Florida Institute of Technology

Improving Design Phase Evaluations for High Pile Rebound Sites

The Mysterious Case of the Bouncing Piles

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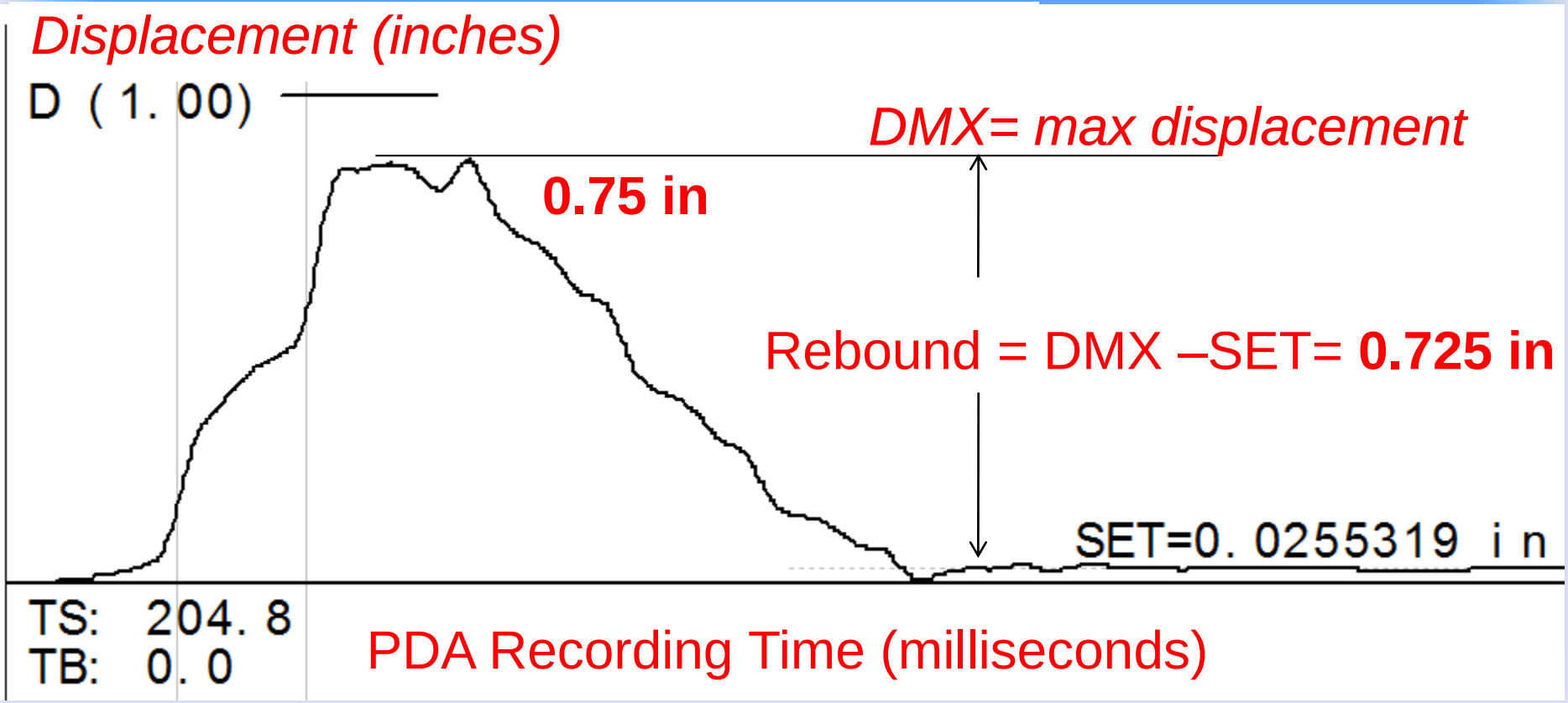
Defining the Problem

- **Excessive Pile Rebound and/or Bouncing**
  - High Displacement Piles
  - Typically driven by Diesel Hammers
  - Cause Dilation of Very Dense Saturated Silty Sands to Sandy Silts
- **Capacities & Depths not achieved**

