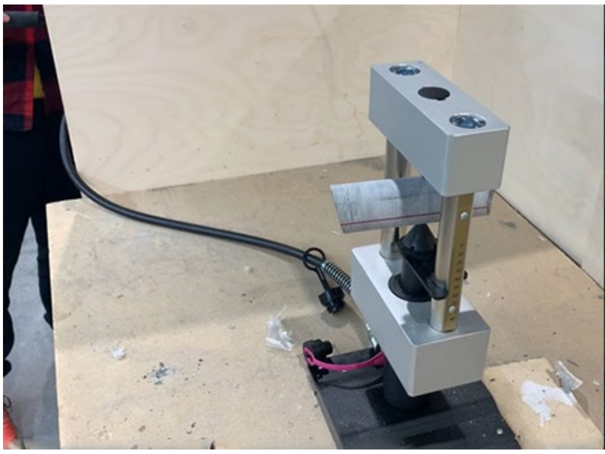
Geotechnical Data in Nordic Projects – Effective RQD and Beyond

By

Michael Di Giovinazzo




Introduction

Whilst geotechnical data is vital to operating pits and underground mines, simple rock mass quality data can provide a solid foundation for the development of an understanding of the rock mass response to mining at an early stage in the mine study process. This data can be collected from resource drilling programmes for little extra time and cost. The spatial extent of resource drilling provides the opportunity for a high volume of data to be collected across a deposit.

SRK's experience in the Nordic region has highlighted that there is a good focus and intention for basic geotechnical data collection during geological logging campaigns. This is often limited to RQD and some structural logging of the oriented core. However, the standard and quality of many data sets is variable and often require either much repair work or, in the worst case, is unusable for a project.

SRK has observed through project reviews that the cause of poor quality geotechnical data at the resource drilling stage is simply a lack of understanding of why the data is collected and how it is applied. When simple training is given to the existing geological logging teams, this provides the context of how geotechnical data will eventually be applied in mining studies. Consequently, the data collectors are better informed of the value of the data they collect. Once this awareness is developed, there is a purpose to the effort and the data is obtained with strong attention to quality (coupled with inbuilt automatic quality controls to limit error). Therefore, this data has a higher value (for the effort) and it is then useful for elements of rock mass characterisation, hydrogeological appraisal, and early-stage mining studies.

SRK has developed or adapted the existing logging systems for several clients in order to establish an industry accepted standard in useful geotechnical data capture. Existing logging systems that operate in generic or proprietary software systems have been re-organised and modified to meet a minimum standard (or simply to meet the intention of the original authors behind the rock characterisation systems).

As a result, and as projects have matured from advanced exploration into early-stage mining assessments, there is increased confidence in the quality of data. The established initial database is extensive and can limit the extent and requirement for specific geotechnical drilling campaigns with associated cost savings as the project advances through the study stages.

When ‘full’ geotechnical logging has been carried out, logging parameters are chosen to calculate ratings for a rock mass classification system which has been designed originally for a specific application in rock engineering (tunnel or slope, supported or unsupported underground mining, etc). It is possible to convert from one classification system to another by using formulae published by several authors since the 1980s (such as between the NGI Q system and the RMR or GSI systems). These conversion formulae were developed in specific areas in the mining and rock engineering industries and within certain rock mass environments. They were not originally established for extensive application in every rock mass environment and the authors specify that local conversions should be derived – and be applicable to the excavation style.

SRK’s observation in reviewing numerous Nordic datasets is that these conversion formulae are blindly applied, and even on poor quality original data. In worst-case scenarios, this data is then fed as material property inputs into the empirical and numerical analysis. This is a recipe for disaster as the true nature of the rock mass (and the various parameters) is not fully understood when the calculated numeric ratings of rock quality are propagated by formulae only and then advanced analysis is undertaken.

With minimal extra time, enough parameters can be collected enabling the independent calculation of multiple classification systems - which in turn increases the confidence of material inputs into empirical and numerical analysis feeding into mining assessments.

Correct RQD

Core recovery measurement and RQD is the mainstream of basic data collection that is applied prolifically in the logging programs. This is often claimed to be a suitable extent of geotechnical data collection but RQD only provides an index to the level of fracturing in core, and only on the core that is recovered in a drilling run. This basic parameter is often collected with simple avoidable errors such as:

Logged RQD length greater than the recovered core length.

Large intervals longer than drill run length, and therefore over-looking short areas of fractured ground or core loss and biasing the RQD ratings.

RQD logging intervals normalised to 1m length to simplify the logging (and calculation), but not acknowledging the natural variation in rock quality.

Not separating large intervals of core loss as a separate RQD interval.

A few extra parameters

Additional to RQD, the collection of a few other parameters enables the confident calculation of ratings in multiple rock classification systems. Each system has 3-4 categories, but if an extra 1-2 parameters are collected, then independent calculation in the various classification systems is possible. After basic training, logging time increases by 10-20% to collect enough parameters to estimate rock strength, frequency of open fractures, how many sets (similar 3D orientation) of fractures, and what is the condition of the fractures and infill. This data is then available from many more drillholes, by the same logging team, and in the same drilling program. Ideally, this should be completed before the core is cut for sampling and on the least disturbed core since drilling.

Category	Parameters	Classification Systems				Comments for Basic Data collection
		Beniawski's RMR (1989)	Barton Q (1974)	Laubscher MRMR (1990)	Laubscher IRMR (2000)	
Intact Rock Strength	UCS	X	X	X	X	Recommended
Open Fracture Frequency	RQD	X	X	X	-	Usually collected
	FF/m	X	-	X	X	Usually collected
	Joint sets	X	X	X	X	Recommended
Open Joint Strength	Roughness	X	X	X	X	Recommended
	Infill Strength	X	X	X	X	Recommended
	Joint Alteration	X	X	X	X	Recommended
Cemented Joints Quantity Strength	CJ/m	-	-	-	X	complete
	CJ Strength	-	-	-	X	complete

Fractures

The quality and volume of oriented core for structural logging is generally good in Nordic programs. The orientation and spacing of fractures is vital to understand the block sizes of the rock mass in 3D. When these features are measured, the joint surface and infill condition can also be logged easily. This assists in understanding which controlling fracture group will influence the stability of an excavation oriented in a particular direction. Major fracture zones and also variably healed fabric can be oriented in 3D which support resource modelling, hydrogeological assessment and estimation of whether rock will fracture under high mining induced stress.

Strength Estimation.

Generally, the Nordic rock mass is made up of strong competent rock with a minority of weak rock types and generally shallow weathering profiles. Rock strength testing need not be limited to a few hand-sized samples that are crushed in a laboratory at high cost – and generally, the best quality sections of core need to be selected for submission to labs. Nordic rock types are often foliated with mineral alignment which creates a strength variation parallel or perpendicular to that fabric.

Field strength testing has been implemented in the logging facilities of a number of Nordic projects using a Point Load Testing (PLT) machines. These machines are easy to set up and their use is quickly learnt and applied effectively by the geological logging team. The unit fits into a rugged case and can be set up quickly by one person. The core sample is placed between two conical platens and a hand operated hydraulic pump is used to break the core sample. A digital readout records the breakage load which can then be converted into the intact strength of the rock. SRK has also successfully applied PLT testing to cut half core when full core strength comparison and validation was possible.

Coupled with a simple field index of the logger's strength estimation of the core, the PLT testing provides many data points that are recorded and then calibrated against the laboratory strength testing, which could also be conducted at a later time. The variation in rock strength is provided across the deposit rock mass which is very useful for not only mining studies, but also as a guidance input into blastability index estimation, excavatability estimation, and rock crushing requirements.