JUNE 2025

VIEWPOINT

OFFICIAL QUARTERLY MAGAZINE OF CEAI

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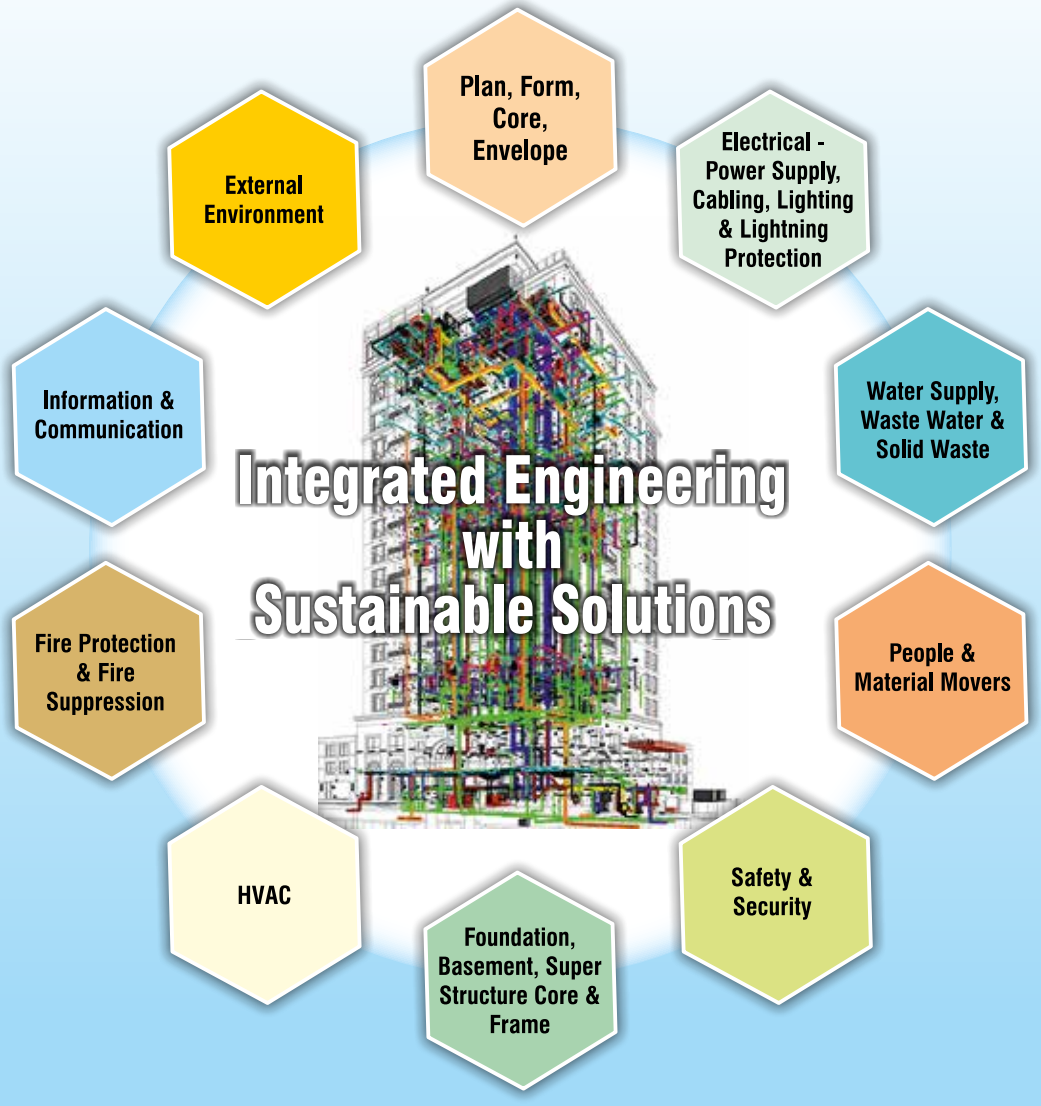
Integrated Engineering of Projects - A Dire Need



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CONTENTS

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- *promotes the interest and works to enhance the status of the Consulting Engineering profession in India*
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- *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*

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Message from Chief Editor

Dear Fellow Engineers and Readers,

The responsibility for anything built or developed in the world begins and concludes with the many professionals involved, mostly engineers, from concept to commissioning; for asset management during its design service life; and later for its demolition or strengthening or repurposing.

The superior quality of an engineered product or structure or infrastructure is ultimately decided by its attributes of safety, strength, robustness, utility, and longevity. Any shortfall or deficient input can impact the quality of the output adversely.

The geotechnical, geological, hydro-geological, seismic, environmental, and other pre-project studies play a crucial part in engineering. Studies, if wrongly or inadequately done, could result in weak foundations, incorrect load computations leading to weak structures not fit for the service intended, misaligned underground tunnels leading to asymmetric deformations and extraneous stresses, or just improperly fitted services. These could result in inefficiencies and failures of varying degrees, sometimes catastrophic with loss of life and limb, in addition to a destructed asset.

Engineering a facility or structure involves establishing the feasibility of a scheme or project, understanding the requirements, defining the scope, and planning for its resources, both man and material. An engineering project, especially a complex one, receives inputs from experts of various disciplines in a coordinated manner as per defined timelines and schedules.

This in simple terms means Integrated Engineering, which involves bringing together different professional disciplines such as town planning, architectural, geotechnical, structural, and the multifarious systems - mechanical, electrical, instrumentation, communication, environmental, etc., within each facility to conceptualise, plan, design and produce deliverables in the form of text and drawings to convey to the contracting firm what has to be built.

When working with subject matter experts of multiple disciplines, it is not unusual to encounter issues of siloisation, of specialist groups who perceive their own role to be of the utmost consequence, resulting in poor communication, and flawed coordination, hindering efficient functioning and producing subpar outputs. There is no surer path to project failure. Or at the very least, at a more basic level, time and cost overruns due to repetitive repair or rework.

A careful study of successful projects and those that have not been so has led the professional fraternity to conclude that Integrated Engineering of design and execution is imperative, especially for large, complex, multi-disciplinary projects.

Considering the importance of Integrated Engineering, CEAI has chosen the theme of ‘Integrated Engineering of Projects – a Dire Need’ for this quarter’s issue of VIEWPOINT so that professionals could benefit, with contributions from an eclectic mix of Experts across sectors who have chipped in with their experiences and appreciation of the dire need for Integrated Engineering.

Happy Reading and learning!

Sayona Philip

CEAI Consulting Engineers Association of India

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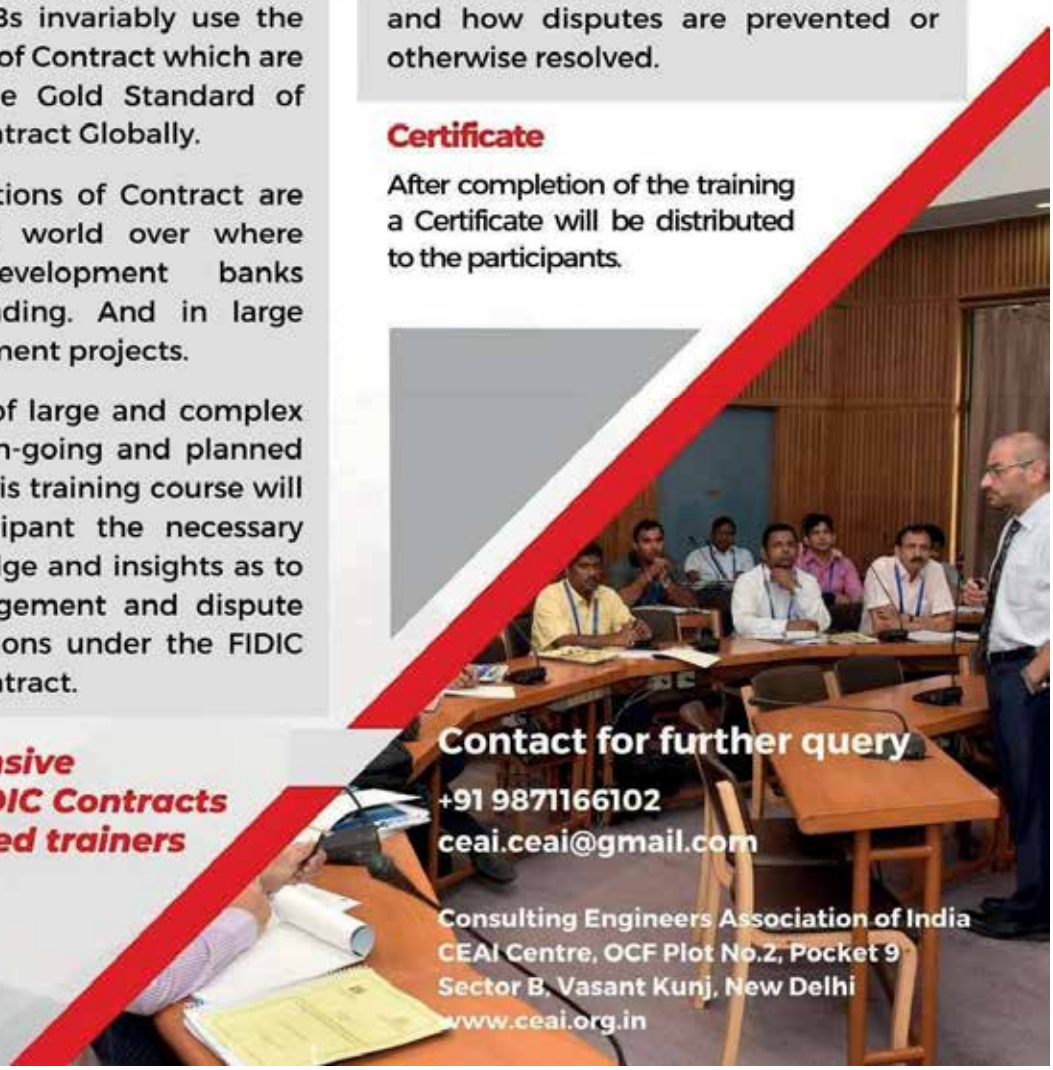

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01

Integrated and Coordinated Development of Projects Through Professional Synergy

V Suresh, FIE, FRICS, FACCE, HoF-IGBC
Chairman, IGBC Policy and Advocacy
Chairman, BIS Committee on National Building Code of India
President Emeritus, FOCUS
Former CMD, HUDCO

Introduction

To provide a safe, healthy, and sustainable habitat, careful consideration needs to be given to the building construction activity. Building planning, designing, and construction activities have developed over the centuries. They have increasingly shifted from traditional local and vernacular practices to technological transformation, keeping in view the size, scale, and scope of the built environment. Those perforce demand high levels of inputs from professionals of different disciplines such as architecture, civil engineering, structural engineering, functional and life safety services including special aspects relating to critical utility services - HVAC, plumbing, electrical, communication, landscaping, etc. for conceptualization, spatial planning, design and construction of buildings using various material and technology streams, various services including operation, maintenance, repairs and rehabilitation aspects throughout the service life of the building.

The built environment sector now absorbs traditional practices while adopting the latest developments in knowledge for the disciplines relevant to a building, which inter alia include computer-aided working, and sensor-aided activities in the various stages of conceptualization, planning, designing, constructing, maintaining and repairing of the buildings. That would cover multi-faceted requirements for climatic zones, to meet the requirements of different regions of the country, both urban and rural, by taking into consideration factors such as climatic and environmental conditions, geographical terrain, vulnerability to natural disasters, ecologically appropriate practices, use of eco-friendly materials, use of appropriate conventional and alternative technologies, reduction of pollution, protection and improvement of local environment and also socio-economic considerations, towards the creation of sustainable human settlements.

Interestingly, these are being looked after by multi-disciplinary professional teams through a well-coordinated and **integrated approach** for utilizing appropriate knowledge and experience of qualified professionals, right from conceptualization through construction and completion stages of a building project and indeed during the entire life cycle of the facility. The **'integrated approach'** takes care of not only the functional, aesthetic, and safety aspects, but also the operational and maintenance requirements. Besides, value engineering and appropriate management techniques can be more easily applied to achieve the aim set forth for construction of a building fully meeting the specified and implied needs of spatial functions, user requirements, structural safety and durability aspects, health safety, fire safety, public

safety, electrical safety, environmental safety and life safety and more importantly leading to sustainable development.

The 'integrated approach' provides the maximum benefit for the building and its services in terms of objectives such as quality, timeliness and cost-effectiveness. In the team approach which is an essential pre-requisite for integrated approach, the aim is to maximize the efficiency of the total system through appropriate optimization of each of its sub-systems, and ensuring coordination among various disciplines and agencies that are involved during planning, design, construction, operation and maintenance of buildings and the associated infrastructure. It is imperative to have timely inputs from each of the professional disciplines to be optimized so that the total system's efficiency is maximized. Avoidance of wastage, clash between inputs leading to rework from various groups are important facets that would be appreciated during the construction and installation management stages. During those stages, there is a need for absolute *tal-mel.*

With digitalisation of construction and management, use of Building Information Modelling (BIM) is increasingly found to be relevant and its benefits appreciated, especially with integrated professional inputs from various disciplines and well-set time lines and sequences for action.

Integrated Team Approach

A land development/ building project and the built facility during its service life involve the following major stages:

a. Location/ Siting,
b. Conceptualization and Planning,
c. Designing and Detailing,
d. Construction/ Execution,
e. Operation and Maintenance, and
f. Decommissioning and Deconstruction/ Dismantling/ Demolishing OR Modifying for using the facility for a different purpose.

Each stage necessarily requires professionals from many disciplines who need to work together as a well-coordinated team to achieve the desired product delivery with quality, safety and other objectives, in an effective manner.

Appropriate multi-disciplinary teams need to be constituted to successfully meet the requirements of different stages. Each team may comprise need-based professionals depending upon the nature, magnitude and complexity of the project:

a. Town Planner
b. Architect
c. Civil Engineer
d. Structural Engineer
e. Geotechnical Engineer
f. Geologist and Hydro-Geologist
g. Electrical Engineer
h. Lighting Specialist
i. Plumbing Engineer
j. Fire Protection Engineer
k. Mechanical and Heating, Ventilation and Air Conditioning Engineers (HVAC)
l. Lift, Escalator and Moving Walk Specialist
m. Acoustics Specialist
n. Information/ Communication Technology Engineer
o. Health, Safety and Environment Specialist
p. Environment/ Sustainability and Green Building Specialist
q. Urban Designer
r. Horticulture and Landscape Professional
s. Security and Surveillance Systems Specialist
t. Interior Designer
u. Quantity Surveyor
v. Project Manager
w. Construction Manager
x. Accessibility and Universal Design Specialist
y. Project Planning & Monitoring
z. BIM & Digital Twin Specialists

Apart from these, other specialist professionals may also be required depending on the purpose and usage of an area or building or even a part of those.

Post completion and commissioning, the operation and maintenance team (O&M) would step in to ensure that the building performs as intended on all functional and service facets.

The right level of the O & M team and the Assets & Facility (A & F)/ Estate Management team take over a project on completion. In large projects, it is desirable to associate the basic A & F management team along with the professional team, as above, from preliminary stages during the design and construction stages as well.

Depending on the size and complexity of the project, the professionals are selected considering their qualification, experience, and expertise in the relevant field and their ability to work together in a coordinated and integrated manner.

That is a very significant requirement. The National Building Code of India (NBC) covers in detail the professional qualifications, experience, and competence level to deal *with various services for the stages of the evolution process of the built environment.*

Design Team

In building projects, various aspects like form; space planning; aesthetics; fire and life safety; structural adequacy; plumbing services; lighting and natural ventilation; electrical and allied installations; air conditioning, heating and mechanical ventilation; acoustics, sound insulation and noise control; installation of lifts and escalators; building automation; data and voice communication; other utility services installations; landscape planning, design and development; urban planning; etc. need to be kept in view right at the concept stage. The project requiring such multi-disciplinary inputs needs a coordinated approach among the professionals for the proper integration of various design inputs. For this, and to take care of the complexities of multi-disciplinary requirements, a design team of professionals from the required disciplines should be constituted at the appropriate stage.

For a project, the multi-disciplinary integration should be initiated right from the concept stage, and that team should finalize the plan. The composition of the team would of course, depend on the nature, magnitude, and complexity of the project.

Planning and design being an evolutionary and participatory process, the participation of the owner is crucial to spell out the requirements at all stages, so that the same can be ensured by the design team.

To ensure proper implementation of the design, the design team needs to be associated during the construction/ execution stage to periodically explain the requirements and to check that what is being built is what was intended.

Project Management and Construction Management Teams

The objective of Project Management or Construction Management is primarily to achieve the accomplishment of a project in accordance with the designs and specifications in a stipulated time and cost framework, to the specified quality, etc., with a degree of assurance prior to commencement and satisfaction on completion and commissioning.

While the teams at the project site would vary depending on the project scale, size, and complexity, the key requirements are to execute the project with engineering acumen in time while exercising cost control and ensuring all quality concerns and safety protocols.

For large projects, separate teams of experienced professionals from the required disciplines may be constituted for project management (including planning and scheduling) and for construction management, depending upon the complexities of the project.

The **Construction Management teams** should have *Inspection, Quality Assurance, Testing and Handover specialists* for construction/ installation works related to structural, non-structural, finishing, building and plumbing services.

Operation and Maintenance/ Assets and Facility/ Estate Management Team

Operation, maintenance and repairs also require a multi-disciplinary approach to ensure that all the requirements of the users are satisfactorily met. The Assets and Facility Management team or the Estate Management team, also must have inter-disciplinary coordination so that the maintenance, etc. is done in a manner which would cause the least inconvenience to the users but at the same time ensure that there is no mismatch or damage to the structure, finishing, fittings and fixtures, and to preserve the integrity of other critical services. Performance Assurance of all services with 24/7 schedules is a must for internal and external infrastructure.

Periodical inspections and audits are necessary and essential for the Structural, Mechanical, Plumbing, Fire, Electrical, Safety, Security, and Surveillance systems and decide the measures to be adopted and executed to ensure their proper functioning. Other systems, though not as critical, also need to be periodically audited.

Special repairs, rehabilitation and retrofitting are specialized jobs that demand complete knowledge of the existing structure/ installations. That is where the BIM and the Digital Twin are a big boon.

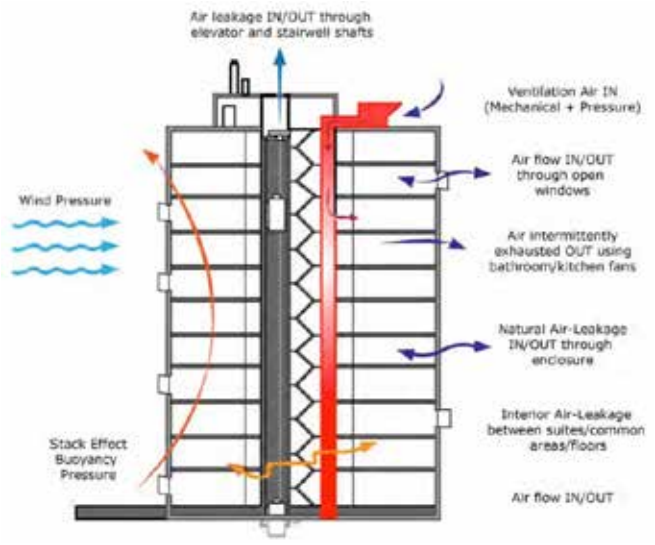

Figure-1: Natural Air-Flow in a Building
(Source: https://archi-monarch.com/what-is-building-services-in-tall-building/*)*

Design Team

The main functions of the design team constituted for the project are planning, designing and development as under:

a. Formalization of the design brief in consultation with the owner.
b. Site survey, geotechnical and geological investigations.
c. Preparation of alternative concept designs, highlighting their pros and cons.
d. Selection of a concept in consultation with and with the consent of the owner.
e. Sizing the system.
f. Development of design, involving:
g. integration of architecture, structure, and services,
h. synthesizing the requirements of each discipline, and
i. interaction with one another within the design team, plus the prospective vendors and contractors, and the owner.
j. Preparation of preliminary designs and drawings and obtaining the owners' approval.
k. Preparation of preliminary cost estimates for approval of the owner.
l. Preparation of work-breakdown structure and programme for pre-construction activities.
m. Assisting the client to obtain approvals of the Authority/ Authorities.
n. Preparation of detailed specifications and construction/ fabrication working drawings with integration of inputs of all concerned disciplines.
o. Preparation of detailed design of each discipline for various services.
p. Peer review/ Proof checking of the designs and drawings in case of major/ important projects, depending upon their complexity and sensitivity.
q. Preparation of detailed cost estimate.
r. Obtaining final approval from the client.
s. Preparation of bill of quantities, specifications, and tender documents.
t. Visiting the work site, vendors workshop, etc. and exercising checks, witnessing tests, etc.
u. An unwritten job of the design team, but an essential

one, is to help the contractors and vendors develop and improve the standard of their work, plant and equipment. That way the industry grows and so does the nation.

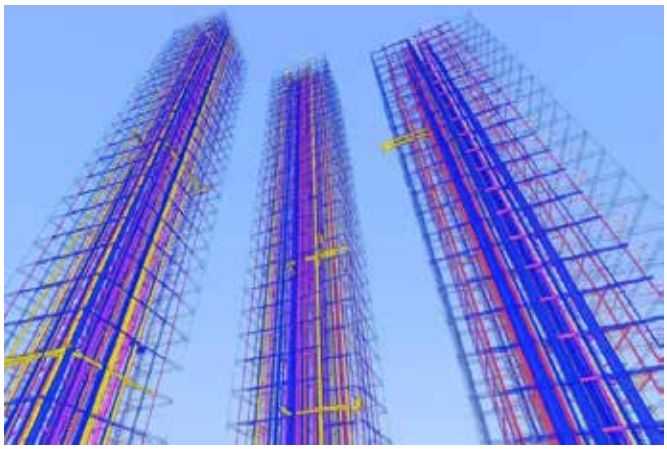

Figure-2: MEP Services in High-Rise Buildings
*(Source:*https://www.rdaep.com/blogs/mep-system-in-skyscraper/*)*

The design phase is an important one where there must be very close integration with inputs from all design professionals in a coordinated and integrated manner. The concept design to architectural spatial design in a three-dimensional mode must be supported with the structural design systems linked with geoclimatic, geological, and topographical features, which will emerge with inputs from architects, civil engineers, geo-technical engineers, structural engineers and those from all the services.

The most important aspects of building services with right design inputs for Lighting, Ventilation, HVAC systems, Vertical and horizontal transportation [including lifts, escalators and moving walks],

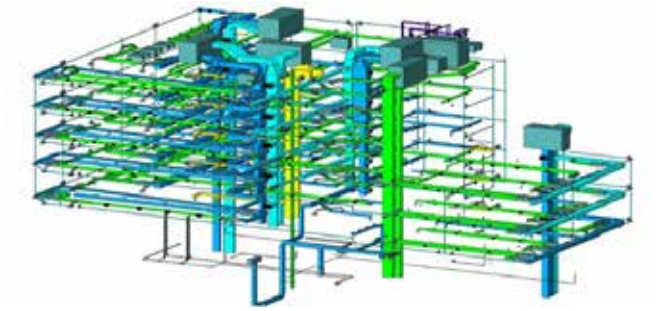

Figure-3 Complexity of Services in a Tall Building
(Source: https://www.bimservicesindia.com/blog/how-mep-services-with-bim-creates-an-efficient-building/

Information and Communications Technology **(**ICT) systems and Electrical installations needed for the same will come from Mechanical, Electrical, Plumbing, Fire & Communication (MEPFC) specialists' teams. The space planning and structural support teams must coordinate with the needs of the Building Services team.

Equally important are the Fire Protection Engineering [Fire and Life Safety] inputs, depending on the complexity of buildings.

For proper performance of the buildings, the Plumbing services teams must be brought in for water supply, sanitation, storm water drainage, solid waste management and gas supply needs.

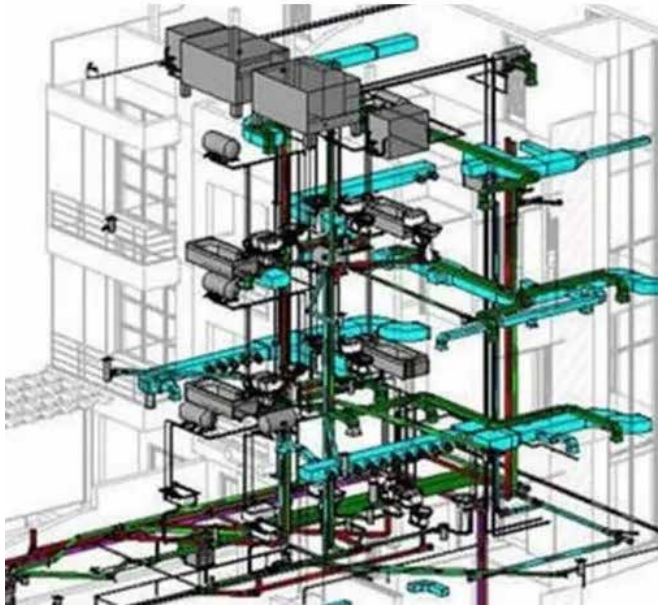

Figure-4: View of Plumbing Services
(Source: https://gdiengdesign.com/rising-to-the-challenge-designing-mep-systems-for-high-rise-buildings/ *)*

The most important inputs needed for the construction team at project site are the well-coordinated and integrated architectural, structural, MEPFC services drawings with all details as "Good For Construction/ Installation" drawings with no clashes and fouling in the three dimensional spaces into which all the structural, non-structural, services and finishing items must be built and provided.

Integration and Coordination of Cross-Cutting Requirements

There are many issues in building design that have cross-functional requirements to be complied with as follows:

a. *Structural Safety and Fire Safety:* The design of various members, like columns, beams, and slabs are done with the right focus on structural sufficiency and integrity as per Part 6 Section 5. Buildings can be of differing types of construction [Type 1 to 4] from a fire protection point of view under Part 4 on Fire and Life Safety. Hence, NBC sections dealing with Structural Concrete require additional minimum dimensions of RCC members for fire resistance and increased cover for specified fire resistance and fire protection. Similarly, in Structural Steel construction, additional fire resistance requirements are prescribed for three-sided fire exposure conditions and web penetration situations.

b. *Electrical Safety and Fire Safety:* There are many requirements regarding Fire Safety in Part 8 Section 2 for Electrical Installations, like Cable types, including FR, FR-LSH, Metal Sheathed and circuit integrity. Besides, if the MV/ LV Switch room is in a place other than in Substation, then extra precautions would be necessary.

c. *Mechanical Engineering for HVAC and Fire Safety:* The spread of fire in the case of HVAC systems is a matter of concern. Hence, ductwork design, provision of dampers and fusible links become important where both professionals need to take care. Hospital buildings and healthcare facilities are yet another area where the requirements are critical and to be implemented with zero tolerance for variation due to the state of patients in weak health conditions. It is seen that quite often, accidents in hospitals with fire conflagration and smoke generation create problems for evacuation. Correct designs of the ventilation systems and the smoke control systems are critical requirements. Underground services facilities and parking in basements need special additions for their ventilation system.

d. *Lifts and Escalators and Fire Safety:* Requirement of Fireman's Lift, at least one per building and one in each bank of lifts requires close coordination between the professionals of both systems. With taller buildings being built in a big way, Fire Evacuation Lifts will soon become a necessity for very tall buildings. The fire protection needs for the lifts and the lift shafts need special attention for smoke venting, and other compartmentation needs around lift lobbies are also to be provided.

e. *ICT and Telecommunication Facilities:* Information highway in buildings is the new imperative need for all modern buildings. The conduits, slots, sleeves, and ducts play an important role in ensuring the smooth functioning of ICT systems in all conditions. The wires and cables must be routed and laid to run through pipes/ ducts, which can continue to remain isolated and safe in times of fire with fire barriers at wall and slab junctions.

f. *Environment Engineer/ Public Health Engineer and Fire Protection Consultants:* Assured water supply availability for firefighting purposes through separate storage or downcomers is very critical. The wet and dry risers with downcomers, automatic sprinkler systems for many sensitive locations, play an important role. For the electrical equipment areas, the systems would be different. In any case, buildings beyond certain heights will need inbuilt fire protection and suppression systems. With increasingly large piped gas supply installations in buildings, the precautionary and protective systems must be considered right from the design stage, especially the entry pipelines from city/ service utility lines.

g. *Assets and Facility/ Estate Management Team and Building and Plumbing Services Teams:* This is a crucial facet that needs coordinated and integrated attention of all professionals dealing with the critical utility services and the Assets and Facility Management teams for ensuring 24/7 performance of all facilities and services. BIM and Digital Twins with completed documentation/drawings of all completed works and good BMS systems and

control rooms are also necessary, as they will help enhance the working performance and provide a greater degree of reliability and dependability.

h. *Structural Glazing Envelopes and Safety Concerns:* This has become a crucial area where joint action is needed for buildings with structural glazing envelopes for smoke control. Periodic maintenance schedule needs to be drawn up and followed. Here also, professionals from different areas would have to work in unison.

Figure-5: Fire Safety for Buildings
(Source: https://www.linkedin.com/pulse/7-layers-fire-safety-required-modern-buildings-al-emran-hossain-nkfvc/ *)*

Sustainable Development and Climate Change Interventions

Future development of buildings and the built environment must necessarily be in consonance with the Sustainable Development Goals 2030, as well as the Climate Change Net Zero Carbon goals by 2050/ 2070. Considering the Global and the National Building Code of India (NBC)/ Energy Conservation and Sustainable Building Code (ECSBC) needs as well as the revised building regulatory framework, increasing levels of Green Building certification is already taking place in a phased manner. Use of low-carbon emission-based building material products and services with the least embodied energy will be a challenging need in the years to come. Net Zero Energy, Net Zero Water, Net Zero Waste and Net Zero Carbon are already in vogue in developing countries and India is also catching up. Hence, Sustainability and Green Building Professionals must work very closely with the building professional teams right from the planning and design stages.

Construction and Execution

The main functions of the teams constituted for Project Management/ Construction Management are:

a. Specify criteria for selection of constructors and the plant & equipment vendors;

b. Specify quality control, quality audit system and safety system;

c. Short-list constructors;

d. Have pre-bid meetings with the intending constructors;

e. Receive and evaluate tenders;

f. Select the constructors and the plant & equipment vendors;

g. Execution and supervision;

h. Monitor for quality, time, cost control and other project management functions;

i. Prepare/ certify the completion (as-built) drawings;

j. Assist in getting statutory approvals at various stages; and

k. Ensure availability of operation manuals for field use.