Pile Rebound *Old School Recording*

Courtesy of GRL Library

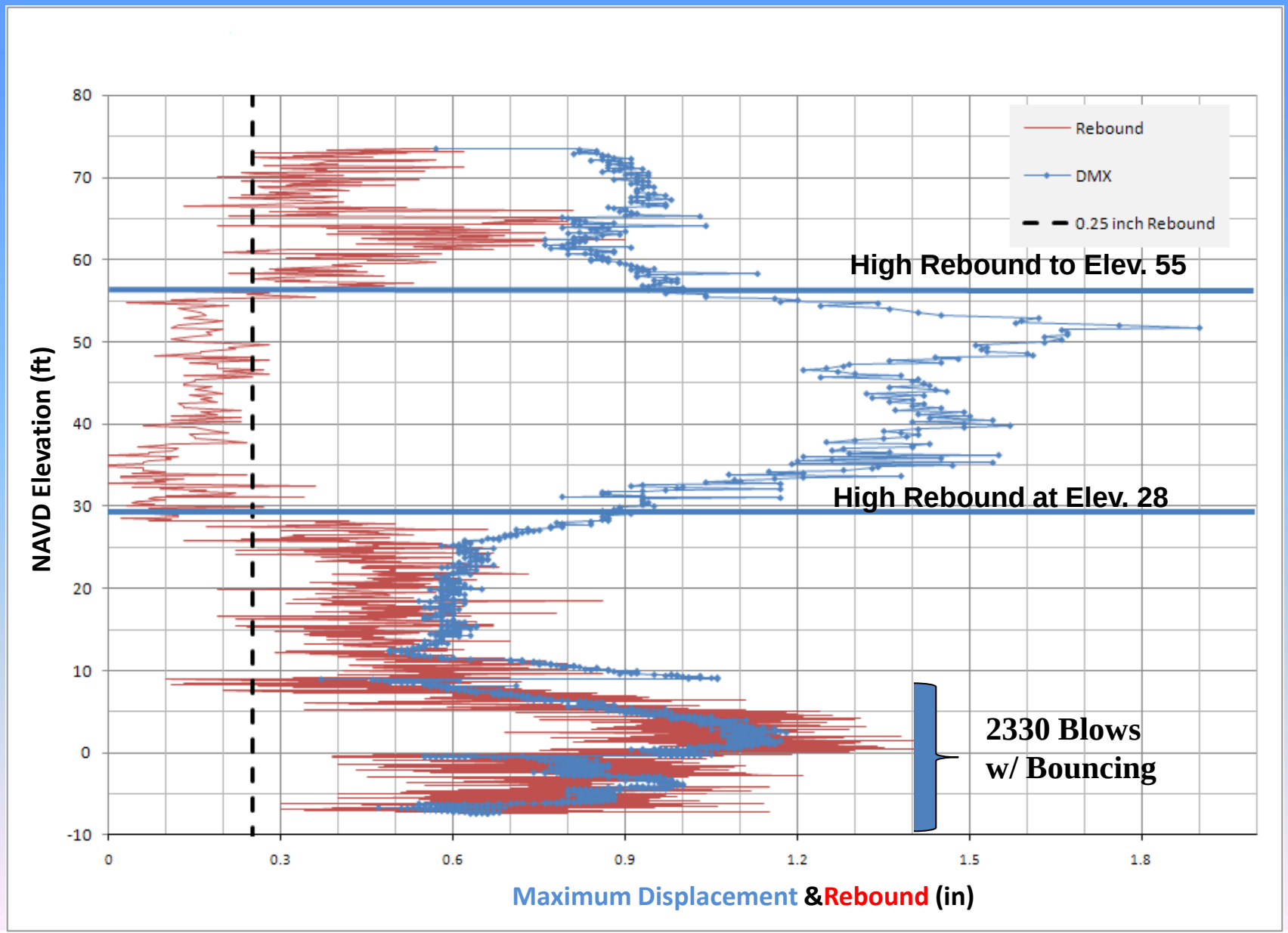
Digital Record of Rebound from PDA sensors



Phase I

- Retested Soils at 3 sites with PDA data
  - I-4/SR 408 Anderson Street Overpass
  - I-4/John Young Parkway
  - Ramsey Branch Bridge SR 83 US 331 over Choctawhatchee Bay: District 3
- SPT, CPT, PMT, DMT, PocketPen
- Shelby Tubes
  - CU Triaxial, Permeability etc.

