Analytical conclusions and proposals for technical condition and effective use of facilities on Tashkent magistral canal

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Abstract. The socio-economic development of the Tashkent region (Uzbekistan) depends largely on natural resources, especially water resources, as in other regions. One of the canals that supply water to the Tashkent province is the Tashkent magistral canal (TMC). In terms of size, the second of the canals receives water from the left bank of the Chirchik River. The TMC has been 82 years since its start of use. Hydrotechnical facilities on the TMC are typical of the II class. There are many hydrotechnical facilities on the canal: one main structure, four water dampening facilities, two destructive water discharges, four duckers in the canal, 45 water dischargers, one waterfall, seven under-canal duckers, two pipes under the canal, nine aqueducts, nine canal access, thirteen road bridges, one railway bridge, one pedestrian bridge. This article presents the technical condition of the TMC and its hydrotechnical facilities and recommendations developed based on the technical condition. On April 9-13, 2022, field observation work was carried out to study the technical condition of the TMC and hydrotechnical facilities. It reviewed the availability of technical documents of TMC facilities, instructions for their use, information on maintenance of mechanical equipment, working drawings, previous inspection reports, and other materials. In addition, the conclusions of the inspection carried out by the State Inspection "Davsuvkhujalikzorat" and the results of the technical inspections carried out by the employees of the TMC administration and project parameters of water facilities were studied.

1 Introduction

One of the main sources of life on Earth is water. It is known that humanity, flora, and fauna, in general, no creature can live without water [1–4]. Although two-thirds of the Earth is covered with water, 97.5% of it is salt water and is unusable. The remaining 2.5 percent are freshwater resources, 79 percent of which are permafrost, 20 percent of groundwater, and 1 percent of rivers and lakes [5, 6].

The socio-economic development, which has the largest population among Central Asian countries, depends largely on natural resources, especially water resources, as in

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other regions. In addition, the development of the economic sectors of our country, including the agricultural sector, cannot be imagined without water resources [7–10]. Based on this, the main goal of the republic's water management in the future is to accelerate reforms in the water management system, to use the available water resources wisely, to grow abundant crops from agricultural crops through the widespread implementation of economic irrigation technologies and ensure food safety [11,12].

Among the wide-ranging institutional reforms implemented in Uzbekistan in recent years, measures are being taken to increase the efficiency of state management in the field of water management and to improve the water resources management system. Many measures are being implemented to improve the reclamation of irrigated lands, improve the efficiency of water resources use, improve the accounting system, and strengthen the material and technical base of water management organizations [13–16].

At the same time, shortcomings and problems remain in the management and use of water resources, in the design, construction, and reconstruction of water management facilities, and in ensuring the safety of water management facilities. Because many water management facilities have been in service for more than 30-40 years and insufficient attention is paid to their use, man-made situations and emergencies have been observed in some water management facilities in recent years [13,17,18].

As the period of operation of hydrotechnical facilities increases, the timely, qualitative, and complete fulfillment of the requirements arising from the rules and guidelines for the safe use of hydrotechnical facilities is required. Because of the long-term use of hydrotechnical structures, it can cause wear and tear of the devices, equipment, and equipment located in them, and changes in the indicators set according to the projects of the structures [14,16,19,20].

It is known that the hydromelioration system consists of complex irrigation and drainage networks, various hydrotechnical structures, and auxiliary devices. The reliability of such a system depends on its operation, the organization of maintenance during use, and the nature of possible failures in its elements. Therefore, it is necessary to evaluate the hydromelioration system, like other large systems, from the point of view of reliability.

Humanity has faced the problem of building reliable and durable structures since ancient times. Even in the present period, despite the great progress made in the field of water management and reclamation construction, failure of facilities and accidents often occur. This can be cited as the non-observance of reliability rules [21–23].

Today, the total length of irrigation canals in the Republic is 28458 km, of which 18718 km are earthen, 9203 km are covered with concrete, 536 km are canal network, and the number of hydrotechnical structures in them are more than 54000.

