

DRIVEN CONCRETE PILE FOUNDATION MONITORING WITH EMBEDDED DATA COLLECTOR SYSTEM



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**INTERNATIONAL FOUNDATION CONGRESS & EQUIPMENT EXPO
MARCH 15-19, 2009
ORLANDO, FLORIDA**

Introduction



- Majority of Florida bridges are supported on deep foundations;
- Most common deep foundation:
Precast Prestressed Concrete piles
- All test piles are monitored with the PDA

CURRENT FDOT PRACTICE

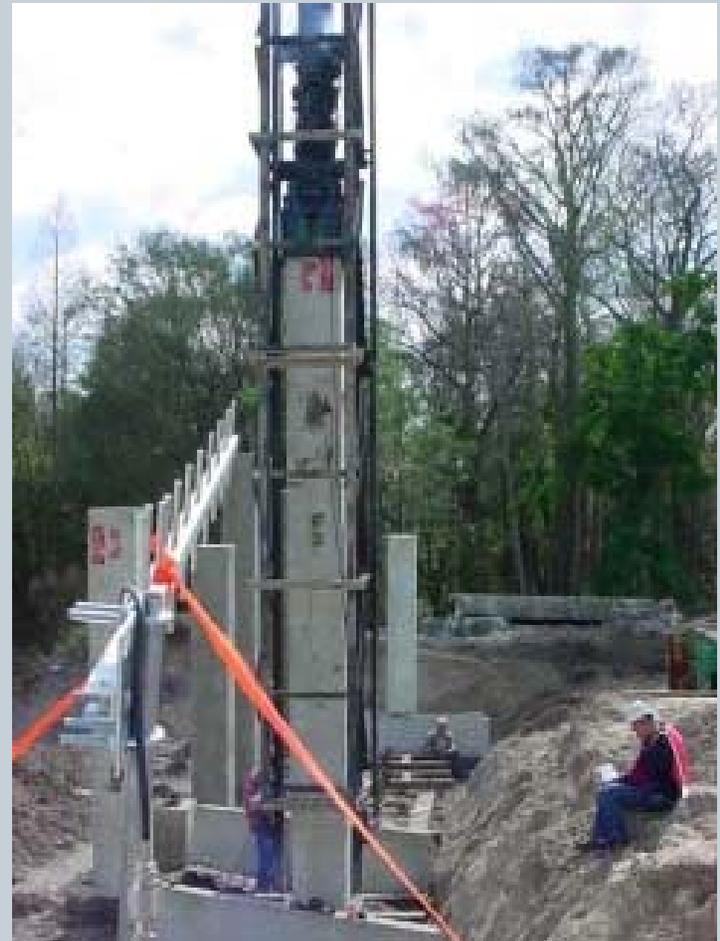


- Test Pile Program
 - Pre-field WEAP
 - PDA
 - CAPWAP
 - Final WEAP
- Install Production Piles

EMBEDDED DATA COLLECTOR

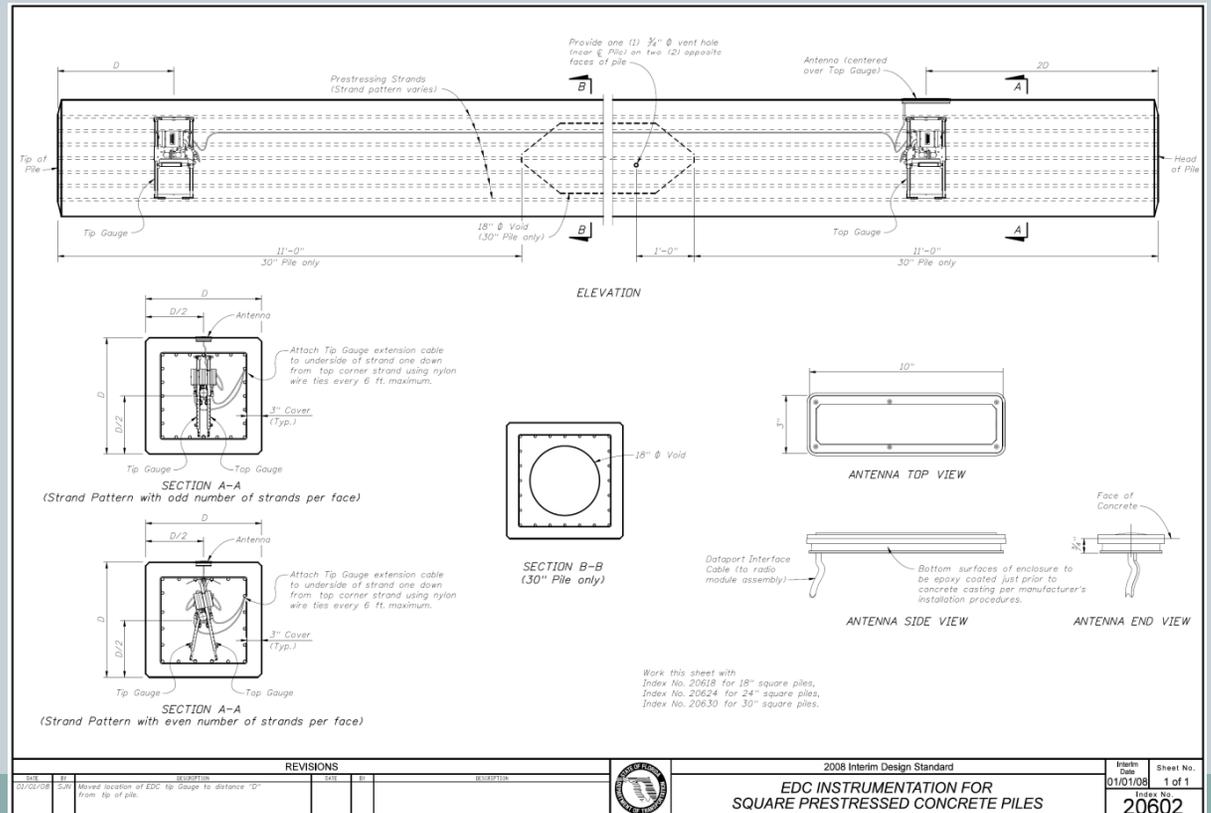


- Alternate method was investigated through FDOT sponsored research
- University of Florida's Final report issued on August 2002
 - Theory
 - First generation hardware and software
 - Construction Project BB349
- Smart Structures, Inc. holds the license to develop the UF/FDOT patented technology.



