

# ENGINEXUS

Articles  
Drawings  
Poems  
Review Paper  
Photography

Calculations Meet Perfection



**Department of Civil Engineering Magazine-2026**

St Thomas College of Engineering and Technology  
Mattanur , Kannur , Kerala

# EngiNexus'26

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CIVIL ENGINEERING MAGAZINE

ST. THOMAS COLLEGE OF ENGINEERING AND TECHNOLOGY

# EngiNexus'26

Civil Engineering Association

St. Thomas College of Engineering and Technology, Kannur

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## MESSAGE FROM CEO



I am delighted to note that Civil Engineering Department is bringing out the latest issue of their department magazine, "EngiNexus."

Within these pages, you will find a diverse array of articles from both students and faculty, alongside a proud record of their recent achievements and essential institutional updates. This platform does more than just document our progress; it celebrates the dedication, innovation, and collaborative spirit that propel the department forward.

I extend my sincere appreciation to the editorial team, contributors, and faculty members whose hard work has made this publication possible. May "EngiNexus" continue to inspire our students to pursue excellence and remain lifelong learners as they shape the world of tomorrow.

Er. Rijo Thomas Jose  
CEO



## MESSAGE FROM PRINCIPAL



It gives me immense pleasure to witness the release of our Civil Engineering Department's magazine, "EngiNexus," for the academic year 2025-26. This publication is far more than a collection of articles; it serves as a vital bridge between the rigorous theories of our classrooms and the dynamic, rapidly shifting landscape of the global infrastructure industry. As we look toward the future, the identity of the civil engineer is undergoing a profound transformation. We have shifted from being merely "builders" to becoming stewards of the built environment, recognizing that the dual challenges of climate change and resource depletion have placed our profession at a critical crossroads. In this new era, sustainability is no longer a luxury or a niche specialization; it is the foundational pillar upon which all modern construction must stand.

The construction industry remains one of the world's largest consumers of natural resources, and with that reality comes a profound responsibility: we hold the greatest power to effect positive global change. I am heartened to see our students and faculty pivoting their focus toward Advanced Green Materials, minimizing carbon footprints through the use of recycled aggregates, structural bamboo, and low-carbon cement alternatives. Furthermore, our emphasis on Passive Energy Design and the Circular Economy ensures we are rethinking the lifecycle of infrastructure to eliminate the concept of "waste" through innovative deconstruction and material reuse. By integrating these eco-friendly practices, we aren't just erecting structures; we are safeguarding the environment for the generations that will follow us.

Finally, I would like to extend my heartfelt appreciation to the staff and student editors for their invaluable efforts in the curation and timely publication of this edition.

Dr. Shinu Mathew John  
PRINCIPAL



## MESSAGE FROM HOD



It gives me immense pleasure to present the EngiNexus, the departmental magazine of the Civil Engineering Department, St. Thomas College of Engineering and Technology, Kannur for the Academic year 2025-26. I extend my heartfelt congratulations to the students and faculty members who have contributed their efforts and creativity to bring out this publication successfully for the current academic year.

Our department continues to strive for academic excellence while encouraging students to explore practical knowledge and emerging trends in civil engineering. During this academic year, several academic and technical activities were organized to enhance the professional skills and exposure of our students. Workshops on Building Information Modelling (BIM) and Total Station provided valuable hands-on training in modern surveying and digital construction practices.

The department also conducted a series of expert talks that broadened the technical perspectives of our students. These included sessions on Geophysical Investigations for Rock Mass Characterisation in Engineering Projects, Concepts of Numerical Modelling in Rock Engineering, 3D Printing in Construction: Present and Future, Case Studies in Geotechnical Engineering, Pedestrian Mobility Challenges and Strategies for Improvement, and Reclaimed Asphalt Pavement. These interactions with experts from academia and industry helped students understand real-world engineering challenges and innovative solutions.

Practical exposure is an essential component of engineering education. In this regard, students were taken for site visits to Pazhassi Dam, Kerala Water Authority Peruvathuparamba, Irikkur, and the construction site of Pinarayi Education Hub, Pinarayi, where they observed various construction practices and infrastructure development activities. Such visits bridge the gap between theoretical learning and field applications.

The department also successfully organized the RAET'26 Conference, which served as a platform for sharing research ideas and promoting academic collaboration. In addition, the Graduation Day celebration of 2021-25 batch marked an important milestone, recognizing the achievements and hard work of our graduating students as they step into their professional careers.

I sincerely appreciate the dedicated efforts of the editorial team, faculty members, and students whose enthusiasm and teamwork made this magazine possible. I hope that this edition of EngiNexus will motivate our students to pursue innovation, research, and professional excellence in the field of Civil Engineering.

I wish the editorial team and contributors continued success in their future endeavors.

Vijila Balakrishnan  
HOD,CE



## EDITORIAL

It is with great pride that we present the latest edition of EngiNexus, the technical magazine of the Department of Civil Engineering, St. Thomas College of Engineering and Technology, Kannur, published with the support of our Civil Engineering Association SATTAVA.

Civil Engineering plays a fundamental role in shaping the infrastructure that supports modern society. From transportation networks and water resources to sustainable buildings and environmental protection, civil engineers contribute significantly to the development and well-being of communities. As the discipline continues to evolve with rapid technological advancements, it becomes essential for aspiring engineers to stay informed about emerging technologies, innovative construction practices, and sustainable engineering solutions.

This magazine serves as a platform for our students to express their ideas, creativity, and technical insights in various areas of civil engineering. The articles included in this edition reflect the enthusiasm and curiosity of our students in exploring contemporary engineering challenges, research developments, and practical applications in the field.

I sincerely appreciate the efforts of the editorial team, faculty members, and students whose dedication and hard work made this publication possible. Their commitment and collaboration have contributed to the successful release of this magazine.

I hope that EngiNexus will inspire students to deepen their knowledge, nurture innovative thinking, and continue striving for excellence in the field of Civil Engineering.

Vijila Balakrishnan &  
Manasa Mukundan  
Staff Editor



**VIJILA BALAKRISHNAN**  
HOD,CE



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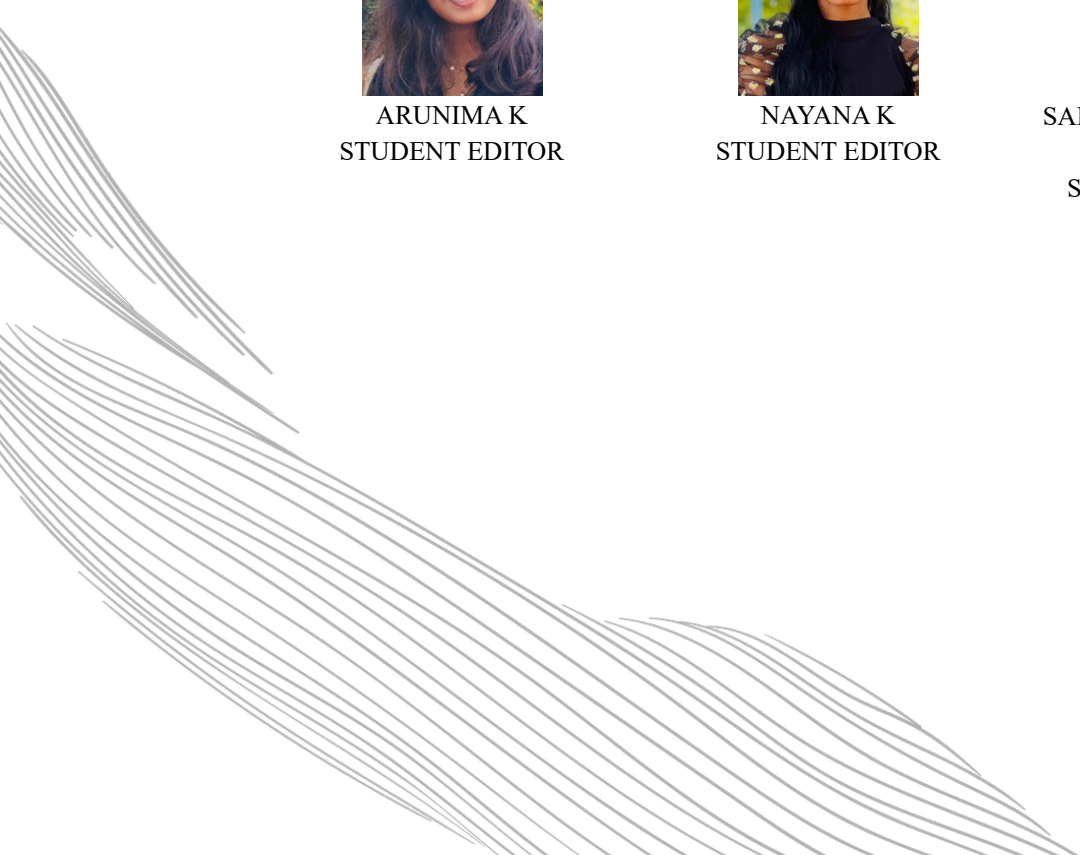
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STUDENT EDITOR



**SADARSH SANTHOSH**  
**BABU**  
STUDENT EDITOR



# VISION

To grow as a globally recognized centre in civil engineering with a focus on innovation and research by combining technical and ethical qualities.

# MISSION

## **M1 : Professional Skills**

To provide a better environment to encourage innovative and research thinking among students.

## **M2 : Life-Long Learning**

Instill in students contemporary knowledge in order to achieve academic and professional excellence with global perspective through experience of lifelong learning.

## **M3 : Engage with Society**

Impart a sense of community responsibility and leadership qualities to better meet the challenges of sustainable growth.

# PROGRAM EDUCATIONAL

# OBJECTIVES (PEOS)

## **PEO1**

Achieve excellence in the professional practices of Civil Engineering by utilizing the acquired knowledge and technical skills supported by modern day tools.

## **PEO2**

Participation in decision making and nation building by adopting energy efficient and sustainable practices in Civil Engineering.

## **PEO3**

Encourage innovative thinking and entrepreneurship by research and higher studies in advanced areas of Civil Engineering.

# PROGRAM SPECIFIC

# OUTCOMES (PSOs)

## **PSO1**

To solve engineering problems related to Civil Engineering by systematic techniques, skills and tools to meet the ever growing needs of sustainable infrastructural development.

## **PSO2**

Design and build Civil Engineering-based systems in the context of structural, geotechnical, transportation and environmental requisites.

# PROGRAM OUTCOMES (POs)

## **PO1**

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

## **PO2**

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

## **PO3**

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.

## **PO4**

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

## **PO5**

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.

## **PO6**

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.

PO7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

## **PO8**

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

PO9 Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

## **PO10**

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.