Anderson Street PDA vs. Elevation



Silt Content Summary

Site Name	Rebound Soil Silt Content (%)	Increase in Silt Content (%)
Anderson Street	19	40
John Young	17	20
Ramsey Branch	20	100

N Values Summary

Site Name	N In Rebound Soil (blows/ft)	Increase in N In Rebound Soil (%)
Anderson St	27	290
John Young	16	220
Ramsey Branch	7	600

Pocket Penetrometer q_u, & CPT q_c, f_s Summary

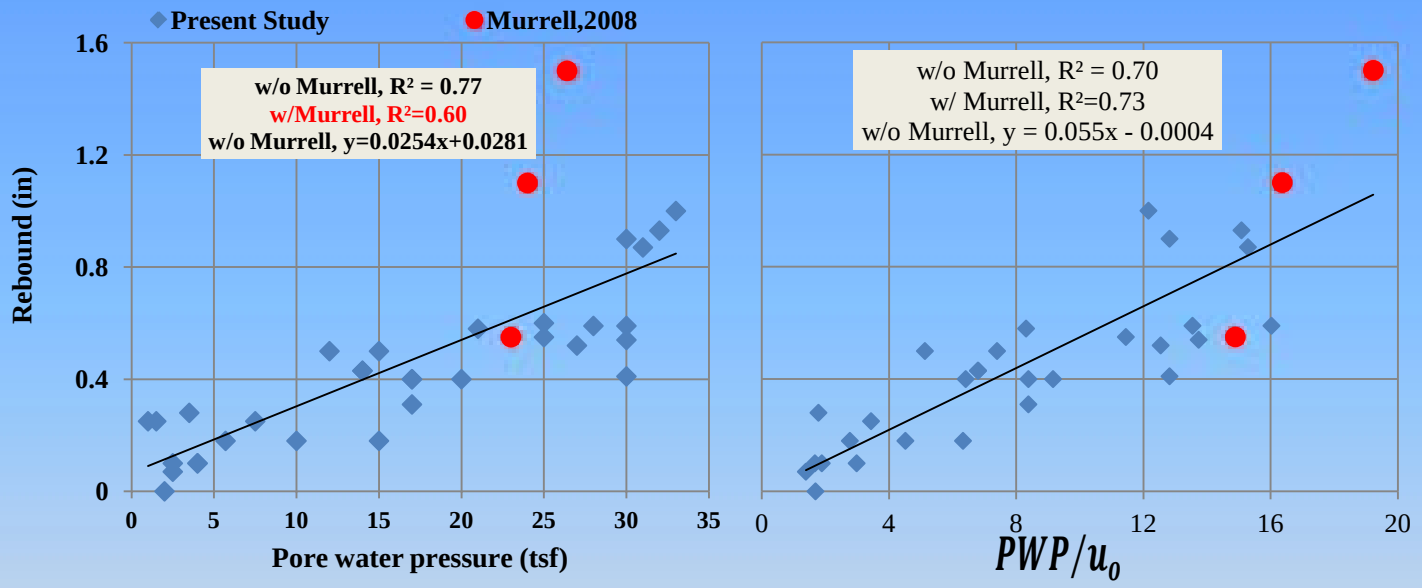
Site Name	Pocket Penetrometer Increase in q_u In Rebound Soil (%)	CPT Increase in q_c In Rebound Soil (%)	CPT Increase in f_s In Rebound Soil (%)
Anderson St	260	100	250
John Young	200	0*	-10*
Ramsey Branch	40	750	780

