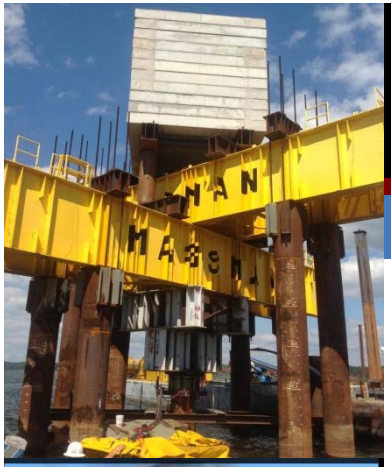

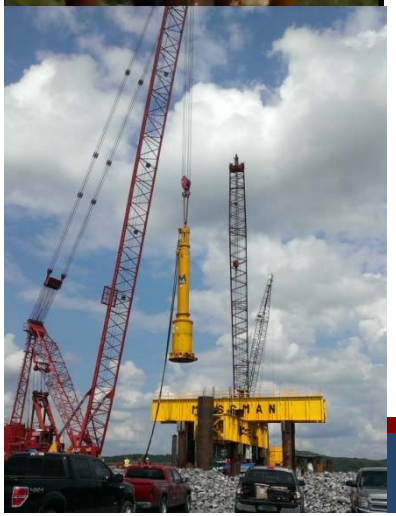

Kentucky Lake Bridge
Pipe Pile Load Test Program
45th Annual STGEC
Mobile, AL – October 27-30, 2014

Presented by:

Darrin Beckett - KYTC

Ron Ebelhar - Terracon Consultants

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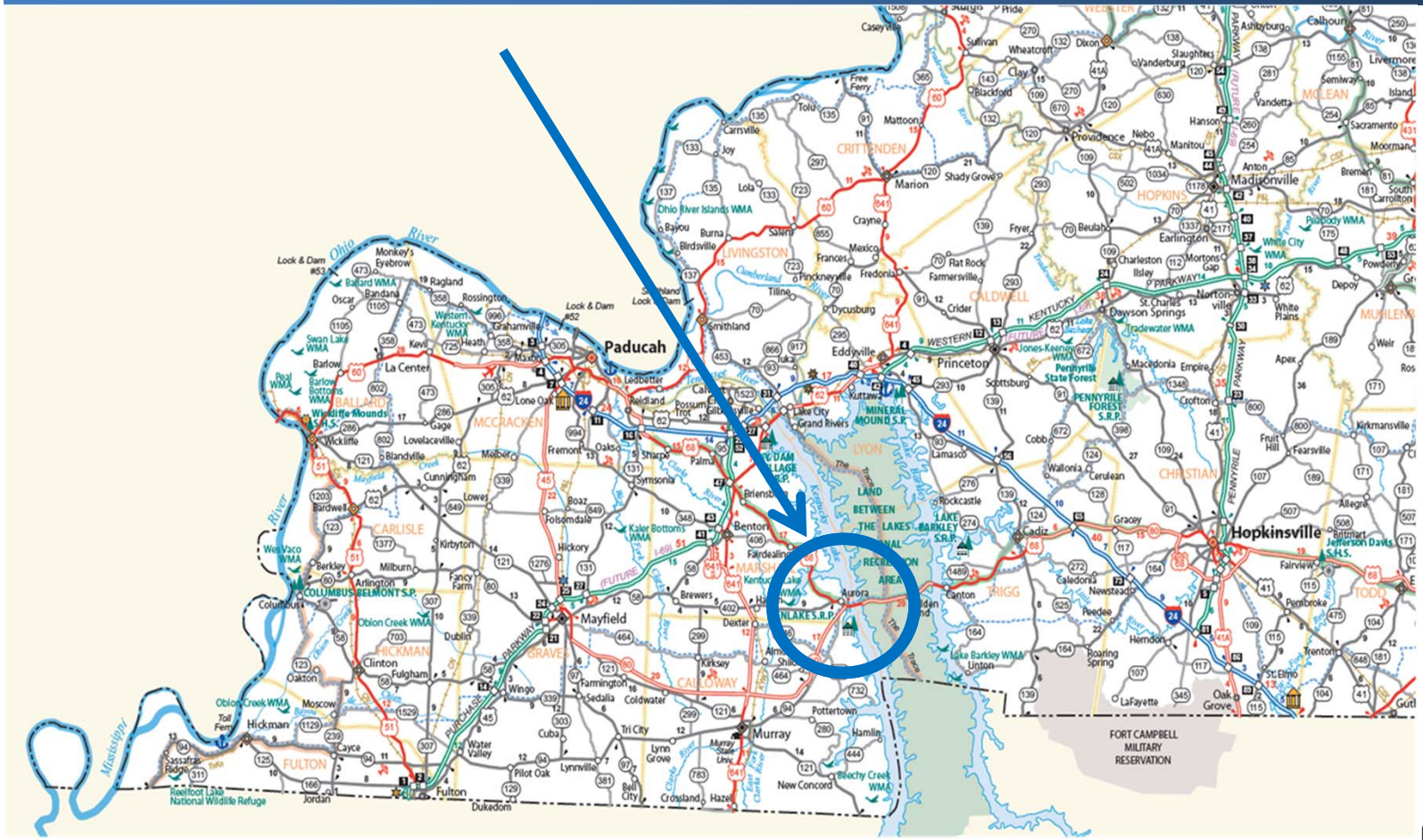
Project Site



