
# Construction Phase Foundation Design Re-Evaluation


Sayed M. Sayed, PhD, PE, DBIA | GCI, Inc.
Hisham N. Sunna, PhD, PE, | Ayres Associates, Inc.
Pamela R. Moore, MSCE, PE | GCI, Inc.


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GRL NEWSLETTER — No. 23

INFORMATION GATHERED BY THE ENGINEERS OF GOBLE RAUSCHE LIKINS AND ASSOCIATES, INC. — JUNE 1994

**ORLANDO: CITY OF PILE CONFERENCES**

The first big Orlando piling conference in 1994 was the **1994 PDA Users Days**, held on February 18 and 19 at the Renaissance Hotel. More than 60 engineers participated, primarily from the Americas. As usual, the focus of this event was directed at the day-to-day knowledge needs of the pile testing professionals. However, lively discussions and presentations on new developments added the needed spice. Guest speaker Dr. Bengt Fellenius, Anna Geodynamics Inc. (AGI), Canada spoke on "The Critical Depth. How it came into being and why it does not exist"; Dr. D. Michael Holloway, InSituTech, California; Mark Mongeau, Ardaman & Associates and Dr. S.M. Sayed of Geotech Consultants International Inc., of Florida lectured on geotechnical and engineering professional subjects entitled " Difficulties encountered with long H-piles installations", "Marketing Engineering Services" and "How the geotechnical engineer uses PDA results", respectively.

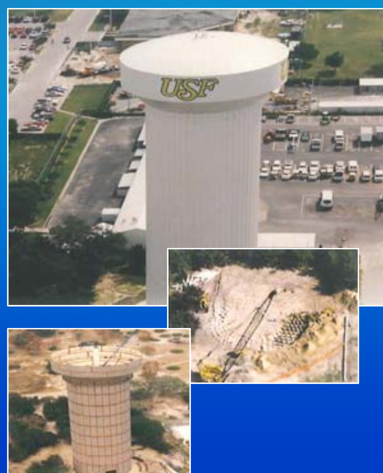
**GRLWEAP NEWS**

Contrary to the initial experiences reported by a few users, GRLWEAP actually **does** run under WINDOWS™ as a non-Windows application. User Scott Simons, International Construction Equipment (ICE), North Carolina actually made himself a little icon. He feels, however, that GRLWEAP runs faster under DOS.

A vibratory hammer analysis option was revealed to the Orlando Users Days crowd. This option realistically analyzes vibratory hammer pile driving given an equally realistic estimate of the soil resistance **at the time of driving**. The figure below shows a screen display of pile displacements. Our readers are also reminded that measurements of pile

Dr. S. M. Sayed of Geotech Consultants International, Inc. of Florida lectured on "How the geotechnical engineer uses PDA results".

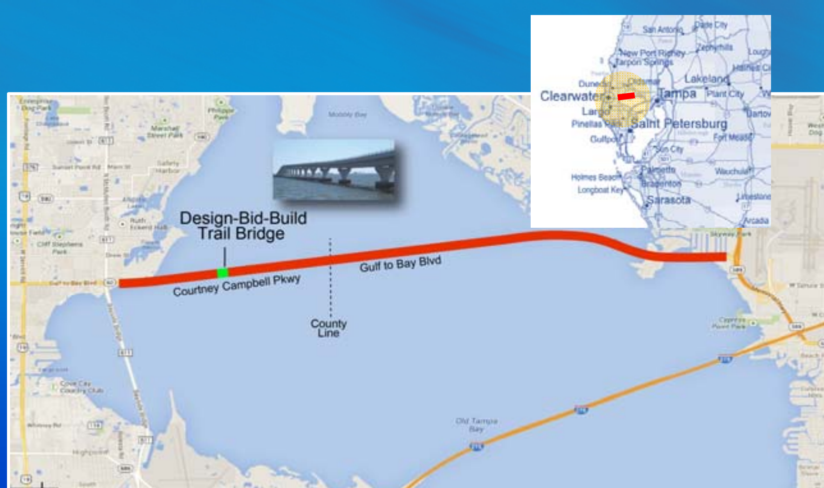
# Elevated Water Storage Tank
## University of South Florida




- Services Provided by GCI
  - Foundation Recommendations
  - Pile Driving Analyses
  - Pile Integrity Testing
  - Production Pile Monitoring and Inspection
- Main Project Elements
  - Design/Build (D/B) Project Delivery
  - Design by PDM (CB&I)
  - Construction by PDM (CB&I) and HyCon
- Awards
  - 1998 Elevated Tank of the Year for the 1.2 million-gallon Hydropillar



