MKAJ 1073 ENGINEERING ROCK MECHANICS

ROCK QUALITY DESIGNATION (RQD)

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Rock Quality Designation, RQD:

The most basic engineering classification introduced by Deere in 1964, is an index of assessing rock quality quantitatively.

It is more sensitive index of the core quality than the core recovery ((length of core/length of core barrel) × 100 %)

The RQD is a modified per cent core recovery which incorporates only sound pieces of rock core that are 100 mm or greater in length along core axis.

RQD = $\{(\Sigma X_i) / (\text{total length of core, L})\} \times 100\%$.

X_i = core length $\geq$ 100 mm

L = length of core recovered (1.5m if barrel is full)

Wash boring machine

Double tube core barrel is used to obtain rock core samples during wash boring. Length of barrel is 1500 mm.

If core barrel is full with rock sample (100 % recovery, R) then, the total length of core is 1500 mm.

Triple tube core barrel ensures minimal disturbance to the core sample

Core samples obtained from rock drilling

Method of obtaining RQD:

CORE SAMPLES OF IN SITU ROCK MASS: ISRM recommends a core size of at least NX size (54.7 mm dia.) drilled with double-tube core barrel using diamond coring bit. Method of obtaining RQD:

Artificial (not natural) fractures or joints (that occurs during drilling) can be identified by close fitting (matched joint surface) of cores and fresh (unstained) surfaces.

All the artificial joints are ignored while counting the core length for RQD.

A slower drilling rate will also give a better RQD

Correlation between RQD and Rock Mass Quality

S. No.	Rock mass quality	RQD (%)
1	Very poor	0 - 25
2	Poor	25 - 50
3	Fair	50 - 75
4	Good	75 - 90
5	Excellent	90 - 100

Method of obtaining RQD:

RQD is perhaps the most commonly used method to characterise the degree of jointing in borehole cores, although this parameter also may implicitly include other rock mass features like weathering and 'core loss'.

(2) Indirect method:

SEISMIC PROPERTIES OF ROCK: The seismic survey method makes use of the variations of elastic properties of the rock strata that affect the velocity of the seismic waves travelling through them, thus providing useful information about the subsurface materials (e.g. cavities, dense rock, jointed rock).

(2) Indirect method:

The following information of the rock masses can be inferred from seismic data:

(a) Location & configuration of bed rock and geological structures in the subsurface.

(b) The effect of discontinuities in rock masses may be estimated by comparing the in situ compressional wave velocity with sonic velocity of intact drill core obtained from the same rock mass.

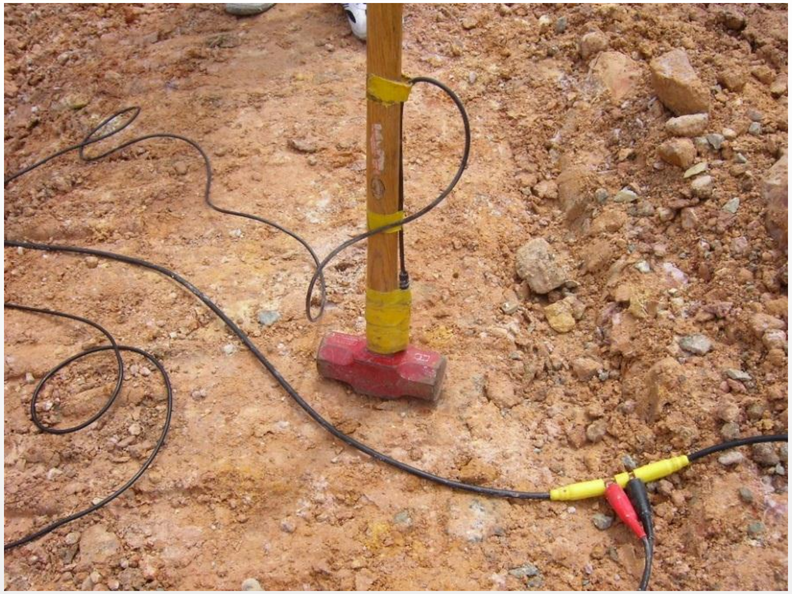
[Since in situ rock are fractured and jointed hence, compressional wave velocity is lower compared to intact core]

Based on seismic data of in situ rock mass and intact rock sample, RQD can be estimated:

$$RQD\ (\%) \approx \text{Velocity ratio} \approx (V_F / V_L)^2 \times 100$$

Where V_F is in situ compressional wave velocity (obtained from seismic refraction method in the field), and V_L is compressional wave velocity in intact rock core (obtained from ultrasonic velocity test in laboratory).

Sonic velocity test on core sample (non-destructive test) to give Vp of rock sample in laboratory



(3) Indirect method:

VOLUMETRIC JOINT COUNT OF IN SITU ROCK MASS:
Where cores are not available, RQD may be estimated from number of joints (discontinuities) per unit volume J_v.

