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MODELING AND CONTROL OF CARGO TRANSPORTATION PROCESSES IN RECLAIM SYSTEMS OF FISH FARMS

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ABSTRACT

The article highlights the issues related to resource-saving technologies in fish farming when transferring cargo using optimal variants of mathematical modeling. Optimal options for managing and increasing the work capacity of objects of reclamation of fish farms.

Introduction. Article 13 of the Law of the Republic of Uzbekistan "On the safety of hydraulic structures" dated August 20, 1999 "Inspection of hydraulic structures" When inspecting hydraulic structures, in order to assess compliance with the rules and regulations for the safety of hydraulic structures, user organizations, as well as during the operation of hydraulic structures, their construction , reconstruction, overhaul, restoration or during conservation, control over the activities of contractors is carried out.

On this basis, structures are built in ameliorative systems (locks, rectifiers, canals, pumping stations, water separators and other structures), fisheries (fish passages, fish elevators, fish barriers, fish ponds, etc.), water supply and water distribution (water intake, pumping stations, treatment structures, regulated basins, industrial lakes, internal networks, water supply (tunnels, pipes, aqueducts, dams, canals, storm and rain outlets in the design, operation, maintenance and repair of various loads from one movement of the place, loading and unloading processes account for the majority of total labor and capital costs [1].

Increasing the productivity and economic efficiency of these processes can be achieved through the introduction of new energy efficient technologies, including their optimal planning and management. Such technology, in turn, includes such issues as choosing the most optimal of the possible migration trajectories and placing cargo in containers of the most optimal shape and size, taking into account their physical and mechanical properties and other characteristics. These problems can be solved using the method of mathematical modeling of load transfer processes. The method of mathematical modeling allows automatic control of processes using algorithmic programming [3].

The movement of objects in space in the form of various loads can be carried out with various trajectories, including along a straight line, with a constant radius of curvature, or along a variable arc (Fig. 1).

It is known that the position of the body in space is determined by the functions $f(X,Y,Z)=0$ (1) in the Cartesian coordinate system and $F(\rho,\alpha,\beta)=0.$ (2) in the polar coordinate system [2]. Then for Figure 1 (1 and (2)). Relationship between expressions is written as follows:

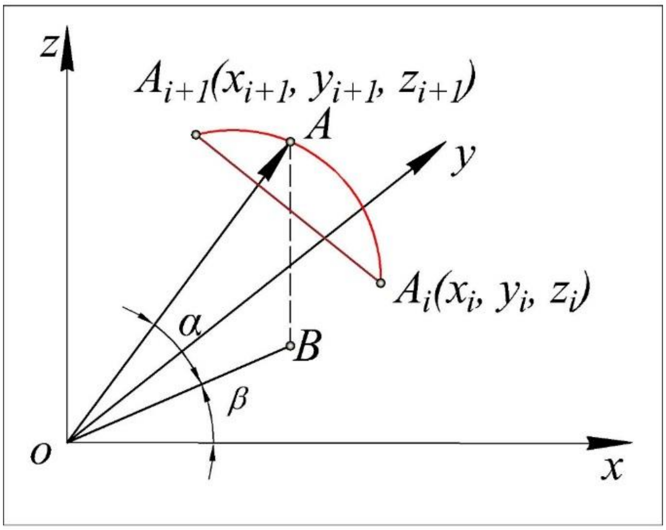

fig.1

$$\left.\begin{aligned} X_A &= \rho_A \cos\alpha \cos\beta \\ Y_A &= \rho_A \cos\alpha \cos\beta \\ Z_A &= \rho_A \sin\alpha \end{aligned}\right\} \quad (3)$$

The distance of movement of goods in space, for example, from position to position, can be determined by the following expression:

$$d=\sqrt{\left(X_{Ai+}-X_{Ai}\right)^2+\left(Y_{Ai+1}-Y_{Ai}\right)^2+\left(Z_{Ai+1}-Z_{Ai}\right)^2} \quad (4)$$

