

6th INTERNATIONAL CONFERENCE

on
**RECENT ADVANCES IN MECHANICAL
ENGINEERING AND NANOMATERIALS**

Organized By

**Department Of Mechanical Engineering
& Civil Engineering**

**St. John College of Engineering and Management,
(Palghar)**



Abstract Book

ICRAMEN 2026

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ICRAMEN 2026

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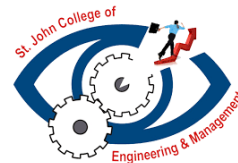
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Editors

Dr. Kishor Rambhad
Dr. Buddharatna Godbole
Mr. Kiran Beldar



Department of Mechanical Engineering

&

Department of Civil Engineering

**ST. JOHN COLLEGE OF ENGINEERING AND MANAGEMENT,
PALGHAR, INDIA**

In Association with



**RESEARCH ASSOCIATION OF MASTERS IN ENGINEERING,
INDIA**



St. John College of Engineering and Management (SJCEM)

Vevoor, Manor Road, Palghar (East), Maharashtra, India

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&
Department of Civil Engineering**

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PREFACE

ICRAMEN 2026 is committed to provide a peer reviewed platform to outstanding researchers to exhibit their findings for the furtherance of technology. We are devoted to continuous innovation to better support the wishes of our communities, making sure the integrity of the research we publish and championing the importance of open research.

ICRAMEN 2026: 6th International Conference on Recent Advances in Mechanical Engineering and Nanomaterials is focused on the development and integration of mechanical and nanomaterial technologies, inviting well-known experts and scholars at home and abroad, as well as scientific researchers and industry practitioners in the field of mechanical and material, to jointly discuss the cutting-edge technologies of mechanical and nanomaterial and their new applications in different industries and build a innovation ecosystem. ICRAMEN 2026 aimed to showcase state-of-the-art methodologies and technologies in Engineering and Technology. It focused on new ideas and paves the way to disseminate the latest innovations and practices. It facilitates opportunities to network, collaborates and exchange ideas with renowned leaders, scientists, and researchers in Mechanical Engineering and Nanomaterials. It acts as a crucial platform for industry and academia to foster innovative ideas, theories, frameworks and applications. ICRAMEN 2026 was encouraged recent and futuristic advancements, challenges, and new strategies in the frontiers of Mechanical Engineering and Nanomaterials.

About the Editor

Dr. Kishor Rambhad is a distinguished academician in the field of Mechanical Engineering, with a B.E. in Mechanical Engineering, M.Tech. in Heat Power Engineering from Visvesvaraya National Institute of Technology and a Ph.D. in Mechanical Engineering from Rashtrasant Tukadoji Maharaj Nagpur University. He currently holds the position of Associate Professor & HOD in the Mechanical Engineering Department at St. John College of Engineering and Management, Palghar, with an extensive academic career spanning over 19 years. He has made significant contributions to research and innovation, with over 47 research papers published in international journals and 21 research papers presented in conferences, 4 granted patents, and 2 copyrights to his credit. He has contributed as an author of book chapters published by international publishers. His expertise is sought after in editorial roles, having served as reviewer and editorial board member for reputed journals. Dr. Rambhad has successfully guided numerous undergraduate and postgraduate projects, and is recognized for his involvement in NBA and NAAC accreditation processes, curriculum development and academic leadership. His research interests include Desiccant Dehumidification, HVAC, Renewable Energy, heat transfer and computational fluid dynamics (CFD).

Dr. Buddharatna J. Godbole is an Associate Professor and Head of Civil Engineering at St. John College of Engineering and Management, Palghar, with over 15 years of experience in teaching, research, and academic leadership. He holds a Ph.D. in Environmental Engineering from Rashtrasant Tukadoji Maharaj Nagpur University and has made significant research contributions with 34 journal publications, 4 international book chapters, 2 granted patents, and 6 conference publications. His expertise includes environmental engineering, sustainable construction materials, and water and wastewater treatment. He has successfully led NBA accreditation and re-accreditation and established a Centre of Excellence in Sustainable Construction Materials. He actively contributes as a session chair, reviewer, and FDP coordinator under AICTE ATAL and NITTTR, and is engaged in consultancy services such as environmental audits and surveys. A lifetime member of IWWA and ACCE, he is dedicated to advancing sustainable engineering, resilient infrastructure, and innovation-driven research.

About St. John College of Engineering and Management

St. John College of Engineering and Management (SJCEM) is an Autonomous institute, established in the year 2008, is located in Palghar, Maharashtra. The college is part of the St. John Technical and Educational Campus and is affiliated to the University of Mumbai. SJCEM offers a range of undergraduate and postgraduate programs in engineering and management disciplines, including Artificial Intelligence and Machine Learning, Civil Engineering, Computer Engineering, Information Technology, Electronics and Computer Science, Mechanical Engineering, Computer Science and Engineering (Data Science), Bachelor of Business Administration, Master of Business Administration and Master of Computer Application.

The campus is situated in a serene environment in Vevoor, Palghar (East), providing a conducive atmosphere for learning and research. SJCEM has achieved significant milestones, becoming the youngest engineering college under the University of Mumbai to receive "Autonomous Status" from the UGC and the 1st engineering college in Palghar District to do so.

SJCEM is committed to imparting quality education and fostering holistic development, aiming to nurture socially responsible engineers, entrepreneurs, and leaders.

Vision and Mission of SJCEM

Vision

“Excellence in Engineering Education & Creating Next-Gen Leaders / Managers in the Service of Society”

Mission

- To impart quality engineering education for holistic development
- To provide conducive environment for joyful learning, innovation and research
- To promote innovative technology enabled teaching and learning process
- To nurture socially responsible engineers, entrepreneurs and leaders
- To enhance employability skills to meet the changing industrial trends

About Research Association of Masters in Engineering

Research Association of Masters in Engineering is committed to providing a peer reviewed platform to outstanding researchers to exhibit their findings for the furtherance of technology. They are devoted to continual innovation to better support the wishes of their communities, making sure the integrity of the research they publish and championing the importance of open research.

They invite young students, scientist, researchers and academicians to contribute their research and convert their research work in technical papers. The publication also helps in enhancing awareness about the need to become innovative and research minded. They provide a forum to publish complementary aspects in science and engineering using computational methods and experimental measurements, and to stress the importance of their harmonious development and integration. Their aim is to become an effective medium for inspiring the innovators and researchers to bring out their contributions in the form of research papers, articles, case studies, review articles and innovations in the fields of Engineering, Science and Technology.

About ICRAMEN 2026

ICRAMEN 2026 is a three-day international conference that aims to showcase state-of-the-art methodologies and technologies in Mechanical Engineering and Nanomaterials. It focuses on new ideas and paves the way to disseminate the latest innovations and practices. It facilitates opportunities to connect collaborates, and exchange ideas with renowned leaders, scientists, and researchers in Mechanical Engineering and Nanomaterials. It acts as a crucial platform for industry and academia to foster innovative ideas, theories, frameworks and applications. ICRAMEN 2026 will encourage recent and futuristic advancements, challenges and new strategies in the frontiers of Mechanical Engineering and Nanomaterials.

Conference website: icramen.rame.org.in/sjcem2026/

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Message from the Chairman



Research, innovation and invention play a pivotal role in gaining a competitive edge for learners in this era of rapid technological and scientific advancement.

St. John College of Engineering and Management (SJCEM) is a premier autonomous technical institute committed to delivering quality education in all major disciplines of Engineering and Management. With strong associations with national organizations and the integration of the National Education Policy (NEP) into its curriculum, the institute provides a holistic and multidisciplinary learning experience. SJCEM places significant emphasis on extracurricular activities to foster the all-round development of its students.

Our world-class infrastructure, state-of-the-art equipment and a team of competent, talented, and dedicated faculty members contribute to an impactful learning environment that meets global standards. The institute is dedicated to nurturing a culture where new ideas, research, and scholarship thrive paving the way for the emergence of creators, innovators, leaders, and entrepreneurs.

SJCEM has a long-standing tradition of organizing seminars, conferences, workshops, and symposiums that stimulate intellectual growth. One such flagship event is ICRAMEN 2026, an International Conference that serves as a distinguished platform to deliberate on the latest trends in science and technology, analyze challenges and explore innovative solutions. It facilitates the exchange of ideas, cutting-edge research and fosters collaboration among academicians, researchers and industry professionals.

With the conferment of autonomous status from the Academic Year 2024–25, SJCEM is better poised to design and deliver an enriched academic ecosystem tailored to evolving global standards.

I believe that young researchers deserve such opportunities to excel in their respective domains. I wish all participants a successful, safe and enriching experience at ICRAMEN 2026.

Mr. Albert W. D'Souza

Chairman - Aldel Education Trust

Message from the Principal



At the outset, I extend my heartfelt congratulations to the organizing committee of ICRAMEN 2026 for successfully bringing together scholars, researchers, and professionals from across the globe to share their knowledge, innovations, and research outcomes.

The wide spectrum of topics covered under the conference tracks spanning Engineering, Management and Technical Education has fostered a truly interdisciplinary platform. This comprehensive approach has evoked an overwhelming response and provided a 360-degree perspective on emerging research areas and industry trends.

Such events are not only vital for knowledge dissemination but also act as catalysts in nurturing a culture of research, innovation and critical inquiry. The rich deliberations and insightful sessions held during ICRAMEN 2026 will undoubtedly leave a lasting impact, inspiring participants to explore, ideate, and contribute meaningfully to their respective fields.

I wish all the delegates, presenters and organizers continued success and fruitful engagement. May ICRAMEN 2026 mark yet another milestone in the journey of academic excellence at SJCEM.

Dr. Kamal Shah
Principal,
SJCEM, Palghar

Message from the Conference Chair



It gives me immense pleasure to welcome you all to the 6th International Conference on Recent Advances in Mechanical Engineering and Nanomaterials (ICRAMEN 2026), organized by the Department of Mechanical Engineering & Department of Civil Engineering, St. John College of Engineering and Management (SJCEM), Palghar.

In an era driven by innovation and interdisciplinary research, this conference serves as a dynamic platform for researchers, academicians, industry professionals and students to come together and deliberate on the recent trends, challenges, and advancements in the fields of Mechanical Engineering and Nanomaterials. Research, as we know, is a journey of continuous exploration and rediscovery that fuels the growth of knowledge, technology and sustainable solutions for society.

At SJCEM, we are committed to fostering a culture of research and innovation. ICRAMEN 2026 reflects this vision by encouraging the exchange of ideas, collaborative learning and knowledge sharing on both national and international fronts. The conference also aims to bridge the gap between academia and industry by inviting experts to share insights from real-world practices and emerging technologies.

I take this opportunity to congratulate all participants and thank our keynote speakers, reviewers, organizing team, and sponsors for their valuable contributions. I am confident that the discussions and research presented during this event will inspire further exploration and collaborative initiatives.

Wishing you all an enriching and insightful experience at ICRAMEN 2026!

Dr. Kishor Rambhad

Conference Chair – ICRAMEN 2026

Head, Department of Mechanical Engineering

St. John College of Engineering and Management, Palghar

Message from the Convener



It gives me immense pleasure to welcome you all to the 6th International Conference on Recent Advances in Mechanical Engineering and Nanomaterials (ICRAMEN 2026), organized at St. John College of Engineering and Management, Palghar. In today's rapidly evolving technological landscape, the integration of Mechanical Engineering, Civil Engineering, and Nanomaterials has become crucial in addressing global challenges and advancing sustainable development. As we move towards achieving the Sustainable Development Goals (SDGs), innovation, interdisciplinary research, and strong industry-academia collaboration play a vital role in developing resilient, sustainable, and future-ready infrastructure and technologies.

ICRAMEN 2026 aims to provide a dynamic platform for researchers, academicians, industry professionals, and students to present cutting-edge research, exchange ideas, and explore emerging trends in engineering, materials science, and sustainable civil infrastructure. The conference seeks to bridge the gap between theory and practice by encouraging knowledge sharing, fostering collaboration, and promoting innovative and sustainable solutions to real-world problems.

At St. John College of Engineering and Management, we are committed to nurturing a culture of excellence, innovation, and sustainability-driven research through quality education and advanced engineering practices. This conference reflects our vision of empowering minds and contributing meaningfully to technological advancement, environmental responsibility, and societal well-being.

I extend my sincere gratitude to all keynote speakers, reviewers, organizing committee members, sponsors, and participants for their valuable support and contribution. I am confident that ICRAMEN 2026 will lead to insightful discussions, innovative ideas, and impactful collaborations in the domains of engineering and sustainability.

I wish you all a productive, enriching, and memorable experience.

Dr. Buddharatna J. Godbole

Convener – ICRAMEN 2026

Head, Department of Civil Engineering

St. John College of Engineering and Management, Palghar

Message from Co-Convener



It is with great enthusiasm that I extend a warm welcome to all participants of the 6th International Conference on Recent Advances in Mechanical Engineering and Nanomaterials (ICRAMEN 2026), hosted by the Department of Mechanical Engineering and Department of Civil Engineering, St. John College of Engineering and Management (SJCEM), Palghar.

This conference stands as a testimony to the spirit of collaborative innovation and the pursuit of scientific excellence. ICRAMEN 2026 brings together a distinguished assembly of researchers, academicians, industry experts, and students from across the globe to engage in meaningful discourse, present pioneering work, and explore the evolving landscape of Mechanical Engineering and Nanomaterials.

At SJCEM, we firmly believe that progress emerges from synergy—between disciplines, institutions, and individuals. This event is an embodiment of that belief, aiming to foster impactful dialogue, promote knowledge dissemination and build bridges between theoretical research and industrial applications.

I would like to express my heartfelt appreciation to our keynote speakers, paper reviewers, organizing committee and sponsors for their invaluable support. Your contributions are the pillars that uphold the success of this scholarly gathering.

May this conference serve as a catalyst for new ideas, enduring collaborations and transformative research journeys.

Wishing you a rewarding and intellectually enriching experience at ICRAMEN 2026!

Mr. Kiran Beldar

Co-Convener – ICRAMEN 2026

Assistant Professor, Department of Mechanical Engineering

St. John College of Engineering and Management, Palghar

Message from the President, Research Association of Masters in Engineering,



I am very happy to share that St. John College of Engineering and Management in association with Research Association of Masters in Engineering is organized an International Conference on Recent Advances in Mechanical Engineering and Nanomaterials (ICRAMEN 2026) during 30th April – 02nd May 2026.

The fast advancements in technology make the promotion of technical competence in the workforce highly essential nowadays. One of the main problems for scientists is the implementation of their highly specialized research in many domains of human knowledge and interdisciplinary study. This problem must be seen as an opportunity for human resources development in a variety of areas. The other significant problem is to discover how these material advancements may be utilized to better the everyday job and the common person's surroundings. In these recent years there has been a lot of focus to promoting cross-disciplinary research with issues in Science and Engineering.

I'm confident there will be many intellectually engaging contacts and the presentation of constructive ideas which would benefit a broad spectrum of participants in the conference on current achievements in Science and Engineering.

I congratulate the entire team and extend my best wishes for its success.

Dr. Manoj Kumbhalkar

President, Research Association of Masters in Engineering,

Message from the Chief Guest



It gives me immense pleasure to extend my heartfelt greetings and best wishes to the organizers for the 6th International Conference on Recent Advances in Mechanical Engineering and Nanomaterials (ICRAMEN 2026), being organized by the Department of Mechanical Engineering and Civil Engineering, St. John College of Engineering and Management, Palghar, in association with the Research Association of Masters in Engineering (RAME), India.

In the rapidly evolving landscape of engineering and technology, platforms like ICRAMEN 2026 play a vital role in fostering innovation, collaboration, and knowledge exchange. The integration of Mechanical Engineering with emerging fields such as Nanomaterials has opened new frontiers for research and development, significantly impacting industries ranging from energy and manufacturing to healthcare and sustainability.

I am particularly pleased to note that the conference is being conducted in a hybrid mode, enabling participation from researchers and experts across the globe. This inclusive approach not only enhances accessibility but also promotes diverse perspectives and global collaboration an essential need in today's interconnected world.

St. John College of Engineering and Management has consistently demonstrated its commitment to academic excellence, research, and holistic development. Organizing such an international conference reflects the institution's vision of nurturing innovation and contributing meaningfully to the scientific community.

I am confident that ICRAMEN 2026 will provide an excellent platform for participants to present their research, exchange ideas, and engage in fruitful discussions. I encourage all delegates to actively participate, collaborate, and make the most of this opportunity to build networks and explore future research directions.

I congratulate the organizing committee for their dedicated efforts in planning this prestigious event and wish the conference great success.

Prof. Emmanuel Bamfo-Agyei

Editor-in-Chief,
African Journal of Applied Research
Dean School of Graduate Studies,
Cape Coast Technical University, Ghana

Message from National Advisory Committee Member



It is a privilege to extend my greetings as a National Advisory Board Member for the International Conference on Recent Advances in Mechanical Engineering and Nanomaterials (ICRAMEN 2026). This conference stands as a dynamic forum where innovative minds converge to discuss transformative developments in two of the most rapidly evolving domains—mechanical engineering and nanomaterials.

The integration of nanotechnology into mechanical systems has redefined the scope of design, efficiency, and functionality. As we transition into a future driven by smart manufacturing, energy optimization, and miniaturized solutions, platforms like ICRAMEN 2026 become critical for knowledge dissemination and collaborative growth.

I applaud the organizers for their initiative in assembling a diverse and esteemed group of contributors from academia and industry. I am optimistic that the ideas exchanged and the research presented during this event will inspire forward-thinking strategies and pave the way for groundbreaking innovations.

Wishing all attendees a successful and stimulating conference experience.

