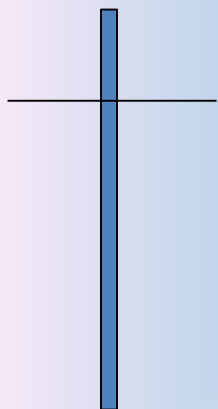
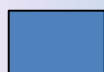




Identification of High Pile Rebound Soils:

The Mysterious Case of the Bouncing Piles Phase II



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Defining the Problem

Excessive Pile Rebound and/or Bouncing

- ❖ High Displacement Piles

- ❖ Typically Driven by Diesel Hammers

- ❖ Very Dense Saturated Silty Sands to Sandy Silts

FDOT Section 455-5.10.3 Practical Refusal

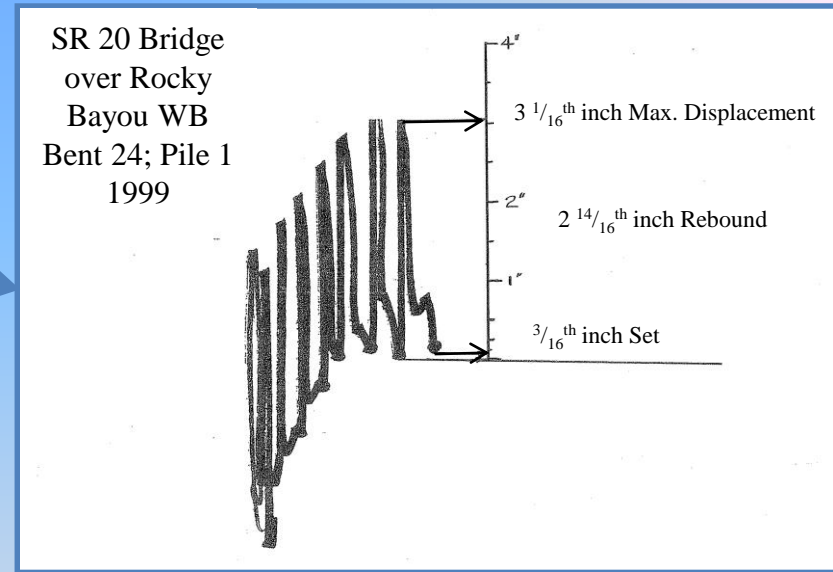
Design Capacities & Depths Not Achieved



Project Overview

🐾 Florida Pile Driving Sites experience > 0.25 inch rebound

❖ Manual Data



🐾 Engineers & Contractors need to anticipate this problem



Approach

-  Soil Property Evaluations
-  Cyclic Loading Evaluations
-  Field Testing Evaluations



Phase I

Retested Soils at 3 sites

- ❖ 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

 Shelby Tubes



Fines Content and N-Value Summary

Site Name	Fines Content Rebound Soil (%)	N Rebound Soil (blows/ft)
Anderson Street	19	27
John Young	17	16
Ramsey Branch	20	7

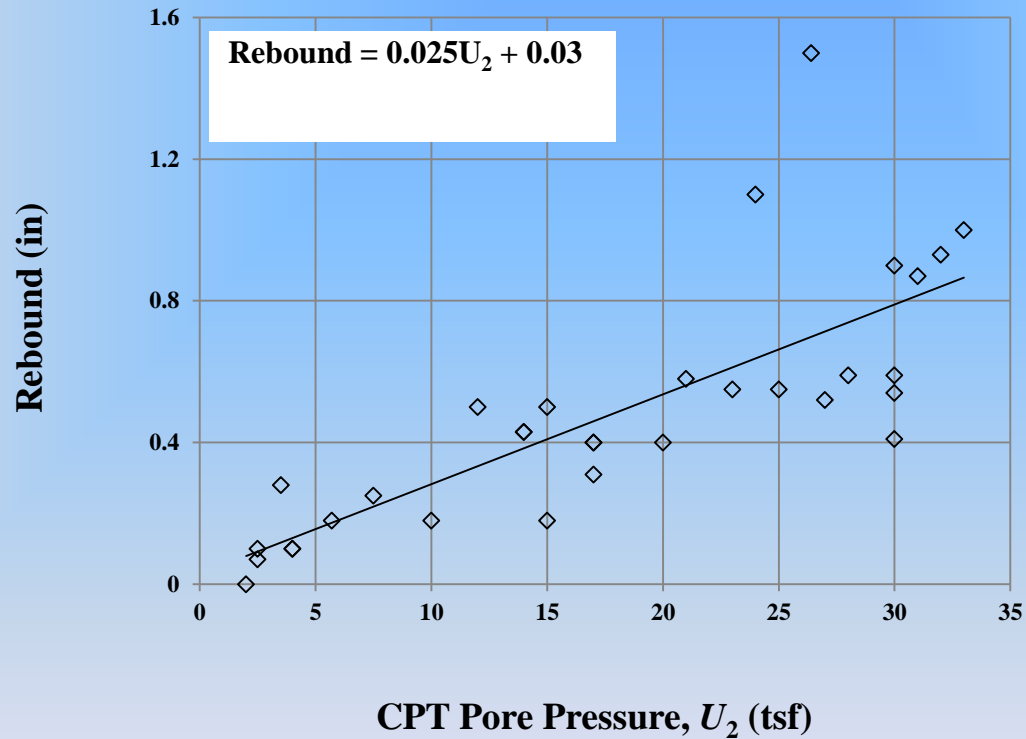


Interim FIT research

- 🐾 FDOT SMO worked with us
- 🐾 Jarushi (2012) tested additional sites
- 🐾 Correlations
 - ❖ Fines content
 - ❖ SPT N-values
 - ❖ CPTu pore pressure
- 🐾 Plotted data on Soil Behavior Charts