# Trail Bridge Location



Design-Bid-Build Bridge

# Construction (Post-Design) Services

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## Boring Locations

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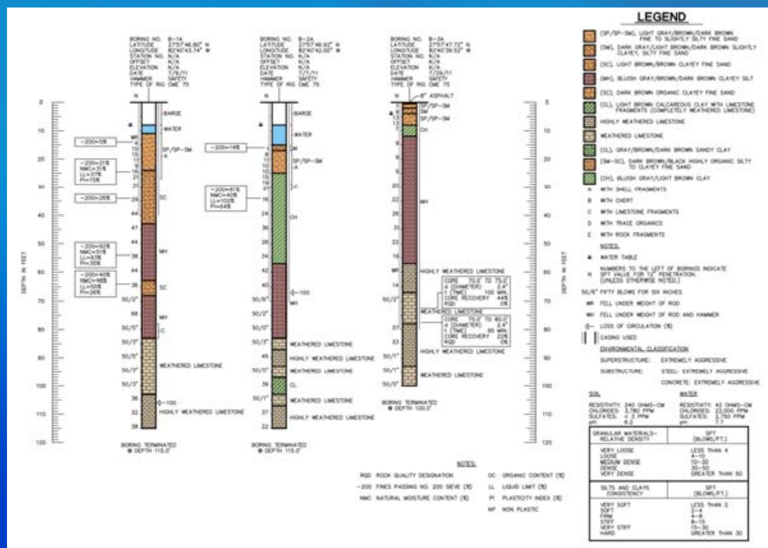
# Boring Profiles

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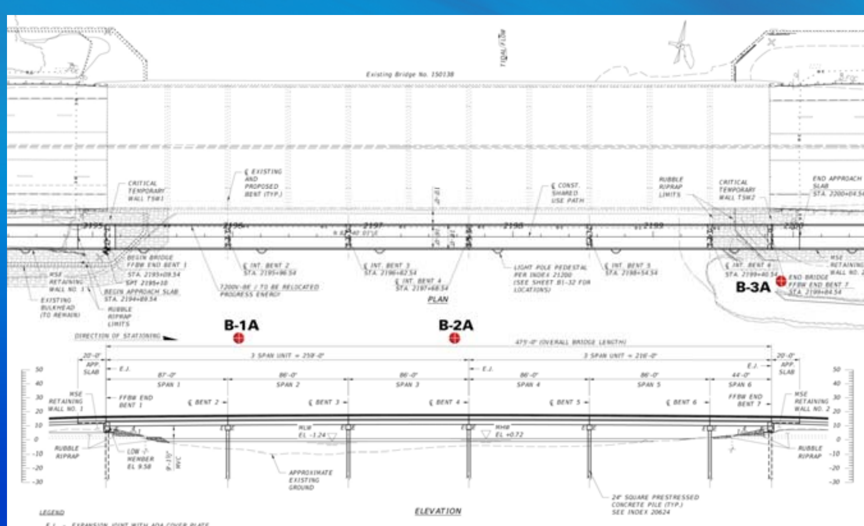
# Bridge Plan and Elevation



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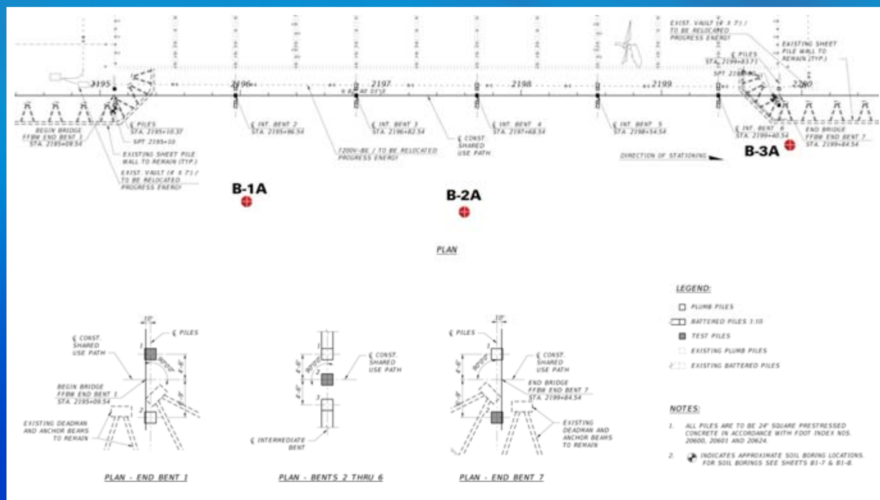
# Foundation Layout

