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METHOD FOR INCREASING THE ACCURACY OF ROLLING BEARING RINGS MICROGEOMETRY BY ADJUSTMENT OF SUPERFINISH DEVICES DYNAMIC STIFFNESS

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Abstract: *The theoretical analysis of dynamics of superfinishing process indicates on possibility to adjust of superfinishing mechanism inertia due that is possible to provide acquisition of required waviness of processing details. Due adjusting of stiffness at superfinishing is achieving reduction of height of waviness up to roughness level.*

Keywords: *Superfinish; waviness; bearing; stiffness; inertia; roughness.*

1. INTRODUCTION

Currently are differentiated the following types of irregularities of job surfaces: ovality, sideness, waviness and roughness.

As ovality are called irregularities revealed by the two-point measurement. Irregularities with pitch from 1/5 up to 1/6 of the circumference length of the workpiece is called as sideness and from 1/6 up to 1/500 – as waviness. The irregularities with smaller pitch are referred to surface roughness.

From above mentioned irregularities more complex is to provide the necessary height of waviness that most significantly impacts on bearing life [1,2].

The analysis of micro geometrical parameters of high-quality surfaces showed that the waviness height depends on the previous lapping operations of the grinding process [l, 3]. The grinding process typically does not provides obtaining of waviness heights less than 0.6 μm, as this requires consuming of large time, highly skilled operators, expensive equipment, etc.

It is known that [3] to on finishing operations, including superfinishing is provided achieving of desired roughness without substantial geometric correction of job surface parameters.

* **Professor**

2. BASIC PART

The aim of this work is to study the dynamic stiffness of machine, device, tool, detail system at superfinishing in order to find the possibility of correcting of geometrical parameters.

Abrasive stick with mass *m* (Fig. I) is pressed against the superfinishing surface with force *P*. At detail rotating with a certain speed by the force *P* stick will make in radial direction oscillating motion with amplitude equal to the height of waviness, sideness and ovality, i.e. will describe the trajectory of point motion on this surface.

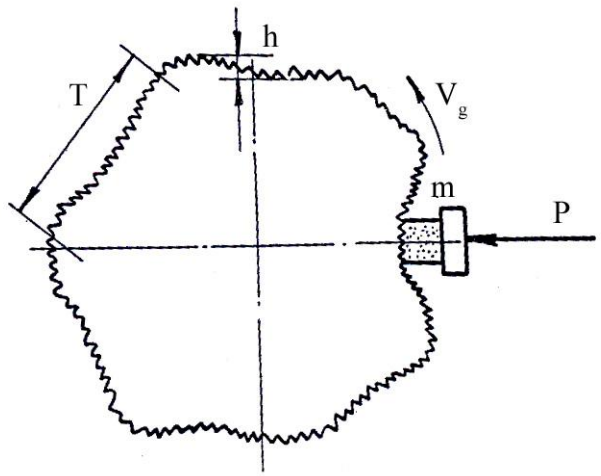

Fig. 1. Superfinishing process

It is obvious that at increase of speed V_g would arise a situation when due to the inertia of mass *m* the stick will not be able to copy the ring surface. Such scheme gives the possibility to carry out a partial correction of error, in particular, the height of waviness *R* and, at the same time are maintained the cutting properties of the abrasive stick due to self-sharpening.

On Fig. 2 is presented a schematic diagram of superfinishing head, where in the point *B* superfinishing stick touch wavy job surface that moves with the speed V_g. *G* is the weight of superfinishing head with mass *m*. P – is the force for stick pressing to the surface. In carrying out the pressing head turns about a hinged fixed point *A*. *L*, ℓ, S_1 and S_2 are linear design parameters of superfinishing head.

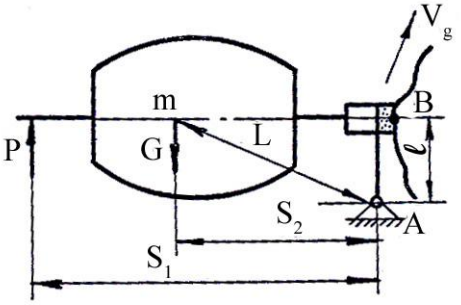

Fig. 2. The schematic diagram of superfinishing head

Let's consider the acceleration of a certain moving point of system on the example of the movement of arbitrary point *B* of the working surface of superfinishing stick at machining of wavy surface, causing the oscillatory motion of this point.

The linear acceleration of the considered point will be as:

$$a = \Theta \cdot \ell, \tag{1}$$

where: Θ – is the angular acceleration of a point *B* relative to a fixed point *A* around that this superfinishing head has the ability to oscillating at the motion-tracking of the stick in the direction perpendicular to the machining speed;

ℓ – is the distance from the considered point of stick up to a fixed point of system of superfinishing head.

The angular acceleration of arbitrary movable oscillating point of any system about a fixed point of the same system mechanism will be defined by the following relation:

$$\Theta = \frac{\sum M}{\sum I}.$$

where $\sum M$ – is the sum of the moments of forces acting in the considered point;

$\sum I$ – is the sum of the moment of inertia of the system related to a fixed point.

For the case shown in Fig. 2 the angular acceleration of point *B* related to point *A* will be as:

$$\Theta = \frac{P \cdot S_1 - G \cdot S_2}{I}, \tag{2}$$

where $I = mL^2$ – is the reduced moment of inertia of system related to point *A*.

If we introduce the value (2) in formula (1) we will obtain:

$$a = \frac{(P \cdot S_1 - G \cdot S_2)}{mL^2}. \quad (3)$$

From the expression (3) is clear that acceleration in the direction of wave trough, i.e. perpendicular to the main motion V_g depends on the mass of head, its linear structural parameters and one of parameters of a superfinishing process modes - pressure *P*.

Now let's define the kinematics of the arbitrary point *B* movement of superfinishing stick on the wave surface.

Let's consider a wave on that moves the point *B* (Fig. 3). On X axis is measured the current coordinate of waviness pitch, and on Y axis the wave height.

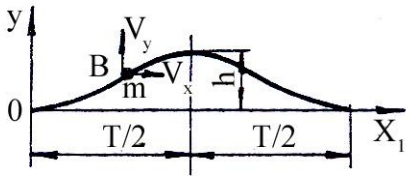

Fig. 3. The wave on that moves the point *B*

The speed of point *B* motion will be:

$$V_y = \frac{dy}{dt} = \frac{dy}{dx} \cdot \frac{dx}{dt} = V_x \frac{dy}{dx}. \quad (4)$$

To simplify the calculations the wave would be represented as an isosceles triangle (Fig. 4). Then the trajectory of point *B* on the left side of wave will be expressed by equation $y = C \cdot x$ and at the peak of wave

$$\frac{dy}{dx} = C. \quad (5)$$

Then the (4) will be written down as

$$V_y = V_x \cdot C. \quad (5)$$

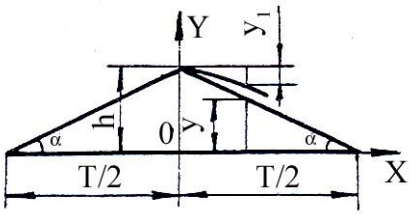

Fig. 4. The isosceles triangle

To superfinishing process was carried out only on the peaks of waves, i.e., would be cut

the waves and there has been a correction of waviness, point *B* after passing the peak of wave (Fig. 4) should not touch the surface of wave trough up to the next peak. In this case, the motion of point *B* is defined as:

$$y_1 = -V_y \cdot t + \frac{Vt^2}{2}, \tag{7}$$

where

$$X = V_x \cdot t; \quad t = \frac{X}{V_x}. \tag{8}$$

If we introduce (6) and (8) in expression (7) we obtain the motion of point *B* after passing the peak of wave:

$$y_1 = -C \cdot x + \frac{ax^2}{2V_x}. \tag{9}$$

The right part of trajectory of wave (Fig. 4) will be defined building the equation:

$$y = h - C \cdot x, \tag{10}$$

where

$$C = \frac{h}{T/2} = \frac{2h}{T}. \tag{11}$$

Due the above stated condition the contact of point *B* with wave after passing the peak of wave does not take place, i.e.

$$h - y_1 > y. \tag{12}$$

Let's introduce in the condition (12) the value of y_1 from (9) and *y* from (10), we will obtain

$$2C_x > \frac{ax^2}{2V_x^2}. \tag{13}$$

By taking into account the (11) the condition (12) from inequality (13) would be expressed as:

$$a = \frac{16 \cdot V_x^2 \cdot h}{T^2}. \tag{14}$$

Ground on the analysis of dynamics of superfinishing process from (3) and (4) for given superfinishing head we will obtain:

$$mL^2 = \frac{T^2(P \cdot S_1 - G \cdot S_2) \cdot \ell}{16 \cdot V_x^2 \cdot h}. \tag{15}$$

There should consider the case when the superfinishing process is carried out according to the scheme shown in Fig. 5.

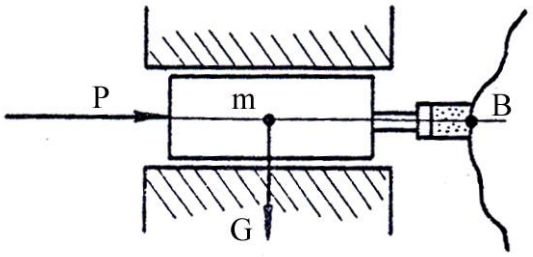

Fig. 5. The superfinishing process scheme

In this case, the equation (15) will be as

$$m = \frac{T^2 \cdot P}{16 \cdot V_x^2 \cdot h}. \quad (16)$$

An analysis of equations (15) and (16) shows that it is easier to adjust the inertia of superfinishing head by changing the value of *L* [equation (15)] than with a mass *m* [equation (16)], as the value *L* is squared. Therefore the scheme shown in Fig. 2, where we have an arm providing the influence of the center of gravity on the inertia of head, is more acceptable.

The analysis of dynamics of superfinishing [equation (I5)] shows that the process would be carried out smoothly, copying unevenness of job surface (at this inertia of superfinishing head is small)

$$mL^2 < \frac{T^2(P \cdot S_1 - G \cdot S_2) \cdot \ell}{16 \cdot V_x^2 \cdot h}$$

and rigidly (when inertia of superfinishing head is high)

$$mL^2 > \frac{T^2(P \cdot S_1 - G \cdot S_2) \cdot \ell}{16 \cdot V_x^2 \cdot h}.$$

The analysis of presented relation (15) shows that for each structure of superfinishing head the linear values (S_1, S_2, L) are constant.

The value $(P \cdot S_1 - G \cdot S_2)$ determines the necessary specific pressure in contact and depends on the selected processing modes.

In the processing process is possible to change the value V_x. However, since the processing

speed is limited and depends on technical specifications of superfinishing stick and processed material, the actual processing speed has its upper limit for each individual case.

Consequently, correction of waviness, depending on the design of the head and accepted processing modes would be obtained at the according inertia of superfinishing head mL^2. This is achieved by adjusting the corresponding mass m of head and adjusting the distance of its center of gravity, displacement of a specific part of the head mass.

3. CONCLUSIONS

Based on the above mentioned is possible to make the following conclusions:

1. To correct the waviness of superfinishing surfaces in the direction of the processing velocity vector the superfinishing head should has adjustable inertia in the direction perpendicular to the job surface.
2. The analysis of the superfinishing of wavy surfaces showed:
   a) the possibility of creating of superfinishing head with adjustable scheme of superfinishing (rigid, semi-rigid, floating) by changing the inertia of superfinishing head;
   b) that the best sensitivity of adjustment is obtained in the presence of angular acceleration at the stick of superfinishing head in the direction perpendicular to the processing speed vector.

The application of results of carried out research showed that by adjusting the stiffness of machine, device, tool, detail stiffness at superfinishing is achieved reducing the height of waviness up to the roughness level.

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СПОСОБ ПОВЫШЕНИЯ ТОЧНОСТИ МИКРОГЕОМЕТРИИ КОЛЕЦ ПОДШИПНИКОВ КАЧЕНИЯ РЕГУЛИРОВАНИЕМ ДИНАМИЧЕСКОЙ ЖЕСТКОСТИ СУПЕРФИНИШНОГО УСТРОЙСТВА

В.А. Шилакадзе

Теоретический анализ динамики процесса суперфиниширования показывает возможность регулирования инерции суперфинишного механизма, с помощью которой можно обеспечить приобретение требуемой волнистости обрабатываемой поверхности. За счёт регулирования жёсткости при суперфинишировании достигается снижение высоты волнистости до уровня шероховатости.

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NON-LINEAR DEFORMATION OF REINFORCED WITH RIBS PLATES

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Abstract: *In the work are considered rectangular plates with rectangular hole, the edges of that are reinforced with ribs and reinforcement rods. The method of analysis, based on linearization of decisive equations by successive loadings method and application of discontinuous functions, gives the possibility to taking into account of concentration of stresses and non-linear deformation of structures and materials.*

Keywords: *Plate; deformation; cut; discontinuous function; rib.*

1. INTRODUCTION

The airship – aircraft, helicopter, dirigible, missile of spacecraft – would undergoes the applying loadings and non-permissible variation in shape, i.e. would has sufficient strength and stiffness. To this requirement that represents the necessary condition of safe operation, would satisfy the arbitrary engineering structure, as well as aircraft structure would be outlined in addition also by minimal mass [1]. Naturally that requirements of minimal mass are in contrast with requirements of sufficient strength and stiffness. Solution of these contradiction represents one of main problems, arising at design of aircraft; it is carried out at analysis, design and experimental testing of structure in whole, as well as its separate elements and significantly stipulates the effectiveness of aircraft. The successfully solution of this problem is determined first of all, by degree of completeness and trustworthiness of information that is available by designer related to interrelation between geometrical parameters of structure, properties of materials and permissible level of its loading. This interrelation is formed in process of strength analysis of aircraft and its elements that provides the determination of design loadings; selection of design diagrams and models, adequately describing the real elements of structure; analysis of mode of deformation, stability and dynamical behavior of separate models and their sets;

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transition from design models to real objects and evaluation of their capabilities. The existence of wide class of design diagrams, modeling the elements of various destination structures , as well as special, requiring rather complex mathematical apparatus methods for solution of issues on mode of deformation [2], stability and dynamical behavior of models, stipulates the origination of special scientific subject – structural mechanics [3].

Rather important is problem of consideration of various structural singularities (ribs, contour elements) that makes impossible to apply pure theory of smooth shells.

To problem of taking into account the ribbing of shells are existing several approaches. Some authors distribute the elastic properties of ribs, and if the lasts are arranged eccentrically, obtain the design diagram as two-layered shell, in that fictitious layer, simulating the ribs, as a rule is orthotropic. Other authors solve the contact task for shell and rod system. Also are existing the other approaches.

In the book of G.N. Savin and N.P. Fleshman [4] mainly are considered the following plates: circular with concentrically arranged ribs; thin with reinforced edges; reinforced with rather thin ribs; as well as are solver the inverse tasks for plates with holes, having reinforced edges and circular ribbed plates. Most of tasks are reduced up to number, information is collected in Tables and is presented by diagrams.

In the book of M.P. Sheremetev [5] is solved planar task of theory of elasticity for plates with stepped–variable thickness, reinforced plates, including on contour, by thin elastic constant cross-section rods, for infinite plates with holes partially reinforced on contour. Is applied the apparatus of complex variable function.

To analysis of plates and shells, reinforced with ribs, are devoted the research of E.S. Greben [6]. Large number of works on theory of analysis of ribbed shells were carried out in 1967-1975 by scholars of krasnoiarsk sholls, guided by N.P. Abramov. For such works are belonging book of B.M. Krasnopeev, N.P. Abovski and L.V. Endzhievski [7]. To ribbed shells are devoted book of S.A. Timashev [8], as well as I.V. Andrianov, V.A. Lecnichaia and L.I. Manevich [9]. In the last are considered asymptotic methods of determination of mode of deformation of plates and shells with periodically changing structure (ribbed, corrugated, folded) at static and dynamic impacts. Is revealed the singularity of behavior of such structures and fields of application for their solution of approximation methods. Are considered plates and shells of

rotation, in particular, cylindrical. Are discussed also non-linear tasks of theory of smooth plates and shells.

2. BASIC PART

For taking into account the cut displacement vectors and angles of rotation are presented as [10]:

$$\bar{U}^* = \bar{U} + \sum_{i=1}^{2} \Delta \bar{U}_i \cdot H_{xi} H_{yyi} + \sum_{y=1}^{2} \Delta \bar{U}_j \cdot H_{yj} H_{xxj};$$

$$\bar{\gamma}^* = \bar{\gamma} + \sum_{i=1}^{2} \left(\Delta \bar{\gamma}_{iy} \cdot H_{xi} H_{yyi} + \Delta w_i \cdot \delta_{xi} H_{yyi}\right) + \sum_{i=1}^{2} \left(\Delta \bar{\gamma}_{2j} \cdot H_{yi} H_{xxi} + \Delta w_j \cdot \delta_{yj} H_{xxi}\right), \quad (1)$$

where $\Delta\bar{U}_i$, $\Delta\bar{U}_j$ – are the vectors of relative displacements of points on edges of cuts, in parallel of axis OX and OY accordingly;

$\Delta\bar{\gamma}_{iy}$, $\Delta\bar{\gamma}_{2j}$ – are angles of breaks of deformed surface of plate on line of breaks;

$H_{xi} = H(x - x_i)$, $H_{yi} = H(y - y_i)$ – are the Heaviside functions;

$H_{yyi} = H(y - y_i) - H(y - y_{2i})$, $H_{xxj} = H\left(x - x_{ij}\right) - H(x - x_{2i})$ – are the functions, compiled from Heaviside functions.

Introduction of dependencies (1) due geometrical and linearized physical relations in equilibrium equations leads to simultaneous decisive equations as:

$$[L]\bar{U}_m = \bar{P}_m - \sum_{i=1}^{2} ([\bar{L}_{1i}]\Delta\bar{U}_{1im} + [\bar{L}_{2i}]\Delta\bar{\gamma}_{1im}) H_{yyi} + \sum_{i=1}^{2} \left([\bar{L}_{1ij}]\Delta\bar{U}_{ljm} + [j]\Delta\bar{\gamma}_{2jm}\right) H_{xxj}, \quad (2)$$

where $[L]$ – is the matrix operator with variable coefficients as regular functions;

$[\bar{L}_{1i}]$, $[\bar{L}_{2i}]$, $\left[\bar{L}_{1ij}\right]$, $\left[\bar{L}_{2j}\right]$ – are the matrix operators with coefficients as delta functions and their derivatives.

For the first approximation (when m=1) system (2) is reduced to simultaneous biharmonic equations

$$\nabla^4 U_e = \sum_f \ell_e\left(P_f\right) + \sum_f \ell_{ef}\left(U_f\right) + \sum_f \bar{\ell}_{ef}\left(\Delta U_f\right) + \sum_f \bar{\bar{\ell}}_{ef}\left(\Delta\gamma_f\right), \tag{3}$$

e=1, 2, 3; *f*=1, 2, 3.

Operators $\bar{\ell}_{ef}$ contains as coefficients delta functions and their derivatives up to third order. This indicates on existence of cuts and holes causes discontinuous character of distribution of displacements, stresses and moments, therefore most evident is revealed in adjacent of angles of holes.

The ribs are considered as reinforcement rods by introduction of concept of generalized stresses and moments [11-12]

$$\begin{matrix} T^* = T_e + T_{er} + T_{ea}; \\ M^* = M_e + M_{er} + M_{ea}, \end{matrix} \quad e = 1,2, \tag{4}$$

where T_e, M_e – are the stresses and moments in smooth part of plate,

T_{er}, M_{er} – are the stresses and moments in ribs, determining by formulae

$$\begin{aligned} T_{er} &= \sum_k (E_k F_k \varepsilon_k + E_k S_k w_k^{''})\delta(x_e - x_{ek}); \\ M_{er} &= \sum_k \left(E_k J_k w_k^{''} + E_k S_k \varepsilon_k\right)\delta(x_e - x_{ek}). \end{aligned} \tag{5}$$

Let's accept x_1=x, x_2=*y*;

E_k, F_k, S_k, J_k – are the modulus of elasticity and geometrical characteristics of rib;

T_{ea}, M_{ea} – are the stresses and moments id reinforcement rods.

At this the reinforcement rod is considered as rib, having finite stiffness on te4nsion-compresion and zero stiffness on bending related to own axis. The moments from reinforcement rods are arising due their eccentric arrangement. Therefore T_{ea} and M_{ea} are determined by formulae (5), at this in them would be accepted values $E_k = E_a$, $E_a = F_p$ - are the modulus of elasticity and cross-section area of reinforcement rod, and the moment of inertia and static moment would be determined by dependencies

$S_a - F_a h_k; J_a h_k^2$,

where h_k – is the distance from center of gravity of reinforcement rod cross-section up to neutral plane of plate.

By introducing of expressions (4), (5) in the equilibrium equations with taking into account the geometrical and physical relations leads to simultaneous decisive equations in displacements

that after linearization by method of successive loadings in the first approximation will be as [13-15]

$$\nabla^4 U_e = \sum_f \ell_e \left(P_f\right) + \sum_f \ell_{ef} \left(U_f\right), \tag{6}$$

where ℓ_e – are the operators with regular coefficients;

ℓ_{ef} – are the operators with coefficient as delta functions and their derivatives.

For solution of obtained equations the desired functions are introduced as

$$U = U_1 + U_2 = \sum_k \sum_{i=1}^{2} A_{ik}\,(x) \sin \beta_k\, y + \sum_\ell \sum_{j=1}^{2} B_{j\ell}\,(y) \cos \alpha_\ell\, x;$$

$$V = V_1 + V_2 = \sum_k \sum_{i=1}^{2} C_{ik}\,(x) \cos \beta_k\, y + \sum_\ell \sum_{j=1}^{2} D_{j\ell}\,(y) \sin \alpha_\ell\, x;$$

$$w = w_1 + w_2 = \sum_k \sum_{i=1}^{2} E_{ik}\,(x) \sin \beta_k\, y + \sum_\ell \sum_{j=1}^{2} F_{j\ell}\,(y) \cos \alpha_\ell\, x. \tag{7}$$

At this functional coefficients $A_{ik}(x)$, $B_{j\ell}(y)$, $C_{ik}(x)$, $D_{j\ell}(y)$, $E_{ik}(x)$, $F_{j\ell}(y)$ contains the disconticnuous finctions, the algorithm for determination of that is stated in the work [11]. The values of divergence of edges of cuts $\Delta\bar{U}$ and angles of breaks $\Delta\bar{\gamma}$ are determined from the conditions of equality to zero of stresses and moments on edges of each cut, if edges of hole are bounded by ribs, then these values are determined from compatibility conditions of ribs deformations and edges of cuts

3. CONCLUSIONS

Developed method of analysis of plates reinforced with ribs in linear and non-linear statement and obtained at this design formulae gives the possibility to describe all singularities in distribution of components of mode of deformation in adjacent of violations of regularity, reflects the changes and redistribution of stresses and moments in process of loading.

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НЕЛИНЕЙНАЯ ДЕФОРМАЦИЯ ПЛАСТИН, ПОДКРЕПЛЁННЫХ РЁБРАМИ

Г.О. Кипиани, Г.А. Окропиридзе, А.Г. Пересашвили

В работе рассматривается прямоугольная пластина с прямоугольным отверстием, края которой подкреплены рёбрами и армирующими стержнями. Методика расчёта, основанная на линеаризации разрешающих уравнений методом последовательных нагружений и на применении разрывных функций, позволяет учитывать концентрацию напряжений и нелинейную деформацию конструкций и материалов.

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OSCILLATIONS OF MULTI-LINK STRUCTURALLY-INHOMOGENEOUS PRISMATIC SHELL STRUCTURE

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Abstract: *In the article are generated decisive equations of task on determination of dynamical characteristics of structurally-inhomogeneous prismatic shell structures from visco-elastic material, design diagram of that would be presented as arbitrary composition from multilayered non-circular cross-section cylindrical shells and straight stringers.*

Keywords: *oscillations; shell; structure; algorithm.*

1. INTRODUCTION

Trends of development of the construction industry, airspace engineering, shipbuilding, chemical and power engineering and many other branches of modern technology are characterized by the increasing complexity of design solutions at design of various objects, which are usually presented by thin-walled spatial structures and on one hand makes raise requirements for the reliability of these objects in operation, and on the other hand - to reduce its weight and material consumption.

At the design of complex structures, along with the traditional metallic materials increasingly are applied polymeric materials and composites on their basis. Manufactured from composite materials, modern machine building structures are composed of a set of elastic and viscoelastic damping elements with different rheological properties, various types of supporting and reinforcement, elastic and viscoelastic constraints with significantly different rheology.

Such mechanical systems are classified in the works [1, 2,] as structurally inhomogeneous and the task to develop reliable methods for their analysis, so far has not lost its relevance.

* **Professor**

Request for practice requires the creation of more accurate methods for solving such problems, and should be focused on computer technology, widely implemented in the design, engineering, and research organizations, higher education institutions. These methods and based on them algorithms should be maximally taken into account the actual conditions of the structure behavior, carry our calculations without exceed geometric idealization, consider the real rheological properties of the structural elements, maximally approximate the design scheme to full-scale design and as a result of calculations to make science-based selection of its parameters.

The carrying out numerical experiments for complex structurally inhomogeneous structures gives the possibility to understand the qualitative picture of the influence of various parameters and provide sound recommendations, not only at the design stage, but also for the carrying out of model and natural experiment, significantly reduce the volume of experimental researches.

Development and implementation in practice of the finite element method makes possible to solve the problem of creating of a universal program for solving of statics and dynamics problems of arbitrary type and purpose structures. On the existence of such programs and software systems would make judgments by publications.

One of such narrower, but rather widely applied, classes is a class of thin prismatic shell structures that represents an arbitrary composition of the non-circular cross-section cylindrical shells and straight stringers. For the analysis of such structures more effective is the application of discrete-continuum model [3].

Currently are well developed methods, algorithms and programs for solving of statics and dynamics problems of thin prismatic structures made from an elastic material [4], as well as thin-walled structurally inhomogeneous structures consisting from shells of revolution and frames [5, 6].

2. BASIC PART

As test task for offered in the work computational complex let’s consider eigenmodes of multi-link structurally-inhomogeneous prismatic shell structure that represents as arbitrary composition from multilayered non-circular cross-section cylindrical shells and straight stringers (Fig. 1). With elastic shell elements (layers) also are elements (layers) from viscoelastic material.

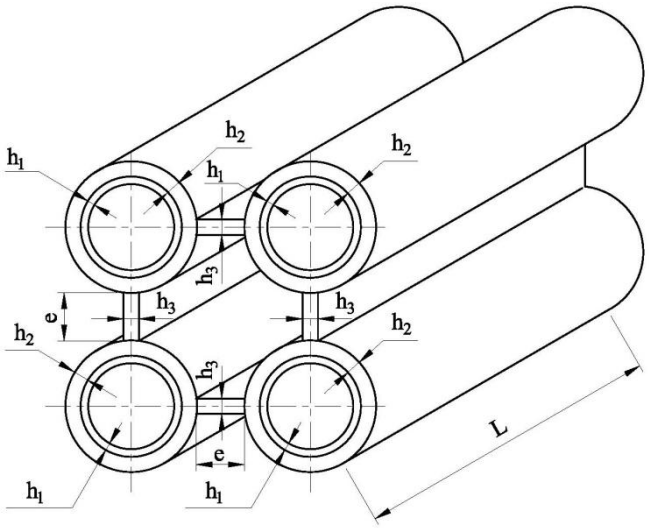

Fig. 1. Arbitrary composition from multilayered non-circular cross-section cylindrical shell

The task is to determine the range of eigenmodes of such multi-link structurally-inhomogeneous prismatic shell structure, corresponding damping coefficients, as well as optimal physical-mechanical and geometrical parameters of structure, realization of that gives the possibility to provide most rational, in our case, optimal dissipative properties of whole item.

The inner layer of cylindrical shell is elastic, with mechanical properties: $E_1=2\cdot10^6$ kg/sm², $\rho_1=8\cdot10^{-6}$ kg/sm³, $\nu_1=0.3$. The outer layer of cylindrical shell is viscoelastic, with mechanical properties: $E_2=2\cdot10^4$ kg/sm², $\rho_2=8\cdot10^{-7}$ kg/sm³, $\nu_2=0.3$. For describing of rheological processes in viscoelastic material is selected weak-singular core of type $R(t)=Ae^{-\beta t}t^{\alpha-1}$, where the parameters have the following values: A=0.01, α=0.1, β=0.05. The crosspieces between cylindrical shells are accepted as viscoelastic.

For such multi-link structurally-inhomogeneous prismatic shell structure is necessary to provide two variant of analysis. At this butt ends of structure are accepted as simply-supported.

In the first variant of analysis as variable parameter is assumed instantaneous modulus of elasticity of crosspieces – E_3. The geometrical dimensions are as following: L=300 sm, R=10 sm, ℓ=5 sm, $h_1=h_2=0.3$ sm, $h_3=0.4$ sm.

In the second variant of analysis as variable parameter is stated the thickness of viscoelastic layer of cylindrical shell – R_2. The geometrical dimensions are as following: L=300 sm, R=10 sm, ℓ=5 sm, $h_1+h_2=0.6$ sm, $h_3=0.4$ sm., as instantaneous modulus of elasticity for

crosspieces is accepted $E_3=2\cdot10^4$ kg/sm². The overall thickness of cylindrical shells is not changed.

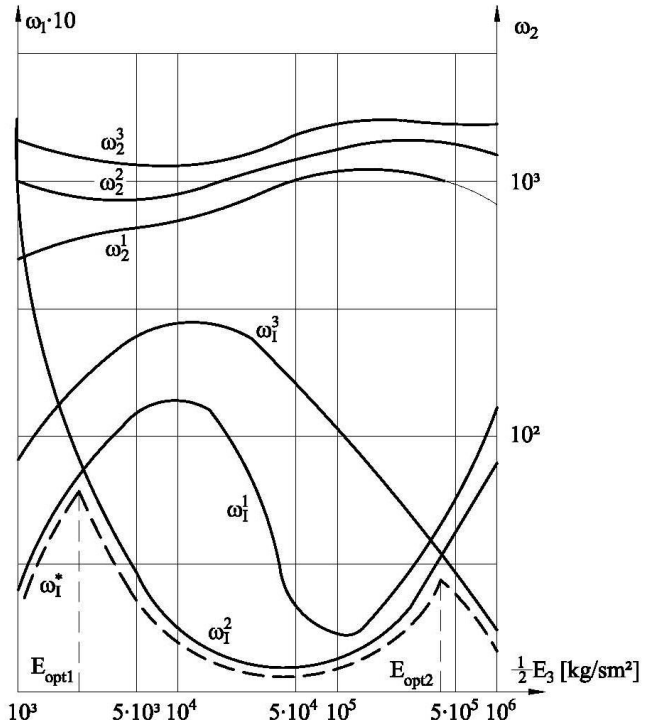

Fig. 2. Dependency of first 3 lowest eigenmodes of structure

By developed in the article problem-oriented programs is carried out multi-parametric analysis of considered (Fig. 1) multi-link structurally-inhomogeneous mechanical structure. In particular for first variant of analysis on Fig. 2 are stated dependencies of first 3 lowest eigenmodes of structure $(\omega_R^1, \omega_R^2, \omega_R^3)$ and damping coefficients $(\omega_I^1, \omega_I^2, \omega_I^3)$on instantaneous modulus of elasticity of crosspieces – E_3. The existence of structural inhomogeneity gives the possibility to construct the characteristic of determining damping coefficient $-\omega_I^*$ for 3 lowest eigenmodes of multi-link structure, values of resonance amplitude oscillations on that, and therefore also dynamic overloading on whole item that are strictly regulated by its performances. Are obtained optimal values of instantaneous modulus of elasticity of crosspieces E_{opt1} and E_{opt2}, realization of that at design of structure gives the possibility to rationally damping the lowest eigenmodes.. The experimental validation of obtained theoretical calculations indicates that realization of E_{opt1} and E_{opt2} gives the possibility to decrease the dynamical overloading on whole item at resonance up to 3÷3.5 times. At this characteristic of determining damping coefficient

ω_I^* in dependency of E_3 is non-monotonic, i.e. exists the maximum, at that dissipative properties of structure are revealed most intensively. Due this is obvious the existence of synergism effect of viscoelastic properties fo mechanical system that qualitatively differs in terms of dynamics the multi-link structurally-inhomogeneous structures from structurally homogeneous ones.

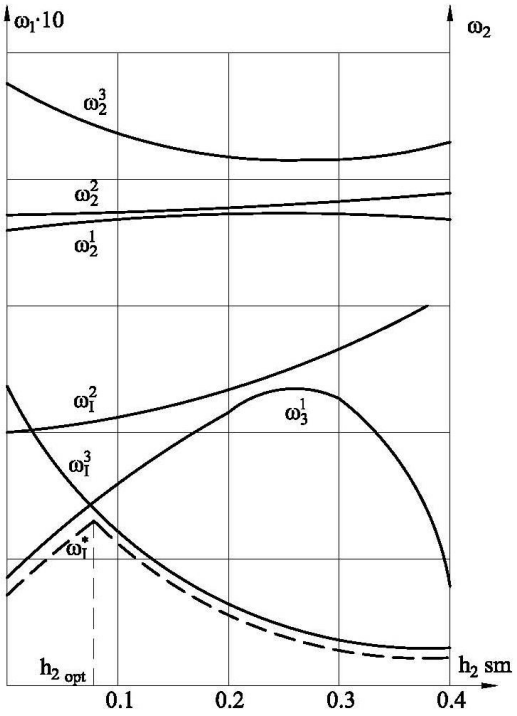

Fig. 3. Dependency of eigenmodes and damping coefficients

For second variant of analysis when as variable parameter is stated thickness of viscoelastic layer of cylindrical shell – h_1 analytically are obtained dependencies of eigenmodes and damping coefficients (Fig. 3). As result of calculations are obtained values of determining damping coefficient ω_I^* for whole structure in dependency of thickness of viscoelastic layer of cylindrical shell – h_2. Is found the optimal value of h_2 (Fig. 3) of viscoelastic layer, realization of that at design of stated mechanical structure gives the possibility to decrease the dynamical overloading on item at resonances in average up to $1.5 \div 2$ times. At this most intensively the damping of oscillations were carried out on lowest, most dangerous in terms of operation of item frequencies.

3. CONCLUSION

Is carried out multi-parametric analysis of influence of geometrical parameters and rheological properties of materials of elements of structure on damping coefficients. Is confirmed the revealed earlier for simple mechanical systems synergism effect fo dissipative properties for structurally inhomogeneous prismatic structures

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КОЛЕБАНИЯ МНОГОСВЯЗНОЙ СТРУКТУРНО-НЕОДНОРОДНОЙ ПРИЗМАТИЧЕСКОЙ ОБОЛОЧЕЧНОЙ КОНСТРУКЦИИ

М.С. Вазагашвили

В работе сформированы разрешающие уравнения об определении динамических характеристик структурно-неоднородных призматических конструкций из вязкоупругого материала, расчётная схема которых может быть представлена в виде композиции из многослойных цилиндрических оболочек некругового сечения и прямолинейных стрингеров.