Kentucky Official Highway Map

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Proposed Bridge Rendering

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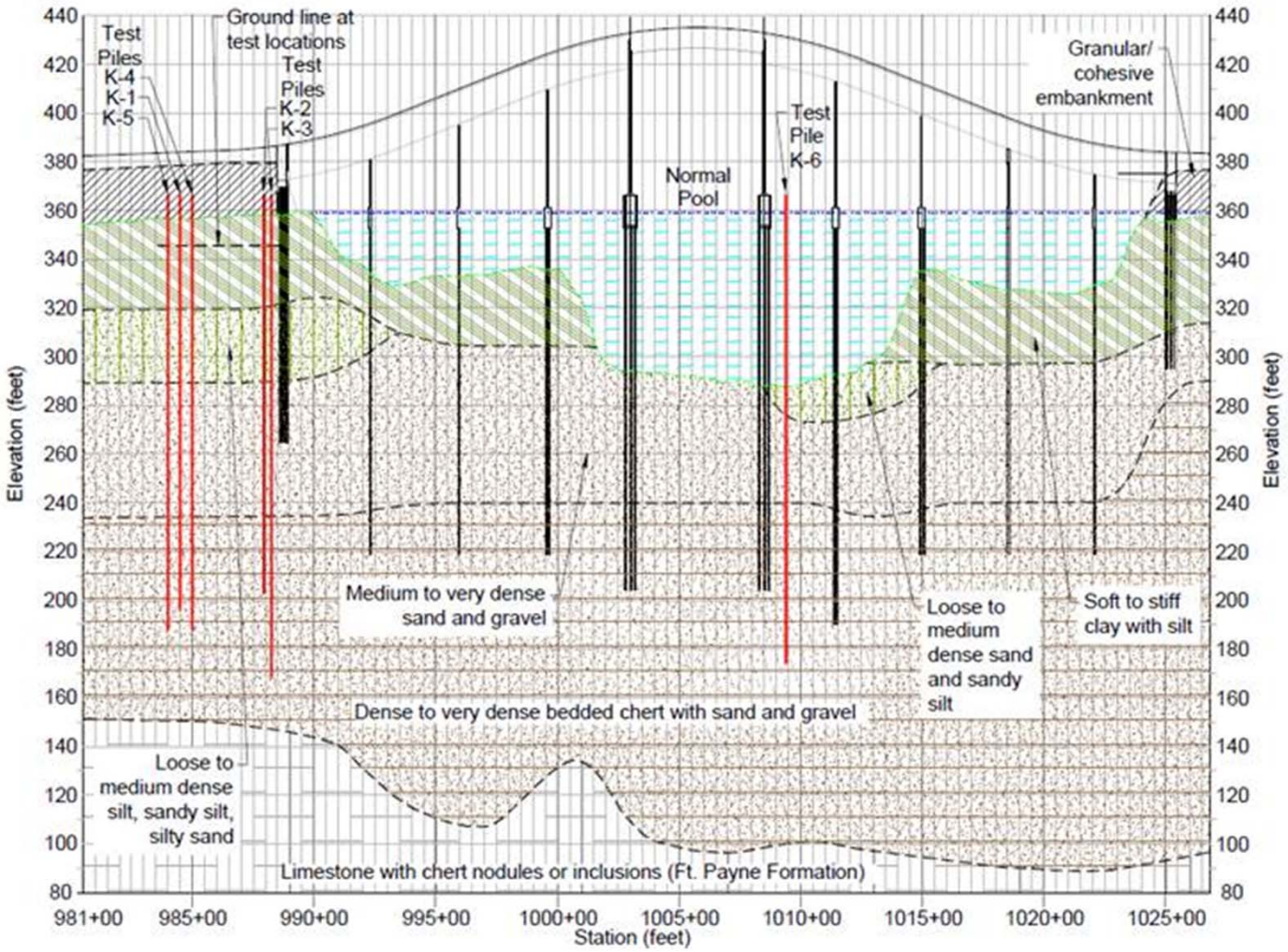
www.lakebridges.com

