

LESSONS LEARNED IN INSTALLING CONCRETE PILES IN POTOMAC GROUP SOILS

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and

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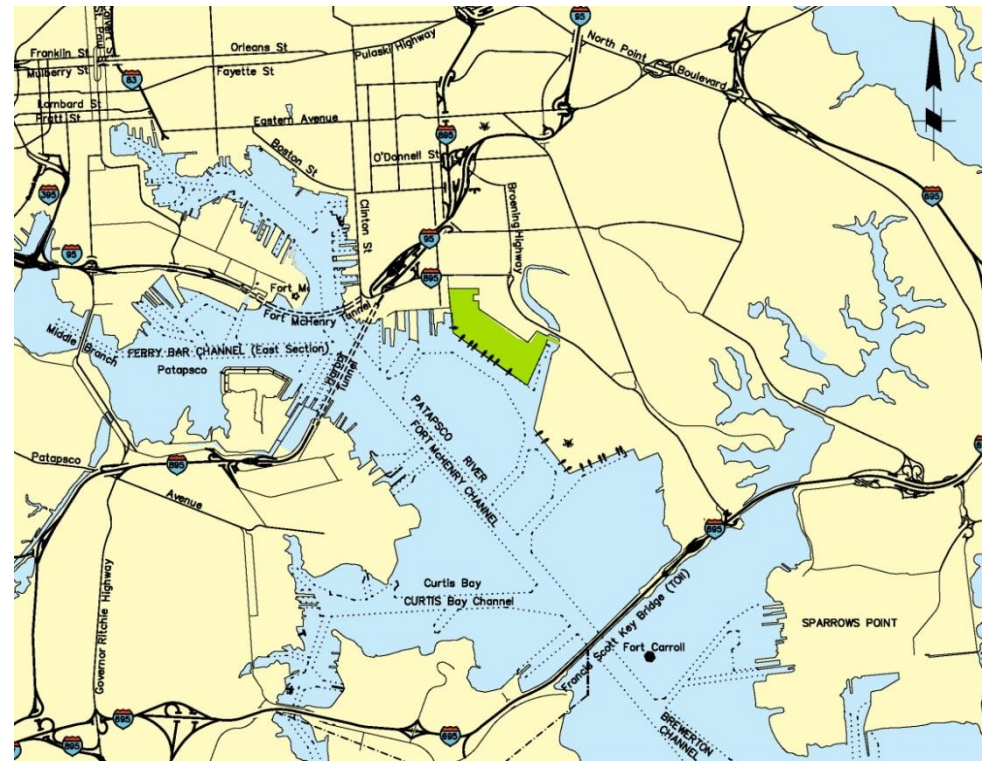
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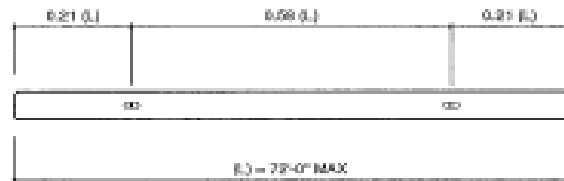
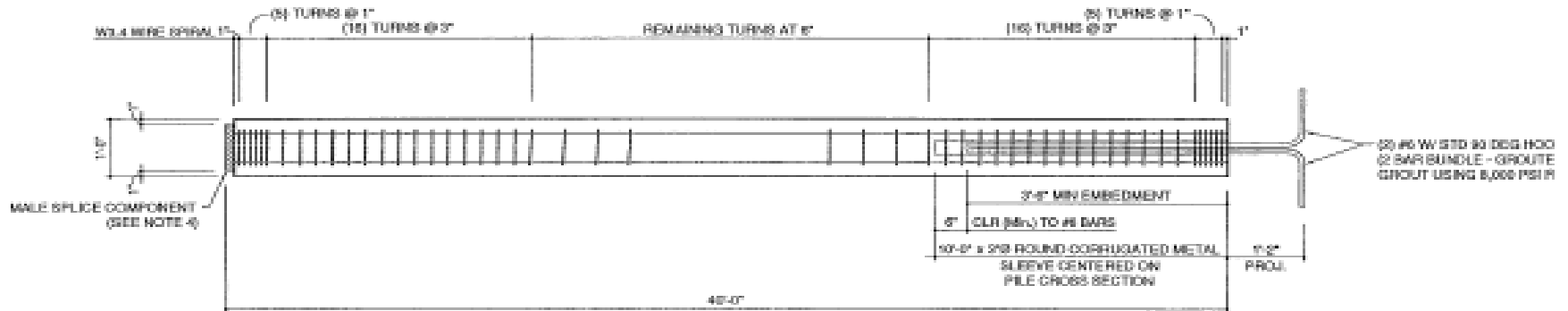
Need for Projects

- Baltimore has 50' deep federal channel
- Goal is to accommodate future “New Panamax” container ships
- Maryland Port Administration decides to construct new Berth 4 at Seagirt
- MPA also decides to construct a new wharf and berth at Masonville

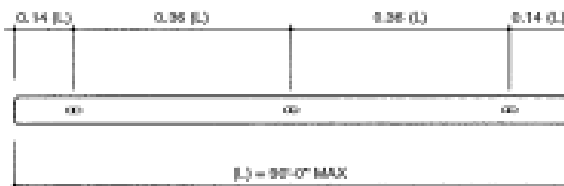


What We Want to Tell You!

- Why HP Stingers Were Used in P/S Piles.
- Installation Challenges and Solutions.
- Why QA/QC (Integrity and Capacity) Testing Was Needed.

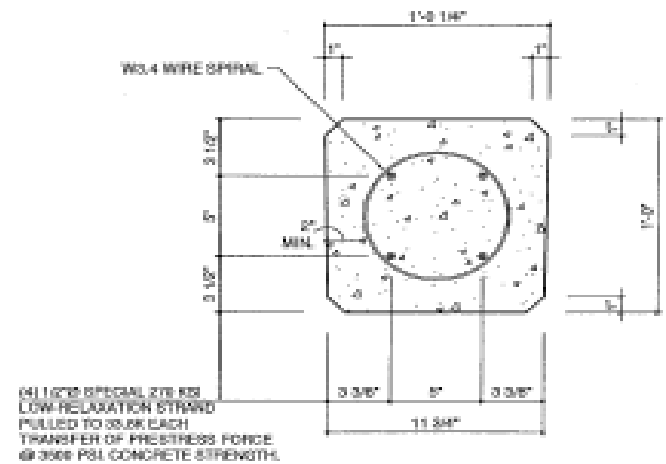


TWO POINT PICK-UP



THREE POINT PICK-UP

PICK-UP POINT DIAGRAMS



Pile Stresses



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P/S Pile Types



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Why P/S Concrete Piles

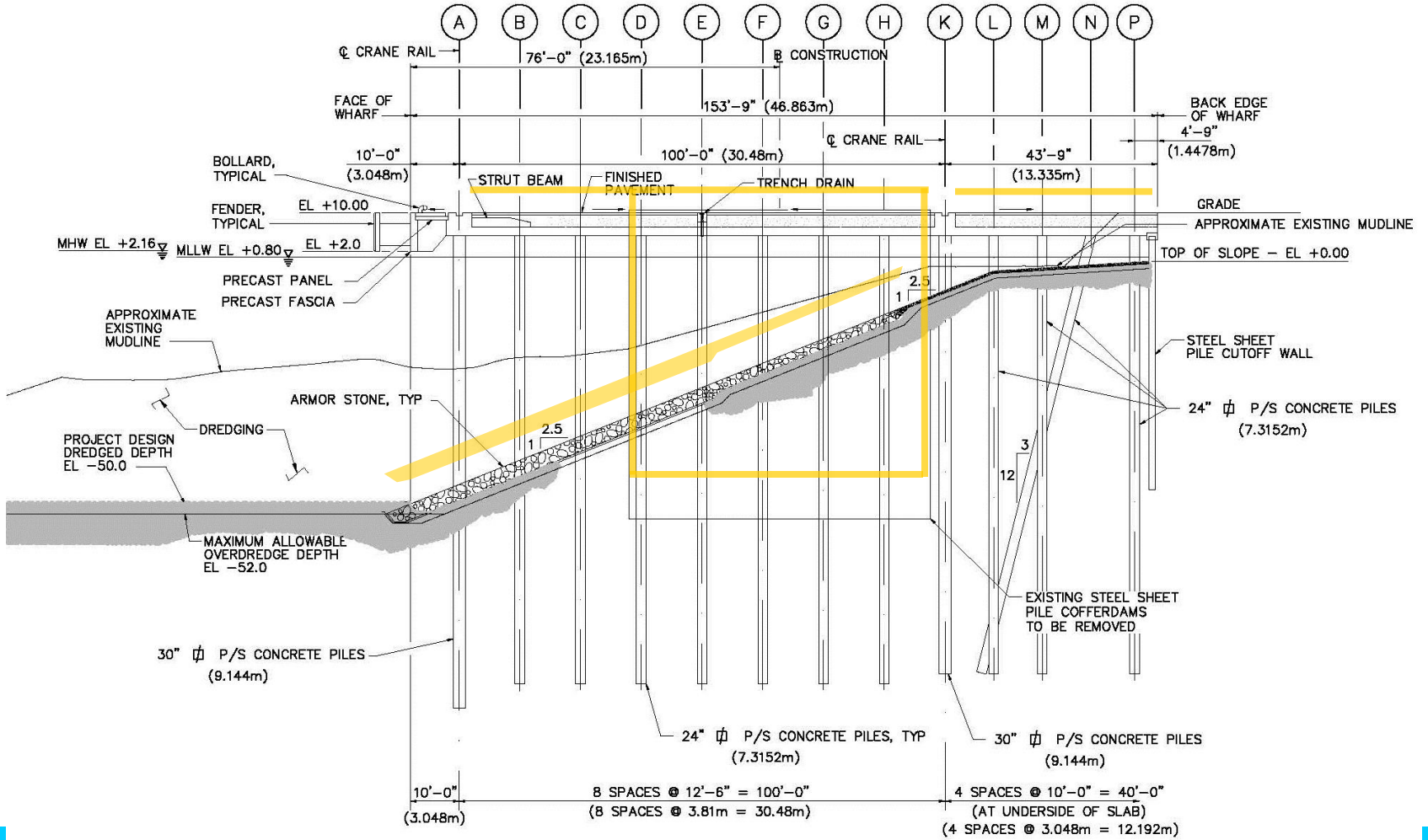
- Prestressed (P/S) Concrete Piles Selected for Both Terminals
- 300 to 400 ton Allowable Capacities
- High Stiffness
- Lower Initial Cost
- Lower Life Cycle Costs

