Materials of Conferences

THE MATHEMATICAL MODELS, LIING IN BASE OF MODELING OF THE HOOKS FISHING SYSTEMS

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The Mathematics is an universal language of any science. She possesses the stupendous potential, allowing solve the most complex technical and economic problems. As was pointed out by K. Marks «Any science only then reaches the perfection, when she manages to use the mathematics». The Industrial fishing, as science, must rest in identical mathematical models (MM) fishing gears and fishing systems. But MM themselves do not yet solve the problems industrial fishing. For their decisions necessary to develop the algorithms of the decision of the tasks and corresponding to computer programs. Thereby, only triad ***Mathematical Model-Algorithm-Program (MM-A-P)*** allows to solve the tasks industrial fishing.

Since, the majority of the mathematical models element fishing systems present itself systems of the differential equations, that happens to to solve the marginal tasks for these systems. Hitherto no general algorithm of the decision of the marginal tasks. The Decision of each marginal task requires the individual approach and intuitions.

At present we learned; learnt to solve many marginal tasks industrial fishing, connected with modeling Trawls, Long Lines and Traps of the fishing systems and with just cause can confirm that industrial fishing today rests in powerful mathematical foundation.

The Trouble is concluded in that that hitherto in fishing of the Russia works little specialists, solving tasks by method of computer modeling with use the triad MM-A-P that greatly holds up the progress in this branches.

Introduction. Flexible ropes and fishing hooks is main by elements any longline fishing system. The Decision of the problem about the form and tension of the flexible rope (thread, chain) in field of power to gravity, got by J. Bernoulli in 1691 [7]. Bernoulli has got the general decision for symmetrical thread. In the event of asymmetrical thread he complemented it before symmetrical way of the complex mathematical transformations.

Material and methods. Proceed with development of the methods of mathematical modeling hook fishing systems, and having got acquainted with work J. Bernoulli [7], author came to conclusion that its decision for asymmetrical flexible rope too in a complicated way for practical use under mathematical modeling hook fishing systems with asymmetrical manline, which are basically used on providence. So was necessary search for other way of the decision of this problem.

Balance flexiblerope in resting liquids is described by vector equation

$$d(T\vec{\tau})/dl + \vec{q} = \vec{0}. \qquad (1)$$

Here $\vec{q}$ – a weight 1 m flexible rope in water; T – Tension of the flexible rope in the current point; $\vec{\tau}$ – ort of tangent to flexible rope, directed aside growing of the arc coordinate l.

Projektion this equation on axis x and z, shall get the differential equations of the balance of the flexible rope in resting liquids in Cartesian coordinate system:

$$\begin{aligned} &d(T\dot{x})/dl = 0;\\ &d(T\dot{z})/dl = -q_z. \end{aligned} \qquad (2)$$

The Author received general decision of the system (2) in the form:

under $q_Z \neq 0$:

$$\begin{gathered} x = p_x\left[\operatorname{arsh}((l + C_3)/p_x) - C_1\right];\\ z = p_X \cdot \operatorname{ch}(x/p_X + C_1) - C_2;\\ l = p_X \cdot \operatorname{sh}(x/p_X + C_1) - C_3;\\ C_1 = \operatorname{arsh}(T_{AZ}/T_{AX});\quad C_2 = p_X \cdot \operatorname{ch}C_1;\quad C_3 = p_X \cdot \operatorname{sh}C_1;\\ T_{AZ} = 0{,}5q_Z\left[l_K + z_{BA}\sqrt{1 + 4p_X^2/(l_K^2 - h_{BA}^2)}\right];\, q_Z > 0;\\ T_{AZ} = 0{,}5q_Z\left[l_K - z_{BA}\sqrt{1 + 4p_X^2/(l_K^2 - h_{BA}^2)}\right];\, q_Z < 0;\\ T_{AX} = 0{,}5|q_Z|\sqrt{\left[(2p_Z - l_K)^2 - h_{BA}^2\right](l_K^2 - h_{BA}^2)}\Big/h_{BA};\\ T_B = T_A - q_Z \cdot z_{BA};\quad z_{BA} = z_B - z_A;\quad h_{BA} = |z_B - z_A|;\\ p_X = -T_{AX}/q_Z;\, p_Z = T_{AZ}/q_Z;\\ q_z = k_W G_z = k_W mg;\quad k_W = 1 - m_W/m; \end{gathered} \qquad (3)$$

