

Chronicle

17th International Conference “Mechanika”

Prof. Dr. habil. M. Daunys, Chairman
Assoc. Prof. Dr. V. Nenorta, Scientific Secretary

International Conference “Mechanika-2012” is organized as one conference of the cycle “Science and Industry of Lithuania”. The conference “Mechanika-2012” took place on 12, 13 April at the Faculty of Mechanical Engineering and Mechatronics of Kaunas University of Technology. The Conference is organized by Kaunas University of Technology in cooperation with Lithuanian Academy of Science, IFToMM National Committee of Lithuania and the Baltic Association of Mechanical Engineering (BAME). The purposes of the conference are to discuss current problems of research, education, and industry in the country; to present results of the most recent research in specific subject areas. Among participants are the leading specialists from other institutions of higher education and scientific institutes, authorities in technical sciences and other areas, and representatives of industry and business organizations. The Conference Committee selected 96 presentations from the 104 and after the second selection 69 reports are published in the Proceedings of the 17th International Conference “Mechanika”.

The conference proceedings cover the following topics:

- strength of materials and structural elements;
- mechanical technologies;
- dynamics of mechanical systems;
- engineering materials and their application.

Besides the papers from Kaunas University of Technology, Vilnius Gediminas Technical University, A. Stulginskis University, Šiauliai University, there were presented the papers from institutions of Baltic Region and from other countries: Silesian University of Technology (Poland), University of Bihač, (Bosnia and Herzegovina), Lappeenranta University of Technology (Finland), Central Scientific Research Institute of Structural Materials “Prometey”, Kaliningrad State Technical University (Russia), Riga Technical University (Latvia), Czech Technical University (Czech) and companies of Lithuania. There were 161 participants (from KTU – 67, other science and education institutions of Lithuania 50, Lithuanian industry – 10, foreign countries – 34).

Prof. Dr. habil. M. Daunys opened the conference, congratulated the participants and explained the procedure of the Conference.

Dean of the faculty of Mechanical Engineering and Mechatronics Dr. A. Vilkauskas congratulated the participants, made an overview report on scientific research activities in Kaunas University of Technology and Lithuania in the area of mechanical engineering.

In the plenary session two reports about problems in the Lithuanian science of mechanics were made.

Prof. Dr. habil. Minvydas Ragulskis from the Research Group for Mathematical and Numerical Analysis of Dynamical Systems of Kaunas University of Technology presented the report “*Nonlinear vibrations in science and engineering*”.

Nonlinear vibrations play an important role in a diverse field of scientific and engineering applications. A general overview of different topics directly related to nonlinear oscillations and chaos is given in the plenary talk. Phase control of dendritic neural networks, evolutionary algorithms for time series forecasting, dynamic visual cryptography, adaptive quadratures for realtime applications, nonuniform embeddings in multidimensional phase spaces, chaotic time-averaged moire fringes, the construction of analytic solitary solutions to nonlinear differential equations – all these diverse fields are based on the fundamental principles based on the dynamics, evolution and control of nonlinear oscillations. A number of interesting solutions, methods and applications are discussed. The concept of dynamic visual cryptography which is a new branch in the science of digital image security is discussed in detail. The fuzzy time series forecasting methods based on the optimal attractor embedding outperform state-of-the-art predictors for such benchmark tests as Mackey-Glass series. An analytical criterion which determines if a solution to a nonlinear differential equation can be expressed in a form comprising finite number of standard functions is derived. It is shown that this criterion generates the structure of the solution automatically and outperforms alternative perturbation-based methods. As mentioned previously, all these developments are closely related and originated by the theory of nonlinear dynamical systems and chaos. Modeling of optical effects in virtual computational environments, novel numerical techniques and applications, dynamic visual cryptography, control and characterization of chaotic nonlinear systems build the ground for new challenging possibilities in mathematical and numerical analysis of dynamical systems.

