Geotechnical Engineering

2013 Design Training Expo

100 Percent Dynamic Testing of Concrete Piling

Rodrigo Herrera

100 Percent Dynamic Testing of Concrete Piling

- Nominal Bearing Resistance
- Acceptable risk – AASHTO Code
- Resistance factors
  - ✓ Pile length
  - ✓ Cost
- Specifications
  - ✓ Design-Bid-Build
  - ✓ Design-Build

100 Percent Dynamic Testing of Concrete Piling

100 Percent Dynamic Testing of Concrete Piling

- How do we know when to stop driving?
  - ✓ Minimum tip requirements are satisfied
  - ✓ Driving criteria is met

Depth	Blows	Stroke/ Pressure	Note No.	Depth	Blows	Stroke/ Pressure	Note No.	Depth	Blows	Stroke/ Pressure	Note No.	Depth	Blows	Stroke/ Pressure	Note No.
1			1	34	6	5.5	4								
2				35	9	6.79									
3				36	15	6.14									
4				37	19	7.66									
5				38	21	7.44									
6				39	26	7.94									
7				40	25	7.57									
8				41	26	7.99									
9				42	31	7.94									
10				43	45	7.57									
11			2	44	41	8.25									
12	1		3	45	41	8.35									
13	6	5.3		46	40	8.44									
14	5	5.5		47	43	8.33									
15	5	6		48	40	8.39	5								
16	7	5.5		49	43	8.29	6								
17	6	6.5		50	35	8.36									
18	6	5.95		51	35	8.52									
19	6	5.96		52	39	8.52									
20	8	6.36		53	55	8.9	7								
21	8	6.45													
22	10	6.65													
23	10	6.62													
24	7	6.41													
25	8	6.22													
26	6	6.22													
27	5	5.08													
28	4	5.15													
29	2	—	4												
30	2	—	4												
31	2	—	4												
32	2	—	4												
33	4	—	4												

100 Percent Dynamic Testing of Concrete Piling

- How do we know when to stop driving?
  - ✓ Minimum tip requirements are satisfied
  - ✓ Dynamic testing
    - External or internal instrumentation

100 Percent Dynamic Testing of Concrete Piling

- In both cases – driving is stopped past minimum tip when the Nominal Bearing Resistance (NBR) is achieved as per Specs

PILE DATA TABLE														
INSTALLATION CRITERIA								DESIGN CRITERIA						
PIER or BENT NUMBER	PILE SIZE (in.)	NOMINAL BEARING RESISTANCE (tons)	TENSION RESISTANCE (tons)	MINIMUM TIP ELEVATION (ft.)	TEST PILE LENGTH (ft.)	REQUIRED JET ELEVATION (ft.)	REQUIRED PREFORM ELEVATION (ft.)	FACTORED DESIGN LOAD (tons)	DOWN DRAG (tons)	TOTAL SCOUR RESISTANCE (tons)	NET SCOUR RESISTANCE (tons)	100-YEAR SCOUR ELEVATION (ft.)	LONG TERM SCOUR ELEVATION (ft.)	RESISTANCE FACTOR-ϕ
End Bent 1	24	229	NA	-20	74	NA	NA	145	4.0	NA	NA	NA	NA	0.65
Pier 2	24	255	NA	-28	NA	NA	-28	166	NA	NA	NA	NA	NA	0.65
Pier 3	24	272	NA	-30	68	NA	-13.7	177	NA	NA	NA	NA	NA	0.65
Pier 4	24	272	NA	-35	NA	NA	-31.5	177	NA	NA	NA	NA	NA	0.65
Pier 5	24	305	NA	-35	98	NA	-35	198	NA	NA	NA	NA	NA	0.65

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- Nominal Bearing Resistance
  - ✓ "Davisson capacity"
    - Acceptable displacement criteria

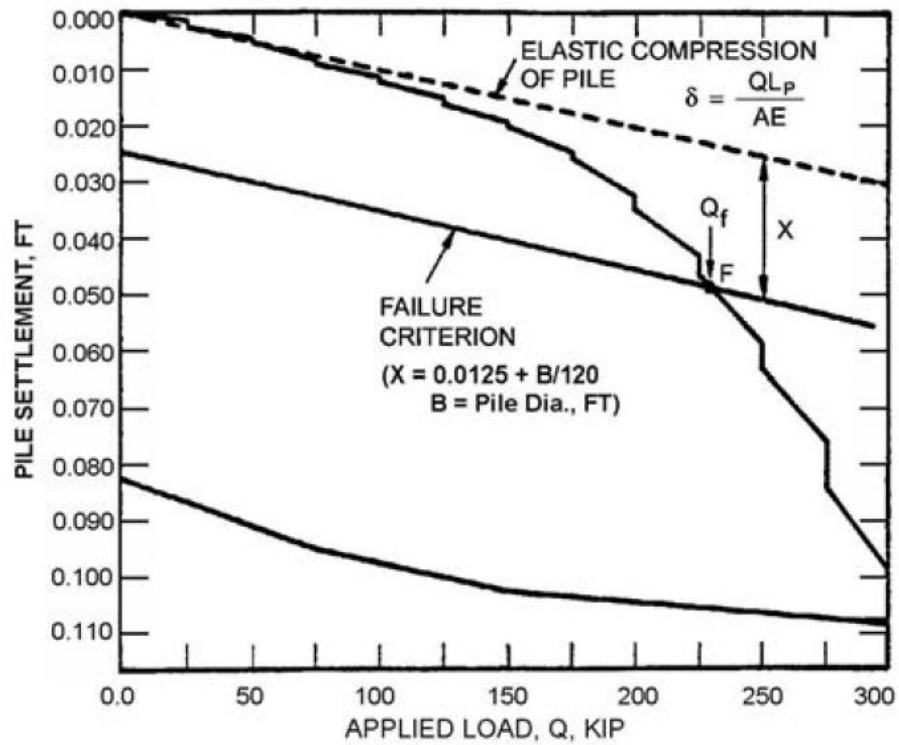

Figure C10.7.3.8.2-1—Alternate Method Load Test Interpretation (Cheney and Chassie, 2000, modified after Davisson, 1972)

AASHTO

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- The failure load is defined as the load that causes a pile/shaft top deflection equal to the calculated elastic compression plus 0.15 inches plus D/120….

Specifications for 24” and smaller

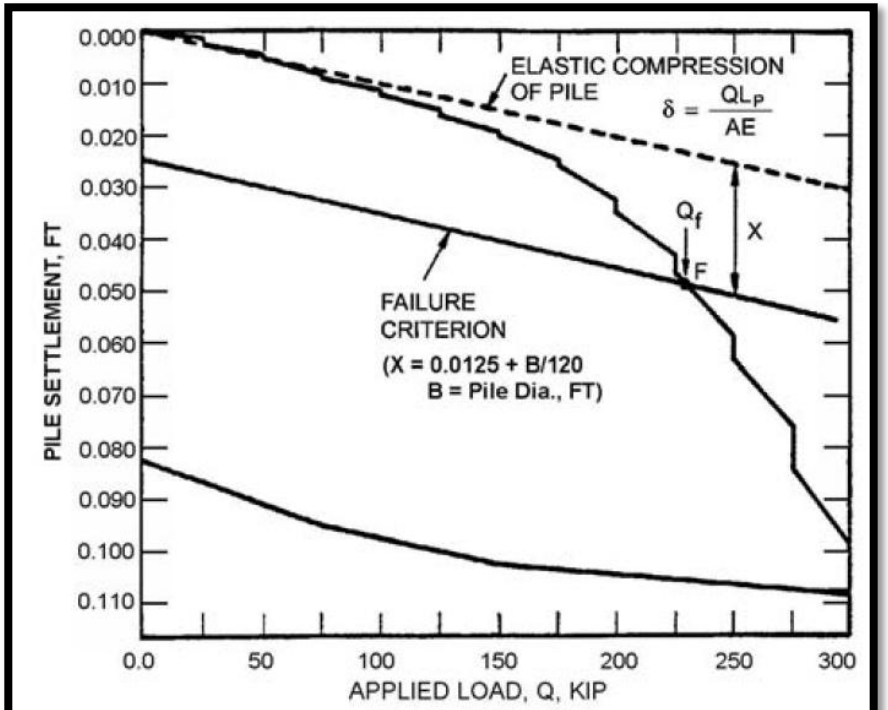

Figure C10.7.3.8.2-1—Alternate Method Load Test Interpretation (Cheney and Chassie, 2000, modified after Davisson, 1972)

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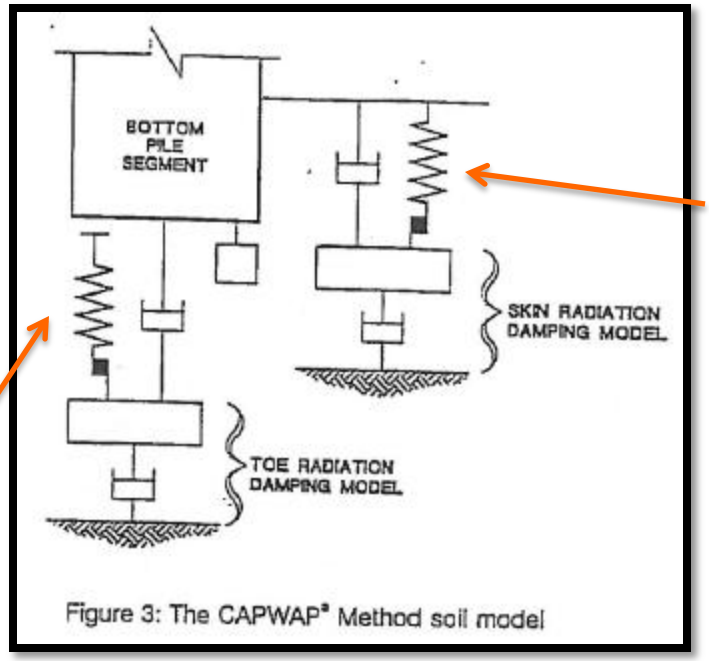

Figure 3: The CAPWAP® Method soil model

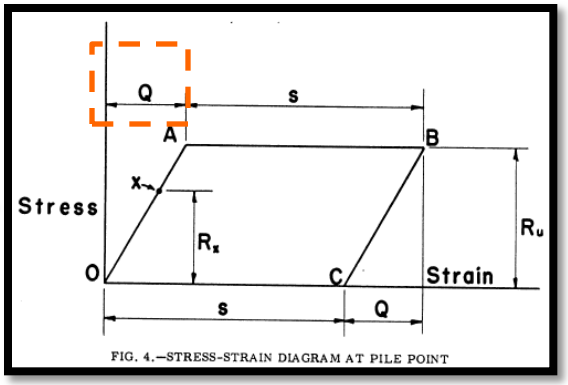

FIG. 4.—STRESS-STRAIN DIAGRAM AT PILE POINT

Skin quake ≈ 0.15”

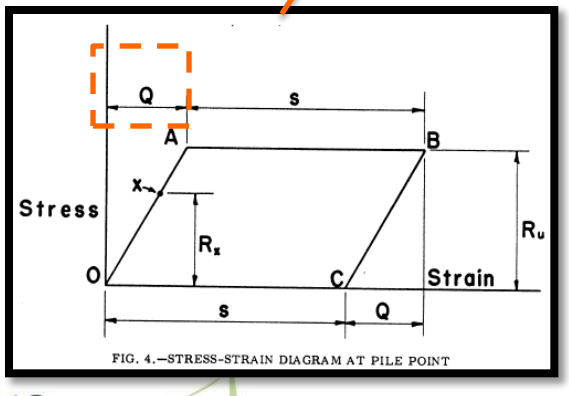

FIG. 4.—STRESS-STRAIN DIAGRAM AT PILE POINT

Toe quake ≈ D/120

Reasonable “first guess” values

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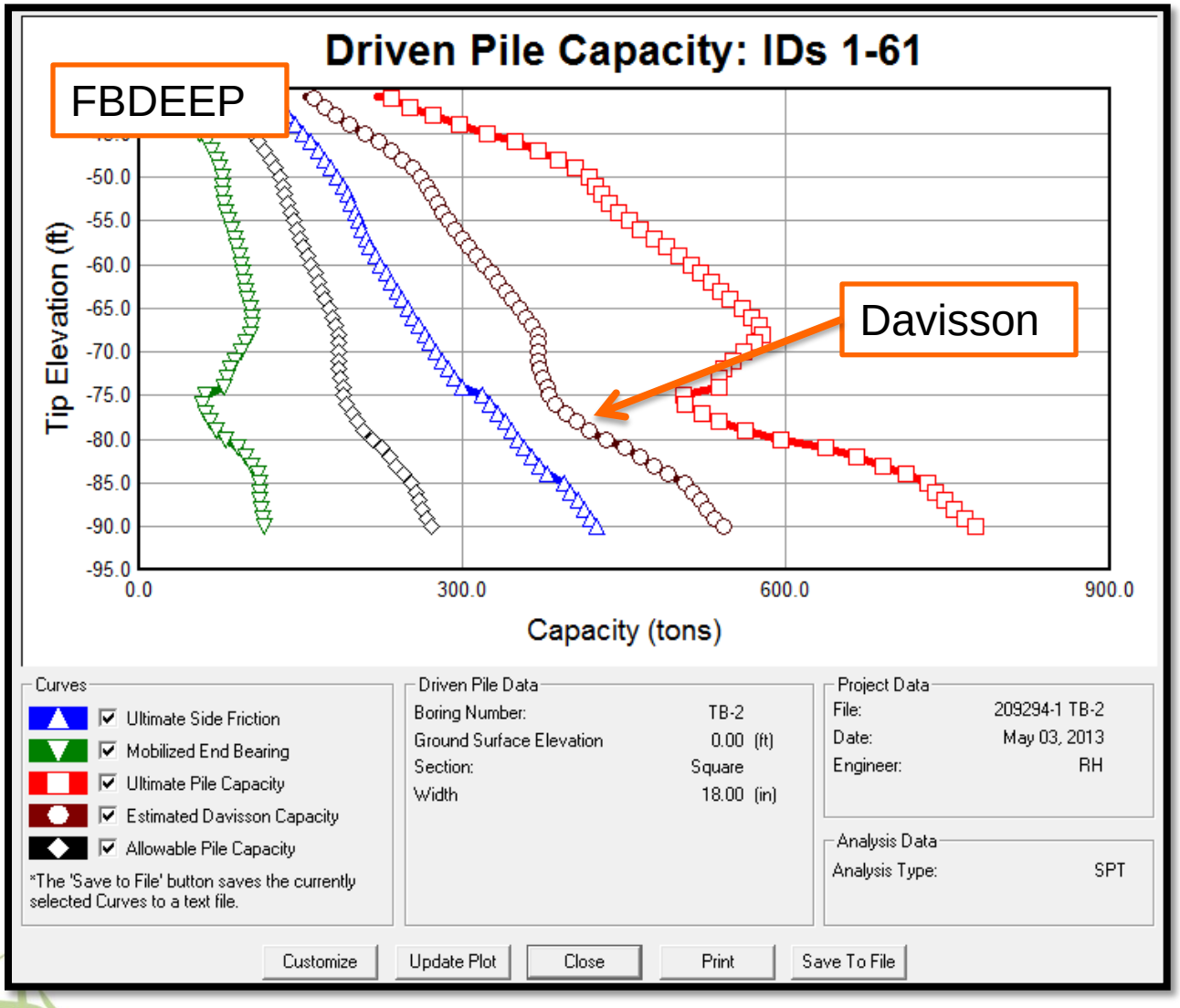

