i-MACE

4th International Conference of Innovation in Mechanical & Civil Engineering

(*i*-MACE 2025)

22nd – 23rd August 2025

Souvenir

Organized by:

Pimpri Chinchwad College of Engineering (PCCoE), Pune

i-MACE 2025

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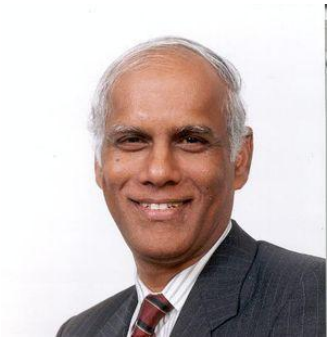
Executive Director, PCET

Dr. Govind N. Kulkarni
Director, PCCOE

Message from Chief Guest



Prof. Rao R Tummala

Emeritus Professor,
Georgia Tech University, USA

With the visionary leadership of Hon'ble Prime Minister Shri Narendra Modi ji and Hon'ble Minister of Electronics and Information Technology Shri Ashwini Vaishnaw ji, India began to emerge as a semiconductor nation with initial semiconductor and package manufacturing plants for "Make in India". Making in India means making products. Making products requires manufacturing. Manufacturing can only be performed by companies. Companies need technologies, educated manpower and suppliers to manufacture. To make any product such as smartphone, requires 12 strategic technologies. This is the vision behind this IDSPS program to build India into a product nation with 12 National industry co-development Centers, one for each technology, headed by 12 global industry leaders and 12 academic Faculty and directors in a consortium mode.

India's potential is unlimited. Most domestic and foreign companies in India today are primarily focused on design and software. This is a small fraction of India's capabilities. As both an industry and academic pioneer and expert, I recommend integrated systems leading to India become a Systems Foundry as the long-term technical vision for the country, integrating designs, semiconductors, components and interconnections at system level. India has all the fundamentals, except two. India is correcting its manufacturing weakness by setting up the initial manufacturing plants. These plants are most important for two reasons: (1) India will demonstrate for the first time that it has the manufacturing infrastructure, (2) These plants produce legacy nodes that are still in high demand globally.

The IDSPS initiative proposed here corrects the other weaknesses by developing next-gen manufacturable technologies, educated- workforce and global industry partnerships to design and demonstrate next gen prototypes. Such a program provides a sustainable manufacturing path as well as bridge the manufacturing gap between India, with its initial legacy manufacturing technologies, and advanced countries focusing on manufacturing technologies for 2030. With this new focus on large scale, Manufacturing R&D, Technology Workforce, and Global industry partnerships, India can grow its electronics market by 5-10x in the next ten years.

Message from Director

Dr. Govind N. Kulkarni

Director,
Pimpri Chinchwad College of Engineering, Pune

It gives me immense joy to welcome all dignitaries, keynote speakers, researchers, academicians, industry professionals, and participants to the 4th International Conference on Innovations in Mechanical and Civil Engineering (*i*-MACE 2025), hosted by Pimpri Chinchwad College of Engineering, Pune.

In the past three years, i-MACE has steadily grown into a respected international platform. Each edition has brought together quality research contributions from leading institutions such as IITs, NITs, reputed universities, industry, and international collaborators. What began as an initiative to create a space for dialogue and innovation has now become a conference known for its academic depth and practical relevance.

The *i*-MACE 2025 conference, with its theme “Smart Living: Exploring Sustainability, Connected Technologies & their Potential”, reflects advancements in smart infrastructure, energy efficiency, and green technologies, addressing global challenges like urbanization and climate change for sustainable, intelligent, and human-centric development. The discussions and research presented here will surely contribute to building smarter, greener, and more resilient societies.

I must acknowledge the response we received in terms of paper submissions. The rigorous review process, led by distinguished experts, ensures that only the most relevant and high-quality work finds a place in this conference. My heartfelt appreciation goes to the advisory board, organizing committee, reviewers, and our dedicated staff for their untiring efforts. I also extend my gratitude to our sponsor, Henkel Adhesives (Loctite), for their valuable support and active engagement.

Above all, I congratulate all the authors and participants. Your ideas, research, and innovations are the true strength of *i*-MACE. I firmly believe that this year’s conference will not only spark new collaborations but also open fresh opportunities for academia and industry to work hand in hand.

I wish *i*-MACE 2025 every success and look forward to meaningful and fruitful deliberations.

Message from General Chair

Dr. Narendra Deore

Dean R&D and Professor (Mech.),
Pimpri Chinchwad College of Engineering, Pune

It gives me immense pleasure to welcome you all to the 4th International Conference on Innovations in Mechanical and Civil Engineering (*i*-MACE 2025). This year's conference theme, "Resilient and Adaptive Smart Technologies," is highly significant in the present era of rapid technological advancement and resonates deeply with the broader forum on "Smart Living: Exploring Sustainability, Connected Technologies, and Their Potential."

The theme reflects the urgent need for innovations in Mechanical and Civil Engineering that are not only smart and adaptive but also capable of withstanding uncertainties. We can collectively work toward sustainable development and engineering practices that serve society for generations by prioritizing resilience and adaptability. Smart living is no longer aspiration — it is now essential for building resilient communities, efficient cities, and greener economies. The possibilities are vast, encompassing digital connectivity, intelligent systems, sustainable infrastructure, and energy-efficient solutions.

I am confident that the deliberations and interactions during *i*-MACE will inspire creative solutions, generate valuable insights, and strengthen our collective commitment to building a future that is technologically advanced, socially inclusive, and environmentally responsible.

On behalf of the organizing committee, I extend my heartfelt thanks to all contributors, reviewers, sponsors, and participants for their invaluable support in making this conference a success. I wish you all an engaging and intellectually thought-provoking experience at *i*-MACE 2025.

Message from Co - Chair

Dr. Shailendra Banne

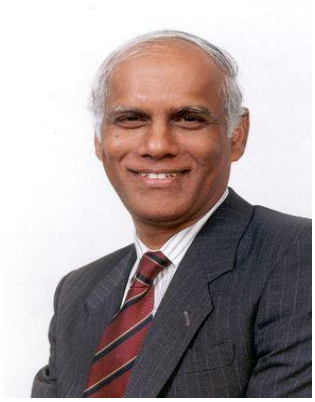
Assistant Professor (Civil),
Pimpri Chinchwad College of Engineering, Pune

It is a matter of great joy and pride to welcome you all to the 4th International Conference on Innovations in Mechanical and Civil Engineering (*i*-MACE 2025). This year, the conference theme "Smart Living: Exploring Sustainability, Connected Technologies, and Their Potential" brings together ideas that are highly relevant to our times. The theme reminds us that technological progress cannot be looked at in isolation—it must go hand in hand with sustainability, resource efficiency, and improving the quality of life.

We live in an era where technologies such as the Internet of Things, artificial intelligence, and smart infrastructure are rapidly influencing the way we build, work, and live. Their true value, however, will be realized only when they are aligned with sustainable practices and centered around human needs. This conference is therefore a timely platform to exchange ideas, discuss challenges, and imagine practical pathways for a future that is both smart and sustainable.

I would like to sincerely thank the organizing committee for their hard work, the speakers for sharing their expertise, and all the participants for adding value through their active involvement. I hope the sessions and discussions over these days will not only enrich our understanding but also inspire collaborations that continue well beyond the conference.

Chief Guest



Dr. Rao R. Tummala
Emeritus Professor
Georgia Tech University, USA

Dr. Ranga Srinivas Gunti
Head, Capability Building
Tata Motors (PV-EV)

Plenary Speakers

Dr. Shailesh I. Kundalwal
Professor
Department of Mechanical Engineering,
Indian Institute of Technology, Indore

Mr. Ashish P Kulkarni
Rear Admiral
Department of Mechanical Engineering,
Madras University

Conference Committee

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Mr. S. B. Gorade	Dr. S. D. Kurhade	

i-MACE 2025 Program Schedule

***i*-MACE 2025 DAY 1: 22nd August 2025**	
8.00 AM to 9.45 AM	**: Registration: Lab 9107LA,** Building No. 9
8.15 AM to 9.30 AM	**: Breakfast:** Architecture Building, zeroth floor
10.00 AM to 11.30 AM	**: Inauguration Function:** PCET Auditorium, Architecture Building
11.45 AM to 1.15 PM	**: Session 1 (Paper Presentations),** Building No. 9
1.15 PM to 2.00 PM	**: Lunch:** Architecture Building, zeroth floor
2.00 PM to 3.00 PM	**: Plenary session I: Dr. Shailesh I. Kundalwal** (Mechanical Seminar Hall)
3.00 PM to 3.15 PM	**: Tea Break**
3.15 PM to 5.15 PM	**: Session 2 (Paper Presentations),** Building No. 9

***i*-MACE 2025 DAY 2: 23rd August 2025**	
08.00 AM to 09.00 AM	**: Breakfast,** Architecture Building, zeroth floor
09.00 AM to 11.00 AM	**: Session 3 (Paper Presentations),** Building No. 9
11.00 AM to 11.15 AM	**: Tea Break**
11.15 AM to 1.15 PM	**: Session 4 (Paper Presentations),** Building No. 9
1.15 PM to 2.00 PM	**: Lunch**
2.00 PM to 3.00 PM	**: Plenary session II: Mr. Ashish P Kulkarni** (Mechanical Seminar Hall)
3.00 PM to 4.30 PM	**: Session 5 (Paper Presentations),** Building No. 9
4.30 PM to 5.30 PM	**: Valedictory Function,** (Mechanical Seminar Hall)

Abstracts

TRACK M1 **PAPER ID 79**

Design and Thermal Analysis of Fin Plate Heat Exchanger

Omkar Dhage[1,*], Sanjivan Bhoite[1], Mayuresh Desai[2]

[1]*Department of Mechanical Engineering, Pimpri Chinchwad College of Engineering, Pune, 411044, India*
[2]*Enpro Industries Pvt Ltd. Gat no. 215/2 Alandi Markal Road, Taluka Khed, Markal, Maharashtra 412105, India*

ABSTRACT

Heat transfer is one of the most important concepts in engineering. Heat exchangers are used in industries for recovering waste heat from the sources and used it where needed to meet the requirements of application needs. Utilizing the waste heat will increase the total efficiency of the system. This research investigates the heat transfer between flue gas (hot fluid, double pass) and air (cold fluid, single pass) in a plate-fin type crossflow double-pass heat exchanger. It also evaluates heat exchanger performance by means of a computational fluid dynamics (CFD) analysis in Ansys Fluent. Results are compared with theoretical calculations in order to validate them. First, looking for design, a two-pass crossflow heat exchanger was hypothesized and a calculation of the heat exchange area theoretically by LMTD and NTU methods were carried out. Then this region from the theoretical calculation was integrated into 3D model by Autodesk Inventor. This 3D model was used for further CFD analysis in Ansys Fluent. The model was used to study various parameters such as mass flow rate of the fluid, outlet temperature of the flue gas and air, the pressure drops on both sides, and the fluid velocity on both sides. Comparison of the heating performance of the air shows a maximum deviation of 1.18% between CFD results and theoretical calculations which validates the CFD model in an acceptable deviation range. The present study demonstrates that the CFD analysis provides satisfactory results when compared with theoretical calculations of the heat exchanger, which can be used to analyze several designs without the necessity of prototyping (as this would incur an additional expense).

Keywords: *Heat exchanger, LMTD method, NTU Method, Ansys fluent, CFD*

TRACK M1 **PAPER ID 87**

Numerical Modelling and Simulation of a Type III High Pressure Vessel Made of Sustainable Composite Based Vitrimer Adhesive

Sumit T. Kumbhara[1,*], Pravin R. Kale[1], Sandip Budhea[2]

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[2]*National Institute of Technology, Calicut 673601, India*

ABSTRACT

The study investigates the structural integrity and sustainability potential of Type III composite overwrapped pressure vessels (COPVs) utilizing vitrimer-based matrices. Vitrimers, with their dynamic covalent bond networks, offer a recyclable and reprocessable alternative to conventional thermoset epoxies. A validated finite element model based on ASTM D2585 geometry was developed in Abaqus using the Wound Composite Modeler (WCM) plugin to simulate filament winding configurations. The composite overwrap incorporates T800 carbon fibers embedded in vitrimer and epoxy matrices for comparative analysis. Cohesive zone modeling (CZM) was applied to characterize vitrimer interfacial performance via single lap joint (SLJ) calibration. The vessel was subjected to both burst pressure and autofrettage simulations, applying Hashin and Tsai-Wu failure criteria. Results indicate that vitrimer-based COPVs demonstrate mechanical performance comparable to epoxy systems, with additional advantages in post-failure healing and environmental recyclability. This work underscores the promise of vitrimers in advancing sustainable high-pressure hydrogen storage technologies.

Keywords: *Vitrimer-based composites, glass fiber-reinforced polymers (GFRP), hydrogen tanks, numerical modelling, finite element analysis (FEA), Burst pressure analysis, autofrettage analysis*

TRACK M1 **PAPER ID 108**

Prediction and Optimization of Laser Cutting Parameters for Material Removal Rate in Acrylic Sheets

Raju Bhosale[1,*], Gaurav Patil[1], Tanuja Londhe[1], Vedant Narkhede[1], Tejashree Patil[1]

[1]*Department of Mechanical Engineering, Pimpri Chinchwad College of Engineering, Nigdi, Pune-44, India*

ABSTRACT

Laser cutting is a widely used manufacturing process for producing complex specimens with high precision and efficiency. This study focuses on optimizing the CO2 laser cutting parameters to increase the material removal rate on acrylic sheets. The primary cutting parameters considered for optimization and significantly influencing the MRR are laser power, scanning speed, and nozzle head gap. Employing a statistical experimental approach, the Taguchi Method and L18 orthogonal array method are used to design an experiment that analyzes the influence of cutting parameters on MRR. To determine the optimal set of cutting parameters Taguchi approach was used, and to determine the most influential parameters on MRR, the experimental results were analyzed. By maintaining efficiency and precision, the enhanced MRR is aimed by this process. The importance of strategic parameter optimization is achieving high-quality productivity and efficiency by the research.

Keywords: *CO_2 laser Machining, Acrylic Sheet, Laser Power, Scanning Speed, Nozzle Head Gap, MRR*

TRACK M1 **PAPER ID 155**

A Real-Time Corrective Framework for Fault Mitigation in Tapered Roller Bearings Using Vibration Analysis and ANN

Harshal Ramesh Aher[1,*], Nilesh C Ghuge[1]

[1]*Matoshri College of Engineering and Research Center, Nashik. Affilated to SPPU Pune*

ABSTRACT

Ensuring the operational reliability of rotating machinery demands timely detection and mitigation of bearing faults. While previous research has evaluated machine learning models for condition monitoring, this study advances the field by focusing on the experimental validation of real-time corrective measures for fault control in tapered roller bearings (TRBs). Artificial defects—including circular, square, and line shapes—were introduced on inner and outer races and rollers using Electro-Discharge Machining (EDM). A custom-built test rig was used to acquire vibration signals under varying operating conditions involving speed, load, and induced unbalance. Kurtosis was extracted as the primary feature to detect impulsive vibrations indicative of bearing damage.An Artificial Neural Network (ANN) model was developed to predict kurtosis levels and categorize fault severity. Uniquely, these predictions were employed to trigger corrective actions such as adjusting load, modifying speed, or correcting unbalance. The ANN model demonstrated strong agreement with experimental results, achieving an R^2 value of 0.9701 and a low MAE of 0.1341.The study proposes a predictive-corrective feedback loop that enables real-time decision-making, significantly reducing fault progression and extending component life. A fault classification system based on kurtosis thresholds supports timely interventions and helps avoid unplanned machine downtime. This work highlights the practical relevance of integrating data-driven models with experimental validation to achieve intelligent fault mitigation in industrial bearing systems. The approach promotes a shift from passive monitoring to proactive fault control, improving reliability and maintenance planning.

Keywords: *Vibrations, Bearing, Fault Daignosis, ANN*

TRACK M1 **PAPER ID 160**

Innovative Approach for Supply Chain Management of Medical Oxygen in India

Parag Muley[1,*], Daesh Jogani[1], Atharva Gawde[1], Manish Patil[1]

[1] *Sardar Patel College of Engineering, Mumbai*

ABSTRACT

The COVID-19 pandemic exposed critical vulnerabilities in the supply chain of Liquid Medical Oxygen (LMO) in India, particularly during the second wave when hospitals faced acute shortages. The inefficiency stemmed from uncoordinated logistics, lack of real-time tracking, and absence of predictive mechanisms for demand. This project presents a centralized, web-based platform designed to address these issues by digitizing the LMO supply management system at the hospital level. The platform incorporates modules for real-time inventory tracking, order management, emergency alerts, and demand forecasting using Single Exponential Smoothing (SES). A site visit to Mukund Hospital, Mumbai, was conducted to evaluate the current LMO logistics and validate the practicality of the proposed system. Findings revealed a heavy reliance on manual records and telephone-based order placement, leading to delays and miscommunication during crisis periods. The implemented platform simplifies data entry, visualizes usage patterns, and improves communication between hospitals and suppliers, thereby mitigating supply disruption risks. A detailed cost analysis of LMO transport from INOX plants in Gujarat to hospitals in Mumbai highlighted opportunities for financial optimization through improved planning and digital tracking. The proposed solution ensures that hospitals maintain sufficient oxygen stock, respond rapidly to emergencies, and manage their procurement efficiently. This paper emphasizes the role of technology in enhancing healthcare logistics and provides a scalable model that can be deployed across medical institutions in India to strengthen critical care infrastructure.

Keywords: *Liquid Medical Oxygen, COVID-19, Healthcare Logistics, Hospital Management, Supply Chain Optimization, Demand Forecasting, Emergency Preparedness, Digital Health Platform, Order Tracking, Oxygen Shortage Solution*

TRACK M1 **PAPER ID 200**

AI-Driven Prediction and Optimization of FDM 3D Printing Parameters for Enhanced Tensile and Flexural Strength

Sheetal Sahare[1,*], Prashant Anerao[2], Pratham Dedgaonkar[2], Arjun Deokule[2], Amodini Dhadge[2], Divjot Singh Saluja[2]

[1]*Department of Civil Engineering, Vishwakarma Institute of Technology, Pune*
[2]*Department of Mechanical Engineering, Vishwakarma Institute of Technology, Pune*

ABSTRACT

Fused Deposition Modelling (FDM) is one of the most widely adopted additive manufacturing techniques. Traditionally, petroleum-based plastics have been used in 3D printing, however, in recent years, sustainable alternatives such as Polylactic Acid (PLA), Wood-PLA, and Acrylonitrile Butadiene Styrene (ABS) have gained increasing attention. Despite these advances, a persistent challenge in FDM lies in achieving consistent and superior mechanical properties, particularly tensile and flexural strengths, when employing sustainable materials and bio-composites. In this study, a two-stage Artificial Intelligence (AI) framework is developed to optimize FDM process parameters for enhanced mechanical performance. In the first stage, a multi-output XGBoost regression model is employed to predict tensile and flexural strengths of printed components based on key parameters: layer thickness, infill density, nozzle temperature, and material type (PLA, ABS, Wood-PLA). In the second stage, a bounded continuous optimization technique (L-BFGS-B) is applied to infill density and nozzle temperature, while keeping layer thickness and material constant, to identify parameter settings that maximize a weighted combination of tensile and flexural strengths. The proposed framework achieved high predictive accuracy ($R^2 > 0.9$ for both properties) and demonstrated significant strength improvements compared to default FDM settings. A user-friendly Streamlit prototype was also deployed, enabling practical adoption of the model by end-users. The study highlights that the AI-driven optimization approach not only reduces trial-and-error experimentation and conserves material resources, but also provides a scalable foundation for future multi-objective optimization in additive manufacturing.

Keywords: *FDM, Machine Learning, Optimization, Tensile Strength, Flexural Strength, PLA.*

TRACK M1 **PAPER ID 216**

Artificial Neural Network Modelling and Intelligent Optimization for H-Type Fin-Tube Projection Resistance Welding Systems

Kiran Sirsath[1,*], Bhanudas Bachchhav[2], Somnath Nandi[1]

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[2]*Department of Mechanical Engineering, All India Shri Shivaji Memorial Society's College of Engineering, Pune*

ABSTRACT

Projection resistance welding is commonly used for joining H-type fins to tubes in heat exchanger systems. However, maintaining consistent weld quality is challenging due to electrode wear and sensitivity to welding parameters such as current, time, and pressure. Excessive heat can cause expulsion and electrode degradation, while low input results in weak joints. Optimizing these parameters is essential for ensuring reliable and strong welds. This study presents an Artificial Neural Network (ANN)-based approach for modelling and intelligent optimization of welding parameters in H-type fin-to-tube projection resistance welding systems. A supervised ANN model was trained using experimental data across a range of process conditions. The optimized model accurately predicted weld strength and identified ideal parameter combinations with low mean squared error, validating its precision and robustness. The ANN-based model enables intelligent, data-driven control of the welding process, significantly reducing trial-and-error, manual tuning, and energy waste. This work demonstrates how smart modelling and optimization techniques can transform conventional welding into a more sustainable, adaptive, and efficient manufacturing system.

