Innovation Center of Faculty of Mechanical Engineering

Faculty of Mechanical Engineering, University of Belgrade

Center for Business Trainings

CNN TECH

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

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MINISTRY OF EDUCATION OF THE REPUBLIC OF SERBIA

Programme

and

The Book of Abstracts

04 – 07 July 2023

Zlatibor, Serbia

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

CNN TECH 2023

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

CNN TECH 2023

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The organizing committee of the 7th International Conference of Experimental and Numerical Investigations and New Technologies – CNN TECH 2023 wishes to sincerely thank all the institutions and individuals who, by means of personal engagement and constructive action, helped organise this conference.

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

We would like to thank the University of Belgrade - Faculty of Technology and Metallurgy for supporting the young researchers of this conference.

We are also grateful to companies, **3D Republic** and **Shimadzu**, who have significantly contributed to the organization and realization of the conference.

PREFACE

Dear Friends and Colleagues,

welcome to the CNN Tech 2023 Conference and the fabulous mountain of Zlatibor!

With 118 papers (19 by international authors) and contributions by authors from different countries, the International Conference of Experimental and Numerical Investigations and New Technologies CNN Tech 2023 successfully sets a high level for future conferences. Participation of a large number of domestic and international authors, as well as the diversity of topics, justifies our efforts to organise this conference and contribute to the 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 2023 focuses on the following topics:

- Mechanical Engineering,
- Engineering Materials,
- Chemical and Process Engineering,
- Experimental Techniques,
- Numerical Methods,
- New Technologies,
- Clear sky,
- Dental Materials and Structures,
- Advanced Materials and Technology,
- Artificial intelligence
- Student session and
- Successful Project Stories.

For the first time, we have a new section “Successful Project Stories” dedicated to showcasing inspiring results from exceptional projects that have achieved remarkable success in their respective fields. Apart from plenty of interesting lectures, the participants will have a chance to lighten up and communicate in friendly and relaxed settings. The organising committee of CNN Tech 2023 would like to express gratitude to the Ministry of Education and the Ministry of Science, Technological Development and Innovation for the financial support of the

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

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PROGRAMME

Tuesday, July 04, 2023	
19:00 to 21:00	Registration and Welcome cocktail – in front of the HALL A
Wednesday, July 05, 2023	
12:00 to 12:30	Registration – in front of the HALL A
12:30 to 13:00	Opening Ceremony – HALL A *dr Aleksandar Sedmak, prof. Emeritus* *Ministry of Education of the Republic of Serbia* *dr Nenad Mitrović* *dr Miloš Milošević* *Svetozar Kolesar - New trends in additive manufacturing, Republic of the third dimension*
13:00 to 15:00	**INVITED LECTURES – PARALLEL SESSION 1 – HALL A** *Chairman: dr Goran Mladenović* Nataša Obradović - APPLICATION OF NANOTECHNOLOGY IN COSMETIC INDUSTRY-CIRCULAR AND SUSTAINABLE APPROACH Mina Volić - NOVEL HYDROGEL-BASED SYSTEMS FOR FOOD APPLICATION Adriana Peleš - FRACTAL ANALYSIS AND MICROSTRUCTURE DEVELOPMENT OF BaTiO3 AND PVDF BASED MULTIFUNCTIONAL MATERIALS Nenad Tadić - PLASMA ELECTROLYTIC OXIDATION. STRUCTURAL, OPTICAL AND PHOTOCATALYTIC PROPERTIES OF STRUCTURES OBTAINED BY THIS PROCESS Milan Kalajdžić - REDUCING GREENHOUSE GAS EMISSIONS IN THE MARITIME INDUSTRY: CHALLENGES AND OPPORTUNITIES Toni Ivanov - HYDROGEN AS A SUSTAINABLE FUEL FOR AVIATION PROPULSION

13:00 to 15:00	**INVITED LECTURES – PARALLEL SESSION 2 – HALL B** Chairman: dr Aleksandra Dragičević Stefan Jovanović - APPLICATION OF ANALYTICAL AND INSTRUMENTS FOR DETERMINING THE MECHANICAL PROPERTIES OF MATERIALS IN THE QUALITY CONTROL OF DENTAL MATERIALS, Shimadzu Corp. Maja Zebić - ADVANCES IN DENTAL COMPOSITE CURING Ljiljana Đukić - ACTIVITY STATE OF DENTINE-DERIVED TGF-B1 RELEASED AFTER RESTORATIVE DENTAL MATERIALS TREATMENT Ksenija Zelić Mihajlović - APPLICATION OF FINITE ELEMENT METHOD IN DENTISTRY Aleksandra Mitrović - ANALYSIS OF MECHANICAL AND PHYSICAL-CHEMICAL PROPERTIES OF DENTAL COMPOSITE CEMENTS Zorana Golubović - DETAILED CHARACTERIZATION OF PLA AND PLA RESIN ADDITIVELY MANUFACTURED MATERIALS Božica Bojović - STRAIN RATE DEPENDENT MECHANICAL PROPERTIES OF 3D PRINTED ABS AND PLA RESINS USING THE DLP TECHNIQUE	
15:00 to 15:30	Coffee break - in front of the HALL A	
15:30 to 17:00	**POSTER SESSION (all papers) – HALL A**	**Erasmus+ project "Driven" MULTIPLIER EVENT (HALL B)**
17:00 to 20:00	Free time	
20:00 to 23:00	Gala dinner	
Thursday, July 06, 2023		
12:00 to 12:30	Registration - in front of the HALL A	
12:30 to 13:00	Opening Ceremony *Ministry of Science, Technological Development and Innovation of the Republic of Serbia* *Innovation fund of the Republic of Serbia*	
13:00 to 15:00	**WORKSHOP - REGIONAL INNOVATION FORUM 2023 – HALL A** *Chairman: dr Žarko Mišković and dr Miloš Milošević* • HOW TO PITCH YOUR IDEA AND HOW TO FIND AN INVESTOR FOR A STARTUP? - winners of SmartStart and Catapult projects and investor/mentor ○ Ivana Berić - Innovation fund of the Republic of Serbia ○ Investor / Mentor - Nicolas Rabrenovic ○ StudENTER - Team leader Nikola Jokic o Anoris Technology - Director Nenad Krstic ○ B2bee - Chief operations officer Luka Radovanovic ○ RotoDyna - Director dr Nebojsa Gnjatovic ○ MISP - Team leader Isaak Trajkovic	

15:00 to 15:30	Coffee break - in front of the HALL A	
15:30 to 16:30	**WORKSHOP – PARALLEL SESSION 1 – HALL A** • HOW TO GET ERASMUS PROJECTS? dr Nenad Marković, University of East Sarajevo **WORKSHOP – PARALLEL SESSION 2 – HALL B** • HOW CAN STARTUPS PROTECT THEIR INTELLECTUAL PROPERTY? Zorica Obradović, The Intellectual Property Office of the Republic of Serbia **WORKSHOP – PARALLEL SESSION 3 – HALL C** • INTEGRATING NEW CLIENTS INTO THE EEN NETWORK dr Snežana Kirin, Innovation Center of the Faculty of Mechanical Engineering	**B2B MEETINGS** **in front of the HALL A**
16:30 to 18:00	**POSTER SESSION (all papers) – HALL A**	
18:00 to 21:00	**Dinner - HOTEL RESTOURANT**	
Friday, July 07 2023		
From 10:00	**Zlatibor excursion (optional)**	
12:00 to 13:30	**B2B MEETINGS - HALL A**	
13:30 to 14:30	**Closing Ceremony and final remarks – HALL A**	

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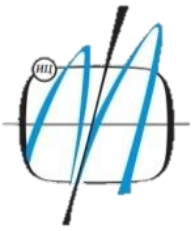


THE ACADEMY
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ABSTRACTS

Mechanical Engineering

Invited lecture

REDUCING GREENHOUSE GAS EMISSIONS IN THE MARITIME INDUSTRY: CHALLENGES AND OPPORTUNITIES

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Abstract

The maritime industry plays a significant role in the trade of goods worldwide. According to statistical data, about 80% of world trade by volume and over 70% by value is transported by sea. This highlights the key importance of the maritime industry as the backbone of international trade, but also contributes significantly to greenhouse gas (GHG) emissions. Challenges in reducing emissions stem from the industry's heavy reliance on fossil fuels, especially heavy fuel oil, which emits significant amounts of carbon dioxide (CO2) and other pollutants.

This research provides an overview of International Maritime Organization (IMO) Greenhouse Gas (GHG) regulations, which play a crucial role in reducing emissions, and their implications for the design and operation of cargo ships. The IMO has initiated a policy to decarbonize ships by introducing energy efficiency regulations, with short-term goals that progressively strengthen requirements. The IMO has also announced ambitious medium and long-term targets, which aim to reduce CO2 emissions from transport for a 40% by 2030 and a 70% reduction by 2050 compared to 2008 levels.

To achieve these goals, the maritime industry implemented operational and technical measures. Operational measures, such as slow steaming, resulted in a significant reduction in power. Technical measures have also been implemented, including energy-saving devices and the use of liquefied natural gas (LNG) as fuel. However, these measures alone are not sufficient to achieve significant emission reductions. Therefore, the future is the application of alternative fuels for propulsion purposes, capable of reducing GHG emissions by up to 100%. However, these technologies are still under development, expensive, and face safety and scalability challenges.

The findings contribute to the understanding of the implications of the IMO GHG regulations on the design and operation of cargo ships and highlights the need for alternative fuels to achieve significant emission reductions, advising the future direction of the industry towards sustainable and environmentally responsible shipping practices.

Keywords

Maritime industry, IMO regulations, energy efficiency, shipping decarbonization.

Acknowledgement

This work is contribution to the Ministry of Science and Technological Development of Serbia funded contract 451-03-47/2023-01/ 200105 from 3 February 2023.

Invited lecture

STRAIN RATE DEPENDENT MECHANICAL PROPERTIES OF 3D PRINTED ABS AND PLA RESINS USING THE DLP TECHNIQUE

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Abstract

The most commercially widespread extrusion-based additive manufacturing technologies use thermoplastic filament materials, as opposed to vat polymerisation technology, which uses photopolymer resins. Thus,, for non-industrial applications and customised parts, ABS and PLA thermoplastic materials were mostly used for FDM printers, until the appearance of PLA and ABS resin for DLP. The development of a new resin material, ABS and PLA, presents a great challenge for customising 3D printing, as well as the comparing their mechanical properties.

In the present study, we focus on investigating the tensile, flexural, and compressive mechanical properties of ABS and PLA materials used in the DLP process. Five specimens for each resin were modelled and printed according to standard ISO 527-2, and tested on a standard testing machine. The analysis included additional processing of collected data using Matlab, and comparison of fractured surface images acquired by microscopy.

The obtained results showed that the differences in the mechanical properties of ABS resin in comparison to PLA resin are not unilateral. PLA specimens' ultimate tensile strength (UTS) is higher for tensile and flexural test and lower for compression tests. In the case of elastic modulus, PLA specimens exhibit higher values for all three mechanical tests. Elongation at yield has higher values for ABS specimens in tensile and compression tests compare to PLA specimens. Definitely, both resin materials after DLP processing reveal better mechanical behaviour under compression compared to tension stress. Selection between these two is case sensitive and strongly depends on the 3D printed part application.

Keywords

Additive manufacturing, DLP, ABS resin, PLA resin, Mechanical properties.

Acknowledgement

This research was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia by Contract No. 451-03-47/2023-01/ 200105 from 03.02.2023.

TOPOLOGY OPTIMISATION AS METHOD FOR IMPROVING THE DESIGN PROCESS OF TIPPING SEMI-TRAILER

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Abstract

When designing a new and improved product, besides engineering knowledge, time, and money, it is important to utilize modern techniques throughout the development process. Therefore, brainstorming, which is the earliest stage in the process, can be more accurate and productive for the development team with initial material distribution data in the form of a typical topology optimization (TO) result based on predetermined technological, geometrical, economical, and homologation constraints. Design objectives such as: reducing mass or displacements are tangible variables when using the TO approach and are suitably desired by the development team.

This paper presents a simulation study based on the finite element method used in the development process for designing a chassis for a typical tipping semi-trailer vehicle. The expected load cases are described and calculated for specific directions of movement, including the longitudinal bending during tipping, longitudinal torsion during tipping on uneven ground, and lateral bending during short turning of the potential new chassis. Based on the envelope simulation results from the multiple scenarios with the predefined constrains, a topology geometry model has been created. For this, a two-stage process of optimizing is presented, first optimizing the 2D initial area, then a 3D solution for minimum structural compliance of the extruded initial 2D design.

Siemens Simcenter is used as the main tool for pre-processing and post-processing, and the solving is performed with Nastran's topology optimization SOL200 solver.

Keywords

Tipper trailer science, product development process, topology optimization, Nastran SOL200.

Acknowledgement

This research as part of a larger project is supported by STAS. The company STAS as (trailer) constructor is an established name in Belgium, today is one of the largest manufacturer of tipping trailers and moving-floor trailers in Europe. Their trailers can be aluminum and steel, but mainly they are famous for their extremely solid aluminum chassis, also separately suplied.

3D PRINTED FIREARM, AMMUNITION AND MILITARY EQUIPMENT

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Abstract

Additive manufacturing (AM) is recognised as a valuable method for producing functional parts in many global industries. It has increasingly been applied in military manufacturing companies due to its specific characteristics. What started as a simple technique several decades ago, mostly used for rapid prototyping, now holds an important place in military industry when it comes to producing completely functional parts and mechanisms for weapon and different types of equipment. An understanding of different 3D printing methods and compatible materials allows engineers to create standard parts with reduced manufacturing costs and parts that are difficult to machine. One of the crucial benefits of 3D printing application in military industry is flexibility in manufacturing process, especially in terms of production site mobility. That literally means that soldiers can now create new parts on 3D printers directly in battlefield, just by receiving right files for 3D printing from engineers. This paper reviews advances in AM application for the military industry through different examples of 3D printed weapon and military equipment. Relevant 3D printing technologies are described, along with the discussion of potential problems in this area of manufacturing and possible solutions. The perspective of this method was analysed based on current challenges, compatibility with experimental techniques and numerical methods, along with some suggestions for modernization and new areas of military application.

Keywords

Additive manufacturing, military, weapon, flexibility, 3D printing.

CRACK GROWTH ANALYSIS OF DAMAGED THIN-WALLED STRUCTURAL COMPONENTS USING X-FEM

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Abstract

This paper considers determination of the crack growth trajectory and residual fatigue life for two-dimensional thin-walled structural elements under mixed modes. The rapid development of computer technology, which marked the last three decades has brought about real solutions to problems are increasingly demanding in terms of numerical simulations. With proper application of numerical modelling is possible to reduce the cost and time required to develop new or to monitor the integrity of existing products in the real exploitation conditions. The basic dependences betweens the geometric and physical variable in the theory of thin walled shell type structural element consists mainly in setting up links between the state of stress, strain and external load, which is described by differential equations, ordinary or partial. In the case of complex and large construction systems such as aircraft structures exposed to arbitrary loads, including complex boundary conditions, solving differential equations by analytic methods is very difficult or impossible. The solutions require using numerical methods, most often, using extended finite element method (X-FEM). This paper considers the extended finite element simulation of cracked thin-walled aircraft structural components. A special attention in this study is focused in domains of crack growth simulations of damaged thin walled in domain mixed modes. To determine stress intensity factors (SIF`s) of cracked thin-walled stiffened shells on aircraft wing type structure and lugs special singular finite elements are used. Good agreement between present computation results using singular finite elements and analytic solution is obtained. Results of numerical simulations by X-FEM are compared with experimental results. Residual life along “curve” mixed mode crack growth trajectory is determined numerical and experimental. Crack growth trajectory obtained by the present numerical simulation and residual life are compared with own experimental results.

Keywords

Thin-walled structures, fracture mechanics parameters, crack growth analysis, X-FEM.

Acknowledgement

This research has been supported by the research grants No. 451-03-68/2022-14/200066, of the Serbian Ministry of Education, Science and Technological Development.

