NIRMANA

VOLUME-12

DEPARTMENT OF CIVIL ENGINEERING
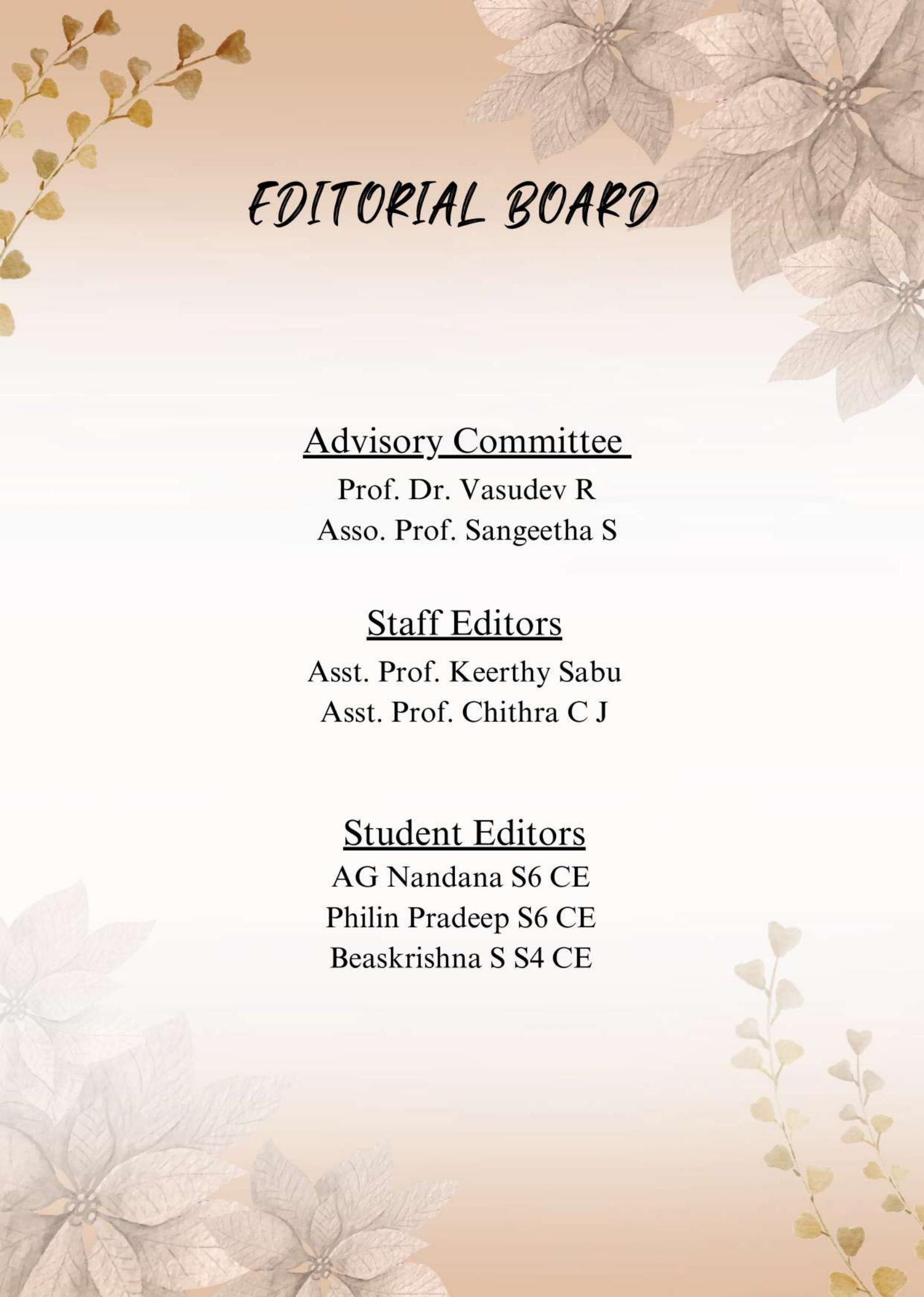
EDITORIAL BOARD

ABOUT DEPARTMENT OF CIVIL ENGINEERING

THe Department of Civil Engineering, TIST (Estd. 2006) offers Under Graduate course B.Tech in Civil Engineering (NBA accredited up to 2026) and Post Graduate course M.Tech in Construction Engineering and Management. The department continues to conquer new frontiers of knowledge through quality research work, Conferences, Workshop, QIP and FDP programs for enhancing the Teaching Learning process and moulds the students to be change agents with high professionalism, ethics and sustainability in addition to the curriculum objectives. The department is in close association with Institution of Engineers (IE), Indian Society for Technical Education (ISTE) American Society Of Civil Engineering(ASCE) and has an active student chapter of Indian Concrete Institute (ICI) and Indian Green Building Council (IGBC). The design wing "Rachana" of the department takes up research and consultancy work to offer technical advisory support to various leading organizations like KMRL, Naval base, STICON, PWD, LSD, etc. The department also undertakes the socially relevant projects like Sampoorna Jalasuraksha, Rebuild Kerala Initiative through which students learn humanitarian concept and their duties towards the society. The department focuses on emerging as a center of excellence in the field of cost- effective green building materials.

