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IMPROVEMENT OF HYDRAULIC MODEL OF WATER FLOW DYNAMICS IN KATA FERGONA MAIN CHANNEL

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Abstract: The hydraulic model of the water flow dynamics of the Great Fergana Main Canal was improved and the influence of the damping (support) formation of the water flow in the hydraulic structure was clarified based on this model. Now, the equation for determining the depth of the damped (supported) water flow, which is formed during the connection of streams, has been derived.

Key words: "Soh-KFK" hydrotechnical facility, picket PK1995+00, support, wall, stable, Reynolds, Froude number

267 thousand hectares of our country and 18.5 thousand hectares of the irrigated areas of the Republic of Tajikistan are supplied with water through the Big Fergana Main Canal.

The main water sources of the Big Fergana Main Canal are the Norin Darya (420 m3/s), Karadarya (100 m3/s) and Sokh (12 m3/s) rivers.

Currently, along the length of the main canal, 7 additional water discharge facilities are being used. In particular, additional water resources from the Sokh Tashima canal will be put into the canal through the hydrotechnical facility located at the picket PK1995+00 of the main canal. A Google map of the location of the hydrotechnical facility at picket PK1995+00 of the trunk canal is presented in Figure 1.

Figure 1. Map of the location of the hydrotechnical facility.

According to urban planning norms and rules for the design and construction of hydraulic facilities, the angle of connection of water discharge facilities to the channel is required to be in the range of 30-60 degrees. Otherwise, damping of the water flow (support) is formed in the water intake channel, which has a negative effect on the movement of water flow in the channel.

According to the results of the field research, the Sokh drainage structure is connected to the channel at an angle of 94 degrees. In this case, during the vegetation period, the water flow between the pickets PK1995+00–PK1984 of the channel is damped, and the average speed of the water flow between these pickets decreases to 0.05-0.12 m/s. This situation brings technical and technological issues related to the transportation of water to the next sections of the main channel. In addition, as a result of the deposition of a large amount of muddy sediments in the canal, the water carrying capacity of the canal decreases by 45-50 percent.

For this reason, we set the scientific-technological process as the goal of hydraulic calculations.

In order to achieve the intended goal, we defined the following tasks on the example of the research object (Great Fergana Main Canal):

• Improvement of the hydraulic model of the water flow in the parts of the Big Fergana Main Canal where water-discharge hydrotechnical structures are located;

• Improvement of the hydraulic methods of connecting the water flow of hydraulic engineering facilities with the downstream;

• Improving the hydraulic model of water flow dynamics in the Great Fergana Main Canal.

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The contiguous parts of streams in irrigation canals can be divided into different sections, taking into account their characteristics. In particular, it is necessary to pay special attention to the areas of transit and accumulated water flow along the width of the channel in the part of the Big Fergana Main Canal where the Sokh dumping facility is located. It will be possible to divide the section of the Big Fergana trunk canal located at picket PK1995+00 into the following sections (Fig. 1):

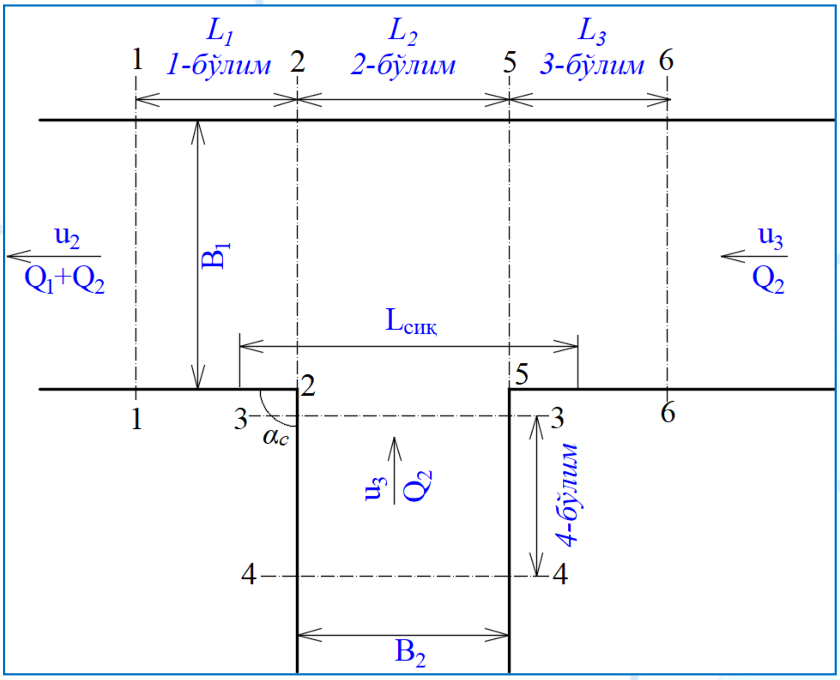

Figure 2. Water flow connection scheme

Section 1. The area of transition of water flow movement to a stable movement mode. This section is bounded by cuts (1-1) and (2-2);

Section 2. Area of water flow compression. This area is formed between cuts (2-2) and (5-5), the compression of the receiving flows from the disposal facility and the main channel and the increase in the curvature of the flow lines are observed;

Sections 3 and 4. Sections bounded by shears (5-5) and (6-6) and (3-3) and (4-4) in the area of water flow damping (support). In these sections, water flow damping occurs, the depth of the water flow increases, and the speed decreases.