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SCIENTIFIC BASIS OF MANAGEMENT OF TRANSPORT COMPANIES INTERACTION

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Abstract. *It is scientifically proved in the article that the modeling of traffic flows is one of the priorities of the transport systems study. Based on the process approach to the transport and logistics system, business processes that ensure the functioning and transport companies' interactions management were defined.*

Keywords*: interaction of enterprises, interaction management, transport and transport system.*

Problem statement. Creation of efficient transport system based on a balanced approach, as the integrated transport system should be based on fair and equal treatment of all modes of transport. Technological interaction between different types of transport is often associated only with the use of a single technology in the areas of cargo handling. Transfer points play an essential role in the interaction of different types of transport, however, this approach does not fully solve the problem of transport interaction.

Analysis of recent research. The concept of interaction, as a philosophical category, reflects the process of mutual influence of one object to another, resulting in a change in the state of these objects, a mutual transition from one state to another. Interaction takes place at presence of the relationship - direct and indirect, internal and external. It should also be mentioned that any interaction is related to the exchange of information and material motions. I. Gordienko, M.Grigorak, O. Katerna, V.Koba, E.Krikavskii, V. Kulaev, A .Fedulova, E. Owl, Y. Chichkan-Hlipovka, N.Chukhray and others, conducted the study of various aspects of the formation and the development of interaction between economic entities related to the transport sector. However, these studies investigated the problem of companies' interaction management, belonging to the various modes of transport, in particular the formation of transport and logistics system, insufficiently.

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The purpose of the article is a scientific justification for transport companies' interaction management.

Results. The problem of ensuring interaction between enterprises, based on economic interests, are the subjects of many foreign and domestic studies. We may find in the literature identification of three research areas, the formation of which began in the second half of the twentieth century:

- "stakeholders" approach, founded by R. Freeman;
- the concept of "economic interests", which was developed by such scholars as V. Radaev, Y. Tumanyan and I. Radionova;
- the latest development of the "stakeholders" theory, which take into account peculiarities of the transition to a market economy, and is highlighted in the papers [2, 6].

The literature analysis allowed us to determine that the theoretical bases of enterprises interaction in the transport sector were laid abroad in the mid-1990s and are based on scientific research in the field of general management, logistics management and functional logistics.

In our view, the interaction of transport companies is a system of relationships between the subjects of the system is implemented using a variety of forms, including the role of each of them in the economic process. It should be noted that the economic cooperation plays a key role among other forms (organizational, legal, logistical, and informational) of interaction within the transport and logistics system. Its substance, in our opinion, is the implementation of joint industrial activity aimed at getting by all the parties of interaction the material income using an available resources. Economic interaction can be achieved through a technological cooperation system, as well as through the joint implementation of development projects.

During the research, it was found that the object of control in the transport system is movement and transformation of all types of resources and the formation of the flow of goods and services. The set of these flows forms the so-called «logistic flow ", which can be defined as the movement of tangible and intangible assets, formed and provided with a set of interrelated processes and structures. The concept of «logistic flow» solves the problem of the relation between different types of flows, structure and functions of the logistics system, and is a set of different types of flows that are available in the logistics system. According to I. Gordienko, the

category "logistics flow" occurs when such flows apply methods and principles of logistics management [2].

To determine the properties of the logistics flow, in our opinion, the following items should be included:

- target orientation - the organization and the logistics flows movement management considered not as a goal itself, but as a way to achieve the common goal of business activity;
- system organization – interrelation and interdependence of the processes that determine the power, intensity and other parameters of the logistics flow;
- territorial localization - the organization of resources movement within the economic interests and the real powers of the enterprise;
- resourceness, because the basis of all the components of the logistics flow is a certain type of resources;
- legitimacy - the availability of the subject's logistics flow management or its components in the wholeness or the individual components of the property rights on the resources and related activity (possession, disposal, use) and others;

In addition, the basis of effective logistics flow management is a process consistency in space and time.

According to I. Gordienko, the movement of tangible and intangible resources, which are the basis of the logistics flow can occur in both forward and backward, reverse direction within the logistics system. The functional component of the logistics flow, in turn, is as a set of processes, providing a space and time sequence of appropriate resources movements [3]. In other words, it comes to the logistics flow management function, which should be the basis for the design of the logistics system structure. In turn, the implementation of the function of logistics flow management requires the development of appropriate methods, techniques, procedures.

Logistic system as a result of interaction between enterprises, in our opinion, can be differentiated by forms and identifications, as well as the degree of intensity and closeness of the connection between counterparties. This approach enables companies to formulate the interactions of different types of transport, depending on the closeness of the relationship between economic entities:

- a simple economic and economic cooperation between transport enterprises;

- partnerships that can be the result of economic cooperation with the external contractors, or between various divisions of the integrated organization of corporate type;
- informational interaction among the companies, implementation of which usually leads to the formation of tie relations between counterparties;
- the integration of companies that can be implemented on the basis of information technologies, or by consolidation or intercompany participation;
- economic cooperation of enterprises, which can serve as a basis for the formation of a horizontally integrated corporate structures capable of ensuring the full technological cycle of production.

It should be noted that these kinds of interactions are, in fact, the stages of development of the relationship between counterparties in the formation and operation of transport and logistics system - from simple economic cooperation of transport companies to the formation of associations of enterprises, including the implementation of innovation and investment projects for modernization of the transport industry.

Considering that the integration of economic entities is a type of interaction between enterprises, in our opinion, the concept of logistics management of processes of formation and development of regional transport and logistics systems should be aimed at the integration of members of the system. It allows to suggest that the important levers and mechanisms of transport and logistics formation systems are the establishment, maintaining and management of the interaction of participating firms. The basis of this or that kind of cooperation in transport and logistics systems is the establishment of mutually beneficial partnership between counterparties, which, in turn, requires the identification, accounting and coordination of economic interests of major stakeholders.

In general, we join the opinion of the authors that by the interaction of different types of transport understand the mechanisms by which certain transport types are combined in the system to improve the overall efficiency of transport activity through rational use of the advantages [2, 5]. At the same time, cooperation at economic level is realized in two forms: alternative substitution and mutual complementation. The essence of the interaction at the technical level is the coordination of different types of transport. In our opinion, the integrity of the transport system increases with a clear distinction and consistent implementation of the

integration functions by the transport subsystems of different levels. It allows declaring the scientific concept of the coordinated operation of transport systems of different functional levels.

The methodological principles, that underlie the concept, are the following:

- objects of transport subsystems of different functional levels should be functionally separated and integrated;
- resources of transport systems are to be used according to their functionality;
- structure of the transport systems should be aimed at the maintenance of transport links;
- configuration of transport networks should not lead to the formation of transit functions.

Conclusions. Effective management of the transport companies interaction provides access to new markets by offering the customers integrated services and increasing the enterprises efficiency by reducing costs.

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НАУЧНОЕ ОБОСНОВАНИЕ УПРАВЛЕНИЯ ВЗАИМОДЕЙСТВИЕМ ТРАНСПОРТНЫХ ПРЕДПРИЯТИЙ

В.А. Новак, В.Н. Марченко, В.В. Передерий

В данной статье научно обосновано, что моделирование транспортных потоков является одним из приоритетных направлений изучения транспортных систем. На основе процессного подхода к рассмотрению транспортно-логистической системы, определены бизнес-процессы, которые обеспечивают функционирование и управление взаимодействием транспортных предприятий.

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FACTORS OF LEADERSHIP POTENTIAL DEVELOPMENT OF AIR CARRIERS

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Abstract: *In the article the main features of strategic leadership of airlines were studied, the factors of leadership potential development of air carriers under uncertainty conditions were scientifically justified, the role of strategic flexibility in the change management aimed at strengthening leading positions in the market was analyzed.*

Keywords: *air carrier, leadership potential, strategic leadership, strategic flexibility.*

Definition of the problem in general and its connection with important scientific and practical tasks. The current international environment of air companies is characterized by increased uncertainty, dynamics and complexity defining the need for implementation of modern approaches to strategic decision-making and strategic development management. Air carriers are under constant pressure of changes occurring in the environment, which encourages them to introduce internal transformations, using changes as an instrument of survival, development and even competitiveness and leadership. In these circumstances, strategic leadership and leadership potential development are important issues for the successful long-term functioning of air company that determines the relevance of this research direction.

Analysis of the latest researches and publications where the solution of the problem was initiated. The issue of and leadership potential development of enterprises is partially studied in the works of a number of scientists, such as S. Billinger, E. Darnell, E. Fleisch, T. Friedli, V. Kaza, M. Kickuth, E. Widati [1;3;5;6]. In particular, the problem of strategic leadership development was analyzed by I. Ansoff, M.H. Nejad, W.G. Rowe, P. Lawrence and others [2;7]. However, the problem of leadership potential development of air carriers under uncertainty conditions through strategic flexibility application is reflected in scientific literature insufficiently.

The main objective of the article is to study the main features of strategic leadership of airlines, determine the factors of leadership potential development of air carriers under uncertainty, and in particular to analyze the role of strategic flexibility in the change management aimed at strengthening leading positions in the market.

Exposition of the basic material. Strategic leadership in air carrier's environment represents the ability to forecast, maintain flexibility and empower others to implement strategic changes as needed.

* Associated Professor

Since about 70% of change business initiatives fail, change management should not be implemented just for the desire to change, regardless of the circumstances of the air company activity. Changes should be justified by the existing need.uccessful implementation of transformation measures for modern air enterprises is provided by the effective strategic leadership. Competent leaders implement changes directly affecting organizational behavior, allowing the air company to succeed both in a particular operational activity direction and in a strategic perspective.Powerful multinationals spend over $500 thousand annually in average for leadership development and implementation of change measures, and an average of $1 mln. during the period of implementation of development programs while receiving income in excess of $2 mln. In air companies sufficient changes are implemented every year, and significant – on average every 4-5 years. Effective leadership in the air company is essential condition, a kind of impulse for the vision and strategy implementation. This is especially important when implementing large-scale, deep transformational changes, as in this case complex support for radical change in company management and principles of its functioning is extremely sufficient. In the process of change management leaders assume not only the function of generators of new ideas (innovators), but also managers, as they direct the process in the right direction, while continuing to lead the workers. Leaders help implement changes in life. They establish feedback organizing effective team work, maintain an effective communication system, creating a favorable partnership, education and trust environment in the organization, allowing to avoid resistance to changes in some cases.

Leaders in air companies should possess specific competencies using in change management, exploring the factors that determine the need to implement change measures, analyze stimulating and braking factors affecting the change introduction and develop measures to overcome existing barriers, monitor the implementation of development strategies and assess their effectiveness.

Strategic leadership provides a focused impact on the company activities and stimulates it to adjust actively, improve effectiveness and occupying the leading positions in the air transport market. In turn, the strategic leadership of the enterprise depends on the ability of the latter to support and implement changes, continuous learning and customer satisfaction.Effective strategic leadership combined with effective adjustment model and optimal business strategy ensured the success of powerful air transport companies, including air carriers-leaders.Managers of air companies should consider external changes not only as threats to the preservation of a strong competitive status, but as additional development opportunities. Under the right leadership, the company will generate additional strengths and increase their leadership potential. Implementation of strategies for leadership will create new top-level strategic objectives in the future in the light of new opportunities as a result of the successful strategic fit to the market conditions.

Increasing the dynamism and complexity of the air transport international competitive environment, information flow intensification, scientific and technical development and internationalization deepening in all economic sectors require a quick response to market changes from air company management. Thus, strategic flexibility addresses as a particularly important aspect of the international activity management of the air carrier, determined by the ability of the company to operate in conditions of environment uncertainty and variability, quickly perceive and apply the latest knowledge and technologies and to act in accordance with current and future market trends.

Formation of sustainable competitive advantages of an airline, strengthening its leading position in the air market, is possible in case of possession of the ability to reorganize flexibly and optimize resource potential application due to external environmental factors. This will ensure proper support for decision making process and the air company can realize its objectives more effectively. To realize the benefits of strategic flexibility the concepts of re-engineering and change management are often used by air carriers.

Strategic flexibility is not sustainable for the air carrier, as changes occur continuously, so it is advisable to carry out continuous monitoring of environmental factors, implementing changes timely in response to new conditions. Otherwise, a company could lose one of its main competitive advantages – strategic flexibility. Competence, knowledge and resource potential are the basis for strategic flexibility of air carriers.

There are four phases of the strategic flexibility achievement – forecast (determining change factors, forecasting situations using scenarios), formulating (definition of strategic alternatives and their assessment), concentration (accumulation of resources to implement the strategy) and implementation (implementation of the chosen strategy) [3]. Each stage is important and affects the outcome.

A significant strategic flexibility of air carrier can ensure growth in sales of air services, improvement in the competitiveness and effectiveness of a company activity on the whole through better targeting of consumers.

The main interrelated dimensions of the company strategic flexibility are as follows:

- resource flexibility (the ability to monitor changes in the market and use existing business opportunities);

- market flexibility (the ability of air companies to assess the costs of all resources and identify alternative use) [5].

Both resource and market flexibility are important in achieving leading positions at the air market by air companies.

The air carrier strategic flexibility, becoming its competitive advantage, is provided by coordinating the above mentioned aspects. It is also necessary to distinguish two levels of strategic flexibility – corporate and individual (decision-maker flexibility).

At a time when the air company grows, develops its leadership potential using a strategy of horizontal, vertical or diagonal integration (or a combination of these strategies), it is especially important to maintain flexibility and mobility, preventing inappropriate management system development. However, it is through the development of partnerships between international airlines by intensifying cooperative integration and interaction the creation of greater resource flexibility is provided. To ensure the benefits of strategic flexibility and realization of business opportunities the air company should focus on the current needs of the market, as well as on potential changes in the international environment.

Thus, the factors that could form the basis of a strong leadership potential of air carrier are as follows:

- complex use of strategic leadership benefits;
- effective strategic planning (adequate vision, objectives and strategies);
- use of new technologies and innovations;
- rational use of the air company resources;
- optimal allocation of financial resources in the implementation of goals;
- developed air routes network;
- high quality of air services;
- flexible and efficient organizational structure of the air company;
- favorable organizational culture;
- high competent managers and human resources;
- high level of information provision;
- developed system of knowledge management;
- effective management of business processes;
- developed partnerships with other actors on the air transport market.

Conclusions. Strategic leadership is a key factor in the implementation of adaptation measures and forming a better environment in which the company will be able to reach certain goals. Strategic leadership provides a focused impact on the air company activity and stimulates it to improve effectiveness, competitiveness and occupy leading positions in the market. Along with this strategic flexibility of an air carrier can promote strong leadership potential formation, as it implies not reactive, but proactive response to the challenges in international environment under current conditions. This arrangement makes it possible to manage the company's international activities by creating sustainable competitive advantage through leadership.

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ФАКТОРЫ РАЗВИТИЯ ЛИДЕРСКОГО ПОТЕНЦИАЛА АВИАКОМПАНИЙ

Л.Л. Литвиненко

В статье исследованы основные черты стратегического лидерства авиакомпаний, научно обоснованы факторы развития лидерского потенциала авиаперевозчиков в условиях неопределенности, проанализирована роль стратегической гибкости в управлении изменениями, направленныи на укрепление лидирующих позиций на рынке.

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PROSPECTS FOR THE ORGANIZATION OF PRODUCTION OF GROUND SUPPORT EQUIPMENT FOR AIRCRAFT IN UKRAINE

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Abstract. *In the article the authors examined trends in the development of the aviation industry in the regions and in developed countries separately, investigated capacities of Ukraine in engineering complex technology, the necessity of creating a modern complex engineering in Ukraine, the analysis of the effectiveness of the research industry and potential customers in the field of ground support equipment for aircraft.*

Key words: *ground support equipment, tender, aircraft, IATA, business environment*

Formulation of problem. Analyzing the dynamic development of the national economy, one can observed a situation that Ukraine need founding or updating in all industries to meet high European standards. This also applies to aviation industry, where Ukraine had a great success in previous.

Research methods. This work was based on analysis of analytical reviews specialized periodicals, scientific publications, Internet resources, etc., collected by the authors during the research of this problem.

The main objective of the article. The purpose of this study is to analyze the need of founding new industry in present economic situation in Ukraine and business environment of European Union.

Exposition of the basic material. After the election of Ukraine clear course to join the European Union, European integration has become even more important. This applies to all sectors of the economy. In this paper we will focus on secondary sector of the economy, including manufacturing and construction of complex machines.

Now, in the context of world globalization is growing importance of air freight and transport. This applies to both cargo and passenger air transportation. Fast, high-quality, reliable services are always in demand among consumers.

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According to the data of International Air Transport Association for 2014 year, consumers see a substantial increase in the cost they receive from air transport for this year. It is expecting that 1% of the global GDP will be sent by air transport in 2014, reaching nearly $ 750 billion. Flights accelerated with increasing 5.9% this year, the best since 2011, moving on 5.5% trend of the past 20 years (Table 1).

Table 1.

Median success rate of organizational change efforts

Worldwide airline industry	**2012**	**2013**	**2014**
Spend on air transport, $billion	679	710	746
% change over year	9,8	4,6	5
% global GDP	0,9	1	1
One-way fare, $/pax. (2014$)	256	239	231
% change over year	-3,9	-6,4	-3,5
Freight rate, $/kg (2014$)	2,44	2,28	2,18
% change over year	-6,5	-6,9	-4
Passenger departures, million	2,977	3,141	3,32
% change over year	4,6	5,5	5,7
RPKs, billion	5523	5839	6183
% change over year	5,3	5,7	5,9
FTKs, billion	187	191	197
% change over year	-1	1,8	3,1
World GDP growth, %	2,5	2,4	2,8
World trade growth, %	1,9	2,7	3,6

Source: IATA, ICAO, EIU report.

Importantly, according to IATA, investment in aerospace stable rise since 2012 giving the right to conclude that the further development of this industry will rise (Fig.1). This confirms the following schedule. If aviation were a country, it would rank 21st in the world in terms of gross domestic product (GDP), generating $606 billion of GDP per year, considerably larger than some members of the G20 (and around the same size as Switzerland). By 2026, it is forecast that aviation will contribute $1 trillion to world GDP.

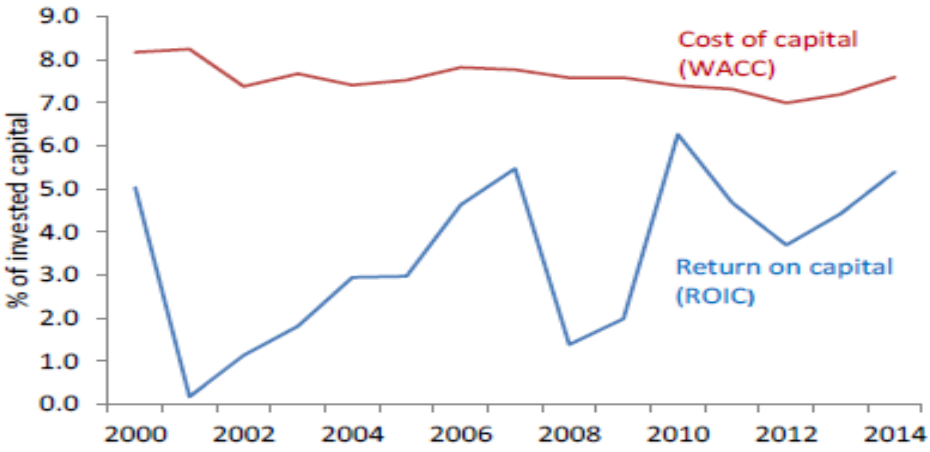

Fig. 1. Return on capital invested in airline industry

Source: IATA, ICAO, EIU report.

As for the regions of the world, Europe is second in the success and popularity of air travel. It effects due to high competition in the market, which makes it favorable and beneficial for the use of consumers in this kind of transport. Increasing the number of air transport making demand forwards making more aircraft. At the same time, increasing their number requires special equipment for aircraft maintenance, namely, passenger stairs, conveyor loaders, ground power source, ground source startup, heating installations, and more.

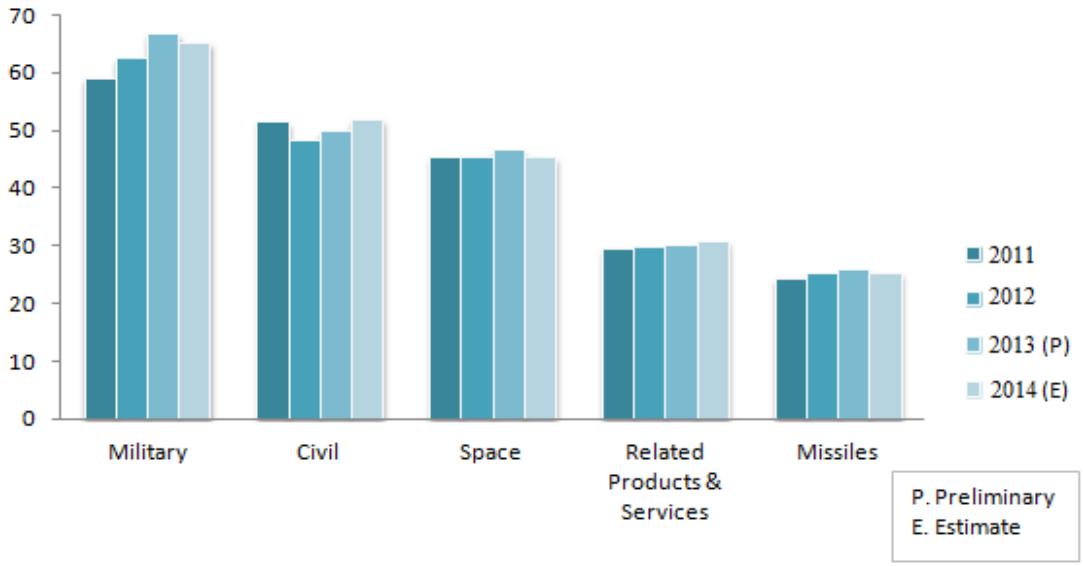

Fig. 3. Aerospace sales by product group, USD, Bn. (2011-2014)

Source: Aerospace Industries Association based on companies reports

As we can see from the previous figure, level of production equipment for servicing aircraft is not sufficient to ensure the demand in it.

The first question to which we must answer: "Does Ukraine need production of this specific equipment?". Yes, it does. This production is not a nationwide scale of course. Euro 2012 gave impetus to the reconstruction and construction of new airport terminals in Ukraine. As result, it boosted a long-term process of renewal air fleet and ground support equipment for aircraft.

At the same time, the post-Soviet space has no producers of this kind of machinery and equipment in general. The availability of high-quality products at such a convenient area will import a large number of products to neighboring countries. So yes, Ukraine needs this type of engineering.

The next and crucial question: "What is necessary for the implementation of production?" As in other industries, there is also investment is required. It is must not be massive scale of production but several plants or factories would be enough. Also requires special designed specifications for this equipment. Redeeming them may cost a large sum. Most companies simply do not want to get rid of their own patents. The way out of this situation would be the creation of engineering and research complex. The key mission facing the complex: development and improvement of existing old sheets and specifications to the present time to produce competitive equipment in future. The geopolitical situation of Ukrainian is affected by economic factors including technology and scientific advancement as the bases of industrialization. In the Ukraine the government is not doing much to improve the existing technologies, techniques and methods and by consistent implementation of principally new scientific knowledge and technologies.

International technological and scientific exchanges, transfer of intellectual potential are subject to central government intervention.

The current situation of electronic commerce is weak with approximately 13% of users in the country. The problem is the low level of Internet penetration that does not allow developing e-commerce to a larger extent. Another problem is that the government is trying to resolve the legal framework for Internet connections where no regulations exist. Furthermore, the penetration process is tightly controlled but not done efficiently.

As we can see from this comparative diagram, engineering for 25 years has undergone a large decline, but still Ukraine have plants and factories (Fig.4).

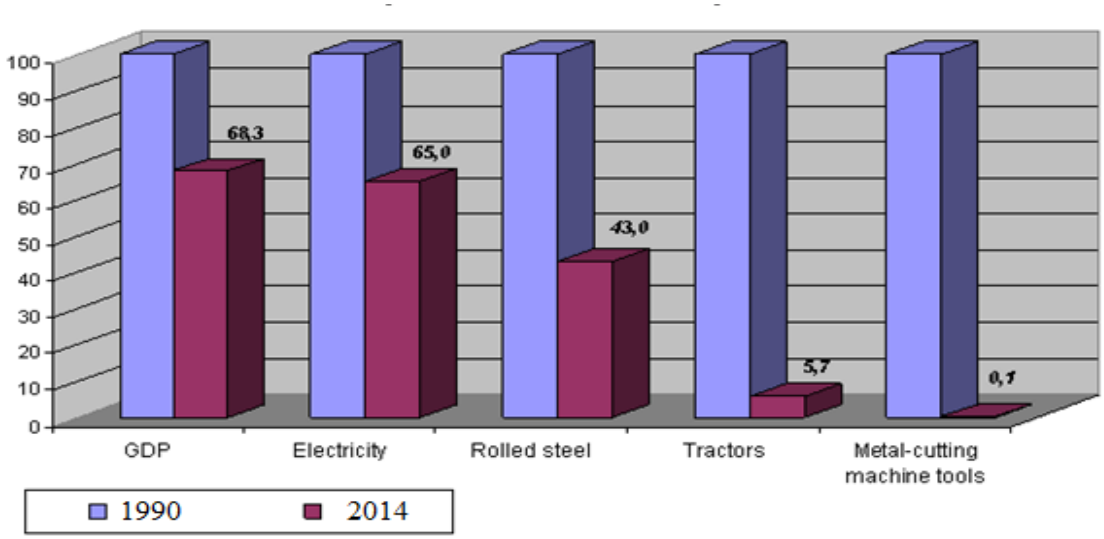

Fig. 4. Ukraine. Decline of GDP and real-economy output (2014 as % of 1990 level)

It is not necessary to build new factories and plants; one option is upgrading or expansion of existing areas. For example, the presence of the specifications for the manufacture of tow tractors for aircraft makes possible to create such equipment on the tractor factory.

Business process model of this kind of manufacturing will be next. Considering the current state of the market price, products manufactured in Europe, has appropriate quality but costs much higher than those in China. This is particularly relevant issue in current exchange rates. On the other hand, previous experience and stereotypes about Chinese product quality does not allow airports to choose Chinese equipment.

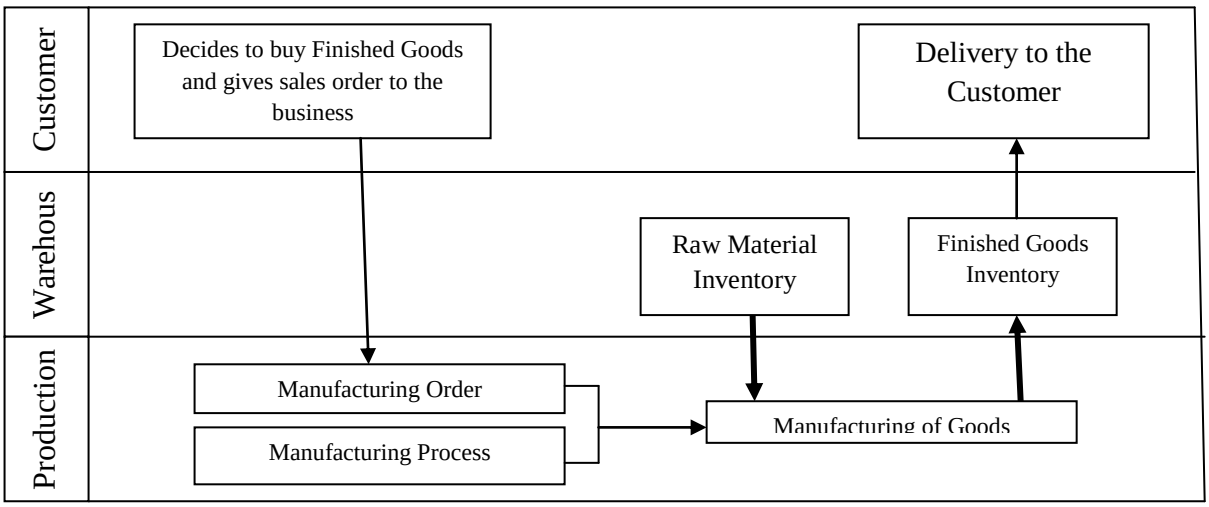

Fig. 5. Manufacturing Process involving assembling of items to create finished equipment

Source: compiled by authors

Other problems are the long time of supply of the products and spare parts, warranty problems and more. As a result, on the market there are two opposites, and does no intermediate option. Ukraine, with the geographical location, in the presence of its own production equipment, cheaper than in Europe and better then China's, could take its own market niche of production ground support equipment.

Conclusions and suggestions. Analyzing the current economic situation of Ukraine, positive trends in aviation industry, condition of ground support equipment market, we can conclude that Ukraine need founding a new industry. Obtaining with such geographical position, present production capacity, experience in aircraft building, Ukraine has good chances in found production of ground support equipment.

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industry and potential customers in the field of ground support equipment for aircraft.

ПЕРСПЕКТИВЫ ОРГАНИЗАЦИИ ПРОИЗВОДСТВА АВИАЦИОННОЙ ТЕХНИКИ НАЗЕМНОГО ОБСЛУЖИВАНИЯ В УКРАИНЕ

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В статье рассмотрены тенденции развития авиационной промышленности, как в регионах, так и в развитых странах отдельно, исследованы производственные мощности Украины в машиностроении сложной техники, обоснована необходимость создания современного комплекса машиностроения в Украине, проведен анализ эффективности работы комплекса и поиск потенциальных клиентов в области техники для обслуживания воздушных судов.

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METHODS OF FORECASTING TRANSPORTATION OF CARGOS

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Abstract. *The article is devoted to forecasts of basic cargo traffic by Ykraine railways. Are scienficaslly justified methods of cargo traffic forecasting*.

Key words: *transport, cargos, railroads, forecast, transportation ratio.*

Problem statement in general form. Duty of any government is solving problem of economical growth considering which we should understand tendency development economic elements. Economic growth is determined and calculated by using 2 connected methods:

- As the increase in real gross domestic product or net national product for a certain period of time

- As the increase in a certain period of time real gross domestic or net national product per capita

Analysis of recent researches and publications.

In the development of the rail transport CPIS and its individual structures and facilities, it should be complied with the requirements of the relevant normative documents approved or agreed by the Ministry of Regional Development, Construction and Housing Services of Ukraine [1], the Ministry of Infrastructure of Ukraine [2]

The aim of the article is the forecast of transportation of main cargos by Ukrainian railways.

The **main material of the research.** The result of economic growth is derived from the operation of the main production factors, their qualitative and quantitative level. Factors and processes, which are able to provide a sufficiently rapid economic development, are analyzed in the various theories of economic growth. The main problems of the theory of growth is the trend and the sources of growth and its sustainability, the impact of the chosen model of technology policy, the rate of renewal of the national economy structure, factors and measure results.

The most important device for the analysis of a number of trends in economic growth is the so-called neo-classical production function. On the one hand, it is a function of the equilibrium

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state production and demonstration of its factors of production (capital, labor and land), and on the other hand, the relationship between the national product and the wealth of society interrelated factors used in economics to retrieve it.

As noted by A. Tchaikovsky, the goal of building production functions and ratings is to quantify, measure the nature and extent the influence of factors of production to the final result of activity. The most important areas of use of industrial potential are an analysis of the efficiency of production resources. Taking into account the production capacity, it is the ability to investigate the efficiency of production facilities, transport systems, environmental and other factors not in isolation but in their interactions, to identify the boundaries of the interchangeability of the most rational factors and their proportions in terms of the final result of production. Considering the operation of the production potential for the study of economic development of a rail transport as a whole and the individual lines, the same as inactive enterprises, the author has developed a model of economic growth for the gross domestic product as a whole and for the individual branches of the current economic system of Ukraine, especially rail infrastructure.

Quality of available statistical information significantly affects not only the process of parameterization, but also the quality of the model and results of simulation of the entire process as a whole. Realizing the forecasting process, using information on the dynamics of economic performance presented in the form of time series of indicators. Time series of the economic variable is the sequence of its values measured at regular intervals during the period. Rail transport is the leader of the Ukrainian market. In terms of turnover, the segment of railway transport was in 2014 - 59% .

Considering the structure of basic goods, according to the author, in order to predict the volume of rail transport in the future, it would be advisable to carry out the forecast activities of the industry, given the turbulent state of the national economy of Ukraine. The author carried out the forecast for all types of transported goods, but in this article is an example of calculation method on the basis of cargo transportation has the highest rate - coal (26.8%). The author's investigation is the most important characteristics of the national economy of Ukraine annual statistical reports for 2003 - 2014 years. For the volume of consignments of goods by rail is characterized by a close link with the volume of industrial output, agricultural output in the

country. Information on the volume of major products of national industry and agriculture is formed on the basis of the data of The Government of Ukraine.

Between the volume of freight shipments and production volumes of major products industry and agribusiness are closely linked, as also evidenced by the correlation coefficient of performance equal to 0.8415.Thus, the projected volume of shipments of cargo, according to the author, can be defined as the product of the forecast total production of major products industry and agribusiness and predictive factors of transportation.

To identify trends in a number of dynamic factors transported using autocorrelation functions of the original series and the dynamics of a number of growth dynamics.

Autocorrelation is statistical relationship between the sequences of a number of values taken from the offset, for example, for the random process - with a time shift [2, 3].

To predict the auto regression model should be used to shift the growth rate for 5 years. Using standard regression analysis procedures set parameters of so called model (formula 1)

$$x_t = 0{,}5902 + 0{,}3981 \cdot x_{t-5}, \quad (1)$$

X- the growth of dynamic ratio of transportation in a certain year.

Table1

Prediction of ratio of transportation

Year	Ratio of transportation	Growth of ratio of transportation	Growth of ratio of transportation With the shift of 5 years
2014	0,765	–	–
2015	0,772	1,0090	1,0520
2016	0,751	0,9734	0,9626
2017	0,746	0,9928	1,0113
2018	0,732	0,9819	0,9839
2019	0,713	0,9738	0,9635
2020	0,707	0,9919	1,0090

The volume of coal production in 2014, substantially less than the level of production in previous years. Because coal production forecast for 2015 is based on analysis of data from

2014. For subsequent periods using the forecast differences of the first order, without regard to the data compiled in 2014.

For trend forecasting equation is used, constructed according to the August - December 2014, which has the form:

$$x_t = 1626 + 70 \cdot t, \quad (2)$$

x – the volume of production of coal for 1 year, thousands tons

t – the number of the month starting January 2014

In order to identify trends in the dynamic series production volume of coal used by the autocorrelation function of the dynamics number difference of the first order. To predict it is advised to use AR model shift increments of 6 years. Using standard regression analysis procedures the parameters of this model is set (formula 3).

$$x_t = 49{,}2 + 0{,}8723 \cdot x_{t-6}, \quad (3)$$

x -volume of growth of coal production during 1 year, thousands tons

Using the model (3), defined forecast increased in production in the 2016-2020, which is respectively 49 tons, 6770 tons , 2668 tons , 1 260 tons, 549 tons.

