I-210 Interchange at Cove Lane
A Geotechnical Perspective

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Associate & Geotechnical Engineer
Overview

- Project Background

- Exploration & Geology

- Design & Construction
  - Settlement & Stability
  - MSE Walls
  - Foundations
Project Background
Project Location and Need
Project Need
Fast-Track Schedule

- First Contact: Aug 2012
- Bid & Letting: Spring 2013
- Groundbreaking: Fall 2013
- Completed: Spring 2015
Exploration and Geology
Site Geology
Geotechnical Investigation

- 4 weeks of explorations
- 40 drilled soil borings
- 85 Cone Penetration Tests (CPTs)
- 11,200 linear feet
- Large field effort
  - 3 Drill Rigs
  - 2 CPT Rigs
  - 1 Pontoon Drill Rig
- Lab testing complete a few weeks after exploration (occur simultaneously)
Subsurface Profile
Exploration Results

Undifferentiated Alluvium

Pleistocene-Era Coastal

0.5 Miles

I-210 at Cove Lane

North
Design and Construction

Overview
Overview of Design & Construction

- Settlement & Stability
- MSE Walls
- Foundations & Ground Improvement

North 0.5 Miles

- Undifferentiated Alluvium
- Pleistocene-Era Coastal
- Shallow Foundation
- Deep Foundation
- Mechanically Stabilized Earth Wall
- Embankment

Ground Improvement
Construction Sequence to Maintain Traffic

Phase I: Northern Ramps
Phase II: Eastbound Mainline

0.5 Miles

North
Construction Sequence to Maintain Traffic

Phase I: Northern Ramps
Phase II: Eastbound Mainline
Phase III: Westbound Mainline

0.5 Miles

North
Design and Construction
Settlement and Stability
Settlement Prediction

![Consolidation Settlement](image)

- max [stage]: 37.62 in
- max [all]: 39.39 in
# Stability Evaluation

## I-210 at Cove Lane Interchange

*Cline Canal Bridge North Approach Embankment*

<table>
<thead>
<tr>
<th>Condition</th>
<th>No Strength Gain - Placed at Once</th>
<th>Stability Safety Factor with 6-Week Strength Gain Between Stages</th>
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<tr>
<td></td>
<td>1st Staged 2-ft Lift (2' Total)</td>
<td>2nd Staged 3-ft Lift (5' Total)</td>
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<td>3 Grids &amp; Fabric</td>
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Staged Loading: Embankment

- Additional Surcharge
  - 14 weeks

- Planned Embankment Load
  - 24 weeks

- Wick Drains

Dimensions:
- 12 feet
- 28 feet
- 16 feet

Ground Line
Staged Loading: Settlement

Time (years)

Consolidation Settlement (in)

1ST STAGE 2' HIGH FOR 6 WEEKS

~ 4' AFTER 6 WEEKS

2ND STAGE 5' HIGH FOR 6 WEEKS

~ 12' AFTER 12 WEEKS

3RD STAGE 8' HIGH FOR 6 WEEKS

~ 19' AFTER 18 WEEKS

4TH STAGE 11' HIGH FOR 6 WEEKS

~ 27' AFTER 24 WEEKS

5TH STAGE 5' SURCHARGE FOR 8 WEEKS

~ 34' AFTER 32 WEEKS

REMOVAL 5' SURCHARGE BACK TO FINISHED GRADE

~ 34' AFTER 1 YEAR

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
Wick Drain Installation
Preload and Surcharge Lifts
Design and Construction
MSE Walls
Stability Evaluation
MSE Wall Construction
MSE Wall Record
Design and Construction
Foundations and Ground Improvement
Deep Foundation: Driven Timber Piles

Mechanically Stabilized Earth (MSE) Wall

Load Transfer Platform

Ground Line
Pile Design
Pile Capacities

- Typical Timber Pile Design: 20-25 Ton (40-50 kips)
- Project Timber Pile Design: 60 Ton (120 kips)
- Project Concrete Pile Design: 150 Ton (300 kips)
- LRFD: Resistance Factor = 0.75
Pile Installation Observation

- 1-foot Marked Increments
- Wave Equation Analysis (WEAP)
Static Load Test

- 3*Design Load
- LA DOTD and ASTM Method
Static Load Test Results

Displacement (inches) vs. Load (kips)

- SES Measured Displacement
- SES Dial Displacement
- Ultimate Capacity
- 3*Design Load
- Davisson Criterion
Dynamic Pile Testing

Initial Drive and Restrike
Pile Driving Analysis

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<td>BPM 60.2 bpm</td>
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<td>EMX 10.797 k-ft</td>
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<td>BTA 100.0 (%)</td>
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<td>RA2 225 kips</td>
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<td>RMX 206 kips</td>
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<td>LE 52.50 ft</td>
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CAPWAP