WHAT IS EMBEDDED DATA COLLECTOR?

- FDOT Design Standard Index 20602
- Instruments cast into solid concrete piles;
- Two instrumentation levels, pile head and tip



WHAT IS EMBEDDED DATA COLLECTOR?

- Wireless data transfer
- Antenna connects to laptop PC
- Monitoring concrete piles during driving;
- Estimates soil damping for every blow during driving;
- Real-time estimates of static resistances, i.e., side, tip and total.



CALCULATION METHODS



- **Fixed Case Method**
 - constant damping (input by operator)
- **Dynamic Case Method**
 - dynamic damping (calculated for every hammer blow)
- **Paikowsky Method**
 - energy-displacement approach
- **UF Method**
 - dynamic damping (calculated for every hammer blow)

PURPOSE OF EVALUATION



- To compare the EDC to the results from the “gold standard” PDA & CAPWAP;
- To generate a database of projects using EDC for resistance factor calibration

EDC EVALUATION

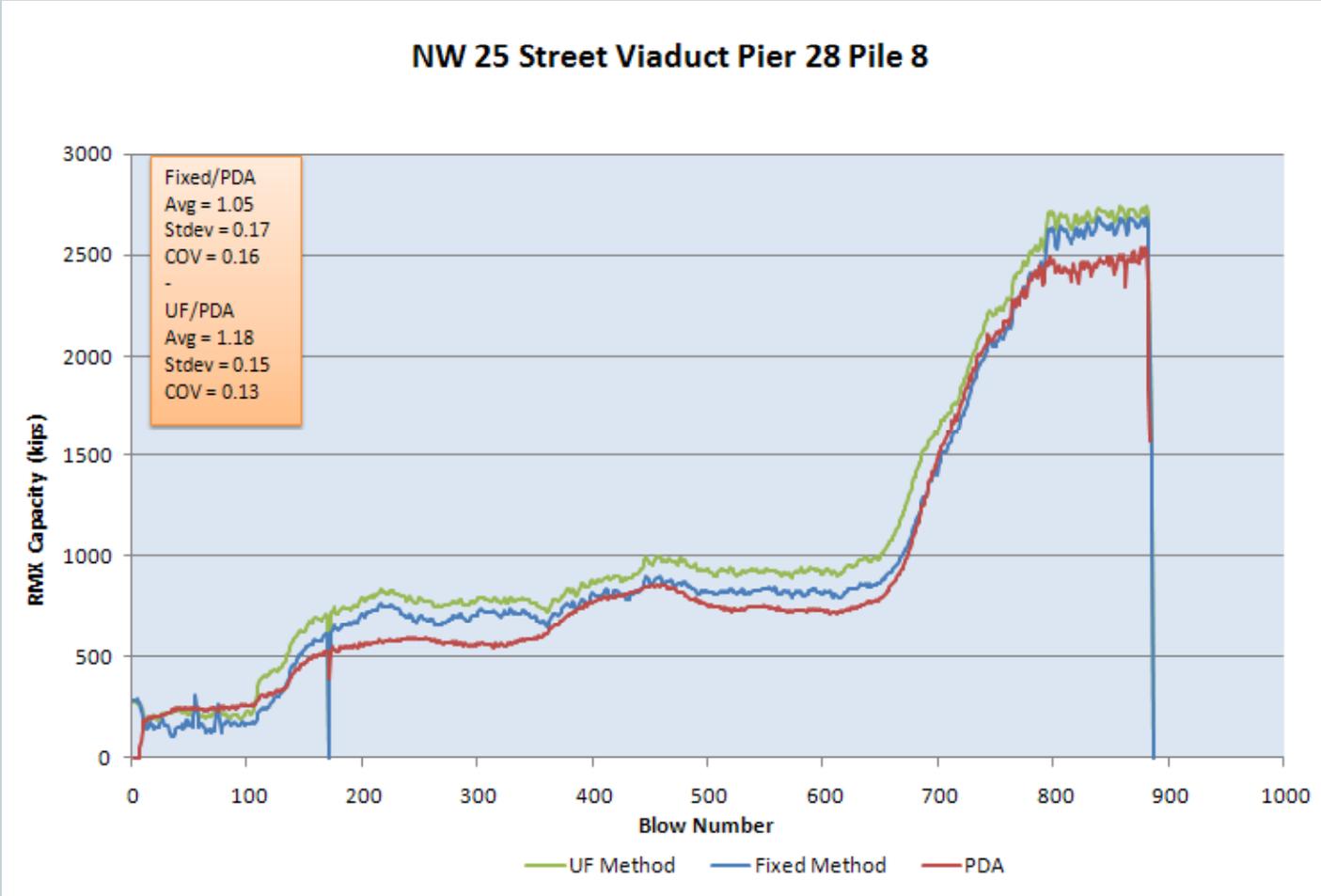


- Phase 1: Compare EDC to PDA and CAPWAP
 - EDC data is collected and reported by different engineers than those collecting the PDA data.
 - Neither engineer gets to see the other's data until test pile program is complete and both reports turned in.
 - All project related decisions made based on PDA data and analyses.

