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Natural Studies for Forming Stable Channel Sections

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Abstract. The article is devoted to improving the hydraulic parameters of irrigation channels. It reflects the results of field studies of the authors, highlights the problems that arise during the operation of channels and their negative consequences. The causes of intense deformation processes as a result of changes in the hydraulic parameters of irrigation channels are considered. It is shown that in order to determine the optimal parameters, in order to reduce possible deformations, it is necessary to take into account the kinematic parameters of the flow. A new dependence is proposed for calculating the channel cross-sectional shape, taking into account the kinematics of the turbulent flow and the interaction of the flow with the soil of the channel bed, and also gives recommendations for improving the hydraulic parameters of the irrigation channels in the earthen channel.

1. Introduction

According to numerous field data, the flow velocities are distributed fairly evenly across the channel, significantly decreasing only within the coastal slopes, where the effect of transverse vortex structures, which are comparable to the transverse dimensions of the flow, is more pronounced.

The channel of the channel, exerting an effect on hydraulic resistance and the internal kinematic structure of the flow, acting on the boundary surface of the channel, changes its shape [2; 3; 5].

The cross section of the channels should have sufficient channel stability with respect to non-wipe, indelibility and shape stability of the cross section over a long period of operation [7; 8; 14].

All these factors, at present, are not yet reflected in the theoretical dependences, therefore the indirect method has been widely developed, when the characteristics of stable channels are determined from field data. Such research areas are widely developed in the CIS countries, the USA, France and India, and the dependencies that determine the stable shape and size of channels are established on the basis of statistical processing of observational materials on operating channels operating in a stable mode without erosion and siltation [6; 10; 9 ;fourteen] .

The concept of stability is presented as the absence of such an interaction between the flow and the channel, which can cause directional channel deformations, planned and deep. In contrast to them, local deformations can occur, especially in the initial period of operation, associated with the heterogeneity of the mechanical properties of the soil along the route, they should be eliminated to avoid their subsequent transformation into a factor of directional deformations [1; 4; 11; 13].

It follows that in stable channels, the velocity structure of the flow along the section width is in dynamic accordance with the shape of the channel. Such channel channels are called dynamically stable. Thus, it turns out that dynamically stable sections of the channels are determined by a combination of a number of factors, the main of which are: the relationship between the velocity structure of the flow and the shape of the channel, in which there is a certain distribution of speed over the entire cross section of the channels; quantitative in the fractional composition of all soil categories of the bed of clay fractions that change the physical and mechanical properties of the soil; turbidity of the flow, suppressing the turbulence of the flow in the natural area and changing the roughness of the bed, which creates a condition for increasing the permissible speed for erosion [3; 5; 7; 8; 14].

As known, the channels, depending on the operating mode, environmental conditions and other parameters, are divided into statically and dynamically stable, corresponding to two limiting conditions of the channel, in which its deformation is impossible. Under static equilibrium, in which transport of channel-forming sediments is not observed and the flow flows at maximum speeds without erosion.

To assess the formation of a stable cross section of irrigation channels, the results of field and laboratory studies of a number of researchers, including our studies, were analyzed.

Field studies conducted on the Parkent, Tashkent and BFK channels made it possible to evaluate the formation of a statically stable section. As the results of the analysis show, the design maximum speed in the channel is observed at certain costs, which occur only during the peak of the growing season [1; 16; 17; 18; 22].

From the analysis of field and laboratory data of a number of researchers it follows that on the channels, after many years of operation, the design parameters change, the trapezoidal section takes the form of a curved shape. Such phenomena were also observed in our research objects that, after many years of operation, the channels formed design parameters corresponding to a stable cross section depending on the kinematic characteristics of the flow (Fig. 1-2).