Dr. Pramod Walke

Dean Academics and Deputy Director

Professor in Mechanical Engineering

G H Raison College of Engineering, Nagpur

Message from the International Advisory Committee Members



It is a privilege to be associated with the 6th International Conference on Recent Advances in Mechanical Engineering and Nanomaterials (ICRAMEN 2026), organized by St. John College of Engineering and Management, India. I am delighted to offer my best wishes to the entire team behind this commendable initiative.

Conferences like ICRAMEN 2026 play a pivotal role in advancing global research by providing a collaborative platform for scholars, innovators, and industry experts. The fusion of mechanical engineering principles with the transformative potential of nanomaterials opens up exciting avenues for research and application.

As an International Advisory Committee member, I am truly impressed by the vision and academic rigor reflected in the themes of this conference. I am confident that the insights shared and connections built during these two days will lead to significant contributions to science and technology.

Wishing all participants a thought-provoking and fruitful experience. May ICRAMEN 2026 continue to grow in reach, impact, and academic distinction.

Dr. Wadhah Hussein Al Doori

Member, International Advisory Committee

Professor, Tikrit University, Tikrit, Iraq

Message from the Keynote Speaker



It gives me immense pleasure to extend my heartfelt best wishes to the organizing committee, participants, and esteemed delegates of the 6th International Conference on Recent Advances in Mechanical Engineering and Nanomaterials (ICRAMEN 2026), being held at St. John College of Engineering and Management, Palghar, from 30th April to 2nd May 2026.

Conferences like ICRAMEN 2026 serve as a vibrant platform for academicians, researchers, and industry professionals to come together, share innovative ideas, and explore the frontiers of knowledge in Mechanical Engineering and the rapidly evolving domain of Nanomaterials. I am truly honoured to be a part of this intellectual gathering as a Keynote Speaker and to witness the dedication and enthusiasm of emerging scholars and professionals.

I commend the efforts of the organizing team for their commitment to fostering research and collaboration. May this conference inspire new thoughts, ignite meaningful discussions, and contribute significantly to the global body of knowledge.

Wishing ICRAMEN 2026 great success and a lasting impact in the academic and industrial community.

Dr. Jaafar Q. Kadhim

Keynote Speaker

Department of Electrical Engineering,

College of Engineering, Mustansiriyah University, Iraq

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ABSTRACTS

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Material Science and Nanomaterials

ICRAMEN_2026_007

Influence Of Plasticizing Additives on The Physical and Mechanical Properties of Gypsum Materials

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Abstract. The article presents the results of studies conducted to study the effect of superplasticizers of the FREM S3 brand based on naphthalene-formaldehyde resin and the SZhZ-3 brand based on polycarboxylate ether on water demand, setting kinetics and strength of gypsum materials used in ceramic industry enterprises producing porcelain and earthenware and sanitary ware. It is noted that the positive effect of the SDZ-3 additive on the formation of the optimal structure and strength of the gypsum material is significantly higher than that of the FREM S3 additive. **Keywords:** gypsum material, water demand, setting kinetics, strength, naphthalene-formaldehyde resin, superplasticizer, polycarboxylate.

ICRAMEN_2026_055

Numerical study of the center of gravity in the strengthening zone of steel with corrosion

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Abstract- In this paper, an unusual approach is used. The method of statistical mathematics is applied to determine the center of gravity in the strengthening zone in the stress-strain curve. The change of the center of gravity is numerically studied, and this part of the stress-strain diagram is represented as a function, respectively, it is divided into known figures, from which the center of gravity can be determined. Experimental data of corroded steel test specimens are used and mathematical processing is made using stochastic, average and RMS methods. Finally, the obtained results are presented, and it is noted that they also confirm that corrosion affects only strain, and not stress on steel.

ICRAMEN_2026_056

Design and Structural Analysis of Different Types of Flywheels for Wind Turbine Energy Storage

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Abstract— There has been an increasingly growing interest in flywheel-based energy storage mechanisms within the energy generation industry over the past couple of years. They offer large storage capacity, high energy density, and very rapid responses, which are normally less than one second. The According to reports, Flywheel Energy Storage Systems (FESS) are a useful way to lessen the sporadic character of renewable energy sources like wind power. This paper is mainly concerned with systematic design, modelling, and analysis of flywheel designs that can be used in the next generation of energy storage. This project aims at the design of an efficient, cost-effective, and mechanically reliable flywheel system has a high charge-discharge rate, a long lifespan, and a high energy density.

ICRAMEN_2026_100

Sustainable Fabrication of Ca/Al-Layered Double Hydroxide (LDH)-Coated Sand from Marine Waste for Efficient Removal of Tetracycline Contamination in Water

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Abstract- This study aimed to develop a reactive composite material for treating antibiotic contamination in water. Inert sand was transformed into an effective adsorbent for removing tetracycline (TC) from aqueous solutions by immobilizing calcium-aluminum bilayer hydroxide (Ca/Al-LDH) nanoparticles on its surface. The research employed a sustainable methodology for preparing these particles. Calcium ions (Ca²⁺) were extracted from shellfish shells (marine waste) using acetic acid at an optimal concentration of 9000 mg/L. Aluminum ions (Al³⁺) were obtained from low-cost alum. Sodium dodecyl sulfate (SDS) was used as a surfactant to improve nanoparticle dispersion and coating uniformity on the sand surface. The synthesis conditions were systematically optimized by investigating the effects of factors such as pH, surfactant dosage, calcium-to-aluminum (Ca/Al) molar ratio, and the amount of sand added. The results showed that the optimal conditions for preparing the adsorbent were: pH 8, 0.1 g of SDS, a 1:1 Ca/Al molar ratio, and 1 g of sand added per 50 mL of solution. Under these conditions, the coated sand achieved 54.1% removal of tetracycline at an initial concentration of 40 mg/L after 3 hours of contact. The comparison demonstrated that the surfactant SDS significantly outperformed CTAB in all experiments. Material characterization assays (such as XRD, FTIR, and SEM) confirmed the successful deposition of Ca/Al-LDH nanoparticles on the sand surface, resulting in a lamellar structure that significantly enhanced the surface reactivity of the inert substrate. This study presents a sustainable approach to converting marine biological waste into high-value nanomaterials, providing a cost-effective and environmentally friendly solution for treating antibiotic pollution in wastewater.

ICRAMEN_2026_102

Sustainable Green Synthesis of Supported Fe₃O₄/SiO₂/AgVO₃ Magnetic Nanocomposites for High-Efficiency Removal of Textile Dyes and Recyclable Environmental Remediation

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Abstract- The increasing discharge of synthetic dyes from the expanding textile sector has raised serious environmental concerns due to their persistence, toxicity, and resistance to natural degradation. In this study, a green synthesis approach was successfully employed to fabricate Fe₃O₄-based magnetic nanocomposites coated with SiO₂ and AgVO₃, aiming to develop sustainable and magnetically recoverable nanomaterials for aqueous dye removal. Two structural configurations were prepared, including supported and core-shell Fe₃O₄/SiO₂/AgVO₃ nanocomposites. The green synthesis route minimized the use of hazardous chemicals, providing an environmentally friendly alternative to conventional preparation methods. Comprehensive characterization using XRD, FTIR, VSM, AFM, and TEM confirmed the successful synthesis, strong magnetic properties, and uniform morphology of the prepared nanocomposites, as well as the effective formation of silica and AgVO₃ coating layers around the magnetic core. The magnetic properties enabled rapid separation and recovery of the nanomaterials from aqueous solutions. The incorporation of the SiO₂ interlayer improved structural stability and enhanced the dispersion of active sites, contributing to improved functional performance. The photocatalytic performance of the synthesized nanocomposites was evaluated using methylene blue as a model synthetic dye pollutant. Both supported and core-shell configurations demonstrated high removal capability, with the supported Fe₃O₄/SiO₂/AgVO₃ nanocomposite exhibiting superior removal efficiency due to improved accessibility of reactive sites. The effects of key operational parameters, including solution pH, light intensity, initial dye concentration, nanocomposite dosage, hydrogen peroxide concentration, and reaction temperature, were systematically investigated to determine optimal conditions. In addition, reusability tests demonstrated that the nanocomposite maintained stable performance over five consecutive cycles, confirming its durability and recyclability. Scavenger experiments were also conducted to identify the dominant reactive species and to better understand the degradation mechanism. Overall, the green-synthesized Fe₃O₄/SiO₂/AgVO₃ nanocomposites, particularly in the supported configuration, demonstrated excellent removal performance, strong magnetic recoverability, structural stability, and reusability. These findings highlight their potential as sustainable and effective nanomaterials for advanced wastewater treatment and environmental remediation applications.

ICRAMEN_2026_132

Optimization Of Trim Portion Of B- Type Pillar Of Regular Passenger Vehicle Using Natural Reinforcement

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Abstract- The B-Pillar is an important component in passenger vehicles, contributing significantly to occupant safety upon collision. Conventional B-pillar trims made of ABS have limited strength and stiffness, needing better reinforcement methods. This study looks into the use of natural fiber reinforcement, namely sisal fiber, to improve the structural performance of the B-pillar trim while being lightweight and environmentally friendly. Finite Element Analysis (FEA) was used to compare the behaviour of various reinforcing materials, and the findings showed that the sisal fiber-reinforced model had less deformation and a higher load-bearing capability. A prototype was created using a manual hand lay-up procedure that involved placing sisal fiber layers over the existing B-pillar trim with a resin matrix. Compression testing was used to undertake experimental validation using a Universal Testing Machine (UTM). The experimental results were consistent with the simulated outcomes, confirming the efficiency of the reinforcement. The study shows that sisal fiber composites are a cost-effective, environmentally friendly, and structurally efficient alternative for automotive applications, representing a viable approach to lightweight and sustainable vehicle design.

ICRAMEN_2026_135

Numerical Study of Modal Characteristics on Jute Fiber Based Hybrid Polymer Composites Reinforced with Metal Wire Mesh

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Abstract. Natural fiber–reinforced polymer composites are increasingly explored for lightweight structural applications; however, their limited stiffness and vibration resistance restrict broader use. The present study focuses on the numerical modal analysis of jute-based hybrid polymer composites enhanced with glass fibers and metallic reinforcements, including stainless steel 304 wire mesh, aluminium wire mesh, and aluminium perforated sheets. A series of hybrid laminates with different stacking sequences and configurations were modeled using finite element analysis to investigate their dynamic behavior. The study evaluates the influence of interlaminar hybridization, fiber orientation, and the incorporation of metallic layers on natural frequencies and mode shapes. Special attention is given to the role of metal reinforcements in improving stiffness and altering the vibration response of the composite structures. The numerical results indicate that both stacking sequence and the type and placement of metallic reinforcements significantly affect modal characteristics. Laminates with outer glass fiber layers and strategically placed metal inserts exhibit higher natural frequencies and improved dynamic stability. Overall, the study highlights the effectiveness of hybridization in tailoring the vibration performance of composite laminates, making them suitable for applications requiring enhanced dynamic response and structural efficiency.

ICRAMEN_2026_157

Effect of Welding Parameters on Bead Geometry and Microhardness in GMAW: A Statistical Approach

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Abstract-The quality and performance of welded joints in Gas Metal Arc Welding (GMAW) are strongly governed by bead geometry and associated material properties. This study presents an experimental and statistical investigation of bead width, bead reinforcement (height), and microhardness using Analysis of Variance (ANOVA). Weld deposition was carried out on mild steel plates by systematically varying arc voltage, wire feed rate, and torch travel speed, employing an ABB IRB 1520 robotic welding system coupled with a KempArc DT 410L power source. Post-weld evaluation involved microstructural examination using scanning electron microscopy, dimensional measurements through ImageJ software, and hardness assessment via Vickers microhardness testing. The collected experimental data were subjected to ANOVA to quantify the influence of individual process variables and their interactions on the selected response parameters. The analysis indicated that process parameters governing heat input play a dominant role in defining bead geometry, with statistically significant effects observed for voltage and wire feed rate. Torch speed contributed to variations in bead formation but with relatively lower statistical significance. Variations in microhardness were linked to thermal histories and cooling rates, as reflected in the ANOVA results. The outcomes confirm that ANOVA-based modeling provides a robust and interpretable means of analyzing welding responses, facilitating effective parameter optimization and minimizing experimental effort. This approach offers practical relevance for improving process consistency and quality control in automated GMAW applications.

Keywords: WAAM, ANOVA, Bead geometry, hardness, additive manufacturing

ICRAMEN_2026_158

Predictive and Optimization Frameworks for Bead Geometry in Wire Arc Additive Manufacturing Using Machine Learning

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Abstract- Wire Arc Additive Manufacturing (WAAM) has emerged as a practical and economically attractive approach for producing large metal components, yet the process continues to be limited by the difficulty of achieving consistent bead geometry. Small variations in heat input, travel speed, wire feed rate, and interlayer thermal accumulation often produce noticeable fluctuations in bead shape, which in turn affect dimensional accuracy, mechanical performance, and surface finish. Over the past few years, researchers have increasingly turned to machine learning and other data-driven strategies to understand and manage these complex, nonlinear interactions. This review brings together the scattered findings on how different machine learning models—ranging from classical regression techniques to modern deep learning architectures—have been used to predict and optimize bead geometry in WAAM. Alongside summarizing existing modelling efforts, the article discusses commonly used datasets, feature engineering practices, sensor-based monitoring methods, and hybrid frameworks that combine physics-based and data-driven approaches. By mapping the strengths and shortfalls of current techniques, the review highlights where progress has been substantial and where further work is still needed, particularly in the areas of large-scale datasets, real-time control, and cross-material generalization. Overall, the review aims to provide a balanced perspective for researchers seeking to develop more reliable, adaptable, and intelligent WAAM systems.

Keywords: WAAM, machine learning, bead geometry, hardness, additive manufacturing

Track

Thermal Engineering and Fluid Mechanics

ICRAMEN_2026_006

Experimental Research on Determining Gas Quantity In A Bubble Absorption Device

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Abstract. This article presents a method for determining the gas content value in the mixing zone of a newly created bubble absorption device and the results of experimental studies conducted on the experimental apparatus. In the experimental studies, gas content values were determined when liquid and gas flows were supplied through ceramic nozzles of various sizes installed in the mixing zones of the device. Based on the experimental results, the limit values of gas quantity and gas velocity were determined. As a result, an opportunity was created to achieve high efficiency in absorbing gas supplied to the device through these limit values. Keywords: Absorption, bubbling, gas quantity, gas velocity, nozzle, size, mixing zone, liquid, gas.

ICRAMEN_2026_025

Experimental Evaluation of an Ammonia-Based Post-Combustion Device for Reduction of Vehicular Exhaust Emissions

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Abstract. Vehicle exhaust emissions significantly contribute to urban air pollution and related health and environmental issues. Notwithstanding the implementation of rigorous emission regulations, a significant number of operational cars persist in releasing pollutants, including carbon monoxide (CO), hydrocarbons (HC), and nitrogen oxides (NO_x), at or exceeding allowable thresholds. This study presents a proof-of-concept experimental assessment of an innovative ammonia-based post-combustion emission control apparatus, wherein exhaust gases are directed via a sealed chamber containing liquid ammonia prior to atmospheric discharge. Emission levels were assessed via standard Pollution Under Control (PUC) instruments for diesel and petrol cars throughout a five-day testing period, both with and without the device. The experimental findings indicate significant decreases in exhaust emissions. Diesel cars had average reductions of in the region of 71-74% for carbon monoxide (CO), hydrocarbons (HC), and nitrogen oxides (NO_x). In petrol automobiles, CO and HC emissions were diminished approximately by 40–62% and 64–74%, respectively, contingent upon the operating conditions. The decrease is primarily ascribed to absorption, alkaline scrubbing, and ammonia-assisted reduction processes during gas-liquid interaction. A preliminary qualitative GC–MS study of the wasted ammonia solution was conducted to investigate the characteristics of absorbed species, albeit this analysis is characterized as exploratory rather than conclusive. The study illustrates that ammonia-based post-combustion treatment can function as an efficient additional emission control method for operational cars. The present study, confined to short-term and steady-state evaluations, underscores the promise of this approach as an economical, retrofittable remedy for diminishing vehicular emissions, necessitating additional research into long-term durability, safety, and catalyst-enhanced optimization.

Keywords: Vehicular emissions; Ammonia scrubbing; Post-combustion treatment; Carbon monoxide; Nitrogen oxides; Hydrocarbons.

ICRAMEN_2026_068

Experimental Investigation of Effluent Evaporation By Using Solar Energy

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Abstract :- The industry generates a considerable amount of wastewater during various processes such as dyeing, washing, and finishing of fabrics. Compared to some heavy industrial effluents, textile wastewater generally contains relatively lower concentrations of highly toxic compounds; however, it still includes dissolved salts, colour residues, and suspended impurities that require proper treatment before disposal. Conventional wastewater treatment methods often involve high energy consumption, complex infrastructure, and high operational costs, which can be challenging for small and medium-scale textile industries. Therefore, the use of renewable energy-based evaporation techniques has attracted attention as a sustainable and cost-effective solution for wastewater reduction. The objective of the present work is to design, fabricate, and experimentally evaluate a solar flat plate collector system for enhancing the evaporation of textile industry effluent using solar thermal energy. In this system, solar radiation is absorbed by a black-coated absorber plate enclosed within a flat plate collector, which increases the temperature of the flowing effluent and accelerates the evaporation process. The experimental setup was tested under outdoor conditions, where parameters such as solar radiation, ambient temperature, wind velocity, and evaporation rate were monitored. The experimental results indicate that evaporation performance increases with higher solar radiation and wind speed. The developed system demonstrates an effective, low-cost, and environmentally friendly approach for reducing wastewater volume in textile industries.

