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MATHEMATICAL MODELING OF DEFORMATION PROCESSES OF THERMOELASTIC PLATES TAKING INTO ACCOUNT TEMPERATURE

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Abstract

In the article, based on the Hamilton variational principle, a mathematical model of the process of geometric nonlinear deformation of thin magnetoelastic plates with a complex structural shape was developed and calculations were performed. In this case, the three-dimensional mathematical model was transferred to a two-dimensional view using the Kirchhoff-Liav hypothesis. Cauchy's relationship, Hooke's law, Lawrence's force, and Maxwell's electromagnetic tensor were used to determine kinetic and potential energy and work done by external forces. The effects of the electromagnetic field on the deformation stress state of the magnetoelastic plate were observed. As a result, a mathematical model in the form of a system of partial differential equations with initial and boundary conditions was created. To solve the equation, a calculation algorithm was developed using the R-function, Bubnov-Galerkin, Newmark, Gaussian, Gaussian squares, and Iteration numerical methods. Calculations were carried out in various mechanical states of the magnetoelastic plate, its boundaries were fixed, one side was hinged and the other side was free, and numerous results were obtained. A comparative analysis of the results of the calculations was presented.

Keywords: Hamilton principle, Bubnov Galerkin, Cauchy equations, Hooke's law, Maxwell's electromagnetic tensor, R-function, Gaussian, Iteration.

INTRODUCTION

Today, researchers are interested in nonlinear theories of electrical conductivity and magnetoelasticity of electromagnetic fields, particularly, theories of the interdependence of two or more physical fields. Thin magnetoelastic structural elements are important structural elements of machine-building, aircraft-building, shipbuilding, and construction facilities.

Many scientists worldwide and in our country have conducted studies on the processes of magnetoelastic deformation of thin electroconductive bodies. In particular Scientists like V. Novatskiy, B. E. Pobedri, D. I. Bardzokas, S. A. Ambarsumyan, G. Ye. Bagdasaryan, M. V. Belubekyan, K. A. Rakhmatulin, V. K. Kobulov, B. Kurmanbaev, Sh. A. Nazirov, T. Yuldashev, A. A. Kholzhigitov, R. Sh. Indiaminov, F. M. Nuraliev work on the topic. The analysis of the literature shows that the problems of mathematical modeling of the processes of geometric nonlinear deformation of magnetoelastic thin plates with an electrically conductive complex structural shape under the influence of an electromagnetic field have not been sufficiently studied. Thus, it is worth continuing studies on this issue.

Mixed boundary value problems of generalized thermo-electro-magneto-elasticity theory for homogeneous anisotropic solids with internal cracks are studied in the article [2]. Using potential methods and theory of pseudo-differential equations in finite manifolds, existence and uniqueness of solutions are proved. In the article [3], a nonlocal first-order deformable plate model is presented to study the buckling and subsequent buckling of magneto-electro-thermoelastic (METE) nanoplates under magneto-electro-thermo-mechanical loadings.The mathematical model is described by a system of nonlinear equations for temperature and displacement, and heat release occurs in the source subregion V. Vasileva et al. identified in the article [4]. The behavior of an anisotropic material under limited deformations under the influence of external force factors in a non-uniform stationary temperature field has been studied [5]. The description of these processes requires the formulation of a boundary value problem taking into account the interaction of force and temperature factors. A size-dependent nanoplate model was developed to describe the free vibrational and torsional motions of magneto-electro-thermo-elastic (METE) rectangular nanoplates[6]. Nonlocal elasticity theory, along with third-order shear deformation theory, has been applied to size-dependent mathematical modeling of nanoplates. Hamilton's principle, Galerkin's method and Duffing type ordinary differential equations are used.

MATERIALS AND METHODS

Based on the Hamilton-Ostrogradsky variational principle, a mathematical model of geometric nonlinear deformation of a magnetoelastic plate was developed [1]. A three-dimensional mathematical model was converted to a two-dimensional one using the Kirchhoff-Liav hypothesis. The geometric nonlinear strain tensor was obtained using the Cauchy relation and Hooke's law.

