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Transport capacity of flow in earthline channels

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Abstract. The theory of river flow transport is the major cause of the development of the irrigation sector and largely determines the stability of the irrigation scheme. Crop water requirements vary due to climate and crop growth stages. For this reason, the flow of sediments changes during the irrigation season. In this article, to evaluate the canals' carrying capacity, research in natural field conditions was carried out in the Amu-zang canal belonging to the "Amu-Surkhan Irrigation Systems" basin administration. Flow transportability in natural channels was calculated for particles with d=0.05 mm by S.Kh.Abalyans, A.Zamarin, A.M.Arifzhanov, and Engelund and Hansen methods. A histogram of the dependence of flow capacity, channel depth, and average speed on the Amuzang channel was obtained, according to which it was determined that the flow capacity is 1.5-1.8 kg/m^3 in the range of 0.6-0.8 m/s.

1 Introduction

Solving the problem of assessing the effect of water turbidity and river flow on the working regime of the main canals used in our republic, including the canals that receive water from the Amudarya, creates an opportunity to develop effective parameters of river sediment control structures and modernize irrigation networks. Sediment transport is essential in sedimentary geology, civil engineering, and geomorphology. The theory of river flow transport is the main factor in the development of the irrigation sector and largely determines the stability of the irrigation scheme. Sediments and discharges are caused by the movement of water - rivers, oceans, lakes, and seas. The transport of sediment particles also occurs in glacial flows and wind-driven land surfaces. Sediment transport under gravity alone can usually occur on steep surfaces, including hills, cliffs, and continental slopes [3-5]. In particular, many scientists around the world Graf 1971, Vanoni 1975, Yalin 1977, Soulsby 1997 (Rijn, Engelund and Hansen, Ackers, and White (1973), Sleath 1984, Nielsen 1992, Fredse and Deigaard 1992, Brownlie, K.Sh. Latipov, V.K. Debolsky, A.M. Arifjanov) developed various theories on alluvial soils. All of them considered uniform and steady flow conditions and tried to find stable channel sizes for fluid transport. As a result of changes in river flow and factors that directly affect sediment intrusion, traditional canal design methods cannot accurately predict sediment transport capacity. First, it is related to

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the unstable and unsteady conditions of water flow, and second, the changing nature of the water flow. Thus, the actual water movement in the channel differs from the movement assumed in the project. In many cases, it is necessary to cover the high maintenance costs to solve the sedimentation problems. In most cases, irrigation water is taken directly from a river with a high sediment level, turbidity. Usually, at the beginning of the channel, large fractional sediments are retained and returned to the river. The rest of the channel's sediments are taken directly to the fields. Small fractions of sediment particles are rich in minerals and provide an opportunity to improve land reclamation and increase productivity [6, 7]. The channel must be able to prevent silting and transport the required rate of water to the field area. The sediment carrying capacity of the channel for variable flow conditions must be compatible with the sediment supply [8,9]. Transporting all the amount and volume of sediment requires relatively high-velocity currents. In particular, it is urgent to calculate the fuzzy transmission ability of newly designed and currently used channels and evaluate them with existing conditions. [10-12]. Crop water requirements vary due to climate and crop growth stages. For this reason, the flow of sediments changes during the irrigation season. As a result, the required water does not reach the irrigated fields [13]. Coping with sediment is one of the main challenges in irrigation system design. Flow transportability is a complex process and is related to the interaction between the flow and the turbidity particles in the flow. [14]. In this direction, that is, by solving the problems of complicated sediment and discharge transport and the roughness of the channel bottom, van Rijn in 1993 developed one of the sediment transport rate equations, namely - size up to 0.2-2 mm carried out an experiment for the transport of particles, and the model proposed by Rijn is only the basic hydrodynamic parameters depth, flow velocity, wave epoch, the major characteristics of the sediment, i.e., d_{10}, d_{50}, d_{90} It is necessary to know the particles, water temperature and salinity [15, 16]. Einstein's research on sediment transport is widely recognized. To reward his achievements in the field of hydraulic engineering, the American Society of Civil Engineers decided the Hans Albert Einstein Award in 1988, which is awarded annually to those who have made important contributions to the field. As a researcher at the University of California, Hans Albert Einstein was prolific in studying the mechanics of water flow and sediment movement in alluvial rivers. Empirical relations determined in the laboratory and the field experiment suggested the following functional connection, $q_{s^*} = f(\tau_*, R_{ep}, (\rho_s - \rho)/\rho)$, he introduced into these relations fluid-mechanical ideas of turbulence and boundary layers, ideas of probability doctrine, and calculated the complex behavior of alluvial rivers in terms of mechanistically based equations [17]. K.Sh.Latipov, V.K.Debolsky, A.M.Arifzhanov evaluated the fuzzy transfer ability in their theoretical works according to Froud's and Reynold's criteria [18]. In their experiments, Engelund and Hansen estimated the transportability of the flow by taking into account the Schezi coefficient and specific density [19, 20]. The process becomes more complicated when the canal sides are eroded, and the erosion along the canal network as the canal carries the sediment and the canal filling becomes a major problem for irrigation schemes, and it is necessary to find ways to design sustainable canals. 'p money and time wasted.