ICRAMEN_2026_072

Production of Bioethanol from Waste Chikoo and Evaluation of its Blends in Compression Ignition Engine

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Abstract: The depletion of fossil fuels and increasing environmental concerns necessitate sustainable energy alternatives. Simultaneously, fruit waste such as chikoo creates disposal challenges, offering potential for bioethanol production. This study aims to design, fabricate, and evaluate a cost-effective system for producing bioethanol from waste chikoo and to assess its performance in compression ignition (CI) engines using ethanol diesel blends. Waste chikoo was processed through fermentation using *Saccharomyces cerevisiae* and distilled using a custom micro-distillery. The produced bioethanol was blended with diesel as E0, E05, E10, E15, and E20, and tested in a CI engine under load conditions to evaluate brake power, fuel consumption, mechanical efficiency, and frictional power. Approximately 10–12 kg of chikoo yielded 1 liter of bioethanol with 86–88% purity. Engine tests showed that blends achieved brake power of 2.226 - 2.276 kW, mechanical efficiency of 42.8 - 43.76%, and frictional power of 2.924 - 2.974 kW, indicating stable performance up to E20. The study demonstrates a sustainable, low-cost approach for waste-to-energy conversion and validates ethanol–diesel blends as viable alternative fuels.

Keywords – Bioethanol, Waste Chikoo, CI Engine, Ethanol Blends, Alternative Fuel

ICRAMEN_2026_073

Experimental Investigation on Dehumidification Performance of Square Channel Rotary Solid Desiccant Dehumidifier Assisted with PCM Integrated Parabolic Trough Solar Collector

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Abstract- This research study aims to remove the moisture from air and investigate dehumidification performance of square channel rotary solid desiccant wheel. The regeneration of desiccants wheel is effectively served by using PCM integrated parabolic trough solar collector. The PCM serve the purpose of storing the heat and utilised during non-availability of solar energy thus increase the operational hours of combined system. The experiments were performed by using composite desiccants of different composition like, pure silica gel (SG), SG -5A Molecular sieve (90-10) %, SG-LiCl (90-10) % and SG-LiCl-5A Molecular sieve (80-10-10) % by mass with sector angle of 270 ° and 90 ° for process and regeneration purpose. Different process and regeneration mass flow rate of air in the range of 50 to 100 kg/hrs with desiccant wheel speed 10,20 & 30 rph are considered to optimised the dehumidification performance. The results obtained are discussed in this research article also the solar collector performance analysed by integrating Paraffin wax as PCM for increased operational hours characteristics.

Keywords: PCM (Phase Change Material), PTSC (Parabolic Trough Solar Collector), Desiccants, Dehumidification

ICRAMEN_2026_090

Experimental and theoretical study of innovative liquid thermal insulation materials to reduce heat loss

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Abstract. This article presents an experimental and theoretical study of the thermophysical properties of an innovative liquid thermal insulation material based on ceramic microspheres and acrylic polymers, aimed at reducing heat loss. The thermal conductivity coefficient was determined for coatings of 1 mm, 2 mm, 3 mm and 4 mm thickness using the steady-state heat flow method. Experiments were conducted using a specially developed apparatus with five thermocouples and an electric heater. Theoretical calculations were performed using the Maxwell-Eucken model to evaluate the equivalent thermal conductivity of composite materials. The results indicate that the apparent thermal conductivity coefficient under the given experimental conditions ranges from $\lambda = 0.00643\text{--}0.00687\text{ W}/(\text{m}\cdot\text{K})$, which is 5–7 times lower than that of traditional thermal insulation materials (mineral wool, expanded polystyrene). The material provides effective thermal insulation even at 1 mm thickness. Economic analysis indicates that the application of the material results in energy savings of 30–40% and a payback period of 1.5–2 years. The study also highlights the material advantages, including corrosion resistance, environmental safety, and ease of application on complex surfaces.

Keywords: microsphere, liquid thermal insulation, thermal conductivity coefficient, energy efficiency, Maxwell-Eucken model, payback period

ICRAMEN_2026_114

Experimental study of a compact portable air conditioning system for localized cooling

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Abstract - This study presents the design, fabrication, and experimental assessment of a compact portable air conditioning system intended for localized cooling in confined environments such as tents and temporary shelters. The system operates on a vapor compression refrigeration cycle using R134a as the working fluid and is designed for a cooling volume of 216 ft³. A prototype unit comprising a rotary compressor, compact condenser and evaporator coils, and a capillary tube expansion device was developed and tested under controlled conditions. The experimental evaluation demonstrated a temperature reduction of 8.6°C, decreasing the ambient temperature from 30.7°C to 22.1°C. The system achieved a coefficient of performance (COP) of 2.15 with a power consumption of 0.40 kW. Measured airflow of approximately 295 CFM facilitated effective heat transfer, while pressure readings between 1 bar and 11 bar confirmed stable system operation. The findings indicate that compact portable cooling systems can provide effective and energy-efficient localized cooling solutions.

Track

Production and

Manufacturing Processes

ICRAMEN_2026_045

Design & Fabrication of Smart Convertible Stair-Climbing, Bed-To-Wheelchair with Onboard Control

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Abstract- In healthcare and rehabilitation settings, mobility assistance for the elderly and those with physical disabilities continues to be a significant challenge. When transferring patients from beds to wheelchairs or up stairs, carers must provide substantial assistance because conventional wheelchairs are primarily made for movement on flat surfaces. This restriction makes patients less independent and adds to the carers workload. As a result, an integrated mobility solution that facilitates both patient transfer and staircase mobility is required. Objective of the work: The goal of this research is to create a smart convertible mobility system that can be used as a wheelchair and a bed. It will also include an onboard controlled stair-climbing mechanism for safe and effective operation. Methodology (Design + Fabrication + Testing): To guarantee stability, strength, and safety, structural analysis and CAD modelling were used in the system design. Wheels, motors, a control unit, and structural elements made of mild steel were used to construct the prototype. To enable switching between wheelchair and bed mode, a mechanical conversion mechanism was put in place. The load capacity, conversion mechanism efficiency, and stair-climbing performance under controlled conditions were all assessed through experimental testing. Key experimental results (with numerical values) : The developed prototype showed a conversion time of roughly 20–25 seconds between bed and wheelchair modes and successfully supported a load capacity of about 100–120 kg. On typical staircases with a step height of 15–18 cm, stair-climbing tests demonstrated stable operation with a climbing efficiency of roughly 85–90%. Conclusion and practical implication: The proposed smart convertible stair-climbing bed-to-wheelchair system improves patient mobility, reduces caregiver dependency, and enhances accessibility in environments where ramps or elevators are unavailable. The system provides a cost-effective and practical solution for hospitals, rehabilitation centers, and home healthcare applications

ICRAMEN_2026_046

Design and Development of an Automated Stair-Climbing Trolley Using Crawler Mechanism Authors and Affiliation

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Abstract- Material handling across staircases remains a challenging task in industrial, commercial, and residential environments where elevators or ramps are unavailable. Conventional trolleys are ineffective on stairs and require significant manual effort, leading to fatigue, inefficiency, and safety risks. This project presents the design and development of an automated stair climbing trolley using a crawler-based mechanism for efficient and safe transportation of heavy loads. The proposed system is designed to carry loads up to 150 kg using dual crawler tracks driven by NEMA 23 stepper motors. A suitable gear reduction system combined with a chain and sprocket transmission is implemented to achieve the required torque for stair climbing. The structural frame is fabricated using mild steel to ensure strength, durability, and cost-effectiveness. The crawler mechanism provides improved traction, stability, and load distribution compared to conventional wheel-based systems. Theoretical calculations for load, force, and torque requirements were performed and validated through experimental testing. The developed prototype demonstrated stable and reliable performance on standard staircases, with minimal slippage and controlled motion. The system offers a practical, low-cost, and efficient solution for material handling on stairs. This work can be further extended by incorporating advanced control systems, lightweight materials, and shock absorption mechanisms to enhance performance and usability

ICRAMEN_2026_061

Exploring Regression Techniques: From Linear Models to Logistic and Polynomial Approaches along with a comparative study

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Abstract: Regression analysis is a fundamental statistical tool used to model and analyse relationships between variables in data sets. It allows researchers to identify how independent variables influence a dependent variable, enabling predictions, trend analysis, and decision-making across various fields. This paper presents a detailed review of major regression models, including simple linear regression, multiple linear regression, logistic regression, and polynomial regression. Each technique is explained with its assumptions, mathematical formulation, and use cases. The study also highlights the strengths and limitations of each model. This work aims to gain a deeper understanding of regression analysis and its practical application in real-world datasets.

Keywords: Regression models, Linear regression, Multilinear regression, Logistic regression, Polynomial regressions with examples, and Comparative study.

ICRAMEN_2026_063

Arduino-Based Programmable Switching Controller: A Cost-Effective Alternative to PLCs for Small-Scale Industries

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Abstract: This work introduces an affordable programmable switching solution built around Arduino technology, aimed at making industrial automation more accessible. At the heart of the system lies an Arduino UNO microcontroller working alongside a 4-channel relay module and a straightforward interface comprising a 16×2 LCD display with push-button controls. Users can choose between three operational modes—automatic sequencing with adjustable timing, manual override for direct load control, and a configuration mode for customizing delay settings. Before building the physical prototype, the design underwent thorough validation through Proteus simulations to iron out any logic or timing issues. When put to the test, the system performed flawlessly across more than a hundred switching cycles with zero errors, responding in under 100 milliseconds every time. What makes this particularly noteworthy is the cost—the entire setup comes in at roughly one-tenth the price of conventional programmable logic controllers, opening up automation possibilities for smaller manufacturers and educational settings. The design leaves room for future enhancements like wireless connectivity and sensor-based operation.

Keywords— Industrial automation, programmable switching, Arduino, relay control, cost-effective design, SMEs

ICRAMEN_2026_104

Integrated Lean and Green Management for Sustainable Organizational Performance: A Review

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Abstract- The simultaneous pursuit of operational efficiency and environmental responsibility has prompted scholars and practitioners to examine whether lean manufacturing and green management can be deployed as a unified strategic framework. This paper presents a systematic review of 98 peer-reviewed studies published between 2005 and 2024 that investigated the relationship between lean thinking, green practices, and sustainable organizational performance. Drawing on resource-based view (RBV) theory, natural-resource-based view (NRBV) theory, and dynamic-capabilities theory, we develop an integrative conceptual model that maps the antecedents, mediating mechanisms, and performance outcomes of lean-green integration. Our synthesis reveals four recurring integration patterns: sequential adoption, parallel deployment, hybrid embedding, and systemic co-evolution. Evidence consistently shows that firms achieving deep synergistic integration report statistically significant improvements across economic, environmental, and social performance dimensions. Critical enablers include top-management commitment, cross-functional collaboration, supply-chain alignment, and digital infrastructure. Conversely, siloed implementation, resource constraints in small and medium enterprises (SMEs), and inconsistent measurement frameworks are identified as persistent barriers. The review highlights notable research gaps concerning longitudinal assessments, industry-specific boundary conditions, and the role of emerging technologies in amplifying lean-green synergies. The findings provide actionable guidance for operations managers and sustainability officers and lay a rigorous theoretical foundation for future empirical inquiry.

Keywords: Lean manufacturing; Green management; Sustainable performance; Waste elimination; Environmental sustainability; Operations management; Systematic review

ICRAMEN_2026_113

Corrosion Studies on Arc Welded En-8 Lap Joints

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Abstract: In many applications structures are in contact with various corrosive media. This study aims at studying effect of corrosion medium on lap welding joints of En-8 Steel. Corrosive medium considered are salt water, 1M HCl solution and distilled water. Rates of corrosion are computed. Micro structural studies are made and micro hardness values at various zones are determined. It is observed that the corrosive attack of 1M HCl solution is more severe and more intense on HAZ.

ICRAMEN_2026_115

Optimisation of Process Parameters of FSW welding of HE-30 Aluminium alloy

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Abstract: HE-30 Aluminium alloy is extensively used in aerospace, automobile and marine industries. This paper attempted process parameter optimisation of welded joint of HE-30 Aluminium alloy joined through FSW. Three, three level factors namely rotational speed of tool, traverse speed of tool and tool geometry are taken in to account. Responses are Ultimate tensile strength, Yield strength and Percentage of elongation. ANOVA is performed. It is observed that type of tool has got pronounced affect and threaded type of tool is giving the best results.

Keywords: HE-30 Aluminium alloy, Friction Stir Welding, Optimisation.

ICRAMEN_2026_118

Development of Design Calculation Templates for Safety Valve Products as per ASME Section III Standards

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Abstract. Safety valve design requires strict compliance with engineering standards to ensure safe operation under varying pressure conditions, yet conventional manual calculation methods are time-consuming and prone to inconsistencies. This study presents the development of design calculation templates for safety valve products using a structured computational approach. The proposed system integrates engineering equations with automated workflows to standardize input parameters, perform calculations, and validate results efficiently. The methodology incorporates pressure-force relations, material property selection, and thickness calculations within an Excel-based framework, improving repeatability and reducing human intervention. The design process is developed in accordance with ASME Section III and supported by related standards including ASME B36.10, ASME Section II Part D, API 526, and ASME B16.34. A case study demonstrates that the proposed system reduces calculation time by approximately 75% while improving accuracy and consistency compared to manual methods. The developed templates provide a reliable and efficient solution for standardized safety valve design.

ICRAMEN_2026_121

Hybrid YOLOv8 and auto-encoder based welding defect detection model for industrial inspection

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Abstract-Welding serves as an essential process that determines the strength and safety of industrial manufacturing welds. The detection of material defects through cracks and porosity and improper fusion leads to material failure during early stages of the process. Traditional inspection methods require substantial time and high costs while depending on human expertise which creates a high risk of mistakes. The research presents a hybrid deep learning approach which combines YOLOv8 for object detection with an auto-encoder based anomaly detection system. The YOLOv8 model detects known defects, while the auto-encoder identifies deviations from normal weld patterns. The hybrid system, which consists of both supervised and unsupervised learning methods, helps to enhance system reliability. The experimental results demonstrate that the model achieves an accuracy of 70% and a precision of 62% together with a 100% recall rate which guarantees detection of all defective welds. The proposed system is suitable for industrial applications where safety is a priority.

ICRAMEN_2026_126

Single Point Articulation Metrology Test for a Portable Coordinate Measuring Machine

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Abstract. A Portable Coordinate Measuring Machine used in precision measurement has complex physical structure built than conventional coordinate measuring machine. The operating environment in which it is being used experiences many limitations due to varying operator perception skills, probing practices, cyclic changes in temperatures and other factors. The single point articulation test is a quick test considered as an interim test for analysing the articulated arms performance in repeatability to locate point precisely. This paper describes the results of interim check process which is directed by ISO 10360-12 for six kinematic nests with touch probing method of coordinate metrology. Keywords: coordinate metrology, probing, single point articulation test, error.

ICRAMEN_2026_127

Design of Smart Parking System Using Dual-Loop Conveyor Concept

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Abstract- Parking in Indian metropolitan cities is becoming a major challenge due to the increasing number of the people with their own vehicles in urban areas. An analysis of literature on automated parking system (APS) studies has identified four significant gaps in the area of the field that remain unaddressed: an overemphasis on software and sensor development studies, no literature on APS designs that do not need deep civil infrastructure, no literature on structural safety verification of. The entry station has a lift platform that transfers vehicles between the two loops. The system has a capacity of thirty cars in six positions per loop circuit, is propelled by a single low power continuous-loop drive motor, has no deep civil foundation and has all the vehicle movement kept close to the ground giving it better safety and also easier to maintain. Structural verification confirms that all load-bearing members — including the ISMB 250 I-beam rail and hanger frame — sustain a total design load of 34,943 N (with a dynamic amplification factor of 1.25) at a factor of safety ≥ 3.0 and deflection within the $L/500$ limit. Performance evaluation demonstrates a retrieval time reduction of 58–70% compared to conventional puzzle and tower- type APS. This paper presents the academic and engineering justification of this configuration without making the implementation details secret.

Keywords: smart parking system, dual-loop conveyor, overhead hanger loop, ground conveyor loop, lift platform, skid mechanism, automated parking.

ICRAMEN_2026_145

Minimizing Project Cost in Repetitive Work Environments: An Optimization Model

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Abstract. Projects that involve multiple identical or similar activities are commonly referred to as repetitive projects. Such projects arise either from the consistent repetition of a set of activities throughout the project or from the nature of the project's physical layout. In industries dealing with repetitive projects, various resource options are available for each activity, making the selection of the most efficient option a significant challenge for project managers. The present study aims to develop a method to address this problem with the objective of minimizing the total project cost. Since obtaining an exact solution becomes computationally intensive for large-scale problems, an Artificial Bee Colony (ABC)-based heuristic methodology is proposed. The performance of the proposed algorithm is evaluated by comparing its results with those obtained using the complete enumeration technique.

Track

Solid Mechanics and Modeling

ICRAMEN_2026_002

Structural Analysis of Formula 1 Halo Protection Device

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Abstract. The Formula 1 Halo is a lifesaving technology in the engineering of motorsport vehicles, as it offers protection to the driver without compromising the motorsport performance. This is a structural, aerodynamic and vibrational examination of the F1 Halo that incorporates the multidisciplinary design validation. The Halo is verified to meet the requirements of FIA safety with maximum stress of 399.14 MPa (yield strength: 1030 MPa) and deformation of 2.687 mm (limit: 3.0 mm) under 125 kN vertical and 0 separation forces. Calculation fluid dynamics demonstrates 0.368-0.841 coefficients of aerodynamic drag at 30 m /s and 80 m /s and forces are about 1-2 percent of total drag on the vehicle. The modal analysis determines six natural frequencies that are between 63.81 Hz and 373.9 Hz, which proves that they effectively separate resonance frequencies that are associated with natural frequencies and those involved in operation. Grade 5 Titanium (Ti-6Al-4V) showed a high-end performance feature, which proved the structural performance and aerodynamic viability. This combined method shows that the strict computational design can prove the multi-objective design optimization of safety-critical.

