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DETERMINATION OF THE ANANUN RIVER SILT REGIME CHARACTERISTICS IN THE SITE OF MUSHEGH SMALL HYDRO POWER PLANT HEADWORK

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The last decade has seen construction of many small hydro power plants on mountain rivers and their tributaries where no hydrometric measurements have been made. The carried out analysis has shown that the efficiency of the majority of small hydro power plants is smaller than the designed one. The reason lies in not reliable calculations of hydrological parameters of streams. Probability of inaccuracy increases during determination of silt flow. Taking into consideration of importance of correct determination of hydrological parameters the paper intends on the example of the operating Mushegh small scale hydro power facility to suggest forecasting techniques for monthly average flow of silt and their annual flow. The obtained results will enable to make corrections in operating regime of the facility.

Keywords: *watercourse, silt, operating regime, hydro facility.*

Introduction

In the last two years in the Republic of Armenia and Mountainous Karabagh many small scale hydro power plants have been built on not large rivers and their tributaries. Flows of these streams are of clearly defined seasonal character. The ratio of their average monthly minimum and maximum values from time to time exceeds 100. In such conditions for reliable design and effective operation of small scale hydro power plants it is important to correctly evaluate hydrological characteristics of water streams. Yet this problem is often solved with many essential faults. For the absolute majority of active stream of water results of hydrological measurements are wanting. For that reason flows of water streams are determined by calculation or some other techniques [1,2]. In some cases as an analogue one of nearby running rivers is chosen of which hydrological row exists.

In hydrological calculations the probability of inaccuracies increases far more during determination of silt flows. It should be noted that reliable determination of the quantity of silt is very important in terms of calculation of small hydro plants headworks dimensions and safe operation of the entire power system. In addition for small rivers no forecast of silt flow determination often is performed. The problem of that flows removal usually is left on the operating personnel but not always the personnel is enough qualified to solve that problem. Because of hydrological calculations imperfection the majority of presently acting in the Republic of Armenia small hydro power facilities is operated far more below of the designed efficiency. It is well proved that the water stream containing silt and sediments quantities exceeding the permissible level entering in the power house develop intensive wear of turbine blades.

The best part of the above mentioned drawbacks are characteristic of the Mushegh small scale hydro power facility built in Jeruk town, Vayots Dzor province, the Republic of Armenia on the Ananun river which is tributary of the Arpa river.

Conflict settings

Taking into consideration the importance of correct determination of hydrological parameters for both Mushegh small scale hydro power facility and other small scale hydro power plants of the region in the present work by the example of the Mushegh small hydro power facility a prediction technique for determination of silt average monthly quantities is suggested.

Research results

Water feed to the Mushegh small hydro facility is performed from the Ananun river and Sarnaghbiur springs.

Sarnaghbiur springs all the year round have a relatively uniform yield (0.5m^3/s on an average). To determine the average monthly discharge of the Ananun river a method of an analogue river was employed.

In the first version as an analogue river was taken the nearest Dali tributary. There is a very short period (4 years) of monitoring of that tributary. In this case according to calculations the average annual flow quantity of the Ananun river is 0.34m^3/s.

In the second version as an analogue river was taken the Arpa river (Jermuk station) where there is a most presentable row of observations. Calculations have shown that in this case the average annual flow of the Ananun river is 0.63m^3/s. As design data of average values of the two versions were taken into consideration. The obtained results are in Table I. Taking into account Sarnaghbiur springs' runoff in the dam site water intake of the Mushegh small hydro power facility the average annual flow quantity is 0.98m^3/s.

Let us assuming as a basis of the Ananun small river monthly flows determine their respective silt flow. On the basis of results pf many years studies in the region conditions the following functional relation has been obtained for suspended (floating in the water column) silt flow [3].

$$Q_T = 0{,}72\, Q_W^{0{,}95}, \qquad (1)$$

Where Q_w is the water flow in m^3/s.

Now let us try on the basis of the above formula to determine the average monthly suspended silt flows of the Ananun small river. As for the flow of bedded or settled on the bottom of a body of water silt it should be noted that for this region in calculation that flow is taken equal to the half of suspended silt flow [3]. The results of silts flows calculations are tabulated in Table2. The analysis of obtained values has shown that for both the fluid and silt flows have clearly defined seasonal character. Particularly, only in April, May, and June flows are larger that for the rest nine months of the year. Let us determine the volume of all silt transported by the stream during one year.

Assuming volume density of suspended silt equal to 1200-1300kg/m^3, total volume of them transported by the Ananun small river can be during one year can be calculated by the following formula

$$W_{sus} = \frac{0{,}37 * 365 * 24 * 3600}{1250} = 9300 \ m^3$$

Studies of many years have shown that about 50-60 per cent of suspended silt are particles smaller than 0,05mm. They are transient and don't deposited even at very slow rates. Therefore, the volume of deposited suspended silt at the Mushegh small hydro power facility headworks will be

$$W_{sed} = 4650 \quad m^3$$

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Parameter	I	II	III	IV	V	VI	VII	VIII	IX	X	XII	XII	Average annual
Average monthly discharge of the Ananun river (analogue of the Dali river)	0,12	0,12	0,18	1,1	1,56	0,26	0,11	0,09	0,08	0,08	0,09	0,09	0,34
Average monthly discharge of the Ananun river (analogue of the Arpa river)	0.28	0.27	0.29	0.72	2.33	1.53	0.58	0.36	0.32	0.32	0.30	0.29	0,63
Average of the two methods	0,2	0,2	0,23	0,91	1,95	0,9	0,35	0,22	0,2	0,2	0,2	0,19	0,49
Average flows taking into account Sarnaghbiur springs	0,7	0,7	0,73	1,41	2,45	1,4	0,85	0,72	0,7	0,7	0,7	0,69	0,98