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# Pile Data Table

| INSTALLATION CRITERIA | | | | | | | | DESIGN CRITERIA | | | | | | | | | | PILE CUT-OFF ELEVATIONS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PIER or BENT NUMBER | PILE SIZE (in.) | NOMINAL BEARING RESISTANCE (tons) | NOMINAL UPLIFT RESISTANCE (tons) | MINIMUM TIP ELEVATION (ft.) | TEST PILE LENGTH (ft.) | REQUIRED JET ELEVATION (ft.) | REQUIRED PREFORM ELEVATION (ft.) | FACTORED DESIGN LOAD (tons) | FACTORED DESIGN UPLIFT LOAD (tons) | DOWN DRAG (tons) | TOTAL SCOUR RESISTANCE (tons) | NET SCOUR RESISTANCE (tons) | 100-YEAR SCOUR ELEVATION (ft.) | LONG TERM SCOUR ELEVATION (ft.) | Ø COMPRESSION | Ø UPLIFT | PILE 1 | PILE 2 | PILE 3 |
| 1 | 24 | 162 | N/A | N/A | 60 | N/A | -5 | 105 | N/A | N/A | N/A | N/A | N/A | N/A | 0.65 | N/A | 7.09 | 7.09 | N/A |
| 2 | 24 | 299 | 15 | -49 | 75 | N/A | N/A | 145 | 8 | N/A | 49 | 49 | -27.1 | -30.4 | 0.65 | 0.55 | 7.35 | 7.35 | 7.35 |
| 3 | 24 | 299 | 17 | -47 | 75 | N/A | N/A | 145 | 9 | N/A | 49 | 49 | -27.1 | -30.4 | 0.65 | 0.55 | 7.78 | 7.78 | 7.78 |
| 4 | 24 | 342 | 11 | -45 | 80 | N/A | N/A | 135 | 6 | N/A | 87 | 87 | -27.1 | -30.4 | 0.65 | 0.55 | 7.87 | 7.87 | 7.87 |
| 5 | 24 | 342 | 11 | -45 | 80 | N/A | N/A | 135 | 6 | N/A | 87 | 87 | -27.1 | -30.4 | 0.65 | 0.55 | 7.61 | 7.61 | 7.61 |
| 6 | 24 | 305 | 11 | -63 | 90 | N/A | N/A | 105 | 6 | N/A | 93 | 93 | -27.1 | -30.4 | 0.65 | 0.55 | 7.01 | 7.01 | 7.01 |
| 7 | 24 | 93 | N/A | N/A | 60 | N/A | -5 | 60 | N/A | N/A | N/A | N/A | N/A | N/A | 0.65 | N/A | 7.19 | 7.19 | N/A |

$$\frac{\text{Factored Design Load} + \text{Net Scour Resistance} + \text{Down Drag}}{Ø} \leq \text{Nominal Bearing Resistance}$$

TENSION RESISTANCE - The ultimate side friction capacity that must be obtained below the 100 year scour elevation to resist pullout of the pile (Specify only when design requires tension capacity).
TOTAL SCOUR RESISTANCE - An estimate of the ultimate static side friction resistance provided by the scourable soil.
NET SCOUR RESISTANCE - An estimate of the ultimate static side friction resistance provided by the soil from the required preformed or jetting elevation to the scour elevation.
100-YEAR SCOUR ELEVATION - Estimated elevation of scour due to the 100 year storm event.
LONG TERM SCOUR ELEVATION - Estimated elevation of scour used in design for extreme event loading.

PILE INSTALLATION NOTES:

1. All elevations are in Ft., NAVD.
2. Contractor to verify location of all utilities and existing structures prior to any pile driving.
3. Minimum Tip Elevation is required for lateral stability.
4. Pile driving is to commence at the center of the Bent and proceed outward.
5. Under no circumstances shall the piles be installed to tip elevations above the minimum tip elevation.
6. Piles shall be driven to the Nominal Bearing Resistance in accordance with specification 455-5.10.
7. In order to achieve the required minimum tip elevation, it is estimated that difficult driving or excessive pile rebound may be encountered at some locations. Preforming through near-surface dense soils may be warranted at some locations to insure that driving stresses do not exceed allowable limits and that the piles achieve the minimum tip elevation.
8. A driving resistance higher than the Nominal Bearing Resistance (i.e., the Required Driving Resistance (RDR)) may be encountered at elevations shallower than the required minimum pile tip elevation.
9. Øc and Øu Resistance (performance) factors for compression and uplift loading conditions, respectively, per Structures Design Guidelines, Section 3.5.6.