INSTITUTE VISION

To become a globally recognized Institution that develops professionals with integrity who excel in their chosen domain making a positive impact in industry, research, business, and society.

INSTITUTE MISSION

- To provide the ambiance necessary to achieve professional and technological excellence at the global level.
- To undertake collaborative research that fosters new ideas for sustainable development.
- To instill in our graduate's ethical values and empathy for the needs of society.

DEPARTMENT VISION

To transform into a centre creating change agents in civil engineering with professional competency, integrity and ethical values for serving the society with the highest level of proficiency through their chosen domain.

DEPARTMENT MISSION

1) Provide ambience to create civil engineers of global standards to serve the society collaboratively, competently and ethically.

2) To provide an academic environment for lifelong learning nurturing the skills in research and development for the benefit of all stakeholders.

3) To inculcate professionalism in students through team work, effective communication and leadership skills.

4) To encourage and empower the faculty in the field of engineering education and mentoring for enhancing the teaching-learning process.

5) To impart hands on experience to aspiring undergraduates through interdisciplinary research projects, industrial training and consultancy work.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The graduates of Civil Engineering will:

1) Apply technical expertise to identify and resolve any complex civil engineering problems with the help of modern engineering tools and lifelong learning to meet the specified needs of their chosen domain viz employment, higher studies or research and development.

2) Develop cost-effective solutions for a sustainable environment with deep insight in societal and ecological issues by adhering to professionalism.

3) Exhibit professional ethics, management and leadership qualities with good communication skills facilitating to work in a multidisciplinary team for evolving as an entrepreneur, ecological issues by adhering to professionalism.

PROGRAMME SPECIFIC OUTCOMES (PSOS)

Students of Civil Engineering Program will demonstrate:

1) Innovative Design in Civil Engineering: The ability to create innovative designs with new materials of minimum embodied energy through research and development focusing on global quality of life by observing professional ethics.

2) Civil Engineer and Sustainability: The ability to recognize the need of the hour like housing, sanitation, waste management, irrigation, use of renewable energy etc. for a sustainable environment.

3) Civil Engineering Analysis and Design tools: The ability to analyze the effects of natural calamities like earthquakes, landslides etc. including disaster management and to design stable structures for relevant stress resultants.

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

1.Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

2.Problem analysis: Identify, formulate, review research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

3.Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety and the cultural societal and environmental considerations.

4.Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiment, analysis and interpretation of data and synthesis of the information to provide valid conclusions.

5.Modern tool usage: Create, select, and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6.The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7.Environment amd sustainability: Understanding the impact of the professional engineering solutions in societal and environmental contexts, and demonstraten the knowledge of, and need for sustainable development.

8.Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering pratice.

9.Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and multidisciplinary settings.

10.Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as,being able to comprehend and write effective reports and design documentation,make effective presentations, and give and receive clear instructions.

11.Project management and finance: Demonsrate knowlegde and understanding of the engineering and management principles and apply these to one's own work as a member and leader in a team ,to manage projects and in multidisciplinary environments.

12.Life-long learning: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

FORWARD

It gives me immense joy and satisfaction to present before you the twelfth volume of our technical magazine NIRMANA. This annual publication is dedicated exclusively to showcasing academic research papers and articles contributed by our students on diverse topics and issues in the field of Civil Engineering. The technical papers included in this edition are the outcome of continuous exploration and research initiatives undertaken by our students as part of the Civil Engineering program. I am confident that these articles will inspire our students to realize the vast opportunities available in their professional journey and motivate them to pursue excellence in their chosen field. NIRMANA has evolved into a valuable platform for budding civil engineers to exhibit their research knowledge, thereby enhancing their technical writing, analytical thinking, and communication skills. I extend my sincere appreciation to all the students who have contributed their work for this edition and express my gratitude to the faculty members who have guided and mentored them throughout this endeavor.