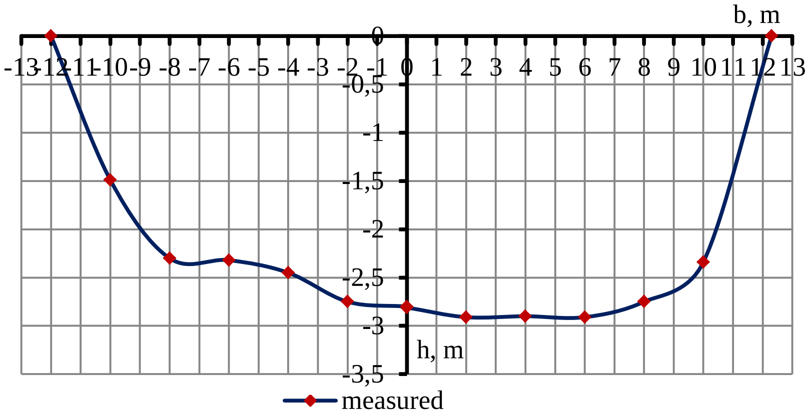

Figure 1. Cross section of the Tashkent channel

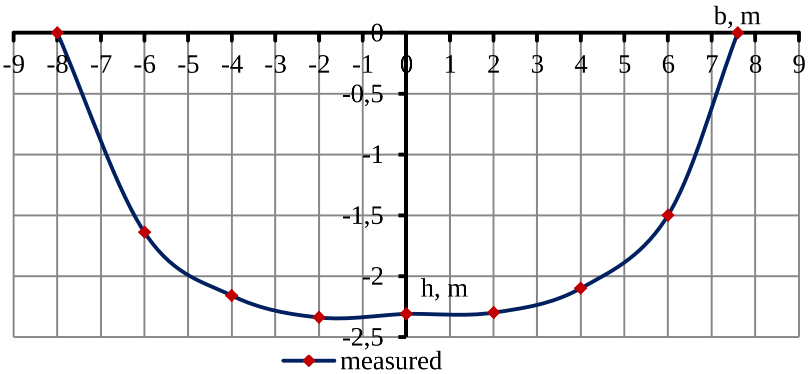

Figure 2. The cross section of the channel BFC

With dynamic stability, the limiting state is the channel of dynamic equilibrium, in which complete transit without deposits or additional saturation due to erosion occurs.

In the study of the formation of dynamically stable channels, as noted above, the channels of the lower reaches of the Amu Darya and the Mirishkor channels were selected.

In normative documents and in scientific works, a number of scientists devoted to the study of channel processes and hydraulic calculation of irrigation channels, it is noted that in the design of irrigation channels a significant role is played by reliable determination of the main hydraulic parameters [10, 11; 12; 15; 19; 22]. This issue is the subject of research by many authors. The vast majority of them when calculating the hydraulic elements of the flow and, in particular, when calculating the shape of the channel do not take into account the turbidity transported by the stream.

Field studies on the channels of the lower reaches of the Amu Darya and on the Mirishkor channel led to the conclusion that the formation of dynamically stable sections is associated with numerous factors, i.e. dynamic and kinematic flow characteristics. Field studies were conducted in the period 2005-2018, the averaged results of which are shown in Fig. 3.8-3.19.

