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CONSTRUCTION PHILOSOPHY

Vol. No. 02 Issue No. 1-2 | Kochi | January/February 2020-21

A new beginning

For the past one year, the world was literally struggling for breath as the Covid-19 pandemic laid waste national economies and millions of enterprises and left billions out of employment. In India, nearly 1.10 crore people have so far been afflicted by the dreaded disease and 1.55 lakh have lost their lives. For every nation, enterprise and individual, return to normality is a big challenge. Nations are throwing caution to the winds and going in for massive financial infusion to revive their economies. The several vaccines are here, but even with the vaccines, the world is likely to make only slow progress and life as we all knew it in the pre-pandemic days is likely only a year or two from now.

Like other segments of the national economy, the construction sector also suffered heavily on account of the pandemic. With nationwide shutdowns and stringent measures taken by the authorities to prevent the spread of the disease, activities in the labour-intensive construction sector came to a grinding halt by April 2020. Financials of enterprises and individuals in the industry sustained a massive dent that is unlikely to get repaired in the foreseeable future. Still, with the national economy reopening, things are looking up.

Two developments have brought some relief to the harried industry—the first, the big infrastructure push that Finance Minister Nirmala Sitharaman has promised in her Budget for 2021-22, and the second, the ICRA projection that stability with return to the construction sector in 2022. The Finance Minister has raised the allocation for capital expenditure in planned for 2021-22 to ₹5.54 lakh crore from ₹4.39 lakh crore. The construction sector will recive a big boost with this. Let us try to make the best use of this budget bonanza.

Together let us raise our voice for quality

Send your articles/feedback to editor@constructionphilosophy.com

Nebu Abraham
Editor

CONVERSATION

Go hi-tech, go green

P. Surya Prakash, Past President, Pre-Engineered Structures Society of India, tells **Nebu Abraham** that the construction industry should adopt precast technology and various other greener options in a big way to tackle the emerging challenges.

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January/February 2021

COVER STORY

Massive capex push for growth

The massive hike in capital expenditure proposed in Budget 2021-22 is a boon for the construction sector, feels **K. C. Suresh Kumar** reviewing the Budget for this special January-February issue of CP. Also reactions to the Budget proposals from industry veterans.

'Stable days ahead'

Tough times might be over for the construction industry for which the outlook is 'stable' for the coming fiscal, says ICRA, the premier rating agency.

Forensic Civil Engineering

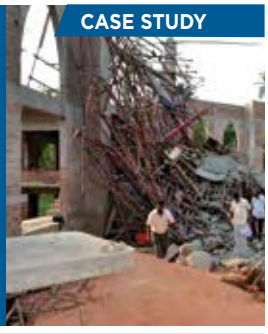
Much to learn from failures

With nearly five decades of experience as a civil engineer behind him, **B.S.C. Rao**, former National President, Association of Consulting Civil Engineers (India), says that forensic civil engineering needs to grow in India as a specialised branch of study.

Lessons from a Church collapse

CASE STUDY

What led to the 2013 collapse of the under-construction central structure of the St. Augustine's Church in Kochi? **Sai Lakshmy** scans the findings of an expert panel led by **Er. Anil Joseph** that went into the causes of the collapse.



Materials world

Ramco takes the 'green' path

Prem Shankar, CEO, Ramco Industries, says why Ramco Hicem fibre cement products are the right choice for all who care for future generations.

Innovation Zone

Leading the way

Asween Santhosh takes a look at the 10 innovators from different parts of the globe, including Pragathi Foundation in India, who have made it to the roll of honour of the World Bank for innovations.

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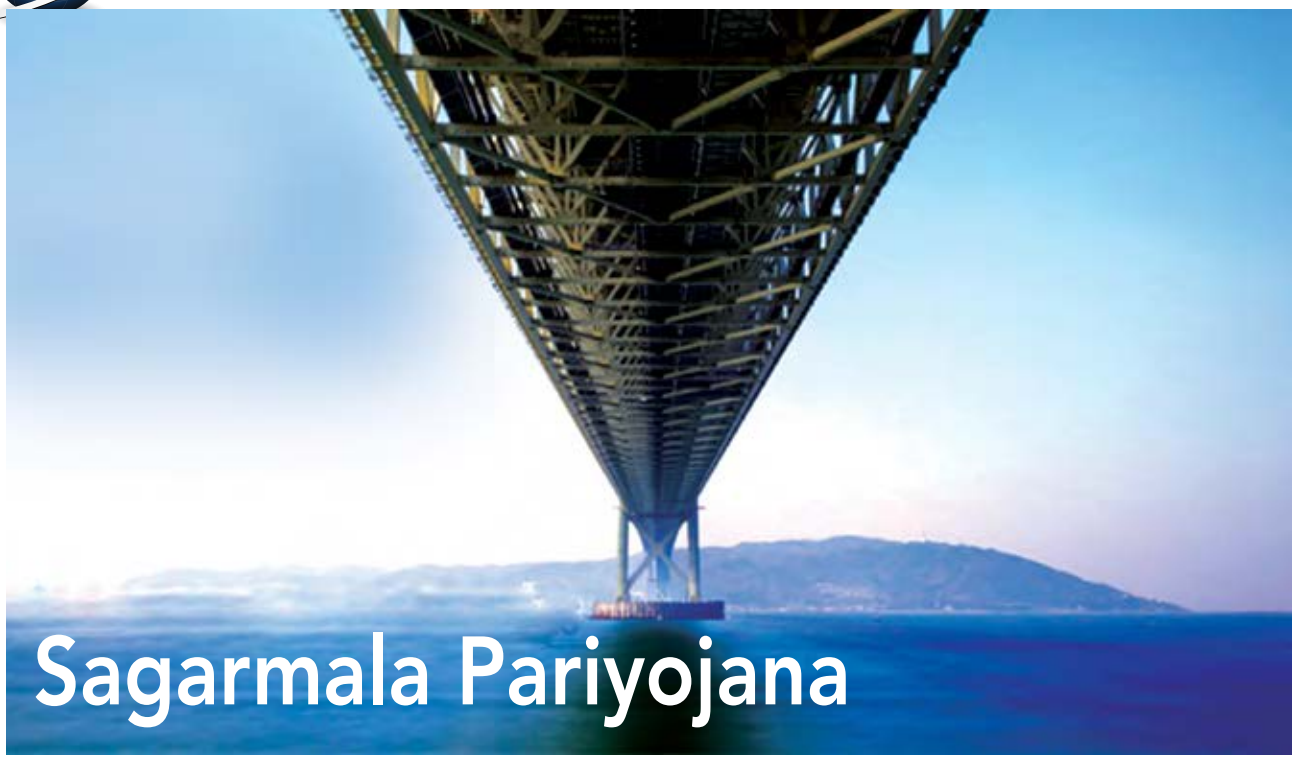


Sagarmala Pariyojana

Sagarmala Project, launched by the Government of India in 2015, is making good progress with works on 100 projects being completed. The projects completed till now are valued at ₹160 billion. Another 212 projects worth ₹2.5 trillion are still under construction.

Sagarmala is the flagship project of the Ministry of Shipping to promote port-led development in the country by exploiting India's 7,517 km long coastline, 14,500 km of potentially navigable waterways and its strategic location on key international maritime trade routes.

Under Sagarmala, 577 projects are proposed to be taken up at an estimated investment of approximately ₹9.2 trillion or US$130 billion.

Bharatmala Project

Bharatmala Pariyojana is a new umbrella programme for the highways sector that focuses on optimizing efficiency of freight and passenger movement across the country.

The government envisages construction of 34,800 km of highways at a cost of about ₹ 5.35 lakh crore under the ambitious Bharatmala Pariyojna. According to the Ministry of Road Transport and Highways, 2,921 km of highways have been constructed so far under the Bharatmala Pariyojna. A total of 322 projects having a length of 12,413 km have were awarded till August, 2020.

Mumbai Trans Harbour Link

Work on the the Greater Mumbai Trans Harbour Link, which is also known as the Sewri Nhava Sheva Trans Harbour Link, is progressing at a fast pace. When completed, the 21.8 kilometre freeway grade road bridge connecting Mumbai City with Navi Mumbai would be the longest sea bridge in India.

The road will be linked to the Mumbai Pune Expressway in the east and to the proposed Western Freeway in the west. The sea link will contain a 6 lane highway, which will be 27 meters in width, with two emergency exit lanes, edge strip and crash barrier. The project is estimated to cost ₹14,262 crore (US$2.0 billion).

The MMRDA estimates that 70,000 vehicles will use the bridge daily. The 16.5 km sea bridge and 5.5 km of viaducts on land on either end of the bridge also includes a 180 meter long steel span, which is the longest steel span in India.

Gujarat-Gorakhpur Gas Pipeline

The proposed Gujarat-Gorakhpur Gas Pipeline will connect 22 LPG bottling plants of the oil marketing companies in Gujarat, Madhya Pradesh, and Uttar Pradesh. The pipeline becomes important from the point of cost saving, given that bulk of the current demand for LPG is being moved by road transport, which is expensive compared to pipeline transportation.

The project, being executed at a capital cost of ₹10,000 crore, will be funded with Rs 6,730 crore of debt and ₹ 3,360 crore of equity. This will be the biggest LPG pipeline in the country. GAIL currently operates a 1,415-km line from Jamnagar in Gujarat to Loni. The line carries 2.5 million tons of LPG annually.

Setu Bharatam Project

Setu Bharatam was launched by Prime Minister Narendra Modi on 4 March 2016. Being implemented at an estimated outlay of ₹102 billion(US$1.4 billion) it aims to make all national highways free of railway crossings. As many as 208 rail over and under bridges (ROBs/RUBs) would be constructed at a cost of ₹20,800 crore as part of the project.

What next for construction industry?

GO HI-TECH, GO GREEN


P. Surya Prakash/ Nebu Abraham

Construction industry should adopt new and greener technologies to face the emerging challenges. With the Covid19 pandemic forcing people to work from their homes, civil engineers must get ready to retrosit work and residencial spaces which have merged into one, says P. Surya Prakash, Past President, Pre-Engineered Structures Society of India (PSI), and mentor to several generations of construction engineers in the country.

Covid-19 pandemic has dealt a heavy blow to the construction industry. What would be the ideal strategy to meet the emerging challenges?

Our troubles began when the workers began the large-scale migration from the worksites to their homes. That was around April 2020. The number of workers on sites came down to roughly 30% of their usual strength by August-September. That forced most of us to turn to technologies that would facilitate construction with reduced workforce. Now, that was a good development. But the trouble with us is that we would forget a problem and its solutions once the problem vanishes!

In March-April we decided we'll convert to pre-

cast. We did all the work. Everything was ready for launch by the time Covid broke out and labour started moving homeward. Then again client decided to go to the comfort zone. Again, there are a lot of the apprehensions about the office space absorption post-Covid. We have already seen many companies cancelling agreements and moving into smaller spaces. Actually. It's almost like 20% the size of their former offices. Most companies gone in for 25% on-site work and a 75% work-from-home and we have all heard Google announcing that they're finding more productivity through work from home and they have reduced the working days from five to four.

So, work from home is going to be the new norm. The construction industry has to brace for retrofitting the workspaces and residential spaces. What I foresee is the possibility of every residence having one virtual office or even two, if both wife and husband are working. This is the new reality. The construction industry—and the real estate segment, in particular—must work towards converting these challenges into opportunities. Now spaces are going to be mixed—not entirely residential nor purely workplace. It's an opportunity in these challenging times.

Now that you have spoken about labour, is it not time we revisited our current labour requirements and practices?

Actually, we have to go for pre-engineering and use new technologies. As early as in 2007, we had conducted a workshop on 'Mechanization in construction. For example, earlier we had natural stones--marble and or granite—flooring, which were labor intensive. Now we have switched to vitrified tiles. You get all kinds of designs you like and that reduces the time needed to lay the tiles and that means lesser number of workers as compared to laying of natural stones!

Next comes paints. Today, since we do the concrete finish, the walls can receive epoxy kind of self-levelling paint and then the paint overcoat looks like tiles or marble. This is the shift. This is pre-engineering. Also we have seen in-situ concrete, which requires only 60% of the labour as compared to the past. Now we are talking about precast construction and precast concrete, were you will require much less labour. Again, we are talking about 3D printing. It may take a long time for 3D printing to become a reality for regular usage, but before that we should switch over to precast which will reduce the number of men needed to do the work.

There are so many engineering colleges today that we are getting less people to do physical verbal labour or skilled labour. We are getting more engineers. So in our work too, we should shift from laborious work to engineering work. As I have always said, we must convert blue collar jobs into white collar jobs.

There is a widespread feeling that the quality of constructions have fallen sharply over the years. Do you think this is true? If so, who or what is to blame?

I am personally facing the problem of quality in almost every project. Dampness, leak and

"We should go in for more automation, precast and other new technologies to reduce the labour component, save on time and money and to ensure optimal use of resources"

paint that peels off become a common thing in structures being built today. This is because there has been a dilution in standards of quality and technical evaluation. Very often is because of unskilled persons entering the worksites and not performing to a certain standard. What we have today is poor design and deailing, poor workmanship and poor supervisory skills.Are there any modern methods to build retaining structures in clayey soil in place of the conventional concrete and steel constructions?

Can adoption of modern technology help improve the quality of constructions?

Yes, because once we go for modern technology, the process will become well-defined and we will be less dependent on manual supervision and execution. This will automatically ensure quality. But there is a danger. There can be dilution of standards in automation too. That must be taken care of. I have founded a society called Pre-Engineered Structures Society of India, where we are trying to develop a handbook for quality benchmarks for the construction industry.

Wouldn't adoption of new technologies result in large-scale displacement of labour resulting in social unrest?

No, no! Actually that is a misconception. Once the automation happens, we would create more process jobs and jobs in quality assurance. As I said earlier, we will convert the blue collar jobs into white collar jobs. There will definitely be more employment because, with pre-engineering, we will spend more man-months on engineering and developing products and customizing them. Ultimately, people will get better quality and reliable delivery at a fixed cost. We can also reduce lot of wastage in terms of man and woman hours and in terms of resources. Also, we will be able to reduce consumption of materials. And, there will be greater safety for the workers.

There is already research going on in areas such as fuzzy logic and neural networks. So you can predict the outcome of a project depending on construction method and reliability of the vendor. Right now, you have to live with the local small contractor who doesn't have quality standards. With pre-engineering, you'll be dealing with benchmarked services. It will automatically bring in more rational way of estimating the partial safety factor. So that's going to be the future and that

will automatically encourage better quality and better technology construction because you'll reduce material and manpower consumption.

Research is going to be a very important challenge...

Yes. Natural resources like cement and steel, aggregates—whether coarse fine—or the sand we use for making fly ash, are going to be in short supply. So, we have to develop new methodologies and go in for green building norms and sustainable development. We have to come up with reusable and recyclable materials in the construction industry. We must minimize material consumption by using new technologies.

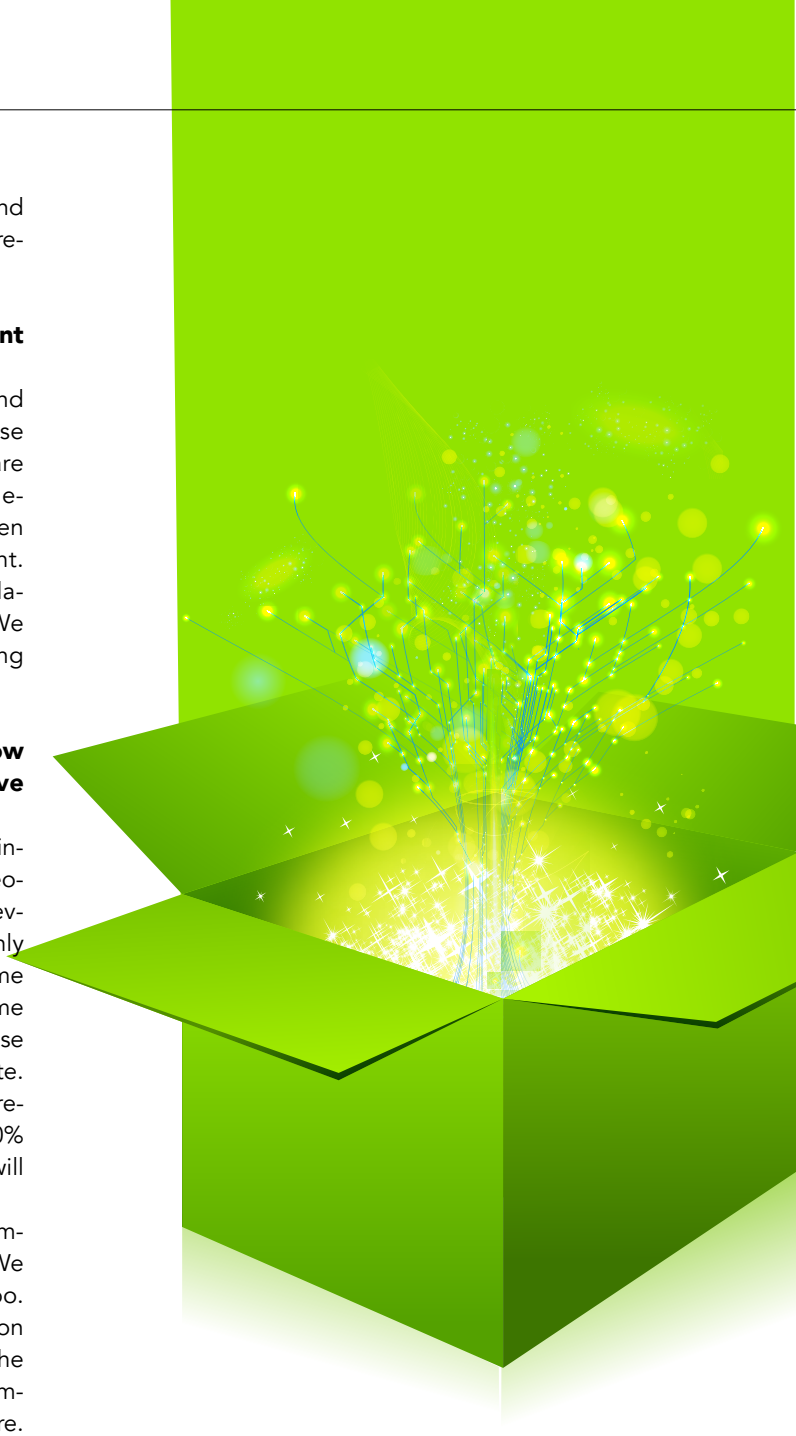
Is sustainability an unattainable goal? How can modern construction industry move towards sustainability?

