CENTRAL ASIAN JOURNAL OF THEORETICAL AND APPLIED SCIENCES

Volume: 04 Issue: 10 | Oct 2023 ISSN: 2660-5317
https://cajotas.centralasianstudies.org

EXPERIMENTAL INVESTIGATION OF FLOW UNDER SLUICE GATES

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Received 28th Sep 2023, Accepted 29th Oct 2023, Online 2nd Nov 2023

Аннотация: *Field studies on improving the methods of determining water discharge under the sluice gates were conducted in the gates receiving water from different water taking points of the Tashkent magistral canal, Tashkent region. The main purpose of the field research is to test the results of the experiments conducted in the laboratory base of the NRU "TIIAME" in natural field conditions.*

Field studies were conducted in irrigation networks located in different geographical conditions of the Republic of Uzbekistan. Acceptance of these areas as a research object directly consists in taking into account the influence of different operating conditions, diversity of the composition of river flows, soil conditions and other indicators.

Ключевые слова: *irrigation, channel, water consumption, useful work coefficient.*

INTRODUCTION

Tashkent magistral canal - receiving water from the Karasuv river, taking point is 36th km of river, the total length is 62 km, the water discharge in the beginning part is 87 m^3/sec, the irrigation area is 70 thousand ha. A reserve on the left side of the river allows irrigation of the land. The channel saturates the low-water Ohangaron catchment with water from the Chirchik River. In the canal, There are branches called the North, South, Borjar, Chilisoy, Left and Right banks. Also, there are some bridges, two dams, three culverts with lengths of 145 m, 94 m and 100 m. Culverts were built at the intersection of the Tashkent canal and the Ohangaron river. From the first culvert, water from the Ohangaron river is poured into the Tuyabogiz reservoir. The main water distribution stations are electrified and provided with telephone connection. The canal was built in 1941, the right and left branches are the largest branches. The length of the right channel is 38 km, the capacity of water transfer is 12 m^3/sec, there are about 30 waterfalls, spillway and water outlets.

According to previous researchs (Fig. 1), the state of reliability of the Tashkent magistralcanal was determined as follows: only 9.4% of lenth of the canal is in good condition, 71.4% is in satisfactory condition, and 18.9% is in unsatisfactory condition.

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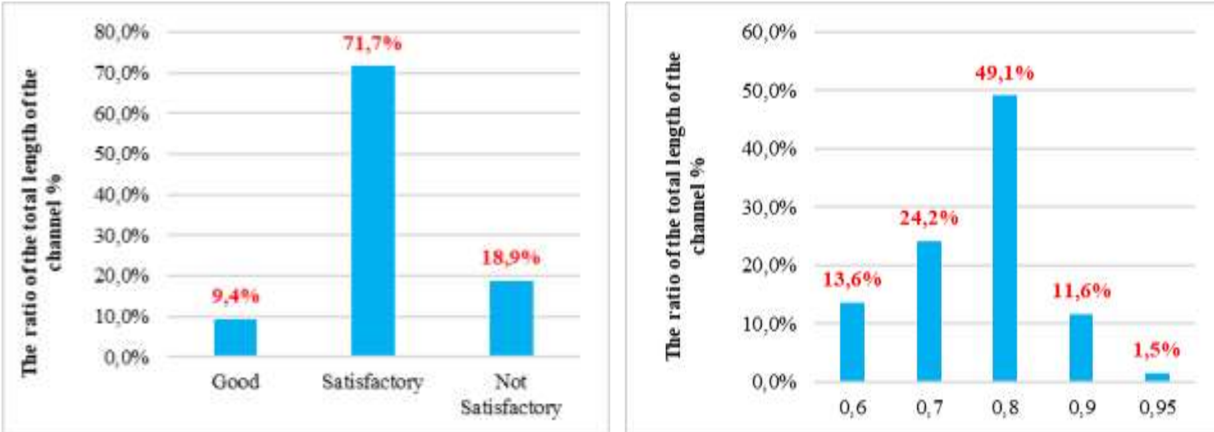
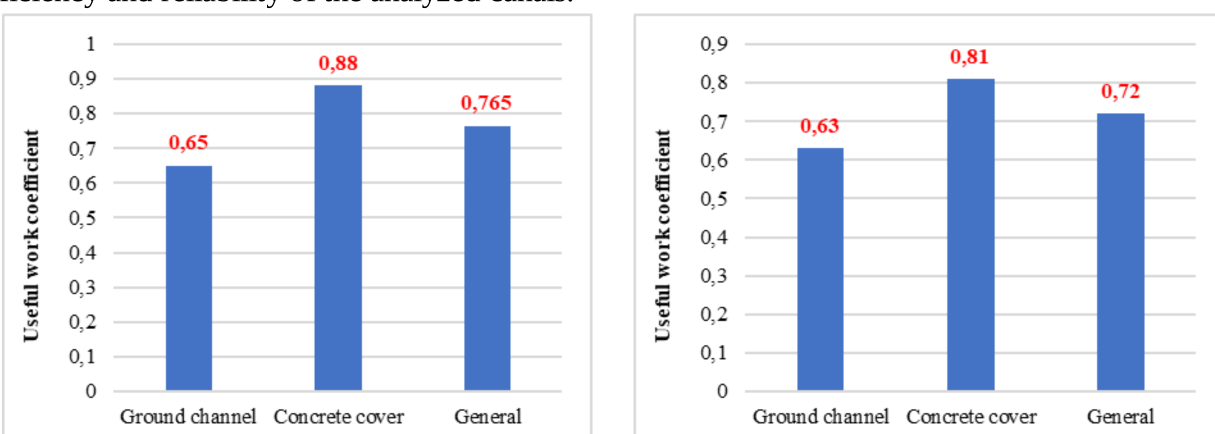