PILE INSTALLATION NOTES (CONT'D):

10. When a required jetting elevation is shown, the jet shall be lowered to the elevation and continue to operate at this elevation until the pile driving is completed. If jetting or preforming elevations differ from those shown on the table, the Engineer shall be responsible for determination of the required driving resistance.
11. No jetting will be allowed without the approval of the Engineer.
12. The Contractor should not anticipate being allowed to jet piles below the 100-year scour elevation or required jet elevation, whichever is deeper.
13. Piles in End Bents 1 & 7 shall be preformed to Elev. -5 to assure there are no conflicts with existing tierods and deadmen.
14. Contractor is alerted that artesian conditions may exist and shall be prepared to modify construction methods as needed if they arise.
15. N/A - Not Applicable.
16. The Pile Installation Data presented on this Sheet has been extracted from the GCI Inc Report of Geotechnical Engineering Evaluation (Table 5), which is signed and sealed by Pamela Moore Florida Professional Engineer Number 39070.

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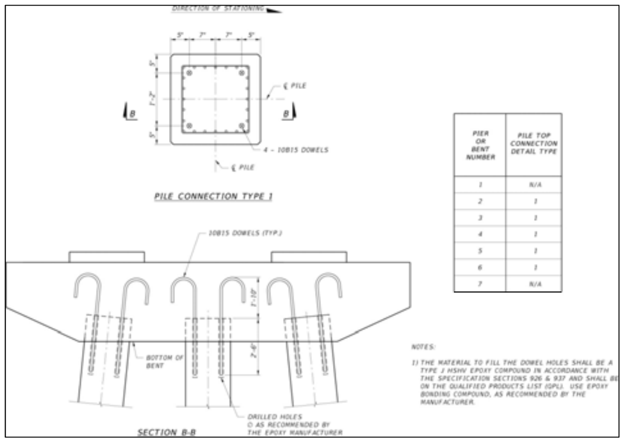
## Pile “Fixed”Connection Detail




| PIER OR BENT NUMBER | PILE TOP CONNECTION DETAIL TYPE |
|---|---|
| 1 | N/A |
| 2 | 1 |
| 3 | 1 |
| 4 | 1 |
| 5 | 1 |
| 6 | 1 |
| 7 | N/A |

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## Design-Bid-Build
## Trail Bridge Construction

Test Pile Program

# Bent 5

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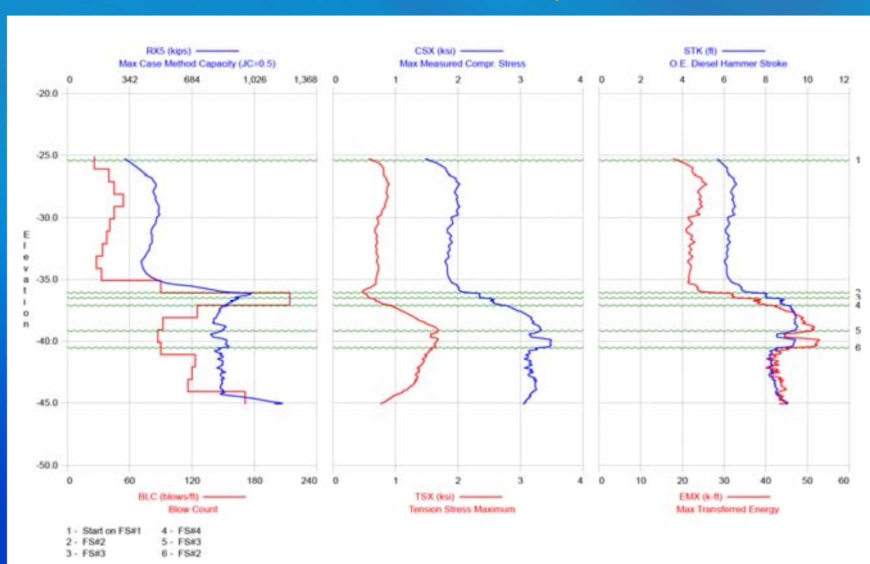
## PDA Results-Bent 5, Pile 2