Earlier, when I used to speak about sustainability or green building technology, people used to say that it will cost more. But now everybody knows that sustainability will actually only cost less. I will tell you my own experience some 20 years back. I converted a conventional dome structure, meant to be built in steel, where we use the steel flat roof with a fibre reinforced concrete. I didn't use steel reinforcement. Instead, I used recycled steel girders and profile deck. I saved 50% of the roof cost. If you use recycled content, it will automatically reduce the cost.

We must also use materials like bamboo. Bamboo is a reusable and sustainable material. We have to develop structural systems with bamboo. Steel is a very good material except for corrosion and fire resistance for which now we have the solutions. We have to come up with the fibre composites which will be stronger. Like carbon fibre. Carbon fibre is almost six times stronger and sustainable compared to steel. These are all things that are happening already. They will take more and more space in construction as we move forward because natural resources are depleting fast and definitely people have to switch to new technologies and new materials.

How can practicing professionals meet the challenges rising every day in the construction industry? Should we go for skill overhaul to meet these challenges?

Covid-19 has brought in this culture of online learning and professionals can do



"Pre-engineering is the way forward, both to reduce wastage and to have a total perspective of the project from the word go."

so during their leisure time. That should help in professional development and upskilling. That is the buzzword today and lot of knowledge is available now on YouTube. We professionals do our work, but the end user comes to us with inputs gathered form the internet. So, if we do not remain updated with that knowledge, we will go out of business. One should spend at least one hour online every day and update oneself in different aspects of our work. There are recorded webinars, YouTube lectures, etc. You browse for a few minutes in LinkedIn every day and lot of information will come to you from across the world. So it's very advantageous for professionals to stay updated.

According to a recent survey, almost 80% of the engineering graduates do not have the necessary skillsets to take up employment or become professionals. What is the way out?

The way out is through internships and apprenticeships. We cannot expect civil engineering graduates to be on the job directly. Very few can do that. One must work for at least one year to learn the ropes. It takes at least five years for a civil engineering graduate to become a real engineer. One should not worry about the pay you get in these five years. During the first five years in my career, I never knew when I could sleep, eat or go home. But those years made me what I am today. So, I always ask my colleagues, if you have the choice to work hard from 25 to 30 years or 55 to 60 years, which one would you choose? It's always better to work hard when you are young and have energy.

How can that happen when the quality of engineering education has fallen sharply?

Thanks to again Covid, students are now used to learning online and attending classes online. I am management faculty in an engineering college. During the past 34 of my teaching years, I have been taking offline classes. But, when I started teaching online I have found that my efficiency in sharing knowledge and passing on information has grown 40%. What I used to teach in 100 minutes in a physical class, I am now able to cover online in 60 minutes. The students also have the advantage of going back to my recorded lecture again to understand me better. Also I am able to share a lot of information through screen sharing, whether it is codes or manuals. I can show them quickly and it is very advantageous for both me and the students.

The students also have the option to learn from anywhere. Average attendance in a class is 75%, which to me is very low. I would always say that the attendance has to be 100%. No compromise on that. Earlier, once we were out of college, we used to have internships during summer vacation. Especially for civil engineers, one year internship is very essential. You call it apprenticeship or internship or training or whatever, a civil engineer should never expect to get selected from the campus and join work earning a five-figure salary and all that. We have to learn first. We should have the practical exposure and we should work hand-in-glove with experienced professionals. Then alone will we be able to grow in this profession.

I always compare a professional to natural stone and a non-professional to vitrified tiles.

Vitrified tiles initially will glitter, but as it is used, it will lose its shine whereas the natural stone will get polished and will have longer life as it is used more. Get trained as an intern or work as an apprentice and then learn the subject. And then, we have to work hard. There is no alternative to working hard and learning everything. No, we cannot be specialists in a few areas. An engineer is expected to know everything about our line of business.

A recent survey states that 80% of the professionals are unemployable...

We had one-tenth of the engineering colleges we have now during the 1990s. And, out of that, only 10% colleges were offering civil engineering, and these were mostly universities and government-run colleges. Now the number of IITs itself has grown fourfold. In place of the six IITs earlier, we have 24 IITs today. And that means there has been an exponential increase in the number of engineering colleges and those offering civil engineering. Now, where do you get the faculty to teach in all these colleges? The UGC has given one faculty for every 20 students. I feel that's not adequate. That's only the bare minimum, but many colleges manipulate even that number. I have seen one college with 480 students intake every year making do with five faculty members, out of which only one has a doctorate and the other four have one or two years' experience after MTech. This is the reality. May be hard to digest, but that is the fact. So, how do you expect quality students if you don't have quality faculty, leave alone the necessary facilities in the college.

So, what is the solution? These colleges must engage with the industry. They must identify industry people with calibre and quality to work as faculty, if necessary, online. The curriculum should be attuned to their expert lectures so that the students will get motivated to work hard. Don't wait till their final year to give them industry exposure. They should be exposed to Industry from the first year with field visits—to construction sites, design offices, and green engineering manufacturing facilities. Then alone will we be able to bring down the 80% you mentioned to 20% unemployment. We have to increase their capacity, upgrade their skills and keep them motivated. That is what we must do.

Do you think country's land management policies need major overhaul?

Of course. We need mixed use development in both our urban and rural areas. Given the changes brought about by Covid, work is happening in both urban and rural settings. So, we should adapt our zoning norms to the new scenario. Town planning must aim to decongest cities and this will be possible only if you encourage the mixed use developments in the outskirts of cities. We have to create the micro clusters where you will have recreation, education commercial offices and social infrastructure, all in one place. These clusters can be connected with public transport. Do not make it rigid. Keep it flexible. Let the master plan be approved cluster-wise and then have a macro level master plan for the city. That will be more sustainable. In fact, I have done some work on this. There should be more rational and scientific ways of deciding this factoring in future growth projections. Then alone will we have sustainable cities.

Reports about structures that fail to meet safety standards are all over the place. How can we address this?

I will just give you a small example of an accident in Singapore. A child fell down from a balcony in an apartment. They found that accident occurred because that though the balcony of the apartment had standard railings, they were not spaced in such a way as to protect little children. The administration immediately revised the building code and issued notices to all the societies to retrofit the railings of the balconies as per the revised code. Within one month, everybody complied. In India, the code change itself will take two decades. IS 456- 2000 is still under revision.

When earthquake fears mounted, IS 1893 got revised in 2002. In Japan, for example, when they have identified that there is a vertical acceleration in the earthquake, they revised the code standard and they've retrofitted all the buildings as per the revised code. When I visited Gujarat the after the Bhuj earthquake, I found that 90% of the buildings were not designed to withstand an earthquake. So this is a very bad state of affairs. We wrote to all the corporations to make it mandatory for a structural engineer to sign and take the responsibility of the safety of buildings, but it has still not been done. Tthe Government of India should bring in an Act making professional engineers accountable for the safety of structures.

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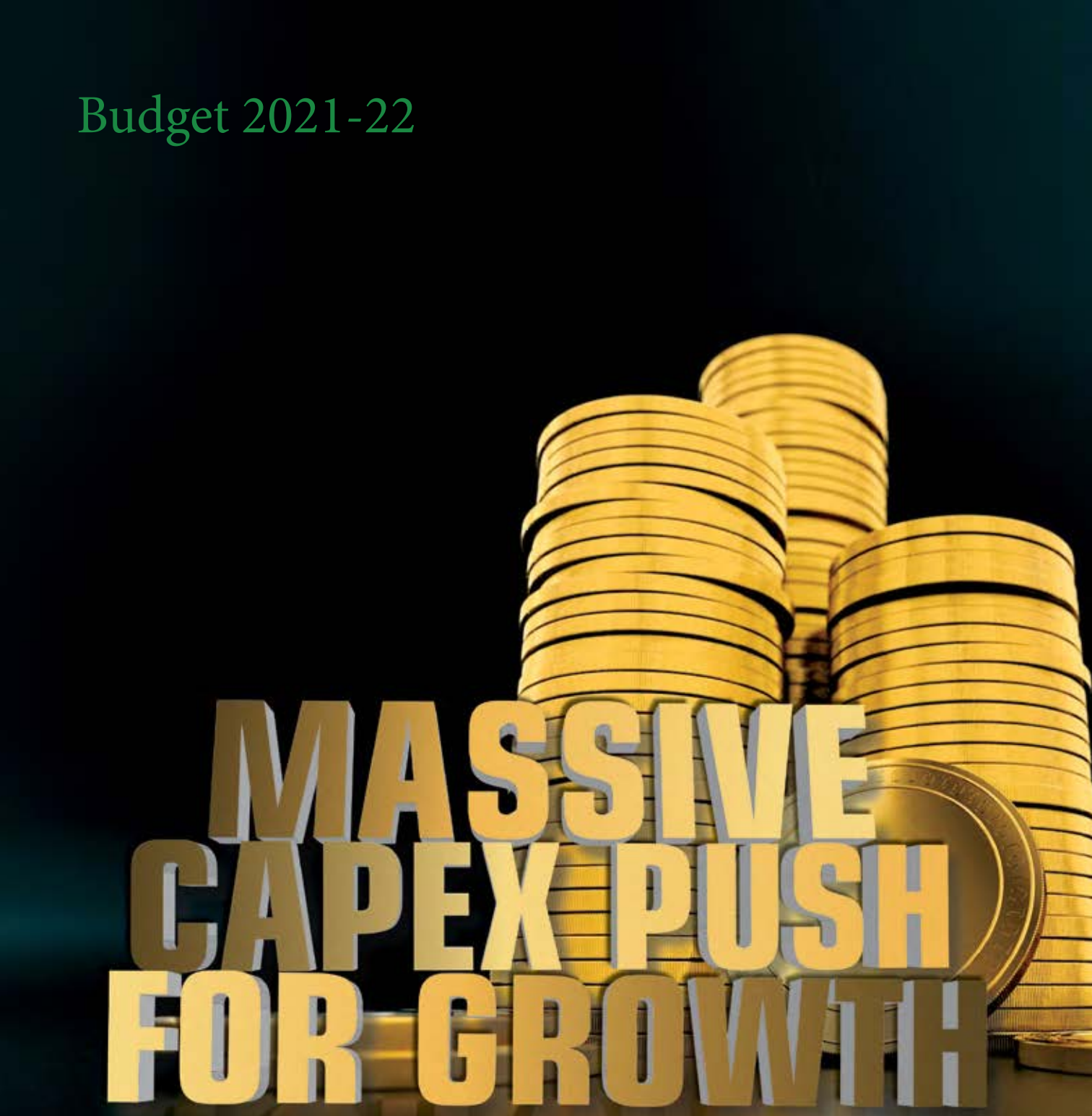


Infrastructure is the buzzword now that Finance Minister Nirmala Sitharaman has used Budget 2021-22 to heave the national economy out of the current crisis with a massive infusion of funds into infrastructure development, writes K. C. Suresh Kumar

For a nation that has been reeling under the impact of total and rolling shutdowns consequent upon the Covid-19 outbreak, the Budget 2021-21, presented in Parlament on February 1 by Finance Minister NIramala Sithamaran, marks a welcome relief.

The Finance Minister has chosen to lay emphasis on infrastructure development with huge capital infusion, which augurs well for the economy not just during 2021-22, but also in the years to come.

From ₹4.39 lakh crore in 2020-21, the allocation for capital expenditure during the coming fiscal has been raised to ₹5.54 lakh crore. This is nothing short of a quantum leap and should see accelerated spending on physical infrastructure, healthcare, job generation, and rural development. Any investment in infrastructure is bound to have long-term multiplier effect as it triggers economic activities, resulting in job generation and more money in the pockets of the people.

While raising the allocation for capital expenditure, the Finance Minister has taken the deliberate decision not to be constrained by the fear of breaching the fiscal deficit cap that the government had set for itself. The promise now is to limit the fiscal deficit to 4.5% of the GDP by 2025-26

Record outlays

The outlay for road and highway infrastructure development is a record ₹1.18 lakh crore, which marks an almost 18% increase over the Budget estimates for 2020-21. The Ministry of Road Transport and Highways (MoRTH) has been working overtime to cover unprecedented distances in road transport and highway development, the current target being construction of 11,000-km of National Highways during the current fiscal. Together, Tamil Nadu, Kerala, West Bengal and Asom would get ₹2.27 lakh crore for highway development projects.

Highway riding would become safer with the construction of four and six-lane highways with advanced traffic management systems, speed radars, variable message signboards, and GPS enabled recovery vans. The National Highway Authority of India (NHAI) would be permitted to go for market borrowing to the tune of ₹65,000 crore. As much as 8,500 km of road projects will be awarded in 2021-22.

The National Infrastructure Pipeline, launched with 6,835 projects in 2019, has now been expanded to 7,400 projects. It will result in incremental aggregate demand in the economy, create more jobs, and make industries more cost-efficient by reducing the cost of logistics and transportation.

boost for affordable housing

The Finance Minister's decision to give a big push for affordable housing has resulted in tax breaks for those availing loans for purchasing affordable housing units. Thus, as much as ₹1.5 lakh would be deducted under section 80EEA from the taxable income of a person who takes a loan

HIGHWAY PROJECTS		
STATE	**LENGTH**	**COST**
West Bangal	678km	₹25,000cr
Kerala	1,100km	₹65,000cr
Tamil Nadu	3,500km	₹1,03lakh cr
Assam	-	₹53,000cr

for the purchase of affordable housing unit. This benefit is over and above the ₹2 lakh deduction against interest paid on a home loan taken to buy a house under Section 24 of I-T Act and takes the overall deduction on interest paid on home loans to ₹3.5 lakh.

REITs & InvITs

The Finance Minister has also announced that Real Estate Investment Trusts (REITs) and Infrastructure Investment Trusts (InvITs) would be allowed to raise more debt capital, which would provide them with additional funds to acquire assets. Similarly, rental housing has received a thumbs up with offer of tax deduction for those undertaking rental housing projects.

Big railway development plans

Railways and Metro Rail Projects across the country has much to feel happy with the Budget 2021-22 as the Finance Minister has gone in for a massive increase in the outlay for the Indian Railways. The Railways has got a record outlay of ₹1,10,055 crore, of which ₹1,07,100 crore is for capital expenditure.

According to the Railway Ministry, the thrust of Annual Plan 2021-22 is on development of railway infrastructure, throughput enhancement, augmentation of speed of trains, signalling systems, development of terminal facilities, improvement of passengers' facilities and amenities, safety works of road overbridges, road under bridges, etc.

- The plan heads allotted highest ever outlays in BE 2021-22 are:
- The plan head for New Lines was Rs 26,971 crore in Budget Estimates (BE) 2020-21. It has been raised to ₹40,932 crore in BE 2021-22, registering an increase of 52%.
- The plan head for Doubling was ₹21,545 crore in BE 2020-21. It is ₹26,116 crore in BE 2021-22, with an increase of 21%
- The plan head for Traffic Facilities was ₹2,058 crore in BE 2020-21. It is ₹5,263 crore in BE 2021-22, marking an increase of 156%
- The plan head for ROB/RUBs was ₹6,204 crore in BE 2020-21. It is ₹7,122 crore in BE 2021-22, registering an increase of 15%.
- According to the Railway Ministry, national projects of Jammu and Kashmir, as well as the states of Uttarakhand, Himachal Pradesh and North Eastern region have been allocated the highest ever outlay of ₹12,985 crore in BE 2021-22 against the RE 2020-21 of ₹7,535 crore i.e. increase of 72%t. Besides, ₹37,270 crore of GBS has been allocated for investment in PSU/JV/SPVs, with allocation for the Dedicated Freight Corridor Corporation of India

(DFCCIL) of ₹16,086 crore, National High Speed Rail Corporation Limited (NHSRCL) of an amount of ₹14,000 crore as well as Kolkata Metro Rail Corporation Limited (KMRCL) of ₹900 crore.

- The national rail plan of Indian Railways has been set up with a core focus to lower the logistics cost and improve Make in India program. Use of indigenous signalling technology, focus on increasing safety, are some of the other announcements in the Budget. The Budget also announced funds for Kochi Metro Third Phase (₹1,527 crore), Chennai Metro (₹63,246 crore), Bengaluru Metro, Nagpur Metro and Nasik Metro.

Rural Infrastructure

Ms. Sitharaman has said that the government would increase spending on rural infrastructure development by 34% to ₹40,000 crore and doubled micro-irrigation corpus to ₹10,000 crore so as to create jobs and boost farm incomes in the hinterland – home to more than 800 million people, whose purchasing behaviour is largely linked to farm output.

The Finance Minister has said that a Jal Jeevan Mission Urban with an outlay of ₹2.87 lakh crore would be implemented over 5 years with the objective of ensuring universal water supply in all 4,378 urban local bodies, with 2.86 crore household tap connections and liquid waste management in 500 AMRUT cities.

She has also announced Urban Swachh Bharat Mission 2.0 with an outlay of ₹1,41,678 crore, to be implemented over 5 years from 2021, focused on complete fecal sludge management, wastewater treatment, source segregation, management of waste from urban construction, and bio-remediation of legacy dump sites.

Power & Renewable Energy

The Budget announced a financial assistance package of about ₹3.06 lakh crore for India's ailing electricity distribution companies (discoms). The funds will be allotted based on a results-based approach tied to the discoms' financial performance. The funds would be spent on infrastructure investment such as installation of prepaid and smart meters, and feeder separation.

Currently, all discoms in the country, whether private or state-owned, are monopolies. A framework will be put in place to give choice to the customer in the form of at least two discoms in every market. Transmission assets of the Power Grid Corporation of India will be rolled out under the asset monetization program.

Focusing on new energy sources, the Finance Minister has announced a National Hydrogen Mission. Aimed at scaling up generation of hydrogen from green sources, the Solar Energy Corporation of India (SECI) and Indian Renewable Energy Development Agency (IREDA) will get an additional capital infusion of ₹1,000 crore and ₹1,500 crore, respectively.

From 'survival' to 'revival'

R. Shankar Raman, Director & CFO, Larsen & Toubro

Presented against arguably the toughest macro-economic backdrop in recent times, Budget 2021 has come in at a crucial juncture. The government has come back with stronger mandates to reignite the economic growth engine while committing itself to fiscal consolidation in the medium term.

