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WIRLESS NETWORKS, THEIR TYPE AND METHODS OF USE [1]

O. Shonia*, I. Kartvelishvili, Z.Beridze**, I. Didmanidze**, L. Kolbaia****

(Georgian Technical University, Merab Kostavave. 75, Tbilisi, 0175, Georgia)

Abstract: *In this work, basic information about the technologies and components of the wireless computer networks are represented. All types of wireless networks (personal, local, regional and global) are discussed briefly and the features of their structure and methods of use are described.*

Keywords: *wireless, wireless personal area network, wireless local area network, wireless metropolitan area network, wireless wide-area network.*

INTRODUCTION

Wireless networks play a great role in people's life, at any location they are – at work place, home or public space. Even when the wireless network is made by the simple reason – provide the communication between people and sources of information without wire, we should clarify the basic concept of the wireless network, discuss the security issues regarding them and then find how they work and what benefits they can give in different cases.

Nowadays the wireless networks are widely used all over the world in order to satisfy the communication demands of great number of users. It is noteworthy that in some parts of the world, the wireless technologies are spread more than the traditional cable communication technologies. Popularity of the wireless networks has several reasons. The price of the wireless devices have noticeably decreased, which gives the opportunity to the service-providers to decrease the price significantly and make it more available for the customers. The installation fee for wireless networks is also reduced at the growing market and it is lower than the fee for installation of cable networks.

There are different types of the wireless networks, but the basic feature of the wireless networks is that the communication is set between the computer devices. Such as personal digital assistance (PDA), notebooks, personal computers, servers, printers etc. Under the personal

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Professor*
Associate professor**

computers, we consider those, which have processors, memory and facilities to response to any of networks. Generally, the cell-phones do not attributed to the computer devices but the latest phones have the certain calculating features and network adapters. Therefore, in the nearest future, the most of the electric devices will be equipped with options to connect to the wireless networks.

In order to provide interaction among the users, servers and database, the wireless networks as transmission facility, uses radio waves or infrared range. This area of the information transmission is invisible for human. Nowadays, most of the manufacturers integrate the network interface cards (NIC), which are known as the network adapters, and antennas in such a way that they are not noticeable for the users. This all, make the wireless device more mobile and useful.

Wireless networks, which provide the connection in different physical zones, are divided in following categories:

- Wireless personal area network (PAN)
- Wireless local area network (WLAN)
- Wireless metropolitan area network (MAN)
- Wireless wide-area network (WAN)

Wireless personal networks are distinguished by the information transmission to the small distances (up to 17 m), which makes them perfect for use within the small area of the building or in “personal zone”. Features of the wireless personal networks are medium; the information transmission speed does not exceed 2MB/sec. In many cases, wireless personal networks replace the wire networks successfully.

Such network provides, for example, wireless synchronization of data with PDA users and their personal computer or notebook. The wireless connection is also possible to printers. Replacement of wire network connection between the computer devices by the wireless network connection is a considerable prevalence, which makes the installation works of the computer devices significantly easy even in case of necessity of their moving to other locations.

The wireless personal networks can provide the interaction of notebooks and personal computers in order to connect to the Internet simultaneously. The operation area of such networks is defined within one room. In the most of the wireless personal networks, radio waves are used for the information transmission. With specification, which is based on Bluetooth, the operation of wireless personal networks is regulated at 2, 4 GHz range, distance – up to 17 meters, transmission speed – 2 Mb/sec.

For the wireless personal networks, the standard is 802.15. The USA famous Institute of Electrical and Electronics Engineers (IEEE) involved in their standard 802.15 for wireless personal networks specification – Bluetooth. Similar technology ensures reliable and uninterrupted solution for such computer devices that are connected within the small zone, at a little distance.

In some wireless personal networks, for transmission of the information from one point to another, the infrared radiation is used. Such specification, which is based on the infrared range (Infrared Data Association, IrDA), regulates the use of directed infrared rays for transmission of information on up to 1 meter-distance. Transmission speed is 4Mb/sec. The preference of such transmission of information is that it protects it from radio disturbances, but it is necessary to place the computer devices in close distance opposite each other.

Wireless regional (city) networks provide service to the zones inside the city. In the most cases at the system implementation it is necessary the fixed connection. For example, in hospital, such network provides the data transmission between the main building and clinics stand away. In addition, the energy company may use the networks of this type to connect the main building with distanced energy facilities throughout the city. As a result, wireless regional networks will connect existed network infrastructures or give the opportunity to the mobile network users to have the connection to the existed network infrastructure.

Consumer Market offers different patented solutions for the wireless regional networks but the manufacturers always follow standards. Some providers use 802.11 standards for creation of the regional networks, but systems of such standard are optimal and satisfy the demands inside the building. They can set up the connection via directed aerials.

Wireless global networks provide the access to the information countrywide and continent-wide. The wireless global networks have the unlimited operation area, which is ensured by the telecommunication companies. The agreements made by the telecommunication operators regarding roaming make possible to communicate through the long distances and provide the fast data transmission among the mobile users. After settlement with only one Telecommunication Company, the user can make connection via the wireless global network from any point of the world to the different Internet services.

The special systems, which are the features of the wireless global networks provides the access to Internet, corporate systems and send-receive of e-mail despite the location of the user – whether it office, home or outside the building. For example, the network subscribers can easily have connection when travelling in a taxi or walking in the streets. The wireless global networks function from such places, where the networks of other types do not have access and the users are not limited due to area.

One of the problems regarding introduction of the wireless global networks is that it could not provide the good connection to the users being inside the building, because the infrastructure elements of this network are located outside the building and the radio signals become noticeably weak. As a result, the users of the wireless global networks that are inside the building may absolutely lose the connection or in the best case, the properties of the connection become significantly worse. Some of the telecommunication companies install the systems of the wireless global networks inside the building, but this requires the considerable expenses and does not appreciated in technical terms.

One of the worldwide wireless technologies are the wireless local area network (WLAN) based on IEEE 802.11. It is mostly used for the wireless data transmission between personal computers and laptops inside the buildings. In comparison with mobile network, this technology gives opportunity to the devices to make connection potentially at a very high speed (but comparatively short distances). Actually, these networks are called WLAN () wireless local networks because they provide the LAN-connection equivalent inside the buildings (Fig. 1).

1. **Wireless local networks provide the information transmission among the computer devices inside the building**

Wireless local networks have high features. They provide information transmission inside and outside of offices that are located inside one large building. The users of such networks use PDAs, notebooks and personal computers with large screens and processors, which have the ability to operate with large systems. Such networks satisfy fully the requirements for the connection parameters of the computer devices of this type.

In number of offices, for example, the local network is arranged in order to provide the access to the computer systems from notebooks. Within the systems of this type, the user that, for instance, is in the conference room or at other place inside the building can easily use the network services, which assists him/her to perform their obligations effectively.

Wireless local networks easily provide those features, which are necessary for uninterrupted performance of the high-level systems. The users of such network can receive the e-mail or video stream of large volume. Wireless local networks fully satisfy the requirements of all office systems.

Wireless local networks, by their features, components and performance of operations are similar to the Ethernet type traditional cable local networks. Nowadays, the wireless local network adapters are built-in in the most of notebooks.

The standard of the wireless local networks is – IEEE 802.11. There are different versions of this standard, which provides the information transmission within the range of 2, 4 and 5 GHz. Main problem of such standard is that, it cannot provide the interaction of computer devices of different versions. For example, the adapters of the computer devices, which are compatible to the wireless local network of standard 802.11a, cannot connect to the wireless local network of standard 802.11b. There are also other problems, for instance, insufficient security measures. In order to eliminate the abovementioned problems of standard 802.11, the organization “Alliance Wi-Fi”, entered all applicable functions in one standard, which is known as – Wireless Fidelity (Wi-Fi). Therefore, if any computer devices are compatible to the Wi-Fi standard, then their interaction is guaranteed.

Wireless personal, local, regional and global networks are inter supplementary and satisfy different requirements, but sometimes it is difficult to distinguish one network from the other. For example, the wireless local network inside the building is able to provide the interconnection between the PDA and personal computer like wireless personal network.

If we consider the future prospects from the user's point of view, then the boundaries among the types of the wireless networks should be annulled. The special network adapters of the personal computers have already been made, which have the operation support for the wireless networks of the different types. For instance, businesspersons and tourists may have modern cell phones, which interact with both wireless local network and wireless global network. All abovementioned provide the wireless connection, therefore, the user in the airport facility, works with his/her e-mail, which uses the wireless local network of common connection, then, while travelling, interacts with the services of other type, which is based on the information transmission via mobile network.

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БЕСПРОВОДНЫЕ СЕТИ, ИХ ТИПЫ И МЕТОДЫ ИСПОЛЬЗОВАНИЯ

О. Шония, И. Картвелишвили, З. Беридзе, И. Дидманидзе, Л .Колбая

В статье представлены основныеключевые сведения о технологиях беспроводных компьютерных сетей и их компонентов. Все типы беспроводных сетей (такие как, персональные, локальные, региональные и глобальные сети) обсужденны кратко и описанны их функции, структура и способы использования.Также,в работе уделено внимание роли и важности беспроводных компьютерных сетей в повседневной жизни человека. Содержательно рассмотрена специфика работы каждого типа беспроводных компьютерных сетей и их значимость для общества.

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ANALYSIS OF PLATES THAT ARE REINFORCED BY THIN CURVILINEAR VARIABLE CROSS-SECTION RODS

G. Kipiani*, G. Okropiridze, V. Sulashvili ****

(Georgian Aviation University, 16, Ketevan Tsamebuli av., Tbilisi 0144, Georgia)

Abstract: *Are derived the general conditions of conjugation of plates with displaced medieval surface by thin variable stiffness rib. From these conditions, in particular, follows the conditions of joint deformation of plates with small depth extrudes, as well as various kinds of conditions of seam of plates with variable stiffness ribs that are applied in the work at solution of tasks of analysis and rational design of thin-walled structures.*

Keywords: *plate; extrude; rod; variable stiffness.*

INTRODUCTION

One of the basic factors of technical progress is the development of fundamentally new types of tools, machines, structures, having increased reliability and comparatively low material consumption. The shells and plates are presented as responsible elements of majority of engineering structures. For performing of necessary functional requirements designer often is forced to weaken them by various shape cuts, for reduction of arising at this concentration of stresses, for increasing of stiffness of thin-walled structures often are applied the lamellar of shell elements with displaced medieval surfaces that are conjugated by thin variable cross-section ribs or by variable depth extrusions. Such combined plates are widely used in mechanical engineering, aircrafts, spacecrafts and other fields of engineering.

By this is explained the constant attention of researchers to development of methods of analysis of ribbed shells and plates [1-12]. Up to nowadays the majority of authors were limited by consideration of constant cross-section ribs that evidently have advantage due their

manufacturability in comparison with variable stiffness ribs. It is clear that in tasks of optimal design the shells and plats with ribs is necessary, where it is possible, to extend the class of reinforcing elements and consider the variable thickness ribs that have the additional

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Professor*
PhD Student**

controlling parameters that gives the possibility to more fully satisfy the basic requirement of low material consumption as well as specific requirements of design aesthetics, convenience in operation and so on.

BASIC PART

Along thickness seam line with washers the plate is reinforced by thin curvilinear variable cross-section ribs. The surfaces, in that are arranged the axes of these rods, are displaced related to plane $z = x + iy$ on the distance $\Delta_k = const$. One of the principal axes of inertia of cross-section of each of rods coincide with the principal normal to axis L_k. The intersection of these axes with medieval plane of plate is the line L_k, along of that occurs the conjugation of system "plate-rib-washer". This assumption is introduced due small width of cross-sections of reinforcing rods. The plate is arbitrary loaded. To stiffness ribs are applied the external bending moments $m_k^0(s)$, shear forces $P_k^0(s)$ and tensile stresses $P_{x,k}^0(s)$ and $P_{y,k}^0(s)$ that are acting in plane of plate (s – is the arch of contour L_k; k=0.1, ⋯,ℓ) (Fig. 1).

The bending moments and forces acting on unit length of k rib from domain S_o (plate) lets designate as $m_k^0(s)$ and $P_k^0(s)$, and the bending loadings acting on unit length of the same ring from the domain S_k (washer) – as $m_{0,k}^0(s)$ and $P_{0,k}^0(s)$ (k=1, 2, ⋯, ℓ). The forces on k rib, acting in the plane $z = x + iy$ (from the adjacent plate) on unit length of rod, let's designate as $X_n^{0k}(s)$, $Y_n^{0k}(s)$, $X_n^{kk}(s)$, $Y_n^{kk}(s)$.

Thus the k rib is under the action of total loading (Fig. 1)

$$m_k\ (s) = m_{0,k}(s) - m_{k,k}(s) + m_k^0(s),$$
$$P_k\ (s) = P_{0,k}(s) - P_{k,k}(s) + P_k^0(s), \qquad (1)$$

$$X_n^k(s) = X_n^{0k}(s) - X_n^{kk}(s) + P_{x,k}^0(s),$$
$$Y_n^k(s) = Y_n^{0k}(s) - Y_n^{kk}(s) + P_{y,k}^0(s). \qquad (2)$$

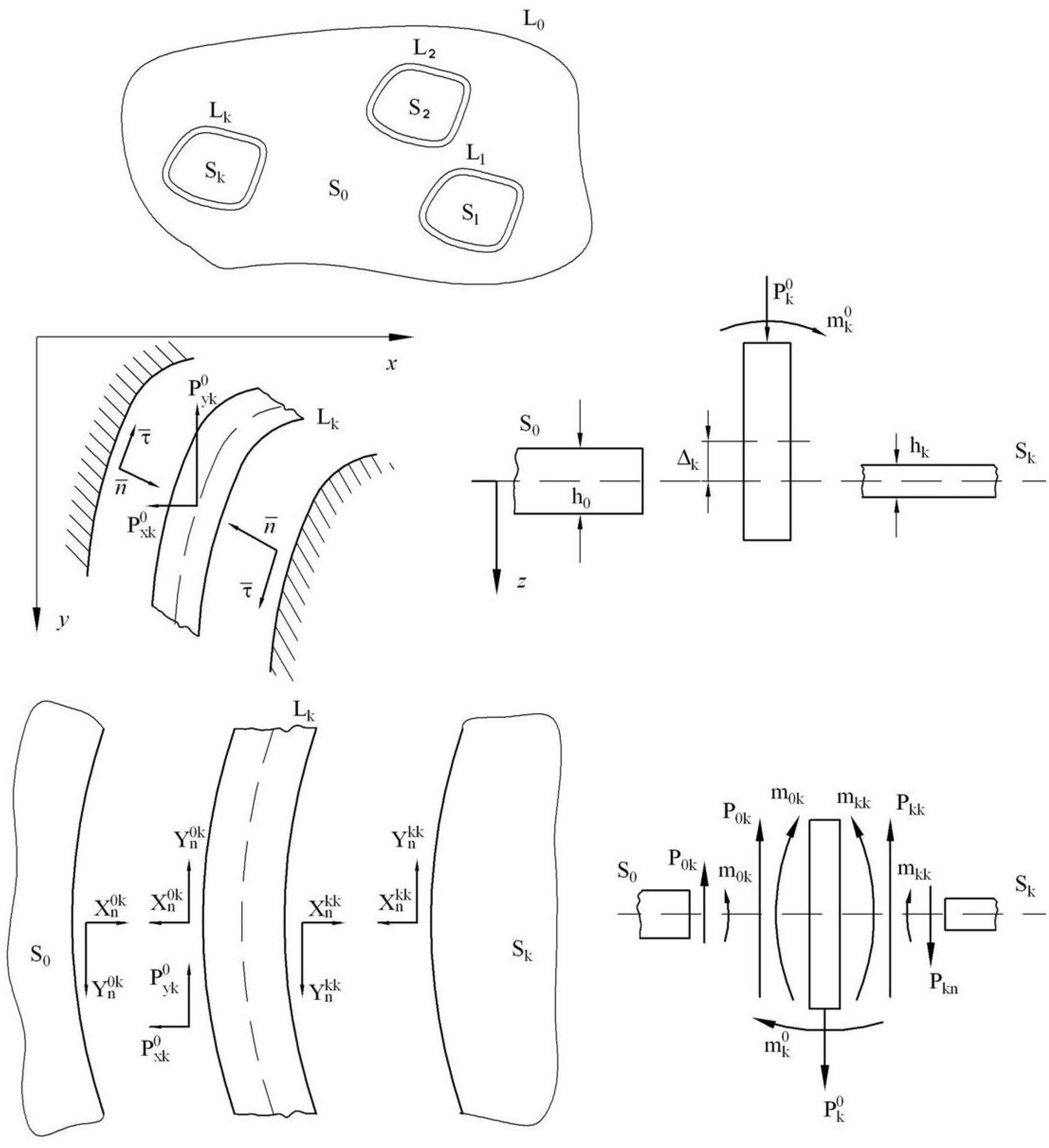

Fig. 1

At joint deformation of plate, k rib and washer under the action of stated loading would be performed the conditions of conjugation [9] that a bit simplifies due that in the considered case we have

$$\omega_x = \omega_z = 0, x_j = 0, \quad y_j = \Delta_k (k = 1, 2, \cdots, \ell; \quad j = 0, k) \tag{3}$$

$$\frac{\partial W_j}{\partial n_j} = Q_{\tau,j}, \;\; u_y = u_{yj} = W_j, \;\; (j = 0, k; \quad k = 1, 2, \cdots, \ell) \tag{4}$$

$$u_x = u_{xj} + \Delta_k \frac{\partial W_j}{\partial n_j}, \;\; u_z = u_{zj} + \Delta_k \frac{\partial W_j}{\partial s_j}, \;\; (j = 0, k; \quad k = 1, 2, \cdots, \ell) \tag{5}$$

As the axes *x* and *z* are collinear accordingly with axes $\vec{n}$, $\vec{\tau}$, it is possible to rewritten the formulae as

$$u_n = u_{nj} + \Delta_k \frac{\partial W_j}{\partial n_j}, \;\; u_\tau = u_{\tau j} + \Delta_k \frac{\partial W_j}{\partial s_j}. \;\; (j = 0, k; \quad k = 1, 2, \cdots, \ell) \tag{6}$$

If we take into account that

$$-i\dot{\bar{t}}\left(\frac{\partial W_j}{\partial n_j} + i\frac{\partial W_j}{\partial s_j}\right) = \frac{\partial W_j}{\partial x} - i\frac{\partial W_j}{\partial y},$$

where

$$i = \sqrt{-1}, \quad \dot{t} = \frac{\partial x}{\partial s} + i\frac{\partial y}{\partial s},$$

and is possible to compile the linear combination of formulae (5) and rewrite them down as

$$\begin{aligned} u_x &= u_{xj} + \Delta_k \frac{\partial W_j}{\partial x}, \\ y_x &= y_{xj} + \Delta_k \frac{\partial W_j}{\partial y}. \end{aligned} \;\; (j = 0, k; \quad k = 1, 2, \cdots, \ell) \tag{7}$$

With taking into account the expression (4) we write down the relations (6) for *j*=0 and *j*=*k* and compile their difference, Finally we will obtain

$$u_{n,0} = u_{n,k}, \qquad u_{\tau,0} = u_{\tau,k} \tag{8}$$

or that is same in the Cartesian coordinates

$$u_{x,0} = u_{x,k}, \qquad u_{y,0} = u_{y,k}. \tag{9}$$

Due the application of accepted in theory of plates standard designations, we further re-designate:

$$u_{x,j} = u_j, \qquad u_{y,j} = v_j \qquad (j = 0, k; \quad k = 1, 2, \cdots, \ell).$$

As a result of introduction of expressions (3), (4), (5), (6), (7), (8) and conditions of seam we after some transformations well obtain

$$\left(\dot{i}_{1,k}(s) Re\{T_k\} + \frac{G_{rk}(s)}{\rho_k(s)} Re\left\{i\dot{t}\frac{d}{ds}\left(\dot{\bar{t}}\, T_k\right)\right\} - Re\left\{\dot{\bar{t}}\int_0^s (X_n^k + iY_n^k) ds\right\} =$$

$$= -Re\left\{\bar{t}\left[\int_0^s \left(P_{x,k}^0 + iP_{y,k}^0\right)ds + C'_{1,k} + C''_{1,k}\right]\right\}, \quad (10)$$

$$Re\left\{\frac{d}{ds}\left[i\dot{t}G_{rk}(s)\frac{d}{ds}(\dot{t}T_k)\right]\right\} + Re\left\{\dot{t}\int_0^s (X_n^k + iY_n^k)ds\right\} =$$

$$= Re\left\{i\dot{t}\left[\int_0^s \left(P_{x,k}^0 + iP_{y,k}^0\right)ds + C'_{1,k} + C''_{1,k}\right]\right\}, \quad (11)$$

$$-2Re\left\{\frac{d}{ds}\left[i\dot{t}\,C_k(s)\frac{d}{ds}\left(\frac{\partial\overline{W}_k}{\partial t}\right)\right]\right\} + \frac{2A_k(s)}{\rho_k(s)}Re\left\{\dot{t}\,\frac{d}{ds}\left(\frac{\partial\overline{W}_k}{\partial t}\right)\right\} + m_k +$$

$$+\Delta_k Re\left\{i\dot{t}\,(X_n^k + iY_n^k)\right\} = m_k^0 - \Delta_k Re\left\{i\dot{t}\left(P_{x,k}^0 + iP_{y,k}^0\right)\right\}, \quad (12)$$

$$2Re\left\{\frac{d}{ds}\left[A_k\dot{t}\,\frac{d}{ds}\left(\frac{\partial\overline{W}_k}{\partial t}\right)\right]\right\} - \frac{2C_k(s)}{\rho_k(s)}Re\left\{i\dot{t}\,\frac{d}{ds}\left(\frac{\partial\overline{W}_k}{\partial t}\right)\right\} -$$

$$-\Delta_k Re\left\{\dot{t}\,[(X_n^k + iY_n^k)]\right\} + \int_0^s P_k(s)ds = \int_0^s P_k^0(s) -$$

$$-\Delta_k Re\left\{\dot{t}\left(P_{x,k}^0 + iP_{y,k}^0\right)\right\} + C_{2,k}. \qquad (k = 0, 1, \cdots, \ell) \quad (13)$$

In these equations

$$T_k = \dot{t}\,\frac{d}{ds}\left[u_k + iv_k + \Delta_k\left(\frac{\partial W_k}{\partial x} + i\frac{\partial W_k}{\partial y}\right)\right], \quad (14)$$

where t – is the affix of point of contour L_k, $\dot{t} = \frac{dt}{ds}$;

ρ– is the radius of curvature of contour L_k;

$C'_{1,k}$, $C''_{1,k}$, $C_{2,k}$– are the real constants. the dot above the function means the derivative in S, $\left(C'_{1,0} = C''_{1,0} = C_{2,0} = 0\right)$.

The condition**s** of seam is possible to express as that would be further applied

$$Re\left\{\dot{t}\int_0^s (X_n^k + iY_n^k)ds - \frac{d}{ds}\left[\rho_k G_{1,k}(s)Re(T_k)\right] +\right.$$

$$+Re\left\{\frac{d}{ds}\left[\rho_k\dot{t}\int_0^s (X_n^k + iY_n^k)ds\right]\right\} = Re\left\{i\dot{t}\left[\int_0^s \left(P_{x,k}^0 + iP_{y,k}^0\right)\frac{d}{ds} + C'_{1,k} + C''_{1,k}\right]\right\} +$$

$$+Re\left\{\frac{d}{ds}\left[\rho_k\dot{t}\left(\int_0^s \left(P_{x,k}^0 + iP_{y,k}^0\right)\frac{d}{ds} + C'_{1,k} + C''_{1,k}\right)\right]\right\}, \quad (15)$$

The conditions (9)-(13), as it was expected, coincide with accordingly condition in the classical works.

CONCLUSIONS

Is proposed and developed effective method of solution of task on bending of isotropic plate of finite dimensions with curvilinear rods, symmetrically reinforced by variable cross-section thin rib.

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РАСЧЁТ ПЛАСТИНОК ПОДКРЕПЛЕННЫХ ТОНКИМИ КРИВОЛИНЕЙНЫМИ СТЕРЖНЯМИ ПЕРЕМЕННОГО СЕЧЕНИЯ

Г. Кипиани, Г. Окропиридзе, В. Сулашвили

Выведены общие условия сопряжения пластинок со смещёнными срединными поверхностями посредством тонкого ребра переменной жёсткости. Из этих условий, в частности, следуют условия совместного деформирования пластин с выдавками малой глубины, а также различные виды условий спая пластин с ребрами переменного сечения, которые использованы в работе при решении задач расчёта и рационального проектирования тонкостенных конструкций.

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Applied and experimental Mechanics

CALCULATION OF PLATES AND SHELLS WITH RIBS RIGIDITY BY THE FINITE ELEMENT METOD

G. Kipiani*, M. Tsikarishvili*, S. Bliadze*, U. Dzodzuashvili**

(Aviation University of Georgia, Ketevan Tsamebuli Ave., 16, Tbilisi, 0144, Georgia.)

Summary: *In this article, the development of the stages of calculating plates and shells with stiffeners is described. It is noted that the theory of ribbed shells is one of the most controversial and incomplete sections of the general theory of shells.We consider shell calculations with longitudinal and transverse stiffeners by the finite element method. In the first embodiment, the stiffener is considered as a beam end element, In the second case, the edges are approximated as thin-walled plates and, finally, in the third case, the edge is represented as a three-dimensional finite element.A comparative analysis of the theoretical and experimental results is given.*

Keywords: *Tension, plate, shell, stiffener, deflection.*

THE MAIN PART

The theory of ribbed shells is, apparently, one of the most controversial and incomplete sections of the general theory of shells. If we turn to the history of the development of the theory of ribbed shells, then three stages are clearly visible.

At the first stage of development, individual problems of the theory of ribbed shells. Characteristic here is the consideration of the ribbed shell (plate) as a composite shell-rib structure. In this case, the equilibrium equations were derived separately for the shell and edges, and then the problem of their conjugation was solved.

The most significant works of the first stage are the works of Yu. A. Shimansky [1,2] and PF Papkovich [3], which were performed in the thirties. In these papers, for the first time, the problem of the axisymmetric deformation of an infinitely long cylindrical shell reinforced by equidistant annular ribs are stated. In the paper of Shimansky [1], is presented a very useful

Professor*
Doctor**

method for solving infinite systems of algebraic equations. In recent years, this technique has been used successfully in

various modifications by many authors, who apparently did not know about the priority of Yu. A. Shimansky.

It should be emphasized that at the first stage the theory of ribbed shells is not essentially considered. The very term "ribbed shell" appeared much later. The consideration of the ribbed shell as a composite construction not only limited the possibilities of the theory, but also excluded a whole series of important problems from consideration.

The second stage is characterized by consideration of the ribbed shell on the basis of the constructive anisotropy scheme. At this stage, a large number of important tasks were solved. However, a number of fundamental problems remained unresolved until now. For example, the limits of applicability of the constructive anisotropy scheme remain extremely unclear, moreover, it is not clear what quantities and in what cases are determined by this scheme reliably and which are not. It is clear that the necessary condition for the applicability of this scheme will be the consideration of edge effects. On the other hand, the formulation of sufficient conditions for the applicability of the constructive anisotropy scheme is largely determined by the very design and conditions of its operation, so it does not make sense to obtain formal sufficient conditions.

The present stage of the development of the theory of ribbed shells begins in 1948, when A.I. Lurie formulated general principles of the theory of ribbed shells.

The theory was based on the principle of minimum potential energy, and the potential energy of the ribbed shell was written as the sum of the energies of the shell proper and the core system - the ribs.

Another approach to the construction of ribbed shells was proposed by V.Z. Vlasov in 1949 [4]. According to V.Z. Vlasov, the ribs were cut off from the shell, and their effect on the shell was replaced by some effort and moments that are subject to further definition. In addition, the condition of continuity of deformations was used.

Common to both variants of the theory of ribbed shells is that two theories are involved: the theory of shells and the theory of rods. The difference lies in the fact that A.I. Lurie treated the ribs as Kirchhoff-Clebsch rods, and V.Z. Vlasov regarded them as thin-walled rods. The fact that two essentially heterogeneous theories are involved in the construction of the theory of ribbed shells leads to an internal contradiction of the very theory of ribbed shells.

Using two heterogeneous theories, it is necessary to attract some unifying beginning. If we take the principle of minimum potential energy as the latter, then, first, serious difficulties arise in writing the field equations, and secondly, they are obtained by non-self-adjoint and non-elliptic type.

If the idea of V.Z. Vlasov is taken as the unifying principle, it is not clear how to bring the moments acting in the edge and shell into correspondence, since in the edge the moment has three components, and in the shell - two. In this case, the equations of the theory of ribbed shells are also non-self-adjoint and non-elliptic.

Most modern works are devoted to the development of these two options. Logically pure theory can be constructed only on the basis of a consistent system of hypotheses, so it seems quite natural to obtain equations of the theory of ribbed shells, considering the motion of a three-dimensional continuum. However, regardless of the version of the theory of ribbed shells, boundary-value problems of the type of problems with infinitely narrow barriers arise here. These problems are very difficult to solve, and to date, a relatively small number have been decided.

In 1952, E.Ya. Herzberg [5] first obtained a rigorous solution for a hingedly supported cylindrical shell with two meridian edges. Since I960, a number of works by VA Zarutskii have been published, in which the stress-strain state of ribbed cylindrical shells is analyzed in detail. In 1962 G, A. Kizila [6] considered a conical shell with meridional edges.

In 1963, VM Ryabov [7] proposed a method of successive approximations for the calculation of ribbed shells, NI Karpov constructed a rigorous solution for calculating cylindrical shells with arbitrarily located stringers.

In recent years, the theory of ribbed shells has developed so intensely that it is difficult to note all the works. We will only say that in the works of E. S. Grebnya [8,9], equilibrium equations were obtained for arbitrary shells reinforced by ribs along the lines of principal curvature.

Although many interesting results have already been obtained in the modern theory of ribbed shells, one has to admit the fact that up to the present time there is not a single point of view on the very theory of ribbed shells or general methods for solving boundary value problems of the theory of ribbed shells.

The purpose of our work is to calculate the strength of ribbed shells by the finite element method, which uses four nodular lamellar end elements, a three-dimensional eight-node end element and a beam end element. The finite element method is a widely used method. A whole series of articles and monographs have been written about this method [10,11,12,13], in this connection it is not appropriate to give the main relations by the finite element method.

Consider the ribbed shell of double curvature, whose dimension in the plan is565× 370mm, the distance between the longitudinal edges is 16 mm, the distance from the edge to the transverse rib is 120 mm, and the distance between the transverse ribs is 340 mm. The thickness of the longitudinal edges is 7 mm, the transverse ribs are 3.5 mm, the ribs height is 26 mm, the thickness of the shell itself is 4.5 mm. Material: aluminum alloy AK-4. Modulus of elasticity of material E = 7100 kgf / mm^2, Poisson's ratio $\nu = 0.3$, the pressure on the surface of the shell is p = 0.0098 Mpa

Boundary conditions: two opposite narrow ends are fixed rigidly, and the remaining edges are freely supported (see Fig. 1).

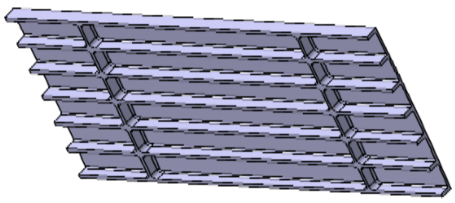

Fig. 1. The shell model

For the first case, the entire shell is modeled by six nodal three-dimensional finite elements, in this case the maximum displacement is $w = 0.077$ mm, Fig.2 (In the center of the shell),and the equivalent stress of von Mises equals1.035 kgf/mm^2, Fig.3.

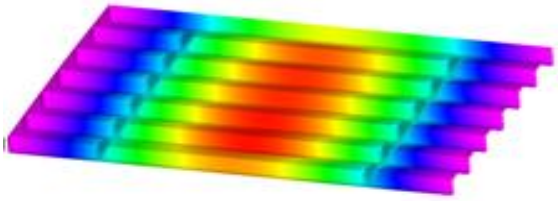

Fig. 2. Displacement

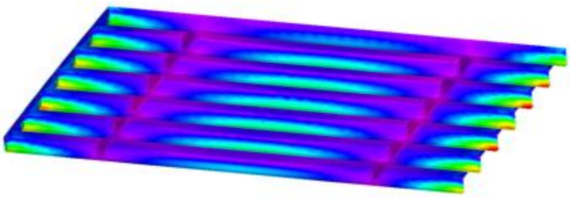

Fig.3. Von Mises stress

In the second case, the base and ribs of the shells were modeled by 4-node plate-like elements;Analysis showed that the maximum displacement is in the center of the shell and is equal to $w = 0.080$ mm(Fig.4), and the equivalent stress of von Mises equals1.04kgf/mm^2(Fig.5).

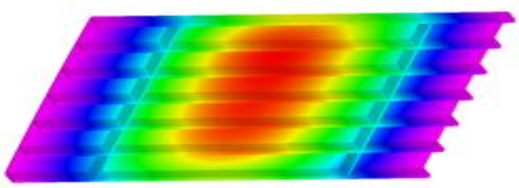

Fig.4. Displacement

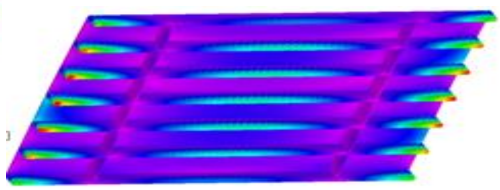

Fig.5. Von Mises stress

In the third case, the base of the shell was modeled by 4-node plate elements, and the edges by beam end elements. The analysis showed that the maximum deflection is in the center of the shell and is equal to $w = 0.0834$ mm(Fig.6),and the equivalent stress of von Mises equals1.271kgf/mm^2, (Fig.7).

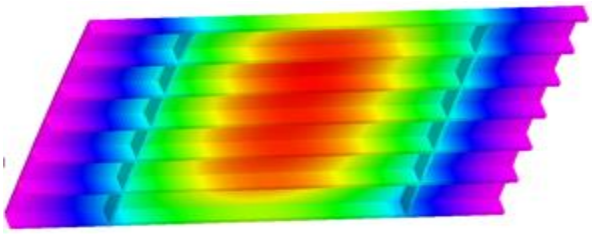

Fig. 6. Displacement

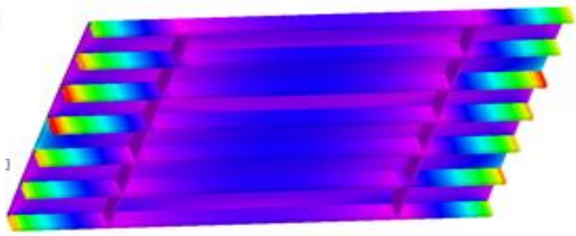

Fig.7. Von Mises stress

For the fourth case, the shell is modeled by eight-node three-dimensional finite elements, and the edges were modeled by beam end elements; In this case the maximum deflection is $w = 0.081$ mm, (In the center of the shell),and the equivalent stress of von Mises equals1.06kgf/mm^2.

The experiments of these shells were carried out on the basis of a certified BS EN ISO 9001 and EN 9100 of JSC "TAM" Tbilisi Aircraft Manufacturing on the surface of the shell, the pressure p=0,0098Mpa.With the use of strain gauges, the movements in the center of the shell and the stress at the fastening points were checked. Fig. 8.

Fig. 8. Experiments.

The maximum displacement was 0.75 mm, and the equivalent voltage was equal to 1.03 kgf / mm^2.

CONCLUSION

The results of the analysis allow us to say that the calculation of the ribbed shell is possible with all four models. In this case, the calculation error with the experimental data is sufficiently small. (<5%).

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РАСЧЁТ ПЛАСТИН И ОБОЛОЧЕК С РЕБРАМИ ЖЕСТКОСТИ ПО МЕТОДУ КОНЕЧНЫХ ЭЛЕМЕНТОВ

Г.Кипиани, М.Цикаришвили, С. Блиадзе, У. Дзозуашвили

В настоящей статье изложено развитие этапов расчета пластин и оболочек с ребрами жесткости. Отмечено, что теория ребристых оболочек является одним из наиболее спорных и незавершенных разделов общей теории оболочек.Рассматриваются расчеты оболочек с продольными и поперечными ребрами жесткости методом конечных элементов. В первом варианте ребро жесткости рассматриваетсякак балочный конечный элемент, во втором случае рёбра аппроксимируются как тонкостенные пластины и, наконец, в третьем случае ребро представлено как трехмерный конечный элемент. Дан сравнительный анализ теоретическими экспериментальным результатам.

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PROBLEMS AND PROSPECTS OF DEVELOPMENT MANAGEMENT INTELLECTUAL POTENTIAL AIR ENTERPRISE

M. Pimzhyna*, V. Novak,*E. Razumova****

(National Aviation University, K. Komarova Avenue, 1, Kiev, 03058, Ukraine)

Abstract: *As a result of analysis of works of leading domestic and foreign scientists, we summarized the main factors positively influencing the formation and development of intellectual potential of the enterprises, as well as the proposed measures are necessary for the successful development of the intellectual potential of air transport enterprises.*

Key words: *intellectual potential, air transport enterprises, management of intellectual capital.*

Definition of the problem in general and its connection with important scientific and practical tasks. The intellectual potential of high-tech companies has a complicated structure and requires development of effective approaches for choosing a reasonable basis and method of its comprehensive assessment from the perspective of development. Particularly acute this problem is to air transport companies. In an unstable economic situation in the domestic manufacturers have problems of development and effective use of their own intellectual potential.

Analysis of the latest researches and publications. Related formation and development of intellectual capacity dedicated work of many foreign and domestic scientists, among them are: S. Ilyashenko, T.Stewart, E.Deming, R.Williams, S.Valdaytsev, D.Popov, A.Morozov, O.Grishnova, O.Kendyukhov, K.Nelarin, N.Muhacheva, S.Khomich, T.Ivanova and others. Features intellectual capital management saw in his writings A. Kendyukhov and A. Mynchenkova. According to their definition, the main principles of intellectual capital are: validity, consistency, continuity, flexibility, effectiveness, reversibility communication, humanism, emergence, synergy, sustainability.

Determination of parts of the problem not solved before. An in-depth study of issues require theoretical and methodological rationale management of intellectual potential of air transport companies.

Student***
Professor*
Associate professor**

The main task of the article is to determine the problems and prospects of development of intellectual potential in air transport enterprises. Achieving this goal is possible through the following tasks:

- examine the main factors that influenced the development of intellectual capacity;
- show the possible prospects of intellectual activity in the aviation industry;
-define the measures necessary for the growth of intellectual potential of enterprises aviation industry.

Exposition of the basic material. At the enterprise level intellectual potential is the foundation of innovation. The source of the formation of intellectual potential of the company is the intellectual resources and financial resources, which manages the company.

An analysis of scientific works of leading scientists, we have summarized the main factors that positively influence the formation and development of intellectual potential in air transport enterprises, as presented in Table 1.

Table 1.

The main factors that affect the intellectual potential of air transport companies

№	Factors	The impact on the intellectual potential of the company
1.	Economic	Determine the set of available or suitable to use the major sources and means of potential elements integrated systems used or could be used for economic growth and socio-economic progress.
2.	Scientific and technical	Characterize the level of available technology and ensure the quality of service of air transport enterprises. Reproduction intellectual potential of society is carried out primarily through the labor market. The positive impact of this factor in enterprise development promotes economic security, both in economic terms and in social and legal.
3.	Legal	Identify issues regarding regulation of intellectual property rights, among which are the ineffectiveness of legislation and weak implementation of orientations for the innovative model of development in the country.
4.	Sociocultural	Formed by the development of education in the country as a whole, especially when training for the industry.
5.	Organizational	Characterize the implementation of mutually beneficial investment relations between science and business. An example is the financial and industrial group, which included PCbehalf Antonov, JSC "Kharkov aircraft factory", JSC "Motor-Sich" and the

		NationalAerospaceUniversity "Kharkiv Aviation Institute".
6.	Demographic	Characterize the size, age structure, life expectancy, health professionals and the migration situation in the country. Change the value of the last index, in most cases, peavey negatively on the formation and development of intellectual potential of enterprises.
7.	Environmental	In modern conditions of social production increases the degree of influence of these factors.

* Overview on [2,3,5]

Thus, the implementation of the positive impact of all the factors provided growth of intellectual capital and improve the quality of service or production as a whole.

The transformation of scientific and technological developments in innovative products eligible for recognition in the world market is the most difficult and most important step in the chain that binds the developer of new techniques and technologies with the consumer. Its difficulty lies in the fact that developers, researchers do not have enough experience in this area of business activity.

Managing the development of intellectual capital of the company at the expense of managing its components. Central, in our view, the problems are forming intellectual potential is the establishment of external and internal factors.

Significant role in the management of intellectual capital management techniques also play used in the enterprise. Most will provide organizational, administrative, economic, social, psychological and legal methods of intellectual capital management.

The external factors include suppliers, competitors, customers and other counterparties, as well as the legal framework for intellectual property rights.

The internal factors - the availability and efficient use of intellectual resources.

Indication of the factors causing the problem of forming intellectual potential of the company, and as a result - the problem of formation of intellectual capital and business intelligence.

Significant intangible assets reflected in the balance sheet is another problem of forming intellectual potential. Thus, when all transactions disposal of assets no longer owned enterprises do not have the material and physical composition and not counted as components of assets.

In turn, intangible assets may continue to be used in the company or may repeatedly perform the process of disposal of the company, while continuing to generate economic benefits.

On the other hand, should take into account the fact obsolescence of the assets of non-compliance with modern requirements.

The intellectual potential of air transport enterprises need of constant improvement. For this purpose, it is necessary, in our opinion, to develop specific measures and programs to carry out careful planning, organization and control over their implementation, implement significant organizational changes innovative content.