Keywords: *Intelligent manufacturing, Resistance welding, H-type fin, Artificial Neural Network, Copper chromium zirconium alloy, Weld strength, optimization, Smart Process Control*

TRACK M1 **PAPER ID 235**

Design Development and Analysis of 3D Printed Mechanical Gripper for Vegetable Seedling Transplanter

Vinaykumar Jadhav[1,*], Dr. Rajendrakumar Tated[2], Dr. Nilesh Ghuge[1], Santosh Sancheti[2], Tejas More[2], and Kiran Gore[2]

[1]Matoshri College of Engineering and Research Center, Nashik
[2]SNJB's K.B.Jain College of Engineering, Chandwad, Nashik, affiliated to SPPU Pune

ABSTRACT

The increasing demand of automation in the field of agriculture leads to development of low cost and efficient automated systems such as in the vegetable seedling transplantation process. In this study a parallel jaw mechanical gripper is modeled with Solidworks and manufactured using 3D printing technology for plug type vegetable seedling. The gripper can handle three types of vegetable seedling viz. Tomato, Chili and Brinjal. The prototype grippers were manufactured using PLA, ABS and PETG material. Actuation of gripper was through Micro Servo SG90 motor as it offers compactness and accuracy. The fabricated gripper was tested for its performance while handling mention variety of seedling, reliability for gripping and picking, structural behavior under load, seedling safety, damage and repeatability during the operation. Material behavior of each material is observed and noted for mechanical stress. PETG offered more structural strength while PLA offered easiness of fabrication, under dynamic loading its effectiveness affected due to its brittleness. Though ABS is mechanically robust, there was fabrication difficulties faced such as surface layer variation due to warping. The torque offered by SG90 Servo Motor was found sufficient for effective gripper jaws opening and closing, validating its feasibility to use in Agricultural Robotics applications. The obtained results indicate that with proper selection and optimized design such 3D printed grippers will work effectively in automated seedling transplanting machines. The present study gives a foundational step for functional and customized robotic solutions in vegetable seedling transplantation systems.

Keywords: *Seedling Transplantation, Mechanical Gripper, 3D printing, Plug Seedling, SolidWorks Simulation, Servo Actuation, Agricultural Robotics*

TRACK M1 **PAPER ID 236**

Design Development and FEA Analysis of Vegetable Seedling Transplanter Chassis

Vinaykumar Jadhav[1,*], Dr. Rajendrakumar Tated[2], Dr. Nilesh Ghuge[1], Santosh Sancheti[2], Tejas More[2], and Kiran Gore[2]

[1]Matoshri College of Engineering and Research Center, Nashik
[2]SNJB's K.B.Jain College of Engineering, Chandwad, Nashik, affiliated to SPPU Pune

ABSTRACT

Development of low cost and affordable seedling vegetable transplanter is an important need for agriculture automation and mechanization particularly for small and medium land holder farmers. For any agricultural implant equipment, the chassis plays a vital role in bearing a load of all mountings in terms of firm support, static and dynamic loading. Also, it is important for any agricultural implant equipment that the chassis should be light weight and can withstand all loads without failure. In this study a chassis is designed with SolidWorks CAD software for a plug type vegetable seedling transplanter. The CAD model of chassis was imported in the FEA (Finite Element Analysis) module and a comprehensive static structural analysis was done for the designed load conditions. The obtained results from FEA analysis confirmed that the chassis frame is rigid enough to withstand all mounting load within the permissible level of Von-Mises stress and without any structural deformation. Post analysis the chassis was fabricated in a workshop using mild steel with Arc Welding process. Fabricated chassis confirms the dimensional accuracy and structural suitability to work in farm conditions. This study gives a foundation for integration of other mechanisms with the chassis frame for further development of vegetable seedling transplanter.

Keywords: *Vegetable Seedling Transplanter, Chassis Design, Finite Element Analysis, SolidWorks CAD, Agricultural Mechanization*

TRACK M1 **PAPER ID 250**

Thermal Management of Electronic Devices Using Passive Cooling Techniques: A Bibliometric Review

Nilesh Gaikwad[1,*], Narendra Deore[1]

[1]*Department of Mechanical Engineering, Pimpri Chinchwad College of Engineering, Pune, India 411033*

ABSTRACT

The global trend of using artificial intelligence techniques to automate processes and the extensive use of the Internet of Things in industries have brought the thermal management of electronic devices into focus. The progress in this field will see an upward trend until effective thermal management innovations and products are brought to the market, which can cater to higher heat loads in compact spaces. To meet this requirement, it is required to attract a larger talent pool in the domain of electronic cooling. The objective of this study is to present a bibliometric analysis of thermal management of electronic devices with passive cooling techniques based on the Scopus publication documents over the last twenty-five years. The analysis explores the publication based on top-performing countries, document and language type, author collaboration and citations, etc. The VoS viewer software is used to visualize the author collaboration and concurrences, keyword-based and country-wise network analysis. The compiled study will provide future researchers with a comprehensive overview of the evolution of thermal management in electronic devices over the past two decades.

Keywords: *Electronic thermal management (ETM), two-phase cooling, vapour chamber, bibliometric review*

TRACK M2 **PAPER ID 118**

Experimental Investigations on Micro-structural Behaviour of DMLS Process-based Al-Si Composites

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[1]*Department of Mechanical Engineering, National Institute of Technology, Tiruchirappalli, Tamil Nadu, India, 620015*

ABSTRACT

This research investigates the microstructural response and mechanical behavior of Al-Si composites made by Direct Metal Laser Sintering (DMLS). The research involves reinforcing AlSi10Mg alloy with ceramic particles silicon carbide (SiC) and aluminum oxide (Al_2O_3) for improving mechanical performance. Five composite types were prepared: the reference alloy, alloys reinforced with 5 wt% SiC and 5 wt% Al_2O_3 separately, and two hybrid compositions of SiC and Al_2O_3 in varying proportions. Mechanical properties consisted of hardness, tensile, flexural, compressive, and impact toughness tests. The hybrid composite containing 2.5 wt% SiC and 2.5 wt% Al_2O_3 showed the greatest property improvement, indicating a 47% enhancement in tensile strength (from 273 MPa to 401 MPa), a 38% increase in compressive strength (from 298 MPa to 411 MPa), and a 43% increase in hardness (from 78 HRB to 112 HRB) over the unreinforced alloy. Flexural strength was enhanced by 35%, whereas impact toughness reduced by 27%, suggesting enhanced brittleness as a result of ceramic inclusion. SEM examination validated better particle distribution, increased interfacial bonding, and lower porosity in hybrid composites. Fractography showed a combination of ductile and brittle types of fracture, particularly in hybrid samples. This research offers valuable insights into the improvement of reinforcement strategy in DMLS-processed Al-Si composites, and the compromise between strength improvement and impact toughness for high-level structural applications.

Keywords: *DMLS, Al-Si composites, silicon carbide, aluminum oxide, mechanical properties*

TRACK M2 **PAPER ID 164**

Mechanical and Tribological Characterization of AA 7475 Hybrid Composites Reinforced with SiC, TiB_2, and Si_3N_4

Pandiaraj Velusamy[1, *]
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ABSTRACT

This study deals with the synthesis and mechanical properties of AA 7475-based hybrid metal matrix composites reinforced with silicon carbide (SiC), titanium diboride (TiB_2), and silicon nitride (Si_3N_4). Three compositions were made with a constant overall reinforcement content of 10 wt%, changing the individual reinforcements' ratios to observe their effect on mechanical behavior. The composites were produced via the stir casting process to provide homogeneous reinforcement distribution and good interfacial bonding. Standardized mechanical tests, such as tensile, hardness, flexural, impact, compression, and wear tests, were performed to assess the performance of every composition. The findings revealed that the composition of reinforcement has an important influence on the properties of the composite. In the samples, the highest TiB_2 content composite (sample C2) possessed maximum tensile strength (185 MPa), compressive strength (328 MPa), hardness (88 BHN), flexural strength (225 MPa), and minimum wear rate (0.011 mm^3/m) because of the superior stiffness and load-carrying capacity of TiB_2. Conversely, the composite with the higher Si_3N_4 content (sample C3) showed the highest ductility and impact energy but the lowest general strength and wear resistance. The well-balanced composition (sample C1) showed middle properties in all the tests, proving the advantage of hybrid reinforcement. This research concludes that optimal reinforcement ratios, especially increasing TiB_2 content at the expense of balanced support from SiC and Si_3N_4, can improve the mechanical and tribological properties of AA 7475 composites considerably. The optimized composites are very much appropriate for automotive, aerospace, and industrial applications where high strength-to-weight ratio, wear resistance, and durability are critical.

Keywords: *AA 7475 composite, hybrid reinforcement, TiB_2, Si_3N_4, mechanical properties*

TRACK M2 **PAPER ID 197**

Parametric Optimization of Micro-Hole Drilling of Inconel 718 using Micro-EDM

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ABSTRACT

Micromachining of advanced engineering materials like ceramics and high-performance alloys is attracting growing interest from researchers across multiple disciplines. Inconel 718, a Nickel-based superalloy, stands out for its exceptional properties, including the ability to maintain high strength and stability at elevated temperatures. However, machining this material, especially at the microscale, is extremely challenging and requires in-depth investigation. Micro Electric Discharge Machining (µEDM) has been shown to be a highly effective technique for producing complex geometries, precise profiles, and contour machining with good surface finish and accuracy, provided that suitable input parameters are used. This study focuses on identifying the optimal combinations of input parameters, namely feed rate, capacitance, voltage, and spindle speed, for micro-drilling Inconel 718 using a Micro EDM setup, employing a Taguchi L18 orthogonal array for experimental design. Key output responses analyzed include material removal rate (MRR), taper angle (TA), and overcut (OC) of the micro-hole. An Analysis of Variance (ANOVA) was conducted to determine the statistical significance and contribution percentage of each parameter. Results indicate that capacitance is the most influential factor, followed by voltage. Confirmatory experiments validated that the selected optimal settings yield enhanced machining performance.

Keywords: *µEDM, Taguchi, ANOVA, Inconel, Optimization*

TRACK M2 **PAPER ID 203**

Climate Change Impact on Agricultural Land Suitability: An Interpretable Machine Learning-Based Eurasia Case Study

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ABSTRACT

A major world issue of food insecurity in the context of climate change and its impact on the suitability of croplands is covered in the current document. This is on fore casting the risks of changes in irrigation regimes and land suitability decline, two of which are vital in providing for food security. In accordance with the Sustainable Development Goals of the United Nations to eliminate hunger and malnutrition, the area of concern is Central Eurasia, An area of focused economic and social vulnerabilities, hence becoming an important case study for observing climate change's effect on agriculture. Employing an interpretable Decision Tree model, the analysis predicts land suitability under several carbon emission scenarios with 100% right. It indicates places in Northern Asia and Eastern Europe most at risk to climate-related hazards. To avoid human it ariancrises, these insights give policymakers the necessary instruments used to manage resources appropriately, such as fertilizer distribution maximization and Water usage. The output indicates just how innovative machine learning—more specifically, Decision Trees—perhaps in comprehension and control how climate change affects food security. This Work helps to achieve agricultural resilience invulnerable areas by providing pragmatic Recommendations for proactive interventions.

Keywords: *Agriculture, classification, climate change, cropland, food security, irrigation, machine learning*

TRACK M2 **PAPER ID 207**

Comprehensive Review of Surface Degradation and Protection Methods in Hydraulic Gate Applications

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ABSTRACT

Hydraulic gates are critical components in water control infrastructure, ensuring the regulation and management of water flow in dams, canals, and reservoirs. However, their operational performance and longevity are often compromised by wear and corrosion. This review systematically explores various wear mechanisms, including abrasive, adhesive, erosive, fretting, and fatigue wear, alongside corrosion types such as uniform, galvanic, crevice, pitting, intergranular, and stress corrosion cracking. These phenomena lead to material degradation, increased maintenance costs, and potential system failures. The review highlights advanced mitigation strategies such as surface coatings, cathodic and anodic protection, and corrosion inhibitors, emphasizing their effectiveness in extending the service life of hydraulic gates. Emerging coating technologies, including thermal spraying and high-velocity oxy-fuel spraying, have demonstrated significant improvements in durability and resistance to wear and corrosion. Case studies and quantitative analyses of economic losses underline the financial implications of neglecting corrosion control, underscoring the need for optimized solutions. Future research directions include the development of environmentally sustainable materials, advanced monitoring techniques, and tailored corrosion control strategies. By integrating multidisciplinary insights, this review aims to provide a comprehensive resource for improving the performance and sustainability of hydraulic gates, ultimately enhancing water management systems worldwide.

Keywords: *Hydraulic gates, corrosion control, abrasive wear, adhesive wear, corrosion inhibitors, economic impact*

TRACK M2 **PAPER ID 215**

Effect of Chemical Treatment of Micro Crystalline Cellulose (MCC) on the Water Absorption and Tensile Strength of MCC/Epoxy Composite

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ABSTRACT

The use of natural fibres in polymer composite materials has formed a new class of composites called Natural Fibre Reinforced Polymer Composite (NFRPC). The main issue with the use of natural fibre in the polymer composite is the compatibility between the polymer matrix and the natural fibre reinforcements. Another important issue is the hydrophilic nature of the natural fibres which not only reduces the tensile strength of the composite but also affects the other properties such as flexural strength, thermal stability etc. In order to overcome these problems, natural fibres are pretreated with certain chemicals to enhance the adhesion at the fibre matrix interface and to make the natural fibres absorb less water. Three different treatment methods of Micro Crystalline Cellulose (MCC) were considered in this study which includes NaOH treatment, Silane (APTES) treatment, NaOH and Silane (APTES) treatment. Composite materials were reinforced with the chemically treated MCC. The effectiveness of each treatment for the water absorption and tensile strength was investigated. The results showed that water absorption at saturation for untreated sample was 9.405% while that for silane treated, NaOH treated and Silane & NaOH treated samples was 8.823%, 5.065%, and 6.157% respectively. The tensile strength for the untreated sample was 57Mpa while that for silane treated, NaOH treated and Silane & NaOH treated samples was 62, 65, and 60 Mpa respectively.

Keywords: *NFRPC, Microcrystalline Cellulose (MCC), water absorption test, Pretreatment, APTES, Silane*

TRACK M3 **PAPER ID 81**

Revolutionizing Gear Engagement: A Critical Review of IoT and Digital Twin Technologies in Clutch Plate Design and Maintenance

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ABSTRACT

Due to concentrated stress, deformation, as well as premature wear, which lower reliability and efficiency, the automotive industry is struggling with clutch solutions under dynamic operational loads. After a thorough literature review, this paper examines these typical problems using advanced analysis. This first stage determines the degree and effect of present strategies by investigating and assessing present clutch mechanism degeneration detection and reduction techniques. The examination will compare chosen techniques to see whether they enhance operational toughness as well as clutch plate accumulating structural integrity after considering the present study. Comparative analysis identifies the optimal methods to postpone or lower operational stresses and wear of the clutch system. This work will suggest a new integrated framework with IoT as well as advanced digital twin technology using comparison method knowledge. The aim is to use the predictive servicing system to increase clutch system reliability and forecast. By means of advanced theoretical research and technology developments, this work will draw attention to potential increases in clutch system lifetime and establish a benchmark for further studies on motor vehicles component resilience, therefore encouraging a basic shift in automotive repair methods.

Keywords: *Clutch System Degeneration, Predictive Maintenance, Digital Twin Technology, IoT, Automotive Repair Methods*

TRACK M3 **PAPER ID 90**

Review Paper on Compliant Mechanisms of Application with Robotics

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ABSTRACT

Compliant mechanisms, which utilize flexible elements to achieve motion and force transmission, have gained significant attention in the field of robotics due to their unique advantages. These mechanisms offer a reduction in part count, increased reliability, and enhanced performance in applications where traditional rigid-body systems may fall short. By leveraging material elasticity and geometric configurations, compliant mechanisms can effectively absorb shocks, adapt to varying loads, and provide precise control over movement. As research progresses, these innovative designs are being integrated into various robotic applications, from soft robotics to surgical instruments, showcasing their versatility and potential to revolutionize how robots interact with their environment. This paper takes place a comprehensive review of different applications of compliant mechanism.

Keywords: *Compliant Mechanism, Soft Robotics, Flexure Hinges, Elastic Deformation, Bio-Inspired Design, Shape Memory Alloys, Additive Manufacturing*

TRACK M3 **PAPER ID 96**

Component Level Maintenance Decision Making in Steam Turbines: A Logic Tree Analysis Approach

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ABSTRACT

Steam turbines are essential in power generation and industrial processes, where equipment reliability directly influences efficiency and economic performance. Due to their complex design and diverse operating conditions, turbine components experience varying stress levels, leading to distinct failure modes and degradation patterns. Traditional maintenance approaches based on fixed intervals or past experiences are often inadequate for addressing these complexities. This paper presents a structured methodology using Logic Tree Analysis (LTA) to enhance preventive maintenance task selection. LTA evaluates critical parameters such as component design, operational duty, environmental exposure, and failure history to determine suitable maintenance actions. This structured approach ensures that preventive measures are both technically sound and economically justified. In contrast to non-standardized practices, LTA provides consistent, logic-based decision-making across components and maintenance teams. The study introduces standardized templates and classification criteria within the LTA framework to improve uniformity and reduce variability in maintenance planning. Aligning maintenance activities with operational risks leads to better resource utilization, fewer unplanned outages, and improved equipment availability. Overall, the findings demonstrate that LTA significantly improves the consistency, reliability, and efficiency of preventive maintenance for steam turbine components. The methodology offers a robust foundation for modern, risk-informed maintenance programs tailored to complex industrial systems.

Keywords: *Preventive Maintenance, Logic Tree Analysis, Steam Turbines, Fault Detection and Maintenance Strategies.*

TRACK M3 **PAPER ID 119**

Design, Analysis, Fabrication and Testing of Carbon Fiber Suspension and Steering Linkages for Solar-Electric Vehicle

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ABSTRACT

This paper presents the design, analysis, and fabrication of lightweight A-arm suspension and tie rod components using carbon fiber composites to improve vehicle performance and reduce non-suspended mass. Epoxy resin and 3K twill weave carbon fiber wlere selected for their superior mechanical properties, manufacturability, and high strength-to-weight ratio. Force calculations were conducted analytically and verified through CAD modeling and finite element analysis using ANSYS and the ACP (Ansys Composite Prep Post) module. The optimal 4-layer composite configuration provided safety factors above 2.0 for both the adhesive and carbon fiber structure under dynamic loads. Components were fabricated by bonding filament-wound carbon fiber tubes to VMC-machined aluminum connectors using the hand layup method. Universal Testing Machine (UTM) testing validated the adhesive joint's strength, supporting a maximum load of 5830 N. The final assembly achieved a 40% weight reduction—reducing component mass from 2 kg to 1.2 kg—while maintaining structural integrity and stiffness. These findings confirm the suitability of carbon fiber composites in high-performance suspension systems for automotive applications.

Keywords: *ACP, ANSYS, Carbon Fiber, VMC*

TRACK M3 **PAPER ID 148**

Comprehensive Case Study on Simulating EGR Cooler Failures and Establishing Correlation Between Failed Parts, FEA, and Testing

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ABSTRACT

Exhaust gas recirculation (EGR) has been used to reduce automotive emissions and improve fuel economy since 1940. For compression ignition (CI) and spark ignition (SI) engines, reducing nitrogen oxide (NOx) and improving fuel economy is achieved with the help of cool EGR technology. EGR Cooler reduces combustion by reducing exhaust gas temperature during recirculation and maintaining volumetric efficiency. In SI engines, an EGR cooler also helps to achieve fuel economy by lowering in-cylinder combustion temperature during engine-high operating conditions, avoiding fuel enrichment and reducing pumping losses during low and medium operating conditions. EGR coolers are designed to work for the engine's lifetime, however, for some reason, they can fail during their lifetime. This paper presents a detailed case study on simulating failure scenarios in an EGR cooler used in off-highway applications. It explores the correlation between real-time part failure, finite element analysis (FEA), and component-level testing. A typical failure was observed at the gas tube due to improper bonding between the coolant fin and the gas tube. FEA simulations under both ideal and worst-case conditions predicted maximum stress zones that aligned well with physical failure locations. The successful validation of these predictions through component-level pressure cycle tests strengthens confidence in predictive CAE methods for failure analysis and fatigue life estimation of EGR coolers, reassuring the audience of the robustness of the research findings.

