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Adjustment Determination of Kinetic Energy and the Amount of Flow in the Area of Spreading, Taking into Account the Development of Inter-Amber Space

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ABSTRACT: At present, major works on main rivers of Central Asia (Amudarya, Zerafshan, Chirchik, and others) have carried out and are working to protect the banks from erosion and to regulate channels for guaranteed water intake into irrigation channles in areas of great length. For this widely used transverse dam (spur). During the interaction of the dam (spur) with the flow, there is an intensive siltation of the inter-amber space. Due to the limited areas for agricultural land in densely populated areas, which usually adjoin the valleys of large rivers, spontaneous and unwarranted development of inter-dammed space on regulated sections of rivers occurs, which may lead to a violation of the design regime of the regulated part of the river. In this regard, the development of methods for the hydraulic calculation of a constrained flow with partial development of inter-dam space is one of the urgent problems of scientific and practical importance in the design of control structures, their construction and operation..

KEY WORDS: inter-dammed space, unwarranted development, irrigation channels, erosion.

I.INTRODUCTION

As it's known, the flow in the river is continuous. An easily mobile medium is characterized by a number of physical parameters (pressure, velocity, temperature, density, viscosity, etc.). In general, these parameters for one reason or another change from point to point in the stream. Therefore it is necessary to talk about these fields of physical parameters. For a given flux, the fields of physical parameters are interconnected by certain relations that follow from such fundamental laws of nature as the law of conservation of mass, the laws of change of momentum and angular momentum, first and second law of thermodynamics. Applying these laws to the flow, one can obtain the basic equations that are used to solve problems of motion of such an environment. The solution of these equations in the general case, when the variables are all physical parameters, is difficult. Therefore, when solving practical problems, they strive to introduce various simplifications. For example, during the flow of a dropping liquid, if it does not heat or cold, the temperature, density and viscosity can be considered constant at all points of the flow. For such an isothermal uniform flow of an incompressible fluid, only the velocity and pressure fields are considered. The whole fluid flow is often three-dimensional. Representing it consisting of a set of elementary streams, we obtain an inkjet flow model that simplifies problem solving, since the movement in each elementary stream is one-dimensional. The jet stream model is the most common type of fluid and gas flow. Jets are considered to be a flow on both sides of the tangential discontinuity surface. The tangential discontinuity is experienced by the magnitude of the flow velocity, temperature, impurity concentration, etc. The surface of a tangential discontinuity is characterized by the presence of unstable vortices moving along and across the flow, due to which a continuous exchange of masses, i.e. transfer of momentum, heat, etc.

As a result, a zone of finite thickness with a continuous distribution of velocity, temperature, and impurity concentrations forms at the boundary of two jets: this region is called the zone of intense turbulent mixing. The simplest case of an intensive turbulent mixing zone is formed when a fluid flows out with a uniform distribution of velocities (and across the flow, due to which a continuous exchange of masses takes place between the jets, ie, the

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transfer of momentum, heat, etc. As a result, a zone of finite thickness with a continuous distribution of velocity, temperature, and impurity concentrations forms at the boundary of two jets: this region is called the zone of intense turbulent mixing.

II. SIGNIFICANCE OF THE SYSTEM

The accuracy of the hydraulic parameters of the steam boosts on the shore protection will increase to 25%.This allows you to choose the design of the building protection facility.

III. METHODOLOGY

The simplest case of an intense turbulent mixing zone is formed when a fluid flows out with a uniform distribution of velocities (U0 = const) into a medium moving with a constant velocity (U = const). This simple is that in this case, in the initial section of the jet, the thickness of the intense turbulent mixing is zero. However, the presence of continuous mass exchange through the tangential discontinuity surfaces (0^1 - 2, 0^1 - 1) (Fig. 1) leads to an increase in the cross section of the zone of intense turbulent mixing on the one hand, and on the other, to the disappearance of the weakly perturbed core. The part of the jet within which there is a core is called the initial section.

