MARCH 2025

VIEWPOINT

OFFICIAL QUARTERLY MAGAZINE OF CEAI

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AI IN CONSULTING ENGINEERING AND CONSTRUCTION

CEAI Consulting Engineers Association of India

Creating Value Ethically for Engineers

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Service to Consulting Engineers

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CONTENTS

Editorial Board Members

Message from President

Dear Members,

It's always a pleasure to write to you, a group of dedicated professionals who are shaping the future of our industry. Your expertise, innovation, and leadership are the backbone of our association, and I want to start by thanking each and every one of you for your continued commitment.

As we move forward into another year of growth and advocacy, I have a few key requests that will help us strengthen our association and expand our impact.

Membership Renewal – Stay Connected, Stay Strong

First and foremost, I encourage you all to renew your membership if you haven't already. Your membership is more than just a renewal - it's a commitment to the profession, to the collective voice we amplify, and to the opportunities we create together. Your dues directly support our advocacy efforts, educational programs, networking opportunities, and resources that benefit all members. If you have already renewed—thank you! If not, please take a moment to do so, and encourage your colleagues to join us as well. A strong membership means a stronger industry.

Share Your Achievements – Let's Celebrate You!

We know that many of you and your organisations are making incredible strides - winning awards, completing ground breaking projects, earning certifications, and contributing to your communities. We want to recognize and celebrate these achievements! Please share any professional milestones with us so we can highlight your successes in our newsletters, website, and social media. Your accomplishments not only inspire fellow members but also showcase the value and expertise within our association.

Investing in AI for a Powerful Future

We find AI is revolutionizing consulting engineering and construction by improving efficiency, accuracy, and decision-making and therefore we bring to you a special issue on this topic. AI is impacting the industry in many ways, viz, Design & Planning, Project Management & Risk Mitigation, Construction Execution, Safety & Risk Management, Post-Construction & Maintenance, etc. The articles presented here give a view of some of the challenges and considerations in its adoption in our industry.

Engage With us on Social Media

Speaking of social media, I encourage all of you to follow, like, and engage with us on our platforms. Social media is one of the most powerful tools we have to share industry insights, advocate for key issues, and spotlight member

achievements. By interacting with our posts - whether by liking, commenting, or sharing - you help extend our reach and strengthen our presence. Tag us in your posts, use our association hashtags, and let's continue building an active, engaged online community.

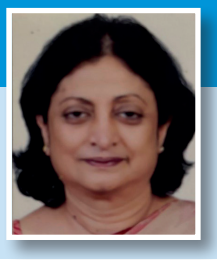
Together, We Go Further

Our association thrives because of you. Your participation, your insights, and your engagement drive us forward. Let's make this year one of growth, collaboration, and success. Renew your membership, share your achievements, and stay engaged with us.

Thank you for your time, your commitment, and for being part of this incredible community. Let's continue to build something great-together!

Warm Regards

Prashant Kapila



Message from Chief Editor

Dear Fellow Engineers and Readers,

There is always a time lag between technological advancements and their widespread adoption. The use of mainframe computers in India started early in the 1950s and moved on to the use of Personal Computers in the 1980s. Thereafter, it evolved gradually and the term digital economy gained traction only in the early 1990s, when the internet began to impact various spheres of economic activity. Similarly, while the concept of BIM was envisioned in the 1970s, its development and actual progression to use as digital representations of physical assets evolved in the 2000s. It was, thus, awhile before it could aid engineers in planning, design and construction of various physical assets. That included buildings, factories, and diverse infrastructure related to transport, utilities, etc. through their life cycle. In India itself it caught on in the late 2000s and gained widespread acceptance in major public projects when National Standards and guidelines were formulated and introduced for adoption.

Work on Artificial Intelligence (AI) also had been going on for long and was once a futuristic concept, but it is now very much an intrinsic part of our everyday lives, some of which we may not fully acknowledge. In a 1968 movie "2001: A Space Odyssey" the supercomputer of the spacecraft takes over from humans and the latter then get control back.

India was a late entrant in the use of AI, in industry, as it started gaining acceptance around 2019 although logic circuits for instrumentation have been in use for long. It is now commonly used in finance, health care, education, agriculture and e-commerce. The extent of usage of AI in engineering and construction to improve efficiency, safety and sustainability, is not so widely known.

Currently, AI usage is most prevalent amongst tech companies. ISRO uses it for its ongoing projects and programs.

In consulting engineering, it is gaining usage within those companies that got off the mark fairly early in digitalisation. Other than multinational companies, that includes larger companies and smaller niche consultancy companies, who use it to enhance efficiency and accuracy in their engineering and non-engineering processes. It is used for data analysis, optimisation in infrastructure projects and smart projects.

One of the first projects that adopted AI was the Prestige Jindal City Project, where it was used for market trend analysis, property value prediction and design optimisation.

Embracing AI-driven solutions can help do away with time spent on tedious repetitive mundane tasks and enable engineers to tackle knotty complex problems effectively. In engineering, it can be used across disciplines starting

from conceptualisation to optimal design engineering outcomes - by analysing data, evaluating alternate options to arrive at superior solutions. In construction and asset management, it is invaluable from a safety point of view, quality control, and in predictive maintenance.

The efficacy of AI is primarily dependent on the quality of data available and the algorithmic logic built into the AI software for a specific use, mainly, by engineers and scientists. There is an apprehension, which is misplaced, that AI will take away jobs of qualified engineers in engineering. AI is at best an adjunct to traditional engineering expertise. However, a professional engineer would inevitably need to inculcate the technical skills, upskill or reskill, to effectively manage and interact with AI systems. Professional organisations and Engineering Experts have to take cognisance of this requirement and address it, the sooner the better.

This issue of Viewpoint on ***'AI in Consulting Engineering and Construction'*** is to promote better awareness of AI amongst the engineering fraternity. It endeavours to give an overview of the advances in digitalisation and the transformative use of AI; its potential across a wide spectrum of activities, its application in engineering and construction for a smarter, safer and more sustainable world, and the proactive need for regulation to mitigate risks.

Happy reading and learning to be AI ready in engineering consultancy and construction!

Sayona Philip

About CEAI

Consulting Engineers Association of India (CEAI) is the apex body of consulting engineers in India having membership of organisations as well as individuals. The membership represents large, medium and small consultancy companies/ organisations both in the private and public sector and eminent individual consultants. EPC organisations are also members of CEAI since they have planning and design engineers, apart from construction management consultants.

CEAI is the Member Association, of the International Federation of Consulting Engineers, commonly known as FIDIC, the acronym for Fédération Internationale Des Ingénieurs-Conseils, representing the Consulting Engineering Fraternity in India. FIDIC has membership of more than 100 Member Association of various countries and is headquartered in Geneva.

CEAI was incorporated in 1996, with the merger of two leading national associations Association of Consulting Engineers (India) {ACE(I)}, incorporated in 1960 and National Association of Consulting Engineers {NACE}, incorporated in 1976. Thus, CEAI has behind it six decades of accumulated knowledge and experience.

- CEAI promotes the interest and works to enhance the status of the consulting engineering profession in India
- CEAI advocates global networking and co-operation
- CEAI's activities include:
  - Quality development of Consultants.
  - Productivity enhancement.
  - Promotion of ethical practices.
  - Facilitation and interaction with government and other authorities/ bodies to streamline and improve the system of engagement of consultants.
- Regional Centres in Jaipur, Bengaluru, Kolkata and Mumbai to broad base activities.

Aims & Objectives

- Promote the professional interest and establish the rights and privileges of the status of consulting engineering profession in India
- Represent the consulting engineering profession within India and abroad. Connect the members locally and globally.
- Disseminate among the members information on all matters pertaining to engineering, especially knowledge and information related to consulting engineering profession by way of holding Conferences, Seminars, Courses, Workshops, Field/ Site Visits, etc. and thus assist in Continuing Education for the Professional Development of Members.
- Act as the principal champion for consulting engineering profession through constantly informing and educating the public and lawmakers about key engineering issues and making it possible to have the voice of the profession heard by the policy makers.
- Promote adoption of equitable forms of contracts and other documents used in consulting engineering practice.

Vision

- To represent, promote and enhance the status of consulting engineers in India as an honoured and dignified profession for nation building and propagate Indian engineering consultancy globally.

Mission

- Promote interests of the consulting engineering profession nationally and internationally.
- Promote sustainable, safe and sound engineering practices.
- Upgrade engineering knowledge and skill.
- Propagate code of professional ethics, safety, health and environment.

Values

- Commitment with tenacity to high ethical values, integrity, professionalism and achieving technical excellence and inclusive development.

Code OF Ethics

- CEAI has adopted a Code of Ethics, to which all members must abide. It is not just for the quality of the jobs they work on, but for the safety and well-being of the public at large.
- CEAI is the profession's most respected voice on the practice of ethical engineering.
- The code specifies the responsibilities of Consulting Engineers towards the society as well as the profession, to refrain from performing services unless competent to do so, to act in the legitimate interest of client, to be impartial, to maintain ethical relations with other consultants.

CODE OF ETHICS

PREAMBLE

Engineering consultancy services make significant contributions to the economic growth and sustainable development of the nation, and in safeguarding health, safety, welfare, and happiness of the society.

For the nation and the society to derive maximum benefits from engineering services, it is essential that, in addition to being of high technical standards, the services provided are of the highest universally accepted moral and ethical standards.

With a view to achieve the stated objective the Consulting Engineers Association of India (CEAI) has framed a "Code of Ethics" which is mandatory for all members of the Association to adopt and abide by.

This Code presupposes that every member of CEAI is a law abiding, truthful, honest, fair and just citizen of the society. In addition, the member must follow the directives of the Code in his/her professional practice.

THE CODE

Each CEAI Member shall:

Responsibility to Society	1	Ensure that he/she shall be ethically and socially responsible, and his/her professional services safeguard and enhance the health, happiness and safety of the society.
	2	Ensure he/she, in his/her profession upholds the principles of environmentally sustainable development and considers climate change in decision-making with appropriate knowledge and training, and also informs clients about the need for its inclusion.
	3	Treat all persons fairly and encourage equitable participation without regard to religion, race, caste, gender, descent, place of birth, or residence, so that everybody works with honesty, integrity, and mutual trust and respect in a transparent manner.
Responsibility to Profession	4	At all times, uphold the dignity, standing and reputation of the profession.
	5	At all times, provide services: (a) in accordance with the principle of 'Duty of Care', implying the obligation to take reasonable steps to avoid foreseeable harm to another person, group, or their property and society; (b) to meet and fulfill the requirements as agreed with the client as per the Design Brief of the client, or as required by the employer as per the employment contract, and give feedback for any changed context; and, (c) to ensure that the said services utilise appropriate technology, and be fit for the design life of the product or facility and for its intended purpose and use.
	6	Always be responsible and accountable for all the professional services provided under his/her responsible charge, including using validated and legal algorithms and software.
	7	Refrain from: (a) expressing in public an opinion on a professional topic unless he/she is sufficiently informed on the facts relating to the topic and he/she is competent to comment on it; (b) making public statements which are not in an objective and truthful manner; (c) casting any aspersions of an unjust or malicious nature; and, (d) performing any service beyond his/her competency.
	8	Imbibe, inculcate and emphasise the Code of Ethics periodically and internally within the organisation and also for oneself.

	9	Maintain knowledge and skills at levels consistent with developments in technology, legislation and management, and apply due skill, care and diligence in the services rendered to the client or employer.
	10	Continue professional development and advancement throughout his/her career.
Integrity	11	Act, without prejudice to the rights of other stakeholders, in the legitimate interests of the client or employer, and perform professional services with integrity and faithfulness.
	12	Act with fairness and justice towards his/her client or employer, and towards vendors, contractors, and other professionals in all matters pertaining to contracts relating to his/her professional services.
	13	Refrain from: (a) indulging or being or getting involved in any activity which in any manner seeks to affect or in any way influence the client or employer with regard to the selection of or the compensation for professional services; and/or affect or influence the impartial judgement of the professional himself/herself; and, (b) participating in any shape or form in the process of giving, promising or taking money, gift, or favour which may influence the judgment or conduct of a person in a position of trust or authority.
	14	Inform: (a) the concerned client or employer organisation's management first, of any unethical or unsafe act or situation; known or learnt by him/her in the course of his/her work or in any other work within his/her competency; and (b) the appropriate authorities, if the client or employer organisation's management is unable or unwilling to address the unethical or unsafe act or situation referred to in (a) above
	15	Facilitate in ensuring legal compliance by client or employer, contractors, vendors and others.
	16	(a) Refrain from utilising any data, information, computer hardware or software in his/her work that might infringe upon any Intellectual Property Rights, without obtaining proper legal clearance; and (b) Use all the data, business plans or strategies, and any other sensitive or confidential documents or materials, whether from the client or employer, or internal to the organisation, in a responsible manner, so that their confidentiality and security are not compromised.
	17	Promote an ethical culture in the organisation based on shared values, beliefs and norms such as trust, honesty, integrity, fairness, confidentiality and accountability, and actively adopt them to uphold professional ethics, and make decisions that are above reproach.
Impartiality	18	Be free of prejudice and personal preferences, in his/her professional advice and judgement.
	19	Refrain from accepting an assignment for services which prejudices his/her independent judgement.
	20	Inform the client or employer of any potential conflict of interest that exists or might arise in the performance of an assignment.
	21	Promote the concept of quality based services to encourage fair competition
	22	Cooperate fully with any legitimately constituted investigative body appointed or setup for inquiry into the administration of any contract where the professional is involved.

Relations with Other Consultants	23	Refrain from directly or indirectly injuring/damaging or attempting to injure/damage the professional reputation or practice or prospects of another fellow professional, except when the fellow professional is incompetent or has violated ethical norms.
	24	Refrain from associating in work with a professional whose methods of practice do not conform to the ethical practices as laid down in this Code.
	25	Refrain from: (a) trying to supplant another professional in any particular assignment; and (b) intervening in work of any kind which to his/her knowledge has already been entrusted to another professional, except when appointed as a Reviewer by the client or employer.
	26	Refrain from taking over the services being provided by another professional unless the client or employer formally appoints the professional to take over the ongoing assignment, after legally terminating the previous contract, and legally indemnifies the appointed professional against any deficiencies and losses already incurred or liable to be incurred due to the errors of omission and commission by the previous professional.
Relation with Clients	27	(a) Refrain from disclosing confidential information concerning the assignment, any technical process or any related matter, of the client or employer without the client's or employer's consent. (b) making comments in public/ social media regarding the work being done for the client.
	28	Publicity material as well as any paper/ article developed, written and published by the professional regarding the project to be as per the contract and the scope of work therein.
	29	Amicably attempt to resolve any issue with the client.
Relation with Employees	30	Provide opportunities for the professional development and advancement to other professionals in his/her employment or control, aimed to foster a culture where people are motivated, engaged, valued and can learn, develop, and grow.

The undertaking

I, the undersigned, certify that on my behalf and on behalf of the organisation, I have read and understood the Code of Ethics of CEAI and hereby undertake to abide by all its provisions and the Rules of the Association both in letter and in spirit, as may be amended from time-to-time, hereafter.

Member Registration No.:	
Name of Organisation: **(for organisational Members only)**	
Name of person signing the declaration:	
Designation: **(for organisational Members only)**	
Signature:	
Place:	
Date:	

AN EXCERPT FROM

India's AI Revolution
A Roadmap to Viksit Bharat

(Ministry of Electronics and Information Technology)

India is undergoing a remarkable transformation in Artificial Intelligence, driven by the visionary leadership of PM Modi. For the first time in India's history, the government is actively shaping an AI ecosystem where computing power, GPUs, and research opportunities are accessible at an affordable cost.

AI Compute and Semiconductor Infrastructure

Here are the key developments:

- Scaling AI Compute Infrastructure
- Opening Access to High-Performance Computing
- Robust GPU Supply Chain
- Indigenous GPU Capabilities
- Affordable Compute Access
- Strengthening Semiconductor Manufacturing

Advancing AI with Open Data and Centres of Excellence (CoE)

- IndiaAI Dataset Platform for Open Data Access
- Boosting AI Model Accuracy with Diverse Data
- Centres of Excellence
- Skilling for AI-Driven Industries
- India's Foundational Large Language Models
- Digital India BHASHINI
- BharatGen
- Sarvam-1 AI Model
- Chitralekha
- Hanooman's Everest 1.0

AI Talent & Workforce Development

- AI Talent Pipeline & AI Education
- India Ranks 1st in Global AI Skill Penetration
- AI Innovation
- AI Talent Hubs

AI Adoption & Industry Growth

- Businesses Prioritising AI Investments
- GenAI Startup Funding
- AI Transforming Workplaces
- AI Empowering Small & Medium Businesses (SMBs)
- Rapid Expansion of India's AI Economy
- AI Startup Support Ecosystem

A Pragmatic AI Regulation Approach

India's pragmatic AI regulation balances innovation and accountability, steering clear of overregulation that could stifle growth and unchecked market-driven governance that may create monopolies. Instead of relying solely on legislation, India is investing in AI-driven safeguards, funding top universities and IITs to develop solutions for deep fakes, privacy risks, and cybersecurity threats. This techno-legal approach ensures AI remains a force for inclusive growth, fostering an ecosystem where innovation thrives while ethical concerns are proactively addressed.

Conclusion

India's rapid advancements in artificial intelligence, underpinned by strategic government initiatives, have positioned the country as a global AI powerhouse. By expanding AI compute infrastructure, fostering indigenous AI models, enhancing digital public infrastructure, and investing in talent development, India is creating an inclusive and innovation-driven ecosystem. The emphasis on open data, affordable access to high-performance computing, and AI-driven solutions tailored to local needs ensures that the benefits of AI reach businesses, researchers, and citizens alike. As AI adoption accelerates across industries, India's proactive approach is not only strengthening its digital economy but also paving the way for self-reliance in critical technologies. With a clear vision for the future, India is set to become a leader in AI innovation, shaping the global AI landscape in the years to come.

Source: Research Unit, PIB, Govt of India

01

AI across Consulting Engineering and Construction

Suhas P. Bhagwat
Founder & CEO
Avroglide Consultants

Himanshu Arora
Co-founder & CEO
Dimensionless Technologies

Introduction

Over the past decade, the world has been witnessing the emergence of several advanced digital technologies that have made, and will continue to make, a huge impact on the way people, industry, as well as the society at large, undertake and execute their day-to-day and long-term activities. Among these technologies are Artificial Intelligence, or AI, (and its off-shoots namely Machine Learning, Deep Learning, Large Language Models, Robotics and so on), Virtual/ Augmented/ Mixed Reality (together referred to as Extended Reality or XR), Internet of Things and Industrial Internet of Things, Drones, Blockchain, 3D Printing, just to name the prominent ones.

The primary reason that these technologies are being accepted by users, especially those from industry and business, is the ability of these technologies to bring in efficiency and effectiveness in operations, higher accuracy, reduced time to complete an activity, reduced costs, as well greater adherence to safety and quality. Above all, many of these technologies have now enabled certain activities and operations to be undertaken, which never were thought possible earlier.

Of specific interest to the Engineering Consultancy, Construction and the allied Industrial sectors is how AI and its associated technologies bring benefits to various operations in the value chain of a project involving large scale construction. This article makes an effort to bring out salient aspects of this technology and the typical use cases in these operations while highlighting the benefits brought to the table.

Basic Elements of AI Relevant to Engineering, Construction and Allied Sectors

Artificial Intelligence is a branch of computer science focused on creating systems that can perform tasks (that have hitherto been possible only through human action and/ or human intelligence) without the involvement or any action by a human. The field of AI has been evolving and growing at an extremely rapid pace and the world has been seeing new developments and advent of advanced applications on a regular basis.

For the purpose of getting an overview, various aspects of Artificial Intelligence can be categorized under different classes as presented in Figure-1.

At its most basic, limiting to applications in Engineering and Construction, AI technology encompasses various techniques that enable machines to simulate human-like intelligence. AI covers several different elements which all have their own characteristics, and help the business operations in different ways.

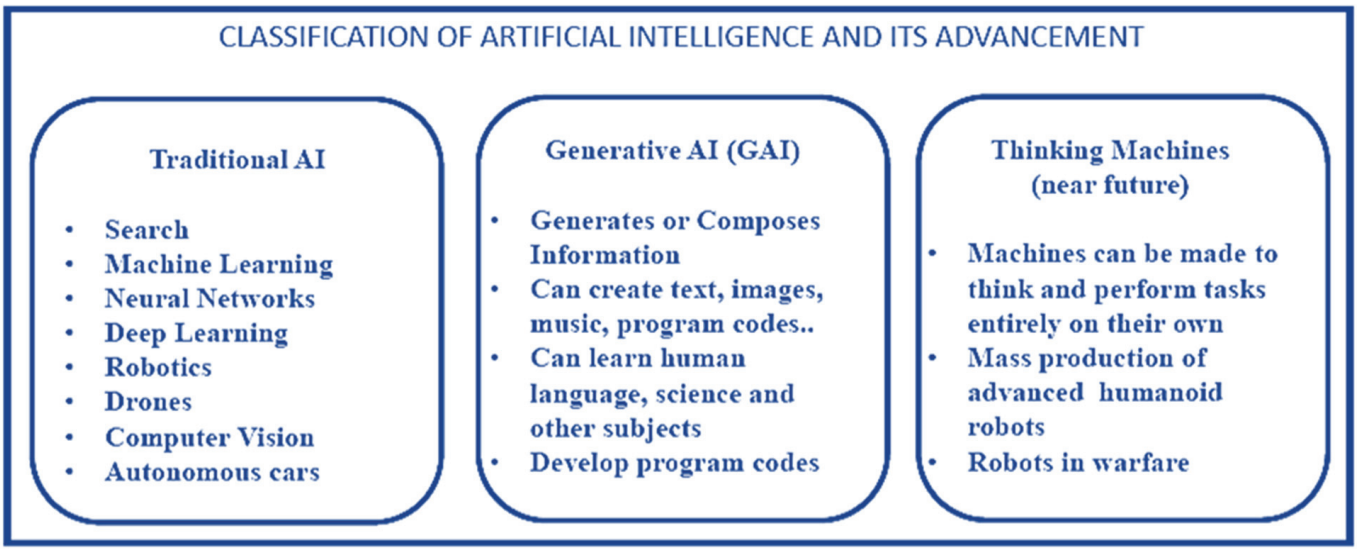


Figure-1: Classification of AI

Machine Learning (ML) –allows computers to learn and improve from data without being explicitly programmed.

- ML uses algorithms to analyze large amounts of data and tries to find patterns in them to make predictions.
- ML models are the output of algorithms, which are used to learn further and make predictions, and in the process improve their performance over time without explicit programming. They become more accurate as they are exposed to more data.
- ML can perform tasks like predictive maintenance, optimization, and automation, freeing up the engineer's time for creative problem-solving.

Deep Learning (DL) is a type of ML that uses Artificial Neural Networks (ANN) to analyze data and solve complex problems. ANNs are designed to mimic the functioning of the human brain by processing data through interconnected nodes to recognize patterns and make decisions. This technique is used for tasks such as image recognition, fault diagnosis, and control systems to make their work more efficient.

- Deep learning models are trained using large amounts of data
- The data is fed into an ANN which is made up of layers of artificial neurons
- Each neuron performs nonlinear transformations on the data
- The model learns to represent the data in an intricate way
- Once trained, the model can process new data in real time

Data is one of the foundational elements of AI since the so-called intelligence originates from the data that is processed and analyzed.

Data Analytics (DA) involves analyzing vast amounts of data followed by detection of patterns and trends, which enables performance of tasks such as predictive modeling, risk assessment, and performance optimization.

Generative AI (GAI), is a type of AI that can create new content like text, images, videos, music. It can learn from and mimic large amounts of data and provides useful outputs as per user requirements.

- GAI uses foundation models, which are large AI models that can perform tasks like summarization and classification.
- It can learn human language, programming languages, art, chemistry, biology, or any complex subject matter.
- It reuses what it has learned to solve new problems.

Examples of uses of Generative AI:

- Chatbots: creates human-like text responses, making them more engaging and capable of maintaining natural conversations.
- Media creation: can create images, videos, and music.
- Product development: Generative AI can create designs optimized to meet specific goals and constraints.
- Virtual Assistants: These can hold engaging conversations with users, responding to their queries in human-like fashion.

While using GAI, it is important to give due consideration to aspects of information security and data privacy, compliance, copyright, and academic integrity.

Some of the popular Generative AI tools are CHAT GPT by Open AI; MS Copilot by Microsoft; Meta AI by Meta; Deepseek (multiple versions AI/V3/MoE...) by Deepseek.

