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FORECASTING THE SUSPENDED SOLID SEDIMENT TRANSPORTED IN THE HEADRACE OF ENGURI DAM

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Abstract: The forecasts of suspended solid sediment transported in the headrace of Enguri reinforced concrete high arch dam (with the height of 271.5 m) is based on the results of the field and laboratory studies accomplished from 2013 to 2015.The goal of the study was to fix the lateral profile in the river in the construction section of Khudoni dam across the river Enguri with an echometer, fix the relevant coordinates by using a GPS and sampling the river water by using a bathometer.It was established that the discharge of the suspended solid sediment transported by the water current in the construction section of Khudoni dam in the river Enguri bed changes by 1.14-1.30 kg/m^3 a second, with respective coordinates: X=0267983, Y=4757922 and X=0268019, Y=4757911, while the discharge of the suspended solid sediment from the river Enguri to the confluence of the river Nenskra changes by 1.46 kg/m^3 a second with respective coordinates: X=0271289 and Y=4760149.In the low-water period of the river Enguri (in summer) when the average current discharge was 261,0 m^3/s, with average velocity of 3.25 m/s, the measurements demonstrated that the average discharge of the suspended solid sediment was 297.54 kg/s.

KEY WORDS: Enguri River, suspended sediment, transportation, Enguri and Khudoni Dams.

1. INTRODUCTION

The problems of protecting land resources of mountain regions as well as of areas located in front of mountains, using their potential as far as possible as well as keeping ecological balance of an environment are directly connected with the objectives of ensuring a proper operation of the hydraulic power system considering extreme factors (Cungeet al., 1890; Gavardashvili, 2010).

The extreme conditions mentioned above are observed on the seismic areas of mountains as well as in front of mountains (covering a significant part of Georgia) expressed in high-scale geodynamic processes, such as landslides and seismic-tectonic settings as well as in headracesof the damas a result of an intensive erosion of the beds of mountain rivers during the rapid filling of the water reservoir.

The long-term practice of operation of hydro-technical facilities on the mountain rivers showed that the prediction of filling up with sediments mostlydoes not come true as the prediction of transporting capacity of sediments in most cases is accompanied by activation of mudflow processes and the effect of filling up a water reservoir with sediments is far more than it has been shown in the prediction (Gavardashvili, 2015; Gvazava et al., 1981).

Therefore, in Georgia that represents a mountainous country the prediction of sediments accumulated in the headrace of high dams requires recalculation in order to calculate exactly an operation period of open water reservoirs (Gvelesiani, 2010; Mays, 2005).

2. METHODOLOGY

In the article for the postulated goal of which the assessment of susceptible deposits on the alignment of new Arch Khudoni Dam was carried out, field studies were conducted. In the calculated 9 alignments (directivity on GPS coordinates), using Bathometers, water samples were taken on the Enguri River, and the laboratory water conditions were estimated for the turbidity of the water during the different periods of the year.

This research was carried out in 2014-2016 and it was established that using the results obtained it is possible to predict the transport capacity of the stream and, taking into account the above, it is possible to clear the balance of solid deposits of reservoirs of the new Arch Khudoni Dam.

The resulting Result leads to Tables 1-4, which have already transferred the Ltd Trans-electric firm to calculate the dead volume of the reservoir deposits.

3. SHORT REVIEW OF WATER RESERVOIRS OF ENGURI AND KHUDONI HIGH ARCH DAMS

The Enguri Dam is one of the highest reinforced-concrete arch constructions in the world located in 33 km from the city of Zugdidi to the north of the Enguri River bed.

The height of the Enguri Arch Dam is 274 m, its width in the river bed equals 660 m while the max level of flooding in the headrace of the construction does not exceed 250m (Cunge et al., 1890; Gavardashvili, 2010; Gavardashvili, 2015).

Volume of the water reservoir of the Enguri Dam equals 1bln and 100mln cubic meter while the area of mirror surface is 10,13mln m^3(Cunge et al., 1890).

