Large Scale Geotechnical Shake Table Testing: Liquefaction induced Lateral Spreading

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UC San Diego

December 13-14, 2018

Large-scale testing facility

Length of 6.7 m (22 ft), width of 3 m (9.6 ft) and height of 4.9 m (16 ft)

Testing Stages

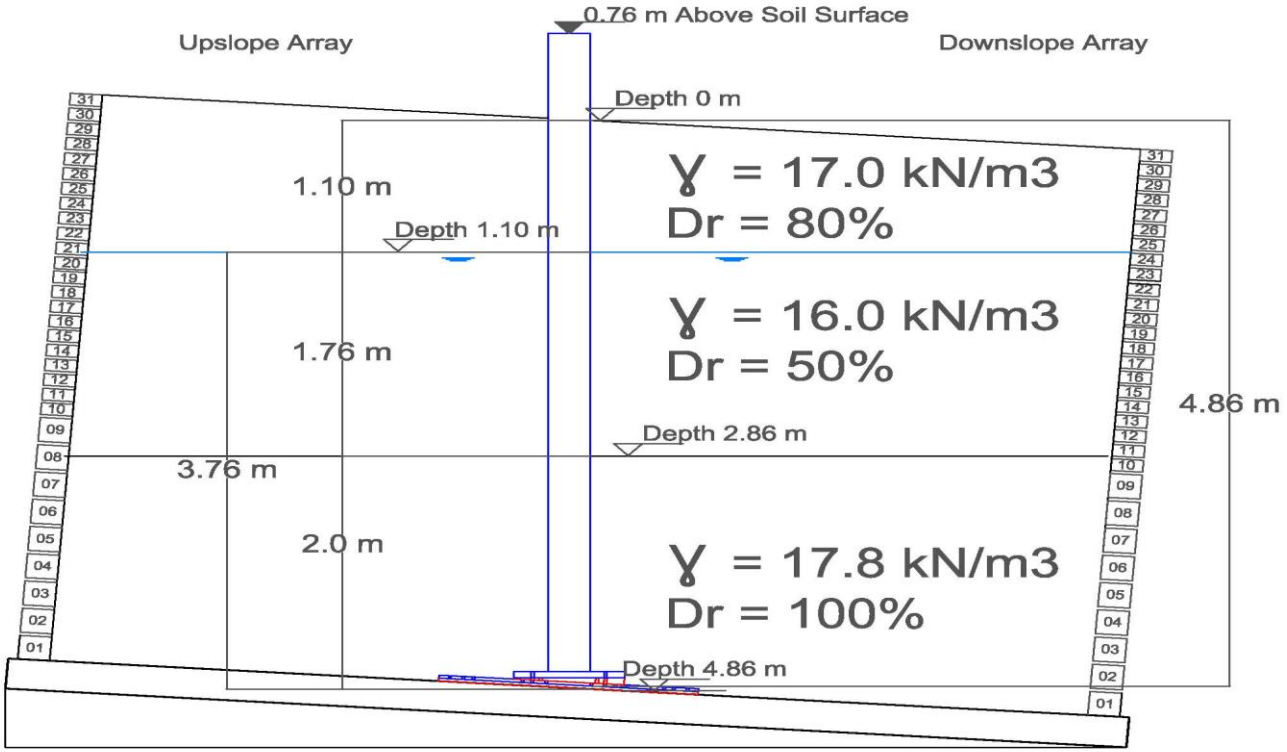
- **Design Stage**
  - What is your main goal? Additional goals?
  - Feasible construction/instrumentation drawings (talk to the staff)
  - Try input motions, table output not always as expected
  - Feasible schedule (talk to staff)
- **Construction Stage**
  - Box Assembly
  - External Parts/Towers/Columns, Needed Equipment: Bobcat,..
  - Target Soil density
  - Regularly check instrumentation, Very hard to troubleshoot buried sensors
  - Be prepared for unexpected problems!!
- **Testing Stage**
  - Make sure all instrumentation are working before hand
  - Camera locations

