

ABSTRACTS

Main achievements of scientists of NTU «KhPI» in the field of mechanics / A. G. Andreev, S. A. Nazarenko // Bulletin of NTU "KhPI". Series: Dynamics and strength of machines. – Kharkiv: NTU "KhPI", 2015. – № 57 (1166). – P. 3-7. – Bibliogr.: 16. – ISSN 2078-9130.

The paper is concerned with the dynamic process of establishment and development of the research and pedagogic activity of the scientists and graduates of the National Technical University «Kharkiv Polytechnic Institute» (NTU «KhPI») in the field of mechanics in the 19 – 21 centuries. The fundamental scientific trends of evolution of mechanics were discovered and explored here. The most important phases of formation and development of the research and design school of the NTU «KhPI» are shown. The world-famous scientists who worked at the NTU «KhPI» or graduated it are mentioned. School of Mechanics of the NTU «KhPI» is developing in the direction of the theoretical, experimental and computer studies of scientific and technical problems of strength, dynamics, reliability, optimization of objects (materials, structures, systems) with a multi-level (nano- micro- meso- macro) structure in extreme loading. It is shown how mathematization of research led to the emergence of new models and methods of analysis of mechanical systems.

Keywords: mechanics, engineering, model, Kirpichov, Lyapunov, Steklov, Landau, dynamics.

High-Speed Deformation of a High-Strength Coated Thin Plate / L.V. Avtomomova, S.V. Bondar, A.V. Stepuk, V.L. Khavin // Bulletin of NTU "KhPI". Series: Dynamics and strength of machines. – Kharkiv: NTU "KhPI", 2015. – № 57 (1166). – P. 8-10. – Bibliogr.: 12. – ISSN 2078-9130.

High-speed deformation of aluminum alloy thin plate with a high-strength double-sided corundum coating was numerically simulated under impact of steel punch with a hemispherical working part.

The dynamic bonded contact problem for viscoelastic-plastic boundary value conditions problem is modelled for large deformations and varying physical and mechanical materials' properties, levels of strain rate and brittle fractures processes. Numerical simulation of impact process was carried out with finite element method based on the autonomous Euler-Lagrange approach, applying the specialized finite element software package ANSYS. Analysis of the found strain and stress fields' distributions demonstrated that the high-strength coating contributes in reallocation of the fields' equivalent stresses and leads only to the lower coating damage in place of the whole plate in depth.

Keywords: shielding plate, coating, beat, contact problem, large deformation, and finite element method.

Web-application for archiving of creep and long term strength data / D. V. Breslavsky, O. O. Breslavska, A. S. Khoroshun // Bulletin of NTU "KhPI". Series: Dynamics and strength of machines. – Kharkiv: NTU "KhPI", 2015. – № 57 (1166). – P. 11-14. – Bibliogr.: 14. – ISSN 2078-9130.

The paper is devoted to description of the software, which made as web-application, for collection, storing and processing the data of creep and long term strength, including the case of creep-fatigue interaction. The short review and analysis of problem is presented. The technology for minimization of creep data storing as well as the architecture of web-application is discussed. Software contains the possibility of imaging three parts of data, which are creep curves, long term strength curves and diagrams of limiting amplitudes and stresses. The values of temperature, stress, grade and literature reference to the data are demanded database fields. The examples of the work with database and with plots are presented.

Keywords: creep, long term strength, creep-fatigue interaction, experimental results, web-application, material data storing.

Plasticity and creep of steel 3 at room temperature / D. V. Breslavsky, V. M. Konkin, V. O. Mietelov // Bulletin of NTU "KhPI". Series: Dynamics and strength of machines. – Kharkiv: NTU "KhPI", 2015. – № 57 (1166). – P. 14-19. – Bibliogr.: 13. – ISSN 2078-9130.