Keywords: *EGR Cooler, Pressure Fatigue, FEA Simulation, Validation, Brazing, Durability Testing, Boiling, Pitting corrosion, CAE, Fouling*

TRACK M3 **PAPER ID 206**

Review on Comparison of Satellite Solar Panel Deployment Methods Centrifugal, Spring-Loaded and Motorized System

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ABSTRACT

Solar panel deployment is a key subsystem in satellite engineering with direct influence on power production, mission lifetime, and system survivability. This review aims to provide an extensive comparison of the three main satellite solar panel deployment concepts: centrifugal, spring, and motorized systems. Each of these approaches has unique strengths and compromise factors associated with mass, reliability, control, and applicability to different mission profiles. Centrifugal deployments use spin-created forces to deploy panels passively, giving a light weight solution for small satellites but with less scalability and control. Spring-loaded systems, utilizing stored mechanical energy, achieve balance between simplicity and reliability but come with mechanical shock risks and irreversibility. Motorized deployments, on the other hand, deliver active control, accuracy in deployment, and retraction but come with added mass, complexity, and resource use. The review paper looks at these mechanisms using selection criteria such as efficiency, redundancy, environmental flexibility and system integration. It also discusses now trends like the ease of smart materials such as shape memory alloys, origami inspired architecture, additive manufacturing and AI based deployment verification as path to next generation solutions. This review aims to help satellite designers select and design deployment systems that meet changing space mission requirements.

Keywords: *Satellite solar panels, Deployment mechanisms, Shape memory alloys, solar arrays technology*

TRACK M4 **PAPER ID 36**

Optimization Of Heat Sink

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ABSTRACT

This paper presents a comparative analysis between a standard heat sink and a custom-designed shark fin heat sink in terms of heat dissipation and fatigue performance under cyclic thermal loading. Simulations were performed using MATLAB for a duration of 60 minutes across different material configurations, including aluminum-copper hybrid, full aluminum, aluminum graphene-coated, graphene-aluminum composite, and functionally graded aluminum-graphene material. The standard heat sink demonstrated faster initial cooling, while the shark fin design showed superior thermal fatigue performance.

Keywords: *Heat sink, Heat transfer, Fins, Fatigue*

TRACK M4 **PAPER ID 52**

Benchmarking Preliminary Design, Aerodynamic Configuration, and Propulsion for Development of N38 Trishool Aircraft

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ABSTRACT

Tactical reconnaissance, surveillance, and air-to-air combat are the key to achieving air superiority in military applications. In a move to develop an indigenous multi-role aircraft, N38 Trishool preliminary design is developed. Several fighter aircraft are benchmarked for extracting their aerodynamic and propulsion configurations. In the absence of publicly available data, key parameters are assumed and validated by using mathematical models. The same are used to estimate the parameters of the current development. CFD simulations are carried out to validate the aerodynamic performance of N38 Trishool aircraft. Based on the result analysis, further design strategies are laid out.

Keywords: *Aircraft, Force, Drag, Lift Factor, Cruise Speed*

TRACK M4 **PAPER ID 72**

Experimental Analysis of Single-Cylinder Gasoline Engine Performance by Adding Cerium Oxide Nanoparticles in Ethanol-Gasoline Fuel Blends

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ABSTRACT

Conventional petroleum fuel storage is limited and on the other hand, the need for the fuel is increasing. The combustion of petroleum fuel also leads to the emission of harmful gases. With the stringent pollution norms in each country, it is also essential to keep the emissions under the limits of pollution norms. This research examines the effect of Cerium Oxide nanoparticles (CeO2) and ethanol as a fuel blend on the engine performance, combustion efficiency, and exhaust gases of gasoline engines. CeO2 has high oxygen affinity and it speeds up fuel burning, resulting in higher power production and fewer pollutants. As test fuels, ethanol-gasoline blends E10, E20, E25, E30, and E35 alongside 50 and 100 ppm CeO2 nanoparticles were created. Experiments were conducted on a single-cylinder variable compression ratio gasoline engine with varying compression ratios (7 to 10) and engine speeds (1300 to 1700). Volumetric efficiency was observed high for 100 ppm of CeO2 at 1700 rpm. Brake thermal efficiency was also improved with the addition of CeO2. The addition of ethanol in gasoline as a fuel blend has increased the specific fuel consumption due to its lower calorific value. Ethanol provides excess oxygen and has improved the combustion process. This leads to a reduction in emissions. This also supported the complete combustion at lower temperatures and reduction of harmful NOx.

Keywords: *Cerium Oxide Nanoparticle, Engine Emissions, Variable Compression Ratio (VCR) Engine Performance, Exhaust Gas Analysis, Performance Parameter, Efficiency Parameter*

TRACK M4 **PAPER ID 103**

Beyond Conventional Cooling: Review on Innovations in Heat Sinks and Fins for Enhanced Thermal Efficiency across Diverse Applications

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ABSTRACT

Effective thermal management systems are critical for various industrial applications, such as CPU cooling, electronics circuit board cooling, and mechanical and automobile systems, ensuring reliable high-speed performance. This study explores novel techniques, both active and passive, along with compound approaches, to enhance heat transfer. Traditionally, area is only one parameter can be manipulated. However, contemporary research introduces innovative parameters like air mixing, mass flow rate, pressure drop, geometry, perforation, Reynolds number, Nusselt number, thermal conductivity, and nanofluid. By expanding the scope of parameters, this research demonstrates how thermal management systems can become more compact and eco-friendlier. The utilization of these methods helps prevent thermal failure, extends product lifespan, optimizes device performance, and mitigates environmental impact by reducing e-waste due to thermal failures. Overall, this paper aims to guide researchers in developing more efficient and environmentally friendly cooling systems.

Keywords: *Lightweight concrete, AAC Block, Compressive strength, Workability*

TRACK M4 **PAPER ID 113**

Performance Evaluation of Gasketed Plate Heat Exchanger: A Comprehensive Review

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ABSTRACT

Heat exchangers are essential components in industries such as chemical processing, dairy and food production, and thermal power generation, where energy efficiency is paramount. Plate Heat Exchangers (PHEs) are highly valued for their compact design, efficient heat transfer capabilities, and adaptability to various applications. Their modular construction allows for easy maintenance and scalability, making them a preferred choice in industries where space efficiency and operational flexibility are essential. Enhancing gasketed plate heat exchanger performance focuses on maximizing heat transfer while minimizing energy consumption and pressure drop. In this paper, Passive surface enhancement techniques and the use of nanofluids are reviewed. Key geometric parameters, notably the chevron angle (β), significantly influence thermal performance, higher β angles increase turbulence, thereby improving the heat transfer coefficient (HTC) and Nusselt number (Nu), but also lead to greater pressure drops (ΔP). However, higher nanoparticle concentrations can increase fluid viscosity, resulting in elevated pressure drops and pumping power requirements. The optimum geometrical parameters for maximum heat transfer are β: 30°-65°, γ: 0.075–0.6 and φ: 1.18–1.3.

Keywords: *Gasketed plate heat exchanger, Heat transfer coefficient, Nanofluid, Chevron angle, Pressure drop, Nusselt number, Effectiveness*

TRACK M4 **PAPER ID 116**

Experimental Benchmarking and CFD Validation of Single Air Jet Impingement Cooling on a Heated Plate

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ABSTRACT

Air jet impingement is widely recognized as an effective technique in thermal management due to its capability to achieve high local heat transfer rates. This study focuses on the design, development, and validation of a dedicated experimental setup to investigate the thermal performance of a circular air jet impinging on a uniformly heated flat surface. The system comprises a thermally insulated heating assembly, a test plate, precision flow measurement instruments including an orifice meter and differential pressure gauge, a pressure regulator, temperature sensors for monitoring surface and flow temperatures, and a Variac-controlled power source to regulate heat input. Experiments were conducted at a constant nozzle-to-plate spacing ratio (z/d = 6), while varying the Reynolds number to analyze its impact on the average Nusselt number. The results demonstrated a clear and consistent increase in the Nusselt number with rising Reynolds number, indicating enhanced convective heat transfer with increasing jet momentum. Experimental findings were benchmarked against Computational Fluid Dynamics (CFD) simulations and established empirical correlations from literature, showing strong agreement and validating the reliability of the setup. The successfully validated system offers a versatile platform for future investigations into advanced air jet configurations, including variations in nozzle geometry, jet inclination angles, and multi-jet arrangements. The insights gained from this study are applicable to the optimization of cooling strategies in high-performance thermal systems across industries such as electronics, manufacturing, and aerospace.

Keywords: *Air jet impingement, Convective heat transfer, Heat transfer enhancement, Reynolds number, CFD simulation, Experimental validation*

TRACK M4 **PAPER ID 146**

Hydrogen-Enriched Diesel Combustion: A Comprehensive Review of Dual-Fuel Engine Performance, Emissions Reduction, and Injection Strategies

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ABSTRACT

Amid rising global concerns over environmental degradation and fossil fuel depletion, hydrogen has emerged as a promising clean energy alternative for internal combustion engines. This review paper synthesizes the findings of recent experimental and simulation-based studies focused on hydrogen-enriched diesel and dual-fuel compression ignition (CI) engines. The literature encompasses a variety of fuelling strategies—including port and manifold injection, direct injection, and advanced combustion modes such as HCCI and tri-fuel (hydrogen-CNG-diesel) operations. Hydrogen integration was found to consistently enhance brake thermal efficiency (BTE), lower carbon-based emissions (CO, HC, PM), and improve combustion stability. Notably, some HCCI configurations reported thermal efficiencies up to 45%. However, higher hydrogen shares often led to elevated NO_x emissions, driven by increased combustion temperatures. Mitigation techniques such as exhaust gas recirculation (EGR), multi-stage injection, and piston geometry optimization have shown potential in addressing these challenges. This review confirms that hydrogen enrichment is a viable path for improving diesel engine efficiency and reducing environmental impact. With further advancements in control strategies, safety, and fuel delivery systems, hydrogen-diesel dual-fuel technology holds strong potential for real-world adoption.

Keywords: *Hydrogen enrichment, dual-fuel engine, diesel combustion, alternative fuels, thermal efficiency, NO_x emissions, hydrogen injection, HCCI, emission control, clean energy.*

TRACK M4 **PAPER ID 169**

A Review on Eco-Friendly Nanoparticle-Enhanced Heat Exchangers Using Twisted Tape Inserts for Enhanced Thermal Performance

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ABSTRACT

Heat Exchangers are most used heat exchange systems in the industrial applications. It can note that the waste heat recovery requires high efficiency heat exchangers. The effectiveness, which is ration of actual to maximum possible heat transfer from heat exchanger, can improvised by using different working materials. Therefore, the nanoparticles find very effective role in heat transfer applications. In most of the heat exchangers, the rate of heat transfer increased by using silicon, silver, copper and titanium-based Nano particles. The use of Nano particles has hazardous effects on human body as well as ecosystem. Here in this paper the extended review presented to create awareness for use of eco-friendly Nano particles such as ferrous/magnetic Nano particles, which are easy to separate before reuse, as well as some additional auxiliary systems for improvisation of heat transfer.

Keywords: *Nanoparticles, Twisted Tape, toxicity of nanoparticles*

TRACK M4 **PAPER ID 191**

Thermal Dynamics of Porous Enclosures Embedded with Hybrid Horizontal-Vertical Spikes

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ABSTRACT

This study investigates the thermal modulation and convective behavior of a fluid-saturated porous enclosure embedded with strategically placed combined horizontal-vertical diathermal spikes. The objective is to lower the heat transfer by strategizing spike placement and configuration under varying Rayleigh numbers. The novelty lies in the strategic insertion of spikes, which disrupt the thermal boundary layers and promote efficient convective heat transfer. A computational approach using the Darcy convection model is employed to analyze temperature distributions, flow patterns, and Nusselt numbers. Key findings reveal that algorithmic identification of these locations is crucial in guiding the insertion of diathermal spikes to minimize heat transfer. The results highlight the potential of diathermal spikes to enhance thermal performance in porous enclosures, providing insights for applications in heat exchangers and energy systems.

Keywords: *Porous, Natural convection, Diathermal Spike*

TRACK M4 **PAPER ID 201**

A Critical Review on Lithium-ion Battery Mechanisms and Diagnosis Method

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ABSTRACT

A Lithium-ion batteries decay every time as it is used. Aging-induced degradation is unlikely to be eliminated. The aging mechanisms of lithium-ion batteries are manifold and complicated which are strongly linked to many interactive factors, such as battery types, electrochemical reaction stages, and operating conditions. In this paper, we systematically summarize mechanisms and diagnosis of lithium-ion battery aging. Regarding the aging mechanism, effects of different internal side reactions on lithium-ion battery degradation are discussed based on the anode, cathode, and other battery structures. The influence of different external factors on the aging mechanism is explained, in which temperature can exert the greatest impact compared to other external factors. As for aging diagnosis, three widely-used methods are discussed: disassembly-based post-mortem analysis, curve-based analysis, and model-based analysis. Generally, the post-mortem analysis is employed for cross-validation while the curve-based analysis and the model-based analysis provide quantitative analysis. In this paper, the mechanisms of lithium-ion battery ageing are reviewed and evaluated.

Keywords: *Li-ion battery, diagnosis methods, aging mechanism, post-mortem analysis, curve-based analysis*

TRACK M4 **PAPER ID 221**

Investigation of Flow-Induced Vibrations in Subsea Manifolds: A Comparative Study of Experimental and Computational Fluid Dynamics Methods

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ABSTRACT

Flow-Induced Vibration (FIV) refers to the oscillatory motion of structures caused by unsteady fluid forces, often resulting from turbulence, vortex shedding, or multiphase interactions. In subsea systems, FIV poses a significant threat to structural integrity, especially under high-pressure, multiphase flow conditions. While prior research has extensively explored FIV in single-phase flows, studies addressing multiphase FIV in realistic subsea environments remain limited. Existing work often simplifies geometry or neglects transient fluid-structure interactions, leaving a gap in understanding the dynamic behavior of such systems. This study investigates FIV in a multiphase (air-water) flow system through both experimental and numerical approaches, focusing on conditions representative of subsea manifolds used in offshore oil and gas operations. A scaled manifold segment is subjected to varying inlet pressures (5–30 bar) to evaluate the influence of pressure fluctuations on flow patterns and induced vibrations. To conduct the process parameter for three variations by changing the pressure value, Material & Thickness of the subsea pipeline. Key findings indicate that multiphase interactions significantly amplify vibration amplitudes, particularly near phase transition zones and geometric discontinuities. Computational Fluid Dynamics (CFD) simulations reveal detailed flow characteristics—velocity fields, phase distribution, and pressure gradients—while structural and modal analyses identify regions prone to vibrations and failure. The novelty of this research lies in its integrated approach, combining high-fidelity CFD with structural dynamics to simulate realistic subsea conditions. By correlating flow-induced forces with structural responses, the study provides a predictive framework for early detection and mitigation of FIV, enhancing the safety and reliability of subsea pipeline systems.

Keywords: *Subsea, Flow Pattern, Flow Induced Vibration, CFD, Multi-Phase Volume Fraction & Modal Analysis*

TRACK M4 **PAPER ID 223**

CFD and Thermal Analysis of Liquid-Cooled High Power Cable and Connector

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ABSTRACT

The rapid growth of electric vehicles (EVs) necessitates high-performance charging infrastructure, which generates substantial heat in cables and connectors, making traditional air-cooled systems inefficient. To overcome this, liquid-cooled systems are increasingly employed, circulating coolants like water-glycol or dielectric fluids to effectively manage heat. This study performed Computational Fluid Dynamics (CFD) simulations to analyse the thermal performance of a liquid-cooled high-power cable and connector system, adjusting coolant flow rates to maximize heat removal and assure safe operation. Experimental temperature rise tests on a 70 sq mm copper DC cable under a 500 A current provided real-world thermal load data, revealing the junction as the hottest point due to resistance. The CFD simulations, using coolant as dimethyl silicone oil and various materials for the cable and connector components, demonstrated that increasing the coolant inlet velocity from 0.5 m/s to 2.0 m/s significantly improved cooling performance. This resulted in a 26% reduction in connector temperature (from 48.47°C to 35.92°C), a 19% reduction in cable temperature (from 52.48°C to 42.47°C), and a 27% decrease in coolant outlet temperature (from 34.18°C to 25.07°C). These findings underscore the critical role of active liquid cooling in preventing overheating and enhancing the safety, performance, and durability of high-power EV charging systems.

Keywords: *Computational Fluid Dynamics, Combined Charging System, Electric Vehicle, High Power Cable.*

TRACK M4 **PAPER ID 224**

Numerical Approach to Investigate the Condensation Over Instrument Cluster Using CFD

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ABSTRACT

The research aims to investigate the condensation over instrument cluster using computational fluid dynamics (CFD). An instrument cluster is an assembly of dials, gauges which provides the data about vehicle status mainly located behind the steering wheel. Condensation in instrument cluster occur due to temperature difference between inner body temperature and outside temperature. Condensation is caused by the high heating component of the instrument cluster, particularly over the printed circuit board (PCB). Air breathers can be utilized to reduce the condensation. Condensation tends to formation of water film formation over the instrument cluster. Literature survey is done in order to understood the simulation physics behind the condensation and film appearance time and disappearance time. The study seeks to accurately simulate the condensation process and identify optimal design modification, such as Number of breathers and their location to minimize the condensation and calculate the film appearance and disappearance time. The Result provides the Film Formation time and disappearance time with Film formation location. Based on the Previous study done by various authors Eluerian wall film is one of the approach to investigate and study the condensation phenomenon. Transient Computational Dynamic Simulation using Eulerian wall film approach is used for the simulation to investigate the condensation, using poly-hex core mesh with the relative humidity and ambient temperature.

Keywords: *Condensation, Computational Fluid Dynamics (CFD), Eulerian Wall Film, Instrument Cluster. Relative humidity*

TRACK M4 **PAPER ID 228**

Fluid-Foam Structure for Enhanced Vibration Damping in Two-Wheeler Seats: A Finite Element Analysis Study

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ABSTRACT

This study examines the characteristics of vibration damping in two-wheeler seats by incorporating a fluid-filled structure into a hyperelastic polyurethane (PU) foam. Two-wheeler riders are subjected to whole-body vibrations due to road irregularities, which can lead to distress, fatigue, and long-term musculoskeletal disorders. Commercial foam materials used in seat fabrication often fail to effectively attenuate low-frequency vibrations, particularly in the 0–30 Hz critical region. For this study, the analysis was conducted using Finite Element Analysis (FEA) with ANSYS Workbench to investigate the dynamic response of the two-wheeler seat with various configurations. This Seat was discretized in consideration of cavities filled with four different fluids, such as Silicone Oil, Synthetic Oil, Castor Oil, and Mineral Oil, within a 40 mm thick hyperelastic foam base. Harmonic analysis was conducted to evaluate real-world excitation scenarios, considering a vertical acceleration of 800 mm/s². Results show a noticeable reduction in vibration amplitudes for all seat configurations filled with fluid when compared with the control foam-alone Seat. The best damping was obtained using Silicone Oil, which reduced the vertical amplitude by 33.60%, and Synthetic Oil by 31.53%. Increased stiffness and additional damping resulting from fluid-structural interaction were the causes of improved performance. Results confirm that fluids in foam-based seats can serve as a passive yet efficient means for vibration control. Experimental validation and practical application in comfort designs in two-wheelers can be extended with this work, serving as a foundation.

Keywords: *Vibration damping, Fluid Filled Foam, Harmonic Analysis, FEA, Whole body vibration*

TRACK M4 **PAPER ID 237**

Experimental Analysis of Cellulose Fiber Insulation Considering Thermal Conductivity Dependence on Density Using Environment Friendly Additives

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ABSTRACT

Cellulose fibre insulation made up of recycled newspaper is used as thermal insulation and acoustic insulation considered as environmentally friendly. Cellulose fibre insulation is sound absorber material and having excellent thermal resistance properties, biodegrability and low thermal conductivity compared to most of synthetic materials. The study was focused, to prepare cellulose fibre insulation from waste newspaper from local market using environment friendly additives like borax, boric acid, aluminium sulfate, Silica gel and calcium carbonate. To combine all these additives by weight with cellulose fibre pulp, binder is used. In convention methods adhesive substance like glue, potato starch is used. In the preparation process of cellulose fibre insulation, fenugreek powder is used as a binder because it has excellent mucoadhesive properties. The mixture of cellulose fibre pulp, additives and binder is carefully selected by percentage of weight. To analyse effect of density on thermal conductivity, cellulose fibre insulation structure was prepared varying thickness from 15mm to 35mm and density range from 280-360 Kg/m3. The paper focused on heat flow direction effect and relationship between density and thermal conductivity on cellulose fibre insulation.

