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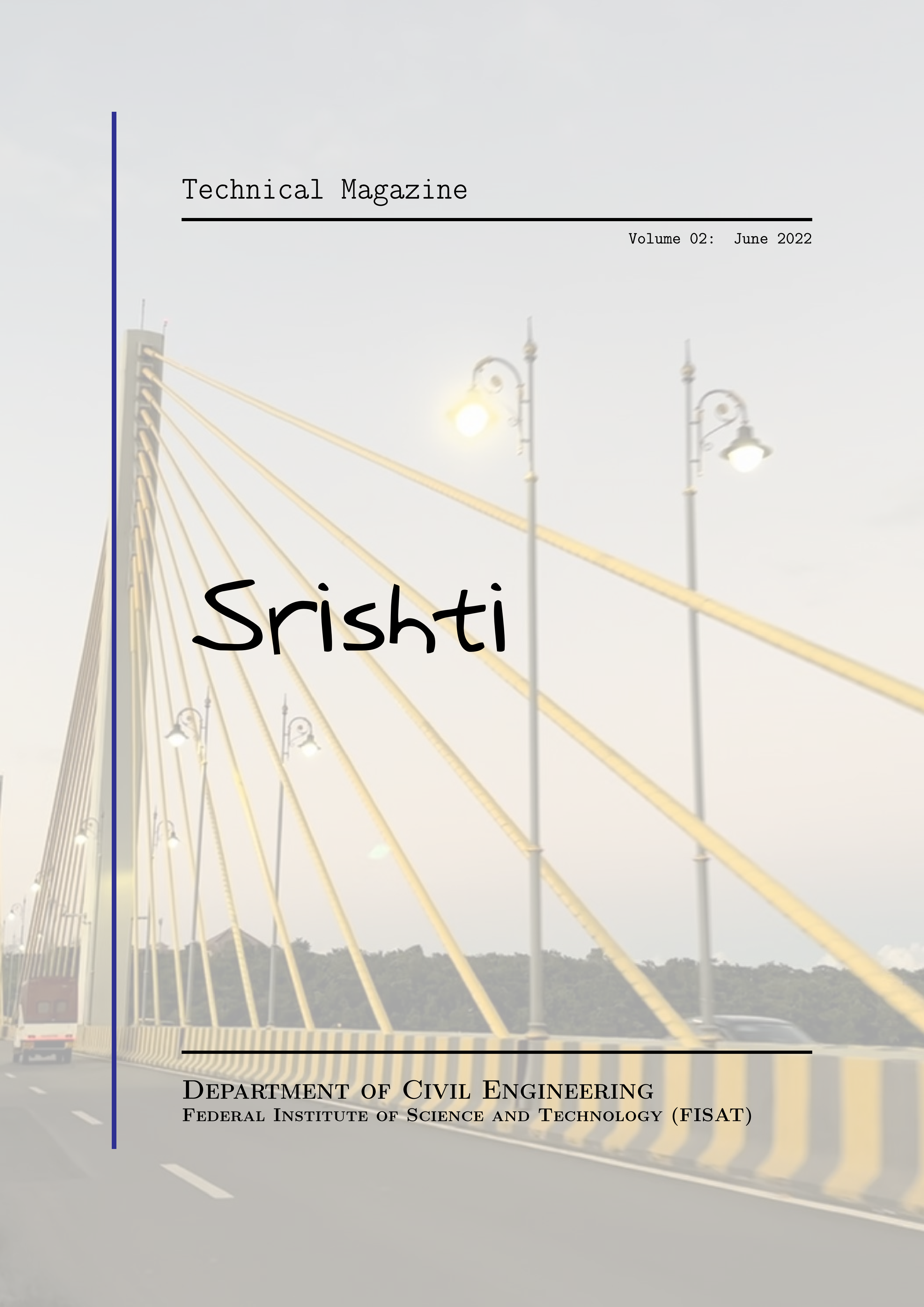
Srishti



Department of Civil Engineering
Federal Institute of Science and Technology (FISAT)

Institute

Vision

To become a world class professional institute with focus on excellence, moulding committed global professionals and technocrats who can meet the demands of business, industry and research.

Mission

- To transform into an advanced centre of technical education, which will, in turn, bring out professionals with superior skills and social commitment.
- To provide state of the art facilities to mould brilliant young talents, enabling them to take up challenging assignments in the highly competitive global scenario.

Department

Vision

Emerge as a Center of Excellence in Civil Engineering, fostering globally competent and socially committed Civil Engineers.

Mission

- To provide a comprehensive education and training at the levels of materials, tools, planning, analysis, design and maintenance of structures.
- To encourage research and development in the field of civil engineering that are useful for the society.
- To equip the graduate with strong ethical and moral values and make them socially committed.

Program Educational Objectives

- The graduates of Civil Engineering will have a successful career in industry and government sector with their strong understanding of civil engineering solutions in a global, economic, environmental and social context.
- The graduates of Civil Engineering will pursue higher studies in the broad domain of Civil Engineering and engage in life-long learning through certifications and activities of professional bodies.
- The graduates of Civil Engineering will be successful as entrepreneurs and become a part of the nation building process serving the society in a responsible and ethical manner.

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Note from HEAD OF THE DEPARTMENT:

It is with immense pleasure that we announce the release of the 2^{nd} edition of our technical magazine ‘Srishti’. This edition would not have been possible without the dedication and contributions of our talented students and faculty members. The articles of our students not only showcase their budding talents but also offer a glimpse into the future of Civil Engineering. The contributions of faculty in the form of research papers and insightful articles enrich our magazine. The pages of ‘Srishti’ showcases the articles which lead to innovation along with a commitment to sustainability. I appreciate the team behind the second edition of ‘Srishti’ and wish you all a happy reading.

Srishti

Department of Civil Engineering
Federal Institute of Science and Technology (FISAT)

Contents

A note from the Editors:

As the Department of Civil Engineering, we proudly present you with the second edition of SRISHTI. SRISHTI discusses about the scientific evolution and progress in the world of civil engineering. We are looking forward to deliver our enthusiasts with the most recent courses and leading-edge technologies of civil engineering. We aspire to create an ingenious abode of learning through this effort. We take this opportunity to convey our gratitude to the Editorial team for their genuine effort and commitment to offer the finest. The faculty members who led us throughout the voyage deserves an exceptional appreciation. Ultimately, we would like to extend our thanks to the contributors who shared their knowledge and expertise to the society through our magazine. Happy reading!

Soil Piping Erosion -A new threat for Kerala

by PANJAMI K,
ASSISTANT PROFESSOR

Soil piping erosion, characterized by subsurface soil removal & resulting in underground channels and cavities, has emerged as a significant concern in Kerala's highland districts. The occurrence of large "pipes" in hilly regions, sometimes passing under infrastructure, poses threats to stability and safety. This article highlights reported incidents of land subsidence and soil piping, emphasizing the necessity for detailed geotechnical and geological investigations, research and mitigation efforts to address this growing concern.

Is Kerala susceptible to soil piping?

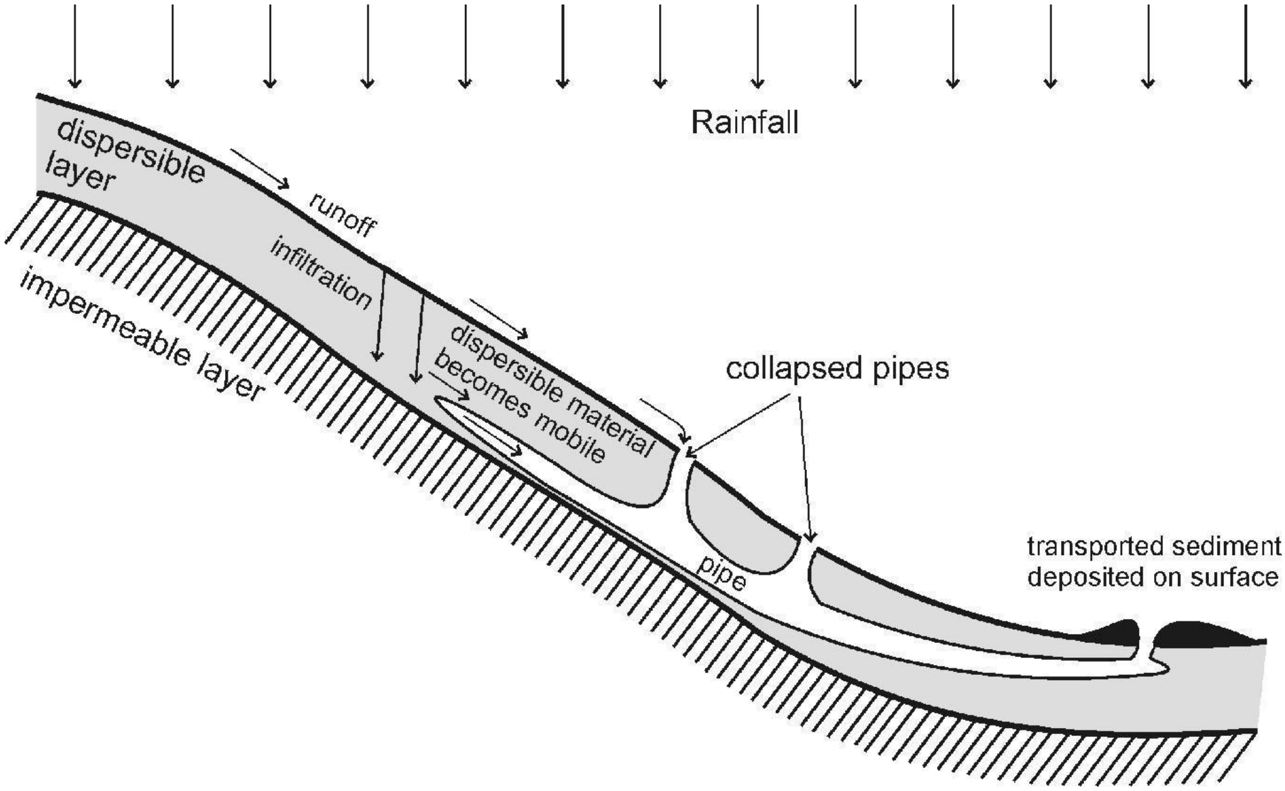
SOIL piping erosion is defined as the removal of subsurface soil, which results in the formation of underground channels and cavities. Soil piping starts as very small pores and causes large failures of soil and engineering structures. It has become a major concern in many of the highland districts of Kerala in the recent past. Huge "pipes" are frequently occurring in the hilly regions and in a few instances, these pipes pass under houses or other infrastructure threatening their stability and safety. One common feature observed in these locations is hard lateritic soil in the top layers with an underlying saprolitic clayey layer. Efforts have been made by researchers to understand the reasons for the phenomenon, but a comprehensive approach in terms of the geological and geotechnical investigations is required to find the fragility of the region.

Common understanding about piping is that these terrains might be consisting of some interspersed layers of pipable materials within the soil profile. During monsoon these layers will be subjected to hydraulic instability. In order to establish the possible reason in the light of the above speculation, the slope layers will have to be investigated by making few boreholes. The samples are to be tested and analyzed for their geotechnical properties.

Piping has been observed in both natural and anthropogenic landscapes in a wide range of climatological, geomorphological and pedological settings (Bryan and Johnes, 1997). Presence of dispersive soils and seepage water are found to be the main reason for piping to occur. Since most of the soil piping cases lead to serious land subsidence problems, it is necessary to study this process in detail and develop a warning system. The current research works aims to understand the soil profile in detail by the geophysical methods and study the properties of soil to check the presence of dispersive soils using double hydrometer analysis. There are many cases reported mainly from Kannur, Kasaragod, Wayanad and Idukki districts.

