Bridge Scour Remediation using Jet Grouting

2011 Transportation Short Course
Structures and Hydraulics II
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TxDOT Bridge Division
Outline

• Burr’s Ferry Bridge (SH 63) Scour at Sabine River

• Jet Grouting Background

• Field Installation of Jet Grouting Column
Burr’s Ferry Bridge at Sabine River
Burr’s Ferry Bridge
at Sabine River

Texas
Louisiana

<Burr’s Ferry Bridge built in 1937>
Toledo Bend Dam at Sabine River

Toledo Bend Dam built in 1969
Peak Stream flow at the Bridge

USGS 08026000 Sabine Rv nr Burkeville, TX

- Dam built
- 120,000 ft³/s
- 50,000 ft³/s
Burr’s Ferry Bridge at Sabine River
Bridge Scour

Pier 3

PILE OMITTED
Bridge Scour

< Cross-Section at downstream >
Bridge Scour

Direction of Flow

Scour
End of History Lecture,
Let’s Talk about Geotech!
# Methods for Soil Improvement

<table>
<thead>
<tr>
<th>Ground Reinforcement</th>
<th>Ground Improvement</th>
<th>Ground Treatment</th>
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<tr>
<td>Stone Columns</td>
<td>Deep Dynamic Compaction</td>
<td>Soil Cement</td>
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<td>Soil Nails</td>
<td>Drainage/Surcharge</td>
<td>Lime Admixtures</td>
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<td>Deep Soil Nailing</td>
<td>Electro-osmosis</td>
<td>Flyash</td>
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<td>Micropiles</td>
<td>Compaction Grouting</td>
<td>Dewatering</td>
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<td><strong>Jet Grouting</strong></td>
<td>Blasting</td>
<td>Heating/Freezing</td>
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<td>Ground Anchors</td>
<td>Surface Compaction</td>
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<td>Geosynthetics</td>
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<tr>
<td>Fiber Reinforcement</td>
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<tr>
<td>Lime Columns</td>
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<tr>
<td>Vibro-Concrete Column</td>
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<tr>
<td>Mechanically Stabilized Earth</td>
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</tbody>
</table>

- Mechanically Stabilized Earth
- Deep Dynamic Compaction
- Drainage/Surcharge
- Electro-osmosis
- Compaction Grouting
- Blasting
- Surface Compaction
- Soil Cement
- Lime Admixtures
- Flyash
- Dewatering
- Heating/Freezing
Jet Grouting

• In-situ mixing of soils with a stabilizer (cement grout) to form columns of soilcrete or soilcement.

• Application: Structural underpinning, Excavation Support, Soil Stabilization, Seepage Barrier/Cutoff walls
# Jet Grouting Injection Methods

<table>
<thead>
<tr>
<th>System</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Single Jet (Grout)</strong></td>
<td>• Simple system and equipment&lt;br&gt;• Good to seal vertical joint&lt;br&gt;• Good in cohesionless soil</td>
<td>• Smallest geometry achieved&lt;br&gt;• Hardest to control heave&lt;br&gt;• Difficult to control quality in cohesive soil</td>
</tr>
<tr>
<td><strong>Double Jet (Grout and Air)</strong></td>
<td>• Most utilizing system&lt;br&gt;• High energy, good geometry achieved&lt;br&gt;• Most experienced&lt;br&gt;• Often most economical</td>
<td>• Very difficult to control heave in cohesive soils&lt;br&gt;• Not usually considered for underpinning&lt;br&gt;• Spoil handling can be difficult</td>
</tr>
<tr>
<td><strong>Triple Jet (Grout, Air and Water)</strong></td>
<td>• Most controlled system&lt;br&gt;• High quality in difficult soils&lt;br&gt;• Best underpinning system&lt;br&gt;• Easiest to control spoil and heave</td>
<td>• Complex system and equipment&lt;br&gt;• Requires significant experience</td>
</tr>
</tbody>
</table>

* <George Burke, 2004>
Jet Grouting Injection Methods

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Sand &amp; Gravel</td>
<td>Clay</td>
<td>Sand &amp; Gravel</td>
<td>Sand &amp; Gravel</td>
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<tr>
<td>Soilcrete</td>
<td></td>
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<tr>
<td>Strength</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Column Dia. (ft)</td>
<td>2 - 4</td>
<td>2 - 3</td>
<td>3 - 6</td>
</tr>
<tr>
<td>Soilcrete</td>
<td>1000-3000</td>
<td>250-1000</td>
<td>500-2000</td>
</tr>
<tr>
<td>Strength</td>
<td>150-750</td>
<td>500-1500</td>
<td>500-1500</td>
</tr>
</tbody>
</table>

- Compare weak rock (700 psi) or concrete strength (3500 psi)
Jet Grouting

• <Courtesy: Menard-soltraitement>
Field Installation
Jet Grouting Design

- Diameter: 4ft
- Center to Center Spacing: 3ft
- Total # of Jet Grouting Column: 38
- Column Length: 25ft
Jet Grouting Design

Step 1 -- Fill in the scour hole with cement stabilized backfill. Excavate out the soil on the river side of the bent and replace with cement stabilized backfill.

Step 2 -- Install the Jet Grout Columns around the footing. The columns are 4' diameter, spaced at 3' centers, and are 25' feet in length.
Jet Grouting

Concrete Backfill

PVC pipe to guide drilling through concrete backfill
Jet Grouting

High pressure jet grout through drill rod
Single Jet Drill Rod

Single Fluid Jet Grouting Nozzle
Grout Spoil Return

Grout spoil return
Spoil Pond
Slurry Mixer and Pump

Slurry Mixer

Grout Pump (Monitor quantity used)
Slurry Mixer
Grouting Pump
Final Repair
Thank you!
# Quality Control

<table>
<thead>
<tr>
<th>QUALITY CONTROL INSPECTION ITEMS</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Drilling</td>
<td>Location, angle, depth, methods to maintain repeatability</td>
</tr>
<tr>
<td>Batching</td>
<td>Preparation of grout slurry for consistency in material content and physical and chemical properties</td>
</tr>
<tr>
<td>Jetting</td>
<td>Checking of drill parameters (lift, speed, rotation rate) and injection parameters (pressure and flow of all components)</td>
</tr>
<tr>
<td>Documentation</td>
<td>Accurate documentation for each element constructed. Construction times and correlation to any sampling performed</td>
</tr>
<tr>
<td>Sampling and Testing</td>
<td>Retrieval of representative samples for external testing</td>
</tr>
</tbody>
</table>

**Source:** Hayward Baker Webpage
Strength Gain with Age

PSI (MN/m²)

- 1500 (10.34)
- 1250 (8.61)
- 1000 (6.89)
- 750 (5.17)
- 500 (3.44)
- 250 (1.72)

Unconfined Compressive Strength

Age (days)

- Sands and Gravels
- Silts and Silty Sands
- Clays
- Organic Silts and Peats

(Source: Hayward Baker Webpage)