a) technical condition b) useful work coefficient

Figure 1. Analysis of the condition of the Tashkent magistral canal

Since the technical condition of the channel is marked as unsatisfactory by 18.9%, it is recommended to carry out its repair and reconstruction works.

As shown in Figure 2, the magistral canal and its branches have a useful performance coefficient (UPC) ranging from 0.63 to 0.88, while only 12 percent have a UPC value of 0.90 or greater. It is known that according to regulatory documents, the magistral canal and its branches should not be less than 0.90 UPC. The coefficient of useful work of the canals not only indicates the water carrying capacity of the canals, but also determines the amount of water lost in it, which in turn indicates the low hydraulic efficiency and reliability of the analyzed canals.



a) the magistral canal b) branches

Figure 2. Useful work coefficients of the Tashkent magistral canal and its branches

Hydrometric measurements in natural field conditions were carried out using traditional and modern methods. Research was conducted at the sluice gate at the water intake of the Sangrau canal, which receives water from the RK-5 canal, which is the first right branch of the Tashkent main canal. The total irrigated area of the Sangrau canal located in Orta Chirchik district of Tashkent region is 1748 hectares. It irrigates 273 hectares of cotton, 497 hectares of grain, and 978 hectares of other crops (Tab 1). Water discharge according to the project is 4.2 m^3/s, currently it is 3.5 m^3/s. The number of gates is 1 piece, the

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depth of the gate is 2.8 m, width is1.50 meters (Fig 3). It was found that the flow level in the lower part of the structure does not affect the flow value coming out of the gate, that is, it is not buried (σ=1).

Table 1

An irrigated area attached to the Sangrau canal

№	Crop types	Area	
		ha	%
1.	Cotton	273	15,6
2.	Wheat	497	28,5
6.	Other crops	978	55,9
	Total:	1748	100