DEVIATIONS MEASUREMENTS OF SLS PA MATERIAL AT COMPRESSIVE SPECIMENS

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Abstract

SLS technology is a popular choice in various industries worldwide because of its ability to produce complex geometry components with less effort when compared to conventional methods. The technology involves using materials in powder forms, such as polyamides (PA), polystyrenes, thermoplastic elastomers, and polyaryletherketones. In this study, the research focuses on compressive PA12 specimens with CAD model dimensions selected according to the ISO 604 standard, with bulk dimensions of Ø10x20 [mm]. The study utilizes a Fuse 1 (FormLabs, Summerville, MA) 3D printer that employs the SLS technology. This printer is capable of producing objects with different shapes and dimensions simultaneously, provided that they are printed at a minimum distance of 5 [mm] apart. The research involves producing four batches of specimens, each differing in printing orientation (i.e., horizontal and vertical) and printing location (i.e., printed on the edge and in the middle of the powder bed). The printed specimens are scanned, and the obtained scans are compared with the original CAD model in the GOM Inspect program. The highest deviations in all four specimen series are in height, ranging from 0.1 up to 0.15 mm. In the case of vertical specimens printed in the middle of the powder bed, there are also deviations in the width of the specimen.

Keywords

SLS, PA 12, compressive specimens, GOM Inspect.

Acknowledgement

The authors acknowledge the support from the Ministry of Education, Science and Technological Development of the Republic of Serbia (contracts: 451-03- 47/2023-01/200213).

THE INFLUENCE OF PARAMETARS OF SAND SOIL ON STATES PH 2D FRAME ON SEISMICS REASPONSE

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Abstract

During earthquakes that exceed the designed level of the structure, the structure gets damaged. Here, the structure-foundation-soil is considered as a system, and the effect of the soil on the piles can be replaced by nonlinear p-y curves. Work on this topic began as early as 1957, based on the analogy between the triaxial test and the form of soil failure, and during the 1970's, a number of researchers made significant progress in the development of appropriate models for different types of soil. Eurocode 8 pays special attention to the selection of earthquakes as a set of accelerograms. For areas within a radius of several hundred kilometers from central Romania and its southern part, the Vrancea hypocenter has a significant influence. In North Serbia and its surroundings, other sources of earthquakes are also possible, but when choosing accelerogram, the response spectra of several Vrancea records should also be used. The SSI model itself, where the soil is replaced by p-y curves, even though it might look complicated, it is significantly simpler and leads to faster results than integral 3D models. By using adequate soil parameters, fairly reliable data can be obtained on the degree and distribution of damage to the SSI system, like plastic hinges. In soil models used for clean sand, the curves used seem significantly more reliable than clayey ones, but here too caution is needed because the degree of compaction (relative density) has a significant effect, and the way of determining it is still not reliable.

Keywords

Soil pile structure interaction SPSI, nonlinear p-y curve, Vrancea earhquake, PH - Plastic Hinge, SSI - soil structure interaction.

Acknowledgement

The work reported in this paper is a part of the investigation within the research from Contract No. 451-03-08/2022-14/200213 from 4. 2. 2022 supported by the Ministry for Science, Technological Development and Inovations Republic of Serbia. This support is gratefully acknowledged by Boris Folić.

ANALYSIS OF THE CONTRIBUTION OF PROTECTIVE BELLOWS ON THE STABILITY OF ALUMINUM FRAMES USED IN PIVOTING JOINT

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Abstract

Numerical analysis of protective bellows attached to aluminum frames of pivoting joints is presented in this research. Five aluminum frames connected by protective bellows are attached to the circular rod and have been extracted from the original geometry of passenger bridge used on ocean cruisers. It was assumed that the circular rod was fixed since the main emphasis in the analysis was on the displacements and stresses of aluminium frames, not rods. The main load considered in the analysis was a force of 2,500 N (simulating the mass of 250 kg) acting perpendicularly to three middle frames. Three frames were loaded since it had been estimated that an average person can apply pressure (with his/her body) on a maximum of three frames at once. The mass of 250 kg was used in calculations to ensure the value of safety factor ν=2.5. Since no data were available about the type of contact between the rod and ends of frames, two approaches were used in the analysis: firstly, contact was considered to be sliding without friction, and secondly contact was considered to be sliding with friction with the value of friction coefficient μ=0.2. Values of displacements and stresses obtained using finite element analyses (FEA) for both approaches and both positions of frames (firm 0° and max. angle45°) are shown and discussed.

Keywords

FE analysis, aluminium frames, forces, friction.

Acknowledgement

The authors acknowledge the support from the Ministry of Education, Science and Technological Development of the Republic of Serbia (contracts: 451-03- 47/2023-01/200105).

THE EFFICIENCY OF ENERGY PRODUCTION FROM SOLAR PANELS DEPENDING ON THE TYPE OF ORIENTATION AND MODE OF THEIR INSTALLATION

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Abstract

Nowadays, every individual strives to achieve energy independence. The most widespread way to achieve that goal is the use of renewable energy sources. This group also includes the energy of the Sun, which is exploited using solar panels. As a relatively new way to obtain energy, solar panels represent a branch of energy that has yet to develop its full potential. This is confirmed by the fact that the average efficiency of the solar panel during operation is about 21%. From this, it can be concluded that the energy losses experienced by solar panels over their lifespan are significant. The losses are primarily due to the low efficiency of the materials from which the solar panels are made, the reflection of solar radiation from the surface of the solar panels, dirt accumulation, as well as the dissipation of heat and electrical energy resulting from the flow of electric current. These are all energy losses that the engineers and designers of such systems cannot influence. However, there are also losses that occur due to improper design. And these are: inadequate installation method and installation angle in relation to the daily path of the Sun, the bad orientation of the solar panel in relation to the south pole, placing the solar panel in such a position that it can be affected by a shadow more than 3%, etc. This paper aims to show how additional maximum utilization of solar panels can be achieved during their operational period. The paper examines how the orientation of installing a solar panel affects its degree of utilization. A comparison will be made between the efficiency of monocrystalline half-cut solar panels in orientation landscape and portrait format. In conclusion, recommendations will be provided to increase the potential production of users of PV systems during the operational period.

Keywords

Solar energy, Photovoltaic module, System efficiency, Energy loses.

DESIGN OF MULTIPRODESK: MULTIFUNCTIONAL RAPID PROTOTYPING DESKTOP MACHINE

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Abstract

Rapid prototyping technology has emerged as one of the most significant technologies that enable the reduction of the product development and production times. The novel low-cost desktop multifunctional machine tool, able to support additive and subtractive manufacturing of symmetrical and asymmetrical cylindrical parts, is presented. The core of the invention is the new concept of the machine tool with a horizontal rotating device chuck (3-axis rotary CNC) as a multifunctional rapid prototyping machine. The specific concept of the machine's geometry enabled reconfigurability, i.e., the simple change of tools for the unique combination of three production technologies on one desktop machine: milling, laser engraving, and rotary 3D printing. Open-source control infrastructure enables end-user customization and machine upgradeability and achieves cost-effectiveness. Innovative design enables additional technological advantages in the desktop rapid prototyping machine tools domain, such as: 1) the possibility of the production of a single cylindrical part completely in one clamping by using a combination of additive and subtractive manufacturing (which achieves effective use of material, energy, and reduced time consumption, increased productivity, increased accuracy); 2) modularity and the open architecture control structure which allows for upgradeability and further development of the machine according to end-user needs (possibility to add supplementary axes per users' demands; 3) digital twin technology. MultiProDesk is a valuable production tool for SMEs in various production technologies where it allows users to adopt mass customization concepts and to reach mass personalization production (as a step to Industry 4.0).

Keywords

Rapid prototyping, 3-axis rotary CNC, milling, laser engraving, rotary 3D printing.

Acknowledgement

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REVITALIZATION OF HORIZONTAL BORING MILL MACHINE USING PLC CONTROLLER AND DC CONVERTER

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Abstract

In this paper is presented revitalization of the horizontal boring mill machine Stankoimport 2620B using a PLC controller manufactured by Schneider Electric and a DC converter manufactured by SSD Parker. As the machine is of an earlier production date, this method of feederate regulation in today's time is a problem because it is difficult to get the components in order to perform the maintenance or repair of the machine. The old control system was based on the use of electron tubes and an electromechanical amplifier. For this reason, a reconstruction was made using modern components for the control and regulation of the speed of the DC motor for feedrate moving. During the reconstruction, all AC motors and a DC motor with a tachogenerator were retained. All motors are tested and the brush holders was replaced on the DC motor and new brushes were installed. For the new part of the control system, which was built into the old control system, PLC software was developed and written, and new DC motor control hardware was installed. After revitalization, the machine was successfully tested in metal machining and the functionality of the installed components was proven. This revitalization was useful because the control panel on the machine remained the same as original state and it was not needed additional training of machine operator and also the electricity consumption and noise was reduced.

Keywords

Horizontal boring machine, DC convertor, PLC controller, speed regulation.

Acknowledgement

The research work is funded by the Ministry of Science, Technological Development and Innovation of Republic of Serbia. Project Contract 451-03-47/2023-01/200105.

3D PRINTING AND CNC MACHINING: AN OVERVIEW OF TECHNOLOGY AND HYBRID MANUFACTURING

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Abstract

Industry and industrial production in today's world represent one of the main drivers of the economy, economy and development. One of the relatively newer methods of production is additive manufacturing or 3D printing. Unlike traditional ways of manufacturing parts, 3D printing adds material layer by layer, and gives the possibility of creating complex shapes that are almost impossible to create with classical methods. It has the potential to reduce material waste, decrease labor cost and fast production. In addition, 3D printed parts do not provide a good enough surface quality, so additional processing is required. In order to improve the surface quality of 3D printed models, CNC technologies can be used for finishing of the parts. CNC technology is a very precise technology, and it ensures high machining accuracy. This paper presents an overview of the possibilities of combining 3D printing and CNC technologies, recommendations for material selection, process parameters, technical data, as well as their use in finishing.

Keywords

3D printing, CNC, Machining, Quality.

IMPROVEMENT OF RELIABILITY OF THE BUCKET-WHEEL EXCAVATOR TROUGH IMPLEMENTATION OF NEW METHOD OF FAULT-TREE ANALYSIS

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Abstract

Welded joints' reliability in responsible welded structures is of the utmost importance. If such a structure, for example, a bucket wheel excavator, suffers dam-age or failure, the financial losses are two-folded – the machine does not deliver the required quantity of coal, while, due to that, the power plant does not deliver sufficient electricity to the industry and households. This paper presents a meth-od, based on the probabilistic and semi-probabilistic approaches to express the coefficient of validity and welded joints weakening, defining reliability as a measure of the quality of installed vital welded structures on the bucket wheel excavators in service. The "fault-tree" analysis was applied to enable a quantitative and qualitative analysis of the welded structure failure causes, diagnostics of behavior, and structural degradation, to evaluate the integrity and estimate the service life of the vital welded structures that have a flaw in the welded joint. The database was created, as well, by which the reliability of the bucket wheel excavators can be increased. The proposed method enables to efficiently test the welded joints during all the phases, from manufacturing, via acceptance to assembling of various welded structures, e.g. machines, like excavators or cranes, or the constructions like bridges, etc.

Keywords

Bucket-wheel excavator, welded structure, fault-tree analysis, welded joint reliability.

Acknowledgement

This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia through grant TR35024 and by the project "Innovative Solutions for Propulsion, Power and Safety Components of Transport Vehicles" ITMS 313011V334 of the Operational Program Integrated Infrastructure 2014-2020 and co-funded by the European Regional Development Fund.

DEVELOPMENT OF A NEW METHOD FOR ASSESSMENT OF STRUCTURAL INTEGRITY AND LIFE OF ORTHOPEDIC IMPLANTS

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Abstract

In this paper, an innovative method that would provide valid results for integrity assessment of orthopedic implants with and without cracks is discussed using a combined experimental and numerical approach. The aim of this investigation was to define the possibilities of the practical application of the innovative method. The research included the identification of factors that affect the behavior of orthopedic implants under realistic exploitation conditions and plays an important role in ensuring that implants have sufficient safety and integrity. The investigations included experimental and numerical analyses of the behavior of biomaterials using standard specimens, as well as complex implant geometries. The proposed innovative method involves the use of contemporary non-contact experimental methods of material and construction testing which enables recording of displacement and deformation fields on the implant during the application of relevant loads. Using the proposed method, the real geometry of the component was studied, which is not possible with traditional methods using classical measuring devices. The results confirm that the application of the suggested combined approach can be used to verify obtained numerical results using experimental methods, to obtain sufficiently accurate models.

Keywords

Orthopedic implants, structural integrity, complex implant geometries, innovative method.

Acknowledgement

This research was financially supported by the Ministry of Education, Science and Technological Development and Innovation of the Republic of Serbia, under Contract number 451-03-47/2023-01/200213.

Engineering Materials

Invited lecture

DETAILED CHARACTERIZATION OF PLA AND PLA RESIN ADDITIVELY MANUFACTURED MATERIALS

Zorana Golubovic

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Abstract

Polylactic acid (PLA) is the most widely studied and used thermoplastic material for additive manufacturing (AM) processes, alongside Acrylonitrile Butadiene Styrene (ABS), It belongs to a class of renewable and biodegradable polymers with versatile applications in various industries. So far, PLA has shown a relatively high modulus of elasticity and high tensile strength compared to other thermoplastic polymers. PLA has mainly been examined in its use in extrusion-based AM technology called Fused Deposition Modeling (FDM), in which material filaments are passed through a hot nozzle, melted, and deposited layer by layer on a build platform. The goal of this research was to characterize and compare the properties of PLA specimens produced in the form of filaments using an FDM printer with those of PLA specimens produced in the form of resin using a Digital Light Processing (DLP) printer. Unlike the FDM process, the DLP as one of the VAT photopolymerization processes, which involves placing the resin material in a tank and curing it with UV light emitted from an LCD screen, resulting in hardening of the polymer with pixel resolution.
For mechanical testing, standardized specimens were prepared and tested on a standard testing machine. An optical microscope was used to determine surface properties and crack cross-sections. The results show that the mechanical properties of the PLA material favor the FDM technology and the filament type of the material, considering that the maximum stress and elastic modulus are higher and the specimens are tougher compared to the DLP specimens. However, DLP technology has the potential to be used with resin form of known filament materials, regardless of the lack of certain properties, by adjusting the printing parameters and specific requirements.

Keywords

Additive manufacturing, PLA, PLA resin, characterization, mechanical properties, microscopy.

Acknowledgement

This research was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia by Contract No. 451-03-47/2023-01/ 200105 from 03.02.2023.

EFFECT OF SECTION THICKNESS ON CAVITATION BEHAVIOUR OF SELECTIVE LASER SINTERED POLYAMIDE 12

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Abstract

The present study focuses the cavitation resistance results of samples obtained by the Selective Laser Sintering technology. All samples were made from Nylon 12 – Polyamide 12 powder, also known as PA2200 in the industry, produced by EOS GmbH. The powder used for building the samples represented a mixture of 50% new powder and 50% recycled powder. Samples with different section thicknesses (0.4mm; 0.8mm and 1.0mm) were subjected to the ultrasonically induced cavitation test method to investigate the effect of geometry on their cavitation behaviour. The change in mass loss during different cavitation times was measured on the tested samples. The morphology of cavitation damage was characterized using Scanning Electron Microscopy (SEM). The results obtained in this paper have shown that section thickness of the samples has a significant influence on the cavitation resistance, with the highest cavitation resistance obtained for the samples a thickness of 0.4mm.

Keywords

Polyamide 12 powder, SLS, mass loss, cavitation resistance, section thickness, SEM, additive manufacturing.

Acknowledgement

This work was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (Contract No.451-03-47/2023-01/200135, Faculty of Technology and Metallurgy, University of Belgrade Contract No. 451-03-47/2023-01/200108, Faculty of Mechanical and Civil Engineering in Kraljevo, University of Kragujevac, Contract No. 451-03-47/2023-01/ 200213, Innovation Centre of the Faculty of Mechanical Engineering, Belgrade, University of Belgrade, Serbia.