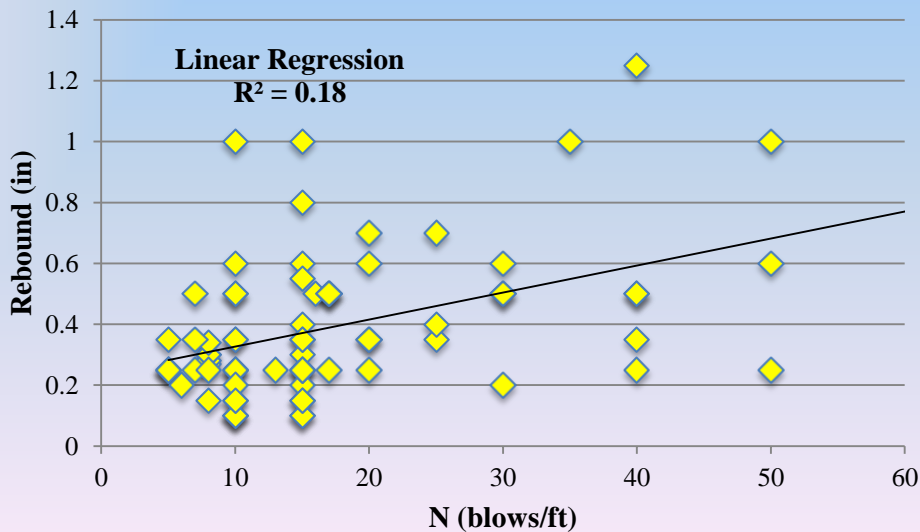
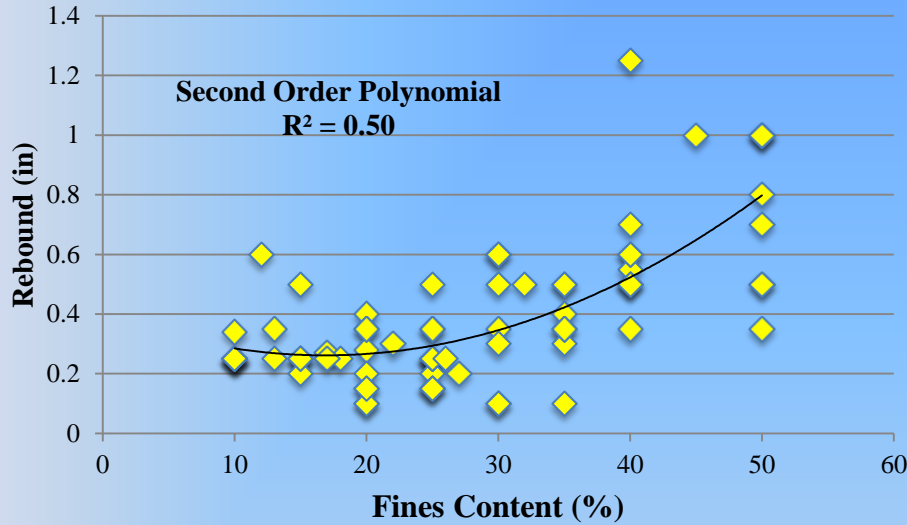
Rebound & CPT Pore Water Pressure



Soils: Typically Fine Sand with Silts or Clays



Fines Content and N vs Rebound



- Still under evaluation
- SPT will penetrate hard/dense layers
- CPT would not
- Weak correlations



Soil Behavior Type [SBT] Charts

Schmertmann (1978)

❖ CPT $q_c - f_s$

Eslami & Fellenius (2004)

❖ CPTu $q_E - f_s$

Robertson (1990)

❖ $Q_{tn} - R_f$ CPT chart

Robertson (1990)

❖ $Q_{tn} - Fr$ CPT

❖ $Q_{tn} - B_q$ CPTu

Schneider et al. (2008)

