Innovation Center of Faculty of Mechanical Engineering

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CNN 2018 TECH

„International Conference of Experimental and Numerical Investigations and New Technologies“

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MINISTRY OF EDUCATION, SCIENCE AND TECHNICAL DEVELOPMENT OF THE REPUBLIC OF SERBIA

Programme and The Book of Abstracts

04-06 July 2018

Zlatibor, Serbia

„International Conference of Experimental and Numerical Investigations and New Technologies“

CNN TECH 2018

04-06 July 2018

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Programme

and

The Book of Abstracts

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CNN TECH 2018

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We particularly wish to thank our sponsor, **The Ministry of Education, Science and Technological development**, Government of the Republic of Serbia.

PREFACE

Dear Friends and Colleagues, Welcome to CNN Tech 2018 Conference and the fabulous mountain of Zlatibor!

With 40 papers (17 by international authors) and contributions by authors from 11 different countries, International Conference of Experimental and Numerical Investigations and New Technologies CNN Tech 2018 successfully sets the high level for the future conferences. Participation of a large number of domestic and international authors, as well as the diversity of topics, justifies our efforts to organize this conference and contribute to exchange of knowledge, research results and experience of industry experts, research institutions and faculties which all share a common interest in the field in experimental and numerical investigations.

This year CNN Tech 2018 focuses on the following topics:

- Mechanical Engineering,
- Materials Science,
- Chemical and Process Engineering,
- Experimental Techniques,
- Numerical Methods,
- New Technologies.

Apart from a plenty of interesting lectures, the participants will have a chance to lighten up and communicate in friendly and relaxed settings.

Organizing committee of CNN Tech 2018 would like to express gratitude to Ministry of Education, Science and Technological development for financial support of the Conference.

On behalf of the Innovation center of Faculty of Mechanical Engineering, Faculty of Mechanical Engineering and Center for Business Trainings, we wish this to be splendid CNN Tech conference filled with many memorable moments.

PROGRAMME AND ORGANIZING COMMITTEE

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ABSTRACTS

Mechanical Engineering

J-INTEGRAL IN ELASTO-PLASTIC FRACTURE

Emina S Dzindo[1*]

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Abstract

The elastic-plastic fracture mechanics parameters evaluated in this paper, i.e. J-integral and CTOD, are not sensitive to calculation technique used. In other words, differences in their values, obtained by changing finite element techniques such as modelling the material behaviour and prescribing the loading, are not significant.

Application of the finite element method to the elastic-plastic fracture mechanics problem was in accordance with ESIS recommendations. Thus, the quadrangle eight-nodded isoperimetric finite elements were used, while the crack tip singularity was modelled by triangular elements with three independent nodes at crack tip and mid-side nodes and mid-side nodes. For the static load case, one should differentiate between the material behaviour, which is described as linearly elastic, and the material behaviour when the plasticity cannot be neglected. In the former case the linear elastic fracture mechanics (LEFM) applies, while in the latter case, depending on the form of the material plastic flow, various forms of elastic-plastic fracture mechanics were used.

The J-integral is path independent, as shown by its evaluation along six different paths, which is another proof of its correct evaluation. The basic aim of this paper is to contribute to the assessment of structural integrity of a cracked combustion chamber, i.e. cylindrical pressure vessel. Toward this end elastic-plastic fracture mechanics parameters were evaluated, which could serve as crack driving forces for any cracked structure. As the relevant parameters, the J-integral and crack tip opening displacement (CTOD) were chosen and evaluated by the elastic-plastic finite element method. The combustion chamber with an axial surface crack was represented as two-dimensional plane strain elastic-plastic finite element model, in a form of edge cracked plate loaded by remote tensile stress.

Keywords

Finite elements, pressure vessel, elastic-plastic fracture, J-integral, CTOD

HEAT AND ELECTRICITY PRODUCTION FROM BIOMASS

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Abstract

In this paper we explain basic principles of biomass energy transformation into heat and electricity. We propose technical system that converts biomass energy through process of combustion in furnace in order to warm the water or other fluid in order to produce heat, or which use steam turbine and generator of electrical energy in order to produce electricity. We give block diagram. Our aim is to develop small technical system that will serve as prototype. We are also interested in batteries development in order to store generated electricity, or to provide electrical energy directly to grid. This kind of technical system can be used as additional way of providing electrical energy in homes. This is so called hybrid energy concept, whereas additional form of electrical energy can be used any form of green energies - wind, solar, water, biomass or geothermal, or electricity from generators, accumulators or batteries.

Keywords

Biomass energy, technical system prototype, electrical energy generation, green energy

AUTOMATIC DETECTION OF CARBON MONOXIDE (CO) IN THE GARAGES OF RESIDENTIAL AND COMMERCIAL BUILDINGS

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Abstract

This paper presents the method of automatic detection of carbon monoxide (CO) concentration. The exhaust gases of the engine contain carbon monoxide toxic gas. Therefore, regulations stipulate that every closed garage must have an automatic detection system for carbon monoxide. It has no colour, taste, smell and air. It is cytotoxic for living beings, as it belongs to the group of chemical buffers and the biggest air pollutants (about 50 percent of poisoning in the world is from this gas).

The exhaust gases of internal combustion engines are one of the biggest atmospheric pollutants with this gas, then exhaust gases that occur during the production of iron, coal combustion in thermal power plants and in the process of production in oil refineries and the chemical industry.

The automatic detection system can detect at the same time and several different gases, with an adequate detector. Thanks to the new technology in the design of the central and gas sensors, the system has a high sensitivity and fast response. When the gas concentration reaches or exceeds the set alarm levels, the control panel immediately illuminates and activates the other outputs for the desired executive functions immediately and sounds.

Keywords

Control system, Automatic detection system, carbon monoxide.

Acknowledgement

This work is a contribution to the Ministry of Education, Science and Technological Development, Republic of Serbia funded project TR35013.

STATIC STRENGTH ANALYSES OF THE STEEL STRUCTURE OF BIOMASS RESERVOIR UNDER HYDROSTATIC PRESSURE

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Abstract

Subject of this paper is numerical analysis of the steel structure of biomass reservoir under hydrostatic pressure as well as additional loads. Reservoir was made from steel grade S235 and presents disassembly construction which contains eight walls of height of 5.5 meters placed on the floor in diameter of 10 meters. The floor is supported on eight legs along the scope and on the four center legs. Static strength analysis was performed by finite element method using 3D model obtained by the producer. Three load cases were analysed: a) hydrostatic pressure obtained by water to the height of 5 meters, b) hydrostatic pressure and snow force on the upper flange of 5.9 kN and c) hydrostatic pressure and biogas pressure on under flange of 8 mbar. Numerical results showed that the structure is not correctly defined. Maximal values of stresses are much higher than allowed for the steel S235, especially in the floor construction and on the joins between the walls and the floor. Reconstruction of the reservoir was suggested. The floor is reinforced by the under frame made from tubes of rectangle cross section and with additional supports in the central zone. These modifications gave lower values of the stresses. However, for use of full capacity of reservoir is necessary to increase thickness of steel cover of the floor and the walls on the height of 1 meter from the floor. Without any changes of the steel construction, producer decided to use reservoir with capacity of 1/5 of full (1m height of water) and moved prototype to farm where assembly of them started.