APPLICATION OF FRACTURE MECHANICS PARAMETERS TO EVALUATE THE INTEGRITY OF ROTATING EQUIPMENT

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Abstract

Assessing the integrity of rotary equipment, such as turbine shafts, is a particular challenge due to the nature of its load. Presence the crack makes the whole problem becoming even more complex and requires the inclusion of more scientific disciplines and tools, such as software packages that can simulate the working conditions of equipment, more precisely, dynamic load that can cause material fatigue of the structure.
The subject of this publication is research of the behavior of rotary equipment, specifically turbine shafts, Hydroelectric Power Plant "Đerdap II" in the presence of cracks with the aim of determining the integrity and remaining service life of turbine shafts. The danger in the presence of a crack with this type of equipment is the possibility of a brittle fracture which is, by its nature, unpredictable, and often with fatal consequences. Special attention is dedicated to the places on the structure that cause stress concentration. The Abaqus and MORFEO software packages, i.e. the principles of the extended finite element method (eng. XFEM), were used to solve the problem of assessing the integrity of the rotary equipment of the hydroelectric shaft.
The main goal can be reduced to explaining the complex condition and general behavior of rotating equipment, i.e. turbine shafts in the presence of cracks caused by fatigue loads and in the presence of stress concentrators. Developed and presented numerical models, as well as experimental procedures provide great applicability in integrity assessment of this type equipment

Keywords

Integrity, Fracture mechanics, Fatigue crack growth, xFEM, Turbine shaft, Brittle fracture.

Acknowledgement

This work was supported by the Ministry of Education, Science, and Technological Development of the Republic of Serbia (Contract No. 451-03-47/2023-01/200213).

A METHOD FOR FRACTURE PROBABILITY ASSESSMENT IN FUNCTION OF J-INTEGRAL IN TRANSITION TEMPERATURE REGIME OF FERRITIC STEEL

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Abstract

In this paper is presented the 1-point method for material behaviour prediction, in terms of fracture toughness, of the ferritic steel EN 1.6310 in the transition temperature regime (-60°C and -90°C). Experiments were carried out at two different temperatures, representing two studies joined in one. Experimental testing was perfomed according to ASTM 1820 standard. This 1-point method is based on statistical processing (of 2-parameters Weibull statistics) of obtained experimental results, i.e. scattered J-integral values, of C(T) specimens with different geometries. Fixing value of one Weibull parameter and taking into account size-dependence of second one, fracture probabilities in the function of J-integral for large C(T)100 and C(T)200 were determined based on testing of C(T)50 specimen size. This research pointed out the sensitivty of proposed method on statistical sample size. One of the aims of proposed method was reducing the cost and price of laboratory tests in overall by predicting material behaviour and testing smaller C(T) specimen size. This research represents an upgrade of the Landes and Heerens works, and it is dedicated to their efforts in understanding and characterisation of transition temperature regime of ferritic steels.

Keywords

Fracture toughness, Weibull statistics, Transition temperature regime, J-integral, Ferritic steel.

Acknowledgement

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STRUCTURAL INTEGRITY ASSESSMENT OF WELDS ON PRESSURE VESSELS

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Abstract

The paper presents assess the integrity of welded joints on pressure vessels made from HSLA steel. Risk based approach is applied using Failure Analysis Diagram to assess likelihood of failure. Special attention is paid on cracks defects by advanced ultrasonic testing which are unacceptable by standards, but difficult to be repaired. Structural integrity assessment was performed based on evaluation of fracture mechanics parameters, which has been used to improve safety of welded structures, focusing on welded joints on pressure vessel, as the most critical components. Simple engineering method is presented, based on the Failure Analysis Diagram (FAD) to explain evaluation of fracture mechanics parameters and their critical values in order to assess structural integrity of welded joints.

Keywords

Integrity, welded joints, pressure vessels, risk analysis.

Acknowledgement

This work was supported by the Ministry of Education, Science, and Technological Development of the Republic of Serbia (Contract No. 451-03-47/2023-01/200213).

EEFFECTS OF ALLOYING ELEMENTS ON THE PROPERTIES OF HSLA STEEL

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Abstract

The first industrial application of elevated and high-strength steel in the form of hot-rolled strips and sheets was the manufacture of pipes and vessels under pressure, as it was possible to reduce the thickness, i.e. to reduce the weightof welded structures. The high-strength low-alloy steels used today are usually obtained by suitable chemical composition and thermomechanical treatment.

Our investigated steel NIOMOL 490 K belongs to the class of molybdenum microalloyed steels, where the microalloying with molybdenum serves to increase the heat resistance of the steel and at the same time strengthen the influence of other alloying elements. This steel grade is designed for the manufacture of welded pressure vessels fabrication and is mainly used for dynamic loading conditions at low operating temperatures.

In the present paper, the tensile and hardness tests were used to determine the effects of alloying elements on the mechanical properties of NIOMOL 490K steel in the temperature range from -60°C to +60°C.

Keywords

Alloying elements, NIOMOL 490 K, Mechanical Properties, High strength low alloy steel.

STRUCTURAL ABILITIES OF CHAIN MADE FROM RECYCLED PET BOTTLES

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Abstract

The structural abilities of chains made from recycled polyethylene terephthalate (PET) bottles have been investigated in this study. With the increasing awareness of environmental sustainability, recycling PET bottles has gained significant attention. However, understanding the structural properties of chains made from recycled PET bottles is crucial for their practical applications. In this research, a series of tests were conducted to evaluate the mechanical properties of chains fabricated from recycled PET bottles. The links are made by cutting plastic bottles into one continuous strip, then that strip is spun tightly ten to fifteen times between a ˝U˝ screws. Then the rest of a strip is folded by 90° and turned around the plastic winding. Last part is securing the last part of a strip within the link, and to use the hot-air gun to squish the outer winding so it holds itself together. The chain is made by directly connecting two already made links within the process of making a middle link, so this kind of chain cannot be undone unless it's ripped. The tensile strength, elongation at break, and stiffness of the chains were measured using standardized testing methods. Additionally, the effects of varying chain dimensions and manufacturing processes on the structural abilities were examined. Shimadzu AGS-X universal testing machine with a 100 kN load cell capacity was used to stretch the samples and measure the force required to achieve a certain deformation. So far the tests were inconclusive because insufficient testing materials. Till now the links sustained load of 2200kN without deformation or any structural changes.The findings of this study suggest that chains made from recycled PET bottles possess sufficient structural abilities for various applications. These chains can serve as sustainable alternatives to traditional materials in industries such as packaging, construction, and manufacturing. Additionally, their adoption can contribute to reducing waste and promoting a circular economy.

Keywords

Recycled pet bottles, upcycling, chain, tensile strength, and structural abilities.

Acknowledgement

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STUDYING THE INFLUENCE OF ELASTANE CONTENT AND DIFFERENT WET PROCESSES ON THE PROPERTIES OF COTTON AND COTTON/ELASTANE SINGLE JERSEY KNITTED FABRICS AND THE REVALORIZATION OF FABRIC WASTE

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Abstract

This paper represents a comprehensive review of the effect of elastane and common wet processes (bleaching, dyeing, and softening) on the properties of 100% cotton and half or full plated cotton/elastane single jersey knitted fabrics. The fabrics were characterized in terms of their structural (fabric weight, thickness, and stitch density), comfort (air permeability and water vapor resistance), mechanical (stiffness, bursting elongation, and bursting strength), and antistatic (volume electrical resistivity) properties. Fabrics' antistatic properties were further improved by in situ synthesis of Cu-based nanoparticles (CuNPs) on their surfaces. Such fabrics can be also considered as bioactive since they possessed excellent antioxidant (determined using the ABTS method) and antimicrobial (against E. Coli, S. aureus, and C. albicans) activities. The last section of this chapter is focused on proposing a novel circular economy solution for the disposal of softened cotton and cotton/elastane knitted fabric waste collected from the textile industry (i.e., after clothing cutting). For that purpose, selected fabrics were revalorized as adsorbents for the widely used textile dye Congo Red and the maximum dye adsorption was tested using isotherm models. Thereafter, the fabrics with adsorbed Congo Red dye were evaluated as antistatic and dissipative fabrics, i.e., as alternative non-metal-based conductive textiles.

Keywords

Knitted Bioactive Fabrics, Softener, Properties.

Acknowledgement

This work was supported by the CIS Institute d.o.o. Belgrade and the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, Contract No. 451-03-47/2023-01/200287.

THE INFLUENCE OF CYLLINDRICAL SPECIMEN GEOMETRY ON THE VALUES OF FRACTURE MECHANICS PARAMETERS

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Abstract

A global problem for industrial plants that contain process equipment operating under high pressure is the assessment of the integrity of the equipment, specifically the pipelines. Standard procedures for determining fracture mechanics parameters (ASTM E1820) for materials used in pressure piping construction cannot be applied to most thin-wall pressure components.. One of the solutions to this problem is the introduction of new procedures and geometries of test specimens. In order to understand the nature of the behavior of the specimens and to determine the parameters whose critical values are important for integrity assessment of the pipeline under pressure, a detailed analysis of the model of the non-standard ring-shaped specimen is necessary. This paper will present the results of the analysis of fracture mechanics parameters obtained by the finite element method using the Simulia Abaqus software package. The properties of the material used in the software correspond to the properties of the P235TR1 pipeline material obtained by tensile testingon cylindrical samples with initial crack. The ratio of crack length (a) to sample width (W) corresponds to standard sample geometries and varies from a/W = 0.4 to a/W = 0.6. The values obtained from SENT (Single Edge Notched Tension) models with the same cross-section and a/W ratio were taken as reference values in relation to which the comparison is made. As a result of this research, the ratio of fracture mechanics parameters of the ring-shaped model (Pipe Ring Notched Tension – PRNT specimen) with a crack and the SENT model was obtained. The values of the J-integral were also obtained, distribution of values along the crack front does not correspond to the profile obtained on the SENT model. As a result of this test, a procedure for determining the critical value of the J-integral for models corresponding to the tested P235TR1 pipe samples was established, which is an important step in establishing a new procedure for testing of pipeline materials.

Keywords

Fracture mechanics, Pipeline, Single Edge Notched Tension specimen - SENT, Pipe Ring Notched Tension specimen – PRNT, Stress intensity factor.

Acknowledgement

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METHODS FOR IMPROVING THE STRUCTURAL INTEGRITY OF BIOMEDICAL CONSTRUCTIONS BY ENHANCING THE MECHANICAL CHARACTERISTICS OF METAL BIOMATERIALS

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Abstract

In this paper, the development of a relatively new method with the aim of improving the mechanical characteristics and microstructure of the surface layer of biomaterials is presented, primarily in areas of stress concentration, using a modern approach of strengthening the surface of the material with laser beams. The biomaterials used in experimental analysis are titanium alloys and stainless steel as they are most common materials for orthopedic plate's usage. Orthopedic plates were irradiated by pico/nanolaser in different operated regimes and with or without transparent and absorptive layers. The results were verified by scanning microscope, optical microscope, profilometry, stress and deformation measurement, and analyzed comparing irradiated and non-irradiated samples. Two groups of samples (one irradiated and one nonirradiated) were investigated with the cracks initiated around the hole, and results were compared and analyzed, with the purpose to better understand the improvement of material characteristics obtained by laser interaction. The results indicate that the development of more efficient and cost-effective methods for improving the structural integrity of biomedical constructions by enhancing the mechanical characteristics and fracture resistance of metal biomaterials used in orthopedics is possible.

Keywords

Mechanical characteristics, microstructure, titanium alloys, stainless steel.

Acknowledgement

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ASSEMBLING BIOMATERIAL SPECIMENS IN A MOULD MADE OF THERMOPLASTIC POLYMER: 3-POINT BENDING TEST

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Abstract

The utilization of biomaterials with mycelia as a stabilizing agent is gaining popularity in the fields of construction and architecture, offering a sustainable solution aligned with the principles of the circular economy. Interdisciplinary research involving biologists, technologists, and engineers is necessary to advance this field where science, art and design converge. These biomaterials contribute to energy reduction and cost-effectiveness, utilizing readily available and recyclable raw materials. Mycelium-based blocks have shown to be more affordable than traditional cement and gypsum blocks while significantly reducing CO2 emissions. The mycelium network, formed by hyphae, can be cultivated into a solid material, providing a defined technological process. This study focusses on performing 3-point bending testing on moulded specimens using additive technology PLA material, following the ASTM D1037 standard. After the growth of mycelium and the formation of the test tube-shaped structure, the samples are dried and characterized to enchance their mechanical characteristics.

Keywords

Biomaterials, mycelia, additive technology, mold, bending test.

Acknowledgement

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Chemical and Process Engineering

Invited lecture

NOVEL HYDROGEL-BASED SYSTEMS FOR FOOD APPLICATION

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Abstract

Food hydrocolloids have a growing interest in the food industry to meet worldwide demands and challenges related to healthier food products. Functional foods, i.e., foods fortified with bioactive compounds such as antioxidants, antimicrobials, vitamins, enzymes, and probiotics, offer health benefits beyond their nutritional value. Many of these high-value active agents have poor water solubility, chemical stability, and bioavailability, therefore requiring delivery systems are needed to overcome these problems. Hydrogel beads, a type of colloidal delivery system, are designed with sustainability, overall health, well-being, and sensory perceptions in mind. Hydrogels are hydrophilic, 3D polymeric networks capable of retaining large amounts of water or biological fluids, with high compatibility with foodstuff. The successful incorporation of hydrogels into the food system requires a thorough understanding of bead production, physicochemical and mechanical properties, and release at different targeted sites. The functionalities of hydrogels can be adjusted for specific applications by altering their composition, dimensions, and interfacial structure. This lecture aims to point out the recent and relevant research in hydrogel systems intended to deliver water-insoluble active compounds such as essential oils. Hydrogels based on natural/food-grade polymers (proteins, polysaccharides, lipids) can serve as prospective alternatives to synthetic polymer-based hydrogels in encapsulation, drug delivery, packaging, and fabrication of structured foods.

Keywords

Hydrogel beads, functional food, active compounds, controlled drug delivery.

Acknowledgement

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ESTIMATION OF THE REMAINING LIFE OF THE IMINODIETHANOL COLUMNS

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Abstract

The paper examines the remaining lifespan of iminodiethanol rectification columns used in long time service iat Oil&Gas plant. The gas rectification process is explained through two crucial steps: the removal of CO_2 from raw gas using imidiethanol and the recovery of the iminodiethanol medium for the next rectification cycle. Considering that unexpected failure of these columns can lead to serious injuries to personnel, significant daily loses, and environment hazards, their regular and through inspection is crucial for maintaining continuous operation. Furthermore, the risk of failure was analysed in detail, taking into account the most probably damage mechanisms that may occur in these types of rectification columns. By calculating the corrosion rate based on measured thickness values and the minimum required thicknesses of column elements, the remaining lifespan of the columns was estimated. In summary, the paper analyses the aforementioned information and determines the date of the next inspection of the columns..

Keywords

Amine corrosion, corrosion rate, remaining life, risk analysis.

Acknowledgement

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REPAIR OF THE CRACK ON THE PIPE ELBOW – A CASE FROM INDUSTRIAL PRACTICE

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Abstract

During operation, piping components are often subjected to various types of damage mechanisms, which can sometimes results in the appearance of cracks. This paper describes a case that occurred on the industrial pipeline with a diameter of 20 inches. Initially, a pinhole leak appeared on the pipe elbow. Improper repair led to further propagation of the pinhole, crack formation and rapid growth. Due to specific reasons, replacing the elbow with the new one was not possible, so welding was the only solution to fix the problem. This paper presents the entire repair procedure, its application in a real industrial plant, as well as all NDT testing conducted before and after repair.

Keywords

Crack, welding, non-destructive testing.

