

The results of the study on the technical condition of hydraulic structures in reservoirs

*Dilbar Ospanova*¹, *Nadejda Dauletmuratova*¹, and *Bahadir Aytmuratov*^{1*}

¹Karakalpak State University, Nukus, Uzbekistan

Abstract. The article discusses the results of a study on the technical condition of operated hydraulic structures in reservoirs. During operation, various effects of long-term use, shortcomings in design, construction and operation of reservoirs as well as factors affecting the reliability of their hydraulic systems are manifested. The article also provides main criteria for ensuring reliable operation of reservoir systems.

1 Introduction

The age of hydraulic structures in the country is 50-60 years or more, and their technical condition has deteriorated due to prolonged use. Their technical capacity and reliability have decreased due to inadequate maintenance. Additionally, a lack of attention to environmental factors during operation has contributed to the decrease in reliability of these structures [1].

In our republic, most of the water reservoirs and hydroelectric plants were built in the mid-20th century and have been continuously used since then. Due to their age, negative changes have often occurred in their technical conditions. Atmospheric, chemical, and aggressive factors also contribute to the deterioration of hydraulic structures and their components in water. This can lead to serious damage to these structures themselves and to elements of hydro-technical systems that depend on them.

In order to provide the economy of Uzbekistan with water resources, there are 59 water reservoirs that are currently being exploited, of which 29 are in channel and 30 are off-river. As a rule, existing flood reservoirs are also used as reservoirs. Their restoration is carried out with the help of special self-propelled channels or a machine-lifting device from water sources for the purpose of replenishing the natural reserves of the regions with water. The total water volume of all water bodies exceeds 20.0 km³, of which 1 billion.m³ more than 5 units, 0.5 to 1 billion.m³ up to 4 units, from 100 to 500 million. m³ up to 15 units, from 10 to 100 million.m³ up to 17 units, 10 million.it consists of less than 18 water bodies per m³ [1-4].

Of the used water jets, 22 of them have been exploited since 15 to 25 years, 26 of them from 25 to 35 years, 11 of them more than 60 years. Of the 59 water bodies being exploited, 22 are classified objects [5-6].

* Corresponding author: bahadiraytmuratov5566@gmail.com

The significance of this issue stems from the fact that, despite considerable progress in the operation of hydraulic structures, a rising rate of failures in these systems has been observed in recent years. These incidents have resulted in incidents at reservoirs, pumping stations, and rivers, causing increased costs for repairing the structures annually.

To address this challenge, changes must be implemented regarding the safety of hydraulic structures. This involves constant monitoring and prompt processing of data from control and measurement devices installed in reservoirs. Additionally, it is essential to analyze compliance with inspection guidelines and evaluate the structural strength using innovative methods. Furthermore, the experience of other nations in this area should be considered. A skilled approach to assessing the safety of current structures is critical for ensuring their continued reliable operation [2-3].

2 Materials and methods

The scientifically based results of this research will allow us to develop effective practical measures to ensure the reliability of hydraulic structures and prevent possible emergencies [4]. In order to ensure that any safety issues with reservoir facilities do not occur or their impact is minimized, it is necessary to identify the causes of these issues and develop measures to prevent them using a separate approach.

To assess the reliability of reservoir hydraulic structures under the influence of various factors, the technical condition of several reservoirs has been studied. One of the main problems in reservoir operation is overfilling, which can lead to the washing of reservoir banks under the influence of waves and the filling of the reservoir with mud [5].

The probability of an accident in water bodies increases when the Earth shakes during floods and in other emergency situations. Due to the daily use of hydraulic facilities and various impacts over the course of their permanent use, factors influencing their reliability arise. In order to ensure the reliable operation of these water bodies, certain fundamental criteria need to be met. [3, 6-9]:

- At the beginning of this year, a structured dispatch plan was implemented, taking into account changing conditions throughout the year. This ensured reliable water supply to all consumers.
- Control the growth of shores, the turbidity of water entering the basin and the application of counter-measures to reduce the useful volume of water in the range of years, while reducing the turbidity rate of the basin.
- High slope of the dam in increasing the reliability of the exploitation of reservoirs prevent such cases as violations of the protective elements, disturbance of the plates in the atmosphere effect (air temperature and humidity change, wind), rupture, silage, absorption.
- In the filtration processes of dams and their foundations, a significant amount of water is wasted from the dams (along with groundwater). Over time, the dams on the soil structure of the dam become larger, as do the cavities that appear. This is due to increased water consumption through seepage, migration of soil layers, and washing out.
- The fact that the ability to prevent and conduct water failures in water-generating facilities is always in a normative state.
- To prevent the failure of mechanical equipment in the waters (accumulation of congestion in the shutter groove, movement of shutter, failure of shutter moving equipment, drives, drives or elements thereof).
- Prevention of cases of damage to waterproof structures and dams caused by the flow of water downstream from reservoirs and failure of adjacent structures (transfer of large

amounts of water through waterproof facilities, falling stones or other objects, poor quality concrete work, changes to river structure during floods, and lower than the dam level).

