ABSTRACT AND REFERENCES

APPLIED MECHANICS

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DEVELOPMENT OF A PROCEDURE FOR THE EVALUATION OF THE STRESSED-DEFORMED STATE OF PIPE-CONCRETE ELEMENTS THAT ARE STRETCHED OFF-CENTER (p. 4-9)

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We developed a procedure for the evaluation of the stressed-deformed state of pipe-concrete elements that are stretched off-center with an entire cross-section. The obtained functional dependences make it possible to establish the magnitudes of stresses and strains in the pipe-shell and the concrete of pipe-concrete elements that are stretched off-center depending on geometrical characteristics and physical-mechanical properties of the element materials.

The procedure takes into account the elastic stage of work of the materials considering the volumetric-stressed state and an increase in the loading from zero to destruction. The advantage of the developed procedure is the proposed simplified method for solving the system of defining equations based on the hypothesis about a joint work of the components of pipe-concrete (steel shell and concrete core) at all stages of loading with an off-center stretching effort. This procedure is implemented by consistently solving separate equations. The developed procedure for the evaluation of the stressed-deformed state of stretched pipe-concrete elements takes into account the negative impact of a bending moment, which is an additional force factor under conditions of the off-center stretching. Analysis of the comparison results of experimental data with those theoretical, obtained by the given procedure, confirms the hypothesis about joint work of the steel shell and the concrete core up until the moment when a pipe-concrete element that is stretched off-center runs out of its bearing capacity.

The proposed procedure for the evaluation of the stressed-deformed state makes it possible with a sufficient accuracy to determine the bearing capacity of pipe-concrete elements that are stretched off-center with different geometrical parameters and mechanical properties.

Results of the study could be applied when designing the structures by determining the bearing capacity of pipe-concrete elements exposed to stretching.

Keywords: pipe-concrete, stressed-deformed state, off-center stretching, theory of elasticity, boundary condition.

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EVALUATION OF THE STRESSED-STRAINED STATE OF CROSSINGS OF THE 1/11 TYPE TURNOUTS BY THE FINITE ELEMENT METHOD (p. 10-16)

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We carried out evaluation of the stressed-strained state of crossings of turnouts by the finite element method in the Ansys programming complex. It was established that under conditions of three-axial compression, at large stresses of vertical compression, the cracks of multi-cycle metal fatigue of the crossing develop.

It was found that the development of defects by the code DS 14.1-14.2 on the rolling surface of the cast part of a wing rail and the crossing's core occurs due to high contact stresses near the edge of the working face of a wing rail and the crossing's core. They occur in this region in the form of cyclically repeated and sign-alternating normal and tangential stresses from cyclically recurring power impacts from the wheels of rolling stock of railroad transport.

It was established that for the normal stresses, values that are maximal by absolute magnitude correspond to the moment when a wheel passes the estiamted cross section of the crossing. For the tangential stresses, on the contrary, at the moment when the wheel is over the estimated cross section, their magnitude is close to zero.

The obtained results of the stressed-strained state of crossings are necessary for the optimal design of transverse and longitudinal profiles of the crossing. This will make it possible to extend operation life cycle of the crossings of turnouts and save state budget resources for their current maintenance and repair.

Keywords: crossing, turnout, finite element method, contact stresses, rolling stock of railroads.

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DEVELOPMENT AND APPLICATION OF THE METHOD FOR POSITIONING DRAINAGE DEVICES IN THE HEAD FAIRING (p. 17-24)

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It is important to minimize the maximum possible pressure gradients in the location of the spacecraft placement. A new engineering method was proposed for an operational estimation of the absolute pressure and its gradient on the outer surface of the cone-cylinder assembly and in the transonic flow around it. The essence of the method lies in the possibility of analyzing dynamics of pressure thru the dynamic factor. This makes it possible to carry out analysis for carrier rockets with various power-to-weight ratios which affects the speed of passing the transonic section. Application of this method enables choosing of locations for installation of drainage devices taking into account minimization of the pressure gradient in the zone of the spacecraft placement. This method, unlike the existing ones, features its independence from the necessity of ballistic calculations. The mathematical model of this method is based on the use of the starting power-to-weight ratio of the carrier rocket. It is defined as the ratio of the carrier rocket weight to the thrust of its engines at the moment of its detachment from the launching table. The boundary conditions for application of the mathematical model were given. The possibility of linear interpolation between all coefficients of the mathematical model was taken into account. The developed method is based on experimental data and can be used for other types of the head fairing assemblies. The method is also intended for design and engineering works.