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TEST TYPE	Avg.	COV	Correl	N
DeBeer	0.768	0.210	0.842	24
Housel	0.822	0.120	0.872	22
Corps of Engineers	0.913	0.095	0.882	24
Davisson	**0.945**	**0.092**	**0.915**	17
Tangent Intersection	0.998	0.086	0.872	24
Shen-Niu	1.008	0.086	0.939	23
Butler-Hoy	1.025	0.081	0.925	24
Brinch-Hansen 90%	1.075	0.044	0.960	15
Fuller-Hoy	1.091	0.067	0.950	24
Mazurkiewicz	1.153	0.072	0.932	24
Brinch-Hansen 80%	1.240	0.176	0.796	20
Chin-Kondner	1.511	0.326	0.515	23

Table 2: Correlations of different failure criteria (after Duzceer & Saglamer, 2002)

CAPWAP

Compared against the average result of 17 static load tests (CW/SLT)

Likins & Rausche, 2004

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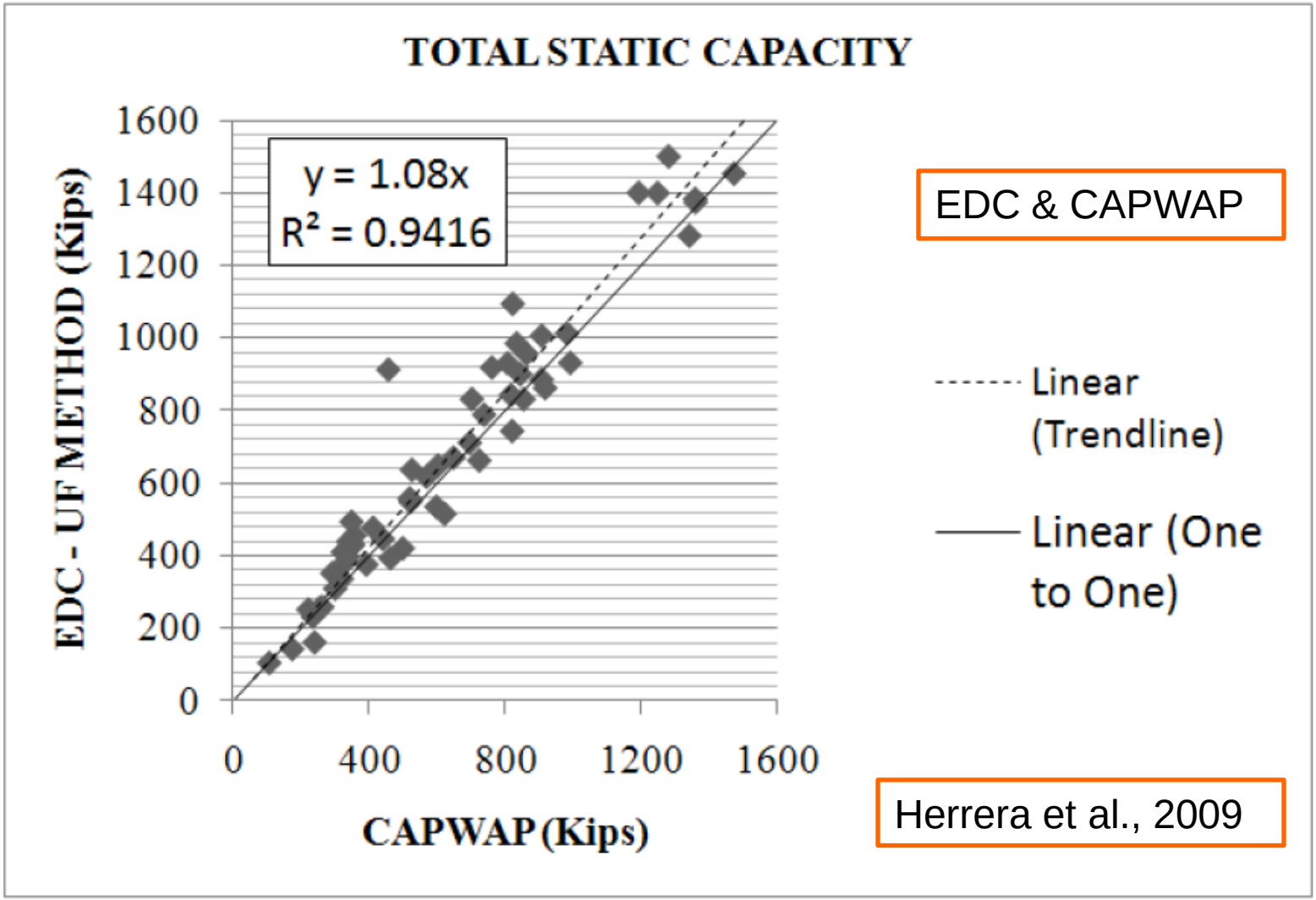

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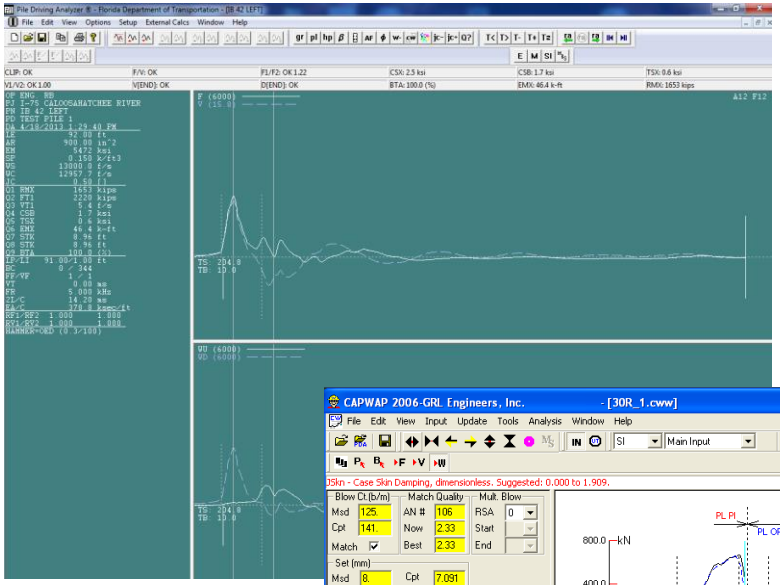
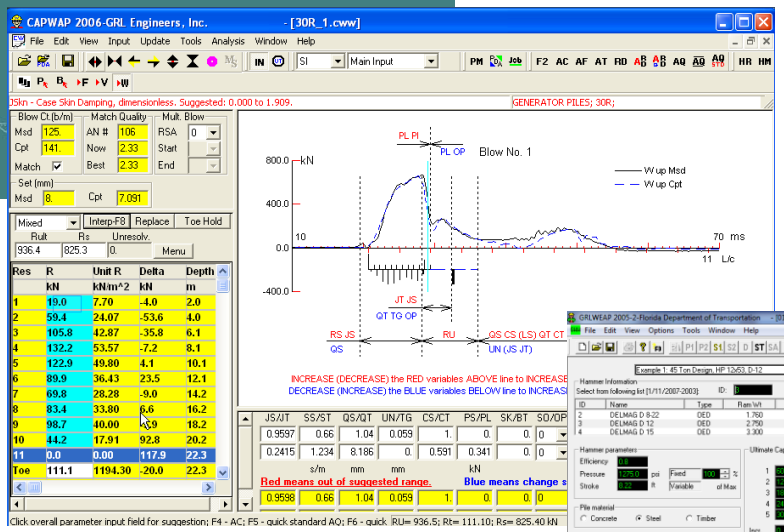
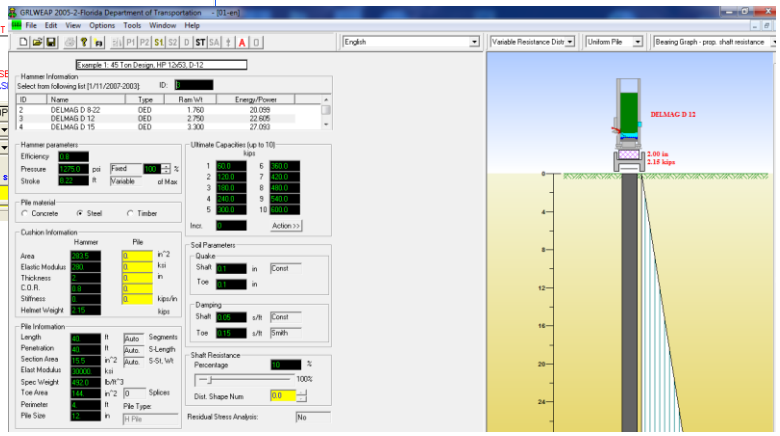


PDA-W



CAPWAP



WEAP

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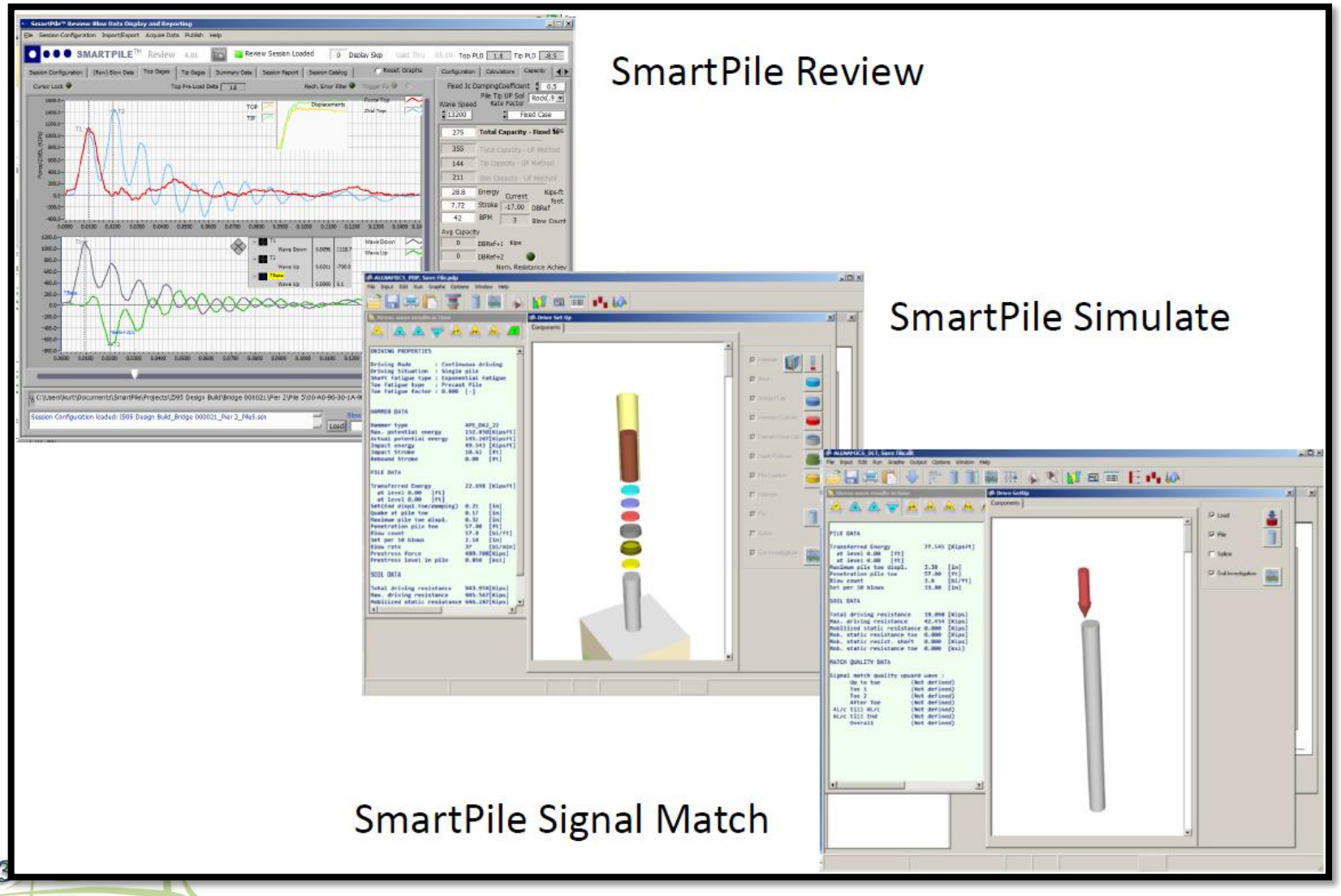
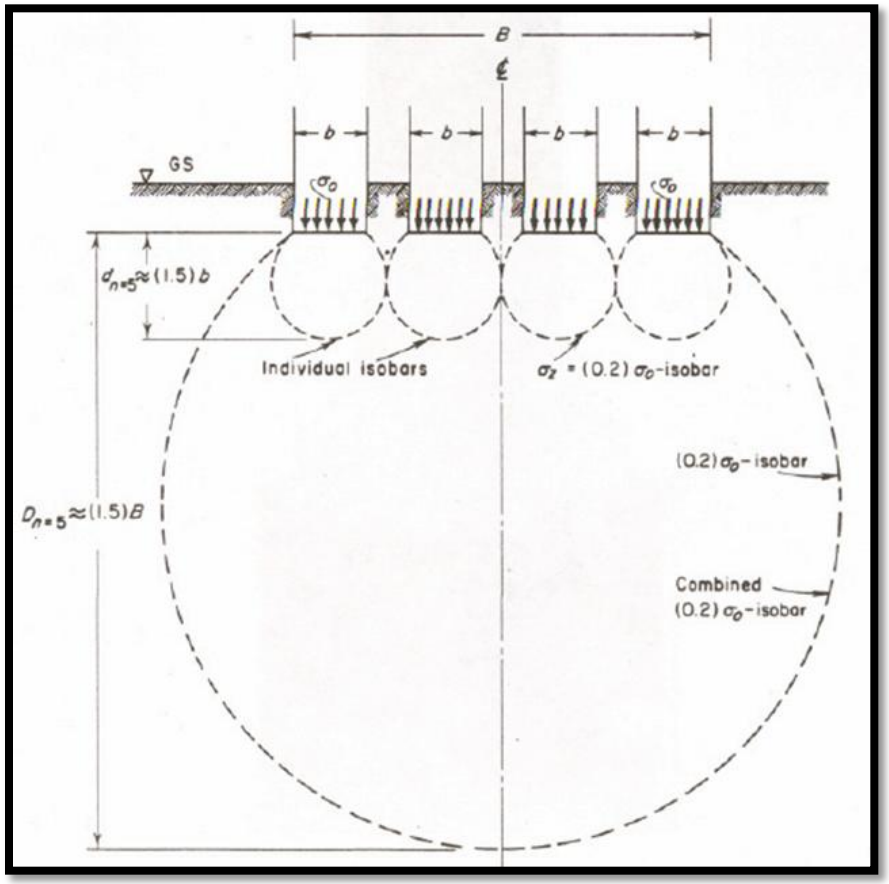
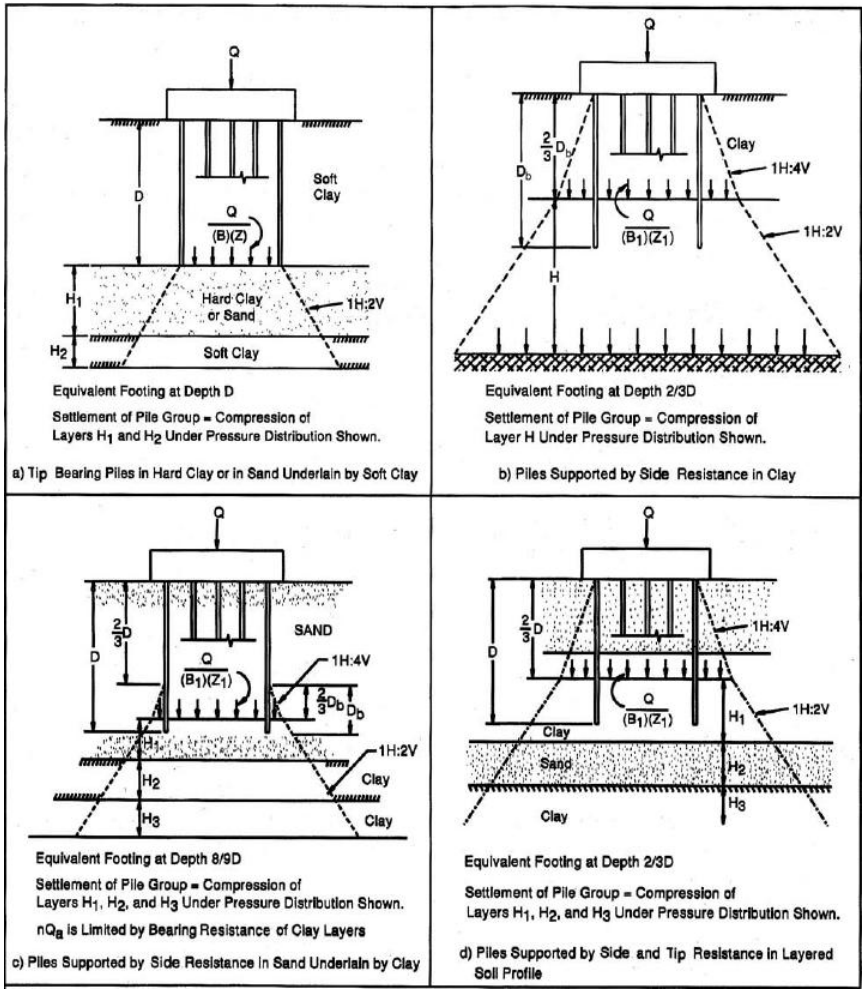