Apart from the specific provisions laid down in the National Building Code of India and project specification, the following considerations, as may apply to the project concerned, should be given due attention:

a. Adopting scientific principles of construction project management, including quality, cost, time, and safety management.

b. Engagement of executing and supervising agencies, which meet the specified norms of skills, specialization, experience, resourcefulness, etc., for the work. That could be composite or component contracts depending on capabilities

c. Ensuring inter-disciplinary coordination during construction.

d. Contract management and techno-legal aspects.

e. Completion, erection, commissioning and trial run of installations/ equipment and their operation and maintenance through the suppliers/ other teams, where necessary.

f. Make available shop drawings as well as as-built drawings for the building and services.

g. Arrange for maintenance and operation manuals from the concerned suppliers/ manufacturers.

Operation and Maintenance of Assets and Facilities/ Estate Management

It is the work of a specialised Operation & Maintenance (O & M) Team or Assets and Facility Management or Estate Management Team.

This aspect has gained importance lately for recording and maintaining constant assessment of the quality of the performance of the buildings and all its facilities and services. Periodic validation of the facilities is to be done by competent professionals through inspection in respect of the safety of the structure, electrical and other installations, and ensuring that all fire safety equipment/ systems are in proper working condition. That would cover periodic audits for various functional aspects, including proposals for repair, renewal, retrofitting, and replacement as the need may be over the life cycle of the built environment.

With sustainable development practices and adopting green building ratings, increasingly in place, the teams will have to deal with integrated energy management, water and wastewater management, solid waste management and other sustainability parameters too. The Building Management Systems, with constant monitoring and actions, give a good idea of the building performance. Specialist Engineering teams are there to deal with the same.

With effects of Climate Change being evident globally and affecting all parts of the world which is witnessing increasing recurrence of natural calamities from heavy and intense rainfall, cyclones, floods, earthquakes, landslides, glacial movement, and fires, it is imperative to have building monitoring from a structural integrity point of view and remedial measures to be taken in the right time.

After the design service life of a building is over, or for other reasons such as redevelopment and proposed change in use of the land and built facility, it may be required to deconstruct a building. Such a deconstruction is preceded by an organized decommissioning. The decommissioning and deconstruction need to be well planned and coordinated among concerned building professionals so as to ensure safety during such operations, as well as retrieval of appropriate products, components, and systems, for their possible reuse or recycling, or disposal as may be appropriate. That may, in turn, require a comprehensive decommissioning and deconstruction (including demolition) plan, which may be prepared during the initial stages of the project and kept available for use at the end of the life cycle of the same.

Role of Building Information Modelling in the Life Cycle of a Built Environment

BIM would enable integrated workflows, digital collaboration, and lifecycle intelligence across planning, design, construction, and facility management. With the convergence of Internet of Things (IoT), Artificial Intelligence (AI)/ Machine Learning (ML), Blockchain, Artificial Reality (AR)/ Virtual Reality (VR)/ Extended Reality (XR), Reality Capture, and Design for Manufacture and Assembly (DfMA), BIM provides a comprehensive digital ecosystem. The key stakeholders are - planners, architects, civil engineers, geotechnical engineers, structural engineers, MEPFC and services specialists, contractors, suppliers, technologists, and facility managers. They all play pivotal roles in implementing the BIM-driven use cases at every stage.

Planning Stage

At the Planning stage, data-driven decision-making, compliance checks, and stakeholder engagement are involved. The Planning Stage related functions, the Stakeholders and the Digital Platform/ Software that could be used are listed in Table-1.

Table-1: Planning Stage related Functions, Stakeholders and Digital Platforms/ Software

Sr. No.	Planning Stage Related Functions	Stakeholders	Digital Platform/ Software
1	Site suitability, zoning compliance, infrastructure mapping	Urban Planners, GIS Experts	GeoBIM
2	Interoperable data exchange across disciplines	Project Managers, Digital Consultants	Open BIM
3	Feasibility Studies: Cost-benefit simulations, Lifecycle impact analysis	Urban Planners, Economists	AI/ML
4	Immersive visualisation of proposals for Stakeholder engagement	Client bodies, Design Consultants	AR/ VR/ XR
5	Regulatory validation	Authorities, Code Consultants	Model - based compliance with planning norms

Design Stage

The Design Stage necessitates intense and extensive coordination, integration, sustainability analysis, and performance simulation to provide drawings and data for construction. The Design Stage related functions, the Stakeholders, and the Digital Platform/ Software that could be used are listed in Table-2:

Table-2: Design Stage related Functions, the Stakeholders and the Digital Platform/ Software

Sr. No.	Design Stage Related Functions	Stakeholders	Digital Platform/ Software
1	Design authoring and clash detection	Architects, Structural & MEPFC engineers, BIM coordinators	BIM & Digital Twin
2	Energy modelling, daylighting, carbon footprint analysis	Sustainability Consultants	Green BIM
3	Optimising design workflows and eliminating non-value-adding elements	Design managers	Lean BIM
4	Model-based inputs for modular/offsite production	Design Engineers, Manufacturers	DfMA/ Prefabrication input
5	To ensure transparent approval history and data security	Legal, Project Controls	Blockchain for design traceability

Construction Stage

During the Construction stage, the teams can use the digital platforms for sequencing, procurement, safety, and on-site integration using digital tools.

The Construction-related functions, the Stakeholders, and the Digital Platform/ Software that could be used are listed in Table-3.

Table-3: Construction Stage related Functions, the Stakeholders and the Digital Platform/ Software

Sr. No.	Construction-related Functions	Stakeholders	Digital Platform/ Software
1	Schedule and cost integration for construction planning	Contractors, Planners, QS Teams	4D/ 5D BIM
2	Reality capture for Progress validation	Site Engineers, Surveyors	Drone photogrammetry and LiDAR
3	Worker Safety, Equipment tracking	Health & Safety officers, Equipment vendors	IoT for site monitoring
4	3D printing integration	Product engineers, Fabricators	BIM model drives the automated printing of components
5	Just-in-time delivery and material flow optimization	Procurement teams, Suppliers	Procurement/ logistics planning
6	Visual verification and guidance using BIM overlays	Field engineers, QA/ QC teams	AR/MR/XR for on-site installation
7	Risk and safety assessment	Safety consultants, Risk managers	Model-based hazard detection and mitigation planning

Assets & Facility /Estate Management Stage

The post-occupancy functions can be performed with ease because of the automated reminder alarms, data collection, and suggested solutions by the Digital Twin and advanced analytics. The functions relating to the Asset/ Facility Management stage, the Stakeholders and the Digital Platform/ Software that could be used are listed in Table-4.

Table-4: Asset/ Facility Management related Functions, the Stakeholders and the Digital Platform/ Software

Sr. No.	Asset/ Facility Management Related Functions	Stakeholders	Digital Platform/ Software
1	Real-time monitoring of asset performance	Facility Managers, IoT integrators	Digital Twin
2	Equipment analytics for lifecycle optimisation	FM Teams, OEMs	AI/ML for Predictive maintenance
3	Smart occupancy and energy consumption reporting	FM consultants, ESG officers	Space and Energy Management software
4	Immersive training and fault diagnosis	Maintenance technicians, Training teams	AR/VR/XR for maintenance
5	Transparent, timestamped project records	Facility owners, Legal advisors	Blockchain (for dispute resolution)

Capacity and Capability Building

It is essential that the Indian construction industry and all the building professionals get increasingly geared to digitalization, especially BIM and Digital Twin applications for all stages of the building process.

It is relevant to note that 37 developed countries have already mandated the use of BIM as a process and tool for BIM-backed deliverables. In the Indian context, many consultants associated with various projects in India and abroad are already in tune with BIM-coordinated and integrated outputs.

Even the leading building agencies, builders, and construction entities are increasingly getting their engineering and other professional teams equipped to deal with the same.

The right level of software for the BIM applications that are available, like the ones for architectural design and drawings, structural design, and drawings, MEPFC outputs, including 3-D [structural, non-structural, finishes and services overlaid] needs to be deployed right at the start of the project. The integrated coordinated outputs help the developing agencies, the design professionals, and the construction teams

The Digital Twin provides access to completed drawings of all elements for takeover by Asset and Facility/ Estate Management teams for their planned actions and interventions.

The National Building Code of India (Part 0, Part 7, and Part 12) by the Bureau of Indian Standards (BIS) supports the change to digitalisation.

BIS is also finalising the national BIM standards to institutionalise the practices across public infrastructure projects.

The period 2025 to 2030 will witness an active phase for digital transformation of engineering projects across projects of all sizes in India; engineering inputs and outputs will be done online.

The Way Forward

India's transition to digital engineering planning, design, construction and building/ facility management are actively progressing and support is being provided by engineering and allied associations.

With digitalization as the foundation and emerging technologies as enablers, India is well-positioned to lead the future in providing sustainable, efficient, and digitally connected infrastructure.

About IBIMA:

The Indian BIM Association is actively pursuing the development and adoption of digitalisation, especially BIM and Digital Twin in India.

About FOCUS and its Role for Coordinated and Integrated Action and Synergy

The need for a holistic approach to be adopted by all building professionals at all stages of the building process has been increasingly appreciated the world over. The need for well-coordinated and integrated inputs and outputs from all concerned has led to the formation of Forum Of Construction Utility Services [FOCUS] as a professional platform for all multi-disciplinary professionals to work together, with larger goals of efficiency, productivity, and avoid wastages and time and cost overruns. FOCUS is working as a thought leader towards the reform and transformation process.

Acknowledgements

1. The author wishes to acknowledge the contributions by:

2. Er. S Arun Kumar, Director and Head NBC, Bureau of Indian Standards, New Delhi

3. Dr. C. B Amarnath, President, India BIM Association, Chair -National BIM Guideline Initiative (CED29/P3), Bureau of Indian Standards.

4. National Building Code of India 2016 and draft 2025: Parts 0, 2, 4,7, 8, 9, 11 and 12, Bureau of Indian Standards, New Delhi

5. Indian Green Building Council; various publications including NET Zero Mission Interventions, Hyderabad

6. Forum Of Construction Utility Services [FOCUS] and Action Plans, Bangalore.

02

Sustainable Integrated Designs of Buildings: Enhancing Cost Controls for Improving Their Renovation/ Repurposing

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Introduction

The building sector in India is moving at a fast pace and adopting innovation not only in technology but also for their processes and governance. This is evident in the large-scale building projects, from bungalows to tall buildings.

A typical project, whether it is for renovation or repurposing of an existing building/ structure or creating a new building/ structure, must follow a sequence of processes - conceptualisation and preliminary planning, budgetary approvals, detailed planning, design, approvals, compliances, execution, testing, commissioning and handing over.

It is, more often than not, that the existing buildings going in for renovation or remodelling present challenges at the design table as well as during execution due to various physical constraints and due to the lack and uncertainty of data and information primarily because of their age and non-availability of the original designs and drawings.

This paper deals with the work of remodelling/ repurposing of some heritage buildings; the challenges faced during the execution and how the same were addressed using an integrated comprehensive approach during the planning, design and execution phases. Different strategies and technologies had to be conceived and applied for each project so that the end result was a facility redone on sustainability principles.

Comprehensive Integrated Design Strategies

To achieve renovating or repurposing an existing facility involves incorporating comprehensive yet integrated strategies as discussed hereinafter.

Sustainable Integrated Designs

This involves professionals for planning and designing - architects, planners, sustainability experts, modellers, plumbing, electrical and HVAC engineers, structural engineer, waterproof specialist, façade specialist, IT and low voltage specialists, heritage specialists, cost experts - all of whom need to work together to make planning and design decisions. The owners are also involved in accepting and clearing the plan, the cost and the time schedule. It is important and necessary to also make all the other stakeholders such as the end users, contractors, sub-contractors, plant and equipment suppliers, etc., along with the operation teams, a part of the process so as to make it a more cohesive approach and to ensure that all are on the same wavelength.

Technology Integration

The use of Building Information Modelling (BIM), Digital Twin and other digital tools, IT, IoT, low voltage team, light and sound specialists as required.

Sustainable Practices

Incorporating eco-friendly materials, energy-efficient systems and above all, sustainable design practices.

Challenges Encountered

While repurposing and renovating old buildings can be rewarding yet at the same time it also needs to be understood that various challenges are encountered while renovating or repurposing existing buildings. Some of the key challenges faced in such projects are given below.

Structural Integrity and Safety Concerns

Existing buildings, especially the older ones, often have structural issues due to their aging, such as leakage, seepage, weakened wood framing, degraded masonry, or foundation or basement problems etc. The structural integrity of such buildings or the structural elements is always difficult to ascertain. Ensuring that the buildings meet current safety standards without compromising their historical integrity can be a complex exercise. Many of these issues only come to surface as the project progresses when some of the wall sections, structural elements or foundations are opened for changes or repair.

An example was of a building where the flooring was on a wooden beam supported on thick masonry walls at the end. While the architectural designs could be incorporated it was discovered on removing the old flooring and inspecting the old wooden beams that they would not be able to support the new flooring load – they would have sagged. However, with the integrated system design approach that had been adopted, the structural engineer provided an innovative way to transfer part of the load directly to the side and thus prevent overloading of the beams and their

Figure-1: Strengthening the Floor System

Figure-2: Services integration for Heritage Structure

sagging. The architect also changed the design and choice of material to suit the structural limitations. A similar collaboration between the structural team, the architects and the HVAC team helped in providing a modern ducted cooling system. Specialised existing open spaces were identified in the heritage building for the customised HVAC duct system which was designed to suit the air flow requirements for the interior areas.

Material Uses

The heritage buildings were constructed using stone for the structural walls, lime mortar for bonding, and other local materials and construction techniques . Such elements, if opened for any change, may have an impact on the overall structural elements of the building and require very careful handling. The bonding of new construction material with the existing elements is always a challenge. Another common problem is the degradation of foundational materials. Stone and brick, commonly used in heritage buildings,

Figure-3: Integrating Modern Material with Existing Services

at times have cracks or get displaced. Rectifying those issues without compromising the building's integrity demands careful planning, expert execution, and close supervision. At times, an entire section of a building would need to be rebuilt using the original construction techniques to maintain not only historical accuracy but also prevent any structural compatibility issues.

An example was of a building where it was converted from an old office building usage to be a commercial high-end retail space, with the addition of a basement, escalators and lifts. The project necessitated very close collaboration between the structural, architectural, interior and traffic teams to work together to identify the spaces for different usages and the public movement paths to provide workable structural solutions for the same.

Compliance with Modern Building Codes

Bringing an old building up to current building codes, including electrical, plumbing, and HVAC systems, is a difficult job. The updates have to be done in a cautious manner so as to preserve the building's historical fabric. Installing contemporary electrical, plumbing, and HVAC systems without damaging the building's historic fabric requires that the design be done space by space and element by element by a team of the architect, the structural engineer and the service engineer concerned. The major challenge is to ensure that the structure can support the new systems without altering its historical appearance and still meet space planning requirements, as desired.

Regulatory and Heritage Compliance

Renovating historic buildings often involves navigating a maze of regulations designed to protect their architectural significance. That includes extensive documentation and approvals from heritage bodies, a time-consuming part of the project.

Balancing Heritage with Modern Needs

Finding the right balance between preserving the historical aspects of a building and incorporating modern conveniences is another major challenge. Decisions have to be made jointly; the end user requirements also have to remain flexible to what can be achieved based on the existing structural system, and the services to be provided based on the limitations of the spaces available. It is never an easy process, and the finalisation of the planning and design is done based on what the design teams determine as possible and apprise the owners and users and obtain their consent to arrive at the final design decisions. Many times, the sizes of the spaces (cabins, common spaces, etc.) and circulation areas need to be adjusted to maintain the heritage nature of the building.

Figure-4: Modern furnishings in heritage ambience

Environmental Challenges

It is also seen that older buildings sometimes have environmental issues because of the materials used in them, such as asbestos, lead paint, CFC based cooling, and the like. Those need to be addressed carefully to ensure safety and compliance with health regulations. In most cases, all such materials are replaced with current environment friendly materials.

Figure-5: Repairing a Roof

Technological Integration

Installing modern technology and systems in historic buildings is another uphill task. It calls for innovative solutions for each and every system individually as well as collectively. For example, integrating new lighting or HVAC systems without altering the building's appearance requires out-of-the-box solutions. The requirements of making all systems SMART with installations of sensors is at times problematic since signal transmission is affected due to the thickness of the existing wall, their material or even the sizes of the beams and columns and their locations.

To obviate such issues, it is essential that the AV, sound and IT expert work in close conjunction and coordinate space requirements, placement of equipment and gadgets and routing cables, wires, etc. well in time and get the other disciplines – the architects, and the structural and the service engineers to review and approve their plans and schemes.

Installation of rooftop systems for green measures like a solar system or large dish antennas, or towers are to be carefully evaluated and coordinated. Special provisions have to be made with all due safety precautions, especially on sloped roofs. The supporting systems need to be customised for each case.

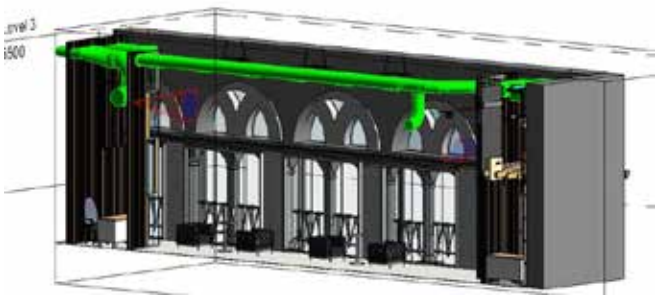

Figure-6: Installing New Tech in Old Heritage

Lessons from Heritage Building Projects

The challenges of repurposing and renovating old buildings to breathe new life into them, preserving cultural heritage to make them functional for modern usage, are a delight for every professional.

Working on the heritage buildings drives home the point that for such a project, a comprehensive integrated approach is a must. It is only then that the challenges mentioned above can be addressed and resolved and help in making the old buildings as high-performing modern assets. Some of the examples of advantages of Sustainable Integrated Designs (SID) in projects done are:

Holistic Planning Minimizes Surprises at Site

SID brings all disciplines—architecture, structure, MEP, sustainability, etc. together at an early stage of a project and thus minimizes disconnects and last-minute redesigns. In the case of two heritage buildings which were renovated for commercial use, all the MEP services integration was done and conflicts with the structure were avoided by determining the sizes (area requirement – in plan or cross section) and the routing of services. That ensured that no redesign or rework was required. The space requirements and routing of the services were finalised in close interaction with the architectural spaces and where necessary, the architectural spaces were built around the services' routes.

Figure-7: Refurbished interiors with integrated MEP

Material Reuse + Adaptive Detailing To Cut Wastage & Time

Sustainable design encourages the reuse of materials and respects existing structures, leading to *lesser demolition and fewer procurement delays*. In one case, there was an option of changing the roof tiles and the rafters. It took some effort to reuse the old Mangalore tiles after cleaning and applying sealing treatment, and also the wooden rafters and purlins, which were also repaired and reused. That saved both cost and time.

Integrated BIM + Sustainability Modelling Prevented Clashes

BIM integrated with energy modelling helped in identifying system conflicts early and aided in optimizing material usage. The creation of a Digital Twin resolved clashes in advance at the design stage itself, along with the accuracy of the building material requirements, which sometimes have a long lead time. In one heritage building renovation, a row of beams was chamfered to accommodate MEP services so as to gain maximum height for the false ceiling at the design stage itself. The integrated model prepared well in advance enabled looking at alternatives and selecting the most suitable. That helped with placing the order for customised beams and other structural elements.

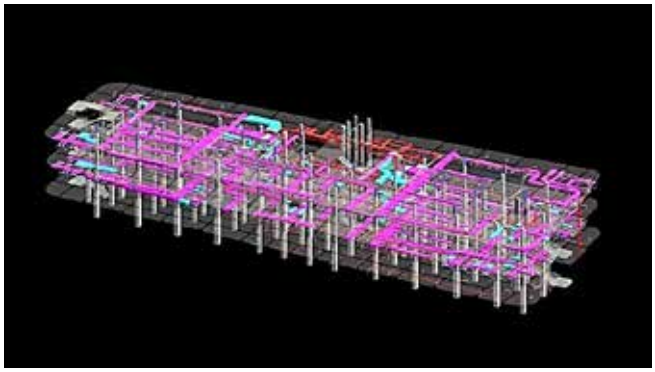

Figure-8: Clash Check and integration of old and new systems in BIM

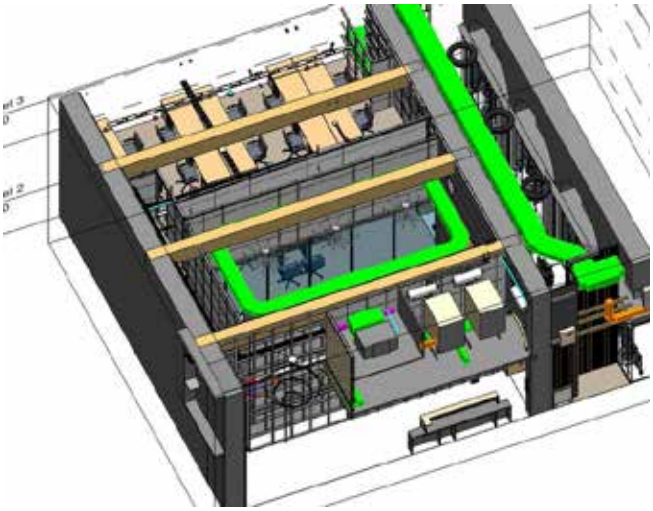

Figure-9: Routing Ducting to avoid existing beams

Water & Energy Systems Designed for Long-Term Use

Rainwater harvesting, greywater reuse, and solar integration are coordinated with the architectural and MEP teams during the concept stage. In one building project, rainwater filters were installed on the terrace down take lines and the water was stored in underground tanks without impacting the looks and space requirements. In another project, a non-functional STP was restored to use grey water for horticulture.

Climate-Responsive Design Reduces Retrofit Risk

In one project, the correct orientation, provision of a shading system, use of proper insulation, and local materials suitable for the climate, reduced long-term thermal discomfort and optimised the system of design. Adopting an integrated approach for sustainability resulted in the integration of passive and active solutions. Provision of shaded spaces, appropriate placement of regularly occupied area and service areas to enhance the performance of the building, specialised glasses (sound, light and heat performance), HVAC system with fresh air intake to avoid sick building syndrome and to bring down EPI from 190 KW/m2/ year to below 96 KW/m2/year for the project, resulted in a high performance A Grade Commercial Building. Energy simulation input at a very early stage helped in design tweaks for sizes of windows, roof insulation, and selection of HVAC equipment and the same paid off with less than 3 years of ROI. The project was awarded the Platinum Green Rating along with 5 Star BEE rating.

Figure 10: Fitting Green technology in the same space

Modular & Prefab Choices Simplify Site Execution

SID encourages modular and dry construction methods - less waste, faster execution, ideal for constrained or heritage-sensitive sites. In one building, a comprehensive integrated approach resulted in the adoption of Aerocon prefab panels to avoid dusty and wet construction methods and also save significant time.

Conclusion

Alignment of all stakeholders - clients, consultants, heritage bodies, vendors, contractors, etc., at an early stage, as a part of comprehensive Sustainable Integrated Designs results in proper and correct dissemination of information about the project and promotes understanding about the project amongst them. The result is a high-performance and cost-effective building. SID prioritizes durable, low-maintenance, locally serviceable systems and finishes and helps building owners to meet those objectives.

AI Powered Robots for Construction

A Canadian Company, named 'Promise Robotics' has paved the way for a complete makeover of the construction industry by developing AI-powered robotic arms, which can read blueprints and analyze how construction can be carried out. These arms also have the capability of understanding the basics and working in the actual construction of walls, floors, and entire buildings

(Source – Construction Today)

03

Case Study of Surya Regional Water Supply Scheme, Mumbai Metropolitan Region

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Introduction

Urban regions across the world are experiencing rapid expansion, placing significant pressure on critical infrastructure such as water supply, energy, and transport systems. In India, the Mumbai Metropolitan Region (MMR) exemplifies these challenges due to increasing population density, urban extension, and environmental sensitivities. It thus calls for infrastructure systems that are not only efficient and scalable but also resilient and sustainable.

Traditional engineering practices, often siloed by discipline, are not sufficient for managing such complex systems. In contrast, integrated engineering brings together multiple disciplines and digital tools within a unified framework, enabling more coherent planning, execution, and long-term management of infrastructure projects.

A well-planned and integrated project minimizes costly changes or additions later, which could disrupt operations and inconvenience facility users. Since substantial investments are involved in infrastructure projects, a sound and collaborative engineering approach is essential. That approach ensures that diverse experts and teams work closely together, seamlessly integrating all components into a cohesive and efficient system.

What is Integrated Engineering?

Integrated engineering is an interdisciplinary approach where civil, mechanical, electrical, environmental, instrumentation & control, and software engineering work collaboratively from conceptualization to commissioning. The use of digital technologies, such as Building Information Modelling (BIM) during planning and construction, and Supervisory Control and Data Acquisition (SCADA) during the scheme's operation & maintenance make a tremendous difference by improving planning and coordination, reducing inefficiencies, enhancing project outcomes, minimising cost and time overruns, if at all.

Adopting Integrated Engineering calls for different experts to plan, design, and build together as one system. Digital tools and teamwork ensure that everything fits together well and works smoothly.

This approach, albeit, involves coordinating multiple engineering disciplines - civil, mechanical, electrical, instrumentation & control, environmental, and digital right from the conceptual stage to commissioning. Such an approach is critical for preventing fragmented construction, which often leads to redundant work, rework, added costs, time overruns and disruptions to end-users.

A truly integrated model ensures:

- Seamless planning, execution, and handover,
- Avoidance of retrofits and duplicative infrastructure,
- Efficient use of digital technologies for design, monitoring, operation and maintenance, and
- Lower life-cycle costs and better long-term maintainability.

Objectives of This Paper

This paper explains the processes and procedures adopted for the 403 MLD Bulk Water Supply to the Western Sub-region of the Mumbai Metropolitan Region known as the Surya Regional Water Supply Scheme:

- The principles and practices of integrated engineering in large-scale infrastructure are briefly dealt with.
- The Surya Regional Water Supply Scheme is presented as a case study.
- The challenges faced and methods adopted for successful implementation are highlighted.
- Recommendations are offered for applying integrated approaches in future infrastructure projects.

Fundamental Concepts in Integrated Engineering

Systems Engineering

Systems engineering provides a structured methodology for managing the complexity inherent in large infrastructure projects. It focuses on clear requirement definition, holistic lifecycle planning, and rigorous validation at every stage.

Building Information Modelling (BIM)

BIM, which is now an indispensable digital tool, enables a data-rich representation of the project's physical and functional aspects, fostering better collaboration and minimizing routing clashes across disciplines. It enhances scheduling, cost estimation & control, and maintenance planning.

Integration Strategies in Complex Infrastructure

Collaboration during Planning and Design

Early engagement of all stakeholders, including clients, consultants, liasoning agencies, beneficiaries, i.e. municipal corporations such as Vasai Virar City Municipal Corporation (VVCMC) and Mira Bhayandar Municipal Corporation (MBMC) are the cornerstone of the Surya Scheme. Right from the design phase, all teams worked collaboratively to ensure cross-disciplinary alignment and prevent downstream conflicts. The Beneficiaries clearly defined their requirements, specifying the location of bulk water supply within the corporation's jurisdiction and pipeline alignments. Memorandums of Understanding (MoUs) were signed with the Beneficiaries prior to commencing design and implementation, covering all technical and commercial terms.

Interdisciplinary Coordination during Execution

Coordination was maintained through regular meetings, co-location of design teams, and the adoption of integrated project delivery methods. Building Information Modelling (BIM) was a help to be able to show all concerned the interdependencies and thus aided in addressing design issues before the construction began. Project Management software also facilitated real-time monitoring of progress.

Technology Enablement during Operation & Maintenance (O&M)

During the O&M phase, digital platforms such as SCADA helped enhance the system performance and ensure greater project transparency.

Engineering Integration and Project Execution

Engineering Integration

It means putting together different systems and parts - like Intake cum Raw Water Pumping Station, Water Treatment Plant, Pipeline, Master Balancing Reservoirs & Control in the water supply systems into one integrated working system. That needs good planning, testing, and teamwork.

The Main Steps in System Integration are:

- Designing
- Procurement
- Erection
- Commissioning

Best Practices

- Effective Communication: Clear documentation and regular updates reduced the risk of misalignment.
- Risk Management: Identifying potential risks early and planning contingencies helped to improve resilience.
- Training and Support: Ongoing capacity building ensured smooth operations and system sustainability.

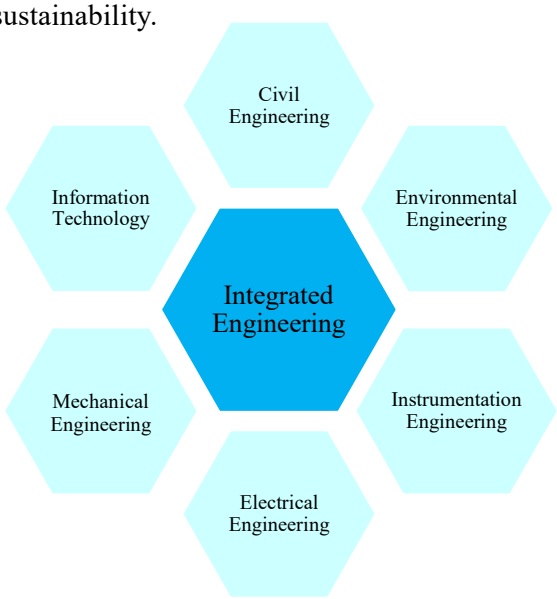

Figure-1: Integration of Engineering disciplines

Case Study: Surya Regional Water Supply Scheme - 403 MLD Bulk Water Supply to the Western Sub-region of Mumbai Metropolitan Region

The Project

The Surya Scheme, implemented by the Mumbai Metropolitan Region Development Authority (MMRDA), is designed to supply 403 MLD of treated drinking water to the fast-growing urban areas in the western sub region of MMR i.e. Mira-Bhayandar Municipal Corporation and Vasai-Virar City Municipal Corporation. The project caters to potable water demand for around 30 lakh population in those regions.

The Surya Scheme, executed under a Design, Build, Maintain, Operate, and Transfer (DBMOT) model, showcases how complexity can be managed through an integrated approach.