❖ $q_{cnet}/\sigma_{vo} - [\Delta u_2/\sigma_{vo}]$ CPTu

 Cone Point = q_c

 Effective Cone Point = q_E

 Friction = f_s

 Friction Ratio = R_f

 Normalized $q_t = Q_{tn}$

 $q_t = q_c - u_2(1-a)$

❖ a = net pore pressure area ratio

 Normalized $f_s = F_r$

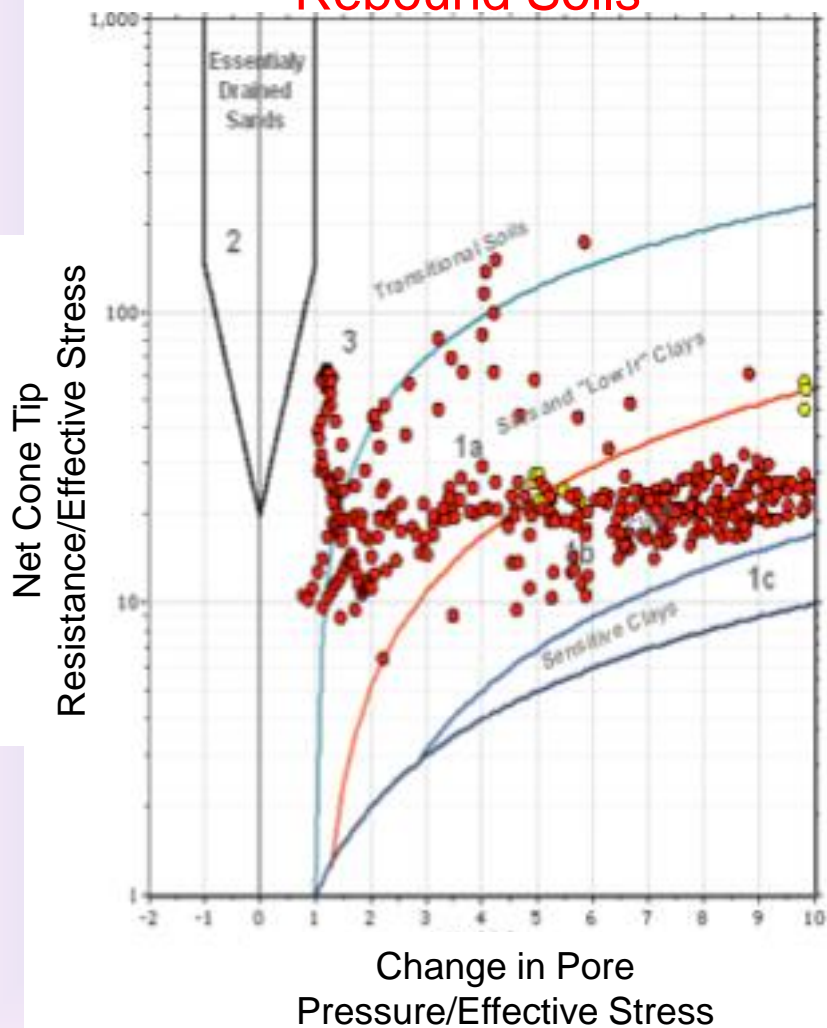
 Pore Pressure Ratio = B_q

 Normalized $q_{cnet} = q_t - \sigma_{vo}$

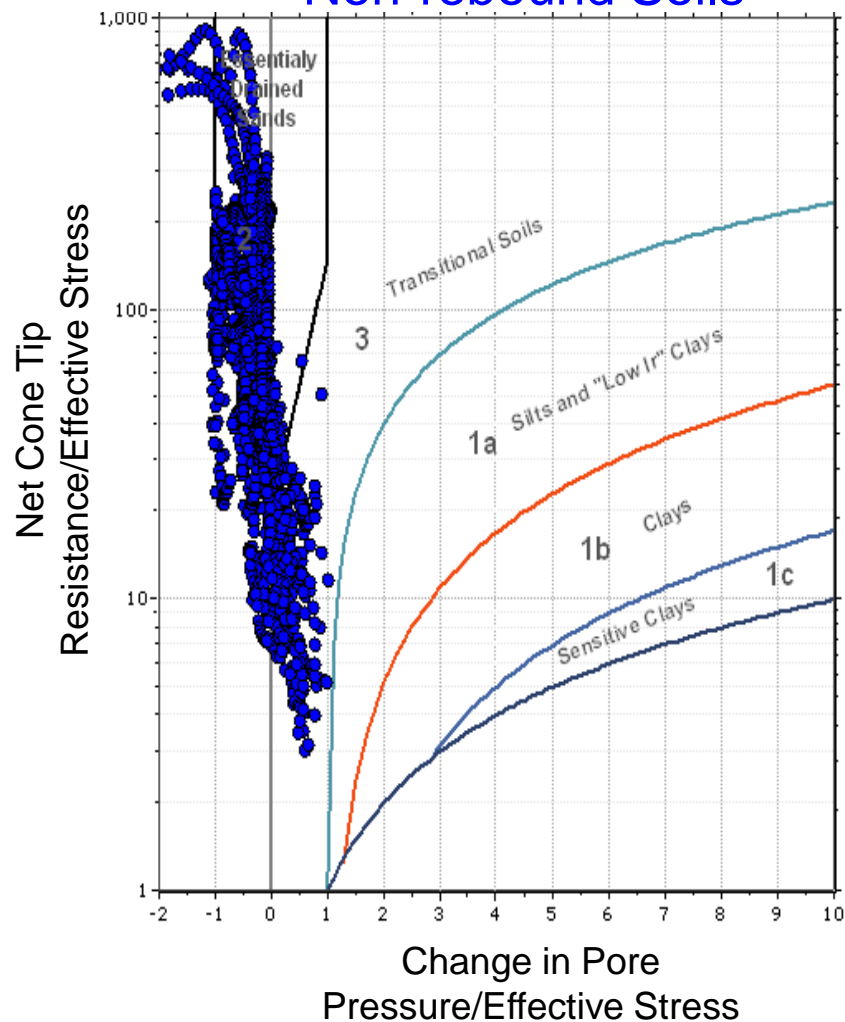


Schneider SBT

Rebound Soils



Non-rebound Soils





Interim Conclusions

 Rebound is a function of

❖ Fines Content ?

❖ N values ?