100 Percent Dynamic Testing of Concrete Piling





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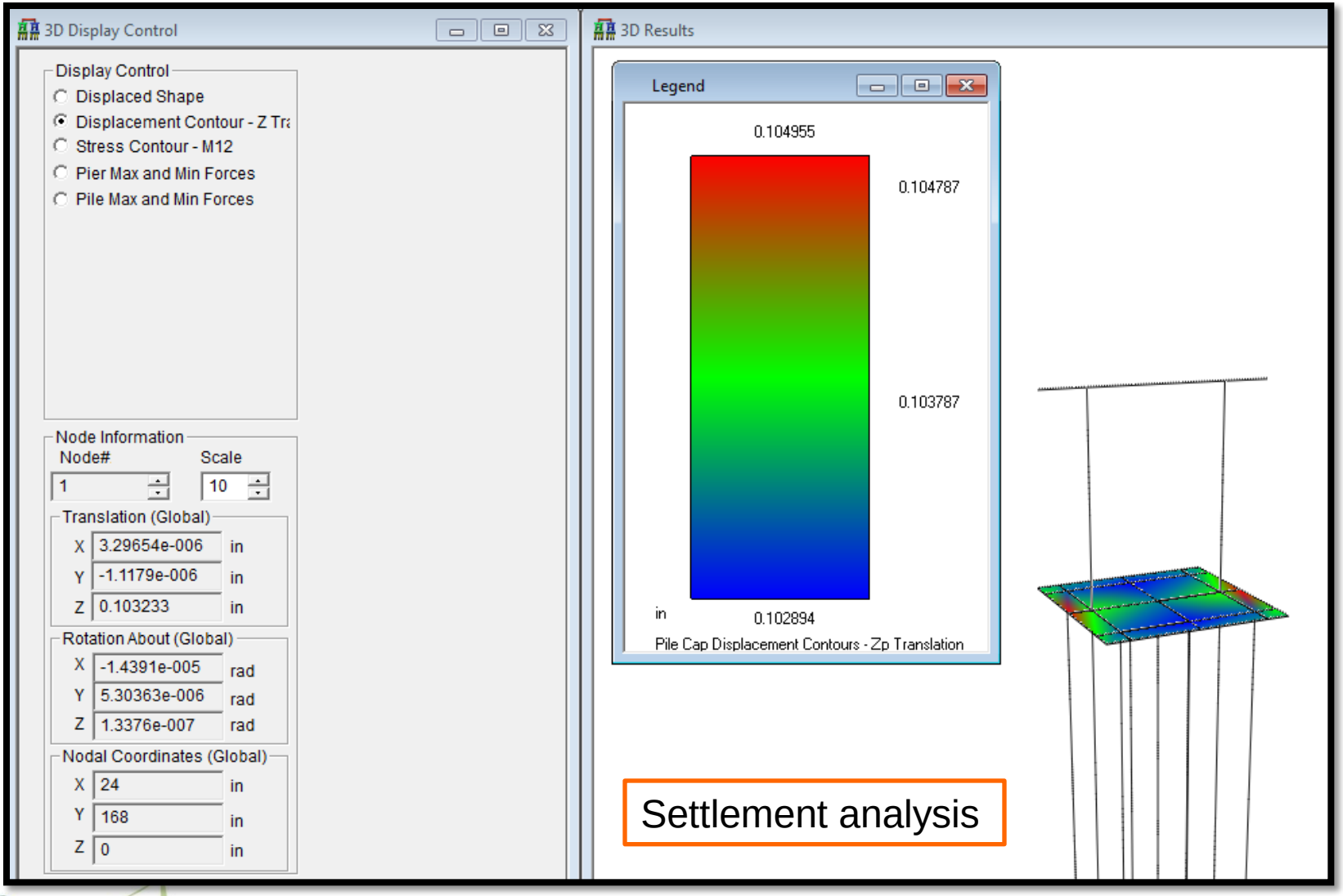

Settlement analysis

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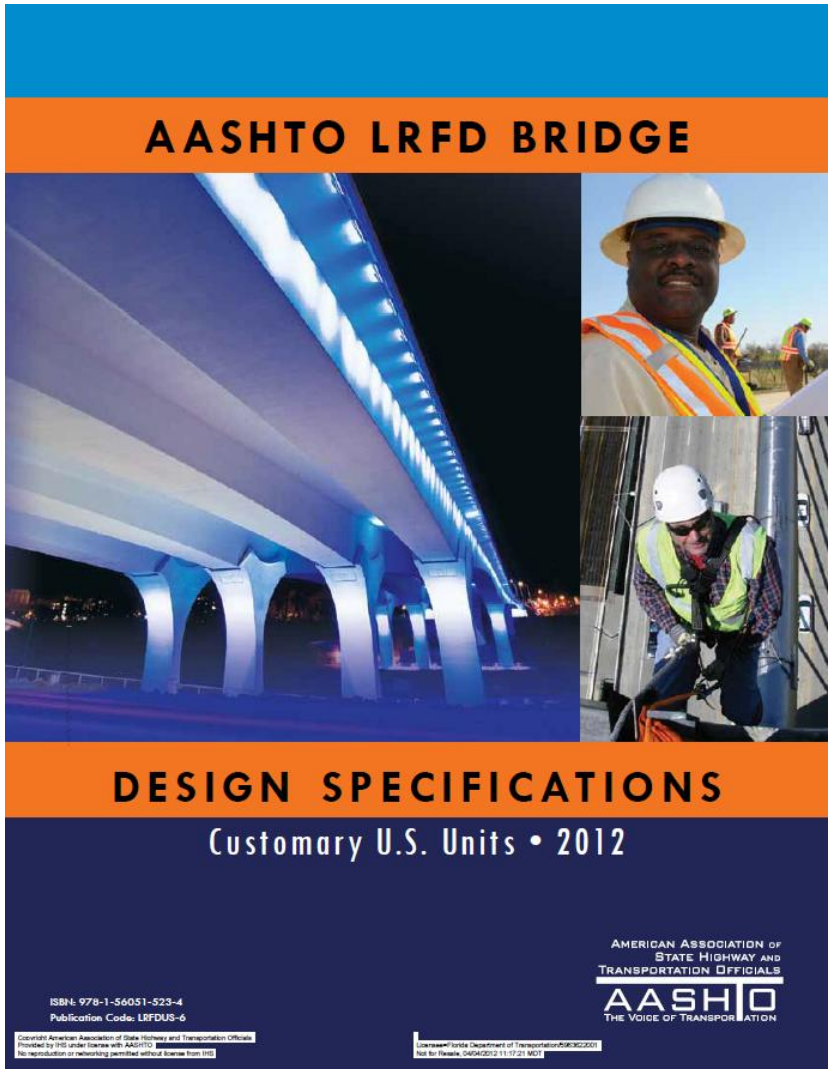
Probability based design code



100 Percent Dynamic Testing of Concrete Piling

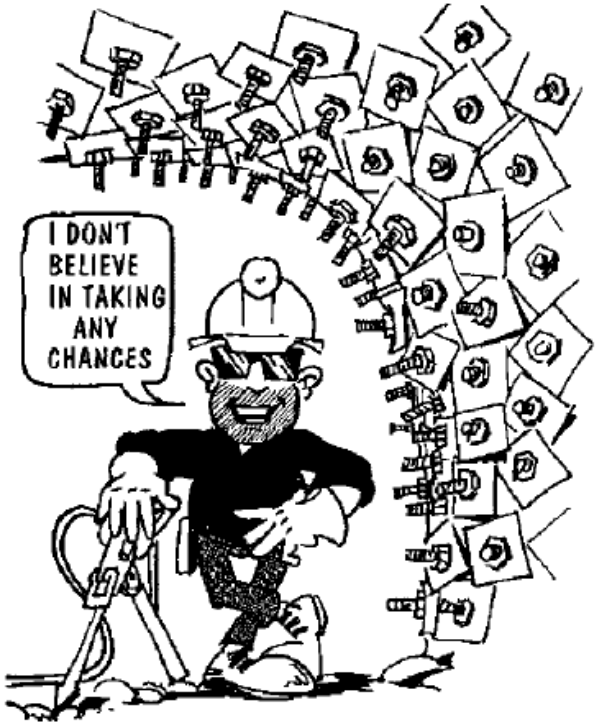


Figure 8.1: Rockbolting alternatives involving individual judgement. (Drawings based upon a cartoon in a brochure on rockfalls published by the Department of Mines of Western Australia.)

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- "…A zero risk level, however, is unlikely to be reached and in most cases it is necessary to accept a certain level of residual risk. This final risk level will be determined by the cost of safety measures weighed against the perceived public reaction to the damage resulting from the accidental action, together with consideration of the economic consequences and the potential number of casualties involved."
- "The risk should also be based on a comparison with risks generally accepted by society in comparable situations."

Eurocode Draft

100 Percent Dynamic Testing of Concrete Piling

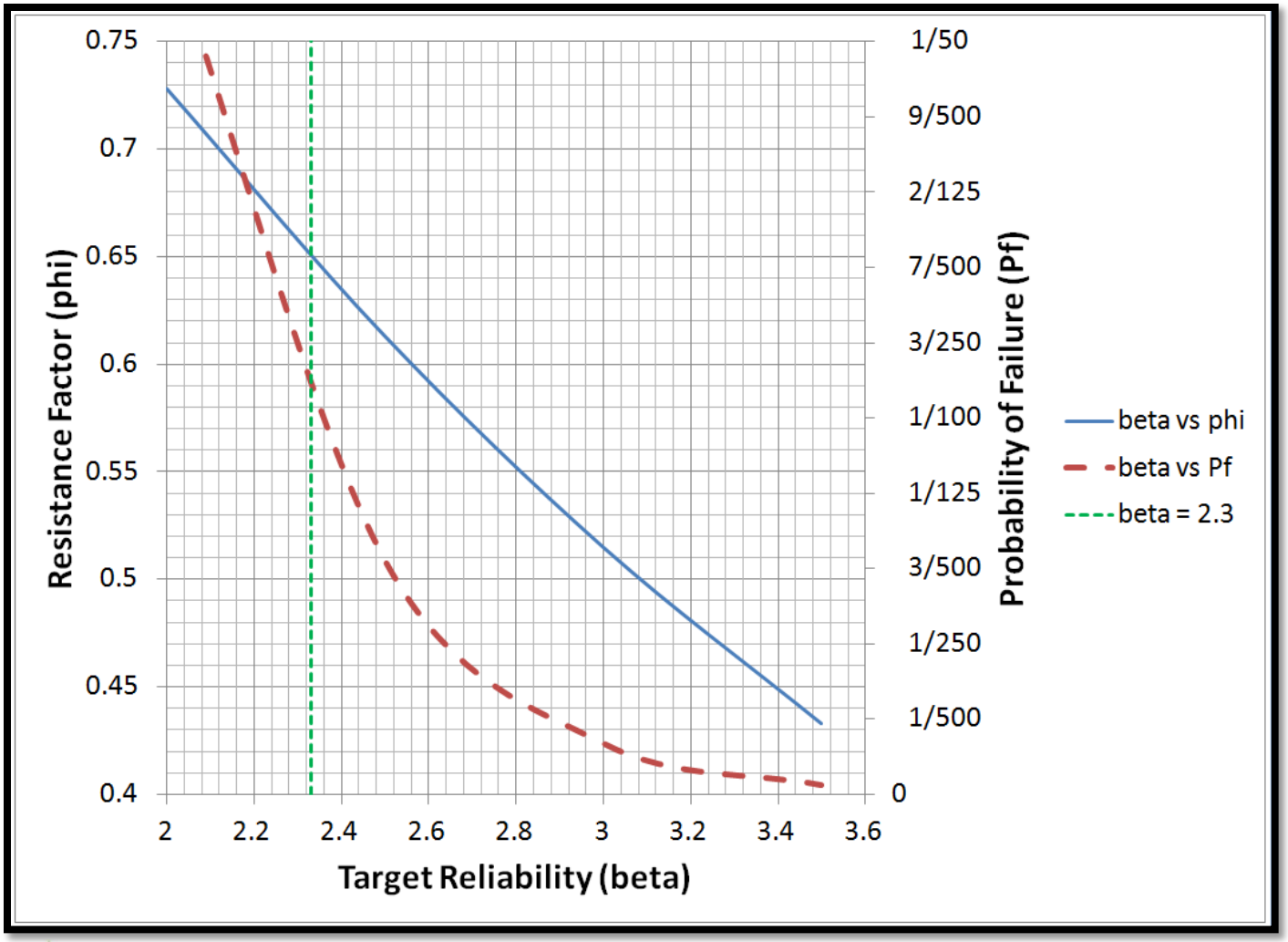
- Acceptable probability of failure for pile foundations
  - ✓ FHWA questionnaire distributed to 298 state highway officials (45 responses)
    - "The assessment for the acceptable maximum failure probability ranged from about 0 to 1%. Pile failure had been experienced by 14% of the respondents."