EDC EVALUATION



NW 25 Street Viaduct Pier 28 Pile 8

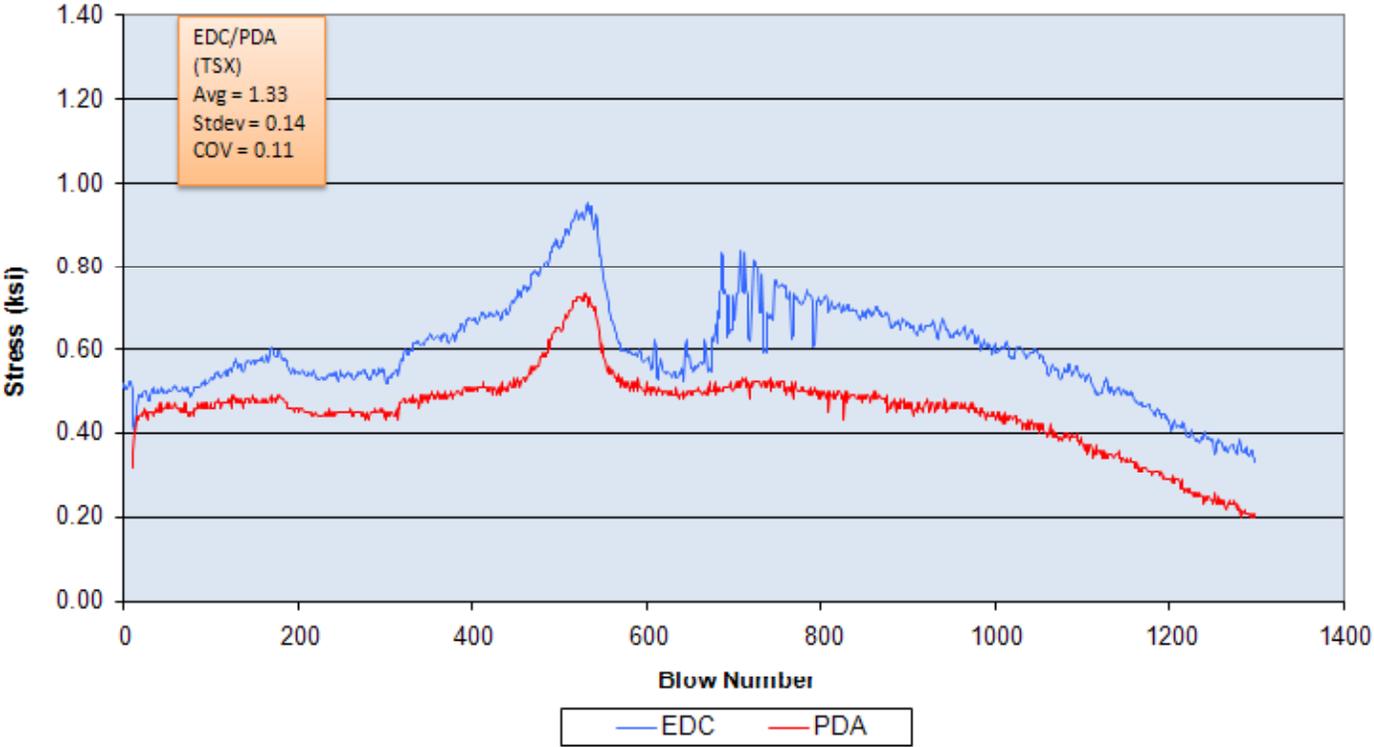


EDC EVALUATION



CR 392 Cypress Creek Pier 4 Pile 4

MAXIMUM TENSION STRESS

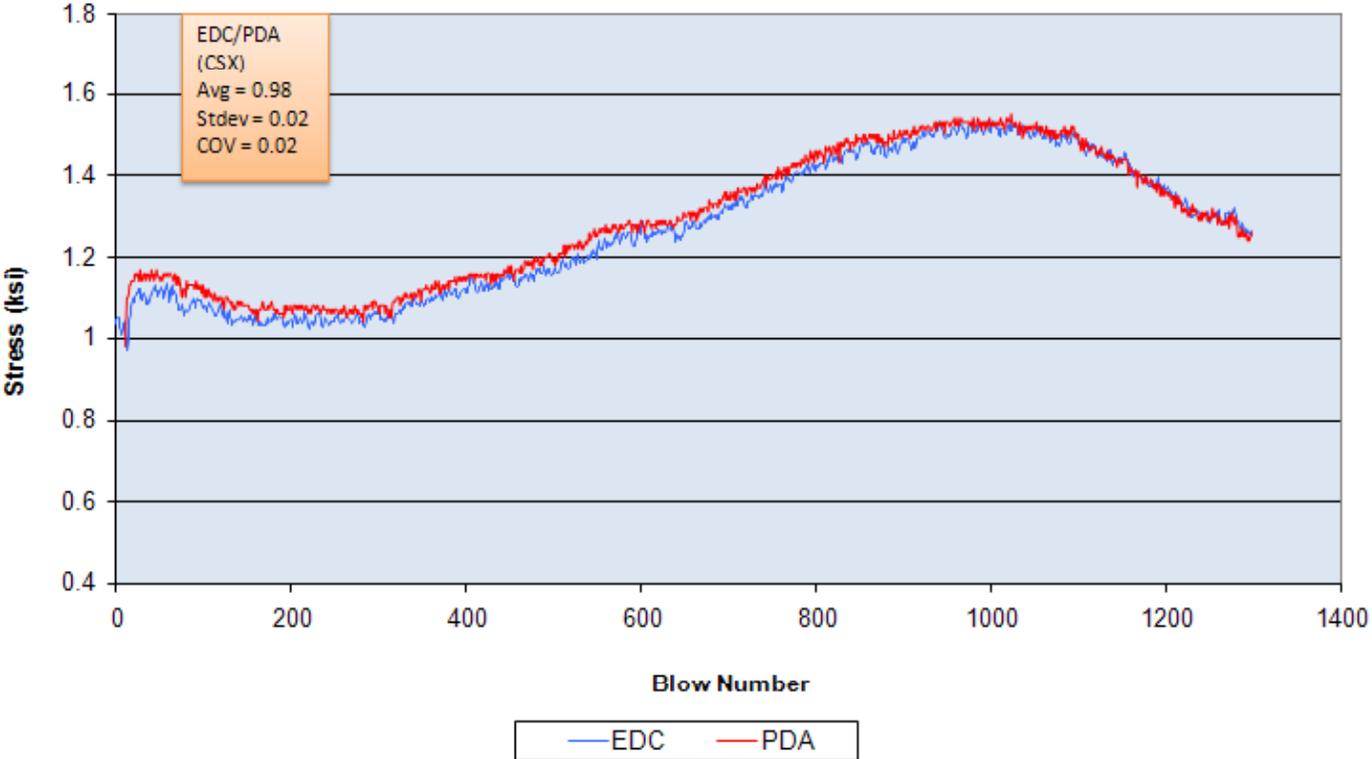


EDC EVALUATION



CR 392 Cypress Creek Pier 4 Pile 4