Capex-led push over a consumption-focused stimulus is the key to spur economic activity, given the larger multiplier effect on employment and growth. In this context, by reckoning a record capex spend of Rs. 5.5 lakh crore, the Budget has struck some right chords. Even at a cursory glance, it is evident that the government has now turned its focus from 'survival' to 'revival'.

Finance Minister Nirmala Sitharaman, in her Budget speech, had re-emphasised that the National Infra Pipeline (NIP) is a specific target that the government is committed to achieve. Accordingly, infrastructure development in roads, railways, metros, ports, waterways, affordable housing and electrification have been identified as an important lever to spur growth.

There is also an increase in the allocation for the Jal Jeevan Mission and Urban Rejuvenation Mission. Importantly, setting up the much-discussed Development Financial Institution for infrastructure financing will catalyse the required push.

Complimenting this capex push is the proposal to recapitalise Public Sector Banks (PSBs) and setting up of an asset reconstruction company to free up the resources for banks to lend. Clearly, the Budget intends to use capital to boost growth.

The proposals for privatisation and monetisation of brownfield assets of PSUs is a welcome move. This will facilitate generation of funds without tinkering with tax laws affecting the common man and businesses. The buoyancy in the Indian stock markets imply that this is the right time for the government to divest stakes in public sector companies through various measures like IPO, strategic sale, etc. Similarly, increase in FDI limits in insurance from 49% to 74% is bound to attract enhanced capital flow to the sector, thereby benefiting the economy.

India requires greater enablement to meet the $5-trillion economy aspiration. While the Atmanirbhar Bharat'' programme has the potential to aid sustainable growth in the manufacturing sector, the overlap between 'regulation' and 'supervision' has led to over-regulation and opacity in the administrative processes.

Steps taken in the direction of minimum government and maximum governance and consolidation of securities regulations will certainly provide an impetus to the ease of doing business in India. So far, with the government's calibrated stimulus packages, the economic recovery has been better than anticipated earlier. However, this comes against the background of record deficit levels and increased borrowings. Undoubtedly, policy-makers have looked beyond convention to ensure that the fiscal stance remains accommodative and pro-growth in these testing times. While the Budget is strong on intent and purpose, actual implementation of the plans will determine its ultimate success.

Budget will aid jobcreation, economic revival

Deepak Goradia, President, CREDAI MCHI

The first budget of the decade has raised the vision of an Atmanirbhar Bharat with huge impetus and spending on infrastructure – key to creation of jobs and reviving the economy in the post-Covid area.

The one-year extension of the Rs 1.5-lakh tax deduction for home buyers' loans for affordable housing units, along with tax incentive for affordable housing developers, is a welcome decision. This will help accomplish the "Housing for All" mission.

The Tax simplification on dividend income from REIT's and INVITS will help mobilise resources for new projects.

We hope there are additional sector-specific measures to support/boost the Indian realty sector.

CAPEX hike a welcome sign

Sankey Prasad FRICS, Chairman & MD (India)Colliers International

Budget 2021-22 is positive as it is driven primarily by an impressive 34% increase in capital expenditure, majorly in the construction and development of real infrastructure. These investments will spur large scale construction activities, which will create many more jobs, generate more income and boost overall demand in the economy.

Not burdening the citizens and businesses of the country with additional taxes is very welcome and will go a long way in strengthening confidence in our economic recovery. We are hopeful that proper and quick implementation of the Government's proposals to disinvest, privatise and monetize assets with also improve the overall business sentiments and environments will bring in large volumes of private investments from abroad where there is high liquidity.

However, there were no specific announcements to boost the ailing real estate sector, other than the extension of incentives for interest payment on affordable homes by another year, tax incentives for notified affordable rental housing and some tax relief for dividends received from REITS. The sector needs to be nurtured in-toto for its contribution to GDP specifically, and more importantly, because of its being a necessary input in all economic activities.

A Budget for growth, with reforms

Kishore Jain, Managing Director,
Jain Heights & Structures Pvt. Ltd.

Budget 2021-22 reassures the country that the Government will take all steps necessary for a post-pandemic economic revival and with a clear roadmap to make India a $5 trillion economy by 2024. 2021 is truly a historic year as India celebrates 75th year of independence.

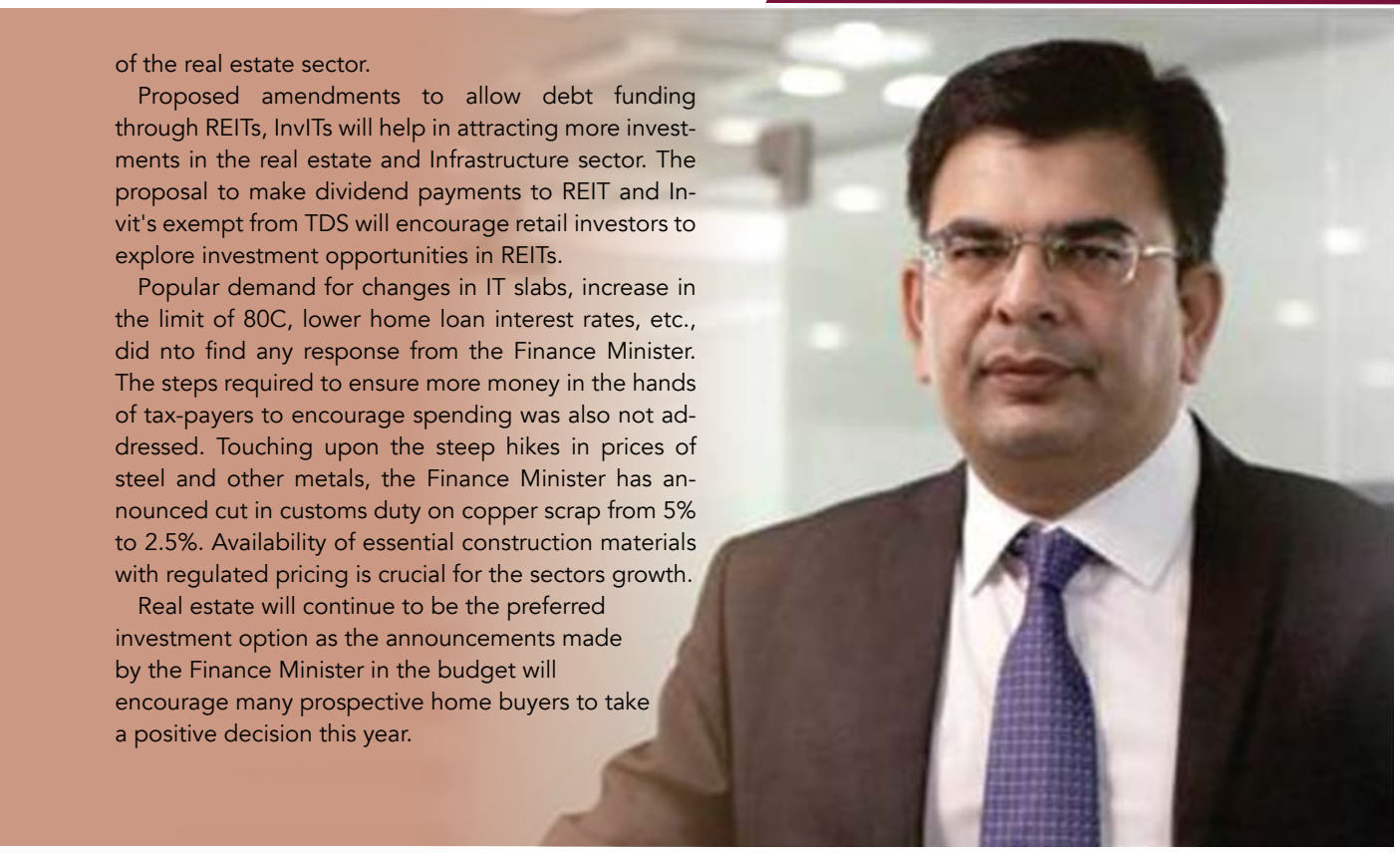
With the Covid 19 vaccine expected to reach the most vulnerable sections of our country this year, there will be clear improvement in the overall customer sentiment and buying behaviour, aiding the revival of the economy.

Continuous focus on infrastructure projects such as massive roads and rail and metro rail projects will play a crucial role in connecting all corners of the country. This would boost demand for housing in these areas and promote economic activity and job creation.

This is a budget for growth with reforms, focusing on healthcare, infrastructure and financial sectors and establishing a stable tax regime and higher borrowing for CAPEX. The decision to extend tax holiday for affordable housing projects and for payment of interest to buyers till March 31, 2022, are both welcome measures. This will boost overall demand for affordable housing, which has been the fastest growing segment

Construction sector should have been declared an industry

Sushma Wilson
Executive Cost Manager
Insight & Analytics, Gleeds



of the real estate sector.

Proposed amendments to allow debt funding through REITs, InvITs will help in attracting more investments in the real estate and Infrastructure sector. The proposal to make dividend payments to REIT and Invit's exempt from TDS will encourage retail investors to explore investment opportunities in REITs.

Popular demand for changes in IT slabs, increase in the limit of 80C, lower home loan interest rates, etc., did nto find any response from the Finance Minister. The steps required to ensure more money in the hands of tax-payers to encourage spending was also not addressed. Touching upon the steep hikes in prices of steel and other metals, the Finance Minister has announced cut in customs duty on copper scrap from 5% to 2.5%. Availability of essential construction materials with regulated pricing is crucial for the sectors growth.

Real estate will continue to be the preferred investment option as the announcements made by the Finance Minister in the budget will encourage many prospective home buyers to take a positive decision this year.

Construction and real estate sector have much to be happy about in Budget 2021-22. For instance, the extension of deduction of 1.5 lakh for loans until March 2022. This move will benefit interested new buyers, opening ip the growth prospects of this sector. This as well as the reduction in stamp duties in states like Maharashtra will help in the revival of the economy.

Additionally, the tax exemption allowed for notified Affordable Rental Housing Projects will help in promoting the supply of Affordable Rental Housing for migrant workers. From an infrastructure point of view, the budget has fared well.

The National Infrastructure Pipeline (NIP) expansion of projects to 7,400 from 6,835 including energy, commercial infrastructure, communication, water, and sanitation along with four states being granted Central funds for their economic corridor would boost economic activity.

With a national rail plan till 2030, massive hike in allocation for healthcare and privatisation of airports (in tier II and tier III cities), we can expect creation of thousands of new job opportunities, which would also translate to economic growth.

The decision to make funds available through debt financing by foreign portfolio investors for the REIT and the InVITs, the proposal to waive TDS on dividend payments and to make applicability of taxes based on treaties are all positive moves setting that can sharpen finances for the sector.

The development cess imposed on diesel and petrol would not affect the consumer much, however, a cess would reduce the room available to the Government on existing levies on the fuel which were increased despite global softening of fuel demand at the peak of COVID-19 pandemic.

The construction sector would have been pleased if the Government had notified construction and real estate as an industry, which would have also given numerous benefits to the entire supply chain. While there is reduction in the custom's duty on steel, the current surge in the prices of various materials such as steel, PVC, copper, etc., may result in short term challenges on material demand and exert pressure on profit margins.

Budget will aid construction sector in the long run

Ravindra Pai, Managing Director, Century Real Estate Holdings

We were hoping the budget would include steps to address the immediate liquidity issues and changes in the GST regime. The Government, however, has focused more on affordable housing while taking far-sighted measures.

With the establishment of a professionally managed DFI, we expect infrastructural improvements leading to more road projects and eventually more housing developments. The health and insurance benefits for construction workers and migrant labourers will support the gig economy and ensure availability of labour supporting the timely completion and delivery of projects.

The extension of tax holiday for affordable housing and increase in the safe harbour limit will definitely help in augmenting housing demand in the mid-income segment. This year's budget, though unlikely to have any immediate impact, will aid the sector in the long-run.

bauma CONEXPO INDIA 2021 cancelled

bauma CONEXPO INDIA, the International Trade Fair for Construction Machinery, Building Material Machines, Mining Machines, and Construction Vehicles will not take place this year.

The event, organised by Association of Equipment Manufacturers (AEM) in association with Messe Munchen, was to have taken place at the India Expo Centre, Greater Noida/Delhi NCR.

The decision to cancel the event comes after deliberations between the organisers and all stakeholders and a comprehensive study of the market. It was found that the safety protocols and uncertainty about the likely turnout of international participants, mainly due to travel restrictions imposed by various countries and organizations made it unwise to hold the event.

It was felt that the organizers' goal to offer all participants optimal conditions for a successful trade fair would be difficult to implement under the current circumstances.

The next bauma CONEXPO INDIA will take place in 2022 in New Delhi.

M&T Expo - International Trade Fair postponed

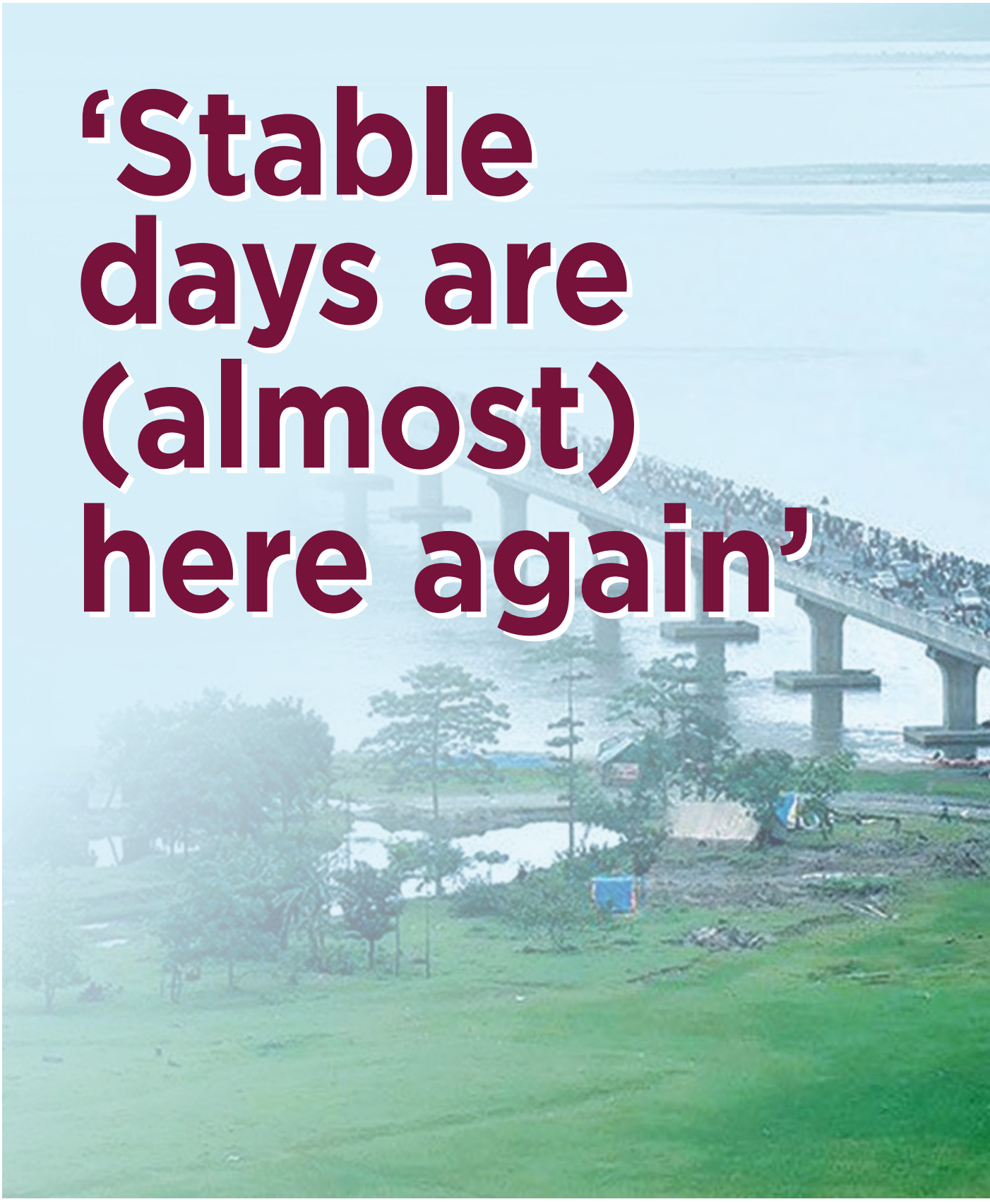
Messe Muenchen do Brasil, organizer of M&T Expo - International Trade Fair of Equipment for Construction and Mining, scheduled to be held in July, has been postponed.

Proposed to be organised in partnership with Sobratema - Brazilian Association of Technology for Construction and Mining, the event was originally scheduled to take place from July 5 to 8.

The decision decision to postpone the event has been taken in consultation with all stakeholders, based on the organisers' principle to provide only the best conditions for doing business, knowledge exchange and relationship building in a safe environment for visitors, exhibitors and partners.

The new dates will be announced soon.

‘Stable days are (almost) here again’



ICRA projects 'stable' outlook for Indian construction sector in fiscal 2022

ICRA, the investment information and credit rating agency, says that the outlook on the construction sector for fiscal 2022 is 'Stable'.

The ratings agency expects the credit profile of construction companies to recover in the coming fiscal after weakening in FY2021. However, companies which are highly leveraged or have high exposure to State government projects could witness a weakening credit profile. As Government bodies are key clients for most construction companies, supportive measures as undertaken in the past, can help strengthen the sector, ICRA says.

The construction sector is on a recovery path post the disruption caused by the Covid-19 pandemic. Project execution was severely impacted during the first half of fiscal 2021 due to the nation-wide lockdown, reverse migration of labour and supply chain constraints. However, in the last few months, the Government has announced a slew of relief measures to support the industry.

Among the positive measures announced by the Government are relaxation on EMD & performance security, relaxation of bidding eligibility criterion and increased frequency of payments for Government tenders. While the pandemic-related uncertainties continue to remain, execution has recovered sharply in the last few months. ICRA expects the pace of execution to improve over

the medium term, supported by adequate orders in hand as well as the recent measures taken by the Government. Further, companies which have a healthy balance sheet and order book are expected to witness an improved performance in FY2022.

