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Research Article

ROCK MASSES ENGINEERING CLASSIFICATION OF ZARANI DAM SITE (SOUTH-EAST OF IRAN)

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ABSTRACT
Zarani dam in the Hormozgan province is located 35 km southeast of Minab. Studied area is located in the western end of the Makran subduction zone. The purpose of this study was to identify the geomechanical rock mass classification of abutments and reservoir area. The research method includes field investigations were done and finally were analyzed data by the rock mass classification systems. The results show that Weighted Quality Index, good to the poor, the mass of sandstone bedrock shale, sandstone, shale and sandstone and shale layers 88, 67, 55 and 32 percent. According to the engineering rock mass classification, on the compressive strength, the resistance level is too low (E) are located. Site's Rock mass, in RMR classification, component rocks poor to good; classified in GSI, a block of rock band (VB/G), stone block / confused - folded (BD/F) and the stone block which are of good quality (BD/G) are located. In the Q system, left abutment rocks, in the weak rocks category and on the right abutment rocks, are in the medium-sized stones category.

Keywords: *Geomechanic, Rock Mass Classification, Zarani Dam, Minab*

INTRODUCTION
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Rock mass classification method is very useful in rock engineering (Barton *et al.*, 1974; Farhoudi *et al.*, 2007). Classification of rock masses is quite general and can be used in practical design (Fairhurst, 1993) Rock masses classification if done carefully, can be a powerful tool used in engineering design (Hudson, 1992). In many projects, classification is the basis for the design of structures (Hedayati *et al.*, 2012). The stone numerical classification system, minimum and maximum point's weakest rock masses is devoted to the great rock masses. To describe rock masses, a type of classification is not sufficient and should be studied several types of rankings (Rahnamarad *et al.*, 2013; Ghafoori *et al.*, 2011). Zarani dam in the Hormozgan province is located 40 km southeast of Minab at latitude 26° 50' 30" N and longitude 57° 15' 10" E (Ansarifar, 2014; Hormozgan Regional Water company, 2012). The access way is asphalt road of Minab to Bashagard (Figure 1). This article, extracted of the author's M.Sc. Thesis of Zahedan Islamic Azad University.

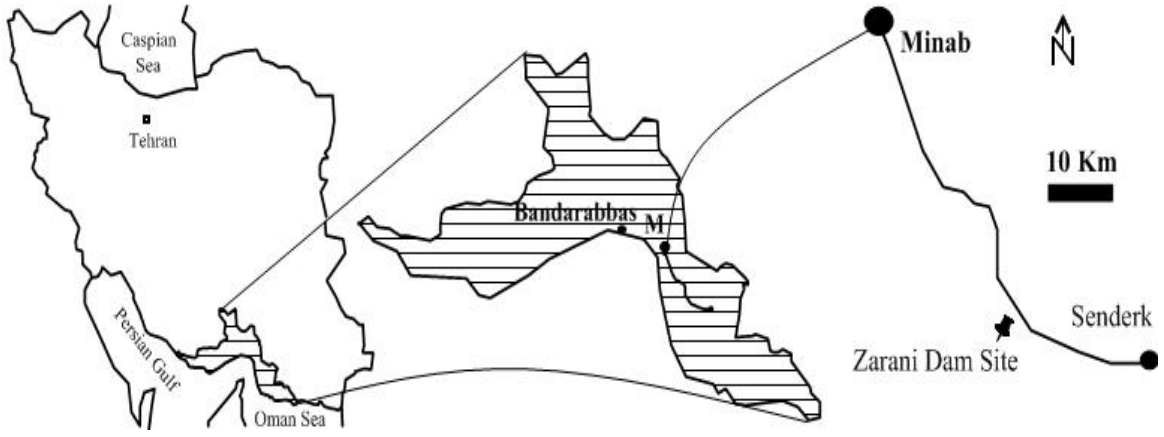

Figure 1: Geographical location and the access way to the site of Zarani dam

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The Geological Site

The study area is located in the western end of the Makran zone. The dominant lithology of the area consists of Middle Miocene Ghushi marl, Middle - Upper Miocene Kheku sandstone unit, Upper Miocene Tiyab sandstone unit, Pliocene conglomerates of Minab and Quaternary deposits (Aghanabati, 2004). Field studies show that dam site is formed the alternating with layers of thick shale and thin sandstone (Figure 2). Quaternary deposits consist of filler sediments of the riverbed and stream, the debris and slope wash, young sediments of terraces and alluvial deposit. The filler sediments of riverbed and stream with 1 to 2 m thick, is composed of a mixture of sand with angular rock fragments and semi-round to round. The rocks include limestone, sandstone and slightly igneous rocks. Alluvial fan deposits are formed on the some right shore of the stream (McCall, 1997).