Prof. Dr. habil. Arvydas Palevičius from International Studies Centre of Kaunas University of Technology presented the report “*Analysis, design and application of periodical microstructure*”

Interest in diffractive optical elements (DOEs) for optical interconnects, optical imaging, optical data storage, laser machining, optical and optochemical sensors has grown rapidly in recent years. The elements showing high diffraction efficiencies have good optical qualities for variety of practical use. Different methods and materials are used to produce diffraction gratings for DOEs. For characterization of geometrical parameters of such microrelief structures usually various construction microscopes are used, mostly scanning electron or probe microscopes. These direct methods are sometimes destructive and hardly can be employed for in-situ analysis. Therefore indirect optical

interference or diffraction methods are used widely. Angular dependence of relative efficiency (RE) appears a versatile tool to analyze process of origination and replication of diffraction grating in micrometer range. Both shape of the grating and linear dimensions can be reconstructed comparing experimental values of relative efficiency with the simulation results.

On the other hand two-dimensional or three-dimensional periodic structures of micrometer period are widely used in microsystems or devices, e.g. as elements of microfluidic devices. Long deep grooves (in optical terms -phase diffraction grating) can be used as elements for microscale synthesis, processing, and analysis of chemical and biological samples that require manipulation of microscopic volumes of liquids. Usually this can be done with chips with microchannels and microreactors. From this point of view optical methods are very flexible and efficient in control where dimensions of periodic structures are in micrometer range. Optical method, based on measuring of relative diffraction efficiency dependence on illumination angle and wavelength of the light, was proposed to control geometrical parameters of microstructures of high aspect ratio. Comparing computer simulated and experimental values of relative diffraction efficiency depth of the investigated microfluidic channels is obtained with accuracy of 5%. This method also could be used for measuring fluid dynamics in the channels because changes of the refraction index in the system could be easily measured.

DOEs, periodical microstructures and holograms are important in the areas of scientific research, medicine, commerce and industry. In mass production it is essential to use high-quality originals to make high-quality replicas. In order to do that new methods of production and development are created. One of such new methods of production and development is Computer-generated hologram (CGH). Computer-generated hologram is described mathematically by computing the phase and amplitude information of the wave propagation produced by an object. There are many applications which use CGH, such as diffractive-optical elements for storage of digital data and images, precise interferometric measurements, pattern recognition, data encryption and three-dimensional displays. One advantage over conventional holograms produced by optical means is that the object used for recording CGH holograms does not need to exist, i.e. it may be described mathematically. With respect to their fabrication, phase-only CGH have been highly investigated since they are more light efficient. Therefore Matlab program for modelling of CGH, based on Gerchberg-Saxton (GS) algorithm, is created. Modified Fourier transformation with GS algorithm introduces greyscale levels into hologram and lets completely to reconstruct the image, while diffraction efficiency of CGH reaches 45%.

Microelectromechanical systems (MEMS) is a driving technological factor in transportation, communication, health care and other areas of science and technology. Various fabrication technologies are used to manufacture micro or nanostructures. Microstereolithography, electron beam lithography, laser-micromachining, photolithography are the methods widely used for the fabrication of prototype microstructures. But most commercial activities have been focused on the replication methods. Therefore an aluminum vibration platform is designed in order to increase the quality of thermal replica; the piezoelectric ele-

ment was chosen as the source of high frequency vibrations. High frequency vibration generated by a piezoelectric actuator can enhance the thermal imprint process of microstructures into a polymer. It is determined optically that high frequency excitation during the thermal embossing process of the nickel periodical microstructure increases the quality of replicas.

Optical, mechanical and surface properties becomes significantly important when we deal with nanocomposite thin films used to construct smaller, faster, cheaper and more efficient optical sensor devices, which would be routinely employed as components in MEMS and MOEMS. Investigations proposed new nanocomposite structures as plasmonic materials with improved optical and mechanical properties, which may be applied for a number of technological applications: microelectromechanical devices, optical devices, various plasmonic sensors, or even in DNA nanotechnology.

1. Strength of materials and structural elements

Prof. Dr. habil. A. Ziliukas, Chairman
Assoc. Prof. Dr. V. Leisis, Secretary

Two sessions took place in the section of Strength of Materials and Structural Elements and 24 presentations were made in it. More than 28 listeners participated in this section from Czech Technical University (Czech Republic), Kaliningrad State Technical University (Russia), Silesian University of Technology (Poland), Vilnius Gediminas Technical University (VGTU), Siauliai University, Aleksandras Stulginskis University and Kaunas University of Technology (KTU).