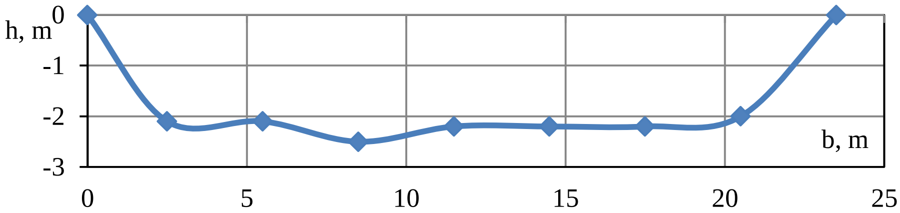

Figure 3. Cross section of the May-Jap Channel

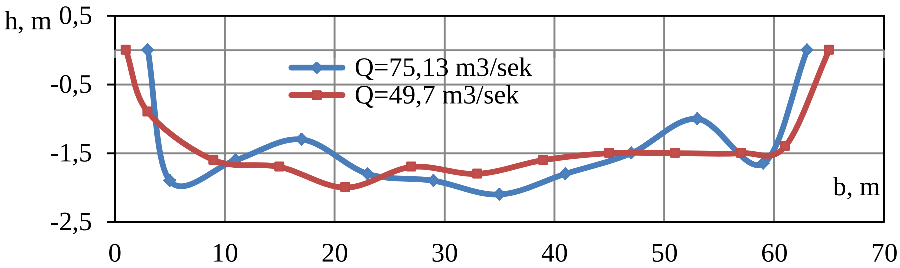

Figure 4. Cross section of the Rice channel

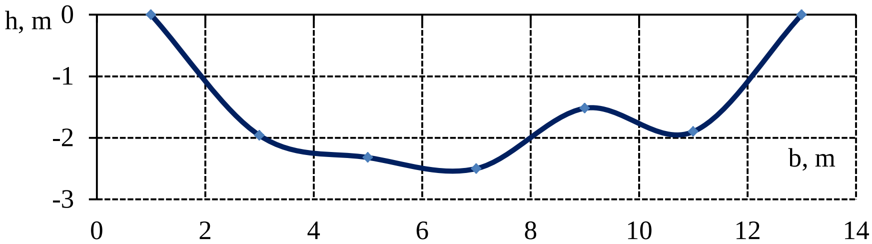

Figure 5. Cross-section of the channel Bes-zap

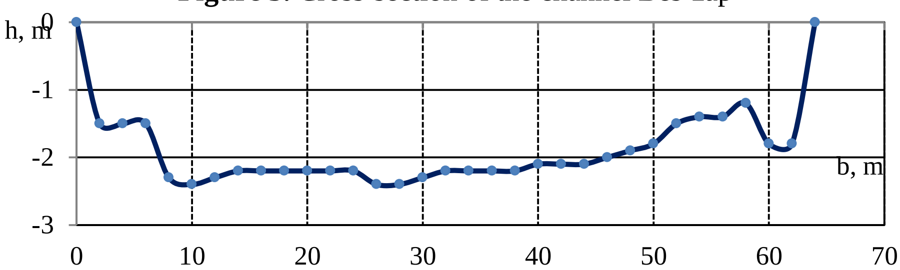

Figure 6. Cross section of the Enasay channel

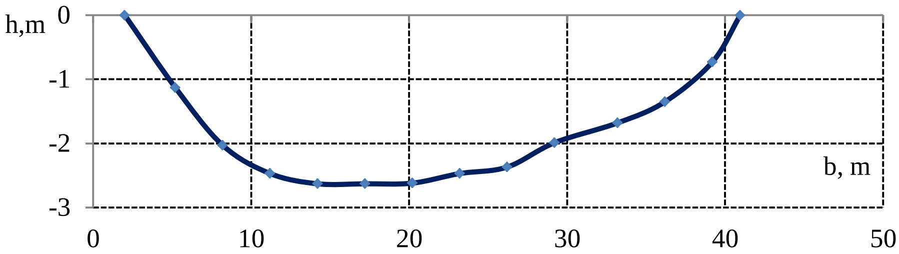

Figure 7. Cross section of the Mirishkor channel PC 245+00, Q=28,2 m^3/sek

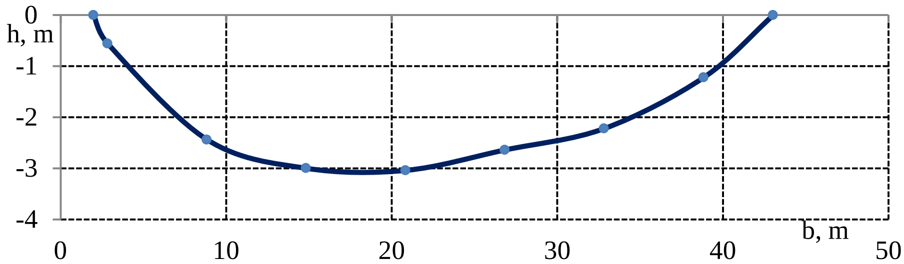

Figure 8. The cross section of the channel Mirishkor PC 245 + 00, Q = 58,8 m^3/seк

