



Proceedings of the
**INTERNATIONAL CONFERENCE ON
INTEGRATED ENGINEERING AND
SUSTAINABILITY**



Editors:

Dr.M.Vijay

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FOREWORD

It gives us immense pleasure to present the proceedings of the International Conference on Integrated Engineering & Sustainability- ICIES2026, held on 26th March 2026 at Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu. This conference, jointly organized by the Departments of Aeronautical, Aerospace, Agricultural, Civil, Mechanical Engineering, and Robotics & 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 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 Integrated Engineering & Sustainability - ICIES2026 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
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PRINCIPAL MESSAGE

It is a moment of great pride for Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, to host the **International Conference on Integrated Engineering & Sustainability- ICIES2026**. 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

Vice Principal

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VICE-PRINCIPAL MESSAGE

I am delighted to extend my warm greetings to all the participants of the **International Conference on Integrated Engineering & Sustainability - ICIES2026**, 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 Vice Principal, 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 innovation.

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Chapter 01

Low-Carbon Sustainable Concrete Using Recycled Materials and AI-Based Mix Optimization

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ABSTRACT

The construction industry is a major contributor to global carbon emissions, with conventional cement production accounting for approximately 8–10% of total CO₂ emissions worldwide. Recent research has therefore focused on developing low-carbon, sustainable concrete by incorporating recycled materials and advanced computational techniques. This study investigates the combined use of recycled aggregates, industrial by-products such as fly ash and silica fume, and natural fibers to enhance the mechanical and durability properties of concrete while reducing environmental impact. Experimental analysis demonstrates that replacing a significant portion of cement with supplementary cementitious materials improves compressive strength, reduces permeability, and enhances resistance to chemical attacks. Additionally, the inclusion of agricultural waste materials like coconut fibers and wheat straw ash has shown promising results in improving tensile strength and crack resistance. These innovations contribute to resource conservation and waste management, addressing key sustainability challenges in modern construction.

Keywords: CO₂ emissions, Coconut fibers, Tensile strength, Chemical attacks

Chapter 02

Clinical Nutrition: Bridging Food and Medicine for Better Health

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ABSTRACT

Clinical nutrition is a specialized field of healthcare that focuses on the role of diet and nutrients in the prevention, management, and treatment of diseases. It involves assessing patients' nutritional needs and developing personalized dietary plans to improve health outcomes. Clinical nutrition plays a crucial role in managing conditions such as diabetes, cardiovascular diseases, obesity, malnutrition, and gastrointestinal disorders. The practice integrates knowledge from biochemistry, physiology, and food science to ensure proper nutrient intake and metabolism. Healthcare professionals, including dietitians and nutritionists, work closely with patients to monitor their nutritional status and provide appropriate interventions. Nutritional therapy may include oral diets, enteral nutrition, or parenteral nutrition depending on the patient's condition. With the increasing prevalence of lifestyle-related diseases, clinical nutrition has become an essential component of modern healthcare. It not only supports recovery but also enhances quality of life and prevents complications. Overall, clinical nutrition bridges the gap between food and medicine, emphasizing the importance of proper nutrition in maintaining optimal health.

Keywords: Clinical nutrition , Metabolism, lifestyle-related diseases, Healthcare

Chapter 03

Advances in Clinical Nutrioscience: Integrating Nutrition into Disease Prevention and Therapeutic Care

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ABSTRACT

Clinical Nutrioscience is an emerging interdisciplinary field that combines principles of nutrition science, medicine, and biochemistry to improve patient health outcomes through targeted dietary interventions. This paper explores the evolving role of clinical nutrioscience in the prevention, management, and treatment of chronic and acute diseases. With the global rise in lifestyle-related conditions such as Type 2 Diabetes, Cardiovascular Diseases, and Obesity, there is a growing need for evidence-based nutritional strategies in clinical settings. The study highlights how personalized nutrition plans, based on individual metabolic profiles and health conditions, can significantly enhance recovery and reduce complications. It also examines the application of advanced nutritional therapies, including enteral and parenteral nutrition, in critically ill patients. Furthermore, the integration of modern technologies such as nutrigenomics and data-driven dietary assessment tools is discussed as a means to optimize treatment outcomes. Clinical nutrioscience emphasizes a holistic approach by addressing both physiological and lifestyle factors influencing health. Healthcare professionals, including clinical dietitians and physicians, play a vital role in assessing nutritional status and implementing appropriate interventions. The findings suggest that incorporating nutritional science into mainstream healthcare not only improves quality of life but also reduces healthcare costs. Overall, clinical nutrioscience serves as a vital link between diet and medicine, promoting long-term health and disease prevention.

Keywords: Nutrioscience ,Diabetes, Cardiovascular Diseases, Obesity

Chapter 04

Enhancing Iron Bioavailability in Millet-Based Foods through Fermentation

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ABSTRACT

Iron deficiency anemia is prevalent in developing countries. This study explores fermentation techniques to enhance iron bioavailability in millet-based foods. Results show a 30% increase in iron absorption with 48-hour fermentation. The process also improves zinc and calcium bioavailability. Recommendations for food fortification and dietary diversification are discussed. The research focuses on controlled fermentation for 48 hours using naturally occurring lactic acid bacteria. The results indicate a significant reduction in phytate content, leading to approximately a 30% increase in iron bioavailability. In addition to iron, the study also observed improved absorption of essential minerals such as zinc and calcium, which are critical for overall health and development. The fermentation process enhances the nutritional profile without compromising taste or acceptability, making it a practical and cost-effective solution for low-income populations.

Keywords: Iron bioavailability, Fermentation, Millet, Anemia, Food fortification

Chapter 05

Fundamentals of Clinical Nutrition and Diet Therapy

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ABSTRACT

This course provides a comprehensive introduction to clinical nutrition and its role in healthcare. It focuses on the application of nutrition principles in the prevention and management of diseases such as Type 2 Diabetes, Cardiovascular Diseases, and Obesity. Students will learn to assess nutritional status using anthropometric, biochemical, and clinical methods. The course also covers the development of individualized diet plans based on patient needs and medical conditions. Emphasis is placed on understanding macronutrients and micronutrients, their metabolism, and their impact on health. Practical sessions include case studies and dietary analysis to enhance decision-making skills. By the end of the course, learners will be equipped to provide basic nutritional counseling and support clinical interventions effectively.

Keywords: Cardiovascular Diseases, Dietary analysis , Decision-making skills

Chapter 06

Advanced Clinical Nutrition and Metabolic Care

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ABSTRACT

This course explores advanced concepts in clinical nutrition with a focus on metabolic processes and disease management. It examines nutritional interventions for complex conditions such as Cancer, Chronic Kidney Disease, and critical illness. Students will study metabolic stress, nutrient utilization, and the role of therapeutic diets in recovery. The course also introduces enteral and parenteral nutrition support and their clinical applications. Emphasis is placed on evidence-based practice and recent research in nutritional science. Through clinical case discussions, learners will develop skills in designing and monitoring nutrition therapy plans. This course prepares students for specialized roles in hospitals and healthcare settings.

Keywords: Cancer, Chronic Kidney Disease, Through clinical case discussions

Chapter 07

Pediatric and Maternal Clinical Nutrition

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ABSTRACT

This course focuses on nutritional requirements during pregnancy, lactation, and childhood. It addresses the prevention and management of conditions such as Anemia, Malnutrition, and growth disorders. Students will learn about nutrient needs at different life stages and the importance of early nutrition in long-term health. The course emphasizes breastfeeding, complementary feeding practices, and maternal diet planning. Practical training includes growth assessment and dietary planning for infants and children. By the end of the course, students will be able to support maternal and child health through effective nutritional strategies.

Keywords: Growth disorders, Malnutrition, Dietary planning

Chapter 08

Innovative Sustainable Concrete Using Recycled Aggregates and Nanomaterials

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ABSTRACT:

Sustainable construction has become a critical focus in modern civil engineering due to increasing environmental concerns and resource limitations. This paper investigates the use of recycled aggregates combined with nanomaterials to develop high-performance, eco-friendly concrete. The study evaluates mechanical properties, including compressive strength, tensile strength, and durability, while minimizing carbon footprint. Laboratory tests demonstrate that incorporating recycled aggregates up to 30% and nano-silica improves strength and reduces permeability compared to conventional concrete. Additionally, the integration of nanomaterials enhances microstructural bonding, contributing to long-term durability. The research also addresses practical applications in structural and non-structural elements, highlighting cost-effectiveness and environmental benefits. Recommendations include optimal mix proportions, quality control measures, and implementation strategies for sustainable construction projects. The findings suggest that combining recycled materials with nanotechnology can significantly advance green construction practices, supporting the global transition toward sustainable infrastructure while meeting performance standards.

KEYWORD: Nano-Silica, use of recycled aggregates, Non-Structural elements ,Implementation Strategies

Chapter 09

Climate-Resilient Rice Varieties for Flood-Prone Areas in Indi

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ABSTRACT:

Floods devastate rice crops in India's Gangetic plains, affecting millions of farmers. This study develops flood-tolerant rice varieties using marker-assisted breeding, incorporating SUB1 and SNORKEL genes. Field trials across Bihar, West Bengal, and Assam show a 20-30% yield advantage over conventional varieties under submerged conditions. The varieties also exhibit comparable grain quality and resistance to major diseases. Adoption potential is high, with over 50,000 farmers expressing interest. Seed dissemination strategies include partnerships with state agriculture departments and NGOs. Economic analysis reveals a 40% higher net return for farmers adopting these varieties. Future research will focus on pyramiding additional tolerance traits.

KEYWORD: India's Gangetic plains, SNORKEL genes, Economic analysis

Chapter 10

Bio-Efficacy of Neem-Centred IPM in Managing Brinjal Pests

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ABSTRACT

Brinjal faces severe pest pressure from shoot borers and fruit borers, leading to excessive pesticide use. This research evaluates neem-based IPM combining botanical extracts (neem oil, karanja oil) and biocontrol agents (Trichoderma, NPV). Results show a 40% reduction in pesticide use and 25% increase in yield compared to conventional practices. The IPM strategy also improves soil health and beneficial insect populations. Economic analysis confirms profitability for farmers, with a benefit-cost ratio of 2.5:1. Farmer field schools and demo plots aid dissemination. Future work will explore nano-formulations of neem for enhanced efficacy.

Keywords: Karanja oil , NPV, Trichoderma, Nano-formulations

Chapter 11

Impact of Conservation Agriculture on Soil Health in Maize-Wheat Systems

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ABSTRACT

Intensive tillage degrades soil health in Indo-Gangetic plains' maize-wheat systems. This study assesses conservation agriculture practices (zero-tillage, residue retention, crop diversification) over 5 years. Results show improved soil organic carbon (15%), water retention (20%), and reduced erosion (30%) compared to conventional tillage. Maize yields increase by 10-15%, wheat by 12-18%. Soil microbial activity and beneficial fauna also improve. Adoption barriers include initial investment needs and knowledge gaps. Policy support and custom hiring services can enhance uptake.

Keywords: Agriculture practices , soil organic carbon , Maize, Microbial activity

Chapter 12

Post-Harvest Losses in Tomato: Causes and Management Strategies

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ABSTRACT

Tomato post-harvest losses are alarming (20-30%) in India, impacting farmer incomes. This research identifies key loss factors (handling, storage, transportation) and evaluates interventions like wax coating, ventilated packaging, and cold storage. Results show a 30% reduction in losses with integrated practices. Economic analysis reveals ₹15,000-₹20,000 per hectare additional income for farmers. Scalability is feasible via packhouses and cold chains. Awareness programs and infrastructure support are critical for adoption. Future work will explore nanotechnology-based packaging.

Keywords: Packhouses, Nanotechnology, Economic analysis

Chapter 13

Clinical Nutrition Interventions in Pregnancy and Early Childhood Development

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ABSTRACT

This course explores the nutritional needs during pregnancy, lactation, and childhood. It focuses on the prevention and management of conditions such as anemia, malnutrition, and growth-related disorders. Students will gain an understanding of nutrient requirements across different life stages and recognize the critical role of early nutrition in promoting long-term health. The course highlights the importance of breastfeeding, appropriate complementary feeding practices, and effective maternal diet planning. It also includes practical training in growth monitoring and dietary planning for infants and young children. By the end of the course, students will be equipped to enhance maternal and child health through appropriate nutritional interventions.

Keywords: Maternal Nutrition, Pediatric Nutrition, Pregnancy Nutrition, Lactation Nutrition

Chapter 14

**From Soil Preparation to Sustainable Harvesting IN
KUWAIT**

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ABSTRACT

Agriculture is a fundamental human activity that involves the cultivation of crops and the rearing of animals to produce food, raw materials, and other essential resources. The agricultural process begins with land preparation, including soil testing, plowing, and leveling to create suitable conditions for plant growth. This is followed by seed selection and sowing, where high-quality seeds are planted using traditional or mechanized methods. Crop management practices such as irrigation, fertilization, and pest control play a critical role in ensuring healthy plant development. Modern agriculture increasingly incorporates advanced technologies like precision farming, automated irrigation systems, and data-driven monitoring to improve efficiency and yield. Harvesting is the final stage, involving the collection of mature crops, followed by processing, storage, and distribution. Sustainable agriculture emphasizes environmentally friendly practices, including soil conservation, water management, and reduced chemical usage, to maintain ecological balance and ensure long-term productivity. Overall, the agricultural process is a dynamic system that combines traditional knowledge with modern innovation to meet the growing global demand for food.

Keywords : Soil Preparation, Irrigation, Crop Management, Precision Farming, Sustainable Agriculture.

Chapter 15

STRATEGIC LANDSCAPE AND AGRICULTURAL MAINTENANCE IN BAHRAIN

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ABSTRACT

The maintenance of integrated landscape and agricultural systems in Bahrain's hyper-arid environment necessitates a sophisticated resource-management framework designed to counteract extreme thermal stress and high soil salinity. At the core of this approach is the transition from conventional irrigation to high-precision delivery systems, primarily subsurface drip irrigation, which minimizes evaporative loss and targets the rhizosphere directly. This technical infrastructure is augmented by the systematic application of organic amendments and heavy mulching to enhance the cation exchange capacity and moisture retention of the naturally porous, sandy substrate. By stabilizing soil temperatures and reducing the desiccation caused by the "Shamal" wind patterns, these methods create a more resilient microclimate for both ornamental and productive flora. Effective management further relies on a strategic selection of salt-tolerant and drought-resistant species, such as *Phoenix dactylifera* and *Ziziphus spina-christi*, which are biologically adapted to the local electrical conductivity (EC) levels of the groundwater. Maintenance cycles are strictly aligned with the region's phenological windows; intensive pruning and fertilization are consolidated within the temperate months of November through March to ensure metabolic recovery before the onset of extreme summer heat. Ultimately, the successful upkeep of these fields depends on a balanced "precision-resource model" that synchronizes mechanical irrigation, chemical salinity control, and biological timing to achieve long-term ecological and structural stability.

Keywords : Arid Land Stewardship, Subsurface Drip Irrigation, Salinity Mitigation, Thermal Stress Management, Precision Maintenance Timing.

Chapter:16

OPTIMIZATION OF ELECTROCHEMICAL DISCHARGE MACHINING OF HIGH ENTROPY ALLOY USING METAHEURISTIC ALGORITHMS

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ABSTRACT

This study investigates the optimization of Electrochemical Discharge Machining (ECDM) parameters for machining High Entropy Alloy (HEA), a material known for its high strength and wear resistance. The objective is to enhance machining performance by maximizing material removal (MR) while minimizing tool wear (TW). Experiments were designed using an L16 orthogonal array in Minitab, considering applied voltage, duty cycle, and electrolyte type as input parameters. The experimental data were analyzed using regression models developed through Design of Experiments (DOE) to establish the relationship between process variables and responses. Based on these models, multi-objective optimization was carried out using several metaheuristic algorithms, including PMF, M-IFDO, BES-GO, ESSO, and CMIHT. Among these, the PMF algorithm provided the best performance by achieving an improved balance between MRR and TWR. The optimized parameters obtained from PMF were validated through experiments. The results showed an MR of 26 mg and TW of 10 mg, with deviations from predicted values due to practical machining conditions and process variability. Despite these differences, the optimization approach proved effective in identifying suitable machining parameters. This work demonstrates that metaheuristic optimization can be a useful tool for improving ECDM performance in advanced materials.

Keywords: Electrochemical Discharge Machining, High Entropy Alloy, Material Removal Rate, Tool Wear Rate, Metaheuristic Optimization.

Chapter:17

ANALYSIS OF THERMAL MANAGEMENT STRATEGIES IN LiFePO₄ BATTERY PACK

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ABSTRACT

Lithium Iron Phosphate batteries are used a lot in vehicles and energy storage systems because they are very safe and can handle high temperatures. This study is about a way to design battery cells that are shaped like hexagons. The old way of making battery cells is to make them cylindrical. The hexagonal shape is better because it lets us pack more cells together and makes the whole thing more compact. We used a computer program called COMSOL Multiphysics to see how the hexagonal cells would work when they are being used. The computer program showed us that the hexagonal cells would have an even temperature and fewer hot spots. So, the new hexagonal Lithium Iron Phosphate cell design is better for keeping the batteries cool and working well which is important, for battery packs.

Keywords: Lithium Iron Phosphate Battery, Hexagonal Battery Cell, Thermal Analysis, COMSOL Multiphysics Simulation, Battery Pack Optimization.

Chapter:18

FABRICATION OF 3D PRINTED THERMOFORMEABLE HAND WRIST FRACTURE SUPPORT USING POLYLACTIC ACID

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ABSTRACT

This project focuses on the fabrication of a lightweight and environment friendly alternative to traditional Plaster of Paris (PoP) casts for hand wrist fracture support. The PoP supports are often heavy, bulky, and poorly ventilated, which can cause discomfort and skin irritation for patients during the healing period. To overcome these issues, this project aims to design and develop a generalized hand-wrist fracture support that is mechanically strong, and capable of providing effective immobilization. The hand-wrist fracture support was designed using SolidWorks 2025 and subjected to structural simulation in Ansys 18.2 to ensure durability. Initial analysis revealed that the thickness of 1mm was insufficient to withstand the folding forces and then by increasing the thickness to 2mm, which successfully withstood the folding forces. After that 2mm support was fabricated using Fused Deposition Modeling (FDM) 3D printing technology with Polylactic Acid (PLA) material. After 3D printing the weight of the printed part before moulding was 36.243 g. Then the support was immersed into hot water at approximately 70°C for a minute duration in order to reach the glass transition temperature (T_g) of PLA, after which it uniformly softened and was moulded directly to the patient's hand. Finally, the post-moulding measurements showed a weight of 36.275 g, indicating only a minor increase due to slight moisture absorption during heating. The printed hand-wrist fracture support would be comfortable, well-ventilated, strong, and provides effective immobilization.

Keywords: Orthopedic Cast Alternative, Fused Deposition Modeling, Hand Wrist Fracture Support, Glass Transition Temperature (T_g), Thermoforming.

Chapter:19

EXPERIMENTATION ON MULTIMATERIAL ADDITIVE MANUFACTURING ON PRODUCTION APPLICATION

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ABSTRACT

Conventional gear manufacturing mainly uses single materials such as alloy steels, cast iron, or engineering polymers like Nylon and ABS. These materials involve trade-offs between strength, wear resistance, cost, and manufacturability. Metallic gears provide high strength and durability but are heavy, expensive to machine, and require lubrication. In contrast, polymer gears are lightweight and corrosion-resistant but have lower load capacity and shorter wear life. This study explores Multi-Material Additive Manufacturing (MMAM) as an advanced approach to overcome these limitations by enabling optimized material distribution within a single component. A hybrid spur gear is designed using Nylon in the tooth region for its low friction (0.2–0.35) and high wear resistance, and ABS in the core for structural support and reduced cost (20–30% lower than Nylon). The methodology includes CAD modeling, dual-extrusion fabrication, and experimental testing under controlled loads. Performance metrics such as wear rate, torque transmission, friction, and dimensional accuracy are evaluated and compared with single-material gears. Results indicate improved performance, including reduced tooth wear, smoother operation, 15–25% cost savings, and 10–20% weight reduction. This work demonstrates the practical application of MMAM in functional components, moving beyond conceptual use. By enabling region-specific material selection, it allows performance optimization without redesigning the entire gear.

Keywords :

MMAM ,Hybrid Polymer Gear, Wear Resistance, Friction Reduction, Material Optimization & Tribological Performance.

Chapter:20

DESIGN AND STRUCTURAL EVALUATION OF A PATIENT SPECIFIC ARM FRACTURE SUPPORT FOR IMPROVED COMFORT AND PERFORMANCE.

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ABSTRACT

The serious challenge for the healthcare system globally due to the bone fracture treated by the traditional method have a certain disadvantageous including limitation of mechanical resistance, water sensitivity, inadequate hygiene and odors due to lack of proper ventilation makes patient inconvenience and time delay of recovery. This study evaluates the design and structural characterization of our own arm fracture support modeled using PLA material properties for simulation, specifically for palm support designed using data from 3D scanning of human arm and analysis done by Finite Element method (FEM). Mimic of human hand was taken by 3D scanning and the model of the fracture support created as four more variants using blender. These various models were evaluated by the method of FEM using Altair SimSolid. A force of 400N was applied which was significantly larger than the loading condition of human beings on the area of palm and tangential to the palm area which is the most probable location of human arm were naturally disturbed during day-to-day activity. in the condition of 400N loading the overall displacement occur in the fracture supports were ranging 0.99 to 3.1 mm and the stress values ranging 19.1 to 32.3 MPa, these range taken from all four models and the final optimized support selected by the factor of safety above 1.5, on mechanical loading, low weight, low material conception and better ventilation. The simulation outcome clearly shows a 3D printed orthopedic support able to apply suitable mechanical correction force on a specific area to ensure optimal alignment and enhance patient comfort.

Keywords: Orthopedic support, Finite Element Analysis, PLA, Stress Analysis.

Chapter:21

IMPROVING THE ECDM PERFORMANCE OF TOOL STEEL USING ELECTROLYTE CONCENTRATION AND BORAX ADDITIVE

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ABSTRACT

Electrochemical Discharge Machining (ECDM) is used for machining hard materials like D3 tool steel, which is difficult to machine using conventional methods. In this study, the performance of ECDM is improved by modifying the electrolyte conditions. Two types of electrolytes are used: Sodium Nitrate (NaNO_3) with distilled water, and NaNO_3 with Borax additive. The concentration is varied as 50 g, 60 g, and 70 g. A total of 30 experiments is conducted by varying voltage and duty cycle. The machining is performed using a tungsten carbide stationary tool with constant machining time. The performance is evaluated based on material removal and tool wear using weight difference measurement. The results show that the addition of Borax improves machining performance, with higher material removal and lower tool wear compared to NaNO_3 alone.

Keywords: Electrochemical Discharge Machining, D3 Tool Steel, Sodium Nitrate, Borax Additive, Electrolyte Concentration.

Chapter:22

DESIGN AND DEVELOPMENT OF A SOLAR-POWERED IOT-ENABLED ONION STORAGE SYSTEM FOR POST HARVEST PRESERVATION

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ABSTRACT:

Post-harvest losses of onions remain a critical challenge for small scale farmers, with spoilage rates often exceeding 30-40% due to suboptimal storage conditions. This study presents the design, development, and performance evaluation of a solar-powered IoT-enabled onion storage system featuring trays, automated ventilation, and real-time environmental monitoring. The system integrates temperature, humidity, and ethylene gas sensors with bidirectional fans for active moisture control and spoilage detection, powered entirely by solar energy for sustainable off-grid operation. Key innovations include automated temperature and humidity regulation using sensor triggered ventilation (maintaining 25-30°C and 65-75% RH), early spoilage detection via ethylene monitoring, and remote Internet of Things (IoT) dashboard for real-time alerts. The partially enclosed box design with vents optimizes airflow while protecting against external contaminants, drawing from proven storage structures while eliminating mechanical complexity. This integrated solution addresses gaps identified in existing Internet of Things (IoT) storage systems by combining solar autonomy, user-friendly modularity, and predictive maintenance for small-scale farmers.

Keywords: Onion storage, IoT-Enabled System, Solar-Powered Storage System, Post-Harvest Preservation, Environmental Monitoring.

Chapter:23

Design and Fabrication of Milk Spoilage Detection System

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ABSTRACT:

This research investigates about the quality of the milk since milk is a highly perishable food product prone to microbial degradation, leading to spoilage and health risks. This paper presents the design and fabrication of a low-cost milk spoilage detection system using multiple sensors including MQ135 Gas Sensor Module, DHT11 Temperature and Humidity Sensor, W1209 Temperature Controller Module, and a pH Sensor Module for Arduino integrated with Arduino Uno R3. The system monitors gas emissions, environmental conditions, and acidity changes in milk to determine spoilage levels. Experimental analysis demonstrates that the integration of multi-sensor data improves accuracy and enables real-time detection.

Keywords: Milk spoilage, MQ135, pH sensing, Arduino, IoT, Food safety, Gas detection.

Chapter:24

Influence of Cooling Rate on Mechanical Properties of Underwater Friction Stir Welded Dissimilar Aluminium Alloys

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ABSTRACT

The increasing demand for lightweight structures in aerospace, marine, and transportation sectors has driven interest in solid-state joining of dissimilar aluminium alloys. This study investigates the thermo-mechanical behavior and mechanical performance of underwater friction stir welded AA6061-T6 and AA7075-T6 joints under controlled cooling conditions. Experiments were conducted at rotational speeds of 800–1400 rpm and traverse speeds of 40–100 mm/min, achieving cooling rates of 16–74 °C/s through regulated water flow. Compared to conventional FSW, peak weld temperature decreased by approximately 110 °C, resulting in significant microstructural refinement with nearly 62% grain size reduction in the stir zone. Mechanical properties improved notably, with ultimate tensile strength increasing from 235 MPa to 292 MPa and microhardness from 82 HV to 97 HV, attributed to suppressed precipitate coarsening and enhanced material flow at higher cooling rates. A deep neural network model trained on experimental data achieved a prediction accuracy of 95.8% ($R^2 = 0.958$) for tensile strength, while statistical analysis ($p < 0.01$) confirmed a strong correlation between cooling rate and mechanical performance. The findings establish an integrated experimental and AI-based framework for optimizing cooling-assisted friction stir welding of dissimilar aluminium alloys.

