Society for Rock Mechanics & Engineering Geology (Singapore)

A Professional Developmental Course

Rock Mechanics and Empirical Methods in Rock Engineering

- by Dr. Nick Barton, *developer of the Q-system*

12 PDU
6 STU

3-5 Sept 2014
9.00am – 5.30pm
Holiday Inn Singapore
Orchard City Centre

First-Come-First-Serve
(Limited Places)
Half-day field logging practice (practical)

S$850 (Members)
S$950 (Non-members)
S$700 (Students)

This two-day short course will cover some key elements of the lecturer's internationally applied developments in rock mechanics and rock engineering.

The course will start with a thorough treatment of the Q-system of rock mass classification and its many site-interpretation and tunnel-design aspects. Extensive work in TBM tunneling, with the Q_{TBM} prognosis method for estimating penetration rate PR and actual advance rate AR, will also be described, and illustrated by many case records.

International experiences will be reflected in numerous case record examples, from hydropower projects and from metro projects, including a dramatic cavern collapse. Mapping techniques, core logging interpretation, and so-called 'histogram-logging' will be emphasized. Fundamentals of rock joint characterization will be covered as these are fundamental to many areas of rock engineering and numerical modelling.

Scan to register!

www.cma.sg/events.html

SPEAKER: Dr. Nick Barton, Nick Barton & Associates, Norway

Dr. Nick Barton was educated in the University of London from 1963 to 1970, and has a B.Sc. in civil engineering from King's College, and a Ph.D. on rock slope stability from Imperial College. He worked for two periods in the Norwegian Geotechnical Institute, Oslo, eventually as Division Director, then Technical Advisor, and was also four years in the USA, becoming Manager of Geomechanics in Terra Tek, now Schlumberger. Since 2000 he has had his own international rock engineering consultancy, registered as Nick Barton & Associates in Oslo, and also has an office in São Paulo. He has consulted on several hundred projects in a total of 35 countries, and has published widely (280 papers, and two text books). He has ten international awards including election as Doctor Honoris Causa (Honorary Doctor) in Argentina. Recently he gave the 6th Mueller Award Lecture of ISRM, in the Beijing ISRM congress in 2011. This is awarded once every four years.

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Day 1: Wednesday, 3 September 2014

TIME	PROGRAMME
09:00 – 11:00	***INTRODUCING Q-SYSTEM OF ROCK MASS CHARACTERIZATION*** Background, motivation, characteristics of Q. The six Q-parameters explained with numerous examples, including Q-roughness Jr-parameter links to the more sophisticated JRC. Q-histogram logging. Q-Tables and general logging advice. Also Q-RMR comparison.
11:00 – 11:30	***TEA BREAK / QUESTIONS***
11:30 – 13:00	***LINKING Q TO USEFUL PARAMETERS FOR DESIGN*** Core logging examples, including faulted and weathered rock. Rock mass strength estimation from Q (CC and FC). P-wave velocity, and effects of weathering and depth on velocity, and the links to Q. The Q-based estimation of permeability for clay-free and clay-bearing rock masses, the latter with Q modified. Deformation modulus estimation at depth, from seismic velocity or from Q, for dam-site characterization. Tunnel and cavern convergence estimation, from empirical Q formulae.
13:00 – 14:00	***LUNCH***
14:00 – 15:00	***TUNNEL SUPPORT SELECTION FROM Q CLASSIFICATION, AND SUPPORT ELEMENT PROPERTIES*** Historical development of Q for B+S(mr) mesh-based support. NMT tunnel support philosophy, as applies in diversion tunnels and access tunnels. Tunnel support design with B+S(fr) fibre-reinforced shotcrete support. Temporary or permanent support. Physical performance of S(fr) and bolting. Reinforced RRS arches for bad ground. Cost versus Q and tunnel size.
15:00 – 15:30	***TEA BREAK / QUESTIONS***
15:30 – 16:30	***PRE-GROUTING AND WATER CONTROL*** Water control methods in tunnels. Simplified interpretation of Lugeon tests for pre-injection grout design. Comparing joint aperture estimates with available grout-particle sizes. High-pressure injection concepts and pressure decline. Some performance and volumetric data from pre-injected tunnels. Rock quality improvement from Q-parameter improvement, by high-pressure pre-injection.
16:30 – 17:00	***DISCUSSION AND QUESTIONS***