Design Stage

- **Main goal from Test**
  - Measure horizontal movement, need ramp
  - Strains
  - Pile Movement
- **Additional goals**
  - What else can we measure from the test
  - Settlement ?
  - Small sub-studies, Useful?
  - Recording during filling
  - Document all details, might be needed

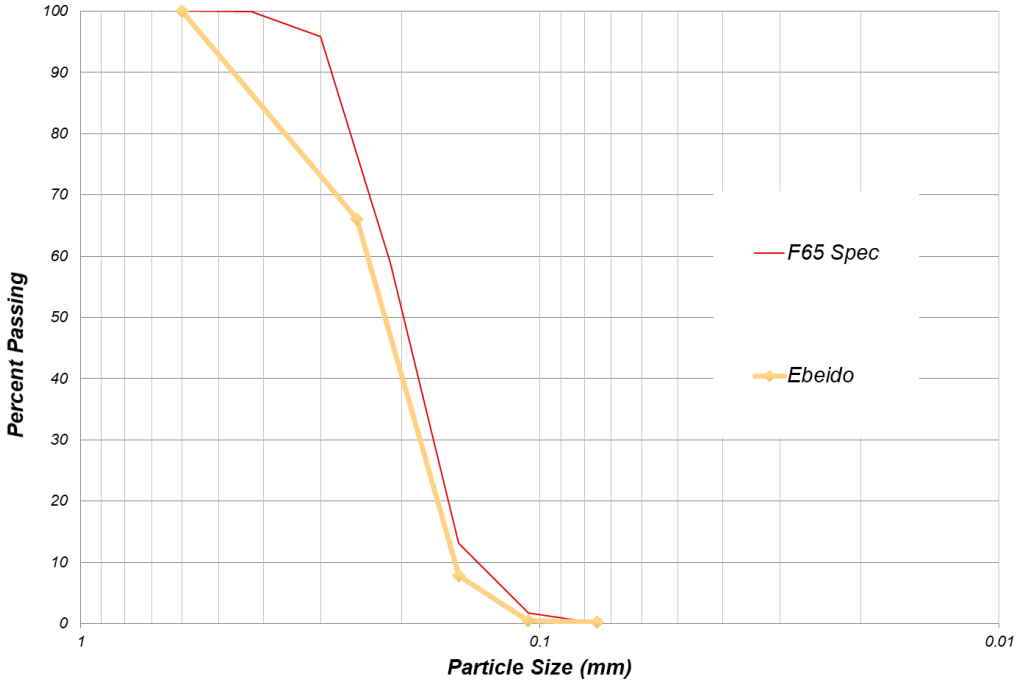
Design Stage

- **Prepare construction drawing early**
  - Will they meet test goal? Pile cross-section, Strength
  - Pile took 2 months to be prepared
  - Desired soil stratification