With best wishes and warm regards,

Dr. Vasudev R
HOD, CIVIL
DEPARTMENT, TIST

CHIEF EDITOR'S MESSAGE

On behalf of our dedicated editorial team, I extend heartfelt gratitude to all who have contributed to the success of our magazine in the past year. Your commitment to advancing the field of Civil Engineering through insightful research and quality publications has been invaluable.

As we embark on the new academic year, I am delighted to share that our magazine, NIRMANA, continues to be a beacon in the academic realm, serving as a crucial reference for projects and seminars in Civil Engineering. With an unwavering focus on quality, safety, and impactful research outcomes, we remain committed to providing a platform that fosters growth and innovation.

The twelfth edition (2023–2024) aims to be a valuable resource for students, covering a wide array of topics, including student articles, technical writings, and project highlights. It is directly linked with the project work of the academic year 2023–2024, presenting in a nutshell the significant research carried out in Civil Engineering.

I express my sincere appreciation to all the faculty coordinators, student coordinators, contributors, and supporters who have played a pivotal role in shaping the magazine's success. Your dedication is instrumental in ensuring that NIRMANA continues to be a cornerstone for students seeking the latest insights into Civil Engineering.

Best regards,

Asst. Prof. Keerthy Sabu

Editor-in-Chief

BTECH PROJECT ABSTRACTS

DEVELOPMENT OF ECO-FRIENDLY CLAY BRICKS USING SUGARCANE BAGASSE ASH AND FLY ASH

Fired clay bricks exhibit certain limitations. They contribute to pollution due to their high energy consumption, leading to increased greenhouse gas emissions. This project centres on the distinctive clayey soil of the Kuttanad region, serving as the foundation for the development of environmentally friendly clay bricks. By integrating readily available waste materials such as fly ash and sugarcane bagasse ash, the study aims to enhance brick attributes while prioritizing sustainability. Sugarcane bagasse refers to the fibrous remnants left after extracting juice from sugarcane or similar plants. Bagasse ash, a byproduct of burning bagasse for energy or other uses, holds potential in applications like soil enhancement, construction materials, and manufacturing processes. Similarly, fly ash, a finely powdered byproduct of burning pulverized coal in power plants, finds common use in construction due to its ability to strengthen and increase the durability of materials. Initially, the clay underwent a series of tests including Specific Gravity, Natural Water content, Particle Size Distribution, Atterberg's Limit, Unconfined Compression (UCC), and Proctor Compaction. These tests were conducted to determine the grade and strength of the clay soil. The project then involved adding varying proportions of fly ash 5%,10%,15%,20%,25% by weight of clay, to identify the optimal percentage through tests like Unconfined Compression (UCC) and proctor compaction again. Subsequently, different proportions of sugarcane bagasse 7.5%,10%,12.5%,15%,17.5% by weight of clay were introduced to the mixture established through the prior tests. The most suitable values for both additives are determined based on the outcomes of these tests, guiding the preparation of the final brick composition. Finally, a brick was developed as the end result of this project which is equivalent to class C of burnt brick and it can be used for temporary structures like non load bearing walls, partition walls, infill walls, decorative purposes etc.

Keywords: Kuttanad clay, Sugarcane bagasse ash, Fly ash.

ADITHYAN K B
MEGHA V R
NIHAL SHAJAN

DEVELOPMENT OF BIOPLASTIC FROM ORGANIC SOLID WASTE

Organic solid waste is an environmental threat worldwide. However, the organic waste has a great potential for the generation of fuels and high value products. Bioplastics are 100% biodegradable, compostable or recyclable free from hazardous chemical and toxic substance. Bioplastics can significantly reduce the environmental impact in terms of energy consumption and greenhouse effect. Utilizing organic solid waste as a feedstock of plastics production, offers multiple advantages. It helps to reduce waste and prevent landfill or incineration and related pollution. It also provides a circular economy approach by transforming waste into valuable materials. One such solution is to convert organic fraction of organic solid waste into bioplastic, which will be environment friendly. The project is focused on the conversion of organic fraction of solid waste into bioplastic.