According to [9] the general form of geometric nonlinear deformation obtained according to the Cauchy relation is as follows:

$$\begin{cases} \delta\varepsilon_{xx} = \delta\dfrac{\partial u}{\partial x} - z\delta\dfrac{\partial^2 w}{\partial x^2} + \dfrac{1}{2}\dfrac{\partial w}{\partial x}\delta\dfrac{\partial w}{\partial x}; \\ \delta\varepsilon_{yy} = \delta\dfrac{\partial v}{\partial y} - z\delta\dfrac{\partial^2 w}{\partial y^2} + \dfrac{1}{2}\dfrac{\partial w}{\partial y}\delta\dfrac{\partial w}{\partial y}; \\ \delta\varepsilon_{xy} = \delta\dfrac{\partial u}{\partial y} + \delta\dfrac{\partial v}{\partial x} - 2z\delta\dfrac{\partial^2 w}{\partial x\partial y} + \dfrac{\partial w}{\partial x}\delta\dfrac{\partial w}{\partial y} + \dfrac{\partial w}{\partial y}\delta\dfrac{\partial w}{\partial x}. \end{cases}$$

The electromagnetic field forces of the magnetoelastic plate were developed using the Lawrence force and Maxwell's electromagnetic tensor as in [7]. As a result, a mathematical model representing the process of geometric nonlinear deformation under the influence of electromagnetic field forces was developed [8].

$$\begin{cases} -\rho h\dfrac{\partial^2 u}{\partial t^2} + \dfrac{\partial N_{xx}}{\partial x} + \dfrac{\partial N_{xy}}{\partial y} + N_x + R_x + q_x + T_x = 0, \\ -\rho h\dfrac{\partial^2 v}{\partial t^2} + \dfrac{\partial N_{yy}}{\partial y} + \dfrac{\partial N_{xy}}{\partial x} + N_y + R_y + q_y + T_y = 0, \\ -\rho h\dfrac{\partial^2 w}{\partial t^2} + \dfrac{\partial^2 M_{xx}}{\partial x^2} + 2\dfrac{\partial^2 M_{xy}}{\partial x\partial y} + \dfrac{\partial^2 M_{yy}}{\partial y^2} + N_{xx}\dfrac{\partial^2 w}{\partial x^2} + N_{yy}\dfrac{\partial^2 w}{\partial y^2} + N_{xy}\dfrac{\partial^2 w}{\partial x\partial y} + \\ + \left(\dfrac{\partial N_{xx}}{\partial x} + \dfrac{\partial N_{xy}}{\partial y}\right)\dfrac{\partial w}{\partial x} + \left(\dfrac{\partial N_{yy}}{\partial y} + \dfrac{\partial N_{xy}}{\partial x}\right)\dfrac{\partial w}{\partial y} + N_z + R_z + q_z + T_z = 0. \end{cases} \quad (1)$$

Initial and boundary conditions are as follows:

$$
\begin{cases}
\rho h \dfrac{\partial u}{\partial t}\delta u\Big|_t = 0,\ \rho h \dfrac{\partial v}{\partial t}\delta v\Big|_t = 0,\ \rho h \dfrac{\partial w}{\partial t}\delta w\Big|_t = 0, \\
\left(N_{xx} + N_{Px} + N_{Tx}\right)\delta u\big|_x = 0,\ \left(N_{xy} + N_{Py} + N_{Txy}\right)\delta v\big|_x = 0, \\
M_{xx}\delta \dfrac{\partial w}{\partial x}\Big|_x = 0,\ M_{xy}\delta \dfrac{\partial w}{\partial y}\Big|_x = 0, M_{yy}\delta \dfrac{\partial w}{\partial y}\Big|_y = 0,\ M_{xy}\delta \dfrac{\partial w}{\partial x}\Big|_y = 0, \\
\left(N_{yy} + N_{Fy} + N_{Tyy}\right)\delta v\big|_y = 0,\ \left(N_{xy} + N_{Fx} + N_{Tyx}\right)\delta u\big|_y = 0, \\
\left[N_{xx}\dfrac{\partial w}{\partial x} + N_{xy}\dfrac{\partial w}{\partial y} - \dfrac{\partial M_{xx}}{\partial x} - \dfrac{\partial M_{xy}}{\partial y} + N_{Pz} + N_{Txz}\right]\delta w\Big|_x = 0, \\
\left[N_{yy}\dfrac{\partial w}{\partial y} + N_{xy}\dfrac{\partial w}{\partial x} - \dfrac{\partial M_{yy}}{\partial y} - \dfrac{\partial M_{xy}}{\partial x} + N_{Fz} + N_{Tyz}\right]\delta w\Big|_y = 0.
\end{cases}
$$