Keywords: Underwater friction stir welding; Cooling rate; Dissimilar aluminium alloys; Grain refinement; Mechanical strength; Artificial intelligence; Thermal modeling; Solid-state joining

Chapter:25

EXPERIMENTAL ANALYSIS OF GREEN HOUSE SOLAR DRYER FOR AGRICULTURAL PRODUCTS

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ABSTRACT

Fossil fuels have contributed for a drastic growth all around the world. Though it was accepted and used at a faster pace it had contributed to various Climatic Changes due to its fast-depleting reserves, cleaner, greener, sources of energy have received impetus. Solar Energy is most important among renewable energy resources due to its quantitative abundance, especially in tropical countries like India. This Project is aimed on Experimental Analysis of green House solar Dryer for Agricultural products, where the products (Dragon Fruit, Fig, Paneer Grapes, Cluster Beans) are dried with both the Forced solar drying and Open sun drying method. The comparison between the methods were studied to determine the most efficient drying method. The performance for the Solar Collector which is a combination of sensible thermal storage system combined with a 3-pass flow heat exchanger was evaluated. The products after drying have undergone Image processing for HSV values and had been tested to determine the Nutrition level present between Open sun dried and Forces solar dried products. Drying Rate is evaluated numerically by the measured data and found to be that the Drying Rate of Forces solar dried products are higher than Open sun-dried products. Similarly, the time taken for the product to attain its saturated weight is compared for further verification in the efficiency.

Keywords: Solar energy; Forced solar dryer; open sun drying; drying rate; thermal energy storage; heat exchanger; image processing (HSV); nutritional analysis.

Chapter:26

RAPID DECOMPOSITION OF SOLID WASTE BY ACTINOMYCETE

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ABSTRACT

The rapid increase in population and urbanization has led to a significant rise in organic solid waste generation, which, when not managed properly, results in land pollution, greenhouse gas emissions, and serious health hazards. Conventional composting methods are slow and inefficient, taking 60–90 days and producing inconsistent results. The primary problem identified is the delay in decomposition and poor nutrient quality of the final compost. The objective of this study is to explore the use of Actinomycetes, a group of filamentous bacteria with strong enzymatic capabilities, to enhance the rate of organic waste decomposition. The methodology involves segregating biodegradable solid waste like vegetable peels, fruit scraps, paper waste, and decomposing it under controlled aerobic conditions by inoculating with Actinomycetes cultures. During the composting period, temperature, moisture content, pH, and texture were regularly monitored. To evaluate the compost quality, the enriched compost was applied to Gongura (*Hibiscus sabdariffa*) plants, which are nutrient-sensitive and suitable for biological testing. The results indicated that compost inoculated with Actinomycetes decomposed fully in just 25–30 days, compared to the traditional method. Moreover, the compost showed enhanced nutrient levels (NPK), better texture, odor control, and a significant increase in plant height and growth rate. The solution provides an eco-friendly, affordable, and scalable approach for both rural households and urban composting systems. In conclusion, Actinomycetes play a crucial role in accelerating the composting process, producing high-quality manure, reducing landfill waste, and promoting sustainable agricultural practices through improved soil fertility.

Keywords: Decomposition, Sustainable, Nutrient, Emissions, Waste

Chapter:27

ASSESSMENT OF PHYSIOCHEMICAL AND BIOLOGICAL WATER QUALITY OF ARUMBAVUR LAKE, PERAMBALUR, TAMILNADU

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ABSTRACT

Open dumping of solid waste has become a serious environmental problem in many rural and urban areas. Waste materials such as plastics, paper, food waste, and hazardous substances are often dumped in open lands without proper segregation or treatment. This improper disposal practice affects the quality of soil, water, and air around the dumping site. The leachate generated from the waste percolates into the soil and contaminates the groundwater, making it unsafe for drinking and irrigation. Air quality also deteriorates due to the emission of foul odour and smoke from burning waste materials. The soil near the dumping yard loses its fertility due to the accumulation of toxic substances and heavy metals. In this study, the effects of an open dumping yard on the nearby environment are analyzed by collecting and testing soil, water, and air samples from the surrounding area. The results show that pollution levels are higher near the dumping site compared to uncontaminated areas. In this project, an environmental assessment is carried out. The study results indicate that open dumping leads to significant pollution and poses health hazards to nearby residents. Hence, proper waste segregation, recycling, and scientific disposal methods are essential to reduce environmental degradation and promote a clean and healthy environment. This project aims to create awareness and suggest suitable measures for sustainable waste disposal and environmental protection.

Keywords: open dumping, solid waste, environmental pollution, groundwater contamination, air quality, waste segregation, sustainable waste management

Chapter:28

PERFORMANCE ANALYSIS OF SOLAR DRIER

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ABSTRACT

The increasing demand for food preservation and reduction of post-harvest losses has led to the development of efficient drying techniques. Conventional open sun drying methods often result in poor quality due to contamination, uneven drying, and environmental factors. This project focuses on the performance analysis of a solar dryer for drying fruits(Pineapple,Apple,Guava ,Banana). Solar energy, being an abundant and renewable resource, is utilized to enhance drying efficiency while reducing dependency on fossil fuels. The experimental study compares solar drying with traditional open sun drying based on parameters such as temperature, relative humidity, drying time, and moisture content. The solar dryer provides a controlled environment that increases temperature and reduces humidity, leading to faster moisture removal. The initial moisture content of the selected samples was significantly reduced to safe storage levels through solar drying.In addition, image processing techniques were employed to evaluate the quality of dried products using HSV color analysis. The results indicate that solar drying offers better product quality, reduced drying time, and protection from external contaminants compared to open sun drying.The study concludes that solar dryers are an effective, economical, and sustainable solution for agricultural and medicinal product preservation, especially in regions with high solar radiation.

Keywords: Solar energy ; Forced solar dryer; open sun drying; drying rate; thermal energy storage; heat exchanger; image processing (HSV); nutritional

Chapter:29

DESIGN AND FABRICATION OF REMOTE - CONTROLLED GRASSCUTTING AND CLEANING MACHINE

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ABSTRACT

This Project explore into the design of remote-controlled grass cutting and cleaning machine that the machine used to clean the grass surface by the remote control to operate the machine. The process of make the lawn to be undefined by over growth of the grass and that's gives a bad appearance and I also cause any infection and more attack of insects and the nutrient content will be also made losses in soil manures. To prevent from these trouble we have an solution by cut the grass by a machine is which included by the materials of blade, motor, Gbro board, physical remote, driven motor and vacuum motor and batteries and motor gear. These components are been used to assemble a machine and that process the method of cut the grass into a piece of particle with the help of blade and motor and that is able to move by the wheels and it is operated by the Gbro ESP32-S3 controller is programmed on it and last the vacuum motor help to clean the area by suctioned pressure act on the piece of grass is move upwards to the vacuum travel into storage tank that collect the wasted grass and the process is also done by the machine itself. The method of agriculture mechanization is induced by the blade through the vacuum collect it. This project focuses on the design and development of a remote-controlled multipurpose lawn-maintenance machine integrating both grass-cutting and vacuum-based cleaning mechanisms. The system uses a DC motor-driven rotary blade for cutting operations and a compact suction motor for debris collection. The system aims to reduce human labour, enhance operational safety, and provide an efficient method for grass trimming and ground cleaning

Keywords: Driven motor, Remote-controlled multipurpose, rotary blade, Gbro ESP32-S3 controller, vacuum motor

Chapter:30

TESTING AND CHARACTERIZATION OF PALMYRA PALM – COCONUT LEAF STALK FIBER REINFORCED HYBRID GREEN COMPOSITE

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ABSTRACT

Considering the rising imperative of need to produce materials which are sustainable and lightweight, current studies have more often concentrated on incorporation of agricultural wastes fibers into polymeric composite. This research paper describes the manufacturing and mechanical testing of a composite hybrid that is green, and under this, the reinforcing fibers are the Palmyra palm leaf stalk fibres and the coconut leaf stalk fibres embedded in an epoxy resin. The fibers were extracted, washed and an alkaline pre-treatment using the 5% NaOH to enhance interfacial adhesion to the matrix. The castings were done under compression moulding at a fixed matrix to fiber volume ratio of 80:20 and random orientation of the fibres to minimise the anisotropic effects. Mechanical testing was conducted using standardized procedures as tensile testing according to ASTM D3039, impact testing by Izod procedure that was used according to ASTM D256 and Shore D hardness testing according to ASTM D2240. The resulting hybrid epoxy matrix was found to be stronger than the bare epoxy and single-fiber composites, with tensile strength of 37 MPa, impact strength of 27.35 J/cm² and Shore D hardness of 81.3, which is an increase of 12.12%, 13.5% and 3.6% respectively. The resultant improvements in mechanical performance could be attributed to the speed of movement of stress across the matrix-fibre interface, the high quality of interfacial adhesion, and the synergistic effect between the two different natural fibres. Taken together, these results support the idea that Palmyra-coconut hybrid green composites demonstrate significantly better strength and toughness coupled with utilizing renewable materials, which highlights the fact that they may be applicable in lightweight, eco-friendly engineering applications.

Keywords: (5 keywords): Hybrid green composite, Palmyra palm leaf stalk fiber (PPLSF), Coconut leaf stalk fiber (CLSF), Epoxy resin, Compression moulding.

Chapter:31

IOT POWERED MUSHROOM CULTIVATION

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ABSTRACT

The IoT Powered Mushroom Cultivation System is designed to automate and optimize the environmental conditions required for efficient mushroom growth. Traditional mushroom farming often relies on manual monitoring and natural ventilation, which can lead to inconsistent temperature, humidity, and carbon dioxide levels, ultimately affecting crop quality and yield. This project proposes an autonomous cultivation chamber that uses sensors to continuously monitor parameters such as temperature, humidity, CO₂ concentration, and substrate moisture. A microcontroller processes this real-time data and automatically activates actuators like foggers, exhaust fans, and water pumps to maintain optimal growing conditions. By implementing a sensor-actuator feedback system, the proposed setup ensures environmental stability and reduces the dependency on manual labor. The system also helps prevent common issues such as stipe elongation caused by excess CO₂ and pinhead abortion due to low humidity. The automated chamber is expected to improve productivity, reduce water usage through precision fogging, and shorten the cultivation cycle compared to traditional methods. Overall, this project demonstrates how IoT-based automation can provide a reliable, scalable, and efficient solution for modern mushroom cultivation.

Keywords: IOT(Internet Of Things), Mushroom Cultivation, Automation, Sensor-Actuator Feedback System, Environmental Monitoring.

Chapter:32

INNOVATIVE INVESTIGATION OF BITUMEN AS A PARTIAL REPLACEMENT OF BITUMEN WITH MOLASSES

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ABSTRACT

Bituminous concrete is a composite material composed of mineral aggregates, bitumen as a binder, and air voids. With the increasing global demand for energy and the rising consumption of bitumen and petroleum products, there is a pressing need for sustainable and environmentally friendly alternatives. Moreover, the emission of carbon dioxide during the heating of bitumen poses significant environmental and health concerns. To address these challenges, this study investigates the use of molasses, a by-product obtained from sugarcane processing, as a partial replacement for conventional bitumen binder. A comparative analysis was conducted between conventional bitumen and molasses-modified bitumen using standard laboratory tests, including penetration, ductility, softening point, and Marshall stability tests. Specimens were prepared with a constant bitumen content of 4%, while molasses was added in varying proportions of 4%, 6%, 8%, 10%, and 12% by weight of bitumen to determine the optimum mix. The results indicate that the incorporation of molasses improves the Marshall characteristics of the mix. The strength and stability were observed to increase significantly at 6% bitumen content with 8% molasses addition. The modified binder showed higher penetration and softening point values, while the specific gravity remained nearly unchanged. However, ductility decreased with increasing molasses content. Furthermore, the reduction in bitumen usage contributes to lower carbon dioxide emissions. Overall, the study concludes that 8% molasses is the optimum content, making it a feasible and eco-friendly alternative for bituminous concrete.

Keywords: Bituminous Concrete, Molasses, Partial Replacement, Marshall Stability, Eco-friendly Pavement

Chapter:33

EXPERIMENTAL INVESTIGATIONS ON RECYCLED COARSE AGGREGATE USING UREASE ENZYME

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ABSTRACT

The construction industry is currently experiencing rapid growth, leading to a significant increase in the demand for natural aggregates and the accumulation of construction and demolition waste. Recycled coarse aggregate (RCA) presents a sustainable alternative; however, its widespread utilization is limited due to inherent deficiencies such as high porosity, adhered old mortar, and reduced mechanical strength. In this study, an eco-friendly bio-mineralization approach is proposed to enhance the properties of RCA. Urease enzyme was extracted from lemon peels and utilized to catalyze the hydrolysis of urea, facilitating the precipitation of calcium carbonate (CaCO_3). The precipitated CaCO_3 deposits within the pores and microcracks of RCA, resulting in improved density and interfacial bonding characteristics. Concrete specimens were prepared using enzyme-treated RCA and evaluated through compressive strength and split tensile strength tests at various curing periods. The results demonstrated that concrete incorporating treated RCA exhibited superior mechanical performance compared to concrete with untreated RCA. Overall, this method provides a cost-effective, sustainable, and environmentally friendly strategy for improving the quality of recycled aggregates, thereby promoting their efficient utilization in green concrete production.

Keywords: Urease Enzyme, Recycled Coarse Aggregate, Compressive Strength, Tensile strength, Workability

Chapter:34

IOT- BASED MICROCLIMATE ZONING SYSTEM FOR ENVIRONMENTAL REGULATION

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ABSTRACT

Rapid changes in environmental parameters such as temperature and humidity significantly affect human comfort, agricultural productivity, and industrial processes. Conventional environmental control systems regulate conditions uniformly across large areas, often leading to energy inefficiency and poor localized performance. To address this challenge, this project proposes an IoT-based Microclimate Zoning System that enables precise, zone-wise monitoring and regulation of environmental conditions. The system uses distributed sensor nodes equipped with temperature and humidity sensors to continuously collect real-time data across multiple micro zones. These nodes communicate through wireless IoT protocols to a central controller, which analyses variations, detects anomalies, and activates localized actuators such as coolers, heaters, humidifiers, or exhaust fans based on specific zone requirements. A cloud-based dashboard provides real-time visualization, alerts, and remote control, ensuring continuous optimization. The proposed solution enhances environmental stability, reduces energy consumption through selective actuation, and provides scalable adaptability for greenhouses, smart buildings, warehouses, and livestock management environments. Overall, the system offers a cost-effective and intelligent approach to maintaining ideal microclimate conditions with improved accuracy, responsiveness, and sustainability

Keywords: IoT (Internet of Things), Microclimate Zoning, Temperature and Humidity Monitoring, Energy Efficiency, Smart Environmental Control.

Chapter:35

BACTERIAL CONCRETE WITH SUGARCANE BAGASSE ASH (SCBA)

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ABSTRACT

Concrete is the most widely used construction material, yet its susceptibility to micro-cracking from shrinkage and environmental stress remains a critical durability flaw. These cracks facilitate the ingress of harmful agents, leading to reinforcement corrosion and high maintenance costs. To address this, self-healing concrete utilizing Microbiologically Induced Calcium Carbonate Precipitation (MICCP) has emerged as a sustainable solution. This study explores the synergistic integration of *Bacillus subtilis*—a bacterium capable of thriving in alkaline conditions to precipitate calcite—and Sugarcane Bagasse Ash (SCBA), an industrial by-product used as a pozzolanic partial cement replacement. By replacing cement with SCBA at levels of 0%, 10%, and 20% in M25 grade concrete, the research aims to reduce the construction industry's carbon footprint while enhancing structural integrity. Experimental evaluations of compressive and split tensile strengths at 7 and 28 days demonstrate that the combination of bacteria and SCBA significantly improves mechanical performance and durability. While the *Bacillus subtilis* promotes autonomous crack healing through calcite formation, the SCBA contributes to pore refinement and decreased permeability. The findings suggest that this hybrid approach offers an eco-friendly, cost-effective, and innovative alternative to conventional repair methods, effectively extending the service life of concrete structures through enhanced self-healing capabilities and reduced environmental impact.

Keywords: Bacterial Concrete, Sugarcane Bagasse Ash, *Bacillus subtilis*, Self-healing Concrete, Durability, Sustainable Construction

Chapter:36

EXPERIMENTAL STUDY ON LASER SHOCK PEENED IrO_2 COATED TITANIUM ELECTRODES FOR WASTEWATER APPLICATIONS

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ABSTRACT

The treatment of wastewater through electrochemical oxidation has become an effective method for removing persistent pollutants because it can degrade complex contaminants without producing harmful secondary products. Among the different electrode materials used, Iridium Oxide (IrO_2) coated titanium electrodes are widely used as stable anodes due to their strong corrosion resistance, high catalytic activity, and long operational life. However, the efficiency of these electrodes mainly depends on surface characteristics such as coating adhesion, structural stability, and the availability of electroactive sites. Improving these surface properties can significantly enhance the performance and durability of electrochemical wastewater treatment systems. In this study, Laser Shock Peening (LSP) is used as an advanced surface modification technique to improve the properties of IrO_2 -coated titanium electrodes. LSP employs high-energy laser pulses to create shock waves on the electrode surface, producing deep compressive residual stresses and refining the microstructure. This process improves coating adhesion, reduces surface defects, and increases surface roughness, which helps create more active reaction sites. As a result, the treated electrodes are expected to show improved electrochemical activity and better stability during long-term operation. The modified electrodes were analyzed using Scanning Electron Microscopy (SEM) to study surface morphology and X-ray Diffraction (XRD) to observe microstructural changes after treatment.

Keywords: Electrochemical Oxidation, Laser Shock Peening (LSP), Iridium Oxide (IrO_2) Electrode, Wastewater Treatment, Surface Modification.

Chapter:37

Experimental Investigation of Electro Discharge Machining Characteristics on Nickel-Copper 400 Alloy

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ABSTRACT

Electro Discharge Machining (EDM) is a non-traditional machining process widely used for machining hard and difficult-to-cut materials. In this study, an experimental investigation is carried out to analyze the machining characteristics of Nickel-Copper 400 alloy which is known for its excellent corrosion resistance and high strength. The experiments are conducted by varying key EDM process parameters such as peak current, pulse-on time, pulse-off time, and voltage. The performance measures considered include Material Removal Rate (MRR), Tool Wear Rate (TWR), and Surface Roughness (SR). The results show that peak current and pulse-on time significantly influence the machining performance. Higher current increases MRR but also leads to increased tool wear and surface roughness. Optimal parameter combinations are identified to achieve improved surface finish with acceptable machining efficiency. This investigation provides valuable insights into optimizing EDM parameters for machining Monel 400 alloy in industrial applications.

Keywords: Electro Discharge Machining, Monel 400, MRR, TWR, Surface Roughness

Chapter:38

A MACHINE LEARNING FRAMEWORK FOR CUSTOMER CHURN PREDICTION IN THE BANKING SECTOR

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ABSTRACT

Customer churn prediction is a critical challenge in the banking sector, as customer attrition directly impacts revenue and long-term business sustainability. This study proposes a robust and scalable machine learning framework to predict customer churn using the widely adopted Churn_Modelling dataset. The dataset comprises demographic and financial attributes such as credit score, geography, gender, age, tenure, balance, number of products, credit card ownership, and active membership status. A comprehensive data preprocessing pipeline is implemented, including handling missing values, one-hot encoding of categorical variables, and feature scaling using StandardScaler to ensure model stability. Two classification models, Logistic Regression and Random Forest Classifier, are developed and evaluated using standard performance metrics. Feature importance analysis is conducted using ExtraTreesClassifier to identify the most influential attributes. Experimental results demonstrate that the Random Forest model outperforms Logistic Regression, achieving an accuracy of 86% along with improved precision, recall, and F1-score. The findings reveal that age, account balance, and active membership significantly influence churn behavior. The novelty of this work lies in the integration of a complete preprocessing and feature evaluation pipeline with comparative model analysis tailored to banking data, providing actionable insights for effective customer retention strategies.

Keywords: Customer Churn, Machine Learning, Random Forest, Predictive Analytics, Banking Analytics

Chapter:39

EXPERIMENTAL INVESTIGATION OF THERMAL PERFORMANCE ENHANCEMENT IN EVACUATED TUBE SOLAR COLLECTORS USING Fe₃O₄ AND Fe₃O₄ –GRAPHITE NANOFLUIDS

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ABSTRACT

Due to their improved thermophysical properties, nanofluids have garnered attention for improving evacuated tube solar collectors (ETSCs). This study compares the performance of mono (Fe₃O₄) and hybrid (Fe₃O₄+ graphite) nanofluids in a base fluid under regulated conditions. To ensure uniform dispersion and stability, magnetic stirring and ultrasonication are used to create nanofluids. Nanoparticle concentrations from 0.025 to 0.1 wt% are tested to determine how they affect ETSC system thermal efficiency and heat transmission. The hybrid nanofluid has better dispersion stability than the mono nanofluid due to particle contact and less agglomeration, according to sedimentation observation and zeta potential tests. Nanofluids dramatically improve ETSC thermal performance. Significantly, the hybrid nanofluid (Fe₃O₄+ graphite) outperforms the mono nanofluid in thermal efficiency and heat absorption capacity. The synergistic effect of Fe₃O₄ nanoparticles and graphite nanoparticles optimizes stability, fluid dynamics, thermal conductivity, and heat transfer pathways

Keywords : Nanofluid, Heat absorption Energy efficiency, Stability, Heat transfer

Chapter:40

A REVIEW ON COMPLIANT TRANSTIBIAL AMPITUDE DEVELOPED BY FUSED DEPOSITION MODELLING

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ABSTRACT

The compliant transtibial amplitude represents a transformative solution for individuals with transtibial amputations, designed to enhance mobility, comfort, and overall quality of life. This paper delves into the development of such devices using Fused Deposition Modelling (FDM), a pioneering additive manufacturing technology that offers unparalleled customization and cost-effectiveness. Through an extensive review of existing methodologies, this study explores critical parameters such as material selection, layer height, infill density, and mechanical testing metrics. The findings highlight significant advancements in energy storage and return (ESAR) mechanisms, lightweight materials, and patient-specific customization, while also identifying limitations, including durability challenges and limited gait adaptability. The paper concludes with a comprehensive analysis of areas for improvement and potential future research directions, aiming to bridge current gaps in prosthetic design and functionality.

Keywords: Transtibial amputation, Fused deposition modelling, Additive manufacturing, Printing parameters, Compliant mechanism.

Chapter:41

INDOOR AIR QUALITY MONITORING FOR BUILDING

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ABSTRACT

Indoor Air Quality (IAQ) plays a vital role in maintaining a healthy and comfortable environment inside buildings. Poor indoor air quality can lead to various health problems such as headaches, allergies, respiratory issues, and reduced productivity. The Indoor Air Quality Monitoring for Building project focuses on designing a system that continuously monitors the quality of air inside indoor spaces using sensors and microcontrollers. The system uses sensors to detect parameters such as dust particles, temperature, humidity, and harmful gases present in the air. An Arduino Uno microcontroller is used to collect data from the sensors and process it effectively. The monitored data is then transmitted to a mobile application using IoT technology, such as the Blynk platform, allowing users to view real-time air quality levels from anywhere. If the air quality exceeds safe limits, the system can alert users so that necessary actions can be taken to improve ventilation and maintain a healthy indoor environment. This project helps in improving awareness about indoor pollution and ensures a safer living and working environment. It is useful in homes, offices, schools, and commercial buildings. By implementing this system, building occupants can monitor air conditions easily and take preventive measures to maintain better air quality and overall health.

Keywords: Indoor Air Quality (IAQ), Air Pollution Monitoring, Environmental Sensors, Smart Building Technology, Air Quality Management.

Chapter:42

EXPERIMENTAL STUDY ON HYDROSTATIC STABILITY OF PARTIALLY SUBMERGED RECTANGULAR BLOCK

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ABSTRACT

Hydrostatic stability of partially submerged rectangular blocks (HSSB) is an emerging concept in lightweight construction materials designed for floating and marine applications. Conventional concrete blocks possess high density ranging from 2200–2400 kg/m³, making them unsuitable for floating structures. In contrast, HSSB blocks are manufactured using cement, fly ash, lime, gypsum, water, and aluminum powder or liquid aluminum, which generates hydrogen gas during the reaction process. This results in the formation of millions of air voids within the block, significantly reducing its density to about 500–800 kg/m³. The primary objective of this study is to develop lightweight concrete blocks capable of floating while maintaining sufficient compressive strength and durability. The experimental methodology includes material selection, mix design preparation, casting, curing, and laboratory testing. Various parameters such as density, compressive strength, and buoyancy characteristics are evaluated. The results indicate that HSSB blocks exhibit good floating capability due to their porous structure and reduced density. Additionally, proper control of aluminum content and curing methods enhances the mechanical properties of the blocks. These lightweight floating blocks can be effectively used in marine structures, floating platforms, and flood-prone areas. This study contributes to the development of sustainable and innovative construction materials with improved hydrostatic performance.

KEYWORDS: Hydrostatic Stability, Lightweight Concrete, Floating Blocks, Density Reduction, Compressive Strength.

Chapter:43

EXPERIMENTAL STUDY ON STRENGTH AND DURABILITY OF HIGH-PERFORMANCE CONCRETE INCORPORATING RECYCLED AGGREGATES AND SILICA FUME

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ABSTRACT

The increasing demand for concrete aggregates and the depletion of natural resources have driven the search for alternative materials. Recycling concrete provides a sustainable solution by reducing waste and conserving natural aggregates. Recycled concrete aggregate (RCA) can be used as a partial replacement for natural fine aggregates in new concrete. With the advancement of concrete technology and the need for higher strength and durability, especially in aggressive environments, improving concrete performance has become essential. This study focuses on developing High-Performance Concrete (HPC) of M60 Grade using RCA and mineral admixtures. Limited research in India has addressed the durability aspects of HPC with RCA. The objective is to evaluate the mechanical and durability properties of HPC mixes with varying levels of RCA replacing natural fine aggregates and to determine the optimum cement replacement level with silica fume at a 0.30 water-binder ratio. Mechanical properties such as compressive, tensile, and flexural strength were analyzed, along with durability factors including water absorption, acid resistance, and alkalinity.