The Tashkent magistral canal (TMC), named after I.A. Palvonov, was built in 1940. It was reconstructed in 1958 and 1965. Water is taken from the Left Bank Karasuv River (PK 377), which receives water from the Chirchik River. According to its location, the main canal is in the territory of Urta Chirchik, Pskem, and Buka districts. In terms of size, the second of the canals receives water from the left bank of the Chirchik River.

The TMC has been 82 years since its start of use. For this reason, the issue of modernizing the operation of hydrotechnical facilities in the system of the TMC is an important task. For this reason, the issue of modernizing the operation of hydrotechnical facilities in the system of the TMC is an important task.

Based on this goal, the research aims to solve the following tasks:

Analysis of project materials of the TMC.

Analysis of the current state of structures on the TMC.

Development of technical measures for the safe operation of the TMC

2 Method

On April 9-13, 2022, field observation work was carried out to study the technical condition of the TMC and hydrotechnical facilities. It reviewed the availability of technical documents of TMC facilities, instructions for their use, information on maintenance of mechanical equipment, working drawings, previous inspection reports, and other materials. In addition, the conclusions of the inspection carried out by the State Inspection "Davsuvkhujalikzorat" and the results of the technical inspections carried out by the employees of the TMC administration and project parameters of water facilities were studied. At the time of the inspection, water was transferred along the entire length of the TMC, and 58.6 m^3/s was taken from the main structure.

Hydrotechnical facilities on the TMC are typical of the II class. There are many hydrotechnical facilities on the canal: one main structure, four water dampening facilities, two destructive water discharges, four duckers in the canal, 45 water dischargers, one waterfall, seven under-canal duckers, two pipes under the canal, nine aqueducts, nine canal access, thirteen road bridges, one railway bridge, one pedestrian bridge.

The purpose of the TMC is to irrigate the irrigated lands on the left bank of the Akhangaran River. The total length of the TMC is 61.1 km, with the help of which crops on 65 thousand hectares of land are irrigated.

The main structure is part of the waterworks at PK377+25 of the Left Bank Karasuv River, and it is designed for the maximum water consumption Q = 87.0 m^3/sec. The structure is divided into 6 standard spans with a width of 3.0 meters, and the thickness of the middle wall is 0.8 m. Flat shutters are installed in the spaces equipped with electric lifters.

Duker on PK1+90 was built through the Left Bank Karasuv River with the aim of $Q = 87.0\, m3/sec$. It is rectangular with three standard spans, dimensions BxH=2.5x2.5m, made of reinforced concrete, and equipped with flat shutters equipped with electric lifters.

Fig. 1. Duker on PK1+90.

The catastrophic spillway at PK347+18.5 was designed to discharge Q = 36.0 m^3/sec. The inlet head consists of one span, the dimensions of which are BxH=6.0x4.0 m, equipped with a segmental shutter, which is moved using electric elevators. This facility discharges part of the water from the TMC to the Akhangaron River.

Dukers (Under Akhangaran River). The 1st duker PK349+45, the 2nd duker PK353+60, and the 3rd duker PK370+00 passed through the Akhangaran River are designed for water consumption Q = 74.0 m^3/sec, 4 reinforced concrete pipes, sizes B x H=2.5 x 2.0. The length of the first duiker is 145.0 m, the second is 94.0 m, and the third is 100.0 m.

Water facilities in PK401+00. This structure consists of a dewatering facility, the Gayrat destructive water discharge facility on the right bank, and the Sharkhiya water facilities discharge facility on the left bank. The water humidification facility is equipped with a screw-type, flat shutter actuated by electric hoists, it consists of 3 spans with the dimensions B x H = 6.0 x 2.5 m, and the water throughput is designed for Q = 65.0 m^3/sec.

The main structure supplying water to the "Northern network" in PK445+10. The structure is single-span, with dimensions B x H = 3.0 x 2.0 m, equipped with a flat shutter operated by electric lifts, and water consumption 6 m^3/sec.

"Southern branch" main structure at PK472+45. The main structure of the "Southern network" was built together with the bridge; it consists of two spans, the dimensions of B x H=2.0 x 2.0 m. It is equipped with a flat shutter operated by electric lifts; water consumption is 12 m^3/sec.