A preliminary study into soil piping was conducted by the author as part of the master's degree (NIT Kurusketra) with the help National Centre for Earth Science Studies (NCESS) under the guidance of Dr G Sankar (Scientist G, NCESS) in the year 2016. In that study, core cutter samples were used to identify the properties of the soil. It was found that the soil samples collected from the affected region do not show any peculiar geotechnical properties compared to other natural sites. The study indicated that a more comprehensive understanding of the soil properties in the locations of soil pipes will be essential to develop a suitable low-cost solution for this problem. It is hypothesised that an advanced subsurface exploration along with soil testing can throw some light into the cavity forming mechanism, which can help identify a suitable mitigation method.

> "Soil piping starts as very small pores and causes large failures of soil and engineering structures. It has become a major concern in many of the highland districts of Kerala in the recent past."



Land Subsidence by Piping Erosion

Subsidence is a global problem that occurs mainly because of exploration of underground water. Increasing development of land and water resources threatens to exacerbate existing land subsidence problems and initiate new ones. Loss of subsurface support is found to be the major reason for subsidence. Water percolating through pervious surficial materials gets diverted to weak pervious portions and dispersive soils erode out with this water leading to huge cavities. In order to produce surface subsidence, the erosion mechanism is believed to require three conditions:

- an impermeable stratum at the top of pervious easily erodible material to form as a roof for the tunnel formed,
- water must have access to the erodible material with sufficient head to transport grains of silts or sand and
- proper outlets available for the disposal of flowing water and carrying sediments. (Aalen, 1969).

Subsidence was observed in all of the piping cases reported in Kerala. A few serious incidents reported are included below.

Nelliyadukkam locality, Kasaragod district

Nelliyadukkam locality, Karindalam panchayath, Kinanur village, Vellarikundu taluk of Kasaragod district, which is situated 12 Km east of Nileswaram town. Soil piping incident in this area has occurred in 2014 August 2. The subsided area is located adjacent to the house of Mr.Balan V. K. The foundation of the house under construction was damaged by the soil piping phenomenon.

Kottaykkal Area, Malappuram district

Kottaykkal area of Perumannaklari Panchayat near Kottakkal in the Tirur taluk of the Malappuram district of Kerala is another case. The affected site is located about 6 Km from Kottakkal town in the Perumanna village. Deep ground fissures/ cracks with varied displacement were observed (2018) in two plots in a residential area on a laterite mesa in the Perumannaklari panchayat. Elongated in a roughly E-W direction these fissures form an oval shape bordering the ground subsidence locality. The subsided portion is sloping in the direction of South – South East direction.

Irikoor locality, Kannur district

In Irikoor, Kannur, hole forms on the ground suddenly(2020), and takes a woman on roller coaster into neighbour's well.

Pic 1 - The pit formed in the earth near washing area of a house in Ayippuzha; Pic 2 - Locals and fire force preparing to save Umaiba from the well

Mavady locality, Idukki district

In Idukki, Mavady, with the intense burst of rain from August 14 to 18, 2018 caused changes in slope stability and lead to hydro-geological instability in certain areas of Idukki district.

Pattilamkuzhi locality, Thrissur district

In Pattilamkuzhi, Thrissur, the area had a series of major landslide events on 15th August 2018. Land subsidence was induced by soil piping (subsurface soil erosion). The failure has occurred on the slope facing NE. Sinking of a well (N10° 31' 56.7" E76° 21' 44.2") was observed. A combination of soil piping driven subsidence, rotational slides and aborted slides were detected in the region.

> Soil piping has got its wide concern after the recent flood of Kerala in 2018. Detailed Geotechnical and Geophysical investigations are required to be conducted in the piping affected regions of Kerala.

Soil piping has got its wide concern after the recent flood of Kerala in 2018. Detailed Geotechnical and Geophysical investigations are required to be conducted in the piping affected regions of Kerala. Geophysical methods such as Ground penetrating radar, Electrical resistivity Survey, Multi-Channel Analysis of Surface wave are helpful in understanding the subsurface soil stratum without the top surface being affected and detailed bore log studies helps in understanding the peculiar soil properties. National Disaster Management Authority (NDMA) recently included the piping erosion in the disaster list and those who lost their property due to piping erosion will get a maximum of 10 lakhs as compensation ■

> *"Our department recently got a funding from Kerala Technological University to do detailed research in this topic which will be helpful for the society. "*

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by Jinu V Rajan, S3 SECM

Controlled implosion of multi-storeyed Buildings

Controlled implosion is a strategic technique used for demolishing multi-storeyed buildings, which involves precise placement and timing of explosives to ensure the structure collapses inward, minimizing damage to its surroundings. The implosion process requires careful planning, including surveying, hazardous material removal, and selection of appropriate explosives. Safety measures like site surveys and monitoring, are crucial to protect workers and neighboring properties during this process.

Need for demolition

During the life of concrete structures, they often meet with some situations like disasters, city reconstruction, or higher residence demand due to population. All these lead to demolition or reconstruction of existing structures. The demolition process is carried out with the help of equipments, machineries, explosives or manual techniques without affecting the surrounding and with legal approval from the local authority. The main purpose of demolition is to prevent the accidental collapse of any part of the building and also to ensure the safety of public, workers and neighboring properties. Today various kinds of demolition methods are available, but the method of implementation of demolition work varies depending upon the area where it will be held, time available, building material, the purpose of demolition, the way of debris is going to be disposed. One of the methods adopted for demolition of multi-storeyed buildings is controlled implosion which is the strategic placing of explosive material and timing of its detonation so that the structure collapse on itself in a matter of seconds, minimizing the physical damage to its immediate surroundings.

A true implosion usually involves a difference between outward and inward forces or external (higher) and internal (lower) pressure that are much larger, such that the structure will collapse inward into itself. To cause the object to collapse, it requires some kind of pressure from the outside pushing it. They are caused by having greater pressure on the outside of an object than on the inside. Building implosion techniques usually do not rely on the distinction between internal and external pressure to collapse a structure.

> "The main challenge in bringing a building down is controlling the way it falls. When a building is surrounded by structures that need to be preserved, then demolition is done such that it collapses straight down into its own footprint."

Instead, the collapse occurs by weakening or removing critical supports so that the building can no longer withstand the force of gravity and falls under its own weight. The main challenge in bringing a building down is controlling the way it falls. When a building is surrounded by structures that need to be preserved, then demolition is done such that it collapses straight down into its own footprint. The blasters set the explosives such that each building falls towards the centre of the building. Another option is to detonate the columns at the centre of the building before the other columns Depending on how the structure falls, generally there are two kinds of implosion – Falling like a tree and falling into its own footprint. Falling like a tree is the commonly used type of implosion where the building is made to fall like a tree to the side-ward. This type of demolition is recommended when free space is available besides the building. To control the falling direction of the building, sometimes steel cables are tied to the building. Falling into its own footprint is used if the structure around the building is to be protected and where free spaces are not available. Explosives are set in the floor below the middle part of the building and the explosives must be heavy enough to demolish the building at once.

Falling like a tree

Falling into its own footprint

The steps involved in a successful implosion involves surveying followed by removal of hazardous materials. Explosives are selected, columns are drilled and loaded with explosives. When the current is distributed through the wire, it heats up and ignites the flammable substance, setting off the main explosives. The commonly used explosives are dynamites, water gels and emulsions, RDX and PETN.

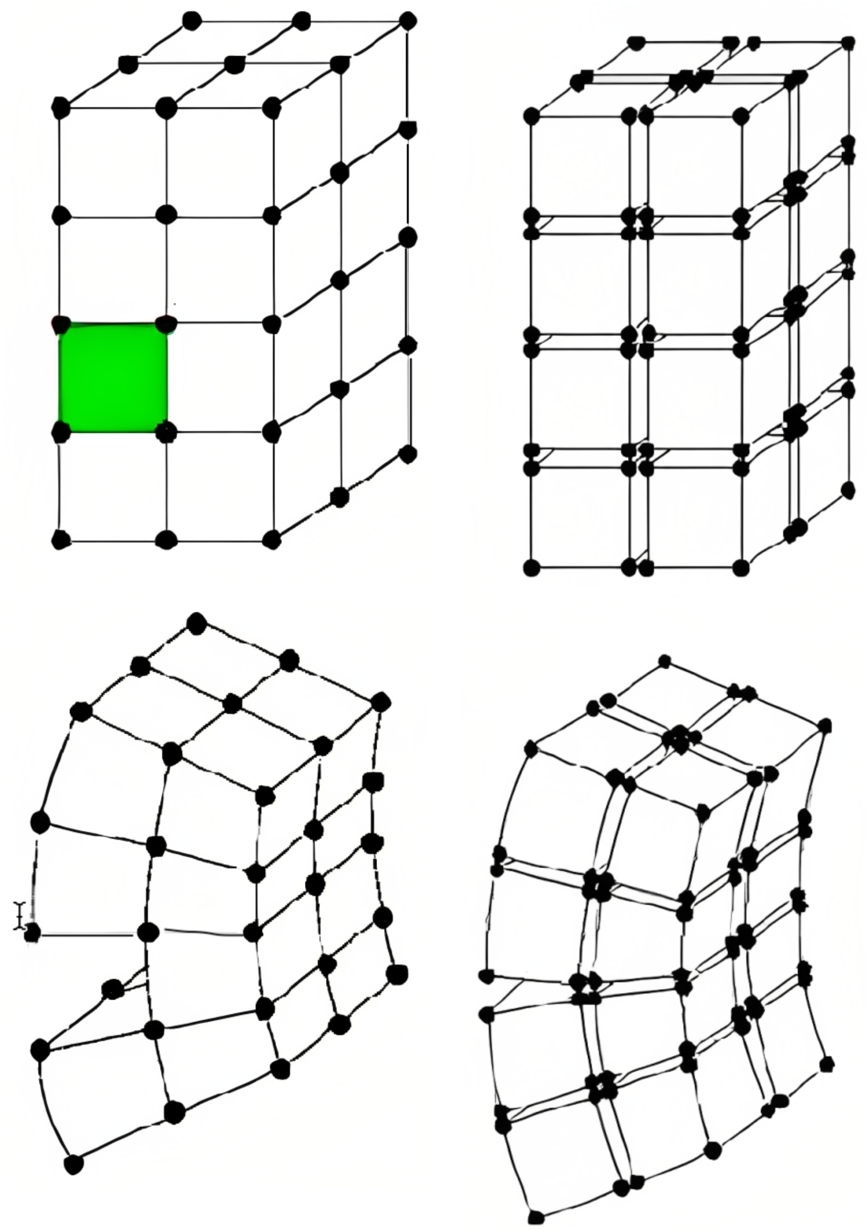
During implosion process, Military and Civilian formula can be used. It forms plastic hinges in shear walls, columns, bridge abutments etc. All these are tested in field and produce a plastic hinge by cracking the concrete matrix around the reinforcing bars thus shifting compressive loads into the steel resulting in the yielding of steel.

Element Analysis of controlled demolition of buildings by explosives can be done using LS-DYNA. LS-DYNA gives different methods for modeling failure such as element erosion and disconnection of elements at nodes.

> “It forms plastic hinges in shear walls, columns, bridge abutments etc. All these are tested in field and produce a plastic hinge by cracking the concrete matrix around the reinforcing bars thus shifting compressive loads into the steel resulting in the yielding of steel.”

