Innovation Center of Faculty of Mechanical Engineering

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CNN TECH

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

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Programme

and

The Book of Abstracts

29 June – 02 July 2021

Zlatibor, Serbia

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

CNN TECH 2021

29 June – 02 July 2021

Hotel Mona, Miladina Pecinara 26, Zlatibor, Serbia

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Programme

and

The Book of Abstracts

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CNN TECH 2021

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The organizing committee of the 5th International Conference of Experimental and Numerical Investigations and New Technologies – CNN TECH 2021 wishes to sincerely thank all the institutions and individuals who by means of personal engagement and constructive action helped organizing this conference.

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

We are also grateful to companies, **3D Republic**, **Shimatzu**, **Trokuttest, IMW Institute** and **Inter Cert** who have significantly contributed to the organization and realization of the conference.

PREFACE

Dear Friends and Colleagues, Welcome to CNN Tech 2021 Conference and the fabulous mountain of Zlatibor!

With 90 papers (17 by international authors) and contributions by authors from 12 different countries, International Conference of Experimental and Numerical Investigations and New Technologies CNN Tech 2021 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 2021 focuses on the following topics:

- Mechanical Engineering,
- Engineering Materials,
- Chemical and Process Engineering,
- Experimental Techniques,
- Numerical Methods,
- New Technologies,
- Clear sky,
- Sustainable Design and New Technologies,
- Advanced Materials and Technology,
- Artificial intelligence and
- Student session.

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 2021 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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PROGRAMME

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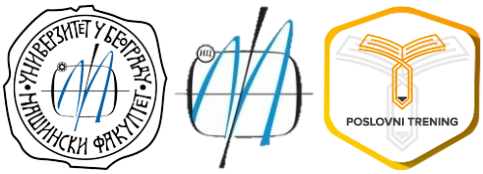

ABSTRACTS

Mechanical Engineering

Invited lecture

VIBRATION MONITORING, ANALYSIS AND DAMPING AT THE HYDRO POWER PLANT

Emil Veg[1]

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Abstract

Vibration monitoring is well proven procedure for estimation of a condition of a machine system. Excessive vibrations indicate the unexpected problems in operation. Moreover, vibration analysis often can help to discover the cause of the problem.
In this paper procedure for system monitoring, data logging, collected data analysis and necessary actions for vibration level dampening at the hydro power plant is described.
In order to lower the level of vibration of an operating machine it is necessary to measure vibration intensity and frequency first. Then, through the Fast Fourier Transformation (FFT), collected data is transformed from the time to the frequency domain. Frequency domain signal indicates the possible causes of elevated vibration amplitudes. Every cause of perturbation forces and high vibration levels has its own distinctive frequency domain graph. Frequency of dominant amplitudes (most commonly seven highest amplitudes are taken into consideration) determines the cause of the problem. Rotational machines most often have a problem with dynamic imbalance and/or shaft misalignment. These problems are discovered by excessive vibrations at the rotational frequency and double rotational frequency respectively. On the other hand static structures most commonly change their modal characteristics (natural frequency) due to loss of structural integrity.
When the cause of the excessive vibrations is determined it is possible to design the optimal solution. In this case, it was provided through the tailor made modular lightweight steel construction, mounted in order to raise the stiffness of the oscillatory system

Keywords

Please Vibration monitoring, Vibrodiagnostics, Modal analysis

Acknowledgement

Results shown are part of the project financed by Ministry of Education, Science and Technological Development of the Republic of Serbia, by the Contract 451-03-9/2021-14/200105 signed on 05.02.2021.

DESIGN AND RAPID PROTOTYPING OF MEDICAL DEVICES – CASE STUDY: MECHANICAL VENTILATOR

Zarko Miskovic[1*], Radivoje Mitrovic[1], Milos Milosevic[2], Goran Petrovic[1], Goran Mladenovic[1], Isaak Trajkovic[2], Dejan Markovic[3]

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Abstract

In the year 2019th, 77.000 new ventilators were more than enough to meet the market demand worldwide. However, during the peak of the COVID-19 pandemic, large cities alone need more than additional 30.000 machines per city (example: New York). At the time, almost all ventilator manufacturers have boosted their production by 30-50% but, they still weren't able to deliver the required production growth. One way to solve the medical devices shortage problem is the development and large-scale production of new medical devices. The main issue of this approach is the complexity of medical devices as a mechanical system, especially taking into account the obligatory medical verification. That's the main reason why existing standardized medical equipment should be used as a basis for the development of the new prototypes. This approach is implemented during the development of the new mechanical ventilator. Used methods include all traditional product development activities (such as the definition of desired characteristics, comparative analysis of literature and existing ventilators, definition of different variant solutions, and selection of best technical solution for further development) followed by the modern product development methods: 3d modeling, FMEA and rapid prototyping using advanced 3d printers. The verification of the new mechanical ventilator prototype was successfully performed, setting up a basis for further improvements. The developed prototype has numerous advantages compared to the competition (i.e. it is much cheaper and easily produced with comparable technical characteristics) but its main advantage is a brand-new system for patients' exile air sterilization and filtration.

Keywords

Machine Design; Product Development; Rapid Prototyping; Mechanical Ventilator; Medical Devices;

Acknowledgement

The authors of this paper would like to express his sincere gratitude to the management of the Faculty of the Mechanical Engineering at the University of Belgrade, as well as to the Innovation Center of the Faculty of Mechanical Engineering in Belgrade for their support of the realization of the corresponding independent project.

AFFECT ON FORECASTING RELIABILITY SAFETY ENGINE IN MEDICAL INSTITUTIONS

Marko Ristic[1], Ljiljana Radovanovic[2], Jasmina Perisic[3], Ivana Vasovic[4], Goran Otic[5]

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Abstract

Many fundamentally important devices used in health care facilities require significant and uninterrupted supply of electricity. If a power outage occurs, significant generator to life support machines and all other necessary medical appliances that work in order to sustain human life, continue to operate unhindered. Unlike aggregates that people use in their homes, aggregates used in health care are of a different type, even unlike typical emergency power unit, the spare system aggregates in the hospital must enter into operation almost immediately with full force. Hospitals are complex and sophisticated systems designed to provide current power supply. During a power outage, generator sets with diesel engine DEG (diesel electric generators) provide reliable, direct and full power of electricity. Forecasting reliability of diesel engines for generator used by medical institutions is one of the most important factors that will not reach the link. In this paper we analyze the state of the diesel engine as the most complex set of aggregate through an emergency condition. Properties accidental conditions are shown through: the exposure time, the coefficient of coverage and type of the original defect. Forecasting methods that will be used are: analytical forecasting and statistical forecasting. Forming forecasting methods using numerical methods to the analysis of controlled variables solve the task of forecasting and therefore the task of improving reliability. It is important that hospitals have a reliable unit (DEG). Planning reliability and modeling of accidental situation, we see primary defects, so that in time we can eliminate potential defects.

Keywords

electricity, reliability, forecasting methods, numerical methods

Acknowledgments

Research described in this paper are financed from Ministry of Education, science and technological development Republic of Serbia.

A NATURAL REGULARIZATION OF LINEARDISCRETE DESCRIPTOR TIME DELAY SYSTEMS

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Abstract

This paper provides novel method for strong regularization of the linear discrete descriptor time delay systems. We study open loop: $E\mathbf{x}(k+1)=A_0\mathbf{x}(k)+A_1\mathbf{x}(k-h)$ *with the compatible vector valued function over the subspace of initial conditions, given by* $\mathbf{x}(k)=\boldsymbol{\psi}(k),\ -h\le k\le 0$, *where* h *positive constant integer constatnt. In the discrete case, the concept of smoothness has little meaning but the idea of consistent initial conditions being these initial conditions* $\mathbf{x}_0$ *that generate solution sequence* $(\mathbf{x}(k)>0)$ *has a physical meaning.*

Approach is based on use of classical proportional and derivative feedback of the type: $\mathbf{u}(k)=F\mathbf{x}(k+1)+F_0\mathbf{x}(k)+F_1\mathbf{x}(k-h)+\mathbf{p}(k)$ *such that the closed loop system:* $(E+BF)\mathbf{x}(k+1)=(A_0+BF_0)\mathbf{x}(k)+(A_1+BF_1)\mathbf{x}(k-h)+B\mathbf{z}(k)$ *is regular. In order to achive that, the assumpion of full row rank matrix* $(E\ B)$ *must be satisfied. A special case, has been considered when the solution of linear matrix equation* $(E+BF)=I$ *exists,* I *being the unit matrix.*

Due to two free matrices F_0, F_1 *it is clear that that the spectra of closed loop eigenvalues can be located arbitrarily using controllability properties of finite frequency modes.*

Keywords:

Discrete systems, Descriptor systems, Time delay systems, Regularization

A NATURAL REGULARIZATION OF LINEARCONTINUOUS SINGULAR TIME DELAY SYSTEMS

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Abstract

This paper provides novel method for strong regularization of the linear continuous singular time delay systems. In this study we analyzed: $E\dot{\mathbf{x}}(t)=A_0\mathbf{x}(t)+A_1\mathbf{x}(t-\tau)$ *with the compatible vector valued function over the subspace of initial conditions, given by :* $\mathbf{x}(t)=\boldsymbol{\varphi}(t),\ -\tau\le t\le 0$, *where* $\tau>0$ *is constatnt time delay. A novel method is based on use of classical proportional and derivative feedback of the type:* $\mathbf{u}(t)=K\dot{\mathbf{x}}(t)+K_0\mathbf{x}(t)+K_1\mathbf{x}(t-\tau)+\mathbf{w}(t)$ *such that the closed loop system:* $(E+BK)\dot{\mathbf{x}}(t)=(A_0+BK_0)\mathbf{x}(t)+(A_1+BK_1)\mathbf{x}(t-\tau)+B\mathbf{w}(t)$ *is regular. In order to achive that, the assumpion of full row rank matrix* $(E\ B)$ *must be satisfied. A special case, has been considered when the solution of linear matrix equation* $(E+BK)=I$, *exists* I *being the unit matrix.*

It has been shown that the closed loop system modal frequencies could be assign arbitrarily if and only if the singular time system is strongly controllable upon the state.

Due to two free matrices K_0, K_1 *it is clear that that the spectra of closed loop eigenvalues can be located arbitrarily using controllability properties of finite frequency modes.*

Keywords:

Continuous systems; Singular systems; Time delay systems, Regularization

START-UP COMMUNITY AND THE ACCELERATION SERVICES IN THE DANUBE MACRO-REGION: CASES OF AUSTRIA, BOSNIA AND HERZEGOVINA, HUNGARY AND SLOVENIA

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Abstract

This paper investigates the supply (access to finance) and demand (innovation-driven SMEs and talent communities) perspectives in the Danube macro-region (DMR). The purpose of this research is to identify relevant challenges for all participants of the quadruple-helix model in the DMR and create recommendations for upgrading the business (support) infrastructure and venture finance in the observed region, with special focus on the acceleration services and the new available digital services. Conclusions are based on case studies of regional assessments of Austria (Styria), Bosnia and Herzegovina ((BIH) Republika Srpska (RS)), Hungary (Central Region (CR)), and Slovenia (Western Slovenia (WS) and Eastern Slovenia (ES)).

Keywords

Start-ups, Access to finance, Danube Macro-Region

Acknowledgement

The article is created within the programme group P6-0372, and it is supported by Slovenian Research Agency (ARRS) – No. 5442-1/2018/89.

PERFORMANCE MANAGEMENT AND LEAN MANUFACTURING IN ORDER TO ENSURE SUSTAINABLE DEVELOPMENT OF THE ORGANIZATION

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Abstract

Continuous measurement and monitoring of organizational performance indicators, especially early ones, concerning the processes in the organization, applied technologies, knowledge, and competencies of employees, are very important for identifying places where it is possible to achieve certain improvements. Balanced Scorecard as a strategic performance management system allows organizations to define strategic goals through four perspectives (learning and growth, processes, users, finance) and performance indicators to monitor the fulfillment of these goals. In the paper will be presented the Balanced Scorecard model, developed in the QPR software program, in a pilot organization, to indicate the benefits of such comprehensive monitoring and measurement of performance indicators and on the possibility for timely identification places for implementation of methods and techniques for improving particularly "early" performance indicators (process perspectives and learning and development). Lean manufacturing focused on reducing "waste" in work processes and exploiting employees' potential, enables preventive actions to improve organizational performance, especially within the process perspective and the perspective of learning and growth, which lead to improved performance in other perspectives.

Although each of these approaches, Balanced Scorecard, and Lean manufacturing, can independently provide significant results in monitoring, measuring, and improving organizational performance, synergistic action can achieve much more and ensure business continuity. In this regard, the presented model of Balanced Scorecard will point out the benefits of such monitoring and measurement of organizational performance through which it is possible to provide early identification of places in the organization where the use of Lean manufacturing tools is necessary, choose an appropriate combination of Lean tools and measure the effect of the application of these tools.

Keywords

Performance management, Lean manufacturing, performance indicators

APPLICABILITY OF RAPID TOOLING IN INJECTION MOLDING APPLICATION

Milos D. Pjevic[1*], Mihajlo D. Popovic[1], Goran M. Mladenovic[1], Ljubodrag M. Tanovic[1], Radovan M. Puzovic[1]

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Abstract

In the field of mass production, injection molding accounts for a large percentage of the technologies used in the applied technologies. One of the main disadvantages when it comes to injection molding is the cost of tools. This can greatly affect the price of the finished product if there are multiple iterations of product development through various prototypes. For initial tools used in running production or in product design, it is necessary not only to be as cheap as possible, but also to make their production time as short as possible. The increasing application of additive technologies in the field of rapid tooling, gives a wide space in the possibility of lowering the price of the final product. The applicability of additive technologies in injection molding has not been sufficiently researched, although the possibility of application is huge. In this paper, the main emphasis is on the applicability of additive technologies in injection molding of an initial series or a smaller series of the parts. The conclusion is that not only additive technologies can be applied in the production of core and cavity or complex parts of injection molding tools, but the minimum time that is required to produce the tool is significantly reduced, which directly affects the price of the final product.

Keywords

Rapid Tooling, Additive Technologies, Injection Molding, Tools

TRENDS IN THE DEVELOPMENT OF LOGISTICS

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Abstract

New challenges for the Russian economy are dictated by the growing dynamics of the internal market. This paper will deal with new trends in logistic management and their benefits to the regional economy to improve regional distribution system performance. We will compare two basic trends (Spruce and Lebedev, 2011) and stress their benefits and flaws to companies and small entrepreneurs. In the end, we will learn about their logistics performance measurement model as a tool for company assessment on the example of the company that produces spare vehicle parts. This logistics performance measurement model is based on the Logistic Scorecard perspective, that consists of two parts: identification of business strategy logistic and model editing. The logistics mission should meet the needs of goods that correspond to the right place, at the right time and in the desired conditions, and thus provides benefits to the company. It takes a long time for companies to understand the importance of logistics to develop a competitive advantage over competitors.

Keywords:

logistics system, logistics, economy, internal market

.

CONFIGURING A CLASS OF MACHINES BASED ON RECONFIGURABLE 2DOF PLANAR PARALLEL MECHANISM

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Abstract

The parallel 2DOF (Degrees Of Freedom) mechanism presented in this paper is the basis of many research of the authors. There are many significant results for the presented mechanism, and some of them will be presented in this paper. The main goal of the research regarding the parallel mechanism is to create a hardware and software system that will be used to configure machine tools with three or more DOF. The software system consists of two parts. One part is a set of applications intended for machine analysis and defining optimal configuration, and the other part is a control system of the machine adapted to the hardware of the machine, its configuration and its purpose. For the presented mechanism, the kinematic model of the mechanism will be presented first. Based on the kinematic model, equations representing solutions of kinematic problems will be derived. The derived equations will be in a generalized form with some variable parameters of the machine and in such a form correspond to every possible configuration of the reconfigurable mechanism. The equations will initially be used to analyse some basic configurations, and then to analyse some configurations that have not been analysed and presented so far. Also, equations in this form that are applicable for all possible configurations of mechanism, are part of both parts of software system. The final result of the presented procedures is one machine that has optimized parameters in accordance with the appropriate production process and with a configured control system that corresponds to the configuration of the machine.

