ABSTRACT AND REFERENCES

APPLIED MECHANICS

THE LOAD FACTOR IN CALCULATING THE STRENGTH OF THE SEPARATOR OF ROLLER BEARINGS (p. 4-7)

Anatoly Gaydamaka

The strength of separators of roller bearings taking into account their operation, performance and design features is proposed to estimate using the load factor of separator, comprising the dynamic factor of external load, dynamic factor of load on separator by rollers, load factor of separator at misalignment, stress concentration factor. Dynamic factor of external load of bearing assesses intensity of the load, acting on the bearing assembly of the machine, and is defined by the industry reliability service. Dynamic factor of load on separator by rollers is determined by calculating the shock load of the separator with rollers and according to the mechanism of motion transmission from the roller to the separator. The load factor of the standard separator at misalignment to the locator ring of the bearing is determined by the model of contact between two non-centrally loaded cylinders. Determining the stress concentration factor is performed by calculating the separator design using the finite element method. The conducted studies of the load factor of separators of roller bearings will be used to develop an analytical method for calculating the separator strength.

Keywords: separator, roller, misalignment, bearing, dynamic factor, load, stress

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THE IMPACT OF LIFTING THE MERIDIAN LINE OF THE SUSPENSION ON THE ACCURACY OF THE INERTIAL SENSOR (p. 8-12)

Volodimir Karachun, Viktorij Mel'nick

Numerical analysis of the effectiveness of reducing the impact of a shock N-wave of hypersonic flight using the methods of design and technology solutions is carried out. In particular, through the transition from surfaces with non-zero Gaussian curvature of the moving part of float suspension of two-stage inertial sensor to surfaces with non-zero Gaussian curvature. Technical realization of this transition lies in an artificial lifting the meridian line of float by the value δ in the middle frame. Elastically deformed surface of float suspension in the case of cyclic loading by diffuse sound field with intensity 200 Nm^{-2} and frequency 3000 s^{-1} is presented. Numerical values of maximum elastic displacements of the suspension surface in the middle frame of the moving part of a commercially available device are given, and the systematic inaccuracy of sensor for several variants of lifting the meridian line of the float is determined. In particular, lifting the meridian line of the middle frame by the value of $(1,7\div1,8)10^{-3}$ m allows to provide the systematic inaccuracy of the device in the acoustic field at the level of its sensitivity threshold, i.e. not higher than 0.45 deg s^{-1}. Results can be used for testing prototypes and assessing the compliance of operating devices with the passport requirements.

Keywords: systematic inaccuracy, inertial sensor, meridian line, middle frame, gyro suspension

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MATHEMATICAL MODELING AND CALCULATION OF FORCED RESONANT VIBRATIONS OF COMPOSITE ELECTROMECHANICAL SYSTEM (p. 12-17)

Ivan Lastivka

Resonant vibrations of composite electromechanical symmetric three-element system “metal plate - piezoceramic cylindrical panels” are considered. Forced vibrations are made under the influence of external alternating electric field, supplied to the electrodes of piezoceramic segments of cylindrical panels, previously polarized in the tangential direction.

Based on the improved theory, such as the S.P. Timoshenko’s, the system of differential equations of forced vibrations of the system, taking into account energy dissipation of relatively radial and tangential displacements, turning angle of the normal to the panel surface and longitudinal displacements of the plate is written. For the closure of the equation system, boundary conditions - kinematic and dynamic conditions of connecting cylindrical piezoceramic panels with the metal plate are formulated and written.

Integration of the full system of differential equations of vibration is performed, the dependence of radial displacements of panels and longitudinal displacements of plates on the vibration frequencies in the range, which includes the first two working resonant frequencies are found.

Amplitude-frequency characteristics of vibrations on the example of the central point of the panel (maximum radial displacements) and the end point of the plate (maximum longitudinal displacements) are built. Evaluation of the stress-strain state of the studied electromechanical system on the frequency of principal resonance considering energy dissipation is carried out.

Keywords: modeling of vibrations, metal plate, piezoceramic cylindrical panels, energy dissipation, stress-strain state.

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REDUCING THE DYNAMIC LOAD IN ROPES OF DRUM HOISTS (p. 17-22)

Tatyana Osypova, Artem Nesterov

Dynamic power transients in the rope wire of single-drum and double-drum hoists taking into account the dissipation of ropes and damping devices, which significantly absorb longitudinal vibrations, reduce the amplitude and time of vibration damping are considered in the paper. Oscillatory

processes in hoist ropes are described by differential equations in moments of elastic forces with constant factors and graphically shown on the oscillograms. Dynamic parameters of hoist ropes (maximum amplitude of dynamic moment, stationary dynamic loads, rope dynamic factor) when varying the dissipation factor of damping devices are determined. As a result of researches, the dependencies of dynamic factors of hoist ropes on varying the values of dissipation factor of damping devices are constructed, which show that, with an increase in the dissipation factor, dynamic factor of long ropes reaches almost 1 and of short ropes decreases slower because of their high rigidity. Using damping devices will allow to reduce the dynamic loads in the hoist ropes and improve performance characteristics of hoists in general.