Thus, the projected production volumes of coal are:

- 2015 - 35052 t,
- 2016 : 35 052 + 49 = 35 101 t.,
- 2017 : 35 101 + 6 770 = 41871 t,
- 2018 : 41 871 + 2668 = 44539 t,
- 2019 : 44539-1260 = 43279 t,
- 2020 : 43279 + 549 = 43828 t.

Using this way, through the implementation of techniques presented, the author received forecast data not only for the extraction of coal, but the main goods transported by rail in Ukraine. They are used to calculate indicators - departure of goods up to 2020.

The author's aggregate dynamics and forecast of shipments of goods are shown in Fig. 1. Such an understanding of the functioning and development of railway transport in particular, and the scope of low-density traffic in general, allows to take into account the economic interests of polarized, contradictory positions identified with the unity of the requirements of contemporary social transformations.

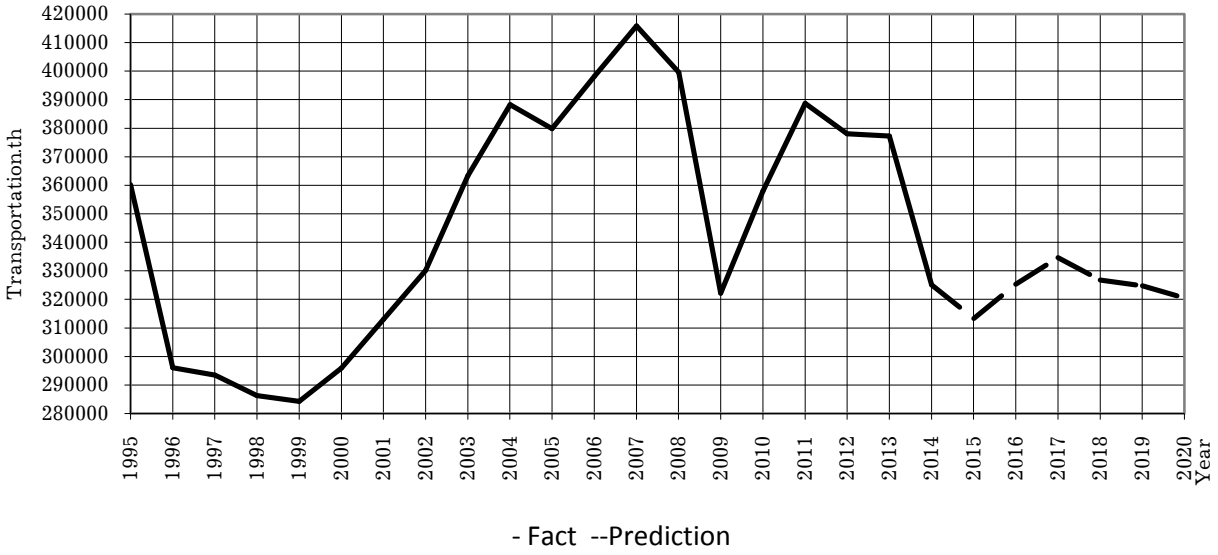

Fig. 1. Dynamics and forecast of transported cargo

Conclusions of the research. In addition, in the above definition of cargo-oriented paradigm of formation of economic relations in the sphere of freight traffic, which is closely associated with the dominant conditions of economic equilibrium freight traffic activity, and, therefore, eliminates the possibility of inefficient functioning, economic imbalance and destructive form of positive value and contribute to the restoration of the reproductive processes of railway transportation.

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МЕТОДЫ ПРОГНОЗИРОВАНИЯ ТРАНСПОРТИРОВКИ ГРУЗОВ

О. Кириленко

Статья содержит информацию о прогнозировании объемов перевозок основных видов грузов железными дорогами Украины. Научно обоснованы методы прогнозирования транспортировки грузов.

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THE POSSIBILITY OF TORNADO ANALYSIS

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Abstract: *In this paper, due analytical evaluation of the processes taking place in the tornado, is shown the dependence of maximum velocities on pressure fluctuations and is proved that within the range of pressure possible, moderate deviations is possible the existence of Fudzita scale low category tornadoes. As for the extreme large-capacity tornadoes, their existence is expected only in the case of extreme large variability in atmospheric parameters, which is less forecasting, therefore, it is shown that tornadoes are belonging to nature's mysterious phenomena whose calculation and prediction by classic, universally recognized methods is practically impossible.*

Keywords: *Tornado; analytical evaluation; pressure fluctuation; atmospheric phenomenon*.

1. INTRODUCTION

Many scientists and researchers, who are observing this phenomenon, consider that in tornadoes may occur such energy that practically could not be explained based on the fundamental laws of thermodynamics and hydro-aerodynamics. For this reason, the mentioned phenomenon is often referred as the mysterious phenomenon of nature. In this paper, we are interested to actually study this issue.

2. BASIC PART

As is known, the solution of Reynolds simultaneous differential equations by numerical methods is associated with certain assumptions. At the same time, it does not provide a way to obtain qualitatively clear dependence between the parameters of physical processes. Therefore, we try to obtain the exact analytical solutions through schematization of processes (Fig. 1) that means that the tornado flow, with sufficient precision, would be considered as one dimensional, which greatly simplifies the problem of calculating the vertical velocity. At the same time, at pressure calculation in the vertical flow would be taken into account the fact that peripheral

* **PhD Student**

upward flow also produces rotational movement. During the rotary movement to the center direction pressure drop also would be calculated with great precision for such movements (Qweet type movements) by well-known characteristic equations.

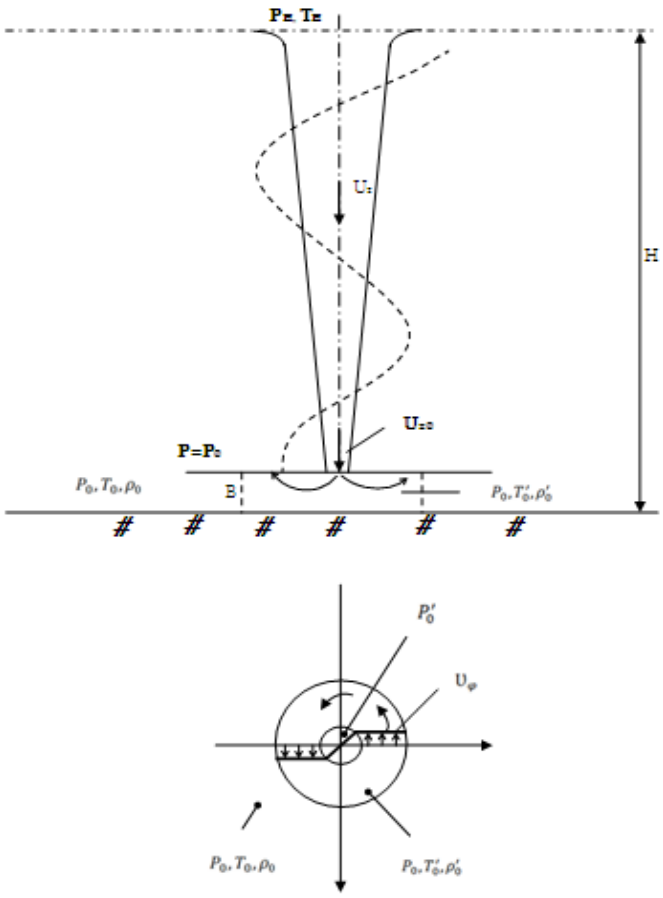

Fig. 1. Vertical flow chart

In such a situation, the equation of motion and the law of conservation of energy gives the possibility to determine at land surface the vertical velocity of downward flow, as well as the rotational velocity on periphery. In the published by us paper [5] it is shown that the vertical and horizontal rotational velocities of flow may be specified by the following expressions:

$$(2+m)W_{\varphi}^2 = F(H) + (2(1-m)(p_0 / p_H)\Delta p_T - 6(\overline{p} - p_0))/\rho_0 \ , \quad (1)$$

$$W_{z0}^2 = 3W_{\varphi}^2 + 6(\overline{P} - P_0)/\rho \, , \quad (2)$$

$$F(H) = 2gH - 2(1-m)c_P T_H \left[\left(\frac{p_0}{p_H} \right)^{\frac{k-1}{k}} - 1 \right] . \quad (3)$$

where $\overline{P}$ - is the average pressure of after flow the collision and turn at surface that with sufficient approximation would be considered as equal to the atmospheric pressure ($\overline{P} \approx P_0$). Δp_T − is in the pressure originated in upper layers due existence of turbulence (normal component of turbulence tensor, which is determined based on the turbulent energy). m- is the water mass share in cloud.

As it is clear from the presented formulae, the vertical flow velocity, in addition to a height (H) of tornado, is depending on the air parameters (P_H , T_H) in upper layers of the, cloudiness and air pressure (P_0) at land surface. The table below presents the values of this function at various heights of tornadoes when pressures and temperatures are characterized by their average nominal values. These values are taken from the standard height tables of the atmosphere.

$g = 9{,}8 \ \ m \ / \sec^2 \qquad c_P \approx 1000 j / kg * K$

$P_0 = 100000 Pa,$

Table 1

H , m	P_H , Pa	T_{Hs} , K	$T_H = T_{HS} + \Delta T$ k	M	W_φ , m/sec	W_z , m/sec
500	95460	285	305	0,066	38	65,9
1000	89880	281	301	0,067	37,5	65
1500	84560	278	298	0,067	36,3	62,8
2000	79500	275	295	0,068	34,6	60
2500	74690	271	291	0,069	33,62	58,2
3000	70120	268	288	0,069	30,58	53,0
3500	65780	265	285	0,07	26,97	46,7
4000	61660	262	282	0,071	21,9	38,0
4500	57750	258	278	0,072	18,6	32,1
5000	54050	255	275	0,072	-	-

The calculation was conducted in the clouds conditions in comparison with cloudless atmosphere at a relatively high temperature ($\Delta T = 20K$), which is characterized by the existence of weighted water in the clouds up to 7 percent.

First of all, it should be noted that when on sky, as well as on the land surface we have a standard atmospheric pressure (103 000 Pa), tornadoes are not expected.

We were interested and carried out calculations in such a case, when the atmospheric pressure is less up to 3% (100 000 Pa). The results are reflected in the Table 1. As it is clear, if there are not the pressure deviations in the atmosphere, the most powerful tornado is expected to be up to 500 meters or more low in height. In addition, the vertical velocity of tornado at the land does not exceed 66 m/s and the circular velocity is equal up to 38 m/s. Thus, these velocities are significantly lower than the registered maximum velocities in tornadoes. For this reason, we were interested what affects makes pressure variation on sky on velocity of tornado. To this end, we reduce the pressure at the land surface and at same percentage increase it on the upper layers. It was revealed that, independently of the height of tornado, as result of the same percentage variation of pressure leads to the similar velocity of a tornado at the land. In particular, we have determined what should be the variation in pressure, in order to obtain accordingly to the Fudzita scale certain power tornado. For example, if at the earth's surface the pressure is decreased up to 2.4 percent and on the height of 500 meters will be increased up to 2.4 percent, we obtain the first category tornado. It is interesting that we obtain the similar velocity tornado if we increase up to 2.4 percent the pressure on arbitrary height. Similarly will be obtained by Fudzita scale tornadoes in other power. The results are given in Table II.

As we can see, the Fudzita scale high category of tornados is expected only at extremely high variation in pressure. For the existence of highest, fifth-sixth category tornado is necessary in both direction the pressure variation up to 10 percent or 20 percent increase in the pressure only in the upper layers, which is highly unlikely (talking on the pressure, we should consider the total pressure, or originated due thermodynamic pressure and turbulence the sum of the pressure).

Table 2

Category	Speed (m/sec)	Pressure increasing in upper layers (%)	Pressure decreasing at earth surface (%)	Pressure increasing only in upper layers (%)
F0	55-85	1,4%-2,4%	-1,4%-2,4%	2,8%-4,8%
F1	86-110	2,4%-3,4%	-2,4%-3,4%	4,8%-6,8%
F2	111-135	3,4%-4,8%	-3,4%-4,8%	6,8%-9,6%
F3	136-165	4,8%-6,8%	-4,8%-6,8%	9,6%-13,6%
F4	166-200	6,8%-10%	-6,8%-10%	13,6%-20%
F5	<200	<10%	<-10%	<20%

3. CONCLUSIONS

From the above mentioned, we can do following alternative to each other conclusions:

1.) Accordingly of the Fudzita scale high-power tornadoes are not characterized by so much velocity and referred in literature such high wind speeds are not appropriate to reality (measurement error).

2.) At high-power tornadoes in atmosphere pressure would be predicted variations up to 15-20 percent.

3.) The physical essence of tornadoes is not reflected based on the generally accepted classical theories and very registration of extremely high speeds is originated not due to variation in pressure, but other, more complex physical phenomena of nature, which could not be explained by traditional methods.

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О ВОЗМОЖНОСТИ РАСЧЁТА ТОРНАДО

Г.А. Апциаури

В работе путём аналитической оценки, происходящих в торнадо процессов показана зависимость максимальных скоростей от изменения давления и обосновано, что в рамках возможных изменений давления допустимо существование торнадо низких категорий по шкале Фудзита. Что касается торнадо очень больших мощностей, их существование ожидается только в случае больших изменений атмосферных параметров что менее вероятно, Соответственно, показано, что торнадо принадлежит к необъяснимым явлениям природы, расчёт и прогнозирование которых классическими, всемирно признанными методами практически невозможны.

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DISPERSION OF ELECTRONS ON IONIZED ADMIZTURES IN SEMICONDUCTORS IN QUASI-TWO-DIMENSIONAL SEMICONDUCTOR SYSTEMS

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Abstract: *In this paper there are calculated dependences between relaxation period of electrons and energy and between mobility and temperature in quasi-two-dimensional, non-degenerated semiconductor nanostructures using common model of admixture center. There is shown, that electrons' relaxation period and their mobility depends on depth of nanostructure, and depends greater on the radius of short-range potential influence (first coordination sphere radius). Also there is shown, that electron's relaxation period* $\tau(\varepsilon)\sim\varepsilon$ *and mobility* $\mu(KT)\sim(KT)$ *and there is calculated thermal electromotive force for this system.*

Keywords: *Semiconductors, nanostructures, ompurity centers, effective masses*

The problem of dispersion of electrons on ionized admixtures in semiconductor in semiconductor crystals in 3D system was solved by Conwell-Weisskopf [1]. They considered the potential of impurity center using Coulomb approximation and they got the same result for dependence between electrons' relaxation and energy. It turns out, that in case of comparatively high temperature and concentration, when still dominates dispersion on ionized admixtures, result of their method is quite different (1-1.5 degrees), then experimental results [2, 3]. Besides, this theory doesn't show the individuality of admixture, though it is well-reflected in experiments [4].

Group of authors (A. Gerasimov, Z. Gogua and A. Tsertsvadze) offered the common model of impurity center [5]. According to it, impurity center in the first coordination sphere

is considered as free atom in vacuum, and outside of it – as usual, in continuum approximation. According to this potential of impurity center will be:

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$$\phi(r)=\frac{z^*e}{r}\theta(r-r_0)+\frac{ze}{\varepsilon_0 r}\theta(r-r_0) \quad (1)$$

z* is impurity atom's effective charge, z – impurity atom's charge in continuum approximation, r_0 is radius of the coordination sphere, ε_0 is the dielectric constant, $\theta(x)$ is step function of Heavyside. Effective charge of impurity atom can be defined using Slater's free atom model [7]: $z^*=n^*\sqrt{\frac{I}{E_H}}$, where I is the first ionization energy of impurity atom, E_H is the absolute value of basic state energy of free hydrogen atom? n* is the main quantum number, which is defined using Slater's rule [7]. z* shows us individuality of atom. Owing to this model, the problem of expressing deep and shallow impurity levels with one, common model is solved [5]. Problem of emitting and non-emitting dispersion of charge careers on impurity centers [8, 9] and problem of dispersion of electrons on impurity centers for (1) potential, when z=1, can be worked solving Poisson's equation. So, we'll get the shielded potential of impurity center [6]:

$$\varphi(r)=\frac{z^*e}{r}\theta(r-r_0)+\frac{e}{\varepsilon_0 r}e^{-qr}\theta(r-r_0) \quad (2)$$

where q is the inverted value of Debye's radius. Using this potential, in case of non-degenerated electron gas, it's possible to calculate relaxation period and mobility of electron. When

$$4\left(\frac{z^*\varepsilon_0}{z}\right)\left(\frac{r_0}{a_0}\right)^2\left(\frac{m^*}{m}\right)\left(\frac{\varepsilon}{E_H}\right)>>1 \quad (3)$$

m* is the electron's effective mass, and m is free electron's mass. In Borne approximation we'll get:

$$\tau(\varepsilon)=\frac{\sqrt{2}}{4\pi}\frac{\varepsilon_0 mE_H}{z^*e^4\sqrt{m^*n_1}}\left(\frac{a_0}{r_0}\right)^2\varepsilon^{1/2}\sim\varepsilon^{1/2}; \quad (4)$$

$$\mu=\frac{\sqrt{2\varepsilon_0 h^2}}{3\sqrt{(\pi m^*)^3 z^* n_1 e^2 r_0^2}}(k_0T)^{1/2}\sim(k_0T)^{1/2}, \quad (5)$$

where a_0 is Bohr in Hydrogen atom, n_1 is concentration of ions in given material and k_0 is Boltzman constant. So, the rule of ,,three second'' turns in rule of ,,one second''. As (4) and (5) formulas show, realizing (3) condition, in calculation of relaxation period and mobility of atom, main role plays the potential of impurity center (1st part of (2) potential). Physically, it means,

that (3) condition is realized in high temperature range and if concentration of admixture is rather high, then dispersion on ionized impurity will be more dominating, then other mechanisms. In these conditions de Broglie's wave length of electron decreases and part of the area, where potential of impurity center is defined $\left(\frac{r_0}{\lambda}\right)$, increases. So, this becomes more „sensitive''. Results of calculations using (4) and (5) formulas are rather closer to experimental data, than Conwell-Weisskopf's and Brooks-Herring's theories [6]. In nanostructures, (quasi-two-dimensional semiconductor structures) it's logical to operate using our model of impurity center, then in 3D systems, because in flat nanostructures, there is defined area, which is consistent to area, where impurity potential is quite greater, then in continuum approximation. In papers [10, 11, 12] is shown that it isn't effective to use continuum approximation when we are solving dispersion problems and authors consider the potential of impurity center as short-range potential.

Besides, we must say modestly, that author of [13] paper, points to operate using this model in solving of problem of ionization energy of donor impurity, which is located in quantum wires.

If we have quasi-two-dimensional system (flat nanostructure) with W depth, then (2) potential in polar coordinates will be:

$$\varphi(p,z)=\frac{z^*e}{\sqrt{p^2+z^2}}\theta(r_0-p)\theta(r_0-z)+\frac{e}{\varepsilon_0\sqrt{p^2+z^2}}e^{-q\sqrt{p^2+z^2}}\theta(p-r_0)\theta(z-r_0) \qquad (6)$$

In given quasi-two-dimensional system, Bloch's function of quasi-free electron looks like this [10, 12]:

$$\psi(r,z)=\sqrt{\frac{2}{SW}}\sin\left(\frac{\pi z}{W}\right)e^{-i\bar{K}_H\bar{P}}U_{\bar{k}H}(\vec{p},z), \qquad (7)$$

where S is area of structure, $\vec{k}_H$ is component of impulse on Slater's plane and $U_{\bar{k}_H}(\vec{p},z)$ is Bloch's modulating factor. Our calculating of $\tau(\varepsilon)$is based not on usual method, on but results in paper [10], where is said that is we consider potential of impurity center as short-range potential, then correspondence of relaxation periods in case of 2D and 3D systems doesn't depend on type of potential. It equals to:

$$\frac{\tau_{2D}(\varepsilon)}{\tau_{3D}(\varepsilon)} = \frac{2kw}{3\pi}, \tag{8}$$

where k is wave vector of electron in 3D systems: $k = \sqrt{\frac{2m^*}{h^2}\varepsilon}$

Based on this and the formula, which we got earlier for $\tau_{3D}(\varepsilon)(4)$, we'll get:

$$\tau_{2D}(\varepsilon) = \frac{1}{6\pi^2}\frac{\varepsilon_0 m^2 w}{z^* h^3 n_i}\left(\frac{a_0}{r_0}\right)^2 \varepsilon \sim \varepsilon \tag{9}$$

So, electron's relaxation period depends on W depth of structure, also it depends o the radius of area of influence of inner potential (1st part of (2) potential).

In case of quasi-two-dimensional systems, electrons' mobility with non-degenerated electron system, based on [10] and [14] papers we can write:

$$\mu_{2D}(kT) = \frac{2e}{3m^*(k_0T)^2}\int_0^\infty \tau_{2D}(\varepsilon)\varepsilon e^{\frac{\varepsilon}{k_0T}} d\varepsilon, \tag{10}$$

where k_0 is Boltzman constant. If we add (9) formula to this expression, we'll get:

$$\mu_{2D}(kT) = \frac{5e\varepsilon_0 m^2}{9\pi^2 m^* z^* h^3 n_1} w\left(\frac{a_0}{r_0}\right)(k_0T) \sim (k_0T) \tag{11}$$

In [15] paper there is calculated mobility of 2D electron gas, during sipersion on correlated distributed admixtures. According to these results, electrons' mobility in quas-two-dimensional GaAs depends in direct proportion to temperature.

And for quasi-two-dimensional systems thermal electromotive force will be [1]:

$$a_{2D}(T) = \frac{\pi^2}{3}\left(\frac{k_0}{e}\right)\left(\frac{k_0T}{E_f}\right)\left(1 + E_f\frac{\delta In\,\tau_{2D}(\varepsilon)}{\delta\varepsilon}\right)_{\varepsilon=E_f} \tag{12}$$

E_f is Fermi energy. So, based on (9) formula $\left(1 + E_f\frac{\delta In\,\tau_{2D}(\varepsilon)}{\delta\varepsilon}\right)_{\varepsilon=E_f} = 2$, so

$$a_{2D}(T) = \frac{\pi^2}{3}\left(\frac{k_0}{e}\right)\left(\frac{k_0T}{E_f}\right) \tag{13}$$

Our calculations' main criteria are Heisenberg's condition of using kinetic equation $\tau(\varepsilon) >> \frac{h}{\varepsilon}$. This condition, based on (9) formula lay down this condition:

$$w >> \frac{6\rho^2 z^* h^4 n_1}{\varepsilon_0 m^2}\left(\frac{r_0}{a_0}\right)^2 \frac{1}{(k_0 T)^2} \qquad (14)$$

e.g. if we consider non-degenerated, heavily, heavily doped with shallow impurities Ge and Si crystal , when $n_1 \sim 3\cdot 10^{18} cm^{-3}$, on room temperature there still dominates dispersion on ionized admixtures [2]. That means, that $w >> 2 \div 3nm$.

Results, got in this papers, $\tau(\varepsilon) \sim \varepsilon$ and $\mu(k_0 T) \sim (k_0 T)$ are different from results in other papers [10, 11], also there is defined the individuality of impurity with effective main quantum number n* and with ionization energy of electron (first ionization energy).

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РАССЕЯНИЕ ЭЛЕКТРОНОВ НА ИОНАХ ПРИМЕСИ В КВАЗИ-ДВУХМЕРНЫХ ПОЛУПРОВОДНИКОВ

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В работе исследовано рассеяние электронов на ионах примеси в двухмерных системах. Задача решается в единой модели примесного центра. В результате исследования получено, что время релаксации системы пропорционально энергии электронов и подвижность электронов пропорционально температуры.

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Mathematical Elasticity
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TWO DIMENTIAL EQUILIBRIUM EQUAITION FOR A SHARPENED SHELL

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***Abstract**: Paper covers equilibrium equation for sharpened shell. Correct problems for this equation are studied. The theory of shells has many applications in elasticity including in aircraft. As a rule equilibrium equations of shells are represented by three dimensional equations. To simplify these equations many theories exist, among them is I. Vekua's "Hierarchic shell theory" (see [1]), where the displacement function is decomposed by series. After that one obtains the infinite number of two dimensional equations. We will consider so-called zero approximation, from which we obtain one, two dimensional, second order differential equation. Our goal is to investigate this equation.*

***Keywords:** sharpened shell, differential equation, boundary problem.*

To determine the shell we will consider the function $\varphi(t)$ with following properties: $\varphi(t)\colon [-a,a]\to R; \varphi\in C^2[-a,a];\ \varphi(t)=\varphi(-t);\ \varphi(a)=a;\ \varphi(t)>t, 0\le t<a; \varphi(0)=k>0;\ \varphi(t_1)\le\varphi(t_2), 0\le t_1\le t_2\le a.$

We introduce the following curves:

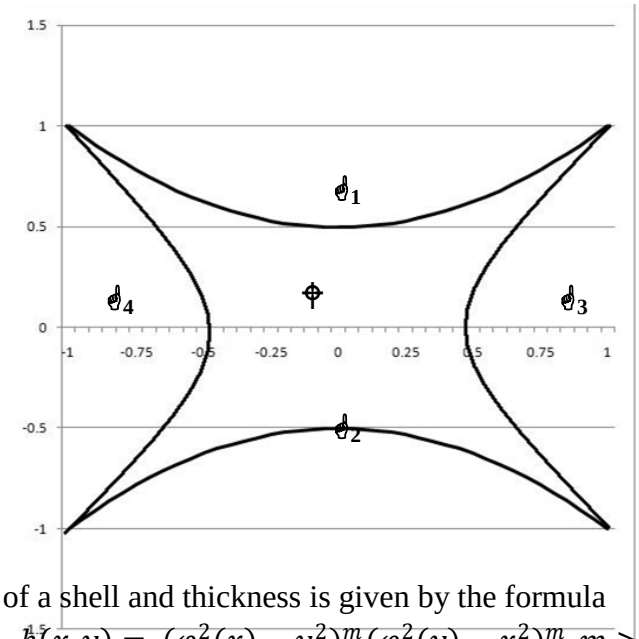
$$\Gamma_1=\{(x,y), y=\varphi(x), -a\le x\le a\};$$
$$\Gamma_2=\{(x,y), y=-\varphi(x), -a\le x\le a\};$$
$$\Gamma_3=\{(x,y), x=\varphi(y), -a\le y\le a\};$$
$$\Gamma_4=\{(x,y), x=-\varphi(y), -a\le y\le a\}.$$

Let Ω be a bounded domain with boundary

$$\partial\Omega=\Gamma_1\cup\Gamma_2\cup\Gamma_3\cup\Gamma_4.$$

* Professor

See graph.



Ω is a middle surface of a shell and thickness is given by the formula

$$h(x,y) = (\varphi^2(x) - y^2)^m(\varphi^2(y) - x^2)^m, m > 0.$$

The equilibrium equation on the domain Ω has a form

$$div(hgradu) + hcu = 0, \quad (1)$$

where u is a displacement, $c(x,y) < 0$ is a given function.

We can rewrite equation (1) in the following form

$$h\Delta u + \frac{\partial h}{\partial x}\frac{\partial u}{\partial x} + \frac{\partial h}{\partial y}\frac{\partial u}{\partial y} + hcu = 0 \quad (2)$$

Now calculate the derivatives of $h(x,y)$;

$$\frac{\partial h}{\partial y} = 2m\varphi(y)\varphi'(y)(\varphi^2(x) - y^2)^m(\varphi^2(y) - x^2)^{m-1} - 2my(\varphi^2(x) - y^2)^{m-1}(\varphi^2(y) - x^2)^m$$

$$\frac{\partial h}{\partial x} = (\varphi^2(y) - x^2)2m\varphi(x)\varphi'(x)(\varphi^2(x) - y^2)^{m-1}(\varphi^2(y) - x^2)^m - 2mx(\varphi^2(x) - y^2)^{m\,m-1}$$

Insert these expressions in equation (2) and divide both parts of equation (2) by$h(x,y)$ we will obtain

$Lu \equiv$

$\Delta u + (2m\varphi(x)\varphi'(x)(\varphi^2(x) - y^2)^{-1} - 2mx(\varphi^2(y) - x^2)^{-1})\frac{\partial h}{\partial x} + (2m\varphi(y)\varphi'(y)(\varphi^2(y) -$
$x2-1-2my\varphi 2x-y2-1\partial h\partial y \quad +cu=0$ (3)

The equation (3) represents second order elliptic partial differential equation with singular coefficients. One can consider the same equation as degenerate equation with order degenerate on the whole boundary.

The theory of degenerate elliptic differential equations has almost a hundred years of history (see [2]). It turned out that the set of solutions of degenerate elliptic differential equations are a poor ones compared to the set of solutions of uniform elliptic differential equations. Thus, the classical problems, for example the Dirichlet problem, which are correctly set for uniform elliptic equation have no solution for degenerate elliptic equations. It is important to distinguish the classes of problems which are correctly set for the degenerate elliptic equations. In our case correctness of the set problems are defended on the power of degenerate and the geometry of the boundary.

Such problems where Ω is a rectangle were investigated in the articles [3], [4], [5].

Firstly, we will consider the case where $m < 1$ and we will show that the Dirichlet problem is correctly set for the equation (3). As it is well known (see [2], [6], and [7]) for this we must construct bounded solution for the equation (3). The existence of this solution is obtained from the principle of extremum and Shauder estimates (see [2], [8]).

The next step is to prove that the boundary condition is satisfied

$$u|_{\partial\Omega} = \psi(x, y), \tag{4}$$

Where $\psi(x, y) \in C(R^2)$.

It is sufficient to show that in each point of boundary $\partial\Omega$ there exists a function barrier.

Definition. The function $v(x, y)$ is called the barrier in the point $(x_0, y_0) \in \partial\Omega$ if the following conditions are satisfied at some domain of this point:

1) $v(x, y) > 0$ and $v(x_0, y_0) = 0$;

2)$Lv < 0$.

At first we will consider the case when$(x_0, y_0) \in \Gamma_1$, $(x_0, y_0) \neq (a, a)$ and let us show that the function $v(x, y)$ is a barrier in the point (x_0, y_0)

$v(x, y) = (\varphi^2(x) - y^2)^\beta + (x - x_0)^2 + (y - y_0)^2, 0 < \beta < 1$.Condition 1 is satisfied. To check condition 2 condition we will make the following calculation

$$\frac{\partial v}{\partial x} = 2\beta\varphi(x)\varphi'(x)(\varphi^2(x) - y^2)^{\beta-1} + 2(x - x_0),$$

$$\frac{\partial^2 v}{\partial x^2} = 2\beta\varphi'^2(x)(\varphi^2(x) - y^2)^{\beta-1} + 2\beta\varphi(x)\varphi''(x)(\varphi^2(x) - y^2)^{\beta-1} + 4\beta(\beta - 1)\varphi^2(x)\varphi'^2(x)(\varphi^2(x) - y^2)^{\beta-2} + 2,$$

$$\frac{\partial v}{\partial y} = -2\beta y(\varphi^2(x) - y^2)^{\beta-1} + 2(y - y_0),$$

$$\frac{\partial^2 v}{\partial y^2} = -2\beta(\varphi^2(x) - y^2)^{\beta-1} + 4\beta(\beta - 1)y^2(\varphi^2(x) - y^2)^{\beta-2} + 2.$$

Hence

$$Lv = 2\beta\varphi'^2(x)(\varphi^2(x)-y^2)^{\beta-1} + 2\beta\varphi(x)\varphi''(x)(\varphi^2(x)-y^2)^{\beta-1}$$
$$+ \ 4\beta(\beta-1)\varphi^2(x)\varphi'^2(x)(\varphi^2(x)-y^2)^{\beta-2} + 4 - 2\beta(\varphi^2(x)-y^2)^{\beta-1}$$
$$+ \ 4\beta(\beta-1)y^2(\varphi^2(x)-y^2)^{\beta-2} +$$
$$[2m\varphi(x)\varphi'(x)(\varphi^2(x)-y^2)^{-1} - 2mx(\varphi^2(y)-x^2)^{-1}]\big[2\beta\varphi(x)\varphi'(x)(\varphi^2(x)-$$
$y2\beta-1+2x-x0+$
$$[2m\varphi(y)\varphi'(y)(\varphi^2(y)-x^2)^{-1} - 2my(\varphi^2(x)-y^2)^{-1}]\big[-2\beta y(\varphi^2(x)-y^2)^{\beta-1} + 2(y-y_0)\big]$$
$$+ cv =$$
$$4\beta(\beta-1)(\varphi^2(x)\varphi'^2(x)+y^2)(\varphi^2(x)-y^2)^{\beta-2} + 2\beta\varphi'^2(x)(\varphi^2(x)-y^2)^{\beta-1}$$
$$+ 2\beta\varphi(x)\varphi''(x)(\varphi^2(x)-y^2)^{\beta-1} + 4 - 2\beta(\varphi^2(x)-y^2)^{\beta-1}$$
$$+ 4\beta m\varphi^2(x)\varphi'^2(x)(\varphi^2(x)-y^2)^{\beta-2} + 4m(x-x_0)\varphi(x)\varphi'(x)(\varphi^2(x)-y^2)^{-1}$$
$$- 4\beta mx\varphi(x)\varphi'(x)(\varphi^2(x)-y^2)^{\beta-1}(\varphi^2(y)-x^2)^{-1}$$
$$- 4mx(x-x_0)(\varphi^2(y)-x^2)^{-1} + 4m(y-y_0)\varphi(y)\varphi'(y)(\varphi^2(y)-x^2)^{-1}$$
$$- 4my(y-y_0)(\varphi^2(x)-y^2)^{-1}$$
$$- 4\beta my\varphi(y)\varphi'(y)(\varphi^2(y)-x^2)^{-1}(\varphi^2(x)-y^2)^{-1} + 4\beta my^2(\varphi^2(x)-y^2)^{\beta-2}$$
$$+ cv =$$
$$4\beta(\beta-1+m)(\varphi^2(x)\varphi'^2(x)+y^2)(\varphi^2(x)-y^2)^{\beta-2} + 2\beta\varphi'^2(x)(\varphi^2(x)-y^2)^{\beta-1}$$
$$+ 2\beta\varphi(x)\varphi''(x)(\varphi^2(x)-y^2)^{\beta-1} - 2\beta(\varphi^2(x)-y^2)^{\beta-1}$$
$$+ 4m(x-x_0)\varphi(x)\varphi'(x)(\varphi^2(x)-y^2)^{-1}$$
$$- 4\beta mx\varphi(x)\varphi'(x)(\varphi^2(x)-y^2)^{\beta-1}(\varphi^2(y)-x^2)^{-1}$$
$$- 4mx(x-x_0)(\varphi^2(y)-x^2)^{-1} + 4m(y-y_0)\varphi(y)\varphi'(y)(\varphi^2(y)-x^2)^{-1}$$
$$- 4my(y-y_0)(\varphi^2(x)-y^2)^{-1}$$
$$- 4\beta my\varphi(y)\varphi'(y)(\varphi^2(y)-x^2)^{-1}(\varphi^2(x)-y^2)^{-1} + 4 + cv.$$

As $m < 1$, we can choose β so that the sign of Lv will be dependent on the expression

$$\varphi^2(x)\varphi'^2(x) + y^2.$$

Hence, in some neighborhood of the point (x_0, y_0) $Lv < 0$.

