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On the Issue of Determining Capacity of Spillway Structures of Gazalkent at Hydroelectric Complex

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ABSTRACT:In this article presents results of experimental laboratory research to determine compliance with the capacity of the costs of water, etc., for different combinations and maneuvering procedures spillway gates with full and partial opening them, etc.

KEYWORDS: Coefficient of flow, water flow, pressure, water level, speed, throughput, waterworks, upstream, shutter, spillway.

I.INTRODUCTION

The solution of various issues of the operation of hydraulic structures, the optimal use of water, the introduction of cost accounting in the water sector is impossible without establishing a reliable and accurate water metering.

Accurate determination of water consumption is one of the necessary conditions when designing a hydraulic structure.

The size of structures, the volume of work on their construction, and, consequently, the cost of construction depends on the correct selection of the flow coefficient during the design of structures. In addition, during the operation of waterworks, there is a need to regulate the flow rate and therefore, gates are installed on the structures, and water is passed in the flow mode from under the gates.

The reliability of cost accounting for structures under these conditions has not yet been sufficiently developed.

II. METHODS OF RESEARCH

Using the example of the Gazalkent hydroelectric complex, the results of studies on determining the discharge coefficient of a spillway structure with various schemes of gate openings are presented.

The investigated surface spillway includes: a supply channel, a water intake structure with a shield part, a discharge path in the form of a quick flow with an end structure.

The shield part of the dam is made with three holes, each in the clear width of 14 m, overlapped by segment gates.

Directly behind the shield part of the dam, a water part (well) is arranged, which is intended mainly for the smooth transfer of the water flow from the shield part of the dam to the concrete rapid flow, the axis of which is located at an angle of 850 with respect to the axis of the entrance part of the structure.

In terms of speed, the confuser 32 m long is interfaced with a water well; the width in the initial section is 18 m, in the end section 14 m. Behind the confuser there is a rectilinear section of the fast current with a length l = 161.4 m with a slope i = 0, 05628 and then a curved radial section with a total length l = 63.4 m; with a turning radius of R = 79 m, a

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slope of i = 0.04899, and, finally, a horizontal section of the rapid current with a length of I = 5.0 m with an end structure

Key research questions included:
- experimental hydraulic studies of spillway throughput at various gate openings.
- determination of flow coefficients "μ" for various combinations of gate openings.

To resolve these issues, a fragmentary (spatial) hydraulic model was constructed according to the rules of gravitational similarity, i.e. Froude 1:80.

The following parts were reproduced on this model: a part of the supply channel section, a shield part of the spillway, a water well, and a 65 m long flow section.

Spillway throughput was determined by skipping various water flow rates and various gate openings on the model.

As you know, the coefficient of discharge of the spillway in the event of the outflow from under the segment shutter into the horizontal tray without flooding from the downstream side was determined from the formula [3]

$$\mu = \frac{Q}{a\sum b\sqrt{2g(H_0-\varepsilon a)}} \qquad (1)$$

where: a – shutter opening amount;

$\sum b$ - total width of holes;

ε - vertical compression ratio;

H_0 - depth before construction, taking into account the speed of approach.

The value of the vertical compression ratio of the jet when it flows out from under the segmented shutter was determined by the Khimitsky formula [3]

$$\varepsilon = \frac{1}{1+\sqrt{\kappa(1-\acute{\eta}^2)}} \qquad (2)$$

where: $\acute{\eta} = \frac{a}{H}$К = 0.4sin ϴ
ϴ – the angle of the segment shutter with the horizon equal 45^0

Due to the lack of flooding from the downstream side at all water flow rates, the discharge capacity of the spillway turned out to depend on the marks of the water levels in the upper pool, the size of the gates opening and the number of working holes[4,5,6,7,8].

Determine the calculated dependence of the spillway discharge, the experiments also determined the discharge coefficients “μ” for various combinations of gate openings: all three holes work simultaneously, two holes work, one is closed, one hole is working, the other two are closed, etc.