Keywords: hoists, dynamic loads, damping devices in ropes, dissipation factor, dynamic factor.

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ONE-DIMENSIONAL MATHEMATICAL MODELS OF TENSION AND COMPRESSION OF SOLIDS (p. 23-27)

Igor Vengerov

Mathematical models of tension and compression processes for one-dimensional solid systems based on behavior analysis at an applied constant load of chains of particles with finite mass are considered. One-, two-, and N-particle discrete models are built. For the latter, limiting transitions to the continuum (continuous models) are performed. The phenomenon of failure of the Hooke's law for all models without considering the mechanical energy dissipation and its validity when taking into account the dissipation is revealed.

Relevance of the conducted researches is caused by previously unnoticed paradox: the Hooke's law, which describes the steady state of a macroscopic body with constant load applied to it, is used as the basis for the elasticity theory, equations of which are dynamic. In addition, in the Hooke's law there are no mechanical energy dissipation "traces", which is a very rough idealization.

Telegraph tension-compression equation, alternative to the Lame's equation in the elasticity theory is obtained. Unlike the latter, the equation found describes the evolving displacement field and can serve as a basis for generalizations: plasticity and creep equations in homogeneous and heterogeneous media. Relation, corresponding to the Hooke's law and describing the steady state of a deformable rod taking into account the mechanical energy dissipation is obtained.

The obtained results are of theoretical and practical importance since determining relations between the Hooke's law and discrete models and deriving telegraph viscoelasticity equations are prerequisites for improving the theory of deformation of solids and for the mathematical modeling of movements of real continuous media (rocks in particular).

Keywords: tension and compression processes, limiting transition to the continuum, Hooke's law.

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PARAMETERS OPTIMIZATION OF CENTRIFUGAL JUICER WITH AUTO-BALANCER BY MINIMIZATION OF TIME OF AUTOBALANCING OCCURRED (p. 28-32)

Valery Goncharov, Gennadiy Filimonikhin

A method for optimizing the parameters of passive auto-balancer in rotary machines in terms of minimizing the functional quality as a decay time of transition. It is based on the theory of planning multifactorial experiment, analysis of the experimental data using programs STATISTICA_6, MathCad. Technique is aimed at:

- construction of the approximating model correlation between functional quality and controlling factors of a rotary machine with auto-balancer;
- search the factor values for constructed model at which the functional quality takes the smallest and largest value.

Correlation is constructed as the equality of two functional expressions. Left-hand side is the expression relative to the functional quality. Right-hand side is the expression on the factors. The specifics of the problem is that the predicted minimum value of the functional quality should not be less than the acceleration time of the rotor.

As the right-hand side offered two varieties of functions: the Taylor series expansion in powers of the factors of the first and second order; with hyperbolic components. As the left side proposed three types of functions, suitable for finding the values of the functional quality, respectively the largest, smallest, as the smallest and largest.

Was conducted testing the proposed method for 3D model of juicer with auto-balancer.

The proposed method may be standard in the optimization of the parameters of passive auto-balancers in rotary machines by time decay of transients.

Keywords: centrifugal juicer, auto-balancer, parameters optimization, multifactorial experiment, regression function.

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SIMULATION OF SHOCK INTERACTION BETWEEN BODY AND FREE-SURFACE FLUID (p. 32-36)

Vladimir Katan

The problem of interaction between the plate, placed at some angle to the free surface of the fluid at an instant change in the plate elements velocity with the fluid is solved in the paper. Such a task can simulate the behavior of the steering body or active vessel stabilizer, as well as the operation of various elements of automatic equipment of hydraulic systems. The feature of the considered problem is the possibility of the liquid separation on individual body surface areas, on which the normal velocity component of the body elements is directed opposite to the fluid.

The literature contains an analytical solution of a similar problem only for the particular case, when the plate is perpendicular to the free surface. In the paper, this result is generalized for the case of arbitrary angle, an exact analytical solution of problems for the attached flow at any angle is obtained and the special case of inclination, at which an exact solution also exists for the flow with forming a separation zone is found.

For an arbitrary angle of the plate, hydrodynamic problem taking into account the separation is solved in quadratures. The usefulness and importance of the obtained data is that, as a result of the research, the impulsive pressure on the plate sides, which can be used for defining the total impulse force and moment, if to interpret the plate as a steering body was determined.

Keywords: shock interaction between body and free-surface fluid, shock motion.

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THE FLOW STABILITY WITH THE SMALL DISTURBANCES AND THE TURBULENCE APPEARANCE CONDITIONS INVESTIGATIONS (p. 36-41)

Andrij Oliinyk, Rostyslav Skrypiuk, Volodymyr Sheremeta

A mathematical model of the flow of viscous fluid in the pipeline in the presence of leakages through its surface, which is based on the Navier-Stokes equation system in a two-dimensional rectangular area with a special type of boundary conditions is developed. They take into account the geometric configuration of the leakage area. It is believed that the fluid motion is performed under the pressure drop, which is steady along the length. To solve this system, numerical finite difference method, which allows to realize the scheme, which on the first step is implicit on the longitudinal coordinate, and on the second - on the cross, is developed. The stability study using the spectral feature method is carried out, stability conditions for the case of calculating the flow with the set parameters and for a given type of the pipeline geometry are determined. Calculations for a wide class of boundary conditions are conducted. The patterns of the velocity distribution of various configurations of leakage areas and in their absence are defined. It is found that the effects of leakage presence are especially noticeable in the zone near the pipeline wall.