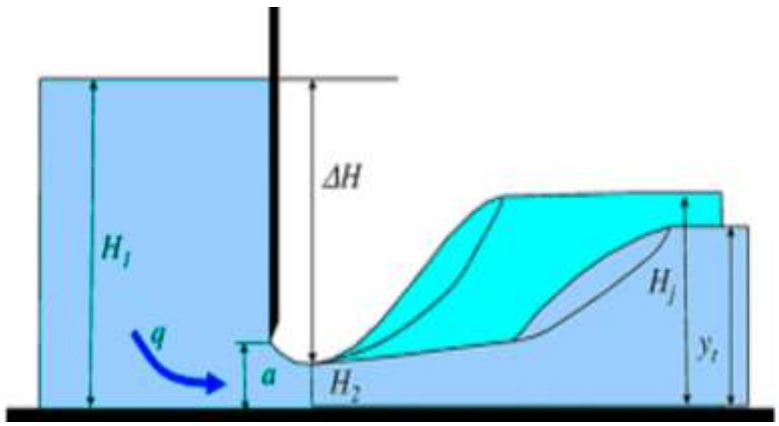

Figure 3. Calculation scheme of the object of field research

METHODS AND MATERIALS

For different values of the gate opening height α, the flow rate was measured using a hydrometric flowmeter GR-21 (taring equation ϑ= 0.423n+0.018) at the water measuring station in the lower bef, and the water discharge Q was determined. Calculations were carried out using the velocity field method at a hydropost of the fixed channel type located downstream of the water intake. Field studies were carried out according to the method of conducting in laboratory conditions. In field studies, water discharge was measured in real time, while Q=f(H) of this hydropost and the water discharge passing through the sluice gate installed at the water intake were calculated using the available calculation formula. The field survey datas are presented in Table 3 below.

Based on the obtained results, the discharge coefficient for the gate μ was determined in the following calculation sequence.

$$\mu_d = \frac{Q_{general}}{b \cdot a \cdot N \cdot \sigma \cdot \sqrt{2g(H_0 - \varepsilon \cdot a)}}$$

Where: *a*– gate rise height;

b – gate width;

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H_0 – total pressure.

ε – vertical compression coefficient, its values are calculated by N.E. Zhukovsky's equation or can be determined by A.D. Altshul's formula:

$$\varepsilon = 0{,}57 + \frac{0{,}043}{1{,}1 + \frac{a}{H}}$$

Table 3

Results of field research at water taking point of Sangrau Canal

Number of experiments	H, m	a, m	Estimated water discharge passing through the sluice gate	Discharge of water passing through the hydropost
			Q, m³/сек	Q, m³/сек
1	0,45	0,35	0,8	0,6529
2	0,58	0,32	0,76	0,7418
3	0,60	0,29	0,55	0,7003
4	0,65	0,26	0,51	0,6678
5	0,68	0,23	0,45	0,6172
6	0,73	0,20	0,45	0,5677
7	0,78	0,17	0,4	0,5069
8	0,86	0,14	0,35	0,4456
9	0,96	0,11	0,3	0,3742
10	1,01	0,08	0,25	0,2806
11	1,11	0,05	0,1	0,1847
12	1,27	0,08	0,15	0,3158
13	1,35	0,11	0,35	0,4465
14	1,36	0,14	0,51	0,5682
15	1,35	0,17	0,65	0,6843
16	1,32	0,20	0,74	0,7905
17	1,25	0,23	0,76	0,8761
18	1,19	0,26	0,8	0,9574
19	1,08	0,29	0,85	1,0018
20	0,90	0,32	0,85	0,9824
21	0,80	0,35	0,85	0,9877
22	0,64	0,38	0,8	0,9148

RESULT AND DISCUSSION

The following results were achieved within the framework of the conducted research. First, the relationship between calculated and measured values of water discharge was compared (Fig. 4).

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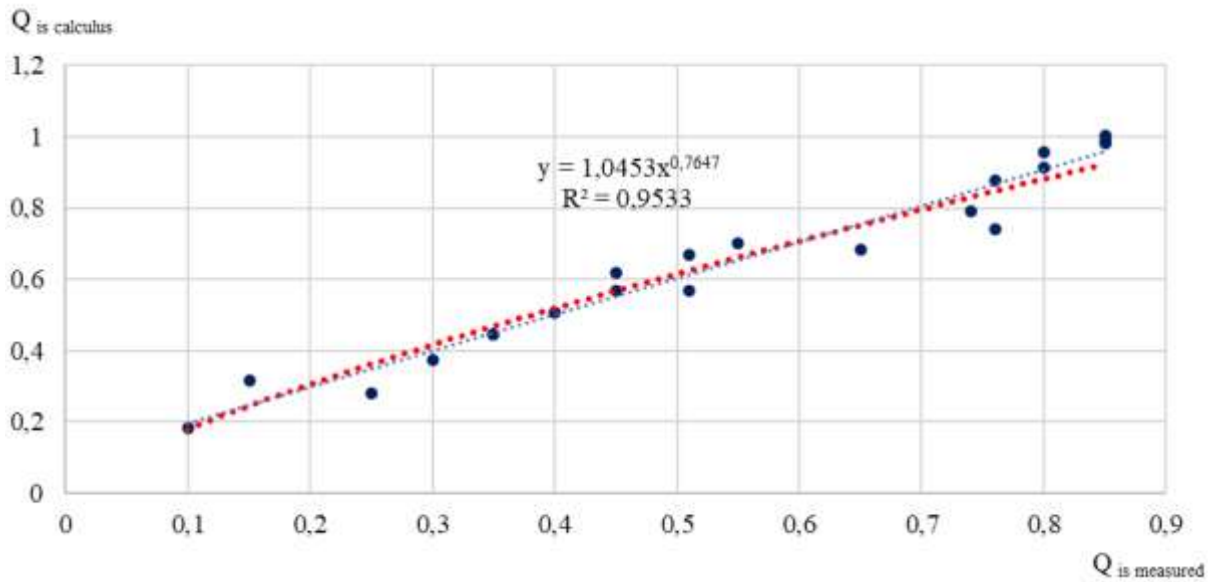