❖ CPTu pore pressure

 Schneider et al SBT charts show clear differences



Phase II Research Objective

 Prove these correlations and SBT charts are reliable







Phase II Tasks

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



Literature Findings

-  High Displacement Piles
-  Florida -- Eastern Canada -- Washington State
-  Rebound & High Toe Quake occur
-  Rebound Soils Dense or Hard



Critical Cyclic Parameters

Reference	CSL	LFC	Load Duration (s)	Soil Description
Putri et al. (2012)	0.3-0.38	N/A	N/A	Clay with sand
Awad (1975)	0.37-0.5	N/A	45	Silty clay
Moses and Rao (2003)	0.25-0.7	N/A	6, 12, 20	Marine clay
Puppala et al. (2004)	0.2, 0.4, 0.6	N/A	1	Sandy clay soils
Shahin et al. (2011)	0.36, 0.71	N/A	1	Soft Clay
Okur et al. (2008)	0.35	N/A	10	Fine grain soils
Dash and Sitharam (2009)	0.128-0.154	21%	1	Silty sand

- 👉 CSL= Critical Stress Level 0.25 to 0.60 typical
- 👉 LFC= Limiting Fines Content Generally not reported
- 👉 Load Durations slow



HPR Testing Summary

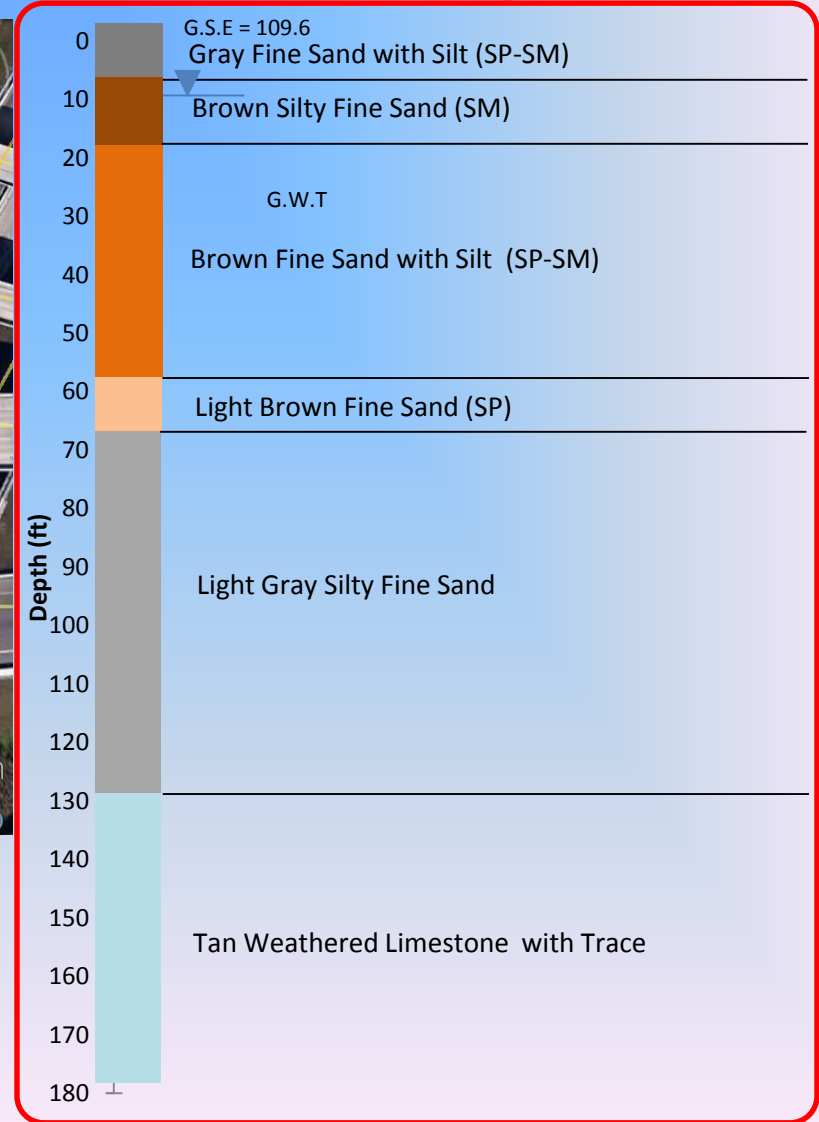
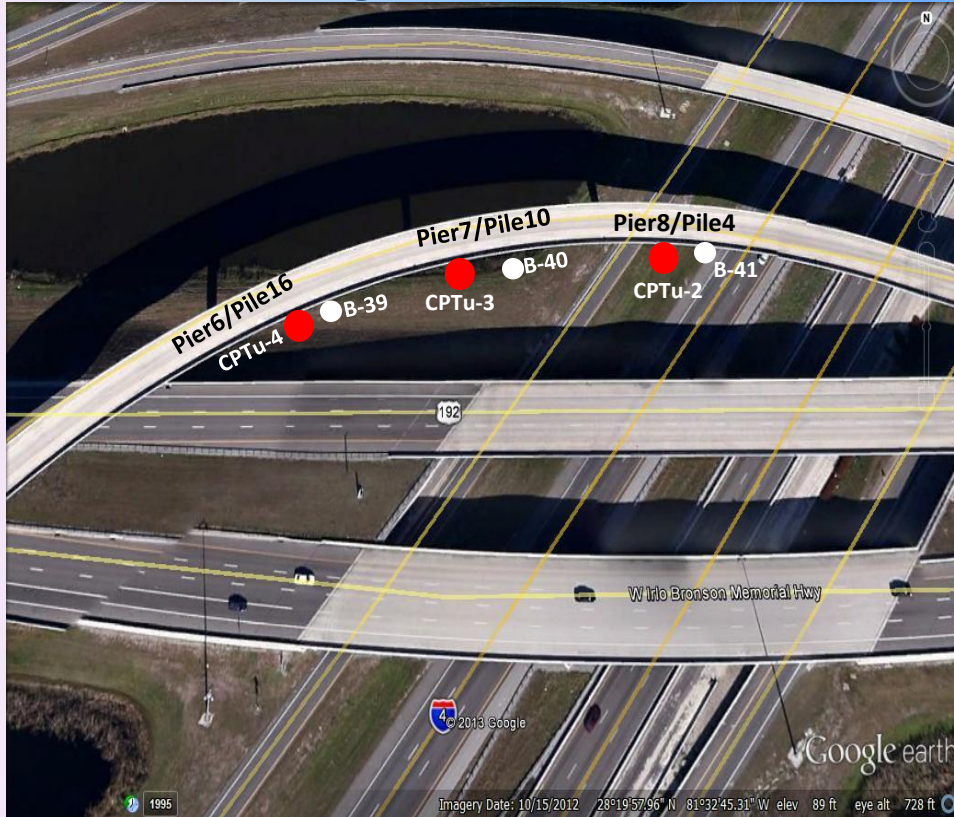
Sites No.	Description	County	Soil Data Retrieved	PDA Data Retrieved
1	Anderson St. Overpass at I-4/SR-408	Orange	Yes	Yes
2	I-4/SR-408 Ramp B	Orange	Yes	Yes
3	I-4/US-192	Osceola	Yes	Yes
4	I-4 Osceola Parkway	Osceola	Yes	Yes
5	I-4/SR-423 John Young Parkway	Orange	Yes	Yes
6	I-4/SR-482 Sand Lake Rd.	Orange	Yes	Yes
7	SR-50 and SR-436	Orange	Yes	Yes
8	SR -417 and International Drive	Osceola	Yes	Yes
9	SR-528 and US 441	Orange	Yes	Yes
10	SR-83 Ramsey Branch	Walton	Yes	Yes
11	SR-528 over Indian River	Brevard	Yes	Yes
12	I-10 at Chaffee Road	Jacksonville	Yes	Yes
13	Heritage Parkway Palm Bay	Brevard	No	Yes
14	I-4 Widening Daytona	Volusia	Yes	Yes
15	SR-83 Ramsey Branch Revisited	Walton	Yes	No