Key words: Bioplastic, Biodegradable, Solid waste

BHAGYA LAKSHMY SASIDHARAN
RONA ROMEY
ROOPAK CHACKO MATHEW

ASSESSMENT OF MODE SHIFT TOWARDS NON-MOTORIZED TRANSPORTATION IN INFOPARK, KOCHI

The widespread usage of motorized transportation has improved our everyday comfort and convenience, particularly in the growing urban surroundings. However, the greater reliance on automobiles have also resulted in many environmental problems, significantly raising pollution and blurring the metropolitan landscape. Motorization has an impact on human health, the environment as a whole, and the balance of nature. It is essential to switch to sustainable forms of transportation to handle this growing problem. One of the sustainable solutions for this is shifting towards non-motorized transport (NMT). But nowadays the willingness to shift towards NMT is depriving. The key step in achieving the goal is to find a creative solution to promote NMT transit. In this study, we focus on the idea of introducing piezoelectric pathways at Infopark, Kochi (from Infopark phase 1 main gate to phase 2) and to analyze the willingness of commuters to shift to piezoelectric pathways. From an extensive literature review, a self-descriptive questionnaire was created, which included socio-demographic characteristics, trip characteristics, and questions about people's attitudes and behaviours. The goal is to explore the behavioural factors that play a crucial role in influencing mode shift. Through our research, we aim to develop a mode shift model and devise policy strategies that encourage the people to adopt Non-Motorized Transportation.

Keywords: Non-motorized transit, Piezoelectric power generation, Mode shift, policy- making.

ALBIN P THOMAS
KRISHNAPRASAD N M
MEENAKSHI V BIJU

GREY WATER TREATMENT USING MICROBIAL FUEL CELL

The study endeavors to examine the application of Fibre Reinforced Polymer (FRP) as a structural strengthening technique in the context of corrosion-induced degradation in reinforced concrete (RC) beams. Corrosion, a pervasive challenge in RC structures, poses threats to their integrity, reducing load- bearing capacity and potentially compromising safety.This project involves conducting experimental tests on RC beams exhibiting different levels of corrosion-induced degradation, aiming to gauge the restorative and enhancing capabilities of the FRP strengthening method. Throughout the experimental process, we systematically apply the FRP technique to beams with varying degrees of corrosion, meticulously assessing their structural performance. Parameters such as load-carrying capacity, deflection behavior, and failure modes undergo thorough analysis. This evaluation extends to a comparative study with control beams, providing a baseline for quantifying the effectiveness of the FRP strengthening method. The significance of this investigation lies in its potential to offer practical insights into the resilience of corroded RC structures when subjected to FRP strengthening. By elucidating the impact on load-bearing capacity and failure modes, the study contributes valuable knowledge for developing strategies to address and mitigate the structural consequences of corrosion in RC beam.

Keywords : Corrosion , CFRP , Load-bearing capacity , Failure modes, Energy Ductility.

GOURY NANDANA A S
ABHIRAMI RAJ
NIVEDH MANJUSH

EXPERIMENTAL INVESTIGATION ON THE PERFORMANCE OF SMART SPRINKLER IRRIGATION SYSTEM

Water scarcity in agriculture can lead to soil salinization, alkalization, and environmental degradation; therefore, this study aims to propose an IoT-based smart irrigation system to reduce water consumption and control efficiency in agriculture. A sensor-enabled smart sprinkler irrigation system was created. The optimum moisture content of the soil was found for the calibration of sensors and for determining other irrigation parameters like field capacity, permanent wilting point, irrigation interval, etc. A water test was done to determine the pH of the water to ensure that it was suitable for agricultural purposes. The truth table for deciding whether irrigation was needed or not was developed by collecting hourly weather data for several days. The performance of the smart sprinkler was evaluated by finding sprinkler uniformity and efficiency using case studies. A web application was developed with the help of embedded C to remotely turn on and off sprinklers, set watering times, and adjust the watering schedule based on soil moisture levels. This web application controls irrigation and supplies the appropriate amount of water from the pump. A microcontroller monitored temperature, humidity, and soil moisture to calculate plant water requirements, which is usable and effective on Android smartphones. This project optimises water usage, improves crop yields, and conserves resources, reducing water wastage and the inefficient use of resources in traditional methods.

Keywords: Water scarcity, efficiency in agriculture, sensor enabled smart sprinkler irrigation system, web application