under $q_Z = 0$:

$$T = C_4 = \text{const}; \quad z = C_5 x + C_6,$$

where m_W – a mass of water, displaced by 1 m flexiblerope; m – linear density of the tightrope (the mass 1 m flexiblerope); q_Z – a projection on axis z weight in water 1 m flexiblerope; l – an arc coordinate of the current point of the flexiblerope; l_K – a length of the flexiblerope; C_1, ..., C_6 – a constants; A, B – initial and end point of the flexiblerope; z_A, z_B – coordinates initial and end point of the flexiblerope; T_{AX}, T_{AZ} – a projections of the Tension of the flexiblerope in point A on axis x and z; p_X, p_Z – a parameters of the flexiblerope.

The Second, the third and eighth equations in (3) – an integrals J. Bernoulli.

At reception of the system (3) was used cartesian coordinate system Axz, which axis z is directed on speedup of the free fall i.e., Fig. 1. Begin coordinates (the point A) was chosen on one of the end of the flexible rope. Moreover begin cartesian coordinate system and begin counting out the arc coordinates coincide. Besides, correlation was used for differential of the arc coordinate, where before radical will take the sign (+). It faithfully only then, when and have an alike signs. So at decision of the concrete practical problems axis x necessary to direct so that with growing of the arc coordinates l grew and abscissas x, as shown in Fig. 1.

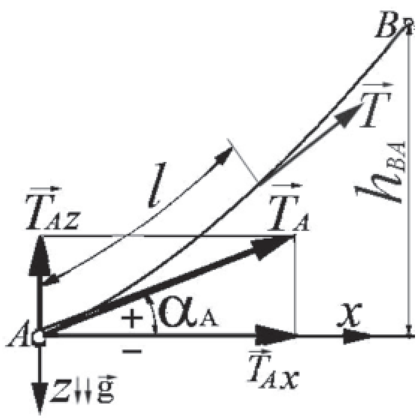

Fig. 1. Parameters of the asymmetrical rope in resting water

The System (3) are a mathematical model of the uniform still flexible rope in resting liquids. Moreover the form of the flexible rope (symmetrical, asymmetrical) counts for nothing. This system allows to execute mathematical modeling any flexible flexible rope in resting water, made from material as heavy of water, when (the polyamides $k_W = 0{,}10$; полиэстер $k_W = 0{,}13$), so and easier water, when (the polyethylene $= -0{,}07$; полипропилен $k_W = -0{,}14$, danline $k_W = -0{,}10$). On the base MM (3) designed methods modeling any hook fishing systems (stationary horizontal and vertical pelagical and bottom Longlines) in resting water. The Ensemble example, illustrating these methods of modeling was provided in monograph [3; 4].

For symmetrical flexible rope, when axis of the coordinates are chose so, as shown in Fig. 2, are executed condition: $z_A = z_B$, $C_1 = C_3 = 0$, $C_1 = p_x$ MM (3) takes the type:

$$x = p_x \operatorname{arsh}(l / p_x); \quad z = p_X \cdot \operatorname{ch}(x / p_X) - p_X;$$

$$l = p_X \cdot \operatorname{sh}(x / p_X);$$

$$b_k = 2x_B = 2p_x \operatorname{arsh}(l_k / 2p_x); \qquad (4)$$

$$T_{AX} = T_O = |q_Z| (l_k^2 - 4h^2)/8h;$$

$$T_{AZ} = 0{,}5 q_Z l_k; \quad p_X = -T_{AX} / q_Z.$$

Here b_k – a chord of the flexible rope (mainline); l_k – a length of the flexible rope; h – an arrow of the sagging.

The Equations (4) are a mathematical model of the symmetrical flexible rope in resting water, they are broadly used at modeling manlines of the stationary pelagical hook Longlines.