Keywords

Parallel mechanism, Hybrid mechanism, Complex machine tool, Reconfigurable machine tool, Inverse and direct kinematics problem

Acknowledgement

The presented research was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia by contract no. 451-03-68/2020-14/200105.

Engineering Materials

Invited lecture

PHASE MORPHOLOGICAL AND ANTIMICROBIAL PROPERTIES OF HAP-TIO_2 NANOMATERIALS OBTAINED BY DIFFERENT SYNTHESIS ROUTE

Miljana Mirkovic[1*], Suzana Filipovic[2], Pavle Maskovic[3], Vladimir Pavlovic[4]

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Abstract

Due to the growing number of people infected with the new corona virus in the world, there is an increase in bacterial infections, which weakens the immunity. New knowledge about simple and low cost synthesis methods of materials with good structural and antimicrobial properties are of great importance nowadays. Combination of bio ceramic Hydroxyapatite material with good biocompatible characteristics and Titanium dioxide material with good degradation properties of organic molecules when combine together has ability to absorb and decompose the bacteria. Hydroxyapatite/titanium dioxide nanomaterials have been prepared by tree different synthesis route. The morphology and semi quantitative chemical analysis were characterized by scanning electron microscopy with energy dispersive X-ray analysis (SEM-EDX). Phase and structural characterization of obtained materials were determined using X-ray powder diffraction method (XRD). The crystallite sizes of the obtained materials were evaluated in the average range from 8 nm to 15 nm. Due to phase analysis by XRD characterization the peak shows presence of anatase phase with hydroxyapatite. Based on XRD peaks positions the hexagonal hydroxyapatite phases are formed in every synthesis route with TiO_2 anatase phase. The microstructural studies confirmed that the nanosized HAp coated in a different way with TiO_2 depending on a synthesis route. EDX analysis confirmed presence of Ti, Ca, P, O in obtained materials. The IR spectroscopy confirmed vibrational bands characteristic for HAp and titanium with anatase phase. The investigated materials show satisfactory antimicrobial properties.

Keywords

Hydroxyapatite, TiO_2, nanomaterials, antimicrobial properties

Acknowledgement

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INFLUENCE OF PRINTING PARAMETERS ON DIMENSIONAL STABILITY OF SENB SPECIMENS MADE FROM PLA AND PLA-X MATERIALS

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Abstract

The subject of this paper is to show how two similar materials, namely PLA and PLA-X, influence on geometrical properties of additively manufactured SENB (Single-Edge Notched Bending) specimens. Observed geometrical properties are specimen density and percentage error of measured specimen dimensions i.e., specimen thickness (B), width (W) and length (L). CAD model dimensions of all specimens are 13 × 26 × 114.4 [mm], and for all specimens plane-strain criterion is met according to the ASTM D5045-14 standard for fracture toughness assessment of plastic materials. SENB specimen notch width and depth are 1.5 × 10.5 [mm], respectively. For each material specimens were 3D printed in five different batches, with variation in layer height, infill density, printing orientation and specimen humidity. Considered layer heights are 0.1 and 0.2 mm, infill densities taken into account are 50 and 100 % and all specimens have rectilinear or circular printing orientation. Fifth batch includes dried specimens for both materials. Results show that the maximum density for both materials have the specimens with 100% infill density and 0.1 mm layer height. Also, the highest dimensional error concerning specimen thickness (B) is measured in the same batch for both materials. The maximum error with regard to specimen width is measured in the batch with 50% density and 0.1 mm layer height. Largest dimensional deviation in specimen length is measured in dried PLA specimens, showing the effect of specimen drying on dimensional accuracy of the largest specimen dimension. Conversely, in the same batch PLA-X material shows minimal deviation.

Keywords

Additive manufacturing, PLA, PLA-X, geometrical properties, SENB specimen

Acknowledgement

This research is financially supported by European Union’s Horizon 2020 research and innovation program ‘’SIRAMM’’, under grant agreement No. 857124.

INVESTIGATION OF TENSILE PROPERTIES OF CARBON/EPOXY SANDWICH PANELS WITH DIFFERENT FIBER ORIENTATION USING DIGITAL IMAGE CORRELATION

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Abstract

Carbon fiber epoxy composite sandwich panels are employed in a wide range of technical applications due to their exceptional properties. The experimental characterisation of carbon fiber reinforced composite sandwich panels with varied fiber orientations (0°/90° and ±45°) was reviewed in this work utilising tensile testing and a full field non-contact 3D Digital Image Correlation (DIC). Carbon fiber prepregs with epoxy resin systems and Aramid synthetic fibers were used during the research. The materials' characteristics were established using full-field data collected from 3D DIC measurements and a series of experiments performed in compliance with ASTM standards. Maximum stress and strain, break stress and strain, toughness at complete regions, and modulus of elasticity were measured and compared for both materials. A digital image correlation approach was used to record the adherend's full-field, out-of-plane deformation, strain distribution, and strain development along the bond line, allowing the fracture process to be visibly described. Because DIC generates the displacement field, the strain field must be calculated from it. It was concluded that the orientation of the fibers notably influenced the tensile characteristics of the tested materials significantly. The results showed that specimens with 0°/90° fiber orientation had greater break stress and brittle fracture, whereas specimens with 45° fiber orientation twisted in the fiber direction and had greater elongation values while sustaining the applied load. Scanning electron microscopy (SEM) investigation of the fibers and honeycomb core, as well as fracture surfaces, was undertaken to supplement previously acquired data.

Keywords

Sandwich panels, Tensile properties, Digital Image Correlation, SEM

SURFACE PROPERTIES ANALYSIS OF METALLIC ADDITIVE MANUFACTURING MATERIALS

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Abstract

This research covers the surface roughness analysis of metallic materials obtained through Additive Manufacturing. The analysis was performed on five different parts, which were made from 17-4 PH stainless steel. Parts differ in geometry and the target surfaces for this analysis are: support surface for the part 1, bottom raft surface for parts 2- 4 and the top surface of the manufactured part 5. This particular stainless steel material properties are high strength, corrosion resistance and hardness compared to other metallic materials allowing this material to have a wide range of applications. The surface roughness of the parts are obtained in three ways: along the printing direction, transverse to the printing direction and also the layer roughness was estimated on lateral surfaces.

Surface roughness measuring device used for this research is MarSurf SD26 (Mahr GmbH, Gottingen, Germany). Measuring length of the device is 26 mm with speed range from 0.1 to 1 mm/s. In this research the lowest measuring speed is used. Surface roughness device outputs are mean and maximum roughness depth, R_z and R_{max} respectively. The results for part 5 layer roughness values R_z and R_{max} match, showing that the part was printed with exceptionally high accuracy along the vertical i.e., Z direction. Measurements made in the transverse direction to the printing path show that the R_z value in part 2 has twofold higher values compared to part 5, leading to the conclusion that printed parts have smoother surfaces than printed rafts.

Keywords

Roughness, 17-4 PH, MarSurf SD26, R_z, R_{max}

Acknowledgement

The authors would like to thank the support from European Union’s Horizon 2020 research and innovation program (H2020-WIDESPREAD-2018, SIRAMM) under grant agreement No 857124.

MONITORING OF FRACTURE MECHANICS PARAMETERS ON SINGLE ENDGE NOTCHED TENSION SPECIMENS MADE OF PLA MATERIAL

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Abstract

In order to characterize the fracture toughness of single edge notched tension (SENT) specimens, this paper describes the experimental determination of fracture mechanics parameters such as crack mouth opening displacement (CMOD) and crack type opening displacement (CTOD) on SENT specimen samples. Additive production techniques were used to make these specimens. This is an FDM (Fused Deposition Modeling) technique and the material used is polylactide amide (PLA, German RepRap Premium Filament). The experiment was performed on two models of test specimens that differed in geometry. The specimens differed in the length of the notche and crack, while the cross-sectional area of the specimens was equal. The experiment was performed at room temperature and relative humidity of 40%, a few days after production. Universal machine for testing the mechanical properties of materials (Shimadzu AGS-X 100kN) in the control of displacement at a speed of 0.5mm / min was used. Using the Aramis 2M system, digital image correlation was used to obtain CMOD and CTOD (δ-5) values according to a standard procedure using a point-point distance command that measures the distance between points with an accuracy of one thousandth of a millimeter. The repeatability of the results indicates the same trend in the fracture of SENT specimens made by this technique of additive production and from this material as the results with low values of standard deviation.

Keywords

PLA, biomaterials, additive manufacturing, fracture mechanics parameters, CMOD, δ-5

Acknowledgement

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TRIBOLOGICAL BEHAVIOR OF SULFATE BASED IONIC LIQUIDS AS LUBRICANT ADDITIVES – REVIEW

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Abstract

Ionic liquids (ILs) are salts, entirely composed from positively charged bulky organic cation, and negatively charged organic or inorganic anion. Due to their chemical composition, they exhibit some unique properties, e.g., low vapor pressure, high thermal stability, non-flammability, broad liquid range, etc. Possibility to synthesize wide variety of different task specific ionic liquids in combination with their unique properties made them attractive as candidates for a various type of applications, e.g., chemical synthesis, extraction processes, solvent replacement, engineering fluids, lubricants etc.

In this paper we have focused on review of our previous work related to the studies of tribological behaviour of sulphate based ionic liquids used as lubricant additives in steel – steel contact lubrication under the boundary lubrication conditions.

Obtained results have revealed strong influence of the cation composition as well as the influence of the anion alkyl chain length on tribological behaviour of lubricant mixtures. For specific contact conditions, e.g., specific ambient temperature and contact load, optimum ionic liquid additive concentration was found. The surface protective films generated throughout the chemical reactions between ionic liquid and nascent metal surfaces in the sliding contact area were detected and lubricant mechanisms were proposed. Furthermore, a strong correlation between lubricant mixture stability and base oil polarity was detected, and optimal base oil candidates were proposed.

Keywords

Ionic liquids, additives, boundary lubrication, steel, surface protective film, lubricant mixture stability

CRACKS IN WELDED JOINTS

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Abstract

Cracks in welded joints can be classified according to their positions. Type I and II cracks occur in the weld metal, whereas Type I cracks are limited to it, and Type II cracks may propagate into the parent material as well. Type III cracks occur in the coarse-grain heat-affected zone and Type IV cracks occur and propagate in the area of HAZ adjacent to the PM/HAZ boundary. Type IV cracks are the most dangerous type since these cracks have the highest void forming rate, which results in quicker fracture, compared to creep tests in the case of nonwelded homogeneous specimens.

Type IV cracks occur in welded joints made of crack-resistant steels, due to increased cavity-forming rate caused by the presence of coarse-grain carbides in fine-grain and intercritical annealed areas within the heat-affected zones. Type IV crack initiation was observed in steels with less to 12% chrome content. The problem can be eliminated by technical treatment – repeated austenitization and tempering, however, this is rarely achievable due to the way in which structural components are designed. Thus these components need to be designed in a way that ensures that creep strength and life reduction are taken into account. Type IV cracking is a well-known problem in ferrite steels, its significance is greater in the new class of steels because the difference in the rupture strength of the base metal and the weld joint seems to be greater for these steels than conventional Cr–Mo steels. In many cases, the crack of critical size was responsible for a failure. It has been generally recognized that crack occurrence in welded structures cannot be completely excluded and the effect of crack existence and growth has to be analysed when structure safety is considered.

Keywords

Crack, welded joints, weld metal, type IV cracks, HAZ

Acknowledgement

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APPLICATION OF GENERATIVE DESIGN ON THE BRACKET MODEL

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Abstract

The parametric representation of design geometry is the most widely used approach to generative design because of parametric computer-aided design (CAD) tools. Recently, generative design has begun to use topology optimization, taking advantage of the ability to represent different topologies in given spaces. Topology optimization is originally a design optimization methodology to find a single best design, but it can be used as an exploration methodology through the following approaches: finding local optima, finding a Pareto set by solving a multiobjective (disciplinary) optimization problem, and diversifying the definition of a topology optimization problem. This paper presents the process of applying generative design and optimization to a bracket model. The main goal of this paper is to optimize the overall weight of the bracket by thinning specific areas of the 3D model elements according to the calculated minimal strain energy. The entrance to the process is the original solution of the bracket. Topological optimization according to previously defined parameters was applied to the original solution, so that the output from the process would be the final model of the bracket model. Structural topology optimization aims to find the best distribution of materials within prescribed limits using an optimization algorithm in order to achieve some exceptional structural performance.

Keywords

Generative design, Topology optimization, 3D modeling.

Chemical and Process Engineering

INFLUENCE OF ANODIZATION VOLTAGE ON PHOTOCATALYTIC ACTIVITY OF TIO_2 NANOTUBES

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Abstract

TiO_2 under UV light generates charge carriers (electrons and holes) that take part in the process of decomposition of pollutants, which is a well-known fact for the past few decades. For this reason, TiO_2 is used for photocatalytic purification water and air. Photoactivity of TiO_2 depends on the amount of generated charge carriers, and one part of those carriers are lost through the process of recombination. In order to improve photoactivity, it is necessary to speed up transport of electrons and holes. For better and faster charge carrier transport a unidirectional path is desired, which can be obtained by synthesizing 1D morphology. Anodization of titanium foil is a good way to obtain perpendicular nanotubular morphology onto a substrate. Nanotubular morphology can be optimized via operative conditions of anodization: applied voltage, anodization time and type of electrolyte. In this work, TiO_2 nanotube arrays were synthesized by anodization of titanium foil at different voltages: 10 V, 15 V, 20 V and 25 V. Based on FESEM (Field Emission Scanning Electron Microscopy) micrographs, the microstructure of nanotubes was analysed and data concerning wall thickness, outer diameter of nanotubes and active surface were considered. Also, the influence of nanotube morphology on optical properties was determined. Results of our research show that the increasement in anodization voltage influenced on the appearance of redshift in the absorption spectrum. The sample synthesized at 20 V showed the highest photocatalytic activity due to the optimal nanotube length and nanotube diameter.

Keywords:

TiO_2, photocatalysis, anodization voltage, nanotube morphology

Acknowledgement

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THE SMART PACKAGING AND APPLICATIONS IN INDUSTRIAL FOOD PROCESSING

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Abstract

The scope of this review paper is to explore opportunities of smart and interactive packaging in industrial production of goods and parts, as well as in food processing. Packaging is one of the important phases after processing the food. Nowadays it is often necessary that packaging is made smart, either active, or intelligent. Active packaging provides prolonged shelf life of food, by absorbing or adsorbing substances or by emitting chemical agents to eliminate harmful compounds. Intelligent packaging contains electronic components monitoring changes in environmental parameters which could influence the food quality and compromise its viability. These electronic components are often without the power supply, operating as energy harvesters.
Packaging can be enhanced using special materials. There are a lot of opportunities for innovation and application of packaging materials based on various types of smart materials. Smart materials can react to changes in environmental conditions by changing some of its characteristics. Maintaining proper transport and storing conditions of the perishables is necessary to keep and ensure high quality, safety and usability of the goods. This is important not only in food and beverage but also in pharmaceutical production.
In order to enhance customer experience, goods can have electronic tags installed in packaging that is able to provide more information of the product, or to authenticate the geographic origins, and give traceability of the product with proof of the proper storing. Furthermore applications can be developed for mobile devices that can stream information of the product to the customer’s cell phone. Augmented reality can be employed by the manufacturer or the customer, giving opportunities to explore use of the product before actual sell.

Keywords

electronic tagging, energy harvesters, industrial computer systems, smart materials, smart packaging.

Acknowledgement

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AUTOMATION OF THE BAG FILTER CLEANING IN INDUSTRIAL AIR PURIFICATION SYSTEM

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Abstract

Industrial automation and mechatronics have increasingly important roles in the global economy and in the modern industry. The importance of air filtration in various industries is emphasized since the air quality makes a waste impact on the quality of life. Environmental protection and preservation of air quality near industrial plants are regulated and required by the legislation. Automation, ecology, and education of experts in these fields are necessary to reach and achieve Industry 4.0.