Acknowledgement

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PHOTOCATALYTIC DEGRADATION OF ACETAMIPIRID IN A QUARTZ PHOTOREACTOR

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Abstract

One of the major challenges associated with pesticide use is the significant water pollution, including surface and underground water, which is particularly concerning due to the vital role of underground water for sustaining life on Earth. Only a small portion of pesticides target the intended harmful organisms, while the majority ends up contaminating the ground and water sources. Most pesticides are toxic to some extent, highlighting the need for methods that can partially or completely mitigate their negative impacts on humans, flora, and fauna. In recent years, photocatalytic degradation has gained prominence as a more effective alternative to traditional physical, chemical, and biological processes for wastewater treatment, offering superior organic pollutant breakdown capabilities. Ideally, the photodegradation process yields minimal byproducts, primarily water, CO2, and a limited amount of secondary waste, thereby minimizing its environmental impact. In this study, the photodegradation of the pesticide acetamiprid was investigated using a TiO2-based photocatalyst in a double-wall thermoregulated quartz reactor. Solar-simulated Ultra Vitalux (UV) lamps (300W) were employed as a substitute for UVC radiation. Acetamiprid concentration was determined using a UV method, and the degradation kinetics followed a pseudo-first order. Complete degradation of acetamiprid was achieved after 210 minutes. Chemical oxygen consumption (COD) measurements further confirmed the success of photocatalytic degradation, indicating its potential for industrial wastewater treatment.

Keywords

Acetamipirid, photocatalytic degradation, UV-VIS, wastewater.

Acknowledgement

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HISTORICAL DEVELOPMENT AND IMPORTANCE OF INDUSTRIAL ECOLOGY

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Abstract

Human actions have caused the deterioration of the environment over time, putting many natural resources at risk. The utilization of energy derived from plants and animals, as well as the extraction and processing of raw materials, has led to increased pollution of the environment. The advancement of industry and technology has resulted in expanded industrial capacities, leading to the emergence of new processes, technologies, products, and types of waste. Additionally, social changes such as urbanization and improved living standards have further intensified pollution due to increased consumption and energy usage. Global issues related to nature conservation highlight the urgent need for a shift in human behaviour towards nature. It is imperative to halt the physical degradation and destruction of the environment and raise awareness among society about the importance of preserving nature and the environment for future generations. Industrial ecology is rooted in the concept of emulating natural ecological systems. Just as ecological systems in nature thrive through intricate networks, industrial systems aim to operate in a similar manner. In nature, organisms coexist within a web of connections, engaging in symbiotic relationships where they consume each other and utilize each other's waste products. By applying this analogy to industrial processes, the goal is to create interconnected systems that promote sustainability and resource efficiency, mimicking the harmonious cycles found in nature's ecosystems. By disseminating knowledge about the necessity of environmental protection and leveraging scientific research findings, progress can be made in mitigating and improving the current environmental situation.

Keywords

Environment, Pollution, Importance of industrial ecology.

Acknowledgement

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INDUSTRIAL ECOLOGY IN MINING AND MINERAL INDUSTRY

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Abstract

Industrial ecology is dedicated to investigating and analysing the effects of industrial practices on the environment. Its primary objective is to explore various research areas and develop strategies to enhance the efficiency of industrial processes with the ultimate aim of reducing their detrimental impact on the environment. The concept of industrial metabolism, developed by Ayers, is a way to understand how industries utilize materials and energy, as well as how to properly dispose of any waste produced. It is a systematic approach that tracks the flow of materials and energy within industrial systems, and can identify inefficient processes or products that have negative impacts on the environment. The mining and mineral processing industry is an industry based on resources that requires extensive use of energy and capital. In order to optimize these components a performance management system is necessary to show trends, scales, and relationships of consumed, emitted, dispersed, and discarded materials. Developing relevant indicators for measuring sustainable development would be the first step in establishing a performance measurement system. Adopting a strategy of cleaner production is the key to operationalizing the concept of industrial ecology in the mining and minerals industry. The key elements for managing cleaner production program are: commitment at the corporation level, integrated environmental and corporate management systems, selecting expert team members, identifying and monitoring environmental costs as well as other operation costs, and applying methodology for cleaner production implementation.

Keywords

Industrial ecology; environment; industrial metabolism; mining and mineral processing industry; cleaner production.

Acknowledgement

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Experimental Techniques

Invited lecture

PLASMA ELECTROLYTIC OXIDATION. STRUCTURAL, OPTICAL AND PHOTOCATALYTIC PROPERTIES OF STRUCTURES OBTAINED BY THIS PROCESS

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Abstract

Plasma electrolytic oxidation is an environmentally and economically acceptable technique for obtaining oxide thin layers on various metals. The technique has numerous advantages over other more developed and used techniques for the synthesis of thin films. The obtained layers have a controlled morphology and composition, good mechanical and thermal properties, high resistance to wear and corrosion, excellent adhesion to the substrate and are suitable for application in various industrial branches.

The process itself includes the formation of plasma, i.e. microdischarges that lead to the development of locally high temperatures (103 K – 104 K) and pressures (~ 102 MPa), resulting in various plasma-chemical, electrochemical and thermodynamic reactions. These reactions enable the formation of both amorphous and crystallized oxide structures consisting of the components of the used electrolyte and substrate. It is possible to form layers with different physical and mechanical characteristics, different phase composition, which are suitable for many applications.

This paper will present a relatively new method for the formation of optical and photocatalytic active materials. The research included numerous improvements of the method in order to obtain highly active materials in the degradation of organic pollutants. For the development of a commercially acceptable photocatalyst, a real pollutant, i.e. an organic dye, was used as a model in the testing, while simulated solar radiation was used in the photocatalytic reactor. The obtained results show that by suitable optimization of plasma electrolytic oxidation, very active photocatalysts can be obtained, the effect of which can be up to 95% decomposition of pollutants after 12 hours of irradiation. The lecture will cover the results obtained for several different photocatalytic systems, from the process of forming the photocatalysts themselves to their detailed characterization and testing of photocatalytic performance.

Keywords

Plasma electrolytic oxidation, Photocatalysis, Photoluminescence, Coatings, Composite materials.

Acknowledgement

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RADIO-FREQUENCY ELECTRICAL CHARACTERIZATION OF VIABLE-CELL SUSPENSIONS

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Abstract

Suspended viable cells significantly influence the relative complex permittivity (dielectric constant) of the suspension. This influence depends on the concentration, viability, size, and even the cell shape. Hence, by measuring the permittivity, various fermentation processes can be monitored (e.g., in wine making and preparation of milk products). Thereby, the complex impedance (or admittance) between electrodes immersed into the suspension is measured and the permittivity is obtained by a suitable de-embedding procedure.
There exist various data in the literature on this influence, but they do not provide sufficient information for wide implementation of the technique. The aim of the paper was to experimentally investigate various aspects of the measurement procedures and establish practical guidelines and limitations.
Measurements were performed using an LCR meter, a classical vector network analyzer, and a nanoVNA analyzer, in the frequency range from 10 Hz to 100 MHz. Various suspension containers and systems of electrodes were designed and manufactured.
Bipolar systems of electrodes were found to be more suitable for higher frequencies than tetrapolar ones. Open electrode systems were found to be more prone to the influence of the environment than shielded systems (e.g., coaxial).
Good results were obtained for simple yeast suspensions. However, the presence of other cells and dispersed solids (e.g., in pressed grape juice) was found to completely overshadow the yeast cells. Electrochemical effects on the electrodes were found to be insignificant above around 200 kHz. Bubbles on electrodes, delamination, high concentrations of ions, and even temperature variations significantly hindered measurements in many cases.

Keywords

Food processing, viable cells, permittivity measurements.

Acknowledgement

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AUTOMATED LIBRARY INVENTORY USING STEPPER MOTOR AND ARDUINO BOARD

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Abstract

The goal of this paper is to propose a mechanism for scanning books in libraries, making library inventory easier, and doing so by using a stepper motor-based slider, controlled by an Arduino board. In the development of a bookshelf scanning system, various linear electro-mechanical and/or mechanical drives were compared, and a preference is given to screw-nut sliders due to their precision and accuracy. Other types of slider drives explored are linear ball bearing sliders or belt-driven sliders. The system includes a linear drive with a stepper motor, a base plate with a barcode scanner and Arduino board. Arduino Uno board is used to control the stepper motor, incorporating two limit switches to detect the end-of-travel. When the limit switch is touched (and depending on which one), the stepper motor either halts or changes its direction of rotation. The Arduino code is obtained from two open-source resources. The code for Arduino Microcontroller Board should include instructions for determining the direction and steps of the motor, based on input from the sensors that detect when the carriage has reached the end of the track. Currently, the project is undergoing further development and construction.

Keywords

Barcode Scanning, Embedded Systems, Library Automation, Linear Drives, Mechatronics.

Acknowledgement

Acknowledgements are extended to The Academy of Applied Technical Studies Belgrade for their support.

A METHOD DEVELOPMENT FOR ANALYSING FOOD TEXTURE AND EXAMINING CRISPINESS

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Abstract

Presented sensory method is based on the data provided by the universal testing machine Shimadzu SG 1kN (Japan). The loading is applied by control of displacement of 1 mm/min. The squeezing was performed until there were no more cracks detected. For crispy food, a resulting force typically increases until a certain point, when it starts cracking, which is detected by repeatedly reduced and again increased force during a considerable range of displacement. Total number of measurements depends on the subjects and ranges between ten and twenty thousand. The raw data was preprocessed, resulting in less than one thousand measurements. Counting changes in the sign of the first derivative of applied force is performed for subranges of applied forces. Presented method provides insight into chewing crispy food, calculating the force for which most cracks occur, as well as how many cracks occur in each subrange. The testing was applied to a wide range of vegetables. Most distinguished results are obtained using onion crisps, i.e. thin slices of onions dried until crispy.

Keywords

Food, experimental techniques, method development, crispiness.

Acknowledgement

The authors acknowledge the support from the Ministry of Education, Science and Technological Development of the Republic of Serbia (contracts: 451-03- 47/2023-01/200213).

COMPRESSION DETERMINATION OF DIFFERENT TYPES OF DRIED VEGETABLES

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Abstract

The texture is a crucial attribute of food, as it affects not only its sensory perception but also its functionality in processing and preservation. In food science and technology, evaluating texture involves using various analytical methods that measure mechanical properties such as hardness, cohesiveness, and viscosity. Among these techniques, compression testing is widely used for evaluating the texture of solid foods, especially those with a high degree of firmness or brittleness, such as dried vegetables. Compression testing involves applying a force on a sample of food until it deforms or fractures. This research used dried onions, carrots, and peppers as test samples to investigate their texture and compression properties. The researchers used a Shimadzu AGS-X universal testing machine with a 1 kN load cell capacity to compress the samples and measure the force required to achieve a certain deformation. The results showed that the texture and compression properties of the dried vegetables were greatly influenced by which part of the vegetable was tested. For instance, a significant difference was observed between the inner and outer parts when testing the dried onions. The outer part of the onion was found to be much harder than the inner part, resulting in a higher compression force required to break the sample. This finding suggests that the texture and compression properties of dried vegetables are determined by their inherent characteristics and internal structure and composition.

Keywords

Food textures, universal testing machine, *compression testing, dried vegetables.*

Acknowledgement

The authors acknowledge the support from the Ministry of Education, Science and Technological Development of the Republic of Serbia (contracts: 451-03- 47/2023-01/200213).

INFLUENCE OF TEMPERATURE ON CRACK INITIATION AND CRACK GROWTH RESISTANCE OF WELDED JOINT CONSTITUENTS FOR STEEL SA-387 GR. B WELDS SUBJECTED TO CYCLIC LOADS

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Abstract

The paper presents the analysis of the influence of the temperature and exploitation time on the measure of fracture resistance of welded joint constituents of a new and exploited low-alloyed Cr-Mo steel A-387 Gr. B from the aspect of application of high-cyclic fatigue parameters and fatigue crack growth parameters. Exploited parent metal is a part of a reactor mantle which was working for over 40 years and is in the damage repair stage, i.e. part of its mantle is being replaced with new material. Wohler's curves were constructed, i.e. fatigue strength, coefficients C and exponents m in Paris equation and values of fatigue threshold Kth were determined at room and working temperature. Based on the testing results, analysis of fracture resistance represents the comparison of values obtained for characteristic areas of welded joint and the justification of the selected welding technology.

Keywords

Crack, low-alloyed steels, welded joints, fatigue strength, fatigue crack growth parameters.

THE ROLE OF RELAY VALVE WITH KINKED CHARACTERISTICS IN BRAKING WAGONS WITH DIFFERENT BRAKES IN A FREIGHT TRAIN

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Abstract

This paper explains the problem of more pronounced heating of the wheels and wear of the brake shoes of equally loaded railway vehicles with SS or S2 tread brakes compared to wagons with S0 or S1 brakes when they are in the same train composition. As the mass of the railway vehicle increases and the square of the speed increases, the energy that is converted into heat during braking increases. In the case of tread brakes, this heat is dissipated to a lesser extent through the shoes, and to a greater extent through the wheel. Due to the uneven temperature field, parts of the wheel expand differently, and thermal stresses arise in the wheel. During extreme braking, the thermal stresses in the circumferential part of the wheel can exceed the yield point of the material, and as a result, permanent deformations occur due to circumferential compression. After cooling, residual tensile stresses are created in the direction of the wheel circumference. In extreme cases, this can cause the wheels to crack. For this reason, it is necessary to limit the intensity of braking, especially during long-term partial braking due to speed regulation on railway down slopes. However, the maximum braking force must not be limited. This is achieved by introducing a variable load relay valve with kinked characteristics. The Kink valve is a relay valve of a special design, which, based on the level of loading of the wagon, maps the pressure in the brake cylinder, so that when braking from 80 to 100% of the maximum pressure at all loads, the braking force is proportional to the load, and during partial braking, in the case of a load over 14.5 t/axle, the braking force is reduced, so that the wheels do not overheat during frequent partial braking.

Keywords

Freight wagons, braking, relay valve, kinked characteristics, wheel overheating.

Acknowledgement

Authors express gratitude to Ministry of Education, Science and Technological Development of Republic of Serbia, Project Contract 451-03-9/2023-14/200105.

NUMERICAL AND EXPERIMENTAL STUDY OF FATIGUE STRENGTH OF HELICOPTER COMPOSITE TAIL ROTOR BLADES

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Abstract

This work was focused on defining loads and spectrum loading of helicopter tail rotor blades because original metal construction of these blades were replaced with a new construction of blades made from composite materials. The tail rotor blades usually have no drag hinges, and large alternating moments occur due to Coriolis forces caused by the blade flapping. These moments considerably influence dynamic strength and fatigue life of the blade. On the other side aerodynamic loads of the tail rotor blades are significantly increased because of the main rotor vortex wake influence and have to be determined reliably. Aerodynamic loading of helicopter Mi-8 tail rotor blades is obtained using commercial CFD software code. To determine aerodynamic load of helicopter tail rotor blades using CFD here the complete helicopter configuration including: fuselage, main rotor blades and tail rotor blades was modelled. These loads were used to define the spectrum with which experimental fatigue tests were performed. The horizontal flight with 90% of never exceed speed is considered representing transport mission case that covers 30% of the total flight time. The unsteady solver and sliding meshes for both rotors are employed. The tail rotor blade is tested under static loads and fatigue load spectrum. In this research some aspects of the fatigue strength tests of helicopter composite tail rotor blade under spectrum loading were considered. The tail rotor composite blade was tested to fatigue under combined inertial and aerodynamic loads spectrum up to 3010 flights without initial damages.

Keywords

Composite structures, helicopter tail rotor blades, CFD simulations, fatigue.