Recent Marine Projects

Project	P/S Pile Size (Inch)	Ultimate Capacity (Kips)	Hammer	Energy (ft-kips)
Seagirt Berth 4	24/30	800 - 1640	D80 / D100	212 - 265
Masonville	30	1200	D80	212
GSP, NJ	30	1300	D160	393
Paulsboro, NJ	24	1600	D100	265
Dundalk Berth12	24	800	D46	122
WWB	24	1500	B65-05	212

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Seagirt Wharf Section



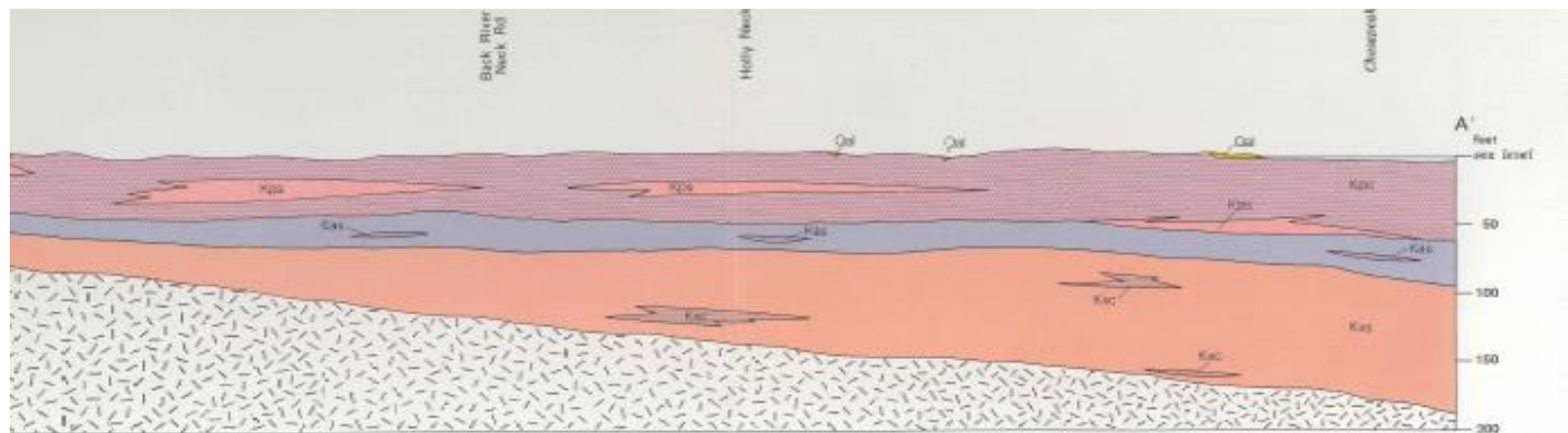
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Geologic Setting