Keywords: High-Performance Concrete (HPC), Recycled Concrete Aggregate (RCA), Silica Fume, M60 Grade, Durability Characteristics, Mechanical Properties, Acid Resistance, Fine Aggregate Replacement.

Chapter:44

PREPARATION AND STABILITY ANALYSIS OF Fe_3O_4 AND MWCNT NANOPARTICLE PERFORMANCE IN HEAT TRANSFER APPLICATIONS.

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ABSTRACT

Due to their outstanding thermophysical properties, nanofluids have garnered attention for improving heat transfer performance. Fe_3O_4 (magnetite) and MWCNTs are mixed in a base fluid to create a hybrid nanofluid, which is tested for thermal performance and stability. To ensure nanoparticle dispersion, magnetic stirring and ultrasonication are used to produce the nanofluid. The stability of the nanofluid is assessed using sedimentation observation, zeta potential analysis, and UV-Vis spectroscopy. The synergistic interaction between Fe_3O_4 nanoparticles and MWCNTs enhances dispersion stability. The effects of different concentrations (0.025 to 0.1 wt%) on thermal conductivity and heat transfer efficiency are explored. Experimental results show that the hybrid nanofluid has better thermal conductivity and convective heat transfer than mono nanofluids and base fluids. Fe_3O_4 enhances magnetic responsiveness and dispersion stability, whereas MWCNTs enhance heat transfer via high thermal conductivity channels. The improved hybrid nanofluid works well in advanced thermal systems including solar collectors, heat exchangers, and cooling devices, according to the study.

Keywords: Nanofluid, Heat absorption Energy efficiency, Stability, Heat transfer

Chapter:45

AI-BASED ROAD FIRE ACCIDENT DETECTION AND AUTOMATED ALERT SYSTEM USING COMPUTER VISION

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ABSTRACT

Roadside fire accidents present serious risks to human life, vehicles, and infrastructure, requiring fast and reliable detection systems. Traditional fire detection methods that rely on smoke and heat sensors often face limitations such as delayed response, restricted monitoring coverage, and high installation costs, making them less effective in open roadside environments. This project proposes an AI-based roadside fire accident detection and automated alert system using computer vision to ensure real-time and accurate fire detection.

The system utilizes the YOLOv8 deep learning algorithm to analyze video streams from roadside surveillance cameras and identify fire and smoke under varying environmental conditions. When a fire incident is detected, the system automatically sends alerts with location details to emergency services and stores the event data in a cloud database for monitoring and analysis.

This solution improves early detection, reduces response time, enhances public safety, and supports the development of smart and intelligent transportation systems.

Keywords: YOLOv8, Roadside Surveillance, Deep Learning, Automated Alert System, Smart Transportation

Chapter:46

Experimental Investigation of Electro Discharge Machining Characteristics on Nickel-Copper 400 Alloy

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ABSTRACT

Electro Discharge Machining (EDM) is a non-traditional machining process widely used for machining hard and difficult-to-cut materials. In this study, an experimental investigation is carried out to analyze the machining characteristics of Nickel-Copper 400 alloy which is known for its excellent corrosion resistance and high strength. The experiments are conducted by varying key EDM process parameters such as peak current, pulse-on time, pulse-off time, and voltage. The performance measures considered include Material Removal Rate (MRR), Tool Wear Rate (TWR), and Surface Roughness (SR). The results show that peak current and pulse-on time significantly influence the machining performance. Higher current increases MRR but also leads to increased tool wear and surface roughness. Optimal parameter combinations are identified to achieve improved surface finish with acceptable machining efficiency. This investigation provides valuable insights into optimizing EDM parameters for machining Monel 400 alloy in industrial applications.

Keywords: Electro Discharge Machining, Monel 400, MRR, TWR, Surface Roughness

Chapter:47

EVALUATION OF WASTEWATER TREATMENT USING HYACINTH BEAN SEED POWDER & BANANA PEEL POWDER

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ABSTRACT

Wastewater treatment is crucial for safeguarding the environment and public health, particularly in places where access for treatment technologies is restricted. This study evaluates how well natural, inexpensive biosorbents like hyacinth bean seed powder and banana peel powder, improve the quality of water. Standard laboratory tests such as hardness, acidity, alkalinity, and chloride content were used to evaluate the effectiveness of the treatment. Under carefully monitored circumstances, wastewater samples were treated with different concentrations of the produced powders. The findings exposed that acidity and alkalinity had stabilized and that hardness and chloride levels had significantly decreased. Due to its high cellulose and pectin content, banana peel powder demonstrated a great adsorption capacity, whereas hyacinth bean seed powder aided in coagulation and the elimination of dissolved contaminants. According to the results, these biodegradable polymers may be useful and environmentally beneficial substitutes for initial wastewater treatment. They are especially well suited for small-scale and rural applications due to their accessibility, affordability, and little environmental effect.

Keywords: Sewage Water, Hyacinth Bean Seed Powder, Banana Peel Powder

Chapter:48

Experimental Investigation of a Single-Pass Solar Flat Plate Air Heater with Turbulence Promoters and PCM

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ABSTRACT

The performance of a conventional solar air heater is reduced because of low convective heat transfer from the absorber plate to the flowing air. The present study is on a single pass solar flat plate air heater in which the forced convection heat transfer is improved with the help of cylindrical rod turbulators and the use of phase change material (PCM) energy storage system. The inline or the staggered arrangement of the rods is examined for the effect of the arrangement on flow characteristics, heat transfer, and pressure drop. The system includes PCM for thermal draining in the peak heating and releasing in the off-sunshine that offers enhanced thermal stability. A controlled air flow is maintained with the blower and CFD modelling analysis is performed to check the temperature distribution, velocity profile and flow characteristics in the collector. The findings show that adding cylindrical rods enhances convective heat transfer more significantly compared to a smooth absorber plate. The temperature of the outlet air rises due to an inline configuration, which raises the air temperature from about 300 K to 312-318 K, correspondingly, resulting in a thermal efficiency between 45 and 50%. The staggered pattern configures for better mixing and production of turbulence. The outlet temperature thus increases to 318–328 K along with efficiency of 55–65%. Incorporating PCM enhances the storage of heat energy.

Keywords: Solar air heater; Single-pass collector; Turbulence promoters; Cylindrical rod turbulators; Thermal energy storage; Forced convection; Heat transfer enhancement; Thermal efficiency; Pressure drop.

Chapter:49

WATER QUALITY MONITERING SYSTEM USING PH AND TURBIDITY SENSORS

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ABSTRACT

Water quality monitoring is an essential process to ensure the safety and suitability of water for drinking, agriculture, and industrial purposes. A water quality monitoring system using pH and turbidity sensors is a simple, cost-effective, and efficient solution to continuously observe water conditions in real time. This system mainly focuses on measuring two important parameters- pH value and turbidity level. The pH sensor is used to measure the acidity or alkalinity of water on a scale from 0 to 14. A pH value of 7 indicates neutral water, values below 7 indicate acidic water, and values above 7 indicate alkaline water. Maintaining proper pH is important because extreme pH levels can corrode pipes, affect aquatic life, and make water unsafe for human consumption. On the other hand, the turbidity sensor measures the cloudiness or haziness of water caused by suspended particles such as dirt, silt, microorganisms, and organic matter. High turbidity levels may indicate contamination and can reduce light penetration in water bodies, affecting aquatic ecosystems. In this system, both sensors are connected to a microcontroller such as Arduino or Nedelcu, which collects and processes the sensor data. The system can be powered using a battery or solar panel, making it suitable for rural and remote areas. It can be installed in water tanks, rivers, lakes, bore wells, or water treatment plants for continuous monitoring. A water quality monitoring system using pH and turbidity sensors is a practical and innovative solution to ensure clean and safe water for communities while supporting sustainable water resource management.

Keywords: Water Quality, pH Sensor, Turbidity Sensor, Microcontroller, Arduino, Real-Time Monitoring, Contamination, IoT, Water Treatment, Environmental Engineering.

Chapter:50

EXPERIMENTAL INVESTIGATION OF A SINGLE-PASS SOLAR FLAT PLATE AIR HEATER WITH TURBULENCE PROMOTERS

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ABSTRACT

Solar energy is one of the most important renewable energy sources for agricultural drying, industrial process heating and space heating requirements; solar energy is pollution-free. In drying and heating applications solar energy plays an important role as a renewable energy source, where the air is a medium to improve heat transfer in single-pass solar flat-plate collectors. The thermal performance of a single-pass solar flat plate collector area of a rectangular GI sheet of 500 mm length and 250 mm width and thickness of 1 mm absorber plate. The tapered cylinder is placed over the absorber plate; the elements disturb the air flow and increase the heat transfer rate in a single-pass solar collector. This work explores the enhancement of heat transfer by using turbulence promoters. A CFD-based analysis is carried out to evaluate the effect of configurations on velocity and temperature distribution. This experiment's simple surface modifications on the absorber plate can significantly improve the overall heat transfer performance of a single-pass solar flat-plate air heater. The results show that the cylinder without turbulence promoters produces a lower outlet temperature due to limited air mixing, whereas using turbulence promoters improves heat transfer by approximately 10-20%.

Keywords: Solar air heater; Single-pass collector; Turbulence promoters; Cylindrical rod turbulators; Thermal energy storage; Forced convection; Heat transfer enhancement; Thermal efficiency; Pressure drop.

Chapter:51

ANALYSIS AND DESIGN OF MONOCOLUMN SUPPORT SYSTEM FOR LIGHT WEIGHT STRUCTURE

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ABSTRACT

Mono-column structures are buildings supported primarily by a single, centrally positioned column that carries the major vertical loads. This type of structural system is particularly suitable for areas prone to flooding, as elevating the building on one robust column reduces ground obstruction and allows water to flow freely during flood events. Compared with conventional reinforced concrete and steel frame structures, mono-column systems provide a larger serviceable floor area because the absence of multiple interior columns maximizes usable space and enhances functional flexibility. The reduced foundation footprint also minimizes land usage and creates additional space at ground level, which can be effectively utilized for parking or open activities. In these structures, the central column supports the entire load while the surrounding beams and slabs act as cantilevers to ensure stability. This project focuses on the planning, structural analysis, design and drawings for a mono-column structure, highlighting its advantages and practical applications.

Keywords: Mono-column structure, Single-column support, Cantilever system, Flood-prone areas, Structural analysis, Structural design

Chapter:52

ROAD ACCIDENT PREVENTION

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ABSTRACT

Road accidents have become a major public safety issue due to increasing vehicle numbers, overspeeding, and lack of driver awareness. This project focuses on developing an effective road accident prevention system to reduce the number of accidents and improve road safety. The proposed system uses simple technologies and safety measures to alert drivers and prevent collisions at critical locations such as U-turns, intersections, and sharp curves. The system works by detecting approaching vehicles and providing warnings through visual or audio signals to drivers. Sensors or detection mechanisms can be used to identify vehicle movement and activate warning lights, alarms, or display boards. These alerts help drivers reduce speed and stay cautious while approaching accident-prone areas. The system can also be installed on highways, busy city roads, and near schools or hospitals to enhance safety. This project aims to create a low-cost, efficient, and easy-to-implement solution that can be widely used in developing regions. By providing early warnings and improving driver awareness, the system helps minimize human error and prevents potential collisions. The implementation of such systems can significantly reduce road accidents, protect human lives, and improve overall traffic management.

Keywords:Road accident prevention, vehicle detection, warning system, accident reduction, and highway safety.

Chapter:53

Detection Of Reinforcement Corrosion Concrete Block

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ABSTRACT

Reinforcement corrosion in concrete structures is a major issue that affects durability, safety, and service life of buildings and infrastructure. The Reinforcement Corrosion Detection project focuses on developing a system that continuously monitors the corrosion level in reinforced concrete using electrochemical sensing techniques. The system utilizes a copper-copper sulfate reference electrode to measure the potential difference between the reinforcement steel and the surrounding environment, which indicates the likelihood of corrosion activity. An ESP32 microcontroller is used to collect and process the sensor data efficiently. The monitored data is transmitted through IoT technology to a mobile application or web platform, enabling real-time monitoring from remote locations. If the corrosion level exceeds the threshold limits, the system provides alerts to users for timely maintenance and preventive actions. This project helps in early detection of corrosion, reducing repair costs and preventing structural failures. It is highly useful in bridges, buildings, and other reinforced concrete structures. By implementing this system, engineers and building managers can ensure better structural health monitoring and enhance the longevity and safety of constructions.

Keywords: Reinforcement Corrosion, Structural Health Monitoring, Copper-Copper Sulfate Electrode, ESP32 Microcontroller, IoT Monitoring, Concrete Durability.

Chapter:54

Development and Performance Evaluation of Sustainable Composite Pellets Using Bagasse, Perlite, and Graphite with ANN-Based Strength Prediction

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ABSTRACT

This study examines the development of eco-friendly composite pellets using sustainable materials viz., sugarcane bagasse, perlite and graphite, with the intention of addressing the depletion of natural aggregates and associated environmental concerns in construction. Pellets were produced using a cold bonding technique with an alkaline solution and allowed to cure under ambient conditions. Physical and mechanical properties including compressive strength, bulk density, water absorption and specific gravity were evaluated through the experimental program. Compressive strength increased with molarity in all material combinations. Graphite-based pellets exhibited comparatively higher strength and lower water absorption, whereas perlite-based pellets showed reduced density with relatively higher porosity. Sugarcane bagasse demonstrated a balanced behaviour, indicating its potential as a sustainable material. Microstructural observations through SEM revealed a comparatively dense matrix with a polydisperse particle distribution, which may be associated with the observed strength development.

Keywords: Sustainable composite pellets; Lightweight aggregates; Sugarcane bagasse; Perlite; Graphite; Compressive strength; Strength prediction; Sustainable construction materials

Chapter:55

PREDICTIVE MODELLING OF FOOTBALL INJURIES USING MACHINE LEARNING

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ABSTRACT

This project presents an interactive, data-driven system for predicting football injury risk using player workload metrics, historical injury information, and machine-learning-ready visual analytics. The model evaluates key indicators such as the Acute: Chronic Workload Ratio (ACWR), total distance covered, high-speed running load, sprint metrics, accelerations, decelerations, and prior injury history to classify each athlete into Low, Medium, or High injury risk categories. By incorporating both internal and external workload variables, the system provides a holistic view of player readiness and vulnerability. A web-based dashboard built with React, Tailwind CSS, and Canvas- powered custom charts enables coaches and analysts to upload player datasets, visualize workload trends, and compare individual performance patterns with ease. Multiple visualizations—including ACWR distribution graphs, workload comparisons, scatter plot analyses, distance-based workload breakdowns, positional load averages, and overall risk-distribution charts—support detailed, evidence-based assessments of player conditions. These visual tools allow users to instantly interpret complex workload interactions that contribute to injury risk. The system also supports optional integration with Supabase for secure data storage and user authentication, allowing personalized squad data management and seamless digital workflows across teams. This expands the solution from a standalone analytical tool into a scalable platform that can accommodate multiple squads, long-term data tracking, and historical trend analysis. Overall, this project delivers a real-time, practical, and highly interpretable injury prediction solution that helps sports scientists and coaching teams proactively identify at-risk athletes, adjust training loads, and plan individualized recovery strategies. By minimizing non-contact injuries and improving player availability, the system contributes significantly to long term performance optimization, strategic squad planning, and the overall competitive success of a football organization.

Keywords: Injury Risk Prediction, Acute: Chronic Workload Ratio (ACWR), Player Performance Analytics, Machine Learning in Sports, Data Visualization Dashboard

Chapter:56

INVESTIGATION ON PERFORMANCE OF PARTIAL REPLACEMENT OF E-WASTE WITH FINE AGGREGATE IN M40 GRADE CONCRETE

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Abstract

The increasing generation of electronic waste (e-waste) and the depletion of natural fine aggregates have become major environmental concerns in recent years. This study focuses on the investigation of the performance of M40 grade concrete by partially replacing fine aggregate with processed e-waste materials. The e-waste is collected, cleaned, and crushed into suitable sizes to be used as a substitute for natural sand at different replacement levels. Concrete specimens are prepared with varying percentages of e-waste (such as 5%, 10%, 15%, and 20%) and tested for key properties including workability, compressive strength, and split tensile strength. The results indicate that partial replacement of fine aggregate with e-waste up to an optimum level yields satisfactory strength and performance, while higher percentages may lead to a reduction in mechanical properties due to weaker bonding characteristics. The study highlights the potential of e-waste as a sustainable alternative material in concrete production, contributing to effective waste management and conservation of natural resources. This approach promotes the development of eco-friendly concrete suitable for various construction applications.

Keywords: E-waste, Mechanical properties, Fine aggregate, Compressive strength, Split tensile strength

Chapter:57

TRIBOLOGICAL ANALYSIS OF WEAR IN Mg ALLOYS – A Review

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Abstract

Magnesium (Mg) alloys are non-toxic, biodegradable, and biocompatible special metallic biomaterials for biomedical applications, but less corrosion-resistant in physiological and chloride-containing environments. This often limits their use as potential biomedical implants due to loss of their mechanical integrity. This can be addressed by adopting several approaches such as surface modifications and coatings as well as pre-treatments including anodization, micro arc oxidation, and electro-deposition. To further provide insights into better ways to improve the corrosion resistance of Mg alloys in saline and physiological environments, the present work provides a comprehensive overview of the electrochemical properties of Mg alloys as biodegradable material. More importantly, the corrosion and corrosion fatigue mechanisms in surface modified Mg alloys are explicitly reviewed.

Keywords: Biodegradation, Alloy Development, Surface Treatment, Biomedical Implants

Chapter:58

SMART CITIES AND IOT IN INFRASTRUCTURE

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ABSTRACT

The rapid urbanization and population growth have necessitated the development of smart and sustainable infrastructure. Smart cities integrate advanced technologies such as the Internet of Things (IOT) to enhance the efficiency, reliability, and quality of urban services. IOT enables real-time data collection, monitoring, and control of infrastructure systems including transportation, energy, water supply, and waste management. By embedding sensors and communication devices into physical infrastructure, cities can optimize resource utilization, reduce energy consumption, and improve decision-making processes. This study focuses on the role of IOT in transforming conventional infrastructure into intelligent systems capable of self-monitoring and adaptive response. The proposed approach highlights the implementation of smart grids, intelligent traffic management systems, and automated waste management solutions. Additionally, the integration of cloud computing and data analytics enhances predictive maintenance and reduces operational costs. The research emphasizes the importance of interoperability, security, and scalability in IOT-based smart city frameworks. The findings demonstrate that IOT-driven infrastructure significantly improves urban sustainability, reduces environmental impact, and enhances the quality of life for citizens. This work provides insights into future developments and practical implementation strategies for smart city infrastructure.

Keywords: Smart Cities, Internet of Things (IOT), Infrastructure, Sustainability, Automation

Chapter:59

SUSTAINABLE CONCRETE USING M-SAND AND CERAMIC TILE WASTE FORENHANCED STRUCTURAL PERFORMANCE

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ABSTRACT

The increasing demand for sustainable construction materials has led to the exploration of alternative resources to replace conventional concrete constituents. This study investigates the development of sustainable concrete by incorporating industrial by-products and waste materials, specifically Manufactured sand (M-sand) as a replacement for natural river sand and Ceramic Tile Waste (CTW) as a partial replacement for coarse aggregate. Concrete mixes were prepared with varying replacement levels and their performance was evaluated through mechanical properties such as compressive strength, split tensile strength and flexural strength. The use of M-sand improves particle packing and reduces dependency on natural river sand, while ceramic tile waste enhances strength due to its angularity and hardness. The experimental results indicate that the combined use of M-sand and Ceramic Tile Waste leads to comparable or improved structural performance relative to conventional concrete. Additionally, the approach contributes to effective waste management and conservation of natural resources. The study demonstrates that such sustainable concrete can be a viable alternative for structural applications, promoting eco-friendly and cost-effective construction practices.

Keywords: Fine aggregate, Coarse aggregate, Manufactured sand (M-sand), Ceramic tile waste, Compressive strength, Split tensile strength.

Chapter:60

COASTAL EROSION MONITORING IN CUDDALORE DISTRICT BY USING GOOGLE EARTH ENGINE

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ABSTRACT

Coastal erosion is a major environmental issue affecting coastal regions due to natural processes such as waves, tides, and sea level changes. This study focuses on monitoring coastal changes in Cuddalore district using remote sensing and Geographic Information System (GIS) techniques. Multi-temporal satellite data for the years 2015, 2018, 2021, and 2025 were used for analysis. The data were processed using the Google Earth Engine platform. Image preprocessing techniques such as cloud masking and scaling were applied to improve accuracy. Water bodies were extracted using NDWI and MNDWI indices. These indices help in distinguishing between land and water areas. The land and water areas were calculated for each year. The results show an increase in water area over time. At the same time, a decrease in land area was observed. This indicates coastal erosion and shoreline retreat. Graphs and maps were used to visualize the changes. Rainfall data were also analyzed to understand environmental influences. Based on the results, future coastal changes were predicted. Suitable coastal protection measures such as rubble mound seawalls were recommended.

Keywords: Coastal Erosion, Remote Sensing, GIS, NDWI, MNDWI, Shoreline Change, Land Loss, Water Area Change, Google Earth Engine, Cuddalore District

Chapter:61

Design and Fabrication of Eco Friendly Paddy Winnowers by Using Solar Energy

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ABSTRACT

Paddy (*Oryza sativa*) is one of the most important staple food crops globally, consumed by nearly three-fourths of the world's population and serving as the primary calorie source in India. Despite its significance, post-harvest losses remain a major challenge, with outdated drying, milling, and storage methods contributing to grain deterioration. Among post-harvest operations, threshing and winnowing are critical for ensuring grain quality and storability. Traditional winnowing methods in rural India are labor-intensive, time-consuming, and dependent on wind conditions, while hand-operated winnowers suffer from low separation efficiency. Power-operated winnowers improve performance but rely on grid electricity, which is often unavailable or unreliable in rural regions. To address these limitations, solar photovoltaic (PV) powered paddy winnowers offer a sustainable alternative by utilizing abundant solar energy in tropical countries like India. Such systems reduce dependence on conventional electricity; lower operating costs, and enhance grain cleaning efficiency. The present study proposes the modification and evaluation of an existing PV-powered paddy winnower to improve performance. The objectives include designing an energy-efficient winnower and analyzing its operational efficiency under solar energy utilization. This innovation aims to minimize post-harvest losses, improve grain quality, and provide a cost-effective, eco-friendly solution for farmers in regions with limited access to conventional power supply.

Key words: solar energy, paddy, fan, winnower.

Chapter:62

INVESTIGATION ON PERFORMANCE OF PARTIAL REPLACEMENT OF E-WASTE WITH FINE AGGREGATE IN M40 GRADE CONCRETE

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Abstract

The increasing generation of electronic waste (e-waste) and the depletion of natural fine aggregates have become major environmental concerns in recent years. This study focuses on the investigation of the performance of M40 grade concrete by partially replacing fine aggregate with processed e-waste materials. The e-waste is collected, cleaned, and crushed into suitable sizes to be used as a substitute for natural sand at different replacement levels. Concrete specimens are prepared with varying percentages of e-waste (such as 5%, 10%, 15%, and 20%) and tested for key properties including workability, compressive strength, and split tensile strength. The results indicate that partial replacement of fine aggregate with e-waste up to an optimum level yields satisfactory strength and performance, while higher percentages may lead to a reduction in mechanical properties due to weaker bonding characteristics. The study highlights the potential of e-waste as a sustainable alternative material in concrete production, contributing to effective waste management and conservation of natural resources. This approach promotes the development of eco-friendly concrete suitable for various construction applications.

Keywords: E-waste, Mechanical properties, Fine aggregate, Compressive strength, Split tensile strength

Chapter:63

TRIBOLOGICAL ANALYSIS OF WEAR IN Mg ALLOYS – A REVIEW

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Abstract

Magnesium (Mg) alloys are non-toxic, biodegradable, and biocompatible special metallic biomaterials for biomedical applications, but less corrosion-resistant in physiological and chloride-containing environments. This often limits their use as potential biomedical implants due to loss of their mechanical integrity. This can be addressed by adopting several approaches such as surface modifications and coatings as well as pre-treatments including anodization, micro arc oxidation, and electro-deposition. To further provide insights into better ways to improve the corrosion resistance of Mg alloys in saline and physiological environments, the present work provides a comprehensive overview of the electrochemical properties of Mg alloys as biodegradable material. More importantly, the corrosion and corrosion fatigue mechanisms in surface modified Mg alloys are explicitly reviewed.

Keywords: Biodegradation, Alloy Development, Surface Treatment, Biomedical Implants

Chapter:64

DEVELOPMENT OF AN EFFICIENT SOLAR DRYER WITH SILICA COATED GLASS PREPARED FROM RICE HUSK ASH

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ABSTRACT

The increasing demand for sustainable food preservation techniques has led to the development of efficient solar drying systems. Conventional open sun drying methods suffer from major drawbacks such as contamination, uneven drying, dependency on weather conditions, and significant post-harvest losses. Furthermore, traditional solar dryers often utilize standard glass covers that do not optimise solar radiation transmission or thermal efficiency, thereby limiting drying performance. There is a need for a cost-effective, eco-friendly solar dryer that enhances heat retention and improves drying efficiency using locally available agricultural waste materials. The proposed system involves the development of an indirect-type solar dryer integrated with silica-coated glass prepared from rice husk ash (RHA). Rice husk ash, an abundant agricultural waste, contains a high percentage of amorphous silica. The extracted silica is used to coat the glass surface to enhance solar transmissivity and thermal insulation properties. The system is designed to improve drying rate, reduce drying time, and enhance product quality while promoting waste valorization. Experimental analysis includes temperature distribution, moisture reduction rate, and drying efficiency evaluation.

