1. Introduction

The effective use of hydraulic structures and their reliability are largely dependent on hydraulic and hydrological regime of river sediments. A number of hydraulic structures in Uzbekistan were built in the second half of the last century. Throughout the exploitation period, river sediments accumulated in the hydraulic structures and complicate the efficient use of facilities. Scientific explanation of situation happens in hydro technical constructions and creation of calculation methods is an urgent issue for research in this area.

Results of theoretical and experimental studies on the researches about sediment movements in open irrigation systems shows that the work performed in this direction was provided mainly during the laminar flow velocity and only few researches provided about sediment distributions in turbulent flow regime [1-4 and others].

Analysis of existing methods is described in more detail in the scientific works of S.A. Abbalyants, A.K. Karaushev, Y.A. Ibad-zade, K.Sh. Latipov, A.M. Arifjanov and other scientists [1,4,5,7].

2. Methods

One of the easiest methods to calculate the distribution of river sediment along the flow length is proposed by A.Gostunsky [2]. A.N.Gostunsky (1) recommended to use this method for hydraulic calculation of sediment reservoirs. The essence of the method is that the amount of sediment in the stream consist of two parts – extra sediment and similar sedimentary of flow velocity:

$$S_i = S + S_t$$ (1)
there: $S_t$ – extra sediments which needs to accumulate in sediment reservoir;

$S_i$ - sediments in flow (average sediment volume in the cut);

$S$ - sediment volume which that corresponds to the conductivity of the stream;

Later on with taking as base model of A. Gostunsky scientists S.A. Abalyants, A.V. Karaushev, A. Khachatryan, Yu.A. Ibad-zaderar and others provided researches and developed methods of calculations [1,2,3,5,8].

However, with the analyzing of the equations that represent the distribution of sediments along the length of the stream, we become the following conclusions:

a) the structure of the equations of current calculations is essentially identical, i.e. the distribution of sediments along the length of the stream (punctuation) expresses the exponential or similar law;

b) in all equations participates parameter $S$, which represents the flow potential. It should be noted that the differentiation of the equations representing the distribution of sediments over the length of the stream is differs in terms of determining the conductivity of the stream.

Therefore, the development of method that accurately estimates the conductivity of the flow gives the ability to solve a number of practical issues. Even for creating hydraulic calculation of irrigation sediment reservoirs.

The analysis of existing methods for calculation of sediment distribution length in constructions shows that these methods are mainly created for nonconforming constructions, in those methods mean velocity of the stream were chosen as unchanged along the length of the section being studied [3,7-12].

Long-term observations, experimental and field research, and theoretical conclusions show that the main cause for the change in the flow of sediments in the stream is connected with change in the flow rate. This value depends on the area of the flow area.

Therefore, the calculation of the distribution of the sediment by the length of the stream in the transverse part of the expansion and narrow stream we need to know the average velocity of the flow. However, theoretical designs representing the distribution of the sediments along the flow-length for the current currents flow have not been completed yet.

The variable cross-flow is non-linear, and the non-linear motion can be expressed differently depending on the differential equation of the hydraulic process [3,5].

This article summarizes the results of research on methods of calculating the distribution of river sediments at hydrotechnical constructions and analysis of data obtained in natural field conditions. The distribution of river sediments in constructions depends on the blur (s) flow and the hydraulic parameters of the river.

In the case of sedimentary streams, we see that the current flow consists of two flows discharge. That is, the flow of flow is $-l$, the water flow from $Q_1$, and the constant flow of the sediments $-Q_2$. We write the links between them as [2,3]:

$$Q_2 = sQ_1$$

In that case

$$Q = Q_1 (1 + s)$$  \hspace{2cm} (2)

Used D. Bernoulli's equation for representing the differential equation of the motion of the turbulent flow in the structures.

In the unstable motion ($\frac{dQ}{dl}$), flow depth $h$, flow width $b$, movement section $\omega$, average velocity and other flow elements will vary according to the flow length.