Now we will consider the point(a, a). Let us show that the barrier has a form $v(x,y) = (\varphi^2(x)-y^2)^{\beta}(\varphi^2(y)-x^2)^{\beta} + (x-a)^2 + (y-a)^2, 0 < \beta < 1.$

We introduce the following notation

$$v_1(x,y) = (\varphi^2(x)-y^2)^{\beta}(\varphi^2(y)-x^2)^{\beta} \qquad (5)$$

Then

$$v(x,y) = v_1(x,y) + (x-a)^2 + (y-a)^2,$$

The condition 1 of barrier is satisfied. The singularity of Lv depends only on term $v_1(x,y)$ We will calculate only Lv_1.

$$\frac{\partial v_1}{\partial x} = 2\beta\varphi(x)\varphi'(x)(\varphi^2(x)-y^2)^{\beta-1}(\varphi^2(y)-x^2)^{\beta} - 2\beta x(\varphi^2(x)-y^2)^{\beta}(\varphi^2(y)-x^2)^{\beta-1},$$

$$\frac{\partial v_1}{\partial y} = 2\beta\varphi(y)\varphi'(y)(\varphi^2(x)-y^2)^{\beta}(\varphi^2(y)-x^2)^{\beta-1} - 2\beta y(\varphi^2(x)-y^2)^{\beta-1}(\varphi^2(y)-x^2)^{\beta},$$

$\frac{\partial^2 v_1}{\partial x^2} =$
$2\beta\varphi''^2(x)(\varphi^2(x)-y^2)^{\beta-1}(\varphi^2(y)-x^2)^{\beta}+2\beta\varphi(x)\varphi''(x)(\varphi^2(x)-y^2)^{\beta-1}(\varphi^2(y)-x^2)^{\beta}+$
$4\beta(\beta-1)\varphi^2(x)\varphi''^2(x)(\varphi^2(x)-y^2)^{\beta-2}(\varphi^2(y)-x^2)^{\beta}-4\beta^2x\varphi(x)\varphi'(x)(\varphi^2(x)-$
$y2\beta-1\varphi2y-x2\beta-1-2\beta\varphi2x-y2\beta\varphi2y-x2\beta-1-4\beta2x\varphi x\varphi'x\varphi2x-y2\beta-1\varphi2y-x2\beta-1+4\beta\beta$
$-1x2\varphi2x-y2\beta\varphi2y-x2\beta-2,$

$\frac{\partial^2 v_1}{\partial y^2} = 2\beta\varphi''^2(y)(\varphi^2(x)-y^2)^{\beta}(\varphi^2(y)-x^2)^{\beta-1}+2\beta\varphi(y)\varphi''(y)(\varphi^2(x)-y^2)^{\beta}(\varphi^2(y)-$
$x2\beta-1+$
$4\beta(\beta-1)\varphi^2(y)\varphi''^2(y)(\varphi^2(x)-y^2)^{\beta}(\varphi^2(y)-x^2)^{\beta-2}-4\beta^2y\varphi(y)\varphi'(y)(\varphi^2(x)-$
$y2\beta-1\varphi2y-x2\beta-1-2\beta\varphi2x-y2\beta-1\varphi2y-x2\beta-4\beta2y\varphi y\varphi'y\varphi2x-y2\beta-1\varphi2y-x2\beta-1+4\beta\beta$
$-1y2\varphi2x-y2\beta-2\varphi2y-x2\beta.$

Now calculate the product of first derivatives on coefficients.

$(2m\varphi(x)\varphi'(x)(\varphi^2(x)-y^2)^{-1}-2mx(\varphi^2(y)-x^2)^{-1})\big(2\beta\varphi(x)\varphi'(x)(\varphi^2(x)-$
$y2\beta-1\varphi2y-x2\beta-2\beta x\varphi2x-y2\beta\varphi2y-x2\beta-1=4\beta m\varphi2x\varphi'2x\varphi2x-y2\beta-2\varphi2y-x2\beta-$
$8\beta mx\varphi(x)\varphi'(x)(\varphi^2(x)-y^2)^{\beta-1}(\varphi^2(y)-x^2)^{\beta-1}+4\beta mx^2(\varphi^2(x)-y^2)^{\beta}(\varphi^2(y)-x^2)^{\beta-2},$

$(2m\varphi(y)\varphi'(y)(\varphi^2(y)-x^2)^{-1}-2my(\varphi^2(x)-y^2)^{-1})\big(2\beta\varphi(y)\varphi'(y)(\varphi^2(x)-$
$y2\beta\varphi2y-x2\beta-1-2\beta y\varphi2x-y2\beta-1\varphi2y-x2\beta=4\beta m\varphi2y\varphi'2y\varphi2y-x2\beta-2\varphi2x-y2\beta-$
$8\beta mx\varphi(y)\varphi'(y)(\varphi^2(x)-y^2)^{\beta-1}(\varphi^2(y)-x^2)^{\beta-1}+4\beta my^2(\varphi^2(x)-y^2)^{\beta-2}(\varphi^2(y)-x^2)^{\beta}.$

Hence

$$\begin{aligned}Lv_1 = {} & 4\beta(\varphi^2(x)-y^2)^{\beta}(\varphi^2(y)-x^2)^{\beta}[(\beta-1+m)(\varphi^2(x)\varphi''^2(x)+y^2)(\varphi^2(x)-y^2)^{-2}\\ & +(\beta-1+m)(\varphi^2(y)\varphi''^2(y)+x^2)(\varphi^2(y)-x^2)^{-2}\\ & -2(\beta+m)x\varphi(x)\varphi'(x)(\varphi^2(x)-y^2)^{-1}(\varphi^2(y)-x^2)^{-1}\\ & -2(\beta+m)y\varphi(y)\varphi'(y)(\varphi^2(x)-y^2)^{-1}(\varphi^2(y)-x^2)^{-1}]+\\ & 2\beta\varphi''^2(x)(\varphi^2(x)-y^2)^{\beta-1}(\varphi^2(y)-x^2)^{\beta}+2\beta\varphi(x)\varphi''(x)(\varphi^2(x)-\end{aligned}$$
$y2\beta-1\varphi2y-x2\beta+2\beta\varphi'2y\varphi2x-y2\beta\varphi2y-x2\beta-1+2\beta\varphi y\varphi''y\varphi2x-y2\beta\varphi2y-x2\beta-1.$

As $m<1$ and the expression $t\varphi(t)\varphi'(t)\geq 0$ so $Lv_1<0$. Hence $v(x,y)$ is a barrier in the point(a,a). Because the domain Ω is symmetric the barriers in other points of boundary are built in a similar way.

Thus we have the following

Theorem 1. If $0<m<1$,then the problem (1), (4) has an unique regular solution $u\in C(\bar{\Omega})\cap C^2(\Omega)$.

We have shown the existence of the solution, uniqueness follows from the principle of extremum.

Now we will consider the case when $m \geq 1$, for this we need additional condition on function $\varphi(t)$, particularly

$$\varphi(t) \equiv 0, a - \delta \leq t \leq a, \tag{6}$$

For small enough δ.

Let

$$\omega(x,y) = -\omega_1(x,y) - d_1 v_1(x,y) - d_2\omega_2(x.y) + d_3,$$

Where $d_1, d_2, d_3 > 0$,

$$\omega_1(x,y) = \ln(\varphi^2(x) - y^2)\,(\varphi^2(y) - x^2),$$

$$\omega_2(x.y) = e^{\lambda(x^2+y^2)}, \lambda < 0,$$

And the function $v_1(x,y)$ is defined by the formula (5).

Let us calculate $L\omega$.

$\frac{\partial\omega_1}{\partial x} = 2(\varphi(x)\varphi'(x)(\varphi^2(y) - x^2) - x(\varphi^2(x) - y^2)[(\varphi^2(y) - x^2)(\varphi^2(x) - y^2)]^{-1},$

$\frac{\partial\omega_1}{\partial y} = 2(\varphi(y)\varphi'(y)(\varphi^2(x) - y^2) \quad - y(\varphi^2(y) - x^2)[(\varphi^2(y) - x^2)(\varphi^2(x) - y^2)]^{-1},$

$\frac{\partial^2\omega_1}{\partial x^2} = -4(\varphi(x)\varphi'(x)(\varphi^2(y) - x^2) - x(\varphi^2(x) - y^2))^2[(\varphi^2(y) - x^2)(\varphi^2(x) - y^2)]^{-2} +$
$2\left(\varphi'^2(x)\right)(\varphi^2(y) - x^2) + \varphi(x)\varphi''(x)(\varphi^2(y) - x^2) - 4x\varphi(x)\varphi'(x) - (\varphi^2(x) -$
$y2)\varphi 2y - x2\varphi 2x - y2 - 1,$

$$\frac{\partial^2\omega_1}{\partial y^2} = -4(\varphi(y)\varphi'(y)(\varphi^2(x) - y^2) - y(\varphi^2(y) - x))^2[(\varphi^2(x) - y^2)(\varphi^2(y) - x^2)]^{-2}$$
$$+ 2\left(\varphi'^2(y)\right)(\varphi^2(x) - y^2) + \varphi(y)\varphi''(y)(\varphi^2(x) - y^2) - 4y\varphi(y)\varphi'(y)$$
$$- (\varphi^2(y) - x^2))[(\varphi^2(y) - x^2)(\varphi^2(x) - y^2)]^{-1}$$

Further

$[2m\varphi(x)\varphi'(x)(\varphi^2(x) - y^2)^{-1} - 2mx(\varphi^2(y) - x^2)^{-1}]\,\frac{\partial\omega_1}{\partial x} = 4m(\varphi(x)\varphi'(x)(\varphi^2(y) -$
$x2 - x\varphi 2x - y2)2\varphi 2y - x2\varphi 2x - y2 - 2,$

$$(2m\varphi(y)\varphi'(y)(\varphi^2(y) - x^2)^{-1} - 2my(\varphi^2(x) - y^2)^{-1})\frac{\partial\omega_1}{\partial y}$$
$$= 4m(\varphi(y)\varphi'(y)(\varphi^2(x) - y^2)$$
$$- y(\varphi^2(y) - x))^2[(\varphi^2(x) - y^2)(\varphi^2(y) - x^2)]^{-2}.$$

Hence

$$L\omega_1 = 4(M-1)[(\varphi(x)\varphi'(x)(\varphi^2(y) - x^2) - x(\varphi^2(x) - y^2))^2$$
$$+ (\varphi(y)\varphi'(y)(\varphi^2(x) - y^2) - y(\varphi^2(y) - x))^2][(\varphi^2(x) - y^2)(\varphi^2(y) - x^2)]^{-2}]$$
$$+ 2\left[\left(\varphi'^2(x)\right)(\varphi^2(y) - x^2) + \varphi(x)\varphi''(x)(\varphi^2(y) - x^2) - 4x\varphi(x)\varphi'(x)\right.$$
$$- (\varphi^2(x) - y^2))\left(\varphi'^2(y)\right)(\varphi^2(x) - y^2) + \varphi(y)\varphi''(y)(\varphi^2(x) - y^2)$$
$$\left. - 4y\varphi(y)\varphi'(y) - (\varphi^2(y) - x^2)\right][(\varphi^2(y) - x^2)(\varphi^2(x) - y^2)]^{-1} + c\omega_1.$$

Now calculate $L\omega_2$.

$$\frac{\partial \omega_2}{\partial x} = 2\lambda x e^{\lambda(x^2+y^2)}, \frac{\partial \omega_1}{\partial y} = 2\lambda y e^{\lambda(x^2+y^2)},$$
$$\frac{\partial^2 \omega_2}{\partial x^2} = 4\lambda^2 x^2 e^{\lambda(x^2+y^2)} + 2\lambda e^{\lambda(x^2+y^2)},$$
$$\frac{\partial^2 \omega_2}{\partial y^2} = 4\lambda^2 y^2 e^{\lambda(x^2+y^2)} + 2\lambda e^{\lambda(x^2+y^2)}.$$

Thus

$L\omega_2 = 4\lambda^2(x^2+y^2)e^{\lambda(x^2+y^2)} + 4\lambda e^{\lambda(x^2+y^2)} + 4\lambda mx[\varphi(x)\varphi'(x)(\varphi^2(x)-y^2)^{-1} -$
xφ2y−x2−1eλx2+y2+4λmyφyφ′yφ2y−x2−1−yφ2x−y2−1eλx2+y2+cω2=4λ2(x2+y2)
eλx2+y2+4λeλx2+y2+4λmxφxφ′x−y2φ2x−y2−1+yφyφ′y−x2φ2y−x2−1+cω2.

Let us make the following estimates on the domain

$$\Omega_\varepsilon = \{(x,y), 0 \le \mathrm{x} \le \mathrm{a}, \varphi(\mathrm{x}) - \varepsilon < y < \varphi(\mathrm{x}), \varepsilon > 0\},$$
$$y^2 - x\varphi(x)\varphi'(x) \ge (\varphi(\mathrm{x}) - \varepsilon)^2 - x\varphi(x)\varphi'(x) = \varphi^2(x) - 2\varepsilon\varphi(x) + \varepsilon^2 - x\varphi(x)\varphi'(x)$$
$$= \varphi(x)\left(\varphi(x) - x\varphi'(x)\right) - 2\varepsilon\varphi(x) + \varepsilon^2 \ge (\varphi(x) \ge x)$$
$$\ge \varphi^2(x)\left(1 - \varphi'(x)\right) - 2\varepsilon\varphi(x) + \varepsilon^2.$$

As $\varphi'(x) < 1$, so one can choose ε such that $(y^2 - x\varphi(x)\varphi'(x)) > 0$ on Ω_ε.

Thus, one can select the constants, first d_1, then ●, after d_2 and finally d_3 in a such way, that $L\omega < 0$ in Ω.

Thus we have the following theorem.

Theorem 2. Let $m \ge 1$ and condition (6) takes place then the equation (3) has a unique bounded solution $u(x,y) \equiv 0$.

We have already noted that the equation (3) has a bounded solution. One must show its uniqueness. Let $u(x,y) \in C^2(\Omega)$ is solution, then for every $\varepsilon > 0$ there exists sub domain of Ω such that the following estimate takes place

$$|u(x,y)| \le \varepsilon\omega(x,y).$$

Let (x_0, y_0) be a fixed point in Ω, and then from the last estimate we get $u(x_0, y_0) = 0$. Hence, $u(x,y) \equiv 0$ in Ω.

We have allocated the classes of problems which are correctly set for the elliptic differential equation with singular coefficients. We have shown that the correctness of the set problems is dependent both on the singularity and the geometry of boundary of the considered domain.

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УРАВНЕНИЕ ВТОРОГО ПОРЯДКА РАВНОВЕСИЯ ПОЛОГОЙ ОБОЛОЧКИ

Г.Г. Девдариани

В работе рассматривается эллиптическое дифференциальное уравнение второго порядка с сингулярными коэффицентами. Изучены некоторые корректно поставленные задачи для этого уравнения. Корректность зависит от порядка сингулярности и от геометрии границы области. Такого рода задачи возникают в теории тонких пологих оболочек. Библ. 8. Англ.

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Control Systems Theory
Mathematical modeling

CONTROL OF CHAOTIC PROCESSES USING SYNERGETIC METHODS

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Abstract: *Not long ago, scientists thought that complex chaotic movement can only be created only in some multidimensional systems, but it turned out that it is also possible in nonlinear deterministic third rank systems. The processes that are common in nonlinear dynamic systems belong are chaotic. Mathematical models of such processes contain polynomial and quadratic nonlinearity that are widespreadin objects with different nature. Because of these objects, the problem for controlling of chaotic processes that gets more and more attention within scientific literature.*

Keywords: *nonlinear systems, chaos, point of bifurcation, mathematical models, synergetic methods, potential function, control, feedback.*

Let us discuss the following system of differential equations as an example:

$$\dot{x}(t) = \sigma y - \sigma x$$
$$\dot{y}(t) = -y + rx - xz \quad (1)$$
$$\dot{z}(t) = -bz + xy$$

Where β, r, b are constant parameters. Expression (1) represents the well-known Lorenz model, which describes diverse natural processes.The system (1)has a strange attractor on fractal dimension on some set.On this set, the system has increased sensitivity for initial parameters and that is reason for generating chaotic movement processes inside the system.

Let us explore the properties of Lorenz's mathematical model [1]. Firstly, let us look at its stationary state when $\dot{x}_s(t) = \dot{y}_s(t) = \dot{z}_s(t) = 0$, therefore, according to the system (1) we get:

$$x_s = y_s, \quad y_s - rs_s + x_s z_s = 0, \quad x_s y_s - bz_s = 0 \quad (2)$$

Which can be written as

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$$x_s^3 + b(1-r)x_s = 0 \tag{3}$$

It is clear that in (3) these following stationary movements are possible:

a) $x_s = 0, y_s = 0, z_s = 0$ (4)

b) $x_s = y_s = \pm\sqrt{b(r-1)}, z_s = r-1$ (5)

Let us discuss the linear approximation of the Lorenz's model for understanding the sustainability of stationary states of equations (3) and (4). In this case, we can neglect quadratic members, so for the state (4) we get the equation system

$$\begin{aligned} \dot{x}(t) &= \sigma(y-x) \\ \dot{y}(t) &= rs - y \\ \dot{z}(t) &= -bz \end{aligned} \tag{6}$$

From (6)it is possible to derive that the third equation is not in any way connected with the first two, while the component $z(t) = z_0 e^{-bt}$ will fade while $z \to 0$, as in order to determine the components b > 0, x(t) and y(t) we need to solve the following characteristic equation

$$\lambda^2 + (\sigma+1)\lambda + \sigma(1-r) = 0 \quad . \tag{7}$$

The value $r_c = 1$ value represents the limit of linear state and is called a point of bifurcation [1]. Thus, the equation (4) is linearly sustainable when 0≤r≤1and is not when r≥1. In synergetics the parameter r is called the controller parameter.

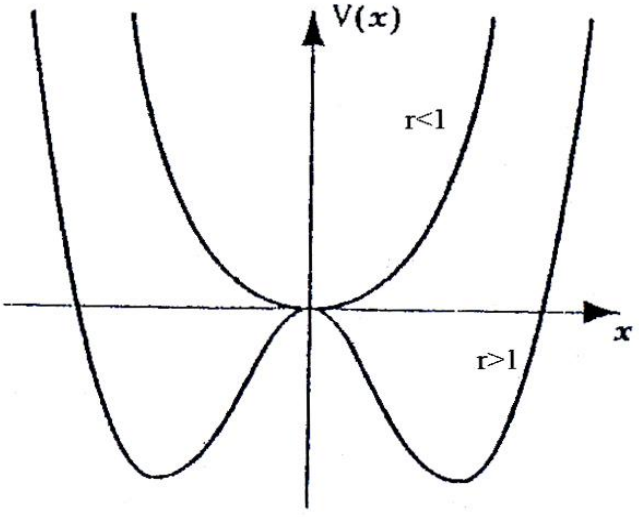

Fig.1. Potencial phasic portrait

In order to clearly observe reasons for generating chaos let us transform the Lorenz's equation (1). Let us introduce the variable $y = x + \frac{1}{\sigma}\dot{x}(t)$ from the first equation and the variable $z = \frac{1}{b}(xy - \dot{z})$ into the second equation. We get [3]:

$$\frac{1}{\sigma}\ddot{x}(t) = F = -\frac{1+\sigma-x^2}{\sigma}\dot{x}(t) + (\dot{r}-1)x - \frac{1}{b}x^3 + \frac{x}{b}\dot{z}(t) \quad (8)$$

Now let us introduce the potential function

$$V = -\frac{r-1}{2}x^2 + \frac{1}{4b}x^4, \qquad (9)$$

Which has different forms in cases when r>1 and r<1 (Fig.2.). The value of the function (14) is constantly increasing on both sides of x_s=0 stationary state.

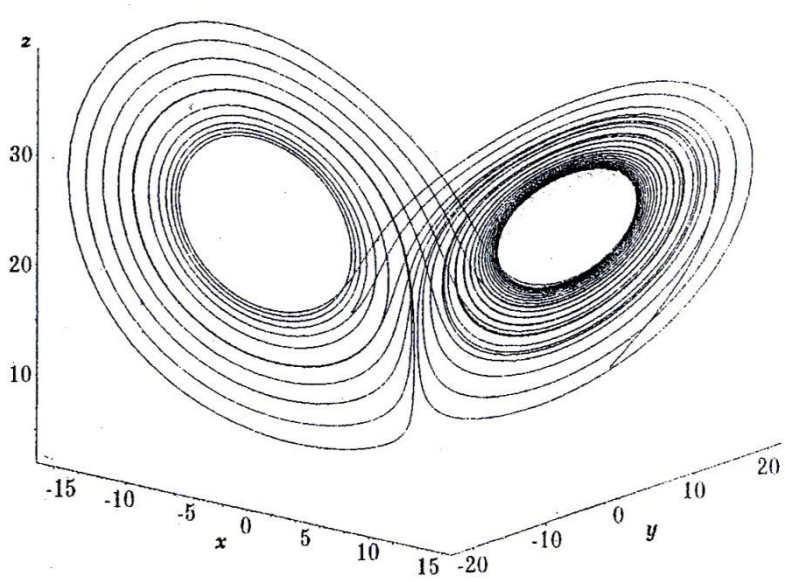

Fig.2. Phasic trajectory of Lorenz's model

By the time when the controller parameter r "moves" over the value of 1, r>1 generates bifurcation and there are also one non-sustainable (x_s=0) and two sustainable states

$$x_s = \pm\sqrt{b(r-1)} \qquad (10)$$

Using the potential function (14), we are now able to rewrite the equation as follows:

$$\frac{1}{\sigma}\ddot{x}(t) = -\frac{1+\sigma-x^2}{\sigma}\dot{x}(t) - \frac{\partial V}{\partial x} + \frac{x}{b}\dot{z}(t), \qquad (11)$$

Which is convenient for analysis. The resulting equation (11), without its last parameter represents the equation of movement of material point with friction force of x(t) inside the V(x) potential hole, which has a friction coefficient that changes its sign from positive to negative, as $x^2 \geq 1+\sigma$.

The last member of the equation (11) has the form of a rigid force, whose coefficient of elasticity $-\frac{1}{b}\dot{z}(t)$ depends on time. In case when the derivative $\dot{z}(t)$ has the value that is not minor, than this member represents some kind of a compulsion force, that depends on variables y and z. If we neglect the connection between z and x, than the last member can have a form of some kind of random force [2]. In other words, the material point, which can be represented with the equation (11), will move inside a two-humped potential hole, also the coefficient can change its sign.

The above presented ideas point to the chaotic nature of behavior of Lorenz's model, as an attractor. Figures 1 and 2 show the movement processes for different values of parameter r, which confirms the complex chaotic nature of Lorenz's model trajectory.

Thus, after impacting high rank n>3 deterministic objects with bifurcation mechanisms generation of complex chaotic processes is a possibility. Mathematical models of such processes contain polynomial and quadratic nonlinearity, which is common with objects of different nature. Because of these objects, the problem for controlling of chaotic processes that gets more and more attention within scientific literature.

Let us now discuss the problem of maintaining a concrete biological population on optimal level, that taking into account the concurrence while trying to get food, can be represented by the equation of the following structure [2]

$$\dot{x}(t) = \alpha x - \beta x^2 - \mu, \qquad (12)$$

Where x is the number of members of concrete species inside a population, α,β are positive numbers, μ is the controlling parameter. Using the equation (12), we are able to describe the model of fishing. In this case, μ represents quota of fishing. Firstly, let $\mu=\mu_0$ be a predefined value. Let us find the maximum quota of fishing. To do this, let us take the derivative of the right side of equation (12) with respect of x, we get the following results:

$$x_{\max} = \frac{\alpha}{2\beta} \text{ and } \mu_0 = \frac{\alpha^2}{4\beta} \qquad (13)$$

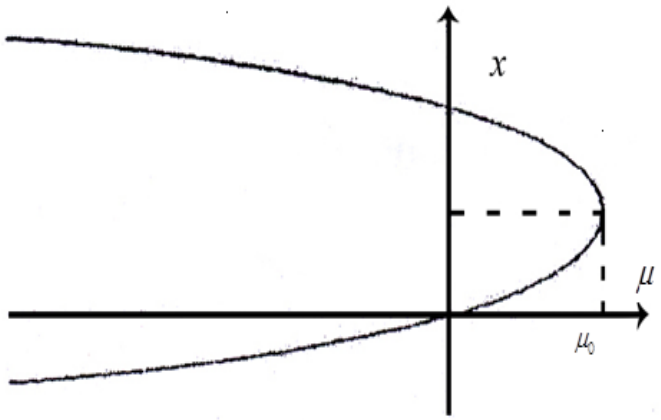

Fig.3. the graph of stationary state

To explore the equation (12) let us first examine its stationary state:

$$\alpha x_s - \beta x_s^2 - \mu = 0. \qquad (14)$$

From the equation (14) let us define a dependency $x_s(\mu)$

$$x_s = \frac{\alpha \pm \sqrt{\alpha^2 - 4\beta\mu}}{2\beta}, \qquad (15)$$

The graph of (14) is shown on Fig.3. with parameters α=β=1.

The graph of the dependency $x_s(\mu)$ has two branches, which merge into each other for values of μandx_s, that are defined by (13). This event is called bifurcational and the point whose coordinates are calculated by the expression (13), is called the bifurcational point of the system. Let us explore the behavior of the system near this point. To do this, let us introduce the deviation $y = x - q_0$ and use it into the potential function, which for our example, has the following form:

$$V = \frac{\mu - 1}{2} x^2 + \frac{1}{4\beta} x^4$$

With simple transformations we can get the following movement equation:

$$\dot{y}(t) = \alpha q_0 - \beta q_0^2 + (\alpha - 2\beta q_0) y - \beta y^2 - \mu \qquad (16)$$

Where q_0 is the coordinate of the point.

The nature of the equation (16) depends on the value of the controlling parameter μ. Let us select optimal values for $\mu=\mu_0$ and $q_0=x_{max}$, so that they guarantee the maximum value of fishing quota. As a result of this, we get an expression

$$\dot{y}(t) = -\beta y^2 \tag{17}$$

Whose root has the following form:

$$y(t) = \frac{y_0}{\beta q_0 t + 1} \tag{18}$$

It can be seen from the expression (16), that the root of the equation is sustainable (y=0) for starting parameters $y_0=x_0-x_{max}>0$ and is not sustainable (y→0) for $y_0<0$. From these follows an important conclusion: the root of the initial equation (21), which describes the state of the population, is sustainable, when $x_{\max} = \frac{\alpha}{2\beta}$ only in cases that satisfy the condition $x_0<x_{max}$. Thus, the optimization (maximization) of the fishing quota value with rigid controlling results in disrupting the sustainablity of the existing state, which can cause the destruction of the population in case of some small fluctuations. This is the result of the event caused by the point of bifurcation, that corresponds with the maximally rigid plan of fishing. This event is being studied in dynamics and systematicality of modern nonlinear systems.

Now let us show how we can use the control theory for avoiding the destruction of the population, which is caused by the maximally rigid fishing plan. To show this, let us use the equation (16) and explore the controlling parameter μ as a function of y. In other words, change the rigid plan $\mu=\mu_0$ with the feedback:

$$\mu(t) = -\alpha q_0 + \beta q_0^2 - \gamma y, \tag{19}$$

Taking the latest expression into account, the expression (1.59) takes the following form:

$$\dot{y}(t) = (\alpha - 2q_0\beta - \gamma)y - \beta y^2$$

If we now introduce the substitution $\eta = \alpha - 2q_0\beta - \gamma$, thus the expression (16) can be rewritten as following:

$$\dot{y}(t) = \eta y - \beta y^2 \tag{20}$$

Whose root is the following

$$y(t) = \frac{\eta y_0}{\eta e^{-\eta t} - \beta y_0 \left(e^{-\eta t} - 1\right)} \tag{21}$$

If we select $\eta<0$, i.e. $\gamma>\alpha-2q_0\beta$, then from the expression (21) we can show, that when $t\to\infty$, the deviation $y\to 0$. This means that the equation (17) is absolutely sustainable to y=0. It follows, that the control $\mu(y)$ ensures sustaining the population on the state q_0. In addition to that, this value can also be optimal $q_0 = x_{\max} = \frac{\alpha}{2\beta}$. Taking $\mu(y)$ into account, the equation (12) can be written like following, with respect of initial variable x (t):

$$\dot{x}(t) = (\alpha - y)x - \beta x^2 + \frac{\gamma a}{2\beta} - \frac{a^2}{2\beta}$$

If we assume that $\gamma = \beta q_0 = \frac{\alpha}{2}$, then the equation will have the following form:

$$\dot{x}(t) = \left(\frac{\alpha}{2} - \beta x\right)x,$$

this describes the critical bifurcation and represents a logistical equation. The root of this equation has the following form:

$$x(t) = \frac{\alpha x_0}{\alpha e^{-\frac{\alpha}{2}t} - 2\beta x_0\left(\alpha e^{-\frac{\alpha}{2}t} - 1\right)} \quad .$$

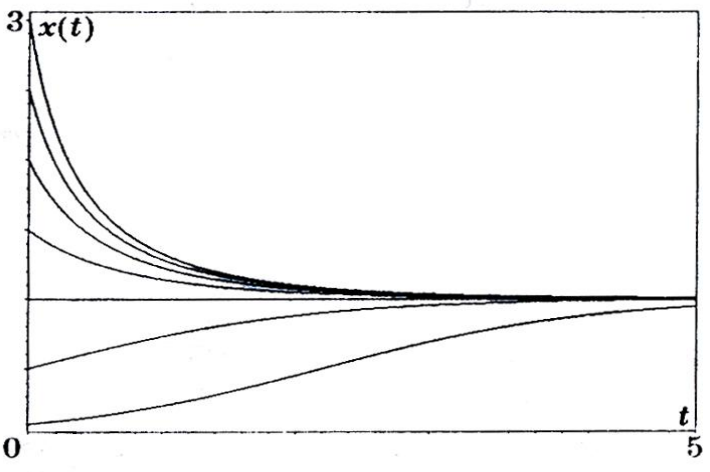

Fig.4. The transitional process of synthesized system

Which is asymptotically sustainable towards the trajectory $x_s = \frac{\alpha}{2\beta}$ and also corresponds to the optimal value of fishing quota. The system always reaches this state with any set of initial parameters, which is shown by the curves shown on Fig.5, which was generated by the modelling of the system.

Thus, introducing feedback function *(γx*) enabled us to move from bifurcation, which would have caused a disaster, onto the logistic equation, which has the self-organizing ability. In addition to that, it is possible to realize the provided fishing quota, which may also be optimal. Small deviations of γ inside the feedback function may cause some setback in productivity, but it ensures we avoid the disaster, which could take place while using the $u=\mu_0=const$ rigid plan.

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УПРАВЛЕНИЕ ХАОТИЧЕСКИМИ ПРОЦЕССАМИ МЕТОДАМИ СИНЕРГЕТИКИ

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Недавно, ученые считали, что сложное хаотическое движение может возникнуть только в некоторых многомерных системах, но оказалось, что это также возможно в нелинейных детерминированных системах третьей степени. Процессы, которые возникают в нелинейных динамических системах, хаотичны. Математические модели таких процессов содержат многочленную и квадратичную нелинейности, которые широко распространены в объектах с различной природой. Проблемы управления хаотических процессов привлекают все больше внимания в научной литературе.

В статье исследовано сложное хаотическое движение, которое возникает в фазовом пространстве в нелинейных детерминированных системах третьей степени. Рассмотрена задача сохранения биологических популяции на оптимальном уровне с учетом добычи пищи. Показано,что, с использованием обратной связи система переходит из состояния на лоджистическое, которое обладает признаком самоорганизации.

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Control Systems Theory
Appled Sciences

ORIGIN OF SYNERGETICS AND DEVELOPMENT ON THE BOUNDARY OF CENTURIES

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Abstract: *Disciplinary is the main characteristic of Synergetics. The last one means collaboration of various scientific directions. Disciplinary means two stages. On the first stage specialist of one of the fields refers to ideas of Synergetics, uses them for his/her task and finds resolution. Many people can so. On the second stage, with the obtained result he/she returns to his/her field and convinces colleges in originality of given decision. According to experience, fewer scientists can deal with the second stage.*

Keywords: *nonlinear systems, chaos, bifurcation, Thermodinamic, selforganisation, theoty of catastrops, sinergetic, systems analisys mathematical models, potential function, control, feedback.*

In the middle age of XX century, new direction of science – Synergetics has originated, which has paid attention of many scientists, because it referred to spectrum of problems, which were actual problems [3]of nature and humanitarian sciences. Synergetics is international discipline direction, which studies general regularities in self-organization of complicated systems.

In the frame of Synergetics fundamental discover has been implemented. Universe as a whole matter, from physical level – to biological and social level, has the property of self-organization, self-development. Also, it has been discovered, that self-organization algorithms have much common among each other in various systems of nature. Despite the external likeness of processes, equations during their mathematical description have practically coincided with each other. In these equations only physical content of sizes was different. [1,3,4].

Many concepts, such as bifurcation, attractor, nonlinearity, dissipate structures, feedback and other. Which before were known only for narrow circle of specialists, has become known for scientist of various fields.

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Synergetics has been developed in the frame of following scientific directions:

1. Physics of cooperative events of Hermann Haken.
2. Thermodynamics of non-balance processes.
3. Nonlinear dynamics.

Date of origin of Synergetics is 1973 year, when the first conference on problems of self-organization was held; on this conference, professor of Stuttgart University, Hermann Haken made report on new science - Synergetics.

Basic regulations of Hermann Haken were published in magazine "Review of Modern Physics" as an article on 1975; in which Haken has mentioned that processes of self-organization are seen in systems of various natures, privately, in lasers, atmosphere hurricane, in groups of wild animals, chemical reactions during forming complicated molecules, Galactic and in some social events – during process of cross from less regulated to more regulated. Collective, arranged processes have place in all these systems. They all behave themselves similarly and subject to common mathematical regularity.

Haken has discovered analogy also between forming of Benard cells and phase crossing. He has mentioned three common lines:

1. Co-ordination, collectivity and cooperativeness, any independent process cannot come of self-organization independently, only by mutual co-ordination.
2. Systems may be only opened, which change energy or substance with environment. For example, Benard cells and laser ray can exist only in case, if they receive energy from outside.
3. Systems are misbalanced. Phase crossing in lasers, forming of Benard cells may be ascribed to misbalanced phase crossings.

On the next stage Haken has searched that mathematical apparatus, by which he was able to describe process of self-organization. Haken has used well known two mathematical theories:

1. Stochastically theory – for description of misbalanced processes.
2. Bifurcation theory – for description of phase crossings.

Haken in self-organization systems has divided their common characteristic – mutual co-ordination of its elements (cooperativeness) and has made common mathematical model of this event.

From Newton time it was proved in physics that all mechanical processes are reversible. Only second Law of Thermodynamics that any isolated system of Thermodynamics during period transmits into such condition of thermodynamic balance that is irreversible in time.

According to Law of Thermodynamics, tendency of equalization of temperature and throw of energy exists in nature, time is irreversible. German physicist and mathematician Rudolph Clausius (1822-1888) come to conclusion by this Law: because during time all substances have to come to condition of thermodynamic balance, "heat death" of universe is unavoidable.