Large Language Model, or LLM: an advanced version of "Natural Language Processing – NLP", is another type of Generative AI that focuses specifically on language related tasks. LLMs excel at processing, understanding, and producing text in human language. LLMs synthetically generate written text, such as drafting business emails, creating reports on a given event, or summarizing long documents.

There are further offshoots of AI, in combination with several other technologies, such as Robotics, AI in combination with XR and/or IIOT and so on.

Applications of AI in Engineering and Construction Projects

Just as AI technologies have been proving to be an immensely useful tool for advancement of any segment of the economy and the ecosystem in a country, they are also assisting professionals in the field of Engineering and Construction leading to several and significant benefits through their deployment.

Some use cases for AI applications and tools in engineering and construction phases of large-scale projects are discussed below.

Engineering

- Generation of material quantity take-offs for various disciplines and areas such as civil, mechanical, electrical, plumbing, communication, fire, horticulture, etc. for projects
- Generative design, an AI-driven process, allows architects and engineers to input specific design goals and constraints, such as materials, budget, and building codes, and receive a range of optimized design options. This approach speeds up the design process and ensures that the final plans are more efficient and cost-effective.
- Quick scanning of tender documents and auto-generation of structured summary of the same which helps the Proposal Engineering team in taking a bidding decision, assist in risk assessment, and many other ways.
- AI assistance which enables raising of queries to search voluminous specifications and pick out the relevant provisions in the same, thus saving the engineer's time and effort.
- Parsing large sets of drawings for a project and identifying any missing drawings or drawings under old revisions as against the current ones mentioned in the drawing list/ schedule.
- Creation of 3D models from 2D images through AI applications.

Project Management and Construction

- Analysis of vast amounts of data from past projects to predict potential hurdles, risks, possible delays and recommend efficient scheduling for the project in hand. It thus allows managers to take proactive measures to keep projects on track.
- Automatically check for quality and completeness in construction documents

- Through Computer Vision, monitor construction sites in real time, identify safety hazards and alert the management immediately, thus helping prevent accidents and improve overall safety compliance.
- Optimize project schedules and resource allocation
- Place orders and schedule just-in-time delivery of materials, deployment of man-power resources.
- Assess and manage the environmental impact of construction projects
- Analyze and digitize construction documents and plans

Objectives of An AI Tool and Criteria for Selection of An AI Agency

The Engineering Consultancy and EPC / Construction organizations typically do not have in-house capability to create AI tools and applications required for their operations. Therefore, in order to leverage the power of this emerging technology, these organizations typically source these tools and applications from specialist AI firms. It becomes necessary to keep some broad objectives in mind while defining the AI Use Cases and for generating specifications for the same.

- The AI tool needs to be driven by a strong sense of purpose.
- The AI tool should be custom-designed for a specific Use Case.
- The Use Case needs to be defined in a way to free up engineer's time from the repetitive and mundane activities so that the time can be spent on activities which need the relevant expertise and experience of the engineer.
- Possible expansion considerations for the Use Case need to be kept in mind so that the AI tool can be configured accordingly.

While selecting an AI service provider for procuring a particular AI tool, it is advisable to check certain overriding factors to ensure the right selection of the AI Agency capable of providing appropriate solutions for the defined use cases. The criteria for selection of an AI Agency would thus include the following.

a) Proven Track Record and Case Studies

Choose a provider that has proven service delivery in implementing similar AI solutions. Listing success stories of other clients and case studies show that they can deliver the tool meeting the specifications.

b) Scalability and Flexibility for Future Growth

These aspects are essential so as to accommodate the organization's future expansion. Hence, AI firms that can build in this design flexibility are preferred. Long-term solutions enable organizations to meet new needs without having to redesign their whole system.

c) Customization for Specific Engineering Needs

Each Engineering firm has its own needs and systems. Therefore, the AI solutions to be developed for them need to incorporate the required work-flows and procedures defined by the Engineering firm.

d) Real-Time Monitoring and Decision-Making

The on-stream processing capabilities are important for making immediate decisions based on the data. The AI solution must be capable of sending reports in real-time to address changes in operations as they occur.

e) Security and Compliance with Industry Regulations

Importance of these aspects cannot be over-emphasized. Adherence to these regulations helps shield the organization's valuable information, reduce the risk of cyber-attacks, and also helps compliance with legal requirements.

f) Support, Training, and Vendor Collaboration

Training is crucial for AI implementation to be successful. Adequate training materials also need to be available. This is to ensure that AI solutions' integration, problem-solving, and fine-tuning go as planned. The AI firm is also required to provide continuous support after the training is completed.

And last but not the least, the AI solution has to be cost effective, should make tangible business sense, improve processes, slash operating costs, and lead to business growth.

Some Useful AI Applications for Engineering and Construction

Over the recent past, the market has seen the emergence of several AI Developer groups who have developed useful and effective AI tools with the capability to bring in significant improvement in efficiency of concerned operations in the engineering and construction space. Some of them are listed below along with their details as available.

BEAM AI (1): It is a useful application for automation of Material Take-off (MTO) for all types of building projects. It covers MTOs for various disciplines, namely civil. mechanical, electrical, instrumentation, plumbing, etc. as well as work quanta. The application provides the benefit of quick inputs for further processing of downstream activities in the project, namely getting quotations from vendors, arriving at cost estimates and actions for procurement. Effectively this is seen to result in significant saving in the cycle time for these activities as well the associated manhour costs, thereby leading to better chances of winning projects as well as helping the execution activities.

InspectMind (2): This provides an AI tool for inspection of the construction work. It incorporates integration of LLM and advanced computer vision which enhances accuracy and efficiency in inspection processes. It is equipped with features like AI generated report previews, efficient photo capture, handsfree inspection and photo inputs with smart glasses. The AI powered platform streamlines the reporting process, significantly reducing the time it takes to write detailed and high-quality reports. The tool processes the diverse data collected from construction sites and creates a comprehensive report, thus reducing the Engineer's effort to write the same. The report can also be shared via a link or downloaded into a MS Word or pdf document. A word of caution in this regard is that the Engineer should not totally rely on the report as generated, but use it as a base to add. This would apply to all computer-generated reports.

Transcend Design Generator (TDG) (3): This is an effective AI tool that can generate diverse design concepts and design ideas for an upcoming capital project by repurposing existing similar projects and iterating on proposed plans for the project at hand. The tool gives a holistic insight into how the project can be completed within the specified time while identifying potential bottlenecks and inefficiencies in various phases of the design and engineering processes.

PlanSwift (4): It is another AI based software for material take-off and estimating, and is designed to help construction professionals to quickly and accurately create cost estimates. It simplifies the estimating process, enabling users to improve accuracy and efficiency. It permits quick calculations, enhancing productivity during the estimating phase. It has an easy-to-use interface featuring drag-and-drop tools that simplify the estimating process. It also works seamlessly with other accounting and project management tools so as to streamline workflows.

PropelPro (see note below): This platform has specialized modules addressing different aspects of bidding and proposal activities for large scale EPC and other types of construction projects, or projects handling any part of the value chain such as Engineering Consultancy, Engineering Management, Construction Management and so on, in different business segments. The platform also has the ability to handle various contracting modes namely EPC, LSTK, BOO, BOOT, etc.

The first module, **PropelScout,** handles opportunity identification by analyzing tender announcements across multiple procurement platforms. The module employs natural language processing to categorize opportunities according to technical parameters, project scope, within identified geographies. The system evaluates the alignment between available tenders and organizational capabilities, enabling firms to make data-driven decisions about which opportunities to pursue.

The second module, **PropelRead**, addresses document processing challenges inherent in tender analysis, especially for voluminous tender specifications amounting to thousands of pages. The module utilizes artificial intelligence to extract and organize information from the tender documents through automated analysis. PropelRead systematically identifies essential elements covering both commercial and technical tender specifications, presenting these as structured and customized summaries of the same.

A distinctive feature of PropelRead is its template-based information presentation system. The module categorizes different types of capital projects and applies appropriate templates for information extraction. For instance, technical tenders for Oil & Gas projects require specific data organization that differs from tenders for Water Treatment Plants or Road, Highway, Rail, Metro, Buildings, Industrial construction projects, although the commercial part of these tender specifications may be very similar to each other. These templates contain pre-configured information categories relevant to each project type. The system's architecture allows for template customization based on organizational preferences, enabling companies to modify information categories according to their proposal development protocols.

PropelRead also incorporates addendum/ corrigendum/ amendment management functionality, a critical aspect of tender processing. The system employs comparison algorithms to analyze original tender documents alongside subsequent revisions, automatically identifying modifications between the versions. When changes are detected, the system integrates these updates into the extracted information while maintaining the records of the modifications. This technical approach to version control ensures that the proposal team works with the current requirements throughout the bidding process, addressing a common challenge in document management in this phase.

PropelRead further has a feature to help in the "Bid-No-Bid" decision by management when the tender is received. The tool examines various provisions and requirements specified in the tender and compares the same with certain policies and the prevailing position of the organization based on which this decision is enabled, right at the start of the bidding efforts.

Figure-2 shows the features and functionalities of the different modules.

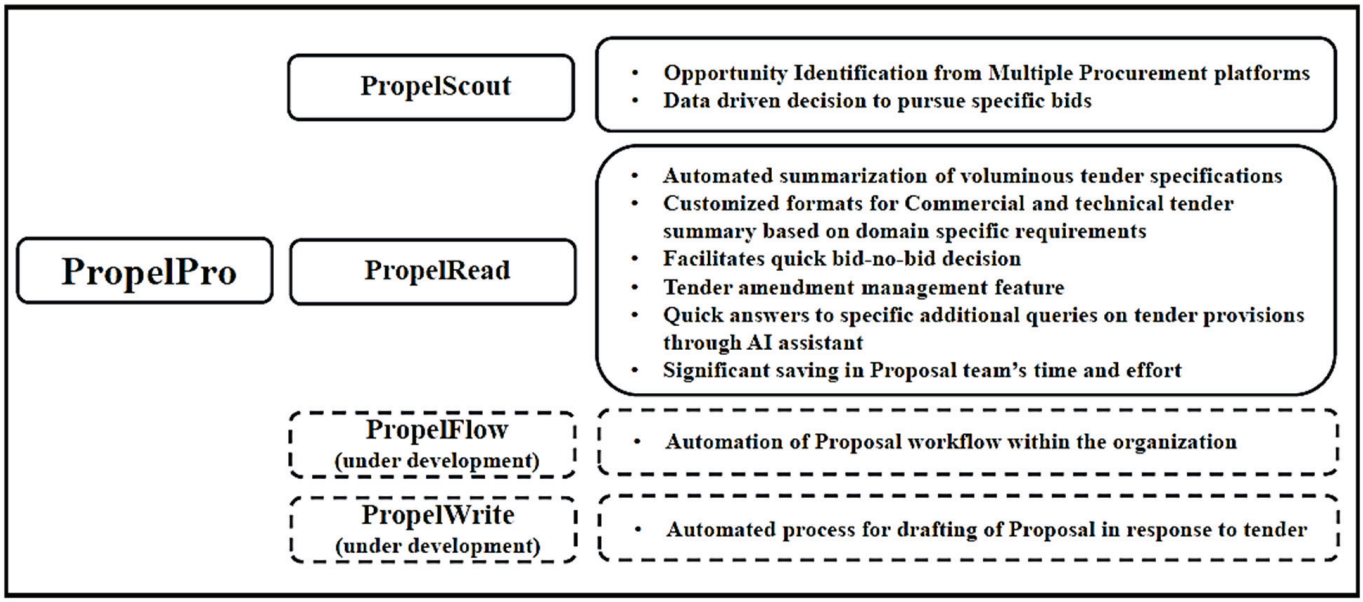


Figure-2: AI Features and Functionalities of Modules under PropelPro Platform

Another feature of the tool is its AI tender assistant that can respond to specific queries of the user from the tender document. It is like a chatbot and is useful in case some specific information is not covered in the standard format. The feature enables users to raise queries on the tender specifications and get necessary clarifications over and above the information earlier extracted in the structured form.

Modules of PropelPro currently under development include **PropelFlow** and **PropelWrite** that offer Tender Management and AI powered proposal drafting capabilities respectively.

Together, these modules would form an integrated workflow where different aspects of proposal generation connect with each other seamlessly.

Implementation of such systems in Project organizations has shifted how proposal teams allocate their time, reducing administrative document review and allowing for greater focus on developing technical solutions and strategic responses. This represents one aspect of the broader digital transformation occurring within proposal management practices in the EPC/ Construction sector.

Concluding Remarks

The expertise of engineers in understanding complex systems and domain-specific knowledge enables them to leverage AI tools for problem-solving and process optimization. By integrating AI into workflows, engineers deliver solutions that align with the evolving technological landscapes. They are then able to lead innovation across any field where engineering is used.

It is important to note that AI is a tool, and it cannot replace the human intellect and thus the Engineer per se. AI, however, has the capability to enable Engineers to spend time gainfully on more intelligent and value-added activities rather than the mundane and routine ones that Engineers now perform. Engineers can harness AI when selecting a project's best path forward so that more innovative, sustainable options can be explored and examined for projects. The AI tools nonetheless need guidance and adjustments from Engineers' real-world expertise. By deploying AI, Engineers can provide better conceptualization, planning, designing and construction for projects in order to meet the challenges of the evolving markets.

About PropelPro: It is an AI platform developed by Dimensionless Technologies, the firm co-founded and headed by Himanshu Arora, one of the authors of this article.

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02

Generative *Vision AI* for Safety in Construction

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Abstract

The Construction sector has long grappled with high-risk working conditions. Common hazards - such as falls from height, incidences of struck-by moving equipment or tools or implements or fellow workers, and inadequate use of personal protective equipment (PPE) - continuously pose risks to both productivity and human life. In recent years, *Vision AI* has emerged as a powerful tool for mitigating these challenges. By analysing real-time video feeds from CCTV, drones, and other imaging sources, *Vision AI* systems can automatically detect, flag, and help resolve safety violations on construction sites. These technologies promise to reduce injuries, improve compliance with regulatory standards like the Occupational Safety and Health Administration (OSHA) in the United States, and elevate the overall safety culture of projects.

This article examines how *Vision AI* empowers proactive hazard monitoring and discusses its importance in modern construction practices. This article assesses several state-of-the-art AI solutions and highlights the Go4Zero™ - an integrated platform designed to unify hazard detection, regulatory compliance, and data-driven analytics. Through real-world examples, it demonstrates how AI-driven solutions reduce accidents, enhance accountability, and foster a safety culture that goes beyond mere reactive incident management. As *Vision AI* rapidly becomes a cornerstone of construction risk mitigation, stakeholders who adopt these technologies stand to benefit from fewer injuries, lower insurance premiums, and stronger overall project performance.

New Eyes on an Old Problem

Construction sites are inherently hazardous. A single project might involve heavy machinery, precarious scaffolding, high-voltage wiring, and large numbers of subcontractors moving in and out. Even the most thorough safety programs can miss fleeting hazards - like a worker forgetting a harness "just this once". All that gets reflected in troubling statistics: falls account for about 38.8% of construction-related deaths, and the industry itself comprises roughly 21% of all private-sector fatalities in the United States[1].

The numbers underline how difficult it is for supervisors, no matter how skilled or well-intentioned, to maintain round-the-clock vigilance across every area. That gap is exactly where *Vision AI* steps in. By analysing video feeds in near-real time, a well-trained model can detect when a worker appears without required PPE, or when someone steps into a crane's drop zone. Once it spots trouble, the AI triggers alerts-through text, mobile app, or even on-site alarms (audio or audio-visual) - dramatically shortening the time between hazard emergence and corrective action.

A Growing Ecosystem of AI Solutions

Over the past few years, multiple platforms have embraced *Vision AI* to reduce risks on construction sites. Smartvid.io (Newmetrix), for example, scans photos for missing hard hats or safety glasses, with companies like Skanska using the tool to tackle recurring hazards more effectively[2]. Meanwhile, viAct focuses on real-time camera monitoring: if it sees a worker stepping near an active excavator or forklift, it can immediately warn on-site personnel[3]. Another system, Everguard Sentri360, merges camera analytics with wearable tags to create proactive collision avoidance zones for heavy equipment[4].

Drones have also entered the mix: DroneDeploy Safety AI analyses aerial imagery to catch compliance breaches such as unfenced trenches, missing guardrails, or unprotected rebar protrusions[5]. By scanning thousands of square meters from the sky, it covers angles that ground-level supervisors may not see.

However, detection alone doesn't always translate to improvement. Some solutions go further by using predictive analytics and historical patterns to identify hotspots before incidents happen[6]. Others tie hazard detection directly into project management dashboards, so that each flagged issue becomes a ticket requiring resolution. That approach ensures that "we spotted something" doesn't just sit in a log – of someone's follows up.

Spotlight on Go4Zero™

Among the growing lineup of *Vision AI* tools, **Go4Zero™** (by KGraph AI Solutions Pvt. Ltd.) aims to unify detection, incident management, and continuous improvement into one comprehensive safety solution. At the heart of Go4Zero™ is an AI "safety agent" that tracks activities around the clock, referencing both official regulations (like OSHA 1926.501 for fall protection) and each organization's specific rules.

When Go4Zero™ detects a risk - say, a missing safety net on an elevated platform-it sends an immediate alert to the right individuals while also logging the event in a central repository. What is crucial is that the system doesn't stop at notification. It offers recommended steps for remediation, referencing job hazard analyses (JHAs) and near-miss data from similar scenarios. In that way, a single platform not only flags the problem but also nudges teams toward a solution. Over time, the aggregated data helps managers spot patterns: Are most violations happening at night? Are new subcontractors struggling with site protocols? Do certain zones need more robust guardrails or better signage?

Turning Near Misses into Teachable Moments

One of the persistent challenges in safety is the "near miss"-a moment when an accident almost happens but doesn't quite cross that threshold. Near misses can be immensely valuable for learning, yet they often go unreported. Workers might not realize how close they came to injury, or they might not see it as worth filling out a detailed incident form.

Vision AI changes that. Because it's always watching, it can capture these near misses on video, log them automatically, and potentially piece together the root causes. Suppose a camera feed shows a worker climbing a scaffolding without a harness. Even if they come back down safely, the AI records the breach. Go4Zero™ takes it further, linking that recorded event to the relevant standard or JHA clause and prompting the safety manager to investigate: "Why was the harness unused? Is there an issue with equipment availability or training?"

Over time, these small interventions-prompted by AI-can add up. At Suffolk Construction sites, for instance, repeated reminders about missing PPE through an AI tool led to a measurable reduction in injuries, as reported in internal safety audits[2]. Similarly, Koçtaş, a large retail operator, recorded an 89% drop in missing hard hats after deploying AI that recognized and flagged such violations on the spot[8]. In both cases, the real value wasn't just catching a single lapse-it was shifting the entire workforce's behaviour through consistent oversight.

Why OSHA Compliance Gets Easier with AI

Construction firms face strict regulatory requirements worldwide. In the U.S., OSHA enforces a wide range of standards related to fall protection, scaffolds, excavation safety, hazard communication, and more. Large contractors often manage dozens of concurrent tasks, each subject to different rules. Relying on manual checklists alone can mean hazards slip under the radar until an official inspection-or worse, until an accident occurs.

Vision AI helps by effectively performing a continuous audit. A platform like DroneDeploy Safety AI specifically trains on OSHA 1926 standards, recognizing if guardrails are missing or scaffolds are too close to power lines[5]. Go4Zero™ goes one step further by mapping each detected breach to the corresponding regulation. If it sees workers removing safety netting prematurely on an elevated deck, it references OSHA 1926.501, logs a violation, and tells the site supervisor exactly how to fix it. This automation not only prevents accidents but also provides evidence that the contractor is being proactive. Should an official drop by, the site can demonstrate a track record of identifying and addressing issues in near real time.

Real-World Examples: Prevention in Action

Nothing underscores the potential of *Vision AI* like averted accidents. In one scenario, a large contractor in the Middle East used an AI-driven system to monitor crane-lift operations. When a worker inadvertently stepped under a suspended load, the AI triggered an alarm-prompting the crane operator to halt the lift instantly[7]. That single intervention likely saved a life, all within seconds of detection.

Meanwhile, Skanska tested AI-based photo analysis to flag missing vests, generating quick corrective actions that likely prevented unnoticed hazards from escalating[2]. Koçtaş, as noted earlier, saw near-immediate improvements in PPE adherence once cameras began reminding people to grab their hard hats[8]. Such success stories show that even a small change - like consistent prompts for safety gear - can drive a significant decline in incidences when backed by thorough, automated monitoring.

Photo-1: Construction site monitoring

The Go4Zero™ Edge: From Alert to Closure

Unlike basic detection software, Go4Zero™ is built around a structured workflow that guides each hazard from "open" to "closed." If someone nearly collides with a forklift, Go4Zero™ not only logs the event but also checks company protocols: perhaps signage is inadequate, or a walkway needs re-routing. The system prompts managers to confirm the corrective measures. This level of follow-through transforms a simple notification into an operational improvement-reducing the odds that the same hazard reappears.

Because Go4Zero™ links up with near-miss databases, site histories, and even training videos, it can also push relevant content to teams. If scaffolding issues repeat,

Photo-2: Workers properly equipped with PPE

the system might recommend a refresher on safe scaffolding assembly. Over time, the solution becomes a living safety guide, tapping into broader experience rather than just reacting in the moment.

Costs, Culture, and Convergence

Vision AI doesn't just reduce accidents; it can also boost a project's financial and operational health. A safer site means fewer shutdowns, fewer regulatory fines, and often better insurance terms. Some contractors see significant drops in their Experience Modification Rate (EMR) after adopting AI-based oversight, lowering premiums in the long run[6]. Others highlight improved worker morale and productivity: employees feel more confident when they know that hazards are likely to be spotted quickly.

Of course, technology is only half the equation. Culture matters. An AI system might flag dozens of risks, but if managers fail to act, or if workers ignore the alerts, the system's impact stalls. Early adopters often stress that *Vision AI* must integrate seamlessly into existing safety processes. Short daily briefings - "These are the top hazards the AI caught yesterday; here's what we're doing today to prevent them" - go a long way toward building acceptance. When people see that the AI isn't a "gotcha" system but a partner in protecting them, cooperation tends to rise.

Embracing a Safer Tomorrow

The construction industry is gradually shedding its reputation for lagging behind on technology. Now one can see drones capturing 3D site models, IoT

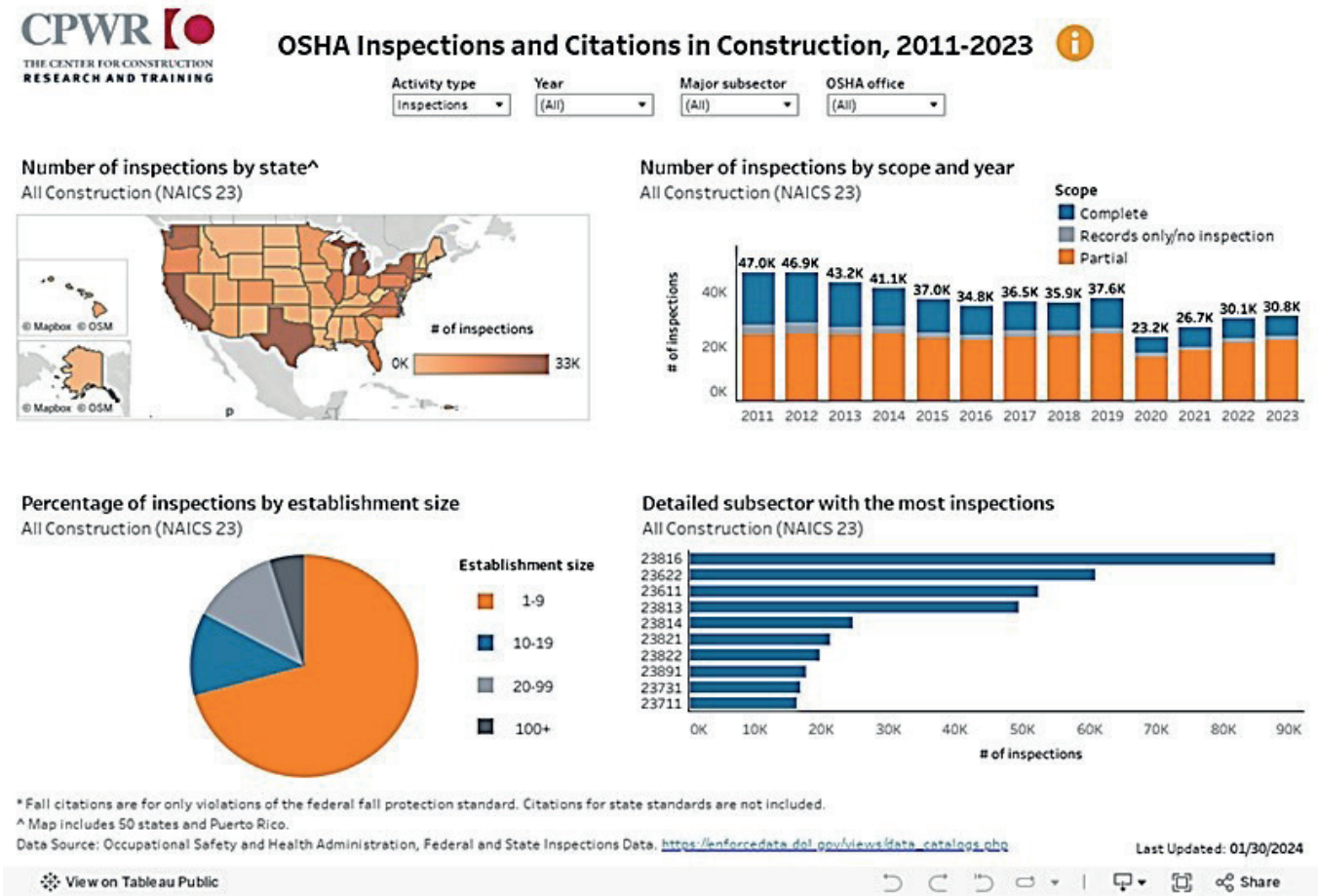

Figure-1: Regulatory Compliance Dashboard – A sample interface showing real-time open hazards mapped to OSHA standards, letting managers immediately see what needs attention.

sensors reporting equipment usage, and BIM software coordinating designs among architects, engineers, and contractors. *Vision AI* complements these changes by offering an always-on vantage point.

