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**FRACTURE OF COMPOSITE AND HIGHLY ELASTIC MATERIALS
AT COMPRESSION ALONG TWO PARALLEL CLOSELY SPACED
PENNY-SHAPED CRACKS**

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The axisymmetric problem of fracture of composite and highly elastic materials with two parallel penny-shaped cracks under compression along the crack plane was considered. As materials, a composite with the given characteristics of a transversely isotropic body and a highly elastic material with a Bartenev-Khazanovich potential were investigated. The analysis of critical shortenings made it possible to evaluate the applicability of the "beam approximation" in solving such problems.

**ON IMPROVEMENT OF THE CONVERGENCE METHODS
OF SUCCESSIVE APPROXIMATIONS IN SOLVING
THE BOUNDARY-VALUE PROBLEMS
OF THERMOVISCOPLASTICITY**

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A procedure has been suggested to increase the convergence velocity in the process of successive approximations for the boundary-value thermoviscoplasticity problems using the constitutive equations of the theories of simple loading processes as well as of small curvature processes. A supposition equality of specific work of the specimen and the body elementary volume deformation under corresponding values of tangent stresses intensities und shear strains is assumed as the basis. It is shown in concrete examples that the proposed method has diminished the number of approximations almost twice.

METHOD OF COMPONENT DECOMPOSITION FOR DETERMINING THE UNSTATIONARY THERMOPLASTIC STATE OF PLATES AND SHELLS

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The object of research is the method of approximate calculation of the temperature and stress-strain state of spatial bodies of non-canonical shape, plates and shells. The purpose of the work is to create a new version of the method of increased accuracy for determining the non-stationary stress-strain state of thin-walled heterogeneous structural elements under non-isothermal loading. The method of research is the method of component splitting using differential operators for approximation and interpolation of the solution between nodes of cubic spline functions and stress spline functions. Initially, the difference between the results obtained according to the explicit scheme and with the help of the iterative procedure may differ even qualitatively, but with an increase in the number of iterations, there is a noticeable tendency for their convergence. The use of the apparatus of spline functions makes it possible to write down new, more accurate difference expressions for the differential operators included in the splitting scheme. This made it possible to increase, at least by an order of magnitude, the accuracy of coordinate calculations when solving the non-stationary problem of the theory of thermoelasticity for plates and shells.

ON TAKING INTO ACCOUNT THE REAL PROPERTIES OF COMPOSITES IN THE ANALYSIS OF STRESS CONCENTRATION IN THIN-WALLED MEMBERS OF ROCKET AND SPACE TECHNOLOGY

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Polymeric composite materials can exhibit nonlinear-elastic properties. In addition, spatially reinforced composites are characterized by the so-called "not small" shear stiffness. A phenomenological approach was used to describe the nonlinear-elastic properties of composites. To improve the convergence of the numerical method based on the shear model, a mixed functional was proposed, in which the shear strain is additionally varied. The technique allows to analysis the nonlinear elastic state of shells made of composites of arbitrary shear stiffness, including the limiting case of the Kirchhoff–Love hypotheses.

EXPERIMENTAL STUDIES OF THE INFLUENCE OF THE LONGITUDINAL CONNECTING THICKENING OF THE CYLINDRICAL SHELL WALL ON THE CRITICAL STRENGTH OF THE LOSS OF STABILITY

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The results of experimental studies of the influence of the stiffness of the longitudinal connecting seam on the lateral surface of the cylindrical shell on the critical force of loss of stability during axial compression and torsion are given. Instead of solving the problem of manufacturing models of cylindrical shells under the same conditions in the presence and without a connecting seam, a technique is proposed for implicitly studying this aspect of the problem by studying the effect

of the location of one circular hole of different diameters, at different distances from the connecting thickening in the middle cross-section on the critical force of stability loss. The results are presented in the form of graphs of the critical force dependencies on the angle of the hole relative to the connecting seam. The data obtained can be useful for substantiating the reliability of mathematical models of the processes of loss of stability of shell structures.

SPLITTING ALGORITHM FOR DETERMINING THE TEMPERATURE FIELD OF AN UNEVENLY HEATED THIN-WALLED LAYERED SHELL

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The report considers the problem of determining the non-stationary (in the settling mode) axisymmetric temperature field in thin layered shells of rotation during combined heat exchange with the environment. New calculation iterative formulas for the numerical solution of the two-dimensional non-stationary heat conduction equation with increased time accuracy have been obtained. The results of calculations based on the developed methodology are compared with solutions obtained using the ANSYS software complex.