Forming of nonlinear thermodynamics was done in 50 years of XX century. Lars Onsager (laureate of Nobel Prize in the field of Chemstry) has done first steps for its development.

Belgium physician Ilya Prigozhin (1917-2003) has done his bit in developing of nonlinear thermodynamics. He has established that internal relaxation counters with processes, which make misbalance, in system. Ilya Prigozhin has extended theory of Onsager by it.

Representatives of Brussels school of Ilya Prigozhin (G. Nicholas, I. Antoniu, A. Babloyants, V. Basios, I. Stengers and other scientist) have been researching various systems of nature (physical, chemical, biological, social and other) and have established that common conditions, which cause starting of self-organization processes, these are:

1. System has to be opened (have to change energy of information with nature).
2. Processes have to be in condition far from thermodynamically balance.
3. Originating and strengthening of fluctuations in system is necessary, which concuss old order and takes the system to new order.
4. Self-organization relies on positive feedback (changes, which are caused area of system, is gathered and strengthened by system itself).
5. Self-organization may begin only in such systems, which have necessary (critical) quantity of mutual acting elements.
6. Processes of self-organization are held accompanying with abolishment of time symmetry during transmission from one structure to another.

The scientists considered that above mentioned conditions were necessary, but not enough for starting process of self-organization.

The school of Prigozhin has done big bit in development and popularization of Synergetics in the world.

Colleges and students of Prigozhin held works in this direction even today. Edgar Moren is continuing his tradition in France. Moren is representing Synergetics as enginery of cognize of complex and demands to be done radical reforms based on Synergetics in social management, education and in all practical fields of activities of human being.

Two stages of developing of Synergetics are divided.

Age of dissipative structures. Mathematical apparatus of Synergetics was the theory of bifurcation and the theory of ordinary differential equations on this stage.

Some tasks were not solved on the first stage of Synergetics, such as general conditions of self-organization, which is changeable in concrete case. Parameters of order?

The second stage of development of Synergetics is called "period of dynamic chaos". Scientists have discovered that simple dynamic systems change into complex. For example, attractor of Lorentz. But even this stage has left some questions in science.

It has been discovered, that in nonlinear dynamic most of algorithms used for analyze of data are effective in case if phase space of the system is small. How to behave with big systems? How to cross theory of dynamic chaos to reality?

Controversy between scientists has been developed. Synergetics was not "theory of everything" any more, as philosophers and humanitarians considered before 10-20 years. Parts of scientists begin talking about forming of new paradigm of Synergetics, which may be not common and simple, but deeper and concrete.

Nonlinear science has been developing even today. International scientist conferences are regularly held on this theme. Books with series of Synergetics are established in publishing house "Shpringer", which has exceeded 100 volumes. Since 2002 publishing of series of books "Synergetics from past to future" have started in Moscow publishing house "Editorial URCC". Many scientific journals are dedicated to nonlinear science:"Прикладная нелинейная динамика", "Chaos, "Nonnlinearity", "Physical Reviews E" and other. Scientific journals establish articles on themes of Synergetics.

The works of academician I. Prangishvili are known, in which principles and methods of systemic approach and universal systemic regularities are given. Most of natural and social systems are subjected on them.

Disciplinary is the main characteristic of Synergetics. The last one means collaboration of various scientific directions. Disciplinary means two stages. On the first stage specialist of one of

the fields refers to ideas of Synergetics, uses them for his/her task and finds resolution. Many people can so. On the second stage, with the obtained result he/she returns to his/her field and convinces colleges in originality of given decision. According to experience, fewer scientists can deal with the second stage.

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ПРОИСХОЖДЕНИЕСИНЕРГЕТИКИ И РАЗВИТИЕ НА ГРАНИЦЕ ВЕКОВ

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Синергетика - международное дисциплинарное направление, которое изучает общую регулярность в самоорганизации сложных систем. синергетика развиваласс в структуре следующих научных направлений: Физика совместных событий Германа Хакена, термодинамика процессов нелинейной динамики.

Итак, синергетика возникла, как теория кооперативных явлений в задачах лазерной тематики, но постепенно приобретала более общий статус теории, описывающей незамкнутые, нелинейные, неустойчивые, иерархические, развивающиеся системы. Уже в области естествознания существует оппозиция такому толкованию синергетики. Кто-то предпочитает говорить о нелинейной динамике, или теории диссипативных систем, теории открытых систем, теориидинамического хаоса, аутопоэзисе и т.д.

Синергетика, как наука, бурно развивается сегодня, и мы должны ждать новых результатов в течение следующих лет.

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Control Systems Theory
Mathematical modelling

SOLVING THE PPOBLEM OF ANALYTICAL DESIGNING OF MULTILINEAR AGGREGATED REGULATORS WITH SYNERGETIC METHODS

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Abstract: *In article it is considered a problem of analytical designing of the aggregated regulators with use of synergetic methods. The abundance of outer or inner invariants can be changed based on whether goals of the system are constant or dynamic. In other words, we can make selection of types that are corresponding to dynamic invariants inside the physical (chemical, biological, economic) control systems and thus implement its self-organizing ability.It is shown that at decisions этоu tasks a considerable and independent problem is formation of criterion of the corresponding quality.*

Keywords: *nonlinear systems, self-organizingchaos, point of bifurcation, synergetic methods,*attractors, *control systems,differential equation.*

In comparison with classical methods of control analytical designing of aggregated regulators (ADAR) is based on conceptual regulations of synergetics.These regulations determine the strategy of controlling not only separate objects, but also the self-organizing of the whole system and collective processes. The abundance of outer or inner invariantscan be changed based on whether goals of the system are constant or dynamic. In other words, we can make selection of types that are corresponding to dynamic invariants inside the physical (chemical, biological, economic) control systems and thus implement its self-organizing ability.

Let us move on to discussing some concrete procedures for the synthesis of aggregated dynamic regulators, which are based on the generalized method of analytical designing of the aggregated regulators (ADAR).

According to the method, representing points of the system (1) are located in the intersection area of manifolds $\Psi_1 = 0,..., \Psi_m = 0$ with interaction from outer controls. The movement along this area can be described by the inner dynamic equation of decomposed system:

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$$\dot{w}_{j\psi}(t) = g_j(w_{1\psi},...,w_{\mu\psi},v_{i+1},...,v_n,x_{1\psi},...,x_{m-1\psi}),\ j=1,...,\mu;$$
$$\dot{x}_{i\psi}(t) = f_i(x_{1\psi},...,x_{m-1\psi},v_{i+1},...,v_n), i=\mu+1,...,m-1 \quad ,$$

where $v_{i+1},...v_n$ are inner controls.

The $v_{i+1},...v_n$ synthesis of control represent the separate inner task of controlling the sub object. The Sequential-parallel unity of invariant manifolds is used for solving this task.

The main differences of the new approaches in control theory from classical theory are as follows:

- The main objects of attention become invariant manifolds, which are attracted to the behavior of synthesizable systems – they are called attractors and that brings us to the dynamic decomposition of system control, therefore to the simplification of its behavior.
- It is possible to derive the desired low dimension evolutionary equations, which describe the sustainable asymptotic modes and represent the equations of dynamic state.
- The cascading synthesis of parallel-sequential manifolds of inner controls, that are interconnected dynamically, ensure the desired influence of the system on attractors.

The method of analytical designing of aggregated regulators, which is based on the aggregation – decomposition procedure, uses the unity of Lyapunov parallel and sequential functions.At the beginning, we take the simplest Lyapunov functions $V_s = 0,5\psi_s^2$ against macro variables $\psi_s(x_1,...,x_n)$, for the equation (1).

The above mentioned unity of Lyapunov functions represent kind of an analogy of Lyapunov vector function and so in the ADAR method there are discussions about the sustainability of dynamic systems of control. In other words, in the synergetic approach the Lyapunov vector function is connected to the procedure of analytic designing of aggregated regulators.

Let us discuss the features of analytical designing of scalar regulators for nonlinear dynamic objects, for solving the task of synthesis of control systems of different kinds of nonlinear scalar objects. Modeling of the above procedure was done with MAPLE software.

Example. Let us suppose, that the object can be described by the differential equation:

$$\dot{x}_1(t) = ax_1^3 + x_2; \dot{x}_2(t) = u \qquad (2)$$

In cases where a > 0, the object (2) is not sustainable, as when $x_2(t) \to 0$ coordinate $x_1(t) \to \infty$ and that presents additional requirements for control laws $u(x_1, x_2)$, which must ensure the stability of the system $(x_1 \to 0, x_2 \to 0)$ for any initial conditions. Let us use the ADAR method for synthesizing such control systems. To do this, let the ψ function be the following:

$$\psi_1 = x_2 + \beta x_1 + b x_1^3 \tag{3}$$

If we introduce (3) into the equation:

$$T_1 \dot{\psi}_1 + \varphi(\psi_1) = 0$$

We get the following general expression:

$$u_1(x_1, x_2) = -(3bx_1^2 + \beta)(ax_1^3 + x_2) - \frac{1}{T_1}\varphi(\psi), T > 0 \tag{4},$$

That is selected according to the function $\varphi(\psi_1)$ and enables us to get different control laws. These laws ensure the asymptotic sustainability of the representing point near the manifold $\varphi(\psi_1) = 0$ (3), as the function $\varphi(\psi_1)$ is chosen so that the differential equation $\varphi(\psi_1) \cdot \psi_1 > 0$, which describes the movement along $\psi_1 = 0$, looks like this:

$$\dot{x}_{1\psi 1}(t) = -\beta x_{1\psi 1} - (b-a)x_{1\psi 1}^3 \tag{5}$$

To assess the sustainability of (5) we use the Lyapunov function $V = 0,5x_{1\psi 1}^2$, whose derivative by time is the following:

$$\dot{V}(t) = -\beta x_{1\psi 1}^2 - (b-a)x_{1\psi 1}^4 < 0 \tag{6}$$

It follows, that inequalities $\beta > 0, b \geq a, T_1 > 0$ represent the condition of asymptotic sustainabilityin the whole of the synthesized (4)-(6) closed system

$$\dot{x}_1(t) = ax_1^3 + x_2;\ x_2(t) = -(3bx_1^2 + \beta)(ax_1^3 + x_2) - \frac{1}{T_1}\varphi(\psi_1). \tag{7}$$

Let us determine the first integrals of system (7), for this we represent it as follows:

$$\frac{dx_1}{ax_1^3 + x_2} = -\frac{T_1 dx_2}{T_1(3bx_1^2 + \beta)(ax_1^3 + x_2) + \varphi(\psi_1)} = dt. \tag{8}$$

If we introduce $\psi_1 = 0$ and accordingly, $\varphi(0) = 0$ into the function (8), after the integration we get the first integral $ax_1 + bx_1^3 = -x_2$, which matches the expression $\psi_1 = 0$ (5). We

have ensured that the given integrated manifold $\psi_1 = 0$ (5) really represents the candidate for attracting the nonlinear system.

When $\varphi = \psi_1 = x_2 + \beta x_1 + a x_1^3$, the control law (6) is represented like this:

$$u_1 = -\frac{\beta}{T_1} x_1 - \frac{1}{T_1} x_2 - \frac{a}{T_1} x_1^3 - (3a x_1^2 + \beta)(x_1^3 + x_2). \qquad (9)$$

Fig.1. shows the movement trajectories of this closed system for parameters $\beta = 1, a = 1, T_1 = 1$. As we can see in the Fig.1. the phase trajectories are wrapping the $\psi_1 = 0$ (5) manifold and are gathering towards it at the coordinate origin point. In addition to this, the system is asymptotically sustainable to transitional processes with non-periodic damping nature.

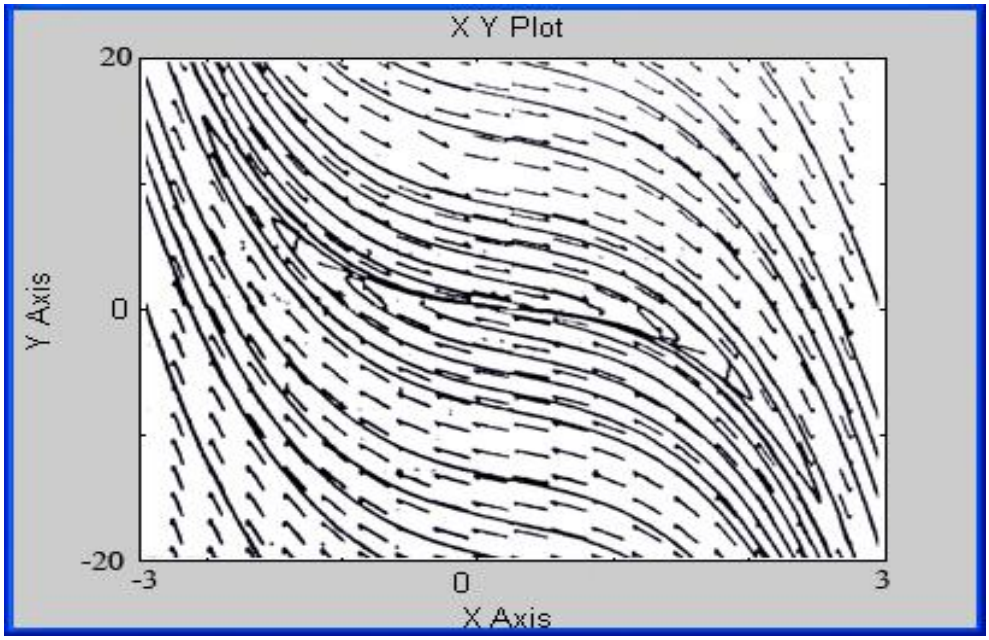


Fig.1. transitional process the movement trajectories of closed system

for parameters $\beta = 1, a = 1, T_1 = 1$

Now let us assume, that there is a limitation $|x_2| \le A$ for the x_2 coordinate. In this case, if we introduce the function

$$\psi_2 = x_2 + A th\left(\beta x_1 + b x_1^3\right), \qquad (10)$$

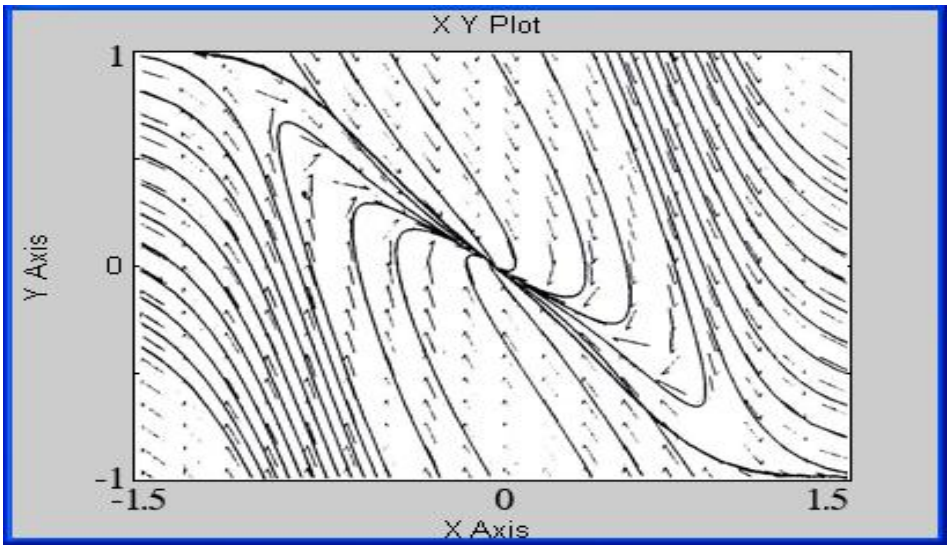
For the control law, we get an expression

$$u_2 = -\frac{A(\beta + 3bx_1^2)(ax_1^3 + x_2)}{ch^2(\beta x_1 + bx_1^3)} - \frac{1}{T_1}\varphi(\psi_2), T_2 > 0 \quad (11)$$

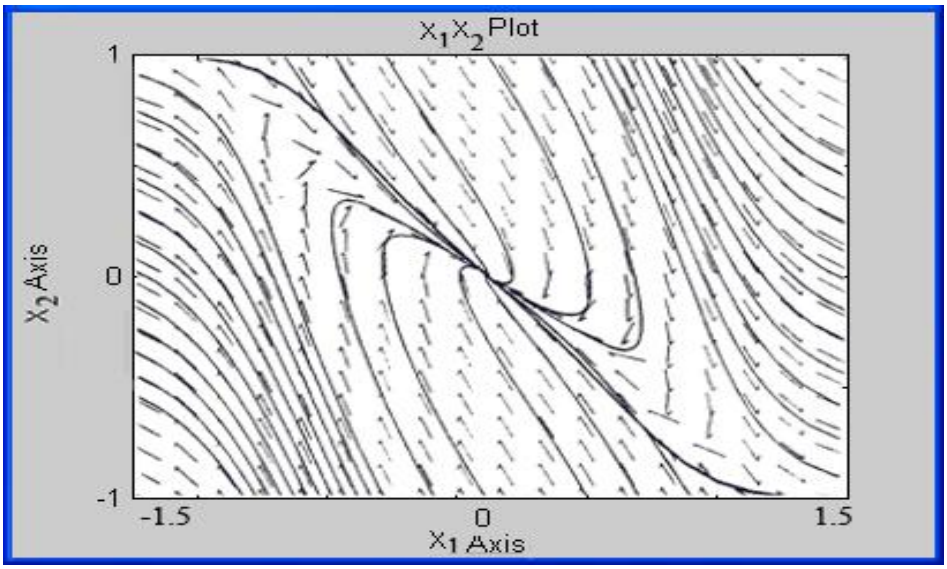
Which relocates the representing point $\psi_2 = 0$ (10).The function $\varphi(\psi_2)$ selected near the manifold and the dependence of the parameters β and a ensures the desired quality of transitional processes. The movement equation along the manifold $\psi_2 = 0$ is the following:

$$\dot{\psi}_{1\psi 2}(t) = x_{1\psi 2}^3 - Ath\left(\beta x_{1\psi 2} + bx_{1\psi 2}^3\right). \quad (12)$$

From the movement equation (12) it follows that conditions $\beta > 0, b \geq 1$ ensure its asymptotic sustainability only in some areas. This means, that if we introduce the limitation $|x_2| \leq A$ and therefore, the function ψ_2 (10), the area of asymptotic sustainability is decreasing. Fig.2. shows the movement trajectories a and b for functions $\varphi = \psi_2, \varphi = th\psi_2, \varphi = \mathrm{si}\,gn\psi_2$ and parameters $b = 1, T = 1, A = 1$, that confirm the existence of asymptotically sustainable areas of non-periodic transitional processes for synthesized systems.



a)



b)

Fig.2.transitionalprocessmovementtrajectoriesof closed system ($b=1, T=1, A=1$**)**

With small deviations, when $\psi_{2\text{inf}} = x_2 + A\beta x_1$ u_2 and u_1 control laws $(A=1)$ are optimal according to these quadratic criteria:

$$J_{\text{inf}} = \int_0^x \left[\beta^2 A^2 x_1^2 + (1+\beta^2 A^2 T^2) x_2^2 + T^2 u^2 \right] dt \,. \tag{13}$$

In the criteria (13), the choice of weighted coefficients depends on desired on quality of transitional processes. So, when analytically designing the aggregated regulators (6), (11) control laws u_1 and u_2.

Ensure the asymptotic sustainability into the whole, or into $|x_2| \le A$ area and also ensure the requirements for closed systems.

Thus, with using the generalized method of analytical designing of aggregated regulators it is possible select the types according to the dynamic invariants from physical (chemical, biological, economical) control systems and thus, implement its self-organization ability.

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ОБОБЩЕННЫЙ МЕТОД АНАЛИТИЧЕСКОГО КОНСТРУИРОВАНИЯ АГРЕГИРОВАННЫХ РЕГУЛЯТОРОВ

В.Сесадзе, Г.Чикадзе, А.Кекенадзе

В настоящее время наиболее передовое фундаментальное направление в теории и технике управления включает физическую теорию управления, синергетический подход к проблемам управления, теорию самоорганизующихся регуляторов с экстраполяцией, теорию нечетких и нейросетевых систем управления и др.

Итак, синергетический метод АКАР является новым направлением в теории управления, которое расширяет понимание сложных процессов управления, так как учитывает общие объективно-энергетические и энтропийно-информационные субстанции в пространстве и времени.

В статье расмотрена проблема аналитического конструирования оптимальных агрегированных регуляторов исползованием синергетических методов. Показано что при решенний этой задачи значительной и независимой проблемой является формирование критерия соотвествующего качества.

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REVEALING OF POTENTIALLY DANGEROUS SITUATIONS IN NORMATIVE-LEGAL DOCUMENTS AND UNDERLINE THE CRITERIA IN THEM

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Abstract:*The work presents visualization of interrelation of normative-legal documents and revealing of potentially dangerous situations during the analysis and legal collision invention importance while drafting the mentioned documents, publishing systematization and underline criteria in them.*

Keywords: *normative-legal documents, potentially dangerous situations, the criteria (criterion).*

1. INTRODUCTION:

Last period it is observed the continuous lawmaking activities. Due to development of Georgian legislative basis, substantially increased the number of normative-legal acts – laws, ordinances, orders. For example, in Georgian Parliament sessions with the adoption of the law systematically occurs changes and amendments in law, but a draft-laws, ordinances, other normative legal documents number is rather big. The questions that are related to lawmaking activities traditionally provoke active discussions in juridical sciences. Attention must be paid onlawmaking activities technical aspects that are often in the shadow, the aim of them is to defense the proper rules and norms during draft-law registration and legislative process actualization. By the practice, the requirements for legislative documents' registration, for its structure and content is high enough.

Normative-legal documents' united interrelated structure is complex object, that requires new mathematical and theoretical method research, creation of automated program means and lawmaking and normative activities support, that in future may rise theoretical informatics independent directions. The above listed factors define normative-legal documents' intercommunication structural analysis and new methods and means (program complex) developing area research actuality, to discover potentially dangerous situations in case of lawmaking norm failure.

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** **Doctor**

Potentially dangerous situation means the consideration of rules and norms of lawmaking process, on the basis of potentially dangerous criteria, some documents and revealing of potentially dangerous situations in their "backyard" intercommunication, which means inconsistency of lawmaking process rules and norms and which are attached to a special documents. Potentially dangerous criteria mean rules that are specified by experts groups on the basis of juridical document or empirically formulated expressive form on theoretical-versatile logic languages.

2. MAIN PART:

Normative-legal documents and their intercommunication mathematical method gives us chance formally determinate potentially dangerous documents "backyard" parts, by logical expression of lawmaking norms failures. In future it's necessary to determinate potentially dangerous situations criterions.

Due to abovementioned let's reveal subset$L^1,L^2,\ldots,L^A$, multiplicity L and$C = \{C_1,C_2,\ldots,C_A\}$–system conditions (criteria), each criterion C_a, $a=1,\ldots,A$,in total is a predicate, which argument is:Sdocument multiplicity, connection matrix – $L$and numbers$i,j = 1,\ldots,n,$that gives$s_i$connection between document and s_j. $l_{ij}$is potentially dangerous by C_a criterions and considers to subset L^a, $a=1,\ldots,A$, then and only then, when it satisfies criteriaC_a:

$$l_{ij} \in L^a \Leftrightarrow C_a\,(S,L,i,j) = 1, \text{where } L^a \subseteq L,\ C_a \in C,\ i,j=1,\ldots,n,\ a = 1,\ldots,A. \quad (1)$$

In other words, each criteria $C_a$presents predicate, that arbitrarily connects $l_{ij}$to potentially dangerousunions - L^a. it is analogue for the documents:

$S^1, S^2,\ldots,S^B$ – subset, multiplicity S and $C' = \{C'_1, C'_2,\ldots,C'_B\}$ – system condition (criterion). The document $s_i$is potentially dangerousand considers to S^b, $b = 1,\ldots,B$, then and only then when it satisfies criteriaC'_B:

$$s_i \in S^b \Leftrightarrow C'_b\,(S,L,i,) = 1, \text{where} S^b \subseteq S,\ C'_b \in C',\ i,=1,\ldots,n,\ b = 1,\ldots,B. \quad (2)$$

In Thesis (dissertation) one of the complicated and milestone stage is normative-legal document and their "backyard" intercommunication potentially dangerous element criterion logical apparatus creation and formulation. Potentially dangerous criteria system constantly experiences evolution, fulfills and gets modern.

All listed criterions are presented in standard form, by proper definition, extracts and links regulated normative-legal acts, thatare the reason for creation and are written in two formats: algorithm and formal, by logical expression. Let's bring next ticks:

s_x – is testable normative-legal act, after we got abbreviations by text, for example:

Parliament apparatus letter – the letter of apparatus №3-22/385 of 15.10.2006 "About Methodic recommendations during juridical-technical registration of draft-law", Tbilisi, 2006.

Ordinance – legislative meeting ordinance №11-5623 "About Methodic recommendations during juridical-technical registration of regional draft-law", Tbilisi 2007 year.

Criterion №1. Making changes in normative-legal documents, that contain directions in the text of other normative-legal acts' repealing or changing – is potentially dangerous.

Let's discus the normative-legal acts, that became basis for criterion: the extract from normative-legal act – mainly the changes happen in legislative acts. On the whole the changes in legislative act by its substitute legislative act is impossible.

Because of abovementioned lets' see the algorithm definition:

1. If$T(s_x) = \mu_2$ ან $T(s_x) = \mu_3$ –pass on to point 4.
2. All l_{xi} link selection,that is in texts$_{x,}$ if$\lambda_1$or$\lambda_2$are foundpass on to point 4.
3. Log out.
4. All link selection in s_x,λ_1 type links are revealed as potentially dangerous.

Due to logical expression form the record will be follow:

$$C_1(S, L, y, x) =$$

$$\left[\begin{matrix} l_{yx} = \lambda_1 \wedge (T(S_x) = \mu_2 \vee T(S_x) = \mu_3 \vee \exists z\ (l_{xz} = \lambda_1 \vee l_{xz} = \lambda_2)) \\ x, y, z = 1, \dots, n \end{matrix}\right] \quad (3)$$

Criterion №2. To declare invalid the documents, that makes changes in normative-legal acts and is itself invalid – is potentially dangerous.

Normative-legal acts that are the basis of criterion are the follow: extract from normative-legal acts – the list of legislative acts, that are the subjects for repealing: legislative acts, that completely are subjects for repealing. Here, they are mentioned as private positions, as the legislative acts, so all that legislative acts where before was made changes by main legislative acts.

Lets' discuss algorithmic definitions.

1. All l_{xi}link selection that are given in text s_x.
2. Ifl_{xi}link isλ_2 *type*, then:

2.1.On each $s_i$documentselectl_{yi}link.

2.2. If l_{yi}isλ_1 *type*(substitute), then:

2.2.1. $\lambda_2$typel_{xy}link checking in text s_x,if the link doesn't exist, then $s_x$is revealed as potentiallydangerous (in its "backyard" may be insufficient connections).

Due to logical expression form the record will be follow:

$$C_1^{'}(S,L,x)=[\exists\, y(l_{xy}=\lambda_2) \wedge \exists z(l_{zy}=\lambda_1 \wedge l_{xz}\neq\lambda_2),\ x,y,z = 1,\ldots,n] \quad (4)$$

Criterion №3. The existence of link in valid normative-legal act – is potentially dangerous.

The normative-legal acts that are the basis for criterion: extract from the normative-legal acts – the links only can be made for legislative acts that are in force. It's impossible to make links on invalid legislative acts and draft-laws.

An algorithmic definition:

1. All l_{xi}link selection that are in textss_x.

1.1. Alll_{yi} link selection on $s_i$document.

1.2 If there is found λ_2 even one $type l_{yi} link l_{xi} in\ s_x text$– is potentially dangerous.

The record due to logical expression form:

$$C_2(S,L,x,y)=[\exists z(l_{zy}=\lambda_2),\ \ x,y,z = 1,\ldots,n] \qquad (5)$$

Criterion №4. The existence of type λ_1 (substitute) or λ_2 (invalid) link in normative-legal acts' text, that enact new legal regulations – is potentially dangerous.

The normative-legal acts that are the basis for criterion: extract from normative-legal acts - with that draft-laws which enacts new legal regulations, must be presented for discussion independently from legislative acts and their structural units that are subjects for amendment. The existence of the articles in a new regulation draft-laws, which legislative acts or structural units are subjects for amendment – can't be allowed.

An algorithmic definition:

1. If$T(s_x) \neq \mu_1$–log out.
2. Alll_{xi}link selection, that are in $s_x$text, $\lambda_1 and \lambda_2$ type links are potentially dangerous.

The record due to logical expression form:

$$C_3(S,L,x,y)=[T(s_x)=\mu_1 \wedge (l_{xy}=\lambda_1 \vee l_{xy}=\lambda_2), \quad x, y = 1,\ldots,n] \quad (6)$$

Criterion №5. The invalidation of normative-legal documents, that made changes or repealed normative-legal acts – are potentially dangerous.

The normative-legal acts that are the basis for criterion: extract from normative-legal acts - if the law contains articles by which previously adopted laws became invalid, then in case of necessity given law invalidity means that it gets invalid despite is there such articles or not.

An algorithmic definition:

1. All λ_2 type l_{xi} link selection that are in text s_x.

1.1. l_{iy} link selection substitutein s_i document text.

1.2. if there is foundeven one λ_1 *or* λ_2 *type from* l_{iy}, l_{xi} linkin texts s_x – is potentially dangerous.

The record due to logical expression form:

$$C_4(S,L,y,x)=[l_{yx}=\lambda_2 \wedge \exists z(l_{xz}=\lambda_1 \vee l_{xz}=\lambda_2), \quad x, y, z = 1,\ldots,n] \quad (7)$$

Criterion №6. Free type normative-legal document link may be potentially dangerous, if in future it will be changed or replaced.

Substantiation: During lawmaking process, when the normative-legal act is mentioned, not for its changing or repealing, the lawmaker means its current content and if in future normative-legal act will be changed or replaced, then before mentioned links, will be potentially dangerous.

An algorithmic definition:

1. All l_{ix} links selection on documents s_x, λ_1 (changes)and λ_2 (repeals) type for link research.
2. If such link will not be found – log out, otherwise all λ_3 type (willful) links on s_x that exist in earlier documents texts, are declared potentially dangerous.

The record due to logical expression form:

$$C_5(S,L,y,x)=[\exists z(l_{zx}=\lambda_1 \vee l_{zx}=\lambda_2), \quad z > y, \quad x,y\, z, = 1,\ldots,n] \quad (8)$$

Criterion №7. The number of changes in normative-legal documents (reload) may cause the reason for its publication in a new redaction. The normative –legal acts that are basis for criterion: Extract from normative-legal document acts – the law structural unit is publish in case if: ….the law structural unit was changed repeatedly.

An algorithmic definition:

1. Computeλ_1 *(changes) type links by*s_x.
2. If the number of links more than definite *K* constant, s_x*is declared potentially dangerous (document may be overloaded by changes).*

The record due to logical expression form:

$$C'_2(S,L,x) = \left[\begin{matrix}\left(\exists M = \{l_{x_1x}, l_{x_2x}, \dots, l_{x_nx}\}\right) | \forall_i : l_{x_ix} = \lambda_1 \wedge \quad |M| > K,\ i = 1, \dots n, \\ x, x_i = 1, \dots, n\end{matrix}\right] \quad (9)$$

Criterion №8. If normative-legal act validity is defined by time, during this period, the links that influences on them may be potentially dangerous, if by this time they didn't set in force or in future stops acting.

The normative-legal acts that are the basis for criterion: extract from normative-legal acts – links only can be made on legislative acts that are in force (valid). It's impossible to make links on invalid legislative acts and draft-laws.

An algorithmic definition:

1. Check validity date in texts$_x$. If isn't ($P(s_x) = [\emptyset]$) – log out.
2. Check up the term: Is the $s_x$valid at that period. If valid – log out.
3. All links in $s_x$are declared as potentially dangerous.

The record due to logical expression form:

$$C_6\ (S,L,y,x)=[P(s_x) = \emptyset \wedge Now(\,) \notin P(s_x),\ \ x,y = 1,\dots,n] \quad (10)$$

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ОПРЕДЕЛЕНИЕ ПОТЕНЦИАЛЬНО ОПАСНЫХ СИТУАЦИЙ В НОРМАТИВНО-ПРАВОВЫХ ДОКУМЕНТАХ И ВЫЯВЛЕНИЕ КРИТЕРИЙ В НИХ

О. Шония, Л. Колбая

Теоретическое и экспериментальное исследование потенциально опасных ситуацийв нормативно-правовых документов и управление нормативно-правовых документов представляет большой интерес. В статье представлены те факторы, выполнение которых объязательно, чтобы опознатьпотенциально опасные ситуации в нормативно-правовых документов.Работа представляет визуализацию взаимосвязи нормативно-правовых документов и раскрытие потенциально опасных ситуаций во время анализа. Приведены структурные схемы основных задач и каждая из них охарактеризована своим функциональным назначением.

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DEVELOPMENT OF MATHEMATICAL METHODS OF VISUALIZATION OF NORMATIVE-LEGAL DOCUMENTS

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Abstract: *Huge number of legislative information and dynamics of its changes requires from lawyers, students, businessmen and every interested persons to use modern methods and instruments during the process of working with legal information. Nowadays such instruments are legal directory system the aim of which is to provide users by authentic legal information. The work shows normative-legal documents and their interrelation mathematic model development in the legal directories systems.*

Keywords: *legal directory system, normative-legal documents, mathematic models.*

1. Introduction:

During law-making process, adopting normative-legal documents, during their official publication it's necessary to observe the rules exactly. The whole interrelation structure of legal document is a complex object that needs new mathematical and theoretical method researches. The aim of normative-legal documents interrelation visualization and analysis is to reveal new methods, and is appealed to discover potentially dangerous situations, legislative collisions and resistances, normative act duplicate in electronic legal-directory system during law-making process and juridical-technical legislative act adopting process. The mentioned method is distinguished by use of automated analysis and intercommunication instruments.

Directory-legal systems represent quite new phenomenon of legal truth. As the public law awareness and legal culture means formation, they have a close relationship with legal reality phenomenon, such as lawmaking, law realization, law enforcement, legislation. As the elements of legal truth, directory-legal system is not fully explored by juridical science yet. But the practice confirms that in the near future the sphere of its utilization will increase during lawmaking and legal awareness process.

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****Doctor**

Directory-legal systems' main purpose is certain legal information formation during important desision making process, provide user simply and operatively by confident, full normative and other kind information.

2. Main part:

Due to abovementioned problems normative-legal documents and their intercomunication mathematic method is developed. Let's discuss formal part of model in detail.

First of all we must creat normative-legal document array (united data basis) $S = \{s_1, s_2,...,s_i..,s_n\}$, where s_i is array of I document, $i = 1,...,n$, n _ the total amount of documents in array.

The document structure s_i represents arranged attribute set $\langle a_{i1}, a_{i2},.., a_{ik}, R_i \rangle$, where $a_{i1}, a_{i2},.., a_{ik}$ - is informative attribute of i document (such as: name (headline) number, receiving date and etc.), and R_i – is special attribute for connection with other documents in S. Each document s_i may be connected (may have link) with any number of other document, but the attribute R_i contains link array, written in special format, that present pair <document #, link type>. Document's S multiplicity is arranged by receiving date growth – by one of its' informative attribute.