2 Materials and Methods

Amu-zang Canal is an irrigation canal in the Surkhandarya region. From the right bank of the Amudarya, the water of the Amudarya is brought up to the Zang hydroelectric dam. To evaluate the carrying capacity of the canals, research in natural field conditions was carried out in the Amu-zang canal belonging to the "Amu-Surkhan Irrigation Systems" basin administration.

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Fig. 1. Satellite image of the Amu-zang channel

The total length of the Amu-zang Canal is 56.6 km, and the maximum water consumption is 120 m^3/sec. The cross-section along the length of the channel is trapezoidal (according to the project), 44.9 km of which is earthen, and 11.8 km is concrete. The annual water flow period is 10 months; from February to November, the channel works in full mode, and the total flow is 9091,000 to be used for irrigation purposes. Field research was conducted in the Amu-Zang main channel's PK 30 and PK 35. In the studies, it was observed that the water consumption in the canal changes during the season, which leads to changes in other hydraulic dimensions of the canal (Fig. 2).

Fig. 2. Deformation processes in pickets PK 30-35 of Amu-Zang channel

Deformation processes in the Amuzang channel (flooding and washing) have been observed to change the cross-section of the channel, i.e., the channel designed in the form of a trapezoid turns into a curved surface (parabola) due to mudflow. The resulting changes create new hydraulic processes in the channel and affect the carrying capacity of the stream. The design and operational parameters were determined during the research to determine the channel's carrying capacity.

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Table 1. Indicators of Amu-zang channel about annual flow

Amu-Zang channel	Q, m^3/s	B, m	b, m	h, m	ϑ, m/s
From PK0+30 to 35+00	75	34	17	5	0.6

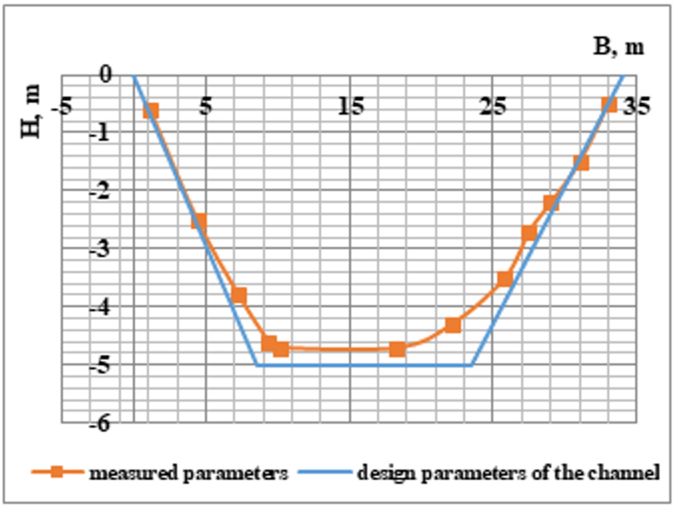

Fig. 3. Due to many reasons, flow of water in canal varies throughout year

3 Results and Discussion

Then, as a result, smooth movement is disturbed [10,11]. Naturally, channel blurring reduces the channel's efficiency. It can be seen that due to the turbidity of the water, the shape of the channel differs significantly from the design parameters throughout the year. We get the following expression for the fuzzy transfer capability of the current:

$$S_1 = \alpha \frac{\vartheta^3}{g \cdot R \cdot W} \tag{1}$$

where $\alpha = \sqrt{\frac{W_0}{W}}$; at the buyer, W_0=optimal hydraulic size, W= hydraulic size, i is slope;. In an equation different from existing methods, α is a variable quantity; its value changes depending on the sort of movement and power condition of the particles in the flow [10].

Based on the results obtained in the channel, the formula of carrying capacity of the channel by S.X. Abalyans:

$$S_2 = 0.018 \frac{\vartheta^3}{R \cdot W} \tag{2}$$

The formula (based on Y Zamarin's formula) recommended in "Construction norms and rules" (ShNQ 2.06.03-97):
Where, $2<W<8$ mm/s,

$$S_3 = 700\left(\frac{\vartheta}{W}\right)^{\frac{3}{2}}\sqrt{Ri} \quad (3)$$

And in Engelund and Hansen's formula based on Shezy coefficient and specific density:

$$S_4 = \frac{0.05\vartheta^5}{C^3 d_{50} g^{0.5}(s-1)^2} \quad (4)$$

C is Shezi coefficient ($m^{0.5}/s$), d_{50} is particle size (m), s is specific density (particle density/water density), ϑ is average depth speed. We will also calculate based on the proposed formula.