Keywords

Biomass, Finite Element Method, Hydrostatic Pressure, Static Strength Analysis, Biogas

Acknowledgement

The research work is funded by the Ministry of Education, Science and Technological Development of Republic of Serbia, Projects TR35045 and TR35031.

Invited lecture

NUMERICAL AND EXPERIMENTAL ANALYSIS OF STRENGTH OF STRUCTURAL ELEMENTS IN HYDRO - POWER PLANTS

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Abstract

In this paper is presented the summary of investigation about the numerical and experimental analysis of strength of structural elements in Hydro - power plants. The investigation contains numerical and experimental part. In the numerical part of investigation FEM will be applied for to obtain the values of stresses and strains in the specified spots and characteristic strips which will be recognized as critical places of the structural elements. In the experimental part of investigation, experiments will be conducted in both laboratory and exploitation conditions, to confirm the values obtained through the FEM. Investigation will be based on the three significant directions. These are:
1) values of stress and strain in the specified parts of the pipeline
2) values of vibrations and dynamic loads, in the turbine rotor, and shaft,
3) dilatations in the pipeline caused by temperature changes in the pipeline environment.

Keywords

FEM, stresses, strains, Hydro - power plants, experimental analysis

Invited lecture

THE SOLAR MEASUREMENT STATION FOR EXAMINATION OF THE THERMAL RECEIVER FOR SOLAR ENERGY

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Abstract

The use of renewable energy sources is becoming increasingly apparent, including solar energy, which is directly or indirectly the only source of life on Earth. Monitoring of the manifestation of solar radiation and the exploitation of this type of energy predominantly imposes the need to measure a number of parameters related to radiation itself, as well as radiation receivers and other devices of the system. Thermal receivers with liquid as a solar energy transmitter have now become consumer goods with a large number of manufacturers. Their examination is important with several aspects; from scientific research, for their further research and development, but also from the perspective of consumers, as they obtain reliable information on the quality of solar collectors, on the basis of which they choose the most optimal solution. The aim of the paper is to examine one design of the measurement station for testing solar collectors with all components, as well as presenting possible test methods according to the standard SRPS M.F5.050. The paper presents a solar measuring station where the described measuring devices are used for measuring the parameters in the operation of the solar thermal panel and give examples of the presentation of the processed results.

Keywords

Heat transfer, solar collector, measurement station, energy efficiency, solar energy

COMPARISON BETWEEN DIFFERENT CALCULATION PROCEDURES OF LOADS CAUSED BY TEMPERATURE DILATATION IN PIPELINES

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Abstract

The problem of loads caused by the temperature dilatations in pipes and its effect on strain and stress state of the entire pipeline is common problem in engineering practice. This paper describes three methods for calculation of loads that can occur in the pipeline caused by temperature differences. The study presented in the paper analysed the L shaped pipeline configuration with an operating temperature at 200°C, pipeline material P235GH, angle between legs of the L shaped pipeline is 90°, pipe dimension DN 300 and operating pressure is 10bar (absolute pressure). The calculation was presented according to standards EN 13480-3 and AD 2000 and Russian method commonly used in engineering practice. The three methods have different engineering approaches for solving the same type of the problem, so the specific differences were presented in the paper. All the results are presented in unified tables for easier comparison and analysis. It can be conducted that all three presented methods showed similar results and choosing the most suitable one for the practical application is mainly determined by the type of the result needed for the specific application.

Keywords

Temperature dilatation; L shaped pipeline configuration; standards, EN13480-3; AD 2000; Russian method

Invited lecture

INNOVATION MANAGEMENT- LEAN ENTERPRISE

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Abstract

Management is highly important function in today's dynamic business environment. Many historical milestones have shaped management process. Some of these are the Industrial Revolution, Bessemer process, scientific management, serial production at Ford's factories, the human relations movement, management science, reengineering, flexibility, computer age, time-based competition, global marketplace, and environmental issues. Globalization enabled creation of global supply chains, creation of new world-class organizations and unions and brought great competition. International trade barriers have fallen. And new trade agreements have created.

The aim of this paper is to present lean approach as a modern production system developed by Toyota Motor Corporation in order to ensure best quality, lowest prices and shorter preparation periods by eliminating unnecessary costs. Toyota managers shifted the focus of the manufacturing engineer from individual machines and their utilization, to the flow of the product through the total process. They concluded that by right-sizing machines for the real volume needed, introducing pull production system, self-monitoring machines to ensure quality, lining the machines up in process section, and having each process step notify the previous step of its current needs for materials.

Keywords

Innovation management; Lean approach; modern production system

IDENTIFICATION AND RECOGNITION OF VEHICLE ENVIRONMENT USING ARTIFICIAL NEURAL NETWORKS

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Abstract

Object detection using deep learning over the years became one of the most popular methods for implementation in autonomous systems. Autonomous vehicle requires very reliable and accurate identification and recognition of surrounding objects in real traffic environments to achieve decent detection results. In this paper, special type of Artificial Neural Network (ANN) named Convolutional Neural Network (CNN) was used for identification and recognition of surrounding objects in real traffic. The new model based on CNN was trained and developed to be able to identify and recognize 4 different classes of objects: cars, traffic lights, persons and bicycles. The developed model has shown 94.6% accuracy of object identification and recognizing on the test set.

Keywords

Artificial Neural Networks, Convolutional Neural Network, Object Detection, Vehicles Environment

DESIGN STUDY OF THE DIFERENT METAMATERIAL SHAPES

Boris Kosic[1], Misa Stojicevic[1], Zorana Jeli[1], Branislav Pokonstantinovic[1], Aleksandra Dragicevic[1]

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Abstract

Different geometry of metameterials has ability to withstand a certain level of deformation, and is used to replace joints in certain assemblies of technical systems. Using this characteristic of metametrials, all movements could be accomplished with deformation of technical system structures.
This paper cover examination on two different kind of geometry structure of metamaterials, regular and irregular octagon, and the influence of their geometrical structures, as a new concepts for formation of technical systems. A larger number of simulations have been conducted by changing internal structure and orientation of metamaterials. Also, those metametarials have been used on some of the model of pliers. Further, the pliers models were simulated, and results were compared with the results from previous simulations. For each simulation the results were presented as stresses and displacements with the same load, but different direction of force. SOLIDWORKS 2016, as a powerful tool for this kind of analysis, had been used for simulation, design of the 3D models and whole study. The results obtained from simulations, using design study, define the level of deformation which structures can withstand, and therewithal, they gave the ideas for methodology of the concept for preparing geometry of metametrials.

