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The thin metal-metalloid coatings have high hardness, hence, high wear resistance; that's why they can be used in tribology. The study of frictional contact of such coatings is important for

the optimization of their tribological characteristics. The coating consists of two layers, which are in perfect adhesion with each other and with the substrate material. Elasticity modulus of the upper layer is greater than the substrate modulus, the second layer is essentially thinner than the upper layer, and the material of this layer is the softest. Under assumption that the influence of friction on the distribution of contact normal stresses is negligible, axisymmetric contact problem is considered for an elastic counterbody; two models of the coating were used to solve the problem. The first model is a three-layered elastic half-space with the perfect adhesion between the layers. The mechanical characteristics and the thickness of the second layer make it possible to use the Winkler layer as a model. In this case an approximate model of two-layered elastic half-space with imperfect adhesion at the interface is considered. For both models we use the previously developed numerical-analytical method of solution based on Hankel integral transforms. The technique of the coating deposition makes it possible to vary the thickness and hardness of the upper layer. For different loads we compare the results of the contact problem solution based on two models of the coating. For some cases the difference between the contact pressure distributions is negligibly small. These results were used to calculate the subsurface stresses inside the upper layer for the case of sliding friction. This calculation of internal stresses is three-dimensional problem, which is solved using double Fourier integral transforms and the boundary element method. The influence of the value of friction coefficient on the stress concentration is considered.

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Studying shock-wave flows arising at supersonic flow deceleration to subsonic speed in the channel is an important problem of fluid mechanics. At the same time, the majority of such researches are conducted for stationary regimes. In this work, the possibility of active control of shock-wave flows is shown, using periodic influence on an air stream. For the first time, the speed of pseudoshock moving in plane and axisymmetric channels is measured. The ways of flow control and burning regimes in a supersonic air stream which can be used at the organization of effective heat supply in combustion chambers of prospective high-speed engines have been proposed and tested.

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Mathematical model for usage and refined strength analysis of nanostructured flexible graphite O-ring seals

A mathematical model for thermoelastic deformation of seals is developed taking into account a cylindrical nature of anisotropy type of flexible graphite, experimental data for elastic, strength and thermophysical characteristics of materials (the properties differ in radial, hoop and generatrix directions). An initial operation mode of O-ring seals, produced on a large scale and used for rod seal in the gland cocks, has been considered. The influence of thermoforce loading conditions on the character of stress-strain distributions along cross-sections of seals and seal packs has been investigated using numerical FEM solutions of 3D stationary boundary value problems. Estimation of real damage mechanisms (i.e. damage from tension or compression in radial, hoop and axial directions, and from transversal and antiplane shear) and their affection on initial strength, a comparison of different loading modes (i.e. reciprocating motion in sealing bush or opposite direction, and torsion of the rod), height and conditions on contact surfaces (i.e. ideal contact, friction or slip) between seals on the maximum values of radial, hoop, axial and shear stresses have been calculated. The locations of damaged domains obtained from computational experiments are in a good agreement with the results of O-ring seals experience.

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Methods of boundary elements (MBE) can be successfully used when computing many problems of elasticity theory. One of the MBE is called the Method of fictitious loadings (MFL). The basis of the MFL, as well as MBE, is constituted by the presentation of any solution as linear combination of some basic solutions of the elasticity theory with indetermined coefficients which are determined from boundary conditions of the concrete problem. The MFL can be successfully used when computing contact problems of elasticity theory. The demonstration of the MFL as an example of a problem of a hard stamp subsonic movement on border of an elastic semi-surface is given in this article. In this problem it's required to determine the deflected mode of elastic environment and to find a contact region of stamp with environment. In this article numerical solution results are produced, where the stamp has a foundation like a parabola when the velocity is less than the Rayleigh wave velocity and vice versa.