ICRAMEN_2026_003

Cylindrical Roller Bearing Modal Frequency Analysis for Early Failure Detection

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Abstract. This study examined the dynamic behaviour of healthy and defective cylindrical roller bearings using modal analysis as a non-destructive diagnostic technique. Frequency and phase responses were measured with a Coco-80 FFT analyser, and repeated experiments confirmed the reliability of the results. A comparison of experimental and Finite Element (FE) simulated responses showed good overall agreement, with only slight deviations in natural frequencies. These differences were attributed to modelling and measurement processes, non-linear effects, and minor geometric variations between the actual and simulated bearings. Defective bearings exhibited reduced acceleration amplitudes at natural frequencies and their harmonics, along with phase angle deviations at specific frequencies. Such changes are linked to defects such as cracks, voids, notches, or material impurities that disrupt the smooth transmission of vibrational energy. The findings confirm that frequency response analysis supported by validated Finite Element (FE) simulations is effective for early fault detection and predictive maintenance in rotating machinery. Keywords: Roller bearing, Modal analysis, Frequency Response Function (FRF), Impact hammer testing, Free-free boundary condition.

ICRAMEN_2026_071

Mesh Convergence and Error Analysis in Finite Element Modeling of Beam Structures

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Abstract. This study presents a reproducible workflow for mesh convergence analysis in beam-type finite element models by integrating analytical validation, systematic h-refinement, and uncertainty quantification using the Grid Convergence Index (GCI). The finite element method is applied to discretize the beam structure, while a three-mesh sequence with a constant refinement ratio is employed to evaluate convergence behaviour. Richardson extrapolation and the GCI method are used to estimate the observed convergence order and the uncertainty from discretization. The results show that the numerical solutions converge to the analytical solutions as the mesh is refined, with both displacement and stress errors decreasing steadily. The observed order of convergence is approximately second order ($p \approx 2$) for the midspan bending stress quantity of interest (QoI). On the other hand, how quickly a solution converges depends on the specific problem and can vary based on the shape, the boundaries, and the types of elements used. The research also shows that stress results near constraints or where loads are applied can be affected by stress concentrations or singularities. A conservative fine-mesh discretization uncertainty of approximately 1.3% is reported. The results, in their entirety, corroborate the assertion that systematic refinement substantially mitigates discretization error, and that convergence assessment, driven by the quantity of interest, is indispensable. This framework offers a dependable and transparent methodology for enhancing the precision and reliability of finite element simulations, with the potential for application to more intricate engineering challenges.

Keywords. Finite element method, mesh convergence, discretization error, Grid Convergence Index, Euler–Bernoulli beam, cantilever beam, stress verification.

ICRAMEN_2026_086

Design and Optimization of Power Transmission System for Automobile (Go-Kart)

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Abstract: The power transmission system plays a crucial role in determining the performance, efficiency, and reliability of a go-kart. This study focuses on the design and optimization of a power transmission system specifically tailored for a go-kart application, with the objective of achieving maximum power transfer, improved acceleration, and enhanced overall efficiency. The system includes key components such as the engine, clutch, chain drive, sprockets, and axle assembly, all of which are carefully selected and designed to work in synchronization. The design process begins with the selection of an appropriate engine based on power and torque requirements. These parameters are further used to determine the optimal gear ratio, which directly influences acceleration and top speed. A chain drive mechanism is preferred due to its simplicity, cost-effectiveness, and high efficiency in power transmission. The selection of sprocket sizes is optimized to balance torque multiplication and speed, ensuring smooth operation under varying load conditions. Optimization techniques are applied to reduce energy losses, minimize wear and tear, and enhance durability. Factors such as chain tension, alignment, lubrication, and material selection are critically analyzed. Lightweight materials are considered to reduce the overall mass of the system, thereby improving fuel efficiency and vehicle performance. Additionally, stress analysis is conducted on transmission components to ensure structural integrity and safety under dynamic loading conditions. Simulation and performance analysis are used to validate the design, allowing for adjustments in gear ratios and component dimensions. The optimized system demonstrates improved efficiency, reduced mechanical losses, and better responsiveness compared to conventional designs. The study highlights the importance of proper design and integration of transmission components in achieving high performance in small-scale automobiles like go-karts.

ICRAMEN_2026_110

Design and Analysis of Automotive Crash Box

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Abstract. The crash box is a critical energy-absorbing component in modern automotive structures, designed to minimize the impact forces transmitted to the passenger cabin during a collision. This project focuses on the design and optimization of an automotive crash box with the aim of improving crashworthiness while maintaining lightweight and cost-effective characteristics. Various geometric configurations, materials, and structural parameters are analyzed to enhance energy absorption, reduce peak impact forces, and improve deformation behavior under axial and oblique loading conditions. Numerical simulations using finite element analysis (FEA) are employed to evaluate performance parameters such as specific energy absorption, crush force efficiency, and deformation modes. Design iterations are carried out to identify the optimal configuration that provides a balance between safety, manufacturability, and material efficiency. The optimized crash box design is expected to significantly enhance vehicle safety, reduce material wastage, and contribute to the overall improvement of automotive crash management systems. Keywords – Finite Element Analysis, Automotive Crash box, Energy absorption, Material Selection, Impact Analysis, Vehicle safety.

ICRAMEN_2026_111

Numerical Analysis of Structural and Modal Performance of Steel, Aluminium, Jute-Based Composites, and Carbon Fiber Reinforced Polymer Composites for Lightweight Bus Flooring

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Abstract- Lightweight and structural efficient floor system is critical in enhancing the performance, fuel efficiency and the payload capacity of the modern passenger buses. This paper demonstrates a numerical exploration of the bus floor thickness optimization and efficiency in terms of metallic and composite materials under practical service loading. An SML compliant S7 bus platform (BS-VI) was taken as a reference model and a simplified ladder frame supported floor domain, which symbolizes realistic seating areas, was created in ANSYS Workbench. To simulate realistic load transfer, static structural simulations were conducted with a gravity-based passenger loading with the use of seat-support locations. Candidate materials such as jute composite, carbon-fiber laminates, Tufnol, stainless steel (SS304), and aluminum (Al 6063-T5) were tested within the range of 10 to 50 mm thickness. Structural performance was measured in terms of the total deformation and equivalent stress. The findings imply that the thickness was a very significant factor on the stiffness response and high-modulus carbon-fiber laminates offer great reduction in weight and acceptable levels of deformation relative to traditional metallic floors. The methodology suggested is based on the combination of realistic geometry, support conditioning, distributed passenger loading, and parametric change in thickness in a single finite element framework. The results facilitate the choice of structurally efficient and cost-effective materials to be used in designing lightweight bus floors and offers a set of data that can be used in future data-driven optimization research.

ICRAMEN_2026_129

Finite Element Analysis of Stress Distribution in Pressure Vessels under Internal Pressure

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Abstract- This study presents a finite element investigation of stress distribution in a cylindrical pressure-vessel segment subjected to internal pressure, using real simulation results obtained on the cloud-based platform SimScale. A three-dimensional linear static structural model was solved with the platform's integration of the Code Aster solver, employing an automatically generated unstructured tetrahedral mesh of approximately 1600 elements. Internal pressure was applied to the inner surface, while one end of the vessel was constrained by a fixed support to remove rigid-body motion. Three pressure levels were simulated: 1, 2, and 3 MPa. The corresponding peak von Mises stresses extracted from post-processing were 4.35 MPa, 8.70 MPa, and 13.06 MPa, respectively. The results demonstrate a strongly linear pressure–stress relationship (best-fit slope ≈ 4.355 MPa/MPa; intercept ≈ -0.007 MPa; $R^2 \approx 0.9999996$), consistent with linear elasticity and proportionate loading. Stress contours show that the maximum equivalent stress occurs at the inner wall, which is consistent with thick-cylinder elasticity where hoop stress is highest at the bore and drives the distortion-energy measure. Mesh-related influences, boundary- condition-induced gradients near the constrained end, and the limitations of linear modeling are critically assessed, and extensions to nonlinear plasticity and burst-pressure prediction are proposed.

Keywords. Pressure vessels; finite element analysis; internal pressure; von Mises stress; stress distribution; mesh influence; linear elasticity; thick-walled cylinder.

ICRAMEN_2026_159

Integrated aerodynamic and structural evaluation of a NACA 4412 wind turbine blade: a coupled fluid-structure interaction approach

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Abstract. This paper considers a 5 meters wind turbine blade that has a profile of NACA 4412 profile using integrated fluid and structure simulation. Flow behavior is the solution to averaged Navier- Stokes equations and is based on the k-omega SST method of turbulence closure. Rather than computing forces individually, pressure distributions are directly fed to a mechanical structure of glass fiber composite materials. The highest efficiency is achieved at angles of approximately 6-8 degrees as the blade gets in contact with the incoming air. Although load patterns may vary, the structural response is not affected by the operating conditions. Stress is also greatest at the blade root - and deformation is most at the tip. The research demonstrates that combined analysis is essential to performance gains and structural safety. Forces are not treated independently but by linking them, more design insights can be realized.

Track

Recent Advances in Science and Engineering

ICRAMEN_2026_024

Artificial intelligence and machine learning-based battery management systems for electric vehicles: a comprehensive review of cell balancing, state estimation, and dynamic reconfiguration

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Abstract. Electric vehicles have already emerged as a critical solution for sustainable transportation. Yet, the widespread adoption of electric vehicles in the market is usually hindered by the challenges which are related to battery performance, safety, and the lifespan of the batteries. Battery packs used in electric vehicles are generally lithium-ion battery packs, which consist of hundreds to thousands of individual cells. These battery packs experience inevitable cell-to-cell variations due to manufacturing tolerances, thermal gradients, and aging disparities, which can lead to cell imbalance, generally limiting the usable capacity and reducing the driving range. Battery management systems also known as BMS use passive or active balancing strategies that usually operate on fixed rules and cannot be adapted to dynamic operating conditions or continuously changing cell health states. Recently advances in artificial intelligence and machine learning have opened new avenues for designing of intelligent BMS systems which enable adaptive state-of-charge and state-of-health estimation along with predictive cell balancing and dynamic battery pack reconfiguration. In this paper we have systematically reviewed the state-of-art AI based approaches for EV battery management published between 2021 and 2025 which cover machine learning algorithms for SOC/SOH prediction, different deep learning architectures for example LSTM CNN transformer, reinforcement learning for adaptive control and intelligent balancing techniques. Most importantly, we review conventional balancing methods along with emerging AI-driven techniques which can help us to identify the key research gaps which include hardware-related validation, scarcity of the dataset, and scalability challenges which exist. This review can also help us to propose future directions towards hybrid physics, ML models, digital twins, federated learning approaches, and standardized benchmarking protocols. This detailed review discussed in the paper serves as a roadmap for researchers and practitioners for developing next-generation intelligent BMS systems focused on safe, efficient, and long-lasting EV battery systems.

ICRAMEN_2026_053

**DEVELOPMENT OF STACKED DIELECTRIC RESONATOR ANTENNA WITH
MICRO-STRIP FEED**

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Abstract- This paper presents an analysis of stacked rectangular dielectric resonator antenna using microstrip feed. We have designed this antenna to work in sub 6-G band for high speed applications. This antenna operates at resonant frequency 4.5 GHz. Results show minimum levels of co and cross polarization levels of E and H field is less.

Keywords: Rectangular Dielectric Resonator Antenna, Microstrip feed

ICRAMEN_2026_054

India specific scenario generation for autonomous vehicles to enhance vehicle safety

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Abstract- Autonomous Driving in India requires a strong perception system which is dependable in Unstructured traffic conditions which can be seen in India. This paper presents multimodal perception framework to deal with problems such as unpredictable behaviour of pedestrian, weak lane discipline, deteriorated road infrastructure etc. Different scenarios are created to depict a real-world scenario in roadrunner simulation environment for stationary objects and bad weather conditions. The system collects information from multiple sensors such as camera, LiDAR and RADAR and combines it using a sensor fusion approach. By combining data from different sensors, the system avoids depending on a single path of information and improves the overall reliability and accuracy of the results. Experimental observations shows that the system can constantly detect objects and calculate their distances using data from these sensors.

ICRAMEN_2026_075

Development of a Unity Based AR Application of Automotive Chassis Load distribution

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Abstract-Immersive technologies are the future of learning methodologies in engineering education, particularly in the automobile domain where strong visualization and conceptual understanding is required. In chassis body engineering, students traditionally rely on theoretical formulations, diagrams, two-dimensional images, and online video resources to understand complex topics such as static and dynamic load distribution. This paper represents development of marker less Augmented Reality AR based applications designed to enhance experience in learning automotive chassis engineering. Developed using Unity, the system integrates CAD models imported from standard design software and provides an interactive user interface combining essential theoretical concepts with AR-based visualization. The application utilizes plane detection to detect the surface so as to position the chassis models in a real environment, allowing users to scale, rotate, and examine them from multiple angles. It also includes controls to toggle static and dynamic load conditions, enabling real-time visualization and comparative analysis of load distribution across different chassis configurations. The proposed approach improves spatial understanding and engagement by bridging the gap between theory and visualization. The framework demonstrates the potential of AR in engineering education and can be extended to include stepwise theoretical analysis and visualization of other automotive systems.

ICRAMEN_2026_082

Analytical and Neural Strategies for Solving Differential Equations: Towards Complementary Frameworks

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Abstract: Differential equations are the backbone of mathematical modelling in science and engineering. Solving DE is a major task in all filed because of their complexity. There are various methods to solve DE, one of the traditional methos is transform technique. It takes important role in analysing and solving DE by converting them into algebraic expressions. The mainly used transform techniques are Laplace and Fourier transforms. Because of the varies types of DE, transform techniques have some limitations especially when the DE are nonlinear and high-dimensional in nature. In recent years, neural networks are used as an alternative for solving DEs. This paper details various approaches to solving DEs, mainly analytical methods, transform techniques, and neural network strategies with comparison and conclude with hybrid approaches which lead to future developments in solving real-world problems.

Keywords: Laplace transform, Fourier transform, Z- transform, Neural network and hybrid model.

ICRAMEN_2026_088

A Comprehensive Review on Design of Energy Harvesting Antennas for Charging Low Power Devices

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Abstract-With the increase in low-power electronics applications such as the Internet of Things (IoT), wireless sensor networks, and wearable electronics, there is an increasing demand for renewable energy sources that go beyond conventional battery systems. In this context, radio frequency energy harvesting (RFEH) is emerging as a viable technology that allows for the harvesting of ambient electromagnetic energy with conversion into usable electrical energy. This review discusses the state-of-the-art in the area of energy harvesting antennas, including their design methodologies, performance metrics, and implementation issues. It reviews various antenna configurations applicable to energy harvesting, such as wideband, multiband, and fractal antennas and their integration with rectifying systems to form complete rectenna systems. Much progress has been made on various technical issues, including impedance matching methodologies, device performance improvements through optimization and miniaturization techniques for harvesting systems. Further, in the area of metamaterials, intelligent systems and hybrid energy harvesting technologies are emerging as possible solutions to the problems highlighted in this review of the available literature. The purpose of this review is to provide an account of most of the significant papers that have been published recently and to elucidate the current progress in this area, as well as to highlight persistent problems and possible future approaches for the development of efficient energy harvesting antennas for low-power devices.

Keywords: RF Energy Harvesting, Rectenna, Microstrip Patch Antenna, Triple-Band Antenna, IoT, Voltage Doubler Rectifier.

ICRAMEN_2026_105

Early Diagnosis of Diabetic Retinopathy using Machine Learning

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Abstract- Diabetic retinopathy (DR), or the destruction of retinal cells, is one of the most common consequences of diabetes and hence the significant decline of vision. If the condition is not recognized and treated in time, it might cause the occurrence of blindness that cannot be undone. Unfortunately, DR does not have a permanent cure, hence, proper diagnosis and efficient management are the only ways to avoid loss of sight. Normally, the doctors who specialize in eye disorders scrutinize the images of the retina taken with a fundus camera to detect signals of the disease. Nonetheless, this manual process is usually very expensive, requires a lot of time, and is prone to errors made by a human being. Recently, however, computer-aided diagnosis has come forth as a more convincing option. Among the various approaches, deep learning has taken the lead due to its considerable impact on medical image analysis, where the superiority of convolutional neural networks, also in identifying and analyzing retinal pictures has been proven, they are applied for the assessment of medical images. The most recent methods for the analysis and identification of DR using color retinal photography determined by algorithms based on deep learning were found and verified in this study. Moreover, the color of the fundus in the visual DR data was examined. Moreover, the paper points out some problematic areas that need to be researched more. The proposed system achieved an accuracy of 96.62% using Random Forest classifier on the MESSIDOR dataset, demonstrating its effectiveness for automated diabetic retinopathy screening.

Keywords— Diabetic Retinopathy (DR), Fundus Image, convolutional neural networks, Automated Disease Classification etc.

ICRAMEN_2026_106

Algorithmic approach and comprehensive review of connected certified domination in graphs

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Abstract- This paper presents a algorithmic framework for connected certified domination number and comprehensive review of the research concerning Connected Certified Domination (CCD) in graph theory, focusing on the parameter known as the Connected Certified Domination Number. The CCD concept integrates three fundamental constraints: domination, certification, and connectivity. Motivated by applications in secure and fault-tolerant network design, this review synthesizes the key theoretical developments across various facets of the field. We survey the characterization of Connected certified domination number for fundamental graph classes, including explicit formulae for paths and cycles and explore its relationships with other classical domination parameters such as domination number and connected domination number. Furthermore, we analyze the structural properties of graphs concerning CCD, examining extremal graphs and results of the Nordhaus-Gaddum type. Crucially, the paper addresses the algorithmic and computational complexity of the CCD decision problem, confirming its NP-completeness for general graphs while noting polynomial-time solutions for restricted classes like trees. Also we have added an efficient algorithm, supported by a flowchart representation, is proposed to compute the connected certified domination number (CCDN) of a graph. The review concludes by highlighting current open problems and charting future directions for research in applied graph theory. Keywords: Connected certified domination number, criticality of CCDN, stability, bounds, algorithm to find CCDN.

