Effect of Polymer Slurry Stabilization on Drilled Shaft Side Shear Over Time

GRIP 2016
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Problem Statement (recall)

- Construction methods affect drilled shaft side shear resistance which is not fully addressed by design.

- The primary objectives of this study are to quantify the time effects on side shear (if any) from prolonged open excavation where polymer slurry is present and determine what changes would be needed in the specifications.
Problem Statement

- Bentonite and polymer slurries work differently (e.g. filter cake / no filter cake).
- Present specifications for bentonite largely do not apply to polymer.
FDOT 2014 455-15.11.5 specifications state: Any unclassified excavation work lasting more than 36 hours (measured from the beginning of excavation for all methods except the Permanent Casing Method, which begins at the time excavation begins below the casing) before placement of the concrete requires overreaming the sidewalls to the depth of softening or removing excessive slurry cake buildup. Ensure that the minimum depth of overreaming the shaft sidewall is 1/2 inches and the maximum depth is 3 inches. . .
Effects of Exposure Time on Side Shear
(Majano, 1992, and Majano and O’Neill, 1993)
Effects of Exposure Time on Side Shear
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S – solid vinyl polymer
E – emulsified polymer
A – attapulgite
B – bentonite
Effects of Exposure Time on Side Shear
Corrected 24h Bentonite

25% reduction in shaft diameter
Effects of Exposure Time on Side Shear
(Majano, 1992, and Majano and O’Neill, 1993)

“Although the perimeter shear values yield by some slurries showed an improvement in the load transfer with time (e.g. bentonite) it is erroneous to assume that longer exposure times produce better drilled shafts. Visual analysis of the model shafts indicated deterioration in their geometrical dimensions which can be extrapolated to field practice to suggest that the detrimental effect on structural integrity of the foundation.”

Majano, 1992
Past Study
(Upper Viscosity Project 2014)
Past Study
(Upper Viscosity Project 2014)
Time Exposure
Effects of drilling slurries on Side Resistance (Brown, 2002)
Time Exposure
(Brown, 2002)

![Graph showing the relationship between load (tons) and exposure time (h) for different materials.](image-url)

- Emulsified Polymer
- Solid Vinyl Polymer
- Bentonite
Stress Relaxation – (Chang and Zhu, 2004)

![Graph showing stress relaxation over time.](image-url)

- **DMT-1**
- **Normalized Lateral Stress**
- **Time (minute)**

1. Boring
2. Leaving hole open
3. Filling hole with water
4. Soaking under water
5. Casting
6. Curing
Small Scale Test Shaft Program

- ~36 shafts
- 4in diam. 8ft long
- Sandy / silty sand
- 0, 1, 2, 4, 8 and 24h exposure times
- 3 different polymer type
Small Scale Test Shaft Program

Not to Scale
Excavation
Mixing
Concreting
Static Load Test

- Modified Quick Test
- Load Increments of 500lbs
- Max. Displacement of 4in
Load Testing
Bentonite Load Tests
Polymer Load Tests

Displacement (inches) vs. Load (kips)

- KB1-4h
- KB2-8h
- KB3-24h
- KB4-2h
- KB5-1h
- KB6-0h
Shaft Extraction
Cutting & Cross Section
Bentonite

0h

24h
KB Polymer

0h

24h
“Filter Cake”

Graph showing the relationship between Filter Cake Thickness (inches) and Exposure Time (hours). Two lines are shown:
- Bentonite
- KB Polymer
“Filter Cake”

![Graph showing the relationship between load (kips) and filter cake thickness (inches) for Bentonite and KB Polymer.](image)

- **Load (kips)**
- **Filter Cake Thickness (inches)**

- **Bentonite**
- **KB Polymer**
Exposure Effects

The graph illustrates the effect of exposure time on the fraction of 24-hour bentonite for both bentonite and KBI polymer. The exposure time is measured in hours, ranging from 0 to 30.

- **Bentonite**
  - The fraction of 24-hour bentonite initially increases and then decreases over time.
  - After an initial peak, it stabilizes around 1.2.

- **KBI Polymer**
  - The fraction of 24-hour KBI polymer decreases steadily over time.
  - It stabilizes around 1.0 after an initial decrease.

The graph shows a comparison between the two materials, highlighting the differences in their exposure effects.
Summary

- Two of four sets of shafts were cast and tested
- Most bentonite strength reduction occurs within 8hrs
- Polymer shows no reduction with time (at present)
- Extended exposures times up to 48hrs will be added to test matrix