საქართველოს მეცნიერებათა ეროვნული აკადემიის მოამბე, ტ. 18, №3, 2024
BULLETIN OF THE GEORGIAN NATIONAL ACADEMY OF SCIENCES, vol. 18, no. 3, 2024

Geology

Estimation of Fracturing and Rock Mass Rating of the Area of Shuakhevi HPP Hydrotechnical Structures

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(Presented by Academy Member David Shengelia)

The hydrotechnical facilities of Shuakhevi HPP are located in the Ajara region. The HPP project includes headworks and a network of derivation tunnels, through which the rivers Chirukhistskali and Skhalta flow into the central reservoir of Didachara. From here, water is supplied to the HPP building through the Didachara-Shuakhevi derivation tunnel. To select the location of the hydrotechnical facilities, an assessment of the fractured rocks of the area was carried out including the determination of rock mass rating (RMR), rock tunneling quality (Q) and rocks blockiness. It was established that according to RMR data, the rocks in the area of hydrotechnical facilities of the Shuakhevi HPP building are classified as "medium" and "good" classes, and according to the Q index, they are attributed to the second group. The composing rocks belong to the medium and highly weathered class. Taking into account the results from software processing of the performed works in DIPS (Graphical and Statistical Analysis of Orientation Data), it was planned to strengthen and cover the tunnels with reinforced concrete. *© 2024 Bull. Georg. Natl. Acad. Sci.*

Shuakhevi hydro power plant, Adjariststskali river, rock mass raiting

The hydrotechnical facilities of Shuakhevi HPP are located in the Adjara region, namely in the territory of Shuakhevi and Khulo municipalities. The study area includes the middle reaches of the Achariskalli river basin and its left tributaries – the Skhalta and Chirukhistskali river valleys. In the mentioned section, the river beds are V-shaped with steep slopes.

The geological structure of the area includes the Middle Eocene Kintrishi and Burnati suites, which are intruded by Middle-Upper Eocene small dyke bodies of syenitic and dacitic composition [1-3].

In order to select the location of the hydrotechnical facilities, an assessment of the fractured rocks of the area was carried out, including the determination of rock mass rating (RMR), Rock tunneling quality (Q) and blockiness of the rocks [4-6]. The purpose of the conducted research was to select a safe environment for the hydrotechnical structures of Shuakhevi HPP, with less water filtration and a low degree of rock weathering. It was also necessary to determine the planetary fracturing

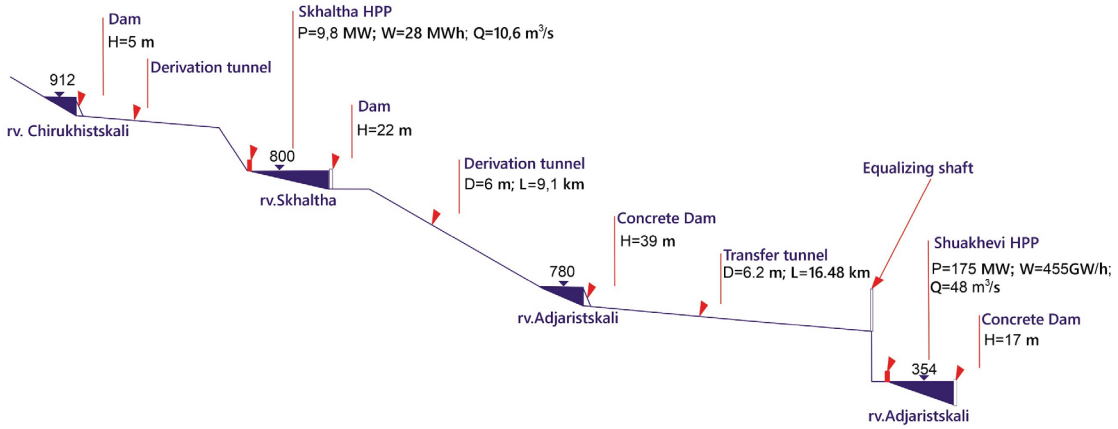

Fig. 1. The principle scheme of the layout of Shuakhevi HPP engineering structures.

and blockiness of the fractures, which allows determining the kinematics of the rocks.

