ENGINEERING PROPERTIES AND ROCK MASS CLASSIFICATION OF KARACAY DAM DERIVATION TUNNEL (HATAY-TURKEY)

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Abstract

Mediterranean region, within the boundaries of the province of Hatay (southeast of Turkey), irrigation, drinking water and the aim of producing electricity, the Big Basin Karacay, Big Karacay Dam and Hydroelectric Power Plant (HEPP) construction continues. This project is planned to be constructed within the scope of the derivation tunnel, engineering geology, is the subject of review in this study.

Big Karacay Dam Derivation Tunnel is located on the route Kızıldağ Ophiolites. State Hydraulic Works on the route of the tunnel made by the foundation drilling results, field and laboratory studies using the results obtained by discontinuous measurements of rock mass classification systems, applied to the route. The tunnel route for the best, worst and average assessments have been made according to the conditions. The results of this study are, RMR class very good-poor rock, maximum unsupported span between 20 cm to 3.5 m, stand-up time between 16 years 7 months with a immediate collapse.

Key Words: Big Karacay Derivation tunnel, geotechnical evaluation, the rock mass classification, RMR, discontinuity

1. Introduction

The importance of the rock mechanics are raising by the long underground excavation in the rocks. Each day construction and excavation methods are developing and the same time researches developing too. But rock mass classification systems are most useful methods in the design project. In this study, engineering properties of derivation tunnel route and around was researched. And Rock Mass Classification System (RMR) was applied on Big Karacay Derivation Tunnel.

In this study, engineering geological map was done in the tunnel route and the surrounding area. A total 15 boreholes were done on the tunnel area and laboratory tests were done from the cores. On evaluating the boreholes, the laboratory data and discontinuity measurements (ISRM, 1981), the rock mass of the tunnel was classified according to RMR classification system (Bieniawski, 1989).

Tunnel route was separated three structural regions (as two portals and middle of tunnels) and all discontinuity data are collected each regions on the field (Table 1). All data of each structural region was evaluated according to the best, the worst and average conditions. Discontinuity parameters, orientation, spacing, persistence, roughness, wall strength, aperture, filling, seepage, number of sets and block size were described and rock masses of each region on the tunnel route are defined.

Table 1. Structural regions and distances.

STRUCTURAL REGION	Distance
Portal A (entrance portal)	Km:0+000-0+101 m
Middle Region A	Km:0+101-0+227 m
Middle Region B	Km:0+227-0+383 m
Portal B (exit portal)	Km:0+383-0+575 m

The Bİg Karacay Dam is constructed near the Hatay province in the southeast Turkey (Figure 1). There is a derivation tunnel in the project which is 575 m and circular shape with a 5.00 m diameter.