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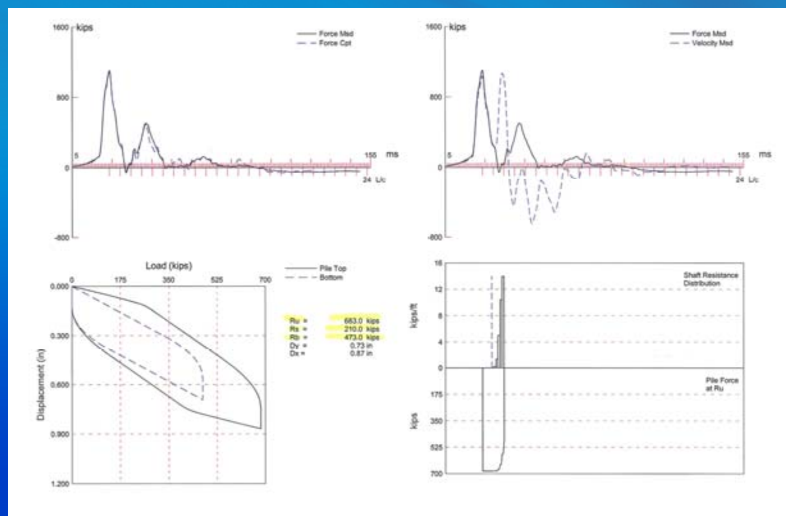
## CAPWAP Results – Bent 5, Pile 2 (EL -36.1')

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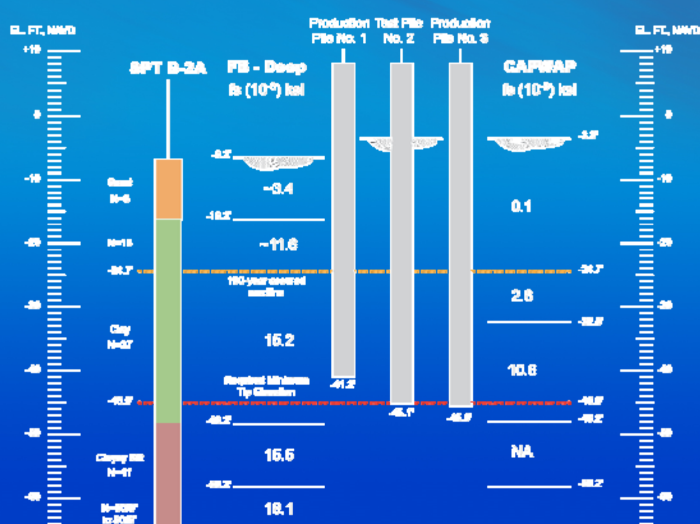
## Bent 5, Test Pile 2
## T-Z & Torsional Soil Models



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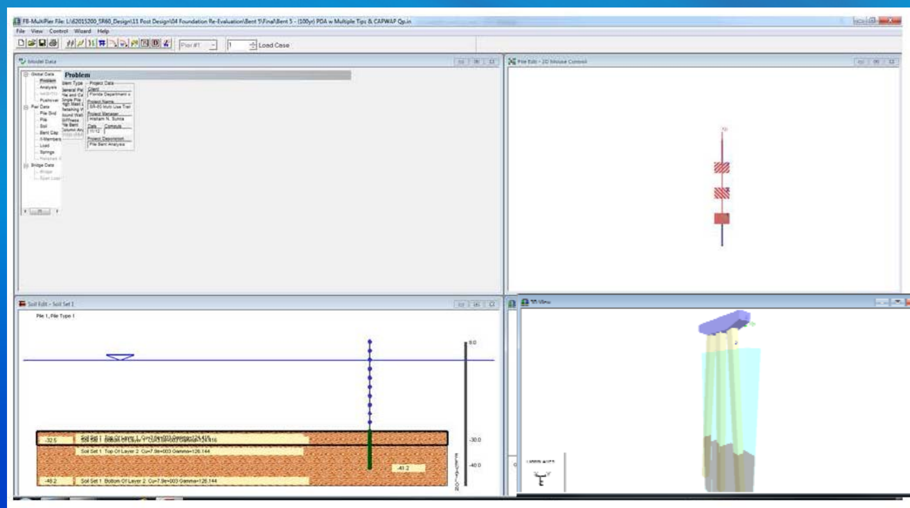
# Bent 5 100 year PDA



