ABSTRACTS

Błażej Czajka
Investigations into the Stability of Thin-Walled Composite Structures with Top-Hat Cross-Sections

This paper presents a study of compressed thin-walled composite columns with an open cross-section. The tested specimens with a top-hat cross-section were made of CFRP material. Two arrangements of composite layers [0/-45/45/90]s and [90/0/90/0]s were compared. The paper focuses on the buckling phenomenon and the determination of the critical loads of the structure. It includes both numerical analyses using the finite element method (FEM) and validation on real specimens made using the autoclave technique. A comparison is made between the results obtained by both methods. The critical forces of the real specimens were determined using the P-wc3 approximation method. Both the evaluation of the buckling shape and the values of the critical forces showed a significant correlation between the experimental and numerical tests. This paper also compares the tested lay-ups.

Marcin Konarzewski, Michał Stankiewicz, Marcin Sarzyński, Marcin Wieczorek, Magdalena Czerwińska, Piotr Prasuła, Robert Panowicz
Properties of Rubber-Like Materials and Their Blends in Wide Range of Temperatures – Experimental and Numerical Study

Elastomers are widely used in many industries. Their use requires thorough knowledge of their strength and stiffness parameters over a wide temperature range. However, determination of the parameters of such materials is still a challenge. Therefore, the paper presents research methodology allowing determination of the properties of rubber-like materials in a wide range of stretch and temperatures (from +50°C to -25°C) by using the example of styrene-butadiene rubber (SBR) and natural rubber (NR) elastomers. Additionally, two blends, chloroprene rubber/nitrile-butadiene rubber (CR/NBR) and NR/SBR blends, were also considered. Based on physical premises, a polynomial and Arruda–Boyce hyperelastic constitutive models parameters were determined using two different methods, namely curve-fitting and the successive response surface method.

Adam Charchalis, Marcin Kneć, Daria Żuk, Norbert Abramczyk
Use of 3D Optical Techniques in the Analysis of the Effect of Adding Rubber Recyclate to the Matrix On Selected Strength Parameters of Epoxy-Glass Composites

The article presents a method of modifying the strength properties of epoxy–glass composite by changing the percentage composition of the matrix by the addition of rubber recyclate. Taking into account environmental protection and economic conditions in the process of recycling and utilisation of waste, it is advisable to look for applications of non-degradable waste materials. Based on epoxy resin, a glass mat with a random direction of fibres and rubber recyclate, a test material with different percentage compositions was produced. Samples from the manufactured materials were subjected to a static tensile test on a ZwickRoell testing machine using the ARAMIS SRX measuring system. In addition, CT (computerized tomography) scans of the inside of the samples were made using a ZEISS METROTOM 6 Scout tomograph, and observations of the internal structures were made using a scanning electron microscope. The use of optical and microscopic techniques enabled the precise determination of strength parameters of the examined composites and the analysis of the behaviour of samples under load. The analysis of deformations over time in the examined samples showed a beneficial effect of the addition of rubber recyclate on the elastic properties of the examined composites.

Djamel Ouzandja, Amina Tahar Berrabah
Deterministic Seismic Damage Analysis for Concrete Gravity Dams: A Case Study of Oued Fodda Dam

One of the major dangers for seismic damage of concrete dams is the propagation of cracks in dam concrete. The present study undertakes a numerical investigation of the seismic damage for Oued Fodda concrete gravity dam, located in the northwest of Algeria, considering the impacts of properties of joints along the dam-foundation rock interface and cross-stream earthquake excitation. Three-dimensional transient analyses for coupled dam-foundation rock system are carried out using Ansys software. The hydrodynamic effect of reservoir fluid is modelled using the added mass approach. The smeared crack approach is utilised to present the seismic damage of dam concrete using the Willam and Warnke failure criterion. The dam-foundation rock interface joints are presented with two ways, adhesive joints and frictional joints. The Drucker–Prager model is considered for dam concrete in nonlinear analyses. Consideration of the study results indicates that the frictional joints model can reduce the seismic response and damage hazard of the dam body to a better extent compared with the adhesive joints model. Furthermore, the application of cross-stream earthquake excitation reveals the significant effect on cracking response of the dam in the two models of joints.

