MODELING THE CAPACITY OF THE PRESSURED WATER OUTLETS OF RESERVOIRS

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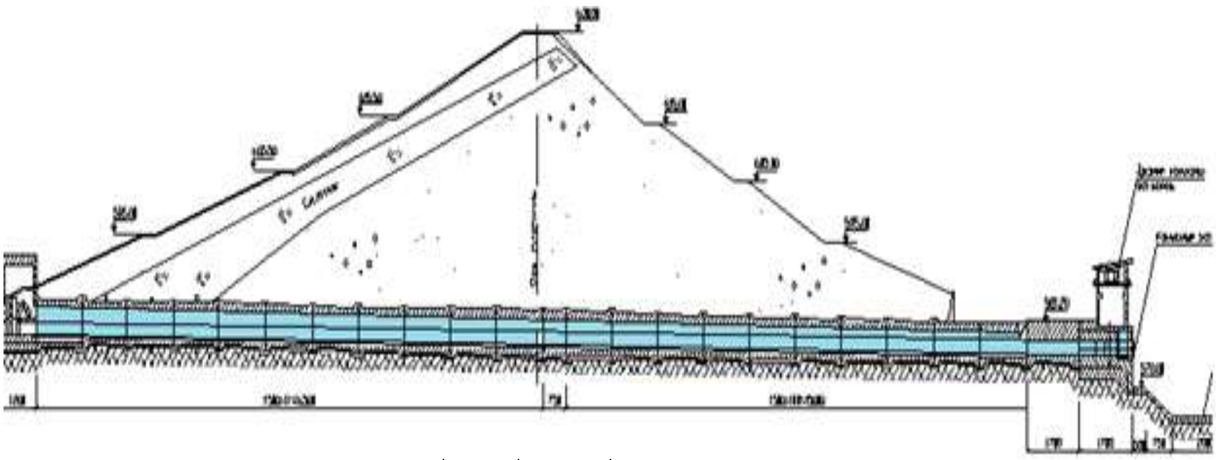
Abstract. Modeling of hydraulic problems of the dynamics of the structure of the outlet and spillway of high-pressure reservoirs is studied with special attention in the world. This is due to the breadth of the complex of technical problems of water energy, as well as the presence of hydraulic phenomena in a wide range of processes characteristic of this branch of the national economy.

Keywords. spillway, reservoir, pressure, potential energy, flow rate.

High-pressure/low-pressure dam: earth type, with a loamy screen, material pebble-sandy soil, maximum height - high-pressure-70.0 m., low-pressure-30.0 m; length along the crest-high-pressure - 420 m., low-pressure - 210 m, 5.6 million m3. base soils - gravel, sandstone. Drainage - closed drainage from reinforced concrete pipes. [1]

Outlet: type - gallery, metal pressure pipeline D-2440mm. design flow rate - 32.0 m3/s. shutters - flat sliding bxh = 1.5x2.5 m, 2 cone D-2200mm. (Fig.1.)



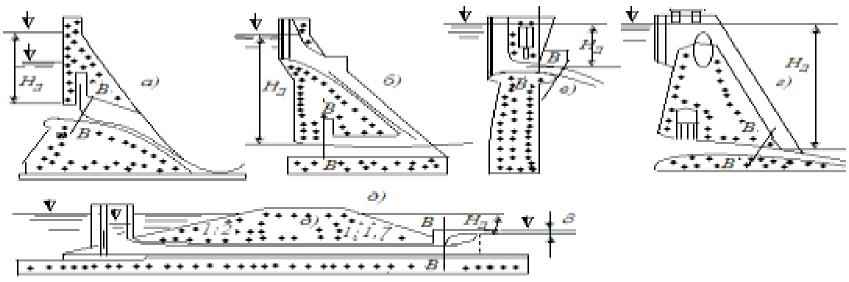


Fig.1. Section along the outlet axis of the Karkidon reservoir

Tubular spillways are used in the pressure spillways of the Karkidon reservoir. Tubular spillways can operate in pressure (Fig. 2, c, d, e) or partially pressure modes (Fig. 2 a, b). From the side of the upstream to the alignment of the gates, the mode is always pressure, and then - pressure or non-pressure. The water flow through the tubular spillway is calculated by the formula:

$$Q = \mu\omega\sqrt{2gH_Д} \quad (1)$$

Q - pressure section flow; $H_Д$ - effective pressure. [2]