For the two sections of the stream with a small $dl$ distance, differentiation of D. Bernoulli's equation can be written as follows:
there: $\frac{dH}{dl}$ - the change in the length of the flow can be expressed as follows:

$$\frac{dH}{dl} = -\left( i - \frac{dh}{dl} \right)$$  \hspace{1cm} (4)

There: $i$ - channel angle inclination;

$\frac{dh}{dl}$ - loss of pressure along the length $-dl$. In slow changeable motion, this expression can be written by the hydraulic inclination:

$$J = \frac{dh}{dl}$$  \hspace{1cm} (5)

there: $J$ - hydraulic inclination.

$\frac{d}{dl} \left( \frac{\alpha Q^2}{2g} \right)$ - on can describe the variation of speed brake as follows:

$$\frac{d}{dl} \left( \frac{\alpha Q^2}{2g} \right) = \frac{d}{dl} \left( \frac{\alpha Q^2}{2g \omega^2} \right)$$

Bearing in mind that the flow motion in a stable motion is varies according to the depth and width of the flow, on can write the following expression:

$$\frac{d}{dl} \left( \frac{\alpha Q^2}{2g \omega^2} \right) = \frac{\alpha Q^2}{g \omega^3} \left( \frac{\partial Q}{\partial h} \frac{dh}{dl} + \frac{\partial Q}{\partial b} \frac{db}{dl} \right)$$  \hspace{1cm} (6)

The uneven movement depends on the degree of intensity of the hydraulic flux (calm and disturbing). For slowly changing voltages, the hydraulic inclination can be equal to the smoothness of the hydraulic fluid:

$$J = \frac{Q^2}{C^2 \omega^2 R}$$

Taking into account the above, with following to the changes in the mathematical transformation, we change the depth of the flow through the length of the turbulent stream by moving (4), (5) and (6) (3) in the nonlinear motion:

$$\frac{dh}{dl} = -i \frac{\alpha Q^2}{g \omega^3} \left( \frac{\partial Q}{\partial h} \frac{dh}{dl} + \frac{\partial Q}{\partial b} \frac{db}{dl} \right) + \frac{Q^2}{\omega^2 C^2 R}$$  \hspace{1cm} (7)

there: $R$-hydraulic radius; $C$- coefficient of Schezi; $\omega$ - transversal cutting surface of the stream – cut of movement; $\alpha$ - coefficient of Corriolis.

This equation represents the differential equation of the nonlinear motion of the water flow, while the difference in flow equation (2) is determined by the expression.

The equation (7) can be written in the following way, only considering the depth of the current motion in the prismatic form and assuming that $\frac{\partial Q}{\partial h} = B$: 

$$\frac{dh}{dl} = -i \frac{\alpha Q^2}{g \omega^3} \left( B \frac{dh}{dl} \right) + \frac{Q^2}{\omega^2 C^2 R}$$
The solution of the given equation gives the opportunity to determine the direction of flow of the stream, representing the change of the level of fuzzy flow in the upper part of the hydraulic structures.

An analysis of research on the dynamics of river sedimentary movements and an analysis of the authors' findings in this area has shown that the variation in the flow in the stream depends on the variation of the kinematic and dynamic parameters of the stream [1,3,4,5,6].

Changes in the current movement of hydraulic structures cause changes in the flow velocity, resulting in the change in the transmitting capacity of the stream. If the flow of the stream exceeds the carrying capacity, then the accumulator processes are observed, while the flow of the stream decreases from the carrying capacity and erosion processes are observed.

It should be noted that during the operation of hydraulic structures, the rise (decrease) and decrease of the current level, i.e. uneven movement. This leads to a change in the flow velocity along the length of the length and, as a result, the transmissive capacity of the stream also changes. For hydraulic structures that work in the non-leak-proof manner, it is more difficult to achieve a clear description of the process, using computational formulas based on straight-line motions.

The solution of this equation (8) requires the determination of the flow stream (s). Based on the above analysis, we use a mathematical model suggested by K.Sh. Latipov and A. Arifjanov on the basis of molecular-kinetic theory to represent the distribution of river sediments in the volatility of hydrotechnical constructions.