NUMERICAL STUDY OF NONLINEAR DEFORMATION OF SHELL MEMBERS OF ROCKETS WITH HOLES

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Within the framework of classical and refined shell models, a numerical technique has been developed for calculating stress concentrations in thin-walled members of rockets, taking into account physical and geometric nonlinearities. The proposed technique is based on the use of the stepwise loading procedure, the modified Newton–Kantorovich method, the initial stress method, and the finite element method. The geometric relations are written in vector form based on the geometrically nonlinear theory of shells in the quadratic approximation, and the physical ones are based on the theory of flow with isotropic strengthening for metals and the deformation theory of plasticity of anisotropic media for composite materials. With the help of the developed methodology, the concentration of stresses in spherical, cylindrical and conical members of rocket and space engineering structures, weakened by circular and rectangular holes, was investigated.

FEATURES OF THE SPHERICAL PARTICLE MOTION BY THE PLANE BOUNDARY OF A LIQUID UNDER ACOUSTIC FIELD

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Main features of a rigid spherical particle motion in the vicinity of plane boundary of the ideal compressible liquid under acoustic field are studied. The case of incident wave propagating in perpendicular to the bounding plane is studied in details. As a result, the spherical particle appears to be located in the field of standing wave having its node at the boundary surface. The acoustic radiation force

(ARF) is chosen as a measure of interaction between the acoustic field and the particle. The velocity field potential obtained as a solution of a linear problem of the incident wave diffraction on the spherical particle along with the wave reflection from the plane surface is used to attack the problem. ARF dependence on the liquid density to the particle material density ratio, on the distance between the particle and the boundary as well as on the acoustic field parameters are studied in details. It was found that there exist incident wave frequencies causing zero ARF. They correspond to stable or unstable equilibrium positions of the particle. Variation of the frequency causes the spherical particle vibrations about the stable equilibrium position.

DYNAMIC THERMOMECHANICAL RESPONSE OF METAL PLATE TO THERMAL PULSE LOADING

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Axisymmetric problem on the thermal pulse irradiation of the steel circular plate is investigated in the frame of dynamic coupled thermomechanics with making use of thermodynamically consistent model of inelastic material behavior. Thermal dependencies of physical and mechanical properties of the material are taken into account. The problem statement obtained is essentially nonlinear. This stiff-type nonlinearity demands application of the numerical approaches to be attacked. The problem is solved by means of FEM technique. Evolution in time and regularities of strain-stress and thermal states of the metal circular plate are studied. Dynamic effects accompanying the irradiation and following gradual cooling processes are investigated in details. Dynamic and quasistatic components of the stress field as well as residual state characteristics are studied.

APPLICATION OF COMBINED FRAME-ROCK BOLT SUPPORT TO REDUCE WATER INFLOW INTO MINE WORKINGS

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Spatial arrangement of steel-polymer rock bolts makes it possible to form an impenetrable rock-bolt structure around the mine working. In this way, two tasks are solved at the same time: the mine working is kept in a stable state and its waterproofing is performed. However, if the mine working is located in watered unstable rocks, then even after the rock bolts setting, the gash of wet edge rocks is possible. The combined frame-rock bolt supporting ensures the stability of the mine working, its waterproofing and protection against the collapse of wet edge rocks into the mine working due to the use of steel frames and wire mesh in addition to steel-polymer rock bolts.

FUZZY CONTROL MODEL FOR AQUARIUM

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The task of building a fuzzy control system for biochemical processes in an aquarium of the "herb" type is under consideration. A fuzzy model of aquarium management should stabilize biochemical processes in such a way as to satisfy the needs of both fish and plants. The input and output linguistic variables are declared,

IF-THAN rules for fuzzy inference system are set. These rules provide: control over the day-night cycle and water temperature, maintenance of sufficient level of carbon dioxide and oxygen in water, maintenance of a stable and harmless nitrogen cycle, maintenance of Redfield ratio (ratio of nitrogen to phosphorus), control over levels of iron and potassium in water.

STRESS-STRAIN STATE OF A PLATE WITH WEDGE-CUT NOTCH UNDER COMPLEX LOADING

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On the basis of the developed numerical algorithms, boundary value problems for a rectangular plate with a wedge-shaped notch are solved for various angles of the wedge and for various external loading schemes. Taking into account the processes of complex loading, stress-strain state and zones of plasticity near wedge-shaped notch were built. This made it possible to investigate the previously unconsidered question of the influence of the loading history on the parameters of the stress-strain state of such a plate. It is shown that it can be significant. For comparison, solutions to similar problems were obtained within the framework of the flow theory with isotropic hardening under the same schemes of external loading, as well as using the deformation theory under simple loading. It indicates that the simplest variants of the theory of plasticity, usually used in calculations, make it possible to obtain satisfactory results only under simple loading.

