

An aerial photograph of a construction site. In the center, there is a large pile of dark, corrugated metal sheets. To the left, a worker in a white shirt and blue pants is standing near some equipment. Various construction materials, including pipes and cables, are scattered around. In the background, there are several buildings and a parking lot with many cars. The scene is brightly lit, suggesting a sunny day.

Ground Investigation by Horizontal Directional Drilling

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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



Drilling Rig Setup



Drilling in Operation

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



Scope of this Site Investigation by HDD

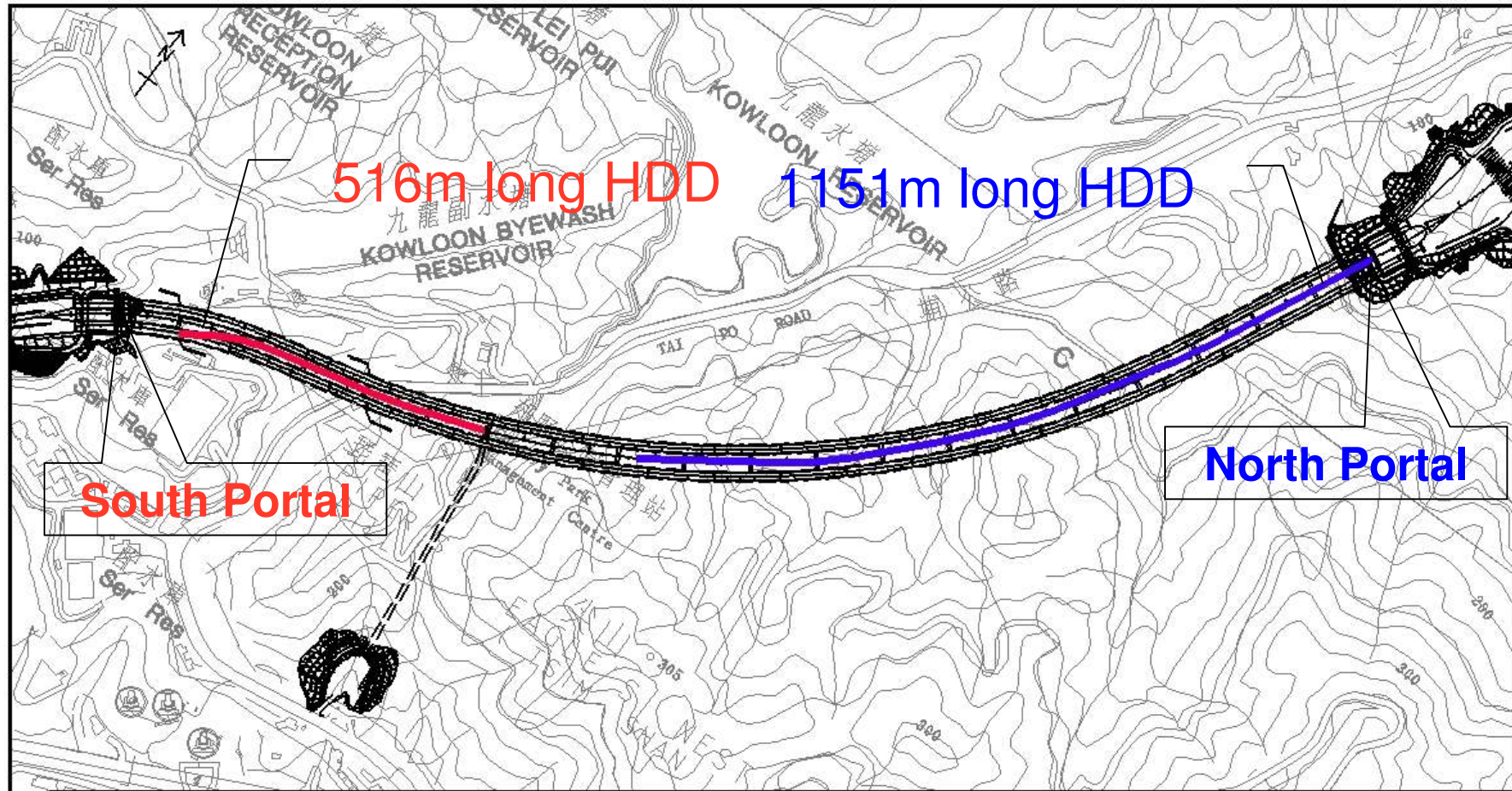
To facilitate:-

- 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



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



Casing Platform

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



DeviTool

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



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



Temporary
Platform

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