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# The Concrete Lined Canals' Diagnostic and Monitoring Methods: TASHKENT MGISTRAL CANAL

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**ABSTRACT**: Lining of canals is an important for irrigation systems as it improves the flow characteristics and minimizes a loss of water, controls and retentions the canal shape, leads to increase hydraulic efficiency and resistance to erosion. The research is devoted to improve the concrete-lined canals technical state assessment and diagnose methods by using a modern (non-contact) equipment. The research object is the Tashkent Magistral Canal at the Chirchik-Ahangaran Basin providing water to agricultural areas. The concrete lined canals commissioned 30-40 years ago need to be assessed and diagnosed, as well as regularly monitored in order to prevent further damages. The results indicate that the regular monitoring by the proposed method serves for the follow-up quality control of the concrete lined canals.

**KEY WORDS**: canal, concrete lining, hydro structures, assessment, monitoring

## I.INTRODUCTION

The role of hydrotechnical structures in the agricultural sectors is very important, and special attention is paid to the development of reliable and effective technologies for the irrigation systems use. Canal lining is adopted as one of the measures to control the hydraulic efficiency of the irrigation systems, which depends on its quality (Akkuzu E., Balonin N., and et. al.2010). In this regard, study the technical state of concrete-lined canals and structures, extend their service life, improve a diagnostic system using new information technologies and carry out continuous monitoring to ensure their reliable operation, conducting preventive maintenance and restoration activities are important issues.

Since a canal lining is adopted as one of the measures to control the hydraulic efficiency of the irrigation delivery system, the problems of technical condition, reliability assessment and service life extension of hydrotechnical structures and hydraulic performance of lined canals are need to be continuedly monitored including detail study processes (Alimov A., Balonin N., Volosukhin V., Ghulam Zakir-Hassana, Dolgushev I., Kolganov A., Kosichenko Y. and others). In particular, the conditions and criteria of reliability of irrigation canals have been determined by many scientists and engaged in improvement of the theoretical basis for determining the operation process of concrete-lined canals (Altunin V., Baev O., Sklyarenko E., Kraatz D. and et. al.). The study of water permeability through the cracks of concrete linings of canals was carried out by Abelishvili G.V., Bandurin M. A., Martin, C. A., Gates T. K., Lomize G.M., Marley V. E.

The benefits derived from the lined canal are very high. At the same time there are some disadvantages observed as well as if the lining is damaged it is difficult to repair it, the lined canal is a permanent structure hence it is difficult to reconstruct the outlets, a canal lining requires a heavy expenditure (Shilpa Devi Gadde and et. al.2019). The analysis of scientific works has shown that the damaging process of concrete lines of canals takes place due to long term hydrodynamic processes in the canal and appearance of cracks, its silting (Bandurin M. 2010). It has been established that vertical stresses grow along the channel axis, and horizontal stresses grow perpendicular to the channel axis. A loss of stability of reinforced concrete elements occurs with an increase in the size of the defect and their displacement takes place (Volosuhin Y.2012).

The aim of the research was to improve of the concrete-lined canals technical state assessment and diagnose methods by using a modern (non-contact) equipment, improve the useful work coefficient calculation methods and propose the canals' service life increasing measures.

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## II. STUDY AREA AND METHODOLOGY

The total length of the irrigation canals system in the Republic of Uzbekistan are over 25,500 km, of which 9,300 km (36%) are lined with concrete. Most of the irrigation systems were built more than 30 - 40 years ago. During the operation process many changes have occurred in these canals and accordingly water transfer efficiency has changed. At present, the technical conditions of most main and inter-farm canals and hydrotechnical structures have deteriorated in the operation process and have not met the demand. According to the data analyzes their average efficiency decreased to 60-70% (Baev O., Sklyarenko E. 2020).

The Tashkent Magistral Canal (TMC) at the Chirchik-Ahangaran Basin was selected as a research object. The TMC was built and commissioned in 1940. Water source is Chirchik River, the canal abstracted water from left bank of the river. The canal provides water to Buka, Ahangaran, Urtachirchik, Bekabad, Pskent and Akkurgan districts of the Tashkent region for irrigation of 70 000 hectares agricultural lands. The canal length is 72 km of which 35 kilometers are concrete lined. Its maximum capacity is 87 m3/s, normal operating – 79 m3/s, minimum discharge is 20 m3/s. The following 120 structures are installed on the canal: 22 hydro-structures (water intakes, spillways, and etc.), 15 bridges, 11 duckers, 9 aqueduct and 63 hydro posts. The canal parameters change along with length is indicated in Table 1.