The system for automatic control of air purification systems for an industrial plant is designed and implemented. The filter bags are used for cleaning of air stream exiting the industrial plants. After some period of operation, the bags must be cleaned of dust. Pulse shaking provides better and longer operation of the air filter bags. The operation of the air purification system is automated using a programmable logic controller (PLC).

The PLC FATEK FBs10MAT-AC is programmed to control the operation of four pneumatic valves used to shake the filter bags. A FATEK touch panel P5043 is chosen to make operating and setting the PLC more user-friendly. The control algorithm is given and the corresponding code is in the form of a Ladder Diagram. The rungs are individually commented in detail, which helps to make the program more explainable, transparent, and easier to follow, providing better clarity and easier editing and maintaining in the future.

The system is designed, built, tested, and put into operation. A plan for fine-tuning and a proposal for expanding the system are also suggested.

Keywords

Automation, Industrial air filters, Mechatronics, Programmable Logic Controllers (PLCs), Touch-panels.

SOLDERING TECHNOLOGY OF INSTALLATION PIPES IN THE MANUFACTURING PROCESS OF VRV SYSTEMS

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Abstract

This paper presents application of the soldering technology used for installation pipes of modern VRV (Variable Refrigerant Volume) systems. The work defines important materials and methods of soldering and welding of installation pipes as well as, steel and copper characteristics, Freon and related tools. VRV offers the possibility of increasing the length of the pipeline, and since the system can be designed in a flexible way, it fits buildings of different shapes and dimensions. Nowadays, many buildings operate on the basis of separate heating, cooling and hot water systems. As the result, large energy losses occur. To achieve a much more efficient alternative, a VRV concept has been developed, which controls up to 50% of a building's energy consumption. This has great potential for cost reduction.

VRV systems, their configuration, mode of operation, installation, and application are presented in this research. A detailed example of installing a VRV system, copper pipes and tools necessary for installation is presented. At high temperatures, there is a problem with the soot inside the pipe during soldering copper pipes. The main goal of the paper was solving the problem that occurs during the installation of the VRV system, also removing the soot inside the pipe. VRV systems represent highly reliable air conditioning systems that bring users a number of benefits and profits after a certain period of use.

Keywords:

VRV systems, air conditioning, materials, soldering, welding

Acknowledgement

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Experimental Techniques

Invited lecture

DAMAGE TOLERANCE ANALYSIS OF AIRCRAFT STRUCTURAL ELEMENTS

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Abstract

An investigation in this work is focused on strength analysis of aircraft structural components with initial damages under cyclic loads. Damage tolerance is the ability of an aircraft structure to sustain damage, without catastrophic failure, until such time that the component can be repaired or replaced. This analysis relates to structural elements of wing type training airplane structure with initial damages under cyclic loads. Initial damages are defined at the critical areas (structural components) of the aircraft wing, and numerical is simulated behavior of so that damage structure. For the determination of fracture parameters here are used special singular finite elements on the one side and analytic expressions on the other side. Special attention focuses on the development of rational numerical procedures for life estimation of lugs with initial damages. For the determination of stress concentration factors and stress intensity factors to lugs are used analytic expressions and finite element method (FEM). FEM is used too in establishing analytic expressions for stress intensity factors to structural components with initial cracks. For precise determination of stress intensity factors of cracked structural elements here special singular finite elements are used. Results of numerical simulation for crack growth as well as residual life estimations are compared with responsible and own experimental results. At the damaged lug problem on the place wing-fuselage joint of light training aircraft carried out comparisons numerical and experimental results. Good agreement between numerical and experimental results is obtained.

Keywords

Aircraft structure, Fracture mechanics, Damage tolerance analysis, Singular finite elements

CFD LOAD AND STRENGTH ANALYSIS OF TACTICAL UNMANNED AERIAL VEHICLE MADE FROM COMPOSITE MATERIALS

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Abstract

Attention in this paper is focused on the computation fluid dynamic (CFD) numerical load simulation of a tactical unmanned vehicle on the one hand and the stress / strength analysis on the other. FLUENT software code was used here for precise determination loads of wing and horizontal tail of unmanned aerial vehicle (UAV). The CFD calculation and static strength testing results of specific UAV horizontal tail were illustrated. The specific attention was given to definition of aerodynamics loads acting on UAV wing, the structural analysis and experimental tests of UAV wing and horizontal tail. Commercial CFD software was used in this paper to precisely define the aerodynamic load of the UAV. The aim of this work is to perform a one-way fluid-solid interaction (FSI) for UAV structural design, in which the aerodynamic loads obtained by CFD analysis are applied to the vehicle structure for stationary static FE analysis. Composite components for structural analysis were modelled using layered shell finite elements. Computation results based on Finite Element Method (FEM) were compared with experimental results (displacement and stress state). A good correlation was achieved. The above case studies demonstrate that CFD is a versatile and essential tool for analyzing many flow problems involving UAVs and their subsystems. The strength analysis of wing or horizontal tail of UAVs was performed experimentaly. Measurement of deformations and stresses was performed by a system of strain gauges. Horizontal tail of UAV was tested for verification of loading conditions. Good agreement between computation and experimental results has been obtained.

Keywords

Tactical unmanned aerial vehicle (UAV), Wing and horizontal tail constructions, CFD load simulations, Composite materials, Experimental strength analysis.

Acknowledgement

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EXPERIMENTAL AND NUMERICAL ANALYSIS OF HOT WATER BOILER IN START UP REGIME

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Abstract

The aim of the paper is to investigate the transient regime of hot water boiler numerically and experimentally. In the regime of starting up, as the most critical one, measurements were done on the boiler critical element. The operating characteristics as well as safe and reliable operation conditions of hot water boilers are limited by thermal stresses that occur in their structure. The greatest thermal stresses occur in transient operating regimes such as starting-up, changing operation mode or sudden shutdown, resulting in uneven heating or cooling of boiler elements. Large temperature gradients cause high thermal stresses that are especially critical in elements with thick walls. As thermal stresses may limit the heating and cooling rates of temperature changes, boiler structure is exposed to variable temperature and stress field. The largest absolute value of thermal stresses occurs at the inner surface, where direct measurements are not possible to take, since the inner surface is in direct contact with hot water under high pressure. This was the reason to measure the temperature of boiler structure inside the boiler, on tube plate, as one of the critical part of the boiler. In this paper the experimental results of temperature measurement of tube plate were presented, during the regime of starting-up. Numerical model done by FEM was verified by experimental results.
The performed analysis showed that the tube plate of the first reversing chamber, the boiler element with the thickest wall, is exposed to the highest thermal stresses. This part of the boiler is exposed to temperatures t>500 ℃ and it is exposed to creep. In conditions of creep, continuous accumulation of plastic deformations occurs at a rate that depends on the level of stress, temperature and material characteristics.

Keywords

Hot Water Boiler, Start up, Thermal stresses, Experimental measurements, FEM

Acknowledgement

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STRUCTURAL ELEMENTS WITH GEOMETRIC DISCONTINUITIES-NUMERICAL AND EXPERIMENTAL DETERMINATION OF STRESS AND STRAIN STATE

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Abstract

The results gained from longterm research regarding the behavior of structural elements with geomrtric discontinuities are presented in this paper. The base of this paper is the analysis of complex geometries of various loaded elemnts and the impact of the geometry on stress and strain state. Numerical analysis was conducted by applying the finite element method in a "KOMIPS“ and „ABAQUS“ software package. Experiments were performed at the Laboratory for stress and deformation measurements, Faculty of Mechanical Engineering, Belgrade University, using "GOM“ equipment and "ARAMIS" software application. This paper demonstrates how it is possible to anticipate the results by applying FEM. The results gained by numerical and experimental analysis are presented in the last two chapters. Furthermore, their comparative analysis is presented.

Keywords

Structural elements; FEM; experiment; stress; deformation

EXPERIMENTAL RESEARCH OF MECHANICAL CHARACTERISTICS OF RAILWAY VEHICLES SAFETY COUPLING COMPONENTS

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Abstract

The coupling system provides a mechanical connection between European railway vehicles. Screw couplings are designed as a safety device in railway vehicles with coupling links and screw as two main components intended to break. Failure of these components is necessary when the load between vehicles is exceeded, otherwise more significant draw gear elements will fracture. The analysis of train break cases shows that the failure of the links occurs only in an approx. 6% of cases. Therefore, the links taken from exploitation after more than 30 years in operation were tested to determine their mechanical characteristics. Tensile testing was performed according to the ISO 6892-1 standard with a continual force and a minimal and maximal test speed prescribed by ISO 6892-1. The values of mechanical characteristics of coupling links are substantially improved during production after heat treatment by hardening and tempering. However, test results of mechanical characteristics didn't meet all prescribed limits for the minimum requirements according to UIC 826. The current regulations of mechanical characteristics were not in force in time of link production. Examination of the tested links showed a ductile fracture and the cross-sectional area shows the planar stress state.

Keywords

Railway; Coupling; Fracture; Experimental investigations

Acknowledgement

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THE INFLUENCING FACTORS ON THE INTEGRITY OF ORTHOPAEDIC IMPLANTS

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Abstract

Taking into account the importance of research in areas important for successful design and ensuring the integrity of implants placed inside the body, the main focus of this paper is a procedure for analysing the integrity of orthopaedic implants. Within this paper, the problems that lead to the need for surgery and placement of prostheses are presented, and an overview of current approaches to the design and research of orthopaedic prostheses is given. The reasons for achieving and ensuring the integrity of the joint replacement prosthesis are explained, from the point of view of surgeons and engineers. The most significant influencing factors on the integrity of orthopaedic implants are analysed, which include the type and geometry of the prosthesis, surgical implementation techniques, biological and mechanical factors, as well as the characteristics of the biomaterial. The design parameters that should be considered in orthopaedic implants are also the fracture mechanics parameters, so it is necessary to understand the occurrence of crack initiation and its further propagation, to prevent catastrophic implant fracture. Examples of application of the optical experimental method of testing the behaviour of biomaterial with crack are presented, when it is possible to monitor the crack initiation and crack growth, until the final failure of biomaterial, in terms of detailed presentation of displacement and deformation fields formed in the material. It can be concluded that the study of the behaviour of biomaterials used to make orthopaedic prostheses under the action of external loads plays an important role in ensuring the integrity and safe operation of the implant. It is especially important to define under what conditions their fracture occurs and what factors influence the dynamics of load-bearing.

Keywords

Orthopaedic implants, structural integrity, implant failure, biomaterial, crack

Acknowledgement

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POSSIBLE SOLUTION OF IMPLEMENTATION OF THE OMIS METHOD IN EXISTING COLONOSCOPE FOR IN VIVO CANCER SCREENING

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Abstract

In the modern world, cancers are diseases that have become one of the main causes of premature death in all generations. The best solution for this type of disease is prevention, which consists of initial exams, screening, and monitoring. A proposal for a new construction solution was proposed based on many years of work in colorectal cancer classification using Opto-magnetic imaging spectroscopy. The solution involves the implementation of the OMIS method in existing colonoscope solutions for in vivo examinations of patients.
The technical characteristics of the device allow for two modifications. According to the first solution, it is possible to perform imaging with diffused and polarized light with an additional source of polarized light that would be placed in the biopsy channel, and for diffused light, the existing light source would be used. An existing CCD sensor would acquire images. In this way, an LED would be passed through the suction channel to illuminate the desired region at the Brewster angle. In another solution, a modification of the probe tip is proposed, which would include the OMIS lighting system, ie LED for diffused light and LED for polarized light, and the already existing CCD sensor would be used as an acquisition device. Such a solution would require an increase in the diameter of the colonoscope probe, which would contribute to the discomfort of the examination itself.
Although the technology itself is not a direct treatment, one of its potential future applications is the evaluation of a new colon and rectal cancer treatment strategy, "wait and watch", which allows those treating without residual cancer to safely follow imaging instead of surgery. With further improvement, OMIS can enable real-time "optical biopsy" of colorectal tissue, which could target diagnostic and therapeutic interventions to target areas of abnormal mucosal growth.

Keywords

Opto-magnetic imaging spectroscopy, colonoscopy, cancer, classification, imaging

Acknowledgement

Presented results are the result of research supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia under Contract 451-03-9 / 2021-14 / 200105 from February 5th, 2021.

MODELING AND TECHNO-ECONOMIC OPTIMIZATION OF A COGENERATION PLANT FOR COMBUSTION OF BIOGAS

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Abstract

Although livestock farming is a significant part of agricultural market in Serbia, there are just seldom cases where biogas cogeneration is applied. In this paper, energy efficient energy supply technologies and potentials for their application in livestock farms are analyzed, with focus on cogeneration for combustion of biogas. Potential to produce biogas is assessed based on the capacity of the case study farm. A methodology for pinpointing profitable energy supply options which also provides significant energy and CO2 savings is applied. A case study of a pig farm was used to perform an energy balance. Potentials for application of energy supply technologies based on local resources have been estimated in the study. The effects of integration of proposed technologies were also estimated. The energy consumption and supply model were for a typical meteorological year were created using TRNSYS software. Verification of the model was done based on the on-site visit gathered measured data, for limited points in the energy supply system, which corelate to the TRNSYS model. Investment in a biogas cogeneration plant showed profitability potential. Optimal power of the cogeneration unit was determined based on Genopt-Trnsys optimization, with respect to the determined biogas production and tecno-economic optimization criteria.

Keywords

Cogeneration, biogas, optimization, Trnsys, modeling verification

Acknowledgement

This research was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Contract No.#451-03-9/2021-14/200109)

MICROSTRUCTURE AND MECHANICAL PROPERTIES OF ANODIZED SURFACE OF ULTRAFINE-GRAINED TI-13NB-13ZR ALLOY FOR BIOMEDICAL APPLICATION

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Abstract

Anodized surface on coarse-grained (CG) and ultrafine-grained (UFG) Ti-13Nb-13Zr alloy was obtained using electrochemical surface modification in the 1M H_3PO_4 + NaF electrolyte. Scanning electron microscopy (SEM) was used to characterise the microstructure of anodized surface, while mechanical surface properties were determined from the nanoindentation test. Numerical analysis of deformation of oxide film exposed to nanoindentation is performed on simplified 2D finite element models, with the main aim to determine the influence of the dimensions of the nanotubes on resistance to external loading. Software package Simulia Abaqus is used. It was shown that the homogeneous oxide film was formed at longer time period, while inhomogeneous oxide film was formed at shorter time period, for both materials. The oxide film was composed of nanotubes, whose deformation after the nanoindentation test is characterized by SEM. The surface of anodized alloys has lower mechanical surface properties (modulus of elasticity and nanohardness) than surface of non-anodized ones, which make them more acceptable for biomedical usage. Numerical calculations revealed the influence of morphology of the anodized surface layer on its load carrying capacity.

Keywords

High-pressure torsion, Nanoindentation, Mechanical surface properties, Anodized surface microstructure, Ultrafine-grained Ti-13Nb-13Zr alloy

Acknowledgements

This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Contracts No. 451-03-9/2021-14/200287, 451-03-9/2021-14/200135). The authors of this paper owe great gratitude to Dr Anton Hohenwarter from the Erich Schmid Institute of Material Science, Leoben, Austria, for the preparation of the UFG TNZ alloy.

Numerical Methods

Invited lecture

A FINITE ELEMENT MODEL OF MORTISE AND TENON JOINT

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Abstract

The objective of this study was to investigate contact forces and deformations of two mostly used joints in furniture industry: oval tenon and a mortise, and dowel and a hole. As furniture representative which is exposed to both static and dynamic loads, chair was taken as a work objective. Durability and strength of chairs are influenced by a large number of correlated factors which make the overall stress-strain situation very complex. The theoretical analysis was performed using the finite elements method, whereas experimental verification of the results, obtained analytically, was carried out on a chair model resulting from optimization. Verification of the obtained stresses and strains was carried out using strain gauges positioned on chair samples. Analysis was carried out according to European norms. During the production of test pieces' types of fit and types of joints were varied. Based on the results of the comparative analysis of the strain on chair elements measured using strain gauges, and the strain achieved on a virtual model, it can be concluded that the type of the finite element, mesh size, displacements, the way of load transfer, as well as the parameters used for material defining were properly selected. Based on the obtained results of the analysis of joints, by the finite elements method, models for dimensioning details and joints were determined. By applying the finite elements method, it is possible to analyse and determine stress distribution and sizes in various chair joints, and calculate the dimensions of elements and joints.