ANANDHU SUMESH
KAVYA RAJESH
SAYOOJ D KRISHNA

EXPERIMENTAL INVESTIGATION ON THE UTILIZATION OF
WASTE PLASTIC AND GLASS BOTTLES
FOR MOSAIC TILES

Mosaic tiles are a type of decorative tile typically composed of small, often colorful pieces of ceramic, stone, or other materials. To reduce plastic and glass wastes and their adverse effect on the environment, they can be utilized in the production of mosaic tiles which has a wearing layer and backing layer. For backing layer, a high-performance mortar is developed by partially replacing cement by 10% silica-fumes and 10% metakaolin and with the addition of 2% steel fibers. The study also investigates the utilization of waste plastic chips in this high- performance mortar with optimum steel fiber and hence various percentages of waste plastic chips (10%, 15%, and 20%) are added and its optimum percentage taken as 20% by analyzing the flexural strength. And the resulting high erformance mortar mix with optimum steel fibres and optimum percentage of waste plastic chips is used as backing layer for mosaic tiles whereas wearing layer consists of glass chips embedded in cement marble grout. These mosaic tiles were tested for its flexural strength, water absorption, flatness of tile surface, perpendicularity of sides and straightness of sides. Average flexural strength of mosaic tiles is obtained as 4.77 N/mm2, whereas average water absorption of mosaic tiles is obtained as 2.46% which satisfies the requirement for flexural strength and water absorption as per IS 1237: 2012. Results of flatness test, perpendicularity test and straightness test also shows that they are within the limit as prescribed by IS 1237: 2012. And therefore this tile proves to be a better alternative for the normal tiles. Thus this project has tried to promote sustainable waste reduction practices and environmental responsible construction practices.

Keywords: Mosaic tiles, Waste glass bottles, Waste plastics, High performance mortar.

GOPIKA VINOD
PARVATHI SOMAN
DIYAMONICA V.C

EXPERIMENTAL INVESTIGATION ON PROPERTIES OF CONCRETE INCORPORATING FERROCK

Concrete accounts for 8 to 10% of total CO2 emissions, mainly due to cement. Cement in concrete is the fourth largest source of anthropogenic carbon emissions. The world's infatuation with this high carbon intensive material has grown to be real pandemic as the accumulation of these emissions contributes to the growing threat of Global climatic catastrophe. For each one ton of cement created more or less eight ton of CO2 is released. It's alarmingly polluting the environment. So this study evaluates the potential of using ferrock as partial replacement to cement. Ferrock is an iron based binding compound which comprises of waste materials to form a carbon negative building material. Iron dust along with small proportions of limestone, fly ash, oxalic acid and meta-kaolin make this a novel substance. Iron dust reacts with carbon dioxide and rust, which creates an iron carbonate matrix to form ferrock while it dries. The best possible proportion of ingredients are found to be iron dust (60%), fly-ash (20%), metakaolin (10%), limestone (8%) and oxalic acid (2%). From the literatures it was found that fully cured samples contain between 8 and 11% captured CO2 by weight. Ferrock is therefore "carbon negative" unlike Portland cement, which is a major source of CO2 and other air pollutants. In this work cement is partially replaced with various percentage of ferrock and the mechanical properties and carbon dioxide absorption are therefore evaluated.

Keywords: Carbon negative, Ferrock, CO2 emission, Iron dust, Meta-kaolin

ALAN K PAUL
ANJU JAYAROY
P B KRISHNA PRABHA

ESTIMATION OF PEDESTRIAN LEVEL OF SERVICE OF CROSSWALKS AT SIGNALIZED INTERSECTIONS

Pedestrian Level of Service (PLOS) is a concept used in urban planning and transportation engineering to assess and quantify the quality of walking conditions and experiences for pedestriansin various urban environments. It directly impacts the safety and convenience of people. PLOS is often quantified using scales or grades, similar to the level of service concepts used for vehiculartraffic. These grades range from A to F, providing a simple way to communicate the quality of the pedestrian experience to policymakers, planners, and the public. The aim of this study is to estimate the pedestrian level of service at signalized intersection. Both quantitative and qualitative parameters will be identified for the estimation of the same. For obtaining data pertaining to qualitative analysis, a questionnaire based survey will be conducted. Physical characteristics such as footpath width,potential to vehicle conflict, obstructions, continuity, footpath surface and user characteristics viz. safety and security, walking environment, comfort, availability of crossing facilities are the factors found to influence the PLOS qualitatively.. Pedestrian delay, one of the key performance indicators for pedestrian level of service, can be obtained through video graphic survey. Road inventory survey will be done for obtaining field data. By considering LOS as dependent variable and significant factors as independent variables, models will be generated. The goal of considering pedestrian level of service is to assist planners in developing more pedestrian-friendly urban environments that encourage walking, improve safety, and support active transportation modes as a means of reducing congestion and promoting healthier lifestyles.

Keywords: Pedestrian Level of Service, Traffic, Signalized Intersection

HARIPRIYA V
ROSHAN JOSEPH
SREYA SREEKUMAR

MTECH PROJECT ABSTRACTS

EXPERIMENTAL INVESTIGATION ON THE UTILIZATION OF HYPO SLUDGE AND STEEL SLAG IN CONCRETE

In construction Industry, consumption of cement is increasing day by day, carbon dioxide gas will be emitted during the manufacture of cement which cause environmental harm as well as cost is also increasing. Environmental problems are causing due to the mining of fine aggregate.

