Chronicle of the International conference

devoted to the centenary of academician A. Malmeisters

The conference was opened with a welcome speech by President of the Latvian Academy of Sciences academician J. Ekmanis. He outlined the contribution of academician A. Malmeisters in to the development of science in Latvia. A. Malmeisters was Head of Latvian Academy of Sciences from 1970 to 1984 − longer than any other president in its history. Moreover, academician A. Malmeisters also made a great personal contribution to the evolution of the new field of the mechanics of materials − the mechanics of polymer and composite materials. He carried out a series of pioneer scientific investigations in this field. A. Malmeisters was also the founder of the Institute of Polymer Mechanics, its first director and permanent scientific leader.

At the beginning of his report devoted to an analysis of the results of scientific efforts of academician A. Malmeisters academician V. Tamužs briefly told his biography. In 1953, A. Malmeisters developed the theory of local deformations, which was meant to describe the deformation of plastic materials under complex loadings. In 1957, A. Malmeisters summarized the results of his investigations concerned into the properties of concrete in the monograph "Elasticity and inelasticity of concrete" and defended his doctoral dissertation in 1958. From 1961 to 1963 A. Malmeisters was rector of Riga Polytechnic Institute, but in 1963 was nominated as director of a new institute – the Institute of Polymer Mechanics of the Latvian Academy of Sciences, where he also headed the Laboratory of rheology. Academician A. Malmeisters is the founder of the journal of „Mechanics of Composite Materials" ("Polymer Mechanics" from 1965 to 1979) and its Editor-in-Chief of many years. Academician A. Malmeisters was also the initiator of the All-Union and later International conferences "Mechanics of Composite Materials", which received wide international recognition. He was the first (in 1965), who described the strength envelopes of orthotropic composites with a tensor polynomial and proposed a method for determining its unknown coefficients. A. Malmeisters is author of a number of well-known monographs and scientific papers. He is the founder of a well-known scientific school in the field of mechanics of composite materials, biomechanics and theory of shells and structures.

The scientific schedule of the conference included ten review reports presented by scientists from the USA, Sweden, Russia, Belorussia and Latvia.

The report of Prof. K. Reifsnider (University of South Carolina, USA) was devoted to the analysis of damage accumulation in materials and structures based on monitoring the changes in their state during flexure fatigue loading. The change of state is judged from impedance variations, which are measured by using the electric impedance spectroscopy. It has been shown that the impedance (resistance as a function of frequency of the input excitation) is a material property, and can be used to evaluate the state of the material. It was found that a distributed microdamage in glass-fiber-reinforced epoxy composite materials greatly affects many details of recorded impedance data and that the impedance is very sensitive even to very small amounts of damage (e.g., at early stages of long-term loading). The results obtained allow one to infer that the degradation of material properties during a long-term fatigue loading can be quantified in terms of remaining 'ductility', for which the change in impedance at high and low frequencies as may be used an analogue.

The report of Profs. A. A. Kul'kov, A. D. Mitkevich, V. L. Strakhov, and V. Kaledin (Central Scientific Research Institute of Special Mechanical Engineering, Russia) was devoted the to mathematical modeling of thermomechanical processes in fiber-reinforced materials and structures subjected to extreme thermal actions. It was concluded that a multi-element space frame is suitable for modeling practically all existing building structures. The system of equations describing the thermal part of the problem is solved by the finite-difference method, while the static part of the problem – by the finite element method. A software package based on an algorithm developed for solving various problems has been created and tested by calculating an existing engineering structure in Moscow.

Profs. Yu. Gorbatkina and V. G. Ivanova-Mumjieva (N. N. Semenov Institute of Chemical Physics, RAN, Russia) devoted their report to the problem of adhesion of dispersedly-filled epoxy resins to solid bodies. The subject of investigation was the influence of a dispersed filler on the adhesion strength of polymer binders, especially the epoxy resin. It is established that adhesion strength depends on the nature of arising bonds and their quantity, the imperfection of the interface between the binder and filler particles, and the structure and properties of interfacial layers. Exactly the last factor enables one to increase the adhesion strength, which can be determined by means of pull-out tests with fibers embedded in a polymer matrix. Various types of dispersive filler have been investigated: aerosol, clay, Al_2O_3 powder, black, and carbon nanotubes. A nonlinear relationship between the adhesion strength and the weight content of filler was found experimentally. The application of aerosil particles as a nanofiller gave an increase in the adhesion strength of up to 25%, while the filling with carbon nanotubes had no effect. The main conclusion of this investigation: the introduction of a microgranular filler can be considered as a good method for increasing the adhesion strength of a polymer binder to solid bodies.

Profs. J. Varna (Lulea University of Technology, Sweden) and R. Talreja (Texas A&M University, USA) presented a report on a new approach to the analysis and prediction durability of composite materials with account of their damage mechanisms (degradation of stiffness and strength). This approach is based on a multiscaled modeling of material structure: from a representative unit of microstructure through the micromechanics of a substructure to the macrostructure. Various types of damage were considered: multiple cracks, debonding at the interfaces, delaminations, and fiber breaks. For their description, the vectors and tensors were used. Appropriate mathematical models were derived, and experimental investigations were carried out to determine the structural parameters required for the models. The validity of the approach developed was tested with the example of prediction mechanical properties of cross-ply laminates [0°/90°] properties with account of damage accumulation.

