



Typical Geotechnical Risks in the Middle East

By Tayo Roberts

Introduction

- What is Geotechnical Risk
- Typical Geotechnical Risks
- Mitigation and Managing Geotechnical Risks
- Conclusions

Typical Geotechnical Risks in the Middle East

What is Geotechnical Risk?

All construction projects interact with the ground at some point - without appropriate investigation and assessment the ground is a RISK



Typical Geotechnical Risks

- Karst features – cavities and solution features
- Variable ground conditions
- Sabkha
- Liquefaction of superficial materials
- Bearing Capacity (e.g. loose sand or soft clay) – differential settlement
- Slope stability (excavations, shafts, shoring / retention systems)
- Shallow groundwater table & Nuisance water
- Quality of ground investigation
- Geotechnical design (e.g. wrong assumptions, wrong geotechnical models)

Geotechnical Risks

- Karst Features



Deep cavity encountered within sandstone (Abu Dhabi)



Cavity encountered within sandstone (Al Falah area, Abu Dhabi)

Geotechnical Risks

- Karst Features



Deep cavity encountered within Limestone (Doha, Qatar)

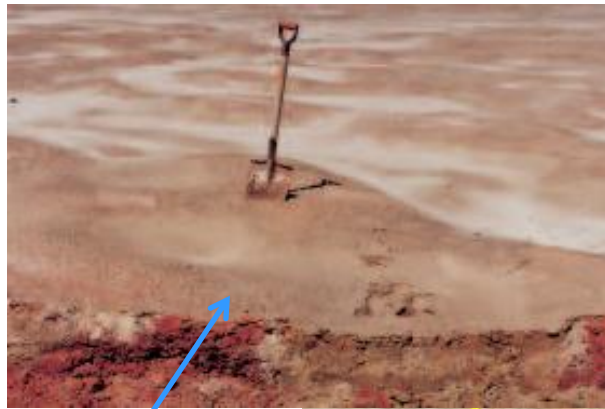


In-filled Cavity encountered within Limestone (Riyadh, KSA)

Typical Geotechnical Risks in the Middle East

- Sabkha Deposits

Coastal Sabkha



Sabkha Matti



Madinat Zayed

United Arab Emirates

© 2010 LeadDog Consulting
Image © 2010 DigitalGlobe
© 2010 Europa Technologies

Inland Sabkha



Geotechnical Risks

- Liquefaction
- Bearing Capacity Failure



Geotechnical Risks

- Slope stability



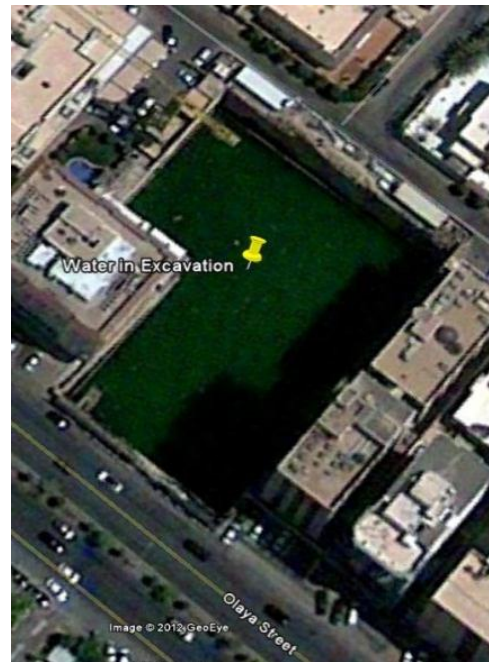
Typical Geotechnical Risks in the Middle East

