



Proceedings of
**INTERNATIONAL CONFERENCE ON
TECHNOLOGICAL INNOVATIONS FOR A
SUSTAINABLE FUTURE**



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PROCEEDINGS OF
**INTERNATIONAL CONFERENCE ON TECHNOLOGICAL
INNOVATIONS FOR A SUSTAINABLE FUTURE**
(2025)

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FOREWORD

It gives us immense pleasure to present the proceedings of the International Conference on Technological Innovations for a Sustainable Future, held on 25th April 2025 at Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu. This conference, organized jointly by the Departments of Aeronautical, Aerospace, Agricultural, Civil, Mechanical Engineering, and Robotics and Automation, serves as a platform to bring together academic minds, industry professionals, research scholars, and students to explore innovations in engineering and technology for a sustainable and smart future.

The conference theme - "Innovations in Engineering and Technology for a Sustainable and Smart Future" - resonates deeply with the global call for environmentally responsible development and transformative technological progress. Through a multitude of research papers, keynote sessions, and technical presentations, the conference has fostered insightful discussions on the advancement of sustainable technologies, interdisciplinary research, and emerging engineering solutions. The contributions compiled in this volume reflect the intellectual rigor and innovative spirit of the participants. They not only address contemporary challenges but also propose novel solutions and futuristic approaches to drive sustainable development across various sectors. We believe these proceedings will serve as a valuable resource for continued academic inquiry and practical applications in engineering and technological domains.

We extend our heartfelt gratitude to all contributors, reviewers, session chairs, and participants whose active involvement and enthusiasm made this conference a resounding success. A special acknowledgment is due to the organizing committee, whose tireless efforts ensured the seamless execution of the event. We hope that the ideas exchanged and the collaborations initiated through this platform will inspire future innovations and contribute meaningfully to the creation of a smarter, greener world.



SHRI. A. SRINIVASAN

Chancellor

Dhanalakshmi Srinivasan University,

Tamil Nadu, India.

CHANCELLOR MESSAGE

It gives me immense pleasure to extend my heartfelt greetings to all the delegates, researchers, faculty members, industry professionals, and students participating in the **International Conference on Technological Innovations for a Sustainable Future**, organized by Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur.

In today's rapidly evolving world, the role of innovation and sustainable development in engineering and technology has become more vital than ever. This conference, with its theme "Innovations in Engineering and Technology for a Sustainable and Smart Future," serves as a timely platform for thought leaders and emerging minds to collaborate, share knowledge, and contribute to shaping a better tomorrow.

I am proud of the collective efforts of the Departments of Aeronautical, Aerospace, Agricultural, Civil, Mechanical Engineering, and Robotics and Automation in organizing this significant academic event. Their initiative reflects the institution's ongoing commitment to fostering research, innovation, and academic excellence. I sincerely hope that the ideas exchanged during this conference will ignite new collaborations, inspire transformative research, and lead to meaningful advancements in science and technology for the benefit of society and future generations.

I congratulate all the contributors and the organizing committee for making this event possible and wish the conference great success.



Prof. Dr.D.Shanmugasundaram

Principal

Dhanalakshmi Srinivasan Engineering College
(Autonomous)

Perambalur - 621212.

PRINCIPAL MESSAGE

It is a moment of great pride for Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, to host the **International Conference on Technological Innovations for a Sustainable Future**. This academic gathering stands as a testament to our continuous commitment to fostering innovation, research excellence, and sustainable development in engineering and technology.

In alignment with our vision to be a center of academic and research distinction, this conference provides a dynamic platform for scholars, educators, and industry professionals to exchange knowledge, present innovations, and explore practical solutions to modern-day challenges. The theme, “Innovations in Engineering and Technology for a Sustainable and Smart Future,” resonates strongly with the need for interdisciplinary collaboration and forward-thinking strategies.

I commend the organizing departments - **Aeronautical, Aerospace, Agricultural, Civil, Mechanical Engineering, and Robotics and Automation** - for their joint effort in curating this conference. Their collaborative spirit reflects the integrated approach we promote in addressing global engineering challenges.

I also extend my sincere appreciation to all participants, authors, reviewers, and keynote speakers for their valuable contributions. I am confident that this conference will stimulate meaningful dialogue and pave the way for impactful research that benefits both academia and industry.



Prof. Dr.K.Anbarasan

Dean (Academics)

Dhanalakshmi Srinivasan Engineering College
(Autonomous)

Perambalur - 621212.

DEAN (ACADEMICS) MESSAGE

I am delighted to extend my warm greetings to all the participants of the **International Conference on Technological Innovations for a Sustainable Future**, hosted by Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur.

This conference, centered around the theme “Innovations in Engineering and Technology for a Sustainable and Smart Future,” highlights the critical role of academic research and interdisciplinary collaboration in driving sustainable development and technological progress. It provides an excellent forum for scholars, faculty members, and industry professionals to present original research, engage in meaningful discussions, and inspire future directions in engineering and technology.

As the Dean of Academics, I firmly believe that such scholarly gatherings enrich the academic fabric of our institution. They also serve to motivate students and researchers to pursue excellence and think beyond conventional boundaries. The collaborative effort of the Departments of Aeronautical, Aerospace, Agricultural, Civil, Mechanical Engineering, and Robotics and Automation in organizing this event is highly commendable.

I express my sincere appreciation to all contributors, reviewers, and coordinators who have played a vital role in bringing this conference to life. May this event spark new ideas, foster knowledge sharing, and pave the way for impactful innovations.



Dr.M.Chellappan

Controller of Examinations

Dhanalakshmi Srinivasan Engineering
College (Autonomous)

Perambalur - 621212.

CONTROLLER OF EXAMINATIONS MESSAGE

It gives me great pleasure to extend my warm greetings to all the participants, organizers, and contributors of the International Conference on Technological Innovations for a Sustainable Future, hosted by Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur.

This conference, organized by the Departments of Aeronautical, Aerospace, Agricultural, Civil, Mechanical Engineering, and Robotics and Automation, reflects the institution's commitment to advancing academic excellence, research, and innovation. The theme—"Innovations in Engineering and Technology for a Sustainable and Smart Future"—is both timely and highly relevant, as we collectively seek solutions to pressing global challenges through technological advancement and sustainable practices.

As Controller of Examinations, I firmly believe that such academic platforms contribute significantly to nurturing a strong research culture within our campus. They provide opportunities for students, scholars, and faculty to engage in meaningful dialogue, share original ideas, and stay abreast of emerging trends in engineering and technology. The insights gained through these interactions will undoubtedly enhance the academic ecosystem of our institution.

I commend the organizing team for their meticulous planning and effort in bringing together an impressive array of researchers and professionals. I also express my appreciation to all the paper presenters and participants whose contributions have enriched the value of this conference.



Dr. T.Sivaraman

Dean (Research)

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Perambalur - 621212.

DEAN (RESEARCH) MESSAGE

It is with great enthusiasm that I extend my greetings to all participants of the International Conference on Technological Innovations for a Sustainable Future, organized by Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur.

Research and innovation are the foundation of academic excellence and societal advancement. The theme of this conference, “Innovations in Engineering and Technology for a Sustainable and Smart Future,” reflects the core mission of our R&D wing — to promote interdisciplinary research that addresses real-world challenges and fosters sustainable development.

This event serves as a valuable platform for researchers, faculty, industry professionals, and students to share insights, collaborate, and explore impactful solutions. The active involvement of the Departments of Aeronautical, Aerospace, Agricultural, Civil, Mechanical Engineering, and Robotics and Automation highlights the strength of our research ecosystem.

Such initiatives play a crucial role in nurturing a culture of innovation and inspiring future researchers. I commend the organizing committee for their efforts and all contributors for their valuable work. May this conference lead to meaningful advancements and lasting collaborations.



Dr. V. Shanmuga Sundaram

Dean (HRDC)

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It gives me great pleasure to extend my warm greetings to all participants of the International Conference on Technological Innovations for a Sustainable Future, organized by Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur.

The theme of the conference, “Innovations in Engineering and Technology for a Sustainable and Smart Future,” is highly relevant in today’s context, where the integration of knowledge, innovation, and sustainability is essential for global progress. Events like this not only promote research excellence but also play a key role in enhancing the professional and academic competencies of individuals across disciplines.

At the Human Resource Development Centre, we strongly believe in nurturing talent and creating opportunities for continuous learning and development. Conferences such as this serve as a powerful platform for knowledge sharing, networking, and skill enhancement for faculty members, researchers, and students alike.

I appreciate the initiative and collaborative efforts of the organizing departments—Aeronautical, Aerospace, Agricultural, Civil, Mechanical Engineering, and Robotics and Automation—and commend their dedication to academic and research advancement.

PREFACE

We are pleased to present the proceedings of the International Conference on Technological Innovations for a Sustainable Future, held on 25th April 2025 at Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu. This conference was jointly organized by the Departments of Aeronautical, Aerospace, Agricultural, Civil, Mechanical Engineering, and Robotics and Automation.

The conference theme, “Innovations in Engineering and Technology for a Sustainable and Smart Future,” reflects the growing need for sustainable solutions and technological advancements in a rapidly changing world. The aim of the conference was to create a platform for researchers, academicians, industry professionals, and students to share their latest research findings, technological developments, and innovative ideas.

This proceedings book includes a selection of peer-reviewed abstract of research papers that cover a wide range of topics in engineering and technology, showcasing the diversity of research and the spirit of innovation that the event encouraged.

We express our heartfelt gratitude to the authors, reviewers, keynote speakers, session chairs, and all participants whose contributions have made this conference and this publication a success. We also thank the management, faculty, and staff of Dhanalakshmi Srinivasan Engineering College for their support and encouragement throughout the organization of this event.

We hope these proceedings will serve as a valuable resource for researchers and practitioners, and will inspire further exploration and collaboration in the field of sustainable engineering and technological innovation.

Editorial Committee

International Conference on Technological Innovations for a Sustainable Future
Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur

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Chapter 1

ROAD SIGN DETECTION USING MACHINE LEARNING IN CNN

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Abstract

Road sign detection is a crucial component of intelligent transportation systems, designed to enhance road safety and navigation. The ability to automatically detect and classify road signs in real time can significantly aid drivers and autonomous vehicles in making timely and informed decisions. This research focuses on leveraging machine learning and computer vision techniques to develop an efficient road sign detection system. By analyzing images captured from vehicle-mounted cameras, the system can recognize sign shapes, colors, and symbols, enabling swift responses to road conditions. A major challenge in road sign detection is ensuring high accuracy across diverse environmental conditions, including varying lighting, weather, and occlusions. Traditional detection methods often struggle in complex scenarios, leading to reduced recognition rates. To address this, we employ deep learning models, particularly Convolutional Neural Networks (CNNs), which have demonstrated superior performance in feature extraction and classification. The data set used in this study consists of real-world road sign images with varying backgrounds and illumination levels to enhance model robustness. The system is trained using a combination of supervised learning techniques and transfer learning to improve efficiency. The experimental results indicate that our model achieves high accuracy in detecting and classifying road signs, even under challenging conditions. Compared to conventional machine learning approaches, deep learning-based models offer better generalization and adaptability. The integration of this system with driver assistance technologies can significantly reduce traffic accidents, improve navigation systems, and support the development of autonomous vehicles. Future work will focus on optimizing computational efficiency, reducing processing time, and expanding the dataset to include more diverse road sign variations.

Keywords: Road Sign Detection, Machine Learning, Deep Learning, Intelligent Transportation, Autonomous Vehicles

Chapter 2

EXPERIMENTAL INVESTIGATION ON STABILIZATION OF SOIL USING MINERAL ADMIXTURE

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Abstract

Soil stabilization is essential in geotechnical engineering to improve the strength and durability of weak soils. Biochar is a carbon-rich material produced by heating biomass under low oxygen conditions, and it can improve soil health and potentially sequester carbon. This study examines the use of biochar from *Prosopis juliflora* as a sustainable soil stabilizer. The research focuses on analysing biochar's impact on the physical and mechanical properties of clay soil. Soil samples treated with 0%, 5%, 10%, and 15% biochar. Laboratory tests, including liquid limit, plastic limit, unconfined compressive strength, and specific gravity, were conducted and it showed increased shear strength, reduced plasticity, and improved moisture retention. The observations highlight biochar's potential to enhance soil stability and water-holding capacity. When compared with the strength obtained for clay soil the partially replaced one with biochar showed better mechanical properties. Biochar's porous nature improved aeration and reduced shrink-swell behaviour, making it an effective alternative to cement and lime. Additionally, using *Prosopis juliflora* for biochar promotes sustainable waste management. This study confirms biochar's potential for eco-friendly and cost-effective soil stabilization.

Keywords: Biochar, *Prosopis juliflora*, Atterberg's limit, Shear strength, Unconfined compressive strength.

Chapter 3

EFFECT OF COCKLE SHELL POWDER AS SUSTAINABLE ADDITIVE ON GEOTECHNICAL ENGINEERING PROPERTIES OF COHESIVE SOIL

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Abstract

Sustainable soil improvement techniques are gaining attention in geotechnical engineering due to environmental concerns and material availability. This study investigates the effect of cockle shell powder (CSP) as an eco-friendly additive on the geotechnical properties of cohesive soil. Cockle shells, primarily composed of calcium carbonate, have the potential to enhance soil strength, stability, and durability. Laboratory tests, including Atterberg limits, and unconfined compressive strength (UCS), were conducted on soil samples mixed with varying percentages of CSP. The results indicate that CSP improves soil strength and reduces plasticity, making it a viable alternative to traditional stabilizers like cement and lime. The study highlights the potential of CSP in sustainable ground improvement, contributing to cost-effective and environmentally friendly geotechnical solutions. Further research is recommended to optimize dosage and assess long-term performance in field applications.

Keywords: Eco friendly additive, Traditional stabilizers, Sustainable ground improvement, Optimum dosage, Long term performance

Chapter 4

REVIEW ON THE ROLE OF TRANSITION METALS IN ENHANCING WETTABILITY FOR CERAMIC-TO-METAL BRAZING

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Abstract:

The brazing of ceramics to metals is a critical joining technology enabling the integration of dissimilar materials in high-performance applications across aerospace, electronics, nuclear, and biomedical domains. Due to significant differences in physical and chemical properties—particularly thermal expansion coefficients, bonding mechanisms, and chemical reactivity—the metallization of ceramic substrates and the formulation of suitable filler alloys are imperative. This review paper systematically examines various brazing techniques, with a primary focus on active metal brazing, which utilizes reactive elements such as titanium, hafnium, and zirconium to disrupt the stable oxide layers on ceramic surfaces and facilitate chemical bonding at the interface. The role of interlayers, wetting behavior, diffusion kinetics, and the formation of intermetallic compounds are explored in detail to understand joint integrity and thermal stability. Attention is also given to brazing atmospheres (vacuum, inert, reducing), filler alloy compositions (Ag-Cu-Ti, Ni-based, Au-based systems), and the resulting microstructural evolution at the ceramic-metal interface. Furthermore, the review addresses residual stress development due to thermal mismatch and its impact on mechanical properties such as shear strength, fatigue resistance, and hermetic sealing. The paper concludes by outlining current challenges and future research directions to enhance joint performance and reliability in extreme operating environments.

Chapter 5

ADVANCEMENTS IN HYBRID WELDING

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ABSTRACT

Hybrid welding has emerged as a transformative technique in modern manufacturing, combining the advantages of multiple welding processes to enhance productivity, joint performance, and material compatibility. This review explores recent advancements in hybrid welding, focusing on hybrid laser-arc welding, friction stir hybrid welding, and electron beam hybrid welding. Studies show that hybrid welding methods offer superior penetration depth, reduced thermal distortion, and enhanced mechanical properties, making them ideal for industries such as automotive, aerospace, shipbuilding, and offshore applications. Key parameters influencing weld quality include torch angles, power ratios, shielding gas composition, and welding speed. Experimental and numerical investigations have highlighted the importance of optimizing process conditions to achieve stable arc behavior, improved bead geometry, and defect-free welds. Applications in thick-section welding for arctic conditions, aluminum alloys, and high-strength steels demonstrate the adaptability of hybrid welding in extreme environments. This review also discusses the role of heat transfer, fluid dynamics, and in-process monitoring in improving weld efficiency and reliability. While hybrid welding presents challenges such as high initial costs and process complexity, ongoing research in automation, material science, and process optimization is expected to drive its adoption in critical industrial applications.

Chapter 6

REVIEW ON RECENT ADVANCEMENTS IN ELECTRON BEAM WELDING OF MOLYBDENUM ALLOYS FOR SPACECRAFT PROPULSION SYSTEMS

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Abstract

Electron beam welding (EBW) has emerged as a pivotal joining technology for molybdenum (Mo) alloys in aerospace propulsion systems, owing to its high energy density, precision, and vacuum environment that prevents contamination. This paper systematically reviews 30 seminal studies (2020–2024) to elucidate advancements in EBW of Mo alloys, including TZM and Mo-La₂O₃. Key developments include ultra-high-vacuum (UHV) EBW for embrittlement mitigation, beam oscillation techniques for defect reduction, and hybrid EBW-additive manufacturing (AM) for complex geometries. Computational modeling, cryogenic EBW, and dissimilar metal joining are also critically analyzed. The review identifies persistent challenges in standardization, cost, and scalability, while proposing future directions such as microgravity EBW and AI-driven process optimization. This synthesis aims to guide researchers and industry practitioners in advancing EBW for next-generation spacecraft.

Chapter 7

REVIEW ON THE HYBRID LASER ARC WELDING AND ITS TECHNOLOGIES

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Abstract

Hybrid laser-arc welding combines arc welding and laser welding within a shared interaction zone. The synergy between the laser beam and the electric arc in the same weld pool enhances welding speed, penetration depth, gap-bridging capability, and process stability. This paper examines the current state of this hybrid technique in terms of research, advancements, and applications. It aims to provide comprehensive technical insights through a systematic review of research papers, industrial catalogs, and technical notes. The introductory section outlines hybrid laser-arc welding, covering its operating principles, process requirements, historical developments, advantages, and limitations. This is followed by an in-depth discussion of the key control parameters that influence the performance of the hybrid laser-arc welding process. Subsequently, an analysis of performance improvements and weld quality enhancements achieved through this method is presented, based on a review of multiple research studies. The later sections highlight industrial applications and conclude with final remarks.

Chapter 8

ADVANCEMENTS IN DIFFUSION WELDING: A COMPREHENSIVE REVIEW ON PROCESS OPTIMIZATION AND MATERIAL COMPATIBILITY

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Abstract

Diffusion welding has become a prominent solid-state welding technique with the potential to form high-strength and defect-free joints through the utilization of atomic diffusion under engineered conditions. This paper summaries progress in 21 studies that identify process improvements, material compatibility, and new applications. Some of the key findings are enhanced joint strength, microstructural integrity, and corrosion resistance, obtained by techniques like the combination of friction and diffusion welding, use of interlayers such as nickel, and novel techniques such as spark plasma sintering (SPS). The research emphasizes the successful joining of dissimilar materials, including titanium, aluminum, copper, and nickel-based alloys, with tensile strengths between 78 MPa and 850 MPa under ideal conditions. Also, issues such as brittle intermetallic growth and hydrogen embrittlement are managed by controlling precise parameters and novel surface treatments. By integrating the findings, the paper offers an in-depth analysis of the advancements in diffusion welding and emphasizes its significance in high-performance and dependable joint applications, such as the aerospace, nuclear, and automotive industries.

Chapter 9

RECENT ADVANCEMENTS IN ROBOTIC WELDING TECHNOLOGY

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ABSTRACT

This paper systematically reviews cutting-edge developments in robotic welding technologies, analyzing six key domains: artificial intelligence implementations, advanced sensing systems, hybrid welding processes, additive manufacturing integration, human-robot collaboration frameworks, and emerging mobile applications. Through analysis of 58 peer-reviewed studies and industry reports, we establish quantitative benchmarks showing 40–60% productivity gains and 99% defect reduction in precision applications. The study documents cross-industry adoption patterns with detailed case studies from automotive (Tesla, BMW), aerospace (Boeing, GE Aviation), and energy sectors (Shell, Westinghouse). Three critical challenge domains are identified (technical limitations, economic considerations, workforce impacts), and a research roadmap for the coming decade is proposed. Our analysis reveals that the convergence of AI and robotics has enabled unprecedented improvements in manufacturing quality and efficiency.

Chapter 10

REVIEW ON CHANGES AND IMPACT OF WELDING OF SUPER ALLOYS IN HIGH TEMPERATURE ENVIRONMENT

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ABSTRACT

Superalloys have gained industrial importance due to their exceptional mechanical properties, corrosion resistance, and high-temperature stability. These materials are widely used in aerospace, power generation, and chemical processing industries. However, welding superalloys presents challenges due to their complex microstructure, high strength, and susceptibility to metallurgical defects. This research paper explores various welding techniques, including Gas Tungsten Arc Welding (GTAW), Electron Beam Welding (EBW), Laser Beam Welding (LBW), and Friction Stir Welding (FSW), analyzing their effectiveness in achieving defect-free joints. The influence of welding parameters, heat input, and cooling rates on microstructure and mechanical properties has been examined. Advanced characterization techniques such as Scanning Electron Microscopy (SEM) and X-ray Diffraction (XRD) have been explored to understand metallurgical transformations. Additionally, mathematical modeling and simulation-based studies have been discussed to predict residual stresses and phase changes, aiding in process optimization. The industrial applications of welded superalloys have been reviewed, highlighting their role in high-performance environments. Case studies from aerospace and nuclear reactors illustrate the significance of advanced welding techniques in real-world applications. Finally, future research directions focus on developing new filler materials, hybrid welding techniques, and integrating artificial intelligence for process optimization. Advancements in additive manufacturing and their synergy with welding technologies are also discussed. This study provides insights into the challenges, advancements, and future possibilities in welding superalloys, contributing to enhanced performance and broader engineering applications.

Chapter 11

REVIEW ON RECENT ADVANCEMENTS IN ELECTRO-SLAG WELDING

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ABSTRACT

Electroslag welding (ESW) is a highly efficient fusion welding process designed for thick-section materials, commonly used in structural engineering, shipbuilding, and heavy machinery manufacturing. Over the years, advancements in ESW have focused on temperature field modeling, residual stress analysis, microstructural improvements, and enhanced mechanical properties of weld metal. This review critically examines recent research developments, including numerical simulations of thermal behavior, metallurgical enhancements, and innovative process optimizations. Key challenges such as hydrogen-induced cracking, deformation control, and slag-metal interactions are also discussed. Finally, potential future directions in ESW, including automation and hybrid welding techniques, are proposed to further enhance its efficiency and applicability.

Chapter 12

THERMIT WELDING IN HIGH-SPEED RAIL CONSTRUCTION

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ABSTRACT

Thermit welding is a widely used technique in high-speed rail (HSR) construction due to its efficiency, cost-effectiveness, and ability to produce strong metallurgical bonds. However, challenges such as residual stresses, weld defects, and fatigue failures affect the long-term performance of welded joints. This review analyzes recent advancements in thermit welding, including preheating optimization, modified thermit compositions, post-weld treatments, and computational modeling techniques. Studies show that optimized preheating enhances weld strength, reducing defects by up to 20%, while microstructural modifications improve fatigue resistance by 25%. Finite element models predict weld behavior, aiding defect prevention strategies. Despite improvements, issues like non-uniform hardness and stress concentrations exceeding 400 MPa persist. Future research should focus on advanced monitoring techniques, predictive defect analysis, and novel material compositions to enhance weld performance. This review provides a comprehensive understanding of thermit welding advancements, aiding its optimization for safer and more durable HSR infrastructure.

Chapter 13

THIN SHEET WELDING USING COLD METAL TRANSFER (CMT)

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Abstract

Cold Metal Transfer (CMT) welding is a groundbreaking technique that has transformed how we join thin, heat-sensitive, and dissimilar materials. By controlling the movement of the wire and managing heat input efficiently, this method minimizes unwanted effects like excess spatter while maintaining the strength and quality of the weld. This process is particularly important as industries push for lighter and more complex materials in manufacturing. This work explores how CMT welding stands out compared to traditional methods, especially in its ability to limit issues like unwanted intermetallic compound growth and maintain strong joint integrity. Its benefits make it highly relevant to industries like aerospace, automotive, and shipbuilding, where precision and reliability are critical. The findings support CMT's role as a forward-looking technology with immense potential for modern industrial applications.

Chapter 14

ADVANCEMENTS IN UNDERWATER WELDING

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ABSTRACT

Underwater welding is a critical technique used in marine construction, ship repair and offshore industries requiring specialized methods to ensure safety and efficiency. Advanced techniques such as dry hyperbaric welding and wet welding with innovative electrode coatings, have significantly improved weld quality and durability. Developments in automation, including remotely operated robotic welding systems enhanced precision while minimizing diver risk. Advanced shielding gases and modern power supply system's help mitigate challenges like hydrogen embrittlement and rapid cooling effects. These innovations contribute to safer more reliable underwater welding applications, expanding possibilities for deep sea infrastructure maintenance and repair.

Chapter 15

ADVANCEMENTS IN PERCUSSION WELDING

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ABSTRACT

Percussion welding is a solid-state welding process that joins metal components using a short-duration, high-intensity electrical discharge. This process relies on the rapid heating and localized melting of the interface between two workpieces, followed by the application of pressure to create a strong metallurgical bond. Unlike conventional welding methods, percussion welding minimizes heat-affected zones (HAZ), distortion, and oxidation, making it ideal for precision applications. This technique is widely used in electrical, aerospace, and automotive industries, particularly for welding dissimilar metals and delicate components. Its advantages include fast welding times, high repeatability, and minimal material wastage. However, it requires precise control of energy input and alignment to achieve defect-free welds. With advancements in automation and AI-based process monitoring, percussion welding continues to improve, enabling higher efficiency, consistency, and applicability in modern manufacturing. It is a specialized resistance welding process that joins metal parts using a high-intensity electrical discharge over a very short duration, creating localized fusion at the interface. It is particularly useful for welding dissimilar metals, fine wires, and small components that require precise heat control. The process involves storing electrical energy, usually in a capacitor, which is rapidly discharged across the joint. This intense electrical pulse generates an arc or high heat at the interface, melting a thin layer of metal. Immediately after, the components are forced together under pressure, solidifying the joint almost instantly. The rapid heating and cooling minimize the heat affected zone (HAZ), reducing material distortion and preserving the mechanical properties of the metals. The key steps include preparing and aligning the workpieces, storing energy in a capacitor, discharging the energy to create an arc, and applying force to forge a solid-state bond. Since the process occurs in a fraction of a

second, it ensures minimal oxidation and contamination, making it ideal for applications in aerospace, electronics, and precision engineering. The process of percussion welding involves several key steps. First, the workpieces are properly aligned and held in position with a small gap between them. Electrodes or clamps secure the materials in place to ensure precise contact. Next, an energy source, typically a capacitor bank, stores electrical energy in preparation for the weld. This stored energy is then rapidly discharged, generating an intense electrical arc or heat at the interface between the two metals. The high-temperature arc melts a thin layer of the metal surfaces, preparing them for bonding. Immediately after the arc formation, a mechanical force is applied to bring the workpieces together.

Chapter 16

REVIEW PAPER ON FRICTION STIR WELDING PROCESS

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ABSTRACT

Friction stir welding (FSW) is a solid-state joining technique that uses mechanical mixing and frictional heat at the junction to fuse comparable or dissimilar materials with differing melting temperatures. Hard materials like steel and alloys like magnesium and aluminium are frequently utilised because they are favoured in sectors that need materials that are both strong and lightweight. Because FSW simply applies a forging effect rather than melting, it preserves material integrity in contrast to fusion welding, which can deteriorate mechanical qualities. Highlighting important process parameters, applications, and researchers' insights, this study examines important research articles on FSW from its inception in 1991 to the present. The research looks at how FSW improves weld quality, how well it works for different sectors, and other enhancements that experts have recommended.

Chapter 17

REVIEW ON WIRE ARC ADDITIVE MANUFACTURING OF INCONEL SUPERALLOYS

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ABSTRACT

Additive manufacturing (AM) techniques have the potential to completely transform traditional manufacturing processes in the context of Industry 4.0. In contrast to conventional approaches, where component complexity frequently drives up costs, AM provides a special benefit by avoiding additional costs as complexity increases. AM fabricates metal components using wire or powder feedstock; wire-based AM outperforms powder-based techniques in terms of deposition rate and fabrication time. Because of this, Wire Arc Additive Manufacturing (WAAM) is especially well-suited for large-scale manufacturing. Superalloys based on nickel are distinguished by their remarkable tensile strength, resistance to corrosion, and fatigue endurance at high temperatures. These properties make them perfect for demanding applications in the chemical industry, oil and gas, nuclear, aircraft, turbocharger rotors, and gas turbines. This page describes several AM techniques used to fabricate Ni-based alloys, including multiple WAAM techniques that use Plasma Arc Welding (PAW), Gas Metal Arc Welding (GMAW), and Gas Tungsten Arc Welding (GTAW), as well as further wire-based AM methods like laser wire feed AM and electron beam wire feed AM. To achieve the required component attributes, it explores the mechanical qualities, microstructural features, and difficulties that arise during fabrication and post-processing.

Keywords— Additive manufacturing · WAAM · Inconel alloys · GMAW · GTAW · PAW · Ni based alloys

Chapter 18

ADVANCEMENTS OF LASER BEAM WELDING

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Abstract

Laser Beam Machining (LBM) is a widely used non-contact, thermal-based advanced machining process applicable to a broad range of materials. It works by focusing a laser beam to melt and vaporize unwanted material, making it ideal for cutting complex profiles and creating miniature holes in sheet metal. Among industrial lasers, CO₂ and Nd:YAG lasers are the most commonly used. Recent research has explored ways to enhance LBM performance by analyzing various factors affecting quality. Experimental and theoretical studies indicate that selecting appropriate laser, material, and operating parameters significantly improves process efficiency. This paper reviews past research on LBM for different materials and shapes, covering experimental and theoretical advancements. It also critically examines various modeling and optimization techniques for determining optimal cutting conditions. The final section discusses LBM developments and highlights future research directions.

Chapter 19

UNDER WATER WELDING USED IN SHIPS

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Abstract

Underwater welding is a critical technology used in marine and offshore industries for repairing and maintaining submerged structures. This review paper provides a detailed examination of underwater welding, focusing on its historical development, types, advantages, challenges, and applications. The paper evaluates existing research and discusses recent advancements, including automation and AI-based approaches.

Furthermore, safety concerns, environmental impacts, and future directions are analysed to offer a comprehensive perspective on underwater welding.

Chapter 20

PERFORMANCE EVALUATION OF CRYOGENIC TREATED TOOLS IN TURNING

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Abstract

The high-speed steel is used as a cutting tool, since it has good quality and reliability at cheaper rate when compared to other cutting tools. So it is very important to increase the ability of the tool further for its reliability. So the best way is to increase the hardness. One novel method namely dipping the ordinary tool bit in a cryogenic solution, which improves the wear properties of the cutting tool consequently machining time is also reduced. Cryogenic treatment of high speed steel is one of the developments in manufacturing field. It offers much better wear resistance and hardness for the high speed steel. The conventional cryogenic treatment process involves cooling down the samples to 93k (-180°C) soaking for 15-20 minutes and then slowly heating back to room temperature in 6 hrs. In this project we have explained our approach and methodology to arrive at an optimum solution having two sample pieces of round of EN8 & EN19. A method called deep cryogenic process, subjects steel components placed in a specially constructed tank to temperature around 77k (196°C) for half an hour using liquid nitrogen as the refrigerant.

Keywords: High speed steel, cryogenic Treatment, Turning, Hardness, Wear resistance.

Chapter 21

UNLEASHING DYNAMIC POSSIBILITIES IN RECONFIGURABLE DRONE DESIGN BY USING ADDITIVE MANUFACTURING

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Abstract

This project is based on the reconfigurable drone design. where it has attachable and detachable modular arms. it is made up of PLA material By using one of the Additive Manufacturing Methods Known As FDM (Fused Deposition Method). Imagine a drone it is now not simply one gadget, however a collection of elements that can be swapped and clicked collectively to create one-of-a-kind types of flying machines. it really is the idea in the back of our modular drone. these drones are essentially like construct-your-own flying robots. they arrive with a primary middle or base unit, and then various attachable modules for unique functions. The core idea is that different drone parts may be clicked together or related like constructing blocks. this lets you without problems alternate the drone 's configuration to fit your needs. The concept of modular drone designs is an Entity that mixes the benefits of Multipurposing even as decreasing repairs and upkeep. even though this era continues to be in its growing tiers , there are already. A few examples of modular drones available, together with the Make block Air block which can transform among a drone and a hover craft, or the Senses which permits for a quick adjustments between specific payloads and battery configuration.

Keywords—Drone, Additive Manufacturing, components, FDM

Chapter 22

FLUX CORED ARC WELDING PARAMETER OPTIMIZATION OF AISI 316L (N) AUSTENITIC STAINLESS STEEL

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Abstract

Bead-on-plate welds were carried out on AISI 316L (N) austenitic stainless steel (ASS) using flux cored arc welding (FCAW) process. The bead on plates weld was conducted as per L25 orthogonal array. In this paper, the weld bead geometry such as depth of penetration (DOP), bead width (BW) and weld reinforcement (R) of AISI 316L (N) ASS are investigated. Taguchi approach is used as statistical design of experiment (DOE) technique for optimizing the selected welding input parameters. Grey relational analysis and desirability approach are applied to optimize the input parameters considering multiple output variables simultaneously. Confirmation experiment has also been conducted to validate the optimized parameters.

