Journey through a Project
(Large-Scale Geotechnical Testing)

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Outline

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- How to Plan Geotechnical Testing
  1. Model Construction
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  3. Filling / Excavation
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- Case Studies
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  2. U-Shaped Retaining Wall
  3. Retaining Wall with dense *c*-ϕ soil
- Lessons Learned from Case Studies

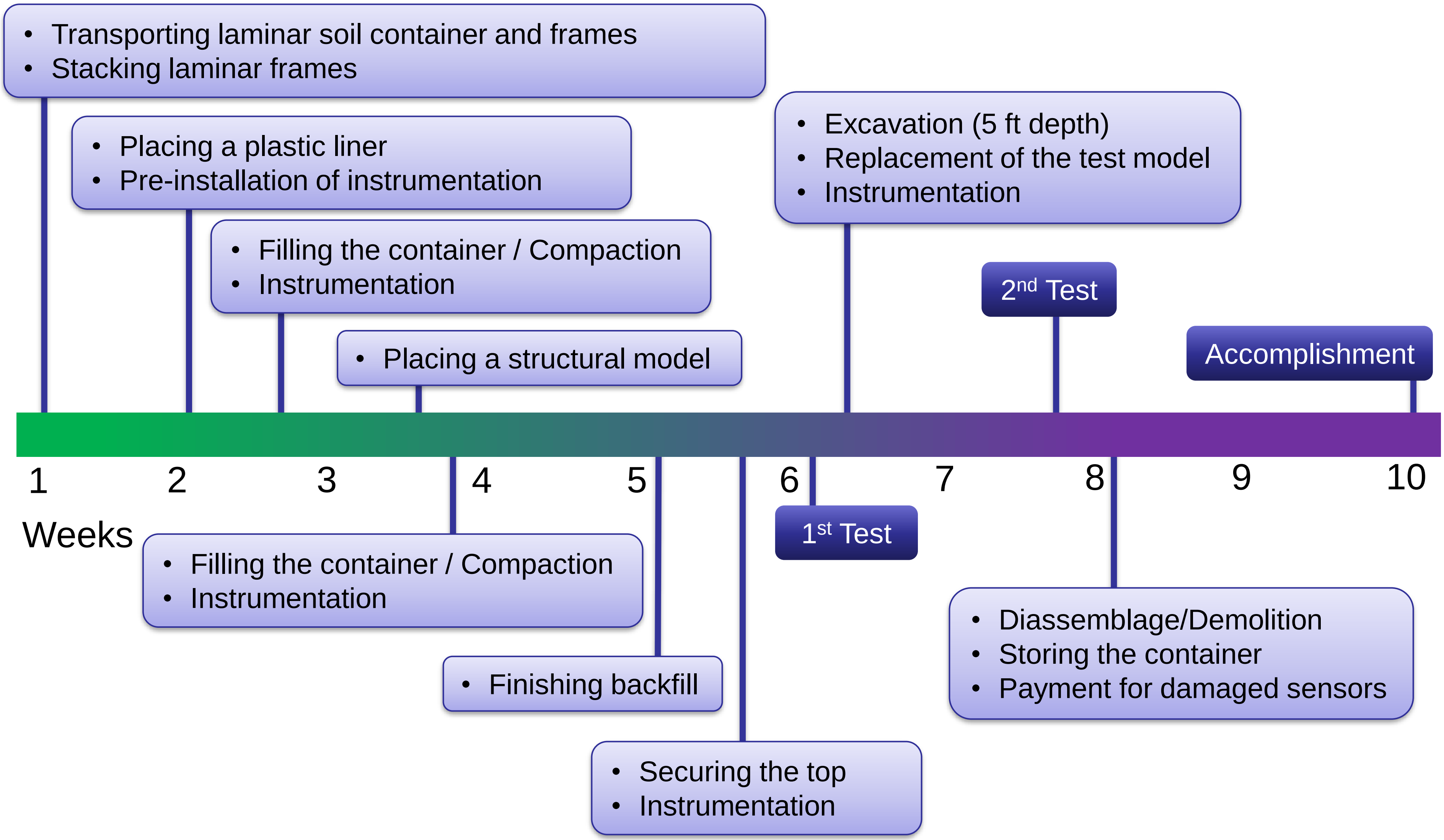
Laminar Soil Container

Laminar Weight to Soil Weight Ratio (target)	8 — 15%
Length to Height Ratio	L/H < 2.0
Width to Height Ratio	W/H < 1.0
Deflection Due to Soil-Water (2000 kg/m^3)	L/1000
Ratio of Frequency of Lateral Support (f_{lat}) to Interested Maximum Frequency (f_{max})	$f_{lat}/f_{max} > 2.5$
Ratio of Out-of-Plan Acceleration to Maximum Horizontal Acceleration	0.1 — 0.25
Ratio of Maximum Vertical Acceleration to Maximum Horizontal Acceleration	0.5 — 0.67
Laminar Frame to Soil Weight Ratio / Lateral Support to Soil Weight Ratio	< 0.1

Test Model Construction

Test Model Construction

Timeline of Geotechnical Testing



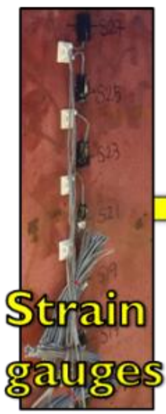
Filling The Box / Excavation

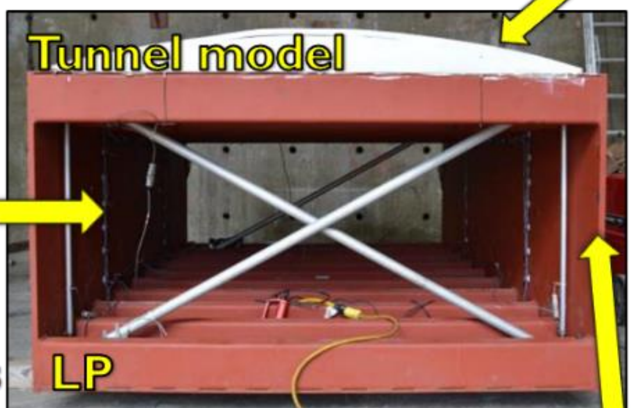
- **Dry Sand (Carroll Canyon Type II)**

- **Saturated Sand (Ottawa Sand)**

Instrumentation

- Accelerometers
- String potentiometers (SP)
- Linear potentiometers (LP)
- Strain gauges
- Pressure sensors