Keywords:

3D model, metamaterial, design study, Solid Works, simulation

Acknowledgement

This work was financially supported by the Ministry of Science and Technological Development of the Republic of Serbia through project No. TR 35011.

THE NEW METHOD FOR REMOVING HIGHLY CORRELATED VARIABLES FROM DATASETS

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Abstract

Reducing of the data dimensionality is necessary and required for optimal model performance in machine learning. Two different approaches, frequently used in practice to solve this problem, were considered with the aim to build the new one. The basic idea of the first approach is to reduce dimensionality by removing highly correlated variables which implies that multiple variables measure the same characteristic of a phenomenon that has been observed. It is done by removing all variables with high average correlation. In this way, variables are removed regardless to its significance to model accuracy, and as a result model accuracy can noticeably drop.

The second approach implies necessary quantification of variable impact on model outcome and to sort them according to these values for the better understanding of the data, relationship between variables and the model outcome. By using this approach, variables with lowest importance are removed from the data set, and can lead to an increasing in the performance and accuracy of the final model.

In the datasets with the highly correlated variables (e.g. sets of spectroscopy data), the most important variables can be with the highest average correlation, and after removing those variables the accuracy of the model can be significantly reduced. Based on the previous facts, the new method that uses the most important variables with lowest correlation is proposed, as a combination of the previous two approaches. The main idea of this approach is to notably reduce dataset dimensionality using the variables that have small correlation and where the accuracy remains high.

Keywords

Machine learning, highly correlated data, variable importance, data dimensionality

Materials Science

ANALYSING SAMPLES AND SPECIMENS IN DENTAL BIOMECHANICS

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Abstract

In vitro experiments include proper materials whether human's or humans' substituents to avoid invasive clinical procedures. In such cases, researchers can use blood, urine or some other stuff but try to close in vitro conditions to in vivo-physiological conditions as much as possible. Following study intended to show examples of the samples and specimens application in dentistry research field with biomechanical consideration. In experimental investigation, specimen is considered as an individual issue that represents a class while sample is a part of anything taken or presented for inspection, or shown as evidence of the quality of the whole. The aim of this report was to represent differences between sample and specimen in dentistry research and to show the possibilities of biomechanical investigation of these materials used for in vitro setup. In dental biomechanics, cadaveric teeth and bone, bone substituents artificial membrane, strips/bands, saliva and replacements made for various indications can be used for the purpose of biomechanical analysis. Determination and measuring of strain in these biomaterials was the main criterion in the interpretation of the results presented in this biomedical report. Differences were shown in the methodological approach involved preparation of specimens/samples and loading conditions. Findings provide that all of these tissues and artificial organs can serve for investigations in dental biomechanics if adequate conditions are conducted. Nevertheless, human cadaveric tissues were found to be the best choice when considered achieving of physiological conditions.

Keywords

Biomaterials, dental samples, biomechanical analysis, cadaveric specimen, artificial organs and tissues

TGA AND DTA ANALYSIS OF SOFT CONTACT LENSES BASED ON POLY (HYDROXYETHYL METHACRYLATE) AND FULLERENES

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Abstract

Hydrogels have emerged as effective materials for variety of applications due to unique network structure that enables very high levels of hydrophilicity and biocompatibility. Hydrogels based on 2-hydroxyethyl methacrylate (HEMA) are of a great interest in biomedical applications. Hydroxyethyl methacrylate based hydrogel lenses are still the most popular type of soft contact lens. The aim of this paper is comparative thermal stability study of the basic material and nanophotonic materials synthesized by the company Soleco (Milan, Italy). The basic and nanophotonic materials for soft contact lenses were obtained using radical polymerization of 2-hydroxyethyl methacrylate respectively i.e. 2-hydroxyethyl methacrylate and fullerene, fullerol andfullerene metformin hydroxylate, respectively. Fullerenes were used due to theirs unique structure and properties. For soft contact lenses thermal analysis, Differential thermal analysis (DTA) and Thermo gravimetric analysis (TG) were used. The thermal properties of all four materials were examined. Results have shown that the thermal stability of nanophotonic materials is significantly improved comparing to the basic material. Further research is necessary to show if it is possible to develop a new generation of materials for soft contact lenses.

Keywords

Fullerenes, HEMA, soft contact lenses, nanophotonic materials, thermal analysis

Acknowledgement

The authors are grateful to Optix (Belgrade, Serbia) and Soleko (Milano, Italy) for providing the material used in this study.

EXPLORATION OF THE CHANGES OF PROPERTIES OF WATER VAPOUR RESISTANCE OF CO/PES FABRICS DURING MAINTENANCE

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Abstract

Human thermal comfort depends on the combination of clothes, climate conditions and physical activity. Clothing maintenance by washing affects its diffusion and thermal properties. Water vapour permeability and thermal resistance of clothing are key parameters for the assessment of clothing during exploitation – wearing. The paper examined the interrelatedness of physical, mechanical and thermo physiological properties of fabrics as well as changes of a thermo physiological property – water vapour resistance (R_{et}) during washing of 6 fabrics used for making clothing assemblies (for particular conditions of application). Standard methods were applied for examining physical and mechanical properties of fabrics, whereas hot plate measurements were used for testing water vapour resistance (R_{et}). The obtained results indicated that certain properties yarns used in the production of fabrics and constructional characteristics of fabrics significantly affect the water vapour resistance and its changes during washing. The results were used for establishing a mathematical model for predicting the behaviour of the fabrics during washing that are used for a particular clothing assembly in the phase of exploitation – wearing.

Keywords

Textile materials, water vapour resistance, thermal resistance, hot plate, thermal comfort

EXPERIMENTAL STUDY OF TEXTILE DEFORMATION USING 3D DIGITAL IMAGE CORRELATION METHOD

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Abstract

Textiles are unique due to their structure and formability properties. In order to predict the behaviour and properties of textile materials, standard investigation methods are not always sufficient. In this paper, a more detailed study is performed and additional results were obtained when the 3D Digital Image Correlation (DIC) method was adjusted to the standard test method. The digital image analysis method is one of the newly proposed methods used to determine textile deformation behaviour. It is possible to capture the formation of localized deformation zones, besides capturing the deformation of the woven fabric. The procedure of digital video camera recording is simple, but preparation and processing on a computer are relatively demanding concerning processing time and data preparation for analysis. The processing time for displacement calculation depends on the image resolution, number of images, chosen area sizes on images for analysis, number of facet centers and characteristics of the computer used for results processing. Obtained results are adequate and satisfy the requirements of accuracy applied to material science. Therefore, the application of the image analysis method for the investigation of deformed textile materials is possible.

Keywords

Textile, deformation, 3D Digital Image Correlation Method

Acknowledgement

This research was supported by Ministry of Education, Science and Technological Development of Republic of Serbia under Projects TR35031 and TR35040.

