THE STATE OF
GEOTECHNICAL
PRACTICE AT LA DOTD

Steve Meunier, P.E.
Administrator
LA DOTD Pavement & Geotechnical Services
Pavement & Geotechnical Section

- Comprised of a staff of 22 engineers and technicians
- Responsible for the design and oversight of all of the Pavement & Geotechnical Engineering for LA DOTD
Pavement & Geotechnical Section

- Currently have 3 Statewide Geotechnical Retainer Contracts in place
  - $3M Amounts each
- In the process of putting out two more Geotechnical Retainer Contracts
  - Anticipate $2M each
PREDOMINATE FOUNDATION TYPES IN LA BRIDGE PROJECTS

• Driven Piles in Footings & Pile Bents
  – Prestressed Concrete Piles, with and without splices
  – Steel Pipe Piles
• Drilled Shafts in Footings and Column Bents
NEW AASHTO LRFD BORING REQUIREMENTS

- Retaining Walls
  - Borings spaced every 100-200 ft with alternating locations in front and rear of walls
  - Anchored walls require additional borings in anchorage zone
  - Soil-nailed walls also require additional borings at distance of 1.0-1.5 ht of walls
NEW AASHTO LRFD BORING REQUIREMENTS

• Deep Foundations: (not for slab spans)
  – Structure widths less than 100-ft
    • A minimum of 1 boring per substructure
    • At 100-200 ft spacing (LA DOTD Interpretation)
  – Structure widths greater than 100-ft
    • A minimum of 2 borings per substructure
    • At 100-200 ft spacing (LA DOTD Interpretation)
**SAMPLE BORING LOG**

<table>
<thead>
<tr>
<th>Soil Type and Color</th>
<th>Stress</th>
<th>Maximum Cons. Limit</th>
<th>Plasticity Limit</th>
<th>SPT N</th>
<th>Sample</th>
<th>Elevation</th>
<th>STA. Location</th>
<th>Test Pile No.</th>
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<tbody>
<tr>
<td>Med-Stiff B.G. Cl.</td>
<td>25</td>
<td>63</td>
<td>33</td>
<td>2.1</td>
<td>-</td>
<td>22.4</td>
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<tr>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
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<td>121</td>
<td>33</td>
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<td>20</td>
<td>3.4</td>
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<td>-</td>
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<td>-</td>
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<tr>
<td>-</td>
<td>188</td>
<td>39</td>
<td>1.34</td>
<td>55%</td>
<td>39</td>
<td>6.6</td>
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<tr>
<td>Loose Dr. Cl. Sa.</td>
<td>-</td>
<td>-</td>
<td>90</td>
<td>66.6</td>
<td>90</td>
<td>71.6</td>
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</table>

- **Measured Elevations**
- **Water Table Depth**
- **UU-Triaxial Compression tests performed on at least 75% of clay samples**
- **Latitude and Longitude**
- **Project Stationing and Offset Distance**

**SAMPLE BORING LOG**

- **BORING NO:** 17
- **STA.:** 29+10
- **LATTITUDE:** 3363460
- **LOCATION:** PROPOSED
- **LOG MILE:** 2.12-01
- **LOG MILE:** 70,000
- **LOG MILE:** 100,000
PILE FOUNDATIONS...What’s new?

• Recent 2010 AASHTO LRFD Revisions
  – Removal of site variation considerations
  – Changes to Resistance Factors for Driven Piles

• New Revisions to LA DOTD Specifications...work in progress
  – Section 804, Driven Piles
PILE FOUNDATIONS...2010
AASHTO LRFD Revisions

• 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. RF=0.80

• Same as above, without dynamic testing. RF =0.75
PILE FOUNDATIONS...2010
AASHTO LRFD Revisions

- Driving criteria established by dynamic testing conducted on 100% of production piles. RF=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 production piles. RF=0.65
Wave equation analysis, without pile dynamic measurements or load test but with field confirmation of hammer performance. RF=0.50

FHWA-modified Gates dynamic pile formula (End of Drive condition only). RF=0.40

ENR dynamic pile formula (End of Drive condition only). RF=0.10
PILE FOUNDATIONS...Revisions to LA DOTD Specs

- Moving in the direction of implementing a semi-Performance Spec format
- Relaxation of pre-boring specs in North Louisiana
- Employing WEAP Analyses for all projects
LOAD TESTS

• Static Load Tests very common in LA
• Statnamic Load Tests
  – Readily used in sands
  – Not as comfortable in clays due to interpretation issues
• Will entertain placing a load test on a permanent pile under certain conditions
PILE FOUNDATIONS...Revisions to LA DOTD Specs

• Semi-Performance Spec format...basically
  – If piles driven to tip (not vibrated)
  – Within dimensional tolerance
  – Without structural cracks or unbroken
  – Verified to meet load capacity
  – We’re in good shape
PILE FOUNDATIONS…Relaxation of Pre-boring Specs

- Contractor to propose recommended pre-boring criteria for project to Construction
- Must be accompanied with WEAP analysis to demonstrate adequacy of hammer to drive piles for your proposed condition
PILE FOUNDATIONS…Relaxation of Pre-boring Specs

• DOTD will review submittal
• If approved, Contractor will be allowed to install piles subject to Load Test or PDA load verification of installation method
# TYPICAL PILE DATA TABLE