Presentation Scope

1. Subsurface Conditions
2. Pier Foundation Design Considerations
3. Load Test Program Considerations
4. Load Test Program Results

1. Subsurface Conditions



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Comprehensive Field Sampling / Testing Program

- Conventional Soil Borings
  - Extensive Laboratory Testing
- Piezo-Cone Penetration Tests
- Specialized In-Situ Tests
  - Downhole & Crosshole
  - P-S Suspension Logging
  - Pressuremeter
  - Shear Wave Seismic Reflection

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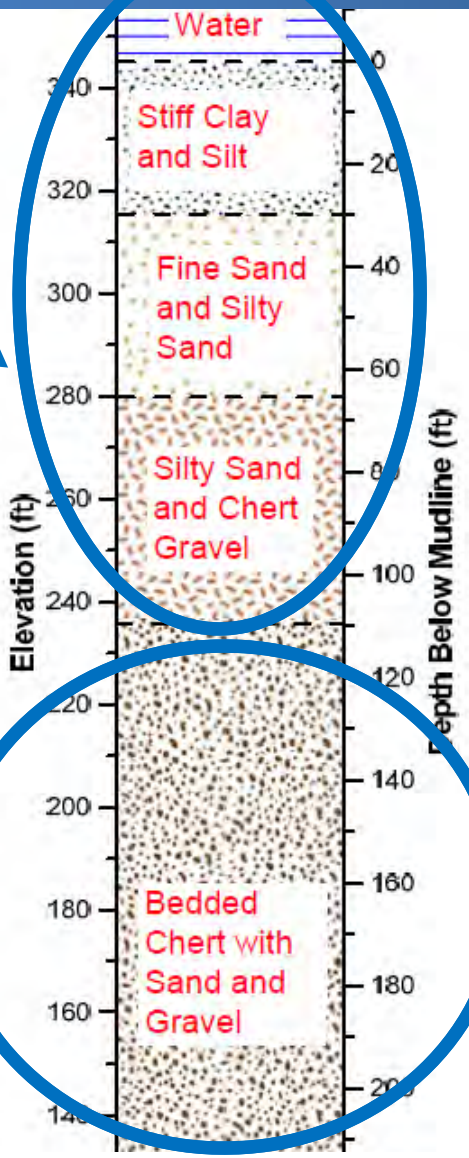
Typical Soil Profile