H160-1
End of Initial Drive
60’ Timber Pile
14” Butt Diameter
8.25” Toe Diameter
Refused at 51’ penetration
**Dynamic Test Results**

- 60’ Timber Pile
- 14” Butt Diameter
- 8.25” Toe Diameter
- Refused at 51’ penetration
- Blow Count at End of Initial Drive = 25 blows/4”

**H160-1 End of Initial Drive**

- Ru = 177.9 kips
- Rs = 145.6 kips
- Rb = 32.3 kips
- Dy = 0.69 in
- Dx = 0.85 in
H160-1 End of Initial Drive

H160-1 Beginning of Restrike

25 blows/4"

54 Minutes Setup

32 blows/1"

\[
\begin{align*}
Ru &= 177.9 \text{ kips} \\
Rs &= 145.6 \text{ kips} \\
Rb &= 32.3 \text{ kips} \\
Dy &= 0.69 \text{ in} \\
Dx &= 0.85 \text{ in}
\end{align*}
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\begin{align*}
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Rs &= 241.7 \text{ kips} \\
Rb &= 8.9 \text{ kips} \\
Dy &= 0.58 \text{ in} \\
Dx &= 0.70 \text{ in}
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\]
Timber Pile Setup

\[ y = 1.7823x \]
Cline Canal Bridge
Record Keeping and Documentation

- Standard Reports
  - Daily Field Reports
  - Pile Driving Logs

- Project Specific Visual Tracking
  - MSE Wall
  - Pile Driving

- Communication (Summarized Daily Results)

- Statistical Analysis (Dispute Resolution)
## PILE DRIVING RECORD

**PROJECT**  
I-210 Interchange at Cove Lane in Lake Charles, LA

**CONTRACTOR**  
Johnson Brothers

**STRUCTURE**  
201-WB

**TYPE OF PILE**  
Timber

**LENGTH OF PILE DRIVEN**  
70’

**LENGTH OF PILE AS-BUILT**

**ELEVATION OF GROUND**

**ELEVATION OF CUT-OFF**

**AIR PRESSURE**  
(Blank)

**PAY LENGTH**  
70’

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### AVERAGE BLOWS PER MIN.

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**Remarks**

- **Note Any Change In Conditions:** Note If Pile Length Changed and If Change Was Instructed by You or Electected by Contractor (And Why Change Was Made). Note Final Blow Count: 15 Blows /2” Note If Predrill Predrill Start/End Time, Predrill Depth

**Pile Driving Inspector:** ESM

**Signature:** [Signature]
# Pile Locations Completed

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Dates:
- 11/20/2014: 40
- 11/19/2014: 35
- 11/17/2014: 31
- 11/14/2014: 35
- 11/13/2014: 33
- 11/12/2014: 38
- 11/18/2014: 20
- 11/15/2014: 21
# Pile Productivity Tracker

**Phase III, I-210 Interchange at Cove Lane**

<table>
<thead>
<tr>
<th>Pile Crew</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<tbody>
<tr>
<td>Total Piles</td>
<td>883</td>
<td>764</td>
<td>814</td>
<td>457</td>
<td>94</td>
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<tr>
<td>Days of Work</td>
<td>35</td>
<td>22</td>
<td>28</td>
<td>23</td>
<td>28</td>
</tr>
<tr>
<td>Average Daily Production</td>
<td>25.2</td>
<td>35.6</td>
<td>29.1</td>
<td>19.9</td>
<td>3.4</td>
</tr>
</tbody>
</table>

## Day-by-Day Breakdown

<table>
<thead>
<tr>
<th>Day</th>
<th>1-Nov Wednesday</th>
<th>2-Nov Thursday</th>
<th>3-Nov Friday</th>
<th>4-Nov Saturday</th>
<th>5-Nov Sunday</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>14</td>
<td>17</td>
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<table>
<thead>
<tr>
<th>Day</th>
<th>16-Nov Wednesday</th>
<th>17-Nov Thursday</th>
<th>18-Nov Friday</th>
<th>19-Nov Saturday</th>
<th>20-Nov Sunday</th>
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<td>1</td>
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</table>

## Notes

- Crew 2 had about 2 hours of downtime due to equipment issues.
- Crew 1 had hammer problems and was down for most of the day.
- Crew 4 hammer not fixed.
- Crew 1 made adjustments to the hammer and increased production.
- Crew 2 experienced delays due to equipment issues.
- Crew 3 had equipment problems and was down for most of the day.
- Crew 4 had delays due to equipment issues.
- Crew 5 had delays due to equipment issues.

**Total Pile To Date = 3032**
Conclusions
Conclusions

- Aggressive Schedules Can Be Met
- Geotechnical Investigation Influenced Design and Construction (know your site conditions)
  - Embankment Settlement
  - Stability
  - Driven Pile Designs
- Pile Testing Saves Budget
- Keeping Good Records Prevents Doubt and Confusion
Questions?
Cypress Roots