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Determination Of The Depth Of Local Erosion In The Downstream Of The Tuyamuyun Hydroelectric Complex By Calculation And Experiment

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ABSTRACT

This article gives the dependence for determining the depth of local erosion in the downstream of the Tuyamuyun hydroelectric complex, obtained by calculation and experiment. Based on the studies on the hydraulic model, correction factors are given to the formula for determining the depth of erosion in the lower pool of the hydroelectric complex. The graphs of the dependence of the coefficients K1, K2, K3 depending on the number of working holes, the levels of the upper and lower buffs.

KEYWORDS

Hydraulic unit, erosion depth, water horizon, lower buffer, upper buffer, modeling, water flow, hydraulics, dam gates, hydraulic studies.

INTRODUCTION

The experience of operating structures on rivers and canals shows that the phenomenon of local erosion is observed to one degree or another in the vast majority of existing structures, which requires significant additional funds for its reconstruction.

In this paper, a dependence is given for determining the depth of local erosion in the

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downstream of the Tuyamuyun hydroelectric complex, obtained by calculation and experiment As you know, there are a number of formulas for determining the depth of the erosion pit, for example,

1. Formula of Studenichnikov B.I.

$$t_p = K_F \ {}^{1,2}\sqrt{\frac{q}{3,6d^{0,25}}} \qquad (1)$$

2. Formula of Levi I.I

$$t = \frac{4 \cdot z\sqrt[3]{q}}{u_o\left[2,5+0,1\left(\frac{z}{h}\right)^{1/6}\right]} \qquad (2)$$

3. Formula of Zamarina E.A.

$$t_p = \left(\frac{q_0}{v_1}\right)\frac{m_1}{m_1+1} \qquad (3)$$

and others

All these formulas are valid for a uniform flow of traffic and include the dependence of the depth of the erosion pit on the soil velocity allowed for erosion or the diameter of the eroded material.

The simplest dependence is as follows []

$$t_p = {}^{1.2}\sqrt{\frac{q}{\upsilon g}} \qquad (4)$$

METHODS OF RESEARCH

However, this formula is applicable for solving a plane problem and does not take into account the spatial conditions of flow spreading.

It is recommended to take into account soil erosion during spatial spreading of the flow by the coefficient K, depending on;

1. Number of working holes of the dam
2. From water horizons upstream and downstream
3. From the location of the working holes within the spillway front.

As a result, the formula for determining the depth of erosion taking into account the spatial spreading of the flow will take the form

$$t_p = K \ {}^{1.2}\sqrt{\frac{q}{v_g}} \qquad (5)$$

where: K – coefficient taking into account all of the above factors

$$K = K_1 * K_2 * K_3 \qquad (6)$$

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q - specific consumption (per 1 running meter) at the dam ,m^3\sec

υ_g – washout flow rate,m\sec

The studies were carried out on a spatial model of the Tuyamuyun hydroelectric complex on a scale of 1:80 natural size, reproducing a section of the headwater at a length of 1 km with a supply channel.

Simulation of hydraulic phenomena was carried out on a model according to the Froude gravity similarity rules $\frac{V^2}{gh} = idem.$

Subsoil in the downstream - clays were reproduced on a model from expanded clay and channel sand from sawdust.

RESULTS

To determine the coefficient K on the model, 3 series of experiments were carried out and its components were found K_1 , K_2 , K_3

Research results are presented in the form of tables, graphs

a) coefficient K1 - determining the influence of the number of working holes on the depth of erosion of the downstream of the hydroelectric complex.

The experiments were carried out both with the full opening of each hole, and with the joint operation of two, four, six holes located in the center of the spillway dam, as well as eight holes.

Studies have shown that with an increase in the number of working holes, and therefore with an increase in the flow rate of water discharged through the dam, the depth of erosion in the downstream increases from 24.8 m with two working holes, and with all eight holes working up to 43 m..

Coefficient "K1" was determined by the formula

$$K_1 = \frac{t_м}{t_p} \qquad (7)$$

Where t_m – depth on the model

t_p - erosion depth obtained by calculation

The results of this series of experiments are presented in table. № 1

Table №1

Number of employees holes	Δ U.B.L m	Δ L.B.L m	$Q_п$ m^3/sec	q m^3/sec	t_p m	t_M m	K_1
2	125	113	1850	77.08	29.1	24.8	0.85
4	125	113	3700	77.08	29.1	32.1	1.11
6	125	113	5550	77.08	29.1	35.5	1,21
8	125	113	7400	77.08	29.1	43.0	1,32

As can be seen from Table 1 and Figure 1. K1 value with an increase in the number of working holes increases from 0.85 to 1.32

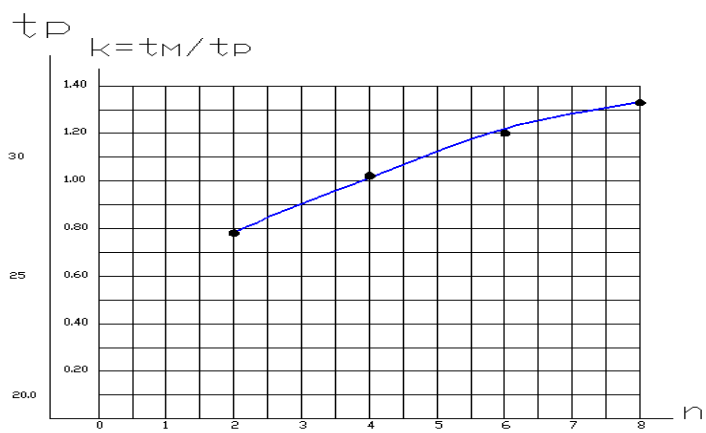

Fig. 1. The graph of the dependence of the coefficient K 1 on the quantity (n) working holes of the waterworks.

