ABSTRACT AND REFERENCES

APPLIED MECHANICS

THE INFLUENCE OF INHOMOGENETIES ON THE CANTILEVER BEAM STIFFNESS (p. 4-7)

Alexander Shamrovsky, Dmytro Kolesnyk, Olena Mikhailutsa

It is proposed in the paper to conduct a computational experiment on the determination of the influence of inhomogeneities on the cantilever beam stiffness using a discrete model of the continuous medium. This approach allows to consider the materials with arbitrary discrete inhomogeneity. Inhomogeneities are represented by various variants of the composition of two materials with different elastic modulus and Poisson's ratios. The study of the influence of these inhomogeneities is supposed to conduct by studying the geometrically nonlinear deformation of the cantilever beam, subjected to the uniformly distributed load. Calculation of the discrete model is made by the method of successive displacements. Based on the obtained calculation results, it is proposed to construct the diagrams of the dependence of dimensionless movement of the end of the cantilever beam along the axes of abscissas and ordinates on the dimensionless load for different schemes of composition of two materials. The obtained dependences allow to draw conclusions on the changes of the stiffness characteristics of the beam depending on the scheme of materials composition. The obtained results completely correspond to the expected results, allowing to draw conclusions on the direct influence on the stiffness of the cantilever beam by the inclusion of material with much higher stiffness than the main. Herewith, the form of the composition of two materials also greatly affects the stiffness of the console as a whole.

Keywords: cantilever beam, inhomogeneities, large displacement, stiffness, discrete model, lattice model

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ASSESSMENT OF THE MARGIN OF SAFETY OF MACHINE PARTS SUBJECT TO ASYMMETRIC LOADING (p. 8-12)

Alecsandr Zheldubovskii, Anatolii Pogrebniak, Mikhail Regulskii, Alexandr Serditov, Yurii Kliuchnikov, Pavel Kondrashev

Creation of engineering structures is closely related to the need of improving the methods for strength calculation. This task is especially relevant with regard to the parts subject to cyclic loadings, causing premature failure as a result of the development of the metal fatigue process. In this regard, it is important to develop the research aimed at finding adequate model approximations that describe the interrelation of durability of a construction material with the range of loading conditions and the number of structural features of parts made of it.

The method of calculating the safety margin of parts of engineering structures subject to the combined effects of static and cyclic loadings is considered in this paper. The focus is on assessing the maximum limit stresses characteristic of the asymmetric loading of structural materials, taking into account the stress concentration as one of the main factors inherent in real structural elements. The proposed approach provides more correct calculation of the margin of safety in the implementation of design works.

Thus, the research results given in this paper are of both scientific and practical interest. The authors proposed a method for assessing the margin of safety of constructional materials subject to asymmetric cyclic loading, based on the previously developed models of the limit state based on the use of power transcendental functions.

Keywords: margin of safety, static and cyclic loadings, maximum stresses, asymmetric loading.

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MICROSCOPIC DESTRUCTION OF A STRUCTURAL INHOMOGENEOUS BAR OF A FINITE LENGTH UNDER A LONGITUDINAL IMPACT (p. 13-16)

Rahim Guliyev, Alizade Seyfullayev, Afat Yuzbashiyeva

The majority of structures in modern technology, industry and production are subjected to the influence of loads. Nowadays, a wide use of polymers and composite materials requires the study of long preservation of hardness and a problem of destruction of the structures made of such materials and subjected to the influence of loads.

Using a characteristic method, the destruction of a structural inhomogeneous bar, which is subjected to an impact in its left end in the direction of its axis, was studied, and the dependences of the first and full moments of destruction after various mechanical characteristics were found by a numerical computation. Finding of an analytical solution, characterizing the study, is rather difficult and, therefore, the problem was solved approximately. The results show that the effect of proportions of mechanical characteristics of the bar parts on the destruction process is significant.