Keywords: *Cellulose fibre insulation, thermal conductivity, additives, density, recycled paper*

TRACK M4 **PAPER ID 241**

A Comprehensive Review on the Performance and Emission Characteristics of Variable Compression Ratio Diesel Engines Fueled with Biodiesel and Enhanced Blends

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ABSTRACT

The transition toward sustainable and cleaner energy sources has intensified research into biodiesel and its integration into compression ignition (CI) engines. This literature review encompasses 52 studies that collectively examine the production, performance, and emission characteristics of biodiesel and biodiesel-diesel blends derived from both edible and non-edible feedstocks. Early investigations have focused on lifecycle assessments and the feasibility of straight vegetable oils and methyl esters as viable alternatives to conventional diesel. Various experimental studies revealed that biodiesel blends generally lead to improved combustion efficiency and significant reductions in carbon monoxide (CO), unburned hydrocarbons (HC), and particulate matter (PM) emissions, although challenges remain in terms of nitrogen oxides (NOx) emissions and cold flow properties. Studies have also evaluated the effects of operational parameters such as fuel injection timing, compression ratio, and the use of exhaust gas recirculation (EGR) on engine behavior, with several indicating optimal configurations for mitigating NOx emissions without sacrificing thermal efficiency. The review further incorporates investigations into waste-derived biodiesel (e.g., used cooking oil, Jatropha, rubber seed oil) and highlights their favorable impact on engine sustainability. Recent advancements, include the incorporation of nano-additives and multifunctional chemical additives to enhance fuel properties. These modern approaches have demonstrated improvements in combustion stability, brake thermal efficiency, and further reductions in harmful exhaust constituents. Notably, nanoparticle-enhanced biodiesel blends in variable compression ratio engines show promise in addressing the trade-offs between emissions and performance.

Keywords: *Biodiesel, Variable Compression Ratio, Diesel Engine, Emissions, Nanoparticles, Optimization, Renewable Fuel*

TRACK M4 **PAPER ID 242**

Thermal Design of Standalone Miniature Liquid Fuel Combustor for Thermoelectric Power Conversion

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ABSTRACT

The increasing demand for portable electronic devices requires energy sources with high power density and extended operational life, which conventional electrochemical batteries fail to deliver for high-energy applications. This work proposes a novel standalone miniature thermoelectric power conversion system based on a variable-area liquid fuel combustor, converting combustion heat into electricity through thermoelectric generator modules. Designed to generate 15 W of electrical power, the system employs a variable-area combustor and a concentric fuel tube to ensure natural circulation of fuel and air, enhancing flame stability. The liquid fuel film temperature at the orifice exit is estimated by equating mass and thermal diffusion transfer numbers at a steady state, assuming a Lewis number of unity. Thermal analysis recommends a 5 mm thin metallic porous medium at the fuel orifice exit to enhance fuel evaporation, thereby improving overall combustion efficiency. The proposed system presents a promising alternative energy source for portable electronic devices requiring high energy density.

Keywords: *Combustion, Miniature Combustor, Thermoelectric Generator, Standalone System*

TRACK M4 **PAPER ID 243**

CFD-Based Performance Optimization of Butterfly Valve through Geometric Modifications for Pressure Drop Reduction

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ABSTRACT

This paper presents a comprehensive computational fluid dynamics (CFD) analysis of butterfly valve performance with the objective of reducing pressure drop and improving flow characteristics through geometric modifications. Three designs were considered: a base model and two modified configurations (Model-1 and Model-2) with streamlined disc profiles. ANSYS Fluent was used to simulate water flow at various disc angles. Results indicate that the optimized models exhibit significantly lower pressure drop and higher flow coefficients compared to the original design. Results derived from the idealized computations and CFD analysis shows the very close agreement. This study demonstrates how CFD can guide effective design improvements in industrial flow control devices.

Keywords: *Butterfly valve, CFD, Flow coefficient, Pressure drop, Valve optimization, FLUENT, Flow Velocity*

TRACK M4 **PAPER ID 248**

A Physics-Informed Neural Network Framework for Transient Heat Conduction in Functionally Graded Materials

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ABSTRACT

This work presents a Physics-Informed Neural Network (PINN) framework for modeling transient heat conduction in functionally graded materials (FGMs) with quadratic variation in thermal properties. Unlike conventional numerical methods that require mesh generation and time integration, the proposed approach embeds the governing partial differential equation (PDE), boundary conditions, and initial condition directly into a physics-based loss function, enabling mesh-free and data-independent learning. The model accepts normalized spatial-temporal coordinates as input and leverages automatic differentiation to enforce PDE residuals, Dirichlet and Neumann boundary conditions, and the initial condition. Validation is performed against analytical benchmarks for a square FGM plate across four gradation indices ($\beta = 1,2,4,8$), representing varying levels of material heterogeneity. The results show strong agreement, with mean percentage errors below 0.5% for moderate heterogeneity ($\beta \leq 4$) and below 3% for the steepest case ($\beta = 8$), where the error decays rapidly during the early transient phase. Spatial temperature profiles further confirm the model's ability to resolve steep thermal gradients without introducing numerical artifacts. These results demonstrate the robustness and scalability of the PINN framework for solving heat conduction problems in graded materials, with potential applicability to multi-dimensional and coupled thermo-mechanical systems.

Keywords:, *Physics Informed Neural Network (PINN), Mesh-Free Modeling, Functionally Graded Structures (FGS), Composite Structures, Deep Learning in Heat Transfer*

TRACK M4 **PAPER ID 249**

Integrated CFD, Harmonic, and Acoustic Analysis of NACA 6409-Based Ceiling Fan Using ANSYS Workbench

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ABSTRACT

The current paper provides a multi-physics full model of the ceiling fan development and analysis related to a NACA 6409 airfoil-based blade profile. After testing the aerodynamic, structural and acoustic performance that is achieved, an iterative process is undertaken with the help of ANSYS Workbench to improve the design. At the initial level, the Computational Fluid Dynamic (CFD) simulation will be performed on varying the speed of fans at 300, 600, and 900 RPM, which is supposed to check the air distribution in terms of pressure, velocity field, and movement of air turbulence. These findings drive the first optimization stages of blade geometry towards enhanced efficiency of the airflow and drag reduction. The second step entails a harmonic structural tally where vibrational modes of the fan are established and natural frequencies avoided to make sure that the design does not resonate and cause over-vibration. In conjunction with this an acoustic analysis is used which forecasts sound pressure levels (SPL) and acoustic power radiation of the vibrational modes of blade vibrations which determine the extent to which blade vibrations add to noise. In the last stage, different blade materials are compared (taking into account properties such as strength, density, damping) as well as the blade orientation/ geometry is additional optimized to reach a good compromise between high aerodynamic efficiency, high structural stability and low noise level. The optimized design is analyzed against the complete set of performance parameters at each of the speeds and leads to a design that has a more efficient airflow, less vibration and lesser noise output. This can be abridged whilst sketching out a valid analysis strategy, in such a way that future projects on the development of more efficient, durable and quieter ceiling fans can be carried out.

Keywords: NACA 6409, SPL, analysis, optimization

TRACK M5 **PAPER ID 3**

An Experimental Analysis of Piezoelectric Generator-Based Energy Harvesting Applied to Bicycle Seats

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ABSTRACT

Innovative methods of energy harvesting in everyday devices and transportation have been encouraged by the increased desire for sustainable and renewable energy sources in recent years. The viability and effectiveness of integrating a piezoelectric generator (PEG)-based system into a bicycle seat to capture mechanical energy from rider movement and transform it into electrical energy that may be used are investigated in this study. A prototype seat equipped with piezoelectric transducers that take advantage of pressure changes and vertical vibrations produced during cycling is being designed as part of the project. It was found that the power generation increased in proportion to the number of tapping when the number of piezoelectric generators increased. At one minute and 100 taping counts, it was found that rectangular sensor alignment with 12 sensors was 14% and triangular alignment with 10 sensors and circular sensor alignment with 12 sensors were 37% and 14%, respectively. The rectangular sensor alignment structure produces the best outcomes, according to the experiment's findings, because it produces more power than alternative configurations.

Keywords: *Piezoelectric Generator, Vibration, Power generation, Energy-Harvesting, Pressure*

TRACK M5 **PAPER ID 69**

Design and Optimization of a Biochemical Fermenter for Ethanol Production from Rice Straw: A Sustainable Biofuel Approach

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ABSTRACT

The global demand for alternative energy has increased research on bioethanol production from lignocellulosic biomass. Rice straw, a vast agricultural byproduct that is highly cellulose and hemicellulose-containing, is an untapped feedstock for renewable ethanol conversion. This study deals with the design and optimization of a biochemical fermenter that aims to improve the pre-treatment, enzymatic hydrolysis, and fermentation processes to increase the production of ethanol. Using an alkali-based pre-treatment method to increase cellulose accessibility and using enzymatic hydrolysis to convert the complex polysaccharides into the fermentable form of sugars was used. To increase the yield and time reduction in processing, Simultaneous Saccharification and Fermentation (SSF) using thermo-tolerant yeast strains was introduced. A full material balance was carried out to determine mass flow at various stages in the processing by each step of unit operations, pre-treatment, SSF, filtration and distillation. This led to the design of a laboratory-scale batch fermenter of optimum dimensions, temperature and ph. The last system showed high conversion efficiency and ethanol recovery, with estimates in daily production of approximately one litre. The cost analysis validated the economic viability of the proposed fermenter design. The solution proposed in the course of this research is scalable, eco-friendly, and supports the development of second-generation biofuels.

Keywords: *Alternative energy, bioethanol, lignocellulosic biomass, Rice straw, ethanol, Saccharification and Fermentation.*

TRACK M5 **PAPER ID 76**

A Review of n-Methylaniline's Role in Enhancing the Power Output of Ethanol-Gasoline Blends

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ABSTRACT

The increasing demand for high-performance, fuel-efficient, and environmentally friendly internal combustion engines has led to research on fuel additives to boost combustion efficiency and control emissions, such as n-methylaniline (NMA), which has emerged as a potential octane booster in ethanol-gasoline blends. With its better octane number, NMA improves combustion characteristics, thermal efficiency, and CSE, making it a promising alternative for sustainable fuel formulations based on current studies. Furthermore, it helps reduce NOx and CO2 emissions without affecting fuel stability. However, concerns about its oxidation stability, toxicity, and long-term effects on engines necessitate further research. Comparing it with MTBE and ETBE reveals differences in degradation behavior and environmental implications, highlighting the need for optimized formulations. Variations of alternative ethanol and other additives have also shown potential in enhancing engine performance and reducing emissions. This paper explores the viability of NMA as a superior octane booster and what insights can be gathered regarding its application in modern fuel systems to balance performance, durability, and sustainability.

Keywords: *n-Methylaniline, octane booster, ethanol-gasoline blends, spark-ignition engines, combustion efficiency, emission reduction, ignition timing, knock resistance, fuel additives, thermal efficiency*

TRACK M5 **PAPER ID 78**

Optimization of Effectiveness for Open and Closed Ground Heat Exchanger by Using ANN

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ABSTRACT

In today's age of increasing energy demand and global warming there is a need to shift to sustainable solutions for space cooling. The conventional air conditioning units are Air Source Heat Pumps (AHSP) which use the outdoor air as a heat sink which further contributes to temperature rise of the ambient atmosphere. The use of ground heat exchangers (GHE) can overcome this problem. The GHEs are buried inside the ground and use the ground as a heat sink. The soil temperature at optimal depth remains constant and is much lower than the atmospheric temperatures especially in hot regions. GHEs are classified as open or closed type. In open systems, ambient air is pre-cooled in the GHE while closed systems use water as a circulating fluid to transfer heat from the heat pump's condenser to the ground, this system is called Ground Source Heat Pump (GSHP). Studies show that the COP of a GSHP is higher than that of an ASHP. This study aims at optimizing the performance of open and closed type ground heat exchangers in horizontal slinky coil configuration of the GHEs. Simulations are carried out in ANSYS for varying input parameters like inlet temperature, flow velocity, soil temperature for different materials, effectiveness predictions are made using Artificial Neural Network (ANN). The obtained data is studied and analyzed for maximization of heat exchanger effectiveness.

Keywords: *GHE, open type, closed type, effectiveness, slinky coil, inlet temperature, flow velocity, soil temperature*

TRACK M5 **PAPER ID 85**

Double Tin Made Hut Makes it Sustainable in Summer Days by Using Solar Energy

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ABSTRACT

This research explores a cost-effective passive cooling solution based on the Trombe wall concept to improve thermal comfort in tin-roofed huts, particularly in slum areas. The conventional Trombe wall, which utilizes thermal mass and solar radiation for heat storage and ventilation, is adapted for use in roof and wall structures made from galvanized iron (GI) sheets. A double-layer configuration with an air gap and strategic ventilation holes is implemented, allowing solar-heated air to circulate and exit, thus reducing heat transfer to the interior. Experimental observations show a significant reduction in indoor temperature by approximately 8°C to 12°C compared to traditional single-sheet huts, with the internal temperature nearing ambient outdoor levels during peak summer. The results confirm that this low-cost, low-maintenance modification effectively minimizes indoor heat gain using affordable materials and passive design principles. The proposed system offers a scalable and sustainable approach to enhance living conditions in low-income communities while supporting environmental sustainability.

Keywords: *Double tin made hut, Holes for ventilations, Minimize indoor heat gain, enhance living condition in low income communities.*

TRACK M5 **PAPER ID 114**

Performance Enhancement of Solar PV Panel

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ABSTRACT

Solar photovoltaic technology harnesses solar energy to generate electricity, while solar thermal systems utilize solar energy to heat fluids, either water or air, for various applications. When installed separately, these two systems can be costly and require significant space. Conventional solar photovoltaic systems have an electrical efficiency of 15 to 20%, with excess heat raising the temperature of the solar panel. A key issue with photovoltaic is that as the panel's temperature goes up, its efficiency declines. To address this, a combined solar PV and Thermal system is judiciously designed using multiwall polycarbonate (PC), sheet. Solar cells are fixed on the PC sheet and atmospheric air is circulated through the flutes of the sheet to remove the heat from the solar cells. Thus, the PV panel temperature is lowered and the overall cell efficiency is boosted. The hot air reaches a temperature in the range of 50 to 55 °C. The agro produce dryer is coupled with the combined system and the hot air is discharged into the dryer to dry the agro produce, such as fenugreek, spinach primarily. Even the fruits, onions, can also be dried using the available hot air. The efficiency of the PV panel is increased by 10 to 12 % with drying as a byproduct. The combined system will offer early payback on the investment and thereby enhance the lifestyle of the farmers/users of the system.

Keywords: *solar photovoltaic, solar thermal, efficiency, PVT system, dryer*

TRACK M5 **PAPER ID 185**

Analyzing the Impact of Nanoparticle-Enhanced Gasoline on Engine Performance and Fuel Emissions

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ABSTRACT

The depletion of crude oil reserves poses a significant challenge, as they are projected to remain resourceful only for the coming decade. This impending scarcity necessitates the urgent development and integration of alternative fuel sources to mitigate the growing demand and reliance on conventional petroleum-derived fuels. In this regard, the use of advanced fuel nano-additives has gained attention due to their potential to enhance combustion efficiency and reduce environmental emissions. This study explores the use of TiO_2 nanoparticles as an additive to an Ethanol-Gasoline blend. Fuel blends were prepared using varying TiO_2 nanoparticle concentrations of 30 and 40 ppm, combined with ethanol concentrations of E20 and E30 on a single-cylinder variable compression engine. The results revealed that ethanol blends (E20 and E30) show improved engine performance metrics at lower speeds and higher compression ratios. E30 consistently outperforms E20 in terms of torque, brake power, and brake thermal efficiency. Specifically, E30 achieves a maximum brake power of 4.5 kW at 1400 RPM and a compression ratio of 9, while E20 records 3.8 kW under similar conditions. Similarly, brake thermal efficiency reaches 24% for E30 and 21% for E20. However, E20 demonstrates slightly better volumetric efficiency, peaking at 73.5%, compared to 73% for E30. Specific fuel consumption decreased for E30 as compared to E20. On the other hand, when TiO_2 nanoparticles were added, HC, CO, CO_2, and NOx emissions decreased with high ethanol and TiO_2 concentrations. Mathematical models were also developed to understand the relation between these parameters and to evaluate their precision and errors.

Keywords: *Titanium dioxide nanoparticles, VCR engine performance, Engine emissions, Nano-fuel, efficiency parameters, Performance parameters*

TRACK M5 **PAPER ID 196**

Experimental Performance Evaluation of Fix Tilt and Single Axis Solar Tracking System

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ABSTRACT

The ever-rising demand of energy from every sector has degraded the environment. There are many ways to harness the solar energy. Use of Solar Photovoltaic and Solar thermal is adopted to harness the maximum of solar energy. Solar thermal system seems to be more complex than photovoltaic. To meet the increased energy demands and to simultaneously maintain environment quality is the thought of concern. This has strived researchers mind to shift towards renewable source of energy. As India being the tropical country enough amount of solar insolation which can be utilized for photovoltaic or thermal application is received. The solar constant is amount of solar insolation falling on per m² at the outer edge of earth atmosphere. It has an approximate value of 1367 watt/m². As India lies in northern hemisphere it is understood that all the PV installations have to be tilted in south direction. Single axis and fix tilt configurations were developed and tested for the performance evaluation. The power output from PV panel of fix tilt collector and single axis were measured and compared with literature for validation. Single axis tracking mechanism shows percentage rise in power output by 27.67% when compared with fix tilt. This study demonstrates how the type of tracker affects overall power generation and provides valuable insights for selecting the most appropriate tracking technology for diverse PV installations.

Keywords: *Single axis solar tracker, fix-tilt collector, solar insolation, performance output, Photovoltaic Panel (PV panel) , Incident rays*

TRACK M5 **PAPER ID 251**

Numerical Analysis of Thermal Saturation in Earth–Air Heat Exchangers under Continuous and Intermittent Operation

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ABSTRACT

In the current scenario, due to climate change and rapid infrastructure growth, maintaining comfortable conditions inside a building envelope is a challenge. Use of a conventional air conditioning system is not sufficient to solve the purpose because it depends on the depleting fossil fuels and is also accountable for global warming. The Earth Air Heat Exchanger (EAHE) can be used to solve this issue to maintain the temperature inside the building within a suitable range. However, continuous use diminishes its effectiveness due to thermal saturation. In the present research, a novel concept for measuring thermal saturation to identify the causes of performance deterioration is introduced. The thermal performance of EAHE in continuous and intermittent modes of operation has been analyzed numerically. In a parametric study, it has been found that changes in volume flow rate have little effect on EAHE's thermal performance when operating continuously in higher thermal conductivity soils, but it significantly reduces in low thermal conductivity soils. Use of high thermal conductivity soils can avoid early thermal saturation, but for low thermal conductivity soils, intermittent mode is the better option.

Keywords: *Thermal saturation, CFD, earth air heat exchanger, soil thermal conductivity, numerical investigation.*

TRACK M6 **PAPER ID 5**

A Novel Approach to Real-Time Tool Wear Monitoring Using Vibration Signal Processing in Single-Point Cutting Tool

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ABSTRACT

In the manufacturing industry, tool wear is a critical factor affecting the quality of machined parts and operational efficiency. This project presents a novel approach to real-time tool wear monitoring by employing advanced vibration signal processing techniques in single-point cutting tools. By analyzing the vibration signals generated during the machining process, the proposed method enables early detection and accurate assessment of tool wear. The approach utilizes sophisticated algorithms to filter and interpret complex vibration patterns, distinguishing between normal and worn tool conditions. Experimental results demonstrate the method's effectiveness under varying machining conditions, highlighting its ability to provide timely alerts for tool replacement. This innovation not only minimizes machine downtime but also enhances product quality by ensuring optimal tool performance. The integration of this system into existing manufacturing processes offers a significant advancement in automated tool condition monitoring, contributing to enhanced productivity and reduced operational costs.

Keywords: *single point cutting tool, vibrational analysis, machine learning, condition monitoring*

TRACK M6 **PAPER ID 16**

Manufacturing Execution Systems (MES): A Comprehensive Overview

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ABSTRACT

Manufacturing Execution System (MES) is essential for bridging the gap between shop floor operations and the enterprise planning level. With MES, manufacturers obtain visibility, control, and optimization of production processes and undertake efficient running operations and better productivity. MES is becoming the platform of the current manufacturing paradigm through the thrust generated by a hunger for higher efficiency, savings on costs, as well as fulfillment of high requirements of stringent quality and regulation measures. This paper presents a comprehensive overview of the definition, components, advantages, disadvantages, and review of MES implementation and its impact on productivity. The study also presents the challenges involved in implementing MES and outlines future trends that redefine its potential. The methodology selected for reviewing the implementation of MES is personal interactions with industry officials, dealing with MES implementation, and a case study approach. On interacting with industry experts, it has been observed that abundant data has been collected through MES, which helps in reducing the losses and improving overall operational efficiency.