Major Components of the Project:

The Project comprised the following:

- Intake and Raw Water Pumping Station of capacity 432 MLD at Kawdas weir on Surya River
- 2235 mm ϕ and 2.225 km long Raw Water Pumping Main
- Water Treatment Plant of 432 MLD capacity at Surya Nagar
- Clear Water Pumping Station at WTP
- Clear Water Pumping Main 2235 mm ϕ x 630 m upto Break Pressure Tank (BPT)
- Break Pressure Tank of capacity 1.08 ML adjacent to WTP
- Clear Water Transmission Main
  - 2235 mm ϕ: 59.349 km
  - 1829 mm ϕ: 22.845 km
- Four tunnels
  i. Mendhvankhind tunnel - 1.7 km long for crossing NH from east to west
  ii. Tungareshwar tunnel - 4.6 km long for crossing of Tungareshwar Wild Life Sanctuary
  iii. Vasai Creek tunnel - 0.9 km long for crossing Vasai creek
  iv. Kaman Creek tunnel - 0.268 km long for crossing Kaman creek.
- River crossings with pipe lines going below the river bed level for Vaitarna, Vandri and Tansa rivers

- Three major rail and road crossings were involved i.e. Vasai-Diva railway line, National Highway-48 and the Thane-Ghodbunder Road
- Seven number of tappings for water supply to the enroute 44 villages
- Two Master Balancing Reservoirs:
  i. Kashidkopar (Capacity:38 ML) – Vasai Virar City Municipal Corporation
  ii. Chene (Capacity:45 ML) – Mira Bhayandar Municipal Corporation
- Instrumentation, Automation and SCADA.

Contract Package

Initially, the project was considered for execution through separate packages - civil works, Pumping Stations, WTP, Electrical Works, Tunnels, SCADA, etc. However, that approach was abandoned due to:

- Battery limit issues between contractors
- Integration difficulties
- Mismatch of timelines
- Contractual ambiguities

A Design, Build, Maintain, Operate, and Transfer (DBMOT) approach was considered as the most appropriate and was adopted for the works and their components which were included in description of the water supply system and its scope of the works. The scope of the contract included the following:

- Raw Water Analysis, Survey and Geotechnical Investigations
- Design of entire system components
- Manufacture, Inspection of Material, Plant and Equipment at the factories and after supply
- Trial Run and Pre-Commissioning Tests and Checks
- Commissioning of the work and Performance Tests
- Training to Employer's Staff
- Operation and Maintenance of Works for 8 years' operation period

Completeness of the Works and System

The Contractor had to ensure that the whole of the works and the system, including each individual component, was designed and constructed in a manner so that the system, as a whole, operates as a fully integrated system which is capable of achieving the required output in an efficient and economical manner, and include all plant, equipment and accessories required for the safe and satisfactory operation of the facilities.

To achieve that, the magnitude of investment in infrastructure and industry would necessitate a robust integrated approach in engineering for project implementation. Doing that in a holistic manner would involve multiple engineering and project disciplines, all working in conjunction in a well co-ordinated manner to enable seamless merging of the diverse subsystems to create a cohesive and harmonious whole.

From concept to commissioning, the process required careful planning, strategic decision-making, and effective coordination using digital tools. A well-integrated project would obviate the need for tampering of a recently built facility to add on or modify another facility, utility or service, creating infructuous expenditure and inconvenience to the facility users.

Integrated Delivery Model

- Experts from different streams/ fields worked together from the beginning.
- Use of advanced construction techniques such as slipform technology, mobile formwork and Precast hollow core
- Use of advanced machineries such as Tunnel Boring Machine to build safely and efficiently.
- SCADA systems help monitor and control the system remotely.
- A long-term plan for ongoing operations and maintenance for 8 years.

The project successfully adopted a Design, Build, Maintain, Operate, and Transfer (DBMOT) framework.

Photo-1: Aerial view of Water Treatment plant (Partially commissioned)

Photo-2: Breakthrough of 4.6 km tunnel crossing Tungareshwar Wildlife Sanctuary

Challenges and Solutions

Technical Challenges

- Tunnel Excavation: It required precision tunnelling in complex geology at depths up to 55 meters.
- Intake Construction: Difficulties were encountered due to deep water levels, hard rock excavation, and monsoon conditions.
- WTP and Reservoirs: High-altitude construction, wind speeds, and poor drainage required adaptive engineering methods.

Logistical Challenges

- Multiple Construction Sites: Demanded rigorous scheduling and synchronized resource planning.
- Material Management: Vendor-managed inventory systems helped prevent delays.

Regulatory and Social Hurdles

- Environmental Clearances: Statutory Approvals from over 25 agencies, including Forest, CRZ, and DTEPA, caused some delays.
- Public Opposition: Resistance at key locations like the WTP and MBRs delayed access and required intervention by law enforcement agency and District Authorities.
- COVID-19 Pandemic: Lockdowns disrupted execution and global supply chains, delaying critical imports and site activities.

Advanced Construction Techniques

To improve efficiency and minimize time delays, the following were adopted:

- Slipform Construction: For continuous casting of Intake and BPT walls.
- Precast Hollow Core Slabs: Used in Clear Water Reservoirs and Master Balancing Reservoirs to accelerate construction.
- Mobile Formwork and Mechanical Sieving: Enhanced productivity and reduced cycle times at Master Balancing Reservoirs

Conclusion

The Surya Regional Water Supply Scheme stands as a robust example of how integrated engineering can transform infrastructure delivery. Its success lies in early planning, interdisciplinary coordination, technology upgradation and integration, and proactive stakeholder engagement.

Recommendations

- Promote Integrated Project Delivery models in public infrastructure projects.
- Invest in training and digital tools to support cross-disciplinary integration.
- Emphasize early-stage planning, environmental and social engagement to reduce implementation hurdles.
- As urban infrastructure grows in complexity and importance, integrated engineering must become the norm. Collaborative planning, technological foresight, and stakeholder cooperation are essential to developing resilient, future-ready infrastructure.

Acknowledgement

The author is thankful to MMRDA for giving permission to write about the Surya Regional Water Supply Scheme.

About STC: Shah Technical Consultants offers consulting services for a range of infrastructure development projects to the organizations concerned by providing expertise in project management, transactional advisory and design consultancy. From project inception through to final handover, success depends on careful planning, informed decision-making, and effective teamwork supported by digital tools.

The Delhi-Mumbai Expressway is a prime example of a large-scale project leveraging *integrated engineering*. This $13 billion, 1100-kilometer expressway incorporates various advanced technologies and methodologies to enhance connectivity and optimize construction. The project utilizes 3D modeling, geosynthetics, drone surveys, and cloud-based software for real-time data transfer and stakeholder communication.

- **Scale: The expressway is massive, connecting major Indian cities and traversing multiple states.**
- **Complexity: It involves diverse construction aspects, including tunnels, elevated sections, and different terrains.**
- **Innovation: It demonstrates the application of cutting-edge technologies like 3D modeling and cloud-based solutions to manage a complex project.**
- **Efficiency: The integrated approach aims to improve efficiency in construction and ensure long-term road durability, even in extreme weather conditions.**
- **Sustainability: Emphasis on grading and drainage contributes to the project's sustainability and long-term viability.**

Source: Google

04

Integrated Edge - Redefining Engineering Consultancy for Cement Plants

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Abstract

The cement industry is the backbone of the development of industries, the housing sector and infrastructure. It is one of the most resource-intensive sectors. As urbanization accelerates and nations develop, the demand for cement grows, and the cement industry becomes a key enabler of the nation's progress. The industry faces many challenges, due to the continuous technological developments, such as, coping with volatile raw material and fuel linkages, energy costs, CO_2 emission, environmental regulations and the need for sustainability.

The traditional multiple Consultants model, where different Consultants manage different engineering activities in different project phases, necessitates resolving communication issues, matching of alignments, providing inputs to get the correct and on-time outputs and a wider canvas for risk management.

This paper presents the **Integrated Edge** framework, which is a unified consultancy approach, integrating the multidisciplinary functions for feasibility studies, procurement assistance, engineering services, supervision of construction, erection, commissioning, and plant operations.

Design of a Modern Cement Plant

Cement Manufacturing Process

To put things in their correct perspective, the process is outlined in brief. The main raw material, limestone, along with the other corrective materials (to make the raw material chemically balanced for cement manufacturing) are crushed and ground into a powdery form. The ground material is calcined at a temperature of around 1450^0C to form clinker. The clinker, after cooling, is ground again, along with Gypsum (to regulate the setting time of cement), to make cement (OPC). For making other types of cement, materials like slag, fly ash, etc. are added.

A typical Process Flow Diagram for a cement plant is shown in Figure-1.

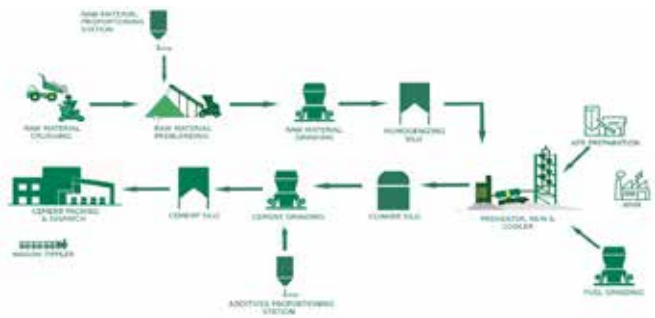

Figure-1: Typical Process Flow Diagram for a Cement Plant

Main Cement Plant Machinery & Storages (Typical for a 3.3 mio tpa capacity plant)

The design and engineering of an integrated cement plant entails dealing with a lot of complexity since it encompasses a wide array of processing systems that have to be integrated. The main systems are mining, crushing, raw material handling, grinding, pyro processing, material storage, packaging, and dispatch. Table- 1 to Table-3 list the major machinery and storages, along with their details for a typical 10,000 tpd (3.3 mio tpa) size plant, which go to show the complexity.

The parameter ranges may vary based on the multiple factors, such as raw material, source and characteristic of fuel, type of cement to be produced, other intricacies and interdisciplinary nature of operations. Apart from complexity and scale of operations involved in successful implementation of the project, there is need for careful interplay among various disciplines of engineering.

Table1: Mechanical Machinery

Machinery (Type)	Parameter Range
Limestone Crusher (Impact/ Hammer)	1,600 – 2,000 tph
Raw Mill (VRM/HPGR)	750 - 800 tph
Coal Mill (VRM)	80-100 tph
Preheater (5/6 stage) – Twin Strings, Inline Calciner	150-170 m high structure
Clinker Cooler (Grate/ Pendulum)	250-275 m^2 grate area
Cement Mill (VRM/HPGR)	2x(300-350) tph
Packers (Rotary) & Loaders	4/5 packers of 240 tph
Limestone Stockpile	1 x 100,000 t
Coal Stockpile	15,000 – 20,000 t
Corrective & Additive Stockpile	As required
Raw Meal Silo	18,000 – 22,000 t
Clinker Storage (Pre-stressed silo)	75,000 - 100,000 t
Cement Storage	4 x 10,000-15,000 t

Table-2: Electrical & Automation Systems

Machinery	Parameter Range
Incoming Power voltage	132 or 220 kv
Power Demand	45 - 50 MW
Power generation from waste heat	15 – 16 MW
Main transformer	2 x 45 - 55 MVA
Distribution Transformer	10 - 14 nos.
Total no. of Drives	800 – 1,000 nos.
Intelligent MCCs	30 - 40 nos.
Total Cabling	1,200 km approx
Process Controllers	07 - 08 nos.
No. of input/output signals(I/0)	10,000 – 12,000

Table-3: Construction & Erection Bill of Quantity

Project Component	Quantities Range
RCC Work	80,000 - 90,000 m^3
Structural Steel	8,000 - 10,000 t
Plate Work	7,000 – 8,000 t
Insulation Work	40,000 - 45,000 m^2
Refractory and Castables	8,000 - 9,000 t
Erection tonnage	13,000 - 15,000 t

Multifaceted Collaboration in Cement Engineering

The cement industry is undergoing a significant transformation, driven by emerging technologies, which enhance the efficiency of the plants and reduce the environmental impact. The use of alternative fuels like biomass, municipal solid waste, and other waste materials, which reduce the usage of fossil fuels in cement plants, etc., is gaining momentum, thus supporting the Circular Economy Principles. Additive materials such as fly ash, blast furnace slag, and calcined clays are partially replacing clinker and thus minimizing the carbon footprint. Innovations like carbon capture, utilization, and storage (CCUS) and green hydrogen usage are revolutionizing the emissions reduction strategies. These technological advancements require

in-depth knowledge and experience to gainfully use them in the cement industry.

A typical Cement plant project requires collaboration of diverse stakeholders and a range of Consulting Services. The range of stakeholders is commonly 50-60. The collaboration encompasses various specialized roles, from the engineering consulting services in 6-8 areas, 6-7 main machinery suppliers, and a larger contingent of 40-50 auxiliary equipment suppliers. Finally, the physical realization of the project at the site relies on the expertise of 8-10 contractors and fabricators, responsible for construction, erection and commissioning of the plant.

The success of cement engineering efforts ultimately depends on prompt, continuous, and cooperative collaboration amongst all the contributors throughout the lifecycle of the project. It includes engineering services of the mechanical, electrical & instrumentation, process, civil, structural, utilities, and environmental engineering disciplines.

Cement Plant Engineering through Integrated Edge Framework vis-a-vis Stand-Alone Consultants

Traditional Style of Consulting Services

In the traditional Consultancy framework for a cement plant, standalone Consultants handle feasibility studies, procurement services, basic/detailed engineering services, and supervision of site activities separately, independently, or in parts, at various stages of the project. Mostly, the work is distributed by engineering discipline. That often results in misaligned objectives, fragmented communication and reactive risk management. The traditional framework causes delays and cost overruns, as participating agencies may have different perspectives and priorities. It results in missed optimization opportunities, which get identified at a later stage of the project.

These challenges can be addressed by providing the **Integrated Edge framework** for the consulting services.

Integrated Edge Framework for Consulting Services

1. Pre-Project Phase

The critical groundwork in the Pre-Project Phase provides the base that shapes the trajectory of the entire project. Market research provides insights into the supply and demand patterns, the competitive landscapes, market dynamics, potential risks, and the anticipated returns, enabling informed decisions regarding the plant capacity and the product mix. That aids in the strategic positioning of the plant in the profitable regions, with favourable entry market conditions.

A vital aspect of that phase involves a comprehensive raw material investigation, where advanced analytical tools and software play a crucial role in evaluating the quality and quantity of the resources. The findings facilitate the selection of the equipment, its type, and the size.

Site selection and its evaluation are crucial for assessing not only the physical suitability of the land, but also for other critical factors like closeness to raw materials, infrastructure availability, environmental considerations, and the logistical aspects.

The coherent framework of Integrated Edge, in the form of a Techno-Economic Feasibility Study, covering all the above aspects, ensures that every decision is based on well-informed data and does not suffer misalignments, as normally faced with the standalone Consultancy model.

2. Project Phase

Once the robust base principles and parameters are established during the Pre-Project Phase, the Project Phase focuses on translating the strategic vision into tangible assets, through efficient Basic Engineering, Procurement Assistance, Detailed Engineering, Supervision of Construction and Erection. The time required for procurement assistance is generally 6 months, 9-12 months for

engineering, 15-18 months for the construction/ erection/ commissioning of the plant, from its start. With various activities overlapping each other, a project is completed in 18-24 months, after ordering the main machinery.

Basic Engineering is the core activity in this phase, involving the development of detailed plant layout, process flow sheets, conceptual general arrangement drawings, heat and mass balances, sizing of the main and auxiliary machinery, and their specifications. The insights gained from **the raw material quality** and availability assessments directly help in critical decisions regarding equipment sizing and technology selection. The target product mix, e.g., proportion of Ordinary Portland Cement, Portland Pozzolana Cement, etc, and the projected capacities derived from the **market studies,** directly influence process flow configurations, machinery and storage sizing, and dispatch facilities.

The **geotechnical investigations** during that stage influence the design of the foundations for the structures and equipment. **Site evaluation** done earlier in the pre-project phase, like topography, establishing the seismic zone and wind directions, guides the plant's layout. The power availability, grid supply voltage, distance from the power source, backup power systems, and the HT line routing decide the location and sizing of the outdoor switchyard and the substation design.

Procurement Management ensures the timely and cost-effective ordering of the equipment through a tendering process. The timing of the Raw Material investigation is matched intricately with the procurement timelines, ensuring that the necessary resources are available when they are needed. The integrated project schedule has to take into consideration the construction sequences, equipment delivery schedules, and site logistics. The **Integrated Edge** continuously monitors the engineering, procurement and site activities.

Detailed Engineering refines the conceptual framework established during basic engineering. In this phase, conceptual layouts are transformed into highly coordinated and specific layouts, where the involvement of a multi-disciplinary team is essential. Clash of structural members with the mechanical equipment, power cable routes, site access roads, truck movements, adequate maintenance access, and safety features are some of the examples where multidisciplinary teams play an important role. In this phase, civil and steel structural fabrication drawings are issued to the contractors for execution. Building Information Modelling (BIM) may be used to facilitate the work.

In projects, where different Consultants handle different disciplines in different phases, the non-availability of real-time cross-disciplinary communications and a shared data environment results in rework and delays become a common feature. The advantage of **Integrated Edge** includes real-time coordination, seamless data sharing and faster decision-making**.** It also mitigates risks and ensures that the project is executed without errors and delays.

The **Construction Phase** sees the **multidisciplinary teams,** including civil, mechanical, electrical, and quality control specialists on the ground. Close and continuous supervision of all the construction, fabrication and erection activities is essential to ensure strict adherence to the design, drawings and specifications, quality standards, and project timelines. The **Integrated Edge framework** provides key benefits over the standalone Consultants. It also improves change management by ensuring that all the teams are informed about design or procurement changes, enabling quick adjustments. With the **Integrated Edge** framework, all the activities are aligned from the beginning, quality is consistently maintained, and the potential issues are resolved on time.

3 Operations Phase

The **Operations Phase,** which marks the transition from project execution to the production phase and sustainability of the plant also goes through smoothly. In that phase, the efficiency, reliability, and environmental performance of the facility are achieved. Benchmarking for the same is also done. In that phase, a comprehensive Plant Operations Management, Predictive and Preventive Maintenance programs, and Sustainability Monitoring aspects are addressed.

Unlike standalone Consultants, who may lack historical project context, **Integrated Edge** multidisciplinary teams leverage full project traceability, ensuring that the plant's operation phase is a seamless extension of the design and execution visions.

Safety, Ethics and Integrity

Integrated working requires fostering a culture of ethical awareness within the organization, with mechanisms in place to support transparency and integrity at all levels. Consultants, in addition, must advocate continuous learning and staying informed about the latest technologies.

Consultants involved in the field of plant engineering must uphold high standards of honesty, professional integrity, and ethical conduct in all their practices. Independence and objectivity must be maintained.

The **Integrated Edge framework** helps to ensure that each project aligns with the highest standards of safety, ethics and integrity.

Conclusion

Integrated Edge framework transforms the approach to engineering Consultancy for a cement plant. It overcomes the drawback inherent in the traditional dis-integrated consultancy, which spans all the phases of a project. By combining excellence with responsibility and integrity, integrated working provides holistic end-to-end solutions. **Integrated Edge** needs commitment to ethical practices, adopting cutting-edge innovations, and environmental stewardship, which all go to minimise risks, maximise returns, and empower clients to build resilient, energy-efficient, and high-performance plants.

Acknowledgement

The authors are thankful to Holtec for allowing the publication of this article on the Integrated Edge framework, which is deployed by Holtec.

THE CONCEPT OF INTEGRATED ENGINEERING, as a formal approach to engineering education and practice, gained prominence in the late 20th century. While the idea of integrating different engineering disciplines has existed for a long time, the formalized concept with dedicated programs and curricula emerged in the 1980s and 1990s. Specifically, the Engineering Council UK identified the need for such a program in 1988. Furthermore, the University of British Columbia (UBC) and University College London (UCL) are known for developing integrated engineering programs in the early 2010s. *(Source: Google)*

05

Integrated Engineering of Projects: A Strategic Imperative for Modern Capital Delivery

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Introduction: Navigating New Project Realities

The delivery of capital projects is undergoing a fundamental shift. Across industries such as infrastructure, power, chemicals, and metals, organisations face mounting pressures to deliver projects with greater speed, efficiency, safety, and sustainability. At the same time, projects themselves are becoming more complex, involving numerous interfaces, diverse technologies, and strict regulatory compliance.

In this context, traditional engineering models, where teams operate in functional silos and rely on sequential handovers, are no longer sufficient especially for infrastructure projects. In the sectors such as power, chemicals, metals, etc., the process per se governs, but integrated engineering developed quite some time ago and became more prevalent when digital systems became available. Prior to that, it was all manual, and making coordinated drawings was very time-consuming. Digitalisation for projects in infrastructure, buildings, etc. came in much later. The silo approaches lead to fragmented decision-making, duplication of effort, and uncoordinated execution. The consequences are rework, cost escalation, delays, and in some cases, compromised safety and quality.

Integrated engineering has been recognised as a strategic response to those challenges. It brings together all engineering functions, project stages, and stakeholders into a unified, collaborative framework. This article presents an in-depth exploration of the integrated engineering approach, its enabling technologies, organisational requirements, and real-world value in project delivery.

The Problem with Fragmented Engineering

Traditional engineering practices generally followed a linear and discipline-specific workflow. Process engineers earlier finalised their layout and designs and forwarded those as design inputs to the mechanical and civil teams. Similarly, electrical design began only once the mechanical equipment was frozen. That resulted in a time lag, with each team working with assumptions that are later revised, sometimes drastically.

Information was typically exchanged through static documents on paper, sketches or drawings. With digitalisation, spreadsheets, etc. replaced paper. When teams were distributed across geographies, the challenge was of keeping everyone aligned increased. Without a shared model or centralised data environment, decisions taken by one discipline were not visible to others until much later in the digital process.

The implications of isolated working were significant. If piping routes clashed with structural supports, or if electrical panels were oversized for the available space, changes had to be made at site. That led to construction rework, delays in commissioning, and increased project costs. More critically, the performance and safety of the facility could be affected.

Integrated engineering addressed those issues by encouraging multi-disciplinary collaboration from the outset. Rather than treating design as a relay race, it transformed it into a concurrent and coordinated effort, where all the engineering disciplines contribute to a shared outcome.

Core Principles of Integrated Engineering

Integrated engineering is based on the principle that projects must be treated as systems. Every part of the design influences and is influenced by others. That interconnectedness requires a model that supports early coordination, continuous collaboration, and complete lifecycle visibility.

Three foundational pillars underpin integrated engineering:

1. **System-wide thinking**

   Engineering teams work not just on their specific scopes but with an understanding of how their work fits into the overall system. That requires early participation from all disciplines and active involvement of downstream functions such as construction and commissioning.

2. **Data-centric collaboration**

   Instead of relying on documents, teams work in shared digital environments where real-time models, specifications, and decisions are updated. That enhances transparency and reduces the risk of working with outdated information.

3. **Lifecycle continuity**

   From concept through to operations, integrated engineering ensures that data is not lost or recreated at each phase. Asset information, operating parameters, and design logic remain available to all stakeholders, supporting better decision-making throughout the project lifecycle.

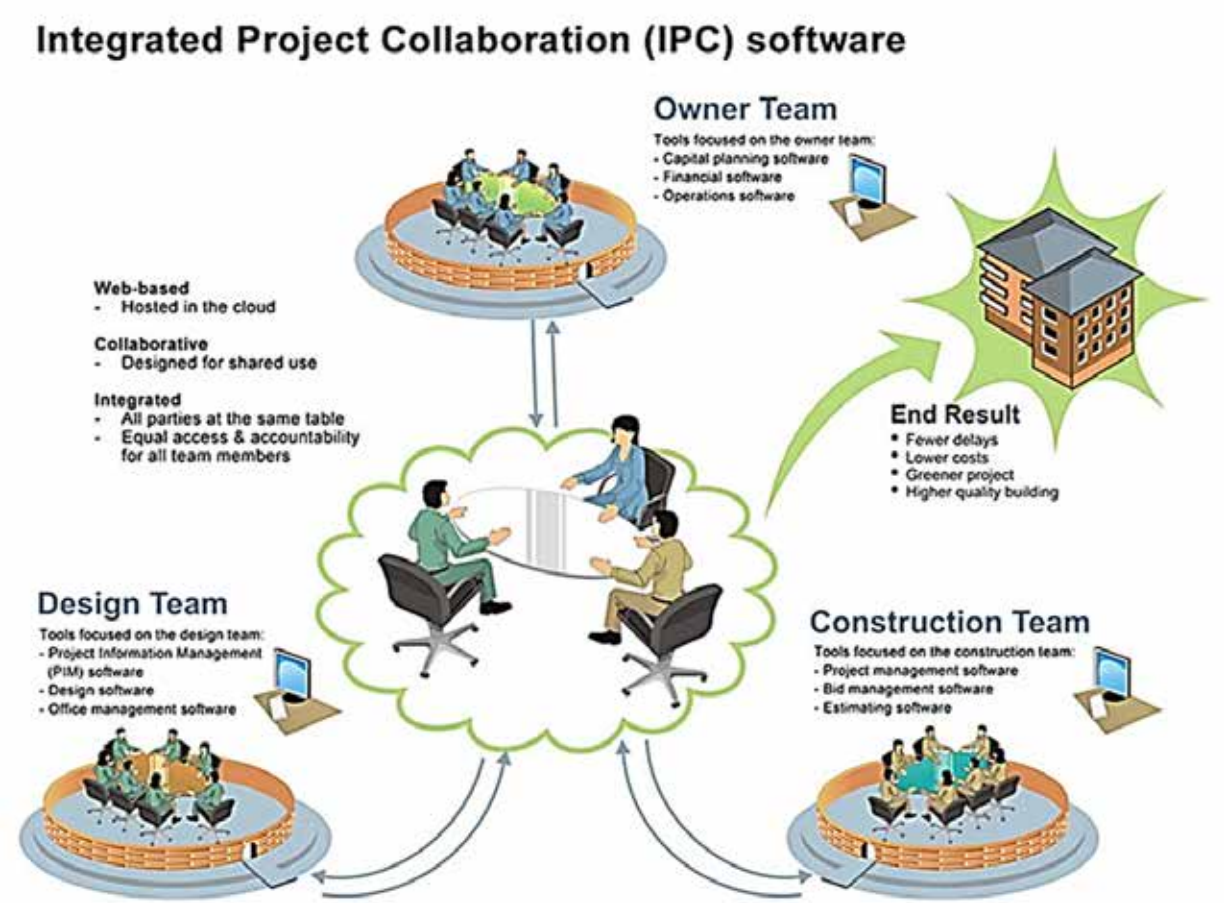
The Role of Technology in Enabling Integration

Digital engineering platforms enabled faster adoption of integration of the engineering disciplines. Engineers could use them to build intelligent, three-dimensional models that go beyond visual representation. The models embed logical connections, material specifications, design rules, and performance parameters. Software such as AVEVA E3D, Siemens COMOS, Hexagon SmartPlant, and Autodesk Revit enable real-time, collaborative modelling. Modelling tools such as Aveva E3D, PDS, Cadmatic, and similar advanced 3D design software platforms play a pivotal role in enabling seamless integration across disciplines in complex engineering projects. These tools provide a unified digital environment for piping, structural, electrical, and instrumentation design, ensuring that all stakeholders work with a common, accurate model. By offering intelligent object modelling, clash detection, and real-time design coordination, they significantly reduce rework, enhance design accuracy, and shorten project cycles. Their ability to integrate with procurement, construction, and project management systems supports data consistency and traceability throughout the project lifecycle. These platforms exemplify how technology drives integrated engineering, allowing for better collaboration, improved visualization, and ultimately more efficient execution of large-scale industrial and infrastructure projects.

The digital platforms allow all disciplines to work concurrently. When a process parameter changes, it automatically updates related equipment, piping layouts, electrical loads, and control logic. Clash detection tools identify interferences early, thus reducing errors during construction. When cloud-based platforms are used, remote teams can collaborate seamlessly, accessing the same models and data sets without delays.

Integrated engineering environments also allow vendors to contribute models and specifications directly into the system. Their equipment data can be validated early in the design process, preventing mismatches and integration issues. Furthermore, integration with simulation and costing tools helps assess the impact of design decisions on the budget, performance, and environmental compliance.

To ensure success, organisations must define protocols for data governance, access rights, version control, and model maturity. Without these structures, even the best tools can lead to confusion rather than clarity.



RACI Matrix: Defining Roles for Seamless Coordination

In a multi-stakeholder environment, ambiguity in roles and responsibilities can become a major barrier to integration. Integrated engineering depends not only on shared tools but also on clearly defined ownership. That is where the RACI matrix becomes indispensable.

RACI stands for:

- **Responsible**: The person or team who completes the task.
- **Accountable**: The authority that approves the output and is ultimately answerable for its success.
- **Consulted**: Those who provide input or guidance during the task.
- **Informed**: Those who need to be kept updated on progress or decisions.

Consider the development of a piping and instrumentation diagram. The Process Engineer is responsible for preparing it. The Engineering Manager is accountable for ensuring that it aligns with the

overall design. The Instrumentation and Piping teams are consulted for layout and operational inputs. The construction and commissioning leads are informed to ensure downstream readiness.

The RACI matrix brings structure to this collaboration. It ensures that no task begins without clarity, no decision is taken without consultation, and no one is left unaware of the changes that affect their scope. When implemented digitally, it can be linked to model objects, workflows, and deliverables, making it a living governance tool.

Integrated projects benefit immensely from this clarity. Review cycles are shortened, responsibilities are respected, and delays caused by approval bottlenecks or miscommunication are significantly reduced.

Integrating Procurement and Vendor Engagement

Procurement is often treated as a downstream activity, but in an integrated engineering environment, it becomes an integral part of the design process. Equipment vendors are key contributors to technical accuracy, layout planning, and construction sequencing.

Long-lead items are identified during the early design phase. Vendors are selected not only for price but for their readiness to support digital collaboration. Those capable of providing detailed three-dimensional models, performance data, and design validation inputs are prioritised. These models are reviewed and integrated within the digital engineering environment to ensure early alignment.

Procurement teams, working closely with engineers, can identify potential risks in delivery schedules, interface mismatches, or constructability issues. The proactive approach reduces surprises and supports modular construction by aligning engineering with fabrication and logistics from the outset.

Vendor participation in design reviews further strengthens integration. Their practical insights help refine equipment specifications, support decisions on maintainability, and confirm installation feasibility. That leads to better design quality, fewer change orders, and improved safety outcomes at site.

Organisational Alignment for Integrated Delivery

Technology and governance tools must be supported by organisational change. Integrated project teams must be built to operate collaboratively, with shared goals and open communication.

Instead of discipline-based reporting lines, cross-functional delivery teams should be formed. These teams include representatives from engineering, procurement, construction, safety, operations, and commissioning. Team co-location, either physically or virtually, enhances responsiveness and fosters mutual understanding.

Leadership roles such as Integrated Engineering Manager or System Integration Lead are crucial. These individuals ensure that decisions are evaluated for their system-wide impact, that conflicts between disciplines are resolved early, and that the shared model is maintained with consistency.

Project review structures should also be realigned. Rather than conducting discipline-specific meetings, integrated design reviews should involve all key functions. These sessions focus not only on technical compliance but also on constructability, operability, and lifecycle cost. That results in better informed decisions and more robust designs.

Training programmes and performance appraisals should encourage integrated thinking. Engineers must be supported to develop cross-functional awareness and be evaluated not just on their technical output but also on their contribution to overall project success.

