Technical Magazine

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Srishti

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

Happenings around the world!!!

- Second wave of COVID-19 pandemic hit the world and our country went into lockdown from 05 April to 15 June 2021. The Covid variant B.1.617.2 which was first discovered in India was labeled as 'Delta' by WHO on 31 May 2021. This whole strain of coronavirus was named 'Delta'.
- Atal Tunnel (also known as Rohtang Tunnel), named after former Prime Minister of India, Atal Bihari Vajpayee is a highway tunnel built under the Rohtang Pass in the eastern Pir Panjal range of the Himalayas on the Leh-Manali Highway in Himachal Pradesh, India. At a length of 9.02 km, it is the highest highway single-tube tunnel above 10,000 feet (3,048 m) in the world. With the existing Atal Tunnel and after the completion of under-construction Shinku La Tunnel, which is targeted to be completed by 2025, the new Leh-Manali Highway via Nimmu–Padum–Darcha road will become all-weather roads.
- A huge explosion shook Lebanon's capital Beirut on August 4, resulting in deaths of over 200 people. Nearly 2,750 tonnes of unsafely stored ammonium nitrate exploded at a storehouse near Beirut port. It was detected by the US Geological Survey as a seismic event of magnitude 3.3 and is one of the most powerful non-nuclear explosions in history.

" What am I? "

Identify the object given in the picture above and send in your entries. First correct entry will be featured in the next magazine. Details in pg 24.

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Contents

A note from the Editor:

Welcome to the first issue of SRISHTI, from the Department of Civil Engineering FISAT. This edition of SRISHTI discusses the recent technical advancements and innovations in the field of civil engineering. We are really happy to bring you the latest trends and technologies prevailing in the civil engineering world. We really hope this creates an innovative learning environment. We take this opportunity to express our gratitude to the Editorial board for their sincere effort and dedication to put forward the best. The faculty members who guided us through this journey deserves a special appreciation. Finally we thank the contributors who were generous to share their experience and knowledge to the society through our magazine.

Impact of COVID-19 in the Construction Industry: A Closer Look

by SNEHA BENOY, S1 SECM

The construction industry has come to a standstill due to the pandemic; the coronavirus impact. Despite the prevailing gloomy situation, the industry is expected to post a sharp rebound and grow by 11.6% in 2021, owing to lower base and pent up demand. The industrial construction sector would also likely benefit from the global shifting of supply lines from China, with the Indian market offering benefits such as large captive market and low cost labour

Civil Engineering perspective of the pandemic

THE first human cases of COVID-19, the disease caused by the novel coronavirus, subsequently named SARS-CoV-2 were first reported by officials in Wuhan City, China, in December 2019[1]. The economic crisis caused by the outbreak of Coronavirus (COVID-19) has severely disrupted the economy, with devastating effects on global trade and it has simultaneously affected households, businesses, financial institutions, industrial establishments and infrastructure companies. Similarly, construction and engineering projects around the world have been jeopardized in various ways by the COVID-19 pandemic, and many projects have closed. As a result, there has been a financial recession in the construction industry in almost all countries and has created unemployment. Companies started to layoff their employees and stopped the ongoing projects. The construction sector of India contributes more than 5 per cent to the nation's GDP and 78 per cent to the gross capital formation and all in all, this situation has caused great concern, uncertainty and unrest in the construction industry. The pandemic has limited the business around the world and companies have shifted to the Work-From-Home (WFH) concept remotely to accommodate and run the business and services. The construction industry is far different from other industries and it typically requires on-site involvement of all the project members. During the pandemic, the situation drastically deteriorated by firstly shortage of construction material supply, which then impacted the construction industry. Following the spread of the virus, many countries started implementing several measures to reduce movement of people, and that has mainly obstructed the construction because it requires on-site work and every project member must be available to work, check, and monitor all the work activities.

Role of Construction Sector

With huge ongoing project opportunities, India is the third largest contributor to economic growth with more than 50 million people engaged in the construction sector. While exclusive construction activity comprises of real estate (residential building) and non-residential construction in commercial and industrial segments (industrial sheds, prefabricated buildings), the construction of roads, railways, urban infrastructure, ports, shipping, civil aviation, coastal waterways etc also fall under the construction and infrastructure sector which is to be considered as one critical sector only.

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Apart from the highly interdependent nature of this sector with a number of other segments of the economy, one unique feature of the construction sector relates to its contribution to the growth of manufacturing. The growth in construction is inextricably linked with growth in manufacturing of machinery and equipment, basic metals, fabricated metals, and of electrical equipment. The sector has grown by an average of 5.2%

in the last five years. However, India's gross domestic product (GDP) expanded at the slowest pace in 11 years for the fourth quarter and FY20 as the COVID-19 took hold in March, and following full impact of prolonged lockdown period. The recent poignant issue of migrant labours journey back to their native places under the lockdown period is a grim testimony to the insecurity and transient nature of the job market they have entered into.

Impact of COVID-19

The construction industry has come to a standstill due to the pandemic; the coronavirus impact. Before the pandemic, the construction sector accounted for around 7.7 per cent of global employment, with projections for 2020 indicating that it would contribute to 13.4 percent of global GDP [2]. It is estimated that most of the construction sites are running at 50% of their run rate. This is because the fear of infection is keeping the workers' attendance at less than 70%. As per the industry body, at present, there are close to 20,000 ongoing construction projects at the pan India level. These engage a workforce of around 8.5 million only in construction work. Some of these projects are delayed while others are cancelled owing to COVID-19. Besides, there are supply chain bottlenecks that result in reduced or no supply of equipment and materials including structural steel and glass from Asia. Construction investors have been exposed to the impacts of the COVID-19 outbreak as delays in completion dates of construction projects may jeopardize project profitability [3]. Due to these disruptions, many contractors around the world have had to activate specific contractual provisions giving entitlements to additional time and financial resources [4]. Informality is prevalent in parts of the construction industry and they generally lack the capacity to provide safe working conditions. Informal workers in the construction sector typically have low income and limited resources to withstand economic shocks. In order to survive, many informal economy workers have therefore had to keep working, putting themselves and their families at risk of contracting COVID-19. The need to promote the transition from the informal to the formal economy in the construction sector is therefore urgent.

> "The pandemic's long-term impacts on construction supply chains may include a shift towards greater supplier diversity, use of regional suppliers, and increases in local inventories of critical components or materials, among others."

Coping up with the present scenario

Governments, employers, workers, organizations, and other sectoral stakeholders have stepped up their efforts to address and mitigate both the short- and long-term challenges of COVID-19 and the consequent economic and social crises. Measures to support construction enterprises, jobs and incomes, and to implement guidance on the protection of workers' safety and health, are being pursued to reactivate the sector and harness its potential for kick-starting economies. In India, as part of the Pradhan Mantri Gareeb Kalyan Yojana package in response to the pandemic, the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) has been allocated additional budget to increase MGNREGA wages. MGNREGA is a public employment programme enacted in law in 2005, and may be instrumental in ensuring paid employment in the context of the crisis, especially for affected groups, such as women and to migrant workers returning to rural areas. MGNREGA can contribute to build the infrastructure towards more resilient livelihoods in rural India, as there is great emphasis on infrastructure to help cope with drought. Some social protection measures specifically target the informal economy and migrant workers in the construction sector; others are not limited specifically to the sector. A cash transfer programme for construction workers has been implemented in India. Every construction worker aged between 18 and 60 who has been working in construction for at least 90 days in the past year, is eligible to receive a one-time cash benefit. By May 2020, 32 million registered construction workers had benefited from the scheme.

