



# Large Scale Geotechnical Shake Table Testing: Liquefaction induced Lateral Spreading

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# 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

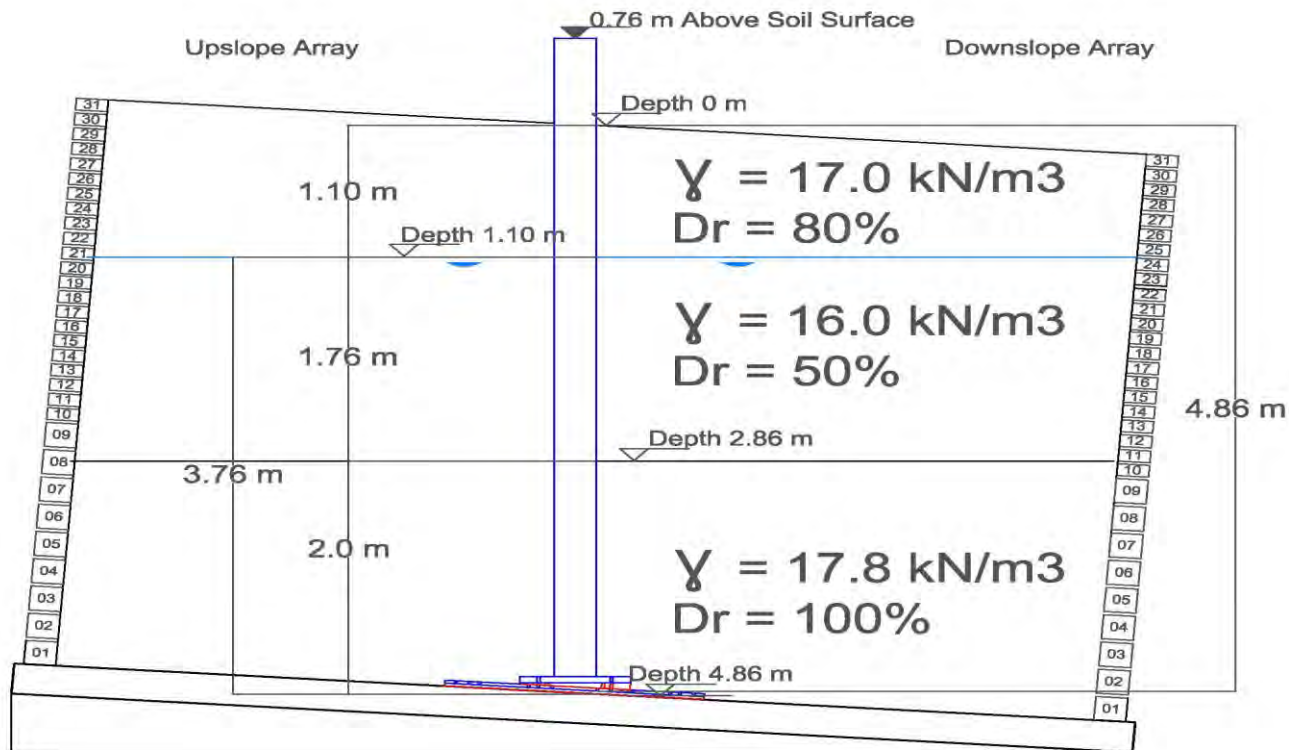
- What else can we measure from the test
- Settlement ?
- Small sub-studies, Useful?
- Recording during filling
- Document all details, might be needed