Acknowledgement

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Numerical Methods

Invited lecture

FRACTAL ANALYSIS AND MICROSTRUCTURE DEVELOPMENT OF $BATIO_3$ AND PVDF BASED MULTIFUNCTIONAL MATERIALS

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Abstract

Barium titanate ($BaTiO_3$) and polyvinylidene fluoride (PVDF) based multifunctional materials are attracting a great scientific interest due to their excellent piezoelectric, pyroelectric and ferroelectric properties. These materials undergo controlled transformations through physical interactions and respond to environmental stimuli, such as temperature, pressure, electric and magnetic fields. Their properties strongly depend on synthesis procedures and obtained microstructures. This include intergranular contact surfaces of $BaTiO_3$ based materials, as well as, porous structure and cross-linking patterns of PVDF prepared by electrospinning. It has been found that these microstructures can have fractal structure and that the fractal analysis can be used as a powerful tool for describing structural and functional properties of these materials. Having this in mind, in this research we have used different fractal methods for the reconstructions of various $BaTiO_3$ and PVDF microstructure morphologies. Fractal analysis has been performed by using scanning electron microscope micrographs and computational modeling tools. Fractal dimension of irregular morphologies which exhibit fractal regularity were determined by using box-counting method. This method enables the analysis of self-similar microstructure morphologies by quantifying the rate at which an object's geometrical details develop at increasingly fine scales. Theory of Iterated Function Systems and Voronoi tessellation, have been used for modeling $BaTiO_3$ random microstructures and PVDF porous structures. A python algorithm was created to determine the distribution of pore areas in SEM micrographs. Algorithm's distribution of calculated pore surface areas was compared with measured pore surface areas and fractal reconstructions of different morphologies and their connection with functional properties were analyzed.

Keywords:

PVDF, $BaTiO_3$, Electrospinning, Fractals, Voronoi tessellation.

Acknowledgement

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STRESS AND STRENGTH ANALYSIS OF SANDWICH CONSTRUCTION: NUMERICAL AND EXPERIMENTAL STUDY

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Abstract

The subject of the work refers to the analysis of the strength of elements of sandwich constructions in domain of civil engineering and aircraft structures. The paper describes the experimental and numerical investigation of the behaviour of polyisocyanurate (PIR) sandwich panels subjected to a tension and compression load. In order to obtain optimal results, laboratory and numerical analyses of the specimens were compared. The loads that are considered in this paper are compression loads. Laboratory tests were performed on small dimension sandwich wall panels (width 100 mm). In addition to the laboratory tests, a numerical analysis was carried out on the models. Numerical analysis was carried out in ANSYS software code. The numerical model accurately predicts the results of laboratory tests in the mechanical testing of sandwich panels. Special attention in this investigation is focused on compression behaviour of sandwich construction. Computation results are compared with own experimental results. Good agreements between computation and experimental results are obtained.

Keywords

Sandwich constructions, Numerical simulations, Experimental results, FEM, Failure analysis.

Acknowledgement

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COMPARATIVE ANALYSIS OF THIN-WALLED Ω PROFILE EXPOSED TO THE ACTION OF CONSTRAINED AND UNCONSTRAINED TORSION

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Abstract

The paper presents analytical and numerical determination of the equivalent stress and deformation of the open section thin-walled „Ω“ cantilever beam loaded with torsion. This work could be divided into three parts. In the first part, equivalent stress and deformation were obtained using analytical calculation for an encastred model over the entire cross section during unconstrained torsion. In the second part, the finite element method was applied to the beam models during unconstrained torsion, and the obtained results were compared with the analytical calculation. The third part of the paper presents the numerical model for constrained torsion. In this paper, computational models are made, the static calculation is carried out analytically and using the finite element method. The zones of stress concentration are identified and the process of stress reduction and its concentration is presented. The conclusions obtained by examining this type of structures may be involved in the design process of new similar structures. The findings obtained during the implementation of this work can be directly applied to identify the behavior of real structures in their working conditions, i.e. in their exploitation.

Keywords

Thin-walled beams, finite element method (FEM), equivalent stress, deformation, cross-section.

VARIATIONS OF THE AHP METHOD, AND APPLICATION OF THE AHP EXPRESS METHOD IN THE MULTICRITERIA EVALUATION OF COMPANIES

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Abstract

This research paper focuses on the application of multicriteria decision-making methods, specifically the Analytic Hierarchy Process (AHP), Fuzzy AHP, and AHP Express, in real-life examples. The problem of multi-criteria valuation of a company's growth, specifically the decision on which of the four existing products to invest into the greatest extent, is examined. The paper aims to compare the results obtained from the three variations of the AHP method, which are widely discussed in the literature, using Excel software for implementation.

The research findings reveal a decision-making paradox, which serves as a crucial point of analysis and lays the foundation for further research in the fields of management engineering and decision-making. The paper contributes to the body of knowledge on multicriteria decision-making methods by providing insights into the behavior of different variations of AHP in real-life engineering problems.

Moreover, it is noteworthy that the methods described in this paper are based on numerical methods and optimization techniques, making it relevant for researchers and practitioners in the field of engineering. The research findings have practical implications for decision-making processes in various engineering and management contexts, where multiple criteria need to be considered.

Overall, this paper contributes to the field of decision science and provides valuable insights into the application of multicriteria decision-making methods for engineering problems, specifically in the context of company growth valuation. The findings of this research have implications for management engineering and decision-making and pave the way for future research in this area.

Keywords

Multicriteria decision-making, analytical hierarchy process, company growth evaluation, management engineering, decision-making paradox.

FAILURE EVALUATIONS FOR WING SKIN WITH ELLIPTICAL FLAW UNDER DYNAMIC LOADING

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Abstract

The vast majority of large moving structures inevitably face safety-critical flaws such as corrosion and cracks. Therefore, it is of a great importance the development of computational models for reliable fatigue performance assessments in order to prevent sudden failure caused by part-through flaws, such as quarter-elliptical and semi-elliptical cracks.

Through this research work, the failure of safety-relevant aircraft skin with surface elliptical flaw is analyzed under dynamic loading, employing novel computational framework. The new solving technique based on damage tolerance concepts is developed to allow solutions for crack growth rates by generating driving force interactions in the vicinity of crack tip. Further, by extending Huang-Moan crack growth concept a new set of analytical formulae is proposed to explore the wing skin life and effects of stress ratio. Case studies and experimental results will be provided to demonstrate the analysis of different classes of damaged wing skins, as means of evaluating relevant safe-integrity performances during design and operations under service loadings.

In order to achieve effective and efficient decision making in long-term performance assessments of moving structures, the balance between safe-integrity protection and relevant loading profiles should meet damage tolerance-based requirements. Thus, theoretical outcomes, successfully verified, will demonstrate that this research work supplies notable information about elliptical flaw phenomenon and provides insight on improving safe-integrity performance design of failure-critical aircraft skin.

Keywords

Computational framework, fatigue life, surface elliptical flaw, wing skin.

Acknowledgement

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THE CURRENT STATE OF THE OPEN-SOURCE ENGINEERING SOFTWARE

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Abstract

There has been a growing interest in mesh generation, CFD, parallel computing, and design optimization, leading to the development of numerous high-quality open-source numerical simulation software over the past two decades. This work provides an overview of such software, some of which have been frequently used by the author of this paper. The aim is to analyse the current state and development of these software tools. While comparisons with corresponding commercial software are made, the main focus is to access the extent ot their use in research, particularly in recent years, and explore the latest innovations and advancements in the verification and validation process. Special attention is given to the most advanced software, which can be easily installed on various operating systems. Additionally, recent software tools are highlighted, particularly those that have gained prominence due to new models that are the focal point of current research and their innovative approaches.

Although most open-source software for numerical simulations is Linux-based, there is a frequently asked question in the research community regarding Windows versions. The rapid development of information technologies has pushed the boundaries and necessitated communication between operating systems. One of the resulting solutions is the Windows subsystem for Linux (WSL), which addresses the well-known Linux/Windows compatibility issue. In this work, the WSL is treated with special attention, recognizing its potential as a solution to bridge gap between Linux-based software and Windows users.

Keywords

Numerical simulations, open-source software, FEM, FVM, Windows Subsystem for Linux (WSL2), CAELinux, Salome platform, CFD, OpenFOAM, Elmer FEM, NETGEN, Gmsh.

ANALYSIS OF STATIC STRENGTH OF SPECIAL TOOL FOR ASSEMBLING WAGON BODY

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Abstract

This paper presents the results of a finite element analysis (FEA) conducted on the static strength of an assembly comprising a special tool used for assembling the wagon body including the underframe, body sides, ends, and roof. The assembly was designed by “AMM MANUFACTURING“ from Kragujevac, Serbia. The elements of the assembly were specially designed endure the operational load experienced during the wagon body assembly process without undergoing any permanent deformation. A numerical analysis was performed on the aforementioned special tool, which serves as a support tool for assembling the wagon body. The special tool was constructed using structural and stainless steel. The finite element model (FEM) was created based on a a 3D CAD model obtained from “AMM MANUFACTURING“ and the analysis oof the static strength was carried out using suitable software. The numerical analyses were conducted in compliance with relevant standards. The results obtained demonstrates that the assembly of a special tool is capable of withstand the operational load during the wagon body assembly process without experiencing any permanent deformation.

Keywords

Railway Industry, Special tool, Numerical Model, Wagon Body.

Acknowledgement

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ANALYSIS OF STATIC STRENGTH OF THE PRODUCTION TOOL FOR MOUNTING AND INTERNAL TRANSPORT THE CAB OF THE MIREO HIGH-SPEED TRAIN

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Abstract

The subject of this paper is the static strength analysis of a support production tool used for the mounting and internal transport of the cab of the MIREO high-speed train. The assembly of the production tool was designed by "AMM MANUFACTURING" from Kragujevac, Serbia. Numerical analyses were conducted using the finite element method (FEM). The elements of the assembly were specifically designed to withstand the operational load during the assembly of the "Mireo Cab" and internal transport, without experiencing any permanent deformation. The structure of the assembly was constructed using various materials, including structural steel grades S235JRG2 and S355J0, quenched and tempered steel grades C45 and 42CrMo4, PE500, and bolts of grades 8.8 and 10.9. The creation of the finite element model (FEM) and the analysis of static strength were performed using a specific software package. The results of the numerical analysis indicate that the assembly of the production tool can safely endure the working load, equivalent to the mass of the "Mireo Cab," without undergoing any permanent deformation. Based on the static strength results, the customer has received manual instructions for the proper usage of the assembly, particularly during lifting and internal transport.

Keywords

High-speed train, Finite Element Analysis, Production Tool, Railway Industry.

Acknowledgement

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MICROHARDNESS OF FRICTION STIR WELDED LAP JOINT OF ALUMINIUM ALLOY

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Abstract

The paper presents the results of research into the possibility of production lap joint of aluminum alloy. Friction welding process was used to weld two aluminum alloy 5754-H111 plates into lap joint. Friction stir welding ensures joining of materials without melting and using additional material. By correctly selecting technological parameters of the welding process, a lap joint was successfully produced. Visual inspection of the face and root side of the weld metal is presented in the paper. Microhardness $HV_{0.15}$ was measured at the face of lap joint as well as through the cross section of the joint. The hardness was measured to include all structural zones of the joint: base metal, heat affected zone, thermo-mechanically affected zone and nugget. As expected, the resulting weld metal microhardness reached the microhardness value of the base material.

Keywords

Friction stir welding, lap joint, aluminium alloy, microhardness, visual inspection.

NUMERICAL STRESS AND STRAIN CALCULATION OF OMEGA CANTILEVER BEAM MODEL LOADED WITH TORSION

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Abstract

This paper presents the analytical and numerical determination of the equivalent stress *and strain* of the open section thin-walled „Ω“ *cantilever beams* loaded with torsion . Analytical calculation was used to calculate the equivalent stress and strain values for the model encastred across the entire cross-section at the one end, while the other end is free *(model 1)*. *The finite element method was applied for the calculation of the same* „Ω“ *cantilever beam model exposed to the action of torsion, and the stress and strain values were obtained by numerical calculation. Numerical simulations have been performed using KOMIPS software. Analytical and numerical results were compared and discussed. In this paper, a numerical model for constrained torsion was also created in ABAQUS and SolidWorks software. A cantilever beam with an omega profile is encastred at one end, while at the other end there is a welded plate (model 2). Numerical models are created, and the static calculation is done using the finite element method. The zones of stress concentration are identified and presented. Finally, the equivalent stresses values of the model 1 and model 2 were compared. The conclusions obtained by examining this type of structures may be involved in the design process of new similar structures. The findings obtained during the implementation of this work can be directly applied to identify the behavior of real structures in their working conditions.*

Keywords

Thin-walled beams, finite element method, equivalent stress, deformation, omega cross-section.

POSSIBILITIES OF USING NUMERICAL SIMULATIONS IN DEFINING THE OPTIMAL POSITION OF BURNER HEADS OF THE REGENERATIVE BURNER SYSTEM FOR TUNDISH PREHEATING IN THE STEEL INDUSTRY

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Abstract

The paper presents the result of numerical simulations performed to optimize the position of burners and off-gas exit for a tundish preheating system. The optimization of the position of burner heads and off-gas exit at the tundish top cover has been done by application of StarCD CFD software for numerical simulations. 3D model of a tundish and its top cover consists of 300195 control volumes. Optimization of position for burner heads and off-gas exhaust at the tundish top cover brought a uniform temperature field inside the tundish refractory layer during the transient preheating process with minimal fuel consumption.

Keywords

Numerical CFD simulation, Tundish preheating system, Design optimization, Transient heating process.

New Technologies

Invited lecture

APPLICATION OF NANOTECHNOLOGY IN COSMETIC INDUSTRY-CIRCULAR AND SUSTAINABLE APPROACH

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Abstract

Nanotechnology and controlled delivery systems are innovative areas of science due to their various advantages and applications in the cosmetic industry. In recent years, nanomaterials are an emerging field of research, as they offer many benefits over traditionally used cosmeceuticals. Controlled drug release, augmented bioavailability, product stability, and improved dermal penetration are the main advantages associated with nanotechnology-based products. The implementation of nanoparticles in cosmetic formulations offers a new way of using and application of bioactive and/or functional ingredients. This type of new technology has an important role and contribution to a circular economy and more sustainable industrial production. The extracts rich in polyphenols and seed oils with antibacterial, antifungal, anti-inflammatory and antioxidant potential are widely used in cosmetics. The reuse of natural raw materials (secondary products of the fruit juice processing industry) as a source of various bioactive compounds and their encapsulation using nanomaterials offers an innovative approach for protection of active components and product quality improvement. The entire recovery process which includes the application of green extraction technology of bioactive compounds and their nanoencapsulation supports a non-linear "take-make-dispose-recycle" model. This lecture aims to give a short overview of nanotechnology application perspective in the cosmetic industry with a special focus on the significance of this technology in circular economy and product quality improvement compared to traditional cosmeceuticals. The different nano-systems and their use in commercial formulations as well as safety assessments regarding the use of nanomaterials in cosmetics will be also presented.

Keywords:

Nanotechnology, cosmetics, encapsulation techniques, controlled drug delivery, circular economy.

Acknowledgment

This work was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (Contract No. 451-03-47/2023-01/200287) and Circular voucher “*Extraction and encapsulation of bioactive components from waste raw materials obtained from raspberry processing - application in the cosmetic industry*” funded by the Global Environment Fund (GEF), the Ministry of Environmental Protection and United Nations Development Programme (UNDP).

CAD/CAM APPROACH TO AUTOMATION OF THE PRODUCTION PROCESS

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Abstract

This paper presents the application of Industry 4.0 in the production of machine parts using a CNC machine and an industrial robot. The functional structure of the flexible production cell, its configuration, programming methods and application in industry are explained in detail. The complete technology design was carried out using the ESPRIT software package, which involved selecting the processing system, introducing auxiliary accessories, selecting the required sequence of operations, defining the tool, defining the processing mode, creating the tool path, and generating the NC code for the CNC machine. With the help of a digital model of the machine (known as a digital twin), a controller emulator, machine parameters and a post processor, the system provides precise simulation and machine-optimized NC code. ESPRIT offers factory-developed post-processors for most types of machines and control units, which generate NC code without requiring subsequent modifications. It is also possible to create special post processors for special types of machines and applicationsIn this particular case, due to the workpiece geometry and production speed, the 4+1 strategy was chosen on the 5-axis machine, involving the simultaneous movement of four axes and the indexical movement of one axis. Real-time machine CAM programming represents a fundamental change in the way tool paths are created, resulting in longer tool life, shorter cycle times and better machine utilization.

