APPROXIMATE CLASSIFICATION OF COHESIVE SOIL AND ROCK (ROBERTSON, 1987)

No.	Description	Uniaxial compressive strength lb/in2	kg/cm2	MPa	Examples
S1	VERY SOFT SOIL - easily moulded with fingers, shows distinct heel marks	<5	<0.4	0.04	
S2	SOFT SOIL - moulds with strong	5-10	0.4-0.8	0.04-0.08	
S3	FIRM SOIL - very difficult to mould with fingers, indented with finger nail, difficult to cut with hand spade	10-20	0.8-1.5	0.08-0.15	
S4	STIFF SOIL - cannot be moulded with fingers, cannot be cut with hand spade, requires hand picking for excavation	20-80	1.5-6.0	0.15-0.60	
S5	VERY STIFF SOIL - very tough, difficult to move with hand pick, pneumatic spade required for excavation	80-150	6-10	0.6-1.0	
R1	VERY WEAK ROCK - crumbles under sharp blows with geological pick point, can be cut with pocket knife	150-3500	10-250	1-25	Chalk, rocksalt
R2	MODERATELY WEAK ROCK - shallow cuts or scraping with pocket knife with difficulty, pick point indents deeply with firm blow	3500-7500	250-500	25-50	Coal, schist siltstone
R3	MODERATELY STRONG ROCK - knife cannot be used to scrape or peel surface, shallow indentations under firm blow from pick point	7500-15000	500-1000	50-100	Sandstone, slate,
R4	STRONG ROCK - hand-held sample breaks with one firm blow from hammer end of geological pick	15000-30000	1000-2000	100-200	Marble, granite, gneiss
R5	VERY STRONG ROCK - requires many blows from geological pick to break intact sample	>30000	>2000	>200	Quartzite, dolerite, gabbro, basalt

TABLE 2

4. DEGREE OF BREAKAGE

Degree of Breakage is a visual and thus somewhat subjective estimation of the quality of the rock in terms of the number of fractures or breaks. General categories, numerical equivalents and qualifying descriptions are given below. Photographic illustrations of the Degree of Breakage Classifications are given in Fig. 2.

CATEGORY	NUMERICAL EQUIVALENT	MEAN SPACING OF BREAKS OR DIAMETER OF FRAGMENTS (in.)	QUALITY DESCRIPTIONS
A-	1		Mostly fault gouge with/without minor rock fragments
A	2	<½	Gouge and crushed rock
A+	3		Crushed rock with/without minor gouge
B-	4		Crushed rock - no gouge
B	5	½ to 2	Crushed rock - diameter of pieces <2 in.
B+	6		Broken rock - fracture spacing <2 in.
C-	7		Mean spacing 2 to 3 in.
C	8	2 - 4	Mean spacing 3 in.
C+	9		Mean spacing 3 to 4 in.
D-	10		Mean spacing 4 to 6 in.
D	11	4 - 8	Mean spacing 6 in.
D+	12		Mean spacing 6 to 8 in.
E-	13		Mean spacing 8 to 12 in.
E	14	>8	Mean spacing 12 to 14 in.
E+	15		Mean spacing >24 in.

NOTE: Care should be taken to identify all fault/shear zones (Category A). However, for other Degrees of Breakage, the category should be averaged over the length of the core run.