Moving forward, one can anticipate even deeper integrations. Wearables that track worker vital signs and location could feed data to the AI, creating alerts when an exhausted worker nears hazardous machinery. Some platforms, including Go4Zero™, is already experimenting with predictive analytics, forecasting which areas or teams may need extra oversight based on historical patterns. Ultimately, this multi-layered approach promises a future where accidents are caught before they happen - or never happen at all.

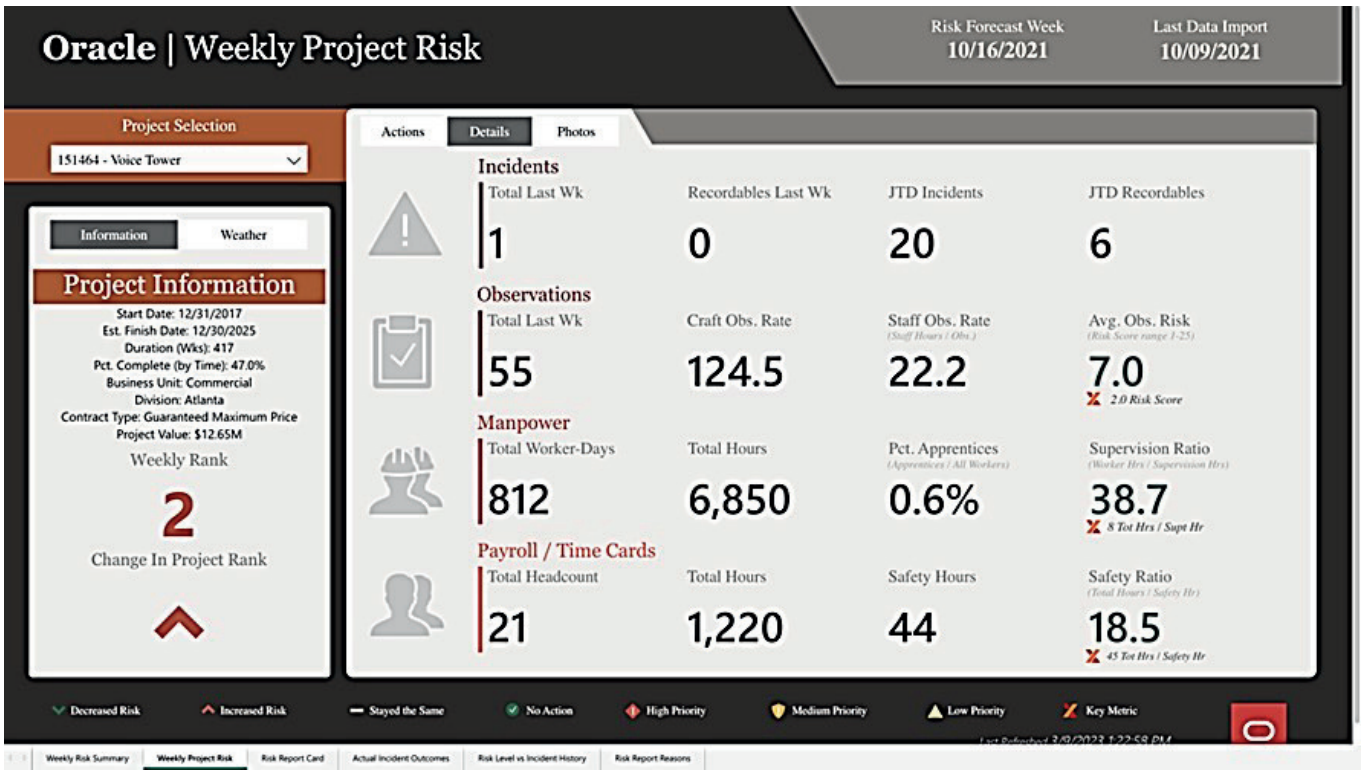

Figure-2: Case study highlight - Example of an AI-driven safety dashboard (Oracle's "Safety Risk" panel, originally Smartvid.io).

Conclusion: Charting a Course to Zero Incidents

For decades, construction safety goals like "zero incidents" have appeared on motivational posters and in corporate handbooks. Yet the practical hurdles to achieving zero have been daunting. *Vision AI*, especially when coupled with robust workflows like those in Go4Zero™, offers a tangible way to close the gap between ideal and reality.

By scrutinizing live video feeds around the clock, mapping each risk to relevant regulations, and nudging teams to fix problems in real time, solutions like Go4Zero™ help transform near-misses into learning moments. Meanwhile, recorded footage, automated reports, and integrated knowledge bases fuel a cycle of continuous improvement.

While it's unlikely that there would be total eradication of accidents anytime soon, but the momentum is undeniable. Early adopters report double-digit drops in recordable incidents, better compliance scores, and more engaged workers. As *Vision AI* becomes standard

practice, the industry will edge closer to a safer future-one where unforeseen hazards are as rare as they are swiftly resolved. With the ultimate goal being truly zero incidents, the advanced, integrated platforms like Go4Zero™ show how to get there.

Note: Go4Zero™ is a industrial safety AI software product developed by KGraph AI Solutions Pvt. Ltd. It is available as a licensed product for use cases across all industries.

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03

AI – Transforming Engineering Projects

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Abstract

The world has seen many innovations over the centuries and the big one now is Artificial Intelligence (AI). It has begun to affect all spheres of human activities; hence it is natural that it impacts the engineering industry also. Its use can be seen in optimizing operations, reducing costs, improving safety, and enabling sustainable practices. AI technologies such as machine learning, generative design, natural language processing, and predictive analytics are being applied to various stages of engineering projects, right from conceptualising, field investigations, data collection, planning, design, construction management, operation, maintenance, and asset management. This article explores the widespread applications of AI in consulting engineering and construction projects, examining its potential to further streamline and improve the processes and their execution at every stage. Examples are given of some projects which have used AI very effectively. The article also looks at the challenges and opportunities of adopting AI, along with the future directions for AI in the sector.

Introduction

Engineering is the application and adaptation of scientific principles; hence AI really becomes useful when it is applied equally to aid scientific research and development. That, however, is a more fundamental

Figure-1: View of Automation in Construction

Figure-2: 3D Image of Building Construction

realm hence this article focuses on AI's application to engineering, particularly to consulting engineering and construction[1], which are characterized by complex workflows for large-scale projects, ever reducing timelines, cost concerns, ensuring safety, safeguarding the environment, and meeting sustainability requirements.[2] Despite advances in technology, the industry has struggled with inefficiencies and slow adoption of digital tools.

The main advantage of digitalisation and thence AI is that it is not dependent on the knowledge and experience of an individual person, since all the past learnings are captured, stored, readily accessible and are utilised to project what would be the best option and the way forward. It is that capability that AI provides, and it can go a long way to offer transformative solutions that can aid in addressing various issues. AI technologies, through their ability to process vast amounts of data, learn from it, and predict future outcomes, provide significant improvements in project efficiency, quality, and safety.

AI has become increasingly central to optimizing project workflows by enhancing design processes, improving project management, enabling predictive maintenance, ensuring sustainability and asset management.[3] This paper delves into these applications, providing a general overview of how AI is transforming the consulting engineering and construction industry. It covers the different phases of an engineering project.

Conceptualisation, Planning and Designing

The conceptualisation, planning and designing phases are the most crucial stages, since they spell out the essential parameters, define the scope, list out the necessary resources, and the overall execution strategy for the project. AI can play a critical role in improving the accuracy and efficiency, in each of the phases.[4]

a. Generative Design

Generative design, an AI-driven process uses algorithms to generate multiple design solutions based on predefined constraints such as material types, structural requirements, and environmental factors. Through machine learning, AI can produce optimized, innovative designs that a human engineer might not have initially considered, all of which can contribute to greener construction practices; refer Figures-3 and 4.

- **Collating Project Data**: AI algorithms can put together project data collected from various sources – client/ owner's brief (requirements), field work, field tests, laboratory tests, model tests, wind tunnel test, desk study, etc. and generate reports that integrate them and how they affect and guide the concepts, designs, and planning for a project. Such a collation would prevent any data not being considered and avoid rework at a later stage.
- **Optimization of Concepts and their Design Solutions**: AI algorithms can generate numerous conceptual and their design alternatives, helping engineers explore unconventional design solutions that optimize material usage, ensure structural integrity, and provide cost-effective solutions, amongst other factors.
- **Reduced Design Time**: By automating the iterative process of concept and design, generative design accelerates the development of structures, potentially cutting design time.

Figure-3: AI Driven 3 D View

- **Optimized Material Usage:** Generative design also allows the planners and designers to consider environmental factors, such as energy consumption and sustainability, ensuring that the designs are more energy-efficient and eco-friendly. By using AI to create optimized designs, material wastage can be reduced thus contribute to greener construction practices.

- **Fit for Purpose:** AI could ensure that the designs do not infringe any safety, reliability and integrity requirements but still provide facilities that are fit for the purpose intended for the design service life. That would obviate legal issues at a later date.

B. Building Information Modelling (BIM)

BIM, an intelligent 3D model-based process provides insights into the physical and functional characteristics of a project.[5] AI enhances BIM by allowing for better collaboration and communication amongst stakeholders and improving data management.

- **Real-time Updates**: AI-enhanced BIM models allow for the dynamic updating of construction plans and designs. That enables teams to immediately recognize conflicts or design errors, which reduces the likelihood of redesigns or project delays.

- **Early Detection of Clashes**: Although BIM shows clashes in designs (e.g., plumbing running into electrical systems) but using AI tools integrated into it they are shown early in the process thus improving the design routing, the accuracy of the layouts and timeliness of the project. AI tools can also check if the service shafts and ducts are of adequate size to allow access for physical checks and maintenance.

- **Project Documentation**: AI algorithms can also support automatic generation of project documentation, reducing the time spent on their manual drafting and ensuring the accuracy of the project documents. They also extract data and trigger alerts for activities to be executed.

Project Management

Effective project management is critical to delivering projects on time, within budget, and to high-quality standards. AI technologies have brought in new opportunities to enhance the planning, scheduling, and management of projects.[6]

A. Project Scheduling and Resource Management

AI can assist in generating project schedules by analysing historical project data, identifying dependencies, and calculating the most efficient timelines. Machine learning algorithms can also predict potential delays based on external factors such as weather conditions, material shortages, or workforce availability.

- **Predictive Analytics**: AI tools use predictive analytics to forecast project completion dates with high accuracy, by analysing data such as project type, previous performance, and real-time progress updates. These tools can adjust schedules dynamically based on any emerging issues or delays, optimizing the overall timeline.

- **Efficient Resource Allocation**: AI can optimize resource usage by forecasting material, labour

Figure- 4: AI driven construction site for future perspective.

(skilled and unskilled), plant and equipment requirements, ensuring that resources are allocated effectively. This leads to better cost control, reducing material wastage and avoiding unnecessary labour costs.

AI can also integrate with supply chain management tools to automatically order all the resources, when necessary, ensuring that resources arrive just in time for construction, which reduces both storage costs and delays.

Risk Management and Safety

Safety is a primary concern in construction, with the industry being amongst the most hazardous in terms of workplace accidents, due to the spread and mobile nature of the tasks to be performed. AI helps improve safety by using real-time data to predict and prevent accidents.[7]

- **Predictive Safety Monitoring**: By analysing past accidents and real-time site conditions, AI can predict potential hazards and recommend preventive measures. AI tools can also be used in wearable safety devices (PPEs) to monitor workers' health and environmental conditions, identifying dangerous situations before they escalate.
- **Automated Inspection**: AI-powered machine vision and drones can automatically scan project sites to identify safety hazards, ensuring that workers and managers can address risks immediately.

Sustainability and Energy Efficiency

The construction industry is responsible for a significant portion of global energy consumption and carbon emissions. As a result, sustainability and energy efficiency have become critical goals in projects. AI can play a pivotal role in designing and constructing more sustainable structures. The fact that AI per se, especially generative AI, is an energy guzzler, also needs to be addressed for truly sustainable solutions. However, that is material for another article.

- **Energy Efficiency:** AI-based tools can optimize building designs for energy consumption. For example, AI can be used to simulate how different design choices, materials, and building configurations affect energy use. The same if done by hand would require much longer time and there would still be chances of some parameter being missed. The AI tools can suggest ways to reduce energy demand by adjusting heating, cooling, lighting, and ventilation systems in real-time.[8]
- **Smart Building Systems:** AI-integrated building management systems monitor and control the energy usage of a building. AI can automatically adjust settings such as HVAC and lighting based on occupancy, weather forecasts, and other environmental variables, thereby reducing energy waste and optimizing operational costs.
- Lighting Systems can be linked to daylight and reduce artificial light intensity and thus save energy.
- **Sustainable Material Selection:** AI can assist in selecting sustainable materials by evaluating their environmental impact and lifecycle cost. By integrating data on material properties, availability, and environmental impact, AI tools can recommend the most sustainable materials for specific projects.
- **Reducing Waste**: AI tools can also be used to track materials on a construction site, ensuring that waste is minimized and resources are utilized effectively. AI models can predict the exact quantities of materials needed, helping to eliminate over-ordering and reduce construction waste.

By using AI in material selection and waste management, construction projects can reduce material wastage.

Maintenance and Building Operations

Once a building is constructed, its long-term operation and maintenance are critical for preserving value and minimizing its running and maintenance costs. AI can support building maintenance through predictive analytics, real-time monitoring, and automated systems that ensure the building systems operate and function efficiently.[9]

a. Predictive Maintenance

AI-powered systems analyse historical data, sensor data, and real-time performance metrics to predict any issues with the structure per se and equipment failure before it happens. That helps facility managers anticipate maintenance needs, schedule repairs proactively, and avoid costly emergency fixes.

- **Embedded Sensors**: IoT-based embedded sensors, when integrated with AI systems, can provide continuous monitoring of the structure and provide data vis-à-vis change in material properties, stress, strain, fatigue, crack width, etc.
- **Smart Sensors**: IoT-based sensors, when integrated with AI systems, can provide continuous monitoring of building infrastructure, such as HVAC, plumbing, and electrical systems. By predicting wear and tear, AI can identify issues early and schedule maintenance during off-peak hours, reducing disruptions to building occupants.

Predictive maintenance has been shown to reduce maintenance costs as compared to reactive maintenance models.

b. Building Operations Optimization

AI can also improve day-to-day building operations, such as lighting, heating, and cooling. By learning from past data and adjusting to real-time conditions, AI can ensure that building systems are optimized for both comfort and efficiency.

- **Energy Use Monitoring**: As mentioned earlier, AI can continuously monitor energy usage patterns and recommend adjustments to improve efficiency, thereby reducing utility bills and contributing to the building's sustainability goals.

Benefits for Engineering Projects

a. **Enhanced Efficiency and Productivity:** AI technologies help automate repetitive tasks, reduce human errors, and streamline complex workflows. By providing better insights and analytics, AI helps project teams work smarter and more efficiently.

b. **Cost Reduction:** AI reduces construction costs by optimizing design, improving project management, enhancing resource allocation, and minimizing rework. In many cases, AI can lead to substantial savings in total project costs.

c. **Improved Safety:** AI tools that monitor construction sites in real-time can predict potential safety risks and provide proactive measures, reducing accidents.

d. **Sustainability:** AI contributes significantly to sustainability efforts by reducing energy consumption, waste, and carbon emissions. It enables architects and engineers to create more energy-efficient buildings while minimizing the environmental impact of the projects.

Case Study of AI-Driven Transformations in the Construction Industry

An Overview: AI is significantly transforming the construction industry, enabling companies to streamline processes, reduce costs, improve safety, and enhance sustainability as explained in Table-1, The adoption of AI technologies in various areas such as site design, project management, robotics, and building automation is revolutionizing the way construction projects are executed. The integration of AI allows for better decision-making, predictive maintenance, real-time safety monitoring, and optimization of resources.

Key Use Cases and Applications of AI in Construction Projects

a. **Generative Site Design:** AI optimizes site selection, architectural designs, and environmental compliance through predictive modelling and machine learning. It helps in improving the design process and anticipating project outcomes.

- DII (Ukrainian startup) has developed Reader, an AI-powered platform to automate the interpretation of engineering drawings.

b. **Project Management:** AI aids in optimizing scheduling, resource allocation, risk management,

and cost estimation. It also assists in simulating different scenarios and their potential impacts on project timelines and resources.

- TruBuild (Saudi Arabian startup) offers software to streamline contract management and improve project outcomes.

c. **Construction Robotics:** AI-powered autonomous robots and exoskeletons enhance construction efficiency, reduce labour costs, and improve worker safety by performing tasks such as site cleanup, excavation, and material transport.

- RoBIM Technologies (Canadian startup) develops a cloud-based tool for simulating robotic processes in construction.

d. **Site Safety Monitoring:** AI systems monitor environmental factors, detect unsafe behaviours, and predict potential hazards. These systems improve worker safety and ensure compliance with safety regulations.

- Autosafe (Hong Kong-based startup) creates AI-driven safety solutions that track workers, machines, and hazardous conditions.

e. **Green Construction:** AI ensures sustainability by recommending eco-friendly materials, optimizing energy consumption, and aiding in the management of water and waste systems. It also assists in complying with green building certifications.

- Urban Machine (Australia-based startup) uses AI to inspect high-rise buildings' facades for defects, contributing to sustainable construction.

f. **Automated Inspection:** AI automates the inspection process using drones, cameras, and sensors. It detects structural defects, ensures compliance with specifications, and reduces the time and labour required for quality assurance.

- Voltin (US-based startup) uses AI for autonomous facade assessment and defect detection in high-rise buildings.

g. **Smart Buildings:** AI improves building automation by optimizing energy usage, HVAC systems, lighting, and occupant comfort. It helps in managing building systems more efficiently and ensuring predictive maintenance.

- Parmetan (US-based startup) offers an AI-powered platform to manage building analytics and optimize energy usage.

h. **Advanced Quality Control:** AI facilitates automated quality checks using computer vision and deep learning. It detects flaws in construction materials, improves non-destructive testing, and helps maintain high standards of construction quality.

- PreML (German startup) provides AI-based visual inspection systems for quality control in construction.

i. **Automated Regulatory Compliance:** AI helps in managing documents and ensures compliance with construction regulations and environmental standards. It automates document management, regulatory tracking, and contract management.

- Certchain (UK-based startup) offers an AI-powered modular solution for regulatory compliance in construction.

j. **Budget Optimization:** AI improves budget management by analysing real-time project expenses and simulating different project scenarios. It helps construction companies manage costs effectively and reduce financial risks.

- Cubia (Spanish startup) offers an AI platform for real-time cost tracking and project management.

Emerging Technologies and Future Outlook

The integration of AI in construction continues to evolve with the support of major investors like Y Combinator, Techstars, and Andreessen Horowitz. The funding landscape for AI startups in construction is robust, with startups securing significant investments

for the development of advanced AI solutions. As AI technologies mature, their applications will continue to grow, making the construction industry more efficient, sustainable, and safe.[10] In India, AI adoption in construction is growing, with startups and companies tackling challenges like urbanization and infrastructure. Government initiatives like the Smart Cities Mission are also driving this trend, and AI is expected to play a key role in India's fast-growing construction market.[11]

Table 1: AI Applications in Construction & Startups to Watch

AI Application	Key Use Cases	Startup to Watch
Generative Site Design	Site selection, architectural design optimization, environmental compliance	DII (Ukraine)
Project Management	Scheduling, resource allocation, cost optimization	TruBuild (Saudi Arabia)
Construction Robotics	Exoskeletons, autonomous vehicles, excavation, and material transport	RoBIM Technologies (Canada)
Site Safety Monitoring	Hazard detection, worker safety, environmental monitoring	Autosafe (Hong Kong)
Green Construction	Eco-friendly materials, energy monitoring, water conservation	Urban Machine (Australia)
Automated Inspection	Site mapping, defect detection, thermal imaging	Voltin (US)
Smart Buildings	Energy efficiency, HVAC optimization, building automation	Parmetan (US)
Advanced Quality Control	Structural health monitoring, quality inspections	PreML (Germany)
Automated Regulatory Compliance	Document management, regulatory updates tracking, contract management	Certchain (UK)
Budget Optimization	Labor cost management, resource allocation, cost forecasting	Cubia (Spain)

The table highlights how AI is revolutionizing the construction industry across various sectors, helping businesses optimize processes, reduce costs, and increase safety and sustainability. Emerging startups are at the forefront of this transformation, driving innovation and securing substantial funding for future growth.

Note: Although examples have been given of startups outside India, there are also startups in India who have developed or are developing AI solutions.

Table-2 lists some projects where digitalisation along with AI resulted in savings on many fronts. For example:

- *Beijing National Stadium* used **Generative Design** and **BIM Integration**, leading to a **10% reduction in material and labour costs.**
- *Sydney Metro* achieved a **12-15% labour cost reduction** through AI-driven project scheduling and resource optimization.
- *The Dubai Expo 2020* saved **$200 million in cost overruns** by applying **Predictive Analytics** for Risk Management.
- *London Crossrail* reduced **safety-related costs by 20%** through AI-powered safety monitoring.
- *Hudson Yards* optimized **energy efficiency**, saving **15-18% on energy bills over five years**.

These case studies highlight AI's ability to optimize costs, accelerate timelines, and provide substantial financial returns, making it an invaluable tool in modern construction projects.

Table-2: Case Studies of AI-Driven Cost Reductions in Construction Projects

Project/ Case Study	AI Application	Cost Savings	Impact on Project	Source
Beijing National Stadium (Bird's Nest)	Generative Design, BIM Integration	10% cost savings in materials and labour	Optimized structural design led to reduced material wastage and faster build time.	McKinsey[12], 2023
Sydney Metro	AI-driven Project Scheduling, Resource Optimization	12-15% reduction in labour costs	AI optimized labour allocation and resource management for on-time project completion.	Turner & Townsend[13], 2024
Dubai Expo 2020	Predictive Analytics for Scheduling and Risk Management	$200 million savings in cost overruns	AI helped forecast risks early and adjusted schedules for timely delivery.	BCG[14], 2022
London Crossrail	AI-based Construction Safety Monitoring and Automation	20% reduction in safety-related costs	AI drones and sensors tracked real-time conditions, identifying hazards and improving worker safety.	LSE[15], 2022
New York's Hudson Yards	AI in Energy Optimization and Sustainability Design	15-18% savings in energy bills over 5 years	AI optimized HVAC systems and energy-efficient materials, contributing to long-term savings.	Accenture[16], 2024

Time saving as compared to traditional methods is also projected to be significant as can be seen from Table-3.