The problems of the strength and fracture of structural elements were analyzed in these presentations.

The newest methods of evaluation of materials and calculation of structural elements were presented. The problems of composite mechanics and biomechanics were solved. Very interesting presentations was made by the colleagues from Poland. The specific FE modelling of human bone was presented by A. John, P. Wysota, M. Duda and G. Kokot from Silesian University of Technology.

A. Pritykin from Kaliningrad Technical University analyzed the problems of strength and stability of perforated beams.

J. Sykorova from Czech Technical University has presented the new method which allows to describe the fatigue of concrete. Presented method based on fuzzy logic which allows consideration of load level during cyclic loading and the number of freeze-thaw cycles and can be apply for estimation of residual stiffness of the affected concrete. The specific problem related to the application of image processing in cyclically loaded structures was presented by M. Petric

M. Leonavičius and G. Petraitis from VGTU presented the results on performed analysis of the effect of the in-homogeneity derivatives on the cyclic strength of spheroid cast iron.

J. Tretjakovas (VGTU) presented the suggested model which can describes the method of determining the pressure acting on the diaphragm during its static rupture. The obtained pressure-time curve authors will be applied in future research to simulate the dynamic behaviour of the diaphragm's model.

The newest results related to the strength of reinforced concrete were presented by V. Pilkavičius from VGTU.

The results on a numerical stress state analysis of elastically deformed layered sandwich-type structures at a near the edge region were presented by N. Partaukas from Kaunas University of Technology (KTU). The results presented by author shows that the normal and equivalent stress varies between the bounds calculated according to different equations.

The problem of the transient temperature field in the plate juncture zones of the thin-walled branched structure were analyzed in the presentation made by S. Turskienė from Siauliai University.

Four presentations was made to share the results of investigation mechanical behaviour of furniture and flexible polymer materials effected by biaxial tension. The authors of these presentations are L. Gegeckiene, V. Saceviciene, D. Zubauskienė, G. Busilienė, E. Strazdienė, V. Urbelis from KTU.

The newest results obtained in the experimental study of stone wool slabs, under long-term compressive load used for thermal insulating flat roofs, cast-in-place floors, external basement walls was presented by L. Steponaitis from VGTU.

Experimental results of the effect of dynamic loads on the deformation characteristics of prestressed reinforced concrete box-girder viaducts was presented by S. Zadlauskas from KTU.

D. Šatikas from KTU presented an investigation of strut construction of carbon composite standard ankle foot orthoses on the developed physical prototype fatigue evaluation stand and finite element method analysis. The purpose of the evaluation was to find out the regions of maximum stress and strain concentration occurring during the normal walking cycle and to give the recommendations to the orthosis strut design and manufacturing process optimization.

Investigation of arm muscle activity while lifting weight was presented by R. Maskvytis from KTU. The second workshop of section A finished with A. Jutas (KTU) presenting results on the strength question in chain elements overloaded during maintenance of bio-fuel conveyor.

In conclusion, the presented studies highlighted the actual problems of strength and fracture mechanics of materials and structural elements:

- strength and fracture mechanics;
- experimental measurements and computational methods application;
- composites mechanics and biomechanics.

It was clarified that metallic and nonmetallic composite materials are widely used but specific attention it must be taken into account to assess their durability and reliability. A large part of scientific problems are solved using computer software and numerical methods. That's just as well a lot of young researches take part in the conference. Both the scientific value and perspective allows us to foresee that the higher strides will be reached in the domain of strength and fracture mechanics.

2. Mechanical technologies

Prof. Dr. habil. A. Bargelis, Chairman
Assoc. Prof. Dr. R. Mankutė, Secretary

The 23 research papers in the Conference section of Mechanical Technologies from Lithuania and other four foreign European countries have been presented in session of this workshop. The investigation and new developments in various fields of mechanical technologies has been examined. There were proposed new ideas as a product modular design and module-based shape optimization, investigations of welding technologies and robotising, peculiarities of fabrication technologies as CNC milling, punching, laser cutting, and welding, manufacturing robotising and so on. New concepts of wind power stations and application for renewed energy systems have been presented also. Exceptional research papers of mechanical technologies workshop have been given from Finland, Latvia, Poland and Ukraine, and also from Lithuanian universities and research centres.