Keywords

Industry 4.0, CAD/CAM, digital twins, artificial intelligence.

HYBRID FRICTION STIR WELDING – LAP JOINT OF ALUMINIUM ALLOY PLATES

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Abstract

Hybrid friction stir welding is an innovative technology for joining aluminium in the solid state. This process allows for efficient joints to be obtained without defects. By adding an additional heat source, the base materials are preheated, resulting in significant advantages in both cases, such as faster and better plasticization of the base material, reduce FSW tool wear and clamping forces, faster welding speed, and improved weld quality. The plasma arc and gas tungsten arc (GTA) procedures for perheating are the most commonly used methods in previous studies. In this work, we attempted to use gas welding for preheating using acetylene (C_2H_2) as the fuel gas. First, we welded an aluminum alloy lap joint using friction stir welding (FSW) and then using the hybrid FSW process. The microhardness of both joints was measured and the results are presented and discussed. The microhardness values of the lap joint using hybrid FSW are lower than the joint obtained using FSW. Microhardness in the base material is about 30 percent lower. This decrease in the microhardness of the base material is consequence of the enlargement of the structure grain due to the high gas welding temperature and the wide flame beam. Microhardness values in the nugget zone are the same in both cases of welding.

Keywords

Hybrid friction stir welding, preheating, lap joint, microhardnes.

APLICATION OF ROUGH MACHINING WITH BALL END MILL CUTTER IN 3 AXIS FREE FORM SURFACE MANUFACTURING

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Abstract

The ball end cutter is a commonly used tool for rough machining free-form surfaces. This paper presents a procedure for rough machining parts with free-form surfaces on 3-axis machines. To achieve this, a model for predicting cutting forces is developed and implemented in a software solution for automatic technology design. This software solution has been previously tested and described. The procedure enables the optimal utilization of the tool while considering the maximum allowed cutting force for the selected tool diameter. The tool diameter is automatically determined based on the analysis of the surface geometry and is chosen to be smaller or equal to the minimum surface radius. The software solution includes an input of the part CAD model in STL file format and a tool database specific to the machine used. After upgrading the software with new strategies for rough machining, the generated NC code was tested on a CNC machine, and manufacturing was performed within the specified tolerances and surface roughness. The research was conducted at the Department of Production Engineering at the Faculty of Mechanical Engineering in Belgrade, where this topic has been actively studied for many years and is still under development. The described software solution is beneficial as it allows users to operate with minimal knowledge of CAM systems.

Keywords

CAD/CAM systems, ball end mill cutter, free form surface milling.

Acknowledgement

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INFORMATION AND QUERY IN BIM

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Abstract

Most of today's BIM technologies, which enable the creation and maintenance of digital models of buildings throughout their lifetime, treat information as a set of structured data. This approach resulted in numerous standards and technologies aimed at the completeness and quality of the information model itself. If we pay attention to the fact that the first papers that formulated the mathematical theory of information inextricably link information with communication, we will see that the party receiving the message represents a key part in the understanding of information. What's more, information does not exist without the receiving party. All information models represent only a source of information, not information. In order to ensure that the end user receives the desired information, it is necessary to find ways to represent the end user needs and define ways to query the BIM model in accordance with them.

Querying IFC file is not an easy task. Parsing directly file format is a problem due to the structure of the STEP file. To overcome these limitations, other representations based on XML, RDF and OWL formats have been developed. Second approach is to use a database management system (DBMS) to access and query information. Since IFC format is full of relationships the graph database is effective solution.

The paper analyzes the existing solutions for the representation of the IFC format through databases and Linked data technologies and determines the ways in which they can be connected with the existing technologies for the representation of information requirements.

Keywords

Information, BIM, Query, Information requirements.

Acknowledgement

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RENEWABLE ENERGY ALTERNATIVE SELECTION AT THE MUNICIPAL LEVEL

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Abstract

Energy is a prerequisite for development of today's companies, municipalities and whole societies. Renewable energy sources (RES) are gaining increasing importance and share in the energy systems of many countries. But, selection among different renewable energy sources request analyzing numerous criteria, stakeholders interests, costs, legal regulations etc. For this reason, multi-criteria decision-making methods (MCDM) are often used for the selection of renewable energy alternative. There are numerous MCDM methods that are used in literature and practice to select most suitable renewable energy alternative. In this paper, analytical hierarchy process (AHP) is applied to assess four renewable energy alternative (hydro, wind, photovoltaic and biomass) in Štrpce municipality. Also, there are numerous criteria in literature that are used to select renewable energy alternative. In this paper six criteria are used: investment, efficiency, land requirements, GHG emissions, price of energy and operation and maintenance jobs. According obtained results first ranked is hydro alternative.

Keywords

AHP, renewable energy, Strpce.

FORCE PREDICTION MODELS IN BALL END MILLING OF FREEFORM SURFACES

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Abstract

Simulating the process of NC milling of freeform surfaces is of fundamental importance in computer aided manufacturing (CAM). In order to accurately predict cutting force in sculptured surface machining with ball end mill, tool posture, cutting edge, contact state between cutter, and workpiece are studied. Cutting force prediction is very important to optimize machining parameters, monitor the machining state and to reduce the possibility of tool breakage. In order to predict the cutting force of surface machining with a ball end mill, different materials and geometry of the tool/workpiece are studied. In this paper, the state of the art is presented in the field of force prediction in ball end milling and the advantages of different methods for determining the cutter-workpiece engagement. The research for cutter-workpiece engagement (CWE) under different cutting conditions is mainly divided into three types: solid modeling, discrete representation, and analytical methods. The resulting surface quality after machining with a ball end cutter is of great importance because finished milling is often the last process step determining the functional performance of a component.

Keywords

Cutting force, ball-end milling, freeform surfaces, CAD/CAM, cutter-workpiece engagement.

Acknowledgement

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Clear sky

Invited lecture

HYDROGEN AS A SUSTAINABLE FUEL FOR AVIATION PROPULSION

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Abstract

In recent years there has been a renewed interest in the application of hydrogen as a primary fuel for aeronautical propulsion. The benefits of using hydrogen in aviation are self-evident. Hydrogen has a large energy density, it is sustainable, produces no harmful gas emissions, is widely available etc. The push for electrification in the aviation sector further increases the possible feasibility of hydrogen as a fuel through its use in fuel cells.
There are many difficulties in its utilization as a viable fuel, however. There are still technical difficulties regarding efficient large-scale production, storage, transportation etc. as well as the corresponding safety concerns. Here, the state of the art in the industry and research is going to be presented with special attention to the most significant challenges. Some of the proposed possible solutions are also discussed and an insight in the arising opportunities is given.

Keywords

Aerospace propulsion, hydrogen fuel, propulsion systems.

Acknowledgement

The results shown here are a result of the research supported by the Ministry of Science, Technological Development and Innovations of the Republic of Serbia under contract 451-03-47/2023-01/ 200105 from 03.02.2023.

TOWARDS INNOVATIVE AND MORE EFFICIENT SOLUTIONS FOR HEAT ECHANGERS IN AEROSPACE INDUSTRY

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Abstract

Heat exchangers used in the aerospace industry have inherent requirements for maximizing heat transfer efficiency, reducing weight and size, ensuring enhanced durability, and enabling customization for different aircraft types. 3D printing technology allows for the utilization of advanced materials such as high-temperature alloys and ceramics, which can withstand the extreme conditions of aerospace environments. Recent studies have highligheted the potential of 3D-printed heat exchangers in various aerospace industry, including spacecraft thermal management, electronics cooling and aircraft engine cooling.

Heat exchangers modeled on the basis of TPMS (Triple Periodic Minimal Surface) structures exhibit high surface area-to-volume ratios and interconnected pore structures, resulting in significant enhancement in heat transfer rates. TPMS has been extensively researched in mathematics and materials science for several decades, with classical examples like the Schwartz surface, Gyroid surface and Diamond surface mainly studied for designing small-scale heat exchangers. Numerous studies have denonstrated improved heat transfer efficiency, structural stability and durability of 3D-printed heat exchangers. However, the design of TPMS structures using existing CAD systems poses challenges and further improvements are needed in modeling process.

Overall, the combination of 3D printing technology and geometry optimization represents the state-of-the-art in heat exchanger research, holding significant potential to transform existing systems and drive the development of innovative and more efficient energy systems in the aerospace industry.

Keywords

Heat exchanger, aerospace industry, design, TPMS, 3D printing.

EFFECT OF PITCH ANGLE ON WIND TURBINE PERFORMANCES

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Abstract

The rising cost of fossil fuels has prompted a shift towards environmentally friendly alternative energy sources, leading to an expansion in the study of renewables. Wind turbines, specially those of the small-scale variety, have emerged as a promising solution for generating sustainable electricity, particularly in rural areas and for smaller consumers. This study focuses on the analysis of pitch angles for three-bladed horizontal axis wind turbines (HAWT) with a diameter of 1.35 m, classified as micro wind turbines. The analysis assumes incompressible and viscous flow, with shear stress transport (SST) equations closed by various turbulence models. The ANSYS program was used for conducting this analysis.

Keywords

Wind, Turbines, Energy, Ansys.

Acknowledgement

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DESIGN OF MODULAR UAV “MODULAR X”

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Abstract

Modular X represents a project of designing and manufacturing a modular unmanned aerial vehicle, more precisely, an aircraft that has the possibility of changing its configuration and purpose. The original tasks that the aircraft should be able to serve is as a training aircraft for future drone operators and to enable testing of a wider range of electronic systems, from recording certain objects on the ground, drone-drone communication and autonomous flight. In the first phase of the project development, 4 possible configurations were investigated: acrobatic aircraft with V tail, VTOL configuration with T tail, VTOL configuration with thruster and inverted V tail and quadcopter configuration. The main characteristics of the aircraft are easy and fast production, cheap and easily replaceable components and the possibility of taking off on different types of terrain.

Keywords

UAV, Modular, Pilot, Testing, VTOL.

PERSPECTIVES OF THE INTEGRATION OF AN ABSORPTION REFRIGERATION CYCLE IN ENERGY PRODUCTION SYSTEM

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Abstract

Global warming and ozone depletion issues have had an impact on novel approaches to integrating some energy production systems. Currently, fossil fuels such as oil, coal, and natural gas still remain the primary sources of energy used to meet the majority of the cooling requirements in vapor compression systems. Additionally, these high-energy consumption systems utilize substances that contribute to ozone layer depletion and typically rely on fluorinated gases (F gases), which can have a global warming impact thousands of times greater than CO2. Extensive research has been done on reuse and waste heat utilization within different systems to achieve a reduction in high carbon fuel consumption. One method aimed at improving the value of available renewable energy sources is the absorption refrigeration cycle (ARC). Through ARC, the concept of “cooling with the heat“ can be achieved, offering various benefits such as the integration of the energy production systems, implementation of sustainable cooling technology in the industries, and the potential establishment of district cooling system. Cooling demands can be met by harnessing solar radiation, biomass energy, waste heat from industrial processes, and geothermal energy.

Regarding the importance of low-temperature heat sources and heat energy reuse, current research focuses on identifying engineering and cost-effective approaches to enhance the efficiency of an integrated system. Such system impacts the output parameters of energy production and consumption, providing vast opportunities to compare different systems from the exergy and economic considerations using various parameters. The comparison criteria and investigation of integrated systems' effects typically revolve around better performance at very low temperatures, carbon dioxide emissions, and cost savings. Despite the presence of obstacles, integrating different energy production systems will have a significant impact in overcoming challenges within the energy production sector.

Keywords

Absorption refrigeration cycle, system integration, renewable energy, low-temperature sources.

Dental Materials and Structures

Invited lecture

ACTIVITY STATE OF DENTINE-DERIVED TGF-B1 RELEASED AFTER RESTORATIVE DENTAL MATERIALS TREATMENT

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Abstract

Restorative dental materials including calcium hydroxide ($Ca(OH)_2$), mineral trioxide aggregate (MTA) and biodentine (BD) induce dental tissue repair/regeneration by releasing bioactive molecules from dentine. Transforming growth factor-beta1 (TGF-β1), crucial bioactive molecule in repair/regeneration, is present in dental tissues in active (acting molecule) and latent form (inactive pool for active form). However, the exact activity state of dentine-derived TGF-β1 released after restorative dental materials treatment is unclear. Evaluation of $Ca(OH)_2$, MTA and BD ability to release active (A-TGF-β1) and latent TGF-β1(L-TGF-β1) from human dentine was the aim of the study. Dentine disks were treated with material/left without treatment (control) and incubated at 37°C/100% humidity/14 days. Afterwards, materials were removed and disks were immersed in PBS at 37°C/24h. Active and total TGF-β1 levels were quantified by ELISA. L-TGF-β1 levels were calculated by A-TGF-β1 levels subtraction from total TGF-β1. A-TGF-β1 levels released by investigated materials and L-TGF-β1 levels released by MTA were significantly higher, while L-TGF-β1 levels released by $Ca(OH)_2$ and BD were significantly lower than control. Comparing investigated materials, the highest A-TGF-β1 levels were released after BD treatment, while $Ca(OH)_2$ released the highest L-TGF-β1 levels. BD released more A-TGF-β1 than L-TGF-β1, while $Ca(OH)_2$ and MTA released more L-TGF-β1 than A-TGF-β1. In conclusion, all investigated materials have the ability to release both, active and latent, TGF-β1 from dentine. Biodentine was superior to MTA and $Ca(OH)_2$ in releasing A-TGF-β1, while $Ca(OH)_2$ showed superiority in releasing L-TGF-β1 compared to MTA and biodentine. This research contributes to the understanding of material-induced dental tissue reparation processes.

Keywords

Calcium hydroxide, mineral trioxide aggregate, biodentine, TGF-β1.

Acknowledgement

The study was supported by Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 451-03-68/2022-14/200129).

Invited lecture

ADVANCES IN DENTAL COMPOSITE CURING

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Abstract

In recent years, there has been an increasing tendency to shorten restorative procedures for dental composites. One approach to achieving this goal is to modify the composites to enable deeper penetration of photo-activating light, which allows for polymerization in thicker layers. At the same time, sources for irradiation emissions are constantly being improved, with a focus on increasing the emitted energy and the area of coverage. The tips of curing units now often cover the entire molar tooth in a single irradiation. To deliver the same amount of energy in a shorter time, radiant emittance must be higher, sometimes reaching up to 6000 mW/cm2. For some curing units, the recommended irradiation time is only 3 seconds. Laser systems emitting at desired wavelengths have also been tested in a few studies, with some emitting for only 1 second. The range of wavelengths emitted is wider and even extends into the red and near-infrared range, which contributes to the material's heating in situ.
However, what users often overlook is the quality of polymerization and whether these advancements represent reliable and safe choices.

Keywords

Dental composites, Light Curing Unit, Polymerization, Polywave,

Acknowledgement

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Invited lecture

APPLICATION OF FINITE ELEMENT METHOD IN DENTISTRY

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Abstract

Finite Element Method has found a place in research in dental research. There is a large body of dental research in the current literature that employs this scientific approach, and the number of such studies is still growing. The reason for this is the ability to create virtual models of teeth and jaws, and apply any king of force that would be impossible to achieve in reality. Furthermore, this approach enables the development of patient-specific models and specific treatment plans for every patient. In our previous research, we developed various models and applied high-intensity forces as well as repeated forces of lower intensity. We analysed the stress distribution in teeth and jaws and effect of fatigue. Recently, we created a sophisticated model of jaws that includes all necessary tissues. This lecture will present our experience with this method.

Keywords

Finite Element Method, dentistry, stress distribution, biomechanics.