Real-World Results from Integrated Projects

Evidence from past projects highlights the effectiveness of integrated engineering. Earlier, in a project, traditional engineering could result in rework accompanied by delays in vendor data, conflicting layouts, and site improvisation, all of which could cause significant schedule slippages.

In a comparable project, the use of shared digital models, early vendor integration, and multidisciplinary collaboration allows the engineering phase to be completed 20 % faster. Construction proceeds with minimal field changes, and the plant achieves timely commissioning.

In a brownfield expansion of a chemical plant, point cloud scans enable a digital model to be of the existing plant. The scans can be integrated with new designs to ensure compatibility. The project proceeds without extending shutdown timelines and achieves full compliance in accordance with safety and process standards.

Over time, it has been demonstrated that integrated engineering delivers real, measurable value. It improves cost control, accelerates timelines, reduces risk, and enhances stakeholder confidence.

Conclusion

Embracing Integration is the New Standard. It is no more a trend or a technological upgrade. It is a fundamental shift in how projects are conceived, designed, and delivered. In a world where infrastructure must be sustainable, reliable, and rapidly deployable, integration is essential.

That transformation is not achieved by tools alone. It requires new ways of thinking, new roles, and new behaviours. It requires collaboration across organisational boundaries and a willingness to challenge long-standing silos.

For countries such as India, with ambitious goals for infrastructure and industrial growth, integrated engineering offers a pathway to deliver with quality, speed, and cost efficiency. Above all – no rework.

For Consulting organisations seeking to remain competitive, it is a strategic capability that must be developed, institutionalised, and continuously improved.

By aligning people, processes, and platforms, integrated engineering enables engineering a better future intelligently, cohesively, and confidently.

06

Transformative Frameworks - Integrated Project Delivery and Engineering - of Projects

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Executive Summary

India's journey toward becoming a high-income nation by 2047 hinges on its ability to deliver resilient, efficient, and sustainable infrastructure. However, traditional project delivery methods- characterized by fragmented planning, siloed execution, and reactive problem-solving -have led to inefficiencies, delays, and cost overruns. This paper advocates for the adoption of Integrated Project Delivery (IPD) and Integrated Engineering as transformative frameworks. These approaches emphasize early stakeholder engagement, multidisciplinary collaboration, digital enablement, and shared accountability. By aligning engineering disciplines and leveraging technologies such as BIM, GIS, IoT, and AI, IPD fosters innovation, enhances operational efficiency, and ensures sustainability.

Key benefits include:

- Streamlined workflows and reduced rework
- Proactive risk mitigation and conflict resolution
- Cost optimization through shared intelligence
- Environmentally responsible design and execution

Real-world case studies - from aviation industries to smart industrial corridors—demonstrate the tangible impact of integrated delivery models. The paper concludes with policy recommendations to institutionalize IPD in public procurement, mandate digital tools, and build professional capacity for integrated, future-ready infrastructure development.

Background

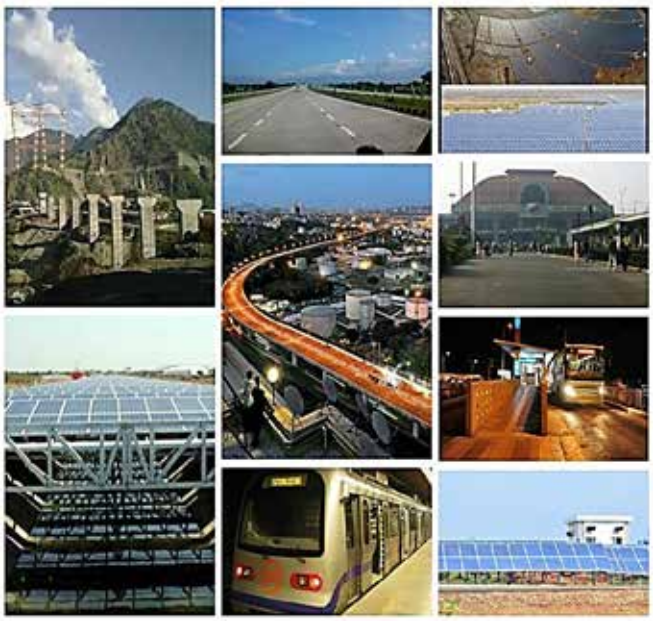
India stands at a pivotal juncture in its development journey. As the nation aspires to become a high-income country by 2047, marking 100 years of independence, it faces the monumental task of transforming its infrastructure landscape to support rapid industrialization, urbanization, and economic growth. Achieving that vision will require not only massive investments, estimated to exceed $4.5 trillion by 2040, but also a fundamental shift in how infrastructure projects are conceived, designed, and executed. One of the most pressing challenges in India's infrastructure development is the fragmented nature of project planning and execution. Projects often suffer from siloed decision-making, a lack of coordination among stakeholders, and inadequate integration across engineering disciplines. That leads to cost overruns, delays, rework, and in many cases, the need to retrofit or modify newly built infrastructure, resulting in wasted public resources and at the same time causing inconvenience to the public.

To overcome these systemic inefficiencies, there is an urgent need to adopt an Integrated Delivery of Projects (IDP) approach. At its core, IDP emphasizes collaborative, multidisciplinary planning and execution, ensuring that all engineering, architectural, environmental, and digital components of a project are harmonized from the outset. This approach is not just a technical necessity but a strategic imperative for building future-ready, resilient, and sustainable infrastructure.

Relevance to India's Development Goals

India's ambitious national programs such as Gati Shakti, Smart Cities Mission, AMRUT, and PM Gati Shakti National Master Plan underscore the importance of integrated infrastructure development. These initiatives aim to break down silos between ministries and departments, promote data sharing, and streamline project approvals and execution. However, to fully realize their potential, these programs must be underpinned by a robust framework for integrated engineering and project delivery.

Moreover, as India increasingly embraces digital infrastructure, green technologies, and urban mobility solutions, the complexity of projects will only grow.



Integrated delivery models will be essential to manage this complexity, ensure interoperability, and align infrastructure development with broader goals such as climate resilience, energy efficiency, and inclusive growth

This paper explores the principles and benefits of integrated engineering, supported by real-world case studies that demonstrate its effectiveness in delivering high-impact infrastructure projects.

What Integrated Engineering Implies

Integrated engineering represents a design-led, project-based methodology that brings together diverse engineering disciplines—civil, mechanical, electrical, computer science, and digital technologies—into a unified framework. It fosters innovation, reduces duplication of efforts, and enhances the overall quality and performance of infrastructure systems. Unlike traditional engineering models that often operate in silos, Integrated Engineering fosters real-time collaboration, data-driven decision-making, and lifecycle-oriented planning. These attributes are essential for managing the increasing complexity of modern infrastructure projects, particularly in rapidly developing economies like India. The result is infrastructure that is not only delivered on time and within budget but is also resilient, adaptable, and future-ready.

Integrated vs Traditional Project Delivery: A Comparative Perspective

Integrated Engineering distinguishes itself from traditional project delivery through its holistic design philosophy and strategic integration of multidisciplinary knowledge. That approach accelerates innovation and supports the development of sustainable, high-performance infrastructure.

The key differences between Traditional Project Delivery and Integrated Project Delivery (IPD) are outlined in Table-1:

Table-1: Key differences between Traditional Project Delivery and Integrated Project Delivery

Parameter	Traditional Project Delivery	Integrated Project Delivery (IPD)
Team Structure Fragmented, assembled as needed, hierarchical control		Integrated from inception, includes all stakeholders, collaborative
Process Flow	Linear, segmented, delayed information flow, siloed expertise	Concurrent, multi-level, early input, transparent sharing
Risk Management	Individually managed, prone to blame-shifting	Shared and collectively managed, promotes cooperation
Compensation Model	Cost-based, focused on individual success	Value-based, tied to overall project success, encourages teamwork
Communication	Verbal/written, slow, prone to misinterpretation	Real-time digital tools, efficient and transparent
Contractual Agreements	Unilateral effort, risk transfer without collaboration	Shared goals, risk-sharing, promote collaboration

Framework for Integrated Engineering: Pillars of Collaborative Innovation

The Integrated Engineering framework is built on the pillars and principles of collaborative working and innovation (Refer Table-2).

Table-2: Pillars and Principles of Collaborative Working and Innovation

Multidisciplinary Collaboration	Professionals from various engineering domains engage in cohesive teamwork to address multifaceted challenges
Early Stakeholder Engagement	Involvement of all key players - engineers, architects, contractors, and clients - from the project's inception
Systemic Integration	The seamless incorporation of multiple disciplines ensures a unified and efficient engineering process
Shared Goals and Accountability	Collective ownership of risks, rewards, and outcomes.
Technology Enablement	Advanced digital tools are employed to enhance workflow efficiency, asset management, and production timelines
Experiential Learning	Project-based learning serves as the primary vehicle for skill acquisition and practical application
Professional Competency Development	Emphasis is placed on cultivating interpersonal and collaborative skills, enabling engineers to function effectively within team-based environments

Outcomes of Integrated Engineering

When implemented effectively, Integrated Project Delivery (IPD) and Integrated Engineering yield transformative outcomes:

- **Enhanced Operational Efficiency through integration**

  By interlinking diverse systems and processes, integrated engineering significantly improves workflow efficiency. The interconnected approach accelerates project timelines, minimizes delays, and boosts overall productivity through visibly streamlined operations.

- **Proactive Conflict Resolution and Risk Mitigation**

  A core tenet of IPD is the early identification and resolution of conflicts through shared data environments and collaborative planning. Integrated engineering supports this by leveraging real-time analytics and digital tools such as Building Information Modeling (BIM) and Geographic Information Systems (GIS). These technologies enable teams to anticipate issues, simulate outcomes, and implement corrective actions before problems escalate, ensuring smoother execution and reducing the risk of costly disruptions.

- **Cost Optimization through shared intelligence**

  IPD promotes transparency and shared financial accountability, aligning with integrated engineering's emphasis on data-driven decision-making and resource optimization. By eliminating redundancies and aligning operational goals, integrated systems reduce waste and enhance cost efficiency. This collaborative financial stewardship not only ensures budget adherence but also fosters innovation through more agile and informed project management.

- **Sustainability as a Core Value**

  Sustainability is embedded in both IPD and integrated engineering frameworks. Through collective goal-setting and integrated design processes, teams can prioritize eco-friendly materials, renewable energy solutions, and efficient construction methods. Technologies such as digital twins and IoT devices further support environmental stewardship by enabling real-time monitoring and adaptive management of energy and resource use. This alignment ensures that infrastructure projects meet both regulatory standards and societal expectations for environmental responsibility.

Integrated Engineering Design Workflow in IPD

Designing and executing large-scale infrastructure projects is a multifaceted endeavour that demands advanced engineering, strategic foresight, and seamless collaboration. These projects are not only technical milestones but also symbols of societal advancement, shaping urban landscapes, enabling economic growth, and improving quality of life. Their inherent complexity requires synchronized coordination across various phases and disciplines, involving engineers, architects, planners, other professionals, contractors, and stakeholders. Success in such ventures hinges on meticulous planning, adaptability, and deep technical expertise. From iconic bridges to energy facilities, these developments exemplify innovation, sustainability, and the enduring impact of collaborative engineering excellence.

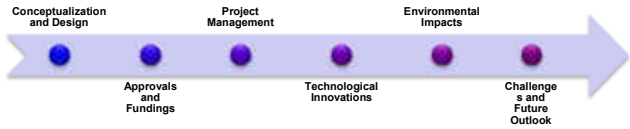


Figure-1: Workflow in IPD

The workflow, as shown in Figure-1, begins with conceptualization and design, where a project's vision is translated into actionable plans. Engineers and designers assess the project's purpose, be it transportation, energy, or public utilities, while considering geographic and environmental conditions, budgetary constraints, regulatory frameworks, and material integrity. For instance, designing a bridge involves geotechnical engineering to determine the soil parameters and decide on the type of foundation,

evaluate the flood levels, scour depth, and associated risks and solutions for those conditions, and select materials that ensure both safety, longevity and maintainability.

Following this, regulatory approvals and funding become critical. Engineers engage with regulatory bodies to ensure compliance with environmental, safety, and zoning standards. This phase includes preparing technical documentation, demonstrating feasibility, and addressing stakeholder concerns. Simultaneously, collaboration with financial planners ensures that cost estimates, risk assessments, and funding strategies align with the project's viability and long-term goals.

The construction and project management phase are where planning meets execution. Effective management involves defining scope and objectives, scheduling resources, mitigating risks, and coordinating multidisciplinary teams. Challenges such as stakeholder conflicts, technical setbacks, or supply chain disruptions are common, necessitating strong leadership and agile strategies to maintain momentum and quality.

A defining feature of modern infrastructure development is the integration of technological innovation. Tools such as Building Information Modeling (BIM) enable the creation of detailed 3D models that enhance collaboration and planning accuracy. Geographic Information Systems (GIS) support spatial analysis for informed decision-making. The Internet of Things (IoT) introduces real-time monitoring through smart sensors, while digital twins simulate and optimize asset performance across lifecycles. Artificial Intelligence (AI) and Machine Learning (ML) facilitate data-driven insights for risk analysis and resource optimization. Drones enhance surveying and inspection, while Augmented and Virtual Reality (AR/VR) provide immersive design visualization and training. Cloud-based platforms centralize data for real-time collaboration, and innovations in materials, prefabrication, robotics, and automation further streamline construction, improve safety, and boost productivity.

Equally important is environmental stewardship and sustainability. Integrated engineering prioritizes eco-friendly materials, renewable energy integration, water conservation, and energy-efficient designs. Projects are increasingly designed with biodiversity in mind, incorporating features such as wildlife corridors and noise-reduction systems to minimize ecological disruption.

Despite these advancements, challenges and future outlook issues remain. Complex stakeholder dynamics, environmental uncertainties, and budgetary pressures continue to test project resilience. However, the future of infrastructure lies in embracing integrated, technology-driven, and sustainable approaches. Engineers will play a pivotal role in this transformation, leveraging innovation to build smarter, greener, and more inclusive cities that stand the test of time.

Some real-world scenarios where integrated delivery generated measurable benefits are given hereinafter:

Industrial Smart Cities and Industrial Clusters

The Industrial Corridor Development Program represents a transformative vision by the Government of India to catalyze industrial growth and urban modernization through the creation of Smart, Sustainable, and Technologically Advanced Industrial Cities. At the heart of the initiative lies the adoption of Integrated Project Delivery (IPD), a collaborative project execution model that aligns stakeholders, disciplines, and technologies from the outset to ensure seamless planning, execution, and long-term value creation.

A cornerstone of the Industrial Corridor Development Program's success is its emphasis on early and sustained collaboration. From the initial planning stages, the program brings together central and state governments, urban planners, engineering consultants, contractors, and technology providers. This early engagement ensures that all parties are aligned on project objectives, timelines, and deliverables, significantly

reducing duplication of efforts and fostering a shared vision. The result is a unified project ecosystem where ownership and accountability are distributed across all stakeholders.

The program's interdisciplinary integration is a hallmark of IPD. Civil, electrical, mechanical, environmental, and ICT/ telecom engineers and other professionals work in tandem from the design phase, enabling the development of smart infrastructure systems that are efficient, resilient, and future-ready. This convergence of expertise facilitates the deployment of integrated utilities, intelligent transport systems, and digital governance platforms - hallmarks of a truly Smart City.

Transparent communication and real-time decision-making are enabled through robust digital infrastructure. Centralized data platforms and real-time dashboards provide stakeholders with up-to-date project metrics, enabling swift resolution of issues and agile adaptation to evolving project needs. This transparency builds trust and ensures that decisions are informed, timely, and aligned with strategic goals.

The program also exemplifies lean and integrated project management. A centralized governance framework oversees contracts, quality assurance, and value engineering, ensuring that resources are optimized and waste is minimized. This lean approach enhances operational efficiency and accelerates project timelines without compromising quality.

Innovation and technology enablement are deeply embedded in the program's DNA. The corridors leverage Industry 4.0 technologies - such as advanced analytics, IoT, and AI - to enhance infrastructure performance and service delivery. Smart grids, automated logistics hubs, and sensor-based monitoring systems are integrated into the urban fabric, making these cities not only intelligent but also adaptive to future challenges.

Recognizing the importance of human capital, the program invests in capacity building and knowledge sharing. Structured training programs, workshops, and digital learning platforms equip local authorities and professionals with the skills needed to manage and sustain these complex ecosystems. This ensures that the benefits of the program extend beyond infrastructure to institutional resilience and long-term development.

A defining feature of the program is its relationship-based leadership model. Strong inter-agency coordination and stakeholder engagement foster a culture of collaboration and mutual respect. This approach is critical for navigating the complexities of large-scale infrastructure development and for maintaining momentum across multiple project sites.

Finally, the program maintains a strong community and ecosystem focus. Projects are designed with inclusivity and environmental stewardship in mind, incorporating green spaces, water conservation systems, pollution control measures, and affordable housing. These elements ensure that the industrial corridors are not only engines of economic growth but also models of sustainable and inclusive urbanization.

In summary, the industrial Smart Cities program demonstrates how Integrated Project Delivery, when applied at scale, can revolutionize infrastructure development. By aligning people, processes, and technologies from the outset, the program delivers smart cities that are efficient, resilient, and responsive to the needs of both industry and society.

Integrated Asset Management and Digital Strategy for Sustainable Water Infrastructure

A leading water utility company in the Middle East launched a transformative digital asset validation and condition assessment program aimed at enhancing infrastructure performance, reducing water loss, and supporting climate-resilient water management. Central to this initiative was the development and deployment of an AI and Machine Learning (ML) powered condition assessment tool, integrated within a broader digital ecosystem.

The initiative began with a strong foundation of proactive stakeholder engagement and collaborative planning. Delivery partners, including technology providers, data scientists, and infrastructure experts, worked together to define a unified vision for digital transformation. This early alignment ensured that the AI/ ML tools were designed with a deep understanding of operational realities, regulatory requirements, and environmental goals.

The core of the digital transformation was the AI-enabled condition assessment platform, which incorporated and applied to CCTV inspection footage to automatically detect anomalies such as cracks, corrosion, and blockages in pipelines. Machine Learning was used to train on historical failure data and environmental variables to predict asset degradation and failure probabilities.

This innovation significantly improved operational efficiency by reducing downtime, lowering maintenance costs, and enhancing service reliability. It promoted water conservation and ensured regulatory compliance through transparent, auditable infrastructure data.

Following a successful pilot, the platform is now poised for broader deployment across the utility's network. Future enhancements include the integration of reinforced learning for adaptive maintenance, expansion of the digital twin to cover stormwater and wastewater systems, and the use of edge AI for real-time analytics at remote sites, ensuring continued innovation and scalability.

To ensure long-term success, the initiative invested in knowledge transfer and capacity building. Structured training programs and system integration workshops equipped teams with the skills and tools needed to manage infrastructure proactively. This emphasis on institutional development fostered a culture of continuous improvement and operational excellence, ensuring that the benefits of the initiative would endure well beyond its initial implementation.

Concluding Insights and Policy Recommendations

To effectively enhance Integrated Project Delivery (IPD) and support India's ambition of becoming a high-income, climate-resilient nation by 2047, targeted policy reforms are essential. These should begin with embedding IPD into public procurement frameworks, shifting from cost-centric to value-based project selection. Mandating digital tools like BIM, GIS, IoT, and AI will improve design precision, enable real-time monitoring, and foster collaboration. Policies must also promote early, cross-disciplinary engagement and incentivize sustainable design practices. Capacity building through training and curriculum reforms will equip professionals with the skills needed for integrated, digital-first project delivery. Crucially, sustainability must be a core policy pillar, requiring infrastructure projects to meet environmental performance benchmarks, integrate renewable energy, and adopt circular economy principles. Establishing dedicated IPD governance bodies will ensure coordination, accountability, and conflict resolution. Real-time data governance and automated, transparent reporting will further support informed, adaptive decision-making. These reforms will enable India to deliver efficient, inclusive, and future-ready infrastructure that not only drives economic growth but also aligns with global sustainability goals and addresses the challenges of rapid urbanization and climate change.

References

1. Integrated Engineering - A Fascinating Comprehensive Guide - DotCom Magazine-Influencers And Entrepreneurs Making News
2. Integrated Project Delivery: A Guide – AIA National | AIA California Council
3. The Engineering Behind Large-Scale Infrastructure Projects: Engineering Institute of Technology
4. Global Infrastructure Outlook report, The Global Infrastructure Hub, a G20 initiative

07

Integrated Engineering of Projects: A Dire Need for India's Growth Trajectory

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India, the world's fourth-largest economy, is on an ambitious growth trajectory to become the third largest by 2027, with a projected GDP of US$ 5 trillion, according to estimates by the International Monetary Fund (IMF). By 2047, marking the centenary of Independence, India aims to achieve a US$ 30 trillion economy, embodying the vision of a Viksit Bharat - a fully developed nation characterized by economic prosperity, technological innovation, social equity, and sustainable infrastructure. That transformative journey requires addressing the complexities of rapid urbanization, escalating mobility demands, and constrained resources.

India has experienced remarkable growth over the past two decades, establishing itself as a global economic powerhouse. In the fiscal year 2023-24, the country's spending reached an unprecedented ₹10 lakh crores (₹10 trillion), demonstrating the government's dedication to driving economic development through improved connectivity, trade facilitation, and enhanced quality of life. Initiatives like the PM Gati Shakti National Master Plan, launched in 2021, coordinate efforts across ministries such as Railways, Road Transport, and Civil Aviation to develop seamless, multimodal networks. India now possesses the world's second-largest road network, with 1.46 lakh kilometers of National Highways forming the critical backbone of transportation. The aviation sector has also transformed, becoming the third-largest domestic market globally, fuelled by policy reforms and increasing passenger demand.

Defining Integrated Engineering - A Holistic Approach

Integrated Engineering transcends traditional project delivery by uniting diverse disciplines into a cohesive framework. Unlike siloed approaches where disciplines operate independently, integrated engineering emphasizes early stakeholder engagement, collaborative design, and lifecycle thinking. It ensures that all projects, whether highways, metro systems, airports, or water networks, are planned and executed with precision, efficiency, and foresight. The key principles include:

- **Early Collaboration**: Engaging all stakeholders - engineers, architects, planners, contractors, and clients - from the conceptual phase prevents misalignments and reduces rework. For example, co-designing electrical ducts, communication ducts, gas ducts, water supply pipelines, sewer lines, stormwater drainage, and pedestrian pathways during planning avoids costly retrofits and enhances safety.

- **Digital Innovation**: Advanced digital tools now allow for real-time simulation and early conflict detection, helping to identify system clashes before construction starts. Dynamic modelling technologies also enable continuous performance monitoring and proactive maintenance planning, ensuring long-term operational efficiency.
- **Lifecycle Thinking**: Integrated engineering considers the entire project lifecycle, from design to decommissioning, ensuring that projects remain viable and adaptable to future challenges like climate change or population growth.

Traditional, siloed methods of development, characterized by fragmented planning and execution, fall short in addressing today's complex challenges. Integrated engineering - a multidisciplinary, systems-oriented approach that brings together planning, design, construction, and lifecycle management - forms the foundation for India's future growth.

An Integrated engineering approach is presented in this paper by two projects: the Kolkata East-West Metro Corridor and the Chaudhary Charan Singh International Airport Terminal 3, Lucknow. These projects highlight how technical expertise across engineering disciplines, digital innovation, and stakeholder collaboration delivers sustainable and high-impact infrastructure.

Kolkata East-West Metro Corridor: Navigating Urban Complexity

The Kolkata East-West Metro Corridor, featuring India's first under-river metro tunnel beneath the Hooghly River, represents a landmark achievement in urban transportation. The ambitious project confronted significant challenges, including tunnelling through a densely populated city with complex geotechnical conditions and a heavy monsoon period. The key design and project management consultant demonstrated integrated engineering through comprehensive planning, digital innovation, stakeholder coordination, and a strong focus on sustainability. Extensive geotechnical surveys and risk assessments were conducted to map soil conditions and anticipate seismic risks, ensuring the structural integrity of the tunnel while minimizing disruptions to Kolkata's urban fabric.

Advanced digital simulation tools were used to enable real-time visualization of the tunnel's design, identifying potential clashes between structural, electrical, and ventilation systems early in the process. Additionally, intelligent modelling tools provided a dynamic representation of the project, allowing for real-time tracking of construction progress and forecasting of future maintenance needs, thereby supporting long-term reliability.

Effective collaboration between contractors, government agencies, and local communities was facilitated through public consultations, aligning on safety, environmental, and operational goals to minimize disruptions to residents and businesses. Sustainability was prioritized through the integration of energy-efficient ventilation systems, low-carbon materials, and innovative water management solutions to address Kolkata's flooding risks, significantly reducing the project's carbon footprint while enhancing resilience to climate challenges. The completed corridor enhances urban mobility, alleviates traffic congestion, and supports Kolkata's economic growth, setting a benchmark for complex urban projects through the seamless integration of disciplines and advanced technology.

Chaudhary Charan Singh International Airport – Terminal 3, Lucknow

Terminal 3 at Lucknow's Chaudhary Charan Singh International Airport, was executed as a forward-thinking, sustainable terminal that aligns with the Airports Authority of India's (AAI) vision for enhanced regional connectivity and environmental stewardship. The project demanded a balance of accelerated construction timelines, long-term scalability, and ecological responsibility. A holistic approach ensured success through meticulous planning, sustainable design, advanced digital tools, and comprehensive oversight.

Early ground surveys and geophysical radar investigations enabled mapping of underground utilities and assessing soil conditions, establishing a solid foundation. Detailed Master Plans and 3D models were used to optimize spatial efficiency for future expansion while integrating local cultural aesthetics. The terminal has solar panels, rainwater capture, and energy-efficient MEP systems to minimize operational expenses and environmental footprint in accordance with India's climate objectives. They enabled providing a cost-effective and eco-friendly facility to function as designed throughout its life cycle, including the utilization of 2,500 LED lights to minimize energy consumption.

Utilizing advanced 3D modelling and virtual walkthroughs enabled streamlining stakeholder approvals and improved design accuracy, resulting in more efficient project planning and execution. Clash detection mitigated conflicts between structural and MEP systems, keeping the project on time and within budget. Robust financial modelling, transaction advisory, and bidding management were also provided to secure economic viability, while rigorous on-site supervision upheld uncompromising quality standards.

The result was a state-of-the-art terminal that elevates passenger experience, strengthens regional connectivity, and serves as a benchmark for scalable, sustainable infrastructure. Terminal 3 reinforces Lucknow's position as a vital regional hub, embodying the power of integrated engineering to meet community and environmental needs.

Sustainability: The Heart of Integrated Engineering

Environmental responsibility needs to lie at the heart of the planning, design and construction philosophy. Renewable energy, low-carbon materials, and climate-resilient design principles must be incorporated to create infrastructure that not only minimizes the environmental footprint but also responds to some of the most urgent challenges facing the world today, including extreme weather conditions and resource scarcity.

The Impact on Projects of other Sectors

The integrated engineering approach extends across diverse sectors, amplifying its impact on India's infrastructure landscape.

a. Transportation domain: In the Mumbai Metro Line 3, cutting-edge tunnelling methods have been combined with thoughtful urban planning to boost connectivity across the city. Environmental and social benefits of the project - Road decongestion leading to improved air quality in a city currently displaying a PM 2.5 value at 5.8 times the WHO guidelines and providing efficient and convenient public transportation to a previously under-serviced district.

b. Water sector: The Jal Jeevan Mission (JJM) was supported by designing sustainable water supply systems that prioritize rural accessibility and long-term maintenance. JJM, which was initiated in 2019, has delivered tap water connections to over 15.44 crore rural households by February 2025, covering nearly 80% of rural India and significantly improving health and living standards.

c. Tourism and Sports sectors. Projects are being done in partnership with the Mizoram Tourism Development Authority. In sports, it is for the Birsa Munda International Stadium in Rourkela, Odisha, which will be home to India's largest hockey stadium with a 20,000 spectator capacity. These projects showcase the ability to adapt an integrated approach to diverse contexts, delivering solutions that are technically sound, socially impactful, and environmentally sustainable.

d. Swachh Bharat Mission (Grameen): Over 10,000 villages are being helped to achieve ODF Plus status by integrating technical expertise with community engagement, delivering sustainable sanitation solutions that empower rural communities. In the Urban95 Phase II program in Pune, Egis as the consultant, collaborated with the Pune Municipal Corporation and the Bernard van Leer Foundation to create child-friendly urban spaces, enhancing livability through integrated urban planning.

All the projects demonstrate how integrated engineering extends beyond technical execution to foster social equity, environmental responsibility, and community well-being.

A Unified Vision for India's Future

What is 'Vital' is India's commitment to igniting a culture of innovation, unleashing the power of its human capital, and building future-ready infrastructure that not only bridges regional divides but also unlocks the limitless promise of Bharat in its entirety - from the grassroots to the global stage. Integrated engineering is key to the vision, through breaking barriers of fragmentation, leveraging digital technologies, and focusing on lifecycle management.

With India accelerating its development agenda, mainstreaming integrated engineering as a way of working will ensure timely completion, budget not being exceeded, and sustained dividends. The integrated approach will help change and develop assets that enrich communities, enhance the quality of life, and contribute to India's economic and environmental goals. By working together, innovating, and prioritizing sustainability, it is possible to design a future not only to satisfy current needs but also to establish the foundations of a successful, sustainable, and inclusive India.

About Egis: A Leader in Integrated Engineering

Egis is a world leader in architecture, consulting, construction engineering, operations, and mobility services. We design and deliver projects that meet the challenges of the climate crisis while fostering balanced, sustainable, and resilient development. With a staff of 20,500 professionals in over 100 nations, we provide cutting-edge expertise and creative solutions to our customers. Egis combines multidisciplinary expertise, digital innovation, and client-centric collaboration to deliver transformative infrastructure. Its approach rests on four core pillars:

a) Multidisciplinary Expertise:

b) End-to-End Service Delivery;

c) Client-Centric Collaboration;

d) Technology-Driven Innovation.

Egis is committed to ensuring that 75% of its projects are eco-designed by 2025., and 100% by 2030. With more than 40 years of technological innovation at the heart of our purpose, we are committed to fighting climate change and improving living environments by means of intelligent, sustainable solutions. we provide low to zero carbon solutions across every stage of a project — from consulting to operations and maintenance.

08

Integrated Water Supply Systems for Islands of Maldives – Case Study

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Abstract

The Republic of Maldives, an archipelago located approximately 500 kilometres south-west of India, comprises 1,192 coral islands. Of those, 200 are inhabited, 90 are designated as tourist resorts, and the remainder are uninhabited. The islands are grouped into 26 geographical atolls, which are further organised into 20 administrative atolls. The highest elevation across the islands is less than 2.5 metres above the mean sea level. A significant proportion of the Maldivian population faces challenges in accessing safe drinking water and improved sanitation facilities. As a result, the island communities are contending with groundwater contamination caused by inadequate sanitation infrastructure and excessive groundwater extraction. To tide over these issues, the Government of the Republic of Maldives decided to develop the water supply systems on four islands, viz. R. Maduvvaree, Sh. Foakaidhoo, B. Dharavandhoo, and Hdh. Nolhivaranfaru, which have a combined population of 7,079.