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# Axial Pile Capacity-Bent 5, Pile 2

| Pile Tip Elevation Ft., NAVD | Capacity, Tons | | | Comments |
|---|---|---|---|---|
| | Ultimate Total | Ultimate Skin | Ultimate Tip | |
| -36.1 | 341 | 105 | 236 | PDA w/CAPWAP BN #426 |
| | 238 | 164 | 74 | FB-Deep @ Existing Mudline |
| | 173 | 97 | 76 | FB-Deep @ 100-Yr. Scoured Mudline |
| | 337 | --- | --- | PDA Maximum Case Method Capacity @ BLC = 90 Blows/Ft. |
| -40.1 | 412 | --- | --- | PDA Maximum Case Method Capacity @ BLC = 87 Blows/Ft. |
| -41.0 | 307 | 212 | 95 | FB-Deep @ Existing Mudline |
| | 223 | 135 | 88 | FB-Deep @ 100-Yr. Scoured Mudline |
| -45.0 | 400 | 250 | 150 | FB-Deep @ Existing Mudline |
| | 317 | 173 | 144 | FB-Deep @ 100-Yr. Scoured Mudline |

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Test Pile Program

# Bent 6

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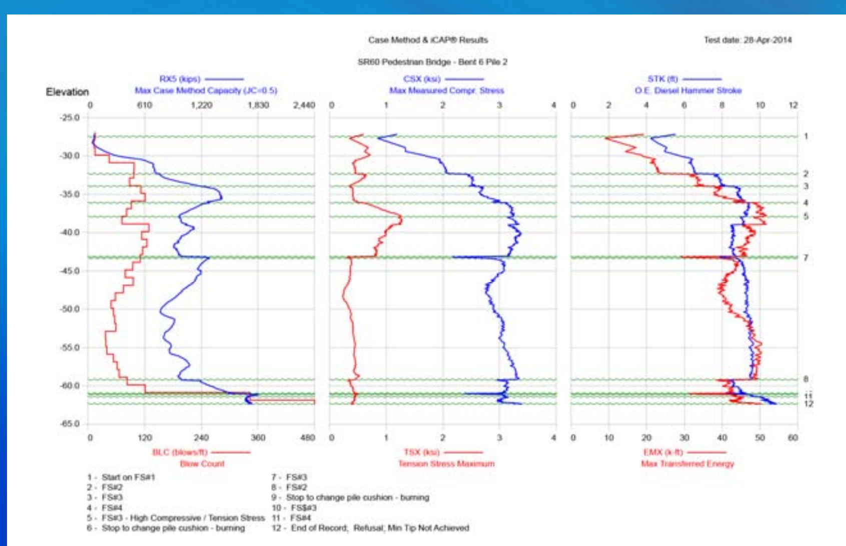
## PDA Results-Bent 6, Pile 2



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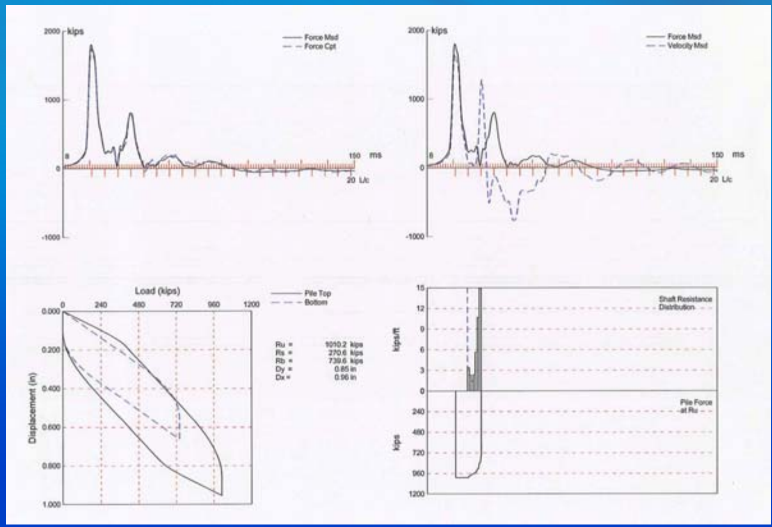
# CAPWAP Results – Bent 6, Pile 2 (Before Cushion Change – EL -43')

