ABSTRACTS

Łukasz Jastrzębski, Bogdan Sapiński
Experimental Investigation of an Automotive Magnetorheological Shock Absorber

The study summarises the experimental examination of an automotive magnetorheological (MR) shock absorber under electrical and mechanical excitations, investigates its current and force responses and the energy dissipation in the system. The aim of experiments was to acquire measurement data that allows in next step of the research program to engineer an energy harvesting device for the absorber. The work covers basic technical data of the absorber, description of the experimental set-up, scenario of testing program and test results of the device. Of particular importance is the influence the operating current, piston displacement amplitude and piston velocity have on the absorber's response.

Aleksandr Blokhin, Arcadiy Nedyalkov, Lev Barakhtanov, Aleksandr Taratorkin, Abram Kropp
Multistage Mechanical Transmissions with Automatic Control for Advanced Trucks and Buses

The study considers the basic trends of development of modern mechanical transmissions of trucks and buses. It provides the developed various series of multispeed transmissions with automatic control and a number of transmissions from 6 to 16 for trucks and buses. The paper shows the basic parameters of the standard series of new transmissions received on the basis of innovative technical solutions. It provides the results of experimental studies of 16-speed transmissions on a special test stand and on the road as part of a truck transmission. Theoretical and experimental data on the gear change time are compared.

Paweł Skalski, Klaudia Kalita
Role of Magnetorheological Fluids and Elastomers in Today's World

This paper explains the role of magnetorheological fluids and elastomers in today's world. A review of applications of magnetorheological fluids and elastomers in devices and machines is presented. Magnetorheological fluids and elastomers belong to the smart materials family. Properties of magnetorheological fluids and elastomers can be controlled by a magnetic field. Compared with magnetorheological fluids, magnetorheological elastomers overcome the problems accompanying applications of MR fluids, such as sedimentation, sealing issues and environmental contamination. Magnetorheological fluids and elastomers, due to their ability of dampening vibrations in the presence of a controlled magnetic field, have great potential present and future applications in transport. Magnetorheological fluids are used e.g. dampers, shock absorbers, clutches and brakes. Magnetorheological dampers and magnetorheological shock absorbers are applied e.g. in damping control, in the operation of buildings and bridges, as well as in damping of high-tension wires. In the automotive industry, new solutions involving magnetorheological elastomer are increasingly patented e.g. adaptive system of energy absorption, system of magnetically dissociable [hooks/detents/grips], an vibration reduction system of the car's drive shaft. The application of magnetorheological elastomer in the aviation structure is presented as well.

Mojtaba Biglar, Magdalena Gromada, Feliks Stachowicz, Tomasz Trzepieciński
Synthesis of Barium Titanate Piezoelectric Ceramics for Multilayer Actuators (MLAs)

In this paper the characteristics of BaTiO3 ceramics synthesized by solid state method is presented. In order to receive the monophase ceramics the double activation and calcination were applied. A spray drier was used to granulate the powder of BaTiO3. Isostatic and uniaxial pressing were applied to manufacture the barium titanate pellets. The properties of fabricated BaTiO3 ceramics were determined at different stages of production. After the sintering phase, the hardness, the bending strength, the fracture toughness, and the coefficient of thermal expansion of barium titanate sinter were estimated. The BaTiO3 powder is characterized by spherical grains and the average size of 0.5 μm. The small value of the specific surface area of granulate ensured good properties of material mouldability and finally allowed to receive sinters of high density.

Katarzyna Topczewska
Thermal Stresses Due to Frictional Heating with Time-Dependent Specific Power of Friction

In this paper influence of temporal profile of the specific friction power (i.e. the product of the coefficient of friction, sliding velocity and contact pressure) on thermal stresses in a friction element during braking was investigated. Spatio-temporal distributions of thermal stresses were analytically determined for a subsurface layer of the friction element, based on the model of thermal bending of a thick plate with unfixed edges (Timoshenko and Goodier , 1970). To conduct calculations, the fields of dimensionless temperature were used. These fields were received in the article (Topczewska, 2017) as solutions to a one-dimensional boundary-value problem of heat conduction for a semi-space heated on its outer surface by fictional heat flux with three, different time profiles of the friction power.