Element erosion:

All elements which have reached failure satisfying a given criterion are removed by this algorithm. The user sets a critical value within the defined material law. This value indicates the critical plastic strain at failure. During the computation, when the plastic strain of an element reaches this value, the element is automatically deleted and the analysis continues with the rest of the elements. The advantage of this algorithm is that it is directly applicable to an existing discretization. Special modeling techniques are not required. It does not increase the computational effort, since the number of equations to be solved remains the same. The method of material failure becomes very efficient and straight-forward one. It has certain limitations such as the removal of the elements during the simulation results in non consistent computations in terms of volume, mass and energy. Since a lot of contact surfaces are deleted due to material failure, contact conditions between the structural parts cannot be well described. This problem is more intense during vertical collapse.



Node split algorithm:

It does not remove elements from computation. Until a failure criterion is reached, the analyst specifies sets of nodes which are constrained to be tied together. A failure criterion is the average volume weighted plastic strain. When this is reached nodes of neighbor elements which carry this plastic strain are disconnected, while the other tied connections of the element remain unchanged. The nodes of the elements form the sets which are constrained to be connected until failure. Thus, the failure criterion is checked for each individual set of nodes and not for elements.

There are different cases where controlled implosion is used as demolition method worldwide. This method is used where all other methods are inapplicable. This method was used for the demolition of 4 multi-storeyed buildings in Maradu panchayat recently. The four waterfront apartments were Alfa Serene, Kayaloram, Jain Coral and Holy Faith. After nine months of construction, the local body noticed that the site fell under Coastal Regulatory Zone-III where construction is not allowed within 200m from the coast. Thus the buildings were constructed violating the CRZ rules. For demolishing the apartments, Vijay steel from Chennai and Edifice Engineering from Mumbai were picked up. The Municipality fixed January 11 and 12 for pulling down the apartments. The meeting conducted by the Government appointed technical committee decided to complete the demolitions in two days on 11 and 12 Jan 2020. There were two towers in Alfa Serene which was demolished in two separate implosions, while the other three were subjected to one implosion each. Holy Faith and Alfa Serene were demolished on 11 Jan 2020. Golden Kayaloram and Jain Coral were demolished on the next day. Site survey, seismographic monitoring, air quality survey were done before and after demolition.

Safety is considered as the most important part of demolition. By taking necessary precautions and using safe equipments, injuries can be reduced and countless lives can be saved. Safety of workers and neighbouring buildings must be given prior importance. It must include trained employees, fire precautions, equipment maintenance etc. Site surveys, air quality monitoring & seismic studies must be conducted before and after demolitions. The procedure of implosion must be carried out by minimizing the risks of causing damage to people and properties ■

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Are you GATE ready?

1. In friction circle method or slope stability analysis, if *r* defines the radius of slip circle, the radius of friction circle is ______?
2. If the water content of a fully saturated soil is 100%, the void ratio of the sample is ______?
3. What type of stress occurs when two equal and opposite forces act tangentially across a surface?
4. The measure of a material’s resistance to fracture when a crack is present is known as ______.
5. In a statically determinate structure, the number of unknown reactions and equilibrium equations are .
6. Which construction method involves creating a framework of vertical columns and horizontal beams to support the floors and roofs of a building?
7. What is the term for a construction method that involves pouring concrete into forms that are left in place after the concrete hardens, providing a smooth and uniform finish?
8. What type of road classification is typically designed for high-speed travel between cities and major regions?
9. What is the process of reducing the concentration of pollutants in a water body by using natural processes like wetlands or artificial systems?
10. What is the process of measuring distances and angles between a series of points in order to determine the shape and dimensions of a land parcel called?
11. The difference between the true meridian and the magnetic meridian at a specific location is known as .
12. Which property of a fluid measures its resistance to shear deformation and is defined as the ratio of shear stress to shear rate?
13. The Reynolds number in fluid mechanics is a dimensionless quantity used to predict the flow regime. It depends on the fluid’s density, velocity, viscosity and ______.
14. Which type of flow in an open channel occurs when the water depth is greater than the critical depth, and the Froude number is less than 1?
15. Which type of hydraulic machine is commonly used to lift water from a lower level to a higher level using an impeller?

by NILUFER NOUSHAD, S2 SECM

The Fast Track to Success: How Innovative Construction Techniques are changing the industry

As the world continues to grow and advance, so do the demands for faster, more efficient construction methods. Traditional construction methods are often time-consuming and costly, leading to project delays and inflated budgets. In response, the construction industry has been embracing innovative and fast track building methods to meet these demands. This article will explore the future of construction and how fast track building methods are revolutionizing the industry.

Fast Track- Need of the hour

Introduction to fasttrack building methods

FAST track building procedures are a group of building approaches designed to hasten the construction process. These techniques are intended to speed up project completion without sacrificing quality or safety. Fast track building techniques, which can range from prefabrication to modular construction, are becoming more and more common in the building sector. The accelerated construction schedule is one of fast track building technologies primary benefits. The planning and design stages of conventional building might take months or even years, and they are followed by a protracted construction process. Contrarily, fast track building techniques can reduce the construction period in half. As a result, projects can be finished more quickly, lowering costs and increasing efficiency. Fast track construction has a focus on effectiveness and speed. Different project components are worked on concurrently rather than finishing each phase in order. As a result, tasks can be completed more quickly and with greater flexibility, allowing for last-minute alterations.

> Project completion times with conventional construction techniques might range from months to years. This timeline can be greatly shortened via fast track construction, which can be especially useful for commercial projects where speed is of the essence. The cost-effectiveness of fast track construction is another advantage.

Careful planning and coordination are essential to expediting construction. To guarantee that each phase is finished on schedule and to the specified quality standards, all parties participating in the project must closely collaborate. This applies to designers, engineers, builders, and subcontractors.

Benefits of Fast Track Construction

Fast track construction has many advantages. Its speed may be the most important benefit. Project completion times with conventional construction techniques might range from months to years. This timeline can be greatly shortened via fast track construction, which can be especially useful for commercial projects where speed is of the essence. The cost-effectiveness of fast track construction is another advantage. There is less downtime and resources can be used more effectively because several project phases are completed concurrently. Both clients and contractors may save money as a result of this. Greater versatility is also possible with fast track development.

Project modifications are simpler to make, and schedule modifications to accommodate unanticipated events are also possible. Fast track construction techniques also result in higher construction quality. These techniques enable more exact and accurate construction, lowering the possibility of mistakes and flaws. Modern tools and technology are also used to ensure that building projects are finished to the highest standards.

Fast track construction techniques are also more environmentally friendly than conventional ones. These techniques can lessen the negative effects of construction projects on the environment by using less resources and creating less waste.

The Traditional Construction Process vs. Fast Track Construction

The traditional construction process typically involves completing each phase of the project in sequence. For example, the design phase is completed before the construction phase, and the construction phase is completed before the finishing phase. This approach can be time-consuming and inflexible, making it difficult to adjust to changes along the way. Fast track construction, on the other hand, involves completing different phases of the project simultaneously. This allows for greater flexibility and speed, making it a more efficient and cost-effective approach to construction. While traditional construction methods may be appropriate for certain projects, fast track construction is becoming increasingly popular due to its many benefits.

Current challenges in the construction industry

Fast track building techniques provide many advantages, but there are also difficulties that the sector must overcome. The lack of skilled labour is one of the main problems. There is a need for individuals who are skilled in fast track building procedures as the demand for these methods increases. The lack of trained people may cause projects to be delayed and cost more money. The requirement for more sophisticated tools and technologies presents another difficulty. Fast track construction techniques require current tools and technology to be successful. To remain competitive, construction companies must spend money on the newest equipment and software. However, this can be costly, and not many businesses have the money to invest in this way. The building business needs to work together more and communicate more, to sum up. The use of fast track building techniques necessitates careful coordination between contractors, engineers, and architects. Project delays and cost overruns can happen without good communication.

> Fast track construction, on the other hand, involves completing different phases of the project simultaneously. This allows for greater flexibility and speed, making it a more efficient and cost-effective approach to construction.

Overview of innovative construction techniques

There are many innovative construction techniques that are being used in the industry today. Some of the most popular techniques include:

Prefabrication

Prefabrication is a fast track construction method where components are manufactured in a factory setting and then transported to the building site for final assembly. This method can help reduce costs and time spent on labor due to the fact that components need only be assembled at the job site instead of fabricated from scratch. Prefabricated components typically require less time to assemble than those fabricated on-site.

Modular construction

Modular construction involves constructing whole units or modules off-site in a factory or warehouse setting and then transporting them to the job site for assembly. The major advantage of this method is its speed; modular structures can be assembled much faster than traditional structures since all of the modules come pre-made with minimal assembly required. This method also reduces waste as materials used in construction are more efficiently used in modular settings than traditional ones. By selecting building materials that best fit your specific project needs, you can ensure that you take full advantage of fast track construction methods without compromising on quality or safety.

Building Information Modelling (BIM)

Building Information Modelling (BIM) is a digital tool that is used in the construction industry to create 3D models of buildings. This tool can help to improve communication and collaboration between architects, engineers, and contractors, as well as improve the accuracy of construction.

Other technologies, such as drones, 3D printing, and virtual reality, are also being used in fast track construction. These technologies can help improve safety, reduce costs, and increase efficiency.

Lean Construction Principles: Reducing Waste and Maximizing Value

The application of lean construction concepts is one of the most crucial elements of fast track construction processes. In order to increase production, quality, and safety, lean construction focuses on minimising waste and maximising value. It is crucial to have a thorough understanding of how a project can be divided into manageable components and completed quickly in order to accomplish this. This calls for a clear understanding of how each element fits into the bigger picture and how to design them to add the maximum value. By using less resources and prefabrication or modular construction methods, for instance, you can cut back on waste. Work more efficiently by properly and effectively outlining the entire process, which will allow for improved planning and scheduling. Finally, you can use the newest technological solutions to boost teamwork, streamline communication, lessen paperwork, and manage progress in real-time. Lean construction principles assist ensure that fast track building approaches will be successful in completing projects more quickly without compromising quality or safety by taking these measures to reduce waste while maximising value throughout all stages of a project.

Streamlining the Design Process for Fast Track Projects

The design phase is crucial to the building process and, when done correctly, may save a tonne of time. Streamlining the design process is essential to keeping projects on schedule and within budget while using fast track construction.

To make sure that all goals are achieved without compromising on quality or safety requirements, designers must collaborate cooperatively with other project team members. Prefabricated materials have to be selected because of their precision, adaptability, and simplicity of installation. This makes the process faster and more effective by reducing waste and rework related to on-site construction. The following are some methods for accelerating the design process:

- Purchasing software that produces 3D models fast so that modifications may be tracked precisely before building starts;
- Reducing errors through the use of a thorough plan that incorporates the opinions of all parties;
- Utilising off-site, prefabricated, and modular construction methods for some of the building's components;
- Coordinating closely with suppliers and contractors to make sure that everyone's schedules coincide with the project's timetable;
- When developing projects for quick turnaround, follow these techniques to save time without sacrificing quality.

Managing Fast Track Construction Projects for Success

It might be challenging to oversee a construction project that is moving quickly. If done well, it might shorten the construction period by weeks or even months, saving a lot of money. But if it's not handled properly, it may cause delays and added expenses.

There are a few strategies to keep in mind when managing a fast-track construction project to ensure success:

Pre planning:

Prior to starting any construction project, be sure to determine its scope, timing, and the essential contractors and subcontractors that will be working on it. You can do this to keep yourself organised and on track at all times.

