ABSTRACT AND REFERENCES

APPLIED MECHANICS

MODELING OF THE STRESS-STRAIN STATE OF LAYERED ORTHOTROPIC PLATES ON ELASTIC FOUNDATION (p. 4-9)

Sergey Ugrimov, Yuriy Tormosov, Victor Kutsenko, Igor Lebedinetc

The problem of the analysis of the stress-strain state of hinged layered plates on elastic foundation is considered. Bending of the layered plate on the Pasternak foundation at its mechanical loading is investigated. Original two-dimensional discrete-structural generalized theory of multi-layered plates is used to study the orthotropic plate bending. This theory is based on developing the displacement vector components of each layer in the power series along transverse coordinate. It allows to calculate displacement and stress tensor components of each layer with the required accuracy.

The possibilities of the proposed approach are demonstrated on the examples of studying the response of layered plates on elastic foundation. The reliability of the results, obtained on its basis is determined through comparison with the data, presented in known scientific publications. The effect of the elastic foundation parameters on the stress-strain state of multi-layer structures is investigated. It was found that with an increase in the number of power series terms, displacement and stress demonstrate good convergence. It is shown that the elastic foundation shear stiffness significantly affects the stress-strain state of the hinged layered plates.

Keywords: layered plate, orthotropy, elastic foundation, stress-strain state, statics.

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DEVELOPMENT OF THE SYSTEM DIAGNOSTIC DAMPING CHARACTERISTIC OF THE ROLLING STOCK DAMPERS (p. 10-15)

Vladimir Yeremenko, Petro Shegedin, Anton Pereidenko

The paper describes developed by authors information-measuring system of diagnosing damping characteristics of rolling stock dampers. The system includes the hardware for gathering and digital processing of vibration accelerations and software for accelerometer sensor signal processing. It suggests testing procedure to determine the damping characteristics and algorithms to calculate damping parameters, namely the logarithmic decrement and natural oscillation frequency of the structure. It proposes to use an alternative error-correcting method, which lies in calculating the logarithmic decrement in the frequency domain.

The advantage of this method is the high determination accuracy of damping parameters and the absence of high-frequency noise effect on the calculation result since the frequency and quality factor determination proceeds in the low frequency signal range and noise is of high-frequency nature. The paper also proposes software, developed in the LabVIEW graphical programming environment that implements the standard and the suggested algorithms and presents the comparative analysis of the experimental data processing results. It also shows the results of system approbation during testing the locomotive CHS-8 and passenger cars.

Keywords: information-measuring system, diagnostics, rolling stock, accelerometer, logarithmic decrement, damping.

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DIFFERENT PENDULUM TYPE DYNAMIC VIBRATION ABSORBER APLICATION (p. 15-19)

Victor Martyn, Bohdan Diveyev, Ihor Dorosh

The paper considers the methods of calculation and optimization of different pendulum type dynamic vibration absorbers for the vibration reduction of elongated elements. Discrete-continuous models of the dynamics of oversize elongated elements based on the Timoshenko beam theory with attached discrete elements are presented. Algorithms for the vibration reduction of elongated machine elements are obtained.

Noise and vibration are associated with many mechanical systems including industrial, household appliances, transportation machinery and buildings. Many of these structures are made up of beam type elements. Once the system parameters are defined, beam system vibration can be reduced using passive damping.

The dynamic vibration absorber is effective, reliable and inexpensive device to reduce vibration, caused by harmonic or narrow-frequency disturbance. In the classical theory of dynamic vibration absorber, the primary structure is modeled by a mass-spring system, though other models also find interesting theoretical and engineering applications. In particular, pendulum type systems with a solid body at a fixed rotation point play an important role as a model in many branches of mechanical engineering, transport and construction. The application effect of the pendulum type dynamic vibration absorber with shock masses may significantly differ from using the mass-on-a spring system.

Research and optimization of different type dynamic vibration absorbers are performed. Timoshenko beam with different clamping conditions and different type dynamic vibration absorbers are used as a model for many real systems, described in the literature. Methods of decomposition and numerical synthesis are considered based on the adaptive schemes. Structures of elongated elements of machines and buildings with regard to their interaction with the system of dynamic vibration absorbers are examined. The optimization method of dynamic vibration absorbers to reduce excessive vibration of the Timoshenko beam system under harmonic and shock perturbations is developed.

Keywords: dynamic vibration absorber, Timoshenko beam, pendulum, elongated element, mass-spring system, adaptive schemes, optimization.

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ANALYSIS of METHODS FOR DETERMINING of STATIC WOOD HARDNESS (p. 19-24)

Aleksandr Kosmach, Andriy Kadyk

Reliable determination of materials hardness, including different types of wood plays an important role in study of processes that are associated with manufacture of products, strength, stability, thermal conductivity, sound insulation, etc.

