Ground Investigation
by
Horizontal Directional Drilling
presented by
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Horizontal Directional Drilling (HDD)

• Working Principle
• Construction Procedure
• Recent Application
• Lessons Learnt
• Suggested Improvement
Working Principle

- Define the trajectory and tolerance
- Straight section - Conventional Wireline Drilling
- Curve section - Steerable Drilling System
- Navigation by toolface angle
- Borehole surveying (i.e. to get the azimuth and inclination)
Construction Procedure

• Drilling Machine Setup
Construction Procedure

- Steering Adjustment

Adjusting the Toolface
Construction Procedure

• Changing Bit

NQ Bit

DeviDrill Bit
Construction Procedure

- Reading the Toolface
Construction Procedure

- Surveying

DeviTool

Verifying Data
Construction Procedure

• Sampling
Recent Application

• Route 8
  – Eagle’s Nest Tunnel & Associated Works
Route 8 between Cheung Sha Wan and Sha Tin
Scope of this Site Investigation by HDD

To facilitate:-

- Planning of Temporary Support Systems in Tunnels
- Excavation Sequencing
- Blasting Works
- Grouting
- Programming
HDD Successfully Drilled

- 1151m long from North Portal

- 516m long from South Portal (excluding the reservation pipe length of 34m)
HDD Successfully Drilled

516m long HDD  1151m long HDD

South Portal  North Portal
Equipment Employed for HDD

- Rotary Drilling Rig
- Devico Directional Drilling Equipment
  - DeviDrill
  - DeviTool
  - Peewee
- Conventional Wireline Drilling
  - NQU Wireline Drilling System
  - Mud Pump
Grouting Unit

- Mixer
- Agitator
- Grout Pump
- Inflatable Packer
Rotary Drilling Rig

For the first 550m drilling while Hydraulic Drilling Rig
Drill Rods

DeviDrill core length in maximum of 3m
NQU wireline drilling system coring in length of 6m
Devico Directional Drilling Equipment

“DeviDrill” is a wireline operated steerable core barrel
Devico Directional Drilling Equipment

Diamond Bit and Adjustable Eccentric Housing

Diamond bit

Adjustable eccentric housing
Devico Directional Drilling Equipment

DeviDrill Bit in N-Size
Devico Directional Drilling Equipment

“DeviTool” is to record information from 3D-magnetometers and accelerometers to define magnetic and gravity tool face, azimuth and inclination of the borehole.
Devico Directional Drilling Equipment

“Peewee” is a small diameter electronic multi-shot survey device
Water Outflow Measurement

- Collection Basic
- Settlement Tank
- Measuring Tank
- Flow Meter + Pressure Transducer
- Datalogger + Desktop Computer
- Wireline Packer
Water Outflow Measurement

Datalogger

Flow Meter
Site Constraints

- At North Portal
  - Site formation works completed in advance under SHT Contract
  - Sufficient working spaces, no particular site constraint

- At South Portal
  - Not enough working space
  - Concerns with respect to the existing WSD Tai Po Road Treatment Works, i.e. underground water tank and filter bed
Setting Up for HDD at North Portal

Northbound Tunnel

Setting up for HDD

Southbound Tunnel
HDD & Tunnel Excavation in progress
Site Formation Works at South Portal

Setting up HDD at the rear of South Portal
Site Setting Up at South Portal

- Setting up Hydraulic Drilling Rig
Site Setting Up at South Portal

- Set up Hydraulic Drilling Rig and Drill Rod
Site Setting Up at South Portal

- Setting up Temporary Platform for supporting steel casing
Site Setting Up at South Portal

- Drill Rod to be extended into the terrain
Site Setting Up at South Portal

- Toolface Orientation

Temporary Platform
Site Setting Up at South Portal

- Control Panel for Drilling Operation
Site Setting Up at South Portal

- Drilling in Operation and Safety Fencing
Lessons Learnt

• Correct use of drill bit affects progress;
• Steering rate is obtainable initially upon literature;
• Actual rate is affected by the geology significantly; therefore, a more precise or site-specific rate should be verified by the available GI information
• High water pressure (i.e. 25 bar) should be kept especially at steering
Lessons Learnt

- Refurbishing drill bit (without replacing) by lowering the RPM and maintaining a constant penetration rate;
- Optimal bend radius – 1.2°/10m;
- Maximum bend radius – 4.8°/10m;
- Straight Section – 30m/day (average);
- Curve Section – 8m/day (average)
Further Enhancement

- Modified steering barrel to get toolface angle information (i.e. by acoustic / EM wave) without retracting the inner tube
- Joint orientation mapped with reference to the azimuth reading taken by the accelerometer and magnetometer
Thank You