Shubham Jain, Senior Vice-President and Group Head, Corporate Ratings, ICRA, in a statement said: "The infrastructure sector is the key contributor to the construction sector's order book. With a sharp increase in infrastructure investment planned under the NIP, the construction sector is likely to see significant opportunities in the medium term. A major part of the NIP is towards transportation (roads, railway, etc), energy/power and urban infrastructure. The players which are focussed on these segments and have a healthy balance sheet are well-placed to capitalise on these opportunities."

According to ICRA, the order book position of most of the construction players is currently adequate, which provides medium-term revenue visibility. With a huge pipeline of projects to be awarded in the infrastructure sector under the National Infrastructure Pipeline (NIP), ICRA expects the new order inflows for construction companies to remain healthy in FY2022. However, delays in land acquisition, funding issues, and state government priorities remain key risks to the new order inflows. The order inflows from non-infrastructure segments

Adequate order book position, a strong pipeline of projects and Government measures to boost infrastructure will prove beneficial for the construction industry during financial 2021-22, says the ICRA outlook report

like industrial and real estate (excluding affordable housing segment) is expected to remain muted, with weak private sector capex growth.

Operating profitability is expected to remain stable with the benefits of improved execution scale; though this would also be dependent on any steep variation in key raw material and labour cost and increased competitive intensity. The working capital cycle for the larger construction players has remained at higher level in the past, owing to slow realization of receivables, and slow-moving legacy projects. This has been met partly by higher creditors, thus percolating to sub-contractors working capital cycle as well. Some of the recent measures taken by the Central Government are helping companies involved in such projects by way of faster bill realisation and lower Bank Guarantee (BG) requirements.

Lower BG requirements will help release the margin money blocked and enhance companies' ability to scale-up. On the other hand, companies which are working on state government contracts are likely to see elongation of their receivable cycle in the near term. Due to these factors, overall, the working capital position in FY2022 is expected to remain range-bound and at similar levels as in the past.

With the increased scale of operations in the next fiscal, the debt of construction companies is expected to increase, albeit marginally, except in the case of increase in working capital intensity or investment in asset-owning models like the Hybrid Annuity Model (HAM) based projects where the increase in borrowing could be higher. Low-interest rates and reduced BG requirement will help in keeping the overall finance expenses under control.

With this, the credit metrics of construction companies are expected to improve in FY2022. However, some players in the sector remain highly leveraged and their liquidity pressure is likely to persist as the lenders remain cautious towards the infrastructure/construction sectors. Their ability to raise funds via stake sale in its subsidiaries, monetisation of assets, or dilution of equity will be key factors in improving liquidity and the capital structure.

Prem Shanker
CEO, Ramco Industries Limited

The global construction scenario is fast evolving and moving towards environment friendly materials because of the scarcity of sand, brick and even water.

India is also fast adopting green dry construction technology. After successfully launching Ramco Hilux Calcium Silicate Boards in the last decade, Ramco Industries sensed the need to launch fibre cement boards which were stronger and could be used in external applications.

Ramco introduced Ramco Hicem Fibre Cement Boards in the year 2015. Its laminar process gives it a stable crystalline structure and it is made as per IS:14862-2000. This structure brings an added advantage to Ramco Hicem, by making it more durable and dynamically stable.

Within a short span of three years, Ramco Hicem has become a board of choice for builders across South Asia. Right from Altair, a high rise

Ramco Industries Limited

Pioneering Green Dry Construction

The world's forests are being felled at the rate of 1.5 acres every second. Forests and other precious natural resources can be saved only if we opt for green products as our construction materials. This was the inspiration behind Ramco Fibre Cement Board Range.

skyscraper in Colombo to the serene Kettuvellam (boat house) in Alappuzha, Kerala, Ramco Hicem is preferred for its high strength and outstanding features.

The versatile nature of the product lends itself to various applications apart from the defined segment for partitions and ceilings. Ramco Hicem outperforms all the existing building materials on all parameters.

Ramco Hicem Boards have a wide range of dry construction applications in offices, residential, industrial and commercial segments. Ramco Hicem Fibre Cement Tiles are an excellent choice for grid false ceilings laid through an exposed grid system.

These tiles come in different textures - Marina, Valley View and Cedar, which increase the aesthetic ambience of interiors. Ramco Hicem Tiles offer superior thermal insulation properties and help to minimize air-conditioning power consumption.

Ramco Hicem Planks are fibre cement sidings which offer a perfect solution for cladding requirements. These planks are fire-resistant, water-resistant and termite-resistant and have a high impact strength which make them an ideal choice for protection of exterior walls from extreme climatic conditions.

The autoclaved wood grain texture planks give exteriors a stylish finish and enhance the look of structures. The planks can be coated with acrylic paint to suit colour preferences.

Ramco Hicem Fibre Cement products are part of Ramco's vision of green construction and is a GreenPro certified product from CII-Green Products and Service Council. GreenPro is a mark of guarantee that the product which bears the GreenPro label is environment friendly throughout its life cycle.

Former Railway Board chairman V.K. Yadav conferred with Eminent Engineer Award

The Institution of Engineering and Technology (IEF) has conferred the prestigious "Eminent Engineer Award" for 2020 on former Railway Board chairman Vijay Kumar Yadav.

This award has been given to him for his outstanding contribution towards modernization of Indian Railways and the several reform measures he had initiated before demitting office on December 31, 2020.

Mr. Yadav had earlier served as General Manager of South Central Railway at the Rail Vikas Nigam Limited, the Dedicated Freight Corridor Corporation of India Limited and in the United Nations Industrial Development Organization. He belongs to the Indian Railways Service of Electrical Engineers 1980 batch.

Life Time Contribution Award in Engineering 2020 for Prof. K.A. Padmanabhan

Prof. K.A. Padmanabhan, Professor of Eminence, Department of Mechanical Engineering, Anna University, Chennai, and former Director, IIT Kanpur, has been selected for the Life Time Contribution Award in Engineering 2020 of the Indian National Academy of Engineering (INAE).

Prof. Padmanabhan has made outstanding contributions to engineering education and materials research. His models for optimal super-plasticity and Inverse Hall-Petch Effect in different classes of materials are described as "breakthroughs from India" by the journal "Nature Materials."

His papers with H Gleiter on the structure of interfaces and grain boundaries are also considered pioneering. His research on mechanical behaviour of stainless steels for Fast Breeder Programme, development of alloy equivalent for AFNOR 7020, establishing a facility for superplastic forming for Indian Space Programme and development of multi-stage forging technology for undercarriage base plate fitting for supersonic aircraft for Indian Defence Research have benefited mission-oriented programmes.

International Award of Merit in Structural Engineering 2020 for Ahsan Kareem

Professor Dr. Ahsan Kareem has been conferred with the International Award of Merit in Structural Engineering 2020.

A Robert M Moran Professor of Engineering and Director, of the Natural Hazards Modelling Lab at the University of Notre Dame in the US, he did his PhD; MSc; BSc (with Distinction) from the Colorado State University; University of Hawaii/MIT and Pakistan University of Engineering and Technology.

His field of expertise is in structural dynamics: wind, waves, earthquake load effects.

Prof. S.N. Mitra award for Prof. L.M. Patnaik

Prof L.M. Patnaik, INSA Honorary Scientist and Adjunct Professor, National Institute of Advanced Studies, Bengaluru, and former Vice-Chancellor, Defence Institute of Advanced Technology (DIAT), Pune, has been chosen for the 2020 Professor S.N. Mitra Award.

Prof. Patnaik has made significant research contributions in the area of Computer Science. He proposed a novel concept of adaptive genetic algorithms to solve complex optimization problems encountered in science, engineering and management applications.

His novel parallel architecture called Extended Hypercube yields performance better than most commercial computers for problems involving extensive communication such as simulation of human brain.

Professor Jai Krishna Memorial Award 2020 for Dr. V. Ramaswamy

Dr. V. Ramaswamy, Professor, Department of Metallurgical Engineering, PSG College of Technology, Coimbatore, has been selected for the annual Prof. Jai Krishna Memorial Award 2020.

Dr. Ramaswamy has made outstanding contributions in the field of Ferrous Metallurgy. He developed many new steel products such as dual phase steels, Duplex stainless steels, heat resistant steel for Indian Railways etc. He had also helped the strategic sectors by developing 9Cr-1 Mo steels for Atomic Energy and Si-Cr-Ni steels for defence applications.

JSW Cement is **India's leading producer** of **Green Cement.** JSW entered the cement market with a vision to ensure a sustainable future for the country by producing **eco-friendly cement.**

Today the construction industry is witnessing a shift towards the use of eco-friendly materials and technologies. Given the environmental and economic benefits, **Port Land Slag Cement (PSC)** is an emerging category for housing as well as other infrastructure projects. The engineering fraternity has always considered PSC & **Ground Granulated Blast Furnace Slag (GGBS)** to be **technically superior** especially when **durability** and **life cycle costs** are prime considerations. This will help in building a self-reliant India.

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B.S.C. Rao

Forensic Civil Engineering

Science of learning from failures

Every failure has adverse consequences; major failures and disasters leave in their wake not only serious damage, financial loss and loss of time but also, quite often, death and destruction, while minor failures may cause injury or loss of money. Every failure occurs for a reason, or many reasons. The failure is only the culmination and consequence of a series of cumulative contributory causes.

B.S.C. Rao is a highly qualified consulting civil engineer living in Bengaluru, with over 47 years of experience in the planning, design, construction, and management of large engineering, industrial and infrastructure projects – especially in Mass Rapid Transit Systems, in which he has over 36 years' experience.

He was formerly Executive Director of Bengaluru Mass Rapid Transit Ltd. (BMRTL) (precursor to the current BMRCL) and was responsible for planning and structuring the erstwhile Elevated Light Rail Transit System Project on which the Namma Metro Project, now being executed, is broadly based. He has been consultant and technical advisor for several companies and projects in transportation infrastructure and MRT systems and was a member of several government advisory committees.

He was also a two-term Chairman (2003-2007) of the Bangalore Centre of the Association of Consulting Civil Engineers (India) and its National President (2011-2013). As Chairman, he conceived and organised the series of biennial Conferences on **"Recent Developments in Design and Construction Technologies" (REDECON)** for ACCE(I)-BLR since 2005, which has gone through eight editions till date.

During his Presidency of ACCE(I), he introduced **Forensic Civil Engineering (FCE)** in India as a subject through national conference on FCE in 2013 and an international conference in 2016 organised by him. He is currently busy with the Third International Conference which is proposed to be held in 2021. He has had an abiding interest in Forensic Civil Engineering, and has done much to popularise the subject in the country for many years. Mr. Rao's email address is: **bscr_assoc@yahoo.com.**

Not a day passes by without our reading in the newspapers about the collapse of a building causing loss of many lives or the collapse of a bridge or extensive flooding caused by heavy rains, causing untold misery to the people, or still further, about recently repaired asphalt roads developing dozens of potholes immediately after the first heavy rain.

Every failure has adverse consequences; major failures and disasters leave in their wake not only serious damage, financial loss and loss of time but also, quite often, death and destruction, while minor failures may cause injury or loss of money. Every failure occurs for a reason, or many reasons. The failure is only the culmination and consequence of a series of cumulative contributory causes. Nevertheless, from each of them we can learn several useful lessons that will help ensure that such failures will not recur.

But this process of discovering the causes which led to the failure, 'which is known as *forensic engineering*', can be a long, tedious, and sometimes, frustrating and time consuming exercise. Forensic Civil Engineering is the application of forensic investigation principles and techniques to investigate failures of civil engineering structures.

The broad term "Forensic Engineering" encompasses within itself a huge field of both theoretical and empirical investigative engineering techniques, analyses, testing equipment, etc. It also includes important issues of ethics and the social responsibility of the engineer - what s/he owes, and how answerable and responsible s/he is, to society.

The forensic engineer comes into his own when s/he is called upon to provide the engineering background and support to the due process of law which usually is set into motion after any accident, failure or disaster. In forensic engineering, there is an **intimate connection between the practice of two professions – engineering and law.** Unfortunately, this is either not fully appreciated or is played down as not being important. And that brings us to the need to define formally what forensic engineering is. There are several 'definitions' available in the literature and between them cover almost all the facets of 'forensic engineering'.

Forensic engineering investigations

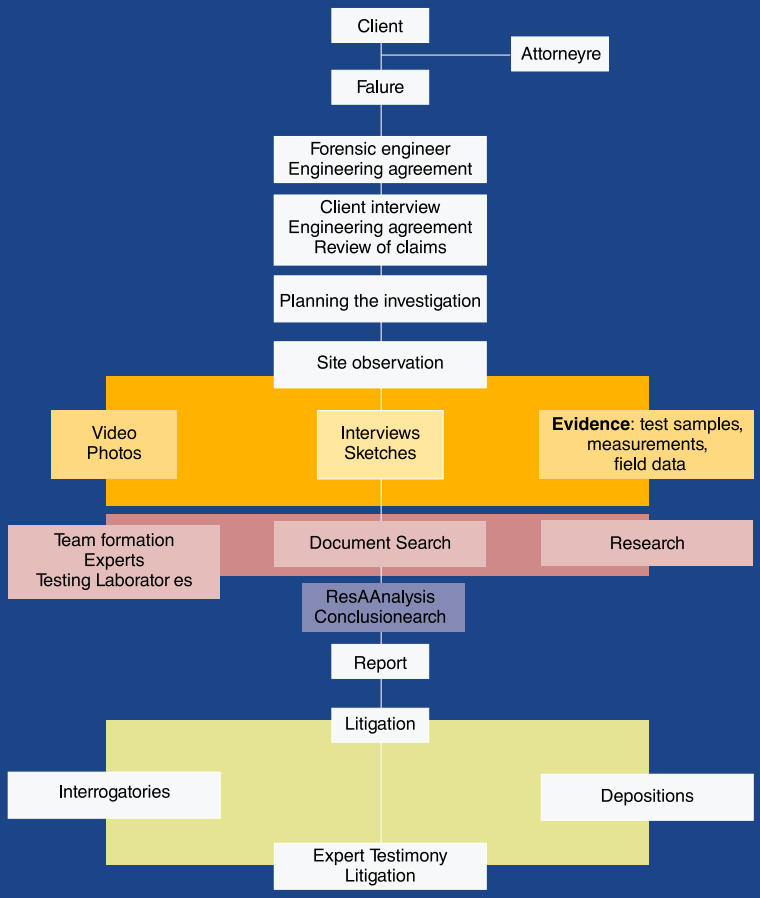
Materials and structures behave in reasonably predictable ways, but when subjected to loads and stresses greater than what they have been

designed for, they will fail – partially or completely. Human beings and organisations, on the other hand, behave in unpredictable ways, and therein lies a major problem for the investigator because s/he also has to find out who was responsible, why and how.

Every failure ultimately has one immediate cause which precipitated the failure, but which would be the culmination of multiple contributory causes. The effects can be minor, major or disastrous and can have deep and lasting impact on the people and on the profession. The term 'failure' - whether accidental or intentional - is understood in its broadest sense to mean a failure of structure, component or performance which results in damage to, or loss of, life, property or money.

Thus, the process of forensic engineering investigations would require the investigator to follow an ordered and sequential series of steps, working backwards from the failure event. These steps would solve, in simplified terms, the following:

1. Describe or 'define' the failure
2. Collect evidence – physical, material, photo/video, oral (through interviews), documentary;
3. Analyse the evidence – which itself would involve several activities including material testing;
4. Hypothesize the possible sequence of events that led to, and the root causes for, the failure;
5. Validate the hypothesis through structural analysis, model and material testing, research, literature review etc.;
6. Arrive at a conclusion regarding the cause(s) that resulted in the failure;
7. Prepare the final report fully describing the process adopted, with supporting documentation, and the conclusions reached. If required, the forensic engineer may also have to make an estimate of loss. How thoroughly this is done will play a crucial and vital role in a court of law or in any settlement between the involved parties.



This process is graphically illustrated in the flow-chart shown alongside

It is not the role of the forensic engineer to fix culpability or responsibility. S/he only presents facts, as they appear, and it is for the court to rule on responsibility, culpability and damages.

Tools and techniques

The forensic engineer needs to use different kinds of tools and techniques for a complete analysis of the evidence gathered by him/her. These include both empirical and theoretical methods.

Empirical methods cover essentially the many well established non-destructive tests as well physical testing at materials testing laboratories. These are all well-established and well-known methods, and do not require further elaboration.

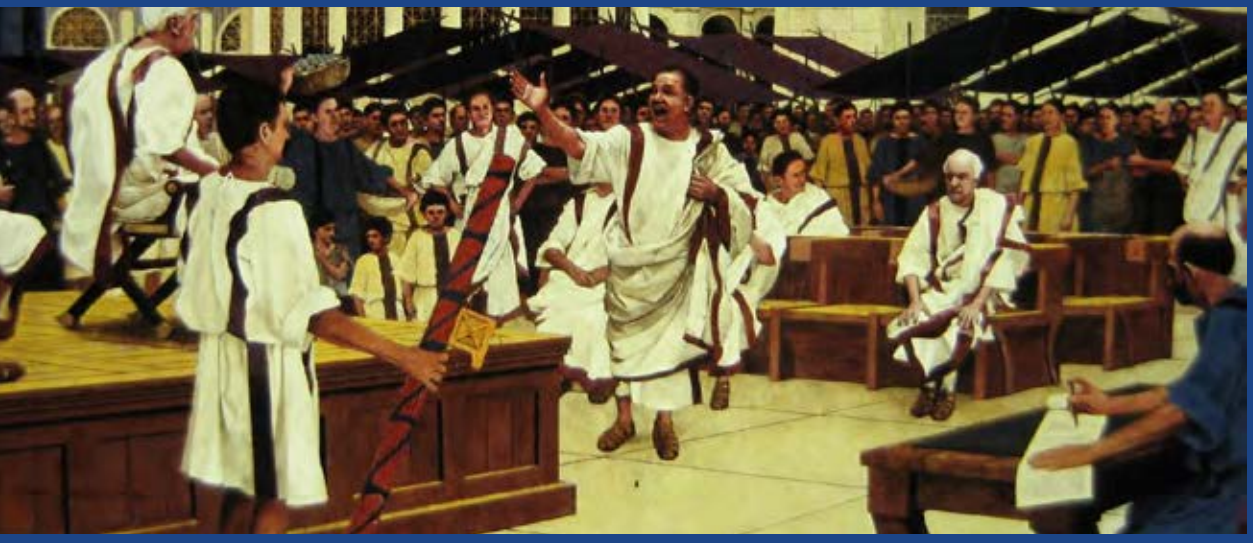
Theoretical Methods

There are several modern, well-established and formal analytical tools, techniques and procedures which are commonly used to carry out forensic engineering and major accident investigations, which occur due to several connected and inter-related causes. These methods can be used for different kinds of investigations, and complex accidents and failures may require the use of more than one technique to get a complete picture of the nature, number, sequence and severity of the underlying causes.