So, for the development of intellectual potential of air transport companies, in our view, should implement the following measures:

- greater attention to the systematic study of the market and establish long-term partnerships with customers transport services, search for new forms of cooperation, surveys of external organizations and customers, suppliers, government representatives to identify ways to improve the efficiency of enterprises.

- develop effective and original motivation for air transport enterprise mechanism that provides for systematic sociological research among staff, to determine its level of job satisfaction, awareness of strategy, plans for air transport, etc. The

- improve management style, making decentralization and development of horizontal ties, wide involvement of staff to process management improvement, introduction of new forms of dialogue with staff and building communications

- develop cognition, systematic training and personnel reserve to ensure ongoing modernization and replacement of fixed assets (aircraft equipment to dispatch etc)

- greater attention to the analysis and use of advanced domestic and foreign experience and continuous improvement of the business aviation industry.

To ensure the effective operation of each air transport company must be managed at the highest level, by qualified workers who have their work creating a positive image among consumers. That is, to effectively manage the development of intellectual capacity required elements in which air transport enterprises could exercise their conversion, the development and functioning. In our opinion, planning to ensure a high level of intellectual capacity of staff should include as setting goals, developing plans and bring them to the performers and staff wish to improve. Thus, the need to identify areas of investment in staff development, particularly in coaching, social development, improve the system of personnel evaluation.

It should particularly pay attention to the fact that the intellectual potential of the company largely depends on the state of each of its components, and requires improvement of existing and development of new scientifically based theoretical and methodological provisions whose implementation will promote integrated management ensuring a decent intellectual potential businesses. It is advisable to make provision in stages of training in higher educational institutions for retraining and its increase, which will increase the economic development of the company. Under such conditions, the company will be created competitive jobs, which in turn is the key to attracting highly skilled professionals.

It should be emphasized that intellectual potential is one of the most important factors of long-term success of the enterprise, such as categories, which ensures the formation of its unique competitive advantage. Maximizing the use of intellectual potential on a practical level requires further development of clear theoretical and methodological approaches to management. It is also advisable to determine the intellectual potential of not only the whole enterprise and its divisions, but each employee.

Conclusions. In the current context of globalization and the formation of an innovative economy entrepreneurs undergo major changes, the growing expansion of the role and use of new knowledge embodied in the form of intellectual capital. Successful development, economic strength and competitiveness of enterprises aviation industry depends on their ability to collect and effectively use intellectual potential. Under such conditions, there is an urgent need to intensify research on the effective management of intellectual potential. Further researches should be directed to the development of intellectual potential management mechanism that will allow it to increase the efficiency of formation and use, promotes innovative development of enterprises aviation industry and the economy as a whole.

Effective management of enterprises and intellectual potential contribution of investment in development, training and retraining of personnel - is the key to profitability. Successful management of intellectual potential formation of provides unique competitive advantages of air enterprise.

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ПРОБЛЕМЫ И ПЕРСПЕКТИВЫ УПРАВЛЕНИЯ РАЗВИТИЕМ ИНТЕЛЛЕКТУАЛЬНОГО ПОТЕНЦИАЛА АВИАТРАНСПОРТНЫХ ПРЕДПРИЯТИЙ

М. Пимжина, В. Новак, Е. Разумова

В результате анализа работ ведущих отечественных и зарубежных ученых нами обобщены основные факторы, положительно влияющие на формирование и развитие интеллектуального потенциала предприятий, а также предложены меры, необходимые для успешного развития интеллектуального потенциала авиатранспортных предприятий.

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PERSPECTIVE DIRECTIONS OF DEVELOPMENT OF THE TRANSPORT SYSTEM TAKING INTO ACCOUNT THE STRATEGIC PRIORITIES OF THE NATIONAL ECONOMY

O.M. Kyrylenko, O.V. Ilienko*, V.O. Novak* , O.M. Krapko*****

(National Aviation University,C. Komarova Avenue, 1, Kiev, 03058, Ukraine)

Abstract *This article examines the processes of harmonization of economic and legal bases of functioning of the transport system of Ukraine, which theoretically will allow access of our country to advanced European technology and investment, the main challenges for effective harmonisation of integration processes, namely the need to ensure the conformity of the national transport system of high standards and technical requirements of the transport markettaking into account he perspectivies of the national economy.*

Keywords: *transport system, the transport market, railways, management, economics.*

Problem statement in its general view. Its connection with important scientific or practical tasks.

Significant positive developments that occurred during 2012-2015 towards the development of infrastructure, including rail transport [7], have greatly increased the logistical and technological preconditions for effective development of the industry, have contributed to overcoming a number of infrastructural bottlenecks that hindered the process of economic development. Meanwhile, continued technological updates should be combined with the dissemination of organizational modernization, adaptation of the transport in the conditions of competitive activity in the domestic crisis and the economy.

In connection with the existence of systemic imbalances in the transport sector costs associated with a failure to comply with safety and environmental safety are rising, reliability of the transport system is being reduced, quality of transport services of domestic enterprises is decreasing and population keeps this dercrease tendency [12], there is a tendency of reorientation of transit traffic to bypass Ukraine.

Associte professor**
Professor*
Docent***

Given the significant role of the transport complex in the efficient functioning and competitiveness of the national economy, the continuation of the modernization process in this direction is considered as one of the main directions of state policy at the present stage.

Analysis of the latest researches and published works where the solution of this problem is initiated. The unresolved part of the general problem.

The process of transformation (reform) of transport-road complex in the context of the task of improving the infrastructure component of the country has the goal of creating an integrated transport infrastructure, which not only adequately meets the needs of companies in the transportation of passengers and cargo, provided the reduction in transport costs in the cost of production, using commercially reasonable rates, and would ensure effective implementation of transit potential of our country [9].

In the sphere of development of transport-road complex, designed for meeing the needs of economic development, improvement of the quality of life of citizens, the priorities for 2016. should be[1, 2, 4]: creating a new architecture of the bodies responsible for the management and improvement of the transport system on different types of transport. It is necessary to lay the foundations for regulation of activities of subjects of natural monopolies in the transport sector at the state level and to form a National Commission which performs state regulation in the sphere of transport; development and improvement of the legal framework for further implementation of reforms in the transport sector, harmonisation of standards in the transport sector with EU standards, increased transportation safety and service quality during the delivery of goods and passenger service, reforming the system of tariffs for transport services; implementation of projects of national importance for the development of national infrastructure, including using the resources of international organizations for financial support, technical assistance of the international community[6].

Marking the previously unsolved parts of generic problem, which are the subject of this article.

It is therefore very relevant for today is the search and development of perspective directions of development of transport system of Ukraine taking into account the strategic priorities of the economy.

Formulation of the purposes of this article. The purpose of the article is the study and determination of prospects and directions of development of the transport system on the basis of the established strategic priorities of economic development.

Exposition of the main material.

Given the above, the main objective of transport development in Ukraine in conditions of recovery from the crisis should be as follows [11].

The first: adoption of measures of modernization of industry within the transportation sector, which, in particular, include: development of program documents and co-Finance, development of roads between regional centers and industrial nodes, and rural roads; development of mechanisms for priority use of vehicles of domestic production in the implementation of state and regional programs that will update park of freight and passenger vehicles; the adoption of the state target economic program of development of road transport, which should include measures for improving the quality and level of safety of transportation of passengers, mail, baggage, cargo and creation of a competitive environment on the market for transport provision, reducing pollution, improving energy efficiency of rolling stock, provision of infrastructure development of road transport industry; the introduction of European standards of flight safety and passenger rights on the basis of instruments provided by the new Air code of Ukraine; development of internal air transport on the basis of the promotion policy available on transportation tariffs, promoting fair competition between Ukrainian and foreign companies in the market of international passenger traffic; ensuring the implementation of the Strategy of development of the domestic industry in the field of avionic of Ukraine up to 2020 – a state program that will determine the priority directions of development of aviation industry in conjunction with the strategic guidelines for the development of aviation transport of Ukraine; implementation of segregation of management functions of state regulation, supervision, control in the sphere of safety of navigation, surveillance and control in the sphere of activity of seaports, their administrations, in the face of increasing global instability, owners of sea terminals, port operators, other entities sea ports and the consumers of their services (goods, works); implementation of new tariff policy of cargo handling, which will enhance the competitiveness of Ukrainian ports; ensuring the implementation of the Strategy of development of seaports of Ukraine for the period up to 2015 for the improvement of capacities on processing of container cargoes in commercial sea ports and expanding the geography of operation of ferry lines [8]; legislative regulation for development of navigation on the inland waterways; promote the development of multimodal transportations attracting river transport, including through the development of appropriate logistics infrastructure (loading facilities in ports, warehouses, etc.); ensure the stable operation of objects of water transport infrastructure, forming a single management system safety of navigation on inland waterways; implementation of the State target program of the railway reform in 2010-2019 [8], in particular the reform of "Ukrzaliznytsia", with the aim of creating new legal and economic model of railway transport management, development of competitive environment on the transport market in the segment of railway transportation.

The second, attraction of foreign investment to accelerate structural changes in the transport sector [1]. In particular, for intensifying cooperation of Ukraine with international organizations that contribute to attracting investment resources of the partner countries, it is necessary to take measures for Ukraine's gaining membership in the world Association of Agencies for investment promotion and establish contacts with the relevant branch of the UN Conference on trade and development; to ensure the dissemination of information on strategic and practical solutions in the development of partnerships at the state level and the private sector in the field of transport in Ukraine with the mission of finding potential investors and creditors; to deepen cooperation with the investment agencies of leading countries in the way of negotiating and signing memoranda of cooperation.

The third: the development and implementation of partnership-level state and the private sector to provide financial resources in infrastructure development, including rail transport [2]. This is based on the Law of Ukraine "On public-private partnership", as revised on December 1, 2012 and capabilities that provide the Tax and Customs codes, to encourage the development of public-private partnership in the field of transport as a mechanism to reduce the requirements regarding the state budget, develops the processes of modernization and updating of production resources road-transport complex of Ukraine, it is necessary to develop the Concept of public-private partnerships in the transport sector, in which, in particular, include mechanisms to involve the private sector in designing, financing, construction, reconstruction of objects of transport infrastructure; dissemination of positive experience of implementation of public-private partnerships in transportation; to calculate the optimal models of public-private partnerships and risk reduction mechanisms between the parties for the implementation of projects, including in transport-road sector; introduce mechanisms to promote the development of the financial services market to support a public-private partnership and the scheme of project financing [4]; to implement special training of specialists on public-private partnerships.

Fourth: the effective implementation of the national projects in the field of transport, which are necessary to create and update the list of priority projects of national importance for the development of transport infrastructure; to ensure the implementation of decisions adopted by the resolution of the Cabinet of Ministers of Ukraine "Some issues of implementation of the project "Infrastructure facilities of Kyiv region" on September 19, 2011. No. 982 in terms of compliance with deadlines, certain feasibility studies of project components; to carry out activities aimed at identifying barriers and challenges of investing in Ukraine, and contribute to their solution by bringing to the industry domestic and international experts, in particular by further road shows abroad, a separate media campaign in Ukraine, the pressing of the web portal as an effective means of informing and providing services for investors; to ensure the implementation of agreements with the Chinese side on the implementation of the national project "Air Express" construction site; direct railway communication between M. Kiev and the International airport.

The transition of the economy to intensive development and the fence is respect-delusions of the political course towards integration into the European Union requires the adoption of adequate solutions for the development of the transport sector in the long term [5].

The governmental Ukrainian decree of 20 October 2010 No. 2174-p approved the Transport strategy of Ukraine for the period until 2020 - a holistic system document of a strategic nature concerning the further development and functioning of the transport sector of Ukraine's economy, expansion of international transportation links, efficient use of transit's potential, structural reforms in the transport [10].

Following spheres also need reforming: the management system of the railway [6], sea and road transport, roads.

Level of transport safety is low. Much worse in comparison with EU countries the accident rate in road transport.

The planes of domestic airlines is repeatedly included in the "black list" of airlines banned to implement flights to EU countries. Due to the poor management of the safety of navigation the State Flag of Ukraine is included in the "black list" of the Paris Memorandum.

The aim of the Strategy is determination of conceptual bases of forming and realization of state policy on ensuring STA-sustainable and efficient functioning of the transport industry, the creation of conditions for socio-economic development, improve the competitiveness of the national economy [10].

The principles for the development and implementation of the Strategy: ensuring the accessibility of transport services for all segments of the population, in particular persons with disabilities, low-income citizens; harmonization of plans of development of transport infrastructure with the General scheme of planning the territory of Ukraine, schemes of land use; implement rigid anti-monopoly policy; the liberalization of price formation in the market of transport services; the functioning of transport enterprises on the principles of sustainability; the concentration of financial resources on the essential tasks of development of the industry of transport; provision of environmental safety, mandatory compliance with environmental standards and regulations when performing activities in the field of transport [3]; encourage the development of energy-saving and environmentally friendly modes of transport.

Improving the efficiency of state management in the field of transport by: reforming the system of state management of railway transport, automobile roads, and sea commercial ports, improving the activity of bus stations; provision of state regulation of activity of economic entities in the field of transport in accordance with European standards and education after the reform of the railway transport regulatory body in this area; improving human potential and the level of social protection of transport workers; structural reforms aimed at developing and improving market relations in the field of transport; creation of a competitive environment in the market of transport services; ensure coordination between various transport modes; creation of conditions to ensure rapid movement of transit goods; improving the system of licensing of separate types of activities in the field of transport; implementation of the effective tariff and price policy aimed at balancing the interests of transport companies and users of their services.

Conclusions. Thus, the study shows that the most promising directions of development of transport system in boundaries of market economy are: the renewal of rolling stock, improvement of the investment climate in the industry, transport market liberalization and integration of national transport system with the European and international transport systems, improving the efficiency of state management in the field of transport.

Prospects for further research in this direction. In general, the definition of perspective directions of development of transport network of Ukraine confirmed close relationship with prospects of functioning of sectors of the national economy that create cargoes and projected their need for the consumption of transport products.

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ПЕРСПЕКТИВНЫЕ НАПРАВЛЕНИЯ РАЗВИТИЯ ТРАНСПОРТНОЙ СИСТЕМЫ С УЧЕТОМ ПРИОРИТЕТОМ НАЦИОНАЛЬНОЙ ЭКОНОМИКИ

О. Кириленко, О. Ильенко, В. Новак, Е. Крапко

В статье исследуются процессы гармонизации экономико-правовых основ функционирования транспортной системы Украины, что теоретически даст возможность доступа нашей страны к передовым европейским технологиям и привлечение инвестиций, раскрыты основные проблемы на пути к эффективной гармонизации интеграционных процессов, заключающиеся в необходимости обеспечения соответствия национальной транспортной системы высоким стандартам и техническим требованиям рынка транспортных услуг с учетом приоритетов национальной экономики.

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FEATURES OF RISK MANAGEMENT IN AIRLINES

V. Novak*, I. Basaraba*, V. Perederii****

(National Aviation University,C. Komarova Avenue, 1, Kiev, 03058, Ukraine)

Abstract *Problems of application of risk management in airlines are considered in the article . It was described the main causes and principles of application of risk management that are based on the analysis, generalization and systematization of scientific sources. It was determinated the main goals and objectives of risk management and formed approaches of risk management in airlines.*

Keywords: *risk management, approach of continuity management of airlines, identification of risks, crisis management, infrastructure of risk management.*

Problem statement in its general view. Its connection with important scientific or practical tasks.

Practice management attests that it has become a growing conviction in recent years that the company is not able to detect new effects that are rapidly developing to such time as they become widespread. Only when the changes in the environment threaten the existence of the company, it means that the company really was in crisis.

Risk management in airline has its serious specificity that was dictated by the features of aviation companies.

Analysis of the latest researches and published works where the solution of this problem is initiated. The unresolved part of the general problem.

Problems of application of risk management in enterprises are often considered by scientific community. These issues are described in the scientific work of authors such as L. Bondarenko, E. Danilova, A. Gerasimov, V.A. Lototskyy, V. Malyukov, K. Raevskii, R. Schiller, V. Sushko, V. Vitlinskiy, A. Yastremskyi V. Ivanov, A. Stoyanov, L. Kovalenko, V. Usoskin, E. Dolan, E. Altman, B. Buhvald, T. Koh, E. Rid etc. However, there are

underdeveloped main goals and objectives of risk management, scientific approaches to risk management in airlines.

Professor*
Student***
Associate professor**

Exposition of the main material.

In terms of management, any crisis is a turning point in the functioning of any system, during which it is exposed from the inside, which requires a qualitatively new response from her side. The main feature of the crisis is that it threatens to breach.

The factors include the crisis arising, causes and level of organizational identity of persons that are involved in the crisis.

Crisis situations and events can occur at different levels: individuals, groups, businesses (organizations, companies), industry, region, country, group of countries.

In the general crisis are characterized by the following parameters:

- infiltrations priority goals and values;
- effect of surprise for those responsible who overcoming the crisis;
- acute shortage of time to respond of the threat.

Nowadays the vital question of effective control by the airline in a dynamic environment during achieving their goals. Aviation is the most high-tech activities and at the same time the most risky. This is because the losses due to crashes is enormous amounts. Sometimes there are cases when the airline lost so large that it is not able not only to cover their losses, but they compensate the other parties. In this regard, applies risk management process to avoid such situations.

Until recently, the risk management was considered as fragmented and highly specialized approach to risk management. Now it is an integral part of the management of airlines. Risk management is considered as a system management methods that includes analysis, evaluation and control of risks [3,4].

It should be noted that the process of risk management consists of three main stages: detection of violations, risk assessment and reduction of risk.

Identifying violations is an important phase of the airline. Such violations give impetus to improving the operation of airlines and further provides a diversion from such errors [1].

Most scientists argue that is necessary apply continuous approach to managing the airline to airline constantly works on the market. Continuity of operation of the airline depends on the level of risk that may arise in its activities.

In our opinion, development of scientific Vyatkin V.N. is merited attention in terms of the traditional approach to management continuity airlines and the risk management scheme has the form that is shown in Figure 1.

Fig. 1. The traditional approach to management continuity airlines [2]

As for the risk assessment, this stage involves the definition and calculation of losses that can bring the appropriate violation. Accordingly, after this, you need to decide how to avert a situation that will result in large losses.

In our view, the main objectives of the use of risk management in airlines are:

• dissemination of culture in combating risks airlines

• increase staff,

• improve security activities,

• increase the airline's reputation and expansion trends and the impact of its activities.

Nowadays, there are many risks that may have a place in the airline. Among the most common we have identified the following:

• risks related to aircraft and other property of the airline;

• risks of occurrence of an airline to third parties;

• financial risks (risks of financial commitments, credit, risk investment, etc.);

• risks of information technologies (ticketing system, internal information network);

• risks that effect the entire staff of the airline and are associated with its activity (especially for errors in the work of top managers)

• risk by a third party (terrorist attacks, etc.);

• natural and technological risks;

• risks from competitors;

• unforeseen circumstances (force majors) and others.

Practice of the world's leading aviation countries indicates that infrastructure risk management is impossible without real awareness of senior management of the airlines existing risks and the need to prevent a rational decision.

The attitude of top management to the management of business risks, in our view, is reflected in the overall organizational risk management policy, which should clearly define the airline range of risks. Therefore, at the initial stage should form a system of risk management in the airline down. But at the same time, an effective risk management system is formed and successfully implemented at the middle management level.

Conclusions. Thus, according to the authors, for the effective functioning of the system must ensure that the following main challenges faced by the airline:

• optimization of value potential, competitive advantages, risks and rates of the airline;

• implementation of system and situational approaches to assessment and risk management;

• optimize the preparation, adoption and implementation of management decisions in the airline by improving the style and methods of management at all levels;

• improving the management of the airline by making adequate control structure.

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ОСОБЕННОСТИ ПРИМЕНЕНИЯ РИСК-МЕНЕДЖМЕНТА В АВИАКОМПАНИЯХ

В. Новак, И. Бассараба, В. Передерий

В статье рассмотрены проблемы применения риск-менеджмента на авиапредприятиях. На основе анализа, обобщения и систематизации научных источников рассмотрены основные причины и основы применения риск-менеджмента. Сформированы подходы к управлению рисками на авиапредприятиях. Определены основные цели и задачи риск-менеджмента.

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PREREQUISITES OF FORMING UNIVERSAL MECHANISMS TO OPTIMIZE PRODUCTION AND LOGISTIC ACTIVITY OF AIR CARRIERS IN ORGANIZING MULTIMODAL DELIVERY OF OVERSIZED CARGO

S.Lytvynenko**

(European University, Academician Vernadsky 16-V Blvd., Kyiv, 03115, Ukraine)

Abstract: *The article investigates the prerequisites for creating universal mechanisms to optimize production and logistic activities of air carriers in the organization of multimodal delivery of oversized cargo. It was proved that such a need may arise for air carriers exclusively on delivery of oversized cargo in multimodal connection, wherein the air carrier acts as 3PL provider for a time.*

Keywords: *multimodal delivery, oversized cargo, air carrier, mechanism.*

Definition of the problem in general and its connection with important scientific and practical tasks. In terms of extraordinary strengthening of competitive struggle in traditional markets of transport services air carriers pay more attention to new, previously inaccessible markets. One of these markets is the market of air delivery of oversized goods. Traditionally, the market was established for air carriers from Russia and Ukraine, operating AN-124-100 and AN-225 aircraft, which is probably the only possible transport vehicle for the delivery of oversized cargo by air transport. However, customers now need a comprehensive solution to the problem of the delivery of oversized cargo, namely the need to deliver these cargoes on one of the key principles of logistics – «door to door». Therefore, there is a practical need for creating of multimodal chain of oversized cargo delivery by a principle «door to door» based on certain universal mechanisms of optimization of production and logistic activity of air carriers.

Analysis of the latest researches where the solution of the problem was initiated. The problem of multimodal delivery of oversized cargo was actively studied in the scientific literature. In most cases, researchers explore issues related to the delivery of these cargoes by road, rail or sea transport modes in specific combination.

Associate professor**

It should be noted the work of A. Gunin [1] who dedicated his research to the formation of models of oversized cargo supply chain management by the logistics provider and project effectiveness evaluation. The scientific work of A. Kotenko, A. Lavrukhin, P. Shylayev, A. Svitlychna, V. Shevchenko and A. Pylypeyko [3] is devoted to the determination of optimal variant of transportation based on the

formalization of costs in transportation of oversized and heavy cargo by different transport modes, as well as determining the economic feasibility of using a particular transport mode or their combination.

Thescientific work of E. Havryushkov [2] is dedicated to the development of methodological bases and methodical guidelines on making management decisions in the system of multimodal transportation of cargoes to improve the economic effectiveness of decisions taken within both a single organizational and production system and the country’s transport sector on the whole. The basic principles of multimodal transportation planning, proposed by T. Litman in [8], are a fundamental in nature and should be used to develop any tools of optimizing activity of multimodal delivery subjects. Many scientific problems related to the delivery of oversized cargo were studied by N. Troitska. Among the latest scientific works of authors under her guidance, it should be noted [5], concerning the problems in transportation of new generation equipment and [4], where features of oversized cargo transportation for oil refinery reconstruction were defined. The works of author collective led by J.E. Florez and J. Garcia [6; 7] are devoted to the study of multimodal transportation through application of application tools.

It should also be said that the author had previously resolved a number of important tasks related to the optimization of production and logistic activities of air carriers in the organization of multimodal delivery of oversized cargo, in particular opportunities in using information systems were identified, cooperation prospects of charter airlines and peculiarities of implementing joint projects were determined, economic and organizational bases of using cargo handling equipment in air transportation of super heavy and oversized cargo were developed.

However, these research papers do not contain tools for the optimization of production and logistic activity of air carriers in the organization of multimodal delivery of oversized cargoes.

Themainobjectiveofthearticle is to develop prerequisites for the creation of universal mechanisms for the optimization of production and logistic activities of air carriers in the organization of multimodal delivery of oversized cargoes.

Exposition of the basic material. The first step is to determine what for universal mechanisms for optimizing production and logistics activities of air carriers are needed and why they are the most relevant exactly in the organization of multimodal delivery of oversized cargoes. The point is that the air carrier usually operates as the Traditional Transportation Provider, i.e. 2PL provider, performing only functions related to the cargo delivery from point A to point B. At the same time there is a need to air carriers engaged in oversized cargo transportation to consider possibility on opportunities for providing entire complex of cargo delivery by a «door to door» principle.

Solving the problems of multimodal delivery of oversized cargo was a challenge for many companies, in particular, “Heavy Lift Group”, being an international group of specialized transport companies combining their efforts in delivering these types of cargoes. Also among such companies the following should be noted: “ADM Team Heavy Weight”, “Consolidated Shipping Services L.L.C.”, “Globalink Logistics Group Ltd.”, “Ipsen Logistics”, “The Riedl Group”, “Valley Group”, “Transport Systems (Transy) Ltd.” and others.

It should be noted that despite a variety of companies involved in organization of oversized cargo delivery the problem of ensuring its multimodal delivery with the involvement of air transport still remains unresolved to the end. There are several air carriers engaged in oversized cargo shipping in the global market, including airlines “Volga-Dnepr” and “Antonov Airlines”. These carriers often faced a problem of aviation part disruption in multimodal delivery of oversized cargoes, due to the fault of the delivery organizer or companies responsible for the delivery by other transport modes. For the air carrier this immediately poured in significant financial costs (day downtime of AN-124-100 aircraft is worth up to $150,000), which very rarely can be compensated in full volume, as the cargo owner pays only for the cost of delivery. Certainly such risks can be preliminary insured, but it is also not a panacea. Also airlines had to face with overpriced rates on the development of projects for oversized cargo delivery, initially by air, which forced them to consider the possibility of developing such projects through their own efforts. Currently, the airlines “Volga-Dnepr” and “Antonov Airlines” already have significant own successful experience in planning projects of deliver oversized cargo delivery by air transport. The next step was the development and successful implementation of such projects also in the multimodal connection by air carriers.

In view of the above mentioned circumstances air carriers gradually began to take over a part of functions associated not only with the aviation component of the oversized cargo delivery. Of course, the implementation of additional functions not typical for purely carriers, i.e. 2PL operators, making such carriers providers of a higher level. The author considers that as the carrier of oversized cargoes in this case take over a number of functions that are inherent for 3PL providers, namely the design and use of special information solutions, road transport management, consolidation of shipments, repacking and labeling, providing the complex of handling operations, so it can be considered as so-called “basic 3PL provider” (Third Party Logistic) or Integrated Logistics Service Provider.

However, air carrier can not always perform functions of 3PL provider, even in the basic set, because, on the one hand, – it is irrational in terms of spending its own resources and, on the other, – there is simply no such need in the delivery organization only by air.

It is in these circumstances a need in forming universal mechanisms for the optimization of production and logistic activity of air carriers arises, since only their use will make it available for the airline to effectively provide, if necessary, performing functions of 3PL provider, while remaining a 2PL provider.

What benefits will air carrier in performing functions of the Integrated Logistics Service Provider gain? The answer to this question is obvious, he will get significant advantages in the competition, which according to the latest concepts of the company strategic management (the concept of dynamic capabilities and new integrated concept based both on the resource concept and the concept of dynamic capabilities) consist in: obtaining advantages through unique product, distinct from competitors’ product – by enabling clients to receive unique product of comprehensive oversized cargo delivery on the «door to door» principle; creating the highest quality resource combination – through the use of different combinations of resources while performing functions of the Integrated Logistics Service Provider and Traditional Transportation Provider; in getting new opportunities due to the effective combining of internal and external competitive advantages – through efficient application of their own resources and providing new competitive opportunities in the competitive rival against market competitors; in forming new unique forms of the enterprise management – based on application of new approaches to the classification of logistic providers.

Conclusions. In the process of carrying out the study it was found that air carriers pay increasing attention to new, previously inaccessible markets, including the market of oversized air transportation. Also the need to meet the demand in this market by a comprehensive solution to the problem of oversized cargo delivery, namely the need to deliver these cargoes in multimodal connection on the «door to door» principle, was identified. It was determined that despite the whole significance of the problem there are no available tools to optimize production and logistic activities of air carriers in the organization of multimodal delivery of oversized cargo in scientific works. Preconditions of causing a necessity for creating universal mechanisms optimizing production and logistic activity of air carriers in the described conditions were identified. It was proved that such need for air carriers may occur only on delivery of oversized cargo in multimodal connection, herewith the air carrier became Integrated Logistics Service Provider for a time, while remaining Traditional Transportation Provider.

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ПРЕДПОСЫЛКИ СОЗДАНИЯ УНИВЕРСАЛЬНЫХ МЕХАНИЗМОВ ОПТИМИЗАЦИИ ПРОИЗВОДСТВЕННО-ЛОГИТИЧЕСКОЙ ДЕЯТЕЛЬНОСТИ АВИАПЕРЕВОЗЧИКОВ ПРИ ОРГАНИЗАЦИИ МУЛЬТИМОДАЛЬНОЙ ДОСТАВКИ НЕГАБАРИТНЫХ ГРУЗОВ

С.Л. Литвиненко

В статье исследованы предпосылки создания универсальных механизмов оптимизации производственно-логистической деятельности авиаперевозчиков при организации мультимодальной доставки негабаритных грузов. Доказано, что такая необходимость может возникнуть для авиаперевозчиков исключительно при доставке негабаритных грузов в мультимодальном сообщении, при этом авиаперевозчик становиться, на время 3PL оператором.

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PROVIDING AIR ENTERPRISES' BUSINESS EXCELLENCE THROUGH STRATEGIC LEADERSHIP DEVELOPMENT

L. Lytvynenko**

(National Aviation University, K. Komarova Avenue 1, Kiev, 03058, Ukraine)

Abstract: *In the article the role and basic terms of the air enterprise strategic leadership development were determined and analyzed. Interconnection between application of strategic leadership and business excellence indicators of the air enterprise was studied. It was identified that leadership approach to management allows achieving long-term goals of the air enterprise development through the implementation of strategic changes necessary for a more effective economic activity performance in the face of uncertainty and dynamic factors of the environment, while maintaining a sufficient level of flexibility and agility.*

Keywords: *strategic leadership, leadership approach, business excellence, critical success factors, key performance indicators, air enterprise, enterprise development.*

Definition of the problem in general and its connection with important scientific and practical tasks. The development of air enterprises in the conditions of increased risk and uncertainty define the need for the introduction of modern management approaches, more corresponding to the features of business functioning at the domestic and international markets. The most relevant trend is the use of leadership approach to the enterprise development management.

Analysis of the latest researches and publications where the solution of the problem was initiated.K.B. Boal and P.L. Schultz in [1], V. Dusya and M. Crossan in [2], W.G. Rowe and M.H. Nejad in [6] analyzed peculiarities and main directions of strategic leadership applicationin terms of changeable environment. In turn, S. Hodlin in [3] studied ways of coming to business excellence as the strategy ensuring integral quality in all activities of the enterprise. A. Joyce in [6] and L. Mayers in [6] focused on leadership in the aviation industry as the basic aspect for the future development.

Associate professor**

However, there are no thorough developments in the aspect of providing air enterprises' business excellence through strategic leadership development, which will be the main object of the interest in this research.

The main objective of the article is to determine the role and basic terms of the air enterprisestrategic leadership development, identify interconnection between application of strategic leadership and business excellence indicators of the air enterprise, analyze the implementation of leadership approach to the air enterprise development management.

Exposition of the basic material. The development of strategic leadership can be defined as an essential condition for the effective functioning of air enterprises at the market, because it creates the force necessary for active combat with competitors, as well as power unattainable for them for a certain period of time. Such strong business entities may be the first ones in establishing successful innovations and most successful in the implementation of new business initiatives.

During researches it was determined that the strategic leadership development is characterized by complexity because it requires versatility in its providing. In most cases only essential and thoughtful organizational changes will lead to the achievement of significant results, the effects of which are felt over the long run. Therefore, the survival provision or supporting prosperity of the air enterprise should be provided by incremental measures taken based on the leadership approach.

So, leadership approach to management allows achieving long-term goals of the air enterprise development through the implementation of strategic changes necessary for a more effective implementation of economic activity in the face of uncertainty and dynamic factors of the environment, while maintaining sufficient level of flexibility and agility.

The basic terms of the air enterprisestrategic leadership development are as following:

- flexibility and adaptability necessary to preserve mobility in responding to changes in the external environment and relevant trends at the air transportation market;

- wide scale of thinking, that focus not only on narrowly outlined directions of development, which remains unchanged for a long period of time, but on the broad prospects and opportunities created by changes in the business environment of the air enterprise, mainly due to the effective change management and encouraging knowledge management;

- emphasis on human resources development and ensuring effective teamwork;

- innovativeness that provides aiming at the perspective and continuous improvement in meeting the future needs of customers and reducing risks associated with the uncertainty of the international competitive environment; in turn, leadership itself will be an impulse for intensifying enhancements;

- concentration on the development of partnerships necessary to make better offers to consumers of air enterprises – products with a higher value for them, especially by concluding agreements on cooperation and establishment of partner networks (success of the aviation product depends on many interacting parties, so it is necessary to establish effective interrelationships with them).

Air enterprises that meet the above mentioned terms have much greater prospects for the survival and development than their competitors losing in this.

With the strategic leadership development it is essential to combine two aspects: individual leadership (development of highly competent strategic leaders focused on creating the optimal organizational structure at the air enterprise, rational use of resources and formation of the enterprise strategic vision in accordance with the fundamental long-term targets) and business leadership of the enterprise (providing conditions for the formation of “business excellence”, needed to increase competitiveness at the domestic and foreign air transport markets).

For instance, business excellence in the airline business can be displayed through key performance indicators in such aspects as capacity growth, air tariffs, load factor, leverage, airline margins, cost effectiveness, etc. For airline the basic critical success factors are represented by strong strategic leadership, results oriented strategic management, strict cost management, diversification of revenue sources, effective communications and information application, innovation introduction and continuous business process improvement, optimal air route network development, effective personnel management and increasing loyalty level.

Analysis of the features of the implementation of leadership approach to the management of enterprise development has allowed defining its basic characteristics, as presented by the author in Fig. 1.

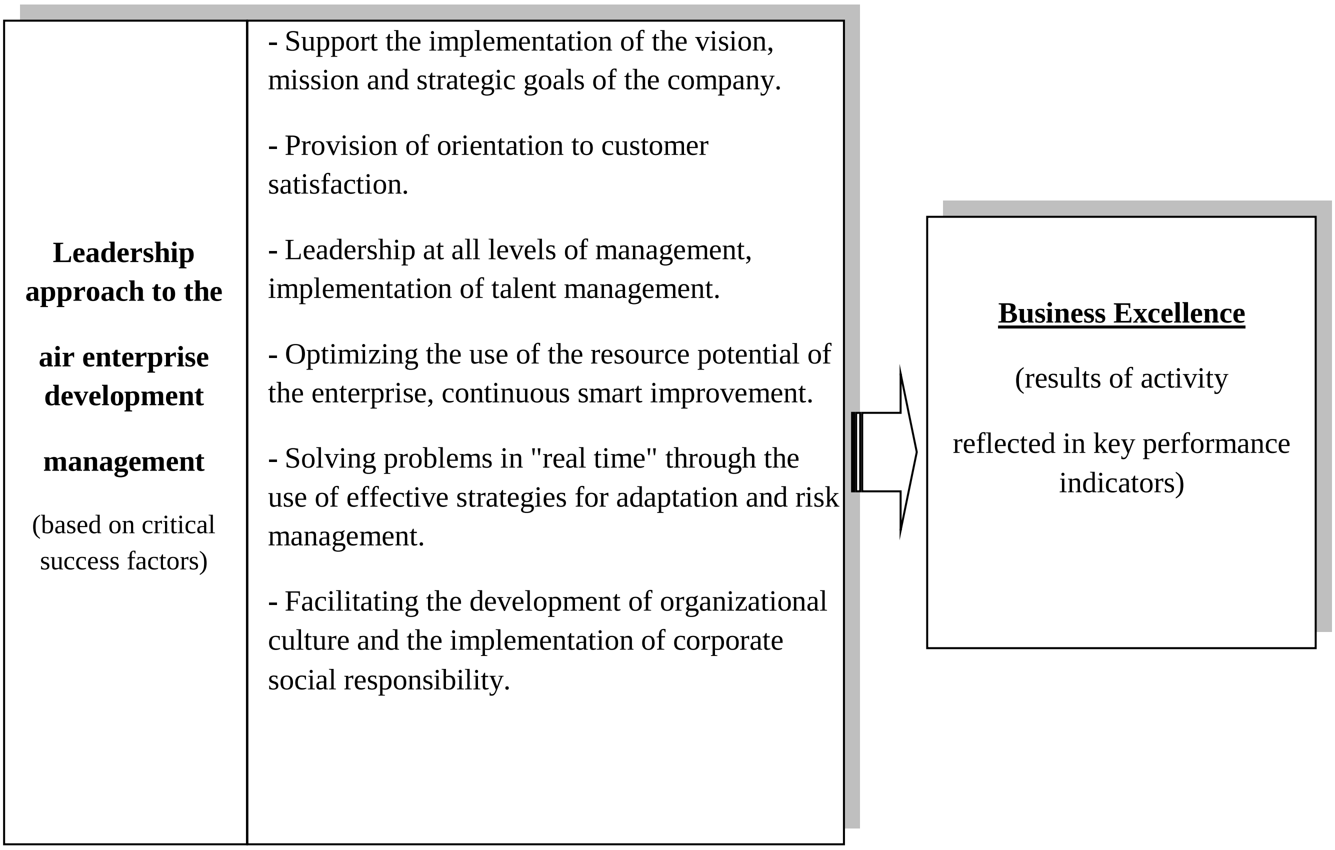

Fig. 1. Application of leadership approach to the air enterprise development management

Source: developed by the author

The top 10 airlines of 2016 according to the annual Customer Satisfaction Survey are “Emirates”, “Qatar Airways”, “Singapore Airlines”, “Cathay Pacific”, “ANA All Nippon Airways”, “Etihad Airways”, “Turkish Airlines”, “EVA Air”, “Qantas Airways” and “Lufthansa” [7]. These rankings represent airline excellence from the point of view of passengers. So, it is really important to consider critical success factors of the air enterprise not only from the side of the enterprise itself, but also from the side of stakeholders and target audiences – customers.

A key feature of the leadership approach to the air enterprise development management is focus on long-term outcomes, supporting effective teamwork and cooperation aimed at solving problems of development of the air enterprise or its survival in the market.

The use of strategic leadership ensures not only stability of the company activity in the current moment, but also creates a way to achieve long-term prospects. That is, with the help of today's changes in operating parameters the air enterprise creates its own future, existing reserves are activated.

Strategic leadership should contribute to the creation of favorable environment for management decision-making (effective choice of the existing strategic alternatives of the air enterprise development), as well as directly to their realization (implementation of strategic actions). Herewith, completely new culture of leadership development at all management levels of the air enterprise, based on competences, is formed.

According to the author, air enterprises using a leadership approach to development management, improving its operations, are subject to special interest on the part of national and foreign partners, which could lead to the creation of powerful forms of cooperation. This, in its turn, provides a mutually beneficial exchange of technologies, material resources, information, experience, improves the competitiveness of enterprises and creates a completely new value to the consumer.

The main results of the implementing leadership approach to the air enterprise development management are defined:

- transparency and clarity of the value orientations of the enterprise managers, staff, customers and partners, which corresponds to the modern principles of corporate social responsibility;
- improving the efficiency of relations in the sphere of production, supply and scientific cooperation with other enterprises and organizations;
- increase of labor productivity and profitability of the air enterprise by coordinating activities and the selection of optimal methods for achieving goals;
- increase in market share, since the implementation of this approach can allow to enhance the leadership potential of the enterprise (business excellence);
- achieving a high level of loyalty among consumers.

Conclusions. As a result of studies of current practices of air enterprises it was concluded that modern approaches to the development of organizational strategic leadership should be based on the orientation on the perspective and recognition of existing regularities in the development of air enterprises to better respond to them, forming strategic vision, goals and strategies appropriate to the operational realities, identifying the need to implement changes at the enterprise, the optimum mobilization of all resources within a reasonable time to obtain the desired result.

Thus, air enterprises' business excellence, reflected in key performance indicators, can be supported by the strong strategic leadership development through enhancement of critical success factors.

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ОБЕСПЕЧЕНИЕ ДЕЛОВОГО СОВЕРШЕНСТВА АВИАПРЕДПРИЯТИЙ ПУТЕМ РАЗВИТИЯ СТРАТЕГИЧЕСКОГО ЛИДЕРСТВА

Л.Л. Литвиненко

В статье определены и проанализированы роль и основные условия развития стратегического лидерства авиапредприятия. Изучена взаимосвязь между применением стратегического лидерства и показателями делового совершенства авиапредприятия. Было установлено, что лидерский подход к управлению позволяет достичь долгосрочных целей развития авиапредприятия за счет реализации стратегических изменений, необходимых для более эффективного осуществления хозяйственной деятельности в условиях неопределенности и динамических факторов окружающей среды, сохраняя при этом достаточный уровень гибкости и маневренности.

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SYSTEM MODELING OF MARKETING INTERNATIONAL BUSINESS SECURITY

O. Ilienko*

(National Aviation University, K. Komarova Avenue 1, Kiev, 03058, Ukraine)

Abstract:*The article considers the model of construction of such concepts as: " marketing strategy global economic security of subjects of international entrepreneurship" and "marketing for international business", as well as the urgency of the need to create a new concept of "marketing international business security", justified by the existing conditions of the development of the world economy, which today is very complex and not stable.*

Keywords*: international business security; international marketing; globalization; marketing strategi; economic security system.*

Introduction. In view of features a high degree of uncertainty and instability, andincreased risk of entering the market to international business entities, in modern conditions of the world economy development, there is a need to ensure the maximum connection of the international economic security system and international marketing system, not formally, as it was in the pre-crisis period, but consciously and with a certain scientific approach.

Problem statement. The general mechanism of international business entity operation based on international business security and modern system of marketing that is the one that provides system efficient existence and operation in general marketing complex, separately for each country, on the territories where its target markets are situated.