This paper focuses on the design and implementation of the comprehensive Integrated Water Resource Management (IWRM) project, aimed at providing safe, potable, and sufficient water to the residents of the selected islands. The water supply system adopted was a hybrid system, incorporating both rainwater harvesting and groundwater extraction. The system features advanced treatment technologies, such as ultrafiltration and reverse osmosis, integrated into a unified storage and distribution network.

Introduction

A large part of the population in the Republic of Maldives lacks access to safe drinking water and proper sanitation facilities. The current water source is rainwater, which is harvested in private household

tanks and community storage tanks. The storage capacity is not sufficient, and it was thus necessary and essential to install a proper water supply system to provide potable water to the population of the islands.

The Ministry of Environmental & Energy (MEE) of the Government of Maldives awarded the work for developing integrated water supply facilities in the four Islands, namely R. Maduvvaree, Sh. Foakaidhoo, B. Dharavandhoo, and Hdh. Nolhivaranfaru.

The project necessitated data collection, topographic survey, geotechnical investigation, rooftop measurements, and design of the water supply facilities in each of the four islands and, thereafter, supervision of the execution of the schemes. The schemes for all the four islands are functioning properly and have benefited the population of the islands.

Integrated Water Supply – Definition

The term Integrated Water Supply for the project meant taking raw water from different sources and treating it with different technologies, then combining the treated water for supplying through a single network. For the four islands, there were two sources, rainwater and ground water. Both after treatment are stored in a common tank. Ultrafiltration was used for treating Rainwater and Reverse Osmosis for groundwater. The treated water is supplied to the residents through a pumped distribution network and house service connections.

Project Areas

The areas of the four islands are shown in Table-1 and their location in the map in Figure-1.

Table-1: Geographical locations and Areas of the Islands

Island Wise Description	R. Maduvvaree	Sh. Foakaidhoo	B. Dharavandhoo	Hdh. Nolhivaranfaru
Atoll	Raa Atoll	Shaviyani (SH.) Atoll	Baa Atoll	Haa Dhaalu Atoll
Location	5° 29′ 05″ N, 72° 53′ 56″ E	6° 19′ 35″ N, 73° 08′ 57″ E	5° 09′ 30″ N, 73° 07′ 50″ E	6° 41′ 49″ N, 73° 07′ 12″ E
Distance from Male (km)	159.55	239.87	116.30	281.59
Length (km)	0.65	1.050	1.33	3.8
Width (km)	0.325	0.680	0.480	0.9
Area of Island (Ha)	22.60	70.90	56.10	172.0

Figure-1: Administrative divisions of the Maldives (Source: https://www.mymaldives.com/maldives/atolls/)

The Project

The intent of the project was to develop proper water supply systems to facilitate safe, potable and adequate quantity drinking water for the population on each of the four islands. There are only two sources of water – Rain water and Ground water.

Rainwater

Rainwater is collected from the rooftops and conveyed through a network of pipes to the treatment site.

Borewell

The water from a 35 meter deep bore well is the feed water for the Reverse Osmosis Plant. The pumping capacity was designed such that one pump can supply the required feed water for the Reverse Osmosis Plant. The conductivity of Boreholes was to be 50,000 µS/cm, and if that was not there at 35m depth, the borehole was drilled further to achieve the required conductivity.

Figure-2: Typical RWH Installations in Maldives
Source: Design of RWH in Maldives

Sample Analysis

The Rainwater and the Groundwater samples were analysed to determine the treatment that would be necessary. The test results are given in Table-2.

Table-2: Results of Water Quality for Rainwater and Groundwater

S No.	Parameter of Water Quality	Value
1	Rainwater	
2	TSS (mg/l)	100
3	pH	7
4	TDS (mg/l)	25
5	Ground Water	
6	TDS (mg/l)	375
7	Chlorides as Cl^- (mg/L)	10
8	Ammonia as NH_3 (mg/L)	0.287

Treated Water Standards:

The rainwater and borewell water were treated to meet the water quality standards as per WHO.

Rainwater Harvesting (RWH)

The Rainwater harvested from a roof can be used for potable purposes by storing it in a tank after taking it though proper filtration to remove the dirt and floating materials.

The data collected for Sh. Foakaidhoo Island indicated that the average annual rainfall of Maldives is 1800 mm.

The rain water from the roof is led through eaves gutters to down take pipes which are connected to a first flush device, provided on all down take pipes so that no solid or floating matter enters the network.

The rainwater flows by gravity through the conveyance network and collects in a lift well at the entry of the treatment plant site where it is treated by ultrafiltration process and then stored in reservoirs.

Existing Roof Top Harvesting System

Existing Rainwater Storage Tanks

Ground (Borewell) Water

Based on the raw water analysis of the groundwater, Reverse Osmosis was adopted for treatment to remove the salt, dissolved or suspended chemical species as well as biological substances and other effluent materials from the raw water.

Brine Disposal

The brine, the reject water of the desalination process was disposed off in accordance with the Desalination Plant Regulation of EPA in the Maldives.

The outfall pipelines were High Density Polyethylene, class PN16, with a T-head diffuser installed at the termination point of the outfall.

Supervision and Construction Management

The execution activities were monitored by a dedicated team on each Island.

Design of the Integrated Water Supply Scheme

The components of the Water Supply Scheme on each island were Collection, Treatment, Storage, and Distribution.

Collection & Conveyance System

Hydraulic designs were done based on the calculation of the peak discharge for the conveyance of rainwater to the treatment site for further distribution/ use.

Based on the rainfall data for the period of 2006 to 2015, the design rainfall intensity of 52.78 mm/ hr was adopted for the calculation of peak discharge.

The rainwater collected is pumped from the Collection Well to the raw water tank of the WTP for further treatment.

Treatment Methods

Ultrafiltration System

Packaged treatment plants, prefabricated and pre-wired, almost plug-and-play systems were provided, being more suitable for use in remote areas and by local communities in an affordable manner. The ultrafiltration-based water treatment system produces potable water quality by filtering bacteria, viruses and particles from raw source water.

Reverse Osmosis Plant

a. Pretreatment

Raw water from the bore well is filtered through multimedia filters or screen filters and bag filters before being fed to RO membranes. The primary filtration protects the high-pressure pump and RO membranes from very fine particles.

b. Reverse Osmosis

The pump is designed to supply the required feed water for the RO Plant at the design pressure. The reverse osmosis membranes filter the feed water to produce 30 – 33 % of fresh water; the rest is concentrated brine.

Two RO plants were installed to meet the daily demand. The effluent water quality conformed to the EPA water quality guidelines and standards.

Post Treatment & Water Storage

The water from the RO process is passed through a Degassifier to remove the dissolved Hydrogen Sulphide and then led to the treated water storage tank by gravity. A disinfectant solution is dosed into the inlet pipe of the storage tank.

Integrated Storage

A raw water storage tank was provided based on typical deficit and surplus water balance calculations. The treated water storage tank is for 7 days of water demand. These Islands, being small and within the Indian Ocean prefabricated RTP tanks were installed.

Distribution

The water distribution system has been designed for a capacity to meet the water supply needs of the consumer under all demand conditions. For the project Island Sh. Foakaidhoo, the total quantity of water for potable purposes was based on a 20 Lpcd demand.

Pumped System

A pumped distribution system has been provided for each of the four Islands.

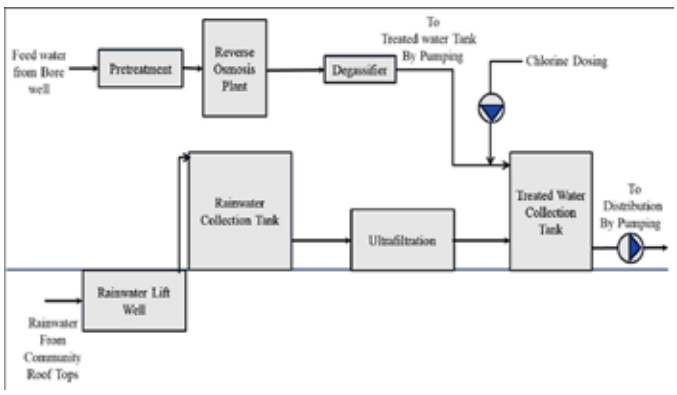

Figure-3: Schematic Diagram of Water Supply Scheme

RO Plant

Administration Building

Degassifier

Pumping System for Distribution

UF Plant

MGF

Overall Layout of the Treatment Site

RTP Tanks

Conclusion

The scheme of integrating the Rainwater and the Borewell water is functioning well, and the residents of all four Islands have benefitted. Many challenges were faced while executing the project, especially to optimise the rate of groundwater extraction since the water table is very high. Ultimately, it was heartening to see the satisfied consumers whose hardships had been set aside with the implementation of the scheme.

Acknowledgement

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References

1. Design Criteria and Technical Specifications - Design and Construction of Water Treatment and Supply System
2. Guidelines and Manual for Rainwater Harvesting in Maldives, Ministry of Housing Transport and Environment, Government of the Republic of Maldives, Technical Support, World Health Organization, Male, Maldives July 2009
3. Manual on Water Supply and Treatment, CPHEEO, MoUD, New Delhi, India

09

Integrated Engineering - To Make Complex Projects Work Seamlessly

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Introduction

Imagine building a large hospital - a place that must operate without fail, every second of every day. Now imagine dozens of specialist teams, each working in different areas and systems such as electrical systems, air conditioning, plumbing, medical gases, and more, often without knowing what the others are doing. What happens? Delays. Rework. Cost overruns. Frustration. That is why Integrated Engineering is no longer a luxury - it is a necessity. Especially in critical projects like healthcare infrastructure, a siloed approach almost guarantees problems. Integrated design and coordination from day one can be the difference between success and costly failure.

The Challenge: Complexity In Modern Projects

Hospitals are among the most complex structures to design and build. They must be planned, designed and built as integrated entities and provide for:

- Uninterrupted high-reliability power systems,
- Specialized HVAC solutions for infection control,
- Medical gas pipelines adhering to global standards,
- Smart IT, Security, and Nurse Call systems, and
- Fire safety systems, water treatment, and waste management systems

Each system is essential, but each also competes for space and resources inside the same building. Without early coordination, systems clash - literally and figuratively - leading to rework, delays, and performance compromises.

Hospitals represent some of the most intricate infrastructure projects due to the wide array of critical systems that must operate seamlessly and continuously. From structural integrity to life-saving equipment, and from infection control to sustainable operations, hospitals demand a level of integration that goes far beyond typical building projects.

The Mistake: Working In Silos

Traditionally, different engineering teams and vendors work independently, meeting only at late stages of design or construction.

That leads to :

- Issues related to medical equipment layout, location and determination of connection points for services,
- Overlapping or criss-crossing routes (e.g., HVAC ducts clashing with electrical and communication cable trays/ ducts, pipelines, shafts, etc.),
- Missing inputs from specialized equipment vendors,
- Delayed compliance with codes and regulations, and
- Wasted time and money correcting problems that better planning could have prevented.

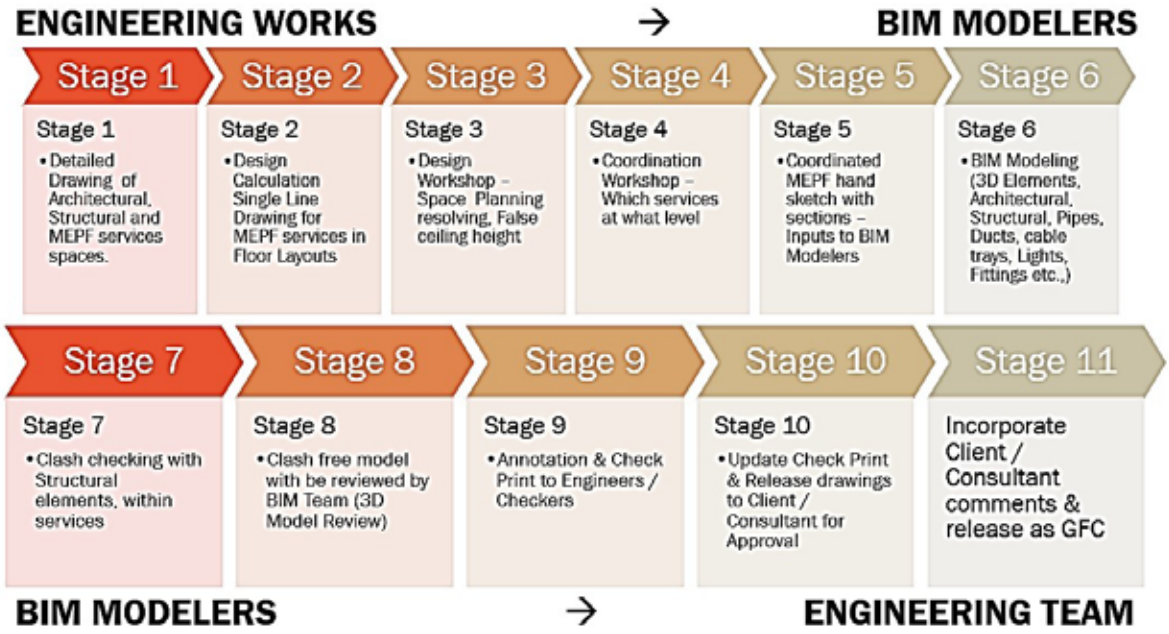
The real-world impact? Projects that are late, over-budget, and less reliable once operational.

The Solution: Integrated Engineering From Day One

Integrated engineering means bringing together all disciplines - architects, structural engineers, MEP specialists, Instrumentation & Control / Communication system specialists, equipment vendors, and contractors - at the earliest stages of design.

How integration transforms projects:

- Early Design Workshops: All stakeholders contribute their needs up front - no surprises later.
- Single-Line Coordination: Major systems (air ducts, pipelines, cable trays) are laid out together on common plans.
- Clear Interface Planning: Roles and responsibilities are defined clearly, avoiding overlaps and gaps.
- BIM and 3D Modelling: Advanced visualization tools detect clashes virtually before they happen physically.
- Future-Proofing: Designs accommodate future technology upgrades and expansions without major disruption.
- The result? A hospital that not only functions smoothly today but is ready for tomorrow's needs.



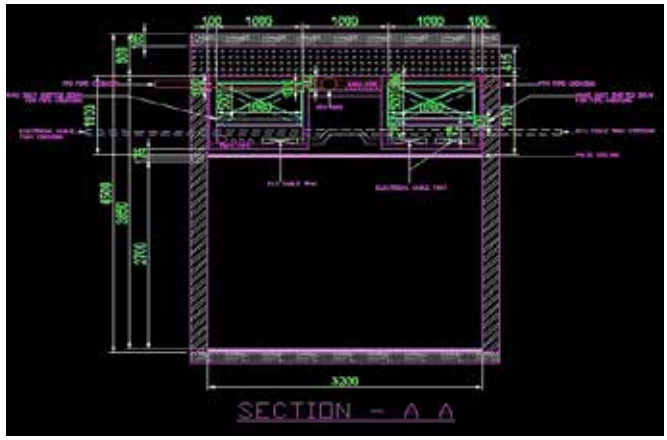
Real-World Benefits Seen

Projects adopting integrated engineering consistently experience:

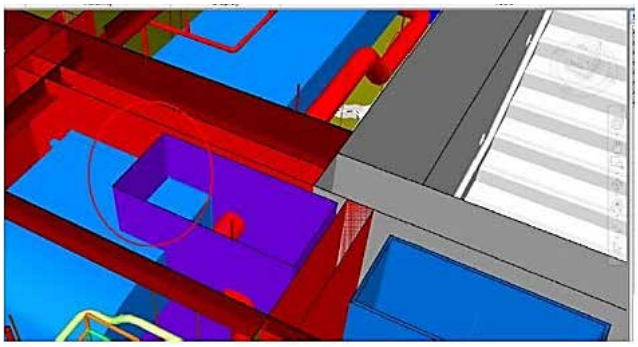
- Faster Approvals: Comprehensive documentation satisfies regulatory bodies quickly.
- Reduced Rework: Early clash detection prevents costly corrections later.
- Cost and Time Savings: Better coordination reduces material waste and delays.
- Enhanced Safety and Maintenance: Clear zoning and planned access make maintenance safer and easier.
- Future Flexibility: Infrastructure designed with upgrades in mind avoids early obsolescence.

Bio Medical System/ Equipment	Sample Interface Matrix Among Various Trades In Hospitals								
	Architec-ture	Interior	Structure	Electrical	Extra Low Voltage	Plumbing	HVAC	Fire Protection & Alarm System	Medical Gas
Modular Operation Theatre (OT)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Kitchen Equipment	✓	✓	✓	✓	×	✓	✓	✓	✓
Laundry	✓	✓	×	✓	×	✓	✓	✓	✓
Central Sterile Storage Department	✓	✓	×	✓	✓	✓	✓	✓	✓
CT Scan	✓	×	×	✓	✓	×	✓	✓	×
X Ray	✓	×	×	✓	✓	×	✓	✓	×
Ultra sound	✓	×	×	✓	✓	×	✓	✓	×
MRI	✓	×	×	✓	✓	×	✓	✓	×
Minor OT	✓	✓	✓	✓	✓	✓	✓	✓	✓
Intensive Care Unit Beds	✓	×	×	✓	✓	×	✓	✓	✓
Pneumatic Tube System	×	×	×	✓	✓	×	×	×	×
Medical Gas Pipe Line System	×	×	×	×	×	×	×	×	✓
Nurse Call System	×	×	×	✓	✓	×	×	×	×
Blood Bank & Lab	✓	×	×	✓	×	✓	✓	✓	×

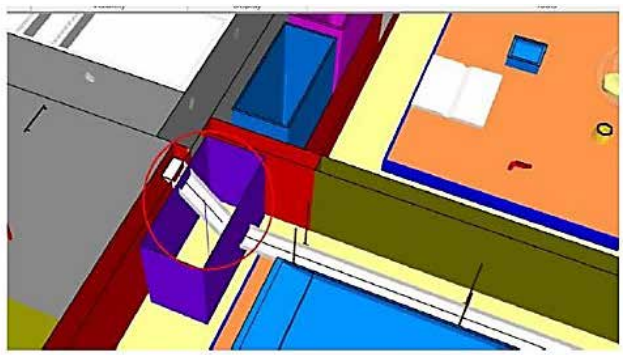
A Hospital Layout



Cross-Section Showing Services



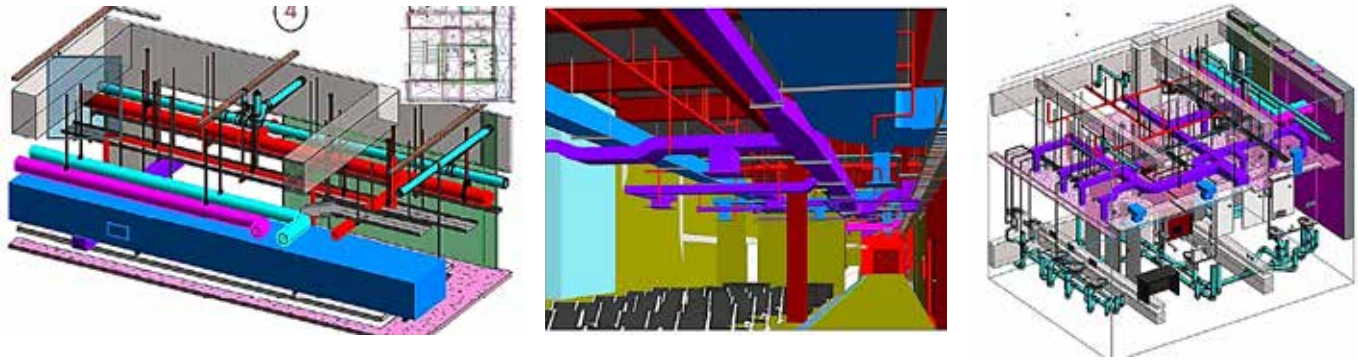
Ceiling Vs HVAC Duct



ELEC Tray Vs HVAC Duct

Clash Detection in BIM

BIM - NAVIS VIEWS



Key Takeaways For Project Leaders

If you are planning or managing a complex project, here is what the focus should be on:

- Start integration early: Bring all disciplines together during conceptual design, not after.
- Define interfaces clearly: Identify battery limits (where one team's responsibility ends and another's begins).
- Invest in visualization: Use BIM or 3D tools to spot conflicts early.
- Involve vendors early: Specialized inputs (e.g., for medical equipment, kitchens, CSSD) must shape design decisions.
- Plan for flexibility: Allow space and system resilience for future needs.

In short, the cost of integration is small compared to the cost of fixing mistakes.

Conclusion

In critical infrastructure projects - whether hospitals, airports, or smart cities - the challenges are only increasing. Specialized systems, high expectations, and tight timelines demand a new way of working.

Integrated engineering is not just about better coordination. It is about delivering safe, sustainable, and future-ready infrastructure.

As the saying goes: A hospital never sleeps - and neither should our commitment to getting it right the first time.

10

Waste to Watts in the Cement Industry: Driving Energy Transformation by Sustainable Heat & Power Generation

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Dy. General Manager

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Introduction

In this era marked by rising energy efficiency and increasing environmental concern, the transformation of industrial waste, municipal waste and utilisation of the untapped waste gases in the cement plants has emerged as both a technological imperative and moral responsibility. The role of the integrated engineering consultant for implementation from concept to commissioning, having in-depth knowledge of all streams and having a strong background is not only pivotal but transformative as well.

The article highlights not only the technologies that enable Waste to Watts transformation but also the role played by integrated engineering consultants in making this transformation visible, scalable, reliable, and an impactful one-stop solution for the Cement Industry.

Necessity of Energy Efficiency for Cement Industry

Cement is the world's most widely used construction material. Cement is the binding material that is mixed with aggregates such as sand and gravel and water to form concrete. Over three tons of concrete are produced each year per person for the entire global population, making it the most widely used manufactured product in the world.

The cement industry is an energy-intensive industry and third largest energy utilizer after power and steel industries. It needs both Electrical as well as Thermal energy for its operation. The thermal energy is used mainly during the burning process, while electrical energy is used for material crushing /grinding systems, as well as gas handling and transport systems in the cement manufacturing process. Cement plants are spending a considerable part of the manufacturing cost of cement to meet their energy demands. In fact, energy cost is considered as a major factor in the pricing of cement.

Being an energy-intensive industry, cement is one of the largest industrial sources of greenhouse gas emissions globally, contributing approximately 7 - 8% of global CO_2 emissions. As the demand for cement continues to rise, the sector faces increasing pressure to reduce its environmental emission footprint. A promising solution is the "Waste to Watts" approach, an innovative model that turns various waste streams into energy, helping cement manufacturers to reduce dependency on fossil fuels, cut emissions, and manage industrial and municipal wastes sustainably.

"Waste to Watts" heat recovery system could increase the efficiency of the cement plants as well as reduce the amount of CO_2 emissions to the environment.

The Indian cement industry has always been attempting to adopt the best available energy-efficient technologies, in fact better than most of the developed countries. The alternative to fossil fuel by installing a Waste Heat Recovery Power Plant has been a trend setter for the global cement industry. The specific energy consumption has been reducing with continuous up-gradation and change in process technologies.

A Typical process flow of the cement manufacturing process is shown in Figure-1.

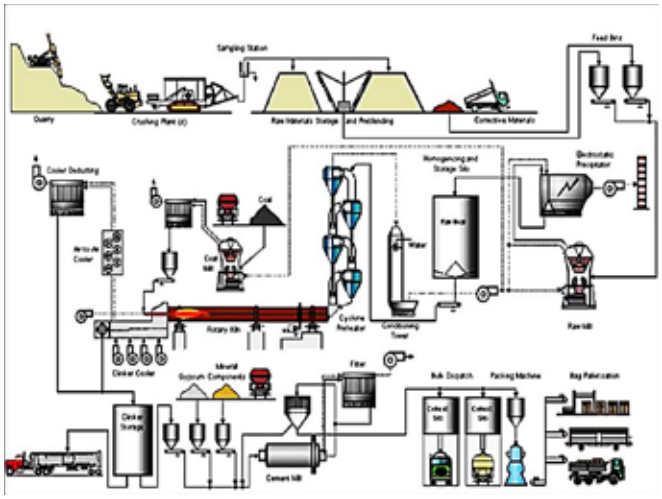

Figure-1: Cement Manufacturing Plant

What is Waste to Watts?

"Waste to Watts" refers to the transformation of waste into electrical energy or usable thermal energy. In the cement industry, this is primarily achieved through two mechanisms, viz. Co-processing of Waste as Alternative Fuels (AFR) and by Waste Heat Recovery Systems (WHRS), which are briefly described. The expected benefits are highlighted.

Co-processing of Waste as Alternative Fuels (AFR)

Alternative fuel utilization has achieved substitution of conventional fuel by up to 35% and the industry is aiming to be carbon neutral in the near future.

- **AFR in Cement Plant**

  Alternative Fuels and Raw Materials (AFR) refer to the use of non-traditional sources in cement manufacturing such as industrial by-products, agricultural residues, and municipal waste. The adoption of AFR is being increasingly promoted due to its potential benefits - reducing reliance on fossil fuels, lowering production costs, and minimizing environmental impacts. A typical arrangement of AFR feeding in a cement plant is shown in Figure- 2.

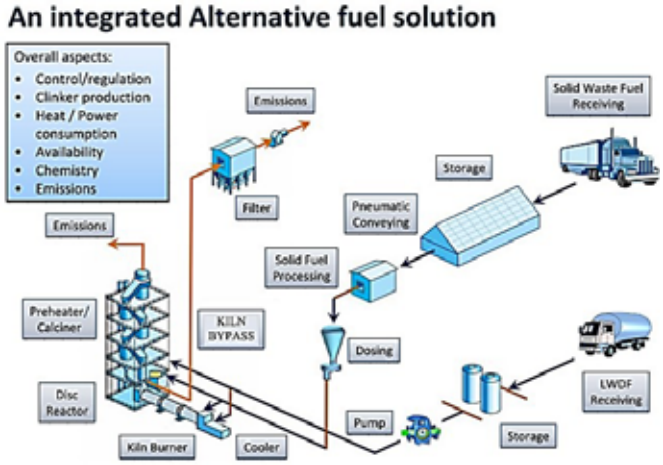

Figure-2: AFR Feeding Arrangement in a Cement Plant

Integration of AFR in cement plants significantly impacts various aspects of the cement manufacturing process.

1. **Higher Thermal Efficiency and Calorific Value**

   Some AFR, such as industrial by-products or agricultural residues, have a higher calorific value compared to traditional fossil fuels. That can lead to increased energy input into the kiln system.

   With the right selection of AFR, cement plants can achieve optimal combustion conditions, resulting in more complete fuel burning.

2. **Reduced Fossil Fuel Consumption**

   By replacing a portion of conventional fossil fuels with AFR, cement plants can reduce their overall fuel costs and at the same time achieve a reduction in the CO_2 emission. The system also contributes

to cost savings, increases the temperature stability of the kiln, which is also beneficial for WHR generation.

3. **Enhanced Heat Recovery Capacity**

   AFR combustion can produce higher flue gas temperatures and improve the thermal gradient. When waste heat is captured through WHR systems, the increased available heat can lead to greater electricity generation or higher efficiency in the pre-heating processes.

4. **Increased Flue Gas Volume**

   The use of AFR can lead to an increase in flue gas volume, which enhances the heat exchange area of WHR systems. More flue gas results in a higher heat recovery potential.

5. **Burning of the Waste Material from Industry & Municipalities**

   The disposal of the waste material from industries and municipalities is of great concern, but with improved technology, the waste can be burned in the clinkerisation process of a cement plant, thereby helping the community in the disposal of the combustible waste**.**

   - In addition to operating cost benefits, the CO_2 emission reduction, 10% of replacement of fossil fuel (on thermal basis) with bio mass or alternate fuel can save 18.5 kg CO_2 /MT of clinker produced.
   - With the present operating capacity of 500 mio tpa of cement, the overall CO_2 reduction shall be approx. 9 to 9.5 mio tpa at 10% substitution and 31 to 34 mio tpa for substitution of 35%.

Waste Heat Recovery Systems (WHRS)

- The cement plants can convert residual heat from processes into electricity, thus closing the loop between waste generation and energy consumption.
- In a cement plant, nearly 35% heat is lost, primarily from the preheater, bypass and cooler waste gases. This energy is tapped by installing a Waste Heat Recovery Power Plant (WHRPP). The waste heat recovery per Ton of the cement produced is in the range of 30 to 45 kWh/ton and is characterized by a significant amount of heat loss, mainly by the flue gases and the air stream used for cooling down the clinker.
- The cost of installation of WHRPP is around Rs. 10 to 12 crores per MW and depends on the capacity of the Power Plant. Since no fuel is required for operation, the operating cost is less than Rs. 0.5-0.65/ kWh (excluding interest and depreciation) compared to a conventional Power plant with cost of generation of Rs. 6.5 to Rs. 7.5/kWh and is very volatile due to the fuel cost volatility. The cost of power supply from the Utility Grid in the range of Rs. 6.0 to Rs. 8.0 per kWh.
- In addition to operating cost benefits, the CO_2 emission reduction per MW of power generation is approximately 6500 tons per annum, thereby contributing to environmental protection.
- With the present operating capacity of 500 mio tpa of cement, the overall CO_2 reduction would be approximately 14 to 15 mio tpa.

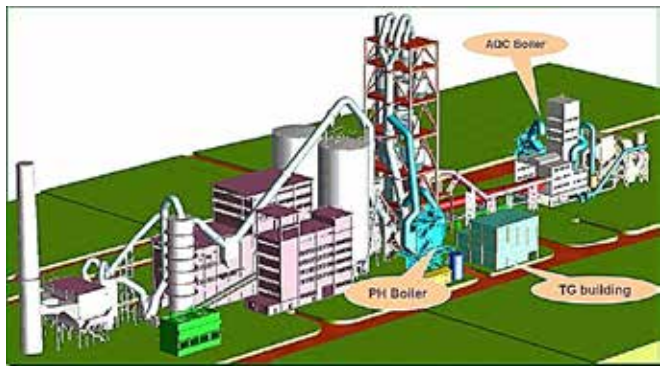

Figure-3: WHR system in Cement Plant

Salient features of Waste Heat Recovery Systems (WHRS)

WHRS use Steam Rankine Cycle (SRC) or Organic Rankine Cycle (ORC) systems to convert kiln exhaust gases into electricity.

