Abstracts

Shul'zhenko N. G., *Asaenok A. V.*, *Zaitsev B. F.*, *Grishin N. N.*, *and Gubskii A. N.* **Creep of Steam-Turbine Diaphragm under Variable Loading Conditions** // Problems of Strength. – 2016. – No. 6. – P. 5–12.

The authors put forward a procedure of creep analysis for variable loading conditions, which involves the use of the incremental creep theory and finite element method. Variable loading with load increase and relief at a constant temperature is considered as a stepwise process. The authors study a growth of deflections and stress relaxation in a intermediate-cylinder diaphragm of a steam turbine in various loading modes as well as special features of residual stress distribution in fixed blades.

Pokhmurs'kyi V. I., *Rats'ka N. B.*, *Vasyliv Kh. B.*, *and Vynar V. A.* **Improvement in the Wear Resistance of the Nb–Ti Alloy System by Using Thermodiffusion Oxidation** // Problems of Strength. – 2016. – No. 6. – P. 13–20.

The paper analyzes the influence of thermodiffusion oxidation on the structure, physico-mechanical and tribological properties of a niobium-titanium alloy. The method of combined chemical and thermal treatment of a niobium-titanium alloy is proposed to form a surface composite layer containing oxide inclusions of rutile-type $Ti(Nb,Al,V)O_2$ in the matrix. It is shown that for the volume fraction of oxide inclusions in the gas-saturated layer of 40–50%, the wear resistance of the alloy increases, also under the influence of hydrogen.

Tsybanev G. V. and Novikov A. I. **Refinement of Deformation Approach-Based Model of Materials' Fatigue Damage Kinetics** // Problems of Strength. – 2016. – No. 6. – P. 21–35.

The experimental data on inelastic cyclic deformation of various metallic materials are analyzed with the aim to determine the mechanisms governing their variation during cyclic loading. Groups of materials with similar kinetics of inelastic deformation are selected, and the analytical relations for their description are proposed. The variation of inelastic strains under conditions of the material fatigue is closely associated with their hardening-softening, which description requires the calculated model of cyclic yield strength variation. The proposed model for the selected groups of materials makes it possible to describe their inelastic deformation and damage behavior under fatigue conditions.

Lavinskii D. V. and Morachkovskii O. K. **Elastoplastic Deformation of Bodies Interacting through Contact under the Action of Pulsed Electromagnetic Field** // Problems of Strength. – 2016. – No. 6. – P. 36–45.

A formulation is presented for the problem of elastoplastic deformation of the system of electrically conductive bodies under the action of pulsed electromagnetic field. The numerical technique for solving the problem is based on the finite element method. Deformation of bodies interacting through contact during the pulsed magnetic treatment of materials is analyzed. The influence of the manufacturing and design parameters of the inductor–workpiece system on its stress-strain state is investigated.

Drozdov A. V., *Kharchenko V. V.*, *Potapov A. V.*, *Klimenko D. V.*, *Kharchenko V. N.*, *and Samusenko A. A.* **Computation Software for Strength and Elastic Characteristics of Polymer Composites** // Problems of Strength. – 2016. – No. 6. – P. 46–55.

A CFRP Strength software is described that provides computations of strength and elastic characteristics of polymer composite materials under basic loading modes viz in tension, compression, and bending in accordance with operating test standards for the material of this class. The software also permits of statistical evaluation of strength properties with a Weibull two-parameter distribution.

Kaplun P. V. and Lyashenko B. A. **Determination of Residual Stresses in Surface Layers upon Ion Nitriding by Microhardness Values** // Problems of Strength. – 2016. – No. 6. – P. 56–63.

This paper presents the results of investigations on the value and distribution of residual stresses in nitrided layers of 20Kh13 steel upon ion nitriding in hydrogen-free media. The effect of nitriding parameters on the depth and hardness of the nitrided layer as well as on residual stresses in the surface layer is analyzed. The procedure for the determination of residual stresses at the arbitrary point of the nitrided layer depth by the microhardness values at the given point is developed.

Buiskikh K. P., *Kisilevskaya S. G.*, *Kravchuk L. V.*, *Zadvornyi E. A.*, *and Feofentov N. N.* **Kinetics and Mechanisms of Degradation of the Surface Layers of Gas-Turbine Engine Structural Components under Cyclic Thermal Loading during Initiation and Propagation of Thermal Fatigue Cracks** // Problems of Strength. – 2016. – No. 6. – P. 64–72.