Results of experimental investigations at the room temperature of specimens made from steel 3 are presented in a paper. It was found, that steel 3 at room temperature demonstrates essential creep, when strains are more than 2%. The anisotropy of creep properties for considered steel was fixed. The values of constants which are included in suggested state equations for steel 3 at temperature 20 C were determined. Comparison between experimental and calculated data show the satisfactory ability of use the suggested state equations for numerical simulation of stress-strain state's varying in conditions, when load causes the instant stresses which are more than yield limit as well as instant plastic strains occur.

Keywords: plasticity, creep, state equations, creep curves, anisotropy of creep properties, rolling, experimental investigations, plane samples.

Creep calculations at steady growth of temperature / D. V. Breslavsky, S. O. Pashchenko, O. A. Tatarinova // Bulletin of NTU "KhPI". Series: Dynamics and strength of machines. – Kharkiv: NTU "KhPI", 2015. – № 57 (1166). – P. 20-24. – Bibliogr.: 15. – ISSN 2078-9130.

The mathematical statements of creep and transient heat transfer three dimensional problems are presented in a paper. Finite Element Method is used for solution of boundary problems as well as time step integration method for initial ones. The algorithms which are the foundations of developed software are discussed. The values of constants, which are included in state equations for wide range of temperatures, are obtained. The simultaneous solutions of analyzed problems have been performed by use of example of heating the bronze bar in tension. The time dependencies of temperature and creep strain were obtained by numerical way. The correctness of developed software was estimated.

Keywords: creep, state equation, creep curves, transient heat transfer, temperature, Finite Element Method, bronze bar.

The inverse problem under nonstationary deforming of a rectangular plate with additional viscoelastic support / A. V. Voropay // Bulletin of NTU "KhPI". Series: Dynamics and strength of machines. – Kharkiv: NTU "KhPI", 2015. – № 57 (1166). – P. 25-29. – Bibliogr.: 5. – ISSN 2078-9130.

Mechanical system consists of hingedly supported medium-thickness rectangular plate with additional concentrated viscoelastic support. The nonstationary concentrated transversal load, which initiates vibration, is acting on the plate. The formulation and the solution of one inverse non-stationary problem for the mechanical system are given. The identification problem of unknown non-stationary load causing the deformation of the plate with additional support is considered. The simulation of the plate deforming is based on S. P. Timoshenko's refined theory. The researches are reduced to the system of Volterra integral equations. The solving of such Volterra integral equations is ill-posed problem, which is solved numerically with using of Tikhonov's regularization algorithm. Stable analytical and numerical solution of ill-posed problems for considered mechanical system is obtained without the use of iterative computational schemes. The unknown external load and reaction between the plate and additional support vs. time are obtained consequently. Special attention paid to the regularization parameter choosing. The results of numerical calculation for inverse problem are presented.

Keywords: medium-thickness plate, identification, nonstationary loading, viscoelastic support, Volterra integral equation, Tikhonov's regularization algorithm.

Computer access of balancing of high-speed shafts of transmission machines/ V.N. Grischenko, R.V. Boykov // Bulletin of NTU "KhPI". Series: Dynamics and strength of machines. – Kharkiv: NTU "KhPI", 2015. – № 57 (1166). – P. 30-35. – Bibliogr.: 19. – ISSN 2078-9130.

At development of engines a lot of time spared the choice of its rational structural form and separate details. However, it is well known that character of distributing of the masses of mobile parts of mechanism substantially influences on dynamic stresses of machines. The analysis of breakages of crankshafts of engines shows that their greater part carries fatigue character and caused variable on a value forces from pressure of gases and inertia forces from revolved and forward locomotive the masses.

In-process on the base of package of ANSYS the algorithm of the starting computer balancing of high-speed details which from data of electronic drafts is unbalanced is offered. It is suggested yet on the stage of planning to bring in purposeful corrections in the beforehand chosen project parameters which improve quality of functional. The conducted calculations of model of crankshaft of diesel rotined that by the insignificant changes of sizes of counterbalances it is possible substantially to decrease starting mental instability.

