## Abstracts

*Kharchenko V. V. and Chirkov A. Yu.* **Some Aspects of Inclusion of Loading History in the Fracture Strength Analysis of Reactor Pressure Vessels under Thermal Shock Conditions** // Problems of Strength. – 2016. – No. 5. – P. 14–21.

The paper addresses some aspects of inclusion of loading history in the fracture strength analysis of reactor pressure vessels under thermal shock conditions. The strength assessment of a reactor pressure vessel and its lifetime extension are shown to essentially depend on reliability of results of elastic-plastic modeling of stress-strain kinetics and determination of design values of the fracture mechanics parameters. The present findings of the finite-element analysis demonstrate that the loading history must be taken into account in the determination of the temperature dependence of stress intensity factor for a postulated specified crack. It is shown that, in the fracture toughness analysis of a reactor pressure vessel, the temperature dependence of the stress intensity factor has to be derived from the results of the analysis of kinetics and mode of loading of metal at the crack tip under thermal shock conditions. For construction of the above dependence, we proposed approach, which accounts for the active loading and unloading processes occurring in the metal in the crack front vicinity. Incorporation of the loading history into the analysis of the temperature dependence of the stress intensity factor using the proposed approach forcan permit revealing some additional margin of strength during the substantiation of lifetime extension for a reactor pressure vessel under thermal shock conditions.

*Gogotsi G. A.* **Fracture of Ceramics with Different Conical Indenters: Edge Chipping** // Problems of Strength. – 2016. – No. 5. – P. 22–28.

Mechanical tests for evaluating the fracture resistance of ceramics on chipping rectangular specimen edges were first performed with conical diamond indenters of 11–800 μm tip radii. In the experiments elastic silicon-nitride $Si_3N_4$ ceramics and inelastic zirconia TS ceramics, displaying a phase transition on fracture, were used, soda lime glass served as the object for comparison. The fracture resistance of those materials was shown to increase similarly when the above indenters are employed. Chip scars formed on the specimen edges of $Si_3N_4$ ceramics do not actually differ from those observed in glass tests (pseudoconical, nail-like, arbitrary). With an increase in the tip radius, the first ones grow in number. It does not take place in the tests of TS ceramics. Comparative fracture resistance estimates obtained with the edge chipping method using different fracturing tools were established to be invalid.

*Lepikhin P. P.*, *Romashchenko V. A.*, *and Beiner O. S.* **Theoretical Investigation of Fracture in Stress Waves of Anisotropic Cylinder under Internal Explosion** // Problems of Strength. – 2016. – No. 5. – P. 29–51.

Fracture and stress-strain state (SSS) of significantly anisotropic composite cylinders have been analytically and numerically investigated under internal explosion. Four possible types of fracture have been determined, including spallation fracture. The features of wave the SSS and strength of thin- and thick-walled shells as well as the dependence of the maximum permissible critical mass of the charge on the cylinder thickness have been established.

*Drozdov A. V.*, *Kharchenko V. V.*, *Dzyuba V. S.*, *Kravchuk L. V.*, *Potapov A. M.*, *Sirenko V. N.*, *Gusarova I. A.*, *Klimenko D. V.*, *Kharchenko V. N.*, *and Samusenko A. A*. **Multifunctional Data Acquisition and Control System Rigging the Beds and Units for Strength Tests of Models and Structure Elements from Composite Materials** // Problems of Strength. – 2016. – No. 5. – P. 52–60.

A PMX-TEST multifunctional data acquisition and control system rigging the beds and units for strength tests of models and structure elements from composite materials is described. The system provides the multichannel measurement of strains, pressures, and temperatures. The corresponding PMX-TEST-Monitor software ensures digital and graphical representation of experimental data, their accumulation and storage for further processing.

*Pisarenko G. G. and Matokhnyuk L. E.* **Determination of Fatigue Resistance Characteristics Based on High-Frequency Testing Results Considering Structural and Operational Factors** // Problems of Strength. – 2016. – No. 5. – P. 61–73.