Keywords: *MES, Operations, Industry, Losses*

TRACK M6 **PAPER ID 25**

Application of Artificial Intelligence and Machine Learning in Electric Discharge Machining Process: A Review

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ABSTRACT

Electric Discharge Machining (EDM) has been considered a significant nonconventional machining process for intricate and hard-to-machine materials for many years. Over the past few years, EDM has generated much interest in integrating Artificial Intelligence (AI) methods, as it reveals new prospects for process parameter optimization, surface improvement, and predictive accuracy enhancement. Artificial intelligence (AI) is increasingly utilized in electrical discharge machining (EDM) operations. It's intriguing to see that deep learning methods have achieved a notable 97.4% accuracy in predicting thickness variations during wire EDM. There are three main techniques for optimizing EDM parameters, which use swarm intelligence algorithms. A variation of EDM that uses alloy powders in the dielectric has shown improvements in surface roughness, called powder mixed EDM (PMEDM). For example, when machining SKD61 steel, adding tungsten carbide powder to the dielectric improved surface roughness up to 57.98% over standard EDM. These developments demonstrate how AI can improve EDM procedures and results. AI Advancements in EDM and PMEDM processes give the Transformative potential of a smart manufacturing system. Manufacturers employ machine learning (ML) and artificial intelligence (AI) models to achieve high predictive accuracy, enabling accurate control of machining parameters and enhancing efficiency and quality. The PMEDM, which introduces alloy powders like tungsten carbide into the dielectric medium and significantly improves outcomes like surface finish and achieves smoother surfaces. Together, these AI-integrated techniques promoted more efficient, accurate, and high-quality EDM and PMEDM processes.

Keywords: *Artificial Intelligence, Machine Learning, Deep Learning, Electrical Discharge Machining, Material Removal Rate, Surface Roughness*

TRACK M6 **PAPER ID 34**

Performance Evaluation of MoS_2 Enhanced Jatropha Oil as a Sustainable Cutting Fluid in CNC Turning Operations

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ABSTRACT

The research investigates the behaviour of MoS_2 reinforced Jatropha oil as an environmentally friendly cutting fluid in CNC turning machining. MoS_2 additives were added to Jatropha oil at different percentages of 0.5%, 1%, 1.5% for comparison of their influence on machining performance. Cutting tests were conducted on a CNC lathe machine with varying cutting speed (40, 80, and 120 m/min), feed rate (0.2, 0.4, and 0.6 mm/rev), and depth of cut (0.1, 0.3, and 0.5 mm). The Taguchi method was adopted for the experimentation design, and surface roughness (Rs) and tool wear (Tw) were considered as the primary machining responses. Signal-to-noise ratio and ANOVA analysis showed MoS_2 concentration and cutting speed to have appreciable effects on the responses with feed rate and depth of cut having smaller effect. 3D surface plots of Rs and Tw also indicated that the most optimal combination of reducing machining responses was at elevated MoS_2 concentration and cutting speed and minimal feed rate and depth of cut. Additionally, lubricated and dry thermal analysis established that MoS_2-refined Jatropha oil considerably reduced heat formation, resulting in greater tool longevity and surface integrity. With MoS_2 lubrication, tool workpiece interface temperature was dropped to 190°C, the temperature of chip to 250°C, and the work surface to 160°C. This decrease is due to the solid lubricant property of MoS_2, which creates a thin protective coating, minimizing direct tool-workpiece contact and friction. Moreover, increased heat evacuation by chips avoids thermal softening of the tool, maintaining dimensional accuracy and increasing tool life. These results illustrate the promise of biodegradable lubrication in metal cutting as an environmentally benign substitute for traditional cutting fluids and improved machining efficiency.

Keywords: *MoS_2 additive, Jatropha oil, CNC turning, sustainable lubrication, tool wear reduction*

TRACK M6 **PAPER ID 109**

Development of Adaptive Robotic Gripper with underactuated mechanism and force feedback for enhanced object manipulation in smart manufacturing

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ABSTRACT

The need for interacting robotic systems capable of effectively understanding their environment has grown significantly in recent years. As human dependencies on sophisticated robotic systems are increasing across medical, industrial, defence as well as home applications. Robotic hands, in particular, play a crucial role in manipulation tasks that involve picking, holding, analyzing, and manipulating objects in smart manufacturing industries. This paper presents the development of an adaptive, underactuated robotic gripper using 3D printing technology, that is designed for efficient and controlled grasping. A four-bar linkage underactuated mechanism provides compliant two-phalanx finger design. It is integrated with passive force-sensitive resistor (FSR) sensors for feedback. The characterization of the FSR sensors enables precise force control, allowing the gripper to handle objects with varying weights in a closed-loop system. Results from empirical testing demonstrate the gripper's potential for secure and adaptable object manipulation, opening avenues for its application in dynamic and unpredictable environments.

Keywords: *Adaptive Robotic Gripper, Underactuated Mechanism, Force sensor feedback, Object manipulation, 3D printing*

TRACK M6 **PAPER ID 163**

Modern Approaches to Fruit Ripeness Classification: A Survey of Vision-Based and Machine Learning Techniques

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ABSTRACT

Fruit ripeness is a crucial factor determining the quality, marketability, and ultimately the economic value of fruit crops. Traditionally, ripeness assessment has relied heavily on manual inspection by skilled personnel. This approach, while widely practiced, suffers from inherent subjectivity, inconsistencies, and is labor-intensive, posing significant challenges, especially for large-scale operations. The increasing demand for efficient and objective methods has spurred extensive research in automating fruit ripeness classification. This research paper presents a comprehensive overview of the evolution of fruit ripeness classification, tracing its trajectory from manual grading to the advent of sophisticated computer vision and machine learning techniques.

Keywords: *Fruit ripeness, fruit crops, fruit ripeness classification, ripeness stages, relationships between image features and ripeness stages, improvement in accuracy and robustness of ripening methods*

TRACK M6 **PAPER ID 199**

Digital Twin Technology: A Comprehensive Review of Its Transformative Impact with Emphasis on Industrial Heat Exchangers

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ABSTRACT

Digital Twin (DT) technology is revolutionizing engineering by creating real-time virtual replicas of physical systems, effectively bridging the gap between the physical and digital worlds. This transformative innovation is reshaping conventional engineering practices across multiple domains, including mechanical, civil, electrical, automotive, biomedical, and energy sectors. By continuously integrating sensor data, historical records, and live operational inputs, DTs enable enhanced simulation, monitoring, and optimization of system performance. Various researchers have proposed definitions and conceptual frameworks for DTs, underscoring their evolving significance in modern engineering. A major focus of this review is the application of DT technology in industrial heat exchangers as it is a crucial component in thermal management systems used in power plants, chemical processing, and HVAC operations. These systems often suffer from fouling, corrosion, and mechanical degradation, leading to reduced efficiency and increased maintenance costs. DTs offer a proactive solution through real-time diagnostics, performance prediction, and optimized cleaning strategies. When integrated with artificial intelligence and machine learning, DTs further enhance forecasting, decision-making, and adaptive control capabilities. This paper presents a comprehensive analysis of DT technology from various perspectives, including definitions, classifications, core features, and enabling technologies. It also explores current challenges and outlines future directions for DT applications, particularly in the energy sector.

Keywords: *DT, Fouling, Fault Detection System, Recurrent Neural Networks, Output Evaluation Process, Principal Component Analysis, Reinforcement learning (RL)*

TRACK M7 **PAPER ID 39**

A Process-Oriented Approach to Reducing Noise in Hypoid Differential Gears: Addressing the Migration Phenomenon

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ABSTRACT

Hypoid gears play a crucial role in automotive differentials, helping transfer torque smoothly between angled shafts. Their performance relies heavily on precise geometry, which can change during heat treatment. This study looks into differential gears to understand how gear distortion happens during heat treatment in Universal Batch Quench (UBQ) and Continuous Gas Carburizing (CGC) furnaces. Ten gear sets were inspected using the Gleason P26 system. It was found that gears placed near the corners of the furnace were more distorted, affecting their tooth profiles and contact patterns. ANSYS-based simulations supported these findings. A structured inspection method is recommended to reduce errors and improve gear quality and noise, vibration and harness (NVH).

Keywords: *Hypoid gears, Continuous Gas Carburizing, Universal Batch Quench, NVH*

TRACK M7 **PAPER ID 82**

Investigating Bumper Beam Materials and Geometries for Crash Performance in Passenger Vehicles

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ABSTRACT

Increasing vehicle count on the road, in addition to poor lane management and concentration issues during parking, has resulted in an increased number of collisions. Although most collisions can be prevented, there is the rare case where the collision is unavoidable, and most of the impact is borne by the bumpers of the vehicle. These are placed on the front and rear end of the vehicle. They are also critical in preventing damage to the most expensive parts, such as the engine, radiator, cooling system, and headlights. Its bumper beam, for example, is a required crash safety component designed to absorb impact energy in the event of a crash. Such driving postures are indispensable to vehicle safety as improving the design of bumper beams. This paper studies the best bumper beam cross section and material. In low to moderate-speed collisions, the vehicle's kinetic energy is absorbed by the plastic deformation of the bumper beam. Material selection was done using a data sheet based on research papers identifying the best material for certain operating conditions. A Three-point bending test was conducted using LS-DYNA software to investigate the energy absorption capabilities of four different cross-sectional designs that are presently used in current vehicles. The parameters for consideration in the study were energy absorption and Specific Energy Absorption (SEA), where the most effective design has been evaluated. It was revealed that the cross-sectional geometry has a great impact on the crashworthiness of bumper beam.

Keywords: *Specific Energy Absorption (SEA), Bumper Beam, Hyper-Mesh, LS DYNA, Cross sections*

TRACK M7 **PAPER ID 105**

Bicycle Car for Urban Delivery Services

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ABSTRACT

This paper explores the design and development of a Bicycle Car tailored for urban delivery services, addressing challenges like environmental impact, operational costs, and delivery personnel safety. The test model integrates a lightweight chassis, ergonomic features, and an electrical assist system, aiming to provide a sustainable, cost-effective alternative to traditional motorized vehicles for last-mile delivery. The development process encompasses an extensive literature review, design, prototyping, and testing, focusing on structural stability, balance, motor performance, and load capacity. Practical tests showcase its adaptability to urban logistics, emphasizing the vehicle's maneuverability, safety, and efficiency. The study concludes that the Bicycle Car offers a viable solution for last-mile delivery while contributing to greener cities. This is aligned with the 11th goal of the Sustainability Goals adopted by the United Nations, that is, to make cities and human settlements inclusive, safe, resilient and sustainable. This paper also discusses the future enhancements, like features and technological integrations, recommended to elevate the functionality and user experience. This initiative underscores the potential of innovative transportation solutions in addressing urban delivery challenges sustainably.

Keywords: *Bicycle Car, Transportation, Urban, Delivery*

TRACK M7 **PAPER ID 229**

Design and Development of A Sustainable Automatic Writing Machine for The People with Physical Disabilities

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ABSTRACT

An Automatic Writing Machine (AWM) facilitates writing and drawing on paper without using human hands, making it especially valuable for people with physical disabilities, automation enthusiasts, or professionals who need to complete repetitive writing or drawing tasks with consistency and speed. It operates using motors, sensors, and a computer or microcontroller to move a pen across the page, following a set of instructions and responding to commands, pre-programmed text, or handwriting patterns. The AWM integrates mechanical parts such as arms and sliders with software that determines what to write, interpreting digital instructions to achieve precise pen movement. Components including motors, belts, pulleys, and frames are carefully selected to ensure smooth motion along the X and Y axes, typically driven by stepper motors controlled through drivers and powered by an Arduino microcontroller. The pen-holding mechanism is designed to lift and lower the pen along the Z axis to form the desired letters or drawings. This work demonstrates how simple mechanical systems combined with basic programming can create an effective tool for automatic writing, highlighting the synergy between hardware design and coding to solve real-world problems. By integrating basic electronics with control algorithms, the AWM emerges as a cost-effective and educational device suitable for students and makers.

Keywords: *AWM, Micro-controller, Stepper motor, G-code*

TRACK M7 **PAPER ID 240**

Dimensional Design of Sliding Block Type Self Centering Vise Clamp

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ABSTRACT

In mass and batch production, robust and precise clamping mechanisms are essential for maintaining workpiece stability, machining accuracy, and repeatability. Conventional screw-based clamps often present limitations such as lengthy setup times, non-uniform force distribution, and misalignment issues—particularly in flexible manufacturing systems (FMS). To overcome these challenges, this study presents the dimensional design and development of a sliding block type self-centering vise clamp, developed in collaboration with Supra Technologies, Rajkot, for industrial applications. The proposed clamp eliminates screw-based components by employing a wedge-actuated sliding block mechanism, enabling automatic centering, uniform clamping force, and compatibility with varied workpiece geometries. Wedge theory was applied to analytically estimate clamping forces based on hydraulic input pressure. The design was developed using Autodesk Inventor for Computer-Aided Fixture Design (CAFD), allowing precise 3D modeling and simulation of component interactions. The clamp was fabricated using CNC-machined, case-hardened alloy steel to ensure strength and wear resistance. Its compact structure reduces the fixture footprint, making it suitable for highvolume production environments. The final design offers a screw-free, low-maintenance, and deformation-resistant clamping solution for modern machining applications.

Keywords: *Fixture Design, Hydraulic Fixture, Screw-free Clamping, Clamping Force*

TRACK M7 **PAPER ID 247**

Effect of Cutting Parameters on Surface Roughness, Chip Morphology and Tool Wear in Machining Additively Manufactured vs Conventional IN718 alloy

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ABSTRACT

This study investigates the milling performance of additively manufactured (AM) Inconel 718 (IN718) and conventional alloy by analyzing the tool wear and surface roughness at various machining conditions. Experiments were conducted at cutting speeds (80-100-120 m/min), depths of cut (0.2-0.4-0.6 mm), and feed rates (0.08-0.1-0.12 mm/rev) all at three levels respectively. The work aims to establish the parametric role while machining both the alloys to identify the optimal process parameters. The machined surface roughness (Ra) values reveal significant differences in machinability, showing the lowest Ra of 0.389 µm in machining AM IN718, while the highest was 1.001 µm. However, in case of pure IN718, the lowest Ra is 0.533 µm and highest is 0.996 µm. The results suggest that AM IN718 tends to produce better finish under similar conditions, indicating variation in the material characteristics. Tool wear was evaluated in terms of flank wear (Vb) and insert degradation, which is highest in AM IN718 with a measured value of 0.886 mm. In contrast, the highest wear for pure IN718 was 0.2874 mm. Such tool wear trends show that increase in cutting speed and depth of cut generates high tool wear. Hence, this study provides a first-hand insight into the milling behaviour of IN718 in both forms, which aid in optimizing milling parameters.

Keywords: *Additively Manufactured (AM), Inconel 718 (IN718), Flank wear (Vb), Surface roughness (Ra), cutting speed (CS), Depth of cut (DOC), Feed rate (FR)*

TRACK M8 **PAPER ID 68**

Assessment of Critical Success Factors for Building A Sustainable EV Manufacturing Ecosystem Using Industry 4.0 Framework- An Integrated ISM-Fuzzy MICMAC Approach

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ABSTRACT

Industry 4.0 is perceived as the go-to solution for achieving improvements in the 3Ps – Productivity, Profitability, and Performance of businesses. Digitalization, Internet of Things (IoT), big data, and cybersecurity are its core components and have been reshaping the future of automotive manufacturing globally. The advent of 5G networks is driving their uptake at the shop floor and across the automotive supply chain. This technology-driven framework brings momentum to the sector as it enables informed decision-making and real-time data analysis, thereby improving the important KPI – productivity. As the world progresses towards cleaner emission objectives, the electrification of the transportation sector is inevitable. Electric Vehicles (EVs), being sophisticated machines with over 70% software content, require precise manufacturing processes. The EV powertrain includes complex components such as batteries made up of numerous compactly packed cells, Motors needing special expertise, integrated power electronics, efficient battery management systems, and DC-DC converters with high-frequency switching. Understanding the concept and operation of Industry 4.0 in EV production is necessary for achieving high-quality output and operational efficiency across the value chain. The research paper explains the critical success factors (CSFs) contributing to a sustainable EV manufacturing ecosystem through Industry 4.0 adoption, using an Interpretive Structural Model (ISM) – Fuzzy MICMAC approach. As per the analysis, success factors such as technology readiness, top management's support, government policy, and strong data governance are critical for building a sustainable EV manufacturing ecosystem in India. Findings will support EV stakeholders and academicians in understanding CSFs enabling Industry 4.0 implementation in India's EV ecosystem.

Keywords: *Industry 4.0, EV Manufacturing, Sustainable manufacturing, ISM, Fuzzy MICMAC*

TRACK M8 **PAPER ID 115**

Machine Learning-Based Object Recognition Using Sensory Glove for Smart Manufacturing in Industry 4.0

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ABSTRACT

For applications in industry 4.0, the development of soft sensors with high sensitivity and quick response times is particularly useful. The goal of this work is to compare various machine learning techniques for object recognition, concentrating on the Cuboid, Sphere, Cylinder, and No Object classes for three-dimensional object recognition. A dataset of output voltages with different hyperparameters is used to assess the effectiveness of various models, including Support Vector Machines (SVM), K-Nearest Neighbors (KNN), Random Forest, Decision Tree, and Logistic Regression. SVM and KNN models demonstrate the best accuracy scores around the 99% in our findings. We also show how better model performance can be achieved by adjusting hyperparameters and removing outliers. The results of this study show how machine learning techniques used to recognize objects and offer guidance on choosing the best models and hyperparameters for related applications. With the wearable glove, robotic systems, healthcare, manufacturing, and logistics can all benefit from a potentially affordable solution that allows robots to recognize and manage objects with exceptional flexibility and accuracy.

Keywords: *Supervised machine learning, Support Vector Machines (SVM), K-Nearest Neighbors (KNN), Random Forest, Decision Tree, and Logistic Regression, Flex sensor*

TRACK C1 **PAPER ID 73**

A Comprehensive Overview on Microfiber Contamination: Unravelling the Environmental and Health Impact of Synthetic Fabrics

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ABSTRACT

A serious environmental issue brought on by the extensive usage of synthetic textiles in apparel is microfiber pollution. These textiles emit microscopic plastic fibers, or microfibers, when they are washed. These fibers frequently make their way past wastewater treatment facilities and into aquatic environments, endangering both human health and marine life. The focus of this study is on the negative consequences of microfiber pollution, including air quality deterioration, water and energy usage, and chemical pollution from detergents. Additionally, eating or breathing in microfibers poses serious health hazards. Practical steps can be taken to reduce this pollution, including selecting sustainable textiles, modifying washing procedures, and utilizing microfiber-catching equipment. Furthermore, to promote significant development, structural adjustments, including public awareness campaigns and policy campaigns, are necessary. To combat microfiber pollution and safeguard the environment and public health, this study highlights the pressing need for practical solutions.

Keywords: *Microfibers, Microfiber pollution, Health hazard, Microfiber-catching equipment.*

TRACK C1 **PAPER ID 74**

Performance Evaluation of Recycled Steel, Plastic Waste, and Natural Fibers on the Rheological and Mechanical Behavior of Sustainable Fiber-Reinforced Concrete

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ABSTRACT

Fiber concrete research and development has significantly increased in response to environmental issues such as global warming. Interest is piqued and their eventual usage in a range of applications is encouraged by the clear advantages these materials have over others, such as their low cost and minimal environmental impact. This study assesses the strength properties of mix M25 grade concrete when recycled steel waste fiber, plastic waste fiber, and natural fiber are present. The experiment involved adding 0.5%, 1%, 1.5%, 2%, 2.5%, and up to 4% by weight of natural fiber, plastic waste fiber, and recycled steel fibers to concrete. Steel waste fiber, plastic waste fiber, and natural waste are used in different amounts. The cube examples of concrete were hardened and their strength was determined; similarly, the cylindrical and beam specimens were cast and put through testing using a universal testing machine (UTM). In order to investigate the rheological properties of concrete, such as its uniaxial compressive strength, splitting tensile strength, and flexural strength, concrete mix compounds were developed. According to the findings, concrete's mechanical properties are improved by the addition of steel waste fiber and natural fiber when compared to the control mix. The mechanical performance was improved after 28 days of curing by combining 1.5% natural fiber, 3.5% steel fiber, and 2.5% plastic waste fiber in comparison to the norm. The results of this study show that concrete's compressive strength may be greatly increased by adding steel and natural fibers to make it stronger than regular concrete. This makes concrete a more durable and economical building material.