Advantages of Waste Heat Recovery (WHR) in the Cement Industry

1. **Energy Efficiency Improvement**

   WHR systems capture and reuse heat from cement production processes e.g, kiln and cooler exhaust, reducing the need for external energy sources and enhancing overall thermal efficiency.

2. **Reduction in Electricity Consumption**

   By generating electricity from recovered heat (typically via steam turbines or Organic Rankine Cycle systems), cement plants can meet part of their power demand internally, lowering dependence on grid electricity or fossil fuel-based generators.

3. **Lower Operational Costs**

   WHR leads to significant cost savings in the long term by reducing energy bills and exposure to volatile energy prices.

4. **Greenhouse Gas (GHG) Emissions Reduction**

   By decreasing fossil fuel use and electricity consumption from external sources, WHR systems contribute to lower CO_2 emissions, thus helping companies meet sustainability and regulatory targets.

5. **Improved Competitiveness**

   Reduced energy costs and carbon emissions give cement manufacturers a competitive edge, especially in markets with carbon pricing or strict environmental regulations.

6. **Increased Equipment Life**

   WHR can moderate temperatures in some process areas, leading to less thermal stress and potentially longer equipment lifespan.

7. **Energy Security and Reliability**

   On-site power generation through WHR enhances energy reliability and reduces vulnerability to power outages or grid fluctuations.

Benefits from Installing a Waste Heat Recovery Power Plant

Waste to Watts is not just an energy solution - it is a paradigm shift in how the cement industry operates. By converting waste into a resource, the sector can significantly reduce its carbon footprint, enhance energy efficiency, and contribute to broader circular economy goals. With supportive policy frameworks, stakeholder collaboration and continued innovation, Waste to Watts has the potential to revolutionize cement manufacturing and become a global model for sustainable industrial transformation.

Advantages of Integrated Consultancy Services for Project Implementation

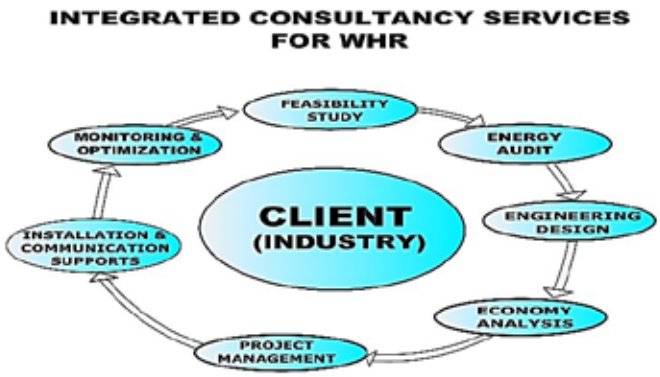

Figure-4: Integrated Consultancy Services

Engaging an integrated consultancy service for engineering the process and power with due support from mechanical, electrical, instrumentation, civil engineering, etc., offers several significant advantages in the industrial sectors where energy efficiency and sustainability are key. The main benefits are:

1. **Seamless Project Execution**

   Integrated consultancy handles the entire project lifecycle, from feasibility studies and design to commissioning and performance monitoring, ensuring smooth coordination across all stages. That reduces delays, avoids scope overlaps, and optimizes resources.

2. **Holistic Technical Expertise**

   The integrated approach brings multidisciplinary

expertise under one roof (mechanical, electrical, civil, thermal, instrumentation, etc.), allowing for more effective design and integration of WHR systems with existing industrial processes.

3. **Optimized Design & Customization**

   Integrated consultants can tailor solutions based on in-depth knowledge of plant operations, waste heat profiles, and available technologies (e.g, ORC, Steam Rankine Cycle). That leads to better heat recovery efficiency and ROI.

4. **Regulatory and Environmental Compliance**

   Consultants providing Integrated consultancy are well-versed in local and international regulatory frameworks, Environmental Impact Assessments (EIA), and emission norms, ensuring a smoother approval process and sustainable plant operation.

5. **Cost and Time Efficiency**

   With a single point of responsibility, integrated consultancy reduces interface risks between vendors, EPC contractors, and project stakeholders. That minimizes cost overruns and shortens project timelines, and brings value engineering for the project.

6. **Performance Assurance**

   In addition to the above, due to vast experience and data bank, post-commissioning services such as performance audits, efficiency optimization, and predictive maintenance planning help ensure the plant runs at peak efficiency throughout its lifecycle with the highest reliability.

7. **Access to Latest Technologies**

   Integrated consultants have strong industry networks and access to the latest WHR technologies and global best practices, which help clients adopt innovative and future-ready solutions.

Conclusion

"Waste to Watts" has become a necessity considering the very high cost of fuel and power. Almost 30 to 35 % of the thermal and electrical energy requirements of a Cement plant are met by the AFR and the WHR Power Plant thereby making their installation techno-commercially lucrative. That also contributes to energy conservation and reduction of CO_2 emission by a phenomenal value of 45 to 49 mio tpa.

The technology has also become very reliable and proven, with reliability of over 96%.

There is strong potential for increasing AFR to make Cement Plants Carbon neutral.

The role of the integrated consultant with in-depth knowledge of the Cement process and power plays a pivotal role in improving efficiency, making it environment friendly and improving the reliability of the Cement plant.

Acknowledgement

The authors are thankful to Holtec for allowing this article on Waste to Watts to be published.

11

Integrated Engineering Approach for Water Infrastructure Projects

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Abstract

An Integrated Engineering Approach is not just a technical and/or commercial strategy - it is a transformation in how water infrastructure projects are conceived, designed, executed, and operated. With India facing mounting water challenges, design engineering consultancies, EPC firms, government agencies, and urban planners must work collaboratively to adopt such modern, integrated practices. The result will be more resilient, cost-effective, and sustainable water systems that meet the needs of both current and future generations.

Owing to the typical nature of the water industry, where standardisation of large centralised water infrastructure is not feasible due to required expenditure and unique site constraints, the need for this approach is even more relevant.

This article discusses the core principles of integrated management from an EPC firm's perspective. It starts from the project conceptualisation stage involving multiple stakeholders till the commissioning and handover of the project, and even to operation & maintenance, while explaining the significance of application of digital tools, interdisciplinary collaboration, and integration with procurement and supply chain management. The article also highlights some of the key practices followed for the knowledge management system, technical and executional feedback loop mechanism for continual improvement, inbuilt programs for process simulation and performance evaluation, the quality processes laid out for each project activity, and so on.

Core Principles of Integrated Engineering Approach in a typical EPC firm in Water Industry

Early Multi-Stakeholder Collaboration

The recipe for a successful water infrastructure project starts with the selection of the cuisine itself! Even before the project is awarded to the EPC firm for execution, the first step involves active roles of the client and the consultant of the project. The main expectations from them include:

- well-defined project definition and objectives
- clear understanding of deliverables
- clear scope, roles, and responsibilities of the stakeholders and execution roadmap
- funding availability and payment terms
- identification of anticipated challenges, risks, and opportunities and their management communication protocol, prompt, proactive and positive support during execution.

Integrated engineering thrives on early collaboration of all stakeholders at the project organization and planning stage - clients, consultants, EPC contractors, NGOs and the community. Joint planning workshops should be conducted to align expectations and define project goals, Key Performance Indicators (KPIs), and compliance requirements. Public-Private Partnership (PPP) projects benefit significantly from joint decision-making through discussions/ dialogues, quantitative risk assessments and benefit analysis.

Adoption of Integrated Engineering Software Platforms

India's infrastructure sector is rapidly embracing digitization, yet water projects often lag in integration. Digital platforms such as Building Information Modelling (BIM 3D), Geographic Information Systems (GIS), adapting to IoT and AI platforms can be a game changer.

- BIM allows real-time collaboration across disciplines - civil, structural, mechanical, electrical, and instrumentation, creating a unified model of the infrastructure.
- GIS integration enables spatial analysis for site selection, hydraulic modelling, and flood risk management.
- Tools like AutoCAD 3D/ Aveva E3D, and Revit facilitate 3D design, Bentley OpenFlows for hydraulic simulation, and interoperability between various subsystems.
- Using IoT, Artificial Intelligence, and Digital Twin to analyse data and extract insights, simulate, model and optimize for process and operational efficiency gains, and to predict preventive maintenance of the plants.

Digital Twin, Modelling and Simulation

- Create a Digital Twin of the WTP/ WWTP for real-time visualization and simulation of operations.
- Use process simulation software (e.g., ONDEOR at SUEZ, BioWin and other) to optimize treatment processes, energy use and chemical dosing before physical construction.
- Tools like WaterGEMS, SewerGEMS and others help model water distribution networks, sewer collection and stormwater drainage.
- Tools like Aveva E3D Model, STAAD Pro, Navisworks, ETAP and others play a vital role in clash identification, structural and piping integrity.

Simulation ensures design adequacy under varying load conditions, especially important for Indian cities with high seasonal variations.

Figure-1: Representation of a Wastewater Treatment Plant Layout in E3D

Design for Modular and Prefabricated Construction

Integrated engineering supports a certain amount of standardized, modularized, and prefabricated designs if the site conditions are favourable.

a. Use of standard and patented products/unit processes help in quicker design and development of detailed design drawings.

b. Prefabricated pumping stations, clarifiers, and treatment units can reduce on-site work, improve safety, and cut construction time. That is particularly effective in space-constrained or remote areas where on-site construction is difficult.

Interdisciplinary Collaboration

a. Establish an integrated project team with a clear communication protocol and clear roles and responsibilities division amongst the disciplines.

b. Use collaborative platforms to coordinate design reviews, clash detection, assigning, scheduling,

monitoring, tracking tasks/ changes and actions, and document control. That reduces costly on-site modifications.

c. To achieve all that, an Engineering Manager is assigned as the interface to coordinate with all the disciplines of engineering, sourcing and project management, and the site team.

d. Clash-free designs are essential for complex systems like wastewater treatment plants, where multiple utility lines run close together. 30%, 60% and 90% Model review meetings are conducted with participation of all disciplines to optimise and make clash free design.

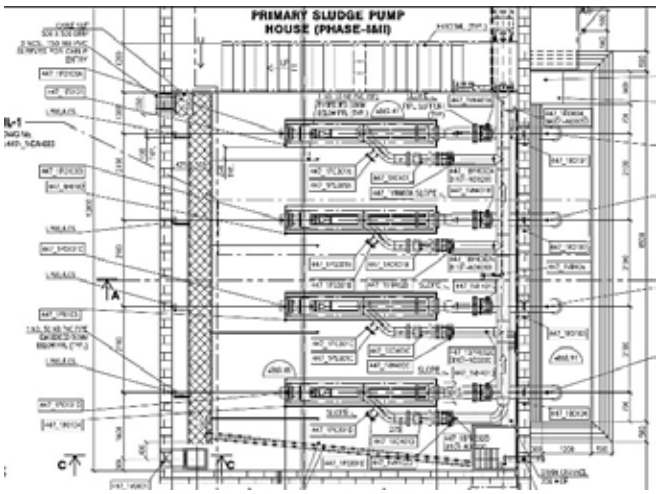

Figure 2: Representation of a Pump House in a GA drawing (2D)

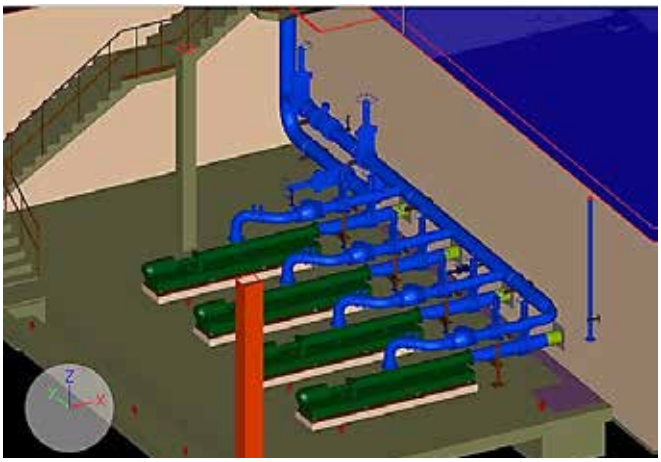

Figure 3: Representation of same Pump House arrangement in Navisworks (3D)

Integrated Procurement and Supply Chain Management

a. Engineering data should seamlessly feed into procurement systems to automate the Bill of Quantities (BoQs) and reduce material mismatches.

b. Integration with Enterprise Resource Planning (ERP) systems (like SAP or Oracle) ensures alignment between design, inventory, and execution.

c. That minimizes delays and cost overruns, which are common issues in large centralized water infrastructure projects.

d. Joint Engineering, Project Management, and Supply Chain meetings are conducted to review the Engineering, Procurement and Construction activities progress.

Integrated Lean Project Management

a. Apply Lean principles and processes to reduce rework, improve workflow and enhance efficiency.

b. Use of lean management techniques like Value Stream Mapping (VSM) to visualize and analyse the flow of materials and information required to deliver a product or service, from its origin to the customer. It helps identify and eliminate waste, optimize the entire process for increased efficiency and value.

Life Cycle and Sustainability Focus

Integrated Engineering takes a long-term view of performance, maintenance, and sustainability.

a. Lifecycle Assessments (LCAs) help in selecting low-carbon materials and energy-efficient technologies.

b. SCADA, Digital Twin systems, IoT sensors, AI platform can be embedded into design for real-time monitoring, predictive maintenance, and performance reporting.

Integrated Commissioning and Handover

Commissioning must be considered right from the design stage.

a. Using Digital Handover Packages, O&M teams

receive full documentation, including P&IDs, manuals, and SOPs digitally.

b. Commissioning digital streamline site acceptance, trials, and regulatory clearances.

Training and Capacity Building

For integrated engineering to be successful, EPC firms, municipal engineers, and contractors must be trained in using new tools and methods.

a. Government schemes like AMRUT 2.0 and Jal Jeevan Mission are now incorporating digital capacity-building modules.

b. Collaborations with engineering institutes, software/ technology providers, equipment suppliers/ vendors, and industrial associations can bridge the skill gap.

Feedback Loop for Continuous Improvement

Post-implementation monitoring should inform design improvements for future projects.

a. Projects can use performance dashboards, remote sensing, and data analytics to track KPIs like water quality, energy use, and downtime.

b. This creates a feedback loop for continuous engineering improvement.

c. A Knowledge Management database and a system of REX (Return of Experience) for recording experience gained, enable the feedback loop.

d. Multiple REX meetings, for recording experience, conducted at various stages of the project help to establish ongoing evaluation of the project challenges.

Integrated Implementation Phases in EPC Project

An overview of the implementation phases in an EPC project are shown in Figure-4.

Figure-4: Implementation Phases in an EPC Project

Organisation & Planning Phase

The purpose of the Planning phase is to establish the scope and resources of the project, to define its objectives and to prepare actions required to attain those objectives, across project disciplines. Actions taken during the stage are:

- Mobilize the Project Manager (PM) and the main project team members, particularly the Contract Manager. Involve the proposal manager during the whole project starting period.
- PM to present the project strategy established during the proposal phase (costs, schedule, staffing, risks and opportunities (R&Os)), clarify the project objectives, review the list of contractual obligations and constraints.
- PM to plan and prepare the Project Management Plan (PMP) based on the work package, and for all Disciplines (Engineering, Supply-Chain, Construction, Commissioning, Project Control):
  - Review the requirements and detail the scope of works and associated deliverables
  - Review the main milestones (studies, permitting, handover...)
  - Define the resources, the organization and corresponding responsibilities
  - Estimate the duration and cost of each activity
- The PMP gets validated during the Target defined meeting
  - Validation of the project scope (deliverables) for all Disciplines
  - Validation of the project execution strategy (costs, schedule, staffing, R&Os)
  - Formalization of the project baselines (time and cost)
  - Validation of the General Specification

Health Safety and Environment

The primary aim is to achieve the safety objective of *'Zero serious and fatal accidents'*. Everyone has an obligation to take care of each other and provide quality means to avoid accidents and ill health.

These measures are categorised in the following order of priority:

- Avoiding, reducing or eliminating the risk (where possible, at the source and by limiting exposure to risk factors),
- Implementing collective protective measures, and
- Implementing individual protective measures.

In situations requiring control of risks with potential for serious accidents, simple use of "human" safety barriers (training, periodic drills, instructions) is not adequate. Physical safety barriers (instrumentation, equipment, automated controls) are to be preferred.

Risk analysis methods are documented and outcomes disseminated and made available to the personnel involved (both permanent and short-term) as part of workplace orientation and training, as well as to employees of subcontracted companies in the establishment of prevention plans.

The studies are reviewed and updated at least once a year to reflect any changes in regulations or internal guidelines and results from accident analyses.

Execution Phase

Execution activities consist primarily of developing detailed engineering activities for realizing the purchase, construction, commissioning and startup related activities of the plant as well as the constitution of the as-built documents. Refer Figure-5.

Figure-5: Activities during Execution Stage

Engineering

The engineering activities comprise four phases, shown in Figure-6:

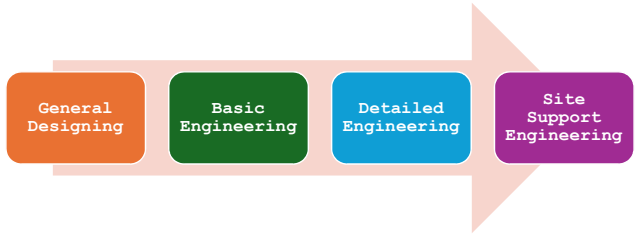

Figure-6: Engineering Activities

1. **General Design:** The list of project engineering deliverables is prepared by the Engineering Manager in consultation with the Discipline Managers, based on the analysis of the scope and requirements of the contract and the list produced during the bid stage. Each deliverable is associated with one discipline, which will be the owner of the deliverable, although contributions from other disciplines may be required for preparing the deliverable.

2. **Basic Engineering:** The objective of the activity is to finalise the general design documents to fit interfaces and initiate the activities of detailed engineering, procurement or construction. The basic engineering documents may be 'refined' during the detailed engineering phase.

3. **Detailed Engineering:** Detailed engineering documentation includes all documents required for the procurement, manufacturing, construction, commissioning and acceptance of the plant. It also includes the final study documents for the on-site delivery of equipment and material: specifications, bill of quantities (BOQ). The contents of the detailed studies (particularly isometrics and support) are defined according to the context and strategy of the project, especially the skills and practices of construction companies in the geographical area of the project.

   Detailed Engineering is developed unto the '*good for execution*' status of all documents produced in the phase and also the previous phases.

During this stage, it is also ensured that the drawings and documents submitted by the suppliers are consistent with the documents produced during previous phases.

4. **Site Support Engineering:** The activity usually starts once construction crews are mobilised on site. The objective of this engineering is to directly solve all the questions, clarifications or adaptations required on site.

Apart from the above phases, the engineering activities involve **Quality Control of engineering production** through the following:

- Quality of production
- Plant design compliance reviews
- Plant design progress reviews (internal / multi-disciplinary)
- Interdisciplinary consistency checks (internal / multi-departmental)
- Disciplinary technical audit and
- Engineering documentation audit

Supply Chain

Supply chain activity is divided into the phases as shown in Figure-7.

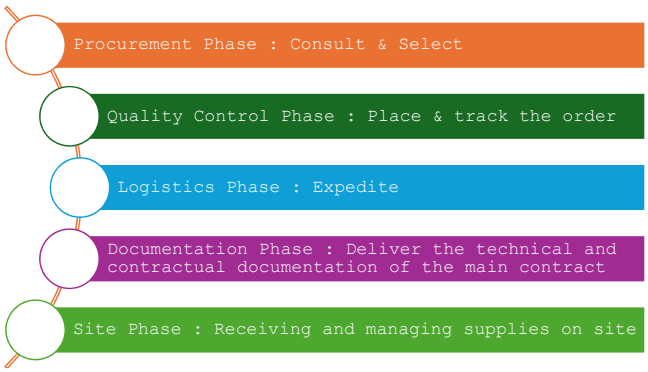

Figure-7: Activities for Supply Chain

1. **Procurement Phase:** The objective is to consult the market suppliers for selecting the supplier or subcontractor and preparing the issuance of the order.
2. **Quality Control Phase:** The objective is to ensure that the equipment and or service is in conformity with the order and supplied as per the schedule and agreed terms.
3. **Logistics Phase:** The objective is the delivery of the equipment on site before the due date, in accordance with the delivery date specified in the order.
4. **Documentation Phase:** The objective is to deliver the final documentation (manuals, maintenance manuals, storage manuals and quality control file) related to the equipment of the whole project under the main contract. The engineering discipline compiles all the manuals, while the supply chain discipline performs the quality control.
5. **Site Phase:** The objective is to receive and record all equipment required by the construction discipline according to the order and in line with the schedule.

Apart from the above phases, the engineering and supply-chain activities involve **external interface management,** including:

- Client interfaces and validation of production
- Schedule interfaces with internal stakeholders (for critical tasks/materials)
- Interface with suppliers and subcontractors (third parties) and
- Interface with internal stakeholders of the project or partners

Construction

The construction activities are divided into three main phases. These phases are not strictly successive, but in theory, if they overlap, they can often require a recovery period for different zones. Refer Figure-8.

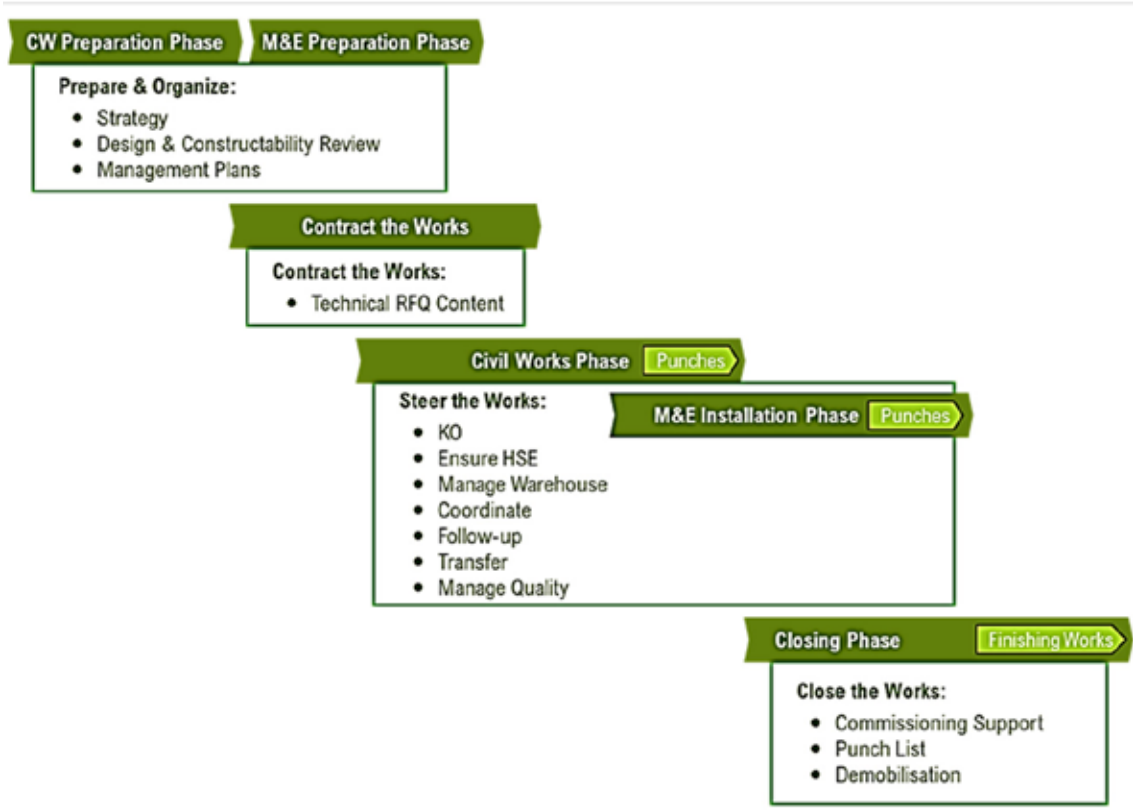

Figure-8: Construction Phases

Commissioning

Commissioning activities of a project essentially refer to preparing and organizing for the start-up and for the equipment tests, first individually and then by process systems, to attain full operation of the plant as per the specifications document. The process involves the following phases:

- System Integration Testing
- Functional Testing (equipment, Controls)
- SCADA & Automation Setup and
- Final Inspection & Client Acceptance

Closing Phase

The purpose of the closing phase is to finalise all activities across disciplines to formally complete the project. The following steps are involved:

- Close the project commitments
- Clear the punch list items
- Obtain the client/operator's HSE organisation and procedures and
- Manage the project warranties

Common Challenges in Large Water Infrastructure Projects

Unique Nature of Water Infrastructure Projects

Unlike small infrastructure projects and industrial projects, large water infrastructure projects cannot be fully modularized and standardised. Every project and its requirements are unique, and hence tailor-made solutions are required to be provided for each such project. To ensure the delivery of such customised projects, the need for a competent and well-coordinated Engineering, Procurement and Construction system is imperative.

Outsourcing vs In-house Competencies

In today's global landscape, enterprises of all sizes -from multinational corporations to small and medium-

sized businesses- frequently leverage outsourced engineering services to realise their infrastructure projects. This approach grants access to specialised expertise and resources without the necessity of maintaining in-house teams. However, beneath the surface, several nuanced yet significant challenges accompany such outsourcing arrangements.

Communication and collaboration often become impeded due to factors like language differences, time zone disparities, and cultural variations, leading to potential misunderstandings and project delays. Moreover, ensuring consistent quality control proves difficult, primarily due to the diminished sense of ownership among external teams. In contrast, in-house engineering teams benefit from seamless coordination, established rapport, and shared cultural alignment, fostering a more cohesive working environment.

Consequently, while outsourcing can offer cost efficiencies and flexibility, it is prudent to cultivate and retain in-house competencies wherever feasible. The strategy not only mitigates risks associated with quality and communication but also reinforces a culture of accountability and long-term organisational growth.

Challenges Faced During the Last Phase of Project Execution

In the final 10 - 15% of a water infrastructure project's physical completion, there is often a tendency to expedite the process. By this stage, the budget is typically depleted, resources are being demobilised, and client pressure to conclude the project intensifies. This critical phase demands heightened attention and robust support from management. If executed meticulously, it can culminate in the plant's successful performance; however, succumbing to pressure and compromising on quality checks may lead to its failure.

Key Takeaways

- A well-integrated collaborative approach is the cornerstone of successful project execution. While setbacks offer valuable lessons, a balanced allocation of resources and workload is essential for optimal performance. This requires seasoned judgment and strategic foresight.
- For clients and consultants, embracing a stakeholder-centric approach to contract execution is imperative, aligning all parties towards shared objectives and mutual success.
- Balancing the retention and development of in-house talent over outsourcing preserves institutional knowledge and critical competencies but also provides the benefit of diversity and cost effectiveness, driving ownership and accountability.
- Particularly during the final phase of project execution, management's greater understanding of stakeholders, its collaboration, offering support and guidance are crucial to navigate challenges and ensure quality and safety standards are upheld.

Acknowledgement

The content is adapted from the DB Project Management Guide and other internal database of SUEZ.

About SUEZ

SUEZ aims to provide optimum treatment infrastructure along with services and solutions for improvement of drinking water and non-drinking water utilities for municipal and industrial customers/ clients. SUEZ has been active in the Indian water and wastewater market since 1978. Since then, it has been consistently delivering smart and sustainable solutions, by working closely with global business units and partners transferring knowledge and technologies and sharing experiences, ensuring the citizens of India get access to safe drinking water, effective utilization of wastewater for circular economy and customers with technologies that help them achieve their objectives. SUEZ in India operates over 300+ state-of-the-art water and wastewater treatment infrastructural units for municipalities and industries. 7.5 billion litres of safe drinking water is produced in SUEZ-run treatment plants every day, catering to 55 million people. 1 billion litres of wastewater from municipalities and industries are treated by SUEZ, using advanced technology. Furthermore, 10 million people benefit from the Group’s expertise in water distribution and sewer network management.

12 Advocating Integrated Engineering for Sustainable Construction

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With the global temperature rising at an alarming rate, countries are facing a dire need to adopt sustainable methods of development in order to ensure a better tomorrow. This need has been further intensified with the ongoing wars and acts of aggression in various countries, which have significantly increased the global pollution and environmental degradation levels, thus bringing pressure on other countries to work towards reducing their carbon footprint before time runs out.

For developing countries like India, this need has brought additional concerns as the sectors promoting development and economic prosperity are now required to be bolstered with sustainable methods, thus giving rise to monetary and knowledge barriers. In addition to that, with India on a mission to attain net-zero carbon emissions, it is under pressure to actively work towards familiarizing itself with sustainable means of sectoral development, to facilitate the achievement of its long-term ambitions.

It has thus become essential to introduce innovative solutions within its various sectors for establishing a balance between economic growth and sustainable development.

Sustainable Development

In 2016, the members of the United Nations (UN) established 17 Sustainable Development Goals (SDGs) to act as a 'blueprint for peace and prosperity for the people and the planet, now and into the future'[1]. With a target of 2030, the SDGs promoted positive changes such as decreased poverty, improved health, and economic growth, amongst others.

To such effect, many industry pioneers and countries started promoting the idea of sustainable construction practices, with leading organizations like the International Federation of Consulting Engineers (FIDIC) adopting the Climate Change Charter, undertook to 'advocate for the UN SDGs, sustainable development, and climate change mitigation'[2].

While the SDGs do not explicitly define the role of the construction and engineering industry in promoting sustainable development, the various goals enshrined within, including 'industry, innovation, and infrastructure', and 'sustainable cities and communities'[3], implicitly incorporate environmentally responsible principles, thereby offering a renewed outlook to various countries.

However, even with the establishment of a specific timeline for the achievement of the SDGs the progress paths adopted by different nations were seemingly inadequate. The need for a different approach was highlighted by the 2024 Progress Report published by the United Nations, as per which merely 17 per cent

of the SDG targets were 'on track', while the progress recorded for approximately half of the goals was minuscule to medium[4].

As a result, with the targets being far beyond expectations, contributions from major sectors like that of construction and infrastructure assumed greater roles, for the achievement of sustainable targets, as provided by the UN SDGs.

Construction and the Environment

Other than its role as one of the leading contributors to economic prosperity, the construction sector is also a substantial catalyst for a persistent increase in the air pollution rates of developing and developed countries alike. In India, the industry contributes approximately 20-30% to the overall air pollution, and further consumes a large number of natural resources.

These inadvertent deviant consequences attached to the industry practices act as a deterrent to the achievement of the SDGs, thus causing an overall breakdown of the different efforts made for achieving sustainability in development. It goes without saying that beyond the consequences mentioned, the construction industry bolsters the growth of an economy.

To tackle environmental degradation, the government has been working towards enforcing and promoting a number of measures, seeking to substantially reduce the carbon footprint of the construction industry without reducing its contribution to economic prosperity. While a few of the measures pertain to green buildings and smart city integration, the rate at which these plans are being implemented is rather inadequate, as compared to the rate at which the Earth's temperature is constantly increasing.