Case Study 1: Shallow Tunnel Testing

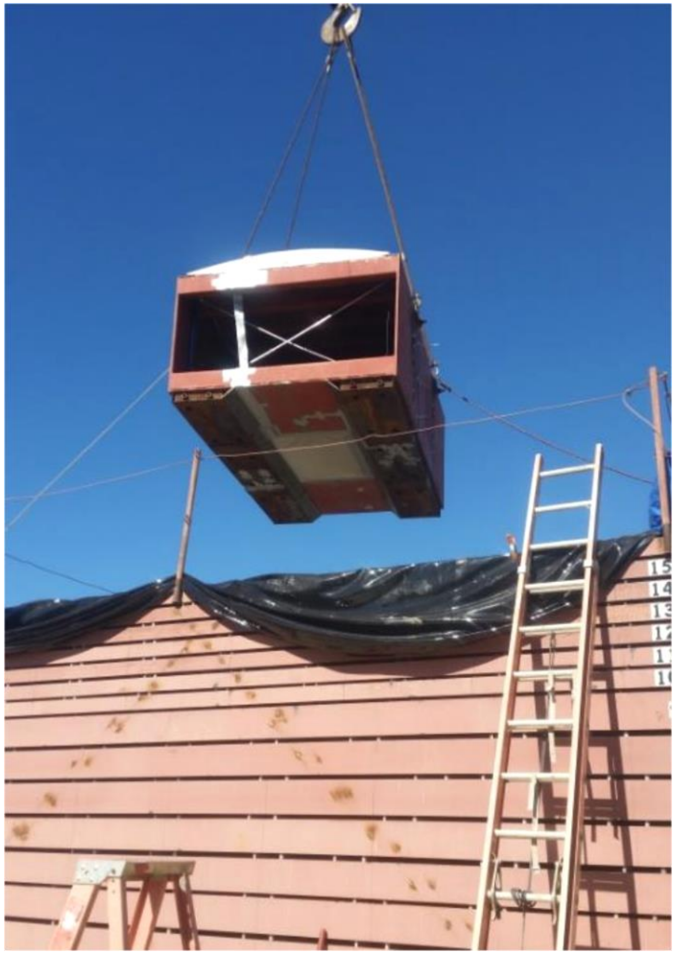
➢ **Objectives**

1. To evaluate seismic response of a shallow tunnel under different ground conditions:

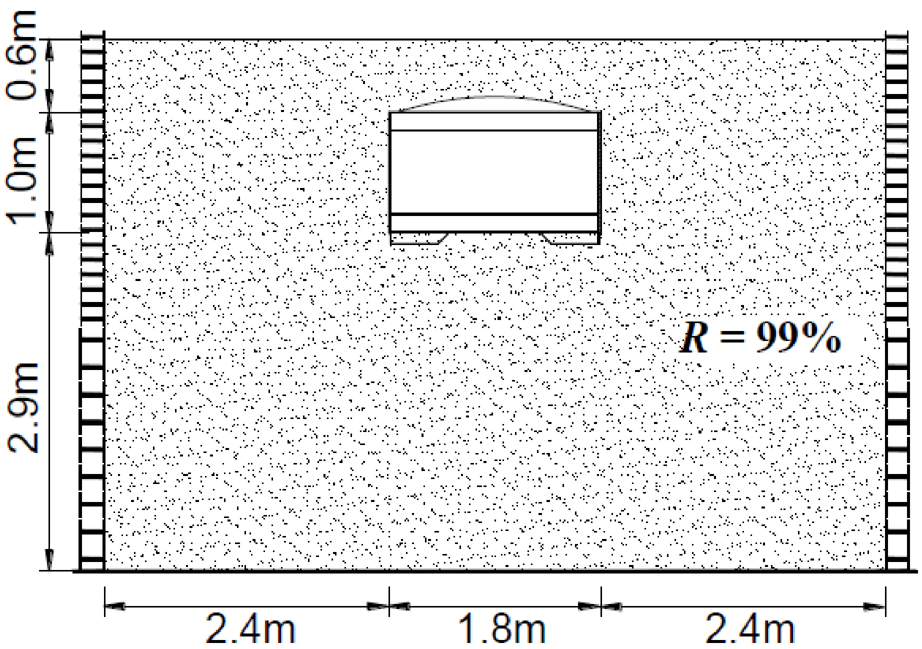
   1) Backfill soil material properties

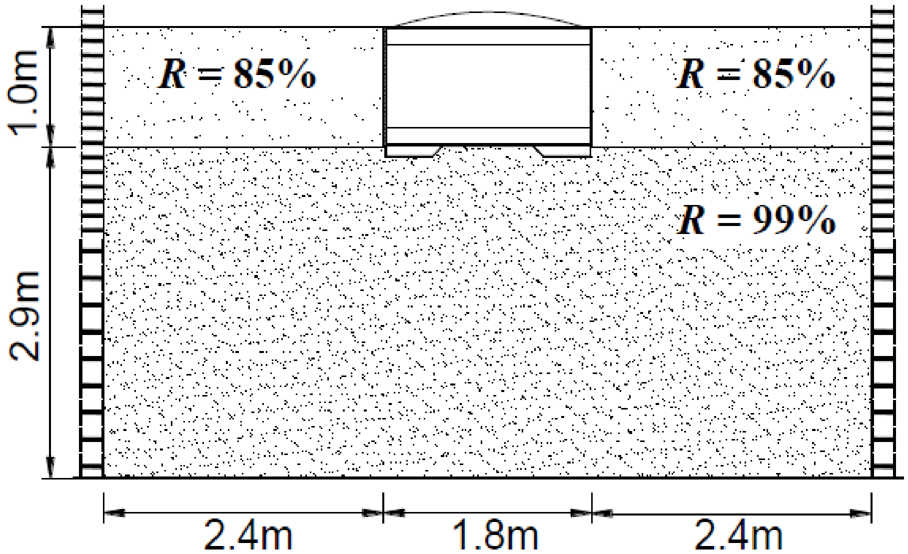
   2) Thickness of overburden soil (burial depth)

