Abstracts

Vorob'ev E. V., *Strizhalo V. A.*, *and Anpilogova T. V.* **Strain-Hardening of Notched Steel Specimens during Their Deep Cooling down to 4.2 K** // Problems of Strength. – 2017. – No. 5. – P. 5–10.

In this study, the stress concentration effect on the low-temperature strain-hardening of 12Kh18N10T and 03Kh20N16AG6 steels is investigated. It is shown that cooling of notched specimens from these steels to the temperature of liquid helium results in the increase of their ultimate strength values by 165 и 240%, respectively, whereas the structural factor contribution is significantly reduced for the former steel and remains unchanged for the latter one.

Daneshfar M., *Hassani A.*, *Aliha M. R. M.*, *and Berto F.* **Evaluating Mechanical Properties of Macro-Synthetic Fiber-Reinforced Concrete with Various Types and Contents** // Problems of Strength. – 2017. – No. 5. – P. 11–22.

Concrete, as one of the most widely used construction materials, has a brittle behavior. Adding fibers with different types and contents would affect the ductility behavior and mechanical properties of concrete. Hence, an experimental study was conducted to investigate effects of type and content of polymer fibers on mechanical properties of fiber-reinforced concrete such as flexural strength, compressive strength, indirect tensile strength, and elastic modulus. In the present research, the concrete samples were made and, then, evaluated, using three different types of polymer fibers, including twisted, barchip, and fibrillated, with the contents of 0.2, 0.4, and 0.6 volume percentages, respectively. The results showed that by adding fibers to the concrete samples, the flexural and tensile strength was increased by 19.6–81.69% and 0.84–34.29%, respectively; besides, the addition of the fibers to concrete reduced the compressive strength and elasticity modulus by 4.57–26.32% and 12.48–37.08%, respectively. The concrete containing twisted and barchip fibers, despite the different types of fibers, had similar flexural performance.

Marchuk A. V., *Gnedash S. V.*, *Apunevich A. A.*, *and Vovk A. V.* **A Study of the Effect of Friction between Delaminated Layers on the Stress-Strain State of Thick Laminated Anisotropic Cylindrical Shells by the Semianalytical Finite Element Method** // Problems of Strength. – 2017. – No. 5. – P. 23–31.

An approach to studying the stress-strain state of axisymmetrical cylindrical shells with allowance for the delamination of layers by friction between them has been constructed within the framework of the three-dimensional theory of elasticity. The approach is based on the separation of shell across its thickness into a number of constituent shells with fixed curvature of each layer at the level of its median surface. To approximate the unknown functions in plan, linear polynomials are used, and their distribution over the thickness is found on the basis of the analytical solution of the corresponding system of differential equations. The proposed approach may be classified as a semianalytical finite element method. The effect of friction in the delamination zone on the stress-strain state of the shell has been analyzed.

Hashemi M. and Zhuk Ya. A. **Prediction of Thermal Instability-Initiated Performance Losses by Nanocomposite Structure Elements under Cyclic Loading** // Problems of Strength. – 2017. – No. 5. – P. 32–50.

The method of predicting thermal instability-initiated performance losses by nanocomposite structure elements is developed. It is based on the model of monoharmonic approximation of the material response to cyclic loading, amplitude ratios between main field variables, and concept of complex moduli. The methods of evaluating the moduli of accumulation and losses of nanocomposite components as well as the model allowing for the effect of the fiber-matrix contact surface were evolved. The modified homogenization procedure based on the Mori–Tanaka method was elaborated to obtain the complex moduli of a nanocomposite with random or unidirectional nanofiber orientation. Temperature- and amplitude-dependent complex moduli were used to study the effect of dissipative heating on the mechanical stability of a polymer nanocomposite bar under combined static and

monoharmonic loadings. The effect of a load amplitude and volume content of nanofibers on the thermal instability of the bar was investigated.

Pavlyuk Ya. V. **Modeling of the Stress Relaxation of Nonlinear Viscoelastic Materials under Unsteady Deformation Conditions** // Problems of Strength. – 2017. – No. 5. – P. 51–59.

The paper considers a problem of stress relaxation calculation of nonlinear viscoelastic materials under unsteady deformation conditions. To describe the deformation process, a nonlinear creep model of the Rabotnov type with time-independent nonlinearity is used. A fractional exponential function is used as a heredity kernel. An experimental evaluation of the calculation results under the conditions of one-step deformation, partial unloading and cyclic deformation of plexiglass has been performed.

Pelykh V. N. **Prediction of the Limit State and Life of Structural Materials under the Action of Symmetric Cyclic Bending and Static Torsion** // Problems of Strength. – 2017. – No. 5. – P. 60–66.

The paper considers a limit state and fatigue life calculation problem of prismatic bars under the joint action of symmetric cyclic bending and static torsion. The solution is constructed using the equivalent stress method. A cyclic stress under symmetric cycle conditions was chosen as an equivalent stress. The results of the calculation have been evaluated experimentally for alloyed steels and an aluminum alloy as an example.

Burov A. E., *Lepikhin A. M.*, *Makhutov N. A.*, *and Moskvichev V. V.* **Numerical Analysis of Stress-Strain State and Strength of Metal Lined Composite Overwrapped Pressure Vessel** // Problems of Strength. – 2017. – No. 5. – P. 67–79.

The results of computational studies of the stress-strain state and strength of a metal lined composite overwrapped pressure vessel are presented. It is shown that the features of the stress-strain state of the metal liner and its interaction with the composite shell significantly influence the deformability and strength of the pressure vessel. The ultimate pressure and the main factors influencing the geometry stability of the vessel are determined.