Muhammad Amir, Jamil Abbas Haider, Jamshaid Ul Rahman, Asifa Ashraf
Solutions of the Nonlinear Evolution Problems and their Applications

In this article, a well-known technique, the variational iterative method with the Laplace transform, is used to solve nonlinear evolution problems of a simple pendulum and mass spring oscillator, which represents the duffing equation. In the variational iteration method (VIM), finding the Lagrange multiplier is an important step, and the variational theory is often used for this purpose. This paper shows how the Laplace transform can be used to find the multiplier in a simpler way. This method gives an easy approach for scientists and engineers who deal with a wide range of nonlinear problems. Duffing equation is solved by different analytic methods, but we tackle this for the first time to solve the duffing equation and the nonlinear oscillator by using the Laplace-based VIM. In the majority of cases, Laplace variational iteration method (LVIM) just needs one iteration to attain high accuracy of the answer for linearization anddiscretization, or intensive computational work is needed. The convergence criteria of this method are efficient as compared with the VIM. Comparing the analytical VIM by Laplace transform with MATLAB's built-in command Simulink that confirms the method's suitability for solving nonlinear evolution problems will be helpful. In future, we will be able to find the solution of highly nonlinear oscillators.

Natalia Morkun, Gerhard Fischerauer, Vitalii Tron, Alona Gaponenko
Mineralogical Analysis of Iron Ore using Ultrasonic Wave Propagation Parameters

Availability, relative simplicity and low cost, combined with ever-increasing capabilities, have led to a significant increase in the use of ultrasonic measurements of mining process variables in recent times. The scope of application varies from the study of the characteristics of raw materials and products of its processing to the operational assessment of the current parameters characterising the state of the process equipment. The purpose of this study is to develop methods for obtaining information about the characteristics of mineral raw materials as a result of ultrasonic logging of wells in a rock mass. The proposed approach makes it possible to improve the quality of information support for the management of technological processes of mining and processing of ore and thereby improve the quality of products supplied to the metallurgical stage and reduce overall production costs.

Mohamed Mohamed, Amjad Hamza, Tarig Elzaki, Mohamed Algolam, Shiraz Elhussein
Solution of Fractional Heat-Like and Fractional Wave-Like Equation by using Modern Strategy

This paper introduces a novel form of the Adomian decomposition (ADM) method for solving fractional-order heat-like and wave-like equations with starting and boundary value problems. The derivations are provided in the sense of Caputo. In order to help under-standing, the generalised formulation of the current approach is provided. Several numerical examples of fractional-order diffusion-wave equations (FDWEs) are solved using the suggested method in this context. In addition to examining the applicability of the suggested method to the solving of fractional-order heat-like and wave-like equations, a graphical depiction of the solutions to three instructive cases was constructed. Solution graphs were arrived at for integer and fractional-order problems. The derived and exact solutions to integer-order problems were found to be in excellent agreement. The subject of the present research endeavour is the convergence of fractional-order solutions. This strategy is considered to be the most successful way of addressing fractional-order initial-boundary value issues in science and engineering. This strategy is presented here.

Janusz T. Cieśliński, Paulina Boroń, Maciej Fabrykiewicz
Stability Investigation of the PCM Nanocomposites

Ensuring the stability is a key issue to be solved for the technical application of nanocomposites. In this work, fatty acid P1801 served as base phase change material (PCM)P1801, and its main ingredients are palmitic acid (58%) and stearic acid (38%). Titania (TiO_2) and alumina (Al_2O_3) with mass concentrations of 1% and 5% were selected as nanoparticles, while polyvinylpyrrolidone (PVP) or oleic acid (OA) with mass concentrations of 5% were tested as surfactants. On the basis of the measured temperature distributions in the sample, which is subject to melting and solidification processes, it was determined which of the tested nanocomposites are stable and which are not. In addition, a thermal test was proposed to assess the stability of the produced nanoPCM, which consists in measuring the temperature distribution versus time according to a precisely given procedure.