Keywords

Wooden chairs, FEM, mortise and tenon joint, glue line, rigidity

THE POTENTIAL FOR FORECASTING THE PARTICULATE MATTER LEVELS IN COMPLEX URBAN ENVIRONMENT

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Abstract

In this study, we employed regression analysis by means of machine learning eXtreme Gradient Boosting method for estimating the relationships between particulate matter (PM_{10}) concentrations and a number of parameters including benzene, inorganic gaseous pollutants (SO_2, NO, NO_2, NOx), Global Data Assimilation System-modeled (GDAS1) meteorological parameters, as well as daily and weekend PM variations in Belgrade, Serbia. The data was provided by the Institute of Public Health Belgrade, Serbia. The successful and reliable predictions were provided with relative errors in the range from approx. 19% to 26% and correlation coefficients higher than 0.95. The lowest relative error and the highest correlation coefficient were obtained for monitoring station of rural/industrial type located in Ovca, while the highest difference between modeled and measured values were detected at urban-type monitoring stations Novi Beograd and Institute of Public Health Belgrade, both of which are exposed to traffic emissions. The modeling results were not satisfying for rural/industrial monitoring station located in Veliki Crljeni (relative error>30%, corr. coefficient<0,8), which implies that the dynamic of PM_{10} emissions at the selected monitoring site were not governed by the available data on pollutant concentrations and meteorological parameters.

Keywords

Particulate matter, air pollution forecast, machine learning

Acknowledgement

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THE IMPACT OF HUMIDITY AND TEMPERATURE ON PARTICULATE MATTER ENVIRONMENTAL FATE

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Abstract

In urban environments, particulate matter, benzene, NOx, and SO_2 originate from common anthropogenic sources including traffic and industrial emissions, as well as fossil fuel burning for the purpose of heat and electricity production. In this study, the influence of relative humidity and temperature on PM_{10} concentrations in the Belgrade urban area was investigated using SHapley Additive exPlanations (SHAP) attribution method. In the presence of higher humidity or moisture in the re-suspended particles, and in the presence of soot and inorganic oxides as catalyzers (MgO_2 or Fe_2O_3), SO_2 will be adsorbed on the particle surface resulting in the secondary aerosol formation. Unlike SO_2, NOx tends to be less water-soluble, which makes them less prone to adsorption to the particle surface. In the presence of sunlight and hot weather, NOx and volatile organic compounds will more often participate in photochemical reactions with hydroxy, peroxy, and organic radicals in the air, resulting in the formation of tropospheric ozone.

The impact of intensive fossil fuel combustion for heating purposes contributes to an increase in PM_{10} concentrations by an average of 10 μg m^{-3}. In the case of using fuels with high sulfur content, this increase can be as high as 20 μg m^{-3}. With the temperature in the range from 0 to 25°C, the effect of temperature on suspended particles is negligible, while during warmer weather, at temperatures exceeding 25°C, the resuspension of particles contributes to an increase in particle concentrations to about 4 μg m^{-3} on average.

Keywords

atmospheric aerosols, meteorological factors, artificial intelligence

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THE IMPACT OF GASEOUS POLLUTANTS ON PARTICULATE MATTER DISTRIBUTION

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Abstract

In this study, we used eXtreme Gradient Boosting machine learning and SHapley Additive exPlanations (SHAP) explainable artificial intelligence methods to examine the relationships between PM_{10} and other air pollutant concentrations in the urban area of Belgrade. The data was provided by the Institute of Public Health Belgrade, Serbia. As shown, the most significant relative impact of benzene levels (50%) on the increase of PM_{10} concentrations up to several tens of μg m^{-3} was recorded at the occasions when benzene concentrations exceeded 5 μg m^{-3} and the concentrations of NO_2 were low (combustion of fossil fuels). The same effect was less pronounced at higher NO_2 concentrations. Taking into consideration the relative impact of SO_2 on PM_{10} levels and the observed relationship between NO and PM_{10}, four dominant environment types that describe the PM level dynamics were distinguished. In the first-type environment, the decrease of PM_{10} levels noticed for SO_2 levels below 50 μg m^{-3} and the dominance of sources with a significant share of NO (> 120 μg m^{-3}) were attributed to traffic emissions. The ambiance recognized as type 2 with no effect on PM levels is characterized by low gaseous oxide concentrations. The third and the fourth type of environment are characterized by SO_2 values exceeding 50 μg m^{-3} and their significant impact on the increase of PM_{10} concentrations.

Keywords

particulate matter, inorganic gaseous pollutants, explainable artificial intelligence

Acknowledgement

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SPATIO-TEMPORAL ANALYSIS OF MOBILITY PATTERNS IN THE CITY OF BELGRADE

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Abstract

Information about human mobility is essential for sustainable development planning. It is crucial for urban and transportation planning and the role of mobility in reducing contributions of human activities in air pollution and fighting climate change. While *human* mobility patterns are typically stable over space and time, they can dramatically change due to critical events, such as earthquakes and epidemics. We still lack a detailed description and understanding of how these critical events influence mobility patterns. In this work, we combine artificial intelligence tools with tools and methods from complex network theory to study human mobility patterns in the City of Belgrade during the COVID-19. We use data about mobility in the City of Belgrade between May 2020 and January 2021 from the Facebook Data for Good dataset. The City of Belgrade is divided into 201 cells with information on the mobility before and during the crises within and between the cells. The time resolution of the data is 8 hours. We use the k-mean clustering technique to cluster the data and find five clusters with different average mobility patterns. All mobility time series have trends and cycles, but they differ between clusters. While residential and suburban area clusters have the peaks of activity during the working days, clusters including central municipalities have the peak of activity during Saturday afternoon. Our results show that different city areas react differently to COVID19 information and that this aspect has to be considered in air pollution and crisis management planning.

Keywords

mobility patterns, time series analysis, k-means clustering

Acknowledgement

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ENVIRONMENTAL FACTORS GOVERNING PARTICULATE MATTER DISTRIBUTION IN AN URBAN ENVIRONMENT

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Abstract

In this study, we employed SHapley Additive exPlanations (SHAP) attribution method to investigate the PM_{10} concentrations in Belgrade (Serbia) and interpret the behavior of regression machine learning eXtreme Gradient Boosting method obtained on benzene, inorganic gaseous pollutants, Global Data Assimilation System-modeled meteorological parameters, as well as daily and weekend PM_{10} variations. The data was provided by the Institute of Public Health Belgrade, Serbia. As it was concluded, PM_{10} concentrations were dominantly defined by a variable assigned to emission source intensity variations. The impact of the emission sources on registered PM_{10} concentrations was not continual, but rather showed variations of up to 50%, when compared to impacts of other analyzed factors. The most important variables which describe PM level dynamics in the urban area of Belgrade include meteorological variables momentum flux intensity, standard lifted index, volumetric soil moisture content and temperature, as well as concentrations of benzene, NO, NOx, and SO_2.

Keywords

criteria air pollutants, machine learning, explainable artificial intelligence

Acknowledgement

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FE ANALYSIS OF THE SUPPORT ASSEMBLY OF THE PORT BAY BRIDGE

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Abstract

Port bay bridge (PBB) presents unique challenges in design and construction compared to the conventional bridge. This research aims to present a 3D finite element analysis of the PBB supports. At all points of supporting parts (wheels, plate, and pin) where one tunnel is in a contact with another tunnel, the same supporting elements are used, and what differs at these points are loads that have to be carried. Since it is expected that pins will be the load-carrying elements with the highest stress, the safety factors will be evaluated according to the stress calculated on pins. Reactions forces will be applied on both wheels equally; that is, any reaction force must be divided by two first (since there is pair of supports at all points), and then obtained value must be divided again by two (since there are two wheels on each support). The moment on the pin equals zero when F1 and F2 are equal (this is an ideal case); otherwise, the twisting moment (torque) occurs. Possible values of twisting moments are also analyzed and presented later in this paper.

Keywords

Port bay bridge, design, forces, FE analysis, safety factors

Acknowledgement

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FINITE ELEMENT AND FRACTURE MECHANICS ANALYSIS OF A CRACKED PRESSURE VESSEL

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Abstract

Stress distribution, as obtained by the finite element method (FEM), and corresponding fracture mechanics parameters, have been used to assess integrity of a pressure vessel. Once the stress distribution is known, the most critical area can be analysed with assumed crack to estimate its critical length according to fracture mechanics parameters and basic laws. Toward this end, the Failure Assessment Diagram (FAD) is used to calculate the crack length corresponding to the limit curve. As one can see, coordinates in FAD are ratio of net stress and critical stress (X axis, $S_r=S_n/S_c$) and ratio of stress intensity factor and its critical value (Y axis, $K_r=K_I/K_{Ic}$). Once net stress and stress intensity factor are known, as well as their critical values, coordinates of a point corresponding to any crack length can be calculated and positioned in the FAD.

Keywords

Finite Element Analysis, Structural Integrity, Fracture Mechanics, Crack, Pressure Vessel

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HYBRID PSO-NEWTON-RAPHSON ALGORITHM FOR INVERSE KINEMATICS PROBLEM IN ROBOTICS

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Abstract

Newton-Raphson method is a deterministic numerical method for solving a system of nonlinear equations. In robotics, it is used to solve inverse kinematics problems. In order to converge towards the optimal solution, the Newton-Raphson method requires a good initial value guess, which can be challenging to obtain. The Particle Swarm Optimization (PSO) algorithm is a stochastic optimization technique for solving nonlinear problems. The advantage of the PSO, in this case, is its ability to search a large amount of data. The PSO can narrow down potential solutions close to the optimal solution and use them as an initial guess for the Newton-Raphson method. Then, the Newton-Raphson method takes over and converges towards the desired optimal solution. In this paper, the feasibility of the hybrid PSO-Newton-Raphson algorithm for solution of robot inverse kinematics problem is investigated for a six-degree of freedom robot arm. All six joints of the robot arm are revolute. The cost function for the PSO algorithm is formed as a function of error between the desired and actual position of the robot arm end-effector. The numerical simulation is carried out to verify the applicability of the proposed concept.

Keywords

Inverse kinematics, particle swarm optimization, robot, nonlinear numerical method.

Acknowledgement

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DEVELOPMENT AND STRENGTH ANALYSIS OF THE SUB-ASSEMBLY IMPLEMENTED IN THE BEARING STRUCTURE OF THE "AVENIO" TRAM

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Abstract

Railway vehicle “Avenio” is a Siemens low-floor tram model. One of the steps towards the successful production of this tram is reflected in the optimal production of each sub-assemblies and element. The most important aspect of the development and production of elements is the safe operation of the vehicle system and comfort drive during exploitation. In addition, it is necessary to take into account the cost-effectiveness of its manufacture as well as maintenance costs. In order to reduce the production and maintenance costs of the whole system, the production of one of the components of this tram that is called a “tilt stabilizer” was optimized. This element has a very important role within the vehicle construction because it controls the inclination of the vehicle body in relation to the bogie around the longitudinal axis. This way reduces the discomfort to passengers caused by centrifugal force and prevents further narrowing of the vehicle profile. The primary design of this assembly is based on the welded construction. The device consists of 4 mechanical elements built into the tram structure. Bearing in mind that welded construction characterizes a higher cost of production, the idea was to design subassembly for the production on a numerically controlled machine and to successfully replace the current method of production in this way. For the newly adopted solution of the model, a static strength calculation was made which determined that the tested model satisfies the load conditions that occur in the structure. Static strength analysis was performed by finite element method in the "Ansys Workbench" software package, according to the criterion for equivalent "von - Mises" stresses. Results showed that modified structure and applying of new production method give absolutely acceptable assembly with requested strength and significantly lower life cycle costs.

Keywords

Railway Industry, Rolling Stabilizer, Bogie, Finite Element Method

Acknowledgement

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VALIDATION OF AN OPEN-SOURCE FINITE-VOLUME METHOD SOLVER FOR VISCOPLASTIC FLOWS

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Abstract

In the present paper, we discuss implementation details of a free and open-source numerical solver based on the finite volume method for numerical simulation of viscoplastic non-Newtonian fluids. In addition to the fact that they are involved in many industrial applications, both their physical properties and their rheological behavior make them challenging for numerical simulation. Viscoplastic fluids are known to behave as solid unless the shear stress reaches a critical level, known as yield-stress, beyond which they behave as liquid. In most cases, both yielded and unyielded regions coexist in the fluid domain. In mathematical model of viscoplastic fluid, the constitutive equation is a non-differentiable function. This is often overcome by using the approximate constitutive equation that has a regularized form, e.g. the Papanastasiou regularization model. Using the same approach, we assess the influence of regularization parameters on simulation convergence and results accuracy. In this study, we give implementation details of viscoplastic fluid models in freeCappuccino open-source Computational Fluid Dynamics code. Moreover, we perform validation on several well known benchmark cases and compare proposed approach with those existing in published literature. We also perform a parametric analysis and show the effect of Reynolds and Bingham numbers on the extent of the yielded regions. Conclusions of the study have relevance in practical application of computational fluid dynamics to viscoplastic fluids in particular and to non-Newtonian fluids in general.

Keywords

Computational Fluid Dynamics, Finite Volume Method, Non-Newtonian fluids, Bingham fluid, Papanastasiou regularization

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New Technologies

Invited lecture

DEVELOPMENT OF AN OUT OF VACUUM SOLUTION FOR PARTICLE DETECTOR ELECTRONICS USING COMMERCIAL CAD SOFTWARE

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Abstract

The development of an Out of Vacuum (shortly named: “OoV”) solution for particle detector electronics, as a part of the upgrade of the ATLAS Forward Proton (AFP) detector, is presented in this paper. The AFP detector is housed on a flange inside a Roman Pot (RP) station that comes very close to the beam of the LHC during data taking when there are interactions/collisions at Point 1. In order to minimize multiple scattering, the RP bottom side/window separating the detector from the bream is made very thin (200 μm) and hence, in order to protect it from ultra high primary vacuum of the LHC, it is kept in a secondary vacuum. However, some particle tracking detector electronics, in particular MCP-PMT (Micro Channel Plate Photomultiplier Tube) was proven to show strong deterioration or even malfunction under vacuum. Hence, the flange needed to be modified in order to allow operation in ambient air. The new design also includes a quartz window, serving also as the interface between the LQ bars channeling light produced by Cherenkov radiation in secondary vacuum and the MCP-PMT in air on the other side. The quartz window is mounted on an MCP-PMT holder and fixed between the spacer and a nut from the upper side, as well as with an O-ring from the bottom side, making it much less mechanically stressed due to pressure differences. It is also possible to adjust the height and angle of the MCP-PMT holder by means of four high precision screws. Bellow is used as the interface between the MCP-PMT holder and the flange, allowing sealing and vertical adjustment. There are two O-rings mounted on the bellow; one between the flange from the upper side and second on the MCP-PMT holder on the bottom side. The MCP-PMT itself is mounted Inside the MCP-PMT holder, kept in place using also the cable holder with heat conducting pads. The holder is also kept in place by means of four clamps from the outer side. An FEA analysis was conducted as well based on the designed CAD model. After verification, first prototype was made, which was used for extensive testing of proper sealing. After an official review by CERN experts, the solution was approved for installation.

Keywords

OoV solution, MCP-PMT, AFP

Acknowledgement

The author wishes to thank the Ministry of Education, Science and Technological Development of the Republic of Serbia for providing financial support that made this work possible (by the contract: 451-03-68/2020-14/200105).