## Bent and Pile Information - Lawrence Bridge

<table>
<thead>
<tr>
<th>BENT NO.</th>
<th>STATION</th>
<th>PILE TYPE</th>
<th>NO. OF PILES</th>
<th>MAX SERVICE AXIAL LOAD (TONS)</th>
<th>MAX FACTORED AXIAL LOAD (TONS)</th>
<th>SOIL RESISTANCE FACTOR</th>
<th>REQUIRED PILE RESISTANCE (TONS)</th>
<th>PILE CUT-OFF ELEV.</th>
<th>PLAN PILE TIP ELEV.</th>
<th>PLAN PILE LENGTHS (FT.)</th>
<th>PILE ORDER LENGTHS (FT.)</th>
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<tbody>
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<td>1</td>
<td>121-30</td>
<td>24&quot; PPC</td>
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<td>119</td>
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<td>324</td>
<td>224</td>
<td>172</td>
<td>92</td>
<td>80</td>
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</table>

**Minimum required resistance if prebored to scour is the Factored Load divided by the Soil Resistance Factor**

\[ 224 \times 0.8 = 179 \]

The scour zone resistance is equal to the minimum required resistance without preboring to scour minus the factored load divided by the soil resistance factor.

**Scour Zone Resistance**: 324 - 224 T

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**Determination of Pile Bearing Capacity**: The pile bearing capacity determination shall be made by use of the above equation.

**Required Pile Resistance**: Required pile resistance "without preboring" will be used to verify pile bearing capacity if preboring to the scour elevation is not performed. If preboring to scour is performed, the required pile resistance "with preboring" should be used for pile bearing capacity verification.

**Test Pile Number**: Test pile and monitor pile notes:
- 1. Pile order lengths will be provided after test pile loading has been evaluated.
- 2. Test pile shall be tested to failure or the load indicated in the test pile data table.
- 3. The first 16-inch pile at bent 1 and bent 5 shall be monitored dynamically. A 1-day retrace may be required at each monitor pile.
• Basically, Contractor can opt to use a smaller hammer when pre-drilling through scour zone
• Or, can opt to use a larger hammer and drive through the scour zone
  – This becomes increasingly more difficult on deep channels with large scour zones...essentially in North Louisiana
• WEAP Analysis helps to make these field decisions
Pile groups require analyses for group capacity, settlement and lateral loads.
**MAXIMUM UNSUPPORTED PILE LENGTHS BASED ON L/d=20**

<table>
<thead>
<tr>
<th>Pile Size</th>
<th>Max. Unsupported Length</th>
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<tbody>
<tr>
<td>14-inch</td>
<td>23-ft</td>
</tr>
<tr>
<td>16-inch</td>
<td>26-ft</td>
</tr>
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<td>18-inch</td>
<td>30-ft</td>
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<tr>
<td>24-inch</td>
<td>40-ft</td>
</tr>
<tr>
<td>30-inch</td>
<td>50-ft</td>
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</table>
DRILLED SHAFTS - TYPICAL DELIVERABLES

• CALCULATIONS AND GEOTECH MODELS
• SHAFT DATA TABLE – PLAN TIPS
• CONSTRUCTION RECOMMENDATIONS
• GENERAL NOTES
• LOAD TESTING DESIGN SHEET
• SPECIAL PROVISIONS
DRILLED SHAFT DESIGN GRAPH

RAGLEY OVERPASS BORING #1 BENT #1

EXAMPLE ONLY

Load (tons)

Settlement (in)

Lower Bound  Higher Bound  Average Bound  1.5 X D.L.  2.0 X D.L.
DRILLED SHAFT CONSTRUCTION

- REVIEW DRILLED SHAFT INSTALLATION PLAN
- FIELD SUPPORT
  - EXCAVATION LOG
  - CONCRETE PLACEMENT LOG
  - CONCRETE VOLUME GRAPH
  - INSPECTION REPORT – SLURRY TEST DATA
  - INTEGRITY TESTING ANALYSIS/RECOMMENDATIONS
    - CSL LOGS
    - ADDITIONAL TEST EVALUATION (CORING, ETC.)

2011 Louisiana Transportation Conference
TYPICAL EXCAVATION EQUIPMENT

2011 Louisiana Transportation Conference
REINFORCING CAGE PLACEMENT
DRILLED SHAFTS – TYPICAL LOAD TESTS

- Conventional Top-Down Static Load Test, RF=0.70
- Bi-Directional (O-Cell) Test, RF=0.70
- Rapid Load (Statnamic) Test, RF=0.55-0.65
- High Strain Dynamic Load Test, RF=0.55-0.60
TYPICAL O-CELL CURVE

Osterberg Cell Load-Movement Curves
66” Test Shaft - Missouri Pacific R.R. / U.S. 90 Overpass - Ragley, LA

- Upward Top of O-cell™ (Net Load)
- Downward Base of O-cell™ (Gross Load)

Movement (in.)

O-cell™ Load (kips)
BASE GROUTING OF SHAFTS

• Base Grouting of shafts has been utilized on two large Mississippi River Bridge projects…John James Audubon and Huey P. Long Bridge with success

• JJA used an oscillator with full-depth casing and HPL used a rotator with full-depth casing

• Base-Grouting also being used to remediate soft-bottom shafts with success
HUEY P. LONG ROTATOR SYSTEM
TYPICAL BASE GROUTING SYSTEM
• QUESTIONS?....
• COMMENTS?....