Figure 4. Relationship between calculated and measured values of water discharge

The graph shown in Figure 4 above shows that the difference between the measured and calculated water discharge is very high. This shows that there is a great need for research in this area. According to the analysis, the difference between measured and calculated water discharge ΔQ is from 0.14 to 0.16 m3/s.

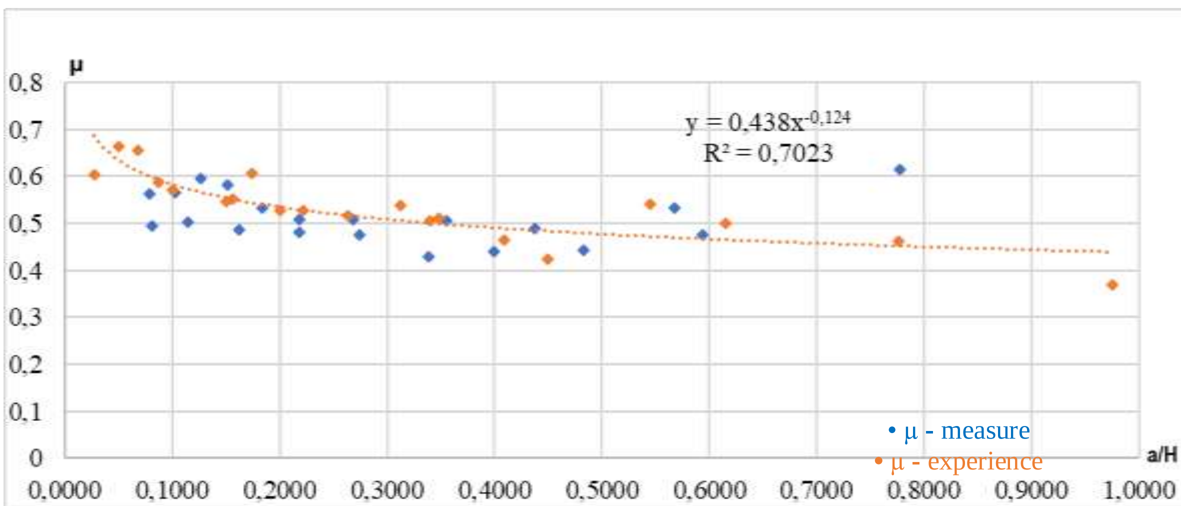

Figure 5. Comparison graph of laboratory and field experiments at Sangrau Canal intake

The results of the measurements in Table 3 and the analysis of the graph 5 showing the results of the field research show that different results were obtained when calculating the flow of water flowing through the sluice gates by hydropost and calculation formulas. This requires conducting research on further improvement of measurement and observation methods and tools. In these cases, the water discharge data measured at the hydroposts and determined by the standard curve are close to each other and can be accepted as requirements for actual measurements. Taking the water discharge measured at the hydropost as the actual water discharge, the water discharge calculated according to the calculation formula (1) of the water discharge passing through the gate differs sharply. This is due to the fact that the

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main reason that this formula (1) is limited to the purpose of determining the water permeability of structures at the design level is due to the fact that the discharge coefficient is assumed to be constant when calculating the flow of water flowing under the gate.