Table 2. Calculation of carrying capacity of channel

h, m	*ϑ, m/s*	*R*	*I*	*W_0 mm/s*	*α*	*S_1*	*S_2*	*S_3*	*S_4*
5	0.62	3.5	0.00006	2.49	0.105	0.292	0.492	1.226	0.097
4	0.71	2.7	0.00006	2.49	0.105	0.569	0.958	1.502	0.153
3	0.75	2.67	0.00006	2.49	0.105	0.679	1.142	1.631	0.172
2.5	0.76	2.65	0.00006	2.49	0.105	0.712	1.197	1.664	0.211
2	0.77	2.5	0.00006	2.49	0.105	0.784	1.320	1.695	0.625
1	0.78	2	0.00006	2.49	0.105	1.019	1.715	1.730	0.964

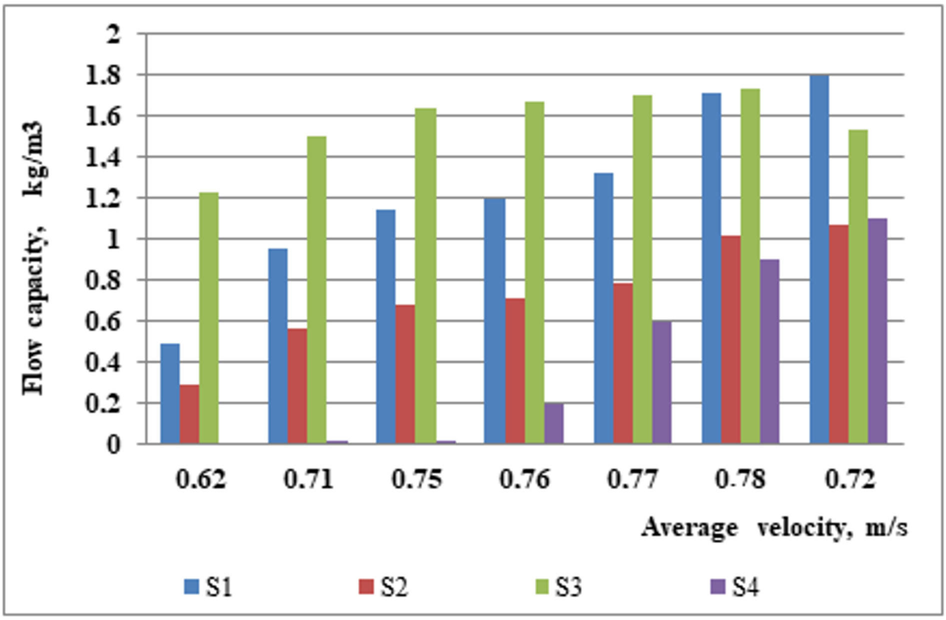

Fig. 4. Dependence of flow capacity on speed and depth

4 Conclusions

From the analysis of the obtained results, it is known that the carrying capacity in the channel changes dramatically in all four methods. That is when calculated based on the formula (1), when the flow rate increases to ϑ =0.62-0.78, the carrying capacity of the channel increases from 0.292 to 1.019 almost 4 times, based on the formula (2) from 0.492 to 1.715 4 times, based on the formula (3) from 1.226 to 1.730 approximately 2 times, and in formula (4) when the speed of the flow is in the range of ϑ =0.62-0.75, the carrying capacity of the flow remains almost unchanged, but after the speed exceeds 0.76, a very large change of up to 9 times was observed, or the carrying capacity is starting from 0.097 and reaching 0.964. So, the deformation processes occurring in the channel are directly related to the carrying capacity of the channel. At the moment, the results show the possibility of using the proposed formula (1) in practice in evaluating the carrying capacity of the channel and the deformation processes in the channel. The scientific works of the world's leading scientists who conducted scientific research on determining the carrying capacity of the flow in the channels were analyzed from the Scopus and Web of Science databases. Deformation processes in the Amuzang channel (sludge pressure and washing) and the cchannel's cross-section change

Based on the field experiments, the turbidity of the Amuzang channel was calculated using the formulas recommended by S.Kh.Abalyans, A.Zamarin, A.M.Arifzhanov and Engelund and Hansen. According to the results, it was found that the method recommended by A.M. Arifzhanov is suitable for real conditions.

A histogram of the dependence of flow capacity, channel depth, and average speed on the Amuzang channel was obtained, according to which it was determined that the flow capacity is 1.5-1.8 kg/m^3 in the range of 0.6-0.8 m/s.

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