The colleagues from Lappeenranta University of Technology (LUT, Finland) presented two research papers by four researchers. T. Kassi and M. Lehtovaara examined the effect of entry into the Emerging Offshore wind power market; J. Martikainen with co-author E. Hiltunen presented research for development of aluminium boat's hull modularization to enhance robotic welding. Robotics welding needs many specialized tooling as fixtures and jigs, therefore, the product modularization can help to decrease the volume of welding jobs. J. Martikainen (LUT) presented research of peculiarities and quality welding processes in sheet aluminium works industry applying laser and other high technologies. Group of researchers from Latvia, Riga Technical University illustrated newest research results in machining area of stainless steel and other hard alloys seeking qualitative products and high productivity. Another their research is divided to the analysis of buoyancy and design features of the underwater vehicle. Investigation of characteristics piezoelectric actuator used for the synthetic jet flow control has been carried out as a common research of Lithuania and Poland researchers R. Rimašauskienė (KTU) and W. Ostachovicz (Szewalski Institute, Poland). Two common research papers (Lithuania and Ukraine) were related with investigation of formation Braille font and resistance to mechanical effect (I. Venytė et al.) and development of 3D Technological systems workflow (A. Mikhaylov et al.).

The researchers from VGTU presented three papers for the theoretical investigation of Multiobjective approach to grillage optimization with adaptive Genetic algorithm (D. Mačiūnas), and research of graphical methods for designing welding joints in engineering drawings (A. Sokas, V. Vilkevič), and research the influence of fixed transition for the Wortmann FX 66-S-196 VI airfoil at Low Reynolds number (V. Naujokaitis).

Researchers from KTU presented the biggest part of research papers. R. Mankutė showed the newest results of examined manufacturing data applying integrated computer aided manufacturing system for learning students and industry needs; J. Margelevičius et al. presented 2 papers in research field measurements of dispersion discreet element dimensions and errors of digital graphic element formation, V. Kazanavičius et al demonstrated security

model of embedded software for mechatronics systems, L. Čepukonė and M. Jucienė pointed the influence of laser treatment on fabric friction parameters. These research topics are interesting for industrial companies which are willing for cooperation and common work. The MSc and BSc students of Mechanical Engineering and Mechatronics faculty prepared and demonstrated six research papers. It is a result of their research work in accordance of study plan. The MSc students N. Toliušienė, A. Sasnauskaitė, D. Sventickas, A. Ozdemir, J. Navickas are involved in research of various industrial processes problems as productivity, creation of new production methods seeking higher work efficiency. The interesting research – consideration of knowledge base for laser cutting machining was made by second year BSc program student N. Ausmanas. First year PhD student J. Tilindis presented paper related with application of lean production system tools for manual assembly process improvement.

The scientists of KTU and other Lithuanian universities actively participated in the workshop. The useful discussions together with their colleagues from foreign countries have been arranged and close co-operation planned. Many questions and discussions among workshop participants were pointed out. The second day of workshop has been divided for foreign guests' visits in industrial companies of Kaunas.

3. Dynamics of mechanical systems

Prof. Dr. Habil. A. Fedaravičius, Chairman
Prof. Dr. R. T. Toločka, Secretary

For the section of Dynamics of mechanical systems 27 Scientific papers were provided. Apart from the hosts of the conference, representatives from KTU, reports were authored by representatives from the VGTU and JSC "Precizika Metrology" (Lithuania), the presentations were given by the traditional guests and participants of this conference from Bosnia and Herzegovina, Latvia and Russia. This year not so many matured scientists participated in the section's work but the young researchers have distinguished themselves by a number of interesting reports prepared and, in the majority of cases, excellently presented.

In the articles of the foreign guests I. Karabegovič, E. Husak, E. Karabegovič, B. Novkinič (University of Bihač, Bosnia and Herzegovina) analyzed the problems of industrial robots applications and tool holder vibrations during cutting process. The results of experimental investigation of vibrational tool dynamics are presented by M. Ubartas, V. Ostaševičius, V. Jūrėnas, R. Daukševičius (KTU, Lithuania). The problems of research of dynamical properties of ferro fluid and other engineering materials from VGTU (Lithuania) A. Klevinskis, V. Bučinskas, E. Zdancevičius, D. Markauskas, R. Kačianauskas, were presented.