Future Impact

Leading organizations are doing all they can to set themselves up for success amidst the pandemic. They are using this time to pivot and make changes like auditing their processes, undergoing digital transformations, and restructuring their processes to be more pandemic-resistant. Because we are not yet through the pandemic, we will not fully know the impacts on projects until 2021 or 2022, but we are seeing organizations doing their best to adapt while taking care of their employees. Governments have also granted deadline leniency, for example in renewable energy projects in India, Germany, and the United States. The global pandemic will continue to strengthen these three construction industry trends: Standardization – while projects themselves are each unique, they all have things in common, so it is crucial to set up good parameters. Digitization/Automation – using technology to automate and become more efficient. Modularization – more and more work is now taking place in factories and warehouses opposed to on-site. The pandemic's long-term impacts on construction supply chains may include a shift to-

wards greater supplier diversity, use of regional suppliers, and increases in local inventories of critical components or materials, among others [5]. Despite the prevailing gloomy situation, the industry is expected to post a sharp rebound and grow by 11.6% in 2021, owing to lower base and pent up demand [6]. Growth will also be driven by investments in the National Infrastructure Plan, the newly-announced Affordable Rental Housing Complex (ARHC) scheme and investments in the industrial segment due to Indian government's push towards 'Atma Nirbhar Bharat', which aims to reduce imports and make the country self-reliant. The industrial construction sector would also likely benefit from the global shifting of supply lines from China, with the Indian market offering benefits such as alarge captive market and low cost labour ■

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NAVAKERALAM - Flood & Re-building


by GOURI R KRISHNA, S1 CEA
& AKHIL PREM P, S1 CEA

The scale of effort required to 'Rebuild Kerala' is proportional to the magnitude of the calamity. The floods that hit Kerala in 2018 and 2019 had destroyed 14,000 km of Public Works Department roads, 82,000 km of local roads and 221 bridges. By using a host of technologies, the experts accurately and scientifically assessed damages to life and property, devoid of manipulation from any of the stakeholders.

REBUILD KERALA

THE scale of effort required to rebuild Kerala is proportional to the magnitude of the calamity. The floods that hit Kerala in 2018 and 2019 had destroyed 14,000 km of Public Works Department roads, 82,000 km of local roads and 221 bridges. According to the reports by LSGD, the rains and the landslides destroyed or damaged nearly 27,000 houses and 40,000 hectares of farmland. The government's preliminary estimates put the losses at Rs 20,000 crore, but the final figures were much higher. Chief Minister Pinarayi Vijayan had talked about building a 'new Kerala' or 'Nava Keralam', but building back several areas from scrap is not as easy and simple as it sounds. The lack of funds was the biggest constraint faced by the authorities. The CM's Relief Fund collected nearly Rs 721.45 crore till August 27, besides the Centre's assistance of Rs 600 crore, which still wasn't enough.

Nava Keralam is the government's vision of converting the crisis into an opportunity by more explicitly embedding the idea of building a green and resilient Kerala. Keralites were determined not to give up in every step of the way. The Government of Kerala has embarked on an ambitious 'Rebuild Kerala Initiative' with the objective of building resilience and mitigating risk, adopting the concept of 'building back better'. The Rebuild Kerala Initiative presented a unique approach in rebuilding the State. The Government established the Rebuild Kerala Initiative (RKI) to "bring about perceptible changes in the lives and livelihoods of its citizens by adopting higher standards of infrastructure for recovery and reconstruction, and to build ecological and technical safeguards so that the restructured assets could better withstand floods in the future". Actions were taken to prepare project documents and submit them to various funding agencies via departments such as Agriculture, Water Resources, Environment, Public Works, Local Governance, Transport, Fisheries and Disaster Management. Considering the fact that the flood had destroyed the livelihoods of lakhs of people, the mitigation of damage caused to the livelihood and rebuilding of lost assets cannot be prolonged.

Civil engineers have been in the forefront in developing a safe built environment, public policy, global performance-based codes and standards and research agenda as a mitigation tool to combat various disasters. It has been also realized that despite several challenges and constraints, civil engineers had been playing a very crucial and diversified role in disaster management activities. According to the government estimate, the material losses came around Rs 25,000 crores and for rebuilding Kerala, technology was the answer. In order to meticulously quantify the extent of the loss, technological tools rooted in the science of geographical information systems were used. Geographic information system (GIS), a framework for gathering, managing, and analyzing data that analyses spatial location and organises layers of information into visualisations using 3D maps is the most relevant technological tool in this scenario. High-quality spatial data is a prerequisite to disaster mitigation and infrastructure development using GIS.

> "Civil engineers have been in the forefront in developing a safe built environment, public policy, global performance-based codes and standards and research agenda as a mitigation tool to combat various disasters."

The application of remote sensing technology, as well as image pro-

cessing, determined the exact length and breadth of roads that had been affected, the land which was submerged or inundated, the green cover that had been lost and the extent of soil erosion. As for the loss of houses, the re-survey records form the base layer and the geo-referenced cadastral map became another layer and satellite imageries as another layer in a GIS environment. For documenting the loss, an attribute table with the survey / re-survey number, the building number assigned by LSGDs, the name of the land owner, and other attributes in the department registers were entered.

By using a host of technologies, the experts accurately and scientifically assessed damages to life and property, devoid of manipulation from any of the stakeholders. While rehabilitating, the authorities seeked safer places and incentivised the replaced stakeholders for moving out from their familiar territory to unknown areas.

Civil engineers are the backbone of a nation's building and development, and their role should not be neglected in a nation's development. The engineers on their part should be proud of what they do and contribute effectively towards the growth of their country and the world at large ■ □□□□□

Machine Learning and Artificial Intelligence in Civil Engineering

Wikipedia uses the definition given by Tom M. Mitchell for Machine Learning - "the study of computer algorithms that can improve automatically through experience and by the use of data". It is considered as a part of Artificial Intelligence (AI) which is a broader domain of study striving to create human-like intelligence. The article gives a glimpse of the various applications of ML in Civil Engineering.

by UNNI KARTHA G PROF., CE

Boon or Bane for Civil Engineering?

WE have been hearing a lot about Machine Learning (ML) and Artificial Intelligence (AI). This article tries to explain what is meant by ML and AI and explores its applications in the domain of Civil Engineering.

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Ever since machines were created, human beings have been trying to make it intelligent just like himself. The early attempts were to make robots which can do things just like humans do. There has been varying degrees of success with this. The challenge has always been to make machines learn and think like humans. The advancements in digital technologies - the digital computer - has accelerated this quest to make machines that can mimic human learning and decision making. This led to the birth of Artificial Intelligence. In simple terms, AI is the broad domain that encompassess all those efforts human beings are making to create machines which can mimic themselves. Machine Learning is one way of achieving the bigger goal of making intelligence.

The first computers developed were designed to perform explicitly programmed tasks - the one we are very familiar with. Such programs use algorithms developed manually and are deterministic in nature. It is mostly run using conditional statements. In due course of time, scientists were able to develop algorithms which can help the computer to develop its own algorithm to predict or solve problems. Such programs require minimal human intervention and are broadly classified as Machine Learning algorithms.

