Abstracts

Lebedev A. A., *Golubovskii E. R.*, *Lokoshchenko A. M.*, *Muzyka N. R.*, *Lamashevskii V. P.*, *Shvets V. P.*, *and Efimenko E. V.* **Assessment of the Limiting Levels of Dispersed Damage in Materials under Steady-State Conditions of Static and Cyclic Loading** // Problems of Strength. – 2012. – No. 6. – P. 5–13.

The results on the analysis of possible ways of using the concept of dispersed defects in practice when making the admissible damage analysis of structures are presented. The experimental data on the limiting damage to some alloys widely used in mechanical engineering, which are obtained by the LM-hardness method using specimens fractured after the operating time under conditions of creep and cyclic fatigue, are processed and generalized. A linear correlation is found between the levels of the limiting damage and working stresses during the operating time. A version of the procedure for determining the parameters of the correlating equation from the results of basic experiments is proposed.

Gulenko A. G., *Buchatskii A. A.*, *Margolin B. Z.*, *Kashtanov A. D.*, *and Fedorova V. A.* A **Study of Crack Propagation in Austenitic Steels under Creep Conditions Including the Influence of Thermal Pre-Ageing** // Problems of Strength. – 2012. – No. 6. – P. 14–33.

Based on processing of a large body of experimental data obtained for austenitic steels 304 and 316, the authors have determined the coefficients for the equation of crack growth rate as a function of the C^*-integral under creep conditions. To analyze applicability of this equation to Russian austenitic steels, an investigation of the crack growth rate was carried out for the base metal, weld, and heat-affected zone in steels 10Kh18N9 and 08Kh16N11M3 in the initial (austenized) state and upon a long-term thermal ageing. The authors propose a method of how to allow for thermal ageing in the calculations of the crack growth rate under creep conditions.

Orynyak I. V., *Yakovleva E. S.*, *and Dubik Ya. R.* **The Application of the Combined Method of Weight Functions for the Determination of a Through-Wall Crack Opening Area in a Shell** // Problems of Strength. – 2012. – No. 6. – P. 34–55.

The crack opening area of a through-wall crack in a shell is one of the main design parameters in the leak-before-break concept. The available methods for determining this parameter essentially consider the shell as a plane body and disregard the linearly varying component of the displacement field (as in the plate theory). Based on a combined method of weight functions, a simple procedure is put forward to derive an approximate expression for the fundamental field of displacements under the action of a concentrated force and moment onto the crack faces in the form of a sum of a uniform component and a component that linearly varies through the wall thickness. This provides, in particular, convenient formulas to find the crack opening area in a polynomial field of membrane stresses as well as linear ones. For a cylindrical shell with a longitudinal or transverse crack, the calculated values of the crack opening area are compared with those reported elsewhere. The contribution of the linear component to the total crack opening area is assessed.

Kharchenko V. K. and Bukhanovskii V. V. **High-Temperature Strength of Refractory Metals, Alloys and Composite Materials Based on Them. Part 2. Molybdenum and Niobium Alloys** // Problems of Strength. – 2012. – No. 6. – P. 56–66.

The results of investigations of the mechanical characteristics of molybdenum and niobium alloys and their welded joints, which are used in space-rocket hardware, have been generalized. The investigations were carried out under short-time, sustained static and low-cycle loading conditions on small time bases in a temperature range of 290–2270 K.

Matokhnyuk L. E., *Yakovleva T. Yu.*, *and Byalonovich A. V.* **Prediction of Gigacycle Fatigue Resistance Characteristics of Metals from High-Frequency Test Data. Part 2. Application of Fatigue Damage Accumulation Model** // Problems of Strength. – 2012. – No. 6. – P. 67–80.

A model of formation and development of local plastic strain regions is proposed on the basis of an analysis of the main physical processes taking place in a metallic material under the action of cyclic loads. An equation of material state for the instant of time directly preceding fatigue

crack initiation has been derived, in which cyclic loading frequency in explicit form as a factor directly affecting the damage accumulation rate and stress ratio are taken into account. The equation is the basis for the prediction of fatigue resistance characteristics, large loading bases as well, at different frequencies, including low ones, from high-frequency test data.

Stepanov G. V., *Babutskii A. I.*, *Chizhik A. V.*, *and Gromov V. E.* **Pulse Electric Current Effect on Mechanical Properties of Titanium Aluminide Produced by the Self-Propagating High-Temperature Synthesis Technique** // Problems of Strength. – 2012. – No. 6. – P. 81–92.