Keywords: polymer, longitudinal impact, nonlinear heredity, damage, healing of defects, durability

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INVESTIGATION OF FREE OSCILLATIONS OF THE SPHERICAL SHELL CONTAINING A LIQUID BY THE INVERSE METHOD (p. 16-19)

Guldasta Mamedova, Mexseti Rustamova, Samir Aqasiev

The problems of free oscillations of shells, contacting with the continuous medium are considered in the known works of various authors. As a rule, the problems are reduced to the transcendental equations or the systems the solution of which by analytical methods is not possible. The results of the investigation are presented in the form of tables or graphs, obtained by numerical methods. The problem of axisymmetric free oscillations of elastic thin-walled spherical shell, containing a compressible liquid is considered in the paper. Herewith, the equations of motion are constructed in radial motions and with the use of special potential. The problem is reduced to the investigation of the homogeneous system of two equations with respect to the radial motion and the mentioned potential. The condition of non-triviality of the system solution leads to the transcendental equation. In the known works, the solution of the specified transcendental equations is found by numerical methods. The analytical solution, binding the frequency of the system shell - liquid with the frequency of the shell without the liquid is constructed by the inverse method. This solution allows to investigate the phenomenon of the analytical method and to build the frequency spectra.

The potential motion both of shell and liquid is considered. The equation of the shell motion in special potentials is used. The liquid motion equation is represented by the wave equation. The liquid motion is proposed as non-separable.

Keywords: oscillations, wave, frequency, density, shell, pressure, potential.

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MODELING AND PREDICTION OF MATERIAL WEAR BY UNFIXED ABRASIVE (p. 20-25)

Anatolii Kuzmenko, Ivan Bylokur, Oleg Vyshnevskyi

The generalized multifactor model of the interaction of friction surface with unfixed particles of abrasive, developed on the basis of similarity and dimension theory provides the determination of parameters of material wear. The use of the developed analytical dependences of determining the rate of linear wear of materials allowed significant reduction of the amount of basic experimental researches. The dimensionless multifactor criterion of similarity and the criterion equation allow estimating the influence of sliding distance, material hardness, sizes of particles of abrasive and abrasive pressure upon the sample on wear by unfixed abrasive. The correctness of the constructed model of abrasive wear in the unfixed abrasive was experimentally proved. The method of using the developed model for the prediction and evaluation of technical condition of operating supporting nodes of friction of cylindrical machine parts in the interesting point of time was justified.

Keywords: diagnostics, abrasive wear, test pattern, wear model, model parameters.

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JUSTIFICATION OF PARAMETERS OF ELASTIC SYSTEM OF VIBROCONVEYOR MACHINE WITH COMBINED KINEMATIC VIBROEXCITATION (p. 25-30)

Igor Palamarchuk, Vladyslav Palamarchuk, Vadim Drachishin

Transport-technological machines due to combining several operations in one production cycle, providing treatment continuity and easy adherence to production lines are in wide demand in the fields of agro-industrial complex. The use of vibrating conveyor machines adds potential capabilities of technological action intensification to the noted features. Thus, the main problems remain, such as reduction of dynamic loads on supporting units and system balancing.

To solve such problems, the constructive and technological measures are substantiated in this research paper to reduce the dynamic loads on supporting units of the drive mechanism by defining the basic criteria of assessing the elastic system of technological machine and obtaining their analytical expressions, combining the elements of kinematic and force vibroexcitation. Calculation of the kinematic characteristics of mechanical vibroexciters of technological machines allows determining the main dependencies of parameters of transport-technological or conveyor vibrating systems, that is important in their design and construction of the elastic system of vibration equipment.

Based on the analysis of modern equipment of vibration technological and transport-technological machines, the classification of the main structural elements of their elastic system was developed. The effect of additional elastic component from the deformed transporting element in the design of vibroexciters was justified by the example of calculation of conveyor vibrating machine.

Keywords: vibroexciter, motion dynamics, kinematic drive, vibrating conveyor, elastic system.