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Day 2: Thursday, 4 September 2014

TIME	PROGRAMME
09:00 – 10:30	***TBM PERFORMANCE AND PROGNOSES*** Fundamentals of cutter action, rock breakage and cutter wear. Penetration rate, advance rate and aspects of time and utilization. Case record analysis and geological reasons for deceleration. Performance with open gripper and double-shield machines. The Q_{tbm} model of performance prognosis. Examples of Q_{tbm} application from Chile, Brazil, Spain, Norway.
10:30 – 11:00	***TEA BREAK / QUESTIONS***
11:00 – 12:30	***RISK TO TBM TUNNELLING FROM FAULTS AND HIGH STRESS*** Long tunnels and TBM. Interpretation of TBM difficulties in terms of Q_{tbm} model. The concept of 'multiple unexpected events'. TBM tunnelling difficulties, with examples from Italy, Kashmir, Taiwan, Chile, China, Peru. Stress-strength and rock failure problems. Use of probe drilling and pre-grouting in Hong Kong sewage tunnel.
12:30 – 13:30	***LUNCH***
13:30 – 15:00	***ANISOTROPY IS EVERYWHERE – TO SEE AND TO MEASURE*** This one hour lecture was given to introduce the subject of anisotropy at an international workshop in 2013. Richly illustrated examples are given from geology, rock mechanics and rock joint behaviour, stress measurement, seismic anisotropy, hydro-geology and permeability, with illustration from rock engineering projects from several countries. The widespread presence of anisotropic behaviour stands in strong contrast to today's pre-occupation with colourful isotropic continuum modelling.
15:00 – 15:30	***TEA BREAK / QUESTIONS***
15:30 – 16:30	***LESSONS FROM A SHALLOW METRO CAVERN COLLAPSE*** A metro-station cavern collapsed suddenly during construction, causing the death of seven people. Numerous boreholes had indicated 3 to 4 m of rock cover beneath 16-18 m of sand, soil and saprolite. Heavy structural support was therefore used as temporary support, instead of rock bolts and shotcrete. The combination of 'unexpected events' combined to cause an unprecedented accident, which was 'unpredictable in the circumstances'. The risks involved with (too) shallow metro-line and metro-station design are emphasised.
16:30 – 17:00	***INVESTIGATIONS AND DESIGN OF THE LARGEST CAVERN EVER BUILT FOR PUBLIC USE*** The largest cavern ever built for use by the public, effectively doubling the previous largest span, was built in jointed gneiss in Norway, for initial use in the 1994 Winter Olympic Games. Q-logging site investigation, cross-hole tomography, stress measurement and numerical UDEC-BB modelling and NMT-style permanent support design for this 62 m span cavern are described, including follow-up mapping and monitoring. The 'Class A' predictions of performance proved to be very accurate.
17:00 – 17:30	***DISCUSSION AND QUESTIONS***

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Day 3: Friday, 5 September 2014 (Optional, First-Come-First-Serve)

TIME	PROGRAMME
09:00 – 12:00	***FIELD LOGGING PRACTICE: DRILL-CORE, TUNNEL (OR QUARRY) SITE Q-histogram LOGGING*** The best way to 'interrogate' a rock mass so that its engineering quality can be assessed in a quantitative way, is to perform Q-histogram logging. This utilizes a logging sheet where all six Q-parameters, their ratings, and brief descriptions are given in a compact 1-page format, with space/rectangles for recording tens, hundreds, even thousands of observations. An EXCEL program subsequently calculates the statistics. Most frequent observations/ratings, e.g. 95/9 x 1.5/2 x 0.66/2.5 are found immediately. This can be performed using core, observing rock in tunnels, or along quarry benches.

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For enquiries, please contact the SRMEG Secretariat via Email: srmeg@cma.sg or Tel: +65 6336 2328

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