## **PO11**

Project management and finance: Demonstrate knowledge 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.

## **PO12**

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

# Recent Advances in Wastewater Treatment Technologies for Sustainable Water Management

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Wastewater treatment is a crucial aspect of modern environmental management, aimed at protecting water resources and ensuring public health. With rapid population growth, urbanization, and industrialization, the generation of wastewater has increased significantly across the world. A large portion of this wastewater, particularly in developing countries, is discharged into the environment without proper treatment. This leads to severe contamination of water bodies, degradation of ecosystems, and the spread of waterborne diseases. Therefore, effective and sustainable wastewater treatment technologies are essential to address these challenges and ensure safe water management.

Wastewater originates from multiple sources depending on human activities and industrial processes. The major sources include domestic, industrial, agricultural, and stormwater runoff. Domestic wastewater, commonly referred to as sewage, is generated from household activities such as bathing, cooking, washing clothes, and sanitation. It contains organic matter, nutrients, suspended solids, and microorganisms. Industrial wastewater varies depending on the type of industry and often contains hazardous chemicals, heavy metals, oils, and toxic substances. Agricultural wastewater results from irrigation runoff and livestock farming, carrying fertilizers, pesticides, and organic waste. Stormwater runoff is generated during rainfall and collects pollutants such as oil, debris, and sediments from urban surfaces.

The characteristics of wastewater play a key role in determining suitable treatment methods. These characteristics are broadly classified into physical, chemical, and biological properties.

Physical characteristics include colour, odour, temperature, turbidity, and suspended solids. Chemical characteristics involve parameters such as pH, biochemical oxygen demand (BOD), chemical oxygen demand (COD), nutrients, and toxic substances. BOD indicates the amount of oxygen required by microorganisms to decompose organic matter, while COD measures the total oxygen needed to chemically oxidize pollutants. High values of BOD and COD indicate high levels of pollution. Biological characteristics include the presence of microorganisms such as bacteria, viruses, protozoa, and algae. Some of these microorganisms are pathogenic and can cause diseases like cholera, typhoid, and dysentery.

Conventional wastewater treatment involves a series of stages designed to progressively remove contaminants. Preliminary treatment is the first stage, where large floating materials, grit, oil, and grease are removed using screening, grit chambers, and skimming tanks. This stage protects equipment and improves the efficiency of subsequent processes. Primary treatment involves sedimentation, where wastewater is allowed to settle in tanks so that heavier solids form sludge at the bottom while lighter materials float on the surface. This stage removes a significant portion of suspended solids and organic matter.

Secondary treatment focuses on the biological removal of dissolved and colloidal organic matter. The most widely used method is the activated sludge process, where microorganisms are used to break

down organic pollutants in the presence of oxygen. Other methods include trickling filters, where wastewater passes over a bed of media supporting microbial growth, and oxidation ponds, which use natural processes involving algae and bacteria. These methods significantly reduce organic pollution and improve water quality.

However, conventional treatment methods are not always sufficient to remove emerging contaminants such as pharmaceuticals, personal care products, and microplastics. As a result, advanced wastewater treatment technologies have been developed to enhance treatment efficiency. Membrane filtration technologies are among the most effective methods. These include microfiltration, ultrafiltration, nanofiltration, and reverse osmosis, which use semi-permeable membranes to remove fine particles, dissolved substances, and microorganisms. Membrane bioreactors combine biological treatment with membrane filtration to produce high-quality effluent suitable for reuse.

Advanced oxidation processes (AOPs) are another important innovation in wastewater treatment. These processes generate highly reactive hydroxyl radicals that can break down complex organic pollutants into simpler, less harmful substances. Techniques such as ozonation, UV radiation combined with hydrogen peroxide, and Fenton oxidation are widely used. These methods are particularly effective in removing toxic and persistent pollutants that are difficult to treat using conventional methods.

Biological nutrient removal processes are designed to eliminate excess nitrogen and phosphorus from wastewater. These nutrients, if discharged into water bodies, can cause eutrophication, leading to excessive growth of algae and depletion of oxygen.

Processes such as nitrification and denitrification convert nitrogen compounds into nitrogen gas, while phosphorus is removed through biological or chemical methods. Constructed wetlands are also gaining popularity as an eco-friendly treatment option. These systems mimic natural wetlands and use plants, soil, and microorganisms to remove pollutants through physical, chemical, and biological processes.

Sludge management is an essential component of wastewater treatment. Sludge generated during treatment contains concentrated pollutants and must be properly treated before disposal. Sludge thickening reduces its volume by removing excess water, while digestion stabilizes organic matter. Anaerobic digestion is widely used as it produces biogas, a renewable energy source containing methane. Aerobic digestion is another method that stabilizes sludge in the presence of oxygen. Sludge dewatering further reduces water content using mechanical equipment, making it easier to handle and dispose of.

Modern wastewater treatment systems emphasize not only pollutant removal but also resource recovery and reuse. Treated wastewater can be reused for various purposes such as agricultural irrigation, industrial cooling, and landscaping. This helps conserve freshwater resources and reduce water scarcity. Additionally, nutrients like nitrogen and phosphorus can be recovered and used as fertilizers, contributing to sustainable agriculture. Energy recovery is also possible through the use of biogas generated during sludge treatment.



Despite these advancements, wastewater treatment faces several challenges. High operational and maintenance costs, energy consumption, and the presence of emerging contaminants are major concerns. Developing countries often face additional challenges such as lack of infrastructure, technical expertise, and financial resources. Addressing these challenges requires proper planning, investment, and adoption of appropriate technologies.

Future trends in wastewater treatment focus on sustainability, efficiency, and innovation. Smart wastewater treatment plants using artificial intelligence and automation are being developed to optimize performance and reduce costs. Decentralized treatment systems are gaining importance, especially in rural and remote areas. Energy-neutral and energy-positive treatment plants aim to produce as much energy as they consume. The concept of a circular economy is also being applied, where wastewater is viewed as a resource rather than waste.

In conclusion, wastewater treatment plays a vital role in protecting the environment and public health. While conventional methods have been effective, the adoption of advanced treatment technologies is necessary to address modern challenges. The integration of sustainable practices, energy efficiency, and resource recovery will ensure effective wastewater management and contribute to a secure and sustainable water future.



Dr. Arun Kumar S  
Associate Professor  
Civil Engineering Department



## Use of AI and Robotics in Waste Management

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The rapid growth of urbanisation, industrial development, and population has led to a dramatic rise in the volume and complexity of waste generated worldwide. Traditional waste management systems, which rely heavily on manual methods and simple collection–disposal processes, are no longer efficient enough to address current waste challenges. In this context, Artificial Intelligence (AI) and robotics have emerged as transformative technologies capable of modernising waste management practices and making them smarter, faster, and more sustainable. These innovations align closely with the goals of civil engineering, which focuses on sustainable infrastructure, environmental protection, and public health improvement. By integrating AI-driven systems and intelligent robotic machines, waste management processes are becoming more accurate, efficient, and environmentally responsible.

AI plays a major role in improving decision-making within waste systems. Machine learning algorithms and computer vision technologies can analyse immense amounts of data to classify, predict, and optimise waste-handling operations. For example, AI-based image recognition helps identify waste types on conveyor belts in recycling plants, improving sorting accuracy and reducing contamination. This leads to higher recycling rates and more effective resource recovery. Additionally, AI enables route optimisation for collection vehicles by analysing data from smart bins, fill-level sensors, and GPS systems. These optimised routes save fuel, reduce emissions, and lower operational costs. Predictive analytics powered by AI can also forecast future waste generation patterns, helping authorities plan infrastructure and allocate resources more efficiently.

Robotics further enhances the waste management process by automating physically demanding and hazardous tasks. Robotic arms and automated sorting machines are increasingly being used in material recovery facilities to pick, separate, and handle recyclables with greater speed and precision than human workers. These robots operate efficiently in environments where sharp objects, toxic substances, and unpleasant conditions pose high risks to manual labourers. Their integration not only boosts operational productivity but also significantly improves worker safety. Robotics also supports automated waste collection, allowing smart vehicles and machines to collect waste with minimal human intervention. Technological innovations have also improved waste sorting, recycling, and disposal processes. Modern sorting facilities use optical sensors, infrared cameras, magnetic separators, and AI-enabled robotic systems to segregate waste materials accurately. This ensures that plastics, metals, glass, and paper are recovered effectively, supporting the circular economy. Recycling technologies powered by AI can detect contamination levels, identify valuable materials, and manage waste streams more efficiently. In disposal systems such as landfills and incineration plants, AI helps monitor gas emissions, detect leaks, and regulate combustion, ensuring compliance with safety and environmental standards. IoT-enabled sensors and drones monitor landfill conditions in real time, reducing environmental risks and improving long-term waste management outcomes. The environmental benefits of adopting AI and robotics in waste management are significant.



By improving sorting efficiency and recycling accuracy these technologies reduce the amount of waste sent to landfills, preventing soil and groundwater contamination. Smart collection systems minimise unnecessary vehicle movements, lowering greenhouse gas emissions and fuel consumption. Better segregation of organic materials reduces methane emissions from landfills, contributing to climate change mitigation. Moreover, the recovery of recyclable materials reduces the need for extracting raw natural resources, conserving energy and protecting ecosystems. AI-driven monitoring systems also help maintain air and water quality by detecting harmful pollutants early.

From an economic perspective, automation lowers labour costs, improves operational efficiency, and increases the revenue generated from high-quality recyclables. Efficient sorting reduces contamination, enabling recycling plants to produce cleaner materials that can be sold at higher market values. Waste prediction tools help cities avoid unnecessary pickups, saving fuel and maintenance expenses. Additionally, better waste management reduces healthcare costs by improving environmental hygiene, minimising the spread of diseases, and lowering public exposure to hazardous materials. Despite its many advantages, the adoption of AI and robotics does come with challenges. The initial cost of implementing

technologies such as smart sensors, automated sorting machines, and robotic systems is high, making it difficult for smaller municipalities or businesses to invest. These systems also rely on accurate, high-quality data to function correctly, and poor data input can lead to inefficiencies or errors. Automation may also result in job displacement for workers engaged in manual waste handling, although it creates new Opportunities in technology maintenance. Regular maintenance of advanced equipment is essential and can add to operational expenses. Additionally, the production and disposal of electronic equipment used in AI systems can contribute to e-waste if not handled responsibly. Looking ahead, the future of AI in waste management appears extremely promising. Fully automated recycling plants, smarter predictive systems, and advanced robotics are expected to dominate the industry. With continual improvements in machine learning, computer vision, and IoT integration, AI systems will become more adaptable, intelligent, and capable of handling complex waste streams. This will support long-term sustainability goals, enhance circular economy practices, and create cleaner urban environments. Ultimately, the integration of AI and robotics represents a crucial step towards creating efficient, sustainable, and technologically advanced waste management systems worldwide.