The meaning invested in the concept of "acting head" will be established from the Bernoulli equation, compiled for sections 0-0 in the upstream and in the range of the outlet. For any elementary trickle, the upstream head above the threshold of the hole:

Fig.2. Tubular spillways.

$$T_0 = z + \frac{p}{\rho g} + \frac{u^2}{2g} + \sum \varsigma \frac{u^2}{2g} \tag{2}$$

Multiplying both parts of the equality by the elementary flow rate $dQ = ubdz$ and integrating over the height of the section, we obtain: [3]

$$T_0 b \int_{-c}^{T} u_0 dz = b \int_0^a \left(z + \frac{p}{\rho g} \right) udz + b \int_0^a \frac{u^3}{2g} dz + b \sum \varsigma \int_0^a \frac{u^3}{2g} dz \tag{3}$$

Assuming that in the output section of the speed at all average speeds, we arrive at the expression:

$$T_0 b \int_{-c}^{T} u_0 dh = \vartheta b \int_0^a \left(z + \frac{p}{\rho g} \right) dz + \frac{\vartheta^2}{2g} b \int_0^a \vartheta dz + \sum \varsigma \frac{\vartheta^2}{2g} b \int_0^a \vartheta dz \tag{4}$$

Attributing all members of this expression to the expense $Q = \vartheta ba = b \int_0^b \vartheta dz = b \int_{-c}^{T} u_0 dz$, we get:

$$T_0 = \frac{\int_0^a \left(z + \frac{p}{\rho g} \right) dz}{a} = \left(1 + \sum \varsigma \right) \frac{\vartheta^2}{2g} \tag{5}$$

and

$$Q = \mu \omega \sqrt{2g \left[T_0 - \left(z + \frac{p}{\rho g} \right)_{cp} \right]} \mu \omega \sqrt{2gH_Д} \tag{6}$$

here $\mu = \frac{1}{\sqrt{1 + \sum \varsigma}}$ - flow rate; $\omega = ab$;

$$\left(z + \frac{p}{\rho g} \right)_{cp} = \frac{\int_0^a \left(z + \frac{p}{\rho g} \right) dz}{a} \tag{7}$$

- the average potential energy in the outlet section, which is further denoted as - Π;

$$H_Д = T_0 - \left(z + \frac{p}{\rho g} \right)_{cp} = T_0 - \Pi \tag{8}$$

$H_Д$ - effective pressure.

Thus, the current pressure $H_Д$ - is the difference between the specific energy of the flow in the upstream and the average potential energy in the outlet section (in units of the water column). [4-5]

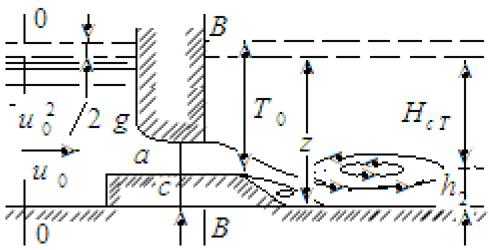


Fig.3. To the definition of the current pressure.

The average potential energy in the outlet section of the spillway is determined from the pressure diagram in this section, the nature of which depends on the mode of outflow from the hole (Fig. 3). Counting the specific energy from the horizontal plane 0-0 passing at the level of the threshold of the hole, and integrating over the height of the hole, we obtain the values of the average potential energy Π - in the hole relative to the level of the threshold. [6]

Free outflow from the hole (Fig. 2.4., a). The pressure above and below the jet is atmospheric; on the jet axis, the excess pressure corresponds to the height of the water column, equal to 0.2a. If we take the pressure over the entire cross section of the jet equal to atmospheric $p = 0$, that:

$$\Pi = \int_0^a \frac{zdz}{a} = \frac{a}{2} \quad H_Д = T_0 - \frac{a}{2} \tag{9}$$

Here and below z it is measured from the threshold of the hole.

Conclusion:

An expression is obtained for the average potential energy in the outlet section and the effective head. Operating head $H_Д$ - is the difference between the specific energies of the flow in the upstream and the average potential energy in the outlet section. The average potential energy in the outlet section of the spillway is determined from the pressure diagram in this section, the nature of which depends on the mode of outflow from the hole.

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