Cretaceous Age Potomac Group

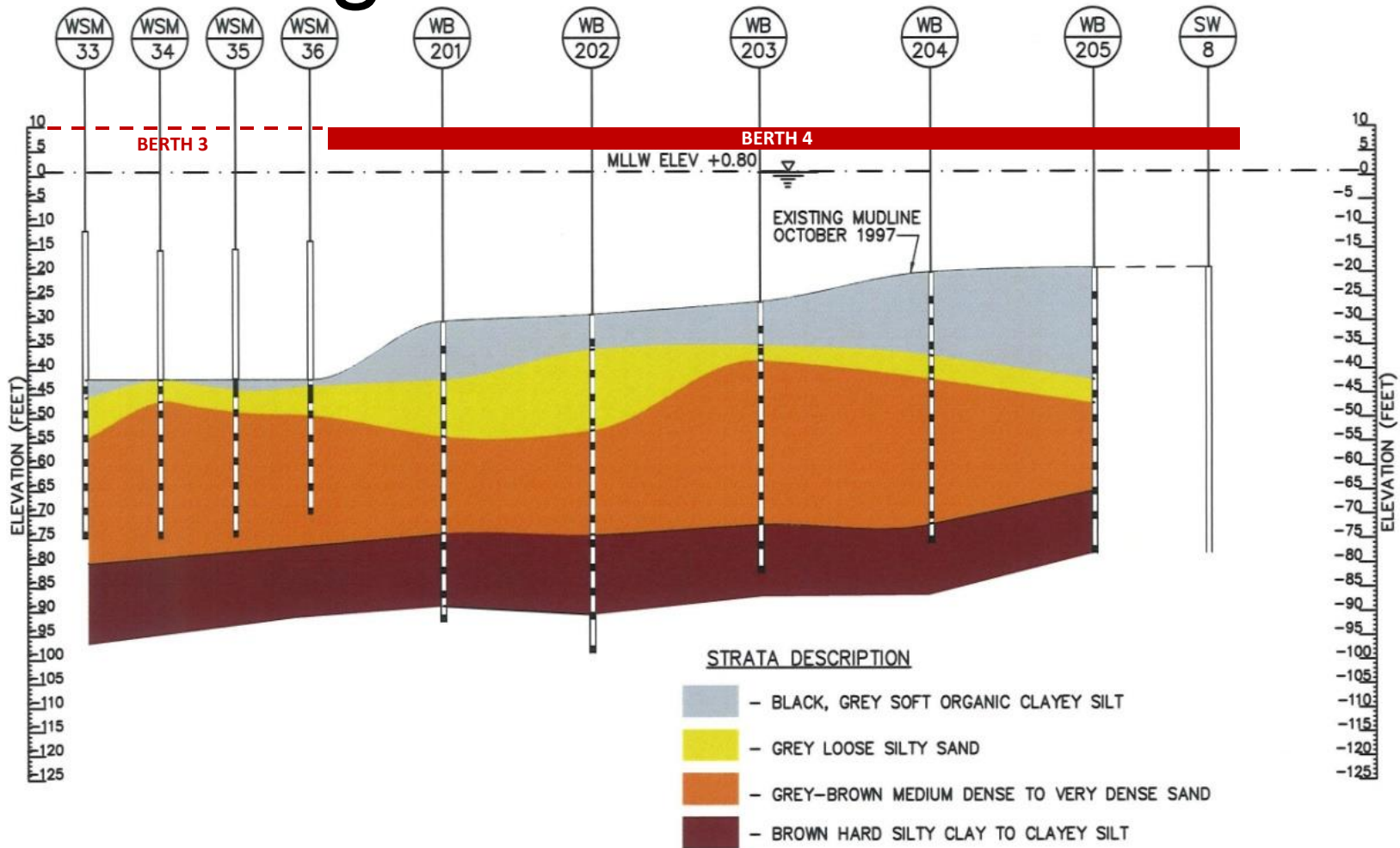
Dense Sand, Stiff to Hard Clays

Cobbles and Gravel Layers



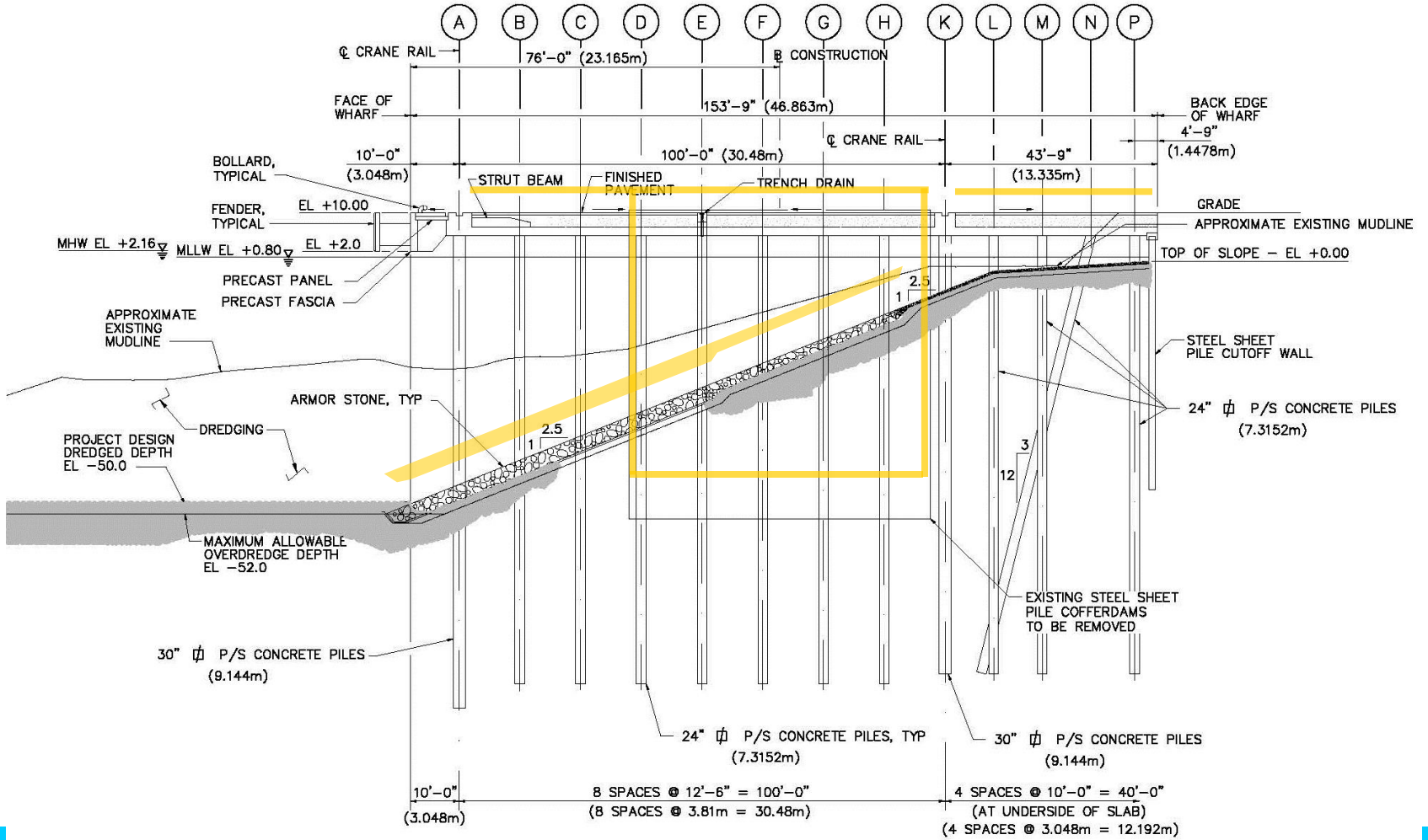
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Seagirt Subsurface Profile



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Seagirt Wharf Section



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What Did Not Work

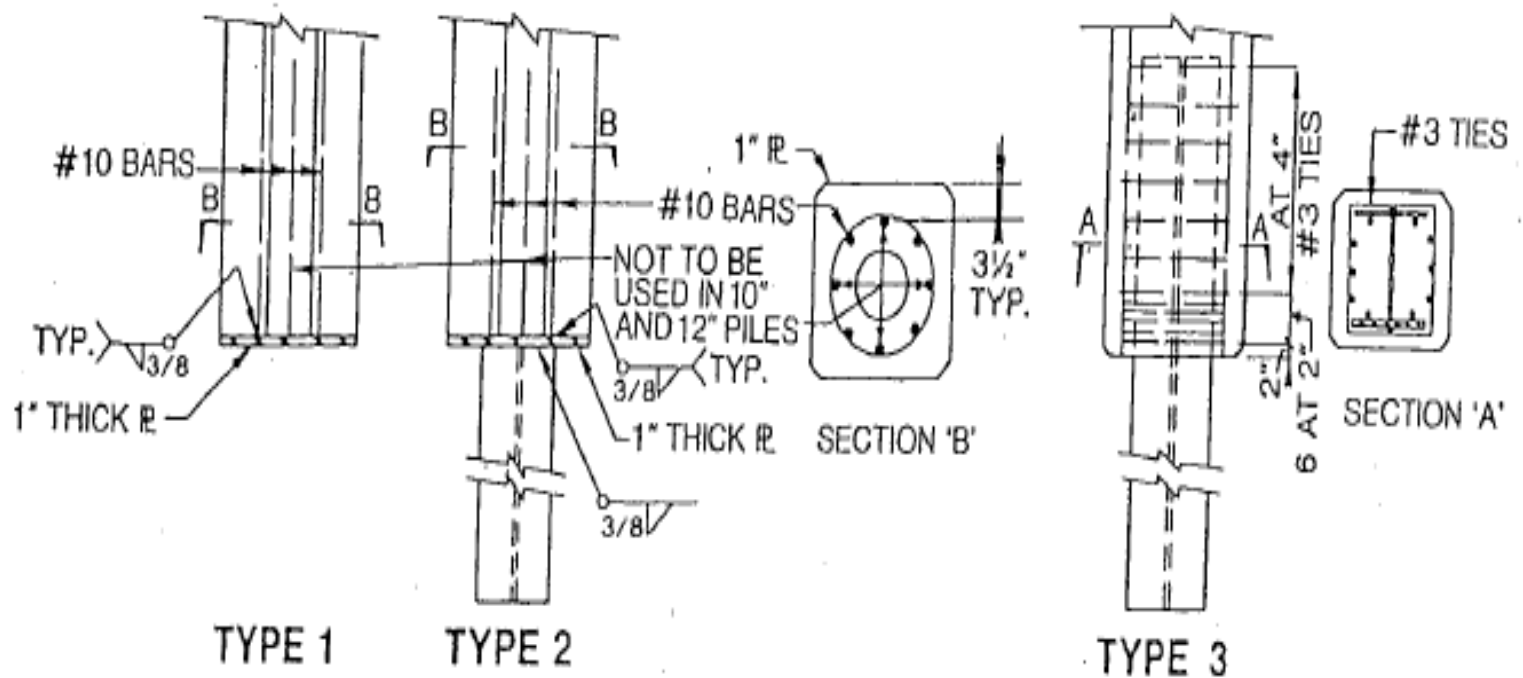
- Change Hammers
- Play with Pile Cushions
- Jetting

Pile Tip – Rock Point



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Pile Tips-HP



Construction Challenges

PROBLEM 1: Achieving sufficient penetration into hard clay stratum to achieve fixity for 30" waterside crane beam piles

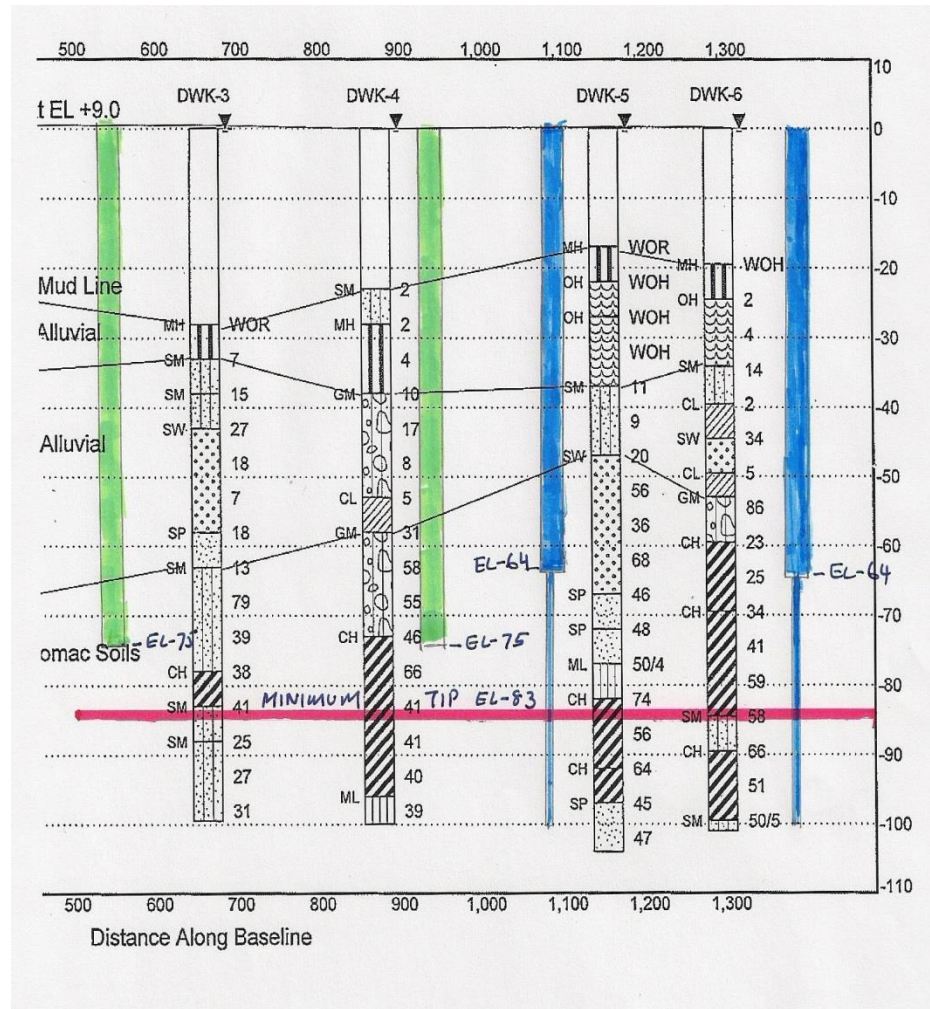
SOLUTION: Install HP 14 x 89 stinger on bottom of pile. Cast inserts into pile for stinger assembly anchorage.