Acknowledgement

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Invited lecture

ANALYSIS OF MECHANICAL AND PHYSICAL-CHEMICAL PROPERTIES OF DENTAL COMPOSITE CEMENTS

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Abstract

This paper aims to investigate the mechanical, physical, and chemical properties of currently available dental cements. The study involved a comparative analysis of four different self-adhesive resin-based dual-curing composite cements: Maxcem Elite (Kerr, USA), Relyx U200 (3M, ESPE, Germany), Multilink Automix (Ivoclar Vivadent, Liechtenstein), and SeT PP (SDI, Australia). The selection of materials with diverse compositions and indications was intended to encompass a wide range of permanent dental cements used for adhesive cementation, enabling a comprehensive characterization of their properties. Resin-based composite cements exhibit excellent aesthetic properties, satisfactory mechanical strength, and acceptable biological characteristics, making them suitable for restoring anterior and lateral teeth. However, this group of materials also has significant drawbacks. These include polymerization shrinkage, incomplete conversion of monomers to polymers, and a rise in temperature during polymerization that may potentially harm the dental pulp. Polymerization shrinkage can compromise the contact area between dental tissues and the restorative material, leading to the formation of marginal microcracks, which can allow the penetration of saliva and microorganisms. Furthermore, unreacted monomers can negatively affect the mechanical properties and biocompatibility of these materials. By conducting a comparative analysis and characterization, this study has enhanced our understanding of the properties of the examined dental cements, surpassing the existing research in this field. It is worth noting that all the tested materials are commercially available and widely used by patients globally. Therefore, the findings of this study offer a valuable opportunity for a comprehensive and practical assessment of different dental cements, thereby making a meaningful contribution to the field.

Keywords

Dental composite cements, Polymerization shrinkage, Materials properties.

Acknowledgement

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DIGITAL ORTHODONTICS – ONE APPROACH

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Abstract

3D modeling is becoming an increasingly everyday orthodontic practice, which after two decades of research and development is becoming a basic element of e-orthodontics. The research, development and application of geometric entities (GE) on 3D models for diagnosis, planning and monitoring of orthodontic therapy, using general CAD (Computer Aided Design) systems. Statistical analysis and synthesis of 54 orthodontic parameters (28 for the upper jaw and 26 for the lower jaw), on a sample of 155 patients. All three hypotheses were confirmed: suitability for the application of GE, higher accuracy of the 3D model and greater tooth displacement in the first six months of therapy. The benefits of applying a dental arch model using a spleen from 3 to 8 degrees, depending on the patient's condition, have also been proven. Finally, the accuracy of the 3D modeling scanner was investigated, as a basic element for this research. The application of GE to define orthodontic parameters provides new possibilities for accurate and reliable analysis of the orthodontic condition of the patient, as well as for modeling the shape of the dental arch and researching the accuracy of the scanner.

Keywords

Orthodontics; 3D modeling; diagnosis; therapy.

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Advanced Materials and Technology

CHARACTERIZATION OF MECHANICALLY ACTIVATED ZRO_2-C POWDER MIXTURES

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Abstract

Mechanical activation represents a very useful technique for powder processing prior to sintering process. First of all, it makes powders homogenized, leads to attrition of powder particles, and makes powder mixtures more reactive. Secondly, it can lead to mechano-chemical reaction, and finally, lowering of sintering time and temperature. Mixtures of ZrO_2 and C were mechanically activated by high-energy ball milling. Powders were milled for times from 0 to 120 minutes in air atmosphere. Mechanically activated powder mixtures were characterized by various techniques, such as particle size analysis (PSA), X-ray powder diffraction (XRPD), scanning electron microscopy (SEM), Fourier-transform infrared (FTIR) spectroscopy, Raman spectroscopy, and diffraction scanning calorimetry along with thermo gravimetry (DSC-TGA). As milling time increased, surface area of powders increased, indicating significant particle size reduction. Mechanical activation for 15 minutes provides the best balance between particle size reduction and reactivity for the powders.

Keywords

ZrO_2-C, mechanical activation, SEM, XRD.

ELEVATED TEMPERATURE THERMAL PROPERTIES OF ZRB_2 WITH TUNGSTEN ADDITIONS

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Abstract

The thermal properties of zirconium diboride (ZrB_2) ceramics with tungsten additions of up to 5 wt% were characterized up to 2000°C. Densification was promoted by the addition of 0.5 wt% carbon. ZrB_2 ceramics were prepared from commercially available powder by hot pressing. The crystalline phases present were determined by x-ray diffraction. The microstructure and density change as a result of the addition of tungsten, but this does not affect much the thermal behavior of ZrB_2 at room and elevated temperatures. Thermal diffusivity at 200°C decreased from 0.158 cm^2/s for nominally pure ZrB_2 to 0.149 cm^2/s for ZrB_2 with 5 wt% Tungsten carbide (WC). The thermal diffusivity decreased with increasing temperature, reaching a value of 0.145 cm^2/s at 2000°C for ZrB_2 with 5 wt% Tungsten carbide (WC). Heat capacity, unlike thermal diffusivity, did not change during thermal cycling. Thermal conductivity, which was calculated from thermal diffusivity, heat capacity, and density, was as high as 77.9 W/(m·K) at 2000°C for ZrB_2 with 5 wt% Tungsten carbide (WC). Any level of Tungsten carbide (WC) contamination reduces thermal conductivity. Properties, including hardness, oxygen content, elastic modulus, strength were measured and will be discussed.

Keywords: Tungsten carbide; Zirconium diboride; Hot pressing, Thermal properties; Microstructure.

Acknowledgement

This project was funded by the Hypersonic Materials Manufacturing Program of the U.S. Air Force Office of Scientific Research through contract FA9550-22-1-0064 as well as by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, Agreement on realization and financing of scientific research work of the Institute of Technical Sciences of SASA in 2023 (Record number: 451-03-47/2023-01/200175). Missouri S&T UHTC Group.

TIME-DEPENDENT BEHAVIOUR OF PHOTOSENSITIVE RESINS IN MSLA TECHNOLOGY

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Abstract

Vat photopolymerization is an Additive Manufacturing (AM) technology that enables the production of dimensionally accurate components. Due to its accuracy, this technology has led to the development of various sub-types, each with different methods of introducing UV light to the liquid resin in the vat. UV light can be introduced through a mirror system (SLA), a projector (DLP), or an LCD screen that acts as a photomask over a projector's light, allowing for the curing of the entire layer in one pass (MSLA). The material of interest in this study is a standard translucent resin used in MSLA, with a UV light wavelength of 405 nm. Previous extensive mechanical characterization of this material has shown a high dependence on the final component properties on layer thickness and curing times.

The objective of this research is to analyse the time-dependent behaviour of these materials. Specifically, closed-loops compression tests have been conducted, subjecting the material to loading and unloading sequences at strain levels of 5 and 25 %. To clarify, a strain level of 5 % falls within the elastic region of the material, while a strain level of 25 % is considerably within the plastic region. Various testing speeds were applied, namely 1, 5, 10, 25, and 100 mm/min. The influence of testing speed on the materials' energy absorption capacity is evident. The highest difference is observed between 10 and 25 mm/min, indicating that the material's ability to store energy is significantly reduced after a testing speed of 10 mm/min.

Keywords

Additive Manufacturing; Vat photopolymerization; MSLA; photosensitive resin; time-dependent behaviour.

Acknowledgment

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APPLICABILITY OF CONSTRUCTION AND DEMOLITION WASTE IN GEOPOLYMERS – A SCREENING TEST

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Abstract

In this study, the applicability of construction and demolition waste (C&DW) in geopolymerization technology was investigated. The C&DW components, concrete and solid bricks, were collected from demolition sites in Belgrade, Republic of Serbia. The concrete sample came from a demolished fifty-year-old construction road, while the remains of solid bricks originated from a 1930s building. Prior to mechanical testing, the C&DW components were characterized by XRD analysis for their mineralogical composition. The results showed that the concrete waste consisted mainly of quartz (SiO_2) and calcite ($CaCO_3$), while the brick waste sample contained anorthite from the feldspar group ($CaAl_2Si_2O_8$), wollastonite ($Ca_{0.957}Fe_{0.043}O_3Si$) and mullite ($Al_{2.4}O_{4.8}SiO_6$).

The mechanical properties were examined using the screening method on three geopolymer mixtures, one of each mixture of concrete and brick powders and a mixture of both C&DW components. According to the standard SRPS EN 12390-3:2010 for cubic samples, the geopolymer samples were prepared with alkaline activators for testing the compressive strength as the dominant parameter in the mortar and concrete evaluation. The compressive strength values increased in the range of 2.4 MPa for concrete, 10.2 MPa for brick, and 10.8 MPa for the mixed geopolymer sample. The low compressive strength result of the concrete sample was the consequence of the mineral composition, i.e., the absence of aluminosilicate. However, the brick and the sample with a combination of both types of waste showed moderately satisfactory compressive strength, which could be the starting point for further investigations.

Keywords

Brick, concrete, compressive strength, recycle.

Acknowledgement

The research presented in this paper was completed with the financial support of the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, with the funding of scientific research work at the University of Belgrade, Vinča Institute of Nuclear Sciences (Contract No. 451-03-47/2023-01/200017), Innovation Fund, Republic of Serbia (Project Proof of Concept, ID 5755), the University of Belgrade, Faculty of Civil Engineering (Contract No. 200092) and the University of Belgrade, Innovation Centre of Faculty of Mechanical Engineering (Contract No. 451-03-47/2023-01/ 200213).

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Artificial intelligence

ROBOT MOVEMENT PROGRAMMING AND SIMULATION GENERATION FOR PICK AND PLACE MATERIALS IN ABB ROBOT STUDIO

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Abstract

This paper describes a program for robot movement for pick and place materials using ABB Robot Studio. Program allows students to make a complete workspace for robot control via virtual work space and make simulation for robot movement. Students can make their own 3D model of the work piece and import it to the virtual workspace. Advantage of making the simulation is exposing errors without direct contact with robot and its workspace. If no errors are present in the simulation students generate the program code for robot movement in accordance with demanding conditions. At the end of the exercise of pick and place materials the students were introduced to the Robot Studio software package. Students were able, after the exercise, to build a robot workspace for material transfer with the help of the lecturer. The advantage of doing the exercise is that the students get to know the software directly, which enables the design of certain objects within the program itself. In order to improve the exercise, the objects of manipulation had different forms, where the students were given the chance to design the parts themselves in the SolidWorks program and to import that 3D model into Robot Studio by saving the modelled part with SAT extension, then add another task for the robot to move around the contour of the object after placing the part, simulating the type of a milling process, where students use the knowledge gained from placing the targets of the end effectors.

Keywords

Robotics, artificial intelligence, simulation, education.

APPLICATION OF ROBOTS IN DEMANDING CONDITIONS

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Abstract

In this research it is presented adapting the robot to work in demanding conditions such as servicing a forge press. The main risk associated with the deployment of robots is the robot's workspace. The robot's ability to move in free space, change configuration and perform unexpected movements can cause risks to personnel working and standing in the robot's workspace. In addition to mechanical barriers, protective light curtains that use infrared light rays to detect objects or persons entering the closed robot workspace are used as prevention in the protection of the robot workspace. Servicing presses, hammers and volume forming machines is one of the most difficult jobs for a man in the industry (high temperature, unclean environment, short cycle times and monotony that inevitably leads to injuries). In the paper, an analysis of the operation of the forging press type VPE400 by the ABB IRB 6640 robot is performed. A piece of steel is taken out of the induction furnace by the ABB IRB 6640 manipulator robot and placed under the forging press while it is still hot. By lowering the given press, i.e. by the action of great force, a shaping the metal is done.

The process of adapting the semi-automated forging line where the robot manipulates the forging preparations from the induction furnace to the press and from the press to the forging storage area is described in details, and all necessary protective measures in accordance with demanding conditions are shown.

Keywords

Robotics, artificial intelligence, demanding conditions.

ETHICAL CONSIDERATIONS AND HUMAN RIGHTS REGARDING AI IN AUTONOMOUS VEHICLES

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Abstract

As Artificial Intelligence (AI) technologies used in autonomous vehicles (AV) are rapidly advancing, numerous questions arise around ethics. The aim of the research is to give an overview of ethical considerations in development and deployment of AV. An interdisciplinary approach is used in addressing interrelation of AI technologies and human rights. Including, but not limited to ethical implications of engineer's choices, there are several technical challenges of AV that rely on AI, the design and type of systems and sensors, as well as algorithms for perception and decision-making. One of these systems would be the usage of LIDAR rather than the camera's computer vision algorithms, as a means of reducing the chance for misuse of data, whose protection is enshrined in General Data Protection Regulation (GDPR). The recent literature shows dilemmas that development of AI in general is facing, but when those technologies are implemented in AV the systems safety, reliability, and effectiveness are essential. Vitaly important is that the system is designed for making decisions in complex and unpredictable situations, such as avoiding accidents, navigating through crowded areas, and reacting to unexpected events, without violating any human right. Based on the idea that all human beings have inherent dignity, certain human rights are considered absolute. The right to life is an absolute human right which means it is universal and inalienable, and in this context deaths from road traffic accidents can be considered as violation of that right, but more concerns are arising in questions of responsibility for accidents.

Keywords

Artificial intelligence, autonomous vehicles, human rights, ethics, GDPR.

A BRIEF OVERVIEW OF CURRENT VECTOR DATABASE SOLUTIONS FOR KNOWLEDGE DISCOVERY

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Abstract

Finding similar objects is a very common operation in modern AI systems. Nearest neighbour search is an essential step in information retrieval, recommender systems, large scale classification, and many more. Recently, with the growing increase of available data, a need for database-like subsystem has emerged to enable fast access and large scale data storage in format directly usable by machine learning models. Vector databases are relatively new paradigm, sharing some features with established database systems and introducing a new index structure. As the state of the field is in its infancy, many problems yet need to be addressed, and many potential improvements are still to be investigated. An overview of existing vector database systems and their role in solving common AI tasks is presented, as well as areas for future research.

Keywords

Vector embeddings, natural language processing, vector databases.

DATAFLOW HARDWARE FOR REAL-TIME HIGH-SPEED CAMERA IMAGE PROCESSING

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Abstract

The computing model based on conventional control-flow paradigm inherently has problems with the bus as the bottleneck of the system and under-utilization of transistors available on a chip. Billion of transistors are utilized to execute only few instructions simultaneously. Dataflow paradigm efficiently solves these problems by processing in parallel thousands of arithmetic operations, where the execution is spread over the dataflow chip. However, once configured, dataflow hardware can execute only the algorithm it is configured for. Additionally, it is suitable only for those instructions that are repeated over and over again. Thus, it is often reconfigurable and used jointly with a control-flow hardware that is responsible for reconfiguring dataflow hardware, preparing data for the execution, and handling results. High-speed cameras can produce thousands of frames per second. The fast processing is a must. Many such cameras have the possibility to process images. However, users are limited to functionalities provided by vendors. Connecting a high-speed camera with a reconfigurable dataflow hardware offers supreme performance, allowing a custom code to be executed jointly with other algorithms that might be already implemented for the control-flow or dataflow hardware.

Keywords

Control-flow programming, dataflow programming, image processing.

INDOOR USER LOCALIZATON BASED ON VISION TRANSFORMER FOR AMBIENT ASSISTED LIVING APPLICATIONS

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Abstract

Image-based indoor localization has evolved to the point whereby wearable camera chips and mobile phones apps that give user location are readily available. This has allowed research effort to focus on analysis and interpretation of the data that such devices provide and to use this information in a variety of ambient assisted living applications including tourist-oriented services that enhance user experience in museums and galleries, as well as assistive technology for the memory and visually impaired. In this paper we propose an approach based on an end-to-end vision transformer (ViT)-based architecture that exploits the relationship between different indoor locations (which we refer to as positions) and the corresponding visual scene information in an image through positional cross-attention. We achieve this by learning a query for each indoor location and scene type. Furthermore, we learn a separate representation for different indoor scenes, as different scenes in the same location are often defined by completely different visual features. To obtain this we group pixels into semantic concepts, to produce a compact set of visual tokens. Then, to model relationships between semantic concepts, we apply the vision transformer to these visual tokens. Then, we project these visual tokens back to pixel-space to obtain an augmented feature map from which we deduce the user indoor location. Based on the obtained user location in addition to the taken images one can get more substantial information about user activities and thus improve the overall user experience.