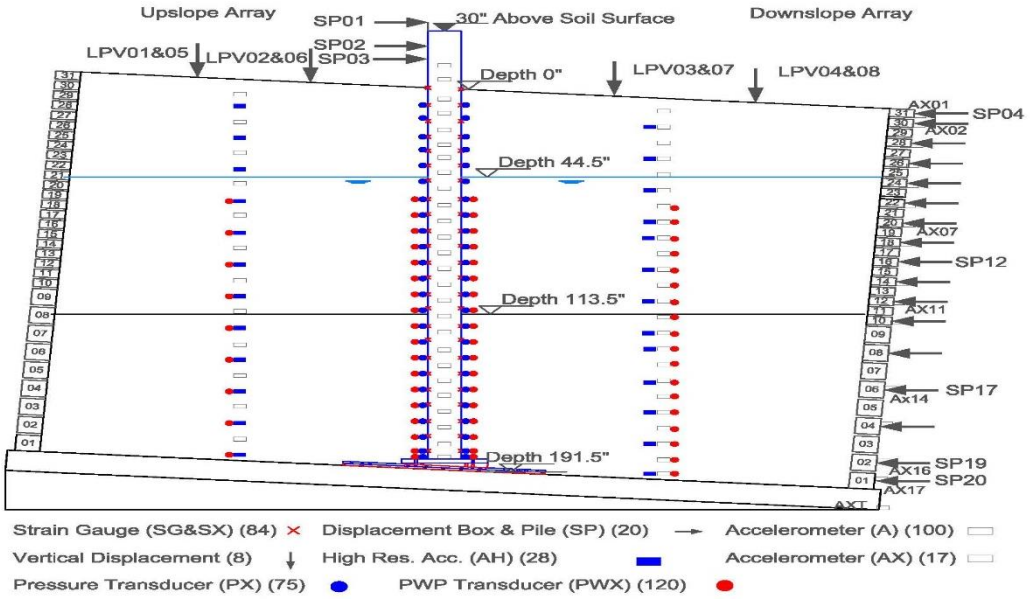
Design Stage

- **Type of Sand Needed ?**
- **Available Soil**
  - Coarse Dense Sand
  - Ottawa F65 Sand
  - San Diego local Sand (San Ysidro)
  - Other arrangements?



Design Stage

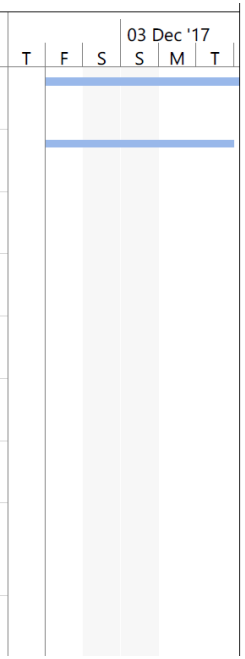
- **Instrumentation plan**
  - Required number of sensors
  - Available sensors on-site (Additional sensors require 2++ months to arrive)
  - Available data acquisition channels and compatibility with additional sensors
  - Special sensors may require special DAQs



Design Stage

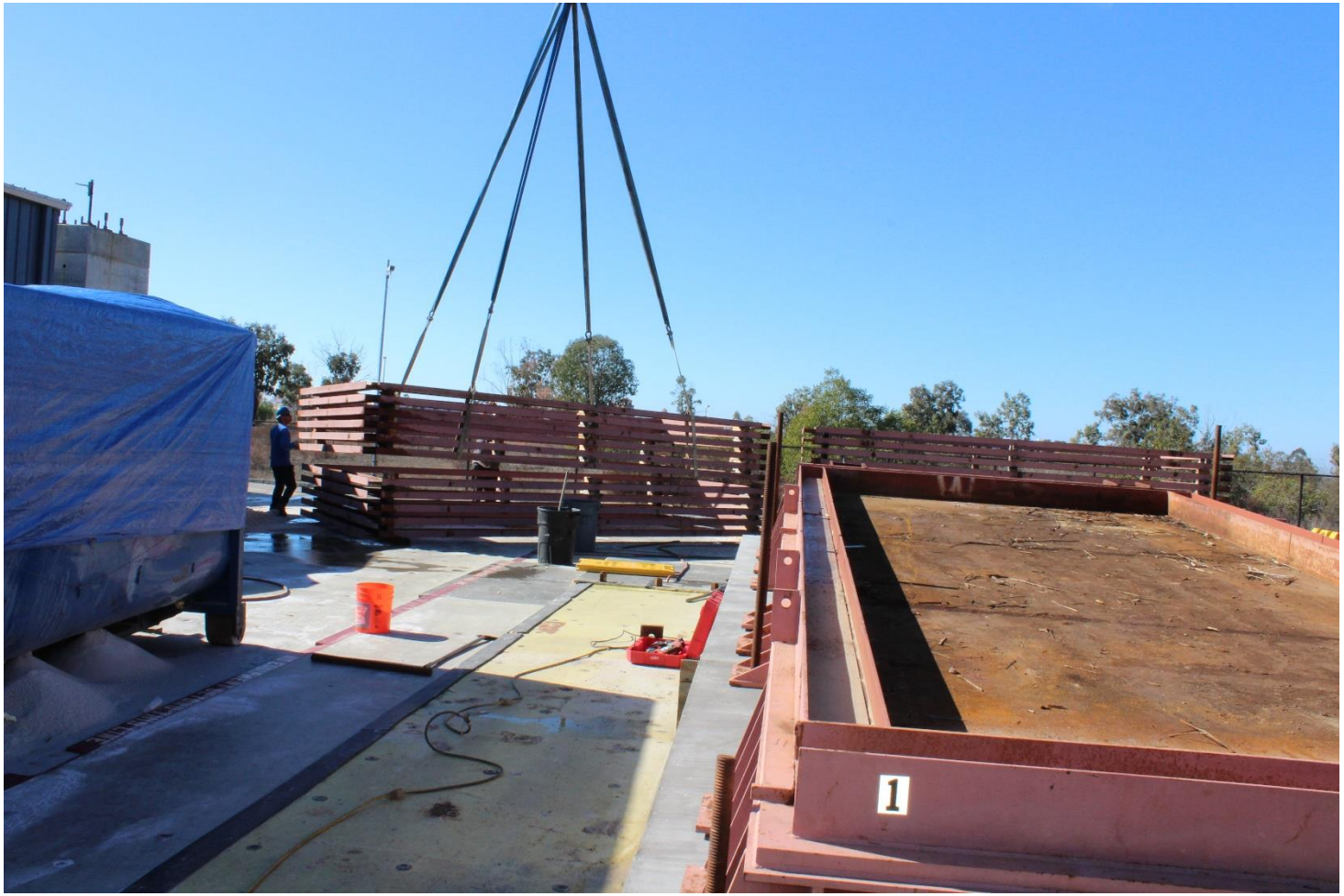
- **Prepare schedule early**
  - Communicate with Staff
  - Be realistic
  - Geotechnical large scale projects require a lot of manpower
  - Any changes to planned work will require much more time than needed if planned early