Thus, even though the measures like the aforementioned may have worked to the benefit of the country, the publication of the 2024 Progress Report underscores the need for a new approach- one that can deliver the results with minimal to no increase in the consumption of resources.

Integrated Engineering – A Dire Need

In the late 1990s, the Government of India (GoI) paved the way for a landmark project, by way of which citizens were provided with an easy and accessible mode of conveyance within the National Capital of Delhi. The Delhi Metro Rail Project is an infrastructural marvel that proved to be a successful case study promoting project development through a collaborative approach between various engineering disciplines, commonly known as 'integrated engineering' (IE). Other than being an accessible mode of transportation, the project also advanced the carbon emission goal by working towards the incorporation of energy-efficient methods of operation.

Since the development of the Delhi Metro, the GoI has implemented a number of projects in IE mode, one of which is the GIFT City, another infrastructure masterpiece, situated in the state of Gujarat. On account of such strides, it may be reasonable to infer that the concept of integrated engineering (IE) is thus not novel to India, but the application of those principles across the board is what is necessary. While doing that, an aspect that may need to be adequately explored is the combination of IE with sustainable construction.

Through an optimal combination of the features inherent to the concept, IE can facilitate the adoption of sustainable means within the construction processes efficiently and as per the needs of the contract. To achieve this, however, the GoI may be required to include various clauses within the contracts, which mandate the use of recycled/ sustainable raw materials. The clause should also allow the experts to adopt an efficient strategy to cause an overall reduction of the carbon footprint of the project.

IE may even be used by the nation to further the use of advanced technology, including artificial intelligence, within the construction projects, wherein such use may be ideal for implementing innovative and efficient sustainable measures within the various processes of planning, design and construction.

A hint may be taken by India from the regulations of different countries, like the United Kingdom and Canada, where, while the inclusion of AI in construction is yet to be realized, the concept of IE, in its various forms and names, has been included, as a preferred, and somewhat compulsory method of project development. Even FIDIC, in its 'Nature-Positive Infrastructure Playbook', calls for an early involvement of both internal and external stakeholders 'when implementing nature-positive solutions into the early lifecycle stages of infrastructure development'[5].

A practical example of efficient utilization of the concept may be drawn from the upgradation of the Ringsend Wastewater Treatment Plant, undertaken in Ireland on FIDIC modes of contract. Having been commissioned in 2023, the project involved close coordination between various key experts for upgrading the Treatment plan in such a manner as to reduce the reliance of the country on the finite resource, phosphate[6].

Another good example is the Clean Ports and Clean Oceans project, which sought to reduce the plastic pollution from the oceans of Philippines by bringing various stakeholders together. This FIDIC project which was implemented by the World Wide Fund[7], attained tremendous success for its innovative methods and transformative objective and set new milestones for the world.

Adoption of these or similar practices may thus not only work in favour of the net-zero ambitions established by the nation but may also bring India's construction processes in line with the best international practices.

In fact, due to the developing nature of the construction industry within the nation, the GoI may be able to take a step further, by including IE as the preferred method for the development of 'green buildings' and 'smart cities', thereby further strengthening its endeavours towards a greener and cleaner India.

The Zero Carbon Emission Target and the Bigger Picture

As mentioned above, India has been on the verge of substantially reducing its carbon contribution through diversified initiatives in the form of energy-efficient transportation, or through 'green energy production'.

It is, however, necessary to mention that for attaining the anticipated targets, not only of those concerning the carbon emissions, but also the UN SDGs, the Indian construction industry may be required to make adequate contributions in this space. An easy way of achieving such active inclusion may thus be, through the use of IE in a substantial number of sustainable construction projects, wherein, by promoting sustainable measures from the first phase of development and allowing a collaborative approach between different engineering disciplines, India may be able to bring about, a reality to its net zero carbon emission goal, while simultaneously making considerable contribution towards the achievement of UN SDGs.

With an open space in the construction and infrastructure regulatory domain of India, this addition may even act as a step necessary for regulating the industry practices and their resultant impact on the environment.

It is worth noting that the inclusion of IE may not cause added complexities in the projects undertaken by the GoI, on account of the necessary knowledge pre-existing within the Indian construction domain, with respect to IE projects and their success ratio.

However, while the resultant effect of various measures undertaken by the Indian administration may depend on external circumstances, the ultimate buck, however, may lie with the stakeholders, to promote active measures to give effect to a sustainable and better future.

References

1. UNITED NATIONS, https://sdgs.un.org/goals (last visited May 8, 2025).

2. FIDIC, FIDIC CLIMATE CHANGE CHARTER 11 (FIDIC 2021).

3. Supra note 1.

4. General Assembly Economic and Social Council, Progress towards Sustainable Development Goals, 2, 3 (2024), https://unstats.un.org/sdgs/files/report/2024/SG-SDG-Progress-Report-2024-advanced-unedited-version.pdf.

5. FIDIC, Playbook expanded to encourage nature-positive infrastructure, International Federation of Consulting Engineers, (May 8, 2025, 03:07 PM), https://www.fidic.org/node/45011

6. INFRASTRUCTURE GLOBAL, https://infra.global/projects/ringsend-wastewater-treatment-plant-upgrade-phosphorus-fixation-Project/#:~:text=As%20a%20core%20component%20of,sensitive%20environment%20of%20Dublin%20Bay (last visited May 20, 2025).

7. World Wide Fund, Clean Ports, Clean Ocean: Lessons learned from addressing Plastic Pollution in Philippines, https://wwfph.awsassets.panda.org/downloads/clean-ports-clean-oceans-lessons-learned-from-addressing-plastic-pollution-in-the-philippines.pdf.

Some interesting investments:

a) An investment of Rs 3000 cr is planned in Telengana for a pumped storage project. Pre-project activities are currently underway. The project is being developed by Singareni Collieries Company Limited .

b) An investment of Rs 485 Cr is planned in Baramulla, Jammu and Kashmir for a 240 MW run-of-the-river hydroelectric project. NHPC has invited bids for the electro-mechanical (E&M) works.

c) A new Rs 185 crore multimodal logistics/industrial park and warehousing construction project is being developed in Maharashtra. The project is a key initiative by the Government of India. Currently in the Environmental Clearance stage

d) An investment of Rs 300 crore is planned for an industrial park expansion project in Thiruvallur, Tamil Nadu. The project is scheduled to begin construction in January 2026 and conclude in 10 months

Source: Agencies

13

Dire Need For R&D in Technology and One Year Apprenticeship For Graduating Engineers

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Former Dean of Faculty of Technology, Delhi University

Abstract

For execution of engineering projects, India urgently needs a large pool of properly qualified and trained technical manpower. Although the universities and technical institutions are producing a large number of engineers, both at UG and PG levels, there is a gap between what the institutions produce and what the industries need. One of the major causes is lack of training in the industry, whether at a project site, a plant, or a design office, through structured Apprenticeship as in other professions. Another important reason is the flight of graduates for higher studies abroad. R&D is also woefully ignored by the industry. The Author has discussed these problems in depth and suggested an Apprenticeship for engineers and R&D supported by the industry, so that the country flourishes and the dream of "Viksit Bharat" can be fulfilled.

Introduction

India, with a population of over 1460 million the largest democracy in the world. With an annual intake of about 1.49 million graduates and 75,000 postgraduates from around 8,936 technical institutions, India possesses a large pool of technical manpower. According to the Statista Research Department, Feb 12, 2025, only 72% of engineering graduates in India are employable. It is unfortunate that many of the young, bright students with leadership and entrepreneurial qualities, and also those with an R&D bent of mind, leave the country every year for opportunities abroad due to their inherent desire to prosper, flourish and fulfil their ambitions. Such talented engineers could have contributed immensely to "Viksit Bharat"-as envisaged by the Government of India and also make it the third largest economy in the world.

Brain Drain and Migration of Talent

The Hon'ble Prime Minister Shri Narendra Modi, while addressing the Indian diaspora in the USA had said that the *"brain drain would be turned into a brain gain anytime"* with their willingness to help India; there was a large positive response to that. All the same, what needs to be addressed is to put into practice the ways and means for India to partake of that positive response.

With more than 60 years of teaching, research and consultancy experience in engineering in India, the author is of the view that as an immediate effect the country gets deprived of utilising the merits and talents of those going abroad. The 'gain' would result when those talents contribute for a "Viksit Bharat" either while being abroad or by returning to India. To bridge the existing gap between India and other developed countries, as far as science, engineering and technology are concerned, India should be less dependent on

other countries that are technically advanced. That can be done by developing, nurturing and expanding R&D across all spheres. To minimise the migration of talent from India, suitable opportunities commensurate with the requirements must be established and made remunerative to stem the search for greener pastures.

Reasons for Migration of Talented Engineering Graduates from India

Indian engineering institutions and colleges turn out around 1.5 million graduates, 75,000 postgraduates and 1500 PhDs every year. Except for IITs/ IISCs/ IIITs/NITs and some premier private engineering colleges, the quality of engineering graduates and post-graduates from most of the technical institutions in India needs to be brought up to the mark. Currently, out of the total of 5,868 engineering and technology institutions that are approved by the All India Council for Technical Education (AICTE), India has 23 IITs, 25 IIITs and 31 NITS. The others are from a large number of state-level colleges and private institutions. Thus, the numbers graduating from the private colleges are large in comparison to the government ones. What is therefore necessary is an upgradation of the standard of teaching and the facilities, including R&D in almost all the private colleges/ institutions.

Under the prevailing circumstances, the majority of the bright and meritorious students in engineering and technology leave India for higher education and research abroad due to their better infrastructure, quality of teaching, research guidance and facilities available. They enjoy higher pay and perks and recognition of their work. Due to several incentives offered by the developed countries, better quality of life and due recognition, talented persons have little incentive to return to India after completion of their studies. Most of the IITs. IIITs and the NITs also need to relook at their faculty strength, especially the quality and update their infrastructures. Government funding is a fundamental requirement for that.

To elevate their status, the engineering institutions in India require the following:

- Faculty with the required capabilities, competencies and field/ industrial/ design office experience,
- Improved physical infrastructure,
- Facilities and funds for R&D - fundamental and applied research,
- Linkage of R&D as per industry's requirement,
- Curriculum to be updated to keep pace with the times and the requirements of the country,
- Be more selective in the intake of post-graduate students, and
- There should be a two-way flow from Institutions to Industry and vice-versa.

Thus, the priority or focus needs to be on upgrading the quality of existing Institutions, including the IITs, IIITs, and NITs, in terms of infrastructure and faculty involved in teaching and R&D, and bringing them up to par, rather than just building new Institutions.

Upgrading Post Graduate Education

The majority of the students from private institutions who join PG courses are not motivated and are reluctant to do hard work, partly because of their poor UG background, but mostly due to a lack of proper guidance. They utilize the scholarship, libraries, and hostel facilities for preparing for public service examinations/ seeking an appropriate job/ awaiting the result of admission to foreign universities/ institutions for a more assured future. Instead of hard work, most of them seek admission to PG courses in IITs for an *IIT stamp*.

The PG courses need to keep pace with the industrial scenario and requirements. At times, the faculty would also need to update and upgrade their knowledge and capabilities.

Remaining concurrent, if not ahead of the curve, is the Key.

Suggestions for Improving Quality of PG Education in India

The standard of PG education in India should be made comparable to that in developed countries like the USA, Europe, Australia, Canada, etc. What the engineering/

technical institutions need are not only well-qualified faculty members but also those who have an aptitude for teaching, a thirst for knowledge, the ability to think and solve problems *ab initio* and also have experience or be associated with working on projects, in a plant, or at a design office.

Young postgraduates with strong fundamentals and motivation for research and development (R&D) form the backbone of a technical institution. They should also undergo a year of apprenticeship training in the field, at a plant, or at a design office. They should be recruited very carefully and trained under the vigilant supervision of senior faculty members. It should never be forgotten that it is the teachers who mould a student to be professionally competent and it is they who mould and deliver the professionals that the country and its people need. AICTE may consider reintroducing the earlier scheme 'Teachers Training Program' or 'Teaching cum Research Assistantship' by recruiting young engineers/ technologists to undergo postgraduate/ PhD programmes in India.

Improving R&D and Consultancy

R&D and consultancy works act as a nucleus for all developmental activities. University professors and young Research Scholars working under them comprise an enormous pool of expertise and resources which must be tapped to solve many challenging problems faced by the society, in a fast-changing world with global competition, and to do R&D in a time-bound manner.

A major problem being faced by the educational, research, consultancy and industrial institutions today is attracting and retaining qualified and deserving engineers/ technologists. That's primarily because of the lack of quality institutions and low remuneration.

Another factor is that most of the research work in India merely ends with publications; there is little or no application in the field. To tide over that sound knowledge, information, initiative, hard work, perseverance and above all the spirit and drive for creativity are essentially needed for pursuing research and development works leading to innovation and excellence with *'Eureka'* moments. The quality of education and research in science, engineering, and technology must be upgraded further in India to stem the tide of migration of talent.

Whereas USA and China invest 3.6% and 3.7% of their respective GDPs in R&D annually, India's annual investment in R&D is only about 0.64%. However, with the government in the USA reviewing its policies on funding of educational institutions and R&D, and the visa policies, only time will tell what its impact will be on India. Hopefully, it will result in a reduction in the 'brain drain'.

Apprenticeship for Engineering Graduates

To prepare, guide, and groom young engineering graduates, they must be properly trained. All engineering students MUST also undergo SIX WEEKS of training after their 2nd and 3rd years. Thereafter, on completion of their final year, they MUST undergo ONE year apprenticeship on the job at project sites, in plants, in design offices, etc., just as other graduates of other professions have to undergo. All that must be under the guidance of senior engineers who have empathy for the young and are willing to share their knowledge and experience unbridled. The degree should be awarded only on successful completion of a one year Apprenticeship.

Engineering organisations, across the country, be they large, medium, small or micro, MUST recruit and pay Apprentice Engineers and ensure that they get adequate training in their respective discipline and allied soft skill areas of the profession – report writing, drafting specifications and contract documents, legal, finance, ethical, etc. The sense of duty to the country and society needs to be instilled in them. The apprenticeship would help in identifying and resolving numerous problems that the country faces and provide inspiration to serve the country.

Conclusions

For India to forge ahead, R&D in science and technology is imperative. Consultancy works within the country should have a domestic firm as the lead firm. Only then can India rise as it has in the Space and Nuclear sectors. The country will then not need to purchase know-how from abroad; it will become an independent powerhouse of knowledge and save enormous costs. Paid Apprenticeship will help graduates learn and put forth new ideas vis-à-vis the industrial practices being followed. Some of them may be motivated to work for the country to solve the social and economic problems that are being faced now or may be faced in the future. Talented and capable persons from all disciplines would act as nuclei around which other developments could take place with the participation of large numbers of technical and skilled persons for successful upliftment and becoming "Viksit Bharat" by 2047.

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References

1. https://timesofindia.indiatimes.com/education/news/pursuing-engineering-once-a-fad-now-a-dilemma-only-10-percent-of-15-lakh-graduates-likely-to-land-jobs-this-year/articleshow/114686084.cms#:~:text=%E2%80%9CTo%20break%20it%20down%2C%20India,skill%20readiness%2C%E2%80%9D%20says%20Ramesh.%2C%E2%80%9D%20says%20Ramesh.

2. Statista Research Department, Feb 12, 2025. https://www.statista.com/statistics/738200/employability-among-engineering-graduates-india/

3. 'Brain drain' can become 'brain gain' any time, Modi points in his SAP Centre address; The Times of India, September 28, 2015

4. https://dashboard.aishe.gov.in/hedirectory/#/institutionDirectory

5. https://www.shiksha.com/engineering/articles/top-engineering-colleges-in-india-other-than-iit-nit-and-iiit-blogId-144327

6. Mazumder, S.K. (2008)," Quality Improvement Through Collaboration Between Educational, Research a Consultancy Institutions in India" pub in the Journal 'Consulting Ahead' by Consultancy Development Centre, Vol.2 Issue-1 January

7. Mazumder, S.K. and Rakesh Mehrotra (2019) "Role of R&D - In Shaping Future Engineering Profession" CEAI's ViewPoint of June 2019, pp 20-24

8. Mazumder, S.K. (2017) "Engineering Education in India-Need for Industry-Institute Interaction", Keynote speech delivered during the conf. titled "Preparing engineers- technologist for role in industry" organised by Engineering Council of India at AICTE auditorium, Vasant Kunj, N.D.67 on 10 Nov. 2017

9. Rama Rao, P. (2013), "Higher technical education in India: prospects, challenges and the way forward" INSA Public Lecture. New Delhi, February 14,

10. Subbarao, E.C. (2013), "India's higher engineering education: Opportunities and tough choices", Current Science 104: 1.

14

Inculcating A Safety Culture in Building Occupants – A Dire Need

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Introduction

When the word safety is mentioned, it is normally associated with safety in industrial and allied plants, large establishments, construction sites, etc., all places where several people, mobile machines, plants and equipment are involved. Even training is oriented toward just those. However, it is worth finding out what training is imparted to occupants of residential buildings. Unfortunately, very little bordering on none. For that matter, it is not imparted even to occupants of commercial buildings.

With high-rise and tall buildings becoming the order of the day and the scenario in India is moving to skyscrapers, it is essential that each and every occupant, and not just one from each household or a few persons from each establishment, be imparted training on the safety aspects. It needs to be ingrained in them that each one is responsible for safety in their individual capacity, and collectively as well. The function is not solely that of the Safety Officer/ Manager of the building.

Training

With all work shifting from manual to electrically powered equipment and gadgets, and their numbers are increasing day by day, the occupants must be imparted proper training on their usage; the manner and mode in which they are to be kept when not in use; or when no person is supervising their functioning/ running. It is only when all the occupants abide by the policies and procedures that may be framed for a building that there are very good chances that that building will remain safe at all times.

The training to be imparted to occupants of buildings would depend on the kind of functions that are performed in the building. Two types are discussed in this article – residential and commercial, since for industrial and other sectors the number of parameters and factors to be considered are many, depending on the specific sector.

Residential Buildings

Training Sessions

The first session should be common for all the occupants, and they should be apprised of the objective and what is expected at the end of the training.

Thereafter, the training sessions – theoretical and physical, should be held separately for different age groups of say 7 to 12 years, 13 to 18 years, adults above 18 to 60 years and those older than 60 years. The groups should be limited to a maximum of 40 to 50 persons so that the trainer can judge whether all in the group understand what is being shared.

On completion of the separate sessions, there should again be a common one for all the occupants, and their feedback should be taken to judge as to how much they have understood and will be able to readily adopt. It would also help the trainers modify the course content, the manner, and the modes of training.

Training Subjects

The training should inter alia cover a brief on the building's architectural and structural aspects, all the services, and the safety and security systems. The main ones are listed for guidance.

a. Electrical (supply, wiring, circuit breakers, switches, etc.),

b. Proper usage of appliances, plant & equipment in the building, the Society's office, storage areas, if any, pantry, etc.

c. Mechanical (HVAC, natural ventilation),

d. Plumbing (water supply, waste water, storm water), solid waste,

e. Fire,

f. Lifts,

g. Inflammable material, if any, in common areas, façade, and in each flat/ premises,

h. Emergency evacuation (fire, earthquake, flooding),

i. Communication & IT,

j. PA system,

k. Housekeeping – flats and common areas,

l. Storage and handling of inflammable and corrosive materials,

m. Safety systems,

n. Security systems,

o. First Aid basics,

p. Areas where the floor could be slippery or have inadequate protection, especially for senior citizens, and

q. Areas where children should not be allowed.

r. Safe usage of digital gadgets, especially the Internet & Mobile phones

There can also be other requirements.

Training Periodicity & Aspects to be Covered

The training sessions should be conducted periodically as a refresher and reminder, and to also educate new members of the Society.

Some of the aspects that need to be covered and emphasised are:

a. Abide by all the Rules and Regulations of the Local Body/ Local Authority. It would be good if an abstract of the relevant clauses were handed over to each occupant either in paper form or digitally.
b. No changes in the external features of the building by way of addition of any shade, grill, etc., since that, apart from marring the aesthetics, hampering maintenance, affects smoke exhaust and emergency egress.
c. No work on any structural member – columns, beams and slabs. However, drilling to install a screw to hang fixtures, frames, artefacts and the like may be done, but with care.
d. No tampering with any service installation as provided. If and where necessary, it should be done through the Society, so as to ensure that the systems do not get affected in any way.
e. Access control at all entrance doors.
f. Access to all egresses should be kept free of any obstruction and have a clear, unobstructed path leading to them
g. All signage, especially those concerning hazards and evacuation–emergency or otherwise are clear, easily legible even in the night, and not obstructed in any manner,
h. If a religious ritual involving fire is being performed inside any premises, then the Society should be informed, and the smoke detector should be shut off for that duration, to prevent the alarm from going off.
i. When there is no person inside the premises, switch off:
j. All electrical fixtures and appliances except the refrigerator.
k. Gas connection – at the cylinder or the inlet valve in case of a piped supply. Advisable to switch it off every night before retiring for the night.
l. Do not use any inflammable material inside the premises unless work is being done by trained personnel.
m. Clothes Iron: Always rest a clothes iron when not in use, on a stand, even if temporarily, while ironing.
n. Ovens – no combustible material to be used for accessing the inside to place or remove any item.
o. Do not leave open electrical wires, even temporarily.

Some Aspects to be Covered

Vehicular Parking: The vehicle parking should be done such that quick egress is possible in an emergency. No obstruction, which prevents quick egress, especially at night or on holidays should be allowed. All bends should have more than the stipulated minimum radius to allow vehicles to move out quickly. The same applies to the slopes of ramps.

Flooding of Compound & Basement: With flooding becoming more common, all electrical fittings and fixtures in open areas and basements should be waterproof and installed at a reasonably higher level. Charging stations should be avoided in basements.

Signages should be in English and the local language, plus also provided as visuals (graphical).

Handouts and Record Keeping

The occupants should be given a list of Dos & Don'ts as a hard copy and a soft copy.

As a mark of their having assimilated what is given in the list and of having attended the training sessions, each individual should record their name, mobile number, premises number, etc. in a Register, which the Society should maintain.

Commercial Buildings

Commercial buildings could be for mixed usage – offices, shops, restaurants, storage areas, etc., and hence the number of people at any time would be large. Thus, the awareness of safety requirements for the staff in all the establishments is all the more crucial.

Training Sessions

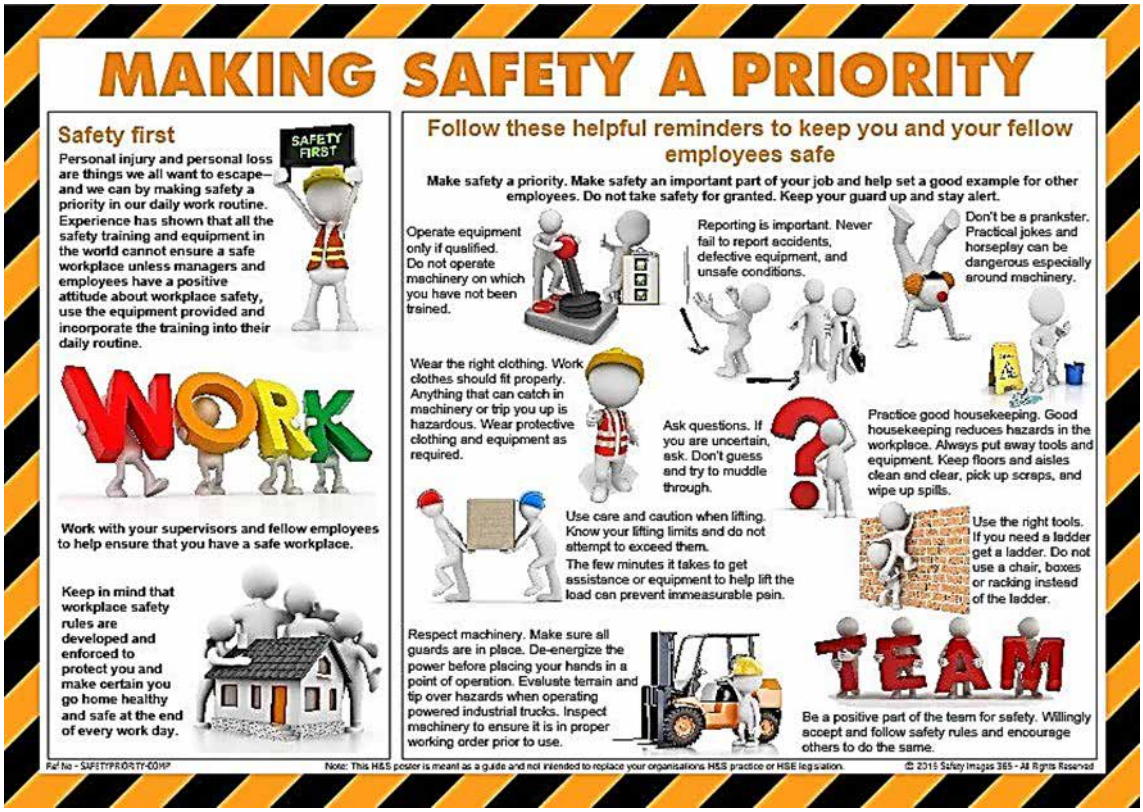
The first training session should be common for all the occupants, regardless of what their area is being used for. and they should be apprised of the objective and what is expected at the end of the training.

Thereafter, the training sessions – theoretical and physical, should be held separately for different usages. The groups should be limited to a maximum of 40 to 50 persons so that the trainer can judge whether all in the group comprehend what is being shared.

On completion of the separate sessions, there should again be a common one for all the occupants and their feedback should be taken to judge as to how much they have understood and will be able to readily adopt. It would also help the trainers to modify the course content, the manner, and the modes of training.

The training should inter alia cover all that has been listed for Residential buildings plus the specific requirements and hazards that would be associated with each type of establishment.

In addition to those, the personnel in commercial buildings also need to be trained to use fire extinguishers, guiding and helping visitors to assembly areas, lifting techniques for heavy loads, and the use of Personal Protective Equipment (PPE).



Continuity and Updating of Training

Learning and training are a lifelong affair. It is always good to attend refresher classes to keep up to date with new developments in the methodology, tools, and techniques related to safety and security.

BE ALERT

KEEP UPDATED

BE SECURE

BE SAFE

ANNOUNCEMENT SOON.....

15

An Ethics Program: A Business Case for Sustainable Business Practices

Deepak Kumar
Ethics & Compliance Officer
SYSTRA India

Ethics is no longer a peripheral concern in the dynamic and complex world of construction and infrastructure development - it is a foundational pillar. As projects grow in magnitude and complexity, there is a pressing need for the adoption of transparent, responsible, and accountable practices. Beyond compliance with local laws, organizations are under an obligation to comply with global anti-corruption regulations like FCPA, UK Bribery Action, World Bank regulations, etc. During public procurement, the organizations are prohibited from any practices pertaining to Fraud, Corruption, Coercion, Anti-Competition, and Conflict of Interest. To meet the sustainability commitment, it is important to address the need of safety, human rights, diversity, and data privacy.

SYSTRA India has implemented robust ethics programs designed to ensure adherence to legal requirements while fostering a culture of respect and accountability. Overseeing this program is a dedicated compliance officer, who maintains an independent reporting line to the Group Compliance officer and the Managing Director of SYSTRA India, ensuring effective and impartial implementation of the ethics program. 'Business Ethics and Compliance policy' establishes the tone at the top. The Ethics Policy is further reinforced by SYSTRA's 'Code of Ethics' and 'Anti-Corruption Code of Conduct', which articulate the company's core values and behavioural standards. Various other guidelines are available on various ethics topics like conflict of interest, due diligence, sponsorship and charity, etc. SYSTRA India promotes a speak-up culture wherein the employees are encouraged to report unethical practices, for which a dedicated reporting channel has been formalized.

SYSTRA India believes that maintaining ethical standards is a shared responsibility across all levels of the organization. Awareness of the code of ethics, anti-corruption code, zero tolerance for violations, raising ethics alert, etc., is important for an inclusive approach to implementation. It's mandatory for all employees to attend the classroom training and complete the e-learning modules on ethics during onboarding, with mandatory refresher courses at regular intervals thereafter.

While engaging with business partners, SYSTRA India conducts rigorous due diligence to mitigate potential ethical risks from the external party. The business partners are formally apprised of the company's ethical standards, and adherence to the same is expected.

The Group's Ethics Directorate maintains robust oversight through regular progress reviews of the ethics roadmap and control mechanisms. Quarterly reports are thoroughly analyzed in collaboration with group leadership, with actionable insights implemented across operations. The Directorate further facilitates global knowledge sharing through regular meetings with compliance officers from all SYSTRA subsidiaries worldwide, enabling the exchange of best practices and critical updates.

SYSTRA India is certified for ISO 37001 standard, which is a testament to its commitment to maintaining the highest ethical benchmarks. As an industry leader, SYSTRA India remains steadfast in its mission to uphold integrity and preserve the trust of all stakeholders.

S.No.	Government of India/ Agencies' Announcements
1	In its Policy Circular dated 12 July 2025, the National Highways Authority of India has announced the incorporation of provisions within the Standard Agreements for EPC, HAM and BOT projects, which shall deal with the resolution of Disputes through Dispute Resolution Boards/Conciliation. According to the provisions, parties claiming disputes shall approach the Authority or the Independent Engineer (AE/IE) for amicable settlement at the first instance. Failing mediation/in the absence of intervention from the AE/IE, the dispute may be referred to Dispute Resolution Boards, against the decision of which, the option of conciliation must be explored. In effect, the Standard Operating Procedure mentions arbitration to be the last resort.
2	The National Highways Authority of India, in its press release dated June 12, 2025, has announced its decision to restrict a maximum of 10 projects per Engineer for consultancy firms for supervision of construction or maintenance of National Highway projects. The decision has been taken with the purported objective of enhancing the quality and supervision mechanism of the NH Projects. In furtherance of this, the press release stated the inclusion of specific detailed clauses within the guidelines for consultancy firms implementing and maintaining National Highway projects on HAM and EPC mode.
3	April 2025 marked a significant milestone for the Indian Construction industry, as the Government of India approved the construction of the Laser Interferometer Gravitational Wave Observatory (LIGO) India. The project shall be developed at INR 1600 Crores and will make significant strides in India's contribution to the hunt for gravitational waves. It is anticipated that LIGO shall be completely operational by 2030.

CEAI NEWS

CEAI EVENTS IN THE QUARTER

Webinar on Post-Disaster Rehabilitation & Rebuilding: Need of Integrated Management Principles

CEAI Future Leaders Forum organised a webinar on "***Post-disaster Rehabilitation & Rebuilding: Need of Integrated Management Principles"*** on 4th April 2025.