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Geotechnical Considerations

- Piles must penetrate into hard clay and dense sand (possible gravel/cobble layer)
- Min. tip elevation of EL -83 for lateral fixity



Pile Construction



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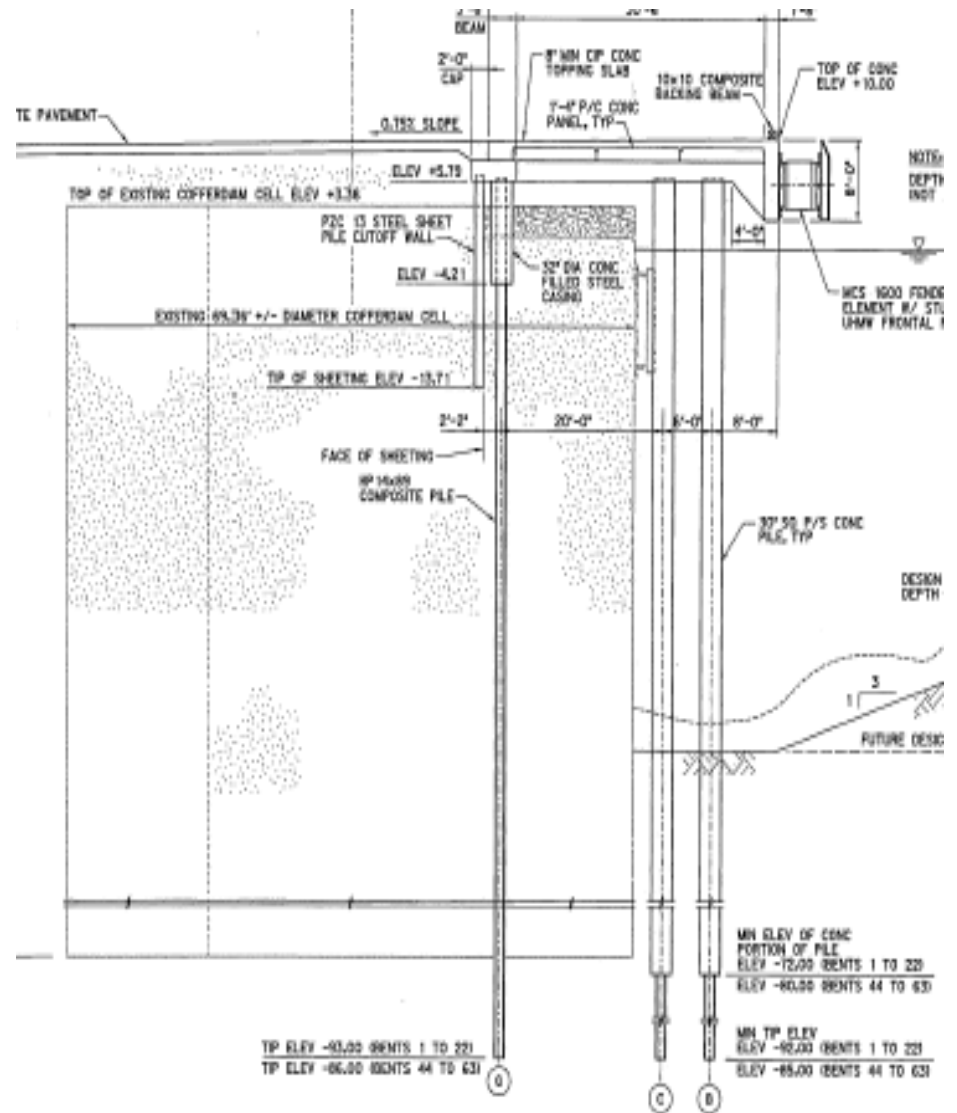
Masonville Marine Terminal

- Wharf was under design during the time of construction at SeaGirt
- Design called for 30 inch P/S concrete piles with a design load of 600 kips
- Test program had Cast In HP Stingers with Stinger lengths of up to 25 feet
- Project also allowed “Predrilling”

Masonville Wharf Section

30" P/S with 5-25 ft long Stinger

Similar geologic setting as Seagirt



MASONVILLE WHARF



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Predrilling with a Lubricated Bit



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“Driving a P/S Pile with a HP Stinger is Like Trying to Drive a Sailboat in Reverse Using Just the Rudder” B Fellenius.



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Overview of Test Program

The Test Program Consisted Of:

- Static Load Testing
- Statnamic Load Testing
- High Strain Dynamic Testing
- Embedded Data Collector Testing

Seagirt Marine Terminal Berth4

- 30-inch Crane Rail Test Pile – 95ft Long.
- Driven to Refusal 20blows/inch at 3ft Below Minimum Tip.
- 110 ft-kip Hydraulic Hammer
- Design Capacity 410-tons.
- Ultimate Capacity 820-tons.

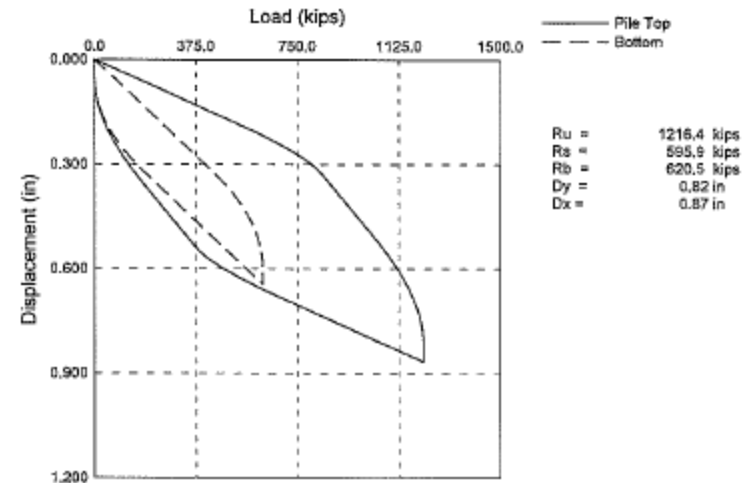
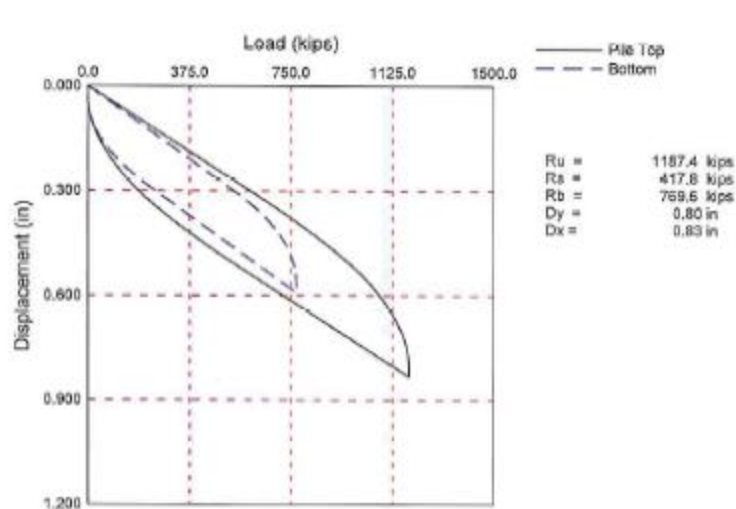
PDA Test



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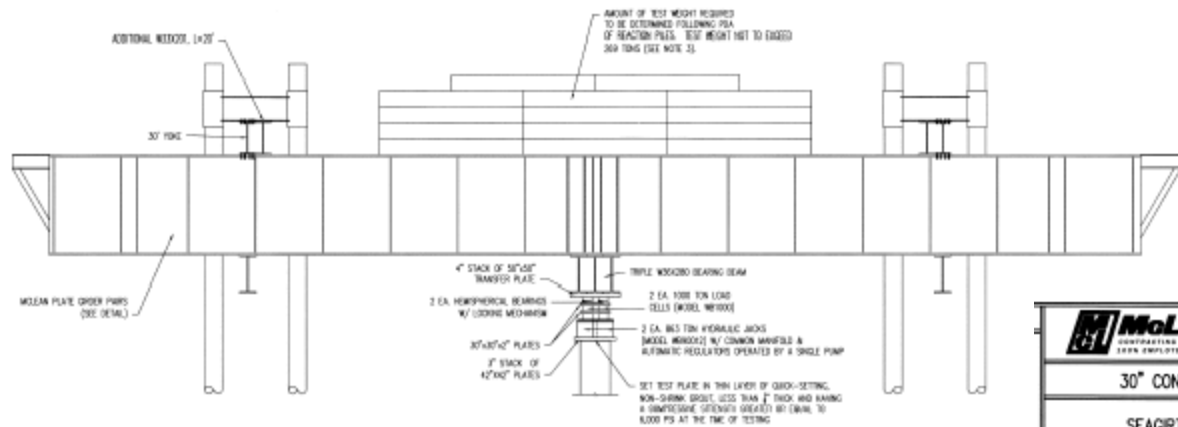
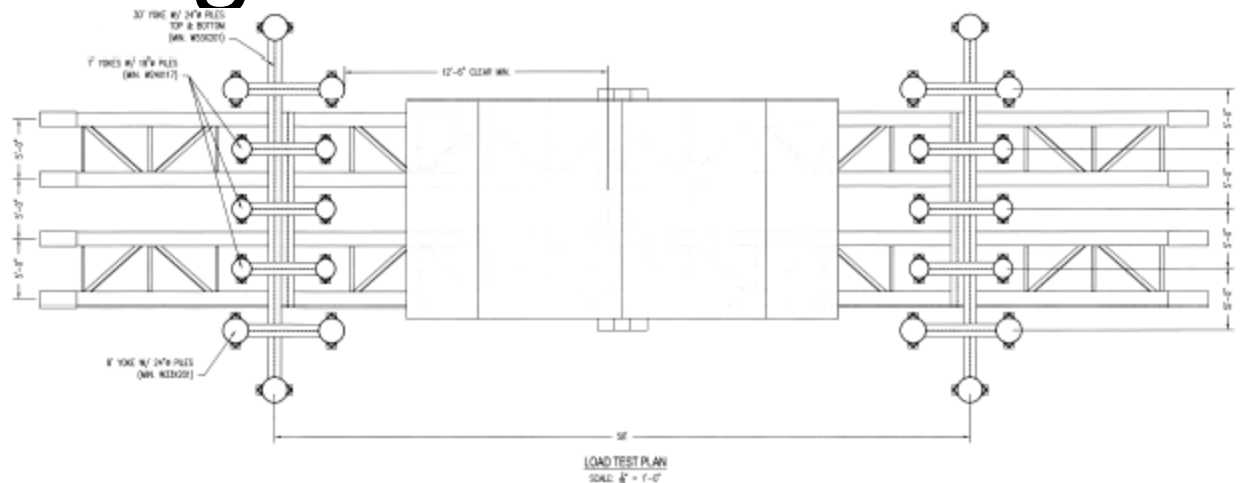
Seagirt Marine Terminal Berth4