NCHRP 507

100 Percent Dynamic Testing of Concrete Piling

In general, resistance factors for bridge and other structure design have been derived to achieve a reliability index, β, of 3.5, an approximate probability of failure, P_f, of 1 in 5,000. However, past geotechnical design practice has resulted in an effective reliability index, β, of 3.0, or an approximate probability of a failure of 1 in 1,000, for foundations in general , and for highly redundant systems, such as pile groups, an approximate reliability index, β, of 2.3, an approximate probability of failure of 1 in 100 (Zhang et al., 2001; Paikowsky et al., 2004; Allen, 2005). If the resistance factors provided in this Article are adjusted to account for regional practices using statistical data and calibration, they should be developed using the β values provided above, with consideration given to the redundancy in the foundation system.

100 Percent Dynamic Testing of Concrete Piling



100 Percent Dynamic Testing of Concrete Piling

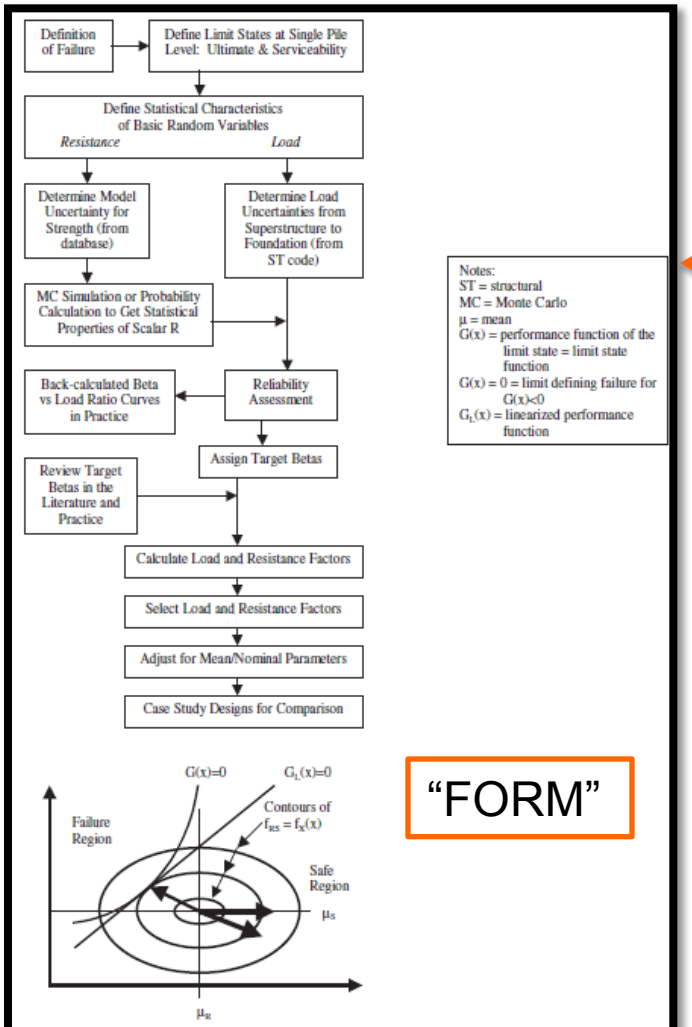
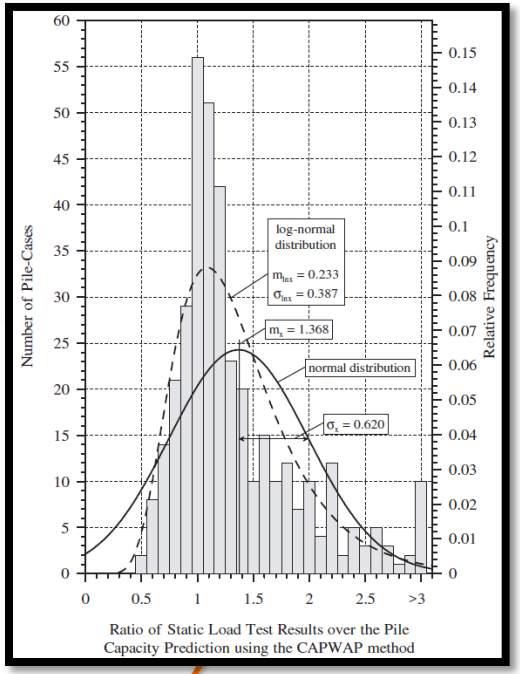


Figure 5. Resistance factor analysis flow chart (after Ayyub and Assakkaf, 1999 and Ayyub et al., 2000), using FORM developed by Hasofer and Lind (1974).

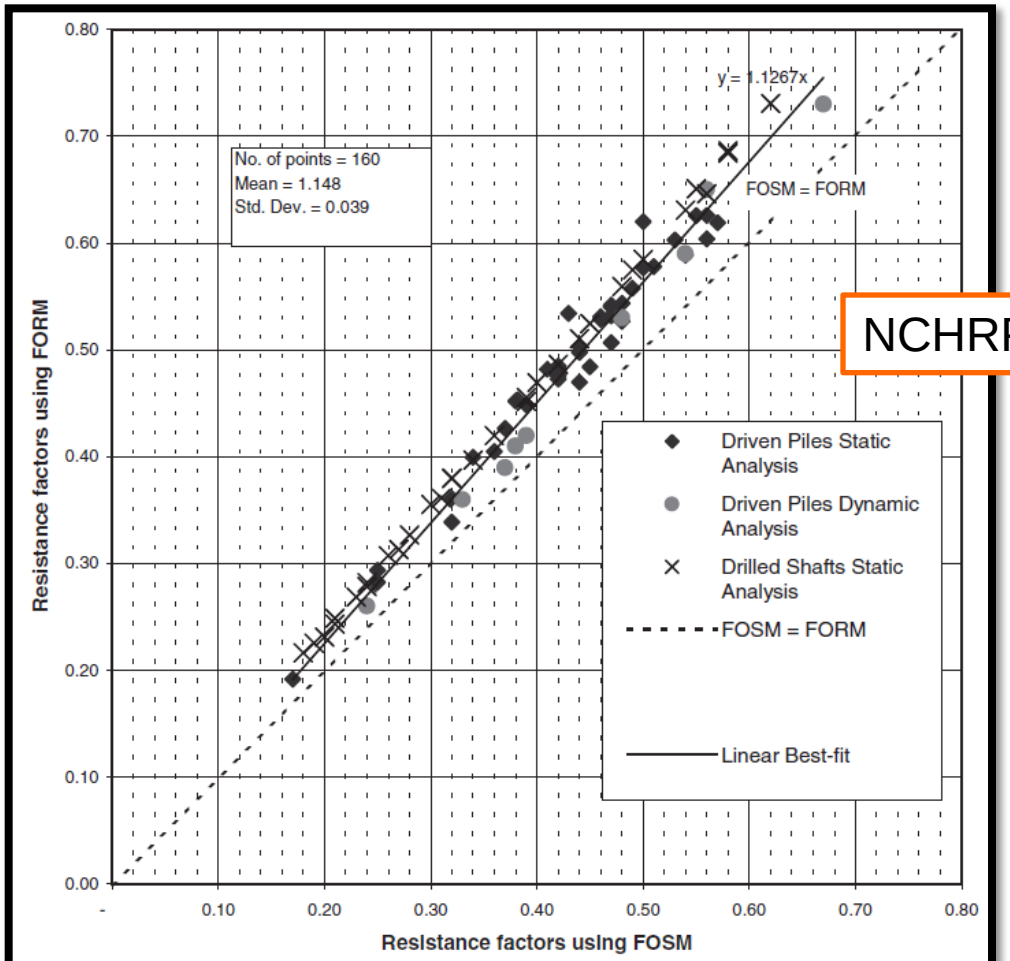
"FORM"



$$\phi = \frac{\lambda_R\left(\frac{\gamma_D Q_D}{Q_L} + \gamma_L\right)\sqrt{\left[\frac{\left(1 + COV_{Q_D}^2 + COV_{Q_L}^2\right)}{\left(1 + COV_R^2\right)}\right]}}{\left(\frac{\lambda_{Q_D} Q_D}{Q_L} + \lambda_{Q_L}\right)\exp\left\{\beta_T\sqrt{\ln\left[\left(1 + COV_R^2\right)\left(1 + COV_{Q_D}^2 + COV_{Q_L}^2\right)\right]}\right\}}$$

"FOSM"

100 Percent Dynamic Testing of Concrete Piling



NCHRP 507

Figure 41. Comparison between resistance factors obtained using the First Order Second Moment (FOSM) vs. those obtained by using First Order Reliability Method (FORM) for a target reliability of $\beta = 2.33$.

100 Percent Dynamic Testing of Concrete Piling

CALIBRATING RESISTANCE FACTORS IN THE LOAD AND RESISTANCE FACTOR DESIGN FOR FLORIDA FOUNDATIONS

State Project No.: 99700-3339-010
UF Project No.: 4910450457112
WPI No.: 0510772
Contract No.: BA512

Investigators

Michael C. McVay
Ching L. Kuo
William A. Singletary

Driven Pile	Bridge Foundation	Compression	Modified RB-121 (SPT-94)	2.0	2.45-2.57	0.70	2.5	0.65
			PDA (EOD)	2.5	3.04-3.14	0.55	2.5	0.65
			PDA (BOR)	2.5	2.40-2.50	0.55	2.5	0.55
			Wave Equation Analysis	3.0	2.28-3.11	0.45	2.5	0.35
			Static Load Testing	2.0	-	0.70	2.5	0.75
		Uplift	Modified RB-121 (SPT-94)	2.0	-	0.70	-	0.55
			Static Load Testing	2.0	-	0.70	-	0.65
		Lateral Load	Structure Stability Consideration	-	-	-	-	1.0

100 Percent Dynamic Testing of Concrete Piling

$$\sum \gamma_i Q_{ni} \leq \varphi R_n \qquad (1)$$

Factored load ≤ factored resistance

where

γ_i = load factor applicable to a specific load component;
Q_{ni} = a specific nominal load component;
$\Sigma \gamma_i Q_{ni}$ = the total factored load for the load group applicable to the limit state being considered;
φ = the resistance factor; and
R_n = the nominal resistance available (either ultimate or the resistance available at a given deformation).

100 Percent Dynamic Testing of Concrete Piling

3.5.12 Pile Driving Resistance [10.7.3.8.6]

A. The Geotechnical Engineer calculates the required nominal bearing resistance (R_n) as:

$$\text{(Factored Design Load + Net Scour + Downdrag)} / \varphi < R_n \quad \text{[Eq. 3-1]}$$

Where: φ is the resistance factor taken from Table 3.5.6-1.

Structures Design Guidelines

100 Percent Dynamic Testing of Concrete Piling

AASHTO 6th Ed.

Table 10.5.5.2.3-1—Resistance Factors for Driven Piles

Condition/Resistance Determination Method		Resistance Factor
Nominal Bearing Resistance of Single Pile—Dynamic Analysis and Static Load Test Methods, φ_{dyn}	Driving criteria established by successful static load test of at least one pile per site condition and dynamic testing* of at least two piles per site condition, but no less than 2% of the production piles	0.80
	Driving criteria established by successful static load test of at least one pile per site condition without dynamic testing	0.75
	Driving criteria established by dynamic testing* conducted on 100% of production piles	0.75
	Driving criteria established by dynamic testing,* quality control by dynamic testing* of at least two piles per site condition, but no less than 2% of the production piles	0.65
	Wave equation analysis, without pile dynamic measurements or load test but with field confirmation of hammer performance	0.50
	FHWA-modified Gates dynamic pile formula (End of Drive condition only)	0.40
	Engineering News (as defined in Article 10.7.3.8.5) dynamic pile formula (End of Drive condition only)	0.10

* Dynamic testing requires signal matching, and best estimates of nominal resistance are made from a restrike. Dynamic tests are calibrated to the static load test, when available.

100 Percent Dynamic Testing of Concrete Piling

Table 3.5.6-1 Resistance Factors for Piles (all structures)

Pile Type	Loading	Design Method	Construction QC Method	Resistance Factor, φ
Driven Piles with 100% Dynamic Testing	Compression	Davisson Capacity	EDC or PDA & CAPWAP	0.75
			EDC or PDA & CAPWAP & Static Load Testing	0.85
			EDC or PDA & CAPWAP & Statnamic Load Testing	0.80
	Uplift	Skin Friction	EDC or PDA & CAPWAP	0.60
			EDC or PDA & CAPWAP & Static Uplift Testing	0.65
Driven Piles with ≥5% Dynamic Testing	Compression	Davisson Capacity	Driving criteria based on EDC or PDA & CAPWAP	0.65
			Driving criteria based on EDC or PDA & CAPWAP & Static Load Testing	0.75
			Driving criteria based on EDC or PDA & CAPWAP & Statnamic Load Testing	0.70
	Uplift	Skin Friction	Driving criteria based on EDC or PDA & CAPWAP	0.55
			Driving criteria based on EDC or PDA & CAPWAP & Static Load Testing	0.60
All piles	Lateral (Extreme Event)	FBPier[1]	Standard Specifications	1.00
			Lateral Load Test[2]	1.00

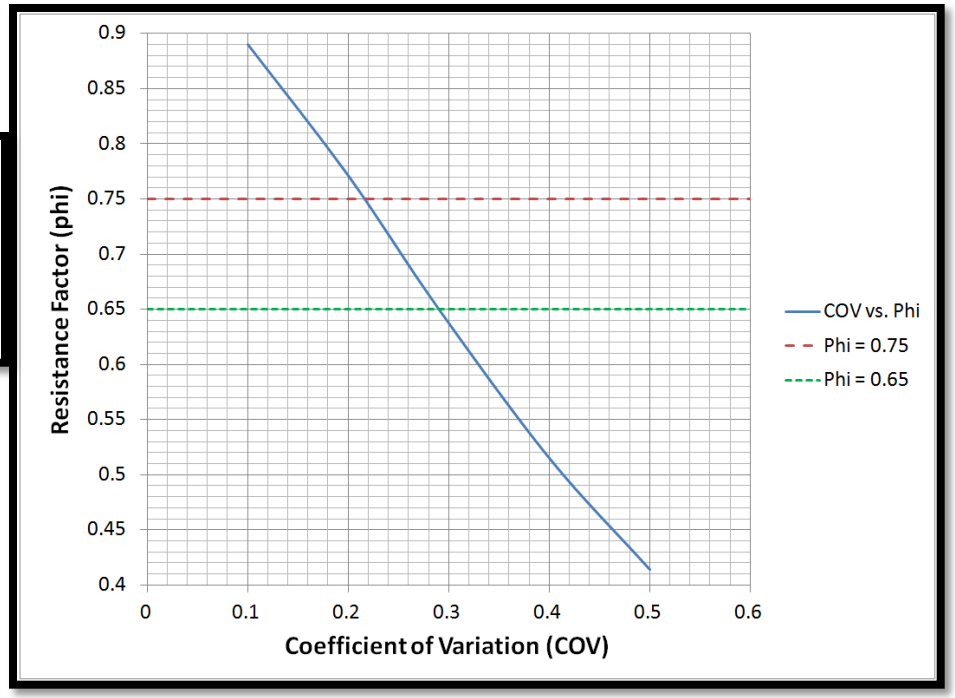
1. Or comparable lateral analysis program.
2. When uncertain soil conditions are encountered.