2. To provide recommendations for the current Caltrans seismic design criteria for shallow tunnels



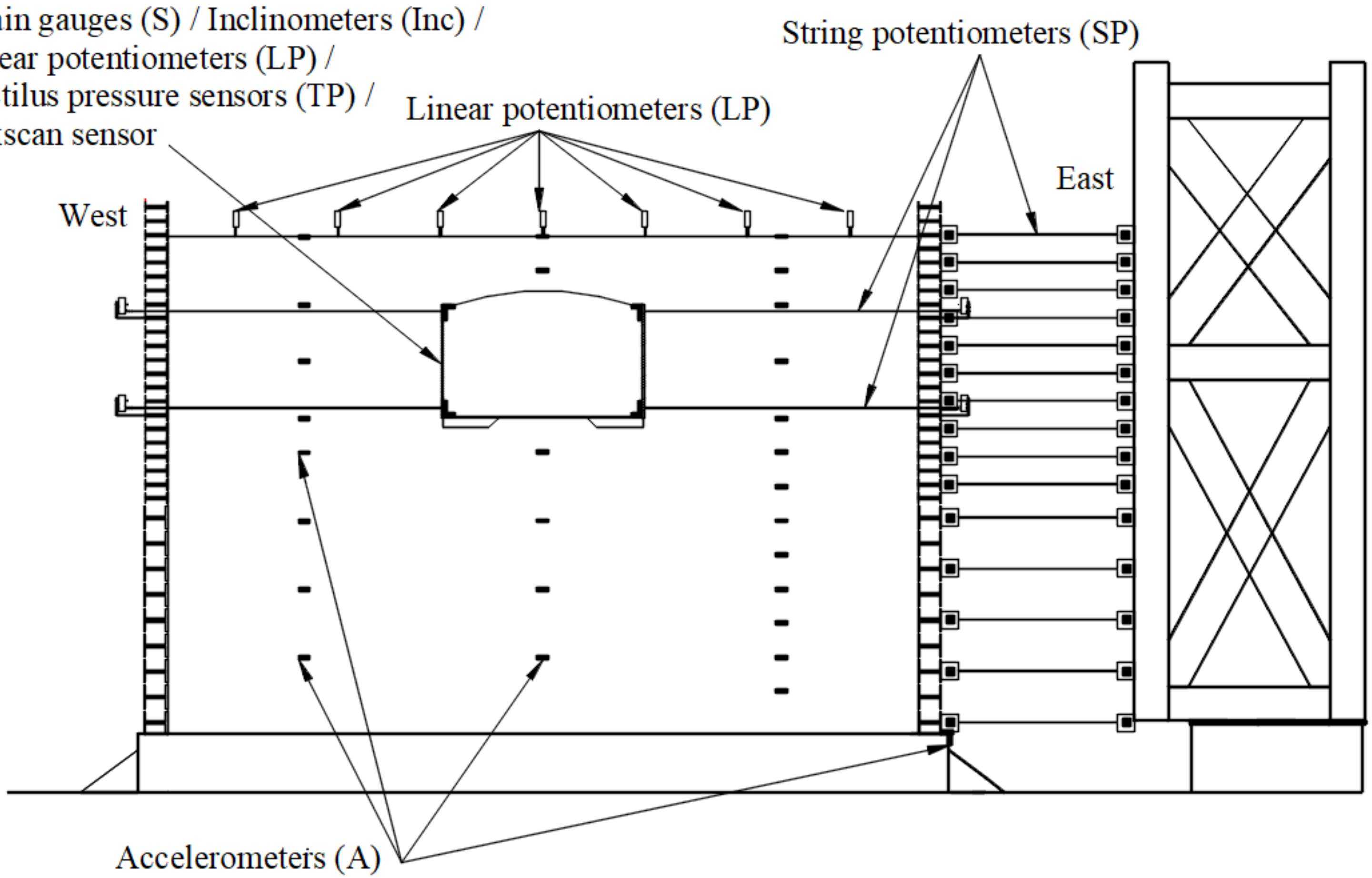
Test Model Configurations



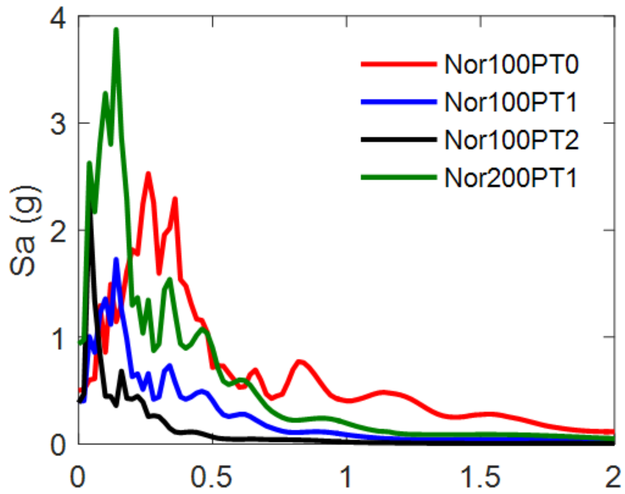


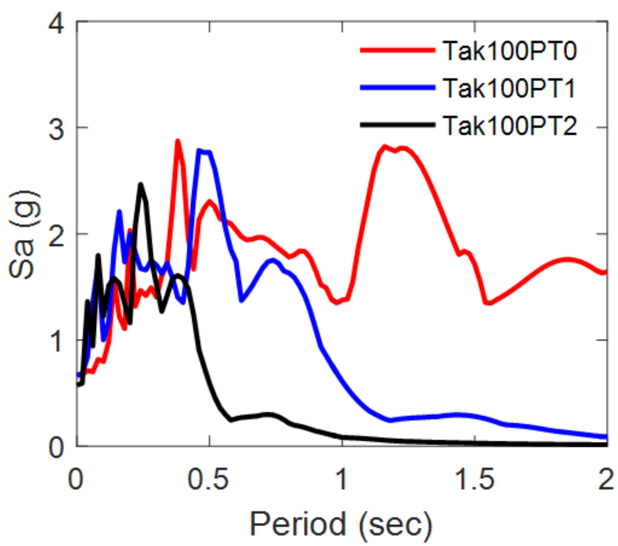
Instrumentation

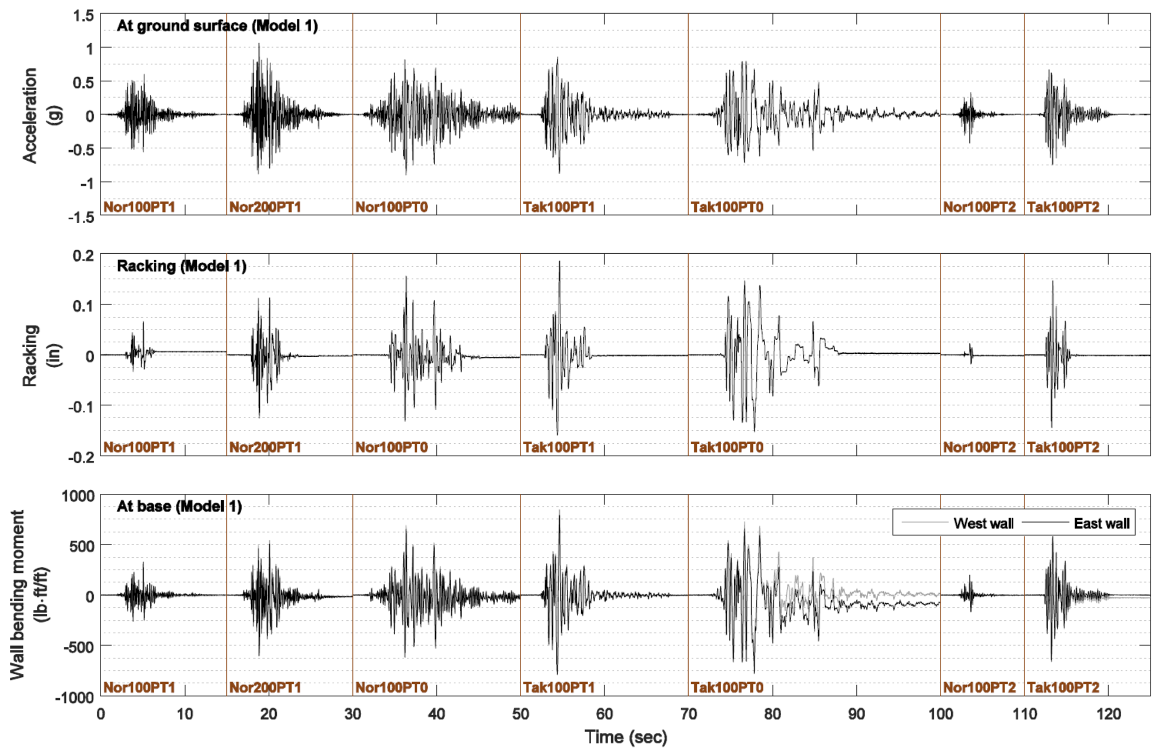
- **Over 200 Channels**



Dynamic Response of Tunnel



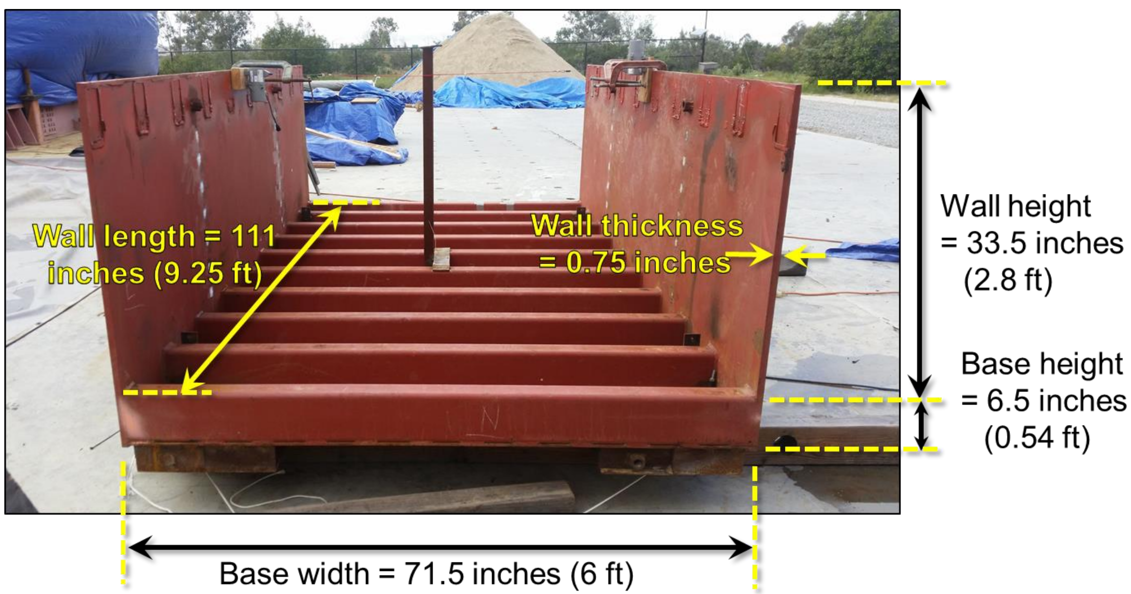


