Abstracts

Khamaza L. A. **Determination of the Crack Size Corresponding to the Endurance Limit of Metals and Alloys in the Presence of a Stress Concentration** // Problems of Strength. – 2018. – No. 2. – P. 5–17.

Based on the assumption that there exists a proportional relationship between the quantity $\sqrt{area}$, which characterizes the stress raiser size, and the size of crack at the endurance limit of a specimen with stress raiser, a procedure for the calculation of the size of such a crack is proposed. The size of non-propagating cracks at the endurance limit of specimens with stress raisers has been calculated for a number of structural materials using the proposed procedure and known data on endurance limit and defects of different size and shape, which are evaluated with the parameter $\sqrt{area}$. The effect of stress gradient and concentration on the crack size at the endurance limit of various materials is considered. It has been shown that the crack size at the endurance limit of specimens with defects firstly increases with increasing stress gradient and theoretical stress concentration factor and, secondly, always remains larger than the size of non-propagating crack, which is observed at the endurance limit of smooth specimen.

Lobanov L. M., *Pashchin N. A.*, *Mikhodui O. L.*, *and Sidorenko Yu. M.* **Electric Pulse Component Effect on the Stress State of AMg6 Aluminum Alloy Welded Joints under Electrodynamic Treatment** // Problems of Strength. – 2018. – No. 2. – P. 18–26.

The residual welding stresses negatively influence the welded joint lifetime, and they are the chief cause of brittle metal fracture, i.e. corrosion cracking. The development of efficient methods to reduce the welding stresses, which are noteworthy for low energy costs and ease of realization, is customary important for the modern welding production. One such method is the electrodynamic treatment (EDT) based on the electric current pulse passing through the welded joints at the instant of dynamic load application to it. In the optimization of the parameters it is appropriate to test the pulse electric current effect on the residual welding stresses. The procedure of investigation of the EDT electric pulse component effect on the stress state of AMg6 aluminum alloy welded joints is proposed. It is established that the electric current pulse passing through the welded joint metal enhances the EDT efficiency in reduction of residual welding stresses. It is shown that the electrodynamic effect initiates the plastic tensile strains in metal, their interaction with the plastic welding compressive strains reduces residual stresses in the welded joint. Here the electric current pulses passing increases the peak values of the plastic tensile strains, which results in the more efficient electrodynamic effect on the residual welding stresses decrease in AMg6 alloy. The results lend credence to the physical model describing the electroplastic effect on the welding joints' stress state.

Kabannik S. N., *Zinkovskii A. P.*, *and Stel'makh A. L.* **Determination of the Subsonic Flutter Stability Boundary of Blade Rows at Large Angles of Attack** // Problems of Strength. – 2018. – No. 2. – P. 27–37.

This paper presents an experimental-numerical method for determination of the subsonic flutter stability boundary of blade rows at large angles of incident flow. The aerodynamic test rig for determining the unsteady aerodynamic loads is described. The test results are presented for a straight cascade of airfoils in a wide range of variation in the angle of attack and reduced vibration frequency, based on which the regularities in the effect of the angle of attack on the subsonic flutter stability boundary of blading are established.

Wang Z. Q., *Yu Z. W.*, *Sun X. Y.*, *Li H.*, *and Wang Y. J.* **Multiscale Modeling-Based Assessment of Elastic Properties of SLGS-Polymer Nanocomposites with Double-Atom Vacancy Defects** // Problems of Strength. – 2018. – No. 2. – P. 38–44.

In this study, which is a continuation of our earlier work, the effect of double-atom vacancy defects (DAVD) on the elastic properties of single-layered graphene sheets (SLGS)-polymer nanocomposites is assessed by the multiscale modeling. According to the latter approach, the polymer matrix is

modeled by finite element approach, while the SLGS and interphase layer are simulated at the atomistic scale by the molecular structural mechanics approach. In view of the Lennard–Jones potential concept, it is assumed that the SLGS and polymer matrix are related by van der Waals reciprocity. The fact that the elastic modulus of a polymer with 5% volume fraction of SLGS is increased by 17 times is demonstrated by numerous simulation results. It is also shown that the elastic modulus of SLGS-polymer nanocomposites with DAVDs is deteriorated with an increase in the number of DAVDs and improved with the increased volume fraction of SLGS.

Lvov G. I. and Okorokov V. O. **Experimental Study of Autofrettage** // Problems of Strength. – 2018. – No. 2. – P. 45–57.

The autofrettage of alloy D16 disks is investigated experimentally. The results of the experimental modeling are compared with the numerical calculations. A mathematical model of plasticity is developed based on the performed cyclic tension–compression tests of flat specimens. Additional functions of the previously accumulated plastic strain are incorporated into a nonlinear kinematic hardening model. The damage parameter is included according to the effective stress concept to describe a decrease in the elastic modulus during elasto-plastic deformation. Experimentally obtained distribution of residual circumferential and radial strains has shown a good agreement with the numerical results.