Unsolved problem of the general problem. There is a need to form part of space of international business activity with complex methodological approach of strengthening of international economic security as the main direction of achieving high and self-development of the business activity, and in modern conditions of active expansion of globalization processes in the world economic system.

Analysis of recent researches and publications. The problems of world market and individual target markets proved that in order achieve strategic goals and to solve current problems of the international business entities it is necessary:

Professor*

to analyze and systematize marketing information and knowledge about the interconnections that exist and suddenly emerge in the world market; to intensify ensuring the international economic security with the aim of reducing general risks of international business activity and improving the approaches of international marketing; to find the best ways to satisfy the international level target consumers. A great number of papers of domestic academic economists is dedicated to basics of modern philosophy of economic security formation; these scientists include AbchukV. (2005) [1], T. Tsyhankova (2004) [2], A. Starostina (2007) [3], O. Martianov (2005) [10], Y. Makohon (2004) [5], D. Lukianenko (2001) [6],I. Lylyk (2007) [7], V. Vasylenko (2003) [8], O. Kanishchenko (2005) [9], M. Yankovskyi (2004) [4], as well as foreign: [1], V. Kotylko (2007) [11] and others, are devoted to the issues of study and market risks reduction and the role of marketing in solving problems of risks.

The purpose of this scientific research is model of providing marketing international business security, which is based on principles of international marketing as the basis for establishment of areas of development of modern business processes in the world economy in crisis conditions.

Results. In the field of marketing analysis (both at the national and international level), both in research and in the application layer, currently in the calculation and forecasting of main market metrics and marketing parameters prefer quantitative methods and models that can be grouped as follows:

- statistical methods of decision making theory (used for stochastic analysis and reaction characteristics of target consumers to any changes in market conditions and economic marketing space;

- simulation models (there is the possibility of use in unstable conditions, as well as in terms of any changes that affect the marketing environment and increasing competition. Used in cases when you don't have the ability to take the analytical solution, but the system that is analyzed consists of elements that lend themselves to quantitative characteristics);

-regression analysis (used in cases where it is necessary to establish the relationship between the specific marketing indicators market parameters or their groups);

- multidimensional approaches, which include factor and cluster analyses (are used for justification of marketing decisions, if necessary, establishment of numerous interrelated variables);

- game theory;

- models based on the construction of a decision tree;

- deterministic approaches operations research, which include linear and nonlinear programming (used in cases of the need to find the best marketing and management decisions in the presence of a rich number of interrelated variables).

But in conditions of considerable growth of interest and attention to the introduction of marketing methods and approaches to the management of business processes (especially internationally) to strengthen the system of economic security has several problems, both theoretical and methodological nature, which are based on the following considerations and circumstances:

-reducing attention to the diagnosis of the external environment of international business processes at various levels of doing business (mega-, macro-, meso-, micro);

- lack of specialization of methods, depending on the level of research and analysis, which reduces the quality and accuracy of forecasts, and therefore reduces the level of enterprise economic security of subjects of international business;

- the difficulties in the choice of approaches and methods for managing the marketing part of the business economic security (especially at the international level in the conditions of globalization in the global economy);

-the lack of adequate attention to marketing issues in international business economic security;

- insufficient study of the mechanism for establishing the criteria, parameters and indicators of an estimation of efficiency of the marketing component of the overall system to strengthen the business economic security and management.

Therefore, it is important first of all to define the main principles of the choice of the direction of the organization management mechanism, marketing component of international business for economic security in conditions of globalization. It is also necessary to determine the place and role of this mechanism in the overall system efficiency management of international entrepreneurship. It is necessary to consider the orientation of the subjects of international business processes to increase its own competitiveness and competitiveness of products, the production of which he specializes (under products, you should understand all activities where specializes enterprise). In addition it is necessary to create competitive advantages at all levels of international economic space (mega-, macro-, meso - and micro-). Thus, the goal of strengthening the economic security of subjects of international businesses using the marketing component with maximum consideration and heterogeneityinconsistency the competitive environment of the global market is impossible without maximum flexibility, strategy formation control of international marketing.

Based on the foregoing, we have formed a fundamentally new concept in the theory of economic security - "marketing the safety of the subjects of international business activity", which aimed at increasing the competitiveness of products, subject of international business process; assurance of the protection of the business and market interests of the subject of the international business process.

In this connection it is necessary to concentrate attention on the marketing component of the international economic security.

All the above developments are provided the opportunity to form an independent scientific and applied direction of "global marketing strategy of economic security of subjects of international entrepreneurship", the essence of which consists in development of scientific-methodological and theoretical-conceptual frameworks support strengthening of economic security of subjects of international entrepreneurship (and thus the development of world economic system) in crisis conditions of formation and development of globalization processes based on the use of marketing strategies for international business (Fig. 1).

Based on the analysis of the nature of business security of business entities international business, international security and international marketing present their definitions, distinguishing features and characteristics of globalization in the economy, and also based on the simulation of the overall system of control mechanisms of economic security of business entities at different levels of management (taking into account peculiarities of functioning of business entities in the domestic markets, the markets of other national economies and the global market), modeling of the mechanisms of management of marketing activity at the international level, we have proposed the interpretation of the concept "international marketing business security" as a multidimensional, multifaceted design ensure state protection of market interests and the stability of functioning of subjects of international activity separately at the national level, the country level, where is located the target markets, the level of the world economy, the formation and functioning of which is based on the development of a set of measures aimed at ensuring the concept of marketing forecasting; planning, organization and management of all aspects and elements of the international activities in the business sector; promotion of, trafficking in and consumption of finished products maximum while meeting the needs of each member of the international business process, with the aim of maximising long-term profit (reducing costs, increasing productivity and competitiveness of what is offered at the international level, competitiveness of the subject of international business and as a consequence boost the competitiveness of the country as a whole). This can be achieved by a constant search for new technological solutions to enhance the efficiency of the use of marketing tools with maximum protection an individual approach to the specific markets each national economy individually and directions of change processes that occur in the world economy as a whole.

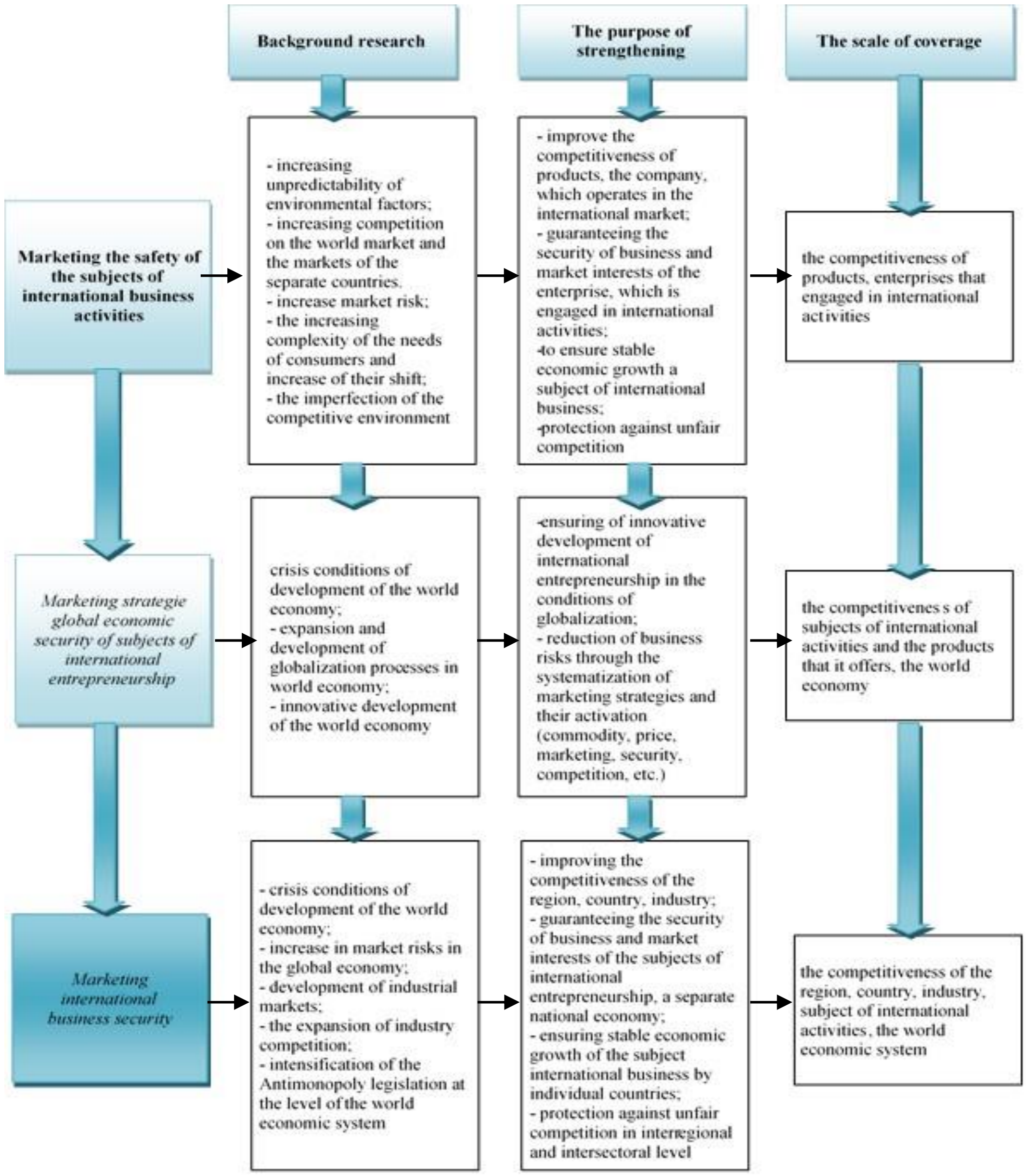

Fig 1. The model of the formation of the categories of "marketing strategie global economic security of subjects of international entrepreneurship", "marketing international business security"

Thus, on the basis of the basic premises, goals and scope of marketing international business security, we have formed a system of marketing international business security with the definition of its main objectives, functions, subjects and objects of regulation and systems of marketing international business security through the management of international business processes in the globalization of the world economy by using the classical model of "input-output", which shows the relationship of the main elements of the business environment of the international market and delivery systems marketing international business security (Fig.2).

Consequently, the proposed definitions of "marketing strategy global economic security of subjects of international entrepreneurship" and "marketing international business security," demonstrated features of the scientific category of "marketing international business security" and justified its necessity in modern conditions of development of the world economy, which are characterized as very complex and contradictory.

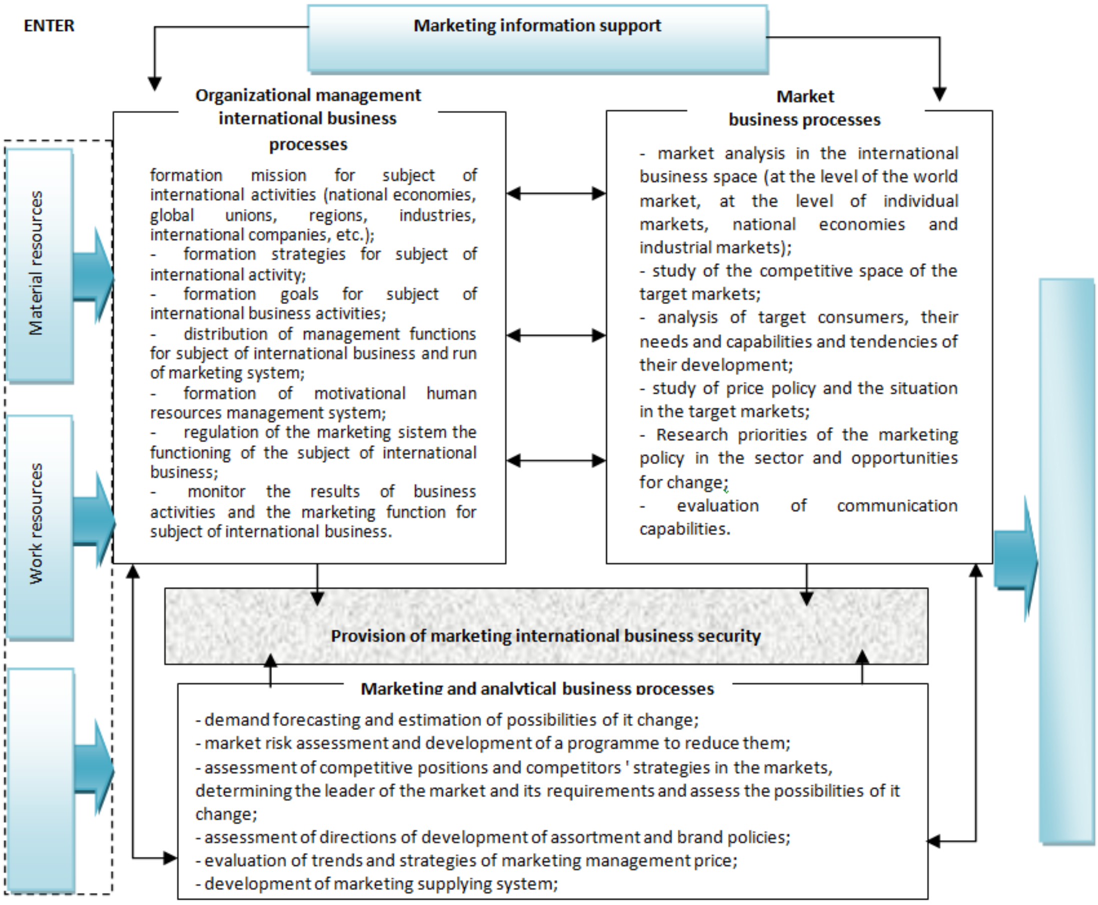

Figure 2. The model of providing marketing international business security by managing business processes.

The major prerequisites for the formation of a fundamentally new scientific and applied concepts is the reduction of market risks in a crisis economy with a simultaneous increase of activate of innovative development of the world economy, countries and international business in the conditions of intensive development of globalization processes.

Conclusions. Thus, when establishing and developing international business activity to strengthen the international economic security of international business entities in establishment of its mission and long-term strategy it is necessary to focus on opposition to changes, which is impossible without development, implementation, management and development of international marketing.

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МОДЕЛИРОВАНИЕ СИСТЕМЫ МАРКЕТИНГОВОЙ МЕЖДУНАРОДНОЙ ПРЕДПРИНИМАТЕЛЬСКОЙ БЕЗОПАСНОСТИ

О.В. Ильенко

В статье сформирована модель построения таких понятий, как: «маркетинговая стратегия глобальной экономической безопасности субъектов международного предпринимательства» и «маркетинговая международная предпринимательская деятельность», а также доказана актуальность необходимости создания нового понятия «маркетинговая международная предпринимательская безопасность», обоснованная существующими условиями развития мировой экономики, которые на сегодняшний день очень сложные и не стабильные.

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TO THE PROBLEM OF PROVIDING ECONOMIC SECURITY ON ENTERPRISE

E. Danilova**

(National Aviation University, Kosmonavta Komarova ave. 1, Kyiv, 03680, Ukraine)

Abstract:*In the article the types of economic security of the enterprise considered, the effect of the region and the state as a whole on the formation process of economic security of the enterprise analyzed, and alsoinvestigated the effect of other factors and threats (external and internal), which can be a barrier to the effective development of the company.*

Key words*: economic security, enterprise, region, security system, Resourcesecurity, flow security, threats.*

Formulation of problem. In the current economic situation, the majority of global companies operate in conditions of uncertainty, unpredictability. Unstable political and socio-economic situation in the world reinforce the degree of risk of the decision-making and operation of companies in general. Therefore, the problem of ensuring economic security of the enterprise is becoming increasingly important.

Research methods. This work 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 article is to analyze the problem of providing economic security on enterprise, examine the influence of state or regional institutions on enterprise economic security.

Exposition of the basic material. Today acutely raises the question economic security of enterprise in terms of information and rapid evolution. The company, focused on the efficient and continuous operation requires adequate economic security for the continued existence on the market. Economic security considered at not only on the level of one company, but on a global, territorial, regional, national, and on international. All levels relate to each other and ensure an uninterrupted operation.

Associate professor**

Different approaches to defining the concept of "economic security» were analyzed and concluded that among scientists there is no single point of view on the essence of the concept, but most of them noted a significant role of the state in the process of formation of economic security of the enterprise [4, 6].

Using direct and indirect intervention methods, the state affects the economic and social development of the country, therefore, a common problem for companies and state acts as the formationincludingeconomic security.

It was determined that in order to ensure economic security of the enterprise it is important to take into account regional peculiarities of company location: natural resources, labor potential of the enterprise, education and qualification level of employees, the level of provision of the population, etc., and, on this basis, it was concluded about the necessity of development and improving the economic security of the region in which the enterprise is located.

It is also was examined the structure of the economic system of the region, such as:

- enterprises, households;
- regional authorities;
- factors of production market;
- the financial market;
- goods and services market.

It is also analyzed the main threats to the economic security of the region, namely:

1. Economic - decrease in production volumes, depletion of the scientific and technical potential, growth of resource-industry against decrease in high-tech industry, growth of the level of financial dependence on imports in the region.

2. Social –increase of unemployment, declining level and quality of life at the region, the demographic situation, deterioration of the environment, crime rate, etc. [7].

The essence of economic security of the region is the ability of the economy and the ability to provide the quality of life at the proper level, socio-economic and socio-political stability and prevent the occurrence or even counteract the effects of internal and external threats at optimal cost of resources and their rational use.

The basis of economic safety of enterprise is its phased economic development that aims at producing necessary goods and services to the largest customer satisfaction and preservation of all important information related to these activities[2].

Economic safety conditioned by the influence of many factors. Some factors for a specified period of time can be considered conventionally defined, such as number of employees, fixed assets, but others tend to quick change (prices of goods and services, fluctuations in supply and demand, the level of investments) and not subject to precise definition. Because of this, the company may face strong competition; destabilize the national economy and the world system in general[1].

The security policy should include a system of views, knowledge and solutions in this field, which will create the most favorable environment for achieving the goals of the company.

For rapid response to threats to economic security that can be brought before now, manager must have an idea of the kinds of economic security. The authors reviewed the classification of economic security based on the distribution of the subjects (incoming and outgoing flows of resources and basic resources in the system) and objects (source localization threats) (fig. 1).

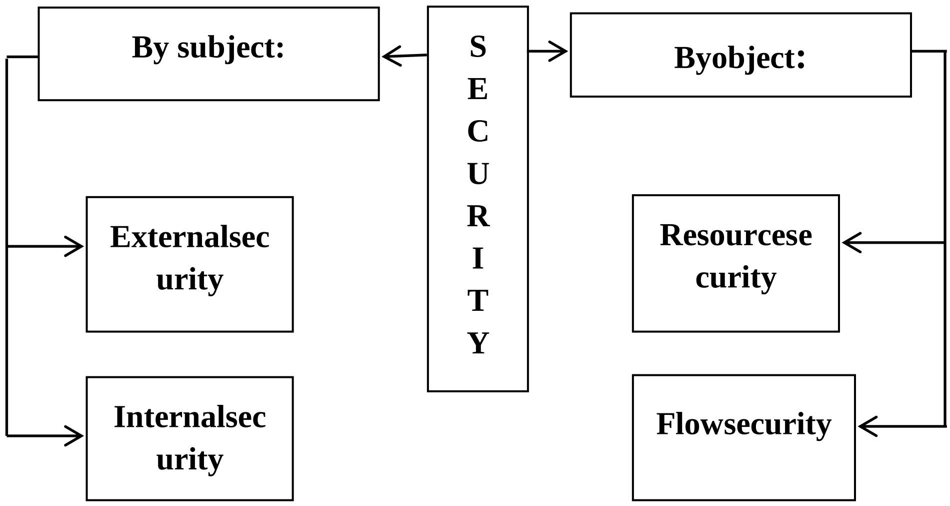

Fig.1. Types of economic security
***based on [5]**

External subjects of economic security are institutions of government, human rights institutions, customs and tax control. External institutions ensure regulatory impact of macroeconomic and socio-political context of economic activities, define the scope of options for interaction between business entities, and relieve some of the potential threats.Also with the regulatory and protective influence of external actors can have a negative impact, becoming a source of threats to the economic security of the company. Institutions of government are also the sources of political instability and inconsistent government policies, which hampers the normal conduct of business and calls into question the advisability of investing in the most promising, innovative projects.

Internal subjects of economic security specialists are specially organized security services, specialists from other departments that perform separate functions of security, organization managers (decision makers). The company may engage support from external entities to ensure economic security.With intra-organization of economic security, the subjects may be employees of the department of research and development, sales department, or someone from departments of strategic planning, marketing, IT, etc. In big corporations, economic security issues may engage employees of different departments at the same time in the presence of the controlling canter (security).

Resource security:

1. Personnel. It includes protection for human resources quality.

2. Technical and technological. It related to the protection of technical and technological resources of the enterprise from potential damage, emergency conditions and equipment failures, damages (intentional or accidental), fires and other force majeure, as well as the threat of obsolescence.

3. Raw. This implies the provision of reliable, stable supply, quality control of raw materials received from suppliers.

4. Trading. It aims to ensure that the product has been produced by the enterprise in a timely manner and effectively implemented in the market or properly stored (protected against quality loss, theft, fraud).

Flow security:

1. Financial. One of the key types of security, since it is the first financial flows falls under the influence of negative factors.

2. Transportation. Transport safety means not only protection of the transported raw materials and products, but also the safety of all traffic flows in the company, their reliability, protection against fraud and damage.

3. Information. This type of security was the basis for the formation of a trend in studies of Western scholars and the formation of knowledge management concept, market research and others. The most active in recent years developed the idea of the so-called "competitive intelligence". Competitive intelligence, in fact, is a system of economic security and competitiveness of the enterprise

Given the above,thenecessary condition is to develop strategies to ensure and support economic security, which focuses on maintaining the integrity of the company, preventing and avoiding information leakage, quickly and effectively adapt to future change and continuous development. The main requirements are clear understanding the limitations of available resources, clarity of wording problems, flexible response to changes in the environment and reach their goals.

There are three types of strategies are used depending on the nature of the problem. The first type - a strategy focused on sudden and obligatory response. The second - aimed at forecasting the possible dangers of a comprehensive study of the situation not only in the middle of the enterprise, but also outside. The third - a strategy related to damages. It is use when it is impossible to use strategies first and second type[3].

From the fullness and complexity of application of measuresfor a specific problem, solution depends on successful company defense. Unable to create a single unified economic strategy for the protection of enterprises, i.e. for each activity should be directly own protection system that includes the features of the enterprise.

Economic safety characterized by the following properties: performance, flexibility, adaptability, efficiency, organization. At the optimal ratio of these properties, the company can quickly and adequately respond to threats, be persistent and constantly grow.

It is almost impossible to develop the most effective security system for its implementation immediately. It will grow with the company.

Conclusionsandsuggestions. The economic security of the region - is not only the current state of natural resources, the production, the region's financial capacity, but also the development and implementation of innovative approaches and activities aimed at the development and countering external and internal threats, which, in turn, will enable companies in the region to raise the level own economic security.

Considering the above, it was concluded that it is from the company depends on the choice of methods and means to ensure the protection of economic, resulting from the scale and nature of threats. All components are linked and only their complex interaction provides efficient operation and economic security.

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К ПРОБЛЕМЕ ОБЕСПЕЧЕНИЯ ЭКОНОМИЧЕСКОЙ БЕЗОПАСНОСТИ ПРЕДПРИЯТИЯ

Э.И. Данилова

В статье рассмотрены виды экономической безопасности предприятия, проанализировано влияние региона и государства в целом на процесс формирования системы экономической безопасности деятельности предприятия, а также исследовано другие факторы влияния и угрозы (внешние и внутренние), которые могут стать барьером на пути эффективного развития предприятия.

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DETERMINATIONOF THE MAXIMUM RUNNING SPEED

A.Gigineishvili*, K. Tskhakaia*, R. Kikvidze*, M. Bibiluri**

(Georgian Aviation University, KetevanTsamebuli ave 16.Tbilisi, 044, Georgia).

(Georgian Technical University, Merab Kostava ave 75, Tbilisi, 0175, Georgia)

Abstract:*In the work there is conducted the analysis of sprinter and stayer average and instantaneous speeds trough the relevant distances. There is defined, that their optimal values until the oxygen's full exhaustion. There is showed, that the runner can't run withmaximum average speed for a long time – the sprinter is able to maintain the average maximum speed until the 200 m and the stayer until 2000 m (till the oxygen's full exhaustion).*

Keywords: *sprinter, staier, instantaneous speed.*

The article deals with the respective distances sprinter's and staier'saverage speed and the instantaneous analysis.Established their optimum values of oxygen flow rate to the full.It is shown that a runner can have a maximum average speed of long running– sprinter can maintain the maximum average speed of 200 m – to, and even 2000 m staier's – up (full exhaustion of oxygen).

Movement of the body are introduced to describe the concepts of instantaneous and average velocity. Instantaneous called bandwidth, which is the body of the trajectory at a given point in a given moment.Consider a linear motion (Fig. 1)

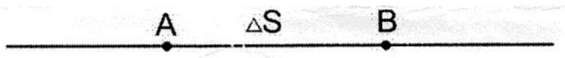

Fig.1.

For determination of the instantaneous speed of movement in a point A during uniform motion, is enough,ΔS distance from A – B divided by time Δt, during which the distance traveled will be

$$v = \frac{\Delta S}{\Delta t} \tag{1}$$

Full Professor*
Associated Professor**

This body will have a speed of any AB path, including the A spots, but if the movement is uneven,this formula for determining the instantaneous speed to do it.In this case, point B to come closer A – and so we must select the trajectory AB section of the movement can be considered equally.If such a finite section could be found, then you should consider the limit when A→B (ie $\Delta S \to 0$, $\Delta t \to 0$) and (1) is written as:

$$v = \lim_{\Delta t \to 0} \frac{\Delta S}{\Delta t}$$

Since the last time on the functions (2) – relate the increment function of marginal increment of the argument,when the latter aspires to zero, from their analysis is known, that this limit is called the derivative of the function argument.We got to the final instantaneous velocity equals the distance from time to time:

$$v = \frac{dS}{dt} \qquad (3)$$

Therefore, the speed of the instant determination of the need to know the S = S (t) function face (it must be defined in each point of the trajectory. If it does not know, then we can not know the speed of the path anywhere at any time: or, in this case, we know nothing about the nature of the movement.To him, the idea of something still in deploying high-speed concept

$$< v > \equiv v_{average} = \frac{\Delta S}{\Delta t}$$

Where ΔS is the total length of the trajectory Δt even the time that the body has made to reach this distance on the surface (1) and (2) formulas are almost the same, but its content is a big difference between them–the(1) formula is fair for any path through the station and the station can determine the movement of the character (ie, the instantaneousspeed at each point), the(4) formula connects the previous distance (path length) of the time, within which it has been driven at a distance, so that we do not know the nature of the movement and speed of the importance of not in any point of this comparison we get formulas, the average speed of the uneven movement rate at which the body is the same distance in the same time it would have been equal to its movement.If the uneven division of the possible trajectories of n sections and separate sections of the well-known passage of time Δt_i, we can write:

$$< v > = \frac{\Delta S}{\Delta t} = \frac{\Delta S_1 + \Delta S_2 + ... + \Delta S_n}{\Delta t_1 + \Delta t_2 + ... + \Delta t_n} = < v_1 > \frac{\Delta t_1}{\Delta t} + < v_2 > \frac{\Delta t_2}{\Delta t} + ... + < v_n > \frac{\Delta t_n}{\Delta t} \qquad (5)$$

Where the $< v_i >= \frac{\Delta S_i}{\Delta t_i}$ individual is the i –th station in the average speed of $\Delta t = \sum_{i=1}^{n} \Delta t_i$ time during which the body was moving and $\Delta S = \sum_{i=1}^{n} \Delta S_i$ passed distance.

Determine the maximum average speed, which can be run athlete.Obviously, it will depend on the size and gasarbeni distance runners will be able to maintain a certain period of time.Athletes who run 200 m the distance, are sprinters, more than – straier's.Experimentally established that the average speed of the race runner straier less than what can be seen in figure 2.This reflects the attitude of the average speed of the running distance – runner medium speed gradually increases to about 200 m – up ≈10,5 m / s and then decreases monotonously.

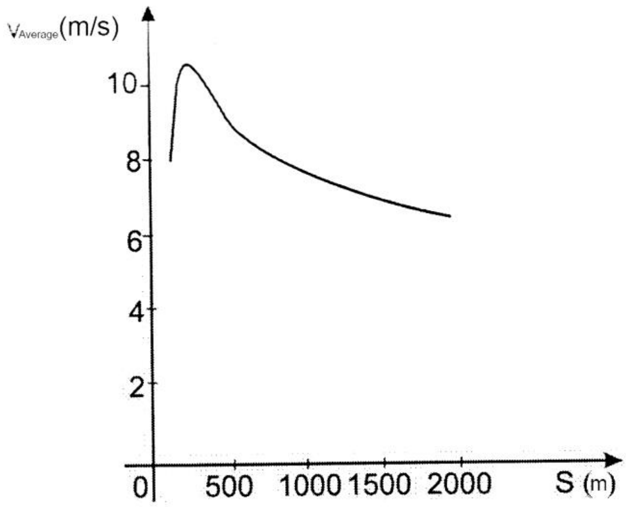

Fig. 2.

Sprinter immediately reaches a maximum speed of light ≈ 2 seconds – then it (see. Fig. 3) The maximum value of the average speed as a boat figur 2 – can be seen rising from the first 2 seconds – the time it comes staiers, it will not be able to keep the entire distance of the average maximum speed. This is caused by a deficiency of oxygen in the muscles, ie oxygen supply by reducing the time for this reason that the sprinter can keep a maximum average speed, until you spend spare oxygen (oxygen reduction takes place 300 meters – after).

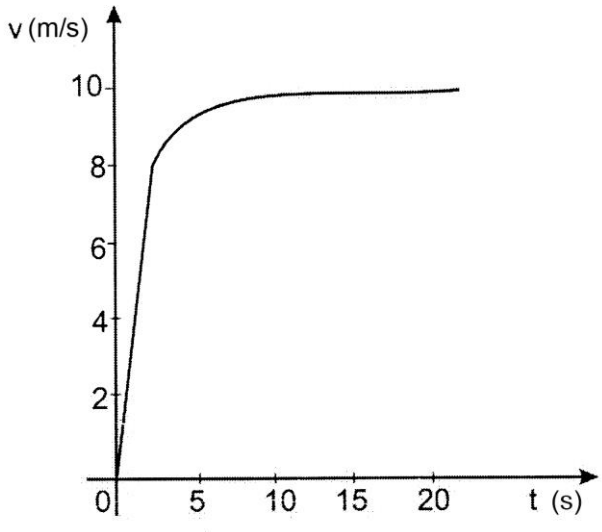

Fig. 3.

Runners, a record, to establish, to select a maximum average speed, not the oxygen ran out to the finish line (only sprinter runs the maximum average speed over the distance).

The mitochondria of the oxidation – reduction reactions.It is the so-called „stove“, a source of energy.Chloroplasts contain chlorophyll, which absorbs light and converts it into chemical energy. Substances and conversion of energy during a complex organic compounds – proteins, fats and carbohydrates, and the collapse of the energy they release. This process is called dissimilation of the energy shift. In addition there is a new parallel synthesis of complex molecules which result in energy absorption. This process is called assimilation.These two processes are inextricably linked, and their combination is called metabolism.

Metabolism vitality necessary condition. Every cell, every part of the organism is in the process of continuous circulation of substances. During assimilation, for example, has a place in the light of the inorganic synthesis of organic compounds.

$$6CO_2+6H_2O+h\gamma \rightarrow C_6H_{12}O_6+6O_2 \quad (6)$$

Where the light is $h\gamma$ kvantis energy, while $C_6H_{12}O_6$– glucose.All living organisms on the earth to the current processes for the chemical energy is mainly used to provide some green plants. It can be said that the photosynthesis energy supply comes from a kind of bridge between the role of the sun and the earth life.In addition, during photosynthesis, the most atmospheric part of the molecular oxygen.

Matter and energy, and about six valentobisa considering that the energy in the body, mainly in the form of heat, conduct active metabolic rate increases.This process is regulated by the breath. Obviously, running the body more oxygen (more energy).

Live cells can be considered as energy converters, for example, kimiurisa – electric (the nerve and brain cells), tunes – electric (in the ear), light – electric with the (debt), kimiurisa – mechanical (the muscle) and so on. Contraction of muscles can utilize nutrients such as glucose ($C_6H_{12}O_6$) molecules of the chemical energy of 20 – 40%, the remaining part of the heat is transferred, but not entirely lost: is used to keep the body temperature constant, if people do not run the muscles, the body heat generated is not enough to warm the body in cold weather. In this case, the muscle begins to involuntary contractions (people trembling) and the heat generated by them helps the body maintain normal temperatures. During muscle contraction glucagon oxygen, and ATP posporkreatinis – is declining, while the carbon dioxide. Lactic acid and inorganic phosphate increases, because of the time spent on the process of oxygen and carbon dioxide occurs. It can be assumed that the compression is related to an oxidation process, is of great importance to the fact that the muscle contractions and the subsequent partial recovery without oxygen. Our muscles need to carry a big job. Although suppose, during physical activity and breathing rhythm of the heart muscle contractions become stronger, the oxygen is not enough to perform the job. Very large load, for example, 100 meters race glukogeni lactic acid more rapidly falling apart, rather than lactic acid oxidation can.So, the place has a lactic acid accumulation.In this case, they say, the muscle has „insufficient oxygen“.Long-distance runners keeps running so-calledthe second means of breathing. Lung and heart tissues at this time due to the work of the newly formed lactic acid enhanced the NADPH enough oxygen gets to the number. So do not grow „oxygen debt“.In cases where multiple compression during muscle exhaustion and glucagon stock of lactic acid accumulation due to the inability to compress, say that the muscles get tired.

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К ОПРЕДЕЛЕНИЮ МАКСИМАЛЬНОЙСКОРОСТИ БЕГА

А. Гигинеишвили, К. Цхакая, Р. Киквидзе, М. Бибилури

В работе проведен анализ средней и мгновенной скоростей спринтера и стайера на соответствующих дистанциях. Установлены их оптимальные меличины до полного расхода кислорода. Показано, что бегун не может бежать с максимальной средной скоростью, только спринтер может сохранить максимальную среднюю скорость до 200 м, а стайер до 2000 м (до полного расхода кислорода).

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OPTIMIZATION OF DESIGN SCHEMES AND PARAMETERS OF MOTOR-GENERATORS FOR AVIATION GAS TURBINE ENGINES

A. Maisuradze[*], L. Maisuradze[**] Z. Gobianidze*

(Georgian Aviation University, 16, Ketevan Tsamebuli av., Tbilisi 0144, Georgia)

(Georgian Technical University, 75, Merab Kostava av., Tbilisi, 0175, Georgia)

Abstract: *In this research work is analyzes one of the actual issues including in the concept of a" fully electrified aircraft" (FEA), the first stage of that is the implementation of a "more electrified aircraft" (MEA). This makes it necessary to replace the traditional electric generators and starter generators driven by the drive gearboxesto motor-generating devices based on permanent magnets and built-in "cold" rotating and stationary parts of the gas turbine engine (in the rotor and stator).*

The mathematical algorithms concerning optimization of design of aviation motor-generators on the minimum weight and electrotechnical materials are developed.

In this paper, an electric machine, represented as a non-linear function of several variables, is analyzed using systems of linear algebraic equations..

Keywords: *fully electrified aircraft; dual-flow turbojet engine; fan; motor-generator; permanent magnets; electrical windings; rotor; stator.*

INTRODUCTION

To further improvement of the flight performance and operating data of aircrafts many well-known aviation companies have developed the concept of creating a fully electrified aircraft (FEA) [4], [9], the first stage of which is the implementation of a "more electrified aircraft" (MEA). At the same time, the functions and layout of the aggregates and units of the power plant are significantly changing. The engine will not have a drive gear box in its old form. The starter generator instead of the external arrangement will be integrated inside the engine in a high-pressure cascade. The auxiliary power plant will be used only for generating of electric power. Thus, the increase in the FEA level of electrification will be accompanied by an increase in the capacity of both electric power sources and the power supply systems as a whole. In such

Professor*
MA Student**

aircrafts, depending on the speed of flight, the generator drive would be provided by an air turbine and APU.

For these design diagrams of existing dual-flow turbojet engine (DFTE) and taking into account the patent № RU2490497 C2 (2006), "Turbojet engine with electric generator arranged in fan" [2], it is advisable to analyze the development prospects of the built-in fan (in the cascade of the compressor of low and high pressure) the engine motor-generator motor in which permanent magnets are attached to the peripheral part of the fan blades, and in the case of the second contour opposite of the magnets are arranged electrical windings .

The arrangement of electric generators in the fan and in the cold zone of the low and high pressure compressors provides a number of positive factors. The main advantage is that is created more space to arrange the electric generator. The case of the second contour, which is part of the engine nacelle, has enough large dimensions to arrangement of the windings that gives the possibility to realization of large electric current capacities both in the generator and motor operating modes. In addition, the fan is in the cold zone, which prevents overheating of stationary electric windings and rotating permanent magnets.

On the basis of the above mentioned, it is advisable to install the main generator in the fan (or backup stages of the low-pressure compressor) which will be driven into rotation by a low-pressure turbo compressor cascade, and arrange the starter generator in the cascade of a high-pressure compressor [3]. In the process of engine starting it will work in the starter mode and then after the start it will switch on the generator mode. Moreover, in takeoff mode, when the high-pressure turbine is at its maximum heat-stressed state and at the low-gas mode, when the engine is occurred in an unstable operating mode, the starter generator can switch to the motor mode, i.e. it will not take-off power and in contrary transfer additional power to the turbo compressor shaft.

The presence of two electric motor generators - the main built in the fan or the backup part of the low-pressure compressor and the second motor-generator arranged in the front part in the cascade of high-pressure compressor, gives the possibility to apply them as starters in the process of starting the engines, and then to redistribute the take-off of power between two electric generators that more contributes to the stable operation of engine.

On Fig. 1 is presented the structural diagram of the bypass turbojet engine in the fan 2 of that is built the main electrical generator and in the high-pressure compressor spool 11 is built-in the starter-generator 9,10. In this case, at the ends of fan blades are fixed the permanent magnets

5 and in the housing of second contour 6 (engine nacelle 3) are arranged the electrical windings 4 and AC to DC converters. The scheme also shows existing on these engines the kinematic chain of the gear drive of the launch system 17,18,19,20,21.

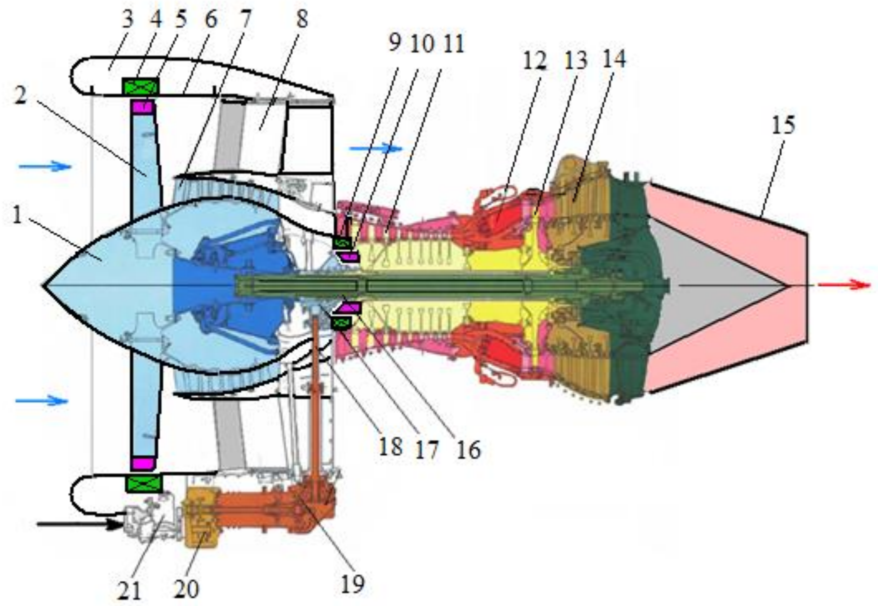

Fig.1. Construction arrangement of bypass turbojet engine with existing system of air launch from APU and promising built-in generator in fan and built-in starter-generator in high pressure compressor spool

1-fan spinner; 2- fan blade; 3-nacelle of second contour housing; 4- classical working winding of built-in electric generator; 5-permanent magnet; 6-housing of second contour of engine; 7-low pressure compressor spool; 8-pass of second contour of engine; 9-classical working winding of built-in starter-generator; 10-permanent magnet of built-in starter-generator; 11-high pressure compressor spool; 12-combustion chamber; 13-high-pressure turbine spool; 14-low-pressure turbine spool; 15-jet nozzle of first contour; 16-high-pressure turbine shaft; 17-bevel gear realizing torque transmission from air starter on high-pressure turbo-compressor spool; 18-vertical spring of torque transmission; 19-bevel gears of torque transmission from air starter gear box on vertical spring; 20-air starter gear box; 21-air turbine of starter

BASIC PART

In the previous paper [10]by authors was considered the "Optimization of design schemes and parameters of motor-generators for aviation gas turbine engines" and in the presentedpaper are analyzed the issues with respect of "Optimization of design of aircraft motor-generators on minimal mass and electric engineering materials".

The goal of optimal design is to minimize the total mass of electric engineering materials: mass of permanent magnets, magnetic conductors, laminated magnetic conductor of the stator, winding wire of the stator.

In practice, the most common are two structures of magnetic systems of rotors.

In the first case, the integral magnetic conductor is annular, smooth, in the second case, insertions from a soft magnetic conductor are used to form alternating poles along the circumference of the rotor.

Both options have positive and negative sides.