Deductive and Inductive Analysis

In forensic engineering there are two fundamental ways in which analytical models can be created, and which are both useful in getting a

What is 'forensic'?



In Roman times, a criminal charge meant presenting the case before a group of public individuals in the 'forum'. Both the person accused of the crime and the accuser would give speeches based on their sides of the story. The individual with the best argument and delivery would determine the outcome of the case.

The word 'forensic' comes from the Latin forēnsis, meaning 'of or before the forum'. This origin is the source of the two modern usages of the word forensic: (i) as a form of legal evidence and (ii) as a category of public presentation.

Carper, Kenneth. L, 2001; What is Forensic Engineering, CRC Press LLC

complete understanding of any problem. They are known **Deductive Analysis** and **Inductive Analysis.**

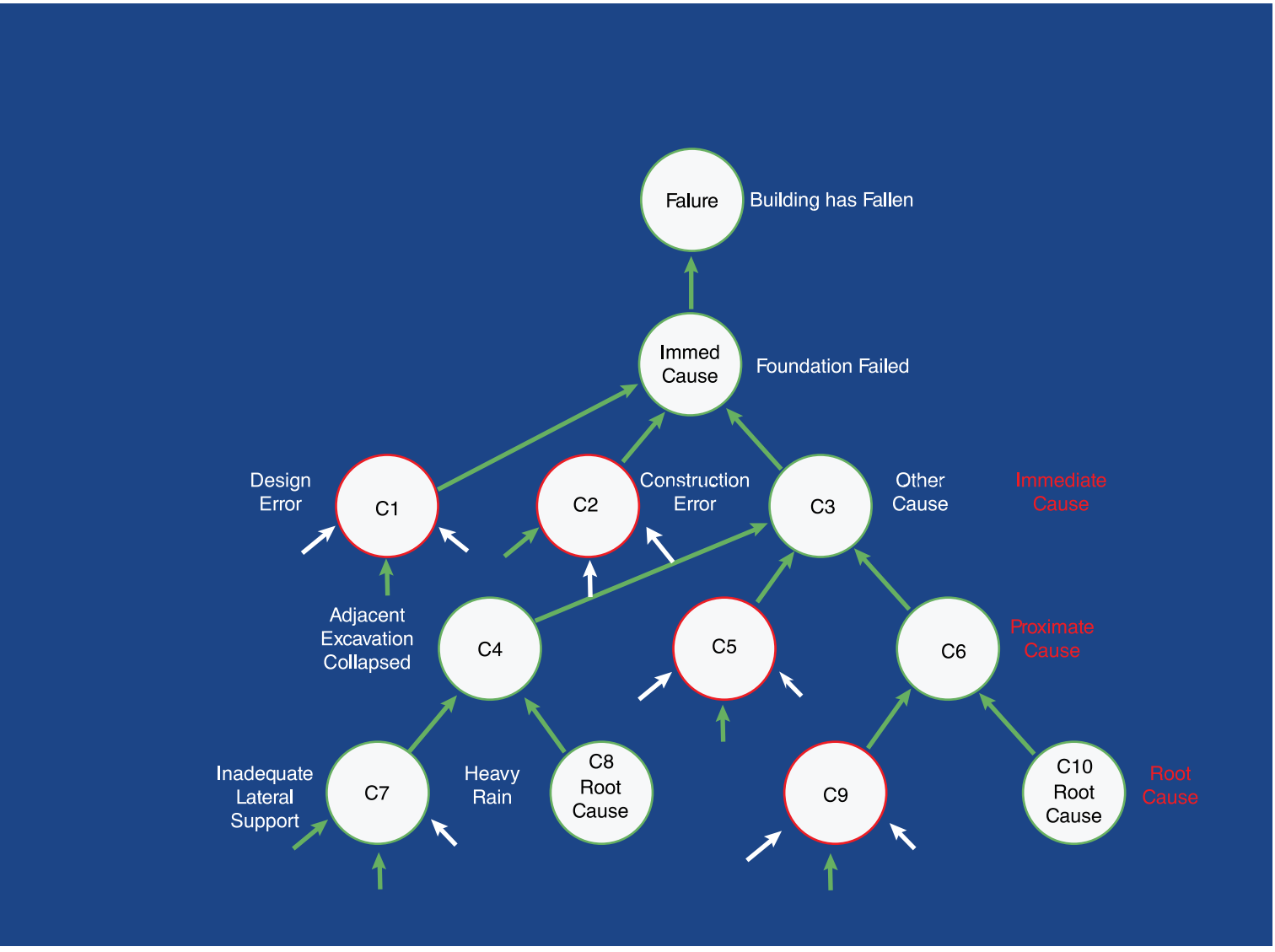
Deductive Models (Consequence to Root Cause)

Deductive reasoning or deductive logic is called a **'top-down'** method in which one starts with a 'top event' (say a failure or an accident which has already occurred) and works backward (or downward) from there finding causes at each stage until one reaches the root cause(s).

The immediate (first level) causes, which are both necessary and sufficient for the accident, are theorised and listed and checked for consistency with the evidence at hand. Each of these first level causes is analysed to discover what are the second-level causes for its occurrence and so on until there can be no more sub-causes. At each stage the formal tests must be applied – whether each cause was both necessary and sufficient and whether it is consistent with the observations/evidence at hand.

The relationship between the causes and the resulting event at each level, ie., whether the causes are responsible individually or in combination, must also be established. The last tier/level then constitutes the set of **root causes** for the top event – the failure or accident. So in Deductive Modelling, we start with a top event and work backwards to discover its root causes, ie., going from the general to the specific.

Specific techniques include Causal Analysis [including Root Cause Analysis (RCA), Events and Causal Factors Charting (ECFC)], Event Trees,



Fault Tree Analysis (FTA), Barrier Analysis, etc.

One of the simple methods is known as the **'Why-Because Analysis'** and is illustrated below.

Inductive Modelling
(Cause to Consequence)

Inductive Modelling or inductive logic is just the opposite of the deductive approach and is also called a **'bottom-up method'.** The object of inductive modelling would be to find out what would be the several consequences of any **initiating event.** The technique becomes very useful, and is applied extensively, in reliability engineering to ensure that equipment and processes operate safely and do not result in serious consequences when there is a failure in any part. It helps in devising 'fail-safe' provisions and procedures.

Here we start with an initial event and work our way **upwards** to discover the several levels of consequences that follow from that initial event. The immediate possible **consequences** of the initial event are first listed (first level); again the possible consequences that result from each of the first level possibilities are listed (second level) and so on, until all the possible consequences have been completely accounted for. This then enables appropriate action to be taken for designing systems in such a way that these consequences do not recur and thus ensure the reliability and safety of the system.

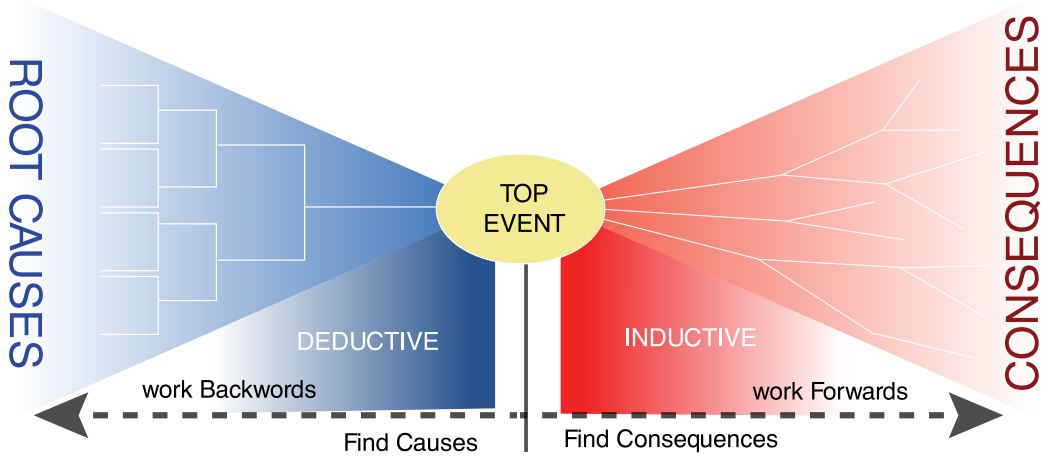
Some Inductive Modelling techniques are Change Analysis, Management Oversight and Risk Tree (MORT), Sequentially Timed Events Plotting(STEP), Human Error Analysis (HEA)/ Human Reliability Analysis (HRA), Integrated Accident Event Matrix, Failure Modes, Effects and Criticality Analysis (FMECA), etc. Specific techniques can be incorporated into more integrated analytical methods such as Incident Cause Analysis Method (ICAM) and more comprehensive methods such as the System Safety Accident Investigation (SSAI). These are based on the methods adopted for hazard identification, risk assessment and management and reliability engineering.

The difference between the two models can be graphically illustrated in what is known as the **'Bowtie Diagram'**

Expert witness

The principal job of the forensic engineer is to establish in thorough detail the root causes for an accident or failure. But it does not end there, since, in the wake of such a failure/accident, issues of liability and culpability crop up, especially when there is damage and destruction, and more so when there is injury or loss of life. The forensic engineer is then called upon to give evidence in a court of law as an **'expert witness'.** This is the second, and very important, role which the forensic engineer has to play.

A weak case can be won, or a strong case lost, depending how well or how badly the expert witness presents evidence and how well s/he can hold his ground and retain her/his assurance and self-confidence under even the most intense cross examination. S/he therefore needs to be very thorough in her/his investigation and preparation of evidence; very knowledgeable about the case details and the subject; very clear, factual, dispassionate and articulate in her/his presentation of the evidence and finally be able to stand up to cross-examination with confidence and without



Forensic Engineering: Some Definitions

The dictionaries define "forensic" as follows: Forensic – adj - of or used in connection with courts of law (Oxford); related to or used in the law and tracking of criminals (Longman's)

There are, however, several formal and comprehensive definitions for "Forensic Engineering" available in the literature some of which are given here for information.

Forensic engineering can be considered to be "the investigation of materials, products, structures or components that fail or do not operate or function as intended, causing personal injury or damage to property. The consequences of failure are dealt with by the law of product liability. The field also deals with retracing processes and procedures leading to accidents in operation of vehicles or machinery. The subject is applied most commonly in civil law cases, although may be of use in criminal law cases. Generally the purpose of a Forensic engineering investigation is to locate cause or causes of failure with a view to improving performance or life of a component, or to assist a court in determining the facts of an accident. It can also involve investigation of intellectual property claims, especially patents."[1]

A "legalistic" definition of forensic engineering has been provided by Milton F Lunch, former General Counsel to the National Society of Professional Engineers (NSPE) as follows:

"Forensic Engineering is the application of the art and science of engineering in the jurisprudence system, requiring the services of legally qualified professional engineers. Forensic engineering may include the investigation of the physical causes of accidents and other sources of claims and litigation, preparation of engineering reports, testimony at hearings and trials in administrative or judicial proceedings and the rendition of advisory opinions to assist the resolution of disputes affecting life and property." [2]

Yet another definition is given by Randall K Noon: Forensic Engineering is the application of engineering principles, knowledge, skills and methodologies to answer questions of fact that may have legal ramifications"[3]

Wikipedia Forensic engineering; http://en.wikipedia.org/wiki/Forensic_engineering, 21052012
Carper, Kenneth. L, 2001; What is Forensic Engineering, CRC Press LLC
Noon, Randall K, 2001; "Forensic Engineering Investigation", CRC Press –
This book can be freely downloaded at https://engineeringbookslibrary.com/download/?file=167

losing her/his composure. These define the essential qualities and requirements in an 'expert witness' – who may work for either the prosecution or the defendant, or directly for the court as an independent authority.

An expert witness, in the context of forensic engineering, is a person who is qualified by virtue of her/his professional education, training, specialised knowledge, skill and experience to form definite opinions regarding the special or particular engineering aspects of a case, which would lie beyond the knowledge, experience or capabilities of a lay person. In the case of an engineering failure or accident which is being prosecuted in court, the presiding judge may not have the ability to understand the intricacies and nuances of the engineering evidence and arguments presented or the conclusions drawn therefrom. The services of the (engineering) expert witness then becomes necessary.

There is no rigid rule or stipulation which mandates the employment of an expert witness in every case that comes before the court. It is left to the discretion of the court/judge to decide whether an expert witness is even required or should be allowed to testify. However, if either, or both, of the parties in a case request(s) the court's permission to present expert evidence (testimony), the court cannot refuse to entertain it. Section 45 of the Indian Evidence Act, 1872 lays down that when the court has to form an opinion upon a point of

Gelder, Pieter van et.al (April 2008); Reliability Analysis of Flood Sea Defence Structures, Report No. T07-08-01; FLOODSite Consortium, European Commission

History of Forensic Engineering

As the field of engineering has evolved over time so has the field of forensic engineering. Early examples include investigation of bridge failures such as the Tay rail bridge disaster of 1879 and the Dee bridge disaster of 1847. Many early rail accidents pioneered the use of tensile testing of samples and fractography of failed components.

Early forensic analyses of structural failures led to vastly better understanding of the properties and behaviour of structures and structural materials. Investigation of the collapse of the famous Tacoma Narrows Bridge on 7th November 1940, for example, resulted in a radically new understanding of the aerodynamics of suspension bridges and led to a revolution in the design of long-span suspension bridges – it's a fascinating story[4].

With the prevalence of liability lawsuits in the late 1900s, the use of forensic engineering as a means to determine culpability became widespread in the courts.

https://elkodaily.com/lifestyles/professor-haningtons-speaking-of-science-the-tacoma-narrows-bridge-disasterz/ article_c75e34b2-0ef1-50e1-8bf8-8a9dbb796c15.html

science, the opinion upon that point of a person especially skilled in such science is a relevant fact.

However, the court may not straightaway accept the qualifications and credentials of any person claiming to be an 'expert witness' and may order a separate peer review or special scrutiny or examination of the person concerned by other recognized authorities in the particular field of specialisation. It is also notable that the court is not obliged to accept the testimony of an expert witness, and that such acceptance may be decided on a case-by-case basis.

Much reliance may not be placed on the testimony of a first time expert, and conversely, the fact that an expert has made presentations on many previous occasions does not guarantee that her/his testimony will be accepted in a subsequent case. The acceptance, or otherwise, of expert testimony is the prerogative of the court/judge and depends on whether the court/judge determines that the expert's opinion is helpful in adding clarity

Definitions of failure

Failures of all kinds occur all the time, but what exactly does 'failure' mean? Failures are not always disasters or collapses. Failures can mean something as simple as loss of function, inability to perform as intended or meet specified requirements. For example, the famous and iconic Sydney Opera House was considered to be a monumental project management failure when it was built. Originally slated to be built within four years (1958-62) at a cost of AU$ 7 million, it actually took 14 years to be completed, while the cost ballooned to AU$ 102milion! Even after it was built, it continued to be plagued by a whole host of problems relating to the internal acoustics of the main auditorium in addition to many lacunae in its various electrical and mechanical systems.

But physical failures can range from simple problems like sagging, sinking, structural weakness (eg. seepage of water), cracking all the way to total collapse.[5]

Schmidt, Jon A (Jan 2009), The Definition of Structural Engineering, Structure Magazine, January 2009 issue, http://www.structuremag.org/article.aspx?articleid=829

to the understanding of the case or not.

In summary, therefore, the duty of the forensic engineer as an expert witness is to lay before the court as clear an explanation as possible of the engineering background and facts and her/his analysis of the case, give her/his expert opinion on what might have caused the failure and answer all queries that may be raised by the court and/or the opposing party so that the presiding judge (or jury as the case may be) may in her/his (its) wisdom and judgement reach a verdict. The credibility, assurance and composure of the expert witness during (cross) examination will play a crucial role in whether her/his evidence/testimony will be accepted by the court.

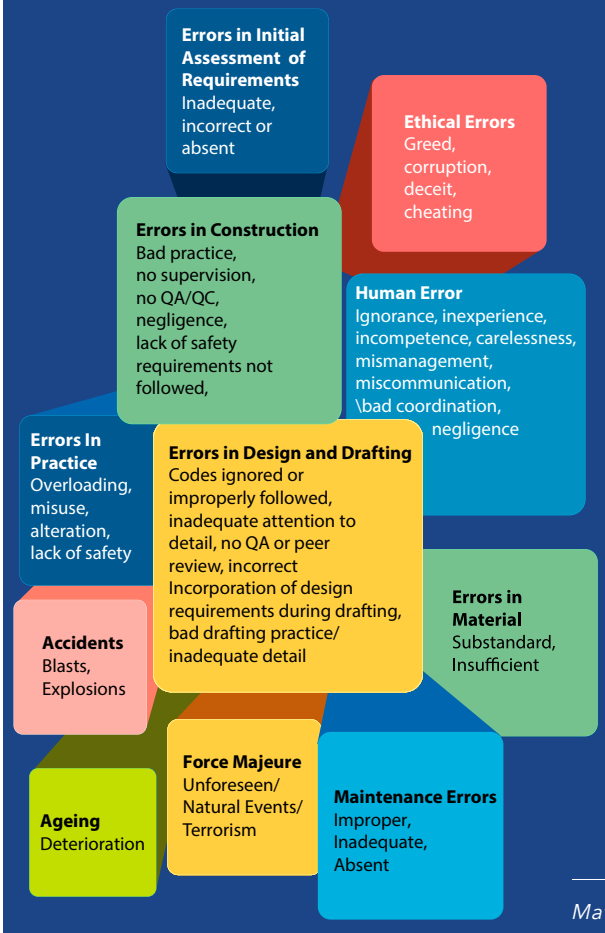
Situation in India

In India, unfortunately, while forensic **science** is well-known, forensic **engineering** is not so well known. However, over the past seven years (since 2013), and perhaps as a consequence of the two Conferences on Forensic Civil Engineering (FCE)

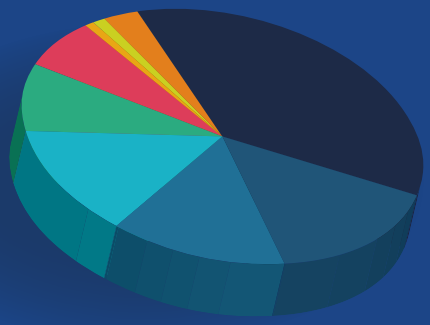
WHY DO FAILURES OCCUR?