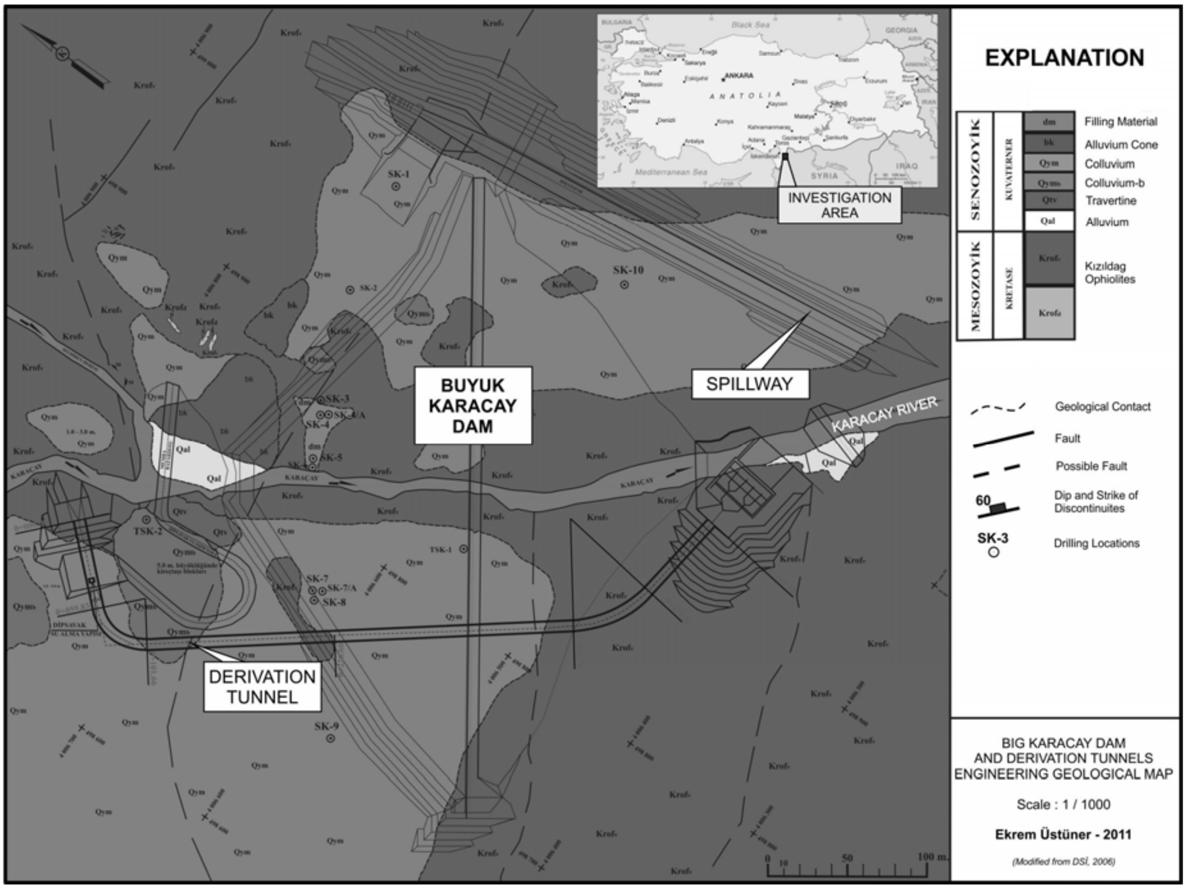


Figure 1. Engineering geology map and derivation tunnel route

In the close vicinity of the research area, Kızıldag Ophiolites the Mesozoic aged ophiolitic rocks (Selcuk, 1985) and Quaternary aged the young sediments were occurred. All of the excavation of derivation tunnel is included in the ophiolitic rocks and Quaternary sediments thickness is low.

2. Engineering Properties and Application of the RMR System

In this study, engineering properties of the Karaçay Derivation Tunnel were determined by using drillings, laboratory works and field discontinuity works.

2.1. Drillings

In order to determine the engineering parameters of the rock mass along the tunnel route and around, a total 15 boreholes was performed. Determination of geological units and tests applied on cores taken at drillings. Rock Quality Designation (RQD) data were taken in logging and maximum, minimum and average RQD data were calculated for each structural region (Table 2.).

Table 2. RQD Value of Structural Regions

STRUCTURAL REGION	RQD, %		
	Maximum	Minimum	Average
Portal A	40	5	16
Middle Region A – B	100	53	60
Portal B	80	12	45

2.2. Laboratory Works

The engineering parameters of the ophiolites are determined by laboratory point load tests. Because we don't have core samples, therefore in large number of samples (54 samples) were taken from each structural regions on the tunnel route. The point load strength values of each sample were calculated and maximum, minimum and average values were given in Table 3.

Table 3. Point Load Strength Index of Structural Regions

STRUCTURAL REGION	$Is_{(50)}$ (MPa)		
	Maximum	Minimum	Average
Portal A	0.87	0.44	0.66
Middle Region A – B	3.82	0.46	2.40
Portal B	4.81	2.29	3.37

2.3. Field Studies

The conditions of discontinuities are very significant for rock mass classification and engineering designs. Therefore, detailed discontinuity surveys were performed in this study. Discontinuity properties were determined according to ISRM (1981) and defined orientation, spacing, persistence, roughness, wall strength, aperture, filling, seepage, number of sets and block size were described and rock masses of each region on the tunnel route are defined.