I-4/US-192 Osceola County

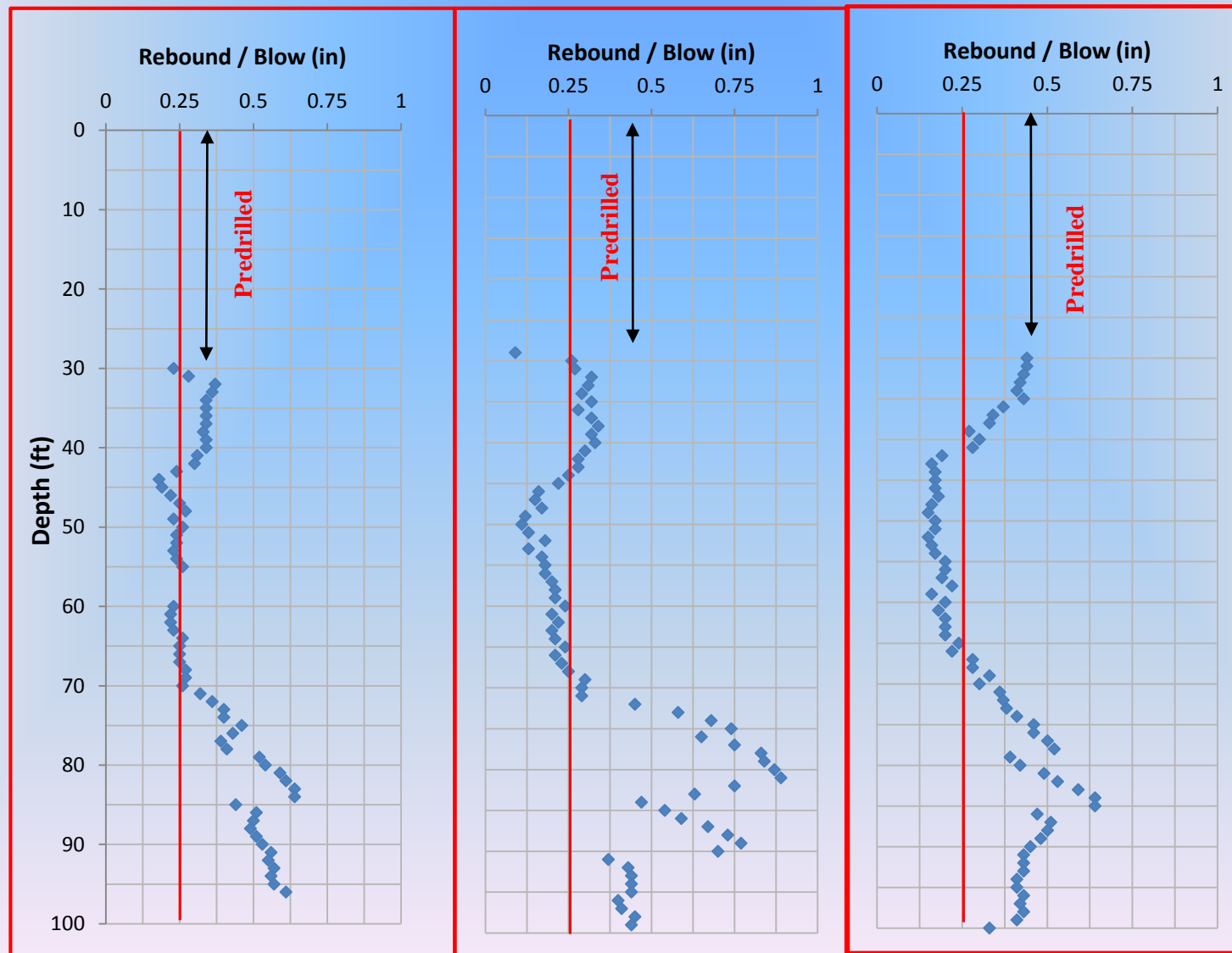
Testing Locations

General





I-4/US-192 ... PDA Data



Pier 6 Pile 16

Pier 7 Pile 10

Pier 8 Pile 4



Rebound



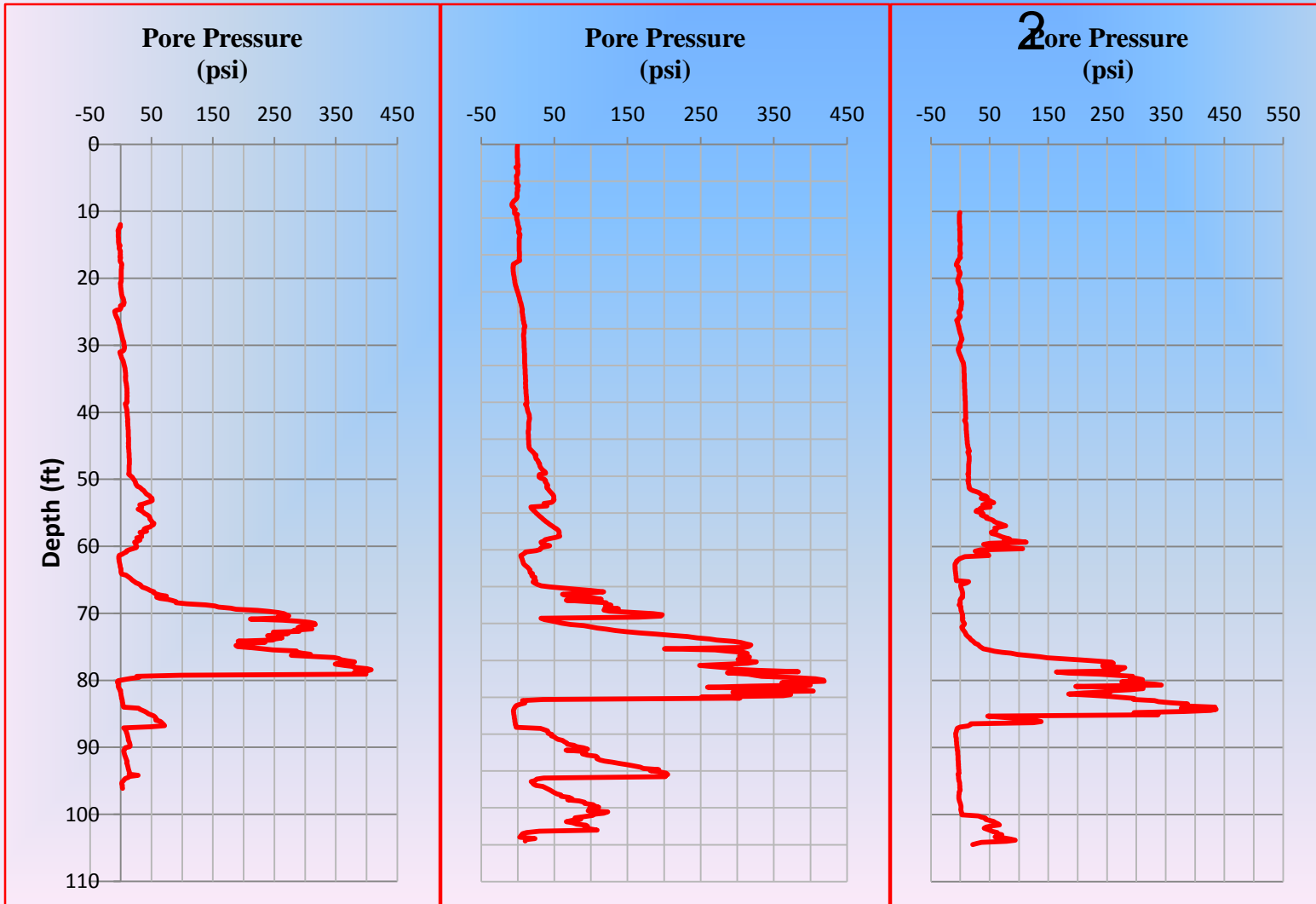
CPTu Data

High Pore Pressure (over 400 psi) at rebound depth (70 ft)