IR SPECTROSCOPYOF THE HIGHER FULLERENE C_{84}-D_2:22 FOR ITS QUALITATIVE AND QUANTITATIVE DETERMINATION

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Abstract

The stable isomer of the higher fullerene C_{84} of D_2 symmetry was isolated from carbon soot by the new and advanced extraction and chromatographic methods and processes. Characterization of the isolated C_{84}-D_2:22was performed by the FT-IR(KBr) method, over the relevant region from 400 to 2000 cm^{-1}, in the absorption mode. A series of various characteristic, dominant and new absorption maxima of this fullerene was registered and confirmed. All the observed infrared absorption bands are in excellent agreement with the theoretical calculations for this molecule. The molar absorptivity, ε, as well as the integrated molar absorptivity, ψ, of its IR absorption bands were determined in adequate and different spectral regions. These results are significant for the qualitative and quantitative determination of the C_{84}-D_2:22 fullerene either in natural resources in space and on the Earth or in artificially synthesized materials, electronic, optical and biomedical devices, polymers, composites, catalysts, nanowires, batteries, sensors, optical limiters, solar cells, nanophotonic lenses with improved optical absorption characteristics, refraction features and wettability, diagnostic and therapeutic agents, pharmaceutical substances, such as for diabetes, targeted drug delivery, in biomedical engineering, applied optics and industry and so forth.

Keywords

Higher fullerene C_{84}-D_2:22, IR spectroscopy, molar absorptivity, integrated molar absorptivity

Acknowledgement

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Chemical and Process Engineering

ASYMPTOTIC STABILITY OF SINGULAR TIME DELAY SYSTEMS: LYAPUNOV'S APPROACH BASED ON JENSEN'S AND COPPEL'S INEQUALITY

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Abstract

In this paper, the asymptotic of linear continuous singular time-delay systems is studied. By using suitable Lyapunov-like function and Jensen's and Coppel's inequality, a asymptotic condition is derived as a set of algebraic inequalities. In that sense the concept of simultaneous stability and attractiveness is extended to singular time-delay systems and some conditions have been derived using two approach based on the classical aggregation functions defined on the space of consistent initial conditions: classical and LMI approach. The first approach is based on the algebraic matrix transformations, while the second approach uses the linear matrix inequalities. LMI approach provides a simple numerical solution and does not impose additional restriction on the state vector. The comparison of this method with some previous one is done and it has been showed that the numerical computation is reduced. Numerical example is given to show the effectiveness of the proposed approaches.

Keywords

Singular linear time delay systems, Asymptotic stability, Subset of consistent initial conditions, LMI methods.

Acknowledgement

This research was partially supported by the Ministry of Sciences and Technology of Republic of Serbia - Mathematical Institute SANU Belgrade Grant OI 174001: 'Dynamics of hybrid systems with complex structures - Mechanics of materials' University of Belgrade, School of Mechanical Engineering.

LYAPUNOV STABILITY OF DISCRETE DESCRIPTOR DELAYED SYSTEMS: APPROACH BASED ON CONVOLUTION AND JENSEN'S INEQUALITY

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Abstract

In this paper, the asymptotic of linear discrete descriptortime-delay systems is studied. By using suitable Lyapunov function defined on the subspace of consistent initial conditions, discrete form of convolution integral and Jensen's inequality, a asymptotic condition is derived as a set of algebraic inequalities. In that sense the concept of asymptoticis extended to discrete descriptor time-delay systems and some conditions have been derived using two approach based on the classical aggregation functions defined on the space of consistent initial conditions: classical and LMI approach. The first approach is based on the algebraic matrix transformations and discrete version of convolution integral, while the second approach uses the linear matrix inequalities. LMI approach provides a simple numerical solution and does not impose additional restriction on the state vector. In both cases only sufficient conditions were derived. The comparison of this method with some previous one is done and it has been showed that the numerical computation is less complicated.

Keywords

Discrete descriptor time delay systems, Asymptotic stability, Subset of consistent initial conditions, LMI approach.

Acknowledgement

This research was partially supported by the Ministry of Sciences and Technology of Republic of Serbia - Mathematical Institute SANU Belgrade Grant OI 174001: 'Dynamics of hybrid systems with complex structures - Mechanics of materials' University of Belgrade, School of Mechanical Engineering.

PHASE CHANGE BIODEGRADABLE MATERIALS BASED ON ORGANICALLY MODIFIED CLAY, PARAFFIN AND WASTE FATTY ACID (MONG)

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Abstract

Phase change materials (PCMs) are gaining more interest in systems of saving and rational disposal of energy in buildings, air conditioning, agriculture, industry, medicine, etc.In this paper, the mixtures that were analysed for thermal energy storage are also having biodegradable properties. The mixturescomponents are organically modified clay, paraffin and waste glycerine distillation resin (MONG- Matter Organic Non-Glycerol). MONG contain a mixture of fatty acid methyl esters, ethyl esters, free fatty acids and glycerides. Paraffin mixtures have a higher evaporation pressure of most esters, making them more susceptible to weight loss and changes in physical properties due to evaporation. Esters are more stable mixtures that do not lose weight during heating.

In this paper, the samples cooling process at isolated conditions lasting up to 8 hours was examined. The starting temperature was 80°C. A mixture of MONG, modified clay and paraffin in a mass ratio of 1: 1: 1 proved to be more favourable while after 3 hours the temperature dropped to 40°C. The combination of MONG and modified clay at mass ratio 1:1 and pure MONG is more unfavourable because the temperature dropped to 40°C after 2 hours. The FTIR bands indicated the presence of appropriate chemical groups.

The combination of paraffin, MONG and organically modified clays has slower cooling but also slight discontinuity during cooling, while MONG, in combination with organically modified clay, cools faster but gives a continuous flow of cooling without singularity. The economically more effective mass ratio of MONGs and organically modified clays is 2: 1. This combination is suitable for encapsulation in appropriate geometric shapes for application in industry, construction, agriculture and medicine. The advantage of this combination is biodegradability and low price of MONG and organically modified clay.

Keywords

Phase change materials; Thermal energy storage; MONG; Organically modified clay; Biodegradable mixture

Acknowledgement

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Invited lecture

POSSIBILITY FOR REMOVING PRODUCTS OF THERMAL DEGRADATION OF EDIBLE OIL BY NATURAL ALUMINOSILICATES

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Abstract

Everyday food preparation often involves cooking on vegetable oil, where heating at temperatures over 110°C changes the quality of oil due to various chemical reactions. In this paper, the degree of thermal degradation of edible oil was investigated when heating oil at a temperature ranging from 110 to 190°C for 10 and 30 minutes. The reference to the quality of edible oil is the content of free fatty acids (FFA) which increases as the temperature rises, due to hydrolysis.

By removing the thermal degradation products of the edible oil used, it would be possible to prolong the time of use of the oil for other useful purposes, and thus its final disposal as waste, would be postponed, which is in accordance with environmental protection requirements. In line with this, the possibility of adsorption of FFA on natural aluminosilicates was investigated. The results obtained show a decrease in FFA content of 72 to 80 %, depending on the time of warming and the type of adsorbent used.

