Report of “Elasticity and Plasticity theory” departament for 2014.

İn the departament 11 scientific works are carried out on “**Strength, stability and oscillations of viscous, elastic and plastic structural elements**”.

Work A**. Free oscillations of a nonhomogeneous, orthotropic rectangular plate with regard to resistance of nonhomogeneus medium**. **(Gadjiev V.C).**

In the work it is assumed that the resistance of the medium is characterized by the equality

$$q = k_1(x,y)w + k_2(x,y)\frac{\partial^2 w}{\partial t^2} \tag{1}$$

the modules of elasticity and density are continuous functions:

$$E = E_0 f(x,y); \quad \rho = \rho_0 \psi(x,y). \tag{2}$$

Here E , ρ_0 - correspond to homogeneous case the Poisson ratio is constant.

We can show that allowing for (1) and (2) the equation of motion dependent on the w curve is written as follows:

$$D_0\left[f(x,y)\left(\frac{\partial^4 w}{\partial x^4} + 2\frac{\partial^4 w}{\partial x^2 \partial y^2} + \frac{\partial^4 w}{\partial y^4}\right) + \frac{\partial f(x,y)}{\partial x}\left(\frac{\partial^3 w}{\partial x^3} + \nu\frac{\partial^3 w}{\partial x \partial y^2}\right) + \frac{\partial^2 f(x,y)}{\partial x^2}\left(\frac{\partial^2 w}{\partial x^2} + \nu\frac{\partial^2 w}{\partial y^2}\right)\right] +$$

$$+ D_0\left[\frac{\partial^2 f(x,y)}{\partial y^2}\left(\frac{\partial^2 w}{\partial y^2} + \nu\frac{\partial^2 w}{\partial x^2}\right) + 2\frac{\partial^2 f(x,y)}{\partial x \partial y}\left(\frac{\partial^3 w}{\partial y^3} + \nu\frac{\partial^3 w}{\partial x^2 \partial y}\right)\right] +$$

$$+ 2D_0^k\left[\left(\frac{\partial^2 f(x,y)}{\partial x \partial y} + \nu\frac{\partial^2 w}{\partial x \partial y}\right)\right] + k_1(x,y)w + k_2(x,y)\frac{\partial^2 w}{\partial t^2} + \rho_0\psi(x,y)\frac{\partial^2 w}{\partial t^2} = 0. \tag{3}$$

Here $D_0 = \dfrac{E_0 h^3}{12(1-\nu^2)}; \quad D_0^k = \dfrac{G_0 h^3}{9}$

In the first step the method of separation of variables is used, the curve is found in the form:

$$w(x,y,t) = V(x,y)e^{i\omega t} \tag{4}$$

If we write expressive (4) in the equality (3), the solution of the equality obtained with respect to the function V(x) is constructed by the Bubnov- Galerkin method and the calculation is conducted in the first approximation.

Work B. **Determination of load-bearing cupidity of plates and shells strengthened by multiple fibers. (Ilyasov. M. Kh).**

Flow criteria of three layer composite shells and plates strengthened by medium layer fibers are constructed. It is assumed that the matrix, shells and plates materials have unstrengthened ideal plastic features and resist differently to stretch and compression. It is accepted that the thickness of shells (edge layers) and sizes of cross sections of fibers are rather small with regard to thickness of the matrix. The contact of shells and fibers is complete. Using the associated flow principle, the deformation rates are determined. Special cases are considered, convenient and simple flow conditions are determined.

The obtained results were applied to load- bearing capacity of cylindrical shells, annular and circular plates subjected to different loads, appropriate estimates of coefficient were found.

Work C. **Investigation of boundary value problems in smooth, ribbed plates and shells. (Musayev.Kh.I)**

In the work the forced lateral oscillations of thin-shelled are studied. The equilibrium equation with respect to cylindrical form curve is written as follows:

$$D\frac{d^2W}{dx^2}+Eh\frac{W}{R^2}=P^3$$

Here D is cylindrical rigidity, E is a modulus of elasticity, R is a radius. It is seen that the solution of the problem is reduced to the solution of the beam lying on an elastic foundation.