Keywords: Solar Dryer, Rice Husk Ash, Silica Coating, Drying Efficiency, Sustainable Energy.

Chapter:65

DESIGN AND FABRICATION OF CHAFF CUTTER FOR SMALL SCALE FARMERS

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ABSTRACT

The design and fabrication of a chaff cutter for small-scale farmers is aimed at improving fodder preparation efficiency while reducing labour, time, and feed wastage in rural livestock farming. Traditional fodder cutting methods using hand tools such as sickles are labour-intensive, time-consuming, and often result in non-uniform fodder size, which affects feed utilization and animal intake. To overcome these limitations, a low-cost and efficient chaff cutter was designed and fabricated using locally available materials to ensure affordability and ease of maintenance. The developed machine consists of a mild steel frame, feeding hopper, rotating shaft, cutting blades, and a power transmission system operating on the rotary cutting principle to produce uniformly chopped fodder. The design emphasizes operator safety, structural durability, simple operation, and suitability for both manual and motorized use depending on farmer requirements. The fabricated chaff cutter improves the quality and uniformity of fodder, enhances digestibility, reduces feed rejection, and supports better livestock management practices. In addition, the machine minimizes dependence on manual labour and offers a practical, economical, and sustainable solution for small-scale farmers. Overall, the project demonstrates an effective agricultural engineering approach to improving fodder processing and promoting mechanization in rural farming systems. “The fabricated chaff cutter operated with an electric motor of 0.75 kW and achieved an approximate cutting capacity of 100 kg/h at a total fabrication cost of about ₹6,000, making it an economical and efficient solution for small-scale farmers.”

Keywords: Chaff cutter, fodder cutting, small-scale farmers, agricultural machinery, livestock feeding, rotary cutting mechanism, low-cost fabrication, mild steel frame, rural agriculture, and fodder management.

Chapter:66

DESIGN AND DEVELOPMENT OF A HAND-PUSHED FERTILIZER APPLICATOR FOR HORTICULTURAL CROPS

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ABSTRACT

The efficient and precise fertilizer application is critical for enhancing crop productivity and minimizing nutrient losses in horticultural crops. Traditional methods such as manual broadcasting often result in uneven distribution, excessive application, and increased labor drudgery, leading to poor nutrient use efficiency and environmental concerns. To address these limitations, a hand-pushed fertilizer applicator was developed for accurate and uniform placement of fertilizers in horticultural fields. The developed applicator is a manually operated, cost-effective device designed to suit small and medium-scale farmers. It consists of a hopper for backpack granular fertilizer storage, metering mechanism, a delivery tube, and a furrow opener with a lance setup for precise placement of fertilizers near the root zone. The device operates on a push mechanism, where the end effector act as the metering unit, ensuring controlled discharge of fertilizers based on push effect and field conditions. The design emphasizes simplicity, durability, and ease of operation under varying field conditions. It is capable of handling both granular and powdered fertilizers, with adjustable settings for application rate and depth to meet crop-specific nutrient requirements. The applicator reduces the need for manual bending and repetitive movements, thereby improving operator ergonomics and reducing fatigue. Performance evaluation indicates that the hand-pushed fertilizer applicator ensures uniform distribution, improved placement accuracy, and reduced fertilizer wastage compared to conventional methods. It also enhances field capacity and operational efficiency while lowering labor requirements. The device contributes to sustainable agriculture by reducing nutrient losses through volatilization and runoff, thus improving fertilizer use efficiency. The hand pushed applicator offers a practical solution for precision nutrient management in horticultural crops. Its low cost, ease of maintenance, and adaptability make it highly suitable for adoption by smallholder farmers, promoting improved productivity, resource conservation, and environmentally friendly farming practices.

Keywords: applicator, fertilizer, horticultural crops, metering mechanism, nutrients

Chapter:67

EXPERIMENTAL STUDY ON NATURAL NANO WATER REPELLENT CONCRETE

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ABSTRACT

Water absorption through capillary pores is a key factor that affects the durability and service life of concrete structures. The concrete mix includes natural hydrophobic components like nano-treated lotus leaf extract, processed duck feather fibers, and beeswax, which work together to reduce water penetration. The nano-structured surface of the lotus leaf has excellent water-repelling capabilities. Duck feather fibers decrease pore connectivity and strengthen the internal structure. Beeswax acts as a natural waterproofing agent by coating the pores and limiting moisture movement within the concrete. Experimental tests, including water absorption, compressive strength, and durability assessments, are conducted to evaluate the performance of the modified concrete. The findings are expected to show a significant decrease in water absorption without weakening mechanical strength.

Keywords: Natural nano materials, Hydrophobic concrete, Water-repellent concrete, Lotus leaf extract, Duck feather fibers, Beeswax, Water absorption reduction, Sustainable construction materials, Eco-friendly concrete, Concrete durability

Chapter:68

DESIGN AND FABRICATION OF SALT SPRAY CORROSION TESTING MACHINE

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ABSTRACT

A salt spray corrosion testing machine comprising a sealed corrosion-resistant chamber configured to conduct accelerated corrosion testing. The system includes an atomizing nozzle assembly adapted to generate a uniform saline fog using a controlled compressed air supply and a standardized sodium chloride solution. A heating and temperature regulation unit maintains the chamber environment at prescribed test conditions, while a specimen support structure positions multiple test samples at defined angles to ensure uniform exposure. The apparatus further incorporates a micro-controller-based control system for precise regulation of spray cycles, temperature, test duration, and shutdown operations. The closed-chamber configuration ensures repeatability, safety, and isolation from external environmental variations. The novelty of the invention lies in the integrated modular control and spray distribution architecture that enables consistent fog density and reduced solution consumption while maintaining full compliance with international corrosion testing standards.

Keywords: Salt Spray Corrosion Testing Machine, Sealed corrosion-Resistant Champer, Atomizing Nozzle, Microcontroller-Based Control System, Uniform Saline Fog

Chapter:69

DESIGN AND SCHEDULING OF COMMERCIAL COMPLEX USING SOFTWARE

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ABSTRACT

This project focuses on the design and scheduling of a commercial complex using specialized software tools to ensure accuracy, safety, and timely project execution. The structural design of the building was developed using industry-standard software to analyze loads, evaluate structural components, and optimize material usage in accordance with relevant codes and standards. At the same time, project scheduling software was used to prepare a detailed Work Breakdown Structure (WBS), allocate resources, and develop a realistic construction timeline. The integration of design and scheduling tools improved coordination between structural planning and project management, resulting in enhanced efficiency, reduced errors, and better decision-making throughout the project lifecycle. The project demonstrates how software-based methodologies can significantly improve planning, design, and execution of commercial buildings. The design and construction of commercial complexes require advanced technological tools to ensure structural stability, functional efficiency, and timely delivery. This study presents a comprehensive approach using engineering and project management software to model structures, perform load analysis, and generate precise plans and layouts. It also includes activity sequencing, resource allocation, critical path identification, and risk assessment, ultimately enhancing coordination, minimizing delays, improving material utilization, and supporting data-driven decisions. Overall, the study concludes that software-integrated planning increases accuracy, efficiency, and reliability in modern commercial construction projects.

Keywords: Commercial complex, Structural design, Project scheduling, Work Breakdown Structure (WBS), Project management.

Chapter:70

SELF HEALING CONCRETE

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ABSTRACT

Concrete is the most widely used construction material in the world, yet it is highly susceptible to cracking due to environmental stress, shrinkage, and load variations. These cracks not only reduce structural durability but also increase maintenance costs and compromise safety. This study focuses on the innovative concept of self-healing concrete, a smart material designed to autonomously repair cracks and extend the service life of structures. Self-healing concrete incorporates healing agents such as bacteria, encapsulated polymers, or mineral admixtures that activate when cracks form. In particular, bacteria-based self-healing mechanisms utilize microbial activity to precipitate calcium carbonate, effectively sealing cracks without external intervention. This process enhances durability, reduces permeability, and improves resistance to environmental degradation. The research highlights different self-healing techniques, their working principles, and performance characteristics compared to conventional concrete. Experimental observations indicate that self-healing concrete significantly reduces crack width and restores mechanical properties to a considerable extent. This paper emphasizes the potential of self-healing concrete as a sustainable solution for modern infrastructure challenges. By integrating biological and chemical healing mechanisms, this technology represents a major advancement in construction materials. The findings suggest that self-healing concrete can play a vital role in future smart infrastructure systems, improving durability, safety, and cost-efficiency.

Keywords: Self-healing concrete, cracks, bacteria, calcium carbonate, durability, sustainability, smart materials, repair, microstructure, permeability, strength, infrastructure, eco-friendly, innovation, construction.

Chapter:71

AI-BASED ADAPTIVE TRAFFIC SIGNAL CONTROL SYSTEM USING REAL-TIME CONGESTION DATA

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ABSTRACT

This project focuses on building a smart traffic signal system that can adjust itself based on real-time traffic conditions. Unlike traditional signals that follow fixed timers and often cause unnecessary delays, this system uses AI to make better decisions on the go. By using cameras and sensors, it observes how many vehicles are on the road, how long they've been waiting, and how crowded each lane is. Based on this information, it automatically changes signal timings to reduce congestion and keep traffic moving smoothly. Busy lanes are given priority, while less crowded ones are managed efficiently to avoid wasted time. The system also keeps learning from past and current data, improving its performance over time. As a result, it helps reduce travel time, saves fuel, and lowers overall traffic stress. It can even respond to sudden situations like accidents or rush hours. Designed with future cities in mind, it can be expanded easily and can give priority to emergency vehicles when needed. Overall, it makes urban transportation smarter, faster, and more efficient

Keywords: Artificial Intelligence (AI), Adaptive Traffic Control, Real-Time Data, Computer Vision, Smart City Systems.

Chapter:72

SPATIOTEMPORAL ANALYSIS OF LAND USE AND LAND COVER (LULC) DYNAMICS IN KANCHEEPURAM DISTRICT BY USING GOOGLE EARTH ENGINE

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ABSTRACT

This study presents a geospatial framework for Land Use and Land Cover (LULC) change detection and future prediction in Kancheepuram District using cloud-based remote sensing techniques. Multi-temporal satellite data from the Dynamic World dataset were processed within the Google Earth Engine platform to generate LULC maps for the years 2018, 2021, and 2025. The classified outputs were restructured into four major categories: water, built-up, bare land, and vegetation, enabling efficient analysis and interpretation. A Cellular Automata- based model was applied to simulate future land cover scenarios for 2030 and 2050 by capturing spatial neighborhood interactions. Change detection analysis was carried out to identify significant transitions, particularly vegetation-to-built-up conversions, indicating rapid urban expansion. Furthermore, area statistics and transition matrices were computed to quantify temporal variations and assess land transformation patterns. The results highlight a steady increase in built-up areas and a decline in vegetation, emphasizing the impact of urbanization in the study region. This integrated approach combining remote sensing, geospatial analysis, and predictive modeling provides a reliable framework for sustainable urban planning and environmental management.

Keywords: Land Use Land Cover (LULC), Change Detection, Cellular Automata, Google Earth Engine, Remote Sensing, Urban Expansion, Dynamic World Dataset, Spatial Analysis, Future Prediction, Kancheepuram District

Chapter:73

PROCESS PARAMETER OPTIMIZATION IN HIGH-PRECISION WIRECUTTING EDM OF SUPER ALLOYS

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ABSTRACT

Inconel 718 is a nickel-based superalloy widely used in aerospace, power generation, and high-temperature applications due to its excellent mechanical strength, corrosion resistance, and thermal stability. Despite these advantages, machining Inconel 718 using conventional methods is challenging because of its high hardness, tendency to work-harden, and low thermal conductivity. These properties lead to rapid tool wear, increased cutting forces, and poor surface quality, making it a difficult-to-machine material. To address these challenges, Wire Electrical Discharge Machining (WEDM), a non-traditional machining process, is employed. WEDM is particularly suitable for machining hard and complex materials as it removes material through electrical discharges rather than mechanical cutting. This study focuses on investigating and optimizing the WEDM process parameters for machining Inconel 718 to improve machining performance. The key machining parameters considered in this research are peak current (I_p), pulse ON time (T_{on}), and pulse OFF time (T_{off}), as they significantly influence the machining outcomes. The experiments were designed using the Taguchi method with an L18 orthogonal array, enabling efficient analysis of multiple parameters with a reduced number of experiments. Machining performance was evaluated based on surface roughness (R_a) and kerf angle, which are critical indicators of surface quality and dimensional accuracy. Experiments were conducted on a CNC WEDM machine, and measurements were taken using a surface roughness tester and an optical system for kerf angle evaluation. The experimental data were analyzed using Analysis of Variance (ANOVA) to determine the significance of each parameter. Results indicate that peak current and pulse ON time significantly affect both surface roughness and kerf angle, while pulse OFF time contributes to stable machining conditions. The study identifies optimal parameter settings that enhance surface finish and reduce kerf angle.

Keywords: Inconel 718, Wire Electrical Discharge Machining (WEDM), Surface Roughness (R_a), Kerf Angle, Peak Current (I_p), Pulse ON Time (T_{on}), Pulse OFF Time (T_{off}), Taguchi Method, ANOVA, Process optimization, superalloy machining.

Chapter:74

Effect Of Trailing Edge Serrations In NACA2202 Airfoil

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Abstract

Trailing edge noise is a major source of aerodynamic sound in airfoils operating at moderate to high Reynolds numbers, affecting applications such as wind turbine blades, unmanned aerial vehicles (UAVs), and aircraft wings. This study examines the aerodynamic and aeroacoustic performance of trailing edge serrations applied to a standard NACA airfoil. Inspired by owl feather structures, these serrations act as passive flow control devices that disrupt coherent vortex shedding at the trailing edge, thereby reducing broadband noise. Numerical simulations and analytical methods were used to compare baseline and serrated configurations over varying angles of attack and flow velocities. The analysis focuses on key serration parameters, including amplitude and wavelength, and their effects on noise reduction, lift, drag, and boundary layer behavior. Results show that properly designed serrations significantly reduce trailing edge noise by altering pressure fluctuations in the wake region, while maintaining aerodynamic performance. In some cases, a slight improvement in lift-to-drag ratio was observed at moderate angles of attack, indicating potential aerodynamic benefits alongside acoustic gains. Overall, the findings highlight the effectiveness of trailing edge serrations as a passive noise control strategy. The study provides practical design insights for optimizing serration geometry, supporting their integration into aeronautical and renewable energy systems to achieve quieter and more efficient airfoil performance.

Keywords: Trailing Edge Serrations; Airfoil Aeroacoustics; Noise Reduction; Boundary Layer; Aerodynamic Performance

Chapter:75

INVESTIGATION OF MECHANICAL CHARACTERISTICS OF AL 7075 REINFORCED WITH HYBRID COMPOSITES

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ABSTRACT

Metal Matrix Composites (MMCs) have gained significant attention in engineering applications due to their improved mechanical properties and lightweight nature. Aluminium alloy 7075 is widely used in aerospace and automotive industries because of its high strength-to-weight ratio. However, its hardness can still be improved by reinforcing it with suitable particles. In this study, Al7075 is reinforced with Silicon Carbide (SiC) and brake powder to develop a hybrid metal matrix composite. The composite is prepared with reinforcement compositions of 5%. The mechanical characteristics of the developed composite are evaluated mainly through hardness and tensile testing. The results help in understanding how reinforcement materials influence the mechanical performance of the base alloy.

Keywords: Metal Matrix Composite, Al7075, Silicon Carbide, Brake Powder, Mechanical Properties

Chapter:76

NUMERICAL OPTIMIZATION AND ACOUSTIC PERFORMANCE ANALYSIS OF AN EXHAUST NOZZLE USING CFD TECHNIQUES

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ABSTRACT

This project focuses on the aeroacoustic analysis and noise mitigation of jet exhaust flow from a turbofan engine nozzle, where jet noise—primarily generated by high-velocity turbulent shear layer interactions between exhaust gases and the surrounding atmosphere—forms a significant portion of overall aircraft acoustic emissions. Reducing this noise is essential for improving environmental compatibility and meeting stringent aviation noise regulations. The study employs passive flow control techniques by incorporating chevron geometries and tab devices at the nozzle exit to enhance jet mixing characteristics. Chevrons modify the exhaust plume structure by generating streamwise vortices that promote stronger interaction between the jet core and ambient airflow, leading to improved turbulent mixing. This enhanced mixing reduces large-scale coherent turbulent structures that are mainly responsible for dominant acoustic radiation, thereby decreasing overall noise levels. The analysis further explores the relationship between turbulence intensity, velocity decay rate, and acoustic pressure fluctuations within the exhaust plume. The results demonstrate that optimized chevron configurations significantly reduce jet noise through controlled enhancement of mixing and suppression of coherent turbulence. Overall, the study highlights that passive nozzle modification techniques provide an effective, practical, and efficient solution for reducing turbofan exhaust noise while preserving aerodynamic performance and engine efficiency.

Key words - Aeroacoustics, Exhaust Nozzle, Chevron Nozzle Analysis, Aircraft Noise Reduction.

Chapter:77

GENERATIVE ADVERSARIAL NETWORKS IN THE DARK WEB: SECURITY THREATS AND FUTURE DIRECTION

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ABSTRACT

Generative Adversarial Networks are increasingly being exploited within Dark Web ecosystems, reshaping the landscape of cybercrime and anonymity. Originally designed for creative and data-driven applications, GANs now enable the generation of deepfake identities, synthetic media, counterfeit documents and realistic phishing content. Their ability to produce highly convincing outputs enhances social engineering attacks, facilitates identity fraud and strengthens illicit marketplace operations. This paper examines the role of GANs in the Dark Web, highlighting emerging threats such as AI-powered ransomware-as-a-service, adversarial attacks against detection systems and the proliferation of synthetic trust mechanisms in hidden communities. Critical research gaps are identified, including the need for adversarial robustness, ethical governance and interdisciplinary approaches to threat intelligence. Future directions emphasize developing counter-algorithms, enhancing detection frameworks and balancing privacy with security in the evolving algorithmic landscape of the Dark Web.

Keywords: Generative Adversarial Networks, Dark Web Ecosystems ,Deepfake Identities ,Synthetic Media , Threat Intelligence

Chapter:78

PREDICTION OF RICE CROP PRODUCTION IN THANJAVUR DISTRICT USING GEE

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ABSTRACT

Thanjavur district, widely known as the “rice bowl of Tamil Nadu,” is crucial for regional food security, but predicting its multi-crop seasonal rice production is challenging due to persistent monsoon cloud cover and spectral mixing from fragmented smallholder farms. This project, “Prediction of Rice Crop Production in Thanjavur District Using Google Earth Engine (GEE),” develops a cloud-based machine learning framework to map historical trends and forecast production up to the 2027–28 water year. To address GEE memory and processing constraints, a targeted ROI approach was implemented by restricting analysis to taluk-level boundaries. The study integrates Sentinel-1 SAR (VH polarization) data with Sentinel-2 optical imagery, enabling continuous, weather-independent monitoring during key agricultural phases. An unsupervised K-Means clustering algorithm processes 48-month temporal datasets to derive eight years (2017–2025) of rice extent and seasonal cropping patterns. For prediction, a dual-model pipeline is used: an Ordinary Least Squares linear regression model forecasts spatial crop extent with 82.8% accuracy through hindcasting validation, while a supervised Random Forest classifier with 50 trees predicts seasonal cropping choices, achieving 65.1% accuracy and a 0.535 Kappa coefficient using a 70/30 stratified split. The outputs are combined through a “mathematical weld,” ensuring seasonal predictions align with valid spatial boundaries. Finally, predicted crop areas are multiplied by official five-year average yield data to estimate production tonnage. This system delivers a reliable, weather-resilient decision-support tool for agricultural planning and food security in the Cauvery Delta region.

Keywords: Google Earth Engine, Multi-Sensor Fusion, Machine Learning, Phenological Mapping, Spatial Area Forecasting.

Chapter:79

FUEL INJECTION AND FLAME HOLDER OPTIMIZATION IN GAS TURBINE ENGINES TO ENHANCE FUEL-AIR MIXING EFFICIENCY

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ABSTRACT

Gas turbine engines rely heavily on efficient fuel-air mixing and stable combustion to achieve optimal performance and thrust generation. The effectiveness of combustion is influenced by injector design and flame holder configuration, which directly affect mixing characteristics and flame stability. This study investigates the optimization of fuel injection parameters and flame holder geometry to enhance combustion efficiency using computational fluid dynamics (CFD) analysis .A three-dimensional model of the gas turbine combustion chamber, including compressor outlet, fuel injector, V-gutter flame holder, and exhaust nozzle, was developed to simulate turbulent non-premixed combustion. The governing equations of mass, momentum, energy, and species transport were solved using a realizable k- ϵ turbulence model. The results show that optimized injector configuration improves fuel-air mixing, enhances temperature uniformity, and reduces total pressure losses across the combustion chamber. Improved flame anchoring was observed in the recirculation zone created by the flame holder, ensuring stable combustion. Additionally, flow and velocity analysis confirmed better exhaust characteristics contributing to increased thrust efficiency. The findings demonstrate that proper optimization of fuel injection systems and flame holder design significantly improves combustion performance and overall gas turbine engine efficiency.

Keywords : Gas Turbine Engine ,Fuel-Air Mixing ,Flame Holder Design ,Computational Fluid Dynamics (CFD) ,Combustion Efficiency

Chapter:80

DESIGN AND DEVELOPMENT OF MICROBIAL BIOCAPSULES FOR SELF HEALING SOIL STABILIZATION

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ABSTRACT

The main aim of this project is to develop a microbial bio-encapsulation system using sodium alginate capsules for improving soil fertility and promoting sustainable agricultural practices. Excessive use of chemical fertilizers in agriculture has led to soil degradation, nutrient imbalance, and environmental pollution. Therefore, there is a need for an eco-friendly method that can enhance nutrient availability while protecting beneficial soil microorganisms. In this project, beneficial microbes are encapsulated inside sodium alginate beads through a simple bio-encapsulation technique. The microbial culture is mixed with sodium alginate solution and dropped into a calcium chloride solution to form spherical capsules. These capsules act as protective carriers that safeguard the microorganisms from environmental stress and help in their gradual release into the soil. The bio-capsules are applied near the root zone of plants where they slowly dissolve and release the microbes. These microorganisms help in improving nutrient cycling, enhancing plant growth, and increasing soil microbial activity. The encapsulation method also increases the shelf life and effectiveness of microbial inoculants. This project aims to provide a sustainable, cost-effective, and environmentally friendly solution for improving soil health and crop productivity through microbial bio-encapsulation technology.

KEYWORDS : Bio-encapsulation, Sodium Alginate Beads, Microbial Capsule, Calcium Chloride Gelation, Controlled Release of Microbes, Soil Fertility Improvement.

Chapter:81

EXPERIMENTAL INVESTIGATION OF ENERGY ABSORPTION AND THERMAL STABILITY IN HYBRID KEVLAR/POLYUREA-MODIFIED EPOXY RESIN COMPOSITES

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ABSTRACT

This research focuses on the development of a high-performance hybrid sandwich composite designed for blast and impact-resistant applications. The growing need for materials that combine superior impact strength with excellent thermal stability is particularly important in aerospace, defence, and automotive sectors. In this study, a novel hybrid composite panel was fabricated and experimentally evaluated. The structure consists of face sheets reinforced with three layers of Kevlar on both the top and bottom surfaces to improve load the-bearing capacity and damage resistance. The core layer was engineered using a specially formulated matrix containing polyurea granules uniformly distributed within a resin system to enhance energy absorption characteristics. The laminate was manufactured using the hand lay-up method, followed by a 24-hour curing process to achieve proper cross-linking and structural integrity. Mechanical and thermal performance tests were carried out to assess the effectiveness of the developed composite. Thermogravimetric Analysis (TGA) confirmed that the material maintains structural stability up to 700oC, indicating strong resistance to high-temperature environments. Impact testing demonstrated a maximum energy absorption capacity of 80.06kj/m, highlighting the combined effect of Kevlar reinforcement and the polyurea modified core in reducing impact damage. The results confirm that the developed Kevlar polyurea hybrid sandwich composite offers excellent impact resistance and thermal durability, making it a promising material for protective structures, blast mitigation systems, and structural damping applications.

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EXPERIMENTAL INVESTIGATION OF ENERGY ABSORPTION AND THERMAL STABILITY IN HYBRID KEVLAR/POLYUREA-MODIFIED EPOXY RESIN COMPOSITES

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ABSTRACT

This research focuses on the development of a high-performance hybrid sandwich composite designed for blast and impact-resistant applications. The growing need for materials that combine superior impact strength with excellent thermal stability is particularly important in aerospace, defence, and automotive sectors. In this study, a novel hybrid composite panel was fabricated and experimentally evaluated. The structure consists of face sheets reinforced with three layers of Kevlar on both the top and bottom surfaces to improve load the-bearing capacity and damage resistance. The core layer was engineered using a specially formulated matrix containing polyurea granules uniformly distributed within a resin system to enhance energy absorption characteristics. The laminate was manufactured using the hand lay-up method, followed by a 24-hour curing process to achieve proper cross-linking and structural integrity. Mechanical and thermal performance tests were carried out to assess the effectiveness of the developed composite. Thermogravimetric Analysis (TGA) confirmed that the material maintains structural stability up to 700oC, indicating strong resistance to high-temperature environments. Impact testing demonstrated a maximum energy absorption capacity of 80.06kj/m, highlighting the combined effect of Kevlar reinforcement and the polyurea modified core in reducing impact damage. The results confirm that the developed Kevlar polyurea hybrid sandwich composite offers excellent impact resistance and thermal durability, making it a promising material for protective structures, blast mitigation systems, and structural damping applications.