Table-3: AI's Role in Construction Project Time Management

AI Technology	Time Savings (Compared to Traditional Methods)	Impact	Source
Predictive Analytics for Project Scheduling	10-15% reduction in project delays	AI tools predict delays (e.g., weather, material shortages), allowing real-time adjustments.	McKinsey[12], 2023
Automated Design Optimization (Generative Design)	Up to 50% reduction in design development time	AI-generated design alternatives can be evaluated in a fraction of the time compared to manual design.	AutoDesk[17], 2022
AI-powered Construction Robotics	Up to 30% reduction in manual labour time	Robotics powered by AI can perform tasks faster, especially in repetitive or hazardous work.	PWC[18], 2023
AI-Integrated BIM for Clash Detection	Up to 40% reduction in project rework time	AI detects potential design clashes early, reducing the time spent on rework.	Autodesk[19], 2023
AI-Powered Construction Drones	15-20% reduction in survey and inspection time	Drones integrated with AI can survey large sites and detect issues faster than manual inspections.	Safety Tech[20], 2023

Factors to be considered

Despite its many advantages, AI adoption in consulting engineering and construction is an uphill task on account of three major factors, viz:

- **High Initial Investment**: The cost of implementing AI solutions can be high, especially for micro, small and medium-sized enterprises (MSMEs).
- **Data Privacy and Security**: AI relies on vast amounts of data, hence ensuring data privacy and security is critical.
- **Skilled Workforce**: There is a need for skilled professionals who can design, implement, and maintain AI solutions in construction. Companies need to build up talent in this area.

The Future of AI in Engineering Projects

The future of AI in consulting engineering and construction is very promising. Innovations in autonomous construction, robotics, smart cities, smart people and goods movers, smart highways, smart railways, etc. will shape the next generation of AI-powered construction projects. These technologies will continue to evolve and provide even greater efficiencies and capabilities to the industry.

Conclusion

AI is revolutionizing the consulting engineering and construction industries from design and planning to project management and maintenance. AI technologies like machine learning, generative design, and predictive analytics are transforming workflows and are addressing and improving the key parameters - efficiency, costs, safety, and sustainability. Although the high initial investment and need for skilled professionals present challenges, AI's potential to optimize engineering project practices and provide smarter, more sustainable products is undeniable. As the technology matures and adoption spreads, the construction industry is poised to enter a new era of innovation and progress. Integration of AI will streamline operations and also contribute to greener, safer, and more cost-effective construction practices, making it an essential tool for the future of the industry.

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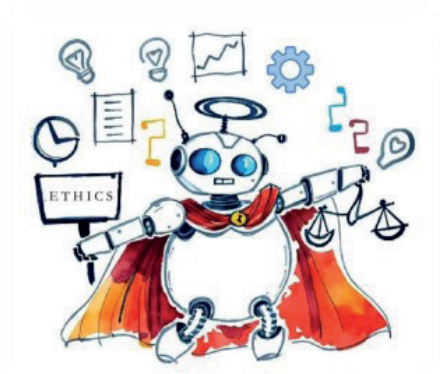
AI: A Beacon of Fairness in the Digital World

In circuits bright and code so true,
AI has the ability to guide us through.
A guardian keen, both wise and fair,
It helps ensure that we genuinely care.
From fairness, justice, equality, and right,
It can help bring corruption to light.
Through data vast and insights deep,
It can safeguard the promises that we keep.
So, hand in hand, with hearts aglow,
Let us keep the ethical standards high and help the industry grow.



By Vandana Randhawa & Alok Bhowmick

04

AI – A Boon for Consulting Engineering and Construction

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Abstract

Artificial Intelligence (AI) is rapidly transforming the consulting engineering and construction industry. AI-powered tools enhance design optimization, streamline project management, improve risk assessment, and increase overall efficiency. This article explores AI's role in various phases of engineering and construction, discussing its impact on decision-making, sustainability, and digital transformation. The insights provided herein align with the broader goals of digital engineering, predictive maintenance, and generative design, offering a roadmap for future advancements.

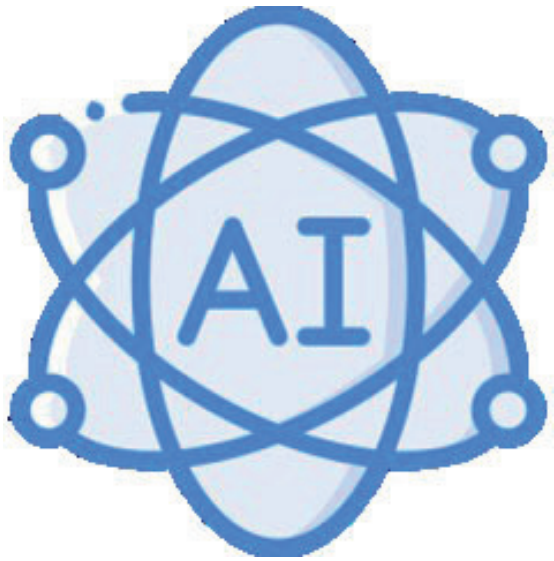

Figure-1: Artificial Intelligence

Introduction

Figure-2: Statistics of Projects, MoSPI, 2024

The consulting engineering and construction sector is witnessing a paradigm shift with the advent of AI and digital technologies. Traditionally, the industry has relied on manual, experience-based decision-making, which, while effective, often leads to inefficiencies, cost overruns, and schedule delays. The growing complexity of projects, coupled with the increasing demand for sustainability and resource optimization, has necessitated a shift towards data-driven decision-making.

Artificial Intelligence is playing a crucial role in bridging this gap by enabling automation, predictive analytics, and real-time monitoring. AI applications in engineering and construction leverage advanced computational capabilities, machine learning algorithms, and large datasets to improve accuracy, reduce human error, and enhance project execution. From generative design that rapidly iterates optimal structural layouts to AI-powered predictive maintenance that minimizes unexpected breakdowns, the benefits of AI integration are far-reaching.

The integration of AI into Building Information Modeling (BIM) is also redefining how projects are conceptualized, designed, and managed. AI-powered tools analyze historical data to offer predictive insights, allowing engineers and project managers to anticipate challenges before they arise. This proactive approach enhances efficiency, reduces risks, and ensures the successful delivery of projects within budget and time constraints.

The need for AI adoption in consulting engineering and construction is further driven by advancements in digital twin technology, smart infrastructure, and IoT (Internet of Things) applications. AI's capability to analyze vast amounts of data from sensors, drones, and monitoring systems allows for more informed decision-making and optimized asset management.

This article delves into the diverse applications of AI in consulting engineering and construction, the associated benefits and challenges, real-world case studies, and future trends that will shape the industry. By embracing AI-driven methodologies, engineering firms can drive innovation, improve project outcomes, and remain competitive in an increasingly digitalized world.

AI Applications in Consulting Engineering and Construction

1. Generative Design and Parametric Modeling

Generative design uses AI algorithms to generate multiple design iterations based on predefined parameters and constraints. AI processes large datasets, optimizes geometry, and considers structural integrity, material efficiency, and environmental impact to create innovative solutions.

Figure-3: Generative Design and Parametric Modeling

Parametric modeling allows engineers to define relationships between different design elements and update entire models dynamically when changes occur. In metro and infrastructure projects, AI-driven parametric modeling enables engineers to create highly optimized structures that balance cost, safety, and sustainability. The result is an accelerated design process that reduces the time spent on iterative modifications, enhances collaboration, and ensures regulatory compliance.

2. AI in Project Management and Scheduling

AI-powered tools analyze project schedules, historical performance data, and real-time site progress to optimize scheduling and resource allocation. Machine learning algorithms detect patterns in past projects, predict possible delays, and suggest corrective actions.

Figure-4: AI in Project Management and Scheduling

AI-driven project management platforms can automate routine administrative tasks, track progress, and provide real-time insights into potential risks. These tools integrate with BIM and digital twins to create a comprehensive project control environment where data from multiple sources is analyzed to ensure timely and cost-effective delivery. AI-based chatbots and virtual assistants further support project managers by providing instant updates and recommendations.

3. AI for Lean Construction

Lean construction focuses on minimizing waste and maximizing value. AI-driven solutions enhance lean construction methodologies by providing predictive insights into resource utilization, site logistics, and workflow optimization.

AI-powered computer vision and drones track material consumption, labor efficiency, and equipment utilization in real-time. These insights allow project managers to adjust operations dynamically, reducing excess material usage, eliminating idle time, and improving productivity. Additionally, AI-driven supply chain management systems optimize procurement and logistics, ensuring just-in-time delivery of materials to reduce storage costs and wastage.

4. AI in Construction Safety and Risk Mitigation

AI-driven computer vision applications analyze video feeds from construction sites to detect unsafe practices, monitor worker compliance with safety regulations, and identify potential hazards in real-time. These systems can automatically alert supervisors about safety violations, enabling immediate corrective action.

AI-powered drones conduct aerial inspections of construction sites, identifying structural defects, assessing site conditions, and ensuring compliance with safety protocols. AI-driven risk assessment models use historical data and predictive analytics to assess potential risks, offering strategies to mitigate issues before they escalate into major problems.

By integrating AI into safety management, construction firms can significantly reduce accidents, enhance workforce protection, and improve overall site safety culture.

5. AI in Digital Twin and Smart Infrastructure

Digital Twin technology creates virtual replicas of physical assets, enabling engineers to simulate real-world conditions and optimize performance. AI enhances digital twins by continuously analyzing sensor data, environmental variables, and operational metrics to improve decision-making.

In smart infrastructure, AI-powered digital twins monitor bridges, tunnels, roads, and metro networks in real-time, detecting early signs of structural stress, wear, or failure. AI-driven simulations allow engineers to test different operational scenarios, predict maintenance needs,

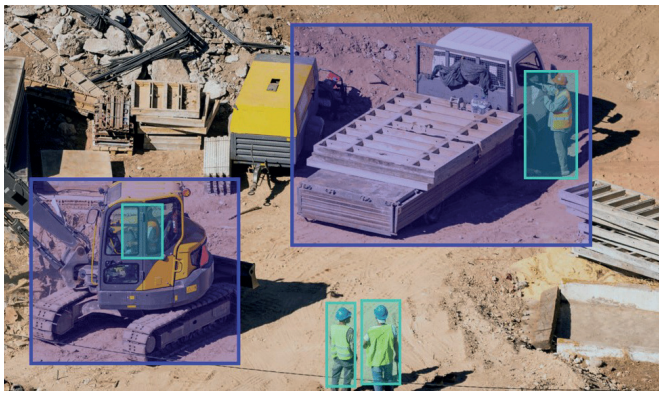

Figure-5: AI in Construction Safety and Risk Mitigation

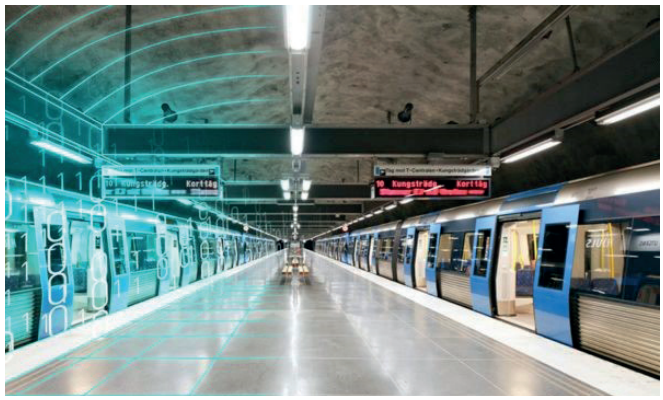

Figure-6: AI in Digital Twin

and implement proactive solutions that extend asset lifespans.

Digital twins also facilitate better urban planning by analyzing transportation patterns, optimizing traffic flow, and integrating renewable energy solutions into smart cities. The application of AI in digital twins enhances predictive analytics, reducing operational costs and improving sustainability.

6. Predictive Maintenance and Asset Management

AI-based predictive maintenance systems leverage IoT, sensor data, and historical maintenance records to anticipate equipment failures before they happen. By analyzing vibration patterns, temperature fluctuations, and operational anomalies, AI can predict the remaining useful life of assets such as bridges, metro systems, and high-rise buildings.

This predictive approach helps in scheduling maintenance activities proactively, reducing unexpected downtime and extending the lifespan of infrastructure. AI-powered asset management platforms also assist in inventory tracking, ensuring that spare parts are available when needed, thereby minimizing project disruptions, and improving cost efficiency.

Figure-7: AI in Predictive Maintenance and Asset Management

Integrated Project Delivery (IPD) Using AI to Create a Digital Ecosystem

Integrated Project Delivery (IPD) is a collaborative approach that aligns all stakeholders, including architects, engineers, contractors, and owners, through a unified workflow and shared digital ecosystem. AI plays a critical role in making IPD more efficient by facilitating real-time data exchange, improving communication, and automating decision-making processes.

- **BIM and AI Integration: AI-enhanced BIM models allow seamless data sharing,** improved clash detection, and enhanced predictive modeling for early-stage design validation.
- **AI in Contract and Risk Management:** AI-powered smart contracts using blockchain technology ensure transparent, automated, and dispute-free transactions between stakeholders.
- **AI-Driven Real-Time Analytics:** AI dashboards process vast project data, offering insights into cost control, scheduling, and resource allocation.
- **Automated Quality Control and Compliance:** AI-powered vision systems monitor construction quality, detect defects, and ensure adherence to industry standards.

By leveraging AI, IPD fosters a truly digital ecosystem, ensuring efficiency, cost-effectiveness, and enhanced collaboration in engineering and construction consulting.

Benefits and Challenges of AI Adoption

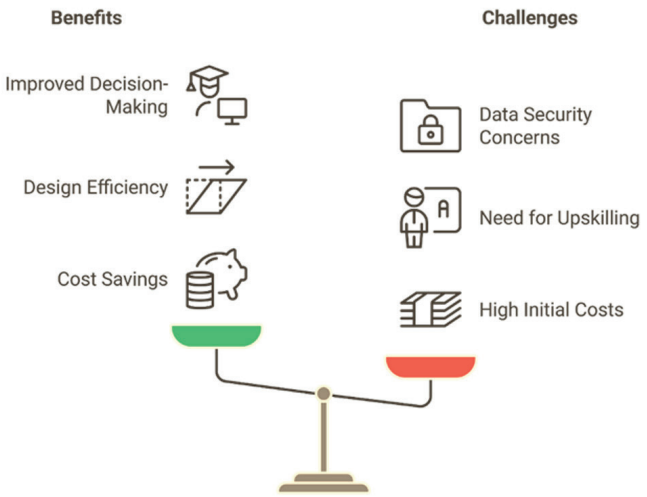

Figure-9: Benefits and Challenges of AI Adoption

1. Benefits of AI in Engineering and Construction

Figure-10: Benefits of AI

- **Enhanced Design Accuracy and Efficiency**

  AI-powered generative design and parametric modeling tools enable engineers to explore a vast number of design iterations in a fraction of the time compared to traditional methods. These tools ensure that designs are optimized for material use, structural integrity, and environmental impact, leading to more efficient and cost-effective solutions.

- **Improved Decision-Making with AI-Driven Insights**

  AI integrates real-time data analysis, predictive analytics, and machine learning algorithms to support informed decision-making throughout a project's lifecycle. AI-driven simulations, risk assessments, and performance monitoring allow engineers and project managers to identify potential issues before they arise and take proactive measures.

- **Cost Savings through Predictive Maintenance and Lean Methodologies**

  Predictive maintenance, powered by AI and IoT, helps monitor the condition of infrastructure assets and construction equipment. By analyzing real-time sensor data, AI can predict failures before they occur, reducing unexpected downtime, minimizing repair costs, and extending asset lifespans. AI-driven lean construction methodologies also reduce material wastage, optimize supply chains, and improve workforce productivity, further driving cost efficiency.

- **Increased Construction Safety with AI-Powered Monitoring**

  AI-powered computer vision, drones, and real-time monitoring systems enhance construction site safety by detecting hazardous conditions, tracking worker compliance, and alerting managers to potential risks. AI-driven safety monitoring reduces accidents, ensures adherence to safety protocols, and enhances overall worker protection.

- **Reduced Environmental Impact through Optimized Material Use**

  AI enhances sustainability by optimizing material selection and usage, reducing carbon footprints, and improving energy efficiency in construction projects. AI-driven models analyze environmental factors to recommend eco-friendly building materials and sustainable design strategies, contributing to green construction practices and energy-efficient infrastructure.

2. Challenges and Barriers

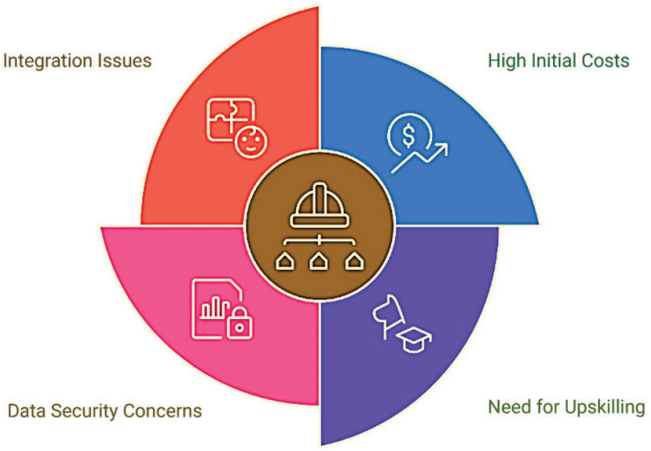

Figure-11: Challenges and Barriers of AI

- **High Initial Investment and Implementation Costs**

  AI adoption requires significant financial investment in software, hardware, and infrastructure. AI-powered solutions, such as generative design tools, digital twins, and real-time monitoring systems, require sophisticated computational power and integration with existing workflows, which can be costly.

- **Need for Upskilling Engineers and Construction Professionals**

  The integration of AI in consulting engineering and construction necessitates a workforce that is well-versed in AI applications, data analytics, and digital tools. Many professionals in the industry lack AI expertise, making it essential to invest in training programs and skill development initiatives to bridge the knowledge gap.

- **Data Security and Privacy Concerns**

  AI-driven systems rely on large volumes of project data, site monitoring feeds, and IoT sensor inputs. Protecting this data from cyber threats, unauthorized access, and breaches is a major concern. Organizations must implement robust cybersecurity measures and data governance policies to ensure the confidentiality and integrity of AI-driven operations.

- **Integration with Legacy Systems**

  Many engineering and construction firms still use legacy software and traditional workflows, making it challenging to integrate AI-driven solutions seamlessly. The transition to AI-enabled processes requires strategic planning, system upgrades, and interoperability solutions to ensure smooth adoption without disrupting ongoing projects.

Future Outlook and Emerging Trends

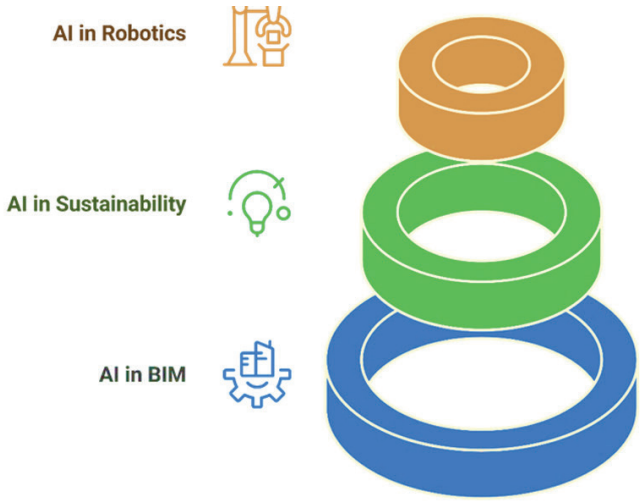

Figure-12: Future Outlook

AI-powered Construction Robotics

The future of construction is being shaped by AI-driven autonomous robotics, which will revolutionize efficiency, productivity, and safety. AI-powered robotic systems, including autonomous excavators, robotic bricklayers, and 3D-printing robots, are set to minimize human labor for repetitive, hazardous, and labor-intensive tasks.

Figure-13: AI-powered Construction Robotics

- **Autonomous Heavy Machinery:** AI-driven bulldozers, excavators, and graders are already being tested to operate with minimal human intervention, enhancing precision and reducing project delays.
- **AI-powered Drones:** Drones equipped with AI-based computer vision are increasingly used for site inspections, progress tracking, and safety monitoring, ensuring efficiency and reducing manual surveying time.
- **3D Printing in Construction:** AI-driven 3D printing robots are now capable of fabricating entire structures, reducing material waste, accelerating timelines, and lowering labor costs.
- **Wearable Robotics:** AI-powered exoskeletons assist construction workers in reducing physical strain, improving efficiency, and reducing injury risks.

As AI-driven robotics continue to evolve, they will enable fully automated construction sites, reducing dependency on human labor and improving overall project performance.

AI-driven Sustainability Solutions

The construction industry is one of the largest contributors to global carbon emissions, and AI is playing a crucial role in driving sustainable construction practices. AI-powered sustainability solutions are helping firms achieve net-zero carbon emissions by optimizing material use, improving energy efficiency, and reducing environmental impact.

Figure-14: AI-driven Sustainability Solutions

- **AI-driven Energy Optimization:** AI algorithms analyze energy consumption patterns in buildings and suggest ways to enhance efficiency, including the integration of renewable energy sources such as solar and wind power.
- **Sustainable Material Selection:** AI helps engineers and architects select eco-friendly building materials by evaluating lifecycle carbon footprints, durability, and cost-effectiveness.
- **AI-powered Waste Reduction:** AI-powered systems track material usage on construction sites and predict ways to minimize waste, ensuring efficient use of resources.
- **Smart Water Management:** AI monitors water consumption on construction sites and within smart buildings to reduce excessive use and identify leaks in real-time.
- **Carbon Emission Monitoring:** AI-based sensors track carbon emissions throughout a project's lifecycle, allowing real-time adjustments to reduce environmental impact.
- By leveraging AI-driven sustainability solutions, consulting engineering firms and construction companies can move toward more environmentally responsible practices while meeting global sustainability targets.

Advancements in AI-based BIM (Building Information Modeling)

Building Information Modeling (BIM) has already transformed the way engineering and construction projects are planned and executed. The integration

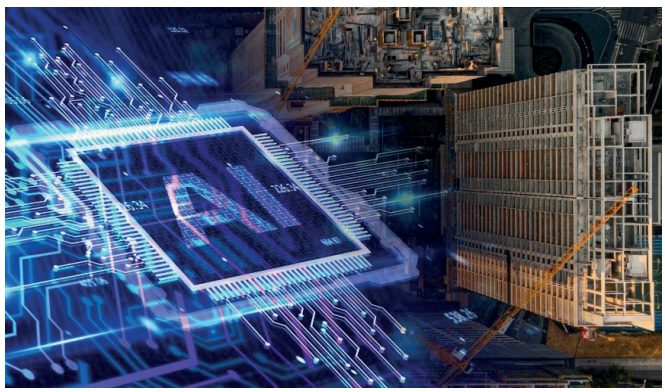

Figure-15: Advancements in AI-based BIM

of AI into BIM will take this transformation further, enabling more intelligent, automated, and predictive project execution.

- **AI-enhanced Design Automation:** AI-driven BIM tools automate the generation of complex designs, reducing manual work and improving accuracy. AI can analyze historical project data to recommend optimal design strategies based on performance metrics.
- **Clash Detection and Risk Mitigation:** AI-powered BIM enhances real-time clash detection, preventing costly design conflicts before construction begins. AI also predicts potential project risks by analyzing site conditions, previous project data, and regulatory compliance.
- **AI-enabled Cost Estimation:** AI-integrated BIM models provide precise cost estimates by analyzing historical project costs, market trends, and real-time supplier pricing, helping firms optimize budgets.
- **Real-time BIM Collaboration:** AI facilitates enhanced collaboration by integrating real-time cloud-based BIM platforms where architects, engineers, and contractors can make data-driven decisions collectively.
- **AI and Digital Twins:** AI-driven BIM integrates with Digital Twin technology, enabling real-time monitoring of infrastructure, predictive maintenance, and performance optimization.

With AI-enhanced BIM, engineering and construction firms can achieve higher levels of automation, accuracy, and efficiency, driving the industry towards fully digitized project delivery.

Conclusion

AI is revolutionizing consulting engineering and construction by enhancing efficiency, safety, and sustainability. The integration of AI-driven solutions across project lifecycles is not only optimizing design accuracy and resource management but also fostering a

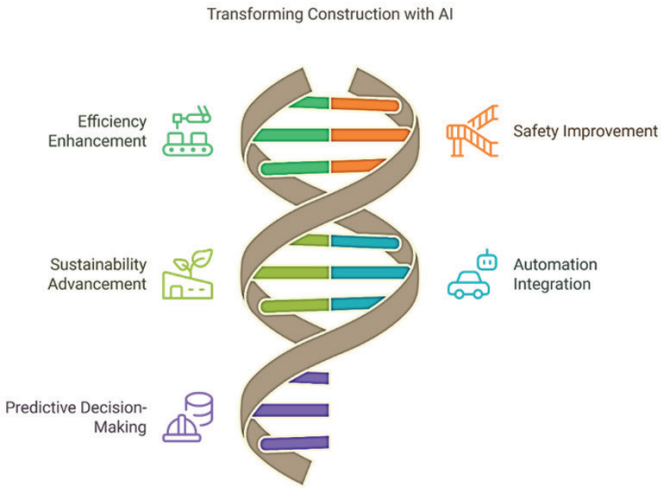

Figure-16: Transforming Construction with AI

new era of automation and predictive decision-making. From generative design and predictive maintenance to AI-driven lean construction and integrated project delivery, the industry is experiencing a transformation that is set to redefine how projects are conceived, executed, and maintained.