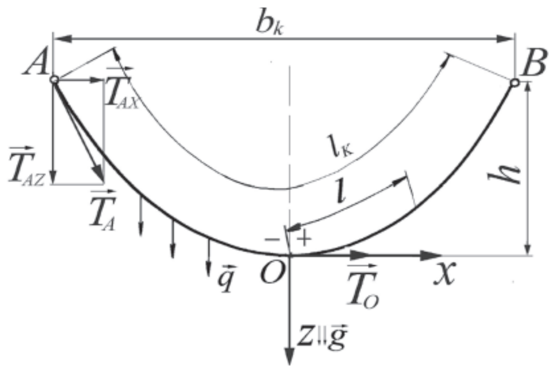

Fig. 2. Parameters of the symmetrical flaxible rope in resting water:
T_O, T_A – Tensions in lower point O and end point A; q – weight in water 1 m of the flaxible rope

The Mathematical models flexible rope (3) and (4) allow modeling any of the stationary hook fishing systems in resting water.

For modeling ropes with account of the currents we shall consider the balance of the rope in flow of water (Fig. 3).

The Vector equation of the balance of the flexible rope in flow of water:

$$d(T\vec{\tau})/dl + \vec{q} + \vec{r}_W = \vec{0}. \qquad (5)$$

Here $\vec{r}_W$ – hydrodynamic power, coming on unit of the length of the rope.

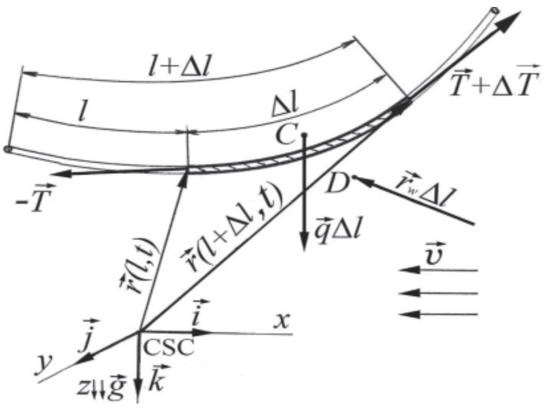

Fig. 3. Forces acting on an element of the rope in the water stream (KYC – earth coordinate system, the z axis is directed along the plumb line) $\vec{T} = T\vec{\tau}$ – tension of the rope at the current point; $\vec{\tau}$ – Unit vector tangent to the axis of the rope directed towards growth arc coordinates

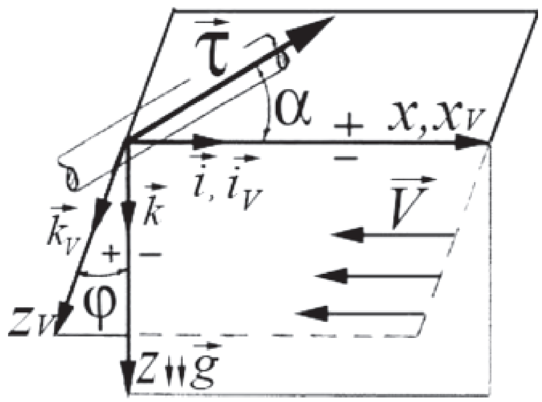

Fig. 4. Terrestrial xyz and flow $x_V y_V z_V$ coordinate systems of the flexible rope: $x_V \uparrow\downarrow \vec{V}$, $z_V \subset (\vec{\tau}\vec{V})$; $z \downarrow\downarrow \vec{g}$; α – a corner of the attack of the flexible trope; φ – a corner of the list to planes of the flow of the flexible rope; $\vec{\tau}$ – ort axis of the rope

At study of the balance flexible rope in flow of water use two coordinates system: terrestrial xyz and flow $x_V y_V z_V$ (Fig. 4).