Chapter:83

PERFORMANCE EVALUATION OF STEEL FIBRE REINFORCED HIGHPERFORMANCE CONCRETE

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ABSTRCAT

Construction with cement concrete is most widely used technique around the world. Even though conventional cement concrete provides good workability with adequate compressive strength, but the lack of ductility and lean resistance to crack leads to brittle failure of concrete under tensile load. It shows construction field requires additional structural durability with advanced modifications for the conventional concrete. To overcome this kind of issue it is required to introduce steel fiber in concrete and to enhance the performance. For this, we select 5D steel fibers to improve the performance and to control the crack formation in concrete. Experimental investigations are undergoing for the grade of M60 concrete. Initially we did the basic mechanical properties for raw materials and arrive the design mix. After that we prepared the concrete moulds for compressive strength test, split tensile strength test and flexural strength test. Currently we tested the 7 days strength test and all we got positive performances and waiting for the 28 days test. In future, we also planned to conduct the micro characterization and influence of 5D fibers in concrete behavior.

Keywords: Concrete, High Performance Concrete, 5D fibers

Chapter:84

OPTIMIZED FUEL INJECTION FOR AFTERBURNER PERFORMANCE

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ABSTRACT

After burners are employed in low-bypass turbofan engines to provide additional thrust during take-off and high-speed flight conditions. The performance of an afterburner largely depends on effective fuel-air mixing, combustion stability, and minimization of total pressure losses. This study investigates the optimization of fuel injection parameters to enhance afterburner performance using computational fluid dynamics (CFD) analysis. A three-dimensional model of the afterburner section, including diffuser, fuel spray bars, flame holder, and convergent-divergent nozzle, was developed to simulate turbulent non-premixed combustion. Axial temperature and pressure distributions were analysed to evaluate combustion efficiency and expansion characteristics. The results indicate that optimized fuel distribution improves temperature uniformity, enhances combustion stability, and reduces total pressure losses across the system. Exhaust plume analysis further confirms improved thrust-producing jet behaviour. The findings demonstrate that appropriate fuel injector design significantly improves afterburner efficiency and overall engine performance.

KEYWORDS : Afterburner ,Computational Fluid Dynamics (CFD) ,Fuel Injection Optimization, Combustion Stability, Thrust Enhancement

Chapter 85

Evaluation of Nettle Fibres as an Eco-Friendly Reinforcement Material in Lightweight Structures

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ABSTRACT

The growing demand for sustainable materials has led to increased interest in natural fibres as effective alternatives to synthetic ones. This study investigates the potential of Nettle fibres, an underutilized natural resource. The fibres were extracted through a manual retting process and subsequently characterized for their chemical, morphological, thermal, and mechanical properties. Chemical analysis determined the presence of cellulose, hemicellulose, lignin, pectin, moisture, and wax. X-ray diffraction (XRD) results indicated a crystallite size of 3.9 nm and a crystallinity index of 76.5%. Fourier Transform Infrared Spectroscopy (FTIR) confirmed various functional groups corresponding to the fibre's chemical composition. Thermogravimetric analysis (TGA) showed that the fibres are thermally stable up to 400 °C. Tensile testing of single fibres revealed a strength of 75.6 MPa, attributed to their high cellulose content. Scanning Electron Microscopy (SEM) provided insights into the surface morphology of the fibres. Overall, the results suggest that Nettlefibres have significant potential as reinforcement materials in lightweight composite applications.

Keywords: Nettle fibres, cellulose, hemicellulose, lignin, pectin, moisture, XRD, FTIR, TGA, SEM

Chapter 86

Valorization of Hemp Hurd and Cocoa Pod Husk into Biocarbon-Reinforced PLA Bio-composites using fused deposition modelling

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ABSTRACT

This study investigated the mechanical, tribological, flammability and thermal behaviours of polymer composites reinforced with 30 vol.% hemp hurd microfibers and filled with 1–5 vol.% cocoa pod husk biocarbon, with and without silane surface treatment. The untreated (PHU) and silane-treated (PHT) composites were compared with the neat polymer (P) and fiber-only composite (PH). The results revealed a significant enhancement in performance with the incorporation of biocarbon fillers, which became more pronounced when silane treatment was applied. Among all compositions, PHT1 (3 vol.% treated biocarbon) exhibited the highest tensile strength of 138 MPa and flexural strength of 156 MPa, owing to strong interfacial bonding and uniform filler dispersion. Meanwhile, PHT2 (5 vol.% treated biocarbon) demonstrated superior wear resistance with a specific wear rate of 0.0182 mm³/Nm, improved flammability resistance with the lowest flame propagation speed of 5.6 mm/s, and the highest thermal stability, with decomposition temperature reaching 284°C, due to the formation of a compact and stable char layer and reduced particle pull-out. SEM analysis confirmed these trends, showing well-integrated and cohesive microstructures in treated composites (PHT1 and PHT2), while untreated specimens exhibited fiber pull-out and filler agglomeration. Overall, the findings confirm that the synergistic combination of hemp hurds and silane-treated biocarbon provides an effective pathway to enhance composite performance for structural and functional applications.

Keywords: Hemp hurd microfibers , Cocoa pod husk biocarbon , Silane surface treatment, Tribological behavior, Bio-based fillers

Chapter 87

A Comprehensive 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 88

Experimental Investigation on Friction and wear characteristics of Waste Plastic oil with Zirconium oxide additives using a Four-Ball Tribometer

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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 89

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* fiber, natural fiber composites, fiber stirrups, reinforced concrete, sustainable construction

Chapter 90

**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.

Keywords: EDM, MRR, Cylindricity, Composite materials.

Chapter 91

**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 92

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 93

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 94

**ENHANCEMENT OF MECHANICAL AND CHEMICAL
PROPERTIES IN STEREOLITHOGRAPHY-PRINTED
ACRYLATE COMPOSITES REINFORCED WITH GRAPHENE
OXIDE NANOFILLERS**

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ABSTRACT

High-resolution fabrication of complex polymer components is made possible by stereolithography (SLA); however, neat acrylate-based resins frequently have poor mechanical performance for structural applications. In order to create high-performance polymer nanocomposites, this study examines the reinforcement of a commercial SLA-compatible acrylate resin with graphene oxide (GO) nanofillers at concentrations of 0.2–1.0 weight percent. In order to create stable photocurable suspensions appropriate for SLA processing, GO was synthesized and evenly distributed using ultrasonication. Defect-free specimens were produced using optimized printing parameters (laser power, scan speed, and layer thickness), which were then post-cured under UV and thermal conditions. Significant improvements were found through mechanical characterization using uniaxial tensile testing, flexural testing (three-point bending), and hardness measurements. At 0.5 weight percent GO, tensile strength and Young's modulus increased by up to ~25–40% compared to neat resin, which was attributed to effective load transfer and interfacial bonding. However, higher loadings (1.0 weight percent) showed slight aggregation-induced reductions in elongation at break. Scanning electron microscopy (SEM) analysis of fracture surfaces verified enhanced filler-matrix adhesion and the shift from brittle to more ductile failure modes. Thermal gravimetric analysis (TGA) and solvent immersion (water, ethanol, and acetone) were used to assess chemical stability. The results showed that GO barrier effects and crosslinking reinforcement resulted in decreased swelling (up to 10–15% lower water absorption) and increased thermal decomposition onset temperature (~15–30 °C higher). Restricted chain mobility was confirmed by dynamic mechanical analysis (DMA), which showed increased storage modulus and glass transition temperature shifts.

Keywords: Stereolithography, Graphene oxide, Ultrasonication, Scanning electron microscopy, Thermal gravimetric analysis

Chapter 95

Wear And Friction Characteristics of Al6061/ZrB2 Metal Matrix 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 96

**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.

Keywords: Aviation Battery Cooling, Heat Sink Fin Optimization, ANSYS Thermal Analysis, Convective Heat Dissipation, Battery Thermal Management System (BTMS)

Chapter 97

**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.

Keywords: Annular Combustor CFD, Swirler Turbulence Intensity, Thermal Barrier Coatings (TBC), Yttria-Stabilized Zirconia (YSZ), Nickel-Based Superalloys

Chapter 98

**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.

Keywords: Electromechanical Actuator (EMA), Thrust Vector Control (TVC), Roller Screw Mechanism, Spacecraft Gimballing System, Structural Finite Element Analysis (FEA)

Chapter 99

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.

Keywords: Eddy Current Braking (ECB), Lenz’s Law Application, Electromagnetic Retarder, Frictionless Deceleration, Hybrid Braking Systems

Chapter 100

**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 summarizes 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.

Keywords: Solid-State Diffusion Bonding, Dissimilar Material Joining, Interfacial Microstructure, Spark Plasma Sintering (SPS), Intermetallic Phase Control

Chapter 101

**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.

Keywords: Electroslag Welding (ESW), Thick-Section Joining, Thermal Field Modeling, Slag-Metal Interaction, Residual Stress Analysis

Chapter 102

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.

Keywords: Aerodynamic Optimization, Boundary Layer Control, Wind Turbine Blade Design, Flow Separation Mitigation, Sustainable Power Generation,

Chapter 103

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.

Keywords: Sub-Scale Aerodynamics, Modular Wind Tunnel, Computational Fluid Dynamics (CFD), Tabletop Experimental Setup, Airflow Optimization

Chapter 104

**EXPERIMENTAL STUDY ON CHARACTERISTICS OF
CEMENT MORTAR WITH PERLITE AND VERMICULITE**

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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.

Keywords: Thermal insulation, Vermiculite, Perlite and obsidian

Chapter 105

**AN EVALUATING THE ENDURANCE PROPERTIES OF
REINFORCED CONCRETE WITH STEEL AND
POLYPROPYLENE FIBERS UNDER NATURAL WEATHERING
CONDITIONS THROUGH EXPERIMENTATION**

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ABSTRACT

Fibre reinforced concrete (FRC), FRCs is more likely to deteriorate both within and externally. This explains why, despite FRC's many benefits, the building sector is hesitant to implement it. Examining the impact of natural weathering on prestressed concrete girders is the primary goal of this study. These girders are made up of two girders reinforced with steel fibers (SFRC), two with polypropylene fibers (PPFRC), one with both fibers, and one control mix. For a period of 26 months, the specimens were exposed to the open atmosphere naturally. Unit weight, compressive strength, water absorption, porosity, sorptivity coefficient, chloride penetration test, scanning electron microscope analysis, and energy dispersive X-ray analysis are among the durability properties that were examined. It was over.

Keywords: Prestressed concrete, Sorptivity, Polypropylene fibers, Durability, Compressive Strength.

Chapter 106

**FIRED CLAY BRICK PARTIAL DOPED WITH COCONUT
SHELL ASH**

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ABSTRACT

This study experimentally analyzed the engineering properties of the fired clay-coconut shell ash bricks. In this study 0 to 20% of coconut shell ash was blended with the brick clay. Main focus of this research was to utilize the natural agro waste for environmental protection, introducing low-cost eco-friendly building materials as well as to improve the self-employments by practicing the traditional brick making method. For the analysis dry density, compressive strength was conducted on fired clay bricks by following the standard recommended testing machineries. The results reveal that the mechanical and physical properties improve with the doping of coconut shell ash. However, the optimum value of coconut shell ash to be doped for the manufacturing of fired clay bricks were originates to be high. The percentage varies from 0%, 5%, 10%, 15% and 20%.

Keywords: Coconut Shell Ash, Clay Brick, Alternative Building Material, Water Absorption, Compressive Strength.

Chapter 107

**EXPERIMENTAL INVESTIGATION ON CONCRETE USING
IRON SLAG AS A PARTIAL REPLACEMENT OF FINE
AGGREGATE**

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ABSTRACT

The environment problems are very common in India due to generation of industrial byproducts. Due to industrialization enormous byproducts are produced and to utilize these byproducts is the main challenge faced in India. Iron slag is one of the industrial byproduct from the iron and steel making industries. Considering the physical and chemical properties of metallurgical slag and a series of possibilities for their use in other industrial branches, so it is used in the field of civil constructions. Iron slag was used to replace 15%, 30%, 45% and 60% of sand by weight. The strength of concrete increases rapidly with increasing the iron slag content and the optimum value of compressive strength is obtained at 45% replacement. After 45% replacement the strength decreases. Similarly in the case of tensile strength, the strength increases with the increase in iron slag content and the optimum value of split tensile strength is obtained at 30%. The study confirm that the use of iron slag overcome the pollution problems in the environment. The results shows that the iron slag added to the concrete had greater strength than the plain concrete.

Keywords: Metallurgical slag, iron slag, split tensile strength

Chapter 108

**AN EXPERIMENTAL INVESTIGATIONS ON SOIL
STABILISATION OF BLACK COTTON SOIL USING
ALCCOFINE AND LIME**

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ABSTRACT

Black cotton soil (BCS) is one of the major soil deposits of India. High clay content present in this soil leads to unfavourable volume change behaviour of the soil. Black cotton soil shrink and swell with decrease and increase in water content respectively. This behaviour is due to the presence of a clay mineral called as montmorillonite. Shrinking and swelling of soil causes structural problems. Many procedures have been developed to improve the mechanical properties of soil by incorporating a wide range of stabilizing agents or additives. Alccofine is a micro-fine slag which has significant applications when mixed with concrete. In this paper, an attempt had been made to modify the swelling behaviour of soil by mixing black cotton soil with different proportion of alccofine and lime. Alccofine of different proportions varying from 5 to 45% were mixed with black cotton soil with 1% lime and without lime and their swell behaviour was studied. Unconfined compression strength were determined for alccofine proportions of 5%, 15%, 25% and 35% mixed with black cotton soil along with 1% lime and without lime respectively. The degree of expansion of soil is reduced from very high to moderate with 20% Alccofine and with 15% Alccofine when 1% lime is added. Alccofine and lime significantly increased the unconfined compressive strength of the composite material.

Keywords: Metallurgical slag, iron slag, split tensile strength

DURABILITY OF REINFORCED CONCRETE IN MARINE ENVIRONMENTS

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ABSTRACT

The long-term durability of reinforced concrete in marine environments is a critical challenge, where the synergistic effects of chloride-induced corrosion and harsh microclimates impose severe economic and safety risks. Seashore zones subject concrete to aggressive Chloride ion penetration via capillary suction and diffusion, which is most deleterious in the splash zone where wetting-drying cycles and high oxygen availability accelerate degradation. As chloride concentrations exceed a critical threshold, the alkaline passivating film of Ferric Oxide Hydrate on the steel reinforcement destabilizes, initiating anodic reactions that produce expansive ferric hydroxides. Consequently, this study evaluates high-performance binary and ternary cementitious blends incorporating materials like fly ash, silica fume, and Ground Granulated Blast-furnace Slag. These pozzolanic additives refine the pore network by converting soluble Calcium Hydroxide into dense Calcium Silicate Hydrate gel, effectively reducing the Effective Diffusion Coefficient and enhancing chemical chloride-binding. By integrating service-life modeling based on Fick's Second Law of Diffusion with advanced electrochemical monitoring, the study demonstrates that prioritizing concrete cover thickness and low water-to-binder ratios is more critical than compressive strength alone. The findings conclude that stringent permeability controls and the adoption of corrosion-resistant materials are vital for the sustainability of coastal infrastructure against rising sea levels and volatile maritime climates

Keywords: Chloride-Induced Corrosion, Marine Durability, Supplementary Cementitious Materials, Service Life Prediction, Microstructural Refinement.

Chapter 110

**BOND STRENGTH AND INTERFACE CHARACTERISTICS
BETWEEN 3D-PRINTED CONCRETE AND CONVENTIONAL
STEEL REINFORCEMENT.**

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ABSTRACT

Medical waste management has become a critical environmental and public health concern, especially with the increasing generation of healthcare-related waste. In recent years, innovative approaches have explored the reuse of treated medical waste materials in the construction industry as a sustainable solution. This study focuses on the potential utilization of non-hazardous and properly sterilized medical waste—such as plastics, glass, and incineration ash—in construction applications. The research highlights methods for processing medical waste to ensure safety, including sterilization and segregation techniques, before incorporating it into construction materials like concrete, bricks, and road base layers. The use of such recycled materials can reduce landfill burden, conserve natural resources, and lower construction costs. However, strict regulations and quality control measures are essential to prevent environmental contamination and health risks. The findings suggest that with appropriate treatment and monitoring, medical waste can be effectively transformed into valuable construction resources, promoting sustainability and circular economy practices in both healthcare and construction sectors.

KEYWORD: 3D Concrete Printing (3DPC), Bond-Slip Behaviour, Interfacial Transition Zone (ITZ), Anisotropy, Steel Reinforcement

Chapter 111

**BOND STRENGTH AND INTERFACE CHARACTERISTICS
BETWEEN 3D-PRINTED CONCRETE AND CONVENTIONAL
STEEL REINFORCEMENT.**

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ABSTRACT:

This study investigates the bond strength and interfacial characteristics between 3D-printed concrete (3DPC) and conventional steel reinforcement, a critical factor for the structural viability of additive manufacturing in construction. Unlike traditional casting, 3DPC involves a layer-by-layer deposition process that creates inherent anisotropy and potential weak planes at the interface. Experimental pull-out tests were conducted to evaluate the bond behaviour, comparing 3DPC specimens with traditionally cast counterparts. Key parameters analysed include the printing direction relative to the reinforcement, layer delay time, and the microstructural evolution at the steel-concrete interface. Results indicate that the bond strength is significantly influenced by the rheological properties of the mix and the mechanical interlock achieved during extrusion. Scanning Electron Microscopy (SEM) analysis reveals distinct interfacial transition zone (ITZ) features in 3D-printed samples, often characterized by higher porosity compared to vibrated concrete. These findings provide essential data for developing constitutive models and design codes for reinforced 3D-printed structures, ensuring they meet the safety and performance standards of modern civil engineering.

KEYWORD: 3D Concrete Printing (3DPC), Bond-Slip Behaviour, Interfacial Transition Zone (ITZ), Anisotropy, Steel Reinforcement

Chapter 112

**OPTIMIZING COMBINED HARVESTING TECHNIQUES FOR
ENHANCED EFFICIENCY AND REDUCED LOSSES IN PADDY
CROPS**

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ABSTRACT

This study evaluates the performance of combined harvesters in paddy fields across India's major rice-growing regions, focusing on optimizing operational parameters for minimal grain loss and maximum throughput. Field trials were conducted with varying cutter-bar speeds, forward speeds, and moisture levels to determine optimal settings. Results show that operating at 1.2 m/s forward speed and 18% moisture content reduced harvesting losses by 30% compared to traditional methods. The paper discusses economic viability, farmer adoption challenges, and future tech integrations like AI-based loss prediction systems.

Chapter:113

DESIGN AND FABRICATION OF ELECTRIC PROPELLED CUBESAT FOR EFFICIENT ORBIT TRANSFER AND ATMOSPHERIC DATA RELAY

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ABSTRACT

CubeSats are miniature satellites that provide a cost-effective platform for space research and technological demonstrations. In recent years, electric propulsion systems have gained significant attention for small satellite missions due to their high efficiency and low propellant consumption. This project focuses on the analysis and application of a Hall Effect Thruster for orbit transfer in CubeSat missions. The study begins with the basic concept of electromotive force propulsion and progresses toward the working principles and advantages of Hall Effect Thrusters in space applications. The Hall Effect Thruster is a type of electric propulsion system that uses electric and magnetic fields to ionize and accelerate propellant, producing thrust. Compared to conventional chemical propulsion systems, Hall Effect Thrusters offer higher specific impulse and improved fuel efficiency, making them suitable for long-duration missions and orbital maneuvers. In this project, the performance of the Hall Effect Thruster is analyzed for orbit transfer operations in CubeSats, considering parameters such as thrust, specific impulse, and propellant utilization. A comparative study is also carried out between Hall Effect Thrusters and other propulsion methods used in small satellites, highlighting differences in efficiency, thrust generation, and propellant requirements. Graphical analysis of thrust versus specific impulse is included to illustrate the performance characteristics of electric propulsion systems. The study also discusses the potential integration of the propulsion system with CubeSat subsystems for atmospheric data relay missions. The results indicate that Hall Effect Thrusters provide an efficient and reliable propulsion solution for small satellite orbit transfer and station-keeping operations. Due to their compact size, high efficiency, and lower propellant consumption, they are well suited for CubeSat missions that require extended operational lifetimes and precise orbital control. This project demonstrates the feasibility of implementing Hall Effect Thruster technology in CubeSat platforms for future space missions.

Keywords: cubesat, solar powered, electric propulsion, hall effect, space technology

Chapter:114

CONCEPTUAL DESIGN AND EXPERIMENTAL DEMONSTRATIONS OF EAD PLASMA PROPULSION SYSTEM

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ABSTRACT

Electro aerodynamic (EAD) plasma propulsion has emerged as a promising alternative to conventional propulsion systems for low-speed and small-scale aerospace applications. This paper presents the conceptual design and experimental demonstration of an EAD plasma propulsion system that generates thrust through ionized airflow without the use of moving mechanical components. The system operates on the principle of ion wind, where a high-voltage electric field ionizes air molecules, accelerating charged particles to induce a net airflow and produce thrust. The conceptual design focuses on optimizing electrode geometry, material selection, and power supply configuration to enhance ionization efficiency and thrust generation. An asymmetric electrode arrangement is adopted to maximize electric field intensity and airflow acceleration. A prototype model is fabricated and tested under controlled laboratory conditions to evaluate performance parameters such as thrust, input power, and thrust-to-power ratio. Experimental results demonstrate the feasibility of EAD propulsion for low-thrust applications, offering advantages such as silent operation, reduced mechanical complexity, and minimal maintenance. However, limitations including low thrust density and high voltage requirements are identified. The study concludes that EAD propulsion holds potential for micro aerial vehicles and hybrid propulsion systems, with future improvements focused on efficiency enhancement and scalability.

Keywords: Electro aerodynamic propulsion, Plasma propulsion, Ion wind, UAV, Electric propulsion, High-voltage systems.

Chapter:115

DESIGN AND FABRICATION OF REUSABLE LAUNCH VEHICLE WITH VTOL CAPABILITY

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ABSTRACT

Reusable Launch Vehicles (RLVs) have gained significant importance in modern aerospace engineering as they enable the recovery and reuse of launch systems, thereby reducing mission costs and improving the sustainability of space transportation. This research presents the design and fabrication of a small-scale reusable launch vehicle prototype with Vertical Take-Off and Landing (VTOL) capability, developed to demonstrate the integration of aerodynamic design, propulsion, avionics, stabilization, and recovery mechanisms. The vehicle structure was fabricated using PLA material through Fused Deposition Modeling (FDM) based 3D printing to achieve a lightweight yet structurally stable configuration suitable for prototype testing. A modified hybrid nose cone geometry derived from von Kármán and ogive profiles was implemented to improve aerodynamic efficiency and reduce drag while maintaining structural simplicity. The prototype integrates a custom-developed flight computer based on the ESP32 microcontroller, designed to perform real-time sensor data acquisition, processing, and subsystem control. The avionics architecture incorporates a 9-degree-of-freedom Inertial Measurement Unit (IMU), barometric pressure sensor, and GPS module for monitoring flight parameters such as altitude, acceleration, and orientation. Real-time telemetry communication is achieved through a LoRa transmitter-receiver system, enabling continuous monitoring of flight data through a Python-based ground station dashboard.

Keywords: Reusable Launch Vehicle, Hybrid Nose Cone Design, Real-Time Telemetry Monitoring, Deployable Landing Legs, Custom Flight Computer

Chapter:116

DESIGN AND ANALYSIS OF COMPANION AUXILIARY ROVER FOR IMPROVED EXPLORATION COVERAGE

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ABSTRACT

Planetary exploration missions often face limitations in coverage, redundancy, and terrain adaptability when relying on a single rover system. This project proposes the design and analysis of a companion auxiliary rover that operates alongside a primary exploration rover to enhance mission efficiency and spatial coverage. The auxiliary rover is conceived as a lightweight, modular, and cost-effective system capable of performing complementary tasks such as terrain scouting, hazard detection, localized data collection, and communication relaying. The study focuses on the mechanical design, mobility optimization, and control architecture of the auxiliary rover to ensure seamless coordination with the primary unit. Path planning strategies and cooperative exploration algorithms are analyzed to maximize area coverage while minimizing energy consumption. Additionally, simulations are conducted to evaluate system performance in varied terrain conditions, emphasizing robustness, fault tolerance, and mission adaptability. By introducing a multi-rover cooperative framework, this project demonstrates how auxiliary systems can significantly improve exploration efficiency, reduce mission risk, and enable more detailed scientific investigations in challenging extraterrestrial environments.

Keywords: Multi-rover systems, Autonomous exploration, Terrain adaptability, Cooperative robotics, Space mission efficiency

Chapter:117

VISION BASED AUTOMATION LANDING AND DOCKING PROCEDURE USING A DEPLOYABLE MICRO DRONE FOR REUSABLE LAUNCH VEHICLES

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ABSTRACT

Reusable launch vehicles (RLVs) demand highly precise and reliable landing and docking systems to ensure rapid turnaround and mission reusability. This project presents a vision-based automated landing and docking framework that leverages a deployable micro drone as an auxiliary guidance system. The proposed approach utilizes onboard cameras and computer vision algorithms to provide real-time relative positioning, trajectory correction, and target identification in dynamic and uncertain environments. The micro drone is designed to deploy during the terminal descent phase, acting as a mobile visual reference and assisting in aligning the RLV with the designated landing or docking platform. Image processing techniques such as feature detection, optical flow, and marker-based tracking are integrated with control algorithms to enhance navigation accuracy. The system is further supported by simulation-based analysis to evaluate performance under varying environmental conditions, including wind disturbances and low-visibility scenarios. Results indicate that the integration of a vision-assisted micro drone significantly improves landing precision, reduces dependency on ground-based infrastructure, and enhances overall system robustness. This concept offers a scalable and cost-effective solution for future reusable space missions, contributing to safer and more autonomous recovery operations.

Keywords: Vision-Based Navigation, Reusable Launch Vehicles (RLVs), Autonomous Landing and Docking, Micro Drone Assistance, Computer Vision Algorithms

Chapter:118

CFD ANALYSIS OF ROCKET NOZZLE

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ABSTRACT

The rocket nozzle is the quiet sculptor of thrust, shaping high-pressure combustion gases into a focused, supersonic jet. This project presents a Computational Fluid Dynamics (CFD) analysis of a rocket nozzle to investigate flow behavior, pressure distribution, and performance characteristics under varying operating conditions. A convergent-divergent (De Laval) nozzle geometry is modeled and analyzed to study compressible flow phenomena, including shock formation, expansion waves, and boundary layer effects.