SENSOR DETECTION OF HONEYCOMB CONTENT

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Abstract

Humans and honey bees have had an important relationship from the beginning of civilization. AIthough we are living in a digital world, beekeeping principles have not changed for the last 250 years. Beekeeping still requires manual monitoring of bee colonies and rely mainly on human labor, knowledge, and experience. Novel beekeeping approach in the form of precision beekeeping relies on a set of sensors used to monitor the health and productivity of beehive colonies. The main inspiration for this paper represents is a research conducted by Powner et al., and the positive effect on bees' health after infrared light exposure. Our research investigates the possibility of honeycomb content detection using infrared sensors with similar characteristics to the one used in the Powner's research. We construct a system of one honeycomb, one sensor, power supply, and signal measurement equipment. Using this system we perform experiments on four possible real-life situations of honeycomb content: empty, with honey, with pollen, and with the brood. Experimental results obtained using the system for honeycomb content detection show promising results. They prove that it is possible to detect honeycomb content using infrared sensors in each of four real-life situations.

Keywords

Sensors, Infrared, Honey comb, Detection, Precise beekeeping

STRATEGIC IMPORTANCE OF SERBIAN HIGH-TECH BUSINESS INCUBATORS

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Abstract

There is no doubt that high-tech start-ups require support from government institutions on one hand, and nourishment from private sector on the other, but there is also no denying the fact that those start-ups are crucial for Serbian economy and tech landscape as a whole. All of the previously conducted research shows that high-tech business incubators represent a significant part of economic development. This paper aims to examine the role of business incubator on SMEs (small and medium-sized enterprises), and high-tech start-ups and explore which types of support drive this impact, but also to investigate impact on wider economic and social landscape in Republic of Serbia. Furthermore, the overall benefits of government investing in incubators are elaborated with review of private vs public ownership and differences in opportunities that they provide. Examination of a large set of KPIs (key performance indicators), rationalizes the need for strategic governance and systematic support in order for efficiency and effectiveness to be achieved. Results should provide proper model for development of innovation ecosystem and entrepreneurship support by using business incubator as a tool. If managed properly, incubators can drive innovation and progress through wide range of services such as management support, financial resources, technical services or simply offering adequate office space. This will enable them to become a key component of national development strategy since they can help high-tech companies to survive and develop in most critical initial phase.

Keywords

High-tech Start-ups, Business Incubator, Entrepreneurship Ecosystem, Performance Management

APPLICATION OF 3D TECHNOLOGIES IN THE FUNCTION OF PROTECTION OF CULTURAL HERITAGE OF MONTENEGRO

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Abstract

As a country with a rich history and cultural heritage, Montenegro certainly has an obligation to protect and adequately manage it. A wide range of buildings (churches, bridges ...), exhibits (furniture, weapons, ...), cultural monuments, works of art, and others, which over the centuries have been exposed to a certain form of the devastation caused by weather or illegal actions, requires adequate a system of recording, management and especially protection in the broadest form of the word. To this aim, this paper proposes, among other things, the method of application of modern 3D technologies, in the function of the development of a digital register of cultural heritage in Montenegro for adequate, efficient, and effective recording, management and protection, development of a 3D digital database of cultural heritage for restoration according to the model that fully corresponds to the original, making a 3D database for the needs of the so-called, reversible engineering, ie repair due to damage, according to the computer model that fully corresponds to the original, etc. In this way, the authors of the paper will come to an excellent basis for the realization of an integrated and centralized information system for the management and protection of cultural property in Montenegro. At this stage, the object of research of this paper is cultural assets in Montenegro, and only specimens from part of the movable and part of immovable cultural heritage, based on which an algorithm will be created for later mass application to the entire cultural heritage.

Keywords

3D technologies, cultural heritage, information system

ROUGH MILLING WITH END MILL CUTTER IN APLLICATION FOR FREE FORM SURFACES MACHINING

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Abstract

This paper has presented the development of a sequel of conducted research in the field of free form surface machining at the Faculty of Mechanical Engineering in Belgrade. In order to machine as much as a possible material, it was developed machining strategy for rough machining with end mill cutter with a big diameter as the part of free form surface machining. Rough machining according to the developed strategy allows obtaining an approximate shape of the free form surface in the shortest possible machining time. After rough machining, one part isn't present big deep of cut for finish machining with ball end mill cutter which is also the final step in machining. Using this strategy is possible to reduce the cost of production and according to that cost of the final product. The developed strategy was implemented in the CAM application and using it NC code was generated. Experimental verification of generated NC code was performed on horizontal working centre and measurement of a machined part was performed after machining too. With analysis of measured dimensions, it was verified usage of developed strategy which was implemented in CAM application.

Keywords

CAD/CAM systems, Free form surfaces, Rough machining, End mill cutter

Acknowledgement

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APPLICATION AND CHARACTER OF DESIGN FOR RECYCLING (DFR): CHALLENGES AND OPPORTUNITIES

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Abstract

Design for Recycling (DfR) is essentially one of the eco-design strategies. The overall goal of this strategy is to achieve sustainability of production - responsibility to future generations. The basic approach to sustainability is Industrial Ecology, which is based on the imitation of natural processes that are in harmony with the environment. Industrial Ecology (IE) is concerned with the shifting of current industrial process - open loop systems - to a closed loop system where wastes can be reused. In addition to IE there are Green Technologies (GT) – goods and services which can avoid pollution rather than treat pollution. One of this services is Design for Environment which can be divided into two fields - Design for Recycling (DfR) and Dematerialization. While Dematerialization is concerned whit "doing with less", Design for Recycling (DfR) is there to promote material loops. In recent years, the impact of Design for Recycling (DfR) and its growing influence have been increasingly noticed. Design for Recycling (DfR) is concerned with the product life cycle which covers all activities from raw material extraction, manufacturing, and use to final disposal. Resource depletion is on the rise. For that reason, Design for Recycling (DfR) objectives are: avoidance of waste, reduction of landfill demand and reduction of toxicity. Recovery priorities are: re-use of materials, material recycling and energy recovery. Re-use is a series of activities that involves the collection, separation and processing of certain waste being put into new use. Materials which are put into new use are the one which have highest priority form environmental point of view and which require non-destructive disassembly. Regarding the design process there are several strategies which have to be adapted, and these are: material choice, reduction of material quantities, process techniques improvement, transportation and impact during usage and overall optimization the life cycle of a product. The goal of this paper is to present relatively new eco-design strategy called Design for Recycling (DfR) and to analyse practical and methodological approaches to the design process in the Design from Recycling projects.

Keywords

Design, Design for Recycling, Eco-design strategy, Sustainability, Re-use

ANALYSIS OF THE MATERIALS USABILITY IN ADDITIVE PRODUCTION TECHNOLOGIES

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Abstract

Nowadays it is in growing usage of additive production technologies, especially the FDM (Fused Deposition Modeling) method. The most commonly used materials in 3D printing are ABS (Acrylonitrile butadiene styrene) and PLA (Polylactic acid). ABS is a thermoplastic polymer of petrochemical origin, while PLA is a material that is most often fabricated by fermenting vegetable corn starch or sugar cane. PLA has a not so much unpleasant odor and is considered a biodegradable material, which is also the basic properties of this material. It melts at 190°C to 230°C. It is most often used for prototyping parts production. Since the material is biocompatible to the human body, various implants are made from it. Unlike PLA, ABS requires a higher melting point than PLA, usually 210°C to 260°C. It is used in 3D printing, instruments, sports equipment, parts that need to be resistant to falls, knife handles, mobile phone holders for cars, toys, etc. As they have similar values of tensile strength, both materials are adequate for prototype application, provided ABS has higher flexural strength and better elongation before cracking. Unlike PLA, ABS can withstand high dynamic loads. Based on the σ-ε diagram, it can be concluded that ABS has a larger plastic reserve than PLA.

Keywords

FDM, PLA, ABS, Additive production

Acknowledgement

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ADDITIVE TECHNOLOGY DESIGN FOR 3D PRINTIGN AND APLICATION TO FAST PRODUCT DEVELOPMENT

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Abstract

Quality of produced part depends based on generated G-code for 3D printing. Nowdays, various softwares for 3D printing technology design are presented. In this parer is presented procedure from product design to funcional prototype production using additive technologies. Product design and was conducted using commercial CAD software package. At the very beginning, it starts with a physical model that did not satisfy its full function. The first CAD model had greatly the same dimensions as the physical model, but some new geometrical features was implemented to new CAD model as well as some small details dimensions. Printing is performed by FDM (Fused Deposition Modeling) method on a 3D printer German RepRap x400. This technology allows a large selection in the selection of printing parameters of the desired object. All these parameters are defined in the software for production design, in this case Simplify 3D which allows generation of the G-code. Using generated G code the first prototype was produced and after that the CAD model was corrected in order to satisfy its full function.

Keywords

Fast product development, CAD, Additive production, PLA

Acknowledgement

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INTRODUCTION OF WORK INTEGRATED LEARNING (WIL) IN UNIVERSITY EDUCATION IN SERBIA

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Abstract

The overall aim of this paper is work-integrated learning (WIL) in university education that considers the Company as a learning environment together with the University. It is a form of training that brings three actors together: the Company, the student, and the University. The work described in this article is directed to the modern organized industry with the technically novel equipment for industrial processes, where the students, which are trained to expertise vital for the certain company, will gain practical knowledge that can be immediately applied, and the up-to-date approach will contribute to enhancing master study programs. WIL in higher education institutions and companies that typically implying graduates from these departments cooperate to adopt existing degree programs to better meet the needs of all involved stakeholders and society. Together they are creating a new learning environment that combines classroom knowledge within a work experience in the company.

Keywords

Work integrated learning, modern organized industry, learning environment, work experience, practical knowledge.

Acknowledgement

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Clear sky

INFLUENCE OF THE URBAN HEAT ISLAND ON INCREASED ENERGY USE FOR COOLING OF BUILDINGS

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Abstract

This paper investigates the effect of the increased air temperature due to urban heat island in the city of Belgrade on cooling energy demands of representative school buildings. Another objective of this paper is to evaluate the reliability of urban heat island intensity (UHII) factor as an indicator of urban cooling. The diurnal patterns of air temperature based UHII and variations in urban and rural area cooling were analyzed and discussed. The detailed air-temperature based UHII patterns were determined in several urban locations in the city of Belgrade and in one rural location near Belgrade. A three-dimensional numerical-analytical model was created and numerical simulations of the thermal flow field of the selected part of the urban environment were performed. The results of the measurements were used as boundary and initial conditions. The analysis of the experimental and numerical results have established the dependence of urban heat island intensity on urban and meteorological parameters, as well as the dependence of increased energy consumption during the summer period on the intensity of thermal islands. It is noted that the air-temperature based UHIIs were higher in the night-time while being lower or negative during the daytime. UHII for the urban environment was found to be in the interval from 4.8 °C to 9.5 °C. Energy consumption for cooling on examples of the representative school buildings ranged from 19.4 kWh/m^{2}a to 57.4 kWh/m^{2}a, depending on location.

Keywords

Urban heat island, numerical simulation, building cooling

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COMPARATIVE ANALYSIS OF CONVENTIONAL DIESEL AND ELECTRIC BUS CHARACTERISTICS - TECHNICAL AND ENVIRONMENTAL ASPECTS

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Abstract

The proper functioning of urban public transport is imperative in larger city areas. Thus the bus is still the most commonly used type of passenger transport. Taking into account the daily frequency of these vehicles, the emission and impact of harmful substances on the environment are very important. One of the most important factors when inspecting a vehicle is checking the emission of exhaust gases, which is a significant indicator of the regularity of the power group. If the emission is above the permitted limits, it is important to prevent further bus exploitation. Because of the aforementioned problems the advantage is given to electric vehicles, and as a representative of the propulsion, electric batteries with LTO (lithium titanium) capacity of 90.5 kWh that can be charched fast at the terminals are considered.

This paper analyses one city line where a comparison of technical features, energy efficiency and environmental effects between the existing diesel and new electric buses was made. Based on the set models, appropriate load simulations, and the obtained results, it was established that 12 electric buses replace 9 articulated buses according to the frequency of passenger transport.

In terms of energy efficiency, two modes of electric buses operation were analysed: the first without air conditioning and heating system, and the second at a temperature of -10 °C. Based on detailed research, it is recommended to introduce electric buses in public transportation, both in terms of cost-effectiveness and in environmental protection.

Keywords

Bus, public transport, electric propulsion, analysis of technical characteristics, environmental protection

Acknowledgement

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CHARACTERIZATION AND ANALYSIS ADHESION OF COPPER COATINGS ELECTRODEPOSITED ON FLEXIBLE SUBSTRATES

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Abstract

In this study, electrodeposition of nano-crystalline copper coatings (ED-Cu) from the sulphate bath on different substrate by the regime of direct current (DC) has been investigated. Composite systems of copper thin coatings (5-20 μm) on metal foil of copper, brass and stainless steel were fabricated. Electrodeposition was performed at constant current density (50 mA·cm^{-2}) in the open type electrochemical cell with application magnetic stirrer (100 rpm) in order to mixing electrolyte. Adhesion of coatings on different substrates was investigated by Vickers microindentation hardness testing in order to determinate relation between microhardness of the coatings and adhesion strength of the coatings to the substrates. The observed adhesion parameter is called the critical reduction depth. In order to evaluate the results of adhesion obtained by Vickers method, bidirectional bending test technique was performed to assess the adhesion behavior of ED-Cu coatings to the substrates. Bidirectional bending test machine was specially designed for this study. The mechanism performs bending of the sample under controlled and automated conditions. The critical cycle number (start of detachment of the coating from the foil) is observed. Then, the values of adhesion parameters obtained by applying two different measurement methods were compared. A comparative investigation showed that the ED-Cu coatings produced on brass substrate had much better adhesion then the same coating on steel, but weaker adhesion than Cu on Cu foil. It has also been confirmed that with increasing thickness of the copper coatings, adhesion decreases.

Keywords

Copper coatings, microhardness, critical reduced depth, adhesion, bending test, the critical cycle number.

Acknowledgement

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STRUCTURAL ANALYSIS OF SMALL-SCALE COMPOSITE PROPELLER BLADE

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Abstract

Contemporary, light-weight, unmanned air vehicles almost exclusively imply propeller rotors that enable them to hover, as well as to move vertically and horizontally at acceptable amount of required power (that is usually supplied by electric motors). Rotor main parts are blades − curved, rotational lifting surfaces subject to conjugate aerodynamic, inertial and gravitational loads. Their skin is usually made of composite materials, i.e. glass or carbon fibres (or their combination) immersed in epoxy resin. Additional inner structural elements may include shear webs, spar caps, ribs or foam fillers. The goal of the presented research study is conducting and validating structural analysis of a propeller blade by finite element method. Different structural models (containing just skin, or skin with foam filler), materials (glass or carbon, uni-or biaxial plies), and ply-up sequences (differing in layer numbers and orientations) are considered. The complete blade geometry is modelled, including the root and tip sections. The blade is clamed at the root, while computed aerodynamic, inertial and gravitational forces are distributed along its surface (and volume). Since the blade operates in axisymmetric conditions, it was possible to perform static structural analyses. Obtained results include deflection (and deformation) fields, normal and shear stress distributions along the plies, etc. From the acquired numerical values, it is possible to define an adequate blade structure that will be able to withstand all working loads (multiplied by necessary safety factors) and ensure safe flight of the aircraft. Future research may include modal or fatigue analyses of propeller blades.

Keywords

Propeller blades, Structural analysis, FEM, Composite structure

Acknowledgement

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NUMERICAL SIMULATION OF AIRFOILS FOR AIRBORNE WIND TURBINE

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Abstract

The rising concerns about global warming have increased interest in developing renewable and environmentally friendly energy sources such as wind, solar, etc. Wind energy can provide applicable solutions to the global climate changes. This energy is expected to take much more part in power generation in the coming years. Wind turbines are types of power plants that use renewable energy, wind, to generate electricity. A new type of wind turbine is beginning to be studied globally- airborne wind turbines.
Airfoils, as cross-sectional shapes of blades, wings or sails, are used universally in geometrics such as turbines, aircraft, etc. One of the important subjects in fluid mechanics is studying the fluid flow around an airfoil. Using different numerical techniques, the conservation equations of two-dimensional compressible flow over NACA airfoils were solved in this paper. Three different turbulence models, $k-\omega$ SST, the Spalarat Almaras and transition SST, were used for the closure of system of equations. Velocity and pressure fields obtained around these NACA airfoils were analysed, and their aerodynamic performances were compared. Program used in this paper is engineering simulation software- Ansys (Fluent).