A NONLINEAR PHENOMENOLOGICAL MODEL FOR DESCRIPTION OF THE PROPERTIES OF FORM MEMORY MATERIALS

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The paper proposes a new phenomenological model for describing the properties of materials with shape memory under significant deformations (*P. Steblyanko, Y. Chernyakov, A. Petrov, V. Loboda, Theoretical, Applied and Experimental Mechanics, No8: 205 (Springer Verlag: 2019)*). The model takes into account the heat released in the process of phase transitions in material points of the body. This made it possible to describe a number of experimental data on different samples at different temperatures and load conditions, to obtain the necessary constants of the proposed phenomenological model.

In the case of deformation of a thermo-pseudo-elastic-plastic material, the physical relationships of the theory of plasticity (the theory of flow with kinematic and translational strengthening) were generalized, which made it possible to apply the developed phenomenological model in solving problems of thermomechanics at the continuum level.

In order to improve the time approximation of the method to the third order, a convergent iterative procedure is proposed. The initial approximation for it will be the results calculated using the formulas of the explicit scheme of the splitting method. The effectiveness of the generalized method was investigated and the accuracy of the obtained results was assessed. A new class of problems on the non-stationary deformation of spatial bodies made of alloys that have the properties of shape memory and thermo-pseudo-elastic-plasticity is presented and solved on the basis of the proposed method.

COMPUTER SIMULATION OF HYDRODYNAMIC PROCESSES DURING SURGICAL OPERATION ON THE EYES

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In this paper, we consider the problem of modeling hydrodynamic processes during eye surgery for cataracts. At the second stage of the operation (after removal of the lens), the cloudy lens masses are washed out from the capsular bag and the anterior chamber of the eye. To describe this process, a two-dimensional model with averaging over the depth of the eye chamber is used. The replacement fluid enters the eye chamber through one circular opening and flows out through another opening and an incision at the border of the region.

The model of a potential incompressible fluid is used to describe the internal flows of a fluid. A boundary value problem is formulated for the potential of the velocity vector in a circular region. The solution of the problem is found using the finite element method using the mathematical package Matlab. Calculations were carried out for various values of geometric and physical parameters.

RESEARCH OF THE TEMPERATURE DEPENDENCE OF THE MATERIAL SURFACE IN THE AREA OF THE STRESS CONCENTRATION FROM THE SPEED OF LOAD AT THE SAMPLES FROM POLYCARBONATE

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The results of experimental studies on determining the temperature in the zone of stress concentrators in polycarbonate samples during bending are given. The energy of the thermal pulse was measured by a calorimetric device of the ICT-1n type and a two-beam oscilloscope C1-69. The duration of the heat flow was recorded by the C1-69 oscilloscope. Registration of the stress-strain state in the vicinity of concentrator holes was carried out by the caustic method. The dependences of the temperature in the concentrator zone on the load speed are plotted. Temperature pictures obtained with the help of a thermal recorder are given. The obtained results can be useful for building a method of non-destructive control of structural elements.

INCREASING THE RELIABILITY OF CLUSTER INFORMATION PROCESSING SYSTEMS

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With the development of computer networks, two or more computers began to be called clusters (servers or workstations), connected into a single system by special software and hardware. Such clusters can be considered as a computing system with distributed memory and distributed management. The system provides enough high level of parallelization, reliability, availability and ease of maintenance relatively low costs. One of the strict definitions of the term "clustering" is the expression: "implementation of the unification of machines, which is a single whole for the operating system, system software, applications and users".

DEVELOPMENT OF A TEXT DISTORTION CORRECTION ALGORITHM TO IMPROVE THE QUALITY OF TEXT RECOGNITION ON IMAGES

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Optical Character Recognition (OCR) is a technology that allows you to convert scanned documents, PDF files or photos into text format. Presentation of information in text documents is more convenient than in graphic images, because it allows you to speed up and simplify the process of further processing of documents, reduce memory costs for storing and transmitting information. But on scanned images or photos, text often has a skew, which degrades the quality of recognition results. This is the problem of using OCR systems. Therefore, there is a need for pre-processing of the image. An algorithm for correcting the skew of the text block on images was developed, which made it possible to improve the quality of character recognition by the OCR system. Also, an application was created in Python using the free Tesseract OCR library. Image processing methods from the OpenCV library were used to implement the algorithm. The user interface contains two buttons that allow you to load the image and correct the skew. Text recognition results are displayed in a text field.

MATHEMATICAL MODELING OF VISCOPLASTIC FLUID FLOW ON A CONIC SURFACE

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The problem of the spatial flow of a film of a viscoplastic fluid over the surface of a cone with a noncircular cross section under the action of gravity is considered. To describe the film flow, the model of a viscous incompressible fluid is adopted. The conditions of "sticking" on the surface of a solid body, as well as the conditions of continuity of stresses and the normal component of the velocity vector - on the surface separating liquid and gas are taken as boundary conditions. To close the system of differential equations, the Shvedov – Bingham viscoplastic fluid rheological model is used. To simplify the system of equations, the small parameter method is used, in which the relative film thickness is chosen. The solution of the equations of continuity and fluid motion (taking into account the main terms of the expansion) is obtained in an analytical form. A boundary value problem is formulated for an unknown film thickness. Calculations of liquid film flows over the surface of conical bodies with cross sections in the form of an ellipse, as well as a triangle with rounded edges, are made.