An analysis of field measurements of channel cross sections shows that, despite the fact that the channels were designed as engineering structures with clearly regulated speeds, flow rates and depths, their channels were deformed when interacting with the flow, which led to some change in the geometric and kinematic parameters of the channels. This is due to the fact that when designing the channels, the type of the cross section of the channel is first selected, and then the elements of the selected section are determined by the average static determination. Thus, the course of the formation of the channel form is disrupted, which is proved on the basis of experimental and field data of a number of researchers.

From fig. 1-8 it is seen that in all cases the transverse profiles of the channels acquired a more gentle outline resembling a polygonal or parabolic profile, regardless of the flow rate and soil conditions of the bed.

Thus, both field and laboratory data confirm that earth channels under certain conditions are subject to channel deformations, which flow in the direction of formation of stable cross sections in which the flow velocity characteristics and the channel shape are in a certain dynamic relationship.

In some cases, transport of suspended sediment is one of the main factors determining the size of the channel cross section and therefore, when designing the channels, the turbidity of the flow should be taken into account [6; 7; 8; 9; 22]. In this case, the fundamental factor in determining the hydraulic characteristics of the channel is the flow rate , bed bedbed and turbidity of the stream. However, the latter factor is not always fully taken into account when designing channels.

The current situation in this area requires additional studies on the possibility of using previously obtained methods of hydraulic calculation in new conditions, as well as obtaining calculation formulas suitable in a wider range.

Therefore, refinement, development and implementation of rational, optimal, and most importantly, adequate calculation methods in the design and operation of irrigation channels are especially important. At the same time, one of the most important points in this problem is the question of determining the shape of the channel cross section corresponding to the condition of stability of the channel cross sections.

To develop this direction, we consider the equations of motion of a weighted flow in open channels given in [5; 6; 7; 17; 20; 21]. For the case of steady uniform motion, we obtain an equation describing the shape of the cross section of the channel:

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$$y = \frac{1}{\alpha} arcch\left(\left(\frac{1}{\alpha\rho gi(f_1\mu_1 + f_2\mu_2)} - \frac{ch\alpha z - 1}{ch\alpha h - 1}\right)\times(ch\alpha b - 1) + 1\right) \quad (1)$$

y,z- coordinate axes. The y axis is vertical, the z-axis is horizontal;
h - channel depth, m;
b- channel width at the top, m;
$\alpha = \sqrt{\frac{L}{\mu}}$, *L*- parameter taking into account the turbulent characteristic of the flow; $L = 0{,}0025 \cdot \frac{\sqrt{i}\cdot\sqrt{g}\cdot\rho}{n \cdot h^{\frac{1}{2}}}$

ρ - water density, kg / m3;
g - acceleration of gravity, m / s2;
μ - dynamic viscosity coefficient, Hs / m2.
f_1, f_2 - phase concentration;
i - slope of the water surface;
n- is the roughness coefficient of the channel channel;
ch - hyperbolic cosine of the angle;
sh - hyperbolic sine of the angle;

When $A = \frac{L_2}{\alpha\rho gi(f_1\mu_1 + f_2\mu_2)}$, suppose that for specific conditions the values A are considered constant.