Geotechnical Risks

- Shallow Groundwater



2012



September 2010



June 2010

Geotechnical Risks

- Nuisance water



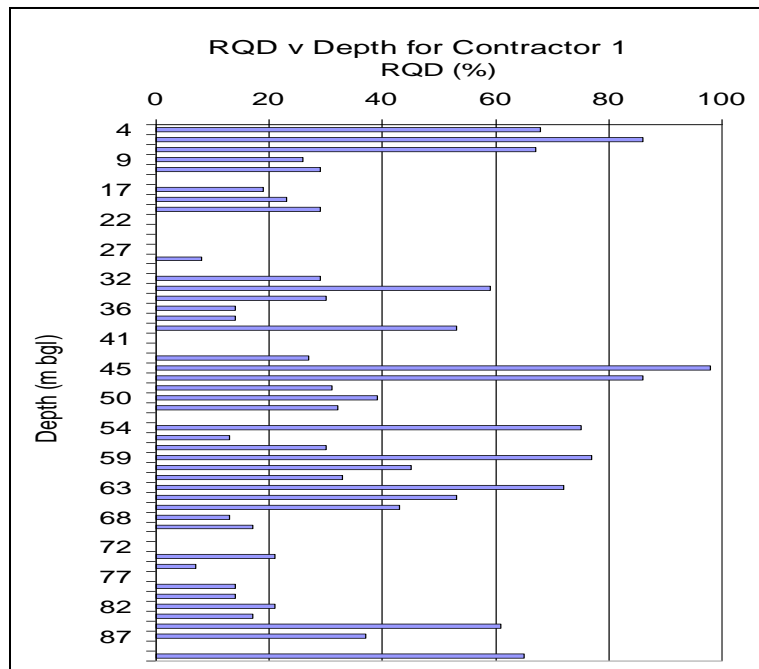
Geotechnical Risks

- Quality of ground investigation

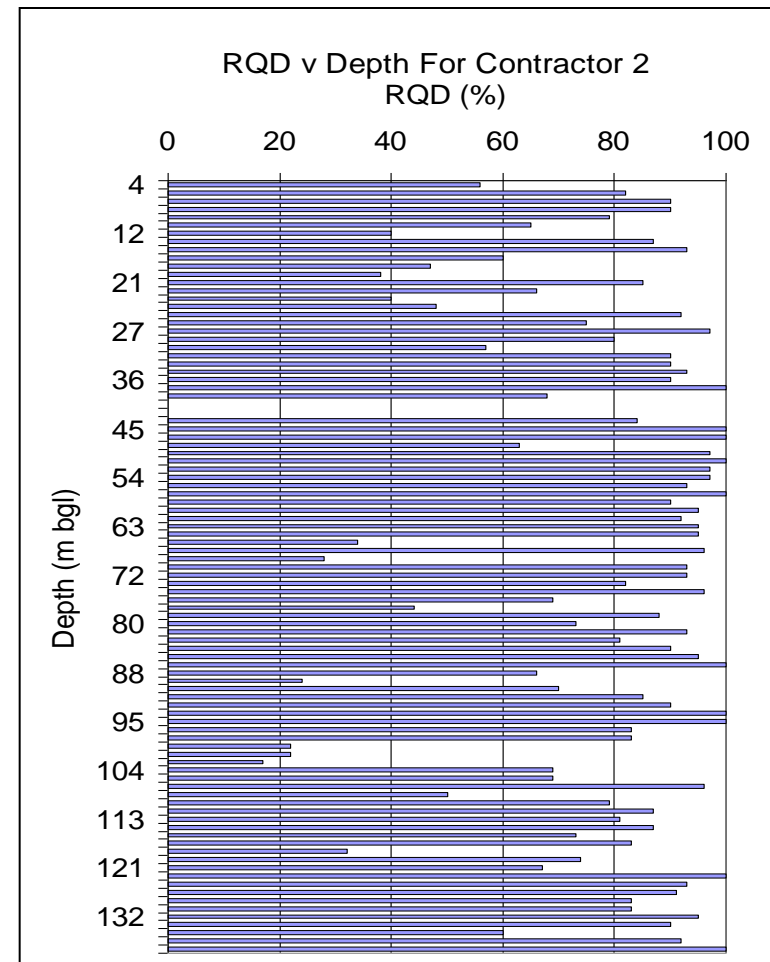


Geotechnical Risks

- Quality of ground investigation



RQD achieved for 2
different contractors

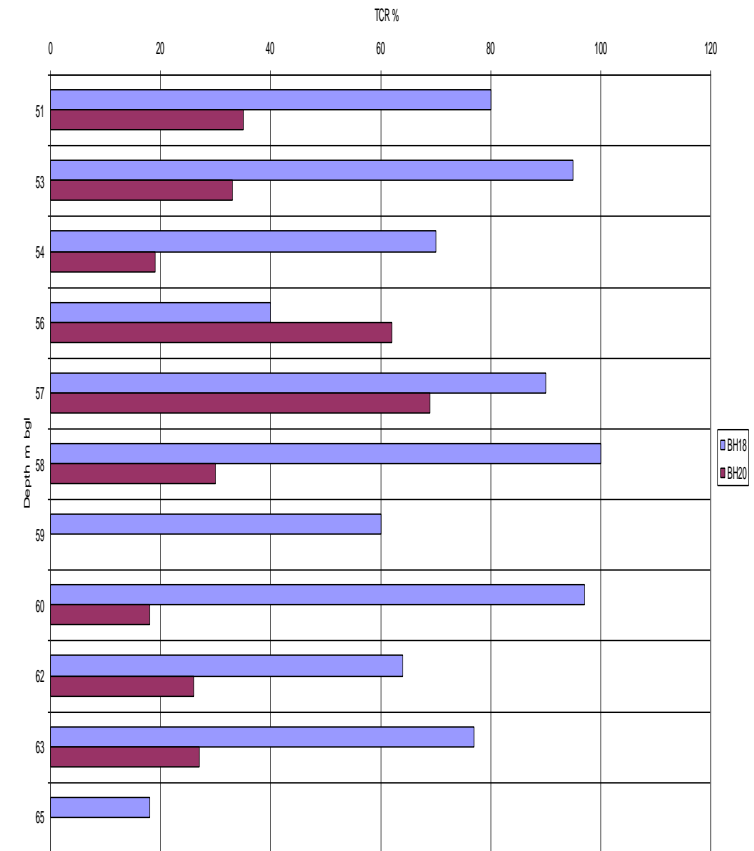


Geotechnical Risks

- Quality of ground investigation



Cavity encountered under bridge abutment – not shown on BH log, no GI supervision



Total core recovery 80mm core diameter v 63mm core diameter

Geotechnical Risks

- Incorrect Assumptions in Geotechnical design