The results of the experimental research show that as a result of the change in the height of the opening of the gate, it is confirmed that the hydraulic processes change and affect the discharge coefficient. The results of experimental research were also confirmed in field conditions. Based on this situation, it is necessary to take into account the variability of the discharge coefficient during the flow of water under sluice gates under field conditions.

If it is possible to accurately measure the water discharge measured at the hydropost for the condition of free flow through the sluice gates, it is possible to achieve economic efficiency by reducing the number of structures in the management and distribution of water resources in the internal networks of the economy.

Figure 6. Studies at the sluice gate of the Sangrau Canal

Figure 7. Studies at the sluice gate of the Sangrau Canal

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CONCLUSION

From the results of the above research, it is known that in the case of a/H=1, so the effect of the gate on water discharge is reduced. In it, only the threshold and side supports can be affected to a certain extent.

In this study, the ratio of the opening height of the gate to the water level at the top, the case of a/H<1 was considered. So, in the case of H>a, the effect of the gate is observed, if the relationship between the two terms is H>a, then the discharge coefficient approaches μ→0. Therefore, the graph of μ=f(a/H) was found to be in the following form.

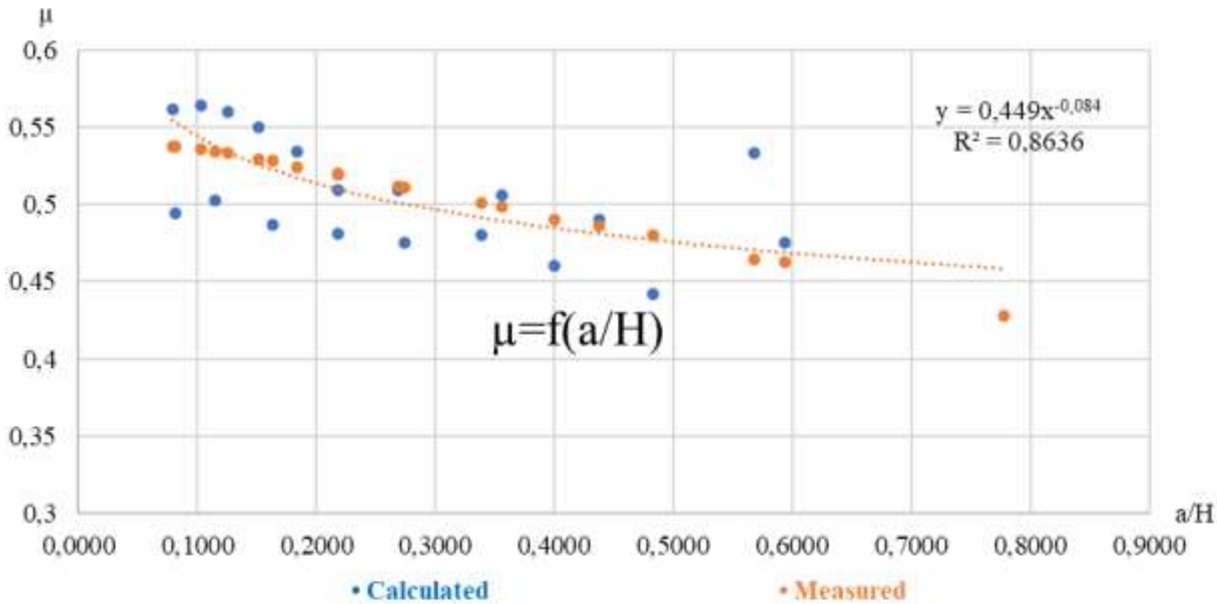

Figure 8. The graph of the change of the discharge coefficient of the sluice gate depending on the a/H ratio

Nowadays, with the help of open gates, which are used for the purpose of water distribution in domestic networks, it is possible to determine water discharge at the level of current requirements. Also, on the basis of experiments, it was possible to determine the discharge coefficient (μ) for sluice gates depending on dimensionless hydraulic elements, and the link μ=f(a/H) (Fig. 9) was created at the level of introduction to production.

These obtained results were developed for the condition of free flow of water under the gates (not buried) at the first stage, and the continuation of experiments on damped (buried) conditions at the next stage will serve to increase the effectiveness of research in this direction.

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