ABSTRACT AND REFERENCES

APPLIED MECHANICS

ELABORATION OF STRENGTH MODEL OF CYLINDRICAL JOINT WITH INTERFERENCE FIT (p. 4–8)

Oleksandr Kupriyanov, Nataliya Lamnauer

In the case of using the cylindrical joins with interference fit it is important to have a prediction of how much load it carries. For estimating the results of experiments the law of normal distribution is most often used. It is not suitable because of the physical reasons since it has no lower limit.

A three-parameter probabilistic model of the strength of the cylindrical joins with interference fit is proposed. It allows calculating the allowable carries value on the results of the small number of experiments. The model contains finite lower bound strength. It is found evaluation of all three model parameters and it is given the method of their calculation for small sample. It is explained the practical application of the model. The model is tested on the strength results experiments of 11 shaft-hub joins with diameter 60 mm. It confirmed its efficiency and effectiveness. An example of the strength and failure rate curves of joins is constructed, that is match with experimental data. Model will be use in mechanical engineering for predicting strength of the cylindrical joins in a case of limited number of experiments.

Keywords: strength of joins with interference fit, lower bound strength, the percentage of gamma-strength, failure rate.

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COMPUTER SIMULATION OF WAGON BODY BEARING STRUCTURE DYNAMICS DURING TRANSPORTATION BY TRAIN FERRY (p. 9–14)

Alyona Lovskaya

The increased pace of Ukraine's integration into the system of international transport corridors necessitates the development of combined transport systems. Train ferry services are one of the most promising in this direction. To ensure the movement safety of wagons on train ferries, estimating the forces acting on them in a rough sea is needed.

An analysis of the literature, describing the features of the sea transportation of wagons, led to the conclusion that the issue has been neglected to date. In this connection, a computer model of the strength of the fragment of the train ferry with the wagon bodies, placed on its decks, which takes into account the range of the main forces acting on the ship and wagons in a rough sea was developed.

The computer simulation results allow to determine the magnitude of dynamic loads on the wagon body bearing structure during transportation by train ferry.

The studies may be taken into account when designing new-generation wagons at wagon works that will increase the motion safety of wagons in the sea.

Keywords: wagon, wagon dynamics, structure loading, rail and water transport, train ferry services.

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RESEARCH OF ENHANCED BASE STRAIN ON LANDSLIDE-PRONE SLOPES UNDER ANTHROPOGENIC IMPACT (p. 14–22)

Eduard Petrenko, Mahdi Gharakhanlou

Design and construction in landslide-prone areas are associated with both ensuring the soil mass stability and evaluating possible appearance and enhancement of the natural and anthropogenic factors. Finite element method is the most rational solution for this class of problems. Further development of computational methods is associated with the expansion of using the mathematical analogs of ground models based on numerical calculation methods. For such problems, a model that allows to consider natural conditions and variable anthropogenic factors in landslide-prone areas, taking into account the plastic deformation of soils within the "slope-retaining structure-building" system was proposed. The paper deals with the stress-strain state of the landslide-prone slope and influence of an-

thropogenic factors on the process. The simulation was performed using the SATER.SOIL software package.

The results have allowed to determine the areas of plastic deformation of the soil, which allowed to estimate the degree of approximation to the ultimate stress state along the slope at all stages of loading, taking into account natural and anthropogenic factors. The change in the stress-strain state of the soil mass using various engineering protection structures and their effectiveness within the "slope-retaining structure-building" system was considered.

Keywords: slope, landslide-prone area, finite element method, retaining wall, base.

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NUMERICAL ANALYSIS OF JERRY CAN STRENGTH UNDER STATIC AND DYNAMIC LOADS (p. 23–29)

Alexander Gondliakh, Andrey Chemeris, Vladyslav Onopriienko

Such material as high-density polyethylene is used for producing jerry cans, fuel tanks, liquid storage and transportation tanks.

Significant shortcomings that may arise in the strength analysis of five-liter jerry cans for storing petroleum products were determined.

Based on the APPROX software system using the finite element moment scheme, a system that allows the numerical strength analysis of jerry cans of different shapes and sizes, with the possibility to set different physical and mechanical properties of materials, including composite materials, in a particular statics and dynamics problem statement was implemented.

A finite-element model of the jerry can was built, and numerical analysis of the strength under static and dynamic loads taking into account the load nature (stacked storage, kick) was performed.

As a result of the numerical analysis, the values of the stress-strain state of the jerry can were obtained, and stress concentration zones were identified.