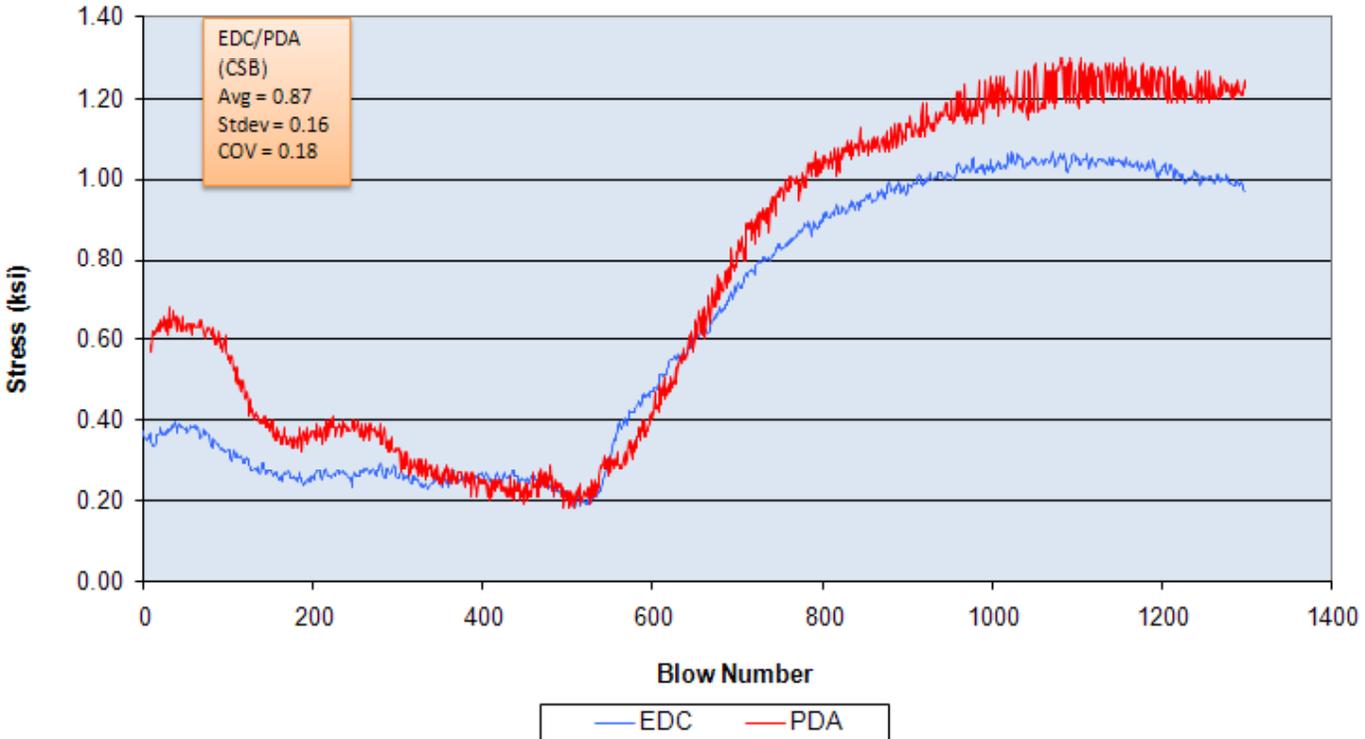
MAXIMUM COMPRESSIVE STRESS



EDC EVALUATION



CR 392 Cypress Creek Pier 4 Pile 4
MAXIMUM COMPRESSIVE STRESS AT PILE TIP

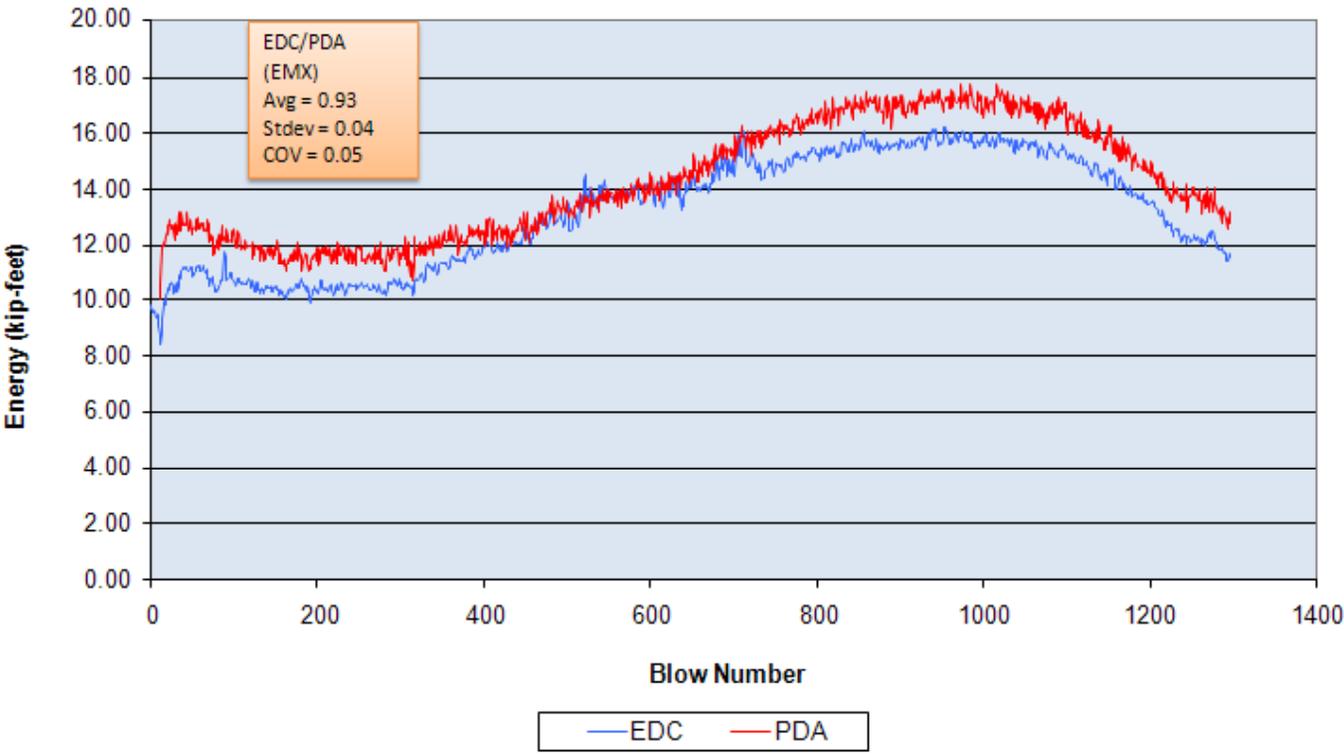


EDC EVALUATION



CR 392 Cypress Creek Pier 4 Pile 4

ENERGY