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SYSTEM OF VIBRO- AND SHOCK PROTECTION WITH DRY FRICTION (p. 31-33)

Yuri Kyrychuk

Despite the large number of discussions about the systems of shock- and vibroprotection, little attention has been paid to vibroprotection with dry friction. The single-axis system of vibro- and shock protection with dry friction, which at the given level limits the maximum acceleration of the isolated body at the single high-level shocks and at vibrations with the absent static zone of stagnation near the equilibrium, is first considered in the paper. The system is designed for providing the operational protection of the navigation device, installed on the aircraft, against shock overloads of large amplitude. The system design, principle of operation, the method for obtaining the mathematical model are given in the paper, components

of this model are shown. The obtained results prove the prospective of the new system of shock- and vibroprotection in use in navigation complexes of aircrafts, operating in extreme conditions.

Keywords: shock absorber, vibroprotection, vibration acceleration, damper, acceleration, mathematical model, shock protection, dry friction

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RESEARCH OF THE PROCESS OF ELIMINATION OF LARGE NUTATION ANGLES BY PASSIVE AUTOBALANCERS (p. 34-38)

Gennadiy Filimonikhin, Vladimir Pirogov, Irina Filimonikhina

This paper studies the process of eliminating large nutation angles arising from inaccurate initial rotation or imbalance of the spin-stabilized spacecraft using passive auto-balancers (pendulum, ball and liquid). An analogy in the operation of various types of passive auto-balancers (nutation dampers) (pendulum, ball and liquid) during removal of large angles of nutation was established. For pendulum, ball and liquid auto-balancers approximate law of changing large nutation angles in the case of axisymmetric and non-axisymmetric lifting body was obtained. It was found that the rate of changing the nutation angle is significantly affected by the ratio between the axial moments of inertia of the lifting body and the coefficient of viscous drag forces. The empirical formula was proposed for estimating the residual nutation angle resulted from incorrect installation of passive auto-balancers (nutation dampers) on the spin-stabilized spacecraft, as well as an example of its application for a specific Brazilian satellite (SACI-2) was given. It is shown that improper installation of the auto-balancer (nutation damper) on the lifting body can cause residual nutation angle even in the case of "steady" lifting body. The results can be used in the design of passive auto-balancers (nutation dampers) (pendulum, ball and liquid) for spacecrafts or spin-stabilized artificial satellites of the Earth.

Keywords: passive auto-balancer, nutation angle, damper, spacecraft, lifting body.

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REDUCTION OF ACOUSTIC ERROR OF THE FLOAT DIFFERENTIATING GYRO BY PASSIVE METHODS (p. 39-41)

Viktorij Mel'nick, Volodimir Karachun

The subject of the research is one of simply implemented methods of passive acoustic isolation of two-stage float gyro from effects of penetrating high level acoustic radiation by giving a catenoidal shape to the moving part of suspension.

The research is based on solving the problem of optimizing the meridian line of the shell of suspension, which allows to minimize elastic displacements of the float suspension surface in acoustic fields and, thus reduce the value of acoustic errors of differentiating gyro to the level of sensitivity threshold.

Numerical analysis of the influence of δ deflection of the shell of float suspension in the midship frame proves the effectiveness of passive methods for correcting the value of acoustic error during flight operations.

The results can be used in industry to create inertial means of flight-navigation equipment of aircrafts. They can also find application in the bench certification of board equipment for functional capacity in the operational mode.

Giving the catenoidal shape to the moving part of float suspension of gyro is supported by simplicity of technical realization, effect of reducing the errors of device in acoustic fields of flight operations and prospect of further improvement on the basis of resonance phenomena.

Keywords: bias, two-stage gyro, catenoid, acoustic radiation, sensitivity threshold

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CALCULATION OF STRESS-STRAIN STATE OF STAMP RIGGING ELEMENTS (p. 41-44)

Natalia Dyomina

The approach to the study of the stress-strained state of stamp rigging elements, taking into account the contact interaction is proposed in the paper. For this purpose, the integrated mathematical model was proposed, differing by the new approach: to determine the stress-strain state, instead of the traditional single-level mathematical model, the integrated multi-level mathematical model is used, taking into account the contact interaction of punches, matrixes and punch-matrixes, blanks and base plates of stamps.