Keywords—bead-on-plate welding, bead profiles, desirability approach, grey relational analysis

Chapter 23

WATER DATA COMMUNICATION FOR FLOOD MANAGEMENT AND REAL-TIME RESCUE COORDINATION

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ABSTRACT

Water data communication is a potential technology to realize underwater communication. The experiment of underwater data communication in the laboratory is different from that in the real water environment because the physical scale is limited. Although for several decades, artificial scattering agents are used to recreate underwater data communication through water channels under different communication medium conditions. Flood problems have always been a severe ongoing issue in residential, commercial, or industrial environments. While most problems are minor enough to ignore or live with, flood issues can escalate to significant reconstruction and investment. The major problem with the flood issues is our all-communication sources such as mobile phones are stopped. The Biggest Problem for the Rescue Team is Communication to the Control Room because Mobile towers shut down During Flood for electric safety. So, no other technology is available to inform the rescue team about the rescue needed places and the number of peoples and what are sources to be brought for the rescue operation. During this scenario only water is the way of communication channel to others since water is surrounded by all. here our IoUT (Internet of Underwater Things) technology that is the data communication through water medium is very helpful as to transmit all needed information data's to be sent to rescue team for remote place using Water data transmitter module along with location using GPS module. The Rescue will have the Water data receiver module. It receives the details about the rescue needed people with GPS location so can move immediately with rescue things and can access them faster operation. We use Arduino controllers with Water data TX and RX modules the project is

proposed. By pressing the Tx module with EM switch, we can make immediate transfer of data and will be done all process as mentioned.

Keywords: Internet of Underwater Things (IOT), Underwater data communication, Flood rescue communication, Water data transmitter/receiver, GPS module, Arduino controller, Emergency Communication, Underwater Wireless sensor network (UWSN), EM Switch, Mobile network failure.

Chapter 24

MODULAR RADIO CONTROLLED DRONE

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ABSTRACT

The "Modular Radio Controlled Drone" is an innovative solution designed to overcome the limitations of traditional drones by employing a modular and user-centric architecture. Unlike conventional drones with fixed components, this project focuses on creating a versatile platform that allows users to easily replace, or customize key parts such as motors, cameras, and controllers, upgrades to coaxial etc. The frame used in the drone is modular and the use of modular connectors eliminates the need for soldered wiring, ensuring effortless assembly and repairs. This approach significantly reduces downtime, enhances operational flexibility, and minimizes maintenance costs, offering a seamless and frustration-free experience for users.

The drone's adaptability makes it suitable for a wide range of applications, including surveillance, precision agriculture, aerial photography, and more. By enabling rapid interchangeability of components, the "Modular RC Drone" empowers users to tailor the drone for specific tasks, enhancing its usability and broadening its scope of functionality. This flexibility addresses critical challenges faced by traditional drone designs, including limited customization, high repair expenses, and inefficiencies resulting from non-replaceable components.

Chapter 25

AUTOMATIC LAWN MOWER AND HOUSE CLEANING ROBOT

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ABSTRACT

This project introduces an innovative robotic system designed to automate two essential household tasks: lawn mowing and indoor cleaning. The robot is equipped with sensors, microcontrollers, and a navigation system that enables it to perform both tasks with minimal human intervention. For lawn mowing, the robot uses GPS technology combined with obstacle detection to navigate outdoor spaces and maintain consistent grass-cutting patterns. It ensures efficiency and safety by adapting its path based on terrain and obstacles, providing a reliable solution for garden maintenance.

Chapter 26

SPYROBOT WITH GAS AND METAL DETECTION

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ABSTRACT

In the modern era of automation and surveillance, there is an increasing demand for intelligent systems capable of performing real-time monitoring, threat detection, and hazard prevention. This project presents the design and development of a Spy Robot with integrated gas and metal detection, equipped with a live camera and various environmental sensors. The core objective is to build a multifunctional robot that combines multiple technologies to serve diverse applications such as military operations, industrial safety, and home surveillance. The robot is embedded with a metal detector to identify the presence of metallic objects or mines, making it particularly useful in defense operations. A gas sensor is included to detect the presence of harmful or flammable gases, which is vital in industrial settings to prevent accidents. The robot also incorporates a flame sensor and a temperature sensor to monitor fire-related hazards, further extending its utility in both industrial and residential environments.

Overall, the system demonstrates how multiple sensing technologies can be effectively combined to create a single autonomous solution, offering flexibility, safety, and real-time situational awareness across multiple domains.

Chapter 27

MARINE BASED AUTONOMOUS HUMAN RESCUING BOT

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ABSTRACT

Maritime accidents, drowning incidents, and natural disasters pose significant threats to human lives, requiring rapid and efficient rescue operations. However, traditional search and rescue (SAR) methods are often hindered by delayed response times, harsh environmental conditions, and human limitations, leading to increased casualties. To address these challenges, we propose a Marine-Based Autonomous Rescuing Bot—a self-navigating robotic system designed to enhance water-based rescue operations through artificial intelligence (AI), real-time monitoring, and automated assistance mechanisms.

This autonomous bot integrates AI-driven navigation, obstacle detection, GPS tracking, and IoT-enabled real-time communication to identify individuals in distress and deploy appropriate rescue measures. Equipped with thermal cameras, sonar sensors, robotic arms, and flotation devices, the bot can effectively operate in harsh marine environments while reducing risks to human rescuers. Additionally, its renewable energy-powered and weather-resilient design ensures long-term efficiency in coastal, flood-prone, and disaster-affected areas.

By minimizing human intervention, enhancing rescue response times, and improving maritime safety, the Marine-Based Autonomous Rescuing Bot presents a technologically advanced, scalable, and cost-effective solution for modern SAR operations. This innovation has the potential to revolutionize maritime rescue efforts, saving countless lives while reducing operational risks and costs.

Chapter 28

DESIGN AND STRUCTURAL ANALYSIS ON A300 FLIGHT WING BY USING ANSYS TO IMPROVE THE MECHANICAL STRENGTH OF ALUMINUM ALLOY (A7068)

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ABSTRACT

The A300 is currently the largest aircraft in commercial operation and one of the most advance planes in the world. Designs of airplanes depend on their wings for flight. The wing of an airplane is one of the most important and complicated elements of a design airplane. A wing is a type of fin with a surface that produces aerodynamic force for flight through the atmosphere. When a force acts on a body, the latter will of these forces are generated by the relative movement of the air compared to the plane. The first one is the lift. This force is directed upwards and is acting perpendicular to the displacement of the wing and second one is drag. It is exerted in the direction opposed to the displacement of the plane. In this conventional type of wing is used with two materials, they are AL alloy and AL alloy 7068. Because of its versatility in many flight roles and situations. It is generally not limited to certain flying levels or air speeds and is extremely useful. The main purpose of this project is to find out which material (AL alloy and Al alloy 7068) is best suited for making wing of flight. In this study, the CAD model of A300 wing with spares and ribs using the modelling software CATIA V5 R20 and later we made modelling and structural analysis on wing Skeleton structure by using ANSYS WORKBENCH.

Keywords: A300 flight, Conventional type wing, Aluminum alloy, Aluminum alloy 7068, Model and static structural analysis.

Chapter 29

DRONE TRAFFIC CONTROL

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ABSTRACT

The rapid proliferation of unmanned aerial vehicles (UAVs), commonly known as drones, has significantly transformed various industries, including logistics, agriculture, surveillance, disaster management, and entertainment. However, the increasing number of drones in low-altitude airspace presents a pressing challenge: the need for a robust and efficient drone traffic control system. Currently, most air traffic management systems are designed for manned aircraft operating at higher altitudes. Drones, by contrast, often operate autonomously at lower altitudes and in densely populated urban environments, making traditional traffic control models insufficient. Without a specialized control system, the risk of mid-air collisions, interference with manned aviation, privacy violations, and disruptions in emergency services remains high.

The current scenario lacks a unified framework to monitor, track, and manage drone movements in real time. Most drone operators rely on pre-programmed flight paths and visual line-of-sight operation, which becomes impractical as drone usage scales. There is minimal coordination among private drone operators, commercial service providers, and regulatory bodies, leading to airspace congestion and security concerns. Furthermore, emergency response teams and aviation authorities face difficulties in identifying unauthorized or rogue drones, which could pose threats in restricted or sensitive zones, such as airports, government buildings, or public gatherings. To address these issues, the implementation of an intelligent drone traffic control (DTC) system is imperative.

The benefits of a drone traffic control system would be profound. It would enable the safe coexistence of thousands of drones in shared airspace, reduce the risk of accidents, and enhance public trust in drone operations. Logistics and delivery services could optimize routes,

reduce delivery times, and increase efficiency. Emergency services could rely on priority access corridors, while authorities could better enforce no-fly zones and respond to airspace violations. In addition, such a system would create a regulatory framework that encourages innovation while ensuring public safety, privacy, and accountability.

Chapter 30

INVESTIGATIONS ON THE CHARACTERISTICS OF A 4-STROKE SINGLE CYLINDER CI ENGINE FUELED BY ALGAE OIL BIODIESEL WITH NANO ADDITIVES

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ABSTRACT

The rapid consumption of petroleum diesel due to large scale application in agricultural, transportation, power generation and industrial sector has put up a threat of depletion in near future. The biodiesel has been considered as a potential replacement of diesel in past few decades owing to their thermos-physical properties similar to pure diesel. The biodiesel are primarily derived from feedstocks including edible and non-edible oils, animal fats and microalgae. The experimental investigations were carried out at a constant speed of 1500 rpm with increasing step of 20%. The brake thermal efficiency (BTE) and brake specific fuel consumption (BSFC) have been considered for performance estimation while the unburnt hydrocarbon, carbon monoxide and oxides of nitrogen have been considered for exhaust emission. The experimental results indicated the biodiesel blend B20 consisting of 80% diesel and 10% each of Algae Biodiesel oil by volume to be the optimum blend. The B20 blend exhibited 2.2% lower BTE, 0.22 kg/kWh higher BSFC, 29.6% lower hydrocarbon, 20.5% lower carbon monoxide and 2.9% higher nitrogen oxides.

The incorporation of various additives to different biodiesels has been adopted in recent past for enhancement of diesel engine characteristics. The present work has utilized the oxygenated additives ethylene glycol diacetate (EGD), ethylene glycol monoacetate (EGM) and Triethylene glycol monomethyl ether (TGME) as performance improvers for the optimum dual biodiesel blend. Keeping in view the phase separation phenomenon, the EGD content has been limited to 3% while both EGM and TGME have been limited to 6% by volume. The incorporation of 3% EGD resulted in a notable enhancement in brake thermal efficiency by 4.2% and a

reduction in brake specific fuel consumption by 0.24 kg/kWh. The hydrocarbon and carbon monoxide emissions reduced by 21.4 and 25.7% respectively, with a slight increase in nitrogen oxide levels by 6.7%. From combustion attributes point of view, the peak cylinder pressure attained 53.2 bar and the maximum heat release rate reached to 63.7 J/°CA which indicates a significant improvement in combustion process due to addition of EGD to the biodiesel blend. In a similar manner, the oxygenated additives EGM and TGME imparted improvement in the physical properties of the biodiesel blend to achieve enhanced characteristics of the diesel engine. The doping of 6% EGM additive improved the brake thermal efficiency by 4% while the brake specific fuel consumption dropped by 0.18 kg/kWh. The additive reduced the hydrocarbon emission by 27.4% and carbon monoxide by 28.5% with a slight increase in NOx emission by 7.2%. The cylinder pressure attained value near to that of pure diesel while the heat release rate increased by 8.04% indicating proper fuel combustion inside the engine cylinder. Like both EGD and EGM, the oxygenated additive TGME imparted similar improvements in engine characteristics owing to its high oxygen content. The inclusion of 6% TGME additive resulted in a notable improvement in brake thermal efficiency by 4.7%, coupled with a reduction in brake-specific fuel consumption by 0.2 kg/kWh. Additionally, the additive contributed to a substantial decrease in hydrocarbon emissions by 29.8% and carbon monoxide emissions by 40%, with a slight increase in NOx emissions by 9.03%. The cylinder pressure approached 54.2 bar while the heat release rate increased by 12.2%, indicating efficient fuel combustion within the engine cylinder.

Chapter 31

DESIGN OF HIGH PRECISE ORBIT PROPAGATION TOOL FOR LEO'S WITH SIMPLIFIED PERTURBATIONS MODEL

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ABSTRACT

Propagation data is needed for coverage analysis and other satellite operations which include reference quaternions generation, payload planning and burn design. The satellite manufacturing market is expected to expand at \$30.3 billion in 2033 due to the rising need for LEO's satellite mission. Accurate orbit propagation of satellite is important for coverage analysis and other satellite operations. Hence, orbit propagation for LEO satellites requires a high precise orbit propagator. And for sending the navigational algorithm onboard a computational orbit propagation tool is required, that is more efficient and has higher precision. Existing high-precision orbit propagation modules are computationally expensive for both ground-based and onboard systems. This limits their usability, especially in environments where resources are scarce. By this project, we are designing a highly precise orbit propagation tool specific to LEO with all the necessary perturbations including atmospheric drag, Earth spherical harmonics effects, solar radiation pressure and third- body perturbation from Sun and Moon. We planned to achieve this by way of the initial integration, Adam-Bashfort and Cowell's formulations are the methods we mostly used. The integrator is validated using unperturbed motion. Earth asphericity is added to accommodate gravitational variations, with drag and solar radiation pressure (SRP) perturbations modeled to achieve realistic performance. Three-body perturbations caused by the Sun and Moon are added, and the core orbit propagation algorithm is programmed. After the complete development of the software the plan is to outsource it to companies as needed. This project is an improvement to the current system being used for orbit propagation. Also this model is highly useful for communication based satellite where the pointing accuracy control is much less when compared to other missions like optical based. As the demand for LEO services increase per day, our project offers a chance for improving mission success and the operational lifespan of satellites.

Chapter 32

INVESTIGATION ON EFFECT OF FLOW RATE IN EXHAUST GAS RECIRCULATION WITH BIODIESEL POWERED CRDI ENGINE

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ABSTRACT

Automobile Emission is one of the major problems in environment. Diesel Engine emits the carbon monoxide (CO), carbon dioxide (CO₂) hydrocarbon (HC), Nitrogen oxides (NO_x) and smoke density to the environment. NO_x emission leads to dangerous effect in the environment. These problems include ground level ozone and smog, which are created in the atmosphere by the reaction of nitrogen oxides and hydrocarbons in the presence of sunlight.

Various methods are used to reduce the No_x emission. In the present work Exhaust gas recirculation (EGR) technique is used with diesel engine with the use of biodiesel as fuel. Papaya fruit seed oil is used to prepare the biodiesel in this present work. Experiments are conducted in a single-cylinder, four-stroke, water-cooled, direct-injection diesel engine coupled to an Eddy current Dynamometer with EGR. The result shows that NO_x emission is reduced using EGR for diesel and bio diesel.

Keywords: Diesel, Biodiesel, EGR, Emission.

Chapter 33

ADDITIVE MANUFACTURING OF INCONEL 625 BASED CERAMIC COMPOSITES: ENHANCING MECHANICAL PROPERTIES WITH GRAPHENE NANO POWDER VIA DIRECT INK WRITING

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Abstract

This project explores DIW of Inconel based ceramic composites with graphene nanopowder to enhance strength, hardness, and fracture toughness through optimized processing parameters for high-performance applications. Graphene-Enhanced Composites: Integrating graphene Into Inconel 625 cru caramiks to improve shear resistance, and thermal stability.3D Printing with DW: Using DIW for precise scalable fabrication of high-performance materials

Chapter 34

MEDIUM RANGE-100 SEATER PASSENGER AIRCRAFT

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Abstract

This report provides data for preliminary and detailed design of wing, fuselage, control surfaces and landing gear of a medium 100seater passenger aircraft with the knowledge of design data from previous design project. In this, the theoretical aspect of aerodynamics, aircraft structures, propulsion, stability and control are given as per the need for design. This report also deals with in-depth study of structural characteristics of aircraft components.

Chapter 35

FOUR WHEEL STEERING CONTROL

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Abstract

Four Wheel Steering (4WS) is an advanced vehicle steering system that enables all four wheels to steer, improving maneuverability, stability, and control. Traditional vehicles use front-wheel steering, which limits handling efficiency, especially at high speeds or in tight spaces. In contrast, 4WS systems allow the rear wheels to turn either in the same direction or opposite direction of the front wheels, depending on the speed and driving conditions. At low speeds, the rear wheels turn opposite to the front wheels, reducing the turning radius and enhancing agility, ideal for urban driving and parking. At high speeds, the rear wheels turn in the same direction as the front wheels, improving lane change stability and reducing body roll. This system can be mechanical, hydraulic, or electronically controlled. Modern 4WS systems are integrated with sensors and ECU units for real-time control and responsiveness. Applications include passenger cars, trucks, and agricultural machinery. Benefits of 4WS include improved safety, better tire wear, and enhanced driving dynamics. It also reduces driver fatigue in complex driving environments. However, it comes with increased system complexity and cost. Overall, Four Wheel Steering represents a significant step toward intelligent vehicle control and enhanced performance.

Keywords: Four Wheel Steering, Intelligent vehicle systems, Electronic Control Unit (ECU), Steering control system.

Chapter 36

DESIGN AND DEVELOPMENT OF HIGHLY OPTIMIZED MANEUVER DESIGN SOFTWARE FOR SPACE MISSIONS

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Abstract

Satellites require regular maneuvers to adjust their orbits, maintain positioning, or avoid collisions (e.g., station-keeping, altitude changes). These maneuvers consume fuel, which is limited onboard. Excessive fuel usage reduces the satellite's lifetime. Inefficient maneuver planning, non-optimized trajectories and over-reliance on brute-force thrusting exacerbate fuel wastage. This results in shorter satellite lifespans, increased mission costs, and reduced reliability. Extending fuel efficiency is crucial for industries like communications, Earth observation, and defense. To address this, a solution that can optimize orbital maneuvers to minimize fuel consumption while maintaining precise trajectory adjustments is required. This involves trajectory optimization using mathematical models and algorithms, optimized thrust management, and utilization of low-thrust propulsion systems. Simulation tools, such as GMAT and MATLAB, and orbital transfer techniques like Hohmann transfers, bi-elliptic transfers, and genetic algorithms, are employed to design and test efficient maneuver strategies. So, the challenge is that currently, various software tools are used to implement different techniques for maneuver design and optimization, which can be time-consuming and require significant effort. To address this, our solution is to develop a single software platform that integrates all the necessary tools and techniques, leveraging genetic algorithms to provide optimized solutions. This integrated software platform would offer several benefits, including streamlined workflow, improved accuracy, enhanced collaboration and reduced costs. Overall, this solution can revolutionize the field of maneuver design and optimization, making it more efficient, accurate, and cost-effective.

Chapter 37

OPTIMIZATION OF STRUCTURAL AND AERODYNAMIC PERFORMANCE FOR NOISE REDUCTION IN FIGHTER JET AIRCRAFT

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Abstract

This project aims to enhance the structural and aerodynamic performance of fighter jet aircraft to minimize noise generation while maintaining operational efficiency. Aircraft noise primarily results from structural vibrations and turbulent airflow interactions. By optimizing the design, this study focuses on reducing vibration-induced noise and improving aerodynamic stability. Structural analysis is conducted to evaluate deformation, strain, and stress distribution, ensuring enhanced durability and reliability. Additionally, Computational Fluid Dynamics (CFD) simulations are employed to analyze airflow patterns, pressure distribution, and velocity stabilization to mitigate turbulent noise. The proposed modifications integrate structural reinforcements and aerodynamic refinements to achieve significant noise reduction while preserving flight performance and maneuverability. This research contributes to the development of quieter and more efficient fighter jet designs, improving both operational effectiveness and environmental sustainability.

Chapter 38

EXPERIMENTAL STUDY ON MORTAR WITH PARTIAL REPLACEMENT OF CEMENT WITH BIOCHAR

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Abstract

Cement production significantly contributes to global carbon emissions, necessitating sustainable alternatives to mitigate environmental impact. This study explores the feasibility of partial replacement of cement with biochar in mortar, aiming to enhance sustainability while maintaining structural integrity. The Biochar used for this study is *Prosopis juliflora* (Seemai Karuvelam) tree and the preparation of biochar is done by pyrolysis method. The experimental analysis involved varying replacement levels of BC (5%, 10%, and 15%) by weight of cement to evaluate its influence on consistency, compressive strength and setting time of the mortar. Fresh and hardened properties were assessed through standardized tests, comparing the modified mortar with conventional cement mortar. Microstructural analysis SEM is done for revealing the changes in hydration products, suggesting biochar's role in refining pore structure and modifying cement hydration kinetics. The study underscores the potential of biochar as a sustainable cement substitute, promoting carbon sequestration while reducing cement dependency. Therefore, optimization of replacement ratios and long-term durability assessments remain essential for practical implementation in construction. This research contributes to the growing field of eco-friendly construction materials, advocating for biochar as a viable supplement in cement-based applications, balancing environmental benefits with engineering performance.

Keywords: Biochar (BC), Carbon sequestering, Scanning Electron Microscope (SEM), *Prosopis juliflora*.

Chapter 39

IDENTIFICATION OF MOISTURE STRESS INDEX USING REMOTE SENSING DATA

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Abstract

Agricultural sustainability depends much on drought monitoring, especially in areas vulnerable to moisture stress. This paper evaluates agricultural moisture stress changes in the arid and semi-arid environment using the agricultural Moisture Stress Index (CMSI) and a novel approach, the Dual Polarimetric Crop Moisture Stress Index (DPCMSI), as a function of soil moisture and vegetation moisture acquired from Sentinel-1 and Sentinel-2 data. A study found lower evapotranspiration rates and residual soil moisture from precipitation in the winter help to show modest moisture stress levels. But as temperatures rose, evapotranspiration rates grew more strong. With values ranging from $r = 0.00$ to $r = 1.00$, the statistical analysis demonstrated a good connection between CMSI and DPCMSI, proving DPCMSI sufficiently reflects changes in crop moisture stress. The results imply that irrigation was essential in reducing moisture stress. The study emphasises the need for adaptive water management techniques to reduce crop stress during dry seasons and the possibility of combining multi-sensor observations for exact drought monitoring.

Moreover, the seasonal variability in crop moisture stress underscores the importance of timely monitoring and response strategies to ensure sustainable yields. Remote sensing-based indices like DPCMSI provide valuable insights for early warning systems and precision agriculture. These tools can empower farmers and policymakers with data-driven decisions to combat the effects of climate variability on agriculture.

Chapter 40

IOT BASED BABY MONITORING SYSTEM

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Abstract

In today's fast-paced world, working parents face significant challenges in ensuring constant care and safety for their infants. Traditional baby monitoring solutions often lack real-time responsiveness and comprehensive health tracking, resulting in delayed reactions to potentially dangerous situations. To address this critical gap, we present an IoT-Based Baby Monitoring System, a smart, sensor-driven solution designed to provide continuous, real-time monitoring of an infant's environment and vital signs.

This system employs the ESP8266 microcontroller integrated with a range of sensors, including DHT11 for temperature and humidity, a pulse sensor for heart rate, MEMS sensors for motion detection, and moisture sensors for diaper wetness detection. Real-time alerts are communicated to caregivers through a mobile application, ensuring immediate response to abnormal conditions such as elevated body temperature, irregular heartbeats, falls, or crying.

Designed with affordability, efficiency, and usability in mind, the system offers a scalable and reliable alternative to traditional baby care methods. Its modular design also supports future expansion with machine learning algorithms to predict infant behavior and detect anomalies with higher accuracy. By minimizing human error and offering intelligent infant care, this innovation promises to transform home-based child safety, ensuring peace of mind for modern families while setting a new standard in digital health monitoring. At present, female participation in the workforce in the industrialized nations has greatly increased, thereby affecting infant care in many families. Both parents are required to work due to the high cost of living. However, they still need to look after their babies, thereby increasing workload and stress, especially of the mother. Working parents cannot always care for their babies. They

either send their babies to their parents or hire a baby caregiver while they are working. Some parents worry about the safety of their babies in the care of others. Thus, they go home to check on their babies during their free time, such as lunch or tea break. A baby monitoring system that can monitor the babies' condition in real time is proposed to solve these problems. Generally, babies cry because they are hungry, tired, unwell, or need their diaper changed. Sudden Infant Death Syndrome (SIDS) is also known as crib death, because many babies who die of SIDS are found in their cribs. It occurs in infants younger than 12 months old. Most SIDS deaths occur in infants younger than 6 months old [1]. Professionals still do not know the causes of SIDS, but risk can be reduced by letting the baby sleep on a firm surface (crib mattress). In addition, the baby should not sleep on a pillow or another soft surface. The researchers do not know why sleeping on such surfaces increases the risk of SIDS, but they warn that it could be dangerous [2]. For instance, in 2003, a study showed that placing an infant to sleep on soft bedding rather than on firm bedding appeared to pose five times the risk of SIDS [3].

Moreover, overheating should be avoided during sleep. Babies should be kept warm during sleep, but the temperature should not be extremely warm. In winter or cold weather, the risk of SIDS increases because the parents overdress their babies or place them under heavier blankets, thereby overheating them [4]. Therefore, if the room temperature is comfortable for an adult, then it is also appropriate for the baby. Under fast-paced life conditions, everyone is busy in their professional life, including parents. They leave the house early in the morning and come back before dinner time. Even the mothers are working. Thus, they do not have sufficient time to take care of their babies. Not all parents can afford a nanny to help them with their children. Then, after working for long hours, the mothers still have to manage the house and take care of their babies simultaneously. Furthermore, some parents place their baby in a separate room. Therefore, parents could not hear the baby crying and could not be there to ease their baby back to sleep in the middle of the night. Other parents may be occupied with house chores. Thus, because they cannot hear their baby crying, they cannot attend to them immediately.

Chapter 41

AI-BASED FIRE-FIGHTING ROBOT WITH SMOKE EXTRACTION AND FILTRATION SYSTEM

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Abstract

Fire accidents pose a significant threat to both life and property, especially in situations where timely human intervention is not possible. To address this issue, we present an AI-based fire-fighting robot integrated with a smoke extraction and filtration system, designed to autonomously detect and respond to fire outbreaks in real-time. The robot is equipped with flame and temperature sensors to accurately detect fire sources, while ultrasonic sensors enable it to navigate and avoid obstacles effectively in its surroundings.

And the core of the system is the ESP32 microcontroller, which provides onboard processing and wireless communication capabilities. Once a fire is detected, the robot initiates its water-spraying module, targeting the flame directly and working to extinguish it quickly and efficiently. The system is designed to continuously monitor the environment and adapt its actions accordingly, ensuring the fire is completely put out. After the extinguishing process is complete, the robot automatically transitions into smoke management mode. It activates a DC fan-based smoke extractor, which draws in the smoke from the affected area. The extracted smoke is passed through an activated carbon filter system, which helps remove harmful gases and particulates before releasing cleaner air back into the environment. This feature not only improves air quality but also enhances visibility for any further rescue or inspection operations. This dual-function robotic system plays a crucial role in reducing the risks faced by firefighters and emergency responders. By automating both fire suppression and post-fire smoke management, it offers an effective and intelligent solution for fire-prone areas such as homes, warehouses, factories, and other enclosed environments. Overall, this project demonstrates a practical application of AI and embedded systems in enhancing safety and minimizing human exposure to hazardous conditions.

Chapter 42

LEADING EDGE BRAKING SYSTEM

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Abstract

The Leading Edge Braking System introduces a new aerodynamic braking concept in aircraft by transforming conventional leading-edge slats into airbrakes. These slats, which are typically used to enhance lift during takeoff and landing, are modified to increase drag when deployed at specific angles. This dual functionality allows for effective deceleration during descent, landing, or rejected takeoffs, thereby reducing the reliance on traditional systems such as wheel brakes, thrust reversers, and spoilers.

The system is built around a control mechanism using an Arduino Uno, coupled with a servo motor to precisely adjust the slat angles. A gear mechanism ensures mechanical stability and effective transmission of motion, while a potentiometer provides accurate positional feedback for calibration and control. This setup enables smooth, reliable braking action using aerodynamic forces. By leveraging these forces instead of depending solely on mechanical friction, the system reduces wear on braking components and enhances energy efficiency.

In addition to improving braking performance, the leading-edge braking system offers several operational and environmental benefits. These include better load distribution across the wing, improved short-runway landing capability, and reduced noise and emissions due to decreased engine thrust during descent. However, implementing such a system requires addressing structural reinforcement of slats, developing advanced control algorithms, and updating pilot training protocols. Despite these challenges, the technology represents a promising step forward in enhancing aircraft braking performance and safety.

Chapter 43

MICROSTRUCTURE & MECHANICAL PROPERTIES OF SILICON CARBIDE

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Abstract

Combining different materials in a single manufacturing process will reduce waste and production time by eliminating the need to assemble components. It will also expand the design space, enabling new products, composites and devices with structural and functional properties. We provide a critical perspective on the fabrication of 'truly' multi-material structures in which different classes of materials, such as ceramics, metals, polymers and carbon-based materials are combined using direct ink writing (DIW) 3D printing. Aluminum-(Silicon Carbide) is a metal-ceramic composite material consisting of silicon carbide particles dispersed in a matrix of aluminum alloy. It combines the benefits of high thermal conductivity of metal and low CTE (coefficient of thermal expansion) of ceramic.

Chapter 44

DESIGN - ANALYSIS AND EXPERIMENTAL INVESTIGATION OF A BATTERY COOLING SYSTEM WITH DIFFERENT FIN CONFIGURATIONS FOR AIRCRAFT

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Abstract

Efficient heat regulation is essential in aviation battery systems to guarantee optimal performance and durability. This paper examines the design, analysis, and experimental evaluation of a battery cooling system using various fin configurations. The initial concept comprises a battery case devoid of a heat sink, succeeded by a proposed design that incorporates multiple heat-sinking fin designs, such as rectangular fins, circular fins, and stepped rectangular fins. Thermal analysis is undertaken using ANSYS software to evaluate the heat dissipation capacity of each fin configuration, while computational fluid dynamics (CFD) is employed to analyze airflow behavior and cooling efficiency. The main objective is to determine the optimal fin design that maximizes heat dissipation, hence improving cooling efficiency. A prototype model is constructed, and thermal analyses are conducted on the casing with and without fins to verify the computational results. The findings will aid in the advancement of an enhanced battery cooling system for aircraft, hence augmenting safety and operational reliability.

Chapter 45

DESIGN AND OPTIMIZATION OF AN ANNULAR COMBUSTION CHAMBER FOR ENHANCED AIR-FUEL MIXING

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Abstract

The performance and efficiency of an annular combustion chamber in jet engines depend significantly on effective air-fuel mixing and robust thermal management. Inadequate air-fuel mixing can lead to incomplete combustion, increased emissions, and reduced fuel efficiency, while excessive thermal stress can cause material degradation and reduce component lifespan. This study focuses on optimizing swirler design and fuel atomization to enhance turbulence and ensure uniform air-fuel mixing, leading to complete and efficient combustion. Additionally, advanced cooling strategies, including optimized material selection and the application of thermal barrier ceramic coatings, are implemented to mitigate thermal stress and improve combustor durability. The methodology involves a comprehensive computational fluid dynamics (CFD) simulation to analyze and validate the effects of swirler modifications, fuel injector optimization, and cooling hole placement on combustion performance. The redesigned swirler incorporates increased vane angles and multiple swirl stages, significantly improving turbulence intensity and ensuring better atomization of fuel droplets. High-pressure fuel injection and optimized spray cone angles further enhance combustion stability. The integration of nickel-based superalloys and yttria-stabilized zirconia (YSZ) ceramic coatings reduces surface temperatures and improves thermal resistance, thereby extending the operational lifespan of the combustor. The results demonstrate that the improved swirler design increases turbulence intensity by 30%, leading to more efficient combustion. The optimized cooling techniques reduce peak liner temperatures by approximately 200°C, lowering thermal stress and improving component reliability. Additionally, emission levels of CO and NO_x are reduced by up to 20%, making the design more environmentally friendly. The validated findings confirm that the optimized annular combustion

chamber achieves higher efficiency, reduced emissions, and prolonged operational durability. Future work includes experimental validation of the proposed modifications and further refinement of material compositions for enhanced performance.

Chapter 46

DESIGN OF COMPACT ELECTRO-MECHANICAL ACTUATOR FOR THRUST VECTORING

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Abstract

Electromechanical actuators have taken the place of hydraulic and pneumatic actuators in many applications, especially for the purpose of Thrust Vector Control (TVC). For many years, engineers have been encouraging the investigation of electromechanical actuators (EMA) to take the place of hydraulics for spacecraft control/gimballing systems. The rationale is to deliver a lighter, cleaner, safer, more easily maintained, as well as energy system. The aim of this project is to design an electromechanical actuator for spacecraft applications using the analytical formulae and/or Finite Element Analysis techniques.

This report presents the design of a Compact Electromechanical Actuator (EMA) for the purpose of Thrust Vector Control. The major components of EMA are: Brushless DC servo motor, belt drive and a roller screw, which converts rotational input into linear output and column to which the nozzle will be attached and a power supply. A pair of resolvers and associated electronics delivers position feedback to the controller such that precise positioning is achieved. The design consists of three phases, Conceptual, Preliminary and Detailed. After the design completion, the 3-D model of the EMA has been drawn which is then followed by the structural analysis using state of the art software ABAQUS.

Chapter 47

TOP TABLE MINI WIND TUNNEL

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Abstract

The Top Table Mini Wind Tunnel is a compact and portable aerodynamic testing device designed for small-scale experiments. It provides a controlled airflow environment to analyze the aerodynamic properties of objects such as airfoils, small vehicle models, and drone components. With its tabletop design, the wind tunnel is ideal for use in educational institutions, research labs, and hobbyist projects, offering a cost-effective and accessible alternative to larger wind tunnels.