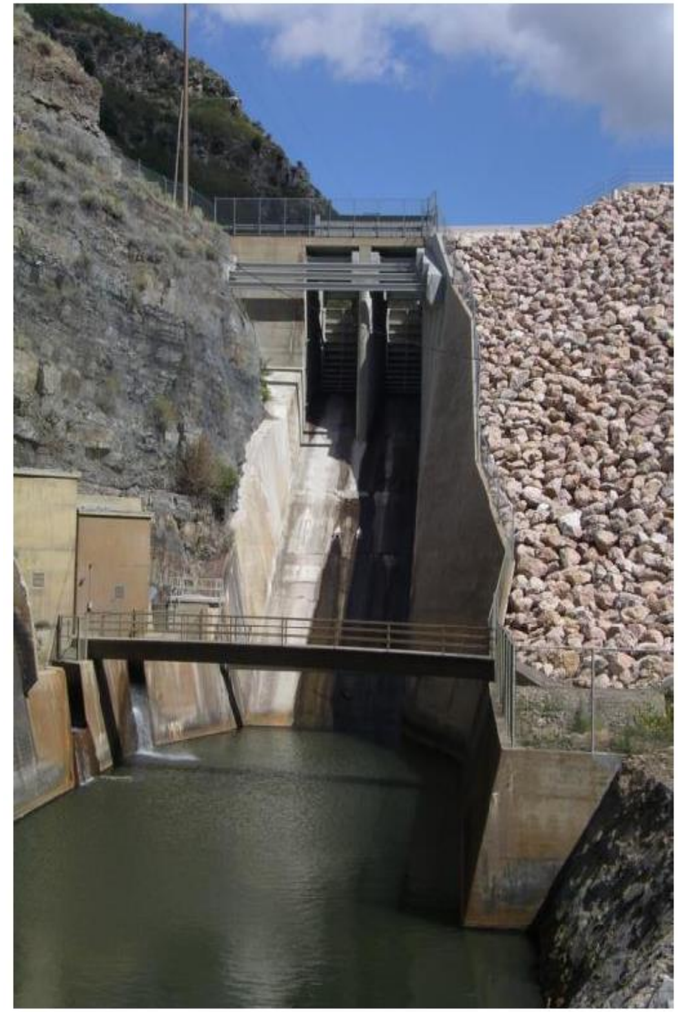


Case Study 2: U-Shaped Retaining Wall Testing

➢ Motivation:

- Spillway walls are abutted on highly compacted soil.
- Stiffness and strength of the retained backfill might be different on one side of the spillway versus the other
- This issue is conceptually addressed by employing soil compacted at different levels on either side of the spillway model in the tests.