The data is important since it allows to determine the optimal wall thickness for this kind of structures and define optimal storage conditions.

Keywords: finite element method, numerical simulation, jerry can, stress-strain state.

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OSCILLATIONS OF A LONGITUDINALLY REINFORCED ORTHOTROPIC CYLINDRICAL SHELL FILLED WITH A VISCOUS FLUID (p. 29–33)

Alizade Imamali Seyfullayev, Kenul Novruzova

The paper is devoted to variational approach to the problem of free oscillations of a longitudinally reinforced orthotropic cylindrical shell filled with a viscous fluid. The Ostrogradskii-Hamilton variational principle has laid the basis for the devised and numerically implemented frequency equation on the shell oscillations. The actual fluid loads upon a longitudinally reinforced orthotropic cylindrical shell are determined via the linearized Navier-Stokes equation. The problem of oscillations of the reinforced by longitudinal ribs

orthotropic cylindrical shell is reduced to a joint integration of fluid membrane equations, if the above conditions on the surface of their contact are observed. The contact and boundary conditions reduce the problem to a homogeneous system of linear algebraic equations of the third order. A nontrivial solution of the system of linear algebraic equations of the third order results in a transcendent frequency equation that is numerically implemented.

Keywords: oscillations, shell, ideal fluid, tension, viscose fluid, reinforcement, variation(al) principle.

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THE RESEARCH OF PLANE LINK COMPLEX-STRUCTURE MECHANISMS BY VECTOR ALGEBRA METHODS (p. 34–38)

Irina Matsyuk, Eduard Shlyahov

One of the ways to improve machines is using mechanisms that have enhanced kinematic and dynamic parameters. Complex-structure mechanisms have such characteristics. Their introduction is hampered by a lack of methods for their synthesis and analysis.

Analytical investigation of the kinematics of plane eight-link mechanism was performed in the paper. At that, in the kinematic chain there are links that form the slide – block pair.

The analytical method of kinematic analysis of plane lever mechanisms of random structure based on the vector representation of links, which allows to use the vector algebra apparatus of the Mathcad package was proposed. Using one-component vectors as unknowns (angular velocities and accelerations) and introducing vector products in equations minimizes the number of equations and the program volume. Research results are presented in a natural form for kinematic parameters, i.e. vector.

The considered approach can be used in the analysis and synthesis of complex multilink mechanisms.

Keywords: complex-structure mechanism, kinematics, vector algebra, numerical solution, Mathcad program.

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TAKING INTO ACCOUNT THE FLUID COMPRESSIBILITY AT ITS UNSTEADY FLOW IN PRESSURE PIPELINES OF FIRE EXTINGUISHING SYSTEMS (p. 38–42)

Oleh Yakhno, Serhiy Stas, Roman Gnativ

The urgency of the research topic, caused by insufficiency of the existing theoretical models and methods for calculating unsteady fluid flows was substantiated. The effect of fluid compressibility on the average velocity at unsteady flow was investigated. The nonstationary problem of fluid flow in the pipeline, when the pressures that vary randomly in time are set on the pipe ends, was considered. Based on this approximate solution, the influence of fluid compressibility on the average flow velocity at $t \to \infty$ that allows to clarify the hydrodynamic parameters of fire extinguishing systems was analyzed.

A mathematical model for calculating the parameters of the pressure fluid flow in pipelines of fire extinguishing systems, taking into account the dissipative processes at the unsteady motion of a compressible fluid was developed. Pressure and velocity distribution laws at unsteady laminar and turbulent flows, which take into account the structural features of the considered flows and the impact of inertia forces were obtained. In turn, the clarifications given will help to optimize the calculation in the design of automatic fire extinguishing systems and improve the operational efficiency of the latter.

Keywords: unsteady motion, unsteady flow, fluid compressibility, flow velocity.

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DEVELOPMENT OF THE MUTUAL INFLUENCE MODEL OF LASER GYROSCOPE DITHERS IN SINS (p. 42–47)

Sergey Ivanov, Bohdan Volovyk, Ihor Slabukhin

The problem of the mutual influence of laser gyroscope dithers in SINS is underinvestigated. No other author has developed the model of the processes, occurring in the SU (sensing unit) during interaction of dithers, which would allow to examine the unit operation at the complex vibration of dithers and take into account the design features of real SINS.