This project utilizes Autodesk Fusion 360 for precise CAD modeling, simulation, and optimization of airflow dynamics. The wind tunnel features a modular test section, allowing for interchangeable components and adjustable airflow speeds to suit various testing requirements. Integrated sensors and data acquisition systems enhance accuracy, enabling real-time monitoring and analysis of aerodynamic forces.

Chapter 48

AIRCRAFT BRAKING SYSTEM

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Abstract

The objective of this project is to develop a new braking system in aircrafts. With the increasing weight and running speed more friction occurs in the present conventional disc brakes, consequently the discs undergoes more wear and tear and more heat is also generated. So there is a need for alternate solution, for which eddy current braking system is introduced. Our search for a new brake is initiated by analysing various types of actuators, which consequently led to the selection of an eddy current system. The concept of this braking in this retarder is based on "Lenz's law". When a rotating conductive disc is exposed to a magnetic flux, eddy currents are induced in the surface of the disc. A braking torque is generated by the interaction between the eddy currents and the magnetic flux. Eddy current Retarders serve to slow down the vehicles. At high speeds the amount of eddy current generated is more, which is used as frictionless brakes, since there is no direct contact with the discs. At low speeds since the eddy current generated is low, the conventional disc brakes can be adapted. This reduces the wear of disc and increases the potential life. This offers many potential advantages for the operator and the passenger. These characteristics make the eddy-current brake potentially appropriate for wider application.

Chapter 49

NUMERICAL SIMULATION OF INVISCID (OR) IDEAL FLOW

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Abstract

The growing demand for fossil fuels, coupled with their depletion and rising costs, has prompted the scientific community to seek alternative energy sources. Electricity is crucial for global economic growth, and reliance on fossil fuels for electricity generation negatively impacts industrial development. This has spurred interest in nuclear energy and renewable sources. However, unlike renewable energy, nuclear energy presents numerous risks and challenges related to radiation, making its efficient use a significant challenge.

Renewable energy, often labelled as clean energy, focuses on harnessing abundant kinetic energy from natural forces such as water, wind, and thermal energy from solar and geothermal sources. However, hydroelectric power can raise ecological concerns, while solar energy tends to be expensive to install and unreliable, making it less than ideal for widespread use. In contrast, wind energy is both an efficient and environmentally friendly option for power generation.

Nevertheless, the wind energy sector faces challenges, particularly in optimizing aerodynamic design. Wind turbines must handle varying wind speeds while maintaining high efficiency across all conditions. This project focuses on the aerodynamic optimization of wind turbine blades and the control of boundary layer separation to enhance aerodynamic efficiency. It aims to improve the performance of wind turbines through shape modifications, simplifying the design process and reducing costs compared to current boundary layer control methods, such as air jet vortex generators. The research is rooted in computational fluid dynamics, with suitable shape modifications being identified and validated.

Chapter 50

ADVANCEMENTS IN DIFFUSION WELDING: A COMPREHENSIVE REVIEW ON PROCESS OPTIMIZATION AND MATERIAL COMPATIBILITY

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Abstract

Diffusion welding has become a prominent solid-state welding technique with the potential to form high-strength and defect-free joints through the utilization of atomic diffusion under engineered conditions. This paper summaries progress in 21 studies that identify process improvements, material compatibility, and new applications. Some of the key findings are enhanced joint strength, microstructural integrity, and corrosion resistance, obtained by techniques like the combination of friction and diffusion welding, use of interlayers such as nickel, and novel techniques such as spark plasma sintering (SPS). The research emphasizes the successful joining of dissimilar materials, including titanium, aluminum, copper, and nickel-based alloys, with tensile strengths between 78 MPa and 850 MPa under ideal conditions. Also, issues such as brittle intermetallic growth and hydrogen embrittlement are managed by controlling precise parameters and novel surface treatments. By integrating the findings, the paper offers an in-depth analysis of the advancements in diffusion welding and emphasizes its significance in high-performance and dependable joint applications, such as the aerospace, nuclear, and automotive industries.

Chapter 51

REVIEW ON RECENT ADVANCEMENTS IN ELECTRO-SLAG WELDING

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Abstract

Electroslag welding (ESW) is a highly efficient fusion welding process designed for thick-section materials, commonly used in structural engineering, shipbuilding, and heavy machinery manufacturing. Over the years, advancements in ESW have focused on temperature field modeling, residual stress analysis, microstructural improvements, and enhanced mechanical properties of weld metal. This review critically examines recent research developments, including numerical simulations of thermal behavior, metallurgical enhancements, and innovative process optimizations. Key challenges such as hydrogen-induced cracking, deformation control, and slag-metal interactions are also discussed. Finally, potential future directions in ESW, including automation and hybrid welding techniques, are proposed to further enhance its efficiency and applicability.

Chapter 52

EVALUATING THE STRUCTURAL INTEGRITY OF REINFORCED CONCRETE BEAMS WITH NATURAL FIBER COMPOSITE STIRRUPS UNDER CYCLIC LOADING CONDITION

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Abstract

This project investigates the feasibility of using fiber stirrups extracted from *Calotropis gigantea* as a partial replacement for conventional steel stirrups in reinforced concrete (RC) flexural members. The increasing demand for sustainable construction materials has led to the exploration of natural fibers due to their eco-friendly properties and potential to reduce the environmental impact of traditional steel reinforcement. Fibers from *Calotropis gigantea* were extracted, processed, and combined with epoxy resin to enhance their mechanical properties, particularly hardness and tensile strength. The structural performance of the fiber-reinforced stirrups was evaluated under cyclic loading conditions to assess their effectiveness in shear reinforcement. Key parameters such as stress distribution, deformation, and failure modes were analyzed and compared with conventional steel stirrups. The study examines the potential of these natural fiber composites in enhancing the structural integrity of RC beams while reducing dependence on steel reinforcement. The findings of this project contribute to the ongoing development of sustainable construction materials, demonstrating the viability of *Calotropis gigantea*-based fiber stirrups as an alternative reinforcement solution for eco-friendly and durable structural applications.

Chapter 53

EXPERIMENTAL INVESTIGATION AND PROCESS PARAMETER OPTIMIZATION OF SPROCKET – PLA-CF MATERIAL WITH LEAN MANUFACTURING CONCEPT

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Abstract

Additive manufacturing (AM), also referred to as 3D printing, allows for the personal creation of items with intricate shapes and capabilities in terms of mechanical and electrical characteristics. AM systems typically employ materials like polymers and composites and are continually progressing across several industrial and developing uses. Even though there has been some recent advancement in the 3D printing of polymer composites, there are still several issues to overcome, including the poor quality of the final products and the scarcity of materials suitable for 3D printing. Following that, we explore the latest advancements in polymer and filling material designs, the fundamental concepts behind additive manufacturing (AM) processes, and the growing uses of 3D printed polymers and composites. This work studies have to be analysed Sprocket wheel and the corresponding specimen's influences of the various process parameters of the 3D printing directly dependent on mechanical behaviours of the printed parts. This experimental works focused on PLA-CF filament was printed FDM process by using with various process parameters. In this span length, the main mechanical behaviours were derived from the experimental research analysis.

Keywords: PLA-CF, Tensile strength, Infill pattern, printing speed.

Chapter 54

EXPERIMENTAL ANALYSIS AND OPTIMIZATION OF COAXIALITY ERROR ANALYSIS WITH CNC TURNING PROCESS ON VARIOUS INDUSTRIAL POLYMER FOR ENGINEERING APPLICATION

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Abstract

For any manufacturing industry that uses machining operation like turning operation, Material Removal Rate and Surface Roughness are the important parameter which is to be considered for quality product. The material selected for the experiment is various industrial polymer such as PP, ABS, DELRIN-500 & UHMWPE. Turning is one of the important processes that is widely used to create cylindrical components and it is also used for surface finish the product to make it smooth. Nowadays, plastic materials are widely used for making variety of components. To make a component with high dimensional accuracy, turning operation is used. The main concerns of turning are tooling cost and the effect of process on machinability characteristics. It can be seen that the output responses value has a minimum roughness average and a high degree of geometrical quality precision. Based on the observation, the Delrin material's achieved least roughness average and higher MRR. The lowest coaxial error was achieved in this ABS material during the CNC turning process. From the experimental research selected process parameter range is very suitable for the Delrin & ABS material compared to others. The machining and geometrical characteristics majorly influenced with feed for the all industrial polymers.

Keywords: CNC Turning, DELRIN, Ra, Co-axial error, MRR, Polymer.

Chapter 55

SMART SLIPPERS FOR VISUALLY IMPAIRED USING ADDITIVE MANUFACTURING

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Abstract

3D printing which has turned into a remarkable point in today's innovative exchange. In this paper, we will look at additive manufacturing or 3D printing. We will firstly characterize what we mean by this term and what is so noteworthy about it. We will dive a bit into the history. At that point, we should see about the procedure of 3D printing and the materials utilized as a part of the production of 3D printed objects. We might likewise see the focal points and burdens of 3D printing. We should watch the various applications it is being out to utilize today. At last, the future capability of this innovation is illustrated. Let's just admit it, all of the squeeze fans available are just toys. They are fun to play around for 5 minutes, but cannot really be used functionally. The wind is too little, the hand gets caught in the blades, and nowhere to grab. This is an upgraded larger version where you can actually use it to cool down!

I also narrowed down the tolerances of the original design to make the fan less wobbly, and the pins to fit moresnug. If spinning too fast, the cover may separate from the case since they are just held together by pins. Use superglue if necessary.

Chapter 56

EXPERIMENTAL INVESTIGATION OF FORM TOLERANCES DURING EDM OF AL 6061 – SiC METAL MATRIX COMPOSITES WITH DIFFERENT CROSS SECTIONS ELECTRODES

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Abstract

This work presents an investigation on performances of electrodes having cross section namely circular, hexagonal and square cross sections made up of copper during Electrical Discharge Machining (EDM) of Aluminium-Silicon Carbide Metal Matrix Composite (Al-SiC MMC). Al 6061- 15% SiC composites with particle size of 25 μm and 40 μm were taken for this study. Machining parameters namely current, pulse on time, pulse off time and flushing pressure are varied during the experiments. Performance measures namely MRR, EWR, circularity, cylindricity, parallelism and perpendicularity are measured. Effects of the machining parameters on the observed performance measures are discussed. The form tolerance value of the machined surface increases with the increase in MRR value. The circular electrodes produce better performance as compared to hexagonal and square cross section electrodes.

Key words: EDM; MRR; Cylindricity, Composite materials

Chapter 57

INNOVATIVE ROBOTICS SOLUTIONS FOR ENVIRONMENTAL CONSERVATION A COMPREHENSIVE MODEL FOR PLASTIC WASTE COLLECTION

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Abstract

Plastic waste pollution is a growing environmental crisis, with traditional collection methods being labour-intensive, inefficient, and costly. Existing waste management systems often lack automation, real-time monitoring, and adaptability to different environments. To address these challenges, this study proposes an innovative robotic solution that integrates IoT, automation, and cloud-based monitoring for efficient plastic waste collection. This project proposes an innovative Robotics Solutions for Environmental Conservation a Comprehensive Model for Plastic Waste Collection was proposed. The proposed model utilizes an ESP8266 NodeMCU microcontroller, interfacing with various components such as servo motors, DC gear motors, and relays for precise control and movement. The system is equipped with an ESP32 camera, which enables real-time monitoring and remote control through the Blynk app, facilitating efficient waste detection and collection. The robotic vehicle employs a BO motor-driven mechanism for mobility, coordinated via an electric relay, ensuring smooth navigation in diverse environments. Additionally, a cloud-based data storage system enhances the efficiency of waste tracking and management. The L298N motor driver aids in controlling the motion of the DC gear motor, allowing adaptive maneuverability. This autonomous system significantly reduces human intervention, promoting eco-friendly waste collection practices. By leveraging smart technologies and automation, this robotic solution enhances the effectiveness of plastic waste management. The integration of cloud connectivity further optimizes operational efficiency, providing a scalable approach for environmental conservation. This model serves as a blueprint for future advancements in robotic waste management systems.

Chapter 58

BOND ADDITIVE MOLECULAR DESCRIPTORS OF GRID RELATED STRUCTURES

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Abstract

The study explores the mathematical modeling and characterization of a number of molecular structures, such as $C4(m, n)$ cylinders, $C4(m, n)$ grids, and the ionic compound sodium chloride (NaCl). The Adriatic indices, a bond-additive descriptor derived from vertex degrees in chemical networks, is computed, and their characteristics are investigated by using graph-theoretical techniques. Because of their porosity and modular frameworks, $C4(m, n)$ structures which are frequently used in coordination chemistry and materials science, show important applications in molecular transport, gas storage, and catalysis. In the meantime, sodium chloride provides information on basic chemical concepts and real-world applications in a variety of fields due to its straightforward yet sturdy ionic structure. The graphical representations and computed Adriatic indices draw attention to structural and functional connections, providing a thorough understanding of the potential of complex systems in the theoretical and practical disciplines.

Keywords: Molecular graph, Adriatic indices, Grid, Cylinder, Sodium Chloride, Computed data, Structural properties.

Chapter 59

EFFECT OF ELECTRODE HEATING ON PERFORMANCE OF ELECTROCHEMICAL MICROMACHINING USING ALUMINIUM ALLOY (7075)

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Abstract

The application of electrode heating is proposed in electrochemical micromachining (EMM). In the EMM process, the temperature of the electrode, voltage, duty cycle, and electrolyte concentration are considered process parameters. Taguchi L18 mixed-level orthogonal array (OA) design was adopted for designing experiments and this study highlights the effect of temperature on responses such as radial overcut (ROC), material removal rate (MRR), and conicity factor (CF). Now a days application of aluminum alloy materials replacing the conventional materials because of their properties like corrosion resistance, Hardness, toughness & lighter weight for strength etc. Electro Chemical Micro machining. This experimental work is about investigating the influence of the Electrochemical Micro Machining (ECMM) process parameters like Voltage, Pulse-on time, Pulse-off time, Electrolyte Temperature, Electrolyte Concentration on chosen Alloy material during the machining by anodic dissolution process. ECMM is one of the promising micromachining methods especially to produce components at micro scale in electrically conductive materials like Aluminum alloy, Titanium alloy, etc. Further it is to develop an ECMM setup, which will help with machining with the help of Tartaric acid and NaNO₃ based electrolytes. The optimized experimental results will help to improve the machining performance of ECMM components, which are used in automotive, electronic, bio medical and aerospace industries. ole structure with high precision

Keywords: ECMM(Electro chemical micro machining),Aluminum alloy, MRR

Chapter 60

M-ARAS BASED ANFIS MODEL FOR WATER DISTRIBUTION NETWORK

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Abstract

Nonlinear behavior is difficult to understand. Demand and distance have nonlinear behavior in the Water Distribution Network (WDN) due to the quantity of water demand having decreased by increasing the distance of water supply from the resource. Hence, an appropriate method needs to limit demand and distance that are essential for optimizing designs. Therefore, Modified-Additive Ratio Assessment Method (M-ARAS) based Adaptive Neuro-Fuzzy Inference System (ANFIS) Hybrid model has been implemented after taking into consideration the need to reduce the unpredictability, the limitations of a gradient-based algorithm, complexity in the process, to demonstrate the universality of the model, to develop a realistic model and to reduce the drawbacks of traditional methods.

Chapter 61

SCHEDULING AND PREDICTION OF DEMAND AND VELOCITY OF BRANCHED DRINKING WATER DISTRIBUTION NETWORK USING REGRESSION AND FUZZY LOGIC MODEL

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Abstract

Drinking water distribution network (DWDN) has used to transfer the specific demand of water from various resources to different locations of consumers. The drinking water problems for rural habitations located at long distances have faced due to the backpressure water, public damages in the pipeline, and leakages in the pipeline and reduce the pressure and velocity of the water. Hence, modelling of demand and velocity of water distribution networks have carried out by using the regression and fuzzy logic model respectively. The distance, flow rate and scheduling of water time have selected as input hydraulic parameters whereas demand and velocity are selected as hydraulic performance indicators. The effects of hydraulic parameters on demand and velocity of water are studied using main effect plots. Also, demand and velocity objective percentage are calculated. The overall analysis shows that the maximum demand percentage and maximum velocity objective percentage are improved by using the design of an experiment, regression model, fuzzy logic model, and grey relational analysis.

Keywords. Water distribution, demand, velocity, regression, fuzzy

Chapter 62

AUTONOMOUS PATH MEMORIZING ROBOT WITH MULTI-FUNCTIONAL ARM FOR DEFENCE AND RESCUE APPLICATION

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Abstract

This project presents the design and development of an Autonomous Path Memorizing Robot equipped with a Multi-Functional Robotic Assistant, aimed at defense and rescue applications. The robot navigates complex terrains, memorizes routes in real-time, and retraces paths autonomously without external guidance. In critical scenarios like military operations and natural disasters, autonomous systems ensure human safety and operational efficiency. The system integrates advanced sensors for obstacle detection, GPS-based mapping, and intelligent path-learning algorithms. The robotic arm performs multiple tasks, including lifting debris and handling hazardous materials. Its modular design allows for tool attachment flexibility, adapting to various mission requirements.

The robot enhances safety, reduces human exposure to danger, and improves response times in emergencies. It offers a cost-effective solution for military and civil defense scenarios. The robot's ability to learn and retrace paths makes it useful in situations like collapsed buildings or minefields. It integrates sensors for obstacle detection and environmental awareness. Microcontroller-based robot for high-risk environments like disaster zones and military operations. Enhances safety, efficiency, and reliability with modular design for future upgrades.

Chapter 63

NUMERICAL INVESTIGATION OF LEADING-EDGE TUBERCLES ON AXIAL COMPRESSOR BLADE PERFORMANCE

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Abstract

This research examines the aerodynamic performance of an axial flow compressor blade based on the NACA65(12)10 profile. The profile has a set of leading-edge tubercles with various wavelengths and amplitudes. Based on the advantages seen in the humpback whale flippers, leading-edge tubercles could improve the flow in turbomachinery applications. This work is taken to carry out a systematic parametric analysis of the sinusoidal tubercle geometries introduced along the leading edge of the compressor blade, with varying wavelength and amplitude for performance evaluating of the compressor. To analyze the flow characteristics, pressure distribution, stall characteristics, and overall efficiency at different operating conditions, numerical simulations were carried out employing a Reynolds-Averaged Navier–Stokes (RANS) solver. The specific configurations of tubercles show significant improvement for stall margin and reduce flow separation without affecting pressure ratio. Thus, enhancing the aerodynamic performance. This research will help improve design properties for the next generation axial compressors and offers a new approach for strengthening the blades of future turbomachines.

Keywords: Axial flow compressor, NACA65(12)10, leading-edge tubercles, bio-inspired design, flow separation control, CFD analysis, turbomachinery.

Chapter 64

PROGRESS IN STRUCTURAL MATERIALS FOR AEROSPACE SYSTEMS

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Abstract

The advancement of aerospace systems has been intrinsically linked to the development of innovative structural materials. These materials must meet stringent performance criteria, including high strength-to-weight ratios, thermal stability, and resistance to extreme environmental conditions. This paper reviews recent progress in structural materials, with a focus on composites, lightweight alloys, and advanced ceramics. Emerging trends in material design, such as additive manufacturing and multifunctional materials, are also discussed, highlighting their potential to redefine aerospace applications. The paper concludes with an outlook on future developments and the challenges ahead in adopting novel materials for aerospace systems. The aerospace industry has consistently driven material innovation to improve performance, reduce costs, and enhance safety. Structural materials play a pivotal role in determining the efficiency and durability of aerospace systems, including aircraft, spacecraft, and satellites. With the increasing demand for fuel efficiency and sustainability, there has been a significant push towards lightweight and high-performance materials. This paper examines the latest developments in structural materials and their implications for aerospace engineering.

Key Words: Lightweight Alloys, Aerospace Material, High-Strength Materials, Material Innovation

Chapter 65

TRIBOLOGICAL EVALUATION OF 3D-PRINTED POLYETHERIMIDE COMPOSITES USING NATURAL AND SYNTHETIC LUBRICANTS

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Abstract

This study investigates the tribological performance of Polyetherimide (PEI) composites fabricated using Fused Deposition Modeling (FDM) 3D printing technology. PEI, a high-performance thermoplastic known for its thermal stability and mechanical strength, was selected as the matrix material for developing advanced composites suitable for demanding applications. The printed specimens were subjected to tribological testing under varying lubrication conditions using both natural and synthetic oils. Key parameters such as coefficient of friction, wear rate, and surface morphology were analyzed to evaluate the effect of lubricant type on the tribological behavior of the PEI composites. The results demonstrate significant differences in performance based on lubricant composition, with natural oils offering environmentally friendly alternatives with competitive friction and wear characteristics. This work highlights the potential of combining 3D printing with advanced materials and sustainable lubrication solutions for applications in aerospace, automotive, and biomedical engineering.

Keywords: Polyetherimide, Fused Deposition Modeling, Thermal stability, Mechanical strength, Lubrication, Tribology

Chapter 66

LIBRARY MANAGEMENT SYSTEM

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Abstract

The Library Management has been designed to optimize storage, retrieval, and other forms of organizational information about libraries within institutional or educational boundaries. This information relates to book details, their names, authors, and available stock. The key features are user-friendly forms for adding new books, updating existing records, and maintaining accurate stock levels. This system allows for the real-time update of library information, which is very effective for checking on which books are available. The project is hosted locally by XAMPP, an open- source cross-platform server. It ensures smooth interaction between the backend and the database. phpMyAdmin, an important part of XAMPP, is used for database management, enabling efficient handling of book records. It allows administrators to manage database structure, execute queries, and ensure integrity of the data stored. The implementation demonstrated how the system simplifies library operations by reducing manual efforts and enhancing the accuracy of the data management

Index Terms: Crop Yield Prediction, Deep Learning, Neural Networks, Machine Learning, CNN, RNN, FNN, MLP, Agriculture, Predictive Models

Chapter 67

EXPERIMENTATION ON CONCRETE BY USING PERLITE AND VERMICULITE TO ANALYSE THERMAL PROPERTY

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Abstract

Temperature is the major threat in our society. Thermal insulation is done in various buildings in order to reduce the effect of temperature. Instead of doing insulation in buildings we use thermal insulating plaster. Thermal insulating plasters are an important means to face the energy efficiency issues in building field, above all in renovation process. In our work on thermal insulating plasters we use perlite and vermiculite as the thermal insulating material. Vermiculite is the mineral which is formed by weathering or by hydrothermal hydration of biotite or phlogopite. Perlite is an amorphous volcanic glass that has a relatively high water content, formed by hydration of obsidian. It is non renewable resource. Thermal tests, including thermal conductivity measurements and heat transfer rate analysis, were conducted on these samples. The results demonstrated that both perlite and vermiculite contribute to reducing the thermal conductivity of concrete, with vermiculite showing superior insulating properties. The specific heat capacity of the modified concrete samples also exhibited improvements, indicating better heat retention. This study suggests that perlite and vermiculite are promising materials for enhancing the thermal performance of concrete, making them viable for applications requiring energy-efficient and thermally-insulated structures. Furthermore, the use of these lightweight aggregates could contribute to the development of more sustainable and environmentally friendly building materials.

Chapter 68

ANALYSIS OF PNEUMATIC LIFT FOR ELDERLY AND PHYSICALLY CHALLENGED PASSENGERS

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Abstract

Transportation is an essential aspect of everyday life for people of all ages and abilities. However, for individuals with disabilities, access to transportation can be a significant challenge. People with disabilities have consistently reported that transportation barriers limit their ability to participate fully in society, making it difficult to attend appointments, school, or social events. Therefore, it is essential to focus on developing technology that promotes an optimum quality of life for the elderly and disabled population, including providing barrier-free environments and seamless transportation means.

This study aims to investigate the accessibility challenges faced by physically challenged and elderly individuals when accessing public transportation, particularly high-floor buses. The current research proposes the development of an easy lift staircase that can be integrated into buses to enable easy accessibility for those with mobility difficulties. The project's main objective is to design and develop a mechanism that will facilitate the transportation of individuals with disabilities by bus, promoting their integration into society while presenting technical challenges in the design process.

The scissor mechanism has been identified as the most suitable lifting mechanism to lift the platform vertically, providing a solution to the challenges encountered by individuals with disabilities when boarding or alighting from a bus. The design process will involve collecting necessary data, including ground clearance and chassis distance, using a measuring device. The

project will primarily focus on designing and developing lifting mechanisms for wheelchairs, including creating a CAD model and performing FEA to determine stresses and displacements.

This project has significant potential to improve the lives of individuals with disabilities by enhancing their access to public transportation and promoting social inclusion. By making public transportation more accessible, individuals with disabilities can participate more fully in their communities, leading to better health outcomes and a higher quality of life.

In addition to promoting social inclusion, improving accessibility for people with disabilities benefits society as a whole. By making public transportation more accessible, cities and communities can become more sustainable and environmentally friendly. Accessible transportation options can also reduce traffic congestion, air pollution, and other negative impacts associated with driving.

Moreover, designing and developing the proposed lifting mechanism would be a significant technical achievement. This project requires a multidisciplinary approach, involving experts from engineering, design, and disability studies. The scissor mechanism proposed in this project could serve as a model for future innovations in accessible transportation.

In conclusion, improving accessibility for individuals with disabilities is an important policy issue that requires attention. This project's aim to design and develop an easy lift staircase will provide a solution to the challenges encountered by individuals with disabilities when accessing public transportation. By promoting social inclusion, improving sustainability, and advancing technical innovation, this project has the potential to make a significant contribution to society.

Chapter 69

PERFORMANCE EVALUATION OF CRYOGENIC TREATED TOOLS IN BORING OPERATIONS

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ABSTRACT

The high-speed steel is used as a cutting tool, since it has good quality and reliability at cheaper rate when compared to other cutting tools. So it is very important to increase the ability of the tool further for its reliability. So the best way is to increase the hardness. One novel method namely dipping the ordinary tool bit in a cryogenic solution, which improves the wear properties of the cutting tool consequently machining time is also reduced. Cryogenic treatment of high speed steel is one of the developments in manufacturing field. It offers much better wear resistance and hardness for the high speed steel. The conventional cryogenic treatment process involves cooling down the samples to 93k (-180°C) soaking for 15-20 minutes and then slowly heating back to room temperature in 6 hrs. In this project we have explained our approach and methodology to arrive at an optimum solution having two sample pieces of round of EN8 & EN19. A method called deep cryogenic process, subjects steel components placed in a specially constructed tank to temperature around 77k (196°C) for half an hour using liquid nitrogen as the refrigerant.

Keywords: High speed steel, cryogenic Treatment, Turning, Hardness, Wear resistance.

Chapter 70

MECHANICAL BEHAVIOUR INVESTIGATION AND PROCESS PARAMETERS OPTIMIZATION OF PROCESSOR FAN COMPONENT BY USING 3D PRINTING

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ABSTRACT

This research conducts to be a comparative analysis and optimization of 3D printing technologies, specifically Fused Deposition Modeling (FDM) with the material PETG-CF. This summary begins with a summary of the history of Additive Manufacturing (AM) technologies and the current state of 3D printing polymers. Following that, we explore the latest advancements in polymer and filling material designs, the fundamental concepts behind additive manufacturing (AM) processes, and the growing uses of 3D printed polymers and composites. This work studies have to be analysed the influences of the process parameter of FDM process for the materials of PETG-CF. During the process PETG-CF filament with Rectilinear pattern along with various process parameter were executed for the manufacturing of various mechanical behaviours specimens. PETG-CF had the highest tensile strength (20.147 N/mm²), the highest hardness (47HRF), the ultimate flexural strength (0.090 N/mm²) and the maximum compressive strength was (0.057 N/mm²). Finally all the process parameters optimized through and ANOVA were found out the each output responses.

Keywords: FDM process, PETG-CF, HRF, Rectilinear pattern, Infill density.

CHAPTER 71

THE MECHANICAL BEHAVIOUR OF SISAL FIBER THROUGH HYBRID LAMINATE

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ABSTRACT:

This study investigates the fabrication and mechanical performance of composite materials reinforced with natural fibers and bound with epoxy resin, with the aim of developing sustainable alternatives to traditional synthetic materials commonly used in rope and fiberglass products. With increasing environmental concerns and the global shift toward biodegradable and eco-friendly materials, natural fiber composites offer a promising solution due to their renewable origin, low cost, and reduced environmental impact. To assess the viability of these composites, three distinct composite plates were prepared using different compositions of natural fibers and varying ratios of epoxy resin. The fiber types used in this study include sisal, coir, and bamboo cotton—all selected for their availability, biodegradability, and favorable mechanical properties. Plate 1 was fabricated using a composition of 35% sisal fiber and 65% epoxy resin. Sisal fiber is known for its high tensile strength and durability, making it a suitable candidate for structural applications. Plate 2 contained a 35% fiber blend consisting of 90g sisal and 15g coir, combined with 65% epoxy resin. The addition of coir, which is rich in lignin and offers good impact resistance, aimed to enhance the toughness of the composite. Plate 3 was composed of a 30% fiber blend made up of 45g sisal and 45g bamboo cotton, reinforced with 70% epoxy resin. The mechanical tests were designed to simulate real-world stressors experienced in applications such as marine ropes, construction reinforcement, and industrial fiberglass components. Results from these evaluations are expected to inform future material design strategies and support the development of cost-effective, environmentally friendly alternatives to synthetic composites. The comparative analysis of the three composite formulations will also help identify the optimal fiber combination and resin ratio for achieving the desired mechanical performance.

Keywords: Natural fibre composites, Epoxy resin, Sustainable materials, Sisal fibre.

CHAPTER 72

WEAR AND FRICTION CHARACTERISTICS OF AL6061/ZRB2 METALMATRIX COMPOSITES FABRICATED BY STIR CASTING PROCESS

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ABSTRACT

This research aims to investigate the tribological behavior of Al6061/nano- ZrB₂ metal matrix composites, which were produced using stir casting. The study emphasizes the potential of these composites in industries such as automotive and aerospace due to their improved mechanical and tribological properties. By adding 3 to 7.5wt.% of nano-ZrB₂ to Al6061, twelve composites were formed, exhibiting enhanced physical, mechanical, corrosion, and tribological characteristics. The electron microscopy analysis confirmed the uniform distribution of nano-ZrB₂, indicating successful manufacturing and optimized material properties. Additionally, the study explores the use of equal channel angular pressing (ECAP) to refine the grain structure of magnesium. Both experimental and numerical methods were employed for analysis. Furthermore, tribological analysis was conducted on AA7075 alloy composites with reinforcements of SiC, B₄C, and waste porcelain. Among these composites, the one with 7.5 wt.% B₄C demonstrated the highest mechanical strength, while the composite with 6 wt.% porcelain exhibited the lowest wear and friction. The composite with 7.5 wt.% porcelain displayed the lowest density and corrosion rate, making it suitable for specific applications. To aid in material selection, a novel AHP/CRITIC-COPRAS method was introduced, ranking the AA7075 composite with 7.5 wt.% porcelain as the most suitable for automotive use. Overall, this research provides valuable insights into material interactions and performance, offering solutions for industries to enhance component performance in the face of technological progress.

Keywords – Aluminium Metal Matrix Composite, Stir casting, Hardness, Wear resistance.

CHAPTER 73

IOT ENABLED SMART BRAKING SYSTEM WITH INTEGRATED ALCOHOL DETECTION AND OBSTACLE AVOIDANCE

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ABSTRACT

This paper outlines the design and benefits of a cutting-edge **Integrated Smart Braking System**, a comprehensive platform that combines **Anti-lock Braking System (ABS)**, **regenerative braking**, and advanced **safety technologies**. As automotive technologies continue to evolve, there is a growing demand for systems that not only improve vehicle control and passenger safety but also support environmental sustainability. This integrated system addresses these needs through its multifaceted approach to braking and safety management. The smart braking system seamlessly merges traditional ABS technology with regenerative braking and intelligent safety features. By doing so, it enhances vehicle stability, energy efficiency, and overall responsiveness during braking scenarios. The system operates in real-time, automatically adjusting the braking force and type depending on driving conditions, vehicle speed, and road traction. This intelligent integration ensures optimal braking performance across diverse environments. ABS technology plays a critical role in preventing wheel lock-up during sudden or emergency braking. By modulating brake pressure, ABS helps maintain traction between the tires and road surface, significantly reducing the risk of skidding. This feature is particularly vital on slippery or uneven roads, where maintaining control is often challenging. Incorporated into the system is a regenerative braking mechanism that captures kinetic energy typically lost as heat during braking. This energy is converted into electrical power and stored for future use, such as powering on board electronics or recharging hybrid and electric vehicle batteries. Not only does this reduce the load on the vehicle's mechanical braking components—thereby minimizing wear and maintenance—but it also supports sustainable and energy-efficient driving practices.

Keywords: Smart braking system, Anti-lock Braking System (ABS), Regenerative braking, Vehicle stability.

CHAPTER 74

IMPACT OF STACKING SEQUENCE ON THE MECHANICAL PROPERTIES OF COTTON-KENAF FIBER-REINFORCED POLYMER HYBRID COMPOSITES

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ABSTARCT

This abstract highlights the significance of plant fibers, particularly kenaf fibers, in various applications such as clothing, paper making, and reinforcement in thermoplastics. Kenaf fibers are praised for their superior strength and hydrophilic nature attributed to the presence of cellulose, hemicellulose, lignin, and pectin. The interfacial linkage between natural fibers and polymer resin is crucial for determining the mechanical and thermal performance of natural fiber composites. Challenges related to poor wettability of natural fibers with polymers due to inherent moisture content are discussed, along with potential solutions involving chemical techniques. The mechanical performance of biocomposites improves with the addition of fiber content up to a certain limit, beyond which it decreases. The Uttarakhand state in India, known for its diverse physiographic features, is highlighted as a fertile land for various fiber plants, including Himalayan kenaf. The extraction of fibers from Himalayan kenaf plants and their utilization in various applications contribute to the economic development of local communities. Additionally, the abstract briefly mentions information about cotton, providing context for the broader discussion on plant fibers. Overall, this abstract provides a comprehensive overview of the properties, applications, challenges, and regional significance of kenaf fibers in the context of Uttarakhand state in India, while also touching upon the topic of cotton.

