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THE QUESTION OF EXPANDING THE TERM OF EXPLOITATION OF HYDROPOWER PLANTS AND RECLAMATION WATER RESERVOIRS

The work gives a design of a new spring-board type construction in the shape of a step to expand the term of exploitation of hydropower plants and reclamation water reservoirs. The work considers the arrangement of cascades within the construction in the main riverbeds and across the first- and second-range rivers, whose system guarantees the reduction of the sediment volume in the water area of the water reservoirs.

Keywords: **hydropower and reclamation water reservoirs, spring-board type construction**

INTRODUCTION

One of the major problems when expanding the term of exploitation of hydropower plants and reclamation water reservoirs in the countries of the world with most of their territory being mountainous is reducing the sediment (solid fractions) volume in the water area of the water reservoirs as much as possible.

The practice has shown that one of the major problems to reduce the term of exploitation of hydraulic structures, including high dams (over 100 m) is rapid filling of the upstream dam with sediment. In order to solve this problem, since 1929, the Water Management Institute of Georgian Technical University (the author of the present article has been engaged in these works since 1981) has been developing the new structures of spring-board type debris control dam (barrages), with the relevant methodology developed to design them. Below, we consider one of them with the relevant structural solution and calculation method [1, 2].

1. NEW DEBRIS CONTROL STRUCTURE OF A SPRING-BOARD TYPE

The designation of a new type spring-board type through debris control structure is the reduction of the current impact force, particularly at catastrophic values of the current parameters, as well as simplification of the structures and reduction in their price.

The advantage of the mentioned structure considered below as compared to the existing one is as follows: a) reliable and long performance of the structure; b) efficient stabilization of mountain rivers, and c) great economic effect, as the presented constructions are to be built with reinforced concrete and secondary materials (obsolete metal railings, etc.), with their proportion amounting to 50-80% of the total building materials [3].

The step debris control barrage [1, 4, 5] is made with horizontally laid reinforced concrete beams (1) with iron beams fixed on them in the vertical plane (2) and with their second ending fixed in the riverbed (see Fig. 1). The endings of the reinforced concrete beams are linked together with concrete heads of an ellipse shape (3) boosting the probability for more efficient performance and better stability of the construction.

The horizontally located reinforced concrete beams loaded with sediment or during the mudflow movement reduce the stream power in the vertical plane, while the ellipse-shaped concrete heads distribute the current all over the width in the horizontal plane.

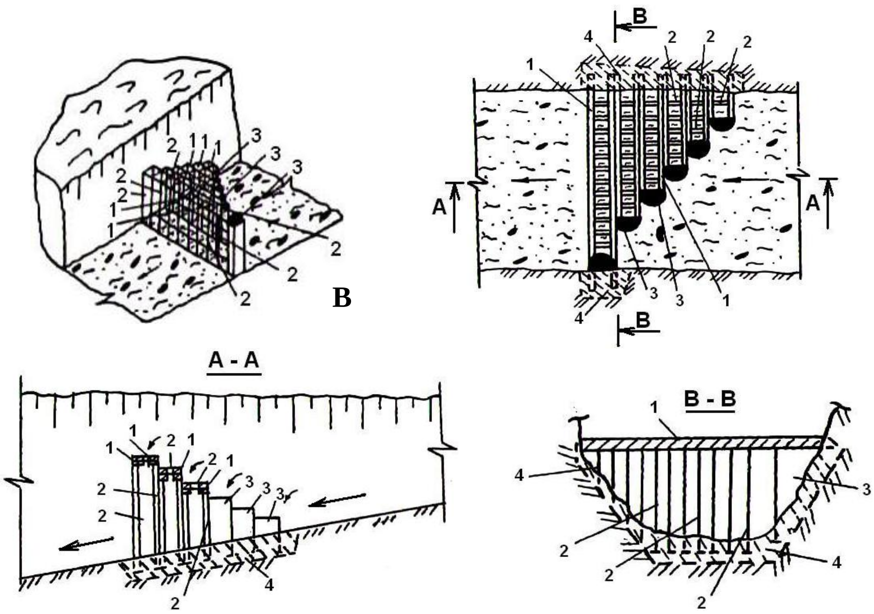

Fig. 1. Step debris control barrage

2. CALCULATION OF THE SPRING-BOARD TYPE DEBRIS CONTROL DAM

The slope (i_0) balancing the mass of solids collected at the headwater of a barrage construction is calculated by the empirical relationship [5]:

$$i_0 = \frac{0.29i}{(d/\Delta)^{0.27} \cdot (t/T)^{0.25}} \tag{1}$$

where i - riverbed slope; d - average diameter of sediments (cm); Δ - maximum width between construction girds (cm); t - the elementary time of operation of construction (sec); T - period of total time for filling up of headwater of construction (sec). Operating limits of dependence (1) are: $(d/\Delta) = 0.125$ to 1.125 and $(t/T) = 0.1$ to 0.9.