Between S document exists intercommunication system $L=\{l_{ij}, i, j=1,...,n\}$, where l_{ij} is s_i document connection with s_j document. $l_{ij} \in \Lambda = \{\lambda_0, \lambda_1, \lambda_2, \lambda_3\}$, so, l_{ij} gets Λ type multi communicational meaning, thereby:

$l_{ij} = \lambda_0$ then, and only then, when for s_i documents there is no link for s_j document in text. i.e λ_0 _ *is* «zero connection». As far as its impossible to have links itself in texts, thus $l_{ij} = \lambda_0$, for all ($\forall_i = 1,...,n$).

$l_{ij} = \lambda_1$ then, and only then, when in s_i document text contains directions for changes in s_j document. i.e. λ_1 - *is* «substitute connection».

$l_{ij} = \lambda_2$ then, and only then, when in s_i document text contains directions for invalidity in s_j document. i.e λ_2 - is «abrogating connection».

$l_{ij} = \lambda_3$ then, and only then, when for s_i document there is a reminder in text for s_j, but the semantic definition of the reminder is not equal not for λ_1 nor λ_2. i.e. λ_3 is willful type connection.

Thus, L multiplicity will be $nX\ n$ size square matrix, which main diagonal contains only λ_0 elements. *L* matrix *i* line realizes interpretation of links in s_i document texts, on all other *S* documents that numbers which are equal to certain column. *L* matrix's *j* column interprets s_j links in *S* documents by numbers that are equal to column numbers.

On next stage its necessary to make document typology. Normative-legal documents are different from each other:

1) By legal space possessive. Mention S^R as regional level normative-legal document unity; $S^1,S^2,...,S^H$ – as regional subjective law and ordinances unity, $S^R,S^1,S^2,...,S^H \subset S,\ H$ - subject unity;

2) Due to act type, lets' note function by T, which stands accordingly between S document unity elements and $M = \{\mu_1,\mu_2,\mu_3\}$ elements. $T(S) \rightarrow \{\mu_1,\mu_2,\mu_3\}$, where:

μ_1, _ is a law that enacts new legal regulations;

μ_2, _ is a law that takes changes in existed legal regulations by current normative-legal acts changing;

μ_3 _ is a law, that invalids any normative-legal acts.

In some case of law-making practice, for normative-legal document validity determination in texts is used directly set terms of adoption and invalidity. For example, "sets in force from 01.01.2015" or "the law sets in force after 10 days from establishment and is valid till January 1, 2017".

Lets' note P function, which argument presents S element totality, the meaning the middle period, when the normative-legal document has force (function P doesn't consider that normative-legal act may lose the power, due to other act adopting, that invalids it). $P(S) \rightarrow TP^*$, *where* TP^* - is all time period totality (Time Periods), Include Ø-s (empty multiplicity), in case if there is no validity terms in text. *T*P Time period has structure: $TP = [TP^1, TP^2] = [date, month, year^1, date, month, year^2]$, $TP^1 < TP^2$.

Also, for new use lets' determine special function *Now( ),* the meaning of which is considered recorded current date in abovementioned formate.

Then, main stage is to find out ''backyard'' of normative-legal document. Let's see the next explanation: s_i document first level « backyard » K^1_i is called subset of S document,

which has s_i link ("backyard" current part) and is joined with document multiplicity, which have links in s_i documents:

$$K_i^1 = K_i^{1+} \cup K_i^{1-}, \text{ სადაც } K_1^{1+} = K^{1+}(s_i) = \bigcup_{j=1}^{n} \mathrm{s_j} \,|l_{ji} \neq \lambda_0,$$

$$K_i^{1-} = K^{1-}(s_i) = \bigcup_{j=1}^{n} \mathrm{s_j} \,|l_{ij} \neq \lambda_0, \qquad i = 1, \dots n. \tag{1}$$

Document s_i "backyard" second level is called $K^2{}_i$ multiplicity, which represents each $K^1{}_i$ document first level "backyard" link-up:

$$K_i^2 = K_i^1 \cup \bigcup_{j=1}^{n} K_j^1 \,|\mathrm{s_j} \in K_i^1 =$$

$$= K_i^1 \cup \bigcup_{j=1}^{n} \left(\bigcup_{k=1}^{n} s_k \,|l_{kj} \neq \lambda_0 \right) |S_j \in K_i^1 \quad \cup \bigcup_{j=1}^{n} \left(\bigcup_{k=1}^{n} s_k \,|l_{jk} \neq \lambda_0 \right) |s_j \in K_i^1 = \tag{2}$$

$$= K_i^1 \cup K_i^{2+} \cup K_i^{2-}, \quad i = 1, \dots . n.$$

By induction n level "backyard" is called multiplicity:

$$K_i^n = K_i^{1+} \cup K_i^{1-} \cup K_i^{2+} \cup K_i^{2-} \cup \dots \cup K_i^{n+} \cup K_i^{n-} =$$

$$= \bigcup_{j=1}^{n} s_j \,|l_{ji} \neq \lambda_0 \cup \bigcup_{j=1}^{n} s_j \,|l_{ij} \neq \lambda_0 \cup$$

$$\cup \bigcup_{m=1}^{n-1} \left(\bigcup_{j=1}^{n} \left(\bigcup_{k=1}^{n} s_k \ |l_{kj} \neq \lambda_0) \ | S_j \in (K_i^{m+} \cup K_i^{m-}) \cup \bigcup_{j=1}^{n} \left(\bigcup_{k=1}^{n} s_k \ |l_{jk} \neq \lambda_0) | S_j \in \right. \right. \quad (3)$$

$$\left. \left. \in (K_i^{m+} \cup K_i^{m-}) \right) \right),$$

where, i = 1,…n; j= 1,…m; n ≥ 2.

Normative-legal document “backyard” concept has special use meaning, in hence of subject specific and distinctive features, that states in out and incoming part dividing.

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РАЗРАБОТКА МАТЕМАТИЧЕСКОЙ МОДЕЛИ ВИЗУАЛИЗАЦИИ НОРМАТИВНО-ПРАВОВЫХ ДОКУМЕНТОВ

О. Шония, Л. Колбая

Огромное число законодательной информации и динамика ее изменений требуют от адвокатов, студентов, бизнесменов использование современных методов и инструментов во время процесса работы с юридической информацией. В статье представленны основные задачи визуализации и анализа взаимосвязей нормативно-правовых документов. Приведена структурная схема основных задач и каждая из них охарактеризована своим функциональным назначением.

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Applied and Experimental Mechanics

ANALYSIS OF HAVING TRANSVERSAL AND LONGITUDINAL STIFFNESS RIBS PLATE BY FINITE ELEMENT METHOD

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Abstract: *In this paper is stated analysis of plate with stiffness ribs by application of the Finite Elements method, at the same time in the first case stiffness ribs are presented as a finite element of rod, in the second case they are represented as the finite element of plate, and in the third case it is represented as a three-dimensional finite element. Are stated the results of the comparative analysis.*

Keywords: *plate, finite element, stiffness rib, stiffness matrix, boundary conditions.*

1. BASIC PART

In the last few decades in the structural mechanical the theory of thin shells represents a particularly popular theory, as such type of shell elements are widely applied in a variety of structures, on this issue are published lot of scientific papers and monographs. All above mentioned is evidenced by the fact that this type of shell structures are applied in the aerospace structures, aircraft engineering, shipbuilding, nuclear reactors and so on, where are applied the complicated nature static and dynamic loads. Such widespread of shell structures raises the providing of plates and shells strength, stiffness and stability conditions. The satisfaction of plates and shells stiffness conditions often is very complex. In order to satisfy the stiffness conditions is introduced so-called additional structural element that in theory of shells and plates is known as the stiffness ribs, and this type of plates and shells are called as having stiffness ribs plates and shells (stiffness ribs would be either longitudinal and transverse (stringers and

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bulkhead)). The plates with transversal as well as longitudinal ribs in terms of calculation are very complicated. Are existing several approximation methods including averaging method, according of that analysis of such type plates is quite approximate. Our objective is to carry out analysis of plate with transverse and longitudinal stiffness ribs by Finite Element method, using a two-dimensional finite element, rod finite element and three-dimensional finite element, is stated the comparative analysis.

Design diagram is presented on Fig. 1

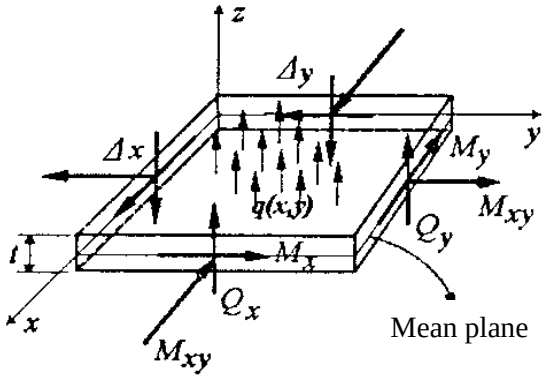


Fig. 1. Design diagram

If the deflection of mean surface is smaller than thickness of the plate, then occurs the following assumption: prior the bending normal of the mean surface remains as normal to this plane after the bending. I.e. at bending for thin plate are ignored the shear deformations. I.e. $\gamma_{uz} = \gamma_{yz} = 0$ (see Fig. 2).

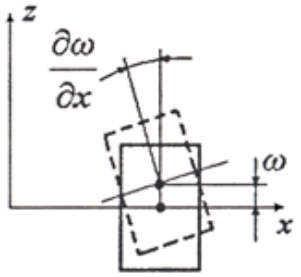


Fig. 2

Let's $\varphi(x, y)$ is deflection of the mean surface of plate, and *u*, ν accordingly are parallel to displacements on *x* and *y* axles for small deflections when the normal inclination angle of each point of the plate is approximately equal to the tangens of this angle, we will write down: $u = -z\frac{\partial \omega}{\partial x}$; $v = -z\frac{\partial \omega}{\partial y}$. Then deformations are equal to:

$$\varepsilon_x = -z\frac{\partial^2 \omega}{\partial x^2}; \quad \varepsilon_y = -z\frac{\partial^2 \omega}{\partial y^2}; \quad \gamma_{xy} = -2z\frac{\partial^2 \omega}{\partial x \partial y}.$$

The equation for stress in the matrix form would be written down as follows (planer stress):

$$\begin{Bmatrix}\sigma_x\\ \sigma_y\\ \tau_{xy}\end{Bmatrix}=\frac{E}{1-\nu^2}\begin{bmatrix}1 & \nu & 0\\ \nu & 1 & 0\\ 0 & 0 & \frac{1-\nu}{2}\end{bmatrix}\begin{Bmatrix}\varepsilon_x\\ \varepsilon_y\\ \gamma_{xy}\end{Bmatrix} \quad (1)$$

Thus, stresses and deformations field will be determined by only one independent variable, the deflectiobn $\varphi(x,y)$.

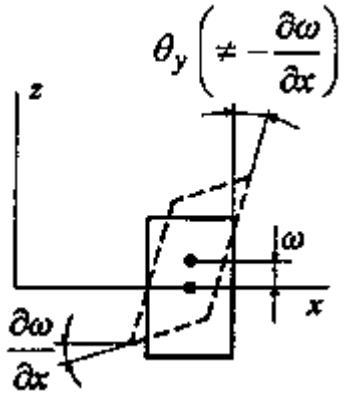
Equilibrium equations for thin plate will be as follows:

$$D\nabla^4\omega = q(x,y) \quad (2)$$

where $D=\frac{Et^3}{12(1-\nu^2)}$ – is the cylindrical stiffness of plate;

$\nabla^4 \equiv \left(\frac{\partial^4}{\partial x^4}+2\frac{\partial^4}{\partial x^2\partial y^2}+\frac{\partial^4}{\partial y^4}\right)$; q(x,y)-is the distributed load.

For the solution of differential equation (2) are necessary boundary conditions, in particular for the rigidly fixed on the contour plate we will have: $\omega=0,\ \frac{\partial\omega}{\partial n}=0$



If the plate thickness t is not so small $\left(\frac{t}{L}\geq\frac{1}{10},\right)$, where L is the characteristic size of the plate then such tiles can not be considered as "thin" plates. In this case $\gamma_{xz}\neq 0,\ \gamma_{yz}\neq 0$, that means that prior deformation the line that is in normal to mean surface, do not stay in the perpendicular of surface after the deformation. In this case, as new variable is represented θ_x and θ_y that represents an inclination angle of perpendicular to the mean surface line prior the deformation (see Fig. 3) accordingly on the *x* and *y* axes. The main relations are:

$u=z\theta_y,\quad v=-z\theta_x,$

ig. 3

$$\varepsilon_x = z\frac{\partial\theta_x}{\partial x},\ \varepsilon_y = -z\frac{\partial\theta_x}{\partial y},\ \gamma_{xy} = z\left(\frac{\partial\theta_y}{\partial y} - \frac{\partial\theta_x}{x}\right),$$
$$\gamma_{xz} = \frac{\partial\omega}{\partial x} + \theta_y, \qquad \gamma_{yz} = \frac{\partial\omega}{\partial y} - \theta_x. \tag{4}$$

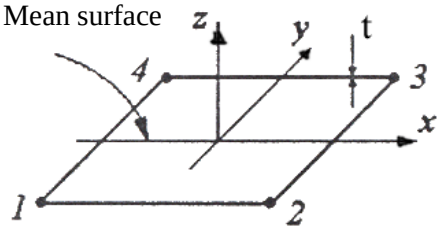


Fig. 4. Four node thin rectangular finite element

The four-node thin rectangular finite element schematically is shown in Fig. 4. Each node has 3 degrees of freedom. Within the ω, $\frac{\partial\omega}{\partial x}$, $\frac{\partial\omega}{\partial y}$ element the displacement of $\omega(x,y)$ point would be written down as follows:

$$\omega(x,y) = \sum_{i=1}^{4}\left[N_i\omega_i + N_{xi}\left(\frac{\partial\omega}{\partial x}\right)_i + N_{yi}\left(\frac{\partial\omega}{\partial y}\right)_i\right]$$

where N_i, N_{xi}, N_{yi} – are the shape functions. The stiffness matrix will be written as follows: $[k] = \int_v [B]^T [E][B]dv$. The thick-walled rectangular eight-node finite element schematically is presented on Fig. 5. In addition, each node has 3 degrees of freedom: ω, θ_x, θ_y for each element linear and angular displacements would be expressed by shape functions as follows:

$$\omega(x,y) = \sum_{i=1}^{n} N_i\omega_i; \qquad \theta_x(x,y) = \sum_{i=1}^{n} N_i\theta_{xi},\ \theta_y(x,y) = \sum_{i=1}^{n} N_i\theta_{yi}.$$

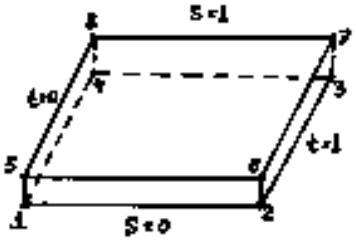


Fig.5 thick-walled rectangular eight-node finite element

Let's consider aluminum 1000×500×3 mm plate with stiffness 3×30 mm ribs, in addition stiffness ribs are arranged along the symmetry axis. The mechanical characteristics of the material are E=7200 kg/mm², Poisson's ratio ν=0.3. This plate is rigidly mounted on the contour and on it is applied the uniformly distributed load with intensity q=0.001 kg/mm². The modeling was carried out in the first case as plate plus rod. The results are presented on the Figure shows.

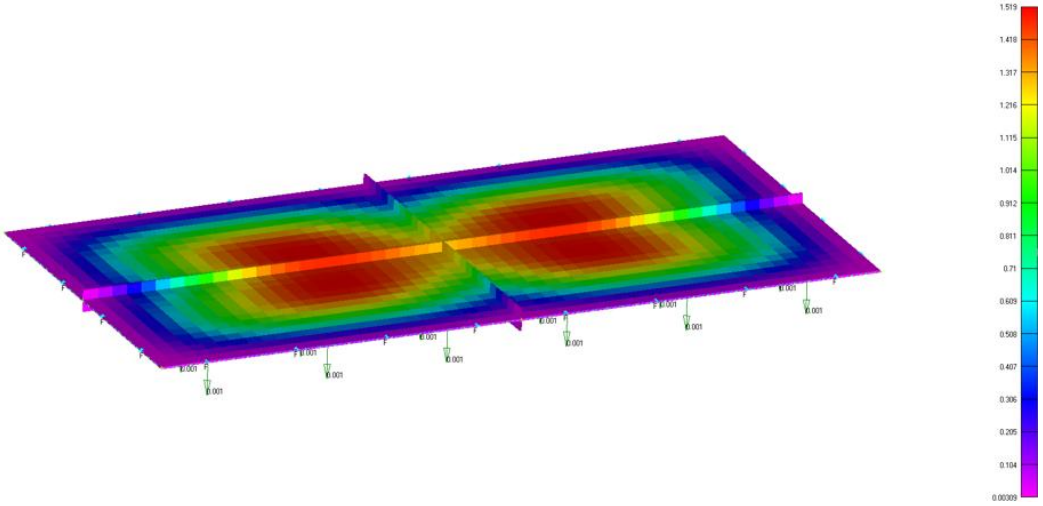


Fig. 6. The maximum deflection of plate where the stiffness ribs are as rods

The maximum deflection δ=1.519 mm, and stresses in the plate and stiffness ribs are presented on Fig. 7,8.

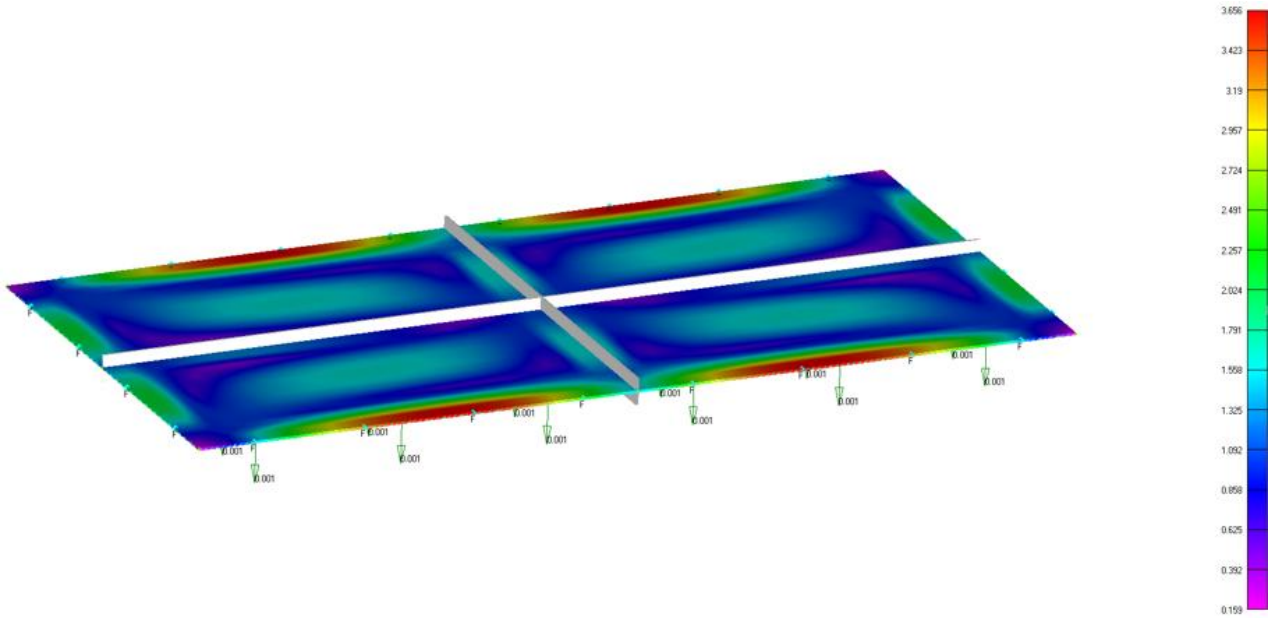


Fig. 7. The maximum stress in the plate where the stiffness ribs are as rods

The maximum stress in the plate: σ=3.656 kg/mm², and the maximum stress in the rod is equal to:

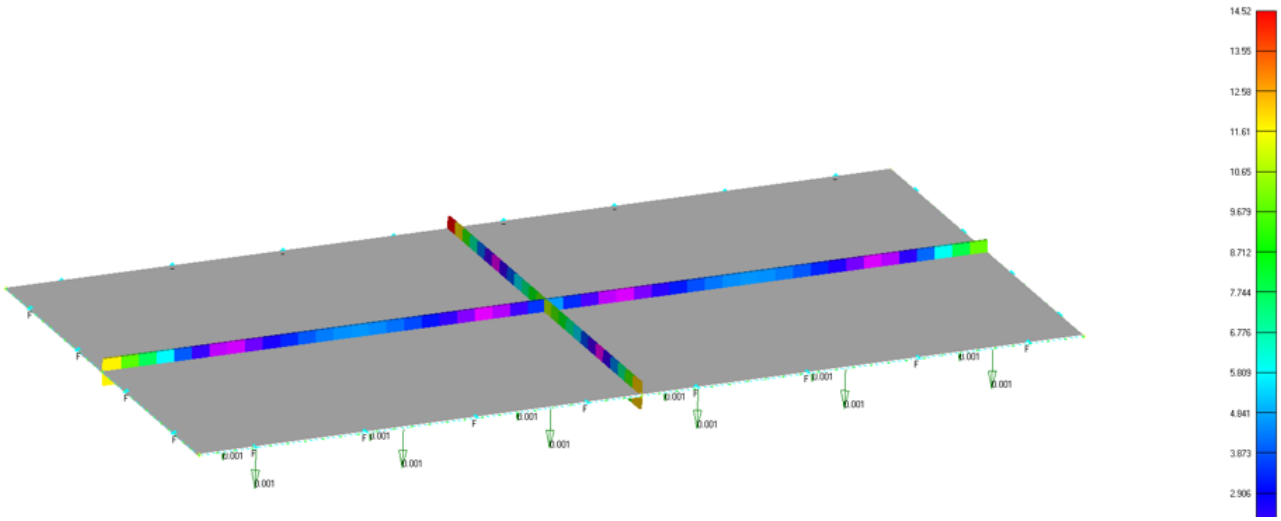


Fig. 8. The maximum stress in rod: σ=14.52 kg/mm²

In the second variant the plate with stiffness ribs was modeled by four node bending element, the maximum deflection of the plate makes δ=0.846 mm (see Fig. 9,10)

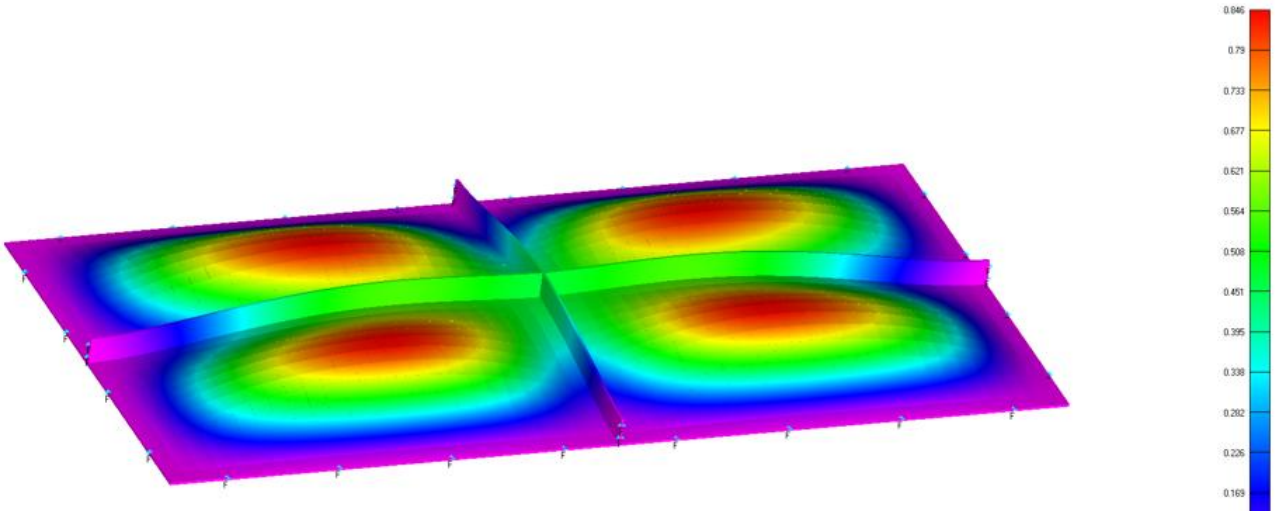


Fig. 9. The maximum deflection of the plate with stiffness ribs as plate and maximum stress is equal to: σ=6.963 kg/mm²

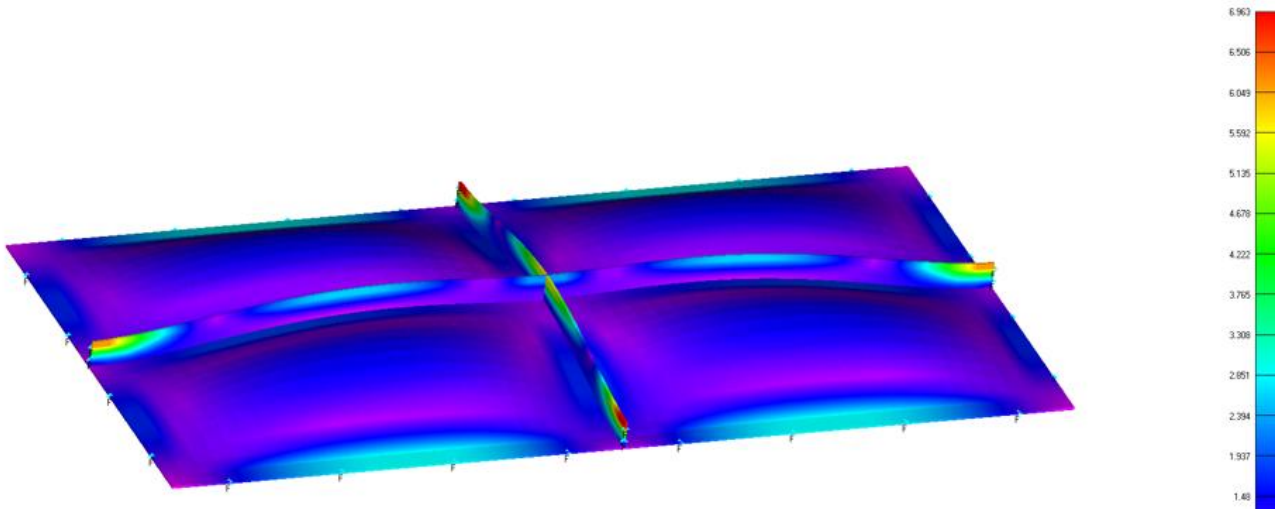


Fig. 10. The maximum stress of the plate with stiffness ribs as plate

In the third version the plate with stiffness ribs is modeled by eight node (parallelepiped) bending element. The maximum deflection of the plate makes δ=0.782 mm (see Fig. 11,12).

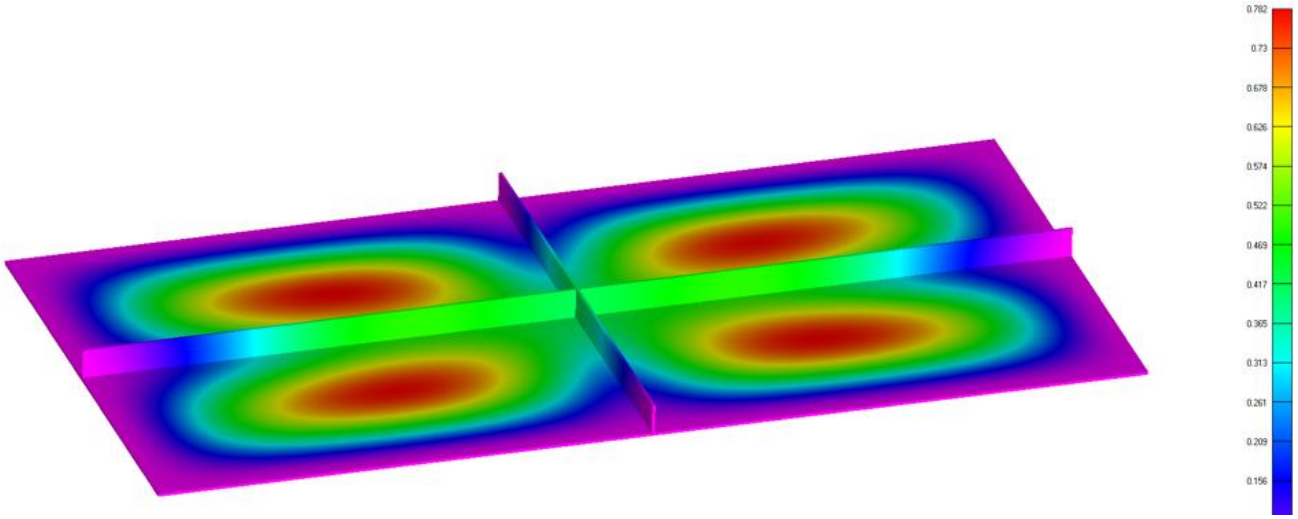


Fig. 11. The maximum deflection of the plate with stiffness rib as three-dimensional finite element

The maximum stress is equal to: σ=7.648 kg/mm².

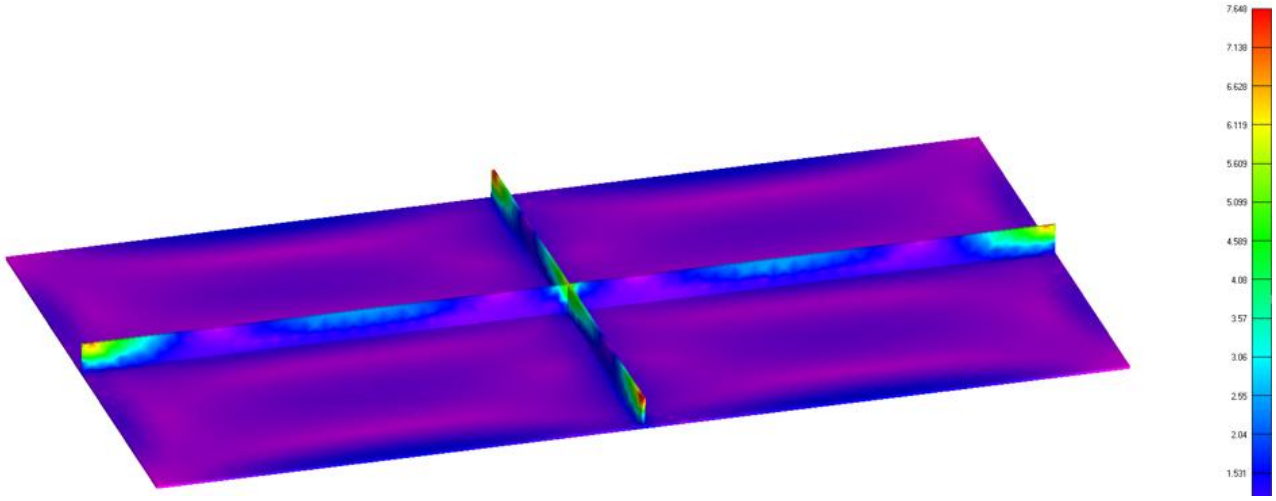


Fig. 12. The maximum stress in the plate with stiffness rib as three-dimensional finite element

The analysis was carried out in software complex Nastran.

2. CONCLUSIONS

As a result of the carried out analysis we can conclude: the calculation of the plate with stiffness ribs is possible by Finite Element as plate of (if plate is thin), as well as by a three-dimensional finite element, the results will coincide with 0.5% accuracy. As for the analysis of model plate plus rod it is different within the range of 10%.

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РАСЧЁТ ИМЕЮЩИХ ПОПЕРЕЧНЫЕ И ПРОДОЛЬНЫЕ РЕБРА ЖЕСТКОСТИ ПЛАСТИНОК МЕТОДОМ КОНЕЧНЫХ ЭЛЕМЕНТОВ

Д. Кипиани, С. Блиадзе, Н. Блиадзе

В статье даётся расчёт пластины с ребрами жесткости применением метода конечных элементов, в то же время в первом случае ребра жесткости представлены в виде конечного элемента стержня, во втором случае они представляются как конечный элемент пластины, а в третьем случае она представлена в виде трехмерного конечного элемента. Изложены результаты сравнительного анализа.

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Applied and Experimental Mechanics

DETERMINATION OF FATIGUE CHARACTERISTICS USING FATIGUE CURVES

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Abstract: *Are presented plotted fatigue (Woehler) curves based on the results of experimental researches of carried out on the Miilux Protection 500 steel samples and based on them fatigue characteristics theoretically obtained using Ansys Workbench software; the experimental and theoretical research results and their coincide are assessed.*

1. INTRODUCTION

In the most of the machine's structure during operation due the complex nature of the loads are originated micro-cracks that further often will be the source of macro-cracks generation. Up to 70% of structures collapses are stipulated due metal fatigue. Unfortunately, currently are not exist approach that gives the possibility to full-scale analysis of certain structure's fatigue. Despite scientists' efforts, practically are not exists such theoretical methods of fatigue analysis, where sill be separated experimental study and with the necessary for arbitrary material basic physical and mechanical characteristics will be also presented the fatigue characteristics.

Therefore is necessary to conduct appropriate research on samples to be determined not only the mechanical characteristics of the material, but also the fatigue characteristics.

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[**] Master
[***] Bachelor

Fig. 1. Sample experiments

Fig. 1. Sample experiments

Fig. 1. Sample in conditions of experiments

2. BASIC PART

For determination of the fatigue characteristics by special testing methods on the laboratory installation were carried out cyclic loads on samples (Fig. 1).

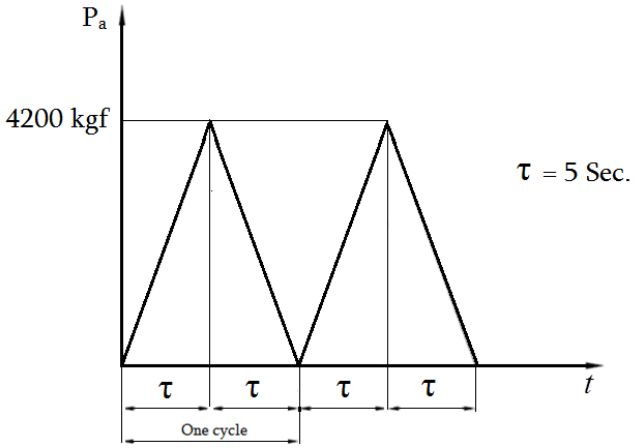

Fig. 2. Sequence diagram of loads

The check of cracks generation in used in the experiment 25 samples after each 10000 cycles was conducted due the magnetic control (MDC-5 magnetic-particle flaw detector). In order to determine the reduction of caused by fatigue ultimate stresses values for fracture of the each sample were carried out in conditions of Fig. 1. After the 150000 cycles, cracks were not observed on the tested samples. Caused due fatigue values of ultimate stresses are represented in Table 1 .