The region with the maximum width of the accumulation zone and the minimum value of the depth of the water flow is taken as the water flow compression shears.

The depth of water flow in section 1 of the main channel is normalized, and this quantity, the other parameters, such as the skin shear surface, water consumption and roughness coefficients, are calculated by the equations of plane motion.

The depths of the incoming and receiving currents are determined by the following expressions before the connection process:

$$h_n = h_б + \Delta h,\ h_b = (h_б)_b + \Delta h.$$

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Now, we derive the equation for determining the depth of the damped (supported) water flow that occurs during the connection of currents. According to the results of theoretical and experimental studies, unstable movement of the water flow occurs in sections 3 and 4 of the channel (Fig. 2). We use the Saint-Venant system of equations to represent this process and improve the flow depth calculation equation for this area. In order to adapt the system of Saint-Venant equations to the object of research, the projections of the forces acting on the limited flow part affecting the water flow in the sections bounded by shears (5-5) and (6-6) and (3-3) and (4-4) on the abscissa axis we write the balance equation in the following form:

$$F_{\text{оғ}}^{x} = F_{\text{ин}}^{x} + F_{\text{ишқ}}^{x}$$

Here: $F_{\text{оғ}}^{x} - m$ -m is the X-axis projection of the gravity force acting on the mass water flow, $F_{\text{ин}}^{x} - m$ m is the X-axis projection of the inertial force of the mass water flow, $F_{\text{ишқ}}^{x}$ –is the X-axis projection of the frictional force that occurs in the layers of connected flows.

The speed of the water flow depends on the wave motion depending on the hydraulic radius: Froud's criterion ($Fr = \frac{u^2}{gR}$), and the mode of turbulent motion in the area of the flow junction: Reynolds ($Re = \frac{uR}{\nu}$) criterion. Therefore, we use these criteria in mathematical modeling.

Here: u-flow speed on a characteristic scale, g-acceleration representing the effect of external forces, R-hydraulic radius, n-kinematic viscosity.

Based on the method of stochastic systems, we will have a mathematical model representing the dynamics of the flow depth in the stable movement of the water flow in the area where the water flows meet.

$$\langle h \rangle = h_0 + (1 + Fr)\frac{g \cdot B \cdot t_0}{V_0} \cdot lnh_0.$$

Based on the results of the field researches and the measurement works carried out in the object, we will carry out the numerical experiment of the equation (3.1.23). The graph comparing the results of the numerical solution of the equation (3.1.23) with the results of the experiment is presented in Fig. 3. The error of comparison is 5 percent.

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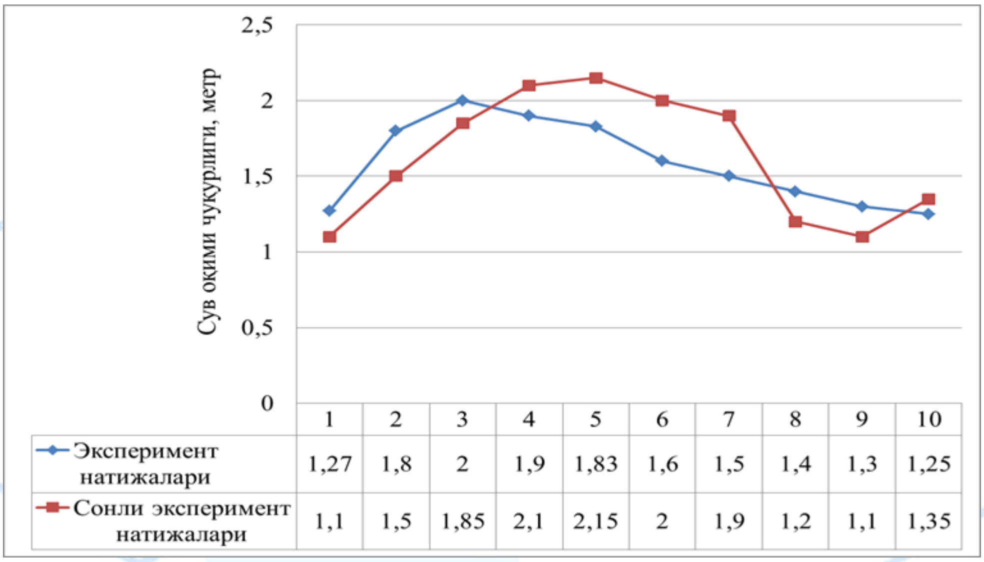

Figure 3. (3.1.23) graph comparing the results of the numerical solution of the equation with the experimental results

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