The engineering applications of AI and ML are immense. In the recent past, there has been an explosion of application of ML in day to day life. It has become a part of our life, from personalised internet search results, advertisement suggestions on the internet, to hotel and movie recommendations to what not. There is a huge debate too regarding whether we should allow so much ML and AI in our day to day life which collect our personal data and invade our privacy. This article keeps aside these concerns and tries to focus on the engineering applications of AI and ML in the major domains of Civil Engineering.

> "It has become a part of our life, from personalised internet search results, advertisement suggestions on the internet, to hotel and movie recommendations to what not."

Structural Engineering:

A specific purpose for which AI is generally used in structural engineering is to determine engineering design parameters when testing is not feasible. There can be significant savings in the time and effort used for conducting experiments. A good example is machine learning algorithms that can predict the strength of structures. AI is also used in Structural health monitoring, damage detection, earthquake engineering, seismic design, optimisation, structural reliability and performance evaluation. Machine learning algorithms have been successfully used to pre-

dict the strength of concrete for various mix designs with good reliability. The most commonly used techniques fall under the category of Artificial Neural Networks and Deep learning. Identifying good structural forms - geometry as well as topology has also been attempted with machine learning algorithms.

Geotechnical Engineering:

Uncertainty is part of nature and Geotechnical engineers are always encountered with this problem. Soil is probably the most uncertain in terms of behaviour of all the materials civil engineers deal with. Machine learning techniques can be used to develop robust predictive models for soil behaviour and also foundation engineering parameters. Another area where machine learning is used is landslide prediction and modelling. It will be possible to use the data acquired from monitoring slopes to predict the potential for failure using machine learning algorithms. Several researches are also reported where machine learning is employed in SPT and CPT data to predict soil strength and stiffness parameters.

Transportation Engineering:

In the field of transportation engineering machine learning has been applied to areas like traffic analysis and control, public transportation management, decisions support for intelligent transportation systems, modelling aspects including behaviour, travel demand, infrastructure usage, traffic analysis, control and optimisation and smart city logistics. We can see a glimpse of traffic congestion prediction and estimated travel times in the mobile apps used for navigation. Use of AI will be a key in developing more sustainable urban transportation systems in the near future.

“Use of AI will be a key in developing more sustainable urban transportation systems in the near future.”

Construction Project Management:

Quality, safety, productivity and time - all these are the most important considerations from a construction project management perspective. AI can play a vital role in improving these aspects. Machine learning has been applied in modeling optimal use of machines, scheduling, human resource management in construction industries. Construction activities can be streamlined through integrated scheduled tasks and through the ability to transfer field report data to other applications. The data from various software that is being used can be used to develop a better workflow in construction projects. The best way to carry out maintenance and repairs of construction equipment can be determined by predicting when and where problems can occur. This can be achieved by integrating machine learning into BIM models in operations and maintenance. Another interesting application of machine learning is to predict risks before they happen which can have huge implications in the safety of project sites.

Surveying and Geographic Information Systems (GIS):

Geographic Information Systems is one area where machine learning is widely used in practice as of now. Aerial photography and satellite images are often classified using machine learning and deep learning algorithms. Commonly used software like ArcGIS and QGIS already employ machine learning algorithms. Information available forms such systems are highly useful in many aspects of civil engineering like planning, monitoring human activities, developing alternative plans in many areas like, agriculture and farming, urban planning, water resources engineering, environmental planning etc. There has been an exponential increase in the use of these technologies in recent years. Technologies and developments in the domains of Big Data and Cloud have directly improved the way data is used in GIS and allied technologies. AI powered geospatial analytics has emerged as an independent field these days.

Environmental Engineering:

Environmental Engineering is the study of human interaction with our environment. This endeavor has become increasingly data intensive in the recent past. The development of sensor technologies has made available a huge amount of data pertaining to our environment like temperature, air quality indices, water quality indices, pollution status and so on. Machine learning has enabled us to analyse such large volumes of data and use it to develop models, predict and derive useful information out of it. Many Machine learning tools are available and are very commonly employed these days in environmental studies. An interesting application of machine learning is the forecasting of municipal solid waste generation and its management in urban environments.

Water Resources Engineering:

Many applications of machine learning can be used in the areas like flood prediction, rainfall-runoff modeling and water resource management. Artificial Neural Networks are used to formulate operating rules for reservoir irrigation systems in recent years. The optimum release of water with multiple connected reservoirs can be modelled and efficiently used for optimising the water required for irrigation, power generation etc. Such problems were considered to be notoriously difficult problems to solve by researchers. Mod-

elling water supply systems for cities have also been successfully modelled using machine learning algorithms.

Conclusions

The past decade has seen AI and ML blooming and touching every walks of our life. Civil Engineering has seen numerous applications of AI and ML and this has enabled us to come out with innovative solutions. AI tools have become common and more popular and are very powerful over the years. All these facts point to the need for civil engineers to be trained in the basics of machine learning during their undergraduate program so that they can use these tools to engineer a better world for themselves. ■

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Comparison between Fatigue Behaviors of Different Types of Concrete

by ANJALI N Y, S1 SECM

Plain concrete is basically that concrete which has no or only very few reinforcements in it and is prepared by mixing hard broken stone jelly of 40 mm size with river sand, cement and water. High strength concrete are superior versions of normal concrete and their requirements involve enhancement in placement and compaction without segregation, long term mechanical properties, early age strength, toughness, volume stability and service life in severe environments. Due to their low shrinkage, low permeability and high strength, they are widely used in the construction industry.

As different the concrete, so different its behaviour

PLAIN concrete is basically that concrete which has no or only very few reinforcements in it and is prepared by mixing hard broken stone jelly of 40 mm size with river sand, cement and water. High strength concrete are superior versions of normal concrete and their requirements involve enhancement in placement and compaction without segregation, long term mechanical properties, early age strength, toughness, volume stability and service life in severe environments. Due to their low shrinkage, low permeability and high strength, they are widely used in the construction industry. Over the past few decades, several researches have been conducted on identifying ways to control the cracking that occurs in concrete and incorporation of fibrous materials into concrete proved to be a success. This idea led to the introduction of fibre reinforced concrete and ultra-high performance fibre reinforced concrete in which short discrete fibres like steel fibres, glass fibres, synthetic fibres or natural fibres were uniformly distributed and randomly oriented within the concrete. Fibres helped in controlling cracking of concrete due to plastic shrinkage and drying shrinkage and they also helped in reducing concrete permeability, thereby minimizing bleeding. Moreover, FRCs and UHPFRCs offer better performance, high durability, increased bearing capacity and toughness when compared to normal and high strength concrete. Understanding the fatigue behaviour of different types of concrete is crucial to civil engineers.