The first-level model is the most effective in terms of assessment of SSS (stress-strain state) of cutting elements of SD (shearing die). Each element of the technological system in it is considered separately from the others, and the interaction forces are known from previous experimental, analytical and numerical studies.

The second-level model considers the contact interaction of elements of stamps with the blank, but only up to the stage of plastic deformation of the stamped material.

The entire interaction process up to the modeling of the division of stamped material is investigated using the third-level mathematical model.

Undoubted advantage of the models of the second and third levels is the ability to determine the contact zones and contact forces, arising between the elements of stamps and blank.

The developed integrated mathematical model is realized in the form of the set of models using the method of finite elements, which allow to conduct a great number of multivariate studies of the stress-strained state of the shearing dies in the automated mode. This makes them valuable for carrying out scientific researches and practical calculations.

Keywords: stress-strain state, stamp, contact interaction, stamp rigging element, technological system

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SINGLE THEORY OF MOVERS ON THE CONTINUOUS FLOWS. SHORT THEORY OF CONCURRENT-ROTATING PROPELLERS (p. 45-52)

Borys Mamedov

In the concurrent-rotating propellers, the second rotor wheel has higher performance than the first one, so the gas flow is injected (absorbed) through the channels between the blades of the first rotor wheel, which in this mode does not compress the gas flow, and functions as rotating guiding device, which allows to obtain the sinusoidal characteristics of the axial velocity change with ensuring zero acceleration of the gas flow at the input edges of the second rotor wheel blades, which compresses the flow and produces thrust. Injection (absorption) of the gas flow through the channels between the blades of the first rotor wheel also promotes the swirling of the gas flow in the area H-B_1 and the emergence of additional gradient of static pressures, grad Pd, which pulls the flow into the bundle before and after the section B1-B1, while before the section B_1-B_1 this additional gradient of static pressure facilitates further acceleration, and in the B1-B_2 section slows down the gas flow, providing its sinusoidal characteristics in the H-B_2 section. Thus, the sinusoidal characteristics of the change of the axial velocity of the gas flow in the H-B_2 section allows to eliminate the kinematic zone of rigid (elastic) impact in the section B_2-B_2 that allows to increase the turnover, and, therefore, the thrust of the second rotor wheel of the concurrent-rotating propellers by 200-300 % as compared to the turnover and thrust of the one-row propellers.

Keywords: kinematic analysis, concurrent-rotating propellers, blown profile thrust and lifting capacity.

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ELASTIC DEFORMATION OF THE BEARING SURFACE OF A PLAIN JOURNAL BEARING OF TURBOCHARGER (p. 53-58)

Viktor Kravtsov, Miroslav Kindratshuk, Alexandr Didenko, Mehrdad Sadeghijalal

The methodology of studying the elastic deformation of the bearing surface at the simultaneous action of forces, gradually arising from start to stop, is proposed on the example of the operation of the journal thrust bearing of turbocharger of the gas compressor unit turbine. For that, the mathematical model was used, which describes the balance and deformation of spatially curved element, its external and internal geometry. The methodology of numerical solution of the problem is based on the combined application of the continuation method and Newton-Kantorovich method.

The problems, which arise in the operation of plain thrust bearings of the compressors of turbo generators are described in the paper, the analysis of the literature on this subject is given. It is shown that, as a rule, local problems, describing any separate process, are still considered in the problems of friction. In this respect, it was pointed out that the process of friction is inseparably linked with the large number of load factors, which have not yet been considered simultaneously. During the description of the methodology, its sense was outlined, the ways of setting the possible loads, which can be applied or taken away during the bearing operation were shown. The possibility of investigating the bearing surface with a non-circular (oval) geometry of the axial line was shown on the example of the plain thrust bearing of the turbocharger. The research results are presented in the form of diagrams, which show the values of some characteristics of the stress-strain state of the bearing surface of the plain journal bearing of the turbocharger with specific physical and geometrical characteristics in dimensionless quantities.

Keywords: friction, bearing surface, elasticity, loads, mathematical model, numerical methods

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