Abstracts

Kharchenko V. V., *Chirkov A. Yu.*, *Kobel'skii S. V.*, *and Kravchenko V. I.* **Improving the Computational Analysis of Stress-Strain State and Fracture Resistance of Welded Joints Between Coolant Headers and PGV-1000M Steam Generator Vessel of Nuclear Power Station** // Problems of Strength. – 2017. – No. 3. – P. 5–20.

The authors have outlined methodological principles and a procedure of performing the updated analysis of stress-strain state and fracture resistance of welded joints between coolant headers and PGV-1000M steam generator vessel. The paper gives the results of the elastic-plastic fracture resistance analysis of a welded joint containing variously shaped surface defects, in modeling a design operation cycle and an accident situation. According to the data obtained, the deformation loading history, residual technological stresses, and inclusion of surface damages have a significant effect on the design assessment of fracture resistance of a welding joint. It has been shown that the conventional linearly elastic calculation of fracture resistance of welded joints has an inadequate degree of conservatism and thus overestimates the strength of joints.

Bobyr' N. I. and Koval' V. V. **Damage-Accounted Assessment of the Stress-Strain State of Structural Elements** // Problems of Strength. – 2017. – No. 3. – P. 21–29.

Engineering calculation methods for stresses and strains in the concentration zones under elasto-plastic deformation of structural elements are presented and analyzed. The Makhutov-modified Neuber equation is shown to be of the most reasonable accuracy for the assessment of kinetics of effective coefficients for stress and strain concentrations. The concept of scattered damage is introduced. The effect of scattered damages on the assessment of the stress-strain state of structural elements is demonstrated by the example of elastoplastic deformation of a hole-containing plate.

Lobanov L. M., *Pashchin M. O.*, *Mykhodui O. L.*, *and Sydorenko Yu. M.* **Effect of the Indenting Electrode Impact Value on the Stress-Strain State during the Electrodynamic Treatment of an AMg6 Alloy** // Problems of Strength. – 2017. – No. 3. – P. 30–42.

The calculation model of the impact indenting electrode interaction with an AMg6 aluminum alloy plate on the electrodynamic treatment of weld joints is described. The problem was solved in the Lagrange two-dimensional statement with an ANSYS/LS-DYNA program. Calculation results for residual stress and plastic strain regions formed on the elastoplastic indenting electrode-impact are presented.

Tsybenko A. S., *Rassamakin B. V.*, *and Rybalka A. A.* **Stress-Strain State Investigation of POLYITAN-2 Nano-Satellite under the Ascent-Stage Quasistatic Overload Conditions** // Problems of Strength. – 2017. – No. 3. – P. 43–50.

The paper provides the strength analysis performed for POLYITAN-2 nano-satellite under quasistatic overload conditions arising at the ascent stage. An efficient solid-state model together with its corresponding finite element model has been developed for the nano-satellite. The numerical investigation of the stress-strain state of nano-satellite has been performed using the ANSYS software package. The maximum relative displacements of structural elements, as well as safety factors, have been determined. Different strength criteria were analyzed for the strength assessment of nano-satellite structural elements made of composite materials. It is found that the considered POLYITAN-2 structure satisfies the critical strength and stiffness requirements.

Pacana J., *Witkowski W.*, *and Mucha J.* **FEM Analysis of Stress Distribution in the Hermetic Harmonic Drive Flexspline** // Problems of Strength. – 2017. – No. 3. – P. 51–62.

The paper deals with the numerical stress calculation in the flexspline tooth rim of the harmonic drive. Due to the complex geometry of the toothed ring in the flexspline, the teeth were modeled as a ring, which height corresponded to the particular stress concentration in the teeth. To study the effect

of type of wave generator on the stress distribution in the flexspline, the following models were elaborated: two-roller, four-roller, cam, and disk. The stress calculations were performed for the two cases: a zero torque load and the torque load value, corresponding to the true operation conditions of the hermetic harmonic drive.

Diosdado-De la Peña J. A., *Balvantín A. J.*, *Limón-leyva P. A.*, *and Pérez-olivas P. A.* **Analysis by Finite Element Method to Redesign a Jointed-Telescopic Crane for Elevation of Personnel** // Problems of Strength. – 2017. – No. 3. – P. 63–77.