Heiko Meironke, Thomas Panten, Martin Hayduk, Frieder Strubel
Development of a Test Rig for the Measurement of Small Wind Turbines in a Wind Tunnel

This paper describes the development, design and function of a test rig for the measurement of small wind turbines in a wind tunnel and presents the first exemplary measurements of the performance characteristics of various horizontal and vertical rotors. A central part of this test rig is the developed control system with an electronic load, which enables an automated recording of the measured values for the evaluation of the power coefficients (c_p) and tip-speed ratio (λ) values. Another challenge emerges owing to the known differences in the power spectrum, because the power coefficients of drag rotors (<20%) are different from those of buoyancy rotors (<40%). The system was adapted to the different ranges by means of a stepless switching using various resistors. The entire control and regulation unit was compactly implemented using a programmable logic controller (PLC) and dynamically linked to the operating parameters of the wind tunnel. This enables an automated operation of the wind tunnel during the determination of the performance parameters of the investigated wind turbines.

Nicol Daniela Jaramillo Rodríguez , Aline Luxa, Lars Jürgensen
Adaptation and Application of a Polarisation Curve Test Protocol for a Commercial PEM Electrolyser on Cell and Stack Level

The present study aims to develop a test protocol based on the literature for electrochemical characterisation of a polymer electrolyte membrane (PEM) electrolysis commercial stack using polarisation curves. For this, a 1-kW water electrolysis test stand with integrated temperature control and measurement systems was built around the stack. Afterwards, the stack performance was characterised under different operating pressure and temperature conditions by using polarisation curves. A measurement protocol was developed based on the literature. To ensure the reproducibility of the results, two rounds of experiments were performed. The experiments were carried out at temperatures between 20 and 60 °C and pressures up to 15 bar. The results show distinct regions in the polarisation curves related to the activation and ohmic overvoltage. The effect of temperature and pressure on the performance is shown and analysed. The performance of single cells in the stack is also measured. The stack polarisation curves are compared with those in the literature, which gives an understanding of the materials used in electrodes and types of membranes.

Michel Zierow, Leon Lesemann
Aerodynamic investigation on the artifact "Bird of Saqqara"

Lost, technical knowledge of ancient cultures is being rediscovered in modern times during archaeological excavations. A presumed example of the innovative power of ancient cultures is the artefact "Bird of Saqqara". In the context of this paper, the aerodynamic characteristics of the artefact are to be determined by a computational fluid simulation, in order to be able to make a statement about the actual flight suitability and to examine the theses of the pre-astronautics critically. Based on a 3D scan, a CAD model of the artefact is created and then a numerical flow simulation is performed. By varying the angle of attack, the dimensionless coefficients can be represented in corresponding polars. The results show that the artefact has a low maximum glide ratio and thus the glide properties are not sufficient for use as a handglider. The centre of gravity of the artefact is located at the trailing edge of the wing and behind the neutral point. The resulting longitudinal stability does not meet modern specifications. Asymmetric lift distribution in the spanwise direction results in uncontrolled roll. Consequently, the artefact cannot fly a straight path. Within the scope of this work, the connection between the "Bird of Saqqara" and an alleged knowledge of aerodynamics in ancient Egypt could not be confirmed.

Vladimir Morkun, Natalia Morkun, Vitalii Tron, Oleksandra Serdiuk, Alona Haponenko, Iryna Haponenko
Formation of Information Base for Controlling Settlement of Solid-Phase Ore Slurry Particles in a Thickener

Thickeners are process units that are often used at mining enterprises. There, they are involved in dehydration of mineral concentration products when water is removed from wet tailings containing metal concentrates. In mineral processing, large quantities of process water are used to separate different minerals from each other, so dehydration plays a major role in ore processing and preparation for concentration. This research aims to develop methods and tools of ultrasonic measurement of characteristics of settlement of solid-phase slurry particles and to assess their possible application to the automatic control system of the thickener to improve its efficiency.

Muhammad Amir, Jamil Abbas Haider, Shahbaz Ahmad, Sana Gul, Asifa Ashraf
Approximate Solution of Painlevé Equation I by Natural Decomposition Method and Laplace Decomposition Method

The Painlevé equations and their solutions occur in some areas of theoretical physics, pure and applied mathematics. This paper applies natural decomposition method (NDM) and Laplace decomposition method (LDM) to solve the second-order Painlevé equation. These methods are based on the Adomain polynomial to find the non-linear term in the differential equation. The approximate solution of Painlevé equations is determined in the series form, and recursive relation is used to calculate the remaining components. The results are compared with the existing numerical solutions in the literature to demonstrate the efficiency and validity of the proposed methods. Using these methods, we can properly handle a class of non-linear partial differential equations (NLPDEs) simply.