Mytsyk B. G., *Kost' Ya. P.*, *and Dem'yanyshyn N. M.* **Effect of Heat Treatment on Relative Change in the Young's Modulus of D16 Alloy under the Action of Low Cyclic Loads** // Problems of Strength. – 2018. – No. 2. – P. 58–65.

Relative changes in Young's modulus caused by cyclic loads, which are by an order of magnitude lower than the yield strength, have been studied on D16 alloy specimens (international analog: 2024 alloy), which correspond to the model of a thin round plate rigidly clamped along the contour. It is shown that the parameter $\delta E/E$ is very sensitive (changes by factors) to structural changes due to alloy heat treatment (annealing, hardening, natural ageing). The obtained results together with the evolution of elastic hysteresis and residual strains (depending on heat treatment), which was studied by the authors earlier, can be taken as a basis of a nondestructive method for the primary assessment of change in the state of structural materials after the action of operational factors.

Kaplun P. V. and Lyashenko B. A. **Effect of Coatings on the Fatigue Characteristics of Steels under Contact Load** // Problems of Strength. – 2018. – No. 2. – P. 66–73.

A new type of technological process is proposed for increasing the life of structural elements under rolling friction. Results of comparative experimental studies on increasing the life of steels under rolling friction, using hydrogen-free integral techniques for the application of gradient coatings with optimal properties, residual stresses and substrate hardness and using ion nitriding and heat treatment.

Tikhomirova E. A. and Sidokhin E. F. **Thermal Cyclic Material Tests Scheduling** // Problems of Strength. – 2018. – No. 2. – P. 74–81.

To schedule the investigations on the thermal fatigue of materials and analysis of the results, it is proposed to use the thermal cyclic test maps (TC-maps) that allow tracing the strain development in a thermal cycle. TC-maps illustrate the diagrams of the temperature-dependent elastic strain, which corresponds to the yield strength of the material, and the free strain variation under constraint conditions. This paper presents the procedure of thermal cycle test map compiling for some materials and their physical as well as mechanical properties. The useful information obtained from the TC-maps is exemplified by some heat-resistant alloys employed for the production of gas-turbine engine blades.

Stepanov G. V. and Chizhik A. V. **Pulse Current Effect on the Stress-Strain State in a Cracked Steel Strip** // Problems of Strength. – 2018. – No. 2. – P. 82–88.

Finite element method-based estimation results for the current pulse effect on the stress-strain state in the vicinity of the edge crack tip in a steel strip are presented. Alternating high-density current along

crack edges is shown to result in local stress-strain state variations near its tip, giving rise to residual plastic strains combined with thermal current-induced ones.

Tsybanev G. V. **Description of the Kinetics of Short Surface Fatigue Crack Growth Using the Parameters of Force Fatigue Curves** // Problems of Strength. – 2018. – No. 2. – P. 89–98.

To describe the kinetics of short surface crack nucleation and growth in metals and alloys, an approach has been developed, which is based on deformation curves in the low-cycle fatigue region. In view of the known Ramberg–Osgood stress-strain relationship, the deformation fatigue curves have been replaced by traditional force fatigue curves. Analysis of known experimental data shows that the kinetics of short surface fatigue crack initiation and growth can be described by the parameters of force fatigue curves for both the low- and high-cycle fatigue regions, which makes such results more informative.

Tereshchenko Yu. M., *Doroshenko E. V.*, *Tereshchenko Yu. Yu.*, *and Gumenyuk P. V.* Gas **Dynamic Action of Annular Blowing on the Aerodynamic Factors of the Resonance Vibration Excitation of Rotor Blades in a Compressor Stage** // Problems of Strength. – 2018. – No. 2. – P. 99–105.

The paper presents the results of a study of the effect of annular blowing ahead of the rotor wheel of an axial compressor stage on the forced vibration excitation of rotor blades. It has been shown that annular blowing smooths the flow velocity field behind the axial compressor stage and reduces the level of vibratory stresses in the root section of the rotor blades.

Ge Y. Q., *Chen X.*, *Wang W. X.*, *and Guo S.* **Surface Strengthening Behavior of Magnesium Alloy with Laser Thermal Loading under Rapid Cooling** // Problems of Strength. – 2018. – No. 2. – P. 106–114.

Laser surface strengthening had been performed on an AZ31B magnesium alloy, while the sample was rapidly cooled in liquid nitrogen. Surface strengthening behavior and mechanism were investigated. Because of strengthening mechanisms of fined grains, super solid solution, dislocation and the existence of the amorphous structure, microhardness, wear resistance and fracture toughness of magnesium alloy was greatly improved. Because of the rapid heating and cooling loading of laser, the grains of the strengthening layer were greatly refined, and amorphous structure was formed. And there were more dislocations in the strengthening layer rather than in the substrate. Furthermore, distortion of lattice caused by large numbers of Al element dissolved into α-Mg also increased the resistance to dislocation motion.