Table 1. The TMC canal characteristics

| # | Canal sections | $Q_{max}$, $m^3/s$ | Width | | Depth m | Side slope | Bed slope | Flow speed, m/s |
|---|---|---|---|---|---|---|---|---|
| | | | bottom m | surface m | | | | |
| 1 | PK0+00- PK 38+47 | 87 | 16 | 27,5 | 3,79 | 1,5 | 0,00014 | 1,14 |
| 2 | PK 38+47- PK 321+60 | 84 | 15 | 27,5 | 3,72 | 1,5 | 0,00014 | 1,13 |
| 3 | PK 321+60 - PK 428+50 | 74 | 14 | 26,2 | 3,70 | 1,5 | 0,00014 | 1,05 |
| 4 | PK 428+50 - PK 611+14 | 65 | 12 | 23,4 | 3,08 | 1,5 | 0,00013 | 0,98 |

28% of the irrigation systems of the Chirchik-Ahangaran Basin have a concrete cover. Information on the technical condition of all irrigation systems in the region, has been collected, studied, and deficiencies were identified. The concrete lining of the canals is damaged in many places, the efficiency of water transfer is low. The concrete lined parts of the TMC are introduced in the Fig.1.

The modern methods of quantitative assessment of the technical condition of water bodies and methods of operational monitoring of water facilities based on using of "non-destructive non-contact test equipment" (BKSU) have been developed. In order to improve the technical diagnostics of water management facilities, research is conducted aimed at assessing their technical condition and the level of damage and damage risk for each facility.

In order to study the concrete-lined parts of the channel, the investigation is carried out using a modern ultrasonic defectoscope model A1220 and determined the damages, thickness, density and its strength parameters.

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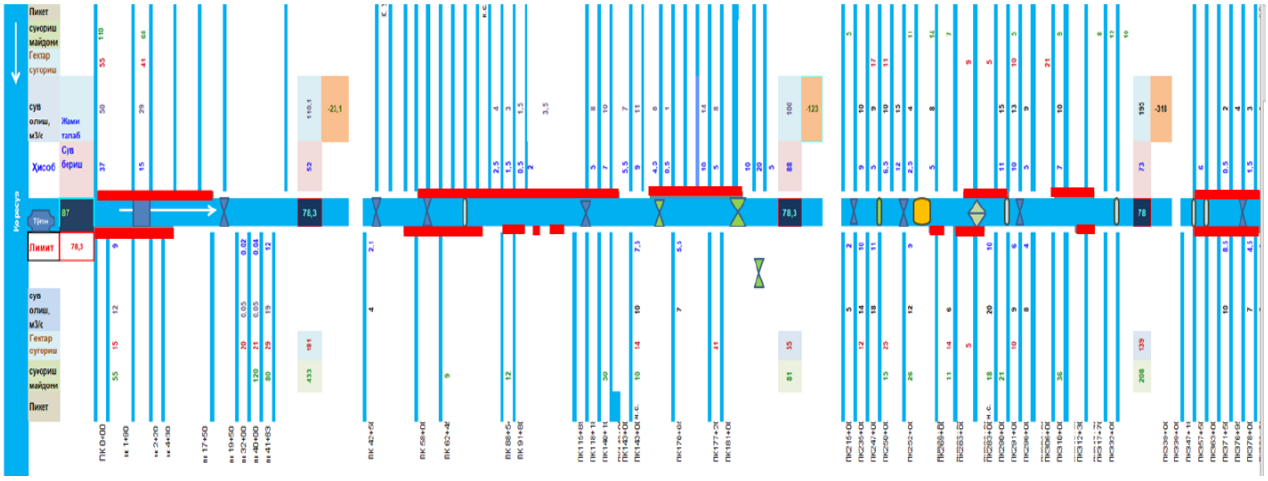
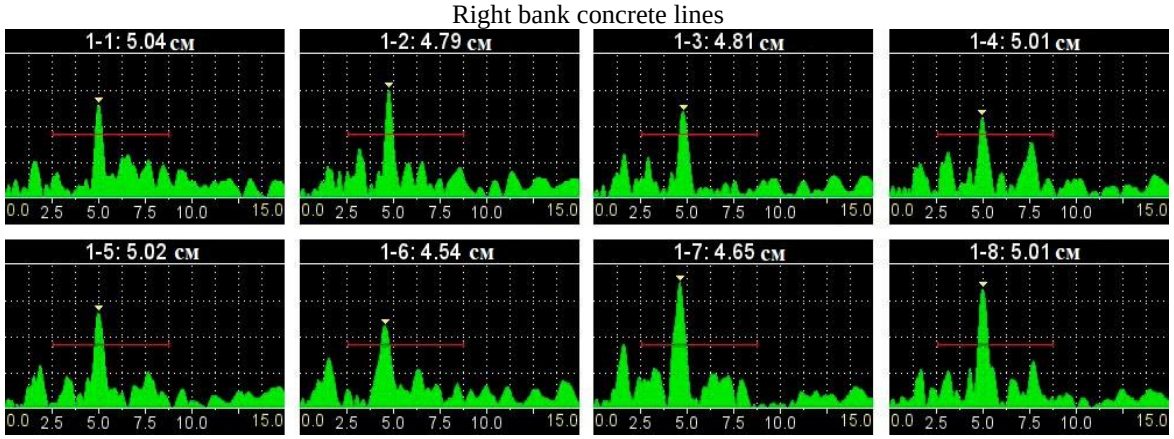