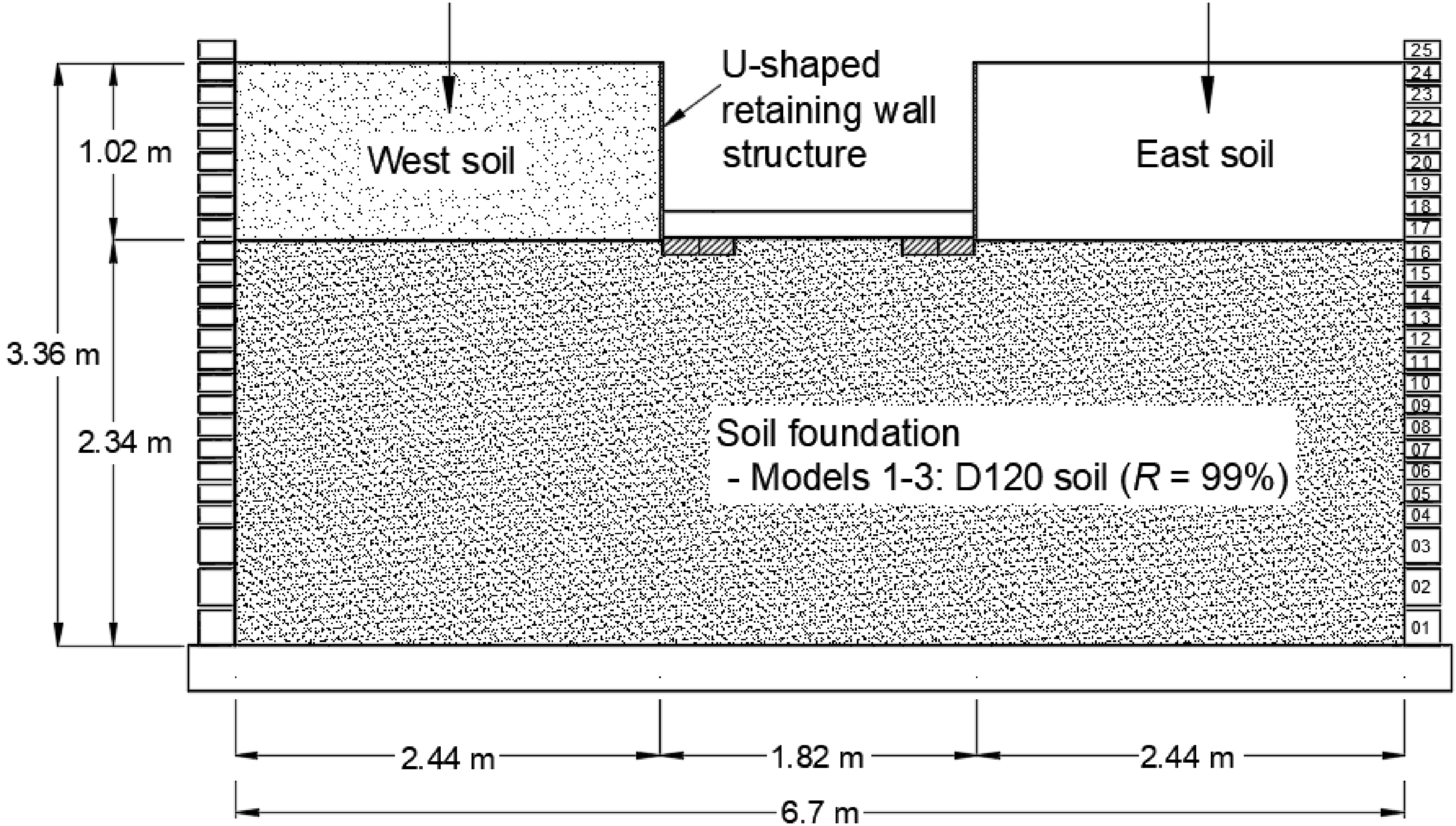




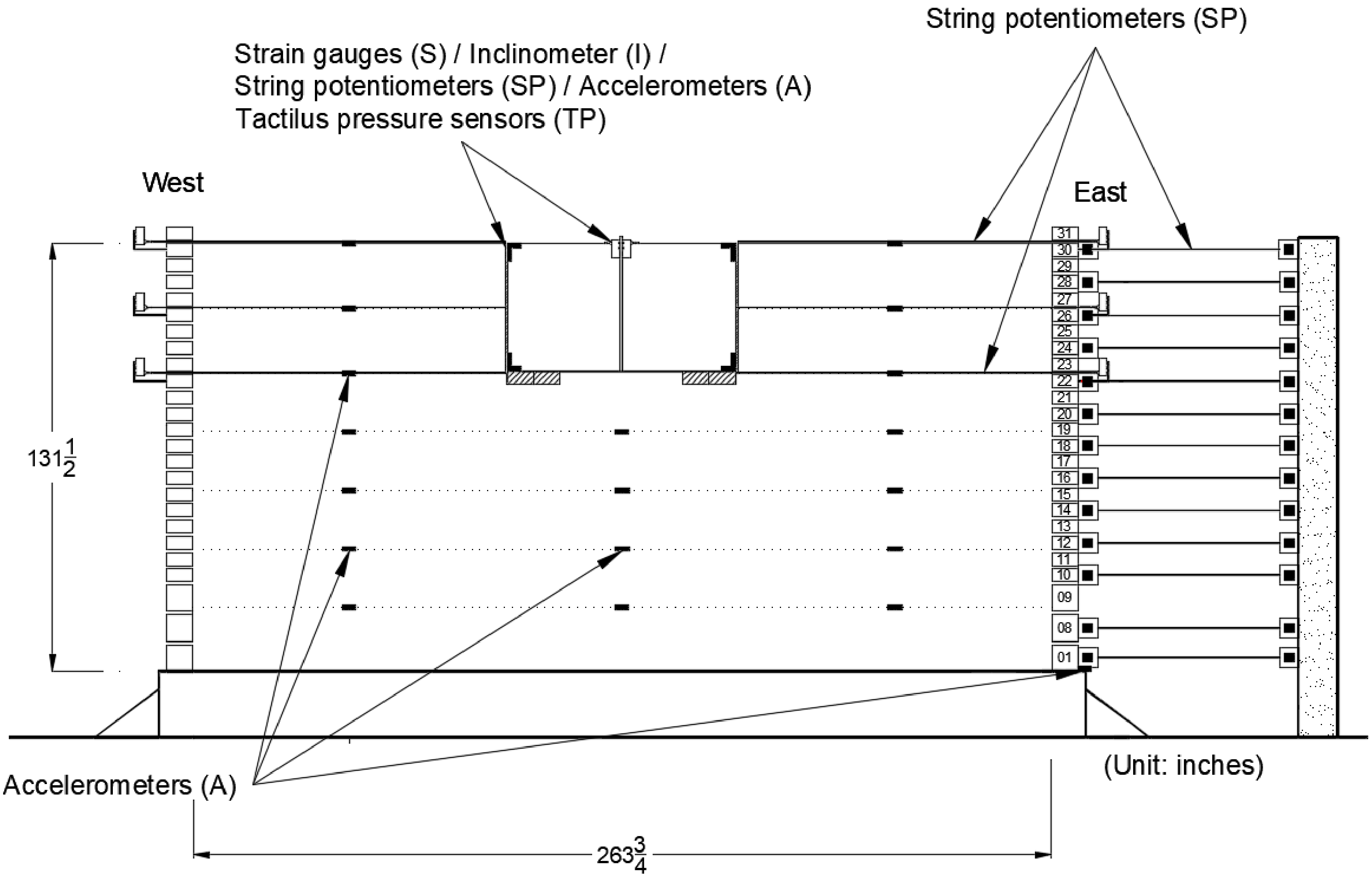
Test Model Configurations

Model 1: D120 soil (R = 99%, γ = 19 kN/m^3)
Model 2: D120 soil (R = 99%, γ = 19 kN/m^3)