In the case of 90% of intercept stones switching by the dam [5, 6] the concentration of debris flow (S') is

$$S' = S - \frac{90 \cdot S}{100} \% \tag{2}$$

where S is the initial concentration of debris flow (%).

The weight γ' of stream [5] after passing debris flow construction will be

$$\gamma' = \gamma_1 + S(\gamma_2 - 1),\ (N/m^3) \tag{3}$$

where γ_1 - weight of water volume (γ_1 = 9810 N/m^3); γ_2 - weight of stone volume (γ_2 = $2.65 \cdot 9810$ N/m^3);

Debris volume held by the dam is calculated by the following relationship [5, 6]:

$$W_T = \frac{S \cdot Q_{max}}{[0.95 + 0.05(d/\Delta)] \cdot (t/T)^{0.58}},\ (m^3) \tag{4}$$

where Q_{max} is the maximum debris flow (m^3/s).

Knowing the construction dimensions and the formation of the structure's upper bief, there is no difficulty in calculating the distance between the barrages by means of the following dependence [5]:

$$L = \frac{H}{i - i_0}\ (m) \tag{5}$$

With this the calculation of the spring-board type barrages in the mudflow type river is finished. The structure's situation scheme can be seen on the Figure 2.

For this the qualitative evaluation of the transport ability of the solid fractions in the barrage interval by the debris flow on the solids was accumulated in the structure's upper blef (in the case of filling of the upper blef). For solving this question the known method was used - the criterion of displacing the solid fractions from the riverbed by envisaging the resistance coefficient of the solids in the riverbed.

The structural sizes and stability of the premise are calculated by considering the major hydraulic, hydrological and topographic properties of the current [5, 7], as well as international building standards and principal hypotheses of bases and foundations [8, 9].

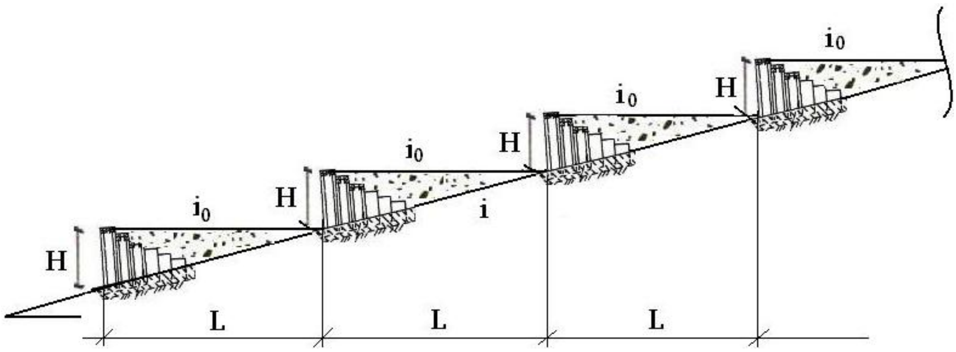

Fig. 2. Layout scheme of the constructions

So, if in the upstream dam, after the dam flooded curve is ended, we arrange the cascades with the premises in the main riverbed and its tributaries with the presented structures, a large portion of solid fractions transported into the bed of an mountainous river will be captured by the debris structures with only relatively more sediment-free current flowing into the water reservoir what guarantees the expanded term of exploitation of hydropower plants or land-reclamation premises.

CONCLUSION

- A spring-board type premise to expand the term of exploitation of hydropower plants and land-reclamation water reservoirs is presented, with its scientific and technical novelty priority protected through relevant patent certificate.
- The calculation method to locate the spring-board type debris premise in a cascade type is developed, which can be used to design it.
- Using the considered premises in practice will ensure the stabilization of the mountain riverbeds what is the guarantee for more efficient seizure of solid fractions and expansion of the term of exploitation of the water reservoirs in mountainous regions.

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PROBLEMATYKA WYDŁUŻENIA OKRESU EKSPLOATACJI HYDROELEKTROWNI I ZBIORNIKÓW RETENCYJNYCH

Praca przedstawia projekt nowego typu konstrukcji o kształcie stopni, zastosowanie, którego przyczyni się do wydłużenia okresu eksploatacji hydroelektrowni i zbiorników retencyjnych. System umożliwia redukcję osadów w zbiornikach.

Słowa kluczowe: hydroelektrownie, zbiorniki retencyjne