2013 Structures Design Guidelines

100 Percent Dynamic Testing of Concrete Piling

- When 100% of the foundation elements are dynamically tested there is an increase in confidence, reflected by an increase in resistance factor
  - ✓ Larger number of piles monitored produces a smaller COV of group resistance

$$\phi = \frac{\lambda_R\left(\frac{\gamma_D Q_D}{Q_L} + \gamma_L\right)\sqrt{\left[\frac{\left(1 + COV_{Q_D}^2 + COV_{Q_L}^2\right)}{\left(1 + COV_R^2\right)}\right]}}{\left(\frac{\lambda_{Q_D} Q_D}{Q_L} + \lambda_{Q_L}\right)\exp\left\{\beta_T\sqrt{\ln\left[\left(1 + COV_R^2\right)\left(1 + COV_{Q_D}^2 + COV_{Q_L}^2\right)\right]}\right\}}$$



100 Percent Dynamic Testing of Concrete Piling

PILE DATA TABLE

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PIER or BENT NUMBER	PILE SIZE (in.)	NOMINAL BEARING RESISTANCE (tons)	TENSION RESISTANCE (tons)	MINIMUM TIP ELEVATION (ft.)	TEST PILE LENGTH (ft.)	REQUIRED JET ELEVATION (ft.)	REQUIRED PREFORM ELEVATION (ft.)	FACTORED DESIGN LOAD (tons)	DOWN DRAG (tons)	TOTAL SCOUR RESISTANCE (tons)	NET SCOUR RESISTANCE (tons)	100-YEAR SCOUR ELEVATION (ft.)	LONG TERM SCOUR ELEVATION (ft.)	RESISTANCE FACTOR-Ø
End Bent 1	24	229	NA	-20	74	NA	NA	145	4.0	NA	NA	NA	NA	0.65
Pier 2	24	255	NA	-28	NA	NA	-28	166	NA	NA	NA	NA	NA	0.65
Pier 3	24	272	NA	-30	68	NA	-13.7	177	NA	NA	NA	NA	NA	0.65
Pier 4	24	272	NA	-35	NA	NA	-31.5	177	NA	NA	NA	NA	NA	0.65
Pier 5	24	305	NA	-35	98	NA	-35	198	NA	NA	NA	NA	NA	0.65

100% Dynamic testing…..

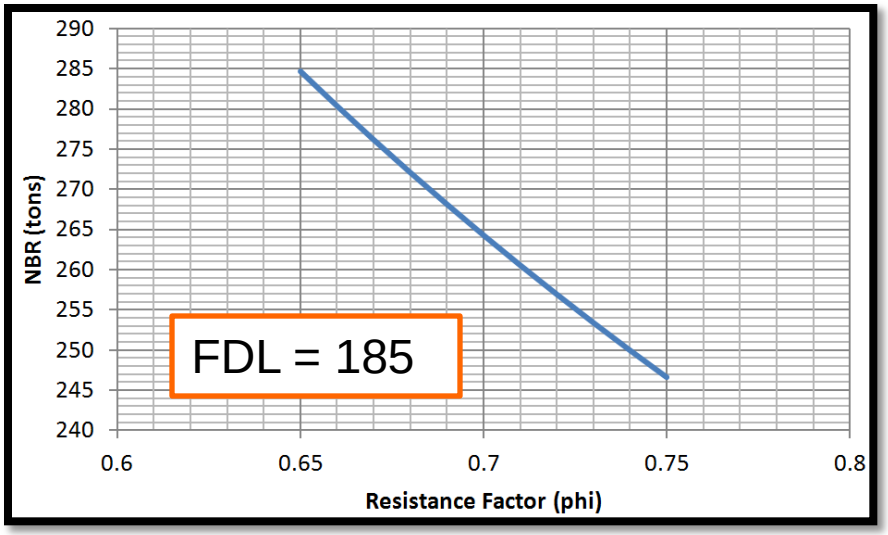
0.75

INSTALLATION CRITERIA								DESIGN CRITERIA						
PIER or BENT NUMBER	PILE SIZE (in.)	NOMINAL BEARING RESISTANCE (tons)	TENSION RESISTANCE (tons)	MINIMUM TIP ELEVATION (ft.)	TEST PILE LENGTH (ft.)	REQUIRED JET ELEVATION (ft.)	REQUIRED PREFORM ELEVATION (ft.)	FACTORED DESIGN LOAD (tons)	DOWN DRAG (tons)	TOTAL SCOUR RESISTANCE (tons)		00-YEAR SCOUR EVATION (ft.)	LONG TERM SCOUR ELEVATION (ft.)	RESISTANCE FACTOR-Ø
End Bent 1	24	~~229~~	NA	-20	74	NA	NA	~~145~~	4.0	NA	NA	NA	NA	65
Pier 2	24	~~255~~	NA	-28	NA	NA	-28	~~166~~	NA	NA	NA	NA	NA	0.65
Pier 3	24	~~272~~	NA	-30	68	NA	-13.7	~~177~~	NA	NA	NA	NA	NA	0.65
Pier 4	24	~~272~~	NA	-35	NA	NA	-31.5	~~177~~	NA	NA	NA	NA	NA	0.65
Pier 5	24	~~305~~	NA	-35	98	NA	-35	~~198~~	NA	NA	NA	NA	NA	65

100 Percent Dynamic Testing of Concrete Piling

- From a geotechnical perspective, a larger resistance factor
  - ✓ Lower required NBR
  - ✓ (possibly) shorter piles
  - ✓ Reduced width (?)
  - ✓ Reduced pile driving time

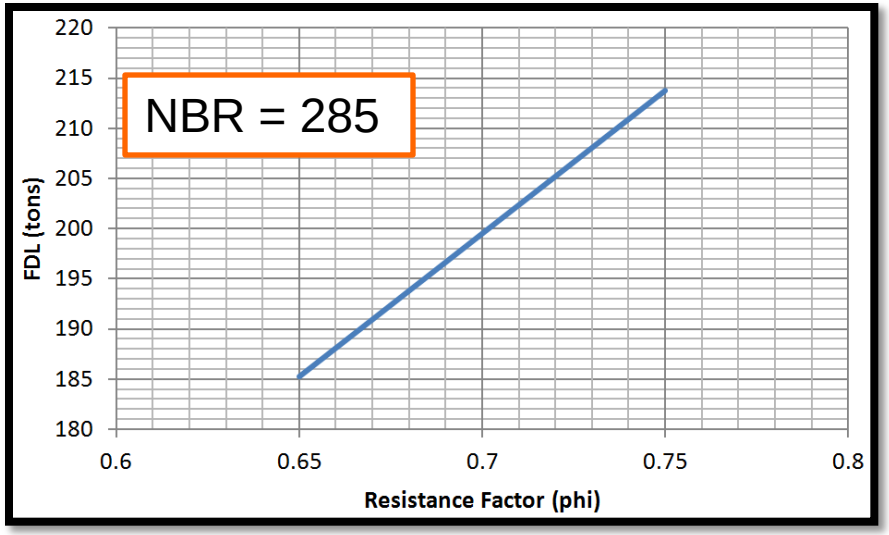
$$NBR = (FDL+NS+DD)/\phi$$



100 Percent Dynamic Testing of Concrete Piling

- From a structures design perspective, a larger resistance factor
  - ✓ Higher FDL/pile
  - ✓ (possibly) longer piles
  - ✓ (possibly) less piles
  - ✓ Construction time (?)

$$\phi * NBR = FDL + NS + DD$$



100 Percent Dynamic Testing of Concrete Piling

- Cost should determine the decision to test all piles

100 Percent Dynamic Testing of Concrete Piling

- Cost analysis justifying the use of 100% dynamic testing must be submitted to the State Geotechnical Engineer in Design Bid Build projects

100 Percent Dynamic Testing of Concrete Piling

Structures Design Guidelines - Chapter 9

9.2.1 Substructure (Rev. 01/13)

A. Prestressed Concrete Piling; cost per linear foot (furnished and installed)

Size of Piling	Driven Plumb or 1" Batter	Driven Battered
18-inch	$55/large qty. - $75/small qty.	$75
24-inch	$70/large qty. - $100/small qty.	$95
30-inch	$120	$140

When heavy mild steel reinforcing is used in the pile head, add $250.

When silica fume, metakaolin or ultrafine fly ash is used, add $6 per LF to the piling cost.

B. Steel Piling: cost per linear foot (furnished and installed)

14 x 73 H Section	$70
14 x 89 H Section	$90
20" Pipe Pile	$105
24" Pipe Pile	$114
30" Pipe Pile	$160

Production piles

100 Percent Dynamic Testing of Concrete Piling

Florida Department of
TRANSPORTATION

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Specifications and Estimates

Specifications and Estimates / Estimates

Historical Cost and Other Information

Specifications & Estimates
Florida's Transportation Engineers

Greg Davis, State Estimates Engineer
Phone: (850) 414-4170
Fax: (850) 414-4199

Pay Item Cost History - (Averages below represent bid prices on Construction projects only)

Cost Per Mile Models for **Long Range Estimates** are available on the LRE page.

The reports below can be ran in either Adobe PDF or Microsoft Excel 2003 or higher. **Free download. Free viewer download.**

- Annual Statewide Averages:
  - January 2012 - December 31, 2012, **in .pdf format, in Excel 2007 format**
  - January 2010 - December 31, 2010, **in .pdf format, in Excel 2007 format**
  - January 2009 - December 31, 2009, **in .pdf format, in Excel 2007 format**

http://www.dot.state.fl.us/specificationsoffice/Estimates/HistoricalCostInformation/HistoricalCost.shtm

100 Percent Dynamic Testing of Concrete Piling

CESPO05 04/08/2013-12.12.35 Page:

Florida Department of Transportation
Item Average Unit Cost
From 2012/01/01 to 2012/12/31

Contract Type: ALL Statewide
Displaying: VALID ITEMS WITH HITS
From: 0101 1 To: 9999999999

Test Piles

Item	No. of Conts	Weighted Average	Total Amount	Total Quantity	Unit Meas	Obs?	Description
0455 87	1	$750.00	$126,750.00	169.000	EA	N	ANCHOR BAR, STEEL
0455 88 3	1	$297.00	$326,106.00	1,098.000	LF	N	DRILLED SHAFT, 36" DIA
0455 88 5	3	$432.59	$2,937,275.00	6,790.000	LF	N	DRILLED SHAFT, 48" DIA
0455107 3	1	$194.00	$134,248.00	692.000	LF	N	DRILLED SHAFT CASING, 36" DIA
0455107 5	3	$346.66	$1,071,868.00	3,092.000	LF	N	DRILLED SHAFT CASING, 48" DIA
0455111	2	$26.60	$201,210.00	7,564.000	LF	N	CORE-PILOT HOLE,DRILLED SHAFT EXCAV
0455112 5	1	$82.64	$894,495.36	10,824.000	LF	N	PILE AUGER GROUTED, 18" DIA
0455120 6	1	$1,200.00	$28,800.00	24.000	EA	N	PILE POINT PROTECTION, 20" ROUND
0455122 3	1	$224.00	$229,376.00	1,024.000	LF	N	UNCLASSIFIED SHAFT EXCAVATION, 36" DIA
0455122 5	3	$292.81	$1,671,964.00	5,710.000	LF	N	UNCLASSIFIED SHAFT EXCAVATION, 48" DIA
0455133 2	18	$5.30	$3,859,544.02	727,597.000	SF	N	SHEET PILING STEEL, TEMPORARY-CRITICAL
0455133 3	13	$43.49	$10,140,520.42	233,191.000	SF	N	SHEET PILING STEEL, F&I PERMANENT
0455142	3	$1,806.12	$265,500.00	147.000	EA	N	CROSSHOLE SONIC LOGGING
0455143 3	9	$123.38	$617,285.70	5,003.000	LF	N	TEST PILES-PREST CONCRETE,18" SQ
0455143 5	8	$132.47	$1,357,277.70	10,246.000	LF	N	TEST PILES-PREST CONCRETE,24" SQ
0455144 20	1	$250.00	$146,290.00	585.000	LF	N	TEST PILES - STEEL, 18" DIA PIPE
0455144 21	1	$120.00	$20,040.00	167.000	LF	N	TEST PILES - STEEL, 20" DIA PIPE

100 Percent Dynamic Testing of Concrete Piling

CESPO05 04/08/2013-12.12.35 Page:

Florida Department of Transportation
Item Average Unit Cost
From 2012/01/01 to 2012/12/31