Dr. A.R Dykes of the British Institution of Structural Engineers, in 1976, is supposed to have famously said, "Structural Engineering is the art of moulding materials we do not wholly understand into shapes we cannot precisely analyze, so as to withstand forces we cannot really assess, in such a way that the community at large has no reason to suspect the extent of our ignorance." It succinctly encapsulates some important reasons why failures can, and do, occur.

Failures can occur for a very large variety of reasons, but invariably there are some that occur more frequently than others. A 'failure' may mean a loss of function or performance (to varying degrees) and not necessarily a complete collapse. Some of the significant reasons why failures occur are the following:



Human failures can occur for many reasons:



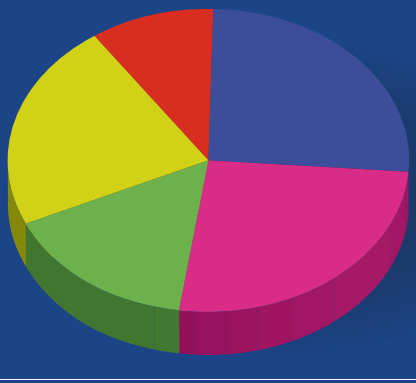
Dr. N Krishnamurthy has reported that in 295 cases of damaged structures, the types of errors in design and planning were as follows:

Failures Due to Errors in Design/Planning

Conceptual errors	34%
Structural analysis	34%
Drawings and specifications	19%
Work and planning and preparation	9%
Combinations (of the above)	4%

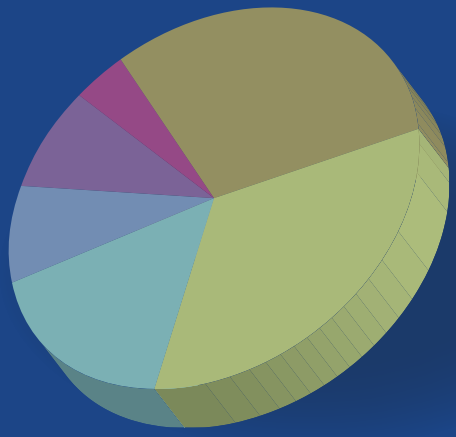
He also adds that in 723 cases of damaged structures, the damage-initiating influence was considered in the building process as follows:

Consideration of Damage Initiating Influence



Matousek,M and Schneider, J., (1976), Untersuchungen Zur Struktur des Zicherheitproblems bei Bauwerken, Institut für Baustatik und Konstruktion der ETH Zürich, Bericht No. 59, ETH
Krishnamurthy, Dr. Natarajan (Nov. 2007),

Insufficient knowledge	36%
Underestimation of influence	16%
Ignorance, carelessness, negligence	14%
Forgetfulness, error	13%
Relying upon others without sufficient control	9%
Objectively unknown situation	7%
Imprecise definition of responsibilities	1%
Choice of bad quality	1%
Other	3%



No consideration	26%
Incorrect consideration	26%
Insufficient consideration	16%
Considered but risk accepted	22%
Consideration unknown	10%

Forensic Engineering in Structural Design and Construction, Structural Engineering World Congress 2007, http://www.profkrishna.com/ProfK-Assets/NK-SEWCPaper(CD).pdf

organised by the author in 2013 and 2016, there has been a growing awareness of this specialty discipline of civil engineering. Consequently, there are, today, some 6 to 8 Colleges and Universities that offer FCE as an M.Tech. elective subject, or even a full two-year M.Tech course (eg. Gujarat Forensic Sciences Institute).

Forensic Civil Engineering is still not recognised as a separate discipline in Civil Engineering, and there is no professional certification available in the country. (For that matter, neither do 'Engineers' have any statutory recognition in the country on the same lines as given to Architects, Doctors, Chartered Accountants, etc.). So, one needs to develop the skills and knowledge required to be a successful Forensic Civil Engineer through self-study and working with senior practising civil engineers and learning from them during their investigations of failures and depositions in courts as an 'expert witness'.

Perhaps, therefore, the time has come, as India grows in stature as a global power, to create a professional institution (or Indian Society) of Forensic Civil Engineers to give this special field of engineering expertise greater exposure and strength, and institutional recognition.

Postscript This article has been an attempt to provide a brief, and rather basic, introduction to the exciting field of forensic (civil) engineering and illustrate, only some essential and important aspects of this very interesting discipline, which was, till recently, relatively unfamiliar to Indian civil engineers.

As it is a very vast subject, it is not possible, in other than a treatise, to cover all aspects in any great detail. However, plenty of very detailed and informative articles, documents and even whole books are available on the Web, and can be freely downloaded. The author had published a longer cover article on the same subject, titled Forensic Civil Engineering in the December 2012 issue of the magazine Built Expressions (now defunct), from which some excerpts have been included in this article.

I hope this article will prove useful to engineers, unfamiliar with this subject, to get some insight into what is meant by 'Forensic (Civil) Engineering' and that the several terms and references given in this article can become starting points for further explorations into the subject. Some additional references are included at the end of this article for the benefit of the reader.

Qualifications of a Forensic Engineer

(Partially adapted from Kenneth L Carper)

The particular skill-sets required to qualify as a forensic engineer, and more particularly as an expert witness, will depend on the specific engineering discipline or field of forensic investigation. There are, however, some common skills that will ideally be required in all forensic engineers, as described below.

He/she must be technically competent

A forensic engineer must have superior technical competency and proficiency in his/her field of specialisation. He/she must have a thorough knowledge of the subject and excellent understanding of structural and material behaviour. He/she must also be a generalist with a broad knowledge of science and engineering as a whole, including disciplines unrelated to his/her own, with the ability to understand the relationship between cause and effect.

This becomes very important when a case goes to court since he/she will have to confront the opposing party, who will employ equally competent engineers, and very cunning lawyers who will question his/her every statement, and try to trip him/her using his/her own arguments, at every step.

Active membership of professional organisations, and authorship of articles in professional journals point him/her out as a professional in good standing amongst his/her peers greatly add to his/her credibility and acceptability in court as an expert witness.

He/she must be a detective

He/she must patiently and diligently collect all the evidence that can be found and be able intelligently to interpret the available data. With his/her experience and engineering knowledge he/she has to become a detective and glean from the mass of seemingly disjointed, and sometimes unconnected, pieces of evidence, a plausible cause and build a strong case that can stand up under close scrutiny in a court of law. This takes a lot of time and effort for the pieces to be fitted together, much like solving a jig-saw puzzle, for theories to be tested and proven and for the final, most reasonable and plausible, picture to emerge. He/she must be able to reconstruct what might have happened and provide solid scientific and engineering bases for his/her conclusions.

He/she must be articulate with good communication skills

An effective and successful forensic engineer will possess the valuable ability to articulate and communicate well, both orally and in written reports and presentations, comprehensively and in simple language (without losing focus) the essence of the methodology and findings to what would be essentially a lay audience (the court, in particular, and to a lesser extent the public, in general). He/she should have the ability to use effectively various media – especially graphics, videos, charts, animations, models, simulations etc. to convey his/her points, without being overwhelming. He/she should also be able to interact effectively with the media and use the opportunity to educate the public.

He/she must be skilful in court

In all those cases which reach the court, and in which the forensic engineer is called as an expert witness, it is essential that he/she is able not only to clearly enunciate his/her thoughts but also, more importantly, be able to maintain his/her composure and self-confidence, especially under hostile cross-examination. A diffident, nervous and flustered witness, who does not have a full command over his/her subject, will be considered unreliable and could jeopardise the outcome of the case and even destroy the reputations of the people involved. But he/she must also not be dogmatic, aggressively assert his/her position or be arrogant. As Carper says, "Forensic practice is not a profession for stubborn 'know-it-alls'"

He/she must be ethical

Above all, and this cannot be overemphasized, the forensic investigator must maintain the highest standards of honesty and integrity. He/she must be absolutely objective and impartial in all that he/she does and use his/her education, training, experience, skill and knowledge in the most professional manner. Most importantly, he/she must not take sides nor be swayed by extraneous pressures and inducements, which inevitably will come into play. Thus the forensic 'expert' engineer must be a person who has great integrity with exemplary ethical standards.

However, in actual practice these ideal ethical standards may become difficult to follow when the engineer is employed by one of the parties in a litigation and comes under pressure to organise his investigation and tailor his/her findings in favour of his/her employer.

Additional references for further study

Forensic Engineering Modern Methods https://www.open.edu/openlearn/science-maths-technology/engineering-and-technology/engineering/forensic-engineering-modern-methods
Forensic Engineering https://en.wikipedia.org/wiki/Forensic_engineering
Introduction to Forensic Engineering (The Forensic Library) by Randall K. Noon, CRC Press (1992).
Forensic Materials Engineering: Case Studies by Peter Rhys Lewis, Colin Gagg, Ken Reynolds, CRC Press (2004).
National Academy of Forensic Engineers http://www.nafe.org/
Introduction to Forensic Engineering. Open University http://www.open2.net/forensicengineering/modern_methods.html .
Forensic (Structural) Engineering - http://civil.columbia.edu/forensic-structural-engineering
Forensic Engineering by Origin and Cause - https://origin-and-cause.com/articles/forensic-engineering/
Forensic Engineering - Introduction and Types of Forensic Investigations-Jan 2020 https://origin-and-cause.com/articles/forensic-engineering/ -
https://blog.beyondsoftware.com/learning-from-failed-projects-sydney-opera-house
https://www.ukessays.com/essays/construction/causes-of-the-sydney-opera-house-failure.php
Risk Analysis Methodologies, http://pachome1.pacific.net.sg/~thk/risk.html
Journal of Performance of Constructed Facilities , Volume 25, Issue 6 (December 2011) http://ascelibrary.org/action/showAbstract?page=522&volume=25&issue=6&journalCode=jpcfev
Ethics in Engineering, State University of New York at Stony Brook. Excellent List of Codes of Professional Ethics http://www.matscieng.sunysb.edu/ethics/
Wikipedia, Engineering Ethics http://en.wikipedia.org/wiki/Engineering_ethics
Galloping Gertie http://www.nwrain.com/~newtsuit/recoveries/narrows/gg.htm
Comparison of the Bridges http://www.nwrain.com/~newtsuit/recoveries/narrows/comp.htm

Associations and institutions for Forensic Engineering

Overseas, forensic engineering is a robust, well-recognised and represented and thriving subject with many professional institutions and practitioners, consultants and courses in academic institutions. Some of these are mentioned below for information.
National Academy of Forensic Engineers, New York nafe@nafe.org
International Board Of Forensic Engineering Sciences, Florida, USA http://www.iifes.org
Engineering Sciences Section of the American Academy of Forensic Sciences
The Society of Forensic Engineers and Scientists, California http://www.forensic-society.org/
Technical Council on Forensic Engineering, ASCE
http://www.asce.org/Content.aspx?id=2147488650
--
American Board of Forensic Engineering and Technology http://www.abfet.us/
The College of Investigative and Remedial Consulting Engineers of Australia, CIRCEA, http://www.circea.org/
The Association of Consulting Forensic Engineers (ACFE), Dublin Ireland
http://www.forensicengineers.ie/
(Note: The following is a footnote. We will have to place the footnotes appropriately with reference to the copy Mr. Rao has sent us. I am unable to extract those on Page One)
12 Parakh, S C (2011), Expert Witness, Medico Legal Issues, 2011, Vol. 55 No.4 pp 421-22, http://www.ijaweb.org/article.asp?issn=0019-5049;year=2011;volume=55;issue=4;spage=421; epage=422;aulast=Parakh

L&T to launch online engineering courses

The online education space, hitherto dominated by start-ups, has now caught the attention of engineering and construction giant Larsen & Toubro. The company is set to enter the online engineering education space with the launch of L&T Edutech in September.

The new venture will introduce industry-led application-based learning for engineering students to improve their employability.

According to S.N. Subrahmanyan, MD and CEO of L&T, L&T Edutech will focus on engineering education across sectors including civil, electrical, mechanical, production and chemical. "Our engineering course will have a lot of practical examples based on L&T's experiences. The courses will be more practical-oriented than theoretical," he added.

Nagendran Sundararajan, former international business head of Manipal Global Education, is leading L&T's new venture.

The venture is part of L&T's plan to adopt digital technologies to future-proof its businesses. In addition to edutech, it will be launching Sufin, a financial supply platform to establish L&T's presence in the e-commerce marketplace.

Public-facing platforms

"L&T has decided to begin two ventures to build public-facing platforms that could be new businesses. Thus, the edutech and Sufin ventures were formed. This is L&T's first foray into the promising platforms business. These are being grown ground-up and will become valuable digital properties for L&T when they go into production and scale up in a couple of years," Subrahmanyan said.

L&T Edutech will focus on three areas — employability assessment and recruitment, reinforced learning, reskilling and vocational skills training.

For professors, too

According to Subrahmanyan, the engineering courses will not just be useful for students but also professors teaching in other institutes to understand the needs of industries.

Though India churns out lakhs of engineering students every year, reports have pointed out that over 80 per cent are unemployable as they lack technical and practical knowledge. L&T has leveraged its internal training expertise to build platforms that could enhance the prospects of engineering students.

IIT-Madras best institute in India in Atal ranking ARIIA 2020

IIT-Madras has emerged as the best institute under the institute of national importance category in the Atal Rankings of Institutions on Innovation Achievements (ARIIA) 2020.

The major indicators for ARIIA were budget, expenses to support and revenue generated (20 marks), infrastructures and facilities to support innovations and start-ups (10 marks), awareness activities for promoting idea generation and innovation (20 marks), promotion and supporting entrepreneurship development (20 marks), intellectual property (IP) generation, technology transfer and commercialisation (14 marks), innovative learning methods and courses (10 marks), and innovations in governance of the institution (6 marks).

For the first time, ARIIA 2020 has a special prize category for women only higher educational institutions. The other five categories are — centrally funded institutions, state-funded universities, state-funded autonomous institutions, private/deemed universities, private institutions.

8 of 23 IITs feature in the Top 10 of MHRD-NIRF 2020 rankings

As many as eight out of the 23 Indian Institutes of Technologies (IITs) figure in the Top 10 of the Ministry of Human Resources Development – National Institutional Ranking Framework (MHRD-NIRF) rankings.

The ranking is based broadly on five parameters, namely (1) Teaching and Learning Resources, (2) Graduation Outcome, (3) Perception, (4) Outreach and Inclusivity and (5) Research and Professional Practice.

The list of 23 IITs and their NIRF ranks stands as follows:

IIT Madras	(Estd. 1959)	NIRF Rank 1
IIT Delhi	Estd. 1963	NIRF Rank 2
IIT Bombay	Estd. 1958	NIRF Rank 3
IIT Kanpur	Estd. 1959	NIRF Rank 4
IIT Kharagpur	Estd. 1951	NIRF Rank 5
IIT Roorkee	Estd. 2001	NIRF Rank 6
IIT Guwahati	Estd. 1994	NIRF Rank 7
IIT Hyderabad	Estd. 2008	NIRF Rank 8
IIT Indore	Estd. 2009	NIRF Rank 10
IIT (BHU) Varanasi	Estd 2008	NIRF Rank 11
IIT Dhanbad	Estd. 1926	NIRF Rank 12
IIT Bhubaneswar	Estd. 2008	NIRF Rank 22
IIT Gandhinagar	Estd. 2008	NIRF Rank 24
IIT Ropar	Estd. 2008	NIRF Rank 25
IIT Patna	Estd. 2008	NIRF Rank 26
IIT Mandi	Estd. 2009	NIRF Rank 31
IIT Jodhpur	Estd. 2008	NIRF Rank 53
IIT Tirupati	Estd. 2015	Not Ranked
IIT Bhilai	Estd. 2016	Not Ranked
IIT Goa	Estd. 2016	Not Ranked
IIT Jammu	Estd. 2016	Not Ranked
IIT Dharwad	Estd. 2016	Not Ranked
IIT Palakkad	Estd. 2015	Not Ranked

SANY India's newly launched Excavator SY80C-9 shines

Developed in line with the company's firm belief 'Quality Changes the World', Sany India's latest powerful Hydraulic Excavator SY80C-9 is garnering praise from all corners of industry clients and reviewers.

Latest to join the Sany India's excavator league, the new Hydraulic Excavator SY80C-9 has earned a name for itself in such a short span of time in the fishery and brick field industry of eastern coastal region in the country.

With best in class specifications and operating expenses, the SY80C-9 excavator is playing a key role in the industry. Built with a powerful Kubota engine and superior synchronization with the hydraulic system, it is the best in its class for operations on a fishery. Sany India's new excavator is truly a blessing in disguise and has turned the tough challenging operation significantly easy.

Sany India, the leading construction equipment company in the country, has already carved a niche for itself in the manufacturing space with its advanced products, which deliver excellent performance and offer high reliability as well as ease of serviceability.

Elucidating about the machine, Mr. Dheeraj Panda , Director (Sales Marketing & Customer Support), Sany Heavy Industry India Pvt Ltd, said, "The latest, hydraulic excavator SY80C-9 with advanced technology and enhanced specifications delivers our promise of productivity and a higher return on investment. It does not only offer higher productivity but also ensures low fuel usage at operations. It is laced with a smart machine alert, robust undercarriage, heavy-duty structure, remote monitoring system, and advanced dynamic control features."

The Government has been focusing increasingly on flawless construction in less time, which has proved to be a boon for the industry. It is a major contributor to the significant rise in the demand for excavators around the world. A major perk with excavators is that they can be used for several purposes including loading, digging, mining, and quarrying. Additionally, they also come with the capability to operate in all directions. Hydraulic excavators are particularly the most preferred because of their ability to provide automated services, higher efficiency, and reduced response time.