Further research should be continued on the regeneration of used edible oil by testing other quality parameters, as well as the application of other adsorbents.

Keywords

Edible oil, thermal degradation, free fatty acids (FFA), adsorption

Invited lecture

APPLICATION OF 3D DIGITAL IMAGE CORRELATION METHOD IN PROCESS ENGINEERING

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Abstract

Process engineering encompasses diverse industrial fields, such as chemical, petrochemical, pharmaceutical, biotechnological etc., and pressure equipment is an indispensable part of every industrial plants. Due to wide range of applications, pressure equipment comes in different shapes, from simple to very complex, and can be subjected to different loadings in its working life (static, dynamic, thermal etc.) so the knowledge of mechanical behaviour is of great importance. This paper presents several examples of application of 3D Digital Image Correlation method (3D-DIC)for simple shaped objects, as well as for geometrically complex structures. A 3D Digital Image Correlation method is an optical method that overcomes the limitations of conventional methods and enables full-field displacement and strain measurement. Aramis system was used for the experimental analysis. Welded joint standardized specimen is used as an example for simple shaped object. For geometrically complex structure, several examples are used: globe valve housing with distinctive sphere/cylinder intersection, cylindrical horizontal pressure vessel with cylindrical nozzles and T joint pipe. Experimental results demonstrate that the 3D-DIC method is adequate for solving geometrically complex problems and provides an opportunity for further development and improvement for practical industrial application.

Keywords

3D Digital Image Correlation method; von Mises strain; Process Engineering; pressure equipment; welded joints;

Acknowledgement

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TGA-DSC-MS ANALYSIS OF PYROLYSIS PROCESS OF VARIOUS BIOMASSES WITH ISOCONVERSIONAL (MODEL-FREE) KINETICS

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Abstract

Pyrolysis process of three different solid biomass samples (hazelnut shell (HS), sawdust (Beech), and sawdust chemically treated (SDCT)) were analysed by simultaneous thermal analysis (STA), coupled with mass spectrometry (MS). Thermal decomposition of these samples was performedand three stages of the pyrolysis process was identified as removal of water, devolatilization, and formation of bio-char. Thermal behaviour of the samples shows the distinctions during the decomposition process related to differences in the sample structure. Regarding to mass spectrometry analysis the main gaseous products released during pyrolysis were identified as H_2, CH_4, H_2O, CO_2 (C_3H_8), CO, and C_2H_6. According to performed characterization and analysis, it was shown that (HS) could be a good combustion fuel, since that during its pyrolysis at high temperature, a more gaseous products compared to other systems, are very favoured. Kinetic analysis based on obtained experimental data were performed with Isoconversional (model-free) method in order to determine variation magnitudes of effective activation energy (Ea) values on conversion fraction (α) during pyrolysis. The variations of Ea with α arise from the different chemical structures among cellulose, hemicelluloses and lignin in tested samples that may affect their effective activation energies.

Keywords

Biomass, Volatilization, Model-free, Pyrolysis mechanisms, Devolatilization index

Acknowledgement

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MATHEMATICAL MODELLING AND PERFORMANCE ANALYSIS OF A SMALL-SCALE COMBINED HEAT AND POWER SYSTEM BASED ON BIOMASS WASTE DOWNDRAFT GASIFICATION

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Abstract

The paper presents a simple mathematical model for designing, optimizing and simulating small–medium CHP scale plant with use of biomass waste downdraft gasification.
A downdraft gasifier has been used as the starting point in the study, due to its low tar content and effective way of using heat in the engine's exhaust gases to dry and pyrolyze the different solid biomass waste. Hot water from the cooling circuit of the engine and from producer gas cooling is directly used for the district heating network, air or steam preheating.
The mathematical model includes modelled components as a downdraft gasifier, an internal combustion engine using the characteristic equation approach method.
The mathematical model enables the outputs of the plant to be evaluated and calculated for different types of biomass and operating conditions. The results demonstrate that it is a useful tool for assessing the performance of CHP plants using several types of biomass waste and enables comparisons to be made between operating conditions for real applications.

Keywords

Biomass, downdraft gasification, CHP

Experimental Techniques

RESEARCH OF LEAN PREMIXED COMBUSTOR BY CHEMILUMINESCENCE TOMOGRAPHY

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Abstract

Investigation of combustion of lean premixed flame in a swirl combustor is performed numerically and experimentally. The flame structure was monitored using CH chemiluminescence imaging. The complex chemically reacting turbulent flow with strong swirl and shear is analysed. The images of axially symmetric flame are acquired and the flame structure investigated, particularly looking for the position of flame front. The position of flame front, which is the area with highest exothermic chemical reactions, is deduced from acquired images. To identify the zone of flame front on the basis of two dimensional image of flame, which is actually three dimensional, the method of image tomography is applied. The tomography of the acquired images is numerically performed using the Abel transform. The in-house developed numerical Abel transform is used to get tomograms. The obtained tomograms enable precise positioning of the flame front and confirm the validity of results of numerical investigation of swirl combustion.*

Keywords

Premixed Flame, Swirl Combustor, Chemiluminescence, Tomography, Abel Transform.

BIOMECHANICAL BEHAVIOR OF RESIN BASED CEMENTMAXCEM ELITE

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Abstract

Resin based cements (RBCs) have become very popular in dental practice for cementation of dental restorations, especially considering all-ceramics, due to improved adhesion features. However, one of the major concerns for the clinical performance of resin based cements is the polymerization shrinkage i.e.strainthat accompanies the chain-growth polymerization of dimethacrylate monomers. Also, RBCs can produce a considerable amount of heat, due to the light energy from the curing lights and exothermic reaction of polymerization.

The purpose of this study was to determine the temperature changes during the photo-polymerization using thermocouples and to measure strain field of the self-etching, self-adhesive RBC, Maxcem Elite (Kerr, Orange, CA, USA) using 3D optical system Aramis 2M (GOM, Braunschweig, Germany) based on Digital Image Correlation method. Three ø5×2 mm sized and three ø5×1 mm samples of Maxcem Elite were prepared by filling teflon ring-type moulds. Digital images were recorded immediately after photo-polymerization of the samples with a LED-curing unit for 20 s, according to manufacturer's recommendation. All measurements were performed at room temperature. Temperature curves indicated similar patterns. DIC showed that peripheral zone of the samples had the highest strain values in both groups. All the results were material-dependent and probably correlated to the composition of each material, which is not fully disclosed by the manufacturers.

