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Analysis of the Technical and Economic Indices for Reservoir Exploitation by the Example of Tolors Reservoir

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ABSTRACT

The comprehensive analysis of reservoir enables to disclose the operational terms of various constructive parts during the dam's exploitation, as well as the problems related to its filtration properties and efficient exploitation. In the current work, planning and cartographic documents of hydro-system on the example of Tolors reservoir have been studied and operational-technical indices of individual constructions have been enhanced and compared with the monitoring results recorded during the dam's exploitation. A number of events have been developed the application of which will promote the provision of the natural exploitative conditions for the reservoirs and their adjacent hydro-constructions.

Introduction

Tolors reservoir was put into operation in 1974. It is located 3.0 km south to the Sisian community, its area makes 4.7 square km, the length is 4.5 km, the maximum water depth - 56.5 m, the total volume - 96.0 million cubic meters, the active (effective) volume - 80.0 million cubic meters. Water is stored in the Tolors reservoir through the Vorotan river stream, as well as through the household water flows from the Sisian and Ayri rivers. The minimum water horizon in the reservoir makes 1625.5 m, since it is impossible to carry out the works of the Shamb Hydro Power Plant below this mark. The Hydro Power Plant of Shamb is located on the right bank of the Vorotan river and has 1716 MW capacity. Water diversion of the HPP has been realized through the round section pressure tunnel with 4.6 m diameter. The flotation ability in the tunnel makes 75.0 cubic meter water per second. The tunnel has 6871.44 m length. The equalizing reservoir installed at the end of water diversion tunnel consists of upper and lower chambers and vertical pipe string connecting the mentioned chambers, the diameter of which makes 6.0 m. The threshold mark of water intake unit is 1618.9 m (Report on hydro-technical structures of Shamb HPP, 2012-2015).

Tolors reservoir is a rock-fill dam with core, which is endowed with high stability rate. In the rock and rock-fill dams stones of different sizes are used, which entails to their tighter structure, as well as to the sedimentation of the stone remnants. The latter increases the filling mass and decreases the subsidence of the dam body as the vacuums