Keywords: Natural fibre composites, Epoxy resin, Sustainable materials, Sisal fibre.

CHAPTER 75

DESIGN AND FABRICATION OF ECO FRIENDLY ELECTRIC SCOOTER FOR SUSTAINABLE TRAVEL

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ABSTRACT:

This project presents the design and fabrication of an eco-friendly electric scooter, engineered to support sustainable travel and contribute to environmentally responsible transportation systems. In the wake of rising fuel prices, increasing urban pollution, and the urgent global need for clean energy alternatives, the adoption of electric mobility solutions has become more important than ever. This project highlights the practicality and effectiveness of such solutions, particularly for short-distance commuting. The electric scooter is powered by a DC motor, selected for its reliability, efficiency, and low maintenance requirements. The motor draws energy from a rechargeable battery, specifically a Lithium Iron Phosphate (LiFePO₄) battery, known for its safety, long cycle life, and environmental friendliness. LiFePO₄ batteries are also more thermally stable and resistant to overheating compared to conventional lithium-ion batteries, making them a superior choice for sustainable applications. Beyond its environmental benefits, the scooter is also designed for economic efficiency. This makes it especially attractive for students, delivery personnel, and urban commuters seeking affordable and reliable mobility. In conclusion, this project represents a significant step toward green transportation by showcasing a practical, sustainable, and user-friendly electric vehicle. It underscores the potential of renewable energy and eco-conscious engineering in shaping the future of urban mobility. The successful implementation of this scooter highlights the viability of integrating clean technology into everyday life, promoting a cleaner and healthier planet for future generations.

Keywords: Electric scooter, Sustainable transportation, Eco-friendly mobility, DC motor, LiFePO₄.

CHAPTER 76

FABRICATION OF BATTERY COOLING SYSTEM IN ELECTRIC VEHICLE

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ABSTRACT

This study focuses on the design, development, and testing of an innovative battery cooling system that integrates a copper tube temperature sensor to improve the thermal management of lithium-ion batteries. With the increasing adoption of lithium-ion batteries in electric vehicles (EVs), renewable energy systems, and portable electronics, effective temperature regulation has become a critical factor in ensuring both safety and performance. Lithium-ion batteries are highly efficient but are also temperature-sensitive. Excessive heat generated during charging and discharging cycles can lead to thermal runaway, performance degradation, and even hazardous failures. To address these challenges, this project introduces a liquid-cooled system with embedded copper tubing and temperature sensing for real-time monitoring and thermal control. At the core of the system is a copper tube-based temperature sensor, strategically placed within the battery pack to obtain accurate internal temperature measurements. Copper is chosen for its excellent thermal conductivity, which allows for fast and precise detection of heat build-up within the battery cells. This approach ensures consistent battery performance and minimizes the thermal stress that often leads to reduced battery life. The system is designed to be compact, energy-efficient, and scalable for use in a range of applications, from compact energy storage units to large EV battery arrays. By maintaining battery temperatures within safe operational limits, the system not only enhances battery life and efficiency, but also significantly improves overall system safety. This study demonstrates a practical and robust solution to one of the most pressing issues in modern battery technology—thermal management. The successful implementation of this copper tube-based cooling system highlights the potential for integration into electric vehicles, hybrid systems, and stationary energy storage solutions, where maintaining battery health is essential for long-term functionality and reliability.

CHAPTER 77

DESIGN AND ANALYSIS OF TRAIN BOGIE

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ABSTRACT:

Railway bogies play a crucial role in ensuring the smooth and stable movement of trains by supporting the vehicle's weight and absorbing dynamic forces from the tracks. Traditionally, bogies have been manufactured as single-piece cast structures, which, while robust, come with significant drawbacks. Cast bogies are inherently heavy and bulky, leading to increased fuel consumption and higher wear on railway infrastructure. Additionally, their production involves complex foundry processes, resulting in high manufacturing costs. Maintenance and repairs are also challenging due to the monolithic nature of cast bogies, often requiring complete replacement rather than targeted fixes. To overcome these limitations, modern railway engineering is shifting toward fabricated bogies, which are constructed using welded and assembled components rather than a single cast piece. This approach offers several advantages, including reduced weight, lower production costs, and easier maintenance. Fabricated bogies allow for optimized material usage, eliminating unnecessary bulk while maintaining structural integrity. Furthermore, their modular design enables quick replacement of damaged parts, minimizing downtime and repair expenses. Fatigue resistance is another key factor, as bogies endure millions of stress cycles over their lifespan. Advanced engineering techniques, such as Finite Element Analysis (FEA), are employed to simulate stress distribution and identify potential weak points in the design. By optimizing material selection, weld configurations, and structural geometry, fabricated bogies can achieve superior performance compared to their cast counterparts.

Keywords: Fabricated Bogie, Bogie Design, Structural Analysis, Finite Element Analysis (FEA).

CHAPTER 78

MODELING AND ANALYSIS OF DESIGN AND ANALYSIS OF DISC BRAKE

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ABSTRACT:

Braking systems represent one of the most critical safety components in any vehicle, with disc brakes being particularly crucial for two-wheelers due to their superior stopping power and heat dissipation characteristics. This study focuses on conducting a comprehensive thermal analysis of a standard two-wheeler disc brake system using ANSYS Steady-State Thermal simulation to evaluate temperature distribution patterns and assess the performance of alternative materials. The research methodology involves creating a detailed 3D model of the disc brake assembly, assigning appropriate material properties, and applying realistic boundary conditions to simulate heat generation from friction and subsequent cooling through convection. Simulation results reveal critical thermal characteristics including peak temperature zones near brake pad contact areas, heat dissipation patterns across the rotor surface, and comparative performance metrics between conventional and advanced materials. The findings emphasize the significant impact of material selection and disc geometry on braking efficiency, particularly in preventing dangerous phenomena such as brake fade and thermal deformation that can compromise stopping power. Furthermore, the study identifies potential thermal stress hotspots that could lead to structural failure over extended usage periods. These insights contribute valuable data for optimizing disc brake designs to enhance reliability and safety in real-world operating conditions. The research also suggests promising directions for future investigations, including the evaluation of novel composite materials with superior thermal properties, innovative disc geometries for improved cooling efficiency, and more sophisticated transient thermal analyses to better understand dynamic temperature variations during braking cycles.

Keywords: Disc brake system, Thermal analysis, ANSYS simulation, Steady-state thermal, Brake fade

CHAPTER 79

SMART VEHICLE MONITORING ROBOT FOR INDUSTRY

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ABSTRACT:

AutoTrack is an intelligent robotic monitoring system designed to enhance safety and efficiency in industrial vehicle operations through autonomous tracking, real-time analytics, and predictive maintenance. Combining advanced sensors (LiDAR, ultrasonic, thermal imaging) with wireless connectivity (5G/Wi-Fi 6) and AI processing, it continuously monitors forklifts, AGVs, and transport vehicles to prevent collisions, detect unauthorized use, and optimize operational workflows. The system's machine learning algorithms analyze vehicle health data to predict mechanical failures, while its anti-theft features using RFID and facial recognition ensure only authorized personnel operate equipment. By providing real-time alerts, enforcing safety protocols, and maintaining automated compliance logs, AutoTrack significantly reduces workplace accidents, equipment downtime, and operational costs. Its adaptable mobility (omni-directional/tracked) allows deployment in diverse industrial environments including warehouses, construction sites, and mining operations. Future developments aim to incorporate swarm robotics coordination and blockchain-secured access logs, positioning AutoTrack as a comprehensive Industry 4.0 solution for smart vehicle management that bridges the gap between physical operations and digital automation.

Keywords: Autonomous vehicle monitoring, Industrial robotics, AI-powered safety, Predictive maintenance, Collision avoidance, IoT tracking, Smart warehouse solutions, AGV.

CHAPTER 80

INCOMING QUALITY CONTROL & REGULIZATION OF INSPECTION REPORT IN GMES

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ABSTRACT:

Incoming Quality Control (IQC) serves as the first line of defense in manufacturing quality management, systematically verifying that all incoming raw materials, components, and semi-finished products meet specified quality standards before entering production processes. As global supply chains grow increasingly complex, IQC has evolved from simple visual inspections to a sophisticated quality gate incorporating advanced techniques such as statistical sampling plans, material composition analysis using XRF spectroscopy, dimensional verification with coordinate measuring machines (CMM), and functional testing with automated inspection systems. A well-designed IQC program typically includes four critical components: comprehensive supplier qualification processes, clearly defined acceptance criteria aligned with product requirements, standardized inspection methodologies, and data-driven corrective action systems. The implementation of digital IQC solutions leveraging IoT-enabled inspection devices and AI-powered visual inspection software has significantly enhanced detection capabilities while reducing human error. The integration of IQC data with enterprise quality management systems (QMS) enables predictive quality analytics, allowing companies to identify and address supply chain quality trends proactively. As lean manufacturing and just-in-time production models become predominant, the role of IQC continues to expand, with leading manufacturers now implementing risk-based intelligent sampling approaches that dynamically adjust inspection levels based on supplier performance data. When properly executed, IQC not only safeguards product quality but also strengthens supplier relationships through transparent quality feedback loops, ultimately contributing to higher customer satisfaction and brand reputation in competitive markets.

Keywords: Incoming Quality Control, Quality Assurance, Supply Chain Management, Statistical Process Control, Supplier Quality Management, Non-Destructive Testing.

CHAPTER 81

AUTOMATIC SEED SOWING MACHINE USING IOT

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ABSTRACT:

India's agricultural sector, which supports nearly 70% of the population, faces significant challenges due to land fragmentation, limited financial resources, and reliance on traditional farming methods. With the average landholding reduced to just two acres per farmer, small-scale cultivators struggle to afford modern machinery like tractors, forcing them to depend on animal-driven ploughs and manual labor. This not only leads to inefficiency but also fails to meet the energy demands required for competitive farming. To address these issues, we have developed a cost-effective, multi-functional agricultural machine designed specifically for small-scale farmers. This innovative equipment integrates three key farming operations—ploughing, sowing, and land leveling—into a single, easy-to-use system. By replacing human and animal effort with mechanized solutions, our design aims to enhance productivity while remaining affordable and accessible. Field tests have demonstrated a 40-50% reduction in labor time compared to traditional methods, along with improved seed placement accuracy and soil uniformity. Additionally, its low maintenance requirements and fuel efficiency make it economically viable for marginal farmers. Beyond immediate productivity gains, this technology has the potential to reduce physical strain on farmers, mitigate animal dependency, and bridge the mechanization gap between Indian agriculture and advanced farming nations. Future enhancements may include solar-powered operation and IoT-based monitoring for precision farming. By democratizing access to mechanized tools, this innovation seeks to empower small-scale farmers, boost agricultural output, and contribute to sustainable rural development.

Keywords: Small-scale farming, Agricultural mechanization, Multi-functional equipment, Low-cost farming tools.

CHAPTER 82

RAILWAY TRACK CRACK BREAK DETECTION SYSTEM USING GPS GSM

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ABSTRACT:

Ensuring the safety and operational efficiency of railway transportation is critically dependent on the early detection of track defects, such as cracks and structural breaks. Failures to identify and respond to these defects in a timely manner can result in severe accidents, including derailments, leading to loss of life, service disruptions, and costly repairs. To address this challenge, this paper proposes a cost-effective and real-time detection system designed to monitor railway track conditions continuously, leveraging Global Positioning System (GPS) and Global System for Mobile Communications (GSM) technologies. The system employs a network of sensors strategically installed along railway tracks to detect anomalies that indicate the presence of cracks or breaks. These sensors are configured to monitor changes in vibration, continuity, or mechanical structure that signify potential faults. Once a defect is detected, the system uses GPS to determine the precise location of the fault. This information is then immediately relayed to relevant railway authorities using GSM communication, along with an automated alert message. It provides continuous, automated surveillance of track conditions, ensuring that even minor defects are promptly identified and reported. Furthermore, the use of widely available and low-cost technologies such as GPS and GSM makes the system highly affordable and scalable, especially for developing regions where railway safety remains a concern. In conclusion, the proposed track monitoring system presents an innovative, efficient, and reliable solution to a long-standing challenge in the railway industry. By harnessing modern communication and positioning technologies, it significantly improves safety standards and sets a foundation for smart railway infrastructure in the era of digital transformation.

Keywords: Rack break detection, GPS-based monitoring, GSM communication, Real-time fault detection,Railway infrastructure.

CHAPTER 83

DESIGN AND FABRICATION METHODS USED IN 3D PRINTING

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ABSTRACT:

3D printing, also known as additive manufacturing, is a revolutionary production method that constructs physical objects directly from digital models. Unlike traditional subtractive manufacturing processes, which remove material from a solid block, 3D printing builds objects layer by layer, offering unprecedented design flexibility, reduced material waste, and the ability to produce complex geometries that would be otherwise difficult or impossible to manufacture. The design phase of 3D printing is critical and typically begins with the creation of a digital model using Computer-Aided Design (CAD) software. Alternatively, objects can be captured using 3D scanning techniques or generated algorithmically through generative design. These digital designs are then exported into machine-readable file formats such as STL (Stereolithography) or OBJ, which contain the geometric and spatial information necessary for the printer to interpret and fabricate the object. The fabrication process varies depending on the chosen printing technology and the materials involved. The most widely used additive manufacturing techniques include: Each method supports a variety of materials including thermoplastics, photopolymers, metal powders, and composites, allowing for tailored material selection based on application-specific requirements. The integration of advanced design and fabrication technologies in 3D printing enables rapid prototyping, mass customization, and on-demand production of parts. This has made additive manufacturing a vital tool across diverse sectors such as healthcare (e.g., prosthetics, dental implants), aerospace (e.g., lightweight structural components), automotive, and industrial manufacturing.

Keywords: Additive manufacturing, Computer-Aided Design (CAD), Digital modelling, STL files,OBJ files.

Chapter 84

REAL – TIME SEISMIC ALERT SYSTEM: AN EXPLORATORY STUDY

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Abstract

Seismic events pose serious risks to rural agricultural communities around the world. These occurrences have huge effects on regional economies and ecosystems, endangering lives and food security. Rural agricultural communities are vulnerable because of their isolated locations, scarcity of resources, and dependence on brittle infrastructure. By detecting seismic waves and promptly alerting farmers and rural communities, this method empowers them to take preventative action against these seismic events using Internet of Things (IoT) technologies. The system promotes sustainable agriculture practices in terms of HSE guidelines. The precise seismic detection and timely notification, enhanced HSE procedures for sustainable agricultural practices, lowered environmental footprint and ensured safe working conditions, farmer education on the operation of the system and emergency response measures, and assistance in seismic-prone areas for sustainable agricultural growth are some of the key features and benefits of the suggested real-time seismic alert system. The study offers accurate seismic detection and timely alerting, avoiding damage and preventing loss of lives. This solution supports food security, livelihood resilience, and sustainable agricultural development within remote agricultural regions vulnerable to seismic upheavals. A feasible substitute is offered by this study which addresses the deficits of current earthquake early warning systems for rural communities around the globe.

Keywords: EEWS, HSE Protocol, IoT, Rural Agricultural Communities

Chapter 85

PRODUCTION AND PERFORMANCE ANALYSIS OF STARCH BASED BIOPLASTICS FROM AGRO RESIDUES

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Abstract

This study explores starch-based bioplastics as a sustainable alternative to conventional plastics, driven by growing environmental concerns and resource depletion. Using renewable resources like corn, potato, and cassava starches, along with plasticizers like glycerol, the research optimizes fabrication processes for desired mechanical, thermal, and biodegradability properties. Performance evaluation reveals competitive mechanical properties and high biodegradability, with challenges in water resistance and thermal stability. Starch-based bioplastics show promise as an eco-friendly alternative to petrochemical plastics. Further development is needed to enhance performance and expand commercial viability in industries like packaging and agriculture. The study provides recommendations for material modification and processing techniques to address existing challenges. Overall, starch-based bioplastics offer a potential solution to plastic pollution, leveraging renewable resources and biodegradability. Continued research and development can help overcome current limitations, paving the way for wider industrial applications and a more sustainable future.

keywords: Bio-degradable, Gelatine, Glycerol, Starch, Vinegar

Chapter 86

AN IOT BASED SEED DISPENSING MACHINE

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Abstract

The IoT-Based Seed Dispensing Machine with Voice Assistance is an advanced robotic system that automates key agricultural tasks such as sowing, ploughing, spraying, and navigation. Powered by an Arduino Uno, it integrates IoT technology for remote monitoring, enabling real-time data collection and operational control. A servo motor ensures precise seed distribution, while two L293D motor drivers control plowing, spraying, and navigation in multiple directions. The system's LCD module provides real-time status updates, enhancing efficiency. By monitoring soil conditions, seed placement, and resource usage, the system supports data-driven farming decisions, optimizing water, energy, and fertilizers. Designed for both small and large-scale farms, it enhances productivity, reduces labour dependency, and promotes sustainable farming practices. Its scalable and adaptable nature makes it a cost-effective alternative to traditional methods, ensuring efficient and reliable agricultural operations while minimizing resource wastage.

Keywords: Arduino UNO, Battery, DC Motor, IOT, Mobile App, Servo Motor, Voice assistance.

Chapter 87

PREPARATION OF CUCUMBER JELLY USING NATURAL COLORANTS

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Abstract

The increased need for healthy, wholesome food substitutes has pushed the research into new products like nutrient-dense jellies. In this research, the production of cucumber jelly with added essential nutrients and fortified with natural food colourings is examined as a functional food item. The base material was cucumbers, which are highly water-containing, vitamin, and mineral foods. The jelly was manufactured by using cucumber juice extracted from cucumber, mixed with gelling agents and sweeteners, and supplemented with natural colouring substances from plant source *Clitoria ternatea*. The goal was to create a visually appealing and nutritionally enhanced product that will appeal to people who desire to switch from traditional jellies to healthy options. Colour, taste, texture, and nutritional value were among the sensory attributes of the formulation that were evaluated. Sensory analysis proved to be favourable consumer acceptance, with the natural colorants contributing a pleasing appearance and the cucumber base contributing a refreshing flavour. Nutrient content analysis proved the existence of essential vitamins and minerals, and the cucumber jelly is thus a functional food with added health value. This research proves the possibility of developing a nutrient-rich, visually attractive jelly with natural food dyes, providing a healthier alternative in the snack and dessert industry.

Keywords: *Clitoris ternate*, feasibility, nutrient – dense.

Chapter 88

IOT BASED REAL- TIME FRUIT QUALITY MONITORING AND GRADING SYSTEM

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Absrtact

The growing demand for high-quality fruits has created a need for efficient grading and monitoring systems. This project introduces an IoT-based real-time fruit quality monitoring and grading system that uses sensors, cameras, and machine learning to assess characteristics like size, color, texture, and ripeness. The system automatically classifies fruits into quality grades based on predefined standards, reducing human error and increasing efficiency. Environmental sensors track temperature, humidity, and light to ensure optimal storage conditions. Real-time data is sent to a cloud platform for continuous analysis, and the system integrates with an Arduino microcontroller and Bluetooth for mobile or web-based monitoring. This automation benefits farmers, distributors, and retailers by improving sorting, packaging, and overall supply chain efficiency. It also helps maintain consistent quality, reduce labor costs, minimize waste, and enhance consumer satisfaction. The integration of IoT and machine learning in agriculture offers a sustainable, scalable solution for both small and large producers, revolutionizing post-harvest handling and addressing the global demand for fresh, high-quality produce.

Keywords: IoT, grading system, sensors, microcontroller, cloud platform, automation, real-time feedback,

Chapter 89

STUDY OF FERMENTATION OF BERMUDA GRASS JUICE FOR THE PREPARATION OF WINE

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Abstract

This study explores the fermentation of Bermuda grass (*Cynodon dactylon*) juice for wine production, highlighting its biochemical composition and potential applications. The process involved purifying the wine to remove unwanted residues, ensuring a refined product. Biochemical analysis revealed the presence of proteins, lipids, and carbohydrates, contributing to its nutritional value. The Bradford method determined a total protein content of 0.265 mg/g, while the vanillin method measured lipid content at 5.532 mg/g. The anthrone method identified carbohydrates at 6.118 mg/g, indicating residual sugar, which affects the wine's sweetness. These macromolecules influence taste, stability, and texture, making the product unique. The research successfully yielded 2 liters of fermented wine, demonstrating the feasibility of utilizing Bermuda grass juice as a substrate for fermentation. Its antioxidant and detoxifying properties suggest possible health benefits. Further optimization of fermentation conditions can enhance taste, alcohol content, and commercial viability. Future studies should focus on improving microbial strains, sensory evaluation, and storage stability. This research supports the use of unconventional plant-based materials for wine production, expanding opportunities in functional beverages and sustainable fermentation practices.

Keywords: Bermuda grass, fermentation, wine production, biochemical analysis, functional beverages.

Chapter 90

DUAL POWERED FOOD DEHYDRATER WITH UV DISINFECTION

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Abstract

This project presents the design and development of a dual-powered food dehydrator that utilizes both solar energy and conventional AC power, integrated with UV disinfection to ensure safe and hygienic food preservation. The primary objective is to create an energy-efficient and sustainable system suitable for rural and urban settings alike. The dehydrator operates on solar power during the day, reducing dependency on the electrical grid and lowering energy costs. In the absence of sunlight or during unfavorable weather conditions, it seamlessly switches to AC power to maintain continuous operation. A UV-C disinfection unit is incorporated to eliminate microbial contaminants from the food surface before and during the drying process, thereby extending shelf life and enhancing food safety. This hybrid solution combines renewable energy usage with modern sterilization techniques, making it an ideal tool for small-scale farmers, households, and food processing units aiming to reduce food spoilage and promote hygienic food storage.

Keywords: Food Dehydrator, Dual Power Supply, Solar Energy, AC Power, UV Disinfection.

Chapter 91

SMART IOT-ENABLED GREENHOUSE AUTOMATION SYSTEM

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Abstract

The increasing demand for sustainable agriculture has driven the need for innovative solutions such as automated greenhouse systems. This paper presents the design and implementation of a Smart IoT-Enabled Greenhouse Automation System aimed at optimizing plant growth conditions through real-time monitoring and control. The system employs a network of sensors to collect critical environmental data, including temperature, humidity, soil moisture, and light intensity. Using IoT technology, this data is transmitted to a cloud-based platform where intelligent algorithms analyze it and automate the activation of actuators such as irrigation systems, ventilation fans, and lighting. The proposed system ensures efficient resource utilization, reduces human intervention, and improves crop yield quality. A user-friendly mobile application is also integrated, allowing remote monitoring and manual control. This work highlights the effectiveness of IoT in modern agricultural practices and proposes a scalable solution for smart farming.

Keywords: IoT, Smart Greenhouse, Automation System, Environmental Monitoring, Precision Agriculture, Sensor Networks.

Chapter 92

AUTOMATION IN WEED CONTROL: ADVANCING CARROT CROP PERFORMANCE

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Abstract

Automation in weed control has revolutionized carrot crop management, enhancing performance and reducing environmental impact. This study explores the application of automated weed control technologies, including machine learning-based detection systems, precision herbicide application, and mechanical weed removal. Our results demonstrate significant improvements in crop yield, reduced weed competition, and minimized herbicide usage. The automated system accurately identifies and targets weeds, allowing for precise control measures. This approach not only boosts carrot crop productivity but also promotes sustainable agricultural practices. Our research highlights the potential of automation in weed control to transform carrot production, reducing labor costs and environmental footprint while increasing efficiency and profitability. This technology has far-reaching implications for the agricultural industry, offering a promising solution for sustainable crop management and food security. By advancing automation in weed control, we can improve crop performance, reduce chemical usage, and promote eco-friendly farming practices.

keywords: Battery, Battery charger, Handle, Rod, Weeder.

Chapter 93

DEVELOPMENT OF AN AI BASED SYSTEM FOR EARLY DETECTION OF PLANT DISEASE FOR TOMATO

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Abstract

Tomato is one of the most widely cultivated and consumed vegetables globally, but its productivity is often threatened by various plant diseases. Early detection and diagnosis of these diseases are essential to minimize crop loss and ensure high-quality yield. This project presents the development of an AI-based system that leverages deep learning techniques to detect common tomato plant diseases at an early stage. The system uses Convolutional Neural Networks (CNNs) to analyze images of tomato leaves and classify them into healthy or diseased categories, including conditions such as early blight, late blight, and leaf mold. A large dataset of labeled tomato leaf images was used to train and validate the model, resulting in high accuracy and reliable performance. The user-friendly system can be deployed on mobile or web platforms, allowing farmers and agricultural professionals to capture leaf images and receive instant feedback on disease presence. This approach not only reduces dependency on manual inspection but also provides a cost-effective, scalable, and time-efficient solution for precision agriculture. The integration of AI in plant disease management represents a significant step toward sustainable farming practices and improved food security.

Keywords: Artificial Intelligence, Tomato Plant, Plant Disease Detection, Deep Learning, Convolutional Neural Networks.

Chapter 94

A STUDY AND FABRICATION AN AUTOMATE CASHEW APPLE AND NUT SEPARATORED

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Abstract

The traditional process of extracting cashew apple from cashew seed is time-consuming, despite the fact that cashews are a valuable fruit with a lot of potential. To assist farmers with this work, a cashew seed sorting machine has been designed and built. These days, cashew apples can be thrown away as trash or used as fertiliser for cashew farms. The goal of the project is to reduce the amount of time and effort needed for the traditional method. The machine can quickly process several basic components to produce usable final goods. The movable plate oscillates and is connected to a rack and pinion mechanism. During this process, a knife edge separates the cashew apple from the cashew nut. The cashew nuts are collected at the bottom of the movable plate, while the cashew apples are collected on the top surface of the stationary plate. This machine reduces processing time and labour costs while ensuring that the cashew fruit is not destroyed. You may feed split cashew apples to anima. This method guarantees that the cashew fruit is not harmed while drastically cutting down on the amount of time and work needed for the procedure. After being separated, the cashew apples are used for other purposes, guaranteeing optimum effectiveness and less waste.

Keywords: Cashew Apple, Cashew Nuts, Cashew And Nut Separator.

Chapter 95

ECO FRIENDLY BIO-PLASTIC IN PACKAGE TECHNOLOGY

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Abstract

Bio-plastics are made from renewal resources, such as sugarcane bagasse, corn starch, and food scraps. Bio-plastics, made from cellulose and starch, are already used in straws, silverware bowls, and packaging because they can either fully or partially decompose. However, they are not as functional or affordable as conventional plastics. The goal of the current study was to turn food waste into bio-plastic. Because it is easy to use and has a high cellulose content, orange peel is used. Simple methods were employed in the laboratory to turn orange peel into bio-plastic fibre. The peels are first dried and ground into a powder using a grinder.

Keywords: Glycerin, gelatin, orange peel powder

Chapter 96

DESIGN AND FABRICATION OF GRAIN COLLECTOR

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Abstract

The Grain Collector is a manually operated mechanical device designed to efficiently gather and store seeds during the harvesting process. The system integrates a seed collection mechanism, a flipping mechanism for directing seeds into storage bags, and a base structure mounted on wheels for mobility. The primary objective is to enhance the efficiency of seed collection while minimizing manual effort and seed wastage. The seed collection mechanism consists of a pull-type assembly that gathers grains from the ground or threshing area. This collected grain is then directed towards a flipping mechanism, which efficiently transfers the seeds into designated storage bags. The system is mounted on a sturdy wheeled base, allowing easy movement across agricultural fields. As the device is manually operated, it requires no external power source, making it an economical and sustainable solution for small-scale and rural farmers. The design and fabrication process focus on durability, ease of use, and cost-effectiveness. Materials used in construction include lightweight metal alloys and durable polymers to ensure robustness and longevity. The mechanical design minimizes energy loss while maximizing collection efficiency. Field testing has demonstrated the system's ability to reduce seed loss, improve collection speed, and offer ease of operation. This grain collector provides a practical, low-cost alternative to motorized grain collection systems, making it an ideal solution for farmers with limited access to mechanized equipment. Future improvements may include modular attachments, ergonomic design enhancements, and automated features for improved efficiency. Overall, this manually operated grain collection system enhances the post-harvest process, reduces labor intensity, and contributes to sustainable agricultural practices.

Chapter 97

FABRICATION OF WEEDING EQUIPMENS USING IOT SENSOR AND CAMERA IN A SMALL BOAT

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Abstract

The fabrication of IoT-based weeding equipment involves the design and development of a small boat equipped with sensors and a camera for efficient weed removal in paddy fields. This innovative device integrates a DC motor for propulsion, powered by a rechargeable battery, ensuring smooth navigation across the waterlogged field. A camera system provides real-time video feed for remote monitoring and precise control of the equipment. Ultrasonic sensors are incorporated to detect obstacles and maintain accurate positioning while navigating through the field. IoT connectivity enables remote operation and data transmission, allowing farmers to monitor and control the weeder from a mobile application or computer. The system also ensures automated or semi-automated weeding operations, reducing manual labor and improving efficiency. The compact size and lightweight design of the boat minimize damage to crops during operation.

Keywords: Paddy field, DC motor, rechargeable battery, Remote Monitoring, obstacle detection.

Chapter 98

SMART IRRIGATION USING IOT

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Abstract

Agriculture is facing increasing pressure to become more efficient, sustainable, and resilient in response to challenges such as climate change, water scarcity, and pest outbreaks. This project presents a Smart Irrigation System using IoT integrated with Pest Repellents, aimed at optimizing water usage while safeguarding crops from pests in an eco-friendly manner. The system utilizes a network of IoT-based sensors, including soil moisture sensors, temperature and humidity sensors, and rain detectors to continuously monitor environmental conditions. Based on real-time data analysis, the system autonomously controls water flow through solenoid valves, ensuring crops receive the right amount of water at the right time. This not only reduces water wastage but also prevents issues like overwatering and under-irrigation. A microcontroller unit (such as Arduino or Raspberry Pi) acts as the system's brain, processing sensor data and triggering irrigation and pest control

Keywords: IoT, pest control, irrigation, Sensor, monitoring

Chapter 99

FABRICATION AND TRIBOLOGICAL PROPERTIES OF E-GLASS FIBER / EPOXY POLYMER MATRIX COMPOSITE

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Abstract

Recently leaf spring manufacturing industries are focusing on composite materials, because of its excellent strength to light weight ratio, durability and high fatigue capability. Generally leaf spring is made from high carbon steel with carbon content varying from 0.9% to 1%. The present experimental work is to fabricate a E-Glass fibre / epoxy polymer matrix composite by hand layup route, fabricated mats were heated by oven under two different temperatures like 400°C and 600°C. The tribological properties of E-Glass fibre / epoxy polymer matrix composites were tested by dry sliding wear tester machine with hardened steel counter face. The different sliding speed was applied [200rpm, 400rpm and 600rpm respectively] with constant load 50N at room temperature. Finally wear rate and COF values were evaluated 0-180sec time period.

Keywords: E Glass, orientation, fiber, epoxy, resin

Chapter 100

INFLUENCE OF ULTRAFINE STEATITE POWDER, SUPERPLASTICIZER, AND VISCOSITY MODIFYING AGENT ON THE RHEOLOGICAL AND MECHANICAL PROPERTIES OF SELF-COMPACTING CEMENT PASTE AND MORTAR

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Abstract

In recent decades, construction materials have advanced significantly, leading to innovative concretes like self-compacting, geopolymer, and self-healing types. These rely on both traditional ingredients and specialized mineral and chemical admixtures. Before applying them in concrete, it's crucial to assess their effects on cement paste and mortar. This study explored the use of ultrafine natural steatite powder as a partial cement replacement at 0%, 5%, 10%, 15%, 20%, and 25% levels. Chemical admixtures included a polycarboxylic ether-based superplasticizer (1.5%) and Glenium Stream 2, a viscosity-modifying agent (0.5%). Tests such as standard consistency, initial setting time, and miniature slump cone were conducted, alongside empirical yield stress calculations. Compressive strength tests were performed on hardened mortar. Results showed that while water demand rose and workability declined with increasing steatite content, compressive strength improved up to a point. Chemical admixtures effectively enhanced workability and overall performance despite the added steatite.

Keywords: Steatite powder, Viscosity Modifying Agent, superplasticizer

Chapter 101

PERFORMANCE EVALUATION OF RECENT DEVELOPMENT IN BIOFILTER REDUCING PARTICULATE MATTER

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Abstract

Air pollution is a central problem faced by industries during the production process. The control of this pollution is essential for the environment and living organisms as it creates harmful effects. Higher levels of air contaminants endanger the health and welfare of millions of people and cause a host of health issues and environmental deterioration. India is one of the nation's most impacted by this disaster; it is home to up to 22 of the 30 most polluted cities in the world. Air pollution has widespread effects on ecosystems, human health, economic output, and social welfare. Achieving sustainable development goals and protecting public health depend on addressing this issue. A modern method of managing air pollution is biofiltration, which involves eliminating odors, volatile organic compounds (VOCs), and other contaminants from the atmosphere. This method has gained prominence worldwide recently due to its ease of use, low cost, high reduction efficiency, minimal energy requirements, and long-lasting effects that do not require further treatment. Sustainable machinery must be considered to reduce pollutants entering air and water sources. Biofiltration strategies have been employed to achieve these reductions in various types of pollutants. Pollutants are adsorbed on the surface of the medium and broken down by immobilized bacteria to produce safe results. In recent years, biofiltration-based systems have shown promise in eliminating hazardous contaminants from wastewater or contaminated air by harnessing the potential of microbiological techniques to reduce a broad range of compounds and VOCs.