CPTu-4

CPTu-3

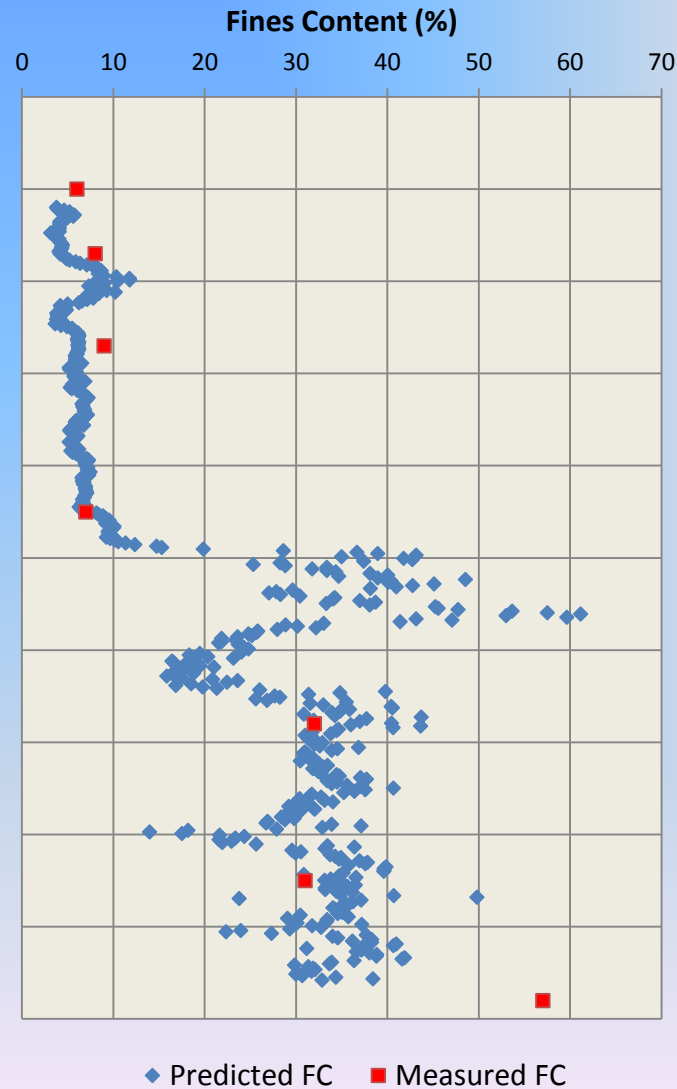
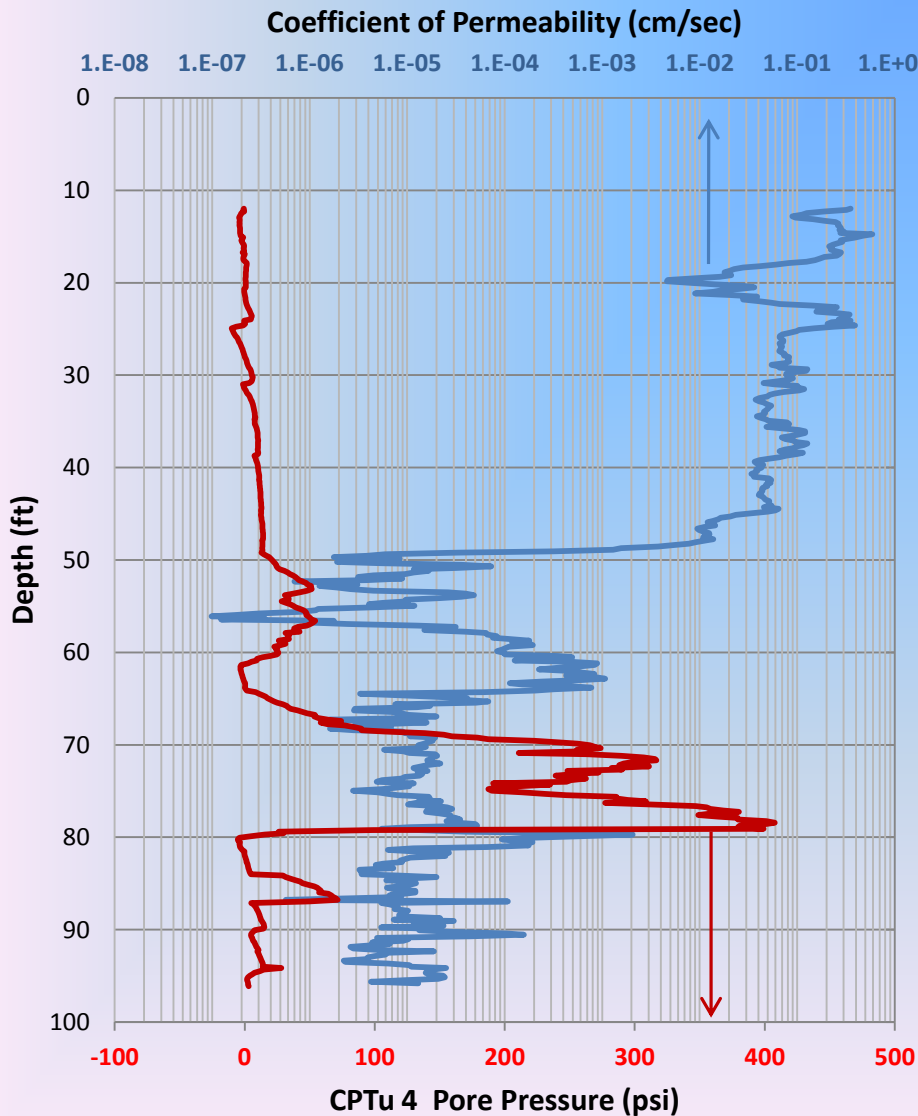
CPTu-