The pattern of deviation from the symmetry of distribution of the value of longitudinal component, depending on the distance to the leakage, velocity change near the pipeline wall, depending on the leakage intensity and parameters of the computational grid is determined. Peculiarities of flow behavior near the wall after the longitudinal component acquired zero value are defined. The results can be used when designing the localization system of small leakages of oil products with different leakage area configurations. In addition, the specified method can be used when studying utility pipelines, process pipelines in various industries. It was found that the developed method adequately describes the studied phenomena. Directions for further research, such as identifying dependencies for different kinds of liquids, pipeline specifications, leakage area configurations, as well as studies of more complex dependencies of pressure on the coordinates of the studied area are defined.

Keywords: symmetry of distribution, Navier-Stokes equations, stability of calculations, leakage areas, pipeline.

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INFLUENCE OF TECHNOLOGICAL PARAMETERS OF HYDROHAMMER DAEWOO DOOSAN ON ITS PERFORMANCE (p. 41-46)

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Nowadays, explosive methods of destruction of oversize rock pieces are obsolete. That is why, mechanical methods of destruction of oversize pieces became widespread recently. One mechanical method is crushing the oversize by hydrohammer. Today, this destruction technology for oversize pieces is studied insufficiently. Investigating the main factors, influencing the working equipment performance, and mineral production mining conditions will allow to increase the destruction process performance.

Experiments were conducted at the Sabarovskiy granite deposit (Vinnitsa, Ukraine). The basic excavator was DAEWOO DOOSAN SOLAR 255LC-V with hydraulic hammer DAEWOO DOOSAN DXB 90.

The publication gives the analysis of timing of oversize destruction by hydraulic hammer. Two bulks of oversize are analyzed - in one bulk, the oversize is laid partially with the working platform width of 10 m and the length of 35 m, in the second, oversize pieces are placed evenly with the working platform width of 15 m and the length of 40 m.

The factors, influencing mechanical oversize destruction efficiency and oversize location influence on the hydrohammer performance are considered, performance and energy intensity dependences on the volume of oversize at its different locations are determined in the paper. Experimental study of crushing the oversize into standard pieces in different technological conditions will allow to optimize the backhoe face plan and form the optimal face width for hydraulic hammers.

Keywords: crushing, hydrohammer, oversize, performance, energy intensity, face, efforts, basis, rebound, stope.

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IMPROVEMENT OF MIXING DEVICES FOR VOLUMETRIC GAS-LIQUID REACTORS (p. 46-52)

Vitaliy Storozhenko, Vsevolod Sklabinsky, Sergey Shabratsky

The laboratory setup, which allows to conduct experimental tests of transit flow hydrodynamics in self-priming mixers, is developed. Flow coefficient dependence on the configuration of an entrance edge of a rectangular slot in the blade cavity is determined. Testing the self-priming mixer for the productivity of the transit flow from the bevel angle or rounding radius of the entrance edge of the hollow blade on the side of the front surface showed an increase in performance of the designed mixers in the self-priming mode by 20-25 % without an increase in rotational speed and geometric dimensions of the mixer as compared to conventional self-priming mixers.

This allowed to identify the directions of improving self-priming mixers to intensify mass transfer processes. Due to the increase in pumping performance, input channel on the front side of the blade has a round or inclined plane with tilt angle to the blade axis.

The obtained results of laboratory tests allowed to draw up the application and get a patent of Ukraine for self-priming mixing device that can be used in indanthrone and anthraquinone chlorination, as well as alkyl benzene sulfonation with gaseous sulfuric anhydride and hydrocarbons ozonation.

Keywords: sulfonation, chlorination, ozonation, flow coefficient, self-priming mixer, indanthrone, anthraquinone, alkyl benzene.

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EXPERT INVESTIGATION OF ROAD HOLDING DURING ITS WHEEL DEPRESSURIZATION (p. 52-57)

Mikhail Podrigalo, Dmytro Klets

The issues of studying vehicle tires, which belong to the category of complex ones, both theoretically and methodologically, play a significant role in an auto-technical expertise. At the same time, the theoretical basis of these studies is not sufficiently developed, and the related problems of forensic and methodological nature require further study and improvement.

The essence of the proposed method of determining the parameters of road holding with a depressurized wheel is to identify indicators of its slip, yaw moment and turning radius in the road plane. In contrast to the known, the developed model allows to take into account different radii of vehicle wheels and friction in the differential. The introduction of the specially proposed method in expert practice allows increasing the evidence role of auto-technical expertise conclusion.

Keywords: vehicle, holding, wheel, slip, blow-off, puncture, yaw moment, forensic examination.

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