Ms Renjitha Nair, Contract Specialist, General Contracting and Trading Services Co. WLL was the speaker at this webinar.

She highlighted the critical importance of adopting integrated management principles - ensuring coordinated action, sustainability, resilience, and community participation. She brought out that through a holistic and well-organized approach, recovery efforts can be made faster, smarter, and more inclusive, helping communities to rebuild and be stronger and safer. It was to get that message across that CEAI FLF organized the webinar to drive home the point that integrated management is essential for addressing today's complex disaster challenges.

India Concrete Congress 2025 & India International Construction & Equipment Expo 2025

The Consulting Engineers Association of India - Eastern & North-Eastern Region (CEAI-E&NER) participated in the *India Concrete Congress 2025 & India International Construction & Equipment Expo 2025* held on April 17th - 19th 2025, at Biswa Bangla Exhibition Centre, Kolkata.

The inaugural address was delivered by Dr. V. Ramachandra, President, Indian Concrete Institute, and Former Technical Head, Ultratech Cement Limited, on ***'Achieving Net Zero Emission in Concrete Construction'***. Mr. Anirban Datta, Chairman, CEAI-E&NER, delivered a keynote address on ***'Construction Planning & Sequencing through 3D, 4D & 5D Simulations and Leveraging Artificial Intelligence'***.

CEAI was an official supporting partner for the Expo. Delegates visited the CEAI Pavilion.

Business Opportunities Seminar 2025

The Asian Development Bank (ADB) hosted a Business Opportunity Seminar (BOS) on April 30, 2025 at the India International Centre in New Delhi.

CEAI was a partnering organisation. The program started with Welcome Remarks by Ms. Arti Mehra, Dy. Country Director, ADB; Introductory Remarks by Ms. Harsha Bangara, Managing Director, India Exim Bank and Keynote Address by Mr. M Nagarajan, Secretary - Department of Finance Services. Representatives from the partnering organizations viz. FIEO, CEAI, BAI and NHBF presented about the activities of their respective

organizations. Mr Prashant Kapila, President spoke about CEAI.

The seminar covered project-specific business opportunities, ADB Procurement Procedures, ADB Consultant recruiting procedures, and the Government of India supported EXIM Bank's lines of credit program and activities.

Webinar On Post Installed Anchorage to Concrete - An Insight into the Indian Standard

CEAI Future Leaders Forum successfully organised a webinar on ***"Post Installed Anchorage to Concrete - an insight into the Indian Standard"*** on 29th May 2025.

Mr. Shounak Mitra, Head of Codes & Approval and Engineering Marketing at Hilti India Pvt. Ltd. was the speaker.

He brought out that the modern construction industry is replete with post-installed fastenings that connect steel to concrete - be it for extremely critical, heavy duty structural application or for light/ medium duty non-structural yet safety critical applications like utilities and façade fixings. Understanding their correct behaviour and specifying their exact performance enable erection of some of the most complex structures. Their increased usage serves to highlight the need to pay greater attention to them. Without sufficient information, post-installed fastenings, often, are designed with poor engineering judgement stemming from a lack of local codal requirements on the topic. He added that IS 1946 - the new Indian Standard for 'Design of Post-Installed Anchorage to Concrete' by the Bureau of Indian Standards is a welcome move and looks to address the current gap in the industry and present a comprehensive guideline for these connection designs.

MOU Signed with Maharaja Agrasen Technical Education Society

CEAI Academy signed an MOU with Maharaja Agrasen Technical Education Society on 30th May 2025.

Industry Association Partner For InnoMetro 2025 Global Expo Program

CEAI proudly participated as an Industry Association Partner at **InnoMetro 2025**, a global expo showcasing groundbreaking innovations and technologies in metro systems, railways, RRTS, high-speed rail, and allied mobility sectors.

Held on **May 21-22, 2025, at Bharat Mandapam, New Delhi**, the event brought together industry leaders, experts, and stakeholders for meaningful discussions and collaborations. CEAI secured a dedicated booth space to promote its services, events, and core activities, fostering engagement with fellow participants and visitors. Several Governing Council (GC) members, along with CEAI staff, represented the association, exchanging insights, networking with industry professionals, and reinforcing CEAI's commitment to advancing engineering excellence in India

Webinar on Advanced Materials in Concrete & Its Sustainability

CEAI FLF organised a webinar on ***"Advanced Materials in Concrete & Its Sustainability"*** on 6th June 2025.

Dr. (Prof.) Mainak Ghoshal Chairman, All India Valuers' Association was the speaker.

The session explored cutting-edge materials being developed and integrated into concrete - such as nano-materials, self-healing concrete, and supplementary cementitious materials (SCMs) that aim to enhance performance while significantly reducing environmental impact. Also how these advancements align with global sustainability goals (like those discussed at WEF and COP)

Webinar On "Strategies For Winning International Projects: Building Global Bridges And Business Excellence

CEAI organised a webinar on ***"Strategies for Winning International Projects: Building Global Bridges and Business Excellence"*** on 12th June 2025.

Dr Manmohan Parkash, Former Senior Advisor, Office of the President, Asian Development Bank was the speaker.

He explained how, with global infrastructure demand on the rise, Indian consultants and contractors have a unique opportunity to expand their footprint in international markets. Drawing from firsthand experience as an architect of the landmark 2017 ADB Procurement Reforms – he outlined strategic pathways for winning international projects. It talked about the multilateral procurement systems, highlighting evolving global expectations, and offered actionable insights on building cross-border partnerships, enhancing proposal quality, and aligning with the principles of value-for-money, quality, and sustainability. His objective was to give the message that Indian firms can and should compete and succeed globally with confidence and by providing excellent performance.

CEAI MEMBER NEWS

There were several honours and accolades for CEAI members during the quarter.

- Mr V N Heggade, Governing Council Member was honoured with the '*S. D. Limaye Award for Excellence in Structural Engineering'* on March 21, 2025. This prestigious recognition was bestowed upon him for his outstanding work and invaluable contributions to the field of structural engineering.
- Dr Harshavardhan Subbarao, Governing Council Member, was elected *President of the International Association for Bridge and Structural Engineering*, (IABSE), Zurich (2025-28).
- Mr Ashish Arora, one of the CEAI Members has successfully completed the requirements of the certified Contract Manager Programme and is recognised as a *FIDIC Certified Contract Manager*.

- Mr Vineet Lochan Gupta, Life Member of CEAI & CEO of Save Techno Engineers (an Engineering Consulting firm) was honoured with the *'Times Business Award 2025'* for *'Excellence in Project Management & Engineering Design Consulting Services'*.
- Holtec Consulting Private Limited (Holtec), a CEAI Member Organisation, *celebrated the 58th Anniversary* of the company's incorporation. Holtec has won several accolades, rewards and recognition over the years. a fruitful story of unwavering commitment, integrity and excellence.

CEAI is proud of the achievements of its Members and wishes them greater success and achievements in the years to come to take the fraternity to greater heights.

FORTHCOMING EVENTS

- The webinar organised by CEAI-WRC on "BIM, Digital Twin, XR & Power BI in Project Management" will be held on Thursday 3rd July 2025, 15:00 - 18:00 hrs (IST.
- CEAI Future Leader Forum is organizing a webinar on "Role and Opportunities for Engineers in the Field of Project Appraisal for Banks & Financial Institutions" on 4th July 2025.
- CEAI-WRC is partnering a Seminar on "Use of Parallel Flange and Tubular Steel Sections" to be held in Ahmedabad on 6th August 2025.
- CEAI-WRC is organising an online Training on "Forensic Engineering" on 23rd August 2025.
- CEAI-WRC is organising a Workshop on "XR and AI in Engineering & Construction Industry" on 13th September 2025 at Mumbai.

FIDIC NEWS

FIDIC Training Program: On 28 & 29 August 2025, CEAI is organizing an open house training program focused on the practical usage of FIDIC General Conditions of Contract. The training will be conducted by an international FIDIC accredited trainer.

FIDIC Annual Global Infrastructure Conference 2025

The FIDIC Annual Global Infrastructure Conference 2025 will take place from 21-23 September 2025, at the Cape Town International Convention Centre. FIDIC's flagship event is a must-attend for the global engineering, construction and infrastructure sector.

Registration Link: https://events.fidic.org/GIC25/register?reg_type_id=831665

FIDIC Asia Pacific Conference 2025

The FIDIC Asia Pacific Annual Conference 2025 will be held under the theme '***New Technologies Transforming the Engineering and Construction Industry'*** from 18-20 August 2025 at The Meru/ Bali Beach Hotel Sanur, Bali, Indonesia.

Registration Link: https://www.fapcbali2025.inkindo.org

OTHER NEWS

Report of the Seminar on Revision of NBC

Held on 13 June 2025 in New Delhi (in Hybrid Mode)

The National Seminar on Revision of the National Building Code (NBC) of India, organized by the Bureau of Indian Standards (BIS) on 13 June 2025, served as a national platform for structured consultation and stakeholder engagement on the ongoing comprehensive revision of the NBC, which guides building design, construction, safety, and sustainability across India.

The Seminar brought together over 4,300 participants in hybrid mode, physically at the India Habitat Centre, New Delhi, and virtually from across the country.

The inaugural session featured insightful addresses by key BIS leaders:

Shri Pramod Kumar Tiwari, Director General, BIS, in his inaugural speech, emphasized the NBC's regulatory relevance for States and Union Territories. He welcomed inputs from stakeholders and encouraged collective feedback to ensure the Code reflects the evolving needs of the nation.

He also released the Seminar Souvenir, which documents key changes across 33 chapters of the NBC, including proposed additions, namely *Vehicle Parking Systems*, and *Steel–Concrete Composite Systems.*

Earlier, Shri D. Bhadra, Head (Civil Engineering Division), BIS, commenced the seminar with a welcome

note and highlighted the importance of this revision exercise in strengthening India's built environment and supporting national infrastructure development.

Shri Sanjay Pant, Deputy Director General (Standardization – II), BIS, outlined the objectives of the seminar, stressing the need for wide-based technical engagement and collaboration in revising such a foundational document. He also traced the history of development of NBC since its first version in 1970 brought out by BIS (the then ISI) at the instance of the Planning Commission and its subsequent revisions in 1983, 2005 and 2016 with amendments to various versions brought out intermittently.

Shri Arunkumar S, Head (NBC Cell), delivered a presentation on the journey so far in the current project of revision of the Code and highlighted the major inclusions and updates in the proposed revised Code.

The technical sessions comprised 19 focused presentations by expert Conveners and members of NBC panels as follows, who elaborated on major updates across different parts of the Code:

Parts 2 & 3: Administration, DCR & General Requirements, Shri V. Suresh, Chairperson, National Building Code Sectional Committee, CED 46

Part 4: Fire and Life Safety, by Shri S. K. Dheri

Parts 5 & 7: Building Materials & Construction Practices, respectively by Dr Shailesh Kr. Agrawal and Shri H. S. Dogra

Part 6: Structural Design, by Prof V. Kalyanaraman, Shri C. Pushpakaran, Prof Rupen Goswami, Shri Pradeep Garg, Shri V. V. Arora and Prof Radhakrishna Pillai 4

Part 8: Building Services, by Prof Rajan Rawal, Shri Ashish Rakheja, Shri A. K. Mittal, Shri N. Nagarajan, Shri P. M. Tipnis

Part 9: Plumbing Services, by Shri Sandeep Goel

Part 10: Landscaping & Signage, by Ar. Samir Mathur

Part 11: Sustainability, by Prof Monto Mani

Part 12: Asset & Facility Management, by Dr C. Velan

Each presentation focused on proposed technical revisions and their anticipated impact on building planning, construction processes, public safety, and long-term infrastructure performance.

The Seminar concluded with an Open House and Q&A session, moderated by Shri Jose Kurian, Chairperson, Civil Engineering Division Council (CEDC), BIS, facilitating meaningful dialogue and feedback from stakeholders across sectors.

This National Seminar is a key milestone in BIS's journey to deliver a future-ready, unified, and robust Building Code, designed to meet the needs of modern India, support sustainable urban growth, and ensure resilience in the built environment.

The audience present at the venue and those online shared their inputs and suggestions, which will be considered by the NBC Sectional Committee when the Code is finalized. The participants were requested to send their any further technical comments within 10 days so as to enable BIS to get the same considered by the relevant technical committees.

The entire seminar is available online in the BIS'YouTube channel and continues to witness increasing views: https://www.youtube.com/watch?v=n8mDofb0EZg

Source: Report of the National Seminar on Revision of NBC_13_June_2025.pdf

CONDOLENCE MESSAGE'

Reg.: 127/047/048 PAN: 301809238

सोसाइटी अफ कन्सल्टिङ्ग आर्किटेक्चरल एण्ड इन्जिनियरिङ्ग फर्म्स्

SOCIETY OF CONSULTING ARCHITECTURAL AND ENGINEERING FIRMS, NEPAL (SCAEF)

(A National Body of Consulting Firms Recognized by Government of Nepal)

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Date: 15 June 2025

Hon. Mr. Prashant Kapila
President
Consulting Engineers Association of India (CEAI)
CEAI Centre, OCF Plot No 2, Pocket 9, Sector B,
Vasant Kunj, New Delhi 110070
India.

Dear Mr. Kapila,

We, all the members of Society of Consulting Architectural & Engineering Firms (SCAEF Nepal) are deeply saddened by the tragic news of crash of Air India Flight AI171 en route to London Gatwick Airport from Sardar Vallabhbhai Patel International Airport in Ahmedabad, Gujarat, India on June 12, 2025.

We would like to express our deepest sorrow on the loss of lives to the people of India and the families of the bereaved and loved ones of the passengers, crew members, and those on the ground who perished in this devastating accident.

In this time of immense sorrow, we stand in solidarity with you.

May the souls of the departed rest in eternal peace, and may the survivors and affected families find strength, comfort, and healing in the days ahead.

With heartfelt condolences,

Er. Thakur P. Sharma
President
SCAEF Nepal

Member | Member

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VIEWPOINT

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

Month & Year	Theme
September 2025	Contractually Addressing Uncertainties in Projects
December 2025	Asset Management for Sustaining Built Facilities
March 2026	Solid Waste Management and the 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 "Contractually Addressing Uncertainties in Projects"

Professionals, the September 2025 issue on the theme that concerns all-***"Contractually Addressing Uncertainties in Projects"***, is challenging.

Professionals dealing with projects are all too aware of the various issues that arise from poorly drafted contracts - contracts that do not specify how matters would be resolved when unforeseeable factors affect a project schedule and costs.

The COVID-19 pandemic rang alarm bells across the globe since it was an occurrence that knew no boundaries and respected no one; all were equal in its tidal wave. The unforeseen event caused uncertainties in contracts with serious financial consequences.

Uncertainties can also arise due to the client not being clear about the scope or not specifying the requirements *ab initio* or amending them during the project. They can also emerge if the contractor, for whatever reason, has not anticipated some work requirement or situation.

The ever-increasing size and complexity of projects over large geographical areas with varying terrain, biota, climate, geology, soil, etc., enhance the risk potential and require contracts that can mitigate them.

Professionals involved in project activities, in any field of work, are welcome to share, on 'ViewPoint', their experience on complex projects executed, issues that arose and were resolved, and recommend different ways on how contracts should provide for uncertainties.

Articles can also be on how digitalisation could support in alerting, tracking, evaluating and resolving matters related to uncertainties in projects.

The ViewPoint invites Professionals and Organisations engaged in project work and in the preparation of Contracts to share their experiences by providing *Case Studies* of relevant projects, especially engineering projects, on practical issues encountered and how they addressed unanticipated challenges. Also on how they pre-empted setbacks on major projects by helping Clients prepare suitable contracts providing for uncertainties in projects and achieving positive outcomes without financial loss, etc.

Photographs, charts, diagrams, drawings, etc., would benefit readers for a better appreciation of the issues encountered and how they were addressed.

Articles for the *September 2025 edition* of ViewPoint need to reach CEAI by **25 August 2025**. Articles have to be in MS Word - 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.

All Professionals are encouraged to use CEAI's ViewPoint to showcase the capabilities and achievements of Engineers in India plus educate and guide young 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, Multilateral Funding Institutions in India, and other organisations related to or dealing with the engineering profession. Thus, all stakeholders partnering in development and progress are its readers.

Support from CEAI members and stakeholders is 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 disseminate information on how Consulting Engineers are helping society improve the quality of life and are doing so sustainably. The rates for advertisements in ***VIEWPOINT*** are given below:

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)
Back Cover	25,000.00	45,000.00	80,000.00
Inside Front Cover	18,000.00	32,400.00	57,600.00
Inside Back Cover	18,000.00	32,400.00	57,600.00
Full Page (Colour)	12,000.00	21,600.00	38,400.00
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Notes: ****GST @ 5% or as prescribed will be added to the above rates.***

2) **VIEWPOINT SPONSOR ADVERTISEMENT:**

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CEAI ACADEMY – TRAINING PROGRAMMES

1. A soft skills workshop series is being planned with Ms Vijay Shree from Metaacogsworld. The LEAD360 Series is a curated leadership development program designed to equip field professionals, particularly in engineering and construction domains, with essential leadership, communication, and decision-making skills. The series comprises three focused workshops, each blending core theoretical inputs with practical applications to meet on-ground challenges.

The first workshop will be held on 4th July 2025 at CEAI HQ.

LEAD 360: Field-Ready Leadership Mastery Series

Workshop Planner: LEAD360 - Field-Ready Leadership Mastery Series

Workshop Name	Focus Areas	Topics Covered
1. LEAD360: Communicate to Command	Communication & Client Interaction	Effective Communication at Site- Presentation & Reporting Skills - Client & Stakeholder Handling
2. LEAD360: Lead with Impact	Leadership, Time & Stress Management	Leadership & Team Management - Time Management for Construction - Stress Management in Fieldwork
3. LEAD360: Decide, Resolve & Thrive	Decision Making & Professional Conduct	Problem Solving & Decision Making- Conflict Management on Site - Negotiation Skills for Engineers - DEI, POSH & Professionalism

Registration link: https://forms.gle/mRAU7wLLNDXEhgRw9

2. **Training on "Engineering Law, Contractual Problems of Project Execution & Mechanism of Amicable Settlement of Differences" on August 23 to 26, 2025.**

Overview:

This comprehensive four-day training program is designed to equip participants with an in-depth understanding of engineering law, contract management in project execution, and mechanisms for amicable dispute resolution. The sessions are structured into lectures, case studies, interactive moot court exercises, and real-world practical applications.

Program Structure:

Day 1: Engineering Law (August 23)

- Introduction to Engineering Contracts and Legal Concepts
- Sessions on statutes, rules, void contracts, contract interpretation, and the Indian Contract Act
- Faculty includes legal experts like Dr. Vandana Bhatt, Dr. Milind Wankhede, and Ms. Sadiqua Fatma

Day 2: Contractual Problems of Project Execution (CPPE) & Dispute Resolution (August 24)

- Handling contractual issues such as claims, extensions, and penalties
- Sessions on DRB, DRE, arbitration, and conciliation under legal frameworks
- Lectures by industry professionals, including Mr. Ramnanjit Singh and Mr. Ishaan Khanna

Day 3: Practical Applications (August 25)

- Real-life case studies and law applications
- Hands-on working lunch session and a focus on practical courtroom skills
- Includes expert sessions from Mr. Ajit Kumar Misra and Mr. Gagan Anand

Day 4: Outcome and Evaluation (August 26)

- Written exam and moot court sessions (teams will argue simulated legal cases)
- Feedback and certificate distribution
- Faculty: Dr. Milind Wankhede and Dr. Vandana Bhatt

Certification:

Participants attending **at least 75%** of the lectures will receive a certificate.

3. Training Program on Design of Chimneys and Stacks for Power Plants & Other Industrial Applications starting 30 August 2025

Course Description

The ***"Design of Chimneys and Stacks for Power Plants & Other Industrial Applications"*** is a structured and industry-relevant online training program jointly organized by **CEAI Academy** and the **CEAI Eastern & North East Region.**

The 10-session series, spread across five weekends, will bring together top experts from the field to deliver in-depth knowledge on the design, analysis, advanced design techniques, innovation, safety and risk aspects in chimneys and stacks used in power plants and other industrial setups.

Participants will gain a strong foundation in the types and functions of chimneys and stacks, learn about environmental and regulatory considerations, and dive deep into thermofluid dynamics, structural stability, load analysis, and vibration control. The course explores advanced design tools like **Computational Fluid Dynamics (CFD)** and **wind tunnel analysis,** alongside dedicated sessions on both **steel** and **RCC stack designs**.

In addition to technical aspects, the program highlights **safety management, risk mitigation strategies**, and introduces **emerging technologies** and **state-of-the-art construction methods**. The final session focuses on **real-world case studies**, helping participants connect theory with practical applications.

Whether you are a consulting engineer, infrastructure planner, academic, or construction professional, this program offers valuable insights and actionable knowledge to enhance your capabilities in chimney and stack design.

A brief on the faculty who are Subject Matter Experts is given below:

Faculty:

Mr. R L Dinesh graduated as a Civil Engineer from Mysore University in 1987 and completed his post-graduation in Industrial Structures from Regional Engineering College, Suratkal, in 1989. He began his career as a Structural Engineer at Sterling Engineering Consultancy Pvt. Ltd., where he served for five years and in 1995, he joined Tata Consulting Engineers Ltd. He had a remarkable career there for 30 years and superannuated in May 2025 as Discipline Head and Senior General Manager. Throughout his distinguished career, Mr. Dinesh was deeply involved in the detailed engineering of power plants and the design of special structures such as chimneys, silos, bunkers, and other critical industrial infrastructure.

Mr Anirban Datta is a Graduate Mechanical Engineer with over 25 years of industry experience, specializing in the design and analysis of critical piping systems and pressure vessels across refineries, petrochemical units, thermal power plants, and steel and metallurgical plants. He holds an MBA in Energy Management and is the Founder & CEO of PIMECAS Engineering Solutions. He has worked in CESC and TATA Consulting Engineers Limited.

His expertise extends to the engineering and design of plant utilities such as steam, water, air, gas, HVAC, and systems for loss prevention and materials handling. He has worked on major projects involving chimneys and flue gas systems for CESC, NTPC, and TATA Consulting Engineers Limited. Mr Anirban has led teams for project feasibility, detailed project reports, contract and project management, cost estimation, and techno-commercial evaluation. He is certified in ASME

codes, GHG accounting, and SDG implementation, and actively contributes to training and skill development. He is a Chartered Engineer and currently serves as Chairman CEAI-Eastern & North-Eastern Region and Honorary Secretary of Institution of Engineers (India)-West Bengal.

Dr N Bandyopadhyay is a professional Civil Engineer primarily in the area of bridge and structural engineering. He has been responsible for design of a large number bridges in various parts of India and abroad. His specialization is in Analysis, Finite Element Analysis and Numerical Methods. He has excellent exposure to multiple aspects of Computer Aided Engineering in Consulting Engineering Organizations. He has actively participated in professional bodies and has been a member of Indian Road Congress (IRC) Code Committees and IABSE Working Commissions. Dr Bandyopadhyay has published several articles in professional journals.

Dr K Suresh Kumar is a Principal/Vice President – Global Consulting, RWDI. Currently based in Dubai, UAE, Dr Suresh is a recognized leader in the field of wind engineering. He has 35+ years of experience internationally as a Wind Engineering Researcher/ Consultant. Dr Suresh spearheaded the establishment of RWDI's 5th wind tunnel in Thiruvananthapuram (Trivandrum), India, where he successfully led a team of 50 technocrats for 15 years before moving abroad. He has had the privilege of working as a wind consultant on many iconic structures worldwide including the world's tallest tower, the Burj Khalifa in Dubai, and a few supertall towers. Dr Suresh has published/ presented numerous papers in international journals/ conferences and is active professionally worldwide.

Tentative Schedule:

Please find below a tentative Schedule for the *Training Program* to be held from 30th August 2025 to 27th September 2025. The sessions will be held as per timings below:

On Saturdays: 10 30 am to 12 30 pm

On Sundays: 11 00 am to 1 00 pm

Topics	Lecture No.	Topic	Faculty	Date	Proposed Duration
Basics of Industrial Chimney and Stack Design	L1	Functions of Chimneys and Stacks in Industries	RLD	Saturday, 30th August	2 hours
	L2	Types of chimneys and stacks	RLD		
	L3	Environmental considerations and dispersal of particulate matters including regulatory compliances	AD		
	L4	Thermofluodynamic design considerations and sizing of chimneys	AD		
Design and Analysis of Steel Stacks	L1	Load analysis and wind load considerations	RLD	Sunday 31st August	2 hours
	L2	Assessment of structural stability	RLD		
	L3	Design for thermal expansion and contraction	RLD		
Advanced Design Techniques	L1	Computational fluid dynamics (CFD)	NB	Saturday 6th September	4 hours
	L2	Vibration analysis	NB		
	L3	Wind tunnel analysis	KSK	Sunday 7th September	

Topics	Lecture No.	Topic	Faculty	Date	Proposed Duration
Design and Analysis of RCC Stacks	L1	Load analysis and wind load considerations	RLD	Saturday 13th September	4 hours
	L2	Assessment of structural stability	RLD		
	L3	Design for thermal expansion and contraction	RLD	Sunday 14th September	
Safety and Risk Management in Chimney and Stack Design	L1	Focus on safety aspects in design of chimneys and stacks	AD	Saturday 20th September	2 hours
	L2	Risk assessment and mittigation	AD		
Innovations in Chimney and Stack Design	L1	Optimization of design for efficiency and cost-effectiveness	AD	Sunday 21st September	2 hours
	L2	Emerging technologies in chimney and stack construction	AD		
	L3	State-of-the-art fabrication/contruction techniques for Chimneys & Stacks	AD		
Case Studies	L1	Analysis of real-world chimney and stack designs	RLD	Saturday 27th September	2 hours

Faculty:
RLD – Mr R L Dinesh; AD – Mr Anirban Datta; NB – Dr N Bandyopadhyay; KSK – Dr K Suresh Kumar

Course Fees:

The Course Fee will be as follows:

a) CEAI Members – Rs 4000+18 % GST

b) Non Members – Rs 5000+18% GST

c) Students – Rs 2000+18% GST

Sponsorship Opportunities are also available

4. Intensive Training Course on "IRC Codes of Practice For Highway Bridges"

Training programs will be held *every Friday and Saturday from 5th September - 21st November.*

About the Course:

As India's infrastructure landscape rapidly evolves, bridge engineering stands at the heart of safe, durable, and cost-effective connectivity. The Indian Roads Congress (IRC) plays a key role in shaping this progress through regular updates to the codes that govern bridge design and execution across the country.

To help professionals stay ahead, CEAI Academy introduces a comprehensive pre-recorded training series, curated and delivered by leading experts, many of whom are directly involved in code formulation. These modules focus on the practical application and interpretation of key IRC codes and are designed for flexible, self-paced learning.

Training Modules & Fees:

Module	IRC Codes Covered	Fee
Module 1	IRC:5, IRC:6, IRC:SP:114	₹14,000 + GST
Module 2	IRC:112	₹13,000 + GST
Module 3	IRC:24, IRC:22	₹11,000 + GST
Module 4	IRC:78 (Part 1 & 2)	₹8,000 + GST
Module 5	IRC:83 (Part I, II, III & IV)	₹19,000 + GST

Registering for all 5 modules? Get a **10% discount** on the total fee.

Discount Options

(Applicable on the above module fee structure)

Group Registrations (Per Participant):

- 5+ participants: 10% discount
- 10+ participants: 15% discount
- 20+ participants: 20% discount

CEAI Members: 20% discount
Students from Academic Institutions: 50% discount
Faculty from Academic Institutions: 50% discount
Multiple Module Enrolment: 10% discount

*Participants can avail of **only one discount** at a time.*

Sponsorship Opportunities

Benefits	Silver	Gold	Diamond
Free Delegate Passes	2	3	4
Ad Slots in CEAI Journal *ViewPoint*	2	3	4
Sponsorship Fee	₹2 Lakhs + GST	₹3 Lakhs + GST	₹4 Lakhs + GST

Register Now: https://forms.gle/gHqhig7zpQkAyKtKA

FIDIC OPEN HOUSE TRAINING PROGRAM

With the accelerating growth of a fast-developing economy, International financial institutions are increasingly seeking to participate in India's growth story by investing funds in infrastructure projects. These Multilateral Development Banks (MDBs) consistently utilize FIDIC Conditions of Contract, which are widely recognized as the global gold standard for contract conditions.

Hence, CEAI is organizing an open house training program focused on the practical usage of FIDIC General Conditions of Contract. This program will take place on August 28th and 29th, 2025. The training will be conducted by an international FIDIC accredited trainer.

This training program is designed to be highly beneficial for senior professionals involved in project and contract management from all stakeholder groups, including clients, consultants, contractors, and lawyers.

Tech Quiz

1. **What is reverse engineering?**
   a. The automation of one engineering artifact from another
   b. Capability that supports iterative environments
   c. The reversal of the production process
   d. The generation or modification of an abstract representation from an existing artifact

2. **What is the primary goal of project management?**
   a. To satisfy all stakeholders
   b. To maximize profits
   c. To ensure the project is the most innovative
   d. To complete the project on time and within budget

3. **Quality planning is the process of developing a quality plan for?**
   a. Managers
   b. Clients
   c. Projects
   d. Team leaders

4. **What does SMART stand for in project management goals?**
   a. Simple, Manageable, Accurate, Reliable, Timely
   b. Specific, Measurable, Achievable, Relevant, Time-bound
   c. Sustainable, Measurable, Agile, Reliable, Timely
   d. Systematic, Measurable, Achievable, Risk-free, Timely

5. **The Cost of Nuclear fuel in nuclear power plant economics is considered as**
   a. Running cost
   b. Maintenance cost
   c. Capital Cost
   d. Development Cost

6. **Which of the following is required to transport stormwater runoff from roofs, parking lots, streets, and highways?**
   a. Wastewater sewers
   b. Water sewers
   c. Storm sewers
   d. Sanitary sewers

7. **Which of the following machines require input from humans but can interpret the outputs themselves?**
   a. Actuators
   b. Sensor
   c. Agents
   d. AI system

8. **Which type of terrain presents the greatest challenge for highway alignment and construction?**
   a. Flat terrain
   b. Hilly terrain
   c. Desert terrain
   d. Coastal terrain

9. **Aerial surveys in highway engineering primarily use which type of aerial platform?**
   a. Helicopters
   b. Fixed-wing aircraft
   c. Blimps
   d. Drones

10. **Which property of bitumen makes it suitable for waterproofing applications?**
    a. High viscosity
    b. Low ductility
    c. Impermeability
    d. High penetration

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.

Compiled by Neha Jain, TCE/ Rajiv Maini, CEAI

Answers to Tech Quiz March 2025 issue
1. (c), 2. (b), 3. (c), 4. (b), 5. (c), 6. (c), 7. (a), 8. (a), 9. (c), 10. (d)

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Contact details

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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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