Academician K. Rocens with coauthors V. Goremikins and J. Šliseris (Riga Technical University, Latvia) presented a report, devoted to some rational structures and macrostructures of composites. Methods for increasing the specific strength and the specific load-carrying capacity of the structures were considered. In this respect, the most promising structures are those having the shape of a hyperbolic paraboloid, compressed thrusts and pretensioned trusses, layered guys, and profiles made of pultruded composites for roadways of bridges. Examples of structural designs with nonsymmetric laminates ensuring a curved surface shape required were shown. Rational schemes for profiles made of pultruded composites and designed for truss constructions were considered, and promising structures of suspension bridges with pretensioned cables were demonstrated. In the concluding part of the report, the basic principles of design of multiply veneer for fabricating plates with a required shape for floors and walls of auto trailers were presented.

N. K. Myskin, Y. M. Pleskachevskii, and S. V. Shilko (Institute of Metal-composite Systems, Belorussia) reported on the problems of mesomechanical analysis of the heterogeneous materials used in biomechanics and tribology. At the beginning of his report, S. Shilko emphasized that many scientific ideas of academician A. Malmeisters, which once were ahead of their time, are now embodied in the new composite materials. The reviewer presented an applied conception of physical mesomechanics, in particular based on the use of fractal analysis, and illustrated with examples of dispersedly-filled (asphalt concrete) and knitted materials. He demonstrated the estimation of the self-healing effect of defects of different spatial orientation in a metal block fabricated by continuous casting. Also, the examples of modeling of the mechanical behavior of biomechanical objects: cardiovascular system, bone tissue and muscles were presented. The principles of selection of an optimal training load for professional sportsmen and of diagnostics of human conditions during the training process were formulated and illustrated by a great number of examples.

The report of Prof. V. V. Kovriga (POLYPLASTIC Group, Russia) was devoted to the problems of fabrication of reinforced pipes, used in the natural gas industry and water and heat supply. A wide range tubes of different diameter (from 20 to 6000 mm) were designed and manufactured from cross-linked polyethylene and polyvinylchloride. The pipes for operation under a pressure of up to 20 bars are manufactured from special polyethylene trademarks without an additional reinforcement, but those for operation at a pressure of up to 40 bars are made with reinforcing layers from aramid fibers by the method of wet winding. The same technology is applied for manufacturing reinforced pressure pipes of large diameter. The report was illustrated by a great number of examples.

Prof. A. Krasnikovs (Riga Technical University, Latvia) presented a report on the problems of mechanics and micromechanics of concrete reinforced with short steel fibers. It was demonstrated. The results obtained in modeling the behavior of the reinforced concrete attested to its high strength and pseudoplastic behavior after the beginning of cracking. Also experimental data were obtained by performing tests on the pull-out of steel fibers of different shape from concrete specimens and tests on full-scale concrete beams. A manufacturing technology of reinforced concrete with a very high compressive strength (up to 400 MPa) has been developed based on nanotechnological know-how. A start has been made on investigations into the employment of short glass and carbon fibers for reinforcing concrete. The main unsolved problem is how to achieve a uniform distribution of the reinforcing fibers in the bulk of concrete.

In the report of J. Brauns (Latvian University of Agriculture, Latvia), problems of mechanical and hygrothermal design of laminated composite structures were considered. The designing is based on the theory of laminates with account of the anisotropy of elastic and thermal properties of composites, which dictates the coupling effects between the normal and tangential stresses and strains. Examples of optimal designing of wind turbine blades with a built-in of function adaptability to the loads applied were presented. Diagrams for allowable design parameters were shown. The influence of fiber orientation in composite layers on the swelling and mechanical characteristics was demonstrated with the example of fibrilite.

Prof. R. Tepfers (Chalmers University of Technology, Sweden) centered on the problem of concrete manufacturing technology. He indicated that one of the principal problems concerning the fabrication of high strength concrete is the optimization of its porosity. Moreover, the process of aggregation of filler particles in concrete depends on the content of cement in it. The greater the degree of particle aggregation the higher the stress concentrations in concrete. The reporter explained in detail the manufacturing process of lime concrete, and told about the chemical reactions taking place during the fabrication and consolidation of concrete. It was emphasized that the compressive strength of concrete significantly depends on of the water-to-cement weight. In order that the porosity be low, this ratio must be equal to 0.4. Investigations have shown that an increase in concrete strength can be achieved by introducing microsilica and superplasticizers and by using the vibrotechnique. The main conclusion of the report: the lower porosity, the higher the strength and durability of concrete.

The Editor-in-Chief of the journal „Mechanics of Composite Materials” academician V. Tamužs thanked all speakers for the presentation of interesting reports, containing new scientific results, and suggested that they are submitted as the papers for publication in a special issue of the journal Mechanics of Composite Materials devoted to academician A. Malmeisters.