Then, in a more simplified form for the channel shape, we have:

$$y = \frac{1}{\alpha} arcch\left(\left(A - \frac{ch\alpha z - 1}{ch\alpha h - 1}\right)\times(ch\alpha b - 1) + 1\right). \quad (2)$$

Now consider the use of the proposed equation for computational purposes. The analysis of this formula was carried out by comparing and comparing the calculated data with field and laboratory data of R.M. Karimov, H.Kh. Ishanova and E.K.Rabkova, as well as the author on channels located in different natural and geographical territories of the Republic of Uzbekistan. analysis are shown in Fig. 9-10.

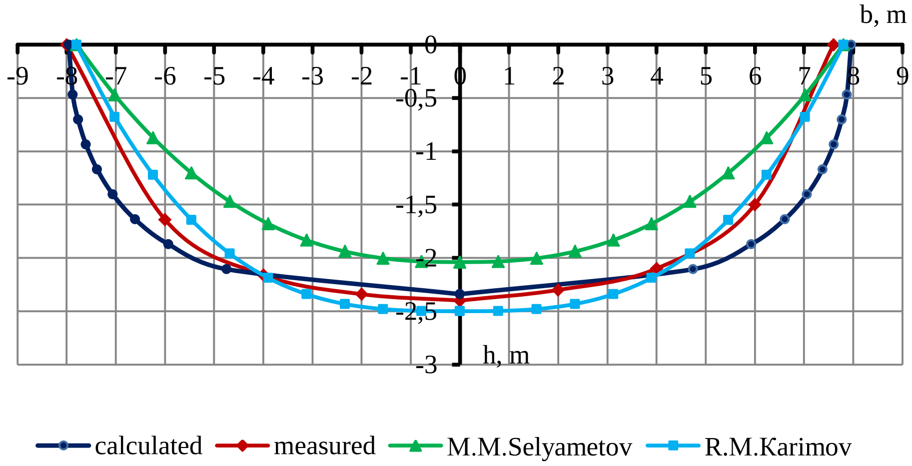

Figure 9. Comparison of calculation results with field data on the BFK channel

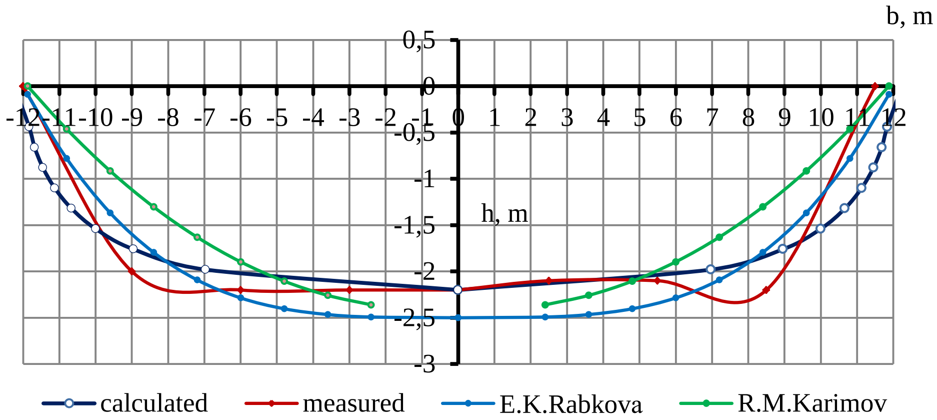

Figure 10. Comparison of calculation results with field data on the May-Zhap channel**.**

A comparative analysis of formula (2) with laboratory and field data of a number of researchers, as well as with field data obtained by us, shows the advantage and suitability of the proposed formula (2) for calculation purposes.

Thus, based on the analysis of the model of turbulent fluid motion [5; 6; 7; 17], a mathematical model is proposed that describes the shape of the channels of a stable section. The peculiarity of the method is that here the hydraulic elements of the channel are determined directly from the model of flow in the channel taking into account factors, which is confirmed by field studies conducted on the channels of Parkent, Tashkent, BFK, Mirishkor in the lower river. Amu Darya. The universality of the method lies in the fact that hydraulic elements at a given flow rate, slope and type of soil are determined directly from the proposed model.

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