- Dynamic Load Test – Initial and Restrike
- Superposition Capacity 1365 kips



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Seagirt Load Test Frame



	8750 MOLLEAN WAY GLEN BURNIE, MD 21060-0408 TEL: 410-853-8700, FAX: 410-853-8718
	30" CONCRETE PILE STATIC LOAD TEST
SEAGIRT MARINE TERMINAL, BERTH IV BALTIMORE, MD	

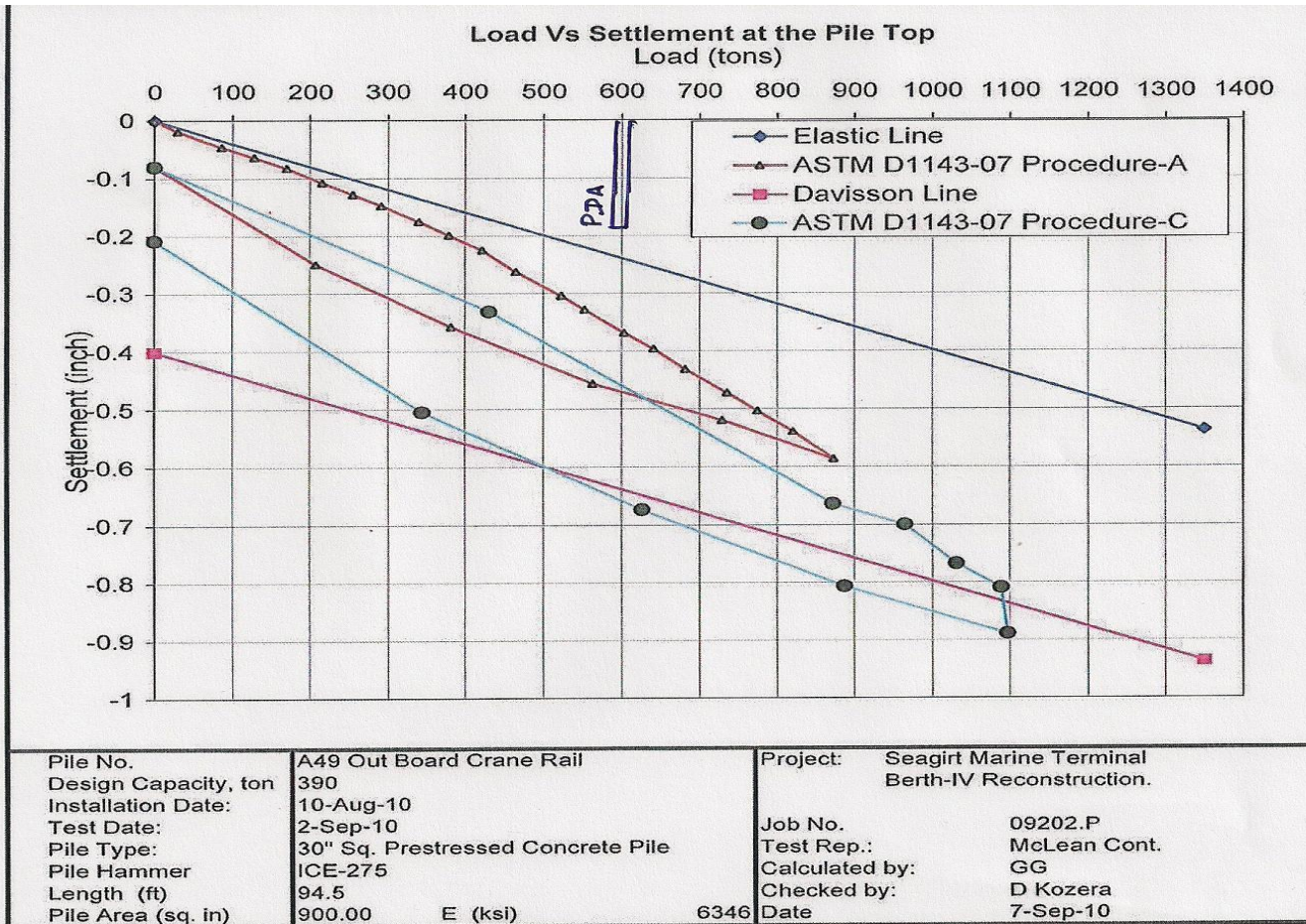
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Seagirt Static Load Test



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Static Load Test Results



PDA CAPACITY ON RESTRIKE 600 - TONS AT 20 BLOWS/0.5

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Masonville Marine Terminal

- 30-Inch Square Concrete Pile with HP14x89 Stinger.
- Design Capacity 240-tons.
- Concrete Pile Length 80-91ft. Stinger length 5-25 ft.
- Pre-augured to within 5-ft of Concrete Tip.
- 260 and 212 ft-kip Open End Diesel Hammers.

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List of Tests

- Traditional Top Only Externally Mounted Dynamic Test
- Top and Tip Embedded Data Collector Dynamic Test
- Fully Instrumented Static Load Test.

Statnamic Load Test - Ready



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Statnamic Load Test - Set



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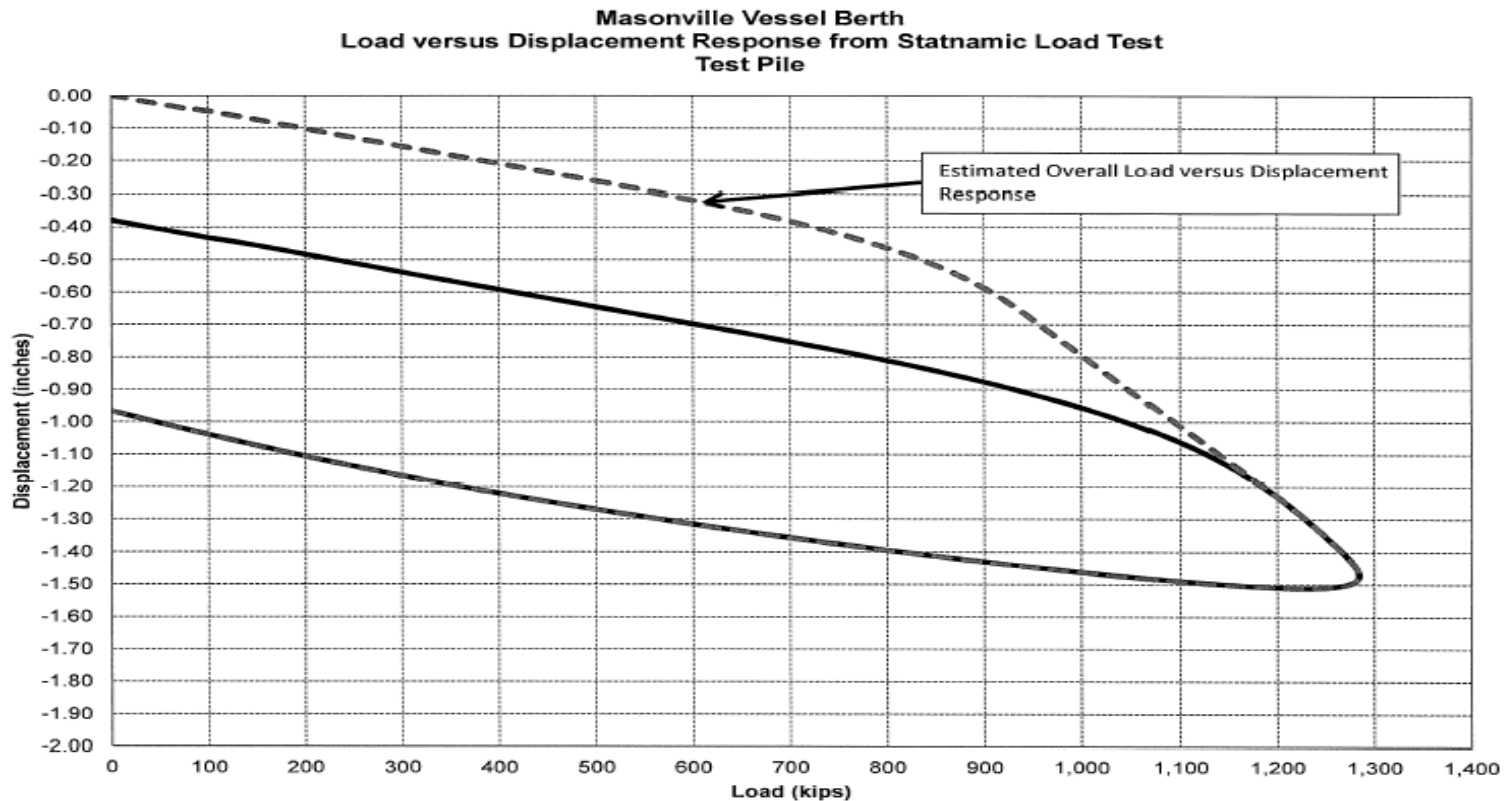
Statnamic Load Test - Fire