If it is necessary to express this distance in polar coordinates, then expressions (3) change as follows:

$$\begin{aligned} X_A &= \rho_A \cos\alpha_A \cos\beta_A & X_{Ai+1} &= \rho_{Ai+1}\cos\alpha_{Ai+1}\cos\beta_{Ai+1} \\ Y_{Ai} &= \rho_{Ai}\cos\alpha_{Ai}\cos\beta_{Ai} \quad \text{and} & Y_{Ai+1} &= \rho_{Ai+1}\cos\alpha_{Ai+1}\cos\beta_{Ai+1} \\ Z_{Ai} &= \rho_{Ai}\sin\alpha_{Ai} & Z_{Ai+1} &= \rho_{Ai+1}\sin\alpha_{Ai+1} \end{aligned} \quad (5)$$

then

$$d=\sqrt{\begin{aligned}&\left(\rho_{Ai+1}\cos_{i+1}\cos\beta_{i+1}-\rho_A\cos_i\cos\beta_i\right)^2+\left(\rho_{Ai+1}\cos_{i+1}\cos\beta_{i+1}-\rho_A\cos_i\cos\beta_i\right)^2\\&+\left(\rho_{Ai+1}sin\alpha_{i+1}-\rho_A\sin\alpha_A\right)^2\end{aligned}} \quad (6)$$

Mathematical modeling of these processes is necessary for optimal planning and control of the placement and movement of cargo along any spatial trajectory. To do this, it is better to use the matrix method.

The spatial matrix is defined by the expression A= II aijk II ° in Cartesian coordinates, where the rows define the height k . In this case $1 \le i \le m,\ 1 \le j \le n,\ \ 1 \le k \le \upsilon$ (Fig. 2), the dimensions of the matrix cells are presented as

Let's say you need to move a load υ from $\alpha_{i,j,k}$ cell to cell $\alpha_{i2,j2,k2}$. Naturally, for this, the straight line, indicated by the expression in moments, is considered the most rational.

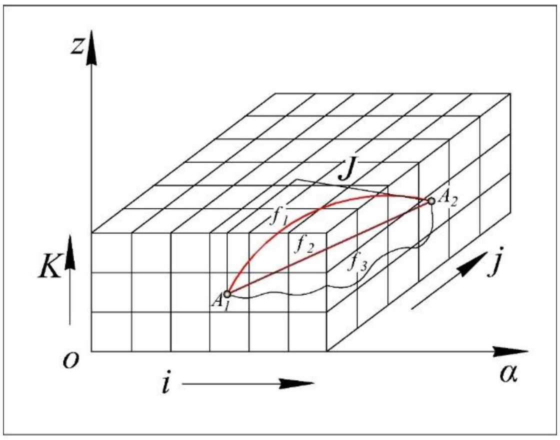

fig.2.

$$d = \sqrt{(i_2 - i_1)^2 + (j_2 - j_1)^2 + (k_2 - k_1)^2} \quad (6)$$

This expression takes $d, i_1, i_2, j_1, j_2, k_1, k_2$ dimensionless quantity, but, if necessary, can be easily converted into dimensional quantities.

Depending on the skill of the operator operating the lifting device and the nature of the obstacles in the way of the load, the trajectory of movement can be straight, fixed and curved with a variable radius of curvature and a broken line, as indicated above. In these cases, expression (7) is written in a different form [4].

If in the load YOX plane; If $k = const$ there is a plane ZOX bias $j = const$; can ZOY move in the load plane $i = const$.

The advantage of using the matrix system is that operations are performed with dimensionless indices , , . In addition, this system allows for mathematical planning and software control of the movement of cargo from any place to the right place along the optimal trajectory.

Consider the issue of modeling the characteristics and the law of movement of the load.

For example, if the load A moves from starting point A_1 to the final A_2 inearly, it can be written as follows:

$$X_A = \frac{X_1 + \lambda X_2}{1+\lambda}, \quad Y_A = \frac{Y_1 + \lambda Y_2}{1+\lambda}, \quad Z_A = \frac{Z_1 + \lambda Z_2}{1+\lambda} \qquad (7)$$

where $\lambda = \frac{A_1 A}{AA_2} = \frac{A_1 A + \lambda Y_2}{A_1 A_2 - A_1 A},$

It is seen, $\lambda = \lambda(t),$ hat the law of motion of the load is expressed as a function of time t. If you need to switch to the polar number system, then.