Model 3: D104 soil (R = 85%, γ = 16.5 kN/m^3)

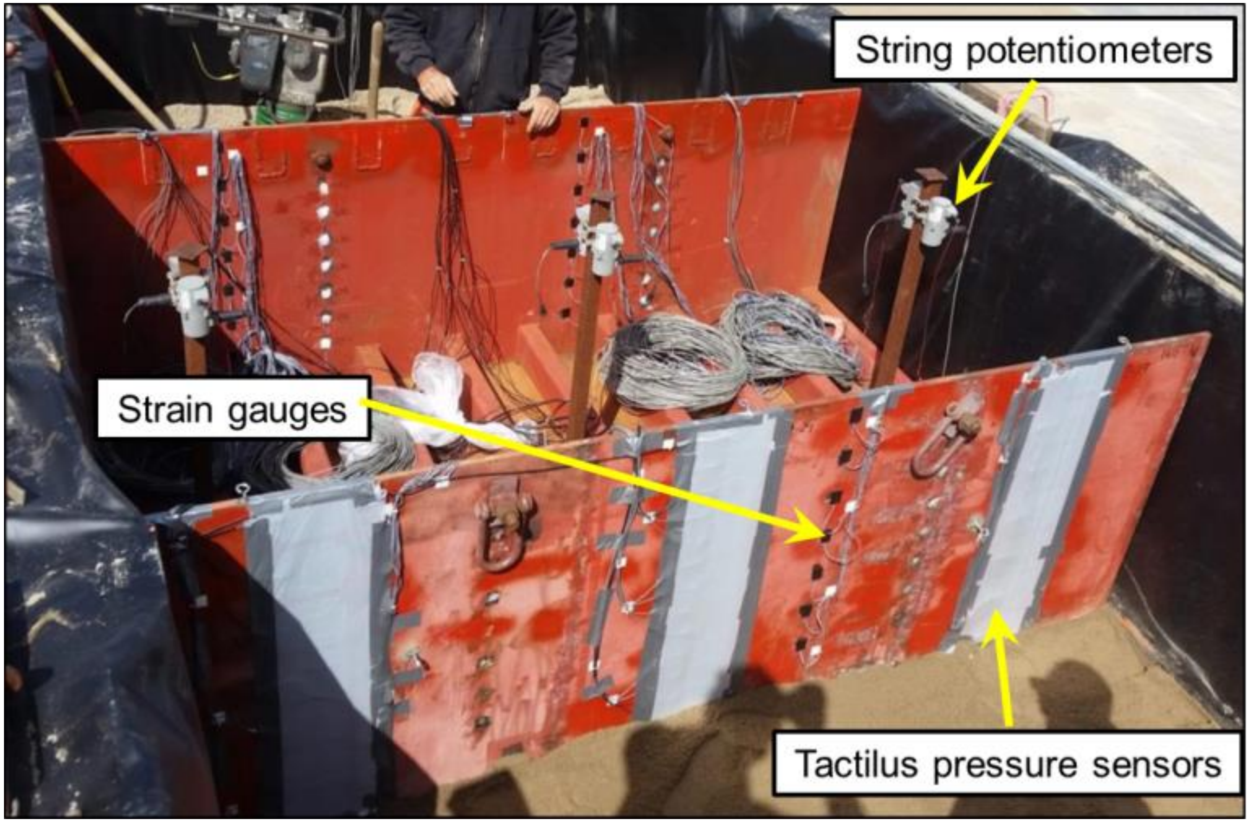
Model 1: D104 soil (R = 85%, γ = 16.5 kN/m^3)
Model 2: D94 soil (R = 85%, γ = 15 kN/m^3)
Model 3: D94 soil (R = 85%, γ = 15 kN/m^3)