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Statnamic Load Test Results

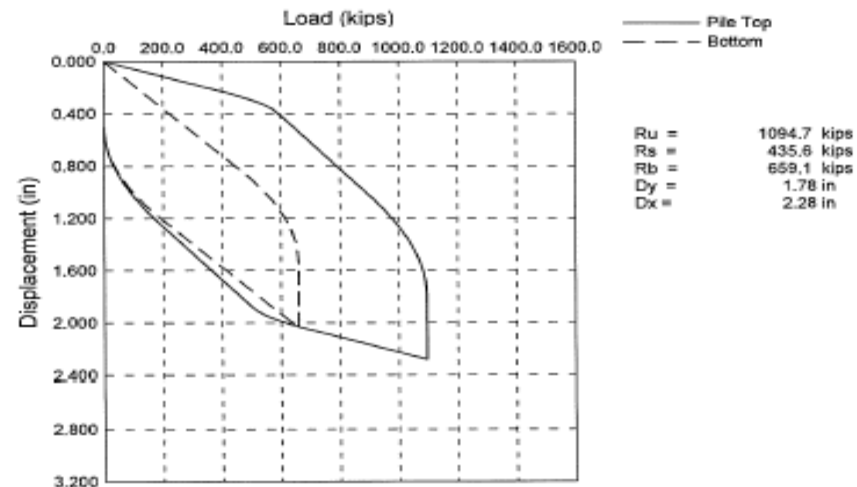
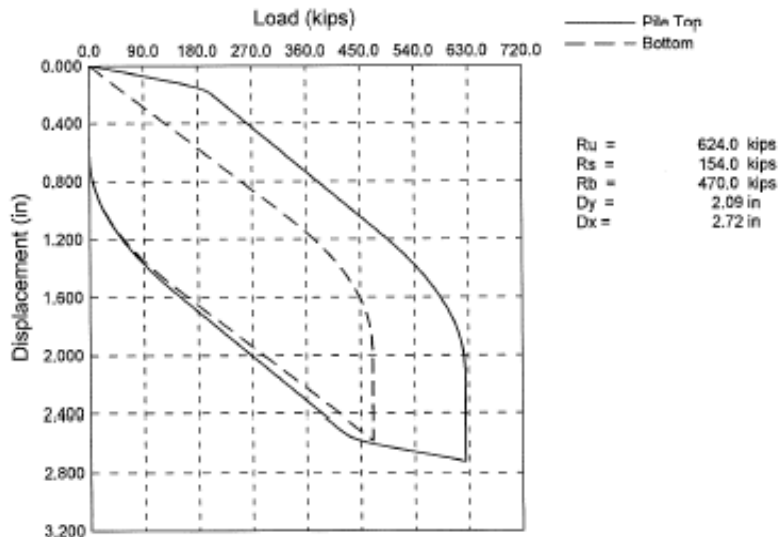
Statnamic Reported Capacity Pile C11 1284 kips.



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Dynamic Load Test - PDA

Restrike capacity Pile C11 1095kips.
Restrike penetration resistance
2 blows/inch.



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Embedded Sensor Data

- Strain and accelerometer Embedded at the top and the tip of concrete pile.
- Sensors are cast in the casting yard.
- Need to pre plan the test pile
- Data transmitted wirelessly to the recorder.