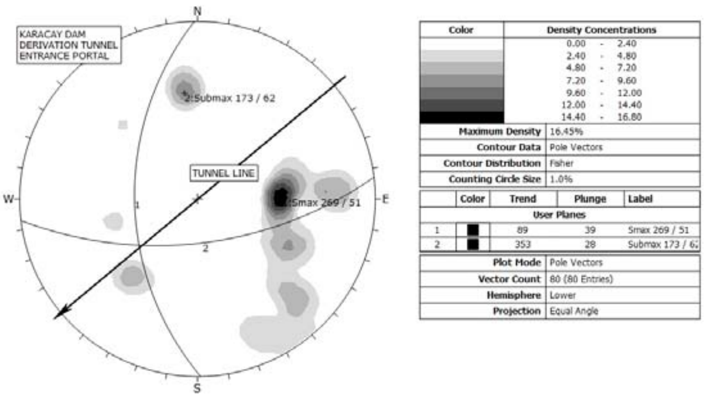


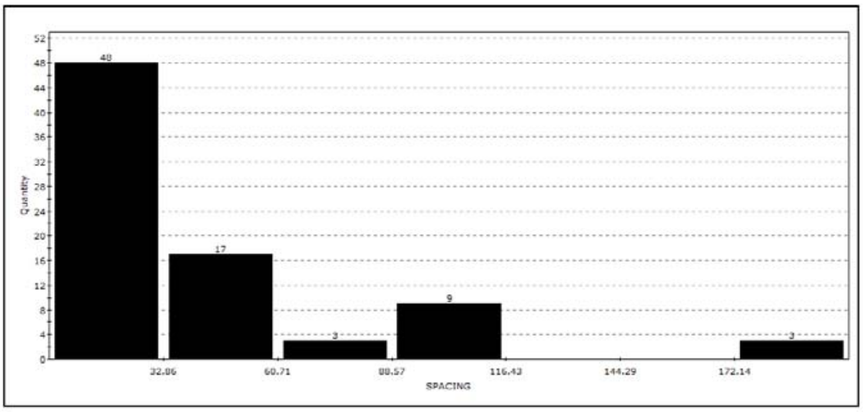
Figure 2. The sample stereonet of major discontinuities of Portal A

Using the software Dips 6.0 the dip and dip direction of discontinuities were plotted. Other properties of discontinuities were calculated by histograms. Figure 2 and Figure 3 shows sample stereonet and histograms of the major discontinuities of Portal A (entrance portal) and Table 4 gives orientation of major sets observed at the investigated area. All of these properties were calculated each structural region according to maximum, minimum and average conditions. Summary of discontinuity properties are given in RMR application.

Table 4. Orientation of major discontinuity sets observed in the study area

STRUCTURAL REGION	DISCONTINUITY SET NUMBER	DISCONTINUITY DIP(°)	DISCONTINUITY DIP DIRECTION(°)
Portal A	Set 1	51	270
	Set 2	63	174
Middle Region A – B	Set 1	56	173
	Set 2	41	117
	Set 3	46	251
Portal B	Set 1	55	293
	Set 2	51	322
	Set 3	61	184
	Set 4	32	343
	Set 5	77	156
	Set 6	43	150

Quantitative Chart of Spacing



mean=42.2875 s.d.=40.6648 min=5 max=200

Figure 3. The sample histograms of discontinuity spacing of Portal A

2.3. Application of the RMR System

The RMR System (Bieniawski, 1989) is used widely underground excavation design. There are five basic classification parameters in the RMR.

1- Strength of intact rock material, (Uniaxial or Point Load strength),
2- Rock Quality Designation, (RQD),
3- Spacing of joints,
4- Condition of joints,
5- Ground water conditions

These five parameters total score are basic RMR value. There are some adjustment parameters, a) orientation, b) blasting, c) weathering, d) strength. Finally, total rating score for the rock mass is final RMR. This RMR score give us rock mass classes and using this score rock mass classes, estimate cohesion and friction angle of the rock mass, deformation module, stand-up time, active unsupported span can be find. RMR application results were given in Table 5-8.