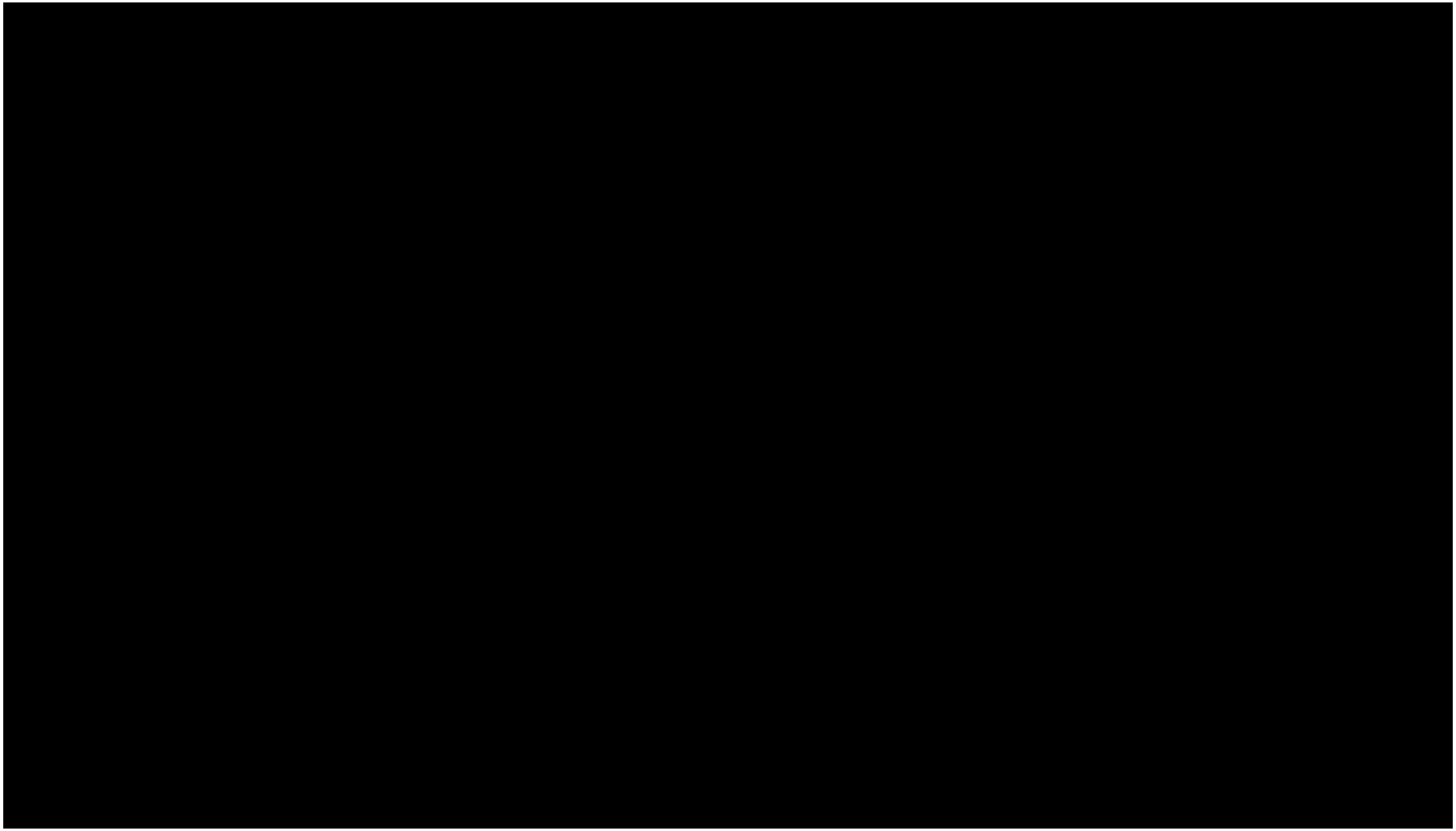
Instrumentation



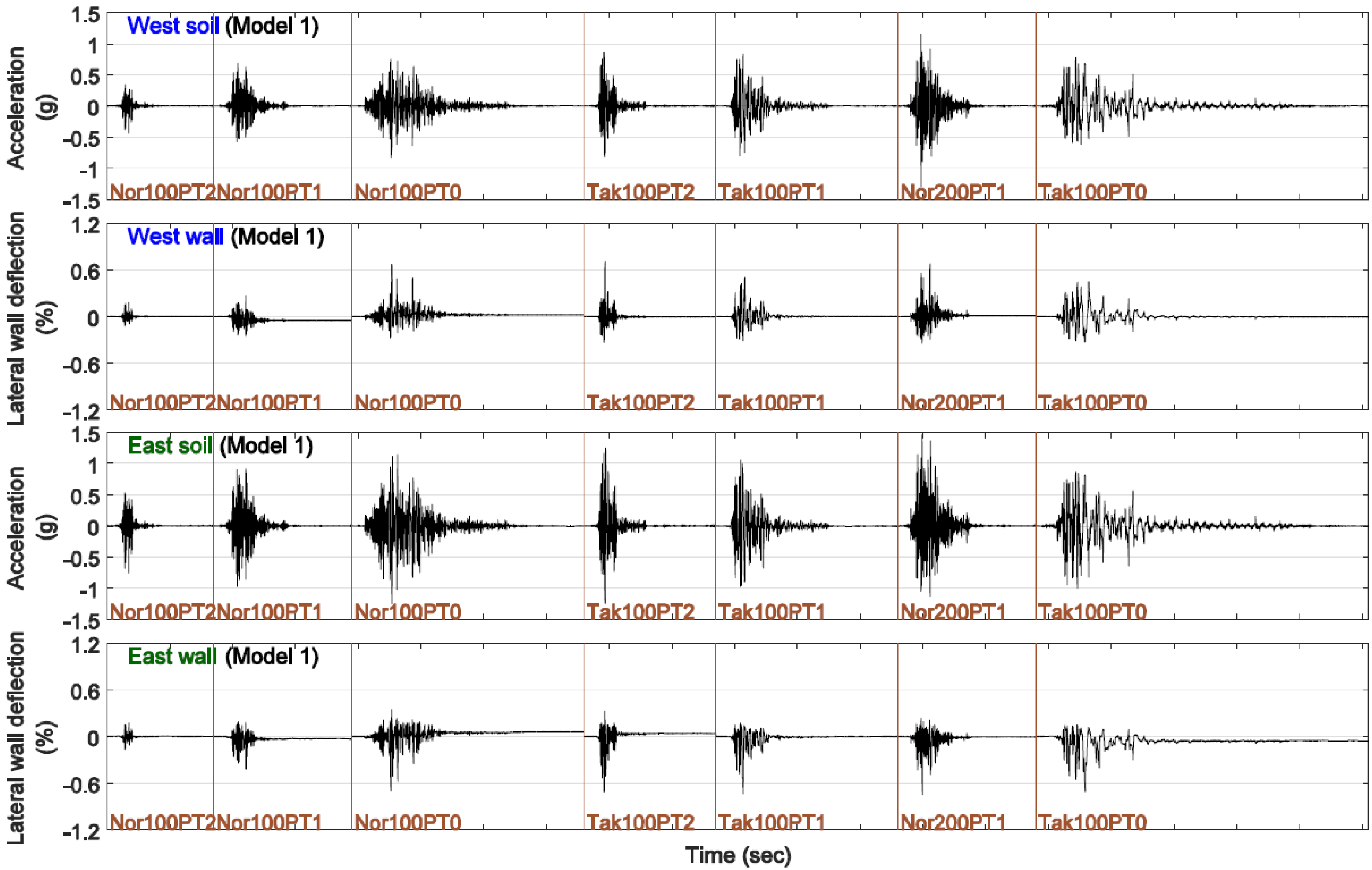
Instrumentation of Retaining Wall



Shake Table Test: Model 1 – Nor100PT0



Lateral Wall Deflection During Shakings



Case Study 3: Lateral Earth Pressure Testing

Wilson, P., and Elgamal, A. (2015). "Shake table lateral earth pressure testing with dense c-ϕ backfill." *Soil Dyn. Earthquake Eng.*, 71, 13–26.

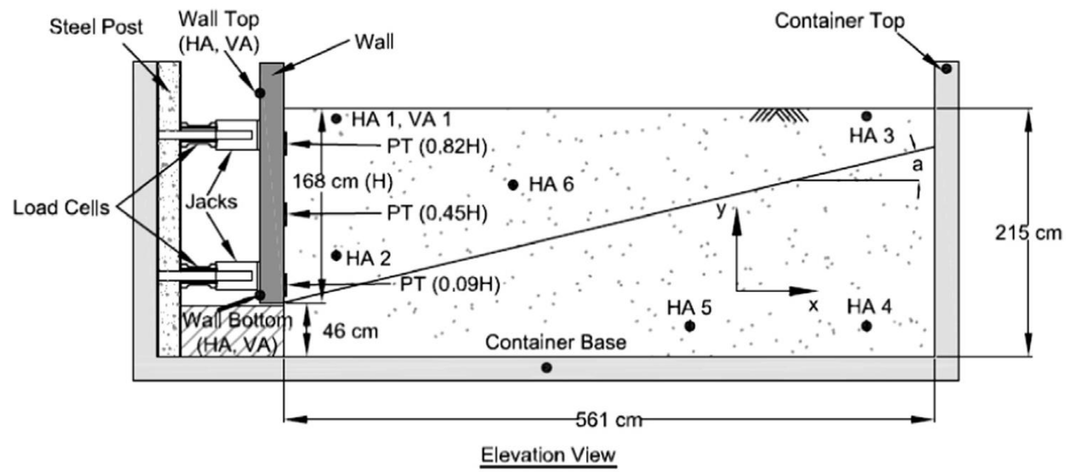
Test Model Configuration

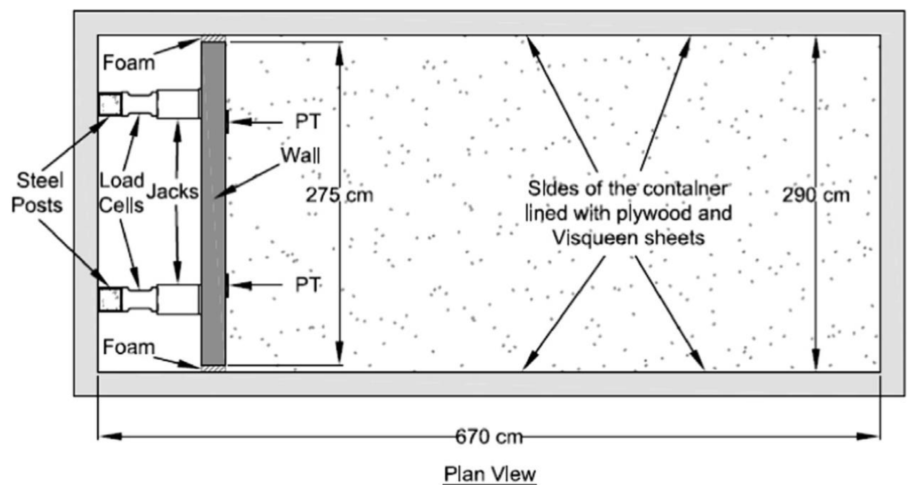
➢ Objectives:

To evaluate:

1) Influence of soil cohesion

2) Effect of small wall movements on the magnitude and distribution of earth pressure.





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Lessons Learned

- **Plan and Manufacture ahead before you arrive on site**
  - Instrumentation: sensor types, calibration,…
  - Plastic liner / plywood
  - Shake table input motions (OLI)
- **Think about staffing**
  - Construction: site staff, local engineering company
  - Backfill/Removal: different approaches depending on soil types and conditions (dry and saturated)
- **Achieve the target soil properties**
  - Plan for secondary tests for shear wave velocity, relative density, and water table
  - CPT / Water table measuring device / Sand cone / Nuclear gauge
- **System identification**
  - High-resolution acceleration (sampling rate at 25,000 Hz, compared to 240 Hz for the main DAQ system)
  - White noise / Hammer test

Thank You