Key words

Resin based cement, Maxcem Elite, thermocouples, strain, 3D Digital Image Correlation

Acknowledgement

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IMPACT OF DENSITY OF POLYURETHANE FOAM ON ABSORPTION POWER OF ENERGY ABSORBER

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Abstract

Safety of railway vehicles is one of the most importance steps in developing and design of them. Passive safety elements have a role to reduce consequences of collision to a minimal by absorbing collision kinetic energy. Applying a proper standard and adequate design of railway vehicle structure has a direct impact on safety of railway traffic. One of many ways for collision energy absorption is the tube energy absorber which works on the principle of shrinking the foam filled tube passing through special cone bushing. Fill made from high density polyurethane has a role to increase deformation resistance during elastic-plastic deformation of the tube. Seamless tube was made from low carbon steel while the cone bushing was made from quench and tempered carbon steel. This type of absorber is designed to install in a line (behind) with standard buffer. Using this type of absorber energy absorption occurs by elastic-plastic deformation of the tube, friction between the tube and cone bushing and pressing of the foam. With the aim to show influence of the density of the foam on absorption power, experimental investigations of tubes filled by polyurethane foam of different density were done. Results of experimental investigations show that increase of density gives higher deformation resistance as well as higher absorption power. Further investigations will be directed to improve of absorption characteristics by chose a most acceptable density of foam.

Keywords

Railway Safety, Passive Safety, Foam Filled Seamless Tube, Experimental Investigations, Polyurethane Foam

Acknowledgement

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STRUCTURAL OPTIMIZATION OF PRESSURE VESSELS USING FEA

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Abstract

The main aim of many researchers is to solve the problem of shape optimization of the pressure vessels in order to save materials and energy during manufacturing, but preserve reliability during exploitation. Structural optimization of several parameters that have main impact on stress, strain and deformation stateof the pressure vessels is presented in this research. Modern approach of stress and strain analysis on pressure vessels involves numerical and experimental testing. Experimental 3D Digital Image Correlation (DIC) method for analysing full field of surface strain and stress including camera system in combination with Aramis software was used. After determination of areas with highest von Mises stresses and strain concentrations, numerical analysis of equivalent 3D model was performed in Ansys Workbench software. Results in critical areas were compared and they showed good agreement. Then, several parameters were chosen for optimization in order to reduce stresses and mass weight of pressure vessel. Response Surface Optimization (RSO) method was used to optimize geometry of the pressure vessel parts (shell, head and nozzles). It is shown that carried out optimization gives the minimum weight of pressure vessel with optimized wall and nozzle thicknesses for the given load.

Keywords

Structural optimization, pressure vessel, digital image correlation method, finite element analysis, response surface optimization method

Acknowledgement

This research was supported by Ministry of Education, Science and Technological Development of Republic of Serbia under Projects TR35031.

EXPERIMENTAL MEASUREMENTS OF THE STRESSES IN THE LOWER LINK OF THE THREE-POINT HITCH MECHANISM

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Abstract

Agricultural machines and their implements are subjected to dynamic loads during farm operations. Depending on the type of operation (e.g. lifting or plowing), lower links of the three-point hitch mechanism are exposed to stresses caused by combination of bending moments and axial forces. In this paper we analysed influence of the soil resistance during plowing on the lower link and the possibility of its failure. The stresses were measured using strain gauges at locations with uniform stress distribution in order to enable more reliable comparison with finite element analysis (FEA). Recorded stresses vs. time were used for identifying mean stresses and amplitudes for different plowing depth and different tractor speeds. Due to the geometry of the lower links and their joints in the three-point hitch mechanism, during plowing and transferring soil resistance, links are loaded not only by axial forces but also by bending moment in the horizontal plane. Under some assumptions, FEA provided us to make relations between the measured stresses and the loads that caused them. Measured stresses show that links have significant safety margin relative to tractor installed power and soil resistance, which enables the possibility of their design optimization. Obtained results may also serve for further analyses of fatigue life prediction, measurement of the draft forces etc.

Keywords

Three-point hitch mechanism, lower link, stress state, strain gauges, finite element analysis

Acknowledgement

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MULTIPARAMETER STRUCTURAL OPTIMIZATION OF PRESSURE VESSEL WITH TWO NOZZLES

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Abstract

Structural analysis of pressure equipment (vessels) has always been a huge challenge for researchers. Pressure vessels are usually subjected to different loads in exploitation and small defects can lead to failure of the equipment, which may result in loss of life, health hazards and damage of property. Modern approach of stress and strain analysis of the influence of welded nozzles on pressure vessels involves numerical and experimental testing. In this research, 3D Digital Image Correlation (DIC) method for analysing full field surface strain and stress, including camera system in combination with Aramis software, was used. After determination of critical areas with highest von Mises stresses and strain concentrations, numerical analysis of equivalent 3D model was performed in Ansys Workbench software. The aim of this paper is to present detailed parameter optimization of pressure vessel with two nozzles based on finite element analysis (FEA) of the structure. Several geometrical parameters were varied to obtain the optimum geometry of the pressure vessel, capable of withstanding the service load without plastic deformation. It is shown that carried out optimization gives the minimum weight of pressure vessel with optimized wall and nozzle thicknesses for the given load.

Keywords

Pressure vessel, Digital Image Correlation method, finite element analysis, optimization, response surface method

Acknowledgement

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STRAIN MEASUREMENT SETUP OF COMPRESSIVELY LOADED MANDIBLE MODEL WITH TEETH AND COMPENSATIONS

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Abstract

In this study, the setup for strain measurement of loaded mandible model with teeth and compensations is presented. During mastication, bite forces exert compressive loads on mandible and teeth. If compensations are present in a patient, failure might occur on tooth-compensation contact due to inadequate processed tooth design resulting in uneven strain distribution. Difference in hardness of teeth and compensations has an additional impact on failure at the location of contact. Obtaining strain field underneath the teeth in ‘’in vitro’’ measurement is substantial in predicting possible failure.
Strain field was measured using contactless optical 3D system ARAMIS 2.0.Aset consisting of two accurately correlated cameras allows recording of relative movement, based on which the strain field was obtained. Proper calibration of the device is substantial for acquisition of results. Mandible models are manufactured using additive technology, allowing for versatile and repeatable results compared to previous researches which included cadaver mandible models. Compensation caps of different design are all made of CoCrMo alloy. Loads are transmitted through a vise, in a force range of 0-150N. Dynamometer is used for applied force measurement. Developed experimental setup allows for application of different cap designs on different set of teeth. Results show how this setup enables comparison of influence of different shapes of compensation and teeth on strain distribution.