Ziborov E.N., Makarchik N.S., Soloviev A.N., Spozhakin A.S., Shevtsov S.N. 259

Reconstruction of damaged state and fatigue strength of composite materials

In this paper we propose a method for reconstruction of cracks in layered composites based on modeling of their internal heat sources and measuring the temperature of a portrait of the body. By using the reciprocity theorem for a body with defects and without them, as well as some analytic test solutions, formulas for determining the rates interface boundary containing the defect and the coordinates of an interior point of the defect are obtained. The second section of the work associated with the decision of the urgent problem of determining the resource polymer composite reinforced structures subjected to mechanical and climatic influences (such as helicopter rotor blades.). A finite-element modeling package ANSYS representative volume of the composites and calculated their fatigue strength. The results of numerical experiments to determine the defects and fatigue strength of composite materials. The numerical calculations have shown high accuracy of the method.

V. N. Zimin..... 264

Space systems: constructions and models

Large-area antennae of multipurpose on-board radio-engineering equipment as well as large-size solar batteries for space vehicles power supply belong to most important systems that have a great influence on Earth satellite development. Large-dimensioned structures are delivered into the orbit in folded state. There they are deployed into the working state. Reliability of the deploy requires solution of complicated tasks of mechanics. So, only application of considered complex models for folded structure deploy can provide a high reliability of large transformable space system.

Kazakov K.E. 269

On a contact of foundations with coatings and punches with complicated base profile

The problem of contact interaction between a foundation with a coating and a rigid punch whose surface is described by a certain function was studied in [1–3]. The solution of this problem was obtained as a series in normed polynomials, for example Legendre polynomials. Soon it became clear that, in the cases where the punch base shape is described by oscillating functions the solution representation as a series in classical orthogonal polynomials is inefficient. It allows us to perform calculations only for punches whose base shape is well described by a finite small number of polynomials. The approach described in this paper allows us to perform calculations for a punches, whose base forms are described by oscillating functions. We consider plane contact problems. We present the statements of the problems and

derive their basic mixed integral equation. The solution of this equation is constructed by using the Manzhirrov generalized projection method [4].

Ghazaryan R. A. Ghazaryan K.B.273

Magnetoelastic vibrations of perfect conductive transversely isotropic elastic layer in external longitudinal magnetic field

Within the framework of elasticity theory plane problem, the propagation of magnetoelastic waves in an transversely isotropic layer is considered. The layer surfaces are free from mechanical stresses. The layer is immersed in external constant magnetic field, direction of which coincides with direction of magnetoelastic wave. The layer has properties of perfect conductor. The dispersion equation is derived and in long wave approximation the equation of bending vibration of thin magnetoelastic plate is derived.

Karapetyan K.A.278

The influence of symmetry infringement of the reinforcement on deformative behavior of glassplastic tubes under the axial tension

The influence of angle deviation from the given zero ($\varphi=0^{\circ}$), caused by technological process and changing within limits $\varphi=6-8^{\circ}$, on the deformability of glassplastic tubes under the axial tension is considered. It is revealed that the relation of the axial deformations of samples with $\varphi=8^{\circ}$ and $\varphi=0^{\circ}$ practically doesn't depend on the level of stress under the short time tests and the duration of observation in case of creep. A qualitatively analogous phenomenon was detected in case of the relation shear and axial deformations for tubes with the deviating reinforcement, too.

Kashirskaya E.N.283

Effect of fatigue stress on resistance metal cutting tools

Proposed a generalized approach to describe the fatigue failure in the cutting tool that based on the theory of random point processes.

Kerobyan A. V.287

Contact Problem for the Elastic Half-Plane Strengthened by Heterogeneous Elastic Stringers of different length in the presence of the interlayer

This work observes contact problem for the elastic half-plane strengthened by the heterogeneous elastic stringers (overlays) which consists of two semi-infinite pieces and one separated finite piece with another elastic characteristics. It is supposed that contact interaction in all parts is realized through a thin layer of glue (another physico-mechanical characteristics) and stringers are deformed under the action of horizontal forces. Using generalized Fourier transforms the determinational problem of unknown contact stresses are reduced to the systems of integral equations Fredholm second kind within the different intervals, which in the case of all admissible values characteristic parameters of problem in the space of Banach may be solved by the method of successive approximations. The particular cases are observed and the character of the change contact stresses is illustrated in the different contact parts.

Kirakosyan R. M., Stepanyan S. P.292

On the stability of orthotropic plate-layer, taking into account its own weight and transverse shear

The collocation method is used to solve the problem of stability of an orthotropic plate-layer, taking into account its own weight and transverse shear. S.A. Ambartsumian's precised theory of anisotropic plates is used. We consider two variants of boundary conditions. We present the dimensionless critical values of loads. Qualitative and quantitative conclusions. Analyzing the results are made.