Scheduling:

Scheduling an accurate timeline that everyone participating in the project can follow is one of the most crucial parts of successfully managing a fast track construction project. To make sure that progress is being achieved effectively while still upholding quality standards, set interim milestones and make realistic deadlines.

Risk management:

Prior to starting any construction project, there are always hazards that need to be taken into consideration. Your fast track construction project will go off without a hitch if possible hazards are identified early on and plans are put in place to mitigate them.

Communication:

It is crucial for the success of any construction project that all parties involved can effectively communicate with one another at all times. Make sure everyone is aware of the timetables, due dates, and expectations so there are no misunderstandings at any stage of the process.

You will have a lot more success managing your fast-track construction project while keeping costs down and quality up if you adhere to these rules.

> "The design phase is crucial to the building process and, when done correctly, may save a tonne of time. Streamlining the design process is essential to keeping projects on schedule and within budget while using fast track construction."

Examples of Successful Fast Track Construction Projects

There are many examples of successful fast track construction projects. One notable example is the Broadmoor Hotel in Colorado Springs, Colorado. The hotel was destroyed by a fire in 2011, and the owners were eager to reopen as soon as possible. Using fast track construction methods, the hotel was rebuilt in just 11 months, which is a remarkable feat considering the size and complexity of the project.

Another example is the Barclays Center in Brooklyn, New York. The arena was built using modular construction, which significantly reduced the construction time. The project was completed in just 24 months, which is a fraction of the time it would have taken using traditional construction methods.

Broadmoor Hotel, Colorado

Barclays Center, Brooklyn

Future of Fast Track Construction in the Building Industry

Fast track construction appears to have a promising future in the building sector. Fast track construction is a method for completing building projects that is gaining popularity as customers want shorter completion timelines and cost reductions. As new tools and methods are created to increase productivity and lower costs, technology will continue to play a vital role in the business.

Fast track building is utilising sustainable materials and methods, which is another trend that is rising. Clients are seeking for more and more ways to lessen their carbon footprint as people around the world grow more ecologically conscious. Fast-track building can be a good approach to cut waste and boost energy efficiency.

Conclusion - Why Fast Track Construction is the Way of the Future for Building Projects

In conclusion, fast track building methods are changing the construction industry for the better. These methods offer many benefits, including reduced construction timelines, improved quality of construction, and increased sustainability. While there are still challenges that the industry faces, such as the shortage of skilled workers and the need for more advanced technology, the benefits of fast track building methods make it clear that these techniques are the future of construction. Fast track construction methods are gaining popularity and significance in construction projects. These methods aim to complete projects more quickly without sacrificing quality or security. You can accomplish projects more quickly and affordably by using fast track building techniques, which combine prefabrication, modular construction, and other methods. When done properly, you may achieve the highest levels of both quality and speed. To guarantee that safety and quality are not compromised when using fast track building techniques, the project must be carefully researched and planned. As we continue to embrace fast track building methods, it is essential that we also embrace collaboration and communication within the construction industry. By working together, we can overcome the challenges that we face and create a more sustainable and efficient future for construction ■ □□□□□

DID YOU KNOW?

ATAL SETU, Goa is the third longest cable stayed bridge in India with a length of 5.1 km. It is also Goa's longest bridge. It has a height of 30m and hence, 2 & 3 wheelers are prohibited on it. A cable stayed bridge has pylons that suspends the cables to support the bridge deck. At night, the illumination in vibrant colours gives the bridge an amazing aesthetic appeal. Next time you are in Goa, check it out or maybe the magazine **COVER**.
Image Courtesy, Cover: Ms. Neeraja N

SOIL PIPING, Kannur caused a woman to fall into a neighbour's well. The ground under her gave way and he slid into her neighbour's well abour 5 m away. What a harrowing experience! Check out the pictures in Pg 4.
Image Courtesy, Article 1: Ms. Panjami K

COCHIN INTERNATIONAL AIRPORT, Kerala is the first ever fully solar powered airport in the world. Aviation is one of the fields which is being reprimanded for the production of greenhouse gases. This initiative ensures sustainable growth and helps mitigate its carbon footprint. It is the first airport in the country built under Public Private Partnership (PPP) mode. Check out the solar farm in Pg 15.
Image Courtesy, Article 4: Adithyan Balachandran, S4 CEA

BURJ KHALIFA, Dubai is the world's tallest building. It was designed to be the centerpiece of large-scale, mixed-use development and it has won several awards. Skyscrapers is a tall, continuously habitable building having multiple floors. Modern sources currently define skyscrapers as being at least 100 meters or 150 meters. Check it out in Pg 22.
Image Courtesy, Article 7: Ms. Nujuma Nazimudhin

PETRONAS TWIN TOWERS, Kuala Lumpur was a skyscaper that held the title of world's tallest building from 1998 to 2004. It has a unique structural system called tube in tube. Each of the towers was contracted under two different construction consortia for the project to be completed in 6 years. The towers feature a double decker skybridge connecting the two towers on the 41st and 42nd floors, which is the highest 2-story bridge in the world. Early into construction a batch of concrete failed a routine strength test causing construction to come to a complete halt. All the completed floors were tested but it was found that only one had used a bad batch and it was demolished. Imagine that! Have a look in Pg 22.
Image Courtesy, Article 7: Ms. Preethi M

by DIVYA S, S8 CEA

Environmental Engineering: Balancing Development and Sustainability

Environmental Engineering stands as a multidisciplinary field that employs scientific and engineering principles to confront environmental issues while fostering sustainability. Amid global challenges like pollution and climate change, environmental engineers play a pivotal role. This discipline amalgamates various engineering sectors, ensuring environmental protection and human welfare. Themes encompass water management, air quality control, waste management, and site remediation. Environmental Engineering pioneers solutions to safeguard the planet while enabling human advancement, perpetuating a harmonious equilibrium between development and ecological preservation.

What and Why of Environmental Engineering

ENVIRONMENTAL Engineering is a multidisciplinary field that focuses on applying scientific and engineering principles to address environmental challenges and promote sustainable practices. As the world grapples with issues such as pollution, climate change, and resource depletion, the role of environmental engineers becomes increasingly vital.

Environmental Engineering involves the application of various engineering disciplines, including civil, chemical, and mechanical engineering, to safeguard the environment and human health. The field aims to find innovative solutions that minimize negative impacts on the environment while supporting societal progress. With the global population on the rise and industrialization expanding, the importance of sustainable practices is more critical than ever.

Key concepts of Environmental Engineering

Water Management:

One of the primary concerns in Environmental Engineering is water management. This includes the treatment and distribution of clean drinking water, as well as the proper treatment and disposal of wastewater. Engineers design and operate water treatment plants, develop systems for stormwater management, and implement strategies for water conservation.

Air Quality Control:

Environmental engineers work to reduce air pollution by designing systems to control emissions from industrial processes and vehicles. They also study air quality to assess the impact of pollutants on human health and ecosystems.

Waste Management:

Effective waste management is crucial for preventing environmental degradation. Engineers develop waste disposal methods, including recycling, composting, and landfill design. They also address hazardous waste disposal to prevent soil and groundwater contamination.

> As the world grapples with issues such as pollution, climate change, and resource depletion, the role of environmental engineers becomes increasingly vital.

Remediation of Contaminated Sites:

Environmental engineers play a significant role in cleaning up polluted sites, such as brownfield and Superfund sites. They design and implement remediation strategies to restore these sites to safe and produc-

Solar farm at Kochi International Airport
Image Courtesy: Adithyan Balachandran, S2 CEA

tive conditions.

Challenges and innovations

Climate Change Mitigation:

Environmental engineers contribute to climate change mitigation by promoting renewable energy sources, designing energy-efficient buildings, and developing strategies to reduce greenhouse gas emissions.

Sustainable Infrastructure:

As cities expand, engineers focus on creating sustainable infrastructure that minimizes environmental impact. This includes designing green buildings, efficient transportation systems, and resilient urban planning.

Emerging Technologies:

Environmental Engineering embraces innovative technologies like nanotechnology and bioremediation to address pollution and contamination challenges more effectively.

Circular Economy:

The concept of a circular economy, where resources are used, reused, and recycled, is gaining traction. Environmental engineers are instrumental in implementing this approach to minimize waste and resource depletion.

Advancements in the field

Smart Sensors and Monitoring:

Advanced sensor technologies enable real-time monitoring of environmental parameters, aiding in early pollution detection and prompt response.

Data Analytics:

Big data analytics and modeling help predict environmental trends and assess the potential impact of human activities on the environment.

Green Infrastructure:

Engineers are integrating natural solutions, such as green roofs and permeable pavements, into urban designs to manage stormwater and enhance sustainability.

Phytoremediation:

This innovative approach uses plants to absorb and detoxify contaminants from soil and water, reducing the need for traditional remediation methods.

Conclusion

Environmental Engineering is at the forefront of addressing environmental challenges and promoting sustainable development. Through the application of engineering principles, innovative technologies, and interdisciplinary collaboration, environmental engineers strive to create a harmonious balance between human progress and the preservation of the planet. As we move forward, the role of Environmental Engineering will continue to be pivotal in shaping a more sustainable future for generations to come ■ □□□□□

Retrofitting of Building

by KRISHNENDHU S, S5 CEB

All around the world, infrastructure is aging and this leads to the concerns of durability and sustenance of these structures. Hence, retrofitting is imperative to be understood by civil engineers to find solution for this growing problem. Building retrofitting, aims to enhance structural performance through strengthening existing elements. Retrofitting addresses issues like shear resistance, seismic load resistance and overall structural capacity. The article highlights cases where retrofitting is required and the methods adopted.

A brief overview of Retrofitting

What is Retrofitting of Buildings?

RETROFITTING is to enhance the performance of the structure by strengthening the existing structure or its elements. In general, the term retrofitting means to improve the shear resistance and the capacity of the structural members to resist seismic loads and eventually the whole structure. Most of the RC columns and beams need enhancement in shear capacity. It is a critical deficiency as it gives no warning of distress before failure. The shear deficiencies are mainly because of insufficient reinforcement provided at the time of construction. Now, retrofitting is an expensive method, but is necessary in some cases. Before deciding to go with a demolition plan or retrofitting, a cost-benefit analysis is carried out to ascertain its practicability.

Retrofitting of buildings is required in case of

- Structural cracks.
- Damage to structural members.
- Excessive loading.
- Errors in design or construction.
- Modification of structural systems.
- Seismic damage.
- Corrosion due to penetration-honeycombs.

Retrofitting Techniques

Broadly classifying, there are two types of retrofitting techniques:

- Local Retrofitting Techniques
- Global Retrofitting Techniques

Global retrofitting techniques are those techniques that enhance the seismic resistance of the structure as a whole, while the local retrofitting technique enhances the seismic resistance of a particular structural member in the structure.

Global Retrofitting

Local Retrofitting

Classification of Retrofitting Techniques

Addition of Shear Walls

The addition of shear walls is one of the most popular methods in retrofitting existing structures. This method limits the global lateral drift, and thus reduces damage to buildings. It is required to be careful of the distribution of walls in the plan as well as elevation so as the regular building configuration is not disturbed. Irregularity in configuration reduces the capacity drastically. Hence, the new concrete for the wall should not be thicker than that of the old frame members. Otherwise, the foundation of the new wall will need very high moment resistance. One of the simplest and cost-effective ways is adding infill to the base of the existing frame of the outer columns.