Table 1

N (10^4)	0.1	0.2	0.5	0.75	1	1.44	2.07	2.97	4.28	6.16	8.86	12.74	18.33
S_a (kgf/mm^2)	155.4	143.3	133.5	122.7	112.8	102.17	93.58	84.64	77.07	69.76	62.77	56.04	50.52
N (10^4)	18.33	26.36	37.93	54.55	78.47	112.9	162.4	233.57	335	483.3	695.2	1000	
S_a (kgf/mm^2)	50.52	45.19	42.02	40.3	39.11	38.08	37.34	36.87	36.52	36.06	35.66	35.31	

$$S_a = \frac{S_{\max} - S_{\min}}{2} = \frac{S_{\max}}{2} \quad ,$$

where $S_{\max}$ and $S_{\min}$ are the maximal and minimal magnitudes of loads.

According to these data was plotted dependency diagram between the number of loading periods and ultimate stresses (Fig. 3), which represents the mentioned material fatigue - Woehler curves (Fig. 3). The diagram is plotted in asymmetrical load conditions of sample, when $R = \frac{S_{\min}}{S_{\max}} = 0$ (Fig. 3).

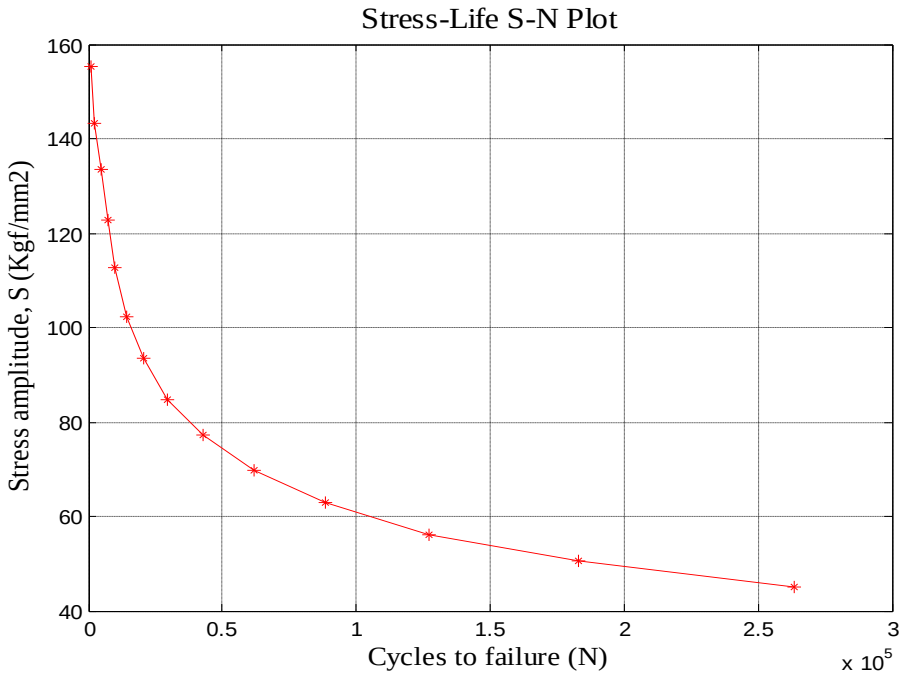

Fig. 3. S-N curve for Miilux Protection 500 steel

For Miilux Protection 500 steel based on experimentally obtained S-N curve by application of Ansys Workbench software Fatigue analysis module was calculated remaining number of standard sample cycles. The geometric dimensions of the sample are given in Fig. 4. Its mechanical characteristics are: ultimate stress $S_{UTS} = 155.44 \ \ kgf / mm^2$, modulus of elasticity $E = 21000 \ kgf / mm^2$, Poisson's ratio $\nu = 0.3$. The sample was rigidly mounted on one side f, while on their other side is applied tension force $P_a = 4200 \ kgf$. The fatigue test was conducted accordingly of presented on Fig. 2 sxheme.

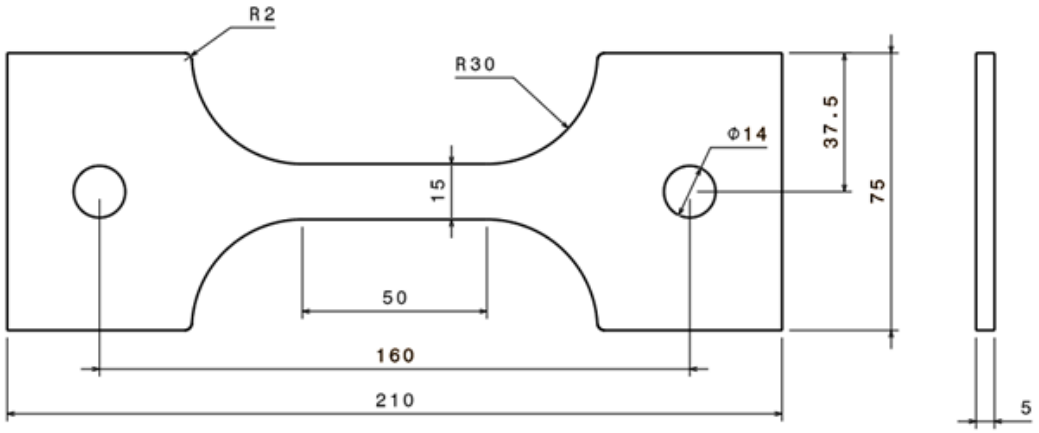

Fig. 4. Geometric dimensions of sample

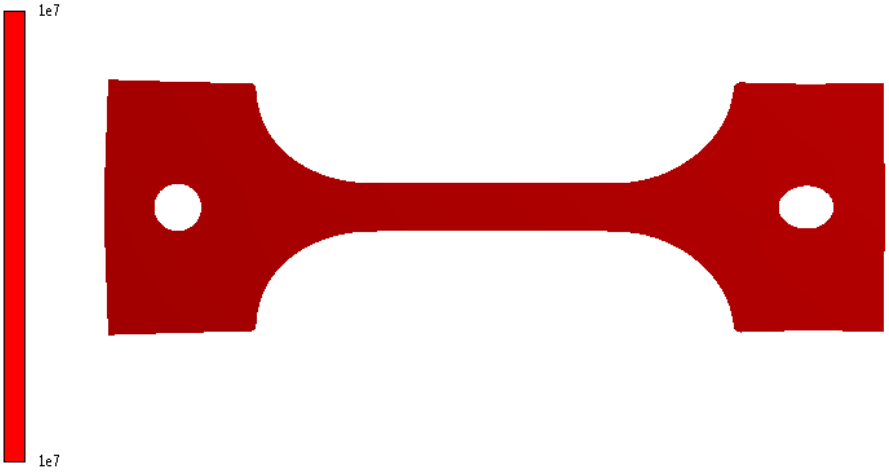

Fig. 5. The maximum number of remaining cycles

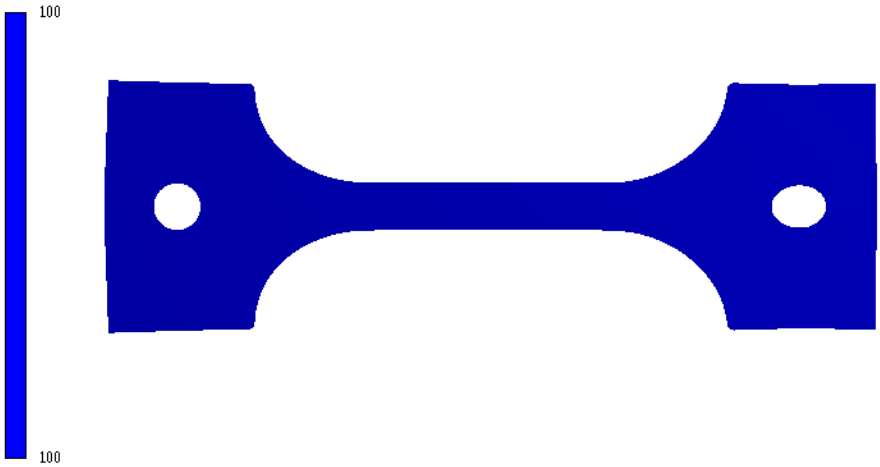

Fig. 6. The maximum number of accumulated fractures

Presented on the Fig. 5 and 6 results show that the mentioned sample under the given variable load conditions did not fatigue and accordingly were not observed accumulated fractures, which means that the sample does not have cracks and remains the infinite number of cycles (remaining number of cycles means that before the expiration of remaining number of cycles crack formation is impossible).

Similarly, when the load is $P_a = 7000$ kgf, the obtained results will be as.

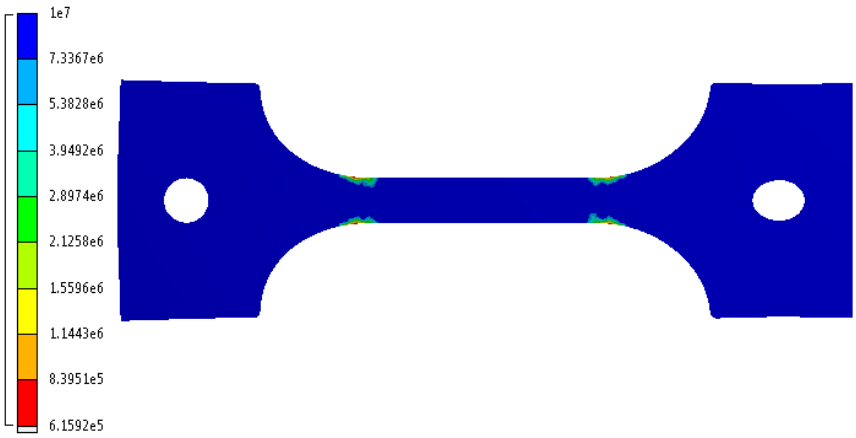

Fig. 7. The maximum number of remaining cycles

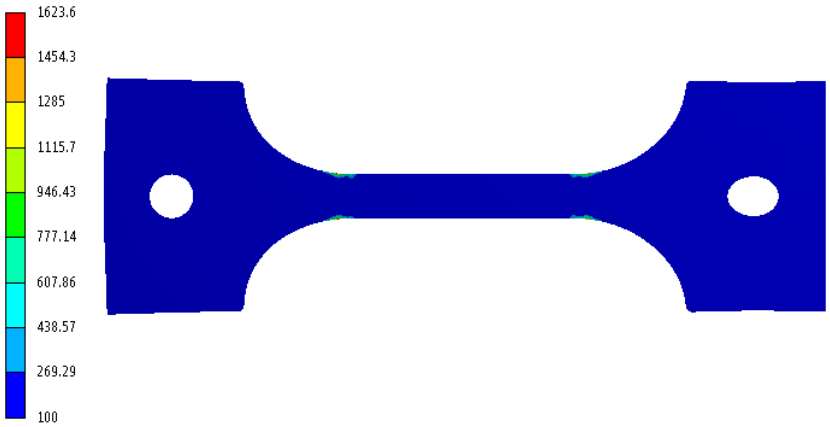

Fig. 8. Maximum number of accumulated fractures

From Fig. 7 and 8 is clear that due increasing in the amplitude of load remaining number of cycles is reduced from infinity up to $6.16 \cdot 10^5$.

3. Conclusion

For Miilux Protection 500 steel experimentally were determined the character of dependency of stresses values on the cycles, based on that for mentioned material was plotted S-N or Woehler curve. For the same material samples by Ansys Workbench software analysis Fatigue module were determined indicators of fatigue. The error between the theoretical data comparing with results of experiments does not exceed 2-5%.

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ОПРЕДЕЛЕНИЕ УСТАЛОСТНЫХ ХАРАКТЕРИСТИК С ИСПОЛЬЗОВАНИЕМ КРИВЫХ УСТАЛОСТИ

Г.Г. Цирекидзе, С.Н. Блиадзе, А.А. Гоголидзе , С.С. Блиадзе

Представлены построенные согласно результатам проведённых на образцах из стали марки Miilux 500 кривые усталости (Вёллера) и теоретически полученные на их основе характеристик с помощью программного обеспечения ANSYS Workbench показатели усталости; оценены экспериментальные и теоретические результаты исследований и их совпадение.

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economics

EUROPEAN COMMON AVIATION AREA AGREEMENT BETWEEN GEORGIA AND THE EU AND ITS MEMBER STATES AND ITS CHALLENGES FOR GEORGIA

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Abstract: *The Georgian-European Union (hereinafter reffered to as "EU") Relation during last years became significantly close. Georgia is seeking to integrate into the EU. Before integrating of the state into the EU, it is necessary requirement of EU that the legislation of Georgia to be harmonized with EU one. In the frame of the mentioned close relations and cooperation, on the one hand Georgia and on the other hand the EU and Its Member States, on December 2 of 2010 signed the "European Common Aviation Area Agreement" (hereinafter reffered to as "ECAA Agreement" or "Agreement"). By signing the Agreement Georgia took the obligation to harmonize its aviation legislation with the EU Regulations and Directives.Considering the mentioned fact, Georgia is currently implementing the obligations derived from the ECAA Agreement.*

Keywords:*European Common Aviation Area Agreement (ECAA Agreement), European Union (EU), Georgian Civil Aviation Agency (GCAA), Ministry of Economy and Sustainable Development of Georgia (MoESD), Special Drawing Right (SDR).*

Purpose of the article: The main aim of the followingarticle is the discussion of the existing problems and challenges which were originated in the implementation process of the ECAA Agreement as the future development of the civil aviationof Georgia is tightly related to the mentioned Agreement.

Exposition and main material: According to the Association Agreement (AA) between Georgia and the EU the gradual liberalization of air transport, which is in compliance with their reciprocical commercial needs and market access, must be governed by the ECAA Agreement between Georgia and the EU and its member States.[6]

Considering the liberal policy in civil aviation domain of Georgia, the ECAA Agreement is very important one which aims to integrate Georgian civil aviation into the wide European aviation area, and in fact it is a prerequisite for the integration of Georgia in the EU, and therefore the Agreement has high importance for Georgian side.Further to the liberal policy announced by Georgia in civil aviation domain

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** Student.
[6]Association Agreement between the European Union and the European Atomic Energy Community and their Member States, of the one part, and Georgia, of the other part, Article 125.

since 2005[7], the EU in 2008 expressed its interest for the integration of Georgian civil aviation into the European Common Aviation Area. Following to the recomentationmade by the EU in 2009, only Georgia from the whole Caucasian Region was proposed to sign the ECAA Agreement. By taking this step, the civil aviation of Georgia formally entered the EU, before the State into the EU and became a good example by its aspirations in the whole East Region States. After several rounds of the negotiations Georgia finally signed the ECAA Agreement in 2010. The ratification from Georgian side was made in 2011. Notwithstanding the signature and the ratification of the agreement, the key provision for the entering into force the agreement is that it must be ratified by all EU member states. At present only 4 states remained to ratify the Agreement.The ECAA Agreement by its composition and provisions is mostly like anordinary bilateral Air Services Agreement, but it has much more important character as one might think at the first sight. The case is that the only aim of the agreement is not to make a legislation base for direct regular flights between the two parties, but also the harmonization of Georgian aviation legislation with the European one. To explain obviously, the Agreement has e.g. Annex 3, which gives the list of the EU Regulations/Directives which must be implemented in Georgia. The overall number of the regulations is more than 50.[8] After implementing all the regulations in Georgia, the level of flight safety, aviation security and other aspects in Georgia will be the same as in the EU, the standards will be similar and the Georgian civil aviation will be a part of European one.At present Georgia has already implemented several regulations, and most of them are being implemented.

Obligations taken by Georgia in accordance with the ECAA Agreement: As it has already been mentioned the essential element for the membership of European Common Aviation Area is the harmonisation of Georgian legislation with the EU aviation legislation.

The regulations and directives to be implemented by Georgia have different character and regulate different kind of issues. In accordance with the regulatory opinion the Regulations and Directives are ordered into several groups: Flight Safety, Aviation Security, Environment Protection, Consumer Protection, Air Traffic Management, Competition Issues, and Social Aspects.

All the regulations must be implemented by Georgia.

Challenges for GCAA

The implementation of the EU Regulations and Directives in Georgia is conducted by the LEPL "Georgian Civil Aviation Agency" (hereinafter reffered to as "GCAA" or "Agency") of the Ministry of Economy and Sustainable Development of Georgia (hereinafter reffered to as "MoESD"). The main activity from the GCAA side is to elaborate draft EU Regulations and directives. After elaboration of such regulatioins, GCAA has to discuss it with the industry and the EU, and after that to submit the draft

[7] Presidential Order №211 of March 23, 2005.
[8]European Common Aviation Area Agreement between Georgia and the EU and Its Member States, Annex 3.

Regulationat theMoESD for their consent. After MoESD approval GCAA adopts the regulation and starts its implementation.It is very easy to describe the process how Georgia makes drafting and adopts a regulation, but the process is much more difficult than its general description.The elaboration and adoption of the EU regulation is as usual long and quite difficult process which requiresmostly 1-3 years period of time (in some case a little bit more or less) and the entire involvement of staff in the whole process.Considering the fact that GCAA has other very important functions besides the implementation of the ECAA Agreement liabilities, we run into the first challenge - lack of resources, which mostly involve human recourses.With the aim to overcome the mentioned challenge and assist Georgia in implementing the EU Regulations, EU funded Twinning project was granted to Georgia for 2 times. At present the second Twining project is underway. Both of the projects were/are very fruitful for Georgian side, as GCAA staff got European knowledge and experience for most of the Regulations. Besides that, the Twining group was/is assisting GCAA staff in drafting the Regulations, which significantly facilitates the implementation process of the regulations.Another important challenge for Georgia is the time frame, in which I assume the short time for implementing all the EU legislation in Georgia. In accordance with the ECAA Agreement, as I have already mentioned above, in order the Agreement to enter into force, it must be ratified by all member states (at present only 4 member states remained to ratify the Agreement), after which, but no more than 2 years the **Joint Committee** will evaluate the implementation of EU Regulations in Georgia[9], and in case of positive decision, the Agreement will be valid.[10]But the GCAA of the MoESD with the cooperation of EU funded projects does its best efforts to accelerate process and implement all the regulations in timely manner.The other challenge which is also rather painful is that some of EU Regulations require establishing a quite new system, mechanism which currently does not exist in Georgia. A very good example is the EU regulation 1008/2008 on the Operating Licence, which establishes the requirements for the financial sustainability of the air company. Every air company will have to hold such operating licence, which will authorize them to perform commercial flights. Issuing such Licence to air companies requires entirely new oversight mechanismwhich must be established in Georgia. Therefore, such regulations also affecting the implementation process, but it is a normal working process.

Challenges for industry: The ECAA Agreement requirements create challenges not only for the Civil Aviation Agency, but also for the Georgian aviation industry.The most important problem is that Georgia has not such strong aviation industry as the EU Member states. Therefore, every modification of legislation, which has even insignificant impact on their operations, is very sensitive and painful for the

[9]European Common Aviation Area Agreement between Georgia and the EU and Its Member States,Annex 2.
[10]European Common Aviation Area Agreement between Georgia and the EU and Its Member States, Annex 2, paragraph 1.

industry.To clarify and approve the mentioned theoretical issue, we would like to bring several examples. According to the ECAA Agreement together with the other regulations, Georgia has to implement 2 very important regulations: Reg. 1008/2008 on Operating Licence (Regulation (EC) No 1008/2008 of the European Parliament and of the Council of 24 September 2008 on common rules for the operation of air services in the Community), as mentioned above and the Regulation 785/2004 on the Insurance Requirements (REGULATION (EC) No 785/2004 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 April 2004 on insurance requirements for air carriers and aircraft operators) for air carriers[11]. The substantial aim of Regulation 1008/2008 is to make the financial regulation of air carriers and ensure their safe operations. The air carrier has to get quite a new licence which is not considered by Georgian legislation until today. Besides that, their operations must be ensured by financial warranty and the carriers must be able to perform flights without delay during 24 months notwithstanding the profitability[12]. Besides that the Air Carrier shall have to submit the business plan for the operations for 3 years in order GCAA to be ensured that the company has the healthy plan of operations. The challenge derived from this regulartion is that after entering into force the mentioned regulation, the airlines registered in Georgia will have to fulfill the new additional requirements.More problematic regulation for Georgian insdustry is the Insurance Regulation, which establishes the minimal limits of insurances. The limits look like as follows:

- For liability in respect of passengers, the minimum insurance cover shall be 250 000 SDRs per passenger.
- In respect of non-commercial operations by aircraft with a MTOM of 2 700 kg or less, Member States may set a lower level of minimum insurance cover, provided that such cover is at least 100 000 SDRs per passenger.
- For liability in respect of baggage, the minimum insurance cover shall be 1 000 SDRs per passenger in commercial operations.
- For liability in respect of cargo, the minimum insurance cover shall be 17 SDRs per kilogram in commercial operations.[13]

For third party legal liability the following limits will be in force after adopting the regulation[14]:

[11] European Common Aviation Area Agreement between Georgia and the EU and Its Member States, Annex 3.
12 Regulation (EC) No 1008/2008 of the European Parliament and of the Council of 24 September 2008 on common rules for the operation of air services in the Community, article 5.
[13]REGULATION (EC) No 785/2004 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 April 2004 on insurance requirements for air carriers and aircraft operators, article 6.
[14] REGULATION (EC) No 785/2004 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 April 2004 on insurance requirements for air carriers and aircraft operators, article 7.

Category	MTOM (KG)	Minimum insurance (million SDRs)
1	<500	0,75
2	<1 000	1,5
3	<2 700	3
4	<6 000	7
5	<12 000	18
6	<25 000	80
7	<50 000	150
8	<200 000	300
9	<500 000	500
10	≥500 000	700

Currently no such limits exist in Georgia; therefore, every requirement is quite innovative for Georgian aviation industry. The industry assumes that they will not be able to fulfill the insurance requirements, but we hope that they will.The Regulation 1008/2008 and 785/2004 are only two examples from that list of regulations, which Georgia has to implement in national legislation. So we can assume that Georgian aviation industry will have to stand in front of such challenges while implementation process.

Problematic solutions: Considering the abovementioned, it is clear that the implementation of the EU Regulations in Georgian one and harmonize legislation is rather difficult process. One may think that Georgia was not ready for such agreement and such many liabilities, but to our mind these problematic issues would be raised any time, whenever Georgia would have signed the ECAA Agreement.We realize that the process is really like impossible, but Georgia must go on the direction towards the EU.The implementation of the regulations was also difficult for other EU States, which have much more developed economy than Georgia. In many countries (for example Sweden), some companies did not manage to satisfy the newly adopted regulations and requirements and stopped their operations. And the Sweden is not the only example.To that in order the liabilities to be facilitated for the aviation industry, there must be close cooperation between the industry on the one hand and the CAA on the other hand and it is.As usual, GCAA when elaborating the draft Regulation, always involves the aviation industry in the process for their comments and remarks. In some cases (mostly in case of EU Directives) their opinion are considered. In other cases, GCAA tries to contact the EU and submit the comments from the industry, and in case of reasonability such ideas are included in the regulation, though the policy of EU and therefore of GCAA is to impose exactly such requirements in Georgian national legislation as it is imposed by Regulation.For Georgian airlines, it is a positive moment that the entire EU aviation market will be open for Georgian air companies, therefore, the airlines will have possibility to make new conections, new flights, transport more passengers and develop itself in this way.Taking into account the

all above noted, to our mind there is no any unresolved problems and Georgian air companies will go on working in their usual working regime.

Conclusion

As a conclusion we might highlight that the signature of ECAA Agreement on December 2 of 2010 was quite a progressive, prosperous and development oriented decision which was made by the Georgian Government.As we have already mentioned, Georgia would anyway and any time have to run into such problems whenever it should have signed the ECAA Agreement. In this case, the process was just accelerated in time and those which would might be done (for example) in 2020, was done in 2010. To say the truth it is very good and progressive decision. The earlier Georgia starts integration into the EU Structures, earlier it will become a member of the EU.All the mentioned creates a base for the development of Georgian civil aviation safely and sustainably, attracting new air companies in Georgian aviation market, encouriging the competition, enhancing the number of passengers, and the realizing much more better the transit potential of Georgia. Besides that, the integration of Georgian civil aviation into the European one, will promote the prestigue of Georgia in the whole aviation world. Considering all the factors, after entering into force the ECAA Agreement, Georgia will be become much more attractive country for flights, or passenger, that will itself have a positive impact on the development of the Economy of Georgia.

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- **Regulation (EC) No 1008/2008 of the European Parliament and of the Council of 24 September 2008 on common rules for the operation of air services in the Community.**

МЕЖПРАВИТЕЛЬСТВЕННОЕ СОГЛАШЕНИЕ О ЕДИНОМ ВОЗДУШНОМ ПРОСТРАНСТВЕ МЕЖДУ ГРУЗИЕЙ И ГОСУДАРСТВАМИ-ЧЛЕНАМИ ЕВРОСОЮЗА И ЕГО СТАНОВЛЕНИЕ В ГРУЗИИ.

Ю. Сухиташвили, М.Миндиашвили, Д.Тепнадзе

Последнее время происходит значительное сближение Грузии с Евросоюзом (в дальнейшем ЕС) . Грузия стремится в ЕС, но интеграция Грузии в ЕС должна отвечать всем требованиям ЕС. В связи с этим законодательство Грузии должно быть максимально приближено к законодательству ЕС.В рамках вышеуказанных тесных отношений и сотрудничества с одной стороны Грузии, с другой ЕС и ее государств, 2 декабря 2010 был подписан договор об использовании “единого европейского воздушного пространства”. В связи с подписанием этого документа Грузия взяла на себя определенные обязательства, что приведёт грузинское законодательство в области гражданской авиации в соответствие с требованиями европейской регуляции и директив.В связи с вышеуказанным Грузия в настоящее время осуществляет исполнение тех обязательств которые истекают из вышеуказанного соглашения.

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Economics

ESTABLISHMENT OF STATE AIRLINE – GEORGIAN LEGISLATION AND EU PRACTICE

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Abstract: *The main purpose of this article is the consideration of essential issues for the registration and operation of state owned airline as well as healthy operations of such air companies. In this frame the requirements of Georgian and EU Legislation will be discussed, as well as the EU practice for the establishing and aiding ofthe airline.*

Keywords:*European union (EU), European Common Aviation Area Agreement (ECAA Agreement),European Court of Justice (ECJ), European Commission (EC), Georgian Civil Aviation Agency (GCAA., limited Liability Company (LLC), Air Operator Certificate (AOC).*

Establishment of the airline according to the Georgian legislation and existing Air Operator Holders.

Establishing an airline is not an easy and short process, as according to the Georgian legislation there are numbers of requirements which must be satisfied. First of all a person/persons must create a company, which will have a legal status (In most cases LLC – limited Liability Company). After establishing such company, if it is eager to get the Air Operator Certificate (essential document for operating flights) the company must satisfy the number of requirements[15] defined by GCAA (Georgian Civil Aviation Agency) Directorial order N142,"The Air Operator Certification Rule", dated 19/07/2013. In case of satisfaction of all the requirements (which is rather difficult one) imposed by order N142,the airlines will be granted Air Operator Certificate which authorizes the company to operate commercial Air Services[16].

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** Student.
[15]Order no. 142 of the Director of the LEPL - Civil Aviation Agency dated 19 August, 2013 on the Approval of "The Air Operator Certification Rule", article 4.
[16]Order no. 142 of the Director of the LEPL - Civil Aviation Agency dated 19 August, 2013 on the Approval of "The Air Operator Certification Rule", article 7.

Nowadays in Georgia, there are about 10 airlines which hold a valid AOC: Georgian airways; Tusheti; TCA; AMS airlines; Bravo air; Air service; Service Air; Air Georgia; Georgian Aviation University; Sky Travel. It should be noted that all of these air companies are private companies and none of them is owned by the Government.

European Union Practice and attitude on the establishment of state airline and state aid

Considering the experience applied in the world, airlines can be established by physical and legal persons, as well as by the Government. Therefore, in any case it's possible a person or group of persons or even the government to be the owner of the airline.

The airline's owner may totally or partly hold the company's shares. In practice those states which are the owners of air companies, occupy 100% of the shares or more than 50% in order to maintain effective control of airline.

The creation, formation and functioning of the Government owned airline is not prohibited by any international act or regulation. Nowadays there are a lot of such companies which are mostly established during pre-liberalization period. For example: LOT Polish Airlines, Czech Airlines, Aeroflot, Flydubai, Qatar Airways, and Iraqi Airways etc. It should be noted that all these airlines are not owned by the Governments with 100% and according to the recent trends Governments are trying to sell their shares of the airline.

Worthy to note that holding of the airline by the state was very popular case in Europe. Such strong and serious Airlines as British Airways, Lufthansa, Air France etc. were also owned by the Government .However, the time has come when the existence of these airlines was under the question because of the serious financial problems and most of them were related to the bankruptcy. Considering of these problems, the airlines immediately were privatized.

Considering the fact that the future development of Georgian civil aviation is closely related to the European Union (as Georgia is a contracting party of the European Common Aviation Area Agreement), to our mind it will be very interesting and fruitful for Georgia to discuss the legislation of EU as well as practice of the EU regarding the establishing or state aid of the airline.

State Aid by the European Common Aviation Area Agreement between Georgia and the EU and its Member States

On December 2 of 2010 Georgia on the one hand and the EU and its Member States on the other side signed the **European Common Aviation Area Agreement (ECAA Agreement)**. By taking this step, Georgia chose the direction towards the EU and took obligations to harmonize Georgian aviation legislation with the EU one. Considering this fact, it is clear that the future perspectives for the development of Georgian civil aviation is closely related to the EU and its requirements. When we talk about establishment of state air company in Georgia, we must necessary consider the mentioned ECAA Agreement. Article 8 of this Agreement is regarding the competition issues and advises that the competitive environment between the two parties will be existed only in case of commercial activities and without state aid or subsidy[17].

State aid or financial assistance from the state to the air company which may affect the competitive environment is against the obligations Georgia accepted by the ECAA Agreement.

According to the Agreement any activity which may affect the competition must be evaluated by the EU legislation, especially by the article 107 of the Treaty on the Functioning of EU and other explanatory notes made by the other institutions of the EU.

The article 107 of the Treaty on the Functioning of the EU reads as follows[18]:

Article 107

1. Save as otherwise provided in the Treaties, any aid granted by a Member State or through State resources in any form whatsoever which distorts or threatens to distort competition by favoring certain undertakings or the production of certain goods shall, in so far as it affects trade between Member States, be incompatible with the internal market.

2. The following shall be compatible with the internal market:

(a) aid having a social character, granted to individual consumers, provided that such aid is granted without discrimination related to the origin of the products concerned;

(b) aid to make good the damage caused by natural disasters or exceptional occurrences;

(c) aid granted to the economy of certain areas of the Federal Republic of Germany affected by the division of Germany, in so far as such aid is required in order to compensate for the economic disadvantages caused by that division. Five years after the entry into force of the

[17]European Common Aviation Area Agreement between Georgia and the EU and Its Member States, signed on December 2, 2010.

[18]Consolidated versions of the Treaty on European Union and the Treaty on the Functioning of the European Union 2012/C 326/01.

Treaty of Lisbon, the Council, acting on a proposal from the Commission, may adopt a decision repealing this point.

3. The following may be considered to be compatible with the internal market:

(a) aid to promote the economic development of areas where the standard of living is abnormally low or where there is serious underemployment, and of the regions referred to in Article 349, in view of their structural, economic and social situation;

(b) aid to promote the execution of an important project of common European interest or to remedy a serious disturbance in the economy of a Member State;

(c) aid to facilitate the development of certain economic activities or of certain economic areas, where such aid does not adversely affect trading conditions to an extent contrary to the common interest;(d) aid to promote culture and heritage conservation where such aid does not affect trading conditions and competition in the Union to an extent that is contrary to the common interest;(e) such other categories of aid as may be specified by decision of the Council on a proposal from the Commission.

So under the Article 107, it is clear that state aid is not prohibited in all cases. Notwithstanding there were several cases in EU Practice when the states assisted the companies financially and exactly this became a bases for starting the investigation process. In the several pages I will review such cases, which attracted the EU attention:

Malev case

The airline "Malev" was established in 1954 and used to make its operations till 2012. From the beginning the Malev had Russian aircrafts (USSR) but recently they held west European aircrafts. The company was under the ownership of the Government of Hungary.

From 1999 till 2007the 99.5% of Malev shares were owned by the "Hungarian Government privatization company APV Rt". The remaining 0.5% was owned by another small companies, which had constantly been trying to privatize the Malev and in 2007 the result was that the Air Bridge ZRT (Air bridge Zrt was founded in 2005 and is based in Hungary) purchased the Malev's 99.9 percent.

In 2010 the company MNV which was owned by the Hungarian state, purchased 95%ofMalev shares and the company became the national airline once again. The remaining 5% was still in

the ownership of Air Bridge. Further to the illegal state aid to the air company, the European Commission (EC) has launched an investigation in December 2010.

On 9thofJanuary, 2012, The European Union deemed that the state aid from the Hungarian Government to the Malev was illegal and the company would never be able to make such profit after its commercial operations. The EU Commission requested the Government of Hungary to put money back from the Airline. Simultaneously, the ECapplied to the airline about the returning back of the aid, which amounted to a total of 171 million US Dollars. In late January 2012 it was clear that Malev could not funded its operators and asked for help from the state. Since its two aircraft had been deprived at international airports in Europe by its creditors, on 3 February2013 the company has cancelled 66 years uninterrupted operation. At the moment when the airline stopped the functioning it had approximately 270.5 million USD debt. On February 4, 2012 the Budapest Metropolitan Court declared bankruptcy of Malevand liquidation process began.

After conducting the investigation the European Commission found that in 2007-2010 the state aid received by the airline was illegal.[19]

Lufthansa case

Deutsche Lufthansa AG, commonly known as Lufthansa (sometimes also as Lufthansa German Airlines) the largest airline in Germany, both in terms of passengers carried and fleet size. The airline was established in 1926 as Deutsche Lufthansa A.G (as Deutsche Lufthansa AG from 1933). Till 1993 the airline was controlled by the German State. The Government owned it's 51 percent (control package). In 1993 Lufthansa increased its capital by selling its shares, government as well as and the shares remained 35%. By 1996 the German State had only an indirect stake in the airline. In 1997 the German State has sold 37.5% of its share and the airline has become almost completely privatized.

At the same time, we should note the fact that the airline, while it was controlled by the state was very in front of the bankruptcy in 1991.

In 1993-1994 the Government of German has started negotiations about privatization of the airline. But the problem was raised from one of the key issues: how to resolve the airline's

[19]Strategies for Eastern European Airlines: The case of Malév Hungarian Airline, AdélNémeth, page 10-17.

accumulated deficit of assistance. Eventually the Government has decided to help the airline with 1 billion German Mark to eliminate the deficit, for airline in purpose to creating a separate pension fund. In 1994 the airline was reorganized.

Air France case

Air France stylized as AIRFRANCE, is the French flag carrier headquartered in Tremblay-en-France, (north of Paris). It is a subsidiary of the Air France–KLM Group and a founding member of the SkyTeam global airline alliance. Air France was formed on 7 October 1933, from a merger of several companies. From 1994 till 1996 the Air France airline got state aid 20 billion French Franc (about 3.3 billion USD) from the French Government. Exactly this issue was discussed by European court of justice and later by EC.