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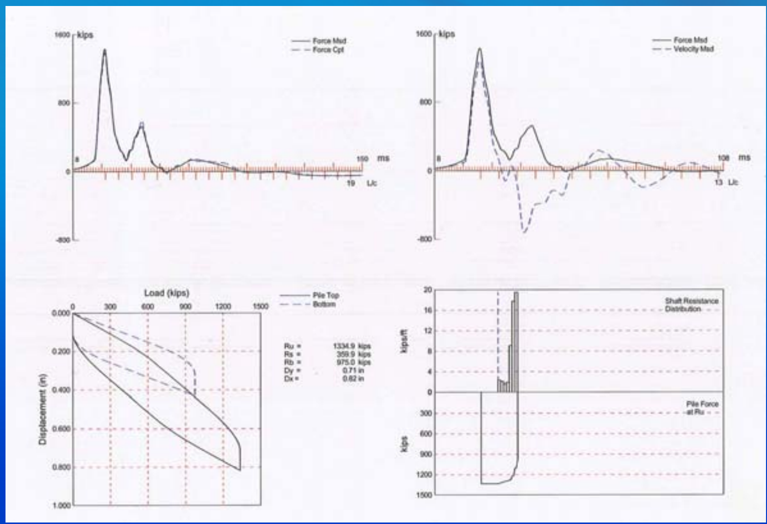
# CAPWAP Results – Bent 6, Pile 2 (After Cushion Change – EL -43')



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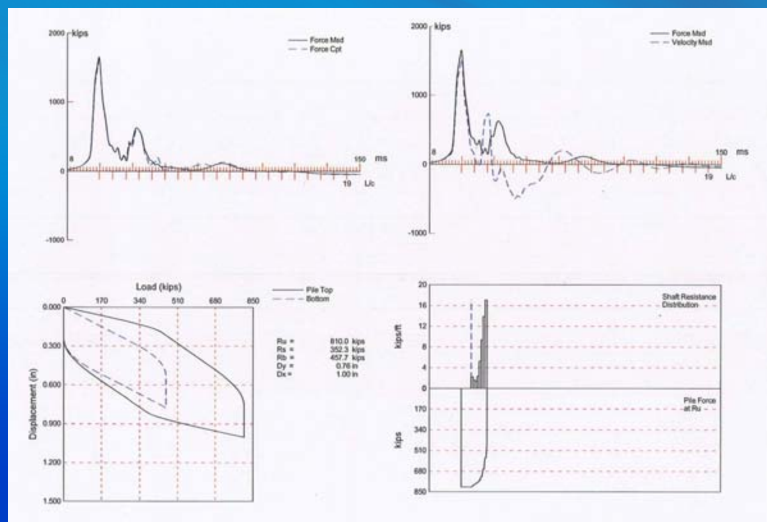
## CAPWAP Results – Bent 6, Pile 2 (EL -50')

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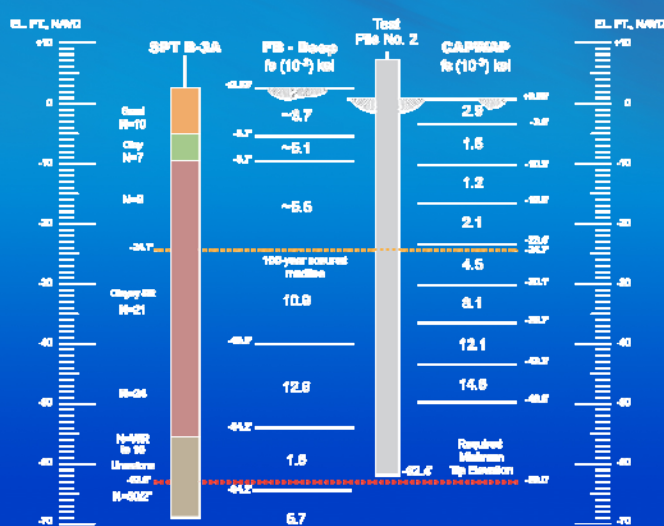
## Bent 6, Test Pile 2 T-Z & Torsional Soil Models



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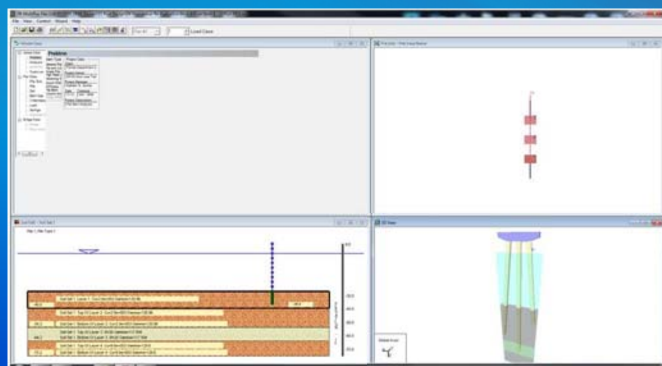
# Bent 6 100 year PDA