Keywords: balancing of rotors, crankshaft, finite of elements method, optimum planning.

The deflected mode of profile connections with interference fit at technological and working loads / D.V.Danilov, A.G.Andreev, A.V.Shepkin // Bulletin of NTU "KhPI". Series: Dynamics and strength of machines. – Kharkiv: NTU "KhPI", 2015. – № 57 (1166). – P. 35-40. – Bibliogr.: 8. – ISSN 2078-9130.

In work the comparative analysis of various variants of profile connections with a tightness for definition of influence of the form of a shaft and the plug on distribution of key parameters describing a is intense-deformed condition is spent: total movings, equivalent stress by von Mises number and contact pressure, centrifugal rotation loadings. The executed researches allow to compare deflected mode of various variants of profile connections and to track influence of connection parameters on its strength and durability, to plan rational ways of hardening.

Keywords: profile connection, tightness, mathematical modelling, ANSYS.

The study of stress state in an elastic plate made of composite materials with an infinite row of equal round circular holes / S. Darya zadeh // Bulletin of NTU "KhPI". Series: Dynamics and strength of machines. – Kharkiv: NTU "KhPI", 2015. – № 57 (1166). – P. 41-44. – Bibliogr.: 8. – ISSN 2078-9130.

The present article is based on the theory of anisotropic linear elasticity using the complex variable. A analytical method for solving macroscopic stress concentration in orthotropic plates with holes is presented. In this work, stress functions satisfying the boundary condition for the anisotropic plate with holes. In this study, a plate under uniaxial tension is considered and the border holes are free from any pressure. The article contains the most important results of research on the concentration of stresses of around holes. In this article the stress near a circular hole was calculated by orthotropic fibre-reinforced plates for four different composite materials. The analysis of the concentration in composite plate is, however, considered as a homogeneous orthotropic material. The results of research dependent upon the distances between the centers of the holes. Also this problem is analysed with the finite element method by package ANSYS. In addition, the results of the analytical method with numerical method are compared.

Keywords: composite plate, unidirectional fibers, numerical method, boundary conditions, stress concentration.

The use of elastic elements for the implementation of the project well profile parameters / V. M. Ivasiv, R. V. Rachkevych, A. R. Yurych, L. R. Yurych // Bulletin of NTU "KhPI". Series: Dynamics and strength of machines. – Kharkiv: NTU "KhPI", 2015. – № 57 (1166). – P. 45-48. – Bibliogr.: 12. – ISSN 2078-9130.

Article objective is creation of technical equipments and mathematical apparatus for guarantee steering of well trajectory.

Construction of controlled deflector and elastic coupling was developed for this purpose. This equipment has such advantages like possibility of non-discrete change of deflect angle and stiffness respectively. Method of intense-deformed state analysis of bottom assembly with controlled deflector and elastic coupling was proposed. Graphic dependences of deflecting load from elastic coupling stiffness and length and deflect angle of controlled deflector was drawn. As result was got that deflecting load is more sensitive to change of elastic coupling stiffness in diapason 1 - 2 kN m². Second result is next: elastic coupling length must be more than 4 m.

Let's note, that controlled deflectors and elastic couplings with different length and stiffness together with drilling parameters allow changing in wide diapason deflecting load on bit. As result, possibility exists to steer well trajectory.

Key words: drilling, well profile, bottom assembly, deflector, elastic coupling.

The holes' influence on the constructional non-homogeneous cylindrical shells free oscillation frequencies / V.A.Kairov, S.A.Morgun // Bulletin of NTU "KhPI". Series: Dynamics and strength of machines. – Kharkiv: NTU "KhPI", 2015. – № 57 (1166). – P. 49-53. – Bibliogr.: 13. – ISSN 2078-9130.