Adding infill walls

Addition of infill walls increases the moment resistance of the existing frame. The infill wall is added in this method between two columns by proper anchorage.

Base Isolation System

It is a cost effective method as compared to other methods. Isolators are placed between structure and foundation and have low horizontal stiffness. At the base of the building or just below the first floor under columns or shear walls, rubber bearing is provided which consists of laminated layers of rubber and steel plates. Isolation gives better protection in earthquake resistance by decreasing the shear force. No additional reinforcement is needed in the superstructure. The resisting overturning moment of the foundation need not be enhanced.

> "It is required to be careful of the distribution of walls in the plan as well as elevation so as the regular building configuration is not disturbed. One of the simplest and cost-effective ways is adding infill to the base of the existing frame of the outer columns."

Jacketing of columns

It is also one of the most popular methods of strengthening the columns in a building. Steel jacket RC jacket fiber reinforced polymer composite jackets at set are quite common.Jacketing increases the concrete confinement, shear strength, and flexural strength of columns.Around the existing columns, new concrete is added with the help of longitudinal and transverse reinforcement. This increases the shear strength of columns along with flexural strength. However, no considerable enhancement in the strength of the beam column joint is found. Ductility also remains the same.

Jacketing of Beams

T-Beam jacketing gives continuity to two columns and increases the strength and stiffness of the structure as a whole. It is kept in mind while implementing this method so that a strong beam weak column system is not formed. The slab is perforated so that the ties can go through it and after that beam is jacketed through the whole of its length.

Beam-column joint jacketing

It is difficult to add reinforcement at this junction as a large amount of reinforcement is fixed in small regions.

Steps Involved in Retrofitting Technique

- The performance requirements for the structure to be retrofitted are first known.
- As the performance requirements to be achieved are known, an inspection of the existing structure is carried out. Inspection of the existing structures is a crucial step while deciding on retrofitting method to be used. Documents are checked and site inspections are carried out for inspection of the structure. Documents give a general overview of the structure when the structure was built and site inspection can give actually accurate data. Depending on the result to be achieved a preliminary inspection or a thorough inspection is done.

  In detailed inspection, materials are considered too. While inspecting the performance criteria of the existing structure, the materials should be dealt with appropriately. The characteristic values of the materials in the existing structure may not be the same as listed while the structure was made. The difference in these values may be because of the load action and environmental factors acting on it. So while implementing retrofitting methods like bonding and jacketing, the values for existing materials should be evaluated.

  In the inspection, the existing structure is analyzed with the help of analytical tools to identify the weak zones. Identifying such regions in the structure can help in identifying suitable retrofitting measures that are optimized for safety and economy.
- The performance of the existing structure is evaluated on the basis of the results obtained in the inspection carried out about the step. Performance of the existing structure is verified based on three aspects tabulated above.
- If the existing structure is not fulfilling the performance requirement; beyond that, if the continuous usage may lead to the conclusion that retrofitting is desired, then the retrofitting design proceeds.
- Out of the many retrofitting techniques out there, a particular method for retrofitting is selected and the materials structural specifications and construction method are listed out.At this stage, the details of the existing structure are already known and along with it, the desired result is also decided.
- After retrofitting, the performance of the structure is again verified whether it has achieved the required criteria or not.

> Inspection of the existing structures is a crucial step while deciding on retrofitting method to be used. The characteristic values of the materials in the existing structure may not be the same as listed while the structure was made.

Issues Arising After Implementation of Retrofitting Techniques

The addition of new members and jacketing are conventional retrofitting techniques. The main drawback of such techniques is the increase in stiffness of the structure after the retrofitting is carried out. Increased stiffness increases the load demand on the structure and ultimately alters the dynamic behavior. Hence, research into retrofitting techniques and re-analysis of the structure after retrofitting is necessary. The modern retrofitting techniques consist of continuous fiber reinforced plate bonding and prestressing.

Some tiny tips for retrofitting: In the case of RC members, the retrofit design should govern flexure instead of ultimate strength. This ensures full advantage of the ductility of the member ■ □□□□□

Quote:

"Engineering is the art of, modelling materials we do not wholly understand, into shapes we cannot precisely analyse, so as to withstand forces we cannot properly assess, in such a way that the public has no reason to, suspect the extent of our ignorance."

- Dr A R Dykes, 1976
British Institution of Structural Engineers

Revolutionizing Civil Engineering: Exploring Emerging Technologies in the 21st Century and its Evolution through the years.

by Ritika Raghu, S4 CE

The realm of civil engineering is experiencing a paradigm shift, driven by cutting-edge technologies that promise to redefine infrastructure's design, construction and maintenance. This article delves into emerging technologies shaping the 21st-century civil engineering landscape. Reflecting on its evolution from ancient marvels to modern mega-projects, civil engineering's fusion with technology is shaping a future where human needs and the environment is harmonising.

Civil Engineering: Peer into the past and the future

In the ever-evolving landscape of civil engineering, the integration of cutting-edge technologies has become a driving force behind innovation, efficiency, and sustainability. From groundbreaking materials to data-driven systems, the field is witnessing a remarkable transformation that promises to reshape how infrastructure is conceptualized, designed, built, and maintained. In this comprehensive article, we will explore a diverse range of emerging technologies that are redefining the boundaries of civil engineering in the 21st century.

The use of advanced materials is revolutionizing the construction industry by enhancing structural integrity, durability, and sustainability. Self-healing concrete, a groundbreaking innovation, employs microorganisms or encapsulated polymers to autonomously repair cracks, thereby extending the lifespan of structures and minimizing maintenance costs. Additionally, the integration of high-performance, lightweight materials such as fiber-reinforced polymers (FRPs) and ultra-high-performance concrete (UHPC) is enabling the construction of resilient and aesthetically pleasing structures that consume fewer resources.

> "The concept of digital twins is revolutionizing asset management and maintenance practices in civil engineering. By creating virtual replicas of physical assets using data from sensors, real-time monitoring, and simulation, engineers can gain insights into structural health, performance, and potential issues."

Sustainable construction is a cornerstone of modern civil engineering, and the adoption of eco-friendly materials like bamboo, recycled aggregates, and bio-based composites is gaining momentum. These materials reduce the environmental impact of construction while delivering optimal structural performance. Moreover, the concept of "green building" has spurred the development of energy-efficient designs, incorporating passive heating and cooling strategies and harnessing renewable energy sources.

Building Information Modeling (BIM) has transcended its initial role as a 3D modeling tool and evolved into BIM 2.0—a dynamic data-driven approach that encompasses the entire project lifecycle. With the integration of real-time data, artificial intelligence (AI), and the Internet of Things (IoT), BIM 2.0 creates "smart" models that enable real-time monitoring, simulation, and predictive analysis. This results in improved decision-making, enhanced collaboration among stakeholders, and streamlined project management.

BIM 2.0 also facilitates the concept of "digital twins", allowing engineers to create virtual replicas of physical structures. These digital twins enable real-time monitoring, performance assessment, and predictive maintenance, contributing to the longevity and operational efficiency of infrastructure.

The concept of digital twins is revolutionizing asset management and maintenance practices in civil engineering. By creating virtual replicas of physical assets using data from sensors, real-time monitoring, and simulation, engineers can gain insights into structural health, performance, and potential issues. This real-time feedback loop enables predictive maintenance, reduces downtime, and enhances safety.

Digital twins have applications in various sectors, from bridges and buildings to transportation systems and water networks. They empower engineers to make informed decisions, optimize maintenance schedules, and ultimately extend the lifecycle of infrastructure assets.

> The field of civil engineering stands on the precipice of transformative change, driven by a multitude of emerging technologies.

The integration of robotics and automation is reshaping the construction industry, making processes more efficient, accurate, and safe. Drones, for instance, are employed for site surveying, progress monitoring, and generating accurate topographic maps. These aerial platforms provide real-time data, improving project planning and decision-making.

Construction robots equipped with 3D printing capabilities are emerging as pioneers in additive manufacturing. These robots can fabricate intricate structures with precision and speed, reducing construction time and labor costs. Autonomous heavy machinery is also gaining traction, enabling tasks such as excavation, grading, and material handling to be performed with higher precision and efficiency.

Artificial Intelligence (AI) is revolutionizing structural analysis and design optimization. AI-driven algorithms process vast datasets to identify the most efficient and cost-effective design solutions. Engineers can quickly assess numerous variables, including material properties, load conditions, and safety requirements, to create optimized designs that meet performance goals.

Moreover, AI plays a crucial role in predicting the impact of external factors on construction projects. By analyzing historical data, AI algorithms can anticipate potential challenges related to weather conditions, material availability, and labor constraints, allowing engineers to proactively plan and mitigate risks.

The integration of renewable energy solutions into civil engineering projects is becoming increasingly prevalent. Solar panels integrated into roads, bridges, and buildings harness solar energy to generate clean electricity. This innovative approach not only optimizes land use but also contributes to sustainable power generation.

Piezoelectric materials embedded in pavements exemplify the potential of energy harvesting from mechanical vibrations. As vehicles traverse these roads, the vibrations generate electricity, offering a unique way to convert motion into energy.

The field of civil engineering stands on the precipice of transformative change, driven by a multitude of emerging technologies. The integration of advanced materials, the evolution of Building Information Modeling (BIM) into data-driven smart models, the advent of digital twins, the rise of robotics and automation, the power of Artificial Intelligence (AI) for structural analysis, and the integration of renewable energy solutions are collectively reshaping the industry.

Civil engineering, a discipline that has shaped the physical world around us for centuries, has a rich and diverse history that reflects the ingenuity, innovation, and adaptability of human civilization. From the construction of monumental structures to the development of sophisticated infrastructure, civil engineering has played a pivotal role in the progression of societies across the globe.

The roots of civil engineering trace back to ancient civilizations that built remarkable structures without the aid of modern technology. The pyramids of Egypt, the Great Wall of China, and the Roman aqueducts are prime examples of the ingenuity and engineering prowess of early societies. These monumental feats were achieved through the application of fundamental engineering principles, precise measurements, and masterful construction techniques.

The 18th and 19th centuries witnessed the Industrial Revolution, a pivotal period that brought about mechanization, urbanization, and radical changes in construction practices. The invention of steam engines and the expansion of railway networks revolutionized transportation and logistics. The iron and steel industries flourished, paving the way for the construction of expansive bridges, skyscrapers, and railway systems. The emergence of standardized materials and engineering codes laid the foundation for modern structural design.

The history of civil engineering is a testament to human creativity, problem-solving, and adaptability. From ancient marvels to modern megaprojects, the discipline has evolved to meet the changing needs and aspirations of societies.

As these technologies continue to mature, they have the potential to enhance the sustainability, efficiency, and resilience of our built environment. Civil engineers and industry professionals who embrace these innovations are poised to lead the way in shaping a future where infrastructure is not only functional but also environmentally conscious and adaptable to the evolving needs of society. The synergy between human ingenuity and technological advancement is steering civil engineering toward a new era of unprecedented possibilities ■ □□□□□

by ALBIN WILSON, S2 CEA

Tall Building Structures and its Different Aspects

Tall buildings, emblematic of modern architecture, stand as iconic symbols worldwide, showcasing human innovation and engineering excellence. This article delves into various facets of tall building structures, exploring their design, engineering, sustainability, and urban impact. Amalgamation of different aspects plays a pivotal role in creating these architectural marvels. As urbanization and sustainability take center stage, these structures exemplify human achievement while shaping the future of modern cities, reflecting a harmonious blend of innovation, design, and environmental consciousness.