where, N_{xx}, N_{yy}, N_{xy} - normal and impact forces on the thickness of the plate. M_{xx}, M_{yy}, M_{xy} - bending and twisting moments of the plate, $\rho -$ density, h- thickness of the plate, $R_x, R_y, R_z, N_x, N_y, N_z -$ resulting volume forces, $q_x, q_y, q_z, T_{zx}, T_{zy}, T_{zz} -$ surface forces, $T_{xx}, T_{xy}, T_{xz}, T_{yy}, T_{yz}, T_{zx}, -$ resulting contour forces $T_x, T_y, T_z -$ temperature.

Computational algorithm of numerical solution of the problem

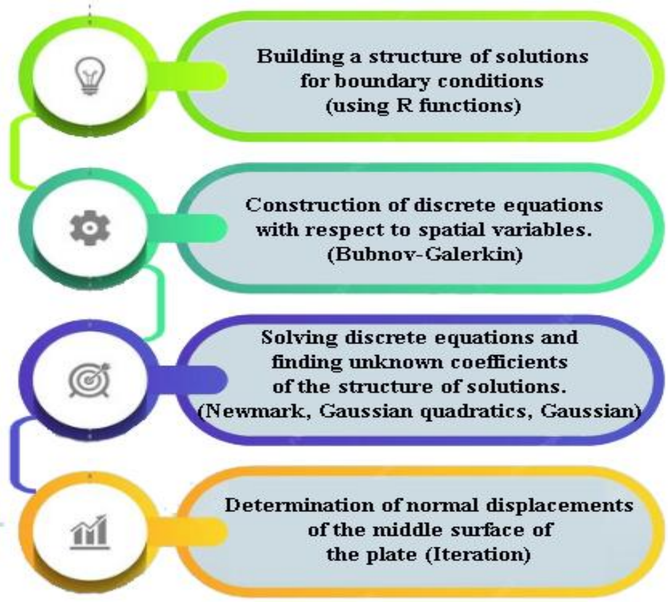

Figure 1. Computational algorithm for solving the equation.

Steps of solving the boundary value problem of a thin magnetoelastic plate using the Iterative method

The bending of the middle surface of the plate along the x,y,z coordinate axis is determined by the Iteration method. In this case, finding the displacement points of the middle surface of a thin plate with a complex shape along the coordinate x,y,z axis includes the following steps [8]:

The following assignments $u_0 = 0,\ v_0 = 0$ were done at the beginning of the iteration (iteration step i = 0).

The value of the third part of the equation $w_0(x,y) -$ is found. In this case, all terms on the right side of the equation are assumed to be equal to 0. As a result, the equation will be as follows:

$$\frac{\partial^2 M_{xx}(w_0)}{\partial x^2} + 2\frac{\partial^2 M_{xy}(w_0)}{\partial x \partial y} + \frac{\partial^2 M_{yy}(w_0)}{\partial y^2} = Q_z, \tag{2}$$

where, $Q_z = -\left(N_z + q_z\right)$

When the iteration step is $i = 1,\ u_1, v_1 -$ are found from the first and second parts of the system of equations (1).

