Abstracts

Romashchenko V. A. **Numerical Analysis of the Dynamics and Strength of Multilayer Composite Spheres under an Internal Explosio**n // Problems of Strength. – 2017. – No. 2. – P. 5–17.

The paper presents the numerical investigation on the stress-strain state of one- and two-layer spheres with spherically transtropic radially reinforced layers under a centrally symmetric internal explosion. A comparative analysis is made between two widely used methods of modeling the explosive loading. The influence of the reinforcing fiber volume fraction and the alternation of layers on the strength of shells is investigated.

Torabi A. R., *Campagnolo A.*, *and Berto F.* **Large-Scale Yielding Failure Prediction of Notched Ductile Plates by Means of the Linear Elastic Notch Fracture Mechanics** // Problems of Strength. – 2017. – No. 2. – P. 18–29.

The main goal of this research is to propose a failure criterion based on the linear elastic notch fracture mechanics (LENFM) for predicting tensile crack initiation from a blunt V-notch, encountering large plasticity at the notch vicinity. First, some most recently published experimental results on tensile failure of V-notched ductile aluminum plates are briefly described. Then, with the aim to avoid complex and time-consuming elastic-plastic analyses, the equivalent material concept (EMC) is employed together with a LENFM-based fracture criterion, namely the averaged strain energy density (ASED) criterion, for predicting the load-carrying capacity of the V-notched aluminum plates. A very good agreement is shown to exist between the experimental results and theoretical predictions of the EMC-ASED criterion.

Lobanov L. M., *Pashchin N. A.*, *Timoshenko A. N.*, *Goncharov P. V.*, *Mikhodui O. L.*, *and Sidorenko Yu. M.* **Effect of the Electrodynamic Treatment on the Life of AMg6 Aluminum Alloy Weld Joints** // Problems of Strength. – 2017. – No. 2. – P. 30–35.

The effect of the electrodynamic treatment on the life of AMg6 aluminum alloy weld joints is evaluated under cyclic loading. This treatment of butt weld specimens was established to result in a lower level of residual welding tensile stresses with their sign change.

Yanagisawa Y., *Kishi Y.*, *and Sasaki K.* **Analysis of Residual Stresses during Heat Treatment of Large Forged Shafts Considering Transformation Plasticity and Creep Deformation** // Problems of Strength. – 2017. – No. 2. – P. 36–48.

The long cooling time during heat treatment of a large forging due to mass effect leads to the creep deformation at not only high temperature but also transformation temperature ranges. Therefore, both the transformation plasticity and the creep together with the phase transformation significantly affect the stress distribution of the forging after the heat treatment. In this study, a FEM model considering both the transformation plasticity and creep was developed. Proposed model was integrated into commercial ANSYS codes via user subroutines. The material properties of the transformation plasticity and creep were also measured experimentally. For experimental verification, the residual stress measurements of the large forged shaft are compared with those of the simulations. The simulations show that the residual stresses were mainly caused by the phase transformation stress. In particular, it is found that both the transformation plastic strain and the creep strain play important roles in simulating the residual stress during heat treatment of a large forged shaft.

Adamchuk M. P. and Borodii M. V. **Determination of Steady Ratcheting Strain Rate under Biaxial Loading Based on Cycle Disproportion Parameter** // Problems of Strength. – 2017. – No. 2. – P. 49–55.

An approach to the determination of steady ratcheting strain rate under biaxial loading depending on the loading cycle geometry is proposed. Based on the data analysis, the microstructural investigation results, as well as the similarity detected between the microstructural formations after deformation at

the stress- and strain-controlled modes of loading it is proposed, to use the cycle disproportion parameter to predict the ratcheting rate. It is shown that the geometric cycle parameters and basic experiments allow one to adequately predict the ratcheting rate for complex cyclic trajectories.

Kulyk V. V., *Lenkovs'kyi T. M.*, *and Ostash O. P.* **Mode I and Mode II Cyclic Crack Resistance of Wheel Steel** // Problems of Strength. – 2017. – No. 2. – P. 56–63.

The characteristics of the mode I and mode II cyclic crack resistance of model wheel steel are compared. The effect of heat treatment of test steel on its microstructure parameters, as well as strength and cyclic crack resistance characteristics, is studied.

Kim C. S. **Variation of Mechanical Characteristics and Microstructural Evolution in AISI 316 Austenitic Stainless Steel Subjected to Long-Term Thermal Aging at Elevated Temperature** // Problems of Strength. – 2017. – No. 2. – P. 64–74.

The objective of this study was to investigate the mechanical degradation of AISI 316 austenite stainless steel as light-water reactor pressure vessel materials in the primary system of nuclear power plants. The influences of long-term aging on the microstructural and mechanical characteristics were studied. The long-term aging tests were interrupted at various stages to obtain different levels of degraded specimens. The test specimens were heat-treated and exposed to an acceleration heat-treatment at 600℃ for up to 10,000 hours. AISI 316 steel showed polygonalshaped grains with many annealing twins, and these tended to become gradually more circular-shaped grains during long-term aging. In the initial material degradation, twins were distributed uniformly within most grains, but they all recovered and disappeared after a prolonged 10,000-hour aging time. Delta ferrite along austenitic grain boundaries transformed into sigma phases and $Cr_{23}C_6$ precipitates during long-term aging, and the area fraction on the grain boundary increased. The peak strength appeared at a 100-hour aging time and then decreased up to 1000 hours. With further aging time, the strength increased to a higher level than the initial state. However, the elongation and toughness decreased continuously, demonstrating the material embrittlement during long-term thermal aging.