Inconsistency of measurements results of static wood hardness, as well as their different units of measurement in many countries around the world raises a number of questions about the appropriateness of particular method of measurement in laboratory and industrial applications. In this regard, based on the scientific literature identified the main advantages and disadvantages of existing techniques and their comparison was shown. To eliminate the subjectivity in the comparison of measurement methods were used decision-making, in particular the prioritization method, and the method of hierarchy analysis.

In this paper, we have shown the main challenges and issues that don't allow using of considered methods.

Was shown generalized classification of existing main methods of determining the hardness of the wood, which includes a number of methods based on subjective assessment of the measurement results.

Using the method of prioritizing it possible to determine that preferred methods for determination of wood static hardness are the structural method, methods of Brinell and Janka. In turn, the method of hierarchical possible to determine characteristics of existing methods for determining the wood hardness, which is key during testing. Such characteristics include integrality, reliability, as well as their sensitivity. Further theoretical and experimental studies should be aimed at improving the performance of these methods characteristics at determining of wood static hardness.

Keywords: analysis, construction, definitions, wood, research, method comparisons, priority, hardness characteristics.

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INVESTIGATION OF OPERATION CONDITIONS OF CONTAINERS MADE IN THE FORM OF LONG TUBES (p. 25-30)

Andriy Dzhus, Alexander Susak

Taking into account the technological features inherent in compressed natural gas transportation it was found that filling containers can be carried out using compressors during the whole process, and by introducing them at some stage. The possibility of different filling process duration was also noted.

According to research results, it was found that for the two-stage filling conditions, temperature on the first three linear sections is characterized by particular nonuniformity. Introduction of the compressor leads to a rapid increase in gas temperature on the first, and later, on the second linear section. The temperature difference in the middle of these sections is 12°C. The nature of the nonuniformity at different process implementation rates is almost the same.

For the container filling conditions with regular compressor use, temperature processes are characterized by especially pronounced nonuniformity in the early stages. The maximum temperature difference in the middle of adjacent sections is up to 6°C. With the increase in gas pressure, temperature processes are partially stabilized.

For a deeper analysis of existing processes and their influence on the stress-strain state of long tube elements, further studies of the gas temperature change, in particular when unloading ships are necessary.

Keywords: compressed natural gas, long tube, simulation, gas temperature change.

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DEVELOPMENT OF UNCONVENTIONAL WAYS TO IMPROVE PERFORMANCE OF THE AXIAL PISTON HYDROMASHINES TAKING INTO ACCOUNT REPAIR ABILITIES (p. 31-36)

Mark Dovbenko, Vadim Evdokimov

As a result of studies, operating conditions of friction pairs of axial piston hydromachine parts were examined and real ways to use a number of tribological techniques to improve their performance were shown. It was found that the most simple methods that increase the performance of the friction units of axial-piston hydromachines, are using surfactants in hydraulic oil, creating conditions for the manifestation of the selective transfer with forming a thin copper film on the steel parts and using mobile insertions of active materials. A summary table with the main advantages of the considered unconventional methods that improve the running-in quality of axial-piston hydromachine parts and their friction units, which is of practical value for the operators and industrials ists during repair works was given. The main advantages and disadvantages of unconventional methods, applicable for improving axial piston hydromachine durability were shown. So using surface active liquid additives increases wear resistance by 3 times, load-bearing capacity by about 2 times with the possibility to replace bronze with steel. Creating conditions for selective transfer provides smaller parameters that increase hydromachine performance and requires another liquid lubricating medium such as glycerin. A more efficient method is using special active solid lubricants, which allows not only to abandon hydrocylinder bronze blocks, replacing them with steel, but also enhance the durability up to 5 times, and fluid working pressure up to 400 atmospheres. This compensates for the costs, associated with manufacturing narrow pockets for a solid lubricant.

Keywords: hydromachine, wear, additives, solid lubricants, selective transfer, flexible inserts, durability, copper films.

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INFLUENCE OF SETTING ANGLE OF THE AIRFOIL CASCADE ON THE FLOW «CHOKING» REGIMES IN THE BLADE CHANNEL (p. 37-40)