$$\begin{gathered}
\rho h \frac{\partial^2 u_1}{\partial t^2} + \left(\frac{Eh}{\left(1-\nu^2\right)} + \frac{h\left(\mathrm{H}_y^2 + \mathrm{H}_z^2\right)}{4\Pi}\right)\frac{\partial^2 u_1}{\partial x^2} + \left(\frac{Eh}{2(1+\nu)} + \frac{h}{4\Pi}\mathrm{H}_y^2\right)\frac{\partial^2 u_1}{\partial y^2} + \left(\frac{Eh}{2(1+\nu)} + \frac{h}{4\Pi}\mathrm{H}_z^2\right)\frac{\partial^2 v_1}{\partial x \partial y} - \\
-\frac{h}{4\Pi}\mathrm{H}_x\mathrm{H}_y\frac{\partial^2 v_1}{\partial x^2} - \left(\frac{Eh\nu}{\left(1-\nu^2\right)} - \frac{h}{4\Pi}\mathrm{H}_x\mathrm{H}_y\right)\frac{\partial^2 v_1}{\partial y^2} = Q_x - S_x(w_0) + F_x(w_0), \\
\rho h \frac{\partial^2 v_1}{\partial t^2} + \left(\frac{Eh}{\left(1-\nu^2\right)} + \frac{h\left(\mathrm{H}_x^2 + \mathrm{H}_z^2\right)}{4\Pi}\right)\frac{\partial^2 v_1}{\partial y^2} + \left(\frac{Eh}{2(1+\nu)} + \frac{h}{4\Pi}\mathrm{H}_x^2\right)\frac{\partial^2 v_1}{\partial x^2} + \left(\frac{E\nu h}{\left(1-\nu^2\right)} + \frac{Eh}{2(1+\nu)} + \frac{h}{4\Pi}\mathrm{H}_x^2\right)\frac{\partial^2 u_1}{\partial x^2} - \\
-\frac{h}{4\Pi}\mathrm{H}_x\mathrm{H}_y\frac{\partial^2 u_1}{\partial x^2} - \frac{h}{4\Pi}\mathrm{H}_x\mathrm{H}_y\frac{\partial^2 u_1}{\partial y^2} = Q_y - S_y(w_0) + F_y(w_0),
\end{gathered} \tag{3}$$

where,

$$S_x(w_0) = \frac{Eh}{2\left(1-\nu^2\right)}\left(\frac{\partial^2 w}{\partial x^2}\frac{\partial w}{\partial x} + \nu\frac{\partial w}{\partial y}\frac{\partial^2 w}{\partial x \partial y}\right) + \frac{Eh}{(2+\nu)}\frac{\partial^2 w}{\partial y^2}\frac{\partial^2 w}{\partial x \partial y}, \quad Q_x = N_x + q_x + T_{zx},$$

$$S_y(w_0) = \frac{Eh}{2\left(1-\nu^2\right)}\left(\frac{\partial^2 w}{\partial y^2}\frac{\partial w}{\partial y} + \nu\frac{\partial w}{\partial x}\frac{\partial^2 w}{\partial x \partial y}\right) + \frac{Eh}{(2+\nu)}\frac{\partial^2 w}{\partial x^2}\frac{\partial^2 w}{\partial x \partial y}, \quad Q_y = N_y + q_y + T_{zy},$$

$$F_x(w_0) = -H_x H_z \frac{\partial^2 w}{\partial x^2} - 2H_y H_z \frac{\partial^2 w}{\partial x \partial y} + H_x H_z \frac{\partial^2 w}{\partial y^2},$$

$$F_y(w_0) = H_y H_z \frac{\partial^2 w}{\partial x^2} - 2H_x H_z \frac{\partial^2 w}{\partial x \partial y} - H_y H_z \frac{\partial^2 w}{\partial y^2}.$$

The values of $w_1 -$ are found in the third part of the system of equations (4).

$$\rho h\frac{\partial^2 w_1}{\partial t^2}+\frac{\partial^2 M_{xx}(w_1)}{\partial x^2}+2\frac{\partial^2 M_{xy}(w_1)}{\partial x\partial y}+\frac{\partial^2 M_{yy}(w_1)}{\partial y^2}+\left(\mathrm{H}_y^2-\mathrm{H}_x^2\right)\frac{\partial^2 w_1}{\partial x^2}-4\mathrm{H}_x\mathrm{H}_y\frac{\partial^2 w_1}{\partial x\partial y}-$$

$$-\left(\mathrm{H}_y^2-\mathrm{H}_x^2\right)\frac{\partial^2 w_1}{\partial y^2}=Q_z-N_{xx}(u_1,v_1,w_0)\frac{\partial^2 w_0}{\partial x^2}+N_{yy}(u_1,v_1,w_0)\frac{\partial^2 w_0}{\partial y^2}+N_{xy}(u_1,v_1,w_0)\frac{\partial^2 w_0}{\partial x\partial y}+$$

$$+\frac{\partial N_{xx}(u_1,v_1,w_0)}{\partial x}\frac{\partial w_0}{\partial x}++\frac{\partial N_{xy}(u_1,v_1,w_0)}{\partial y}\frac{\partial w_0}{\partial x}+\frac{\partial N_{yy}(u_1,v_1,w_0)}{\partial y}\frac{\partial w_0}{\partial y}+\frac{\partial N_{xy}(u_1,v_1,w_0)}{\partial x}\frac{\partial w_0}{\partial y}+F_z\left(u_1,v_1\right),$$