Adwaitha SR  
S8 CE



## Photocatalytic Pavements with Titanium Dioxide for Air Pollution Control.

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Air pollution has become one of the most serious environmental challenges faced by modern cities. With rapid urbanization, industrial growth, and the increasing number of vehicles on roads, harmful pollutants such as nitrogen oxides (NO<sub>x</sub>), volatile organic compounds (VOCs), carbon monoxide, and particulate matter continue to degrade air quality and threaten public health. Traditional pollution-control methods such as catalytic converters in vehicles or industrial filtering systems, although effective, require regular maintenance and do not address the persistent accumulation of pollutants at the ground level, especially along busy roads. As a result, researchers and engineers have been exploring new sustainable solutions capable of passively reducing pollution in urban spaces. Among these innovations, photocatalytic pavements using Titanium Dioxide (TiO<sub>2</sub>) have emerged as a promising technology capable of converting ordinary road surfaces into active pollution-fighting systems.

Photocatalytic pavements incorporate TiO<sub>2</sub> into their surface or structural layers. TiO<sub>2</sub> is a semiconductor material known for its strong photocatalytic properties, which enable it to degrade harmful pollutants when exposed to ultraviolet (UV) or visible light. When sunlight strikes the pavement, TiO<sub>2</sub> absorbs the light energy and generates electron-hole pairs on its surface. These reactive particles trigger chemical reactions with oxygen and water molecules in the atmosphere, producing hydroxyl radicals and superoxide ions. These radicals then attack pollutants such as NO<sub>x</sub> and VOCs, breaking them down into non-toxic by-products like nitrates, carbon dioxide, and water.

Since pavements cover vast areas in urban environments and are constantly exposed to sunlight and vehicle emissions, they offer an ideal platform to apply this technology.

Titanium Dioxide exists in three main crystalline phases anatase, rutile, and brookite out of which anatase exhibits the highest photocatalytic activity due to its optimal surface structure and electron mobility. TiO<sub>2</sub> is chemically stable, non-toxic, inexpensive, and widely available, making it suitable for large-scale construction applications. When incorporated into pavements,

it not only improves air quality but also provides self-cleaning properties by preventing the accumulation of dirt, grime, and organic matter on the surface. Rainwater helps wash away the by-products formed by the photocatalytic reaction, ensuring that the pavement surface continually regenerates its active layer.

Different techniques have been developed to incorporate TiO<sub>2</sub> into pavement structures. The most common approach is surface coating, in which TiO<sub>2</sub> is applied as a thin layer on existing concrete or asphalt surfaces. Although cost-effective and easy to implement, surface coatings may wear off over time due to traffic and environmental exposure. Another approach involves mixing TiO<sub>2</sub> directly into the pavement materials, such as concrete or asphalt. This ensures long-term durability because even if the surface layer erodes, new photocatalytic material becomes exposed. A third method uses cementitious slurries containing TiO<sub>2</sub> applied over porous pavements, offering better adhesion and improved long-term performance.

The choice among these methods depends on the project requirements, cost considerations, and expected traffic loads.

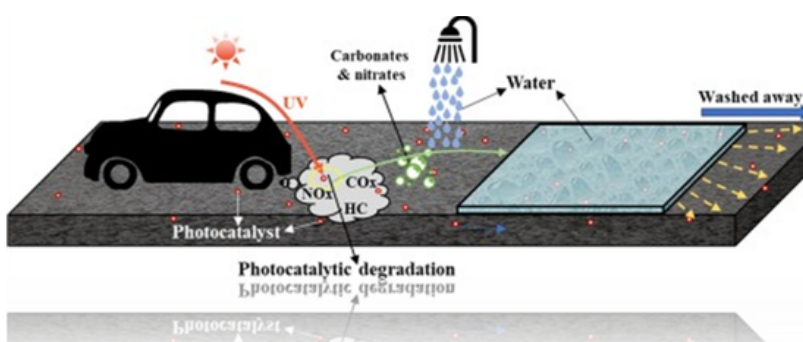
A major challenge of pure  $\text{TiO}_2$  is that it primarily absorbs UV light, which constitutes only a small fraction of the sunlight reaching the Earth's surface. To improve efficiency under natural sunlight, researchers have developed doped  $\text{TiO}_2$ , where metals such as iron, zinc, and platinum are added to enhance visible-light absorption. Iron-doped  $\text{TiO}_2$  has shown particularly promising results, offering higher  $\text{NO}_x$  and hydrocarbon removal rates under real outdoor conditions. Platinum-doped  $\text{TiO}_2$  provides even greater efficiency but is too expensive for widespread pavement applications. Other materials like Zinc Oxide ( $\text{ZnO}$ ) have been explored as alternatives due to their lower cost, but they degrade more easily under moisture and temperature fluctuations and therefore are less durable than  $\text{TiO}_2$ .

Laboratory experiments and field trials conducted across different countries consistently

demonstrate the effectiveness of photocatalytic pavements. Controlled tests show that  $\text{TiO}_2$ -coated surfaces can reduce  $\text{NO}_x$  concentrations by more than 40% under ideal conditions. Field applications in China, Italy, Spain, and other regions indicate that although real-world performance is lower due to weather variations, shading, and traffic wear, significant localised improvements in air quality are still achieved.

For example, a major field trial in Madrid showed measurable reductions in  $\text{NO}_x$  and confirmed that  $\text{TiO}_2$  pavements release negligible nanoparticles, making them safe for public use. The advantages of photocatalytic pavements extend beyond pollution control. Their self-cleaning properties reduce the need for frequent maintenance, while their contribution to cleaner air supports public health and aligns with the goals of smart and sustainable cities. However, challenges such as high material costs, reduced efficiency in shaded or low-light areas, and the lack of standardized guidelines for design and testing must still be addressed before widespread adoption becomes feasible.

Photocatalytic pavements with Titanium Dioxide represent a forward-thinking approach to integrating environmental technology directly into urban infrastructure. By harnessing the natural energy of sunlight to remove harmful pollutants, these pavements offer a passive, continuous, and eco-friendly method to improve air quality. While further advancements are required to enhance efficiency and reduce costs, this technology has strong potential to become a standard component of future sustainable cities, especially in densely populated regions where air pollution is a major concern.



Gouri Nandana  
S8 CE



## Transparent Concrete Using Optical Fibres.

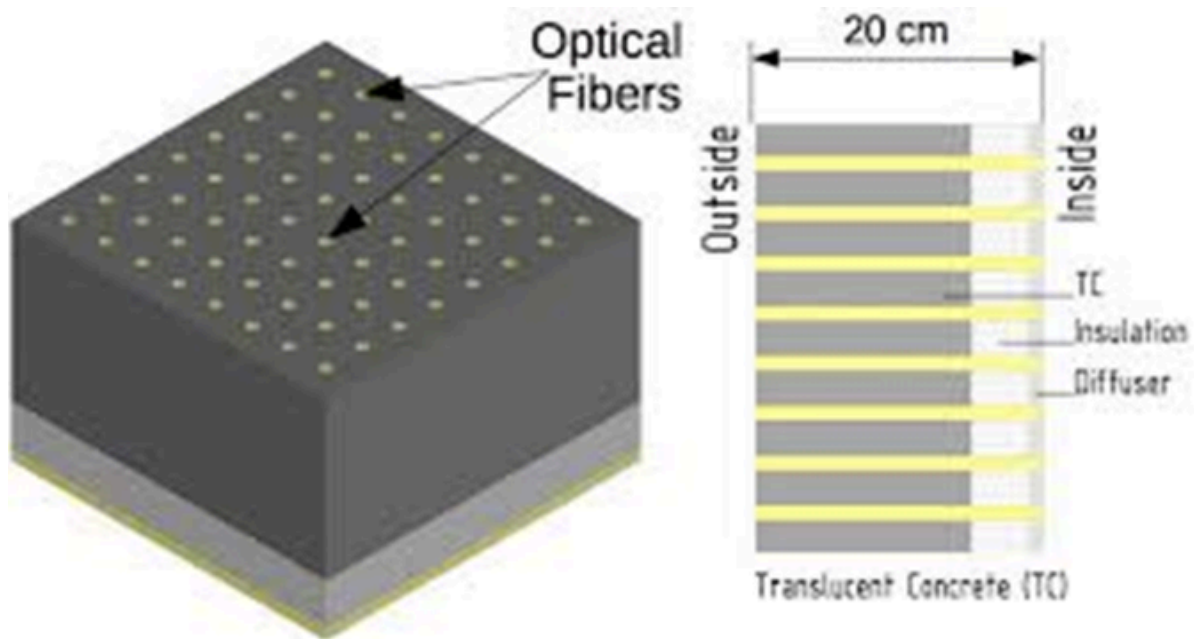
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Transparent concrete, also known as light-transmitting concrete or LiTraCon, represents one of the most innovative advancements in modern construction, combining the structural reliability of conventional concrete with the functional elegance of optical fibre technology. This emerging material was conceptualized to overcome the fundamental limitation of regular concrete its complete opacity which restricts natural light penetration and increases dependency on artificial illumination. As sustainable building practices and energy-efficient designs gain global momentum, the construction industry has turned toward materials that can reduce energy consumption while enhancing aesthetic appeal, making transparent concrete an ideal solution. Developed initially by Áron Losonczy in 2001, the concept relies on embedding thousands of glass or plastic optical fibres within a fine-grained concrete matrix. These fibres operate on the principle of total internal reflection, transmitting natural or artificial light from one surface to the other without compromising structural integrity Unlike glass, transparent concrete does not provide visibility through the surface but creates a diffused glow, offering privacy alongside illumination. The manufacturing process involves meticulous preparation of moulds, precise alignment of optical fibres, and the use of Self-Compacting Concrete (SCC) to ensure uniform flow around the fibres without vibration. SCC plays a crucial role by preventing segregation, ensuring perfect encapsulation of fibres, and producing a dense, void-free structure with a high-quality finish. After casting, the panels undergo controlled curing, trimming, and polishing of exposed fibre ends to maximise clarity and transmission efficiency. Physically, transparent concrete maintains a density and compressive strength comparable to traditional SCC, often reaching 20–40 MPa, making it