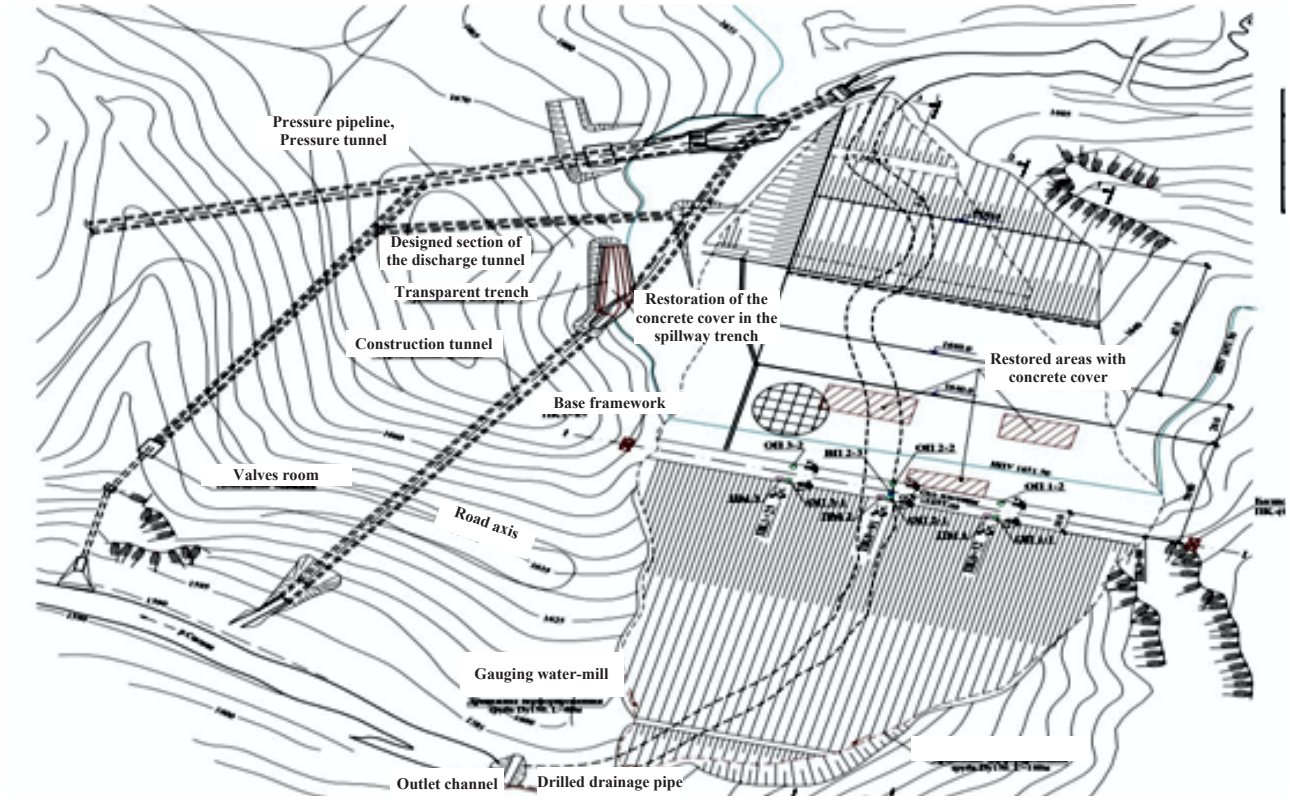

Figure 1. The main plan of the Tolors reservoir and hydro-technical structures (*composed by the author*)[1,2,3].
Source: [1.]Report on the Hydro-Technical Structures of the Shamb HPP, 2012-2015, [2.]Zamarin, E.A., Popov, K.V. (1946). Course on Hydro-Technical Structures, [3.]Baghdasaryan, A.B (1986). Hydro-Technical Structures.

can cause deformations in the dam body. Nevertheless, extremely large amount of rock remnants (more than 20 %-30 %) can bring about the case when the loading of the dam passes not onto the large rocks but on the small ones, which will lead to the subsidence of the dam and to the reduction of the stability in its sections. The minimum weight of individual rocks shouldn't exceed 80 kg, while for the high dams large rocks are preferable (Zhuravlyov, 1979). The body volume of the filling dams is greater than that of in the dams with dry structures (up to 40 %), anyhow the construction of rock-fill dams is considered to be more beneficial, since the dry structure is much more expensive than the structure with rock-fill. In the mixed dams part of the profile is designed through the rock filling regarding the dry race, while in case of the wet race it is implemented through the power-tamped earth (Zamarin, 1946). The core serves as an anti-filtration element in the Tolors reservoir. Anyhow, the core has got high water proofness rate, besides, some problems appear during the core restoration activities (Grimin, 1962). Among the advantages of rock-fill dams the application of local materials, seismic resistance, the construction simplicity, opportunity of the dam's construction throughout the entire year (due to the mechanization of the work), facilitation of the further uplifting of the dam height and the moderate requirements towards the dam base can be involved. The main disadvantages of the rock-fill dams are huge labor intensity and further subsidence of the dam as a result of which there is a great need for updating and re-fitting of the tools in the dam's body. To ease the process of rock-fill dams' construction it is necessary to possibly maximize the mechanized work related to the rocks processing and their transportation (Baghdasaryan, 1986).

Materials and methods

The researches have been conducted through the study of monitoring results on the plan and exploitative indices of the individual structures in the reservoir hydro-system, as well as through analysis and comparison methodology. The plan and cartographic documents of the Tolors reservoir

have been studied in natural conditions, the working terms of individual structures have been examined and then, being compared with the technical exploitative conditions stated upon the standards, the violations and deviations of the exploitative conditions of individual structures in hydro-system have been revealed based on which their upgrading measures have been developed.

The aim of the current research is to study the technical and economic state in the reservoir exploitation on the example of the Tolors reservoir. In the result of our investigations the main breakdowns occurred in the Tolors reservoir and the activities aimed at their elimination have been studied. One of the most common breakdowns is the clogging of the pressure pipeline. Due to the untimely performance of cleaning activities clogging in the sub-chamber cells of the pressure pipelines occurs (Semenkov, Lentyaev, 1973). Because of the clogging the water horizon rises up in the pressure chamber. Here are the activities and their sequence for the breakdown liquidation:

a) Continuous control over the discrepancies between the horizons of the pressure chamber and the sub-chamber of the pressure pipeline.

b) Operation of a refuse-collecting truck and continuous cleaning of the sub-chamber cells focusing the machine work on the most contaminated part in case when no disposal or pressure decline is observed.

c) When complete or partial disposal takes place with pressure decline the opening valve is closed and the working units are switched off (upon the permission of the shift manager).

d) To supply water into the pipeline the raising of the closed panel should be implemented gradually in compliance with the production instructions in the hydro plant.

