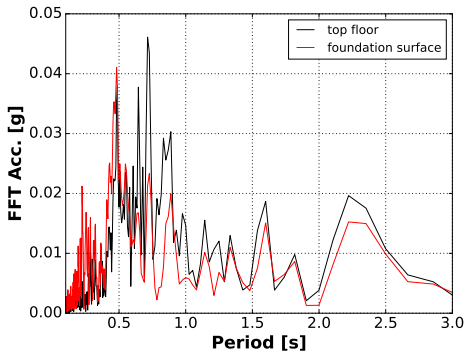


(e) X direction

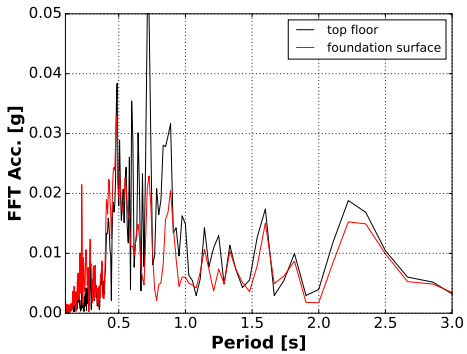


(f) Y direction

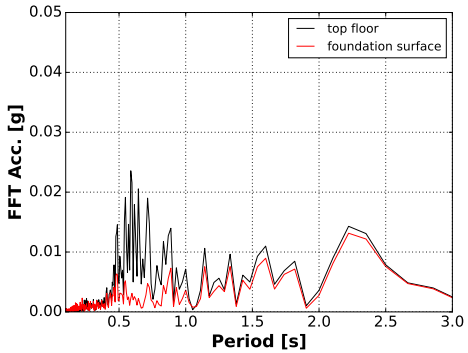
Response Spectra, Foundation vs Roof



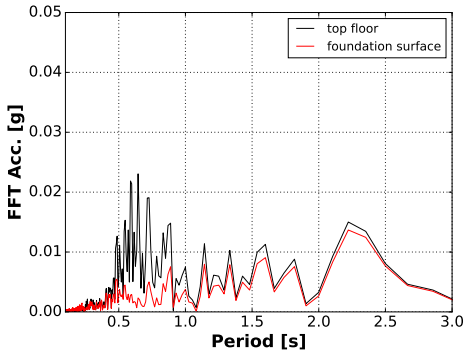
(g) El, Coh



(h) El. Incoh.



(i) Inel. Coh.



(j) Inel. Incoh.

Summary

- Reduction of seismic demand, seismic response due to inelasticity of soil and interfaces/contacts
- Realistic analysis, for engineers to improve safety and economy of infrastructure
- B. Jeremić, H. Yang, H. Wang and B. Lizundia. Direct Analysis Soil-Structure Interaction Case Studies for the ATC-144 Project. UCD-ESSI report, 2021.
- B. Lizundia, C.B. Crouse, S. Harris, B. Jeremić, J.P. Stewart, and M. Valley. A practical guide to soil-structure interaction, FEMA P-2091. Technical Report FEMA P-2091, ATC-144, 2021.