Update – OTD Vacuum Excavation Project

Travis Cottle
Engineer – GTI
March 2019
Goal

• Determine the effectiveness of dry vacuum excavation (Air Lances) to the productivity of hydro excavation (Water Nozzles)
  – Vacuum Excavation Testing in Northeast Texas (silty clay) – Jan 2019
Truck Used for Testing

- Vactor HXX Paradigm
  - Standard Capabilities
    - Air @ 150 PSI/185 CFM
    - Water @ 10 GPM/2500 PSI
  - Big Air Unit Capabilities
    - Includes a Larger Air Compressor
      - Air @ 250 PSI/300 CFM
Testing Parameters

• Determine Excavation Rate for Each Nozzle
  – Hole Size = 2ft W x 2ft L x 3ft H
  – Soil Types
    • GTI
      – Clay (Compacted Non-Homogenous Clay)
      – Silt (Standard Loose Soil)
    • Texas
      – Natural Silty Clay (Unknown Prior to Testing)
  – Nozzle Types
    • Air Lances
    • Water Nozzles
Nozzle Types

- Air Lances (GTI)
  - Vacmasters Air-Tec – 220 PSI/300 CFM
  - Air Spade 2000 – 90 PSI/150 CFM
  - Air Spade 2000 – 90 PSI/225 CFM
  - Air Spade 2000 – 135 PSI/170 CFM
  - Air Spade 2000 – 180 PSI/280 CFM
- Water Nozzles (both)
  - Vactor HXXpose Nozzle #4 – Spinning, 3.2 GPM @ 2500 PSI
  - Vactor HXXpose Nozzle #8 – Spinning, 6.3 GPM @ 2500 PSI
  - Vactor Reveal Nozzle #4 – Single Jet, 3.2 GPM (Texas only)
  - Vactor Reveal Nozzle #8 – Single Jet, 6.3 GPM

- Air Lances (Texas)
  - Air Spade 4000 – 135 PSI/170 CFM
  - Air Spade 4000 – 200 PSI/280 CFM
  - Air Spade 4000 – 250 PSI/290 CFM

*NOTE: Air Spade 4000 refers to the style of the handle and wand, not the nozzle itself

**NOTE: Big Air Unit Required for:
Pressures >150 PSI or Flows >185 CFM
Differences between Air and Water on Clay Soil at GTI

Air Lance
(Air Spade 2000 – 90 PSI/150 CFM)

Water Nozzle
(Vactor HXXpose #4 – Rotating @ 3.2 GPM)
Differences between Air and Water on Silt Soil at GTI

Air Lance
(Air Spade 2000 – 135 PSI/170 CFM)

Water Nozzle
(Vactor HXXpose #8 – Rotating @ 6.4 GPM)
Differences between Air and Water on Silty Clay Soil in NE Texas

**Air Lance**
(Air Spade 4000 – 200 PSI/280 CFM)

**Water Nozzle**
(Vactor Reveal #8 – Single Jet @ 6.4 GPM)
# Vacuum Excavation Results (GTI Average Excavation Rates)

<table>
<thead>
<tr>
<th>Nozzle Type</th>
<th>Nozzle Name &amp; Rating</th>
<th>Truck Size</th>
<th>Clay Rate [ft^3/min]</th>
<th>Silt Rate [ft^3/min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>Vacmasters Air-Tec – 220 PSI/300 CFM</td>
<td>Big Air</td>
<td>1.7362</td>
<td>2.4826</td>
</tr>
<tr>
<td>Air</td>
<td>Air Spade 2000 – 90 PSI/150 CFM</td>
<td>Standard</td>
<td>0.4274</td>
<td>1.6756</td>
</tr>
<tr>
<td>Air</td>
<td>Air Spade 2000 – 90 PSI/225 CFM</td>
<td>Big Air</td>
<td>0.9843</td>
<td>1.8513</td>
</tr>
<tr>
<td>Air</td>
<td>Air Spade 2000 – 135 PSI/170 CFM</td>
<td>Standard</td>
<td>0.7952</td>
<td>1.3254</td>
</tr>
<tr>
<td>Air</td>
<td>Air Spade 2000 – 180 PSI/280 CFM</td>
<td>Big Air</td>
<td>1.8340</td>
<td>3.1971</td>
</tr>
<tr>
<td>Water</td>
<td>Vactor HXXpose #4 (rotating head, 3.2 GPM at 2500 PSI)</td>
<td>Standard</td>
<td>0.7788</td>
<td>0.8815</td>
</tr>
<tr>
<td>Water</td>
<td>Vactor HXXpose #8 (rotating head, 6.3 GPM at 2500 PSI)</td>
<td>Standard</td>
<td>1.0986</td>
<td>1.4423</td>
</tr>
<tr>
<td>Water</td>
<td>Vactor Reveal #8 (single jet, 6.3 GPM)</td>
<td>Standard</td>
<td>1.2176</td>
<td>1.3355</td>
</tr>
</tbody>
</table>
Vacuum Excavation Results (NE Texas Average Excavation Rates – Silty Clay Soil)