(4)

where, $F_z(w_0)=-(H_y^2-H_x^2)\frac{\partial^2 w}{\partial x^2}+4H_xH_y\frac{\partial^2 w}{\partial x\partial y}+(H_y^2-H_x^2)\frac{\partial^2 w}{\partial y^2},$

The generalized view of solving the system of equations (1) by the iteration method is expressed by the following formula (5,6):

$$\rho h\frac{\partial^2 u_i}{\partial t^2}+\left(\frac{Eh}{(1-\nu^2)}+\frac{h\left(\mathrm{H}_y^2+\mathrm{H}_z^2\right)}{4\Pi}\right)\frac{\partial^2 u_i}{\partial x^2}+\left(\frac{Eh}{2(1+\nu)}+\frac{h}{4\Pi}\mathrm{H}_y^2\right)\frac{\partial^2 u_i}{\partial y^2}+\left(\frac{Eh}{2(1+\nu)}+\frac{h}{4\Pi}\mathrm{H}_z^2\right)\frac{\partial^2 v_i}{\partial x\partial y}-$$

$$-\frac{h}{4\Pi}\mathrm{H}_x\mathrm{H}_y\frac{\partial^2 v_i}{\partial x^2}-\left(\frac{Eh\nu}{(1-\nu^2)}-\frac{h}{4\Pi}\mathrm{H}_x\mathrm{H}_y\right)\frac{\partial^2 v_i}{\partial y^2}=q_x-S_x(w_{i-1})+F_x(w_{i-1}), \quad (5)$$

$$\rho h\frac{\partial^2 v_i}{\partial t^2}+\left(\frac{Eh}{(1-\nu^2)}+\frac{h\left(\mathrm{H}_x^2+\mathrm{H}_z^2\right)}{4\Pi}\right)\frac{\partial^2 v_i}{\partial y^2}+\left(\frac{Eh}{2(1+\nu)}+\frac{h}{4\Pi}\mathrm{H}_x^2\right)\frac{\partial^2 v_i}{\partial x^2}+\left(\frac{E\nu h}{(1-\nu^2)}+\frac{Eh}{2(1+\nu)}+\frac{h}{4\Pi}\mathrm{H}_x^2\right)\frac{\partial^2 u_i}{\partial x^2}-$$

$$-\frac{h}{4\Pi}\mathrm{H}_x\mathrm{H}_y\frac{\partial^2 u_i}{\partial x^2}--\frac{h}{4\Pi}\mathrm{H}_x\mathrm{H}_y\frac{\partial^2 u_i}{\partial y^2}=q_y-S_y(w_{i-1})+F_y(w_{i-1}),$$

and

$$\rho h\frac{\partial^2 w_i}{\partial t^2}+\frac{\partial^2 M_{11}(w_i)}{\partial x^2}+2\frac{\partial^2 M_{12}(w_i)}{\partial x\partial y}+\frac{\partial^2 M_{22}(w_i)}{\partial y^2}+\left(\mathrm{H}_y^2-\mathrm{H}_x^2\right)\frac{\partial^2 w_i}{\partial x^2}-4\mathrm{H}_x\mathrm{H}_y\frac{\partial^2 w_i}{\partial x\partial y}-$$

$$-\left(\mathrm{H}_y^2-\mathrm{H}_x^2\right)\frac{\partial^2 w_i}{\partial y^2}=q_z-N_{11}(u_i,v_i,w_{i-1})\frac{\partial^2 w_0}{\partial x^2}+N_{22}(u_i,v_i,w_{i-1})\frac{\partial^2 w_0}{\partial y^2}+N_{12}(u_i,v_i,w_{i-1})\frac{\partial^2 w_{i-1}}{\partial x\partial y}+ \quad (6)$$

$$+\frac{\partial N_{11}(u_i,v_i,w_{i-1})}{\partial x}\frac{\partial w_{i-1}}{\partial x}+\frac{\partial N_{12}(u_i,v_i,w_{i-1})}{\partial y}\frac{\partial w_{i-1}}{\partial x}+\frac{\partial N_{22}(u_i,v_i,w_{i-1})}{\partial y}\frac{\partial w_{i-1}}{\partial y}+$$

$$+\frac{\partial N_{12}(u_i,v_i,w_{i-1})}{\partial x}\frac{\partial w_{i-1}}{\partial y}+T_z+F_z\left(u_i,v_i\right),$$

Iteration continues until $\left|u_i-u_{i-1}\right|\le\varepsilon,\ \left|v_i-v_{i-1}\right|\le\varepsilon,\ \left|w_i-w_{i-1}\right|\le\varepsilon,$ condition meets. Where $\varepsilon-$is the value of the error $(\varepsilon=0.0001)$.