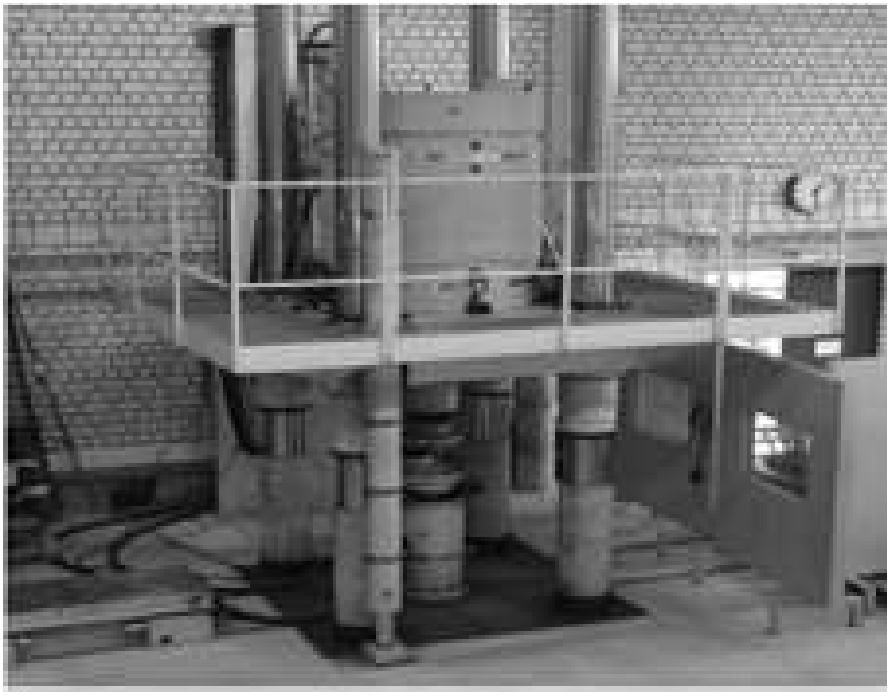
In the present era, the construction industry has gained more efficiency due to refinement in structural analysis and design practices. Likewise, there has been an increase in demands for better understanding of concrete behaviours like creep, shrinkage and fatigue. Structural and highway engineers are highly concerned about fatigue behavior of concrete.

> “Understanding the occurrence of fatigue will aid in better interpretation of existing data on concrete behaviour and it will further prove to be a major boon for the construction industry.”

Concrete fatigue is the behaviour of concrete under repeated loads, each of which are smaller than a single static load that exceeds the strength of the material. It mainly results from dynamic loading of the oscillating type. The most common method of testing done to determine concrete fatigue is flexural test and proper understanding of the phenomenon is gained by conducting experiments over long periods of time. It is also crucial to understand that fa-

tigue strength of concrete is vitally affected by its age and curing, as a carefully cured and aged concrete displays greater fatigue resistance than the inadequately cured and aged concrete. Understanding the occurrence of fatigue will aid in better interpretation of existing data on concrete behaviour and it will further prove to be a major boon for the construction industry. As it is widely known, there are different types of concrete available in the market like plain concrete, high strength concrete, fibre reinforced concrete (FRC) and ultra-high performance fibre reinforced concrete (UHPFRC). Knowing the nature of each of these types of concrete is very important to study their fatigue behaviour and civil engineers are carrying out several laboratory tests to fully understand the fatigue behaviour of the different types of concrete available.

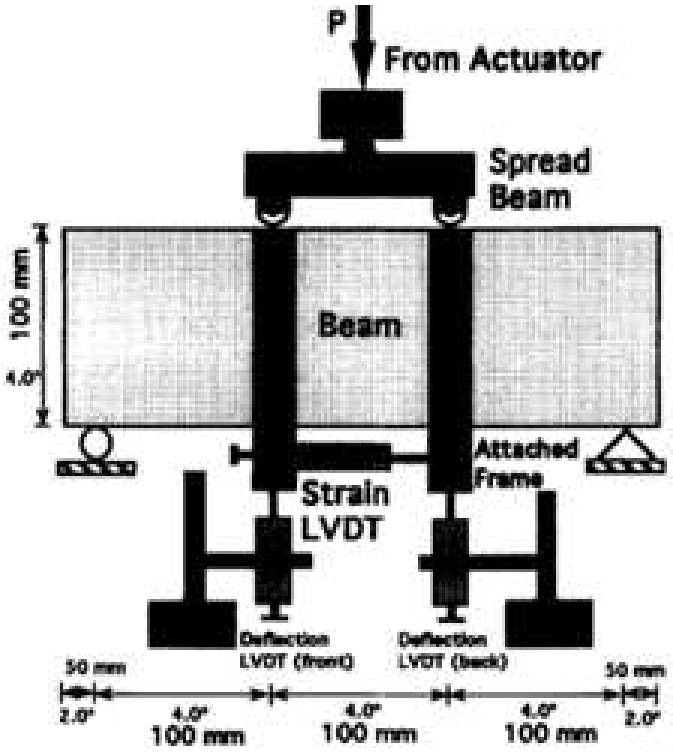
In the case of plain concrete, their fatigue behavior has significant effects on long-term deformation of concrete structures and it is mainly understood by conducting flexural tests on respective concrete specimens in laboratories. Fatigue crack growth was observed during testing of plain concrete and it was characterized by a deceleration stage where the rate of crack growth decreased as the crack grew, which was then followed by an acceleration stage where the crack growth rate increased steadily to failure [1,2]. The fatigue behaviour of high strength concrete also has been considered to be of great importance in recent years as they have been used widely in construction of long-span bridges, off-shore structures and reinforced concrete pavements. Tests were conducted on servo hydraulic universal testing machines using high strength concrete specimens having average 28 days compressive strength of 26 to 103 MPa. The axial deformations and temperatures of specimen surfaces were measured using laser and infrared sensors and High strength concrete specimens were observed to exhibit sudden failure due to fatigue and the coarse aggregate fractured to a much greater extent than in corresponding static control tests [3].



> When compared to plain concrete, high strength concrete has less fatigue life whereas FRC and UHPFRC has more fatigue life when compared to plain concrete.

The fatigue testing of fibre reinforced concrete (FRC) was conducted using a hydraulic testing machine and deflections in the test beams were measured using electromechanical transducers like LVDTs placed at adequate locations. It was observed that presence of fibre increased the fatigue life in part of the specimen where mortar cracking occurred but did not do so when bond cracking started. Consequently, addition of fibre was deemed to be unable to increase the fatigue limit of concrete [4].

UHPFRC are cementitious fibre reinforced composite materials having tensile strength higher than 10 MPa, compressive strength higher than 180 MPa and low permeability when compared to normal concrete. The concrete specimens used for testing of UHPFRC had an age of 56 days, and consisted of 66-80% blast furnace slag and 3% steel fibres having a length of 13mm and diameter of 0.16mm. Transducers were used to determine the deformations observed in the test specimen. Elastic limit strength of 8.2 MPa and strain of 0.32% was observed for the samples. UHPFRC also showed fatigue endurance limit with respect to 10 million cycles above which the fatigue stress induced significant damage leading to rather short fatigue life. The specimens subjected to a given tensile stress showed rather large differences in local deformations. This was due to variations in material properties, in particular elastic limit strength and strain hard-



ening behaviour. These variations in local deformation conferred significant stress and deformation redistribution capacity to the UHPFRC bulk material enhancing thus the fatigue behaviour [5].

The fatigue resistance varies for different types of concrete and researchers carry out compression, tension and flexural tests to determine the fatigue resistance of various types of concrete. It was understood from the tests that the compressive strength was found to be between 10 MPa to 60 MPa for plain concrete, about 140 MPa for high strength concrete, 35-60 MPa for Fiber reinforced concrete (FRC) and 150MPa for Ultra-high performance fiber reinforced concrete (UHPFRC).