$$\rho_A = \sqrt{X_A^2 + Y_A^2 + Z_A^2} = \frac{\sqrt{(X_1 + \lambda X_2)^2 + (Y_1 + \lambda Y_2) + (Z_1 + \lambda Z_2)^2}}{(1+\lambda)^2} =$$

$$= \frac{\sqrt{\rho_1^2 + \rho_2^2 + 2\lambda(X_1 X_2 + Y_1 Y_2 + Z_1 Z_2)}}{1+\lambda} \qquad (9)$$

where $\rho_1^2 = X_1^2 + Y_1^2 + Z_1^2; \quad \rho_2^2 = X_2^2 + Y_2^2 + Z_2^2.$

The law of angle change can be found from expression (5):

$$\frac{Y_{Ai}}{X_{Ai}} = tg\beta_{Ai}; \qquad \frac{Y_{A_1}}{X_{A_1}} = tg\beta_{A1}; \qquad \frac{Y_A}{X_A} = tg\beta_A$$

then

$$X_{A1}^2 + Y_{A1}^2 + Z_{A1}^2 = \rho_A^2 \cos^2 \alpha_{A1}$$

$$X_{A2}^2 + Y_{A2}^2 + Z_{A2}^2 = \rho_A^2 \cos^2 \alpha_{A2}$$

$$X_{A2}^2 + Y_A^2 = \rho_A^2 \cos^2 \alpha_A$$

Thus, modeling the position and movement of the load by the matrix method allows you to move it along any spatial trajectory, depending on the nature of the obstacles in the path of the load and the design of the technical means of moving the load.

It is necessary to take into account the characteristics of the goods and the obstacles and restrictions that may be encountered on their way when planning and managing the placement of goods in various situations in space and their optimal movement along a given trajectory.

Objects (loads) that can be moved in space may have different parameters in terms of mass, configuration and shape. Therefore, it is necessary to resolve the issue of taking into account the dimensions of goods placed in a particular container. In this regard, we will try to mathematically describe the configuration of various bodies that have a volumetric character. We know from practice that objects can have cubic, parallelepiped, prismatic, conical, cylindrical and other shapes.

To perceive such loads, we choose an ellipsoid as a more suitable geometric figure (Fig. 3). This is due to the fact that by choosing certain constant parameters of the ellipsoid, for

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example, we can completely block loads of any configuration, including such structural elements as concrete columns, slabs, tanks of various shapes [6.7].

We know the ellipsoid equation has the following form

$$\frac{\zeta^2}{a^2}+\frac{\eta^2}{b^2}+\frac{\upsilon^2}{c^2}=1 \qquad (10)$$

If it is necessary to move piles and columns of different shapes (Fig. 4), the ellipsoid enclosing them (see Fig. 3) will have an elongated shape due to the parameter. If the moving body has the shape $a=b=c=r.$ cube (Fig. 5, 6), then such a figure can be placed on a sphere of radius r, so that any body can be included in an ellipsoid. The question may arise why such actions are needed? This question can be answered in the following way; the object being moved will have both a geometric and a center of gravity, and they may or may not coincide with each other.

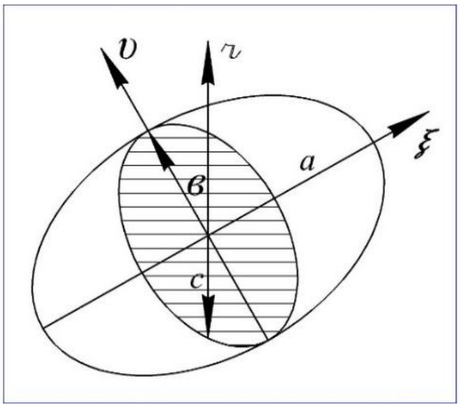

fig.3.

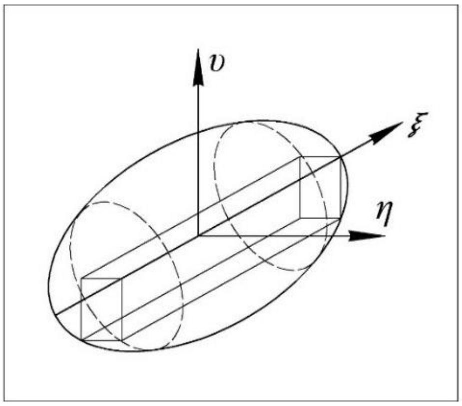

fig. 4.

