ABSTRACT AND REFERENCES

APPLIED MECHANICS

EXPERIMENTAL RESEARCH OF THE STRESS-STRAIN STATE OF REINFORCED-CONCRETE BUILDING IN THE CASE OF PROGRESSIVE COLLAPSE (p. 4–9)

Alexander Shapovalov, Viktoria Rudenko

An experimental research of the stress-strain state of the seven-story reinforced-concrete layout of the building with the size about 2·2 m and the cell of column 0,5·0,5 m, in case of failure of the middle column of extreme row of the first floor was carried out. For evaluating the operation of the damaged layout of the building, deformations of the neighboring columns, placed in the same cell with a remote column were defined, and movements of floors, located above the dangerous cell were analyzed. Intensive deformation growth in columns adjacent to the removed column and their reduction in neighboring cells was revealed. Deformation growth was in the range of 30–40 % compared with deformation growth in a gradual proportional loading, which indicates a promising destruction of the dangerous area without an avalanche process. Such phenomenon of destruction is based on the rational arrangement of stiffening diaphragms. The structural diagram of the building layout was a rigid beamless frame conjugate in the form of rigid unyielding block. The method of loading the layout was carried out using the loading blocks, each weighing on average 60 kg, gradually stacked on the floors. Removal of the column was performed by a special method using a removable conical insert of the middle part of the column.

Keywords: stress-strain state of layout of reinforced-concrete frame elements, progressive collapse.

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STABILITY INVESTIGATION OF THE STEADY MOTIONS OF AN ISOLATED SYSTEM, CARRYING OUT PLANE MOTION (p. 9–20)

Vladimir Pirogov

The paper investigates the conditional stability of steady motions of a flat model of an isolated system consisting of a rotating LB, material point, which creates its static imbalance, and two identical mathematical pendulums, mounted on the longitudinal axis of the LB and moving in the plane of the static imbalance, the relative motion of which is prevented by the viscous resistance. It was found that in the case where there is imbalance and pendulums can eliminate it with a certain reserve, there is one basic motion; in the absence of imbalance, there is a one-parameter family of basic motions; in the case of maximum imbalance, which can be eliminated by pendulums, there is one basic motion, but it generates pseudo-family of basic motions. Also, it was found that some basic motions are conditionally asymptotically stable, if they, or family, or pseudo-family of basic motions are isolated. In the absence of imbalance, the presence of a single zero root of the characteristic equation does not affect the stability of the one-parameter family of basic motions, and is responsible for the transition from one to another steady motion of the family. In the case of maximum imbalance, the presence of a single zero root of the characteristic equation does not affect the stability of the basic motion, and is responsible for the transition from one to another steady motion of pseudo-family. Transients, depending on the system parameters can be aperiodic or oscillatory-damped. It was found that the side motions are unstable.

Keywords: lifting body, pendulums, motion stability, spacecraft, passive autobalancer, damper.

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ANALYZING THE ROTATION OF AN INVISCID VORTEX TUBE (p. 20–24)

Vitaliy Budarin

The study suggests a precise solution of the problem of distributing radial and circumferential stresses in the wall of the hollow cylindrical quasi-solid core of a vortex tube. The solution is based on two other well-known equations of linear elasticity theory – the Lamé problem and the problem of stress in a rotating tube.

The above equations are approached with the superposition theorem. As a result, we get two equations for determining the circumferential and radial stresses in the wall of the core of any structure. The problem simultaneously refers to two models of a continuum – a solid body without shear stresses and a fluid without convective acceleration. We have shown that stress differences at a point of the fluid are caused by the flow structure and noted similarity to the effect of stress concentration in a solid body.

We have distinguished a particular case of the obtained equations for a solid core, which coincides with the equation of the dynamics of an ideal fluid. The equation for the speed at which the core disintegrates is derived from the condition when the circumferential stress is equal to zero. We have supplied examples of the findings practical use.

Keywords: quasi-solid core of the vortex, distribution of stresses in the wall, cross-sectional structure effect.

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EXPERIMENTAL INVESTIGATION OF INTERACTION BETWEEN NON-RESTRICTED FLOW AND FLEXIBLE PIPELINE (p. 24–29)

Fedir Bendeberya

The main results of the research of the flow around the flexible pipeline by the unrestricted flow of Newtonian fluid were considered. This issue is very important in the operation of vessels of the oil-producing fleet when the tandem operation of the oil platform and multi-purpose support vessel. In the underwater operation of the flexible pipeline, due to the nonlinear processes of formation and separation of discrete vortices or vortex sheet from the surface, vibration and undamped self-similar oscillations occur.

A description of the main features of this process at arbitrary and forced dynamic oscillations of the flexible pipeline was presented.

It is shown that the flow velocity increase always leads to unstable operation modes of the pipeline and the vortex separation from the pipeline surface has a clear impact, starting from the vortex shedding frequency corresponding to the Strouhal number Sh=0,1.

The described research results indicate the possibility of reducing the negative impact of parametric oscillations of flexible pipelines in the operating conditions of vessels and allow to eliminate the causes of accidents related to their depressurization.

Keywords: flexible pipeline, oscillation frequency, flow velocity, vortex separation, frequency capture.