In 1998 the European Court of Justice (ECJ) considered that the massive state aid from French Government given to the Air France was illegal, as the aid from the Government was not in compliance with the common market demands and it had negative impact on the competition as the Air France discovered in the privileged conditions compared to other airlines. It should be noted that afterthe ECJ made a decision, hearings of the case was not over. The topic has become a subject of discussion by theEC in 1998. The Commission has studied the issue and finally decided that the French state aid did not infringe with the EU rules. The state aid was compatible with the common market rules of the European Union and European Economic area agreement. The decision made by the ECJ was canceled[20].

Olympic Airlines

Olympic Airlines was the flag carrier airline of Greece with head office in Athens. They operated services to 37 domestic destinations and to 32 destinations world-wide. Their main base was at Athens International Airport, with hubs at Thessaloniki International Airport, "Macedonia", Heraklion International Airport, "Nikos Kazantzakis" and Rhodes International Airport, "Diagoras". Olympic Airlines also owned a base at London Heathrow International Airport. By December 2007, the airline employed about 8,500 staff.

[20]Strategies for Eastern European Airlines: The case of Malév Hungarian Airline, AdélNémeth, page 5-7.

Olympic Airline case is really a notable one, under which the Greek state aid given to the company was declared as a violation of the rules in 1994. After the reorganization of the Airline, in 2004 the company continued its functioning. However the airline was losing money. In 2006 the Greek State offered new aid to the Olympic Airlines, which also was considered as illegal as it was against with existing legislation of the European Union. The essential aim of the state subsidy was to cover aircraft leasing costs and airline debts including the charges to the Greek Civil Aviation Authority. The state aid received by the airline was considered as non-compatible with European Union legislation and by the EC. As a result the Olympic Airline had to refund money back[21].

we'd like to mention such strong and huge airlines as British Airways and Iberia, which were also under the ownership of the Government but later they were privatized after which their development process was much more accelerated.

Its notable fact that, during last years the privatization procedures of the Airlines has been underway. During 2012 the Czech Republic has reopened Czech Airlines-'s procedures for the sale, as well as the Latvian airline Air Baltic- has already announced in Financial Times the sale of 50% of the flight. The state of Estonia has announced one of possible variant about closing of the Estonian airline, while Serbia was trying to sell the Jat Airways Airline to Etihad Airways which is established in Abu Dhabi.

Joining to the European Union of the new states had two side for these state airlines. On one hand the European Union's common air market was opened for these airlines and this fact could contribute increasing these airline's income and on the other hand the Competition Law of the European Union has restricted the chance of state aiding for airlines. On the base of such restrictions the EC has started the investigation about state aids which was given to these airlines: **Air Baltic; Adria Airways**[22]; **Estonia Air**. The EC has also stated the depth investigation about **Lot Polish Airlines in 2013**[23]**.**

Conclusion

[21]Strategies for Eastern European Airlines: The case of Malév Hungarian Airline, AdélNémeth, 6-7;
[22]European Commission, Press release, Brussels, 20 November 2012 - State aid: Commission opens in-depth inquiry into state measures in favor of Slovenian airline Adria Airways.
[23]European Commission, Press release, Brussels, 6 November 2013 - State aid: Commission opens in-depth inquiry into €200 million restructuring aid for LOT Polish Airlines.

As a rule, when the Government helps the Airline, it gives to an Airline a privilege compared to other companies. Accordingly, the agreement on the Functioning of the European Union prohibits the state aid, except the cases when the State aid is due to the development of the general economic situation[24]. The compliance of the State aid given to the Airlines with the European Union (EU) rules, provides the EC. If the State is going to help an Airline, in this case the Government is obliged to announce to the EC about this fact. This rule applies to all these countries, which are the members of the European Union and the states which have undertaken to bring the EU legislation as well as. As regards the establishment of the State airlines, the EU legislation does not contradict the establishment of the State Airline and their functioning. The clear example of this are some of European States which have their own Airlines.

The most important fact regarding this issue is that the state aid or subsidy given to the air company, which put them in dominant and uncompetitive position, is prohibited by the EU principles regarding the competition. In case of such fact the EC launches the appropriate investigation process. On the other side we must necessary note that besides such state aid it is almost impossible to establish an airline. Herewith, we must also take into our mind the Article 107 of the Treaty on the Functioning of the European Union, which allows several cases when the state aid would not be deemed illegal.

Considering the all abovementioned it is obvious that the European Union does not prohibit the possibility to establish a state airline, if there is no illegal state aid.

Therefore, taking into account that Georgian civil aviation is closely related to the EU requirements, the EU provisions are also applicable to Georgia. So, at the end of this article I would like to express our opinion, the considering the all above said it seems that the establishment of state airline or its illegal state aid has no future in Georgia.

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[24]Consolidated versions of the Treaty on European Union and the Treaty on the Functioning of the European Union 2012/C 326/01, article 107.

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- **European Commission, Press release, Brussels, 6 November 2013 - State aid: Commission opens in-depth inquiry into €200 million restructuring aid for LOT Polish Airlines**

СОЗДАНИЕ ГОСУДАРСТВЕННЫХ АВИАКОМПАНИЙ ГРУЗИНСКОЕ ЗАКОНАДАТЕЛЬСТВО И ПРАКТИКА ЕВРОСОЮЗА

Ю. СУХИТАШВИЛИ, Д. ГЕЛАШВИЛИ

Основной целью данной статьи является рассмотрение вопросов регистрации и эксплуатации государственных авиакомпаний, а также вопросы оценки функционирования таких авиакомпаний. В этом ключе также обсуждены основные аспекты оказания государственной поддержки в создании таких авиакомпаний согласно требованиям законодательства Грузии и ЕС.

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SUMMARIES

METHOD FOR INCREASING THE ACCURACY OF ROLLING BEARING RINGS MICROGEOMETRY BY ADJUSTMENT OF SUPERFINISH DEVICES DYNAMIC STIFFNESS. **V. Shilakadze. "**Aviation Transport". Tbilisi, 2016, № 1 (11), pp. 11-18 , (Engl)
The theoretical analysis of dynamics of superfinishing process indicates on possibility to adjust of superfinishing mechanism inertia due that is possible to provide acquisition of required waviness of processing details. Due adjusting of stiffness at superfinishing is achieving reduction of height of waviness up to roughness level. 5 ill. Bibl. 12. Engl.; sum. in Russ.

NON-LINEAR DEFORMATION OF REINFORCED WITH RIBS PLATES. **G. Kipiani, G. Okropiridze, A. Paresishvili. "**Aviation Transport". Tbilisi, 2016, № 1 (11), pp. 19-24 , (Engl)

In the work are considered rectangular plates with rectangular hole, the edges of that are reinforced with ribs and reinforcement rods. The method of analysis, based on linearization of decisive equations by successive loadings method and application of discontinuous functions, gives the possibility to taking into account of concentration of stresses and non-linear deformation of structures and materials. Bibl. 12. Engl.; sum. in Russ

OSCILLATIONS OF MULTI-LINK STRUCTURALLY-INHOMOGENEOUS PRISMATIC SHELL STRUCTURE. **M. Vazagashvili. "**Air Ttransport". Tbilisi, 2016, №1 (11) , pp. 25-30 , (Engl.).

In the article are generated decisive equations of task on determination of dynamical characteristics of structurally-inhomogeneous prismatic shell structures from visco-elastic material, design diagram of that would be presented as arbitrary composition from multilayered non-circular cross-section cylindrical shells and straight stringers. 3 ill. Bibl. 6. Engl.; sum. in Russian.

SCIENTIFIC BASIS OF MANAGEMENT OF TRANSPORT COMPANIES INTERACTION **V. Novak, V. Marchenko, V. Perederii. "**Air Ttransport". Tbilisi, 2016, № 1 (11), pp. 31-36, (Engl.).

It is scientifically proved in the article that the modelling of traffic flows is one of the priorities of the transport systems study. Based on the process approach to the transport and logistics system, business processes that ensure the functioning and transport companies' interactions management were defined.

FACTORS OF LEADERSHIP POTENTIAL DEVELOPMENT OF AIR CARRIERS **L. Lytvynenko"**Air Ttransport". Tbilisi, 2016, № 1 (11), pp. 37-41 , (Engl.).

In the article the main features of strategic leadership of airlines were studied, the factors of leadership potential development of air carriers under uncertainty conditions were scientifically justified, the role of strategic flexibility in the change management aimed at strengthening leading positions in the market was analyzed.

PROSPECTS FOR THE ORGANIZATION OF PRODUCTION OF GROUND SUPPORT EQUIPMENT FOR AIRCRAFT IN UKRAINE **E.I. Danilova "**Air Ttransport". Tbilisi, 2016, № 1(11), pp. 42-48 , (Engl.).

In the article the authors examined trends in the development of the aviation industry in the regions and in developed countries separately, investigated capacities of Ukraine in engineering complex technology, the necessity of creating a modern complex engineering in Ukraine, the analysis of the effectiveness of the research industry and potential customers in the field of ground support equipment for aircraft.

METHODS OF FORECASTING TRANSPORTATION OF CARGOS **Kyrylenko O.N. "**Air Ttransport". Tbilisi, 2016, №1 (11) , pp. 49-54 , (Engl.).

The article is devoted to forecasts of cargo flow on railway transport.

THE POSSIBILITY OF TORNADO ANALYSIS. **G. Aptsiauri. "**Aviation Transport". Tbilisi, 2016, № 1 (11), pp. 55- 60 , (Engl)

In this paper, due analytical evaluation of the processes taking place in the tornado, is shown the dependence of maximum velocities on pressure fluctuations and is proved that within the range of pressure possible, moderate deviations is possible the existence of Fudzita scale low category

tornadoes. As for the extreme large-capacity tornadoes, their existence is expected only in the case of extreme large variability in atmospheric parameters, which is less forecasting, therefore, it is shown that tornadoes are belonging to nature's mysterious phenomena whose calculation and prediction by classic, universally recognized methods is practically impossible. Il. 1. Bibl. 4. Engl.; sum. In Russ.

DISPERSION OF ELECTRONS ON IONIZED ADMIZTURES IN SEMICONDUCTORS IN QUASI-TWO-DIMENSIONAL SEMICONDUCTOR SYSTEMS **K. Davitadze, Z. Gogua, T. Minashvili "**Aviation Transport". Tbilisi, 2016, № 1 (11), pp. 61-66 , (Engl)

In this paper there are calculated dependences between relaxation period of electrons and energy and between mobility and temperature in quasi-two-dimensional, non-degenerated semiconductor nanostructures using common model of admixture center. There is shown, that electrons' relaxation period and their mobility depends on depth of nanostructure, and depends greater on the radius of short-range potential influence (first coordination sphere radius). Also there is shown, that electron's relaxation period $\tau(\varepsilon)\sim\varepsilon$ and mobility $\mu(KT)\sim(KT)$ and there is calculated thermal electromotive force for this system.

TWO DIMENTIONAL EQULIBRIUM EQUATION FOR A SHARPENED SHELL **G.Devdariani**. **"**Aviation Transport". Tbilisi, 2016№ 1 (11), pp. 67-74 (Eng).

Paper covers the second order elliptic differential equation with singular coefficients. Paper aims to investigate some actual problems for this equation. Such type of equations arises in the theory of prismatic shells with the thickness degenerate. Correctness of the set problems is defended on the degree of singularity of coefficients and the geometry of the domain boundary.

CONTROL OF CHAOTIC PROCESSES USING SYNERGETIC METHODS **V.Sesadze, V.Kekenadze, G.Chikadze, N.Sesadze "**Aviation Transport". Tbilisi, 2016№ 1 (11), pp. 75-82 (Eng).

Not long ago, scientists thought that complex chaotic movement can only be created only in some multidimensional systems, but it turned out that it is also possible in nonlinear deterministic third rank systems. The processes that are common in nonlinear dynamic systems belong are chaotic. Mathematical models of such processes contain polynomial and quadratic nonlinearity that are widespreadin objects with

different nature. Because of these objects, the problem for controlling of chaotic processes that gets more and more attention within scientific literature.

In article difficult chaotic movement which arises in phase space in the nonlinear determined systems of the third degree is investigated. The problem of preservation biological populations at an optimum level taking into account competition in obtaining food is considered. It is shown that to feedback use in system there is a self-organization.

ORIGIN OF SYNERGETICS AND DEVELOPMENT ON THE BOUNDARY OF CENTURIES

V. Sesadze, N. Sesadze, Sh. Davitelashvili, I.Chvedelidaze "Aviation Transport". Tbilisi, 2016№ 1 (11), pp. 83-87 (Eng).

Synergetrics - the international disciplinary direction which studies the general regularity in self-organization of difficult systems. synergetrics I developed in structure of the following scientific directions: Physicist of joint events Herman Haken, thermodynamics of processes of nonlinear dynamics. So, the synergetrics has arisen as the theory of the cooperative phenomena in problems of laser subject, but gradually acquired more general status of the theory describing not closed, nonlinear, unstable, hierarchical, developing systems. Already in the field of natural sciences there is an opposition to such interpretation of synergetrics. Someone prefers to speak about nonlinear dynamics, or the theory of dissipative systems, the theory of open systems, the theory of dynamic chaos, an autopoezisa, etc.Synergetics, as a science, has being developed even today and we have to wait for new results within the next years.

THE GENERALIZED METHOD OF ANALYTICAL DESIGNING OF THE AGGREGATEDREGULATORS **V.Sesadze, G.Chikadze, A.Kekenadze "**Aviation Transport". Tbilisi, 2016№ 1 (11), pp. 88-94 (Eng).

Now, the most advanced fundamental direction in the theory and technology of management includes the physical theory of management, synergetic approach to problems of management, the theory of the self-organized regulators with extrapolation, the theory of indistinct and neural network control systems, etc.So, the control analytical designing of aggregated regulators synergetic method is the new direction in the theory of management which expands understanding of difficult management processes as considers the general objective and

power and is entropy - information substances in space and time.In article it is considered a problem of analytical designing of the aggregated regulators with use of synergetic methods. The abundance of outer or inner invariants can be changed based on whether goals of the system are constant or dynamic. In other words, we can make selection of types that are corresponding to dynamic invariants inside the physical (chemical, biological, economic) control systems and thus implement its self-organizing ability. It is shown that at decisions этои tasks a considerable and independent problem is formation of criterion of the corresponding quality.

REVEALING OF POTENTIALLY DANGEROUS SITUATIONS IN NORMATIVE-LEGAL DOCUMENTS AND UNDERLINE THE CRITERIA IN THEM **O.Shonia, L. Kolbaia** **"**Aviation Transport". Tbilisi, 2016№ 1 (11), pp. 95-101 (Eng).

In legal system normative-legal documentsuninterrupted systematic growth conditions necessity of this document interrelated visualization and analysis active use, to avoid potentially dangerous situations in term of law-making norm failure, legal collisions and resistances, increase adopted law systematization, effectiveness of law inventory and monitoring procedures. The work presents visualization of interrelation of normative-legal documents and revealing of potentially dangerous situations during the analysis and legal collision invention importance while drafting the mentioned documents, publishing systematization and underline criteria in them.

DEVELOPMENT OF MATHEMATICAL METHODS OF VISUALIZATION OF NORMATIVE-LEGAL DOCUMENTS **O.Shonia, L. Kolbaia** **"**Aviation Transport". Tbilisi, 2016№ 1 (11), pp. 102-106 (Eng).

Huge number of legislative information and dynamics of its changes requires from lawyers, students, businessmen and every interested persons to use modern methods and instruments during the process of working with legal information. Nowadays such instruments are legal directory system the aim of which is to provide users by authentic legal information. The work shows normative-legal documents and their interrelation mathematic model development in the legal directories systems.

ANALYSIS OF HAVING TRANSVERSAL AND LONGITUDINAL STIFFNESS RIBS PLATE BY FINITE ELEMENT METHOD **D. Kipiani, S. Bliadze, N. Bliadze "**Aviation Transport". Tbilisi, 2016№ 1 (11), pp.107-115 (Eng).

In this paper is stated analysis of plate with stiffness ribs by application of the Finite Elements method, at the same time in the first case stiffness ribs are presented as a finite element of rod, in the second case they are represented as the finite element of plate, and in the third case it is represented as a three-dimensional finite element. Are stated the results of the comparative analysis.

DETERMINATION OF FATIGUE CHARACTERISTICS USING FATIGUE CURVES **G.G. Tsirekidze, S.N. Bliadze, A.A. Gogolidze, S.S. Bliadze "**Aviation Transport". Tbilisi, 2016№ 1 (11), pp.116-122 (Eng).

Are presented plotted fatigue (Woehler) curves based on the results of experimental researches of carried out on the Miilux Protection 500 steel samples and based on them fatigue characteristics theoretically obtained using Ansys Workbench software; the experimental and theoretical research results and their coincide are assessed.

EUROPEAN COMMON AVIATION AREA AGREEMENT BETWEEN GEORGIA AND THE EU AND ITS MEMBER STATES AND ITS CHALLENGES FOR GEORGIA **Y. Sukhitashvili, M. Mindiashvili, D. Tepnadze "**Aviation Transport". Tbilisi, 2016№ 1 (11), pp. 123-129 (Eng).

The Georgian-European Union (hereinafter reffered to as "EU") Relation during last years became significantly close. Georgia is seeking to integrate into the EU. Before integrating of the state into the EU, it is necessary requirement of EU that the legislation of Georgia to be harmonized with EU one. In the frame of the mentioned close relations and cooperation, on the one hand Georgia and on the other hand the EU and Its Member States, on December 2 of 2010 signed the "European Common Aviation Area Agreement" (hereinafter reffered to as "ECAA Agreement" or "Agreement"). By signing the Agreement Georgia took the obligation to harmonize its aviation legislation with the EU Regulations and Directives.Considering the mentioned fact, Georgia is currently implementing the obligations derived from the ECAA Agreement.

ESTABLISHMENT OF STATE AIRLINE – GEORGIAN LEGISLATION AND EU PRACTICE **Y. Sukhitashvili, D. Gelashvili "**Aviation Transport". Tbilisi, 2016№ 1 (11), pp. 130 -138 (Eng).

The main purpose of this article is the consideration of essential issues for the registration and operation of state owned airline as well as healthy operations of such air companies. In this frame the requirements of Georgian and EU Legislation will be discussed, as well as the EU practice for the establishing and aiding ofthe airline.

РЕФЕРАТ

СПОСОБ ПОВЫШЕНИЯ ТОЧНОСТИ МИКРОГЕОМЕТРИИ КОЛЕЦ ПОДШИПНИКОВ КАЧЕНИЯ РЕГУЛИРОВАНИЕМ ДИНАМИЧЕСКОЙ ЖЕСТКОСТИ СУПЕРФИНИШНОГО УСТРОЙСТВА. **В.А. Шилакадзе. "**Авиационный транспорт". Тбилиси. 2016, № 1 (11), с. 11- 18, (Англ.)

Теоретический анализ динамики процесса суперфиниширования показывает возможность регулирования инерции суперфинишного механизма, с помощью которой можно обеспечить приобретение требуемой волнистости обрабатываемой поверхности. За счёт регулирования жёсткости при суперфинишировании достигается снижение высоты волнистости до уровня шероховатости. 5 ил. Библ. 12. Англ.

НЕЛИНЕЙНАЯ ДЕФОРМАЦИЯ ПЛАСТИН ПОДКРЕПЛЁННЫХ РЁБРАМИ. **Г.О. Кипиани, Г.А. Окропиридзе, А.Г. Паресашвили. "**Авиационный транспорт". Тбилиси. 2016, №1 (11), с. 19-24 , (Англ.)

В работе рассматривается прямоугольная пластина с прямоугольным отверстием, края которого подкреплены рёбрами и армирующими стержнями. Методика расчёта, основанная на линеаризации разрешающих уравнений методом последовательных нагружений и на применении разрывных функций, позволяет учитывать концентрацию напряжений и нелинейную деформацию конструкций и материалов. Библ. 12. Англ.

КОЛЕБАНИЯ МНОГОСВЯЗНОЙ СТРУКТУРНО-НЕОДНОРОДНОЙ ПРИЗМАТИЧЕСКОЙ ОБОЛОЧЕЧНОЙ КОНСТРУКЦИИ. **М.С. Вазагашвили. "**Воздушный транспорт". Тбилиси. 2016, №1 (11) , с. 25-30 , (Англ.).

В работе сформированы разрешающие уравнения об определении динамических характеристик структурно-неоднородных призматических конструкций из вязкоупругого материала, расчётная схема которых может быть представлена в виде композиции из многослойных цилиндрических оболочек некругового сечения и прямолинейных стрингеров. 3 ил. Библ. 6. Англ.

НАУЧНОЕ ОБОСНОВАНИЕ УПРАВЛЕНИЯ ВЗАИМОДЕЙСТВИЕМ ТРАНСПОРТНЫХ ПРЕДПРИЯТИЙ **В.А. Новак, В.Н. Марченко, В.В. Передерий** "Воздушный транспорт". Тбилиси. 2016, № 1 (11) с. 31-36 , (Англ.).

В данной статье научно обосновано, что моделирование транспортных потоков является одним из приоритетных направлений изучения транспортных систем. На основе процессного подхода к рассмотрению транспортно-логистической системы, определены бизнес-процессы, которые обеспечивают функционирование и управление взаимодействием транспортных предприятий.

ФАКТОРЫ РАЗВИТИЯ ЛИДЕРСКОГО ПОТЕНЦИАЛА АВИАКОМПАНИЙ **Л.Л. Литвиненко** "Воздушный транспорт". Тбилиси. 2016, № 1 (11) с. 37-41 , (Англ.).

В статье исследованы основные черты стратегического лидерства авиакомпаний, научно обоснованы факторы развития лидерского потенциала авиаперевозчиков в условиях неопределенности, проанализирована роль стратегического гибкости в управлении изменениями, направленном на укрепление лидирующих позиций на рынке.

ПЕРСПЕКТИВЫ ОРГАНИЗАЦИИ ПРОИЗВОДСТВА АВИАЦИОННОЙ ТЕХНИКИ НАЗЕМНОГО ОБСЛУЖИВАНИЯ В УКРАИНЕ **Э.И. Данилова**"Воздушный транспорт". Тбилиси. 2016, №1 (11) , с. 42-48 , (Англ.).

В статье рассмотрены тенденции развития авиационной промышленности, как в регионах, так и в развитых странах отдельно, исследованы производственные мощности Украины в машиностроении сложной техники, обоснована необходимость создания современного комплекса машиностроения в Украине, проведен анализ эффективности работы комплекса и поиск потенциальных клиентов в области техники для обслуживания воздушных судов.

МЕТОДЫ ПРОГНОЗИРОВАНИЯ ТРАНСПОРТИРОВКИ ГРУЗОВ **Кириленко О.Н.** "Воздушный транспорт". Тбилиси. 2016, №1 (11) , с. 49-54 , (Англ.).

Статья содержит информацию о прогнозировании объемов перевозок основных видов грузов железными дорогами Украины. Научно обоснованы методы прогнозирования транспортировки грузов.

О ВОЗМОЖНОСТИ РАСЧЁТА ТОРНАДО. **Г.А. Апциаури. "**Авиационный транспорт". Тбилиси. 2016, №1 (11), с. 55-60 , (Англ.)

В работе путём аналитической оценки происходящих в торнадо процессах показана зависимость максимальных скоростей от изменения давления и обосновано, что в рамках возможных изменений давления допустимо существование торнадо низких категорий по шкале Фудзита. Что касается торнадо очень больших мощностей, их существование ожидается только в случае больших изменений атмосферных параметровб что менее вероятно, соответственно, показано, что торнадо принадлежит к необъяснимым явлениям природы, расчёт и прогнозирование которых классическими всемирно признанными методами практически невозможно. Ил. 1 Библ. 12. Англ.

РАССЕЯНИЕ ЭЛЕКТРОНОВ НА ИОНАХ ПРИМЕСИ В КВАЗИ-ДВУХМЕРНЫХ ПОЛУПРОВОДНИКОВ **К. Давитадзе, З. Гогуа, Т. Минашвили "**Авиационный транспорт". Тбилиси. 2016, №1 (11), с. 61-66, (Англ.)

В работе исследовано рассеяние электронов на ионах примеси в двухмерных системах. Задача решается в единной модели примесного центра. В результате исследования получено, что время релаксации системы пропорционально енергии электронов и подвижность электронов пропорционально температуры.

УРАВНЕНИЕ ВТОРОГО ПОРЯДКА РАВНОВЕСИЯ ПОЛОГОЙ ОБОЛОЧКИ **Г. Девдариани** «Воздушный транспорт» Тбилиси , 2016 №1 (11), с.67-74 (Анг).

В работе рассматривается эллиптическое дифференциальное уравнение второго порядка с сингулярными коэффицентами. Изучены некоторые корректно поставленные задачи для этого уравнения. Корректность завысит от порядка сингулярности и от геометрии границы области. Такого рода задачи возникают в теории тоньких пологих оболочек.

УПРАВЛЕНИЕ ХАОТИЧЕСКИМИ ПРОЦЕССАМИ МЕТОДАМИ СИНЕРГЕТИКИ
В.Сесадзе,В.Кекенадзе, Г.Чикадзе, Н.Сесадзе «Воздушный транспорт» Тбилиси , 2016 №1 (11), с.75-82 (Анг).

Недавно, ученые думали, что сложное хаотическое движение может возникнуть только в некоторых многомерных системах, но оказалось, что это также возможно в нелинейных детерминированных системах третьей степени. Процессы, которые возникают в нелинейных динамических системах, хаотичны. Математические модели таких процессов содержат многочленную и квадратичнуюнелинейности, которые широко распространены в объектах с различной природой. Проблемы управления хаотических процессов привлекает все больше внимания в пределах научной литературы.

В статье исследовано сложное хаотическое движение, которое возникает в фазовом пространстве в нелинейных детерминированных системах третьей степени. Рассмотрена задача сохранения биологических популяции на оптимальном уровне с учетом добичи пищи. Показано,что, с использованием обратной связи система переходит из состояния на лоджистическое, которое обладает признак самоорганизации.

ПРОИСХОЖДЕНИЕСИНЕРГЕТИКИ И РАЗВИТИЯ НА ГРАНИЦЕ ВЕКОВ **В. Сесадзе, Н. Сесадзе, Ш. Давителашвили, И.Хведелидзе** «Воздушный транспорт» Тбилиси , 2016 № 1 (11), с. 83-87 (Анг).

Синергетика - международное дисциплинарное направление, которое изучает общую регулярность в самоорганизации сложных систем. синергетика развивался в структуре следующих научных направлений: Физика совместных событий Германа Хакена, термодинамика процессов нелинейной динамики.

Итак, синергетика возникла, как теория кооперативных явлений в задачах лазерной тематики, но постепенно приобретала более общий статус теории, описывающей незамкнутые, нелинейные, неустойчивые, иерархические, развивающиеся системы. Уже в области естествознания существует оппозиция такому толкованию синергетики. Кто-то предпочитает говорить о нелинейной динамике, или теории диссипативных систем, теории открытых систем, теориидинамического хаоса, аутопоэзисе и т.д.

Синергетика, как наука, бурно развивается сегодня, и мы должны ждать новых результатов в течение следующих лет.

ОБОБЩЕННЫЙ МЕТОД АНАЛИТИЧЕСКОГО КОНСТРУИРОВАНИЯ АГРЕГИРОВАННЫХ РЕГУЛЯТОРОВ **В.Сесадзе, Г.Чикадзе, А.Кекенадзе** «Воздушный транспорт» Тбилиси , 2016 №1 (11), с. 88-94 (Анг).

В настоящее время наиболее передовое фундаментальное направление в теории и технике управления включает физическую теорию управления, синергетический подход к проблемам управления, теорию самоорганизующихся регуляторов с экстраполяцией, теорию нечетких и нейросетевых систем управления и др.Итак, синергетический метод АКАР является новым направлением в теории управления, который расширяет понимание сложных процессов управления, так как учитывает общие объективно-энергетические и энтропийно-информационные субстанции в пространстве и времени.В статье расмотрено проблема аналитического конструирования оптимальных агрегированных регуляторов исползованием синергетических методов. Показано что при решенний зтои задачи значительной и независимой проблемой является формирование критерия соотвествующего качества.

ОПРЕДЕЛЕНИЕ ПОТЕНЦИАЛЬНО ОПАСНЫХ СИТУАЦИЙ В НОРМАТИВНО-ПРАВОВЫХ ДОКУМЕНТАХ И ВЫЯВЛЕНИЕ КРИТЕРИЙ В НИХ **О. Шония, Л. Колбая** «Воздушный транспорт» Тбилиси , 2016 №1 (11), с.95-101 (Анг).

Теоретическое и экспериментальное исследование потенциально опасных ситуацийв нормативно-правовых документов и управление нормативно-правовых документов представляет большой интерес. В статье представлены те факторы, выполнение которых объязательно, чтобы опознатьпотенциально опасные ситуации в нормативно-правовых документов.Работа представляет визуализацию взаимосвязи нормативно-правовых документов и раскрытие потенциально опасных ситуаций во время анализа. Приведены структурные схемы основных задач и каждая из них охарактеризована своим функциональным назначением.

РАЗРАБОТКА МАТЕМАТИЧЕСКОЙ МОДЕЛИ ВИЗУАЛИЗАЦИИ НОРМАТИВНО-ПРАВОВЫХ ДОКУМЕНТОВ **О. Шония, Л. Колбая** «Воздушный транспорт» Тбилиси , 2016 №1 (11), с.102-106 (Анг).

Огромное число законодательной информации и динамика ее изменений требуют от адвокатов, студентов, бизнесменов использование современных методов и инструментов во время процесса работы с юридической информацией. В статье представленны

основные задачи визуализации и анализа взаимосвязей нормативно-правовых документов. Приведена структурная схема основных задач и каждая из них охарактеризована своим функциональным назначением.

РАСЧЁТ ИМЕЮЩИХ ПОПЕРЕЧНЫЕ И ПРОДОЛЬНЫЕ РЕБРА ЖЕСТКОСТИ ПЛАСТИНОК МЕТОДОМ КОНЕЧНЫХ ЭЛЕМЕНТОВ **Д. Кипиани, С. Блиадзе, Н. Блиадзе** «Воздушный транспорт» Тбилиси , 2016 №1 (11), с. 107-115 (Анг).

В статье даётся расчёт пластины с ребрами жесткости применением метода конечных элементов, в то же время в первом случае ребра жесткости представлены в виде конечного элемента стержня, во втором случае они представляются как конечный элемент пластины, а в третьем случае она представлена в виде трехмерного конечного элемента. Изложены результаты сравнительного анализа.

ОПРЕДЕЛЕНИЕ УСТАЛОСТНЫХ ХАРАКТЕРИСТИК С ИСПОЛЬЗОВАНИЕМ КРИВЫХ УСТАЛОСТИ **Г. Цирекидзе, С. Блиадзе, А. Гоголидзе , С. Блиадзе** «Воздушный транспорт» Тбилиси , 2016 №1 (11), с.116-122 (Анг).

Представлены построенные согласно результатам проведённых на образцах из стали марки Miilux 500 кривые усталости (Вёллера) и теоретически полученные на их основе характеристик с помощью программного обеспечения ANSYS Workbench показатели усталости; оценены экспериментальные и теоретические результаты исследований и их совпадение.

МЕЖПРАВИТЕЛЬСТВЕННОЕ СОГЛАШЕНИЕ О ЕДИНОМ ВОЗДУШНОМ ПРОСТРАНСТВЕ МЕЖДУ ГРУЗИЕЙ И ГОСУДАРСТВАМИ-ЧЛЕНАМИ ЕВРОСОЮЗА И ЕГО СТАНОВЛЕНИЕ В ГРУЗИИ. **Ю. Сухиташвили, М.Миндиашвили, Д.Тепнадзе** «Воздушный транспорт» Тбилиси , 2016 №1 (11), с.123-129 (Анг).

Последнее время происходит значительное сближение Грузии с Евросоюзом (в дальнейшем ЕС) . Грузия стремится в ЕС, но интеграция Грузии в ЕС должна отвечать всем требованиям ЕС. В связи с этим законодательство Грузии должно быть максимально приближено к законодательству ЕС.В рамках вышеуказанных тесных отношений и сотрудничества с одной стороны Грузии, с другой ЕС и ее государств, 2 декабря 2010 был подписан договор об использовании “единого европейского воздушного пространства”. В связи с подписанием этого документа Грузия взяла на себя определенные обязательства, что приведёт грузинское законодательство в области гражданской авиации в соответствие с требованиями европейской

регуляции и директив.В связи с вышеуказанным Грузия в настоящее время осуществляет исполнение тех обязательств которые истекают из вышеуказанного соглашения.

СОЗДАНИЕ ГОСУДАРСТВЕННЫХ АВИАКОМПАНИЙ ГРУЗИНСКОЕ ЗАКОНАДАТЕЛЬСТВО И ПРАКТИКА ЕВРОСОЮЗА **Ю. Сухиташвили, Д. Гелашвили**

«Воздушный транспорт» Тбилиси , 2016 №1 (11), с. 130-138 (Анг).

Основной целью данной статьи является рассмотрение вопросов регистрации и эксплуатации государственных авиакомпаний, а также вопросы оценки функционирования таких авиакомпаний. В этом ключе также обсуждены основные аспекты оказания государственной поддержки в создании таких авиакомпаний согласно требованиям законодательства Грузии и ЕС.

К сведению авторов статей

Авторы обьязаны представить статьи со строгим соблюдением следующих требований.

1. Статья должна быть представлена в редакцию с рецензией и письменным ответом автора(ов) на заключение рецензента. Авторы с Авиационного университета Грузии и других вузов должны представить постановления советов соответствующих факультетов о целесообразности публикации данной статьи, а авторы с НИИ и предприятий – решения научных или научно-технических советов.
2. Работа подготавливается в Microsoft Word.
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4. Статья должна быть представлена в редакцию на листах белой бумаги размером А4 и дискетой 1,44 MB или CD диском. Размер шрифта 12, интервал 1,5; поля: Top - 3,5, Left – 2,5, Right – 2, Bottom – 2,5. Название работы собирается шрифтом 14; фамилия, имя, отчество автора(ов) – шрифтом 13; название организации, где выполнена работа, указывается в скобках – шрифтом 13; резюме работы выполняется курсивным шрифтом 12; ключевые слова – шрифтом 12; к работе, выполненной на русском языке, после литературы шрифтом 12 прилагается резюме на английском языке с указанием названия труда, имени, отчества и фамилии автора(ов).
5. Таблицы, схемы, графики и формулы должны быть представлены посредством компьютерной [графики] [печати].
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9. Статья должна быть подписана автором(ами).

Памятка рецензента

В рецензии на статью должны быть отражены следующие вопросы.

1. Актуальность темы.
2. Научная новизна.
3. Практическое значение.
4. Методологическая обоснованность методики исследования.
5. Корректность проведенного исследования.
6. Соответствие международным стандартам ISO.
7. Применение международной системы единиц SI.
8. Наличие стилистических, грамматических и терминологических ошибок в тексте.
9. Заключение о целесообразности или нецелесообразности публикации.

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