- The fact that in the water protection zone of reservoirs, it is allowed to conduct activities that only serve the reliable operation of reservoirs and do not adversely affect it.

3 Results and Discussion

As a research object, the Talimarjan Water Reservoir, located in the Nishan district of the Kashkadarya region, was selected. The district, where the reservoir is located, has a seismicity of 7 points. The building's capital class is II, and construction was completed between 1974 and 1983. The reservoir was put into operation in 1985. It has a total water volume of 1,525 million cubic meters and a usable volume of 1.4 billion rubles. The dam is of the same type, with a height of 35 meters and 2 additional heights of 36 meters. The water discharging plant is a type 2 turbine, and the permeability of water in the center of the dam is 360 cubic meters per second (Figure 1).



a



b

Fig. 1. Talimarjan water reservoir: a) reservoir bowl; b) upstream slope position.

According to the results of the study, the technical condition of the reservoir hydraulic structures revealed the following:

- The top of Dam-1 is in satisfactory condition. Deformations were detected in the slabs P23-P60 (P-Picket) at the mark 390.0 m on the slabs supporting the berm. There are also deformations in the slope plates attached to the berm. Some of the reinforced concrete slabs in the dam cladding are in a slippery condition and the deformation seams are exposed. At the 390.0 m mark, there is a filtration rate of 6-8 m/s to the collector through a reinforced concrete pipe that carries the sediment. Sand is collected in the pipe under the influence of wind, which may have passed through the water intake well from the rainwater drainage system. The water intake pipe is not protected by a reverse filter from the soil spilled on it. In P46-70 in the collector, water leaked from the slope, as a result of which the slope soil flowed into the collector and created turbid pressure.
- The drainage pump station is in critical condition. Large depressions have occurred and the advanced camera at the pump station is beginning to break down. The automatic system that controls the pumps based on water levels has stopped working. Fifty percent of the reinforced concrete slabs holding up the advanced camera's slopes are pushed out of place or are missing, as a filter layer has not been created on the ground where they are located. Filtrated water has leaked onto the sides of the dam. The level of leakage is 2 meters above the water level in the reservoir. The slopes without reinforced concrete are being eroded by the flow of filtrated water. The walls of the pumping station are cracking due to uneven settling. When the water from the drainage system reached the pumping station, the road sank. As did a tray or pipe that carried rainwater and a tray that carried water from gutters. The drainage water is flowing into the advanced camera at the pump station through the damaged concrete cover of the rainwater drainage channel.
- In the case of a water level above the 392 meter mark on the lower slope, the rise of filtration water was observed.
- Closed tubular drainage on the right bank of the drain cannot withstand a decrease in the depression curve when the water level is above 392 m, as water is leaking from the wells of No. 7 piezometer at P4÷ 35 and No. 6 and No. 7 piezometer at P5÷ 70.

To observe the vertical and horizontal movements of the dam, fundamental dams, planned elevation marks, concrete and soil surface marks, and depth marks are installed. Hydraulic triangulation points are also installed to measure water level changes.

In dam 1, 234 piezometers are monitored, but 7 are not working and 10 have insufficient water level control when there is none.

In dam 2, only 27 were used, with 6 being periodically dry. Thus, 35 piezometers need cleaning in dam 1. For 7, 76 meters need replacing, and for 6, 67 more will need digging.

Their sensitivity is low and unsatisfactory due to drilling the wells with a muddy solution and pressing the piezometer filters muddy. It is necessary to check them once a year to increase accuracy. In the reservoir, this work has never been done.

According to data from the Bathymetric Center, the useful capacity of the reservoir as a result of turbidity is 58 million. m³.

The physical and mechanical characteristics of the soil on the body and ground of the dam have not been studied since the period of operation.

The average sinking rates of the elevation marks on the top of the Talimarjan reservoir dam 1 are given in Table 1.