* John Young Site more layered

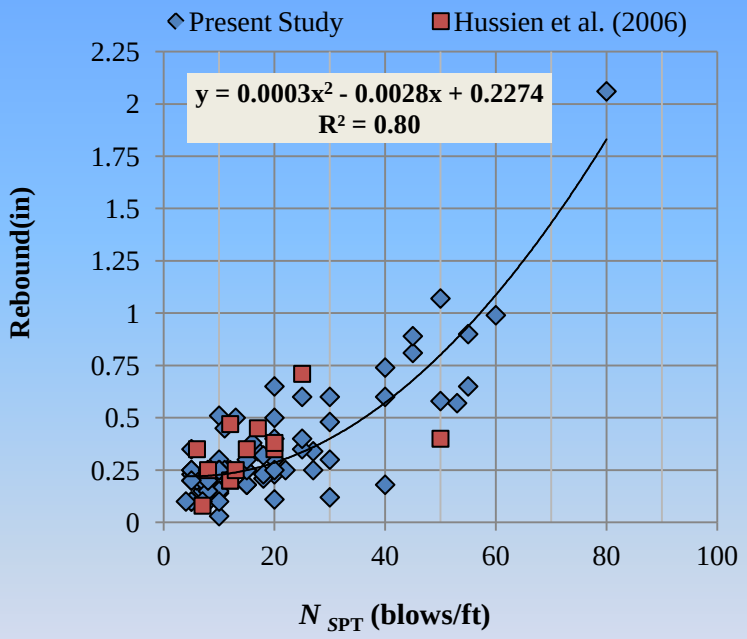
Conclusions

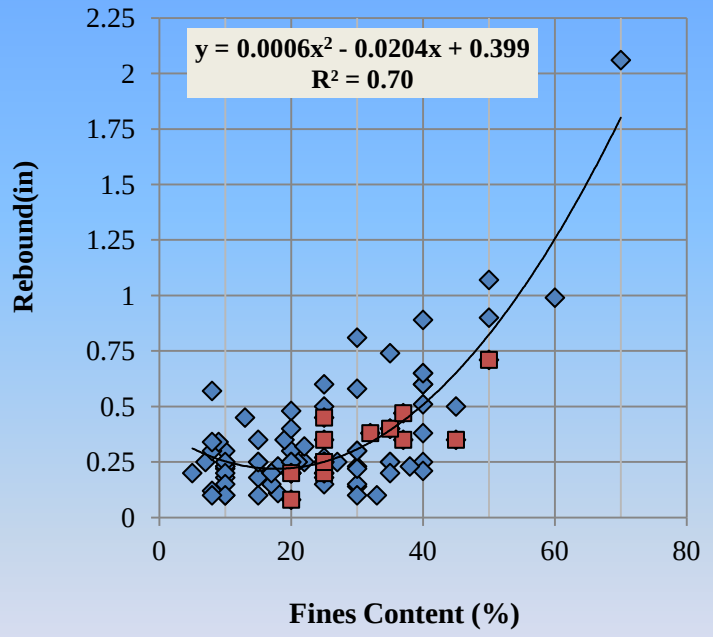
- Parameters that generally increased
  - Silt Content
  - SPT N values
  - Pocket Penetrometer q_u
  - CPT q_c and f_s
- PDA displacement vs. elevation shows rebound zones.
- Bouncing elevations match elevation of the dense or very dense to hard silty sands and clays (SM/SC/CH)

FIT Unfunded Findings
CPTu Pore Water Pressure Correlations



FIT Unfunded Findings
Rebound vs N and Fines Content





Phase II Research Objective

- Prove these correlations are reliable

Project Schedule

RESEARCH TASK
Task 1 Literature Search
Task 2 Develop Locations of New Testing Sites
Task 3 Test Program for New Field Testing Sites
Task 4 Field Data Reduction
Task 5 Laboratory Testing and Reduction of Disturbed Samples
Task 6 Laboratory Testing, Reduction and Analysis of Thin Walled Tube Samples
Task 7 Analyze Reduced Laboratory Data from Disturbed Testing
Task 8 Analyze Reduced Field Data
Task 9 Technology Transfer for Reporting and Presentations

Cyclic Testing

Cyclic Objective

- Determine and evaluate the variations in cyclic pore water pressure during cyclic triaxial testing for high pile rebound soils.