The dynamics problems of machines and mechanisms and vibrations in rotor systems analyzed scientists from University of Tuzla, Bosnia and Herzegovina (D. Sprečić, E. Mujanovič, N. Zuber and other), KTU (J. Jegorenka, R. Bansevicius, V. Kartasovas, V. Barzdaitis).

The report of A. Fedaravičius and V. Buzas presents an investigation of micro rocket engine exhaust plume. Primary analysis of supersonic flow and Mach

discs appearance is being carried out zone of silence is being identified from experimental material and compared with analytical calculations, expansion characteristic is being found.

Active discussions and great number of questions were asked on the presentations "Non-invasive portable biocompatible microopto – electromechanical system adaptation to radial blood flow pulse and velocity analysis" and "Investigation of piezoelectric bending actuator for application in kinetic energy harvesting by authors V. Ostaševičius, K. Malinauskas, R. Daukševičius, V. Jūrėnas, I. Milašauskaitė, R. Gaidys (KTU).

Traditionally the participants developing their activities in the fields of vibratory and acoustic diagnostics and monitoring of mechanical systems. The acoustic emission analysis of fatigue crack development and features of the acoustic emission control for the monitoring of pipeline system of oil heater boilers by guests from Riga Technical University, Latvia (Y. Harbuz, S. Doroshko and other) were presented. The theoretical and practical results of the investigation of new concept of buildings stability monitoring presented the researchers from KTU, (V. Volkovas, M. Eidukevičiūtė, R. Gulbinas, K. Petkevičius, A. Rugaitis and S. Slavickas).

The conference was useful for all participants but especially for young scientists. They became acquainted with achievements of scientists from various institutions and listened to critics and valuable proposals.

4. Engineering of materials and their application

Prof. S. Bočkus, Chairman
Assoc. Prof. A. Čiuplys, Secretary

16 participants took part in the meeting of this section. They represented KTU, VGTU, Saint Petersburg State Polytechnic University (Russia) and Lappeenranta University of Technology (Finland). There were 8 presentations in this section. The problems of materials science, welding, metal forming and coatings were considered.

The presentations from the field of welding predominated. There were four such presentations. Z. Bazaras, B. Timofeev, N. Kykovskiy and V. Vasilieva have considered about properties and microstructure of steel 09Mn2SiA-A welded joints heat-affected zone. It was shown, that microstructure as it distanced from the fusion zone changes and it is reflected on impact strength values. The lowest impact strength values are in the overheating and blue-shortness zones. However, impact strength requirement (29.4 J/cm²) at temperature 50 °C below zero is provided with a high confidence. E. Biekša and A. Bargelis discussed about stainless steel pipes welding keeping sharp production dimensions. A. Kozlovas has considered about welded joint reliability evaluation in accordance with nondestructive testing results. M. Pirinen discussed about productivity and quality in production networking in the welding industry.

Three presentations were from the field of coatings. L. Kuliavas gave the results of ceramic coating wear on carbon steel. In his work coverings from oxide ceramics (Al₂O₃ and Al₂O₃+TiO₂), put by the way of a gas-flame spraying on a surface of the specimens made from carbon steel S235 were investigated. The results showed that abrasive wear of both ceramic coatings are equal independently on the base

material. But the complex ceramic coating is twice more resistant comparing with that of aluminum oxide ceramic coating. R. Lukauskaitė, A. V. Valiulis and O. Černašėjus showed the research results of aluminum alloys coating by Ni or Co based powders by plasma spray. P. Ambroza and E. Pupelis have considered about the investigation results of wear abrasion resistance of overlay welded and impacted by laser beam coatings.

The presentation of V. Jonča and M. Rimašauskas was from the field of metal forming. They presented investigation of incremental sheet metal forming work regime.

The results showed that roughness of the surface depends on such parameters of a tool as movement contour, rotation and movement speeds, roughness a working part of a tool; and properties of material processed. Also it was identified, that aiming to improve the quality of a formed part, it is necessary to use a support plate, which allows obtaining necessary depth of the part.

After the conference, the problems of materials science and perspective of future investigations were discussed.