ICRAMEN_2026_107

Design and Development of a IoT Based Smart Animal Tracker

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Abstract - The rapid growth of the Internet of Things (IoT) has enabled the development of intelligent monitoring systems across various domains, including agriculture and animal management. This paper presents an IoT- based Smart Animal Tracker designed to provide real-time location tracking and monitoring of animals using GPS and GSM technologies integrated with a microcontroller-based system. The proposed system continuously collects location data and transmits it to a cloud platform or mobile application for remote access. Additionally, the system incorporates geo-fencing to generate alerts when animals move beyond predefined boundaries. The collected data is stored for analysis, enabling efficient livestock management and theft prevention. The proposed solution is cost-effective, reliable, and user-friendly, making it suitable for farmers, pet owners, and wildlife monitoring authorities. The system demonstrates the practical implementation of IoT in improving animal safety and smart farm management. **KEY WORDS** IoT: Internet of Things GPS: Global Positioning System GSM: Global System Mobile Communication GEO-Fencing: Geographical Fencing RFID: Radio Frequency Identification ESP32: Espressif 32-bit Microcontroller IDE: Integrated Development Environment GPRS: General Packet Radio Service

ICRAMEN_2026_112

AR/VR Based Multimodal Learning Platform for Dyslexic Students

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Abstract-Dyslexia is referred to as difficulty in learning to decode (read aloud) and to spell. Many students affected with dyslexia find traditional classroom learning stressful because it mostly depends on books and written content. To solve this issue, we put forward a web-based AR/VR learning platform that supports dyslexic students through visuals, audio, interaction, and voice-based activities. The system uses Augmented Reality (AR), Virtual Reality (VR), story-based learning, quizzes, and audio tests. In assessment activities, students are presented with a letter or word and speak it aloud, with correctness verified by the system using speech recognition. This paper describes the design, technical implementation, and educational benefits of the proposed platform, and demonstrates how AR/VR-based learning can make education easier and engaging for dyslexic students. Additionally, this work introduces great contributions including a GRU-based personalization pipeline, an event-sourcing model for interaction tracking, and a privacy-preserving analytics framework.

ICRAMEN_2026_122

Real-Time Gesture-Controlled Robotic Simulation Using Sensor Glove and Human Computer Interaction

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Abstract - The ESP32-based Smart Glove controller that allows intuitive, real-time object control via Wi-Fi is considered in this work. It utilizes the MPU6050 IMU module for wrist rotation measurement (pitch/roll/yaw if enabled), as well as five flex sensors for measuring finger bend angles. The controller is capable of running on AP mode with a built-in web application. It allows direct user interaction and transmitting sensor measurements to the client in real time through the WebSocket protocol. Among the most significant features of the developed glove controller, one can note a robust calibration process to set the starting position and define a gravity direction frame, as well as advanced signal processing algorithms involving sensor readings smoothing and delta-range dynamic learning based on a user-specific range of flex sensor output variations. Additionally, the sophisticated grip detection algorithm that utilizes finger-bend angles averaging with hysteresis is used to avoid accidental toggling when a certain hand position is detected. Finally, the web application allows choosing different objects and controlling their “grab” and “drop” status through spatial movement and grip gesture recognition. Keywords ESP32, Smart Glove, Gesture Recognition, Inertial Measurement Unit, Flex Sensors, WebSockets, Human-Computer Interaction, Real-time Control

ICRAMEN_2026_124

“Design and Development of a Next- Generation IoT and AI-Integrated Earthquake Early Detection and Warning Framework for Public Safety”

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Abstract— Earthquakes occur suddenly and unpredictably, often resulting in severe loss of life and damage to infrastructure. Early detection using Primary (P) waves can significantly reduce these impacts by providing critical warning time before destructive Secondary (S) waves arrive. This paper presents an accurate, low-cost, and real-time earthquake detection and alarm system based on a Wireless Sensor Network (WSN), ESP32 microcontrollers, and machine learning techniques. The proposed system employs ADXL335 accelerometer sensors to capture ground vibration data, which is processed locally on ESP32 nodes using a logistic regression model for earthquake classification. Feature extraction is performed by calculating the standard deviation of tri-axial acceleration signals, enabling fast and efficient detection with minimal computational overhead. The system integrates a star-topology WSN and utilizes Firebase for real-time data synchronization with mobile and web applications. Alerts are delivered through both hardware buzzers and mobile voice notifications to ensure timely user response. Experimental evaluation using a custom-built shaking table demonstrates a detection accuracy of 95.3%, with earthquake identification achieved within 0.5–1 second. The total alert delivery time, including network latency, ranges between 7.5 and 12.5 seconds. The results confirm that the proposed system provides a reliable, scalable, and cost-effective solution for early earthquake warning with simple and accessible user interaction.

Keywords— Skin Disease Classification, Deep Learning, Convolutional Neural Networks (CNN), Vision Transformers (ViT), Explainable AI (XAI), Grad-CAM, SHAP, LIME, Generative Adversarial Networks (GANs), Data Augmentation, Model Compression, Mobile Deployment.

ICRAMEN_2026_125

Hybrid Attendance System using Smart Card and Wireless ESP 32

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Abstract. This thesis presents a Smart Attendance System using ESP32 microcontroller technology, designed to provide a contactless, automated, and efficient solution for attendance tracking in educational institutions and workplaces. The system consists of two ESP32 devices: a master unit and a slave unit. The slave device acts as a portable identity tag, displaying the user's name on an OLED screen and powered by a rechargeable battery, while the master device functions as a central receiver. Communication between the devices is established using the ESP-NOW protocol, a low-power, peer-to-peer wireless communication method that enables fast and reliable data transmission without requiring continuous internet connectivity. When the slave device enters the range of the master device, it automatically transmits user information, including ID, name, and timestamp. The master device receives this data and uploads it to a cloud-based platform using the Google Sheets API, ensuring real-time, secure, and easily accessible attendance records. This eliminates the need for traditional methods such as manual registers, biometric systems, or RFID-based solutions, which often involve higher costs, physical contact, and maintenance complexity. The proposed system is designed to be cost-effective, energy-efficient, and highly scalable, making it suitable for modern environments that require mobility and flexibility. Performance evaluation demonstrates reliable communication, low power consumption, and accurate data logging. The system also enhances user privacy and reduces administrative workload, offering a practical and innovative alternative to existing attendance tracking methods.

ICRAMEN_2026_131

Securing Elections for Digital Voting System with Blockchain Technology

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Abstract- Traditional voting systems face significant challenges, including vote manipulation, fraud, inefficiencies, and lack of transparency, which undermine public trust in democratic processes. This research proposes a blockchain-based digital voting system designed to enhance security, transparency, and efficiency in elections. By leveraging the Ethereum blockchain and Solidity smart contracts, the system ensures that all votes are immutably recorded, preventing tampering or unauthorized alterations. Aadhaar-based voter authentication strengthens eligibility verification, reducing impersonation and duplicate voting, while the InterPlanetary File System (IPFS) provides decentralized storage of electoral documents, enhancing resilience against data loss or breaches. The frontend, developed with Next.js and Semantic UI React, offers an intuitive and accessible interface to encourage voter participation. Smart contracts automate vote recording and real-time tallying, minimizing human error and ensuring accurate election results. Rigorous testing—including unit, integration, and functional tests—validates system performance, security, and usability. The proposed system demonstrates a practical, scalable approach to modernizing elections, fostering public trust, and supporting the integrity of democratic processes worldwide. Keywords: Blockchain-based voting, Smart contracts, Aadhaar authentication, Decentralized storage, Election transparency.

ICRAMEN_2026_143

Indigenous Machine Learning-Based Fleet Management System for Municipal Corporations: A Framework for Sustainable Urban Logistics and Data Sovereignty

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Abstract — Rapid urbanization in India has created a logistical crisis for municipal corporations in areas such as fleet management, solid waste handling, water distribution, and infrastructure maintenance. Traditional methods like static scheduling, manual oversight, and dependence on foreign software have led to inefficient resource utilization, higher operational costs, environmental degradation, and concerns over data sovereignty under the Digital Personal Data Protection (DPDP) Act. This research proposes an indigenous, machine learning-based solution using a hybrid framework that combines DBSCAN for dynamic demand clustering and a customized Genetic Algorithm integrated with Google OR-Tools to solve a multi-objective capacitated vehicle routing problem with time windows. The model incorporates green routing objectives to reduce carbon emissions and balance driver workloads. Tested on synthetic data representing large Indian cities, the system achieved a 19.1% reduction in emissions and a 20% improvement in fleet utilization compared to traditional methods, demonstrating that open-source, locally developed solutions can provide a secure, cost-effective, and sustainable alternative aligned with Atmanirbhar Bharat and global sustainability goals.

ICRAMEN_2026_160

Transient Stability Enhancement in IEEE 14-Bus Power System Using PSO-Optimized Unified Power Flow Controller

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Abstract—Transient stability has become a critical concern in modern power systems due to increased loading, frequent disturbances, as well as reduced system inertia associated with renewable energy integration. The present work investigates the enhancement of transient stability in IEEE 14 bus system using a Unified Power Flow Controller coordinated with Particle Swarm Optimization for adaptive parameter tuning. The objective is to minimize the rotor angle deviations, reduce the settling time, as well as improve the overall damping performance under the severe fault conditions. A three-phase fault is applied at a critical bus, and system response is evaluated under the three scenarios, namely without UPFC, with the fixed parameter UPFC, as well as with the PSO optimized UPFC. The simulation results indicate that the proposed method reduces the maximum rotor angle deviation from 118° to 46° , while the settling time decreases from 6.2 s to 1.8 s. Additionally, the critical clearing time improves from 0.21 s to 0.34 s, which demonstrates the enhanced stability margin. The speed deviation is also reduced from 0.045 p.u. to 0.015 p.u., which confirms the improved damping characteristics. The novelty of the study lies in the systematic integration of PSO based adaptive control with the UPFC in the standard benchmark system, which provides the robust as well as efficient framework for the stability enhancement in the modern power networks.

Keywords—Transient Stability, UPFC, PSO, FACTS, IEEE 14-Bus System, MATLAB/Simulink

Track

Civil Engineering and Sustainable Infrastructure

ICRAMEN_2026_015

Structural Evaluation and Retrofitting of a Commercial Building

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Abstract -This paper describes of structural evaluation and retrofitting of a commercial building. It explains the need for strengthening of columns as the building is being added with an extra story. This procedure starts by gathering information about the existing building from the building owner. The AutoCAD plan with structural details is acquired and then the non-destructive tests are performed to know the current strength of the existing building. The building is analyzed for the current loads and the additional loads using ETABs software. Suitable retrofitting methods are then selected for the under-strength elements to increase the strength and the designs are done manually for selected methods. The best one is chosen and again analyzed in ETABs after retrofitting is done to the building. The existing footings are checked for additional loads from adding an extra story. The cost comparison is done between the selected retrofitting methods and then the thesis winded up with conclusions.

Keywords Retrofitting, Structural evaluation, NDT, AutoCAD, ETABs.

ICRAMEN_2026_016

A Comprehensive Analysis of Smart Traffic Management Systems for Emergency Vehicle Operations in Urban Networks.

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Abstract— Rapid urbanization and rising traffic congestion have greatly affected the operating efficacy of emergency vehicles in metropolitan traffic systems. When response times are too lengthy, urban emergency management systems don't work as well and public safety is at danger. Intelligent traffic management systems have become a viable option in this context, using cutting-edge communication technology, intricate control algorithms, and real-time data. This article gives a detailed look into intelligent traffic management systems for emergency vehicle operations in metropolitan networks, focusing on how well they operate, how adaptable they are, and how they affect overall traffic performance. The suggested system combines sensors that operate with the Internet of Things, communication between automobiles and infrastructure, adaptive signal management, and predictive traffic modeling to dynamically prioritize emergency vehicles while keeping the network stable. Comprehensive microsimulation studies were performed on a simulated urban traffic network under diverse traffic demand conditions and emergency situations. To measure success, we looked at things like the response time reduction ratio, the amount of time it took for vehicles to go through the network, the amount of pollution, the amount of fuel utilized, and the amount of time it took for emergency vehicles to get to their destinations.

The results show that the proposed intelligent traffic management system cuts down on the time it takes for emergency vehicles to get to their destinations and the time they spend waiting at intersections by a huge amount compared to traditional fixed-time control and basic signal preemption techniques. There have been no serious problems with non-emergency traffic while these renovations were being made. The plan helps long-term goals for urban transportation by cutting down on fuel usage and pollution. According to the study, intelligent traffic management systems might be a useful and scalable strategy to improve how quickly smart cities respond to emergencies.

Index Terms— Smart traffic management; Emergency vehicle priority; Intelligent transportation systems; Urban traffic networks; Signal pre-emption; Smart cities.

ICRAMEN_2026_017

Ambient Air Quality Status and Mapping of Criteria Pollutants using GIS-Bengaluru City, India.

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Abstract- Air quality is one of the major ecological parameters, which has been undesirably influenced by 28th economic development of the city. Quick urbanization and industrialization consume added unwanted elements to the unpolluted air and by this means increasing air pollution. Deterioration of the air quality is mainly due to fuel combustion activities like transportation, industrial, domestic sectors and re-suspension of road side dust which contributed to increasing pollution in Bengaluru city. The vehicles with poor quality continue to grow in multiple ratios, and the traffic congestion resulting from transportation changes, contributes even greater deterioration of environment in urban areas of Bengaluru city. Hence the main focus of present investigation was to ascertain the ambient air quality status at selected residential, industrial and sensitive areas of the city. The air quality data has been collected for major air pollutants like SO₂, NO₂ and RSPM from KSPCB for 12 AQM stations. The AQI analyzed over a period of years from 2021-24 reveals that 1 sensitive, 3 industrial, 3 commercial and 1 traffic junction areas.

Keywords: Air quality, Air Quality Index (AQI), Respirable Suspended Particulate Matter (RSPM), Geographical Information System, Automated Quality management.

ICRAMEN_2026_018

Analyzing Traffic Congestion and Signal Delays at Critical Intersections in Nagpur City

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Abstract— Traffic congestion at signalized intersections in Indian cities has worsened due to increasing car ownership and rapid urbanization, which has a detrimental effect on travel efficiency, safety, and environmental sustainability. Inadequate signal management, varied traffic conditions, and high traffic demand may make signalized crossings major bottlenecks in urban road networks. The purpose of this study is to analyze the performance of signal timing and traffic congestion at certain signalized intersections in Nagpur City. To represent the current traffic situation, measurements for signal timing, queue lengths, control delays, and traffic volume classifications were recorded during peak hours. Control delay, saturation level, queue length, and quality of service are some of the traditional traffic engineering indicators used to evaluate the intersection's performance. The results show that during peak hours, a number of junctions operate under oversaturated conditions, leading to long queues and substantial control delays—both of which contribute to less-than-ideal service levels. The main causes of congestion were identified as unbalanced turning movements, an inadequate distribution of green time, and geometric limits. The findings highlight the need of improving particular geometrical aspects and adjusting signals based on data in order to boost junction efficiency. This study sheds light on the effectiveness of junctions in a variety of traffic situations and provides practical recommendations for improving urban traffic management and developing long-term mobility plans for rapidly developing cities like Nagpur.

Index Terms— Traffic congestion, Signalized intersections, Control delay, Level of service.

ICRAMEN_2026_019

Analysis of Electric Vehicle Adoption Effects on Urban Mobility and Infrastructure Systems of urban areas of Nagpur city

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Abstract— Electric vehicle (EV) adoption is changing urban transportation networks, particularly in developing countries where congestion, pollution, and infrastructure difficulties are becoming worse. Nagpur is a rapidly developing Tier-II city in India, and this study looks at how the city's transportation and infrastructure systems have changed because of the rise of electric vehicles. This study uses secondary data on vehicle registrations, charging facilities, traffic composition, and emission parameters to examine trends in the penetration of electric cars, the geographical sufficiency of charging infrastructure, the effects on mobility patterns, the requirements for infrastructure, and the environmental consequences. The results show that the adoption of electric vehicles has been on the increase, with electric two- and three-wheelers taking the lead. These vehicles are crucial for last-mile connection. However, the development of charging infrastructure has lagged behind the popularity of electric cars, leading to disparities in coverage between regions and the prospect of future adoption restrictions. There has been no significant relief from congestion caused by the continued growth in total vehicle ownership, even if the adoption of electric vehicles does contribute to demonstrable improvements in tailpipe emissions of carbon dioxide and local air toxins. Combining car electrification with other comprehensive sustainable transport solutions, such as electrifying public transportation, developing infrastructure, and implementing coordinated energy-transport policies, is necessary to address systemic urban mobility concerns, according to the research. This study offers policymakers and urban planners options for balancing the environmental benefits of electric vehicles with successful urban mobility by providing real data from a medium-sized Indian metropolis.

Index Terms— Electric vehicles; urban mobility; charging infrastructure; transport electrification; air quality; sustainable transportation.

ICRAMEN_2026_020

Factors Influencing Independent Mobility and Mode Choice in School Transportation: A Behavioral Analysis

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Abstract— School bus riders' ability to choose their own route and method of transportation has a major impact on sustainable mobility, traffic congestion, and road safety. Using primary data collected from a survey of parents and guardians of school-aged children in Nagpur, India, this study investigates the behavioral factors impacting the choice of school transport mode and independent mobility. The results show that motorized transportation accounts for over 60% of school travel, with private autos accounting for roughly 30% of all trips, and active modes, such as walking and cycling, making for less than 30% of the total. Only 35% of the people who were evaluated had the ability to move about on their own, and this ability varies greatly between age groups, going from 15% in youngsters aged 6–9 to more than 65% in those aged 14–17. According to the results of the binary logit and probit models, there are many important aspects that impact a child's capacity to walk alone, including the child's age, the distance of the route, the presence or absence of pedestrian infrastructure, and the safety perceptions held by their parents. Increasing the sense of traffic hazard increases the probability of private automobile usage by more than 40%, according to the multinomial logit analysis of mode selection, whereas the possibility of walking falls dramatically beyond 1 km. The findings highlight how parental perspectives and behavioral factors significantly outweigh the effect of objective infrastructure conditions when it comes to deciding how students get to and from school. In order to improve autonomous and sustainable school transportation in medium-sized Indian metropolitan regions, the study emphasizes the requirement of integrated, child-focused, and perception-aware planning techniques.