In addition, it will be necessary to solve the problems of dynamics and kinematics of moving bodies, the permeability and elasticity of bodies between obstacles and restrictions. Therefore, we rewrite the ellipsoid equation in the following form:

$$\frac{(X-X_2)^2}{a^2}+\frac{(Y-Y_2)^2}{b^2}+\frac{(Z-Z_2)^2}{c^2}=1 \qquad (11)$$

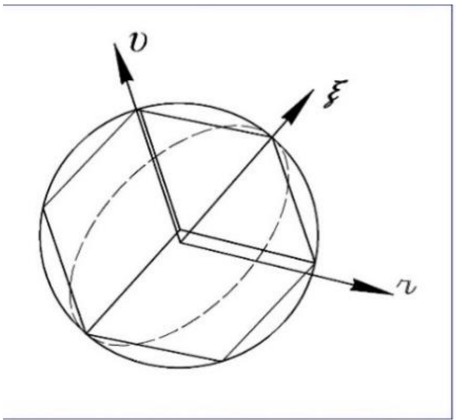

fig.5.

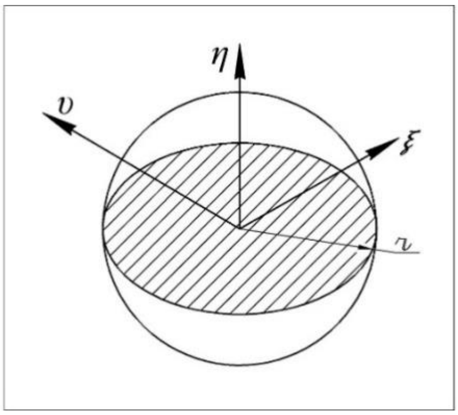

fig.6.

We know that the above

$X_A - X_A(\lambda), \quad Y_A - YA(\lambda), \quad Z_A - Z_A(\lambda),$ и $\lambda = \lambda(t)$

Thus, now we will be able to determine the spatial position of a moving load at any time depending on the time of movement. In addition, if the moving load is represented by an ellipsoid over the surface, then the location of the load (for example, a cage of rails) should also have the shape of an ellipsoid, but the ellipsoid should be covered by the cage, and not by the cage. ellipsoid cell. Then, by comparing the dimensions of the inner and outer ellipsoids, we can solve the modeling of spatial problems of load transfer, i.e. rational use of space, i.e. problems of an economic nature.

Here again it should be noted that, depending on the nature and material of the goods being transported, the lifting devices can be rotated at an angle θ one way or the other around the axis OZ in the process of moving. In this case, for non-stationary forklifts (Fig. 7), the following conversion equations are used:

$$\left.\begin{aligned} \overline{X} &= (X - X_0)cos\theta + (Y - Y_0)\sin\theta \\ \overline{Y} &= -(X - X_0)\sin\theta + (Y - Y_0)\cos\theta \\ \overline{Z = Z} & \end{aligned}\right\} \text{ или or } \left.\begin{aligned} & X - X_0 + \overline{X}cos\theta - \sin\theta \\ & Y - Y + \overline{X}cos\theta - \overline{Y}\cos\theta \\ & Z = \overline{Z} \end{aligned}\right\} \quad (12)$$

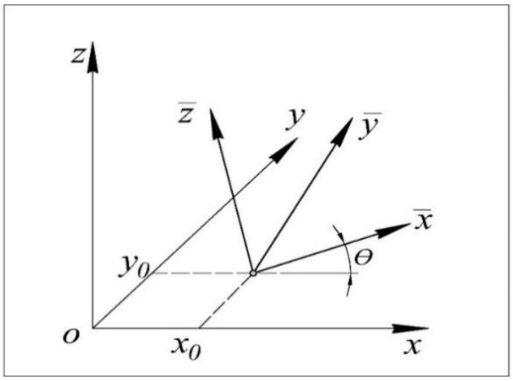

fig.7.

Thus, mathematical expressions for the geometry and kinematics of moving loads are created in terms of their placement in a given volume, taking into account almost all possible cases.

Conclusion.

1. Increasing the productivity and economic efficiency of cargo transportation processes in reclamation systems can be achieved through the introduction of new energy and resource-saving technologies, including their optimal planning and control using mathematical modeling.
2. A matrix method for mathematical modeling of the placement and movement of cargo along any spatial trajectory is proposed.
3. Capacitive models are offered considering the configuration of the loads and their configuration for optimal placement.

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