In the paper, the general structure of the mutual influence mathematical model of laser gyroscope dithers in SINS was obtained, and the parameters of the model for a real unit were identified. The mathematical model allows to evaluate linear and angular displacements of each LG (laser gyroscope) from internal vibroimpacts, including a noise component during the SINS SU operation. Knowing the displacement data, SU systematic errors, including conical motion error and measurement axes displacement error can be estimated. The model significantly reduces the simulation time compared to simulations using the finite element method.

The work can be used as a guide for obtaining and identifying the mutual influence model of several physical bodies placed on one elastic object.

Keywords: laser gyroscope, dither, mathematical model, strapdown inertial navigation system.

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THE ANALYSIS OF MIXTURE KINEMATICS IN THE MIXER BODY FRAME WITH A SCREW ELEVATOR WITH VARIABLE GENERATRIX (p. 48–52)

Bogdan Korobko, Alexey Vasiliev, Ivan Rogozin

To improve the mixing intensity and vertical screw belt mortar mixer efficiency, it was proposed to use screw belts with generatrices that have a variable inclination angle to the screw axis, depending on the placement height. Studies of working processes for machines with a new mixer design have not been performed or are unknown. Therefore, a theoretical research and analysis of the mixture kinematics in the mixer body with new geometric parameters were conducted. The motion of elementary discrete mixture particle was considered as complex. It was divided into translational, together with a movable coordinate system, connected with the working body, and relative, by the screw belt surface. For given conditions, the motion patterns of the mixture particle were built. It has allowed to obtain the equations of motion coordinates of the particles, the equations for determining their relative and translational velocities, as well as for determining the direction of the velocity vectors. All types of accelerations that occur under these conditions were found. The equations for determining the magnitude and direction of the acceleration vectors of the relative and translational motions, as well as the Coriolis acceleration were obtained.

The dependencies and motion patterns can be used for further research of new mixers with variable inclination angle of screw belt generatrices, as well as for calculating the forces of resistance to the working body motion and the mixer power consumption. The results may be useful in selecting a rational layout of the working bodies of mortar mixers in the space. This will allow to improve the quality of the design works.

Keywords: construction, mortar preparation, screw, screw generatrix, ellipse.

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DEVELOPMENT OF TRIBOPHYSICAL FOUNDATIONS OF LUBRICITY OF LIQUID-CRYSTAL ADDITIVES TO BASE OILS (p. 53–57)

Sergey Voronin

The model of the tribological system using liquid crystals as anti-friction and anti-wear additives in the base oil was presented in the paper. The model takes into account functional dependences between input and output characteristics of the system through the functional dependence between input characteristics and characteristics of the internal state of the system. Further research in the paper is aimed at establishing the patterns that describe the impact of the internal state of the tribosystem on the main output characteristics – friction force and wear rate under various contact conditions. Dependence for determining the total specific friction force in tribosystems considering the molecular component of the specific friction force in boundary films of liquid crystals and mechanical friction component was given. Dependences for determining the linear wear rate at elastic and elastic-plastic contact in tribosystems were also presented. Such dependences were obtained taking into account the properties of liquid-crystal boundary film. The results of experimental studies of sliding tribosystems on friction machines using liquid crystals as additives to base oils were shown. In studies, the patterns of changes in specific friction force and wear rate in tribosystems depending on the main characteristics of the phase state of liquid-crystal additive were obtained.

Keywords: tribosystem, base oil, liquid-crystal additive, lubricity, friction, wear.

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ANTI-SWAY CONTROL METHOD WITH DYNAMIC CORRECTION OF THE SUSPENSION LENGTH FOR SHIP-TO-SHORE CRANES (p. 58–63)

Victor Busher, Mykola Mukha, Anatoliy Shestaka

The analysis of the ship-to-shore crane behavior during the horizontal load movement in two coordinates and a simultaneous load lowering or hoisting was performed. For this operation mode, anti-sway control method for the load, suspended by a rope, which is invariant to the ratio of the masses and hoisting speed was proposed. The analysis of the interaction of technological mechanisms with the pull-up rope drives, suppressing load vibrations, caused by disturbance and measurement errors of the load parameters was carried out. By including the movement mechanism observer with the pull-up rope drives and the correction unit of the rope length and lowering/hoisting speed in the control system, a control method that is insensitive to the suspension length measurement errors without using load position sensors was proposed. As a result, a combined method of coordinated drive control to effectively suppress load vibrations during starting/braking of horizontal movement mechanisms, when using which there are no vibrations in steady-state conditions was developed. This allows to position the load at given points and as a result – include the crane in the automated container terminals.

Keywords: anti-sway, movement mechanism observer with pull-up ropes, suspension length correction.

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