# 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

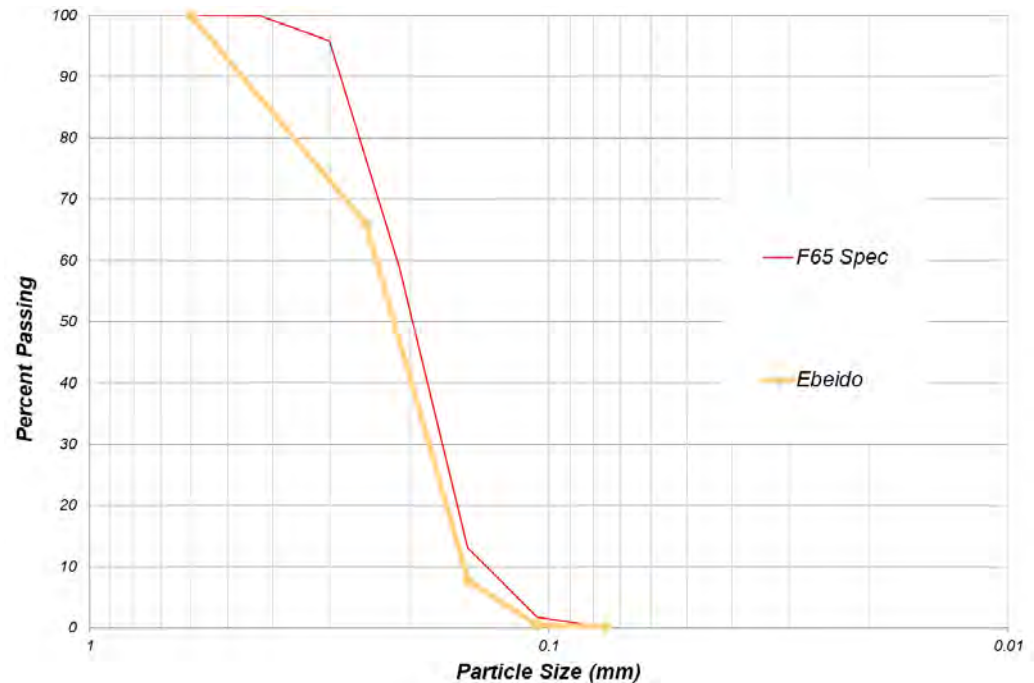


# Design Stage

## ➤ Type of Sand Needed ?

## ➤ Available Soil

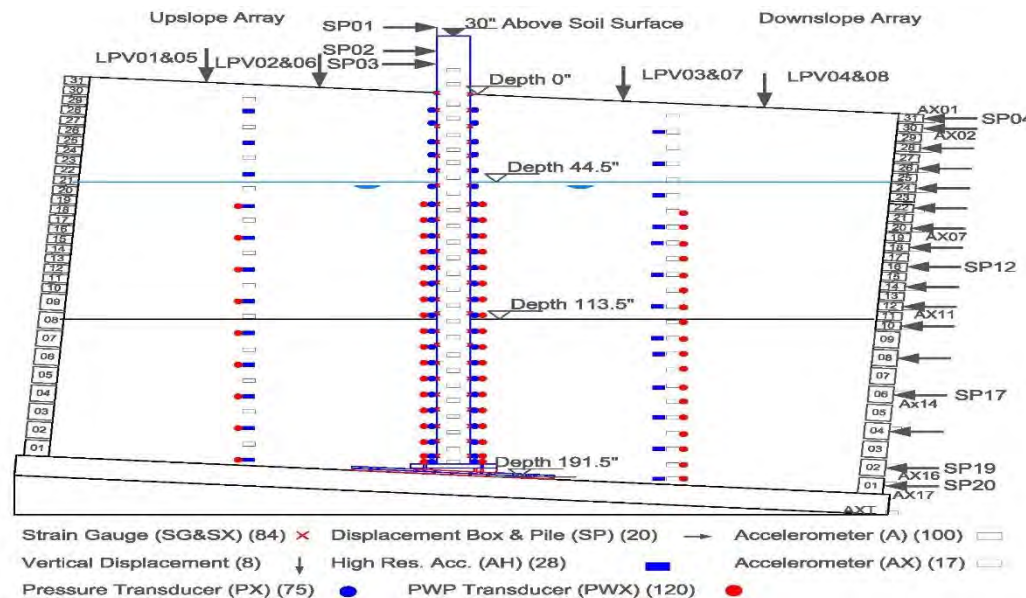
- Coarse Dense Sand
- Ottawa F65 Sand
- San Diego local Sand (San Ysidro)
- Other arrangements?