- concrete lined parts

Figure 1. Concrete lined parts of the TMC

Measurement was organized in the following order: on the right bank the areas with a surface of 2 m2 were selected, divided into 20 cm squares, and measurements were made using the device in each square. It is necessary to hold the device at each point for 10 seconds. Then, the left bank was also measured as mentioned above. Measurements on the right and left banks were carried out in 8 blocks.

Right bank concrete lines




Left bank concrete lines

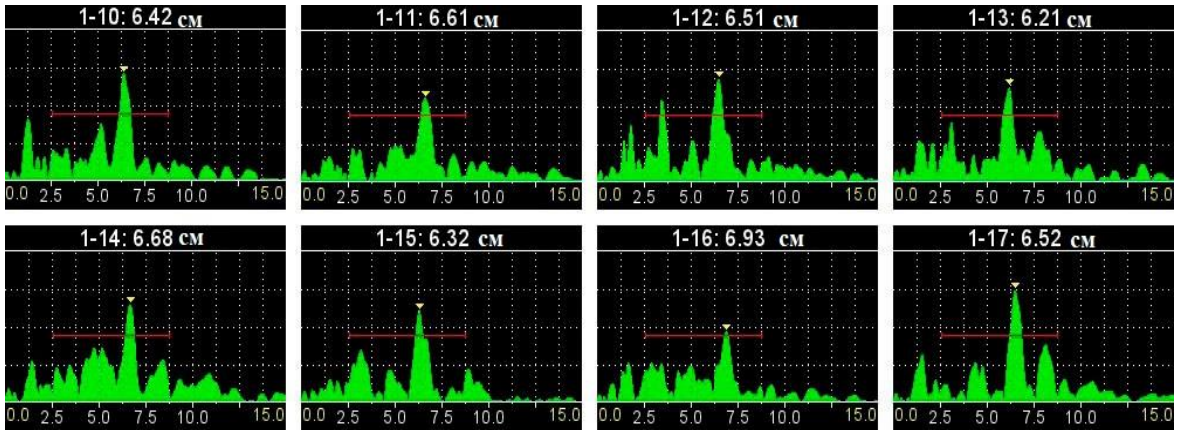



Figure 2. An A-scan image of a concrete pavement

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The thickness of the concrete cover, the defects in the composition and the distance between the reinforcements and their quality (rust) were determined. Figure 3 shows the X-ray image of the concrete, location of the reinforcements, distances between them, and changes in the quality of the concrete mass.

