Geotechnical Data Management

Design Applications for Rock Characterization

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Two Case Histories of Data Management

• Case histories
  ❖ Large-scale underground mine site characterization
  ❖ MnDOT T.H. 53 relocation project

• Key points:
  ❖ Both projects required rock characterization
  ❖ One data set was large, and one was very large
  ❖ Data integration, software, and visualization are key
Minnesota T.H. 53 Realignment
Near Virginia, MN
Key Points

• Multiple information sources, each providing a different view of the rock
  ❖ Mapping of rock exposures
  ❖ Drilling
  ❖ DTH logging

• Integration is key

• Software is critical
Roadway Realignment Concepts
TH53 Realignment

Historic Iron Ore Pit

Iron Ore Pit Today
E-2 Alternative

Construct new, shorter, tall bridge through currently inactive mining area, further north of current US 53 alignment.
Principal Motivation–Design of Post Mining Rock Slopes
What Methods and Why Chosen?

- RPA Photogrammetry:
  - Orientation
  - Spacing
  - Persistence

- Acoustic Televiewer / Optical Televiewer logging
  - Orientation
  - Spacing
  - Aperture & infilling thickness
RPA-Based Photogrammetry
Equipment & Planned flights
Resulting image with joints identified

3,176 total features mapped
Stereonets
Acoustic & Optical Logging
Down-the-hole tools & methods

- Mount Sopris Instruments (MSI) 5MXA-1000 Matrix logger
- MSI 4WNA-1000 truck-mounted winch
- MSI 2CAA-1000 three-arm caliper probe
- Advanced Logic Technologies (ALT) ABI40-2G acoustic televiewer
- ALT OBI40 Mark V optical televiewer
- Borehole survey tool: GYRO SHOT®

Photo courtesy of Hager Geosciences, Inc.
Plan View of Boring Program
ATV/OTV Logs

- Depth
- 3D virtual core
- OTV image (unrolled)
- ATV image (unrolled)
- Caliper
- Features
Some statistics

• Seventeen coreholes were logged

• Logged footage was about 6,800 ft

• Number of features logged
   Total about 12,320
   Bedding features logged was about 8,703
   Joint features logged was about 3,617
## Raw data from ATV/OTV

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Combined Data
Orientation Results

Photogrammetry (all domains, excl bedding)

ATV/OTV (all domains, excl bedding)

Photogrammetry & ATV/OTV (all domains, excl bedding)

All Data
KATS (Itasca’s In-House Kinematics Analyst)

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![Graph showing friction angle distribution](image)

Data Management for Rock Design
East Highwall Fault
East Highwall Fault
Investigating Fault Location
Oblique View
Looking Down Strike of Shear Plane
East Pier Fault
3D 3DEC Models
Comprehensive Model
Model with Joints
FOS 1.5 Plasticity
FOS 1.5 Displacement Contours

Displacement magnitude
Plane: active on
1.5000E-01
1.4000E-01
1.3000E-01
1.2000E-01
1.1000E-01
1.0000E-01
9.0000E-02
8.0000E-02
7.0000E-02
6.0000E-02
5.0000E-02
4.0000E-02
3.0000E-02
2.0000E-02
1.0000E-02
0.0000E+00

~1/2"
FOS 1.5 Magnified Displacements
Software Tools

• GoCAD
  - Data integration and visualization
  - Targets the geology and geomechanics market
  - Developed for the petroleum industry

• Excel
  - @Risk
  - Visual Basic routines

• Access
How did the characterization help the project?

• Primary input for isthmus slopes, also contributed to design of east pier and abutment

• Increased reliability of kinematics analysis of possible block and wedge failures

• Demonstrated that three joint sets are vertical and one is subvertical, and was critical to identifying a slope failure mechanism by flexural toppling

• Assisted with investigation of a fault near the east pier
17 Feb 2016:
Pier 2 Foundations Complete
18 Drilled Piles
Questions?