The study will focus on :

- ✓ Evaluation of pore water pressure generation during cyclic loading in and above rebound zone
- ✓ Influence of fines and silt content on pore water pressure generation during cyclic loading

Testing Program:

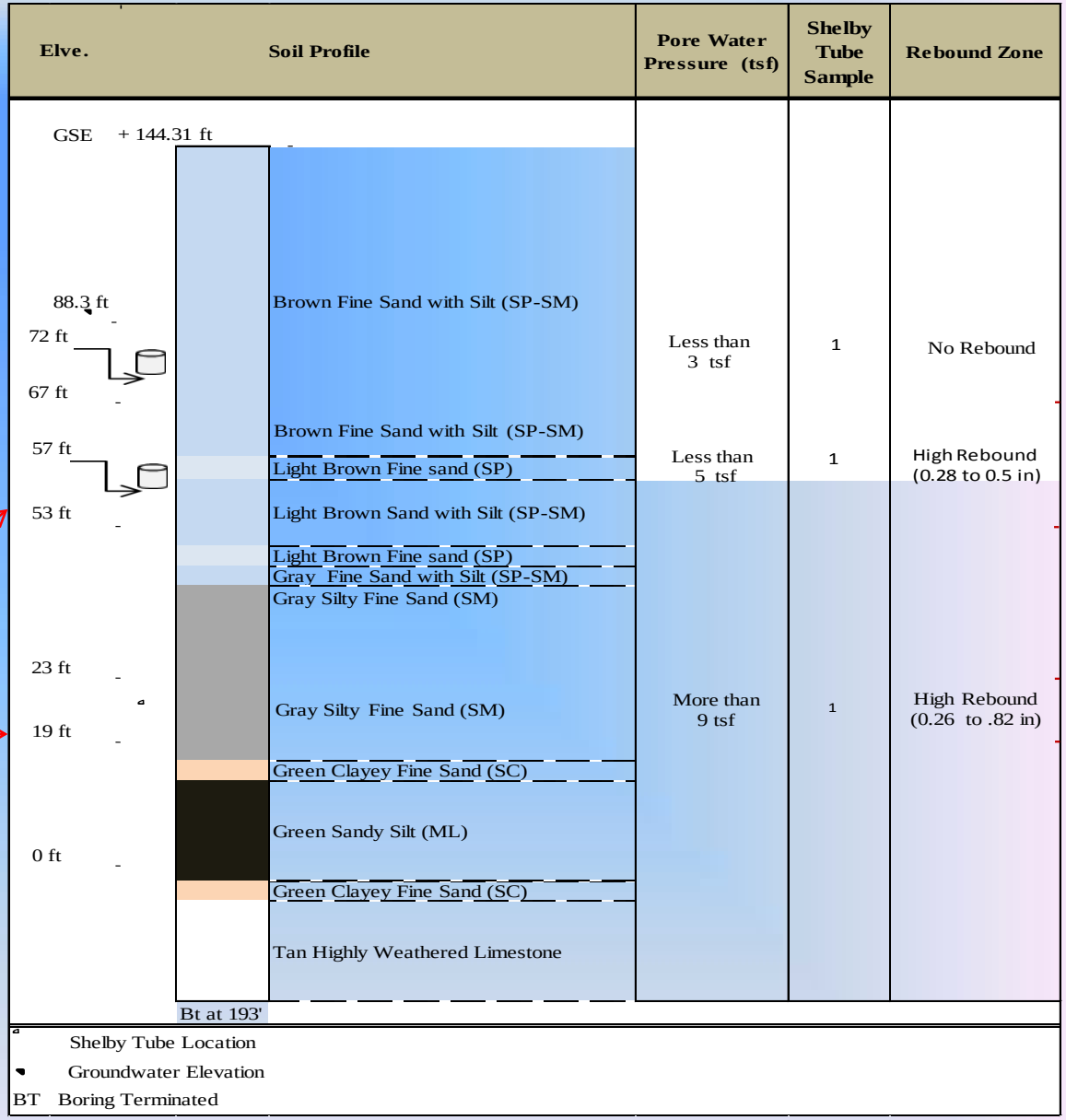
Identify Site Locations

Case	Site Name	Rebound Observed?
1	I 4 and US 192, Orlando, Florida	Excessive Rebound
2	I-4/Osceola Parkway, Central Florida, Osceola County	
3	I 10 and Chaffee Road, Jacksonville, FL	
4	SR 417/International Parkway, Seminole County, FL	Non-Rebound
5	I-4/SR 408 (Ramp B), Orange County, Florida	