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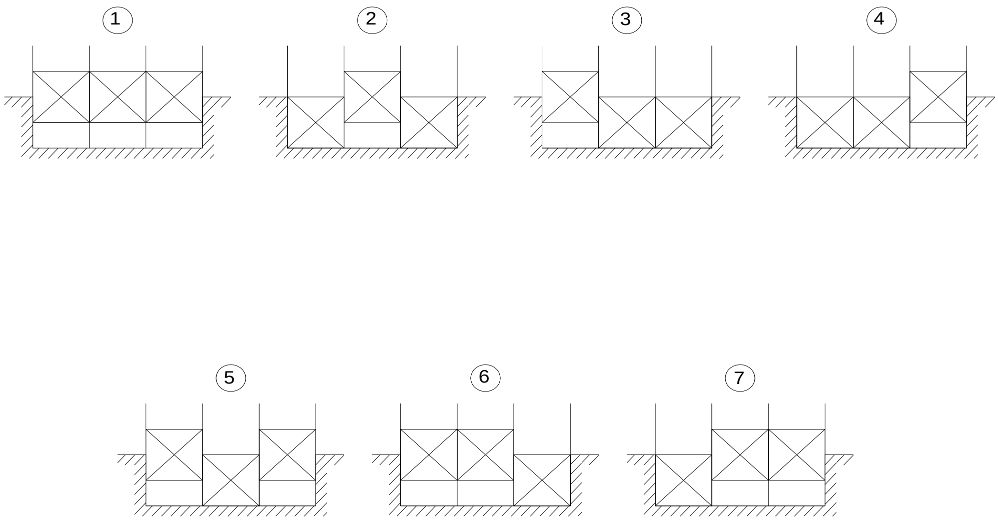
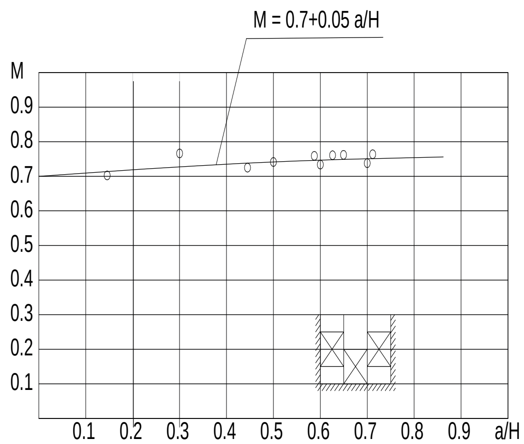


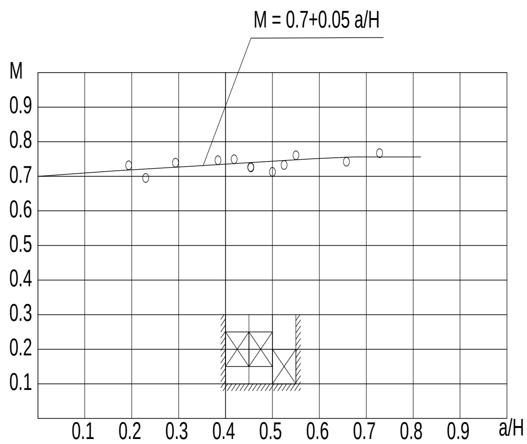
Fig.1. Options of gate operation schemes for various opening schemes investigated on the model of the spillway structure of the Gazalkent hydroelectric complex

Based on these experiments, graphs were constructed$\mu = f\left(\frac{a}{H}\right)$
where: a – shutter opening amount, H - depth of water before construction.
By mathematical processing of the experimental data, it was possible to establish the form of the flow coefficient formula, which has the following form

$$\mu = 0{,}7 + 0{,}05\ \mathrm{a/H} \qquad (3)$$

The experiments showed that the dependence for determining the flow coefficient has the same form regardless of the opening of the shutters.