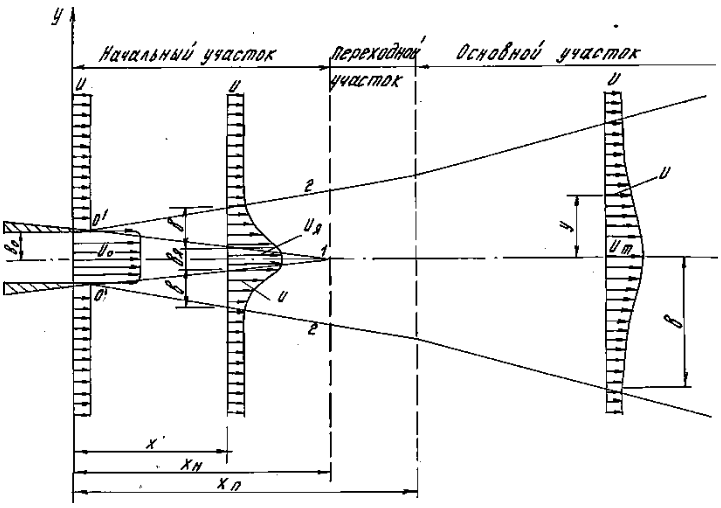

Fig1. Diagram of a submerged free turbulent jet according to G. N. Abramovich

At some distance from the end of the initial section, the jet flow acquires the same form as the flow of liquid from an infinitely small source (in the symmetric case, the source is a point, in the plane - parallel case - a straight line perpendicular to the jet spreading plane). This section of the jet is called the main, between the main and initial parts of the jet is a transition section.

V. EXPERIMENTAL RESULTS

On the basis of numerous experimental studies with free jets by G. K. Abramovich (1) found that the dimensionless velocity profiles across the width of the zone of intense turbulent mixing are affine and obey the Schlichting theoretical dependence

a) in the initial section $(U_{max} - U)/(U_{max} - U_H) = (1 - \eta^{1,5})^2$;

в) in the main section $(U - U_H)/(U_{max} - U_H) = (1 - \eta^{1,5})^2$.

where

U , U_H - average vertical velocity of the flow, respectively, in the zone of displacement and in the zone of reverse currents;

U_{max} - the maximum average speed on the vertical in the offset zone;

η - the relative coordinate of the considered vertical is

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η = (y2 - y) / (y2 - y1) = (y2 - y) / в ,
Where
в - boundary layer width;
y1 , y2 - respectively, the coordinates of the internal and external boundaries of the offset zone;
y - coordinates of the point in question.

In addition, the author proves that in the presence of a counter-flow, the law of increasing the thickness of the zone of intense turbulent mixing does not depend on the ratio of velocities on the surfaces and increases linearly:

в =cx, (4.1)

where C - constant equal to the initial part C = 0,27, on the main C = 0,22.

Based on the studies of M. A. Mikhalev (8), it was necessary to establish the pattern of change in velocity in the core and in the reverse flow region, the law of variation in the core width and the length of the whirlpool zones.

To solve the problem were used:

a) momentum equations;
b) flow conservation equations;
c) the equation of motion recorded for the transit flow with turbulent shear stresses on the lateral surfaces.

The joint solution of the above equations, with some assumptions, allowed the author to completely solve the tasks.

Research of F.G. Gunko (6) found that the boundary between the transit flow and the whirlpool area has a curvilinear outline, the position of which is determined by the main characteristics of the flow and structure. The length of the whirlpool in this case is determined from the usual differential equation of non-uniform motion, written for the transit flow:

$$\frac{dh}{dx} = \frac{i - \frac{Q^2}{\omega^2 C^2 R}\left(1 - \frac{\alpha C^2 R}{g\omega} \cdot \frac{\partial \omega}{\partial x}\right)}{1 - \frac{\alpha Q^2 b}{g\omega^3}}$$

where C , R - Chezy coefficient and hydraulic radius of the transit flow with
Q = const.

The author, , did not take into account the increased resistance of a separate surface between the transit flow and the whirlpool in solving the problem and according to his method it is impossible to obtain the distribution of averaged local velocities in the plan. As is known, for a more accurate assessment of possible re-formations of the channel after the dam installation, local speeds play the main role, and knowledge of the magnitude of the average transit flow rate Vt is not enough. Levi I.I., Solovyova A.G. (8, 12) investigated the flow spreading with a sudden expansion. According to these authors, one of the main factors affecting the length of the whirlpool is shear stress acting on different surfaces. Research of Solovieva A.G. showed that the magnitude of the relationship

λ в / λ д = 10 … 20

where
λ в - the coefficient of hydraulic resistance in the separate surface of the whirlpool;
λ д - bottom resistance coefficient.

I.I. Levi (8), is for the two-sided symmetric expansion of the flow, the equation of momentum in the differential form, firstly, for the compartment, including the whirlpool, is formed (Fig. 2). Two equations written in this way with the continuity equation attached to them, after they are solved together and integrated in finite differences, make it possible to find a change in velocity — V, width — in and water levels along the stream. In this case, the friction forces along the bottom, the friction forces on the “coastal” surfaces and the friction forces on the section surfaces I.I. Levi expresses through the average transit flow rate - V, respectively:

ρλ д V2 в ds ; ρ λ б V2 2h ds ; ρ λ в V2 2h ds .
where в - transit width.