Kovaleva E.D.297

Application of an asymptotic approach to problems of scattering acoustic waves by elastic spherical shells

Application of asymptotic models to problems of scattering of stationary acoustic waves by elastic spherical shells for different value of the relative thickness is considered. A procedure is proposed for constructing an approximate solution, based on matching the expansions of three different asymptotic models of the interaction of the elastic shell with the acoustic medium. In the vicinities of zero frequency the refined Kirchhoff-Love theory of long-wave low-frequency approximation of the elasticity equations is applied. In the vicinities thickness resonance frequency long-wave high-frequency approximations are employed. Outside the vicinities of zero spherical and thickness resonance frequency vibrations of a shell correspond to short-wave motions. Here a flat layer model is used. It is shown for enough small value of the relative thickness that the flat layer model has overlap regions both the refined Kirchhoff-Love theory and the theories associated with long-wave high-frequency approximations. The boundary of the field application of asymptotic models in dependence from value the relative thickness of the spherical shell is obtained. A comparison of numerical data corresponding to asymptotic and exact solutions for middle value the relative thickness shows that the proposed procedure is applicable in frequency regions to first the frequency thickness resonance.

Kovalev V.A., Radayev Y.N...... 302
Classical symmetry groups of three-dimensional equations of the mathematical theory of perfect plasticity

Group analysis of the non-linear system of partial differential equations describing three-dimensional perfectly plastic equilibrium state is carried out. The Tresca yielding criterion is employed to formulate the system to be analysed. Stress state is presumed correspond to an edge of the Tresca prism thus allowing formally consider the static equations independently on the flow rule. The system of static equilibrium equations is represented in the stress principal lines co-ordinate net (isostatic net). By the aid of the standard algorithms of the group analysis of the partial differential equations the symmetry group of this system is obtained.

Kovalev V.A., Radayev Y.N. 307
Algebra symmetry groups of three-dimensional equations of the mathematical theory of perfect plasticity

The corresponding Lie algebra and a first order optimal system of subalgebras of the symmetry group of three-dimensional partial differential equations of the mathematical theory of plasticity are studied. The optimal system in the three-dimensional case is shown consist of 1 three-parametric, 9 two-parametric, 45 one-parametric and 95 individual infinitesimal generators. It is proved that plane strain equations determine the seven-dimensional Lie algebra; a first order optimal system of its subalgebras consists of 1 two-parametric⁴, 7 one-parametric and 19 individual infinitesimal generators. In the case of axial symmetry the system of partial differential equations is characterized by the five-dimensional Lie algebra; a first order optimal system of its subalgebras consists of 1 one-parametric and 20 individual infinitesimal generators.

Kovrizhnykh A. M...... 312
Shear model for creep strain and failure of material

Shear model for accumulation of damage in solid bodies under irreversible strain is proposed. Irreversible strain is believed to be formed under in-plane shears. Normal strain varies proportionally to a respective shear at directions, normal to shear planes [1, 2]. This approach makes it possible to give due consideration of the fracturing and pore development without applying Kachanov –Rabotnov kinetic equation for damage [3, 4]. Material failure is initiated when the maximum shear reaches the critical value and results in the shear-strength loss. The model, based on the maximum shear stress and the exponential law, provided the grounds to solve the problems on strain and failure of an elastic-creeping body at the stages of nonstationary and stationary creep. The study objects are cylindrical and spherical cavities in an infinite body under internal pressure, pure bending of a rectangular cross section bar, and torsion of a round bar. Stresses, creep strains, fracture start time and complete failure time, as

well as the fracture front's position and velocity any time are determined for the considered structural elements.

Kolesnikov V.I., Bardushkin V.V., Sychev A.P., Chekasina I.I., Yakovlev V.B.....317

Effective elastic characteristics and anisotropy of inhomogeneous rocks of quartz matrix – biotit type

Numerical modeling of dependence of effective elastic characteristics of materials quartz matrix – biotit type from concentration and the shape of inclusion has been spent. Quartz crystallites have isometric shapes, inclusions of biotit were modeled by ellipsoids of revolution with a main semiaxis oriented in z direction. Isotropic orientations distribution function (ODF) was considered for quartz crystallites, axial ODF in z direction (coaxial with 6th order axis of biotit) was used for biotit inclusions. The calculated effective elastic modules were used for the determination of the parameter of anisotropy in z direction.