Vasudevan G. and Kothandaraman S. **Effect of Length of External Bar at Soffit on the Performance of Retrofitted RC Beams – A Finite Element Study** // Problems of Strength. – 2017. – No. 5. – P. 80–94.

This paper presents the results of the finite element study on the effect of length of the external bar at soffit on the flexural behavior of retrofitted RC beams. A reference beam specimen and five retrofitted beam specimens with external bar length as variable were analysed using ANSYS 12.0 software and the results are presented. Initial cracking, performance at yielding of internal bar and at ultimate stage, ductility behavior, formation and propagation of cracks were studied and reported in this paper.

Verma S., *Amritphale S. S.*, *and Das S.* **Improvement of Strength and Radiation Protection Properties of Biodegradable Jute Fiber Reinforced Material** // Problems of Strength. – 2017. – No. 5. – P. 95–106.

Over past few years, polymer composites with natural fiber reinforcement, called eco-composites, have achieved a worldwide compliance due to their strong potentiality to save the environment from pollution as a result of their ultimate disposability, as compared to glass-filled composites. Since natural fibers combine a low cost and low density with high toughness, biodegradability, renewability, reduced tool wear, and higher energy recovery. They are carbon dioxide neutral when burned and are present in abundance, which make composites made from them also sustainable and economical. We report a facile method for the improvement of strength and radiation protection properties of biodegradable jute fiber reinforced material by ceramic treatment of red mud. The developed powder was further blended with polyester resin to form thick, viscous radiation protection organic gel-based material. The developed protection gel material was then cured for making advanced non-toxic, biodegradable radiation protection panels using jute as natural fiber reinforcement. The developed radiation protection panels were analyzed by X-ray method with different energies of X-ray photons

and were found to possess highly competent properties. Their various mechanical properties, like tensile, flexural, and impact strength values and morphological features were evaluated. The developed non-toxic, biodegradable, jute fiber reinforced, X-ray radiation protection panels combine good shielding and mechanical properties, which ensures their broad application spectrum ranging from diagnostic X-ray and CT scanner room installations to nuclear power plant and other strategic radiation shielding tasks.

Ismail Ali A. and Al-Habardi K. **On Designing Time-Censored Step-Stress Life Test for the Burr Type-XII Distribution** // Problems of Strength. – 2017. – No. 5. – P. 107–120.

This article presents the optimal designing of time step-stress partially accelerated life test (PALT) under censored data from two-parameter Burr type-XII distribution. The maximum likelihood (ML) approach is used to obtain point and interval estimations of the model parameters. Moreover, optimum test plans for time step-stress PALT are optimally developed. The adopted optimality criterion is the minimization of the generalized asymptotic variance of the ML estimators of the model parameters. For illustration, numerical examples are presented.

Gitman M. B., *Klyuev A. V.*, *Stolbov V. Yu.*, *and Gitman I. M.* **Complex Estimation of Strength Properties of Functional Materials on the Basis of the Analysis of Grain-Phase Structure Parameters** // Problems of Strength. – 2017. – No. 5. – P. 121–130.

The technique allows analysis using grain-phase structure of the functional material to evaluate its performance, particularly strength properties. The technique is based on the use of linguistic variable in the process of comprehensive evaluation. An example of estimating the strength properties of steel reinforcement, subject to special heat treatment to obtain the desired grain-phase structure.

Moltasov A. V. **A Study of the Stress State in Stress Concentration Zones under Tension of an Asymmetrically Reinforced Butt-Welded Joint** // Problems of Strength. – 2017. – No. 5. – P. 131–139.

An analytical method for the description of the stress state in stress concentration zones under tension of an asymmetrically reinforced butt-welded joint has been developed, which takes into account the effect of the reinforcement on the face side on the stress distribution near the root reinforcement. The broken section hypothesis was taken as a basis of the proposed method. Mathematical relationships describing the variation of the first principal stress in concentration zones both along the contour of the root reinforcement fillet and over the joint depth have been established. Formulas for the determination of stress concentration factor at the bottom of the root reinforcement as a function of the characteristics of corresponding broken section have been derived. For a butt-welded joint of 6061-T6 aluminum alloy as an example, which was made by consumable electrode argon-arc welding on a removable pad, it was shown that the stress concentration factor on the root side of the joint may be lower than that on the face side, which is corroborated by the results of high-cycle fatigue tests.

Kaščák L., *Mucha J.*, *Spišák E.*, *and Kubík R.* **Wear Study of Mechanical Clinching Dies during Joining of Advanced High-Strength Steel Sheets** // Problems of Strength. – 2017. – No. 5. – P. 140–153.

This study is focused on the wear of the die cavity of the mechanical clinching tool used for joining microalloyed hot-dip galvanized advanced high-strength steel sheets H220PD+Z. Steel sheets were joined using round, single stroke clinching with rigid die with no flexible elements. The joint forming process takes place within the specially formed cavity of the die. Dies and punches for the mechanical clinching were made of tool steel (1.3343 grade) and subsequently covered by three types of PVD coatings: ZrN, CrN, and TiCN ones. The individual die wear was evaluated during the operation period, which means that 300 joints were produced by each die covered with the corresponding coating. The experimental data obtained were compared with the results of FEA numerical simulation, which substantiated the fact that the dominant part of wear is localized in the radius area surrounding the die cavity.