Yuriy Tereschenko, Ekaterina Doroshenko, Arash Tehrani

The emergence of "choking" regimes of last stages leads to the stall in the blade rows of first stages, appearance of rotating stall and surge, and is one of the main causes of reduced GTE effectiveness on the off-design operating conditions. The paper deals with investigating the impact of setting angle in the airfoil cascade at the critical flow regime. To solve this problem, a series of gas-dynamic calculations for compressor airfoil cascade with different setting angles γ=30°, γ=40°, γ=50°, γ=60°, γ=70° was carried out. The computational domain for this problem consists of one blade and one blade channel. To solve this problem, irregular adaptive grid was selected. The turbulent gas flow calculation was performed by numerical solution of the averaged Navier-Stokes equations (Reynolds equations). To close the Navier-Stokes equations, the Menter's SST turbulence model was chosen. The second-order design scheme with the local use of the first-order design scheme was used for the calculation. Comparison of theoretical and experimental research results have shown that the flow nature in the blade channels and boundary layer formation depend strongly on the airfoil setting angle. With a decrease in the airfoil setting angle there is a significant decrease in the relative value of the minimum actual flow area of blade channels (described in aerodynamics as free area), which leads to a decrease in the Mach number value at the cascade entrance, at which the flow "choking" regime in blade channels by air flow occurs. These features should be taken into account in "choking" regime calculations. The obtained generalized characteristics of "choking" regimes of compressor cascades can be used in calculating "choking" regimes of the axial flow compressor stages and determining the boundaries of gas-dynamic stability of multistage axial flow compressors.

Keywords: compressor, airfoil cascade, critical flow regime, choking, setting angle, flow simulation, stall.

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DEVELOPMENT OF THE COMPENSATION METHOD OF PRESSURE PULSATION EFFECT ON THE MULTI-STAGE HYDRAULIC CYLINDER MOTION (p. 41-46)

Vsevolod Chuiko, Serhii Kulinich

An example of the hydraulic wrench application is a maintenance process, associated with the main circulation pump jack at a nuclear power plant. Mathematical model of the hydraulic drive with two coaxial hydraulic cylinders is investigated to solve the problem of uncontrolled changes in the hydraulic drive system characteristics. The mathematical model considers the parallel connection of discharge chambers, nonlinear flow from the one-piston pump, fluid compressibility, the friction force between the actuator components. The drive operation is investigated at a full rotation of the feed pump crank. The system includes a throttle on the

drain line in order to overcome negative hydrodynamic processes. The characteristics of the drive are investigated, and the throttle characteristics are defined to overcome pulsation. The values of the throttle opening area are determined for each time point, at a constant speed of the drive. Obtained matrix values are regarded as a law, and the speed becomes a calculated value, used to verify the results. Calculations have confirmed the possibility of providing the drive rod velocity, which is close to constant. Further development of the results provides a synthesis of the law of the throttle closing changes. It will provide the technological feasibility for manufacturing and ensure linear, close to constant, effort, generated by the hydraulic drive.

Keywords: hydraulic drive, pulsation, effort, nonlinearity, throttle, law, motion, model, sealing, compensation.

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EXPERIMENTAL RESEARCH OF HYDRODYNAMIC PULSATOR AND ITS INFLUENCE ON PARAMETERS OF OIL (p. 46-51)

Yaroslav Yakymechko

The paper describes an improved design of a hydrodynamic pulsator, which is used in a technological scheme when pulling high-viscosity oils from wells to the surface. Also, a scheme of performing laboratory tests on the hydrodynamic pulsator is presented. The obtained results indicate that when using this device, physical fields i.e. ultrasound, thermal and cavitation, which help to reduce oil viscosity and increase its temperature, appear in the Kohanowski field's oil. It is experimentally determined that under the acoustic field (ultrasound) action, fleeting pressure gradients appear and boundary layers of the fluid are destructed, a non-Newtonian fluid is transmitted to Newtonian. At a certain field intensity (more than 0.1 kW/m$^{2)}$ over 50 % of acoustic energy is transformed into heat. Thus, while oil is simultaneously exposed by thermal (thermo-acoustic effect) and acoustic (ultrasound) fields. In a high-intensity acoustic (ultrasound) field, there are so-called gravitational effects, which lead to a loss of mechanical impurities, solid paraffin and salts.

Keywords: oil, pulsator, vibrations, ultrasound, intensity, viscosity, temperature.

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INVESTIGATION OF STEP ELECTRIC DRIVE AS A CONTROL SYSTEM FOR DOUBLE-SPLIT HYDROSTATIC MECHANICAL TRANSMISSIONS (p. 52-58)

Vadim Samorodov, Nikolay Mittsel

The research deals with developing the control unit for variable displacement axial-piston pump with a hydromechanical control in the test bed of double-split hydrostatic mechanical transmission. Step electric drive was

used as an actuator for controlling the hydraulic pump. During the study, static modes, as well as acceleration and deceleration processes of the tractor were simulated.

As a result, high positioning accuracy of the hydraulic pump swash plate, regardless of speed and load on the output shaft was observed, and developed software has allowed to reproduce linear and nonlinear control laws. The relationship between the braking torque, applied to the output shaft, and a step change in its speed was revealed. Step electric drive in combination with the hydromechanical control of positive-displacement hydraulic machine can serve low-cost alternative to the electric proportional control.

The designed stand is reconfigurable, which allows to perform a number of studies for the hydrostatic transmissions with a differential «at the output» and «at the input» and has the potential for further improvements.

Keywords: transmission, control, step electric drive, torque sensor, inductive sensor, powder brake.

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