Table 5. RMR application to Portal A, Km:0+000-0+101 m

Parameters	RMR Rating		
	Best condition	Worst condition	Average condition
Uniaxial Compressive Strength	0	0	0
RQD	8	3	3
Spacing of joints	15	8	10
Condition of joints	27	12	20
Ground water	15	10	15
Basic RMR	65	33	48
Rating adjustment	0	-12	-5
Total RMR	65	21	43
Rock Mass Classes	Good rock	Poor rock	Fair rock
Weathering adjustment	1.0	0.7	0.90
Blasting adjustment	0.97	0.90	0.94
Final RMR	63.05	13.23	36.378
Deformation Moduls(GPa)	26.1	1.2	4.6
Active unsupported span(m)	3.2	0.20	1.4
Stand-up time	200 days	Immediate collapse	6 hours

(Deformation Module; Bieniawski (1978), Serafim and Pereira (1983): Active unsupported span and stand-up time; Bieniawski (1989): Weathering and blasting adjustment; Kendorski (1983))

Table 6. RMR application to Middle Region-A, Km:0+101-0+227 m

Parameters	RMR Rating		
	Best condition	Worst condition	Average condition
Uniaxial Compressive Strength	7	0	7
RQD	20	13	13
Spacing of joints	15	8	10
Condition of joints	24	7	14
Ground water	15	10	15
Basic RMR	81	38	59
Rating adjustment	0	-12	-2
Total RMR	81	26	57
Rock Mass Classes	Very good rock	Poor rock	Fair rock
Weathering adjustment	1.0	0.70	0.90
Blasting adjustment	0.97	0.90	0.94
Final RMR	78.57	16.38	44.222
Deformation Moduls(GPa)	57.14	1.4	9
Active unsupported span(m)	3.5	0.24	2.3
Stand-up time	16 years-7 months	Immediate collapse	109 hours

(Deformation Module; Bieniawski (1978), Serafim and Pereira (1983): Active unsupported span and stand-up time; Bieniawski (1989): Weathering and blasting adjustment; Kendorski (1983))

Table 7. RMR application to Middle Region-B, Km:0+227-0+383 m

Parameters	RMR Rating		
	Best condition	Worst condition	Average condition
Uniaxial Compressive Strength	7	0	7
RQD	20	13	13
Spacing of joints	15	8	10
Condition of joints	24	7	14
Ground water	15	10	15
Basic RMR	81	38	59
Rating adjustment	0	-12	-5
Total RMR	81	26	54
Rock Mass Classes	Very good rock	Poor rock	Fair rock
Weathering adjustment	1.0	0.70	0.90
Blasting adjustment	0.97	0.90	0.94
Final RMR	78.57	16.38	45.684
Deformation Moduls(GPa)	57.14	1.4	7.8
Active unsupported span(m)	3.5	0.24	2.15
Stand-up time	16 years-7 months	Immediate collapse	60 hours

(Deformation Module; Bieniawski (1978), Serafim and Pereira (1983): Active unsupported span and stand-up time; Bieniawski (1989): Weathering and blasting adjustment; Kendorski (1983))

Table 8. RMR application to Portal B, Km:0+383-0+575 m

Parameters	RMR Rating		
	Best condition	Worst condition	Average condition
Uniaxial Compressive Strength	12	7	7
RQD	17	3	8
Spacing of joints	10	8	8
Condition of joints	23	5	12
Ground water	15	10	15
Basic RMR	77	33	50
Rating adjustment	0	-12	-5
Total RMR	77	21	45
Rock Mass Classes	Good rock	Poor rock	Fair rock
Weathering adjustment	1.0	0.70	0.90
Blasting adjustment	0.97	0.90	0.94
Final RMR	74.69	13.23	42.3
Deformation Moduls(GPa)	49.38	1.2	6.42
Active unsupported span(m)	3.4	0.20	1.9
Stand-up time	5 years-7 months	Immediate collapse	24 hour