Index Terms— Independent mobility; School transportation; Mode choice behavior; Travel behavior analysis.

ICRAMEN_2026_023

Comparative analysis of Impact of Non-Motorized Traffic on Signalized Intersection Performance

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Abstract— In developing countries, signalized intersections handle a variety of traffic situations, with a large amount of urban transit being non-motorized traffic (NMT), which includes pedestrians, bicycles, and cycle-rickshaws. Conventional methods of assessing junction performance, which were primarily developed for consistent traffic, often fail to adequately include the operational impacts of non-motorized transport (NMT). In mixed- traffic areas, this study compares the effects of motorized and non-motorized traffic on the effectiveness of signalized crossings. Information was collected at four urban signalized crossings that were classified according to the level of non-motorized transport (NMT) impact: low (<10%), medium (15-25%), and high (>30%). There was an evaluation of critical performance metrics including saturation flow rate, average control delay, queue length, and quality of service via analytical delay models and field observations. The results show that saturation flow rate decreases significantly when NMT is present; for example, at low NMT crossings, the average value drops to almost 1800 veh/h/lane, while at high NMT junctions, it drops to about 1400 veh/h/lane, a loss of about 25%. During peak hours, the average control delay increased from 28–35 seconds per vehicle under low non-motorized transport (NMT) conditions to more than 90 seconds per vehicle at high NMT crossings, demonstrating a non-linear relationship with the quantity of NMT. Without specifically accounting for NMT effects, classic delay models anticipated delays that were 30–40% longer than what was actually seen. Queue length analysis revealed a 35-45% increase in NMT effect junctions compared to fewer NMT impact areas. According to regression analysis, there is a strong positive relationship ($R^2 = 0.78$), confirming that NMT is a statistically significant factor in determining how well an intersection performs. The findings highlight the shortcomings of existing performance evaluation methods in various traffic situations and show that non-motorized traffic has a substantial impact on the functioning of signalized crossings. The study highlights the need of including adjustment factors particular to NMT into approaches for capacity and delay computation in order to provide more accurate analysis and complete plans for urban traffic management.

Index Terms— Non-motorized traffic, Signalized intersections, Mixed traffic conditions, Control delay, Saturation flow, Intersection performance evaluation.

ICRAMEN_2026_029

Performance Assessment of Saturation Flow Estimation Models for Heterogeneous Urban Traffic: Evidence from Signalized Intersections in Mumbai

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Abstract— Signalized intersections in developing nations deal with a multitude of traffic conditions, much urban transit is the non-motorized traffic (NMT), composed of pedestrian, bicycles, and cycle-rickshaw. Traditional techniques of measuring junction performance which were mainly designed to measure regular traffic usually do not provide a proper measure of the operational effects of non-motorized transport (NMT). This paper is a comparative study of the impact of motorized and non-motorized traffic in signalized crossings in mixed-traffic regions. Data were obtained in four crossings in the cities that are signalized and were categorized based on the proportion of non-motorized transport (NMT) affected: low (<10 percent), medium (15-25 percent), and high (>30 percent). Critical performance measures such as saturation flow rate, average control delay, queue length and quality of service was evaluated through analytical models of delay and field measurements. The findings indicate that there is a huge reduction in the saturation flow rate in the presence of NMT, whereby at low NMT crossings the saturation flow rate is reduced to nearly 1800 veh/h/lane, whereas at the high NMT crossings, it is reduced to approximately 1400 veh/h/lane, equivalent to a loss of approximately 25. At peak times, the mean control delay of vehicles of 2835 seconds in low non-motorized transport (NMT) conditions grew above 90 seconds per vehicle in high NMT crossings, showing a non-linear dependence on the number of NMT. Classic delay models not explicitly considering effects of NMT had predicted delays which were 30-40% slower than they had been observed. The queue length analysis indicated that NMT effect junctions were more by 35-45 percent than NMT impact areas. Regression analysis reveals that the relationship between NMT and the performance of an intersection is a strong and positive relationship ($R^2 = 0.78$), which proves that NMT is a statistically significant predictor of intersection performance. Its results indicate the inadequacy of the current performance evaluation approaches in different traffic scenarios and indicate the fact that non-motorized traffic can significantly affect the operation of signalized crossings. The research notes that in the efforts to compute capacity and delay of the urban traffic, the adjustment factors specific to NMT have to be incorporated into the study to give a more realistic analysis and comprehensive plans of the traffic management.

Index Terms— Non-motorized traffic, Signalized intersections, Mixed traffic conditions, Control delay, Saturation flow, Intersection performance evaluation.

ICRAMEN_2026_031

Analytical Comparison of Open Roads and Civil 3D Platforms for Highway Infrastructure Design

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Abstract— The design processes have been transformed through the use of digital design platforms in transportation infrastructure projects that have enabled the use of data-driven modeling, higher accuracy, and multidisciplinary collaboration. The OpenRoads Designer by Bentley and Autodesk Civil 3D are popular modeling tools of highway design. Though they are very common in the professional practice, these platforms have not been compared systematically when it comes to highway infrastructure design. This paper compares OpenRoads Designer and Civil 3D as the contemporary roadway design systems. The case study of an identical highway corridor was constructed in both software systems as a comparative analysis one by one. In order to remove the input bias and provide mutual consistency, the computational parameters, the geometric design standards and standardized input data were utilized. The assessment model was based on the efficiency of the corridor modeling, the ability to design the geometry, the ability to propagate the design modification and update, the administrative nature of data and interoperability, the output with estimate of quantities. Objective study was done by quantitative criteria such as quantity consistency, design time and qualitative such as process complexity and usability. The ease of learning and instead greater flexibility when it comes to geometric design suggest that Civil 3D can be used on smaller to medium-sized transport projects and CAD- based processes. Complex and iterative design modifications constrained the performance of the stability of the corridors and update propagation. Conversely, Open Roads Designer worked better in parametric corridor modelling, automatic design update, and consistency in quantity estimate in large scale BIM oriented highway infrastructure projects. The model-based and rule-based nature of Open Roads reduced the human intervention and enhanced the reliability of design. The results indicate that the design software of transportation infrastructure should be selected according to the size and complexity of the project, as well as demands in organizational workflow not according to the familiarity with the tool. This comparative review of two large roadway design platforms in a systematic and comparative way offers useful information to engineers, planners and infrastructure organizations. Therefore, it assists in the decision-making of digital highways engineering.

Index Terms— Highway infrastructure design; OpenRoads Designer; Civil 3D; BIM; corridor modeling; geometric design; software comparison.

ICRAMEN_2026_032

Seismic Performance Evaluation of Reinforced Concrete Buildings on Sloping Ground with Optimized Shear Wall Placement

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Abstract- Rapid urban expansion within the hilly regions has increased the demand for reinforced concrete buildings constructed on sloping terrain, where structural irregularities associated with uneven foundation levels significantly influence the seismic performance. Buildings located on inclined ground experience the stiffness asymmetry, unequal column heights, as well as torsional response during earthquake excitation, which may affect the structural safety when the structural configuration is not carefully designed. The present study examines the influence of the shear wall placement on the seismic response of the multi storey reinforced concrete building constructed on the sloping ground. The G+10 building model was developed using the ETABS software and the structural analysis was performed through the response spectrum method according to the provisions of the IS 1893 (Part 1):2016. Four structural configurations were investigated, which include the bare frame model as well as the three shear wall arrangements placed at the central core, the building corners, and the building perimeter. The analytical outcomes indicate that the incorporation of the shear walls considerably enhances the structural performance where the reduction in the lateral deformation and the torsional response was observed. The maximum roof displacement in the Seismic Zone V decreased from 118.6 mm in the bare frame configuration to 74.5 mm in the peripheral shear wall configuration, which corresponds to nearly 37% reduction. The maximum storey drift decreased from 11.3 mm to 7.1 mm, where the torsional irregularity ratio was reduced from 1.28 to 1.07. The results demonstrate that the peripheral placement of shear walls provides the most effective configuration for improving the seismic stability of reinforced concrete buildings which is constructed on the sloping terrain.

ICRAMEN_2026_033

Evaluating the Impact of the Chennai Metro Rail System on Traffic Congestion and Travel Behavior in Chennai City

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Abstract- Rapid urbanization and motorization have significantly transformed transportation systems in metropolitan cities across developing countries. The unprecedented growth in private vehicle ownership, coupled with inadequate expansion of road infrastructure, has resulted in severe traffic congestion, increased travel time, higher fuel consumption, and deteriorating air quality. Urban congestion not only affects commuter productivity but also imposes substantial economic and environmental costs on cities. In this context, sustainable and high-capacity public transportation systems have become essential for ensuring efficient urban mobility. In India, metropolitan cities have witnessed exponential growth in vehicular population over the past two decades. This surge has intensified traffic congestion, particularly in central business districts and major arterial corridors. Conventional bus-based public transport systems, although extensive, often face limitations in terms of speed, reliability, and passenger capacity due to mixed traffic conditions. Consequently, metro rail systems have emerged as a preferred mass rapid transit solution to mitigate congestion and provide a reliable alternative to private vehicles. Chennai, one of India's major metropolitan cities, has experienced rapid urban expansion, industrial growth, and increasing travel demand. The steady rise in two-wheelers and cars has contributed to recurring congestion across key corridors of the city.

ICRAMEN_2026_042

Feasibility Assessment of Automated Rapid Transit System in BKC, Mumbai

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Abstract-The Bandra Kurla Complex (BKC) in Mumbai is one of India's most significant commercial districts, experiencing rapid growth in travel demand and severe last-mile connectivity challenges. Conventional modes such as taxis, autos, and buses are unable to efficiently handle peak-hour congestion, resulting in increased travel times, environmental impacts, and reduced mobility efficiency. In response, this study evaluates the feasibility of implementing an Automated Rapid Transit System (ARTS) as a sustainable, high-capacity, and technology-driven mobility solution for BKC. The paper conducts a comprehensive assessment based on technical, operational, economic, and environmental criteria. The analysis includes traffic survey interpretation, travel demand estimation, corridor alignment feasibility, projected ridership for future years, and benefit–cost evaluation. Findings indicate that ARTS demonstrates strong technical suitability within BKC's constrained right-of-way, high operational efficiency due to automated, on-demand service, and positive economic indicators including travel time savings and reduced vehicle emissions. The results confirm that ARTS can significantly enhance last-mile accessibility to BKC's business clusters while contributing to sustainable urban mobility. The study concludes that ARTS is a feasible and impactful transport solution for high-density business districts such as BKC.

Keywords: Automated Rapid Transit (ART), Personal Rapid System (PRT), Feasibility Assessment, Public Transport Modes, Last-Mile Connectivity, Bandra Kurla Complex (BKC), Travel Demand Analysis

ICRAMEN_2026_051

Hydro-chemical and Isotopic Assessment of Groundwater in Kozhikode, Kerala

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Abstract—Understanding groundwater quality and hydrological processes in the context of climate change, river basin management, and increasing flood events is vital for sustainable water resource planning. This isotopic hydrological study investigates the groundwater systems of Kerala’s Kozhikode district, focusing on urban and peri-urban zones that are particularly vulnerable to monsoonal variability and anthropogenic stress. Stable isotopes of oxygen (¹⁶O, ¹⁸O) and hydrogen (¹H, ²H or D) were used as conservative tracers to examine recharge sources, mixing processes, and the impacts of shifting climatic patterns. The local meteoric water line (LMWL), derived from δD and δ¹⁸O values, closely matches global trends while revealing distinct isotopic signatures for southwest and northeast monsoons—highlighting seasonal shifts critical to flood prediction and water availability. Hydrochemical analysis revealed strong correlations between electrical conductivity and major ions (Na⁺, K⁺, Ca²⁺, Mg²⁺, Cl⁻, HCO₃⁻/CO₃²⁻, SO₄²⁻), suggesting ongoing mineralization along groundwater flow paths. Although most groundwater samples were classified as freshwater (TDS < 1000 mg/L), localized brackish zones in urban coastal areas indicate saline intrusion or contamination from domestic wastewater—factors exacerbated by urban flooding and poor drainage infrastructure. Hill-Piper diagrams show shifting hydrogeochemical facies between pre- and post-monsoon periods, with dominant types such as Ca-Mg-Cl-SO₄ and Ca-Mg-HCO₃ reflecting both natural weathering and anthropogenic inputs. Rainfall recharge contributions to aquifers were quantified as 35% for urban alluvium, 39% for urban laterite, and 42% for peri-urban laterite, underlining the spatial variability in groundwater vulnerability and resilience. Notably, over 66% of urban and 95% of peri-urban aquifers in thick lateritic midland terrain were found to be exceptionally suitable for drinking water. These findings underscore the importance of integrating isotopic tools into flood risk management, aquifer recharge mapping, and climate-resilient urban planning—linking geological history with present-day challenges and future sustainability.

Keywords: Groundwater Quality, Piper plots, hydro geochemical, Electrical conductivity, Stable isotopic, Hydrology.

ICRAMEN_2026_057

Structural Performance Optimization of G+12 Reinforced Concrete Buildings Using Belt Truss and Outrigger Systems

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Abstract—Rapid urban expansion has intensified the requirement for multistory buildings capable of resisting lateral forces generated by wind and seismic activity. In mid-rise structures, the conventional reinforced concrete frame system often exhibits considerable lateral displacement and inter-story drift, which influences the structural response and the serviceability conditions. The present study examines the structural response of the G+12 reinforced concrete building incorporating the belt truss and outrigger system where the objective is the enhancement of lateral stiffness as well as the improvement of structural efficiency. The three-dimensional structural model was developed using the ETABS platform where multiple outrigger arrangements were positioned at different elevations of the building height. The structural analysis considered the gravity loads together with wind loads evaluated according to the provisions of the IS 875 as well as the seismic loads defined by the IS 1893. The analytical outcomes show that the conventional frame configuration produced the roof displacement of 112.6 mm under the seismic excitation. When the single outrigger was installed at the mid-height level corresponding to 0.5H, the displacement decreased to 76.8 mm which reflects the reduction of nearly 31.8%. The dual-outrigger arrangement generated the minimum displacement value of 69.2 mm and increased the overall structural stiffness by approximately 66.5% relative to the baseline structural model. The obtained results confirm that the optimized positioning of the belt truss and outrigger system significantly improves the lateral performance of the mid-rise building while preserving the efficient utilization of structural materials.

Keywords— Structural optimization, Outrigger system, Belt truss, Multistory buildings, Seismic performance, Lateral load resistance etc.

ICRAMEN_2026_059

Stabilization of domestic sewage blended red soil using bagasse ash

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Abstract. Domestic sewage contamination deteriorates the geotechnical properties of red soil by increasing plasticity and reducing strength. Stabilization using sugarcane bagasse ash (up to 20%) significantly improves strength and compaction characteristics through pozzolanic reactions, making it an effective and sustainable solution.

ICRAMEN_2026_062

Hydraulic Optimization of River Sub-Channels for Sediment Reduction and Pump Protection under Low Discharge Conditions: A Literature Review

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Abstract. Sediment-laden flow remains a major source of hydraulic efficiency reduction, deposition, clogging and wear in pumps, intakes, forebays and turbomachinery, especially during low flow conditions, in which uneven flow structures and local sediment deposition are exacerbated. This paper reviews the state of knowledge on hydraulic measurement and control to mitigate sediment problems and protect pumps, principally through geometric redesign, sediment-exclusion devices, numerical and physical modelling, turbomachinery erosion, smart control, and sediment properties. The literature indicates that geometric changes to intake channels, forebays, areas near pumps, and river sub-channels can increase flow uniformity and eliminate sediment deposition areas. Sediment exclusion structures consisting of submerged vanes, baffles, rectification devices, and overflow reservoirs also contribute to pump/forebay protection, but depend on hydraulic and geometric conditions for effectiveness. Numerical and experimental methods, particularly integrated CFD and physical model analysis, are the primary source of information for assessing design performance and erosion potential. In summary, the literature suggests that sediment control and pump protection constitute an integrated systems challenge involving interactions between hydraulic geometry, sediment transport, erosion control and system operation. Additional advancements require more standardised, validated and holistic approaches.

ICRAMEN_2026_070

Dynamic analysis of high-rise building using outrigger and belt truss system

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Abstract- The increasing trend of vertical development in urban regions has led to the construction of high-rise buildings, which are highly sensitive to lateral forces such as earthquakes and wind loads. Controlling lateral displacement and inter-storey drift is a critical aspect in the design of such structures. In this study, a 240.9 m high-rise reinforced concrete building is analyzed using ETABS software to evaluate the effectiveness of outrigger and belt truss systems. Three analytical models a conventional building, a single outrigger system, and a double outrigger configuration were compared. Dynamic analysis using the response spectrum method reveals that the double outrigger system reduces the natural time period from 10.1s to 8.1s and decreases peak wind displacement by approximately 20%. The findings indicate that the use of multiple outrigger levels significantly improves structural performance and lateral stiffness.