Keywords: *Fiber Reinforced Concrete (FRC), Plastic Waste Fiber (PWF), Natural Waste Fiber (NWF), Recycled Steel Waste Fiber (SWF), Rheological properties*

TRACK C1 **PAPER ID 145**

Selection of Bacteria in Microbially Induced Calcite Precipitation (MICP) Process for Various Soil Particle Size: Review

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ABSTRACT

There are several techniques used to enhance the characteristics of soil but most of the soil improvement techniques consume significant amount of mechanical energy in producing material and on-site operation which are not environmentally beneficial. MICP based on urea hydrolysis has attracted widespread attention due to its usefulness and the best mineralization efficiency. Calcite precipitation in soil considerably increases the soil properties such as shear strength, density, unconfined compressive strength, etc. Use of bacteria in soil improvement remarkably reduces the carbon footprint compared to other traditional methods. In this study, the various particle size of soil and the effectiveness of the bacteria is reviewed. This study will help the selection of the bacterium for MICP with respect to the particle size and its percentage present in the soil sample. MICP is more dependent on urea hydrolysis and the strength of soil depends on the bonding between the soil particles due to calcite precipitation. Urea hydrolysis is dependent on the bacterium used in soil and the nutrient provided to the bacterium.

Keywords: *Soil Improvement, Bacteria, Micp, Calcite Precipitation*

TRACK C1 **PAPER ID 149**

Uncovering Patterns and Anomalies in Urban Sewage Data Using Exploratory Data Analysis

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ABSTRACT

The effectiveness and robustness of sewage treatment plants (STPs) are gaining meaningful importance to the lives of urban centers and the environment, in reference to how fast the urbanization process is shaping up in India. The problem with seasonal changes, changing hydraulic loads, and intrusions of storm water create an issue in ensuring consistent influent quality and stability of the process. The paper provides a case study using Exploratory Data Analysis (EDA) on a two-year data set (2022-2023) of Naidu Hospital STP in Pune, Maharashtra to analyze trends and anomalies in the critical parameters of the Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) with respective rainfall data in the same period of time. EDA methods such as time-series visualization, pattern identification and value cluster were used to draw knowledge without using predictive or black-box models. Findings indicated high seasonal effects in the BOD having definite peak during monsoon months, whereas COD became progressively stable with time. The paper emphasizes the usefulness of EDA as a small and dynamically useful performance diagnosis and anomaly detection to update the system when operating resource-limited STP. The method can not only improve the transparency of operations, but facilitate data-oriented environmental governance within an emerging urban environment.

Keywords: *Exploratory Data Analysis, Sewage Treatment Plant, BOD, Rainfall Impact, Urban Wastewater Analytics*

TRACK C1 **PAPER ID 170**

Optimization of Soil Layer Configuration in Multi Soil Layering Systems for Domestic Wastewater Treatment

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ABSTRACT

In earlier times, soil was commonly used as a natural filter to treat wastewater. Today, the treatment and safe disposal of domestic wastewater has become one of the major challenges facing our country. When left untreated, this wastewater gradually pollutes rivers and other water bodies, leading to serious environmental consequences. In rural and village areas, where homes are located away from each other and centralized treatment facilities are often not feasible, decentralized wastewater treatment solutions are essential. One such effective and affordable approach is the Multi Soil Layering (MSL) system—a natural, low-cost method for treating domestic wastewater at the local level.. This study's primary aim is to demonstrate the Multi Soil Layering System experimental setup for treating domestic wastewater and optimize the number of layers for most effective treatment . For the experimental investigation, two lab scale models with dimensions of 50cm(L), 20cm(W), 50cm(H) were pre fabricated by acrylic sheets and Soil Mixture Blocks (SMB) with dimensions of 12cm(L), 20cm (W), 5cm (H) comprised of Soil, Sawdust, Iron scrap and Charcoal in the ratio 70:10:10:10, Permeable Layers (PL) comprised of Gravels of diameter 1-3 cm.

Keywords: *Domestic wastewater, Decentrailized Treatment, Multi Soil Layering (MSL), Soil Mixture Block (SMB), Permeable Layer (PL), Hydraulic Loading Rate (HLR)*

TRACK C1 **PAPER ID 179**

Prediction of Sea Floor Profile in Approach Channel

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ABSTRACT

Morphological variations in approach channels are complex in nature as they are affected by bed currents, tides, sea creatures' movement, turbulence created by ships, movement of sediment caused by approach channel banks, salinity of sea water, formation of saline wedge by intermixing of river water and dredging. The dredging in approach channels is essential to accommodate larger vessels, greater transit speed and better maneuverability. There is a nonlinear relationship between the increase in cross section areas brought about by changes in channel depths and the shoaling rate. This makes precise estimation of dredging volume challenging. The previous works have used basic numerical integration methods for volume prediction. However, the prediction accuracy when compared to actual sea bed profile is poor. This study attempts to develop method for improving precision in dredging volume estimation. Dredging volume is determined by applying Lagrange interpolation method. The available bathymetry data is utilized to develop a non-linear relationship between observed channel depths and dredging volume. The equations are further applied to channel geometry data (depth, base width and side slope) and sea bed profile is predicted. This method provides a fairly good prediction accuracy when validated using the actual sea bed profile. To estimate the overall cost of the dredging effort, a precise volume measurement is required. The present methods are unable to provide the required precision and hence cannot be used for determining dredging costs. Since dredging is a very expensive activity, accurate cost estimates can be obtained with improved volume prediction. Furthermore, a detailed understanding of the sea profile will make navigating the dredging operation easier

Keywords: *Linear interpolation, Lagrange interpolation, dredging volume, bathymetry, capital dredging, maintenance dredging, morphology*

TRACK C1 **PAPER ID 187**

Effective Removal of Turbidity Using Moringa Oleifera Seeds Powder

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ABSTRACT

Water is used for many purposes by human being but the purity of water must be up to the desired limit and fit for drinking. This research focusing on solution of common problem of turbid water resulting water pollution and access the safe drinking water by developing simple, effective, low cost and user-friendly technique. Coagulation represents removal of turbidity by addition of some coagulants which has chemical substances such as aluminum sulphate, calcium hypochloride etc. These chemical coagulants are effective and well recognized, application is disadvantageous due to high cost and production of large sludge volume, adverse effect on human health and environmental issues. This research encountered the suitability of powder from moringa oleifera seeds as an environment friendly natural bio coagulant for clarification for turbid water. Tests were carried to decide optimal dose of moringa oleifera powder for specific ranges of turbidity. According to the results, it has higher efficiency of turbidity removal than all other chemical coagulant. This study recommends to use morninga oleifera seeds powder for removal of turbidity without affecting other parameters.

Keywords: *Purity of water, Turbidity, Chemical Coagulants, Moringa Oleifera, Optimal dose.*

TRACK C1 **PAPER ID 222**

Upcycling Polymer Fraction from End-of-Life Solar Panels as a Sand Alternative in Paver Block Production

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ABSTRACT

The increasing volume of end-of-life (EoL) solar panel waste presents significant environmental challenges, necessitating sustainable recycling solutions. This study explores the utilization of polymeric fractions derived from crushed solar panels as a replacement for fine aggregates in concrete paver blocks. Paver blocks were produced with varying polymeric fraction replacements 0%, 15%, 30%, and 45% and evaluated for compressive strength, flexural strength, tensile splitting strength, and water absorption as per IS:15658 (2021) standards. The results indicated that compressive strength remained within acceptable limits across all replacement levels, while flexural strength showed improvement, particularly at 45%, suggesting enhanced bending resistance. Tensile splitting strength exhibited minimal variation, ensuring that crack resistance was maintained, while water absorption increased slightly but stabilized beyond 30%, preserving controlled permeability and durability. Furthermore, the Synthetic Precipitation Leaching Procedure (SPLP) test was conducted to assess the leaching potential of hazardous substances from the polymeric fraction under simulated acid rain conditions. The findings confirmed that the material did not release harmful contaminants, reinforcing its suitability as an eco-friendly construction material. This study highlights the potential of polymeric fraction in sustainable paver block production, reducing reliance on artificial sand and promoting circular economy principles..

Keywords: *End-of-Life (EoL) solar panels, Polymeric fraction, Sustainable construction materials*

TRACK C1 **PAPER ID 226**

Removal of Turbidity by Use of Moringa Oleifera Seeds Powder Tablets

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ABSTRACT

Human beings are totally dependent on pure water for consumption and other daily uses. The water plant-based materials are one the best method to treat raw turbid water to its desired limit. In this paper, the properties of Moringa Oleifera seeds are examined and very much suitable for coagulation and flocculation, hence to remove turbidity at desired level. The application of this easily available, naturally occurring, cheap and eco friendly Moringa Oleifera seeds powder for removal of turbidity is efficient. It is also important to aware rural regions peoples about consumption of pure water. The cheap and easily available tablets from Moringa Oleifera seeds powder can be invented for use to remove turbidity. Approximately 1gm weigh tablets can prepare for easy use. The number of tables required for removal of turbidity is calculated according to initial turbidity level and optimal dose.

Keywords: *Turbidity, Moringa Oleifera, Optimal dose, Tablets, Rural regions.*

TRACK C4 **PAPER ID 231**

Selection of Method for Separating Polymer and Glass From End of Life Solar Panel Waste

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ABSTRACT

The rapid growth of solar power as a clean and efficient energy source has led to an increase in solar waste. Typical solar panel waste consists largely of glass (>70 %) and the rest is metals (Si, Cu, Ag) and polymers (EVA, PVDF, PET). The process of recycling solar panels, which involves separating each layer, is complicated, highly energy-consuming, and costly. Most of the solar panel waste thus ends up in landfill. Our Team has developed a novel recycling technique, where EOL solar panel waste, in which the crushed laminates, obtained after separating aluminum frame and junction box from EOL solar panels, is segregated in 3 size fractions. The largest size fraction (>4.75mm) called polymer rich fraction primarily consists of polymers (EVA, PVDF, PET) with embedded glass particles. The present work aims at identifying the most efficient method for separating glass particles and polymers, so that each component can be recycled in various construction applications. For this, four primary approaches were explored: mechanical, thermal, density separation and chemical processes. The mechanical process involves, post shredding of polymer rich fraction to <2mm size with a customised shredder. While the density separation method involved separating the polymer from the glass using water, the chemical method utilized three solvents—toluene, cyclohexane, and o-dichlorobenzene at room temperature and at temperatures between 50°C and 80°C, for separating the glass particles from the polymers. The results indicated that Density separation using water achieved over 85% glass recovery and 90% polymer floatation in an eco-friendly and low-cost manner. Among the tested solvents, toluene demonstrated the highest polymer separation efficiency at all temperatures, making it ideal for recovering newer encapsulants like POE and EPE..

Keywords: *End-of-life solar panels; Solar panel recycling; Glass-polymer separation; Photovoltaic waste management; Sustainable recycling methods; Polymer recovery.*

TRACK C1 **PAPER ID 238**

Impact of Water Quality of Mula - Muth River in Pune: Input from Citizen

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ABSTRACT

Mula-Mutha River in Pune is one of the most vulnerable water bodies to pollution because of urbanization, industrial effluent, and untreated sewage. This research assesses the water quality of the river in terms of scientific analysis identifying major pollutants like heavy metals, biochemical oxygen demand (BOD), chemical oxygen demand (COD), and microbial pollution. The inputs were also obtained from the community by distributing the questionnaires and asking them to provide water samples, direct observation, and immediate data on the pollution effects on the findings concerning major polluted areas with eco-friendly restoration plans for the river, stressing the need for community participation in environmental protection. The relevance of community involvement, in terms of environmental monitoring and scheme making for the restoration of the Mula-Mutha River ecosystem, has thereby been illustrated through this investigation.

Keywords: *Water Quality, Mula-Mutha River, Pollution, Citizen Science, Urbanization, Environmental Monitoring*

TRACK C1 **PAPER ID 239**

Integrating GIS and Probabilistic Models for Flood Risk Mapping

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ABSTRACT

Floods are the most frequent type of natural calamity. Floods are part natural and part man-made fault because of excessive unplanned urbanization many urban areas get flooded. Majorly flood causes damage to human life and public infrastructure. Floods are more common along the coast. Floods have recently become one of Maharashtra's Ratnagiri district's greatest common and devastating natural disasters. The goal of this study is to create a flood susceptibility map of the Ratnagiri district using geographic information system (GIS) software. A flood susceptibility map is created using the frequency ratio model and ten different flood influencing factors, including elevation, slope, rainfall intensity, soil drainage, landform, and distance from the river. Additional factors considered include lithology, soil type, and land use land cover. The frequency ratio model employs bivariate statistical analysis to assess the relationship between flooding and each flood influencing factor. For this study 80 flood locations were taken, 70% of data i.e., 56 locations were used for the flood susceptibility model, and 24 locations were used for validation. The generated map was reclassified into 5 classes i.e., very low (0.83-3), low (3-4.6), moderate (4.6-6.2), high (6.2-7.8), and very high (7.8-9.1). Flood susceptibility analysis indicates that 13.55%, 26.86%,27.48%, 20.61% & 11.51% areas are very low, low, moderate, high, and very high vulnerable class, respective. In order to validate the study AUC value was determined. The validation results revealed a greater AUC value of 0.93 i.e. 90.3%. This map will assist the district administration in developing a flood mitigation plan as well as reducing damage caused by future flooding.

Keywords: *Flood susceptibility map, FR model, Ratnagiri district, GIS, AUC.*

TRACK C1 **PAPER ID 86**

Optimization of Pellet Composition for Green Energy Generation

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ABSTRACT

India generates around 62 million tons of municipal solid waste (MSW) annually, of which 12–15% is garden waste. This organic fraction is often mismanaged through open-dumping or burning, contributing to methane emissions, air pollution, and biomass loss. Existing MSW-derived pellets often contain synthetic materials, limiting their environmental sustainability. This project aimed to develop fully organic biomass pellets using biodegradable, locally available materials, with garden waste as the primary feedstock. Additives coconut husk, cow dung, sawdust, and molasses were chosen based on availability, economic viability, and sustainability. Physico-chemical and thermal properties were evaluated using standardized methods: oven drying for moisture content, muffle furnace for ash and total volatile solids (TVS), and bomb calorimetry for calorific value. Eight blends were formulated and tested theoretically and experimentally, with the optimal composition determined as 60% garden waste, 20% coconut husk, 5% cow dung, 10% sawdust, and 5% molasses. Produced pellets from optimized composition achieved a calorific value of 3807.98 kcal/kg, moisture content of 10.46%, ash content of 8.33%, and bulk density of 0.73 g/cm³, aligning with ISO/ENplus standards. CHNS analysis showed carbon at 43.38%, hydrogen at 6.423%, nitrogen at 0.890%, and sulfur at 0.251%. While carbon was slightly below and sulfur slightly above the ideal, all values were within acceptable ranges for non-woody biomass. This paper demonstrates the potential for clean biofuel production from garden waste, aligning with SDGs 7 (Affordable and Clean Energy), 12 (Responsible Consumption and Production), and 13 (Climate Action).

Keywords: *Waste-to-Energy; Biomass Pellets; Garden Waste; Biofuel; Green Energy; Calorific Value; Pelletization; Elemental Analysis.*

TRACK C2 **PAPER ID 121**

Comparative Analysis of Thermal Profiles in Rural and Urban Areas Using UAV Thermal Mapping a Case Study of Bhadkambe and Mira Bhayandar

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ABSTRACT

Urbanization and industrial expansion have significantly altered local microclimates, intensifying surface temperatures and air pollution. This study investigates spatial temperature distribution in two contrasting regions Mira Bhayandar (urban) and Bhadkambe (rural) using UAV-based thermal mapping. A DJI M3T drone captured high-resolution thermal imagery, processed with Pix4D to derive Land Surface Temperature (LST) maps. Results indicate significantly higher surface temperatures in Mira Bhayandar due to high building density, impervious surfaces, and sparse vegetation, exacerbating the Urban Heat Island (UHI) effect. Conversely, Bhadkambe's greenery and low population density contribute to milder thermal variation. A correlation between elevated temperatures and increased pollutant concentrations was observed, highlighting urban heating's role in deteriorating air quality and respiratory health. GIS-based analysis reinforces the importance of climate-resilient planning and promotes green infrastructure, urban forestry, and reflective surface materials to mitigate thermal stress. This study supports sustainable urban development through integration of drone-based remote sensing in environmental monitoring and policy-making.

Keywords: *Urban Heat Island, UAV Thermal Mapping, Land Surface Temperature, Mira Bhayandar, Bhadkambe, Air Pollution, GIS, Climate Resilience*

TRACK C2 **PAPER ID 131**

A Comparative Study of Conventional and Alu-Form (Mivan) Formwork in High Rise Buildings

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ABSTRACT

Time is of the essence in any construction project, particularly in high-rise buildings where repetitive tasks are executed in sequence. This study presents a comparative analysis of conventional formwork and Aluform (Mivan) formwork systems in high-rise construction, focusing on efficiency, cost-effectiveness, time management, and construction quality. Data was collected from a sixty-storey residential project, analyzing construction speed, material wastage, labor requirements, and structural quality using quantitative techniques. A mixed-method approach was employed, involving site observations, interviews with construction professionals, and detailed time-cost analysis for both formwork systems. The results indicate that Aluform (Mivan) formwork significantly enhances productivity by reducing construction time and labor dependency. In contrast, while conventional formwork may be more suitable for small-scale or budget-sensitive projects, it demonstrates lower efficiency in high-rise applications due to increased labor needs and longer slab cycles. Although the initial investment for Aluform is higher, the long-term advantages such as formwork reusability, enhanced speed, and superior finish justify its use in large-scale developments. The findings aim to guide decision-makers in selecting the appropriate formwork system based on project scale, cost considerations, and desired construction outcomes.

Keywords: *Aluform formwork; Mivan technology; Conventional formwork; High-rise buildings; Construction efficiency; Labor productivity; Formwork systems; Cost analysis.*

TRACK C2 **PAPER ID 136**

Corelative Study of Electric Resistivity and Rapid Chloride Penetration Test in Cement Concrete - A Review

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ABSTRACT

In civil engineering, the longevity of concrete structures is crucial, especially in settings where chloride intrusion can cause structural degradation and reinforcement corrosion. To provide long-term performance and service life, the resistance of concrete against chloride penetration must be evaluated. The Rapid Chloride Penetration Test (RCPT) and the Electrical Resistivity Test (ERT) are two commonly used methods that have drawn a lot of attention because of how well they assess the permeability and durability of concrete. Concrete's permeability and durability, especially its resistance to chloride ion penetration, are commonly assessed using the ERT and the RCPT. In order to create a trustworthy relationship between these two methods for evaluating durability, this study examines the relationship between RCPT and electric resistivity measurements. The findings demonstrate the usefulness of resistivity measurements as a non-destructive substitute for chloride permeability (RCPT) by showing an inverse relationship between the two parameters, with higher resistivity corresponding to lesser chloride penetration.

Keywords: *RCPT, Electric resistivity, concrete, surface resistivity, durability*

TRACK C2 **PAPER ID 137**

Electric Resistivity for Non-Destructive Testing: A Review with Conductive Model

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ABSTRACT

Concrete electrical resistivity has been performed as a durability parameter because this is a nondestructive, simple, fast, and reliable technique for evaluation of reinforced concrete field structures. Objective of this paper is to review existing research on electric resistivity as nondestructive testing used in construction field. Mainly two methods are considered for electric resistivity measurement that is surface resistivity (SR) and bulk resistivity (BR). The factor influencing during the testing are mainly considered for review. Furthermore, multi-phase conductive models are carefully analyzed to understand the evolution of concrete resistivity. However, values vary in the connections reported by various researchers in the literature. The discrepancies are often attributed to the fact that ER values are influenced by numerous material and environmental conditions.

Keywords: *Electrical Resistivity, Non-Destructive Testing, Surface Resistivity, Bulk Resistivity, Concrete*

TRACK C2 **PAPER ID 143**

Climate-Specific Natural Illumination (Daylight Illuminance) Assessment and Statistical Regression Analysis

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ABSTRACT

Daylight illuminance is considered the prime component for designing energy-efficient buildings. Adequate daylight levels inside the building space increase productivity and the health of occupants. In many cities of India, daylight illuminance data is not available. In this work, an attempt has been made to generate the annual data of daylight illuminance levels. This paper discusses the daylight illuminance measurement and its assessment for the moderate climate zone of India; it presents the case study of Pune city. The work further discusses the development of multivariable regression models to estimate daylight illuminance intensities. The models are based on measured daylight illuminance intensities at specific intervals from February 2023 to January 2024. The study finds a better association (0.769, 0.862, and 0.747) between daylight illuminance and specific climate variables during cloudy days (July) compared to other climatic seasons. The average percentage errors of the regression models vary from 3.65% to 11.94 %, indicating better accuracy.

Keywords: *Daylight illuminance, analysis, multivariable correlation coefficients, multivariable regression.*

TRACK C2 **PAPER ID 156**

Impact of Infrastructure Development on Real Estate Property

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ABSTRACT

The infrastructure development all over the world and in India is rapidly accelerated in those days. This infrastructure development has direct positive effect on real estate valuation.The infrastructure and real estate are directly proportional for effective economic growth, the investment in the infrastructure such as transport links through highway constructions , through new railway lines, new Airways effects on real estate subsequently. Energy network and urban development can greatly increase the property values in the affected areas. In this paper, we are going to analyse how various aspects like increased accessibility, transit oriented development, economic growth and urbanisation enhanced quality of life. Investor confidence affect real estate market. In this paper, few example as case studies are discussed in relation to infrastructure and real estate.