At a stress level of 0.7, the fatigue life was observed to be 10603 cycles for plain concrete, 3484 cycles for high strength concrete, 180000 cycles for FRC and 10 million cycles for UHPFRC [1,6,7]. This indicates that when compared to plain concrete, high strength concrete has less fatigue life whereas FRC and UHPFRC has more fatigue life when compared to plain concrete. Fatigue life of ultra-high performance fibre reinforced concrete is over 100 times more than that of fibre reinforced concrete and 10000 times that of high strength concrete ■

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CONSILIO 2020: 'Why innovation matters'

by NEERAJA N,
ASSISTANT PROFESSOR

Consilio is a one day exhibition organised by the Association of Civil Engineers (ACE) to showcase the Design Projects of the fifth semester students. The 2020 pandemic confined everyone and everything to the virtual world and forced the department to conduct the project exhibition online mode, an innovation forced by situation. The third edition of the exhibition of the Department of Civil Engineering, Consilio was hence declared as 'the virtual exhibition'. It showcased the different schools of thought and introduced newer avenues in engineering, albeit online. The next year holds the hope for more such events that may introduce us to newer problems and their solutions

Innovation is important

ENgineering as a subject demands innovation and it is the constant drive for innovation by the human spirit that has helped build the civilization as it is today. Small design changes in existing systems have given way to efficient or better ones. This enables us to understand the relevance of engineering principles in ideation and innovation. Simple modifications can sometimes be the road to efficient and sustainable products and systems. Design Project is an innovation based design course offered in the BTech: 2015 curriculum, oriented towards this philosophy and requires students to modify or create products and/or systems which provide alternate solutions to existing problems.

Consilio is a one day exhibition organised by the Association of Civil Engineers (ACE) to showcase the Design Projects of the fifth semester students. The 2020 pandemic confined everyone and everything to the virtual world and forced the department to conduct the project exhibition online mode, an innovation forced by situation. The third edition of the project exhibition of the Department of Civil Engineering, Consilio was hence declared as 'the virtual exhibition', Consilio 2020. The exhibition also became a part of the evaluation process.

> "Simple modifications can sometimes be the road to efficient and sustainable products and systems."

The event envisaged to identify and award best projects under 5 different categories which includes the best design project, industrially relevant project, socially relevant project, innovative project and best presentation. The winning project was an 'Automatic Tank Cleaning System' which demonstrated an innovative use of syphon action. It was a simple setup using a bucket and pipe when connected to the tank would segregate the sludge into the bucket. Clean water can be extracted from the top. The project 'Power Stairs' won the industrial relevance category and ideated the use of piezoelectric energy in stairs to generate electricity and demonstrated the technology using a model. It is a step towards alternative energy and its clean generation. The socially relevant project award was given to 'Pollution Absorbing brick' which proposed a brick masonry using couplers. The polluted air entering into the coupler (placed in the masonry) gets filtered by cyclonic action and filtration. The sediments are then collected in a hopper that can easily be removed and cleaned. The winner of the innovative project category was 'Hydraulic Footpath' which proposed an elevated footpath that in emergencies would double up as a pavement by dropping to road level using hydraulic action. This facilitates the use of footpaths during emergency situations without com-

promising its utility. The videos that left an impact were 'Safety Helmet' and 'Effective Space Planning under Flyovers'. These ideas, as the title suggests, introduced topics such as the importance of safety in construction by stressing the additional features required in helmets and why commercial spaces and urban landscaping are important for a sustainable city's infrastructure.

The Institution provides support for innovative and entrepreneurial endeavours through student clubs that encourage ingenuity. Those who are interested may participate in diverse projects carried out by these clubs. Among the prominent clubs in our institution for innovation are IEDC and IIC.

INNOVATION AND ENTREPRENEURSHIP DEVELOPMENT CENTRE

INSTITUTION'S INNOVATION COUNCIL
(Ministry of HRD Initiative)

The projects undertaken covered a multitude of products and systems and several have employed concepts like clean energy, alternate energy systems, fluid mechanics, building construction and technology, built environment, sustainability and sensors. The design projects helped us in furthering both the goals of understanding the basics of engineering and pursuing innovation. The exhibition introduces us to a new line of thought and helps to explore new realms in science and technology. The next year holds the hope for more such events that may introduce us to newer problems and their solutions ■

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Construction of Concrete Shells By Pneumatic Forming of Hardened Concrete

by CATHERINE JOBY, S3 CEA

A concrete shell, also commonly called a thin shell concrete structure, is a structure composed of a relatively thin shell of concrete, usually with no interior columns or exterior buttresses. The shells are most commonly flat plates and domes, but may also take the form of ellipsoids or cylindrical sections, or some combination thereof. Cost efficient systems like pneumatic formwork helps in speedier construction and drives its widespread implementation.

Shells: Concrete for modern forms

A concrete shell, also commonly called a thin shell concrete structure, is a structure composed of a relatively thin shell of concrete, usually with no interior columns or exterior buttresses. The shells are most commonly flat plates and domes, but may also take the form of ellipsoids or cylindrical sections, or some combination thereof. Concrete shells date back to the 2nd century. The oldest known concrete shell is the Pantheon, Rome, which was completed about AD 125 and is still standing. It has a massive concrete dome of 43m in diameter, with an oculus at its center. This paved the way for many other magnificent structures like the Zeiss planetarium, Germany(2016) and the Opera House, Sydney(1973). Unlike popular structures that utilise grid arrangements and simple connections to construct the framework to build the structure on, shell structures are complex by shape/geometry and require moulds suited to specifications to be constructed. To overcome the obstacles for the popular use of concrete shells, including the production of complex formwork and necessary supporting falsework, the Institute for Structural Engineering at the Vienna University of Technology has invented a new construction called “Pneumatic Forming of Hardened Concrete”(PFHC). The PFHC has two main components:

- Pneumatic Formwork system
- Flat concrete plate

Pneumatic Formwork

The formwork used is a huge contributor to the final shape and finish of the structure and can be termed as a temporary or permanent formwork. As modern architecture began to induct complex shapes and forms, the complexity of formwork also increased. Conventional formwork systems, such as shuttering with boards are too expensive to be used for double-curved shells. Computer Numerical Control (CNC) milled molds of foam are accepted in most construction projects. They offer good aesthetic performance but they lead to wastage of material, low production speed, and high cost per element. Therefore, flexible formwork is the trend now. Flexible formwork that employs inflatable membranes is called pneumatic formwork.

> “Flexible formwork is the trend now. Flexible formwork that employs inflatable membranes is called pneumatic formwork.”

Concrete Plate

The flat concrete plate cannot be completely continuous as the transformation from a plane plate into a curved surface causes large circumferential strain. The concrete will not be able to absorb these strains. Therefore, wedge-shaped cutouts are provided in the initial flat plate. The provision given in the form of wedges can be understood from the example of a flattened orange peel. If one tries to flatten the hemispherical half of an orange peel into a plane surface, wedge-shaped gaps will open. That is, shells are not developable.

Advantages of PHC

- Like the arch, the curved shapes often used for concrete shells are naturally strong structures.
- Allows wide areas to be spanned without the use of internal supports, giving an open, unobstructed interior
- The use of concrete as a building material reduces both materials cost and construction costs, as concrete is relatively inexpensive and easily cast into compound curves.

Concrete shell structures have a large span to depth ratio to similar structures. While conventional slab-on-beam structures can be built with a span-to-effective-depth ratio of 8 to 25,the same ratio is much higher for shells. Combined with the fact that they are structurally very efficient, a wide range of uses can be thought of by making use of this feature. The factors that obstructed these opportunities before were the high cost of framework and associated labour. But now, since a cost efficient and simpler system has been developed, more structures incorporating shells can be built ■ □□□□□

Quote:

"Whatever tasks are entrusted to us, we should carry them out to the best of our abilities, with total dedication and commitment, without expecting any rewards or recognition."