Keywords: Biofiltration techniques, Pollutants removal, VOC, Residence time, Sustainable environment

Chapter 102

FLY ASH AS A RESOURCE FOR SOIL REMEDIATION AND ENVIRONMENTAL SUSTAINABILITY

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Abstract

Fly ash, being a byproduct of burning coal at high temperatures, has been viewed historically as a nuisance waste globally. However, its useful applications are now being investigated to conserve waste, avoid disposal expense, and generate value-added materials. The traditional method of disposal through landfills contributes to the spoilage of fertile land and groundwater pollution. Notwithstanding this, fly ash has been recognized as an effective soil ameliorant capable of enhancing the physical, chemical, and biological characteristics of poor soils, making available important nutrients to plants. When fly ash is blended with organic manure and microbial inoculants, it has the potential to increase plant biomass yields. The implementation of these findings in landfill disposal strategies remains problematic. The key problem is the diversity in the coal ash composition from various power plants, making comparison across researches difficult. The other challenge is that there is limited research on plant growth in soil-covered fly ash because most of the research is concerned with mixtures of soil and fly ash. Furthermore, soil characteristics are very different, and there is no easy comparison between soils. Fly ash was incorporated in calcareous and acid soils up to 8% of their weight in a greenhouse experiment. Plant growth was enhanced by the treatment, with rising pH, calcium, magnesium, and sulfate content. Certain elements, such as phosphorus and iron, were found to be less available to plants. Long-term consequences on plant chemical composition were also encountered.

Keywords: Fly ash, Plant biomass, Plant chemical composition, Biological characteristics of poor soils

Chapter 103

EFFECT OF COLD PLASMA TREATMENT ON THE ESSENTIAL PROPERTIES OF ANALOG RICE

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Abstract

Cold plasma treatment has emerged as a promising non-thermal method for enhancing the physicochemical and nutritional qualities of food products. This study investigates the effects of cold plasma treatment on analog rice, which is commonly used as a rice substitute for various food applications. The treatment was applied to improve the texture, cooking properties, and nutritional value of analog rice made from alternative grains. The results indicate that cold plasma treatment significantly influences the water absorption capacity, texture, and cooking time of the analog rice. Additionally, cold plasma enhanced the bioavailability of essential nutrients, such as antioxidants and vitamins, through surface modifications and structural changes. These findings suggest that cold plasma can be an effective, environmentally friendly method for improving the quality of analog rice and other plant-based food alternatives.

Keywords: Cold plasma, analog rice, physicochemical properties, nutritional enhancement, food processing

Chapter 104

MICROWAVE-ASSISTED TREATMENT IN PLANT-BASED FOODS

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Abstract

Microwave-assisted treatment (MAT) has emerged as an innovative and efficient technique in the food processing industry, particularly in plant-based foods. This method utilizes microwave energy to generate rapid, uniform heating, enhancing food quality while reducing processing time and energy consumption. The application of MAT in plant-based foods, including fruits, vegetables, grains, and plant-based proteins, offers several advantages such as improved nutrient retention, enhanced flavor, and better texture. Additionally, MAT can be employed in various processes such as blanching, drying, pasteurization, and sterilization, contributing to the development of healthier and more sustainable food products. This review explores the principles of microwave heating, its impact on the nutritional and sensory qualities of plant-based foods, and the challenges and opportunities associated with its implementation. Recent advancements and future trends in the application of MAT to improve food safety, quality, and sustainability are also discussed.

Keywords: Microwave-assisted treatment, plant-based foods, food processing, nutrient retention, food quality.

Chapter 105

MICROWAVE-ASSISTED EXTRACTION OF COLORANTS FROM PLANT SOURCES

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Abstract

Microwave-assisted extraction (MAE) has become a prominent technique for extracting bioactive compounds, including natural colorants, from plant sources. The application of microwave energy in the extraction process significantly enhances the efficiency, speed, and yield of colorants compared to traditional methods. This approach uses electromagnetic waves to heat solvents and plant matrices, facilitating the release of anthocyanins, carotenoids, betalains, and other plant pigments. MAE offers several advantages, such as reduced solvent usage, lower energy consumption, and improved extraction kinetics, making it an environmentally friendly and cost-effective alternative. This review examines the principles of microwave-assisted extraction, the factors influencing extraction efficiency (e.g., microwave power, solvent type, and extraction time), and the optimization of process parameters. Additionally, the potential applications of plant-based colorants extracted using MAE in the food, cosmetics, and textile industries are discussed, highlighting the increasing demand for natural alternatives to synthetic dyes. Challenges, including scale-up processes and the preservation of colorant stability, are also addressed, offering insights into future directions for the industrial adoption of MAE for colorant extraction.

Keywords: Microwave-assisted extraction, plant colorants, natural dyes extraction efficiency, sustainable processing, and natural alternatives.

Chapter 106

DRYING AND GERMINATION RATE OF MAIZE AND RYE FOR MALTING AND BREWING

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Abstract

The malting and brewing industries rely heavily on the controlled drying and germination processes of cereals such as maize and rye to optimize enzyme activity and extractable fermentable sugars. Drying and germination rates are critical factors that influence the quality of the final malt and, ultimately, the brewing process. This study investigates the impact of different drying methods on the germination rates of maize and rye, focusing on their suitability for malting and brewing applications. Various drying techniques, including hot air drying, microwave-assisted drying, and freeze drying, were evaluated for their effects on moisture content, germination capacity, and enzymatic activity. Additionally, the optimal germination conditions (temperature, humidity, and time) were determined to maximize the yield and quality of malted maize and rye. Results indicate that drying methods that preserve the integrity of the seed and minimize thermal damage led to higher germination rates, while excessive or uneven drying conditions result in reduced enzyme activity, adversely affecting the malting process. The study highlights the importance of fine-tuning drying and germination parameters for different cereal types to achieve optimal quality malt for brewing, with a focus on sustainable practices in the production of maize and rye malt.

Keywords: Drying methods, germination rate, brewing, enzyme activity, fermentation, cereal processing, and malt quality.

Chapter 107

EFFECT OF DIFFERENT AUTOMATED DRYERS ON MILLET PROCESSING

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Abstract

Automated drying technologies play a crucial role in the processing of millet, a staple cereal widely consumed for its nutritional value and versatility. The drying process significantly impacts millet's quality, texture, nutritional retention, and shelf life. This study explores the effects of various automated drying methods, including hot air drying, fluidized bed drying, and microwave-assisted drying, on the processing characteristics of millet. Key factors such as drying time, energy consumption, moisture reduction, and the preservation of essential nutrients (e.g., proteins, vitamins, and minerals) are analyzed to determine the most efficient drying method for millet. Results indicate that different automated drying systems exhibit distinct advantages in terms of drying speed, energy efficiency, and nutrient retention, with microwave-assisted drying showing the potential for higher nutrient preservation while reducing drying time. The study also evaluates the impact of each drying method on millet's texture, flavor, and overall product quality, providing insights into their suitability for large-scale commercial processing. This research contributes to the development of optimized drying techniques for millet processing, enhancing both the quality and sustainability of millet-based food products.

Keywords: Automated drying, nutritional retention, product quality, cereal processing, and sustainable food production.

Chapter 108

NATURAL LEAVENING AGENTS FROM UNDERUTILIZED SEEDS

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Abstract

Natural leavening agents, traditionally derived from yeast and sourdough cultures, play a critical role in bread making and the fermentation of various food products. However, there is growing interest in exploring alternative, underutilized seed sources for their potential as natural leavening agents. This study investigates the viability of seeds from underutilized plants such as millet, sorghum, amaranth, and quinoa as natural leavening agents in bread and other fermented food applications. These seeds are rich in beneficial microorganisms, enzymes, and bioactive compounds that can promote fermentation and improve the texture and nutritional profile of the final product. The research examines the microbial diversity, fermentative potential, and leavening efficiency of seed-based cultures, comparing them with traditional methods in terms of rising capacity, fermentation time, and sensory characteristics. Additionally, the nutritional benefits of utilizing these underutilized seeds, including improved protein content, fiber, and essential micronutrients, are highlighted. This study offers insights into the sustainability and health benefits of incorporating underutilized seeds as natural leavening agents, contributing to both food innovation and the reduction of food waste by tapping into less commonly used plant resources.

Keywords: Natural leavening agents, underutilized seeds, fermentation, bread production, alternative leavening, and microbial diversity.

Chapter 109

AI-BASED OPTIMIZATION FOR SEED PROCESSING AND EXTRACTION OF BIOACTIVE COMPOUNDS

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Abstract

The extraction of bioactive compounds from seeds is a critical process in various industries, including food, pharmaceuticals, and cosmetics. Traditional extraction methods can be energy-intensive, time-consuming, and inefficient, often leading to suboptimal yields and environmental impacts. The integration of artificial intelligence (AI) into seed processing and bioactive compound extraction has the potential to revolutionize these processes, improving efficiency, sustainability, and product quality. This study explores AI-based optimization techniques, including machine learning algorithms, neural networks, and predictive modeling, to enhance key stages of seed processing and extraction. The focus is on optimizing parameters such as temperature, pressure, solvent type, extraction time, and seed pre-treatment to maximize the yield and purity of bioactive compounds such as antioxidants, fatty acids, and phytochemicals. AI tools can predict the optimal conditions, reduce trial-and-error experimentation, and automate process control in real-time. The paper also discusses the potential for AI to assist in scaling up seed processing operations while ensuring product consistency and quality. Ultimately, this approach paves the way for more sustainable and efficient bioactive compound extraction from seeds, contributing to the growing demand for natural ingredients in various sectors.

Keywords: AI optimization, seed processing, bioactive compound extraction, machine learning, sustainability, and predictive modelling

Chapter 110

PREDICTIVE MODELS FOR DETERMINING DRYING AND COOKING RATES OF VARIOUS RICE VARIETIES

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Abstract

The drying and cooking processes are critical factors influencing the quality, texture, and nutritional value of rice. However, these processes can vary significantly between different rice varieties due to inherent differences in grain structure, moisture content, and composition. Predictive models based on machine learning and statistical techniques offer a promising approach to understanding and optimizing drying and cooking rates across a range of rice types. This study develops and evaluates predictive models to estimate the drying kinetics and cooking times of various rice varieties, including long-grain, short-grain, and aromatic types. Using experimental data on moisture content, temperature, relative humidity, and cooking conditions, the models predict the optimal drying parameters and cooking times required to achieve desired quality characteristics such as texture, aroma, and nutritional retention. By employing machine learning algorithms such as regression analysis, artificial neural networks (ANN), and support vector machines (SVM), the models can account for the complex relationships between rice variety, processing conditions, and final product quality. The study highlights the potential for these predictive models to support better process control, reduce energy consumption, and improve the consistency of rice processing.

Keywords: Predictive models, drying rate, cooking rate, energy efficiency, and process optimization.

Chapter 111

INVESTIGATION ON EFFECT OF SOLAR ELECTRIC BIKES

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Abstract

Global warming and increasing fuel prices in India, taking these two problems in consideration, it is the step towards reducing the use of more fuel consuming vehicles and attract the eye of people towards its alternatives i.e. Solar bike. The main aim of this project is to present the idea of harnessing the various energy and use it in today's existence of human life. Now-a-days there are so many vehicles on road, which consumes more fuel and also hazards our environment. A method of upgrades a conventional electric powered bicycle over to Solar-Powered Electrical Bike that is powered by an electric motor which gets its supply from photovoltaic (PV) panels.

Chapter 112

DESIGN AND DEVELOPMENT OF AUTOMATIC PET FEEDER

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Abstract

With the growing demand for smart pet care solutions, automated pet feeders have gained popularity. This paper presents a robotic pet feeder that utilizes servo motors, RFID recognition, and sensor-based automation to efficiently dispense food. The system incorporates a microcontroller (Arduino/Raspberry Pi) to control food portions based on pet identification using RFID tags. Additionally, a rotating bowl mechanism and load cell sensors ensure accurate feeding. The system enhances convenience for pet owners while ensuring a regulated diet for pets.

Keywords: Automated Pet Feeder, Robotics, IoT, RFID, Smart Pet Care

Chapter 113

DESIGN AND FABRICATION OF HEAVY LIFTING SYSTEM USING CHAIN BLOCK

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Abstract:

The design and fabrication of a heavy lifting system using a chain block is an essential development that addresses the need for efficient, safe, and reliable lifting solutions in industries that require handling heavy loads. Chain blocks, often referred to as manual hoists, are mechanical devices designed to lift or lower objects by utilizing a chain-driven mechanism, requiring minimal human effort while maximizing lifting capacity. This type of system is particularly beneficial in environments where powered lifting equipment may be impractical due to space constraints, cost limitations, or specific operational requirements. A chain block operates through a system of gears and chains, where the user pulls on the chain, which is then wound around a gear mechanism to lift or lower the load. The key components of the system include a high-strength steel chain, a sturdy lifting hook, and a precisely engineered gear system. These components work together to provide high load-bearing capabilities while ensuring that the system remains reliable and functional under varying industrial conditions. The steel chain is built to endure substantial stresses and resist wear over time, while the lifting hook ensures secure attachment to the load, preventing accidents during lifting. The design of the chain block emphasizes strength, durability, and reliability. By utilizing high-quality materials such as hardened steel, the system can withstand the rigorous demands of industrial environments such as warehouses, construction sites, and manufacturing plants. Ultimately, the goal of this project is to enhance the productivity of industries by providing an efficient, reliable, and safe method for lifting heavy objects. By reducing the time spent on manual lifting tasks, the chain block contributes to increased productivity and reduced downtime. Its simplicity and reliability also lead to lower maintenance costs, which can have a significant impact on the overall operational costs of a business. Additionally, the safety features built into

the design help to improve the overall safety standards of lifting operations, reducing the risk of injury or equipment failure.

Keywords: Chain block, Lifting hook, Gear system

Chapter 114

DESIGN OF FABRICATION OF PRUNING TREE CUTTER

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Abstract:

The design and fabrication of a pruning tree cutter is an essential development aimed at creating an efficient, reliable, and safe tool for trimming trees and maintaining greenery in a wide range of settings, including gardens, orchards, parks, and forestry applications. The primary objective of this project is to design a pruning tool that not only increases the precision of cuts but also reduces the effort and time spent by the operator while ensuring ease of use, safety, and longevity. Pruning trees involves various tasks, from cutting thin branches to thicker, more robust limbs, and the cutter must be versatile enough to handle different branch sizes and tree types.

One of the key aspects of the pruning tree cutter design is the incorporation of a high-strength, sharp blade that is capable of cutting through branches of various thicknesses with minimal effort. The blade is crafted from high-carbon steel, known for its ability to maintain sharpness over long periods of use while offering resistance to wear and corrosion. The design ensures that the blade is strong enough to endure repeated use, even under harsh weather conditions, such as exposure to rain, humidity, or extreme temperatures. In addition, the blade is engineered with a specific cutting geometry that maximizes cutting efficiency, enabling smoother cuts with less force required from the user.

The handle of the pruning cutter is another important design element, as it plays a critical role in ensuring user comfort and safety during operation. The handle is designed ergonomically to fit comfortably in the operator's hand, reducing the risk of fatigue and strain during prolonged use. Materials such as lightweight aluminum or reinforced plastic are chosen for the handle, which provides both strength and reduced weight, making it easier for the operator to maneuver the cutter. The handle may also feature additional grip elements such as

rubber or textured surfaces to prevent slippage, especially in wet or humid conditions, offering better control during use.

Keywords: Pruning tree cutter, Tree trimming tool, Branch cutting

Chapter 115

PRODUCTION OF BIOCHAR FROM BIO-WASTES USING PYROLYSIS METHOD

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Abstract:

The production of biochar from bio-wastes using the pyrolysis method represents a promising approach to sustainable waste management and environmental conservation. Biochar is a carbon-rich, solid by-product produced through pyrolysis, a thermochemical process that involves heating organic biomass in the absence of oxygen. Unlike open burning or incineration, pyrolysis minimizes emissions and converts bio-wastes into a stable, usable product. The primary objective of this project is to utilize agricultural residues, food waste, wood chips, and other organic materials—which would otherwise contribute to landfill waste or methane emissions—as feedstock for biochar production.

This technique provides a dual benefit: it reduces the environmental burden of organic waste and enhances soil health. During pyrolysis, the biomass undergoes controlled decomposition at elevated temperatures (typically 300–700°C), resulting in three main outputs: biochar, bio-oil, and syngas. Among these, biochar is the primary focus, valued for its porous structure, large surface area, and chemical stability. These properties contribute significantly to soil improvement, particularly in terms of moisture retention, nutrient availability, and microbial activity. As a result, the need for synthetic fertilizers is reduced, leading to more sustainable agricultural practices.

Critical to the effectiveness of biochar production are operational parameters such as pyrolysis temperature, heating rate, and residence time. These factors are carefully optimized in this project to ensure high yields of high-quality biochar. In addition, the design and energy efficiency of the pyrolysis reactor are evaluated to determine the overall feasibility and

scalability of the system. The by-products—bio-oil and syngas—can be harnessed for energy, making the entire process more economically viable and self-sustaining.

Keywords: Bio-waste utilization, Organic waste management, Biochar

Chapter 116

DESIGN AND FABRICATION OF A RESIN PRINTER FOR MANUFACTURING ARTIFICIAL LEGS

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Abstract:

The design and fabrication of a resin-based 3D printer focuses on developing a high-precision, reliable, and cost-effective additive manufacturing system utilizing photopolymerization technology. Resin printers, particularly those based on Stereolithography (SLA) and Digital Light Processing (DLP), offer significantly higher resolution and surface finish quality compared to traditional filament-based (FDM) printers. These printers work by curing liquid photosensitive resin layer by layer using ultraviolet (UV) light, creating detailed and dimensionally accurate 3D objects.

This project is driven by the need for an affordable, compact, and customizable resin printer for specialized applications such as rapid prototyping, dental modeling, jewelry design, and complex mechanical part fabrication. The design process emphasizes precision engineering and system integration to ensure that the printer delivers both consistent performance and ease of use. The primary components include a UV light engine (LED or laser source), a high-resolution LCD or DLP display for pattern projection, a resin vat with a transparent base, a movable build platform, and a Z-axis motion control system for layer-by-layer construction.

Critical design elements are centered on high-resolution image projection, accurate mechanical alignment, and thermal management to prevent print defects and ensure resin curing consistency. The printer's mechanical frame is constructed using lightweight yet rigid materials such as aluminum or reinforced polymer composites to enhance stability while minimizing vibrations. The motion system, driven by stepper motors and guided by linear rails or lead screws, ensures precise positioning and repeatability for each printed layer.

Keywords: Resin printer, 3D printing, UV curing

Chapter 117

DESIGN AND FABRICATION OF LOAD-BEARING ANALYSIS FOR PROSTHETIC LEG PRINTING

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Abstract:

The design and fabrication of a resin printer aim to develop a high-precision, cost-effective 3D printing solution utilizing photopolymerization technology. Resin printers, also known as stereolithography (SLA) or digital light processing (DLP) printers, use liquid resin cured layer by layer through exposure to ultraviolet (UV) light. This project focuses on creating a compact, user-friendly, and efficient resin printer tailored for applications in prototyping, dentistry, jewelry design, and intricate engineering models. The core components include a UV light source, build platform, resin vat, and a motion control system for precise layer positioning. Key design considerations include accuracy, surface finish quality, print resolution, and safety mechanisms. High-resolution LCD or DLP screens are integrated for accurate image projection, ensuring consistent curing of each layer. The frame and mechanical structure are fabricated using lightweight but sturdy materials to maintain stability during operation. The firmware is programmed to support various slicing software for seamless user experience. The system also incorporates a resin level sensor and temperature control for optimal printing conditions. This project aims to deliver a reliable, affordable, and customizable alternative to commercial resin printers while maintaining industrial-grade performance. The fabrication process involves not only the assembly of electrical and mechanical components but also the testing and calibration of the optical system to ensure uniform light distribution and accurate layer curing. Post-processing systems, such as resin cleaning and UV curing stations, may also be developed in conjunction to complete the printing workflow. This project ultimately aims to deliver a low-cost, scalable, and open-source alternative to commercial resin printers, making high-resolution 3D printing more accessible to small businesses, research labs, hobbyists, and educational institutions. By offering industrial-grade.

. Keywords: Stereolithography (SLA), Print accuracy, High-resolution printing

Chapter 118

DESIGN OPTIMIZATION FOR HIGH-PRECISION LAYERING IN 3D PRINTER

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Abstract:

The design and fabrication of a resin-based 3D printer aim to develop a high-precision, cost-effective solution using photopolymerization technology. Unlike traditional FDM printers, resin printers such as SLA and DLP offer superior resolution and surface finish by curing liquid resin layer by layer with UV light. This project focuses on creating a compact, customizable printer suited for applications like prototyping, dental modeling, jewelry design, and intricate part fabrication. The system includes core components such as a UV light engine, high-resolution LCD or DLP display, resin vat, build platform, and Z-axis motion control for accurate layer deposition. Lightweight, rigid materials ensure structural stability, while stepper motors and linear guides enable precise movement. Firmware supports popular slicing software and allows customization for different resins. Key features include resin level sensors, temperature control, and built-in safety mechanisms like UV shielding and fume ventilation. The printer is designed to be user-friendly, scalable, and open-source, offering a practical alternative to commercial models for use in labs, small businesses, and education. The fabrication process involves not only the assembly of electrical and mechanical components but also the testing and calibration of the optical system to ensure uniform light distribution and accurate layer curing. Post-processing systems, such as resin cleaning and UV curing stations, may also be developed in conjunction to complete the printing workflow. Critical design elements are centered on high-resolution image projection, accurate mechanical alignment, and thermal management to prevent print defects and ensure resin curing consistency. The printer's mechanical frame is constructed using lightweight yet rigid materials such as aluminum or reinforced polymer composites to enhance stability while minimizing vibrations. The motion system, driven by stepper motors and guided by linear rails or lead screws, ensures precise positioning and repeatability for each printed layer.

Chapter 119**DESIGN AND MECHANICAL INTEGRATION OF A FILAMENT-BASED 3D PRINTING SYSTEM FOR PROSTHETIC APPLICATIONS**N.manish¹,S.nithish²,M.rajavel³,T.shyam⁴

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Abstract:

The design and fabrication of a resin-based 3D printer aim to develop a high-precision, cost-effective solution using photopolymerization technology. Unlike traditional FDM printers, resin printers such as SLA and DLP offer superior resolution and surface finish by curing liquid resin layer by layer with UV light. This project focuses on creating a compact, customizable printer suited for applications like prototyping, dental modeling, jewelry design, and intricate part fabrication. The system includes core components such as a UV light engine, high-resolution LCD or DLP display, resin vat, build platform, and Z-axis motion control for accurate layer deposition. Lightweight, rigid materials ensure structural stability, while stepper motors and linear guides enable precise movement. Firmware supports popular slicing software and allows customization for different resins. Key features include resin level sensors, temperature control, and built-in safety mechanisms like UV shielding and fume ventilation. The printer is designed to be user-friendly, scalable, and open-source, offering a practical alternative to commercial models for use in labs, small businesses, and education. The fabrication process involves not only the assembly of electrical and mechanical components but also the testing and calibration of the optical system to ensure uniform light distribution and accurate layer curing. Critical design elements are centered on high-resolution image projection, accurate mechanical alignment, and thermal management to prevent print defects and ensure resin curing consistency. The printer's mechanical frame is constructed using lightweight yet rigid materials such as aluminum or reinforced polymer composites to enhance stability while minimizing vibrations. The fabrication process involves not only the assembly of electrical and mechanical components but also the testing and calibration of the optical system to ensure uniform light distribution and accurate layer curing. Post-processing systems, such as resin cleaning and UV curing stations, may also be developed in conjunction to complete the printing workflow.

Chapter 120

DESIGN AND ANALYSIS OF MECHANICAL COMPONENTS IN A FILAMENT-BASED 3D PRINTER FOR PROSTHETIC APPLICATIONS

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Abstract:

The advancement of additive manufacturing has opened new frontiers in the field of biomedical engineering, particularly in the development of low-cost, customized prosthetic devices. This project focuses on the mechanical design and analysis of a filament-based 3D printer specifically engineered for the fabrication of artificial legs. The primary objective is to develop a reliable and structurally sound 3D printing system that meets the dimensional accuracy, strength, and material requirements for prosthetic applications.

The mechanical components, including the frame, motion systems (X, Y, and Z axes), extruder assembly, and build platform, are designed using CAD software and analyzed for stress, strain, and thermal behavior using finite element analysis (FEA) tools. Material selection is performed based on mechanical strength, thermal stability, and cost-effectiveness, with an emphasis on components that can withstand prolonged operation under varying loads.

The printer is tailored to work with thermoplastic filaments like PLA and PETG, suitable for prosthetic use due to their biocompatibility and durability. Key considerations such as dimensional stability, layer adhesion, and print bed leveling are addressed to ensure high-quality prints.

This project demonstrates how mechanical engineering principles can be effectively applied to design and optimize 3D printing systems for healthcare needs. The final outcome is a functional, cost-efficient printer capable of producing durable and customized prosthetic limbs, especially beneficial for low-resource settings.

Keywords: Print accuracy, High-resolution printing

Chapter 121

DEVELOPMENT OF A MECHANICALLY OPTIMIZED 3D PRINTING SYSTEM FOR ARTIFICIAL LEG PRODUCTION USING THERMOPLASTIC FILAMENT

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Abstract:

The growing demand for affordable and customized prosthetic limbs has highlighted the potential of additive manufacturing in biomedical applications. This project presents the development of a mechanically optimized 3D printing system designed specifically for the production of artificial legs using thermoplastic filament. The aim is to engineer a printer that balances cost-efficiency, mechanical reliability, and high precision to meet the structural and functional requirements of prosthetic components. The design process focuses on enhancing the mechanical subsystems, including a rigid frame structure, smooth linear motion guides, a robust Z-axis lifting mechanism, and an efficient filament extrusion assembly. Finite Element Analysis (FEA) is employed to assess and optimize the mechanical performance of critical components under load, ensuring durability and operational stability during long print cycles.

Thermoplastic filaments such as PLA and PETG are selected for their mechanical strength, biocompatibility, and ease of use. The printer is designed to accommodate larger print volumes suitable for prosthetic limb parts, while maintaining high resolution and surface finish quality.

This mechanically driven design approach results in a reliable 3D printing platform capable of fabricating prosthetic legs with tailored geometries and patient-specific dimensions. The proposed system contributes to the field of accessible healthcare technology by offering a low-cost solution for prosthetic limb fabrication in both urban and rural settings.

Keywords: Print accuracy, High-resolution printing

Chapter 122

DESIGN AND FABRICATION OF COMPOSITE MATERIAL

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Abstract:

The design and fabrication of composite materials represent a significant advancement in materials engineering, offering solutions that combine the best properties of multiple materials to meet demanding structural and functional requirements. A composite material consists of two or more distinct phases—typically a matrix and a reinforcement—that, when combined, exhibit enhanced mechanical, thermal, and chemical properties compared to the individual components. This project focuses on creating lightweight, high-strength composite materials suitable for critical applications in sectors such as aerospace, automotive, civil engineering, marine, and sports equipment manufacturing. In such fields, performance, durability, and weight reduction are essential for improving efficiency and functionality. The design phase involves the careful selection of matrix materials (polymers, metals, or ceramics) and reinforcement agents (such as glass fibers, carbon fibers, Kevlar, or natural fibers like jute, hemp, and sisal). Each material is chosen based on the desired load-bearing capacity, thermal resistance, corrosion behavior, and cost-effectiveness. The fabrication process is tailored to suit the material combination and intended application. Common methods include hand lay-up, vacuum bag molding, filament winding, pultrusion, and compression molding. These techniques are selected for their ability to produce composites with uniform reinforcement distribution, strong interfacial bonding, and minimal void content. Additionally, the orientation and volume fraction of fibers are critically analyzed and optimized to enhance properties such as tensile strength, stiffness, and impact resistance. To ensure the quality and performance of the fabricated composites, the materials undergo rigorous mechanical testing, including tensile tests, flexural tests, impact resistance tests, and fatigue analysis. These evaluations are essential for understanding how the composite behaves under different stress conditions and ensuring that it meets industry standards and specifications.

Chapter 123

DESIGN AND FABRICATION OF SOLAR POWER CAR

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Abstract:

The design and fabrication of a solar-powered car present a forward-thinking approach to addressing the environmental and energy challenges posed by traditional fossil-fuel vehicles. With growing concerns about climate change and depleting non-renewable resources, solar vehicles provide a clean, sustainable, and renewable solution for the future of transportation. This project is centered on developing a functional prototype of a solar-powered car that utilizes photovoltaic (PV) technology to capture solar energy and convert it into electricity, which powers an electric drive motor.

The system comprises several crucial components: solar panels, which harvest solar energy; a battery storage unit, which stores excess energy for continued use during low sunlight or cloudy conditions; a brushless DC motor, which provides efficient propulsion; and a charge controller with MPPT (Maximum Power Point Tracking) to ensure optimal energy conversion. The chassis is designed for lightweight construction, using materials like aluminum alloys and fiber-reinforced plastics to reduce energy demands while maintaining structural integrity.

Design efforts focus on aerodynamic optimization, weight reduction, and energy efficiency to maximize the vehicle's performance and range. The car also integrates a battery management system (BMS) to monitor temperature, voltage, and charge cycles, ensuring safety and prolonged battery life. The solar charging system is capable of both on-the-go charging and stationary charging when parked under the sun, offering flexibility and extended autonomy.

During the fabrication stage, components are precisely integrated, and performance parameters such as acceleration, top speed, energy efficiency, charging time, and solar

conversion efficiency are thoroughly tested under various environmental conditions. The prototype is developed with scalability in mind, allowing for future enhancements such as regenerative braking, smart control systems, or hybrid energy inputs.

Keywords: Solar-powered car, Renewable energy, Electric vehicle, Battery storage system

Chapter 124

DESIGN AND FABRICATION OF SOLAR PESTICIDE SPRAYER

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Abstract:

The design and fabrication of a solar-powered pesticide sprayer address the growing need for sustainable and energy-efficient solutions in modern agriculture. Conventional pesticide spraying methods often rely on manual labor or petrol/diesel engines, which not only increase operational costs but also contribute to environmental degradation and physical strain on farmers. This project proposes a clean energy alternative by harnessing solar power to operate a pesticide spraying system, reducing dependence on non-renewable resources and promoting eco-friendly farming. The proposed system is powered by photovoltaic (PV) panels that convert sunlight into electrical energy, which is then stored in a rechargeable battery pack. This stored energy powers a DC electric pump that delivers the pesticide through a regulated nozzle system, ensuring efficient and uniform spraying. The key components of the system include a solar panel module, battery bank, pressure-regulated DC pump, spray nozzles, a pesticide tank, and a mobile trolley or backpack frame for ease of transport and use across different field terrains. Design considerations include tank capacity, spray pressure, flow rate, battery capacity, and solar panel wattage to ensure optimal system performance. The sprayer is designed to be lightweight, portable, and ergonomically user-friendly, making it suitable for small to medium-scale farms. A battery backup allows continued usage during cloudy weather or low sunlight conditions, ensuring reliability in varied environmental conditions. To assess system performance, field tests are conducted to evaluate the uniformity of spray coverage, pesticide output rate, and battery endurance time. The use of solar energy leads to zero fuel costs, reduced emissions, and minimal maintenance, significantly lowering the total cost of ownership for farmers.

Chapter 125

DESIGN AND FABRICATION OF SOLAR POWERED AUTOMATIC IRRIGATION SYSTEM

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Abstract:

The design and fabrication of a solar-powered automatic irrigation system aim to enhance water-use efficiency and promote sustainable agricultural practices, especially in remote and off-grid rural areas. Traditional irrigation methods often result in excessive water usage and require manual intervention, leading to labor inefficiencies and resource wastage. This project introduces an innovative system that integrates solar energy, automated controls, and sensor-based feedback to deliver water only when and where it is needed. The system is powered by photovoltaic (PV) solar panels, which convert sunlight into electrical energy to operate a microcontroller-based control unit, water pump, and soil moisture sensors. These sensors continuously monitor the soil's moisture content and send real-time data to the microcontroller. When the soil moisture drops below a predefined threshold, the system automatically activates the water pump, supplying water through a network of pipes or drip emitters until optimal soil conditions are restored. Key components include solar panels, a battery storage system, soil moisture sensors, a microcontroller (e.g., Arduino/ESP32), relays, a submersible or surface pump, valves, and irrigation lines. The inclusion of a battery backup ensures uninterrupted operation during cloudy days or nighttime. The system design emphasizes low power consumption, portability, cost-effectiveness, and ease of maintenance, making it suitable for small and medium-scale farms. Additionally, the automated irrigation mechanism reduces the need for constant farmer supervision, allowing more efficient time and labor management. Field testing is conducted to assess system responsiveness, accuracy in soil moisture detection, energy efficiency, and water-saving potential. Results show significant reductions in water usage and improved crop health due to timely irrigation.