Keywords: *Infrastructure, Valuation, Energy, Transit, Urbanization, property values*

TRACK C2 **PAPER ID 158**

Valuation of Real Estate for Capital Gain Tax

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ABSTRACT

The valuation of real estate plays a crucial role in the accurate computation of Capital Gains Tax (CGT), particularly in a rapidly evolving property market. This study aims to analyze the methodologies used in the valuation of real estate for CGT purposes, with a focus on aligning technical valuation practices with prevailing tax regulations. The project investigates different valuation approaches—including market value, cost approach, and income approach—and evaluates their applicability under the Income Tax Act. Case studies involving residential, commercial, and mixed-use properties are used to illustrate real-life valuation scenarios. Emphasis is placed on factors such as location, property condition, date of acquisition, and inflation indexing, which significantly influence the determination of fair market value (FMV) and cost of acquisition.

The study also explores the role of registered valuers and the guidelines provided by the Central Board of Direct Taxes (CBDT) in valuation processes. The findings highlight discrepancies and challenges in standardizing valuation practices and propose a framework for enhancing accuracy and transparency in CGT calculations. This research contributes to both academic and professional domains by providing insights into bridging engineering valuation methods with statutory tax requirements.

Keywords: *Infrastructure, Valuation, Energy, Transit, Urbanization, Capital Gains Tax, real estate, approaches, residential, commercial.*

TRACK C2 **PAPER ID 182**

The Flood Guard Bridge

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ABSTRACT

This paper presents an overview of the historical development and significance of bridges as a vital component of a nation's transportation infrastructure. Bridges facilitate economic growth by enabling efficient movement of goods and people. However, due to constant exposure to environmental conditions, heavy traffic loads, aging materials, and natural disasters such as earthquakes or floods, bridges are prone to deterioration over time. The high cost of construction and maintenance makes it imperative to adopt effective and economical maintenance strategies. To ensure structural safety and operational reliability, modern bridge management systems are increasingly incorporating real-time structural health monitoring (SHM) solutions. This project aims to design and implement an automated bridge health monitoring system using advanced sensor technologies. Various types of sensors—including strain gauges, accelerometers, displacement sensors, temperature sensors, and vibration sensors—are employed to measure and monitor key structural parameters. The collected data is processed and analyzed to detect anomalies, assess the bridge's current condition, and predict future performance or potential failures

Keywords: *Flood-resistant infrastructure, Smart bridges, Adaptive bridge design, Bridge elevation systems, Sensor based monitoring, Hydraulic bridge mechanisms*

TRACK C2 **PAPER ID 194**

Transforming India's Real Estate Sector: A Comprehensive Review of The Real Estate (Regulation and Development) Act, 2016 (RERA)

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ABSTRACT

In order to regulate and transform India's real estate industry, the Real Estate (Regulation and Development) Act, 2016 (RERA) serves as a significant legislative framework. This review paper provides an in-depth look at RERA, including how it was implemented and how much it has affected the industry. The paper consolidates knowledge about RERA, evaluates its effectiveness in achieving its objectives, identifies areas for improvement, and provides unique insights by critically examining existing literature, research studies, and scholarly articles. The paper begins by emphasizing the urgent requirement for RERA, which addresses long-standing issues such as malpractice, lack of transparency, and the requirement for consumer protection in the real estate industry. It examines the legislation's transformative nature, which aims to protect the interests of homebuyers while simultaneously promoting real estate investment. The paper examines RERA's impact on the real estate landscape, its disruption of market dynamics, and the need for industry participants to adapt to new regulations and procedures in light of the extensive changes it has brought about. Following is a comprehensive examination of how RERA has affected various aspects of the real estate industry, such as the registration of projects and real estate agents, pricing transparency, timely project delivery, and construction quality. The paper examines the difficulties encountered during RERA's implementation, such as delays and enforcement gaps, and emphasizes the need for ongoing improvements to guarantee its effectiveness. This in-depth review's primary objective is to provide distinct insights and perspectives for real estate sector stakeholders, researchers, policymakers, and practitioners. The paper fosters a profound comprehension of the extensive repercussions that RERA has for the Indian real estate industry and proposes objectives for further research to enhance its efficacy by highlighting specific RERA areas that require improvement.

Keywords: *Real estate; Real Estate Act; RERA; Consumer Protection; Project Transparency*

TRACK C2 **PAPER ID 220**

Predicting Delays in Concrete Pumping Operations in Construction Projects - A Comprehensive Review

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ABSTRACT

Concrete pumping is a critical activity in modern construction, enabling fast and efficient placement of concrete in complex and hard-to-reach areas. Pumping operations delays, however, can have an enormous effect on the overall performance of the project, resulting in time overruns, more costs, lower quality, and lost productivity. This review looks at the typical reasons why concrete pumping delays occur, such as technical malfunctions, mix design problems, human error, environmental factors, and insufficient site coordination. With an emphasis on the integration of machine learning models and Internet of Things (IoT)-based real-time monitoring systems, it gazes at the both conventional techniques and the latest innovations used to anticipate and reduce such delays. In addition to demonstrating research gaps, especially in the context of developing nations, the paper identifies key performance indicators for pumping efficiency. This review attempts to give a thorough grasp of how smart technologies and proactive planning can improve the reliability and efficacy of concrete pumping operations in construction projects through the integration of findings from business practices and literature

Keywords: *Concrete Pumping, Delay Analysis, Risk Mitigation, Real-Time Monitoring, Delay Mitigation*

TRACK C2 **PAPER ID 233**

Experimental Investigations on Factors Affecting Initial Curing and Develop Correlations for Their Impact on the Properties of Hardened Concrete

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ABSTRACT

Early curing is an essential stage in cement hardening process since it is at this period that the water reacts with cement particles forming a network of interlocked particles that give concrete its strength and durability. Poor early curing may trigger degradation, as it is manifested by the reduced compressive strength, increased cracking, and elevated permeability, as well as reduced durability of the concrete structure. This paper discusses the unique impact of curing technique on initial curing performance. Eighteen sets of concrete mixes were prepared (two grades (M30 and M40) and three cement types (OPC, PPC, PSC)) were prepared. The experiment evaluates mechanical characteristics, such as compressive strength, split tensile strength, and flexural strength of the hardened concrete samples. The highest measured value of M30 concrete with PSC (29.65 MPa) was observed at 28 days, which was higher than PPC (28.3 MPa) and OPC (27.4 MPa). Statistical tests are used to determine the relationship between factors under investigation and properties of hardened concrete, and they show that there are substantial effects on early curing and later mechanical performance. At 28 days, split tensile strength was measured on 150 mm x 300 mm cylinders and PSC-based M40 concrete showed a significant rise, about 6-10 % compared to OPC. The results help improve the quality and durability of concrete and improve knowledge of the curing process.

Keywords: *Initial curing, compressive strength, flexural strength, split tensile, hardened concrete.*

TRACK C2 **PAPER ID 183**

Review of Use of Crush Sand Fine Dust in Concrete with Partial Replacement of Cement

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ABSTRACT

Crush sand fine dust is the term generally applied to crushed aggregates passing through 4.75mm IS sieve. Since last almost a decade, the Crush sand fine dust is being widely used as a sand or fine aggregate and replaces river sand in the construction industry. We call it manufactured sand or crushed sand. Fine aggregate contributes to approximately 50% of the volume of concrete. It may vary +/- 10% of the total mass of the concrete depending on mix proportion. It is therefore very obvious that, the quality of sand greatly influence the strength of the concrete. The important test to understand the quality of crushed sand is to evaluate the percentage of material finer than 75 micrometres. Higher the percentage of the finer material more it creates bad impact on water demand, shrinkage, workability, strength and durability of the concrete. The fine powder which is having particle size less than 75 micrometres contributes to about 10 to 30% of the crush sand (100 to 300kg per m3 of concrete). This highly affects the quality of concrete in regards to strength, water demand, shrinkage, durability etc. Finer particles affect in two ways first is; it absorbs more water from plastic mix, resulting lesser water for hydration process. Secondly, it also creates the fine coating around the aggregate which weakens the bond between the aggregate and cement paste. It is therefore advisable to control the finer particles in the sand. Though the fine Crush sand fine dust powder is affecting the quality of concrete, if used in proportion may prove to be a good supplementary cementitious material. Many researches are going on to study the effect of Crush sand fine dust in concrete, but most of them are related replacing it with fine natural sand, very few researches are being carried in the recent parts to study the effect of this fine powder when we use it as supplementary cementitious material. Earlier study have shown that there is a possibility that the fine powder of Crush sand fine dust can serve the purpose of a good supplementary cementitious material. Presently many supplementary materials used for replacement of cement are mostly pozzolonic The crush sand dust is non pozzolonic, hence its reactivity with cement may have different reactions, also chemical composition of Crush sand fine dust may vary largely with place to place. But the problem of abandon quantity of this fine material is largely observed and hence it is responsible for many respiratory deceases. In this study author tries to study the present literatures and tries to take out comprehensive literature review related to this material. So that researchers can get idea about the present work going on worldwide as well as future scope in this research area.

Keywords: *Crush sand fine dust, Supplementary cementitious material, concrete*

TRACK C2 **PAPER ID 189**

Comparative Analysis of Infrastructure and Environmental Impacts on Real Estate Valuation in Smart Cities

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ABSTRACT

Currently in India, the real estate industry is experiencing significant growth, with even the smallest areas undergoing development. This development is a result of a combination of infrastructure and real estate across the country. The focus of this research paper is on the major development and financial impacts that affect the real estate industry, including socio-economic factors and the inverse effect of development on the market value of properties. The data collected prom practical cases which have been executed for Valuation. This ultimate purpose of this research is to develop a technique that can assist in finding answers to policies that inflate real estate values artificially for personal gain, a financial impact on the nation's economy. Additionally, this research paper aims to find solutions and create awareness to minimize fraudulent practices and the negative impact of various factors that devalue real estate in the future

Keywords: *Real estate, Infrastructure, economy, valuation.*

TRACK C2 **PAPER ID 190**

Utilization of Agricultural and Industrial Waste in Concrete: A Review of Eggshell Powder and Ceramic Waste

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ABSTRACT

The construction industry is under increasing pressure to adopt sustainable practices, with the cement sector contributing nearly 8% of global CO_2 emissions. This review explores the potential of two promising waste materials—eggshell powder (ESP) and ceramic waste—as eco-friendly alternatives to cement and aggregates in concrete production.

Eggshell powder, composed primarily of calcium carbonate, shows optimal performance when used as a partial cement replacement (5–15%), enhancing compressive and flexural strength, workability, and durability due to its micro-filler effect. As a fine aggregate replacement (up to 20%), ESP improves workability and reduces concrete weight, though strength may decrease at higher dosages due to poor bonding characteristics.

Ceramic waste demonstrates versatility as a cement substitute (up to 30%), fine aggregate (30–50%), and coarse aggregate (5–30%). Its pozzolanic activity and angular shape contribute to improved strength, durability, and resistance to abrasion, chloride ingress, and freeze–thaw cycles. Floor tile waste outperforms wall tile waste due to its lower porosity and higher strength.

Among all uses, ceramic waste as fine aggregate proves the most effective, offering an ideal balance of performance, cost efficiency, and scalability. This review supports the integration of ESP and ceramic waste in sustainable concrete, promoting circular economy practices and reducing the environmental burden of construction.

Keywords: *Eggshell Powder (ESP), Ceramic Waste, Industrial Symbiosis, Life Cycle Assessment(LCA).*

TRACK C2 **PAPER ID 165**

Sun Track Block: Solar Smart Cement with Air Monitoring

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ABSTRACT

This research introduces a smart cement block system designed to enhance urban infrastructure through real-time environmental interaction. The block detects air pollution using an MQ-135 gas sensor and visually communicates air quality levels through embedded RGB LEDs and fibre optic cables, glowing green, yellow, or red based on pollution intensity. Powered entirely by solar energy, the system includes a dual-axis sun tracker using LDR sensors and servo motors to maximize energy efficiency. Designed for smart city applications, this self-sustaining unit offers a low-maintenance, cost-effective solution for raising public awareness about air quality. The prototype has been developed, tested, and evaluated under real conditions, demonstrating its potential for large-scale integration in sustainable urban environments.

Keywords: *Fibre optics, cement block, LED, MQ-135, LDR, servo motor, solar tracker, pollution detection*

TRACK C2 **PAPER ID 172**

Challenges and Mitigation Measures in Implementing the RERA Act on Real Estate Projects in India

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ABSTRACT

The Indian real estate sector, a key pillar of the national economy, has historically grappled with regulatory loopholes, lack of transparency, and widespread delays, often leaving homebuyers vulnerable. To address these concerns, the Real Estate (Regulation and Development) Act, 2016 (RERA) was enacted, aiming to foster greater accountability and reform. Despite its potential, the implementation of RERA faces significant roadblocks, including inconsistent enforcement across states, procedural delays in project approvals, stringent financial regulations affecting developers, low stakeholder awareness, and inefficient grievance redressal systems. This study seeks to identify and analyze these implementation challenges while offering viable solutions. It adopts a comprehensive approach through an in-depth literature review and real-time case studies, culminating in the development of a detailed questionnaire. Data is gathered via interviews and surveys with key stakeholders, including developers, legal professionals, and regulatory officials. The study's insights reveal the core obstacles and recommend actionable measures such as simplifying approval processes, improving financial strategies, launching robust consumer education initiatives, standardizing implementation across regions, and refining dispute resolution mechanisms. By adopting these strategies, RERA's intended reforms can be more effectively realized, paving the way for a transparent, reliable, and investor-friendly real estate environment that supports long-term economic sustainability, and thus achieve objectives of smart cities.

Keywords: *RERA Act, Regulatory Compliance, Real Estate Sector, Sustainable Growth, Legal Framework.*

TRACK C2 **PAPER ID 174**

Development of Comprehensive Framework Enhancing Safety Using Activity Based Safety Risk Assessment and Performance Index in Tunnel Project

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ABSTRACT

Being most complex infrastructure, tunnel projects often endure safety concerns. To mitigate this advanced construction framework is essential. This study aims to develop a framework for an activity-wise safety risk mitigation matrix for tunnel projects, with a focus on improving occupational safety in Indian tunnel construction. The rapid expansion of the tunnel industry, coupled with the increasing complexity of modern projects, highlights the need to prioritize human safety. This research is organized into four phases. The first phase involves compiling safety risk factors through expert inputs and an extensive literature review. In the second phase, the Analytical Hierarchy Process (AHP) is utilized to identify critical safety risk factors (CSRF) based on responses from tunnel experts. Phase three applies a Multi-Criteria Decision-Making (MCDM) approach using the Fuzzy TOPSIS method, incorporating inputs from tunnel experts to identify the most significant safety risk factors related to probability, frequency, and severity. These factors are subsequently mapped to Tunnel Boring Machine (TBM)-based activities to calculate a comprehensive activity wise safety index. Finally, in the fourth phase, a three-dimensional safety risk matrix is developed, integrating likelihood, exposure, and severity with the assistance of 14 tunnel expert inputs, and provides targeted mitigation measures for each activity. The research results in a structured safety risk mitigation framework specifically tailored to TBM-based activities in tunnel construction, enhancing the identification and management of occupational risks and fostering safer practices in the rapidly evolving Indian tunnelling industry

Keywords: *AHP; Fuzzy TOPSIS; TBM; Framework; Safety Risk Assessment*

TRACK C2 **PAPER ID 124**

Influence of Fine Silt Particles in Sand on the Mechanical Properties of Concrete-Review

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ABSTRACT

The rapid expansion of the construction industry and the depletion of high-quality natural sand have necessitated the use of locally available sand, often containing significant amounts of silt. Silt, comprising fine particles smaller than 75 microns, is naturally present in riverbeds and sand deposits. Although standards like IS 383:2016 recommend that the silt content in sand used for concrete should not exceed 8%, in many practical situations—particularly in rural and semi-urban construction—this limit is surpassed due to limited resources and inadequate screening. This review paper presents an in-depth analysis of previous experimental research on the impact of silt content in fine aggregates on concrete performance. It compiles results from various studies examining concrete mixes with silt content ranging from 0% to 15%. The paper explores how varying levels of silt influence both the fresh and hardened properties of concrete—including workability, consistency, compressive strength, flexural strength, permeability, shrinkage, and overall durability. The findings suggest that up to 5%–6% silt content may slightly improve concrete's workability and act as a micro-filler without significantly affecting strength. However, silt levels beyond this threshold tend to reduce compressive strength and durability by weakening the bond between cement paste and aggregates and increasing porosity and water demand. This review also highlights methods to mitigate the adverse impacts of high silt content, including washing of sand, the use of supplementary cementitious materials (SCMs), chemical admixtures, and optimized mix designs. By critically analysing these studies, the paper offers practical recommendations and identifies areas needing further research, such as the long-term effects of silt on structural durability, field-scale application challenges, and the development of guidelines tailored for local materials. The insights derived from this review support the sustainable use of marginal sand resources while maintaining the performance standards required for structural concrete.

Keywords: *Silt content, fine aggregate, concrete performance, compressive strength, workability, durability, IS 383:2016, sustainable construction*

TRACK C3 **PAPER ID 42**

Repair Methods of Rigid Pavement - A Review Paper

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ABSTRACT

This paper provides an extensive analysis of the failure mechanisms in rigid pavements, focusing on the impact of mechanical loads, environmental influences, and deficiencies in material quality or construction practices. It examines prevalent pavement issues such as flexural, transverse, longitudinal, and shrinkage cracks, as well as joint degradation, erosion, and subgrade instability. The paper discusses advanced repair strategies, including partial depth and full-depth repairs, crack sealing, dowel bar retrofitting, and slab stabilization. Furthermore, it explores innovative repair techniques like cross-stitching, slot stitching, and steel reinforcement to mitigate pavement distress and enhance structural integrity. The study also integrates finite element modelling (FEM) to evaluate the efficiency of repair methods under different loading conditions. The objective of this research is to provide a comprehensive review of modern repair approaches, contributing to prolonged pavement lifespan and improved structural performance.

Keywords: *Rigid Pavement, Pavement Failures, Pavement Repair Methods.*

TRACK C3 **PAPER ID 142**

An Experimental Study on Strength Characteristics of Geopolymer Concrete by Different Molarities and Alkali Binder Ratio

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ABSTRACT

Geopolymer concrete (GPC) is a new green replacement to traditional Portland cement concrete that provides lower carbon footprints and improved mechanical properties. This study analyses the strength properties of GPC at different grades by altering the molarity of the NaOH solution and the alkali binder ratio. The principal binder was fly ash, which was activated by a mixture of sodium hydroxide (NaOH) with different molarities. In the present study, the compressive strength and workability of GPC cured at room temperature were also investigated. It was found that there was an increase in compressive strength from 7 to 28 days, ranging from 24 to 40 MPa. NaOH molarities ranging from 8M to 16M and alkali binder ratios of 0.3, 0.35, 0.4, 0.45, and 0.5 for different mix were investigated and research finding shows that with increasing NaOH molarity there were increasing compressive strength up to an ideal limit, after which it declines. In addition, the alkali binder ratio has a substantial impact on the mechanical performance of GPC. The results of this study provide insights into optimizing the mix design for maximum strength.

Keywords – *Geopolymer concrete, molarities, alkali binder ratio, compressive strength, workability.*

TRACK C3 **PAPER ID 178**

Green Concrete from Crushed PV Panels: Durability Perspective of Solar Waste Sand Replacement

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ABSTRACT

The rising volume of End-of-Life (EoL) photovoltaic (PV) panels presents a growing environmental challenge. This study explores the potential of using crushed PV glass, termed Solar Waste Sand (SWS), as a sustainable replacement for manufactured sand (M-sand) in structural concrete. Four concrete mixes - S0, S25, S50, and S75—were prepared by replacing M-sand with SWS at 0%, 25%, 50%, and 75% by weight, respectively. Durability performance was evaluated through water absorption, sorptivity (ISAT), rapid chloride permeability (RCPT), non-steady-state chloride migration, and water permeability tests.

The results revealed that up to 50% replacement with SWS significantly improved durability characteristics. The S50 mix exhibited the lowest water absorption (1.53%), chloride permeability (1830 C), and migration coefficient (9.56×10^{-12} m²/s), indicating enhanced resistance to moisture and ion ingress. These improvements are attributed to refined pore structure and improved particle packing achieved by the angular, dense nature of SWS. A slight performance decline at 75% replacement was observed due to the formation of weak interfacial transition zones.

The findings confirm that SWS can effectively enhance concrete durability up to an optimal replacement level, offering a viable pathway for recycling solar waste in structural applications.