The Bubnov-Galerkin variational method, Gaussian squares, Gaussian, Newmark, and Iteration number methods are used to determine the unknown coefficients in the equation of motion (1). In particular, coefficients $u_i(x,y), v_i(x,y), w_i(x,y)$ of displacement along the OZ axis of the magnetoelastic thin plate are determined [9]

RESULTS

The analytical equation of the field of complex structural form was constructed using the R-function method of V. L. Rivachev [10]. In computational experiments, a symmetrical complex structural form was constructed as shown in Fig. 2. The elastic plate's borders (four sides) are tightly fixed.

Using the R-function, the boundary equation for the symmetric complex field (Fig. 1) was constructed. Numerical results and a graphical representation of the bending of this symmetric complex magnetoelastic plate (Fig. 2) along the coordinate axis under the influence of external forces are presented in Fig. 3.

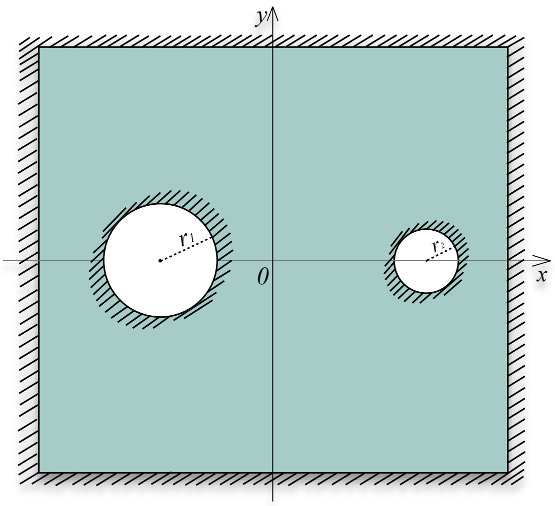

Figure 2. A magnetoelastic symmetric thin plate of complex configuration with tightly fixed boundaries

$$\omega = (f_1 \wedge f_2) \wedge f_3 \wedge f_4$$

where,

$$f_1 = \frac{(a^2 - x^2)}{2a} \geq 0,\ \ f_2 = \frac{(b^2 - y^2)}{2b} \geq 0,\ \ f_3 = \frac{((x-a_1)^2 + y^2 - r^2)}{2r} \geq 0,\ \ f_4 = \frac{((x+a_2)^2 + y^2 - r^2)}{2r} \geq 0,$$

In the calculation experiment, the geometric and mechanical parameters are given as follows:

$a=1, b=1, a_1=0.5, a_6=0.55, h=0.01, r_1=0.2, r_2=0.2\ \nu=0.3,\ q=1,$

$H_x=H_y=H_z=10к Э, E=10^{11}\ H/м^2, T=70.$

Table 1. Bending of a magnetoelastic plate along (Ox) axis

x	y	Values of the function w(x,y,t) when the electromagnetic field is not affected	Values of the function w(x,y,t) when the electromagnetic field is affected	Values of the function w(x,y,t) when the electromagnetic field and tempearture are affected
-1	0	0	0	0
-0.95	0	0.00033	0.00045	0.00066
-0.9	0	0.00084	0.0011	0.0016
-0.85	0	0.00089	0.0012	0.0017
-0.8	0	0.00053	0.00072	0.00107
-0.75	0	0,00015	0,000205	0,0003
-0.7	0	0	0	0
-0.3	0	0	0	0
-0.25	0	0,000129	0,00017468	0,00025667
-0.2	0	0,00051017	0,00069085	0,00101513
-0.15	0	0,0010732	0,0010732	0,0010732
-0.1	0	0,0016874	0,0016874	0,0016874
-0.5	0	0,00220221	0,00220221	0,00220221
0	0	0,0025	0,0025	0,0025
0.5	0	0,002489	0,002489	0,002489
0.1	0	0,002204	0,002204	0,002204
0.15	0	0,001716	0,001716	0,001716
0.2	0	0,001148	0,001148	0,001148
0.25	0	0,000628	0,000628	0,000628
0.3	0	0,000251	0,000251	0,000251
0.35	0	0,000051	0,000051	0,000051
0.4	0	0	0	0
0.6	0	0	0	0
0.65	0	0,000064	0,000087	0,000127
0.7	0	0,000321	0,000321	0,000321
0.75	0	0,000793	0,000793	0,000793
0.8	0	0,001329	0,001329	0,001329
0.85	0	0,0016	0,0016	0,0016
0.9	0	0,00128	0,00128	0,00128
0.95	0	0,000459	0,000459	0,000459
1	0	0	0	0