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Production Piles

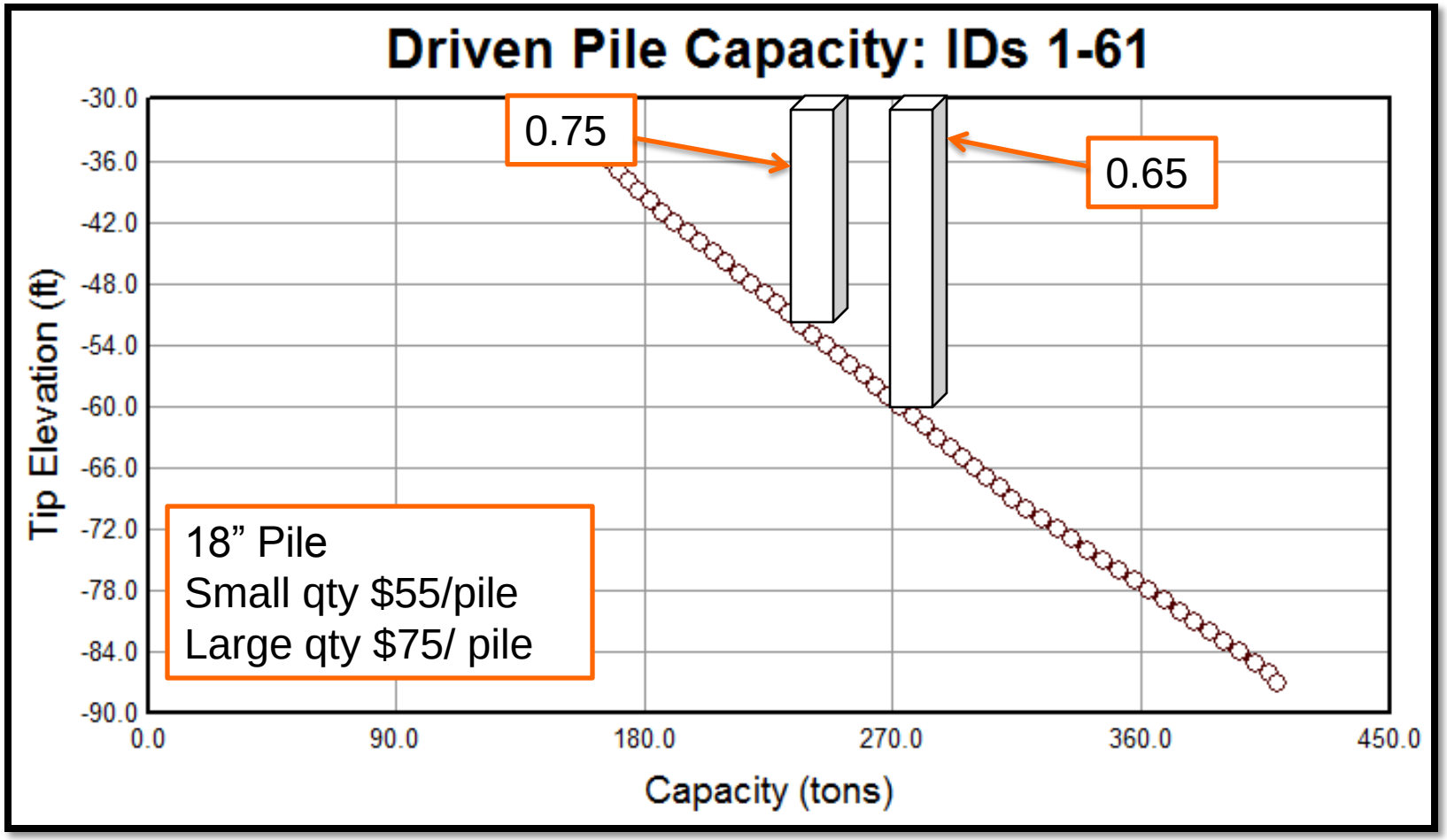
Item	No. of Conts	Weighted Average	Total Amount	Total Quantity	Unit Meas	Obs?	Description
0446 71 1	3	$39.58	$193,942.50	4,900.500	LF	N	EDGEDRAIN OUTLET PIPE, 4"
0448 73	1	$4,718,564.87	$4,718,564.87	1.000	LS	N	PUMPING STATION- DRAINAGE
0450 1 1	2	$76.60	$849,846.00	11,094.000	LF	N	PREST BEAMS, TYPE II
0450 1 7	1	$215.00	$142,760.00	664.000	LF	N	PREST BEAMS, SPECIAL TYPE
0450 2 36	5	$156.82	$2,664,188.94	16,989.000	LF	N	PREST BEAMS: FLORIDA-I BEAM 36"
0450 2 45	3	$196.55	$296,200.00	1,507.000	LF	N	PREST BEAMS: FLORIDA-I BEAM 45"
0450 2 54	2	$147.56	$1,055,503.00	7,153.000	LF	N	PREST BEAMS: FLORIDA-I BEAM 54"
0450 2 63	2	$175.22	$2,442,075.00	13,937.000	LF	N	PREST BEAMS: FLORIDA-I BEAM 63"
0450 2 78	2	$203.82	$2,017,792.00	9,900.000	LF	N	PREST BEAMS: FLORIDA-I BEAM 78"
0450 3 15	1	$104.00	$61,464.00	591.000	LF	N	PRESTRESSED SLAB UNITS,48" X 15"
0450 3 25	1	$130.00	$96,070.00	739.000	LF	N	PRESTRESSED SLAB UNITS,60" X 15"
0450 82	3	$256.50	$105,935.00	413.000	LF	N	BEAMS REPAIR
0450 82 1	1	$300.00	$6,000.00	20.000	LF	N	BEAM REPAIR- MAINT CONTR ONLY
0450 82 2	1	$400.00	$8,000.00	20.000	LF	N	BEAM REPAIR- MAINT CONTR ONLY
0450 82 3	1	$500.00	$10,000.00	20.000	LF	N	BEAM REPAIR- MAINT CONTR ONLY
0450 82 4	1	$500.00	$10,000.00	20.000	LF	N	BEAM REPAIR- MAINT CONTR ONLY
0450 83 1	5	$1,310.95	$57,682.00	44.000	EA	N	BEAM REPAIR, STRAND SPLICES
0450 83 11	1	$800.00	$1,600.00	2.000	EA	N	BEAM REPAIR- MAINT CONT ONLY, STRAND SPL
0450 83 12	1	$1,000.00	$2,000.00	2.000	EA	N	BEAM REPAIR- MAINT CONT ONLY, STRAND SPL
0450 83 13	1	$1,500.00	$3,000.00	2.000	EA	N	BEAM REPAIR- MAINT CONT ONLY, STRAND SPL
0450 83 14	1	$2,000.00	$4,000.00	2.000	EA	N	BEAM REPAIR- MAINT CONT ONLY, STRAND SPL
0455 2	1	$200.00	$2,000.00	10.000	LF	N	TREATED TIMBER PILING
0455 14 3	2	$96.51	$417,095.72	4,322.000	LF	N	CONC SHEET PILING, 10"X30"
0455 18	8	$28,006.28	$392,087.97	14.000	LS	N	PROTECTION OF EXISTING STRUCTURES
0455 34 2	3	$36.93	$641,720.50	17,378.000	LF	N	PRESTRESSED CONCRETE PILING, 14" SQ.
0455 34 3	10	$57.89	$3,283,343.58	56,716.000	LF	N	PRESTRESSED CONCRETE PILING, 18" SQ
0455 34 4	1	$80.00	$1,559,280.00	19,491.000	LF	N	PRESTRESSED CONCRETE PILING, 20" SQ
0455 34 5	9	$81.54	$9,468,417.58	116,117.000	LF	N	PRESTRESSED CONCRETE PILING, 24" SQ

100 Percent Dynamic Testing of Concrete Piling

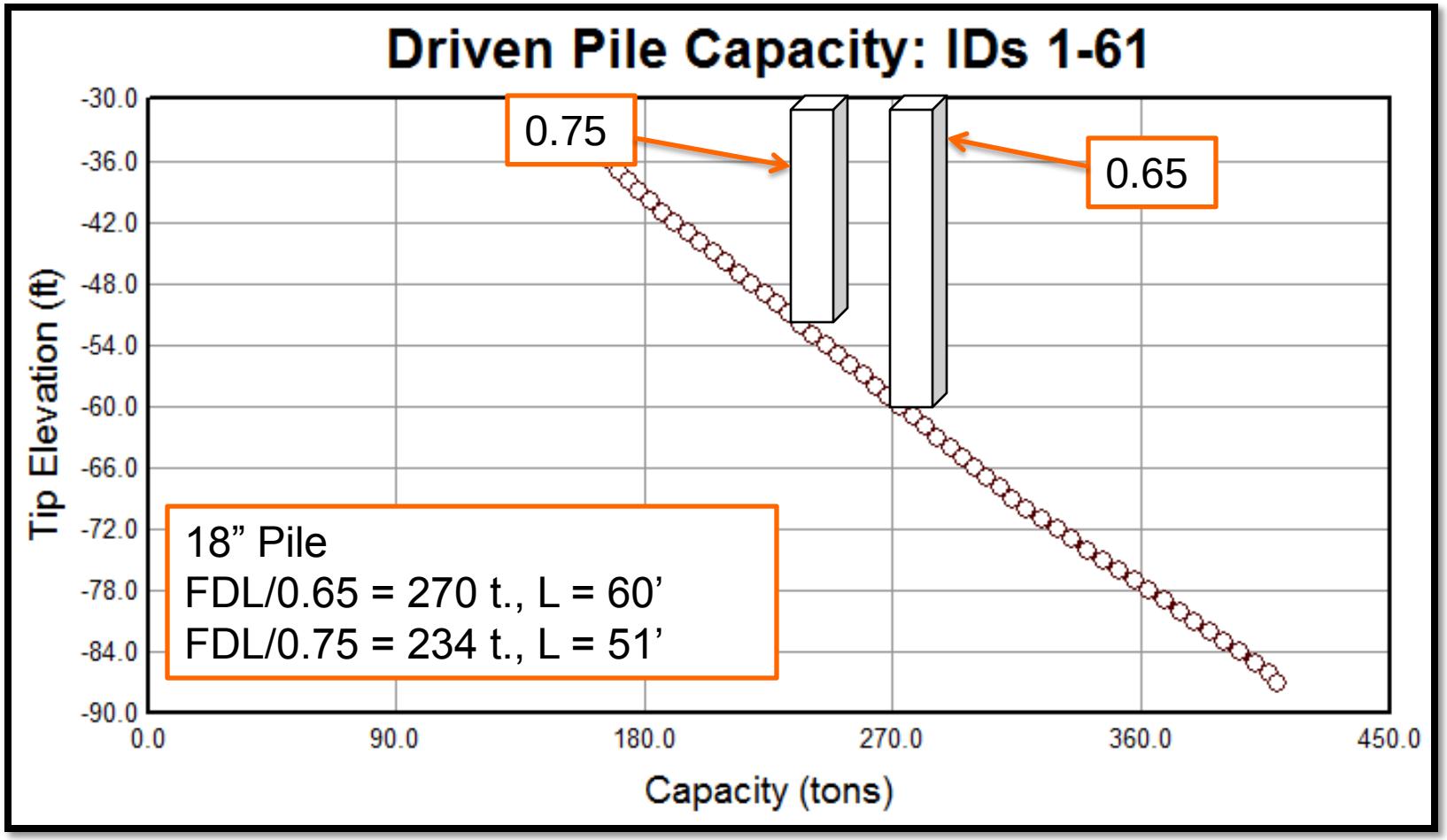
District Coordinators		
District	Coordinator (Titles vary by District)	Phone
One	Plans, Specifications:	
	John Previte	(863) 519-2676
	Fern Jackson	(863) 519-2242
	Ervin Sterling	(863) 519-2919
	Marshall Dougherty	(863) 519-2637
	Gibu Geevarghese	(863) 519-2481
	Edgar Munoz	(863) 519-2536
	Estimates:	
	Gena Batman	(863) 519-2558
	Tommy Thompson	(863) 519-2612
	Mandy Gaugh	(863) 519-2695
Two	District 2 Final Plans Administrator:	
	Vince Camp	(386) 758-3732
	Specifications:	
	Eddy Scott	(386) 961-7831
	Teresa Thrasher	(386) 961-7470
	Estimates:	
	Richard Rountree	(386) 758-3759
	Ronnie Sadler	(386) 961-7363
	Lea-Ann Arnold	(386) 961-7376
	Chris Sweitzer	(386) 961-7418