ICRAMEN_2026_087

Design And Optimization of Hinganghat Underground Sewerage Scheme Under Amrut 2.0 – A Review

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Abstract- Rapid urbanization in Indian towns has resulted in a substantial increase in wastewater generation, placing significant pressure on existing sanitation infrastructure. Underground sewerage systems are essential components of urban environmental engineering, ensuring safe collection, conveyance, treatment, and disposal of sewage while protecting public health and the environment. However, sewerage projects implemented at large scale often involve high capital investment and long-term operational commitments, making technical and economic optimization a critical requirement. The Hinganghat Underground Sewerage Scheme, implemented under the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2.0, is designed to provide comprehensive sewerage coverage to Hinganghat town in Maharashtra. Although the Detailed Project Report (DPR) complies with standard design guidelines, there exists considerable scope for optimization in terms of hydraulic design, pumping dependency, treatment configuration, and lifecycle cost efficiency. This review paper presents a critical assessment of the Hinganghat Underground Sewerage Scheme with a focus on identifying opportunities for technical optimization without altering the approved service area, population coverage, or functional objectives of the project. The study reviews existing literature, national guidelines, and best practices adopted in World Bank–assisted urban sanitation projects to evaluate alternative engineering solutions. Emphasis is placed on optimizing sewer network design parameters, reducing energy-intensive pumping systems, exploring decentralized treatment options, and enhancing overall system sustainability. The findings indicate that rationalization of pipe diameters, improved network alignment, gravity-based flow enhancement, and modular treatment approaches can significantly reduce capital and operation costs while maintaining or improving system performance. The study concludes that optimization-based planning under AMRUT 2.0 can lead to cost-effective, energy-efficient, and environmentally sustainable sewerage systems for medium-sized Indian towns.

Keywords: Underground Sewerage System, AMRUT 2.0, Sewer Network Optimization, Hydraulic Efficiency, Pumping Dependency, Sewage Treatment Plant, Urban Sanitation, World Bank Guidelines

ICRAMEN_2026_089

Impact of Food Delivery Vehicles on the Transportation System in Nagpur City

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Abstract- The rapid growth of app-based food delivery services has changed how people move within cities in India. This study examines how food delivery vehicles affect the transportation system in Nagpur, focusing on traffic congestion, parking issues, travel delays, and road safety. Data was collected through traffic surveys, field observations, and discussions with delivery riders and road users. The results show that delivery vehicles, mainly two-wheelers, increase traffic congestion in busy commercial areas, especially during peak hours. Frequent stopping, improper parking, and pressure to deliver orders quickly disturb traffic flow and increase the chances of accidents. However, these services also provide benefits such as better accessibility, reduced need for personal travel, and increased employment opportunities. The study suggests solutions like creating dedicated delivery parking areas, improving route planning, applying proper rules, and using smart traffic systems. These findings can help planners manage traffic more effectively while supporting modern delivery services in growing cities like Nagpur.

Keywords. Food delivery vehicles, Urban transportation, Parking behaviour, Road safety, Last-mile delivery, Smart traffic management

ICRAMEN_2026_091

Seismic Performance of Reinforced Concrete Buildings: A Study on Shear Wall Configurations and Filler Slab System

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Abstract. Reinforced concrete (RC) structures stand as enduring architectural elements which showcase exceptional strength and construction durability in their widespread usage. Earthquake-prone areas require evaluation of their seismic performance because these regions experience frequent seismic activity. The article examines how these structures respond to seismic activity by testing different shear wall designs and filler slab arrangements. The study aims to investigate the complete understanding of their operational functions to their beneficial effects which seismic protection systems can strengthen through their enhancements. The use of shear walls enables buildings to achieve higher stiffness while preventing excessive lateral movement through their lifter strength capacity. The material operates as a seismic protection system because it absorbs seismic energy through its permanent deformation process. Filler slabs function because they decrease the total building weight which results in decreased seismic force impacts and better energy dissipation for the structure. The development of advanced materials such as ultra-high-performance concrete (UHPC) and fiber-reinforced polymers (FRPs) has resulted in performance enhancements through better design of these elements. Prefabricated modular construction introduces advanced quality control systems which shorten operational time by decreasing multiple construction phases. Evidence shows that shear walls and filler slabs work together to achieve maximum performance when facing earthquake threats. The research results show new research paths which include smart materials and sensor technologies, performance-based design adoption, and sustainability in seismic design. The improvements establish essential resources which develop safe RC structures that withstand seismic events without sustaining damage.

Keywords— Earthquake resilience, filler slabs, prefabrication, reinforced concrete, seismic performance, shear walls etc.

ICRAMEN_2026_098

A Review of Hydraulic Erosion Mechanisms and Protection Techniques for Concrete in Hydraulic Structures

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Abstract. Reinforced concrete (RC) structures stand as enduring architectural elements which Abstract. Hydraulic erosion is a major cause of damage in concrete elements used in high-velocity hydraulic facilities, including spillways, stilling basins, tunnels, and sediment bypass channels. Surface wear develops through the combined action of abrasion, cavitation, turbulence, and moving sediment, gradually weakening concrete and, in difficult situations, impairing serviceability or causing failure. During the past two decades, extensive research has examined the influence of hydraulic conditions, sediment size and concentration, mixture proportions, aggregate type, and the use of fibers or supplementary cementitious materials on erosion resistance. Performance has been investigated through several laboratory approaches, notably ASTM C1138 and water-jet-based techniques that simulate wear mechanisms. More recently, advanced mixtures such as high-performance fiber-reinforced concrete, nano-silica- enhanced concrete, rubberized concrete, and geopolymer-based binders have demonstrated improved matrix compactness and greater mechanical toughness. This review compiles representative findings, compares conventional and emerging concrete types, and explains how both material properties and flow characteristics govern the erosion response. It also highlights unresolved issues, including coupled abrasion-cavitation effects, long-term durability, scale dependency, and the lack of unified standard testing methods for hydraulic concrete. Such insights support more reliable material selection and proportioning in the design of durable hydraulic infrastructure.

Keywords. Erosion, Abrasion resistance, Hydraulic structures

ICRAMEN_2026_101

Need of Feeder System to Enhance Connecting of Nagpur Metro Rail- A Review

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Abstract- Rapid urbanization in developing countries like India has resulted in significant transportation challenges such as traffic congestion, air pollution, increased travel time, and energy consumption. Metro rail systems have emerged as a sustainable and efficient mass transit solution; however, their success largely depends on effective first-mile and last-mile connectivity. The absence of a well-structured feeder system reduces accessibility and discourages commuters from using metro services. This review paper analyzes global and Indian literature on transit planning, feeder system optimization, commuter behavior, and multimodal integration. The study identifies key research gaps in the context of Nagpur Metro, including lack of demand-based feeder planning, poor integration, and absence of advanced optimization techniques. The paper concludes that an efficient feeder system is essential to improve metro ridership, accessibility, and sustainability. Keywords: Nagpur Metro, Feeder System, Last Mile Connectivity, Multimodal Transport, Feeder Bus Routes, Metro Ridership, Transit Accessibility, Public Transport Integration.

ICRAMEN_2026_103

Projecting future precipitation in Northern Iraq applying CMIP6 ensembles and LARS-WG model: A case study of Aqra Region

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ABSTRACT- Climate change presents a heavy burden to hydrological systems in the arid and semi-arid spheres, and thus, there is a need for precision at the local level in order to compensate for the negative impacts on water resources and agropastoral livelihoods. Accordingly, this investigation examines the consequences of climate change on the future precipitation patterns in Aqra City, Northern Iraq, using reliable statistical downscaling techniques. The main goal is to match the rainfall on a daily basis until the near future (2021-2040) using LARS-WG 8.0 stochastic weather generator. Calibration and validation were carried out with historical daily precipitation records taken from NASA, for the baseline interval 1985 - 2015. To account for uncertainties synonymous with the model and prospective socioeconomic pathways, ensemble outputs from General Circulation Models (GCMs), part of the CMIP6 initiative, using Shared Socioeconomic Pathways SSP245 and SSP585, were included in the analysis (six GCMs). Validation results show that the LARS-WG framework has a good fidelity in terms of reproduction of statistical signatures of the observed climate, in terms of good correlations in monthly means and standard deviations, as well as the ability to capture the seasonal wet and dry oscillations typical of this region. Forward-looking exhibits different variabilities in precipitation regimes, but exhibits large inter-model coherences in the set of GCMs selected for the analyses. These results provide key information to decision makers and water resource stewards to help develop sustainable adaptation strategies to offset the growing dangers of global warming.

Keywords: Iraq, Climate change, LARS-WG, CMIP6, GCMs

ICRAMEN_2026_108

Sensor-Based Early Warning and Intelligent Traffic Diversion Framework for Landslide Risk Mitigation in Valley Regions Using Hybrid Machine Learning

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Abstract- Landslides in the valley regions pose the serious threat to the transportation safety, particularly in the areas with the steep terrain as well as intense rainfall, where the existing monitoring approaches are often reactive and lack the integration with the traffic management systems, which limits effectiveness in preventing accidents. The present study proposes the sensor-based early warning as well as intelligent traffic diversion framework that combines real-time monitoring with the predictive analytics. The system utilizes multiple sensors to capture the vibration, the slope inclination, soil moisture, as well as rainfall, where the collected data is processed using the hybrid machine learning model integrating the Random Forest as well as LSTM for the risk classification. The proposed approach achieves the classification accuracy of 95.2%, with F1-score of 0.94 as well as false alarm rate of 3.8%, while the average detection latency is measured at 1.4 seconds, which enables the near real-time response. In addition, intelligent diversion mechanism reduces the traffic congestion by 41% and lowers the accident risk by 62.5% under the simulated conditions. The novelty of work lies in the integration of geotechnical sensing with the intelligent transportation control within unified framework, where the linkage of early warning signals with automated traffic diversion provides the practical as well as scalable solution for enhancing the road safety in the landslide-prone valley regions.

Keywords— Landslide Detection, IoT Sensors, Traffic Diversion, Early Warning System, Machine Learning, Smart Transportation etc.

ICRAMEN_2026_109

Seismic Vulnerability Assessment of Conventional RC and Monolithic Structures Using ETABS and Demand-Capacity Ratio Analysis

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Abstract—The seismic vulnerability of the reinforced concrete (RC) buildings remains major concern in the earthquake prone regions where the structural discontinuities as well as insufficient stiffness result in the severe damage. In context, the present study evaluates as well as compares the seismic performance of the conventional RC framed structures and monolithic systems using the ETABS platform, based on the response spectrum analysis in accordance with IS 1893:2016. The assessment focuses on key response parameters which include the base shear, storey displacement, storey drift, as well as the storey shear, along with the structural safety evaluation using Demand Capacity Ratio (DCR). The results indicate that monolithic structural system exhibits increase in the base shear of approximately 10–11 % because the stiffness remains higher, while the reduction in storey displacement of about 15–18 % is achieved across the seismic Zones II to V. The storey drift values for the monolithic system remain within permissible limits, whereas the conventional framed structure exceeds allowable limits in the higher seismic zones. Furthermore, DCR values greater than unity are observed in the several members of the conventional frame, which indicates the potential structural vulnerability, while the monolithic system maintains values within the safe limits. The novelty of the study lies in the integrated comparative analysis which incorporates the DCR based safety evaluation across the multiple seismic zones, which provides comprehensive understanding of the structural behaviour as well as demonstrates the effectiveness of the monolithic construction in enhancing the seismic resilience.

Keywords—Seismic vulnerability, ETABS, RC frame, monolithic structure, storey drift, base shear, DCR, response spectrum analysis.

ICRAMEN_2026_117

Review On Water Quality Monitoring Using RC Boat: A Technological Solution for Environmental Conservation

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Abstract- The significant impact of water pollution caused by discharge from industries, agricultural runoff, and uncontrolled waste disposal has made the quality of water and aquatic ecosystems a topic of discussion. The classic methods of water testing are usually manual, lengthy, and limited to specific sites which makes them not ideal for the monitoring of vast or distant water bodies. An IoT-enabled Portable Low- cost Remote-Controlled (RC) boat for real-time water quality monitoring is the subject of this project. To measure and transmit water quality parameters wirelessly, the pH and turbidity sensors, Arduino microcontroller, and ESP8266 IoT communication module are all part of the integrated system. By using a smartphone application, the RC boat can be navigated, thus allowing the users to collect data from different places in the water body. The real-time sensor readings are shown on the LCD of the boat as well as on the smartphone interface thus cloud servers or internet connection is not required. This solution will bring more accuracy, flexibility, and mobility to water quality assessment making it ideal for research, environmental protection, and sustainable water resource management.

Keywords: Water Quality Monitoring, IoT, RC Boat, pH Sensor, Turbidity Sensor.

ICRAMEN_2026_136

Integrated Strategies for Enhancing Construction Quality and Reducing Rework: A Focus on Workforce Competency, Proactive Quality Culture, and Leadership Communication in Indian Commercial and Infrastructure Projects

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Abstract—The construction industry is a cornerstone of economic growth and infrastructural development, yet its dynamic and complex nature makes it challenging to consistently maintain quality across project lifecycles. This research focuses on integrated strategies for enhancing construction quality and reducing rework, with a specific emphasis on workforce competency, proactive quality culture, and leadership communication in Indian commercial and infrastructure projects. The study examines how workforce skills, cultural commitment to quality, and leadership-driven communication can be systematically embedded into project practices. It highlights persistent issues such as inadequate training, ineffective communication flows, poor documentation, and weak supplier management, all of which contribute to rework and quality lapses. A structured methodology is applied to evaluate these factors across various project stages—from pre- construction to final handover. To address these challenges, the research employs tools and techniques such as Root Cause Analysis (RCA), Failure Mode and Effects Analysis (FMEA), checklists, quality audits, and real-time digital monitoring. It also explores contemporary frameworks including Total Quality Management (TQM), Lean Construction, ISO 9001 standards, and advanced technologies such as Building Information Modelling (BIM) and automation. The findings indicate that workforce competency development, proactive quality culture, and leadership communication must be integrated early and sustained throughout the project lifecycle. Embedding these strategies not only improves technical performance but also reduces costs, prevents rework, and fosters a culture of continuous improvement, accountability, and stakeholder satisfaction in Indian construction projects.

Keywords: Workforce Competency, Proactive Quality Culture, Leadership Communication, Rework Reduction, Construction Quality, Indian Commercial Projects, Infrastructure Projects, Total Quality Management (TQM), Lean Construction, Building Information Modelling (BIM), Continuous Improvement, ISO 9001, Stakeholder Engagement.

ICRAMEN_2026_137

Lifecycle Management of Self Redevelopment Project: From Feasibility To Handover

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Abstract—Self-redevelopment has emerged as a viable alternative for housing societies seeking to maximize benefits without relying on external developers. However, successful execution requires a structured lifecycle management approach. This research focuses on the end-to-end management of self-redevelopment projects, covering feasibility assessment, legal and regulatory compliance, project planning, tendering, financial benefits, and complete decision-making authority for society members. Several state governments and cooperative banks have also introduced schemes and financial support mechanisms to promote self-redevelopment. However, while the model has clear advantages, it also introduces financing, execution, monitoring, and final handover. A nine-step complex challenges, as housing societies must now manage methodology was developed, beginning with the preparation of a feasibility report, followed by legal clearances, committee formation, financial structuring, and transparent contractor responsibilities that are typically handled by professional developers. These include obtaining legal approvals, arranging finances, planning construction, managing contractors, and ensuring selection. The construction phase emphasizes quality control, risk quality and timely completion. Without structured management, management, and financial discipline, while the final stage ensures proper sales strategy, occupancy certification, and member satisfaction. The study highlights the importance of transparency, strong project management consultancy support, realistic financial models, and parallel approval processes to many societies face difficulties in execution, which may lead to cost escalation, delays, or even project failure.

ICRAMEN_2026_138

Economic analysis of concrete mix enhanced with orange peel based enzyme

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Abstract—Fermentation of orange peel enzyme , cube casting of raw M20 grade of concrete, cube casted with various samples , compressive strength to determine the strength of the orange peel enzyme in comparison of raw M20 grade of concrete without any admixture.

ICRAMEN_2026_139

Factors affecting labour productivity in the real estate industry and suggestions to improve

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Abstract. This research aims to identify the key factors influencing labour productivity in the real estate industry, particularly within the construction and property development sectors. Various elements, including workforce skills, technological integration, project management practices, and external economic factors, play a crucial role in shaping productivity levels. A structured questionnaire was developed based on a comprehensive review of relevant literature, and data was collected from construction sites. The Relative Importance Index (RII) method was applied to determine the most critical factors impacting productivity. The findings reveal that key challenges include work area restrictions, inspection delays, construction methods, a shortage of experienced labour, delays in decision-making, high-quality work requirements, and inadequate training. These factors align with previous studies emphasizing the need for improved safety standards, motivation strategies, and effective management techniques to enhance labour efficiency. Based on these insights, the paper proposes strategic recommendations to improve productivity, ultimately leading to enhanced project efficiency and profitability. Addressing these challenges through better workforce training, streamlined inspection processes, and modern construction techniques could significantly improve labour performance in the industry.

ICRAMEN_2026_140

High-Volume GGBS Concrete: Mechanical Performance and Carbon Reduction

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Abstract. Ordinary Portland Cement (OPC) has a high carbon footprint, which makes it a necessity to have sustainable substitutes in the production of concrete. This paper assesses the performance of high-volume Ground Granulated Blast Furnace Slag (GGBS) concrete with about 60 percent replacement of OPC in an M45 grade mix procured in a Ready-Mix Concrete (RMC) plant. The compressive strength was determined at 3, 7, 14, 28, and 56 days, and microstructure was studied using Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD) and Thermogravimetric Analysis (TGA). The findings have shown that the GGBS-based concrete meets target strength and with high long-term strength gain. Microstructural studies are consistent with the existence of dense hydration products, mostly C–S–H and C–A–S–H phases and low contents of deleterious compounds like delayed ettringite. The XRD data indicate that amorphous phases are predominant, and TGA confirms that it remains hydrated without the unwanted phase transformations. A carbon assessment in the form of a manual shows about 54% reduction of carbon emissions in comparison with OPC based concrete. The experiment establishes that high-volume GGBS concrete is a structurally acceptable and environmentally friendly product to use in modern construction.