While challenges such as high initial investment, the need for workforce upskilling, and data security concerns remain, the benefits of AI adoption significantly outweigh the hurdles. Companies that embrace AI will gain a competitive edge through improved project outcomes, cost savings, and enhanced risk management. The shift towards AI-driven digital ecosystems will enable firms to achieve greater collaboration, transparency, and real-time decision-making across the value chain.

AI is also proving to be a key enabler in achieving sustainability goals within the construction industry. AI-powered tools are helping firms reduce material waste, optimize energy consumption, and minimize environmental impact through smart infrastructure and carbon-conscious design methodologies. This shift is crucial as governments and regulatory bodies push for greener, more efficient construction practices globally.

Looking ahead, the integration of AI with cutting-edge technologies such as robotics, digital twins, and

blockchain will further enhance project efficiency and security. AI-powered construction robotics will drive automation at sites, while AI-driven BIM and digital twins will facilitate real-time monitoring, asset management, and predictive analytics. As AI continues to evolve, the industry must remain adaptable and proactive in adopting these innovations.

Organizations must prioritize AI adoption by investing in technological advancements, reskilling their workforce, and embracing digital engineering methodologies. Collaboration between industry stakeholders, academia, and technology providers will be essential in accelerating AI-driven transformation. Those who leverage AI effectively will be at the forefront of the next generation of consulting engineering and construction, driving innovation and ensuring resilience in an increasingly complex and competitive global landscape.

By embracing AI, engineering and construction firms can transition into a more connected, data-driven, and efficient future. The journey towards AI-enabled construction is not just a necessity but an opportunity to reshape the industry, improve operational efficiencies, and create a sustainable built environment for future generations.

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2. Images courtesy of [Google Images]

Infosys co-founder and chairman Nandan Nilekani has expressed optimism about India's AI-driven future, emphasizing that falling costs, government support, and strategic adaptation will position India as a leader in artificial intelligence. While acknowledging that AI will disrupt employment, Nilekani remained optimistic about the future of work.

"Some jobs will be affected—certain tasks will be automated—but very few jobs will be entirely eliminated," he told MoneyControl. "AI will make humans more productive and create new jobs we haven't even thought of yet."

He also cautioned against over-reliance on AI, emphasising that human collaboration remains key. "You can have all the AIs in the world, but if you can't get five people to work together and collaborate, then you cannot go anywhere," he said.

Instead of focusing solely on technical skills that may become obsolete, Nilekani advocated for adaptable capabilities that AI cannot replicate. He pointed to first-principles thinking as a critical skill: "AI is more mechanistic in its approach. Being able to go back to first principles and analyze something is something AI cannot do."

Pointing to the Chinese AI startup DeepSeek, which recently topped app download charts, Nilekani called it a "big breakthrough," proving that AI models don't require billions of dollars to develop.

Nilekani highlighted the India AI Mission, which he believes will drive significant AI model developments within the next year. He also stressed that AI development is becoming more affordable and efficient, making it possible for India to innovate without massive investments.

"Would I spend a billion dollars on a large language model? No. But if I can develop one for $50 million, sure," he stated, underscoring how rapidly AI costs are dropping.

Nilekani sees India's real AI challenge and opportunity in applying the technology at scale, particularly in education and agriculture. "What I want to see is the application of AI at the population scale. That's the way we have to go," he said.

With AI becoming cheaper and more accessible, along with government-backed initiatives, India is poised to emerge as a global leader in AI-driven transformation across multiple sectors.

Source: Money Control

05

Advances in Digitalisation, Especially AI in Engineering

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Introduction

Digitalisation has reached another cusp and the decade ahead will bring revolutionary changes in everyone's life style. Convergence and interfacing of digital devices which are in daily use such as telephone, TV, computers, ovens, clocks, etc., with speech interface (as against keyboard and mouse), cost effective smart networking and computing in miniature devices will revolutionize the way that business is conducted and also affect one's day to day life. Computers as known today will become boring, and be replaced by things that are first and foremost something else: smart nails, self-cleaning shirts, driverless cars, intelligent door knobs that will let a courier man in but keep a stranger out. Computers will permeate everyday lives yet be invisible: human beings may live in them, wear them, and even eat them.

Digital Devices – Their Impact

The impact of computing devices (smart and intelligent) and internet connectivity has enabled businesses to embrace Information Technology in a friendly and big way. Data Retrieval and Analysis, Net Meetings, Video Conferencing, Tracking of Objects, are some of the common technologies used by businesses worldwide today. They have made obsolete the telephones and the Walkie-Talkies of yesteryears which were used for communication at construction sites, large factories, etc.

The future of digital technology is in miniaturization - though smaller yet powerful devices. The change from bulky landline telephones to smartphones is one such move to handheld pocket size devices. Gone are the days when a handset was a mere calling device. Now calling is just a basic function. Smartphones are doing almost 90% the normal low-end jobs of a laptop or computer and by 2027 there could be a LCD projector getting embedded in a smartphone and all that at an affordable price. A mobile phone has become an integral part of one's life. Between calls, texts, emails, mobile document software and photo-messaging, most normal office jobs can be completed using just a smartphone. It has become an indispensable companion.

In short, digital technology of today is slowly but surely bringing different ways and means to improvise people's lifestyle (professional as well as personal). The devices are becoming smaller, cheaper and feature packed with computing strength, which is opening many vistas for innovation. IT for Value Addition is now the new success mantra.

These communication gadgets are creating a new 'E' life style. Information on any subject, services and facilities is readily available anywhere in the world.

Wearable computers, also known as **body-borne computers,** are the next wave. They are miniature electronic devices that are worn by the bearer under, with or on top of the clothing. One of the main features of a wearable computer is consistency. There is a constant interaction between the computer and user, i.e. there is no need to turn the device on or off. Another feature is the ability to multi-task. It is not necessary to stop what one is doing to use the device; it is augmented into all other actions. These devices can be incorporated by the user to act like a prosthetic. It can therefore be an extension of the user's mind and/or body.

Leading IT major Motorola Solutions released its own head-mounted wearable computer based on Kopin Corporation's Golden-i headset. Aimed at industrial and military users who need to keep their hands free on the job while viewing documents and schematics or getting help from specialists who could be physically anywhere else, the Motorola HC1 Headset Computer places an 800 x 600 (SVGA) full color TFT micro-display at a viewing distance that provides a virtual image size of 15 inches (450 mm). In keeping with the hands-free theme, the headset can be controlled via voice and gesture controls. Stephan Hawking used this Technology to communicate with the world.

Software

The rate of usage of software, created domestically in India, has increased substantially. Convergence

The Golden-i 3.8 headset2

Motorola HC1 Headset Computer with voice recognition and gesture control3

of different technologies such as picture sound and video with location maps have opened new avenues of communication, information and entertainment. While spoken words can be typed/ printed, printed messages can be translated into sound (voice). The voice recording and translating capacities of the machine have created innumerable opportunities in this field.

With advances in GPS and RFID chips in everything and regular use of location trackers such as Google Earth/ Google Maps, etc. tracking of things (objects) and people is becoming easier. Today people are tracked based on correlation of name and ID (mobile or email). Very soon voice and picture dimensions would get added. A picture captured on CCTV or Mobile camera can give suggestions as to who the person is likely to be? The feature is not restricted to persons alone. For physical objects also, based on appearance or size, a lot of information can be provided. In future on a visit to a shopping mall, the scanned picture of an object one wishes to purchase (e.g. a fruit, vegetable, trouser, etc.), the image or video of the object would be analysed and information about it, such as its ruling market price, quality, place to buy cheapest, etc., would be provided.

Augmented Reality (AR) is a live, copy, view of a physical, real-world environment whose elements are *augmented* (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data.

The uses are not limited to personal level only, but can be equally applied on industrial, social and public levels. Different versions of computers will bring a revolution with long-lasting effects. That would lead to discarding a number of traditional concepts, and thus give a chance to new systems to prove their mettle. It would be more evident in governmental and administrative fields, as Inline" will soon transform into "Online" when it comes to a number of tasks. Of course, all that will take a little time but will definitely happen. All that implies that the Digital Age (ICE Age – Information Communication Entertainment) has really arrived.

IBM brings augmented reality to the shopping aisle[4]

Industry 4.0

Industry 4.0, also known as the Fourth Industrial Revolution, represents the convergence of advanced digital technologies like Artificial Intelligence (AI), the Internet of Things (IoT), big data, cloud computing, automation, robotics, and cyber-physical systems to transform manufacturing and production processes. The same will also affect engineering work repertoire in the office as well as in the field or shop floor. In the context of India, Industry 4.0 is an essential step in the country's growth, modernization, and global competitiveness.

The Key Elements of Industry 4.0 are discussed below.

a. Automation and Robotics

The use of robotics and automation in manufacturing is central to Industry 4.0. Indian industries, especially in automotive, consumer electronics, and heavy machinery sectors, are increasingly adopting automated systems for production, assembly lines, and even packaging. Collaborative robots (cobots) are gaining ground, assisting workers in dangerous or repetitive tasks while improving productivity. On the construction site also, there will be a big impact especially when prefabrication systems are adopted. In normal construction as well, robots or pre-programmed equipment can take over hazardous and repetitive tasks.

b. Internet of Things (IoT)

IoT in Industry 4.0 connects machines, devices, and systems to the internet, allowing real-time

monitoring and data analysis. In India, IoT adoption is expanding across industries like agriculture, smart manufacturing, automotive, and energy. Businesses are using IoT for smart monitoring of production equipment, predictive maintenance, energy management, optimizing resources and minimizing downtime.

c. Artificial Intelligence (AI) and Machine Learning

AI is revolutionizing manufacturing processes by enabling systems to make real-time decisions and optimize operations without human intervention. Companies in India are adopting AI for predictive analytics, quality control, and production efficiency.

Machine Learning helps in forecasting demand, inventory management, and optimizing supply chain logistics. It is also enhancing quality assurance by identifying anomalies in production in real time.

d. Big Data and Analytics

In the era of Industry 4.0, big data analytics plays a crucial role in gathering, processing, and analysing vast amounts of data generated by machines, sensors, and supply chain systems.

It is being leveraged to optimize operations, understand customer behaviour, and improve decision-making. For instance, companies in the textile and pharmaceutical industries are utilizing analytics for production planning and inventory optimization.

For construction or production – quality checking for all parameters, even for whatever is mass produced, becomes much easier and can be done in a far lesser time frame with no perception or recording errors.

e. Cloud Computing

Cloud computing facilitates data storage, collaboration, and remote access to software tools, which are helping reduce infrastructure costs and scale operations efficiently.

Cloud-based platforms also support real-time data exchange between supply chain partners, design offices and construction sites, factories, etc. providing instant transfer of drawings, specifications, instructions, feedback from construction site/ factory, thus enhancing collaboration and transparency.

f. 3D Printing (Additive Manufacturing)

3D printing is enabling on-demand production, reducing material waste, and offering the potential for faster prototyping. Companies, especially in aerospace, automotive, and healthcare, are exploring 3D printing to produce complex parts and components.

It is also benefiting micro, small and medium enterprises (MSMEs) by offering cost-effective solutions for custom product manufacturing and reducing dependency on large-scale traditional manufacturing /construction methods.

g. Cybersecurity

As Industry 4.0 increases interconnectivity, cybersecurity becomes critical in safeguarding data, intellectual property, and systems from cyber threats. Industries are investing in advanced cybersecurity measures to protect their operations from cyberattacks, ensuring secure integration of systems across industries.

AI for Consulting Engineering and Construction

The Consulting, Engineering, and Construction (CEC) industry in India is undergoing a major transformation, driven by the integration of Artificial Intelligence (AI) technologies which are playing an increasingly pivotal role in enhancing productivity, improving project management, optimizing designs, and addressing the industry's key challenges, such as cost overruns, delays, and safety concerns.

AI Chatbots: In the realm of AI, chatbots like Google Gemini, DeepSeek are emerging as powerful tools, and India is a fertile ground for their adoption and

are reshaping the Indian landscape across various sectors.

AI is making a significant impact on CEC in India as discussed hereinafter.

a. AI in Design and Architecture

Generative Design: AI-powered generative design tools enable engineers and architects to explore multiple design alternatives, optimizing for parameters like cost, material usage, sustainability, and functionality. Firms are using these tools to create more efficient, cost-effective, and aesthetically pleasing designs for buildings, bridges, and infrastructure projects.

BIM (Building Information Modelling): AI-enhanced BIM integrates real-time data and improves collaboration among stakeholders. It allows better visualization, detailed simulations, and clash detection, ensuring that designs are refined before construction begins. BIM is being used alongside AI tools for smoother workflows and reduced project costs.

b. AI in Construction Project Management

Predictive Analytics for Project Scheduling: AI can predict project timelines and identify potential risks, helping project managers make proactive decisions. AI tools use historical data and machine learning algorithms to forecast delays or cost overruns, which is critical in the infrastructure sector, where many projects very often face delays.

Resource Optimization: AI-driven tools assist in optimizing labour, materials, and equipment, thus ensuring that resources are used efficiently. AI systems help track resources in real time, allowing managers to avoid shortages or overstocking, ultimately reducing waste and costs.

Construction Scheduling: AI-based scheduling software helps construction teams to adapt to changing circumstances by dynamically adjusting schedules and predicting bottlenecks. This is especially useful for large-scale infrastructure projects, such as highways, railways, and metro systems which are spread out over long distances, and airports, docks & harbours, etc.

c. AI in Construction Site Monitoring and Safety

AI-Powered Drones: Drones equipped with AI-powered cameras and sensors are increasingly used to monitor construction sites in real time. These drones can capture high-resolution images, monitor construction progress, and detect safety hazards. This technology is helping construction firms ensure that projects are on track and the workers are safe.

AI and Computer Vision for Safety: AI-powered computer vision systems can scan construction sites for safety hazards, such as workers not wearing helmets or working in unsafe conditions. The safety of construction workers is a major concern; it is these AI tools which can help reduce accidents and ensure compliance with safety regulations.

Automated Monitoring: AI systems monitor the health of workers on site using wearable devices that track vital signs and alert supervisors in case of emergency situations. AI can detect signs of fatigue, heatstroke, or other health risks, promoting a safer working environment.

d. AI in Cost Estimation and Budgeting

Cost Prediction and Estimation: AI tools can analyse historical project data and industry standards to generate accurate cost estimates for construction projects. Cost overruns are common in projects and it is there that AI-driven cost estimation can help deliver more accurate project budgets, and their updates, making it easier for clients and contractors to manage finances.

Real-time Budget Monitoring: AI tools can track expenses in real-time, comparing actual spending against the budget. That allows for quick adjustments to keep projects on track financially and can help contractors avoid the problem of over shooting the budget during the course of the project.

e. AI in Supply Chain and Logistics Management

Supply Chain Optimization: The construction industry often faces challenges related to supply chain disruptions, such as delays in the delivery of materials. AI-based systems can predict material demand, track shipments, and optimize inventory management. This leads to better coordination between suppliers and construction teams, minimizing delays.

Logistics and Fleet Management: AI can help track and manage construction vehicles, reducing fuel consumption and improving delivery schedules. It is particularly valuable in areas where transportation logistics can sometimes be unreliable, leading to delays in project timelines.

f. AI for Sustainability and Environmental Impact

Sustainable Construction: AI can optimize energy consumption, waste management, and water usage in the design and construction phases. In India, where environmental concerns are becoming increasingly important, AI-powered solutions help engineers design green buildings, reduce carbon footprints, and comply with local environmental regulations.

Smart Energy Management: AI systems can monitor the energy consumption of buildings during construction and after completion, offering recommendations for energy efficiency improvements. Project developers and contractors can implement AI to meet sustainability goals while also cutting costs.

g. AI for Risk Management and Quality Control

Risk Detection and Mitigation: AI algorithms can analyse large datasets to identify potential risks related to design, site conditions, or supply chain problems. Consulting firms are increasingly using AI to assess these risks before the start of a project, improving decision-making.

Quality Control: AI systems use data from sensors, drones, and cameras to assess the quality of construction work in real-time. These systems can detect issues such as cracks, material inconsistencies, or structural weaknesses, which can help maintain quality standards and prevent costly rework.

h. AI for Facility Management Post-Construction

Smart Building Management: After construction, AI is used to optimize the operation and maintenance of buildings. AI-powered systems monitor HVAC (Heating, Ventilation, and Air Conditioning), lighting, and security systems to reduce energy consumption and improve occupant comfort. This is particularly relevant for large commercial and residential projects, where energy and maintenance costs are a major concern.

Predictive Maintenance: AI helps predict when equipment or systems would need maintenance or repairs. That is crucial for facilities in India, where infrastructure is sometimes aging, and regular maintenance is often neglected. AI ensures that building systems operate efficiently, thus minimizing downtime and costly repairs.

i. AI in Smart Cities and Infrastructure Development

Smart City Initiatives: India's growing smart cities, including projects like Gandhinagar and Amritsar, are using AI to integrate sensors, data analytics, and IoT to improve urban infrastructure. AI optimizes traffic management, waste disposal, public transportation, and energy use in these cities, improving the quality of life for residents.

Smart Infrastructure: AI is being integrated in traffic management systems, smart grids, and waste management systems to improve urban living. AI models can predict traffic patterns, optimize public transport, and make resource distribution more efficient.

j. Challenges to AI Adoption in the Indian CEC Sector

Initial Investment and Infrastructure: AI adoption requires significant upfront investment in hardware, software, and skilled personnel, which

could be a barrier for small and medium-sized construction firms in India.

Skilled Workforce Shortage: The lack of a skilled workforce trained in AI, machine learning, and data analytics remain key challenges. There is a need for more training programs and educational initiatives to equip engineers and construction professionals with the necessary AI expertise.

Data Privacy and Security: As construction projects increasingly rely on AI, there are concerns regarding data privacy and security, especially when dealing with sensitive information about designs, construction processes, and financials.

Integration with Legacy Systems: Integrating AI technologies with existing construction workflows and legacy systems can be complex. Many firms may face challenges in adopting AI if their current infrastructure is outdated.

The Future of AI in Consulting, Engineering, and Construction in India

The adoption of AI in consulting, engineering, and construction is set to accelerate in India in the coming years. With the government's push for infrastructure development, initiatives like Smart Cities, and a growing emphasis on sustainability and the need to address the climate change issues, the role of AI will only expand. By improving project timelines, reducing costs, ensuring safety, and enhancing overall efficiency, AI is positioning itself as a game-changer in the Indian consulting engineering and construction industry.

With further investment in AI research, skilled workforce development, and technology adoption, AI can significantly contribute to solving some of the biggest challenges facing the construction and engineering sectors in India, driving innovation and ensuring more sustainable and smart infrastructure development.

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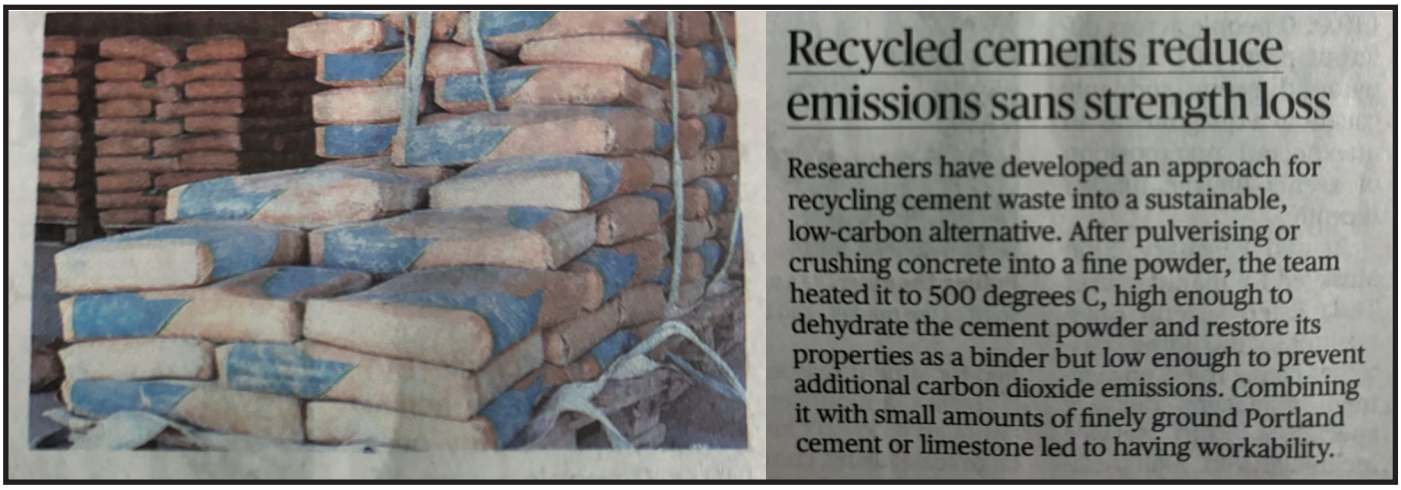

Recycled cements reduce emissions sans strength loss

Researchers have developed an approach for recycling cement waste into a sustainable, low-carbon alternative. After pulverising or crushing concrete into a fine powder, the team heated it to 500 degrees C, high enough to dehydrate the cement powder and restore its properties as a binder but low enough to prevent additional carbon dioxide emissions. Combining it with small amounts of finely ground Portland cement or limestone led to having workability.

Source: The Hindu

06

AI for Revolutionising Plant Operation and Maintenance

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Abstract

The integration of Artificial Intelligence (AI) into plant operation and maintenance is revolutionizing industrial and process plants. AI technologies are being leveraged to enhance process and system efficiencies, reduce O&M costs, and improve overall productivity. While there are numerous benefits for AI adoption, the deployment of AI in plants faces a few challenges too, such as data integration from legacy control systems, real time adaptability issues, people mindset, skill gap, etc. This article explores the various applications of AI in plant operations, with specific examples from thermal, renewable power plants, transmission, distribution, chemical plants, and metals and mining industry. The benefits, challenges, and potential future developments of AI in these sectors are also highlighted.

Introduction

AI is transforming the ways of operating and maintaining industrial plants like power plants, steel plants, chemical plants, manufacturing plants, etc. It is providing better insights to the plant operators and assisting them to optimize plant operation and maintenance. The advent of Generative AI, which is a subset of AI, is furthering the AI journey by allowing the subject matter experts to work with minimal coding solutions. AI encompasses a range of technologies, including Machine Learning, Neural Networks, Image Analytics, and Robotics, which can be applied to optimize processes, predict maintenance needs while ensuring quality control. There are challenges too in the deployment of AI solutions such as data ingestion from the legacy control systems, real time adaptability issues, people mindset, skill gap, etc. However, the challenges can be mitigated through techno-managerial interventions and thereby plant operators can harness the power of AI to achieve higher levels of automation, accuracy, efficiency and minimize failures. Few of the impactful applications of AI in plant operation are discussed below.

