

SMATCH Benchmark, LBNL-NRC Team

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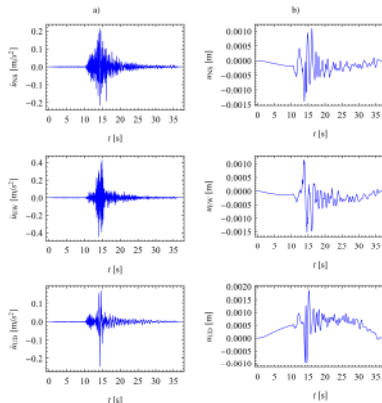


Overview

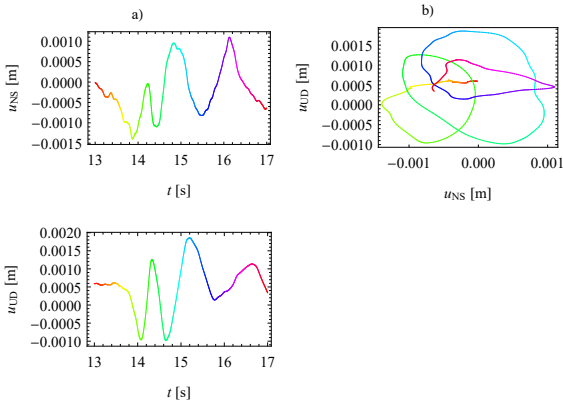
- Introduction
- Cruas SSI Behavior
- Summary

Le Teil Earthquake Motions and Cruas NPP Site

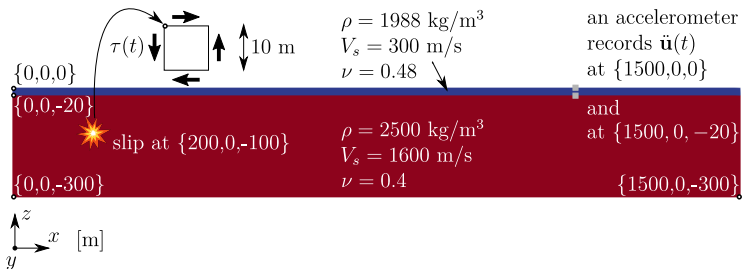
- Super shear EQ:
 $V_{slip} = 1800 \text{ m/s}$,
 $V_s = 1600 \text{ m/s}$,
- Geology: soft surface soil,
soft and hard rock, shallow
- More material data for
soil and interfaces needed
- Seismic wave field:
Rayleigh waves,
Stoneley waves



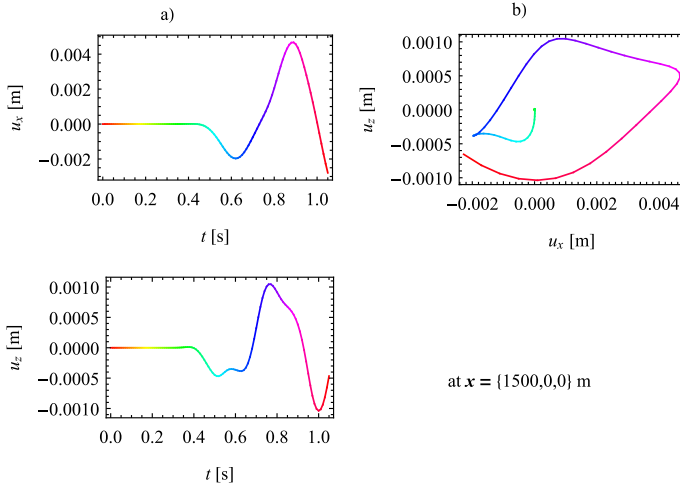
Le Teil EQ, Displacement, Station #1, N-S, U-D



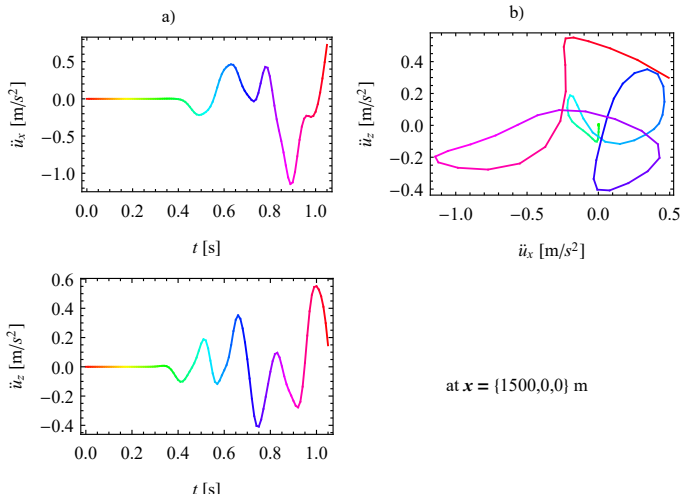
ESSI, Small Regional Scale Model



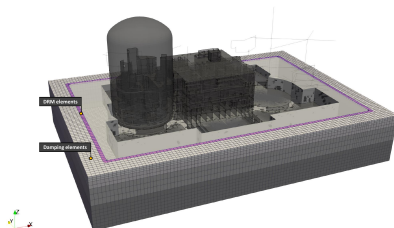
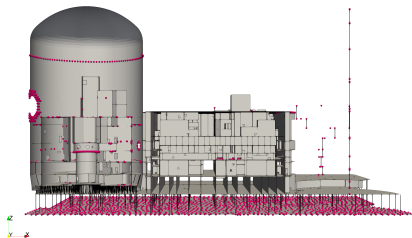
ESSI, EQ, Disp., 1.3km away, Surface ($-0m$)