b) Coefficient K_2 - determining the influence of the water horizon in the upstream on the erosion of the downstream of the hydroelectric complex

Coefficient "K_2" was determined by the formula

$$K_2 = \frac{t_M}{t_p\, K1} \qquad (8)$$

Where, t_m - depth obtained on the model

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t_p - depth determined by calculation formula (5)

The results of these series of experiments are shown in table. 2 and Fig. 2

Number of employees. holes	Δ U.B.L	Δ L.B. L.	$Q_{пл}$ $m^3 sec$	q m^2/sec	$t_p = \left(\frac{q}{v_H}\right)^{\frac{1}{1,2}}$	T_m	$K_2 = \frac{t_M}{t_p\ K1}$
8	120	112,0	4720	49,17	20	26,6	1,01
8	125	112,0	4720	49,17	20	27,7	1,05
8	130	112,0	4720	49,17	20	29	1,1

Table №2

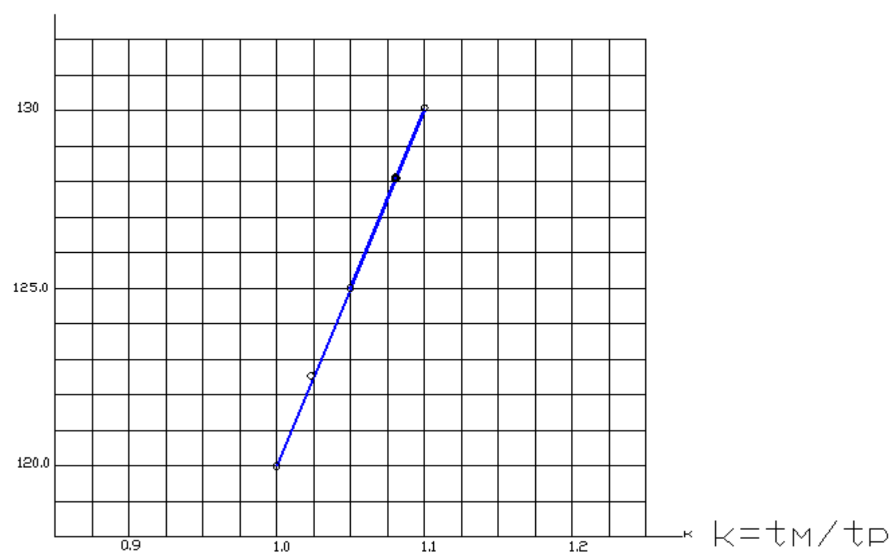

Fig 2. Graph of the dependence of the coefficient K_2 on the water level upper waterworks.

c) Coefficient "K_3" - determining the impact of water-water supply on the depth of erosion in the downstream of the hydroelectric complex.

The influence of the water horizon of the downstream of the hydroelectric complex was determined during the operation of four fully open central spans

$$K_3 = \frac{t_M}{t_p}$$

The water horizon in the headwater was kept constant at 125

Discharge was discharged into the tailwater 3700 m^3/sec , accordingly, the specific consumption was 77,08 m^3/sec.

Studies have shown that when the water levels of the lower pool are higher than 113.5, the erosion does not exceed the calculated ones.

With a decrease in the water horizon in the downstream, the erosion somewhat increases.

The results of these series of experiments are shown in Table 3 and in Figure 3.

Table №3

Number of employees. holes	Δ U.B.L	Δ L.B. L.	$Q_{пл}$ m^{3}sec	Q m^3/sec	$t_p = \left(\frac{q}{v_H}\right)^{\frac{1}{1,2}}$	T_m	$K_3 = \frac{t_M}{t_p}$
4	125	107.5	3700	77.08	29.1	33	1.13
4	125	109.5	3700	77.08	29.1	30	1.03
4	125	113.5	3700	77.08	29.1	29	1.0

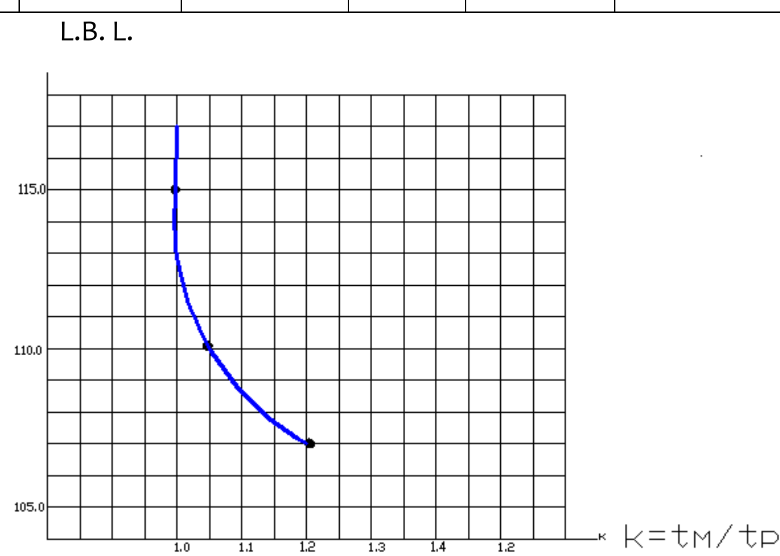

Fig 3. Graph of the dependence of the coefficient K 3 on the water level downstream waterworks

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CONCLUSION

Thus, our proposed dependence for determining the depth of erosion in the downstream of a hydroelectric complex is determined by (9) and can be used in the future when designing such hydroelectric facilities.

$$t= K_1*K_2*K_3 \sqrt[1.2]{\frac{q}{v_g}} \qquad (9)$$

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