WEIGHT OPTIMIZATION OF NON-HOMOGENEOUS ROTATION SHELLS BY METHODS OF OPTIMAL PROCESSES THEORY

*Dzyuba A.P., Dzyuba P.A., Levitina L.D., Sirenko V.M.
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Mathematically and mechanically correct models and methods of application of methods of the theory of optimal processes for reduction of material consumption of elastic inhomogeneous rotation shells of variable stiffness are constructed. The results of weight optimization of shell structures are presented.

PLASTIC FLOW STATE MONITORING

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At proportional loading, the body material fibers, depending on their orientation, can stretch, compress or not change their length. The material fiber direction, that do not change their length is separation line between those that are compressed and stretched. Beyond the elastic limit, this separation line changes orientation relative to the material fibers. A method of plastic flow state monitoring by changing of the deformation sign of material fibers at proportional loading is proposed. The possibility of plastic flow state monitoring during uniaxial tension and compression has been proven theoretically and experimentally.

INFLUENCE OF AN IDEAL FLUID HALF-SPACE ON SURFACE INSTABILITY OF AN INCOMPRESSIBLE ELASTIC HALF-SPACE EXPOSED TO FINITE INITIAL DEFORMATIONS

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The problem of normal waves propagation in a pre-deformed incompressible elastic a half-space that interacts with a half-space of an ideal compressible fluid is considered. The study is conducted based on the three-dimensional linearized equations of theory of elasticity of finite deformations for the incompressible elastic half-space and the three-dimensional linearized Euler equations for half-space of ideal compressible fluid. The problem formulation and the approach, based on the utilization of representations general solutions of the linearized equations for elastic solid and fluid are applied. A dispersion equation, which describes propagation of harmonic waves in hydroelasticsystem is obtained. The effect of the finite initial deformations of elastic half-space and of the half-space of ideal compressible fluid on the surface instability of the hydroelastic waveguide are analyzed.

NUMERICAL AND EXPERIMENTAL MODELING OF THE BEHAVIOR OF FLEXIBLE SHELL ELEMENTS OF STRUCTURES

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The results of a comparative analysis of the application of two mathematical models of deformation of flexible shell elements, obtained by direct integration of boundary value problems of shell mechanics, by the finite element method and experimental research, are presented.

The problems of axisymmetric nonlinear bending of thin ring plates, corrugated membranes of a sinusoidal profile and bellows as a shell of rotation with a complex meridian shape are considered.

Using the necessary optimality conditions of the principle of maximum L. S. Pontryagin obtained the results of the optimal design of a flexible corrugated membrane with a sinusoidal profile of the highest sensitivity.

The results in the form of tables, photos and graphs are presented

ON THE APPLICATION OF MATHEMATICAL MODELING TO THE PROBLEMS OF INTERNATIONAL TRUCK TRANSPORTATION OF SPECIAL CARGO

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The paper considers the application of mathematical modeling to the study and forecasting of transportation of special cargoes in international traffic. The practical significance of the model is determined by the identification of actually existing connections and a justified forecast of the development of the process of international transportation of special cargoes. A common method of estimating model parameters and taking into account the features of the original economic information is used to solve the problem. A correctly constructed multifactor linear model makes it possible to analyze the company's work and forecast the quantitative indicators of international transportation of special cargo at given values of the most important external factors.

THE USE OF IT TECHNOLOGIES IN THE STUDY OF CONTACT INTERACTION OF A PRE-SRESSED CYLINDRICAL STAMP AND TWO HALF-SPACES WITH INITIAL STRESSES

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Taking into account the initial stresses when calculating the critical elements of the structure, machines and structures will allow (when creating them) to more effectively take into account the strength resources of materials by correctly assessing the strength reserves and significantly reduce their material capacity, preserving the necessary fundamental characteristics as a whole. A computer program and algorithm of numerical calculation components deflected mode of contacting bodies with initial stresses was proposed. The problem was reduced to solving an infinite system of algebraic equations.

TO THE PROBLEM OF MATHEMATICAL MODELING OF TURBULENT FLOWS AROUND VEHICLES

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The determination of aerodynamic characteristics of vehicles is associated with the description of turbulent flows. The key issue of computational aerodynamics remains the search for an acceptable compromise between the physical adequacy of the model and the level of its computational complexity. The problems of modeling turbulent flows around vehicles are considered. In this regard, the task of semi-empirical description of turbulence comes to the fore. Their development is evolving towards more and more complex physical and mathematical models. This requires more and more research aimed at expanding the scope of mathematical models.