Mohammad Reza Seifi, Reza Alimardani, Seyed Saeid Mohtasebi, Hossein Mobli, Maumoud Soltani Firouz
A Supervisory Control System for Automation of Horizontal Form-Fill-Seal Packaging Plant Based on Modified Atmosphere Technology

The packaging industry is one of the most important parts of agricultural products processing. A popular method of increasing the shelf life of agricultural products is modified atmosphere packaging (MAP). The main objective of this paper was to increase the adaptability and flexibility of the machines for packaging of different vegetables including lettuces, broccolis, cabbages, cauliflowers, etc. To achieve this goal, a supervisory control and data acquisition (SCADA)-based system was designed and developed for controlling and monitoring of MAP process of fresh vegetables. The system was divided into three physical layers: field devices, remote terminal unit (RTU) and master terminal unit (MTU). For packaging width adjuster system, the R^2, maximum error (ME), mean absolute error (MAE) and root mean square error (RMSE) were obtained as 0.999, 8 mm, 2.96 mm and 3.44 mm, respectively. For packaging height adjuster system, the R^2, ME, MAE and RMSE were obtained as 0.994, 10 mm, 3.53 mm and 4.57 mm, respectively. The SCADA system can be able to accurately adjust the speed of the conveyor and the temperature of the sealing jaws, based on the desired values. For gas injection unit, the value of 1.66 L/min, 0.557 L/min and 0.667 L/min were recorded for ME, MAE and RMSE, respectively. Four types of trends including temperature, speed, flow and digital parameter trends were designed. In addition to displaying screen alarms, the occurred alarms are stored, automatically as a text file for troubleshooting. Finally, the results showed that the designed system can be reliably used for MAP of various varieties of fresh vegetables.

Piotr Gierlak
Neural Control of a Robotic Manipulator in Contact with a Flexible and Uncertain Environment

This article presents the synthesis of a neural motion control system of a robot caused by disturbances of constraints limiting the movement, which are the result of flexibility and disturbances of the contact surface. A synthesis of the control law is presented, in which the knowledge of the robot's dynamics and the parameters of a susceptible environment is not required. Moreover, the stability of the system is guaranteed in the case of an inaccurately known surface of the environment. This was achieved by introducing an additional module to the control law in directions normal to the surface of the environment. This additional term can be interpreted as the virtual viscotic resistance and spring force acting on the robot. This approach ensured the self-regulation of the robot's interaction force with the compliant environment, limiting the impact of the geometrical inaccuracy of the environment.

Damian Augustyn, Marek Fidali
Method of Machining Centre Sliding System Fault Detection using Torque Signals and Autoencoder

The sliding system of machining centres often causes maintenance and process problems. Improper operation of the sliding system can result from wear of mechanical parts and drives faults. To detect the faulty operation of the sliding system, measurements of the torque of its servomotors can be used. Servomotor controllers can measure motor current, which can be used to calculate motor torque. For research purposes, the authors used a set of torque signals from the machining centre servomotors that were acquired over a long period. The signals were collected during a diagnostic test programmed in the machining centre controller and performed once per day. In this article, a method for detecting anomalies in torque signals was presented for the condition assessment of the machining centre sliding systems. During the research, an autoencoder was used to detect the anomaly, and the condition was assessed based on the value of the reconstruction error. The results indicate that the anomaly detection method using an autoencoder is an effective solution for detecting damage to the sliding system and can be easily used in a condition monitoring system.