Numerical simulations are performed using appropriate turbulence models and compressible flow solvers to evaluate key parameters such as Mach number variation, thrust, and nozzle efficiency. The study examines the influence of pressure ratios and geometric parameters on flow separation and overall performance. Results highlight how optimized nozzle design enhances thrust generation and minimizes losses due to flow instability and shock interactions. This analysis provides valuable insights into nozzle performance optimization and serves as a foundation for improving propulsion efficiency in aerospace applications, particularly for launch vehicles and high-speed propulsion systems.

Keywords: Computational Fluid Dynamics (CFD), Rocket Nozzle Design, Supersonic Flow, Thrust Optimization, De Laval Nozzle

Chapter:119

DESIGN AND FABRICATION OF AMPHIBIOUS DRONE FOR SURVEILLANCE

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ABSTRACT

Surveillance in complex environments such as coastal regions, wetlands, and disaster-affected zones demands versatile platforms capable of seamless operation across both air and water. This project presents the design and fabrication of an amphibious drone developed to perform efficient surveillance missions in dual-medium conditions. The proposed system integrates aerial mobility with water landing and navigation capabilities, enabling real-time monitoring in areas inaccessible to conventional unmanned systems. The design focuses on a lightweight yet robust structure, incorporating waterproofing, buoyancy optimization, and propulsion mechanisms suitable for both flight and surface movement. Key subsystems include a flight controller for stable aerial operations, a water propulsion unit for surface maneuvering, and a camera module for live data transmission. Fabrication involves material selection, structural assembly, and system integration to ensure durability and operational reliability. Performance evaluation is conducted through experimental testing and analysis of flight stability, water maneuverability, and transition efficiency between air and water modes. Results demonstrate the drone's capability to perform effective surveillance with enhanced adaptability and reduced operational constraints. This project highlights the potential of amphibious unmanned systems in applications such as environmental monitoring, search and rescue, and coastal security.

Keywords: Amphibious Drone, Surveillance Systems, Unmanned Aerial Vehicle (UAV), Air-Water Transition, Dual-Mode Propulsion

Chapter:120

AIRCRAFT WING INSPECTION AND DAMAGE DETECTION

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ABSTRACT

Aircraft wing integrity is critical to flight safety, and early detection of structural damage plays a vital role in minimizing risks and maintenance costs. This project investigates advanced inspection techniques for aircraft wings, focusing on non-destructive testing (NDT) methods, simulation-based analysis, and comparative evaluation of detection accuracy. Finite Element Analysis (FEA) and Computational Fluid Dynamics (CFD) were employed to model stress distribution and aerodynamic effects under varying load conditions, while ultrasonic and visual inspection methods were assessed for practical applicability. Results demonstrate that integrating simulation with NDT enhances detection sensitivity, particularly for micro-cracks and delamination in composite structures. Comparative analysis highlights the efficiency of hybrid approaches in reducing inspection time and improving reliability. The study underscores the potential of emerging technologies such as structural health monitoring (SHM) and drone-assisted inspections to revolutionize aircraft maintenance practices. This work contributes to safer, more cost-effective aviation operations and provides a foundation for future research in digital twin-based predictive maintenance.

Keywords: Non-Destructive Testing (NDT), Finite Element Analysis (FEA), Structural Health Monitoring (SHM), Composite Damage, Detection Aircraft Wing Integrity

Chapter:121

DESIGN AND ANALYSIS OF SOLAR POWERED UAV

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ABSTRACT

The development of long-endurance unmanned aerial vehicles (UAVs) has gained significant attention with the increasing demand for energy-efficient and sustainable aerial systems. This paper presents the aerodynamic and power system analysis of a solar-powered fixed-wing UAV designed using computer-aided modeling and simulation tools. The proposed UAV configuration employs a high aspect ratio wing and a cambered low Reynolds number airfoil to enhance aerodynamic efficiency and maximize the lift-to-drag ratio. Airfoil and wing performance are analyzed using XFLR5, and a complete three-dimensional model is developed using CAD software. Computational Fluid Dynamics (CFD) analysis is performed to evaluate pressure distribution, velocity contours, and aerodynamic forces. The power system analysis includes estimation of solar energy generation, battery storage, and propulsion power requirements. A power balance model is developed to assess the feasibility of sustained flight under steady cruise conditions. The results indicate that the integration of an optimized aerodynamic configuration with an efficient solar-battery hybrid system significantly improves endurance performance. The proposed design demonstrates the potential of solar-powered UAVs for long-duration applications such as surveillance, environmental monitoring, and communication relay. This study highlights the effectiveness of simulation based design approaches in developing cost-efficient and sustainable UAV systems

Keywords:UAV, SOLAR POWERED, ENERGY-EFFICIENT, AIRCRAFT TECHNOLOGIES, COST-EFFECTIVE

Chapter:122

DESIGN AND ANALYSIS OF BIO INSPIRED LOW NOISE PROPELLER FOR UAV AND UAM

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ABSTRACT

The rapid growth of Unmanned Aerial Vehicles (UAVs) and Urban Air Mobility (UAM) systems has intensified the need for quieter propulsion technologies to enable safe and socially acceptable operations in populated environments. This project presents the design and analysis of a bio-inspired low-noise propeller, drawing inspiration from natural flyers such as owls and insects known for their silent flight characteristics. The proposed propeller incorporates features such as serrated leading edges, trailing-edge fringes, and optimized blade geometry to reduce aerodynamic noise while maintaining thrust efficiency. Computational Fluid Dynamics (CFD) and aeroacoustic analysis are employed to evaluate flow behavior, pressure fluctuations, and noise generation mechanisms. Key performance parameters including thrust, efficiency, and sound pressure levels are analyzed and compared with conventional propeller designs. The study investigates the trade-off between noise reduction and aerodynamic performance under varying operating conditions. Results demonstrate that bio-inspired modifications significantly reduce noise emissions, particularly in the mid-to-high frequency range, while sustaining acceptable thrust levels for UAV and UAM applications. This work contributes to the development of quieter propulsion systems, supporting the integration of aerial mobility solutions in urban environments and advancing sustainable aviation technologies.

Keywords: Bio-Inspired Propeller, Aeroacoustic Analysis, UAV and UAM, Noise Reduction, Computational Fluid Dynamics (CFD)

Chapter:123

STRUCTURAL ANALYSIS OF AIRCRAFT MATERIAL UNDER COMBINED COMBUSTION CHAMBER LOADING

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ABSTRACT

Aircraft propulsion systems expose materials to a fierce cocktail of thermal and mechanical loads, especially within combustion chamber environments where high pressure, elevated temperatures, and cyclic stresses coexist. This project presents a structural analysis of aircraft materials subjected to combined combustion chamber loading, with the objective of evaluating their strength, deformation behavior, and failure characteristics under realistic operating conditions. The study employs Finite Element Analysis (FEA) to simulate thermo-mechanical loading on selected aerospace materials, incorporating temperature gradients, internal pressure, and stress concentrations. Material models are developed to capture properties such as thermal expansion, creep, and fatigue behavior. Boundary conditions replicating combustion chamber environments are applied to assess structural integrity and predict potential failure zones. Results highlight the critical influence of combined loading on material performance, revealing regions susceptible to thermal stress-induced deformation and fatigue damage. Comparative analysis of different materials demonstrates variations in durability, thermal resistance, and safety margins. The findings emphasize the importance of material selection and structural optimization in enhancing reliability and lifespan of propulsion components. This work contributes to improved design strategies for high-temperature aerospace structures, supporting safer and more efficient aircraft propulsion systems.

Keywords: Structural Analysis, Combustion Chamber Loading, Thermo-Mechanical Stress, Finite Element Analysis (FEA), Aerospace Materials

Chapter:124

DESIGN AND ANALYSIS OF HYDROGEN POWERED AIRCRAFT

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ABSTRACT

The growing demand for sustainable and eco-friendly aviation technologies has led to increased interest in hydrogen-powered aircraft systems. This paper presents the design and performance analysis of a hydrogen-fueled aircraft developed using advanced modeling and simulation techniques. The proposed aircraft configuration incorporates lightweight structural materials and an optimized aerodynamic design to enhance efficiency and reduce energy consumption. Airfoil and wing characteristics are analyzed using computational tools to achieve a high lift-to-drag ratio suitable for efficient cruise performance. The propulsion system is based on hydrogen fuel, utilizing either fuel cells or hydrogen combustion engines to generate thrust. Computational Fluid Dynamics (CFD) analysis is conducted to evaluate aerodynamic behavior, including pressure distribution, airflow patterns, and drag forces. Additionally, energy analysis is performed to estimate hydrogen storage requirements, fuel consumption, and overall system efficiency. A detailed energy balance model is developed to assess the feasibility of hydrogen as a primary energy source for sustained flight operations. The results demonstrate that hydrogen-powered aircraft significantly reduce carbon emissions while maintaining comparable performance to conventional aircraft. The integration of efficient aerodynamic design with advanced hydrogen propulsion systems shows promising potential for future green aviation. This study emphasizes the role of simulation-driven design in developing cost-effective and environmentally sustainable aircraft technologies.

Keywords: propulsion system, hydrogen fuel, Computational Fluid Dynamics, aircraft technologies, cost-effective

Chapter:125

DESIGN OF COMPOSITE WING SPAR AND FINITE ELEMENT ANALYSIS

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ABSTRACT

The analysis identifies critical stress regions and validates the effectiveness of optimized layup strategies in enhancing load-bearing capacity and stiffness. This work highlights the potential of composite materials in modern aircraft structures and provides a foundation for efficient and reliable wing spar design in aerospace applications. The wing spar is the backbone of an aircraft wing, carrying primary bending and shear loads during flight. This project presents the design of a composite wing spar and its structural evaluation using Finite Element Analysis (FEA). The objective is to develop a lightweight yet high-strength spar configuration by utilizing advanced composite materials, thereby improving overall aircraft performance and fuel efficiency. The study involves the selection of suitable composite materials and layup configurations to achieve optimal strength-to-weight ratio. A detailed geometric model of the wing spar is developed, followed by FEA to analyze stress distribution, deformation, and failure behavior under aerodynamic and structural loading conditions. Parameters such as fiber orientation, stacking sequence, and load cases are systematically varied to assess their impact on structural performance. Results demonstrate that composite wing spars offer significant weight reduction while maintaining structural integrity compared to conventional metallic counterparts.

Keywords: Composite Materials, Wing Spar Design, Finite Element Analysis (FEA), Structural Optimization, Fiber Orientation

Chapter:126

MULTIPURPOSE AGRICULTURE ROBOT

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Abstract:

Agriculture is the backbone of many developing economies, yet traditional farming methods require significant labor, time, and operational cost. To address these challenges, this project presents the design and development of a Smart Multi-Purpose Agricultural Robot capable of performing essential farming operations such as ploughing, sowing, leveling, and spraying. The proposed robot integrates multiple agricultural functions into a single automated platform, thereby reducing human effort and improving efficiency. A key feature of this system is the implementation of precision spraying using integrated sensors. The robot detects diseased plants based on variations in leaf colour using colour detection sensors. Once a diseased plant is identified, the system automatically activates the spraying mechanism to apply pesticides only to the affected area. This targeted spraying approach minimizes excessive chemical usage, reduces environmental impact, and promotes sustainable farming practices. The robot is designed to operate autonomously or semi- autonomously, making it suitable for small- and medium-scale farms.

Keywords: Precision Agriculture, Disease Detection, Sensor-Based Spraying, Smart Farming, Automation in Agriculture

Chapter:127

SOLAR BASED PEST TRAPPER AND REPELLER

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Abstract:

Rice is a staple food in Indonesia and globally, but its production is threatened by pests such as the brown plant hopper. Conventional pest control methods, including pesticides and traditional techniques, often prove ineffective and have negative environmental impacts. IoT-based solar-powered pest control system that integrates light as an attractant and an electric trap for effective pest elimination. The system features real-time monitoring of voltage, current, and light intensity using an LCD display, powered by a 35 Wp solar panel and managed through an Arduino Uno microcontroller. Experimental results show that brown plant hoppers are most attracted to an LED light with an intensity of 780 lux, operating at 11.5 V and 0.97 A. The system consumes 112.52 Wh, with a full battery charge requiring approximately 6 hours and 7 minutes. In the future, the focus of agricultural pest control will be on developing the fundamental theories, key technologies, and major products and equipment of “preventable,” “controllable,” “treatable,” and “green” pest control throughout the process.

Keywords: Internet-of-things, pest control, solar energy, agriculture, detector.

Chapter:128

EVAPOTRANSPIRATION MONITORING BY USING IOT

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Abstract:

This project presents the design and development of a smart agriculture monitoring and control system based on the Internet of Things (IoT) for real-time evapotranspiration (ET) monitoring. The system integrates multiple environmental sensors to continuously measure key parameters affecting crop water requirements. A DHT11 sensor is used to monitor temperature and humidity, soil moisture sensors measure root-zone water availability, an LDR sensor estimates solar radiation intensity, and an air flow sensor records wind speed. These parameters are essential for estimating evaporation and transpiration components that collectively determine evapotranspiration. The collected data is transmitted wirelessly to a web-based dashboard for real-time visualization, analysis, and storage. By applying sensor fusion techniques, the system estimates crop water loss more accurately and supports precision irrigation scheduling. Based on predefined threshold values, the system automatically controls irrigation by activating a water pump when soil moisture falls below the required level. This IoT-based approach enhances water use efficiency, reduces unnecessary water wastage, and promotes sustainable agriculture practices. The proposed system enables farmers to make data-driven irrigation decisions, thereby improving crop health, optimizing resource utilization, and increasing overall yield.

Chapter:129

PREPARATION OF FISH WASTE INTO ORGANIC FERTILIZER

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Abstract:

The increasing use of chemical fertilizers has caused soil degradation, nutrient imbalance, and environmental pollution, emphasizing the need for sustainable agricultural practices. This project focuses on the conversion of fish waste into a multi-nutrient liquid organic fertilizer, with the inclusion of livestock and kitchen wastes as additional nutrient sources. The aim is to develop an eco-friendly, nutrient-rich, and cost-effective fertilizer that enhances soil fertility and crop Productivity. Fish waste served as a primary source of nitrogen and essential micronutrients, livestock waste contributed phosphorus, organic matter, and beneficial microorganisms, and kitchen waste supplied potassium and additional micronutrients, making all three materials integral to achieving a balanced nutrient profile. A carbon-rich additive, jaggery powder, was incorporated to stimulate microbial activity and enhance nutrient solubilization during fermentation, resulting in a stable and homogenous liquid fertilizer. The resulting fertilizer contains macronutrients, secondary nutrients, and micronutrients, making it suitable for a wide range of crops. It can be applied to vegetables such as tomato, brinjal, and okra, and fruit crops like banana and papaya, which require a balanced supply of nitrogen, phosphorus, and potassium for healthy growth and higher yields. The fertilizer not only provides continuous nutrient availability but also promotes soil microbial activity and reduces reliance on chemical fertilizers, supporting sustainable farming practices.

Chapter:130

SUSTAINABLE PAPER BOTTLES USING BANANA PEEL STARCH COATINGS ON TNPL PAPER SUBSTRATES

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Abstract:

This study develops an affordable, biodegradable paper bottle using locally available TNPL printing paper (90-120 gsm) from college and schools as the structural substrate and banana peel waste as the primary source of starch-based leak-proof inner coating. Banana peels, containing 20-40% starch, were processed via simple wet extraction to yield coating starch, which was gelatinized with glycerol plasticizer (starch: glycerol ratio 5:2) and applied to paper prototypes. Comparative analysis of A4 copier paper, TNPL printing grades, and newsprint substrates showed TNPL paper provided superior mechanical strength (breaking length ~4000m MD), lower water absorption (Cobb60 ~25 g/m²), and better thermal stability up to 90°C compared to alternatives. The banana peel starch coating significantly reduced water vapor transmission rates and demonstrated leak-proof performance for room-temperature liquids over 24 hours. Material cost analysis confirmed near-zero coating cost through waste valorisation, making this solution economically viable for small-scale production in agricultural regions. The approach demonstrates practical circular economy principles, converting fruit processing waste into functional packaging while replacing single-use plastics.

Keywords: Banana peel starch, paper bottle, TNPL paper, biodegradable coating, waste valorisation, sustainable packaging.

Chapter:131

CONTROL ENVIRONMENT WITH CULTIVATING MUSHROOMS SUBSTRATE AS ORGANIC FERTILIZER

Author Affiliation

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Abstract:

The mushroom industry has grown rapidly in recent years in terms of beneficial effects, marketable, and demand. The huge amount of spent mushroom substrate (SMS) was disposed of, especially around the mushroom cultivation complexes. The present study aimed to utilize and use agro-waste for cultivating mushrooms after transforming into production of organic fertilizer. Agro-wastes have huge potential in the form of energy, and nutrient recovery would promote sustainability. India has a wide range of agro-climatic conditions and is largely an agricultural country with a cultivated area of about 4.37% generating about 620 million tons of agro waste annually. The agro-waste to wealth concept is a new global trend associated with transforming agricultural waste into beneficial products of high commercial value, which can range from combination of substrate as organic fertilizer. The transformation of agro-waste utilizes a variety of techniques, namely composting paddy straw, sugarcane bagasse, wood powder, onion waste into potentially useful products such as raw material for packaging conversion of organic fertilizer. The agro-waste to wealth approach has the promising capability to tackle several challenges that are a major concern for agricultural management. Spent mushroom substrate can be used as a substrate for a new cycle of mushroom cultivation or as fertilizer, bio-remediation agent. Mushroom beds were prepared using individual and combined substrates, and their performance was evaluated based on parameters such as dry substrate at paddy straw, sugarcane bagasse, onion peel waste, and wood powder. Substrates play a crucial role in nutritional enhancement by serving as the primary source of agro-waste. In mushroom cultivation systems, substrates such as agro-wastes provide essential carbon, minerals, and energy required for growth, development, and nutritional enhancement. When the substrates are supplemented with compost their agro-wastes their increase the nutritional value significantly.

Chapter:132

CROP PRICE PREDICTION USING MACHINE LEARNING

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Abstract:

Agriculture plays a vital role in the economic development of many countries, especially in India, where a large portion of a population depends on farming for their livelihood. Data preprocessing techniques like cleaning, normalisation and features selection are performed to improve prediction accuracy. The trained model predicts future crop price for different crops and regions, which helps farmers to make better selection about crop selection, storage, and selling time. The proposed system reduces financial risk, improves agricultural planning and supports smart farming practices. This project demonstrates that machine learning can play a significant role in improving the economic stability of the farming community.

Chapter:133

SMART SEED QUALITY SCANNING MACHINE USING SOFTWARE- BASED ANALYSIS AND DATASETS.

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Abstract:

Seed quality assessment is a critical factor in achieving better crop establishment and higher, agricultural productivity. Traditional seed testing methods are mostly manual and laboratory-based, making them time-consuming, costly, and unsuitable for large-scale screening. To address these limitations, this project presents a Smart Seed Quality Scanning Machine using software-based analysis and datasets. • The proposed system uses digital image datasets of seeds to evaluate seed quality through image processing and machine learning techniques. Seed images are collected and organized into datasets representing healthy, damaged, diseased, or low-quality seeds. Software tools are used to extract important features such as seed size, shape, color variation, texture, and surface defects. These features are analyzed using trained machine learning models to automatically classify seeds based on quality. The system operates entirely through software, eliminating the need for destructive testing methods. It provides fast, accurate, and repeatable results, reducing human error and improving consistency in seed grading. The developed model can be extended to different crop seeds by training it with suitable datasets. This software-based approach is cost-effective, scalable, and suitable for agricultural research institutions, seed industries, and smart farming applications. The Smart Seed Quality Scanning Machine thus supports precision agriculture by enabling reliable seed quality evaluation using modern data-driven techniques.

Chapter:134

IOT AND AI-BASED SMART AGRICULTURAL YIELD OPTIMIZATION SYSTEM FOR SMALL FARMERS

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Abstract:

The IoT and AI-Based Smart Agricultural Yield Optimization System is developed to assist small farmers in monitoring farm conditions and improving agricultural practices using modern technology. The system integrates soil and environmental sensors such as soil moisture, pH, temperature, and TDS with an STM32 microcontroller and an ESP8266 module to collect real-time data from the field and transmit it to a cloud platform. Farmers can monitor this data through a web-based dashboard and manage irrigation operations remotely. The collected information is analyzed using basic artificial intelligence and machine learning techniques along with historical weather data to support irrigation planning, soil monitoring, crop selection, and fertilizer usage. The system focuses on affordability and practical implementation, helping farmers make informed decisions, reduce resource wastage, and gradually improve productivity and sustainability in small-scale agriculture.

Chapter:135

THE UNDERGROUND HARVESTER

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Abstract

The Underground Harvester is an innovative agricultural machine designed to efficiently extract root and tuber crops such as potatoes, carrots, and groundnuts with minimal soil disturbance and crop damage. Traditional harvesting methods are labor-intensive, time-consuming, and often result in significant yield loss. This project aims to address these challenges by developing a mechanized solution that integrates digging, lifting, and separation processes into a single operation. The system operates using a set of rotating blades or diggers that loosen the soil beneath the crop layer, followed by a conveyor mechanism that lifts the crops while separating soil and debris. The design emphasizes energy efficiency, ease of operation, and adaptability to different soil conditions. Additionally, the harvester reduces human effort and operational costs while improving harvesting speed and overall productivity. By incorporating modern engineering techniques and ergonomic design, the Underground Harvester provides a sustainable and scalable solution for small- and large-scale farmers. This technology has the potential to enhance agricultural efficiency, reduce post-harvest losses, and contribute to increased food production.

Chapter:136

SEMI AUTOMATIC CONOWEEDER WITH BRUSHLESS DC MOTOR

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Abstract

Manual weeding in puddled rice fields is one of the most labor-intensive and physically demanding tasks in agriculture. While the traditional cono weeder is effective for mechanical weed control and soil aeration, its operation requires significant human effort, leading to rapid operator fatigue and inconsistent weeding efficiency in heavy or sticky soil conditions. This project focuses on the motorization of a conventional conoweeder through the integration of a high-torque Brushless DC (BLDC) motor. The primary objective is to reduce drudgery while maintaining the agronomic benefits of the conoweeder's twin-rotor design. The system incorporates a waterproofed motor assembly, a rechargeable lithium-ion battery pack, and a pulse-width modulation (PWM) controller to allow for variable speed adjustments based on weed density and soil resistance.

Chapter:137

**AN EXPERIMENTAL INVESTIGATION ON INCORPORATION
OF RECOVERED TONER POWDER AS PARTIAL
REPLACEMENT OF CEMENT AND E-WASTE AS PARTIAL
REPLACEMENT OF FINE AGGREGATE IN CONCRETE**

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ABSTRACT

This experimental study investigates the feasibility of using recovered toner powder (RTP) as a partial cement replacement (5-15%) and electronic waste (E-waste) as a partial fine aggregate replacement (5-20%) in concrete. The study evaluates workability, compressive strength, and durability compared to control mix, aiming to develop sustainable, eco-friendly concrete while reducing construction costs and industrial waste. Materials: Utilization of RTP (a by-product containing carbon black and iron oxide) and crushed E-waste Testing of fresh properties (slump cone) and hardened

Chapter:138

AN EXPERIMENTAL STUDY ON PAVER BLOCK USING PLASTIC WASTE AND COCONUT FIBRE

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ABSTRACT

The increasing demand for construction materials and the improper disposal of plastic waste have created serious environmental and sustainability issues. Paver blocks are widely used for pavements, walkways and parking areas, and their large-scale production requires significant quantities of natural sand. To address these concerns, this study investigates the use of waste PET plastic and coconut fibre in the production of eco-friendly paver blocks. In this experimental investigation, waste PET plastic bottles were collected, cleaned and cut into small chips. Plastic particles of size less than 4.75 mm, passing through a 4.75 mm sieve, were used as a partial replacement of fine aggregate at a constant replacement level of 10%. Since the inclusion of plastic in concrete may adversely affect strength due to poor bonding, coconut fibre was incorporated to enhance the mechanical performance of paver blocks. Coconut fibres were obtained from natural coconut husk and chemically treated by soaking in Sodium Hydroxide (NaOH) solution for 30 minutes, followed by drying at room temperature for 24 hours to improve fibre-cement bonding. The treated coconut fibre was added in varying proportions of 5%, 10% and 15%. Paver block specimens were cast using these modified concrete mixes and cured under standard conditions. The performance of the paver blocks was evaluated through compressive strength testing. The results indicate that the combined use of waste PET plastic and treated coconut fibre contributes to improved strength characteristics while promoting sustainable construction practices. This study demonstrates an effective method for utilizing waste materials and conserving natural resources in pavement applications.

KEYWORDS: Paver blocks, waste PET plastics , coconut fibre, fine aggregate replacement, sustainable construction.

Chapter:139

USING PLASTIC WASTE IN THE MANUFACTURING OF PAVER BLOCKS

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ABSTRACT

The increasing generation of waste tyres poses a significant environmental challenge due to their non-biodegradable nature and limited disposal options. This project aims to develop a sustainable, eco-friendly, and cost-effective alternative to conventional concrete pavers by designing and manufacturing plastic based paver blocks that are both anti-slip and highly durable. The objective is to utilize discarded plastic bottles as the primary material, thereby reducing solid waste and promoting circular economy practices. The proposed paver blocks are fabricated using grinded plastics (fine and coarse fractions) bound with foundry sand in varying proportions (20%, 40%, and 60%). Surface texture is enhanced using recycled plastic grind for anti-slip properties, while perviousness is achieved through m sand mix. The manufacturing process involves manual mixing, compaction, curing, and demoulding using low-cost equipment and simple hand tools, ensuring easy scalability and affordability. The project's experimental phase will include evaluating parameters such as density, water absorption, slip resistance, compressive strength, abrasion resistance, and infiltration rate. The collected data will help identify the optimum binder proportion and surface treatment that yield the best balance between strength, permeability, and skid safety.