suitable for non-load-bearing and selected semi-structural applications. The optical properties of the material depend on fibre type, diameter, volume fraction, and alignment, with typical light transmission ranging from 2–5%. Environmentally, the material offers considerable energy benefits by using daylight to illuminate interior spaces, reducing electricity demand and supporting green building certifications. Its aesthetic versatility allows designers to incorporate customised patterns, logos, or motifs through controlled fibre orientation, making it a preferred choice in high-end architecture, luxury interiors, museums, and commercial spaces. Transparent concrete also finds specialised uses in pavements, road safety systems, artistic installations, and security structures where controlled illumination is advantageous. Case studies such as the 2024 installations at Hamburg Central Station and the Bar Steakhouse “Mash” in Germany demonstrate the material’s real-world potential. At Hamburg Central Station, transparent concrete panels introduced improved daylight penetration and reduced reliance on artificial lighting in high-traffic areas, showcasing the material’s functionality in large-scale infrastructures. Similarly, the steakhouse utilised illuminated panels as a design feature, enhancing ambience through dynamic colour-changing effects created with integrated LEDs. These projects highlight the blend of sustainability, aesthetics, and durability that transparent concrete brings to modern design. However, limitations still hinder widespread adoption. High production costs, labour-intensive fibre placement, specialised moulding, and



limited tensile strength pose technical and economic challenges. Large-scale manufacturing requires precision machinery and skilled labour, increasing overall project expenses. Despite these hurdles, future prospects appear promising. Research is exploring automated fibre-alignment systems, nanomaterial incorporation, 3D printing techniques, and the integration of smart technologies such as IoT-enabled lighting and structural health monitoring. Transparent concrete may soon merge with renewable energy systems by embedding photovoltaic cells, turning building façades into multifunctional surfaces capable of both transmitting light and generating electricity. In smart cities, the material could revolutionise sustainable infrastructure through illuminated pathways, energy-efficient buildings, and interactive public installations. Overall, transparent concrete stands as a transformative material bridging the gap between engineering functionality and architectural artistry. By merging strength with light, it supports the future of sustainable, intelligent, and visually compelling construction, representing a significant step toward eco-friendly and innovative urban development.



Murshid M  
S8 CE

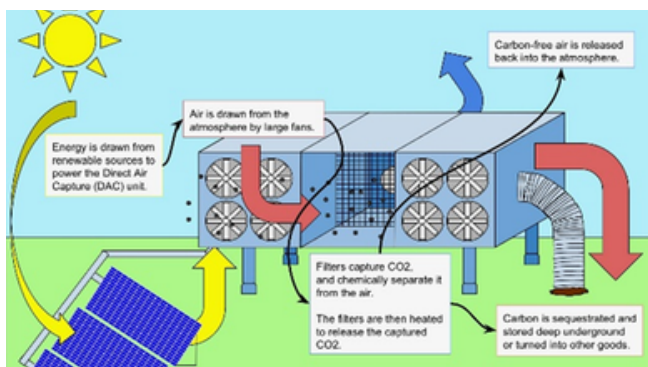
## **Carbon Negative Concrete Using Direct Air Capture Technology**

Carbon-negative concrete produced using Direct Air Capture (DAC) technology represents one of the most transformative innovations in sustainable construction, offering a pathway to convert one of the world's most carbon-intensive materials into a long-term carbon sink. Conventional cement production contributes nearly 8% of global CO<sub>2</sub> emissions, primarily from the calcination of limestone and high-temperature fuel combustion, making decarbonization of the concrete sector a global priority. DAC technology addresses this challenge by capturing CO<sub>2</sub> directly from the atmosphere using solid sorbents or liquid solvents, even at very low concentrations of around 420 ppm. This captured CO<sub>2</sub> is then supplied to concrete manufacturing systems, where it is permanently mineralized through carbonation processes. Unlike traditional emission-reduction strategies—such as the use of supplementary cementitious materials, alternative fuels, or energy-efficient kilns—DAC enables actual net-negative emissions by withdrawing carbon already present in the atmosphere. When combined with carbon mineralization technologies, DAC-derived CO<sub>2</sub> reacts with calcium-rich phases in cement, particularly portlandite and components of C–S–H gel, forming stable calcium carbonate that densifies the concrete matrix. This process not only sequesters CO<sub>2</sub> but also improves compressive strength, reduces porosity, enhances resistance to chloride penetration, and accelerates early-age strength development. The microstructural refinement resulting from calcium carbonate formation strengthens the interfacial transition zone, contributing to long-term durability. Accelerated carbonation curing, carbonation of recycled concrete aggregates,

CO<sub>2</sub> injection during mixing are key utilization routes that allow concrete to store carbon permanently while improving material properties. DAC-integrated concrete production also aligns with circular economy principles by allowing recycled aggregates to absorb additional CO<sub>2</sub>, improving their quality and reducing the need for virgin raw materials. Despite these advantages, several challenges hinder large-scale adoption. DAC systems are energy-intensive due to the low concentration of atmospheric CO<sub>2</sub>, requiring significant energy for sorbent regeneration, air movement, and CO<sub>2</sub> compression. Economic viability is further impacted by high capital and operational costs, although these are expected to decline with technological advances, mass manufacturing, and deployment of renewable energy sources. The absence of unified global standards for measuring CO<sub>2</sub> uptake, durability, and lifecycle emissions also creates uncertainty for industry adoption. Research is advancing rapidly, focusing on enhanced adsorbent materials, integration of DAC units with renewable energy systems, optimization of carbonation methods, and advanced monitoring tools such as digital twins for real-time tracking of CO<sub>2</sub> uptake and structural performance. Case studies included in the report demonstrate successful real-world implementation of DAC-based carbon-negative concrete. The Soletair Power–Carbonaide partnership in Finland produced the world's first industrial-scale carbon-negative concrete by combining building-integrated DAC with CO<sub>2</sub> mineralization, storing up to 100 kg of CO<sub>2</sub> per cubic meter of concrete. In the United States, Heirloom's first commercial

DAC facility in California uses a limestone-based DAC cycle powered by renewable energy, capturing CO<sub>2</sub> that is later mineralized into concrete through CarbonCure systems. Another major demonstration is the NeoCarbon–Carbonaide collaboration, where DAC units placed inside industrial cooling towers capture CO<sub>2</sub> that is subsequently injected into fresh concrete mixes, proving the feasibility of cost-effective CO<sub>2</sub> utilization using waste heat. These examples validate the scalability, durability, and climate benefits of carbon-negative concrete, indicating that such technologies can be deployed commercially within existing concrete manufacturing infrastructures. Policy frameworks, carbon credit systems, and green certification programs such as LEED and EPDs are expected to accelerate the transition by incentivizing low-carbon materials and mandating transparency in embodied carbon reporting. As nations move toward net-zero and climate-positive construction goals, DAC-based concrete stands out as a solution that not only reduces emissions but actively removes carbon from the atmosphere. With advancements in sorbent performance, renewable-powered DAC systems,

optimized mineralization techniques, and supportive global standards, carbon-negative concrete has the potential to transform the construction sector into a crucial ally in global climate mitigation. It shifts concrete from being a major emitter to a permanent carbon sink, offering a promising route toward sustainable infrastructure, environmental resilience, and a low-carbon future. As nations move toward net-zero and climate-positive construction goals, DAC-based concrete stands out as a solution that not only reduces emissions but actively removes carbon from the atmosphere. With advancements in sorbent performance, renewable-powered DAC systems, optimized mineralization techniques, and supportive global standards, carbon-negative concrete has the potential to transform the construction sector into a crucial ally in global climate mitigation. It shifts concrete from being a major emitter to a permanent carbon sink, offering a promising route toward sustainable infrastructure, environmental resilience, and a low-carbon future.



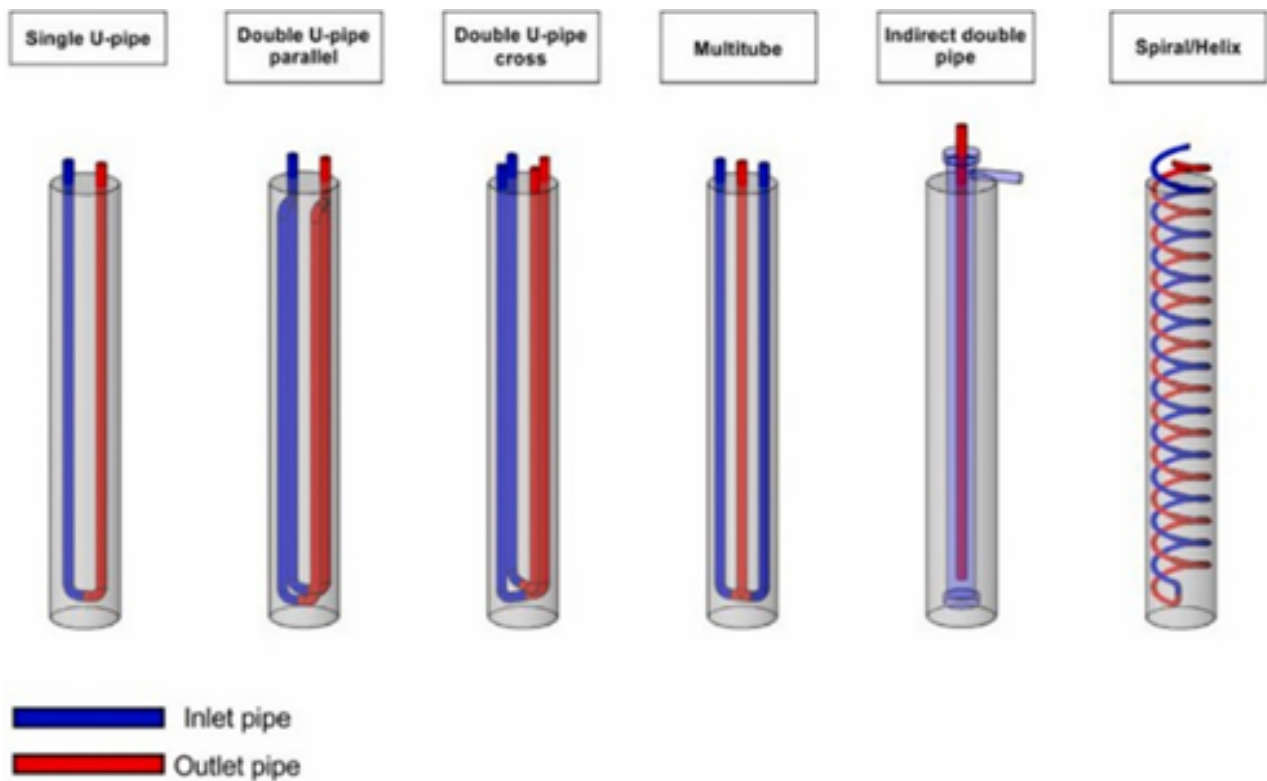
Rajyeshwar R  
S8 CE



## Geothermal Energy Piles

Geothermal energy piles represent an innovative and sustainable advancement in modern civil engineering, integrating the structural function of deep foundation piles with the thermal functionality of ground heat exchangers to provide efficient heating and cooling for buildings. As the world attempts to mitigate climate change and reduce greenhouse gas emissions, geothermal energy systems have become key alternatives to fossil-fuel-based HVAC systems, especially because underground temperatures remain stable beyond depths of about 6–8 metres. These constant temperatures allow geothermal systems, particularly ground source heat pumps (GSHPs), to operate with high efficiency throughout the year. Energy piles take advantage of this by embedding heat exchanger loops—typically made of HDPE, PEX, PVC, or steel—within reinforced or mass concrete piles that are already required to support structural loads. The dual functionality reduces land use, eliminates the need for separate boreholes, and lowers overall installation costs. In operation, a heat carrier fluid circulates through the primary loop embedded in the piles and exchanges heat with the surrounding soil through conduction in the concrete and convection within the pipes. This fluid then passes through a heat pump which acts as the bridge between the primary loop and the secondary circuit installed within the building's floors, walls, or ceilings. In heating mode, heat is extracted from the ground and upgraded by the heat pump for delivery indoors, while in cooling mode, the system removes heat from the building and transfers it back into the ground. The construction of geothermal energy piles involves conventional pile-bored methods where reinforcement