Alluvial Deposits

Bedded Chert



In-Situ Outcrop of Similar Material

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2. Pier Foundation Design Considerations

- Open-ended driven pipe piles selected as appropriate foundation
  - Considered 48”, 60”, 72” & 96” Diameter for Piers - Final Design 72”
  - Prior to this Project 48” Believed to be Largest Diameter Driven Piles by KYTC
- API RP 2A method for axial resistance analyses considers “plugged” and “unplugged” conditions
- Constrictor plates (i.e.“artificial” plugs) to allow required penetration but force the piles to plug to achieve end bearing
- Drivability/Constructability also a key factor in these analyses
  - Many combinations of hammers, target depths considered

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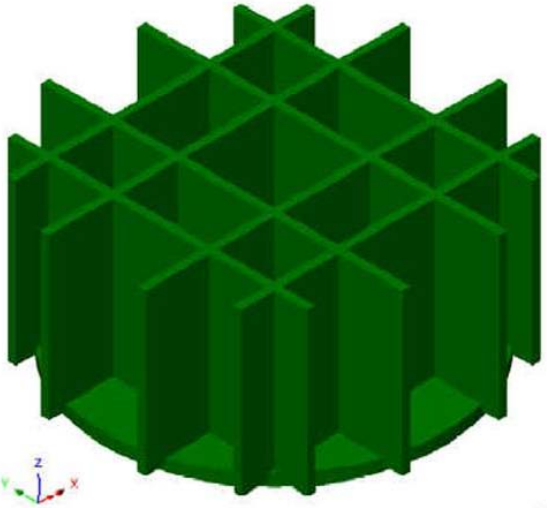
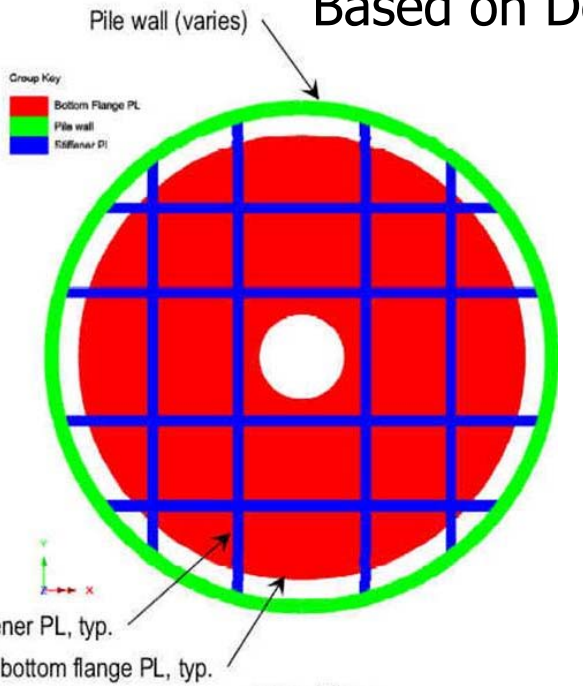
Constrictor Plate (i.e. Artificial Plug)

72" dia. Pile Plug Models

Placed ≈70 to 100 ft. above Pile Tips
Based on Depth to Bedded Chart



Isometric View



Plan View

Partial Model Diagrams

Artificial Plug Design Calculations by Genesis Structures, 2013

Bridge Construction Concerns

"Do not design on paper what you have to wish into the ground."