Oleg Ardatov, Algirdas Maknickas, Vidmantas Alekna, Marija Tamulaitienė, Rimantas Kačianauskas
The Finite Element Analysis of Osteoporotic Lumbar Vertebral Body by Influence of Trabecular Bone Apparent Density and Thickness of Cortical Shell

Osteoporosis causes the bone mass loss and increased fracture risk. This paper presents the modelling of osteoporotic human lumbar vertebrae L1 by employing finite elements method (FEM). The isolated inhomogeneous vertebral body is composed by cortical outer shell and cancellous bone. The level of osteoporotic contribution is characterised by reducing the thickness of cortical shell and elasticity modulus of cancellous bone using power-law dependence with apparent density. The strength parameters are evaluated on the basis of von Mises-Hencky yield criterion. Parametric study of osteoporotic degradation contains the static and nonlinear dynamic analysis of stresses that occur due to physiological load. Results of our investigation are presented in terms of nonlinear interdependence between stress and external load.

Alok Dhaundiyal, Suraj B. Singh
Asymptotic Approximations to the Non- Isothermal Distributed Activation Energy Model for Biomass Pyrolysis

This paper describes the influence of some parameters significant to biomass pyrolysis on the numerical solutions of the non-isothermal nth order distributed activation energy model (DAEM) using the Gamma distribution and discusses the special case for the positive integer value of the scale parameter (λ), i.e. the Erlang distribution. Investigated parameters are the integral upper limit, the frequency factor, the heating rate, the reaction order, and the shape and rate parameters of the Gamma distribution. Influence of these parameters has been considered for the determination of the kinetic parameters of the non-isothermal nth order Gamma distribution from the experimentally derived thermoanalytical data of biomass pyrolysis. Mathematically, the effect of parameters on numerical solution is also used for predicting the behaviour of the unpyrolysized fraction of biomass with respect to temperature. Analysis of the mathematical model is based upon asymptotic expansions, which leads to the systematic methods for efficient way to determine the accurate approximations. The proposed method, therefore, provides a rapid and highly effective way for estimating the kinetic parameters and the distribution of activation energies.

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Andrzej Waindok, Paweł Piekielny
Transient Analysis of a Railgun with Permanent Magnets Support

The calculation and measurement results of transients for an electrodynamic accelerator with permanent magnet support have been presented in this paper. The calculations have been made using the magnetostatic model in the Maxwell software, as well as using a Matlab/Simulink transient model. The waves of mechanical parameters (projectile velocity and acceleration, force) and electric ones (excitation current and capacitor voltage) have been analyzed for different supply conditions (voltage value, capacitance). The efficiency and projectile energy have been studied as well. The mathematical models have been verified experimentally using the original laboratory stand. A good conformity between calculation and measurement results has been obtained.

Iaroslav Pasternak, Heorhiy Sulym
Boundary Element Analysis of Anisotropic Thermomagnetoelectroelastic Solids with 3D Shell-Like Inclusions

The paper presents novel boundary element technique for analysis of anisotropic thermomagnetoelectroelastic solids containing cracks and thin shell-like soft inclusions. Dual boundary integral equations of heat conduction and thermomagnetoelectroelasticity are derived, which do not contain volume integrals in the absence of distributed body heat and extended body forces. Models of 3D soft thermomagnetoelectroelastic thin inclusions are adopted. The issues on the boundary element solution of obtained equations are discussed. The efficient techniques for numerical evaluation of kernels and singular and hypersingular integrals are discussed. Nonlinear polynomial mappings are adopted for smoothing the integrand at the inclusion's front, which is advantageous for accurate evaluation of field intensity factors. Special shape functions are introduced, which account for a square-root singularity of extended stress and heat flux at the inclusion's front. Numerical example is presented.