Tall Building Landscape

TALL buildings have become iconic symbols of modern architecture, dominating city skylines around the world, with their soaring heights and breathtaking designs. They have become iconic landmarks in cities worldwide. These architectural marvels push the boundaries of engineering and design, captivating our imagination and serving as testaments to human ingenuity. These structures stand as testaments to human innovation, pushing the boundaries of architecture and engineering. In this article, we will delve into the various aspects of tall building structures, exploring their construction, design considerations, sustainability efforts, and the impact they have on urban environments.

Structural Design and Engineering

Constructing tall buildings requires meticulous planning and innovative engineering. The structural design of these buildings involves various elements such as foundation systems, vertical load-bearing systems, lateral stability systems, and sustainable material choices. Advanced computer modeling and analysis techniques are employed to ensure the structural integrity and safety of the building.

Foundation Systems

The foundation of a tall building plays a crucial role in supporting the immense weight and transferring loads to the ground. Deep foundation systems, such as piles or caissons, are often used to reach stable soil or rock layers. These systems ensure stability, resist lateral forces, and distribute the building's weight effectively.

Vertical Load-Bearing Systems

Tall buildings rely on vertical load-bearing systems to support the weight of the structure and distribute it evenly to the foundation. Common systems include reinforced concrete or steel frame structures, composite structures, or a combination of these materials. The selection of the appropriate system depends on factors like height, local regulations, cost, and structural efficiency.

Lateral Stability Systems

Given the height and exposure of tall buildings to wind forces, lateral stability is a critical aspect of their design. Engineers employ various techniques, such as bracing systems, shear walls, and outrigger systems, to resist lateral forces and ensure the building's stability during high winds or seismic events.

> Tall building structures continue to redefine our cities and challenge the limits of engineering and design.

Sustainable Design

With the growing emphasis on sustainability, tall buildings are increasingly incorporating eco-friendly design features. This includes energy-efficient building systems, green roofs, natural ventilation, use of renewable materials, and integration of renewable energy sources such as so-

lar panels and wind turbines. The aim is to minimize the ecological footprint of tall buildings and promote a greener urban environment.

Vertical Transportation

Efficient vertical transportation is a significant concern in tall buildings, ensuring smooth movement of people and goods. Advanced elevator systems, including high-speed elevators and double-decker elevators, are employed to minimize travel time between floors. Additionally, innovative technologies like destination control systems optimize elevator operations and energy consumption.

Urban Impact

Tall buildings have a profound impact on the urban landscape and the communities they inhabit. They can contribute to urban densification, promoting efficient land use and reducing sprawl. However, their development must consider factors such as shadowing effects, wind effects at ground level, and the integration of public spaces to ensure a positive urban experience for residents and visitors.

Iconic Tall Buildings

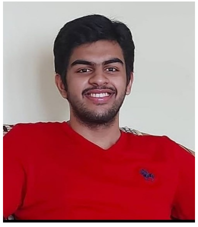
The world is adorned with numerous iconic tall buildings that have captured our collective imagination. Examples include the Burj Khalifa in Dubai, the Shanghai Tower in China, and the One World Trade Center in New York City. These architectural marvels showcase not only incredible height but also stunning designs that reflect cultural, social, and technological aspirations.

Safety and Security

Tall buildings implement robust safety measures to protect occupants and mitigate risks. These include fire safety systems, emergency evacuation plans, structural redundancy, advanced security systems, and resilient design features. Safety codes and regulations are followed to ensure compliance and enhance occupant well-being.

Conclusion

Tall building structures continue to redefine our cities and challenge the limits of engineering and design. Their awe-inspiring heights, innovative designs, and intricate structural systems continue to captivate us. As cities evolve and grow, tall buildings offer solutions to the challenges of urbanization while becoming symbols of human progress. From the complex structural systems to sustainable initiatives and their impact on urban environments, these towering structures are remarkable feats of human achievement. As technology advances and sustainability takes center stage, we can expect even more innovative approaches to shape the future of tall building construction while harmonizing with the needs of our communities and the environment. With sustainability at the forefront, these structures will continue to shape skylines, redefine urban landscapes, and inspire generations to come ■ □□□□□

ASCE Updated Code of Ethics- Impacts on the Civil Engineering Profession

by Jyotika K, S4 CE
& Abhishek Rajesh Nair, S6 CEA

ASCE updated its Code of ethics in October 2020 which incorporates the much needed change in the world view of how Civil Engineers should operate in the current global scenario. The article underscores the ongoing need for engineering ethics in a rapidly evolving technological landscape.

Updated code of ethics- October 2020

Throughout the history of mankind, technology has played an important role in forming the way we live, think and how we approach problems and solve them. From the tallest of the skyscrapers to the smallest nano chip everything has technology behind it. Engineers should be willing to learn new technology to enhance knowledge in their profession and should work only in their field of expertise. With technological advancement not slowing down anytime soon, it's important that engineers have the right principles that guide them throughout their professional careers. It also helps engineers to solve complex problems and to play an important part in how the world functions. Engineers are expected to be honest in their assessment to clients or employers and communicate clearly on the consequences related to their work. Working in a professional way with colleagues, to act wisely at the time of pressure are some of the key qualities in an engineer. Upholding honour, integrity and dignity of the profession is one of the top priorities of engineers.

The code of ethics functions as a commitment to the profession that the engineers will serve for the public welfare, safety and development. It empowers engineers to ensure sufficient quality in work by eradicating unethical and immoral practices. Hence, it is always important that the code of ethics is updated and raised for better development and maintenance.

> "The stakeholders are: Society, Nature, and Built Environment; Profession; Clients and Employers; and Peers, in that order."

The need for engineering ethics and establishment of professional licensing increased in the United States especially after the Boston Molasses disaster of 1919. On October 26, the American Society for Civil Engineering board of direction updated the society's code of ethics, which is a noticeable update of the code since 1974. After the last major revision in 1974, with the addition to canon 8 in 2017, the new changes made in 2020 are to be considered as remarkable. Past President Robin A. Kemper spearheaded this initiative, which began in 2013. With the aim in mind, she recommended the formation of a task committee 5 after initiating debate on the "Code of Ethics for the Twenty-First Century" in her first meeting as president-elect. An eight-person team and a consultant completed the project in two years, which was originally intended to take a year. The structure, format, and wording have all been updated.

The 2017 ASCE code of ethics was mainly divided into eight "canons". These canons mainly focused to uphold and advance integrity, honour and dignity in the civil engineering profession. It emphasised on how the decisions made by civil engineers can affect the welfare, health and safety of the general public. While issuing statements, testimonies the engineers must be truthful and objective. They should not get influenced by people or groups with vested interest. Civil Engineers are expected to act in a professional way to best avoid conflicts of interest. They should have zero tolerance for bribes, fraud and corruption in all contracts. It also highlights the need for engineers to be fair and encourage equal participation without regard to gender, nationality, race, colour, sexual orientation, political affirmation.

The 2020 ASCE president commented, "It has been a while since we had a comprehensive review of our code of ethics, so it was time that we did one". The new "stakeholder model" reorganises our ethical responsibilities by stakeholder and hierarchy. The stakeholders are: Soci-

ety, Nature, and Built Environment; Profession; Clients and Employers; and Peers, in that order. The goal is to improve functionality while making ethical considerations easier to understand. While respecting our profession's ethics, the shortened phrase reflects the intent of the canons. The new ASCE code of ethics of October 2020 focuses on what are the various responsibilities of engineers towards different elements that surrounds them. An engineer must work to protect the health, safety and welfare of the public and enhance the quality of life for humanity. He/She must be honest while sharing professional opinions, assessing colleagues and should have zero tolerance to corruption and violation of laws or policies. A Civil engineer should be aware of the environment he/she is working on and best adopt sustainable development policies. They must be educated enough to make wise decisions while using natural resources.

It is also noticed that the latest version is simpler and understanding in terms of engineering practice. It eliminates all the confusion and conflicts regarding engineers' duties and responsibility. First and foremost, the most obvious change is the difference in words. The word count changed from 2070 to 695. Even though the word count reduced significantly, there is actually no change in quality of content. The new code is clearer and more concise. Other noteworthy aspects of the revised Code of Ethics include: Improved reporting requirements for bribery, and corruption. According to the American Society of Civil Engineers, it is estimated that about $4 trillion spent yearly on engineering and construction is lost to corruption. The additional guidelines were included to ASCE Code of Ethics Cannon 6, which states that "Engineers shall act in such a manner as to uphold and enhance the honour, integrity, and dignity of the engineering profession and shall act with zero-tolerance for bribery, fraud, and corruption". For the first time, a focus on health and safety in the workplace is discussed. The ethical responsibility of an engineer to "adhere to the principles of sustainable development" has been strengthened. The disparity between the old and new codes shows a significant shift in focus. While sustainability and inclusivity were important parts of the previous code, and fidelity and reputation are still important in the new code, the new Preamble prioritises the engineer's role in shaping the lives of others over more pragmatic and internal goals such as business needs and professional advancement.

While the new Code of Ethics has significant structural modifications and a new structure of ethical requirements, a reading of the text reveals more resemblances with the previous code. While the history of ASCE's rules shows gradual but consistent shifts in ethical standards through time, it is obvious that moral precepts like competence, diligence and honesty remain at the heart of modern engineering practise. As a result, it is hoped that the new code revision strengthening security and integrity will assist civil engineers in gaining a better understanding and maintaining their ethical beliefs.

The Wikipedia definition of engineering ethics is "field of system of moral principles that apply to the practice of engineering". Clearly, it states how important is the role of morality to engineering and the need to choose what's right rather than what is easy. In modern society, the need for code of ethics in the engineering world is ever increasing ■

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□□□□□

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Assistant Professor

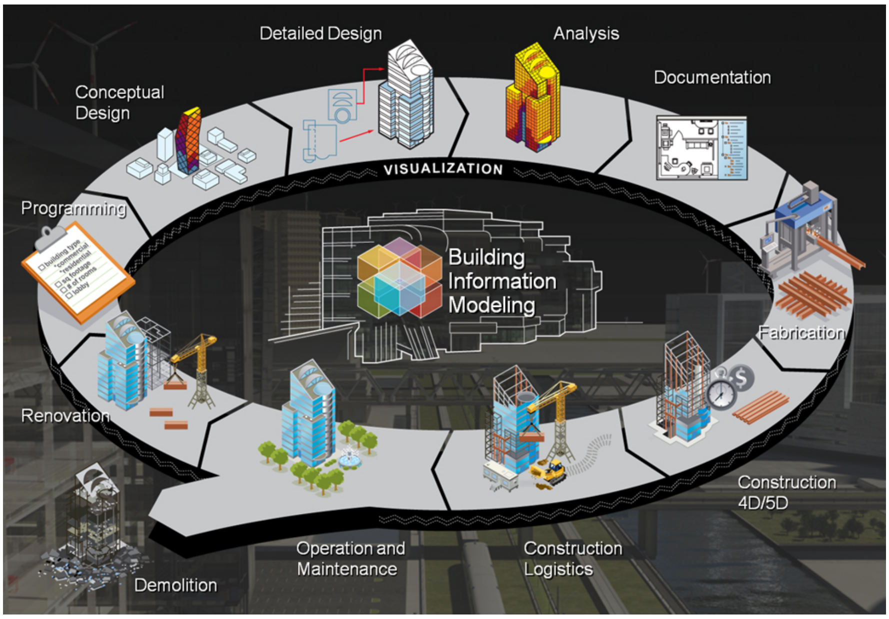
Advancements and Challenges in BIM: Revolutionizing the Indian Construction Sector

The construction industry in India is experiencing a profound transformation, driven by the adoption of Building Information Modelling (BIM). This article explores the evolution of BIM in the Indian construction sector, highlighting its various dimensions, from 3D modeling to advanced concepts like 8D, 9D, and 10D BIM. BIM's momentum is growing in India by not just revolutionizing construction; but also contributing to India's ambitious goals of smart urban planning and human-centric, well-being-focused design.