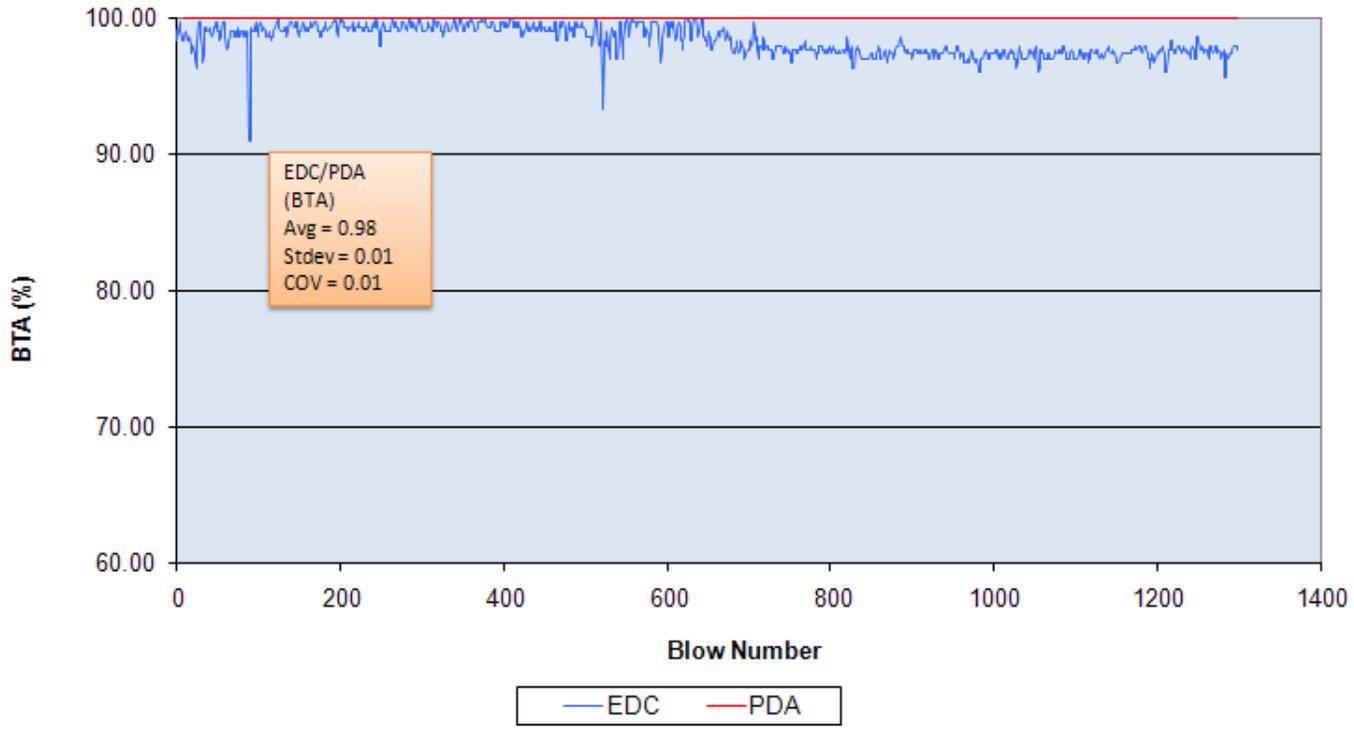


EDC EVALUATION



CR 392 Cypress Creek Pier 4 Pile 4

PILE INTEGRITY



DATABASE



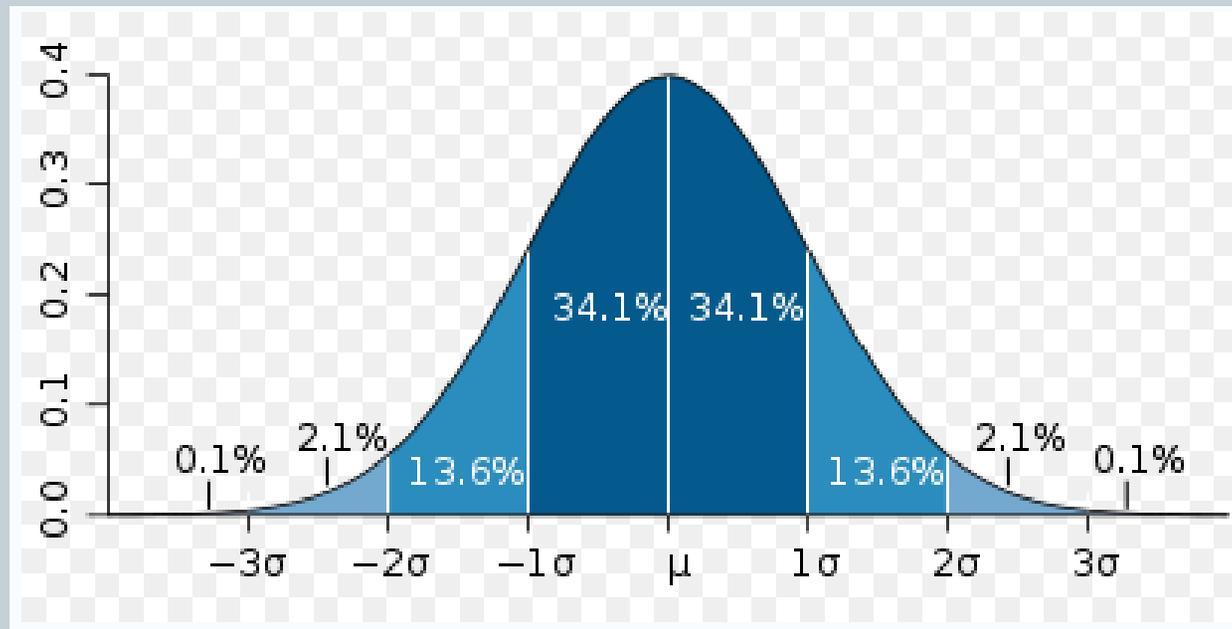
Database Files

	Paper	Current
Bridge Sites	42	46
PDA (.WO1)	122	150
EDC (.ssn)	122	150
CAPWAP	60	74