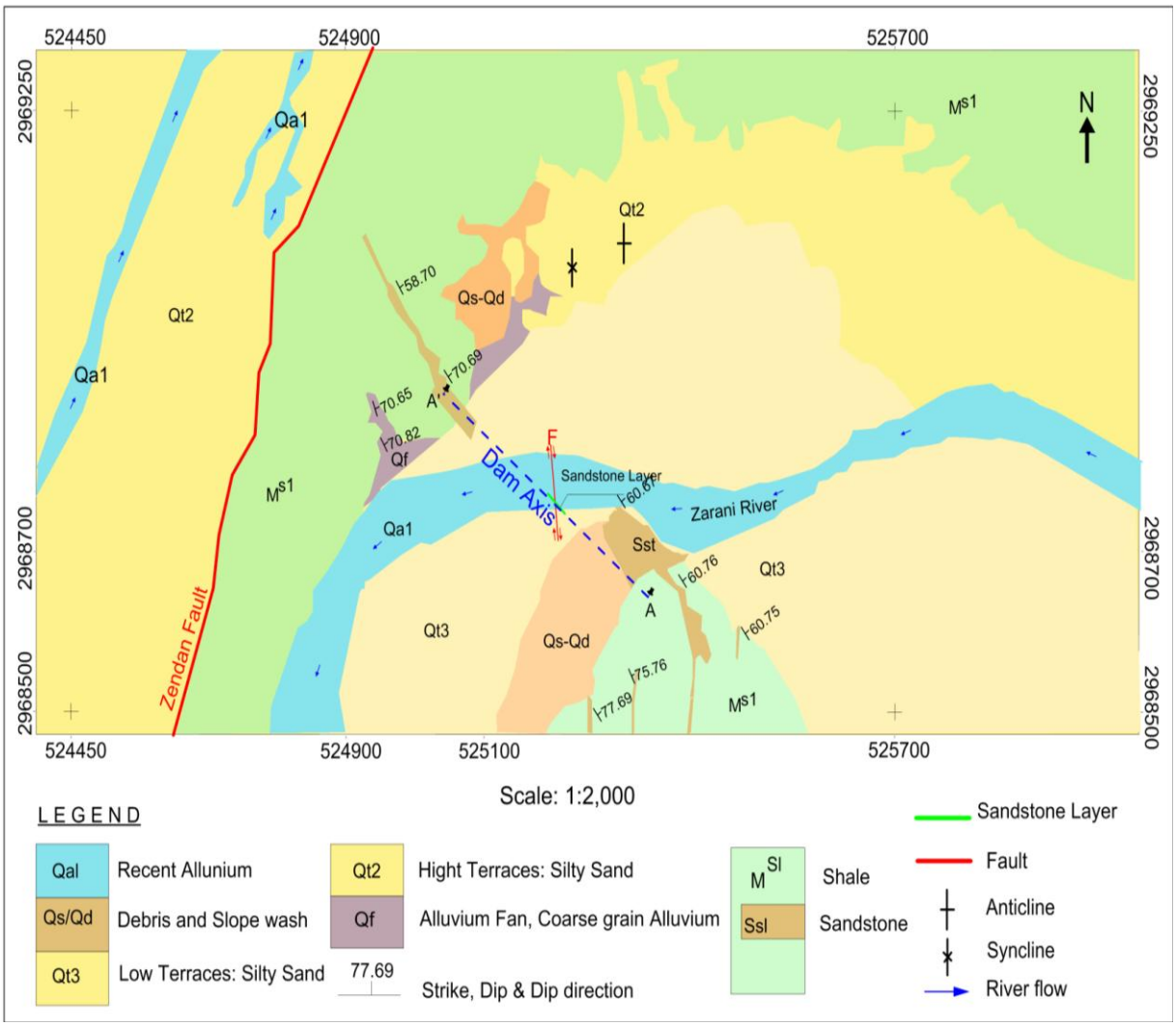

Figure 2: Geological map 1: 2,000 site of Zarani dam (adapted from geological map 1: 250,000 Taherui, McCall, 1985)

Rock Mass Classification

The Quality of the Rock Mass

The bed rock mass quality index, according to the diagram (Figure 3), Quality weighted index, strong to weak, for mass bedrock of shaly sandstone, sandstone- shale, sandstone, shale with interlayers of sandstone and shale was 88, 67, 65, 55 and 32 percent, respectively.

