SUM-271-10.22 Landslide Repair Case Study

OTE.. – October 25, 2016

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Agenda

• Project / Site Background
• Alternatives Feasibility Study
• Slope Repair Design
• Construction
• Q&A
Site Location

SUM-271-10.22 Site
Cuyahoga Valley National Park
SUM-271-10.22 Site
Cemetery
Cuyahoga River
Brandywine Falls
IR-271 Background

- Constructed in late 1960s
- Glaciated portion of the state in the Killbuck-Glaciated Pittsburgh Plateau physiographic region.
- Natural soils beneath the roadway embankment fill at the site may be ravine outwash or lacustrine deposits from the Wisconsinan glacial event consisting of sand and gravel, with possible organic soils.
- These soil deposits are indicated to overlie Berea shale/sandstone and Cuyahoga sandstone of Mississippian Age.
Previous Geotechnical Repairs along IR-271

- SLM 6.90 (2008)
- SLM 7.18 (1997)
- SLM 7.50 (2005)
- SLM 7.56 (2009)
- SLM 8.84 (2007)
- SLM 8.87 (Future, currently under investigation)
- SLM 9.30 (2009)
- SLM 10.22 (2016)
- SLM 10.35 (1997)
Brandywine Falls is approx. 3000 feet downstream from Project Site and it one of the most visited sites in the Cuyahoga Valley National Park.
Project Site

Legend
- Approx. Project Limits
- Original Path of Brandywine Creek
Project Site

Typical Original Cross Section through the Project Site
Project Background

• Landslide observed in 2011
• Eight inclinometers installed by others
• S&ME engaged September 2012
  – Phase 1: exploration, alternatives feasibility study
  – Phase 2: final design recommendations
• Additional movement observed after Phase 1, so performed a supplemental Phase 1 exploration
Site Plan
Site Photos
Site Photos
Site Photos
Site Photos
Alternatives Feasibility Study
Exploration Findings

- Embankment fill and natural soils consist of SILT AND CLAY (A-6a) and SILTY CLAY (A-6b)
- Medium-stiff to stiff conditions in upper 6-10 feet, then becoming very-stiff to hard
- Bedrock elevation varied 30 ft along profile indicating possible buried drainage channel
- Inclinometers showed movement in upper 6-8 feet; no deep movement
## Alternatives Feasibility Study
### Back Analysis

<table>
<thead>
<tr>
<th>Material Name</th>
<th>Color</th>
<th>Unit Weight (lbs/ft³)</th>
<th>Strength Type</th>
<th>Cohesion (psf)</th>
<th>Phi (deg)</th>
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</thead>
<tbody>
<tr>
<td>Stiff - Very stiff fill</td>
<td>135</td>
<td>Mohr-Coulomb</td>
<td>0</td>
<td>25</td>
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<tr>
<td>Very stiff - Hard fill</td>
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<td>Mohr-Coulomb</td>
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<tr>
<td>Very stiff - Hard sandy clay</td>
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<td>Mohr-Coulomb</td>
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<td>30</td>
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<tr>
<td>Weathered Shale</td>
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<td>Mohr-Coulomb</td>
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<td>10</td>
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<td>Shale</td>
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<td>Mohr-Coulomb</td>
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<tr>
<td>Pavement</td>
<td>145</td>
<td>Mohr-Coulomb</td>
<td>0</td>
<td>35</td>
<td></td>
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</tbody>
</table>

Diagram showing various materials and their corresponding properties.
Alternatives Feasibility Study
Options Considered

- Relocate roadway
  - Flatten slope and shift southbound lanes 30 feet east
- ODOT GB-2 bench and regrade
  - Benched excavation and recompaction of upper 10-12 feet of embankment fill; install subsurface drainage
- Soil nail wall
  - Drilled or launched soil nail wall at crest of slope
- Geopier plate piles
  - Staggered array of steel plates driven into the ground
- Combination of above options
Slope Repair Design

Soil Nail Wall Only

Soil Nail Wall with Reinforced Soil Slope
Slope Repair Design
Other Design Aspects

• Hydraulic Analysis (HEC-RAS) was performed to determine the extent of the armoring of the slope adjacent to Brandywine Creek
• Coordination was performed through the NEPA Process with various agencies, public, etc.
Plan Development

- Plans were developed internally by ODOT District 4 In-House Design Section
- S&ME reviewed and assisted with the Plan Development
- S&ME performed a Final review of the plans to ensure they met the Geotechnical Design Requirements
Construction

- March 2016 -- Awarded to Shelly & Sands
- May 2016 -- Construction began
- Late August 2016 -- Soil nail sub-contractor pulled off job site
- ODOT and S&ME collaborated and re-designed the Project in a more conventional ODOT OGE GB2 type design within two weeks
- Project is scheduled to be completed Fall 2016
Construction
Construction

Reinforced Soil Toe Berm 05/25/2016
Construction

Reinforced Soil Toe Berm 06/09/2016
Construction

Reinforced Soil Toe Berm 06/09/2016
Construction

Embankment Construction 07/25/2016
Construction

Brandywine Creek Armor 07/26/2016
Construction

Embarkment Construction 09/27/2016
Questions?

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