What, why and how of BIM.

THE construction industry in India is undergoing a transformation, driven by technological advancements that are reshaping how projects are planned, designed, and executed. Among these transformative technologies, Building Information Modelling (BIM) has emerged as a powerful tool, revolutionizing the construction sector in the country.

In this article, we will delve into the advancements, challenges, and advantages of BIM, along with recent developments in the Indian construction sector. BIM made its foray into the Indian construction industry towards the end of the first decade in this millennium. Typical of any technology adoption curve, BIM was met with a fair share of scepticism across stakeholders. Yet, awareness about its potential benefits, scope of application in design and management of various aspects of the project and subsequent adoption has grown slowly yet steadily in the past decade.



Workflow in BIM

> "Building Information Modelling (BIM) has emerged as a powerful tool, revolutionizing the construction sector in the country."

What is BIM?

Building Information Modelling is a digital representation of the physical and functional characteristics of a building. It encompasses a wide range of data, including geometry, spatial relationships, materials, costs, and schedules. BIM is not just about 3D modelling; it's a collaborative process that involves architects, engineers, contractors, and other stakeholders working together on a single integrated platform. The shift of design communication from 2D (Computer Aided Design) CAD drawings to 3D models which simulate the project, has been a turning point in the history of construction and architecture. BIM models came into the picture as a design aid for 3D modelling, which could help architects and builders, visualize and guide the project to precision. Such a model outdoes the limitations of 2D drawings and integrates all relevant data in the construction lifecycle of the project. The ability of BIM models to assimilate and integrate data with precision, enhances the clear and crisp communication among project stakeholders (clients, architects, engineers and contractors). It is also the stepping-stone for application of advanced technologies such as artificial intelligence, robotics, and others in the construction industry.

BIM is often described in terms of different dimensions, which represent various aspects and levels of information integration beyond traditional 2D and 3D modeling.

- **3D (Spatial Dimension):** This is the most basic level of BIM and involves the creation of three-dimensional digital models of building elements, spaces, and components. It provides a visual representation of the building's geometry. While 3D modelling is a significant component of BIM, BIM goes beyond this dimension to include additional data and information.
- **4D (Time Dimension):** 4D BIM adds the element of time to the model. It involves linking the 3D model with project schedules and timelines. This enables project stakeholders to visualize how the construction will progress over time, aiding in scheduling, sequencing, and project management. It helps in understanding construction phasing, resource allocation, and project timelines.
- **5D (Cost Dimension):** In 5D BIM, cost data is integrated into the model. It allows for the automatic generation of cost estimates and helps in tracking project costs throughout its lifecycle. This dimension helps in budgeting, cost control, and identifying cost implications of design changes.
- **6D (Sustainability Dimension):** 6D BIM focuses on sustainability and environmental aspects. It involves adding data related to energy efficiency, material specifications, and other sustainability factors to the model. This enables the analysis of a building's environmental impact and life cycle assessment, aiding in making eco-friendly design and construction decisions.
- **7D (Facility Management Dimension):** This dimension extends BIM's utility into the facility management phase. It includes data relevant to operations and maintenance, such as maintenance schedules, equipment manuals, and warranty information. It helps facility managers in efficiently managing and maintaining the building throughout its lifecycle.

Hence, BIM is not just 3D modelling because it goes beyond the visual representation of a building's geometry. BIM integrates various data dimensions to provide a comprehensive digital representation of a building and its entire lifecycle. It enables stakeholders to make informed decisions at every stage, from design and construction to operation and maintenance. This holistic approach enhances collaboration, reduces errors, and improves project efficiency and sustainability, making BIM a valuable tool in the construction and building management industries.

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Why BIM?

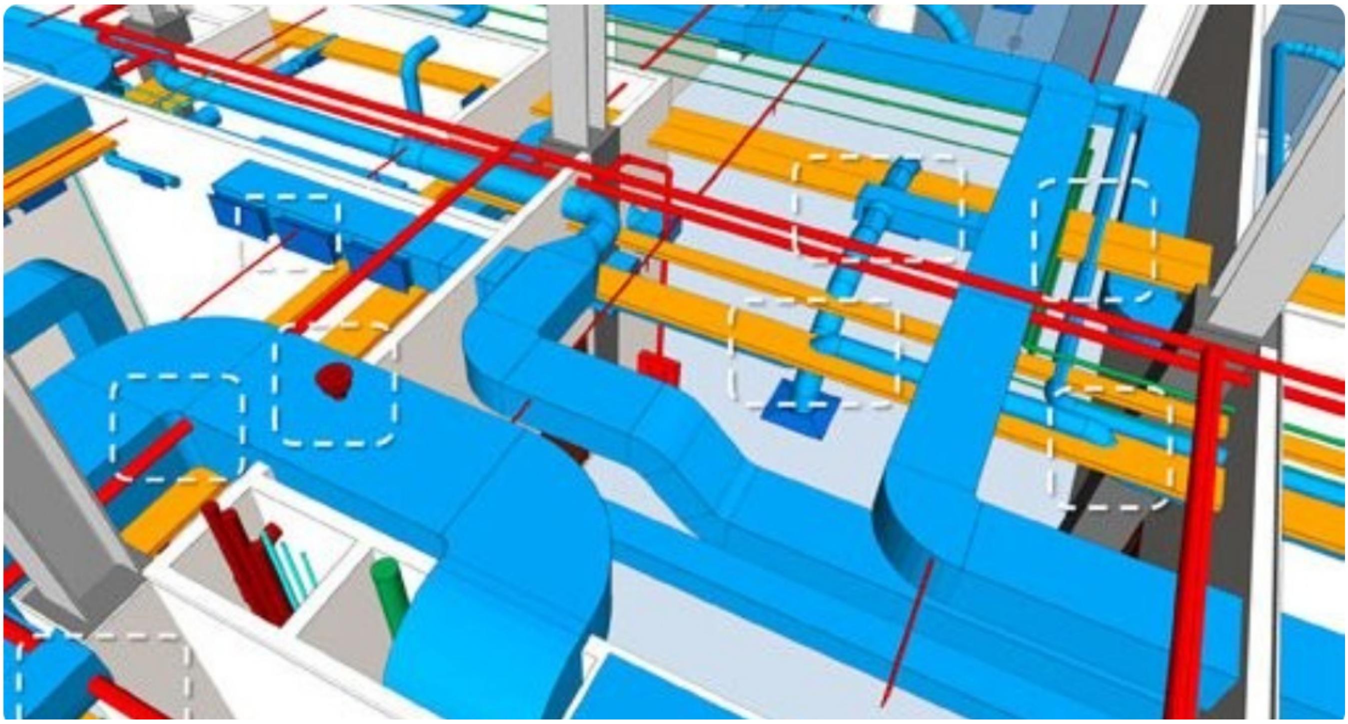
Before the widespread adoption of BIM, the Architecture, Engineering, Construction, and Operations (AECO) industry relied on traditional approaches to design, construct, and manage buildings and infrastructure projects. This traditional approach had several limitations and challenges:

2D Drawings:

The traditional approach heavily relied on 2D drawings, such as blueprints and floor plans, for design and documentation. These drawings lacked depth and detail, making it challenging to convey complex spatial and construction information accurately. As a result, misinterpretations and errors were common during construction.

Fragmented Information:

Information in the traditional approach was fragmented and stored



Clash detection of pipeflow using BIM

in various formats and documents, including paper drawings, spreadsheets, and physical models. This made it difficult to access and update information, leading to inefficiencies, data redundancy, and version control issues.

Lack of Collaboration:

Collaboration among project stakeholders, including architects, engineers, contractors, and facility managers, was limited. Communication often occurred through manual exchanges of documents and drawings, resulting in delays, miscommunication, and a lack of transparency.

Cost Overruns and Delays:

The traditional approach frequently experienced cost overruns and project delays due to errors in design, clashes during construction, and unexpected site conditions. These issues were often identified late in the construction process, requiring costly rework.

Limited Sustainability Analysis:

Traditional methods had limited capabilities for assessing the environmental and sustainability aspects of a project. This led to missed opportunities for optimizing energy efficiency and sustainable design.

Inefficient Facilities Management:

Post-construction, facility managers struggled with managing and maintaining buildings efficiently. They lacked access to accurate as-built information, making it challenging to plan maintenance and renovations effectively.

Limited Visualization:

Traditional 2D drawings and physical models provided limited opportunities for stakeholders to visualize the final outcome of a project. This hindered design exploration and decision-making.

Ineffective Change Management:

Implementing design changes during construction was often cumbersome and costly in the traditional approach. Changes required updates to multiple documents and drawings, leading to confusion and disputes.

Lack of Data Integration:

Traditional processes did not facilitate the integration of data from different phases of a project, such as design, construction, and operations. This hindered data-driven decision-making and performance analysis.

BIM emerged as a transformative technology to address these limitations. BIM with its various dimensions provides a digital platform that allows stakeholders to create, collaborate on, and manage comprehensive 3D models with rich data attributes. This integrated approach enhances communication, reduces errors, supports sustainability analysis, facilitates real-time collaboration, and streamlines the entire project lifecycle. BIM has become a fundamental tool in modern AECO practices, revolutionizing the industry by addressing the shortcomings of traditional approaches.

> The *United States* is one of the pioneers in BIM development and adoption in the construction industry. In India, it evolved from a "Nice-to-Have" tool in 2000s to a "Must Have" by 2015.

Advancements in BIM

Enhanced Collaboration:

BIM fosters collaboration like never before. It allows various stakeholders to work concurrently on a project, sharing real-time updates and information. This streamlined communication minimizes errors and conflicts, leading to more efficient project delivery.

Clash Detection and Resolution:

BIM's clash detection capabilities identify conflicts in designs before construction begins, saving time and resources. This advancement helps avoid costly rework and delays.

Cost Estimation and Management:

BIM facilitates accurate cost estimation and management by integrating cost data into the model. This aids in budget planning and reduces the risk of cost overruns.

Sustainability and Energy Efficiency:

BIM enables the analysis of energy performance and sustainability factors early in the design phase. This helps in creating eco-friendly and energy-efficient buildings.

BIM implementation across the globe

USA and the UK are the leading BIM implementing countries in the world. Australia is one of the adopter countries whose rapid performance is outperforming the more established countries in terms of BIM guide, standards, national specification, and corporate research centre. While the US government enforced BIM to improve productivity and performance of government-built assets, the UK was inspired by the possibility of reducing capital costs and carbon performance and for Australia, the BIM initiative aimed to increase productivity and improve asset management in the built industry.

The *United States* is one of the pioneers in BIM development and adoption in the construction industry. In the US, the General Services Administration (GSA) in 2003 launched the "National 3D-4D program" with the goal to form strategy to gradually implement 3D, 4D and BIM for all major public projects. In 2007, the GSA included BIM for spatial program validation for all its projects. In the *Netherlands*, the Government Buildings Agency has mandated the use of BIM for public projects in 2011. The European Commission announced directive 2014/24/EU, which recommends member states' use of specific electronic tools such as BIM for public works contracts and design contests. *Singapore* mandates the use of BIM in all publicly funded projects in 2015 and *South Korea* in 2016. In the *United Kingdom*, the government has mandated a minimum of Level 2 collaborative BIM on all publicly financed projects from 2016.