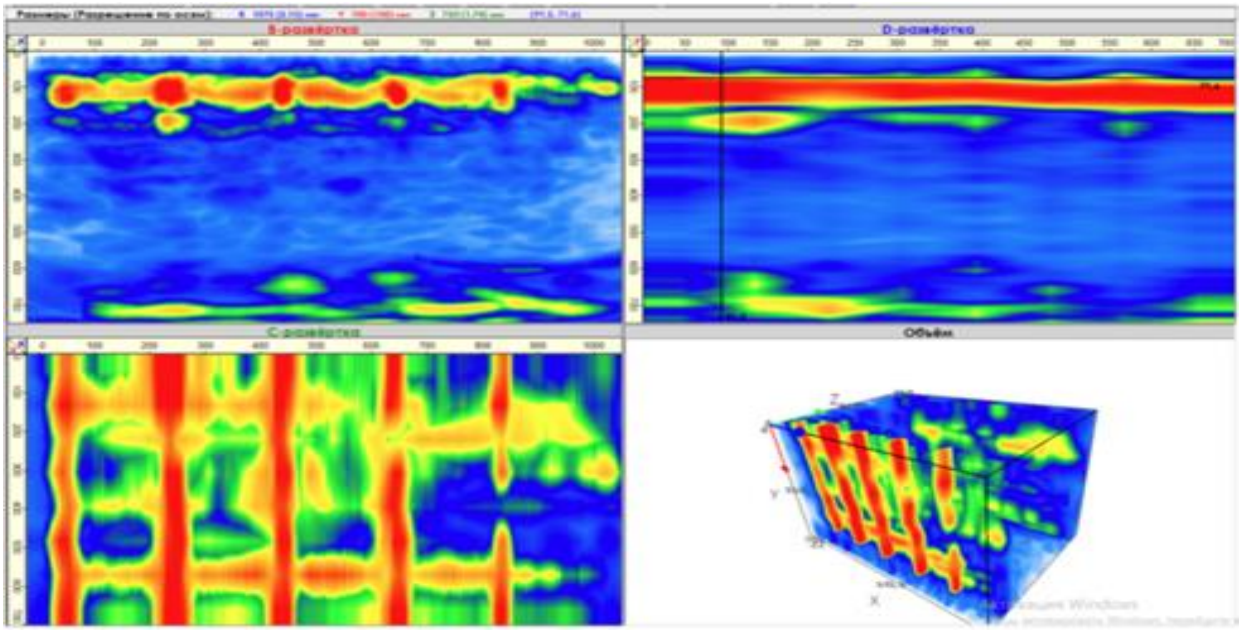
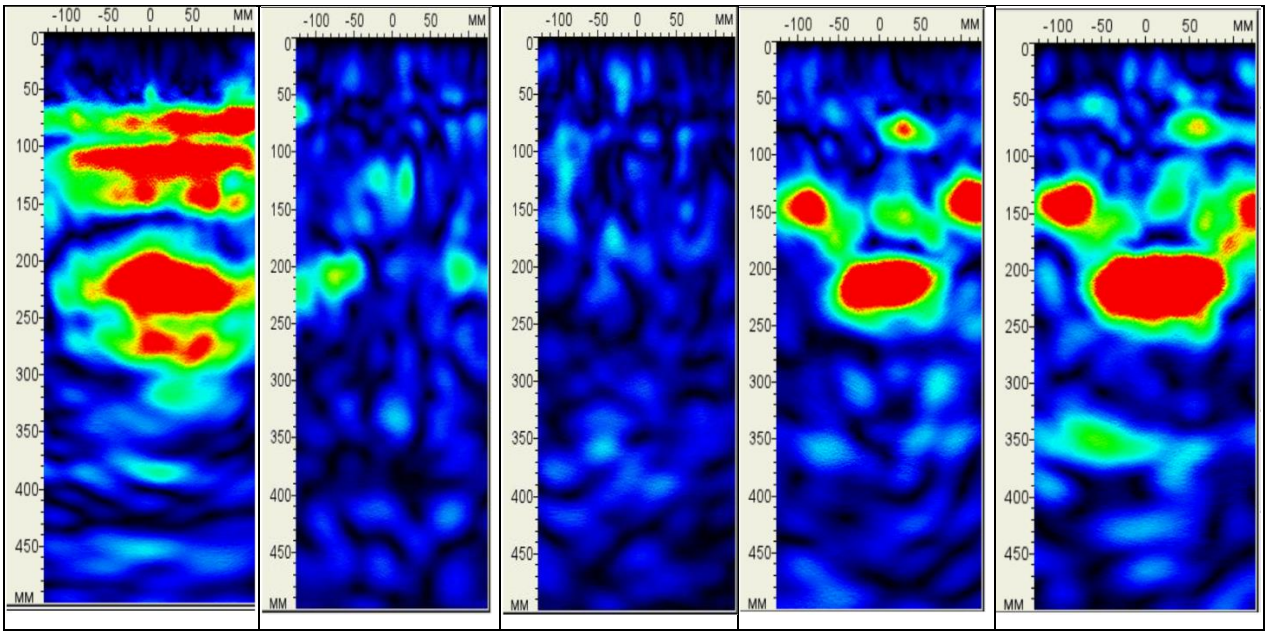