The application of an annular magnetic core from a soft material is a technological one, easily manufactured, however, the volume of permanent magnets are not fully utilized. This fact is caused dueat magnetizing of magnetic system, the magnetic lines are bended and the neutral zone of the magnet increases.

In the second case at magnetizing of magnetic systems, the magnetic lines are straight lines, parallel lines that gives the possibility to fully use the magnet (maximum extraction of magnetic energy). Consequently, the geometric relationships between the dimensions of the magnet and magnetic conductor from soft electrical steel (pole inserts), along with the remaining such geometric dimensions as the length of rotor, height and width of the stator tooth, height of the stator yoke, are independent design variables and completely determines the electrical machine.

At designing the electromechanical transducers with an integral magnetic conductor and annular magnets, the magnetic system has the layout shown in Fig. 2.

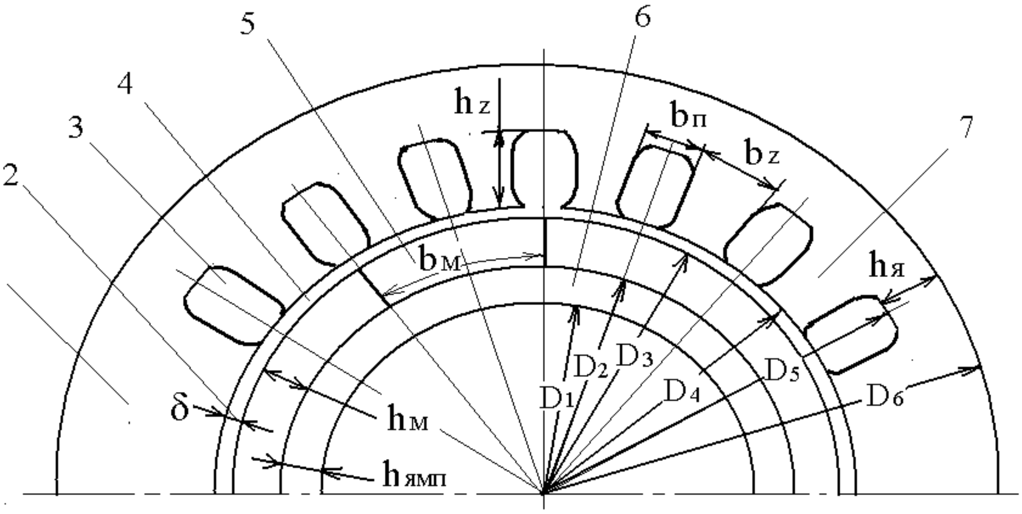

Fig. 2. Magnet system of motor-generator

D_1- is the diameter of the magnetic conductor from soft electromechanical steel диаметрмагнитопроводаизмягкойэлектромеханическойстали; D_2- is the internal diameter of the cylindrical magnet; D_3- is the outer diameter of the rotor; D_4- is the internal diameter of the stator; D_5- is the inner diameter of the stator yoke; D_6- is the outer diameter of the stator; □□- is the air gap.

The whole mass of electrotechnical materials would be represented as five summands. In practice, there are several options for calculating the masses of individual parts of the machine. However, for the verification, preliminary calculations, the following expressions can be used with sufficient accuracy.

For example, the mass of the stator teeth

$$g_{ст.z}=h_z \cdot b_z \cdot z \cdot \ell \cdot g_1 \cdot k_0, \qquad (1)$$

where $h_z \cdot b_z$–is the average height and width of the stator teeth;

z– is the number of stator teeth;

ℓ– is length of the active part of the stator magnetic conductor;

g_1– is the specific mass of the laminated magnetic conductor of the stator;

k_0– is the coefficient correcting mass of the laminated magnetic conductor.

The mass of the stator yoke is equal to:

$$g_{ст.я}= (b_z+b_п) \cdot h_я \cdot \ell \cdot g_1 \cdot z \cdot \cdot b_z \cdot z \cdot k_1, \qquad (2)$$

where $b_п$– is the width of the stator groove;

$h_я$– is the height of stator yoke;

k_1– is the coefficient taking into account (specifying) the mass of the stator yoke.

The mass of a permanent annular magnet is:

$$g_M=h_M\cdot b_M\cdot 2_P\cdot \boldsymbol{\ell}\cdot g_M\cdot k_2, \quad (3)$$

where h_M– is the height of the magnet;

k_2– is the coefficient taking into account the mass of a ring-shaped permanent magnet.

The mass of the annular magnetic core from soft magnetic steel, adjacent to ring-shaped magnet:

$$g_4= b_п\cdot h_{ямп}\cdot b_M\cdot 2_P\cdot \boldsymbol{\ell}\cdot g_M\cdot k_3, \quad (4)$$

wheree g_M – is the specific mass of the magnetic conductor;

$h_{ямп}$– is the height of the ring-shaped magnetic conductor yoke ;

2_P– is the number of pole pairs ;

k_3 – is thecoefficient, which determines the relationship between the width of the groove and the pole.

Weight of stator winding from soft winding wire

$$G_{cu} = b_п\cdot h_z\cdot k_{3.м}\cdot g_{cu}\cdot z\cdot \boldsymbol{\ell}+b_п^2\cdot h_z\cdot \pi z/p\cdot k_{3.м}+b_п\cdot h_z\cdot b_z\cdot \pi/p\cdot z\cdot k_{3.м}, \quad (5)$$

where $k_{3.м}$– is the groove filling the with copper coefficient;

g_{cu}– is the specific mass of copper.

Summing up the above terms, the objective function takes the following form:

$$\Sigma g= h_z\cdot b_z\cdot \boldsymbol{\ell}\cdot z\cdot g_1\cdot k_0+h_z\cdot h_я\cdot \boldsymbol{\ell}\cdot z\cdot g_1\cdot k_1+b_п\cdot h_я\cdot \boldsymbol{\ell}\cdot g_1\cdot b_z\cdot k_1+h_M\cdot b_M\cdot \boldsymbol{\ell}\cdot 2_P\cdot g_M\cdot k_2+$$
$$b_п\cdot h_{ямп}\cdot \boldsymbol{\ell}\cdot 2_P\cdot g_M\cdot k_3+b_п\cdot h_z\cdot \boldsymbol{\ell}\cdot z\cdot g_{cu}\cdot k_{3.м}+b_п^2\cdot h_z\cdot \pi z/p\cdot k_{3.м}+b_п\cdot h_z\cdot b_z\cdot \pi/p\cdot z\cdot k_{3.м}, \quad (6)$$

In electromechanics as conventional limiting functions are accepted: temperature of overheating of individual parts of the machine, power factor, efficiency, service life, reliability, cost, starting and rated power, maximum torque, technological indicators, etc.

Often the output parameters of the machine change places, i.e. the place of objective function takes the cost, or the efficiency, depending on the customer.

To narrow the search interval, it is advisable to carry out preliminary theoretical studies. It is necessary to perform verification calculations, in the area where a priori information is available and to relate analytically the input and output parameters of the machine. To this end, using the appropriate algorithms, we find the relations between the output parameters of the machine and so-called exponents of the bounding functions, in particular:

$$\left.\begin{array}{l} КПД = C_{11}X_1 + C_{12}X_2 + \cdots\cdots + C_{1m}X_n\,; \\ \cos\varphi = C_{11}X_1 + C_{12}X_2 + \cdots\cdots + C_{2m}X_n\,; \\ \cdots\cdots \quad \cdots\cdots \quad \cdots\cdots \quad \cdots\cdots \quad \cdots\cdots \quad \cdots\cdots \\ \theta\,^{o}C \quad = C_{k1}X_1 + C_{k2}X_2 + \cdots\cdots + C_{kn}X_n\,; \\ \cdots\cdots \quad \cdots\cdots \quad \cdots\cdots \quad \cdots\cdots \quad \cdots\cdots \quad \cdots\cdots \\ M_{пуск} = C_{m1}X_1 + C_{m2}X_2 + \cdots\cdots + C_{mn}X_n\,; \end{array}\right\} \quad (7)$$

Expression (7) is the result of preliminary multiple, verification calculations of the electric machine.

where КПД, cosφ, $\theta^{o}C$, ...$M_{пуск}$– are the output parameters of the machine;

X_1, X_2 ...., X_n– are the exponents;

C_{11}, C_{12}, ..., C_{mn}– are the coefficients relating the input and output parameters of the machine in the simultaneous equation (7).

Due solving the simultaneous linear equations (7), we obtain the exponents X_1, X_2 ...., X_n in the form of positive numbers.

The next step in the search for the optimal variant is the compilation of a matrix of so-called positive components of the dual vector.

In this particular case, the matrix consists from eight linear equations, each of which is created by the sum of the product of positive components and constant coefficients.

For example, in the optimization function, the independent variable h_z occurs in the first, in the sixth, in the seventh and eighth terms, and everywhere in the first degree. Consequently, the first equation is written as follows:

$$1\cdot\delta_1 + 0\cdot\delta_2 + 0\cdot\delta_3 + 0\cdot\delta_4 + 0\cdot\delta_5 + 0\cdot\delta_6 + 0\cdot\delta_7 + 1\cdot\delta_8 - X_1\cdot\delta_9 = 0, \quad (8)$$

The equations of positive components for independent variables similarly written down, they give a simultaneous linear equations for positive weights.

$$\left.\begin{array}{l}
1\cdot\delta_1+1\cdot\delta_2+1\cdot\delta_3+1\cdot\delta_4+1\cdot\delta_5+1\cdot\delta_6+1\cdot\delta_7+1\cdot\delta_8+0\cdot\delta_9=1\\
1\cdot\delta_1+1\cdot\delta_2+0\cdot\delta_3+0\cdot\delta_4+0\cdot\delta_5+1\cdot\delta_6+1\cdot\delta_7+1\cdot\delta_8-X_1\cdot\delta_9=0\\
0\cdot\delta_1+0\cdot\delta_2+1\cdot\delta_3+0\cdot\delta_4+0\cdot\delta_5+1\cdot\delta_6+2\cdot\delta_7+1\cdot\delta_8-X_2\cdot\delta_9=0\\
1\cdot\delta_1+1\cdot\delta_2+0\cdot\delta_3+0\cdot\delta_4+0\cdot\delta_5+0\cdot\delta_6+0\cdot\delta_7+1\cdot\delta_8-X_3\cdot\delta_9=0\\
1\cdot\delta_1+1\cdot\delta_2+1\cdot\delta_3+1\cdot\delta_4+1\cdot\delta_5+1\cdot\delta_6+0\cdot\delta_7+0\cdot\delta_8-X_4\cdot\delta_9=0\\
0\cdot\delta_1+1\cdot\delta_2+1\cdot\delta_3+0\cdot\delta_4+0\cdot\delta_5+0\cdot\delta_6+0\cdot\delta_7+0\cdot\delta_8-X_5\cdot\delta_9=0\\
0\cdot\delta_1+1\cdot\delta_2+1\cdot\delta_3+0\cdot\delta_4+0\cdot\delta_5+0\cdot\delta_6+0\cdot\delta_7+0\cdot\delta_8-X_6\cdot\delta_9=0\\
0\cdot\delta_1+0\cdot\delta_2+0\cdot\delta_3+1\cdot\delta_4+0\cdot\delta_5+0\cdot\delta_6+0\cdot\delta_7+0\cdot\delta_8-X_7\cdot\delta_9=0\\
0\cdot\delta_1+0\cdot\delta_2+0\cdot\delta_3+1\cdot\delta_4+1\cdot\delta_5+0\cdot\delta_6+0\cdot\delta_7+0\cdot\delta_8-X_8\cdot\delta_9=0
\end{array}\right\} \quad (9)$$

Obvious is a system of nine linear equations withunknown as $\delta_1, \delta_2, ..., \delta_9$ of positive components.

Due solving the system of equations (9), we can write down the objective function as a product of individual summands in the corresponding powers:

$$\Sigma g_{opt}=\left(\frac{h_z\cdot b_z\cdot \ell\cdot z\cdot g_1\cdot k_0}{\delta_1}\right)^{\delta_1}\cdot\left(\frac{b_z\cdot h_{\text{я}}\cdot \ell\cdot z\cdot g_1\cdot k_1}{\delta_2}\right)^{\delta_2}\cdot\left(\frac{b_{\text{п}}\cdot h_{\text{я}}\cdot \ell\cdot z\cdot g_1\cdot k_1}{\delta_3}\right)^{\delta_3}\cdot$$

$$\cdot\left(\frac{b_{\text{м}}\cdot h_{\text{м}}\cdot \ell\cdot 2p\cdot g_{\text{м}}\cdot k_2}{\delta_4}\right)^{\delta_4}\cdot\left(\frac{b_{\text{п}}\cdot h_{\text{ямп}}\cdot \ell\cdot 2p\cdot g_{\text{м}}\cdot k_3}{\delta_5}\right)^{\delta_5}\cdot\left(\frac{b_{\text{п}}\cdot h_z\cdot \ell\cdot z\cdot 2p\cdot g_{\text{м}}\cdot k_{3\text{м}}}{\delta_6}\right)^{\delta_6}\cdot$$

$$\cdot\left(\frac{b_{\text{п}}^2\cdot h_z\cdot \pi\cdot z\cdot k_{3\text{м}}}{p\cdot\delta_7}\right)^{\delta_7}\cdot\left(\frac{b_{\text{п}}\cdot h_z\cdot b_z\cdot \pi\cdot z\cdot k_{3\text{м}}}{p\cdot\delta_8}\right)^{\delta_8}\cdot\left(\delta_9\right)^{\delta_9} \quad (10)$$

According to the theory of geometric programming, the product of the optimal value of the objective function on the corresponding exponent is equal to the corresponding value of summand.

According to the above mentioned, we can write down the equality:

$$\left.\begin{array}{ll}
\delta_1\cdot\Sigma g_{opt}=h_z\cdot b_z\cdot \ell\cdot z\cdot g_1\cdot k_{0i}; & \delta_2\cdot\Sigma g_{opt}=b_z\cdot h_{\text{я}}\cdot \ell\cdot z\cdot g_1\cdot k_1;\\
\delta_3\cdot\Sigma g_{opt}=b_{\text{п}}\cdot h_{\text{я}}\cdot \ell\cdot z\cdot g_1\cdot k_1; & \delta_4\cdot\Sigma g_{opt}=b_{\text{м}}\cdot h_{\text{м}}\cdot \ell\cdot 2p\cdot g_{\text{м}}\cdot k_2;\\
\delta_5\cdot\Sigma g_{opt}=b_{\text{п}}\cdot h_{\text{ямп}}\cdot \ell\cdot 2p\cdot g_1\cdot k_3; & \delta_6\cdot\Sigma g_{opt}=b_{\text{п}}\cdot h_z\cdot \ell\cdot z\cdot g_{cu}\cdot k_{3\text{м}};\\
\delta_7\cdot\Sigma g_{opt}=\dfrac{b_{\text{п}}^2\cdot h_z\cdot \pi\cdot z\cdot k_{3\text{м}}}{p}; & \delta_8\cdot\Sigma g_{opt}=\dfrac{b_{\text{п}}\cdot h_z\cdot b_z\cdot \pi\cdot z\cdot k_{3\text{м}}}{p}.
\end{array}\right\} \quad (11)$$

After logarithmizing the system of equation (11), and introducing the notation, we obtain the third system of linear equations, in particular:

$$\left.\begin{array}{ll}
b_1=\ell n(\delta_1\cdot\Sigma g_{opt})-\ell n(z\cdot g_1\cdot k_0); & b_2=\ell n(\delta_2\cdot\Sigma g_{opt})-\ell n(z\cdot g_1\cdot k_1);\\
b_3=\ell n(\delta_3\cdot\Sigma g_{opt})-\ell n(z\cdot g_1\cdot k_1); & b_4=\ell n(\delta_4\cdot\Sigma g_{opt})-\ell n(2p\cdot g_M\cdot k_2);\\
b_5=\ell n(\delta_5\cdot\Sigma g_{opt})-\ell n(2p\cdot g_M\cdot k_3); & b_6=\ell n(\delta_6\cdot\Sigma g_{opt})-\ell n(z\cdot g_{cu}\cdot k_{3M});\\
b_7=\ell n(\delta_7\cdot\Sigma g_{opt})-\ell n\left(\dfrac{\pi\cdot z\cdot k_{3M}}{p}\right); & b_8=\ell n(\delta_8\cdot\Sigma g_{opt})-\ell n\left(\dfrac{\pi\cdot z\cdot k_{3M}}{p}\right);\\
z_1=\ell n\cdot h_z;\quad z_2=\ell n\cdot b_п; & z_3=\ell n\cdot b_z;\quad z_4=\ell n\cdot \ell;\\
z_5=\ell n\cdot h_я;\quad z_6=\ell n\cdot h_M; & z_7=\ell n\cdot b_п;\quad z_8=\ell n\cdot h_{ямп};
\end{array}\right\}\quad(12)$$

The third system of linear equations has the following form:

$$\left.\begin{array}{l}
b_1=1\cdot Z_1+0\cdot Z_2+1\cdot Z_3+1\cdot Z_4+0\cdot Z_5+0\cdot Z_6+0\cdot Z_7+0\cdot Z_8;\\
b_2=0\cdot Z_1+0\cdot Z_2+1\cdot Z_3+1\cdot Z_4+1\cdot Z_5+0\cdot Z_6+0\cdot Z_7+0\cdot Z_8;\\
b_3=0\cdot Z_1+1\cdot Z_2+0\cdot Z_3+1\cdot Z_4+0\cdot Z_5+0\cdot Z_6+0\cdot Z_7+0\cdot Z_8;\\
b_4=0\cdot Z_1+0\cdot Z_2+0\cdot Z_3+0\cdot Z_4+0\cdot Z_5+1\cdot Z_6+1\cdot Z_7+0\cdot Z_8;\\
b_5=0\cdot Z_1+1\cdot Z_2+0\cdot Z_3+1\cdot Z_4+0\cdot Z_5+0\cdot Z_6+0\cdot Z_7+1\cdot Z_8;\\
b_6=1\cdot Z_1+1\cdot Z_2+0\cdot Z_3+1\cdot Z_4+0\cdot Z_5+0\cdot Z_6+0\cdot Z_7+0\cdot Z_8;\\
b_7=1\cdot Z_1+2\cdot Z_2+0\cdot Z_3+0\cdot Z_4+0\cdot Z_5+0\cdot Z_6+0\cdot Z_7+0\cdot Z_8;\\
b_8=1\cdot Z_1+1\cdot Z_2+1\cdot Z_3+0\cdot Z_4+0\cdot Z_5+0\cdot Z_6+0\cdot Z_7+0\cdot Z_8;
\end{array}\right\}\quad(13)$$

The solution of simultaneous linear equations (13) gives the optimal geometric dimensions of the electric machine corresponding to the optimal value of the desired objective function, in the following form:

$$\left.\begin{array}{llll}
h_Z=e^{Z_1}; & b_п=e^{Z_2}; & b_Z=e^{Z_3}; & \ell=e^{Z_4};\\
h_я=e^{Z_5}; & h_M=e^{Z_6}; & b_M=e^{Z_7}; & h_{ямп}=e^{Z_8}.
\end{array}\right\}\quad(14)$$

Along with other methods, the application of the method of geometric programming is a convenient tool in the design of such multiparameter objects, as electrical machines, generators, transformers, etc.

CONCLUSIONS

1. In the paper electric machine is presented as a nonlinear function of many variables, is analyzed using simultaneous linear algebraic equations.

2. The linearization of a multivalued function narrows the research interval and simplifies the search of optimal value.

3. Results and method would be used in preliminary calculations of similar objects, machines, generators, transformers, etc.

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ОПТИМИЗАЦИЯ ПРОЕКТИРОВАНИЯ АВИАЦИОННЫХ МОТОР-ГЕНЕРАТОРОВ ПО МИНИМАЛЬНОЙ МАССЕ И ЭЛЕКТРОТЕХНИЧЕСКИМ МАТЕРИАЛАМ

А. Маисурадзе, З. Гобианидзе, Л.Маисурадзе

В данной научной работе проанализирован один из актуальных вопросов, входящий в концепцию создания,,полностью электрофицированного самолета’’ (ПЭС), первым этапом которого является реализация ,,более электрофицированного самолета’’ (БЭС). Этовызывает необходимость замены традиционных электрогенераторов и стартер-генератора, приводящихся во врашение от коробки приводов на мотор-генераторные устройсва, основанные на постоянных магнитах и встроенныев ,,холодных’’врашающихся и неподвижных частях газотрбинного двигателя (в роторе и статоре).

Разработаны математические алгоритмы, касаюшийся оптимизаций проектирования авиационных мотор-генераторов по минимальной массе и электротехнических материалов.

В работе электрическая машина представленная ввиде нелинейной функции многих переменных, анализируется с помощью систем линейных алгебрических уравнении.

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INNOVATIVE IDEA OF CARGO SENDING-RETURN ON SOLAR SYSTEM PLANETS ON THE EXAMPLE OF MARS USING SOLAR ENERGY

G. Kachlishvili***

(Faculty of Precise and Natural Sciences of Tbilisi Ivane Javakhishvili State University, direction of Physics, №3, Chavchavadze avenue,Tbilisi, Georgia)

Abstract: *In the paper is considered an innovative idea of sending and returning cargoes on Mars. It is known that for operating on modernfuel engines, to transport even a small cargo to Mars represents a huge problem, not to mention anything on its back returning.*

According to our idea, due application of solar energy is possible to multiple send and return of heavy loads on the Solar System's planets. Our idea also implies the development and colonization of solar system planets, extraction and transportation of precious substances, safe destruction of various sizes dangerous for Earth asteroids and possibility of greater understanding of the solar system and universe.

Keywords:*orbital accelerator, impulsive engines, Mars rover.*

INTRODUCTION

It is known that the missile gets impetus due the fuel outburst. Fuel momentum outburst in the missile system dt let's designate as $-dm \cdot \vec{u}$. In addition, the impulse acquired by the missile approximately will be as $m \cdot d\vec{v}$**.** Accordingly of the impulse constancy law the impulse is kept in a closed system. Thus$m \cdot d\vec{v} = -dm \cdot \vec{u}$**.**Hence we will obtain:

$$\frac{1}{u}\int_{0}^{v} d\vec{v} = -\int_{m_0}^{m} \frac{dm}{m}. \qquad (1)$$

The solution of the obtained equation is $m = m_0 e^{-\frac{v}{u}}$. This means that the ratio of missile ultimate mass with the initial mass is changing by an exponent law.

Let's assume that gas outburst from the engine by velocity of $\vec{u}$***=3700***m/sec. To reach the second space velocity $\vec{v}$***=11200***m/sec for ***30 tons*** mass missile the required fuel mass will be approximately ***19/20*** of the missile mass. Or for each ***30 tons*** of missile is necessary approximately up to ***28.5 tons*** of fuel. Exactly this makes the biggest problem in the standard model for the launch and return of human on Mars. In particular, the missile must be reach

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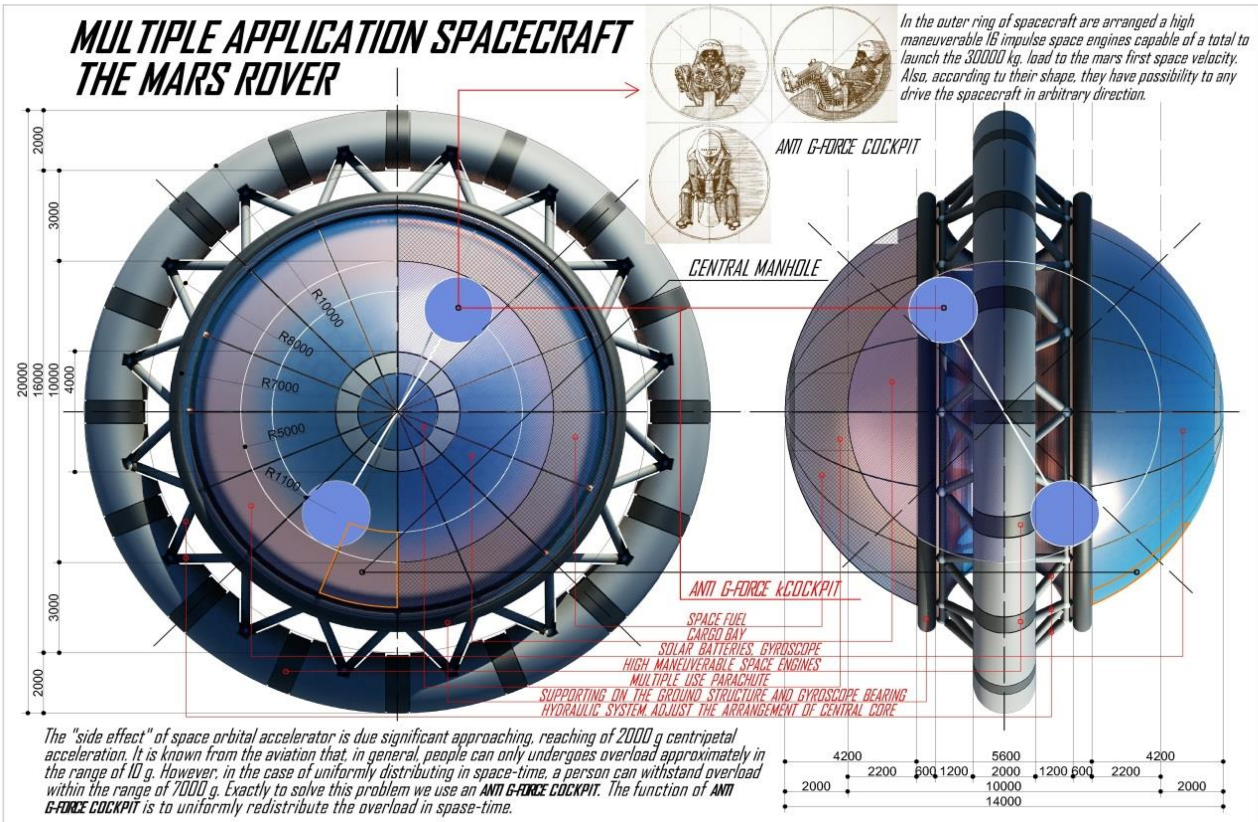
student***

Earth's orbit, then it should be accelerated and approaching the second space velocity, then it is necessary to slow down and reach the orbit of Mars, and then make landing on Mars. In case of return, everythingis in reverse succession. Overall, the missile should be accelerated from ***0*** up to approximately velocity ***26000***m/sec, that is currently almost impossible.

1. BASIC PART

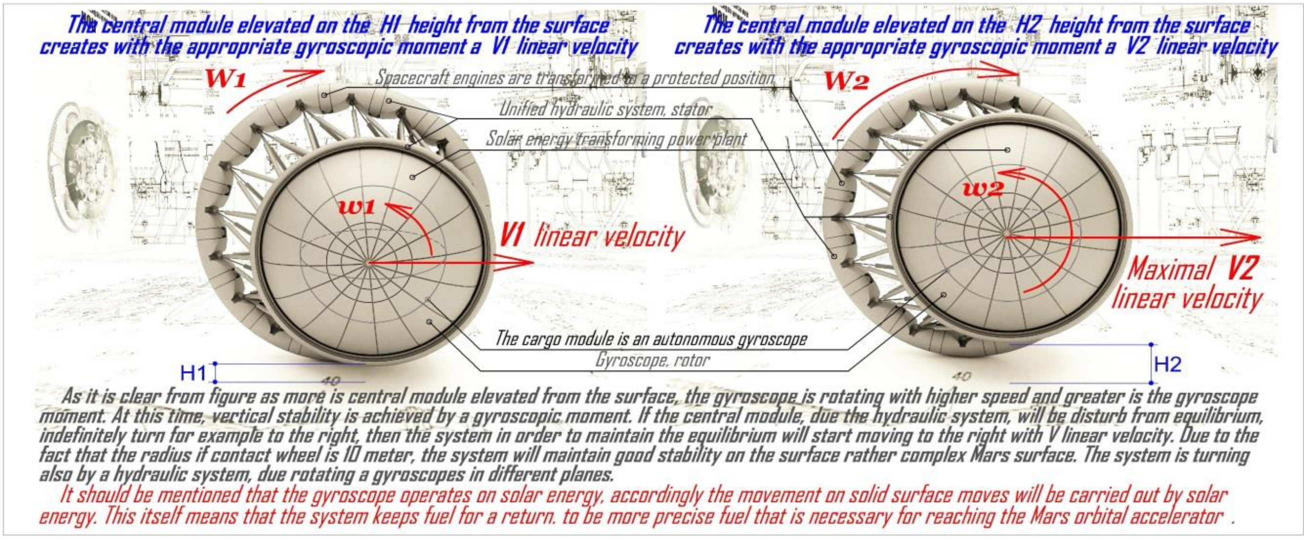
According to ouridea, spacecraft will accelerating die application of fuel up to velocity of ***11500***m/sec(the sum of the first space velocities of Earth and Mars), and the other velocity will be obtained due the solar energy. For this, we invented ***thespacecraft accelerator system***. Let's



consider consistently. In order to optimize mass, the spacecraft must be also a ***Mars rover***.

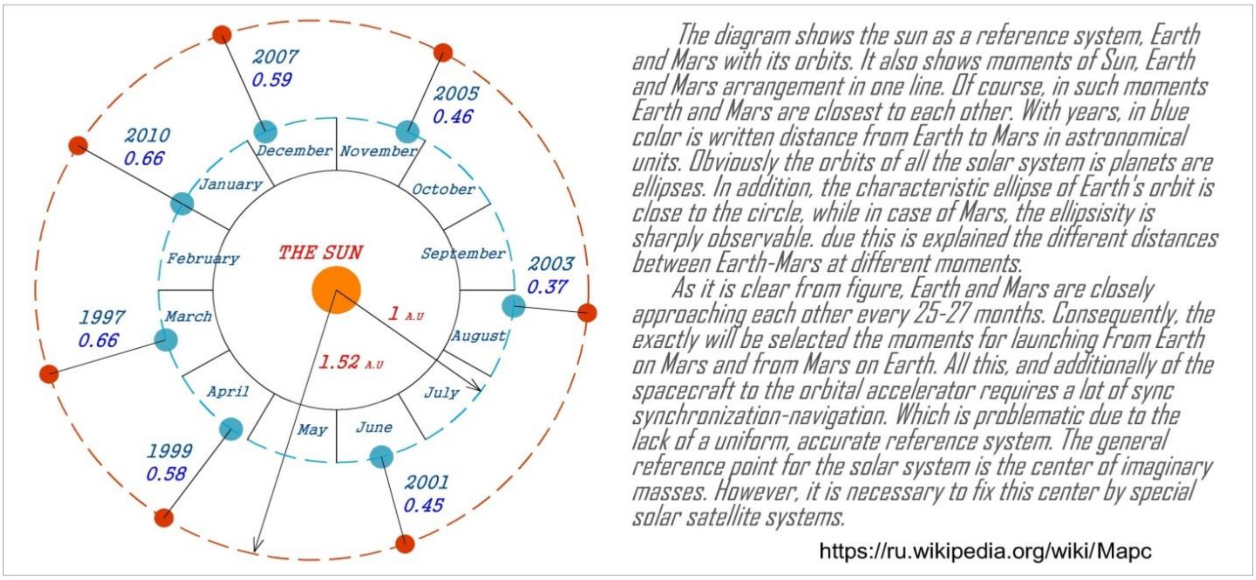
A piloting spacecraft needed to reach Mars

Because Mars's gravitation makes only ***38%*** of Earth's gravity **[1]** is logical to operate the Mars rover on solar energy. In the conditions od small gravity, moving on Mars requires less energy. However, it should be taken into consideration that Mars is ***1.5*** times far from the Sun than Earth and takes less energy from it.



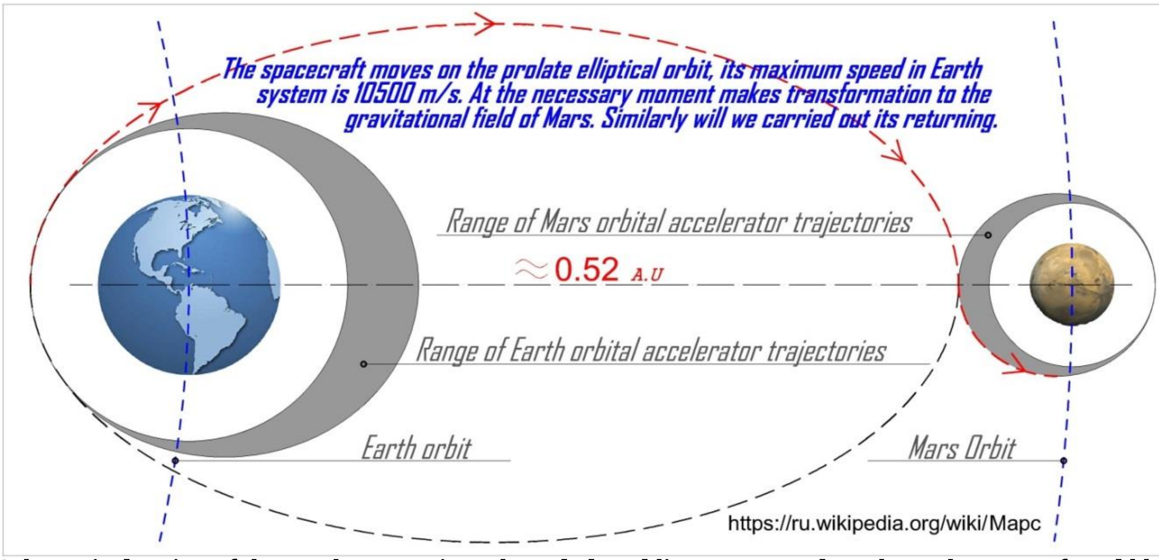
Multiple-use spacecraft-Mars rover

On average, the Earth and Mars every ***25-27*** months are approaching each other at a minimum distance approximately up to ***0.52 A.U.*** Or is opening the connecting Earth-Mars and the Mars-Earth window **[1].** In case of selecting the appropriate moment and trajectory, a new mission may be sent to Mars and the old mission to return to Earth. There are many trajectories for travel to Mars.



Arrangement of Sun, Earth, and Mars, according to years, on one line

Let's consider one of those when the speed of the spacecraft is approaching with the second space velocity (approximately 10500 m/sec) and it moves along the ellipse in the earth's system so that in one of its focus is the Earth and the other end is close enough to Mars. At the required moment, Mars will be near of spacecraft, as result will be caught in his gravitational field.



Schematic drawing of the Earth-Mars trips. The red, dotted line corresponds to the real spacecraft and black dotted line–to the imaginary trajectory. On the black dotted line will move the spacecraft, at the right place and time ifMars would not exists.

Briefly on the space velocities:

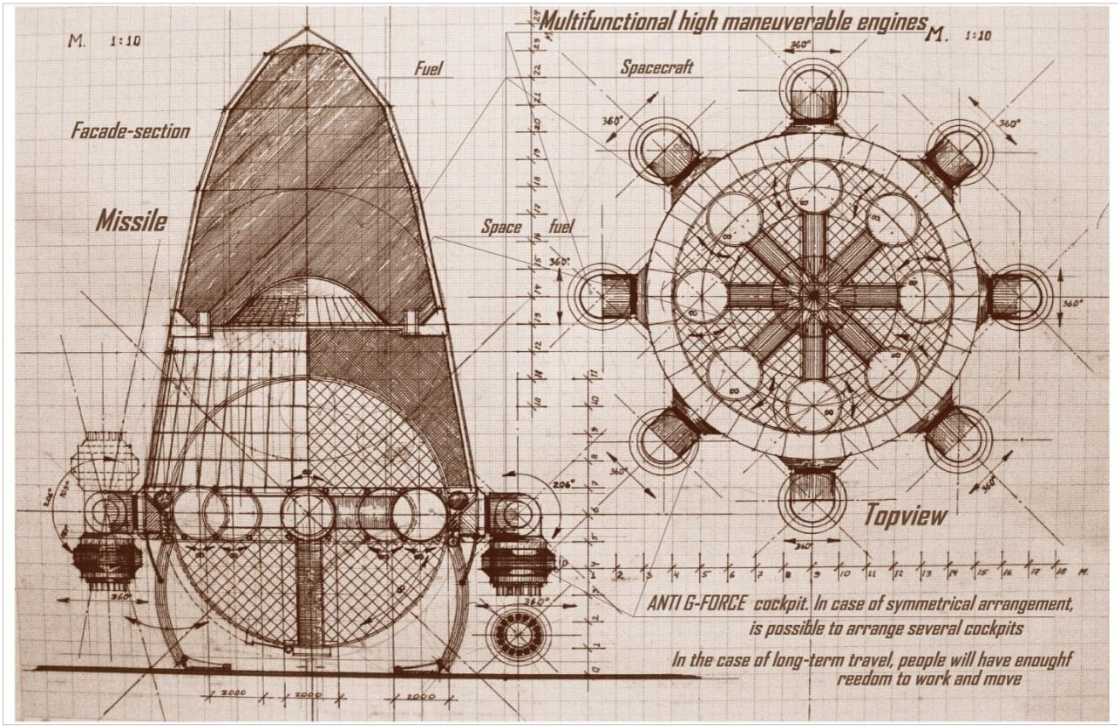
The first space velocity: - the minimum velocity required for body to became the planet's artificial satellite with circuit orbit.$v_1(R)$ is a function of radius.

$$v_1 = \sqrt{G\frac{M}{R}} = \sqrt{G\frac{M}{R_0+h}} \qquad (2)$$

The second space velocity: - the minimum velocity required for body for its possibility to release from the planet's gravitational field. The appropriate trajectory id the parabola.

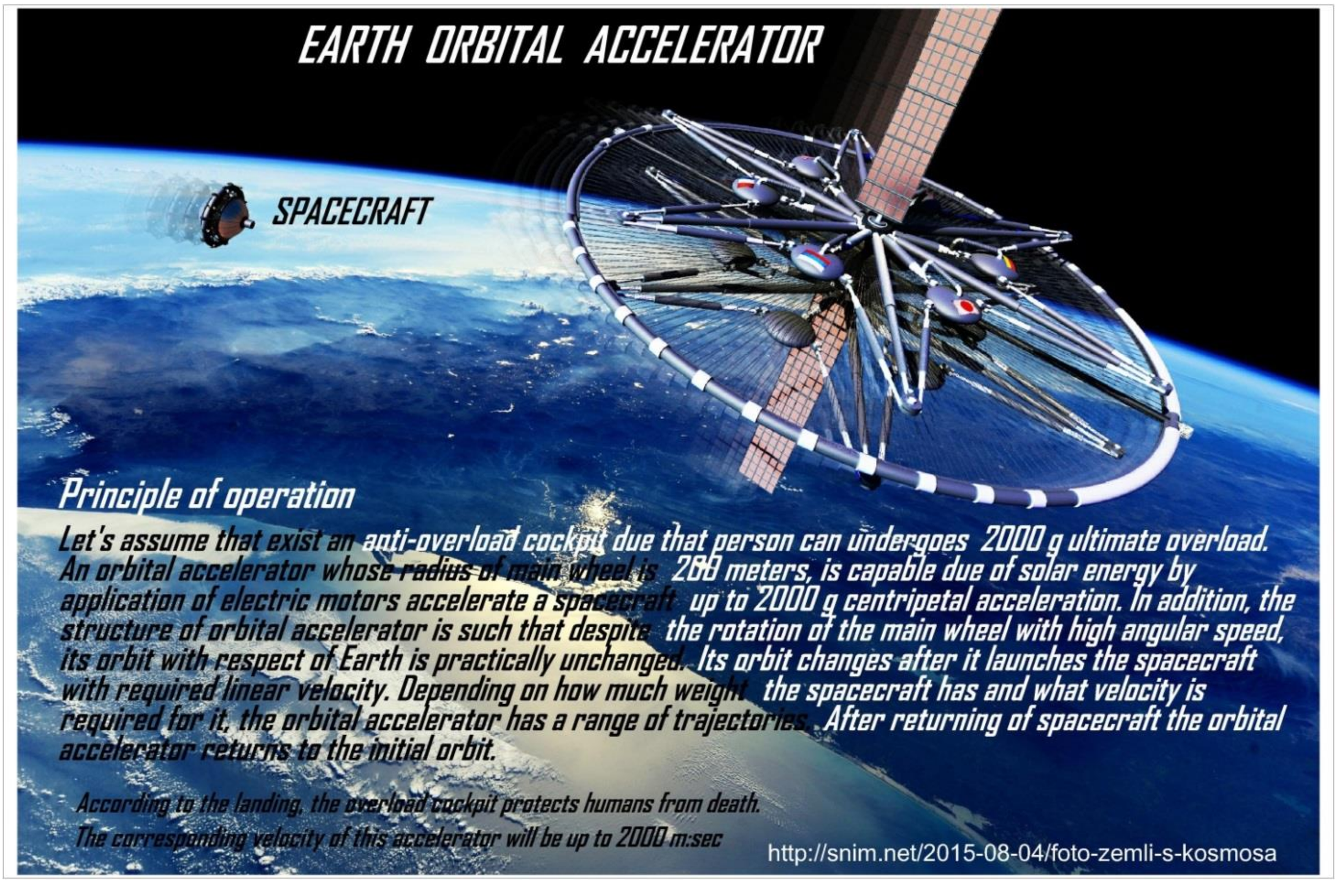
$$v_2 = \sqrt{2G\frac{M}{R}} = \sqrt{2}v_1 \qquad (3)$$

Between the first and second space velocities, the appropriate trajectory of arbitrary velocity is practically arbitrary eccentricity ellipse [2].



Spacecraft and its first accelerating up to first space velocity module

In the first stage, the missile will launch ***20-30ton***spacecraft on the approximately of Earth's first space velocityon the circumference like ellipse orbit. The minimum height of the orbit makes approximately up to***2000 km***from sea level.Then the missile will be removed and the spacecraft will move in autonomous mode. ***Near the Earth, on the certain elliptical orbit is the operating on solar energy an orbital accelerator. Its function is to take the spacecraft, due the electric motors to accelerate it up to2000 g of the centripetal acceleration so that it does not change its own orbit.*** The orbital accelerator changes the orbit only after the launch of spacecraft. When a is launching robot, the structure of that can undergoes the ***2000 g***overload, there is not an acceleration problem of accelerator. The problem occurs in case of launching a human. It is known from the aviation that, in general, people can only undergoes the± ***10 g***overload that is ***200*** times less than necessary.