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INVESTIGATION OF THE POSSIBILITY OF BALANCING AERODYNAMIC IMBALANCE OF THE IMPELLER OF THE AXIAL FAN BY CORRECTION OF MASSES (p. 30–35)

Gennadiy Filimonikhin, Lubov Olijnichenko

Investigate the possibility of balancing of ordinary and aerodynamic imbalances of the impeller of the axial fan by correction of mass. It is assumed that the impeller is made inaccurate. Using the Zagordan's theory of impeller were found the resultant vector and the resultant moment of the aerodynamic forces acting on rotating in the initial still air (gas) axial fan impeller. Find the corresponding their aerodynamic imbalance. It established its analogy with the imbalance of the unbalanced mass. Also, found its difference consisting in dependence of the aerodynamic imbalance on the density of air (gas). Was concluded about the possibility of balancing aerodynamic and ordinary imbalances by correction of mass before operating the fan. Was concluded about the possibility of static or dynamic balancing by passive auto-balancers of ordinary and aerodynamic imbalances during fan operation.

Keywords: axial fan, impeller, aerodynamic forces, dynamic imbalance, aerodynamic imbalance, auto-balancer.

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AUTOMATIC MONITORING THE TECHNICAL CONDITION OF A SHIP HULL DURING ITS OPERATION (p. 36–39)

Olga Zavalniuk

The study is devoted to experimental identifying the critiи cal zones in the maximum values of mechanical strain in ship hull designs. We have chosen the bearing structural elements of the hull which are the most suitable for monitoring the vessel's overall strength. The foci of elevated values of mechanical strain in the vessels' hulls are identified by means of the magnetic method of non-destructive testing. We have measured the coercive force of the material in bearing ship structures such as continuous coamings of cargo holds on both sides of the vessel (which appear to be the most accessible and convenient for control in the field conditions). The coercive force of the material allows measuring of the mechanical strain in the ship's structure without destroying it, on the basis of the corresponding correlation between the strained state and the coercivity of the material. The strained state of the tested elements in critical areas is used to determine the technical condition of bearing elements of the entire ship structure. We have proved that automatic monitoring of the technical condition of merchant marine ships during their operation would significantly increase the reliability and safety of the entire marine fleet.

Keywords: hull, technical condition, coercimetric monitoring.

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ELABORATION AND RESEARCH OF INSTALLATION FOR TWO-COMPONENT VIBRO-BLOWING DEHYDRATION OF FOOD PRODUCTION WASTE (p. 40–46)

Ivan Sevostyanov, Oleksandr Polischuk, Andriy Slabkiy

A scheme of installation with a hydraulic pulse drive for the two-component three-stage vibro-blowing dehydration of large portions of food production waste (spirit bards, beer pellet, beet pulp, coffee slime) was developed. The installation provides a periodic automated dehydration of waste in the closed type press-form with the stage-to-stage increasing intensity of the load, created through periodic reciprocating-helical motions of the press-form. Thus, as shown by the results of the experiments on the vibropress prototype and calculated data, an increase in workflow performance (by 2.3 times), decrease in energy intensity (by 3.3 times), reduction of the final moisture content of dehydrated coffee slime (by 2 %) at an insignificant complication of the installation design and increase in materials consumption in comparison with the one-component vibro-blowing dehydration is provided. Also, parameters of two-component vibro-blowing load of waste such as oscillation amplitude and frequency of the press-form with a portion of the waste, the maximum pressure and the centrifugal force generated in the medium of the waste in the dehydration process, the peak value of the rotation angle of press-form are reasonably selected. Based on the motion equations of actuating elements of the installation at different stages of the operation cycle of its drive, dependences for determining the load parameters, which can serve as a basis for developing a methodology for design calculation of the studied equipment were obtained.

Keywords: installation with a hydraulic pulse drive, two-component vibro-blowing dehydration, food production waste.

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EXPERIMENTAL RESEARCH OF SINGLE-PIECE SEPARATION PROCESS IN MAGAZINE LOADER OF SHOE MACHINES (p. 46–53)

Sergey Popovichenko, Bronislaw Orlovsky

The paper describes the method and design of the experimental setup for investigating the single-piece separation process in magazine loader of shoe machines, in which an additional mechanism for vertical shock impact on the stack of parts in the initial moment of single-piece separation is used to improve the single-piece separation conditions. The influence of factors such as single-piece separation force, vertical shock pulse and the number of parts in the stack on the single-piece separation process was examined. It was found that using the shock pulse allows to reduce the single-piece separation force by 30–40 % compared to its value in the separation of parts from the stack without the shock pulse. It can be concluded about the feasibility of using the shock impact on the stack of parts in magazine loader

of shoe machines to reduce the single-piece separation force and thus improve the separation process conditions.

Keywords: shoe machines, magazine loader , single-piece separation of shoe parts, automatic loading.

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MATHCAD IN THE KINEMATIC AND DYNAMIC ANALYSIS OF THE MANIPULATOR (p. 54–63)

Natalja Ashchepkova

The paper presents a technique for solving the problems of kinematic and dynamic analysis of the model industrial robot and reveals the effects of applying the suggested technique to a three-tier manipulator. The study has proved the expediency of Mathcad in solving the problems of kinematic and dynamic analysis, modeling the motion of the manipulator, as well as synthesis and analysis of the gripper trajectories of the model industrial robot.

This technique can be applied to solve both direct and inverse kinematics problems, determine the boundaries of the gripper reach and perform mathematical modeling of the manipulator motion. The projected path of the manipulator is supplied with the required forces and moments in the kinematic pairs.

The solution process is divided into simple computational procedures. The transformation of matrices, differentiation, as well as solution of differential and transcendental equations is performed due to the inbuilt functions and operators of the Mathcad application package. The suggested method does not require writing, debugging and testing programs. Problems of the kinematic and dynamic analysis of the manipulator are solved quicker and with fewer errors.

The suggested technique is useful in designing robotic systems and synthesizing optimal trajectories of a singular point.

Keywords: kinematic and dynamic analysis of the manipulator, coordinate transformation, law of motion, trajectory.

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