The differential equations of the balance of the flexible rope in flow of water in flow coordinate system, got by author, when axis x and x_V coincide, are of the form of:

$$\begin{gathered}
\dot{T} = q_Z \sin\alpha\cos\phi - r_{XV}\cos\alpha + r_{ZV}\sin\alpha;\\
\dot{\alpha} = (q_Z\cos\alpha\cos\phi + r_{XV}\sin\alpha_{xp} + r_{ZV}\cos\alpha)/T;\\
\dot{\phi} = -(q_Z\sin\phi + r_{YV})/(T\sin\alpha);\\
\dot{x} = \cos\alpha;\quad \dot{y} = \sin\alpha\sin\phi;\quad \dot{z} = \sin\alpha\cos\phi;\quad q_Z = k_W mg;\\
r_{XV} = C_{XV}(0{,}5\rho V^2)d,\quad (x_V, y_V, z_V);\\
C_{XV} = -(c_{11}\sin^2\alpha + c_{12}\sin^4\alpha + c_{13}\cos^2\alpha),\quad \alpha\in(-\infty,\infty);\\
C_{YV} = \pm(c_{21}\sin\alpha\cos\alpha + c_{22}\sin^3\alpha\cos\alpha),\qquad \alpha\in(-\infty,\infty);\\
C_{ZV} = -(c_{31}\sin\alpha\cos\alpha + c_{32}\sin^3\alpha\cos\alpha),\qquad \alpha\in(-\infty,\infty),
\end{gathered}\tag{6}$$

where $\cdot = ddl$ – a derivative on arc coordinate l; T, α – tension and corner of the attack of the flexible rope in the current point; φ – a corner of the list to planes of the flow of the flexible rope; T_0, α_0 – tension and corner of the attack of the rope in lower point O; $r_{X_V}, r_{Y_V}, r_{Z_V}$ – forses of the resistance, lateral and lifting power, happenning to on 1 m rope; $C_{X_V}, C_{Y_V}, C_{Z_V}$ – coefficients hydrodynamic forces of the rope in flow coordinate system; R_X^W – a resistance of the whole rope; $\vec{V}_W$, $\vec{V}_S$ – a velocities of the current and ship.

On the base MM (6) is executed mathematical modeling towrope for towing fishing systems.

The MM (6) possible use for modeling manline of longlines with account of the currents. But in this case it is necessary to take into account the action an hook legs on manline.

The Mathematical model manlines of the hook longlines with provision for evenly portioned on length manline power from pull legs is of the form of:

$$\begin{gathered}
\dot{T} = q_Z^{xp+y}\sin\alpha_{xp}\cos\phi_{xp} - (r_{XV} + t_{XV}^n)\cos\alpha_{xp} + (r_{ZV} + t_{ZV}^n)\sin\alpha_{xp};\\
\dot{\alpha}_{xp} = (q_Z^{xp+y}\cos\alpha_{xp}\cos\phi_{xp} + (r_{XV} + t_{XV}^n)\sin\alpha_{xp} + (r_{ZV} + t_{ZV}^n)\cos\alpha_{xp})/T;\\
\dot{\phi}_{xp} = -(q_Z^{xp+y}\sin\phi_{xp} + r_{YV} + t_{YV}^n)/(T\sin\alpha_{xp});\\
\dot{x} = \cos\alpha_{xp};\quad \dot{y} = \sin\alpha_{xp}\sin\phi_{xp};\quad \dot{z} = -\sin\alpha_{xp}\cos\phi_{xp};
\end{gathered}$$