Keywords

Computer vision, deep learning, vision transformer, indoor localization, AAL.

ACTION RECOGNITION BASED ON VISION TRANSFORMER AND A CONTRASTIVE LEARNING TECHNIQUE

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Abstract

Convolutional neural networks with spatio-temporal 3D kernels (3D CNNs) have shown success in action recognition due to the fact that they can act as spatiotemporal feature extractor from videos of different characteristics. Although the 3D kernels tend to overfit because of a large number of their parameters, the 3D CNNs have improved by using recent huge video databases. Video transformers, on the other hand, have recently emerged as a competitive alternative to 3D CNNs for video understanding and action recognition. However, due to their large number of parameters and reduced inductive biases, these models require supervised pretraining on large-scale image datasets to achieve good performance. In this paper, we propose a supervised technique for video transformers pretraining based on contrastive learning that takes in as inputs a pair of clips sampled from the same video: a long clip and a short clip. The method employs the video transformer to match the representation of the short clip to the representation of the long clip. This forces the model to predict the future and the past from a small temporal window, which is beneficial for capturing the general structure of the video and understanding the action occurring in the video. Moreover, we are able to detect subtle human actions from various co-occurring video scenes which proved that the proposed method is successful in detecting different actions happening simultaneously and throughout the video.

Keywords

Computer vision, deep learning, vision transformer, action recognition, video processing.

Student session

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THE NUMERICAL METHODS FOR EXAMINATION AND DEVELOPMENT OF NEW BIOMATERIALS

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Abstract

Biological materials are taking a leading position in development at the personalized medicine and biomedical engineering level, opening the new door to the development of experimental biomedicine and many other areas of modern science and engineering. Our research is trying to present in an adequate way fundamental mathematical models which are necessary for understanding new biomaterials which give a functional change of tissue, with the aim of performing the general state of an organism or maybe a corresponding pathological process. Such models in addition to predictive or diagnostical methods require a known fundamental therapeutical method that gives meaningful access to the behavior of corresponding parameters before and after the appearance corresponds to medical problems which would very quickly remove possible errors and give adequate recovery system or organ which is being attacked. Here we are focused on some mathematical formalisms which for their universality can explain and predict changes at the surface and molecular level and describe the development and prognosis of disease which significantly helps in the design of increasingly demanding problems of modern medicine. Those methods are based on noncanonical assemblies which fully described the interactions in macromolecules which have to play a general meaning in describing molecular dynamics and fundamental drug delivery properties. The very actual research on new biomaterials is focused on light-matter, and molecular magnetic interactions, which indicates that the Maxwell Equations for matter can be applied to living systems. This is a very promising introduction to the new performance of biomaterials.

Keywords

Drug delivery, light-matter interactions, Maxwell's equation for matter, molecular dynamics, noncanonical assemblies.

INVESTIGATION OF THE TENSILE STRENGTH OF POLYMER MATERIALS OBTAINED THROUGH 3D PRINTING TECHNOLOGIES

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Abstract

The subject of this paper is the experimental testing of 3D-printed polymer materials and their tensile strength. The focus was on testing polymer materials that are easily accessible, cost-effective, and do not have documented mechanical characteristics using inexpensive, hobbyist printers that are significantly cheaper compared to industrial printers. The specimens were manufactured according to the ISO 20753 standard using polylactic acid (PLA). The applied technology for producing these specimens was Fused Filament Fabrication. In this study, the specimens were printed on an Ender 3 printer in a direction perpendicular to the stretching direction to obtain maximum strength. The specimens were designed with a minimal number of walls to support the structure. The variable during this testing was the infill, which ranged from 15% to 100% using a grid geometric structure. After their fabrication, testing was conducted using a Shimadzu AGS - X 100kN universal testing machine with a crosshead speed of 1mm/min. Multiple tests were performed for each infill percentage to ensure reliable results. As expected, specimens with higher infill percentages exhibited greater tensile strength. However, a higher infill percentage also means increased material costs and product mass. The essence of 3D printing lies in not using 100% infill, as it allows for material and time savings, aiming to produce a balanced product with desirable characteristics and minimal mass.
It is planned that further research will focus on investigating the influence of infill pattern on tensile strength, the impact of temperature on tensile strength, and the adhesive forces between material layers.

Keywords

Additive technologies, Fused Filament Fabrication (FFF), Polylactic Acid (PLA), Infill percentage, Tensile strength.

EVALUATION OF RADIOPACITY OF CALCIUM SILICATE AND CALCIUM ALUMINATE CEMENTS WITH ADDITION OF TITANIUM DIOXIDE

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Abstract

Introduction: Calcium silicate (CS) and Calcium aluminate (CAL) cements are used for root canal filling, direct/indirect pulp capping, root canal perforation and tooth apexogenesis / apexification.

The Aim: To assess the effect of titanium dioxide addition on radiopacity of CS and CAL cements.

Material and Methods: Two basic mixtures were used: A) CS+magnesium silicate+bismuth dioxide and B) CAL +CS+magnesium silicate+bismuth dioxide. Nanoparticulated titanium dioxide-TiO2 were added into those mixtures. Basic experimental specimens contained 5%, 10% and 15%TiO2 respectively with following prescriptions: CS+ 5%TiO2, CS + 10%TiO2, CS + 15%TiO2, CAL + 5%TiO2, CAL + 10%TiO2 and CAL + 15%TiO2. Pure cements (Portland cement (PC) and CAL) and mineral trioxide aggregate (MTA) were controls. All cements were mixed in proportion of 1g powder/0,33ml distilled water while MTA was used as manufacturer. Those mixtures were poured into cylindrical moulds according to international standardized organization (ISO 6876). Three samples of each group were radiographed along aluminium step wedge etalon with the steps 'depth increasing from 1-10mm. Radiographs were made by digital radiology device using 0,069s exposition. Radiograms were processed by Adobe Photoshop CS4 (Adobe Inc.) programme where the value of radiopacity was calculated by transforming the grey scale values into mmAl. ANOVA test and programme SPSS (Chicago, USA, IBM) were used.

Results: ISO 6876 (minimum 3mm Al) were met for: CS+ 10% TiO2(3.1±0.3), CS + 15% TiO2(3.29±0.15) and CAL+ 15%TiO2(3.01±0.01) that were statistically significant different among each other. MTA displayed the highest radiopacity (6.6±0.8), significantly more than other cements ($p<0.05$). The significantly lowest radiopacity values exposed pure CAL (1.11±0.02) ($p<0.05$), except compared to PC(1.2±0.6) and CAL+ 5%TiO2 (2.4±0.6)($p>0.05$).

Conclusion: CS mixtures with 10% and 15% TiO2 met ISO requirement where the TiO2 addition did not significantly influenced the radiopacity.

Keywords:
Calcium silicate; Calcium aluminate; Titanium dioxide; Portland cement; Radiopacity; Mineral trioxide aggregate.

APPLICATION OF CERAMIC MATERIALS OBTAINED BY ADDITIVE MANUFACTURING

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Abstract

The realistic alternative to conventional subtractive manufacturing techniques is additive manufacturing (AM). It is a rapidly developing technology that makes it possible to produce sophisticated 3D parts with unique designs at low cost and with minimal environmental impact.
By creating new opportunities to make cutting-edge ceramic components, additive manufacturing (AM) has the potential to revolutionize the ceramic industry. Because there is no longer a need for pricey tooling, production costs and lead times are reduced, and design freedom is increased.
There is high expectation that, if these obstacles are solved, AM technologies will have a significant impact on the manufacturing of industrial ceramic components. These issues include those related to processing ceramic materials using AM technology, such as complex feedstock and sintering requirements. One of the many sectors where this technology is revolutionary is the production of ceramic materials.
There are several applications for ceramic materials created via additive manufacturing. Ceramic materials are used in the energy sector due to their excellent chemical and heat resistance.
Ceramic additive manufacturing enables the production of high-quality, wear-resistant equipment.
These are just a few applications for ceramic materials created using additive printing. Complex geometries are difficult or impossible to build using traditional production methods, but this technology offers flexibility and the ability to do so.
The numerical analysis of the flexural and tensile behaviour of a ceramic specimen created via additive manufacturing is the main topic of this study.

Keywords

Additive method, Ceramic, 3D printing.

THE EFFECT OF THERMAL CYCLING ON SURFACE PROPERTIES OF CAD/CAM HYBRID CERAMIC MATERIAL

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Abstract

The aim of this study was to examine and compare the surface characteristics of the CAD/CAM Hybrid BLOCK (Edelweiss Dentistry) material before and after thermal cycling(TC) the procedure that simulates the process of hydrothermal aging of materials in in vitro condition.

Material and Method:
The clinical research was performed at School of Dental Medicine, Faculty of Mining and Geology and Faculty of Mechanical Engineering University of Belgrade. The study included 30 samples of CAD/CAM Hybrid BLOCK (Edelweiss Dentistry). In the cutting machine, the samples were cut in the shape of a disc, 5mm in diametar and 2mm thick. The specimens were then submitted to the polishing protocol, suggested by the manufacturer. The experimental part included measuring the surface roughness (SR) and view of surface topography by Scanning Electron Microscopy (SEM) before and after thermal cycling procedure.

Results:
There was a stattistical significant difference between groups in both surface roughness parameters (Ra and Rz) before and after TC. After TC materials has shown more iregular curves with higher peaks and deeper valleys contrary to the ones before TC. The result of SEM showed a different surface rougnes of each specimen. Morphological changes, such as cracks and grooves were detected in all groups as a result of polishing procedure. After TC in all groups changes in surface roughness were present.

Conclusion:
Thermal cycling evidently leads to changes in the surface properties of the material. This study provides useful knowledge for future researches under in vivo conditions.

Keywords

Hybrid ceramic materials, thermal cycling, surface roughness, SEM.

Successful Project Stories

DEVELOPMENT OF HIGH-REACH PANTOGRAPHS FOR HIGH-SPEED RAILWAYS

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Abstract

The pantograph's purpose is to transfer electrical power from the overhead contact line to the train's electric propulsion unit. To perform its function adequately, it is necessary to maintain the static contact force between the pantograph and the contact line within the values prescribed by appropriate standards for the entire extension range of the pantograph. The requirement to reach high contact lines complicates the kinematic scheme because the deviation of the trajectory of the pantograph's collector head from vertical is also prescribed by standards. Further, the structural design of the pantograph is challenging because the greater slenderness ratio of the structure makes it difficult to meet the requirements in terms of stiffness and resistance to vibrations. While at low speeds aerodynamic forces are usually neglected, in high-speed pantographs, they have a significant impact and it is necessary to compensate for them. An aggravating circumstance is the requirement that the pantograph should work in both knuckle-downstream and knuckle-upstream directions. This paper aims to present the development of a high-speed high–reach pantograph that is developed through the cooperation of company Minel General Electric and the University of Belgrade – Faculty of Mechanical Engineering as well as to present innovative designs of gravitational and aerodynamical compensations that enabled the satisfaction of requested requirements in terms of geometric and static performance.

Keywords

Pantograph, High-reach high-speed, Gravitational compensation, Aerodynamical compensation.

Acknowledgement

This research was supported by the Innovation Fund of the Republic of Serbia under project 50369 “High reach pantographs for high-speed railways (HRP4HSR)”.

DEVELOPING GUIDELINES FOR THE IMPLEMENTATION OF MICRO-CREDENTIALS IN HIGHER EDUCATION

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Abstract

The Erasmus+ KA220-HED — Cooperation partnerships in higher education Project "Developing Guidelines for the Implementation of Micro-Credentials in Higher Education" addresses the need for high-quality, innovative, and learner-centred education and training that can adapt to a fast-changing society. Micro-credentials are seen as a way to provide targeted acquisition of skills and competences without replacing traditional qualifications. They offer flexibility and can fill existing and emerging skills gaps, making lifelong learning more inclusive and accessible. Micro-credentials also provide opportunities for higher education and training institutions to align with their societal mission and enhance transparency and quality assurance through existing tools and processes. By analysing the legal framework, implementation practices, certification and credit evaluation, quality assurance mechanisms, and the linkage of micro-credentials to National Qualification Frameworks practices in partner countries, Project will develop guidelines for the implementation of micro-credentials in higher education. The guidelines will provide a common understanding and a transparent definition of micro-credentials, ensuring trust and recognition across countries and educational sectors, serving as a theoretical basis for the practical application of micro-credentials, providing concrete solutions for legislators and higher education institutions. Guidelines will be presented at Project final conference to all relevant partners, including government in Serbia, proposing measures for implementing micro-credentials in higher education. The guidelines will remain available for policymakers and higher education institutions, contributing to the development of a European approach to micro-credentials..

Keywords

Micro-credentials, Higher education, Erasmus+, KA220-HED — Cooperation partnerships in higher education.

Acknowledgement

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GOOD PRACTICE FROM AUTOMOTIVE INDUSTRY POWERED BY CIRCULAR ECONOMY IN THE REPUBLIC OF SERBIA

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Abstract

Over the past ten years, the car industry in Serbia has witnessed substantial growth and progress, establishing itself as a prominent player in the region. By attracting numerous international car parts manufacturers, the country has successfully established manufacturing facilities and increased investments in the sector. As a result, Serbia's economy, job market, and technological advancements have all experienced positive effects. Looking forward, the future outlook for Serbia's car industry appears promising due to the country's advantageous location, favourable trade agreements, and supportive government policies, which continue to attract foreign direct investment. The expansion of manufacturing capacities, advancements in technology, and the increasing focus on electric mobility also present new opportunities for Serbian car manufacturers.
The automotive industry in Serbia is now embracing the principles of the circular economy, demonstrating a commitment to sustainable practices and reaping numerous benefits as a result. The adoption of circular economy principles has led to improved resource efficiency, reduced waste generation, and increased economic opportunities. The application of circular economy principles in the automotive industry in Serbia brings forth several key benefits, including:

- *Economic Advancements and Competitiveness*
- *Sustainable Resource Management*
- *Value Creation and Innovation*
- *Collaboration and Partnerships.*
- *Environmental Sustainability*
- *Regulatory Framework and Government Support*
- *Consumer Demand and Social Responsibility*

In conclusion, the automotive industry in Serbia acknowledges the potential and advantages of the circular economy. Through the adoption of circular principles, Serbian automotive companies promote sustainable resource management, foster innovation, and contribute to economic growth while reducing their environmental impact. With ongoing government support, collaboration among stakeholders, and a focus on consumer demands, Serbia's automotive industry is well-positioned to further embrace the circular economy and contribute to a more sustainable future.

Keywords

Circular Economy, Eco-design, Sustainable Development, Automotive Industry, Good Practice.

Acknowledgement

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SMART TRACKING FOR PATHOLOGY LABS: EFFICIENT CHEMICAL AND CONSUMABLE MANAGEMENT"

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Abstract

Approximately 70% to 80% of major clinical decisions are partly based on information from pathology laboratories, highlighting the crucial role of accurate and fast diagnoses in patient care. Optimizing and automating pathological processes not only enhance routine task efficiency but also improve flexibility, productivity, and patient safety. Pressures to redesign and automate pathology laboratories arise from cost considerations, turnaround time requirements, technologist availability, and the need to reduce administrative and pre-analytical errors (which occur at a rate of around 40%). Efficient monitoring of chemical consumption is essential for ensuring high-quality analyses and optimizing patient service in pathology laboratories.

By implementing advanced technologies and additional applications, in conjunction with the Smart PathSoft Platform, pathology departments can effectively track and manage the consumption of chemicals and consumables on a per-patient basis. This approach enables centralized procurement and financing of chemicals, ensuring the availability of quality supplies while reducing costs. Furthermore, institutions gain the ability to assess the cost-effectiveness of each department and make informed decisions regarding resource allocation.

The integration of artificial intelligence and machine learning tools further enhances digital pathology, facilitating accurate tissue/cell labeling and improving diagnostic capabilities. The ability to monitor chemical consumption not only streamlines laboratory processes but also contributes to better patient care and optimized resource utilization in pathology departments.

Keywords

Digital pathology, monitoring chemical consumption, pathology laboratories.

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