This paper proposes a numerical assessment of a crane for elevation of personnel by finite element analysis, validated with experimental data from constituent components of the crane. The original design of the crane consists of a jointed section of coplanar arms and a telescopic section of collinear arms. As a reference, the standard ANSI/SIA 92.2 was used to determine maximum loads and the consequent effects on the constituent components of the crane. This standard is suitable for crane designs distributed and commercialized in Mexico. The proposed numerical analysis is carried out through a finite element analysis, which is based on the assembly method of kinematic pairs, taking into account dynamic loads and their resulting reaction at each element. The mechanical performance of each component is assessed with the minimal security factor parameter. However, in those components where the MSF was insufficiently in accordance with the standard, a variety of modifications to redesign a given component was proposed. Subsequently, a detailed structural analysis on the proposed redesign was carried out, in which higher security factors were obtained in comparison to the original design. Finally, the numerical results of the proposed redesign were validated through experimental measurements of strain, using strain gauges attached on a crane prototype, which was manufactured according to the proposed redesigned model.

Karpinos B. S. and Kulish V. M. **Efficiency of Cooling and Thermal Fatigue Life Estimation of Gas Turbine Blades** // Problems of Strength. – 2017. – No. 3. – P. 78–89.

The paper presents the results of computer modeling of the material states of the cooling turbine blades at unsteady engine operation modes. Linear dependencies between the efficiency of cooling and relative thermal stresses for different heat transfer conditions and constraints are verified. The procedure of the efficient determination of heat-transfer parameters that provide the optimal thermal fatigue life of the blade material is proposed.

Ermolaev G. V., *Martynenko V. A.*, *Olekseenko S. V.*, *Labartkava A. V.*, *and Matvienko M. V.* **Effect of the Rigid Interlayer Thickness on the Stress-Strain State of Metal-Graphite Assemblies under Thermal Loading** // Problems of Strength. – 2017. – No. 3. – P. 90–97.

The effect of the rigid interlayer thickness on the stress-strain state of the assemblies from dissimilar materials on their diffusion welding and brazing was evaluated. The axisymmetric elastoplastic problem was solved via computer simulation on rapid cooling of the assembly after welding. Stress fields and epures were compared at different interlayer thicknesses and in its absence. All stresses in the assembly were established to concentrate in the immediate vicinity of the material-interlayer butt. Stress field patterns in the joined materials do not greatly change, however, stress levels are changing. With an increase in the interlayer thickness, the maximum of tensile stresses in graphite is gradually moving away from the butt, and its value decreases. For reducing the risk of graphite fracture after assembly cooling, it would be appropriate to use a rigid inter-layer no less than 1 mm thick.

Gachkevych O. R., *Drobenko B. D.*, *Vankevych P. I.*, *and Yakovlev M. Yu.* **Optimization of the High-Temperature Induction Treatment Modes for Nonlinear Electroconductive Bodies** // Problems of Strength. – 2017. – No. 3. – P. 98–104.

This paper proposes an approach to the computer simulation of electromagnetic, thermal and mechanical fields in ferromagnetic bodies based on the developed mathematical model for the description of thermo-mechanical processes in electroconductive bodies having different magnetizability and polarizability under electric field conditions. The results of the investigation on the modes of high-temperature induction treatment of bodies made of different ferromagnetic

materials are presented. It is shown that by selecting the electric current frequency at the stage of heating and the subsequent cooling conditions, it is possible either to generate residual stresses in bodies, that are close to the given ones, or to reduce the duration of the heat treatment of workpieces under stress constraints.

Razavi S. M. J., *Ferro P.*, *and Berto F.* **Fatigue Assessment of Ti–6Al–4V Circular Notched Specimens Produced by Selective Laser Melting** // Problems of Strength. – 2017. – No. 3. – P. 105–114.

Additive manufacturing offers the potential to economically produce customized components with complex geometries in a shorter design-to-manufacture cycle. However, the basic understanding of the fatigue behavior of these materials must be substantially improved at all scale levels before the unique features of this rapidly developing technology can be used in critical load bearing applications. This work is aimed to assess the fatigue strength of Ti–6Al–4V smooth and circular notched samples produced by selective laser melting (SLM). Scanning electron microscopy have been used to investigate the fracture surface of the broken samples in order to identify crack initiation points and fracture mechanisms. Despite the observed fatigue strength reduction induced by circular notch compared to that of sooth specimens, notched samples showed a very low notch sensitivity attributed both to hexagonal crystal lattice characteristics of tempered alpha prime grains and to surface defects induced by the SLM process itself.