Therefore, it is high time for us to find a proper replacement for cement and fine aggregate. This project aims to study the utilization of hypo sludge as partial replacement of cement and Steel Slag as partial replacement of fine aggregate. Hypo Sludge is a waste material collected from the Paper Industry. It can be used as substitute for cement in concrete production as it behaves like cement because of silica and magnesium content. Effective utilization of hypo sludge can be a sustainable solution for waste management of paper industry. Steel slag (SS) is a solid waste generated during the conversion of iron into steel in a basic oxygen furnace (BOF) or during the melting of scrap to make steel in an electric arc furnace (EAF). Steel Slag can be effectively utilized as substitute for fine aggregate in concrete. Effective utilization of Steel Slag helps in reducing the environmental problems related to the fine aggregate mining and waste disposal of slag. The project work includes partial replacement of cement by hypo sludge at different percentages such as 5%, 10%, 15%, 20% and 25% by the weight of cement to find out the optimum percentage of hypo sludge content. In this mix, steel slag is partially replaced for fine aggregates at different percentages such as 10%, 20%, 30% and 40% by the weight of fine aggregate to find the optimum percentage of steel slag. Properties such as compressive strength, split tensile strength and flexural strength of these various mixes will be evaluated from which the optimum percentage of steel slag is found. Also the durability properties such as water absorption, acid resistance of concrete mix with optimum percentage of hypo sludge and steel slag will also be studied.

Keywords-Hypo sludge, Steel Slag. OPC, Compressive Strength, Split Tensile Strength, Flexural Strength.

SRUTHYMOL GEORGE

EXPERIMENTAL INVESTIGATION ON FERROCEMENT PANELS WITH HIGH PERFORMANCE MORTAR

Ferro cement is a kind of thin-wall reinforced concrete that is often made of hydraulic-cement mortar and reinforced with thin, continuously laid layers of wire mesh. The mesh may be made of metallic or other suitable materials. It has strong tensile strength, flexural strength toughness, impact resistance, and fatigue resistance. The raw components needed to make Ferro cement are easily accessible. As per ACI the Sand -cement ratio by weight is 1.5 to 2.5 and watercement ratio by weight is 0.35 to 0.5.Compared to steel and wood, Ferro cements are more affordable and more durable. Wire that is 1.6 mm in diameter and placed 19mm apart make up the wire mesh. It could have the same shape as welded wire mesh, square woven wire mesh, expanded metal in the shape of a hexagon, etc.

Due to their thin section and hydraulic mortar reinforcement with steel wire mesh, the panels are prone to micro cracks under service circumstances. The slabs are made as strips of size 450x450x25mm. The objective is to study the behaviour of Supplementary cementitious material on Ferro cement panels and also Numerical analysis is done by using ANSYS 2023 software

Keywords: supplementary cementitious material, flexural strength, Numerical analysis, Finite element technique, Wire mesh, Ferro cement concrete.

ASHMY V BABU

DEVELOPMENT OF SUSTAINABLE CONCRETE INCORPORATING FERROCK

Concrete is the most utilized structural ingredient in civil engineering works and is the second most used substance after water around the world. On an average, approximately 1 ton of cement is produced every year for each human being in the world. Globally, the cement industry alone was estimated to be responsible for 5-7% of all anthropogenically produced carbon dioxide. This resulted to evaluate the ability of ferrock to be used as one of the best possible substitute for cement in concrete. It is an iron based binding compound which utilises many waste materials resulting in the formation of a carbon negative building material. Iron dust which is a waste from iron industries, which would otherwise end up in landfills is used along with small proportions of fly ash, limestone powder, metakaolin and oxalic acid to prepare ferrock. Ferrock is a binder which is a blend of iron dust (60%), fly ash (20%). limestone powder (10%), metakaolin (8%) and oxalic acid (2%). The rate of emission of most dangerous greenhouse gases are reduced by using ferrock. Optimum percentage of replacement is to be found out by partial replacement of cement with ferrock in M30 grade concrete in various proportions of 0%, 5%, 10% and 15%.