TABLE 3

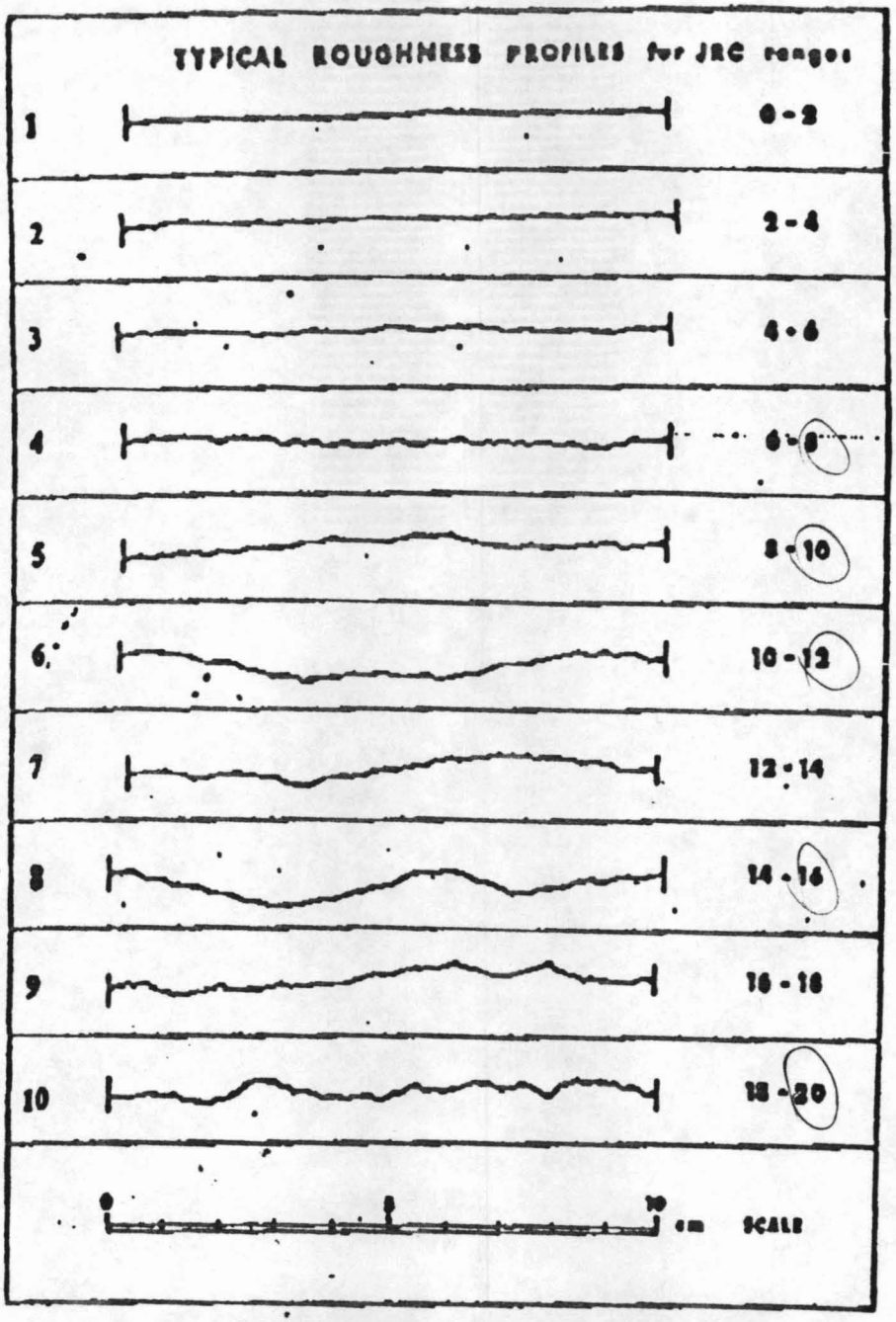

Fig. 19. Roughness profiles and corresponding range of JRC values associated with each one [8].

$$\phi_{peak} = JRC \log_{10}\left(\frac{JCS}{\sigma_n}\right) + \phi_r$$

JRC = joint roughness coefficient
JCS = joint wall compression strength
$\phi_r = \phi_{residual}$

SEE TABLE 5A

~~TABLE 3~~ - JOINT ALTERATION NUMBER (Ja)

Description of gouge	Joint alteration number (J_a) for joint separation (mm)		
	<1.0[1]	1.0-5.0[2]	>5.0[3]
Tightly healed, hard, non-softening impermeable filling	0.75	-	-
Unaltered joint walls, surface staining only	1.0	-	-
Slightly altered, non-softening, non-cohesive rock mineral or crushed rock filling	2.0	4.0	6.0
Non-softening, slightly clayey non-cohesive filling	3.0	6.0	10.0
Non-softening strongly over-consolidated clay mineral filling, with or without crushed rock	3.0	6.0[4]	10.0
Softening or low friction clay mineral coatings and small quantities of swelling clays	4.0	8.0[5]	13.0
Softening moderately over-consolidated clay mineral filling, with or without crushed rock	4.0	8.0[4]	13.0
Shattered or micro-shattered (swelling) clay gouge, with or without crushed rock	5.0	10.0[4]	18.0

TABLE 6

Notes:

1 Joint walls effectively in contact
2 Joint walls come into contact before 100 mm shear
3 Joint walls do not come into contact at all upon shear
4 Also applies when crushed rock present in clay gouge and no rock wall contact

TABLE 6

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~~TABLE 4 - JOINT WATER REDUCTION FACTOR (Jw)~~

~~Condition of groundwater~~	~~Head of water (m)~~	~~Joint water reduction factor (J_w)~~