Earth's orbital accelerator, the mass up to 300 t, maximal diameter up to 400 m. Its main function is to accelerate the spacecraft due solar energy. It also represents a space observatory. In the case of revealing of dangerous foe Earth, it will be possible to change by various means the asteroid orbit or its dismemberment.

The well-known formula for calculation of centripetal acceleration:

$$a_n = \omega^2 R = \frac{v^2}{R}, \qquad (4)$$

where $\omega$is the angular velocity, R –is the radius,v –is the linear velocity.

From this is clear that: $\boldsymbol{v} = \sqrt{\boldsymbol{a_n R}}$.(5)

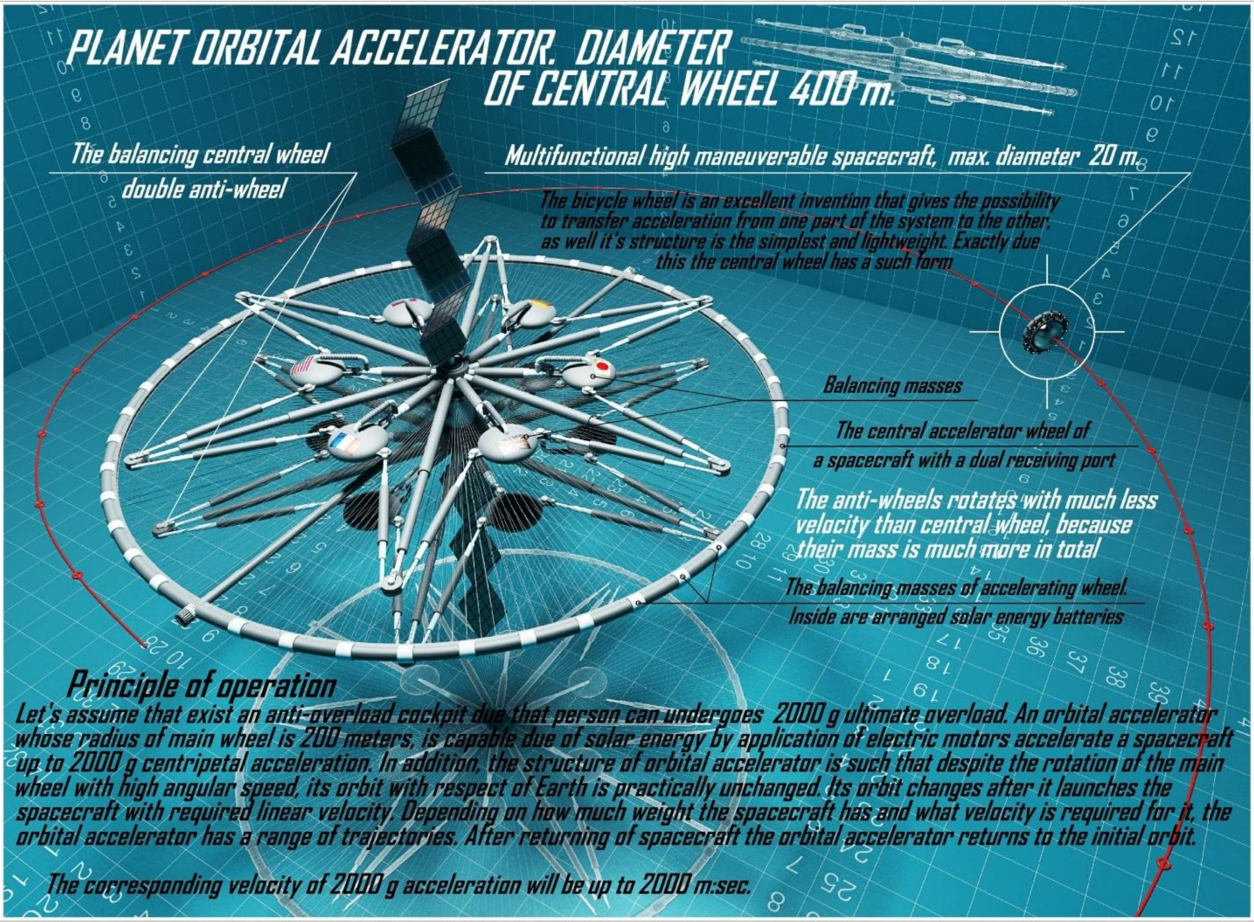
On accelerator is generated at ***2000 g*** acceleration, i.e. $\boldsymbol{a_n = 20000\ m/sec^2}$.

Then accordingly of formula **(5)** we will obtain the spacecraft linear velocity:

$$\boldsymbol{v = \sqrt{20000 \cdot 200} = 2000\ m/sec = 2\ km/sec} \quad (6)$$

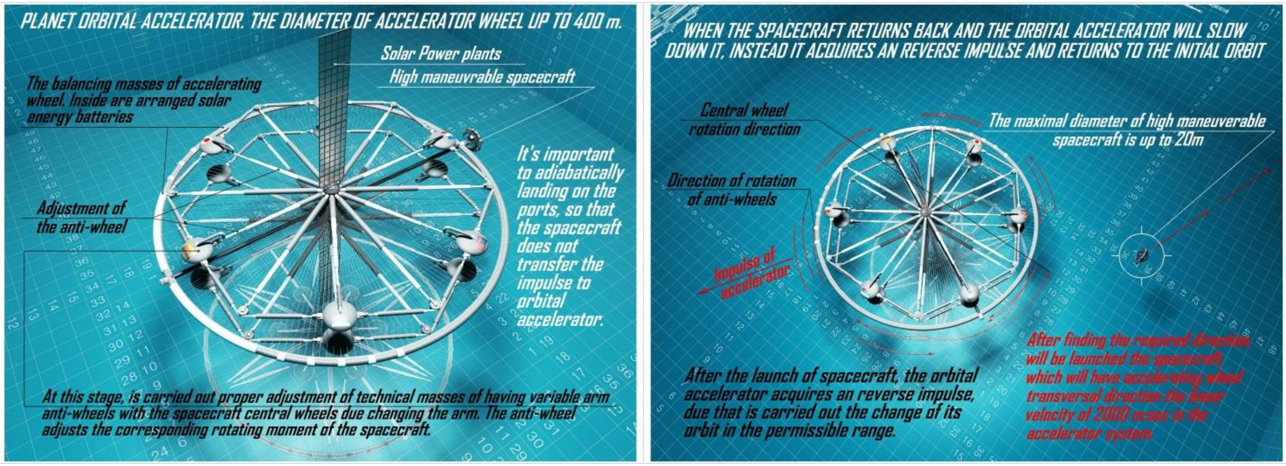
This means that spacecraft will be accelerated on orbital accelerator with 2000 g centripetal acceleration, for that corresponds speed the linear velocity up to 2000 m/sec. Obviously, humans can not withstand such overloads. In case of a manned spacecraft, we are developing two different approaches. However, in order to simplify, let's consider the unmanned mission, i.e., the case of cargo launching.

Let's consider the principle of the work of the presented by us orbital accelerator. It is stipulated that the orbital accelerator,spacecraft, and all on-board equipment can withstand



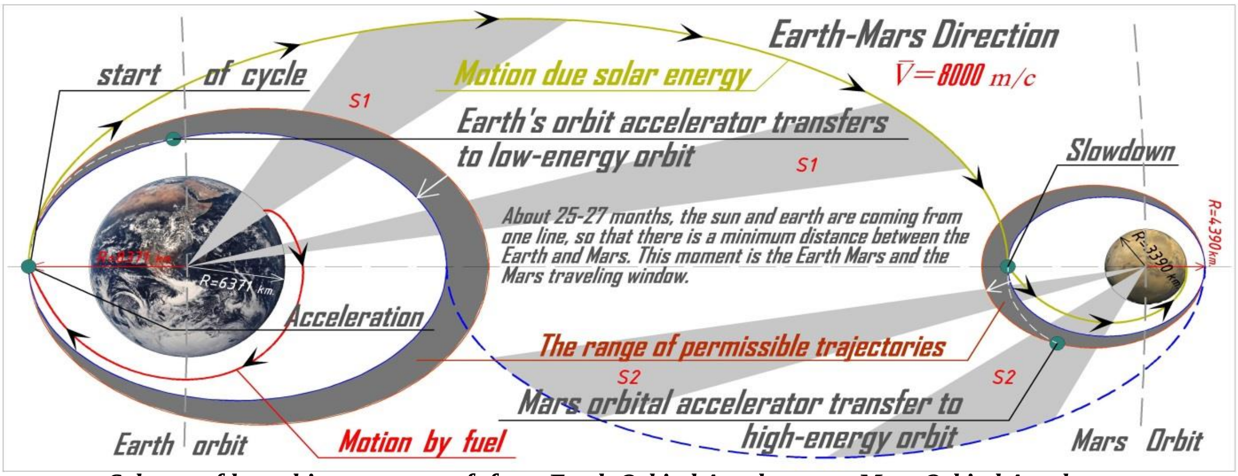
Operating on solar energyorbital accelerator and spacecraft

centripetal acceleration up to $\boldsymbol{a_n = 2900\ m/sec^2}$. The orbital accelerator consists from a central accelerator wheel and two equilibrant anti-wheels. The spacecraft is adiabatically arranged on the central wheel port to avoid momentum transferand does not change the orbit of accelerator. Then existing on the central wheel solar accumulators, in this case the ballast, will be arranged so that the center of mass will remain in the center of the wheel. Then, depending on the weight of spacecraft (within ***30 tons***), the existing on the anti-wheels technical destination ellipsoids will be change their arm, until the rotating moment created at the relatively small



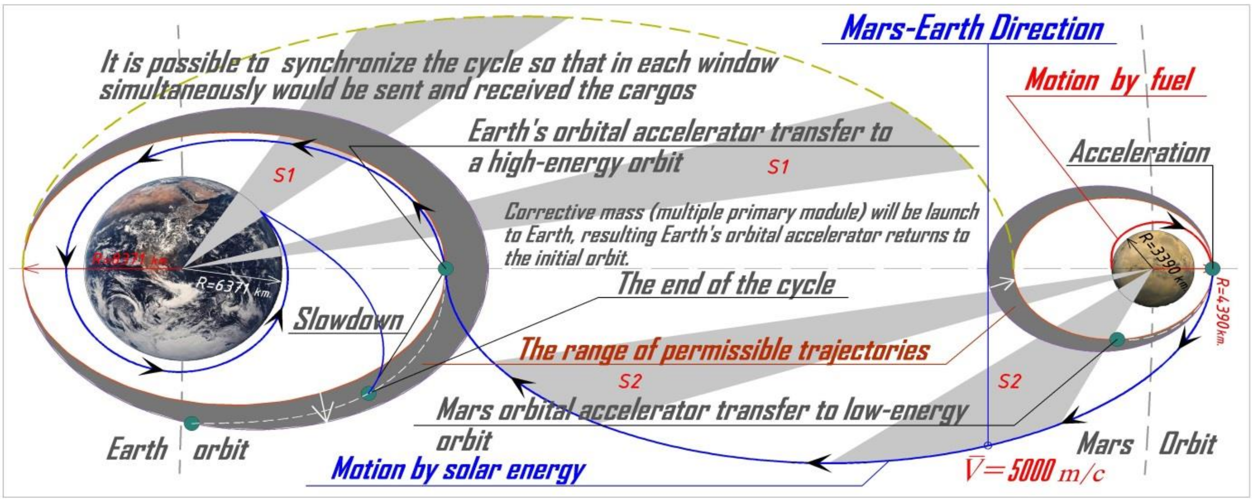
At the right moment the spacecraft will be removed from an orbital accelerator

angular velocity of the anti-wheels does not equilibrate rotating moment of rotating at high velocity, a relatively lightweight central wheel. Obviously, the trajectory of the center of mass will be unchanged. As it is above mentioned, the radius central acceleratorwheel is ***200 m***. The orbital accelerator speeds up the spacecraft up to ***2000 g***centripetal acceleration. **This is the beginning of the cycle.** At this moment the angular speed of the spacecraft makes up to ***1.59 rps*** and the linear velocity up to ***2 km/sec*** in the system of orbital accelerator. After the reaching this velocity and finding of required direction, the spacecraft will be released from accelerator. As a result, the accelerator will gain reverse impulse and move from the elliptical orbit to a lower-energy elliptical orbit. Because the accelerator orbit is an ellipse with respect of the planet, according to Kepler's law, its velacity at various points of the orbit is different. The maximum speed of the orbital acceleration in the Earth system will be $\overrightarrow{\boldsymbol{v_{max}}} \approx \mathbf{8.5}\ \boldsymbol{km/sec}$. Accordingly, according to the principle of non-relative velocities superposition, after the acceleration the velocity of spacecraft will be ***10.5 km/sec***, and the velocity of orbital accelerator will be reduced. In case of maximum load launching (***30 tons***) the trajectory of orbital accelerator will be transformed to the minimum permissible elliptical orbit, the minimum heightof that also is ***2000 km***, but the distance between the ellipse's focuses is small. At this, its maximum velocity is$\overrightarrow{\boldsymbol{v_{max}}} \approx \mathbf{8.3}\ \ \boldsymbol{km/sec}$. **It is clear the mass of orbital accelerator is within the range of 300 tons.** At spacecraft returning from Mars, due the Earth's field influence and the



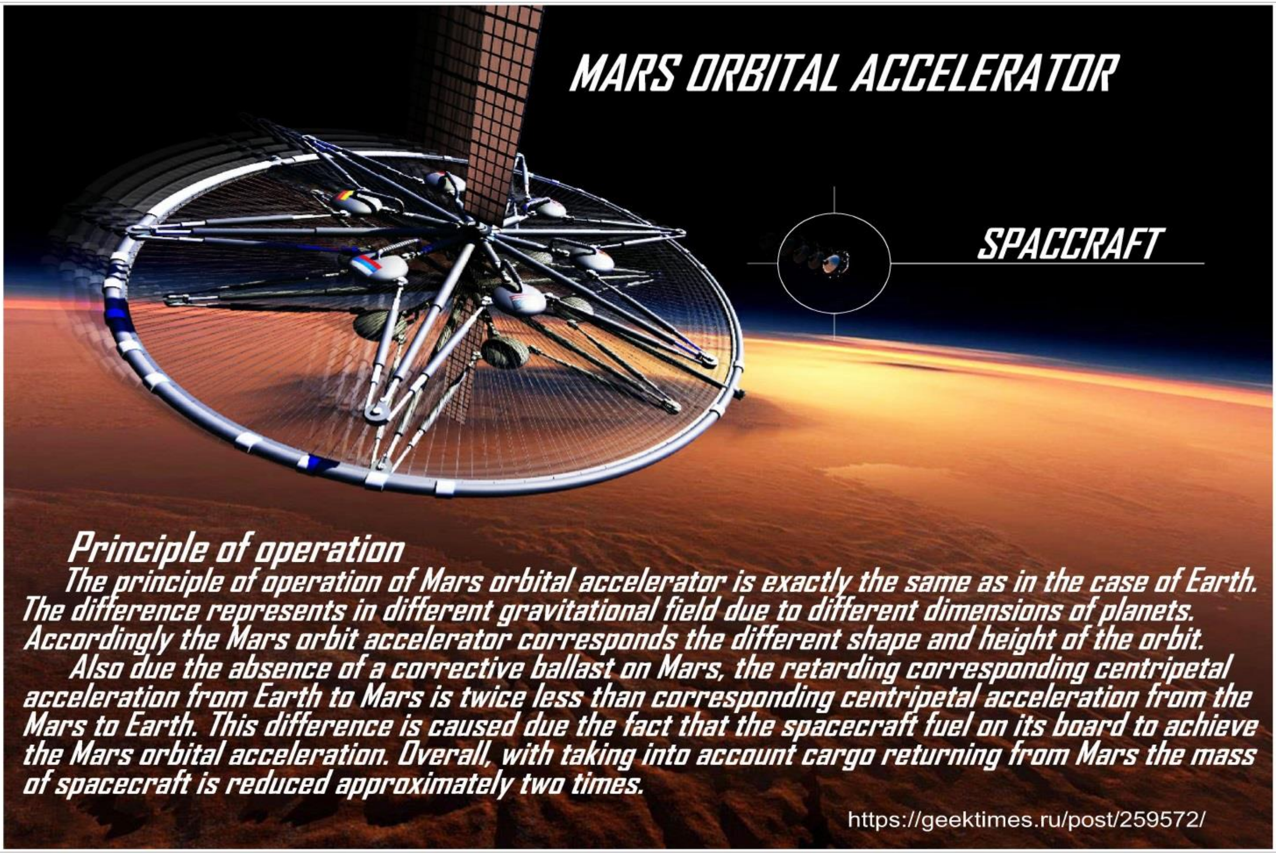
Scheme of launching a spacecraft from Earth Orbital Acceleratorto Mars Orbital Accelerator.
The gray ellipse is the range of accelerator trajectories

acceleration of free fall its velocity will reach up to ***8.3 km/sec*** in the Earth system. As a result, the spacecraft will make adiabatically landing on Earth's orbital accelerator port with almost zero fuel consumption. Because at this moment the mass of the spacecraft is almost halved (no fuel on board) the acceleration of ***2000 g*** of accelerator and its launching on the opposite direction, i.e. at slow down in Earth system the transferred on accelerator impulse will be half of the initial momentum. I.e. the accelerator will have $\overrightarrow{v_{max}} \approx 8.4\ km/sec$velocity.To complete the cycle, Earth's orbital accelerator shouldbe returned to the initial orbit. For this we will use the primary module of spacecraft, missile, which launches it to Earth orbit. Until this moment



Scheme of launching a spacecraft from Earth Orbital Acceleratorto Mars Orbital Accelerator.

it was moving on orbit. At the right its and orbital accelerator trajectories will be crossed and by the same principle it will be returned to Earth. As result, the orbital accelerator will gain additional impulse, its maximum velocity will be equal to the initial$\overrightarrow{v_{max}} \approx 8.5\ \frac{km}{sec}$mpulse, i.e. its orbit will be similar to the initial. **This is the end of the cycle**.

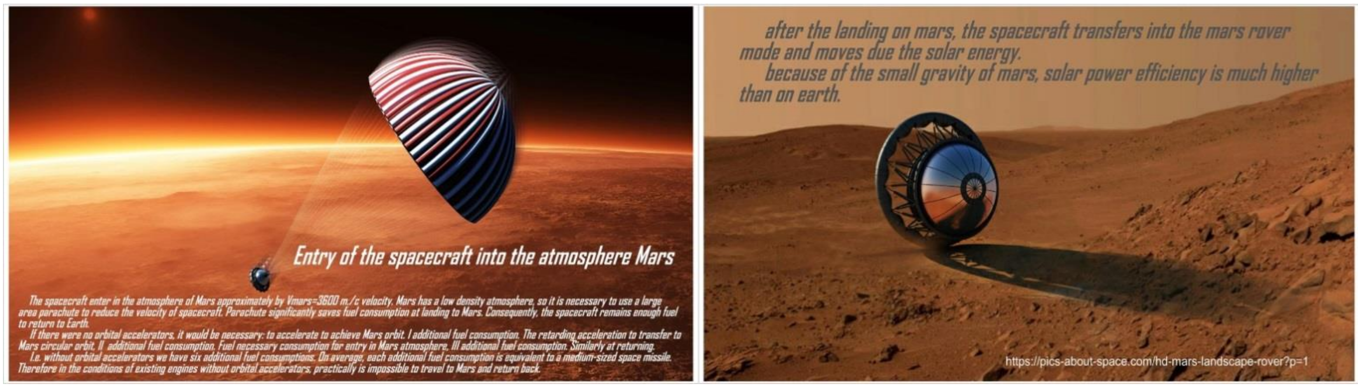


Mars Orbital Accelerator, mass up to 300 t, diameter up to 400 m. Its main function is to accelerate the spacecraft by solar energy. It also represents the studying Mars laboratory

Similar processes occur on Mars Orbital Accelerator, as opposed to the fact that we have no orbit adjustment mass (primary module). As the mass of the spacecraft at returningis halved, so in case of Mars orbital accelerator the corresponding centripetal acceleration on Mars is four times less up to 500 g that corresponding centripetal acceleration from Mars to Earth up to 2000 g. Thus the mentioned accelerator at the end of the cycle will be returned to initial orbit. After the end of the cycle, the spacecraft, as well as the primary module can be used again. Also repeated application has the orbital acceleration system. The new type of engines will significantly reduce the cost and simplify a number of procedures.

For such a movement, it is essential to most precision navigation and synchronization. For the simplification the article does not refer on the action of gravitational field of Sun and other planets on orbital accelerators.

Since the Earth and Mars have atmospheres, it is possible to use a parachute at landing that significantly saves the fuel consumption.The spacecraft in the atmosphere of Mars is entering with velocity of approximately $\overrightarrow{\boldsymbol{v_{mars}}} \approx \mathbf{3.2}\ \boldsymbol{km/sec}.$



Left - a spacecraft with released parachute in the atmosphere of Mars. Right - spacecraft in the mode of movement on Mars. At this time, the 16 space pulsar engines are transformed into a protected position.

CONCLUSION

In the article is considered the problem development and colonization of solar system planetson Mars's example. We have developed a system of orbital accelerators that due using solar energy byapplication of electric motors, will accelerating or slow down spacecrafts, due that several times will reduce fuel consumption and will be realized not only the cargo launch but also its return. Without the orbital acceleration system, the following would be necessary: transfer from the Earth orbit to the orbit of Mars, with I fuel additional consumption. The slowdown on Mars orbit and entering at optimum angle in the atmosphere of Mars, with II additional consumption. Transfer from Mars orbit to Earth orbit, with fuel III additional consumption. The slowing down on Earth's orbit and entering at optimum angle in the atmosphere of Earth - with IV fuel additional consumption. I.e. we would have 4 fuel additional consumptions. Each of them is equivalent to a modern, medium-sized space missile.

A separate problem is the sending of a man who is very sensitive to overloading, but there also is existing a solution.

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ИННОВАЦИОННАЯ ИДЕЯ ПЕРЕВОЗА ГРУЗА НА ПЛАНЕТАЫ СОЛНЕЧНОЙ СИСТЕМЫ ТУДА И ОБРАТНО НА ПРИМЕРЕ МАРСА С ПОМОЩЬЮ СОЛНЕЧОЙ ЭННЕРГИИ

Г. Качлишвили

В наших трудах рассмотрена инновационная идея перевозки груза на Марс и обратно. Известно, что двигатели, работающие на современном топливе, даже при перевозке на Марс в малом количестве груза, составляет большую проблему, не говоря уже о обратной перевозке.

Наша идея состоит в том, чтобы с использованием солнечной эннергии была возможна многократная перевозка груза на планетаы солнечной системы. А также идея состоит в освоении-колонизации планет солнечной системы, находки-транспортировки драгоценных веществ, безопасном разрушений разных астероидов опасных для нашей планеты, и в общем, это хорошая возможность для изучения вселенной.

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GENERALIZED MODELS FOR DESCRIBING OF ELASTIC-VISCOUS BODIES PROPERTIES

B. Abesadze*

(Georgian Aviation University,16, Ketevan Tsamebuli av., Tbilisi 0144, Georgia)

Abstract: *Are stated the generalized models for describing of elastic-viscous bodies, for describing of properties are applied the models that represents certain combination of pure elastic and plastic property bodies. Are compiled combinations of generalized three element models with one elastic and two viscous elements. Are described the relations between stress and strain for each combination. Are obtained creeping, hardening, relaxation curves. Also in the paper are stated four element models with two elastic and two viscous elements*

Keywords: *generalized models; elastic-viscous bodies; Maxwell; Kelvin-Voight, model.*

INTRODUCTION

The generalized models are applied in various fields of engineering: machine building, aircraft engineering. Especially widely they are applied in composite materials in aircraft engineering (for example the glass-fiber matrix and hard rubber filler.

The majority of modern materials represents the composites that gains the determined requires operational and technological properties to technical items. as examples of such items are presented the layered and sandwich type plates, shells [2; 3; 4] that are widely applied in aviation.

The composite materials [5; 6] are heterophase systems that includes two or more components with pronounced boundaries between phases. Usually they consists from hardener and binder.

As material of binder (matrix) would be applied metals, their allows,. ceramics, organic or non-organic polymers and so on.

PhD Student*

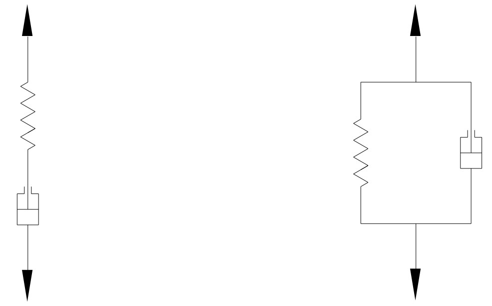
For practice of aircraft engineering especially are attended having high specific strength and stiffness polymer structural composite materials of structural plastics [].

In the paper grounded on the research of experimental data are determined the multi-parameter laws, optimal ways of obtaining of empiric laws accordingly of strength and labour consumption, their fields of application, with describing theories and mathematical models. The above mentioned will be improve caused by acting in aircraft structures creeping residual deformations and displacement forecasting accuracy as well as working on stability typical aircraft structures.

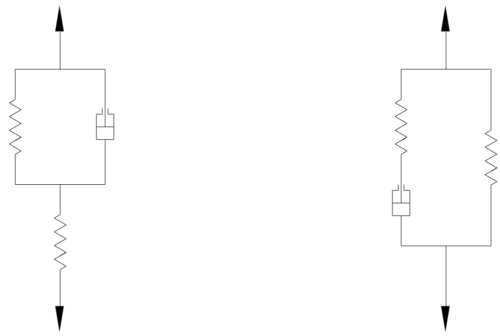
Based on the above mentioned the generalized three element models for describing the elastic-viscous bodies properties with one elastic and two viscous elements and also four element models with two elastic and two viscous elements,, are really actual and has good possibility for describing properties of composite materials

BASIC PART

The properties of the body are different from those of ordinary metals. They are characterized by deformations that besides from loadings are also dependent on time. These materials are characterized simultaneously as the features of the elastic and viscous bodies, and therefore the simplest mathematical relations that describe these deformations $\sigma = E\varepsilon$ (Hook law) and $\sigma = \eta \frac{d\varepsilon}{dt}$ (Newton's law) are no longer valid. Such bodies would be called in general as elastic-viscous bodies. To describe their properties would be possible to apply so-called models that represents the certain combinations of purely elastic and plastic properties. The [1] reference describes the most simple Maxwell and Kelvin-Voight models, as well as the generalized three-element model (Fig. 1,a) and the three-element (Fig. 1,b) model has exactly the same properties as a) type so they do not considered here.



Maxwell model Kelvin-Voight model



a) b)

Three-element models

Fig. 1 Two and three element models

2.1. Three-element models with one elastic and two viscous elements We can also compile other combinations of the generalized three-element models, in which we have one elastic and two viscous elements. Let's consider these cases in detail, i.e. describe the model well as a whole body deformation image.

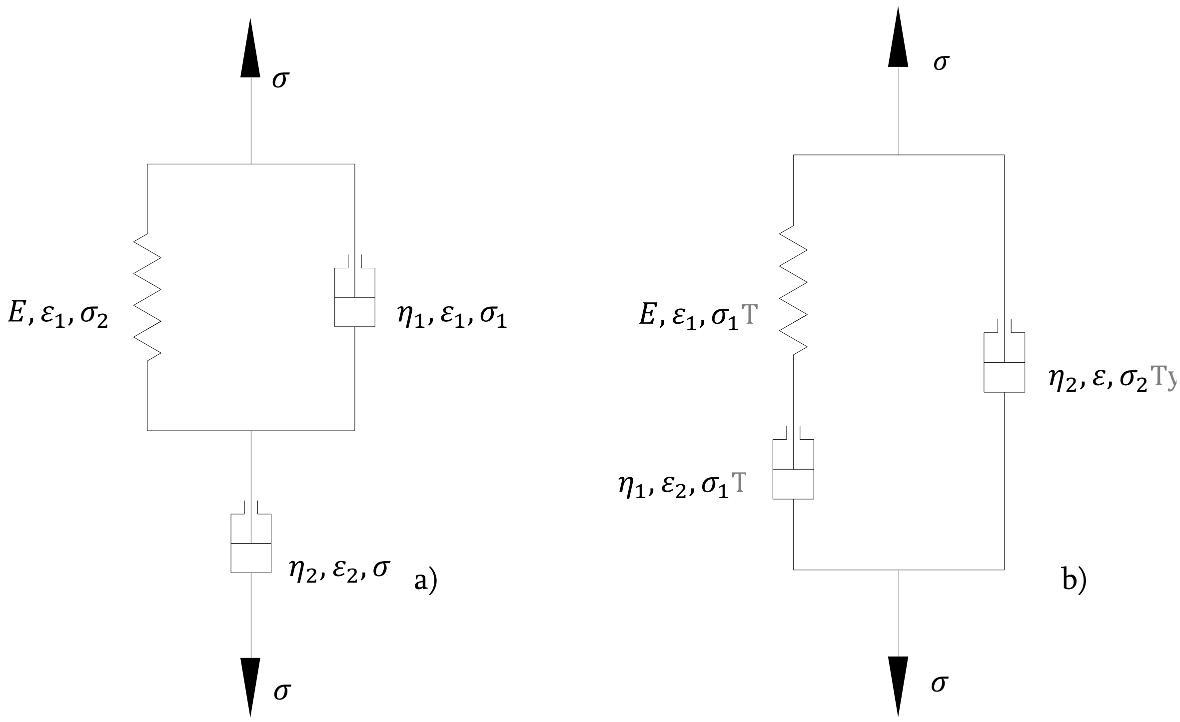


Fig. 2.Two variants of three-element models with one elastic and two viscous elements

From the very beginning it should be noted that both these models reflect the same deformation picture, so let's consider only a) case.

Let's write down for each element relation between stress and strain, as well as the stress and strain of total system:

$$\begin{cases} \sigma_1 = \eta_1 \dfrac{d\varepsilon_1}{dt} \\ \sigma_2 = E\varepsilon_1 \\ \sigma = \eta_2 \dfrac{d\varepsilon_2}{dt} \\ \sigma = \sigma_1 + \sigma_2 \\ \varepsilon = \varepsilon_1 + \varepsilon_2 \end{cases} \quad (1)$$

After excluding the parameters with indexes we obtain the following differential dependence (rjeological equation):

$$\frac{d^2\varepsilon}{dt^2} = \frac{\eta_1 + \eta_2}{\eta_1\eta_2}\frac{d\sigma}{dt} - \frac{E}{\eta_1}\frac{d\varepsilon}{dt} + \frac{E}{\eta_1\eta_2}\sigma. \quad (2)$$

If we consider the slow deformation then we can in expression (2) neglect the derivatives and obtain $\sigma \to 0$. In this way we can not determine the "long" elasticity module.

In comparison with rapidly deformation we can limit only by the first orderderivative, from (2) we will have:

$$\dot{\sigma} = \frac{E\eta_2}{\eta_1 + \eta_2}\dot{\varepsilon} \quad (3)$$

as the "instantaneous" modulus of elasticity would be found from the relation

$$\dot{\sigma} = H\dot{\varepsilon}, \quad (4)$$

thus we obtain from (3):

$$H = \frac{E\eta_2}{\eta_1 + \eta_2}. \quad (5)$$

Let's introduce the additional designation:

$$n = \frac{\eta_1}{E};\ \eta_2 = \eta. \quad (6)$$

Afterthat (2) will be as

$$\frac{d^2\varepsilon}{dt^2} = \frac{1}{nH}\frac{d\sigma}{dt} - \frac{1}{n}\frac{d\varepsilon}{dt} + \frac{1}{n\eta}\sigma. \quad (7)$$

1) Let's consider the constant stress case$\sigma = \sigma_c = const$ (creeping):

from (7)we will obtain:

$$\frac{d^2\varepsilon}{dt^2} + \frac{1}{n}\frac{d\varepsilon}{dt} = \frac{\sigma_c}{n\eta}. \qquad (8)$$

Let's solve the equation (8) with the following initial conditions:

when $t = 0$, then $\varepsilon = \varepsilon_0 = \frac{\sigma_c}{H}$ and $\dot{\varepsilon}(0) = \nu_0 \varepsilon^{\cdot}$ (initial deformation) (9).

As a result we will obtain the following solution:

$$\varepsilon = \left[\sigma_c\left(\frac{1}{H} - \frac{n}{\eta}\right) + n\nu_0\right] + \left[\frac{n\sigma_c}{\eta} - n\nu_0\right] e^{-\frac{t}{n}} + \frac{\sigma_c}{\eta} t. \qquad (10)$$

If after the certain time we will remove the load from system, or$\sigma_c = 0$, then almost instantly will becarried out the formation of new system (due to the existence of a elastic element in the given model) and the values of initial conditions also will be changed. Deformation will become indifferently smaller than is was at the given moment of time and the deformation rate changes its sign. They will become between certain$\varepsilon_0'$and ν_0' ($sign(\nu_0') = -sign(\nu_0)$, as a results of that (10) will be as:

$$\varepsilon = \varepsilon_0' + n\nu_0'\left(1 - e^{-\frac{t}{n}}\right). \qquad (11)$$

Let's plot on one diagram the (10) and (11) expressions we will have:

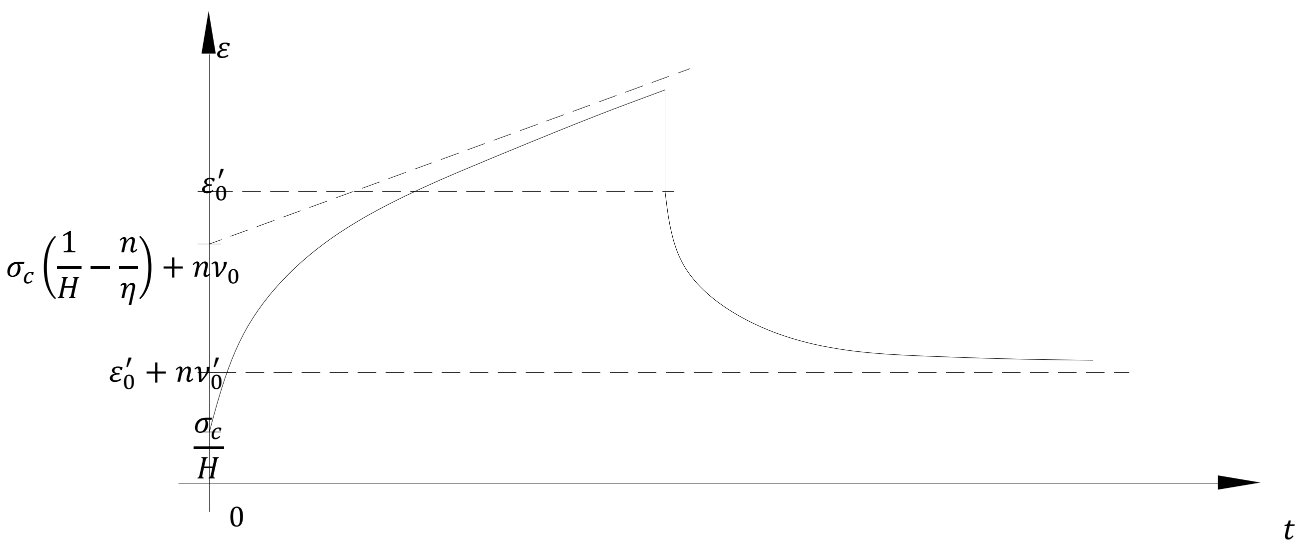


Fig. 3. The creeping and removal of load curves

2) Let's consider the case of constant deformation $\varepsilon = \varepsilon_c = const$ (relaxation): from (7) we will obtain:

$$\frac{d\sigma}{dt} + \frac{H}{\eta}\sigma,$$

after the separate variables we will have

$$\frac{d\sigma}{\sigma} = -\frac{H}{\eta}dt,$$

thatwill be easily integrated and will be as:

$$\ln|\sigma| = C - \frac{H}{\eta}t \;\Rightarrow\; \sigma = \sigma_0 e^{-\frac{H}{\eta}t}. \tag{12}$$

From the initial conditions when

$$t = 0,\ \sigma = \sigma_0 = H\varepsilon_c, \tag{13}$$

then finally

$$\sigma = H\varepsilon_c e^{-\frac{H}{\eta}t}. \tag{14}$$

Its graphic expression is given in Fig.4:

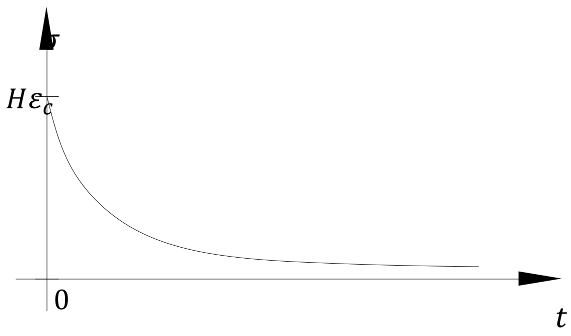


Fig. 4. Relaxation curve

This presented model qualitatively very good expresses the properties of viscous liquids, if we want to reflect the characteristic of deformation of the elastic-viscousbody it is necessary to make the viscosity coefficient $\eta = \eta_2$ larger in comparison with the viscosity coefficient of the second viscosity element $(\eta_1)$of the system that gives the possibility to extent continuous (undefined) deformations in time, or to keep loaded material without breakdown. If the η trends to infinity, then this model will be transformed into a Kelvin-Foight model that can not qualitatively well describe the properties of composite materials.

2.2. Four-element models with two elastic and two viscous elements

Let's consider the variants of the having similar of above mentioned properties four-element models that gives the possibility to obtain the results quite corresponding with the experiment. It should be also noted that all the presented models reflect the same deformation picture, let's consider only the a) variant

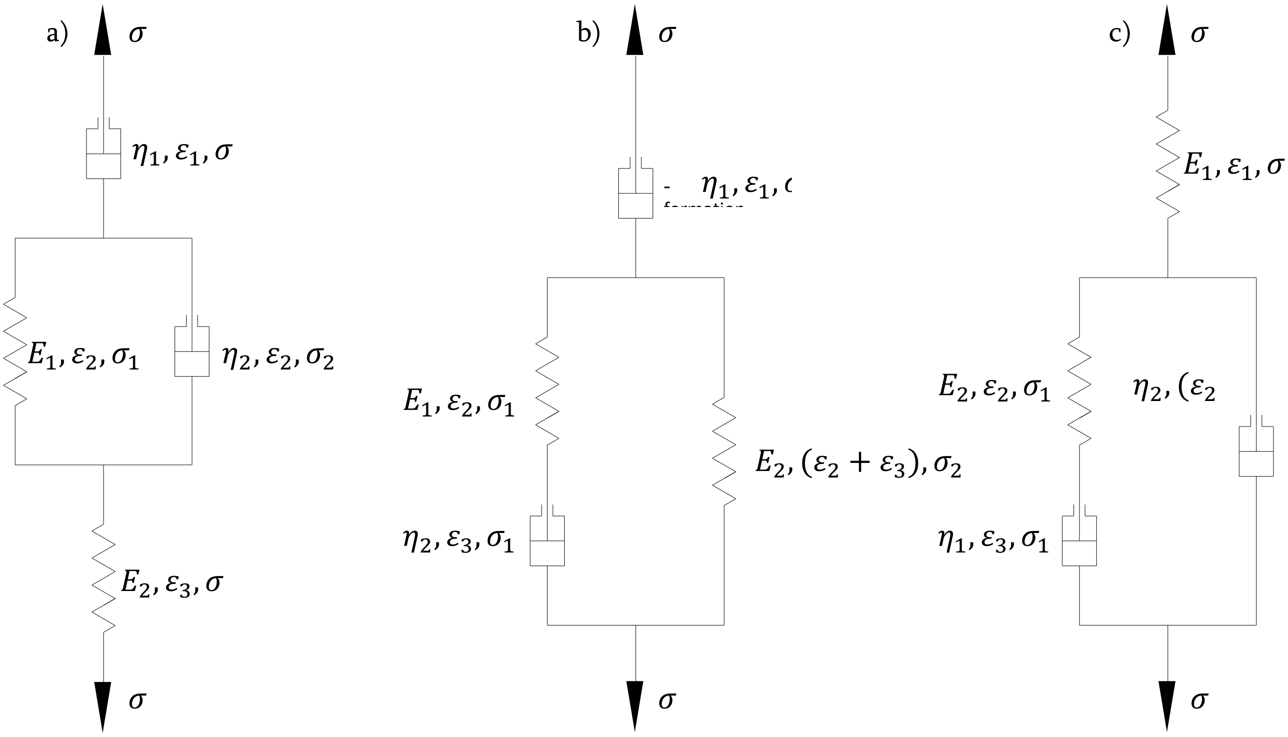


Fig. 7. Four-element models

Let's write down the relationship between the stress and deformation of the constituent elements, as well as the totalstress and deformation of the overall system:

$$a)\begin{cases} \sigma = \eta_1 \dfrac{d\varepsilon_1}{dt} \\ \sigma_1 = E_1\varepsilon_2 \\ \sigma_2 = \eta_2 \dfrac{d\varepsilon_2}{dt} \\ \sigma = E_2\varepsilon_3 \\ \sigma = \sigma_1 + \sigma_2 \\ \varepsilon = \varepsilon_1 + \varepsilon_2 + \varepsilon_3 \end{cases} \tag{15}$$

After excluding parameters with indexes we will obtainthe differential dependence (rheological equation)

$$\frac{d^2\varepsilon}{dt^2} - \frac{1}{E_2}\frac{d^2\sigma}{dt^2} = \frac{(\eta_1+\eta_2)E_2 + \eta_1E_1}{\eta_1\eta_2E_2}\frac{d\sigma}{dt} - \frac{E_1}{\eta_2}\frac{d\varepsilon}{dt} + \frac{E_1}{\eta_1\eta_2}\sigma. \tag{16}$$

During the slow deformation, if we remove the derivatives we will obtain $\sigma \to 0$. Therefore, the "long" elastic modulus also would not be determined. At the relatively rapid deformation, if we will be limited to the first order derivative we will have

$$\dot{\sigma} = \frac{\eta_1E_1E_2}{(\eta_1+\eta_2)E_2 + \eta_1E_1}\dot{\varepsilon}. \tag{17}$$

Due the dependence (4) for "instantaneous" elastic modulewe will obtain:

$$H = \frac{\eta_1E_1E_2}{(\eta_1+\eta_2)E_2 + \eta_1E_1}. \tag{18}$$

რის შემდეგაც (16) მიიღებს სახეს:Let’s additionally introduce the designations:

$$n = \frac{\eta_2}{E_1};\ \eta_1 = \eta;\ E_2 = E, \tag{19}$$

as a result of that expression (16) be as:

$$\frac{d^2\varepsilon}{dt^2} - \frac{1}{E}\frac{d^2\sigma}{dt^2} = \frac{1}{nH}\frac{d\sigma}{dt} - \frac{1}{n}\frac{d\varepsilon}{dt} + \frac{1}{n\eta}\sigma. \tag{20}$$

1) Creeping and removal of load process ($\sigma = \sigma_c = const$).