To prevent the abrupt water filtration in the dam, concrete injection activities are implemented in the hydro-system every year. Anyhow, filtration growth is observed from time to time in the following sections of the dam:

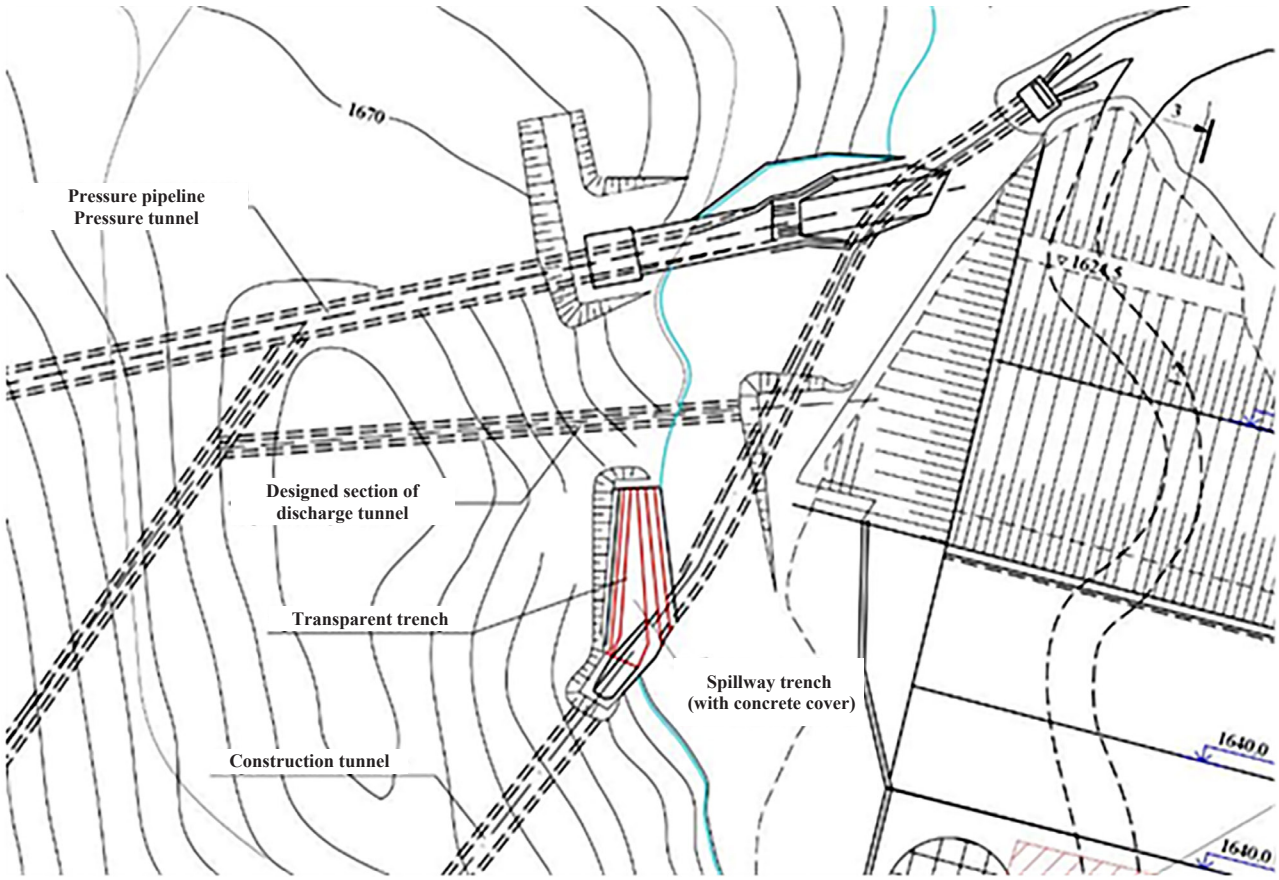

Figure 2. Pressure pipeline of the pressure sub-chamber (*composed by the author*)[1,2,3].

Source: [1.]Report on the Hydro-Technical Structures of the Shamb HPP, 2012-2015, [2.]Zamarin, E.A., Popov, K.V. (1946). Course on Hydro-Technical Structures, [3.]Baghdasaryan, A.B (1986). Hydro-Technical Structures.

- Between the dam's body and foundation footing
- In the dam's body-deeper than the mark of foundation's filler structure
- In the dam's coastal attachments
- Through the dam's body

The filtration growth can lead to the dam's destruction in the lower deck near the water leakage outlet zones (Chugaev, 1985). In case of detecting any leakage through the dam it is necessary to eliminate it in the following ways:

- In case of accident threat, when the leaking water can cause dam's destruction, it is necessary to lower the headwater level down to the threshold mark of water intake unit by means of water diversion.
- To provide the stability of the lower deck and to protect the soil from the tailwater swelling it is necessary to charge it with more water-permeable heavy inverse filter, such as macadam, gravel, etc.
- As a result of investigations, it has been also disclosed that the accidents often happen in case of closed water diversion, which causes destruction of water diversion tunnel. In the closed water diversion the accident happens when at the water diversion point the water horizon exceeds the estimated cost level.