Hydro-technical design during non-leak movement on the basis of the above model. For the distribution of the sediments along the length of the horses, we write the calculation formula:

\[ s = s_0 \left( \frac{\omega_h}{\omega} \right) \exp \left[ -\frac{D}{Q \alpha} \frac{d}{\rho} \sin \omega \omega \right] \]  

(9)

there: \( \alpha \) - the slope of the channel bed;

D – characterization parameter of sediment in the stream:

\[ D = \frac{3 g (\rho_s - \rho)}{2 \rho_f} \left( \frac{d_s}{d_v} \right) \]  

there: \( s_0 \), \( \omega_h \) - the average sediment volume and surface cut of movement;

\( \frac{d_s}{d_v} \) - the parameter that takes into account the differentiality of the particles in flow; \( d_v \) - sediment diameter \( d_o \) - optimal diameter, whose velocity is equal to velocity of flow, is determined on the basis of molecular-kinetic theory;

\( \rho_s \), \( \rho_f \) - suitable density of fluid and sediment particles in the stream.

3. Results

The advantage of the proposed equation is that: in the equation, the distribution of sediments along the length of the flow depends on the change in the flow of hydraulic elements. This allows to express the process in full.

By solving the equations (8) and (9) of these equations, it is possible to calculate the change in the axial length along the river bed and to calculate the distribution of river sediments in hydraulic structures. For the complexity of analytic solutions of these equations, the equation system is solved in a finite way. A computational program was created for that purpose.

No answer. In order to evaluate the proposed methodology, experiments on the field field were conducted. The tests were conducted at hydraulic structures of Mirishkan channel.
In field practice, the following works were carried out: two stairs were selected on the top of the building. Among the selected slopes, the hydraulic elements of the canal were determined, the amount of water consumption and the amount of turbidity measured in the stands. Applications were carried out during the elevation and decline of the flow.

Compared to the results obtained in the natural field conditions, the parameters determined on the basis of the calculation method were compared. The results of the calculation are given in the tables.

Table 1. Change the channel hydraulic parameters according to the flow length (m-measured, c-calculated).

| L, m   | 0   | 200 | 400 | 600 | 800 | 1000 | 1200 |
|--------|-----|-----|-----|-----|-----|------|------|
| H_m, m | 3.3 | 3.2 | 3   | 2.97| 2.85| 2.7  | 2.6  |
| H_c, m | 3.25| 3.19| 2.9 | 2.8 | 2.75| 2.70 | 2.65 |
| S_m, kg/m³ | 0.2 | 0.23| 0.28| 0.3 | 0.36| 0.41 | 0.54 |
| S_c, kg/m³ | 0.2 | 0.22| 0.28| 0.34| 0.39| 0.47 | 0.5  |

Figure 1. Chart of change of water level (1) and sediment value (2) according to the flow length.
Table 2. Change the channel hydraulic parameters according to the flow length (m-measured, c-calculated).

| L, m | 0   | 200 | 400 | 600 | 800 | 1000 | 1200 |
|------|-----|-----|-----|-----|-----|------|------|
| H_m, m | 3   | 3.2 | 3.25| 3.28| 3.36| 3.37 | 3.5  |
| H_c, m | 3   | 3.15| 3.2 | 3.25| 3.35| 3.4  | 3.45 |
| S_m, kg/m³ | 0.3 | 0.26| 0.22| 0.19| 0.12| 0.1  | 0.09 |
| S_c, kg/m³ | 0.3 | 0.24| 0.19| 0.16| 0.14| 0.12 | 0.12 |

4. Conclusion

- Graphs were made based on the results obtained in calculations and field experiments. These graphs show the calculated and measured parameters (see Figure 2). The results were computed on the basis of comparison of calculated and measured parameters (Table 2). As you can see from the analysis of the benchmark estimate, the difference between the measured values and calculated values is 4-8%.
- As a result of the analysis of results, it is clear that in the first case, there is a washing process in the slots (Figure 1). In the latter case, hydraulic grouting, elevation rises, and blurring (Figure 2).
- The method of calculation of sediment distribution along the flow length was developed during the uneven movement of the stream as a result of researches carried out.
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