- Er. E Sreedharan

by GOKUL AJITH, S4 CEA

Abatement Drive - Puzhakkal River, Thrissur

Ninety seven percent of the world's water cover is salty and definitely not potable and out of the three percent, two percent is frozen as ice caps in the poles. The interesting and sad fact is that all of humanity till date have been depending on that meagre one percent of freshwater. It is this one percent that we abuse and use like there's no tomorrow. Water bodies are humanity's lifeline and with the above scary statistics in consideration we might all reach day zero in the near future. Hence, it is paramount that we conserve, respect and maintain our sources for this resource. That's wherein this abatement drive lies-our small contribution to this cause

The kind of feeling we all have when our cell phones are at one percent charge is disturbing, let that concern be reflected in saving this useful one percent for a possible future

Pollution abatement project, a joint venture of the Water Resource Department, Government of Kerala in association with engineering colleges are working towards identifying various polluted rivers, their water quality testing, pollution abatement and future aspects regarding keeping its sanctity. FISAT Angamaly teamed up with the Irrigation Department, Thrissur to identify the pollution levels in the Puzhakal river.

This project was spread over three days and the first day was dedicated for reconnaissance which literally means to conduct the preliminary survey, that is to determine the stretches of the river and the testing points which was later put to test. Different teams were formed for creating and determining the stretch of the Puzhakal river. Google My Maps was used for marking different sampling points and also to create a path or stretch upto which samples must be taken.

Phase two was sampling of river water from the marked points. There was a strict protocol for conducting the sampling. From the collection site to the lab these samples must remain pristine with all the conditions intact, hence cooling the sample at 4 degree celsius. Certain reagents were also added for initiating certain reactions. The sampling points were separated by considerable distance so as to get a diverse set of readings.

Reagents like diluted sulphuric acid and Manganese sulphate were added to the DO bottle (Dissolved Oxygen) and was stored at optimum temperature until the sample could be tested in the state run laboratory under the irrigation department, Thrissur. The raw water from each site was also tested using a multiparameter analyser for temperature,TDS(Total Dissolved Solids),temperature, pH, turbidity etc and from human vision the water was categorised for its colour, odour, aquatic life and plant life.

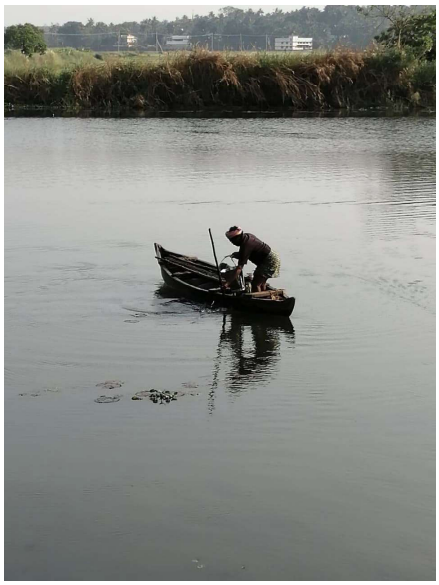
Samples showed varying values when the initial test was done on site. Some sites were totally unfit to even dip our legs and definitely showed high toxicity. This phase of the project was stretched to a third day since the number of collection points were increased so as to collect more data and also to improve the accuracy. The preliminary values were as anticipated from different locations as points near city limits were bound to have high contamination and as we moved to the outskirts the pollution level fell drastically. The latitude-longitude values of each sampling point was tabulated and was forwarded to the irrigation department.

After all the hard work and laborious testing the team was able to fall into various conclusions. The pol-

lution load in the river was found to be higher than the previous report. This is not a surprising find as we humans have never decreased the load on this planet and have only kept burdening the ecosystem.

A few drains which join the main river stretches are found to be highly polluted and are a potential source for pollution in the future. Those polluted water definitely came from the city establishments and hence a comprehensive study into the entire river basin is suggested considering the fragile ecosystem and biodiversity in the Puzhakkal river basin. A comprehensive study into the pollution due to agricultural activities was also suggested. Establishing a flow monitoring station in the stretch to estimate the environmental flow to be maintained was found to be the need of the hour.

Water is an indispensable asset and will always be ahead in time. Slowly we might even see wars being fought just for this colourless, lifesaving and omnipresent liquid. This asset will always be there for our use but not for our misuse.



Let our future generations not stand witness to the horrible water crisis that might dawn upon ■ □□□□□

Education Industry-Changes & Impacts


by SINCHAN DUTTA, S3 CEB
& GOURI R KRISHNA, S1 CEA

The outbreak of coronavirus led to several crisis all around the globe which brought the whole planet to a pause. All sections of society had several implications on mental health, resulting in psychological problems including frustration, stress, and depression.The closure of education institution was a necessity to avoid spread of virus and online learning was thought to an alternative to it.

PoV- Teachers and Students

THE outbreak of coronavirus led to several crisis all around the globe which brought the whole planet to a pause. All sections of society had several implications on mental health, resulting in psychological problems including frustration, stress, and depression. A survey conducted by Delhi Technological University identified the following as the impact of COVID-19 on the students of different age groups: time spent on online classes and self-study, medium used for learning, sleeping habits, daily fitness routine and the subsequent effects on weight, social life, and mental health.The closure of education institution was a necessity to avoid spread of virus and online learning was thought to be an alternative to it.

Online learning was implemented in the educational industry which was thought to be the better option during the pandemic. But such a large-scale implementation had its benefits and drawbacks. The positive influence of pandemic on education is the instant introduction or integration of new technologies into the system. However the negative effect of the pandemic will be presented covering mostly from the perspective of learners. Limited class interaction and inefficient time tables significantly affected the satisfaction levels among students. The peer-to-peer impact in the school environment motivates individuals to work hard and learn social skills, which may not be possible in an online setting. Moreover, the biggest challenge for online learning is the requirement of efficient digital infrastructure and digital skills for both students and teachers. The students from the less privileged backgrounds have experienced larger negative impacts due to the Covid-19 outbreak. Reduction in family income, limited access to digital resources and the high cost of internet connectivity have disrupted the academic life of the students. Globally, 3 out of 4 students who cannot be reached by the remote learning policies come from rural areas and/or belong to the poorest households.

Further, it has been observed that many students have complained that the online education system has created a stressful environment for them in their home as the active observation of the teacher on the student, the workload to be completed from the home and the absence of friends who help them to crack difficult subjects in an environment that is not conductive for them to study in peace.

But this is not all, among the many casualties of the coronavirus crisis is the traditional classroom. While online courses have existed since long before the pandemic, they served a different purpose, giving learners access to modules and subjects they wouldn't have otherwise, or supplementing what individuals were being taught in physical classrooms. The lockdown in India (and shutdowns in other parts of the world), however, have made online classrooms the primary source of educational instruction for students and teachers.

> “Limited class interaction and inefficient time tables significantly affected the satisfaction levels among students.”