cages equipped with looped HDPE pipes are installed before concrete placement. Integrity tests are performed to ensure the pipes withstand the pressures during concreting, and optimal pipe configurations—such as U-loops, W-loops, or multiple vertical runs—are selected based on pile diameter and thermal requirements. The performance of energy piles, however, is influenced by numerous environmental factors, including ground heat flow mechanisms, groundwater movement, initial soil temperature, and soil thermal properties such as conductivity and diffusivity. Groundwater flow, especially in sandy or gravelly soils, enhances heat transfer by advection, while clay soils with limited water movement may reduce system efficiency. Seasonal thermal balance is also critical, as prolonged heating or cooling without adequate recharge may impact long-term performance. Despite challenges, the benefits of geothermal energy piles are substantial: they offer high energy efficiency, reduced operational costs, quiet operation, low emissions, and long system life, with embedded loops lasting over 50 years. They also contribute to green building certifications and provide year-round thermal comfort. Their limitations primarily include high initial costs, dependency on soil conditions, the need for early integration during design, and the requirement for specialised professionals. Case studies demonstrate the practical success of these systems. At Texas A&M University's Liberal Arts Building, 263 energy piles, each 18 m long, were integrated with a GSHP system, resulting in substantial reductions in electricity consumption and over 3,900 metric tons of CO<sub>2</sub> savings across 30 years. The system not only delivered reliable heating and cooling but also improved efficiency through free hot-water production during cooling seasons.



Another notable project is the Library Building in Buron, Luzern, Switzerland, supported by 216 hollow piles—60 of which were converted into thermo-active piles using the Pilothersm system. These piles achieved a heat extraction rate of 40 W/m with a COP above 4, demonstrating exceptional energy efficiency and reduced carbon emissions without requiring additional land or drilling. Future trends indicate rapid technological advancements, such as improved drilling techniques, automated installation, enhanced heat exchanger materials, and integration with smart building systems capable of optimizing energy use based on real-time conditions. Research also points toward hybrid renewable systems that combine geothermal energy with solar or wind power to create near-zero-energy buildings. Moreover, improved numerical modelling, thermal testing methods, and better understanding of soil–pile interaction will refine design standards and increase adoption.

Moreover, improved numerical modelling, thermal testing methods, and better understanding of soil–pile interaction will refine design standards and increase adoption. In conclusion, geothermal energy piles are poised to become a foundational technology in sustainable construction, offering a practical, long-term, and environmentally responsible solution for building energy needs. With continued innovation, supportive policies, and growing awareness, they have the potential to significantly transform heating and cooling practices worldwide.



Sandra P  
S8 CE

# An Integrated Analysis of Groundwater Exploitation and Land Subsidence.

Groundwater is one of the planet's most essential natural resources, sustaining billions of people, supporting agricultural productivity, and enabling industrial and urban growth. As nearly 30% of the world's freshwater reserves lie beneath the ground, aquifers serve as an invisible yet irreplaceable lifeline. However, this critical resource is facing unprecedented stress due to excessive groundwater extraction, largely driven by population growth, agricultural intensification, and rapid urbanization. Across the globe, declining water tables and shrinking aquifers are becoming common, particularly in regions such as India, Mexico, China, Taiwan, and Indonesia. What makes this crisis even more concerning is its direct linkage to land subsidence—a geophysical process where the ground surface sinks as water is withdrawn from underground layers, causing compaction of sediments and loss of structural support. Land subsidence has now emerged as a severe environmental hazard, threatening infrastructure, agriculture, ecosystems, and human settlements.

The impact of groundwater exploitation is most visible in populous and agriculture-dependent countries like India, which is currently the world's largest groundwater user. More than 60% of India's irrigation needs and nearly 85% of its rural drinking water supply rely on groundwater. The Green Revolution, while transforming India into a food-secure nation, also triggered decades of uncontrolled pumping, especially in states like Punjab, Haryana, and Uttar Pradesh. As water-intensive crops and subsidized electricity encouraged the drilling of deeper wells, aquifers became severely overdrawn, causing water tables to fall rapidly. Urban centers like Delhi,

Chennai, and Bengaluru further intensified groundwater depletion due to rising population, inadequate surface water sources, and unregulated borewells. As aquifers shrink, the consequences extend far beyond water scarcity—ground instability becomes a hidden but deadly threat. Land subsidence resulting from groundwater depletion has been documented in more than 200 locations worldwide. In many regions, the process is irreversible due to the permanent compaction of soil layers. Mexico City is one of the most striking examples having sunk over 10 meters in the past century due to excessive groundwater reliance. Similarly, Jakarta sinks by more than 25 cm per year in certain areas, forcing the Indonesian government to plan relocation of its capital. Taiwan's Choushui River Alluvial Fan shows subsidence linked to agricultural pumping, especially from aquaculture-related activities. In India, although less studied, subsidence has been observed in Delhi NCR, parts of Punjab and Haryana, and more critically in the Himalayan town of Joshimath. The Joshimath crisis of 2023 highlighted the alarming consequences of human activity combined with fragile geology. Built on ancient landslide debris, Joshimath experienced sudden land sinking, cracking over 800 houses and disrupting roads, hotels, and essential services. Geophysical investigations showed that groundwater-saturated weak zones, construction in natural spring paths, and geological vulnerabilities intensified the sinking. The resulting crisis displaced families, raised concerns about hydropower projects, and emphasized the need for sustainable planning in ecologically sensitive regions. The relationship between groundwater extraction and land subsidence .

is complex yet clearly established. When aquifers are depleted, underground pore pressure decreases, causing sediment layers especially clay-rich or loose alluvial deposits to compact. This leads to the sinking of the land surface, which can damage buildings, roads, pipelines, rail networks, and drainage systems. Subsidence also alters natural drainage patterns, increasing the risk of flooding, especially in flat or coastal regions. Moreover, once subsidence occurs, the lost water-storing capacity cannot be restored, leading to long-term reduction in groundwater potential. The compounded effects create socio-economic pressures farmers struggle with deeper wells and higher pumping costs, urban areas face infrastructure failures, and ecosystems dependent on groundwater face degradation.

Addressing this crisis requires integrated and sustainable strategies. Reducing groundwater exploitation must begin with greater reliance on surface water.

efficient irrigation techniques, and widespread adoption of rainwater harvesting. Recycling wastewater for industrial and agricultural use can significantly reduce dependence on freshwater aquifers. Technological solutions such as desalination offer potential in coastal regions, while artificial recharge structures like percolation ponds, check dams, and recharge wells can enhance natural replenishment. Policy interventions also play a crucial role. Strict regulation of borewell drilling, real-time monitoring of groundwater extraction, and incentives for water-efficient farming practices are essential for sustainable management. Global examples such as Taiwan's satellite-based monitoring and Mexico's aquifer recharge initiatives

show that scientific innovation can substantially improve groundwater governance.

Community involvement is equally important. Farmers must be encouraged to adopt micro-irrigation techniques and shift from water-intensive crops to more sustainable alternatives. Urban residents need stronger awareness and mandatory rainwater harvesting systems. Local authorities should integrate groundwater considerations into urban planning, especially in areas prone to geological instability. Long-term solutions must also incorporate climate-resilient water management, recognizing that changing rainfall patterns will place additional stress on groundwater resources.

In conclusion, groundwater exploitation and land subsidence represent an interconnected crisis with far-reaching consequences for societies worldwide. Without decisive action, aquifer depletion and land sinking will continue to undermine water security, infrastructure stability, and economic resilience. The insights from India, Mexico, Taiwan, and other affected regions highlight the urgent need for sustainable groundwater management, robust policy frameworks, and community-based conservation efforts. Protecting groundwater today is essential for ensuring environmental stability, economic development, and the well-being of future generations. efficient irrigation techniques, and widespread adoption of rainwater harvesting. Recycling wastewater for industrial and agricultural use can significantly reduce dependence on freshwater aquifers. Technological solutions such as desalination offer potential in coastal regions, while artificial recharge structures like percolation ponds, check dams,

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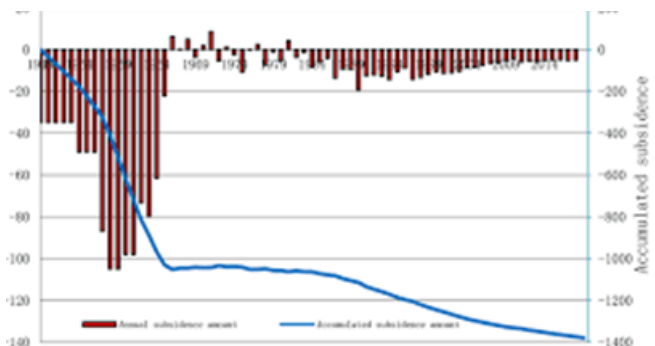


Figure 1: Land subsidence development duration characteristic curve in Shanghai

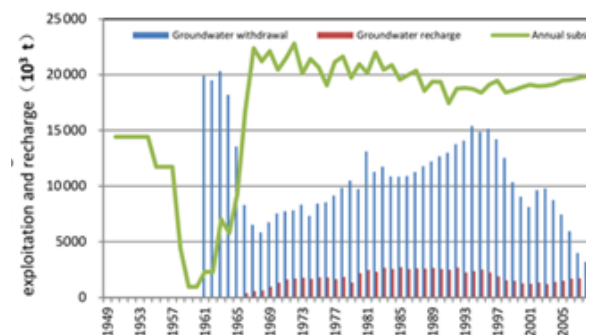


Figure 2: Historical graph of annual groundwater intake and land subsidence in Shanghai.