Research object

Shuakhevi HPP consists of a network of head structures and derivation tunnels, through which the Chirukhistskali and Skhalta rivers flow into the Didachara central reservoir. From there, water is supplied to the HPP building through the Didachara-Shuakhevi derivation tunnel (Fig. 1).

A 5-meter-high reinforced concrete dam has been arranged in the Chirukhistskali river valley. During the periods of high water, the low-threshold dam ensures that the full volume of excess water and solid sediment is channeled into the tail water. Through a 5.8 km long and 3.6 m diameter derivation tunnel, water from the Chirukhistskali dam is discharged into the Skhalta river valley. In order to use the 100-meter difference obtained between the Skhalta river reservoir and the Chirukhiskali river dam for energy purposes, a small power plant with capacity of 9.8 MW ("Skhalta" HPP) was installed near the reservoir of the Skhalta river. In the middle reaches of the Skhalta river, at an altitude of 790 m a.s.l, a reinforced concrete dam was installed to transfer water from the Skhalta river to the Acharistskali river valley. By means of the latter, a day-night regulation reservoir was arranged. Water is supplied from the intake to the central reservoir through a 9.1 km long and 6.0 m in diameter diversion tunnel.

Shuakhevi HPP is supplied with water from the Didachara reservoir, which is located at the confluence of the Acharistskali and Ghorjomi rivers. The Acharistskali and Ghorjomi valleys are flooded with reservoir water. The volume of the reservoir is approximately 623,000 m^3, and the water mirror surface area is 169,000 m^2.

The power unit of Shuakhevi HPP is arranged on the river, on the right bank of the Acharistskali river, above the confluence of the Acharistskali and Chvanistskali rivers. The power unit consists of an above-ground pressure system, a HPP building, a technical water channel and a 220 kW substation.

Methodology

Within the territory of Shuakhevi HPP, hard rock assessment was carried out at the locations of the head structures, tunnel portals, tunnel axis and power unit and RMR and Q were determined. Fracturing of more than 200 hard rock outcrops was evaluated within the territory. The results of the evaluation of fissures on exposures were processed in the DIPS system, which provides stereographic, kinematic and fissure analysis [6]. The final results obtained are used directly in the tunnel construction process, at the stage of selection of reinforcement types (https://www.rocscience.com/software/dips).