Filipkovskii S. V. **Stability and Bifurcations of Vibrations of a Rotor with Axially Preloaded Ball Bearings** // Problems of Strength. – 2017. – No. 2. – P. 75–83.

A model of forced vibrations of a rotor with two axially preloaded angular contact ball bearings and a procedure for studying them have been developed. In the model, vibrations are excited by the joint action of the unbalance and vibration of the supports. Amplitude-frequency characteristics, resonances, the stability and bifurcations of vibrations have been analyzed.

Astanin V. V. and Shchegel' A. A. **Probability Approach to the Problem of Impact-Induced Damage Simulation of Composite Plates** // Problems of Strength. – 2017. – No. 2. – P. 84–98.

The probability damage and fracture model for a composite material under impact loading is proposed. Within this model, the damage parameters are regarded as the probability functions of strain, strain rate, and temperature with a preset probability density. FEM numerical strength computations for fiber-reinforced plates were carried out in the range of impact velocities up to 1200 m/s. The dynamics of energy absorption and plate damage levels with the impact velocity were analyzed.

Ismail Ali A. **Planning Step-Stress Life Tests for the Generalized Rayleigh Distribution under Progressive Type-II Censoring with Binomial Removals** // Problems of Strength. – 2017. – No. 2. – P. 99–115.

In this article, both the parameter estimation and optimal design problems of step-stress partially accelerated life test units whose lifetimes follow the generalized Rayleigh distribution are considered under progressive type-II censoring scheme with binomial removals. The maximum likelihood estimators of the scale and shape parameters as well as the acceleration factor are obtained. The concert of the estimators is assessed. In addition, approximate confidence intervals of the model

parameters are constructed and their coverage probabilities are computed. Moreover, optimum test plans are also developed to improve/guarantee the quality of the statistical inference. Finally, simulation studies and a numerical example are provided for illustrative purposes.

Filatov V. E., *Zinkovskii A. P.*, *Podgorskii K. N.*, *and Glikson I. L.* **On a Procedure for the Determination of the Mechanical Characteristics of Materials in the Case of Tensile Test of Specimens at Elevated Temperatures** // Problems of Strength. – 2017. – No. 2. – P. 116–122.

The paper presents a procedure for the determination of the mechanical characteristics of materials for modern aircraft gas-turbine engines on the basis of results of uniaxial tension tests under elevated temperature conditions. The procedure permits one to allow for measurement errors, which arise from the misalignment of the load chain and temperature effect when using strain gauges of modern testing systems. The evaluation of the procedure is illustrated for the uniaxial tension of specimens of EI962 material (11Kh11N2V2MF steel) as an example.

Sklepus S. N. **Numerical-and-Analytical Method of Investigation of the Creep and Sustained Strength Characteristics for a Multilayer Shell** // Problems of Strength. – 2017. – No. 2. – P. 123–131.

The problem of stress-strain state creep and sustained strength computations for multilayer shallow shells of medium thickness, free form in plan was discussed. The variational statement is done within the refined theory of shells. The solution method for the nonlinear initial boundary creep problem based on combining the *R*-functions', the Rietz, and the Runge-Kutta–Merson methods was developed. An example of creep and sustained strength calculation is given for a two-layer cylindrical shell simulating the thermal barrier coating.

Sarfarazi V., *Haeri H.*, *Shemirani A. B.*, *and Zhu Z.* **Shear Behavior of Non-Persistent Joint under High Normal Load** // Problems of Strength. – 2017. – No. 2. – P. 132–148.

In this paper, the effect of joint separation on the shear behavior of planar non-persistent joints under high normal load has been investigated using PFC2D. Initially, calibration of PFC was undertaken with respect to the data obtained from experimental laboratory tests to ensure the conformity of the simulated numerical models response. Furthermore, the simulated models were cross checked with the results of direct shear tests performed on non-persistent jointed physical models. Through numerical direct shear tests, the failure process was visually observed, and the failure patterns were found reasonably similar to the experimentally observed trends. The discrete element simulations demonstrated that the failure pattern was mostly influenced by joint separation, while the shear strength was linked to the failure pattern and mechanism.

Obodan N. I., *Adlutskii V. Ya.*, *and Gromov V. A.* **Vulnerability Assessment of Loaded Thin-Walled Shells under an External Pulse Action** // Problems of Strength. – 2017. – No. 2. – P. 149–157.

The vulnerability assessment of thin-walled systems under pulse actions is treated as an inverse problem of the bifurcation theory using the phenomenon of growth and saturation of the displacement level during the pre-bifurcation period. Using the computational time series the authors perform the neural network prediction of a thin-walled structure behavior within a time shorter than the progressive collapse duration.

Giginyak F. F. and Maslo O. M. **A Relationship Between Damage in 10GN2MFA Steel and Low-Cycle Strain-Controlled Loading at Different Deformation Frequencies** // Problems of Strength. – 2017. – No. 2. – P. 158–164.

The damage kinetics in 10GN2MFA steel under strain-controlled cyclic loading is studied by the LM-hardness method in order to clarify special features of the damage behavior and determine the limit-state parameters of the material. The authors discuss the findings of the experimental investigations of the damage kinetics in this steel under strain-controlled uniaxial low-cycle loading at different deformation frequencies.