I 4 and US 192, Orlando, Florida

Westbound: End Bent 1

- Rebound Zone
- Shelby Tube Location



Testing Program

Identify Site Location

No Rebound

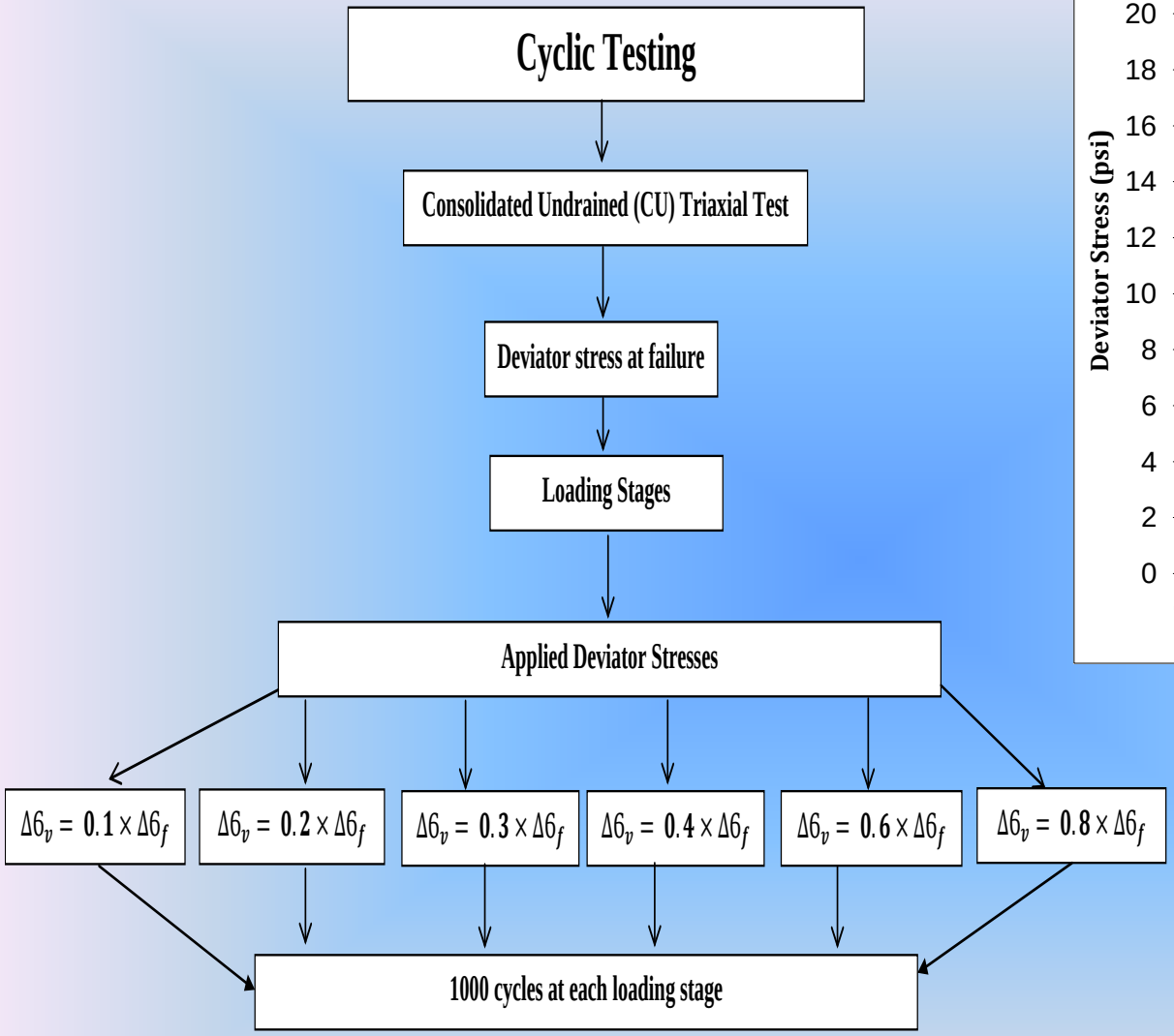
Excessive Rebound

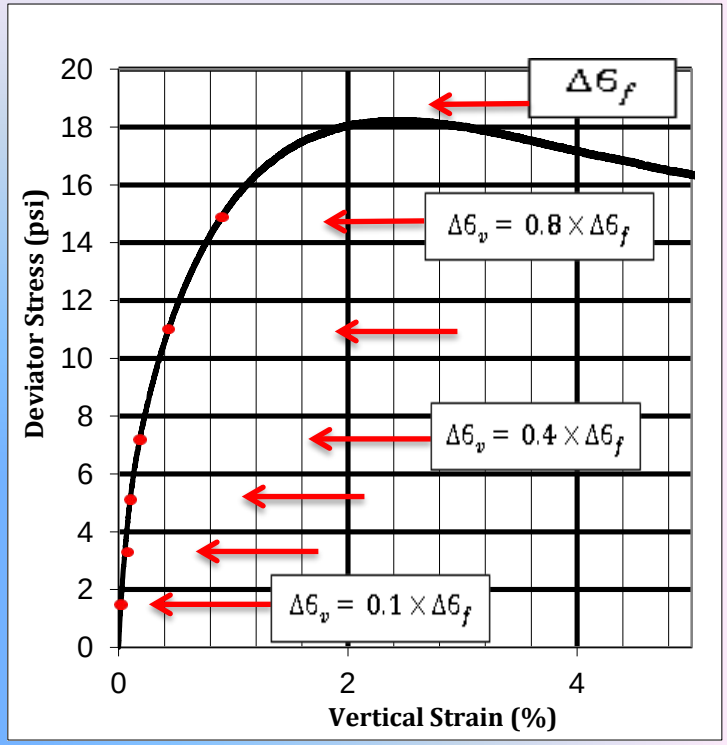
Retrieving Thin Walled Tube Samples

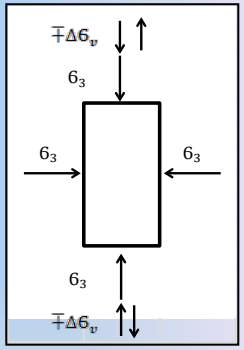
Perform Laboratory Testing on Shelby Tubes at each Site

Physical Properties of Soil

W (%) | **LL (%)** | **PL (%)** | **PI (%)** | **Silt (%)** | **Clay (%)** | **Sand (%)**


Cyclic Testing
Consolidated Undrained (CU) Triaxial Test
Deviator stress at failure
Loading Stages
Applied Deviator Stresses
$\Delta\sigma_v = 0.1 \times \Delta\sigma_f$
$\Delta\sigma_v = 0.2 \times \Delta\sigma_f$
$\Delta\sigma_v = 0.3 \times \Delta\sigma_f$
$\Delta\sigma_v = 0.4 \times \Delta\sigma_f$
$\Delta\sigma_v = 0.6 \times \Delta\sigma_f$
$\Delta\sigma_v = 0.8 \times \Delta\sigma_f$
1000 cycles at each loading stage


Deviator Stress (psi)
Vertical Strain (%)
$\Delta\sigma_f$
$\Delta\sigma_v = 0.8 \times \Delta\sigma_f$
$\Delta\sigma_v = 0.4 \times \Delta\sigma_f$
$\Delta\sigma_v = 0.1 \times \Delta\sigma_f$
0
2
4
0
2
4
6
8
10
12
14
16
18
20


$\mp\Delta\sigma_v$
σ_3
σ_3
σ_3
$\mp\Delta\sigma_v$

Questions