EDC EVALUATION



- PDA estimate > 50 tons
- Data within three standard deviations from the mean used in the development of statistical parameters

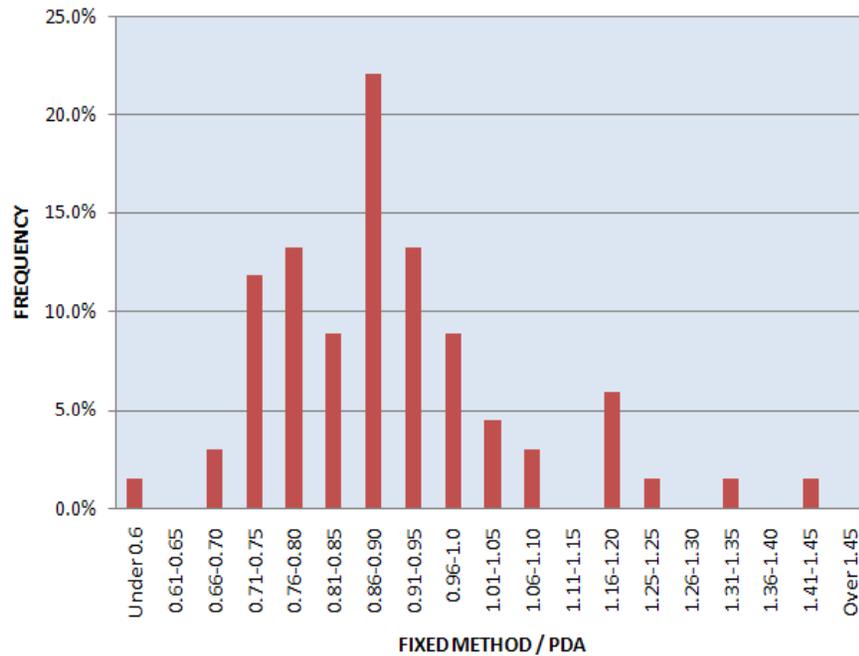


PDA/EDC STATIC CAPACITY

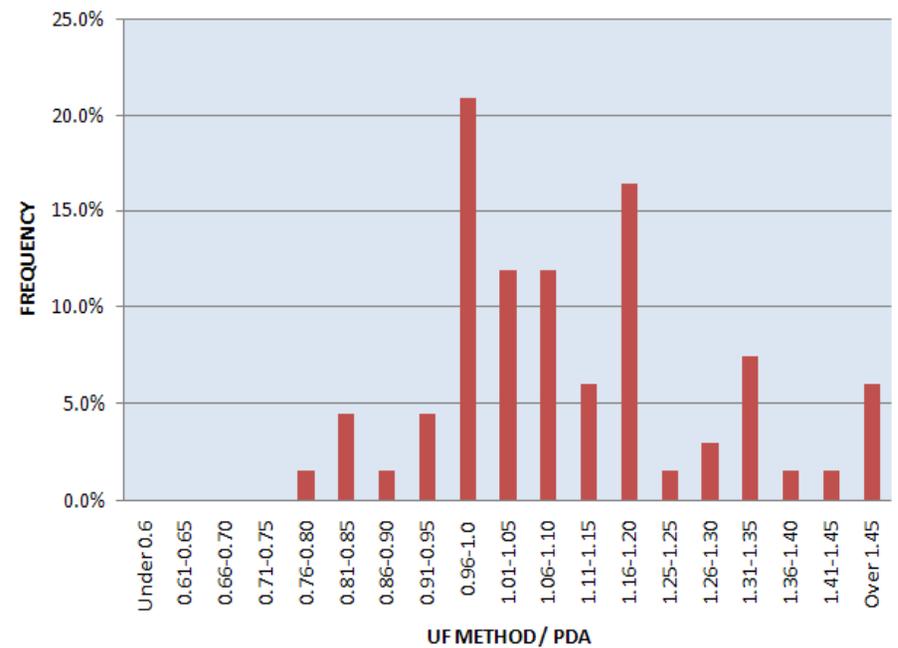


Population "n" = 116,048 blows from 68 piles

FREQUENCY HISTOGRAM



FREQUENCY HISTOGRAM



PDA/EDC STATIC CAPACITY



Population “n” = 135,569 blows from 76 piles

Ratio of Total Static Resistance		
Parameter	Fixed Method/PDA	UF Method/PDA
% of n	98.7	97.4
Mean	0.97	1.08
Median	0.96	1.06
Standard Deviation	0.14	0.17
Coefficient of Variation	0.14	0.15

