Undertaking Stress Measurement

Technical Introduction

Underground rock masses are subjected to compressive stress, which increases, in general, with depth. The rate of increase, however, varies depending on various factors. Worldwide *in situ* stress data indicated that vertical stress varies in a more predictable fashion than horizontal stresses because vertical stress is primarily affected by the weight of overburden. When an opening is introduced in the rock mass, the natural state of stress is disturbed locally as the rock mass attains a new state of equilibrium. The stress around an opening resulting from various man-made activities is termed 'induced stress'. Some selected sites are presented below.

Location	Lithology	Max MPa	Min MPa	Mod Gpa	Depth (m)	Success	Rock Strength
Coal Mine South Africa	Gritstone	4	1	7	41	100%	Very Weak -Weak (1-25MPa)
Coal Mine UK	Siltstone	15	7	9	310	100%	
Coal Mine UK	Mudstone	21	12	15	796	100%	Medium Strong (25-50MPa)
Coal Mine South Africa	Siltstone	5	1	18	110	100%	
Coal Mine India	Sandstone	10	5	18	350	100%	
Coal Mine UK	Sandstone	17	12	19	690	100%	Strong (50-100MPa)
Coal Mine South Africa	Shale	5	1	20	42	100%	
Coal Mine Germany	Sandstone	33	26	21	1575	100%	
Coal Mine USA	Sandstone	41	23	29	578	100%	
Helsinki Water Finland	Granit	9	1	61	50	100%	Very Strong (100-250 MPa)
Copper Mine Zambia	Quartzite	29	9	62	1041	100%	
Zinc Mine Finland	Basalt	63	28	64	1125	100%	
Gold Mine South Africa	Quartzite	84	23	65	2361	100%	
Zinc Mine Ireland	Limestone	29	10	65	800	100%	

Why is it Important

Underground in situ stress is sometimes sufficiently high, relative to the rock mass strength, to cause rock bursting, buckling, heaving or other ground control problems. The understanding of the state of *in situ* stress is of critical importance to the design and construction of engineered excavations underground. In cases where the effects of stress are less dramatic, the optimum shape, orientation, layout and ultimate cost of rock support systems can be significantly by the *in situ* stress.

- High stress can mean slabbing around developments, sometimes violently
- Low stresses can mean loosening of the rock mass and blocky Overbreak
- Deviatoric stresses, or stresses that can make an acute angle to geologic structures, can cause local shearing
- Openings may be orientated to suit the stress conditions
- Optimisation of orientation reduces support costs
- Long term stability is maximised
- Reduction in risks associated with Fall of Ground events
- Adds significant value to project understanding and design criteria

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What is Required to Achieve a Stress Measurement

Several requirements are needed to fulfilled prior to the undertaking of a stress measurement. However these tasks are not onerous and may be achieved with minimal output.

The Test Site

Selection of the test site can often be the most difficult elements of the process. For structural requirements the site needs to fulfil the following conditions.

- In rock that can be cored to give core lengths greater than 20- 30cm
- In rock whose behaviour is not significantly different from that of a homogeneous perfectly elastic medium
- To be located in virgin ground, I.e. not in the vicinity of large open excavations such as stopes or caverns

Equipment and Services

The process of drilling and over coring is a relatively straightforward exercise. The drilling equipment used is lightweight and once it has been transported to site, all in a self-contained box, may be man handled and erected within one hour.

The services required are simply compressed air and water. The air pressure should be in the order of 0.6MPa and not exceed 0.8MPa at a flow rate 80-110l/s. Water is required at approximately 6-12 l/min at a pressure between 0.8-1.2MPa.

The temperature of the water is a very important consideration for successful stress measurement. The temperature of the water is required to be within 2° C of the rock temperature.

For further information please contact:

Peter Altounyan
Technical Director Consultancy
Tel: +44 (0)1283 522201
Email: paltounyan@golder.com