Karl Terzaghi

Bridge Construction Concerns

Uncertainties Could Lead to Potential for:

- Construction Delays
- Construction-Phase Foundation Redesign
- $$$ Overruns on $100M+ Contract

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3. Load Test Program Considerations

- Unusual soil conditions – chert gravel presence in clays & sands & "bedded chert"
- Uncertainties over drivability / achievable depths / axial & lateral resistance
  - Maximum required nominal axial resistance ≈ 9000 – 10,000 kips
- Decision to perform significant design-phase Pile Load Test Program with "Advance Contract"
  - Contract also included Lagoon Bridge & Expanded Causeways
  - February 2013 Letting

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Geotechnical Considerations - Load Test Program Results

Purpose

- Confirm Soil Parameters
- Evaluate Pile Drivability
- Evaluate Hammer
- Evaluate Pile Capacity
- Pile Handling (185’ and 210’ test lengths)

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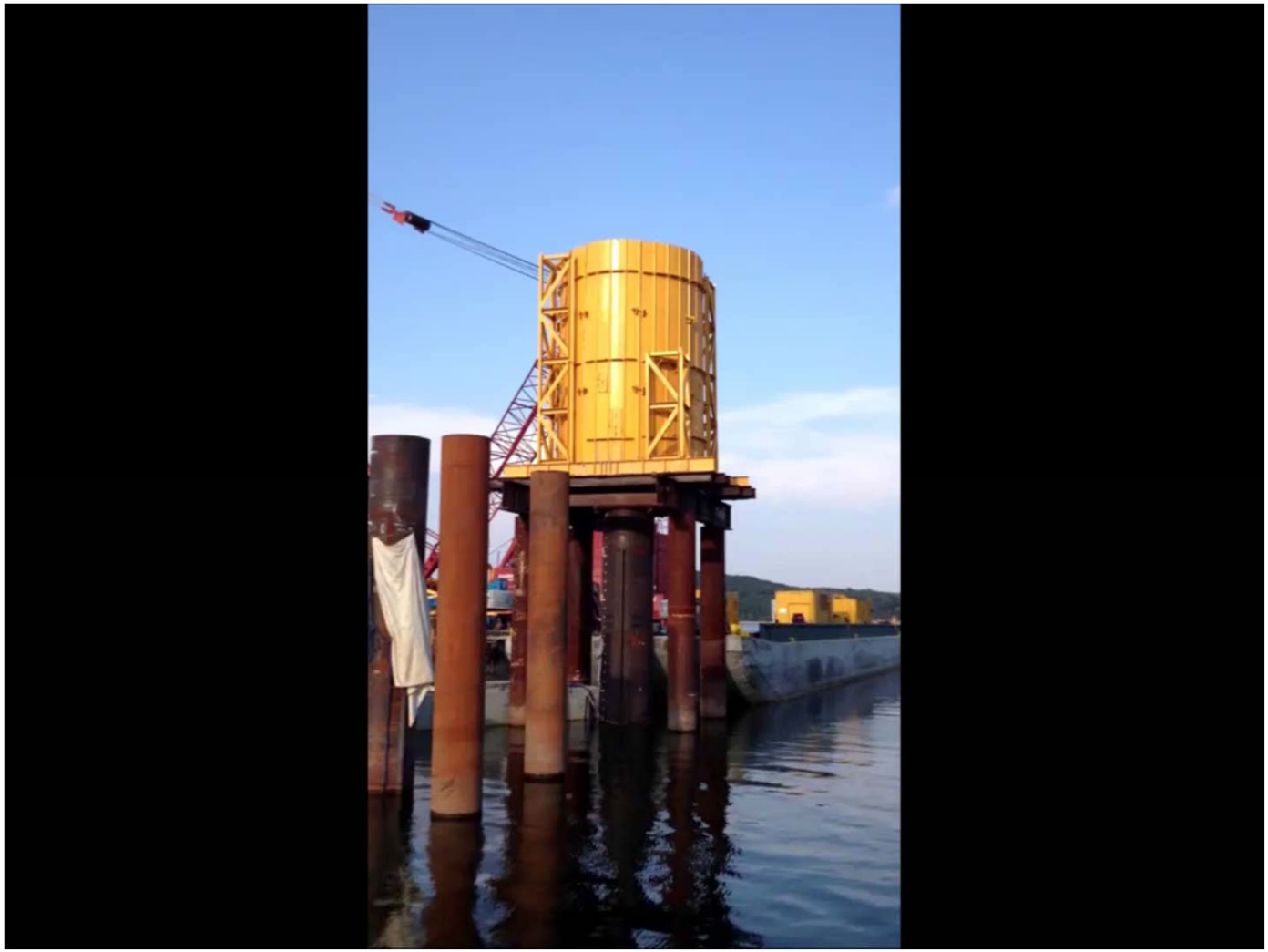
Geotechnical Considerations - Load Test Program Results