http://www.dot.state.fl.us/specificationsoffice/staff.shtm

100 Percent Dynamic Testing of Concrete Piling

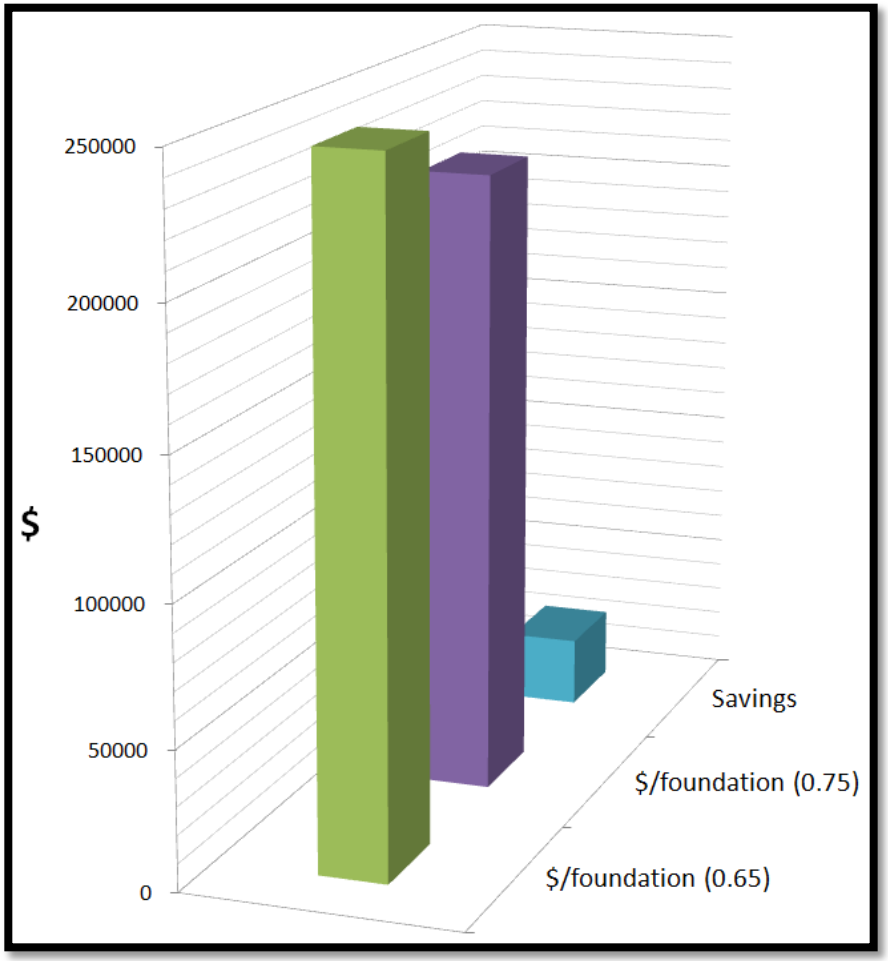


100 Percent Dynamic Testing of Concrete Piling

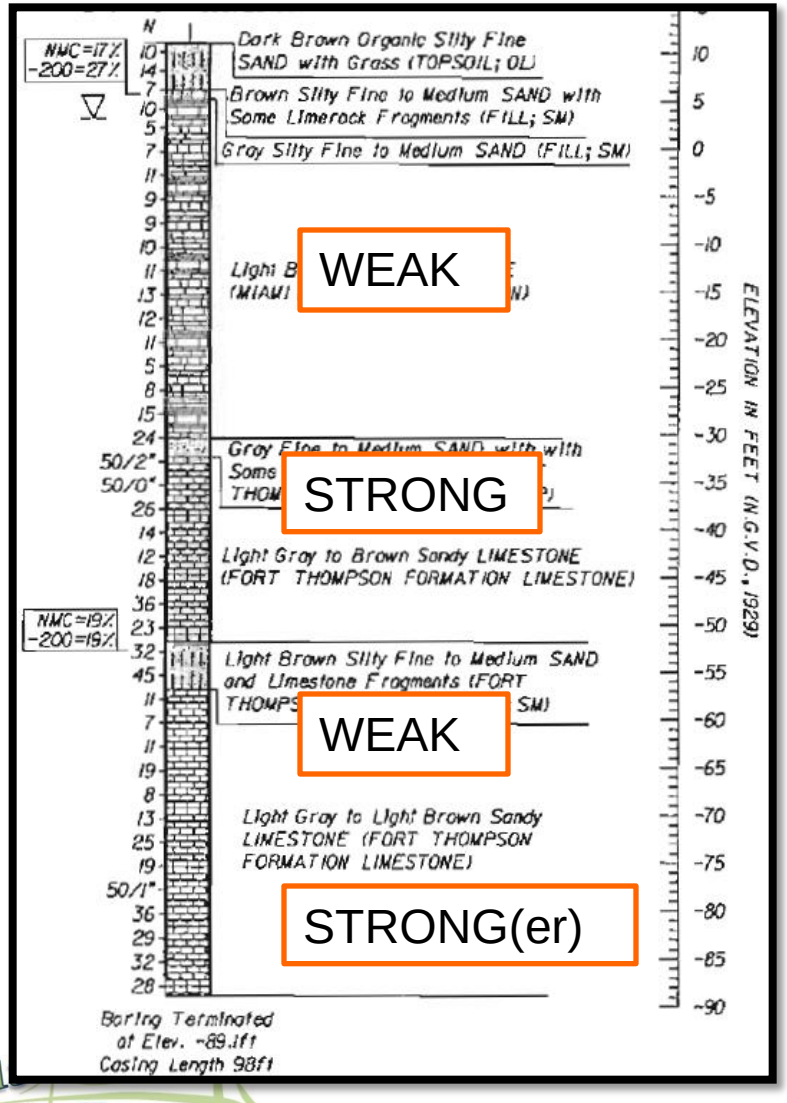


100 Percent Dynamic Testing of Concrete Piling

- Calculate the cost of piling at phi = 0.65 and 0.75
- Will the savings offset the cost of dynamic testing?



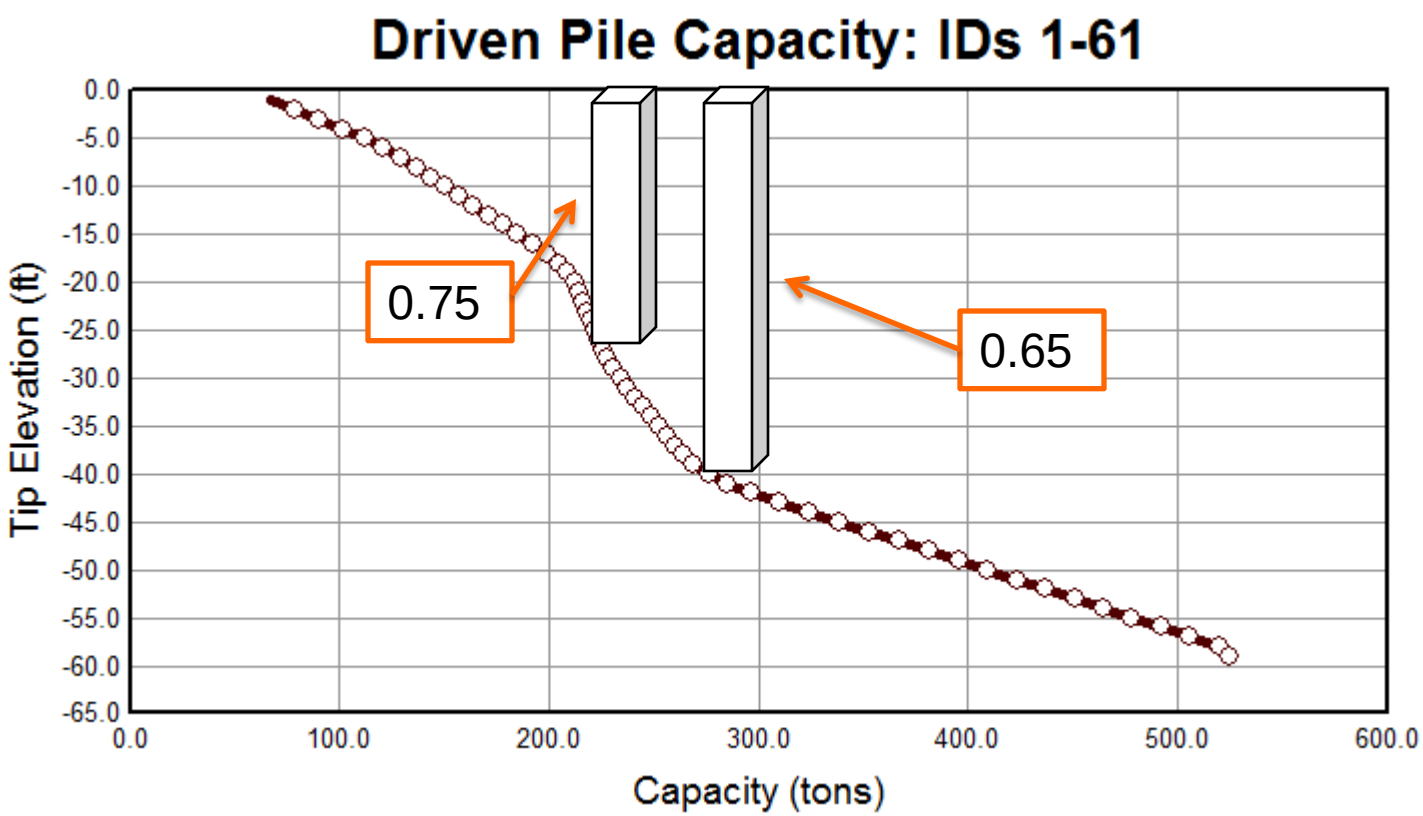
100 Percent Dynamic Testing of Concrete Piling



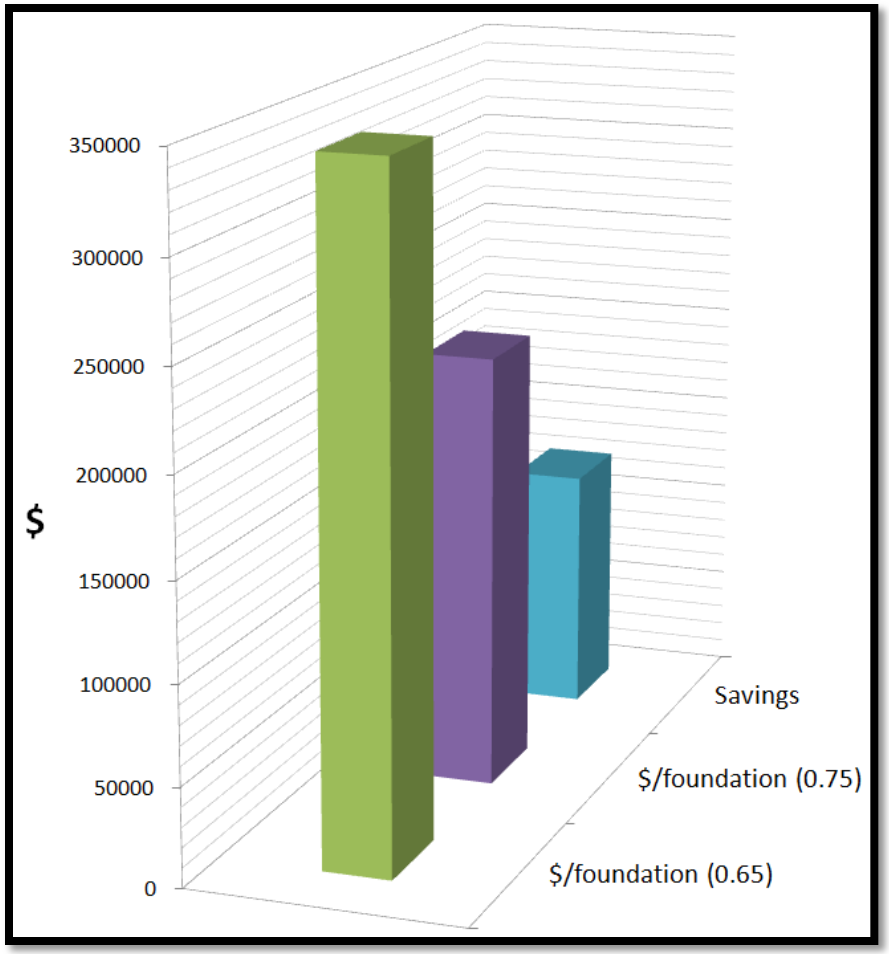
- Variable strength profile

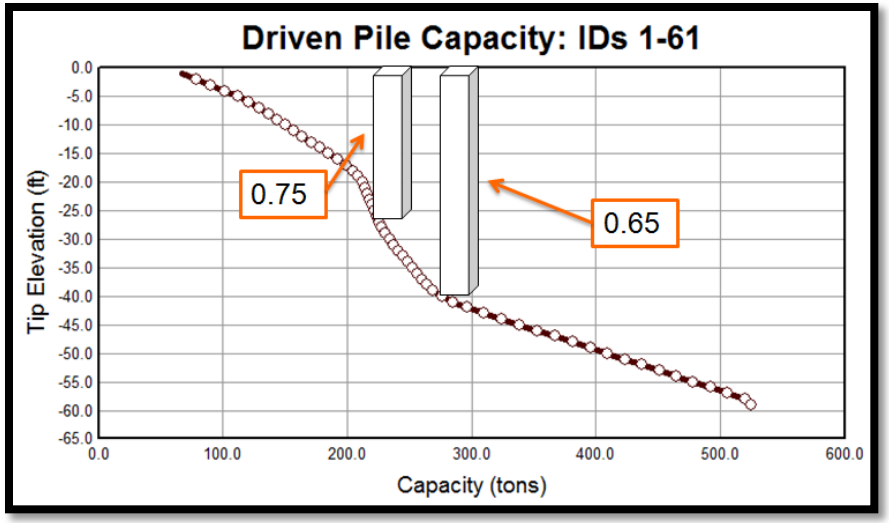
2011 Design Training Expo

100 Percent Dynamic Testing of Concrete Piling



100 Percent Dynamic Testing of Concrete Piling

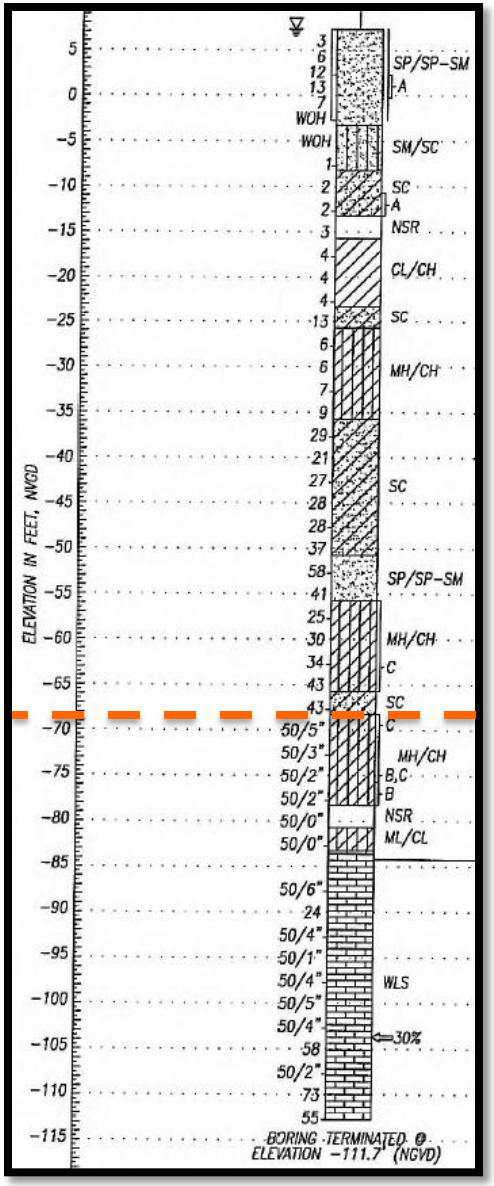




May be better suited for 100% testing

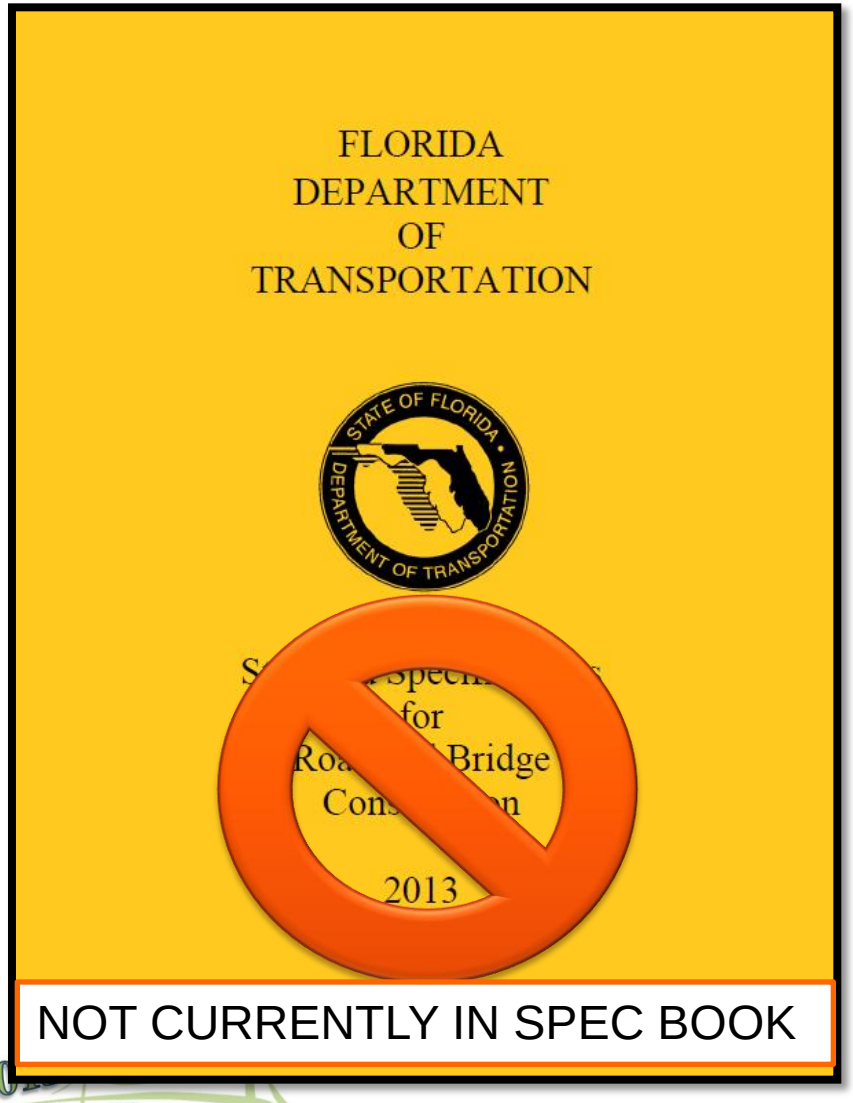
100 Percent Dynamic Testing of Concrete Piling

- Is there any economic benefit to 100% dynamic testing in this profile?
- Same pile length
  - ✓ Higher load per pile at phi = 0.75
  - ✓ Less piles?



