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DEVELOPMENT OF BOUNDARY CONDITIONS FOR MATHEMATICAL MODELS OF UNSTEADY WATER MOVEMENT IN WATER MANAGEMENT FACILITIES

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Abstract: The article explores the potential for designing virtual clothing models based on material characteristics and evaluating the quality of fit using the automated CLO3D program. The article analyzes the problems of developing boundary conditions for mathematical models taking into account the multidimensional distribution of parameters of unstable water movement in space in modern conditions. The author revealed and explained the solution of the system of equations with boundary conditions for modeling two-dimensional water flow in open channels.

Keywords: water management objects, water movement, spatial parameter, multidimensional distribution, mathematical model, boundary condition, open channel, water flow, system of equations.

Introduction. Currently, the problems of mathematical models of unstable water movement, taking into account the multidimensional distribution of parameters in space, occupy one of the main places in the problems of engineering use of water management objects. In modern conditions, the development of boundary conditions for mathematical models, taking into account the multidimensional distribution of parameters of unstable water movement in space, is widely used in practical calculations. The integration of the theoretical principles of limit means for mathematical models, taking into account the multidimensional distribution of parameters of unsteady water movement in space, should fully provide analytical solutions to the problems posed by various fields [1].

Depending on the task and the available means of solving it, simplified (estimated) calculation options are used or mathematical modeling systems are built with a given accuracy of the process description and a detailed result is obtained.

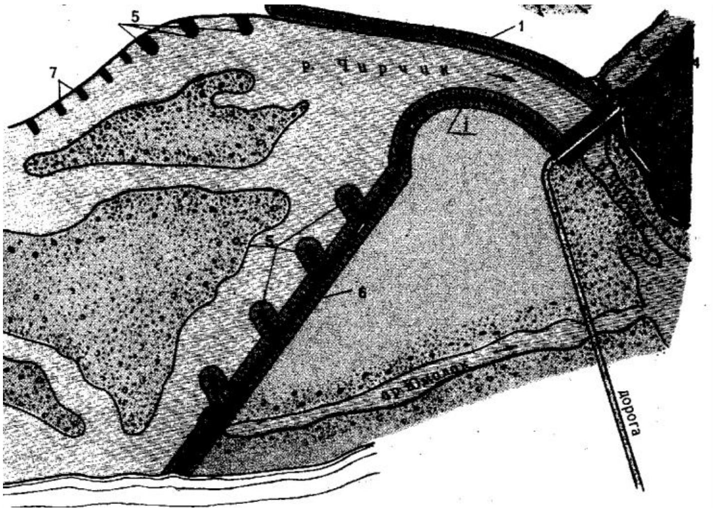
The variational method was developed by N.A. Kartvelishvili and is based on the application of the Bubnov-Galerkin method to calculate the unsteady motion of water. This method allows to bring the solution of the system of equations in particular derivatives (in this case, the system of Saint-Venant equations) to the initial solution of the system of ordinary differential equations, and then to the system of algebraic equations [4]. The successful use of this method was proposed by academician E.E. Makovsky [5], the analytical solution of the linear Saint-Venant equation obtained by him is now widely used in engineering calculations.

V. I. Koren and L. S. Kuchments conducted research on creating mathematical models of unstable water movement [6; 7]. In their research, a wide range of issues related to the creation of mathematical models of the river flow were considered.

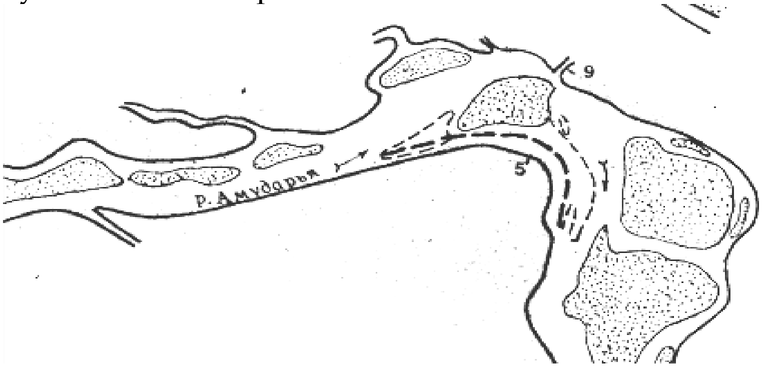
Many authors [8, 9, 10] have considered the mathematical meaning of the corrections for momentum and energy introduced into the equations of motion, as well as the possibilities of simplifying and schematizing the movement of water flows.