Marushchak P. O., *Konovalenko I. V.*, *Chausov M. G.*, *and Pylypenko A. P.* **Damage and Fracture of VT22 Titanium Alloy in Static Tension after the Application of Additional Pulse Loading** // Problems of Strength. – 2017. – No. 3. – P. 115–125.

The paper describes the main regularities of plastic deformation in VT22 titanium alloy and the micromechanisms of its fracture in static tension and in tension after different dynamic non-equilibrium loading modes resulting from the application of additional pulse loads. It is found that irrespective of the result of loading, the fracture of alloy VT22 occurs by the pore nucleation and coalescence mechanism. The physico-mechanical phenomena underlying the formation of ductile tearing dimples on fracture surfaces are analyzed and their relation to the deformation processes is described.

Efremenko V. G., *Chabak Yu. G.*, *Karantzalis A. E.*, *Lekatou A.*, *Vakulenko I. A.*, *Mazur V. A.*, *and Fedun V. I.* **Plasma Case Hardening of Wear-Resistant High-Chromium Cast Iron** // Problems of Strength. – 2017. – No. 3. – P. 126–135.

The effect of plasma parameters on the case hardening of wear-resistant high-chromium cast iron in different structural condition is studied. Correlation relations were established between the initial and finite microstructure of the surface layer formed after plasma hardening at different heating rates. Microhardness profiles across the modified layer are structurally substanhated. Recommendations for optimizing the complex volume-surface cast iron treatment conditions are given.

Kucher N. K. and Samusenko A. A. **Assessment of Elastic Characteristics and Strength Parameters of Unidirectional Polymer Composites at High Temperatures** // Problems of Strength. – 2017. – No. 3. – P. 136–148.

Within the framework of transversally isotropic body, the possibilities of describing the elastic characteristics and load-bearing capacity of unidirectional carbon-reinforced polymer composites at high temperatures are analyzed. The dependences linking the elastic characteristics and strength parameters of the composite with the heating temperature and rate are established. The models for calculation of strength characteristics of ablating composite in cases of tensile or compressive loads codirected with the reinforcement axis are developed and discussed.

Buketov A. V., *Dolgov N. A.*, *Sapronov A. A.*, *Nigalatii V. D.*, *and Babich N. V.* **Mechanical Characteristics of Epoxy-Based Nanocomposite Coatings with Ultradisperse Diamond Particles** // Problems of Strength. – 2017. – No. 3. – P. 149–157.

The mechanical characteristics of epoxy-based nanocomposites with ultradisperse diamond particles used as a filler are investigated. It is shown that the addition of 0.05 weight part of ultradisperse diamond particles per 100 weight part of the epoxy binder material provides the maximal value of the bending strength and reduces the residual stresses in the composite under study. Moreover, the enhancement of the composite elastic modulus is acquired. The IR-spectral analysis results obtained revealed a chemical activity of the nonofiller particle surface, which improves the physical-mechanical properties of the merged composites with the epoxy matrix. The optical microscopic studies of the nanonomposite fractoctographies with the following analysis of their topology have revealed an ordered structure with no observed inclusions, which corresponds to the maximal degree of merging of composite materials at the above level of 0.05 weight part of ultradisperse diamond particles. A uniform stress distribution in the bulk of the material under study strongly suggests a thermodynamic balance of the system after the merging process.

Muzyka N. R. and Lamashevskii V. P. **Assessment of the Service Reliability of Elastoplastic Sheet Materials from Hardness Parameters** // Problems of Strength. – 2017. – No. 3. – P. 158–166.

A new method for the assessment of the service reliability of cracked metallic sheet materials from hardness parameters is proposed. It has been shown that the state of the material in the pre-fracture zone of a uniaxially loaded specimen, which is acted upon by a stress that is close to the ultimate strength of the material, corresponds to the state of the damaged material in the crack tip zone before crack starting.

Savvova O. V., *Babich O. V.*, *Voronov G. K.*, *and Ryabinin S. O.* **High-Strength Spodumene Glass-Ceramic Materials** // Problems of Strength. – 2017. – No. 3. – P. 167–175.

The paper demonstrates the urgency of development of composite materials to be used in body armor plates and the potential of application of spodumene glass-ceramic materials as a layer that combines disintegrating and damping properties in the composite structure of a body armor element. The proposed glass-ceramic materials, when subjected to a two-stage low-temperature heat treatment, undergo a bulk fine crystallization with the presence of β-spodumene, thus achieving high mechanical characteristics.