Instrumentation Systems for Strategic Infrastructure Protection

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  Forest Grove, Oregon
Overview

- Site Description
- Geology
- Geohazards
- Mitigation
- Summary

Project Location

McCook, Illinois
Site Description

- Active quarry in an industrial area
- Located between Des Plaines River, I-55, Chicago Sanitary Ship Canal, and a railroad
- Constructing sewage reservoir
- Slurry wall and grout curtain for protection
Geology

- Overlain by glaciation: Wisconsin Episode
- Northeast of the Sandwich Fault Zone
- Silurian age formation
- Project site includes carbonates: Blocky, jointed limestone and dolomite
Geohazards

~100 feet

Blasting Area
Geohazards

Rockfall source

Slabs of limestone
Geohazards

Tension Cracks

Rubber asphalt
What are the solutions?

Primary Mitigation

Rockfall: drapery
Slope stability: rock reinforcement
What are the solutions?

Primary Mitigation

Rockfall: wire mesh drapery
Slope stability: rock reinforcement

Hi-Tech rappelling to install drapery
What are the solutions?

Rock reinforcement
What are the solutions?

Primary Mitigation

Rock drapery and tie-off anchors

Hi-Tech rappelling to install drapery and instrumentation
Secondary Mitigation
monitoring ground movement:

- Time-Domain Reflectometry (TDR)
- Extensometers with vibrating-wire transducers
- Remote Monitoring Units (RMU)
What is Time-Domain Reflectometry (TDR)

- Instrumentation technique that uses coaxial cable deformation to detect ground movement

Coaxial cable grouted into borehole

Electrical pulse sent down cable

Pulse reflected at crimps and breaks

Severity and distance to reflection is determined
TDR Basic Principles

- Reflectometer generates pulse, sends down coaxial cable
- Reflectometer listens for echoes resulting from changes in cable properties (i.e., damaged sections of cable)
- Distance to damaged cable is determined by time for signal to return
TDR Basic Principles

Horizontal TDR

Damaged cable
Extensometers & Vibrating Wire Transducers

- Installed Horizontally
- Measures deformation between hydraulic anchors
- Displacement measured using vibrating wire transducer
- Data collection through RMU
Extensometer & VW Transducer Continued...

Not to scale

Bench

30-ft

TDR

Extensometer

50-ft
Remote Monitoring Unit

- Program collects TDR and extensometers data
- Capable of generating alerts
- Custom programming for a variety of instruments
Remote Monitoring Units (RMU)

- VW Interface
- TDR Reflectometer
- Radio
- Datalogger
- Multiplexer
- Battery
What does the data look like?

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Battery life and panel temperature

Reflectometer settings

TDR cable from highwall surface to total depth
Location of RMUs

Des Plaines River

I-55

RMU 1

~100 ft

RMU 2

RMU 3

RMU 4

Chicago Sanitary and Ship Canal
Preparing for Installation

Preparing TDR cable

Preparing Extensometers & VW Transducers
Extensometer Assembly
Extensometer Assembly
Installation Begins

PVC sling to assist in the installation of extensometers
Installation Continues...

Extensometer
Installation is complete!
Installation is complete!
Installation is complete!
Summary

GEOHAZARDS
• Rockfall
  • pose a potential threat to personnel in the quarry
• Tension cracks
  • pose a potential threat to integrity of the adjacent highway

MITIGATION
• Primary
  • Rock reinforcement/dowels
  • Scaling
  • Rockfall Drapery
• Secondary
  • Instrumentation installed to monitor movement
    • TDR
    • Extensometers & vibrating wire transducers
    • Remote Monitoring Units

ALERTS
• Personnel alerts
  • Allows quarry personnel to respond to potential geohazards effectively and in a timely manner
THANKS FOR YOUR TIME!