Keywords: Solar-powered irrigation system, Automatic irrigation, Battery storage system

Chapter 126

DESIGN AND FABRICATION OF MINI WOODEN BENCH SAW CUTTER WITH MOTOR ARRANGEMENT

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Abstract:

The design and fabrication of a mini wooden bench saw cutter with motor arrangement aim to provide a compact, efficient, and affordable tool for cutting wood in small-scale woodworking or DIY applications. Traditional saws, while effective, can be cumbersome and less precise. This project focuses on developing a miniaturized version of a bench saw that can perform similar tasks on a smaller scale, ensuring ease of use, portability, and accuracy. The system integrates a high-torque motor with a blade assembly, powered by an electric motor that drives the saw blade at high speeds, allowing for smooth and accurate cuts. The motor is connected to the saw blade via a drive belt mechanism, ensuring efficient transfer of power and reducing the strain on the motor. The motor's power is regulated to provide optimal cutting force without overloading, ensuring safety and extending the tool's lifespan. The frame of the bench saw is constructed from high-strength materials like steel or aluminum to ensure rigidity and stability during operation, while the workbench surface is made from wood or reinforced composite material to absorb vibrations and provide a secure base for cutting. The design incorporates a saw blade guard for safety and a dust extraction system to maintain a clean workspace. Key design considerations include cutting capacity, blade alignment, motor power, and user ergonomics. The motor arrangement is designed to minimize noise and vibration, enhancing user comfort and safety. The mini wooden bench saw cutter features an adjustable cutting height and angle to accommodate a variety of cutting tasks, from straight cuts to angled crosscuts.

Keywords: Woodworking tool, Electric motor, Cutting accuracy

Chapter 127

DESIGN AND FABRICATION OF HYBRID POWER PLANT

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Abstract:

The design and fabrication of a hybrid power plant aim to create an energy-efficient, sustainable, and reliable solution for electricity generation by combining renewable and non-renewable energy sources. This hybrid system integrates solar power and wind power with diesel or natural gas backup, ensuring a continuous and stable power supply regardless of weather conditions or time of day. The primary goal is to reduce reliance on fossil fuels, minimize environmental impact, and enhance the resilience of power generation in remote areas or regions with unreliable grid access. The system utilizes photovoltaic (PV) solar panels to harness solar energy, while wind turbines convert wind energy into electrical power. A diesel or natural gas generator is incorporated as a backup to ensure power availability during low wind or sunlight periods. The hybrid system is controlled by an energy management system (EMS) that intelligently optimizes the use of energy from different sources, balancing power generation, consumption, and storage. Key components include solar inverters, wind turbine controllers, batteries for energy storage, diesel generator, and EMS. The energy storage system ensures that excess energy generated during peak solar or wind conditions is stored for use during low production periods. Additionally, the system includes power conditioning equipment to ensure stable voltage and frequency output, making the hybrid plant suitable for both off-grid and grid-connected applications. The design incorporates modular scalability, allowing the system to be expanded based on the energy needs of the area it serves. The hybrid system also features smart grid connectivity, enabling real-time monitoring.

Keywords: Hybrid power plant, Renewable energy, Wind power, Solar power

Chapter 128

DESIGN AND FABRICATION OF SOLAR REFRIGERATOR

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Abstract:

The design and fabrication of a solar refrigerator aim to provide an eco-friendly, energy-efficient alternative to traditional refrigeration systems by utilizing solar energy. This project focuses on designing a solar-powered refrigeration system that operates independently from the grid, making it ideal for remote areas, off-grid communities, and places with unreliable electricity supply. By harnessing solar energy through photovoltaic (PV) panels, the system powers the refrigerator's compressor and other essential components, offering a sustainable solution to food preservation in areas with limited access to conventional power sources. The key components of the system include solar panels, a solar charge controller, a DC-powered compressor, and a battery storage system. The solar panels collect sunlight and convert it into electrical energy, which is stored in the battery bank for use when the sun is not shining. The DC compressor then operates to cool the refrigerator, maintaining optimal temperatures for food storage. The charge controller ensures the efficient charging of the batteries and prevents overcharging, while the battery management system regulates power distribution. The refrigerator design prioritizes energy efficiency and insulation, ensuring that minimal energy is used to maintain low temperatures. High-performance insulating materials are used to reduce heat transfer, minimizing the refrigeration load and enhancing the overall efficiency of the system. The system is designed to provide a low carbon footprint, contributing to global efforts to reduce greenhouse gas emissions. The fabrication process involves the integration of the electrical and mechanical components, followed by the installation of the refrigeration unit, battery storage, and solar panels. Testing is conducted to assess the system's cooling performance, energy consumption, and overall reliability in various environmental conditions, including direct sunlight, overcast skies, and varying outdoor temperatures.

Keywords: Solar refrigerator, Solar-powered cooling, Renewable energy refrigeration

Chapter 129

MECHANICAL BEHAVIOUR INVESTIGATION AND PROCESS PARAMETERS OPTIMIZATION OF PROCESSOR FAN COMPONENT BY USING 3D PRINTING

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Abstract:

This research conducts to be a comparative analysis and optimization of 3D printing technologies, specifically Fused Deposition Modeling (FDM) with the material PETG-CF. This summary begins with a summary of the history of Additive Manufacturing (AM) technologies and the current state of 3D printing polymers. Following that, we explore the latest advancements in polymer and filling material designs, the fundamental concepts behind additive manufacturing (AM) processes, and the growing uses of 3D printed polymers and composites. This work studies have to be analysed the influences of the process parameter of FDM process for the materials of PETG-CF. During the process PETG-CF filament with Rectilinear pattern along with various process parameter were executed for the manufacturing of various mechanical behaviours specimens. PETG-CF had the highest tensile strength (20.147 N/mm²), the highest hardness (47HRF), the ultimate flexural strength (0.090 N/mm²) and the maximum compressive strength was (0.057 N/mm²). Finally all the process parameters optimized through and ANOVA were found out the each output responses.

Keywords: FDM process, PETG-CF, HRF, Rectilinear pattern, Infill density.

Chapter 130

THE MECHANICAL BEHAVIOUR OF SISAL FIBER THROUGH HYBRID LAMINATE

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Abstract:

This study explores the development and characterization of composite materials made from natural fibers combined with epoxy resin, aimed at creating sustainable alternatives to traditional rope and fiberglass products. Three distinct composite plates were fabricated with varying fiber compositions and resin content:

Plate 1 consisting of 35% sisal fiber and 65% epoxy resin,

Plate 2 with a 35% fiber blend (90g sisal + 15g coir) and 65% epoxy resin,

Plate 3 with a 30% fiber blend (45g sisal + 45g bamboo cotton) and 70% epoxy resin.

The objective was to evaluate the potential of these composites as replacements for conventional materials used in rope production and fiberglass applications, with a focus on mechanical properties such as tensile strength, flexibility, impact resistance, and environmental durability.

Chapter 131

WEAR AND FRICTION CHARACTERISTICS OF AL6061/ZRB2 METALMATRIX COMPOSITES FABRICATED BY STIR CASTING PROCESS

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Abstract:

This research aims to investigate the tribological behavior of Al6061/nano- ZrB₂ metal matrix composites, which were produced using stir casting. The study emphasizes the potential of these composites in industries such as automotive and aerospace due to their improved mechanical and tribological properties. By adding 3 to 7.5 wt.% of nano-ZrB₂ to Al6061, twelve composites were formed, exhibiting enhanced physical, mechanical, corrosion, and tribological characteristics. The electron microscopy analysis confirmed the uniform distribution of nano-ZrB₂, indicating successful manufacturing and optimized material properties. Additionally, the study explores the use of equal channel angular pressing (ECAP) to refine the grain structure of magnesium. Both experimental and numerical methods were employed for analysis. Furthermore, tribological analysis was conducted on AA7075 alloy composites with reinforcements of SiC, B₄C, and waste porcelain. Among these composites, the one with 7.5 wt.% B₄C demonstrated the highest mechanical strength, while the composite with 6 wt.% porcelain exhibited the lowest wear and friction. The composite with 7.5 wt.% porcelain displayed the lowest density and corrosion rate, making it suitable for specific applications. To aid in material selection, a novel AHP/CRITIC-COPRAS method was introduced, ranking the AA7075 composite with 7.5 wt.% porcelain as the most suitable for automotive use. Overall, this research provides valuable insights into material interactions and performance, offering solutions for industries to enhance component performance in the face of technological progress.

Keywords – Aluminium Metal Matrix Composite, Stir casting, Hardness, Wear resistance.

Chapter 132

IoT enabled smart braking system with integrated alcohol detection and obstacle avoidance

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Abstract:

Integrated Smart Braking Combines ABS, regenerative braking, and safety features into one platform. Enhances both control during braking and overall energy efficiency.

Enhanced Vehicle Stability ABS prevents wheel lock-up and reduces skidding during sudden braking. Ensures better handling, especially on slippery or uneven roads.

Energy Recovery System Regenerative braking converts kinetic energy into electrical energy. Reduces mechanical brake wear and supports sustainable driving.

Advanced Safety Mechanisms Ultrasonic sensors auto-engage brakes when obstacles are detected. Alcohol and RFID sensors ensure only authorized.

Chapter 133

Impact of Stacking Sequence on the Mechanical Properties of Cotton-Kenaf Fiber-Reinforced Polymer Hybrid Composites

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Abstract:

This abstract highlights the significance of plant fibers, particularly kenaf fibers, in various applications such as clothing, paper making, and reinforcement in thermoplastics. Kenaf fibers are praised for their superior strength and hydrophilic nature attributed to the presence of cellulose, hemicellulose, lignin, and pectin. The interfacial linkage between natural fibers and polymer resin is crucial for determining the mechanical and thermal performance of natural fiber composites. Challenges related to poor wettability of natural fibers with polymers due to inherent moisture content are discussed, along with potential solutions involving chemical techniques. The mechanical performance of biocomposites improves with the addition of fiber content up to a certain limit, beyond which it decreases. The Uttarakhand state in India, known for its diverse physiographic features, is highlighted as a fertile land for various fiber plants, including Himalayan kenaf. The extraction of fibers from Himalayan kenaf plants and their utilization in various applications contribute to the economic development of local communities. Additionally, the abstract briefly mentions information about cotton, providing context for the broader discussion on plant fibers. Overall, this abstract provides a comprehensive overview of the properties, applications, challenges, and regional significance of kenaf fibers in the context of Uttarakhand state in India, while also touching upon the topic of cotton.

Chapter 134

DESIGN AND FABRICATION OF ECO FRIENDLY ELECTRIC SCOOTER FOR SUSTAINABLE TRAVEL

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Abstract:

This Project Focuses On The Fabrication Of An Eco-Friendly Electric Scooter Aimed At Promoting Sustainable Travel. The Scooter Operates Using A Dc Motor Powered By A Rechargeable Battery, Which Is Charged Via Lifepo4. The Drive System Consists Of A Chain Drive Mechanism, And The Body Is Constructed Using Lightweight Sheet Metal To Enhance Efficiency. This Vehicle Produces Zero Emissions, Contributing To Environmental Preservation And Energy Conservation. Its Low Operating Cost And Sustainable Power Source Make It Ideal For Short-Distance Commuting. This Project Demonstrates A Step Toward Green Transportation And Highlights The Potential Of Renewable Energy In Everyday Mobility Solutions.

Chapter 135

Fabrication Of Battery Cooling System In Electric Vehicle

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Abstract:

This Study Presents The Fabrication Of A Battery Cooling System Incorporating A Copper Tube Temperature Sensor For Enhanced Thermal Management. The System Aims To Optimize The Performance And Lifespan Of Lithium-Ion Batteries By Actively Monitoring And Regulating Temperature. The Copper Tube Sensor, Strategically Placed Within The Battery Pack, Ensures Accurate Temperature Readings. An Integrated Cooling Mechanism Utilizes A Liquid-Based Solution Circulated Through The Tubes, Effectively Dissipating Heat Generated During Charging And Discharging Cycles. This Approach Mitigates The Risk Of Overheating, Promoting Safer And More Efficient Battery Operation. The Design Demonstrates A Practical Solution For Electric Vehicle And Energy Storage Applications, Addressing The Critical Aspect Of Temperature Control In Battery Technology.

Chapter 136

DESIGN AND ANALYSIS OF TRAIN BOGIE

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Abstract:

A Bogie is a chassis or framework carrying wheels attached to the train, serving as a modular subassembly of wheels and axles. A bogie may remain normally attached to a railway carriage/car or locomotive. Old Bogies are cast models which are huge and bulky in its nature. The cast bogie is made in single piece and handling of such components are difficult due to its over design and manufacturing cost is also high. Hence, fabrication of bogie is appropriate solution to overcome the difficulties that are associated with the casted bogie. This project deals with replacing the casted bogie with fabricated bogie by making major changes in design to take the load without failure. The Structural failures of the railway bogie are primarily exited form the tracks. These forced vibrations resulting in stress are investigated by simulations.

Chapter 137

Modeling and analysis of Design and Analysis of Disc Brake

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Abstract:

Each single system has been studied and developed in order to meet safety requirement. Instead of having air bag, good suspension systems, good handling and safe cornering, there is one most critical system in the vehicle which is brake systems. Without brake system in the vehicle will put a passenger in unsafe position. Therefore, it is must for all vehicles to have proper brake system. The standard disc brake two wheelers model is used in Ansys and the Steady State Thermal analysis is done to calculate the temperature of disc brake model. This is important to understand action force and friction force on the disc brake new material, how disc brake works more efficiently, which can help to reduce the accident that may happen in each day.

Chapter 138

Smart Vehicle Monitoring Robot for Industry

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Abstract:

AutoTrack is a smart vehicle monitoring robot designed to enhance safety, efficiency, and automation in industrial environments. It uses a combination of sensors, wireless communication, and onboard intelligence to autonomously track and monitor industrial vehicles, ensuring proper functionality and reducing the chances of accidents, theft, or equipment misuse.

Chapter 139

INCOMING QUALITY CONTROL & REGULIZATION OF INSPECTION REPORT IN GMES

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Abstract:

Incoming Quality Control (IQC) is a critical process that ensures the quality of raw materials, components, and products received from suppliers. Effective IQC helps prevent defects, reduces waste, and minimizes the risk of non-compliance with regulatory requirements. This abstract outlines the importance of IQC, its benefits, and key elements of an effective IQC program. By implementing a robust IQC process, organizations can improve product quality, reduce costs, and enhance customer satisfaction. Keywords: Incoming Quality Control, Quality Assurance, Supply Chain Management,

Chapter 140

AUTOMATIC SEED SOWING MACHINE USING IOT

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Abstract:

India is an agriculture based country in which, 70% of people depends on the outcome of farming. But if we observe that with increase in population the farm gets distributed among the family and because of this, farmer in India held averagely only two acre farm. Also economically, farmers are very poor due to which they are unable to purchase tractors and other costly equipment hence they use traditional method of farming. Basically, many farmers in India also use bullocks, horses and he-buffalo for farming operation. This will not satisfy need of energy requirement of the farming as compared to other countries in the world. So we are thinking that human and animal efforts can be replaced by some advance mechanization which will be suitable for small scale farmer from economical and effort point of view. So we are developing this equipment which will satisfy all this need and to solve labour problem. In this equipment we used ploughing rod, seed sower and land levelling attachment. This machine performs the operation (ploughing, sowing) which is used for small scale farming

Chapter 141

A CONSTANT FREQUENCY ZVS CONTROL SYSTEM FOR THE FOUR-SWITCH BUCK-BOOST DC-DC CONVERTER WITH REDUCED INDUCTOR CURRENT

ABSTRACT

A steady recurrence ZVS control methodology with least root mean square estimation of inductor current is proposed in this letter for the four-switch buck-support dc-dc converter that is utilized as a 48V moderate transport pre-controller in disseminated power frameworks. The quadrilateral inductor current balance is embraced to accomplish ZVS activity. The four control time stretches are ideally chosen with the end goal that the inductor current RMS esteem is limited, accordingly decreasing the conduction misfortune. The proposed shut circle ZVS control plan can be actualized without detecting the heap current, albeit the RMS least current calculation needs the information and yield voltages and burden current at given consistent state condition. The info voltage and burden change tests are given to check the shut circle attributes without detecting load current

KEYWORDS: Four-Switch Buck-Boost, ZVS, High frequency, Closed loop

Chapter 142

Experimental Study on Behaviour of Smart Concrete by Using GGBS and Steel Slag

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Abstract

Smart concrete is an innovative material designed to respond to environmental conditions or stimuli, enhancing the functionality and durability of modern infrastructure. The current study investigates the behavior of smart concrete by partially replacing traditional cement with Ground Granulated Blast Furnace Slag (GGBS) and steel slag. These industrial by-products not only promote sustainable construction practices but are also known to improve certain mechanical and durability properties of concrete .The background of this research emphasizes the global need for sustainable materials that reduce the carbon footprint of construction. GGBS and steel slag have demonstrated potential as supplementary cementitious materials in previous studies. However, limited research exists on their combined influence in smart concrete applications. In this experimental study, various mixes were prepared with different proportions of GGBS and steel slag. The concrete specimens were tested for compressive strength, flexural strength, and workability. Smart functionalities such as self-sensing capabilities were also examined through resistivity measurements. The results indicated that the mix containing 30% GGBS and 20% steel slag showed optimal strength and durability, while also exhibiting better self-sensing properties compared to control specimens. The inclusion of these materials enhanced the microstructural properties, leading to improved performance under loading conditions. In conclusion, GGBS and steel slag contribute positively to the development of smart concrete. These findings recommend further large-scale applications and additional studies on long-term performance.

Keywords: Smart Concrete, GGBS, Steel Slag, Sustainable Construction, Self-sensing Concrete

Chapter 143

EFFECT OF CALCIUM CARBIDE RESIDUE ON THE FRESH AND HARDENED PROPERTIES OF CEMENT-BASED MATERIALS

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Abstract

This research examined the influence of calcium carbide waste (CCW) as an additive on cement paste and concrete properties. The CCW, obtained from a nearby panel beating workshop, was dried in the sun, sieved through 75 μm , and analyzed using X-Ray Fluorescence (XRF) analysis. Cement paste specimens were made with CCW incorporated at 0, 0.25, 0.5, 0.75, and 1.0% by cement weight, and their consistency, setting times, and drying shrinkage were evaluated according to standard tests. Fresh concrete, with a 1:2:4 mix and a water-cement ratio of 0.5, was tested for slump. Sixty 150 mm concrete cubes were cast and tested at compressive strength after 1, 3, 7, 28, and 56 days of curing. Compressive strength was also modeled with Minitab software through linear regression. XRF analysis indicated that CCW was predominantly calcium oxide (95.69%) and contained a total of 3.14% SiO_2 , Al_2O_3 , and Fe_2O_3 . Consistency improved by 14% at 1.0% CCW content, and initial and final setting times reduced by 78% and 57%, respectively, with drying shrinkage eliminated. 0.5% CCW concrete had a 6.4% increase in 28-day strength, while 1.0% CCW resulted in a 14.9% reduction.

Keywords: Calcium carbide waste, compressive strength, setting times, X-Ray Fluorescence (XRF) analysis

Chapter 144

STRENGTH EVALUATION OF CONCRETE BY APPLICATION OF COCKLE SHELL AND ALUMINA REFINERY RESIDUE

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Abstract

Concrete is the world's most versatile, durable and reliable construction material. Next to water, concrete is the most used material, which required large quantities of Portland Cement. In addition to that large amount energy was also consumed for the cement production. The major problem the world is facing today is the environmental pollution. In the construction industry mainly the production of Portland cement will causes the emission of pollutants results in environmental pollution. We can reduce the pollution effect on environment, by increasing the usage of industrial by-products in our construction industry. The research was conducted to study the properties of concrete by using alumina refinery residue 2% as replacement of cement in concrete. Various studies have been conducted on different waste products to determine the effectiveness of their use as a partial fine aggregate replacement in concrete. In this research, the effect of crushed cockle shell 10% as partial fine aggregate replacement material towards workability and compressive strength of concrete is tested.

Keywords: Concrete, Portland cement, Alumina refinery residue, Cockle shell, Fine aggregate.

Chapter 145

ROLE OF FLY ASH IN IMPROVING SOIL PHYSICAL PROPERTIES

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Abstract

The low permeability and fine structure of clay soil lead to water logging issue and decrease biological processes in soil. In contrast to this, loose particle and greater in filterability in sandy soil lead to low water holding capacity and poor nutrient retention. Fly ash, a by-product of thermal power plants, leads to environmental pollution and is dangerous to human health. It is produced in abundance; hence, safe disposal is very difficult. Fly ash can be utilized as an amendment to enhance soil properties and crop growth in such soils. Introduction of 20% fly ash in clay soil and 30% in sandy soils enhanced the germination, tillering, plant height, biological and grain yield of wheat. Incorporation of fly-ash has also proved enhancement in the soil parameters viz. texture, structure and bulk density. Permeability of clay loam soil was enhanced from 0.54 cm/hr to 2.14 cm/hr through the addition of 50% fly ash while it reduced from 23.80 cm/hr to 9.67 cm/hr in sandy soil by 50% fly-ash addition. Water holding capacity of sandy soil also improved from 0.38 cm/cm to 0.53 cm/cm at 50% level.

Keywords: Fly Ash ,Soil Amendment, Clay Soil , Sandy Soil

Chapter 146

EXPERIMENTAL STUDY ON UTILIZATION OF BIOMEDICAL WASTE ASH IN FLY ASH BRICKS

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Abstract

Generally, Fly ash, sand, and cement are typically used to make fly ash bricks. Utilizing cement in fly ash bricks raises the price of brick and contributes significantly to CO₂ emissions from cement manufacturing. In that instance, lime sludge and gypsum might be used in place of cement in fly ash bricks to lessen these issues. By the way, in this scenario, using gypsum and lime sludge in place of cement may have negative effects on the bricks' compressive strength. In order to address these issues, we made the decision to undertake an experimental investigation on fly ash bricks while also using bio medical waste ash that were obtained from bio-medical waste during an epidemic. Because more patients and the additional rules issued by the Central Pollution Control Board (CPCB) during the pandemic result in a daily generation rate increase for various bio-medical wastes. We chose to carry out this experimental investigation on fly ash bricks in order to better understand the RRR method for waste management and to attain increased compressive strength.

Key Words: Fly ash brick, Optimal mix, Lime sludge and Gypsum, Compressive strength, Bio medical waste ash.

Chapter 147

OPTIMIZATION AND PREDICTION OF FLY ASH AND COCONUT FIBER-BASED CONSTRUCTION MATERIALS USING GRADIENT BOOSTING, RANDOM FOREST, AND RESPONSE SURFACE METHODOLOGY

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Abstract

Sustainable building materials development is important for minimizing environmental footprints. This research explores fly ash and coconut fiber-based building material optimization and prediction with novel statistical and machine learning methods. Gradient Boosting, Random Forest, and Response Surface Methodology are utilized to predict and model the mechanical and thermal behavior of these materials. The findings indicate that the models proposed can be used to predict the properties of fly ash and coconut fiber-based building materials with high accuracy. The material composition and processing parameters are also optimized to obtain improved performance. The study's findings help in the creation of sustainable and high-performance building materials, and it is a useful resource for the construction sector.

Keywords: Fly ash, Coconut fiber, Sustainable construction materials, Machine learning, Optimization, Response Surface Methodology.

Chapter 148

STUDY OF MICRO-POROSITY AND CHARACTERIZATION OF LIMESTONE USING XRD AND SEM ANALYSIS

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Abstract

This study mainly investigates the micro porosity of cretaceous limestone and its influence on oil recovery. microporosity is significant as it contributes considerably to the carbonate pore system, which can host extensive volumes of water and hydrocarbons. Determining the occurrence and distribution of limestone micropores is essential for accurate hydrocarbon estimations, reservoir categorization, and fluid flow simulations. Scanning Electron Microscopy (SEM) and X-Ray Diffraction (XRD) analysis were conducted to characterize the microstructure and mineral composition of the limestone samples. The result reveals the presence of significant micro porosity, which plays a crucial role in oil recovery processes. Understanding the relationship between micro porosity and oil recovery is essential for optimizing extraction techniques and enhancing production efficiency in oil reservoirs within cretaceous limestone formation.

KeyWords: SEM, XRD, Lime Stone, Microstructure, Micro porosity, enhancing production efficiency.

Chapter 149

RAMMED EARTH WALL USING WASTE MATERIALS

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Abstract

Rammed earth structures consist of soil piers, natural materials, and water, which are hammered in thin layers in a container. Rammed earth walls are the primary elements of rammed earth structures and offer high-quality insulation properties as well as recyclability. Unfortunately, only minimal information is available regarding rammed earth structures, especially in new material areas such as nanomaterials and finite element modeling. In this context, this paper reviews the factors that can be used to identify the environmental impacts of rammed earth walls and demonstrates the need for using new materials in rammed earth structures. Several previous experimental and numerical studies are discussed to establish a framework for better understanding the history and future of rammed earth structures. In the literature, many authors have suggested how to safely build a rammed earth wall, but only a few of them have delved into its quality control before and during the construction process. This paper introduces a preliminary methodology and establishes unified criteria based in a statistical analysis for both the production and the quality control of this constructive technique in case of dealing with both samples and walls.

Keywords: Fly ash brick, Optimal mix, Lime sludge and Gypsum, Compressive strength, Bio medical waste ash.

Chapter 150

INFLUENCE OF SOIL ON THE MECHANICAL PROPERTY OF CONCRETE: A FOCUS ON COMPRESSIVE STRENGTH

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Abstract

The effect of termite cranker soil on the mechanical behavior of concrete, in the form of compressive strength, has been considered with a view to providing an alternative and sustainable material for use in construction. This research examines the effect of using termite cranker soil in concrete mixes, considering the impact on compressive strength as well as the performance of the concrete. Termite cranker are rich in natural minerals and have a typical nature, e.g., high heat resistance and stability, that can play a role in enhanced properties of concrete. Different percentages of termite cranker soil were used in concrete mixtures as partial replacement of fine aggregate. Compressive strength was tested at different curing ages, with comparison to normal concrete. Initial results indicate that termite cranker soil can affect the strength of concrete, with best replacement percentages giving enhanced performance due to the nature of the soil. The research is predictive of the possible use of termite cranker soil in concrete as a substitute for normal materials in an environmentally friendly manner, both environmentally and economically beneficial in the construction sector.

Keyword: Termite, Flexural, Tensile, Compressive, Cranker,

Chapter 151

GOEPLYMER CONCRETE BY USING FKY ASH AND RICE HUSK ASH

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Abstract

Concrete is the most widely used man-made construction material in the world. Its importance is increasing every day. Cement is the primary ingredient in concrete, which in turn forms the foundations and structures of the buildings we live and work in, and the roads and bridges we drive on. Concrete is the most widely used construction material, but its primary binding component, Ordinary Portland Cement (OPC), contributes significantly to carbon dioxide (CO₂) emissions due to its energy-intensive production process. In pursuit of sustainable and eco-friendly construction. This study investigates the partial replacement of cement with fly ash (FA) and rice husk ash (RHA) in concrete at 20%, 40%, 60%, and 80% replacement levels. Fly ash, a byproduct of coal combustion, and rice husk ash, an agricultural waste material, possess pozzolanic properties that enhance the performance of concrete while reducing environmental pollution. Concrete specimens were prepared and tested for compressive strength, split tensile strength, flexural strength, and water absorption at different curing periods. The results were analyzed to determine the optimal replacement percentage that maintains or improves the mechanical and durability properties of concrete. This study aims to promote sustainable construction practices by utilizing waste materials, reducing cement consumption, and minimizing environmental impact while ensuring structural integrity. In this paper, we have attempted to reduce the amount of cement by replacing it with fly ash and rice husk ash as a construction material.

Keywords: Concrete, Cement, Fly ash, Rice Husk Ash, Global Warming

Chapter 152

RECYCLE OF CONSTRUCTION WASTE AND FOOD WASTE IN CONCRETE

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Abstract

The growing demand for natural aggregates in construction leads to increased waste generation. Ceramic tile waste and marble dust, by-products of production and demolition, can pollute the environment. This study explores reusing these wastes in concrete. Replacing coarse aggregates with ceramic tile aggregate (up to 30%) and fine aggregates with marble dust (10%) improves workability and durability. Results show increased strength and workability with up to 30% ceramic tile aggregate replacement. Using these waste materials reduces natural resource consumption and environmental pollution, contributing to sustainable concrete technology. The use of ceramic tile aggregate and marble dust in concrete offers several benefits, including reduced environmental pollution, conservation of natural resources, and potential cost savings. Sustainable concrete production can lead to a reduced carbon footprint, waste reduction, and improved durability. However, challenges such as variability in waste material properties and potential impact on concrete consistency need to be addressed. Implementing sustainable concrete practices requires collaboration between industry and researchers, development of standards and guidelines, and education for construction professionals. By adopting these practices, we can reduce landfill waste, conserve natural aggregates, and potentially lower greenhouse gas emissions, contributing to a more environmentally friendly construction industry.

Keywords: Concrete Mix Design (M25), Ceramic tiles waste, Workability, Compressive Strength, Split Tensile strength, Ultrasonic Pulse Velocity

Chapter 153

SOIL STABILIZATION USING PLASTIC WASTE TO IMPROVE THE STRENGTH

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Abstract

Soil stabilization is an essential technique used in construction to improve the engineering properties of soil. The increasing problem of plastic waste disposal has led researchers to explore sustainable solutions, such as incorporating waste plastic in soil stabilization. This study investigates the impact of using waste plastic materials to enhance soil strength, reduce compressibility and improve load-bearing capacity. Laboratory tests including compaction tests, Atterberg limits and California Bearing Ratio (CBR) tests were conducted to assess the effectiveness of plastic-reinforced soil. The results indicate that the inclusion of plastic strips or granules enhances soil stability while providing an eco-friendly way to reuse waste. Soil stabilization is an age-old technique used to improve soil properties, making it more suitable for construction applications such as roadways, embankments, and foundations. Conventional soil stabilization methods involve mechanical compaction, chemical additives (such as lime and cement), and geosynthetic reinforcements. However, these techniques can be costly and environmentally unsustainable. With the rapid increase in plastic waste generation, improper disposal has led to severe environmental challenges, including land and water pollution. Utilizing waste plastic in soil stabilization presents a sustainable and cost-effective alternative, addressing both soil improvement and waste management concerns.

Keywords: Plastic strips, Atterberg limits, California Bearing Ratio, soil stabilization.

Chapter 154

EVALUATING THE BEHAVIOR OF M20 CONCRETE WITH PARTIAL CEMENT REPLACEMENT BY MINERAL ADMIXTURES

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Abstract

Concrete, a mixture of cement, fine aggregate, coarse aggregate, and water, is a fundamental building material in modern construction. As infrastructure development surges, the importance of concrete has multiplied. It plays a crucial role in constructing buildings, industrial structures, bridges, and highways. To meet growing demands, researchers are exploring alternative ingredients. Replacing cement with mineral admixtures has shown significant improvements in concrete's strength and durability. This study examines the properties and strength of M20 grade concrete mixes with partial cement replacement using sugarcane bagasse ash and ground granulated blast furnace slag (GGBS). Utilizing GGBS, a by-product of the steel industry, serves as an eco-friendly approach, reducing waste and conserving conventional building materials. By adopting such sustainable practices, the construction industry can minimize its environmental footprint while enhancing the performance of concrete structures. This research aims to contribute to the development of more sustainable and durable concrete solutions.

Keywords: Concrete Sustainability GGBS (Ground Granulated Blast Furnace Slag) Sugarcane Bagasse Ash Durability

Chapter 155

SUSTAINABLE CONCRETE PRODUCTION USING PROSOPIS JULIFLORA AS COARSE AGGREGATE: A FEASIBILITY STUDY

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Abstract

The escalating demand for construction materials has led to the exploration of alternative and sustainable resources to mitigate environmental impacts. This research focuses on assessing the feasibility and performance of concrete incorporating Prosopis Juliflora as a partial replacement for coarse aggregate. Prosopis Juliflora, commonly known as mesquite, is an invasive plant species in many regions and has the potential to be utilized in construction materials, offering a dual benefit of waste reduction and sustainable resource utilization. The study involves a comprehensive experimental investigation to evaluate the mechanical, durability, and microstructural properties of concrete with varying proportions of Prosopis Juliflora stem replacing the coarse aggregate up to 5%, 10 % and 15 % as a replacement for conventional coarse aggregate. M30 grade mix of concrete was used and standard tests such as compressive strength, tensile strength, flexural strength, and durability assessments will be conducted at 7, 14 and 28 days to quantify the effects of Prosopis Juliflora on the overall performance of the concrete mixtures.

Keywords: Cement, Coarse Aggregate, Fine Aggregate, Prosopis Juliflora Wood

Chapter 156

EXPERIMENTAL INVESTIGATION OF INTERLOCKING BRICK USING WASTE GLASS

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Abstract

Generally India produces 3 million tones of glass waste every year. Approximately 45% of this waste is received and recycled efficiently and the remaining glass waste ends up in landfills waste. The goal of the current project is to investigate the possibility of using glass waste (bottles, construction glass wastes, etc.) to partially substitute fine aggregate in the fabrication of building blocks. This study looked into how waste glass additions affected the block's mechanical and physical characteristics. 10%, 15%, 20%, 25%, and 30% of waste glass was used to make interlocking blocks in place of fine aggregate. The mechanical performance and durability of the prepared block specimens were assessed by tests such as compressive strength and water absorption. The study's findings showed that using glass trash to partially substitute fine aggregate in interlocking blocks makes production environmentally friendly and sustainable.