From(20) we will obtain:

$$\frac{d^2\varepsilon}{dt^2} + \frac{1}{n}\frac{d\varepsilon}{dt} = \frac{\sigma_c}{n\eta}, \tag{21}$$

that is exactly equation(8). The solution of this equation and its graphic representation for creeping as well as for removal of loadis given on Fig. 3.

2) Relaxation ($\varepsilon = \varepsilon_c = const$).

From(20) we will obtain:

$$\frac{d^2\sigma}{dt^2} + \frac{E}{nH}\frac{d\sigma}{dt} + \frac{E}{n\eta}\sigma = 0. \qquad (22)$$

(22) represents an uniform second order differential equation with constant coefficients, the general solution of thatwill be written down as follows:

$$\sigma = C_1 e^{k_1 t} + C_2 e^{k_2 t}, \qquad (23)$$

where k_1 and k_2 are thesolutions of the characteristic equation:

$$k^2 + \frac{E}{nH}k + \frac{E}{n\eta} = 0 \qquad (24)$$

$$k_1 = \frac{-E + \sqrt{E^2 - \frac{4nEH^2}{\eta}}}{2nH} < 0 \quad \text{and} k_2 = \frac{-E - \sqrt{E^2 - \frac{4nEH^2}{\eta}}}{2nH} < 0. \qquad (25)$$

Due the initial conditions when

$$t = 0, \sigma(0) = \sigma_0 = H\varepsilon_c \text{ and } \dot{\sigma}(0) = \mu_0\sigma, \qquad (26)$$

for indefinite coefficientswe will obtain:

$$C_1 = \frac{\mu_0 - H\varepsilon_c k_2}{k_1 - k_2} \quad and \quad C_2 = -\frac{\mu_0 - H\varepsilon_c k_1}{k_1 - k_2}. \qquad (27)$$

Finally the expression (23) will be as: `

$$\sigma = \frac{\mu_0 - H\varepsilon_c k_2}{k_1 - k_2} e^{k_1 t} - \frac{\mu_0 - H\varepsilon_c k_1}{k_1 - k_2} e^{k_2 t}. \qquad (28)$$

Its graphic representation is given in Fig.8.

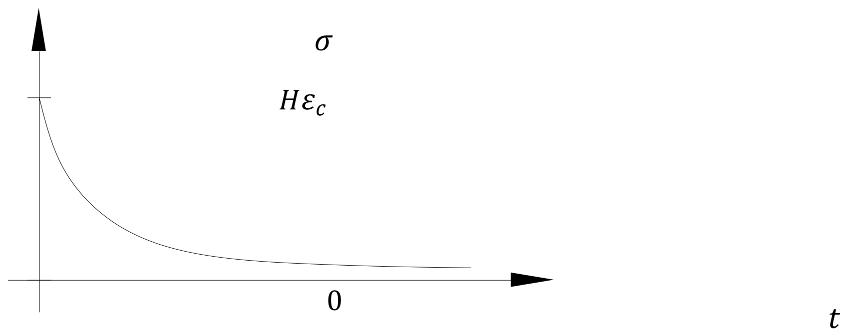


Fig. 8. Relaxation curve

CONCLUSIONS

In contrary to the three-element models, in this case we obtain a rheological equation (20) in that the stress and deformation are symmetrically introduced (containing the first and second order derivatives of both values). In the case of creeping the solutions coincides with the corresponding solution of the three-element models and the conclusions are the same as in the above mentioned case, while the four element models provide more extensive capabilities compared with the experiment, in particular the relaxation curve is not representing only a simple exponent (combination of two exponents) and also we have two independent constants instead of one that gives the possibility to well coincide with the experiment.

If we trend the η coefficient, for the (c) model η_1 to the infinity, then these four-element models will be transformed into generalized three-element models of the Kelvin-Voight that qualitatively well describe the properties of the composed materials, but quantitatively give a larger error compared with the experiment.

In addition, the considered model in terms to describe the creeping gives a second order differential equation, its solutions well coincides with the qualitative results of the experiment and the existence of two indefinite coefficients gives us the possibility to well coincide also the experimental quantitively results. However, at describing the process of relaxation, we obtain a simple expression with one indefinite coefficient and accordingly the possibility of coincidewith the results of experiment is more decreased.

Although the increase of elements in the model complicates its solution, it gives a much better possibilityto coincide with less errors with experimental data. The considered four-element models are a good opportunity to describe the properties of composite materials.

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ОБОБЩЁННЫЕ МОДЕЛИ ДЛЯ ОПИСАНИЯ СВОЙСТВ УПРУГО-ВЯЗКИХ ТЕЛ

Б. Абесадзе

Приведены обобщённые модели для описания свойств упруго-вязких тел. Доля описания свойств использованы модели, в которых представлены определённые комбинации чисто упругих и чисо пластических свойств тел. Составлены комбинации обощённых трёх-элементных моделей с одним упругим и двумя вязкими элементами. ОЛписаны зависимости между напряжениями и деформациями для каждого элемента. Получены кривые ползучести, упрочнения, релаксации. Также в работе приведены четырёхэлементные модели с двумя упругими и двумя вязкими элементами.

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ANALISIS OF SOUND DECAY PROCESS IN AN ENCLOUSED SPASE

M. Chelidze*, M. Tedoshvili*, D. Nizharadze*, J. Javakhishvili*

(LEPL R. Dvali Institute of Machine Mechanics, 10, Mindeli str, Tbilisi, 0186,Georgia)

Abstract: *In the work is considered oscillations and attenuation of sound waves in a closed impedance tube with a sampling of different length depending on the length of the coherent sound waves.The presented method provides the accuracy of measuring sound absorption in materials without the use of a special laboratory and precision devices.In addition, this method is less sensitive to fixing the test samples and less dependent on the arrangement of measuring devices.*

Keywords: *Sound; attenuation; amplitudes; absorption coefficient; decay.*

INTRODUCTION

Sound, a form of energy, is caused by molecules vibrating in a gas, liquid or solid and it propagates in the air as waves by changing of atmospheric pressure i.e. by disturbance of the air pressure [1]. Sound after exposure to solid materials is converted into vibration and thus spreads into them.The frequency or pitch of a noise, measured in hertz, is the number of sound waves emitted per second. High pitched sounds are carried by short and low pitched noises by longer waves.

Noise can be described as unwanted sound, the intensity of sound depends on pressure levels which are measured in decibels (dB). The purpose of acoustic control is to limit noise pollution from external sources or from activities within the building [2]. Sound insulation refers to the ability of the building fabric to resist the transmission of airborne and impact sound. Some existed typical noise levels are given in table 1.

Doctor tecnnical science*

Table 1

Event	dB
Ear drum treshold	140
Aircraft taking off	100
Pneumatic drill	90
Train	80
Vacum cleaner	60
Office	50
Fridge	30

For obtaining sound insulating and absorbing characteristics of the materials mainly are used reverberation room and Sabine equation.It's been over 100 years since Wallace Clement Sabine did his groundbreaking acoustical study at HarvardUniversity.Sabine's equation describes the decay of a reverberant "tail" of sound energy in a room with low absorption relative to its internal volume.Based on this type of energy behavior, Sabine's equation estimates the time required for the reflected energy to become inaudible (-60 dB) after the sound source has been interrupted – the RT60 [1].Reverberation time is a measure of how long it takes a sound to decay in seconds. It is determined by the amount of sound absorption in the room and room volume.

The point is that once the reflected energy becomes diffuse, it decays at the same rate until it is inaudible. The assumption is that the room has low absorption and that the absorption present is uniformly distributed. Unfortunately, the bulk of spaces that require sound reinforcement do not meet these criteria.

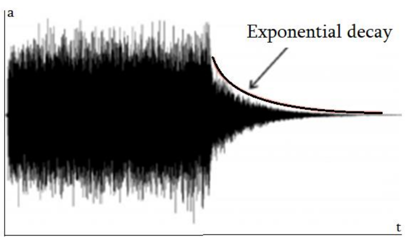

Fig.1. Reverberant energy decays exponentially with increasing time

BASIC PART

The attenuation of the reverberant sound amplitudes shown in Fig. 1 is very compressed and no separate amplitudes are observed. Modern digital technique (technology) allows stretching the sound amplitudes of the reverb Fig. 2÷5.

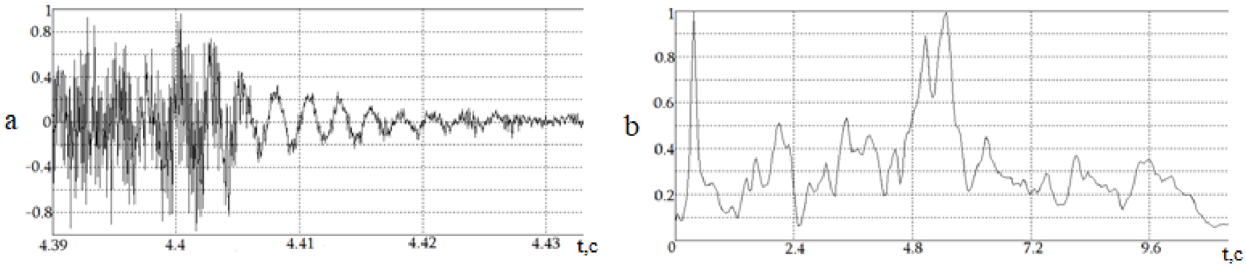

Fig.2. a-Decay reverberant sound of stretched white noise amplitudes in a reverberation room of 80m^3 volume, b- its frequency spectrum.

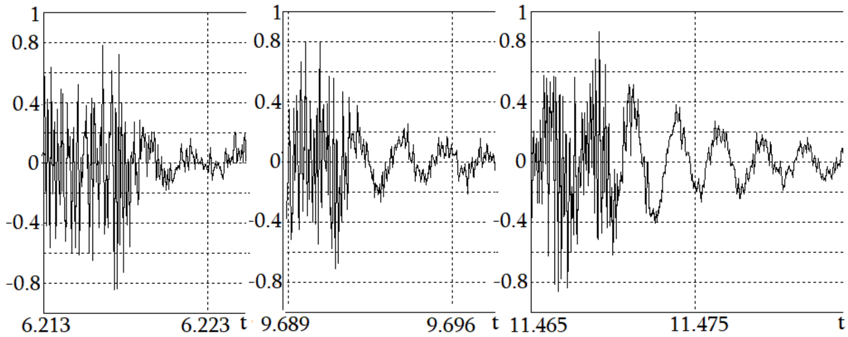

Fig.3. Decay of reverberant sound amplitudes in the room.

Sound researchers have long realized that all of the sound fields in an enclosed space do not follow the rate of decay described by the Sabine equation, which describes sound after it has reflected enough times to become random. The first few reflections, which are often good facsimiles of the direct sound decayed at a different rate. This "early" decay is strongly affected by the directivity of the sound source and surface materials of the objects near it. The early-decay time, or EDT, is often of greater significance to the sound system designer than the statistical decay time described by Sabine.

Unlike the RT60, which can be measured with a stopwatch, the EDT requires the scrutiny of time spans well under one second. Decay time measurements, in general, require the collection of the room's impulse response, IR. The earlier studies shows that the values of obtained sound absorption coefficients are depended on the used investigation methods i.e. values of sound absorption coefficient for at the same materials appeared different.

Often for measuring sound absorption coefficient in materials is used impedance tube. The simple waves of the frequency f radiated from the sound source create plain waves oscillating with f frequency in the tube. The plain waves circulating in the closed impedance tube are reflected many times from the lateral covers of the tube. The obtained reverberating waves are acted on each other, summed and in the tube are created also the stable standing waves of f frequency [3,4].

The incident and reflected flat harmonic waves are summed i.e. depending on their phase they are increased and decreased [5].

$$p = A\cos\frac{\omega}{c}(ct - x) + B\cos\frac{\omega}{c}(ct + x) = A\cos(\omega t - kx) + B\cos(\omega t + kx), \quad (1)$$

where c – the speed of sound propagation, ω-sound oscillation frequency, $k = \frac{w}{c} = \frac{2\pi f}{c} = \frac{2\pi}{\lambda}$

The simple (coherent) waves of the frequency f radiated from the sound source create plain waves oscillating with f frequency in the tube. The plain waves circulating in the closed impedance tube are reflected many times at the stopped ends (from the lateral covers of the tube). The obtained reverberating waves are acted on each other, summed and in the tube are created also the stable standing waves of frequency f [3,6].

The full period of propagation plane waves from one stopped end of the tube to another and back, i.e. one full cycleT_{lon}, is a ratio of the double length of the tube to the speed of sound propagation in air. The speed of sound in air equal 331 m/c at sea level.So in the tube longitudinally are generated stable plane and standing waves. At the time of switching off the noise source, in the tube, the amplitudes of plane and standing waves fall at the same pace. In accordance with formula (1), the value of decay of sound amplitudes in each cycle is equal of the transmitted and absorbed sound energy in the material being at the stopped end of the tube [7,8].

To improve the accuracy of measurement, sound reflection coefficient of the tube wall should be close to 1, i.e. material for the tube should be bronze or steel [6,9].

Fig. 2, 3, 5 shows that the sound absorption magnitudes and amplitudes attenuations speed depend on the time of switching off the noise source i.e. what value has sound amplitudes in the impedance tube at moment of ceasing noise source [10].

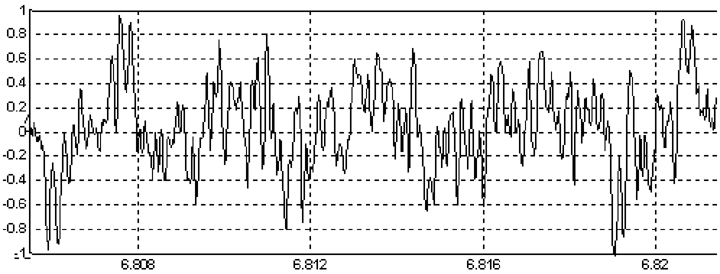

Fig.4. Stretched sound reverberant amplitudes generating in the impedance tube.

The complex sound waves (Fig. 2÷5) generating in the impedance tube is a sum of incidental white noise waves and multiple reflecting waves from the tube lateral cover ends. So the acting waves of sound amplitudes are varying in the process of generating i.e. they increasing and decreasing over time Fig 4.The interaction of incidental and reflection waves in the tube cause the process of summarization (formula (1)) Fig.4.

Follows to note, the time of decay (measured in a sec) reverberant sound amplitudes in a reverberation room (150 m^3 volume Fig. 3) much bigger than reverberation time (measured in msecFig.5) decay in impedance tube which volume does not exceed $0.02m^3$.

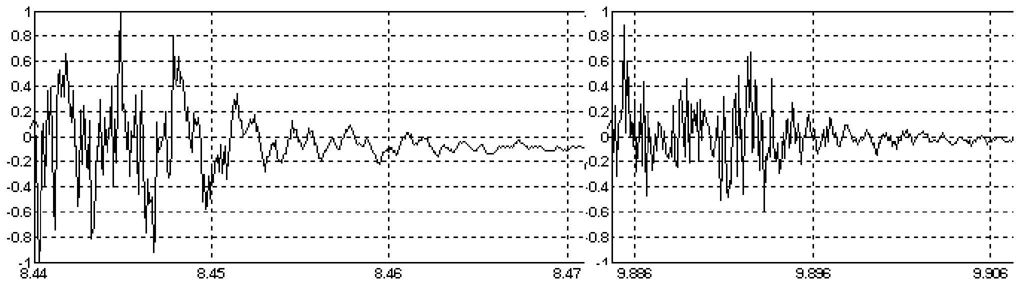

Fig.5.Decay reverberant sound of white noise amplitudes in an impedance tube. The waveform of generating white noise is stretched.

In the case of coherent sound waves, when the length of impedance tube some times bigger to a sound waves length then the attenuation of sound waves happens by group of amplitudes.Each group of sound amplitudes presents the numbers of amplitudes existed in thetube.On Fig. 6 is showing the nonlinear decay of sound amplitudes by the curve of ab.

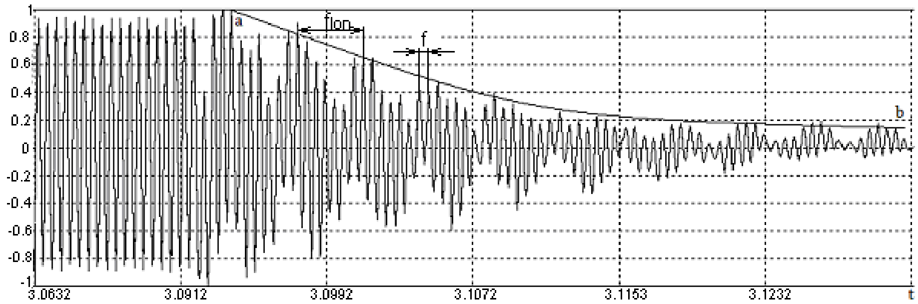

Fig. 6. Decay coherent sound waves in a impedance tube.

Especially it should be noted that in the impedance tube together with waves radiated from the sound source with frequency of f is created and generated in the length of the tube the group of amplitudes of longitudinal sound waves with frequency of f_{lon} Fig. 6,7.The reason of generating longitudinal waves is multiple reflection of sound waves from the stoped ends of the tube [11].

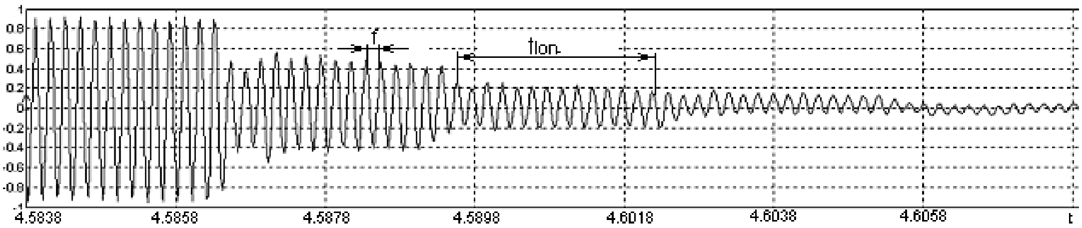

Fig. 7. Step-like decay of coherent sound waves in a impedance tube.

Investigations of genrrating and attenuation of sound waves in the impedance tube by means of modern digital teqnicue have shown that the form and stability of decay sound amplitudes very much depends on the length of impedance tube. On the Fig.8. are shown decay processes of coherent sound waves amplitudes for tube of a different length L_t and sound waves length L_s [12].

If impedance tube length coincides with 1/4 length of coherent sound waves then the frequency of decayed sound amplitudes is equal to the frequency of the forced sound source, Fig. 8a. Analyze of performed works has shown that for determining sound absorption coefficient for materials exact meaning gives the mode L_t=1/4L_s.This happens because of at the switch off of noise source the place of waves coming from source takes place the waves of double reflection with coinciding phases. In the case of no coincidence of phases has place creation of high composite frequencies on the main wave, Fig.8c.

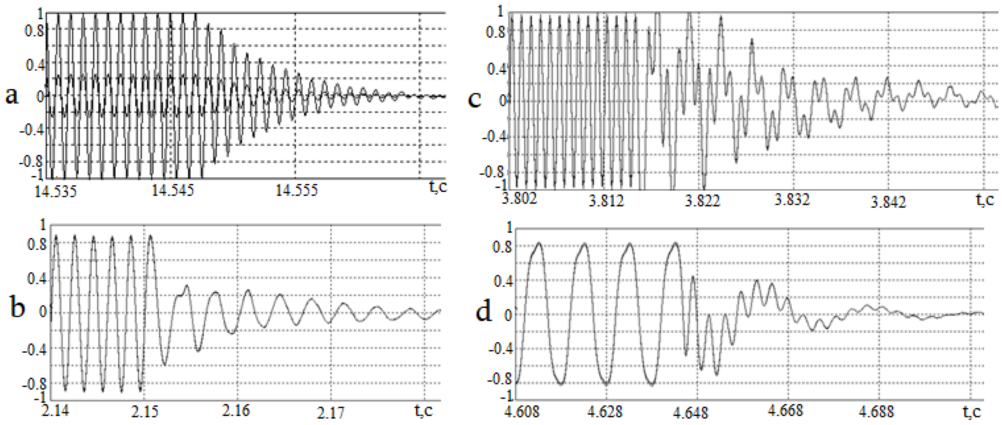

Fig. 8. Decay processes of coherent waves at the time of different tube lengths: a-L_t=1/4L_s;

b-L_t=1/2L_s; c-L_t=2L_s; d-L_t=L_s.

On the Fig.9 is given decay waveforms for defferent materials by means of were calculated sound absorption coefficients, ϕ.

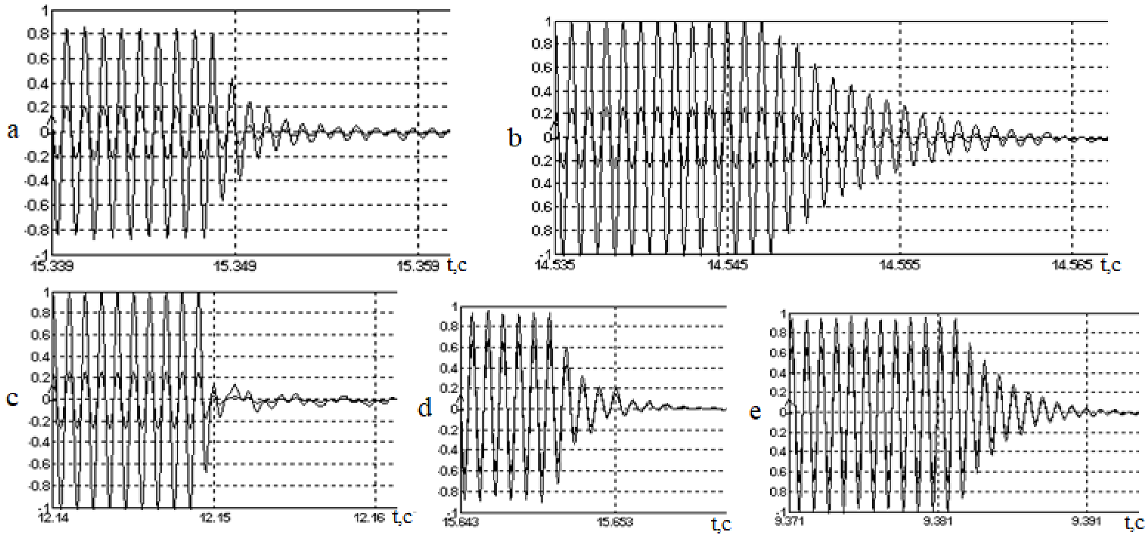

Fig.9.Waveforms of decay different materials: a-dry plate, ϕ=0.26; b-plate with water, ϕ=0.07;

c-cotton-wool, ϕ=0.69; d-dry polystyrone, ϕ=0.21; e-wet polystyrone, ϕ=0.16.

The formula for calculation sound absorption coefficient at linear intervales of sound decay amplitudes, as it happens in the vibration technique, will take the following view.

$$\alpha_k = \frac{A_a - A_b}{mA_a} \qquad (2)$$

where A_a- and A_b- maximal and minimal amplitudes on the calculation interval accordingly, m- the number of amplitudes of decay, or increase on the calculation interval.

CONCLUSIONS

By noted waveforms, graphically, may be determined absorption coefficient in the materials that are new method and must be perspective for further investigation by the viewpoint of elaboration and refinement.

The method of determining of absorption coefficient by means of decay reverberating waves in the impedance tube, at the presence of simple frequency sound source, is enough stable and shows low sensitivity on a whole admission mistakes at the process of measurements.

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АНАЛИЗ ПРОЦЕССА ПОГЛОЩЕНИЯ ЗВУКА В ЗАКРЫТОМ ПРОСТРАНСТВЕ

М.Челидзе, М.Тедошвили, Д. Нижарадзе, Д. Джавахишвили

В работе рассматривается колебание и затухание звуковых волн в закрытой импедансной трубке разной выборочной длинызависимости от длины кохерентных звуковых волн. Представленный метод обеспечивает точность измерения коэффициента звукового поглощения в материялах без применения специальной лаборатории и прецизионных устройств. Кроме того, данный метод менее чувствителенот фиксаций испытуемых образцов и менее зависим от расстановки измерительных приборов.

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SOLVING FLUID DYNAMIC PROBLEMS WITH RVACHEV-OBGADZE RO METHOD

T. Obgadze*, O. Kemularia**
(Georgian Technical University, Merab Kostava str. 77, Tbilisi 0175, Georgia)

Abstract: *In this work, we describe RO* ***Rvachev-Obgadze*** *method. The algorithm for creating boundary equation is created; for which, homomorphisms of T.Obgadze are used. Algorithms based on Navier-Stokes equations are created, for solving tasks of stationary boundaries, which afterwards are tested by set of problems, solved with numerical methods with the help of Mathcad software. Solutions by numerical methods are compared to solutions by famous methods. Absolute and relative error values are given.*

Keywords: *Rvachev-Obgadze RO method, Truncation error, Homomorphism*

DIAGRAM FOR BUILDING RVACHEV-OBGADZE FUNCTIONS AND RO-METHOD OF BOUNDARY ANALYTIC CODING

In practice, we often encounter a variable-expressive functions: “x is a rational number”, “y is a kind person”

Definition: Variable consisting expressions are called predicates.

An engineer from Kharkov, Rvachev has created one of the methods of geometric coding, called the **R-function** method. Subsequently, these functions were used to solve the tasks of mathematical physics [1]. Later, the R-function method was transferred to the modern algebra [2] by Tamaz Obgadze, which allowed us to form the algorithm of the R-function in mathematical accuracy and to generalize the case of multiple areas.

Now let's move to the R-function algorithm, which is represented by a diagram in the category of **bull algebra**, where morphemes are induced by **Natural Homomorphism**:

$$L_1 \to Lp \to L_R, \qquad (1)$$

where L_1 is Boolean algebra based on variables,

$L_p$is Boolean algebrabased on predicates,

$L_R$is Boolean algebrabased on Rvachev functions,

and the arrows are marked by natural homomorphism.

Professor*
student**

Let’s discuss this algorithm for a particular example. Let's say we want to build a complicated circle equation, whereas when we know the consisting parts are graphs of which functions (Fig. 1)

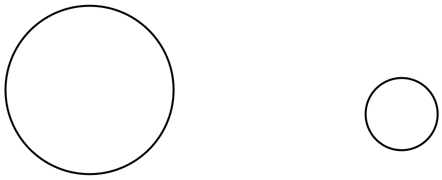


Fig. 1. Two circles, with R and r radiuses

Our task is to create an analytic image of a function that is equal to zero, only at the boundaries of these two circles.

From (1) diagram, we createsupport set in L_1 set of Boolean algebra, that are the variables through which we can describe seeking point set in Boolean algebra set.

$$\Omega_1 = \{(x, y) | (x-a)^2 + (y-b)^2 - R^2 \geq 0\}, \tag{2}$$

$$\Omega_2 = \{(x, y) | R^2 - (x-a)^2 - (y-b)^2 \geq 0\}, \tag{3}$$

$$\Omega_3 = \{(x, y) | (x-c)^2 + (y-d)^2 - r^2 \geq 0\}, \tag{4}$$

$$\Omega_4 = \{(x, y) | r^2 - (x-c)^2 - (y-d)^2 \geq 0\}. \tag{5}$$

These are the sets that allow us to build the set equation of the function of interest:

$$\Omega = (\Omega_1 \cap \Omega_2) \cup (\Omega_3 \cap \Omega_4). \tag{6}$$

When constructing support sets, we use the compatibility "greater than or equal to zero", which in this case is necessary to make a pathway from the Boolean algebraic sets through the homomorphism in the L_p Boolean algebraic predicates. Indeed, through natural homomorphism in $L_p$we will find a predictive equation of the circle of interest:

$$P = (P_1 \wedge P_2) \vee (P_3 \wedge P_4), \tag{7}$$

where P_1 – Is an expression $x_1 \geq 0$,

P_2 – Expression $x_2 \geq 0$,

P_3 – Expression $x_3 \geq 0$,

P_4 – Expression $x_4 \geq 0$,

$$x_1 = (x-a)^2 + (y-b)^2 - R^2;$$

$$x_2 = R^2 - (x-a)^2 - (y-b)^2;$$

$$x_3 = (x-c)^2 + (y-d)^2 - r^2; \quad (8)$$

$$x_4 = r^2 - (x-c)^2 - (y-d)^2.$$

Now let's move to the L_R with **Rvachev's Homomorphisms**:

$$\begin{cases} P_i \vee P_j \Leftrightarrow x_i + x_j + \sqrt{x_i^2 + x_j^2} \\ P_i \wedge P_j \Leftrightarrow x_i + x_j - \sqrt{x_i^2 + x_j^2} \\ \neg P_i \Leftrightarrow -x_i \end{cases} \quad (9)$$

We get the R-function as follows:

$$R = (x_1 + x_2 - \sqrt{x_1^2 + x_2^2}) \vee (x_3 + x_4 - \sqrt{x_3^2 + x_4^2}) \equiv x_1 + x_2 + x_3 + x_4 - \sqrt{x_1^2 + x_2^2} - \sqrt{x_3^2 + x_4^2} + \\ + \sqrt{(x_1 + x_2 - \sqrt{x_1^2 + x_2^2})^2 + (x_3 + x_4 - \sqrt{x_3^2 + x_4^2})^2} \quad (10)$$

Where (8) functions must be taken into account.

In some cases, where equations for elements of circles consisting of several coupling elements are known, it's more appropriate to use Obgadze homomorphism through [2] structures:

$$K_1 \to K_p \to K_R, \quad (11)$$

$$\begin{cases} P_i \vee P_j \Leftrightarrow x_i \cdot x_j \\ P_i \wedge P_j \Leftrightarrow x_i^2 + x_j^2 \end{cases}. \quad (12)$$

Here we have the **compliance**: "True" $\Leftrightarrow$ "Equals to zero";
"False" $\Leftrightarrow$ "Doesn't equal to zero";

In the case of discussed example, supporting set will be:

$$\Omega_1 = \{(x, y) \mid (x-a)^2 + (y-b)^2 - R^2 = 0\}, \quad (13)$$

$$\Omega_2 = \{(x, y) \mid (x-c)^2 + (y-d)^2 - r^2 = 0\}. \quad (14)$$

then,

$$\Omega = \Omega_1 \cup \Omega_2; \quad (15)$$

i.e. $P = P_1 \vee P_2$; (16)

where

$$P_1 - \text{Expression}\,(x-a)^2 + (y-b)^2 - R^2 = 0, \tag{17}$$

$$P_2 - \text{Expression}\,(x-c)^2 + (y-d)^2 - r^2 = 0; \tag{18}$$

therefore,

$$RO = [(x-a)^2 + (y-b)^2 - R^2] \cdot [(x-c)^2 + (y-d)^2 - r^2].$$

As we can see, homomorphisms of Obgadze [2] have greatly simplified the analytical equation of circles with several coupling elements.

Also, in a lot of cases, the analysis of the R-function is significantly simplified [3-4]. Therefore, the final algorithm is called the Rvachev-Obgadze **RO-method.**

SOLVING KOCH ODE (ORDINARY DIFFERENTIAL EQUATION) WITH RVACHEV-OBGADZE RO-METHOD

To interpret **Rvachev-Obgadze RO-method,** let's discuss simple differential equation [6]:

$$\frac{dy}{dx} - y = 0, \tag{19}$$

with the initial boundary condition

$$y(0) = 1. \tag{20}$$

We're looking for a solution in $G[0; 1]$ interval.

Obviously, that the exact solution for this equation looks like this: $y = e^x$, which is easily to check by inserting it in (19) equation.

Now let's create an approximate solution with **Rvachev-Obgadze RO-method.** To accomplish this, we choose the system of the simplest base functions:

$$\varphi_j(x) = x^j. \tag{21}$$

we're looking for this type of solution:

$$y_\alpha = 1 + \sum_{j=1}^{N} \alpha_j x^j. \tag{22}$$

It's clear, that the first member of the equation is chosen based on (20) boundary condition and it's easy to understand, that (22) expression can be rewritten as follows (23):

$$y_\alpha = \sum_{j=0}^{N} \alpha_j x^j, \tag{23}$$

where $\alpha_0 = 1$.

Let's insert (23) expression into (19) equation, we'll get following R error:

$$R(x,\alpha) = -1 + \sum_{j=1}^{N} \alpha_j \left(jx^{j-1} - x^j\right). \quad (24)$$

In case of **colocation method** solution, when looking for α_j coefficient, it's common to use the following equation system:

$$R(x_k,\alpha) = 0,\ x_k \in G[0;1],\ \ k = \overline{1,N}. \quad (25)$$

Obviously, the more point we use in colocation method, the more accurate the solution is, however, the increase in number of points leads to the increase the range of equation system, which often gives badly conditioned matrix (in case of linear operators), which in turn makes it difficult to solve the equation with necessary accuracy. Therefore, the alternative **Rvachev-Obgadze method** was developed.

When solving with **Rvachev-Obgadze method,** to find $\alpha_j$coefficient, metric $L_2(G)$ with induced norm is used, for this coefficient to be defined with a condition to minimize the distance between $R(x,\alpha)$ function and 0.

$$I(\alpha) = \int_0^1 (R(x,\alpha) - 0)^2\, dx \to min. \quad (26)$$

Now compare solution obtained by Rvachev-Obgadze RO-method, to the original solution. Compare absolute and relative errors:

Absolute errors: $\left|e^x - f(x)\right| =$

6.694·10-4
4.658·10-4
9.576·10-5
6.225·10-4
8.571·10-4
6.915·10-4
1.828·10-4
4.293·10-4
7.036·10-4
2.431·10-5

Relative errors: $\dfrac{\left|e^x - f(x)\right|}{e^x} =$

6.057·10-4
3.813·10-4
7.094·10-5
4.173·10-4
5.199·10-4
3.795·10-4
9.079·10-5
1.929·10-4
2.861·10-4
8.942·10-6

Comparing these two sets shows clearly, that Rvachev-Obgadze method in this case, provides a great accuracy.

IMPLEMENTING RVACHEV-OBGADZE METHOD TO STUDY ONE-DIMENSIONAL VISCOUS FLUID FLOW IN A SQUARE CROSS-SECTIONAL TUBE

This task obtains Poisson's equation form:

$$\frac{\partial^2 w}{\partial x^2}+\frac{\partial^2 w}{\partial y^2}+1=0. \tag{27}$$

with the boundary conditions:

$$w=0\ if\ x=\pm 1,\ y=\pm 1. \tag{28}$$

For solving this task with **Rvachev-Obgadze method,** let's create relevant RO-function:

$$RO=(1-x^2)\cdot(1-y^2). \tag{29}$$

Obviously this function satisfies (28) boundary conditions. Therefore, we can search for the solution of (27) equation as follows:

$$w=RO\cdot\sum_{i=0}^{N}\sum_{j=0}^{N}\alpha_{ij}\cdot\varphi_{ij}(x,y), \tag{30}$$

where $\varphi_{ij}(x,y)$ are base functions, and α_{ij} coefficients are discovered by norm minimizing conditions of error function $L_2(G)$

Let's choose the base functions, so all the members in the area won't become equal to 0, for example:

$$\varphi_{ij}(x,y)=(1-x^2)^{i-1}\cdot(1-y^2)^{i-1}. \tag{31}$$

Therefore, we'll get solution for Finlayson [9] expression.

$$w=\sum_{i=0}^{N}\alpha_i(1-x^2)^i\cdot(1-y^2)^i \tag{32}$$

Hence, we get

$$w_{xx}=\sum_{i=2}^{N}\alpha_i\cdot i\cdot(i-1)\cdot(1-x^2)^{i-2}\cdot(1-y^2)^i\cdot(-2x)+$$
$$+\sum_{i=1}^{N}\alpha_i\cdot i\cdot(1-x^2)^{i-1}\cdot(1-y^2)^i\cdot(-2). \tag{33}$$

As for w_{yy}, it has similar form as (30), because of function symmetric characteristic Therefore, we can create an expression of the error function $R(x,y,\alpha)$. For this we need to insert (32) in the equation (27) and make the following transformations:

$$R(x,y,\alpha)=\frac{\partial^2 w}{\partial x^2}+\frac{\partial^2 w}{\partial y^2}+1==\sum_{i=2}^{N}\alpha_i\cdot i\cdot(i-1)\cdot(1-x^2)^{i-2}\cdot(1-y^2)^i\cdot(-2x)+$$
$$+\sum_{i=1}^{N}\alpha_i\cdot i\cdot(1-x^2)^{i-1}\cdot(1-y^2)^i\cdot(-2)+$$

$$G(x,y) := \sum_{k=1}^{N}\sum_{m=1}^{N}\left[\left(\frac{8}{\pi^2}\right)^2 \cdot \frac{(-1)^{\frac{2\cdot k+2\cdot m-2}{2}-1}}{(2\cdot k-1)\cdot(2\cdot m-1)\cdot\left[(2\cdot k-1)^2+(2\cdot m-1)^2\right]}\cdot\cos\left[(2\cdot k-1)\cdot\frac{\pi}{2}\cdot x\right]\cdot\cos\left[(2\cdot m-1)\cdot\frac{\pi}{2}\cdot y\right]\right]$$

$$+\sum_{i=2}^{N}\alpha_i\cdot i\cdot(i-1)\cdot(1-y^2)^{i-2}\cdot(1-x^2)^i\cdot(-2y)+$$

$$+\sum_{i=1}^{N}\alpha_i\cdot i\cdot(1-y^2)^{i-1}\cdot(1-x^2)^i\cdot(-2)+1. \qquad (34)$$

To find out the expansion α_j's coefficients, we use the induced metric with $L_2(G)$norm, to determine these coefficients with distance reduction condition between 0 and the function (R, x, y, α)

$$I(\alpha)=\int_0^1 (R(x,\alpha)-0)^2\,dx \to min. \qquad (35)$$

Let's write a program on Mathcad and compare B solution $w(x,y)$obtained with Rvachev-Obgadze RO method to A solution $G(x,y)$ obtained by Galiorkin method.