The maximum height of the Khudoni reinforced-concrete arch dam is 200.5 m, its length along with the crest - 522.0 m, the crest level - 702.0 m, the crest width – 9.0 m, the width of the dam bottom – 42.1m, the main parameters of the Khudoni water reservoir: normal flooding level (NFL) – 700.0, dead volume level (DVL) – 630.0 (see Fig.1.).

Fig.1 Layout of the Enguri and Khudoni Dams

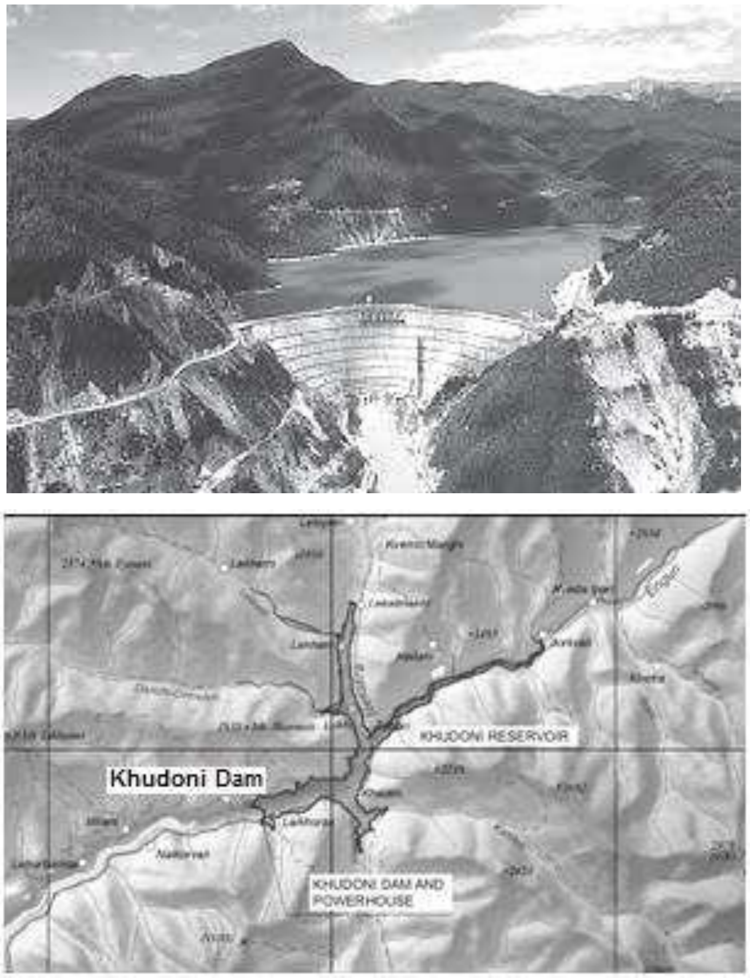

Fig.2 Views of the Enguri and Khudoni water reservoirs

With a view to predicting suspended solid sediments transported in the headrace of the Enguri Dam, a field research was carried out in the design section of the Khudoni Dam from 2014 to 2016 the results of which are provided in the tables below (See Tables 1,2,3).

Table 1

Field data of the Enguri River for July, 2014

Coordinates for sampling	Fraction quantity (gr/mll)	Maximum discharge of the Enguri River (m^3/s)	Average velocity of water (m/s)	Sediment amount in $1m^3$ (kg)	Average discharge of suspended sediment (kg/s)
X=0267983; Y=4757922	2.53	340.0	4.95	2.53	860.20
X=0267983; Y=4757922	2.30	340.0	4.95	2.30	782.00
X=0267983; Y=4757922	2.53	340.0	4.95	2.53	860.20
X=0268019; Y=4757911	2.53	340.0	4.95	2.53	860.20
X=0268019; Y=4757911	2.32	340.0	4.95	2.32	788.80
X=0268019; Y=4757911	2.37	340.0	4.95	2.37	805.80
X=0271289; Y=4760149	2.53	340.0	4.95	2.53	860.20
X=0271289; Y=4760149	2.53	340.0	4.95	2.53	860.20
X=0271289; Y=4760149	2.41	340.0	4.95	2.41	819.40