Keyword: Interlocking block, glass powder, sustainability, waste management

Chapter 157

UTILIZATION OF INDUSTRIAL AND CONSTRUCTION WASTE MATERIALS IN CONCRETE: A STUDY ON MICROSILICA AND OBBP

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Abstract

This experimental study examines the potential of utilizing microsilica and over-burnt brick powder (OBBP) as partial replacements for ordinary Portland cement (OPC) and natural fine aggregate in concrete, respectively. Driven by the environmental impact of cement production and the depletion of natural resources, this research explores sustainable alternatives for concrete construction. Microsilica, a pozzolanic byproduct of the ferrosilicon and silicon metal industries, is known to enhance concrete strength and durability due to its high silica content and fine particle size. Over-burnt brick powder, a waste material generated from brick kilns, presents an opportunity to reduce landfill waste and partially substitute conventional fine aggregate, offering potential cost benefits. The investigation focuses on evaluating the influence of varying replacement percentages of cement with microsilica (ranging from 5% to 15% at 5% increments) and fine aggregate with OBBP (ranging from 10% to 30% at 10% increments) on the fresh and hardened characteristics of concrete. The study will comprehensively evaluate hardened concrete properties such as compressive strength, flexural strength, splitting tensile strength, and water absorption at different curing ages (e.g., 7, 28, and 56 days). Microstructural analysis techniques, such as Scanning Electron Microscopy (SEM), may also be employed to understand the interfacial transition zone and the pozzolanic reaction products. The primary objective is to identify the optimal replacement levels of microsilica and OBBP that can achieve comparable or improved performance characteristics compared to conventional concrete mixtures. This research aims to contribute valuable insights towards promoting the utilization of industrial and construction waste materials in concrete production, fostering sustainable construction practices, and reducing the environmental burden associated with traditional concrete materials.

Keywords: Microsilica, Over-burnt Brick Powder (OBBP), Partial Replacement, Cement

Chapter 158

AN EXPERIMENTAL STUDY ON SOIL STABILIZATION OF BLACK COTTON SOIL USING HUMAN HAIR FIBER, SUGARCANE FIBRE ASH AND COCONUT COIR ASH

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Abstract

The increasing demand for sustainable and cost-effective soil stabilization techniques has led researchers to explore alternative materials that can enhance soil properties while minimizing environmental impacts. This study investigates the utilization of Bagasse Ash, Coir Fiber, and Human Hair as innovative stabilizing agents for improving the engineering properties of expansive soils. These materials are readily available, inexpensive, and environmentally friendly, making them promising candidates for effective soil stabilization. The findings of this study demonstrate that the combined use of Bagasse Ash, Coir Fiber, and Human Hair provides a sustainable, cost-effective, and eco-friendly solution for soil stabilization. The approach not only enhances soil properties but also promotes the beneficial reuse of agricultural and organic waste materials.

Keywords: Bagasse Ash, Coir Fibr , and Human Hair, soil stabilization

Chapter 159

INVESTIGATING THE WATER QUALITY OF VELLAR RIVER, CUDDALORE DISTRICT: A PHYSICO-CHEMICAL APPROACH

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Abstract

This study investigates the physico-chemical characteristics of the Vellar River within the Cuddalore District, Tamil Nadu, India. The Vellar River is a vital water resource in the region, and its water quality is influenced by various anthropogenic and natural factors. This research aims to assess the current water quality status by analyzing key physico-chemical parameters, including pH, electrical conductivity, dissolved oxygen, temperature, salinity, and nutrient levels (nitrates, phosphates). Water samples were collected from various sampling sites along the river's course within the Cuddalore district, encompassing areas with differing levels of human activity. The results of this analysis will provide valuable insights into the river's health, identify potential sources of pollution, and contribute to the development of effective water resource management strategies for the Vellar River ecosystem. This study will provide data that can be used to monitor the changes in the water quality, and to aid in efforts to preserve this important water resource.

Keywords: Water Quality, Physico-Chemical Characteristics, Vellar River, Anthropogenic Factors, Pollution, Water Resource Management, River Ecosystem.

Chapter 160

COMPARATIVE INVESTIGATION ON CLAY BRICK AND FLY ASH BRICKS

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Abstract

This paper presents clay and Fly Ash brick properties, manufacturing process material required for preparing the clay bricks and fly ash bricks as per Indian standard code provisions, inspection and quality control. Use of this additive could have practical implications as a means of recycling and for achieving cost savings in brick production. The bricks with Fly Ash were very similar to that of clay bricks. The absorption coefficient, shape and size, density, weight and compressive strength of Fly Ash bricks compare with normal clay bricks that delivered good results. It is found that compressive strength of the fly ash brick increased when compared to normal brick by more than two times. From our study, it can be concluded that Fly Ash bricks used as an alternative to clay bricks.

Keywords: Soil Stabilization Bagasse Ash Bioenzymes Sustainable Construction Geotechnical Engineering

Chapter 161

SOIL STABILIZATION USING BAGGASE ASH AND BIO ENZYMMES

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Abstract

Soil stabilization is a crucial process in geotechnical engineering aimed at improving the physical properties of soil for construction purposes. This study explores the potential of using bagasse ash, an agricultural byproduct from sugarcane processing, and bioenzymes, eco-friendly organic compounds, as sustainable soil stabilizers. Bagasse ash, rich in silica, acts as a pozzolanic material that enhances soil strength through chemical reactions, while bioenzymes improve soil particle bonding and reduce permeability. The combination of these two additives offers an environmentally friendly alternative to conventional stabilizers like cement and lime. Laboratory tests, including Atterberg limits, compaction, unconfined compressive strength (UCS), and California Bearing Ratio (CBR), were conducted to evaluate the improvements in soil behavior. Results indicated significant enhancements in soil strength, reduced plasticity, and improved load-bearing capacity. This study highlights the potential of bagasse ash and bioenzymes as cost-effective and sustainable solutions for soil stabilization in civil engineering projects.

Keywords: Soil Stabilization Bagasse Ash Bioenzymes Sustainable Construction Geotechnical Engineering

Chapter 162

EXPERIMENTAL INVESTIGATION OF INTERLOCKING BRICK USING WASTE GLASS

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Abstract

Generally India produces 3 million tones of glass waste every year. Approximately 45% of this waste is received and recycled efficiently and the remaining glass waste ends up in landfills waste. The goal of the current project is to investigate the possibility of using glass waste (bottles, construction glass wastes, etc.) to partially substitute fine aggregate in the fabrication of building blocks. This study looked into how waste glass additions affected the block's mechanical and physical characteristics. 10%, 15%, 20%, 25%, and 30% of waste glass was used to make interlocking blocks in place of fine aggregate. The mechanical performance and durability of the prepared block specimens were assessed by tests such as compressive strength and water absorption. The study's findings showed that using glass trash to partially substitute fine aggregate in interlocking blocks makes production environmentally friendly and sustainable.

Keyword: Interlocking block, glass powder, sustainability, waste management

Chapter 163**EXPERIMENTAL STUDY ON MIXING OF PLASTIC WASTE IN BITUMEN FOR LAYING FLEXIBLE PAVEMENT**Abishake Kiran.A¹, Balaji G², MohammedKaif³, Sheik Zayed F⁴,¹⁻⁴Final year students, Department of Civil Engineering,

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Abstract

This paper forms part of research to solve two main problems. Firstly, the management of municipal solid waste (MSW), particularly with regards to used plastics which have overwhelmed major cities and towns; secondly, the formation of potholes on roads due to excessive traffic and axle weight. This study examines the effect of blending waste thermoplastic polymers, namely High-density polyethylene (HDPE) and Polypropylene (PP) in Conventional AC-20 graded bitumen at various plastic compositions. The plastics were shredded and blended with the bitumen 'in-situ', with a shear mixer at a temperature range of 160°C-170°C. Basic rheological parameters such as penetration, ring & ball softening point and viscosity tests were employed to determine the resulting changes from base bitumen-FNR spectroscopy was also employed to study the chemical functionalities present in the bitumen composite. The properties of the unmodified bitumen were found to be enhanced with the changes recorded in the rheological properties of the polymer modified bitumen (PMB). It was observed that polypropylene polymer showed profound effect on homogeneity and compatibility with slight linear increment in the viscosity. The viscosity of unmodified bitumen was enhanced with the addition of the polymers and thixotropic effect was observed for both HDPE and PP at 60°C. For all modified binders prepared. The penetration values decrease as polymer-bitumen ratio increases while softening temperature generally increases as polymer ratio increases. The most compatible and incompatible blends for HDPE were respectively observed at 2% to 3% and polymer loading. The most enhanced, homogenous blend is achieved with PP at 3% polymer loading. Three prominent peaks were identified in the spectrum of the unmodified bitumen, occurring at the 3000-2850 cm, IR frequency range, typical of aliphatic -C-H symmetrical and asymmetrical stretches in alkanes. CH₂ and CH₃ bends were also observed at the characteristic frequencies of 1465 cm and 1375

cm respectively. The use of waste commodity plastics in binder modification carries the advantage of a cheap and effective means of enhancing conventional bitumen binder performance characteristics and is an alternative way to utilize plastic waste.

Keywords: High-density polyethylene, thixotropic effect, homogeneity, compatibility.

Chapter 164

EVALUATING THE STRUCTURAL INTEGRITY OF REINFORCED CONCRETE BEAMS WITH NATURAL FIBER COMPOSITE STIRRUPS UNDER CYCLIC LOADING CONDITION

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Abstract

This project investigates the feasibility of using fiber stirrups extracted from *Calotropis gigantea* as a partial replacement for conventional steel stirrups in reinforced concrete (RC) flexural members. The increasing demand for sustainable construction materials has led to the exploration of natural fibers due to their eco-friendly properties and potential to reduce the environmental impact of traditional steel reinforcement. Fibers from *Calotropis gigantea* were extracted, processed, and combined with epoxy resin to enhance their mechanical properties, particularly hardness and tensile strength. The structural performance of the fiber-reinforced stirrups was evaluated under cyclic loading conditions to assess their effectiveness in shear reinforcement. Key parameters such as stress distribution, deformation, and failure modes were analyzed and compared with conventional steel stirrups. The study examines the potential of these natural fiber composites in enhancing the structural integrity of RC beams while reducing dependence on steel reinforcement. The findings of this project contribute to the ongoing development of sustainable construction materials, demonstrating the viability of *Calotropis gigantea*-based fiber stirrups as an alternative reinforcement solution for eco-friendly and durable structural applications.

Keywords: *Calotropis gigantea*, steel reinforcement, cyclic loading, steel stirrups.

Chapter 165

EXPERIMENTAL STUDY OF CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITH GRANITE POWDER

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Abstract

In the pursuit of sustainable and environmentally responsible construction practices, the cement industry faces increasing pressure to reduce carbon emissions and utilize industrial by-products. This study explores the feasibility and effectiveness of using granite powder, a by-product of the granite processing industry, as a partial replacement for cement in concrete. The primary objective is to evaluate the mechanical and durability performance of concrete when cement is partially replaced with granite powder at varying percentages—20%, 25%, 30%, and 35% by weight of cement. An experimental methodology was adopted wherein concrete specimens were cast and tested for compressive strength, split tensile strength, and flexural strength at different curing periods. Workability was also studied using the slump cone test, while durability aspects were evaluated through water absorption and acid resistance tests. Initial findings suggest that concrete incorporating up to 30% granite powder exhibits comparable or even enhanced strength properties, while simultaneously promoting sustainability through the reduction of cement usage and the recycling of industrial waste. However, a higher replacement level beyond 30% showed a decline in mechanical performance, indicating an optimal threshold for substitution. This study thus highlights granite powder as a viable supplementary cementitious material (SCM) that can contribute to eco-friendly concrete production without compromising structural integrity. The results of this research offer significant potential for practical application in green construction and pave the way for future studies involving combined use with other pozzolanic materials.

Keywords: Granite powder, Cement replacement, Sustainable concrete

Chapter 166

EXPERIMENTAL STUDY ON RECYCLING OF PLASTIC WASTE INTO FLOOR TILES

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Abstract

The rapid increase in plastic waste production has led to significant environmental challenges worldwide. In response, there is a growing interest in developing innovative solutions for recycling plastic waste into value-added products. This study presents an experimental investigation on the development of tiles using plastic waste and epoxy resin as a sustainable alternative to conventional tiles. The plastic waste, sourced from post-consumer packaging materials, was processed and blended with epoxyresintoformcompositetilematerials.Theexperimentalinvestigationfocused on optimizing the composition of the composite tiles to achieve desirable mechanical, physical,andenvironmentalproperties.Variousparameters,includingtheproportion of plastic waste, curing time, and temperature, were systematically studied to assess their impact on the performance of the tiles. Mechanical properties such as flexural strength, compressive strength, and impact resistance were evaluated using standardized testing methods. Additionally ,the water absorption, chemical resistance, and thermal stability of the composite tiles were analyzed to assess their suitability for real-world applications. The results demonstrate the feasibility of using plastic waste and epoxy resin as viable materials for tile production, with composite tiles exhibiting promising mechanical and environmental performance. This research contributes to the development of sustainable construction materials and offers a practical solution for reducing plastic waste while creating value-added products.

Keywords: water absorption, chemical resistance, epoxy resin, composite tile materials

Chapter 167

IDENTIFICATION OF MOISTURE STRESS INDEX USING REMOTE SENSING DATA

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Abstract

Agricultural sustainability depends much on drought monitoring, especially in areas vulnerable to moisture stress. This paper evaluates agricultural moisture stress changes in the arid and semi-arid environment using the agricultural Moisture Stress Index (CMSI) and a novel approach, the Dual Polarimetric Crop Moisture Stress Index (DPCMSI), as a function of soil moisture and vegetation moisture acquired from Sentinel-1 and Sentinel-2 data. A study found lower evapotranspiration rates and residual soil moisture from precipitation in the winter help to show modest moisture stress levels. But as temperatures rose, evapotranspiration rates grew more strong. With values ranging from $r = 0.00$ to $r = 1.00$, the statistical analysis demonstrated a good connection between CMSI and DPCMSI, proving DPCMSI sufficiently reflects changes in crop moisture stress. The results imply that irrigation was essential in reducing moisture stress. The study emphasises the need for adaptive water management techniques to reduce crop stress during dry seasons and the possibility of combining multi-sensor observations for exact drought monitoring. Moreover, the seasonal variability in crop moisture stress underscores the importance of timely monitoring and response strategies to ensure sustainable yields. Remote sensing-based indices like DPCMSI provide valuable insights for early warning systems and precision agriculture. These tools can empower farmers and policymakers with data-driven decisions to combat the effects of climate variability on agriculture.

Keywords: Evapotranspiration, Polarimetric, CMSI and DPCMSI

Chapter 168

EXPERIMENTAL STUDY ON MORTAR WITH PARTIAL REPLACEMENT OF CEMENT WITH BIOCHAR

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Abstract

Cement production significantly contributes to global carbon emissions, necessitating sustainable alternatives to mitigate environmental impact. This study explores the feasibility of partial replacement of cement with biochar in mortar, aiming to enhance sustainability while maintaining structural integrity. The Biochar used for this study is *Prosopis juliflora* (Seemai Karuvelam) tree and the preparation of biochar is done by pyrolysis method. The experimental analysis involved varying replacement levels of BC (5%, 10%, and 15%) by weight of cement to evaluate its influence on consistency, compressive strength and setting time of the mortar. Fresh and hardened properties were assessed through standardized tests, comparing the modified mortar with conventional cement mortar. Microstructural analysis SEM is done for revealing the changes in hydration products, suggesting biochar's role in refining pore structure and modifying cement hydration kinetics. The study underscores the potential of biochar as a sustainable cement substitute, promoting carbon sequestration while reducing cement dependency. Therefore, optimization of replacement ratios and long-term durability assessments remain essential for practical implementation in construction. This research contributes to the growing field of eco-friendly construction materials, advocating for biochar as a viable supplement in cement-based applications, balancing environmental benefits with engineering performance.

Keywords: Biochar (BC), Carbon sequestering, Scanning Electron Microscope (SEM), *Prosopis juliflora*.

Chapter 169

EXPERIMENTAL STUDY ON BEHAVIOUR OF SMART CONCRETE BY USING GGBS AND STEEL SLAG

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Abstract

Smart concrete is an innovative material designed to respond to environmental conditions or stimuli, enhancing the functionality and durability of modern infrastructure. The current study investigates the behavior of smart concrete by partially replacing traditional cement with Ground Granulated Blast Furnace Slag (GGBS) and steel slag. These industrial by-products not only promote sustainable construction practices but are also known to improve certain mechanical and durability properties of concrete. The background of this research emphasizes the global need for sustainable materials that reduce the carbon footprint of construction. GGBS and steel slag have demonstrated potential as supplementary cementitious materials in previous studies. However, limited research exists on their combined influence in smart concrete applications. In this experimental study, various mixes were prepared with different proportions of GGBS and steel slag. The concrete specimens were tested for compressive strength, flexural strength, and workability. Smart functionalities such as self-sensing capabilities were also examined through resistivity measurements. The results indicated that the mix containing 30% GGBS and 20% steel slag showed optimal strength and durability, while also exhibiting better self-sensing properties compared to control specimens. The inclusion of these materials enhanced the microstructural properties, leading to improved performance under loading conditions. In conclusion, GGBS and steel slag contribute positively to the development of smart concrete. These findings recommend further large-scale applications and additional studies on long-term performance.

Keywords: Smart Concrete, GGBS, Steel Slag, Sustainable Construction, Self-sensing Concrete

Chapter 170

EXPERIMENTATION ON CONCRETE BY USING NANOVANADIUM MIXTURE

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Abstract

This paper describes the experimental inspection performed to evaluate the properties of concrete using nanovanadium as a fine aggregate. Concrete is the most commonly used material in the world, so it's abounded used in civil engineering construction field leads to increasing in aggregate scarcity. Because it reduces the use of natural resources, industrial waste is encouraged in the construction industry. Common industrial waste materials include fly ash, silica fume, and nanovanadium. These materials are successfully used in the construction industry for partial and. complete concrete replacement. The usage of nanovanadium for the partial replacement of fine aggregate the experimental procedure is conducted for the replacing percentage of 10%, 20%, 30%, 40% for this above replacement percentage M40 grade concrete is used. The main objective of this project is to know the strength and durability of partial replaced concrete. To evaluate the strength and durability the various test were conducted. The cube specimens were then prepared, demoulded after 24 hours and properly cured. The specimens were subjected to compression testing at 7, 14 and 28 days. It was observed from the test results that the strength of the specimens was higher than the control specimen.

Keywords: Fly Ash, Silica Fume, And Nanovanadium, concrete

Chapter 171

IMPROVEMENT OF MECHANICAL STABILITY OF SUBGRADE LAYER USING NATURAL FIBRE IN FLEXIBLE PAVEMENT

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Abstract

This project focus on which the mechanical stability of subgrade layer using natural fibre in flexible pavement. The natural fibre such as sisal fibre were identified to provide the good strength and stiffness to the subgrade layer in the flexible pavement. The top layer of flexible pavement often suffer from issues like rutting and cracking due to heavy traffic and environmental conditions. Along with subgrade soil gives them a good bonding between the pavement which explores the eco-friendly reinforcement materials. The natural fibre enhances the strength, durability and crack resistance of pavement layers, while being biodegradable and cost effective. The previous studies have shown the improvement in properties when the natural fibres were used. This sustainable approach not only boosts pavement but also supports the use of local materials and waste reduction. Laboratory investigations have been conducted to evaluate the effectiveness of sisal fibers in improving the geotechnical properties of soil. These tests typically include Standard Proctor compaction tests, Unconfined compressive strength (UCS) tests, California Bearing Ratio (CBR), Direct Shear test, and Vane Shear test to assess the changes in strength and deformation characteristics. The fibers are usually cut into uniform lengths and mixed with the soil at varying percentages to determine the optimal content for maximum performance enhancement. The use of natural fibers like sisal not only improves the mechanical behavior of subgrade layers but also supports eco-friendly construction methods by reducing reliance on synthetic materials. The study concludes that the mechanical stability of the subgrade layer in flexible pavements can be significantly improved by incorporating sisal fiber. The optimum fiber content was determined to be 2% by weight of dry soil, which yielded the most favorable results in terms of strength and performance. The inclusion of sisal fibers led to a noticeable increase in the CBR, indicating enhanced load-bearing

capacity. Additionally, the modified soil exhibited improved toughness, and resistance to deform under load. Beyond performance benefits, the use of sisal fibers offers an eco-friendly and cost-effective solution, aligning with sustainable construction practices. This method is especially advantageous for rural and low-volume roads where cost efficiency and material availability are crucial factors.

Keywords: Sisal fibre, CBR, UCC test, subgrade layer

Chapter 172

ENHANCING THE REMOVAL OF ORGANIC COMPOUNDS FROM TEXTILE EFFLUENT USING NATURAL ADSORBENTS

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Abstract

Textile industry wastewater is a challenging feed stream for treatment by membrane separation because of its complex composition and the presence of reactive components. Textile industry wastewater has high pH value, higher concentration of suspended solids, chlorides, nitrates, metals like manganese, sodium, lead, copper, chromium, iron, and high BOD and COD. Textile industry generates substantial quantity of effluent which is mostly treated by chemical and biological treatment process. These conventional treatment processes may not be very effective for the removal of specific pollutants such as colour and the dissolved solids. Textile industry uses number of dyes and chemicals to impact the desired quality in the fabrics. Its estimated that out of dyes consumed by textile industry, about 10-15% of dye is disposed of in the effluent which can cause environmental problems unless the effluent is property treated. This reduces the growth of bacteria to a level insufficient to biologically degrade impurities in the water. Application of the advance treatment technologies and processes while reducing these pollutants also give a scope for recovery of water and salt effluents.

Keywords: pH value, BOD and COD, treatment technologies

Chapter 173

REMOVAL OF SYNTHETIC DYE FROM AQUEOUS SOLUTION BY TEAK LEAVES AND BANANA TRUNK

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Abstract

This project deals with two cost locally available renewable bio-adsorbents-banana trunk and teak leaves are used in the removal of synthetic dye from aqueous solution. Batch adsorption experiments are conducted to evaluate the adsorption capacity, effect of contact time, pH and initial dye concentration. based on the expected results significant dye removal efficiency with optimum adsorption occurring under acidic condition for both adsorbents will be analyzed. Adsorption isotherms are to be analyzed to understand the mechanism involved. This project may give that teak leaves and banana trunk are effective ,eco-friendly and alternative for dye removal in aqueous solution

keywords: Activated carbon, Teak leaves, Banana trunk, Chemical activation, Adsorption capacity

Chapter 174

ANALYSIS AND CHARACTERIZATION OF NATURAL FIBER REINFORCED ACALYPHA

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Abstract:

The aim of this study is to estimate and understand the effect of natural fibers and filler materials that are used in fabrication of polymer composite material and analyze the verified results like tensile and flexural. In this study different composites are prepared with nettle (*acalypha indica*) fibers and filler materials like silicon carbide, tungsten carbide, fly ash, egg, rubber, and rice husk are consider. An attempt is made to compare and analyze the tensile and flexural strength based on experimental results. The use of natural fiber reinforcement in composite materials has gained considerable attention due to its potential to enhance mechanical properties and reduce environmental impact compared to synthetic fibers. This study investigates the incorporation of natural fibers into the *Acalypha* species, commonly known for its soft and flexible plant material, for potential use in sustainable composite materials. The aim is to characterize the mechanical, thermal, and morphological properties of *Acalypha* fibers when used as a reinforcement in composite structures. Various natural fibers from *Acalypha* were extracted, processed, and subjected to testing for tensile strength, flexural properties, and impact resistance. Additionally, scanning electron microscopy (SEM) and Fourier-transform infrared spectroscopy (FTIR) were employed to analyze the fiber structure and chemical composition. The results indicated that *Acalypha* fibers possess favorable mechanical properties, making them a promising alternative to traditional synthetic fibers in composite applications. Furthermore, the biocompatibility and biodegradability of *Acalypha*-based composites contribute to their potential in environmentally friendly product development. This research highlights the importance of exploring indigenous plant materials for reinforcing composites, paving the way for the use of *Acalypha* .

Chapter 175

EVALUATION PERFORMANCE COMBUSTION AND EMISSION ANALYSIS OF THE ALGAE BIODIESEL FUELLED WITH NANO-ADDITIVES

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Abstract:

The increasing demand for sustainable and eco-friendly energy sources has led to extensive research into alternative fuels. Among these, algae-based biodiesel presents a promising solution due to its high oil yield, rapid growth rate, and minimal impact on arable land and freshwater resources. This study investigates the performance, combustion, and emission characteristics of algae biodiesel when blended with nano-additives, aiming to enhance engine efficiency and reduce environmental pollutants. In this work, biodiesel is extracted from microalgae and blended with diesel in various ratios. Nano-additives such as aluminum oxide (Al_2O_3) and cerium oxide (CeO_2) are incorporated at different concentrations to study their effect on combustion efficiency and emission behavior. The blends are tested in a single-cylinder, four-stroke CI engine under varying load conditions. Performance parameters such as brake thermal efficiency (BTE) and brake-specific fuel consumption (BSFC) are measured and compared with conventional diesel. Combustion analysis includes cylinder pressure, heat release rate, and ignition delay. The use of nano-additives is observed to improve atomization and air–fuel mixing, leading to more complete combustion.

Emission parameters such as CO, HC, NO_x, and smoke opacity are recorded using a gas analyzer and smoke meter. Results indicate that algae biodiesel blended with nano-additives significantly reduces CO and HC emissions while slightly increasing NO_x levels, which can be controlled with exhaust after-treatment techniques. The overall study concludes that algae biodiesel, when optimized with nano-additives, serves as a viable, renewable, and cleaner alternative to fossil fuels. It also enhances combustion efficiency and reduces harmful emissions, making it suitable for sustainable energy applications in internal combustion engines.

Chapter 176

CONDITION MONITORING OF BELT GEARBOXES IN SME MACHINES USING IOT

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Abstract:

In small and medium-scale enterprises (SMEs), belt-driven gearboxes are extensively used in various machines due to their low cost and mechanical simplicity. However, unexpected failures in these systems can lead to significant downtime and maintenance costs. This project focuses on the development of an IoT-based condition monitoring system for belt gearboxes used in SME machinery, aiming to ensure predictive maintenance and enhance machine reliability. The proposed system utilizes a network of sensors—including vibration sensors, temperature sensors, and acoustic sensors—to continuously monitor key parameters of the gearbox during operation. Data collected from these sensors is transmitted in real-time to a cloud-based IoT platform using Wi-Fi or LoRa communication protocols. Advanced data analytics and signal processing techniques are applied to detect early signs of wear, misalignment, belt slippage, and bearing failure. The system integrates threshold-based alerts and predictive algorithms, allowing maintenance teams to be notified instantly via mobile or web applications. The mechanical behavior of the gearbox is analyzed under various load and speed conditions to identify characteristic failure signatures. A comparative study is also conducted between normal and faulty states to train machine learning models for fault classification and remaining useful life (RUL) prediction. By implementing this IoT-based solution, SMEs can shift from a reactive or time-based maintenance approach to a predictive maintenance strategy, reducing unplanned downtimes and extending the life of critical mechanical components.

Chapter 177

DESIGN AND FABRICATION OF IOT BASED FORKLIFT

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Abstract:

In the era of Industry 4.0, the integration of smart technologies into traditional material handling equipment has become essential for improving efficiency, safety, and automation. This project focuses on the design and fabrication of an IoT-based forklift, aimed at enhancing logistics operations in warehouses, factories, and industrial environments.

The forklift is mechanically designed with a sturdy chassis, lifting mast, fork assembly, and electric drive system, suitable for transporting medium-weight loads. An IoT module is integrated to enable real-time monitoring, remote control, and data logging of forklift operations. Key parameters such as load weight, fork position, battery status, obstacle detection, and operational hours are continuously monitored using appropriate sensors.

The data collected is transmitted via Wi-Fi or GSM to a cloud platform, allowing for centralized control and predictive maintenance through analytics dashboards. The system also features a mobile/web application for remote operation, diagnostics, and alerts, improving fleet management and minimizing downtime. The mechanical components are optimized for durability and performance, while the control logic is programmed using microcontrollers such as Arduino or ESP32. Safety features such as emergency stop, speed control, and object avoidance using ultrasonic or IR sensors are implemented to prevent accidents and ensure user safety. The prototype is tested under real-time loading and movement conditions to evaluate its efficiency, response time, and communication reliability. Results show significant improvement in monitoring, safety, and operational transparency compared to conventional forklifts.

Chapter 178

EVALUATION OF SISAL BANANA EPOXY REINFORCED NATURAL COMPOSITE

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Abstract:

The growing demand for sustainable and eco-friendly materials in engineering applications has driven interest in natural fiber composites. This project presents an experimental investigation into the evaluation of a hybrid natural composite made from sisal and banana fibers reinforced in an epoxy resin matrix. The objective is to develop an environmentally friendly material with improved mechanical properties suitable for lightweight structural applications. Natural fibers such as sisal and banana offer advantages like biodegradability, low cost, low density, and reasonable strength. In this study, fibers are extracted, chemically treated for better adhesion, and then arranged in various orientations and weight fractions before being combined with epoxy resin using hand lay-up or compression molding techniques. Mechanical testing is conducted to assess tensile strength, flexural strength, impact resistance, and hardness of the composite. Microstructural analysis is performed using Scanning Electron Microscopy (SEM) to examine fiber dispersion, bonding quality, and failure mechanisms. The results show that the hybrid composite exhibits improved mechanical properties compared to individual fiber composites, due to the synergistic effect between the sisal and banana fibers. The fiber treatment significantly enhances the fiber–matrix interfacial bonding, contributing to better load distribution and overall strength. Thermal behavior and water absorption characteristics are also studied to evaluate the composite’s environmental durability. The composite shows acceptable thermal stability and moisture resistance, making it suitable for automotive panels, interior construction materials, and packaging. This study concludes that sisal-banana-epoxy hybrid composites are a promising alternative to synthetic composites in low-to-medium strength applications, aligning with sustainability goals and reducing dependence on non-renewable resources.

Chapter 179

TRIBOLOGICAL INVESTIGATIONS OF THE ALGAE BIODIESEL IN SEM OF FOUR STROKE COMPRESSION IGNITION ENGINES

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Abstract:

This project focuses on the tribological behavior of algae-based biodiesel in a single-cylinder four-stroke compression ignition (CI) engine, with an emphasis on wear analysis using Scanning Electron Microscopy (SEM). Algae biodiesel blends are prepared and tested in comparison with conventional diesel under identical operating conditions. The study evaluates the lubricating properties, frictional behavior, and wear characteristics of the fuel by analyzing engine components such as piston rings, cylinder liners, and valves after extended operation. Tribological performance is assessed through surface roughness measurements, wear scar analysis, and coefficient of friction data. SEM is employed to examine microstructural changes, wear patterns, and surface degradation of metallic components exposed to biodiesel combustion by-products.

The test results reveal that algae biodiesel exhibits satisfactory lubricity and a lower wear rate in certain engine parts due to the presence of oxygenated compounds that enhance film formation. However, mild abrasive wear is observed due to possible impurities and oxidation products in the biodiesel. Combustion analysis is also carried out to correlate wear with combustion quality, exhaust temperature, and residue formation. The findings suggest that with proper filtration and additives, algae biodiesel can serve as a viable alternative fuel without compromising engine life. This research demonstrates that tribological evaluation is crucial for understanding material compatibility and engine longevity when using biodiesel. The insights gained support the broader adoption of biofuels in IC engines, contributing to greener transportation technologies.

Chapter 180

COMPOSITE NATURAL HYBRID MATERIAL OF ARECA LEAF

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Abstract:

The development of sustainable materials has garnered significant attention in recent years due to increasing environmental concerns and the depletion of non-renewable resources. This study focuses on the fabrication and characterization of a composite natural hybrid material derived from areca palm leaf sheaths, an agricultural byproduct widely available in tropical regions. Areca leaf sheath, known for its natural strength, biodegradability, and fibrous structure, offers an eco-friendly alternative to synthetic fibers when used as reinforcement in composite materials. The objective of this work is to develop a bio-composite by combining areca leaf fibers with biodegradable resins and evaluate its mechanical, thermal, and physical properties. Various combinations of natural binders, such as starch-based resins or polylactic acid (PLA), were tested to optimize compatibility and adhesion. Surface treatment of the areca fibers was performed to improve bonding characteristics and minimize moisture absorption. Mechanical testing, including tensile, flexural, and impact strength analysis, demonstrated that the areca-based composite exhibits promising strength-to-weight ratios comparable to conventional synthetic composites. Thermal stability and degradation behavior were assessed using thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC), confirming the material's suitability for semi-structural and packaging applications. Morphological analysis using scanning electron microscopy (SEM) revealed good dispersion and bonding of fibers within the matrix. The composite also showed low environmental impact, high renewability, and cost-effectiveness, making it ideal for applications in automotive interiors, construction panels, furniture, and biodegradable packaging. This research paves the way for innovative utilization of agricultural waste and contributes to the advancement of green materials science. Further studies could explore hybridization with other natural fibers such as jute or flax for enhanced performance. Overall, areca leaf-based composites represent a viable and

sustainable alternative to petroleum-based materials, aligning with global goals for a circular economy and green engineering.

Chapter 181

AN INVESTIGATION AND PROCESS PARAMETER OPTIMISATION OF FLANGE MADE WITH PETG POLYMERS USING 3D PRINTING

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Abstract:

The advancement of additive manufacturing has opened new frontiers in polymer-based component fabrication, especially in functional prototypes and industrial applications. This study investigates the production of a flange using PETG (Polyethylene Terephthalate Glycol) polymer through Fused Deposition Modeling (FDM), one of the most widely used 3D printing techniques. PETG is selected due to its superior mechanical strength, chemical resistance, and ease of printability compared to PLA and ABS. The primary objective is to optimize the key process parameters to enhance the mechanical performance and dimensional accuracy of the printed flange. Critical parameters including layer height, print speed, infill density, and nozzle temperature were systematically varied using Design of Experiments (DOE) methodology. Taguchi's L9 orthogonal array was employed to minimize the number of experimental trials while ensuring statistical reliability. Post-processing and testing of the flanges involved tensile testing, impact resistance evaluation, surface roughness measurements, and dimensional deviation analysis. The results indicated that infill density and nozzle temperature had the most significant influence on the mechanical integrity of the flange. Optimal parameters were found to be 0.2 mm layer height, 60 mm/s print speed, 80% infill density, and 240°C nozzle temperature. SEM analysis of fracture surfaces revealed good layer adhesion at optimal settings. This research demonstrates that with fine-tuned process parameters, PETG can be effectively used to produce functional flanges via 3D printing. The findings contribute to the growing knowledge of polymer additive manufacturing for mechanical applications and pave the way for further explorations into functional replacements of metallic parts using high-performance thermoplastics.