<table>
<thead>
<tr>
<th>Nozzle Type</th>
<th>Nozzle Name &amp; Rating</th>
<th>Truck Size</th>
<th>Excavation Rate [ft^3/min]</th>
<th>Excavation Rate Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>Air Spade 4000 – 135 PSI/170 CFM</td>
<td>Big Air</td>
<td>3.530</td>
<td>3</td>
</tr>
<tr>
<td>Air</td>
<td>Air Spade 4000 – 200 PSI/280 CFM</td>
<td>Big Air</td>
<td>3.621</td>
<td>2</td>
</tr>
<tr>
<td>Air</td>
<td>Air Spade 4000 – 250 PSI/290 CFM - #1</td>
<td>Big Air</td>
<td>2.952</td>
<td>5</td>
</tr>
<tr>
<td>Air</td>
<td>Air Spade 4000 – 250 PSI/290 CFM - #2</td>
<td>Big Air</td>
<td>4.425</td>
<td>1</td>
</tr>
<tr>
<td>Water</td>
<td>Vactor HXXpose #4 (rotating head, 3.2 GPM at 2500 PSI)</td>
<td>Big Air</td>
<td>1.314</td>
<td>9</td>
</tr>
<tr>
<td>Water</td>
<td>Vactor HXXpose #8 (rotating head, 6.3 GPM at 2500 PSI)</td>
<td>Big Air</td>
<td>2.962</td>
<td>4</td>
</tr>
<tr>
<td>Water</td>
<td>Vactor Reveal #4 (single jet, 3.2 GPM)</td>
<td>Big Air</td>
<td>2.220</td>
<td>8</td>
</tr>
<tr>
<td>Water</td>
<td>Vactor Reveal #8 (single jet, 6.3 GPM)</td>
<td>Big Air</td>
<td>2.607</td>
<td>7</td>
</tr>
</tbody>
</table>
Analysis of Results

- Water Nozzles broke up the clay soil at GTI faster, but added extra material (water) which had to be removed by vacuum
  - Resulted in slower excavation rates
- Air Lances with the Standard Compressor were too weak to break up the clay soil at GTI effectively
- Air Lances with the Big Air Compressor were able to break up the clay soil at GTI at similar rates to the tested water nozzles
- Air Lances with the Big Air Compressor were able to break up the silty clay soil in NE Texas faster than the tested water nozzles
  - Only comparable excavation rate was Vactor HXXpose #8
Disclaimers for Vacuum Excavation Results

- Silty Clay Soil tested in NE Texas was naturally compacted
  - Difficulty of breaking up the soil was in between the levels for the Clay and Silt Soils at GTI
- Clay Soil tested at GTI had been excavated and compacted multiple times
  - Not completely homogenous
- Performance of Air Lances has not been verified on harder soil
  - Further testing on Hard Texas Clay Soil recommended
  - Not recommended to use on Caliche (Arizona)
- Results are only based on the types of nozzles evaluated.
Future Work

• Investigate the potential for developing a new Air Lance that can break up Hard Clay Soil as fast as Water Nozzles

• Investigate the potential for developing a new Air Lance for a Standard Compressor that can break up Silty Clay Soil as fast as the Air Lances with the Big Air Compressor

• Test the Air Spade 4000 – 250 PSI/290 CFM on Hard Texas Clay Soil
Questions?