Table 2

Field data of the Enguri River for July, 2015

Coordinates for sampling	Fraction quantity (gr/mll)	Maximum discharge of the Enguri River (m^3/s)	Average velocity of water (m/s)	Sediment amount in $1m^3$ (kg)	Average discharge of suspended sediment (kg/s)
X=0267983; Y=4757922	2.31	310.0	3.85	2.31	716.10
X =0267983; Y=4757922	2.10	310.0	3.85	2.10	651.00
X =0267983; Y=4757922	2.31	310.0	3.85	2.31	716.10
X =0268019; Y=4757911	2.31	310.0	3.85	2.31	716.10
X =0268019; Y=4757911	2.30	310.0	3.85	2.30	713.00
X =0268019; Y=4757911	2.16	310.0	3.85	2.16	669.60
X =0271289; Y=4760149	2.31	310.0	3.85	2.31	716.10
X =0271289; Y=4760149	2.31	310.0	3.85	2.31	716.10
X =0271289; Y=4760149	2.18	310.0	3.85	2.18	675.80

As a result of the analysis of the field research the forecast of filling up of the headrace of the Enguri water reservoir with sediments with the data as of 2016 are provided in the Table 4, the quantitative indicators of which are provided in the table as well.

Table 3

Field data of the Enguri River for July, 2016

Coordinates for sampling	Fraction quantity (gr/mll)	Maximum discharge of the Enguri River (m^3/s)	Average velocity of water (m/s)	Sediment amount in $1m^3$ (kg)	Average discharge of suspended sediment (kg/s)
X=0267983; Y=4757922	1.0	268.0	3.92	2.00	536.00
X =0267983; Y=4757922	1.0	268.0	3.92	1.81	485.08
X =0267983; Y=4757922	1.0	268.0	3.92	2.00	536.00
X =0268019; Y=4757911	1.0	268.0	3.92	2.00	536.00
X =0268019; Y=4757911	1.0	268.0	3.92	1.99	533.32
X =0268019; Y=4757911	1.0	268.0	3.92	1.87	501.16
X =0271289; Y=4760149	1.0	268.0	3.92	2.00	536.00
X =0271289; Y=4760149	1.0	268.0	3.92	2.00	536.00
X =0271289; Y=4760149	1.0	268.0	3.92	1.89	506.52

Table 4

Data for sanding the Enguri water reservoir (2016)

Full volume of the water reservoir (mln. m^3)	Length of thereservoir (km)	Maximum depth of the water reservoir (m/km)	Area of mirror surface of the water reservoir during NFL (km^2)	Accumulation of sediment during one year (mln. m^3)	Total volume of sediments for 2015 (mln. m^3)	Sanding coefficient	Height of sanding near the dam (m)
1092.0	30	230	13.48	3.73	133.1	0.12	40.0

4. CONCLUSION

Therefore, based on the field-scientific research carried out during the low-water period of the Enguri river (in summer), when an average discharge of the flow equals 268.0 m^3/s, with an average velocity of 3.92 m/s, an average discharge of the suspended sediment ranges between 485.08–536.0 kg/s; when an average discharge of the river equals 310 m^3/s, with an average velocity of 3.85 m/s, an average discharge of the suspended sediment ranges between 651.0 – 716.1 kg/s and when an average discharge of the river equals 340 m^3/s, with an average velocity of 4.95 m/s, an average discharge of the suspended sediment ranges between 782.0 – 860.2 kg/s that makes it possible to make an accurate forecast of the sediments suspended in the water reservoir of the Enguri Dam.

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