Chapter:140

INTERLOCKING BRICKS ENGINEERED WITH DURABLE POLYMER A

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ABSTRACT

The increasing volume of polyvinyl chloride (PVC) waste poses significant environmental challenges globally. This experimental study investigates the feasibility of incorporating PVC PIPE WASTE POWDER as a partial replacement for natural aggregates in concrete, evaluating its effects on mechanical properties, workability, durability, and microstructural characteristics. Various mix designs were developed with PVC pipe waste powder replacing fine aggregates at different percentages (5%, 10%, and 15%). The research encompasses comprehensive testing including compressive strength, split tensile strength, flexural strength, and workability assessment through slump tests, water absorption analysis, and microstructural examination using Scanning Electron Microscopy (SEM) and X-Ray Diffraction (XRD).

Chapter:141

AN EXPERIMENTAL INVESTIGATION ON THE USE OF TREATED LEACHATE AS CURING WATER FOR SUSTAINABLE CONCRETE

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ABSTRACT

Concrete curing is a vital process in construction to ensure structural strength and durability through hydration. However, the environmental impact of the water used during this process is often overlooked. This project investigates the chemical characteristics of leachate—the waste water resulting from the curing of concrete. During the curing period, the interaction between water and the cementitious matrix leads to the leaching of various chemical constituents, primarily calcium hydroxide, which significantly increases the alkalinity and mineral content of the water. In this study, concrete specimens were cast and submerged in a controlled water environment. Water samples were collected at intervals of 7, 14, and 28 days and tested for various environmental parameters, including pH levels, Total Dissolved Solids (TDS), Electrical Conductivity (EC), and Hardness.

Chapter:142

INVESTIGATING AND ASSESSMENT AND PERFORMANCE OF ECO-FRIENDLY CONCRETE USING POST CONSUMER WASTE

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ABSTRACT

A professional and comprehensive synthesis of the two research abstracts, tailored for a civil engineering project that integrates both firewood ash and paper pulp into a sustainable concrete mix. The Synergy of Sustainable Concrete: Firewood Ash & Paper Pulp Integration Eco-Innovative Material Fusion: This project advances Circular Construction by combining two distinct waste streams-firewood ash and paper pulp-to create a hybrid sustainable concrete. By repurposing these materials, the study addresses the high environmental and economic costs associated with traditional cement production and natural resource depletion. Optimization of Cementitious Properties: The research investigates firewood ash as a pozzolanic partial replacement for cement in M20 grade concrete. When combined with paper pulp, the mix aims to leverage the ash's ability to enhance compressive strength while the pulp contributes to a more sustainable, lightweight concrete matrix.

Chapter:143

AN EXPERIMENTAL INVESTIGATION ON JULIFLORA ASH IN CONCRETE AS PARTIAL REPLACEMENT OF CEMENT

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ABSTRACT

The rapid growth of the construction industry has led to an increased demand for cement, which in turn causes serious environmental issues such as high energy consumption and large carbon dioxide emissions. In order to promote sustainable construction practices, the use of alternative and eco-friendly materials as partial replacements for cement has become necessary. Neltuma (Prosopis) juliflora is an invasive plant species that grows abundantly in many parts of India and creates ecological problems. When this plant is burned under controlled conditions, it produces ash that contains silica and alumina, which exhibit pozzolanic properties similar to cement. This study investigates the feasibility of using Neltumajulifloraash as a partial replacement of cement in concrete. Concrete mixes were prepared by replacing cement with Neltumajulifloraash at proportions of 0%, 5%, 10%, 15%, and 20% by weight of cement. The fresh and hardened properties of concrete were evaluated through workability tests and mechanical strength tests such as compressive strength and split tensile strength at different curing periods. The experimental results indicate that concrete containing Neltumajuliflora ash shows comparable or improved strength characteristics up to an optimum replacement level. The study concludes that Neltumajuliflora ash can be effectively used as a cost-effective and environmentally friendly partial replacement of cement, contributing to sustainable and green construction practices.

Chapter:144

AN EXPERIMENTAL INVESTIGATION OF RECYCLED PLASTIC FIBRE REINFORCED CONCRETE

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ABSTRACT

The rapid increase in plastic waste has become a serious environmental concern due to its non-Bio-degradable nature. At the same time, the construction industry continuously demands materials with improved strength and durability. This experimental investigation focuses on the use of recycled plastic fibres (RPF) as a reinforcing material in concrete to enhance its mechanical properties while promoting sustainable construction practices. In this study, recycled plastic fibers obtained from waste plastic materials were added to concrete mixes in varying percentages by volume of cement. M20 grade concrete was designed and prepared with different fiber contents, and standard specimens such as cubes, cylinders, and prisms were cast and cured for 7, 14, and 28 days. Tests were conducted to evaluate the compressive strength, split tensile strength, and flexural strength of the fiber-reinforced concrete and compared with conventional concrete.

Chapter:145

SELF CURING CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT USING FERROCK

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ABSTRACT

Self-curing or Internal Curing, there is a scarcity of many part of the areas, drought areas. As the construction require lots of water for mixing and curing. Curing of concrete in construction site is always accompanied with many uncertainties resulting in reduction of the quality of end product. Proper curing of concrete structure is important to meet performance and durability requirements. In conventional curing this is achieved by external curing applied after mixing, placing and finishing. Self-curing or internal curing is a technique that can be used to provide additional moisture in concrete for more effective hydration of cement and reduced self-desiccation. In this Project, we aims to investigate the effectiveness of concrete with the partially replacement of the cement with Ferro rock in self-curing concrete.

Chapter:146

ECO-FRIENDLY PURIFICATION OF POND WATER USING ALUM STONE POWDER AND HERBAL COAGULANT (LEUCAS ASPERA AND VITEX NEGUNDO)

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ABSTRACT

Investigation on surface water treatment using thumbai leaf, nochi leaf and alum stone as natural coagulants. The implementation and careful adaptation of treatment plants is currently the most common method for enhancing water quality, especially for large-scale supplies. Nowadays, natural coagulants are used for water treatment due to their environmental friendliness. thumbai leaf, nochi leaf and alum stone are the known natural coagulants used for water. The main goal of this study was to evaluate the removal efficiency of color, turbidity, TSS, COD, and BOD from surface water by utilizing the blended powder of thumbai leaf, nochi leaf and alum stone. In this study also, pH, stirring speed of the jar test, coagulant dosage, and settling time were also considered as influencing factors on the removal percentages. The maximum pollutants removal efficiency was obtained from alum stone like as removed color (86%), turbidity (46%), TSS (85%), COD (81%), and BOD (88%) at different operating parameters at optimum condition.

Chapter:147

WEAR AND FRICTION CHARACTERISTICS OF A6061/NANO-ZRB2 METAL MATRIX COMPOSITES FABRICATED BY STIR CASTING PROCESS

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ABSTRACT

The Al6061/Nano-ZrB2 metal matrix composite (MMC) exhibits significantly enhanced wear resistance (up to 30-40% vs base Al6061) and reduced friction coefficient due to the incorporation of ZrB2 nanoparticles. Fabricated via the cost- effective stir casting process, this MMC showcases improved strength, hardness, and thermal stability, making it an attractive material for high-performance applications in automotive and aerospace sectors. The uniform dispersion of ZrB2 nanoparticles is crucial for optimizing its properties. With its lightweight and high- performance characteristics, Al6061/Nano-ZrB2 MMC holds potential for various industrial applications. Al6061/Nano-ZrB2 metal matrix composite shows enhanced wear resistance and reduced friction coefficient due to ZrB2 nanoparticles. Fabricated via stir casting, it finds applications in automotive and aerospace sectors.

Keywords:

Al6061/Nano-ZrB2 MMC:

1. Better wear resistance*
2. Lower friction*
3. Stronger*

Chapter:148

EXPERIMENTAL INVESTIGATION ON ALUMINIUM METAL MATRIX COMPOSITE WITH ZIRCONIUM DIOXIDE ADDITIVE STIR CASTING

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ABSTRACT

The development and characterization of aluminium metal matrix composites (AMMCs) reinforced with zirconium dioxide (ZrO_2) additives using the stir casting technique. Aluminium was selected as the base matrix due to its low density, good corrosion resistance, and excellent castability. Zirconium dioxide was chosen as the reinforcement material because of its high hardness, thermal stability, and wear resistance. The composite was fabricated by uniformly dispersing ZrO_2 particles into molten aluminium through mechanical stirring. Key process parameters such as stirring speed, stirring time, and casting temperature were carefully controlled. Different weight percentages of ZrO_2 were added to study their influence on material properties. The cast specimens were prepared according to standard dimensions for testing. Microstructural analysis was carried out to examine particle distribution and interfacial bonding. Mechanical properties such as hardness, tensile strength, and impact strength were evaluated.

Keywords:

Aluminium Metal Matrix Composite, Zirconium Dioxide (ZrO_2), Stir Casting, Reinforcement, Mechanical Properties, Microstructure, Hardness, Wear Behavior, Composite Materials

EXPERIMENTAL INVESTIGATION ON ALUMINIUM METAL MATRIX COMPOSITE WITH TITANIUM DIOXIDE ADDITIVE STIR CASTING

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ABSTRACT

The development and characterization of aluminium metal matrix composites (AMMCs) reinforced with zirconium dioxide (ZrO_2) additives using the stir casting technique. Aluminium was selected as the base matrix due to its low density, good corrosion resistance, and excellent castability. Zirconium dioxide was chosen as the reinforcement material because of its high hardness, thermal stability, and wear resistance. The composite was fabricated by uniformly dispersing ZrO_2 particles into molten aluminium through mechanical stirring. Key process parameters such as stirring speed, stirring time, and casting temperature were carefully controlled. Different weight percentages of ZrO_2 were added to study their influence on material properties. The cast specimens were prepared according to standard dimensions for testing. Microstructural analysis was carried out to examine particle distribution and interfacial bonding. Mechanical properties such as hardness, tensile strength, and impact strength were evaluated. Wear behavior of the composite was also investigated using standard wear tests. Results indicated improved hardness and strength with increasing ZrO_2 content. A relatively uniform distribution of reinforcement particles was observed at optimal stirring conditions. However, excessive reinforcement led to particle agglomeration and porosity.

Keywords:

Aluminium Metal Matrix Composite, Titanium Dioxide (TiO_2), Stir Casting Process, Mechanical Properties, Microstructural Analysis, Hardness, Tensile Strength, Wear Behaviour

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ENHANCEMENT OF MECHANICAL AND CHEMICAL PROPERTIES IN STEREOLITHOGRAPHY-PRINTED ACRYLATE COMPOSITES REINFORCED WITH GRAPHENE OXIDE NANOFILLERS

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ABSTRACT

Stereolithography (SLA) enables high-resolution fabrication of complex parts, but acrylate resins often lack sufficient mechanical strength. This study improves an SLA-compatible resin by incorporating graphene oxide (GO) nanofillers at 0.2–1.0 wt%. GO was synthesized and uniformly dispersed using ultrasonication to create stable photocurable suspensions. Optimized printing parameters and post-curing produced defect-free specimens. Mechanical testing showed notable enhancements, with 0.5 wt% GO increasing tensile strength and Young's modulus by ~25–40% due to efficient load transfer and strong interfacial bonding. However, at 1.0 wt%, slight filler aggregation reduced elongation at break. SEM analysis confirmed improved adhesion and a transition from brittle to more ductile fracture behavior. Thermal and chemical analyses demonstrated reduced solvent swelling and higher thermal decomposition temperatures. DMA results indicated increased stiffness and glass transition temperature. Overall, GO-reinforced SLA composites exhibit improved mechanical, thermal, and chemical performance, making them suitable for lightweight, high-strength engineering applications

Keywords: Stereolithography, Graphene oxide, Ultrasonication, Scanning electron microscopy, Thermal gravimetric analysis

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A STUDY ON TRIBOLOGICAL BEHAVIOUR OF LASER SURFACE TEXTURED EN24 ALLOY STEEL

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ABSTRACT

The coefficient of friction and wear rate. The presence of micro-dimples improved lubricant retention, reduced direct surface contact, and acted as traps for wear debris. Experimental results showed a significant reduction in friction and wear compared to untextured samples. The study demonstrates that laser surface texturing is an effective technique for improving the This study investigates the tribological behaviour of laser surface textured EN24 alloy steel under dry sliding conditions. Laser Surface Texturing (LST) was employed to create controlled micro-dimple patterns on the material surface to enhance its performance. EN24 steel, known for its high strength and toughness, is widely used in mechanical components subjected to friction and wear. The textured surfaces were tested using a pin-on-disc apparatus to evaluate tribological performance and service life of EN24 alloy steel in engineering applications.

Keywords: Tribological behaviour, Laser surface texturing (LST), EN24 alloy steel, Wear resistance, Friction coefficient, Surface roughness, Micro-textures, Lubrication performance, Surface morphology, Mechanical properties

SMART IRRIGATION SYSTEM FOR PRECISION FORMING

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ABSTRACT

A smart irrigation system for precision farming uses advanced technologies such as sensors, IoT, and data analytics to optimize water usage and improve crop productivity. The system monitors soil moisture, temperature, humidity, and weather conditions in real time, enabling farmers to supply the exact amount of water required by crops. Automated control mechanisms ensure efficient irrigation scheduling, reducing water wastage and labor costs. By integrating wireless communication and cloud-based platforms, farmers can remotely monitor and manage irrigation processes. This approach enhances resource efficiency, supports sustainable agriculture, and minimizes environmental impact. Additionally, the system can be customized for different crop types and soil conditions, improving yield quality and consistency. Overall, smart irrigation plays a crucial role in modern agriculture by conserving water, increasing efficiency, and promoting precision-based farming practices for better economic and environmental.

Keywords: Smart Irrigation, Precision Farming, IoT, Soil Moisture Sensors, Water Management, Automation, Sustainable Agriculture, Crop Yield, Data Analytics, Remote Monitoring.

Chapter:153

ROVER DESIGN AND FABRICATION

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ABSTRACT

Line Following is one of the most important aspects of robotics. A Line Following Robot is an autonomous robot which is able to follow either a black line that is drawn on the surface consisting of a contrasting colour It is designed to move automatically and follow the line. The robot uses arrays of optical sensors to identify the line, thus assisting the robot to stay on the track. The array of four sensor makes its movement precise and flexible. The robot is driven by DC gear motors to control the movement of the wheels. The Arduino Uno interface is used to perform and implement algorithms to control the speed of the motors, steering the robot to travel along the line smoothly. This project aims to implement the algorithm and control the movement of the robot by proper tuning of the control parameters and thus achieve better performance .In addition the LCD interface is added in order to display the distance travelled by the robot. It can be used industrial automated equipment carriers, small household applications, tour guides in museums and other similar applications, etc.

Chapter:154

DESIGN AND FABRICATION OF PNEUMATIC AUTOMATIC RAMMING MACHINE

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ABSTRACT

Moulding is one of the important metals forming is the process in manufacturing components for various applications in industry. Casting of any size and shape can be made accurately. Automation in this field helps to improve the foundry environment and accuracy of the cast parts. Efficiency of moulding is affected by various parameters like permeability, collapsibility, adhesiveness etc. So it is a must to avoid defects in casting. The defects occur in sand castings pose a great problem in foundry. On account of defects more than 10% castings are rejected. Even though skilled labour is employed for ramming operation, the packing of molding sand will not be even throughout the molding box. So we have selected the idea of fabricating "PNEUMATIC RAMMER". This rammer is operated pneumatically. By using this rammer molding sand will be packed evenly throughout the box.

Chapter:155

DESIGN OF PIPE INSPECTION ROBOT FOR NON DESTRUCTIVE TESTING

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ABSTRACT

Pipelines are important means of transportation of gas, water, fuel oils, etc. in various fields. The transportation loss occurs due to aging, corrosion, obstacles, crack and mechanical faults in the pipe line. The lifetime of pipeline can be increased by regular inspections and maintenance and recognizing the cracks, damages and faults. This helps in preventing transportation loss and maintaining profitable gross. Thus, this project aims to propose an autonomous robot used for in-pipe inspection which provides easy way of detecting crack and obstacles inside the pipe by using Non-Destructive Testing. This project is conceived to redesign the electronic as well as mechanical control systems. Requirements for the robot were that it must be able to operate in dark, compact and wet conditions. This is also to do for the redesign and construction of such robot. Its employees the electronic and mechanical components and provides video feedback via a custom graphic interface with the help of Non-Destructive Testing (Dye Penetrant Testing.). this allows the operator to operator to operate the robot remotely.

Key Words: Pipe inspection, Robotics, Non-destructive testing, Quality control, Dye penetrant testing

TEST BENCH OF AIR BRAKE SYSTEM

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ABSTRACT

In an automobile organisation like NLC INDIA having fleet strength of more than 450HMT, vehicle brake complaint is a major part. To identify the brake complaints a deep study of late (fail safe dual fall air brake system)with ABS is required. The details frequent and major complaints and remedies for the same has been thoroughly studied and disciplined in this project work. Air brakes are used in commercial vehicles, which require a heavier braking effort than that can be applied by the drivers foot. The following layout shows the arrangement of the air braking systems in heavy vehicles. Compressed air from compressor passes through the un loader valve and maintains its pressure. In the brake chamber this pneumatic force is converted into the mechanical force and then it is converted into the rotational torque by the slack adjuster, which is connected to S-cam. This torque applies airbrakes. Pipelines connect the brake system components. This makes aware and helps to explain one of the best sophisticated, reliable, efficient braking system Fast expanding industrialization of the country needs fast movements of higher safety of men & material. Hence, the relay valve is introduced for distributor valve in Air brake system. Previously trains used Vacuum Braking system but right now there are working Air braking system, as it has exceptional advantages over Air brake system. Now Air Brakes had undergone many changes it has revolutionized speed reducing braking system with better reliable safety and inexhaustibility.

Chapter:157

STUDY AND FAILURE ANALYSIS OF BS-I, II, III & FUEL INJECTION PUMP, TURBO CHARGER

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ABSTRACT

In an organisation like NLC INDIA LTD, having fleet strength of more than 357 numbers of TATA BS-I/BS-II/BS-III Heavy Motor Vehicles, Engine major over Hauling work carried out at ICE/SHOP/NSU/TRANSPORT DEPARTMENT. We are taking Project work “STUDY AND FAILURE ANALYSIS OF BS-I/BSII/BS-III ENGINES AND TURBOCHARGER AND FUEL INJECTION PUMP” An engine is power producing device. Engine is a device which transforms the chemical energy of a fuel into thermal energy as further converted to mechanical energy has thoroughly studying and discipline in this project work .The first automotive emission norm that was in reference to the European standard. While it was equivalent to the euro 1 regulation, the first standard was— known as “India”. It allowed a maximum carbon monoxide emission of 2.2g/km, hydro— carbon+ nitrogen oxides discharge of 0.97g/km, and respirable suspended particular matter discharge of 0.14. To achieve India 2000-companies, the car makers were required.— To re-tune the carburetor, secondary air intake system, exhaust gas— Recirculation system, increase the catalyses along with the addition of a—trimetal coating to the system.

IMPACT OF STACKING SEQUENCE ON THE MECHANICAL PROPERTIES OF COTTON-KENAF-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 bio composites 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 nettle. The extraction of fibers from Himalayan nettle plants and their utilization in various applications contribute to the economic development of local communities. Additionally, the abstract briefly mentions information about Cotton Fiber, 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 Fiber.

Keywords : Hybrid composite, Stacking sequence, Cotton fibers, Kenaf fibers, Mechanical properties, Polymer matrix, Fiber-reinforced composites, Natural fibers

STIR CASTING OF ALUMINIUM 25 REINFORCED WITH SILICON CARBIDE AND ALUMINIUM OXIDE

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ABSTRACT

Aluminium Metal Matrix Composites (AMMCs) have gained significant attention in modern engineering applications due to their superior mechanical properties, lightweight nature, and enhanced wear resistance. This project focuses on the fabrication of Aluminium-based hybrid composites reinforced with 2.5% Silicon Carbide (SiC) and Aluminium Oxide (Al_2O_3) using the stir casting method. The primary objective is to improve the mechanical and tribological properties of aluminium by incorporating ceramic reinforcements. In this work, aluminium is melted in a furnace and reinforced with preheated SiC and Al_2O_3 particles under controlled stirring conditions to ensure uniform distribution within the matrix. Key process parameters such as stirring speed, temperature, and time are carefully maintained to minimize defects like porosity and particle agglomeration. The fabricated composite specimens are then subjected to various mechanical tests, including hardness testing, tensile testing, and wear analysis. The results indicate a significant improvement in hardness and wear resistance compared to unreinforced aluminium, along with a moderate increase in tensile strength. Microstructural examination reveals a relatively uniform dispersion of reinforcement particles, which contributes to the enhanced properties of the composite material. This study demonstrates that stir casting is an effective and economical method for producing aluminium hybrid composites with improved performance characteristics, making them suitable for applications in automotive, aerospace, and structural components.

Keywords: Aluminium 25, Silicon Carbide, Aluminium Oxide, Stir Casting Machine

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PERFORMANCE AND EMISSION ANALYSIS OF DIESEL ENGINE USING WASTE COOKING OIL AND NANO-ADDITIVES

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ABSTRACT

The need for alternative energy resources is increasing drastically due to the problems associated with fossil fuels. In this work, waste cooking oil is considered as the source for biodiesel production as it doesn't interfere the food security. The biodiesel is produced by trans esterification process and 20% of biodiesel is blended with diesel fuel to form B20 as a primary fuel. The Zinc oxide nanoparticle has been introduced as fuel additive along with B20 and its performance and emission behavior of a direct injection diesel engine has been evaluated. The ZnO nanoparticles was synthesized via solve thermal method using cow urine as a solvent and characterized by XRD, SEM and TEM. With the help of ultrasonicator, various proportions of ZnO viz. 10 ppm, 20 ppm and 30 ppm are mixed with B20. The experimental results showed that the addition of ZnO nanoparticles with 30 ppm concentration is better fuel among all tested fuels as it records 1.78 % increase in brake thermal efficiency and 10.34% decrease in brake specific fuel consumption. The emission like CO, HC and smoke were 20%, 15.4% and 17.39% lower than diesel. On the other hand, an increases in concentration of ZnO leads to increase in the emission of NOX.

Keywords: Fossil fuels, ZnO, Trans esterification, XRD, SEM and TEM

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EXPERIMENTAL INVESTIGATION OF MECHANICAL PERFORMANCE ON NATURAL FIBRE USING HYBRID LAMINATE

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ABSTRACT

Natural fibres act a vital role in the area of composites and have established wide acceptance in this area. In this work, stacking orders of hybrid laminates are studied, with glass fibre (E-glass) and natural fibre (sisal) termed as GFSRL (Glass Fibre Sisal Reinforced Laminate) and SGFRL (Sisal Glass Fibre Reinforced Laminate). The purpose of this study is to investigate its mechanical behaviour on the effect of addition of sisal fibre. Both these laminates are made by hand layup technique and then compressed. The GFSRL and the SGFRL specimens are subjected to Axial, Flexure and Impact tests according to ASTM standards. The mechanical performances on the effect of alignments of fibre combinations are experimentally investigated.

Keywords: E-glass fibre, Sisal, Tensile, Flexural, Impact.

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EXPERIMENTAL INVESTIGATIONS ON E-WASTE POWDER AND OTHER MATERIAL TO COMPOSITE MATERIAL

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ABSTRACT

E-waste has become a serious environmental problem due to the rapid growth of electronic devices and improper disposal methods. This project focuses on the experimental investigation of developing composite materials using e-waste powder, cotton shell powder, and standard pro 2.0 resin. The main objective is to utilize waste materials effectively and reduce environmental pollution by converting them into useful engineering products. The composite specimens are prepared by mixing e-waste powder and cotton shell powder with standard pro 2.0 resin as a binding material in suitable proportions. The inclusion of cotton shell powder enhances the eco-friendly and lightweight characteristics of the composite, while the resin improves bonding and structural integrity. Various mechanical tests such as strength, hardness, and durability are carried out to evaluate the performance of the developed material. The results indicate that this combination produces a cost-effective, sustainable, and durable composite material suitable for various engineering applications.

Keywords : E-waste Powder, Cotton Shell Powder, standard pro 2.0 Resin, Composite Material, Mechanical Properties

EXPERIMENTAL INVESTIGATION ON WASTE PLASTIC OIL BIOFUELS: FRICTION AND WEAR ANALYSIS

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ABSTRACT

The rapid increase in plastic waste generation has created serious environmental concerns, prompting the exploration of waste plastic oil (WPO) as an alternative energy source. This study presents an experimental investigation on waste plastic oil-based biofuels with a focus on friction and wear characteristics in engine-related applications. Waste plastics were converted into liquid fuel through a pyrolysis process and further refined to obtain usable fuel blends. The prepared WPO and its blends with diesel were evaluated for key physicochemical properties such as viscosity, density, flash point, and calorific value. Tribological performance was analyzed using a four-ball tribometer under controlled load, speed, and temperature conditions to determine the coefficient of friction and wear scar diameter. The experimental results indicated that WPO blends exhibited comparable lubrication characteristics to conventional diesel fuel. In certain blend ratios, improved wear resistance was observed due to the presence of heavier hydrocarbon fractions. However, higher concentrations of WPO showed slightly increased friction because of lower inherent lubricity. Surface morphology of worn specimens was examined using optical microscopy to understand dominant wear mechanisms such as adhesive and abrasive wear. The findings suggest that optimized WPO-diesel blends can provide acceptable tribological performance while contributing to plastic waste management and sustainable fuel development. Overall, waste plastic oil demonstrates promising potential as a supplementary alternative fuel with feasible friction and wear behavior for compression ignition engines.