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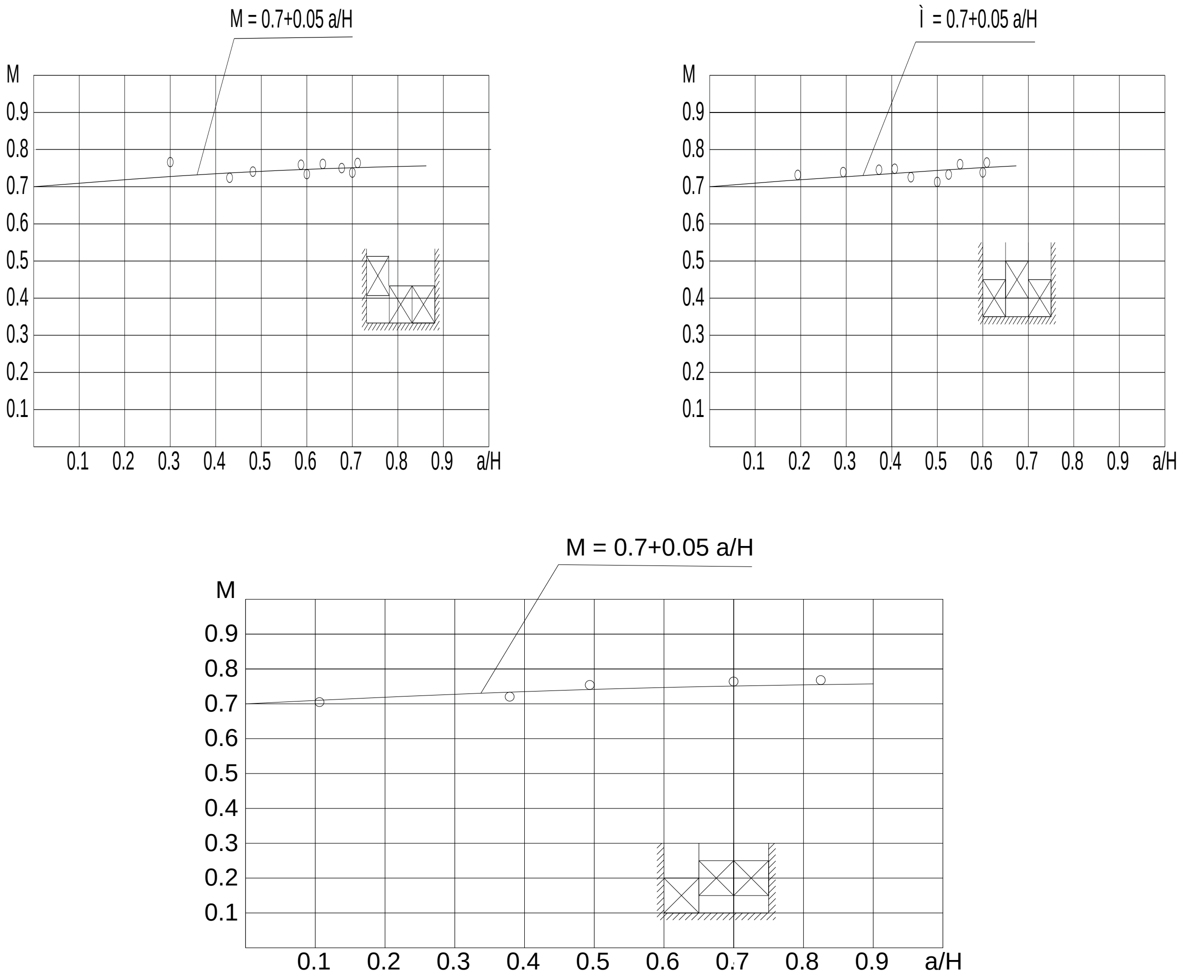

Fig. 2. Graphs of the dependence of the flow coefficient "µ" on the relative opening of the valves "a / H"

Comparison of the experimental values of the flow coefficients "µ" with the calculated flow coefficients showed that they have quite real values and are in the range of 0.7-0.75, which is consistent with data from the literature [2], where it is about 0.65- 0.75.

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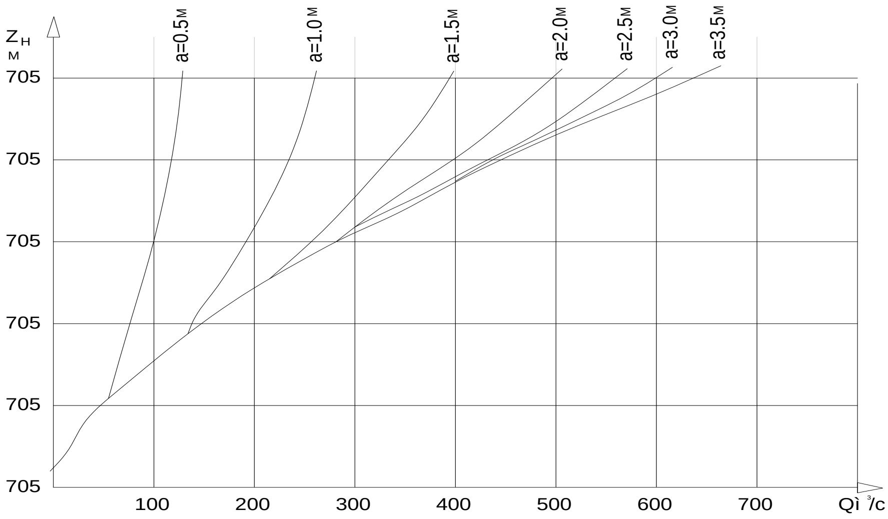

Fig. 3. The graph of the dependence of the water flow "Q" on the water level marks in the upper bay "Zн" and the various openings of the gates at the spillway of the Gazalkent hydroelectric complex.

III. CONCLUSION

Consequently, based on the conducted experimental studies, the following results were obtained:
- the values of the discharge coefficient of the spillway structure are determined for various combinations of gate openings determined by the formula (3)
- a schedule has been drawn up (Fig. 3) by which it is possible to determine the water discharge depending on the water level marks at the upper side of the «Z_n» and various openings of the gates.

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