S Sruthi  
S8 CE

# LIDAR Technology and Its Expanding Role in Civil Engineering.

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LIDAR (Light Detection and Ranging) has emerged as one of the most transformative technologies in the field of civil engineering, revolutionizing how spatial data is captured, processed, and applied in real-world projects. By using laser pulses to measure distances with extraordinary accuracy, LIDAR creates detailed three-dimensional representations of terrain, structures, and natural environments. Unlike conventional surveying techniques that depend heavily on manual measurements and are often limited by terrain and accessibility, LIDAR offers rapid data acquisition, minimal human involvement, and high accuracy, making it a preferred tool for modern surveying and construction applications.

At the core of a LIDAR system lies a sophisticated arrangement of components including a laser source, scanner and optics, receiver, and positioning systems such as GPS and IMU. These components work together to emit laser pulses, capture their reflections, and convert them into georeferenced 3D point clouds. The precision of these datasets allows them to be used for a wide range of applications, from topographic mapping to environmental monitoring. LIDAR systems can be deployed on various platforms airborne, terrestrial, or even spaceborne depending on project requirements. Airborne LIDAR is particularly effective for large-scale mapping, while terrestrial LIDAR systems are used for detailed scanning of structures, roadways, or confined spaces. Spaceborne LIDAR plays a crucial role in global environmental observations and landform analysis.

One of the most significant advantages of LIDAR is its efficiency in generating

high-density spatial data. Traditional ground surveys often involve extensive fieldwork, requiring surveyors to physically access multiple points across sometimes hazardous terrain. LIDAR eliminates much of this effort by capturing millions of data points within seconds, drastically reducing project time and manpower. Furthermore, its ability to operate independently of lighting conditions means surveys can be conducted at any time of day, enhancing productivity and flexibility. In areas covered by dense vegetation, LIDAR's canopy penetration capabilities allow it to record ground elevation even through thick foliage—an area where traditional methods often struggle.

The applications of LIDAR in civil engineering are vast and continually expanding. In hydrographic surveying, LIDAR is used to map underwater topography using green laser technology capable of penetrating water columns. This supports coastal zone management, dredging operations, and environmental assessments. In topographic mapping, LIDAR provides Digital Terrain Models (DTMs) and Digital Surface Models (DSMs), essential tools for flood risk assessment, watershed management, and urban development planning. Urban planners utilize LIDAR-generated 3D city models to analyze land use, plan new infrastructure, and evaluate natural disaster risks. Transportation projects benefit greatly from LIDAR's ability to assist in route selection, slope analysis, cut-and-fill calculations, and monitoring of existing infrastructure for defects or deformation.

Beyond engineering, LIDAR plays a vital role in environmental and geological studies. It supports forest monitoring by providing data on canopy height, biomass estimation, and vegetation health. In geology,

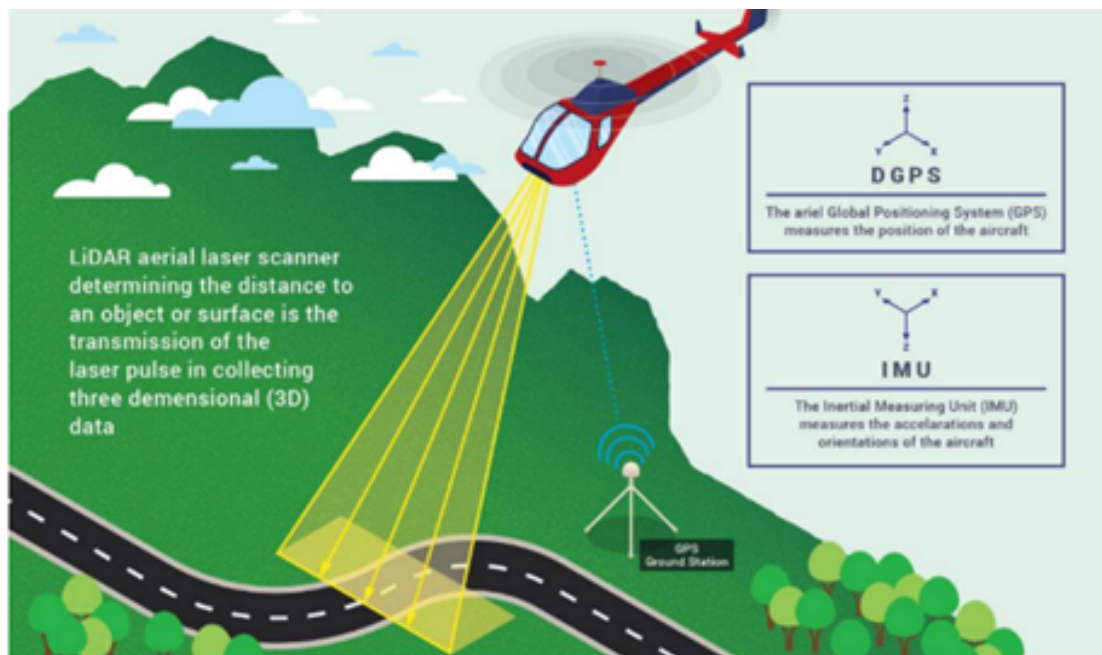
LIDAR reveals subtle terrain changes, fault lines, and landslide-prone zones with unmatched accuracy. Mining and quarrying industries use

LIDAR to measure stockpile volumes, monitor slopes, and enhance worker safety by reducing the need for manual inspections in hazardous areas. These applications highlight LIDAR's versatility and its growing importance in sustainable land and resource management. Despite its numerous benefits, LIDAR does present certain challenges. High initial equipment and operational costs can be prohibitive for smaller projects or organizations. The technology also produces massive amounts of data requiring specialized processing software and skilled professionals to interpret results accurately. Additionally, certain conditions—such as deep water, heavy fog, or reflective surfaces—may limit the effectiveness of LIDAR returns. Regulatory restrictions, especially for drone-based and airborne LIDAR Operations, can also pose challenges in specific regions. Nevertheless, the long-term accuracy, time savings, and multi-use data outputs typically outweigh these disadvantages

Looking ahead, the future of LIDAR in civil engineering appears exceptionally promising. Integration with Artificial Intelligence (AI), Machine Learning (ML), and Building Information Modeling (BIM) is transforming how LIDAR data is used. AI-driven algorithms can automate point cloud classification, detect structural defects, or predict potential hazards, significantly reducing processing time. The development of digital twins virtual replicas of physical assets relies heavily on LIDAR data to provide real-time monitoring and predictive maintenance capabilities.

Robotics and drones equipped with LIDAR offer exciting possibilities for automated inspections, construction monitoring, and disaster response operations. These advancements are paving the way for smarter, safer, and more efficient infrastructure systems. In conclusion, LIDAR technology stands as a transformative force in modern civil engineering, offering unrivaled precision, efficiency, and versatility in spatial data collection and analysis. Its applications span across surveying, environmental monitoring, transportation planning, forestry, disaster management, and beyond. While challenges such as cost and data processing persist, continuous advancements in hardware, software, and automation are rapidly overcoming these limitations. As the demand for accurate, real-time, and sustainable engineering solutions grows, LIDAR will undoubtedly continue to shape the future of construction, infrastructure development, and environmental stewardship. Regulatory restrictions, especially for drone-based and airborne LIDAR Operations, can also pose challenges in specific regions. Nevertheless, the long-term accuracy, time savings, and multi-use data outputs typically outweigh these disadvantages

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Shahana KK  
S8 CE

# Floating Cities: A Sustainable Response to Climate Change and Urban Challenges

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Floating cities represent one of the most innovative and promising solutions for the twenty-first century, emerging at a time when rapid urbanisation, population growth, and climate change threaten the survival and stability of traditional settlements. With rising sea levels endangering coastal communities and land scarcity becoming a critical issue in growing metropolitan regions, floating cities offer a futuristic yet practical alternative by creating self-sufficient, resilient urban environments on water. Built on buoyant platforms and designed with modular layouts, these cities integrate renewable energy, sustainable architecture, advanced water systems, and eco-friendly materials to create habitable spaces that adapt naturally to environmental changes. They not only address the vulnerabilities of coastal populations but also reimagine the relationship between humans and the marine environment.

The concept of living on water is not entirely new. Historically, communities such as the Uros people of Lake Titicaca, the floating villages of Cambodia, and the iconic city of Venice have demonstrated the feasibility of water-based living. Though these examples lacked modern engineering techniques, they laid the foundation for the idea that humans can thrive in aquatic environments. Over time, this idea evolved through mythological imaginations and futuristic proposals. Legends like Atlantis and floating cities in Asian mythology symbolised humanity's desire to build beyond land. In the modern era, innovative thinkers such as Buckminster Fuller and organisations like the Seasteading Institute promoted advanced floating

settlements, emphasising modularity, sustainability, and adaptability. Today, technological progress in marine engineering, renewable energy, and smart infrastructure has made floating cities not only achievable but necessary.

Floating cities are designed with distinctive characteristics that set them apart from traditional urban models. Their modular structure, often based on interlocking hexagonal platforms, allows gradual expansion and efficient land use on water. This flexibility ensures that as populations grow, new platforms can be added without disturbing the existing system. The resilience of these cities lies in their ability to rise and fall with tides, offering a natural defence against rising sea levels and extreme weather events. With advanced anchoring and mooring systems, floating platforms can withstand storms, strong waves, and climate-induced disasters. This inherent adaptability makes floating cities ideal for coastal nations that face increasing vulnerability due to climate change.

One of the strongest motivations for developing floating cities is the urgent need for climate adaptation. Coastal areas across the world, including cities like Jakarta, Mumbai, and Miami, are experiencing recurrent flooding and land subsidence. Traditional methods such as sea walls and land reclamation are costly and often environmentally harmful. Floating structures provide a sustainable alternative because they occupy water surfaces without disturbing marine ecosystems and adjust naturally to

sea-level rise. Furthermore, floating cities offer solutions for climate-induced displacement by providing new habitable zones for populations at risk. Their modular layout ensures that communities can expand or relocate as environmental conditions change.

Apart from climate resilience, floating cities address the global challenge of overpopulation. Urban centres are becoming overcrowded, leading to land scarcity, rising housing costs, and increased pressure on infrastructure. Floating cities open new frontiers for urban expansion without relying on traditional land. They reduce the need for deforestation, land reclamation, and habitat destruction. Their integration of urban agriculture through aquaponics, hydroponics, and vertical farming also supports food security, enabling residents to grow fresh produce locally using recycled water systems. This reduces dependency on external food supplies and contributes to sustainable urban living.