Keywords: power-to-weight ratio, dynamic factor, pressure gradient, transonic zone, drainage devices.

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STUDY OF THE OPERATING ELEMENT MOTION LAW FOR A HYDRAULIC-DRIVEN DIAPHRAGM MORTAR PUMP (p. 25-31)

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A mathematical model of the process of operation of a hydraulic diaphragm mortar pump has been developed. It is aimed to describe the processes occurring during automatic reciprocating motion of the hydraulic cylinder piston under the action of high-pressure oil. Oil flows are formed using a hydraulic distributor. Eight phases of the solution pump cycle were identified.

The use of a hydraulic drive in this mortar pump allows one to get rid of the main drawback inherent in mortar pumps with a reciprocating drive mechanism. This drawback consists in the sinusoidal law of the piston velocity variation. As a result, there is a significant pulsation of the mortar supply pressure. Uniformity of velocity of the hydraulic cylinder during the working cycle helps reduce the level of pulsations and improve technical, economic and operational characteristics of the mortar pump.

Knowledge of the mathematical model of the hydraulic cylinder provides for a better understanding of operational parameters such as:

– sucking capacity of the mortar pump;

– the nature of response of the valves for opening and closing;

– the mechanism of formation of reverse mortar leaks at the closure of valves;

– the mechanism of formation of the level of volumetric efficiency of the mortar pump;

– the degree of uniformity of pulsations in the mortar supply pressure.

The results obtained from the theoretical relationships were confirmed experimentally.

Keywords: mortar pump, hydraulic drive, control sliding valve, efficiency, mortar, feed pressure, pulsation uniformity, plastering, construction.

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EFECT OF THE MEMBRANE THERMODEFLECTION ON THE ACCURACY OF A TENSORESISTIVE PRESSURE SENSOR (p. 32-37)

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Present work examines a contribution of the membrane thermodeflection to the temperature error of a tensoresistive pressure sensor when measuring under conditions of non-stationary thermal effect. The study is based on an analysis of the temperature field in the membrane during thermal shock. It was found that during thermal shock one observes gradients of temperature field by thickness and radius of the membrane.

It is shown that the combination of these gradients generates a thermodeflection of the membrane. It was established that at such thermodeflection relative deformations on the membrane surface can be comparable with the working ones when measuring pressure. Thus, it is found that the thermodeflection is a significant factor for an increase in the temperature error of sensor.

The research revealed that by minimizing heat exchange on the perimeter of sensor membrane it is possible to eliminate the gradient of temperature field along its radius. By so doing, it is possible to minimize the thermodeflection of membrane and decrease temperature error of the sensor. It is proposed to minimize heat exchange on the perimeter of membrane through the thermal insulation, or by a special selection of parameters and materials for the casing of the sensor and the membrane.

Keywords: membrane, thermodeflection, pressure sensor, non-stationary temperature, measurement accuracy.

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IMPROVING INDUSTRIAL PIPELINE TRANSPORT USING RESEARCH OF REGULARITIES OF FLOW OF MIXTURES IN MATERIAL PIPELINE (p. 38-44)

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Highly efficient energy-saving methods of pipeline transport have been developed on the basis of modern scientific approaches. A general concept and its implementation on the synergetic basis have been proposed. It is shown that stochastic motion modes arise while passing through intermittence, i.e. they are the result of collision of asymptotically stable and unstable motion states. It has been established that flow of air-fuel mixtures with inner weaves and inner portion turbulent motions is considered as a process of self-organization with collective flows. At the same time, effective coefficients of transfer of momentum, force and mass of the moving material flow are determined. The hypothesis of emergence of stochastic motion modes that arise during transition through intermittency has been justified, which makes it possible to derive the regularity of collision of asymptotically stable and unstable flows of air-fuel mixtures. The rheological model for flow of non-Newtonian fluids is proposed that takes into account the flow features, which makes it possible to determine the shear stress and viscosity of CWF at different values of the shear velocity. The mathematical model takes into account independent rheological parameters of the suspension, which depend on concentration and granulometric composition of coal, as well as on high-speed transportation modes. It has been established that the process of self-organization of mass transfer in the pneumatic transport pipeline is carried out by additional energy supply of the moving material flow and provides creation of additional vorticity of the flow. There have been determined the main tasks solved by intensification of the processes in the transport pipeline, which makes it possible to increase efficiency of its operation.