Embedded Data Collector

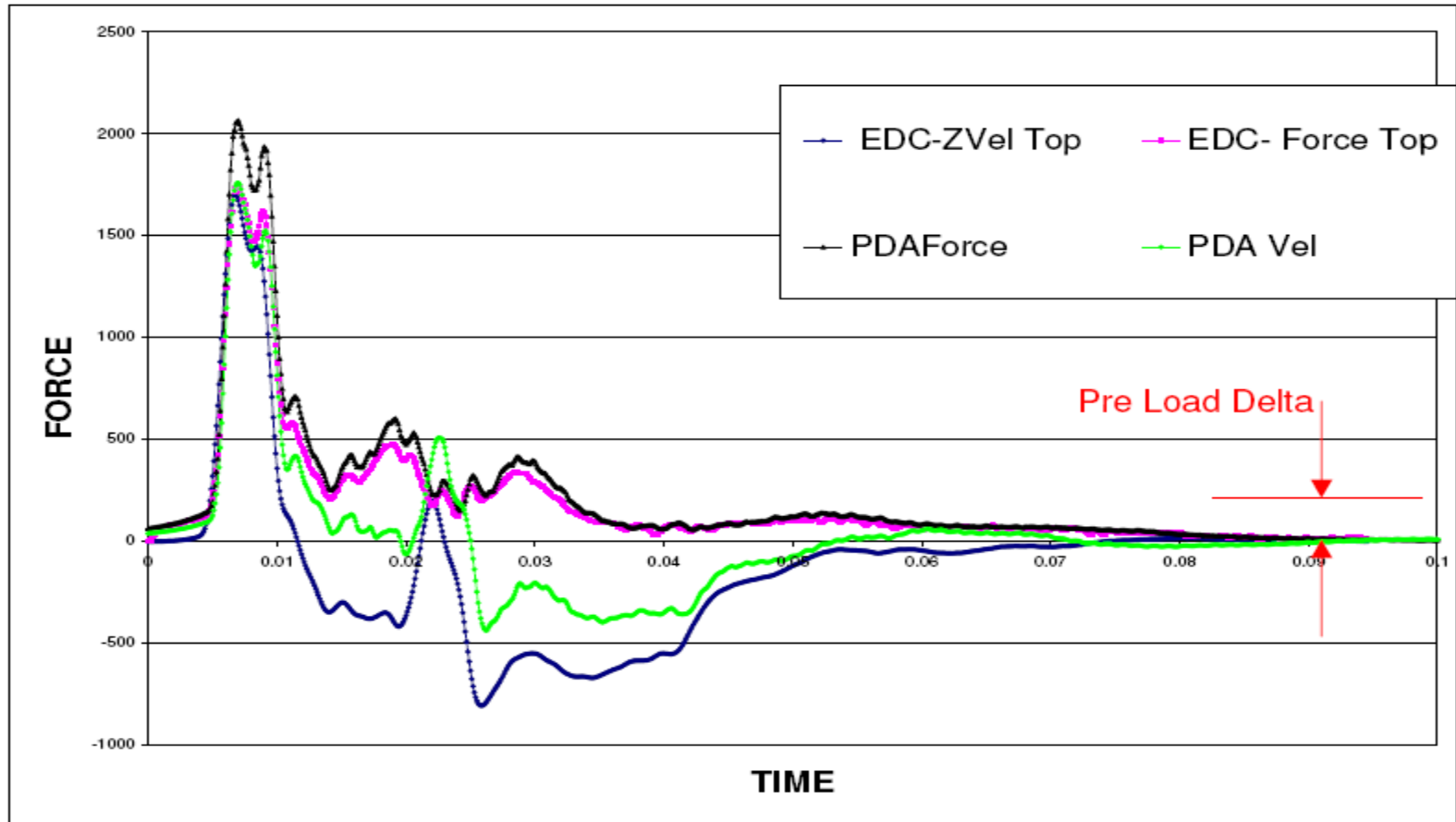


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Embedded Data Collector

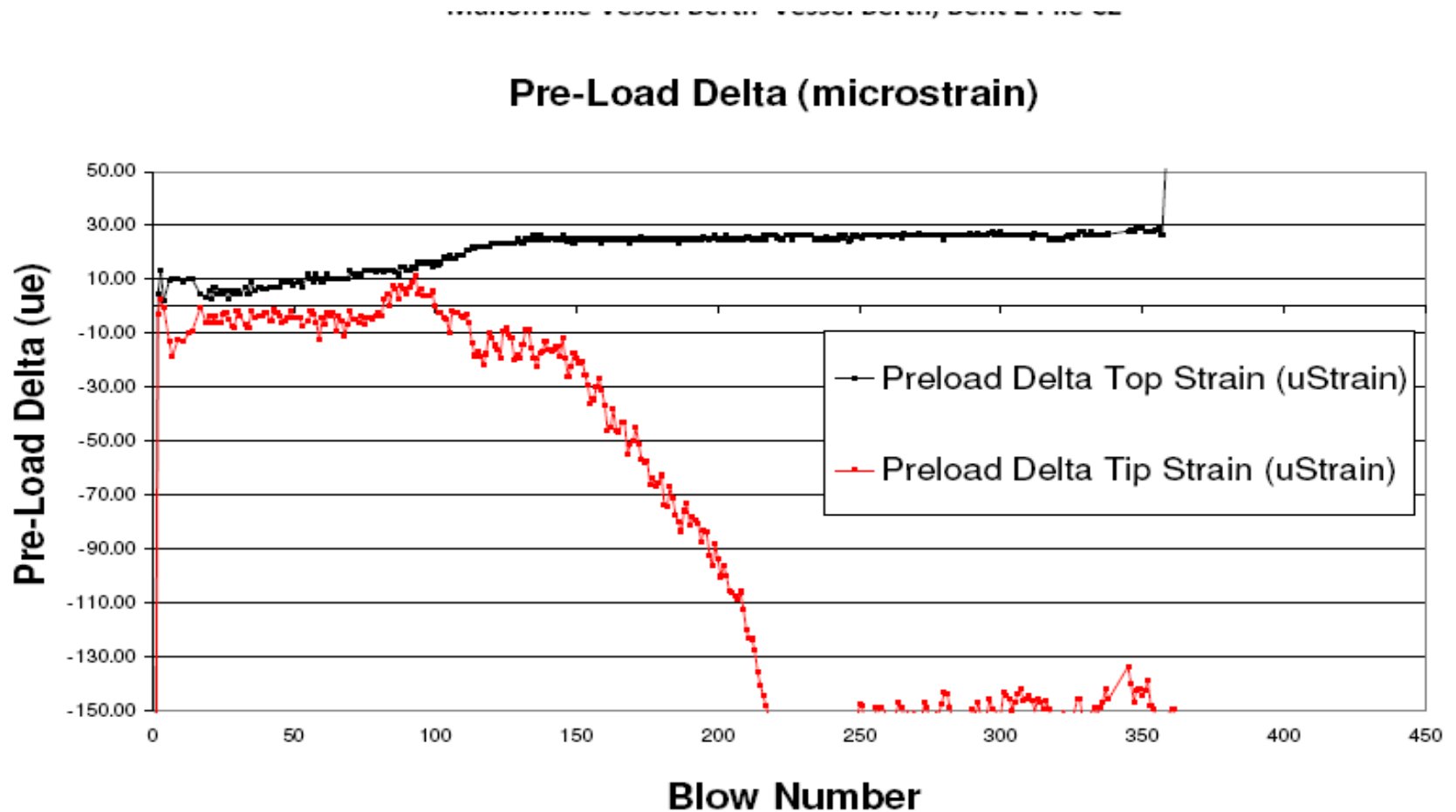
- UF Method Pile Capacity Evaluation.
- Direct Stress Measurement at the Tip.
- Compares Direct Measured Tip Stress with Estimated Tip Stress from Top Only Gauges.
- Measures Change in Pre-Stress During Driving in Real Time.

Pre-Load Delta



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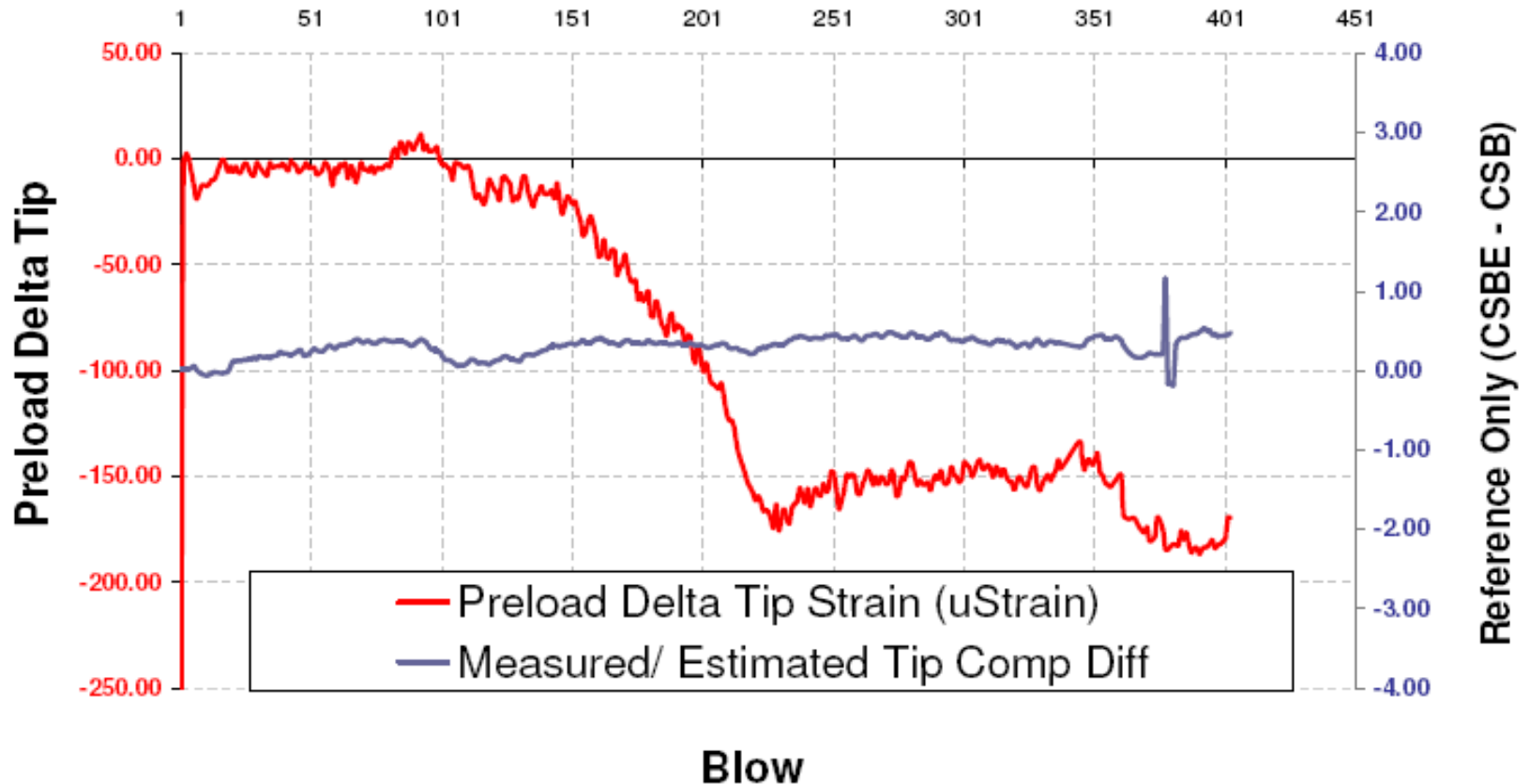
EDC Results- Pile C2 (25-ft Stinger)



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EDC Data File C2(25-ft Stinger)

(Estimated - Measured) Tip Compression versus Tip Preload Delta



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EDC Results Pile C2 25-ft Stinger

- Likely Prestress Loss at the Tip
- But No Significant Variation Between Measured and Estimated Tip Compression Stress
- Tip Accelerometer Water Damaged After Two Day Waiting Period for Restrike.
- What Does that Mean?
- What Do We Do?

EDC Results Pile C2 25-ft Stinger

What does that mean?

Possible damage due to the stinger deflecting.

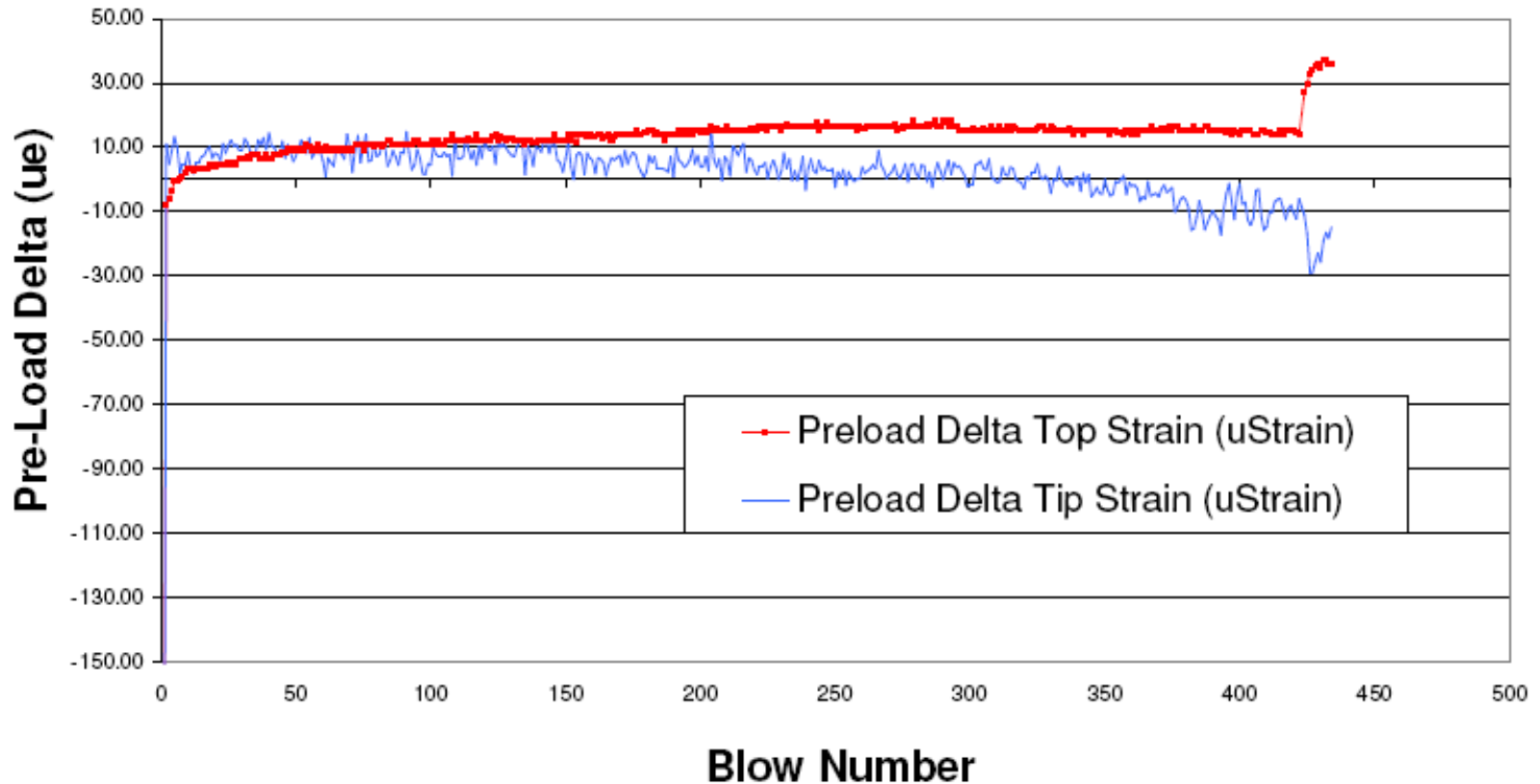
- What did we do?