Mitigation and Managing Geotechnical Risks

- Desk Study & Walkover
- Geotechnical and Geophysical Investigation
- Site Supervision
- Geotechnical Design
- Construction Supervision/ Inspections

Mitigating and Managing Geotechnical Risks

Site Supervision - GI

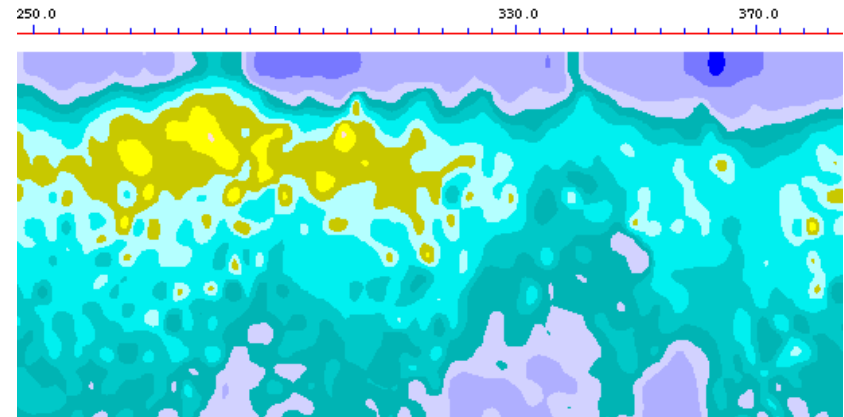
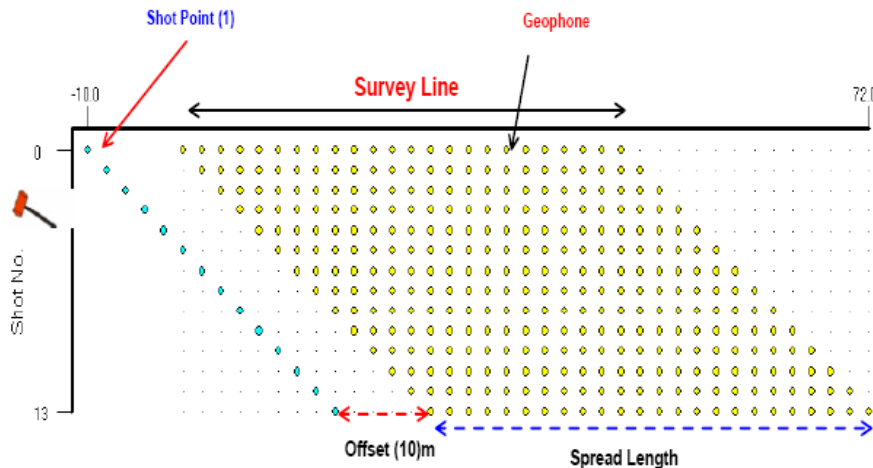
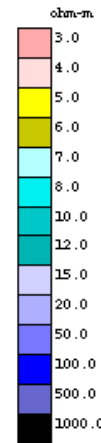
- Quality of GI data impacts confidence in design
- Full-time supervision required to detect non-compliances
- Without adequate supervision & in absence of properly defined specifications & standards quality of work unpredictable
- Identify potential engineering concerns early on site
- Optimization of scope through supervision



