Geotechnical Challenges in Mining

A Presentation made to MIS-EGS in Edinburgh

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February 29th 2012
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Mine components

- Underground mines
- Open pits
- Tailings dams
- Waste dumps
- Plant site
- Leach pads
- Infrastructure
- Water dams
- Well fields
Mine life cycle

- Exploration
- Mine Development
- Post-Closure
- Ongoing Operations
- Temporary Closure
- Operations
- Closure

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Geotechnical challenges

- Design
  - Failure
  - Serviceability
- Controlling factors
- Mine life
  - Development
  - Operation
  - Closure
Global rock slope failure
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Controlling factors

- Material properties + mass fabric = mass properties

- Mass properties + environment = situation

- Situation + engineering change = engineering behaviour
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Rock mass, empirical shear strength

Tailings

Cohesion = 2400kPa
Friction angle = 41°

Cohesion = 360kPa
Friction angle = 10°

Cohesion = 50kPa
Friction angle = 35°
Slope stability

Joint 4
Gneiss

1.94
4.51
1.94

W
W

150
100
50
0
-50

-50
0
50
100
150
200
High factor of safety
Limiting equilibrium
## Mass properties – underground mine

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<th>Material properties + mass fabric = mass properties</th>
<th>Mass properties + environment = situation</th>
<th>Situation + engineering change = engineering behaviour</th>
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Suspension Effect of Roof Bolting

Principles

• Immediate roof strata is carried by bolts anchored into stronger rock above

• Bolt length is governed by distance to stronger rock plus anchorage length

• Number of bolts based on the weight of rock which must be retained and the capacity of the bolts

• Nominal tension is applied to each bolt
Environmental factors

- Material properties + mass fabric = mass properties

- Mass properties + environment = situation

- Situation + engineering change = engineering behaviour
Environmental controlling factors

- Seismicity
- Groundwater – tailings facilities, dams
- In situ stress
- Topography – leach pads
- Climate – infrastructure
- Man-made features – tailings facilities
- Vegetation
Groundwater – seepage at dams and tailings facilities
Grain size incompatibility
Sink holes formed on upstream dam face due to internal erosion, loss of upstream core integrity
Internal erosion
Remedial works
Pore pressure control
Topography – Heap Leach Pad

A. Typical Profile of Site Area

B. Typical Section Through Heap

C. Typical Section Through Pond
Valley leach pad
Site preparation
Sub-base
Liner interface
Solution pipework
Climate – infrastructure, tailings dams

Erosion gullies, waste dump, flow slide
Envelope of reservoir levels

Ensemble of reservoir levels with new model and base data
Combined sensitivity test

Reservoir level (m)

Simulation month (years start October)
To create a new slide, copy and paste this slide before inserting text.
Overtopping
Supernatant pond water
Main embankment

Pond management at closure
Man-made features
Geotechnical challenges – summary

- Design adaptability and simplicity
- Production and life of mine considerations
- Examples of controlling factors
  - Mass properties – application in rock slope and underground engineering, density and strength in earthworks
  - Environmental – seepage and pore pressure control, influence of topography, water management
- Risk management
- Secondary lines of defence
- Monitoring