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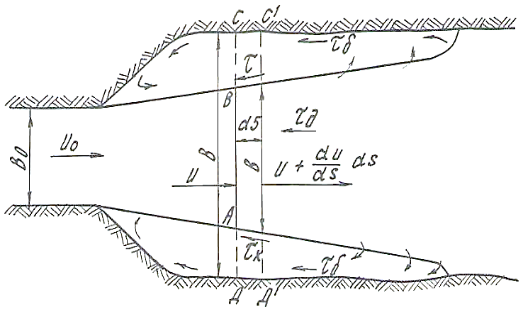

Fig. 2. Calculation schemes for sudden expansion of flow: according to I.I. Levi

In order to establish the rule of changes in the parameters of the turbulent flow in the spreading region, we need to know the rule of change in the kinetic energy adjustment (α) and the momentum (α0). Many researchers in the study of the deformed flow (1, 2, 3, 4, 5, 6, 8, 9, 10) took the magnitudes of the kinetic energy adjustments and the amount of motion constant, in fact, the results of experiments conducted in the laboratory of Tashkent Institute of Irrigation and Agricultural Mechanization Engineers showed their variability along the length of the whirlpool.
Since the distribution of velocities over the width of the flow is known, we can determine the nature of changes in α and α0 using the expressions known from the course of hydraulics (11).

$$\alpha = \frac{\int U^3 \partial\omega}{V^3 \omega} ; \qquad \alpha_0 = \frac{\int U^2 \partial\omega}{V^2 \omega} , \qquad (1)$$

Determining the average transit flow rate from the flow conservation equation and after integrating equation (1), the following dependencies are obtained:

$$\alpha = \frac{(в_я + в)^2 \left[в_я + в(0,347 + 0,2m + 0,2m^2) + m^3 (B_1 - в_я - 1,25в) \right]}{\left[в_z + в(0,55 + 0,45m) + m(B_1 - в_я - в) \right]^3}, \qquad (2)$$

$$\alpha_0 = \frac{(в_я + в)\left[в_я + в(0,416 + 0,268m) + m^2 (B_1 - в_я - 0,684в) \right]}{\left[в_я + в(0,55 + 0,45m) + m(B_1 - в_я - в) \right]}, \qquad (3)$$

Using equations (2) and (3), it is possible to calculate the value of adjustments α and α0 in the area of spreading. Experimental studies have shown that due to the pulsation of turbulent flow between the lines 0-2 and 0-3 (Fig. 1), the lines 0-3 are extended to 0.2ℓm, as shown by N.A. Rakhmanov (9). The results of the experiments showed that the calculated α and α0 gives a good convergence of the experimental values ranging from the section of maximum constraint (section C - C) to the end of the outer boundary of the turbulent flow (line 0 - 2); within the 0.2ℓm interval, equation (2) and (3) gives overestimated values. This is explained by the fact that the Schlichting-Abramovich's formula (1) was obtained for free turbulent jets under the assumption

в = вс + сх.

In the region of 0.2ℓm, this pattern is violated because the flow is limited by the side walls, to eliminate this contradiction, the concept of a fictitious width of the turbulent mixing zone was introduced within 0.2ℓm. In this case, the dummy width is

вф = в + Δв = в + 0,2ℓm tgφ0 , (4)

where φ0 - the expansion angle of turbulent flow outer boundary,
which is determined experimentally, for example for hard (smooth) cannals equal to 0.17 radians;
ℓm - the length of outer boundary of turbulent mixing zone
(Line0–2).

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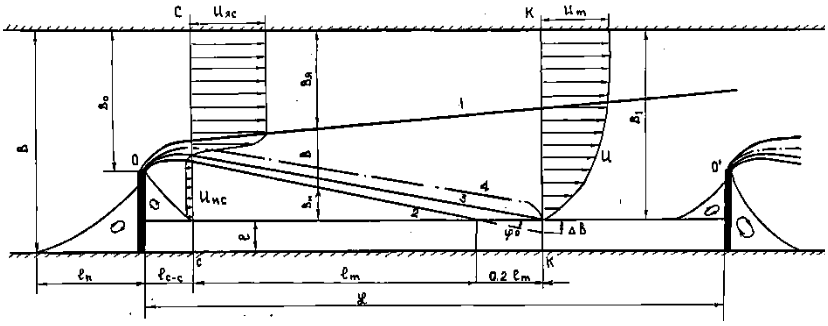

Fig 3: The design scheme for determining the adjustments of kinetic energy and momentum

The value of ℓm can be determined by the following dependency:

$$\ell^*m = \frac{1}{tg\varphi^0}\left(\frac{1-k_0 n}{1-n} - \varepsilon\right), \qquad (5)$$

$\ell^*m = \ell m / в0$; $\varphi 0$ = arc tg (C2 - C1).