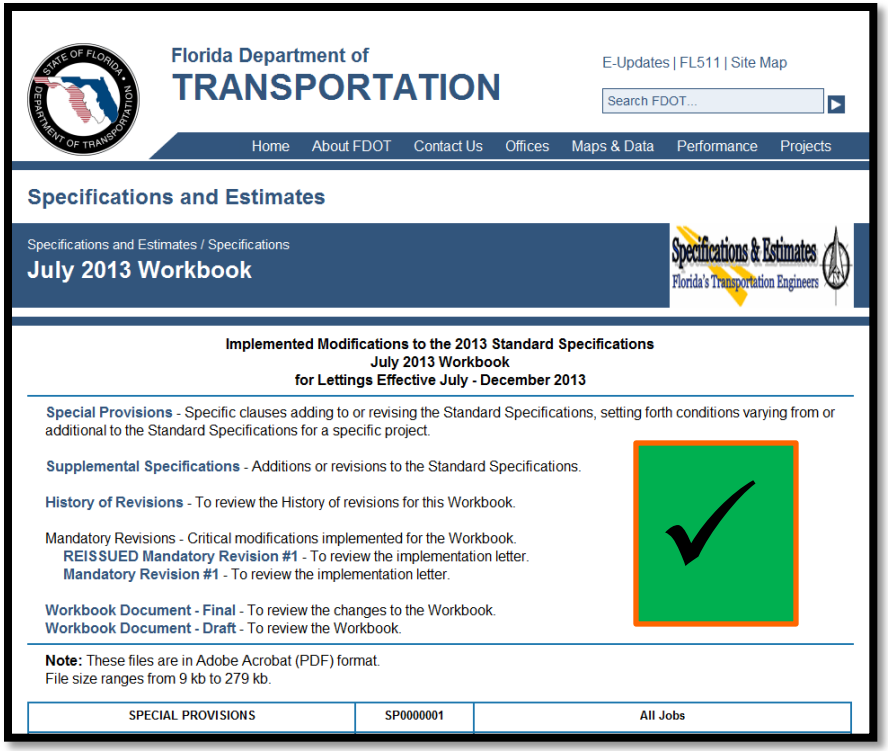
2013 Design Training Expo

100 Percent Dynamic Testing of Concrete Piling

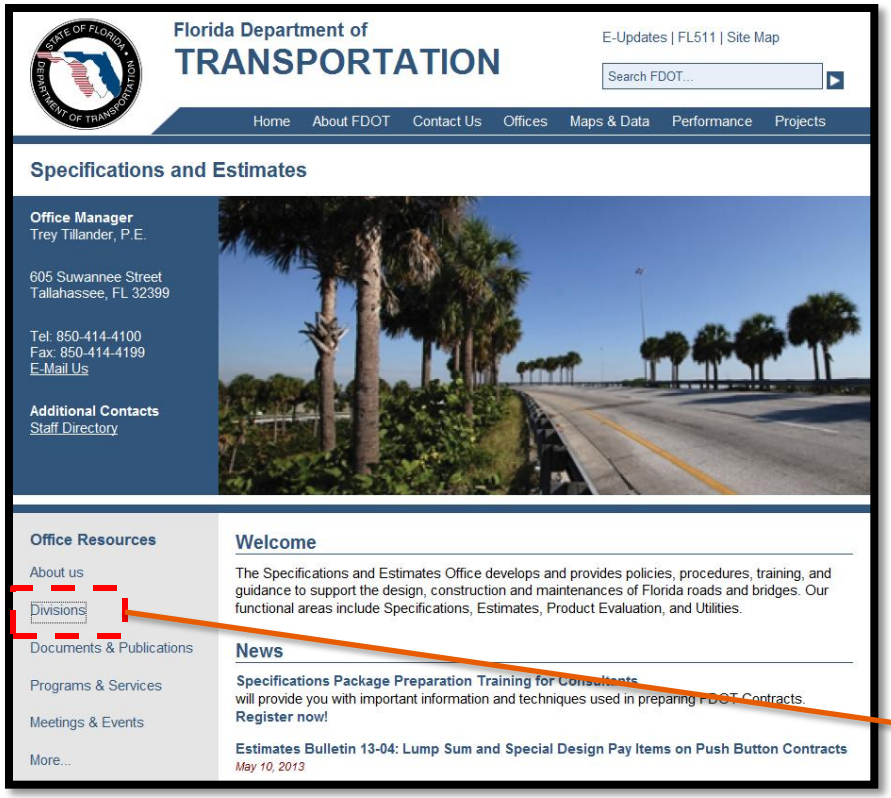


NOT CURRENTLY IN SPEC BOOK

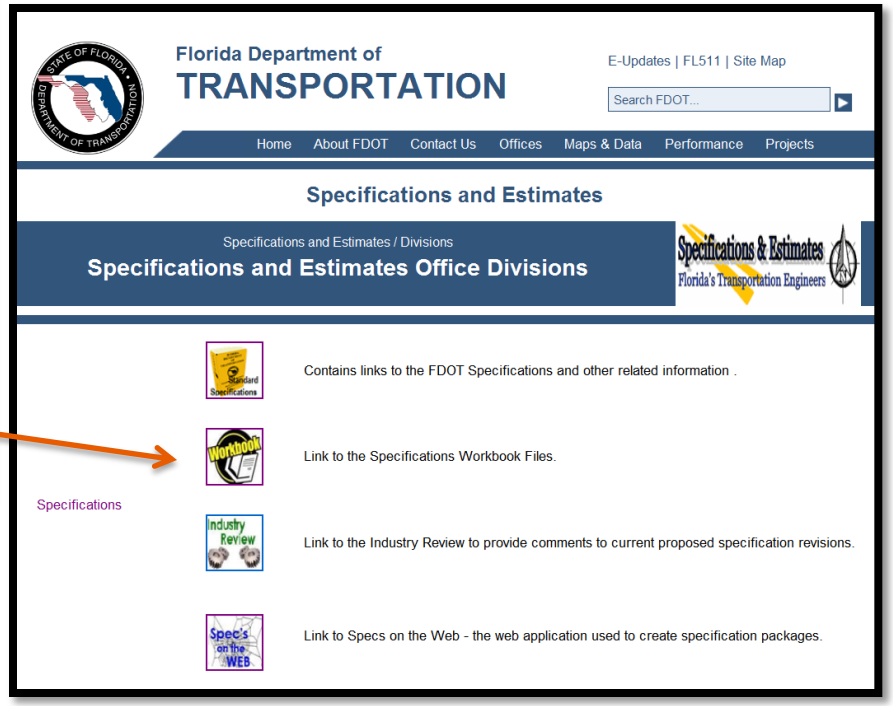
WORKBOOK



100 Percent Dynamic Testing of Concrete Piling



http://www.dot.state.fl.us/specificationsoffice/



100 Percent Dynamic Testing of Concrete Piling

- Workbook
  - ✓ Conventional projects (DBB)

Structures Foundations - Dynamic Testing WITHOUT Test Piles. (REV 6-26-12) (7-12) Change(s) to: 455-1 through 455-12.	SP4550100DTwoTP	Projects with 100% Dynamic Testing of Pile Foundations WITHOUT Test Piles.
Structures Foundations - Dynamic Testing WITH Test Piles. (REV 6-26-12) (7-12) Change(s) to: 455-1 through 455-12.	SP4550100DTwTP	Projects with 100% Dynamic Testing of Pile Foundations WITH Test Piles.

http://www.dot.state.fl.us/specificationsoffice/Implemented/WorkBooks/JulWorkbook2013/

100 Percent Dynamic Testing of Concrete Piling

- Bearing Requirements
  - **455-5.10.1 General:** "……The Engineer may accept a driven pile when the pile has achieved minimum penetration and the minimum required bearing capacity obtained for 6 inches of consecutive driving…"
  - **455-5.10.2 Bearing Criteria:** "… The Engineer will determine pile capacities using dynamic load test equipment utilizing internally or externally mounted sensors according to the methods described herein…"

100 Percent Dynamic Testing of Concrete Piling

- Set-checks and Re-Drives
  - ✓ Potentially reduced on 100% dynamic testing projects

100 Percent Dynamic Testing of Concrete Piling

- Design-Build

DIVISION II CHANGES		
SP1050813	Contractor Quality Control General Requirements	Use when Geotechnical Services are required for the project.
SP4550000	Structures Foundations	Use when Geotechnical Services are required for the project.

http://www.dot.state.fl.us/specificationsoffice/Implemented/DesignBuild/HistoryDB/July13/Default.shtm

100 Percent Dynamic Testing of Concrete Piling

- Design-Build Specifications do not currently address 100% Dynamic Load Tests
- Refer to the applicable SP

Structures Foundations - Dynamic Testing WITHOUT Test Piles. (REV 6-26-12) (7-12) Change(s) to: 455-1 through 455-12.	**SP4550100DTwoTP**	Projects with 100% Dynamic Testing of Pile Foundations WITHOUT Test Piles.
Structures Foundations - Dynamic Testing WITH Test Piles. (REV 6-26-12) (7-12) Change(s) to: 455-1 through 455-12.	**SP4550100DTwTP**	Projects with 100% Dynamic Testing of Pile Foundations WITH Test Piles.

100 Percent Dynamic Testing of Concrete Piling

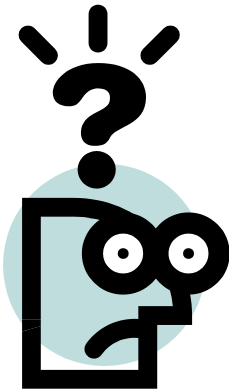
- Set-check all piles (phi = 0.75)
  - ✓ Concrete piles: ALL blows delivered to ALL piles have to be monitored
    - Determine proper wave speed
  - ✓ Steel piles: Follow the Specification requirements for instrumented set-checks

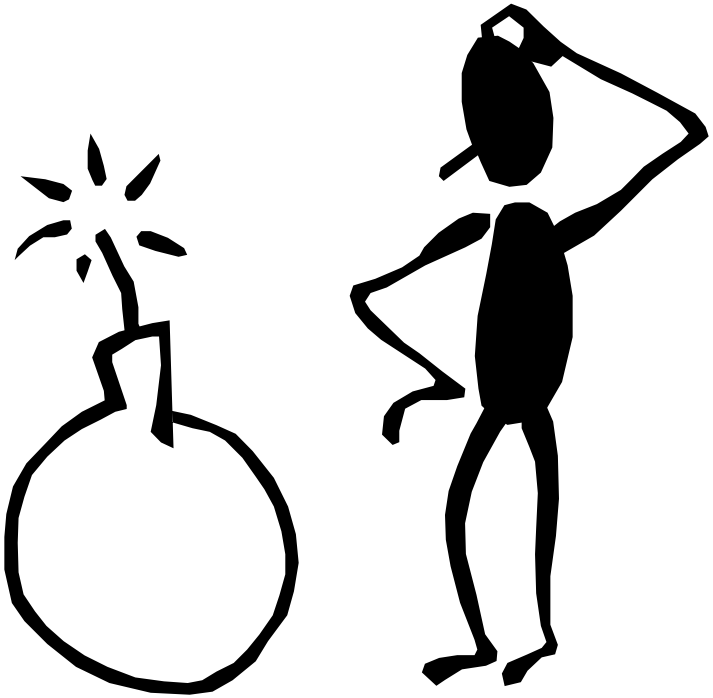
100 Percent Dynamic Testing of Concrete Piling

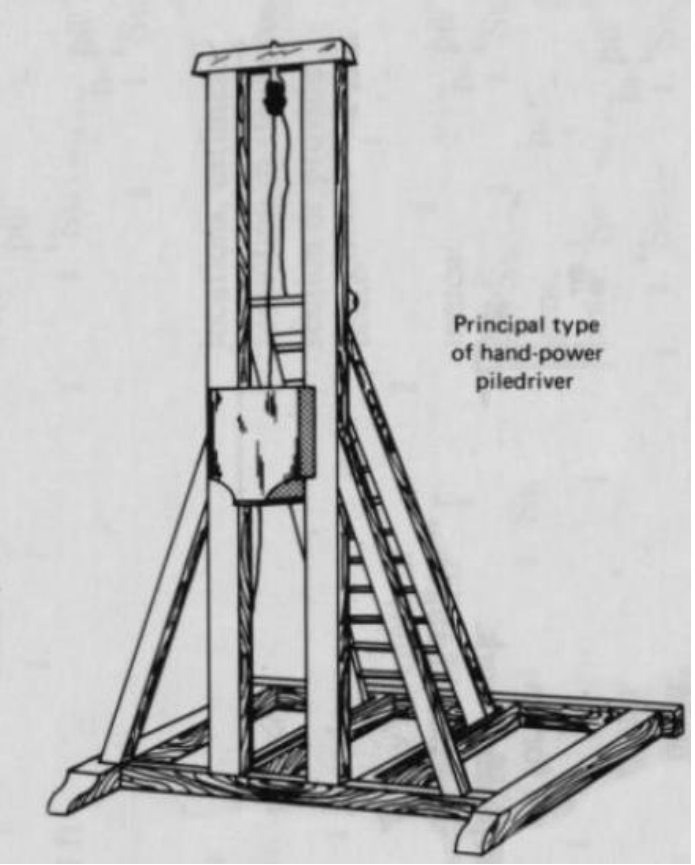
- Freeze – 100% set check (phi = 0.75)
  - ✓ Concrete piles: ALL blows delivered to ALL piles have to be monitored
    - Determine wave speed
  - ✓ Steel piles: Follow the Specification requirements for instrumented set-checks

100 Percent Dynamic Testing of Concrete Piling

- D/B Contracts: 100% dynamic testing does not automatically eliminate the possibility of verification testing





100 Percent Dynamic Testing of Concrete Piling

- Rodrigo.Herrera@dot.state.fl.us