# 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

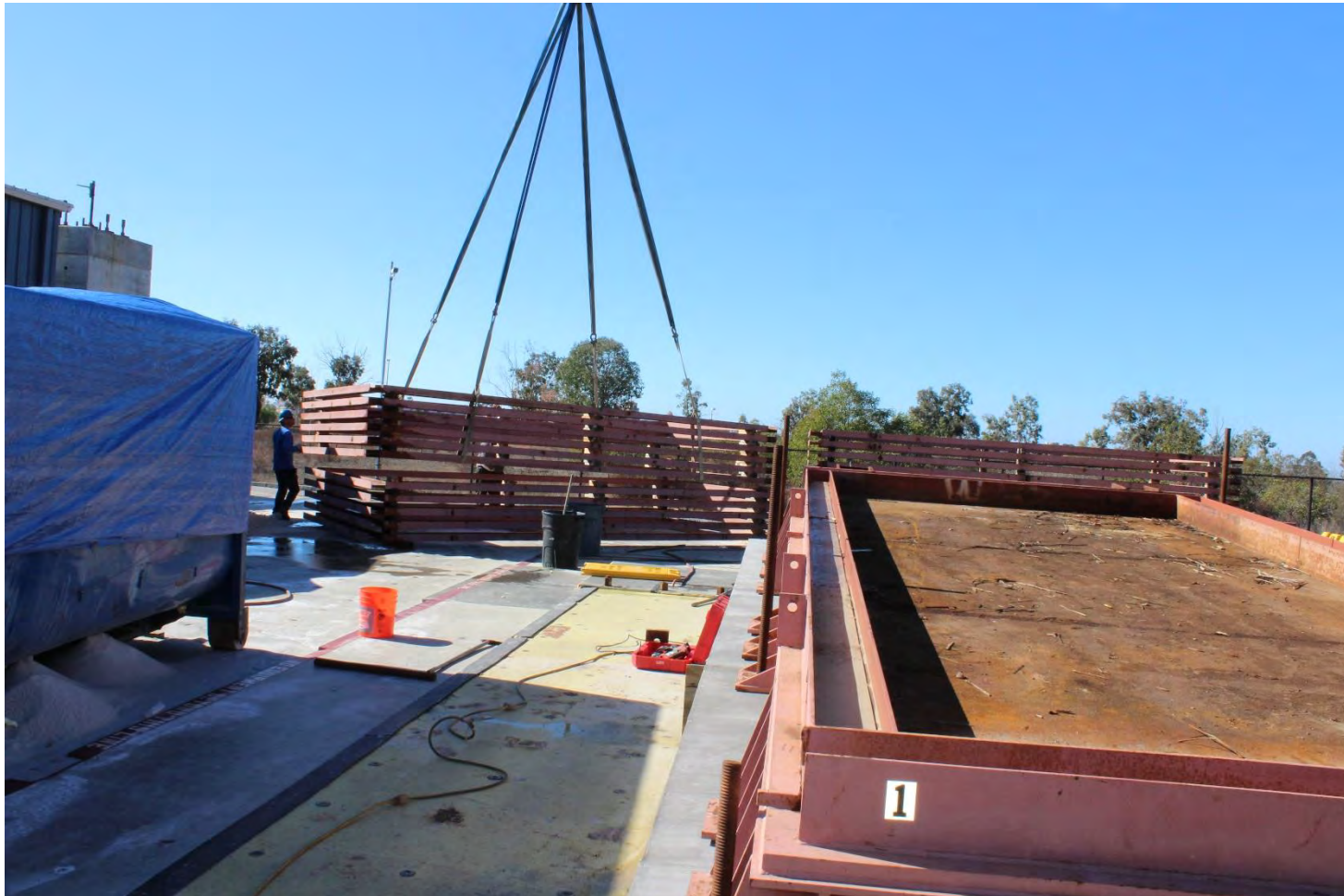
- Communicate with Staff
- Be realistic
- Geotechnical large scale projects require a lot of manpower
- Any changes to planned work will require much more time than needed if planned early