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		Cast Ramp	5 days	Fri 01 Dec '17	Thu 07 Dec '1	
2		Build Tent	3 days	Fri 01 Dec '17	Tue 05 Dec '1	
3		place box on table	5 days	Fri 08 Dec '17	Thu 14 Dec '1	1
4		Weld box Base plate	1 day	Fri 15 Dec '17	Fri 15 Dec '17	3
5		Sand Unloading	3 days	Thu 07 Dec '1	Mon 11 Dec '	
6		Place plastic sheets & liner	1 day	Mon 18 Dec '17	Mon 18 Dec '17	4
7		Prepare instrumentation	5 days	Wed 20 Dec '17	Tue 09 Jan '18	
8		Place instrumentation & pile in box	1 day	Wed 10 Jan '18	Wed 10 Jan '18	7
9		Fill box	4 days	Thu 11 Jan '1	Tue 16 Jan '1	8



Construction Stage

- **Heavy box base tensioned to the shake table**



Construction Stage

- **Box Assembly**
  - Takes time specially if inclined
- **Outside tower/column locations planned early**

Construction Stage

- **Base plate needed for pile anchoring**

Thick plate for pile fixity, designed hole pattern to fit test needs

Construction Stage

Sand Storage Bins

Construction Stage

Construction Stage

- **Getting the required soil relative density**

Control density through meshes

Soil compaction

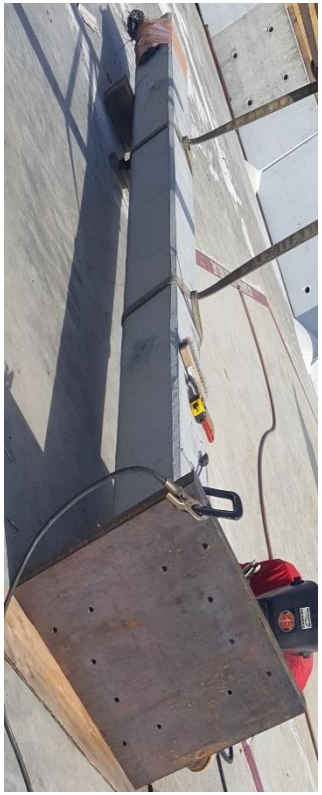
Quality Control (Sand Cone)