Jan Górecki, Ireneusz Malujda, Krzysztof Talaśka, Dominik Wojtkowiak
Dry Ice Compaction in Piston Extrusion Process

The article presents the results of research on the effect of extrusion tube geometry on the axial force being the key parameter of the dry ice piston extrusion process. The tests were carried out with the experimental set-up based on a cylindrical extrusion tube used alone and supplemented with reducer (orifice). The focus of the experiments was to determine the effect of compression tube reducer on the value of the force of resistance FOP in the dry ice compression process. Its value can subsequently be used as the basis for establishing guidelines for designing and building machines for compression and pelletizing of dry ice.

Artur Prusinowski, Roman Kaczyński
Simulaton of Processes Occurring in the Extrusion Head Used in Additive Manufacturing Technology

The purpose of this research is unsatisfactory state of knowledge of the abrasive wear of composites with thermoplastic polymer as matrix material and reinforcing material in the form of short and focused carbon fibers that can be used in additive manufacturing technologies. The paper presents a conceptual design of an extrusion head used in Fused Deposition Technology, which allows for the implementation of appropriately stacked fibers at the level of detail production. Finite element simulation was performed to simulate the thermal effect of the system to demonstrate the effect of head cooling on the system. The assumed extrusion temperature of the material was obtained at a uniform nozzle temperature and stable temperature of the entire system. Flow simulation of thermoplastic polymer was carried out in the designed extrusion nozzle. By supplying 0.5 mm wire of 1.75 mm diameter thermoplastic material to the nozzle, the extrusion rate was 0.192 m/s. The proper design of the extrusion head for the intended applications has been demonstrated and the purpose of further research in this field has been confirmed.

Marta Góra-Maniowska, Józef Knapczyk
Displacement Analysis of the Human Knee Joint Based on the Spatial Kinematic Model by Using Vector Method

Kinematic model of the human knee joint, considered as one-degree-of-freedom spatial parallel mechanism, is used to analyse the spatial displacement of the femur with respect to the tibia. The articular surfaces of femoral and tibia condyles are modelled, based on selected references, as spherical and planar surfaces. The condyles are contacted in two points and are guided by three ligaments modelled as binary links with constant lengths. In particular, the mechanism position problem is solved by using the vector method. The obtained kinematic characteristics are adequate to the experimental results presented in the literature. Additionally, the screw displacements of relative motion in the knee joint model are determined.

Andrzej Milecki, Roman Regulski
Washing Machine Controller with a New Programming

In the paper the newly designed at Poznan University of Technology (PUT) washing machine controller is presented. The commonly used in washing machines sensors, drives and other input-output elements are briefly described. The designed at PUT controller is based on 32-bit STM32 microcontroller. The used in this controller modules are described and their input/output signals and basics of operations are presented. The developed in the controller user-machine communication devices, elements and methods are described. The paper presents new washing machine programming methods and implementation software, such as voice recognition and intelligent programming of washing machine that were applied in the new controller.

Łukasz Bohdal, Katarzyna Tandecka, Paweł Kałduński
Numerical Simulation of Shear Slitting Process of Grain Oriented Silicon Steel using SPH Method

Mechanical cutting allows separating of sheet material at low cost and therefore remains the most popular way to produce laminations for electrical machines and transformers. However, recent investigations revealed the deteriorating effect of cutting on the magnetic properties of the material close to the cut edge. The deformations generate elastic stresses in zones adjacent to the area of plastically deformed and strongly affect the magnetic properties. The knowledge about residual stresses is necessary in designing the process. This paper presents the new apprach of modeling residual stresses induced in shear slitting of grain oriented electrical steel using mesh-free method. The applications of SPH (Smoothed Particle Hydrodynamics) methodology to the simulation and analysis of 3D shear slitting process is presented. In experimental studies, an advanced vision-based technology based on digital image correlation (DIC) for monitoring the cutting process is used.