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	03 Dec '17						
							T	F	S	S	M	T	
1		Cast Ramp	5 days	Fri 01 Dec '17	Thu 07 Dec '17								
2		Build Tent	3 days	Fri 01 Dec '17	Tue 05 Dec '17								
3		place box on table	5 days	Fri 08 Dec '17	Thu 14 Dec '17								
4		Weld box Base plate	1 day	Fri 15 Dec '17	Fri 15 Dec '17	3							
5		Sand Unloading	3 days	Thu 07 Dec '17	Mon 11 Dec '17								
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 '18	Tue 16 Jan '18								



# 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

Column required



# Construction Stage

- **Base plate needed for pile anchoring**



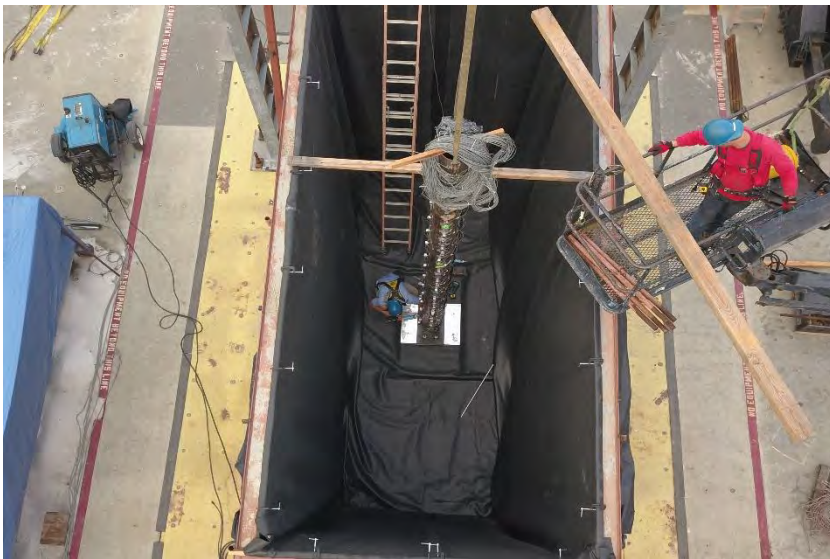
Thick plate for pile fixity, designed hole pattern to fit test needs

# 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

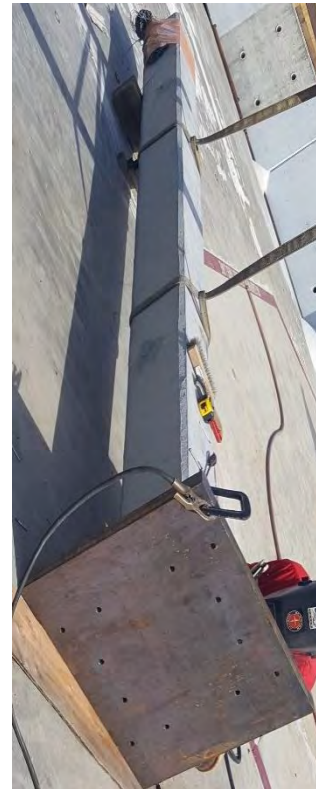
- Weigh all soil that goes in the box
- Sand Cone tests
- Shear wave velocity measurements
- CPT