Methodology & empirical analysis. The article analyzes the problems of developing boundary conditions for mathematical models, taking into account the multidimensional distribution of parameters of unstable water movement in space in modern conditions. Taking into account the multidimensional distribution of spatial parameters of unstable water movement in water management facilities, mathematical models, comparative analysis, and selective observation methods were used. Logical and structural analysis, grouping and comparison methods were used as research methodology.

Results. For rivers, canals and water reservoirs, the fields of spatial variable detection can be different. As an example 1.2. and 1.3. - in the pictures you can see the plan of taking water from the Chirchik River to the Karasuv Canal and from the Amudarya to the Qilichniyazboy Canal.



Picture 1. The plan for taking water from the Chirchik river to the Karasuv canal is high - Chirchik hydroelectric complex and the order of riverside control measures



Picture 2. Taking water from the Amudarya River to the Qilichniyazboy Canal and measures to control the river banks

Due to the spatial distribution of Chirchik and Amudarya rivers in terms of latitude and longitude, these objects should be considered as two-dimensional objects [2]. It is advisable to model the movement of water in these objects on the basis of two-dimensional models. Based on the results of mathematical modeling based on a two-dimensional model for these objects, it is possible to clarify the measures and measures regulating the main structures and channels [3].

For the accuracy of the solution, it is necessary to define the initial and boundary conditions.

The initial conditions describe the entire movement at the time it is taken as the initial.

$$U(x,y,t_0)=U_0(x,y), \qquad (x,y)\in\Omega, \qquad (1.28)$$

where U0(x,u) are given functions of depth and flow rate, Ω is a two-dimensional area.

The field of detection of variables in which the water flow moves has a complex geometric shape in a part of a river or a natural channel.

An important difficulty in setting a two-dimensional problem is defining the boundary conditions [4]. Let us see that the boundary dΩ part of the field Ω consists of liquid and impermeable solid parts, that is, the boundary dΩ={dΩj,, dΩt} parts can consist of several parts. As an example, let's consider a part of a wide rectangular channel (Fig. 1.4), where liquid and solid boundaries are shown.

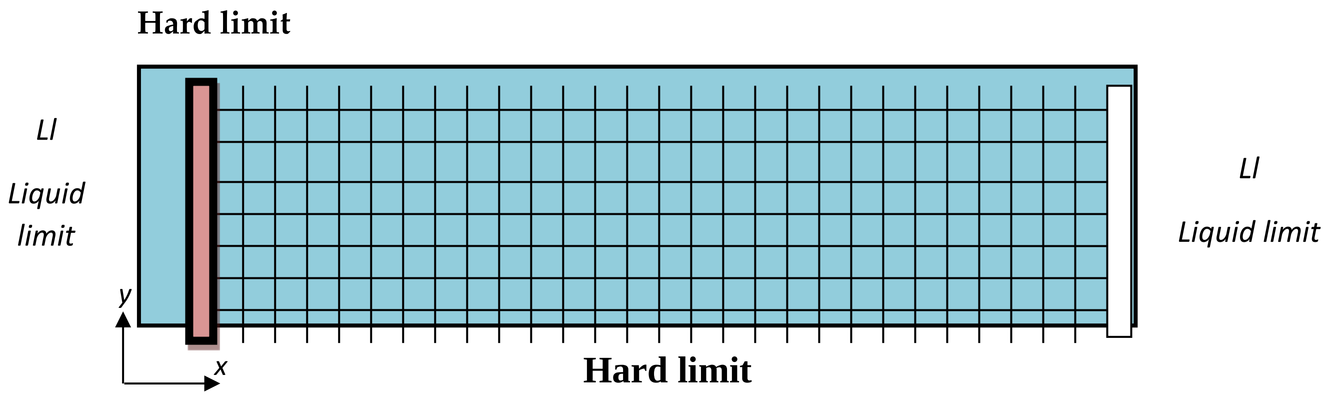


Figure 3. A wide rectangular channel with a barrier device.