Table 1. Average immersion speed of height marks above the dam.

Field picket	Date	2011	2012	2013	2014	2015	2016	2017	2018
	upstream level, m	393.9	383.0	397.5	382.0	393.5	393.9	394.8	396.9
P-14-29	V_s , mm/y	-4.94	-2.60	-5.64	-2.11	-5.49	-2.31	-8.62	-4.25
P 30-45	V_s , mm/y	-13.26	-1.67	-8.84	-2.56	-6.48	-1.34	-7.53	-3.88
P 46-61	V_s , mm/y	-8.44	-2.17	-6.02	-2.72	-5.31	-1.71	-8.36	-3.35
P 64-80	V_s , mm/y	-7.87	-3.26	-6.39	-2.70	-5.79	-2.35	-9.09	-3.52
P 82-98	V_s , mm/y	-	-2.69	-2.63	-2.83	-6.11	-2.62	-7.76	-3.52

4 Conclusion

If we compare the rates of deposit of dam stamps in this table, it seems that the water level in the dam is correlated with the water levels between 2011 and 2018. In 2019, some of these construction works were carried out by company employees at a slower pace, while in 2020, these works accelerated.

In summary, in order to ensure that each factor does not have a significant impact on the results of the analysis, it is necessary to identify the origins of its occurrences based on a separate scientific examination of each of them and take measures to eliminate these sources.

Determining the safety criteria of hydraulic structures and assessing the risk of accident of hydraulic structures, as well as the study of defects that cause complete or partial loss of capacity of the facility and studying the defects and exploring several options to ensure their sustainability is a difficult engineering task.

References

1. V.A. Volosukhin, On problematic issues in the field of safety of hydraulic structures, Monitoring: Science and Safety. Special issue, 84-97 (2019)
2. Safety of hydraulic structures in Central Asia: problems and approaches to their solution, Almaty, 37 (2011)
3. F.A. Gapparov, S.A. Mamatov, Factors affecting the reliability of the operation of reservoirs, "Ecological and geographical aspects of the use and protection of natural resources in a single natural historical area"-Fergana, 108-109 (2010)
4. V.P. Nedriga, Hydraulic structures, Designer's Handbook, Moscow, 543 (1983)
5. Law of the Republic of Uzbekistan "On safety of hydraulic structures"
6. Z. Risboev, Ensuring the safety of large and especially important hydraulic structures, Journal "Uzbekhydroenergy", **3**, 18 (2019)
7. D.T. Paluanov, R.A. Ermanov, Problems in exploiting hydrotechnical engineering structures: solutions and suggestions, International Journal of Advanced Research in Science, Engineering and Technology, India, **6**, **9**, 10862-10864 (2019)
8. D.T. Paluanov, M.Yu. Yangibaev, Problems arising in the operation of hydraulic structures, Collection of reports of the Republican scientific-technical conference on "The role of intellectual youth in the development of science and technology." Tashkent, 181-183 (2019)
9. M.R. Bakiyev, E.I. Kirillova, R. Khuzhakulov, Safety of hydraulic structures, Tashkent (2008)

10. Yusuf Rashidov, Bahadir Aytmuratov, Barno Abdullaeva, Kobeyzin Aytbaev, Calculation and experimental study of water distributor of stratification heat accumulator of solar heating system, E3S Web of Conferences, TT21C-2023, **383**, 04013 (2023) <https://doi.org/10.1051/e3sconf/202338304013>
11. Yusuf Rashidov, Bahadir Aytmuratov, Kobeyzin Aytbaev, Research of water distribution in stratification heat accumulator of a solar heating system, IOP Conference Series: Earth and Environmental Science, IV International scientific and practical conference "Actual problems of the energy complex: physical processes, mining, production, transmission, processing and environmental protection" 24/11/2021-26/11/2021 Moscow, **990** (2021)
12. Yusuf Rashidov, Bahadir Aytmuratov, Kobeyzin Aytbaev, Dinara Isakova, A water heater that adjusts its temperature based on solar energy, International Conference on Current Issues of Breeding, Technology and Processing of Agricultural Crops, IV international conference on ensuring sustainable development in the context and Environment (CIBTA-III-2024), Of agriculture, energy, ecology and earth science (ESDCA2024) (2024)
13. B. Aytmuratov, M.M. Eshmatov, K.R. Aytbaev, D. Isakova, A water heater that regulates itself for solar heating systems. International Conference Of Science, Technology And Innovation (ICSTI-2024) (2024)