Video – Statnamic Axial Load Tests

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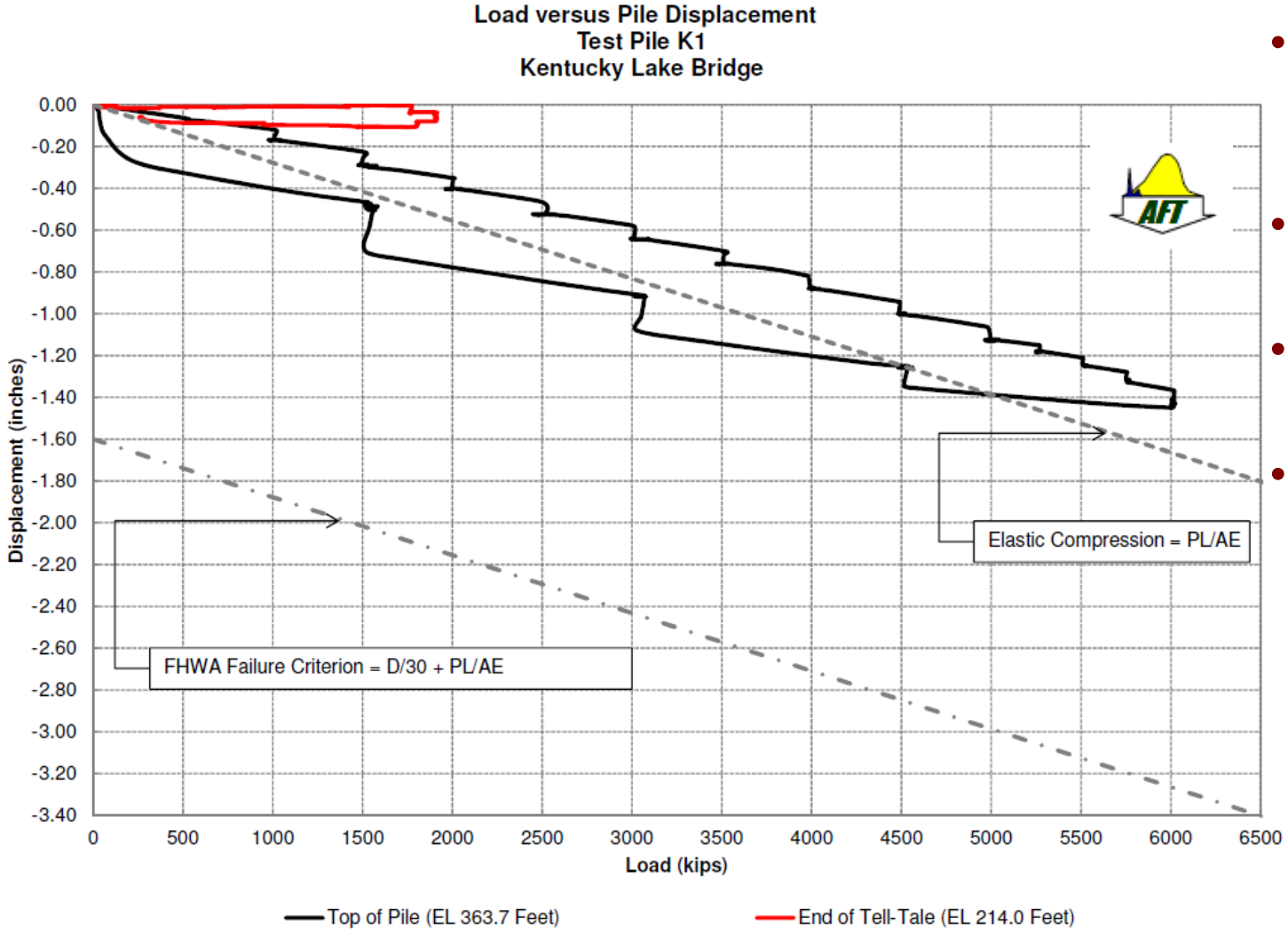
Geotechnical Considerations - Load Test Program Results