Floating cities strongly align with the United Nations Sustainable Development Goals (SDGs), particularly SDG 11 (Sustainable Cities), SDG 13 (Climate Action), SDG 7 (Clean Energy), SDG 14 (Life Below Water), SDG 2 (Zero Hunger), and SDG 9 (Innovation and Infrastructure). Their reliance on renewable energy sources such as solar, wind, and tidal power significantly reduces carbon emissions. Water management systems such as desalination, rainwater harvesting, and greywater recycling ensure efficient resource use. Their construction materials, such as lightweight concrete, marine-grade steel, HDPE, bamboo, and recycled plastics, are chosen for durability and eco-friendliness.

In many cases, floating platforms even serve as artificial reefs, supporting marine

biodiversity and contributing positively to underwater ecosystems.

Economically, floating cities offer numerous opportunities. They stimulate job creation in sectors like renewable energy, aquaculture, eco-tourism, marine research, and sustainable construction. Floating resorts, innovation hubs, and research centres attract investment and global interest. Pilot projects such as Oceanix City in Busan, the Maldives Floating City, and Amsterdam's IJburg community have already demonstrated the viability of floating architecture. These developments show how floating cities can evolve from experimental concepts into thriving urban environments.

However, floating cities also face engineering, environmental, legal, and socio-economic challenges. Marine conditions demand robust materials and continuous maintenance to resist corrosion, waves, and biofouling. Environmental concerns include potential disruption to marine habitats and pollution risks if waste management is inadequate. Legal issues surrounding governance, sovereignty, taxation, and jurisdiction need clear international frameworks. Social acceptance poses another challenge, as people may be hesitant to live permanently on water due to unfamiliarity or perceived risks. Additionally, high construction costs may initially limit accessibility, making it essential to promote inclusive planning and affordable housing models.

Looking ahead, floating cities hold vast future potential. Advances in smart technologies, artificial intelligence, eco-materials, and renewable energy will continue to strengthen their feasibility. As climate pressures intensify, global adoption

of floating cities may become not only a choice but a necessity. These cities could eventually serve as hubs for innovation, cultural exchange, and sustainable economic development. Ultimately, floating cities represent more than an engineering achievement; they embody a visionary approach to human resilience and harmonious coexistence with the environment. They offer a pathway toward sustainable, adaptive, and inclusive urban living for generations to come.



Sana Fathima K  
S8 CE

## Article : Biomimicry in Construction

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Biomimicry in construction is an innovative approach that draws inspiration from nature's time-tested patterns and strategies to solve human design challenges. Instead of forcing buildings to resist the environment, biomimetic design encourages structures to work in harmony with it just as ecosystems, organisms, and natural systems have done for millions of years. By studying how trees distribute stress, how shells withstand pressure or how termite mounds regulate temperature, architects and engineers develop buildings that are more energy efficient, resilient, and sustainable. This nature-inspired philosophy is reshaping modern construction by blending biology, engineering, and environmental science.

One of the most cited examples of biomimicry in architecture is the Eastgate Centre, which was inspired by the natural ventilation system of termite mounds. Termites maintain nearly constant internal temp. despite harsh external conditions by using a network of vents that regulate air flow. Similarly, the building uses passive cooling techniques that significantly reduce the need for conventional air conditioning, lowering energy consumption and operational costs. Even materials science has embraced biomimicry, such as self-cleaning surfaces modeled after the water-repellent properties of lotus leaves. These examples demonstrate how observing natural systems can lead to smarter, more adaptive construction methods

In conclusion, biomimicry in construction represents a powerful shift toward sustainable and efficient building practices. By learning from nature rather than competing against it, architects and engineers can create structures

that conserve energy, reduce waste and improve environmental performance. As global challenges such as climate change and resource scarcity intensify, biomimicry offers practical and inspiring solutions rooted in billions of years of natural innovation. The future of construction may well depend on how closely we continue to observe and emulate the genius of the natural world.



Rigved K  
S6 CE

## Article : Buoyant Foundation in Modern Construction

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Buoyant foundation, also known as floating foundation, is an innovative technique used in modern construction to overcome problems related to weak soils and high groundwater levels. The concept of buoyant foundation is based on Archimedes' principle, which states that a body immersed in a fluid experiences an upward force equal to the weight of the fluid it displaces. In this type of construction, soil is excavated and the building is designed so that the total weight of the structure is nearly equal to the weight of the soil removed. As a result, the building behaves like a floating body within the ground, which helps reduce the pressure exerted on the underlying soil.

In a buoyant foundation system, the downward load of the building is balanced by the upward buoyant force produced by groundwater. When these forces are approximately equal, the net load transferred to the soil becomes minimal. This reduces excessive settlement and improves the stability of the structure. During construction, engineers excavate the ground to the required depth and build a strong, watertight reinforced concrete basement structure. The foundation slab and basement walls are carefully designed to resist hydrostatic pressure and prevent water seepage.

Buoyant foundations provide many advantages in modern construction. They help minimize settlement in soft soil conditions, allow the construction of multi-level basements, and make efficient use of underground space for parking, storage, and other facilities. This technique is commonly used in high-rise buildings, underground parking structures, and metro stations in densely populated cities such as Mumbai, Dubai, and Singapore, where land

availability is limited and underground construction is necessary.

Buoyant foundation construction is also highly important in flood-prone areas. In regions where frequent flooding and high groundwater levels occur, conventional foundations may experience uplift pressure, water infiltration, and structural damage. Buoyant foundations help counteract these problems by balancing the uplift forces caused by water, thereby improving the safety and durability of the structure. They also reduce the risk of foundation failure during prolonged flooding and help maintain the structural stability of buildings. For coastal and low-lying regions, where flooding is a major concern, buoyant foundation systems provide a reliable and sustainable solution for safe construction.



Nayana K  
S6 CE

## Chunar Bridge

Chunar Bridge is a significant infrastructure project connecting Chunar and Varanasi in Uttar Pradesh, India. Spanning the Ganga River, it was inaugurated by Prime Minister Narendra Modi on August 15, 2018. The Bridge has greatly improved connectivity, reducing the distance between Varanasi and Chunar from 35km to 18km, and cutting travel time significantly.

The bridge offers scenic views of the historic Chunar fort and the Ganga River, boosting local tourism and commerce. It has also provided a reliable crossing, replacing the earlier piper bridge that often disrupted during rains. The Chunar bridge has become an important part of the region's infrastructure, supporting economic growth and development.

The construction of Chunar Bridge has facilitated easier access to the Chunar fort, a historical site with a rich past, attracting more tourists and benefiting local businesses. Additionally, the bridge has improved the transportation of goods and services, enhancing trade and commerce in the region.

The Chunar bridge has also generated employment opportunities, both directly and indirectly, contributing to the local economy. It has improved access to health care, education and other essential services for the people of Chunar and surrounding areas. The bridge has also strengthened social connections between communities, fostering cultural exchange and understanding.

The Chunar bridge is a vital link that has brought numerous benefits to the people of Chunar and Varanasi, contributing to the region's progress and development.



Anupriya V  
S6 CE

# Role of Civil Engineers in Disaster-Resistant Construction

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Natural disasters such as earthquakes, floods, landslides, and cyclones cause significant damage to buildings and infrastructure. Civil engineers play a crucial role in designing and constructing structures that can withstand these natural hazards. Disaster-resistant construction focuses on improving the strength, stability, and safety of buildings to minimize damage and protect human lives.

One of the major responsibilities of civil engineers is to analyze the environmental and geological conditions of an area before construction begins. By studying soil conditions, seismic zones, rainfall patterns, and wind loads, engineers can design structures that are suitable for the local environment. For example, in earthquake-prone areas, engineers design flexible structures and use techniques such as base isolation and reinforced concrete frames to absorb seismic energy.

Civil engineers also incorporate disaster-resistant materials and construction techniques. Strong foundations, proper reinforcement, and quality construction materials help buildings resist extreme forces. In flood-prone regions, engineers design elevated structures and effective drainage systems to prevent water damage. Similarly, in coastal areas vulnerable to cyclones, buildings are designed with stronger roofs and wind-resistant features.

Apart from building design, civil engineers contribute to disaster management through the planning of safe infrastructure such as bridges, roads, dams, and evacuation shelters. Proper urban planning, slope stabilization, and flood control systems help reduce the risk of disasters and improve community resilience.

In conclusion, civil engineers play a vital role in protecting society from natural disasters. Through innovative design, advanced technology, and careful planning, they help create safer and more resilient communities. Disaster-resistant construction not only saves lives but also reduces economic losses and ensures sustainable development.



S Sruthi  
S8 CE

## Article: Campus to Career: Where Dreams Begin

The unforgettable journey of friendships, memories, and dreams that shape our future.

“College life is not just about earning a degree; it is about discovering who we are and preparing for who we will become.”

College life is often described as the most vibrant and unforgettable phase of life. It is a time when dreams begin to take shape, friendships grow stronger, and young minds slowly discover their true potential. A college campus is not merely a place for academic learning; it is a world of experiences where students learn, explore, and transform into confident individuals.

Each day in college carries its own unique beauty. The excitement of attending lectures, the nervous moments before examinations, the laughter shared with friends, and the endless conversations in corridors and cafeterias create memories that last a lifetime. Cultural programs, seminars, campus events, and group studies make college life lively and meaningful.

However, the beauty of college life goes far beyond textbooks and classrooms. It is a place where students learn valuable life lessons — the importance of teamwork, leadership, patience, and responsibility. During these years, students begin to understand their strengths, discover hidden talents, and build the confidence needed to step into the world beyond the campus.

What truly makes college life special are the simple yet unforgettable moments — walking through the campus with friends, celebrating achievements together, encouraging each other

during difficult times, and sharing dreams about the future. These moments create bonds that remain strong even when the college days come to an end.

As graduation approaches, a new chapter slowly begins. The lively days of college gradually lead students towards the realities of career life. The transition from student life to career life may feel challenging, but the experiences gained in college become a strong foundation for the future.

Career life introduces new responsibilities, ambitions, and opportunities. It is the stage where the dreams once discussed in classrooms and college corridors begin to turn into reality.

In the end, college life is not just a stage of education; it is a journey of growth, friendship, and self-discovery. It prepares students to face the world with courage, confidence, and hope.

Because for many of us, college is the place where our dreams first take flight — and from there, the journey towards a meaningful career truly begins.



Thulasi E  
Lab assistant

## Light after darkness

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Like dark clouds  
carrying heavy droplets,  
my mind sinks  
into dull and weary thoughts.

Just one gentle touch,  
a passing caress of comfort,  
is enough to stir this restless heart  
into a storm once again.