Amina Tahar Berrabah, Amina Attia, Daoudi Mohammed Habib, Djamel Ouzandja
Effect of Dam–Rock Foundation Interaction Modeling on the Modal Ratio-Related Quantity of Beni Behdel and `El Mefrouch Multi-Arch Dams

Using the Beni Behdel dam and the El Mefrouch dam as example studies, this paper intends to clearly demonstrate how modeling of the interactions between rock foundations and dams impacts the modal behavior of these two multi-arch dams. The uniqueness of this study is that the modal behavior of each dam is represented in terms of related parameters (period, participation factor, ratio, and effective mass), and more precisely in terms of ratio (defined as the ratio between the participation factor of the mode i and the maximum participation factor), as opposed to other works that have expressed this behavior in terms of frequency. In this article, stiff rock foundation, massless rock foundation, and massed rock foundation are the three methods used to simulate dynamic interactions. The investigated dams are three-dimensionally simulated using the ANSYS finite elements code. The modeling of the rock foundation–dam interaction has an effect on the fundamental mode value, its location, and the related parameters, according to the results. Furthermore, it is found that the upstream–downstream direction is not always the most important direction for dams and that interaction modeling influences the resonance bandwidth, which affects the forecast of the resonance phenomenon.

Amin Houari, Kouider Madani, Salah Amroune, Leila Zouambi, Mohamed Elajrami
Numerical Study of the Mechanical Behaviour and Damage of FGM Bent Pipes under Internal Pressure and Combined Bending Moment

The main objective of this work is the numerical prediction of the mechanical behaviour up to the damage of the bends of the functionally graded material (FGM) type ceramic/metal pipes. Firstly, the effective elastoplastic proper-ties of bent FGM pipes were determined using the homogenisation law by the Mori–Tanaka models for the elastic part and TTO (Tamura-Tomota-Ozawa) for the plastic part based on a rule of mixtures per function in the form of a power law. Our work also aims at the use of a meshing method (UMM) to predict the behaviour of the FGM by finite element in the mesh of the model. The analysis was performed using the UMM technique for different loading cases and volume fraction distribution. Two stages are necessary for the analysis of the damage: the first is the model of initiation of the damage established by the criterion of maximum deformation named MAXPE and the second is criterion of the energy of the rupture according to the theory Hillerborg used to determine damage evolution. Both stages involve a 3D finite element method analysis. However, for damage, the XFEM technique was used in our UMM method to predict crack initiation and propagation in FGM pipe bends. The results of the numerical analysis concerning the mechanical behavior showed, that if the nature of the bent pipes is in FGM, a good reduction of the various stresses compared to those where the nature of the pipe is metallic material. The results were presented in the form of a force–displacement curve. The validation of the proposed numerical methodology is highlighted by comparisons of current results with results from the literature, which showed good agreement. The analysis took into account the effect of the main parameters in a bent FGM pipe under internal pressure and bending moment on the variation of the force–strain curves.

Ewelina Ciba, Paweł Dymarski
Modelling of the Viscosity Effect of Heave Plates for Floating Wind Turbines by Hydrodynamic Coefficients

One of the methods of modelling the movement of floating wind turbines is the use of the diffraction method. However, this method does not take into account the influence of viscosity; therefore, in many cases, it needs to be extended with a matrix of appropriate coefficients. The effect of viscosity causes both the added mass coefficient and the damping coefficient to increase. The determined coefficients were entered into the ANSYS AQWA program, and the calculation results of the transfer function determined with the use of linear and quadratic damping were presented. The results were compared with the results of the experiment, indicating greater convergence for the quadratic model.

Jagoda Kurowiak, Agnieszka Mackiewicz, Tomasz Klekiel, Romuald Będziński
Material Characteristic of an Innovative Stent for the Treatment of Urethral Stenosis

The appropriate development and customisation of the stent to the urethral tissues requires the determination of many factors such as strength and degradation. Given the distinctive conditions of urethral tissues, it is important that the design of the stent be properly developed. The selection of a stent material requires knowing its material characteristics and verifying that they are suitable for the future implantation site. In the present study, the development of a polydioxanone (PDO)-based stent was undertaken. The PDO material was fabricated using an additive technique – 3D printing. Then, in vitro tests were performed to determine the degradation time of the material under conditions simulating an aggressive urinary environment. The changes in the parameters of mechanical properties before and after the degradation period were determined, and the changes in the structure of the material before and after degradation were observed. Numerical analysis was performed for the proposed stent design. The results showed that PDO has good mechanical properties, but its degradation time is too short to be used in a urethral stent. Among the innovations of the studies conducted are bending strength tests, which is not a frequently considered aspect so far.