- Static Load Test – 48-inch-diameter pile
- Six 1200-kip jacks
- Test duration 24 hours
- Hold time at 5000 kips (8 hrs)

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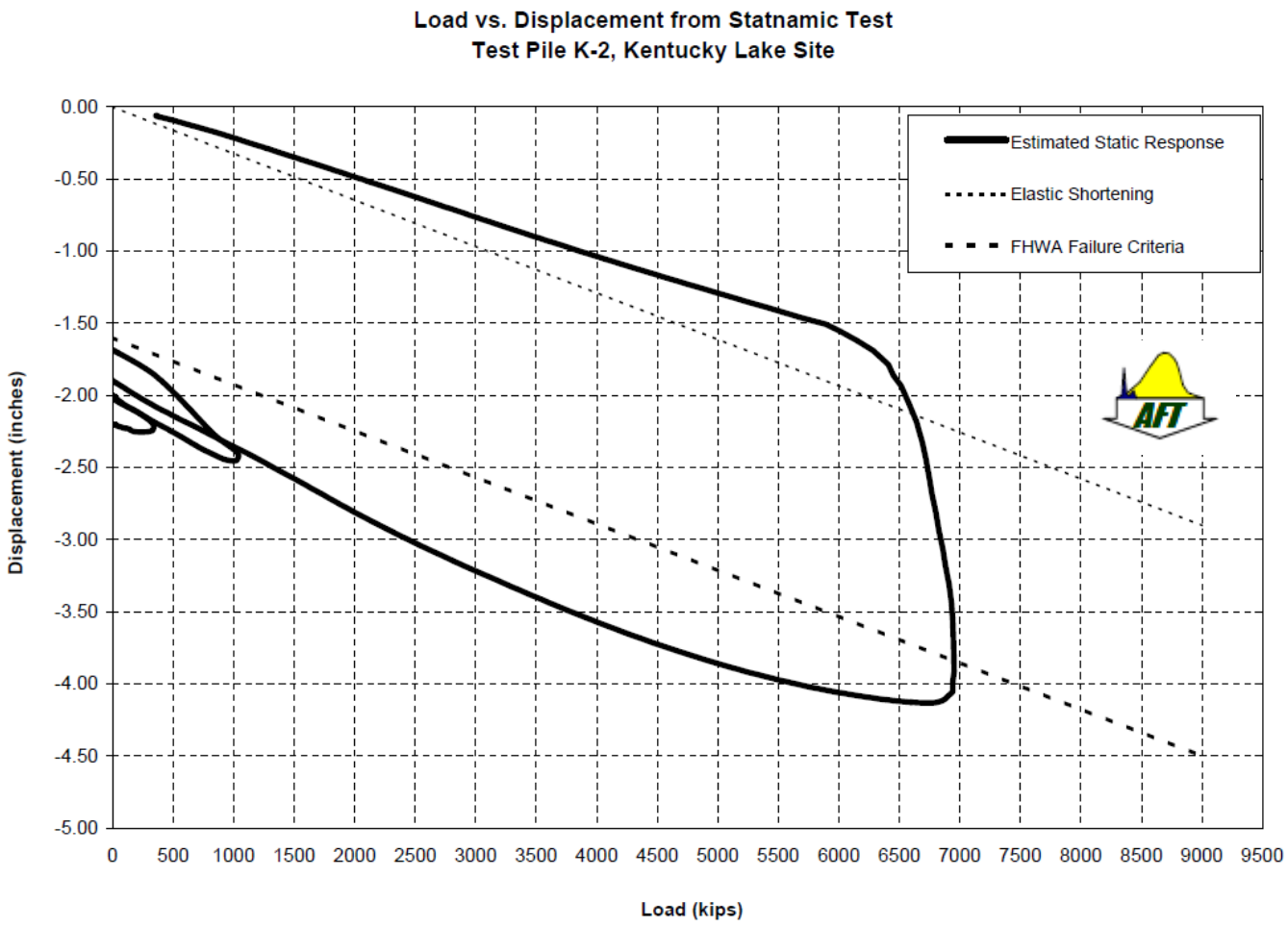
Geotechnical Considerations - Load Test Program Results