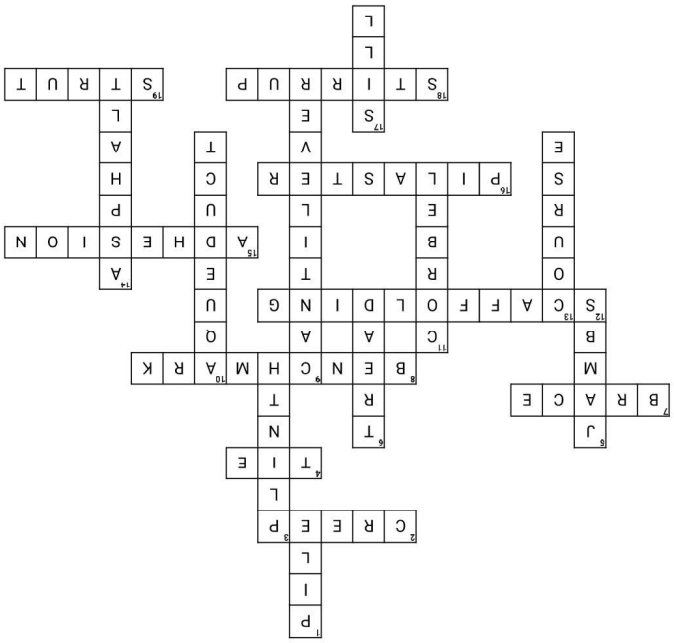
The teachers faced more problems than students as they have to come up with innovative interactive ways online to get students engaged in the current education process. The teachers had to give up their personal space and time to clear doubts and

help students which was earlier restricted mostly to school or college hours. Earlier, that was enough time as it included face to face interaction and hands on methods which are considered more effective. The teachers from technical background are facing problems in conducting online lab session as well, even though there are plenty of virtual lab methods available. Despite the fact that nothing can come close to hands-on sessions, it has become the only means of study possible in the current scenario. Inspite of this set back, hats off to them for engaging with us by sacrificing their private time and helping us to grow as responsible students.

> It has democratised education and helped us realise the possibilities in virtual learning.

Given the timeframe of the outbreak till today, our lives have drastically changed and we had to adapt to a new way of living which certainly became the new normal. Students and teachers had to switch to a virtual mode of education. Conventional lab sessions became virtual lab sessions in many cases. But also, in these harsh times many students got time to attend online webinars of their respective field of studies and gained knowledge. It has democratised education and helped us realise the possibilities in virtual learning. This was a brief scenario of the educational industry in the time of the pandemic and we hope that through successful vaccination drives, conventional mode of teaching can resume ■ □□□□□

Solution to the crossword puzzle on page 24.




by
GOPIKA SUDHEER, S2 CEA &
AISWARYA K S, S2 CEA

3D Printing technology

Three dimensional printing is a promising new technology to erect construction objects. Around the world, new prototype constructions are made by using this method. Integration of Building Information Modeling with the 3D printing building technique are mentioned in comparison with the traditional construction techniques. Houses can be built based on the material life cycle, which can be used in evaluating the environmental sustainability of building materials.

Latest trend in Civil Engineering in India

Technologies are increasing day by day in every sector. The construction field has also changed and given rise to new trends. 3D printing technology to construct buildings may increase sustainability. This article presents the new technology of 3D printing of buildings for sustainable housing in the future. Three dimensional printing is a promising new technology to erect construction objects. Around the world, new prototype constructions are made by using this method. Integration of Building Information Modeling with the 3D printing building technique are mentioned in comparison with the traditional construction techniques. One of the most popular formats for sharing such models is STL format common and it has been accepted by many proprietary softwares. Houses can be built based on the material life cycle, which can be used in evaluating the environmental sustainability of building materials.

What is 3D printing?

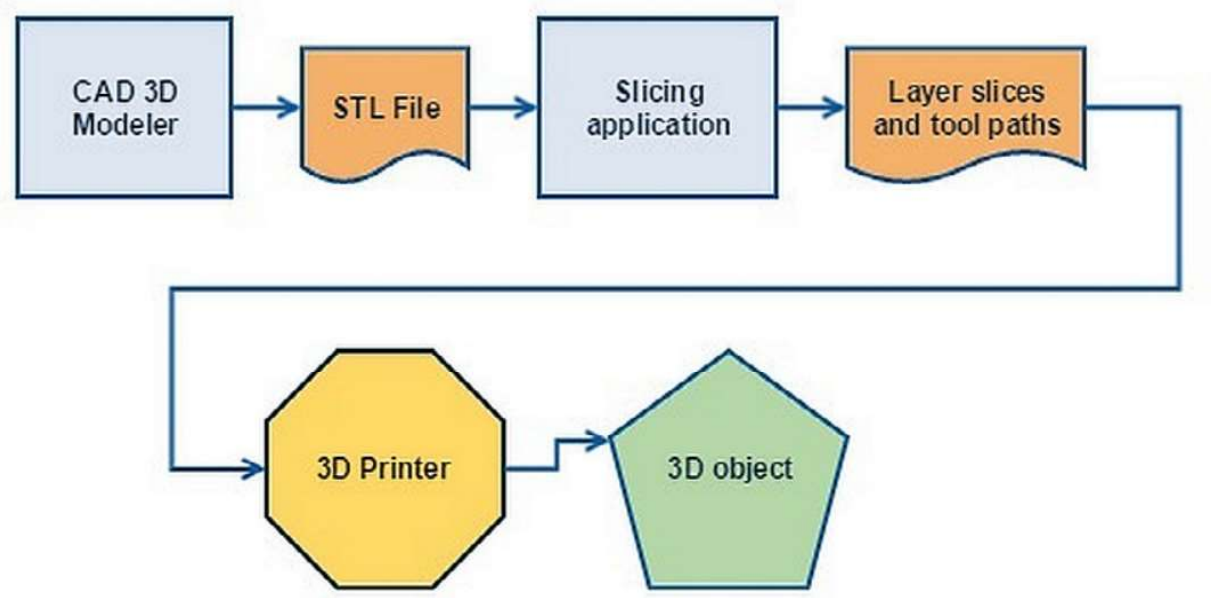
A very simple definition to this question can be given as "3D printing is a process by which physical objects are created by depositing materials in layers based on a digital model". All 3D printing processes require software, hardware, and materials to work together. The first 3D printer was invented in 1983 by Charles W. and over the last decades, 3D printing has become one of the fastest-growing technologies. Over the years, 3D printing crept into everyday life, and these printers became commonly used in industrial practice. As the technology continues to grow, 3D printing technology can be used to create everything from prototypes and simple parts to highly technical final products such as airplane parts, life-saving medical implants, automobiles, and even artificial organs using layers of human cells. There are more ways to use this technology.

The 3D Printing Technology and Materials Information

The starting point for any 3D printing process is a 3D digital model, which can be created using a variety of 3D software programs. For makers and consumers there are simpler, more accessible programs available or scanned with a 3D scanner. The model is then 'sliced' into layers, thereby converting the design into a file readable by the 3D printer. The material processed by the 3D printer is then layered according to design and process. Material is a crucial factor in determining the structure's quality, the ability of architects and strength of designs and machines is also important. 3D printing services have provided a faster, cheaper and more sustainable alternative of construction to the world. Additive manufacturing is all about the material. Depending on its application, the type of material used for 3D printing changes. The material designed and used in 3D printing technology for construction depends on three interpenetrating factors: raw materials, methods of application and methods of production. For structural applications, basic materials like cement, sand and other additives are required. However, while 3D printing, some extra variants are also used.