Construction Stage

- **Quality control for Sand Strata**
  - Weigh all soil that goes in the box
  - Sand Cone tests
  - Shear wave velocity measurements
  - CPT

Construction Stage

- **Monitor instrumentation carefully during filling**
  - Install sensors carefully
  - Take note of orientation and/or any irregularities
  - Take your time (Test costs a lot of money)

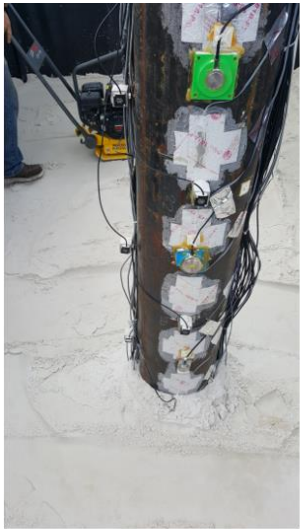


Construction Stage

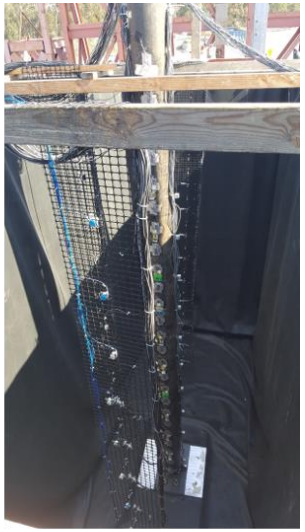
a). Inclined Model before shaking

b). Soil surface before shaking

c). Drone Picture from above the box



d). Compaction of dense layer



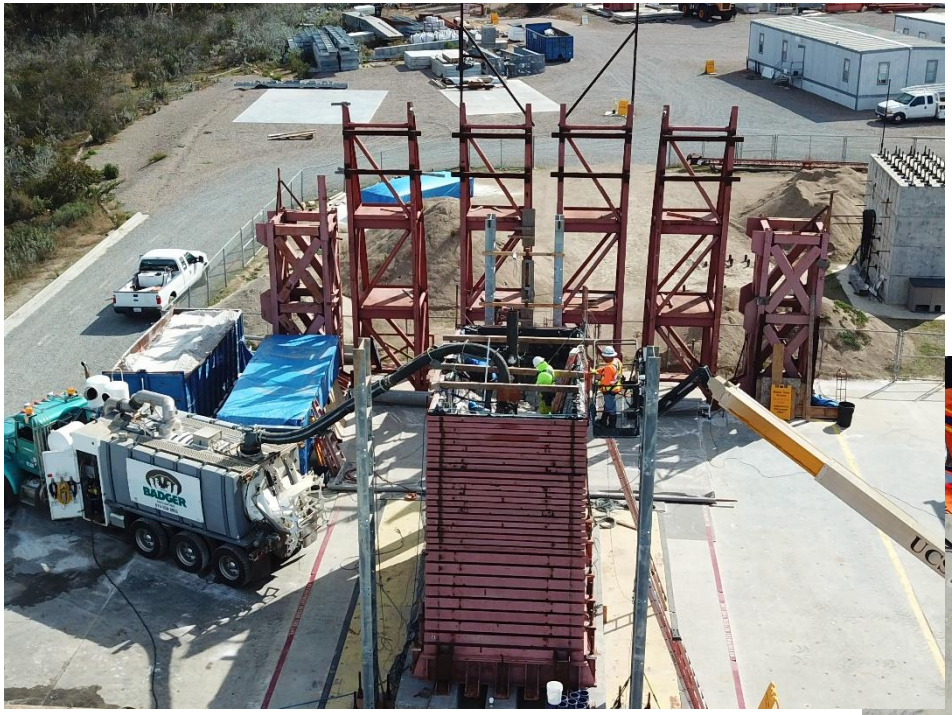