$$\begin{aligned}
&q_Z^{xp+y} = k_w^{xp} m_{xp} g + k_W^Y n_{kp}^S M_Y g / l_S;\\
&r_{XV} = C_{XV}^{xp}(\alpha_{xp}) \cdot (0{,}5\rho V^2)\, d_{xp}, \quad (x_V, y_V, z_V);\\
&R_{XV}^n = C_{XV}^n(\alpha_n) \cdot (0{,}5\,\rho V^2)\, d_n l_n, \quad (x_V, y_V, z_V);\\
&t_{XV}^n = t_X^n; \quad t_{YV}^n = t_Y^n \cos\phi_{xp} + t_Z^n \sin\phi_{xp}; \quad t_{ZV}^n = -t_Y^n \sin\phi_{xp} + t_Z^n \cos\phi_{xp};\\
&t_X^n = n_{kp}^S (R_{XV}^n + R_X^n) / l_S; \quad t_Y^n = n_{kp}^S (R_{YV}^n \cos\phi_n - R_{ZV}^n \sin\phi_n + R_Y^n) / l_S;\\
&t_Z^n = n_{kp}^S (R_{YV}^n \sin\phi_n + R_{ZV}^n \cos\phi_n + R_Z^n + Q_Z^n + Q_Z^{n+kp}) / l_S;\\
&Q_z^n = k_w^n m_n l_n g; \quad Q_z^{n+kp} = k_w^n M_n g + k_w^{kp} M_{kp} g;\\
&C_{XV}^{xp} = -(c_{11} \sin^2\alpha_{xp} + c_{12} \sin^4\alpha_{xp} + c_{13} \cos^2\alpha_{xp});\\
&C_{YV}^{xp} = \pm(c_{21} \sin\alpha_{xp} \cos\alpha_{xp} + c_{22} \sin^3\alpha_{xp} \cos\alpha_{xp});\\
&C_{ZV}^{xp} = -(c_{31} \sin\alpha_{xp} \cos\alpha_{xp} + c_{32} \sin^3\alpha_{xp} \cos\alpha_{xp}), \ (xp, n),
\end{aligned} \tag{7}$$

where q_Z^{xp+y} – a projection on axis z of the weight in water 1 m manline with nodes (double stopper system (Fig. 5)) of the fastening to her of the hook legs; M_Y – a mass of the node of the fastening of the leg to manline; d_{xp}, d_n – diameters manline and leg; l_n – length of leg; t_X^n, t_Y^n, t_Z^n – a projections on axis terrestrial coordinate system tensions of the hook legs, happenning to on unit of the length manline; R_x^n, R_x^{n+kp} ,(x, y, z) – a projections hydrodynamic forces of leg and baits with hooks; α_n – a corner of the attack of the leg; T, α_{xp}, φ_{xp} – tension, corner of the attack of the manline and corner of the list to planes of the flow manline in the current point; r_{XV}, r_{YV}, r_{ZV} – projections of the hydrodynamic forces, happenning to on 1 m manline, on axis flow coordinate system; Q_z^n, Q_z^{n+kp} – weight in water of the leg and bait with hook accordingly; m_{xp}, m_n – linear density of the mainline and leg.

For successful catch hydrobionts necessary to provide the finding all hooks in layer of fish. The Position of each hook is defined his cartesien coordinate in terrestrial coordinate system with beginning of the coordinates at the beginning initially i section of the longline – a point A_i (the Fig. 5).

For successful catch hydrobiontov necessary to provide the finding all hook in layer of fish. The Position of each hook is defined its cartesian coordinate x_{ij}^{kp}, y_{ij}^{kp}, z_{ij}^{kp} in terrestrial coordinate system $A_i xyz$ with beginning of the coordinates at the beginning initially i part of the longline – a point A_i (Fig. 5).

By decisions of the differential equations of the balance mainline (7) define the coordinates a point fastening поводцов to хребтине , then from conditions of the balance of the system «bait-hook-leg» find the coordinates of hooks x_{ij}^{kp}, y_{ij}^{kp}, z_{ij}^{kp}.

Integrating differential equations:

$$\dot{x} = -\cos\alpha_n;$$
$$\dot{y} = -\sin\alpha_n \sin\phi_n;$$
$$\dot{z} = \sin\alpha_n \cos\phi_n$$

we shall get the coordinates a hook in coordinate system under rectilinear legs (Fig. 5):

$$x_{ij}^{kp} = x_{ij} - \cos\alpha_n l_n;$$
$$y_{ij}^{kp} = y_{ij} - \sin\alpha_n \sin\phi_n l_n;$$
$$z_{ij}^{kp} = z_{ij} + \sin\alpha_n \cos\phi_n l_n,$$

where x_{ij}, y_{ij}, z_{ij} – a coordinates of the point of the fastening of j leg to manline on i section of the longline; x_{ij}^{kp}, y_{ij}^{kp}, z_{ij}^{kp} – a coordinates of the fishing hook.