Figure 3. X-ray image of the concrete cover

The measurement results on the right and left banks of the TMC show that the selected area is covered with a concrete up to 25 cm thick, and it was found that 8 mm reinforcement was poured with an interval of 20 cm2. The vertical reinforcement is located at a distance of 20 cm. In the horizontal position, the dimensions have changed from 15 cm to 30 cm. In addition, the defects, internal voids, cracks, which are not visible in the concrete, were shown in the Figure 4.

According to the TMC technical state study results 28.4% of the concrete part is in an emergency condition, 27% is in an average condition, and 44.6% is satisfactory.



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| | | | | |
|---|---|---|---|---|
| Porosity 100-150 mm and 200-250 mm deep | Clean concrete without voids | Clean concrete without voids | There is a gap of 150 mm and 220 mm deep | There is a gap of 150 mm and 230 mm in depth |

Figure 4. B-scan results

## III. RESULTS AND DISCUSSION

The following parameters were identified as indicators of the technical state of the hydraulic structures: compliance of the actual geotechnical, hydrological indicators of the canal and structures with water management mode adopted in the design; adequacy of water permeability of the concrete channels and structures; the satisfactory water level maintenance; compliance of the canals' technical condition with the specified maximum permitted design values during its operation; hydrotechnical structures changes in strength and stability; compliance of installed emergency protection and automation tools of hydrotechnical facilities with standards and technical requirements. At the study the following indicators affecting to state and operation of hydrotechnical structures were taken into account: precipitation, horizontal displacements, tension stresses, deformations, filtration.

The scientific significance of the research results will be reflected at the management of irrigation systems and hydrological processes, evaluation of the technical state of water structures, effectiveness of control tools and monitoring methods, modeling of the reliability of irrigation systems and risk level limits, flow regulation and water balance, efficiency of water using, extending the service life of hydrotechnical facilities. The practical importance is explained by the fact to assess the technical condition of concrete-lined canals using modern (non-contact) equipment, and to clarify the sections of the concrete lining that are likely to break in the near future.

Based on the obtained results improved a procedure for assessing, diagnosing and monitoring the technical condition of concrete canals and hydrotechnical structures has been improved. In addition, assessing the residual life of long-term operated water supply structures and operational monitoring of the technical state of the structures using non-destructive testing methods and the methods of calculating of concrete damage and the appearance of cracks improved.

As a result of the research, a regulatory document for "Assessment, diagnosis and monitoring of the technical state of concrete lined canals and hydrotechnical structures" has been developed and approved by the Ministry of Water Resources of the Republic of Uzbekistan. The opportunities created for efficient delivery and distribution of water resources, reduction of water lost and improvement of water supply for agricultural areas, including a water balance calculation.

## IV.CONCLUSION

Lining of irrigation channels is considered as a potential solution for improving hydraulic efficiency the canals. In the present study the impact of concrete lining on the Tashkent Magistral Canal's efficiency and reduction in technical state of the canal during long operation period have been investigated. Evaluating the efficiency of lined irrigation channels is important for understanding the performance of the irrigation system. The study results provide data on hydraulic efficiency of the system what is important at irrigation of agricultural lands across the country.

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