Keywords

Renewable energy, Wind energy, Wind turbines, Ansys, Flow over airfoils

Acknowledgement

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PRODUCTION PROCESS OF COMPOSITE PROPELLER FOR MULTIROTOR UAV

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Abstract

The application of composite materials in the aerospace industry has begun since the middle of the 20th century. Their use in various elements of aircraft constructions has extended over time. Primary load carrying elements of some aircraft constructions are made of composite materials due to their excellent mechanical properties as well as the good strength-to-weight ratio. Propellers and fan blades of jet engines are increasingly made of high-quality composite materials. Besides the mechanical properties of the material, production technology has a great impact on composite structure quality.

The production process of two-bladed composite propeller is presented in this paper. Manufacturing of composite propeller for multirotor UAV application with suitable technology and relatively cheap materials is the main motive of this work. According to this motive, both (upper and lower) shells of the propeller are made of balanced plain weave glass fiber with epoxy matrix. The vacuum infusion process is used for shell manufacturing. After the polymerization process of shells (24h, 25°C), unidirectional carbon fabric reinforcements in the root zone and expanding polyurethane core are added during the bonding process. Then, the bonded propeller was cured 4h at 70°C.

The high production process quality of the two-bladed propeller with the previously described technology is partly confirmed in this paper. Namely, the checking of propeller geometry and comparison with the CAD model was performed. Results of that comparison showed that a high degree of agreement between produced and CAD model was obtained. Comparison of static test and numerical structural analysis could be subjects of future work. That would provide the final validation of manufacturing technology quality which is described in this paper.

Keywords

Propeller, Composite materials, UAV, Manufacturing

Acknowledgement

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IMPROVEMENT OF MECHANICAL CHARACTERISTICS OF PLA BY APPLYING REMELTING PROCESS

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Abstract

In this paper, bone-shaped samples (dog bone) made of thermoplastic polymer PLA were tested according to the ASTM D638 standard. All samples were made on a WANHAO duplicator i3 plus 3D printer. PLA is the most widely used polymer mainly due to its thermoplastic workability and good mechanical properties. The mechanical characteristics of the materials were compared after the realization of the samples on the 3D printer and after the remelting process. All samples were built in horizontal orientation. Remelting process involves stacking / packing samples in a mold and pressing them with sodium chloride (NaCl) powder. Since sodium chloride (NaCl) is a poor conductor of temperature, it takes some time for the experiment to be realized in order to equalize the temperatures throughout the volume of the mold. The mold thus formed was kept at 210°C for 30-45 minutes. The purpose of salt powder molding is to get even curing without deformation on the surfaces of the parts. The samples become rougher after this treatment and it is necessary to remove excess salt from the structure as well as additional surface treatment. The remelting process proved to be very cheap, but also quite unreliable due to the slow and uneven rise in temperature in the mold. The SHIMADZU AGS-X 100 kN tensile testing machine was used to test the tensile strength of the samples. During the experiment, it was found that the samples with remelting process have a much higher tensile strength compared to the untreated samples. Remelting procedure of PLA greatly improves the mechanical properties and gives better performance to complex parts printed on a 3D printer by reducing the anisotropic characteristics of the polymer. Further research would be related to the testing of other thermoplastic materials such as ABS, PET-G etc. It would be interesting to use other materials for molding and to perform a comparative analysis of the obtained results of the new molding methods with the described method of applying salt powder.

Keywords

Additive manufacturing, FDM, PLA, Remelting process, Tensile properties.

Acknowledgement

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COMPARATIVE ANALYSIS OF THE THREE SYSTEMS WITH CARBON-DIOXIDE AS A WORKING FLUID FOR INDUSTRIAL REFRIGERATION

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Abstract

Carbon dioxide presents long-term solution in terms of sustainability and it is part of the vision for the future with ecological fluids in refrigeration technology, firstly taking in account that is natural, safe and economic refrigerant with great vaporizing latent heat and quite high volumetric refrigeration capacity.
Investigation is based on the efficiency and consumpion of electrical energy analysis for system with two stage compression known as booster, system with parallel compression and multiejector system. Comparative analysis was for summer climatic conditions of Belgrade and for industrial system with 400 kW cooling capacity. Thermodynamic cycle with CO_2 is specific because it has transfer from subcritical to transcritical above the low temperature of 31,1˚C, and under that condition, cycles with this fluid have large loses, especially during throttling.
Results showed that bypass compression instead of bypass valve and using of multiejector (ME) device to recover expansion work, lead to energy savings of 10,3% for parallel compression system and 20,6% for system with ME, comparing to taken, referent, booster system, with note that systems majority of time worked under subcritical conditions (up to eight times).

Keywords

Natural refrigerant, transcritical, industrial instalation, booster system, multiejector

DESIGN OF SMALL-SCALE COMPOSITE VERTICAL-AXIS WIND TURBINE BLADE

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Abstract

Although less efficient than their horizontal-axis counterparts, vertical-axis wind turbines (VAWTs) present an interesting research topic as well as a renewable energy converter with lots of potential for application in both urban and secluded rural environments. This is mostly due to the fact that lift-type VAWTs require lower cut-in speeds, can operate in variable wind profiles, and produce low-level noise. Particularly interesting are small-scale machines that operate in low Reynolds numbers where viscosity effects are particularly noticeable.
The design of a small-scale composite vertical-axis wind turbine blade comprises several steps. First, the blade should be modelled and the expected aerodynamic loads should be estimated with sufficient accuracy. Secondly, structural analysis of its composite elements should be performed for various load cases (including conjugate aerodynamic, inertial, and gravitational loads at different wind speeds and/or wind turbine rotor angular velocities). Finally, manufacturing technology should be defined and the blade should be manufactured as well as experimentally tested so that the starting computational models can be assessed and validated.
The goal of the presented research study is to conduct a complete design process of a small-scale VAWT blade. Aerodynamic loads are numerically estimated by the finite volume method, while structural analysis of the blade is performed by the finite element method. Additionally, the lay-up sequence of the blade inner composite structure is optimized by the particle swarm method. In the end, the designed blade is produced by a wet lay-up manufacturing process. The consistency of strains, measured in several different cases of blade bending, and corresponding numerical values were mostly below 8% which justifies the adopted design procedure.

Keywords

VAWT, Aerodynamic load, Laminated composite, FEM, Multi-objective PSO

Acknowledgement

The research work is supported by the Ministry of Education, Science, and Technological Development of the Republic of Serbia through contract no. 451-03-9/2021-14/200105.

DESIGN AND ANALYSIS OF OPTIMAL BLDC MOTOR PROPELLER

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Abstract

The technological improvements in the field of electric motors, power electronics, and batteries have provided vast possibilities for the implementation of electric propulsion systems on aircrafts. Hence, there has been a lot of interest in this kind of propulsion in recent years. The use of electric components for propulsion can provide a significant increase in efficiency compared to other propulsion methods.

The overall efficiency of electric propulsion systems depends on the efficiency of the individual electric components as well as the efficiency of the propeller. Since every component has its own characteristic as well, matching them in order to obtain maximum overall efficiency for a certain design point can be a daunting task. In this paper, a propeller design methodology for a coupled BLDC motor/propeller is presented and an analysis of the off-design behaviour of the coupled system is performed. For the propeller design, a blade element momentum theory with vortex wake deflection was used while the motor was defined as a first-order direct current motor. The aerofoil characteristics for different Reynolds numbers were determined with the use of the XFOIL software.

It was shown that the high overall efficiency of coupled BLDC motor/propeller can be obtained by the proposed method. This would mean a higher overall efficiency of the entire electric propulsion system since these two elements account for most of the losses in the system.

Keywords

Propeller design, propeller analysis, electric propulsion, BEMT, BLDC

Acknowledgement

The research work is funded by the Ministry of Education, Science, and Technological Development of Republic of Serb

A STUDY ON HIGH VIBRATION BEHAVIORS OF VIPER MK. 22-8 JET ENGINE

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Abstract

Jet engines are machines with high speed turbine-compressor assembly (spool). In order to ensure the functionality of the engine core, a large number of bearings, gears, intermediate shafts are required that are interconnected and depend on the basic engine speed. New engines usually integrate equipment that performs vibration monitoring and diagnostics. Many aircraft today have engines that do not have vibration measurement and monitoring devices integrated. In addition to failures of individual bearings, gear assemblies and shafts, in these "old" engines, vibrations can be caused by material characteristics and structural integrity. Most often, the cause of vibration problems of old engines can be detected and eliminated only by using test bench equipped with vibration measuring and analysis devices. The research is based on an analysis of frequency and magnitude of the vibration accelerations at Rolls & Royce Viper Mk. 22-8 engine, at the harmonics of the engine running speed with aim to identify the engine malfunction.

Keywords

Jet engine, Vibration, Viper Mk. 22-8, Frequency spectrum, Failures identification.

THE WOOD PELLET PRODUCTION IN SERBIA – POSSIBILITY TO IMPROVE ENERGY CONSUMPTION AND GHG EMISSIONS

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Abstract

The focus of this paper is on increasing energy efficiency in production. The research was carried out in two Serbian pellet plants. Attention was paid to the production because this segment has the greatest impact on overall energy consumption in the wood pellets life cycle and on the environment. For the necessary calculations the “GHG Balance of Pellet Production” program, with some upgrades, was used. Proposed measures if applied would decrease specific consumption of wood biomass between 7% and 10%. The proposed improvements would give the best results in the field of environmental preservation. Alternatives in raw material, as well as different substitutes of fuels in pellet production, were presented in order of decreasing GHG emissions and improve energy efficiency.

Keywords

Wood Pellet, Energy Efficiency, GHG Emissions, Natural Drying, CHP.

Sustainable Design and New Technologies

Invited lecture

DEVELOPMENT AND DESIGN OF THE NEW MECHANICAL VENTILATOR

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Abstract

Global estimates suggest that around 5% of COVID-19 patients require intensive care involving a ventilator. So far, almost all ventilator manufacturers have boosted their production but they still can't achieve the required production growth. One way to solve the ventilator shortage problem was to develop and produce different new ventilator prototypes. The main objective of the paper is to present the development and design of one such fully functional ventilator prototype. It is based on the automatization of the ambulance balloon – which is already commonly used for artificial breathing so this solution provides much easier and faster medical verification of the finished product, performed by the independent third party (i.e. Society of Medical Engineers). The ventilator prototype was developed following all phases of the product development procedure, according to the recommendations from relevant medical experts. The new mechanical ventilator prototype has numerous advantages comparing to the similar commercially available products, such as four control modes – volume, pressure, combined and PEEP, full automatization, low price, and capability to work with or without electricity (in the case of power blackouts) but one of its most important advantages is an original system for sterilization of the patients exhale air, additionally protecting medical staff from COVID-19 virus. That system was developed simultaneously with the rest of the ventilator prototype and it treats patients exhale air with UVC light, high temperature, disinfectant (alcohol or chloride compound), and HEPA filtration.

Keywords

Product Development; Machine Design; Medical Devices; Mechanical Ventilator; Rapid Prototyping;

Acknowledgement

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RECYCLING AND UPCYCLING IN DESIGN

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Abstract

The aim of this paper is to show the utilization of sustainable design, through the usage of recycling and upcycling textile and other materials, in the making of a new renewable product with higher use-value. Modern consumer society is based on mass production and consumption of goods and with the innovative development of new technologies and materials, the production process is becoming faster, leading to the accumulation of surplus goods that are quickly filling up the landfills. Today, climate changes and limited natural resources are taken into serious consideration in the process of designing new products. Sustainability holds the answers and has complex goals when it comes to creating designed objects for everyday usage, with all the requirements for reducing the negative impact on the environment. Renewable products offer the idea of a change in lifestyle and habits in a consumer culture. In a search for a sustainable solution, many companies and designers are promoting the more efficient use of resources through recycling and reusing materials, with a dedication to modern esthetics. Sustainable design is becoming more current with higher global ecological requirements and with raising awareness in consumers on environmental issues. Future legislation for manufacturers includes requirements such as waste reduction, increasing the possibility for recycling, and longer life of their products. In this paper, the presentation of design solutions that use renewable principles in their work aims to encourage young artists and designers to incorporate the concept of sustainable design, in their work.

Keywords

Sustainable design, recycling, textile design, consumer society

EXPANDABLE AND ADAPTABLE TEXTILES FOR NEW AGE

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Abstract

A lot has been said and written about the clothing industry's pollution, waste and speed. While clothing manufacturing has doubled since 2000, a staggering 85% of all textiles get thrown away, a third without ever being sold. Speed of fashion is a huge issue – major European companies went from two collections per year in 2000 to five in 2011.and recently some even 24 collections annually.
But, pandemics changed the game completely. In the last year, the world abruptly came to a standstill with lockdowns, isolations, safety measures, unstable financial and labour markets. People turned to buy only the necessities leaving many industries, fashion included lingering and waiting for better days or new ways. Many big companies especially from the US filed for bankruptcy while sustainable and practical innovations might pave the way for a new fashion approach. Company Petit Pli had an idea in 2017 to create a light, waterproof and breathable material for a new concept of children's wear. At the core of this project are the fact that toddlers grow seven sizes in the first two years so they created highly functional and child-friendly alternative outfits that stretch and grow bi-directionally to custom fit a range of sizes. This revolutionary technology found another usage during the Covid crisis by launching MSK – a mask that expands offering better protection and reducing foggy glasses. This got them TIME's 100 Best Inventions of 2020 making waves and opening the door for adult wear.

Keywords

Fashion design, fashion technology, recycled material, fashion,

STABILITY ANALYSIS OF VIBRATIONS IN POWER PLANT SYSTEM

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Abstract

Vibration analysis is very popular field in science due to numerous applications in industry: fluid flow, magnetic field, translating and rotating elements, imbalances, interactions and frictional contacts etc. Power plant systems are dynamic systems that have been singled out as a special problem of vibrations that depend on structural properties, geometry and boundary conditions, which may change with time. The vibration responses measure deviations in spectral and transient characteristics for monitored systems. Eigenvalue analysis, as a fundamental component of electric power system Small-Signal Stability Analysis (SSSA), is performed for monitoring faults or the health condition of a dynamic system by using deviations in the vibration characteristics. Because of the complexity of those systems, it is important to reduce operational costs. In the literature there are several numerical methods for monitoring the health condition of a dynamic system by using deviations in the vibration characteristics that determine the full or a partial solution of a given eigenvalue problem. This solution consists of determining the stability of the system, i.e. of identifying whether a system has departed from the normal state. In this paper we propose numerical solution of this problem based on Geršgorin theorem, that consists of localizing the pseudospectra of the vibration matrix formulated problem. Among several well-known numerical methods, the localization of eigenvalues by applying the well-known Geršgorin theorem stands out for its simplicity and reduction of operating costs.

Keywords

Eigenvalue analysis; numerical methods, vibration, power plant, Geršgorin.

Advanced Materials and Technology

Invited lecture

EFFECTS OF SYNTHESIS PARAMETERS ON STRUCTURE AND PROPERTIES OF THE CERAMIC/POLYMER FILMS BASED ON BACTERIAL CELLULOSE

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Abstract

Cellulose, as the main constituent of plants, is the most common natural material that is widely used. Bacterial cellulose (BC) is a polymer of β-1,4-glucan chains, extracellularly attached to bacterial cells. It possesses the same structure as plant cellulose but its application has many advantages. BC has tinner threads, better crystallinity, mechanical strength and higher purity. By the means of micro- and nano-pores in the structure, it is possible to retain nano particles and enhance the application of obtained nanostructures. BC lacks antibacterial and antioxidative activity, conductivity and magnetic properties, which lowers the possibility of its application in biomedicine and electronics. To overcome previously mentioned deficiency, it is possible to apply bioactive polymers, nanomaterials or solid particles into the structure. High biocidal potential of TiO_2 originates from its photocatalytic properties, and the generation of reactive oxygen species (ROS). At the first site of action, they cause cell membrane damage and afterwards, they attack intracellular components causing cell death. Hydroxyapatite (HAp) is capable to act synergistically with TiO_2 and to accelerate its efficiency. Having in mind all characteristics of previously mentioned components, we have investigated the structure, morphology, mechanical properties and antimicrobial activity of advanced ceramics/polymer films. The influence of synthesis duration on BC structure, produced by Komagataeibacter xylinus species, was investigated. Thereafter, the possibility of TiO_2/HAp ceramic nanocomposite application in BC was examined. The developed structures were analyzed by SEM and EDS analyzes, as well as XRD and FTIR spectroscopy. Mechanical properties were investigated as well.