The free vibrations of thin elastic cylindrical shells weakened by a rectangular hole is studied. Problems of the thin shells' with constructional non-homogeneity free oscillations set the especial place in the modern mechanical theory and practice. The main aim of this work is to investigate the rectangular holes' frequencies and forms. The new, more correct mathematical model, that takes into consideration the shell's constructional inhomogeneity has also been designed. It has been studied that the rectangular holes presence in the shells' constructions and their discrete location cause the local inertial non-homogeneity and influences greatly on the construction's amplitude and frequencies characteristics. The shells system oscillations amplitudes and frequencies are calculated too. The new dependencies, physics and mechanical effects, caused by the shells constructional non-homogeneity are also received. Such dependencies have a big practical value. The comparison of all findings with corresponding problems numerical results and experimental data are also given.

Key words: free vibration, cylindrical shell, rectangular hole, reinforced ribs, vibration and amplitudes characteristics, finite elements method.

Definition of reliability parameters tanker of semitrailer driving on roads with different qualities / O. Larin, K. Potopalska // Bulletin of NTU "KhPI". Series: Dynamics and strength of machines. – Kharkiv: NTU "KhPI", 2015. – № 57 (1166). – P. 54-59. – Bibliogr.: 99. – ISSN 2078-9130.

The paper presents the determination of reliability and life-time of semi-trailers based on random vibrations of driving on roads with different qualities. Damage to the tank capable appears during operation due to the accumulation and development of fatigue or corrosion,

which leads to cracks and depressurization boiler tank. Therefore, development of methods for modeling settlement tank designs to assess their durability and reliability prediction at the design stage and in operation to ensure safety is important for practical problem. For solving problem random vibrations of vehicle with the influence of the lag effect the mathematical model was made. Particularly was considered the mathematical model random impacts vector with lag time effect on axis of vehicle. Finite-element model of the boiler semitrailer tanker was developed. The next step was obtained probabilistic behaviors of the system, such as spectral density and standard deviation of stresses, the influence of the lag effect of external forces using the methods of statistical dynamics. When analyzing the standard deviation at stresses determined that there are dangerous zone near the supports and hatches. Using probabilistic characteristics were obtained determine the parameters of reliability. For each type of load has been calculated effective frequency. The main influence on it was the speed of vehicle, but not the quality of the road surface. The approach to assessing the reliability of construction was offered by criteria for the accumulation of fatigue. The graph probability of failure-free operation is life-time has been defined for all types of loading. In the investigation of the life-time was determined that the quality declines of the road at a speed of 90 km / h life-time decreases rapidly.

Keywords: semi-trailer, boiler tank, heavy vehicle, random vibrations, FEM, life-time, reliability.

Stress-strain state of some types of profile connections with tightness in the axial loads in the PC ANSYS / V.S.Lyzko, A.G. Andreev // Bulletin of NTU "KhPI". Series: Dynamics and strength of machines. – Kharkiv: NTU "KhPI", 2015. – № 57 (1166). – P. 60-69. – Bibliogr.: 10. – ISSN 2078-9130.

The subject of the work is a comparative analysis of some embodiments of compounds with tightness under the action of axial pressure. Research carried out for these connections with a tightness options: round and round the shaft sleeve, round and oval shaft sleeve, the shaft is in the form of a curved square and round sleeve, hexagonal shaft and sleeve round, round and oval shaft sleeve, oval shaft and oval sleeve. The disappearance of the contact pressure is dangerous in terms of the reliability of the connection parts, so the study of the topic is relevant today. The aim is to identify the critical values of axial pressure and characteristics of stress-strain state details, interconnected and, based on these data, the determination of the optimal variant connection. The results are shown in graphs, figures and tables.

Keywords: pressure coupling, thrust, profile connections.

Study of natural oscillations reinforced elements of foundation / S.V. Krasnikov // Bulletin of NTU "KhPI". Series: Dynamics and strength of machines. – Kharkiv: NTU "KhPI", 2015. – № 57 (1166). – P. 70-74. – Bibliogr.: 10. – ISSN 2078-9130.