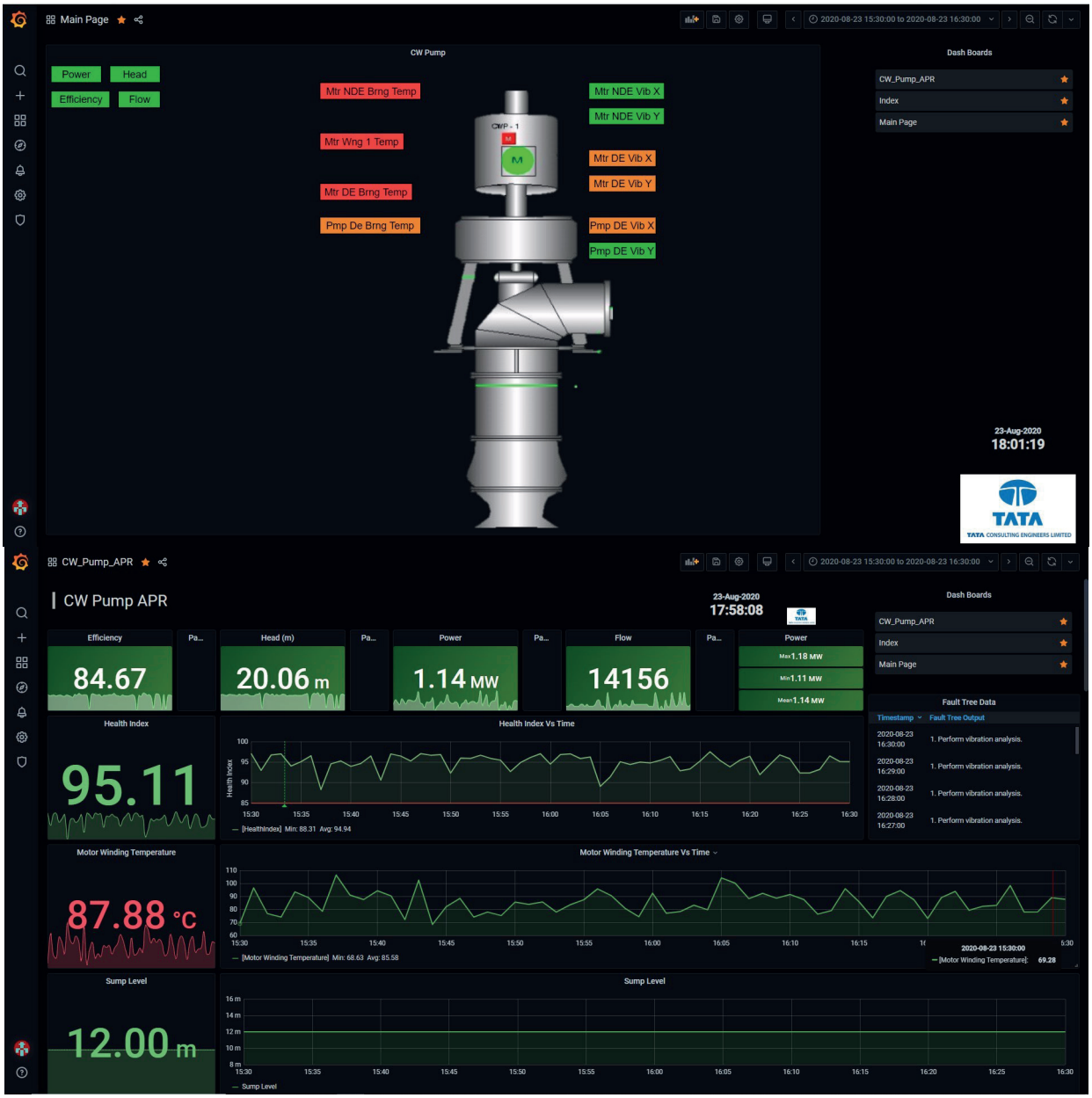
AI for Predictive Maintenance

One of the most useful applications of AI in plant operations is predictive maintenance. Traditional maintenance strategies often rely on scheduled preventive checks or reactive repairs, which can lead to unexpected downtime and increased costs. AI-driven predictive maintenance uses data from sensors and equipment to predict when a machine is likely to fail. Machine Learning algorithms analyze that data to identify patterns, detect and diagnose anomalies, allowing operators to perform maintenance proactively before a breakdown occurs. That approach minimizes downtime, improves productivity, extends the lifespan of plant and equipment, and reduces maintenance costs. As per industry sources, Predictive Maintenance powered by AI is offering key benefits as given below.

- Equipment Uptime: Improves availability by 25-30%
- Cost Savings: Reduces maintenance costs by 15-20%
- Failure Prediction Accuracy: Enhances reliability by 40%

Thermal Power Plants

In thermal power plants, predictive maintenance can be applied to critical components such as turbines, boilers, generators, and critical pumps. By monitoring parameters like temperature, vibration, and pressure, AI algorithms can predict potential failures and schedule maintenance activities accordingly. That reduces the risk of unplanned outages and ensures continuous



Courtesy: TATA Consulting Engineers Ltd
Figure-1: AI based Digital Point Solution for Pumps

power generation. For example, AI-driven predictive maintenance can reduce maintenance costs by up to 20% and increase equipment uptime by 10-15%.

An example of an AI based digital point solution related to pump performance monitoring and diagnostics is shown in Figure-1. The AI based digital tool can assist the operator in monitoring the pump performance and analyse multiple impactful parameters in near real-time to ensure optimal performance levels throughout plant operation.

A few of the capabilities of the AI based digital tool on performance diagnostics of pumps are listed below.

a) Anomaly detection based on historical behavior

b) Detection of parameters for which deviation has occurred from that expected and provide early warning alerts

c) Prediction of pump performance for different load conditions

d) Providing insights into pump failures and the factors that influence pump performance

e) Helping to proactively plan maintenance actions.

A few other AI based solutions would include automatic maintenance health report generation based on equipment inspection or sensor data, boiler combustion process optimization with respect to different coals, predicting boiler overheating issues, predicting the motor failures through signature analysis, turbine failure prediction using vibration analysis, prediction of remaining useful life, etc.

Renewable Energy Plants

For Renewable Energy (RE) plants, such as wind and solar farms, predictive maintenance can optimize the performance of turbines and solar panels. Hotspot detection of panels, soiling and shading detection are areas where AI intervention can lead to considerable benefits. The real time blade angle control with respect to wind speed and direction, blade failure detection, wind turbine failure predictions, etc. are a few areas of AI application in wind power plants. AI can analyze weather data, equipment performance, and historical maintenance records to predict when maintenance is needed, thus ensuring maximum energy output and reducing downtime. That can lead to a 15-20% increase in energy production and a 10-15% reduction in maintenance costs. The increased production from RE plants contributes positively to the decarbonization targets.

AI in Process Optimization and Safety

AI can significantly optimize the process in plant operations. By analyzing vast amounts of data from various sources, AI algorithms can identify inefficiencies and suggest improvements. For example, in a chemical plant, AI can optimize the mixing process by adjusting variables such as temperature, pressure, and ingredient ratios to achieve the desired output with minimal waste. That level of precision not only improves product quality but also reduces energy consumption and raw material usage. Similarly, combustion optimization in coal fired boilers is another example where AI can play a crucial role.

Besides plant operations, safety of workers and equipment is a top priority in plant operations, and AI can significantly enhance safety and risk management. AI-powered systems can monitor equipment and environmental conditions in real-time, detecting potential hazards and alerting operators to take preventive actions. Geotagging the safety sensitive areas and combining it with AI based image analytics can prevent unintended entries of workers in sensitive or potentially hazardous areas. AI can also analyze data from sensors to identify gas leaks, temperature fluctuations, or structural weaknesses, allowing for timely interventions. AI, in addition, can also analyze historical incident data to identify patterns and implement measures to prevent future accidents.

Energy consumption is an important cost factor in plant operations, and AI can help optimize energy usage. AI algorithms can analyze energy consumption patterns and identify opportunities for energy savings. For example, AI can adjust the operation of heating, ventilation, and air conditioning (HVAC) systems based on real-time data, ensuring optimal energy efficiency.

Chemical and Hydrocarbon Industry

In the chemical and hydrocarbon industry, AI can optimize processes such as refining, distillation, and chemical reactions. By continuously monitoring process variables and adjusting parameters in real-time, AI can improve yield, reduce energy consumption, and minimize waste. All that can result in a 10-15% increase in production efficiency and a 5-10% reduction in energy costs.

AI can enhance safety by monitoring the condition of pipelines, storage tanks, and processing equipment. Asset integrity management is a potential area of AI application. AI applications can detect leaks, corrosion, and other potential hazards, allowing for timely maintenance and reducing the risk of accidents. This can result in a 10-20% reduction in safety incidents and a 5-10% decrease in maintenance costs.

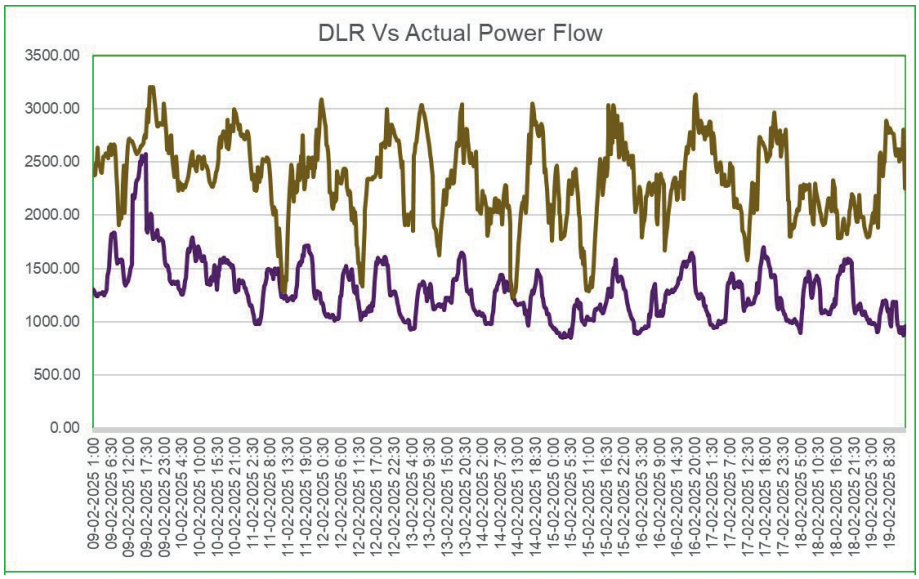
AI-powered robots can perform complex tasks with high precision and consistency, reducing the need for manual labour. The robots can be used for tasks such as inspection in safety sensitive/ unreachable areas with high speed and accuracy. Furthermore, AI algorithms enable robots to learn from their experiences and adapt to changing conditions, enhancing their flexibility and efficiency.

Metals and Mining Industry

In the metals and mining industry, AI can optimize ore processing, smelting, and refining operations. By analyzing data from sensors and equipment, AI can identify bottlenecks, optimize resource allocation, and improve overall efficiency. That can lead to a 10-20% increase in production efficiency and a 5-15% reduction in operational costs.

Power Transmission Industry

In the transmission and distribution sector, AI can enhance power quality control by monitoring the condition of power lines, transformers, and substations. AI based Dynamic Line Rating (DLR) solutions can predict the real time capacity of the transmission with respect to the changing weather parameters thereby assisting the grid operators to unlock the extra capacities in the transmission lines and optimize the operation. In favorable weather conditions, it may help the operators to transmit 30 to 40% extra power compared to the static power flow rating; Refer Figure-2. AI algorithms can detect anomalies such as voltage fluctuations, equipment degradation, and potential faults, allowing for timely interventions and reducing the risk of power outages. This can improve reliability by 10-15% and reduce maintenance costs by 5-10%.



Courtesy: TATA Consulting Engineers Ltd
Figure-2: AI based DLR Solution for a 400kV Transmission Line

AI can, in addition, can predict energy demand and adjust power dispatch schedules to manage transient hours or renewable peak hours.

Practical Challenges in AI Implementation

Unlike other new technology deployments, the implementation of AI in plants involves different sets of challenges such as data ingestion and management, data quality issues, people mindset, cyber security, data privacy issues, etc.

Data integration from legacy control systems is one of the key issues to be addressed for smooth AI implementation in old plants. Upgrading legacy systems to support AI could be expensive hence the transition needs to be well thought out and planned. According to Gartner, 70% of enterprises continue to use legacy infrastructure, and 50% of AI projects fail due to data integration issues. The legacy control systems mostly have outdated technologies which are not designed to integrate with modern data sharing modes. That has created data silos and non-uniformity in data. AI requires structured, accessible data for training and decision-making and the recent advances in technology are bridging the gaps in data integration. Usage of advanced integration technologies like Automatic Programming Interfaces (API), AI based middle wares and AI based cloud applications are helping the legacy systems to integrate with modern systems. Gartner predicts that 70% of legacy systems will be AI-augmented by 2028.

Most of the time, an enterprise level AI deployment would involve centralization and data aggregation from multiple plants. In such a case, the data for the AI applications may come from multiple types of DCS, SCADA, PLC or some sensors which may be using different data formats and connectivity protocols. Protocol converters would be essential to ensure interoperability and unification of data. Similarly, Edge-based data storages/ concentrators would be required where data loss is expected due to connectivity issues. These measures are necessary to ensure data quality for AI applications.

AI deployment is complex and time consuming. It involves data identification, classification, and training of AI models with the right set of data. It would also require a specially skilled team including Data Scientists, Machine Learning (ML) Engineers, and domain experts. Those skill sets may not be readily available in a plant environment.

Most plants do not prefer to expose their Operational Technology (OT) layer for third party integrations due to concerns on cyber security. However, the deployment of AI in plants essentially requires OT-IT integration. Hence, increased awareness on cyber security and implementation of adequate measures to ensure security of plant data from any intrusion/ threats is a prerequisite for AI deployment.

To address the challenges would demand a strategic approach, including investing in data management solutions, enhancing cybersecurity measures, and gradually integrating AI technologies with the existing systems.

Roadmap for AI in Plant Operations

The application of AI in plant operations is continually evolving, with new advancements on the horizon. One promising area is the use of AI for autonomous plant operations, where AI systems can make real-time decisions without human intervention. That level of automation could further enhance efficiency and reduce operational costs.

Energy transition is the need of the hour and AI intervention would accelerate the pace. “Design for digitalisation and AI” is becoming the norm for the industry which involves sensorisation of critical processes to help building accurate digital twins, provision for big data ingestion, processing and AI based interventions for process optimization.

Besides, advancements in AI algorithms, Generative AI, domain specific Large Language Models (LLMs), higher connectivity bandwidths and computing power will enable more sophisticated predictive models and

optimization techniques, and drive further improvements in plant operations.

Conclusion

AI is redefining plant operations across various industries, driving efficiency, sustainability, and cost reductions. With advancements in machine learning and automation, AI continues to enhance predictive maintenance, operational optimization, and safety. The quantified benefits demonstrate AI's transformative impact, making it an essential component of modern plant operations. As AI technologies continue to advance, the potential for further optimizations in plant operations is immense, thus paving the way for a more efficient and sustainable future.

Acknowledgement

The author would like to acknowledge the contributions of various organizations and individuals who have provided valuable data and insights for this article. Special thanks to Tata Consulting Engineers Limited for granting permission to use and cite data.

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DeepSeek is a Chinese artificial intelligence (AI) company that develops open-source large language models (LLMs). DeepSeek's R1 reasoning model, released in January 2025, made the company globally famous.

How DeepSeek works

- DeepSeek's models are available through a web interface, mobile app, and API access.
- DeepSeek's R1 model is said to rival ChatGPT-maker OpenAI's technology, but at a lower cost.
- DeepSeek's popularity and potential caused US tech stocks to fall, and some investors worried about the competitive edge of Western tech giants.

Who founded DeepSeek?

- DeepSeek was founded by Liang Wenfeng, co-founder of the Chinese hedge fund High-Flyer.
- DeepSeek operates as an independent AI research lab under the umbrella of High-Flyer.

DeepSeek's impact

- DeepSeek's rise has underscored the growing influence of China in the AI sector.
- DeepSeek's popularity and potential have called into question whether American firms would dominate the AI market.

Source - Google

07

Catching the Wave of Design Automation and AI in Engineering Design

Pooja Rastogi
Technical Director, Digital
Mott MacDonald

Design technology has changed a lot in the construction industry since I began working on the masterplan for Delhi Airport in 2006, my first project at Mott MacDonald. Advances in automation are replacing repetitive tasks and freeing up time for designers and engineers to focus on high-skilled work that uses their mind power and creativity.

Back in 2006, things were different. One of my tasks on the Delhi Airport Masterplan project was to check that all the drawings and reports we produced incorporated the latest changes and that different versions tallied. I remember thinking there must be a better way than doing this manually – and there is.

If you visit any of our offices today and walk through our digital hub, you will witness the miracles of modern technology in engineering solutions. On one screen you will come across automated embodied carbon calculations, on another screen you'll see a bridge simulation.

By automating repetitive tasks, we can not only reduce hours of effort to a few minutes, we can lower the chance of manual errors. This creates opportunities for massive time and cost savings in the design of airports, metros, hospitals and other vital infrastructure.

Standardising processes and ways of working is also improving quality control, ensuring the same outcome no matter who is carrying out the task. This is helping new recruits to gain confidence working on projects within clearly defined parameters without being afraid of making the wrong decisions.

Automation in Metro Design

Our global design services team recently completed an exciting project to identify where process automation can be applied when designing any metro station, anywhere around the world.

The starting point was to document every design process involved in a generic metro station, which included 14 engineering disciplines. The next step was to create a visual map connecting all the steps together. Then it was easy to identify repetitive processes that could be automated and other processes, which could not.

Beyond BIM and Digital Twins

The next step for BIM is to move it into the fourth dimension i.e. time. Before the construction process starts on site, a digital rehearsal of the construction

process can be programmed to mitigate unforeseen circumstances that may cause delays. It has the added advantage of increasing safety at the site too. Hence, by linking the BIM model with the Primavera/ Microsoft project schedule we can simulate a visual construction sequencing which can be seen over a timeline video.

Digital twins are the new buzzwords in the industry. It is the connection of a physical asset with its digital representation using sensors, which use a backend algorithm to send alerts via SMS or through a dashboard at defined scenarios. Some examples are: sensors inside a building that can record indoor conditions, cameras that can record or sense human presence in space. The data stream is crunched by algorithms on a smart infrastructure platform and the real-time scenario is made accessible for relevant authorities. Many such applications can be useful to manage assets or sites. One such application which we are pioneering is detecting the use of personal protective equipment at sites to ensure the safety of construction workers.

Artificial Intelligence and Machine Learning (AI/ML)

We have made tremendous progress in harnessing the ability of AI/ ML to create scalable and adaptable solutions using computer vision for services that required the presence of an on-site engineer for inspection. We use datasets from previous inspections and train a model to recognise any pattern or configuration in an automated manner for large amounts of data in a real-time scenario. This saves time and money, and allows inspections to continue through cameras mounted on sites even during the peak of the pandemic when movement was restricted due to lockdowns. We have developed these solutions for road and bridge inspections as well as for ecology projects. Other uses of AI/ML include the ability for predictive analysis and scenario forecasting using the power of past data and advanced analytics.

Generative AI, such as Chat GPT, is currently a prominent topic in the market. However, the direct application of large language models to engineering design, aside from serving as a writing assistant for tasks like report production or error checking in Excel and software programming, only scratches the surface of their potential in design production. Microsoft Copilot is one such assistant that is readily available and can be utilized alongside all Office products like Word, Excel, and PowerPoint, as well as between these products to aid in summarization, answering questions, and performing tasks such as formatting documents, slides, and calculations. Imagine being able to ask Excel to perform calculations without needing to know the exact syntax of the formula or creating a PowerPoint slide deck based on your bid document, summarizing your team's meetings, generating action lists, and sending out reminders for incomplete actions. These capabilities are not just ideas for the future but are available here and now, albeit at a premium price. At most, this can assist with 5% of the total workload.

The real benefits emerge when iterative design options can be generated based on a series of prompts and evaluated against various parameters such as sunlight and shade analysis, wind, and the calculation of net to gross areas. These can be calculated at the click of a button and tabulated using a predefined scoring mechanism, aiding in decision-making and significantly reducing front-end time.

Futuristic Scene with High-Tech Robot Used in Construction

The use of AI in Building Information Modelling (BIM) is also in its nascent stages. The data sets behind a BIM model are growing daily, and applying a layer of AI on top of this data can open up numerous avenues for further exploration and analytics, which help in design management and quality checks as per BIM standards. Further AI agents can be deployed for repetitive tasks like those involving weekly BIM coordination checks, publish and federating discipline models and a variety of other repetitive tasks which remove the mundane tasks and frees up engineers and BIM professionals to focus their energy on what matters, which is problem solving and coming up with innovative engineering design solution.

AI in engineering software, such as those produced by vendors like Autodesk and Bentley, is also on the verge of making a significant impact on engineering design. A few smart tools have started to surface, such as reading comments using OCR technology from markups, performing standard analysis on models, conducting model health checks, and converting text to models for simple objects.

However, the lack of interoperability and the sheer variety of file types that are not compatible with each other are impediments to moving seamlessly from analytical design to BIM design and back to analytical design, to keep both the BIM model and the analytical model in sync.

We at Mott MacDonald continue to lead the design, construction and operations of built assets by accelerating the pace of digital transformation and adding benefits of cutting-edge technology to our rich legacy of proven solutions.

About Mott MacDonald:

Mott MacDonald in India is one of the most diverse management, engineering and development consultancies for over past 50 years having capabilities and experience in advisory, buildings, industry, infrastructure, environment, social development and water sectors.

Mott MacDonald provides an array of key services for India's major markets – from business case to development planning to engineering design and project management. As well as being able to cover all stages of a project's cycle, we can offer lifespan assistance via our project management experts.

Mott MacDonald's wide range of customers include national and local governments, public and private utilities, industrial and commercial companies, investors, developers, banks and financial institutions, international as well as bilateral funding agencies and private entrepreneurs.

www.mottmac.com

08

The Role of Artificial Intelligence in India's Infrastructure Goals – Regulation & Risk

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Legacy Law Offices LLP

Introduction

Artificial Intelligence (AI) is that innovative piece of technology which has the potential of transforming the face of the economy. Efficient development and inculcation of AI in India may bring about a tremendous change, and facilitate the very realization of the way things are carried out in the day-to-day affairs of the Government and businesses. From the streamlining of governance to the achievement of India's long-term vision, AI can potentially offer a new nation to its citizens, where ease of doing mundane tasks accompanies everything. That said, AI may on the other hand also be considered to be a possibly dangerous piece of technology which has the ability to take over routine work jobs and increase the burden on the environment by an unprecedented magnitude, if left unregulated. However, people would be freed to concentrate and devote more time to the non-routine works which require reflection and innovation for progress and prosperity.

In November 2022, when a 'now leading' AI driven application was introduced to the public forum, discussions amongst the members of the society were diverted towards the manner in which the technology could bring about a distinctive change and help in the rapid development of all industries. During those discussions, one sector that may have outshone all others in terms of their potential for improvement were engineering and construction, especially the infrastructure sector.

Considered to be the driving force of all developing economies, in terms of India, engineering and construction for infrastructure development contributes to over 9% of the overall Gross Domestic Product (GDP) and employs more than 50 million people across the country.[1] In fact, within the financial vision set by the Government, on the path to achieving a USD 5 trillion-dollar economy by 2027-28[2], the engineering and construction sectors are anticipated to have significant roles.

However, while the aforementioned vision may have a long way to go, efficient inclusion of AI can make the road easier and the destination closer by giving timely alerts of possible slips and also help to reduce the number of hindrances that may potentially risk the achievement. With its massive potential in consulting, engineering and construction, AI-driven technologies may even emerge to be the king-pin by offering assistance in processes like project management, contract management and asset lifecycle management, thus, smoothening the overall project executions, and facilitating timely completions.

Although, one obstacle in the achievement of this extended inclusion of the technology in the construction sector, may be the fact that even after approximately two years since AI has been purported to have 'taken over' the market, regulations concerning its use remain admittedly scarce, a fact which may have the potential to poke holes in the vision for the advanced development of the nation altogether. *This fact, has however, been acknowledged by the Government of India, which has been working towards introducing initiatives in the form of policies and rules, to tackle the shortcomings.*

Understanding the Need for AI and the Surrounding Regulatory Environment

As mentioned above, AI-driven technologies have the potential to facilitate enhanced efficiency in consulting engineering and construction processes, wherein many companies have even started adding different forms of AI technologies to help in the timely completion of projects. One instance of such a transformation may be found in Europe, where a leading construction company has started the use of AI-driven cameras to help in tracking overall project development on a daily basis.

It is also worth mentioning that by putting these forms of innovative technologies to a calculated use, industry players may, in fact, be able to include sustainable means within the construction processes, wherein this particular inclusion, even though critical, has been an undeterred challenge for developing countries.

With such a diverse potential, the inclusion of AI in engineering and construction may be considered to be a vital step towards future development. However, for this step to be taken in an efficient manner, it is essential that the governments of different nations bring into effect, comprehensive legislations or policies, seeking to regulate the use of AI driven technologies to prevent misuse or overuse, in some cases.

A critical initiative towards such prevention was taken by 46 member and 11 non-member countries to the Council of Europe by signing the one-of-its-kind *Council of Europe Framework Convention on Artificial Intelligence and Human Rights, Democracy, and the Rule of Law (CETS No. 225)*. Signed on September 5, 2024, the convention provided 7 'general principles' that are proposed to be implemented by signatory countries to regulate artificial intelligence systems. These included the principles of 'human dignity & individual autonomy', as well as 'privacy and personal data protection.'[3]

While being a necessity in the previously unregulated domain, the CETS No. 225 remains a general convention, with certain unanswered ambiguities, which may be resolved somewhere in the future. It goes without saying that, by its very nature, the convention does not deal with a specific sector, and only provides a stepping stone to the signatory countries, for adopting their own legislations.