Studies of surface layer material of degradation of the most loaded elements of gas turbine engine structural components revealed the essential changes in the structure and elemental compositionof this layer in the thermal fatigue crack initiation zones, as well as along the propagating crack lips. The intensity of the observed changes implies the necessity of their account in the stress-strain state calculations and estimations of the residual life of high-temperature structural components of gas turbine engines.

Colussi M., *Berto F.*, *Mori K.*, *and Narita F.* **Effect of the Loading Rate on the Brittle Fracture of Terfenol-D Specimens in Magnetic Field: Strain Energy Density Approach** // Problems of Strength. – 2016. – No. 6. – P. 73–83.

The aim of the present study is to characterize the fracture behaviour of the giant magnetostrictive alloy commercially named Terfenol-D, both experimentally and numerically. Three-point bending tests have been carried out on single-edge precracked specimens and fracture loads have been measured at different loading rates,in the presence and absence of a magnetic field. In the recent years it has been shown that Strain Energy Density (SED), averaged in a finite control volume, can successfully predict brittle failures of cracked, U- and V-notched specimens made out of several materials. By performing coupled-field finite element analyses, the effect of the magnetic field and of the loading rate on Terfenol-D failures have been analyzed and the capability of SED criterion to capture these effects has been discussed.A relationship between the size of the SED's control volume and the loading rate has been proposed and failures have then been predicted in terms of averaged SED.

Rostamiyan Y. and Norouzi H. **Flatwise Compression Strength and Energy Absorption of Polyurethane Foam-Filled Lattice Core Sandwich Panels** // Problems of Strength. – 2016. – No. 6. – P. 84–94.

In the present study, the effect of the polyurethane foam filled lattice core sandwich panel on the energy absorption and the compression strength was investigated. In the compression tests, it was found that the foam filled sandwich panels have a greater load carrying capacity compared to the sum of the unfilled specimens and the filled polyurethane block. Besides, the energy absorption efficiency of foam filled sandwich panels with higher relative density (5.1 and 5.7%) lattice cores was lower than that of the unfilled specimen when the compressive strain was small, whereas it showed superior when the compressive strain arrived at about 0.1, and the superiority became more pronounced as the strain increased. Moreover, the energy absorption of foam filled sandwich panel's with lower relative density (4.43%) lattice cores was superior to that of the unfilled specimen.

Bardak S., *Tiryaki S.*, *Bardak T.*, *and Aydin A.* **Predictive Performance of Artificial Neural Network and Multiple Linear Regression Models in Predicting Adhesive Bonding Strength of Wood** // Problems of Strength. – 2016. – No. 6. – P. 95–110.

The purpose of this study was to develop artificial neural network (ANN) and multiple linear regression (MLR) models that arecapable of predicting the bonding strength of wood based on

moisture content, open assembly time and closed assembly time of the joints prior to pressing process. For this purpose, the experimental studies were conducted and the models basedon experimental results were set up. As a result of the experiments conducted, it was observed that bonding strength first increased and then decreased with increasing the wood moisture content and adhesive open assembly time. In addition, the increased closed assembly time caused a decrease in bonding strength of wood. The ANN results were compared with the results obtained from the MLR modelto evaluate the models' predictive performance. It was found that the ANN model with the R^2 value of 97.7% and the mean absolute percentage error of 3.587% in test phase exhibits higher prediction accuracy than the MLR model. The comparison results confirm the feasibility of ANN model in terms of predictive performance. Consequently, it can be said that ANN is an effective tool in predicting wood bonding strength, and quite useful instead of costly and time-consuming experimental investigations.

Tang H. M., *Huang L.*, *Bobet A.*, *EzEldin M. A. M.*, *Wang L. Q.*, *Wu Y. P.*, *and Hu X. L.* **Identification and Mitigation of Error in the Terzaghi Bias Correction for Inhomogeneous Material Discontinuities** // Problems of Strength. – 2016. – No. 6. – P. 111–121.