Work D. **Free oscillations of a composite bar on a linear elastic foundation. (Gasimov H.M)**

In the work the free oscillation of a composite bar on a nonhomogeneous elastic foundation is studied. The reaction force of the foundation is taken in the form

$$q=k(x)w \qquad (5)$$

Here *k(x)* characterizes the main features of the foundation and is determined experimentally , *w* is a curvature, *x* is the length coordinate. Allowing for (5), the equation of motion is written as

$$\frac{\partial^2}{\partial x^2}\left[E_c(x)J\frac{\partial^2 w(x,t)}{\partial x^2}\right]+\rho_c(x)F\frac{\partial^2 w}{\partial t^2}+k(x)w=0, \qquad (6)$$

Here *F* is the area of the cross section of the set. *E(x)* is the local elasticity modulus of the composite, $\rho_c(x)$ is the local density, *J* is the inertia moment of the cross scction.

$$E_c(x)=E_f v_f(x)+E_m v_m(x)=v_f(x)(E_f-E_m)+E_m$$

$$\rho_c(x)=v_f(x)(\rho_f-\rho_m)+\rho_m$$

For an isotropic medium,

$$v_f(x)+v_m(x)=1$$

We find the solution of (6) in the form

$$w(x,t)=v(x)e^{iwt} \qquad (7)$$

Here *v(x)* should satisfy the approprate boundary condition. If we write (7) in (6) we get

$$\frac{d^2}{dx^2}\left[E_c(x)J\frac{d^2V(x)}{dx^2}\right]+k(x)V(x)-\omega^2\rho_c(x)FV(x)=0\,. \qquad (8)$$

The solution of equation (8) is consfructed by the Bubnov-Galerkin method and the value of frequency is determined in the first approximation.

Work E. **Stability of local ,curved structure plate (Zeynalova T.Y).**

In the paper ,based on continual theory, the stability problems of a rectaugular plate made of curved structure laminary composite material is considered. The dependence between strain and stress is as follows

$$\sigma_{11}=A_{11}\varepsilon_{11}+A_{12}\varepsilon_{22}$$

$$\sigma_{22}=A_{12}\varepsilon_{11}+A_{22}\varepsilon_{22} \qquad (9)$$

$$\sigma_{12}=A_{66}\varepsilon_{12}$$

Where

$$A_{sp}=A_{sp0}+\sum_{n=1}^{\infty}\varepsilon^n A_{spn}\left[A_{sp0},F(x_1,x_2)\right] \qquad (10)$$

A_{sp0}- is the elasticity coefficient of homogeneus linear anisotropic material, is determined A_{spn} by A_{sp0} and curvature parameters, ε is a small parameter.

The plate is compressed by the force p acting on median surface. For obtaining approximate formula, the energetic method is used.

$$V_{eey} = A(P)$$

Work E. **Nonlinear parametric oscillation of medium- contacing strengthened cylindrical shells with structural curvatures (Mehdiyev M.A.).**

In the work by means of the variational principle, the nonlinear oscillations of viscous-elastic medium-contacing anisotropic cylinder strengthened by bars and subjected to internal pressure is investigated. The two cases of strengthening were considered.

1) By the system of transverse regularly distributed beams.
2) By the system of longitudinal regularly distributed beams.

The medium action was taken into account by the Pasternak model. The anisotropy s effect was studied by the numerical method.

Work F. Free oscillations of pipes with regard to resistance of inhomogeneous medium.(Shukurova N.A).

In the work, taking into account the resistance of the straight part, inhomogeneus foundation of the pipe,the stability problem is investigated. The foundation is characterized by the following mathematical relation

$$q = k(1 + \varepsilon\varphi(x)),$$

Here k is the Winkler cocfficient.

The motion equation of the pipe with inhomogeneus density along the length is written as follows:

$$\frac{\partial^2}{\partial x^2}\left[f(x)\frac{\partial^2 w}{\partial x^2}\right] + k(1 + \varepsilon f(x)) + \rho_0\psi(x)\frac{\partial^2 w}{\partial t^2} = 0$$

The differential equation is solved by the separation of variables and the Bubunov Galerkin method.