Although India chose not to become a part of the CETS No. 225, the Government signed a distinctive pact for protection against the catastrophic harms of AI, in addition to another statement for promoting *Inclusive and Sustainable Artificial Intelligence (AI) for People and the Planet*.

It may be undeniable that the aforementioned pieces of international agreements are crucial to the standing commitments of nations towards AI design, development, and operation. Another incredibly ubiquitous fact, however, is that the actual implementation of these agreements or any other regulation concerning AI or other machine learning data-driven technologies lies within the legislative powers of Governments across the world. Thus, it is for the legislatures to determine actions to prevent the potential risks associated with the use of AI-driven technologies.

Identifying the Potential Risks of using AI

The outputs of AI driven applications are in a majority of cases dependent on the data available to them as well as collected by them during the operation and development process. In the instances where there have been reported shortcomings in feeding appropriate data into the applications, the results have been unexpected or wrong, thus, requiring the process

to be re-initiated in order to attain better or complete outputs. *Another major and more important factor is that AI applications are intrinsically dependent on the algorithmic logic built into the AI software. If that has any lacunae then the result will also not be reliable regardless of the correctness of the data.*

In general use, outputs derived from incomplete or inaccurate data, while being incorrect, may not be seen as a major shortcoming. However, in the context of engineering and construction processes, such erroneous results could inadvertently jeopardize overall project development or, in some cases, even compromise the safety of employees working at the project site. Therefore, where the question of dispute or disaster becomes a possibility, it may be essential to emphasize the need to mitigate the risks associated with AI, either through development or external regulations.

In case of an absence of either of the mitigation measures, one additional complication which may arise may pertain to the machine or human, who shall undertake responsibility for the shortcomings in the data and in the AI programmes per se, which lead to subsequent disputes or disasters. Whereas, while in terms of human responsibility, the ambit may even extend to the developer of the technology used, the liability of the machines, on the other hand, may not even be raised, not only on account of being impractical but even due to a total absence of any legislation enumerating the chain of responsibility in such situations.

For India, which, to an extent, follows the principle of 'vicarious liability' in the employer-employee relationships, the question of liability in case of AI use, may cause an unprecedented chaos, which can result in affecting the development of the nation.

Given the potential impact of these uncertain circumstances on India's vision of becoming a developed economy, it is essential to emphasize the need for regulation to progress alongside the development and adoption of AI-driven technologies.

The Bigger Picture

AI-driven technologies can calculate risks, identify issues, and provide solutions in record time if used in the desired manner. The global construction market is forecasted to grow 85% to USD 15.5 trillion by 2030, and automation could raise productivity growth globally from 0.8% to 1.4% annually[4].

These figures act as an encouraging driver towards India's goal of a USD 5 trillion economy, and it may be appropriate to attribute to AI the vital role that it may play in the realization of that vision. For successful achievement, it may be necessary for the country to invest in the development and adoption of AI-driven technologies in a number of sectors, especially those which significantly contribute to economic development, including that concerning engineering and construction.

It is crucial that this adoption be accompanied by appropriate regulations to facilitate growth of the economy while efficiently tackling the potential risks associated with the technology.

A mutually beneficial approach may, in turn, bring vision to reality and drive India to the brim of being a developed country.

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09

Beyond Blueprints: AI to Build Tomorrow's Infrastructures

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L&T Technology Services (LTTS)

Introduction

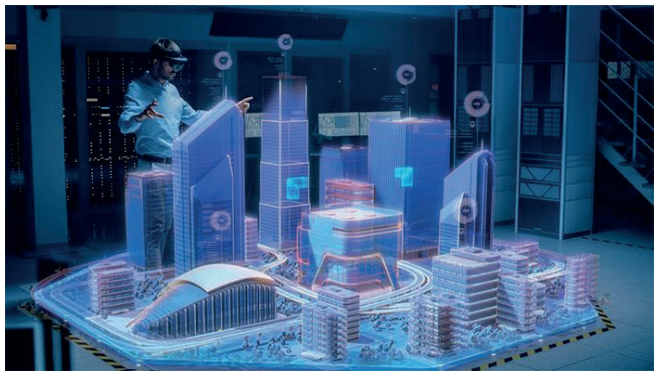
The construction and engineering sectors are no stranger to innovation, but today they stand at the forefront of a revolutionary shift. Welcome to the era of AI, no longer a concept of the future, but a tangible force driving change today, from automating complex processes, to improving design precision, and setting new standards for safety, AI is not just improving processes, it is rewriting the entire playbook.

What's unfolding is not incremental progress; it is a ground-breaking transformation that offers professionals the tools to create smarter, faster, and more resilient infrastructure. This is the future being built today.

The Rise of AI in Construction and Engineering

Picture this: Robotic systems laying bricks with superhuman precision; autonomous excavation preparing sites day and night without fatigue; entire buildings being 3D-printed almost overnight. These are no longer science fiction concepts but real-world applications optimizing project execution. And still, it is just the tip of the iceberg.

AI driven automation is revolutionizing construction methods. High tech machinery eliminates efficiencies and reduces human error ensuring projects can move at



record speed, The design process is likewise undergoing a radical shift with AI-powered generative design tools. By analyzing multiple variables such as material efficiency, cost constraints, and structural integrity, AI creates optimized blueprints that reduce waste and improve sustainability. These innovations not only shorten design cycles but also ensure buildings meet safety and environmental standards from the outset.

Then there is the magic of predictive analytics, allowing project managers to foresee potential risks, optimize resource allocation, and prevent costly delays. By leveraging real-time and historical data, AI enhances decision-making, improving project success rates and reducing cost overruns. Meanwhile, AI-driven predictive maintenance is extending the lifespan of heavy machinery by detecting potential failures before they occur, significantly cutting downtime and maintenance expenses.

Safety has always been crucial in construction, but AI is taking it to the next level. Intelligent surveillance systems can detect hazards such as missing protective gear or unstable structures, while wearable AI-powered sensors monitor environmental factors like air quality and temperature. These innovations not only reduce accidents but also ensure compliance with regulatory standards, creating safer site environments for construction teams.

Sustainability in construction is no longer a challenge; thanks to AI it is an opportunity. By optimizing energy consumption in buildings and reducing material waste, AI helps lower carbon footprints and align projects with green building certifications. Machine learning models are also identifying the most durable and cost-effective renewable materials, ensuring a balance between environmental responsibility and economic feasibility.

Shaping the Future of AI-Driven Construction

The full potential of AI in construction is still unfolding, but the roadmap is clear. Autonomous construction sites, powered by drones and real-time monitoring systems, will create dynamic digital twins that mirror site conditions and optimize workflows. AI-driven design tools will continue to evolve, incorporating advanced factors such as climate resilience and lifecycle costs, making sophisticated design capabilities accessible to a broader audience.

The workforce will also need to adapt to this AI-driven future. Training programs must equip construction professionals with the skills to collaborate with robotics, drones, and AI-powered systems. Industry-academic partnerships will play a crucial role in developing specialized courses that prepare the next generation of engineers for an AI-first world.

Ethical considerations surrounding AI deployment in construction must also be addressed. Transparency in AI decision-making, data privacy, and the impact on labour markets require thoughtful policies to ensure responsible and fair implementation. Establishing guidelines that balance innovation with accountability will be key to AI's long-term success in the industry.

The Future is AI-Driven

AI is actively reshaping construction and engineering today and is no longer a distant promise. From automation and predictive analytics to safety enhancements and sustainability, AI is setting new standards for efficiency and innovation. As companies embrace this technological revolution, the challenge lies in scaling these advancements, integrating AI ethically, and fostering collaboration across the industry.

The AI revolution is here. The plans are drawn, the tools and robots are ready, and the future is being built today. This is no longer a question of *if* AI will shape the future of construction and engineering but *how far* its impact will go.

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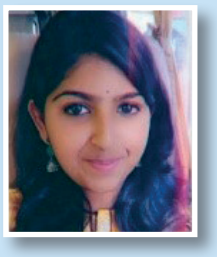
10

The Transformative Role of Artificial Intelligence in Engineering and Construction



Krishna Priya G
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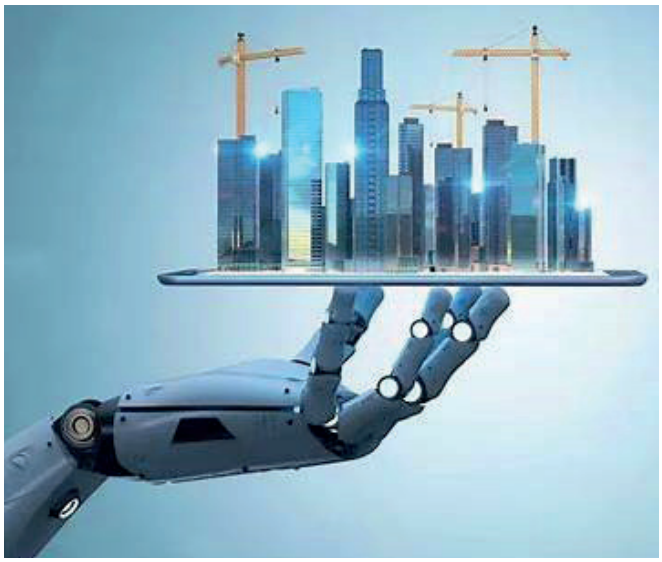
An Overview

The integration of Artificial Intelligence (AI) into engineering and construction is now a reality, and is transforming the industry. As global trends shift toward smarter, efficient, and sustainable solutions, AI has become a pivotal technology driving innovation. From predictive analytics to automated processes, AI is revolutionizing project planning, execution, and delivery. This article explores AI's applications, benefits, challenges, and future potential in these sectors.



Applications of AI in Engineering and Construction

1. Predictive Analytics for Risk Mitigation: AI-powered tools process historical and real-time data to anticipate risks, delays, and budget overruns. Early identification allows stakeholders to take preventive actions, ensuring smoother project execution.

2. Generative Design and Optimization: AI-driven generative design tools enable engineers to explore numerous design possibilities based on specific parameters, fostering creativity and ensuring resource efficiency.

3. Automation of Repetitive Tasks: AI automates labour-intensive tasks, minimizing human error and boosting productivity. Autonomous drones, for example, can do topographical survey and also survey construction sites and track progress.

4. Improved Safety Measures: AI-powered sensors and cameras monitor construction sites in real-time, detecting hazardous conditions and alerting workers to potential dangers.

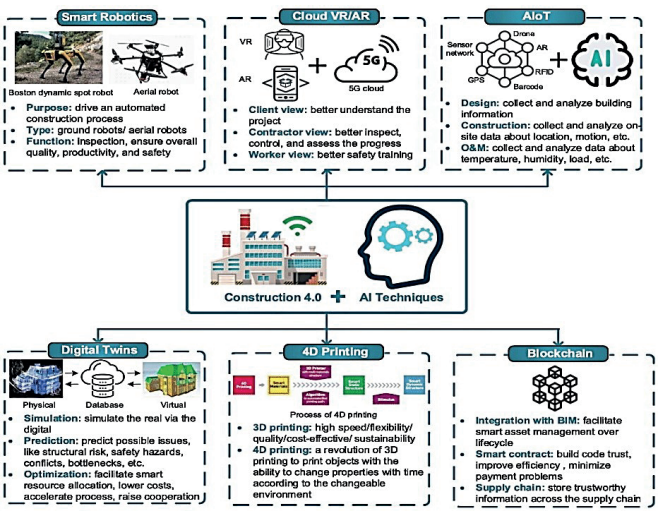
5. Resource Allocation and Scheduling: Machine learning algorithms optimize resource distribution

and project timelines by analysing historical data and predicting bottlenecks.

6. Quality Control and Defect Detection: AI-powered systems inspect materials and structures for defects, ensuring high-quality outcomes and reducing the risk of structural failures.

Benefits of AI in Engineering and Construction

1. Enhanced Efficiency and Precision: Simplifies workflows, reduces manual intervention, and improves accuracy, leading to faster project completion and superior results.
2. Cost Reduction: Minimizes errors, optimizes resource use, and prevents delays, significantly lowering project costs.
3. Sustainability: Enables energy-efficient designs and optimizes material usage, promoting greener construction practices.
4. Data-Driven Decision Making: AI provides actionable insights by analysing complex datasets, empowering stakeholders to make informed decisions.
5. Improved Collaboration: AI-powered platforms facilitate seamless communication among stakeholders, ensuring alignment and transparency.



6. Innovation and Competitive Advantage: Firms adopting AI gain a competitive edge by leveraging advanced technology to deliver superior results.

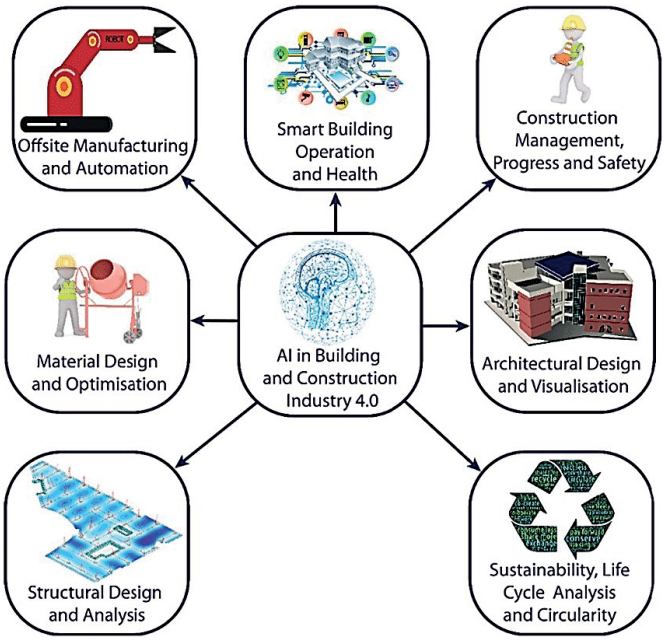
Challenges of AI in Engineering and Construction

1. High Initial Costs: Implementing AI requires significant upfront investment, which can be a barrier for smaller firms.
2. Skill Gap: The industry faces a shortage of professionals skilled in AI and data analytics, necessitating extensive training.
3. Data Privacy and Security Risks: Reliance on data-driven AI systems raises concerns about data privacy and cybersecurity.
4. Over-Reliance on Technology: Excessive dependence on automated systems can lead to complacency and a lack of human oversight.
5. Regulatory Uncertainties: Rapid AI adoption often outpaces regulatory frameworks, creating compliance and accountability uncertainties.
6. Resistance to Change: The traditionally conservative construction industry may take time for adopting AI since the workforce has to be reskilled and geared to adapt to the new requirements and mode of working.

Future Potential of AI in Engineering and Construction

The future of AI in this sector is promising, with possibilities including:

1. Increased Use of Autonomous Machinery: Self-driving construction vehicles and robotic systems which will reduce labour costs and improve efficiency.
2. AI-Driven Smart Cities: Enable better optimization of infrastructure, energy usage, and transportation systems in smart cities.



3. Integration with IoT and BIM: AI, IoT, and BIM convergence will enable better project execution and provide real-time project monitoring and management.
4. Advanced Sustainability Solutions: AI will help to drive net-zero buildings and circular construction practices.
5. Customized Construction Solutions: AI will enable tailored designs meeting specific needs and environmental conditions.
6. Enhanced Disaster Resilience: AI can help design structures which would be more resilient to natural disasters.
7. Global Collaboration and Remote Work: AI-powered platforms will facilitate global collaboration, opening new opportunities for international projects.

As Sophia Patel, Chief Innovation Officer at ConstructTech Solutions, stated, *"AI is transforming how we design, build, and optimize the future—driving efficiency, innovation, and sustainability in every corner of the built environment."*

Conclusion

AI integration in engineering and construction represents a significant industry shift. By enhancing efficiency, reducing costs, and promoting sustainability, AI sets new standards. However, addressing challenges like high costs, skill gaps, and regulatory uncertainties is crucial for successful implementation. The future potential of AI to transform the built environment is immense, and organizations embracing this technology will lead in shaping a smarter, safer, and more sustainable world.

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CEAI NEWS

CEAI GOVERNING COUNCIL 2025 -2026

The elections to the CEAI Governing Council (GC) for the years 2025 - 2026 were conducted and the results were declared on 26th December 2024 by the Returning officer.

President for the Term 2025-2026

During the first meeting of the Governing Council held on 10th January 2025 Mr Prashant Kapila, was elected as the President of CEAI for the term 2025-2026. He is the 14th President of CEAI.

Mr. Prashant Kapila is the Managing Director of Intercontinental Consultants and Technocrats Pvt. Ltd., a leading global engineering consultancy firm headquartered in New Delhi, India. With over 25 years of global experience in the industry, he has made significant strides with numerous consultancy assignments in over 50 countries.

He is a strategic and visionary leader, committed to driving business success through a focus on people, innovation, and execution. He is a member of the FIDIC Board, which further solidifies his outreach on the global engineering landscape.

He is deeply passionate about contributing to the growth of the Consulting Engineering Industry, particularly in developing economies where infrastructure needs are pressing. He is committed to embracing digitalization and creating a platform for knowledge-sharing, innovation, and best practices that will propel the industry forward.

Mr R S Sharma, Immediate Past President welcomed Mr Prashant Kapila as President for the term 2025-2026

Mr R S Sharma, Immediate Past President, Mr JVL Narayana, Immediate Past Vice President and Mr Prashant Kapila

Governing Council Members Elected for the term 2025-2026

CEAI Executive Council

The following GC members were elected by the new GC to the Executive Council for the years 2025-2026:

Vice Presidents

Mr. Alok Bhowmick

Mr. Somenath Ghosh

Secretary

Mr. Navneet Sharma

Treasurer

Mr. Ashish Rakheja

CEAI Committees

The following Committees have been Constituted for the year 2025-2026:

Presidents' Council	*Mr R S Sharma, Chairperson*
Operations Oversight Committee	*Mr Prashant Kapila, Chairperson*
Finance Committee	*Mr Ashish Rakheja, Chairperson*
Membership Committee	*Mr Navneet Sharma, Chairperson*
CEAI Academy	*Mr Alok Bhowmick, Chairperson*
CEAI Foundation	*Mr Somenath Ghosh, Chairperson*
Future Leader Forum	*Mr Aseem Rastogi, Chairperson*
Integrity Management Committee	*Ms Vandana Randhawa, Chairperson*
Seminar & Events Committee	*Mr JVL Narayana, Chairperson*
External Relation Committee	*Mr JVL Narayana, Chairperson*
Sustainable Development Committee	*Mr Ashish Rakheja, Chairperson*
Publication and Communication Committee	*Ms Sayona Philip, Chairperson*

CEAI Regional Centre & Chairpersons

Eastern & North Eastern Region	*Mr Anirban Datta, Chairperson*
Western Region	*Dr Harshavardhan Subbarao, Chairperson*
Northern Region	*Mr Tarun Rawat, Chairperson*
Southern Region	*Mr K Rajkumar, Chairperson*

CEAI National Awards 2024

The CEAI National Awards Ceremony was held on 10th January 2025 at the India International Centre, New Delhi.

Shri J Chandrashekhar Iyer, Former Chairman, Central Water Commission and Former Chairman National Dam Safety Authority was the Chief Guest at the function.

The Awardees were:

❖ Mr. Anal Naresh Shah	*Project Engineering (Individual)*
❖ M/s Balaji Railroad Systems Pvt Ltd	*Project Engineering*
❖ M/s WAPCOS Limited	*Project Engineering*
❖ M/s Tech Tangent Solutions Pvt Ltd	*Engineering Innovation*
❖ M/s Mott MacDonald Private Limited	*Engineering Innovation*
❖ Prof S S Chakraborty	*Life Time Achievement Award*
❖ Prof Mahesh Tandon	*Life Time Achievement Award*

The award winners delivered presentations on their award-winning projects.

Mr. Anal Naresh Shah receiving the Project Engineering (Individual) Award

Tech Tangent representatives receiving the Engineering Innovation Award

Balaji Rail Road representatives receiving the Project Engineering Award

Mott MacDonald representatives receiving the Engineering Innovation Award

WAPCOS representatives receiving the Project Engineering Award

Prof S S Chakraborty receiving the Life Time Achievement Award

Prof Mahesh Tandon receiving the Life Time Achievement Award

Mr R S Sharma, President welcoming members to the AGM Mr JVL Narayana, Vice President and Mr Navneet Sharma, Secretary on the dais with Mr. R S Sharma

CEAI Annual General Meeting

The 28th Annual General Meeting of CEAI was held on 10th January 2025 at 3:30 pm at the India International Centre, New Delhi.

Participants at the AGM

Governing Council & Secretariat Members

CEAI EVENTS IN THIS QUARTER

The report on the events will be available in the next issue of VIEWPOINT

Webinar on "Dam Safety"

CEAI organised a webinar on **"Dam Safety"** on 28th March 2025.

Mr J Chandrasekhar Iyer, Former Chairman, Central Water Commission was the Key Note speaker at this webinar.

Dam safety needs the immediate attention of the Government, decision makers, planners, engineers and academia involved in research and technological innovation. Keeping this in mind, CEAI organised this webinar to address state of the art technologies in dam safety engineering.

Focus on dam safety ensures dams are structurally sound and well managed to prevent failures that could endanger public safety, property, and the environment. This involves ongoing monitoring, inspections, and maintenance, as well as emergency preparedness plans

Conference on "Sustainability Concerns in Water and Sanitation, Clean Energy and Clean Environment" on 26th & 27th March 2025

Eastern & North Eastern Region in partnership with Indian Institute of Engineering Science and Technology, GAABESU-Global Alumni Association of IIEST, ADI Bhattacharyya Foundation, Vermont, USA organized a Conference on **"Sustainability Concerns in Water and Sanitation, Clean Energy and Clean Environment"** on 26th & 27th March 2025 at IIEST, Shibpur

CEAI Member News

Mr Gagan Anand, a CEAI Member, has been appointed as Vice Chair of the FIDIC Contracts Committee, Geneva.

Mr Chandrachudha Bhattacharyya, a CEAI Member, received the Star Civil Consultant of the Year Award from the Oriental Chamber of Commerce on February 19th, 2025.

Mr Ashish Rakheja, Treasurer-CEAI, has been nominated as the Treasurer of ASHRAE Global.

Prof Mainak Ghoshal, a CEAI Member, received the MSME Award in the category Outstanding Service Provider for Micro Enterprises from the BENGAL CHAMBER OF COMMERCE & INDUSTRY (BNCCI)

Col Naresh Bana, a CEAI Member, participated as Speaker and Panelist in Economic Times Infrastructure Summit 2025 at The Grand Hotel on 06 March 2025.

CEAI congratulates all its members on their remarkable achievements.

FIDIC NEWS

FIDIC Board Members visited New Delhi on 04 March 2025 enroute to the FIDIC Board Meeting which was to be held in Goa, India.

In New Delhi they met with NITI Aayog and had interactions with CEAI GC Members and MDBs and various Government/ Implementing Agencies.

Background

FIDIC Board Members are elected by Member Associations at the FIDIC General Assembly Meeting (GAM). They have several key responsibilities which include carrying out the resolutions of the general assembly, preparing an annual report, formulating and modifying by-laws and endorsing audited annual accounts for ratification by the general assembly, appointing members of FIDIC Standing Committees and Task Forces, approving their terms of reference, and monitoring their activities, etc.

The FIDIC Board also conducts strategic planning for FIDIC including the continuous assessment of developments affecting the consulting industry, the planning of actions to reposition FIDIC when required

plus reviewing and updating of the current strategic plan. The Board also periodically reviews and updates, or prepares, new policies where required.

Members of the FIDIC Board represent and play an important role in maintaining and enhancing the organization's image on the global stage. The Board also liaises with appropriate levels of officials of international organizations relevant to FIDIC's interests and conducts regular visits to Member Associations. The Board meets at least three times per year, once coinciding with the FIDIC Global Infrastructure Conference.