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Geotechnical Considerations - Load Test Program Results

Test Program

- Dynamic Pile Testing (PDA)
- Statnamic Load Tests
  - Axial (6950 kips and 8500+ kips)
  - Lateral (4 loads up to 425 kips ESL)
- Static Axial Load Test (6000+ kips)
- Fully Instrumented Piles
  - Soil Resistance
  - Load Transfer (axial and lateral)

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Geotechnical Considerations - Load Test Program Results

Test Piles

- 48” Piles
  - 1” & 1.5” Wall
- 72” Piles
  - 1.5” & 2” Wall
- Near Causeway
- Deep Water
- Open End-partial
- Constrictor Plate

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Geotechnical Considerations - Load Test Program Results

Summary of Results

- Nominal Resistance (capacity) achieved Near Estimated Tip Elevations
- Menck MHU 800S Hammer used successfully
- Relatively Easy to Drive to Target Tip Elevations with plate placed high
- Constrictor Plate Functional for plugging – extended drives
- Deeper Penetrations achievable

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Geotechnical Considerations - Load Test Program Results

Summary of Results

- Pile lengths and wall thicknesses can be handled with heavy marine equipment
- Soil resistance during pile driving is less than long-term static resistance (ranged from 40% to 80%, typically about 70%)

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Geotechnical Considerations - Load Test Program Results

Summary of Results

- Recommendations developed for production pile verification test program
- Dynamic Pile Testing required
- Longer-term pile restrikes required

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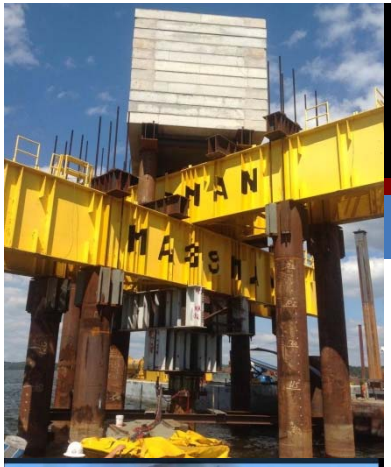

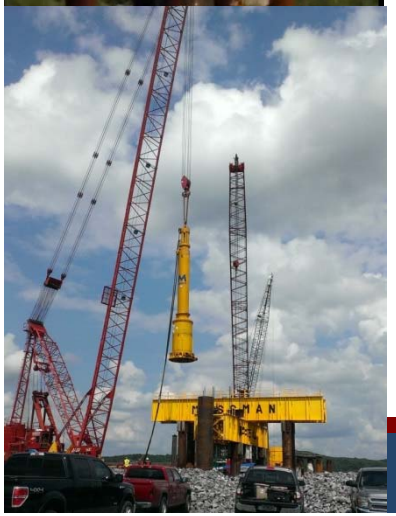

Kentucky Lake Bridge
Pipe Pile Load Test Program

QUESTIONS???????

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