Considering that within a segment of 0.2ℓm, the speed is Uн = 0, and the width of the turbulent mixing zone is вф, from (2) and (3) we get:

$$\alpha = \frac{B^2(1-k_0 n)^2\left[в_я + 0{,}347(в + 0{,}2\ell_m tg\varphi^0)\right]}{\left[в_я + 0{,}55(в + 0{,}2\ell_m tg\varphi^0)\right]^3}, \qquad (6)$$

$$\alpha_0 = \frac{B(1-k_0 n)\left[в_я + 0{,}416(в + 0{,}2\ell_m tg\varphi^0)\right]}{\left[в_я + 0{,}55(в + 0{,}2\ell_m tg\varphi^0)\right]^2}, \qquad (7)$$

The results of the experiments showed the adjustment of the theoretical solution, the difference between the theoretical and experimental values of α and α0 is 2 ... 5% (Fig. 2; 3). Although the values of the theoretical solution α and α0 have good convergence with the experimental results, by the formula (2), (3), (6), (7) without constructing the velocity field of the flow it is impossible to use. To establish a real picture of the velocity field, we need to know the value of α and α0. In order to simplify theoretical studies, the value of α and α0 is determined by processing the results of an experiment using the method of regression analysis [7]. As a result of processing, an approximating equation was obtained (r = 0.95)

$$\alpha = a\left(\frac{1-k_0 n}{1-n}\right)^{0{,}365}, \qquad (8)$$

where a – empirical coefficient;

a = 1,07 - for section C – C;

a = 1,12 - for section K – K .

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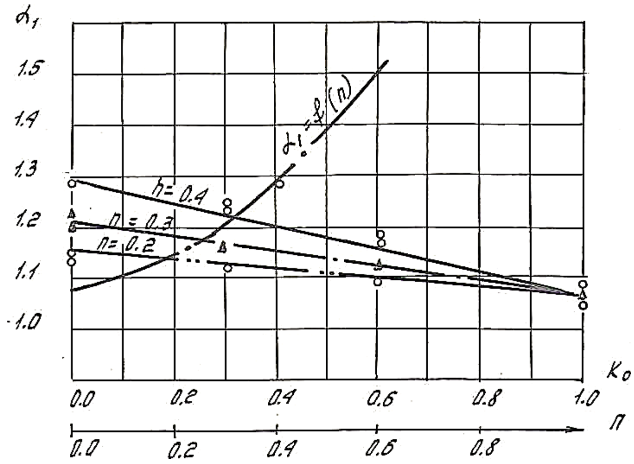

Fig.4 the graph of interconnection $\alpha_1 = f(n, K_0)$

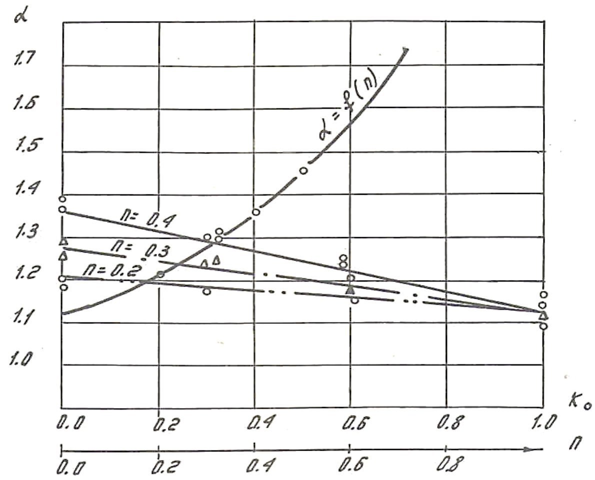

Fig. 5. Dependency graphs α = f (n, K0) and α = f (n)

The correlation coefficient is equal to r = 0.96. There is the following dependencebetween α and α0 by S.T. Altunin [3]

$$\alpha = 3\alpha_0 - 2 \qquad (9)$$

Having calculated the adjustments of the kinetic energy according to the dependence (9), we determine the adjustments of the momentum by the formula:

$$\alpha_0 = \frac{1}{3}(\alpha + 2), \qquad (10)$$

Analysis of fig. 2 and 3 show that the values of the adjustments α and α0 depend on the degree of constraint and the coefficient of development. From fig. 2 and 3, it can be seen that the value of the adjustments α and α0 in the section of maximum compression (section C - C) is obtained more than in other works (4, 5, 6, 9). This is explained by the

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fact that the backwater created by the second dam influences the uneven distribution of the flow velocity across the width of the canal. With an increase in the coefficient of development between the dam space, the influence of the backwater created by the second dam decreases and by reducing the living cross section in the interbarbel space the distribution of the flow velocity will be more uniform, as a result, the values of corrections α and α0 decrease.

VI.CONCLUSION AND FUTURE WORK

The obtained dependences (6), (7), (9) and (10) allow us to calculate α and α^0 with one-way and two-way flow restriction, taking into account the development between the dam space.
They are valid in the presence of the initial part of the jet in the area of spreading.

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