Keywords: pipeline transport, bulk material, intermittency, flow modes, coal water fuel, energy saving.

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MODELING OF OPERATION PROCESSES OF A MOTOR GRADER ENGINE DURING WORK UNDER UNSTEADY LOAD (p. 45-50)

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We proposed a model of operation processes of a motor grader engine under unsteady load during technological processes of road construction works. Theoretic dependences of operation processes of a diesel motor grader engine, described by third order differential equations, were determined. The developed mathematical model of operation processes of a motor grader engine under unsteady mode makes it possible to employ known theoretical provisions to improve the system of air regulation in the commercially available motor grader engines. The model is a description of patterns of influence of differential equations coefficients and the load character on a change in the rotation rate of crankshaft of engine, cyclic fuel supply and hourly fuel consumption.

Numerical modeling was carried out of load throw off and load gain of a motor grader engine using third-order differential equations in relative magnitudes. It was established that at a decrease in the values of coefficients of differential equation the transition process proceeds more intensively. In this case, time of delay in the response to disturbance and the duration of damping the oscillation process decrease. The proposed model would ultimately optimize engine performance under unsteady modes.

Keywords: motor grader operation, operation modes, unsteady load, dynamic characteristics, oscillatory process.

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DETERMINING THE MAGNITUDE OF TRACTION FORCE ON THE AXES OF DRIVE WHEELS OF SELF-PROPELLED MACHINES (p. 50-56)

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Studying the interaction between running systems of wheeled tractors and vehicles and the ground and the road is impossible without determining the traction force. Here we outline the principles of formation of the traction force of tractors and vehicles. The fallability is proven of the position on that the total tangent soil reaction under the action of

the driving wheels on it is the traction force, which is transferred to the rear axle and sets the whole vehicle or tractor in motion.

The driving force of tractors and vehicles is fuel energy, which is converted by internal combustion engine of an energy means into rotations and torque that are transferred using the transmission to the drive wheels. In the machine-tractor units, torque of the engine is also used on the drive of the working machine through the power take-off shaft and creation of the force of traction. The point of application of the traction force is on the axis of the drive wheel.

We derived expression for the calculation of traction force on the axis of the drive wheel. Traction force is approximately twice the force with which the wheel acts on the surface and the surface reaction corresponding to it. Surface reaction is transferred from the road to the drive wheel and counteracts to the wheel rotation.

Defining the principles of formation of the traction force makes it possible to intensify research into technical and energy means in general, and to substantiate the principles of reducing negative impact of the engines in particular on the fertile soil layer.

Keywords: traction force, drive wheel, self-propelled machines, energy means, transmission.

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THE ROTATING CHAMBER GRANULAR FILL SHEAR LAYER FLOW SIMULATION (p. 57-64)

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The simplicity of design solutions of the drum type machines is paradoxically combined with the extremely difficult-to-describe behavior of the treated medium. The workflow efficiency of such equipment is determined by the dynamic activity of the shear part of the fill.

The traditional hypothesis of the two-phase flow regime of the granular fill of the rotating chamber ignores the shear layer formation. However, recent numerical and experimental results approach the flow regimes of the studied medium only in terms of qualitative characteristics.

The analytical model of the behavior of the shear layer of the granular fill near the free surface in the cross-section of the cylindrical chamber rotating around a horizontal axis is constructed. The equations for the mean value and the velocity distribution along the normal to the flow direction of the layer are obtained. They allow determining the shear velocity profile of the layer approximately, depending on the kinematic, geometric and rheological parameters of the system. Granular fill is considered as a continuous medium with the volume-averaged parameters. A plastic rheological model is adopted.

Based on the performed simulation, the fields of stresses and velocities in the fill mass in the cross-section of the rotating chamber are formalized using the system of differential equations of the two-dimensional state of the flowing granular medium. It is shown that such gravitational flow arises from the conditional, additional to gravitational, vertical inertial acceleration, which is due to the previous growth of kinetic energy of the layer in the non-free-fall zone of the fill. It is found that the flow of the shear layer near the free fill surface is realized in the form of gravitational flow without slipping along the supporting boundary surface of the quasi-solid-state zone that is shifted up.

It is found that the values of the average and maximum velocity of the shear layer of the fill depend on the chamber radius, the radial coordinate of the basis of the considered section of the layer, its thickness, filling degree and chamber rotation velocity, friction angle of the fill and angle of inclination of the layer to the horizontal.

Keywords: granular fill, rotating chamber, shear layer, gravitational flow, velocity distribution.

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