GOVIND J

BIM INTEGRATED AUTOMATED FALL HAZARD RECOGNITION MODEL FOR CONSTRUCTION SITE

The construction industry has one of the highest occupational accident incidence rates among all economic sectors. Among that over 60% of fatalities at construction site is due to fall hazard. Currently, building information modelling (BIM) appears to be a valuable tool for analysing occupational safety issues throughout the construction procedure. The objective of this study is to create a computer model of a high-rise building by using BIM technology to help accurately determine the hazards of falling from edges and the hazards from struck by falling objects. The safety attributes is extracted from expert knowledge and literature review. In this research, safety rules of OSHA is adopted for identify hazard. Afterwards a heat map is generated based on the classified hazard for different activities and preventive measures is incorporated into the model. The method may help the safety managers in understanding the details and sequence of work easily, thus contributed to the precise identification of the falling hazards. By using suitable safety equipment for each hazard, in addition to the possibility of using this method as training programme for workers in the work place which give an idea of the nature of work which they may be exposed.

KEYWORDS- Accidents, Fall hazards, BIM, 3D Modelling, OSHA.

SHARNIMA PK

INTEGRATED LEAN TECHNIQUE ON SAFETY AND HEALTH IMPROVEMENT IN CONSTRUCTION

he construction industry is inherently dynamic, presenting unique challenges in ensuring worker safety while maintaining efficiency. This project focuses on the integration of Lean techniques to enhance safety protocols within construction projects. This study explores the application of Lean methodologies to optimize safety processes and mitigate risks in construction operations. The research methodology involves a comprehensive literature review, case studies, and interviews with industry experts to identify current safety challenges and gaps. Lean tools such as 5S, Visual Management, Last Planner System and Kaizen will be adapted to address specific safety concerns within construction sites. The study aims to develop a systematic framework for implementing Lean techniques tailored to the unique characteristics of the construction sector. Ultimately, this research seeks to promote a cultural shift towards proactive safety practices, aligning with the industry's commitment to creating a secure and productive working environment.

Key words: Lean Techniques, Safety Management, 5S Methodology. Value Stream Mapping.

ROSMIN K JOSE

TECHNICAL ARTICLES

BIM AND AR/VR INTEGRATION IN CIVIL ENGINEERING

Building Information Modeling (BIM) has revolutionized civil engineering by enabling digital representation of a project's physical and functional characteristics. It integrates geometry, spatial relationships, materials, scheduling, and cost data into a single intelligent model, improving collaboration, accuracy, and efficiency across the project lifecycle. BIM allows engineers, architects, and contractors to detect design clashes, optimize construction sequencing, and make data-driven decisions before construction begins, reducing errors and rework.

The integration of Augmented Reality (AR) and Virtual Reality (VR) with BIM further enhances project visualization and stakeholder engagement. AR overlays digital information onto the physical environment, enabling engineers to view construction progress, compare as-built conditions with designs, and identify potential issues on-site. VR, on the other hand, provides fully immersive experiences, allowing stakeholders to conduct virtual walkthroughs, explore complex structures, and simulate construction sequences in a safe, controlled environment.

Together, BIM and AR/VR facilitate better planning, coordination, and communication among project teams. They support real-time monitoring of construction progress, resource management, and design verification, leading to improved project efficiency, quality, and safety. Additionally, these technologies enhance client engagement by offering intuitive visualizations and interactive simulations.

The combined use of BIM with AR/VR is transforming civil engineering practices by bridging the gap between digital models and physical construction, fostering innovation, collaboration, and sustainable project delivery. As technology advances, its integration promises even more intelligent, automated, and resilient civil engineering solutions.

AISWARYA RAGHU S6 CE

DIGITAL TWINS IN PROJECT MANAGEMENT

A digital twin is a virtual replica of a physical asset, system, or process that mirrors its real-world behavior in real time. It integrates data from sensors, IoT devices, and other monitoring systems to create an up-to-date, interactive model that can simulate, analyze, and optimize operations. In civil engineering and project management, digital twins provide a bridge between the physical construction environment and the digital model, enabling more efficient planning, monitoring, and decision-making.

In civil engineering projects, digital twins allow project managers to track construction progress, resource usage, and structural performance continuously. By integrating real-time data with predictive analytics, potential issues such as design conflicts, schedule delays, or equipment failures can be identified before they impact the project. This proactive approach reduces risks, prevents costly rework, and ensures timely completion.

Digital twins also enhance collaboration among stakeholders by providing a shared interactive platform for visualization, simulation, and scenario testing. Engineers, architects, contractors, and clients can remotely explore designs, evaluate alternatives, and make informed decisions without interrupting on-site activities. Additionally, environmental and sustainability factors can be integrated into the model, supporting green construction practices.

By adopting digital twins in project management, civil engineering projects become more transparent, adaptive, and data-driven. The technology enables optimized resource allocation, improved safety, and better decision-making, ultimately ensuring higher-quality, cost-efficient, and timely project delivery.