We present results of study on the effect of pulse electric current treatment on bending strength and hardness of intermetallic titanium aluminide produced by the self-propagating high-temperature synthesis technique. It is shown such treatment results in some increase in strength and plasticity of the intermetallide in comparison with the initial state, while its hardness decreases. The results of microstructural analysis show that reduction of the material brittleness after treatment is a consequence of current-induced change of thin structure of a material, redistribution of pores and reduction of the residual tensile stresses.

Chirkov A. Yu. **Construction of Two-Level Integration Schemes for the Equations of Plasticity in the Theory of Deformation along the Paths of Small Curvature** // Problems of Strength. – 2012. – No. 6. – P. 93–124.

The construction of a set of two-level integration ω-schemes for the equations of the flow theory of plasticity, describing anisothermic loading processes along the deformation paths of small curvature, is described. In this case, a stress-strain state is dependent on thermomechanical loading history, and inelastic deformation should be followed over the whole examined time interval in step solving the boundary problem. Basic concepts of the phenomenological model are built upon the Prandtl–Reuss equations of plasticity and the Huber–Mises yield condition. The loading process is divided into several time steps. The equations of plasticity are integrated in a loading step. The general procedure of transformations to construct a set of two-level integration ω-schemes for the equations of plasticity is proposed. The conditions for the agreement between the considered equations of plasticity and the principle of work irreversibility with plastic strain increments and Drucker's hardening postulate are formulated. As an example, illustrating the properties of these equations, the deformation problem is solved for a thin-walled round pipe subject to axial tension and torsional moment. Results of solving the model problem, obtained with different two-level integration schemes, are presented. Practical recommendations as to the choice of the parameter ω are given.

Karachun V. V. and Mel'nik V. N. **Elastic Stress State of a Floating-Type Suspension in the Acoustic Field. Deviation of the Spin Axis** // Problems of Strength. – 2012. – No. 6. – P. 125–136.

The nature of the elastic interaction between the floating-type suspension of a differentiating gyroscope and the penetrating acoustic radiation is analyzed, and the computational models of this phenomenon are constructed. The mechanism of occurrence of additional errors in the gyroscopic angular velocity sensor induced by the diffraction phenomena in the moving part of the device is disclosed. The vector diagrams explain the essence of the spin axis deviation in the reverberated space.

Shul'zhenko N. G., *Zaitsev B. F.*, *Vikman N. E.*, *and Asaenok A. V.* **Vibration Analysis of Rotor with a "Breathing" Crack Using Three-Dimensional Model** // Problems of Strength. – 2012. – No. 6. – P. 137–145.

A procedure for analyzing vibrations in cracked body using three-dimensional model is presented. The process of "breathing" is described by conditions of contact between the crack faces. Some example calculations are provided.

Mazahery A. and Shabani M. O. **Mechanical Properties of A356 Matrix Composites Reinforced with Nano-SiC Particles** // Problems of Strength. – 2012. – No. 6. – P. 146–155.

Metal matrix composites form one group of the new engineered materials in which a strong ceramic reinforcement is incorporated into a metal matrix to improve its properties including specific strength, specific stiffness, wear resistance, excellent corrosion resistance and high elastic modulus. A compocasting method was employed to incorporate SiC nano-particles into the aluminum alloy and fabricate metal matrix nanocomposites with uniform reinforcement distribution. Microstructural characterization of compocast composites show a uniform distribu-

tion of nano-particles, grain refinement of aluminum matrix, and presence of the minimal porosity. It was revealed that the presence of nano-SiC reinforcement led to significant improvement in hardness, 0.2% yield strength and UTS while the ductility of the aluminum matrix is retained.

Sedighi M. and Honarpisheh M. **Investigation of Cold Rolling Influence on Near Surface Residual Stress Distribution in Explosive Welded Multilayer** // Problems of Strength. – 2012. – No. 6. – P. 156–162.

The aim of this study is to investigate the effect of cold rolling on residual stress distribution of aluminum and copper three-ply clad sheets fabricated by explosive welding. After preparation of the explosive-welded multilayer, explosive-welded Al/Cu/Al specimens were rolled at 11, 30, 40, and 56% thickness reduction. The through-depth residual stress profiles near the surface have been extracted for explosive-welded and cold-rolled multilayers by incremental hole-drilling method. Results show that the surface of explosive-welded multilayer is subjected to high tensile residual stresses and will be reduced by cold rolling process. Also, tensile residual stress at the surface of cold-rolled multilayers increases at higher thickness reduction.

Fedorenko B. F. and Luk'yanov V. S. **Assessment of Endurance Limit of Shafts via Model Test Results** // Problems of Strength. – 2012. – No. 6. – P. 163–167.

The procedure for assessment of the endurance limit of the eccentric shaft for horizontal forging machine using the results from tests on its geometrically similar models has been proposed. The assessment is performed using the analytical relation derived by the dimensional analysis method.