ICRAMEN_2026_142

Strategic Planning for Balanced Urban Infrastructure Development of Thane City: A GIS-Based Planning & Primavera Scheduling Approach for a Selected Area of Wagle Estate

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Abstract — Rapid urban growth in Thane city has resulted in increased pressure on infrastructure systems and has led to the formation of unplanned settlements, particularly in areas such as Wagle Estate. The selected Area of Interest (AOI) in Hanuman Nagar represents a densely populated zone with irregular layouts, inadequate road connectivity, and insufficient basic infrastructure, including drainage and utility services. These conditions highlight the need for a structured and balanced planning approach. This study focuses on the use of Geographic Information Systems (GIS) for spatial analysis of the study area, including base mapping and terrain assessment using Digital Elevation Model (DEM) data. The analysis provides an understanding of existing site conditions and infrastructure gaps. Based on this, a conceptual line plan is developed to improve land use distribution, road connectivity, and provision of essential services, along with the inclusion of small commercial zones to support local employment. In addition to spatial planning, Primavera P6 is used to develop a project scheduling framework. Activities are identified, sequenced, and organized into a phased implementation plan based on logical dependencies. The scheduling analysis indicates that the proposed development can be executed within an estimated duration of 26 months under current planning conditions. The study demonstrates that the integration of GIS-based analysis with project scheduling tools provides a practical framework for planning and execution. While the current work is limited to a conceptual planning level, it establishes a strong base for further detailed GIS-based design and implementation in future stages.

Keywords—Arc-Gis, Construction Scheduling, Critical Path Method, Primavera P6, Work Break Structure, Resource Allocation, Mumbai Infrastructure, Urban Development.

ICRAMEN_2026_144

Treatment of Turbid Water Using Selected Plant Seed Coagulants: An Experimental Study

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Abstract- Urban lakes hold significant ecological importance and contribute greatly to sustainable urban development. However, rapid expansion of land use and the continuous discharge of domestic and industrial effluents have led to the degradation of these water bodies in recent years. This present study focuses on evaluating the physical, chemical, and biological characteristics of Futala Lake, located in Nagpur, Maharashtra. The present study aims at analysis of turbidity parameters of effluent and their reduction in concentrations in low and economical process. Discharging of effluent waste water without treating not only polluting surface water it may also show effect on ground water pollution and soil pollution. So, the effluent must be treated in a proper way to meet discharge level requirements. Thus, we have opted for Orange Peel, Neem seeds, Soyabean seeds, Tulsi seeds and Moringa Olifera seeds promising bio flocculant whose seeds are plentifully available in India which are popular and widely used in rural and tribal areas for the purification of water.

Keywords- Sustainable, Biocoagualnts, Futala Lake, Water Treatment, Turbidity, NTU, Plant Seeds

ICRAMEN_2026_146

Treatment of Municipal Wastewater Using Nature-Based Constructed Wetlands: Role of Plant Species and Media in Heavy Metal and Nutrient Removal

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Abstract: The increasing pressure on freshwater resources and the inadequacy of conventional centralized wastewater treatment systems in many developing regions have intensified the search for sustainable, low-cost, and ecologically sound alternatives. Nature-based solutions, particularly constructed wetlands (CWs), have emerged as promising decentralized technologies for treating municipal wastewater, offering the dual benefits of pollution control and ecosystem service enhancement. Constructed wetlands mimic natural biogeochemical processes, utilizing the synergistic interactions among wetland plants, filter media, and microbial communities to remove a wide range of contaminants, including organic matter, nutrients, and heavy metals. However, the treatment performance of CWs is highly variable and depends critically on the selection of appropriate plant species and the physical and chemical properties of the filter media. The role of these components in the simultaneous removal of nutrients (nitrogen and phosphorus) and heavy metals (such as lead, cadmium, copper, zinc, and nickel) from municipal wastewater remains insufficiently understood, particularly under the variable loading and climatic conditions typical of urban and peri-urban settings. This research aims to systematically evaluate the influence of plant species and media composition on the treatment efficiency of horizontal subsurface flow constructed wetlands for municipal wastewater, with a specific focus on nutrient and heavy metal removal. The study will be conducted using a pilot-scale wetland system comprising multiple treatment units, allowing controlled comparison of different design configurations. Three macrophyte species commonly used in CWs—*Phragmites australis* (common reed), *Typha latifolia* (cattail), and *Cyperus papyrus* (papyrus)—will be assessed for their growth characteristics, root zone development, and pollutant uptake capacity. Concurrently, four types of filter media—gravel, crushed brick, zeolite, and a mixture of sand and organic compost—will be evaluated for their hydraulic conductivity, sorption capacity, and long-term stability. The experimental design will follow a factorial arrangement, enabling the assessment of both individual and interactive effects of plant species and media types.

Keywords: Constructed wetlands; nature-based solutions; municipal wastewater treatment; nutrient removal; heavy metal removal; *Phragmites australis*; *Typha latifolia*; filter media; phytoremediation; subsurface flow; sustainable sanitation.

ICRAMEN_2026_147

Optimization of Chemical Dosing for Enhanced Treatment of Textile Industrial Wastewater

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Abstract: The textile industry, particularly denim washing operations, generates large volumes of complex wastewater characterized by high turbidity, intense color, elevated chemical oxygen demand (COD), and significant suspended solids due to the presence of dyes, surfactants, and processing chemicals. In the present study, wastewater samples were collected from the equalization tank inlet of Fabricraft Impex Pvt. Ltd., located at Wanjra Industrial Layout, Kamptee Road, Nagpur (India), to evaluate and optimize the chemical dosing strategy for primary treatment using coagulation–flocculation. The raw wastewater exhibited high pollutant load with COD of 1850 mg/L, BOD of 620 mg/L, TSS of 480 mg/L, turbidity of 850 NTU, and color of 1250 Pt-Co units, indicating the necessity of efficient treatment prior to discharge or further biological processing. Three commonly used coagulants—alum, ferric chloride, and polyaluminum chloride (PAC)—were evaluated along with polymer as a coagulant aid. Laboratory-scale jar test experiments were conducted under controlled conditions to determine the optimum coagulant dosage, pH, and settling time. The optimization study revealed that PAC combined with polymer demonstrated superior performance compared to other coagulants. At an optimum dosage of 60 mg/L PAC and 2.0 mg/L polymer at pH 7.2, maximum removal efficiencies of 88.2% for COD, 84.5% for BOD, 93.5% for TSS, 96.1% for turbidity, and 93.5% for color were achieved. The enhanced performance is attributed to effective charge neutralization, rapid floc formation, and improved settling characteristics. Additionally, the optimized dosing resulted in reduced chemical consumption and lower sludge generation compared to conventional dosing practices. The study highlights the importance of systematic optimization of coagulation parameters using experimental and statistical approaches for improving treatment efficiency and operational sustainability in textile wastewater treatment plants. The developed methodology provides a practical and scalable framework for industrial application, ensuring compliance with discharge standards while minimizing operational costs.

Keywords: Chemical dosing optimization; primary treatment; coagulation-flocculation; denim washing wastewater; wastewater treatment; coagulant dosage; response surface methodology (RSM); machine learning; operational cost reduction; industrial wastewater management

ICRAMEN_2026_149

Sustainable Biofilter Technologies for Domestic Effluent Treatment: Experimental Investigation and Process Modelling

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Abstract: The increasing generation of domestic wastewater in developing regions necessitates low-cost, energy-efficient, and environmentally sustainable treatment solutions. This study presents a comprehensive experimental and modelling investigation of sustainable biofilter technologies for domestic effluent treatment, focusing on the performance of four pilot-scale biofilter configurations: a conventional gravel biofilter (control), a biochar-amended biofilter, a woodchip-based denitrifying biofilter, and a polyculture vegetated biofilter (incorporating *Phragmites australis* and *Iris pseudacorus*). Each system was operated under identical hydraulic loading rates ($0.5\text{--}2.0\text{ m}^3/\text{m}^2\cdot\text{d}$) and organic loading rates ($15\text{--}60\text{ g BOD}/\text{m}^2\cdot\text{d}$) over a 12-month period, treating real domestic wastewater from a residential settlement. Experimental results demonstrated that the vegetated biofilter achieved the highest overall removal efficiencies, with mean reductions of 92% for biochemical oxygen demand (BOD), 88% for chemical oxygen demand (COD), 85% for total suspended solids (TSS), 68% for total nitrogen (TN), and 62% for total phosphorus (TP). The biochar-amended biofilter exhibited superior ammonium removal (81%) due to enhanced ion exchange capacity, while the woodchip biofilter showed the highest denitrification potential (TN removal up to 74%) under carbon-limited conditions. Conventional gravel biofilter yielded moderate performance (BOD removal 71–78%) but suffered from rapid clogging at higher loading rates. Vegetated systems also displayed significant reduction in pathogen indicators (faecal coliforms: 3.2 log reduction) and lower greenhouse gas emissions (CH_4 and N_2O fluxes reduced by 43–56% compared to non-vegetated units). For process modelling, four kinetic models – first-order, Monod, Stover–Kincannon, and a novel hybrid artificial neural network (ANN) – were calibrated and validated against experimental data. The Stover–Kincannon model provided the best fit for organic matter removal ($R^2 \geq 0.96$ for BOD and COD), while the hybrid ANN model accurately captured dynamic nutrient removal patterns ($R^2 \geq 0.91$ for TN and TP) under variable influent conditions. Model parameters revealed that hydraulic residence time (HRT) and vegetation density were the most sensitive factors influencing treatment efficiency. Sensitivity analysis further indicated that optimal performance occurs at $\text{HRT} \geq 8$ hours and organic loading rates below $40\text{ g BOD}/\text{m}^2\cdot\text{d}$. These findings confirm that sustainable biofilters, particularly vegetated and biochar-amended designs, offer robust, low-maintenance alternatives for decentralized domestic effluent treatment. The validated models provide reliable tools for process design, scale-up, and real-time performance prediction. Future work should focus on long-term biofilter resilience and integration with resource recovery (e.g., irrigation reuse).

Keywords: Sustainable biofilters; domestic wastewater treatment; experimental investigation; process modelling; biochar amendment; vegetated biofilters; nutrient removal; Stover–Kincannon model; artificial neural networks; decentralized sanitation

ICRAMEN_2026_153

Comparative Analysis of Landfill Sites in Baghdad: A Case Study of Al-Nubai and Al-Nahrawan Sites

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Abstract: This study presents a comparative analysis of waste inflow at two landfill sites in Baghdad—Al-Nubai and Al-Nahrawan—using statistical and time-series analysis methods. Data collected over twelve months reveals notable differences in waste volumes between the two sites. The results indicate that Al-Nahrawan consistently receives higher waste volumes than Al-Nubai, with Al-Nahrawan having an average waste inflow of 12% more than Al-Nubai over the year. Specifically, Al-Nahrawan saw its highest waste inflow in December, while Al-Nubai experienced a sharp spike in February. The time-series analysis shows growth rate fluctuations throughout the year: Al-Nahrawan exhibited a 20% increase in waste in February, whereas Al-Nubai had a smaller increase of 15%. March showed a decrease in waste at both sites, with Al-Nubai dropping by 5% and Al-Nahrawan by 3%. Despite these fluctuations, statistical analysis using a t-test revealed no significant difference in waste inflow between the two sites, with a t-statistic of -1.045 and a p-value of 0.306, indicating that the differences observed are not statistically significant. Additionally, predicted trends show a steady increase in waste for both locations, suggesting the need for adaptive waste management strategies. Both sites will likely experience increasing waste volumes, but Al-Nahrawan may require additional resources due to its higher waste accumulation. This analysis provides insights for improving waste management systems, optimizing resource allocation, and addressing seasonal fluctuations in waste generation at both landfill sites.

Keywords: Baghdad, Municipal Solid Waste, Al-Nubai Landfill, Al-Nahrawan Landfill, Comparative Statistical Analysis, Leachate Management, Sanitary Landfill Criteria, Environmental Impact Assessment, Soil Contamination, Waste Management Practices, Iraq.

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Smart Sanitation Systems for High-Density Urban Areas

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Abstract—As urban populations swell, traditional sanitation infrastructure is buckling under the pressure of high-density living, leading to public health risks, environmental degradation, and operational inefficiencies. Smart sanitation systems—integrating the Internet of Things (IoT), Artificial Intelligence (AI), robotics, and data analytics—offer a transformative pathway to sustainable, resilient, and equitable sanitation management in cities. IoT-enabled smart bins equipped with ultrasonic fill-level and gas sensors enable real-time monitoring, demand-driven collection, and automated alerts, reducing fuel consumption and preventing health hazards from overflowing waste. For sewer networks, low-cost sensors can monitor water levels, gas emissions, and vibrations, enabling predictive maintenance and preventing hazardous overflows. AI-powered computer vision systems, such as those deployed in Varanasi, detect littering and overflowing bins, triggering immediate responses and improving hygiene. Advanced non-sewered sanitation systems (NSSS) combining anaerobic membrane bioreactors with solar energy have been field-tested in South Africa, treating high-strength blackwater and achieving 97% nitrogen reduction while recycling water for toilet flushing, thus offsetting municipal water demand. Similarly, solar-powered electrochemical toilet units can recover macronutrients and produce disinfected water suitable for flushing or irrigation. Robotic systems like the Bandicoot Mobility+ have successfully cleaned over 5,000 manholes in Chennai, eliminating manual scavenging and enhancing worker safety through real-time camera monitoring and gas detection. Project SHUDH in Hyderabad integrates AI-driven predictive models and satellite-monitored GIS dashboards to forecast blockages and create live maps of sewer networks. Smart public toilets in Delhi (GARV) utilize RFID-IoT technology to monitor usage, water levels, and cleaning frequency, while AI-integrated green toilets with DRDO bio-digester technology are being deployed in Indian schools, featuring automated odour detection and auto-jet cleansing. Despite these advancements, challenges persist, including high costs, the need for data-driven planning, and integrating multiple co-existing systems in unplanned settlements. However, cities like Chennai, Visakhapatnam, and Hyderabad are demonstrating that strategic deployment of AI, IoT, and robotics can improve service efficiency, reduce complaints by up to 60%, and set national benchmarks. Future systems will focus on AI-powered predictive analytics, cloud-based digital twins, and circular economy models that recover water, energy, and nutrients. By embedding intelligence into sanitation, high-density urban areas can transform from crisis management to proactive, health-focused urbanism

Keywords: Smart sanitation, Internet of Things (IoT), Artificial Intelligence (AI), robotics, high-density urban areas, real-time monitoring, predictive maintenance, non-sewered sanitation systems (NSSS), anaerobic membrane bioreactor, solar-powered toilets, computer vision, smart bins, sewer network sensors, manhole cleaning robots, digital twins, circular economy, resource recovery, urban health, fecal sludge management.

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Development of an IOT-based decentralized greywater treatment system for urban residential buildings

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Abstract: Rapid urbanization and increasing freshwater scarcity have intensified the need for sustainable on-site wastewater management, especially for greywater originating from bathrooms, kitchens, and laundries in residential buildings. Centralized treatment systems often face limitations such as high capital costs, extensive piping networks, land constraints, and operational complexities, making them impractical for retrofitting in dense urban areas. This paper presents the design, development, and performance evaluation of an Internet of Things (IoT)-based decentralized greywater treatment system tailored for individual urban residential buildings. The proposed system integrates a compact physical treatment train comprising a coarse screen filter, a sedimentation tank, a sand and activated carbon filtration unit, and an ultraviolet (UV) disinfection chamber. To overcome the limitations of manual monitoring and delayed maintenance, the system incorporates IoT-enabled real-time sensing and automation. Key water quality parameters including pH, turbidity, temperature, and flow rate are continuously measured using calibrated low-cost sensors interfaced with an ESP32 microcontroller. The acquired data is transmitted wirelessly via Wi-Fi to a cloud-based platform (ThingSpeak) for remote visualization, trend analysis, and automated alert generation. An intelligent bypass valve mechanism is implemented: if treated water quality fails to meet prescribed non-potable reuse standards (e.g., turbidity > 5 NTU or pH outside 6.5–8.5), the system automatically diverts the water back to the inlet for retreatment, ensuring only compliant water is directed to end-use applications such as toilet flushing, garden irrigation, and floor washing. Preliminary laboratory-scale and field trials conducted over a four-week period demonstrated that the system achieves average turbidity removal exceeding 92%, chemical oxygen demand (COD) reduction between 75% and 85%, and complete elimination of total coliforms following UV disinfection. The IoT-enabled automation reduced manual intervention by approximately 80% and provided actionable predictive maintenance alerts based on filter pressure drop and UV lamp degradation. The decentralized nature of the system eliminates the need for extensive sewer modifications, reduces freshwater consumption by 35–45% per household, and offers a payback period of approximately 2–3 years through water savings. This work contributes a scalable, low-footprint, and cost-effective solution for urban water resilience, aligning with circular economy and smart city frameworks.

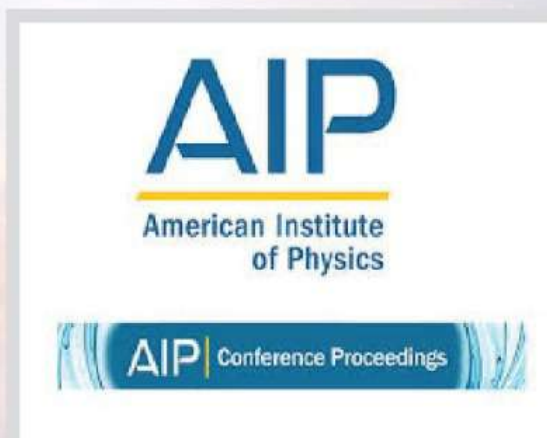
Keywords: IoT-based water treatment; decentralized greywater system; urban residential buildings; real-time monitoring; turbidity removal; ESP32; cloud platform; non-potable reuse; water conservation; smart city

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