LANDSLIDE STABILIZATION USING MICROPILES
STATE ROUTE 837
WASHINGTON COUNTY, PENNSYLVANIA

James R. James, Gannett Fleming, Inc., Pittsburgh, PA

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Charleston, West Virginia August 4, 2005
STATE ROUTE 837
LANDSLIDE STABILIZATION
Washington County, PA

Presentation Outline

• Project Background
• Slope Movement Diagnosis
  • Site Reconnaissance
  • Literature Review
  • Subsurface Investigation
• Design Summary
• Construction Overview
STATE ROUTE 837
LANDSLIDE STABILIZATION
Washington County, PA

PROJECT BACKGROUND
STATE ROUTE 837
LANDSLIDE STABILIZATION
Washington County, PA

Project Stakeholders
Owner: Commonwealth of Pennsylvania,
Department of Transportation

• Designer: Gannett Fleming, Inc.
Project Location
• Union Township, Washington County, PA

• 20 miles south of Pittsburgh

• On the Valley Wall of the Monongahela River
PROJECT SITE

REFERENCE: PENNDOT, WASHINGTON CO. GEN. HWY. MAP
PROJECT SITE

REFERENCE: USGS, MONONGAHELA QUADRANGLE
STATE ROUTE 837
LANDSLIDE STABILIZATION
Washington County, PA

SITE RECONNAISSANCE
Site Reconnaissance Summary

- Distressed pavement
  - Patching
  - Depression/displacements and cracking
- Non-functioning roadway drainage systems
- Toe bulges in soil below the adjacent RR
- Past landslide remediation efforts by the RR
- Outcrop of the Pittsburgh coal seam
SOUTHERN SLIDE

NORTHERN SLIDE

HUSTON RUN

91+50

106+00

116+50

120+00

SOUTHERN SLIDE

NORTHERN SLIDE

TOE BULGES

Monongahela River

ROCK EMBANKMENT PLACED BY RR
APPROXIMATE STATION 100+50
APPROXIMATE STATION 118+00
HUSTON RUN

ROCK EMBANKMENT PLACED BY RR

SOUTHERN SLIDE

106+00

TOE BULGES

SITE OF FORMER COAL TIPPLE

NORTHERN SLIDE

116+50

120+00

Monongahela River
PITTSBURGH COAL OUTCROP
STATE ROUTE 837
LANDSLIDE STABILIZATION
Washington County, PA

LITERATURE REVIEW
Geologic Literature Summary

• Ancient landslide area

• Pittsburgh coal seam mined beneath adjacent areas of land

• Near the axis of the Duquesne-Fairmont syncline
PROJECT LIMITS

ACTIVE OR RECENTLY ACTIVE LANDSLIDE
Complex landslide composed of earthflow, debris slide, earth and rock slump. Identified from historical records, and from scars, debris and other field evidence. Ground extremely unstable; sliding accelerated by excavation, loading and changes in drainage conditions. May include areas with several active slides too small to be shown separately. Questioned where doubtful.

OLD LANDSLIDE
Area of extensive hummocky ground caused by earthflow and earth and rock slump. Lacks clear evidence of active sliding. Relatively stable in natural, undisturbed state, generally not affected by small structures properly sited in areas away from the edge of the toe; can be reactivated by extensive, rapid excavation, loading, and changes in ground water and surface water conditions. Area of old landslide probably includes recent ones not identified from field evidence or otherwise documented. Upslope boundary of landslide generally defined by modified scarp, but downslope (toe) may be gradational and not well defined. Questioned where doubtful.

SOIL AND ROCK SUSCEPTIBLE TO LANDSLIDING

SCALE 1:24 000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER
<table>
<thead>
<tr>
<th>System</th>
<th>Group (Symbol)</th>
<th>Thickness in Feet</th>
<th>Formation (Symbol)</th>
<th>Columnar Section</th>
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<td>Lower Pittsburgh limestone</td>
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Duquesne-Fairmont Syncline (Approximate Location)
STATE ROUTE 837
LANDSLIDE STABILIZATION
Washington County, PA

DESIGN SUMMARY
Subsurface Investigation(s)
- Limited information available from past studies
  - 8 borings
  - 3 inclinometers
- 40 additional borings
  - 4 inclinometers
  - 4 piezometers
- Laboratory test data
  - SPT samples: classification and moisture content
  - Shelby tubes: direct shear strength
  - Bedrock core samples: uniaxial compressive strength
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<th>DEPTH (FT.)</th>
<th>SAMPLE NO. AND CORE RUN</th>
<th>TYPE / CORE RUN</th>
<th>BLOWS / 0.5 FT. ON SAMPLER</th>
<th>RECOVERY (FT.)</th>
<th>RECOVERY %</th>
<th>ROCKY POCKET PENETRATION (TSF)</th>
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<td>6.9 to 7.3 ASPHALT (wearing)</td>
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</tbody>
</table>

END OF BORING @ 7.3 ft

MORE THAN 7’ OF ASPHALT
Analyses

- Subsurface model created based upon site survey, boring data, piezometers and laboratory test data

- Failure plane identified by inclinometer and boring data in native soil near the top of bedrock
Analyses (continued)
• Failure of existing slope modeled by back analysis
  • FS slightly less than 1.0 achieved
  • Rediscovered some pitfalls of back analysis (i.e., water levels)

Soil Strength Parameters:
• FILL MATERIALS: \( \phi = 30^\circ; \quad c = 100 \text{ psf}; \quad \gamma = 110 \text{ pcf} \)
• COLLUVIUM: \( \phi = 14^\circ; \quad c = 100 \text{ psf}; \quad \gamma = 130 \text{ pcf} \)
Analyses (continued)

• Remedial alternatives considered
  • Horizontal drains – deemed inappropriate
  • Excavation and replacement – required detour
  • Anchored soldier pile wall – requires ROW acquisition
  • Tangent caisson wall – $6-7 million

• Ultimately, micropiles were selected
  • Relatively quick construction
  • No need for additional ROW
  • Administratively simpler – buried reinforcement
Net load due to landslide mass: 25.7 kips/foot
GENERAL NOTES - MODIFIED PIPE DOWEL SYSTEM:


2. Design Specifications

3. Design Live Loads
   PL-93 (Live Load Surcharge).

4. The centerline of each segment is defined as a straight line between work points.

5. All work performed outside the PennDOT Right-of-Way should be coordinated with the Railroad in accordance with the project specifications.

6. For Typical Section and additional Details see sheet ... of ....

7. Material Properties:
   - Use Class A Cement Concrete in the Cap
   - Use 3 kel Grout for the Modified Pipe Dowels
   - Use Grade 60 Reinforcing Steel Bars in the Cap
   - Use 80 kel Pipe for the Modified Pipe Dowels
   - Use 36 kel Steel for all Top Plates.
Analyses (continued)

• Concurrent reestablishment/improvement of site drainage

• Approximate final cost of $3.5 million
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CONSTRUCTION OVERVIEW
INSTALLED PIPE PILES