# 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**



**f). Displaced Model after  
shaking**



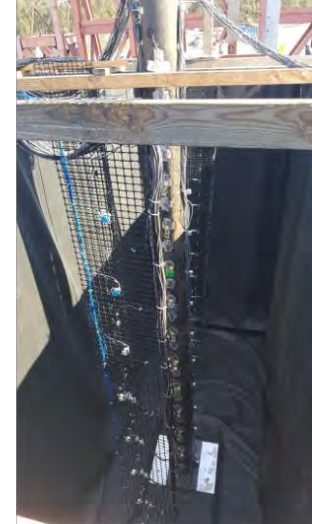
**g). Soil caving around the  
pile after shaking**



**h). Sand placement in the  
box**

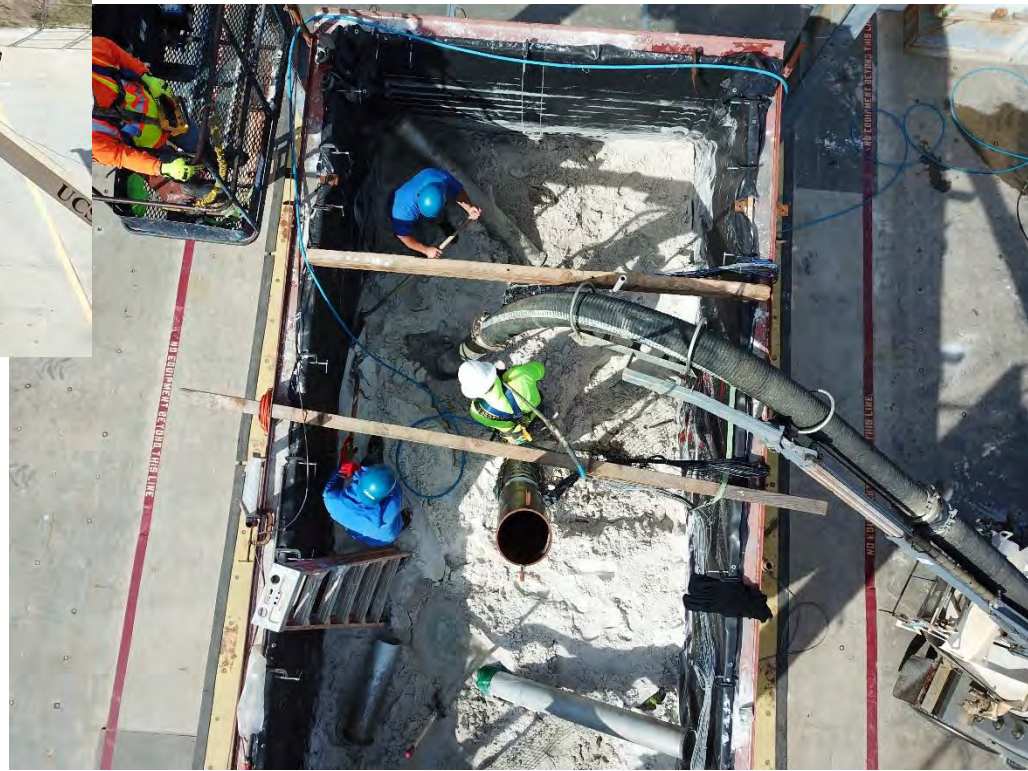


**d). Compaction of  
dense layer**

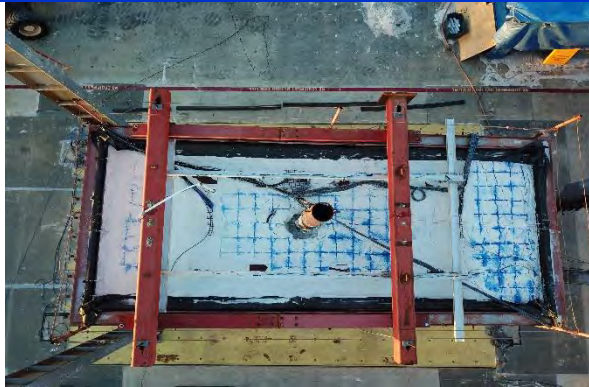


**e). Soil and Pile  
Instrumentation**

# 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**