Water facilities in PK483+58. Its composition consists of water regulating facility and the main structure of the Borijar network. The water humidification facility is equipped with a flat shutter operated by electric lifts and consists of 2 spans with dimensions B x H = 3.0 x 2.0 m. The main structure of the Borijar canal consists of 3 spans with a width of 1.0 meters, equipped with a flat shutter, a screw lift mechanism, and a water flow capacity of 2.0 m^3/sec.

Water regulating facility in PK550+50. It creates pressure in the water supply canal of the "Yem-Korgon" pumping station. Its dimensions are B x H = 2.5 x 1.5 m and consist of 3 spans. Equipped with flat shutters, a mechanism with a screw lift, water flow capacity of 50.0 m^3/sec.

Water facilities in PK611+14. Its composition consists of the main structures of the Right and Left branches of the Tashkent canal, the "Urisarik" catastrophic spillway, and the facility receiving water to the Okchakma pumping station. The main structure of the Right branch is equipped with a 4.0 m wide single-span flat shutter, a two-screw lifting mechanism, and a water capacity of 12.0 m^3/sec. The Left branch main structure is equipped with a 5.0 m wide single-span flat shutter, a two-screw screw lift mechanism, and a water throughput of 26.0 m^3/sec. The "Urisarik" catastrophic spillway consists of a single span of 1.5 m, equipped with a manually operated flat shutter, with a water throughput of 9.0 m^3/sec. The distance from the bottom of the trough to the surface of the water in the lower basin is 8.0 m.

Water intake facilities. They serve irrigation purposes. All of them are made of reinforced concrete pipes equipped with a manually operated flat shutter. Their water permeability is from 0.125 to 1.5 m^3/sec.

Pipes under the canal. The purpose of the pipes is to pass flood and rainwater in streams, which are made of precast concrete in one row. The dimensions of rectangular cross-sections are B x H=2.0 x 2.0 m, and the diameter of some circular ones is from 0.75 m to 1.5 meters.

3 Results and Discussions

On April 9-13, 2022, the results of the field observation on the study of the technical condition of the TMC and the hydrotechnical facilities located in it show that the technical condition of the canal bed and hydrotechnical facilities are not satisfactory. There are many reasons:

Defects in the canal bed. Some sections of the canal route covered with concrete pavement were almost destroyed, and cracks in the concrete pavements at the bottom of the canal and on the side slopes led to the washing of soil under the concrete and the appearance of voids under the concrete. As a result, the concrete pavement has deteriorated, and in some places, there is no concrete pavement at all on the slopes. Some parts of the bottom of the canal are covered with gravel; in some places, it is muddy and filled with various discharges. This, in turn, can damage the structures around the canal in the canal, including:

– In the part of the canal from PK 14+50 to PK 22+50, on the right and left sides of the slope, sediments have accumulated at the bottom.

– In PK 46+50 of the left side of the water protection zone, the slope has been changed arbitrarily.

– In the part of the canal from PK 60+66 to PK 62+45, the damaged areas of the left slope coupling were identified.

– In the PK 80+67 part of the canal, the right and left slopes are covered with vegetation.

– The concrete cover on the left slope of PK 87+80, PK 88+54, PK 88+90, PK 539+04, PK 550+52 is damaged and covered by plants (reeds) in some places.

– On both sides of the canal stretch, PK 91+80, PK 141+65, PK 150+82 to PK 168+50, PK 189+10 to PK 194+00, PK 289 to PK 347 were observed.

– Water leakage occurred on the left slope from PK 120+05 to PK 130+20.

– No engineering facility has been established to allow flood and water disposal facilities to enter the canal.

– Deformation along the canal cross-section was detected in the sections of the canal without concrete covering.

Fig. 2. Defects in the canal bed.

3.1 Defects in the hydrotechnical facilities

The main structure is at PK 0+00. Shutters are not covered with anti-rust coating; their rubber gaskets dry and leak water; when fully closed, water leakage is up to 1 m3/s. The shutters and hydromechanical equipment of the shutters have been in use for more than 70 years and are in bad condition without been replaced. Damaged areas of the concrete cover were observed on the right and left sides of the water-carrying canal. There is no backup power supply.