Keywords: Biodiesel, Trans esterification, Waste plastic oil, Friction , Wear

EXPERIMENTAL INVESTIGATION ON SOLAR PANEL COMBINED WITH ELECTRIC VEHICLE

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Abstract

Sustainable Energy Integration Combining solar panels with electric vehicles creates a self-sustaining transportation system powered by renewable energy Reduction in Carbon Emissions Solar-powered EVs significantly reduce greenhouse gas emissions and dependence on fossil fuels. Energy Independence Vehicles can partially or fully charge using solar energy, reducing reliance on grid electricity Cost Efficiency Over Time Though initial installation cost is high, long-term fuel and electricity savings make the system economical. Onboard Solar Charging Solar panels installed on the vehicle surface can provide supplementary charging while parked or in motion. Smart Grid Connectivity Solar-powered EVs can integrate with smart grids for efficient energy distribution and storage. Battery Storage Optimization Solar energy can be stored in EV batteries, improving energy management and extending driving range. Eco-Friendly Transportation Model. This combination supports clean mobility and promotes a green future.

Keywords: Clean Energy Charging, Cost Saving, Home solar Ev Charging

Chapter:165

GEOMETRIC OPTIMIZATION AND PERFORMANCE ANALYSIS OF DISCBRAKE

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ABSTRACT

The disc brake is a device for slowing or stopping the rotation of a wheel. Repetitive braking of the vehicle leads to heat generation during each braking event. Transient Thermal and Structural Analysis of the Rotor Disc of Disk Brake is aimed at evaluating the performance of disc brake rotor of a sports bike under severe braking conditions and there by assist in disc rotor design and analysis. Disc brake model and analysis is done using ANSYS workbench 16. The main purpose of this study is to analysis the thermo mechanical behavior of the dry contact of the brake disc during the braking phase. The main aim of the project is try to reducing thermal deformation by changing design in disc brake, which is achieved by generating hole on inner surface which is allowing atmospheric air ,due to that thermal stress reducing so crack development also reducing .The thermal analysis is used to determine the thermal deformation and total heat flux established in the disc for a comparison between old design and new design results obtained from FEM is done and all the values obtained from the analysis are less than their allowable values. Hence best suitable design, disc is suggested based on the performance

Keywords: Disc Design Change, Crating Vertical Hole To Allow Air, Controlled Temperature Distribution, Using CAD Software, Ansys To Analyses

Chapter:166

EXPERIMENTAL INVESTIGATION ON MECHANICAL PROPERTIES OF AL 6063 – SIC METAL MATRIX COMPOSITE

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ABSTRACT

Metal Matrix Composites (MMCs) have gained significant attention in engineering applications due to their superior mechanical properties compared to conventional alloys. In this study, an experimental investigation is carried out to evaluate the mechanical properties of Aluminium 6063 (Al 6063) reinforced with Silicon Carbide (SiC) particles. The composite is fabricated using the stir casting method with varying weight percentages of SiC reinforcement. The prepared specimens are subjected to different mechanical tests, including tensile strength, hardness, and impact strength, to analyze the effect of SiC reinforcement on the base alloy. Microstructural analysis is also performed to examine the distribution of reinforcement particles within the matrix. The results indicate that the addition of SiC particles significantly enhances the hardness and tensile strength of the composite, while the impact strength shows varying behavior depending on the reinforcement percentage. The improvement in mechanical properties is attributed to the strong interfacial bonding and uniform distribution of SiC particles in the aluminium matrix. This study demonstrates that Al 6063–SiC composites can be effectively used in applications requiring lightweight materials with improved strength and wear resistance, such as in automotive and aerospace components.

Keywords: Aluminium 6063,Silicon carbide,Metal Matrix Composites,Stir Casting,Mechanical Properties.

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EXPERIMENTAL INVESTIGATION ON STIR CASTING OF ALUMINIUM -1100 & GRAPHITE METAL MATRIX COMPOSITE

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ABSTRACT :

Metal Matrix Composites (MMCs) have gained significant attention due to their improved mechanical and physical properties compared to conventional materials. In this project, Aluminium 1100 is used as the base matrix material and graphite is employed as the reinforcement to fabricate a composite using the stir casting method. Stir casting is a simple and cost-effective technique widely used for producing uniform distribution of reinforcement particles within the matrix. The primary objective of this study is to investigate the effect of graphite addition on the properties of Aluminium 1100. The fabrication process involves melting the aluminium, followed by the addition of graphite particles under controlled stirring conditions to ensure proper mixing. The prepared composite is then cast into molds and allowed to solidify. Various tests such as hardness, tensile strength, and microstructural analysis are carried out to evaluate the performance of the developed composite. The results indicate that the addition of graphite improves wear resistance and enhances certain mechanical properties, while also reducing density. This study demonstrates that Aluminium 1100-graphite composites can be effectively produced using stir casting and can be used in applications requiring lightweight and improved tribological properties.

Keywords : Aluminium 1100, Graphite, Metal Matrix Composite (MMC), Stir Casting, Mechanical Properties, Wear Resistance, Microstructure Analysis, Hardness, Tensile Strength, Lightweight Materials

FABRICATION AND PERFORMANCE ANALYSIS OF ECO-FRIENDLY HYBRID COMPOSITES REINFORCED WITH ORGANIC WASTE

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ABSTRACT

Growing environmental concerns regarding synthetic fiber disposal have shifted material science research toward sustainable, bio-based alternatives. This study investigates the fabrication and performance characterization of eco-friendly hybrid composites reinforced with organic waste. The composites were developed by reinforcing an epoxy resin matrix with organic fillers derived from Cassia Fistula pods and date seeds. A hybridization strategy was employed to mitigate the inherent limitations of individual fillers and optimize the interfacial bonding between the reinforcement and the matrix. The specimens were fabricated using the hand lay-up technique with varying filler weight percentage 15wt% and 20wt% and filler-filler ratio was varied with the ratio of 50:50, 75:25 and 25:75. The performance evaluation included mechanical testing (tensile, flexural, and impact strength) and thermal stability analysis. Experimental results indicate that the hybrid reinforcement significantly improves the tensile strength, flexural modulus, and heat deflection temperature (HDT) compared to the neat resin. Additionally, water absorption behaviour and surface morphology were analyzed to assess the material's durability and suitability for lightweight industrial use.

Key words: Bio-based composites, Hybrid composites, Organic waste fillers, Cassia fistula pods, Date seed powder, Epoxy resin, Hand lay-up technique, Mechanical properties, Thermal stability, Heat Deflection Temperature (HDT), Water absorption behaviour, Sustainable materials, Eco-friendly reinforcement, Interfacial bonding, Lightweight industrial materials.

Chapter:169

EXPERIMENTAL INVESTIGATION ON WASTE PLASTIC OIL BIOFUELS: FRICTION AND WEAR ANALYSIS

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ABSTRACT

The rapid increase in plastic waste generation has created serious environmental concerns, prompting the exploration of waste plastic oil (WPO) as an alternative energy source. This study presents an experimental investigation on waste plastic oil-based biofuels with a focus on friction and wear characteristics in engine-related applications. Waste plastics were converted into liquid fuel through a pyrolysis process and further refined to obtain usable fuel blends. The prepared WPO and its blends with diesel were evaluated for key physicochemical properties such as viscosity, density, flash point, and calorific value. Tribological performance was analyzed using a four-ball tribometer under controlled load, speed, and temperature conditions to determine the coefficient of friction and wear scar diameter. The experimental results indicated that WPO blends exhibited comparable lubrication characteristics to conventional diesel fuel. In certain blend ratios, improved wear resistance was observed due to the presence of heavier hydrocarbon fractions. However, higher concentrations of WPO showed slightly increased friction because of lower inherent lubricity. Surface morphology of worn specimens was examined using optical microscopy to understand dominant wear mechanisms such as adhesive and abrasive wear. The findings suggest that optimized WPO-diesel blends can provide acceptable tribological performance while contributing to plastic waste management and sustainable fuel development. Overall, waste plastic oil demonstrates promising potential as a supplementary alternative fuel with feasible friction and wear behavior for compression ignition engines.

Keywords: Biodiesel, Trans esterification, Waste plastic oil, Friction , Wear

Chapter:170

EXPERIMENTAL INVESTIGATION ON PERFORMANCE AND EMISSIONS OF DIESEL ENGINE FUELED WITH LEMON PEEL OIL METHYL ESTER AND ITS BLENDS

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ABSTRACT

The depletion of fossil fuels and rising environmental concerns have encouraged the exploration of alternative renewable fuels for diesel engines. This study presents an experimental investigation on the performance and emission characteristics of a diesel engine fueled with Lemon Peel Oil Methyl Ester (LPOME) and its blends with conventional diesel. Lemon peel oil, extracted from citrus waste through steam distillation, was converted into biodiesel via the transesterification process to improve its fuel properties. The produced methyl ester was blended with diesel in various proportions and tested in a single-cylinder, four-stroke compression ignition engine under different load conditions. Key performance parameters such as brake thermal efficiency, brake specific fuel consumption, and exhaust gas temperature were evaluated and compared with neat diesel operation. Emission characteristics including carbon monoxide (CO), hydrocarbons (HC), carbon dioxide (CO₂), nitrogen oxides (NO_x), and smoke opacity were measured using standard emission analyzers. The experimental results indicated that LPOME blends showed slightly lower brake thermal efficiency and higher fuel consumption due to their lower calorific value. However, significant reductions in CO and HC emissions were observed because of the oxygenated nature of the biodiesel. Smoke opacity was also reduced, indicating improved combustion. A marginal increase in NO_x emissions was noted at higher blend ratios.

Keywords: Biodiesel, Trans esterification, Lemon peel oil, Performance , Emissions

Chapter:171

EXPERIMENTAL INVESTIGATION ON ALGAE BASED THIRD GENERATION BIOFUELS: FRICTION AND WEAR ANALYSIS

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ABSTRACT

The increasing demand for sustainable energy has accelerated research on third-generation biofuels derived from microalgae due to their high lipid content, rapid growth rate, and minimal competition with food crops. This study presents an experimental investigation on algae-based biodiesel with a focus on its friction and wear characteristics in comparison with conventional diesel fuel. Microalgae oil was extracted, transesterified into biodiesel, and blended with diesel in varying proportions. The physicochemical properties of the prepared fuel blends were evaluated according to standard test methods. Tribological analysis was carried out using a four-ball tribometer to determine the coefficient of friction, wear scar diameter, and load-carrying capacity under controlled operating conditions. The results indicated that algae-based biodiesel blends exhibited improved lubricity compared to pure diesel, resulting in reduced friction coefficients and smaller wear scar diameters. This improvement is attributed to the presence of oxygenated compounds and higher viscosity of the biodiesel.

Keywords: Biodiesel, Trans esterification, Algae oil, Friction , Wear

Chapter:172

EXPERIMENTAL INVESTIGATION ON ALUMINIUM METAL MATRIX COMPOSITE BLENDED WITH ZINC OXIDE ADDITIVE USING STIR CASTING MACHINE

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ABSTRACT

This experimental investigation focuses on the fabrication and characterization of aluminium metal matrix composites (AMMCs) blended with zinc oxide (ZnO) additive using the stir casting technique. Aluminium alloy was selected as the matrix material due to its low density, good castability, and wide engineering applications. Zinc oxide particles were added as reinforcement in varying weight percentages to enhance mechanical and tribological properties. The stir casting process was carried out by melting aluminium above its liquidus temperature, followed by controlled stirring to ensure uniform dispersion of ZnO particles. Proper preheating of ZnO and the addition of a wetting agent were employed to improve interfacial bonding. The fabricated composites were cast into moulds and machined for testing. Mechanical properties such as hardness, tensile strength, and impact strength were evaluated experimentally. Microstructural analysis was performed to study the distribution of ZnO particles within the aluminium matrix. The results indicate that the addition of ZnO significantly improves hardness and strength compared to base aluminium. However, excessive ZnO content leads to particle agglomeration and reduced ductility. This study demonstrates that stir casting is an effective and economical method for producing aluminium–ZnO composites for lightweight structural applications.

KEYWORDS: Aluminium Metal Matrix Composite (AMMC), Zinc Oxide (ZnO), Stir Casting, Particulate Reinforcement, Mechanical Properties, Microstructure Analysis, Hardness, Tensile Strength

Chapter:173

EXPERIMENTAL INVESTIGATION ON MECHANICAL PROPERTIES OF AL 6063 - ALUMINIUM OXIDE , METAL MATRIX COMPOSITE

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ABSTRACT

Metal Matrix Composites (MMCs) have gained significant attention in modern engineering applications due to their enhanced mechanical properties compared to conventional alloys. This study presents an experimental investigation on the mechanical behavior of Al 6063 alloy reinforced with aluminium oxide (Al_2O_3) particles. The composite specimens were fabricated using the stir casting technique with varying weight percentages of aluminium oxide to evaluate its influence on the base material. The prepared samples were subjected to standard mechanical tests, including tensile strength, hardness, and impact resistance, to analyze their performance. The results indicate that the addition of aluminium oxide significantly improves the hardness and tensile strength of Al 6063, while a moderate variation in impact strength is observed depending on the reinforcement percentage. Microstructural analysis reveals a fairly uniform distribution of Al_2O_3 particles within the matrix, contributing to improved load-bearing capacity and resistance to deformation. Overall, the study demonstrates that Al 6063- Al_2O_3 metal matrix composites exhibit superior mechanical properties, making them suitable for applications in automotive, aerospace, and structural components where strength-to-weight ratio and wear resistance are critical.

Keywords: Al 6063, Aluminium Oxide (Al_2O_3), Metal Matrix Composite (MMC), Stir Casting, Mechanical Properties

Chapter:174

Experimental Investigation On Performance And Emissions Of Diesel Engine Fueled With Spirulina Algae Oil Methyl Ester And Its Blends

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ABSTRACT

The growing demand for sustainable and eco-friendly fuels has intensified research on biodiesel derived from microalgae. This study presents an experimental investigation on the performance and emission characteristics of a diesel engine fueled with Spirulina algae oil methyl ester and its blends with conventional diesel. Oil extracted from Spirulina algae was converted into biodiesel through a transesterification process to produce Spirulina Algae Oil Methyl Ester (SAOME). The produced biodiesel was blended with diesel in various proportions and tested in a single-cylinder, four-stroke compression ignition engine under different load conditions. Key performance parameters such as brake thermal efficiency, brake specific fuel consumption, and mechanical efficiency were evaluated and compared with neat diesel operation. Emission characteristics including carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO_x), and smoke opacity were measured using standard gas analyzers. The results indicated that SAOME blends exhibited slightly lower brake thermal efficiency and higher specific fuel consumption due to their lower calorific value. However, significant reductions in CO, HC, and smoke emissions were observed owing to the oxygenated nature of the biodiesel. A moderate increase in NO_x emissions was noted at higher blend ratios.

Keywords: Biodiesel, Trans esterification, Spirulina Algae oil, Performance , Emissions

Chapter:175

PERFORMANCE AND EMISSION ANALYSIS OF DIESEL ENGINE USING WASTE COOKING OIL AND NANO-ADDITIVES

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ABSTRACT

The need for alternative energy resources is increasing drastically due to the problems associated with fossil fuels. In this work, waste cooking oil is considered as the source for biodiesel production as it doesn't interfere the food security. The biodiesel is produced by trans esterification process and 20% of biodiesel is blended with diesel fuel to form B20 as a primary fuel. The Zinc oxide nanoparticle has been introduced as fuel additive along with B20 and its performance and emission behavior of a direct injection diesel engine has been evaluated. The ZnO nanoparticles was synthesized via solve thermal method using cow urine as a solvent and characterized by XRD, SEM and TEM. With the help of ultrasonicator, various proportions of ZnO viz. 10 ppm, 20 ppm and 30 ppm are mixed with B20. The experimental results showed that the addition of ZnO nanoparticles with 30 ppm concentration is better fuel among all tested fuels as it records 1.78 % increase in brake thermal efficiency and 10.34% decrease in brake specific fuel consumption. The emission like CO, HC and smoke were 20%, 15.4% and 17.39% lower than diesel. On the other hand, an increases in concentration of ZnO leads to increase in the emission of NOX.

Keywords: Fossil fuels, ZnO, Trans esterification, XRD, SEM and TEM

Chapter:176

REAL TIME TRAFFIC VIOLATION DETECTION SYSTEM

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ABSTRACT

The The project “Real Time Traffic Violation Detection System” is designed to monitor road traffic and automatically detect violations using embedded systems and image processing techniques. The system utilizes a Raspberry Pi 4GB with a Raspberry Pi Camera Module 3 to capture real-time images of moving vehicles. Infrared (IR) sensors and an ESP32 microcontroller are used to measure vehicle speed. The proposed system is efficient, cost-effective, and suitable for real-time traffic management applications. It enhances road safety by ensuring strict rule enforcement and provides reliable evidence for traffic authorities. Future enhancements may include cloud storage, AI-based recognition, and integration with smart city infrastructure for improved traffic control and monitoring.

Keywords: Number Plate Detection, Raspberry Pi, ESP32, IR Sensor, Speed Detection, Helmet Detection, Traffic Violation Monitoring, Real-time System

Chapter:177

POWER MONITORING AND CONTROL SYSTEM WITH GSM MODULE AND EMBEDDED SYSTEM

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ABSTRACT

The project “Power Monitoring and Control System with GSM Module and Embedded System” is designed to continuously monitor transformer conditions and quickly detect faults such as voltage fluctuations, short circuits, overloads, and power failures. It uses sensors, a microcontroller, and GSM/IoT communication to analyze electrical parameters and send real-time alerts to maintenance personnel. This enables faster fault response, reduces downtime, protects equipment, and improves overall power system reliability. The system is cost-effective, automated, and suitable for both urban and rural applications, with future scope for GPS tracking, cloud integration, and AI-based fault prediction. Overall, this project presents a smart and reliable approach to reducing power losses, improving electrical grid dependability, and supporting the advancement of power infrastructure through automation and digital communication.

Keywords: Power Monitoring, GSM Module, Embedded System, Fault Detection, Real-time Alerting

Chapter:178

A BI-DIRECTIONAL ASSISTIVE COMMUNICATION SYSTEM FOR SIGN LANGUAGE TO SPEECH AND SPEECH TO TEXT CONVERSION

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ABSTRACT

Communication between hearing-impaired individuals and normal speakers remains a major challenge due to the lack of a common language interface. This project proposes a bi-directional assistive communication system that converts sign language into speech and speech into text in real time. The system uses computer vision and machine learning techniques to recognize hand gestures and translate them into meaningful audio output. Similarly, speech input from a normal user is converted into text and displayed for the hearing-impaired person. The model is trained using a dataset of predefined gestures and speech patterns to ensure accurate recognition and fast response. This system aims to bridge the communication gap, enhance inclusivity, and support effective interaction in daily life. It can be widely used in education, public services, and personal communication. The proposed solution is cost-effective, portable, and user-friendly, making it accessible for real-world applications.

Keywords: Sign Language Recognition, Speech to Text, Text to Speech, Machine Learning, Computer Vision, Assistive Technology

Chapter:179

SMART FACE RECOGNITION BASED ATTENDANCE SYSTEM USING RASPBERRY PI

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ABSTRACT

This project “ Smart Face Recognition Based Attendance system using Raspberry Pi ” and dual camera modules for automatic student attendance monitoring. The system is designed to detect student entry and exit, identify faces, and record the in-time and out-time of each student accurately. By using face recognition technology, the attendance process becomes automated, reducing manual effort and minimizing errors or proxy attendance. The captured data is processed in real time and stored in SQL Database for easy access and record maintenance. The use of dual cameras improves coverage and supports better monitoring at classroom entrances and exits. This system is especially useful for educational institutions to maintain attendance records efficiently, save time, and improve reliability. Overall, the project offers a low-cost, intelligent, and practical solution for modern classroom attendance management.

Keywords: Face Recognition, Raspberry Pi 5, SQL Data logging, Image processing, Real-time monitoring .

Chapter:180

AN OFFLINE EMBEDDED VOICE ASSISTANT SYSTEM WITHOUT CLOUD DEPENDENCY

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ABSTRACT

The project “An Offline Embedded Voice Assistant System without Cloud Dependency” is designed to provide an efficient and reliable solution for controlling non-smart electrical appliances without internet connectivity. It also functions as a voice assistant, allowing users to interact with the system using spoken commands. The system uses the ESP32 microcontroller along with a VC02 voice recognition module. The module converts voice commands into hexadecimal signals for processing. These signals are used by the ESP32 to control appliances and perform system operations. A DF Mini Player and speaker provide real-time audio feedback to the user. This enables clear and interactive communication with the system. An RTC module is included for real-time clock and alarm functions. A DHT11 sensor is used to monitor temperature and humidity levels. An offline Bluetooth mobile application allows multilingual voice and text control. An RF module enables wireless control of external appliances. Password authentication ensures secure access to the system. The system works completely offline, ensuring data privacy and reliable performance.

Keywords: Offline Voice Assistant, Automation Control, Embedded System, Multiple Language, Bluetooth Control Application

Chapter 181

Experimental investigation and prediction of ECDM parameters on fiber reinforced SiC composite using hybrid ERNN-based Sparrow Search Optimization

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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

ANT COLONY INSPIRED SWARM ROBOTICS

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ABSTRACT

This project presents an Ant Colony Inspired Swarm Robotics system that replicates the cooperative behaviour of biological ant colonies to enable decentralised, multi-robot coordination. Individual robots communicate indirectly through stigmergy-based signals, mimicking pheromone trails, to collectively perform tasks such as path planning, foraging, and obstacle avoidance without centralised control. Each robot is equipped with proximity sensors, a microcontroller, and wireless communication modules to perceive the local environment and relay positional information to neighbouring agents. The swarm algorithm dynamically adapts to changes in the environment, enabling robust performance even when individual robots fail. Experimental results demonstrate efficient shortest-path discovery, distributed load balancing, and scalable coordination across varying swarm sizes. The proposed system is cost-effective and fault-tolerant, making it suitable for applications in search and rescue, warehouse automation, and environmental monitoring. Future enhancements may include machine learning-based adaptation and heterogeneous swarm configurations for complex multi-mission scenarios.

Keywords: Swarm Robotics, Ant Colony Optimization, Stigmergy, Decentralised Control, Multi-Robot Coordination

HEXAMORPH: ML-ASSISTED AUTONOMOUS FORMATION CONTROL OF ROBOTIC ASSEMBLY PODS

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ABSTRACT

This project introduces HexaMorph, a machine learning-assisted autonomous formation control system for modular robotic assembly pods capable of dynamically reconfiguring their spatial arrangement to adapt to varying mission requirements. The system comprises six independently actuated pods, each embedded with an onboard microcontroller, inertial measurement unit, and short-range wireless communication module. A centralised ML model trained on reinforcement learning techniques continuously evaluates environmental feedback and issues real-time formation commands to individual pods, enabling seamless transitions between predefined and emergent configurations. Inter-pod collision avoidance is achieved through a consensus-based protocol that minimises positional error while maintaining desired geometric patterns. The HexaMorph architecture demonstrates superior adaptability compared to fixed-formation systems, with experimental trials confirming stable convergence across hexagonal, linear, and delta configurations under dynamic obstacle conditions. The proposed framework is scalable, energy-efficient, and applicable to precision agriculture, infrastructure inspection, and collaborative material handling. Future work will incorporate vision-based sensing and cloud-edge computing for enhanced situational awareness.

Keywords: Modular Robotics, Formation Control, Reinforcement Learning, Autonomous Reconfiguration, Multi-Agent Systems

Chapter 184

IOT BASED SOLDIER HEALTH CARE SYSTEM

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ABSTRACT

This project proposes an IoT Based Soldier Health Care System designed to continuously monitor the physiological parameters of soldiers deployed in remote or hostile environments. The system integrates wearable biosensors including a pulse oximeter, ECG module, body temperature sensor, and GPS module interfaced with an ESP32 microcontroller to acquire real-time health data. Acquired parameters are transmitted over a secure IoT communication protocol to a cloud-based monitoring dashboard accessible to military medical personnel at base stations. Threshold-based alert mechanisms automatically trigger emergency notifications when critical anomalies such as abnormal heart rate, oxygen saturation drop, or extreme body temperature are detected. The embedded GPS module simultaneously reports the soldier's precise location to facilitate rapid medical evacuation. The system is lightweight, power-efficient, and designed to withstand rugged operational conditions. Experimental validation confirms reliable data transmission, low latency alerts, and accurate sensor readings under field simulation. Future enhancements include AI-based predictive health analytics and integration with unmanned aerial vehicles for autonomous first-aid delivery.

Keywords: IoT, Soldier Health Monitoring, Wearable Sensors, ESP32, Real-time Alerting, GPS Tracking

MECHANICAL AND MICROSTRUCTURAL ANALYSIS OF EPOXY-BASED HYBRID POLYMER COMPOSITE REINFORCED WITH PALMYRA SPROUTS

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ABSTRACT

This study investigates the mechanical and microstructural properties of epoxy-based hybrid polymer composites reinforced with Palmyra sprout fibres as a sustainable and eco-friendly alternative to synthetic reinforcements. Palmyra sprout fibres were chemically treated using an alkaline solution to improve fibre-matrix interfacial adhesion, and composite specimens were fabricated via hand lay-up technique with varying fibre weight fractions. Tensile, flexural, impact, and hardness tests were conducted in accordance with ASTM standards to evaluate mechanical performance across different compositions. Scanning Electron Microscopy (SEM) analysis was performed to examine the fracture surfaces and assess the quality of fibre-matrix bonding. Results indicate that composites with an optimised fibre loading exhibit significantly enhanced tensile strength, flexural modulus, and impact resistance compared to neat epoxy, attributed to effective stress transfer at the fibre-matrix interface. The microstructural analysis confirms uniform fibre distribution and minimal void content in optimised specimens. The developed composite demonstrates potential for lightweight structural applications in automotive, construction, and packaging industries. Future work will explore hybrid reinforcement with glass or carbon fibres to further improve mechanical performance.

Keywords: Natural Fibre Composite, Palmyra Sprout, Epoxy Matrix, Mechanical Properties, Microstructural Analysis, SEM

About the Principal



Prof. Dr. D. Shanmugasundaram, Principal of Dhanalakshmi Srinivasan Engineering College (Autonomous), Perambalur, Tamil Nadu. With over 29 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.

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