The experimental investigations of the fatigue resistance of various metallic materials were conducted loading in the range of frequencies from a few Hz to 10 kHz with account of the material structure, test temperature, load ratio and availability of stress concentrators.It is shown that the influence of the most process, structural and operational factors on the values of endurance limits manifests itself identically at both low and high loading frequencies. This implies that the main mechanisms of fatigue damage accumulation intrinsic to the particular material remain independent of loading frequency, while deformation rate affects the value of inelastic strains and, consequently, the degree of plastic strain accumulated during a cycle and endurance limit values.The equation is proposed, which describes the material state at the instant of time preceding the fatigue crack growth initiation with account of the cyclic loading frequency as a factor controlling the damage accumulation rate. An experimental verification of the obtained equation showed that difference between the calculated and experimental data on the fatigue resistance is, as a rule, within the experimental data scattering, which confirms the sustainability of the model. The proposed model provides the base for the prediction of the fatigue resistance characteristics, including at large number of cycles, at various frequencies based on high-frequency test results.

*Gorik A. V.*, *Zinkovskii A. P.*, *Chernyak R. E.*, *and Brikun A. N.* **Elastoplastic Deformation of the Surface Layer of Machinery Constructions on Shot Blasting** // Problems of Strength. – 2016. – No. 5. – P. 74–83.

Shot blasting results obtained on metal surfaces to be further treated by applying protective nonmetallic coatings were experimentally investigated under different process conditions. The procedure of evaluating the elastoplastic deformation behavior of the surface layer using the experimental-analytical coefficient, which considers the elastoplastic properties of the material, is described. Results of comparing experimental and theoretical data are summarized. The grounds for a possible fracture mechanism on shot blasting of the surface layer of metal products are presented.

*Dolgov N. A.* **Analytical Methods to Determine the Stress State in the Substrate–Coating System under Mechanical Loads** // Problems of Strength. – 2016. – No. 5. – P. 84–94.

The paper presents the analysis of analytical models to determine the stress state in the substrate–coating system, when a load is applied to the substrate. The results obtained with these models are shown to differ. It is noted that the advantage of the analytical methods as compared to the numerical analysis is the possibility to calculate stresses in the singularity region in the vicinity of the free edge of the coating. The character of the shear stress distribution is analyzed using the analytical models. Examples of using different approaches to determine the critical shear stresses that define the adhesive strength of coatings are given. The analysis of literature sources shows that both simple and more sophisticated analytical models are employed in the investigation of the adhesive strength of coatings.

*Berto F. and Afshar Reza H.* **Inclined Hole under Different Loading Conditions: A Review of Recent Results** // Problems of Strength. – 2016. – No. 5. – P. 95–105.

Three-dimensional (3D) elastic stress distributions in the vicinity of the sharp corners of an inclined diamond hole in a plate are investigated. A detailed 3D finite element model under different loading conditions is analyzed to study the intensity of different fracture modes due to the thickness effect. The stress results are compared with those provided by a recent theory which reduces the 3D governing equations of elasticity to a differential equation system, which includes a biharmonic equation and a harmonic equation. They provide the solution of the corresponding in-plane and out-of-plane notch problem, respectively, and have to be concurrently satisfied. Comparing numerical results and theoretical stress distributions, a good agreement is found.

*Rizov V. I.* **Nonlinear Fracture of Functionally Graded Beams under Mode II Loading Conditions** // Problems of Strength. – 2016. – No. 5. – P. 106–117.

A theoretical study of Mode II fracture in functionally graded beams was carried out. A beam configuration with two symmetric longitudinal cracks was suggested in order to generate Mode II loading conditions. The beam mechanical behavior was described by nonlinear stress–strain relation. The fracture behavior was analyzed by applying the *J*-integral approach. Closed form analytical solutions were derived of the *J*-integral for two laws for variation of the modulus of elasticity along the beam height. Nonlinear analyses of the strain energy release rate were performed by considering the energy balance in order to verify the *J*-integral solutions. The results obtained can be applied to optimize the functionally graded beam structure with respect to the Mode II fracture performance. Also, the analytical solutions derived are very convenient for parametric studies of nonlinear fracture behavior of functionally graded beams. The present paper contributes towards the development of nonlinear fracture mechanics of functionally graded materials.

