Marmet Lock Replacement: Geotechnical Challenges

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Geohazards in Transportation in the Appalachian Region
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Project Overview

- Purpose is to alleviate traffic back ups on the Kanawha River
- Existing and smaller 56’ X 360’ lock chambers inhibit river traffic
- Project adds one larger 110’ X 800’ lock chamber and approach walls, located landward of old locks
- Construction started in summer 2002 with a contract cost of approximately $230 Million
Project Overview

Twin 56' X 360' Chambers
Completed in 1934

Existing Lock – Prior to Construction
Project Overview

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Twin 56’ X 360’ Chambers
Completed in 1934

New 110’ X 800’ Chamber
Completed in 2008

New Lock – Photo taken 1 July 2008
Project Overview

New Lock Construction - Aerial View - May 2005

Existing Lock Chambers

New Lock Chamber Under Construction
Project Overview

New Lock Chamber and Approach Walls

New Lock Construction - Aerial View - May 2005
Project Overview

Sheet Pile Cell Cofferdam

Existing Landwall Portion of Cofferdam

Contractor Designed Anchored Retaining Wall

New Lock Construction - Aerial View - May 2005
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Tied-back Flexible Wall

- Contractor value-engineered construction of ~45 ft. tall tied-back wall in lieu of sloped excavation and two stage vacuum well system designed by government.
- Four rows of tie-backs with lower two socketed into rock and upper two utilizing soil anchors.

- Wall performed well throughout construction (approximately 4 years).
- Slurry trench was located landward of tied-back wall for excavation dewatering purposes.
Embankment Stability

- Characterize Subsurface Conditions
- Laboratory and Field Testing Program
- Estimate Embankment Properties
- Selection of Shear Strengths
- Perform analyses
- Construction Considerations

- Slope Stability Analyses performed by USACE, Huntington District
- Placement Rate Analyses performed by FMSM Engineers (Lexington, KY)
Deep Clay Deposits of the Prehistoric Teays Lake

Prehistoric Lake

Marmet L&D
Mt. Marmet: ~120 ft. design height

Typical Cross Section of Embankment
Factors of safety without foundation treatment were marginal.

Even with wick drains installed to dissipate excess pore pressures, Contractor’s flexibility of scheduling is limited due to additional lateral loads transmitted to the guidewall.

Combination of wick drains and stone columns offer a solution that provides schedule flexibility for Contractor.
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Approx. Limits of Minimum 4 ft. Thick Sand Drainage Blanket

Approx. Extents of Wick Drain and Stone Column Treatment

Downstream Guide Wall
Wick Drains: 1,263 in 3 days
Stone Columns: 1,081 in 3 months
Vibro-displacement Stone Columns

*Image from Hayward-Baker (http://www.haywardbaker.com)*
Artesian pressures in lower aquifer.

Excess pore pressure induced by fill placement or by vibration induced liquefaction.
Performed boring utilizing 2-inch and 3-inch split-spoons to verify that desired properties (free draining, relative densities) were actually being obtained.

Correlations to obtain N-value from 3-inch split-spoon and 300 lb. hammer did not work very well.
After completion of the stone columns/wick drains, 24 vibrating wire piezometers and seven inclinometers were installed.

The piezometers were situated along the length of the embankment and measured pore pressures in four discreet intervals of the soft clay in the soil profile.
The Contractor used lime in order to expedite placement of saturated clays. Generally, mixing 1.5-3% lime by weight has been successful depending on the water content of the clay and weather conditions.
Disposal Embankment

Photograph taken 27 April 2008
Disposal Embankment

Photograph taken 2 June 2008
Summary

- Subsurface soils included a very soft saturated clay.
- Proposed embankment foundation unstable for quick loading.
- To provide Contractor flexibility and ensure stability, combination of drainage blanket and stone columns/wick drains were installed at an overall cost of ~$2.4M.
- Automated piezometers installed to ensure excess pore pressures dissipate as embankment is placed.
- Inclinometers installed to monitor subsurface displacements.
- Since fill placement began in Summer 2002, no problems or concerns. (~2.2X$10^6$ CY placed out of a total ~2.9X$10^6$ CY estimated for completed embankment.)
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Lock Operational

First Lockage: 22 January 2008
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Lock Operational

First Lockage: 22 January 2008
Questions? – THANK YOU!

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Grand Opening!
9/27/1932

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