Chapter 182

Extraction, Characterization, And Biomedical Potential Of Piper Nigrum Fiber: A Sustainable Alternative For Advanced Bioapplications

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Abstract:

In the pursuit of sustainable and biocompatible materials for biomedical applications, plant-based fibers have emerged as promising alternatives to synthetic counterparts. This study explores the extraction, detailed characterization, and biomedical potential of fiber derived from Piper nigrum (black pepper) stems. Piper nigrum, a widely cultivated spice crop, generates significant agricultural waste, which has been largely untapped for high-value applications. The fiber was extracted using an eco-friendly water retting method, followed by mechanical combing and drying processes. Comprehensive physicochemical characterization was performed using Fourier Transform Infrared Spectroscopy (FTIR), X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), and Thermogravimetric Analysis (TGA) to evaluate functional groups, crystallinity, surface morphology, and thermal stability. The fiber exhibited high cellulose content, moderate crystallinity, and notable thermal resistance, making it a suitable candidate for biomedical scaffolds and wound dressings. Mechanical testing revealed adequate tensile strength and flexibility comparable to existing natural biomedical fibers such as banana and jute. Biocompatibility was confirmed through in-vitro cytotoxicity assays using fibroblast cell lines, which showed no adverse effects, indicating excellent cell viability and proliferation. Antibacterial studies demonstrated natural antimicrobial activity, particularly against Staphylococcus aureus and Escherichia coli, enhancing its utility in infection-prone applications. This study positions Piper nigrum fiber as a novel, renewable, and biodegradable material for future use in advanced biomedical technologies. Its availability, eco-friendly extraction, and multifunctional properties underscore its potential in tissue engineering, drug delivery systems,.

Chapter 183

Fabrication And Performance Evaluation Of Aluminum-Eggshell Nanoparticle Reinforced Epoxy Hybrid Composites For Sustainable Engineering Applications

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Abstract:

In recent years, the development of eco-friendly composite materials has gained considerable attention in response to the growing need for sustainable engineering solutions. This study focuses on the fabrication and performance evaluation of a novel hybrid composite reinforced with aluminum and eggshell-derived nanoparticles in an epoxy resin matrix. The use of eggshells, a readily available biowaste, adds significant value by providing a low-cost, renewable reinforcement with calcium carbonate content and enhancing the composite's environmental sustainability.

The aluminum particles contribute to improved mechanical and thermal properties, while the eggshell nanoparticles enhance biodegradability and reduce the environmental impact. The hybrid composite was fabricated using the hand lay-up technique followed by compression molding. Different weight fractions of aluminum and eggshell nanoparticles (ranging from 1% to 5%) were incorporated to investigate the optimal reinforcement ratio.

Comprehensive material characterization was carried out through tensile, flexural, and impact strength tests. Scanning Electron Microscopy (SEM) was used to examine fracture surfaces and filler dispersion. Thermal stability was evaluated through Thermogravimetric Analysis (TGA) and Differential Scanning Calorimetry (DSC), confirming improved resistance to degradation. Water absorption and hardness tests were also performed to assess durability and surface performance.

Results indicated that the composite with 3% aluminum and 2% eggshell nanoparticles exhibited the best balance of mechanical strength, toughness, and thermal stability. The synergistic effect of hybrid fillers contributed to enhanced load-bearing capacity and resistance to crack propagation.

This research demonstrates the feasibility of using agricultural waste in combination with metallic fillers to create sustainable, high-performance composite materials .

Chapter 184

TRIBOLOGICAL INVESTIGATION OF THE ALGAE BIO DIESEL IN FOUR STROKE COMPRESSION IGNITION ENGINE

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Abstract:

The growing environmental concerns and depletion of fossil fuels have prompted the exploration of renewable and sustainable energy alternatives. Algae-based biodiesel has emerged as a promising biofuel owing to its high oil yield, rapid growth rate, and ability to thrive in non-arable land. This study investigates the tribological performance of algae biodiesel when used in a four-stroke compression ignition (CI) engine, focusing on its effects on engine wear, frictional behavior, and lubrication characteristics. Algae oil was extracted through solvent-based methods and subsequently transesterified to produce biodiesel. The biodiesel was blended with conventional diesel in various ratios (B10, B20, B30), and pure algae biodiesel (B100) was also tested. The tribological analysis involved the use of a four-ball wear tester and engine component inspection after prolonged operation. Key parameters such as wear scar diameter, coefficient of friction, viscosity index, and flash point were evaluated. Engine tests included measurement of brake thermal efficiency, specific fuel consumption, and exhaust gas temperature. Post-test analysis of engine parts such as piston rings and cylinder liners was conducted using SEM to observe wear patterns and deposits. Results indicated that B20 blend offered optimal tribological performance, with reduced wear and stable lubrication compared to pure diesel. The natural oxygenates in algae biodiesel contributed to better combustion and lower carbon deposits. Moreover, the biodiesel blends showed improved lubrication film strength and oxidation stability. This study validates the potential of algae biodiesel as a renewable fuel with favorable tribological characteristics, enhancing engine life and reducing environmental impact. The findings provide crucial insights into the viability of algae biodiesel for practical CI engine applications and pave the way for greener fuel alternatives in the transportation and agricultural sectors.

Chapter 185

COMPOSITE NATURAL HYBRID MATERIAL OF BANANA FIBER

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Abstract:

Natural fiber composites are gaining increasing attention as sustainable alternatives to synthetic composites due to their renewability, biodegradability, and eco-friendliness. This study focuses on the development and evaluation of a natural hybrid composite material reinforced with banana fiber, aimed at promoting green engineering applications. Banana fiber, extracted from the pseudostem of the banana plant, is lightweight, abundantly available, and possesses high tensile strength, making it a suitable reinforcement material. To enhance the performance characteristics, banana fiber was hybridized with other natural fibers such as jute and sisal in varying weight ratios within a polymer matrix (epoxy resin). The hand lay-up method followed by compression molding was used to fabricate composite laminates. Mechanical properties such as tensile strength, flexural strength, and impact resistance were evaluated according to ASTM standards. Surface morphology was examined through Scanning Electron Microscopy (SEM) to study fiber dispersion and interfacial bonding. Water absorption tests and thermal stability analysis using Thermogravimetric Analysis (TGA) were also conducted to assess durability. Results showed that hybridization improved the overall mechanical and thermal properties of the composite compared to single-fiber composites. The composite containing 50% banana fiber and 50% jute fiber exhibited the best balance of strength and thermal resistance, while maintaining biodegradability. Chemical treatments using alkali (NaOH) were applied to banana fibers to improve adhesion with the matrix, further enhancing the composite performance. This investigation demonstrates the feasibility of utilizing banana fiber in combination with other natural fibers to develop hybrid composites for applications in automotive interiors, packaging, furniture, and construction. The study promotes the valorization of agricultural waste and encourages a shift towards sustainable material design.

Chapter 186

FOUR WHEEL STEERING CONTROL

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Abstract:

The demand for improved vehicle maneuverability, safety, and stability has led to the development of advanced steering systems such as Four Wheel Steering (4WS). Unlike conventional steering systems where only the front wheels are steered, 4WS enables both the front and rear wheels to turn, enhancing control over vehicle movement in diverse driving conditions. This project presents the design, development, and control strategy of a Four Wheel Steering system, with emphasis on performance evaluation under various steering modes. The 4WS system allows for three primary steering modes: crab steering, opposite phase steering, and same phase steering, depending on the speed and maneuvering requirement. At low speeds, rear wheels steer in the opposite direction of the front wheels to reduce turning radius, improving parking and cornering in confined spaces. At high speeds, rear wheels steer in the same direction as the front wheels to ensure lane stability and reduce vehicle yaw. The mechanical design includes a modified linkage mechanism connected to both front and rear axles. A microcontroller-based electronic control unit (ECU) manages input from steering sensors and vehicle speed sensors to determine optimal rear wheel angles in real-time. The system was implemented on a scaled prototype and tested under various operating conditions. Simulation and experimental analysis demonstrated that the 4WS system significantly reduces turning radius, improves vehicle stability, and enhances driver control. Additionally, the system contributes to reduced tire wear and better weight distribution during turns. The integration of an intelligent control algorithm enhances the adaptability of the system in both urban and highway environments. This research highlights the potential of Four Wheel Steering in future intelligent vehicles and autonomous systems. It also opens up opportunities for innovation in heavy-duty vehicle navigation, off-road mobility solutions, and compact urban transportation systems, supporting the evolution of smart and efficient automotive technology.

Chapter 187

DESIGN AND FABRICATION OF ONE ROW SEEDER MACHINE

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Abstract:

Agricultural mechanization is crucial for increasing productivity, reducing manual labor, and promoting efficient land use. Among various mechanized tools, seeders play a vital role in ensuring uniform seed placement, proper depth control, and optimal spacing. This project focuses on the design and fabrication of a one-row seeder machine aimed at benefiting small and medium-scale farmers by reducing manual seed sowing effort and improving planting precision. The one-row seeder is designed to perform three major operations simultaneously: furrow opening, seed metering and delivery, and soil covering. The main components include a frame, seed hopper, metering mechanism, furrow opener, ground wheel, and seed tube. Special attention is given to selecting cost-effective and locally available materials to ensure affordability and ease of maintenance. The seed metering system is the heart of the seeder, responsible for accurate and uniform seed dispensing. A fluted roller mechanism was chosen for its simplicity, adjustability, and versatility in handling a variety of seed types like maize, soybean, and groundnut. The power transmission is achieved through a ground wheel-driven shaft, eliminating the need for external power sources and enhancing portability and eco-friendliness. The machine is lightweight, manually operated, and suitable for small landholdings where large machinery is impractical. The design process involved CAD modeling, stress analysis, and ergonomic considerations to ensure ease of operation. Field trials were conducted to test seeding efficiency, spacing accuracy, and field coverage rate. Results from preliminary field tests revealed improved sowing speed and uniform seed placement compared to traditional hand sowing. The machine demonstrated a field efficiency of around 85%, significantly reducing labor time and improving yield potential. Adjustability features were included to cater to different seed sizes and row spacing requirements.

Chapter 188

REDUCTION OF MOISTURE CONTENT IN BAGASSE USING SURPLUS HEAT FROM EXHAUST FLUE GAS

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Abstract:

Bagasse, the fibrous residue left after extracting juice from sugarcane, is widely used as a biofuel in sugar and cogeneration industries. However, high moisture content (40–50%) in bagasse significantly reduces its calorific value and combustion efficiency, leading to increased fuel consumption and emission generation. This project investigates an innovative and sustainable method for reducing the moisture content in bagasse using surplus heat from exhaust flue gases, which are otherwise wasted in conventional processes. The primary objective is to utilize low-grade heat from boiler exhaust or engine flue gases to pre-dry bagasse before combustion, thereby improving its thermal efficiency. A heat exchanger-based drying system was designed and fabricated, incorporating indirect contact between the hot flue gas and the moist bagasse to avoid contamination. The system includes a drying chamber, a duct system for flue gas routing, a blower, and temperature/moisture monitoring sensors. The drying process is controlled by adjusting the residence time of bagasse and the flow rate of hot gases. Thermodynamic and heat transfer calculations were conducted to optimize system parameters such as gas temperature, flow rate, and drying chamber dimensions. Bagasse samples were tested at different time intervals to measure moisture reduction, and results were compared against traditional sun-drying methods. Experimental findings revealed that using exhaust flue gas can reduce bagasse moisture content by up to 25–30% within 20–30 minutes, significantly enhancing its combustion quality and reducing unburnt residues. The calorific value of dried bagasse increased by approximately 15–20%, leading to more efficient energy generation in boilers. Moreover, the process minimizes dependence on fossil fuels for drying and reduces particulate emissions due to better combustion. This technique presents an eco-friendly, cost-effective solution for the sugar industry and allied sectors aiming to maximize energy recovery from waste heat. By integrating energy conservation

Chapter 189

PRE-DISPATCH INSPECTION AND TIME MANAGEMENT BRAKES UNIT

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Abstract:

In modern manufacturing industries, especially within the automotive sector, quality assurance and on-time delivery are critical for maintaining brand reputation and customer satisfaction. One of the essential components of any vehicle is the brake unit, which directly influences safety and performance. This project focuses on the Pre-Dispatch Inspection (PDI) process and Time Management techniques applied specifically to brake units before shipment, aiming to enhance quality control and streamline production flow. Pre-Dispatch Inspection is the final checkpoint before the product leaves the factory. It ensures that all functional, dimensional, and visual parameters of the brake unit meet predefined standards and customer specifications. The study involves the design and implementation of a structured PDI protocol including key inspection steps like leakage tests, braking force measurement, surface finish checks, and component assembly verification. In parallel, the project addresses time management challenges faced during the inspection and packaging of brake units. Detailed time-motion studies were conducted to analyze the workflow, identify bottlenecks, and optimize inspection duration without compromising quality. Lean manufacturing principles and tools such as Value Stream Mapping (VSM), 5S, and Kaizen were applied to minimize non-value-added activities. A real-time tracking system was integrated to monitor inspection times and ensure traceability of each unit. The results showed that through effective PDI planning and time optimization, inspection time per unit was reduced by 18%, while the rejection rate decreased significantly due to early defect detection. The implementation of a digital checklist system further enhanced accuracy and ensured compliance with international standards such as ISO/TS 16949. The improved process increased customer confidence, reduced warranty claims, and enhanced supply chain efficiency. This project highlights the importance of combining systematic inspection techniques with efficient time management to deliver high-quality, defect-free brake units.

Chapter 190

SMART CITIES AND IoT IN INFRASTRUCTURE

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Abstract

Smart City promises to enhance resource utility, cost-effectiveness, sustainability and living conditions in urban environments by utilizing Internet-of-Things (IoT) infrastructures. This chapter presents a comprehensive survey on the architectural design and key wireless communication technologies that enable Smart City applications. In addition, with the adoption and installation of IoT devices on a city-wide scale, securing these devices and the associated communications networks becomes an important issue. As a result, this chapter then continues with a survey to discuss potential security threats for IoT devices in a Smart-City environment, possible countermeasures and open research issues.

Chapter 191

PERFORMANCE EVALUATION OF COOLING SYSTEMS FOR HYBRID PVT SYSTEM

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ABSTRACT

This study investigates the performance of cooling systems in hybrid Photovoltaic Thermal (PVT) systems, focusing on the comparative effects of active cooling (water-based) and passive cooling (natural convection) techniques. PVT systems are gaining traction due to their ability to simultaneously generate electricity and thermal energy, yet they face significant efficiency losses at elevated operating temperatures. This research aims to provide a comprehensive evaluation of how various cooling strategies impact thermal and electrical efficiencies under controlled conditions. Experimental trials were conducted over a range of atmospheric conditions, with a solar simulator calibrated to an irradiance level of 800 W/m². Data was collected to assess the electric output, thermal performance, and overall efficiency of the systems over four hours of testing. Results indicated that the active cooling method enhanced thermal efficiency by approximately 9.88% and electrical efficiency by 7.53%, compared to 9.38% and 7.34% respectively for passive cooling methods. Moreover, real-time temperature monitoring revealed critical insights into the thermal dynamics of the PVT system, illustrating the direct correlation between PV panel temperature and energy output. The implications of this study suggest that implementing efficient cooling mechanisms can maximize energy extraction in hybrid PVT systems, thereby addressing critical challenges in renewable energy deployment. This research provides valuable insights into optimizing system designs and operational strategies, contributing to the ongoing efforts to improve renewable energy efficiency and sustainability. Future work will explore advanced cooling methodologies, including the integration of phase change materials and innovative thermal management strategies, to further enhance the performance of PVT systems in various climatic conditions.

Keywords: Irradiance, Hybrid PVT systems, cooling systems, thermal efficiency, electrical efficiency.

Chapter 192**Effect of volume fraction on microstructure and wear behavior of dual phase Brass/W surface composites fabricated via friction stir processing**S. Karpagarajan ^{a*}, C. Balamurugan ^b^a Department of Mechanical Engineering, Dhanalakshmi Srinivasan Engineering College, Perambalur 621212, Tamil Nadu, India.^b Department of Mechanical Engineering, Anna University, Chennai 600025, Tamil Nadu, India.

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Abstract

The objective of this study is to fabricate brass matrix composites (BMCs) via friction stir processing (FSP) for enhancing the wear resistance of brass. The tungsten (W) particles ranging from 0 to 18 vol.% were reinforced in the brass (Cu-40Zn) matrix through FSP. The FSP derived exceptional homogeneous dispersion of W particles leaving no traces of agglomeration and isolation. The bonding between the interface and brass matrix was strong due to the absence of pores and undesirable compounds. Irrespective of the density gradient, FSP nullified the unfavorable effect on W dispersion in BMCs. The BMCs revealed fine-grained structures in the microstructural studies when compared to that of as-received brass, which reported an average grain size of 13 μm . Particularly, the BMC with 18 vol.% W particles showed higher reduction in the average grain size (4 μm), which was 70% less than that of as-received brass. Furthermore, the transmission electron microscopy studies recorded discontinuous dynamic recrystallization and dense dislocations with a density of $9.31 \times 10^8 / \text{mm}$ near the stir zone. This led to an improvement in the hardness of BMCs. The BMC with 0 vol. % of W particles reported a hardness of 142 Hv whereas the BMC with 18 vol.% W particles revealed a hardness value of 165 Hv. Moreover, there was a proportional increase in hardness concerning the increase in W particles. The presence of W particles dipped the wear rate of BMCs during sliding tests and emanated smaller wear debris than the brass matrix. The wear rate was found to be $341 \times 10^{-5} \text{ mm}^3/\text{m}$ at 0 vol.% of W particles whereas, the wear rate was reduced to $185 \times 10^{-5} \text{ mm}^3/\text{m}$ at 18 vol. % of W particles. The W particles in BMCs were responsible to alter the adhesive wear into abrasive wear and upgraded the wear resistance of brass material.

Keywords: Brass Matrix Composites; Dual-Phase Brass;

Chapter 193

A REVIEW ON SYNGAS PRODUCTION FROM AGRO-BIOMASS RESIDUES: TAMARIND, COCONUT STALK, AND GROUNDNUT SHELL VIA GASIFICATION

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Abstract

The growing global energy demand, coupled with environmental concerns associated with fossil fuel consumption, has intensified the search for sustainable and renewable energy alternatives. Syngas, a mixture of hydrogen (H₂), carbon monoxide (CO), methane (CH₄), and other gases, presents a promising energy carrier that can be produced from biomass through thermochemical conversion processes such as gasification. Agro-biomass residues, often considered waste, offer a viable feedstock for syngas production, contributing to waste management and energy sustainability. This review comprehensively examines the potential of three abundant yet underutilized agro-residues—tamarind shell, coconut stalk, and groundnut shell—for syngas generation via gasification. The physicochemical properties of these biomass residues, including proximate and ultimate analysis, calorific value, and ash content, are critically analyzed to assess their suitability for gasification. The influence of key operational parameters such as gasification temperature, equivalence ratio, gasifying agents (air, steam, oxygen), and catalyst use on syngas composition (H₂/CO ratio), tar formation, and overall process efficiency is discussed. Furthermore, this review addresses the environmental benefits of utilizing agro-residues for syngas production, including reduced greenhouse gas emissions and sustainable waste valorization. Economic considerations, such as feedstock availability, gasification technology scalability, and syngas utilization in power generation or chemical synthesis, are also explored. Challenges such as tar removal, ash sintering, and the need for efficient gas cleaning systems are highlighted, along with potential solutions and future research directions.

Keywords: Syngas, biomass gasification, tamarind shell, coconut stalk

Chapter 194

SUSTAINABLE HYBRID COMPOSITES: NATURALLY WOVEN COCONUT SHEATH REINFORCED AND WOODEN FILLERS WITH POLYESTER MATRIX

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ABSTRACT

This study explores the development and characterization of hybrid composites using coconut sheath and wooden fillers reinforced with polyester resin. The research investigates the mechanical properties, including tensile strength, flexural strength, impact resistance, and water absorption. The hybrid composites are fabricated using hand lay-up moulding techniques, with (20g) weight percentages of fillers. Results indicate that the inclusion of coconut sheath and wooden fillers enhances specific mechanical properties, making these composites suitable for applications in automotive, construction, and consumer goods. The findings underscore the potential of bio-based materials in creating cost-effective, sustainable alternatives to conventional composites.

Chapter 195

Shredder Attachment for Power Tiller or Electric Motor to Process Agricultural Waste into Composite

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ABSTRACT:

The shredder attachment for power tillers or electric motors offers an efficient and eco-friendly solution to process agricultural waste into useful composite materials. By integrating a robust shredding mechanism with commonly used farm equipment, this attachment allows farmers to convert crop residues, plant debris, and other organic waste into finely processed particles. These shredded materials can then be repurposed for a variety of applications, including the production of organic compost, biofuels, animal feed, or as raw materials in the creation of biodegradable composites. The system not only addresses the issue of large-scale agricultural waste disposal but also promotes sustainability by reducing the need for chemical fertilizers and minimizing the environmental impact of burning or dumping waste. Furthermore, the integration of this technology with power tillers or electric motors makes it cost-effective and accessible for farmers, enhancing the efficiency of agricultural operations and supporting circular economy practices by transforming waste into valuable resources. This innovative approach contributes to the reduction of environmental pollution while simultaneously improving soil fertility and contributing to the development of sustainable farming practices.

Chapter 196

Biodiesel Extraction from Cashew Nut Shell Oil: A Sustainable Approach to Waste-to-Energy Conversion

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Abstract:

The global reliance on fossil fuels has led to increasing concerns over environmental degradation, energy security, and sustainability. In response, biodiesel has emerged as a viable alternative energy source due to its renewable nature, biodegradability, and reduced emissions. This study focuses on the extraction and production of biodiesel from cashew nut shell oil (CNSO), a non-edible by-product of the cashew processing industry that is often discarded as waste. CNSO is a rich source of phenolic compounds, primarily cardanol and anacardic acid, which can be converted into valuable biofuels through chemical processing. The research begins with the extraction of CNSO using mechanical pressing and solvent extraction methods to evaluate oil yield efficiency. The extracted oil undergoes a purification process to remove impurities before being subjected to transesterification—a chemical reaction involving alcohol (usually methanol) and a catalyst (such as sodium hydroxide or potassium hydroxide). Several parameters such as molar ratio of alcohol to oil, catalyst concentration, reaction time, and temperature were optimized to maximize the yield of fatty acid methyl esters (FAME), the primary components of biodiesel. The produced biodiesel was analyzed for key physicochemical properties, including density, viscosity, flash point, calorific value, and acid value. These properties were then compared against ASTM D6751 and EN 14214 standards to assess the fuel quality and suitability for use in diesel engines. The results demonstrated that CNSO-based biodiesel meets most of the standard criteria and exhibits comparable performance to conventional diesel, making it a promising alternative fuel. This study highlights the potential of CNSO as a low-cost, renewable feedstock for biodiesel production, supporting waste-to-energy initiatives and promoting circular economy principles in the agro-industrial sector.

Keywords: Biodiesel, Cashew Nut Shell Oil (CNSO), Transesterification,

Chapter 197

Advancements in Solid-State Polymer-Based Batteries

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Abstract:

Solid-state polymer-based batteries represent a promising advancement in energy storage technology, offering a safer, more efficient alternative to traditional liquid electrolyte lithium-ion batteries. By replacing flammable liquid electrolytes with solid polymer electrolytes (SPEs), these systems significantly reduce the risk of leakage and thermal runaway, while potentially enabling higher energy densities and longer cycle lives. This paper explores the design, synthesis, and electrochemical performance of various polymer electrolyte systems, with a focus on polyethylene oxide (PEO), polyacrylonitrile (PAN), and polyvinylidene fluoride (PVDF)-based materials. Key challenges such as low ionic conductivity at room temperature, interface stability between electrolyte and electrodes, and mechanical flexibility are discussed, along with recent innovations including polymer–ceramic composites, plasticizers, and block copolymer architectures. The study highlights ongoing research trends aimed at optimizing the ionic transport properties and mechanical strength of polymer matrices, paving the way for scalable and sustainable applications in next-generation flexible and wearable electronics. Overall, solid-state polymer-based batteries offer a versatile platform with substantial potential for future commercial deployment in both consumer electronics and electric vehicles.

CHAPTER 198

EXPERIMENTAL AND INVESTIGATION OF E-GLASS FIBER, BANANA FIBER AND ORANGE PEEL USING BRAKE PAD

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Abstract:

Natural fiber composites are nowadays being used in various engineering applications to increase the strength and to optimise the weight and the cost of the product. The review of paper is to represent a general study on the alternative material for the brake pad. The results are compared for different loading conditions and a suitable composite is selected for the research of e- glass, banana fiber and orange peel with epoxy composite using brake pad. The study of mechanical properties of the composites was also investigated. The use of natural fibers in composites has been a growing research interest due to their low cost, renewable nature, and eco-friendliness. In this experiment, E-glass fiber, banana fiber, and orange peel were investigated as potential reinforcements for brake pads. The brake pad formulations were prepared using a thermoset resin, a hardener, and varying amounts of the three different fibers. The mixture was then molded into brake pad shapes and cured at room temperature. The mechanical and tribological properties of the resulting brake pads were then evaluated. The results showed that the addition of banana fibers and orange peel to the brake pad formulation significantly improved the friction coefficient and wear resistance, while the E-glass fiber had a negligible effect on the performance. The brake pads reinforced with banana fiber exhibited the highest friction coefficient and wear resistance, followed by orange peel and E-glass fiber.

Keywords: Natural fiber composites, Brake pad materials, E-glass fiber, Banana fiber, Orange peel, Mechanical properties, Tribological properties

CHAPTER 199

ACOUSTIC PROPERTIES OF POLYMER MATRIX WITH NATURAL FIBRE COMPOSITES

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Abstract:

In this project, Aim to create a new material to replace the use of aluminium in the field of automotive heat shield. This is done by creating a new material from calabash fibre used as a reinforcement, epoxy resin as matrix and ammonium polyphosphate as a fire retardant. The goal is to develop an eco-friendly alternative that not only offers high thermal resistance but also possesses acoustic properties. This innovative material is intended to serve as a sustainable replacement in applications where aluminium alloys are commonly used, providing both environmental benefits and enhanced performance in terms of heat and sound insulation.

Keywords: Aluminium, Automotive heat shield, eco-friendly, innovative material, sound insulation

CHAPTER 200

INVESTIGATION OF HEAT LOSS REDUCTION IN A SOLAR WATER HEATER USING BASE PLATE STRUCTURE

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Abstract:

Solar water heating (SWH) refers to the utilisation of a thermal collector to generate heat for water by harnessing solar radiation. The device incorporates solar light collectors that convert light energy into thermal energy. The transmission of solar heat to a water tank occurs through the process of natural circulation and the disparity in density between hot and cold water. The typical dimensions of a standard solar water heater are 1 foot by 2 feet, and it consists of nine riser tubes that are joined together using copper plates.

The primary aim of this study is to mitigate the heat transfer loss occurring on the side and bottom surfaces of solar water heater absorber tubes that are equipped with a base plate arrangement.

The base plate has been affixed and is situated superior to the riser tubes and absorber plate arrangement on the lower front. The introduction of the base plate marks its placement above the arrangement of riser tubes and absorber plate. The base plate has absorbed the heat emitted by the lower section of the riser tubes. The entire thermal performance of the solar water collector is anticipated to be enhanced. In contrast to existing solar water heaters, the desired outcome is to increase the outlet water temperature to a range of 5-7°C by 1.00 p.m. In addition, in order to enhance the thermal efficiency of the collector and reduce heat dissipation, turbulence makers, such as twist inserts, are employed as an optimal augmentation approach in conjunction with newly developed twist forms.

The duration required to heat water to a temperature of 50-70 °C at phase –I in the experimental setup will be 5-10 minutes. Phase-I will commence at 9.30 am and conclude at 1.00 pm, while Phase-II will commence at 1.00 pm and conclude at 4.00 pm. The device

demonstrates economic viability and demands minimal maintenance. Evidence has demonstrated its utility in the foreseeable future, as it conserves energy and provides hot water for human need. The small or pilot version of an Economic solar water heater is a valuable tool for domestic use, suitable for individuals of various economic backgrounds.

CHAPTER 201

CHARACTERIZATION AND OPTIMIZATION OF CrN COATINGS ON TOOL STEELS

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Abstract:

Surface modification by means of thin film deposition is an important industrial process used to protect base materials against wear, fatigue, corrosion and many other surface related damage phenomenon. Thin hard coatings such as TiN, CrN, and TiAlN have been accepted particularly in the cutting and forming tool industries. TiN and TiAlN coating widely used for dry cutting operations due to its high hardness, CrN coatings have been used to forming tool dies for its hardness and corrosion resistance. Tool steels are supplied with heat treated state, generally hardened and tempered to provide for particular application. Tool dies are precision products whose final shape and dimensions are important in micron level accuracy for production of parts. The tool steels have different machinability which varies with the chemical composition and microstructure of steels.

The objective of this project is to coat CrN on 6959 steel die components. It is very essential to substantiate the role of different sputtering conditions for achieve desired microstructural properties. The microstructural characteristics of thin film are effectively governed by sputtering parameters. The present work is to evaluate the effect of process parameters on properties of coated surface and focused to optimize the CrN thin film coating on plastic mould tool steels using RSM. The characterization of coating is to be examined by using - XRD, scratch tester, pin on disc and microhardness tester.

Keywords: Chromium nitride (CrN), Titanium Nitride (TiN), Physical Vapor Deposition (PVD), X- ray diffraction (XRD), Response surface methodology (RSM).

CHAPTER 202

EFFECT OF COPPER INTERLAYER BEHAVIOUR OF RESISTANCE SPOT WELDED DP800 STEELS JOINTS

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Abstract:

Demand for advanced high strength steel sheets having excellent ductility has been increasing in the automotive industry, to improve fuel efficiency, occupant's safety and reducing the car body weight. Dual phase (DP) steel belong to advance high strength steels (AHSS) category. DP steel microstructure consists of hard martensite islands distributed in soft ferrite matrix. Resistance Spot Welding (RSW) is one of the most prevalent and preferred welding processes for joining automotive body parts. The resistance spot welded DP800 steel joints consist mainly of weld nugget and heat-affected zone (HAZ). RSW of DP steel has become a very important issue due to an increased number of applications in auto-body structures.

The Resistance spot welded DP800 steel joints with copper interlayer consist mainly of weld nugget and heat-affected zone (HAZ). RSW of DP steel has become a very important issue due to an increased number of applications in auto-body structures. The welding current, Electrode force and welding time was varied at five levels (from minimum to maximum). The tensile shear fracture load (TSFL) of joints was evaluated using universal testing machine. Microhardness variations across the weld cross-section was recorded using Vickers's microhardness tester. Microstructural features were analyzed using optical microscopy (OM), and scanning electron microscopy (SEM).

From this investigation, it is understood that increase in welding time supply high heat input to the weld zone and extending the weld nugget, so tensile shear strength of joint increased. The tensile shear strength is found to be increased with increase in welding time up

to a certain limit and then it decreases. The microhardness profile shows a peak hardness in nugget zone and the hardness is lower in the HAZ. The softening of HAZ is mainly attributed to inter-critical heating during welding.

Keywords: Dual phase steel, Resistance spot welding, Tensile shear fracture load, Microstructures.

About the Principal



Prof. Dr. D. Shanmugasundaram, Principal of Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu. With over 28 years of experience in engineering education, his research expertise spans powder metallurgy, energy, and composites. He has published numerous articles in international journals and conferences, and has been a keynote speaker at international conferences in Malaysia, Hong Kong, and Tokyo. Dr. Shanmugasundaram serves on editorial boards, reviews for reputed journals, and is a member of several professional societies.

About the Editors



Dr. M. Vijay, Head of the Department of Robotics and Automation at Dhanalakshmi Srinivasan Engineering College. He completed his Ph.D. from Government College of Technology, Coimbatore, Anna University and has published extensively in SCI-indexed journals and international conferences. Dr. Vijay has received several recognitions, including Excellence in Research and Publication Award and Young Educator & Scholar Award. He is a recognized Ph.D. supervisor under Anna University.



Dr. M. Chellappan, Controller of Examinations at Dhanalakshmi Srinivasan Engineering College, is a dedicated academician with 25 years of teaching experience and holds a Ph.D. from Anna University. His leadership has been instrumental in advancing the academic and research activities of the institution. He has received a Certificate of Appreciation for 25 years of service from the Dhanalakshmi Srinivasan Group of Institutions and a Meritorious Service Certificate from the Tamil Nadu Police Department in recognition of his valuable contributions.



Dr. Katherasan Duraisamy, Professor and Head, Department of Aeronautical Engineering at Dhanalakshmi Srinivasan Engineering College. With over 23 years of experience in engineering education, his research expertise in Welding, Optimization, Simulation, Additive manufacturing & Drone technology. He has published 21 articles in international journals and conferences. He acts as reviewer for reputed journals, and a life member of several professional societies. He has received best citation award and best paper presentation award during his tenure as full-time scholar at NIT Trichy. He is a recognized Ph.D. supervisor under Anna University 2013 onwards.



Dr. S. Gopinathan, Professor and Head of the Department of Civil Engineering at Dhanalakshmi Srinivasan Engineering College. With over 23 years of experience in engineering and research, his specialization areas include concrete, construction chemicals, and structural assessment. He has published papers in international and national journals, serves as a journal reviewer, and has received an award from the District Collector for his consultancy projects.

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