Update – OTD Vacuum Excavation Project

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Goal

- Determine the effectiveness of dry vacuum excavation (Air Lances) to the productivity of hydro excavation (Water Nozzles)
  - Vacuum Excavation Testing at GTI – Des Plaines, IL (silt & clay) – Oct 2016
  - 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
- Air Lances (Texas)
  - Air Spade 4000 – 135 PSI/170 CFM
  - Air Spade 4000 – 200 PSI/280 CFM
  - Air Spade 4000 – 250 PSI/290 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

*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)

Nozzle Type	Nozzle Name & Rating	Truck Size	Clay Rate [ft^3/min]	Clay Rate Ranking	Silt Rate [ft^3/min]	Silt Rate Ranking
Air	Vacmasters Air-Tec – 220 PSI/300 CFM	Big Air	1.7362	2	2.4826	2
Air	Air Spade 2000 – 90 PSI/150 CFM	Standard	0.4274	8	1.6756	4
Air	Air Spade 2000 – 90 PSI/225 CFM	Big Air	0.9843	5	1.8513	3
Air	Air Spade 2000 – 135 PSI/170 CFM	Standard	0.7952	6	1.3254	7
Air	Air Spade 2000 – 180 PSI/280 CFM	Big Air	1.8340	1	3.1971	1
Water	Vactor HXXpose #4 (rotating head, 3.2 GPM at 2500 PSI)	Standard	0.7788	7	0.8815	8
Water	Vactor HXXpose #8 (rotating head, 6.3 GPM at 2500 PSI)	Standard	1.0986	4	1.4423	5
Water	Vactor Reveal #8 (single jet, 6.3 GPM)	Standard	1.2176	3	1.3355	6

Vacuum Excavation Results
(NE Texas Average Excavation Rates – Silty Clay Soil)

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

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?