Keywords

Bacterial cellulose, TiO_2, Hydroxyapatite, Antimicrobial activity, Acetic acid bacteria

Acknowledgement

This study was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Contracts No. 451-03-9/2021-14/ 200116, 451-03-9/2021-14/ 200175 and 451-03-9/2021-14/ 200017)

CONSTITUTIVE MODELING AND CHARACTERIZATION OF CERAMIC MATERIALS

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Abstract

Advanced ceramic materials, due to their unique material properties, are finding large diversity of technological applications. These applications frequently include complex conditions such as thermal shocks, exposure to abrasive and corrosive wear, solid-state phase transformations, etc. Numerical modeling of these phenomena, apt to capture the overall, macroscopic behavior is rather challenging and often includes complex constitutive models depending on a large number of parameters. Such models are commonly not available within numerical tools employed for the simulations, thus an important task for their meaningful practical applications becomes the numerical implementation, usually within finite element codes. The reliability of these numerical simulations is highly related to the accuracy of constitutive parameters, entering into governing equations. These parameters are generally difficult to assess and often require a large number of experiments. Within this communication certain advancements considering the outlined problems are going to be presented. Specifically, two different contexts will be addressed: numerical modeling and related characterization of elastic hysteresis observed within porous ceramics for the applications of filters in diesel engines; second application concerns a phenomenological approach to model a multi-physics problem of a production of ceramic components that includes a primary phase of powder compaction followed by a subsequent sintering phase.

Keywords

Constitutive modeling, powder compaction, sintering, finite element modeling.

Acknowledgement

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THE INFLUENCE OF MECHANICAL ACTIVATION ON MICROSTRUCTURE AND DIELECTRIC PROPERTIES OF $SrTiO_3$ CERAMICS

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Abstract

In recent years, a lot of interest has been shown in obtaining materials with predetermined properties. The aim is to establish a functional dependence between the synthesis parameters, structural characteristics, and properties of the material. Ceramic materials based on strontium titanate ($SrTiO_3$) are of special interest due to their unique physical-chemical properties. Having in mind the importance of examining the influence of synthesis parameters on the process of obtaining and properties of functional electroceramic materials, and the importance of $SrTiO_3$ as a perovskite material, the motive was to analyze and consider the influence of mechanical activation. It has been established that the time of mechanical activation (0, 10, 30, 60, 90, and 120 minutes) of $SrTiO_3$ powders indirectly affects on electrical properties of $SrTiO_3$ ceramics. It was noticed that in $SrTiO_3$ ceramics the values of relative dielectric permittivity in the radio frequency range (0,3 MHz-3 GHz) are stable, which is important for the fabrication of electronic components. Microstructural SEM analysis showed that the increase in mechanical activation time results in less porous samples. It was found that the value of the relative dielectric permittivity of ceramic samples at room temperature changes following the combined effect of changes in sample density, grain size, as well as changes in the grain boundary region. The maximum value of dielectric permittivity was observed in the sample activated for 10 minutes. Also, the sample activated for 10 min exhibits relatively low values of loss tangent, compared to the other mechanically activated samples, providing the best overall dielectric performance compared to other samples.

Keywords:

strontium titanate, mechanical activation, sintering, electrical properties

Acknowledgment

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BT/ZNO COMPOSITE MATERIALS WITH IMPROVED FUNCTIONAL PROPERTIES

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Abstract

Due to a high-power conversion efficiency (PCE), perovskite solar cells (PSCs) are the most developing area of research in the past decade. Although lead–based inorganic–organic PSCs has achieved the highest PCE of 25.2%, the toxic nature of lead and poor stability of organic components strongly limits its commercialization. This problem can be overcome by developing of inorganic perovskites with a high PCE. Barium titanate ($BaTiO_3$, BT) belongs to the perovskite *crystal* structure materials *with remarkable dielectric, ferroelectric and ferromagnetic properties. In this research, to enhance functional properties of BT we employed functionalization with MEMO silane followed by in-situ alloying with ZnO in different BT to ZnO wt.%. Synthesized ZnO@MEMO@BT composites were tested as photo- and photo-electro catalysts under simulated* sunlight *irradiation. An enhanced catalytic activity of ZnO@MEMO@BT composites, compared to pure BT is probably due to the modified binding energy and an optimized band structure. In order to investigate the origin of improved catalytic efficiency, pristine BT and composites were characterized using a variety of techniques, including X-ray powder diffraction (XRD), Raman and Fourier transform infrared (FTIR) spectroscopy, field emission scanning electron microscopy (FESEM), UV-Vis diffuse reflectance and photoluminescence spectroscopy. The enhanced photo(electro)catalytic activity of the composite materials can be attributed to the synergetic effect of the surface defects and the ZnO/BT heterojunction particles, which enabled charge separation, thereby hindering the recombination of photogenerated carriers.*

Keywords

Barium titanate, Zinc oxide, photo(electro)catalysis, solar cells

Acknowledgement

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MEASUREMENT OF DIELECTRIC PERMITTIVITY USING COAXIAL CHAMBERS AND ELECTROMAGNETIC-MODELING SOFTWARE

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Abstract

Our research group has developed a method for measurement of complex relative permittivity of various dielectric materials in the frequency range from around 1 kHz up to several GHz. Material samples have preferably a disk shape. The thicknesses of the samples can be in a wide range, from about 10 μm (thick films) up to several mm. We have designed and manufactured a set of coaxial chambers, which we use as test fixtures. We have also developed two numerical-simulation programs for the electromagnetic analysis of bodies with rotational symmetry. One program is suitable for the low-frequency analysis. It is based on an electrostatic approach. The other program is based on an electrodynamic approach and it is tailored for microwave frequencies. In measurements, we use impedance meters and network analyzers to obtain the input impedance of a chamber with a sample. Thereafter, we implement our software for the electromagnetic modeling to extract the relative permittivity of the measured sample. As examples of verification of our method, we present here results for the relative permittivities of two sets of samples whose sizes are on the extreme limits of the method. The first set comprises poly (vinylidene fluoride) and mechanically activated ZnO nanoparticle composite films, whose relative permittivities are around 1.8. The second set comprises large, high-density samples of spinel (aluminum magnesium oxide) ceramics, sintered under various conditions. The measured relative permittivities of these samples are around 7.5. In all cases, good agreement with other available data has been obtained.

Keywords

Permittivity, Measurements, Electromagnetic-modeling software, Ceramic materials, PVDF

Acknowledgement

This paper was supported by the Project F133 of the Serbian Academy of Sciences and Arts and by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

PREPARATION AND CHARACTERIZATION OF ZrB_2-TiB_2 BASED COMPOSITES FOR HYPERSONIC SYSTEMS

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Abstract

ZrB_2 ceramics are considered potential materials for hypersonic systems in view of the melting point exceeding 3000 °C and excellent ablation resistance. Second phases, including SiC or CrB_2, further improve the oxidation behavior, whereas a lighter phase, like TiB_2 can decrease the overall weight. In this work, a powder mixture containing ZrB_2, TiB_2, CrB_2 and SiC was mechanically activated using high energy ball-milling. Sintering was performed by hot pressing following different thermal cycles, and subsequent annealing to remove oxide phases and reduce micro-cracking. The microstructure and hardness of the dense ceramics are compared in relationship to the thermal history. Fully dense ceramics were obtained with different oxide-phases amount depending on the sintering cycle and hardness approaching 24 GPa were achieved. Future works will explore the strength and oxidation resistance of this multi-phase system to check its suitability for hypersonic systems.

Keywords

mechanical activation, sintering, XRD, mechanical properties, ceramics.

Acknowledgement

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FDM PRINTING TECHNOLOGY APPLICATIONS IN DENTISTRY

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Abstract

In recent years, 3D printing technology is rapidly developing and constantly leading to new applications. One of the areas which have widely accepted benefits from 3D printing in dentistry, because of its demands to have personalized and customized dental products and appliances. Mostly used 3D printing methods in dentistry include stereolithography (SLA), selective laser sintering (SLS), fused deposition modelling (FDM), and digital light processing (DLP). This paper presents FDM printing technology and its applications in everyday dental practice.

FDM is a widely available technology, easy to be installed, with a relatively reliable quality printed parts. In the fused deposition modelling process, objects are created by layering different types of thermoplastic polymeric filament materials, such as polylactic acid (PLA). The polymer material is extruded through a nozzle device, where a computer controls the temperature and movement of the material. Material is in a semiliquid state, it hardness after the extrusion, and bonds to the previous layer. Parameters for printing that need to be defined are numerous, and dependant on every particular task. Experience from praxis shows that FDM is used for the production and prototyping of pattern of the complete denture, custom bite registrations, basic proof-of-concept models, simple, low-cost prototyping anatomical parts. Disadvantages of this technology are rough surface finish, inhomogeneous density, longer printing time. However, future innovations will alleviate some of the present disadvantages, by, for example, reducing steps that are needed to get the end product.

Keywords

3D printing, dentistry, fused deposition modelling

Acknowledgement

This research is supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

Artificial intelligence

Invited lecture

MODELING OF DAM STRUCTURAL RESPONSE USING ARTIFICIAL NEURAL NETWORKS

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Abstract

Rock-filled embankment dams are built of natural materials consisting of a dam body (stone overburden of various sizes) and sealing elements (usually clay core) to achieve water impermeability. Mechanical stability of dam implies stability of slopes and stability of foundation soil. The dam takes over the hydrostatic load and with its own weight transfers it to the foundation soil. Water seeps through the body of the dam, the foundation soil or rock, and along the contacts of the foundation of the dam with the soil or rock. Water seepage, if it is not within the designed limits and is not controlled, can be the cause of water breakthrough and collapse of rock-filled dams. Flushing of particles occurs when they cannot (by their weight or reliance on other particles) resist the hydrodynamic force of seepage water. The pore pressures between the particles in the clay core and the phreatic line in the downstream support body should be reduced to a minimum. Each dam has a different specific response to subjected hydrostatic and hydrodynamic loading.
This paper aims to model dam response using the database on surface and groundwater level using an artificial neural network. We will use a recurrent neural network structure (RNN), since outputs from previous time instants influence network output as well as measured surface and groundwater level data. To achieve the best model, we will examine from how many previous days we need data or the number of previous days that influences the most.

Keywords

Rock-filled dam, structural response, RNN, artificial neural network

DECISION MAKING STRATEGIES FOR VEHICLE TRACKING SYSTEM

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Abstract

In this research, the logistic data obtained from four companies from Eastern Serbia are analyzed, and the decision model is created considering different aggregating operators. One point of view has included the application of a GPS system for monitoring and measuring important parameters for vehicles. Companies from Western Serbia have implemented this kind of approach to asset monitoring. They have applied a GPS, vehicle, and machine tracking system, and thus had gained a competitive advantage. Using the GPS system, the parameters for the vehicles could be processed, such as time interval, mileage for a given interval, fuel consumption per probe, and fuel consumption per computer board, as well as average fuel consumption, and amount of refuelling - filling, amount of drained fuel and number of discharges, maximum travel speed, average speed, average engine speed, and the effective operating hours. Another approach includes the creation of a decision model which depends on various aggregated operators. For the chosen criteria such as quantity of gasoline drained monthly from the vehicle tank, quantity of gas drained monthly from the vehicle tank, and a number of kilometers traveled monthly. The resulting weight is calculated by applying the SWARA method. The degree of importance is presented in the appropriate tables, taking into account different aggregation operators, such as OWA, IOWA, and OWAWAIMAM.
The optimal results for each company are presented and SWARA method and different aggregate functions are implemented. This approach has shown that decision making strategies depend on the adoption of an adequate method.

Keywords:

decision making, artificial intelligence, system for asset tracking, fuzzy logic, logistics

ROBOTIC WELDING

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Abstract

The goal of this paper is to give the review of the rapid advancement of science and technology which leads to a point in time in which humans will not be working at jobs that they are skilled at anymore. They will be replaced by a machine which will have significantly superior characteristics to those of a human, along with having the ability of independent choice making. That machine is a robot. A robot as a complex technical system has the ability to complete welding tasks with much less effort and in faster time intervals, as its "experience" gets stored in its program memory. Humans are capable of designing and making the robots more experienced and therefore more efficient in completing welding tasks which require great precision and proficiency.

The welding automation using robot application is convenient in both Conventional welding methods as well as in the Nonconventional welding methods. Conventional methods are arc welding and resistance welding. Arc welding uses heat energy and mechanical energy where materials are heated to a temperature above their melting point while the joint is formed due cooling. Resistance welding utilizes heating of the materials locally above their melting point with applying additional pressure in order to produce joint. Nonconventional methods are considered to be newer and are accomplished by bringing energy sources directly to the materials. This is suitable for automation providing higher accuracy and higher precision compared to conventional methods. Nonconventional welding methods suitable for automation with robot application are: Laser welding, Plasma welding and Hybrid welding.

Keywords

Robots, welding, materials, process, automation

Acknowledgement

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Student session

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POSSIBILITIES AND APPLICATIONS OF SLA AND FDM PRINTING - ADVANTAGES AND DISADVANTAGES

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Abstract

The subject of this paper is the evaluation and comparison of currently two main methods to 3D print objects: Stereo lithography (SLA) and Fused Deposition Modeling (FDM), also known as fused filament fabrication (FFF). The study is focused on the processing principle, the material used by each technology, the latest practical examples developed, and domains where they can be applied. In addition, the main manufacturers of these systems were analyzed, their equipment, and the cost range. Both processes add material, layer by layer, to create objects. Stereo lithography (SLA) uses a UV light source to selectively cure resin, while Fused Deposition Modeling (FDM) extrudes semi-liquid plastic in a specific layout to create objects. The biggest advantage of SLA 3D printing is its very high resolution. SLA 3D printing can produce objects with more than double the resolution of FDM printers. Both additive production techniques have rightly entered various fields of industry, medicine, sports, fashion ...etc. and that in accordance with the possibilities they provide are determined in each of these areas by acceptability. As with most technologies, both styles of printing have advantages and disadvantages, and this research is focused on them.

Keywords

3D printing, FDM, SLA, materials

Acknowledgement

This paper and the research behind it would not have been possible without the exceptional support of my mentors. Thank you for letting me be a part of this amazing project.

ATOS CORE 200 AND GEOMAGIC CAPTURE 3D SCANNERS-ADVANTAGES AND DISADVANTAGES

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Abstract

Nowadays 3D scanners allow us to build accurate structures and objects of 3d models at a low cost with less time consumption. We can construct digital 3-dimensional models by the data we have collected. The ATOS Core 200 is an advanced 3D scanner engineered by GOM Germany. Instead of measuring discrete point locations, ATOS Core 200 operates similar to a camera by taking 3D full-field measurements, or scans, of a part. These scans are automatically merged together generating a digital "as manufactured" 3D dense point cloud. ATOS is used in the automotive, aviation, aerospace, and consumer goods industries, their suppliers as well as research institutions and universities. Geomagic Capture scanner captures precise data using state-of-the-art blue LED technology. This device captures almost 1 million points in 0.3 seconds to create detailed models of a physical object, accurate to 0.060-0.118 mm. Geomagic Captures portable scanner and flexible software make it a perfect fit for a variety of applications, from heavy-duty manufacturing to industrial design to automotive to jewelry. The aim of the paper was to compare these two models and present their advantages and disadvantages by analyzing their work.