Keywords: *Solar Waste Sand (SWS); Durability; Photovoltaic waste; Chloride resistance; Sustainable concrete*

TRACK C3 **PAPER ID 184**

Thermal Stresses in Concrete Structures: A Review of Effects on Bridges, Water Tanks, and Pavements

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ABSTRACT

Thermal stresses within concrete slab are a major factor influencing the performance, durability, and lifespan of concrete structures. The stresses occur as a result of temperature differences due to environmental factors such as solar radiation, ambient temperature variations, and changes in seasons. This review paper presents a thorough description of the mechanisms responsible for the development of thermal stresses in concrete slabs, such as differential expansion, restrained deformation, and boundary condition effects. The paper also discusses analytical, numerical, and experimental techniques employed to assess and predict the development of thermal stresses. Special emphasis is placed on considerations like slab geometry, material characteristics, curing practices, and joint details. The effects of thermal stresses on cracking, warping, and long-term behaviour are addressed, as well as mitigation strategies such as the implementation of supplementary cementitious materials, insulation measures, and design adjustments. By integrating existing research findings, this review identifies gaps in knowledge and proposes avenues for future research aimed at improving the thermal durability of concrete slabs exposed to different climatic conditions.

Keywords: *Concrete slab, thermal stresses, climatic condition, differential expansion*

TRACK C3 **PAPER ID 186**

Performance Evaluation of Curing Techniques Based on Compressive Strength and Durability Parameters of Concrete

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ABSTRACT

Curing is a fundamental process in concrete technology, which enables the hydration reaction of cement, necessary for attaining the desired mechanical strength and durability in concrete structures. Traditional water curing process is widely used in practice because of its effectiveness and ease; however, it requires significant amount of water resources, which creates a challenge in regions suffering with water scarcity. This study presents an experimental comparative study of three ways of curing viz. conventional water curing, membrane curing using chemical compounds in the liquid form as well as using plastic sheets. The objective is to evaluate their performance in terms of improvement in compressive strength and durability of concrete. Concrete cubes were prepared and subjected to each type of curing for the period of 7 and 28 days. The cubes were tested further to check the compressive strength and durability. Durability of concrete was assessed based on electrical resistivity measurements. The results indicated that water curing offers the highest compressive strength, while membrane curing using plastic sheet wrapping closely follow and provide substantial benefits in terms of water conservation as compared to the other method of application of chemical compound. The study also revealed that durability of concrete can be reasonably assessed based on concrete electrical resistivity measurements provided the concrete surface is free from coatings, whereas the electrical resistivity method is ineffective for concrete surface layered with curing compounds.

Keywords: *Concrete, Curing, Compressive Strength, Durability, Chemical Curing, Membrane Curing, Sustainable Construction*

TRACK C3 **PAPER ID 217**

Experimental Investigation on the Mechanical Response of Concrete Reinforced with Recron 3S Fiber

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ABSTRACT

This study presents an experimental investigation on the mechanical behavior of concrete reinforced with Recron 3S synthetic fiber, aiming to evaluate its effectiveness in enhancing strength, ductility, and crack resistance. Recron 3S, a polyester-based mono-filament fiber, is known for improving post-crack performance and durability in concrete. In this research, concrete mixes were prepared by incorporating varying percentages of Recron 3S fiber (0%, 0.25%, 0.5%, 0.75%, and 1% by weight of cement) while maintaining a constant water–cement ratio. Standard tests were conducted to evaluate compressive strength, split tensile strength, and flexural strength at 7 and 28 days of curing.

The results demonstrated a notable improvement in tensile and flexural strength with increasing fiber content, with optimum performance observed at 0.75% fiber dosage. The compressive strength also showed marginal improvement, indicating better internal bonding and resistance to crack propagation. The inclusion of fibers significantly improved crack bridging and delayed the formation of microcracks, leading to enhanced ductility and energy absorption. However, beyond the optimum fiber content, workability issues and fiber clumping slightly reduced the mechanical performance.

The study concludes that Recron 3S fiber can be effectively used to improve the mechanical response of concrete, particularly in applications requiring enhanced tensile strength and durability. These findings contribute to the growing body of knowledge supporting the use of synthetic fibers as a cost-effective and efficient reinforcement strategy in modern concrete technology.

Keywords: *Recron 3S Fiber; Fibre Reinforced Concrete; Mechanical Properties; Crack Resistance*

TRACK C3 **PAPER ID 225**

Mechanical Strength Evaluation of TMT Bars Affected by Pitting Corrosion in RC Structures

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ABSTRACT

TMT bars are commonly used in RC structures due to its improved mechanical performance as compared to other types of rebars. Tensile strength of rebar plays vital role in structural performance of RC flexural element. However, reduction in load carrying capacity, serviceability and durability of RC structures due to steel rebar corrosion is one of the major issues in construction industry. In this paper, effect of steel corrosion on mechanical strength of TMT rebars is experimentally investigated and presented. Accelerated corrosion in steel TMT bars embedded in concrete was induced using impressed current technique. Current was stopped when clear and distinct cracks observed on concrete surface. Type of corrosion was observed; rebars were tested for tensile strength and effect of corrosion on ultimate tensile strength was evaluated. From experimental results, it is observed that ultimate tensile strength reduced with the increasing corrosion levels. It is noticed that at higher corrosion levels the failure pattern was shifted from ductile to brittle mode. It is interestingly observed that under tension test all rebars failed at location of maximum pit depth. In 8mm and 12mm diameter bars, minimum 6.50% and 1.83%; and maximum 30.25% and 19% respectively reduction in bar diameter was found at major pit location. Ultimate tensile strength was significantly reduced with percentage reduction in the diameter of the rebars. Rebars diameter at deepest pit influences more on ultimate tensile strength than average reduced diameter of the corroded rebar.

Keywords: *Reinforced concrete; TMT bars; Pitting corrosion; Tensile strength*

TRACK C3 **PAPER ID 227**

Experimental Study on Bond Behavior of Bamboo Reinforced Concrete

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ABSTRACT

A Bamboo-reinforced concrete (BRC) is emerging as a promising alternative to traditional steel-reinforced concrete in construction. This study investigates the bond strength behavior of bamboo-reinforced concrete using two locally available bamboo species *Oxytenanthera stocksii* (Manga) and *Pseudoxytenanthera madhavii* (Messy) from the Western Ghats of Maharashtra. The research aims to evaluate the effectiveness of untreated and chemically treated bamboo as reinforcement in M20 grade concrete through standardized pull-out tests. A total of 12 specimens, including treated and untreated samples from both species, were tested for bond behavior using a universal testing machine in accordance with IS 2770 guidelines. The experimental results showed that surface-treated bamboo specimens exhibited significantly higher bond strength than untreated ones. The Manga bamboo samples displayed superior bond characteristics, with treated specimens achieving an overall bond strength of 0.322 MPa and a maximum pull-out load of 4.65 kN. Messy bamboo samples, while also improved by treatment, showed comparatively lower performance. Observations confirmed that chemical treatments enhance the adhesive and frictional interaction between bamboo and concrete, reducing slip and increasing ultimate bond stress. The findings support the potential of chemically treated bamboo serving as a sustainable reinforcement material in place of steel in reinforced concrete applications. This study lays a foundation for further research on durability, field performance, and standardization of bamboo as reinforcement in structural systems.

Keywords: *Bamboo reinforcement; Bond strength; Pull-out test*

TRACK C3 **PAPER ID 234**

Design of Experiment and Finite Element Evaluation of Stress Concentration in Stepped Flat Tension Bars with Shoulder Fillet

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ABSTRACT

Shouldered, stepped soundness tension bars are largely in fixed and machine structures, demands hasty geometric changes. These features have a positive implication of causing areas of stress concentration, which greatly affects the strength and fatigue behaviours of the component. The paper is a study establishing a methodical analysis of the stress concentration behavior of such geometries in a design of experiments (DOE method) effort and finite element simulation in ABA QUAS. Full factorial design was used to investigate the effect of four major parameters namely bar width, mesh element size, thickness, and Young modulus. The factor of stress concentration (SCF) was calculated that is associated with 16 combinations and the resulting trends were studied by the means of main effect plots and interaction diagrams that were produced in MATLAB. The results indicate that the most dominant factor that influences SCF is mesh size and bar width, whereby, with finer mesh so does the value of localized stress. The narrower the width the greater the value of localized stress. These trends were further confirmed with contours of the stress estimations with ABAQUS, which noted abrupt gradients near the fillet with high-SCF scenarios. The best and worst design configurations were found and this information can be used in the tuning of the design parameters to reduce SCF. Theoretical SCF references are also incorporated in the same study so as to benchmark simulation accuracy. The created MATLAB-ABAQUS workflow can be taken as a scalable approach to fast parametric stress analysis in complex geometries.

Keywords: *Stepped bar; Stress concentration factor (SCF); Shoulder fillet; Finite element analysis (FEA); Design of experiments (DOE); ABAQUS simulation*

TRACK C4 **PAPER ID 26**

Effect of Fly Ash as a Sustainable Modifier in Bituminous Pavement Mixtures

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ABSTRACT

The need for sustainable and economical materials for road construction has resulted in increased interest in using industrial byproducts. The aim of this research is to examine the use of a common industrial byproduct, fly ash, from the combustion of coal for energy as a value-added modifier for bituminous (asphalt) pavement mixtures. The overall goal is to assess fly ash's capacity to improve the performance and durability of flexible pavements by replacing asphalt content with 5%, 10%, 15% 20% fly ash. Laboratory experiments were conducted to modify bitumen with various amounts of fly ash, examining properties for Marshall stability. From the findings, it can be concluded that the fly ash significantly improved the stability and resistance to deformation, indicating that fly ash may be an environmentally and economically friendly alternative to both the current pavement fillers and asphalt mixes. This study finds that fly ash is a modern solution added to bitumen to enhance pavement performance, thus allowing for further sustainable practices in transportation engineering.

Keywords: *Sustainability, fly ash, bituminous mixtures, pavement performance, Marshall stability*

TRACK C4 **PAPER ID 30**

Innovative Integration of Digital Mapping and Geotechnical Analysis for Enhanced Soil Characterization

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ABSTRACT

This study introduces a novel framework that combines advanced digital mapping techniques with traditional geotechnical analysis to improve the characterization of soil behavior in heterogeneous landscapes. By integrating machine learning algorithms with high-resolution geospatial data, the approach refines the prediction of key soil parameters, including shear strength, compressibility, and hydraulic conductivity. The method not only delineates soil units with greater precision but also quantifies spatial variability and connectivity that are critical for reliable geotechnical assessments. Comparative case studies highlight the framework's ability to outperform conventional mapping methods, providing enhanced decision-making support for infrastructure design, environmental remediation, and land management. This integrated approach opens new avenues for future research, bridging the gap between digital soil science and practical geotechnical engineering applications.

Keywords: *digital mapping, machine learning, soil behavior, geotechnical analysis, spatial variability*

TRACK C4 **PAPER ID 59**

Feasibility Study of Crushed Waste Glass as a Sustainable Partial Replacement for Fine Aggregates in Hot Mix Asphalt

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ABSTRACT

The increasing generation of waste glass and the depletion of herbal mixture sources have created a urgent need for sustainable alternatives in the creation enterprise, particularly in avenue improvement. This looks at explores the feasibility of the usage of overwhelmed waste glass as a partial substitute for satisfactory aggregates in Hot Mix Asphalt (HMA). Crushed glass, attributable to its angular shape, hardness, and non-absorbent homes, offers capability blessings in bituminous combinations. However additionally increases concerns regarding adhesion, sturdiness, and long-time performance. In this experimental study, hot blend asphalt specimens have been organized through changing conventional high-quality aggregates with overwhelmed glass at various proportions, 0% (control blend), 25%, and 50% by weight. A series of laboratory exams had been carried out to evaluate the mechanical performance of the changed mixes. These exams covered the Marshall Stability and Flow Test, effects had been analyzed to evaluate the impact of overwhelmed glass on the and suitability of the mix for road production. Based on the check effects, conclusions have been drawn concerning the capacity advantages and barriers of incorporating overwhelmed glass in bituminous mixes. This observed contributes to sustainable production practices with the aid of imparting insights into the reuse of waste materials in avenue infrastructure without compromising performance requirements.

Keywords: *Waste glass, hot mix asphalt, sustainable construction, bituminous mixes, Marshall stability*

TRACK C4 **PAPER ID 181**

Assessment of Spot Speed Studies with Reference to Cost and Time

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ABSTRACT

Spot speed studies play a prominent role in measuring various factors used in the design of highways (roads). The measured speeds are used for geometric design, safety measures, speed trends, capacity analyses, and assessment. It is essential to analyze cost-effective methods where time is constant. This paper gives a brief description and rate analysis to determine spot speed. The paper covers rate analysis for four methods of spot speed determination, namely the stopwatch method, radar meter method, pneumatic road tube method, and time-lapse photography method. It also recommends the best method to be used for a particular type of road according to the precision required. The sequence of methods with respect to cost is "Time-lapse photography method > Radar meter method > Pneumatic Road tube method > Stopwatch method." The sequence of methods with respect to time is "Time-lapse photography method < Radar meter method < Pneumatic Road tube method < Stopwatch method.

Keywords: *Speed, Spot Speed, Rate Analysis, Stopwatch, Radar*

TRACK C5 **PAPER ID 9**

Applications of Digital Twin Technology in Water Infrastructure Systems

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ABSTRACT

The increasing complexities of water infrastructure management and mounting environmental and operational challenges necessitate transformative technological solutions. Digital Twin (DT) technology has emerged as a significant enabler for improving water infrastructure systems' operational efficiency, asset performance, and resilience. This paper presents a comprehensive review of the conceptual evolution of DT technology, its enabling technological foundations, key application domains within water systems, and the associated benefits and challenges of implementation. Emphasis is placed on real-world implementations within the Asia Pacific region, where utilities leverage DTs to overcome region-specific challenges such as water scarcity, climate change impacts, and aging infrastructure. Future research directions are proposed to support the advancement of DT maturity in water utilities globally

Keywords: *Digital Twins; Water Infrastructure Systems; Smart Water Management; Cyber-Physical Systems; Asset Management; Infrastructure Resilience*

TRACK C5 **PAPER ID 11**

Community-Centric Digital Twins for Equitable Water Infrastructure Governance in Low-Resource Settings

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ABSTRACT

Digital twin technology has gained traction as an innovative urban governance and water resource management approach, promising real-time monitoring, simulation, and data-driven decision-making across complex infrastructure systems. However, in low-resource settings, the deployment of digital twins for water infrastructure governance poses critical challenges: limited technical capacity, insufficient stakeholder inclusion, data governance concerns, and a pressing need to address inequities in water service provision. This paper presents a comprehensive overview of how community-centric digital twins can be leveraged to create more equitable water governance structures in low-resource environments. Our objectives are to (1) explore the literature on digital twins and stakeholder engagement in water management; (2) develop a conceptual framework for a community-centric, participatory digital twin that addresses the pressing social, institutional, and technological challenges in low-resource settings; (3) propose methodologies for ensuring robust stakeholder collaboration, transparent data governance, and capacity-building strategies; and (4) discuss evidence-based policies and practical lessons for ensuring equitable and resilient water infrastructure governance. Ultimately, by integrating community participation and social equity principles into advanced digital twin frameworks, water utilities and local authorities can improve resource allocation, enhance water service reliability, and bolster resilience against climate and public health disruptions, moving closer to sustainable and just water governance.

Keywords: *Digital twins; water infrastructure governance; community-centric approach; low-resource settings; participatory design; data governance; equitable water management; stakeholder engagement; resilience; smart city technology*

TRACK C5 **PAPER ID 75**

Analysis of Air Quality Index using Soft Computing Techniques, at Los Angeles and Bakersfield, Unites States of America

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ABSTRACT

Air Quality Index (AQI) is a measure of the quality of air in the atmosphere. Atmosphere consists of the various gases with its fixed concentration. Various air pollutants namely Gases and Particulate Matter (PM) are emitted into the atmosphere by various man-made and some of the natural activities. It is important to know the effect of these pollutants on the AQI. In the present study, an attempt is made to do the analysis of AQI at two stations namely Bakersfield and Los Angeles from United States of America (USA) by using Linear Regression (LR) and Support Vector Regression (SVR) from year 1999 to 2024. The input parameters used are PM2.5, PM10, OZONE, CO, NO2 and output is AQI. The correlation coefficient (r) for Bakersfield and Los Angeles using LR is obtained as 0.74 and 0.73 respectively, Root Mean Square Error (RMSE) as 30.22 and 27.69 respectively and Mean Absolute Error (MAE) as 21.80 and 20.53 respectively. Whereas correlation coefficient (r) for Bakersfield and Los Angeles using SVR is 0.94 and 0.93 respectively, RMSE is 14.9606 and 14.4443 respectively and Mean Absolute Error (MAE) as 9.24 and 10.11 respectively. From this it can be stated that, SVR is having the ability to accurately predict AQI trends, providing valuable insights into pollution levels and their changes over time. This research highlights the potential of these methods in environmental monitoring and decision making.

Keywords: *Air Quality Index (AQI), Linear Regression (LR), Support Vector Regression (SVR).*

TRACK C5 **PAPER ID 100**

Training and Development Needs for Supply Chain Professionals in the Construction Sector: A Systematic Review

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ABSTRACT

The construction industry is confronted with a growing complexity in the management of supply chains, which underscores the necessity of professionals who are well-trained and possess sector-specific skills. A systematic evaluation of the existing literature is conducted in order to determine the primary training and development requirements of supply chain professionals in the construction industry. The study combines results from peer-reviewed publications, industry reports, and real-world investigations that have been published in the last 20 years. Soft skills, digital competencies, deficits in technical knowledge, and project-based collaboration are among the most significant themes. The review also emphasizes the impact of global supply disruptions, sustainability objectives, and emergent technologies on the development of training priorities. The results show that there is an urgent need for integrated, ongoing professional development frameworks that are in line with industry trends and project needs. The purpose of this review is to enhance the academic discourse by providing strategic insights and delineating critical skill areas for educators, policymakers, and construction firms that are seeking to enhance supply chain capabilities.

Keywords: *Construction sector, training needs, industry trends, professional development, supply chain capabilities*

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AI-Driven Safety Solutions in Construction: A Comprehensive Review of Applications and Future Directions

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ABSTRACT

The construction industry is rapidly expanding, with projects becoming increasingly complex. As a result, the industry is undergoing a significant transformation, driven by automation technologies like Artificial Intelligence (AI), which offer innovative solutions to overcome the challenges of conventional construction management practices. AI applications include machine learning algorithms for predicting project outcomes, robotics for automating tasks on-site, and optimization tools for better resource management, among others. Despite these advancements, AI techniques have yet to be fully leveraged for improving site safety management. This study offers a comprehensive review of AI-driven construction safety practices and their potential to enhance safety outcomes. The literature selection follows a structured methodology, including bibliometric analysis and a thorough screening process to identify the most relevant studies on AI in safety. The review underscores AI's potential to significantly improve construction efficiency, safety, and sustainability, while also providing insights into key AI applications and a roadmap for realizing its safety benefits.

Keywords: *AI, Artificial intelligence, Construction, Safety*

TRACK C5 **PAPER ID 166**

Application of Artificial Intelligence to Predict Embodied Energy of Construction Materials

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ABSTRACT

Energy consumption in India is increasing due to rapid urbanization, expansion of infrastructure, development activities and other reasons. Recent construction trend is to construct energy efficient buildings hence evaluation of embodied energy consumption is one of the important tasks in the energy analysis process. The present work determines the embodied energy consumption of specific building construction materials such as cement, Fine aggregate, coarse aggregate, reinforcement and Autoclaved Aerated Concrete blocks). Further, in this work, an effort has been made to develop artificial intelligence (AI) models to predict the Embodied Energy of construction materials

Keywords: *Embodied Energy Consumption, Artificial Intelligent*

TRACK C5 **PAPER ID 219**

Application of Power BI for Controlling Cost and Duration in Real Estate Project - A Comprehensive Review

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ABSTRACT

Reducing Cost and managing time has always been a major challenge in real estate construction projects. Despite the increasing use of digital tools, many team still struggle with fragmented data and delayed reporting, which leads to budget overruns and missed deadlines. In recent years, Microsoft Power BI has emerged as promising Business Intelligence (BI) tools to bridge this gap by offering real time dashboards and interactive data visualization. The objective of this review paper is to explore the use of Power BI in the part of real estate project management, where project teams are finding that they can better monitor project cost and timelines. A systematic review of 16 reviewed journal and conference papers was carried out with the three focus areas: cost control, schedule tracking, and the use of business intelligence tools in the construction industry. This review has highlighted the evolving opportunities of Power BI in construction management, and indicated opportunities for additional examination, such as, practical applications, and long term evaluations of its efficiency in different segments of the real estate industry.

Keywords: *Power BI, Construction management. Business intelligence, cost control, project time tracking, real estate, schedule optimization, data visualization, BI tools adoption.*

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