ESSI EQ, Acc., 1.3km away, Surface ($-0m$)

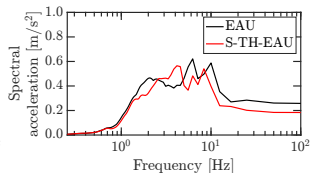
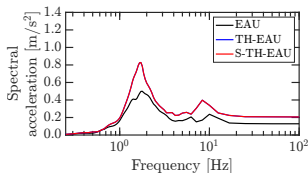
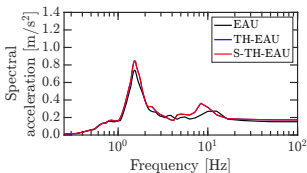
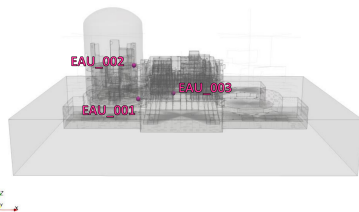


Cruas NPP FEM Model



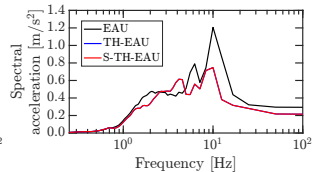
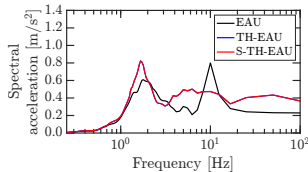
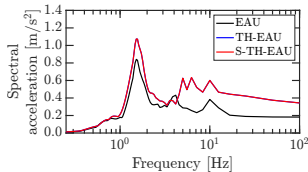
Analysis Comparison, EAU_01

- EAU $\rightarrow$ Analysis
- TH-EAU $\rightarrow$ Measurement



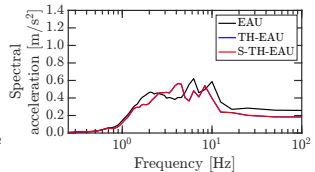
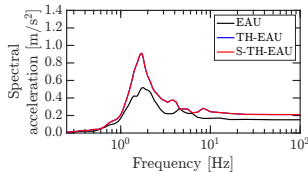
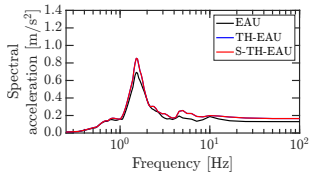
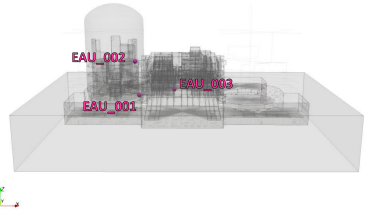
Analysis Comparison, EAU_02

- EAU $\rightarrow$ Analysis
- TH-EAU $\rightarrow$ Measurement



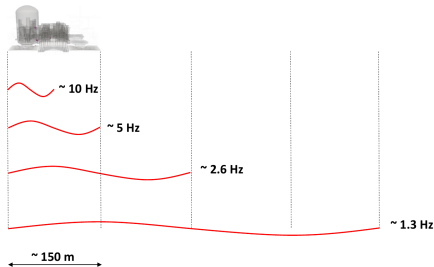
Analysis Comparison, EAU_03

- EAU $\rightarrow$ Analysis
- TH-EAU $\rightarrow$ Measurement



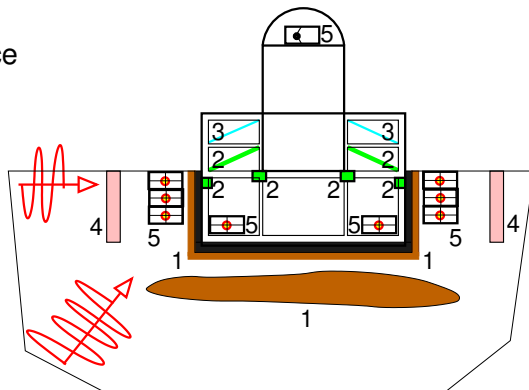
Seismic Wave Lengths, Frequencies

- SSI for long wave lengths/low frequencies is $3 \times 1D/1C$
- SSI for short wave lengths/high frequencies is $3C/6C$



Seismic Shielding of Cruas NPP

1. Plasticity of soil, structure, and the soil-foundation interface
2. Energy dissipators, energy sinks
3. Viscous dampers and viscous coupling
4. External trenches
5. Meta-materials, meta-devices



Summary

- Seismic wave field: Rayleigh, Stoneley waves
- Material behavior: inelastic, energy dissipation
- Base isolators, response sensitivity to aging/stiffness
- Stress motions, test the resilience of SSI system
- Real-ESSI Simulator: <http://real-essi.us/>