EDC EVALUATION



Population “n” = 78,826 blows from 49 piles

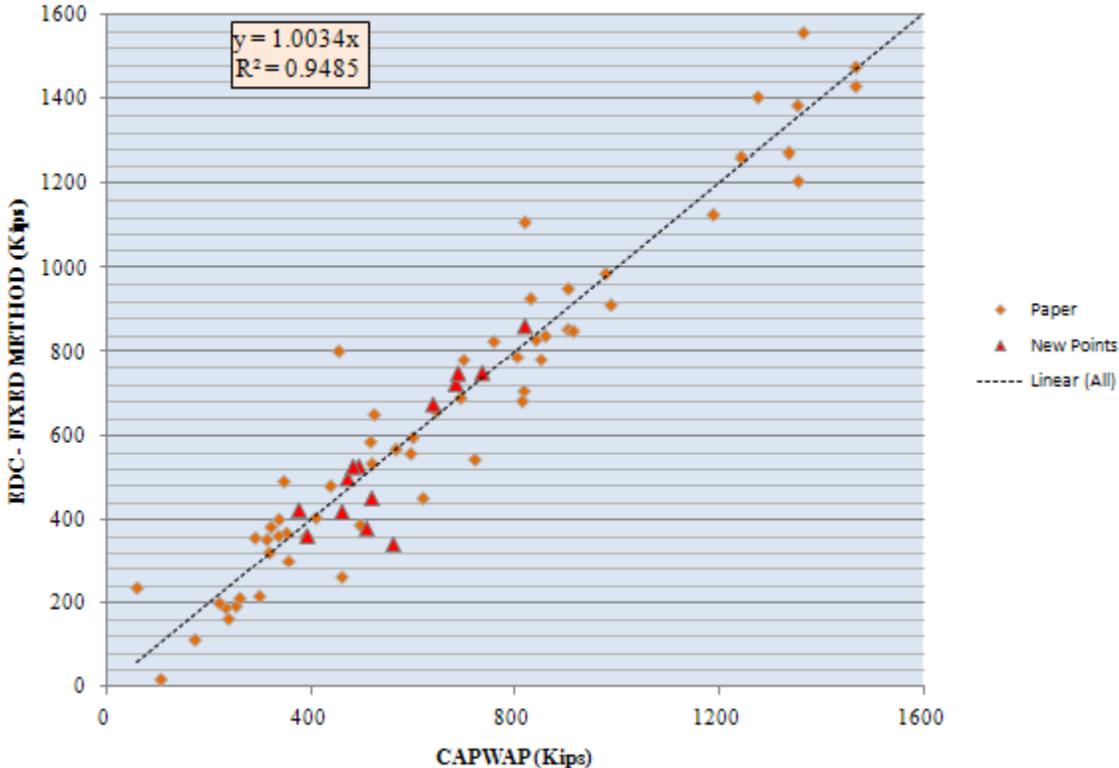
STRESS, ENERGY, INTEGRITY AND BLOW COUNT

EDC/PDA						
	CSX	CSB	TSX	EMX	BTA	Blow Count
Mean	0.92	0.80	1.33	1.00	1.01	0.98
Median	0.92	0.83	1.30	0.96	0.98	1.00
Std. Deviation	0.09	0.20	0.39	0.19	0.03	0.17
Coefficient of Variation	0.10	0.25	0.29	0.19	0.03	0.17