Considered the vibration characteristics of foundations for steam turbines. The results of the study of vibration characteristics typical elements of reinforced concrete foundation are given. The foundation is the backbone of the steam turbine. Type of build the foundation - reinforced concrete. Different versions of reinforcing concrete elements of the foundation are made. Two series models typical element are constructed. The first and second series of models based on small and high degree of reinforcement. For each series models is the basic design are completed. Analysis of vibration characteristics seen with two of point range: quantitative and qualitative. Calculations by thirty variations and analysis of the results are given. It was designed their own forms of oscillations and their frequency. Detail the analysis of natural frequencies typical element. Conclusions on reinforcing schemes that have the greatest impact on their fluctuations. For modeling and calculations used finite element method.

Key words: performance, vibration, natural frequencies, own oscillations, foundation, steam turbine.

Features of automation parametric modeling the dynamics of the rotors of centrifugal compressors with different models / G. Y. Martynenko, A. N. Marusenko // Bulletin of NTU "KhPI". Series: Dynamics and strength of machines. – Kharkiv: NTU "KhPI", 2015. – № 57 (1166). – P. 74-80. – Bibliogr.: 8. – ISSN 2078-9130.

The analysis of natural frequencies and mode shapes of the rotor models, constructed and calculated at software systems of engineering applications. The work confirmed that the use of elastic supports is appropriate. The software product allow building a model of the rotor, carry out calculations of its dynamic characteristics with a visual representation of the results. The program provides a link with the macro and program complex for calculation and with browser to view the results and allows you to change the required parameters of the rotor. Program facilitates the analysis of the dynamic behavior of the rotor, and reduces the time spent in the calculation model and for analysis results.

Keywords: rotor dynamics, magnetic bearings, critical speeds, parametric modeling.

Methodology of experimental investigation of viscoelastic properties of orthotropic material / V. G. Martynenko // Bulletin of NTU "KhPI". Series: Dynamics and strength of machines. – Kharkiv: NTU "KhPI", 2015. – № 57 (1166). – P. 81-87. – Bibliogr.: 25. – ISSN 2078-9130.

The paper considers the techniques for the conducting of an experimental investigation of viscoelastic properties of an orthotropic material. The solved problem of stretching and shearing of a thin viscoelastic plate by constant loads enabled an analytical determination of relaxation kernels. The developed method of a fitting of experimental data gained at different time and temperature points allowed a determination of elastic properties and a relaxation kernel of an orthotropic material with viscoelastic properties, whose the degree of anisotropy is determined by the degree of anisotropy of the elastic properties, using the method of least squares. The described methodology will be used for the estimation of the mechanical properties of thin composite structures.

Keywords: viscoelastic, orthotropy, relaxation kernel, method of least squares.

Most important phases of development optimization of complex structure / S. A. Nazarenko // Bulletin of NTU "KhPI". Series: Dynamics and strength of machines. – Kharkiv: NTU "KhPI", 2015. – № 57 (1166). – P. 87-90. – Bibliogr.: 20. – ISSN 2078-9130.

The paper is concerned with most important phases of formation and development optimization of complex structure. A formal approach to multidisciplinary optimization of complex devices is developed. The stages of optimization of complex devices: the choice of models of analysis, design variables, functional objectives and constraints. Optimization techniques are classified as direct; the first and second order; stochastic; linear and nonlinear programming. The applications of different types of Super Computer Simulation and Optimization Based Design / Engineering (multidimensional, structural, topological, parametric, multicriteria) are shown. On the basis of a mathematical model that takes into account the spatial and temporal fields of different nature (electrical, magnetic, elastic deformation, mechanical and thermal) with use of optimization genetic algorithms and the flexible polyhedron method, the complex structure is developed, which is characterized of reduced weight and size and high efficiency.

Keywords: optimization, mechanics, complex structures, method, CAE, SPDM, model, design.