A simple relationship which may used to convert J_v into RQD for clay-free rock masses is:

$$RQD = 115 - 3.3\, J_v$$

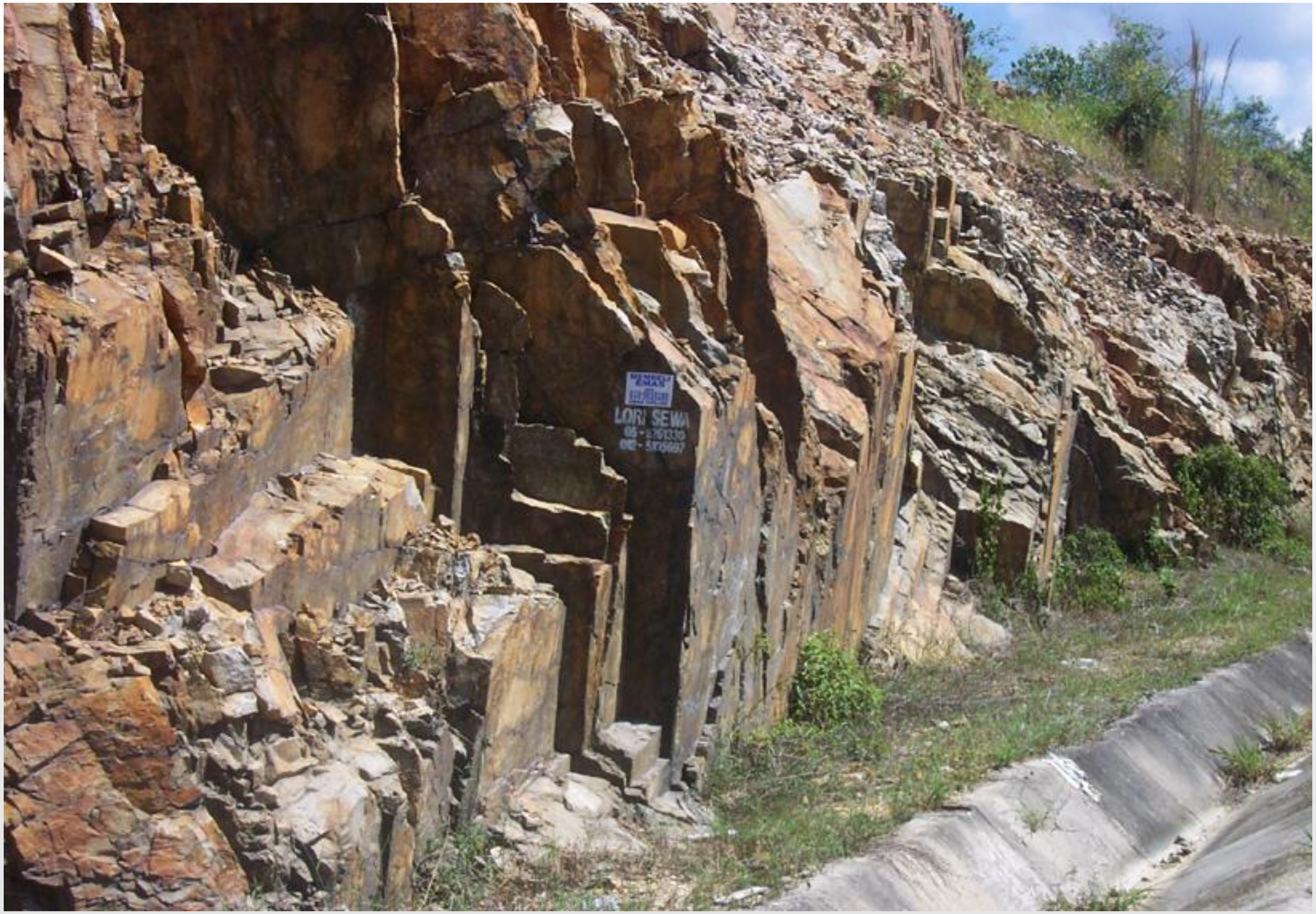
Where J_v represents the total number of joints per cubic meter or the volumetric joint count.

(3) Indirect method:

Jv has been described by Palmstrom (1986) as a measure for the number of joints within a unit volume of rock mass defined by:

$$J_v = \sum_{i=1}^{J} \left(\frac{1}{S_i}\right)$$

Where Si is the average joint spacing in metres for the ith joint set and J is total number of joint sets except the random joint set.



Joint sets in granite – usually 3 sets, almost perpendicular to each other.

(3) Indirect method:

Compared to direct method (RQD using core sample), VOLUMETRIC JOINT COUNT gives an indication on discontinuities orientation (dip & strike).

During drilling and transportation of cores, orientation of discontinuities is lost (rotation and movement of core samples), unless directional drilling is used (very expensive & usually used in petroleum exploration).

S. No.	Term for Jointing	Term for Jv	Jv
1	Massive	Extremely Low	< 0.3
2	Very weak jointed	Very Low	0.3 – 1
3	Weakly jointed	Low	1 – 3
4	Moderately jointed	Moderately high	3 – 10
5	Strongly jointed	High	10 – 30
6	Very strongly jointed	Very high	30 – 100
7	Crushed	Extremely high	> 100

Classification of Volumetric Joint Count, Jv (Palmstrom, 1996)

Though the RQD is a simple and inexpensive index, when considered alone it is not sufficient to provide an adequate description of a rock mass because it disregards joint orientation, joint condition, type of joint filling and stress condition.

References:

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