Mitigating and Managing Geotechnical Risks

Geophysical Testing

- Appropriate techniques for ground conditions
- Confirmation boreholes to confirm identified anomalies



Typical Geotechnical Risks in the Middle East



Mitigating and Managing Geotechnical Risks

Identify, assess, mitigate and manage the risk....

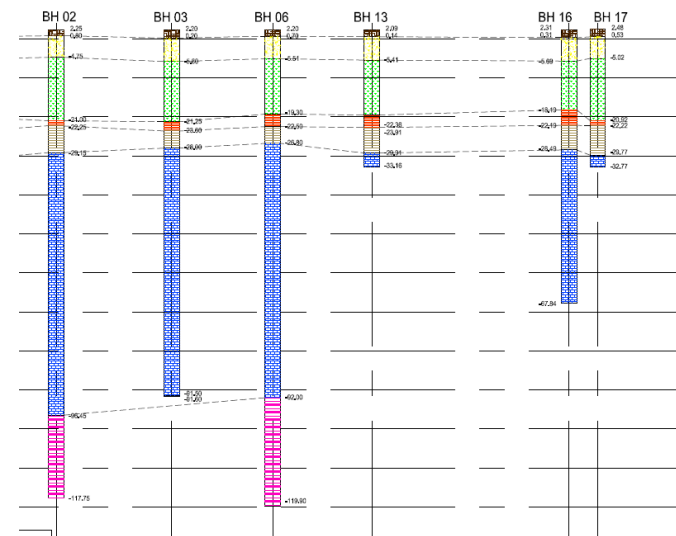
- Develop a conceptual model of ground and groundwater conditions
- Create a register of ground related risks
- Revise and refine through the progression of the project with increasingly detailed data from investigation and construction phases

