The correlation between RMR and Q systems in South west of **Iran**

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Abstract

One of the approches in determining rock structure support is emperical methods in which rock mass classification are important. There are different methods such as RMR, Q, GSI and the others. The data gathered are taken from surface and subsurface area by fracture study and well coring. Many relationships are used between different systems, but in this research their values are assessed by measuring the parameters for each system separately. The aim of this article is to suggest a correlation between them for more than 130 sites in Southern west of iran.

key words: Support, rock classification, correlation, RMR, Q, fracture study

Introductino

Underground openings are driven in intact rocks or rock masses. By excavating them some discontinuities will be created or developed by stress induced distribution, blasting and other activities. To stabilize deformation rocks and reducing displacement and also preventing of falling blocks, it is necessary to design a suitable support system. To do this, Support design can be divided into three common methods such as empirical, analytical, and numerical. To find out deformation around underground opening by analytical or numerical methods, one of the key parameters in elastic environment is modulus elasticity. For rock masses, this parameter can be estimated by experiments in the fields or laboratories and its valuation depends on rock conditions such as discontinuities.

Rock mass classification

Q-System The traditional application of the six-parameters Q-value in rock engineering is for selecting suitable combinations of shotcrete and rock bolts for rock mass reinforcement and support. This is specially the permanent 'lining' estimation for tunnels or caverns in rock, and mainly for civil engineering projects, Barton (2002). These parameters are estimated from the following expression (Barton et al., 1974)

$$Q = \frac{RQD}{J_n} \times \frac{J_r}{J_a} \times \frac{J_w}{SRF} \qquad (1)$$

Where, RQD is the percentage of component drill core sticks>100 mm in length (Deere et al., 1967). Domain, J_n is the rating for the number of joint sets in the same domain. J_r is the rating for the roughness of the least favorable joint set or filled discontinuity, J_a is the rating for the degree of alteration or clay filling of the least favorable joint set or filled discontinuity, J_w is the rating for the water inflow and pressure effects, which may cause outwash of discontinuity infillings, and stress reduction factor (SRF) is the rating for faulting, for strength/stress ratios in hard rocks, for squeezing or for swelling.

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RMR,(Bieniawski, 1974)

Commonly used rock mass classification system is the CSIR geomechanics classification, RMR,. This system uses the six parameters such as UCS, σ_{ci}, RQD, joint spacing, joint condition, ground water condition and joint orientation in respect to opening axes.

Since the Q RMR systems are based on much the same properties, they are highly correlated and can be predicted one from another. Various authors give a relationship in the following form (Rutledge & Preston, 1978; Beniawski, 1989):

$$RMR = ALnQ + B \qquad (2)$$

Where A is typically in the range of 5-15, and B is in the range of 35-60, Zhang, (2004).

The most commonly used relationship between RMR and Q for rock mass classification systems is.

$$RMR = 9LnQ + 44 \qquad (3)$$

$$RMR = 10.5LnQ + 41.8 \qquad (4)$$

- Correlation of longitudinal wave velocity V_p with Q

There have been several stages in the development of empirical development of empirical models that relate E_{mass} the static elastic of deformation modulus and uniaxial compressive strength and the rock quality terms, such as RMR, Q and the others In 2002, for improved sensitivity to widely varying uniaxial compressive strengths, the Q system was re-compiled to improve correlation between engineering parameters and a new parameter, Q_c has been defined by Barton (2002) as below:

$$Q_c = Q\frac{\sigma_{ci}}{100} \qquad (5)$$

Where: σ_{ci} is the strength of intact rock in MPa. The Q'_value where J_w and SRF is set to 1.00 is given by, Barton (2002):

$$Q' = \left(\frac{RQD}{J_n}\right)\left(\frac{J_r}{J_a}\right) \qquad (6)$$

Based on data from hard rock tunneling projects in several countries a preliminary hard rock correlation between Q and V_p was suggested, Barton 1991:

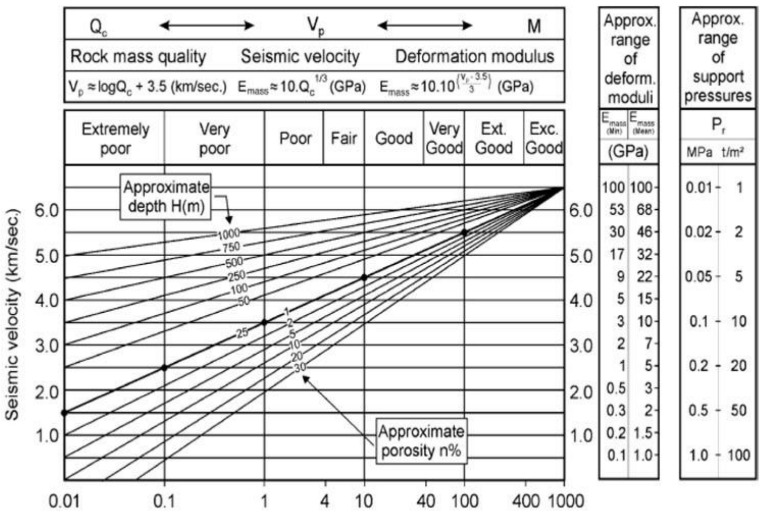
$$V_p \equiv 3.5 + \log Q \qquad (7)$$

Where V_p is in units of km/s.