Keywords:

Dental, Mandible model, Strain field, Optical 3D measurement, ARAMIS 2.0

Acknowledgement

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Numerical Methods

DETERMINATION OF FRACTURE MECHANICS PARAMETERS OF STRUCTURAL COMPONENTS UNDER THERMOMECHANICAL LOADS

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Abstract

Aircraft structural components of general turbine and wing skin in high Mach number flow are important components. It operates at high temperature and under conditions of extreme environmental attack such as oxidation, corrosion and wear. During the service of turbine, components suffer from initiation and increasing tip cracks. These conditions can cause cracking of structural components. The failure damage modes of turbine are classified in terms of main components as flow path parts, rotating such as rotor, groove, disk, and blade. Aero-engine turbine components such as disks and blades are susceptible to environmentally assisted cracking. Unlike fatigue crack growth, this involves crack growth under constant load. If the crack grows long enough, sudden failure can occur with catastrophic consequences. It is therefore desirable to identify the limiting crack size within fixings so that they can be inspected at regular intervals and removed from service before failure occurs. Three dimensional axi-symmetric finite element models were created to simulate a turbine disc and the portion of a blade. The finite element method allowed the prediction of the point of crack initiation and the crack growth using the orientations of the maximum principal stresses. Stress intensity factor (SIF) is the base parameter in strength analysis regarding fracture mechanics. For correct determination SIF in this paper, combining J-integral approach and FEM is used. J-integral is path independent integral around the crack tip.

Keywords

Fatigue, thermomechanical loads, cracked components, fatigue crack growth, low-cycle fatigue, SIF

Acknowledgement

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AN OPEN SOURCE SOFTWARE LIBRARY FOR COMPUTATIONAL CONTINUUM MECHANICS

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Abstract

The paper describes development of an open-source library for computational fluid dynamics and in general computational continuum mechanics. The code is based on finite volume method on arbitrary unstructured polyhedral meshes. The interfaces to highly abstract data types such as arbitrary order tensor fields on discretized finite volume domains, and scalar and vector sparse linear systems resulting from finite volume discretization of partial differential equations are provided. Explicit manipulation of tensor fields through high level, highly abstract programming syntax is explained. Also, implicit operation over tensor fields pertinent to discretization of partial differential operators is provided and explained. The library is developed in modern version of Fortran. Code parallelization is achieved through domain decomposition and implemented using MPI and Open MP. While avoiding the usual class syntax of object-oriented programming, the code has essentially object oriented design .Comparison is made with the well-known Open FOAM library. The purpose of the ongoing development is providing researchers with a tool for easy transfer of mathematical operations of their physical models into functional and efficient simulation software based on finite volume method. The guiding principle of development is exchange of ideas and reproducibility in computational science in general.

Keywords

Engineering Software, Computational Fluid Dynamics, Finite Volume Method, Parallel Computing, High-Performance Computing

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APPLICATION OF FINITE ELEMENT METHOD FOR DETERMINATION OF AXIAL LOAD ON CONVEYOR WING ROLLERS

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Abstract

The impact of the axial load is often completely neglected in the design of the conveyor idlers (rollers) testing machines. The subject of the present research is focused primarily on the conveyor idlers load determination by numerical simulation of the contact between the conveyor belt and idlers. A nonlinear theory of the finite element method is applied, taking into account the effects of large displacements and the contact problems. The basic information required for the presented calculation was the modulus of elasticity of the conveyor belt in the lateral direction. An experimental apparatus in accordance with the DIN 22102 standard was developed and used to determine the load representative value. The adopted approach to the numerical modelling was initially checked by the simulation of the designed experimental testing. A significant match of the results confirmed the applicability of the presented approach to the modelling of the considered problem. The axial load on the wing (side) idlers is generated only during the partial loading of the conveyor. It has considerably high intensity only until the conveyor belt touches the horizontal idler. Applying the gradually increasing load on the conveyor belt in the numerical model and monitoring the vertical distance between the belt and the horizontal conveyor idler, the exact moment of contact was determined. The reaction forces registered in the contact of the belt and the wing idlers are used as the experimental loads in the custom designed conveyor idlers testing machine – where conveyor idlers are tested under the simultaneous action of the radial and axial load.

Keywords

Conveyor idlers, finite element simulations, testing procedure, mechanical design.

Acknowledgement

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EXPERIMENTAL INVESTIGATION OF MECHANICAL BEHAVIOUR OF AL 2024 ALLOY WELDED BY FRICTION STIR WELDING

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Abstract

The Aluminium alloy 2024 plates of 6 mm thickness are welded in circular butt joint geometry by Friction Stir Welding (FSW) process, using the vertical milling machine. The paper presents the results of structural and mechanical testing of the alloyed aluminium alloys AA 2024 welded by the FSW process. The goal of the research was to know the relationship between welding parameters and mechanical and microstructural properties of 2024 joints. The rotation speed of the tool did not change and amounted to 750 rpm, and the welding speed was 73, 116, 150 mm/min. The welded joints obtained were free of errors and with an acceptable flat surface.

Tensile tests were performed orthogonally in the direction of welding on samples. This variation of tensile strength with rotational speeds for a given traverse speed appears to be linked to the energy of the welds. Joint efficiency as high as 97% of base metal could be achieved at 750/116 rpm/(mm/min). Micro-Vickers tests were performed on each sample at three different heights of 0.5 mm from the face, in the middle and 0.5 mm from the root of the weld. The best mechanical strength conditions were obtained using the "mean" value of the welding speed. The testing of welded joints was also performed on bending, around the face, and around the root. Comparing the obtained bending test results, the largest bend angle to the first cracking phenomenon is for welding parameters 750/116 rpm/(mm/min) and amounts to 42°. The value of impact strength increases with welding speed from 73 mm/min to 116 mm/min. But the value of impact strength slightly decreases as the welding speed increases from 116 mm/min to 150 mm/min, which is consistent with ultimate tensile strength.

Keywords

Friction stir welding, aluminium alloy 2024, microstructural properties, mechanical properties

COMPUTATIONAL STUDY OF WNT SIGNALING PATHWAY IN ALZHEIMER DISEASE

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Abstract

Wnt (named after wingless gene in Drosophilia) signalling pathway is important in the regulation of the structure and function of the adult brain. It is found that activity of Wnt signalling pathway is present in the following areas of brain: frontal cortex, cerebellum, hippocampal formation, basal forebrain, and olfactory bulb. Damage or dysfunction of brain cells in these areas can cause many diseases. Here we are concerned with Alzheimer disease, which is connected with impairment of learning and memory in basal forebrain, but this disease also attacks other areas of brain and consequently other functions. Hallmarks of Alzheimer disease are formation of toxic amyloid beta plaques and neurofibrille tangles that leads to neural cell death or prevent normal function of cell. In this paper we consider Wnt signalling mechanism which is found to be connected with Alzheimer disease. It is indirectly or directly connected with formation of plaques or tangles. Here we present set of biochemical reactions that underlie this signalling, and we derive consequent mathematical model. Based on the experimental data from the literature we run simulations and provide computational investigation of the model. We determine key acters and molecules included in the pathway and we look for the regulating molecules as possible targets for drug development. Wnt signalling participates in diverse biological processes that includes neurogenesis, axonal remodelling, formation and maintenance of pre and post synaptic terminals, and in excitatory synaptic transmission. It is also found in other human diseases such as cancer, metabolic diseases, coronary disease, diabetes and obesity, etc.