Somewhere far away in the East,  
I see a sliver of dawn's first light.  
In a life drained of hopes and dreams,  
someone has sent me a lamp of grace...

I will seek,  
I will wander,  
I will face whatever comes,  
until I earn the fortune meant for me...



Jissy VV  
S6 CE

# TECHNICAL FEST 2025 MODELS



# EVENTS

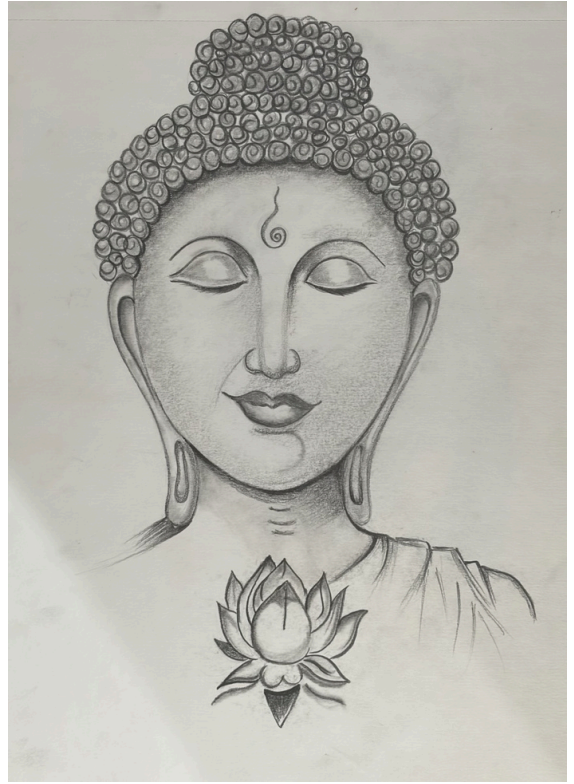
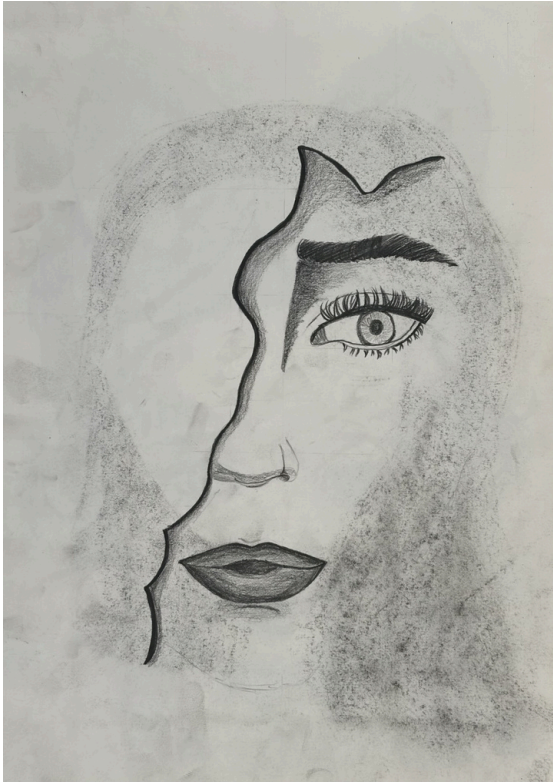




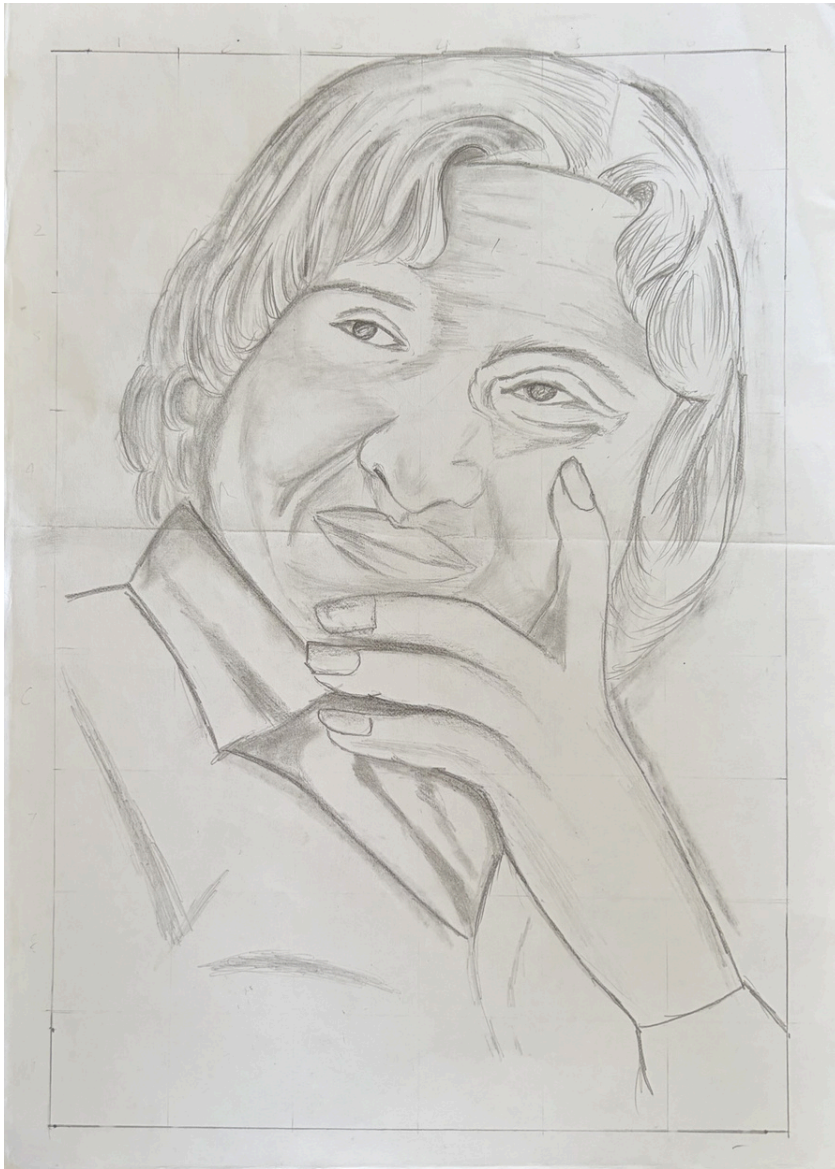
# GRADUATION DAY

CIVIL 2021-2025 BATCH





Raga Radh  
S4 CE



Sandra P  
S8 CE



Sreeshanth K  
S6 CE



Hiba Noushad  
S8 CE



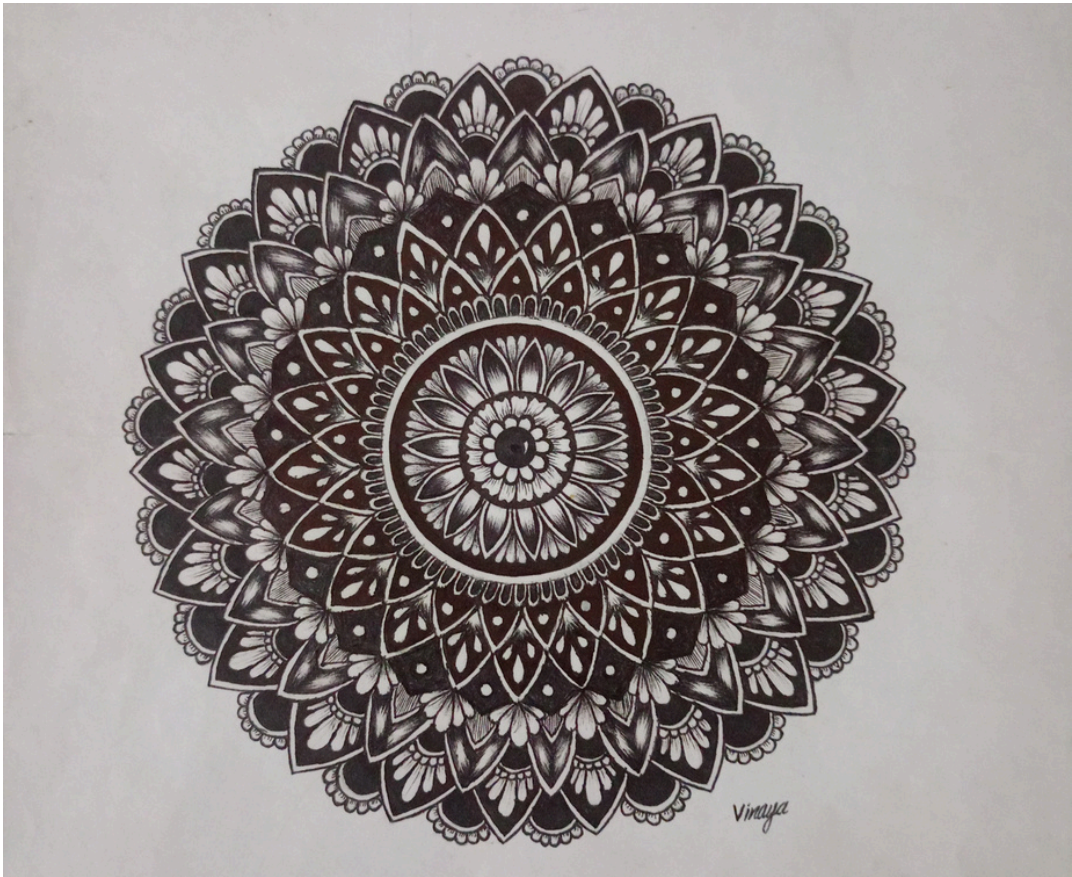


Arunima K  
S6 CE



Riya Rasheed  
S8 CE





Vinaya M  
S8 CE



Sherin PV  
S8 CE





Neeraj NK  
S8 CE



Anjali PV  
S8 CE

## Industrial Visit to Sreenath Prestress Pvt Ltd, Goa



In an endeavor to bridge the gap between theoretical knowledge and practical application, final year students embarked on a transformative industrial visit to Sreenath Prestress Pvt Ltd, Goa. Nestled in the picturesque landscapes of Goa, Sreenath Prestress Pvt Ltd stands tall as a beacon of innovation in the realm of prestressed concrete manufacturing. The students, brimming with anticipation and excitement, meticulously organized their final year trip schedule, allocating a dedicated day for their rendezvous with the industrial giant. Despite the weariness of a long journey, their enthusiasm remained undeterred as they set foot into the premises of Sreenath Prestress Pvt Ltd.

# EVENTS CONDUCTED



# Photo wall





# CLASS PHOTO 2022-2026 BATCH

