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MODELLING OF RESERVOIR SEWAGE CURRENTS REGIME ON THE BASIS OF SOFTWARE FOR EVALUATION OF SHORE STRENGTHENING CONSTRUCTIONS STABILITY

The results of laboratory and field surveys of Vileysko-Minskaya hydrologic system discharge currents were presented. Software for reservoirs currents dynamical pressure counting was developed basing on the results. Modeling in water bodies let invent calculation algorithms for currents speed spread mode counting and banks fixing constructions stability evaluation.

Introduction. More than 150 artificial water objects (reservoirs) of various type with full volume more than 1 million m^3 and the total area of water mirror over 800 sq.km, including more than 20, created on the basis of lakes [1] are In the Republic of Belarus. With the development of industry, agriculture, transport and other branches of industries in the country a great increase of power consumption takes place. For the stability of the state economy in the Republic it is necessary to increase the number and capacities of power stations. The construction of the largest hydroelectric power station in Belarus on the Neman (Grodno hydroelectric power station) is being carried out, and the construction of reservoir cascades of hydropower appointment on the Western Dvina, Dnieper, Sozh is planned. According to the above said the protection of the environment and population from the hydrodynamic dangerous factors leading to different catastrophes becomes of great importance. One of the main questions in the solution of the problem above is forecasting of exploitation of the natural protected and unprotected shore slopes, as conservation of initial condition of shores at the moment of creation reservoirs does not provide effective technical and economic decisions.

Main part. Now full-scale researches of the stability of the constructions and elements of shore strengthening constructions of reservoirs are being carried out by Russian GEC of B.E.Vedeneeva Institute of geography of the Russian Academy of Sciences, jsc darvodgeo (Russian Federation), etc. The most known researches are works by Pyshkin, Yu. A. Sobolevsky, N. E. Kondratyev, E. I. Mikhnevich etc. [2, 3]. The destruction of joints is the most characteristic damage of shore strengthening constructions and that is the reason of further soil carrying out, sag of plates, emergence of cracks and breaks and, as a result, destruction of these constructions. Repair and restoration are often carried out very slowly that increases probability of repeated accidents on these objects.

Therefore to predict negative processes in a coastal zone of reservoirs, natural measurements of current speeds on the Vileysk-Minsk water system cascade reservoirs were carried out by the authors. Then the similar cascade of reservoirs on which measurements of current speeds in the various alignments coinciding with alignments on real objects were carried out in the laboratories.

In the solution of water objects modeling problems to which waterways and reservoirs belong the definition of the corresponding account designs (algorithms) on which the calculation of speed distribution mode and an assessment of constructional stability is to be carried out is of great importance.

Taking into consideration these natural and laboratory researches, software product in the language of Pascal, allowing to calculate the value of speeds and pressures of a liquid stream was worked out.

When ignoring the rotor component of a high-speed stream $\overline{v}(x, y)$, which is important while assessing the process of convective diffusion of various impurities the initial model of (formulas (1) and (2))

$$h\rho UU_x + h\rho VU_y + P_x + \alpha F(h)U - -\gamma(hU)_{xx} - \gamma(hU)_{yy} = 0; \quad (1)$$

$$h\rho UV_x + h\rho VV_y + P_y + \alpha F(h)V - -\gamma(hV)_{xx} - \gamma(hV)_{yy} = 0;$$

$$(hU)_x + (hV)_y = 0 \quad (2)$$

makes possible to describe the potential component of speeds $\overline{v}^*(x, y) = gradP(x, y)$.

The given potential $P(x, y)$ allows to change the system of three equations (1) – (2) into one equation of Laplas type:

$$\nabla(F(x,y)\nabla P) = 0. \quad (3)$$

Boundary conditions for the equation (3) are requirements: the absence of leakage on shore lines and set difference of level marks on entrance and target alignments.

Real conditions for water sticking to a shore edge occur due to artificial increase of roughness at small depths that quite corresponds to reality.

The numerical solution of tasks on the basis of the equation (3) is effectively realized by splitting on spatial factors, that is by the low-critical solution of interdependent one-dimensional tasks.

The Krinitsa reservoir was chosen as a test reservoir. As initial information coordinates of the shore line contour, depth of the reservoir, settlement alignments and islands were set on a coordinate grid.

Laboratory measurements of current speeds on unwashed models of reservoirs with the help of a marker (dye) for studying the characteristics of speed distribution and movement of a spot (distance in unit of time) and measurements of middle speed of the liquid stream by a microcomputer flowmeter-speedmeasurer were carried out.

The analysis of computer modeling data and laboratory researches given above show their identity and state that the data of natural supervision over deformation of shore slopes are correct. On sites with the greatest concentration of marker (maximum speeds) the destruction of plates and coasts (abrasion) that demands their additional strengthening is clearly seen. Washout of slopes is caused as by the wind wave currents (cross-section distribution of speeds), and along shore currents that confirms the results of laboratory modeling.

Conclusion. Analysis and checking whether the laboratory and natural data are similar with the results of the calculations received according to the methods above with the application of the experimental software on the equations of Saint-Venana (Bussinesk – Laplasa), showed that they can be applied on small reservoirs.

Approbation of software product showed that calculation of speed distribution with a margin error about 15% is possible if taking into account the example of Vileysko-Minsky water system reservoirs, that is sufficient for engineering calculations, at a total error of balance of expenses (on any alignments) less than 1%.

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