Kossovich L. Yu. and Kirillova I.V.321

Asymptotic theory of transient waves in thin shells

The paper devoted to mathematical modeling of transient wave propagation in thin shell by asymptotic methods based on exact three-dimensional elasticity. Longitudinal actions of tangential, bending and normal types are considered. An asymptotic model of wave propagation in a semi-infinite shell of rotation is used, which employs the two-dimensional Kirchhoff-Love (tangential and flexural) components, the solutions of the quasiplane problem of elasticity, the parabolic boundary layer near the quasifront, and the hyperbolic boundary layer near the expansion wave front.

Kuvyrkin G.N., Golovin N.N., Zarubin V.S.....326

Thermomechanics space reinforced and thermodecaying composites

The features of thermodeformation space reinforced and thermodecaying composite materials on the basis of carbon are stated from uniform thermodynamic positions. The basic system of the defining equations is formulated. The approach to identification of characteristics of components of space reinforced composites is offered. Results of numerical modeling the temperature fields and stresses in structures are presented.

Kusnetsov S.I.331

Analytical and numerical research of incompressible finite deformable solids

At this paper two methods for solving of problems for hyperelastic bodies are considering. The first method is to use the Ericksen universal deformations. The second method is to find minimum of energy functional. The Mooney-Rivlin potential for incompressible material is used. The experimental method for identification the material constants is proposed.

Kukudzhyanov V.N., Kolomiets-Romanenko A.V.335

On influence of thermo electrical pulse electroplastic effect under simultaneous and separately action of electrothermal field and mechanical loading

The properties material consisted from periodical representative elements with microdefects (cylindrical micropores, flat microcracks) is investigated. Firstly the separate elements is considered. The simultaneous and separate loading of thermoelectrical and mechanical is considered taking into account microdefects of material. The main defect is finding closing of the cracks under electric pulse on the first stage of loading and after due to thermomechanical localization on the ends of cracks and melting the material leads to increasing its porosity. It is shown that the presence of circular cylindrical defects under the influence of an electric current appears weak concentration of temperature, while for planar cuts (microcracks), this concentration is very essential. A further electric shocks to the representative element with cylindrical defects does not lead to their closure due to the small compressive displacement. This result is repeated for the sample with an ordered structure of representative elements. This phenomenon leads to an increase of the strength of the sample, but due to the application of electric current it leads to simultaneously thermal softening of the material. The material

ordered structure of the defects under simultaneous action of electric field and the tension is softening and the increase in the yield plateau. These results clarify the mechanism of change of material properties of termoelectroplastic model.

Lokoshchenko A.M. 340

Some problems of creep and creep rupture of metals

Yu.N.Rabotnov has formulated the theory of metals creep in his monograph [1]. This theory is founded on state equation with structure parameters, which are determined by systems of kinetic equations. Below some problems are considered, which are connected with new special kinds of kinetic equations for circumscription of experimental data. The method is suggested of measuring of structural damage, which is accumulated in metals during a high-temperature creep process in uniaxial extension. A new approach is suggested for the modeling of creep and creep rupture of metals under the simultaneous influence of mechanical loads at a complex stress state and an environment. The possibilities of vectorial interpretation of damage parameters are considered for modeling of creep rupture at stationary and unstationary complex stress states.

Lokoschenko A.M., Teraud V.V. 344

Experimental and theoretical study of the high temperature creep shortening for a circular cylinder

We considered some problems of a circular cylinder, when it is pressed between two meeting rigid die tools under high temperature creep. The theoretical solution proposed takes in account nonlinearity of its physical and geometric properties. Experimental study was carried out on a high temperature press in Mechanics Institute at the Lomonosov Moscow State University. Additional experimental tests allowed to find creep characteristics of the cylinder material under high temperature. It has been as a result established that at shortening the cylinder to some set height different kinematic– power programs it is possible to save about 20 % of energy.