Instrumented Drilling and Downhole Geophysical Logging

A Complementary Survey to Rotary Coring

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Science vs. Engineering

“A good scientist is a person with original ideas. A good engineer is a person who makes a design that works with as few original ideas as possible.”

Freeman Dyson “Disturbing the Universe”, 1979
Report Statements

• “It is clear that additional work will be required before a complete understanding ......”

• "Three of the samples were chosen for detailed study ...”

• “Typical results are shown ...”

• “It has long been known that ...”

• “Based on engineering judgment ....”

• I don’t understand it

• The results on the others didn't make any sense and were ignored.

• The best results are shown

• I haven't bothered to look up the original reference

• Cannot find any proof to back me up
Outline

• Current deployed methodology
• Alternative/integrated solutions
• Benefits /Conclusions
• Risk assessment
Current Methodologies

• QCS
• BS EN ISO Standards
• ASTM

• Centered on coring, sampling, lab testing, in-situ testing.
Current Methodologies

Limitations:

• Discrete sampling and testing
• Bias sampling and testing
• Rock mass properties from borehole data

*Large room for assumptions.*
Alternative Methods

• Diagraphy (instrumented) drilling
• Downhole geophysical tools
  • Caliper
  • Natural Gamma, Spectral Gamma, Gamma-Gamma
  • Full wave sonic
  • Acoustic / Optical Imaging
  • Resistivity / Conductivity
  • Video Imaging
Diagraphy Drilling

• Thrust on bit (W’) – (net thrust)
• Rotation speed (ω₃) – generally set based on the type of drilling conditions taking into account the type of rig and the wear and tear of the bid (lithology dependent)
• Torque (Tₚ)
• Fluid pressure (p)
• Time / drilling speed (u)

• Hold-back pressure – it prevents the drilling rods from penetrating too fast, especially into the very soft ground, or from “free fall”.
Diagraphy Drilling

Parameters influenced by velocity

\[ \Gamma_v = \frac{V_d}{(\omega_d \times D)} \]

Parameters influenced by forces

\[ \Gamma_f = \frac{W'}{(T_q \times D)} \]
Downhole Geophysical Logging

• Caliper – correlation with RQD (?)

• Natural gamma – correlation with clay content

• Acoustic imaging – fracture identification and description

• Full wave sonic – P/S velocities – correlation with stiffness/strength
Benefits / Conclusion

• Complementary to coring activities

• Continuous records / sampling

• Qualitative and quantitative data

• Fast and cheap
Risk Assessment

- Reduced work quality
- Conservative design
- Expensive construction
- Deviation from standards to reach project deadlines
- Equipment overloading
I skimped a little on the foundation, but no one will ever know it!!