Keywords

Wntsignalling pathway, Alzheimer disease, biochemical reactions, mathematical model, computational study

NUMERICAL METHODS IN ASESSMENT OF HIP IMPLANT DESIGN AND INTEGRITY

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Abstract

In this paper a numerical investigation of replacement implant for partial hip arthroplasty is presented. A finite element analysis (FEA) was performed using three-dimensional models to examine the mechanical behaviour of the femoral component at forces ranging from 3.5kN to 6.0 kN. This implant design was chosen for numerical analysis because stress concentration in femoral component lead to implant fracture. Metallic alloys are used for orthopaedic prosthesis, and its femoral head and stem are often made of cobalt-chromium alloy. Results show that the force magnitudes acting on the implant are of interest, and that they can cause implant stress field changes and implant stability problems, which can lead to implant failure.

For the simulation of crack propagation extended finite element method (XFEM) was used, as being one of the most advanced modelling techniques for this type of problem. Extended finite element method (XFEM) used enhancement functions as a means of displaying all forms of discontinuous behaviour, such as crack displacement. Enhancement functions are introduced into the displacement approximation for only a small number of finite elements, relative to the size of the whole domain. Short theoretical background information on the XFEM is provided, as well as the representation of crack and the stress intensity factors computation.

In order to evaluate the influence of initial defects in material on strength and life of structures, finite element analysis is applied to cracks of various shapes, sizes and locations. In these analyses, FEM is limited, since changes in crack topology require additional generating of mesh domain. This represents a significant constraint and complicates crack growth simulation on complex geometries. Extended finite element method, X-FEM was developed in order to make calculations easier, which was required during positioning of arbitrary cracks within a finite element model.

Keywords:

Hip Implant, Stress Intensity Factor, FEM, Numerical Simulations, Extended Finite Element Method

Acknowledgement

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New Technologies

USAGE OF DC-DC CONVERTERS IN SOLAR APPLICATIONS

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Abstract

The paper presents one possible application of the "buck" converter, i.e. the voltage down regulator in the system for supplying LED lighting from solar panels. The "Buck" converter is used to stabilize the voltage on LED lamp. In this paper, the calculation of the system components, i.e. the dimensioning of the inverter, solar panel and accumulator battery according to the needs and requirements of the stand-alone power supply system for the LED lamp, is given. A special accent is given on the calculation of active components (switching transistor and diode) and passive components (choke and capacitor) of the "buck" converter. In addition, a synchronous converter is also considered in the work, so the MOSFET switching transistor is used instead of the diode. Based on the calculation of the components of the converter, a simulation circuit was generated and a simulation of the battery-converter-consumer system in the PSPICE software package was made. Three operating modes with different values of DC input voltage 15 V, 24 V and 28 V. were analysed. With all these modes, it has been proven that this type of converter meets load requirements of a LED flashlight. On the basis of the obtained results, it was concluded that it is possible to practically implement one such system, with acceptable power losses, as well as with the acceptable efficiency for the average daily insolation that is present in these areas for 4 hours.

Keywords

DC-DC converter, Buck converter, MOSFET, Light Emitting Diode, PSPICE

WIRELESS ROBOT ARM CONTROL BASED ON ARDUINO MICROCONTROLLER

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Abstract

Robot arm can be designed for educational or prototype purposes. It can be designed in CAD program, with .nc or .sty files produced in CAM program. It can be further used NC machine or 3D printer to manufacture parts for robot arm. Further, we propose wireless robot arm controller based on Arduino board with microcontroller. Components needed are also four DC generic motors to drive base, shoulder, elbow and hand of robot arm, Bluetooth HC-05 or Wi-Fi HC-12 module to receive and transfer command controls from Android smartphone to Arduino board, breadboard or protoboard to place and connect components in electrical circuit, jumper wires, and battery. Further, we need iShield for Android smartphone and application for control of robot arm from smartphone. Also, it is needed to make code for Arduino microcontroller which responds to input commands, process them, and produce outputs toward DC motors in order to provide movement of robotic arm. For that we will need Arduino IDE software environment. We provide block diagram of components connection, and direction how to assembly it. Robot arm can be further prototyped and tested. It can be used for educational or prototype purposes.

Keywords

Robot arm, wireless control, Arduino microcontroller, educational prototype

ACCURACY OF POLYMER ELECTROLYTE MEMBRANE (PEM) FUEL CELL REFORMER PROTOTYPES USING FDM AND SLA 3D PRINTING TECHNOLOGY IN COMPARISON WITH DIGITAL CAD MODEL

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Abstract

The subject of this paper is the evaluation of accuracy of FDM and SLA 3D printing technologies, in comparison with developed reformer polymer electrolyte membrane (PEM) fuel cell CAD model. 3D printing technologies allow bottom-up approach to manufacturing, depositing material in layers to final shape. Dimensional inaccuracy is still a problem in 3D printing technologies due to material shrinking and residual stress. Materials used in this research are PLA (Polylactic Acid) for FDM technology and standard white resin material for SLA technology. Both materials are commonly used for 3D printing and have good dimensional stability. PLA material is printed in three different resolutions: 0.3mm, 0.2mm and 0.1mm. White resin is printed in 0.1mm resolution. The aim of this paper is to show how different printing resolutions affect dimensional accuracy of FDM models and to compare dimensional accuracy of FDM and SLA printing technologies.

Keywords

Reformer, 3D printing, FDM, SLA, CAD model

Acknowledgement

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MANUFACTURING AND GEOMETRY MEASUREMENT OF PARTS WITH FREE FORM SURFACES

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Abstract

Based on several years of research at the Department of Production Engineering, Faculty of Mechanical engineering, University of Belgrade, Serbia, software for automatic tool path generation for parts with free form surfaces has been developed. Using this software, a tool path for machining of different parts with free form surfaces was generated. The main goal of the conducted research was to generate a tool path with minimal machining time whilst not compromising the machining quality. A multicriteria tool path optimization method was used, in particular the feed rate variation method, in order to obtain a control code (NC) that would allow machining with constant cutting force. Manufacturing of the parts was done at the Mechanical Engineering Faculty in Belgrade, using the ILR HMC 500/40 tool system, according to generated control codes. During the manufacturing it was concluded that the machining of these parts was performed with constant cutting force. Geometrical measurements of manufactured parts were performed at the Department of Physics - University of Liverpool, UK using OGP Smartscope CNC 624 multisensor metrology system. The measurements of the manufactured parts were performed using two methods; contact (touch probe) and contactless (optical) whereby a point cloud of data was obtained. Using the MATLAB® software package, a program code was written that generates a map of the deviation based on the difference between the loaded point cloud and the CAD model. Finally, by analysing generated maps of deviation, it was concluded that the machining was performed within defined specifications. This demonstrated that the developed system is a useful for tool path generation for parts with free form surfaces.

Keywords

Computer graphics, CAD/CAM systems, Free form surfaces, Tool path optimization, Map of deviation

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