Use of the scanline mapping technique in geometric surveys of rock discontinuities can often lead to a bias, in that discontinuities are not always observed when they are at small angles to the scanline. Terzaghi introduced the concept of a blind zone to explain this bias, and developed a widely used procedure to correct for it. Unfortunately, little is known about errors that may occur when the Terzaghi procedure is used outside the blind zone. This paper presents a detailed derivation to show that such errors arise with this application of the Terzaghi procedure. This error was evaluated using simulated orientation data and a case study at Wenchuan, Sichuan, China (2008). The results of these tests suggest optimal values of grid size and sample density for reducing the error.

Deng Y. F., *Li J. F.*, *Jia B. H.*, *and Wei G.* **Numerical Study of Failure Modes and Crack Propagation in 2A12 Aluminum Target against Blunt-Nosed Projectile at Low Yaw Angle** // Problems of Strength. – 2016. – No. 6. – P. 122–138.

Simulation models of 2A12 aluminum targets with thickness 1mm stricken by the high strength 38CrSi blunt-nosed projectiles at different yaw angle have been established with the help of ABAQUS, then the failure mode and crack propagation of target was analyzed after the effectiveness of simulation models had been verified by experiment, also the motion and angle variation of projectile was studied. Simulation result indicated that target would experience staged deformation and destruction during impacting, three typical figures of plugs were obtained, and there was a special initial velocity of projectile which could change the extension of target's crack. For projectile, the trajectory deviation was observed, at the same time the trajectory angle and obliquity angle were increased, this phenomenon could be explained by the radial force between projectile and target, more details illustrated that initial yaw angle and velocity of projectile were two main factors to affect the motion of projectile.

Haeri H., *Sarfarazi V.*, *and Zhu Z.* **Analysis of Crack Coalescence in Concrete Using Neural Networks** // Problems of Strength. – 2016. – No. 6. – P. 139–151.

Fractures in the forms of joints and microcracks are commonly found in concretes, and their failure mechanism strongly depends on the crack coalescence pattern between pre-existing flaws. The determination of the failure behavior of nonpersistent joints is an engineering problem that involves several parameters as mechanical properties of concrete, normal stress and the ratio of joint surface to total shear surface. The impact of these parameters on the crack coalescence is investigated through the use of computational tools called neural networks. A number of networks of threshold logic units were tested, with adjustable weights. The computational method for the training process was a back-propagation learning algorithm. In this paper, the input data for crack coalescence consists of values of geotechnical and geometrical parameters. As an output, the network estimates the crack type coalescence (i.e., mode I, mode II, or mode I-II) that can be used for stability analysis of concrete structures. The performance of the network is measured and the results are compared to those obtained by means of experimental method.

Liu M. S., *Li C. A.*, *Huang J. R.*, *and Ju J. S.* **Numerical Modeling and Mechanical Analysis of Combined Connection with Bolts and Welds** // Problems of Strength. – 2016. – No. 6. – P. 152–161.

In this paper, a detailed finite element model of the combined connection with bolts and welds is created to analyze its failure mode and bearing capacity under shear load. The evaluation of work-together behavior of bolts and welds are focused on. Failure mode and load sharing are discussed through several finite element numerical tests of different weld sizes. Then the more tests, by changing the weld height and length, bearing capacity utilization rate of bolts and welds are obtained. The result shows that the weld's contribution to tension load-bearing capacity is always dominant in the combined connection with bolts and welds. As the weld-to-bolt strength ratio (the ratio of the design value of the weld joints to the bolt joints' bearing capacity) is about 1.0, the welds and bolts in the combined connection can work together with a good performance. And with the increasing of the weld-to-bolt strength ratio, the load sharing of the bolts decrease. When the weld-to-bolt strength ratio exceeds 2.0, the contribution of bolts in the combined connection is negligible.

Drozdov A. V. and Kravchuk L. V. **Universal Data Acquisition and Control System for Strength and Thermomechanical Tests of Materials and Structure Elements** // Problems of Strength. – 2016. – No. 6. – P. 162–168.

A universal GDS-16 data acquisition and control system based on Quantum X MX840 measuring amplifiers and Catman Easy software is described. The system provides multichannel measurement of strains, displacements, pressures, and temperatures, data processing, visualization, and accumulation, which permits strength and thermomechanical tests of materials and structure elements to be performed.