Shorten the stinger length to 5-ft.

Increase the preauger depth and the concrete portion of the pile.

EDC Results Pile C11 5-ft Stinger

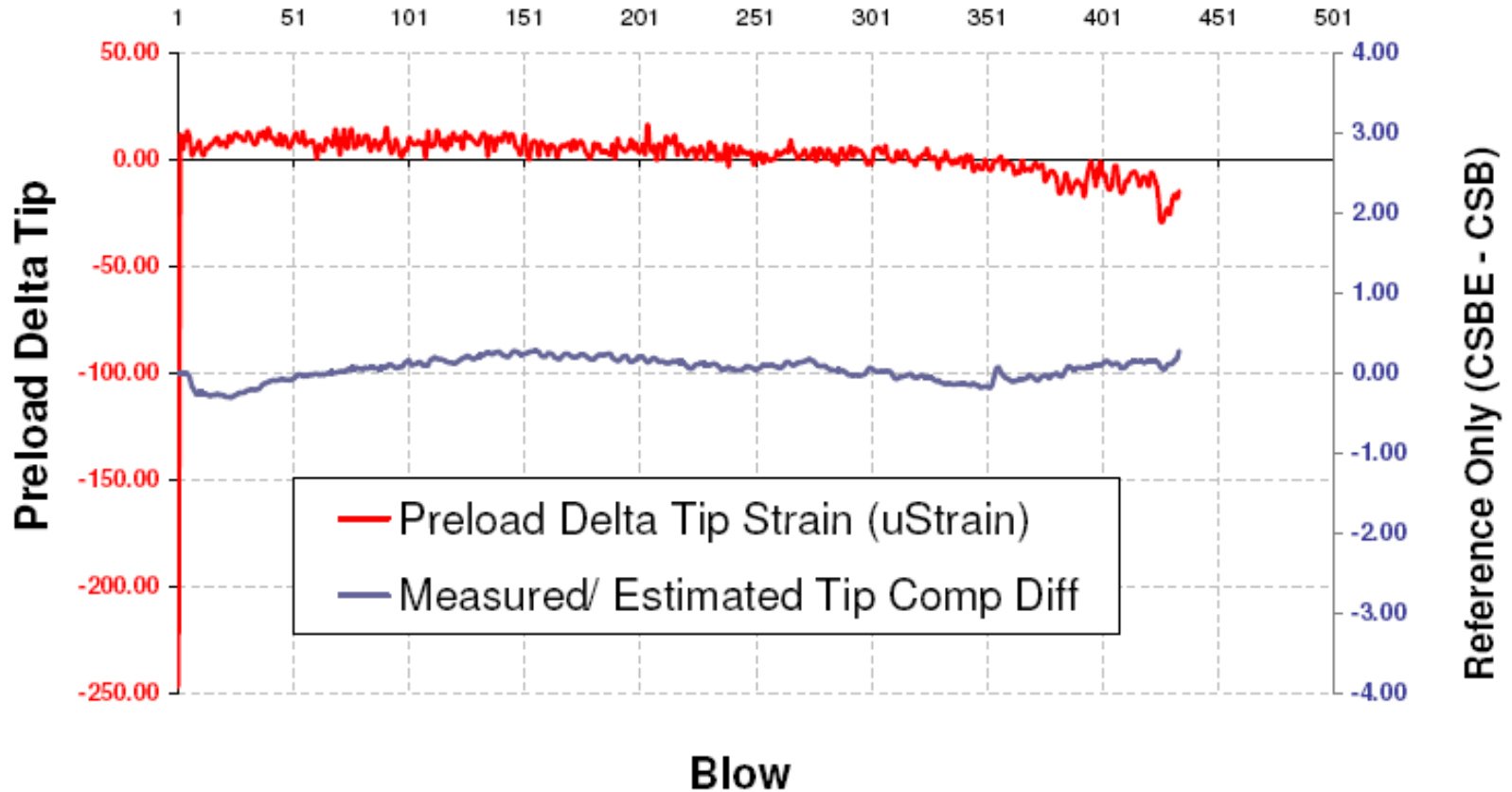
Pre-Load Delta (microstrain)



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EDC Results Pile C11 5ft Stinger

Estimated - Measured Tip Compression versus Tip Preload Delta



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Lesson Learned

- Direct Strain Measurement at the Tip Provides Valuable Information When a Stinger Connection is Used.
- Longer Stinger May Present Challenge Under Certain Soil Conditions.
- Appropriate Pre-drilling Techniques Can be Used Effectively.

Lesson Learned

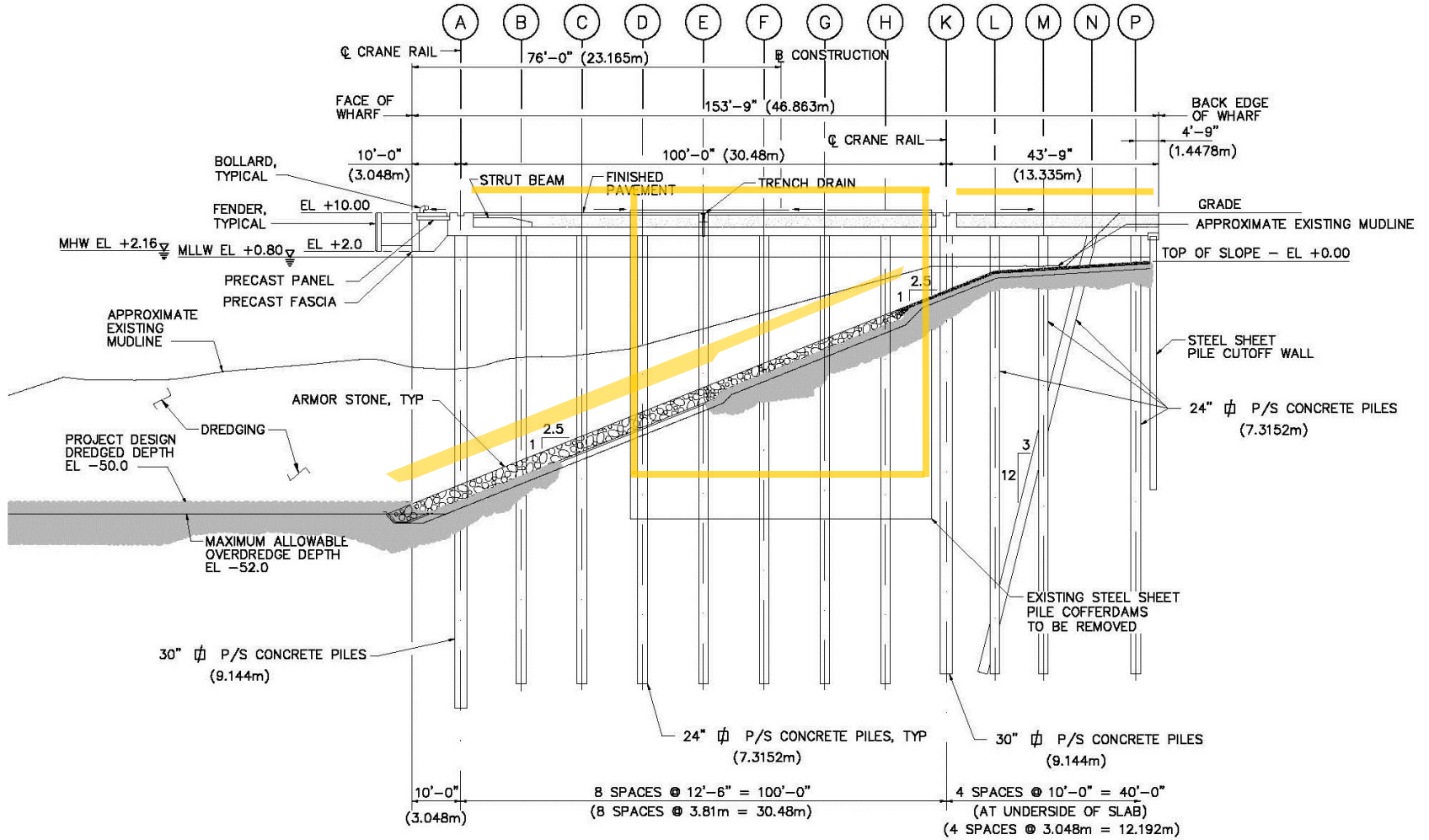
- Need to Mobilize the Pile During Dynamic Test.
- Hammer Size Limited by Driving Stress.

Project	Static Load Test	Statnamic Test	Restrike PDA	Restrike Blow Count
Masonville	NP	1284 kips	1095 kips	2 blows/inch
Seagirt	2200 kips	NP	1365 kips	40 blows/inch

QUESTIONS!
ENJOY THE BREAK

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Seagirt Wharf Section



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