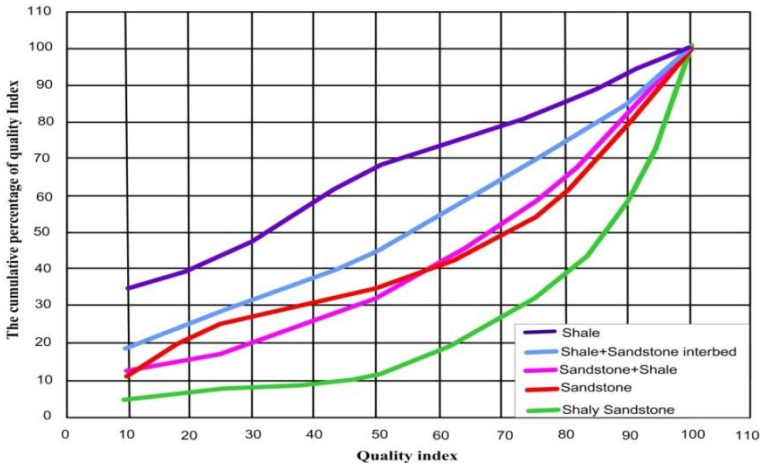

Figure 3: Quality index of bed rock mass of Zarani dam site based on classification (Deer, 1989)

Classification of Rock Mass Based on Compressive Strength

Uniaxial compressive strength of rocks has been considered as an important factor and common for recognizing geotechnical characteristics of the rock a long time ago (Bell, 2007). The results of these tests are presented in Table 1.

Table 1: Engineering classification of rock mass of dam abutment based on compressive strength

	Left abutment sandstone		**Right abutment Shaly sandstone**		**shale**	
	Saturated	**dry**	**Saturated**	**dry**	**Saturated**	**Dry**
compressive strength value(Mpa)	5.65	21.15	16.6	18	9.99	13.03
Strength	Very low		Very low		Very low	
Class	**E**		**E**		**E**	

Geomechanical Classification of Rock Mass of Site

In order to evaluate the classification, the boreholes of foundation and abutments have been studied. The structural properties of the rock mass containing discontinuities, faults and joints were investigated. The results are shown in Table 2.

Table 2: The scoring system of rock mass (Bieniowski, 1989)

Rock and abutment type	**Right abutment**		**Left abutment**
Parameters	**Shale**	**Sandstone**	**Shaly sandstone**
Uniaxial compressive strength(MPa)	13.03	21.15	16.6
Score	2	2	2
index RQD%	32	63	88
Score	8	13	17
discontinuity distance(m)	0.1	0.1	0.1
Score	8	8	8
Condition of discontinuities surface	Smooth	Rough and uneven	Rough and uneven
Score	10	25	25
Underground water	air-dry	air-dry	air-dry
Score	15	15	15
Total score	33	63	67
Rock Class	IV	**II**	II
Description	Poor Rock	**Good Rock**	Good Rock

Geological Strength Index (GSI)

Strength of the rock mass depends on properties of virgin rock fragments and degrees of freedom of the fragments to slide and rotation under different conditions of stress (Hoek *et al.*, 1998). This system is presented in table 3.

Table 3: GSI classification for the rock mass of Zarani dam

Parameter	Right abutment	Left abutment
GSI value	5 ±40	5 ± 49
Description	BD/G – BD/F	VB/G

VB / G: very blocky rock has good quality at surface
BD / F: blocky/ disturbed- folded rock has fair quality at surface
BD/G: blocky rock has good quality

Rock Mass Classification based on Q system

Generally, this classification is a quality classification and in this system, the evaluation of engineering behavior of rock masses is based on numbers or scores.

Table 4: Classification of rock mass of site based on Q system

Position	Right abutment		Left abutment	
Parameter	Description	Score	Description	Score
avrage %RQD	fair (32-88)	60	Fair	63
Jn	Three categories of joints	9	Three categories joints+Random joints	12
Jw	drilling environment is quite dry or with extremely low water flow	1	drilling environment is quite dry or with extremely low water flow	1
Ja	Joint walls altered slightly and have been covered with thin layer of filler material like sand and crushed stone lack of clay	3	joint walls has sand-free clay particles	4
Jr	Soft and smooth to rough and wavy	2.5	Rough, irregular and wavy	3
SRF	A poor area with of clay or materials produced from chemical weathering (drilling depth is less than or equal to 50 m(	5	The presence of a shear zone in strong rock (without clay) drilling depth is less than or equal to 50 m.	0.5
Final score	1.33		7.875	
Q description	Poor		average	

CONCLUSION

Reservoir Formations, hard formations, Pliocene conglomerate, and discontinuous Formation, which is composed of Quaternary deposits and alluvial terraces deposits. Weighted Quality Index, good to the poor, the mass of sandstone bedrock shale, sandstone, shale and sandstone and shale layers 88, 67, 55 and 32 percent. According to the engineering rock mass classification, on the compressive strength, the resistance level is too low (E) are located. Site's Rock mass, in RMR classification, component rocks poor to good; classified in GSI, a block of rock band (VB / G), stone block / confused - folded (BD / F) and the stone block which are of good quality (BD / G) are located.

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