Preparation of computer models for 3D printing

An important element is preparation of computer models for the parts to be manufactured. Fortunately, the level of 3D computer graphics both in terms of software and hardware makes it possible to build such dig-



ital models without much difficulty. It can be done using many commercial as well as Open Source software packages. Firstly, a model is prepared in a 3D modelling application. Then it is exported to a file in a common 3D data exchange format. For the 3D printing industry the most popular format is STL (Stereolithography) . Next, for the majority of 3D printing technologies the saved data is processed to decompose the model into slices. This results in a set of 2D contour lines that are further processed to generate control commands to position printing head or laser beams.

What Does "STL" Mean?

An STL file stores information about your 3D model. The format represents the raw surface of a model with small triangles. The more complex and detailed the structure is, the more triangles will be used to represent the model. Most 3D printable models you can find on the internet are in the STL file format. The existence of this ecosystem, combined with STL-based software iInvestments made by 3D printer manufacturers have given rise to a large user base that's heavily invested in the format.

Slicing

In the slicing step, the geometric model is intersected with parallel planes to obtain the contour of each material layer.

Combining layers

Combining different polymers in different combinations per layer of 3D printed material is leading to the development of an entirely new palette of materials. We are all intuitive about colors and know that mixing different colors gives you different shades. However, the ability to combine multiple materials, hard and soft, transparent and colored–layer by layer–to give rise to a huge range of new materials and properties, is not something that is currently thought about.

Benefits offered

- Onsite or factory applications.
- Fewer resources are required and less waste is generated.
- Reduced transportation costs if products are printed on-site.
- Potential to create more efficient and interesting designs that conventional techniques cannot.
- Lower labor costs.
- Reduced cost of customized design.
- Reduced health and safety risks.

Challenges and Future

It is more expensive than conventional construction due to the high cost of a 3D printer. The lack of familiarity in the industry with 3D printing technologies and applications is also a big challenge to be solved. Currently, a limited number of materials have been used, although experimentation is underway with printers capable of using multiple materials to produce more complex assemblies. The 3D printers can be large and therefore, difficult and costly to place on-site.These are currently slow compared to conventional construction, although they can be operated 24 hours a day. Technology of 3D printing is still young and presents a lot of limitations, but there are high expectations and hopes for the future of 3D printed buildings and building components.

There are different technologies for 3D printing systems. In the last decade, engineering research teams have been experimenting with using 3D printing to build components of buildings and entire homes. However, it is hard to imagine so far that 3D printing could replace traditional

construction in the next few years. It is more possible that both technologies will be present in the industry and 3D printing may be developed along with the traditional techniques, supporting them, especially in the case of more sophisticated building projects ■

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□□□□□

Tvasta Manufacturing Solutions, a start-up founded by alumni of IIT Madras, has made what it says is India's first 3D-printed house. Its first structure, a single-storey house, is 600 square feet and it has been constructed using indigenous concrete 3D printing technology and in collaboration with Habitat for Humanity's Terwilliger Center for Innovation in Shelter. This technology can help build a house in five days, the institute said.
Picture down below

Contest alert:

To participate in the contest on cover page, identify the object in the picture. 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 laboratory equipment used widely for determining strength.

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.

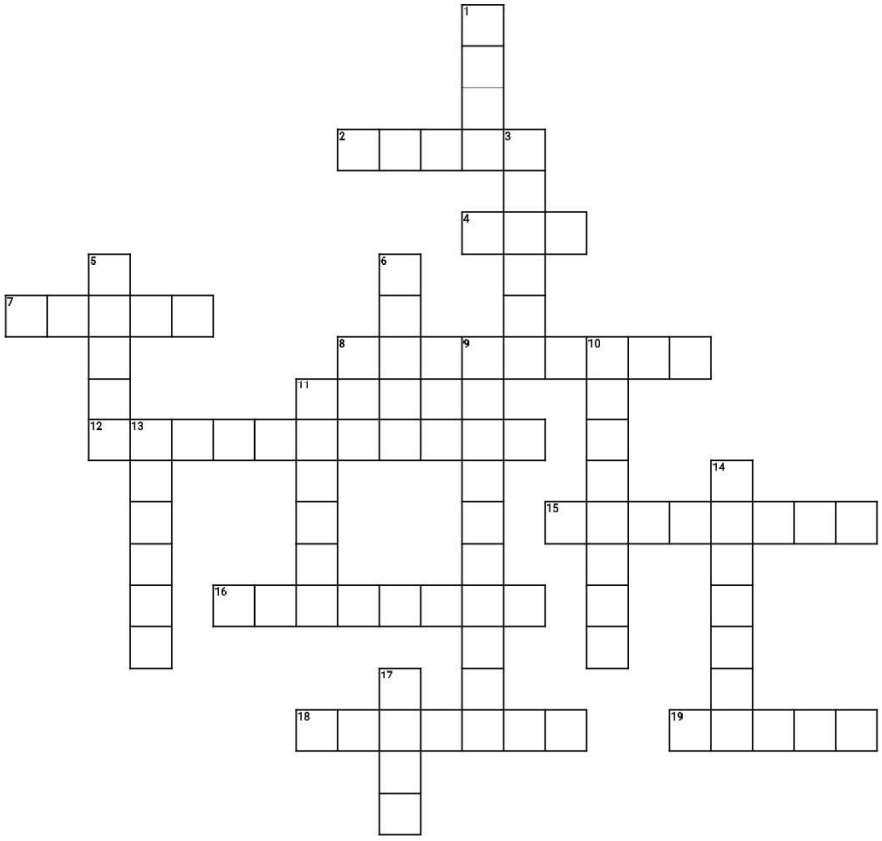
Can you get it right?

What is the theme of World Water Day-2021?
When is it celebrated?
What is the expansion of: FRC, UHPFRC, PCC, LVDT
Pneumatic formwork employs " " membrane.
Pollution Absorption brick won the prize:

Answers given below:

22 March
"Valuing Water"
Plain Cement Concrete, Linear Variable Differential Transformer
Fiber Reinforced Concrete, Ultra High Performance Fiber Reinforced Concrete
flexible
Socially relevant project

CROSSWORD



Across

2 Time dependent deformation due to load

4 The transverse reinforcement provided in a column is called

7 A structural member used to stiffen framework

8 A relatively fixed point whose elevation is known and used as datum for levelling

12 The temporary framework used when the height above the floor exceeds about 1.5m, usually made of timber, is erected close to work, to provide a safe working platform for the workers and to store materials.

15 The tendency for dissimilar particles or surfaces to cling to one another

16 A right-angled columnar projection from a wall or a pier is

18 The transverse reinforcement provided in a beam is called

19 Brace consisting of a bar or rod used to resist compression

Down

1 A column that is driven into the ground to provide support

3 The projecting course at the ground floor level is known as the

5 The sides of an opening of a window or door

6 The horizontal upper portion of a step

9 A projecting horizontal beam fixed at one end only

10 A conduit that carries water over a valley

11 The projecting stone which is usually provided to serve as support for roof truss, beam, weather shed etc

13 A layer of stones or Bricks is called

14 A natural or artificial mixture in which bitumen is associated with inert material matter

17 The bottom surface of a door or a window opening is called

Created by Catherine Joby, S3 CEA

Focus on Excellence

ASCE
STUDENT CHAPTER
Federal Institute of Science and Technology

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ACE
BUILDING BLOCKS OF TOMORROW

Department of Civil Engineering

Federal Institute of Science and Technology (FISAT)

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