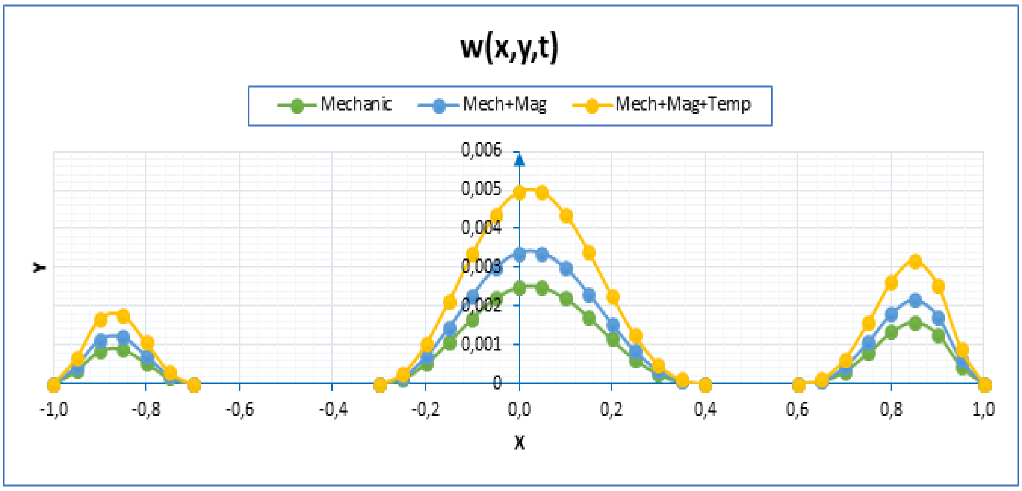

Figure 3. Bending diagram of a magnetoelastic symmetric thin plate on an Ox axis with rigidly fixed boundaries.

In short, the effects of mechanical forces on an electroconductive thin plate and the effect of magnetic field forces on mechanical forces were calculated (Table 1, Figure 3). Results based on calculation experiments show that their mutual difference was 18.4%.

DISCUSSION OF THE RESULTS OBTAINED

According to the experiment, the effects of mechanical forces on the electrically conductive thin plate and the effect of magnetic field forces on the mechanical forces were calculated (Table 2, Figure 4). The results of calculation experiments show that their mutual difference was 18.7%. To prove the validity of the results obtained above, the following study was conducted. By solving the problem, the compatibility of the results of the maximum displacement of the middle plane of the plate along the OZ axis and the existing numerical solutions of M.S. Kornyshin was checked. As a result, compatibility with existing solutions was achieved as follows (Table 3):

Table 3. Comparison results with existing solutions

q*	w_0^* - maximum displacements		%
External forces	M.S. Cornishin results w_0^*	Author's results w_0^*	Comparison of results
12.7	0.171	0.168	1.7 %
19.0	0.252	0.249	1.2 %
28.5	0.365	0.361	1.1 %

CONCLUSION

A mathematical model has been developed in the form of a system of differential equations with specific derivatives, representing the processes of geometric nonlinear deformation of a magnetoelastic thin plate with a complex structural shape. A calculation algorithm was developed to find the unknown coefficients in the mathematical model. The unknown coefficients of the mathematical model were found for the cases of rigidly fixed and hinged thin plate boundaries. Based on the obtained numerical results, the effect of electromagnetic field forces on a thin plate was studied and their comparative analysis was presented. The experiment's results show that the magnetic field force effect on thin magnetoelastic plates. This proves that magnetic field force directly affects the plate's deformation process.

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