ABSTRACT AND REFERENCES

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EFFECT OF TECHNOLOGICAL CAMBER IN THE FACETS OF A CELLULAR FILLER ON ITS PHYSICAL AND MECHANICAL CHARACTERISTICS (p. 6-18)

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Among a variety of technological defects of a cellular filler affecting its physical and mechanical characteristics, one of the most essential is believed to be the initial technological camber of facets in its cell. The paper reports a study into the effect of technological camber of a cellular filler's facets on its physical-mechanical characteristics, which ensures the stabilization of its quality and, consequently, the operational characteristics of structures based on it. In contrast to available studies, we have considered a discrete-element cell model. A cellular filler has been represented in the form of a structure consisting of various elements: facets of a single foil, facets of two glued layers of foil, and imaginary edges – the angular butt joint zones of two neighboring facets. The process of consistent loss of bearing ability by the cell elements of a cellular filler under transverse compression and longitudinal shear has been investigated. This analysis of the performance of separate elements of a cell in the presence of the initial technological camber has made it possible to take into consideration the operational patterns of each of them by building the appropriate load-type chart of filler deformation. On this basis, we have devised an approach that makes it possible to predict the character of cellular filler operation taking into consideration the patterns in accepting the loading by separate elements of the honeycomb cell in the presence of the initial technological camber in them. Recommendations have been given for using the obtained results within the approaches, proposed in a series of studies, for optimizing cellular structures for the mass of design parameters. The recommendations enable the synthesis of a module for the verification optimization unit, which produces a conclusion on the carrying capacity of an optimal, in terms of mass, variant of the sandwich-type structure with a cellular filler, taking into consideration the presence in its facets of initial technological camber within the range of regulated tolerance. Such synthesis at the modern level of production technology of a cellular filler would help implement almost exhaustive capabilities of this type of the filler, as well as the structures based on it.

Keywords: sandwich-type structures, cellular filler, physical-mechanical characteristics, technological camber of cell facets.

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DETERMINATION OF DYNAMIC LOAD FEATURES OF TANK CONTAINERS WHEN TRANSPORTED BY RAIL FERRY (p. 19-26)

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Simulation of the dynamic load of the tank container when transported as part of a combined train on a rail ferry is carried out. Mathematical models taking into account possible interactions of tank containers with the frame of flat cars are developed. Calculations are made for the tank container of 1CS type size placed on the 13-4012M flat car. It is taken into account that the transportation of the tank container is carried out on the "Geroi Shipki" type rail ferry by the Black Sea. It is found that the greatest acceleration acts on the tank container in case of displacement of the flat car relative to the deck and the tank container relative to the frame. The total value of acceleration is about 0.9g.

The stability of the tank container when transported by rail ferry is investigated. Permissible roll angles of the rail ferry that ensure the stability of the tank container relative to the flat car frame are calculated.

Computer simulation of the dynamic load of the tank container when transported by rail ferry is carried out. The calculation is made in the CosmosWorks software environment. The fields and numerical values of the accelerations acting on the tank container are determined. The developed models are verified by the F-criterion.

The research will help to provide safety and to make recommendations on sea transportation of combined trains by rail ferries, as well as to design tank containers with improved technical-economic, strength and environmental characteristics.

Keywords: tank container, dynamic load, load simulation, stability factor, rail ferry transportation.

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STUDYING THE STRESSED STATE OF ELASTIC MEDIUM USING THE ARGUMENT FUNCTIONS OF A COMPLEX VARIABLE (p. 27-35)

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Based on the argument function method and the complex variable function method, we have derived the generalizing solutions to a flat problem on the theory of elasticity using the invariant differential ratios capable of closing the result for the set system of equations. The paper reports the approaches whose application defines not the permitting functions themselves but the conditions for their existence. This makes it possible to expand the range of harmonious functions of varying complexity, which satisfy any boundary conditions in the applied problems that are constantly renewed. Two basic functions have been taken into consideration: trigonometric and fundamental, whose arguments are the unknown coordinate dependences. Introducing the argument functions into consideration changes the approaches to determining permitting dependences because the problem is considerably simplified when establishing a differential relationship among them in the form of the Cauchy-Riemann and Laplace ratios. Several analytical solutions of varying complexity have been presented, which are matched with different boundary conditions. Comparison with the results reported by other authors, at the same initial data, leads to the same result; and when considering the test problem on the interaction between a metal and an elastic half space, it leads to the convergence between defining schemes of force influence on the elastic medium.

Thus, a new approach has been proposed to solving a flat problem from the theory of elasticity, which is associated with the use of argument functions, which makes it possible to close the problem via the differential Cauchy-Riemann and Laplace ratios. These generalizations expand the range of harmonious functions that correspond to different boundary conditions for the applied problems.

Keywords: theory of elasticity, argument functions, Cauchy-Riemann conditions, Laplace equation, boundary conditions.