Keywords

3D scanners, ATOS Core 200, Geomagic Capture

IMPACT OF TRAJECTORY CONSTRAINS ON BEAILC AND COILC CONVERGENCE RATES

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Abstract

Iterative learning control (ILC) is a suitable control method for industrial robot applications where they are required to execute repetitive tasks with high precision. In this paper, the impact of trajectory constraints on convergence rates of two constrained state space ILC algorithms is studied. Taking into account that in reality, robot's operating space is limited, as well as the ILC's transient error growth problem, the following constrained state space ILC algorithms were applied to the nonlinear 3DoF robot manipulator model: Bounded Error Algorithm (BEA) and Constrained Output Algorithm (CO). Both algorithms force the output trajectory to stay inside the predetermined boundaries defined by the safest distance from the desired trajectory and the coordinate limit, making their convergence rates closely dependent on the selection of these boundaries. Herein, tracking simulations of the desired trajectories defined in the generalized coordinates space were conducted in MATLAB and Simulink environments, with the same feedback and learning parameters applied to both algorithms but with different sets of values for state space boundaries, hypercylinder radius ε for BEA and, the maximum and the minimum values of the joints' generalized coordinates Q_i^{max} and Q_i^{min} for CO algorithm set in the way that the simulation results are comparable. Simulation results, analysis of the constraint parameters influence on the convergence rates, and their comparisons for the previously mentioned algorithms are shown later in this paper.

Keywords

Robot control, ILC, bounded error, state space, constrained output

Acknowledgement

The presented research was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia by contract no. 451-03- 68/2020-14/200105 from 05.02.2021 and contract no. 451-03-9/2021-14/200066.

DESIGN OF ROCKET WITH SLOSHING PAYLOAD CAPABLE OF CRUISE FLIGHT

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Abstract

The phenomenon of sloshing can be understood as any motion of a liquid surface. This effect is of most importance in aerospace applications. Sloshing occurs in all aerial vehicles that carry fuel, which induces stability issues. Important examples include aircraft, rockets, and Earth-orbiting satellites. This effect is most noticeable in satellite carriers because their total mass is mostly compromised of liquid fuel. To simulate real-life problems that occur on these types of vehicles, the design of a rocket-airplane hybrid that carries liquid payload as most of its mass is introduced. The challenge is designing a small-scale aerial vehicle that covers all aspects of sloshing problems that can arise in multiple phases of flight while keeping costs low. This design involves the usage of commercial off-the-shelf parts and the usage of a pressurized mixture of air and water as its propulsive force. By incorporating wings into the design, the rocket is capable of aircraft-like cruise flight after its vertical propulsive phase.

The key aspect of reducing the destabilizing effect of sloshing is appropriate to the design of the liquid payload. Two methods are often used to account for this effect, passive and active control. The passive control method was selected due to its practicality, lower complexity, and cost. The addition of baffles and the custom geometrical shape of the payload affects the behaviour of the liquid flow inside the tank. Since it is very difficult to analytically predict the behaviour of sloshing, the VoF (Volume of Fluid) method with the multiphase flow in CFD (computational fluid dynamics) was used for obtaining the results, which assisted in the development of the payload, which was later validated by experiment. It was necessary to have an autopilot for the two phases of flight since the vehicle transitions from vertical to horizontal flight by the use of vectored thrust with the assistance of aerodynamic surfaces.

Keywords

Water rocket design, sloshing effect, CFD, VoF, aircraft stability

IMPACT OF SLOSHING ON AERIAL VEHICLE DYNAMICS

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Abstract

The phenomenon of sloshing can be understood as any motion of a liquid surface. This effect is of most importance in aerospace applications. Sloshing occurs in all aerial vehicles that carry fuel, which induces stability issues. Important examples include aircraft, rockets, and Earth-orbiting satellites. This effect is most noticeable in satellite carriers because their total mass is mostly compromised of liquid fuel. To simulate real-life problems that occur on these types of vehicles, the design of a rocket-airplane hybrid that carries liquid payload as most of its mass is introduced. The challenge is designing a small-scale aerial vehicle that covers all aspects of sloshing problems that can arise in multiple phases of flight while keeping costs low. This design involves the usage of commercial off-the-shelf parts and the usage of a pressurized mixture of air and water as its propulsive force. By incorporating wings into the design, the rocket is capable of aircraft-like cruise flight after its vertical propulsive phase.

The key aspect of reducing the destabilizing effect of sloshing is appropriate to the design of the liquid payload. Two methods are often used to account for this effect, passive and active control. The passive control method was selected due to its practicality, lower complexity, and cost. The addition of baffles and the custom geometrical shape of the payload affects the behaviour of the liquid flow inside the tank. Since it is very difficult to analytically predict the behaviour of sloshing, the VoF (Volume of Fluid) method with the multiphase flow in CFD (computational fluid dynamics) was used for the purpose of obtaining the results which assisted in the development of the payload, which was later validated by experiment. It was necessary to have an autopilot for the two phases of flight since the vehicle transitions from vertical to horizontal flight by the use of vectored thrust with the assistance of aerodynamic surfaces.

Keywords

Water rocket design, sloshing effect, CFD, VoF, aircraft stability

DESIGN OF MIDDLE ALTITUDE SOLID FUEL ROCKET

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Abstract

Rockets can be divided into multiple categories, from small model rockets to enormous spacecraft carriers. This paper focuses on the design of solid fuel, an unguided, reusable rocket for the middle altitude category (3000 meters). The conceptual design was approached by dividing the rocket into several subsystems. Because the rocket has no active guidance control, the optimal aerodynamic design parameters were addressed, such as nose cone shape, and length-to-diameter ratio. The design approach was to have a simple construction while having all the parts easy to replace and modular. The solution for the release mechanism of parachutes was the usage of CO2 pressurized cartridges, which are low cost and reliable, making them reusable. In addition to the analytical methods used for structural analysis, FEM (Finite Element Method) was used for validation purposes. The flight dynamics of the rocket were intensively studied by utilizing analytical methods, while numerical simulations with Matlab, DATCOM, and OpenRocket were used for validation purposes. It was of the author's interest to design a rocket that reaches as precise as possible the height of 3000 meters without entering a supersonic flight regime. The challenge was determining the set flight altitude, for this reason, attention was brought to the drag and mass values of the rocket throughout the flight. The simplistic approach to the assembly and integration methods of the rocket enabled the payload to be easily adjustable in volume and mass. Redundancy is applied to the avionic system that consists of all the necessary sensors and communication equipment, ensuring the safe flight and retrieval of the rocket.

Keywords

Rocket design, reusable, rocket dynamics

AERODYNAMIC DESIGN OF A MIDDLE ALTITUDE SOLID FUEL ROCKET

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Abstract

When designing the motion of unguided sounding rockets, the external forces that act upon the rocket itself must be taken into account as explained in classical, Newtonian physics. This paper focuses on the calculation of the aerodynamic forces caused by the motion of the rocket through the atmosphere at zero angles of attack. Using modified semi-empirical methods and their validation through the use of Computational Fluid Dynamics (CFD), the aerodynamic characteristics of the rocket were obtained. This way, the flight dynamics of the rocket were precisely determined. A componential approach was utilized to define the geometric parameters of the rocket and their contribution to the resulting aerodynamic force. Aerodynamic design and the optimization of the rocket were performed to reach an altitude of 3000m without entering a transonic flight regime. The conducted analyses show that the results between the modified semi-empirical methods and CFD have the same trend, but there is a deviation between the two methods when the rocket enters incompressible flow.

Keywords

Aerodynamics, Computational Fluid Dynamics, Flight Dynamics

LEAD SORPTION FROM WASTEWATERS BY INVASIVE ACER NEGUNDO L. BIOMASS

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Abstract

Due to the tendency of spreading out of its natural habitat and posing a menace to the surrounding species and biodiversity of the area under its influence, Acer negundo L. is known as the deciduous invasive tree species. Even though it is considered harmful for ecosystems, the biomass of this invasive species can be utilized for the purpose of wastewater remediation. A negundo leaf biomass (AN) was investigated for its adsorption potential to bind the lead ions from an aqueous solution. The lead was selected for the sorption experiments, as it is a well-known pollutant often found in various industrial effluents. Acer negundo L. leaves were collected from the protected area of the outstanding natural landscape "Veliko ratno Ostrvo" in Belgrade. Experiments were carried out in a batch system under specific operational conditions. Precise amounts of sorbent were added in the Pb (II) solutions of known initial concentrations, and the optimal operational parameters were further evaluated. Parameters such as lead concentration, pH value, contact time, and sorbent dosage were tested and optimized for increasing the adsorption performance of the obtained sorbent. Maximum Pb (II) uptake occurred at pH 3,5 and sorbent dosage of 2 g/L. Very fast adsorption was noticed by the kinetic study, with equilibrium state achieved after the initial 2 min of sorbent (A. negundo)-sorbate (1 mol/L Pb (II) solution) contact. Obtained data were subjected to equilibrium modeling by using Langmuir and Freundlich equations. Maximum adsorption capacity reached 101,5 mg/g. According to these results, sorbent prepared from Acer negundo leaf powder has an outstanding potential to be applied for lead removal from contaminated waters..

Keywords

Acer negundo L., sorption, lead, wastewater treatment

Acknowledgement

This work was supported by the Ministry of Education, Science and Technology Development of the Republic of Serbia (Contract number 451-03-9/2021-14/200023).

POTENTIAL APPLICATIONS OF NANOMETERIALS IN THE AVIATION INDUSTRY: A REVIEW

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Abstract

Nanotechnologies are a significant part of any field in sciences and technologies that study materials and structures with dimensions below 100 nm, up to the manipulation of each atom and molecule. Also, nanotechnology analyses the particles between 1 and 100 nanometres in various processes in the manufacture of new materials and products of wide application. Aviation is an important industry, and current flight conditions place new demands on materials and electronics used in aerospace systems. This encourages engineers to create new materials and electronic platforms to be used in these conditions. Nanomaterials are often used in the following areas in the aviation industry: nanomaterials and electronics for harsh environments, nanocomposites, nano-scale communication systems, nano-scale power generation and storage, nanoscale coatings, nanostructured thermal protective systems, nano-propellants. The aviation industry has recently made a lot of progress in terms of materials. The main directions of applying nanomaterials (nanostructured materials, polymer nanocomposites, and anti-corrosion coatings) lead to the replacement of traditional materials such as steel or aluminum alloys. For example, the epoxy/clay nanocomposites have provided an affordable replacement for high-performance titanium oxides for use as aerospace tanks. Compared with nowadays materials, nanomaterials have a lower density and much better mechanical properties (yield strength, tensile strength, corrosion resistance). These characteristics of nanomaterials fit perfectly into the concept of reducing the weight of the plane and thus the cost of travel.

Keywords

Nanomaterials, nanocomposites, aviation industry

Acknowledgment

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A REVIEW OF COAL DEMINARALIZATION AND DESULPHURIZATION BY CHEMICAL LEACHING

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Abstract

Coal is a well-known fossil fuel. It was used as a non-renewable energy source for several centuries. Nowadays it is mainly used for electricity generation in power plants or heat generation for industrial and home utilization. There are many types of coal that differ in composition and calorific value, as well as in the amounts of undesired hazard substances produced by combustion. Depending on the coal composition, environmental impact can be reduced by its treatment before combustion. One of the cheap and effective methods is the chemical leaching of coal that reduces sulfur content and the amount of mineral matter (ash). Lowering the ash amount increases the calorific value of coal, reduces its transportation cost, and reduces the negative environmental impact of toxic elements, which are usually present in ash. Another benefit of coal leaching, that results from lowering the sulfur content is reduced emission of toxic gases (SO2 and SO3) during combustion. In order to determine the optimal leaching conditions for the treatment of different types of coal, numerous studies have been done, investigating various chemical reagents, including inorganic and organic acids, alkalis, oxidative reagents, and their combinations [1, 2]. The key parameters that effect leaching efficiency are type and concentration of reagent, reaction temperature, the mass ratio between coal and leaching reagent, coal particle size, and reaction time. The degree of leaching efficiency is measured by the level of demineralization and desulphurization [3].

The current review summarises recent results and further plans for the development of an efficient and environmentally friendly method for the chemical leaching of Serbian sub-bituminous coal.

Keywords

Subbituminous coal, chemical leaching, demineralization, desulphurization.

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ASSESSMENT OF SORPTION CAPABILITY OF ALGINATE IMMOBILIZED PEACH STONE PARTICLES FOR LEAD REMOVAL FROM WATER

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Abstract

Fruit waste produced in huge quantities from the food and agriculture industries causes numerous difficulties in landfills due to their high biodegradability. The reuse of this waste is one of the future requirements for accomplish economic and environmental sustainability. Recent studies have shown that with appropriate modifications (chemical, physical or thermal) this material can be used to obtain a high-quality biosorbent to remove pollutants from wastewater. In this paper, peach stone (Prunus Persica L) particles (PS), as a part of fruit industrial organic waste, were immobilized in sodium alginate (PS-A) and utilized to remove lead from water solutions. The PS-A was characterized and analyzed by Scanning Electron Microscopy (SEM) and Fourier-transform infrared spectroscopy-attenuated total reflection (FTIR-ATR); contact pH and pHpzc were done as well. The effect of operating parameters such as contact time, mass to volume ratio, and pH on the performance of Pb removal in the batch reaction system was investigated. The experimental data were fitted by appropriate kinetic models. The results from this paper indicate that PS-A particles have the potential to be applied as an effective adsorbent of lead ions from an aqueous solution.

Keywords

Water purification, lead, sorption, waste biomass, immobilisation

Acknowledgement

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CONSTRUCTIONAL ASPECTS OF BUCKET WHEEL EXCAVATOR BREAKDOWN

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Abstract

Lignite production in Serbian open cast mines, “Kolubara” and “Kostolac” basins, is one of the most important industrial activities in our country. Lignite is the most important energy potential of Serbia, since 60% of electricity is generated by lignite combustion, and as high as 75% during winter period. Almost complete production from the two mentioned basins is supplied to power stations, while a small amount is supplied to a drying facility and general consumption. Annual lignite production is around 35 million tonnes, a respectable amount even by European standards. Various and numerous mechanization is engaged on the achievement of such production, with continuous action systems in the centre, comprised of bucked wheel excavators, haulage systems with belt conveyors, stackers, material transfer equipment, reclaimers and facilities for coal processing.

The bucket wheel excavator is one of the most complex technical systems in the industry in general. First, it is characterized by a complex hierarchy of the structure, of high value, both regarded as an investment and operational.

In this article it will be presented the fracture of the bucket wheel excavator (BWE) construction during operation, the BWE has developed bad dynamic behaviour, plastic deformation and structural failure. After performed experimental-numerical analysis, resonant dynamic behaviour of the discharge boom has been confirmed. Adding a new tension bar has increased the dynamic stiffness of the discharge boom, and so the resonant behaviour has also vanished. The numerical model is carried out by finite element method and the experiment is carried out by measuring the vibration on a pre-determined number of characteristic locations. The experiment, among other things has confirmed the results of the numerical analysis.

Keywords

Bucket wheel excavator; structural failure; dynamic behaviour

THE BEHAVIOR OF ARMORED STEEL UNDER IMPACT LOAD

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Abstract

Armored steel is used for the production of armored vehicles in the military industry. The role of such vehicles is to transport people and soldiers safely in wartime and to protect them. The main danger for them is infantry weapons and cumulative or classical projectiles. Because of that good armored steel has to have perfect mechanical characteristics. As armored steel must have great hardness, strength, and ductility, toughness (Charpy impact test) and tensile tests were performed on steel Protac 500, produced in Slovak ironworks Acroni. Through the processes of hot rolling and heat treatment, toughness has been increased with a small drop in hardness.

A large number of different types of steel intended for ballistic protection are currently used in the world, most often in the form of rolled sheets and plates. At armored vehicles, two groups of armored steels are used. The first group includes steels with a hardness of 470 HB to 540 HB and the second group includes tougher steels with a hardness of 370 HB - 430HB. Due to the function, ballistics experiments have been performed on the material, made in accordance with the standard VPAM APR 2007. The distance of the target was 10 meters and the calibre of the projectile is 7,62 × 51mm.

Keywords

Armored steel, Charpy impact test, ballistics experiments, Military industry, hardness, strength, ductility, Protac 500

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