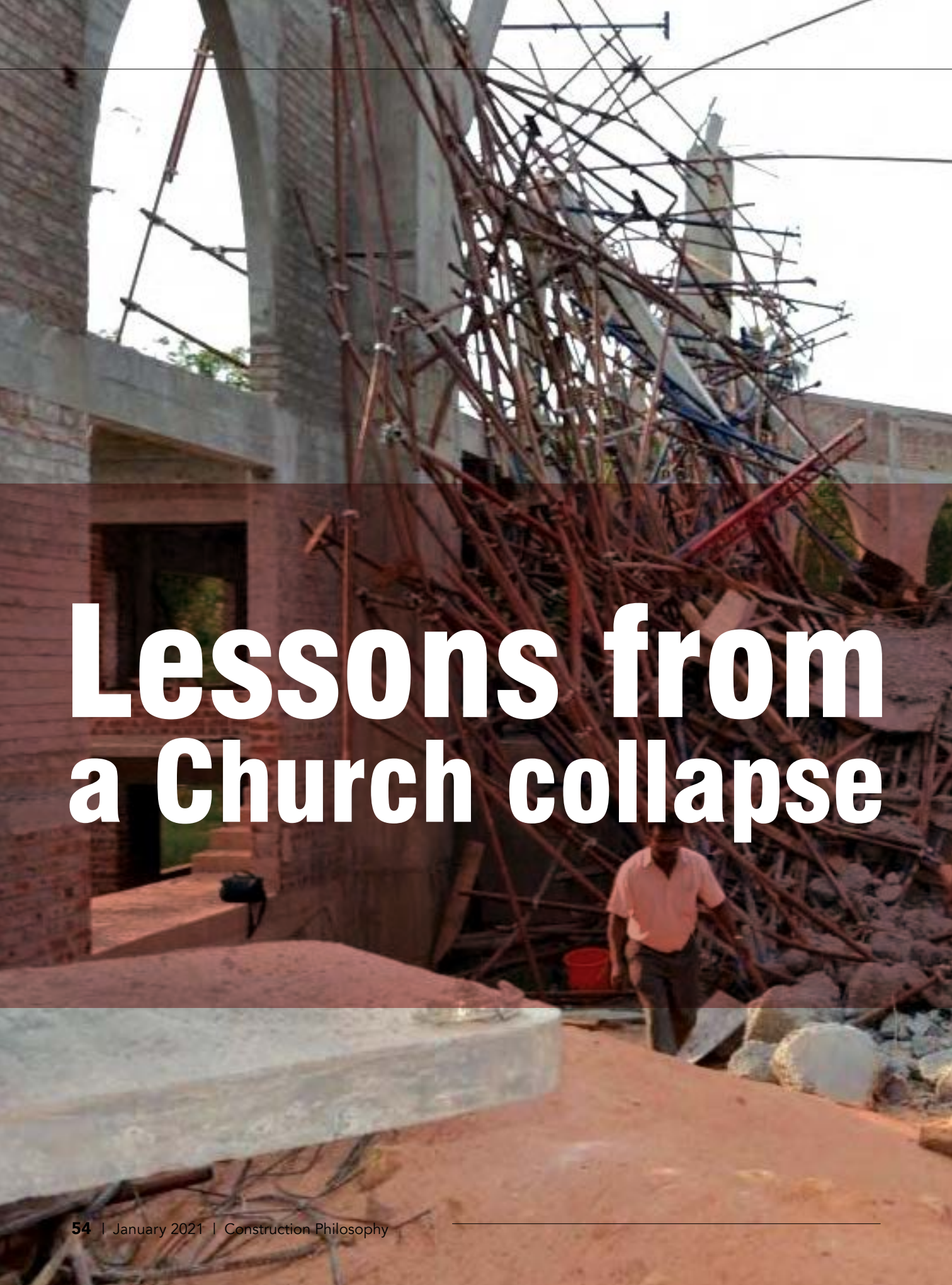
Sharing further Mr Panda stated, "We are all hoping that the demand for excavators will also pick pace as economies recover from the pandemic. In the meanwhile, we at Sany India stand committed to manufacture and provide the best in class products and services to all our customers. Sany continues to bring world-class technologies in our latest excavators in order to help the industries in boosting their productivity."

The advanced Sany hydraulic excavator SY80C-9 can be employed for a variety of applications in addition to brick fields and fisheries like general grading/ landscaping, digging of trenches, holes, foundations, demolition, and construction.

Sany SY80C-9 Hydraulic Excavator is a localized powerful 8 ton machine featuring the popular Kubota engine. It features a DOMCS load sensing system, variable displacement axial piston pumps, and has a bucket capacity of 0.32 m3. It comes with an impressive engine power of 58.5HP (43kW)/2000rpm and a gigantic operating weight of 7920 kg.

Further, its specifications promise superior performance and leave no doubt that the new hydraulic excavator is both durable and highly fuel-efficient.

To learn more about SY 80C-9 Excavator and other enquiries readers may call on 18002093337 or email at customercare@sany.in



Lessons from a Church collapse

Er. Anil Joseph
Sai Lakshmy

The St. Augustine's Church at Aroor in Kochi collapsed while under construction, prima facie due to the inability of the staging system to support the weight of the wet concrete and construction live load.

The St. Augustine's Church at Aroor, on the outskirts of Kochi in Kerala, hit the headlines in April 2013 when the newly church building under construction came crashing, killing two construction workers and injuring 14 others. The original structure, built in 1877, was being replaced with a new one when the accident occurred and an expert panel, led by Er. Anil Joseph, Managing Director, Geostructurals Pvt. Ltd., Kochi, went into the causes of the building collapse.

The following were their findings:

The accident occurred when the temporary structure erected for constructing the main beam that connected the spans of the main hall of the church collapsed. The main beam was being cast using ready mix concrete pumped through a boom placer. The casting of the slab was at a height of about 10m above the ground level and the shuttering was done using multistage to reach the desired height.

In the area of the altar, red earth fills of about 550mm was placed above the natural ground level. The initial plan was to fill earth up to the level of the slab of the altar, but since there was a shortage of red earth availability in the market, the fill levelled and compacted well using JCB. A 60cm x 60cm steel plate was provided at the bottom of the props for distribution of load at the top of the fill.

A level difference of about 150 cm was noted between the length of props which commenced from the top of the fill and those that commenced from the top of concrete. Only about 15% of the props commenced from the concrete slab.

Achrospans were used to span between props to support slab and beam form work. Beam sides were made of plywood sheets stiffened with wooden repairs and slab shuttering was done using MS sheets. Each stage consisted of MS pipe props horizontally connected in both direction by 32mm diameter and 3mm thick MS Pipe using cup lock arrangements.

The shuttering had taken a long time to be completed and the casting was planned for a single day pour. The structure had a central cut out of 6m x 6m as the dome and shuttering was not done in that area. The casting was done for a 16m x 16m area and the quantity of concrete required was 120 m3.

Four stages of props were used to reach the height, most of which was resting on compacted red soil floor of the Church. Some props were resting on the concrete floor which was part of the roof of the basement on the western side. Boom placer was used for concreting in order to prevent jerking at the slab level while using a conventional concrete pump.

Caving of slab concrete was first noticed on the south side of the central cut, which progressed to a collapse taking the form of a funnel shape at the central cut out. This continued till the entire concrete came down.

The casting started at about 10a.m. on the north-west corner and the beam concrete was laid in 2 layers of 40cm each to distribute the loading across the shuttering area. The progressive failure occurred within a duration of 10 minutes. The 3rd layer of the beam along with slab was poured and the concreting of 110m3 was completed by about 6.30 PM, shortly after a heavy thunder and lightning.

Caving of slab concrete was first noticed on the south side of the central cut, which progressed to a collapse taking the form of a funnel shape at the central cut out. This continued till the entire concrete came down.

The inability of the staging system to support the wet weight of the concrete and that of the construction live load appears to be the primary cause of the failure. The absence of diagonal bracing anywhere in the staging supports demonstrated the inability of the system to carry notional horizontal loads.

All the props to props joints were sandwiched by using horizontal pipes which can induce high rotation at joints leading to the formation of multi-

The basement roof slabs and beams had undergone considerable damage due to the collapsed weight of the structure and were demolished and re-constructed.

ple hinges in the supporting system. The asymmetry created by the differential heights of the prop between the filled area and concrete slab likely contributed to the formation of sway on the system leading to progressive collapse.

As the failure happened close to the full load of the structure, the possibility of differential settlement between the props resting on hard surface and the props over the elastic fill could also have been a governing cause. The vibrations from the heavy thunder along with the sudden response of the construction crew to the thunder on the top of platform might have induced additional horizontal load leading to the initialization of the failure of the supporting system at the hinges.

The bent of the column bars indicated that very large horizontal forces had acted on the top of the column during the failure process. This might have induced micro cracks on the columns which acted as a cantilever during failure. This also might have induced considerable stresses on the pile cap and pile below.

On the recommendations of the panel, the 4 main columns and other columns affected due to the collapse were demolished. The basement roof slabs and beams had undergone considerable damage due to the collapsed weight of the structure and were demolished and re-constructed. Strength of the pile cap was checked by taking core samples and conducting pulse velocity test. Integrity test was conducted on all the piles to ensure that no damage had happened on the pile.

Maharashtra cuts real estate premiums by 50%

Noting that the Covind 19 pandemic has dealt a big blow to the housing sector in the commercial hub of India and other parts of the State, the Maharashtra government has decided to reduce all premiums related to the sector by 50%. The reduction in premium cost will help soften the prices and help revive buying. The reduction in premium will benefit all stakeholders—the developers, who will have to bear only reduced construction cost, and customers, with lower prices. The government would also stand to benefit as the measure will revive the sector and result in increase in premium and levy collection.

72-acre township project in Kolkata: Ambuja Neotia, Satyaa sign deal

The Ambuja Neotia group has signed a major development deal with Satyaa Homes to develop a 72-acre township project at Kolkata's Rajarhat. The total retail sales value of the project units is estimated at Rs. 3000-4000 crore. Prominent micro-market in the north-eastern parts of Kolkata, Rajarhat is an important employment hub as it is home to major IT-ITeS companies. The area is also situated in close proximity to the Sector V, Salt Lake and the airport.

Port city of Kochi breathes easy with two major flyovers

The fast-growing Kochi city can breathe a little easier now that two major flyover projects have been commissioned on National Highway which virtually cuts through its central business district. The first of these is located at the .Vyttila junction, considered to be the busiest junction in the state with an estimated 13,000 vehicle crossings every hour. The 720m long flyover has 12m width on both sides and has three lanes. A metro rail bridge passes over the Vyttila flyover at a height of 5.5m. The second flyover, located at Kundannoor, some 2 kilometres away, is 800 m long. Work on the two flyovers was launched on March 26, 2018, at an estimated cost of Rs 74.45 crore. Contrary to the normal practice, both the projects were completed within the stipulated time-frame, saving approximately Rs 8.29 crore. Traffic flow beneath the flyover is being regulated using a signal system installed by the Cochin Smart Mission Limited (CSML).

Salasar Techno wins contract to install ballastless tracks for Bengaluru metro

Salasar Adoruus Infra LLP, a subsidiary of Salasar Techno Engineering Limited, the India-based conglomerate in the engineering and infrastructure industry, has received the contract from TexmacoRail and Engineering Ltd. for the installation of ballastless railway tracks for the Bengaluru Metro Rail Corporation. SalasarTechno will build the ballastless track for about 175 km stretch. The company plans to complete work on 5 km every month. The design for ballastless tracks is highly consistent in track geometry and ensures longevity with low maintenance.

Rooftop solar industry seeks amendments to Electricity (Amendment) Rules 2020

The rooftop solar industry has urged the government to allow net-metering above 10 kilowatt and to remove compulsory gross metering above 10 kW. These changes, the industry says, would help high load consumers to move to clean localised energy, ensuring large-scale adoption of distributed solar energy. India has set an ambitious solar energy generation target, including 40 gigawatt (GW) rooftop by 2022.

KVIC to launch eco-friendly non-toxic wll paint

The Khadi and Village Industries Commission (KVIC) has launched an eco-friendly and non-toxic paint with anti-bacterial properties. The Khadi Prakritik Paints is a first of its kind product based on cow dung as its main ingredient. It is cost-effective as well as odourless and has been certified by the Bureau of Indian Standards (BIS). This paint is available in two forms--distemper paint and plastic emulsion paint, The paint, with anti-fungal and anti-bacterial properties, is free from heavy metals like lead, mercury, chromium, arsenic and cadmium. This technology will increase the consumption of cow dung as a raw material for eco-friendly products and will generate additional revenue to farmers and gaushalas. This is estimated to generate additional income of Rs. 30,000 per annum per animal to the farmers.

Asween Santhosh

L&T Construction, the construction arm of the US $ 21 billion technology, engineering & construction conglomerate, Larsen & Toubro, announced having successfully 3D printed a G+1 (Ground plus One) building with reinforcement for the first time in India.

With the country aggressively pursuing the objective of creating 60 million houses under the 'Housing for All by 2022' programme, this achievement will certainly give a huge fillip for the mass housing segment.

"3D concrete printing is one of the technology disruptors with the potential to radically redefine construction methodologies and I am extremely happy that by demonstrating our growing expertise in 3D printing, we are well positioned to push the boundaries of automated robotic construction," said Mr. M. V. Satish, Whole Time Director & Senior Executive Vice President (Buildings). "3D printing will not only accelerate the pace of construction but also significantly improve build quality," he added.

L&T first to 3D print a Ground + One building in India

L&T has 3D printed a Ground + 1 building of 700 sq. feet built up area at their Kanchipuram facility in Tamil Nadu with a special, in-house developed concrete mix using indigenously available regular construction materials. The building was printed with both vertical reinforcement bar and horizontal distributors using welded mesh that satisfies provisions in the relevant Indian Codes and capable of optimising the cost of construction. Except for the horizontal slab members, the entire building structure was 3D printed 'Cast in Situ' at the job site in an 'open to sky' environment within 106 printing hours, using a fully automated 3D printer.

3D printing is a process, in which the material is printed under computer control to build a 3-dimensional product, typically layer by layer. It is predominantly used in manufacturing industries to print rapid prototypes, complex shapes and small batch production using special polymers, metal alloys, etc. 3D printing with concrete is still largely work in progress across the globe.

Earlier in November 2019, the team had 3D printed 240 sq. feet 1 BHK unit, in line with typical Economically Weaker Section (EWS) building layout, to explore the feasibility of this innovative technology.

BUILD CHANGE

Ten innovators from across the world have won the TechEmerge Resilience India Challenge for their cutting-edge technology solutions in dealing with the twin challenges of immediate disaster response in the time of COVID-19 and building long-term disaster and climate resilience.

The challenge was organized by the World Bank Group, in partnership with the National Disaster Management Authority (NDMA) and CES (Consumer Electronics Show).

The winners will receive World Bank grant funding from a pool of US$1 million, supported by the UK Government and free Cloud Credits from IBM. The top innovators recently showcased their solutions at CES2021, the world's largest consumer technology event.

The challenge has garnered solutions spanning the most cutting-edge technologies–ranging from Artificial Intelligence (AI)-enabled robots; to rebuilding homes; to unify networks for connectivity restoration –all aimed at meeting the needs of some of the most disaster vulnerable coastal and hilly states of India like Uttarakhand, Himachal, Andhra Pradesh and Kerala.

These solutions will be implemented in collaboration with the respective State Disaster Management Authorities (SDMA) to make disaster and climate risk management smarter, more efficient, affordable and accurate.

Success in these states could open the floodgates to a series of transformative, scalable, affordable and accessible resilient technology solutions.

World Bank's honour for 10 innovators

The TechEmerge Resilience India Challenge was organized by the World Bank Group, in partnership with the National Disaster Management Authority (NDMA) and CES (Consumer Electronics Show).

Amongst the winners, US-based Project Owl, will deploy an innovative unified network infrastructure in the air, land or water to provide connectivity in remote and disaster affected areas.

Israel based Seismic AI will provide end-to-end service for Earthquake Early Warning, powered by artificial intelligence using real-time seismic algorithms to estimate the magnitude and expected ground shaking at any location.

Build Change will deploy its AI and 3D modelling-based solution to assess damage to buildings for retrofitting and recovery and will help improve resilient construction practices. The Dutch firm Nelen & Schuurmans' AI-based flood forecasting system and simulation will allow planners to visualize and interact with water flows, simulate rain, storms, break levees, etc.

India's Pragathi Foundation will be deploying wifi based 2-way local radio to boost information access to rural communities in remote, signal dark and disaster vulnerable areas. Other solutions include fully customizable and rugged drones for disaster preparedness and response, autonomous rescue buoys with robotic probes to save lives at sea.

The multi-stage evaluation process involved reviewing over 300 innovative solutions from across the globe, by subject matter experts and independent jurors on specific criteria vis-à-vis the State Disaster Management Authorities (SDMAs), who are the end users. The criteria included demonstrated technology, ability to execute, fit to needs, and innovation, to name a few.

The implementation of the pilots will be undertaken by the Asian Disaster Preparedness Center (ADPC), under the World Bank's Climate Adaptation and Resilience for South Asia Project (CARE).

L&T Construction bags order from Rail Vikas Nigam Limited

The construction arm of Larsen & Toubro (L&T) has secured an order for its heavy civil infrastructure business from Rail Vikas Nigam Limited (RVNL) .The Company has secured the contract for Package-4 of the new broad-gauge line between Rishikesh and Karanprayag in Uttarakhand.

The scope of the project includes construction of tunnels, formation and construction of shaft and other ancillary works from chainage 47.360 to 63.117 km between Rishikesh and Karanprayag. The project also involves the construction of 14.577 km up line and 13.123 km down line tunnel with embankments of approximately 800 meter at both ends.

Out of the two tunnels with covering 14.577 km and 13.123 km, 10.49 km and 10.317 km of the tunnel will be excavated using two new hard rock tunnel boring machines (TBMs) of diameter 9.1 meter and the balance using New Austrian Tunnel Method (NATM). The scope also includes construction of an ellipsoidal-cum-ventilation shaft in the finished cross-section of 79 sq metre and depth of 32 metres.

This will be the biggest TBM to be deployed in the Himalayan region in India and the TBM bored tunnel length of 20.807 km will be the longest for any project in the region. The entire project is to be completed within a stringent timeline of 60 months.

Establishing a rail link between Rishikesh and Karanprayag will not only facilitate easy access to Uttarakhand's pilgrimage sites, but also enable development of backward areas, connect new trade centres and serve the resident population.

The value of the contract ranges between Rs. 2,500 crore to Rs. 5,000 crore. The company is already constructing Package-2 of this project involving 24 km of tunnelling by NATM, construction of minor bridges and formation works.