The FIDIC Board Members who visited India and participated in the CEAI Interaction session were:

Ms. Catherine Karakatsanis	President	Canada
Mr. Alfredo Ingletti	President Elect	Italy
Mr. James Mwangi	Vice President	Kenya
Ms. Chantal Dagnaud	Member	France
Ms. Martina Hess	Member	Zambia
Mr. Manish Kothari	Member	USA
Mr. José Joaquín Ortiz García	Member	Colombia
Mr. Adam Bialachowski	Member	Poland
Mr. Prashant Kapila	Member	India
Mr. Cosmin Tobolcea	Member	Romania
Ms. Helen Davidson,	Chair, DNS Advisory Council	Newzealand

Interaction with NITI Aayog

The FIDIC President, Ms. Catherine Karakatsanis accompanied by Mr Alfredo Ingletti (President-Elect), Mr Prashant Kapila (FIDIC Board Director from India and CEAI President), Mr J V L Narayana, Chair of Seminars & Events and External Relations Committee, CEAI and Mr Sachin Pant, MD&CEO of IQT IN Pvt Ltd and a CEAI Member met the following officials of NITI Aayog at their office in New Delhi:

- Dr V K Saraswat, Member NITI Aayog (Meeting Chair)
- Dr Vivek Kumar Singh, Sr. Advisor
- Dr Ashok Sonkusare, Dy Advisor
- Dr Thyagaraju, Dy. Advisor

The objective of the meeting was to introduce the FIDIC President and President Elect to the officials of NITI Aayog and provide them an insight into the broader activities of FIDIC and emphasise the need to adopt FIDIC Conditions of Contract in the domestically funded projects in India. The key points of the discussions were:

- Dr V K Saraswat welcomed the FIDIC representatives and thanked them for visiting to enlighten the officials of NITI Aayog on the wider activities of FIDIC.
- He mentioned that NITI Aayog works in the development of policy framework, employment generation, and sector level planning and noted the point on adopting FIDIC Conditions of Contract on domestically funded projects.
- He welcomed the role of FIDIC in training and capacity building and requested the FIDIC team to look into increasing training of engineers on design and contract management aspects given the increasing demand for infrastructure and 'Make in India' initiatives taken up by the Government of India.
- He emphasised the importance of Sustainable Development, Carbon Neutrality and Artificial

Intelligence aspects and requested the FIDIC team to provide assistance in technology development and technical know-how.

- Ms. Catherine Karakatsanis clarified to the NITI Aayog team that FIDIC is not a consulting firm but a global organisation that sets standards and guidelines for the consulting engineering and construction industry, particularly known for its suite of standard contract documents used in international construction projects.
- She emphasised that FIDIC strives to promote and execute the strategic goals of the consulting engineering industry, providing standard forms of contracts and resources for its members, and enhancing the image of consulting engineering globally.
- She informed that FIDIC works with Multilateral Development Banks (MDBs) like the World Bank, ADB, JICA, ADB and other international and domestic organisations to promote and execute the strategic goals of the consulting engineering industry, providing standard forms of contracts and resources for its members, and enhancing the image of consulting engineering globally.
- All Member Associations of FIDIC subscribe to and believe that the following principles are fundamental to the behaviour of their members if society is to have that necessary confidence in its advisors.
- Integrity is the key parameter for FIDIC and hence it acts at all times in the legitimate interest of the client and provides all services with integrity and faithfulness.
- Mr. Alfredo Ingletti added that FIDIC strives to create an impartial provision of professional advice, judgement, or decision, to make the implementing agencies aware of any potential conflict of interest that might arise in the performance of services to the client and not accept remuneration which prejudices independent judgement.
- Mr Prashant Kapila highlighted that FIDIC recognises that the work of the consulting engineering industry is critical to the achievement of sustainable development of society and the environment. He also requested Dr V K Saraswat to consider implementing FIDIC Conditions of Contract on domestic projects which would help in providing transparency, reduction of conflicts, cost overruns and time overruns etc.
- Mr Prashant Kapila informed that there is a need to use AI and use of digital/IT technology for efficient design and supervision of projects in the Indian context and requested NITI Aayog to consider implementing the latest technologies in the projects at the planning and policy stage.
- Mr Prashant Kapila explained the initiatives taken by CEAI in promoting FIDIC contract conditions and providing training to industry professionals through the CEAI Academy and enhancing ethical standards through its various initiatives.
- Mr JVL Narayana informed Dr V K Saraswat that with the help of FIDIC about 700 engineers were trained on the National High Speed Rail (Bullet Train) project in 2024 at the site. That gave the engineers a clear idea of how to implement a contract using the FIDIC Contract documents. That was welcomed by NITI Aayog Chair who requested CEAI to carry on such initiatives.
- The meeting ended on a note to exchange ideas that would help in policy formulation, enhancing training, improving the capacity of Indian engineers and working in collaboration on Sustainable Development, Carbon Neutrality and Artificial Intelligence aspects.

Interaction with CEAI Governing Council (GC) Members

Interaction of FIDIC Board Members with CEAI GC Members was held from 12 noon to 13:00 hours at Juniper Hall, India Habitat Centre, Lodhi Road, New Delhi. The session was attended by FIDIC Board Members and CEAI GC Members.

After the brief round of introductions, Mr. JVL Narayana invited Ms. Catherine Karakatsanis (President FIDIC) and Mr. Prashant Kapila to the dais. He extended a warm

welcome to the FIDIC Board Members and briefed them regarding CEAI's objectives, activities and initiatives taken as a Member Association (MA) of FIDIC.

Mr Prashant Kapila (FIDIC Board Member from India and President CEAI) in his address welcomed the FIDIC Board Members to India and detailed the activities carried out by CEAI and initiatives taken by him as the FIDIC Board Director of India. He emphasised the need to understand broader FIDIC activities and the role of FIDIC in sustainable development.

Ms Catherine Karakatsanis, in her address, thanked the CEAI President and the Executive Council team for welcoming them and arranging the interaction session. She gave a brief of the FIDIC activities and explained the roles and responsibilities of each member to the CEAI team and requested Mr Narayana to open the floor for an interaction session. The key takeaways from the interaction session are given below.

Mr Prashant Kapila, President CEAI welcoming the FIDIC Board Members and the participants

Ms Catherine Karakatsanis (Canada), President FIDIC giving her address

Suggestions by CEAI GC Members

- Members mentioned that they do endeavour to advocate the use of FIDIC Conditions of Contract to various Government agencies. However, while FIDIC Conditions of Contract are implemented in projects funded by MDBs, they are hardly used for government funded projects. The Members highlighted that more efforts need to be made to include FIDIC Conditions of Contract on Indian domestically funded projects. In that context, they appreciated the interaction with NITI Aayog.

- Members also felt that if the Central/ State/ Local Government implementing agencies were made more aware of the benefits of using FIDIC Conditions of Contract, which could result in controlling conflicts and disputes, improving transparency and preventing cost overruns and time overruns, the usage would increase tremendously.

- The Members suggested that it would be good to interact with representatives from other countries or MAs on similar issues encountered in their countries and how they addressed those issues. The FIDIC Board Member from Poland mentioned how they had a similar problem in Poland but after 30 years of advocacy, the Polish Government has accepted the use of FIDIC Conditions of Contract in all Government funded projects. It was agreed that interaction sessions with other MAs be planned to understand lessons learnt and adapt them to Indian conditions and vice versa.

- Members put forward their views to understand the initiatives taken by FIDIC in enforcing carbon neutral and climatic change initiatives through FIDIC Conditions of Contract. The FIDIC Board Members highlighted the initiatives taken by FIDIC on those issues and informed that a number of publications were available that could be made available to CEAI for their review and implementation.

- The FIDIC Board Members appreciated the enthusiasm shown by CEAI GC Members. They informed them that FIDIC strives to work with

various implementing agencies to address the issues faced by the consulting engineering fraternity and would request active participation by other MAs in the various initiatives taken up by CEAI.

- Ms Catherine assured support from FIDIC to CEAI and emphasised the role of CEAI in expanding FIDIC initiatives in India.

Interaction with representatives from Implementing Agencies and MDBs

Interaction of FIDIC Board Members with representatives from various implementing agencies and MDBs was held from 14:00 to 16:00 hrs. at Juniper Hall, India Habitat Centre, Lodhi Road, New Delhi.

The session was attended by around 100 participants including CEAI GC Members, representatives from the World Bank, Asian Development Bank and Exim Bank; representatives from Ministries and various Government organisations viz. Department of Expenditure, Delhi Metro Rail Corporation (DMRC), Engineers India Limited (EIL), NBCC (India) Ltd, National Capital Region Transport Corporation (NCRTC), National High Speed Rail Corporation Limited (NHSRCL), Dedicated Freight Corridor Corporation of India Limited (DFCCIL), RITES Limited, National Highways Authority of India (NHAI), Services Export Promotion Council (SEPC), Border Roads, member companies of CEAI, etc.

Mr JVL Narayana welcomed the participants, briefed the gathering on CEAI's activities and set the context for the discussions.

Mr Prashant Kapila welcomed the participants, elaborated on FIDIC activities and the role of FIDIC in sustainable development. He mentioned the golden principles of FIDIC and stated that the Indian consulting industry can reap benefits from FIDIC with its global reach and 650 volunteers working across the globe.

Ms Catherine Karakatsanis, in her address, introduced the FIDIC Board Members and gave a detailed presentation illustrating various activities carried out by FIDIC. Each of the FIDIC Members also presented their roles and responsibilities and the value addition they could bring to the table.

An interaction session followed and some of the key observations were:

- ADB Representative Mr Stephane Bessadi mentioned that ADB stresses using FIDIC Conditions of Contract on its projects and called for a collaborative approach from Clients, Consultants and Contractors in implementing projects. He mentioned that ADB takes initiatives in training Clients, Consultants and Contractors on FIDIC Contract conditions and welcomed FIDIC Board's initiatives. He also suggested that Fit for Purpose should be clearly reflected in the contract conditions.

- World Bank Representative Mr Shanker Lal emphasized the need for simplified versions of contracts and emphasised the need for a bonus clause in contracts for early completion. He also mentioned that the cost of FIDIC training be subsidised so that it gives a chance for wider usage in Indian conditions. Ms Catherine mentioned that getting training done through CEAI would make the costs more reasonable.

- Participants from NCRTC mentioned the need for limitation of liability clauses in the contract and requested clarification on some contract. One of the Board Members provided clarity to their satisfaction.

- Ex-Chairman of Central Water Commission emphasised the need for the use of FIDIC Conditions of Contract in projects funded by the Government of India for Water Resources and Dam Sector Projects as the projects are complex with cost and time overruns.

- The representative from NHSRCL, Mr Sunil Kumar, requested clarification on part time design, Clauses 12.2 and 17.6, etc. Clarifications were given by the FIDIC Board Members on those points. They also requested that detailed queries, if any, be sent for further clarification.

- The participants put forward a request to ensure that FIDIC documents are freely available to the Consultants, Clients, and Contractors at a reasonable price. Mr Prashant clarified that FIDIC documents are made available through CEAI, which FIDIC offers at subsidized rates.
- Participants requested the FIDIC Board Members to review and provide assistance in enhancing the capacity building and training needs of stakeholders in the industry.
- Ms Catherine in her closing remarks thanked the participants for their active participation, and suggested that they put in collective efforts on sustainable development and invited the participants to the Global FIDIC Conference to be held on 21st & 22nd September at Cape Town, South Africa.

The interactive session ended with actions to be carried out by CEAI based on the outcome of the above observations from various sessions

Mr Manish Kothari, Mr Alfredo Ingletti, Ms Hess

Mr James Mwangi, Kenya

Mr Jose Garcia, Colombia

Mr Alfredo Ingletti (Italy), President (Elect) and Ms Martina Hess (Zambia)


CEAI
Interactive Session
with
March 2025
Interactive Session
with
FIDIC
Board Members


RESERVED


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CEAI
Interactive Session
with
FIDIC Board Members
4th March 2025
Sponsored by

FIDIC Board Members and President CEAI

FIDIC Board Members and CEAI GC Members

Presidents CEAI and FIDIC, Ms Chantal Dagnaud, Mr Stephane Bessadi ADB

Mr Adam Bialachowski Poland

FORTHCOMING EVENTS

- CEAI Future Leaders Forum is organising a webinar on "**Post-disaster Rehabilitation & Reconstruction: Need of Integrated Management principles" on 4**th April 2025 at 4:00 pm.

  Ms Renjitha Nair, Contract Specialist, General Contracting and Trading Services Co. WLL will be the Speaker for the above webinar

  Registration Link is: https://us02web.zoom.us/meeting/register/X2zJwTVTQFCz3O-_tV6XQlA

- CEAI-WRC plans to organise a seminar on "**Parallel Flanged Sections and Tubular Sections"** in Ahmedabad in June 2025
- CEAI-WRC is organising a workshop on **"VR and AI in the Engineering & Construction Industry**" on 13-09-2025 in Mumbai
- CEAI-WRC is organising a workshop on "**Claims & Claim Management**" on 22-11-2025 in Mumbai

VIEWPOINT

The themes for the quarterly issues of CEAI's magazine ***"ViewPoint"*** for balance period of 2025-2026 are given below.

Month & Year	Theme
June 2025	Integrated Engineering of Projects – A Dire Need
September 2025	Contractually Addressing Uncertainties in Projects
December 2025	Asset Management for Sustaining Built Facilities
March 2026	Solid Waste Management and Need for Stricter Waste Management Policies
June 2026	Climate Change, Urban Flooding and Landslides
September 2026	Urban Rejuvenation – A Tech Enabled Approach
December 2026	Smart Cities or Smart Villages- Where Should India Invest More

A brief on INTEGRATED ENGINEERING OF PROJECTS – A DIRE NEED

A recent World Bank report notes that India will need to grow by 7.8 percent on average over the next 22 years to achieve the country's aspiration of reaching high-income status by 2047. It notes that India's fast pace of growth between 2000 and 2024 provides the foundation for its future ambitions.

To achieve this, the magnitude of investment required in infrastructure and industry would necessitate a more robust integrated approach in engineering for project implementation.

Doing this in a holistic manner would involve multiple engineering and project disciplines working in conjunction to enable the seamless merging of diverse subsystems to create a cohesive and harmonious whole. From concept to commissioning, the process requires careful planning, strategic decision-making, and effective coordination using digital tools.

A well integrated project would obviate the tampering of a recently built facility for adding on or modifying another facility, utility or service, creating infructuous expenditure and inconvenience to the facility users. The cost and time saved could be gainfully utilised elsewhere.

It is to draw attention to those and other technical aspects that CEAI planned the theme for the June 2025 issue as "Integrated Engineering of Projects – A Dire Need" and are inviting articles from members and readers for the same.

Articles could express one's thoughts on new ways of doing design, construction, renovation, maintenance, etc., adoption or development of new algorithms and technology for integrated engineering in all sectors.

Several consulting engineers and smaller organisations are engaged in such works. CEAI's VIEWPOINT provides an opportunity to all those engaged in such activities to share case studies of their achievements, how they addressed the challenges faced, practical issues experienced and provided innovative solutions. Photographs, charts, diagrams, drawings, etc. would provide readers a better appreciation of the issues encountered and how they were addressed.

Articles are also invited for the following for insertion in any of the issues of ViewPoint.

a) Safety

b) Ethics & Integrity,

c) Contractual Liabilities of Engineers, and

d) Discussion of BIS codes and standards. Writeups could be on:
   - i) Codes which need revision due to clauses which are not practically appliable.
   - ii) Codes which are held up for long time and are not getting released.
   - iii) Areas/ sectors where codes are required.

The articles for an issue need to reach CEAI at least 3 weeks prior to the end of the month of the ViewPoint issue. Articles need to be in Times New Roman 12 with single line spacing with before and after 6 pt and normal margin, on A4 size. A recent clear and bright passport size photograph of the author(s) is to be sent along with the article. For details of formatting please refer to *"Format for Articles for CEAI Viewpoint"* on CEAI's website, under *'Publications'*. The *'CEAI Conditions of Publication*' can also be seen on the website.

We urge all Professionals to use CEAI's ViewPoint to showcase the capabilities and achievements of the Engineers in India plus educate and guide new engineers.

Advertisement in ViewPoint

ViewPoint is circulated to all CEAI Members, FIDIC, Ministries of the Government of India, Public and Private Sector Undertakings, Construction Firms, Contractors, Consultants, Foreign Missions and Funding Institutions in India and other organisations related to or dealing with the engineering profession. Thus, all stakeholders partnering development and progress are its readers.

Support from CEAI members and stakeholders are sought for increasing the number of advertisements so that ViewPoint gains in its stature as a unique Technical Publication for the fraternity and the public at large to spread information about how Consulting Engineers are helping society for improving the quality of life and doing so sustainably. The rates for advertisements in ***VIEWPOINT*** are given below:

In response to queries from potential Sponsor Advertisers, a new category of Sponsor Advertisement has been included in ViewPoint.

1. VIEWPOINT ADVERTISEMENT:

	Rate Per issue* (INR)	Discounted rate at 10% for 2 consecutive issues* (INR)	Discounted rate at 20% for 4 consecutive issues* (INR)
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Notes: ****GST @ 5% or as prescribed will be added to the above rates.***

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ViewPoint Sponsor Advertisement per issue for "THEME SPECIFIC SOLUTION PROVIDERS/ EXPERTS**",** the Rate will be Rs. 35,000/- to cover the following:

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3. Descriptive article on topic

Tech Quiz

1. **Blind Search is used for which of the mentioned situations?**
   a. Advanced Game Theory
   b. Real-life Simulation
   c. Small Search Space
   d. None of the above

2. **Number of bits needed to code 256 operations is?**
   a. 4
   b. 8
   c. 6
   d. 16

3. **How many categories of processes is Artificial Intelligence classified into?**
   a. 2
   b. 5
   c. 3
   d. 4

4. **Which is the go to language for AI?**
   a. Lisp
   b. Python
   c. PHP
   d. Java

5. **Which is the most important component of AI?**
   a. Training
   b. Designing
   c. Learning
   d. Puzzling

6. **Who is the inventor of Artificial Intelligence?**
   a. Geoffrey Hinton
   b. Andrew Ng
   c. John McCarthy
   d. Jürgen Schmidhuber

7. **Which of the following is a branch of Artificial Intelligence?**
   a. Machine Learning
   b. Cyber forensics
   c. Full-Stack Developer
   d. Network Design

8. **How many types of informed search methods are in Artificial Intelligence?**
   a. 4
   b. 3
   c. 2
   d. 1

9. **What kind of surveying is done to determine additional details such as boundaries of fields?**
   a. City Survey
   b. Location Survey
   c. Cadastral Survey
   e. Topographic Survey

10. **The use of the Internet to connect a wide variety of devices, machines, and sensors to empower brick-and-mortar stores by giving them the same access to data that online stores have is a facility that falls under which of the following technologies?**
    a. Artificial Intelligence
    b. Deep Learning
    c. Machine Learning
    d. Internet of Things

The first person to email the correct answers to CEAI info@ceai.org.in will get a congratulatory mail and be acknowledged by publishing the person's photograph in the next issue.

Contributed by Neha Jain, TCE
Answers to Tech Quiz December 2024 issue
1. (c), 2. (b), 3. (b), 4. (d), 5. (e), 6. (a), 7. (e), 8. (c), 9. (e), 10. (a)

Take Off with INDIA

Join CEAI

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Over 60 YEARS of Service to the Profession

CEAI

- *promotes the interest and works to enhance the status of the Consulting Engineering profession in India*
- *advocates global networking and co-operation*
- *helps to keep in touch with the latest professional updates – technical, regulatory, legal, financial, health & safety, environmental, etc.*
- *provides excellent opportunity to present papers in seminars and technical lectures organised from time to time*
- *aids in skill development through regular training programmes including training on FIDIC Conditions of Contract and sharing of legal issues in the Indian context*
- *takes-up various issues confronting the profession with government and other authorities from time to time with the objective of making the conditions of engagement on a fair and equitable basis so that Consulting Engineers can function in the best interest of the country*
- *promotes the cause of Women Engineers with a view to ensure a rightful place for them in the engineering consultancy arena*
- *helps to develop Young Engineers to be the Future Leaders*

JOIN Now & Grow

CEAI Consulting Engineers Association of India

CONSULTING ENGINEERS ASSOCIATION OF INDIA

WE OFFER FIDIC TRAINING COURSES

- **Module I : Practical Use of FIDIC Conditions of Contract**
- **Module II : Management of Claims and Disputes Resolution**
- **Module IV : Contract Management and Administration**

The investment in infrastructure is growing and would continue to grow at an accelerated rate in the near and distant future across the Globe and especially in developing economy like India. The multilateral financial institutions are pouring in funds and want to be a part of the India growth story. These MDBs invariably use the FIDIC Conditions of Contract which are acclaimed as the Gold Standard of Conditions of Contract Globally.

The FIDIC Conditions of Contract are being used the world over where multi-lateral development banks provide the funding. And in large complex Government projects.

With a number of large and complex projects BOTH on-going and planned in the country, this training course will bring the participant the necessary detailed knowledge and insights as to the claim management and dispute resolution provisions under the FIDIC Conditions of Contract.

It covers the identification of project risks, their allocation, and the various causes of claim which can emerge over a construction contract and the way FIDIC addresses those. It details the way to handle claims – preparation, submission, assessment, determination under FIDIC Contracts, and how disputes are prevented or otherwise resolved.

Certificate

After completion of the training a Certificate will be distributed to the participants.

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Contact for further query

+91 9871166102

ceai.ceai@gmail.com

Consulting Engineers Association of India
CEAI Centre, OCF Plot No.2, Pocket 9
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www.ceai.org.in

TATA

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SUSTAINABLE SOLUTIONS

for a *Better Tomorrow!*

ABOUT US

Tata Consulting Engineers (TCE), founded in 1962, has delivered 12,000+ projects across 65+ countries, earning the title *"Engineers to the Nation."* Guided by its vision of Engineering a Better Tomorrow, TCE has shaped iconic projects and adapted to global challenges.

Operating on the Owner's Engineer and Project Consultant (OEPC) model, TCE offers comprehensive engineering solutions, from feasibility to operations, ensuring innovative and sustainable outcomes aligned with client goals.

SERVICES WE OFFER

DESIGN & ENGINEERING

Project Concept Development, Pre-feasibility & Feasibility Reports, Detailed Project Reports, Environmental Study Reports, System Studies, Basic Engineering, Frontend Engineering Design (FEED), OE Services, Detailed Engineering

SUSTAINABILITY SOLUTIONS

Clean and Renewable Energy, Green Infrastructure, Green Fuels and Chemicals, Green Steel & Cement, Energy Transition Technologies

DIGITAL & ADVANCED TECHNOLOGIES

Unified 3D Engineering, 4D, 5D Simulation, Building Information Management, Asset Digitisation & Asset Information Management, Industry 4.0 & Asset Performance Management, Product Engineering, Design and Analysis, Turnkey Machine Development

PROJECT MANAGEMENT & SAFETY

Project Management, Engineering & Constructability Review, Construction Management / Supervision, Program Management, Interface Management, Quality & Safety Audits, Outage & Opex Management, Procurement Management

SECTORS WE SERVE

POWER SECTOR

Nuclear, Hydroelectric, Renewable, Thermal, Transmission & Distribution

HYDROCARBONS & CHEMICALS SECTOR

Green & Sustainable Chemicals, Chemicals & Speciality Chemicals, Refineries & Petrochemicals, Agrochemicals & Fertilisers

MINING & METALLURGY SECTOR

Ferrous Metals, Non-Ferrous Metals, Mineral Beneficiation

INFRASTRUCTURE SECTOR

Water, Built Environment, Transportation, Environmental Engineering, Sustainable Infrastructure

TO KNOW MORE

Visit www.tce.co.in or send an email to tceconnect@tce.co.in

FIDIC PUBLICATIONS

1	FIDIC Contracts Guide (2nd Ed. 2022)
2	EPC Turnkey Contract 2nd Ed 2017 Silver Book Reprinted 2022 with amendments
3	Construction Contract 2nd Ed 2017 Red Book, Reprinted 2022 with amendments
4	Plant & Design Build Contract 2nd Ed 2017 Yellow Book, Reprinted 2022 with amendments
5	The Short Form of Contract (2nd Edition, 2021)
6	Conditions of Contract for EPC Turnkey Projects (First Edition, 1999)
7	EPC/Turnkey Contract 2nd Ed (2017 Silver Book)
8	Conditions of Contract for Construction (First Ed. 1999)
9	Construction Contract 2nd Ed (2017 Red Book)
10	Conditions of Contract for Plant & Design-Build (First Ed, 1999)
11	Plant and design-build contract 2nd Ed (2017 Yellow book)
12	Dredgers Contract 2nd Ed (2016 Blue-Green Book)
13	Client/Consultant Model Services Agreement 5th Ed (2017 White Book)
14	GUIDE to Conditions of Contract for Design, Build and Operate Projects (2008 GOLD BOOK) 1st Ed 2011
15	Conditions of Contract for Works of Civil Engineering Construction (4th Ed. 1987 Reprinted 2011)
16	Conditions of Contract for Design-Build and Turnkey First Edition 1995 Reprinted 2011
17	Conditions of Contract for Underground works (2019 Emerald Book)

Please contact CEAI Secretariat for availability and price.


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