*Arsić D.*, *Djordjević M.*, *Zivković J.*, *Sedmak A.*, *Aleksandrović S.*, *Lazić V.*, *and Rakić D.* **Experimental-Numerical Study of Tensile Strength of the High-Strength Steel S690QL at Elevated Temperatures** // Problems of Strength. – 2016. – No. 5. – P. 118–128.

We present the experimental-numerical analysis of the influence of temperature on mechanical properties of structural high-strength steel class S690QL. Since the steel S690QL belongs to a group of steels with good mechanical properties, the aim of this paper is to determine the highest temperatures at which these good characteristics are kept. Experimental tensile testings of the specimens were performed at five different temperatures in the range from 20 to 550℃. Beside experimental testing, strengthening curves were calculated and numerical analysis using finite element method was performed. Both the experimental and numerical results have shown that decrease of mecahanical properties occurs at approximately 450℃.

*Kandrotaitė-Janutienė R. and Baltušnikas A.* **Investigation of Plastic Behavior of Alloyed Steel Deformed during Martensitic Transformation** // Problems of Strength. – 2016. – No. 5. – P. 129–137.

We present the investigation of permanent strain of steel specimen occurred when metallurgical transformations take place even under small stress applied externally lower than the yield stress of material. Three alloyed steel grades were investigated: THG2000 (Uddeholm, Sweden), 40Kh13 and 95Kh18 (GOST, Russia). All steel grades differ in carbon content and amount of alloying elements and behave differently when transformation occurs. This intensively increased plasticity of steel specimen was observed during bending test when bending stress was just 100 MPa and was less than 10% of yield strength of the steel. The steel specimens were heated to 900–1050℃ temperature and then bent during air quenching. Plastic deflections were observed though all cooling process that involved martensitic transformation as well. Different effect of compression and tensile stresses on microstructure evolution during martensitic transformation was determined by X-ray analysis as both types of stresses were formed in bent specimens.

*Maiboroda V. S.*, *Nalimov Yu. S.*, *Solovar A. N.*, *Bobina M. N.*, *and Teslyuk N. N.* **Effect of Complex Magnetic-Abrasive and Chemical/Thermal Treatment on VT9 Alloy Fatigue Resistance** // Problems of Strength. – 2016. – No. 5. – P. 138–147.

Different modes of complex magnetic-abrasive and chemical/thermal surface treatment for VT9 alloy specimens are discussed. Based on the obtained results of X-ray diffraction, microstructural and durametric analyzes, the appropriate characteristics of the specimen test portion surface layer are obtained. The conducted fatigue tests of VT9 alloy specimens with and without the above complex treatment revealed that the endurance limit of the former ones exceeds that of the latter by 40%.

*Giginyak F. F. and Bulakh P. A.* **Effect of Temperature on the Damage Kinetics of Pre-Deformed Steel 10GN2MFA under Cyclic Loading in a Complex Stress State** // Problems of Strength. – 2016. – No. 5. – P. 148–153.

We analyze the effect of temperature on the damage kinetics of pre-deformed steel 10GN2MFA under conditions of uni- and biaxial tensions.

*Novogruds'kyi L. S.*, *Skrypnyk Yu. D.*, *Stryzhalo V. O.*, *and Opravkhata M. Ya.* **A Setup for Testing Contact Strength of Wheel–Rail Pair Including the Action of Some Operational Factors** // Problems of Strength. – 2016. – No. 5. – P. 154–162.

The paper describes an experimental setup for studying a contact interaction between fragments of real wheels and rails under conditions that correspond to the electric railroad operating conditions.

*Shatskyi I. P.*, *Ropyak L. Ya.*, *and Makoviichuk M. V.* **Strength Optimization of a Two-Layer Coating for the Particular Local Loading Conditions** // Problems of Strength. – 2016. – No. 5. – P. 163–168.

The engineering calculation procedure of the stress-strain state of the two-layer coating under the action of the arbitrarily oriented local loads as applied to the strength optimization of the coating layers' thickness is proposed. The optimal thickness of the substrate resisting the maximal critical load has been derived.