Duker on PK1+90. Barrage (dam) in the Korasuv Riverbed, which protects Duker Pipeline from discharges flowing in the water and ensures the stability of the Duker Pipeline, was broken. Damaged waterpower damper lining in the lower part of Duker.

The catastrophic spillway in PK 339+60. The shutters and manual hydromechanical equipment of the shutters have not been replaced. Their service life had passed. The mechanical equipment is not coated against rust, and the rubber seals are broken. The water carrying channel is not fortified**.**

The following deficiencies were identified in the Dukers (Under Akhangaran River).

The 1st duker in the PK349+45. Duker does not have protective bars at the exit. There are also cracks in the concrete pavement. Lifting screws are temporarily fixed to the shutter's frame with fittings' help. The shutters and hydromechanical equipment of the shutters have been in use for more than 70 years. Expired, must be replaced. The shutters are not coated against rust, and the rubber gaskets are out of order. There is no protective cover on the 3 shutters. The service bridge over the Akhangaran River is broken, and there are no protective fences on the passage. Duker No. 2 in PK 353+60 passed through the Akhangaron river. Duker does not have protective bars on the exit. As a result of damage at the end of the barrage (dam), the duker pipe was opened, and the top of the concrete cover of the outer pipe was damaged. There are no protective bars in the exit part of duker, as well as broken and damaged areas of the concrete cover. Duker No. 3 in PK 370+00 from the Akhangaran river. Duker does not have protective bars at the entrance. At the edge of the Duker pipeline, the density of the upper part is disturbed. Duker has no protective bars on the exit.

In the study of the technical condition of the main regulators in the Northern network (PK 445+07), Southern network (PK 472+45), Ong-Tarmok (PK 611+14), and Borjar network, the following deficiencies were identified: the valves were not coated against rust, rubber seals dried out (not lubricated in time), resulting in water leakage. Some prisons are not fully equipped and do not have lifting mechanisms.

In addition, there are broken areas of the concrete coating in the inlet and outlet sections of the pipes under the channel. 80-90% of the sections of the inlet and outlet sections of the water pipes are covered with mud. Information about the capacity of the water receiving facilities and the amount of land they irrigate is not recorded. Most of the locks' mechanical equipment is in poor condition (defects mainly in the lock sheets, lifting mechanisms, and concrete parts). Bridges do not have railings, and the asphalt pavements on the crossings are damaged. Pedestrian bridges do not have decks or guardrails.

Fig. 3. Defects in some hydrotechnical facilities.

4 Conclusions and Recommendations

The field observation work conducted to study the technical condition of the TMC and the hydrotechnical facilities in it shows that the following recommendations have been developed to improve the reliable and safe operation of the TMC.

First, cleaning the channel bed from mud and various plants is necessary. Because muddy sediments and vegetation at the bottom of the canal interfere with the flow; as a result, there is a risk of flooding on the banks of the canal.

Secondly, it is necessary to eliminate all deficiencies in the canal mentioned above receiving main structure, dukers, and catastrophic spillways (repair of concrete coatings, replacement of hydromechanical equipment, transfer of backup power supply system).

Fourth, in water facilities, anti-corrosion coating of valves, replacement of rubbers, installation of sensors, and protective caps on lifting screws of electric motors and valves.

Fifth, restoration of broken railings and damaged asphalt pavements on bridges for vehicles and operation, restoration of free traffic along the canal bank, repair of road crossings, and the length of the canal, it is necessary to install the columns indicating the kilometer. In addition, it is necessary to build engineering structures in some places of the canal water intake facilities to ensure the reliable operation of communication means and others.

Also, for reliable and safe use of magistral canals, the following should be done: showed that it is necessary to carry out current repair works in all facilities located on the channel once a year based on a certain schedule, during the current maintenance, the sediments deposited in front of the gates should be cleaned, the metal parts of the structures should be painted twice a year with special anti-corrosion and erosion paints, screws of lifting devices must be lubricated, cracks or changes in concrete parts must be repaired, gauging stations included in the structures must always be kept in working condition [13–16, 19, 24–26].

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