$N := 3$

$$wxx(x,y,\alpha) := \left[\sum_{i=1}^{N}\left[\alpha_i\cdot i\cdot(1-x^2)^{i-1}\cdot(-2)\cdot(1-y^2)^i\right]+\sum_{i=2}^{N}\left[\alpha_i\cdot i\cdot(i-1)\cdot(1-x^2)^{i-2}\cdot(-2\cdot x)\cdot(1-y^2)^i\right]\right]$$

$$wyy(x,y,\alpha) := \left[\sum_{i=1}^{N}\left[\alpha_i\cdot i\cdot(1-y^2)^{i-1}\cdot(-2)\cdot(1-x^2)^i\right]+\sum_{i=2}^{N}\left[\alpha_i\cdot i\cdot(i-1)\cdot(1-y^2)^{i-2}\cdot(-2\cdot y)\cdot(1-x^2)^i\right]\right]$$

$S := \text{Minimize}(I,\alpha)$ $\qquad$ $R(x,y,\alpha) := wxx(x,y,\alpha)+wyy(x,y,\alpha)+1$

$$I(\alpha) := \int_{-1}^{1}\int_{-1}^{1} R(x,y,\alpha)^2\,dx\,dy \qquad S = \begin{pmatrix}0\\0.402\\-0.021\\-0.027\end{pmatrix}$$

$i := 0..N$ $\alpha_i := 0$

Given

$\alpha := S$

$I(\alpha) = 0.272$

$$w(x,y) := \sum_{i=0}^{N} \left[\alpha_i \cdot \left(1 - x^2\right)^i \cdot \left(1 - y^2\right)^i \right]$$

$i := 0..4 \quad j := 0..4$

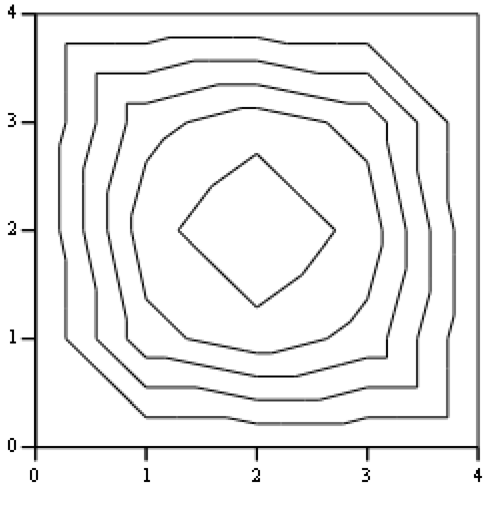
$x_i := -1 + 0.5i$

$y_j := -1 + 0.5j$

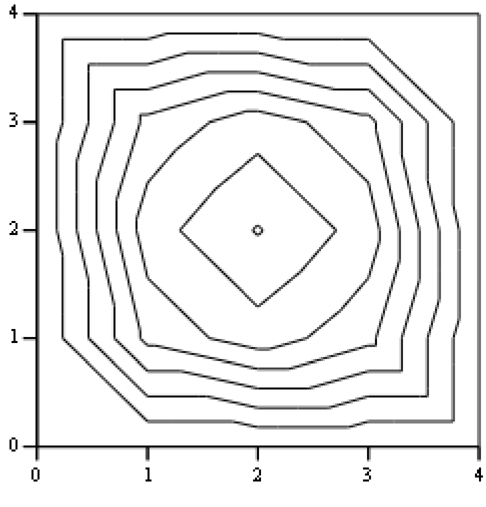
$A_{i,j} := G\left(x_i, y_j\right) \quad B_{i,j} := w\left(x_i, y_j\right)$

$$A = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0.182 & 0.231 & 0.182 & 0 \\ 0 & 0.231 & 0.297 & 0.231 & 0 \\ 0 & 0.182 & 0.231 & 0.182 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$B - A = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0.032 & 0.047 & 0.032 & 0 \\ 0 & 0.047 & 0.057 & 0.047 & 0 \\ 0 & 0.032 & 0.047 & 0.032 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \qquad B = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0.215 & 0.278 & 0.215 & 0 \\ 0 & 0.278 & 0.354 & 0.278 & 0 \\ 0 & 0.215 & 0.278 & 0.215 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \qquad \max(B - A) = 0.057$$



A



B

APPROXIMATE SOLUTION FOR BURGERS' EQUATION WITH RVACHEV-OBGADZE METHOD

The Burgers' equation is characterized by the same nonlinearity as the Navier-Stokes equation system, so when checking a new numerical method of solving the Navier-Stokes equations, it is checked with the Burgers' equation [6-7]. Moreover, in case of some boundary and initial conditions, there is an exact solution for the Burgers' equation. The Burgers' equation has a following form:

$$\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}-\frac{1}{Re}\frac{\partial^2 u}{\partial x^2}=0. \quad (36)$$

Let's try to solve the Burgers' equation when spatial variable $x\in[-1;1]$ interval and $t\geq 0$. Let's say, the initial and boundary conditions are given as follows:

$$u_0(x)=u(x,0)=\begin{cases}1, & if\ x=0\\ 0, & if\ x=1\end{cases}, \quad (37)$$

$$u(-1,t)=1,\ u(1,t)=0. \quad (38)$$

We will use polynomials to an approximate the solution of this task with the **Rvachev-Obgadze method**:

$$T_i(x)=x^i. \quad (39)$$

We're looking for the approximate solution of the **Burgers' equation**with the following formula:

$$u_\alpha(x,t)=\sum_{i=1}^{N}\alpha_i(t)\cdot x^i. \quad (40)$$

In addition, we present the $\alpha_i(t)$ coefficients in the form of a series of time:

$$\alpha_i(t)=\sum_{j=1}^{N}\beta_{ij}t^j, \quad (41)$$

We'll get

$$u(x;t)=1-x+\sum_{i=1}^{N}\sum_{j=1}^{N}\beta_{ij}t^j\,x^i. \quad (42)$$

It's easy to notice that (42) expression takes into account the initial conditions. In this expression the β_{ij}expansion coefficients must be found. For this, we insert the (42) expression in the Burgers' (36) equation and create the $R(x,t,\beta)$ error function. We get

$$u_x=-1+\sum_{i=1}^{N}\sum_{j=1}^{N}\beta_{ij}t^j\cdot i\cdot x^{i-1}; \quad (43)$$

$$u_{xx}=\sum_{i=2}^{N}\sum_{j=1}^{N}\beta_{ij}t^j\,i(i-1)x^{i-2}; \quad (44)$$

$$R(x,t,\beta)=\sum_{i=1}^{N}\sum_{j=1}^{N}j\cdot\beta_{ij}\cdot t^{j-1}\cdot x^i+$$

$$+\left(1-x+\sum_{i=1}^{N}\sum_{j=1}^{N}\beta_{ij}t^j\,x^i\right)\cdot$$

$$\cdot\left(-1+\sum_{i=1}^{N}\sum_{j=1}^{N}\beta_{ij}t^j\cdot i\cdot x^{i-1}\right)-$$

$$-\frac{1}{Re}\cdot\left(\sum_{i=2}^{N}\sum_{j=1}^{N}\beta_{ij}t^{j}\,i(i-1)x^{i-2}\right). \quad (45)$$

Here to find β_{ij}expansion coefficients, metric induced with $L_2(G)$norm is used, to determine these coefficients with distance reduction condition between 0 and the function $R(x,t,\beta)$:

$$I(\beta)=\int_0^1\int_0^\infty (R(x,t,\beta)-0)^2\,dtdx \to min. \quad (46)$$

Let's write a program with **Mathcad** and compare solution $u(x,t)$obtained with Rvachev-Obgadze RO method to a solution $G(x,y)$ obtained by Galiorkin method.

$N := 3 \quad Re := 100$

$ORIGIN := 1$

$$ux(x,t,\beta) := -1 + \sum_{i=1}^{N}\sum_{j=1}^{N}\left(\beta_{i,j}\cdot t^{j}\cdot i\cdot x^{i-1}\right)$$

$$uxx(x,t,\beta) := \left[\sum_{i=1}^{N}\sum_{j=1}^{N}\left[\beta_{i,j}\cdot t^{j}\cdot(i-1)\cdot i\cdot x^{i-2}\right]\right]$$

$$R0(x,t,\beta) := \sum_{i=1}^{N}\sum_{j=1}^{N}\left(\beta_{i,j}\cdot t^{j-1}\cdot x^{i}\cdot j\right) + \left[1-x+\sum_{i=1}^{N}\sum_{j=1}^{N}\left(\beta_{i,j}\cdot t^{j}\cdot x^{i}\right)\right]\cdot ux(x,t,\beta)$$

$$R(x,t,\beta) := R0(x,t,\beta) - \frac{1}{Re}\cdot uxx(x,t,\beta)$$

$$I(\beta) := \int_0^1\int_0^1 R(x,t,\beta)^2\,dxdt$$

$i := 1..N$

$j := 1..N$

$\beta_{i,j} := 0$

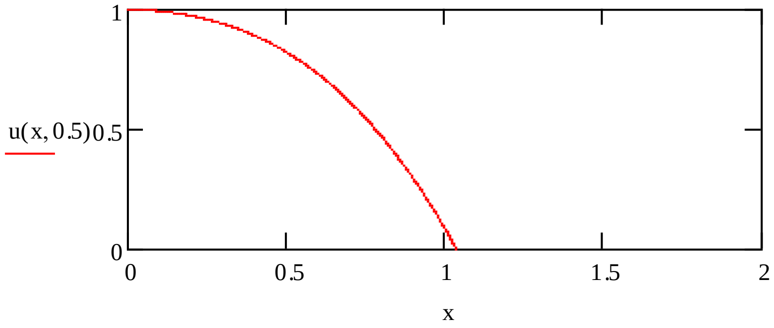
Given

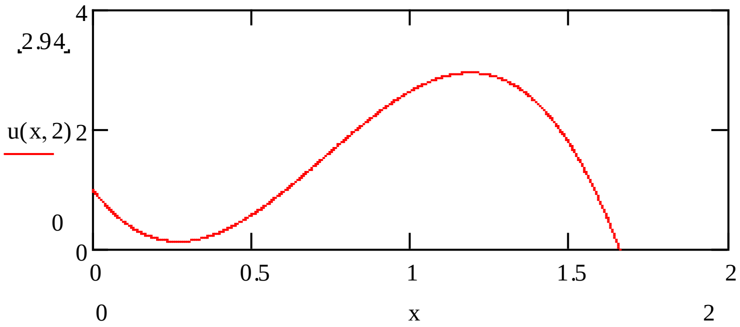
$S := Minimize(I,\beta)$

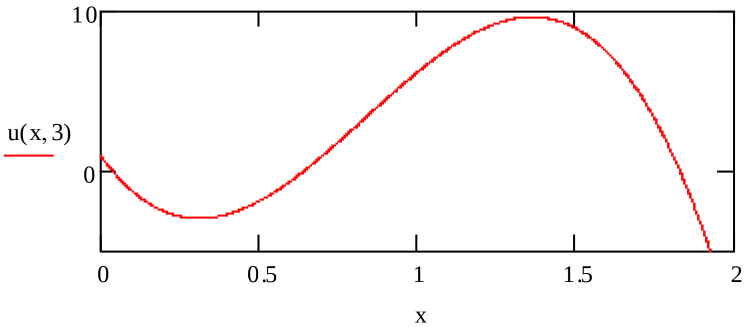
$$S = \begin{pmatrix} 2.499 & -0.677 & -1.039 \\ -1.892 & 1.416 & 1.752 \\ -0.82 & 0.05 & -0.726 \end{pmatrix}$$

$\beta := S$

$$u(x,t) := 1 - x + \sum_{i=1}^{N} \sum_{j=1}^{N} \left(\beta_{i,j} \cdot t^{j} \cdot x^{i}\right)$$







CONCLUSION

The obtained results clarifies, that Rvachev-Obgadze RO method can be used for non-linear tasks of fluid dynamics.

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РЕШЕНИЕ ГИДРОДИНАМИЧЕСКИХ ЗАДАЧ RO-МЕТОДОМ РВАЧЁВА-ОБГАДЗЕ

Т.Обгадзе , О.Кемулария

В работе рассматривается RO-метод Рвачёва-Обгадзе. Строится алгоритм, для построения уравнения многосвязной границы; для этого применяются гомоморфизмы Обгадзе. Разработаны алгоритмы для решения граничных задач, которые проверены решениями ряда тестовых задач на основе Mathcad. Результаты численных расчетов сравниваются с известными точными и численными решениями соответствующих задач. Вычисляются численные значения абсолютной и относительной погрешности в каждой из решенных задач.

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SOLUTION OF THE STATIONARY PROBLEM OF INCOMPRESSIBLE VISCOUS LIQUID FLOW OVER A CYLINDER WITH A ROG METHOD

T. Obgadze*, O. Kemularia**

(Georgian Technical University, Kostava str. 77, Tbilisi 0175, Georgia)

Abstract: *In this work, an algorithm of a numerical solution is created, which determines parameters of stationary flow of a viscous, incompressible fluid around engineering structures, with complex geometrical configuration. For taking into account the condition of fluid's adherence to wall of streamlined structures, RO method of Rvachev-Obgadze is used, and as base functions – regular sources of Obgadze-Gabritchidze OG. Substituting the obtained expansions in the Navier-Stokes equations and satisfying the kinematic conditions, we obtain discrepancies of the problem of flow around structures of a complex geometric forms. The discrepancies obtained for each equation are written in the form $L_2(G)$, where G is a control volume of the flow. The constructed calculation algorithm is based on the Rvachev-Obgadze-Gabritchidze ROG method.*

Key words: *Flow, structure, ROG method*

MATHEMATICAL MODELING OF A STATIONARY FLOW OF A VISCOUS INCOMPRESSIBLE FLUID

Let's consider the problem of a stationary flow around a circular cylinder by a viscous incompressible fluid. This task is 2-dimenstional, therefore mathematical model has a form:

$$u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} = \frac{-\partial p}{\partial x} + \frac{1}{\Re}\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right), \qquad (1)$$

$$u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} = \frac{-\partial p}{\partial y} + \frac{1}{\Re}\left(\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2}\right), \qquad (2)$$

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0, \qquad (3)$$

$$u|_{\partial G} = v|_{\partial G} = 0, \qquad (4)$$

where $G = [-5; 5] \times [-3; 3]$ is a compact space R^2, and ∂G is a boundary of set G;

$(u; v)$-velocity components, p-pressure, $\Re$-Reynold number.

Professor*
Student**

Let us set the kinematic conditions:

$$u(-5;y) = 1 - \frac{1}{9}y^2, v(-5;y) = 0. \tag{5}$$

Kinematic conditions (5) simulates an oncoming flow of a viscous liquid with a parabolic velocity profile in Fig. 1, and boundary conditions (4) - conditions of adhesion of liquid to the walls. Our task is to find the functions: $u(x,y); v(x,y), p(x,y)$ for $\forall(x,y) \in G$.

NUMERICAL METHOD FOR CALCULATING THE DETERMINING PARAMETERS

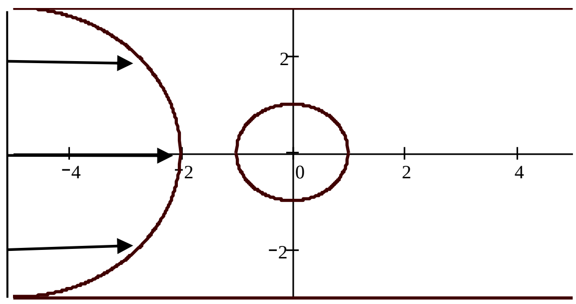

Fig. 1. Scheme for a flow pattern

To solve the problem, we represent the desired functions in the form of expansions:

$$u(x,y,\alpha) = RO(x,y)\sum_i \alpha_i\varphi_i(x,y), \tag{6}$$

$$v(x,y,\beta) = RO(x,y)\sum_i \beta_i\varphi_i(x,y), \tag{7}$$

$$p(x,y,\gamma) = \sum_i \gamma_i\varphi_i, \tag{8}$$

Where $RO(x,y)$ are functions of Rvachev-Obgadze, which becomes equal to zero for all points ∂G of the boundary of the set $G[1-4]$.

In our case, we get

$$RO(x,y) = \frac{(x^2+y^2-1)(9-y^2)}{216}. \tag{9}$$

The denominator 216 is the normalizing factor for $(x^2+y^2-1)(9-y^2)$ on the set G, in other words,

$$max[(x^2+y^2-1)(9-y^2)] = 216. \tag{10}$$

Function $RO(x,y)$ givesthe possibility for calculating (4) boundary conditions for the adhesion of a viscous liquid to the walls of the boundary.

As the basis functions $\varphi_i(x,y)$, regular source functions are used $[1-4]$. To accomplish this, we select the localization points for regular sources(ξ_i,η_i), fig.2.

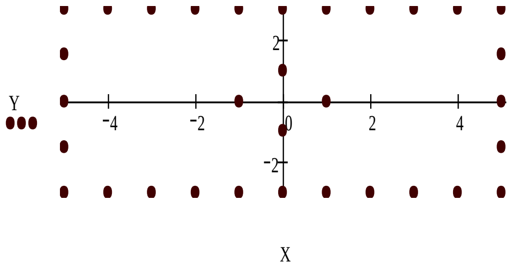

Fig.2. Points of regular source locations (ξ_i,η_i), $i = 1.\acute{3}2$

For solving this task, regular sources of ordinary faces are used:

$$\varphi_i(x,y) = r_i^2 = (x-\xi_i)^2 + (y-\eta_i)^2, \tag{11}$$

Afterwards, we get understanding of determining parameters as:

$$u(x,y,\alpha) = \frac{(x^2+y^2-1)(9-y^2)}{216}\sum_{i=1}^{N}\alpha_i[(x-\xi_i)^2 + (y-\eta_i)^2], \tag{12}$$

$$v(x,y,\alpha) = \frac{(x^2+y^2-1)(9-y^2)}{216}\sum_{i=1}^{N}\beta_i[(x-\xi_i)^2 + (y-\eta_i)^2], \tag{13}$$

$$p(x,y,\gamma) = \sum_{i=1}^{N}\gamma_i[(x-\xi_i)^2 + (y-\eta_i)^2], \tag{14}$$

Where the coefficients of the expansions: $\alpha_i, \beta_i, \gamma_i$ are defined with algorithm:

1. Inserting expressions (12), (13), (14) in (1), (2), (3), (5);
2. Creating the corresponding discrepancies: $R1(x,y,\alpha,\beta,\gamma)$, $R2(x,y,\alpha,\beta,\gamma)$, $R3(x,y,\alpha,\beta), R4(y,\alpha)$, $R5(y,\beta)$;
3. Next, we compose residuals $L_2(G)$:

   $I1(\alpha,\beta,\gamma) = \int_{-3}^{3}\int_{-5}^{5}\left[\left(R1(x,y,\alpha,\beta,\gamma)\right)^2 + \left(R2(x,y,\alpha,\beta,\gamma)\right)^2\right]dxdy;$

   $I2(\alpha,\beta) = \int_{-3}^{3}\int_{-5}^{5}\left[\left(R3(x,y,\alpha,\beta,\gamma)\right)^2\right]dxdy;$

   $I3(\alpha,\beta) = \int_{-3}^{3}((R4(y,\alpha))^2 + (R5(y,\beta))^2)dy;$
4. We make up the total discrepancy:

   $I(\alpha,\beta,\gamma) = I1(\alpha,\beta,\gamma) + I2(\alpha,\beta) + I3(\alpha,\beta);$

5. Further, we minimize the total discrepancy $I(\alpha, \beta, \gamma) \to min$ with conditions $u(-5, y, \alpha) \geq 0.9$ and add the condition of constant flow in the sections $x = -5; x = 0; x = 5.$

As a consequence of solving the problem of conditional minimization, we determine the parameters of the expansion $\alpha_i, \beta_i, \gamma_i$.

RESULTS OF THE CALCULATIONS

After determining optimal values of the defining parameters(table 1.), we obtain formulas for semi-analytical solution of our task.:

$$u(x, y, \alpha) = \frac{(x^2+y^2-1)(9-y^2)}{216} \sum_{i=1}^{N} \alpha_i [(x-\xi_i)^2 + (y-\eta_i)^2], \quad (15)$$

$$v(x, y, \alpha) = \frac{(x^2+y^2-1)(9-y^2)}{216} \sum_{i=1}^{N} \beta_i [(x-\xi_i)^2 + (y-\eta_i)^2], \quad (16)$$

$$p(x, y, \gamma) = \sum_{i=1}^{N} \gamma_i [(x-\xi_i)^2 + (y-\eta_i)^2], \quad (17)$$

Using the *Mathcad* software, we calculate velocity and pressure fields in the flow region of a viscous, incompressible fluid.

$\alpha =$

	1
1	0.015
2	0.315
3	0.005
4	-0.019
5	0.015
6	-0.028
7	-0.002
8	-0.079
9	-0.01
10	-0.096
11	-0.01
12	-0.078
13	-0.002
14	-0.027
15	0.015
16	0.313
17	0.005
18	-0.019
19	0.015
20	-0.029
21	-0.002
22	-0.081
23	-0.011
24	-0.098
25	-0.011
26	-0.081
27	-0.003
28	-0.03
29	-0.02
30	-0.121
31	-0.02
32	-0.126

$\beta =$

	1
1	-0.021
2	-0.053
3	0.004
4	-0.021
5	0.005
6	-0.022
7	0.009
8	-0.01
9	0.01
10	-0.01
11	0.008
12	-0.018
13	0.006
14	-0.023
15	0.004
16	-0.025
17	0.005
18	-0.034
19	0
20	-0.012
21	0.012
22	0.014
23	0.016
24	0.014
25	0.014
26	0.004
27	0.012
28	0.026
29	0.027
30	0.079
31	0.032
32	0.068

$\gamma =$

	1
1	0.011
2	-0.005
3	0.011
4	-0.005
5	0.011
6	-0.006
7	0.011
8	-0.008
9	0.01
10	-0.011
11	0.01
12	-0.013
13	0.009
14	-0.015
15	0.008
16	-0.016
17	0.008
18	-0.016
19	0.008
20	-0.015
21	0.009
22	-0.013
23	0.01
24	-0.01
25	0.01
26	-0.008
27	0.011
28	-0.006
29	0.01
30	-0.011
31	0.01
32	-0.01

Table 1. Optimal values for the coefficients of expansion

We obtain vector field of flow region Fig. 3:

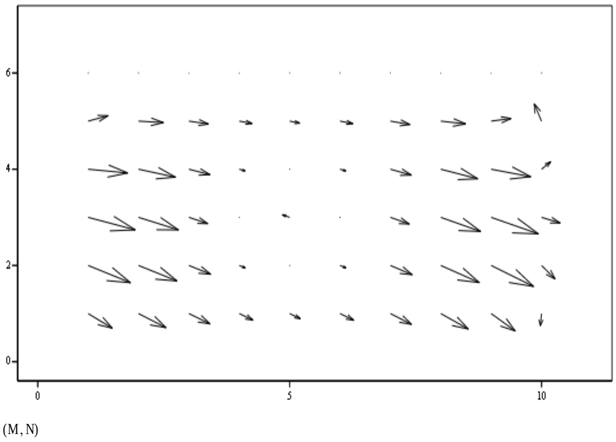

Fig. 3. Vector field of the flow with Reynolds number of 5000

And for different sections of the flow, the velocity components change according to the following rule, fig. 4-8

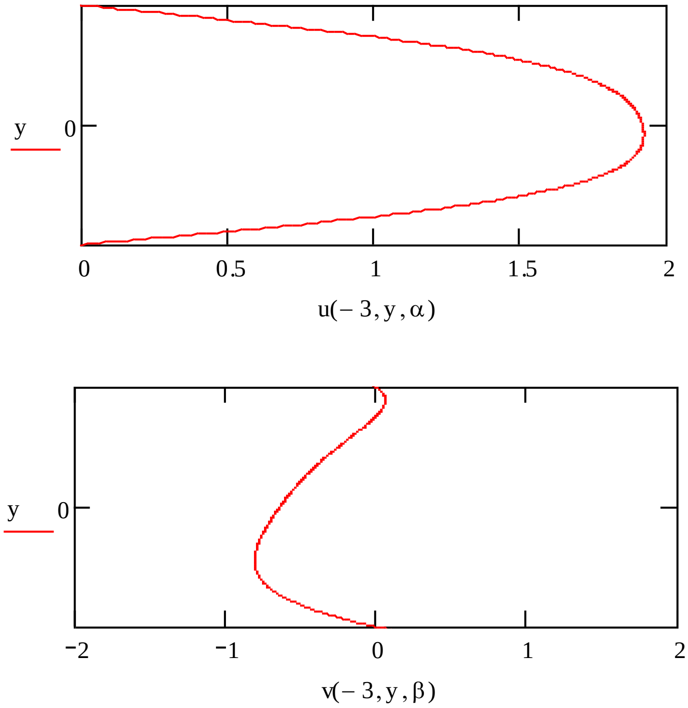

Fig. 4. Velocity components at $x = -3$

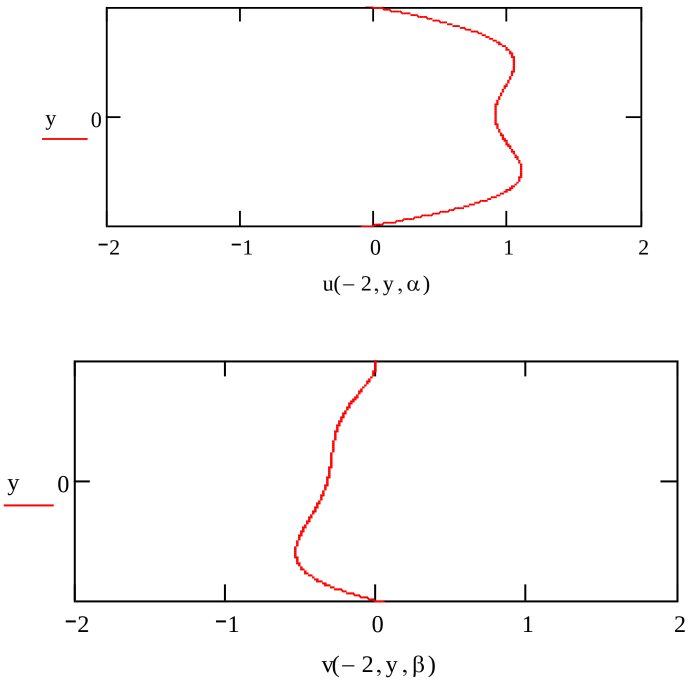

Fig. 5. Velocity components at $x = -2$

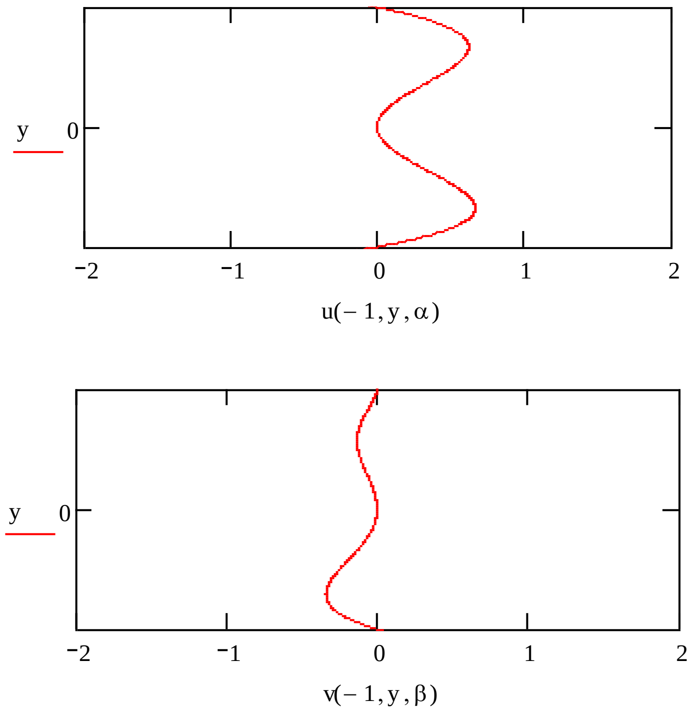

Fig. 6. Velocity components at $x = -1$

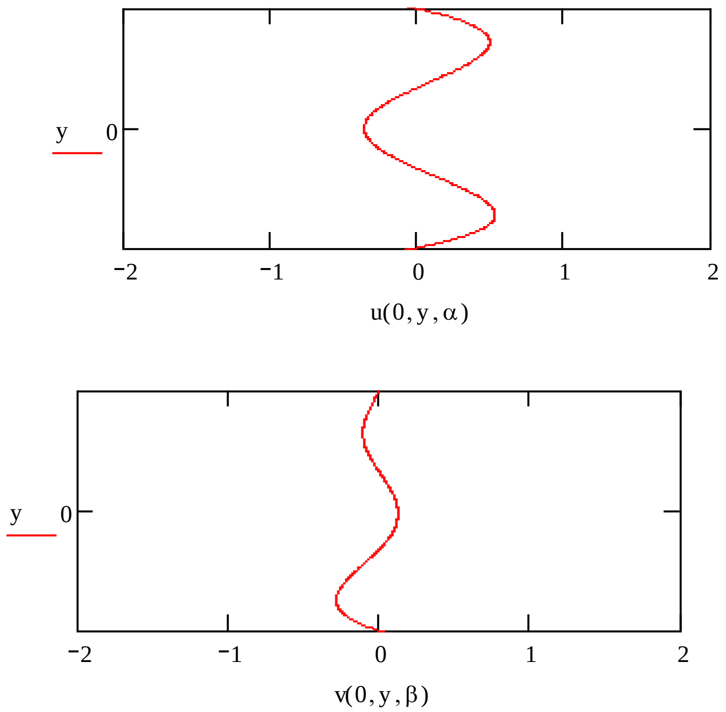

Fig. 7. Velocity components at $x = 0$

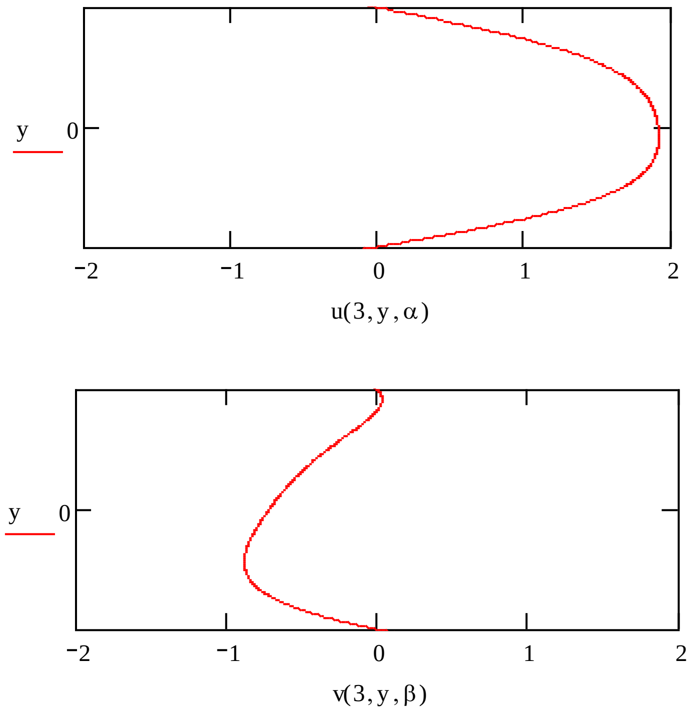

Fig. 8. Velocity components at $x = 3$

As is clear from comparing the calculation results with the known results of calculations by other methods and with the results of known experiments [5-8], the ROG method works well for stationary problems.

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РЕШЕНИЕ СТАЦИОНАРНОЙ ПРОБЛЕМЫ НЕПРЕРЫВНОГО ВЯЗКОГО ПОТОКА ЖИДКОСТИ НА ЦИЛИНДРЕ С МЕТОДОМ ROG

Т.Обгадзе, О.Кемулария

В работе строится алгоритм, численный расчет определяющих параметров стационарного потока вязких, несжимаемых жидких круглых инженерных сооружений, сложная геометрическая конфигурация. Для учета состояния прилипания жидкости к стенкам обтекаемых конструкций применяется метод RO Рвачева-Обгадзе и как основные функции, используются регулярные источники Обгадзе-Габричидзе О.Г. Подставляя указанное разложение в уравнения Навье-Стокса и удовлетворяя кинематическим условиям, мы получаем не вязание задачи о потоке конструкций сложной геометрической формы. Полученное не вязание для каждого уравнения записывается по норме $L_2(G)$, где G-область исследуемого тока. Построенный алгоритм расчета основан на методе ROG метода Рвачева-Обгадзе-Габричидзе.

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MATHEMATICAL MODELING OF WAVE DISTRIBUTION BASED ON EXACT SOLUTIONS OF NAVIER-STOKES EQUATIONS

T.A.Obgadze*
(Georgian Technical University, Kostava str. 77, Tbilisi 0175, Georgia)

Abstract: *In the paper, based on the two-dimensional Navier-Stokes equations for a viscous incompressible fluid, the propagation and gradual, slow damping of tsunami waves are modeled. Exact solutions of the two-dimensional Navier-Stokes equations that describe the propagation of tsunami waves are found. Based on the generalization of the approach, for finding the exact solution of the Navier-Stokes equations, solutions which describe the dynamics of progressive waves of a viscous incompressible fluid are found*.

Keywords: *Mathematical Modeling, Navier-Stokes, Wave, Fluid Dynamics*

INTRODUCTION

Earlier, equations have been constructed for modeling tsunami waves, which were reduced to the Korteweg–de Vries equations [1]. However, we succeeded in finding the exact solution of the two-dimensional Navier-Stokes equations for a viscous incompressible fluid, which allows us to take a fresh look at the problem of the propagation and attenuation of tsunami waves. Based on the developed approach, we find the exact solutions describing the propagation of progressive waves.

MATHEMATICAL MODEL AND EXACT SOLUTIONS OF THE TWO-DIMENSIONAL NAVIER-STOKES EQUATIONS

Consider the two-dimensional flow of a viscous incompressible fluid. The corresponding equations acquire a form:

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} = -\frac{\partial p}{\partial x} + \frac{1}{Re}\Delta u, \quad (1)$$

$$\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} = -\frac{\partial p}{\partial y} + \frac{1}{Re}\Delta v, \quad (2)$$

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0. \quad (3)$$

As usual, boundary and initial conditions are added to this equation system. We act differently. In the beginning, we find exact solutions of a certain type in a general form, and then we will consider the behavior of the solution in various special cases.

Professor*

We start with the consideration of equation (3). It's clear, that for each continuous function $\varphi(x-y)$ this equation (3) is satisfied, on the other hand, as we already know from work [1], for Navier-Stokes equations characteristically, solution expansion by law $e^{-\frac{t}{Re}}$, therefore, naturally, we seek the exact solution of equations (1),(2),(3) in the form:

$$u(x,y,t)=\varphi(x-y)e^{-\frac{t}{Re}}, \quad (4)$$

$$v(x,y,t)=\varphi(x-y)e^{-\frac{t}{Re}}. \quad (5)$$

The representation of the solution in the form (4), (5) satisfies equation (3), and the substitution in (1), (2) gives equations (6), (7), where $q=x-y$:

$$-\frac{1}{Re}\varphi(q)e^{-\frac{t}{Re}}=-\frac{\partial p}{\partial x}+\frac{2}{Re}\varphi''_{qq}(q)e^{-\frac{t}{Re}}, \quad (6)$$

$$-\frac{1}{Re}\varphi(q)e^{-\frac{t}{Re}}=-\frac{\partial p}{\partial y}+\frac{2}{Re}\varphi''_{qq}(q)e^{-\frac{t}{Re}}. \quad (7)$$

To eliminate the pressure from equations (6),(7), we differentiate equation (6) with respect to y, and equation (7) – with respect to x. Subtracting from the second equation - the first, we obtain an equation for determining the form of the function $\varphi(q)$:

$$2\varphi'''_{qqq}(q)+\varphi'_q(q)=0. \quad (8)$$

The general solution of equation (8) has the form:

$$\varphi(q)=\alpha+\beta\cos\frac{x-y}{\sqrt{2}}+\gamma\sin\frac{x-y}{\sqrt{2}}. \quad (9)$$

Thus, the exact solutions of the two-dimensional Navier-Stokes equations are obtained in the form of slowly damped tsunami waves:

$$u(x,y,t)=\left(\alpha+\beta\cos\frac{x-y}{\sqrt{2}}+\gamma\sin\frac{x-y}{\sqrt{2}}\right)e^{-\frac{t}{Re}}, \quad (10)$$

$$v(x,y,t)=\left(\alpha+\beta\cos\frac{x-y}{\sqrt{2}}+\gamma\sin\frac{x-y}{\sqrt{2}}\right)e^{-\frac{t}{Re}}. \quad (11)$$

EXACT SOLUTIONS FOR PROGRESSIVE WAVES

Let us consider the case of progressive waves. In this case, the time dependence of the solution is unknown. Therefore, consider the general representation of the solution of the Navier-Stokes equations in the form:

$$u(x,y,t) = \varphi(x-y)\sigma(t), \tag{12}$$

$$v(x,y,t) = \varphi(x-y)\sigma(t). \tag{13}$$

The representation of the solution in the form (12), (13) satisfies equation (3), and the substitution in (1), (2) gives equations (14),(15), where $q = x - y$:

$$\varphi(q)\sigma'(t) = -\frac{\partial p}{\partial x} + \frac{2}{Re}\varphi''_{qq}(q)\sigma(t), \tag{14}$$

$$\varphi(q)\sigma'(t) = -\frac{\partial p}{\partial y} + \frac{2}{Re}\varphi''_{qq}(q)\sigma(t). \tag{15}$$

To eliminate the pressure from equations (14),(15), we differentiate equation (14) with respect to y, and equation (15) – with respect to x. Subtracting the first equation from the second one, we obtain equation (16) for determining the form of the functions $\varphi(q)$ and $\sigma(t)$:

$$\frac{2\varphi'''_{qqq}(q)}{\varphi'_q(q)} = \frac{\sigma'(t)\cdot Re}{\sigma(t)} = \lambda_0 = const. \tag{16}$$

It is clear that from formula (16) it is possible to obtain a solution **for damped tsunami waves (10), (11)** in the case when$\lambda_0 = -1$.

If $\lambda_0 > 0$ **progressive waves** are produced:

$$u(x,y,t) = \left(\alpha + \beta\cosh\left(\sqrt{\frac{\lambda_0}{2}}\cdot(x-y)\right) + \sinh\left(\sqrt{\frac{\lambda_0}{2}}\cdot(x-y)\right)\right)e^{\frac{\lambda_0}{Re}t}, \tag{17}$$

$$v(x,y,t) = \left(\alpha + \beta\cosh\left(\sqrt{\frac{\lambda_0}{2}}\cdot(x-y)\right) + \sinh\left(\sqrt{\frac{\lambda_0}{2}}\cdot(x-y)\right)\right)e^{\frac{\lambda_0}{Re}t}. \tag{18}$$

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МАТЕМАТИЧЕСКОЕ МОДЕЛИРОВАНИЕ РАСПРСТРАНЕНИЯ ВОЛН НА ОСНОВЕ ТОЧНЫХ РЕШЕНИЙ УРАВНЕНИЙ НАВЬЕ-СТОКСА

Т.Обгадзе

В работе на основе двумерных уравнений Навье-Стокса, для вязкой несжимаемой жидкости, моделируется распространение и постепенное, медленное затухание волн цунами. Найдены точные решения двумерных уравнений Навье-Стокса, которые описивают распространение волн цунами. На основе обобщения подхода, к нахождению точного решения уравнений Навье-Стокса, наидены решения для описания динамики прогрессирующих волн вязкой несжимаемой жидкости.

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HARMONIC WAVES IN ELASTIC ISOTROPIC WEDGE

M.Vazagashvili*

(Georgian Technical University, 77, M. Kostava str., Tbilisi 015, Georgia)

Abstract: *Is offered the method of analytical description of wave field in the elastic wedge. Is carried out the analysis of wave field in the orthogonal wedge and is researched the dependence of phase velocity of angular mode from coefficient of Poisson*

Keywords: *angular mode; extrude; phase velocity; elastic body; oscillations, wedge.*

INTRODUCTION

Lot of quantity results, related to research of character of motion on the localized in adjacent of vertexes of wedge of wave (angular) mode, are obtained with application of approximation approaches based on finite elements method [1] and variation principles [2]. However, as it was mentioned in the work [3], the analytical theories of wedge-shaped waveguide up to nowadays are not existing. The consideration of these issues [4, 5] stimulates the works on construction of exact solution of corresponding boundary-valued task. The specific computations are carried out with respect of case of wedge with right angle at vertex. In the case of arbitrary angle, the idea of construction of general solution upon the same is applied.

BASIC PART

The principal difficulties of stated task is rather clear if consider its obvious relation with task on research of distributed in the wedge harmonic waves [6].

The task is formulated as follow. The isotropic elastic body with velocities of wave's propagation c_1 and shear c_2 is arranged in the domain $x_1 \geq 0$, $x_2 \geq 0$, $-\infty < x_1 < \infty$ in the orthogonal Cartesian system $0x_1x_2x_3$. Is necessary to determine if are existing in the such body the progressive along the axis $0x_3$ waves that are localized in adjacent of rib and such are their properties.

***Professor**

The search of free progressive waves in the stated task obviously is equivalent to search of resonance situations in the certain task on forced motions of waveguide. If we consider the boundary conditions for mechanical stresses σ:

$$\begin{aligned}&\frac{1}{2G}\sigma_{11} = f(x_2)exp[i(vx_3 - \omega t)]; \quad \frac{1}{2G}\sigma_{12} = \frac{1}{2G}\sigma_{13} = 0; \quad x_1 = 0;\\ &\frac{1}{2G}\sigma_{22} = g(x_1)exp[i(vx_3 - \omega t)]; \quad \frac{1}{2G}\sigma_{31} = \frac{1}{2G}\sigma_{33} = 0; \quad x_3 = 0,\end{aligned} \tag{1}$$

where G – is the shear modulus, where with respect of functions f and g is supposed their represent ability by Fourier integrals in the common sense, the issue on existing the free waves is reduced to search of values of wave number v, at that the solution of task for stated angular frequencyω does not exists. As additional condition, there is the requirement of localization of wave field in adjacent of rib of wedge.