CIAL scores a first with floating solar power plants

The Cochin International Airport Limited (CIAL) in Kerala, which became the the world's first solar-powered airport in 2015, has s commissioned two floating solar power plants. With the installation of solar power plants with a capacity of 452 kWh over two artificial lakes, the airport's total installed capacity has increased to 40 MWp helping it to produce around 1.60 lakh units of power a day against per day consumption of around at 1.30 lakh units.

The company has introduced cost-effective high-density polyethylene floats, using French technology, upon which 1,300 photovoltaic (PV) panels have been mounted and laid over two artificial lakes located in the 130-acre CIAL golf course. The plants covering a total area of one acre are connected to the Kerala State Electricity Board Limited (KSEBL) power grid.

The pre-commissioning trials showed that these panels, which cost around Rs. 2 crore to the company, were producing power with maximum output efficiency among eight solar power plants installed by CIAL at various locations in the airport premises. The company executed the project for total sustainability management (TSM) in its golf course where treated water from the sewage treatment plant of the airport is used for water harvesting with the help of 12 artificial lakes.

The water from these lakes is used for irrigating the lawns of the golf course and now, with the installation of the solar power plants, it has leapt one more step forward in TSM. The technical assistance for the project was provided by French company Ciel et Terre. The airport aims to become the second largest power producer in the State after KSEB, adding a 12 MWp solar plant which is nearing completion at Payyannur in Kannur district in north Kerala.

Essar Group eyes steel project in Gujarat

Indian manufacturing giant Essar Group is exploring possibilities to invest in large projects including ports, new and emerging technologies, eMobility, infrastructure, energy, metals, etc., in Gujarat.

Currently, the group is the lookout for land near the coastal areas to set up a steel manufacturing project of ₹35,000 crore, with an annual capacity of 8 million tonnes. It has already submitted a proposal to the Government of Gujarat.

JK Cement launches cement grinding units

JK Cement recently launched a new Grey Cement Grinding unit at Balasinor, Gujarat. Commercial dispatches have already begun from the unit which has a capacity of 0.7mtpa (million tonnes per annum).

The Balasinor plant is spread over a total area of over 8 hectares and has been set up at a total project cost of ₹200 crores. This is a part of the company's total funding outlay of ₹2000 crore for capacity addition to the tune of 4.2 million tonnes at the plant.

Tatas to build new Parliament building

Tata Projects Ltd has won the contract of constructing the new Parliament building at a cost of Rs 861.90 crore, beating Larsen and Toubro, which had bid Rs 865 crore. The construction of the new Parliament building will be completed in 2022, in time of for the 75th anniversary of Indian independence.

The new Parliament building will be constructed close to the existing one under the Central Vista Redevelopment Project.

The new building is triangular in shape and will be built abutting the existing complex, on what is described as 'Plot Number 118' of the Parliament House Estate. The CPWD said the existing Parliament building will continue to function during the entire period of execution of the project.

Tata Power to develop 110 MW solar project for KSEB

Tata power has cornered the contract for developing 110 MW solar power for the Kerala State Electricity Board Limited (KSEBL). The two companies have signed a Power Purchase Agreement (PPA), valid for a period of 25 years from scheduled commercial operation date.

The project has to be commissioned within 18 months from the date of execution of the PPA. The plant is expected to generate about 274 MUs of energy per year and will annually offset approximately 274 million kg of CO_2.

With this, Tata Power's renewable capacity will increase to 4,032 MW, out of which 2,667 MW is operational and 1365 MW is under implementation.

Steel Structure Failures

"Intellectuals solve problems, geniuses prevent them"

Albert Einstein

Varghese A. Johns

At a time when the rise of a nation is most emphatically reflected in its ability to create world-class infrastructure and magnificent skyscrapers, builders and structural engineers cannot but consider structural stability, strength and serviceability as the cornerstones of their creations. Sadly, however, we are currently witnesses to structural failures, which dents the credibility of civil and structural engineers.

The history of humanity is filled with excellent examples of great structural engineering. The Roman bridge of Alcantara (the word "Alcantara" means "Bridge" in Arabic) held the world record for the longest span for more than 1,300 years since its construction by Gaius Julius Lacer in the 2nd century, until the Renaissance.

Regrettably, however, what we see around us today is a proliferation of tragic examples of vulgar engineering, completely divorced from any credible engineering tradition. An example from nearer home is the Palarivattom Flyover on NH 66 in Kerala. Its defective execution has become one of the most notorious scams in Kerala Public Works Department's history. The scam exposed the alleged nexus between politicians, bureaucracy, and contractors. "In India, many incompetent, so-called technical experts come out as engineers every year. But, they do not show moral responsibility to the nation/society" said 'Metroman' Er. E Sridharan.

- From where did the concept of Factor of Safety (Factor of Ignorance) come?
- Why are we particular about Fire Safety in buildings?
- Why should every civil/structural engineer follow applicable codes, standards and best engineering practices and QA/QC for design and construction?

Since humans first started construction, there have been numerous occasions of structural failure. Those failures prompted our predecessors to search for solutions. Those solutions are the codes, standards and practices we follow to prevent recurrence of such failures. As Ralph Waldo Emerson said: "Failures have a scientific value. These are occasions a good learner would not miss."

Every civil/structural engineer should accept the

concept of failure, as in-depth study of failures is essential to better engineering, to obviate failure. Every designed structure is still a man-made endeavour and, therefore, are prone to error. Some designs, let us agree, are predestined to fall short.

All efforts are essential to prevent structural failure as it involves danger to human life and property. There are numerous causes for a structural failure, and there is need for proper analysis of all the factors before construction. Human errors in execution, rather than design processes, are more prevalent as the single major causative factor for structural failures.

To overcome this, a strict Quality Assurance and Quality Control programme should be implemented with clearly set procedures and standards. The entire process should be documented. Strict implementation of the QA programme would result in more efficient and safe design processes and standards.

Steel Structure Failure: Issues and Remedies

When structural engineers design their projects, their goal is typically to create something that is Safe, Secure, and viable for those who would use it. Structural steel helps the construction crew to bring these designs to life by offering a durable, affordable, and long-lasting structural material. Following are some of the main causes of structural failures.

Poor engineering and design

Poor design involves wrong design assumptions and analysis. Prudent design is based on established theories, reliance on accurate data, taking cognizance of the effects of repeated or impulsive stresses, and proper choice of materials based on an in-depth understanding of their properties and behaviour under stress. Many a time failures happen in a project at the drawing board itself due to lack of due diligence by the design engineer.

Flexural issues

Flexural failure happens when a girder or column is subjected to overstress, causing the steel to bend and ultimately buckle. Depending on how strong the structural steel is, most fabrication is designed around thin columns of metal which makes them more prone to buckling when flexural issues manifest.

Shear failure

The most susceptible area of a building's structural design will be where two pieces of structural steel connect. These connections must be able

to withstand a high level of shearing force to stay safe and rigid.

Compression failure

Where two pieces of steel meet, such as a column and a brace, an axial force is applied. If the force is too strong for the metal to endure, you will see the metal beginning to buckle. Great attention must be paid to the slenderness ratio of the members being used in heavy axial compression.

Tension failures

Another possible failure in steel structures happens when too much tension is put on any given member. It takes a significant level of tension to create this type of failure and, most of the time, it occurs only when the structural engineer makes a mistake in the design process. Tension failures are widely known as the most dangerous type of failure.

Insufficient strength with connections

Almost every time you hear about a steel structure failing, it is because of a connection issue. A structural engineer must put in an incredible amount of thought and details when designing the joints and connections to ensure that they are strong enough to provide a smooth load path, strength, and stability without failure.

Calculating the strength of joints and connections is a tedious process. A small miscommunication in the type of bolts, welds, or other materials can lead to insufficient strength and possible failure.

Faulty Construction

Faulty construction perhaps is the most important cause of structural failure. Use of good quality materials, proper construction supervision, timely and effective Inspection by consultant, QA/QC procedures to ensure the requirements as designed are all key to avoiding failures.

The design of structures should satisfy three fundamental requirements:

Stability: The structure should be stable under the action of loads.

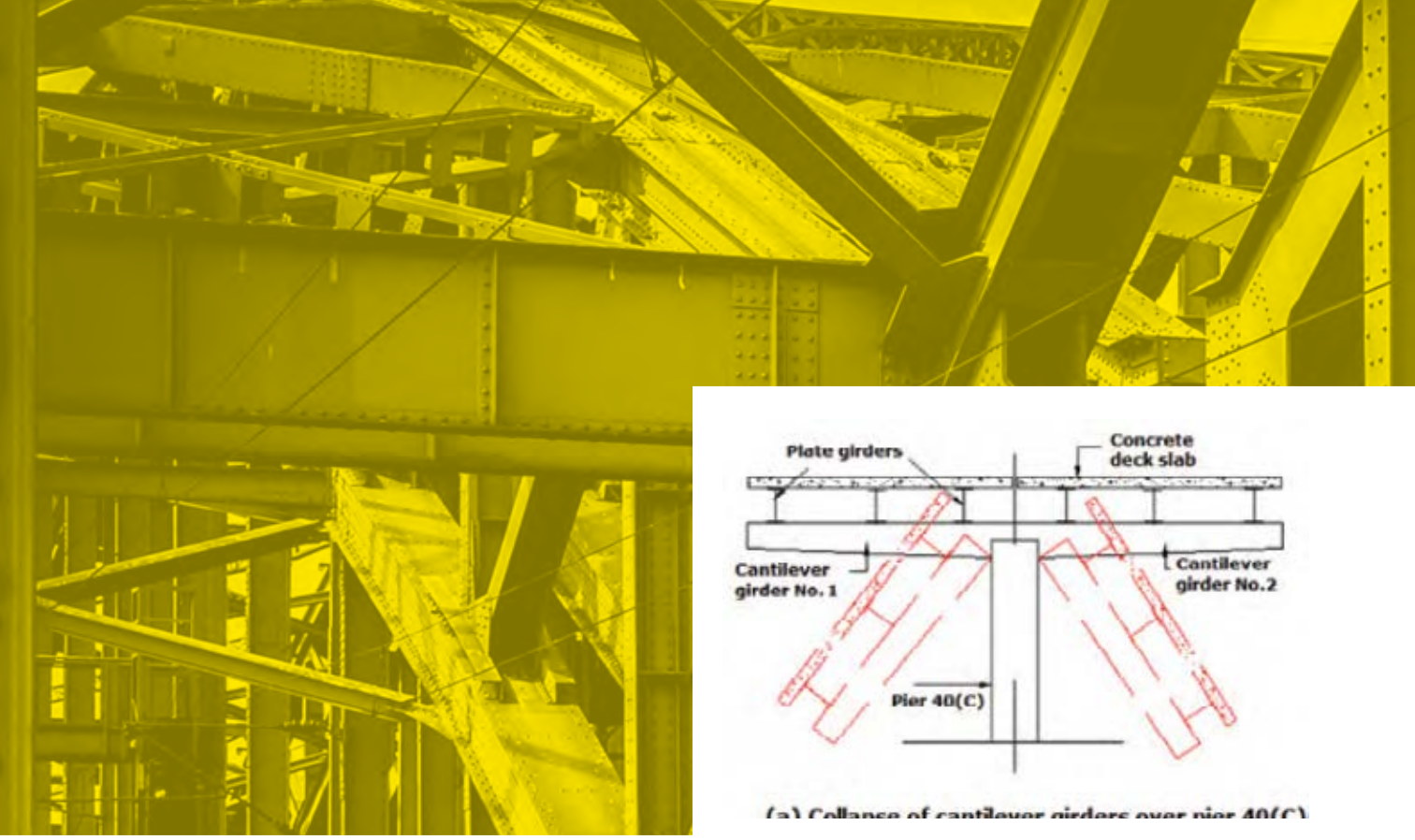
Strength: The structure should resist safely stresses induced by the loads.

Serviceability: The structure should perform satisfactorily under service loads.

How to carry out good structural engineering?

It is difficult to answer this transcendental question, but it is certain that it requires at least the following ingredients:

Profound knowledge: It is impossible to design without a thorough knowledge of the structural



(a) Collapse of cantilever girders over pier 40(C)

behaviour of the different materials, construction processes, etc. The calculation means available may create the false idea that profound knowledge can be replaced by powerful computing tools.

Multiple elements are used to transmit and resist external loads within a structure. These elements define the mechanism of load transfer in a structure known as the load path. The load path extends from the point of application of the force through each structural element to the foundation. An understanding of the critical importance of a complete load path is essential for everyone involved in developing the framing geometry, structural analysis and design, strength of the material and construction.

Hard work and craft

It is wrong to think that the ideal design comes from the inspiration that the muses only bestow upon engineers with talent. In engineering, and possibly in any other field, it is not so. A good design is, fundamentally, the result of hard work and the craft acquired over time.

Permeability

The structural engineer must show high permeability to work in different structural domains (buildings, bridges, or public works). . use different materials (steel, concrete, composite structures, wood, fabric, etc.). Permeability to work at any stage of the life of the structure: design, materials management, construction, maintenance, operation, and demolition.

Humanism

Finally, and importantly, humanism should be a constant reference point for engineers. Good structural engineering cannot ignore society, its history, and its culture. Humanist engineering for living beings, as in the Renaissance, when the person was at the centre and all other things revolved around it (anthropocentrism).

Collapse of the Vivekananda flyover steel girders at Kolkota on March 31, 2016.

The 2.5-km long Vivekananda flyover, located at one of the largest wholesale markets in Asia, extends up to the Howrah station, the gateway to the city. This flyover consists two carriageways made of composite construction, ie., reinforced concrete deck slab over steel plate girders which are supported on steel piers at intervals along the length of the flyov

Failure Analysis

Fig. shows the complete collapse of the two steel cantilever girders of about 7.5 m length over

the central pier 40 (C), which supported the carriageways. Analysis revealed that the collapse was indeed due to the peculiar joint detail adopted by the designer. It is clearly seen that the box section of the cantilever girders was not connected to the vertical face of Pier 40(C) by either bolting or welding.

The design strength of the cantilever girders was provided only by the top plate of the box section which indicated that the failure could have been due to lateral torsional buckling of the girders, as there may be inadequate bracing to their top flanges. But such a collapse would normally occur when concreting work is at an advanced stage because wet concrete weighs more than set-concrete (wet concrete is approx. 3000 Kg per cum whereas set concrete is 2400 kg/cum).

Conclusions

The continuity of the cantilever girders which are made of box section, were provided only through the top flange of the girders and 4 nos. small sized beams placed below it. Otherwise, there are no connections between the pier and the girders at the vertical faces by way of seating or web cleats at the face of the pier to support the girders and to resist vertical shear from the girders. These was certainly a bizarre way of doing the connection details which make us wonder whether there was really any involvement of a qualified structural engineer on this job.

If a third-party proof-checking had been made on the design and drawings of this supporting structure, prior to construction, it would have saved the collapse and prevented loss of 26 lives. In view of this collapse, the whole length of the flyover that has already been built, is to be thoroughly checked for structural safety and stability before it is commissioned. It is also important to introduce compulsory certifications and continuing education in order that such failures are minimized in future.

What to learn from all this:

- Discuss ways to improve designs and design process to prevent structural failure.
- Discuss common causes of construction failures, and their prevention.
- A third-party proof-checking by a competent Engineer / Consultant prior to Construction a must.
- A strict QA/QC program shall be implemented with a set of procedures and standards.

Er. Varghese A. Johns FIE is Director (Special Projects) Dubai Metal Industries, Sharjah, UAE. He was formerly Vice President - Technical, GEO Structurals Ltd, Cochin-Kerala

Indian Bank partners with IIT-Madras to fund startups

Indian Bank is partnering IIT-Madras to offer financial support to startups promoted by IIT-Madras Incubation Cell (IITMIC).

Under the programme, Indian Bank will extend loans of up to Rs 50 crore to the startups to help meet their working capital requirements or purchase of machinery and equipment, among others.

Under the initiative, titled IND Spring Board, IITMIC will refer startups with proven technology and established cash flows to the bank and also extend advisory to the bank on the business model.

Indian Bank Managing Director and CEO Padmaja Chunduru said the bank decided to team up with IITMIC to bridge a huge gap in funding that currently existed in the startup ecosystem. It is a known fact that banks find it difficult to fund startups as they do not meet the requirements under traditional models of financing. Business models involving high technology, lack of visibility of cash flows, high burnout rate, and high failure rate make the due diligence process for assessing viability difficult for banks. As a result, this segment has been almost completely funded by seed capital, or private equity from India/abroad.

Startups were depending more on equity and they had to share profit and ownership of the company to venture capital firms, private equity players or angel investors for mobilising funds. Under the IND Spring Board initiative, loans up to Rs 2 crore are backed by Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE) scheme of the government. In case of debt, the startup just needs to pay interest and principal to the bank, she said.

Financial Services Secretary Debashish Panda, who was also present at the launch, said the initiative will provide financing support to startups and will be a game changer in the banking industry. Despite the COVID-19 related slowdown seen in the last six months, there was a phenomenal surge in activities, not only in rural areas but also in urban areas. "We hope and expect that we will soon be able to tide over the crisis or the damage that COVID-19 has done to the economy" Mr. Panda said.

CivilApp launched

Thiruvananthapuram-based Civilianz has launched CivilApp, a personalized app for civil engineering job seekers and students.

Launching the app, former Indian Space Research Organisation (ISRO) chairman G. Madhavan Nair pointed out that the online education system in the country had its roots in the ISRO Tele Education Programme, initiated in 2005, when he was the ISRO chairman.

"Given the current situation in the world, we are in need of tele education. With the ISRO Tele Education Programme, schools in remote areas were equipped with satellite connectivity so that they could receive classes by experts sitting at distant locations," Dr. Madhavan Nair said.

Mr. Nair pointed out that the engineering profession had a great role to play in nation building. "You engineers virtually play the role of the Creator," he said, and added that the need for quality in engineering education was supreme given this role of engineers. "We have to bridge the gap between expectations and deliveries by ensuring that young men and women get quality education," he said.

Mr. Nair hoped that innovations like the CivilApp of Civilianz would play a very major role in enabling the student community to achieve their goals. Civilianz deserve praise for taking courses online for job seekers and students, he added.

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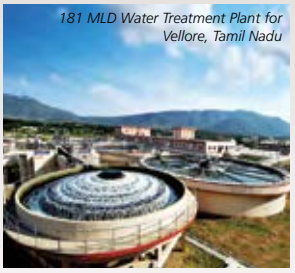
181 MLD Water Treatment Plant for Vellore, Tamil Nadu


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