Table. Rock mass class, RMR and Q of Shuakhevi HPP engineering structures

	Strength	RQD	Spacing of Discontinuities	Condition of Discontinuities					Ground Water	RMR	Q	Rock mass class
				Length	Aperture	Roughness	Infilling	Weathering				
Chirukhi reservoir-Chirukhi – Skhalta tunnel	7	13	15	2	1	1	6	5	15	65	7	II-good
	7	10	10	2	1	1	6	5	15	57	17	III-fair
	12	15	10	4	4	1	6	6	15	73	6	II-good
	8	13	15	4	5	1	5	6	15	68	8	II-good
	13	17	10	4	0	1	2	6	15	72	18	II-good
Shuakhevi HPP	7	18	15	2	4	1	6	5	15	73	30	II-good
	4	13	10	2	4	1	6	5	15	60	4	III-fair
	2	12	15	1	0	5	0	1	15	51	10	III-fair
	7	16	10	2	6	3	6	3	15	68	13	II-good
Skhalta reservoir-Skhalta-Didachara tunnel	15	16	15	2	0	1	2	6	15	72	9	II-good
	12	17	15	2	1	3	4	5	15	74	7	II-good
	12	13	15	2	1	3	2	5	15	68	5	II-good
	12	14	10	2	4	1	6	6	15	70	8	II-good
	12	14	10	4	4	1	6	6	15	72	12	II-good
Didachara-Shuakhevi tunnel	7	16	10	2	4	5	6	5	15	70	20	II-good
	7	10	10	2	1	5	6	5	10	56	7	III-fair
	7	12	15	1	4	5	6	5	15	70	4	II-good
	7	14	10	4	0	5	2	5	15	62	9	II-good
	7	16	10	2	1	5	2	5	10	58	30	III-fair
	4	10	15	2	0	1	2	3	15	52	5	III-fair
	7	17	10	6	1	1	6	6	15	69	28	II-good
	7	17	10	6	1	1	6	6	15	69	18	II-good
	4	13	15	2	1	3	2	3	15	60	9	III-fair
Didachara Dam - Didachara reservoir	12	17	15	4	1	1	2	6	15	73	12	II-good
	12	17	10	2	4	1	6	5	15	72	28	II-good
	12	17	10	2	1	3	6	6	0	57	12.5	III-fair
	12	17	15	4	1	1	2	6	15	73	17	II-good
	7	10	8	2	1	1	6	5	10	50	11	III-fair
	7	12	8	4	1	3	0	5	15	55	7	III-fair
	7	18	15	2	5	5	6	6	15	79	65	II-good
	12	16	15	2	1	1	6	5	15	73	40	II-good
	4	10	8	4	4	1	2	3	15	51	6	III-fair
	12	17	15	2	0	1	6	6	15	74	14	II-good

Discussion

The data for determining RMR and Q on the exposed areas of hard rocks in the location of Shuakhevi HPP hydrotechnical facilities are given in the Table.

As a result of the stereographic analysis (DIPS) of the obtained results, it was established (Figs. 2, 3): RMR in the area of Didachara reservoir and dam ranges from 51-79, and in the area of Didachara-Shuakhevi connecting tunnel area, it is within 52-70.

In the area of Skhalta reservoir and Skhalta-Didachara, as well as Chirukhi reservoir and Chirukhi-Skhalta connecting tunnels, the value of RMR ranges from 60-74, which indicates that they mainly belong to “medium” and “good” class rocks, and according to Q – “medium” and “good” classes of rocks and fall into the second group [5, 6].

The value of RMR in the area of location of Shuakhevi HPP building is within 57-74, which according to classification is defined as “mean” quality, and according to Q - as “medium” class and is attributed to the second group [5, 6].

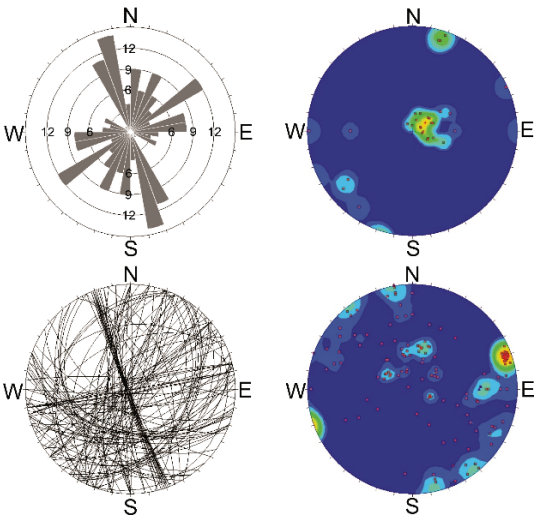

Fig. 2. Stereographic analysis of fracturing in the area adjacent to the Shuakhevi power unit.