He proposed another relationship between V_p and Q_c for the depth of 500 m.

$$V_p = 5.0 + 0.5 \log Q_c \qquad (8)$$

Barton presented a graph demonstrating the relationship between V_p and Q_c with variation porosity, n, and depth, Figure 3



$$Q_c = \left[\frac{RQD}{J_n} \times \frac{J_r}{J_a} \times \frac{J_w}{SRF}\right]\frac{\sigma_c}{100}$$

Figure 1. An integration of V_p, Q, σ_c, depth, porosity and static deformation modulus, E_{mass}

The database employed in this study and analyses:

In the present study, information of more than 130 sites are analyzed and a correlation between RMR and Q system is taken with a good correlation coefficient as compared with the other relationships. (Table 1 to 3, Figure 2)

Table 1.(Kohrang 3 tunnel data)

Q	RMR	Q	RMR	Q	RMR
3.75	51	3.75	54.9	45	81
1.9	47	3.75	54.9	27	73.8
3.75	51	3.3	47.7	45	81
1.9	42	20	76	27	69.3
2.25	47	15	67	15	70
3.75	51	20	76	0.198	31.5
0.66	37	18	73.8	30	76.5
0.44	37	12.75	67	12.37	66.6
3.75	51	18	73.8	0.28	30.6
2.25	47	30	76.5	44.5	76.5
3	47	3.3	47.7	3.3	46.8
2.86	54.9	2.2	47.7	3.3	46.8
2.25	56.8	30	76.5	0.08	18
3.75	57.6	45	81	75	81
1.5	46.8	18	73.8	3.3	48.6

2.25	46.8	45	81	75	81
2.5	46.8	18	73.8	67.5	76.5
3.75	54.9	0.3	31.5	75	81
3.75	52.2	45	81	64	78
1.66	44.1	3.3	47.7	106	78
Q	**RMR**	**Q**	**RMR**	**Q**	**RMR**
1.7	44.1	29.7	76.5	30	60
3.75	52.2	0.3	31.5	37	66
3.75	54.9	30	76.5	30	66
3.75	54.9				

Table 2.(Falat Markazi data)

Q	RMR	Q2	RMR3
0.25	35	3.75	52
0.33	40	0.0078	14
0.89	34	0.0146	19
2.03	41	0.17	36
0.83	41	2.48	53
1.88	46	1.65	49
0.89	50	4.95	54
2.3	57	0.08	25
0.8	54	0.44	32
1.35	58	0.69	44
0.41	49	4.125	52
1.24	57	0.28	37
0.7	58	1.32	45
1.8	63	3.3	55
2.25	48	5.57	58
4.5	53	0.31	44
1.83	49	3.3	52
2.75	53	1.55	48
1.56	50	7.43	55
2.81	53	0.42	47
1.88	59	3.33	52
4.95	61	0.09	22
0.77	44	0.24	34

Table 3.(Golab tunnel data)

Q	RMR	Q2	RMR3
2.5	61	0.41	39
1.25	47	0.19	32
3.3	66	0.45	40
1.65	52	0.29	36
5.5	66	1.1	48
2.77	51	0.37	41
1.2	60	0.8	45
0.6	46	4.8	62
0.2	37	0.41	39
0.11	34	0.19	32

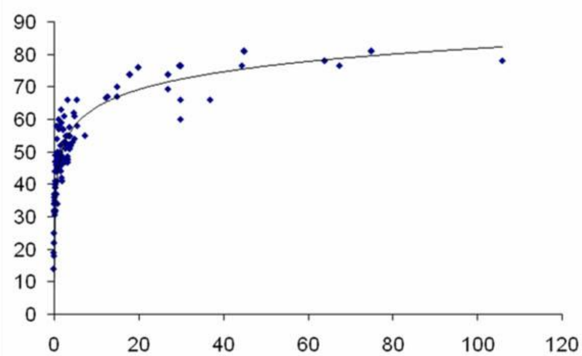


Figure2. Correlation between Q and RMR

Regression analyses: $RMR = 7.833 \ln Q + 45.71$

Correlation coefficient: 0.878

Conclusion

The use of two or more classification systems in design and rock engineering, gives a check of the estimates made. Though there are many similarities between the RMR and Q classification systems, the differences in their structure cause that the commonly used correlation equations between them can lead to severe errors.

In this paper, the relationship between RMR and Q system was analyzed using more than 130 case histories in South west of Iran. The results obtained from these approaches can be a good correlation to compare with others around the world.

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