ADSSC Tunnel Contract 0-1701		Tender Design Risk Register					Tender Design Risk Register					Note: Risk areas identified below should be considered as a minimum. Additional risks to be added as required.					
No	MAIN DISCIPLINE/KEYWORD	HAZARD	Pre Control					MITIGATION					Post Control				
			DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE	DECOMMISSIONING	DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE	DECOMMISSIONING	DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE	DECOMMISSIONING
1	Tunnels	Micro-tunnel/ Pipjack TBM Delivery Delay	3	5	5	1	0	2	<ul style="list-style-type: none"> - Detailed Discussions held with TBM Manufacturer during tender phase - Prepare Comprehensive technical specifications for TBM - Carry out in-process visits to manufacturer's premises 	1	2	2	0	2	G	Lindenberg	
2	Tunnels	Encountering Unforeseeable obstructions – existing and historic structures/ foundations/ piles etc.	3	5	5	3	1	<ul style="list-style-type: none"> - Jacking pipes located at depths which could interfere with existing foundations, especially in Area 2 - Preliminary Site Investigation has been undertaken in some areas and a more detailed phase of investigation planned for post contract award - Survey of existing structures to be undertaken. 	1	3	2	2	1	G	ADSSC		
3	Tunnel	Encountering mixed geology (soil and rock) in tunnel face	4	4	4	1	2	<ul style="list-style-type: none"> - Detailed SI and geological interpretation to be undertaken - Geophysical surveys to determine rock head level as part of further SI on contract award 	3	2	2	1	1	A	Lindenberg		
4	Tunnel	Presence of rock with strengths greater than anticipated from tender data	3	3	2	1	2	<ul style="list-style-type: none"> - Allow for sufficient intermediate jacking stations - Take due account of high strength rock in specification of TEM 	3	1	1	1	1	G	Lindenberg		
5	Tunnel Shafts	Presence of voids in ground on or near jacking pipes horizon in a position to affect tunneling and at shaft locations	3	5	5	2	1	<ul style="list-style-type: none"> - Ensure sufficient additional SI post tender including geophysics - Ensure sufficient grouting capability - Ensure contingency plan for pipjacks at different depths is available 	3	2	2	1	1	A	Lindenberg		
6	Tunnels	Damage to utilities	3	4	4	4	2	<ul style="list-style-type: none"> - Undertake utilities services study, including trial holes - Consult relevant Authorities in advance of works - Protect existing services as per relevant Authorities requirement - Existing services revealed from utilities services study to be included in detailed construction drawings - Arrange any required isolation in advance of works - Contractor to take precautions when excavating in services zone - Carry out settlement monitoring to make sure the settlement, if any, is within the allowable limits. 	2	3	3	2	2	A	Lindenberg		

Mitigating and Managing Geotechnical Risks

Geotechnical Interpretative Report

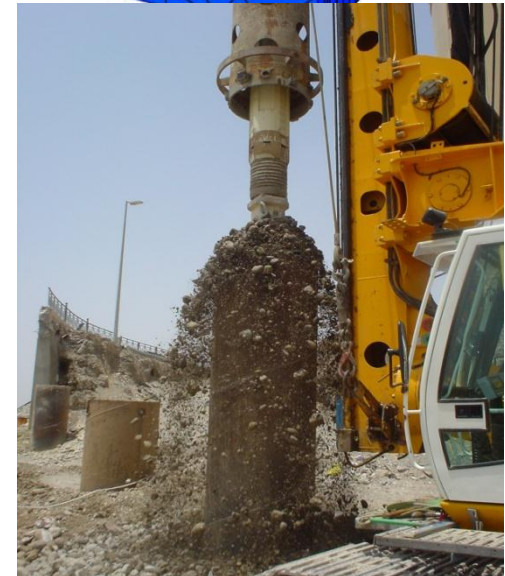
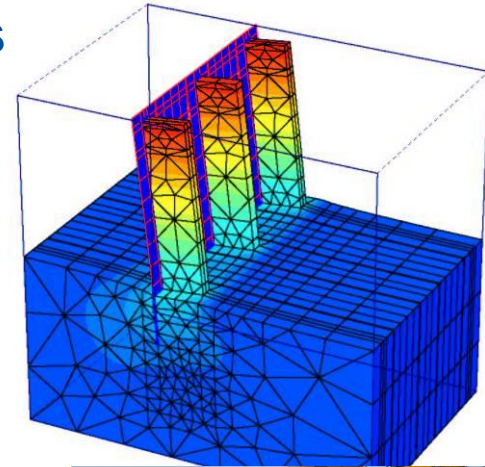
- Checking of contractors Factual Report i.e. exploratory hole logs (material descriptions), laboratory and in-situ testing results
- Develop ground model based on site specific geological profiles
- Establish geotechnical parameters for the materials encountered from in-situ, laboratory testing results and experience of performance
- Identify feasible foundation solutions, ground treatment requirements



