Soil Conditioning Basics in Pressurized Face TBMs

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3 Main Types of TBMs

1. EPB for SOFT GROUND AND COHESIVE SOILS

2. MIXSHIELDS for HETEROGENEOUS GROUNDS / HIGH WATER PRESSURES

3. HARD ROCK TBMS for MINING IN ROCK AND NON GROUND WATER BEARING SOILS

EPB SEATTLE SR-99
MIXSHIELD CHINA
HARD ROCK TUNEL LA CABRERA SPAIN
EPB Shield
- Operation Related to Conditioning

1. Cutterhead
2. Working Chamber
3. Screw Conveyor
4. TBM Shield
EPB Shield
- Operation Related to Conditioning
Actual range of EPB use
- Soils and Conditioning Considerations

- Clay adhesion & clogging: use foam and anti-clay-additives
- Silty sands: use foams
- Coarse, frictioned soil: use Foam & Polymers
- Very coarse, frictioned soil: use Foam, Polymers and Filler suspension
- Open shield: possible
Actual range of EPB use
- Soils and Conditioning Considerations
Benefits of Soil Conditioning in EPBM

- Creating Plasticity
- Dust Suppression
- Short Term Cohesion
- Lower Wear
- Lower Permeability
- Foam

We create chemistry
EPB Shield Foam / Polymer Varietals

- Different foams have different properties
- Foaming capacity
- Stability
- Anti-clay capacity
- Rheological impact (liquefaction / stiffening)
- Drying-up capacity
Soil Conditioning Agent- General Concept

» Soil Rheology

A Carrier ‘or’ Vehicle of soils
Soil Conditioning Agents
- Torque Reduction

![Rheometry data, Torque](image)

- Control at LL
- "321" FER 15 FIR 100
- ACP 147+ FER 15 FIR 100
Soil Conditioning Agents
- Anti-Clay Foams/Polymers

» Anti-Clay Polymer
  - Static and Steric Repulsion
  - Reduction of particle adhesion
  - Flocculation

» Purpose
  - Decrease clogging, adhesion, transport problems
  - Reduction in Torque
  - Increase the TBM speed
Soil Conditioning Agents
- Soil Viscosity

Rheometry data, Viscosity

Control at LL
"321" FER 15 FIR 100
ACP 147+ FER 15 FIR 100
Soil Conditioning Agents
- Specialty Polymers

» Polymers
- Adhesive Polymers
- Super Water Absorbers
- Water Management

» Purpose
- Increase Soil Adhesion
- Stabilize Soil Matrix
- Decrease Water Inflow
EPBM
- FOAM GENERATION Basics

1. Surfactant + Polymer = Additive

2. Additive + Water = Foaming solution

3. Foaming solution + Air =
Soil Conditioning Agents - Specialties

» Super Absorbers

» Anti-washout Polymers
Soil Conditioning Agents
MasterRoc® Polymers

» MasterRoc SWA 705
Conclusions

» Soil Conditioners for all needs
  ■ Gravel to Clayey soils

» Foam Generation, Expansion and Injection Rates play important roles

» Consider Foam Behavior under Pressure

» Transportability, Torque Reduction and Advance rate are affected

» Foam Stability is Key