EDC EVALUATION



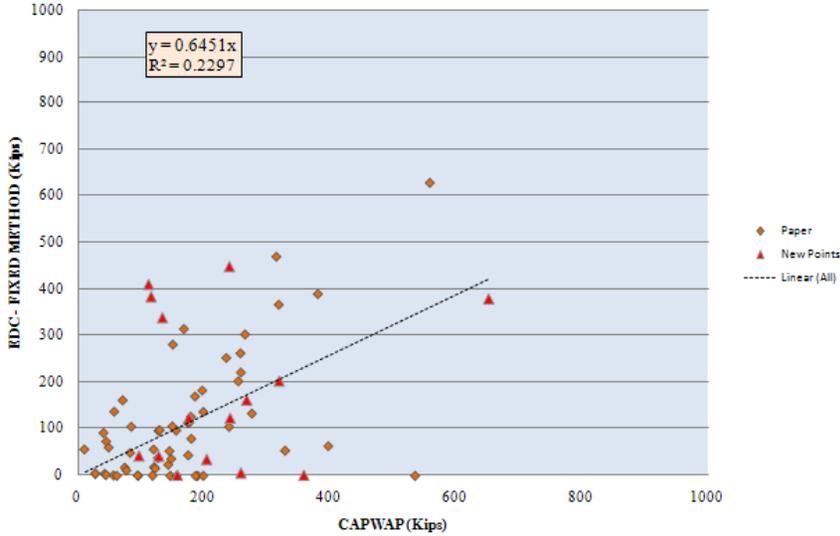
TOTAL STATIC CAPACITY



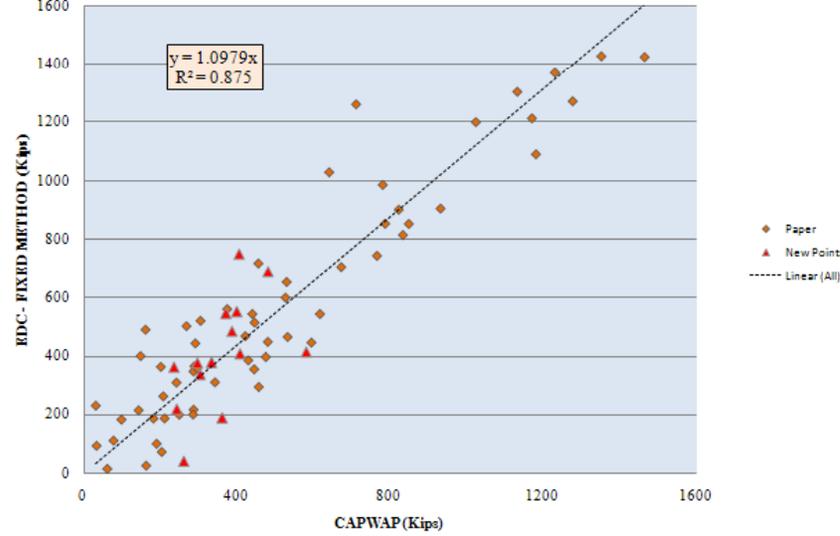
EDC EVALUATION



SKIN FRICTION STATIC CAPACITY



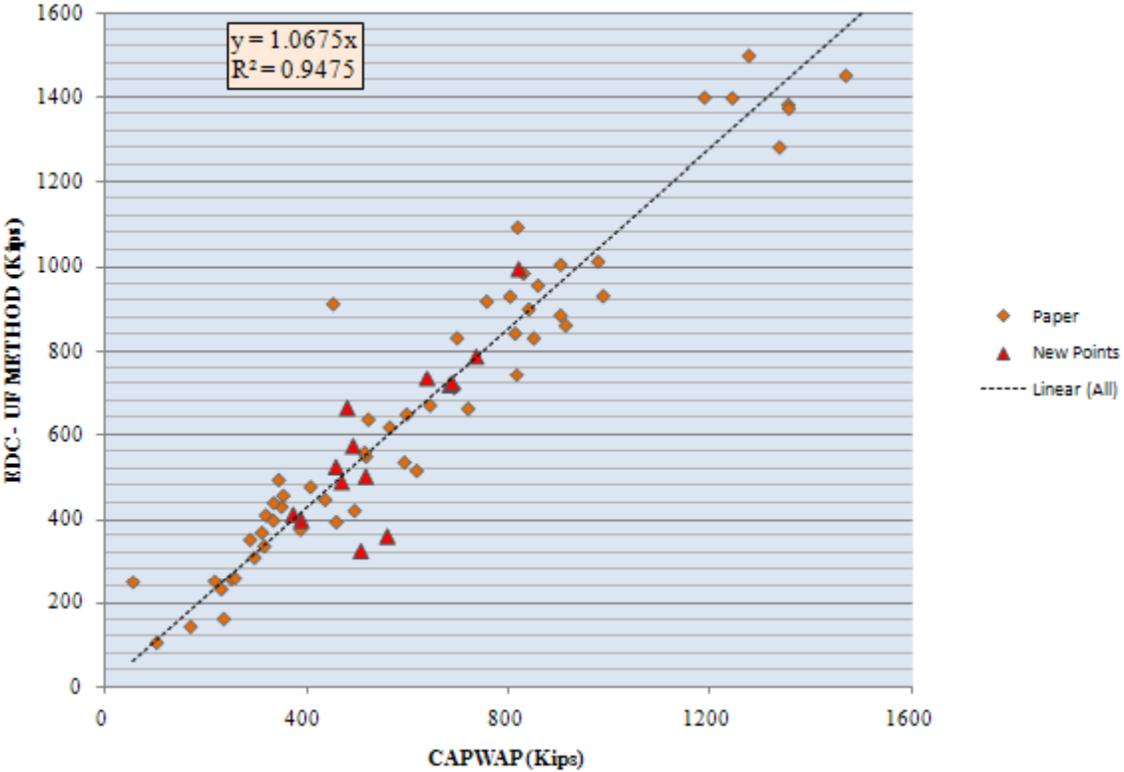
END BEARING STATIC CAPACITY



EDC EVALUATION



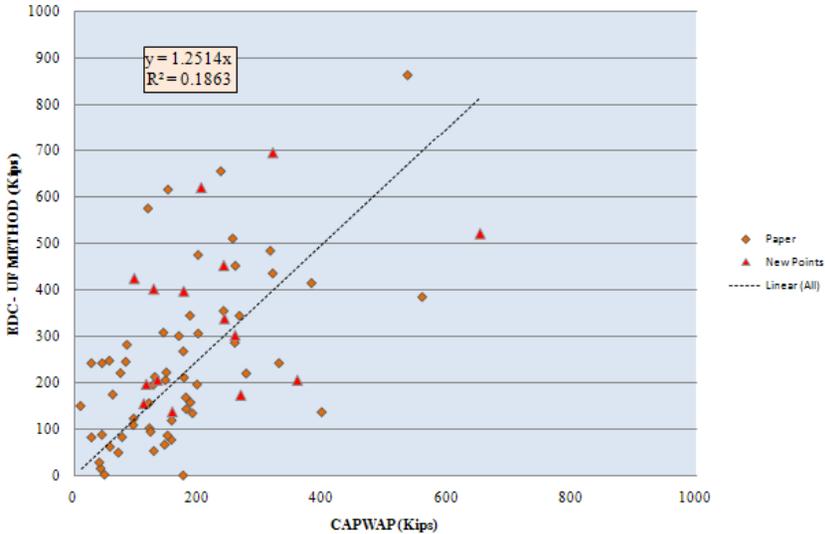
TOTAL STATIC CAPACITY



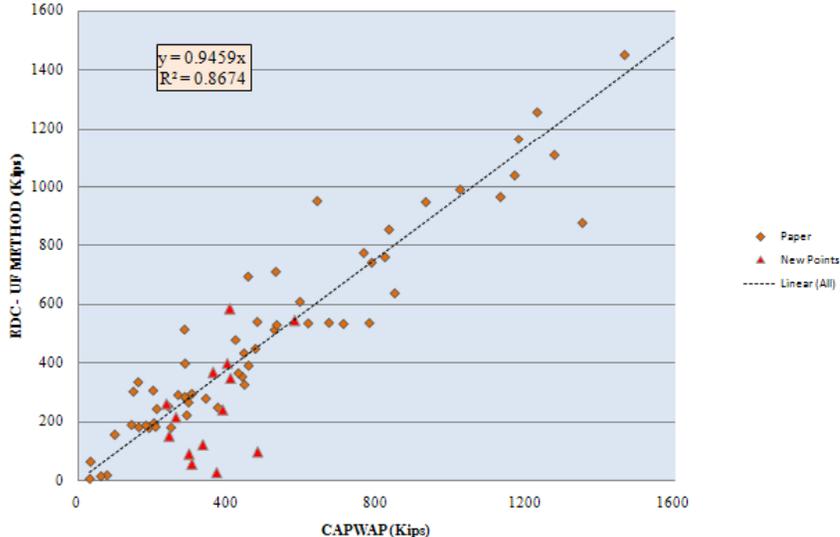
EDC EVALUATION



SKIN FRICTION STATIC CAPACITY



END BEARING STATIC CAPACITY



EDC EVALUATION



- Summary
 - Comparisons of total static capacity indicate that both UF and Fixed methods compare well with PDA with averages within 8 percent and coefficients of variation under 0.20
 - The discrepancies noted in predicted stress levels, particularly in maximum tension stress (TSX) and compressive stress at the bottom of the pile (CSB), are being investigated.
 - Comparisons made with CAPWAP predictions of total static capacity produced mean values within 10 percent with COV under 0.25 for both methods.

Questions??



- Larry.Jones@DOT.STATE.FL.US
- Presentation available March 23 - April 30
 - <http://www.dot.state.fl.us/geotechnical/>
- In Memory of Millard Fuller 1935-2009:

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