(Deformation Module; Bieniawski (1978), Serafim and Pereira (1983): Active unsupported span and stand-up time; Bieniawski (1989): Weathering and blasting adjustment; Kendorski (1983))

3. Result and Discussion

The RMR values of separated as Portal A, Portal B and Middle A-B were determined in the Big Karaçay Dam tunnel route. According to this RMR classification system they obtained results are summarized as:

In Portal A (entrance portal): The RMR value in the worst conditions is 21 (poor rock) and stand up time was determined immediate collapse and in the best conditions it is 65 (good rock) and stand up time was determined as 200 days.

In middle region A: The RMR value in the worst conditions is 26 (poor rock) and stand up time was determined immediate collapse and in the best conditions it is 81 (good rock) and stand up time was determined as 16 years – 7 months.

In middle region B: The RMR value in the worst conditions is 26 (poor rock) and stand up time was determined immediate collapse and in the best conditions it is 81 (good rock) and stand up time was determined as 16 years – 7 months.

In Portal B: The RMR value in the worst conditions is 21 (poor rock) and stand up time was determined immediate collapse and in the best conditions it is 77 (good rock) and stand up time was determined as 5 years – 7 months.

As a result of, according to this evaluation this tunnel excavation was completed without any stability problems.

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ПУТИ ПОВЫШЕНИЯ ЭФФЕКТИВНОСТИ ПРОХОДКИ ТУПИКОВЫХ ВОССТАЮЩИХ ВЫРАБОТОК ПРИ ПОДГОТОВКЕ НА ШАХТАХ КРИВБАССА БЛОКОВ К ОЧИСТНОЙ ВЫЕМКЕ

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Обоснована целесообразность применения при подготовке на шахтах Кривбасса блоков к очистной выемке технологии проходки тупиковых восстающих выработок за один прием взрывания отбойкой скважинных зарядов на компенсационную полость (скважину увеличенного диаметра).

Введение. В технологической цепи добычи железных руд подземным способом наиболее несовершенным звеном является подготовка блоков к очистной выемке. Проходка тупиковых восстающих является одним из наиболее дорогостоящих и трудоемких видов горных работ при подготовке блоков. Разработка оптимальных способов проходки тупиковых восстающих – современное и актуальное направление совершенствования технологии горных работ при подготовке блоков к очистной выемке.

Состояние вопроса. Одним из основных, наиболее трудоемких и несовершенных производственных процессов при добыче железных руд подземным способом является подготовка блоков к очистной выемке. Удельный объем трудовых затрат на эти работы составляет 40-50% общих затрат на добычу руды.

Широкое развитие систем разработки, особенно мощных рудных тел, привело к появлению серии выработок малого сечения, составляющих основу конструктивного оформления систем. При этих системах для подготовки блоков к очистной выемке проходят тупиковые восстающие выработки различного назначения. Трудоемкость и затраты средств на проходку тупиковых восстающих достигают в отдельных случаях до 15% общей трудоемкости и затрат на подготовку блоков к очистной выемке [1,2].

Нерешенные части проблемы, которым посвящена данная статья. Применительно к проходке тупиковые восстающие выработок оптимальный способ проходки по способу разрушения породного массива в достаточной мере не отработан.

Целью работы является разработка концептуальных технологических подходов к возможности снижения трудовых и материальных затрат при проходке тупиковых восстающих выработок.

Задача работы состоит в обосновании возможности повышения эффективности проходки тупиковых восстающих выработок путем оптимизации буровзрывных работ.

Изложение основного материала. В настоящее время в Криворожском бассейне при подготовке блоков к очистной выемке, вскрытии новых месторождений и горизонтов ежегодно проходят порядка 5,6 тыс.м тупиковых восстающих выработок.

Тупиковые восстающие выработки проходят по породам и рудам с коэффициентом крепости f от 3-6 до 16-18, преобладающий объем (72,8%) проходят в горном массиве с