

Instrumented Drilling and Downhole Geophysical Logging

A Complementary Survey to Rotary Coring





"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"

Geotechnica

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

ICC

 Cannot find any proof to back me up

TRADES

SITES

Gold Soonsors

Gulf Laboratories Co. wo





- 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.





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

Geotechnica

0

• Natural Gamma, Spectral Gamma, Gamma-Gamma

Gold Soonsors

Gulf Laboratories Co. wo

SITES TRADES 100

- Full wave sonic
- Acoustic / Optical Imaging
- Resistivity / Conductivity
- Video Imaging



Diagraphy Drilling

- Thrust on bit (W') (net thrust)
- Rotation speed (
 ^m_d) 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 (T_q)
- 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

$$\Gamma_v = V_d / (\varpi_d * D)$$

Parameters influenced by forces

$$\Gamma_{\rm f}$$
 = W'/ (T_q*D)



	Penetration Time (seconds per cm)	Alteration Index	E-Method	Drilling Resistance (kPa)	Ease to Drill	Specific Energy (MJ/m3)
Depth Below Groundlevel (m)						
			the second se			
	4		March	<u>_</u>		

1 1

Deptical (n) Sy	ente	Deciogram	Strata Description	Rodi Core Guality TON SCR RG	Paratration Speed (minin)	Titusk Pressus (ben)	Injustion Photosofe (bars)	Toque (ben) e ŋ w	Roston Speed (RPM) == = = =	Attendical Index	Estenod	Driling Recettance (MPN)	Eser to Dell	Specific Energy (Materia)
Section of the sectio		WINES	titler 12m 42204 title, 20m 12m 42204 title, 20m 12m 42m 12m 12m 12m 12m 12m 12m 12m 12m 12m 1					No.	Shaway	al des mode	AN-MA			
and the second		8		10 71 52 10 71 52 17 15 53				and lighting	and a second		Langent			Jakital
2011				100 85 88 100 54 58 100 89 58 100 52 50					and the second se	0	M.M.W			W.
San Frank		ri M	1245 - BADs Median designs among beformed pay has prevent and SECTOR with prevent draw parts to loss by synthesis preventions at Matter 5-ONs, Daving 1 and research with speech before. SECTOR 1	53 83 83 87 54 67	- Auto			Abre	- And	- And Contraction	N.W.			
10 10 10 10 10		W	Team and the second period of the period second according to the second of the rest of period period of the second second according to (TECP) Conservations on p. (and gives the device Charling quart features (SERIES-JEETCH)	100 74 70 100 38 40 39 31 79 100 80 54				And a second second	No.		ł		and an and a second	
Start Street		199	128 Star Sweighten vie pry te gener (18275), et poss decembre net transmission de plant transmission (1875), Their generations (1996, 1975), Sectore	40 75 61 300 75 61						1	ł	ŧ	1t	t
20111111111		H8H	[3.39] A. Kalley, "any seek get palaset inno-halp benefits 33, "U." M. Antender, off-and to study a strappe," for generic stracks, business. Net, Sand, S. Sandy panel international strappe, "in generic stracks," business. Net, Sand, S. Sandy, panel strategy baset.	100 H2 H2 100 St 73				1			1			
4	Ē	Ŧ	10434G	100 80 77				-		ļ	1			Ś
1		MBH	22 20th Instead on glueboot for annex 3/2726 model	93 70 EB	 }			1		42	st St	4		₹ {
Sand Street		808	B.B 128: Statistic rest previous gravity and the statistic statisti statisti statis statisti statistic statis statistic statistic sta	100 EL EL 100 45 45 100 82 58	med of			-	a land	M. France	the second	E.		Ę
5 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 -		RUS		100 91 65 10 99 99 10 99 99 10 91 75	ſ				No. Contraction of the second second	A. Same				<pre></pre>
3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2		90.6	27 C Ro-E Sto. Vey web to web (git toward pro for power lackets) (KUTME CALONENTS) with accessed its toward promovy, web row and (git power power accesses at the Comp spectrations (KDCALONESCE)	120 83 61 120 87 61 120 88 84 66 75 58 40 50 27				Sur de Minteres	Name of Street, and Street, or Stre	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	- Andrews		Many And	- بالمرد
and and		d4080	32×10^{-10} The invariant sector straig test growth gas, there 30% GeV field in a new panel halows (H10 00%CM)	197 HZ (211				1	- Comp		Ì)		3
1	Ě	RUBGVP R	E. Stell (E. Stell, und is und off Stream) per for press (sociale URE) The SALURENCE Stream in the set of the set of press per pairs and rest and where PLS 2015.00.	10 13 10	- La			hard	al and	Jahr - Jah	Terret	The second second	The second	5







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



CH2MHILL

I skimped a little on the foundation, but no one will ever know it!!

