Slope Stability Evaluation of the Baldhill Dam Right Abutment

Presentation for the 2005 Tri-Service Infrastructure Systems Conference

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4 August 2005
Motivation

History of Right Abutment Displacement
Continued Movements
Expanded Record of Instrumentation
Establish Slope Stability Models

✓ Recent Conditions
✓ Predict Future Loading Conditions
Acknowledgments

MVP Geologists and Instrumentation Group
Omaha District and Local Testing Labs
MWH (formerly Harza Engineering)
University of Minnesota
Topics

Project Background
Pressuremeter Testing
Laboratory Testing Data Interpretation
Slope Stability Analyses
  ✓ Limit Equilibrium
  ✓ Numerical
Main Features
Right Abutment Area of Concern
Stratigraphy
Inclinometer Displacement

Fig. 2.8. Inclinometer Displacement Rate Comparison

Complete Construction of Drilled Shaft Wall (Aug 96)

Note: Cumulative displacement reset to zero for instrument comparisons.
Displacement vs Pore Water Cond.

**Graph:**
- **Y-axis:** Vector AB Displacement Rate (in/yr)
- **X-axis:** Date (mm/dd/yy)
- **Lines:**
  - Black: Incremental Disp. Rate
  - Blue: P30

**Legend:**
- SI-7 and SI-20 (43’ depth)
Pressuremeter Data (D.Shale)

At Rest Horizontal Pressure ($P_0$) = 1.83 tsf
Effective $P'_0$ = 1.24 tsf
Shear Modulus (D.Shale)

Figure D-4b. Pressuremeter Results (Deformed Shale)
Boring 02-156PM, 34.0 feet

Shear Modulus (D. Shale)

![Graph showing Shear Modulus](image)

Pressure (tsf)

Tangential Strain

814 tsf
(77.9 MPa)
Laboratory Testing

Unconfined Compression
Triaxial Shear Strength
  ✓ Unconsolidated-Undrained
  ✓ Consolidated-Undrained w/PP

Direct Shear
Residual Direct Shear
# Effective Shear Strength Parameters

## Material

<table>
<thead>
<tr>
<th>Material</th>
<th>Peak</th>
<th>15% Strain/0.2 or 0.5 in. Displacement</th>
<th>Residual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Triaxial</td>
<td>Direct Shear</td>
<td>Triaxial</td>
</tr>
<tr>
<td></td>
<td>c’ (psf) [kPa]</td>
<td>phi’ (deg)</td>
<td>c’ (psf) [kPa]</td>
</tr>
</tbody>
</table>
FLAC Mesh: With-Project

Boundary Conditions

Elevation: xdisp = 0
Distance: xdisp = ydisp = 0

Null Zones
FLAC Stratigraphy: Pre-Project
FLAC: Pre-1996 Wall
FLAC: Pre-1996 Wall

Historic High GWL
FLAC: Pre-1996 Wall

Historic High GWL
FLAC: 1996 Wall

Historic High GWL

1996 Wall
FLAC: 1996 Wall

Historic High GWL

1996 Wall

Elevation (*10) (ft)

Distance (ft) (*10 both)
FLAC: 1996 Wall

Step: 15755
Max. shear strain-rate
- 0.00E+00
- 5.00E-06
- 1.00E-05
- 1.50E-05
- 2.00E-05
- 2.50E-05
- 3.00E-05
- 3.50E-05
- 4.00E-05
- 4.50E-05

Contour interval = 5.00E-06
Beam Plot
Beam Locations
Water Table

Elevation (*10^2) (ft)

1996 Wall

Extreme GWL
FLAC: 1996 Wall

1996 Wall

Intermediate GWL

Elevation (*10^2) (ft)

Distance (ft) (*10^2 both)

Contour interval = 1.00E-01
Water Table
Beam Plot
Beam Locations

X-displacement contours
-9.00E-01
-8.00E-01
-7.00E-01
-6.00E-01
-5.00E-01
-4.00E-01
-3.00E-01
-2.00E-01
-1.00E-01
0.00E+00
Summary

History of problems
Instrumentation extremely important
  ✓ Understanding mechanism of displacement
  ✓ Identifying geometry of failure surface
Pressuremeter testing (elastic properties)
Laboratory testing (shear strength)
Limit equilibrium (back calculation)
Summary (con’t)

FLAC results

✓ No searching for the critical failure surface
✓ Compute displacements with visual representation
✓ Helps in understanding problem
✓ General agreement with limit equilibrium results
✓ Abutment is stable to past historic high GWL’s
✓ Abutment is at risk of failure to extreme GWL’s
✓ At an intermediate GWL, abutment may be stable, but with much more deflection of the 1996 drilled shaft wall
QUESTIONS?