e). Soil and Pile Instrumentation

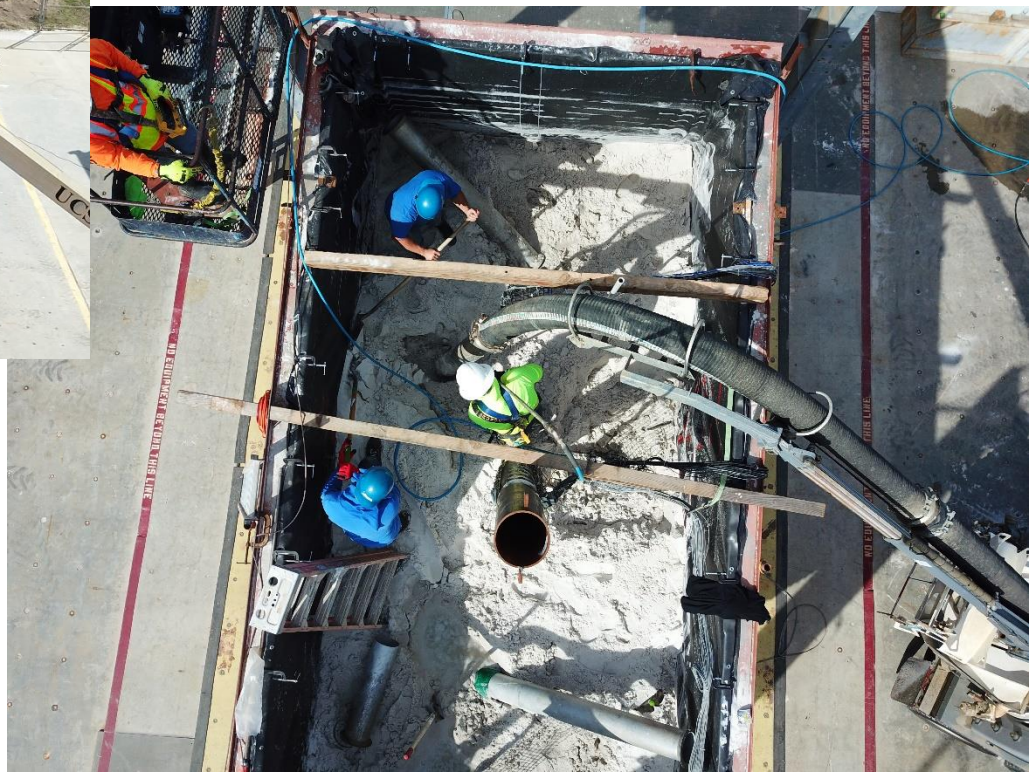
f). Displaced Model after shaking

g). Soil caving around the pile after shaking

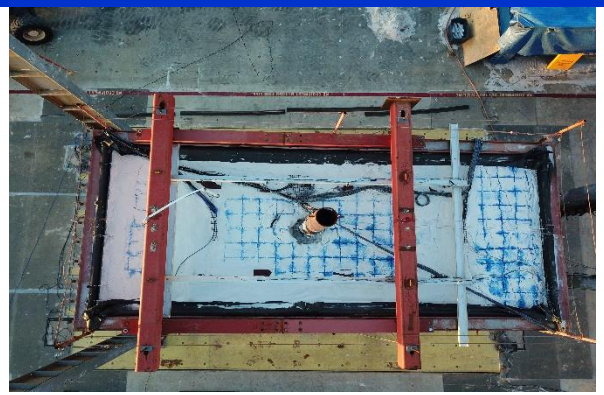
h). Sand placement in the box

Excavation Stage





Cameras



Shaking Day Checks

- **Re-check Instrumentation**
  - Make sure all sensors are working
  - **Check Calibration factors carefully (Mistakes are easily made)**
  - Its worth waiting if something is not functioning properly
- **Check Cameras are recording what is needed**
- **Prepare a testing sheet with testing motions to avoid test day confusion**
- **Motions tested beforehand on the empty table**

Thank you