The sufficient functional arbitrariness in the presentation of scalar and vector potentials for execution of boundary conditions (1) we will obtain as:

$$\Phi(\bar{x}_1, \bar{x}_2) = \frac{1}{2}\left[\int_0^\infty F(s)e^{-p_1\bar{x}_2}\cos sx, ds + \int_0^\infty H(r)e^{-q_1\bar{x}_1}\cos r\bar{x}_2\, dr\right];$$

$$A_\alpha(\bar{x}_1, \bar{x}_2) = \frac{1}{\gamma^2 i}\left[\int_0^\infty B_\alpha(s)e^{-p_2\bar{x}_2}\begin{Bmatrix}\cos s\,\bar{x}_1\\ \sin s\bar{x}_1\end{Bmatrix}ds + \right. \tag{2}$$

$$\left. + \int_0^\infty C_\alpha(r)e^{-q_2\bar{x}_1}\begin{Bmatrix}\cos r\,\bar{x}_2\\ \sin r\bar{x}_2\end{Bmatrix}dr\right].$$

The upper values of functions in the curly brackets will be responsible for α=1, the lower −α=2; $F(s)$, $H(r)$, $B_\alpha(s)$, $C_\alpha(r)$– are the desired arbitrary functions

$$p_\alpha^2 = 1 + s^2 - \frac{C^2}{C_\alpha^2}; \quad q_\alpha^2 = 1 + r^2 - \frac{C^2}{C_\alpha^2}.$$

Form the expressions for potentials (2) easily are calculated the values of shear and stresses. The execution of boundary conditions (1) for shear forces leads to the following equalities:

$$\begin{aligned}
&\sigma_{12}|_{\bar{x}_1=0} = 0 => H(r)q_1 r + C_1(r)q_2\frac{q_2^2+r^2-1}{2} + C_2(r)\frac{q_2^2+r^2+1}{2} = 0;\\
&\sigma_{13}|_{\bar{x}_1=0} = 0 => H(r)q_1 + C_1(r)q_2 r + C_2(r)\frac{q_2^2+r^2+1}{2} = 0;\\
&\sigma_{23}|_{\bar{x}_2=0} = 0 => F(s)p_1 + B_1(s)\frac{p_2^2+s^2+1}{2} - B_2(s)p_2(s) = 0;\\
&\sigma_{21}|_{\bar{x}_2=0} = 0 => F(s)p_1 s - B_1(s)s\frac{p_2^2+s^2+1}{2} - B_2(s)p_2\frac{p_2^2+s^2-1}{2} = 0.
\end{aligned} \tag{3}$$

From them is clear that

$$\begin{aligned}
&C_1(r) = 0; \qquad B_2(s) = 0\\
&F(s) = B_1(s)\frac{p_2^2+s^2+1}{2}; \quad H(r) = -C_2(r)\frac{q_2^2+q^2+1}{2q_1}.
\end{aligned} \tag{4}$$

The satisfaction of boundary conditions for normal stresses σ_{11}, σ_{12} with taking into account (4) and representation of

$$e^{-\alpha z} = \frac{2}{\pi}\int_0^\infty \frac{a^2}{u^2+a^2}\cos uzdu \tag{5}$$

leads to simultaneous integral equations

$$\begin{aligned}
&x(s)\Delta(s) + \frac{C^2}{2\pi c_2^2(1-v)}\int_0^\infty \frac{y(r)r^2}{(1+r^2)(r^2+p_1^2)}\left[\frac{2s^2}{r^2+n^2} + v\frac{2-\frac{C^2}{C_2^2}}{r^2}\right]dr - \bar{g}(s);\\
&y(r)\Delta(r) + \frac{C^2}{2\pi c_2^2(1-v)}\int_0^\infty \frac{x(s)s^2}{(1+s^2)(s^2+q_1^2)}\left[\frac{2r^2}{s^2+q_2^2} + v\frac{2-\frac{C^2}{C_2^2}}{s^2}\right]ds = \bar{f}(r),
\end{aligned} \tag{6}$$

where

$$\begin{aligned}
&x(s) = -B_1(s)(1+s^2); \qquad y(r) = C_2(r)(1+r^2);\\
&\Delta(s) = p_2 - \frac{(p_2^2+s^2+1)^2}{4p_1(1+s^2)}; \qquad \Delta(r) = p_2 - \frac{(q_2^2+r^2+1)^2}{4q_1(1+r^2)};\\
&\bar{f}(r) = \frac{2}{\pi}\int_0^\infty f(\bar{x}_2)\cos r\bar{x}_2 d\bar{x}_2; \quad \bar{g}(r) = \frac{2}{\pi}\int_0^\infty g(\bar{x}_2)\cos s\bar{x}_2 d\bar{x}_2;
\end{aligned} \tag{7}$$

where v– is the Poisson coefficient of wedge material.

The dimensionless (with respect of γ) components of amplitude of displacements vector are determined due densities $x(s)$ and $y(r)$ by relations

$$\bar{u}_1(\bar{x}_1,\bar{x}_2)=\int\limits_o^\infty \frac{x(s)s}{1+s^2}\left(\frac{p_2^2+s^2+1}{2p_1}e^{-p_1\bar{x}_2}-p_2e^{-p_2\bar{x}_2}\right)\sin s\bar{x}_1 ds+$$
$$+\int\limits_o^\infty \frac{y(r)}{1+r^2}\left[\frac{q_2^2+r^2+1}{2}e^{-q_1\bar{x}_2}-(1+r^2)e^{-q_2\bar{x}_2}\right]\cos r\bar{x}_2 dr\,;$$
$$\bar{u}_2(\bar{x}_1,\bar{x}_2)=\int\limits_o^\infty \frac{x(s)s}{1+s^2}\left[\frac{p_2^2+s^2+1}{2p_1}e^{-p_1\bar{x}_2}-(1+s^2)e^{-p_2\bar{x}_2}\right]\sin s\bar{x}_1 ds+$$
$$+\int\limits_o^\infty \frac{y(r)}{1+r^2}\left(\frac{q_2^2+r^2+1}{2q_1}e^{-q_1\bar{x}_2}-q_2e^{-q_2\bar{x}_2}\right)\cos r\bar{x}_2 dr\,; \tag{8}$$
$$\bar{u}_3(\bar{x}_1,\bar{x}_2)=i\int\limits_o^\infty \frac{x(s)s}{1+s^2}\left(p_2e^{-p_2\bar{x}_2}-\frac{p_2^2+s^2+1}{2p_1}e^{-p_1\bar{x}_2}\right)\sin s\bar{x}_1 ds+$$
$$+i\int\limits_o^\infty \frac{y(r)}{1+r^2}\left(q_2e^{-q_2\bar{x}_1}-\frac{q_2^2+r^2+1}{2}e^{-q_1\bar{x}_1}\right)\cos r\bar{x}_2 dr\,.$$

In the general case of wave field in the wedge at application of solution in the forms (8) is necessary to generate the laws of computation of Fourier integral for case of existence of progressive waves. In the considered special case of angular modes the localization of field means that infinite integrals (8) would be own. This excludes the possibility of existence of exponentially increasing with growth of $\bar{x}_1$ and $\bar{x}_2$ displacements as well as running along the axes $0\bar{x}_1$ and $0\bar{x}_2$ waves. The first condition would be satisfied if

$$C<C_1;\quad C<C_2. \tag{9}$$

For satisfaction of the second condition and for providing of possibility of existence of smooth solutions of system (6) is necessary that values $\Delta(s)$ and $\Delta(r)$ does not becomes in zero along the real line. Due this we obtain the additional limitation of phase velocity of progressive angular waves as

$$C<C_2\,, \tag{10}$$

i.e. the angular modes in the wedge (if they exists) will have the phase velocity less the Relay wave velocity.

CONCLUSIONS

For solution of system (6) and further analysis of kinematics of motion in the angular mode useful is the knowledge of asymptotic properties of unknowns $x(s)$ and $y(r)$ at large values of arguments. These properties are expressed by equality

$$\lim_{s\to\infty} x(s) = -\lim_{r\to\infty} y(r) = a_0 = const \qquad (11)$$

that is valid at conditions that functions $\bar{f}(r)$ and $\bar{g}(s)$ are decreasing not slow then $1/_{r^2}$ and $1/_{s^2}$ accordingly [7]. The relation (110 will be important at analysis of mode of deformation of waveguide as well as at development of effective algorithm of solution of system (6).

At transition to integrals in the finite limits will be accepter the conditions

$$x(s) = a_0(s > p); \quad y(r) = -a_0(r > p); \quad a_0 = \frac{x(p) - y(p)}{2}. \qquad (12)$$

After the solution of obtained in such manner finite system easily will be computed all characteristics of wave field.

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ГАРМОНИЧЕСКИЕ ВОЛНЫ В УПРУГОМ ИЗОТРОПНОМ КЛИНЕ

М. Вазагашвили

Предложен способ аналитического описания волнового поля в упругом клине, Проведён анализ волнового поля в прямоугольном клине и исследована зависимость фазовой скорости угловой моды от коэффициента Пуассона.

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LEADING AVIA COMPANIES ADVANTAGES IN THE WORLD

N. Jerenashvili*, A. Kurtanidze*
(Georgian Technical University, 77, M. Kostava str., Tbilisi, 0175. Georgia)
(Georgian Aviation University, 16,KetevanTsamebuliave. Tbilisi, 0103. Georgia)

Abstract: *Aviation is the practical aspect or art of aeronautics, production, development, especially heavier than air aircraft.The airline industry exists in an intensely competitive market. In recent years, there has been an industry-wide shakedown, which will have far-reaching effects on the industry's trend towards expanding domestic and international services.*

Keywords: *Aviation; Industry; companies; airlines;*

INTRODUCTION

In the past, the airline industry was at least partly government owned. This is still true in many countries, but in the U.S. all major airlines have come to be privately held.

In recent years, the European airline industry has exhibited impressively dynamics. Legal and institutional aspects have clearly affected the structure of the market, while cultural forces have influenced spatial mobility and its characteristics. The airline industry, therefore, certainly has progressed. It has also altered the way in which people live and conduct business by shortening travel time and altering our concept of distance, making it possible for us to visit and conduct business in places once considered remote.

BASIC PART

The airline industry can be separated into four categories by the U.S. Department of Transportation (DOT): **International** - 130+ seat planes that have the ability to take passengers just about anywhere in the world. Companies in this category typically have annual revenue of $1 billion or more[2]

Proffesor*
Associate proffesor**

***National** - Usually these airlines seat 100-150 people and have revenues between $100 million and $1 billion.

- **Regional** - Companies with revenues less than $100 million that focus on short-haul flights.
- **Cargo** - These are airlines generally transport goods.
- [http://www.investopedia.com/features/industryhandbook/airline.asp]

The leading consumer-aviation website Skytrax made ranking which are based on the impressions of 19.2 million travelers from 104 different countries. The survey, which covered more than 280 airlines, measured 41 parameters ranging from boarding procedures to seat comfort to the quality of service. [1] Emirates has been named the best airline in the world for 2016 by The Dubai-based airline was presented with the award on Tuesday at a ceremony during the 2016 Farnborough Airshow.

Here are the 20 best airlines in the world, according to the results of the Skytrax survey:

20. Bangkok Airways [2]

Bangkok Airways crack the top 20, it was also awarded with the titles of World's Best Regional Airline and Best Regional Airline in Asia.

19. Austrian Airlines

Economy fliers gave the Star Alliance member high marks for its efficient and effective service, as well as for the wealth of onboard dining and entertainment options.

18. Virgin Australia

In typical Virgin fashion, the airline's fleet of long-haul Boeing 777 and Airbus A330 jets come with interior mood lighting and feature a state-of-the-art 9-inch touchscreen entertainment system.

17. Air New Zealand

This the fifth time that Air New Zealand has won for Best Premium Economy.

16. Asiana

Asiana currently operates a fleet of relatively new Airbus and Boeing jets.

15. Swiss International Air Lines

Though some fliers found economy-seat comfort to be lacking, most praised the cabin crew for its friendly service and the airline for its wide assortment of complimentary adult beverages.

14. Air France

This year, Air France also won the awards for Best First Class Airline Lounge Dining and Best First Class Comfort Amenities. [1]

13. Thai Airways

Thai Airways took home the award for World's Most Improved Airline as well as the title for World's Best Airline Spa Facilities.

12. Hainan Airlines

Reviewers on Skytrax praised the airline for its attentive service and quality business class accommodations.

11. Garuda Indonesia

This year, Garuda's flight attendants took home the award for the World's Best Cabin Crew.

10. Lufthansa

The German national airline also took home the prize for Best Transatlantic Airline and Best Airline in Western Europe.

9. Qantas

The airline received praise for its strong customer service and in-flight entertainment.

8. EVA Air

EVA also took home the prize for the World's Best Transpacific Airline.

7. Turkish Airlines

The airline is a member of Star Alliance and has won the Skytrax award for Best Airline in Europe six years in a row.

6. Etihad Airways

The airline has become famous for its trademark Residence flying apartments as well as its plush first-class and business-class suites.

5. All Nippon Airways

ANA won World's Best Airport Services and Best Airline Staff Service in Asia.

4. Cathay Pacific Airways

Cathay is one of the finest flying experiences in Asia.

3. Singapore Airlines

The airline's home base at Changi International Airport is one of the finest facilities in the world and has been named by Skytrax as the Best Airport in the World four years in a row.

2. Qatar Airways

The airline links over 125 destinations across the globe and is expanding its services from Qatar to 50 new destinations, including direct flights to Los Angeles, Miami, and Dallas.

1. Emirates

Emirates has taken home Skytrax's award for Best In-Flight Entertainment 12 years running.

Business travelers are important to airlines because they are more likely to travel several times throughout the year and they tend to purchase the upgraded services that have higher margins for the airline. [5] On the other hand, leisure travelers are less likely to purchase these premium services and are typically very price sensitive. In times of economic uncertainty or sharp decline in consumer confidence, you can expect the number of leisure travelers to decline. [4]

It is also important to look at the geographic areas that an airline targets. Obviously, more market share is better for a particular market, but it is also important to stay diversified.

CONCLUSIONS

After our in-depth analysis, we have determined that the airline industry is a very unattractive industry to enter into. The current ratio between airlines and the people willing to travel is very balanced so it would not be profitable for a new company to enter into the market. The initial capital needed, as well as the customer base, is very hard to achieve when the industry itself is in the maturity stage. It is for these reasons that the industry is labeled as unattractive.

A final key area to keep a close eye on is costs. The airline industry is extremely sensitive to costs such as fuel, labor and borrowing costs. If you notice a trend of rising fuel costs, you should factor that into your analysis of a company. Fuel prices tend to fluctuate on a monthly basis, so paying close attention to these costs is crucial.

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ПРЕИМУЩЕСТВО ВЕДУЩИХ АВИАКОМПАНИЙ В МИРЕ

Н. Джеренашвили, А. Куртанидзе

Авиация - это отрасль деятельности человечества, связанная с полётом летательных аппаратов,теория и практика полёта по воздуху на летательных аппаратах тяжелее воздуха.Авиационная промышленность существует на рынке с интенсивной конкуренцией. В последние годы произошел обвал в масштабах всей отрасли, который окажет далеко идущее влияние на тенденцию отрасли к расширению внутренних и международных услуг.

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SUMMARIES

WIRLESS NETWORKS, THEIR TYPE AND METHODS OF USE **O. Shonia, I. Kartvelishvili, Z. Beridze, I. Didmanidze, L. Kolbaia. "**Air Transport". Tbilisi, 2017, № 1(12), pp. 11-16 (Eng).

In this work, basic information about the technologies and components of the wireless computer networks are represented. All types of wireless networks (personal, local, regional and global) are discussed briefly and the features of their structure and methods of use are described.

ANALYSIS OF PLATES THAT ARE REINFORCED BY THIN CURVILINEAR VARIABLECROSS-SECTION RODS. **G. Kipiani, G. Okropiridze, V. Sulashvili. "**Air Transport". Tbilisi, 2017, № 1(12), pp. 17-23 (Eng).

Are derived the general conditions of conjugation of plates with displaced medieval surface by thin variable stiffness rib. From these conditions, in particular, follows the conditions of joint deformation of plates with small depth extrudes, as well as various kinds of conditions of seam of plates with variable stiffness ribs that are applied in the work at solution of tasks of analysis and rational design of thin-walled structures.

CALCULATION OF PLATES AND SHELLS WITH RIBSRIGIDITY BY THE FINITE ELEMENT METOD. **G. Kipiani, M. Tsikarishvili, S. Bliadze, U. Dzodzuashvili. "**Air Transport". Tbilisi, 2017, № 1(12), pp. 24-30 (Eng).

In this article, the development of the stages of calculating plates and shells with stiffeners is described. It is noted that the theory of ribbed shells is one of the most controversial and incomplete sections of the general theory of shells.We consider shell calculations with longitudinal and transverse stiffeners by the finite element method. In the first embodiment, the stiffener is considered as a beam end element, In the second case, the edges are approximated as thin-walled plates and, finally, in the third case, the edge is represented as a three-dimensional finite element.A comparative analysis of the theoretical and experimental results is given.

PROBLEMS AND PROSPECTS OF DEVELOPMENT MANAGEMENT INTELLECTUAL POTENTIAL AIR ENTERPRISE. **M. Pimzhyna, V. Novak, E. Razumova. "**Air Transport". Tbilisi, 2017, № 1(12), pp. 31-36 (Eng).

As a result of analysis of works of leading domestic and foreign scientists, we summarized the main factors positively influencing the formation and development of intellectual potential of the enterprises, as well as the proposed measures are necessary for the successful development of the intellectual potential of air transport enterprises.

PERSPECTIVE DIRECTIONS OF DEVELOPMENT OF THE TRANSPORT SYSTEM TAKING INTO ACCOUNT THE STRATEGIC PRIORITIES OF THE NATIONAL ECONOMY. **O. Kyrylenko, O. Ilienko, V. Novak, O. Krapko. "**Air Transport". Tbilisi, 2017, № 1(12), pp. 37-44 (Eng).

This article examines the processes of harmonization of economic and legal bases of functioning of the transport system of Ukraine, which theoretically will allow access of our country to advanced European technology and investment, the main challenges for effective harmonisation of integration processes, namely the need to ensure the conformity of the national transport system of high standards and technical requirements of the transport markettaking into account he perspectivies of the national economy.

FEATURES OF RISK MANAGEMENT IN AIRLINES **V. Novak, I.A. Basaraba, V. Perederii** **"**Air Transport". Tbilisi, 2017, № 1(12), pp. 45-49 (Eng).

Problems of application of risk management in airlines are considered in the article . It was described the main causes and principles of application of risk management that are based on the analysis, generalization and systematization of scientific sources. It was determinated the main goals and objectives of risk management and formed approaches of risk management in airlines.

PREREQUISITES OF FORMING UNIVERSAL MECHANISMS TO OPTIMIZE PRODUCTION AND LOGISTIC ACTIVITY OF AIR CARRIERS IN ORGANIZING MULTIMODAL DELIVERY OF OVERSIZED CARGO **S**. **Lytvinenko. "**Air Transport". Tbilisi, 2017, № 1(12), pp. 50-55 (Eng).

The article investigates the prerequisites for creating universal mechanisms to optimize production and logistic activities of air carriers in the organization of multimodal delivery of oversized cargo. It was proved that such a need may arise for air carriers exclusively on delivery of oversized cargo in multimodal connection, wherein the air carrier acts as 3PL provider for a time.

PROVIDING AIR ENTERPRISES' BUSINESS EXCELLENCE THROUGH STRATEGIC LEADERSHIP DEVELOPMENT. **L.Lytvinenko. "**Air Transport". Tbilisi, 2017, № 1(12), pp. 56-62(Eng).

In the article the role and basic terms of the air enterprise strategic leadership development were determined and analyzed. Interconnection between application of strategic leadership and business excellence indicators of the air enterprise was studied. It was identified that leadership approach to management allows achieving long-term goals of the air enterprise development through the implementation of strategic changes necessary for a more effective economic activity performance in the face of uncertainty and dynamic factors of the environment, while maintaining a sufficient level of flexibility and agility.

SYSTEM MODELING OF MARKETING INTERNATIONAL BUSINESS SECURITY. **O. Ilienko. "**Air Transport". Tbilisi, 2017, № 1(12), pp. 63-70 (Eng).

The article considers the model of construction of such concepts as: " marketing strategy global economic security of subjects of international entrepreneurship" and "marketing for international business", as well as the urgency of the need to create a new concept of "marketing international business security", justified by the existing conditions of the development of the world economy, which today is very complex and not stable.

TO THE PROBLEM OF PROVIDING ECONOMIC SECURITY ON ENTERPRISE. **E. Danilova.** “Air Transport”. Tbilisi, 2017, № 1(12), pp. 71-76 (Eng).

In the article the types of economic security of the enterprise considered, the effect of the region and the state as a whole on the formation process of economic security of the enterprise analyzed, and also investigated the effect of other factors and threats (external and internal), which can be a barrier to the effective development of the company.

DETERMINATION OF THE MAXIMUM RUNNING SPEED. **A.Gigineishvili, K. Tskhakaia, R. Kikvidze, M. Bibiluri. “**Air Transport”. Tbilisi, 2017, № 1(12), pp. 77-82 (Eng).

In the work there is discussed the analysis of sprinter and slayer average and instantaneous speeds trough the relevant distances. There is defined, that their optimal values until the oxygen’s full exhaustion. There is showed, that the runner can’t run on maximum average speed for a long time – the sprinter is able to maintain the average maximum speed until the 200 m and the stayer until 2000 m (till the oxygen’s full exhaustion).

OPTIMIZATION OF DESIGN SCHEMES AND PARAMETERS OF MOTOR-ENERATORS FOR AVIATION GAS TURBINE ENGINES **A. Maisuradze, Z. Gobianidze, L. Maisuradze. “**Air Transport”. Tbilisi, 2017, № 1(12), pp. 83-93(Eng).

In this research work is analyzes one of the actual issues including in the concept of a” fully electrified aircraft” (FEA), the first stage of that is the implementation of a "more electrified aircraft” (MEA). This makes it necessary to replace the traditional electric generators and starter generators driven by the drive gearboxes to motor-generating devices based on permanent magnets and built-in "cold" rotating and stationary parts of the gas turbine engine (in the rotor and stator).

The mathematical algorithms concerning optimization of design of aviation motor-generators on the minimum weight and electrotechnical materials are developed.

INNOVATIVE IDEA OF CARGO SENDING-RETURN ON SOLAR SYSTEM PLANETS ON THE EXAMPLE OF MARS USING SOLAR ENERGY **G. Kachlishvili “**Air Transport”. Tbilisi, 2017, № 1(12), pp. 94-104(Eng).

In the paper is considered an innovative idea of sending and returning cargoes on Mars. It is known that for operating on modernfuel engines, to transport even a small cargo to Mars represents a huge problem, not to mention anything on its back returning.

According to our idea, due application of solar energy is possible to multiple send and return of heavy loads on the Solar System's planets. Our idea also implies the development and colonization of solar system planets, extraction and transportation of precious substances, safe destruction of various sizes dangerous for Earth asteroids and possibility of greater understanding of the solar system and universe.

GENERALIZED MODELS FOR DESCRIBING OF ELASTIC-VISCOUS BODIES PROPERTIES. **B. Abesadze “**Air Transport”. Tbilisi, 2017, № 1(12), pp. 105-115 (Eng).

Are stated the generalized models for describing of elastic-viscous bodies, for describing of properties are applied the models that represents certain combination of pure elastic and plastic property bodies. Are compiled combinations of generalized three element models with one elastic and two viscous elements. Are described the relations between stress and strain for each combination. Are obtained creeping, hardening, relaxation curves. Also in the paper are stated four element models with two elastic and two viscous elements.

ANALISIS OF SOUND DECAY PROCESS IN AN ENCLOUSED SPASE. **M. Chelidze, M. Tedoshvili, D. Nizharadze, J. Javakhishvili. “**Air Transport”. Tbilisi, 2017, № 1(12), pp. 116-124 (Eng).

In the work is considered oscillations and attenuation of sound waves in a closed impedance tube with a sampling of different length depending on the length of the coherent sound waves. The presented method provides the accuracy of measuring sound absorption in materials without the use of a special laboratory and precision devices. In addition, this method is less sensitive to fixing the test samples and less dependent on the arrangement of measuring devices.

SOLUTION OF THE STATIONARY PROBLEM OF INCOMPRESSIBLE VISCOUS FLUID FLOW OVER A CYLINDER WITH A ROG METHOD. **T. Obgadze, O. Kemularia. "**Air Transport". Tbilisi, 2017, № 1(12), pp. 125-137 (Eng).

In this work, an algorithm of a numerical solution is created, which determines parameters of stationary flow of a viscous, incompressible fluid around engineering structures, with complex geometrical configuration. For taking into account the condition of fluid's adherence to wall of streamlined structures, RO method of Rvachev-Obgadze is used, and as base functions – regular sources of Obgadze-Gabritchidze OG. Substituting the obtained expansions in the Navier-Stokes equations and satisfying the kinematic conditions, we obtain discrepancies of the problem of flow around structures of a complex geometric forms. The discrepancies obtained for each equation are written in the form $L_2(G)$, where G is a control volume of the flow. The constructed calculation algorithm is based on the Rvachev-Obgadze-Gabritchidze ROG method.

SOLVING FLUID DYNAMIC PROBLEMS WITH RVACHEV-OBGADZE RO METHOD. **T. Obgadze, O. Kemularia. "**Air Transport". Tbilisi, 2017, № 1(12), pp. 138-146(Eng).

In this work, we describe RO Rvachev-Obgadzemethod. The algorithm for creating boundary equation is created; for which, homomorphisms of T.Obgadze are used. Algorithms based on Navier-Stokes equations are created, for solving tasks of stationary boundaries, which afterwards are tested by set of problems, solved with numerical methods with the help of Mathcad software. Solutions by numerical methods are compared to solutions by famous methods. Absolute and relative error values are given.

MATHEMATICAL MODELING OF WAVE DISTRIBUTION BASED ON EXACT SOLUTIONS OF NAVIER-STOKES EQUATIONS. **T.Obgadze. "**Air Transport". Tbilisi, 2017, № 1(12), pp. 147-150 (Eng).

In the paper, based on the two-dimensional Navier-Stokes equations for a viscous incompressible fluid, the propagation and gradual, slow damping of tsunami waves are modeled.

Exact solutions of the two-dimensional Navier-Stokes equations that describe the propagation of tsunami waves are found. Based on the generalization of the approach, for finding the exact solution of the Navier-Stokes equations, solutions which describe the dynamics of progressive waves of a viscous incompressible fluid are found.

HARMONIC WAVES IN ELASTIC ISOTROPIC WEDGE **M. Vazagashvili. “**Air Transport”. Tbilisi, 2017, № 1(12), pp. 151-156 (Eng).

Is offered the method of analytical description of wave field in the elastic wedge. Is carried out the analysis of wave field in the orthogonal wedge and is researched the dependence of phase velocity of angular mode from coefficient of Poisson

LEADING AVIA COMPANIES ADVANTAGES IN THE WORLD **N.Jerenashvili; A. Kurtanidze. “**Air Transport”. Tbilisi, 2017, № 1(12), pp.157-161 (Eng).

Aviation is the practical aspect or art of aeronautics, production, development, especially heavier than air aircraft. The airline industry exists in an intensely competitive market. In recent years, there has been an industry-wide shakedown, which will have far-reaching effects on the industry's trend towards expanding domestic and international services.

РЕФЕРАТЫ

БЕСПРОВОДНЫЕ СЕТЫ, ИХ ТИПЫ И МЕТОДЫ ИСПОЛЬЗОВАНИЯ. **О.Шония, И. Картвелишвили, З. Беридзе, И. Дидманидзе, Л. Колбая.** «Воздушный транспорт» Тбилиси, 2017, № 1(12), ст. 11-16(англ).

В статье представлены основныеключевые сведения о технологиях беспроводных компьютерных сетей и их компонентов.Все типы беспроводных сетей (такие как, персональные, локальные, региональные и глобальные сети) обсужденны кратко и описанны их функции, структура и способы использования.Также,в работе уделено внимание роли и важности беспроводных компьютерных сетей в повседневной жизни человека. Содержательно рассмотрена специфика работы каждого типа беспроводных компьютерных сетей и их значимость для общества.

РАСЧЁТ ПЛАСТИНОК ПОДКРЕПЛЕННЫХ ТОНКИМИ КРИВОЛИНЕЙНЫМИ СТЕРЖНЯМИ ПЕРЕМЕННОГО СЕЧЕНИЯ. **Г. Кипиани, Г. Окропиридзе, В. Сулашвили.** «Воздушный транспорт». Тбилиси, 2017, № 1(12), ст. 17-23(англ).

Выведены общие условия сопряжения пластинок со смещёнными срединными поверхностями посредством тонкого ребра переменной жёсткости. Из этих условий, в частности, следуют условия совместного деформирования пластин с выдавками малой глубины, а также различные виды условий спая пластин с ребрами переменного сечения, которые использованы в работе при решении задач расчёта и рационального проектирования тонкостенных конструкций.

РАСЧЁТ ПЛАСТИН И ОБОЛОЧЕК С РЕБРАМИ ЖЕСТКОСТИ ПО МЕТОДУ КОНЕЧНЫХ ЭЛЕМЕНТОВ. **Г. Кипиани, М. Цикаришвили, С.Блиадзе, У. Дзозуашвили.** «Воздушный транспорт». Тбилиси, 2017, № 1(12), ст.24-30 (англ).

В настоящей статье изложено развитие этапов расчета пластин и оболочек с ребрами жесткости. Отмечено, что теория ребристых оболочек является одним из наиболее спорных и незавершенных разделов общей теории оболочек.Рассматриваются расчеты оболочек с продольными и поперечными ребрами жесткости методом конечных элементов. В первом варианте ребро жесткости рассматриваетсякак балочный конечный элемент, во втором случае рёбра аппроксимируются как тонкостенные пластины и, наконец, в третьем случае ребро представлено как трехмерный конечный элемент.Дан сравнительный анализ теоретическим и экспериментальным результатам.

ПРОБЛЕМЫ И ПЕРСПЕКТИВЫ УПРАВЛЕНИЯ РАЗВИТИЕМ ИНТЕЛЛЕКТУАЛЬНОГО ПОТЕНЦИАЛА АВИАТРАНСПОРТНЫХ ПРЕДПРИЯТИЙ.

М. Пимжина, В. Новак, Е. Разумова. « Воздушный транспорт». Тбилиси, 2017, № 1(12), ст.31-36 (англ).

В результате анализа работ ведущих отечественных и зарубежных ученых нами обобщены основные факторы, положительно влияющие на формирование и развитие интеллектуального потенциала предприятий, а также предложены меры, необходимые для успешного развития интеллектуального потенциала авиатранспортных предприятий.

ПЕРСПЕКТИВНЫЕ НАПРАВЛЕНИЯ РАЗВИТИЯ ТРАНСПОРТНОЙ СИСТЕМЫ С УЧЕТОМ ПРИОРИТЕТОМ НАЦИОНАЛЬНОЙ ЭКОНОМИКИ **О. Кириленко, О. Ильенко, В. Новак, Е. Крапко.** «Воздушный транспорт». Тбилиси, 2017, № 1(12), ст.37-44(англ).

В статье исследуются процессы гармонизации экономико-правовых основ функционирования транспортной системы Украины, что теоретически даст возможность доступа нашей страны к передовым европейским технологиям и привлечение инвестиций, раскрыты основные проблемы на пути к эффективной гармонизации интеграционных процессов, заключающиеся в необходимости обеспечения соответствия национальной транспортной системы высоким стандартам и техническим требованиям рынка транспортных услуг с учетом приоритетов национальной экономики.

ОСОБЕННОСТИ ПРИМЕНЕНИЯ РИСК-МЕНЕДЖМЕНТА В АВИАКОМПАНИЯХ. **В. Новак, И. Бассараба, В. Передерий.** «Воздушный транспорт». Тбилиси, 2017, № 1(12), ст. 45-49(англ).

В статье рассмотрены проблемы применения риск-менеджмента на авиапредприятиях. На основе анализа, обобщения и систематизации научных источников рассмотрены основные причины и основы применения риск-менеджмента. Сформированы подходы к управлению рисками на авиапредприятиях. Определены основные цели и задачи риск-менеджмента.

ПРЕДПОСЫЛКИ СОЗДАНИЯ УНИВЕРСАЛЬНЫХ МЕХАНИЗМОВ ОПТИМИЗАЦИИ ПРОИЗВОДСТВЕННО-ЛОГИТИЧЕСКОЙ ДЕЯТЕЛЬНОСТИ АВИАПЕРЕВОЗЧИКОВ ПРИ ОРГАНИЗАЦИИ МУЛЬТИМОДАЛЬНОЙ ДОСТАВКИ НЕГАБАРИТНЫХ ГРУЗОВ. **С. Литвиненко**. «Воздушный транспорт». Тбилиси, 2017, № 1(12), ст.50-55 (англ).

В статье исследованы предпосылки создания универсальных механизмов оптимизации производственно-логистической деятельности авиаперевозчиков при организации мультимодальной доставки негабаритных грузов. Доказано, что такая необходимость может возникнуть для авиаперевозчиков исключительно при доставке негабаритных грузов в мультимодальном сообщении, при этом авиаперевозчик становиться, на время 3PL оператором

ОБЕСПЕЧЕНИЕ ДЕЛОВОГО СОВЕРШЕНСТВА АВИАПРЕДПРИЯТИЙ ПУТЕМ РАЗВИТИЯ СТРАТЕГИЧЕСКОГО ЛИДЕРСТВА. **Л. Литвиненко.** «Воздушный транспорт». Тбилиси, 2017, № 1(12), ст.56-62 (англ).

В статье определены и проанализированы роль и основные условия развития стратегического лидерства авиапредприятия. Изучена взаимосвязь между применением стратегического лидерства и показателями делового совершенства авиапредприятия. Было установлено, что лидерский подход к управлению позволяет достичь долгосрочных целей развития авиапредприятия за счет реализации стратегических изменений, необходимых для более эффективного осуществления хозяйственной деятельности в условиях неопределенности и динамических факторов окружающей среды, сохраняя при этом достаточный уровень гибкости и маневренности.

МОДЕЛИРОВАНИЕ СИСТЕМЫ МАРКЕТИНГОВОЙ МЕЖДУНАРОДНОЙ ПРЕДПРИНИМАТЕЛЬСКОЙ БЕЗОПАСНОСТИ**. О.Ильенко** «Воздушный транспорт». Тбилиси, 2017, № 1(12), ст. 63-70(англ).

В статье сформирована модель построения таких понятий, как: «маркетинговая стратегия глобальной экономической безопасности субъектов международного предпринимательства» и «маркетинговая международная предпринимательская деятельность», а также доказана актуальность необходимости создания нового понятия «маркетинговая международная предпринимательская безопасность», обоснованная существующими условиями развития мировой экономики, которые на сегодняшний день очень сложные и не стабильные

К ПРОБЛЕМЕ ОБЕСПЕЧЕНИЯ ЭКОНОМИЧЕСКОЙ БЕЗОПАСНОСТИ ПРЕДПРИЯТИЯ. **Э. Данилова.** «Воздушный транспорт». Тбилиси, 2017, № 1(12), ст. 71-76(англ).

В статье рассмотрены виды экономической безопасности предприятия, проанализировано влияние региона и государства в целом на процесс формирования системы экономической безопасности деятельности предприятия, а также исследовано другие факторы влияния и угрозы (внешние и внутренние), которые могут стать барьером на пути эффективного развития предприятия.

К ОПРЕДЕЛЕНИЮ МАКСИМАЛЬНОЙ СКОРОСТИ БЕГА. **А. Гигинеишвили, К. Цхакая, Р. Киквидзе, М. Бибилури.** «Воздушный транспорт». Тбилиси, 2017, № 1(12), ст. 77-82(англ).

В работе проведен анализ средней и мгновенной скоростей спринтера и стайера на соответствующих дистанциях. Установлены их оптимальные меличины до полного расхода кислорода. Показано, что бегун не может бежать с максимальной средней скоростью, только спринтер может сохранить максимальную среднюю скорость до 200 м, а стайер до 2000 м (до полного расхода кислорода).

ОПТИМИЗАЦИЯ ПРОЕКТИРОВАНИЯ АВИАЦИОННЫХ МОТОР-ГЕНЕРАТОРОВ ПО МИНИМАЛЬНОЙ МАССЕ И ЭЛЕКТРОТЕХНИЧЕСКИМ МАТЕРИАЛАМ. **А. Маисурадзе, З. Гобианидзе, Л. Маисурадзе.** «Воздушный транспорт». Тбилиси, 2017, № 1(12), ст. 83-93(англ).

В данной научной работе проанализирован один из актуальных вопросов, входящий в концепцию создания „полностью электрофицированного самолета'' (ПЭС), первым этапом которого является реализация „более электрофицированного самолета'' (БЭС). Это вызывает необходимость замены традиционных электрогенераторов и стартер-генератора, приводящихся во врашение от коробки приводов на мотор-генераторные устройсва, основанные на постоянных магнитах и встроенные в „холодных''врашающихся и неподвижных частях газотрбинного двигателя (в роторе и статоре).

Разработаны математические алгоритмы, касаюшийся оптимизаций проектирования авиационных мотор-генераторов по минимальной массе и электротехнических материалов.В работе электрическая машина представленная в виде нелинейной функции многих переменных, анализируется с помощью систем линейных алгебрических уравнении.

ИННОВАЦИОННАЯ ИДЕЯ ПЕРЕВОЗА ГРУЗА НА ПЛАНЕТЫ СОЛНЕЧНОЙ СИСТЕМЫ ТУДА И ОБРАТНО НА ПРИМЕРЕ МАРСА С ПОМОЩЬЮ СОЛНЕЧОЙ ЭННЕРГИИ. **Г. Качлишвили.** „ Воздушный транспорт". Тбилиси. 2017, № 1(12), ст.94-104 (англ).

В наших трудах рассмотрена инновационная идея перевозки груза на Марс и обратно. Известно, что двигатели, работающие на современном топливе, даже при перевозке на Марс в малом количестве груза, составляет большую проблему, не говоря уже о обратной перевозке. Наша идея состоит в том, чтобы с использованием солнечной эннергии была возможна многократная перевозка груза на планетаы солнечной системы. А также идея состоит в освоении-колонизации планет солнечной системы, находки-транспортировки драгоценных веществ, безопасном разрушений разных астероидов опасных для нашей планеты, и в общем, это хорошая возможность для изучения вселенной.

ОБОБЩЁННЫЕ МОДЕЛИ ДЛЯ ОПИСАНИЯ СВОЙСТВ УПРУГО-ВЯЗКИХ ТЕЛ. **Б. Абесадзе**„ Воздушный транспорт“. Тбилиси, 2017, № 1(12), ст105-115. (англ).

Приведены обобщённые модели для описания свойств упруго-вязких тел. Доля описания свойств использованы модели, в которых представлены определённые комбинации чисто упругих и чисо пластических свойств тел. Составлены комбинации обощённых трёх-элементных моделей с одним упругим и двумя вязкими элементами. ОЛписаны зависимости между напряжениями и деформациями для каждого элемента. Получены кривые ползучести, упрочнения, релаксации. Также в работе приведены четырёхэлементные модели с двумя упругими и двумя вязкими элементами.

АНАЛИЗ ПРОЦЕССА ПОГЛОЩЕНИЯ ЗВУКА В ЗАКРЫТОМ ПРОСТРАНСТВЕ. **М. Челидзе, М. Тедошвили, Д. Нижарадзе, Д. Джавахишвили.** «Воздушный транспорт». Тбилиси, 2017, № 1(12), ст. 116-124(англ).

В работе рассматривается колебание и затухание звуковых волн в закрытой импедансной трубке разной выборочной длиныв зависимости от длины кохерентных звуковых волн.Представленный метод обеспечивает точностьизмерения коэффициента звукового поглощения в материялах без применения специальной лаборатории и прецизионных устройств.Кроме того, данный метод менее чувствителенот фиксацийиспытуемых образцов и менее зависим от расстановки измерительных приборов.

РЕШЕНИЕ ГИДРОДИНАМИЧЕСКИХ ЗАДАЧ RO-МЕТОДОМ РВАЧЁВА-ОБГАДЗЕ. **Т.Обгадзе , О.Кемулария.** «Воздушный транспорт». Тбилиси, 2017, № 1(12), ст. 125-137(англ).

В работе рассматривается RO-метод Рвачёва-Обгадзе. Строится алгоритм, для построения уравнения многосвязной границы; для этого применяются гомоморфизмы Обгадзе. Разработаны алгоритмы для решения граничных задач, которые проверены решениями ряда тестовых задач на основе Mathcad. Результаты численных расчетов сравниваются с известными точными и численными решениями соответствующих задач.

Вычисляются численные значения абсолютной и относительной погрешности в каждой из решенных задач.

РЕШЕНИЕ СТАЦИОНАРНОЙ ПРОБЛЕМЫ НЕПРЕРЫВНОГО ВЯЗКОГО ПОТОКА ЖИДКОСТИ НА ЦИЛИНДРЕ С МЕТОДОМ ROG. **Т. Обгадзе, О. Кемулария.** «Воздушный транспорт». Тбилиси, 2017, № 1(12), ст.138-146 (англ).

В работе строится алгоритм, численный расчет определяющих параметров стационарного потока вязких, несжимаемых жидких круглых инженерных сооружений, сложная геометрическая конфигурация. Для учета состояния прилипания жидкости к стенкам обтекаемых конструкций применяется метод RO Рвачева-Обгадзе и как основные функции, используются регулярные источники Обгадзе-Габричидзе О.Г. Подставляя указанное разложение в уравнения Навье-Стокса и удовлетворяя кинематическим условиям, мы получаем не вязание задачи о потоке конструкций сложной геометрической формы. Полученное не вязание для каждого уравнения записывается по норме $L_2(G)$, где G-область исследуемого тока. Построенный алгоритм расчета основан на методе ROG метода Рвачева-Обгадзе-Габричидзе.

МАТЕМАТИЧЕСКОЕ МОДЕЛИРОВАНИЕ РАСПРСТРАНЕНИЯ ВОЛН НА ОСНОВЕТОЧНЫХ РЕШЕНИЙ УРАВНЕНИЙ НАВЬЕ-СТОКСА **Т. Обгадзе.** «Воздушный транспорт». Тбилиси, 2017, № 1(12), ст.147-150 (англ).

В работе на основе двумерных уравнений Навье-Стокса, для вязкой несжимаемой жидкости, моделируется распространение и постепенное, медленное затухание волн цунами. Найдены точные решения двумерных уравнений Навье-Стокса, которые описывают распространение волн цунами. На основе обобщения подхода, к нахождению точного решения уравнений Навье-Стокса, наидены решения для описания динамики прогрессирующих волн вязкой несжимаемой жидкости.

ГАРМОНИЧЕСКИЕ ВОЛНЫ В УПРУГОМ ИЗОТРОПНОМ КЛИНЕ. **М. Вазагашвили.**«Авиационный транспорт»,. Тбилиси, 2017, № 1(12), ст.151-156 (англ).

Предложен способ аналитического описания волнового поля в упругом клине, Проведён анализ волнового поля в прямоугольном клине и исследована зависимость фазовой скорости угловой моды от коэффициента Пуассона.

ПРЕИМУЩЕСТВО ВЕДУЩИ**Х**АВИАКОМПАНИЙ В МИРЕ. **Н.Джеренашвили, А. Куртанидзе.** «Воздушный транспорт». Тбилиси, 2017, № 1(12), ст.157-161 (англ).

Авиация - это отрасль деятельности человечества, связанная с полётом летательных аппаратов, теория и практика полёта по воздуху на летательных аппаратах тяжелее воздуха. Авиационная промышленность существует на рынке с интенсивной конкуренцией. В последние годы произошел обвал в масштабах всей отрасли, который окажет далеко идущее влияние на тенденцию отрасли к расширению внутренних и международных услуг

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