BIM Adoption in India

In the early 2000s, the construction industry in India witnessed a shift towards complex buildings with advanced HVAC systems, heightened security, and energy efficiency demands. The limitations of 2D CAD drawings led to the emergence of BIM, initially met with resistance due to unfamiliarity and cost concerns. Over 5-7 years, it evolved into a "Nice-to-Have" tool, appreciated for design improvements, cost savings, and competitive advantages. By 2015, BIM became a "Must Have", with increased awareness and widespread adoption among Indian construction professionals. In 2021, BIM has transitioned into a tool that explores advanced applications, including ERP (Enterprise Resource Planning software) integration for material management and cost prediction, reflecting its journey from a novelty to an essential and multi-functional industry asset.

List of major projects in India
*Image Courtesy:*https://www.bimcommunity.com/news/load/467/bim-implementation-in-india

Infrastructure projects in India incorporating BIM

The *Bharatmala Pariyojana* Project led by the Government of India's Ministry of Road Transport and Highways (MoRTH) aims to enhance connectivity, promote economic growth, and improve infrastructure across India. This extensive project, spanning approximately 83,677 kilometres, began in October 2017 and is expected to be complete by 2024. The use of BIM for construction of highways has played a crucial role in streamlining the design and construction of the *Bharatmala Pariyojana* project.

It facilitated 3D visualization, clash detection, and design optimization, enabling stakeholders to collaborate effectively and make informed decisions. BIM also aided in accurate quantity estimation and cost optimization of the project thereby avoiding cost overruns.

The *Nagpur Metro Rail* project is a 5D BIM project that uses a digital information management system to integrate the 3D models, schedules, and costs of the project on a common data environment. The project also uses drones and geospatial technology to enhance the surveying, monitoring, and quality control of the construction. The project aims to achieve faster delivery, better coordination, higher accuracy, and lower risk by using BIM.

Airport Authority of India (AAI) has identified BIM as the design and planning platform for construction of the New Integrated Terminal Building (NITB) ,90000 sqm Terminal, of *Lokpriya Gopinath Bordoloi International Airport* in Guwahati. It will be one of the first public sector airport project in India to use BIM for entire project lifecycle of Design, Build, Operate.

BIM will help to enhance collaboration of the entire project team– from design, fabrication, and construction to operations and maintenance – to make informed decisions from a common point of understanding. The cloud-based Collaboration for Revit service (an Autodesk BIM Model) provides centralized access to Revit models, and let project team members at multiple sites co-author Revit models regardless of their physical location. This cloud-enabled work-sharing also let team members see each other's work and communicate with one another in real time. From design collaboration, documentation and reviews, to pre-construction, through quality, safety and operations, BIM connects the people, data and workflows in construction projects. With hundreds of people working on the site each day, communication at scale is key. It will enable all the parties to review the master model, see each other's concerns; clashing elements; inaccurate or missing design elements; and critical zones both for coordination and installation. There are other airport terminals across the country where BIM is implemented in various stages. Examples are the Noida International airport and Bangalore terminal.

> BIM's cloud-enabled work-sharing also let team members see each other's work and communicate with one another in real time.

Challenges in BIM Implementation

While BIM offers numerous benefits, its adoption in India is not without challenges:

- **Skill Gap:** The construction industry in India faces a shortage of skilled BIM professionals. Bridging this skill gap through training and education programs is essential.
- **Infrastructure:** Access to high-speed internet and the latest hardware is still a challenge in many parts of India, hindering the seamless adoption of cloud-based BIM solutions.
- **Cost of Implementation:** Initial investment in BIM software and training can be high. However, the long-term benefits often outweigh these costs.

Advantages of BIM in the Indian Context

BIM's advantages are particularly significant in the Indian construction sector:

Time Efficiency:

India's growing population demands fast-track construction projects. BIM accelerates project timelines through efficient planning and collaboration.

Quality Assurance:

BIM's ability to detect clashes and errors results in higher construction quality and fewer defects, ultimately saving costs.

Sustainable Development:

With India's commitment to sustainable development, BIM's ability to optimize energy consumption and materials aligns perfectly with national goals.

Recent Developments in India

Government Initiatives:

The Indian government has endorsed BIM as a critical tool for infrastructure development. It is a good sign that various departments such as AAI and MoRTH are taking initiatives and embracing the advantages to these technological advancements.

Skill Development:

Several institutions and organizations have launched BIM training programs, addressing the skill gap. These initiatives aim to train a new generation of BIM experts. Many university in India have also included BIM in the curriculum to cater to the increasing need of the industry.

Private Sector Adoption:

Leading construction companies in India are embracing BIM to stay competitive. Many large-scale projects, including smart cities and airport expansions, are adopting BIM methodologies.

There are many software tools that can be used for BIM in India, depending on the specific needs and

Render of the Guwahati Terminal

preferences of the users. Some of the most popular and widely used BIM software in India are:

- **Autodesk Revit:** A comprehensive BIM software that supports architectural design, MEP, structural design, detailing, engineering and construction.

AUTODESK® REVIT®

- **Autodesk BIM 360:** A cloud-based ecosystem that connects the project teams and data across the entire project lifecycle.

AUTODESK® BIM 360™

- **BricsCAD:** A CAD design solution that supports 2D drafting, 3D modeling, mechanical design and BIM.

BRICSCAD

- **Tekla Structures:** A BIM software that enables accurate, constructible modeling of any structure regardless of its size or material.

Tekla® Structures

- **Edificius:** A BIM software that integrates architectural design, structural analysis, cost estimating and rendering.

Edificius BIM Modeling Software

Future advancements in BIM

While the concepts of 8D, 9D, and 10D BIM are not as commonly discussed as the earlier dimensions (3D to 7D), they represent advanced stages of information integration and development in the field of Building Information Modeling (BIM). These dimensions focus on expanding the capabilities and applications of BIM even further.

8D (Regulatory and Legal Compliance Dimension):

8D BIM emphasizes the incorporation of regulatory and legal compliance data within the BIM model. This includes data related to building codes, zoning regulations, safety standards, and legal requirements specific to the project's location. By integrating regulatory and legal information, BIM can help ensure that the design and construction processes adhere to all necessary guidelines and regulations. This dimension can be particularly valuable for projects with complex legal and regulatory requirements, such as large-scale developments or projects in highly regulated industries.

9D (Smart Cities and Urban Planning Dimension):

9D BIM extends the use of BIM to the broader context of urban planning and the development of smart cities. It involves integrating data related to urban infrastructure, transportation systems, utilities, and city planning into the BIM model. This dimension allows for a comprehensive understanding of how individual buildings and structures fit within the larger urban environment. It aids in optimizing city planning, sustainability, and infrastructure management. 9D BIM is particularly relevant in the context of rapidly growing urban areas and the need for sustainable urban development.

10D (Human Experience and Well-being Dimension):

10D BIM is a futuristic concept that focuses on the human experience and well-being within built environments. It involves the integration of data related to occupant comfort, health, and well-being into the BIM model. This dimension aims to create buildings and spaces that enhance the quality of life for occupants by considering factors such as indoor air quality, natural lighting, acoustics, ergonomic design, and even emotional well-being. 10D BIM envisions buildings that promote health, productivity, and overall satisfaction for those who live or work in them.

It's important to note that the development and adoption of BIM dimensions beyond 7D are still evolving and may not be widely implemented in practice. These higher dimensions represent ambitious goals for the BIM industry, reflecting a desire to use technology to improve regulatory compliance, urban planning, and the overall human experience in the built environment. As technology and the BIM ecosystem continue to advance, these dimensions may become more relevant and achievable in the future.

Conclusion

Building Information Modelling is undoubtedly transforming the Indian construction sector. The advancements in BIM technology are not only improving project efficiency but also aligning with the country's sustainable development goals. While challenges exist, India is making significant strides in overcoming them, as demonstrated by government initiatives and private sector adoption. As Building Information Modelling continues to evolve, it promises to redefine how India builds its future ■

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Quote:

"The art of engineering is to develop solutions that stand as monuments of intelligence and inspiration"

- Fazlur Rahman Khan

A Bangladeshi-American structural engineer and architect, who initiated tubular structural systems for skyscrapers

Contest alert:

"I rise with grace, a symphony of steel,
In equilibrium's delicate reel.
My counterweight poised, suspended in air,
Lifting pathways for vessels to share.
With gears that turn and mechanisms fine,
I'm a marvel of design, a bridge so divine.
What am I, in the realm of civil's embrace,
A masterpiece engineering has traced?"

Solve the riddle above to participate in the contest.
You may email the answer to civil@fisat.ac.in and **cc** to asce@fisat.ac.in with the subject line **Srishti-Contest**. In the content body, submit the answer along with your name, class and roll number. Maximum of two(2) participants in one entry is permitted. First correct entry will be featured in the next issue of the magazine.
Clue: It is a present in Kochi and is a famous landmark.

Contest answer:

The answer to the contest in last edition is **Universal Testing Machine(UTM)**.

Can you get it right?

Why does soil piping occur?
Commonly used explosives for demolition:
What are examples of polluted sites?
Conventional retrofitting techniques are:
How can we harvest energy from mechanical vibrations?
What is the cornerstone of modern civil engineering?
What year did ASCE revise their code of ethics?

Write to us:

We are looking forward to your feedback. Email us at the information provided above, to submit your feedback and suggestions for improvement.
To make contributions to the upcoming issues, contact the magazine team. They can provide you with further details. The magazine team members and their communication info have been provided in the cover page.

WORDSEARCH

Find the words related to the theme in the title from the puzzle. Words can go in any direction. Words can share letters as they cross over each other.

Structural Engineering

C	B	X	F	X	C	H	P	I	V	Z	Y	C	S	I	G	U	M	Z	L	M	C	R	N	G
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DEPARTMENT OF CIVIL ENGINEERING

Happenings around the world!!!

- World's first 3D printed steel pedestrian bridge opens in Amsterdam on 15 July 2021. It spans nearly 40 feet and is constructed of stainless steel weighing of 6 tonnes. The structure was constructed by Amsterdam-based 3D metal printing technology company MX3D using a wire arc additive manufacturing process that marries advanced robotics with welding. With the aid of four robots, the entire printing process took just six months.
- A huge fire broke out at the Ghazipur landfill on 28 March 2022. This massive mountain of toxic garbage, which was ablaze for over 48 hours, impacted not just those who lived in the immediate vicinity but also everyone who inhaled this smoke.
- Merdeka 118 is a 118-story megatall skyscraper in Kuala Lumpur, Malaysia.I t is the second-tallest structure and building in the world. The building will also be the first in Malaysia to receive a triple platinum rating from worldwide sustainability certifications, including LEED. The spire of the building was completed in October 2021 bringing its height to 678.9 m.
- OCEANIX Busan is the world's first prototype of a resilient and sustainable floating community. The interconnected neighborhoods total 6.3 hectares to accommodate a community of 12,000 people. Each neighborhood is designed to serve a specific purpose - living, research, and lodging. This city will be built off the coast of Busan, a port city which has borne the brunt of rising sea levels and increased rainfall over the years.

Answers to "Can you get it right?"

Dispersive soils and seepage water
Dynamite, Water gels, RDX & PETN
Brownfield & superfund sites
Addition of new members, jacketing
Piezoelectric materials
Sustainable construction
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