AG NANDANA S6 CE

ADVANCES IN COMPOSITE STRUCTURES: DESIGN, PERFORMANCE, AND SUSTAINABILITY

Composite structures have become one of the most significant innovations in civil engineering, offering enhanced strength, durability, and sustainability compared to traditional materials. By combining two or more materials, such as fiber-reinforced polymers (FRP), steel-concrete composites, or natural fibers, engineers can create systems with superior performance characteristics tailored to modern infrastructure needs.

Design innovations in composites aim to balance strength with efficiency. Steel-concrete composites are widely used in bridges and tall buildings, reducing overall weight while maintaining structural safety. FRPs, known for being lightweight and corrosion-resistant, are particularly effective in coastal and marine environments. With the help of advanced computational tools and simulations, engineers can predict the behavior of composites under complex loading conditions, reducing reliance on expensive physical testing.

Performance improvements are driven by material advancements. Carbon, glass, and basalt fiber composites offer high tensile strength, fatigue resistance, and long-term durability. Hybrid composites are being developed to achieve customized properties for specific applications. Meanwhile, modern manufacturing techniques such as pultrusion and 3D printing ensure uniform quality and scalability. In repair and retrofitting, composites extend the service life of aging infrastructure without adding significant weight.

Sustainability has become a central focus in composite research. Natural fibers like jute and hemp, along with recycled materials, are reducing environmental impact. Lightweight composites also cut transportation and installation energy, while life cycle assessments confirm their reduced carbon footprint.

Though challenges remain - such as higher initial costs and limited design codes—ongoing research into smart composites and recycling methods promises a sustainable, efficient, and resilient future for infrastructure.

ALEN PETER S6 CE

RISK MANAGEMENT IN CIVIL ENGINEERING USING DATA ANALYTICS

Civil engineering projects involve complex processes, significant investments, and long timelines, exposing organizations to various risks such as design errors, construction delays, cost overruns, safety hazards, and environmental challenges. Traditional risk management approaches, relying on experience and historical data, often struggle to address these dynamic uncertainties. Data analytics offers a transformative approach, enabling civil engineers and project managers to identify, assess, and mitigate risks more effectively.

Data analytics examines structured and unstructured data from multiple sources—such as project schedules, material performance records, site sensors, and weather data—to detect patterns and predict potential risks. For example, predictive models can anticipate construction delays by analyzing labor productivity, equipment usage, and supply chain reliability. Similarly, safety risks can be reduced by analyzing accident reports, site conditions, and real-time sensor data to prevent hazardous situations.

Cost and financial risks are also managed using analytics, by monitoring budget deviations, procurement trends, and resource allocation. Furthermore, environmental and regulatory compliance risks can be mitigated through data-driven monitoring of emissions, soil stability, and water management.

By integrating analytics into civil engineering risk management, stakeholders can adopt proactive, evidence-based decision-making, enhancing project efficiency, safety, and sustainability. Successful implementation requires high-quality data, robust governance, and continuous model validation. Overall, data analytics enables civil engineers to anticipate risks, optimize resources, and deliver projects on time and within budget while maintaining safety and environmental standards.

ARAVIND ANIL S4 CE

APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN CIVIL ENGINEERING

Artificial Intelligence (AI) is revolutionizing civil engineering by providing data-driven solutions that address the complexity, uncertainty, and non-linearity often present in real-world problems. In structural engineering, AI techniques such as artificial neural networks and genetic algorithms are being applied to predict load-carrying capacities, optimize designs, and improve seismic safety, ensuring stronger and more resilient structures. In construction management, AI enhances planning, scheduling, and resource allocation, with machine learning models predicting delays and cost overruns, while computer vision systems monitor worker safety and track material use. Robotics integrated with AI are automating tasks such as bricklaying, concrete pouring, and inspections, increasing productivity and reducing risks in hazardous environments. In transportation engineering, AI is widely used in traffic management, signal optimization, and predictive pavement maintenance, while also forming the backbone of autonomous vehicle systems that enhance safety and efficiency. In geotechnical engineering, AI helps predict soil properties, slope stability, and settlement behavior, while in environmental engineering it is used for water quality forecasting, pollutant modeling, and sustainable waste management. Infrastructure monitoring and maintenance have greatly benefited from AI, with sensor data from bridges, dams, and tunnels analyzed to detect anomalies early, enabling predictive maintenance that lowers costs and improves safety. AI-powered drones are also being used for inspections of tall and hard-to-reach structures. While challenges such as high computational demands, limited standardized data, and the need for skilled professionals remain, the integration of AI is paving the way for smarter, safer, and more sustainable infrastructure worldwide.

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