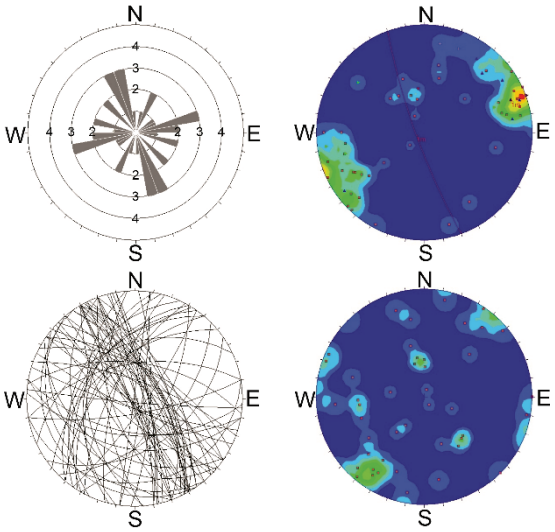

Fig. 3. Stereographic analysis of fracturing in the area adjacent to the Didachara dam of the Shuakhevi HPP.

According to the research data, the rocks composing the area where the structures are located are moderately and strongly weathered and that directly affects the strength of the rocks. In some cases, the rocks are intact, which is due to their lithology. When in contact with water, these indicators deteriorate sharply.

Conclusion

As a result of the research, the following conclusions were established: In the area of the Didachara, Skhalta and Chirukhi reservoirs, Didachara-Shuakhevi, Skhalta-Didachara and Chirukhi-Skhalta connecting tunnel and the Shuakhevi HPP building hydrotechnical structures according to RMR and Q data the rocks were classified as “medium” and “good” class falling into the second group; According to the degree of weathering, the rocks belong to the class of medium and highly weathered rocks, and their strength indicators in contact with water drop to a low level; During the construction of the hydrotechnical structures of Shuakhevi HPP, strengthening and lining of tunnels with reinforced concrete cover was planned taking into account the obtained results.

The research [PHDF-21-1617] was accomplished with the support of the “Shota Rustaveli National Science Foundation of Georgia (SRNSFG)”.

გეოლოგია

შუახევი ჰესის ჰიდროტექნიკური ნაგებობების განთავსების არეალის ამგები ქანების ნაპრალოვნება და ქანების მასის რეიტინგის შეფასება

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**სს ენერგო-პრო ჯორჯია ჰოლდინგი, თბილისი, საქართველო*
***ივანე ჯავახიშვილის სახ. თბილისის სახელმწიფო უნივერსიტეტი, ალექსანდრე ჯანელიძის სახ. გეოლოგიის ინსტიტუტი, თბილისი, საქართველო*

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შუახევი ჰესის ჰიდროტექნიკური ნაგებობები განთავსებულია აჭარის რეგიონში. ჰესის პროექტი მოიცავს სათავე ნაგებობებსა და დერივაციული გვირაბების ქსელს, რომელთა საშუალებითაც მდ. ჩირუხისწყალი და სხალთა თავს იყრის დიდაჭარის ცენტრალურ წყალსაცავში. აქედან, წყალი დიდაჭარა-შუახევის სადერივაციო გვირაბით მიეწოდება ჰესის შენობას. ჰიდროტექნიკურ ნაგებობათა განთავსების ადგილმდებარეობის შერჩევის მიზნით, განხორციელდა ტერიტორიის ამგები ქანების ნაპრალოვნების შეფასება, განისაზღვრა ქანის მასის რეიტინგი (RMR), გვირაბის ქანების ხარისხი (Q) და ქანების ბლოკურობა. დადგინდა, რომ შუახევი ჰესის შენობის ჰიდროტექნიკური ნაგებობების განთავსების არეალში RMR-ის მონაცემების მიხედვით, ქანები „საშუალო” და „კარგ” კლასებად კლასიფიცირდება, ხოლო Q მაჩვენებლის მიხედვით კი, მეორე ჯგუფში თავსდება. ამგები ქანები საშუალო და ძლიერ გამოფიტული ქანების კლასს მიეკუთვნება. ჩატარებული სამუშაოების DIPS-ში (ნაპრალების გავრცელების გრაფიკული და სტატიკური ანალიზი) პროგრამული დამუშავებისას მიღებული შედეგების გათვალისწინებით, დაიგეგმა გვირაბების გამაგრება და მოსახვა რკინაბეტონის საფარით.

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Received June, 2024