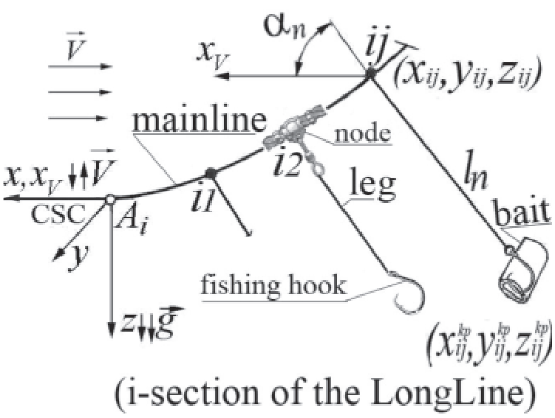

Fig. 5. To determination of the coordinates j fishing hook on i – section of the longline:
CSC – Cartesian System Coordinate;
Node – double stopper system

Under greater length hook legs l_n = 20–30 m their it is impossible consider rectilinear. In this case their features necessary to get the way of the numerical decision of the problem Koshi for differential equations of the balance of the tightrope in flow (5).

On base MM (7) is designed program CM-LongLine (Computer Modeling LongLine) [3], working in ambience Borland Delphi and allowing prototype the longline, вымeтаемые both parallel current, and under any angle to current. She consists of set of the programs, which can work as autonomous, prototyping separate elements of the tier, so and system, prototyping whole tier. The Main form of the programme complex of the modeling tier is shown on Fig. 6.

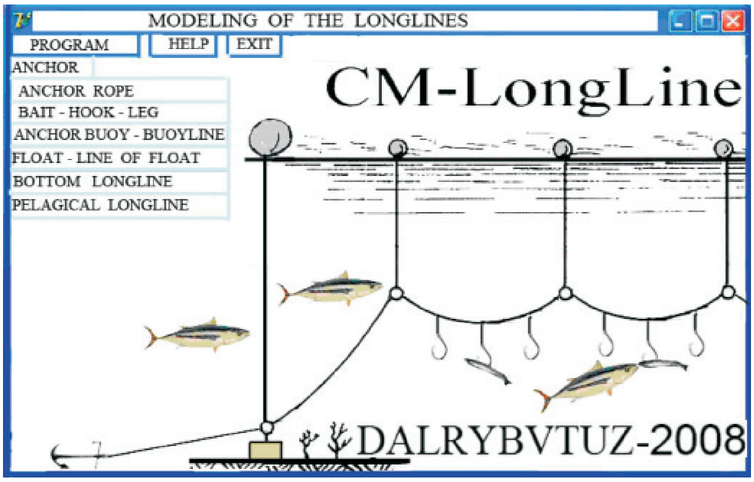

Fig. 6. Main form of the programme complex of modeling horizontal hook longline fishing order with account of the currents CM-LongLine (Computer Modeling Long-Line)

This form contains seven buttons: «Anchor», «Anchorline», «Bait-hook-leg», «Anchor – buoy – buoyline», «buoyline», «bottom longline with buoy in the middle each section», «longline with buoy on end of each section» by means of which are included corresponding to program.

Conclusion

The system differential equations of the balance of the rope in resting liquids (3) and system differential equations of the balance of the in flow (6), and equations of the balance of the manline (7) allow to solve the broad class of the fishing problems. They allow to execute mathematical modeling of the any type horizontal longlines as in resting liquids, so and at presence of the currents.

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THERMIC STRENGTHENING OF MOOVING CORNER PROFILES IN THE STREAM OF ROLLING MACHINE

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The given laboratory experiment are Brought on searching for optimum mode termal processing of building renting for kazakhstan producers. In the given work the opportunity of improvement of quality of reinforcing bar from uninterruptedly-casted bars by deformation and thermal hardening is researched. Complex research and development of technology of deformation and thermal hardening of reinforcing bar from uninterruptedly-casted bars.

Introduction. Shaped profiles of rolling (corners, channels, double-T and others) are characterized by irregular distribution of metals in section, which demands regulated selection of heat from different parts of their section in combined deformational and thermic working with rolling heat.