Zhang Q., *Liu J. M.*, *Liu Y. F.*, *and Li L. Y.* **Study on High-Strength Ring Chain Dynamic Characteristics under Different Launch Parameters** // Problems of Strength. – 2018. – No. 2. – P. 115–125.

The aim of this study is to investigate the mechanical characteristics of the high-strength ring chain under various launch parameters and the energy consumption caused by this. Particularly, the contact dynamics simulation was implemented in ABAQUS to study the launch characteristics impacted by different chain speeds different transportation loads, and the results were proved by experiments. The results show that stable stresses under different launch speeds are diverse, and the launch speed which makes the performance best is 5.6 m/min; stable stresses under different loads are diverse, and in the overload-launch process, the normal force of the chain increases multi-fold so that the chain will be great damaged; The energy consumption caused by the friction among high-strength ring chains under no-load operation occupies 23.8% of the resistance consumption. With the rise in loads, the total resistance consumption grow linearly. As a consequence, the research has great significance for the research of ring chain launch characteristics, the forecast of the chain's operating life and the efficiency improvement of electromotors.

Hou M. X., *Tang M. X.*, *and Hu H. S.* **Optimization of Photoelastic Properties and Stress Relief of Small-Sized Polycarbonate Disks for Granular Material Photoelastic Tests** // Problems of Strength. – 2018. – No. 2. – P. 126–133.

The development of photoelastic tests was strongly enhanced by appearance of polycarbonate, which turned out to be an excellent photoelastic material. In order to obtain small polycarbonate particles applicable for granular material photoelastic tests, small-diameter transparent cylindrical disks are cut from a polycarbonate plate preliminarily subjected to annealing, in order to provide stress relief. The plate-cutting and annealing regimes are optimized by the comprehensive analysis of mechanical and photoelastic properties of polycarbonate disks of various diameters and constant height of 5 mm. The resulting stress-strain photoelastic visualizations and material fringe patterns are analyzed, in order to verify the effectiveness of the proposed material processing and annealing regimes.

Liu M. and Ma Q. X. **Austenite Grain Growth Behavior of 20Mn5 Steel Used for Heavy Hydro-Generator Shaft** // Problems of Strength. – 2018. – No. 2. – P. 134–145.

20Mn5 steel is widely used in the manufacture of heavy hydro-generator shaft due to its good performance of strength, toughness and wears resistance. Some researches about its hot deformation and recrystallization behavior were reported. However, the austenite grain growth behavior of 20Mn5 steel when heated under high temperature was not studied. The austenite grain growth behavior determines the grain size of steel ingot before hot forging and has a great influence on the microstructure evolution during hot forging. In this study, samples from 20Mn5 hollow steel ingot are heated to different temperatures of 850, 900, 950, 1000, 1050, 1100, 1150, and 1200℃ and held for different times of 1, 3, 5, 7, 9, and 11 h before being quenched with water. The experimental results show that the austenite grain size increases with increasing temperature and holding time. When heating temperature ranges from 850 to 1050℃, the growth velocity of austenite grain is small; when heating temperature ranges from 1050 to 1200℃, the growth velocity of austenite grain increases remarkably. A two-stage grain growth model is established to predict the austenite grain size after holding under high temperature. The predicted austenite grain sizes are in good agreement with the experimental ones, which indicates that the model is reliable.

Vėžys J., *Mažeika D.*, *Kandrotaitė-Janutienė R.*, *Dragašius E.*, *Kilikevičius A.*, *and Korobko E. V.* **Sedimentation Influence on Magnetorheological Brake Torque Moment** // Problems of Strength. – 2018. – No. 2. – P. 146–158.

The aim of our research was to determine how sedimentation in magnetorheological fluid influences torque moment of a magnetorheological brake. Five different magnetorheological fluids (MRF-140CG, MRF-122EG, from Lord Corporation, USA, MRHCCS4-A and MRHCCS4-B are from Liquids Research Company, UK and MUDZH-3, made in A. V. Luikov Heat and Mass Transfer Institute, Belarus) were tested. The viscosity of these magnetorheological fluids in the magnetic field of 0–1 T was measured on Anton Paar Physica MCR-301 rheometer. We have selected the fluid with the best parameters to fill up our made magnetorheological brake. To determine sedimentation in magneto-rheological fluid was used patent pending method by measuring fluids' electrical resistivity. Electrical resistivity dependence on sedimentation mathematical model was created. Also four piezo-actuators were used to mix fluid inside the brake. Experimental setup to determine brakes' torque moment was created.