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AERODYNAMICS OF THE TURBULENT FLOW AROUND A MULTIELEMENT AIRFOIL IN CRUSE CONFIGURATION AND IN TAKEOFF AND LANDING CONFIGURATION (p. 36-41)

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Numerical modeling of multi-element airfoil's aerodynamics employs the Reynolds averaged Navier-Stokes equations of incompressible environment, which are related via a single-parametric differential turbulence model by Spalart-Allmaras. The system of initial equations has been recorded with respect to an arbitrary curvilinear coordinate system. The pressure and velocity fields have been aligned by using an artificial compressibility method modified for calculating the nonstationary problems. The system of initial equations has been integrated numerically by applying a control volume method. The counter-flow Rogers-Kwak approximation has been used for convection flows, based on the Roe scheme of third-order accuracy. The turbulence models, in order to approximate the convection components, employed a TVD scheme with the third-order flow limiter ISNAS. The paper reports results from calculating a turbulent flow around a multi-element airfoil in a wide range of the angles of attack. The result of the current research is the performed analysis of the flow field around a multi-element airfoil, pressure coefficients, the lifting force, as well as the drag force. Physical features in a flow structure at flowing around the multi-element airfoil 30P30N have been identified. In the investigated range of the angles of attack, flowing around a airfoil in the takeoff and landing configuration is stationary in nature except for the regions where the flow is detached from sharp edges, such as the slat's inside part and a region in the tail part of the main profile. There are recirculation currents within these regions. With an increase in the angle of attack, dimensions of the detachable zone at the slat's inner surface decrease while remaining almost unchanged in the tail part of the main profile. At the top surface of the main profile there forms a jet of air, due to the acceleration of the flow between the slat and the leading edge of the main profile. The existence of a gap between the main profile and the flap leads to the interference of jet currents at the upper surface of the slat. It has been shown that the takeoff and landing configuration demonstrates the higher values of the lifting force coefficient than the cruise configuration, especially at large angles of attack. The calculation results agree well with the data by other authors.

Keywords: Navier-Stokes equation, Spalart-Allmaras turbulent flows model, multi-element airfoil 30P30N, numerical modelling.

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SUBSTANTIATING THE REQUIREMENTS TO FUNCTIONAL INDICATORS FOR THE MANIPULATORS OF MOBILE ROBOTIC DEMINING COMPLEXES (p. 42-50)

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It has been proposed that humanitarian demining should involve mobile robotic complexes equipped with

manipulators based on mechanisms with parallel kinematic structures. The features of design and characteristics of the manipulators have been considered. We have established special features in equipping the manipulators, used to directly manipulate objects. The geometrical and strength parameters for the threaded connection between a fuse and a mine shell have been determined. A scheme of efforts interaction in the threaded connection has been substantiated. We have found patterns in the emergence of the thread force reactions under a gravitational load of the fuse and at thread tightening. The efforts that arise at unscrewing the fuse of an anti-tank mine by the manipulator have been experimentally determined. The measurements employed specialized equipment in the form of a set of special grips. The result of measurements is the established effort of thread tightening and the momentum loads required for unscrewing the fuse. We have substantiated the rational kinematic and dynamic algorithms of the manipulator operation in the process of unscrewing the fuse. To this end, we measured the displacements of the fuse under the action of asymmetrical force and momentum loads. The measurements of parameters have been performed of cyclic loads necessary to unfix the threaded connection between the fuse and a mine. A special algorithm of dynamical loads on the fuse has been suggested, which ensures rational conditions for its unscrewing. The paper reports results from experimental study into remotely-controlled disposal of explosive objects and unexploded ammunition using an example of an anti-tank mine. We have shown feasibility of the proposed technology of humanitarian demining of territories containing explosive objects.

Keywords: mobile robotic complex, manipulator, anti-tank mine, explosive objects, remote disposal.

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STUDYING THE LOAD JAM MODES WITHIN THE FRAMEWORK OF A FLAT MODEL OF THE ROTOR WITH AN AUTOBALANCER (p. 51-61)

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This paper reports the analytically investigated load jam modes (balls, rollers, pendulums) within a flat model of the balanced rotor on isotropic elastic-viscous supports carrying the auto-balancer with many identical loads.

A physical-mathematical model of the rotor-auto-balancer system is described. The differential equations have been recorded for the system motion with respect to the coordinate system that rotates at constant speed. We have found all the steady modes of motion under which loads get stuck at a constant speed of rotation. In the coordinate system that rotates synchronously with loads, these movements are stationary.

Our theoretical study has demonstrated that the load jam modes in the rotor-auto-balancer system are the single-parametric families of steady movements.

Each jam mode is characterized by a certain load configuration and the appropriate frequency of jams.

In the coordinate system that synchronously rotates with loads:

– the rotor displacement is constant;

– the parameter is the angle defining the direction of the rotor displacement vector;

– loads take certain fixed positions relative to the rotor displacement vector; these positions depend on the rotor rotation speed.

The auto-balancer with n_b identical loads of different configurations has n_b+1 loads. The total number of different types of load jam modes:

– $2(n_b+1)$, if n_b is odd;

– $2n_b+1$, if n_b is even.

The total number of different jam frequencies:

– $3(n_b+1)/2$, if n_b is odd;

– $3n_b/2+1$, if n_b is even.

The total number of different characteristic speeds is n_b+2. The characteristic speeds are the points of movement bifurcations because their transitions give rise to the emergence or disappearance of single-parametric families of movements that correspond to a certain jam mode. At these points, jam modes can acquire or lose stability.

Keywords: passive auto-balancer, Sommerfeld effect, inertial vibration exciter, resonance vibration machine, movement bifurcation.

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