Mitigating and Managing Geotechnical Risks

Geotechnical Design

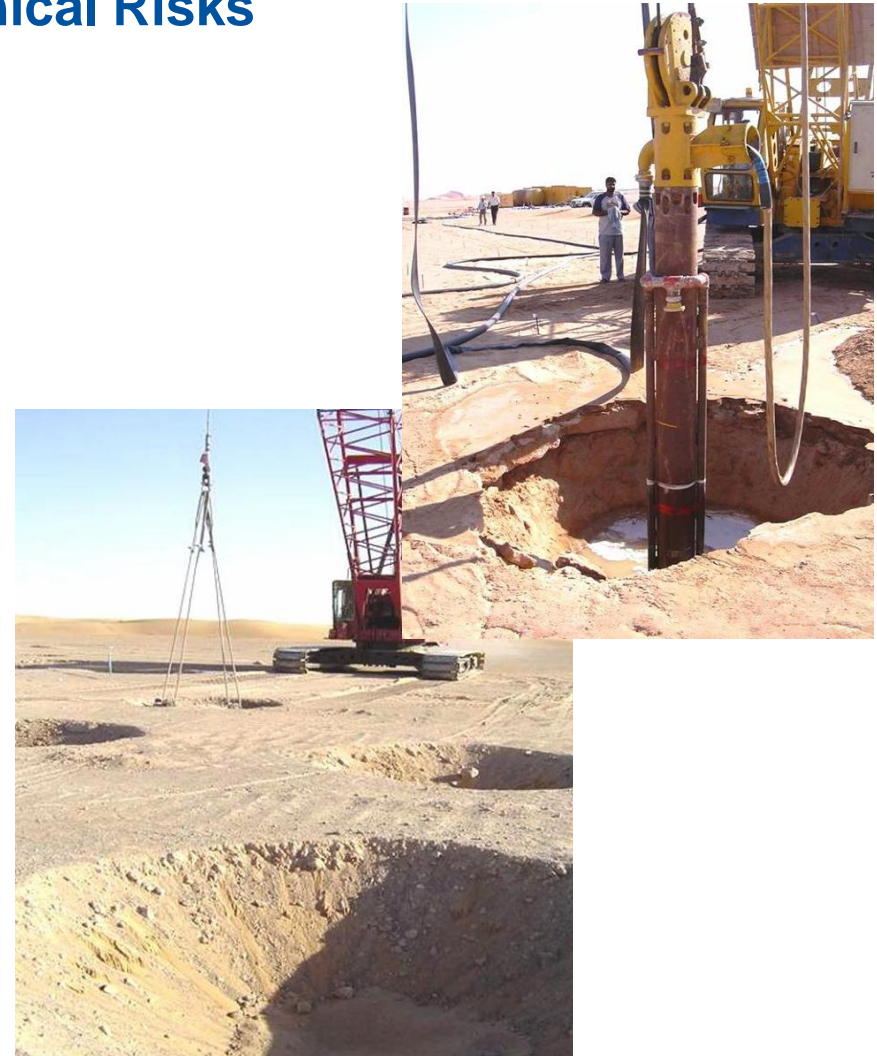
- Foundations – bearing capacity & settlement
- Earthworks – excavation, filling, compaction
- Cut/ embankment – slope stability
- Retaining structures – embedment, loading
- Infrastructure – pavement design, foundations, utilities
- Ground improvement – design & verification



Mitigating and Managing Geotechnical Risks

Construction Supervision

- Supervision of piling, shoring, excavation, earthworks, road formations, ground improvement & reinforcement, anchoring systems
- Monitor slope construction to assess stability of excavations
- Specification & execution of monitoring programmes for shoring systems, slope stability, dewatering impacts



Mitigating and Managing Geotechnical Risks

Construction Supervision

- Review contractors method statements & submittals
- Monitor contractors work against design, specification & method statement
- Confirm material arising from excavations are what's expected
- Prepare site daily records & maintain QA/QC register
- Issue non-conformances & consultant advise notices



Conclusions

- Appreciation of geotechnical risk at design & construction stages
- Early involvement and allowance in projects for geotechnical inputs – design & supervision
- Ensure the right people supervise the works
- Assessment of risk and mitigation measures in risk registers and ownership of risk assigned - ground risk is best managed by a ground professional
- Provide a high standard of full time targeted site supervision (during ground investigation and construction) adopting the right person in the right place principal

Finally, value for our clients (ground related) comes from quality ground investigation, management of ground risks, strong geotechnical design and construction supervision

Questions?

11:30 – 11:45

Morning Break

Sponsored by

itmsoil