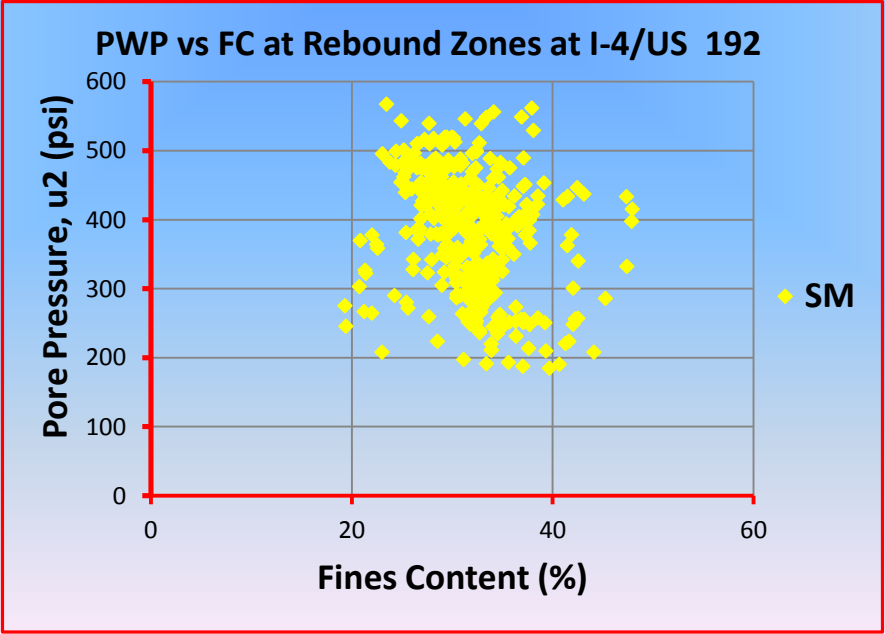
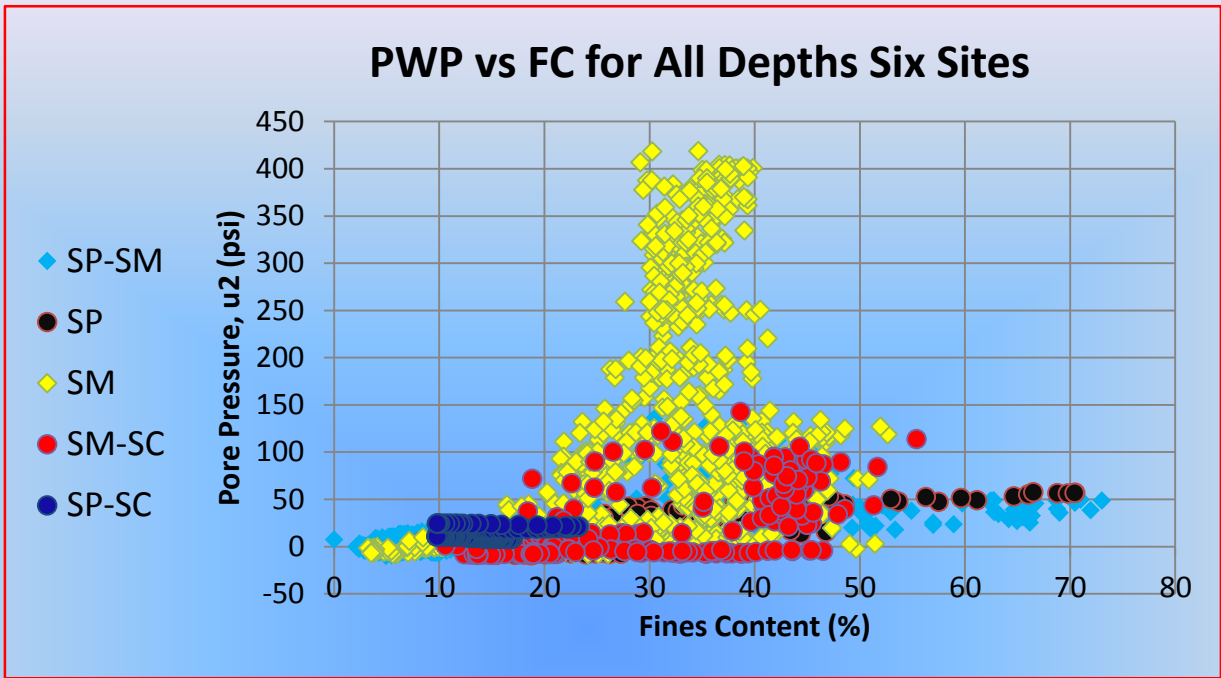


Rebound



Estimated Soil Properties Based on CPTu Data







Questions ?