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# Bent 6, Pile 2
# Axial Pile Capacity

| Pile Tip Elevation Ft., NAVD | Capacity, Tons | | | Comments |
|---|---|---|---|---|
| | Ultimate Total | Ultimate Skin | Ultimate Tip | |
| -43 | 505 | 135 | 370 | PDA w/CAPWAP Before Cushion Change |
| | 667 | 180 | 488 | PAD w/CAPWAP After Cushion Change |
| | 366 | 211 | 155 | FB-Deep |
| -45 | 377 | 226 | 151 | FB-Deep |
| -50 | 405 | 176 | 229 | PDA w/CAPWAP |
| | 370 | 261 | 109 | FB-Deep |

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# Summary

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## Installation Data for 24-Inch Square Prestressed Concrete Piles

| Bent No. | Required Minimum Tip Elevation Ft., NAVD | Actual Pile Tip Elevation Ft., NAVD | | | Recommended Minimum Tip Elevation Ft., NAVD | Comments |
|---|---|---|---|---|---|---|
| | | Pile 1 | Pile 2 * | Pile 3 | | |
| 5 | -45.0 | -41.2 | -45.1 | -45.8 | Pile 1: -41.2<br>Pile 2: -45.1<br>Pile 3: -45.8 | Piles accepted per actual pile tip elevation |
| 6 | -63.0 | -50.0 | -62.4 | -36.6 | -50.0 | Bent accepted with Pile 3 above recommended min. tip based on re-analysis |
| * Test Pile | | | | | | Also, Production Pile |

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Recommended Approach for

# Foundation Design Re-evaluation Using Construction Phase Test Pile Program

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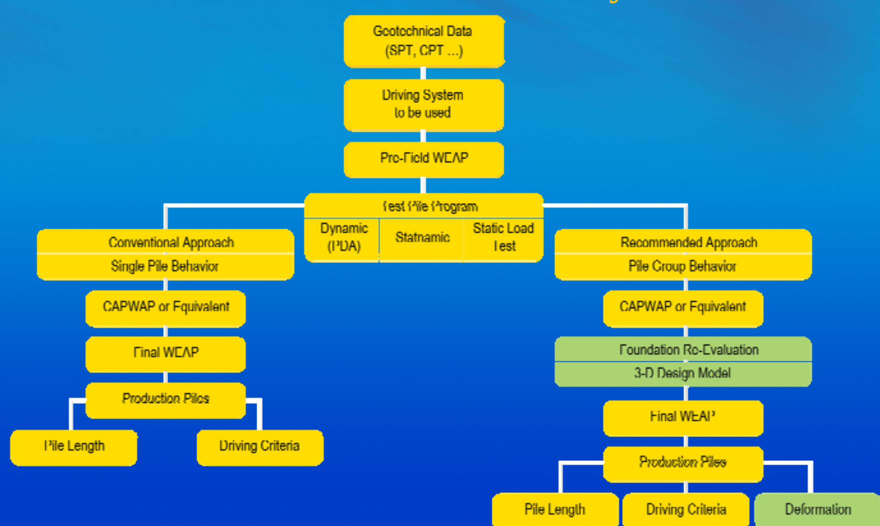
## Construction Phase Assessment of Driven Pile Foundation Systems



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# Conclusions

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- How a Test Pile Program is Used
  - Conventional Approach
    - Based on single pile behavior
    - PDA results or equivalent underutilized
    - Original foundation design not questioned
    - You DO NOT get what you pay for
  - Recommended Approach
    - Based on pile group behavior
    - PDA results or equivalent fully utilized
    - Original foundation design re-visited
    - You DO get what you pay for and MORE
- Foundation Design Re-evaluation Using Construction Phase Test Pile Program is Warranted

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- Discrepancy in Load Transfer Mechanism Between PDA/CAPWAP Results and Theoretical Axial Pile Analysis (i.e., DRIVEN, FB-DEEP, etc.) Undermines the Validity of the Original Foundation Design and Pile Installation Requirements
- Benefits of Recommended Approach
  - Three-dimensional re-visit of the original design of the bridge foundation (refine, optimize, minimize, etc.)
  - The aspects of pile group behavior, freeze and/or relaxation are incorporated in a systemic approach
  - Optimize the project cost and delivery (reliable production pile length, eliminate piles, speedy construction, etc.)
  - Minimize conflicts/disputes during construction
  - REMEMBER, you do not just get what you pay for…but MORE!