In the liquid part of the field boundary there is a hydraulic structure or hydraulic post, in the solid part of the boundary the flow is surrounded by the sides of the channel.

In the liquid part of the boundary, depending on the type of hydrotechnical facility, a change in depth or a change in water consumption is given [5].

$$h_i(x,y,t)=H_i(t),$$
$$q_i(x,y,t)\cos\alpha+p_i(x,y,t)\sin\alpha=Q_i(t), \quad (1.29)$$
$$\alpha=(n,\hat{O}x), \quad (x,y)\in d\Omega_{жi} \quad i=1,n_{ж}$$

where qi(x,u,t) and pi(x,u,t) are the longitudinal and transverse unknown components of flow water consumption, and Hi(t) and Qi(t) are the depth and flow in the corresponding fluid section given functions of consumption change, α is the angle between the limit normal and the x-axis.

Equation (1.29) represents the conditions for a hydropost with a known water level.

If the hydrotechnical facility is in working mode,

$$Q_i(t) = F(H_i(t), h_i(x,y,t), a_i(t)), \quad (x,y) \in d\Omega_{жi} \quad i = 1, n_ж \qquad (1.30)$$

where hi(x,u,t) are the unknown constituents of the stream water level, Hi(t) and ai(t) are the given functions of the change of the upstream depth and the opening of the hydraulic structure in the corresponding liquid part.

In the hard part of the border, the water consumption is equal to zero according to the normal, given in the following form:

$$q_i(x,y,t)\cos\alpha + p_i(x,y,t)\sin\alpha = 0, \quad \alpha = (n, \hat{O}x), \quad (x,y) \in d\Omega_{\text{т}i} \quad i = 1, n_{\text{т}} \qquad . (1.31)$$

The physical meaning of the equation (1.31) is that the total component of longitudinal and transverse water consumption normal to the limit is zero.

$$d\Omega = d\Omega_ж \Upsilon d\Omega_{\text{т}}, \quad d\Omega_ж = \Upsilon_{i=1}^{n_ж} d\Omega_{жi}, \quad d\Omega_{\text{т}} = \Upsilon_{i=1}^{n_ж} d\Omega_{\text{т}i}, \quad (1.32)$$

Then the equation for boundary conditions can be written in operator form

$$\mathbf{E}_i \mathbf{V} = \mathbf{F}_i, \quad (x,y) \in d\Omega_i, \quad i = 1,...,n \quad (1.33)$$

Thus, to model two-dimensional water flow in open channels, the system of equations (1.27) is solved with boundary conditions (1.33).

The system of equations (1.27) belongs to the quasi-linear differential equations with complex boundary conditions of special derivatives in the fields of determination of variables, it is impossible to get an exact solution of the structured problem, therefore, various numerical methods are used for approximate solutions.

Conclusions. The use of the finite element method in the modeling of water flow taking into account the multidimensional parameters of water management objects in space, modeling the dynamics of temporary processes of water resources on a computer, determining the qualitative and quantitative characteristics of the water flow along the length and width of a river or channel, as well as , allows to determine the design parameters that improve the performance of new structures in them, and also significantly reduces the time spent on studying the processes that occur in them compared to full-scale studies and sample studies on a physical model.

In modern conditions, the qualitative and quantitative features of the development of boundary conditions for mathematical models, taking into account the multidimensional distribution of spatial parameters of unsteady water movement in water management facilities, fully provide analytical solutions for the integration of theoretical principles.

References

1. Зияев Р.Р. Зарафшон ҳавзаси дарёлари сув режими фазаларининг иқлим ўзгариши шароитидаги силжишлари. Геогр. ф.ф.д... дисс. автореферати. - Тошкент, 2021. - 46 б

2. Рогунович В.П. Автоматизация математического моделирования движения воды и примесей в системах водотоков //Монография. –Л.:Гидрометеоиздат, 2017. – 264 с.

3. *Архангельский* В.А. Расчёты неустановившегося *движения* в открытых водотоках. -М.; Л. : изд-во АН, 2018.-136 с

4. Кучмент Л.С. Внутригадовое распределение речного стока. -Л.: Гидрометеоиздат, 2012. - 326 с.

5. Хикматов Ф.Х. Закономерности формирования водных ресурсов горных рек в условиях изменения климата. Монография. - Ташкент: “РНМУ”, 2020. - 232 с.

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