Work G. Asymptotic analysis of stress strain state of sphrical shells. (Huseynov F.)

In the work, geometrical equations in the theory of shells are investigated. It is shown that if the arbitrary force acts on the shell surface, the forced oscillations propagate in longitudinal and lateral directions.

Work H. Solution of thermoelasticty problem for perforated heatreleasing medium. (Shanbandayev E.H.)

Intensity factors in heat release for precewise linear elastic hemogeneous medium were determined. The problem solution is constructed on the basis of complex variable and Kolosov-Muskheleshvili potensials.

Work I. Optimazation problem for finding the stress problem of complex body . (Mammadova K. S)

In the work, a complex elastic body partitioned by different elastic materials was cosidered. The reinforced fibre has annular cross section. The body was located in surface deformation on surface stress state. The principal elements were chosen by the Gauss method, and as the obsained system of algebraic eguation is close, the optimization problem was solved by the numerical method.

Work I. Investagation of wave propagation proceses in beams subjected to tangential forces at adges. (Mirzayeva G. R.)

A semi-infinite rectangular prism occupying the part $-a \le x \le a, -b \le y \le b$ of the space in cartesian coordinate system is considered. It the is assemed that the prism is elastic and isotropic

$$\rho \frac{\partial^2 \vec{U}}{\partial t^2} = (\lambda + \mu) grad\, div \vec{U} + \mu \Delta \vec{U}$$

$$\vec{U} = \vec{U}(u, \vartheta, w) \qquad (11)$$

There $\vec{U}$ is displacement vector, ρ in material's density, λ, μ are Lame constants. The problem was considered,with regard to considered inital and auxiliary conditions.

Scientific and organizational problems.

The departmen seminar is held at each mondey at 11^{00}. The collaborators of the department and the collaborators of other institutions represent here research works and the results of dissertation works. The department collaborators take an active part in the institute seminars.

The research associates of the department have taken an active part in the Confernce devoted to 55 years of IMM.

The head of the department V.J.Gadjiev addressed as an opponent of 1 doctor of science (in scientific Council of IMM) and 2 philosophy doctors, the rescarch associate of the department M.Kh Ilyasov was an opponent of 1 doctor of science (Sc. Council of IMM), M.Mehdiyev was an opponent of 1 philosophy doctor.

V.J.Gadjiev s two condidates for a degree have submitted their philosophy doctor dissertations to the scientific council.

Head of the department V.J.Gadjiev gained the grant of SOCAR on the project "Choice of optimal variant of strength characteristics of structural elements used in oilproduction and oiltransportation".

M.Mehdiyev was a winner of the grant competition on "Choice of optimal variant of strength characteristics of structural elements used in oil production and oil transportation".

H.M.Gasymov was a winner of the grant competition "Soltware for operative determination of optimal working conditions of wells by mathematical statistics methods".

The work of one postal tuition cand of a doctor of sci.degree is going on by the plan (Azayev N).

One doctor of scie4nce dissertation is being completed (Kalantarli N.M).

2 of 15 collaborators are doctors of science, 9 are cand. Of sciences. 4 of research associates work part time.

The department needs 1 labaratory assistant.

On the report period 34 scientific works were published, 10 of them in foregn journals, 22 in the Republican journals. 4 papers are in print, 8 abstracts were published, 6 papers are prepared to be published.

Head of department doct.ph.m.s. prof. V.J.Gadjiev.

Important results

M.Kh.Ilyasov Determination of load- bearing capasity of plates and shells strengthened by multiple fibres.

Abstract.

Flow criteria of three layer composite shells and plates strengthened by medium layer fibers are constructed. It is assumed that the matrix, shells and plates materials have unstrengthened ideal plastic features and resist differently to stretch and compression. It is accepted that the thickness of shells (edge layers) and sizes of cross sections of fibers are rather small with regard to thickness of the matrix. The contact of shells and fibers is complete. Using the associated flow principle, the deformation rates are determined. Special cases are considered, convenient and simple flow conditions are determined.