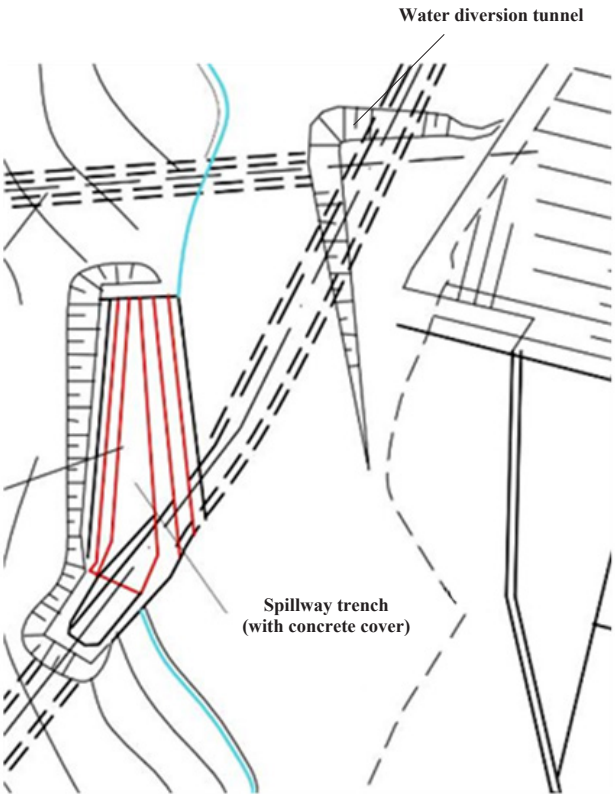

Figure 3. Water diversion tunnel (*composed by the author*).

In case of serious damages in the water diversion tunnel, flooding dangers for the tunnel coating soil appear. Besides, in case of significant tunnel damages, there may be restrictions or termination of the water access into the pressure chamber. In order to eliminate this accident it is necessary to follow the mentioned successive actions: when fixing the damage in the water diversion tunnel it is necessary to disclose the nature and sizes of the damage and in case of any threats, i.e. when the water can destruct the tunnel walls and floor, it is necessary to stop the water supply into the water diversion tunnel. When the destruction nature and sizes are found out restoration works should be implemented.

Results and discussions

In the study results it turns out that there is a need for the observation and regular care for the structural conditions in the hydro-system. Each construction of the hydro-technical structures has it specific exploitative standards, which should be ensured in the result of ongoing monitoring activities. In all main structures the following monitoring activities should be implemented:

- Monitoring over the deformations and cracks appeared in the concrete structures and coating sediments upon the strengthening the decks in the thermal compression dam.
- Monitoring over the filtration through the structures, over the activities in the water supply structures, as well as over the water marks in the piezometric measurements.
- Monitoring over the fluxes, landslides and the moss coverages in the reservoirs.

For the regular exploitation of the reservoirs and their adjacent hydro-structures the preparation activities for floods and the discharge of flood waters are considered to be among the priority tasks. All preparation events should be over 15 days before the start of possible flooding. Every year a plan on the flood waters discharge and the measures for protecting hydro-technical structures should be developed before the start of spring floods. At least a month before the expected floods the relevant committee inspects and evaluates the preparedness of hydro-technical structures for the floods, takes control over the flood

water discharging activities after which the staff starts examining the structures once more. Well before the start of the floods it is necessary to clean the waste storage cages in the ports of water intake units at the central units, so that in case of intensive water inflow no clogging or artificial advancement in water horizon is recorded. It is also necessary to check and test the water intake units and their lifting mechanisms.

In case of increasing household water flows from Sisian and Ayri rivers , as well as at the start of floods the water horizon level in the Tolors reservoir stays within the minimum range but not below the minimum allowable limit (1625 m).

The Tolors reservoir is located 1625 m high above the sea level and due to climatic conditions there can be some problems in winter. In severe frosts freezing of the water supply surface is sometimes inevitable, which is more dangerous for the water intake unit. Under the impact of winds and waves the ice can break down and float towards the water intake unit. In the mentioned period a particular attention should be paid to the cells not allowing their obstruction with ice. In case of air temperature decrease below -10 ^{0}C it is necessary to slightly move the ice in the valves every day to avoid freezing of the moving parts in the valve gasket. When detecting anomalous phenomena in the hydro-technical structures it is necessary to enhance the reasons and to initiate measures for their elimination.

Conclusion

In the result of researches we can come to the conclusion that monitoring on the technical and economic state of hydro-technical structures introduced in this article should be implemented by the end of each exploitative year for the improvement of their exploitation results and safety, so as to avoid the possible accidents. By the example of Tolors reservoir we can state that accidents often happen in the pipeline of the pressure chamber, dam's body and in the water diversion tunnel.

Thus, it is recommended to implement monitoring every year in order to provide uninterrupted work in the mentioned structures.

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