9th Geo3T2 Conference

Drilled Shaft Instrumentation

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Richard L. Engel, P.E.

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Presentation Outline

1. Pomeroy Mason Bridge
2. Ironton Russell Bridge
3. Load Test Database
4. CUY-90 Bridge – Slope Failure
5. ERI-60 - Slope Failure
6. HUR-99-13.77 - Tieback VE
7. MOT-75-12.00 - Piling VE
8. FRA-Dodridge St. -Tiedown
1. Pomeroy Mason Bridge Over the Ohio River

Drilled Shaft Load Testing 2003
Pomeroy-Mason Cable Stay Bridge Vertical and Lateral Load Testing Plan Schematic View
### Table 14. Calculated Allowable Unit Base Resistances

<table>
<thead>
<tr>
<th>Bedrock Horizon</th>
<th>Approximate Elevation Range</th>
<th>Allowable Unit Base Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WV Tower</td>
<td>Ohio Tower</td>
</tr>
<tr>
<td></td>
<td>(psf)</td>
<td>(tsf)</td>
</tr>
<tr>
<td>Shale With Interbedded</td>
<td>478 to 463</td>
<td>491 to 473</td>
</tr>
<tr>
<td>Siltstone</td>
<td>463 to 435</td>
<td>473 to 448</td>
</tr>
<tr>
<td>Siltstone (6&quot; Diameter Shafts)</td>
<td>435 to 421</td>
<td>448 to 434</td>
</tr>
<tr>
<td>Siltstone (8&quot; Diameter Shafts)</td>
<td>435 to 421</td>
<td>448 to 434</td>
</tr>
<tr>
<td>Siltstone (10&quot; Diameter Shafts)</td>
<td>435 to 421</td>
<td>448 to 434</td>
</tr>
</tbody>
</table>

O-Cell Test at Jack Limit = 100 TSF

### Table 13. Calculated Allowable Unit Side Resistances

<table>
<thead>
<tr>
<th>Bedrock Horizon</th>
<th>Approximate Elevation Range</th>
<th>Allowable Unit Side Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WV Tower</td>
<td>Ohio Tower</td>
</tr>
<tr>
<td></td>
<td>(psf)</td>
<td>(tsf)</td>
</tr>
<tr>
<td>Shale With Interbedded</td>
<td>478 to 483</td>
<td>491 to 473</td>
</tr>
<tr>
<td>Siltstone</td>
<td>463 to 435</td>
<td>473 to 446</td>
</tr>
<tr>
<td>Siltstone</td>
<td>435 to 421</td>
<td>448 to 434</td>
</tr>
</tbody>
</table>

O-Cell Average Ultimate Side Friction = 11.2 tsf
Allowable = 5.6 tsf

O-Cell Average Ultimate Side Friction = 4.3 tsf
Allowable = 2.15 tsf
Comparison of Drilled Shafts Deflection with Depth

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2. Ironton Russell Bridge
   Over the Ohio River
   Drilled Shaft Load Testing
   2012
Ironton-Russell Cable Stay Bridge

Test Planning and Preparation

Lateral Load Test

O-Cell Test 9000 Tons
Test Shafts Instrumentation

O-Cell Testing reached capacity without moving the tip beyond 1" (~100 TSF)
3. Load Test Database

26 Lateral Load Tests 1994 - 2012

Ohio Bedrock – Map of Testing
The bedrock map is from the ODNR website
4. CUY-90 Bridge
Cleveland, Ohio - 1998
CUY-90-Innerbelt Bridge

GAS IN THE DRILLED SHAFT EXCAVATION

Stabilization Structure
3-D Stability Analysis

CCG2 Alternative 1
3-D Stability Analysis
CCG2 Alternative 1
CCG2 Alternative 1

CCG1 – Grading

- Horizontal Drains
- Pressure Relief Ducts
- Unloading
<table>
<thead>
<tr>
<th>Area (in²)</th>
<th>Ixx (in⁴)</th>
<th>Iyy</th>
<th>tf &amp; tw (in)</th>
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<tr>
<td>HP 10x42</td>
<td>12.4</td>
<td>119</td>
<td>40.3</td>
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<tr>
<td>HP 14x117</td>
<td>34.4</td>
<td>1220</td>
<td>443</td>
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<tr>
<td>HP 18x204</td>
<td>60.2</td>
<td>3480</td>
<td>1120</td>
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</table>
CUY-90 Bridge

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5. ERI-60-Slope Failure

Drilled Shaft Design
Instrumentation
ERI-60 Elevation

PLAN

203' 254' 254' 230' 190'

PIER 1  PIER 2  PIER 3  PIER 4

ELEVATION

SR 60 Over Vermilion River
12 feet diameter
80 feet long
40 feet into Ohio Shale
Force Diagram

ERI-60 ROCK ANCHOR SCHEMATIC

Horizontal Component

420 Kips/anchor

Moment

Ground Surface

Vertical Component
6. HUR-99-13.77 VE

Innovative retaining wall with narrow footing and vertical rock anchors
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7. MOT-75-12.00 VE
Dayton, Ohio
2013

Perfect Pile
$10,000,000 cost for geotechnical piling

Cost components

- Pile
- Pile points
- Crew time to unload the piles
- Crew time and cost to drive the pile
- Time and material for splices
- Crew time to fill with concrete
<table>
<thead>
<tr>
<th>File</th>
<th>Wall Thick.</th>
<th>Min. wall thick.</th>
<th>Cover</th>
<th>Drilled</th>
<th>Drilled (in)</th>
<th>Under</th>
<th>Diameter</th>
<th>Length</th>
<th>Depth</th>
<th>Thrust</th>
<th>Time to drive</th>
<th>Pile cost</th>
<th>Total cost</th>
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<td>0.247</td>
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<td>47</td>
<td>50</td>
<td>50</td>
<td>18</td>
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### Foundation Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Qty</th>
<th>Description</th>
<th>Cost (in)</th>
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<tbody>
<tr>
<td></td>
<td>33,325</td>
<td>Total service load on pier (approximate)</td>
<td>$13,325</td>
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<tr>
<td></td>
<td></td>
<td>Based on Boring 87-8</td>
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<tr>
<td></td>
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<td>(lower 3) for cost in build cost</td>
<td></td>
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</tbody>
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**8. FRA- Dodridge Street**

**Columbus, Ohio**

**2008**

**Rock Anchors**
Association for Bridge Construction and Design (ABCD)
Northeast Central Ohio Chapters
February 2014
FRA-Dodridge St Bridge

SECTION A-A

- SUBGRADE
- POROUS BIOFILL WITH FILTER FABRIC
- 3'-6" TIE-UP SHEETING CENTERS OR JOINTS
- PROPOSED BEARING
- ELASTOMERIC BEARINGS
- 3'-6" TIE-UP SHEETING CENTERS OR JOINTS
- E-8" 6" DRILLED SHAFT TIE-DOWN (ROCK ANCHOR)

29
Ohio DOT Research Project

State Job Number 134137 and 134348: Design of Rock Socketed Drilled Shafts

- Final Reports are available in PDF at Ohio DOT website:  
  http://www.dot.state.oh.us/Divisions/Planning/SPR/Research/reportsandplans/Pages/StructuresReports.aspx