Table 2

Average monthly water discharge and its respective silt in the site of the water intake of the Mushegh small scale hydro power facility

Parameter	I	II	III	IV	V	VI	VII	VIII	IX	X	XII	XII	Average annual
Design water discharge, Q_w m^3/s	0,2	0,2	0,23	0,91	1,95	0,9	0,35	0,22	0,2	0,2	0,2	0,19	0,49
Flow of suspended silt, Q_T kg/s	0,16	0,16	0,18	0,66	1,36	0,65	0,27	0,17	0,16	0,16	0,16	0,15	0,37
Flow of bottom sediments, q_T kg/s	0,08	0,08	0,09	0,33	0,68	0,33	0,14	0,09	0,08	0,08	0,08	0,08	0,19

As noted above the quantity of bottom silt is also amount to the half of suspended silt. However, their density ranges within 1900 to 2100 kg/m^3. Therefore, the volume of bottom silt will be

$$W_{bed}\ \frac{0{,}37/2*365*24*3600}{2000} = 3000\ m^3$$

Thus, during one year the total volume of bottom and suspended silt transported by the Ananun small river and deposited at the Mushegh small hydro power facility headworks will be

$$W_H = W_{sed} + W_{bed} = 4650 + 3000 = 7650\, m^3$$

By predicted flows of silt the value of obtained annual volume of silt was compared with that calculated by another technique. It is the calculation method for determination of ground volume transported by flood streams [4], and accordingly we get

$$W_{sed} = 19 Q_{\max}^{1,4} I^2 \qquad (2)$$

where W_{sed} is the volume of deposited silt (in thousand cubic meters), $Q_{\max}$ is the maximum calculated value of flood flow (in m^3/s), I is river-bed slope in the area under study. For the Ananun small river we have $Q_{\max}$ = 3,2 m^3/s (5 per cent in case of safety), I =0,25. Under the given conditions the volume of accumulated silt according to Eq.(2) amounts to around 6500m^3. In case of problems similar to the one discussed in this work a close agreement of two values of silt volume calculated by a variety of ways may be deemed to be satisfactory.

Conclusion

The results obtained in the work enable to predict the annual distribution of silt at the Mushegh small hydro power facility headworks and calculate the accumulated volume. Developments done in this paper can be used in prediction of silt regime for water streams having no hydrological measurements.

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ԱՆԱՆՈՒՆ ԳԵՏԻ ՋՐԱԲԵՐՈՒԿԱՅԻՆ ՌԵԺԻՄԻ ԲՆՈՒԹԱԳՐԵՐԻ ՈՐՈՇՈՒՄԸ ՄՈՒՇԵՂ ՓՀԷԿ-ի ԳԼԽԱՄԱՍԻ ԳԵՏԱՀԱՏՈՒՅԹՈՒՄ

Պ.Հ. Բալջյան, Վ.Գ. Հայրապետյան, Ա.Կ. Հարությունյան, Գ.Ս. Նարինյան

Շուշիի տեխնոլոգիական համալսարան

Վերջին տասնամյակում շատ փոքր ՀԷԿ-եր են կառուցվել լեռնային գետերի և դրանց վտակների վրա, որտեղ բացակայում է հոսքի հիդրոմետրիկական չափումները: Վերլուծությունը ցույց է տալիս, որ ՓՀԷԿ-երի հիմնական մասը աշխատում է նախագծայինից զգալի ցածր արդյունավետությամբ: Պատճառը ջրահոսքերի հիդրոլոգիական պարամետրերի մեծությունների ոչ հուսալի հաշվարկումն է: Անճշտությունների հավանականությունը առավել մեծանում է ջրաբերուկների ելքերի որոշման ժամանակ: Հաշվի առնելով հիդրոլոգիական պարամետրերի ճիշտ որոշման կարևորությունը աշխատանքում խնդիր է դրվել շահագործվող Մուշեղ ՓՀԷԿ-ի օրինակով առաջարկել ջրաբերուկների ելքի միջին ամսեկան արժեքների և դրանց տարեկան հոսքի կանխատեսման եղանակներ: Ստացված արդյունքները հնարավորություն կտան ճշգրտումներ մտցնել կառույցի շահագործման ռեժիմում:

Բանալի բառեր. ջրահոսք, ջրաբերուկ, ելք, շահագործման ռեժիմ, հիդրոտեխնիկական կառուցվածք:

ОПРЕДЕЛЕНИЕ ХАРАКТЕРИСТИК НАНОСНОГО РЕЖИМА р. АНАНУН В СТВОРЕ ГОЛОВНОГО УЗЛА МГЭС МУШЕГ

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За последние десятилетие были построены многочисленные МГЭС на горных реках и их притоках, где отсутствует гидрометрические параметры потока. Анализ показывает, что большинство МГЭС работают со значительно меньшей производительностью, чем было проектировано. Причиной тому является не учет реальных гидрологических параметров потоков. Вероятность неточностей увеличивается при определении расхода наносов. Учитывая важность определения гидрологических параметров, в работе поставлена задача предложить метод предвидения среднемесячного расхода наносов и их годового стока, на примере эксплуатируемой МГЭС «Мушег». Полученные результаты дадут возможность для внесения коррекций в режиме эксплуатации сооружения.

Ключевые слова: поток, нанос, расход, режим эксплуатации, гидротехническое сооружение.